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by Walker, except that they are of a reddish brown, reddish on the thorax. The abdomen has a row of spines pointing backwards on the median line and three rows of large black oblong spots on the back and sides; the median row macular, the lateral rows partly connected behind, and each marked rather behind its centre with a large reddish dot. On the basal segments the black markings are more or less connected at the base of the segments.

Enyaliopsis Petersii.

Hetrodes Petersii, Schaum, Ber. Ver. Akad. Berl. 1853, p. 777; Peters's Reise Mossamb. v. p. 119, pl. vii. fig. 7 (1862).

1, Pretoria (*Distant*); 3, Barberton (*Rendall*); 2, Fort Johnston, Nyasaland (*Rendall*); 1, Angola (*Monteiro*).

The frontal horn in some of these specimens is shorter and broader than usual. There are two immature specimens among them.

Acanthoproctus Howarthæ.

Acanthoproctus Howarthæ, Kirb. Ann. & Mag. Nat. Hist. (7) iii. pp. 101, 145 (1899).

1, Brak Kloof, near Grahamstown.

The types were received from E. Karoo, Cape Colony.

LXV.—*On one little-known and one hitherto unknown Species of Saurocephalus.* By O. P. HAY*.

THE fish *Saurcephalus lanciformis* was first described and named by Dr. Richard Harlan in 1824 †. This description and the accompanying figures were reprinted in 1835 in the same author's 'Medical and Physical Researches' ‡. The specimen on which the genus and species were based had been collected about twenty years previously, by Lewis and Clark, at some locality probably in North-eastern Nebraska. It consisted of the greater portion of the left maxilla; but was described by Harlan as belonging to the lower jaw. He also regarded it as having belonged to a reptile allied to *Ichthyosaurus*. Louis Agassiz first recognized the ichthyic

* From the 'American Journal of Science,' April 1899, pp. 299-304.

† Journ. Acad. Nat. Sci. Philad. (1) iii. pp. 331-337, pl. xii. figs. 1-5.

‡ Med. Phys. Res. pp. 362-366, pl., figs. 1-5.

nature of the remains * (although he confounded them with an entirely distinct species); and his conclusions were confirmed by Richard Owen †. Dr. Leidy ‡ corrected Agassiz's errors, and gave more accurate descriptions and figures of the maxillary than had been furnished by Harlan.

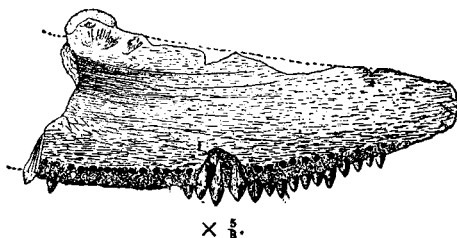
No remains of Harlan's species, other than the maxillary referred to, have hitherto been described. Dr. E. W. Hilgard § has reported the species as occurring in the Vicksburg group of the Eocene, but the identification was undoubtedly erroneous. Dr. William Spillman || has also included this species in his list of fossils belonging to the Tombigbee greensand of the Cretaceous at Columbus, Miss. Although this identification is less improbable than the former, we have nothing to confirm its correctness.

Notwithstanding the scantiness of the material belonging to the type species, our knowledge of the genus *Saurocephalus* has been greatly increased through the descriptions of closely related and more perfectly preserved species. For this additional knowledge we are indebted to Cope and Newton, and more recently to Alban Stewart, of the University of Kansas.

For some time I have had in my possession some remains which on examination prove, in my judgment, to belong to Harlan's species. This material was collected for me in the region of Butte Creek cañon, south of Wallace, Kan.; and the horizon is undoubtedly that of the Niobrara Cretaceous. My material consists of both the mandibles, the right maxilla, the pterygo-palatine arch, and a few other bones.

The maxillary (fig. 1) is rather short and deep. The

Fig. 1.



portion belonging in front of the palatine condyle is missing; but the condyle itself is present. The alveolar border is

* Poiss. Foss. v. p. 102.

† Odontography, p. 130, pl. 55.

‡ Trans. Amer. Philos. Soc. 1857, xi, pp. 91-95, pl. vi, figs. 8-11.

§ Report Geol. & Agric. Mississippi, 1860, p. 142.

|| *Op. cit.* p. 389.

somewhat curved, and is occupied by compressed sharp-edged teeth. Of these there are present twenty-eight; but if we restore the bone, as we can safely do, I believe, by aid of Stewart's figures of *S. dentatus**, we may conclude that there were originally thirty-four teeth, possibly one or two less. The root of the most anterior tooth has been exposed by the fracture, and its fang is seen to be distinctly faceted; so that it presents just such an appearance as the tooth of *S. lanciformis* figured by Leidy†. The roots of teeth situated more posteriorly, whose fangs have been exposed by a tool, are similarly faceted. Cope states‡ that *S. lanciformis* is to be distinguished from his *S. arapahovius* by the lack of facets on the roots of the teeth of the latter.

Leidy estimated that the maxilla in his hands had supported only twenty-six or twenty-eight teeth, and he was probably correct. That maxilla, a larger one than the one in my possession, seems to have been broken just behind the palatine condyle. If now we take from Leidy's drawing the width of the bone at this point and apply it to the alveolar border, we find that it includes ten teeth; the width of my own specimen includes thirteen teeth. It is not impossible, however, that the specimen figured by Leidy had been broken away some little distance behind the condyle. At any rate, I do not believe that the difference of a few teeth, other things being alike, would justify us in regarding the specimens as belonging to different species.

As in the case of the original specimen, there is a shallow groove running along the mesial surface of the maxilla, about 5 millim. from the alveolar border, and from this groove foramina, one for each tooth, enter the bone.

Depth of maxillary at palatine condyle	millim. 38
Distance from anterior end of palatine condyle to hinder end of maxillary	85

The right mandible is shown in fig. 2, five eighths the natural size and showing the mesial surface. The alveolar border is straight and supports thirty-four teeth, of which those occupying the middle of the border are the largest. In general, they are larger than the teeth of the upper jaw. The line which spans thirteen teeth in the maxilla spans ten in the dentary. At the proximal end of the mandible there must have been a process of the dermarticulare, as in related

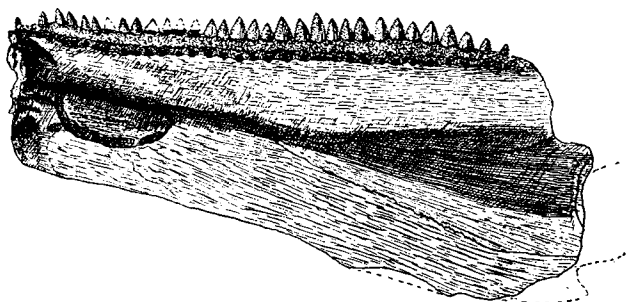
* Kan. Univ. Quart. vii. p. 25, pl. i. figs. 3 a, 4 a.

† Trans. Amer. Philos. Soc. xi. pl. vi. fig. 9.

‡ Cretaceous Vertebrata, p. 216.

forms; but in the specimen figured it is hidden by the overlying ceratohyal, which is not shown in the figure. At the anterior end of the mesial face of the dentary there is found a broad surface, rough with processes and pits, an indication that the two dentaries were strongly bound together. The

Fig. 2.

 $\times \frac{5}{8}$.

extreme anterior end of each dentary is occupied by a surface to which was evidently attached such a prementary as Stewart has described as belonging to several related species. A groove and a row of foramina are present on the median face of the dentary.

	millim.
Length of alveolar border	112
Length of mandible from cotylus ...	130
Depth of mandible at last tooth	56
Depth of mandible at symphysis ...	34

Fig. 3 represents, five eighths the natural size, the pterygo-

Fig. 3.

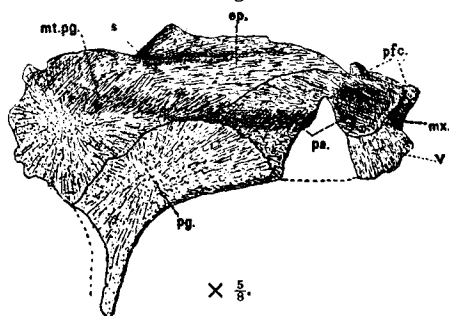
 $\times \frac{5}{8}$.

Fig. 4.

 $\times \frac{1}{2}$.

palatine arch seen from within. A triangular piece is missing from the anterior end, and the lower end of the

ectopterygoid, *pg*, is defective. As I interpret the bones, the arch is remarkable for the large size of the palatine, *pa*. While the sutures which are represented in the figure are very distinct, I am wholly unable to find one separating the entopterygoid, *ep*, from the metapterygoid, *mt.pg*. On the upper border of the arch, at the point indicated by the line *s*, there appears to be an indication of a suture. If such it is, it probably extends downwards to a point near the hinder end of the palatine. The arrangement of the bones is quite different from that found by myself in *Xiphactinus**.

At the lower border of the anterior end of the palatine there is a broad surface, *v*, which was probably in contact with an articulating surface on the vomer. The notch seen in the anterior end is occupied by another articulatory surface, *mx*, for the anterior palatine condyle of the maxilla. The anterior end of the upper border furnished an articulation, *pfc*, with the prefrontal, but this is elongated and rough, not broad and smooth, as it is in *Xiphactinus*.

Anteriorly the palatine is thick and strong. On its outer surface this portion is finely vermiculated above, while the lower portion furnishes a concave articulation for the condyle of the maxilla. The general appearance of this portion may be seen from fig. 4, which represents the palatine of the next species. Below the concave surface for the palatine condyle of the maxilla there is seen a broad rough surface which must have been applied to the inner face of the maxilla. The greater portion of this is wanting in the specimen shown in fig. 4. Its limits are indicated by the dotted line. On the outer face of the metapterygoid, from the highest point seen in fig. 3 there runs downward and backward a sharp ridge which evidently bounded the orbit below. The portion of the metapterygoid above and mesiad of this ridge formed the floor of the orbit. This indicates that the orbit was placed well backward. I find no satisfactory evidences of the presence of teeth on the pterygoid and palatine bones. If we add to the maxillary the probable antero-posterior extent of the premaxillary, we shall find that it is approximately equal to the length of the lower jaw. Hence the latter did not project beyond the upper jaw as it did in the case of those species which Stewart has referred to the genus *Saurodon*.

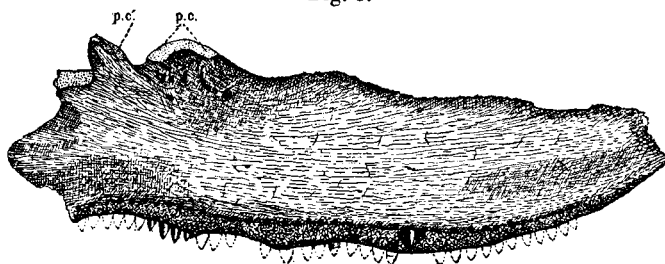
Two characters seem to distinguish *Saurodon* from *Saurocephalus*, viz.: the presence of notches, instead of foramina, for the successional teeth and the projection of the lower

* Zoolog. Bull. ii. 1898, p. 39, fig. 7.

jaw beyond the snout of the fish. I have been inclined to believe that the presence of these two characters is sufficient to distinguish *Saurodon* as distinct. However, I observe in some specimens of this supposed genus that some of the notches become closed into foramina; and we can easily imagine all gradations between notches and foramina high above the alveolar margin. Moreover, it is probable that the other character will fail. Recently Mr. Stewart* has published figures, without description, of remains which he refers to Cope's *Saurodon phlebotomus*. Mandible and maxilla are shown. Measurements show that the maxilla, without the premaxillary, is nearly as long as the alveolar border of the mandible, so that it is almost certain that in this species there was no projection of the dentary beyond the snout. It seems probable, therefore, that *Saurodon* must be abandoned.

I present here (fig. 5) the right maxilla and the premaxillary (fig. 4) of another species of *Saurocephalus*, which I regard as yet undescribed. It is especially distinguished from described species by its elongated maxillary bone. To

Fig. 5.



× $\frac{1}{2}$.

illustrate this, I compare it with Mr. Stewart's *S. dentatus*, which is itself a species with a rather long maxilla. In *S. dentatus* the total length of the maxilla is 142 millim., its height at the palatine condyle 48.5 millim. My specimen has the same height at the condyle; but the total length is 172 millim., a difference of 30 millim., equal to 21 per cent. of the shorter maxilla. My species, therefore, probably had a relatively slender head and a larger mouth than had *S. dentatus*.

In the maxilla figured I count alveoli for thirty-seven teeth; but in the maxilla of the other side, somewhat broken,

* Kan. Univ. Quart. vii. pl. xvi. figs. 4, 5.

the teeth extend backward somewhat farther, so that there must have been forty. At some time in the career of its owner the right maxilla has been fractured obliquely across its middle, and this accident has affected the neighbouring teeth. One of these has thus become exposed nearly half-way to the tip of the fang. This exposure reveals the fact that the fang is faceted, as it is in *S. lanciformis*. The great length of the maxilla distinguishes this species from both *S. lanciformis* and *S. dentatus*, and the facets on the teeth distinguish it from Cope's *S. arapahovius*. Mr. Stewart has not described the condition of the fang of the teeth of his *S. dentatus*.

In fig. 5 *p.c.* represents the palatine condyle; *p.c.'* the anterior palatine condyle which was applied to a surface like that shown in fig. 3 at *mx*.

I propose to call the fish above described *Saurocephalus pamphagus**.

It has been supposed that the foramina, situated one opposite each tooth and on the mesial face of the maxilla and of the dentary, are for the transmission of nerves and vessels to the teeth. Richard Owen† seems not to have so regarded these foramina. He believed that they "lead to the cavities containing the germs of the successional teeth." The latter probably began their development in, or at the bottom of, these foramina; but they soon passed more deeply into the bone. In fig. 1 at *t* there is found a developing tooth whose tip is on a level with the row of foramina; but its root extends high up into the bone. Nerves and vessels entering the tooth by way of the foramina alluded to would have to take a very tortuous course. The functional tooth immediately below the young tooth figured seems already to have suffered some reduction of its fang.

The germs of the teeth of the Saurocephalidæ did not gain a lodgment in the bones of the jaws in the same way that the teeth of the higher vertebrates did. In the latter the fangs were first planted in grooves in the dental borders of the bones; and we must suppose that these grooves, at first shallow, have, in successive generations, deepened and become portioned off to form sockets. In the Saurocephalidæ the teeth, developing originally on the dental border, have gradually migrated away from this border, on the mesial face of the supporting bones, and, by means of the foramina described above, have made their way through the mesial wall

* Inde ruunt alii rapida velocius aura,

Pamphagus et

OVID, *Met.* Bk. iii. l. 209.

† Odontography, p. 131.

of the sockets. The notches found in the species referred to *Saurodon* show the earliest stages of this migration.

The distinguished palæo-ichthyologist, Mr. A. S. Woodward, has recently kindly called my attention to a suggestion made by Prof. E. D. Cope that the Saurocephalidæ are closely related to the Chirocentridæ, represented by the large *Chirocentrus dorab* of the Chinese and Indian seas. I have unfortunately had no opportunity to study a skeleton of this fish; but, judging from the figures of the fish found in Cuvier and Valenciennes, pl. 565, and in Day's 'Fishes of India,' pl. clxvi. fig. 3, its external appearance must be much like that of the extinct *Xiphactinus*. Nevertheless, we have no intimations that the teeth of *Chirocentrus* are fixed to the jaws in any way different from those of ordinary fishes. The fixation of the teeth in sockets is an unusual thing among fishes; and this character alone, it appears to me, is sufficient to remove *Xiphactinus* and its allies from the Chirocentridæ, although not necessarily to a great distance. I suspect that the Saurocephalidæ will, when they are better known, show distinctive characters in the vertebral column also.

LXVI.—*Note on Scapanorhynchus, a Cretaceous Shark apparently surviving in Japanese Seas.* By A. SMITH WOODWARD, F.L.S.

IN his paper on the Cretaceous fishes from Mount Lebanon published twelve years ago *, the late James W. Davis gave an unsatisfactory description and figure of a remarkable new shark under the preoccupied generic name of *Rhinognathus*. He pointed out some of its principal characters, and, notwithstanding the demonstrated presence of an anal fin, placed the fish in the family Spinacidæ. In 1889 †, after a detailed study of the fine series of specimens in the British Museum, the present writer published an amended definition of the genus under the new name of *Scapanorhynchus*, placing it in the family Lamnidæ close to the well-known existing genus *Odontaspis*. The dentition was shown to be identical with that of the latter genus; but other characters, such as the slenderness of the fish, the peculiar elongation of the rostrum,

* J. W. Davis, "On the Fossil Fishes of the Chalk of Mount Lebanon, in Syria," Trans. Roy. Dublin Soc. [2] vol. iii. (1887), p. 480, pl. xiv. fig. 4.

† A. S. Woodward, 'Catalogue of Fossil Fishes in the British Museum,' part i. (1889), p. 351.