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ORIGINAL ARTICLES.

I.—On *Hyperodapedon Gordoni*.

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(*Continued from the November Number, p.* 492.)

In the foregoing description I have confined my remarks to the right side of the skull. The observer will not fail to notice from the figures the disparities existing in the two sides. This asymmetry is particularly conspicuous ventrally, the region from which Huxley principally deduced the arguments in support of his more important speculations. The area of dislocation, the centre of which apparently lies in the crater-like opening of the left præsplenial, extends from the left præmaxillary to the pterygoid in the skull, and as far as the splenial on the lower jaw. Its place of greatest intensity has been marked by a + on the figure, where not only the surface of the bones is most damaged, but where the mandible has been so much compressed that a crest has actually been formed below the row of teeth on its outer wall.

The splenial too has been displaced; the pterygoid is broken across; a deep fissure separates the three inner rows from the regularly placed outer rows of teeth on the palate-bone.

This dislocation is partly responsible for the deception it caused in the location of the posterior nares, and for the supposed boundary of the palate-bone and the maxillary. Huxley himself, in his first paper, inaugurates the description of the dentition by stating his inability to find any suture in the roof of the mouth, but he supposed such to exist somewhere in the groove of the hard gum, into which the lower jaw is received when at rest.

In his second paper he lays particular stress on the fact of there being only a single row of teeth tending in a forward direction on either the palatine or the maxillary. Certainly some of the smaller fragments show no suture within the denticulated space, but there is one which runs parallel with and is situated laterally to the outermost row of teeth, which can be traced without cutting a cross section through it.

This leads us to a consideration of the dentition itself. Lydekker was the first to make known the existence of one to two rows of detached teeth on the posterior margin of the oral surface in the lower jaw of the Indian species, next to the palisade-like row of

teeth. Huxley considered that the Indian specimens probably did not differ specifically from the English specimens, but merely exceeded them in point of size.

As the two fragmentary specimens of undoubtedly British origin show exactly the same arrangement in the dentition of the lower jaw, Lydekker's contention as to the specific value of the character of his Indian specimens therefore breaks down.

The study of the lower jaw of *Hyperodapedon minor* is particularly instructive in this respect, as the principal row of mandibular teeth extends backward considerably further than in *H. Gordoni*.

The dentition of the palate-bones has been accurately described by Huxley, except in the case of the anterior portion of the right side, which he states has three rows, of which the middle one is decayed away, being indicated only by the empty sockets of the teeth. The regularity in distribution of the teeth is somewhat indistinct on the left side of the fore-part of the palate-bone, and it appears to me to depart from the normal plan, a circumstance which I am inclined to attribute to the local displacement already mentioned. In size the teeth increase consecutively from the front backwards. Neither from this fact alone, nor from sections made at a right angle to their longitudinal line of distribution, is information available as regards a succession of teeth. But judging from a fragment of *H. minor*, containing the germs of the teeth, which have as yet not cut through the bone, I should infer that this does not point to a real change of the teeth, but that it rather suggests the mode of a successive supply of them from the rear, which would continue during the whole of the animal's lifetime.

Now, therefore, that the purely palatine nature of the dentition has been proved, there is no further occasion for assuming a change of teeth to apply to it in the same manner as that in which it is accomplished in the maxillaries. Whether or not such a change of teeth, in its actual sense, takes place in other palatal bones, is a matter for further examination. Whatever its outcome, it is not likely to furnish direct counter-evidence against *Hyperodapedon*, the apparatus for prehension in which is so markedly different.

The peculiar anatomical structure of this apparatus implies a number of physiological derivations capable of throwing light into the vast abyss which divides its dental arrangement from that of *Sphenodon*. It would be wrong to imagine the cutting edge of the lower jaw to move backward and forward in the masticating furrows opposing it. This would be an utter impossibility on account of the two furrows converging towards the front. It is more likely that during the process of attrition, they moved obliquely across the upper part of the apparatus, and that the furrows received the lower jaws when at rest, for which purpose they seem to be provided. This is probably the reason too why the tooth-rows which flank them are ground down. In further support of this view of a gradual expansion of the attritive surface in the posterior portion of the lower jaw, is the fact that it was achieved by an increase of the tooth-rows. Another reason why this expansion has

been confined to this particular place is, that the mandibular teeth are in correlation with the presence of a true horned beak, which would have been a natural obstacle to any development of teeth. In this way, and further too by the continuous renewal of teeth, another useful means has been contrived for the process of mastication.

By way of compensation, during the individual development the dentulous surface was so modified that no disadvantage would accrue to the animal through the incapacity of the mucous membrane to remove the worn-down acrodont teeth.

To look for a physiological parallel of this peculiar kind of dentition it is necessary to go to the Placodontia. Of these latter, however, the material at my disposal did not permit of a detailed comparison, but it should be mentioned here that in the Placodonts the maxillary appears to me to bear no teeth, and to be divided from the tooth-row by a suture.

Referring specially to the tendency to expansion, within the dentigerous portion of the posterior part of the lower jaw, by the introduction of new elements, I remember a parallel case, having noticed on the vomer-plate of a species of *Pycnodon*, which is in the Museum at Basle, that the otherwise regular quinto-serial arrangement was augmented by an additional tooth in its widest posterior part.

From the character of the teeth in *Hyperodapedon*, the question arises once more as to the natural haunts of the animal. What is the kind of food required in the case of a placodont animal? Generally this consists of Crustacea, Molluscs, Echinoderms, and other hard-shelled animals. If we take into consideration the dentition alone, coupled with the extraordinary position of the eyes, to which may be added the reduction in size of the posterior extremities, one feels inclined to attribute to it a marine existence; more particularly would this be the case if Huxley's supposition as regards the length of its tail were confirmed. On the other hand, the structure of the manus, in which no tendency to a lengthening of the phalanges can be perceived, is in direct contradiction to this interpretation.

Hyperodapedon, therefore, and probably also *Rhynchosaurus*, will have to be regarded as inhabitants of the littoral. What other terrestrial animal is equipped with a similar dental structure? Or what else could have induced *Hyperodapedon* to frequent the sandy Triassic shores, from whose strata up to the present no signs of petrefactions have been procured, except fossil reptiles.[1]

[1] The writer desires to refer to the remarkable discoveries made prior to 1892 in the Elgin Sandstone, Morayshire, which were described by Mr. E. T. Newton, F.R.S. (Proc. Roy. Soc., Dec. 15, 1892, vol. lii, pp. 389–391; Phil. Trans., vol. clxxxiv), in which he enumerates *Gordonia Traquairi*, *G. Huxleyiana*, *G. Duffiana*, *G. Juddiana*, *Geikia Elginensis*, and *Elginia mirabilis*. Reference was also made to a form resembling *Ætosaurus* (Geol. Mag., 1893, p. 557) named *Ornithosuchus Woodwardi*, and to *Erpetosuchus Granti* (see Proc. Roy. Soc., Dec. 7, 1893, vol. liv, pp. 437, 438; Phil. Trans., 1894, vol. clxxxv B, p. 573, pls. liii–lvi). There were probably also two species of *Thecodontosaurus* from the Trias of Bristol, and perhaps a third from Leamington.

I carefully sought for any evidence of dermal ossification, and detected a few vague signs here and there: for instance, on the eighth rib of the left side, and on the opposed surface, in the vicinity of the ends of the eleventh and the twelfth ribs; also, some small plates of an oval shape on the humeri. Under favourable light the contours of the body, too, seemed to be indicated, notably in the interspaces between the ends of the ribs. Finally, as may be seen from our figure of the counterpart of the right side, a heart-like projection can be observed in the blank space near the fourth rib, differentiating it from other parts, through absence of matrix in that place, from which a fibre of the thickness of a finger starts, tending towards the neck in a decided manner, where it disappears again in the slab. I suspect it to have been a visceral organ, probably the stomach, to judge from its position.

It may be mentioned that there are two specimens of *Rhynchosaurus* in the British Museum in which indications of the skin can also be traced. Lortet has also already described such structures in *Sauranodon*. In one of the *Rhynchosauri*, viz. the type from which Huxley figured its hind-foot (pl. xxvii, fig. 5), the skin is so unmistakable that I have reproduced it here.

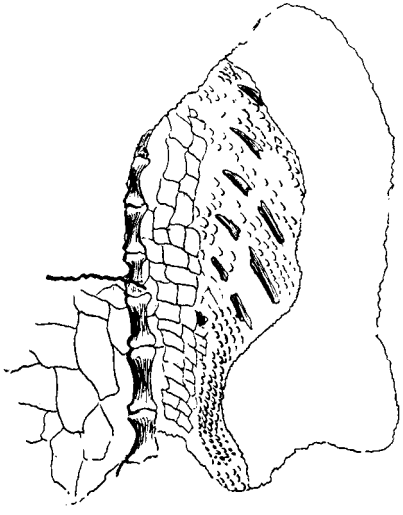

Fig. 3.—Skin from the posterior abdominal region of *Rhynchosaurus articeps*. Two-thirds nat. size. From the specimen preserved in the British Museum (Natural History).

It belongs to the abdominal region, and vividly recalls a fragment from the skin of a Lepidosaurian. But on this head I will not venture upon any evidence of a closer relationship with either the latter or any of the Rhynchocephalians, since we are yet quite ignorant as to the skin structures of the Theromorphæ. A more intimate knowledge of the Lepidosauria from this point of view may even necessitate a change of the name.

The second specimen, disclosing impressions of the skin, is that which supplied Huxley with the type for tab. xxvii, fig. 2. I have been able to detect some smaller scales on this near the remains of the caudal vertebræ, but not so clearly to be seen as in the other example.

I cannot conclude my account of *Hyperodapedon* without making a few remarks on the systematic position of the Rhynchosaurians. Although in the beginning of Huxley's second treatise he strongly supports the theory of an intimate relationship existing between this extinct group and the living *Sphenodon*, his conclusions, however, are that they have only the following characters in common with each other :—

1. A præmaxillary rostrum.
2. A longitudinal series of palatine and maxillary teeth, of which the posterior ones receive between them the mandibular row.
3. An abdominal sternum.
4. Absence of procœlous vertebræ in the præsacral portion.

Of the foregoing characters, number 1 breaks down at once, being based upon a supposed identity of origin in two totally distinct structures ; and the second no less so, as will have been seen in our previous discussion. There remain only the third and the fourth points, upon which it would be futile to base characters for the establishment of a closer relationship between them.

Von Zittel, too, ascribes to the Rhynchosaurians affinities with *Sphenodon*, and places them nearer the latter than to the remaining groups of Rhynchocephalians, as does also Smith Woodward.

Boulenger unites the Proterosauridæ with the Palæohatteridæ to form his Proterosauria. Some of the characters which he assigns to this group are shared also by the Rhynchosaurians, such as the flattened bone composing the pelvis, and especially the opisthocœlous vertebræ of the Proterosauridæ. The Rhynchosaurians and the Champsosaurians are brought under one heading too, with the latter of which, except through convergence of similarities, they have really nothing in common. For the reasons mentioned, then, the classification as proposed cannot be said to be wholly satisfactory.

Recently Fürbringer brought to a conclusion his comprehensive systematic treatise on Reptiles, wherein, following Baur, he separates *Hyperodapedon* from *Rhynchosaurus*, and places the family Hyperodapedontidæ near that of Proterosauria, and the Rhynchosauridæ with the Rhynchocephalia *vera*. I can only follow the views of these authors in so far as they are restricted to the closer relationship existing between *Hyperodapedon* and the Proterosauridæ, and on account of its being already connected with the latter by the possession of opisthocœlous vertebræ. Otherwise I consider a separation of *Hyperodapedon* from *Rhynchosaurus* entirely erroneous, and I can find no apology for it on the part of these authors, except in the insufficiency of the published materials on which they based their conclusions.

After what has been stated as to the dentition and the characters of the skull of *Hyperodapedon*, there exists no further ground for

trying to effect a closer union of the Rhynchosaurians with Rhynchocephalia vera. We ought rather to regard the former family as a branch, in a wider sense, of the Rhynchocephalian stem, totally independent of the true Rhynchocephalians, and linked in all probability in a more direct manner to the lowest organized Proterosauridæ. So long, therefore, as the inferior zygomatic arch is held to be a differentiating character for the Rhynchocephalians, the Rhynchosaurians will have to be attached to them and not to the Theromorpha. At the same time it should be borne in mind that latterly Baur and Case have excluded *Dimetrodon* from the Theromorpha, and have subsequently included it with the Rhynchocephalians, chiefly on account of this character, and it is possible also that a similar transfer awaits the Endothiodontidæ under similar circumstances. It is to the latter that the Rhynchosaurians appear to bear the greatest resemblance, but in this case also the resemblance may be based upon analogy alone.

The principal conclusions I have arrived at are as follows:—

1. All the bones in the skull of *Hyperodapedon Gordoni*, as seen in the specimen in the British Museum (apart from the occipital region), can be identified, except such as may be still embedded in the matrix.

2. The upper side of the skull agrees with the one known for Rhynchocephalians, with this difference, that the postorbital is rather large and removed in position from the orbital.

3. In the lower jaw five bones can be clearly distinguished, to which an angular should be added, analogous to *Rhynchosaurus*.

4. The maxillaries are edentulous; the palatines possess numerous rows of teeth in serial arrangement, which increase in size from the front to the back. They are not changed, but their number is augmented in their hinder margins; their complete wear is prevented by alteration in the position of the attritive surfaces. The suture between the palate-bone and the maxillary lies to the outside of the dentigerous portion, and is probably the same in the Placodontia.

5. *Hyperodapedon*, together with *Rhynchosaurus*, forms a separate group of the Rhynchocephalians, viz. the Rhynchosaurians, which are connected in a direct line with the lowest forms. This group has no affinity with the Rhynchocephalians in a stricter sense; its analogies with the Chelonians, the Endothiodontidæ, and the Champsosauridæ are physiological ones.

Literature.

1. Owen, R.—"Description of an Extinct Lacertian Reptile, *Rhynchosaurus articeps*": Trans. Cambridge Phil. Soc., vol. vii (1842).
2. Huxley, T.—I. Postscriptum to Sir Rod. Murchison, "On the Sandstones of Morayshire (Elgin, etc.) containing Reptilian Remains": Quart. Journ. Geol. Soc., vol. xv (1859), p. 435. II. "On *Hyperodapedon*": ibid., vol. xxv (1869), p. 138. III. "Further Observations upon *Hyperodapedon Gordoni*": vol. xliii (1887), p. 675.
3. Günther, A.—"Contributions to the Anatomy of *Hatteria*": Phil. Trans., vol. clvii (1867).

4. Woodward, A. Smith.—Discussion on A. Irving, "The Red Rock Series, etc.": Quart. Journ. Geol. Soc., vol. xliv (1888), p. 163.
5. Lydekker, R.—I. "Note on some Gondwana Vertebrates": Rec. Geol. Surv. India, vol. xiv (1881), p. 177. II. "Indian Pretertiary Vertebrata": Palæontologia Indica, ser. iv, vol. i (1885). III. "Catalogue of the Fossil Reptilia and Amphibia in the British Museum"; London, 1888.
6. Zittel.—"Palaeozoologie," iii (1890).
7. Boulenger, G. A.—"On British Remains of *Homœosaurus*, with Remarks on the Classification of the Rhynchocephalia": Proc. Zool. Soc., 1891, p. 167.
8. Newton, E. T.—"On some new Reptiles from the Elgin Sandstones": Phil. Trans., vol. clxxxiv (1893) and vol. clxxxv (1894).
9. Woodward, A. Smith.—"Outlines of Vertebrate Palæontology," pp. 186–189; Cambridge, 1898.
10. Newton, E. T.—"On a remarkable Bone from the Chalk of Cuxton": Proc. Geol. Assoc., vol. xvi (1900).
11. Fürbringer.—Tenaische Zeitschr. für Naturw., 1900.

II.—Notes on some Remains of *Cryptocleidus* from the Kellaways Rock of East Yorkshire.

By Thomas Sheppard, F.G.S.

On visiting Brough a short time ago I noticed a small section had been made on the western slope of Mill Hill, about twenty or thirty feet below the top. The excavation is made in soft white sand, which is very ferruginous in places. Beds of hard sandstone, varying in thickness from one to three inches, traverse it in the upper part of the section. These beds of sandstone are practically horizontal, and contain casts of *Belemnites Owenii, Gryphæa bilobata, Trigonia,* and other characteristic Kellaways Rock fossils. In not a single instance was a portion of a shell remaining, the whole of the calcite having been dissolved away. There is only a thin covering of soil; and this contains numerous pebbles of doubtful origin, and some pieces of Roman pottery.

The excavated material is sent to Leeds, where it is used by an engineering firm for moulding.

On examining the pit I noticed a piece of very ferruginous material. It was of rather peculiar shape, however, and on picking up further pieces it became evident that they were small fragments of bone. They had been thrown on a heap on one side, and such bones as were found had to be picked from this heap; consequently their exact horizon could not be determined. Subsequent visits were the means of finding still further specimens, chiefly whole and broken vertebræ, pieces of ribs, etc. On one of these occasions a vertebra was noticed protruding from the quarry face, at a depth of about seven feet; this was in close proximity to the heap from which the other remains had been obtained. This vertebra was extracted, and several others were found on the same level, fitting close together. These vertebræ were nearly circular, and were without the prominent processes which occurred on some of the earlier specimens found on the refuse heap. Evidently, therefore, this was the tail end of the animal, and unfortunately the most