

25. *On the REMAINS of HYPSONDON, PORTHEUS, and ICHTHYODECTES from BRITISH CRETACEOUS STRATA, with Descriptions of NEW SPECIES.* By E. TULLEY NEWTON, Esq., F.G.S., of H.M. Geological Survey. (Read June 6, 1877.)

[PLATE XXII.]

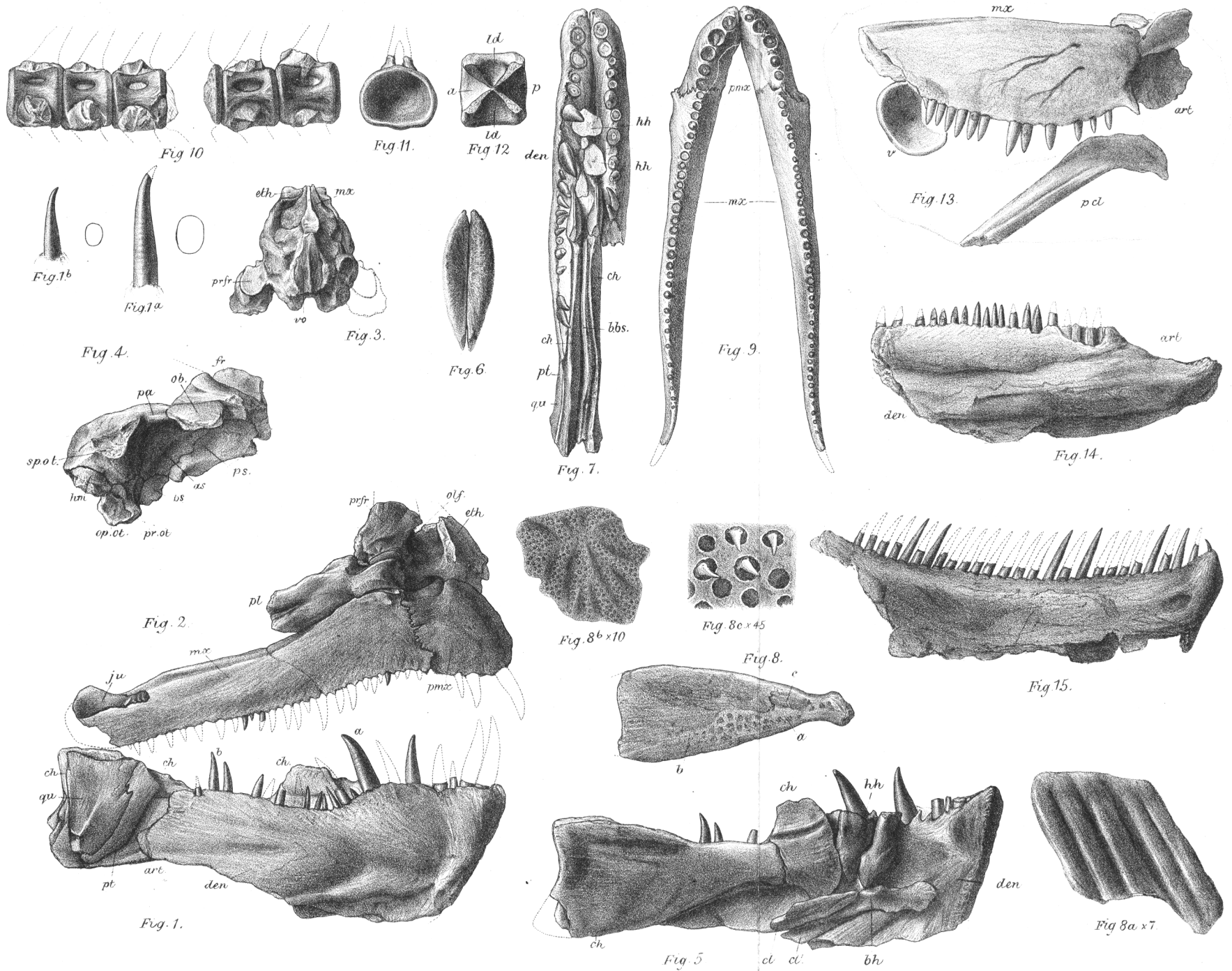
DR. MANTELL in the year 1822, in his 'Geology of Sussex,' described and figured certain fossil bones, obtained from the Upper Chalk near Lewes, as the parts of an unknown fish (p. 241, pl. 42). These remains, which it appears were all obtained from one block of chalk, consisted of an upper jaw with teeth, including the maxilla and præmaxilla, with a vertebra and an indeterminable bone. The maxilla, which is there referred to as a lower jaw, is said to "contain twelve smooth pointed teeth. These are slightly convex, very brittle, and possess a glossy surface. The three anterior ones are gently curved; their fangs are hollow, and placed in sockets that extend almost to the base of the jaw. The nine posterior teeth are of a lanceolate form, and probably destitute of fangs, appearing as if attached to the jaw by ankylosis."

The appearances which led Dr. Mantell to think the posterior teeth differed from the anterior ones, must, I think, have been due to the condition of the specimen, the teeth of which are somewhat obscured by the matrix; for, after a comparison with other specimens, I see no good reason for thinking that the teeth of this jaw differ otherwise than in size.

The præmaxilla, which has the remains of "five tusks or defences," is broken away from the maxilla.

Prof. Agassiz, in the year 1843 ('Poissons Fossiles'), without definitely characterizing his genus *Hypsodon*, alludes to Dr. Mantell's description, and then proceeds to describe the fossil from the Chalk of Lewes, which he calls *Hypsodon lewesiensis* (vol. v. p. 99, pl. 25 a. fig. 2). This specimen consists of a large left mandible imbedded in a block of chalk, with what appear, from their position, to be portions of the right mandible, maxilla, and præmaxilla. The mandible is alluded to as being "very thick, with twelve large prominent teeth, placed somewhat apart, the anterior ones being nearer together than the hinder ones. The upper jaw has large teeth in front, which appear to be implanted in the intermaxillaries, and form several rows at the end of the jaw."

A portion of a cranium is next described (pl. 25 a. fig. 1); and this Prof. Agassiz thought might belong to the same individual as the previous specimen, being from the same locality. There is a quadrate bone (pl. 25 b. fig. 4), and several other bones, upon the same block. Part of a lower jaw is then alluded to and figured



(pl. 25 *b*. fig. 3). This, it is said, appears to have belonged to an individual of large size; the teeth, which are not less than  $1\frac{1}{4}$  inch in height and  $\frac{1}{3}$  of an inch in thickness, are all vertical and very pointed.

Dr. Mantell's specimens are again mentioned and refigured (pl. 25 *b*. fig. 1 *a*, *b*). It is certainly somewhat difficult to understand why Prof. Agassiz should have referred all these specimens to one species; for a comparison of his figures shows a most marked difference between the specimen first described and those subsequently alluded to. If the mandibles represented by plate 25 *a*. fig. 2, and plate 25 *b*. fig. 3, be compared, it will be seen that in the former the teeth are uniform in size and placed some distance apart; while those in the latter are very irregular in size and crowded together, some of them being very much larger than the others. The first mandible, as represented in the figure, shows much of its under-surface, its massiveness being as great in a horizontal as in a vertical direction. Anteriorly the ramus narrows as it turns inwards to meet its fellow at the symphysis, so that the front part of the jaw is much narrower, both vertically and horizontally, than is the hinder part. The second mandible (pl. 25 *b*. fig. 3), although much broken, is evidently seen from the side; and there can be little doubt that its thickness was chiefly in a vertical direction.

Again, the maxilla and præmaxilla of the first specimen (pl. 25 *a*. fig. 2) differ very considerably from those afterwards alluded to (pl. 25 *b*. fig. 1). It might be thought that these differences were partly due to the different positions of the specimens; but such is not the case, for a comparison of the originals (now in the British Museum) shows the differences to be even more decided than they appear to be in the figures.

In Dixon's 'Geology of Sussex,' published in the year 1850, a small lower jaw is figured (pl. 32\*. fig. 9); and although not described in the text, it is named in the references to the plates (p. xiv) *Hypsodon minor*. An examination of the original specimen (also in the British Museum) shows that this mandible, besides being smaller than Agassiz's type of *H. lewesiensis*, is proportionally deeper in a vertical direction, and much thinner; the teeth also have a different character. In all these particulars this little jaw resembles the second mandible alluded to by Agassiz (pl. 25 *b*. fig. 3); and therefore, while the specimens referred to *H. lewesiensis* were all regarded as one species, it was perfectly consistent to refer this jaw to the same genus, although it is now found necessary to remove it to another.

Prof. Cope has more recently made known to us several new forms of fishes from the Cretaceous Rocks of the Western Territories (see more especially the Report of the U.S. Geological Survey of the Territories, vol. ii. 'Cretaceous Vertebrata,' 1875). To receive these he has found it necessary to establish several new species and genera, which have not hitherto been recognized in this country. In his family Saurodontidæ he includes six genera, of which he gives the following synopsis (*l. c.* p. 189):—

*Synopsis of Genera.*

- I. Jaws without foramina on the inner face below the alveolar margin.
- a. Teeth cylindric.
- |  |                       |
|--|-----------------------|
| Teeth of unequal lengths; some of them greatly developed ..... | <i>Portheus.</i>      |
| Teeth of equal lengths .....                                   | <i>Ichthyodectes.</i> |
- aa. Teeth compressed, knife-like.
- |  |                    |
|--|--------------------|
| Teeth of unequal lengths; some of the anterior greatly developed ..... | <i>Erisichthe.</i> |
| Teeth equal .....  | <i>Daptinus.</i>   |
- II. Dentary bones pierced by foramina below the alveolar border.
- |   |                       |
|---|-----------------------|
| Teeth with subcylindric crowns .....      | <i>Saurodon.</i>      |
| Teeth with short, compressed crowns ..... | <i>Saurocephalus.</i> |

Immediately after this synopsis Prof. Cope says:—"There are some other forms to be referred to this family, whose characters are not yet fully determined. Thus *Hypsodon*, Agass., from the European Chalk, is related to the two genera first named above, but, as left by its author in the '*Poissons Fossiles*,' includes apparently two generic forms. The first figured and described has the mandibular teeth of equal length. In the second, they are unequal, as in *Portheus*, to which genus this specimen ought, perhaps, to be referred. \* \* \* \* Retaining the name *Hypsodon* for the genus with equal mandibular teeth, its relations to *Ichthyodectes* remain to be determined by further study of *H. lewesiensis*. The view of the superior walls of the cranium given by Professor Agassiz presents characters quite distinct from what I have observed in *Portheus*. A species of *Ichthyodectes* from the chalk of Sussex, England, is figured, but not described, by Dixon in the '*Geology of Sussex*.'"

From this it is seen that Prof. Cope fully recognized the difference existing between the various specimens referred to *H. lewesiensis* by Agassiz. A comparison of the figures given by Prof. Agassiz of Dr. Mantell's specimen (pl. 25 *b*. fig. 1) with Prof. Cope's figures (*loc. cit.* pls. 39, 41, and 42. fig. 1) will show, I think, conclusively the close affinity between them. The peculiar form of the maxilla and præmaxilla, and the large teeth implanted in the latter, correspond so closely in the two, that at first sight they might be thought to belong to the same species.

Having, in the light of Prof. Cope's memoir, carefully examined Agassiz's type specimens, and compared them with the fish-remains described in the following pages, I am convinced of the necessity of dividing *Hypsodon lewesiensis* as suggested by Prof. Cope; and it is proposed to retain this name for the specimens first described by Agassiz, and upon which the species and genus are really founded (Poiss. Foss. vol. v. pl. 25 *a*. figs. 1, 2, and 4), and to remove Dr. Mantell's specimens and certain others (Poiss. Foss. pl. 25 *a*. fig. 3, and 25 *b*. figs. 1 *a*, 1 *b*, 2, and 3) to the genus *Portheus* of Cope.

*Hypsodon lewesiensis*, Agassiz.

*Hypsodon lewesiensis*, Ag. Poiss. Foss. 1843, vol. v. p. 99, pl. 25 a. figs. 1, 2, and 4, pl. 25 b. figs. 4 and 5.

This species will still be typified by the specimens from the Lewes Chalk indicated above; but the limitations which are proposed render it necessary to modify Agassiz's description. The lower jaw, of which only the anterior part is preserved, is very massive, its thickness being as great horizontally as vertically. Anteriorly the jaw rapidly decreases in size, and, after making a very definite curve inwards to meet its fellow, terminates in a small, slightly swollen symphysis. Twelve teeth\* are preserved; and these are placed at intervals in one row. The spaces between them are obscured by matrix; and it is possible that some of these were occupied by teeth; but, judging from the spaces existing in the upper jaw, it would seem unlikely that the teeth were ever in a continuous series. The teeth are hollow, conical, curved, all very nearly of the same size, and apparently ankylosed to the jaw; probably they have fangs implanted in definite sockets. There are no definite indications of a vertical succession as observable in the genus *Portheus*.

The maxilla is imperfect; where it is broken across it shows a triangular section and a very considerable horizontal thickness. In its present condition it is provided with seven or eight teeth similar to those of the mandible, and arranged in a single row. A well-marked facet, evidently for articulation with the præmaxilla, extends from the anterior part of the outer surface, upwards and backwards, indicating that the latter bone overlapped the maxilla for a considerable distance, and in a manner quite unlike what obtains in *Portheus*.

The form of the præmaxilla cannot be clearly made out; but it evidently has a greater length and horizontal thickness than in *Portheus*, while its vertical dimensions are apparently much less. The outer edge of the broad dentary margin still retains four or five teeth similar in form to those of the maxilla; within these, and separated from them by a distinct space, there are two somewhat larger teeth. Prof. Cope, judging from the figure of the present specimen, seemed to think it might be allied to his genus *Ichthyodectes*; but from what has been said above it will be obvious that such is not the case. The form of the lower jaw is certainly more like that of *Saurodon*; but I am far from being convinced of the propriety of placing it in the group of the Saurodontidæ.

The skull figured by Agassiz from the Chalk of Lewes may possibly belong to the same species; but there is no direct evidence to prove this. If this is truly the skull of *Hypsodon lewesiensis*, then its characters and those of the vertebræ found with it and other bones, upon the same block of chalk, are additional evidence of the distinctness of *Hypsodon* and *Portheus*; for while this skull is broad

\* Some of these teeth appear to have been lost since Agassiz's figure was drawn.

and depressed, that of *Portheus* is narrow and compressed; the vertebræ also are shorter than in *Portheus*, and have not the large lateral pits or depressions.

### PORTHEUS, Cope.

This genus was established by Prof. Cope to receive certain large fossil fishes from the Cretaceous formations of the Western Territories. The genus is fully described; and the more important characters by which it is separated from other genera of the Saurodontidæ are thus given (*loc. cit.* p. 190):—"Teeth subcylindric, without serrate or cutting edges, occupying the premaxillary, maxillary, and dentary bones; sizes irregular; the premaxillary, median maxillary, and anterior dentary teeth much enlarged. No foramina on inner face of jaws. Teeth on the premaxillary reduced in number. Opercular and preopercular bones very thin. Cranial bones not sculptured."

The only examples of this genus at present known in Britain are also from Cretaceous formations; and by far the most perfect specimen with which I am acquainted is the one from the Gault of Folkestone described below as *Portheus gaultinus*, and preserved in the Museum of Practical Geology. There are numerous fragments of jaws belonging to this genus in several provincial Museums and private collections; but their affinity with *Portheus* appears not to have been recognized hitherto.

Prof. Cope's synopsis of distinctive specific characters will help to make more clear the descriptions of new species in the following pages.

### Synopsis of Species.

- a. Two premaxillary teeth:
  - Maxillary arch thin, deep, with narrow anterior condyle; large maxillary teeth five; third mandibular tooth large, behind a cross groove ..... *P. molossus*.
  - Maxillary large teeth three; third mandibular small, without cross groove in front of it ..... *P. thaumus*.
- aa. Three to five premaxillary teeth:
  - Maxillary arch stout, deep, with heavy anterior condyle; larger teeth five ..... *P. lestrio*.
  - Maxillary arch thick and shallow; larger teeth five ..... *P. Mudgei*.
- aaa. Premaxillary teeth unknown:
  - Maxillary bone deeply concave; small..... *P. arcuatus*.

As the representatives of this genus in England are chiefly known to us by fragments of upper and lower jaws, it is particularly convenient to have this synopsis, which is founded upon the characters of the teeth and jaws. Prof. Cope, having had better and more numerous specimens than we possess, has selected these as prominent features, the characters here pointed out being accompanied by other differences in various parts of the skeleton.

*Portheus Mantelli*, n. sp.

*Unknown fish*, Mantell, *Geology of Sussex*, 1822, p. 241, pl. 42.

*Hypsodon lewesiensis*, Agassiz, *Poissons Fossiles*, 1843, vol. v. pl. 25 b. figs. 1 & 2.

It is proposed to give the above name to the specimen from the chalk of Lewes, which was first described by Dr. Mantell as an unknown fish, and subsequently included by Agassiz in his species *H. lewesiensis*, as already mentioned.

The possession of five teeth in the præmaxilla shows that this specimen cannot be referred to either *P. molossus* or *P. thaumus*, which have only two premaxillary teeth; and the same character allies it to *P. lestrio* and *P. Mudgei*. From the former it differs not only in the shape of the maxilla, but also in the size and number of the teeth—*P. lestrio* possessing about forty maxillary teeth, while in *P. Mantelli* there is only evidence of twelve; and, even if the intermediate spaces were naturally occupied by teeth, which is quite possible, yet even then the total number of maxillary teeth could not have exceeded twenty four, and was probably less. These teeth in *P. Mantelli* are absolutely larger and stouter than those in the *P. lestrio* figured by Cope, although the specimen itself is not half the size.

Unfortunately there appears to be no figure of *P. Mudgei*; but, judging from the description, it differs from the present species not only in having four of the premaxillary teeth large instead of three, but also in the massiveness of the entire jaw, and in the difference in form of the maxilla; the maxillary teeth also do not appear to have been so large proportionally as in *P. Mantelli*.

The large specimen represented by Agassiz in plate 25 b. fig. 3 of his '*Poissons Fossiles*,' vol. v. has all the appearance of being part of a mandible of a large species of *Portheus*; but there is no evidence to connect it with the maxilla of *P. Mantelli*, or with any other species.

There is in the British Museum (no. 39063) a large *Portheus* maxilla from the Chalk (formerly in Dr. Bowerbank's collection), which has large teeth, in some respects like those of *P. Mantelli*; but as both ends are imperfect, a close comparison cannot be made. The straightness of the dentary margin, however, seems to point to its being a distinct species.

A fragment of a very large *Portheus* jaw, probably a lower one, from the Chalk of Warminster, also preserved in the British Museum (no. 46389), must have belonged to a species as large as Cope's *P. lestrio*. The teeth are much broken; but portions of five are preserved: they are oval in section, the central largest one having a diameter of about  $\frac{1}{10}$  of an inch, and when perfect must have measured fully 4 inches in length, including the fang.

*PORTHEUS DAVIESII*, n. sp. Pl. XXII. fig. 13.

This species is founded upon a specimen in the British Museum from the Lower Chalk near Maidstone (?). It consists of a right maxilla with the outer surface and teeth in a remarkably good state of preservation, but wanting the posterior extremity. Upon the same block of chalk there is a vertebra and a rod-like bone with a falcate extremity, which may, perhaps, be a post-clavicle.

This maxilla has proportionally a greater vertical thickness than has that of either of the species of *Portheus* described by Prof. Cope or mentioned in this communication. The upper margin is slightly convex from before backwards, and posteriorly has a well-marked groove. The lower or dentary margin is strongly and regularly convex; in its present condition it is provided with twelve straight teeth; the anterior three are small, the median one rather larger, and the remaining eight intermediate in size. The spaces observable between some of these are occupied by alveoli, and may have borne teeth when the jaw was perfect. If such was the case, then so much of the maxilla as is preserved may have possessed fifteen or sixteen teeth; at present there are twelve *in situ*. Anteriorly the bone presents a very rugose surface for articulation with the præmaxilla. The piece of bone attached to the upper portion of this surface is probably no part of the præmaxilla, although occupying its position. The space between the posterior margin of the premaxillary articulation and the first maxillary tooth, shown in figure 13, appears to have been naturally edentulous. The outer surface is flattened and marked by ramifying vascular channels, which pass in a backward and downward direction from foramina situated towards the anterior part of the bone.

This maxilla differs from those of all other species of this genus at present known, in its proportionally greater vertical thickness, in the convexity of the dentary margin, and also in the more uniform size of its teeth. In this last character some approach is made to the genus *Ichthyodectes*; but the larger size of the middle tooth seems rather to ally it to *Portheus*; and in the absence of the præmaxilla, by which its affinities could be more definitely determined, it is thought best to place it in the latter genus.

The vertebra, imbedded in the same block, is deeply biconcave; and the sides present large cavities, similar to those in the vertebrae of other species of *Portheus*.

The rod-like bone has not the character of a rib, nor the appearance of a pectoral spine; but it is quite possible that it may be a ventral spine or a postclavicular bone.

The specific name proposed for this specimen is intended as a mark of respect for my friend Mr. W. Davies, of the Palæontological Department in the British Museum, to whom I am indebted for the kind manner in which he has facilitated my examination of the specimens in the national collection.



*PORTEUS GAULTINUS*, n. sp. Pl. XXII. figs. 1-12.

Mrs. Elizabeth Warne has recently enriched the Museum of Practical Geology by the presentation of a very fine specimen of a *Portheus*, which was obtained through Mr. E. Charlesworth, from the Gault of Folkestone. This specimen includes the greater part of upper and lower jaws of both sides, with a considerable portion of the brain-case and bones of the ethmoidal region, also several vertebrae and fragments of bones which cannot be identified. The generic relationship of this specimen to the American *Portheus* cannot be doubted; specifically it is so closely allied to *P. lestrio*, Cope, that one might at first be inclined to refer it to that species; but, besides its much smaller size, it exhibits certain peculiarities which prevent its being regarded as the same. Each of the parts will now be considered separately.

*Maxilla and Præmaxilla*.—These two bones are represented by Plate XXII. figs. 2 and 9, *mx* & *pmx*; they are so closely fitted together that, it is evident, no movement could have been possible between them. The maxilla extends forwards on the inner side of the præmaxilla to within an eighth of an inch of the front border of the latter bone, which thus comes to lie altogether upon the outer side of the maxilla. The outer surface of the præmaxilla is convex; its hinder border is deeply and irregularly serrated, so that its junction with the maxilla is very distinctly seen. At the lower part of this junction there is a groove which terminates in a deep notch upon the dentary margin. The anterior border is convex, and terminates above in a rounded process: immediately behind this, and therefore upon the upper margin, there is a notch, from which the upper border curves backwards and downwards, and is continued into the serrated posterior border. The dentary margin appears nearly straight in a side view: from below it is seen to be provided with five alveoli (Pl. XXII. fig. 9), the second and third being much larger than the others; and the teeth which they supported were probably not less than an inch in length, as indicated by the dotted lines (Pl. XXII. fig. 2). Upon the left side the 1st, 3rd, and 4th alveoli support functional teeth, while in the 2nd the tooth has scarcely reached the level of the margin, and the 5th seems to be occupied by bony matter. Upon the right side the 2nd, 4th, and 5th have functional teeth, while in the 1st and 3rd the teeth have not reached the level of the margin.

It has already been pointed out by Prof. Cope, that *Portheus* had a vertical succession of its teeth; and this is well shown in the present specimen, both in the præmaxilla, maxilla, and mandible. While the teeth were being thus continually renewed, the alveoli supporting them appear to have been persistent; and not only so, but they seem to have maintained their relative sizes; for while some of the alveoli are completely filled by the fangs of the teeth they support, others, of equal size, contain teeth in various stages of growth, and not nearly filling their cavities.

Apparently as a consequence of this vertical succession, the teeth

are very irregular, and it is not easy, especially in a side view such as figure 2, to determine whether the small teeth are fully grown ones, or are large teeth only partly grown. It becomes necessary therefore to consider the relative sizes of the alveoli and their teeth in order to know whether the latter are fully developed. The importance of knowing this will be obvious when it is remembered that the relative sizes and number of the teeth have been regarded as important specific characters.

The maxilla has two articular surfaces at its upper and front part; the anterior of these is laterally compressed and placed on the inner side of the process of the præmaxilla, with a deep depression intervening. The posterior articular surface lies immediately behind and above the præmaxilla. It is this one which articulates with the palatine bone. The upper margin of the maxilla is strongly grooved, probably on account of its articulation with the suborbital bones. Towards its posterior end it is gradually reduced in thickness; both maxillæ, however, are slightly broken in this region. The dentary border is concave at its anterior part and nearly straight posteriorly. The anterior nine or ten alveoli are small (about  $\frac{1}{16}$  inch diameter); these are succeeded by ten or twelve larger ones (about  $\frac{1}{8}$  inch diameter); behind these there are indications of perhaps eighteen or twenty small ones. Most of the teeth are broken off; but those which remain are somewhat curved inwards—a character also indicated in Cope's figures of *P. lestrio*, but not alluded to in the text.

The right maxilla has a small portion of another bone attached to the upper edge of its posterior extremity, which may be the representative of the *jugal bone*.

Comparing these maxillæ and præmaxillæ with those of *P. lestrio* (*l. c.* pl. 42, fig. 1), it will be seen that the general contour is not the same. In the present specimen the præmaxilla is directed more obliquely backwards, its anterior process is more prominent and placed further forward, leaving a greater space between it and the posterior maxillary articular surface. The groove and notch between the maxilla and præmaxilla are not seen in the figures of *P. lestrio*. The larger teeth of the maxilla are placed further backwards in our specimen; and consequently the convexity of this margin is further from the præmaxilla.

*Mandible*.—The *dentary* portions of both rami are preserved, and, as in other species of this genus, are remarkable for their great vertical depth and compressed form. A small portion of the *articular* bone of the left side is preserved (fig. 1, *art\**); but that of the right is altogether wanting. The outer surface of the dentary has a deep groove towards the lower margin. The anterior portion is swollen, especially its upper part, to accommodate the large anterior teeth. There are depressions upon this surface, which probably indicate the extent to which the articular bone penetrated the dentary portion. A few vascular channels may be traced radiating from a point close to the anterior end. The lower margins are mostly broken away, on account of their being very thin below the

\* This figure has been reversed.

groove, as is shown by the part which is still preserved. Anteriorly the mandible is truncated by the peculiar symphysis, which occupies nearly the entire depth of the jaw (Pl. XXII. fig. 6), and, as seen in a side view (figs. 1 and 5), is set obliquely to its general direction. The symphyseal surfaces are rugose, and show that cartilage must have occupied a space between the two rami. The dentary margin presents two depressions and three prominences (fig. 1), the latter marking the positions of the larger teeth. Anteriorly there are two large teeth (nearly  $\frac{1}{4}$  inch diameter), which are succeeded by a small one (about  $\frac{1}{16}$  inch diameter) and two of median size (about  $\frac{1}{8}$  inch diameter). Next follow three large teeth, the first and last as large as, or larger than the two at the front of the jaw. Succeeding these there are eleven teeth preserved *in situ*, and spaces for probably six or seven others; they vary in size from  $\frac{1}{16}$  to  $\frac{1}{8}$  of an inch diameter. The thinning away of the dentary bone behind these teeth shows clearly that it terminated here; and the total number of teeth, therefore, could not have exceeded twenty-six or twenty-eight. The teeth are slightly oval in transverse section; and the portion projecting above the jaw is highly polished. The larger teeth, when held so as to catch the light, show very obscure annular markings. The greatest peculiarity of these teeth is the remarkable manner in which their extreme points are bent inwards. This is not seen when the jaw is viewed from the side, but is very marked when the teeth are seen from before or behind (figs. 1 a, 1 b). This character of the teeth does not appear to be present in *P. lestrio*; for Prof. Cope makes no mention of it, although he speaks of one of his specimens as having nearly complete dentition; and such an evident peculiarity could not have escaped observation.

*Hyoid*.—Prof. Cope says with regard to the hyoid of *Portheus* and its allies (*l. c.* p. 185):—"Little can be said respecting the *hyoid apparatus* in this family. Some inferior branchi-hyals, preserved in *Portheus thaumus*, are short flat rods. Two long flat bones, in place between the dentaries of a *P. lestrio*, appear to be the distal ceratohyals. They terminate in some crushed basi-hyals, and are covered with minute teeth *en brosse* on the inner faces and superior margins."

Several elements of the hyoid apparatus are preserved in the Gault specimen, and occupy very nearly their normal positions, being wedged in between the rami of the mandible. These bones are partly shown in Plate XXII. fig. 1, but are much better seen from the opposite side when the right ramus is removed (fig. 5). The form of the large bone thus seen (*ch*), and the position which it occupies, indicate that it is the right *ceratohyal* (the left bone is in place, but hidden in this view). These bones are very thin and compressed, especially at their anterior extremities. Posteriorly each has a considerable vertical extent; but this gradually decreases anteriorly for about  $\frac{1}{3}$  of its length; then the anterior fifth suddenly widens again to nearly the same dimensions as the posterior part, and terminates in a fanlike extremity. Both ends of this bone have

a smooth outline, indicative of a cartilaginous articulation with the hypo- and epihyals, the anterior being convex and the posterior concave. The lower margin has a groove, which is widest and deepest at the narrow part of the bone, and is gradually lost before reaching the hinder end; the posterior three fourths of an inch of this margin being a thin, sharp edge. The upper margin is a thin edge from end to end.

Immediately in front of the ceratohyals there are portions of three or four bones which, from their position, seem to be the double *hypohyals* (basihyals of some authors); but this is uncertain, as they are broken, and their true form cannot be made out. There are no traces of any *branchiostegal rays*.

The bone marked *bh* in figure 5, which is below the hypohyals, is compressed anteriorly, but becomes stouter and rod-like posteriorly. Just above these letters the upper margin is expanded laterally into two short wings, having a deep groove between them. The hinder edge of this bone seems to be naturally flattened on each side, and is wedged in between two fragments of bone (*cl*, *cl'*) which appear to be the anterior extremities of the *clavicles*. The bone *bh* is, in all probability, the *basihyal* (glossohyal), which has been thrown out of place. If, however, the two fragments of bone (*cl*) are really the ends of the *clavicles* (and there appears to be no good reason for doubting this), then the bone *bh* occupies precisely the position of an *interclavicle*; and it is not a little remarkable that this peculiarity should occur in a group of fishes having other saurian characters.

Lying between the two ceratohyals, and, indeed, hidden by them until they were separated in the process of cleaning the specimen, there is an extremely thin bone, almost equalling them in size (Pl. XXII. fig. 8).<sup>\*</sup> Its hinder end is broken off; but otherwise it is perfect. The form and position of this bone, lying, as it does, in the reentering angle of the hyoid arch, show clearly that it corresponds to that which Dr. Parker has called the "basibranchiostegal." One feature of this bone which deserves notice is, that its upper portion is covered with thin scale-like plates, which at first might be thought to be the scales. A closer examination, however, shows that such is not the case, but that they are dental armatures. Near the anterior and upper part of the bone there are a few plates (fig. 8, *a*) marked by ridges and grooves which are directed upwards and forwards; and when these are examined with a microscope the surfaces appear smooth and dense in structure. Passing backwards these plates are found gradually to lose their ridges, and about the middle of the bone have their surfaces marked by irregular granulations, which are visible with a pocket-lens. Towards the hinder part of the bone there are a number of smaller plates with radiating ridges (fig. 8, *b*); and when magnified, their entire surfaces are seen to be covered with small pits; these are the bases of minute teeth, some of which are still in place, and others may be seen lying around. At the anterior part of the bone, and

<sup>\*</sup> Fig. 8 has by some mishap been drawn upside down.

extending to its lower margin, there are pitted plates similar to those last mentioned, but without the radiating ridges (fig. 8, c). This dental armature of the "basibranchiostegal" is most likely of the same nature as that mentioned by Cope as occurring upon the inner surfaces of the ceratohyals of a *P. lestrio*, and is to be compared to the minute teeth found upon various parts of the mouth in the pike and other fish; but it is certainly peculiar to find it so far down upon the sides of the bone, which, it would seem, must have stood up in the floor of the mouth as a prominent crest between the hyoid bones. A dried specimen of the branchial arches and tongue of a Tunny, preserved in the Museum of the Royal College of Surgeons, shows similar plates very distinctly.

*Palato-quadrate arcade.*—Parts of the anterior and posterior extremities of this series of bones are preserved in the present specimen. Lying across the left ceratohyal there are portions of two bones (Pl. XXII. fig. 1, *qu* and *pt*). The front edge of the one marked *pt* is a natural free margin; its posterior portion underlies the second bone *qu*, and is partly united to it by a dentate suture. The upper, lower, and hinder margins of the second bone *qu* are broken; and inferiorly it shows the commencement of a sudden thickening. In all probability these bones are parts of the *pterygoid* and *quadrate* bones, and the thickening of the lower portion of the hinder one is really the commencement of the articular condyle.

The front portion of this arcade is represented by the greater part of the *palatine* bone (Pl. XXII. fig. 2 *pl*), which has that peculiar conformation of its anterior part termed by Prof. Cope the "malleolus;" this has a smooth surface above for articulation with the prefrontal, and another below for articulation with the maxilla. A small rugose surface upon the outside of the malleolus appears to have formed part of the external facial surface; but, with this exception, the palatine bone was covered by the suborbital bones, parts of which are still to be seen. The hinder part of the palatine is broken off; but so much as remains lies close upon the upper margin of the maxilla. Internally it is partly hidden by a pitted bony plate, to which many minute teeth are still attached.

*Ethmoidal region.*—This is represented by a mass of bone which it would have been extremely difficult to determine, but that it retains a surface for articulation with the right palatine, and has fixed to its front portion fragments of the anterior articulations of both maxillæ. These landmarks not only show the nature of this bony mass, but also allow its relation to the bones just mentioned to be clearly made out (*eth.* &c. fig. 2). The sutures between the various parts are so obscure that little can be said as to the form of the constituent bones. There are portions of both *prefrontals*, the *vomer* (?), *ethmoid*, possibly a part of the *parasphenoid*, fragments of the *maxillæ*, and of certain dermal bones. The prefrontal appears to have been *perforated* for the passage of the olfactory nerve (*olf*). The bone which is referred to the vomer has no traces of teeth upon it; and it may be that it is the front part of the *parasphenoid* (fig. 3, *vo*).

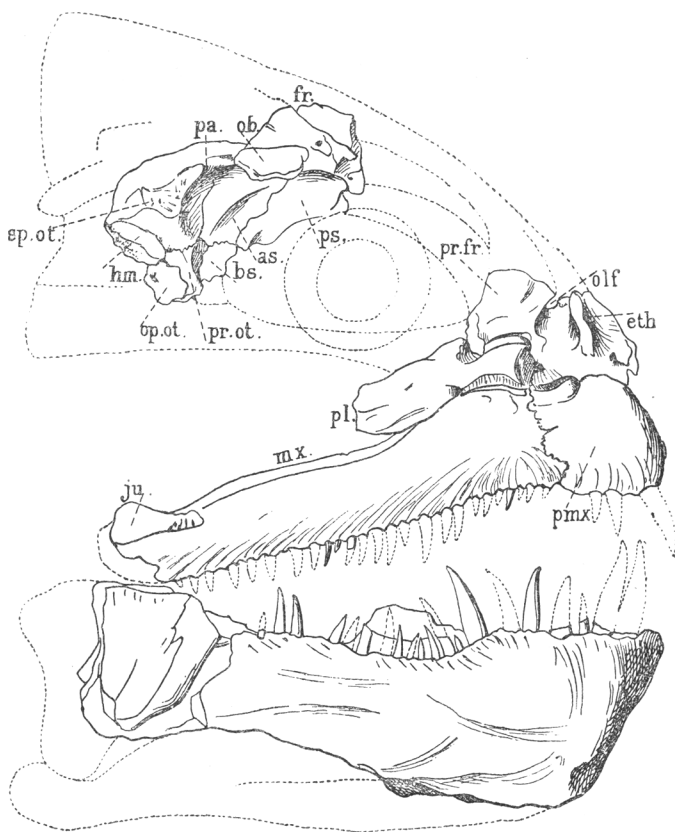
*Brain-case.*—Certain bones forming part of the brain-case were

obtained with this specimen, and are represented upon Plate XXII. fig. 4. Although somewhat broken and compressed, they are sufficiently well preserved to show that the walls of the brain-case were completely ossified. The sutures are so obscure that the determination of the homologies of the various parts is no easy task; however, some of the elements can be identified with more or less certainty. There can be no doubt that the fragment marked *hm* is the proximal portion of the *hyomandibular*; and the bone lying in front of it, and to which it is attached (*sp.ot*), can only be the *postfrontal* (*spenotic*). The upper part of this is broken. The next bone below (*pr.ot*) is perforated anteriorly by a large foramen (probably for the 5th nerve), and occupies the position of the *prootic*, being wedged in between the bones which are believed to be the *basisphenoid*, *alisphenoid*, *postfrontal*, and *opisthotic*? Attached to the hinder part of the *prootic* there is a portion of a bone (*op.ot*) which appears to be either the *opisthotic* or *exoccipital*; but as all the parts behind this are wanting, its true homology cannot be determined. If this fish possessed an *opisthotic*, then the bone in question is that *otic* element; but if, as Prof. Cope thinks, *Porteus* had no *opisthotic*, then this bone must be the *exoccipital*. The *basioccipital* and *parasphenoid* are wanting. The bone marked *bs* seems to be one side of the upper forked part of the *basisphenoid*, occupying, as it does, precisely the position of the Y-shaped bone in the pike, which Prof. Huxley has referred to the *basisphenoid* ('Elements of Comparative Anatomy,' 1864, p. 169). Following upwards from the front part of this bone there is another (*as*), which, from its relations to the surrounding elements, is most probably the *alisphenoid*. The anterior part of the *basis cranii* is formed by the bone marked *ps*, which occupies the position of, and probably represents, both the *presphenoid* and *orbitosphenoids*. Seen from below, this bone is broad posteriorly and narrowed anteriorly, with a median rugose, pear-shaped convexity upon the under surface. From the sides are given off broad wing-like expansions, which pass upwards to meet the *frontal* bone. These wings sweep round anteriorly, so that they meet in the middle line. The bone (*fr*) in front and above the one last mentioned is probably a portion of the *frontal*; from the outer side of this, and just above what must have been the orbit, there is a downward process, having upon it a bone with a rugose surface, *ob*, which it is thought may, perhaps, be a *supraorbital*, but is most probably one of the hindmost of the series of bones which surrounded the orbit. The form of the upper part of the *frontal* seems to indicate that this region of the skull was raised into a prominent crest; and this is a character which Prof. Cope has shown to exist in other species of the genus.

Whether the bone in the region of the letters *pa* is a portion of the *parietal* or not it is impossible to say; but certain it is that immediately below the letters this bone is suturedly united with the one which has been called *alisphenoid*.

The *sclerotic* is well ossified, and parts of four or five plates are preserved; but neither of them is sufficiently perfect to show its precise form.

*Hypothetical restoration of the skull of Portheus gaultinus*  
(see Pl. XXII. figs. 1, 2, & 4).



*bs.* Upper portion of basisphenoid.  
*as.* Alisphenoid. *pa.* Parietal region. *ps.* Presphenoid.  
*fr.* Frontal. *sp.ot.* Sphenotic (postfrontal). *pr.ot.* Prootic.  
*op.ot.* Opisthotic or exoccipital. *ob.* Supraorbital.  
*pmx.* Præmaxilla. *mx.* Maxilla. *ju.* Jugal. *pl.* Palatine.  
*pr.fr.* Prefrontal. *eth.* Ethmoid. *olf.* Perforation for olfactory nerve.

The outline of the entire skull has been introduced in the annexed woodcut, to render the relative positions of the parts more intelligible. The relation of the bones of the ethmoidal region to the maxilla and præmaxilla is quite certain; for, although now separated, the broken surfaces show precisely how they fit together. The direction of the outline-base of the skull is determined chiefly by the direction of the under surface of the vomer. In placing the brain-case in the position it occupies, regard has been paid to Prof. Cope's figures of *Portheus*, as well as to the form of the component bones of the specimen; but its relation to the other parts must only be taken as approximately correct. The outline of the upper and back parts is, of course, purely conjectural. The lower jaw has been placed low down, out of position, so as not to interfere with the maxilla.

The skull has been slightly crushed, in a lateral direction, during the process of fossilization; it is quite certain, however, that it was naturally of a very compressed form.

*Vertebæ.*—The six vertebæ belonging to this specimen agree, in their general characters, with those which have been referred to the American species; but, at the same time, they present certain peculiarities. The length of each vertebra is about four fifths of its width; the terminal faces are deeply concave, and communicate by a small foramen in the centre, as shown in figure 12. One very obvious feature of these vertebæ is the flattening of their lower surfaces; but, as there are slight ridges towards the terminal faces, this is not so clearly seen in figure 11 as in the specimens. Probably this flattening would not be found in the hinder dorsal vertebæ. The basal portions of the neural arches are left attached to the centra; and are imbedded in deep pits, one upon each side of the middle line. They do not appear to have been ankylosed to the centra; for the division between the two is clearly seen. The neural canal is small, the part preserved not measuring more than the fourth of an inch in width. Low down upon the sides of the vertebæ, the enlarged heads of the ribs are seen to be attached to the centra, in the same way as the neural arches—that is, by being sunk in deep pits, but not ankylosed. A large and deep depression, reaching almost to the centre of the vertebra (fig. 12, *l d*), is seen upon each side between the neural arch and the rib (fig. 10). This depression is largest in the hindmost of these vertebæ, and smallest in the anterior one. The three vertebæ which appear to have been furthest from the head have a second much smaller depression upon each side, placed below the larger one; and this also is largest in the hindmost vertebra. Judging from the American species, this loss of the lateral depressions in the front vertebæ of this series shows them to belong to the anterior dorsal region; and probably few intervened between them and the skull.

Several other pieces of bone were obtained, but they are too fragmentary for determination. Two or three of them may, perhaps, be parts of the clavicles, and another possibly a portion of



the parasphenoid; while two others may, perhaps, be pieces of pectoral spines.

*Locality and Distribution.*—As already stated, the specimen above described was obtained from the Gault of Folkestone; but the particular bed from which it came cannot be ascertained. Portions of a pair of mandibles, evidently belonging to this species, but only about half the size of the Gault specimen, are preserved in the British Museum (No. 40146); and these are from the Lower Chalk of Halling. Fragments of this species are also to be found among the fish-remains from the Cambridge phosphatic deposits.

#### ICHTHYODECTES, Cope.

This genus, as defined by Prof. Cope (*l. c.* pp. 189 and 205), includes those forms which, while agreeing with *Portheus* in their main characters, differ from that genus in having the teeth nearly equal in size throughout. The only English specimens referable to this genus with which I am at present acquainted, are:—the one figured in Dixon's 'Geology of Sussex' (pl. 32\*. fig. 9), and named (without any description) *Hypsodon minor*; and the small jaw from the Toulmin-Smith collection described below, *I. elegans*. The first of these is referred to by Cope (*l. c.* p. 206), and considered by him to belong to the genus *Ichthyodectes*. An examination of the original, which is now in the British Museum (No. 28894), confirms this determination. Parts of both rami of the mandible are preserved; and while the right side (that figured by Dixon) has the teeth most perfect, the left side, most fortunately, has the articular portion preserved; and this exhibits the peculiar form found in *Portheus* and *Ichthyodectes*. The uniform size of the teeth allies it most closely to the latter genus.

ICHTHYODECTES MINOR, Egerton. (Pl. XXII. fig. 14.)

*Hypsodon minor*, Egerton; Dixon's 'Fossils of Sussex,' pl. 32\*. fig. 9, p. xiv.

The specimen above alluded to, which was obtained from the Chalk of Sussex†, seems to be more closely allied to *I. anaides* and *I. stenodon* than to either of the other species described by Prof. Cope; but it differs from these, and, apparently, from all the other species, in the possession of remarkably straight teeth, which are not curved inwards as is usually the case. The teeth are hollow; and there is evidence of about eighteen in each ramus, not reckoning the spaces between them, which are in most cases occupied by alveoli, and possibly by broken teeth, the total number of alveoli being about thirty to thirty-three. The alveolar margin is nearly straight, with a slight convexity towards its anterior end. Upon the outer surface, towards

† There is no locality with this specimen at the British Museum; and none is mentioned in Dixon's 'Sussex;' but in Prof. Morris's Catalogue, page 330, it is given as "Chalk, Sussex?; Charing."

its lower margin, there is a deep depression, as in the genus *Porthetus*; and below this the jaw becomes much thinner. The upper and lower margins are nearly parallel throughout the extent of the dentary element; but behind this the depth of the jaw becomes much reduced, the facet of the articular bone being at a much lower level than the alveolar margin. The symphysis must have resembled that of the Gault *Porthetus*; and its length could not have been much less than the greatest depth of the jaw.

The specimen represented by fig. 14 is the left ramus of the jaw figured by Dixon, some of the teeth being completed from the right side.

ICHTHYODECTES ELEGANS, n. sp. Plate XXII. fig. 15.

There is in the British Museum (No. 41687) a small specimen of a left lower jaw from the Toulmin-Smith collection, which was obtained from the Lower Chalk of Dorking. This specimen measures 3 inches in length in its present condition; but the articular portion is wanting. When the piece of chalk containing the specimen was first broken open the jaw itself was split from end to end in such a manner that the roots of all the teeth were exposed. One half was then imbedded in plaster of Paris, and the chalk removed so as to expose the inner surface of the jaw, which is represented in figure 15. Only a few of the teeth are seen in this half; but they have been restored in the figure by reference to the counterpart, in which all the roots and several of the crowns are still preserved. The upper margin, which appears to be entire, forms a regular curve from the hinder end to near the front, where it is interrupted by a projection, similar to that in *I. hamatus*, Cope. This projection bears a small tooth directed obliquely backwards, and therefore in a different direction from the rest of the teeth, which are inclined forward at a considerable angle. The remains of from twenty-five to twenty-eight teeth can be traced along the jaw; they are all very nearly of the same size, as shown by the regularity of the fangs, and were hollow, long, and slender, with a decided inward curvature. The symphysis is deep, as in other species of the genus. The lower margin is incomplete. The articular bone is altogether wanting; but the dentary portion appears to be nearly complete posteriorly.

This mandible differs from that of any species of *Ichthyodectes* hitherto described in the curve of its alveolar margin and in the obliquity of its teeth. The mandibles of the American *I. prognathus*, Cope, and *I. multidentatus*, Cope, however, are not at present known; it is possible therefore that this specimen may belong to one or the other of these species; but, until this point can be settled by the acquisition of better specimens, it has been deemed advisable to let the English species be known by a separate specific name.

## EXPLANATION OF PLATE XXII.

(All the figures on this Plate are reduced one-half linear, except figs. 1*a*, 1*b*, 8*a*, 8*b*, 8*c*, and fig. 15, which are otherwise marked. The dotted outlines simply indicate probable restorations, except in the case of fig. 3.)

*Portheus gaultinus*, n. sp.

- Fig. 1. Outer surface of left lower jaw, hyoid, &c. The teeth which are preserved in the specimen are shaded in this figure; those which have been broken are restored in outline; *den*, dentary; *art*, portion of articular; *ch*, ceratohyal; *qu*, part of quadrate. This figure has been reversed in order to make it correspond with fig. 2.
- 1*a*, 1*b*. Two teeth viewed from behind to show the incurved points. Natural size. The outlines placed beside these, to show their oval form in section, are a little too large.
2. Outer surface of right upper jaw, with ethmoid &c. in their natural positions. Teeth restored in outline, as in fig. 1: *pmx*, præmaxilla; *mx*, maxilla; *ju*, jugal; *pl*, palatine; *pr.fr*, prefrontal; *eth*, ethmoid; *olf*, perforation for olfactory nerve.
3. Bones of ethmoid region seen from below: *eth*, ethmoid; *mx*, fragment of anterior articular process of maxilla, which is lodged in a deep excavation of the ethmoid; *pr.fr*, these letters point to the surface of the prefrontal, which articulates with the palatine; *vo*, anterior portion of vomer (?).
4. Outer surface of right side of brain-case: *bs*, upper portion of basisphenoid; *as*, alisphenoid; *pa*, parietal region; *ps*, presphenoid; *fr*, frontal; *sp.ot*, sphenotic (postfrontal); *pr.ot*, prootic; *op.ot*, opisthotic or exoccipital; *ob*, supraorbital (?).
5. Inner view of left lower jaw with hyoid &c. *in situ*: *den*, left dentary; *ch*, right ceratohyal; *hh*, hypohyals; *cl*, *cl'*, portions of clavicles; *bh*, basihyal.
6. Front view of the symphyseal surfaces of the two mandibular rami.
7. Mandible seen from above, with the hyoid bones between the rami: *den*, left dentary; *ch*, *ch*, ceratohyals; *hh*, *hh*, hypohyals; *bbs*, basibranchiostegal; *pt*, pterygoid; *qu*, quadrate.
8. View of left side of basibranchiostegal; *a*, *b*, *c* show the positions of the plates enlarged in the next three figures. This figure is unfortunately placed upside down.
- 8*a*. Portion of one of the plates with ridges and grooves, enlarged 7 diameters.
- 8*b*. One of the radiating pitted plates, enlarged 10 diameters.
- 8*c*. A small portion of another pitted plate, with minute teeth *in situ*, enlarged 45 diameters.
9. Right and left maxillæ and præmaxillæ seen from below, the two sides in their natural relation to each other.
10. Side view of five dorsal vertebræ, showing the bases of the neural arches, the lateral depressions, and the enlarged heads of the ribs.
11. The third vertebra of fig. 10, seen from behind.
12. Section through another dorsal vertebra, seen from above: *a* and *p*, anterior and posterior concavities; *ld*, lateral depressions.

*Portheus Daviesii*, n. sp.

- Fig. 13. Outer surface of upper jaw &c.: *mx*, maxilla, the hinder part broken; *art*, surface of maxilla for articulation with præmaxilla; *v*, vertebra; *p.cl*, postclavicle or ventral spine.

*Ichthyodectes minor*, Egerton.

- Fig. 14. Outer surface of left ramus of mandible. This is the left ramus of the specimen figured by Dixon in his 'Geology of Sussex,' pl. 32\*. fig. 9: *den*, dentary; *art*, articular (the articular surface for the condyle of the quadrate is immediately below the letters *art*).

*Ichthyodectes elegans*, n. sp.

- Fig. 15. Inner surface of dentary bone of left ramus of mandible. Natural size. The teeth have been drawn from the counterpart of the specimen.