

British Museum, figured by Leith Adams,¹ the length of this region equals the width. The skull agrees with those of *E. primigenius*, and differs from those of *E. indicus* in the narrow proportions of the posterior part of the cranium. The teeth are of the coarse-plated *E. columbi* type. The individual is not very large, though old. The diameter of the tusks at the alveolus is 110 mm. In a fragment of a huge specimen from south-western Texas, the diameter of the tusk at the base is 210 mm.

As a result it is not clear that the two American forms can be distinguished as yet from the *Elephas primigenius*, or from each other, except as probable sub-species, *E. p. columbi*, and *E. p. americanus*. But more perfect material than we now possess may yet enable us to distinguish one or both of these more satisfactorily. No American species of the family exceeded this one in general dimensions, especially the form *E. p. columbi*."

EXPLANATION OF PLATE XIII. FORMS OF PROBOSCIDEAN MOLARS.

- FIG. 1.—*Elephas (Emmenodon) Cliftii*, Falconer & Cautley. The first (?) left upper true molar in an early stage of wear; from the Siwaliks of Burma ($\frac{1}{2}$ nat. size). The lower border of the figure is the inner border of the specimen. (The original preserved in the Museum of the Geological Society of London.)
- FIG. 2.—*Elephas antiquus*, Falconer. The first left upper true molar in a half worn condition; from the Pleistocene of Grays, Essex ($\frac{3}{4}$ nat. size). The lower border of the figure is the inner border of the specimen. (Original preserved in the British Museum, Natural History.)
- FIG. 3.—*Mastodon latidens*, Clift. The third left upper true molar of a small individual in a partially-worn condition: from the Pliocene of Borneo ($\frac{2}{3}$ nat. size). The lower border of the figure is the inner border of the specimen.

EXPLANATION OF FIGURES UPON PAGE 447.

Forms of Skulls and Skeleton of Proboscidea.

- FIG. 5.—*Elephas ganesa*, Falconer & Cautley. Profile of the skull; from the Siwalik Hills ($\frac{3}{8}$ nat. size). [After Gaudry.] The original preserved in the British Museum (Natural History).
- FIG. 6.—*Mastodon (Tetrabelodon) angustidens*, Cuvier. [After Gaudry.] Middle Miocene, Sansan (Gers), France. The entire skeleton restored and greatly reduced.
- FIG. 7.—*Elephas planifrons*, Falc. & Cautl. Profile of skull restored; from the Pliocene of the Siwalik Hills ($\frac{1}{16}$ nat. size). [After Gaudry.]
- FIG. 8.—*Mastodon sivalensis*, Cautley. Profile of skull restored; from the Pliocene of the Siwalik Hills ($\frac{1}{16}$ nat. size). [After Gaudry.]

III.—PRELIMINARY NOTES ON SOME NEW AND LITTLE-KNOWN BRITISH JURASSIC FISHES.²

By A. SMITH WOODWARD, F.G.S., F.Z.S.,

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SINCE the works of Agassiz and Egerton, few contributions have been made to the knowledge of British Jurassic "Ganoid" and "Teleostean" Fishes, and a considerable amount of undescribed material has thus accumulated in various collections. Much more progress has been made upon the Continent, where the Lithographic

¹ Mon. Pal. Soc. 1879, Brit. Foss. Elephants, p. 69, pl. vi. and vii.

² Read before Section C (Geology), British Association, Newcastle, Sept. 1889.

Stones of Bavaria, Würtemberg, and Ain, especially, yield a rich assemblage of forms in a remarkable state of preservation; and it is now an interesting study to compare the British Jurassic fossils with their well-known continental allies. Such an undertaking is facilitated by the recent appearance of Prof. Dr. K. A. von Zittel's admirable critical summary of the extinct Mesozoic fishes;¹ and it is the object of the present notice to offer some preliminary remarks upon a few of the more prominent types observed by the author in English collections.

1. *Eurycormus grandis*, sp. nov.

In 1863, A. Wagner² described a genus of fishes from the Lithographic Stone of Eichstädt, Bavaria, under the name of *Eurycormus*, making known a single species, *E. speciosus*; and in 1887, Prof. v. Zittel added some supplementary information to the original diagnosis, while publishing detailed figures of the vertebrae. No precise particulars, however, concerning the cranial osteology and dentition have hitherto been forthcoming; and the recent discovery by Mr. Henry Keeping, in the Kimmeridge Clay of Ely, of a fine head of *Eurycormus*, not only makes known the occurrence of a new species of the genus in England, but reveals structural features of considerable taxonomic significance. The specimen is preserved in the Woodwardian Museum, Cambridge, and the author is indebted to the kindness of Prof. McKenny Hughes, F.R.S., for the opportunity of undertaking a detailed study of its characters. The skull, jaws, and opercular apparatus agree precisely in general form and proportions with the corresponding parts figured in Wagner's typical species, while two anterior vertebrae exhibit the characters assigned to them by v. Zittel. The Ely species, however, is nearly three times as large as the Bavarian form, and differs (according to Wagner's description) in the superficial tuberculation of several of the head-bones; it may therefore receive the distinct specific name of *Eurycormus grandis*. The maxilla is narrow, and its arched margin is provided with a single close series of small slender teeth; the vomerine or palatine bones (or both) bear a cluster of similar teeth of larger size; and the inner side of the mandible seems to be constituted by the splenial element, provided with at least one series of small teeth, while for a short space near the anterior end of each dentary are observed the sockets of about nine large teeth. Each dentary bone is deep and plate-like, and, though much crushed, doubtless inclined inwards in its inferior half; and a very large elongated azygous jugular plate extends between the rami as far back as the suture between the dentary and angular elements. The hyomandibular bone is more lamelliform than in *Pachycormus*, etc., thus more nearly resembling the same bone in *Caturus*, the *Leptolepidæ*, and modern *Teleostean*s.

¹ "Handbuch der Paläontologie," vol. iii., pts. i. ii. (1887-88).

² A. Wagner, "Monographie der fossilen Fische aus den lithographischen Schiefer von Bayerns," Abh. k. bay. Akad. Wiss., cl. ii. vol. ix. (1863), p. 707, pl. iv.

2. *Strobilodus suchoides*, Owen, sp.

An examination of the type-specimen of *Strobilodus giganteus*, Wagner,¹ in the Munich Museum, has convinced the present writer of its generic identity with the so-called *Thlattodus suchoides*, Owen,² as already suggested with hesitation by v. Zittel (*loc. cit.* p. 229). One more Bavarian type is thus added to the fish-fauna of the English Kimmeridge Clay; and, as will shortly be pointed out elsewhere, there is evidence of still another British species of the same genus ranging as far upwards as the Purbeck Beds (Brit. Mus. 46,911).

3. *Hypsocormus Leedsi*, sp. nov.

The genus *Hypsocormus* was founded by Wagner in 1863,³ and, as remarked by v. Zittel, only two species are yet recognized, these being apparently confined to the Bavarian Lithographic Stone. Characteristic portions of the jaws of two other species, however, have been discovered in the Oxford Clay of Peterborough, by Mr. Alfred N. Leeds, of Eyebury, who has kindly entrusted them to the present writer for elucidation; and although the dentition of the genus has not hitherto been described in detail, the recent acquisition by the British Museum of a fine example of *Hypsocormus macrodon* from Solenhofen, renders a direct comparison of actual specimens possible.

The larger species from Peterborough, which may be appropriately named *H. Leedsi*, is represented by the anterior extremity of the snout associated with two fragments of the skull (No. 39, Leeds Coll.), indicating as large a fish as *H. macrodon*. The snout is obviously a compound bone, but the discussion of the homologies of its parts may be deferred. As in the Solenhofen species just mentioned, it is obtusely pointed, the two sides meeting approximately in a right angle at its anterior termination; and the external surface is finely granulated. As in *H. macrodon*, also, there is a pair of large tusk-like teeth, rounded in section, arising from sockets in the middle of the bone; but, whereas in the species just referred to, these "tusks" are directed vertically downwards, in *H. Leedsi* they are much inclined forwards, and, if perfect, would doubtless project beyond the front of the supporting bone. An irregular cluster of small, stout, conical teeth occurs on each side of the central pair, and two of these outer teeth, larger than the others, are placed directly in front.

The abraded anterior extremity of a large right mandibular ramus of *Hypsocormus* in Mr. Leeds' collection (No. 38) also probably pertains to *H. Leedsi*, corresponding to the above-described snout in size; and this fossil is interesting as exhibiting the form and proportions of the splenial element. The dentary constitutes the outer

¹ A. Wagner, "Beitr. Kennt. lith. Schief. Fische," Abh. k. bay. Akad. Wiss., cl. ii. vol. vi. (1851), p. 75, pl. ii.

² R. Owen, "On a Genus and Species of Sauroid Fish (*Thlattodus suchoides*, Ow.) from the Kimmeridge Clay of Norfolk," GEOL. MAG. Vol. III. (1866), pp. 55-57, Pl. III.

³ A. Wagner, *loc. cit.* (1863), p. 677.

side of the jaw and exhibits the abraded remains of a series of teeth, of moderate size, firmly implanted in sockets; while the splenial is a short, stout, lenticular bone, perhaps entering somewhat into the symphysis, but having its thickest portion immediately behind, supporting two great rounded tusks, in sockets, accompanied in front and behind by an irregular cluster of relatively minute stout conical teeth.

4. *Hypsocormus tenuirostris*, sp. nov.

The second species of *Hypsocormus* in Mr. Leeds' collection is represented by an imperfect snout, associated with a right maxilla and portions of splenial and dentary bones (No. 40). The original fish must have attained only about half the size of the typical specimen of *H. Leedsi*; and it is readily distinguished by the narrow, somewhat elongated, and acutely pointed form of the snout, which, however, exhibits the characteristic superficial granulations. The pair of tusk-like teeth is placed relatively further backwards than in *H. macrodon* and *H. Leedsi*, and seems to have been directed more nearly vertically than in the latter species; so far as can be ascertained, a single irregular series of teeth of small size also occupies the margin of either side, being accompanied only by few minute teeth. The maxilla is very slender, externally tuberculated, and provided with a single series of teeth of moderate size, well-spaced and nearly uniform, and flanked externally by a few minute teeth; the anterior end of the bone terminates in a stout, smooth projection, slightly directed inwards. The portions of dentary bones are somewhat broken, but this element is stouter and larger than the maxilla, provided with a single spaced series of much larger teeth, irregular in size, the most powerful being situated in the front portion of the posterior half of the bone; a cluster of minute teeth also occupies the whole of the external margin. As in the other species of *Hypsocormus*, all the teeth are oval or round in section, not keeled, though more or less vertically striated; and the enamelled apex often occupies less than half of the exerted portion.

So far as can be ascertained from the foregoing specimens, there is a singular resemblance between the dentition of *Hypsocormus* and that of the long-snouted *Protosphyrena* of the Upper Cretaceous. In the last-named genus there are two great upper teeth at the base of the snout,¹ while two equally large teeth occur on either side of the lower jaw near its anterior extremity; the latter, moreover, are similarly fixed in a short stout, lenticular splenial bone immediately behind the mandibular symphysis.²

It may be added that the genus *Hypsocormus* also occurs in the Kimmeridge Clay of Weymouth, portions of jaws being preserved in the British Museum (No. 42,368).

5. *Leedsichthys problematicus*, gen. et sp. nov.

For some years Mr. Alfred N. Leeds, of Eyebury, has obtained

¹ W. Davies, *Geol. Mag.* Dec. II. Vol. V. (1878), Pl. VIII. Fig. 3.

² F. Dixon, "Geol. and Foss. Sussex" (1850), pl. xxxi. fig. 12.

from the Oxford Clay of the neighbourhood of Peterborough a number of large bones of fibrous texture, and often of indefinite form, pertaining to some hitherto unknown extinct vertebrate. The flatter bones were considered by Mr. Hulke, in 1887, as not improbably referable to the dermal armature of a Dinosaur;¹ but, on visiting the collection in 1888, Prof. Marsh expressed the opinion that the remains were piscine, being unlike any of the numerous types of Dinosaurian dermal armour met with in America. At the beginning of the present year,² the writer of this note mentioned the possibility of these fossils indicating the presence of a large Acipenseroid fish in the Upper Jurassic rocks; and it is proposed in the following pages briefly to discuss the few facts already available for consideration. One set of bones undoubtedly pertains to a single individual, and is thus of great value; but many of the fragments are scattered, and, if the interpretations now to be suggested prove correct, the axial skeleton of the trunk still remains to be discovered. No known specimens exhibit any traces of superficial ornamentation, and, though often massive, all the elements have the characteristic fibrous texture of fish-bone.

The associated series of bones just mentioned was spread over an area of probably not less than twelve square yards, and the principal specimens may be enumerated and determined as follows:

1. A large, oblong, flattened bone, of the kind already described by Mr. Hulke. It measures 2 ft. (0.61 m.) in length by 1 ft. 3 in. (0.38 m.) in maximum breadth, is of a squamous character, thinning at each margin, and consists of two thin hard layers separated by a middle layer of soft diploë. In form and characters the bone is very suggestive of a *frontal* element.

2. An elongated bone, 1 ft. 8 in. (0.58 m.) in length, somewhat broader at one extremity than at the other. One long margin is thickened and rounded, while the other is a thin edge; and the broader extremity is thicker than the narrower. This may perhaps be identified as *angular*.

3. An elongated bone, 1 ft. 3 in. (0.38 m.) in length, and the broader extremity of the corresponding element of the opposite side. This is probably the *hyomandibular*. The supposed upper extremity is somewhat expanded, and near this end on the posterior outer margin is a small facette, evidently for the operculum. For two-thirds of its width the bone is thick, but the anterior third is thin, as is also the inferior extremity.

4. Portions of four long narrow bones, the largest being 2 ft. 5 in. (0.735 m.) in length, and not more than $3\frac{1}{2}$ in. (0.09 m.) in maximum width. Each bone is comparatively hard, irregularly <-shaped in transverse section, and seems most nearly paralleled by the ossifications of the *branchial arches* in Teleosteans.

5. A very large number of small, narrow, elongated bones of peculiar shape, probably to be regarded as *gill-rakers*. The largest

¹ J. W. Hulke, "Note on some Dinosaurian Remains in the Collection of A. Leeds, Esq.," Quart. Journ. Geol. Soc., vol. xliii. (1887), p. 702.

² Smith Woodward, "On the Palæontology of Sturgeons," Proc. Geol. Assoc., vol. xi. (1889), p. 31.

of these are about 3 in. (0.075 m.) in length, and $\frac{3}{4}$ in. (0.010 m.) in width. Each is laterally compressed, slightly expanded at one extremity, and rarely straight, but irregularly bent or contorted. The surface is coarsely rugose, and one long border is rounded, while the other is cleft by a longitudinal median furrow. The rounded border is comparatively smooth, but the furrowed edge is coarsely serrated, a series of short oblique ridges terminating in points on each side.

6. Portion of a large squamous bone, longer (deeper) than broad, with one long margin thickened, rounded, and concavely arched. A nearly complete example of the same element, doubtfully forming part of the series, measures 2 ft. 9 in. (0.838 m.) in length, and suggests that it may be identified either with the *preoperculum* or *clavicle*.

7. Portions of eleven very dense, large, rib-shaped bones, only superficially ossified at the broader extremity, but terminating in a well-formed point at the distal end. These bones are rounded or irregularly quadrangular in section, are more or less arched, and vary considerably in relative width or thickness. The broadest and stoutest specimen is much arched, 1 ft. 5 in. (0.43 m.) in length; and a nearly perfect detached example of the same bone shows that this wants a length of at least 8 in (0.23 m.) at the pointed extremity. The largest bone measures 2 ft. 4 in. (0.712 m.) in length, and is straightened; while the smaller examples are more curved and more rounded in section. These bones were evidently arranged in not less than six pairs, and Mr. Leeds' suggestion seems most plausible, that they are the *branchiostegal rays* of the fish.

8. The *fin-rays* are most remarkable, and, judging from the position in which they were discovered, the known specimens may all probably be assigned to the pectoral fin. They consist of fibrous bone, and appear as if composed of numerous long, tapering bony splints, incompletely fused together. The two halves of each ray remain separate, and in some cases they have been proved to attain a length of not less than 5 ft. (1.525 m.). There are no transverse joints, but all the rays exhibit numerous bifurcations, and Mr. Leeds estimates that the distal extremity of each of the largest becomes divided into at least thirty-two small branches.

Smaller more slender fin-rays, probably of the same type of fish, have also been discovered in the Oxford Clay of the same locality. These are gently rounded and transversely articulated, thus suggesting that the specimens just noticed are characteristic only of a powerful pectoral.

As already mentioned, many other detached bones, undoubtedly of the same genus and species, occur in Mr. Leeds' collection; but, of the elements not described above, the form is so indefinite as to render their determination very uncertain. If, however, the few suggestions here propounded are eventually confirmed, it is obvious that many hard parts of the fish still remain to be discovered. No known fish with ossifications of the branchial arches and branchiostegal membrane of the kind here described is destitute of at least some ossifications in the axial skeleton of the trunk; and it will be a strange, indeed, if a monster with such powerful pectoral fins does

not prove to have been possessed of a formidable dentition. It is satisfactory to know that there is good reason to hope for the discovery of much more of the skeleton of the individual discussed above, as soon as the bed where it occurs is worked again; and Mr. Leeds is fortunately acquainted with the precise stratum where the specimen occurs.

The characters of the gill-rakers, branchiostegal rays, and pectoral fin-rays, taken together, justify the definite separation of the fish in question from all known generic types; and it is proposed to apply to it the name of *Leedsichthys* in honour of its discoverer. The Peterborough species may be provisionally termed *Leedsichthys problematicus*, and it is probably the most gigantic Jurassic fish hitherto described.

A group of the characteristic gill-rakers, of equally large size, has also been obtained from the Oxford Clay of Vaches Noires (Brit. Mus. No. 32,581), thus indicating the occurrence of the genus in the Upper Jurassic of the North of France.

6. *Mesodon*.

The genus *Pycnodus*, as now defined, is restricted to the Eocene formations, and all the British Mesozoic fossils originally described under that name are to be distributed among the more precisely defined genera determined on the continent. This is a difficult task, so far as the Jurassic species are concerned, for little more than detached examples of jaws and teeth are known, and there is apparently considerable variation in these parts. The so-called *Pycnodus pagoda*, Blake,¹ from the Portlandian, is evidently a vomer of *Microdon*; but nearly all the other described British Jurassic "species" of *Pycnodus* pertain to *Mesodon*. Fricke, v. Zittel, and others, have already pointed out that to this genus may be referred the Agassizian species *P. Bucklandi*, *P. ovalis*, and *P. rugulosus*, and to the synonymy of the first we would add *P. didymus*, Ag., *P. obtusus*, Ag., and *Gyrodus perlatus*, Ag. The latter name is given to some detached scales from the Stonesfield Slate, ornamented by tubercles instead of rugosities or pits, thus being truly referable to *Mesodon*, and agreeing sufficiently in size with the associated jaws of *M. Bucklandi* to be provisionally ascribed to that form. To *M. rugulosus* we would also assign the undescribed *Pycnodus parvus*, Ag., of which a specimen marked as "type" is in the Egerton Collection. Some so-called species of *Gyrodus*, e.g. *G. trigonus*, Ag., are also most probably referable to the same genus; and the Liassic *Pycnodus liassicus*, Egert., was long ago placed in *Mesodon* by Heckel.

7. *Thrissops*.

Since the researches of Agassiz, Münster, Wagner, and Thiollière, so many Jurassic examples of the genus *Thrissops* have been acquired by various Museums, that it would be interesting to study the characters of the specific types already determined in the light of the new material before making any further additions to the

¹ J. F. Blake, "On the Portland Rocks of England," Quart. Journ. Geol. Soc., vol. xxxvi. (1880), p. 228, pl. x. fig. 10.

nomenclature of the group. In recording the occurrence of the genus in the English Jurassic, it must therefore suffice to remark that the British Museum possesses characteristic remains of a species as large as *T. Heckeli*, Thioll.¹ from the Kimmeridge Clay of Dorsetshire (B.M. Nos. P. 922, P. 3686, P. 6031); while a nearly complete example of a much smaller species has been obtained from the Portland Stone of the Isle of Portland (B.M. No. P. 5538).

8. *Browneichthys ornatus*, gen. et sp. nov.

In the series of vertebrate fossils from the Lower Lias of Barrow-on-Soar, recently obtained for the Leicester Museum by Mr. Montagu Browne, F.Z.S., is an interesting small fish, apparently of a new generic type, which the present writer has been favoured with the privilege of examining. The specimen is only about 0.06 in length, displaying portions of the head and trunk; but, notwithstanding its imperfections, it seems worthy of brief notice as being so different from anything hitherto known. The fish must have been originally elongated in form; and the hinder portion of the head, preserved as far forwards as the front margin of the orbit, suggests the attenuation of the snout. The space occupied by the notochord is vacant, indicating its persistence, but the neural and hæmal arches are well ossified superficially, and there is no evidence of elongated, well-developed ribs. The bones of the head are invested with ganoine, and ornamented with large tuberculations; and at least the front portion of the trunk is covered with thin, deeply-overlapping scales, oval or round in shape, with prominent concentric lines of growth, and externally ornamented with large ganoine tubercles. Three or four relatively large, narrow, pointed ridge-scales, above and below, also indicate a partial or continuous armature of the dorsal and ventral margins. Of the dentition and the fins, nothing can be ascertained from the fossil now described; and although a series of eight slender bones shortly behind the occiput may possibly be the interspinous bones of a dorsal fin, it will be well to await the discovery of other specimens before attempting their interpretation.

So far as can be determined, the new Barrow fossil thus most nearly approaches the early Mesozoic Ganoids, *Belonorhynchus* and *Saurichthys*. From these, however, and from other types with a persistent notochord, it is generically distinguished by the squamation; and employing the discoverer's name, the new form may be termed *Browneichthys*. The type-species may be known as *B. ornatus*.

IV.—AN ANALYSIS OF THE FULLERS EARTH OF NUTFIELD.

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DURING June last I visited the Fullers Earth Pits at Nutfield, near Redhill, Surrey, with the London Geological Field Class, when Professor Seeley suggested to me that I should make an

¹ V. Thiollière, "Poiss. Foss. Bugey," pt. i. (1854), p. 27, pl. x. fig. 1.