

Palaeontology. — "*Apateodus Corneti* (For.) in the Senonian beds of the Southern part of Limburg (Netherlands)." By P. KRUIZINGA. (Communicated by Prof. G. A. F. MOLENGRAAFF).

(Communicated at the meeting of December 29, 1923).

Some time ago an extremely well-preserved skull of a fossil teleostean, which was in possession of Mr. HUB. LEUFKENS¹⁾ of Heerlën, was found near Valkenburg in a small quarry in the chalk with *Belemnitella mucronata* Schloth.

In this specimen (fig. 1—4) only a few portions of the opercles and of the cheek plates have during the decay shifted from their normal position, whereby some have got lost. During the fossilization the skull was not flattened, but slightly pressed obliquely towards the right, so that all the bones are still connected in their normal relative position. While the skull was being extracted from the rock the whole was only slightly damaged.

First of all the matrix was prepared away on all sides, wherever it was possible to do so without interfering with the entire fossil. Thus on the left the nasal cavity and the orbit were cleaned and because the hyomandibular had been damaged a little on that side, this bone was also cleaned on the right side. Ipsilaterally the portions of the opercles were laid bare. Where it was possible, the teeth on either side were exposed. This could only imperfectly be done on the right side, because it was desirable to spare the remains of the premaxillary preserved on that side. At the lower surface the hyoid arch was carefully prepared out from the matrix, as was also the posterior part of the right half of the occiput. In doing so three vertebrae became visible in situ. Scales were not distinguished.

At first glance this skull from Valkenburg somewhat resembles that of a pike, especially when viewed from above; here also the snout is rather obtuse, but it is relatively shorter. Postero-anteriorly the width diminishes gradually. A lateral view of the skull shows that it is slightly flattened. Longitudinally the upperside of the skull is quite straight, transversely the cranial roof is flat between the eyes; behind, as well as before the eyes it is gently rounded towards either side. The occiput is concave, because the

¹⁾ When this communication was already in the press we obtained the skull from Mr. LEUFKENS for the collection of the Geological Museum at Delft, where it is now placed. (N^o. 1273 Ned.).

pteroics project further backwards than the epiotics and the supra-occipital. It is almost vertical to the cranial roof.

The full length from the end of the snout to the posterior extremity of the existing remains of the opercula is 19.2 cm. It may be observed here, that of the opercula only small portions of a width of a few millimeters are lacking. The length of the upper side of the skull is 13.2 cm. The length of the mandible is 13.3 cm. Its suspensorium is, therefore, located just beneath the occiput, so that the mouth, which displays a large number of minute and large teeth, is very wide. The vertical extent from the top of the supra-occipital to the underside of the mandible is 9.4 cm. on the left, and 8.6 cm. on the right side. The height of the skull is in the middle at the back 3 cm. The width is at the back 5 cm., in the middle over the eyes 4.1 cm. and at 1 cm. from the snout it still attains 2.2 cm.

The orbit is almost circular and open towards the back, because the set of circumorbitals has almost entirely disappeared here. The hinder border is marked by a downward prominence of the sphenotic. The anterior border is removed 5.6 cm. from the snout, so that the orbit is located about half way between the snout and the occiput. The height is 4.1 cm., the length is about 4.5 cm. and the depth about 2 cm.

Before the orbit we still distinguish a smaller oblong pit, viz. the nasal cavity measuring $2.6 \times 10 \times 7$ mm.

At this skull the following bones were observed :

supraoccipital,
 pleurooccipital,
 basioccipital,
 epiotic,
 pterotic,
 sphenotic,
 prootic,
 alisphenoid,
 basisphenoid,
 parasphenoid,
 orbitosphenoid,
 pleuroethmoid,
 mesethmoid with nasalia,
 frontal, (preserved partly as an impression)
 vomer,
 palatine, (left and right, with one fang)
 ectopterygoid, (left and right with one fang)
 entopterygoid,

metapterygoid,
 hyomandibular,
 quadrate,
 symplectic, (only on the left)
 maxillary, (chiefly as an impression, the left one is very fragmentary)
 premaxillary, (the left one with three minute teeth and traces of
 two, the right one a single toothlet)
 dentary, (partly as an impression, the left one with six teeth, the
 impression of one tooth and traces of a couple, the right one
 with eight teeth and traces of a few others)
 articulary,
 angular,
 stylohyal, (only the left one is visible)
 epihyal,
 ceratohyal,
 basihyal,
 preoperculum, (only the left one)
 operculum, (only the left one)
 suboperculum,
 interoperculum,
 branchiostegals, (only the right ones)
 postorbitals?

At the back of the occiput there are still the first three vertebrae. Of the bones arranged in pairs both specimens are present, unless otherwise stated.

Of this species large and small fragments have repeatedly been detected, as is apparent from those occurring in several collections in our country and also elsewhere¹⁾; the detached teeth have in this connection been left out of consideration. We shall now give a short description of such remains as are in any way generally important. I deemed it desirable however, to add a complete picture of the anatomy of a skull of this species by utilizing all the collected data.

¹⁾ I gratefully acknowledge my indebtedness to Prof. ESCHER of Leyden, Prof. DOLLO of Brussels and Prof. FRAIPONT of Liege, Mr. LEUFKENS of Heerlen and Mr. UMBGROVE, Bachelor of Geology, of Leyden for granting me access to the above-mentioned remains, so that my inquiry could be as extensive as possible. I have much pleasure also in thanking Miss POPTA for allowing me the free use of skeletons of recent fishes in the "Museum van Natuurlijke Historie" of Leyden, and Prof. VAN BEMMELEN, Prof. VAN KAMPEN, Dr. TATE REGAN and Dr. DE BEAUFORT who furnished me with some books and publications that were not instantly accessible.

A fragment of a mandible (fig. 9) from the Upper-Senonian of the Southern part of Limburg that cannot be localized further, is in the Geol. Museum of Delft N°. 1264 Ned. It is an inner aspect of the anterior portion of the right jaw. Its length is 12.2 cm. The dentary, the only portion left, bears a large number of teeth, which will be described in detail on page 307.

At a shattered skull, from the Upper-Senonian of Valkenburg, and present in the Geol. Museum of Leyden (N°. 8594 of the STARING-collection) the following bones can be distinguished: both frontals, right pleuroethmoid, right ectopterygoid with one large tooth 2.5 cm. long, right palatine with an impression of the fang, mesethmoid, vomer, fragments of the right praemaxillary with still a single toothlet, right and left dentary, right and left articulary, left praeoperculum, rather well-preserved and a few not identifiable bone-fragments. The fragment is about 15 cm. long and 11 cm. broad.

A fragment of a skull, a gaping, though compressed mouth (fig. 10) found in a quarry in the Upper-Senonian at the road from Valkenburg to Sibbe, was lent me by Mr. UMBROVE. Its length is 10 c.m, its height 5 cm. First of all we distinguish here: fragments of the right and left ectopterygoid with a few teeth. The posterior portion of the left ectopterygoid is beautifully preserved. In this bone 4 teeth are found that will be fully discussed lower down on page 306. In front of it we observe the apex of a larger one; the right ectopterygoid exhibits only a portion of a large tooth corresponding to the last-mentioned tooth in the left ectopterygoid. Of the mandible portions of left and right dentary are extant, the anterior portions are lacking. The left dentary is very solid. It displays the hinder border of this bone and contains still 4 teeth of various sizes. Of a couple of other teeth the apex has broken off. The right dentary is seriously damaged and partially preserved as an impression; it only contains the 3 teeth that correspond to the three front-teeth of the left dentary. The left articulary displays a large portion of the joint for the mandible, the right one is merely visible as an impression. Of the hyoid arch epihyal, ceratohyal and perhaps still remains of the anterior bones have been preserved.

Two of the fragments preserved in the Musée Royal d'Histoire Naturelle of Brussels will be discussed now in more detail, first of all a fragment of a skull from the Upper-Senonian of Künrade N°. I G. 6921, belonging to the UBAGHS collection. This fragment is of special interest because the whole occiput and the major part of the sidewall of the skull have been very well preserved, while at the same time the sutures between the different bones are

clearly visible (fig. 12 and 13). The width at the occiput is 3.7 cm. We see here the supraoccipital, both pleurooccipitals with the foramen magnum, the basioccipital, both epiotics, both pterotics and the two overlapped posttemporal grooves. At the left side of this skull-fragment we see also of the other cranial bones the prootic, the sphenotic and a portion of the parasphenoid. As regards the perforations the foramina in the prootic and in the pleurooccipital are conspicuous. At the dorsal side we finally observe fragments of the frontals. Here also the suture between the supraoccipital and the frontals is very distinct. The length of this piece is 5.5 cm. In the second place I mention a skull, originating from the BOSQUET-collection N°. I G. 4289 and found in the flintbearing tuff chalk of Valkenburg, of which the posterior portion has for the greater part disappeared (fig. 11). The length of the whole fragment is 13 cm. The mouth is slightly open, so that the matrix could be removed. The anterior portions of the frontals, the parasphenoid, the left pleuroethmoid, the mesethmoid, the vomer, the two palatines each with one fang were still present. The right palatine is partially damaged. We also distinguish the two ectopterygoidea with a few teeth and the left entopterygoid, besides fragments of the two prae-maxillaries with 8 toothlets. The small fragment of bone lying in the orbit may be a portion of the right entopterygoid. In the mandible remains of the dentary are found on either side, on the left with some eleven teeth and on the right with ten, those in front being the smallest, and also the articulary. The greater part of the latter is merely an impression. Of several of the other bone-fragments some remains still exist here or there.

Lastly we have still to record the fragment, described by Forir as *Enchodus Corneti* (fig. 7 and 8). It is derived from the lowermost Maestricht Chalk of Valkenburg and is in the Geol. Museum of Liege. Unfortunately it was held upside down, so that the mandible has been described as an upper jaw. Consequently the figures and the description of this fossil have also to be altered. The back portion of the skull is quite absent and the snout is slightly damaged. The fragment is 7.3 cm. long, its breadth at the back is 3,8 cm., the height is 3.3 cm. The anterior rest of the parasphenoid, the vomer (chiefly as an impression), nasals^(p), the two palatines are still recognizable. Of the fang of the right palatine only the impression is visible, that of the left palatine is present, but is slightly removed from the front. A fragment of the right ectopterygoid still contains a single large tooth of the length of 2.5 cm., that sticks out through the mandible; the left one has a similar tooth with

two smaller ones behind it. The left praemaxillary has seven teeth while the impression of an eighth is noticeable; the right one has eight of them. Of the mandible parts of the two dentaries have been preserved: the left one with six teeth, three more are scattered among them having got loose from their original location; the right one has still five teeth, an additional detached tooth lying near. Of the left articulary probably the anterior portion is left. Finally a few fragments of the hyoid arch are to be seen, which probably are remains of the ceratohyals, the hypohyals and possibly of the basihyal.

In consideration of the size of the bone-fragments of all the remains described in this paper, we are bound to assume that all, except perhaps that of fig. 12, are derived from fishes of about the same size.

The less important remains, which I found in the Geol. Mus. of Leyden, were a symphysis of a mandible from St. Pietersberg, a fragment of a right half of a mandible found near Valkenburg and a few pieces of bone (ectopterygoid) with teeth from St. Pietersberg, and in the Museum at Brussels I saw two skull-fragments from Kunrade, a skull-fragment from Valkenburg and a portion of a mandible, found between Huls and Simpelveld. These latter fragments are like the preceding ones derived from the Upper Senonian and presumably from the lowermost stratum of the Maestricht chalk.

We shall now proceed to a more detailed description of a skull of uniform size to the first-named specimen.

A considerable portion of the supraoccipital constitutes part of the occiput, while another portion about equal in size belongs to the bones of the cranial roof. The first is a rather stout, more or less hexagonal, concave boneplate which attains a height of 1.2 cm. and a width of 1.6 cm. At the top the crista extends backwards as a rodshaped bone, 4 mm. in length. The other portion is slightly triangular and 1.3 cm. long. The sutures between the supraoccipital and the contiguous bones of the occiput are straight and well displayed as, indeed, are all the other sutures of the occiput. On the other hand those between the upper part of the occipital and the adjacent bones of the cranial roof are not so conspicuous.

The two pleurooccipitals enclose at the hinder part of the skull the foramen magnum and together with the basioccipital they also help to form the base of the cranium. The portion of the pleurooccipital that constitutes part of the occiput is apparently robust and also hexagonal. It attains a height of 1.3 cm. and its largest

width is 1.6 cm. Right at the lower end of each there is a short process which overlies as a zygapophysis the body of the foremost vertebra. The other portion of these bones is about vertical to the first and is quadrangular, its length and height being 8 mm. Near the hinder margin it comprises the slightly oblong foramen of the nervus vagus (X). The foramen magnum is gently rounded, of triangular shape; its height is 5 mm., it is widest at the base (8 mm.).

The basioccipital fits to the first vertebra with an elliptical face. Its height is 8 mm., its width 11 mm. It extends to a length of about 11 mm. along the base of the skull and is at its lower side provided with two keels that increase in width anteriorly.

On either side of the supraoccipital are the epiotics along the upper border of the occiput. They are more or less rhomboidal and stout bones. They do not form, as is often the case, distinct processes, but are slightly curved outwards in some places. The height is 8 or 9 mm., the width 10 mm. Their postero-superior aspect is triangular, measuring 5 mm. by 10 mm. It is these bones that Hay mistakes in *Empo nepaeolica* Cope for parietals (9 page 85 fig. 69).

Opisthotics are evidently lacking.

The pterotics are located at the upper side of the cranium, anterior to the epiotics and lateral to the frontals and the supraoccipital. To a smaller extent, however, they also go to form the lower side of the cranium and the occiput. These three parts are all approximately quadrangular. The pterotics make up the two exterior processes of the occiput, which, though not being very long, stretch farther backwards than the epiotics and the crista of the supraoccipital. The superior aspect of the occiput is, therefore, slightly concave. Moreover the upper part of the pterotics has roofed the posttemporal grooves, which are found on the left and on the right between epiotic and pterotic. Together with the contiguous sphenotic the lowermost piece of the pterotic supports a facet for articulation for the hyomandibular. The upper part of the pterotics is 2 cm. by 2.1 cm., the lower part is 8 cm. wide. The piece forming a part of the occiput is 8 mm. by 6 mm., and borders on the pleurooccipital and on the epiotic.

The sphenotics are very irregularly shaped bones, flanking the frontals and obliquely superior to the orbit. Posteriorly they border on the pterotics. Their shape somewhat resembles that of a trilateral pyramid, as they curve round the side of the cranium as well as round the rim of the orbit. The apex marks the hinder border of the orbit. Thus in front they are part of the wall

of the orbit; as we saw before, on either part a portion forms together with the pterotic a facet for articulation for the hyomandibular. The length along the rim of the orbit is 1.6 cm., along the side of the cranium 1.8 cm., and along the wall of the orbit they are produced 1.2 cm.

The prootics are lying in the lateral walls of the cranium. Superiorly they border on the sphenotics and the pterotics, posteriorly on the pleurooccipitals and inferiorly on the wing-shaped appendices of the parasphenoid. They are pentagonal or hexagonal bones, 1.2 cm. in height. The width is only little greater. They are pierced by a few conspicuous foramina, one for the nervus trigeminus (V), a second for the nervus facialis (VII), while the others transmit various bloodvessels.

The parasphenoid is very long. The hinder part is contiguous to the basioccipital at rather more than 1 cm. from the occiput; anteriorly it still overlaps the hinder part of the vomer. Its length is certainly about 10 cm. At the hinder part the parasphenoid is provided with a couple of wings which, as we observed before, are connected with the prootics. The height is here 1.1 cm., which diminishes anteriorly rather rapidly, but before the wings disappear altogether we still find on either side of the parasphenoid a narrow rodshaped bone, which is at the top attached to the prootic. This leaves on either side a rather wide opening between the wing of the parasphenoid, the prootic and the rodshaped bone. The opening between these bones of the left and the right side is 1.2 cm. in height and 1 cm. in width. Where the wings end, the aspect of the parasphenoid is a transverse section of triangular form (height 3—4 mm.), and right in front it terminates as a thin, gutter-shaped, excavated bone.

The Y-shaped basisphenoid is lying a little in advance of the prootics on the middle of the parasphenoid, and in front of the opening just described (myodoma) at the very spot where the wings of this bone have disappeared. Its inferior part is constituted by a boneplate, measuring 1.4 cm. in length and 0.4 cm. in width. It is connected to the alisphenoid and the prootics by means of the two upper prongs which are much shorter. The total length of the basisphenoid is 1.8 cm.

The alisphenoids are of a very irregular shape. At the base they are very narrow, but further upwards they largely increase in width, inclining outwards, so that they help to form the roof of the orbit. The greatest length is \pm 2 cm., the width 1 cm. Their hinder part borders on the prootics, their upper side on the sphenotics, while between

The right and the left alisphenoid and the prongs of the basisphenoid we can still distinguish the opening for the forward moving blood-vessels, the nervus olfactorius (I) and the nervus ophthalmicus (II). Anteriorly the alisphenoids border on thin, plateshaped bones, which form part of the roof of the two orbits and proceed further as a united, unpaired orbitosphenoid, which descends as a semi-circular plate in the non-ossified interorbital septum. The height of the vertical plate is about 1 cm., its length 1.7 cm.

At first the pleuroethmoids seemed to be short dumb-bell-shaped bones, 1.2 cm. in length and with a median thickness of 6 mm. They are situated anteriorly to each of the orbit between frontal and the arch of the palatine and pterygoids. On further preparation they proved to extend further inward into the front wall of the orbit and into the hinder wall of the nasal cavity, as far as the parasphenoid, so as to approach each other from both sides. The shape and the surface of these inwardly inclined wings are very irregular, their width is 1.3 cm.

The mesethmoid is a small bone (± 2 cm. in length) tapering anteriorly, and hemming in the V-shaped anterior end of the frontals. On either side it passes almost imperceptibly into an oblong bone, which overlies in front the palatine and is continued backward as far as the nasal cavity. This bone I, therefore, look upon as the nasal. Its length is 17 cm., its width 0.7 cm.

At the dorsal side of the cranium the frontals are by far the largest bones. The longitudinal suture between them is very conspicuous. Posteriorly they adjoin the supraoccipital and in front they come very near to the snout. So they are not separated from the supraoccipital by the parietals, as A. SMITH WOODWARD maintains for very closely related species (6 pl. 54 fig. 4a p. 246). He is presumably also wrong in representing the condition as on 6 pl. 11, fig. 1b and 8 page 216, since from this it would follow that the parietals are separated from each other through the contiguity of the frontals and the supraoccipital. So far as I can judge from the material at my disposal the parietals are lacking. The frontals attain a length of 10.4 cm. They attain their greatest width just behind the eyes where they are together 4 cm. in width. From this point backward they decrease in width rapidly though not very regularly. Anteriorly the width decreases only slowly. They hang over the eyes like a sheltering roof. On the surface there are a great many striae, which are still more conspicuous on the interior of the cranium than on the outward surface and which can be observed also in related species. All these striae radiate to all sides

from the centra of ossification postero-superiorly to the eyes, thus forming in the middle of the head a large number of more or less rhombic figures. All other ornamentations are lacking.

The vomer is a much elongated, lancetshaped bone, with a longitudinal groove in the middle. In front of the snout it is visible under the frontals; its hinder part still is covered by the anterior portion of the parasphenoid. Its width is 4 mm., its length probably more than 4 cm.

The visceral skeleton articulates on either side of the cranium by a stout hyomandibular with the pterotic and the sphenotic. The surface of articulation is 2.8 cm. long and 4 mm. wide. Inferiorly the hyomandibular is first narrowing a little, but it soon gets broader again, the anterior margin being all along regularly rounded, while the hinder margin is cut obliquely. Downward it splits up into three branches, the hindmost being the first to appear. This branch is slightly inclined towards the inside; it is small, thin and probably connected the hyomandibular with the opercular. The median branch is short and tapers inferiorly. Its posterior side is straight and was originally lying along the anterior margin of the preoperculum. Between this median branch, the anterior one, the preoperculum and the symplectic there is a wide open space. The anterior branch is the largest. It is slightly bent and suturally united with the metapterygoid. Antero-superiorly to the hyomandibular a low crista is seen to begin, which is curving towards the open space just now alluded to.

The metapterygoid is a thin bone plate, 2.8 cm. by 1.7 cm., and is provided with a vertical ridge at the concave upper margin. The angles are considerably rounded off. Beneath this bone and also adjoining the hyomandibular the quadrate is observed. It is a rather stout bone, more strengthened still in some places; its general form is more or less triangular. The hinder margin is slightly round and displays a curve, just fit for the symplectic to fill up. The upper and the anterior margins are concave. On the lower end we see the condyle for the mandible. The length of the quadrate is 2.5 cm.; the greatest width 2.4 cm. The symplectic running along the hinder margin of a quadrate in the just-mentioned curve, is probably a rodshaped bone, of which we cannot determine the dimensions, since part of the only specimen that came to our notice has underlapped the quadrate.

Of the pterygoids the ectopterygoid is the principal. It extends from before the snout to the quadrate at the back, so that its length is 9 or 10 cm. A side-view shows that it is bent somewhat sig-

moidally and antero-posteriorly it first broadens towards the anterior margin of the orbit, below the orbit it is narrow, but afterwards it broadens again. Quite at the back it is about 2 cm. in height. Anteriorly the ectopterygoid is getting rather slender towards the end. Along the upper rim of the anterior part of the ectopterygoid a plate is running on the inside bearing a number of stout teeth. Its thickness is not considerable, only ± 1 mm., antero-posteriorly it gets narrower and disappears in the middle below the orbit.

The entopterygoid resembles in shape a triangular, bellying sail. Its length is 4.2 cm., its width, which is greatest at the back, is 1.8 cm. It extends from the metapterygoid to close to the pleuroethmoid. The lower margin adjoins completely the superior and internal margin of the ectopterygoid. The upper margin runs up to 6 mm. from the parasphenoid.

It is very likely that the palatine stretches as far as the pleuroethmoid. It measures 0.7 cm. by 4 or 5 cm. A fang is implanted in front. This part of the bone is stout and slightly tumid, antero-posteriorly it passes into a thin, porous boneplate, which is provided with a number of longitudinal tubes ± 1 mm. in diameter. The foremost portion of the ectopterygoid is covered by this plate.

Of the bones in the upper jaw the premaxillary is the smallest. It is a thin more or less elongated boneplate, leaning on the palatine and the ectopterygoid. The upper rim is rounded, the lower one, on which a number of teeth are implanted, is slightly concave. From a little behind the anterior part of the palatine it extends to a little beyond the pleuroethmoid. The maxillary on the other hand is drawn out to a great length, rather narrow and thin. It has probably attained a length of 10 cm. and certainly not wider than 5 or 6 mm. No remains of a supramaxillary have been found. Only a few indications have been found of a series of circumorbitals, such as are described by A. SMITH WOODWARD (p. 246, pl. 54) of *Apateodus striatus* A. S. Woodw., an allied species from the English Chalk. These indications consist in small bone-fragments in the orbit.

The mandible. In each branch of the mandible there are three bones, viz. dentary, articulary, and angular. No indications have been found that there should have been more of them originally. Its length is ± 13.3 cm. The shape is typical. Both halves display only a slight curvature in their long axis and they run nearly parallel over a long distance. Superiorly downward they are, moreover, slightly rounded. The hinder margin is vertical, the superior angle is rounded off. A little before the posterior end the height is greatest, viz. 2.8 cm., or $\frac{1}{4}$ of the length. Anteriorly it is constant

all along the posterior half of the jaw, but then it decreases evenly, a little more rapidly at the symphysis. At the back we see two processes. The lowermost, which is the smallest, forms the infero-posterior angle; a little above it is the condyle.

The *dentary*. This bone is by far the largest of the bones in the mandible. On the whole it is not thick, especially the inferior portion. The upper border is sharp, but it is slightly thickened in the anterior half where the teeth are situated. It extends backwards over a considerable distance, as it forms the whole of the upper border and of the lower border only ± 2 cm. remains free at the posterior end. The posterior border of the dentary runs obliquely forwards from the lower border, then it bends round sharply and ultimately proceeds posteriorly in horizontal direction.

The *articulary* is a rather elongated, triangular bone. Its length is 7.6 cm. Its width behind is 2.3 cm. Infero-posteriorly we see the long process, ± 8 cm. in length, with the articulating surface. This portion of the bone is slightly thickened, while also a thickened strip extends forwards from the condyle. As appears from the above, only a small portion of the articulary is not covered by the dentary, viz. a more or less quadrangular piece of $\pm 1\frac{1}{2}$ by 2 cm. The remainder wedges itself behind the dentary.

The *angular*, the smallest of the bones of the mandible, is only ± 1 cm. long and 3 mm. wide. It forms the inferior angle and sticks out backwards as a process of about 2 mm. in length.

The *hyoid arch*.

The *stylohyals* are small rodshaped bones, a little thicker at the lower side than at the upper. Its length is ± 8 mm., the greatest thickness ± 3 mm. The *epihyals* are a pair of flat bones broadening anteriorly. The greatest width is $\pm 1\frac{1}{2}$ cm., the length $2\frac{1}{2}$ cm., and the thickness ± 4 mm. The *ceratohyals* are rather long and bent slightly inwardly. Posteriorly they attain a height of 1.5 cm. At the extremities they are slightly thicker than in the middle viz. 4.5—5 mm. The length is 4.7 cm. The *hypohyals* are only 8.5 mm. in length, their thickness amounts to ± 5 mm. and their width is 1 cm. Of the foremost bone, the *basihyal*, only a horizontal section was observed. It is triangular in form, its width is ± 6 mm., its length about 4 mm.

Four of the *branchiostegals* have been preserved. They are thin, considerably elongated boneplates impinging on one of the *epihyals* and under the *interoperculum* and *suboperculum* still present there. The width cannot be observed, but it is certainly ± 1 cm. The length of the upper *branchiostegal* is 4.5—5 cm.

The opercular apparatus is complete, four opercles on each side. The preoperculum is approximately level, only along the anterior border the superior part is bent slightly outward. It is a rather large boneplate, approximately semicircular in circumference. The upper part of the anterior border, which was connected to the hyomandibular, is straight, the remaining part is curved. Most likely the height was 7 cm., the width ± 3.5 cm. The centre of growth is located anteriorly in the lower part. Here the bone is also thickest and from here a small number of fine lines radiate out to all sides. For the rest the surface displays only faint, concentric lines. The shape of the opercle is not well definable, the best-preserved specimen being broken in different places. However, from the concentric lines of growth we may conclude that the circumference has been more or less oval; the anterior, and the upper borders were curved less than the other sides. The width is ± 3.5 or 4 cm., the length $\pm 5\frac{1}{2}$ cm. The subjacent suboperculum is, as far as the upper and the anterior border are concerned, covered by the other bones. It seems, however, that this bone is more or less triangular with truncated or rounded angles. The length is ± 6 cm., the width 3 or 4 cm. Fine concentric lines of growth are present. The interoperculum adjoining the mandible has a concave border at its front, where the thin boneplate is slightly thickened. The shape is oblong, the angles are rounded off. The width is $1\frac{1}{2}$ cm., the length 3 cm. On the surface there are a number of fine striae to be distinguished, which radiate from a point very near to the anterior border.

As stated above, the teeth are situated at the palatines, the ectopterygoids, the premaxillaries and the dentaries. They not only vary in shape and size according to the various bones on which they are implanted, but also the teeth of one and the same bone are very different. Where teeth are implanted, the bone is slightly tumid. The palatine bears only one large fang, which may be subterminal, or at ± 1 cm. from the anterior end, a difference that may occur at one and the same skull, and that, to my judgment, is due to the teeth not being shed contemporaneously. The apex is turned to the inside. The tooth has fused with the bone, its base being thereby broadened, it is bent backward like a sickle and tapers to a sharp point. To the right and to the left it is flattened, at the base less than towards the apex. The transverse section is consequently rather oval-shaped at the base; towards the top the anterior and the posterior edge soon gets sharp. The upper surface is glistening and provided with delicate longitudinal striae, which are most

conspicuous at the base. Where they are sharp, the anterior and the hinder edge are on either side provided with fine, transverse grooves, by which they are finely serrated. At the base the dimensions of the transverse section are ± 3 and 4 mm. The length of such a tooth is $\pm 1,1$ cm.

The ectopterygoid bears a small number of teeth, which have grown together with this bone with a broadened base. Before the pleuroethmoid there may perhaps be two, rather widely spaced. (See also 6, pl. 11, fig. 8, fig. 3, and fig. 4. The portion under consideration, however, is designated there as palatine). The foremost of these teeth was not present in any of the specimens at my disposition. The other is located obliquely below the pleuroethmoid. Its length is about 2.5 cm., its width 7 mm. In the fragment originally described as *Enchodus Corneti* For. its point sticks through the lower jaw. The shape is dagger-like. At the base the transverse section is again oval, and towards the tip the tooth is flattening more and more on both sides. The anterior, and the hinder edges are both sharp and provided with fine transverse grooves. For the rest only longitudinal striae are to be seen on the glistening surface, which are most distinct at the base just as with the fang of the palatine. The other teeth of the ectopterygoid are all smaller, their size decreasing towards the end of the series. On the whole, however, all the teeth of this bone agree fairly well as to the shape. The spaces between them differ according as old teeth have or have not been dropped and replaced by new ones, so that also the number may be different. All of them have their apex turned slightly inwards.

Dimensions of the teeth of the ectopterygoid (without the base) of the fragments represented in fig. 7 and 10.

	length mm.	width mm.
1 st tooth (fig. 10)	25	7
2 nd tooth (fig. 7)	18	6,5
3 rd tooth	9	4,5
4 th tooth	9	4
5 th tooth	6	3,5

The premaxillary bears only some very small teeth. I counted 8 at most (type spec. of *Enchodus Corneti* For., on the right premaxillary). They are implanted on the lower border of this bone at various distances from each other and are more turned inwards than the preceding. On either side they are slightly flattened, so that their anterior and their hinder edges are sharp. The surface again

presents fine, longitudinal striae. The length ranges from $1\frac{1}{2}$ to 2mm. and at the base the width is ± 1 mm.

The dentary bears the greatest number of teeth of largely differing sizes. They form one series on a thickened ridge that runs internally just below the upper border, as is also the case with the teeth of the ectopterygoid. In front near the symphysis we invariably find some very minute teeth, about five in number. Behind them we observe a tooth that is a little larger and then follow the two largest teeth of the mandible; the teeth behind them are smaller again. Their size, however, does not decrease regularly; the hindmost, however, are very small. Their distances are varying for the reason mentioned before, so that also their number may vary. Only the anterior half of the dentary bears teeth. The mandible illustrated in fig. 9 presents more teeth than any other represented.

Counting backwards these teeth are of the following dimensions:

	length (mm.)	width (mm.)
1 st tooth	1	0.5
2 nd tooth	1	0.5
3 rd tooth	1	0.5
4 th tooth	1	1
5 th tooth	4.5	2
6 th tooth	10.5	4
7 th tooth	12	5
8 th tooth	5 to 6	3
9 th tooth	5	3
10 th tooth	8	4
11 th tooth	7	4
12 th tooth	1	1

So far as it can be ascertained all the teeth in the dentary are slightly curved backward. The inner, and outer faces are flattened, the outer face most. The diameter at the base is oval. The anterior edge above the base is sharp; the hinder edge on the other hand is rounded, except at the tip, where it also becomes sharp. The transition is marked by a slight notch in the hinder edge, which imparts to these teeth a recurved appearance, that we could also distinguish at the teeth of the ectopterygoid of *Cimolichthys*. Whether this feature belongs to the small teeth in the mandible as well as to the large ones, was not ascertainable. At the anterior edge we observe again the fine, transverse grooves. We see them also at the sharp portion of the hinder edge. The teeth of the mandible again are ornamented with fine, longitudinal striae.

Of the vertebrae only the first three are known for certain. The foremost is not so long as the two following, its length being only 4 mm., whereas that of the second is 6 mm., and of the third 7 mm. The diameter is invariably about 1 cm. There is, moreover, another difference: along the circumference of the foremost vertebra there are only two depressions, separated from one another by a broad strip. The other two have three deeper depressions, separated by rather narrow horizontal ridges. The vertebrae are amphicelous. The neurapophyses are ± 4 mm. in width. Their length was presumably $\pm 1\frac{1}{2}$ —2 cm. Apparently the neurapophyses were not coalesced with the vertebrae, from which they are evidently separated by a little of the rock. Such a residue is always found wherever bones are united by tissues that were originally softer (see e.g. the hyoid arch). The zygapophyses are small and were partially broken off while preparing them out.

As observed before, FORR (3) named one of the fragments described in this paper *Enchodus Corneti*.

When we consider the characteristics of the genus *Enchodus* as they have been described by AGASSIZ (1 page 64) and by A. SMITH WOODWARD (8 page 190 and 6 page 55), FORR's pronouncement appears to be erroneous. For the sake of comparison I quote the following important passage from the work of the latter author:

"Trunk elongate-fusiform, both this and the head laterally compressed. Cranial roof exhibiting a deep median longitudinal depression its lateral and occipital margins ornamented, like the other external bones, with ridges and tubercles of ganoine. Mandible a little prominent, provided with an inner widely-spaced series of large slender teeth, the largest in front, also a marginal series of minute teeth, all nearly or completely solid; premaxilla in the form of a vertical lamina, deepest in front, tapering behind, and with a single spaced series of small teeth; maxilla long and slender, either finely toothed or toothless at the oral border; palatine thickened and tumid, with only one large tooth fixed at its anterior end; ectopterygoid robust, with a single spaced series of large slender teeth, gradually diminishing in size backwards; no teeth barbed. Preoperculum very narrow and deep; operculum strengthened on the inner side by a ridge extending horizontally backwards from the point of suspension; branchiostegal rays about 12 to 16 in number".

Now, none of the bones of the cranium of the species here described, is ornamented with tubercles of ganoine, while the mandible

has only one series of teeth, the smallest in front, the largest behind them and the preoperculum is broad. Furthermore, the vertebrae of *Enchodus* appear to have only two depressions on each side (10, p. 184), while, with the exception of the foremost, the others have three grooves. However, the species agree in that also *Enchodus* has decidedly barbed teeth; only they are not so well developed. The mandible of *Enchodus Faujasi* Ag. bears teeth, more or less S-shaped and flattened laterally. All along the anterior edge these teeth are sharp; of the posterior edge only the upper third is sharp. Transverse grooves were not observed along these sharp edges.

A. SMITH WOODWARD has referred the fragments of the species here described, which are in the Museum of Brussels, to the genus *Apateodus* (6, p. 38), as also appears from the accompanying labels written by himself. The report of the various features of this genus must, however, be brought up to date after the latest observations.

Generic characters of *Apateodus*. Skull triangular, the cheeks flat, superior aspect of the snout rather blunt, upper side of the skull straight, occiput a little concave and vertical, no special ornamentation at the bone beyond the lines on the frontals, which are radiating out from points above the eyes, point of suspension of the mandible beneath the occiput, the supraoccipital in contact with the frontals, the supraoccipital possesses only a very small crista, parietals are lacking, an orbitosphenoid, a basisphenoid and a myodome are all there, the palatine bears one fang, and overlaps part of the ectopterygoid, the ectopterygoid has one series of large dagger-like teeth, decreasing in size backwards, their anterior, and posterior edge is sharp and flattened on both sides, as is also the fang of the palatine, the premaxillary bears one series of toothlets and together with the maxillary, constitutes the borders of the upper jaw, height of the mandible one fifth of its length, hinder border vertical, superior angle rounded, inferior angle projecting, one series of teeth, in front small ones, then follow the largest, and then smaller ones again. The teeth of the mandible are also flattened on either side, but the inner face less than the outer face, and they are recurved, anterior edge sharp, hinder edge rounded except at the very tip, where the hinder edge is also sharp, so that it is slightly barbed, preoperculum broad, circumorbital ring present, branchiostegals long and rather broad boneplates, vertebrae provided with grooves, separated by ridges, the anterior one has broad ridges and two grooves, the other has narrower ridges and

three grooves; the foremost vertebra is much shorter than the following.

Up to the present we know only three species of the genus *Apateodus* from the English Chalk, viz. *Apateodus glyphodus*, C. C. BLAKE from the Gault, *Apateodus striatus* (Ag.) A. S. WOODW., and *Apateodus lanceolatus* A. S. WOODW. from the Turonian.

Of *Apateodus glyphodus* C. C. BLAKE only a few jaw-fragments have been found. This species differs from the fragments, described in this paper, in that the series of minute teeth, which are exhibited in the mandible before the larger ones, occupy a much wider space than those in our species; their number also seems greater. From *Apateodus lanceolatus* A. S. WOODWARD our species differs in the position of the teeth in the ectopterygoid (part of which is called palatine by WOODWARD) which do not point forward, but are directed vertically downward or slightly backward. The anterior and the posterior edges of the teeth in *Apateodus lanceolatus* A. S. WOODWARD are straighter and the teeth are also more slender.

The differences between our species and *Apateodus striatus* (Ag.) A. S. WOODWARD are easiest to determine, since also of the latter the remains are much more complete. The two species are readily discriminated by the smaller angle at which we see the snout of *Apateodus striatus* (Ag.) A. S. WOODW. from a lateral aspect, as compared with our species; also by the relatively broader frontals at the upper side of the skull of *Apateodus striatus*, and by the shape of the part of the cranial roof that is made up of the supra-occipital and the hinder part of the frontals (6 pl. 54).

This leads me to conclude that our species differs from the three English species. I, therefore, propose to designate it by the name of *Apateodus Corneti*.

Originally A. SMITH WOODWARD referred *Apateodus* to the family of the *Scopelidae* (8 page 258), but already soon afterwards he has classed this genus under the family of the *Enchodontidae* (6 page 37), a family he thinks to be related to the *Scopelidae*, the *Odontostomidae* and the *Alepidosauridae*. In the manuals of BOULENGER (11 page 611) and of GOODRICH (12 page 399), as well as in that of ZITTEL (16 page 132), we still find *Apateodus* placed in the family of the *Scopelidae*, while in the latest classification of fishes namely that by C. TATE REGAN (13 page 131) we find *Apateodus* classified near the family of the *Alepidosauridae* in the order of the *Iniomii*.

Apateodus cannot belong to the *Scopelidae* because the premax-

illary does not exclude altogether the maxillary from the border of the upper-jaw, and because the supraoccipital is contiguous to the frontals. Neither can it be connected with the *Alepidosauridae*, which do not possess an orbitosphenoid, while the structure of the skull of *Apateodus* does not admit of giving this species another place in the order of the *Iniomi*. I regret not to have found an opportunity to visit London in order to compare with the recent and with the fossil material. However, the properties of this material that have now become known, made me refer *Apateodus*, according to the classification of TATE REGAN, to the order of the *Isospondyli* as defined by him (13, page 77), notably to the suborder of the *Stomiatoidei*, a group of pelagian, physostomous fishes, some of which live at a great depth. Among them he includes e.g. the following families: the *Astronesthidae*, the *Chauliodontidae*, the *Stomiidae*, and the *Malacosteidae*, which possess no or only very small parietals, and of the fossil-fishes the *Enchodontidae*, which as to structure of the skull bear a great resemblance to *Astronesthes* (17, page 613) and the *Stomiidae* (13, page 82). After all, it seems to me, that *Apateodus* belongs to the family of the *Enchodontidae*. This view may be substantiated by a comparison of pictures of the different genera of that family with those of *Apateodus*, e.g. those of *Enchodus Faujasi* Ag. by SMITH WOODWARD (8, pl. 11 fig. 6) and of *Empo nepaeolica* Cope by HAY (9 page 85 fig. 69). But also when we try to refer *Apateodus* to the system of fishes after BOULENGER and GOODRICH, the result is, that we approach the family of the *Enchodontidae*.

In virtue of the foregoing I include *Apateodus* among this family. In accordance with TATE REGAN's opinion this family belongs to the suborder of the *Stomiatoidei* of the order of *Isospondyli* of the *Teleostei*. It must be concluded, therefore, that the genus *Apateodus* has been a genus of physostomous fishes of prey, which most likely inhabited the open sea. There is, however, no ground for assuming that the species belonging to it, were living at large depths. The facies of the rock both in Holland and in England go against such an assumption. At present the genus *Apateodus* is known to have been found from the Gault to the Upper Senonian.

REFERENCES.

1. L. AGASSIZ. Recherches sur les poissons fossiles, Tome V. Neuchatel 1833—1843.
2. A. C. L. G. GÜNTHER. An introduction to the study of fishes. Edinburgh, 1880.
3. H. FORSK. Contributions à l'étude du système crétacé de la Belgique. 1. Sur quelques poissons et crustacés nouveaux ou peu connus. Annales de la Société géol. de Belgique, Tome 14, 1887, p. 37—42, pl. 1.

4. C. GEGENBAUR. *Vergleichende Anatomie der Wirbeltiere*, Bd. I. Leipzig. 1898.
5. F. B. LOOMIS. *Die Anatomie und die Verwandtschaft der Ganoid- und Knochenfische aus der Kreide-Formation von Kansas*, U. S. A. *Palaeontographica*, Bd. 46, 1899—1900, p. 213—283, pl. 19—27.
6. A. S. WOODWARD. *The fossil fishes of the English Chalk*. London, 1892—1912. *Palaeontographical Society*.
7. O. BÜTSCHLI. *Vorlesungen über vergleichende Anatomie*, 1^e Lieferung, Leipzig, 1900.
8. A. S. WOODWARD. *Catalogue of the fossil fishes in the British Museum*. Part IV. 1901.
9. O. P. HAY. *On certain genera and species of North American cretaceous actinopterous fishes*. *Bulletin of the Amer. Mus. of Nat. Hist.*, Vol. 19, 1903, p. 1—95.
10. L. DOLLO. *Première note sur les Téléostéens du Crétacé supérieur de la Belgique*. *Bull. d. l. Soc. belge de Géologie*, T. VI, 1892, p. 180—189.
11. G. A. BOULENGER. *Fishes (system. Account of Teleostei)* in Vol. VII of the *Cambridge Natur. History*. Edited London 1904 by S. F. HARMER and A. E. SHIPLEY.
12. E. S. GOODRICH. *Vertebrata craniata*. Part 9 in Ray Lankester: *A treatise on Zoology*, London 1909.
13. C. TATE REGAN. *The classification of the Teleostean fishes*. *Annals and Mag. of Nat. Hist.*, Ser. 8, Vol. 3, p. 75, 1909.
14. C. TATE REGAN. *The anatomy and classification of the Teleostean fishes of the order Iniomi*. *Annals and Mag. of Nat. Hist.*, Ser. 8, Vol. 7. p. 120, 1911.
15. S. H. REYNOLDS. *The vertebrate skeleton*, 2nd ed. *Cambridge Zoological Series*. 1913. Cambridge.
16. K. A. VON ZITTEL. *Grundzüge der Palaeontologie*, II^e Abt. *Vertebrata*, 4^e Aufl. Neubearbeitet von F. BROILI und M. SCHLOSSER, 1922.
17. C. TATE REGAN. *The classification of the Stomioid fishes*. *Annals and Mag. of Nat. Hist.*, Ser. 9, Vol. 11, p. 612, 1923.
18. FEL. SUPINO. *Morphologia del cranio dei Teleostei*, Fasc. 1—6, Roma 1904—'06.
19. M. SAGEMEHL. *Beiträge zur vergleichenden Anatomie der Fische*. III. *Morphologisches Jahrb.* Bd. 10, 1881, p. 1—119, pl. 1 en 2.
20. C. B. BRÜHL. *Zootomie aller Thierklassen*, Atlas, Bd. *Fische*. Wien 1877.

EXPLANATIONS OF THE FIGURES.

- Fig. 1. Left lateral aspect of the skull with fang in the palatine, the pterygoids, basisphenoid, orbitosphenoid, symplectic, stylohyal, angular, pterotic, sphenotic, etc. 0.5 nat. size. Coll. Delft.
- Fig. 2. Right lateral aspect of the skull with the premaxillary, remains of the maxillary, the dentary, the opercles and the condyle of the mandible. 0.5 nat. size.
- Fig. 3. Upper side of the skull. Frontals impinge on the supraoccipital, parietals lacking. 0.5 nat. size.
- Fig. 4. Underside of the skull with the hyoid arch, the branchiostegals and the angular. 0.5 nat. size.
- Fig. 5. The first three vertebrae of fig. 2 at the basioccipital, about nat. size, part of the hyomandibular with the process to which the opercular was united.

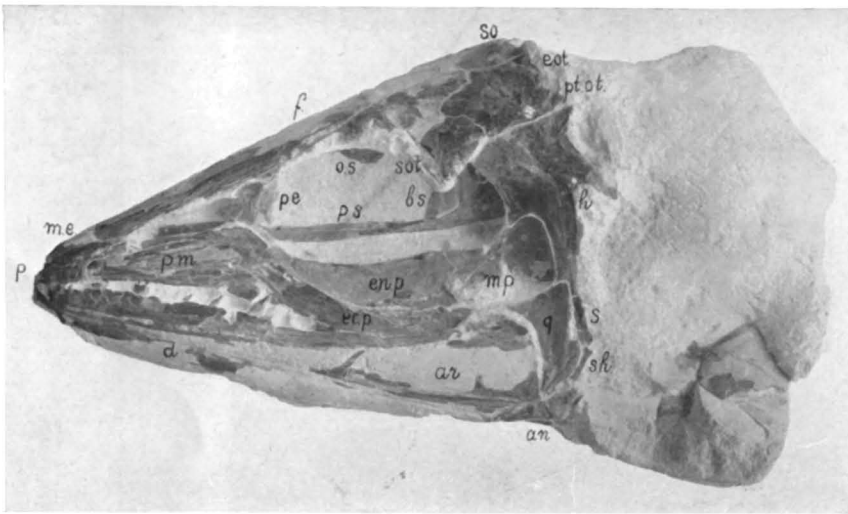


Fig. 1.



Fig. 5.

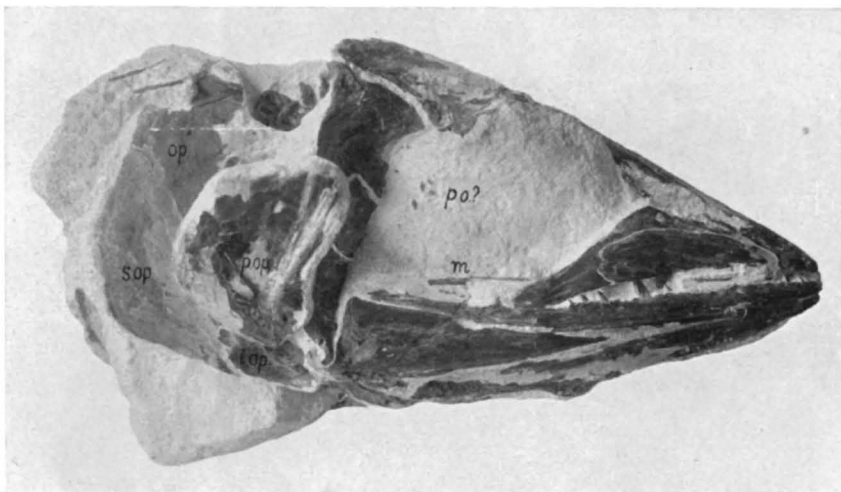


Fig. 2.

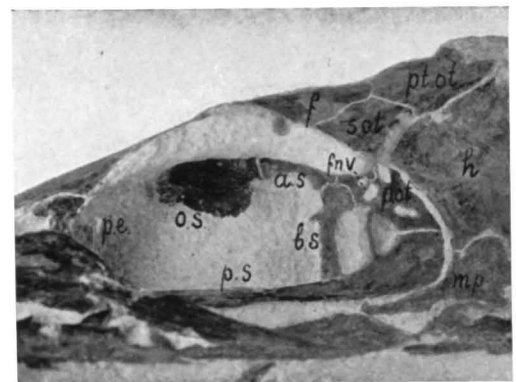


Fig. 6.

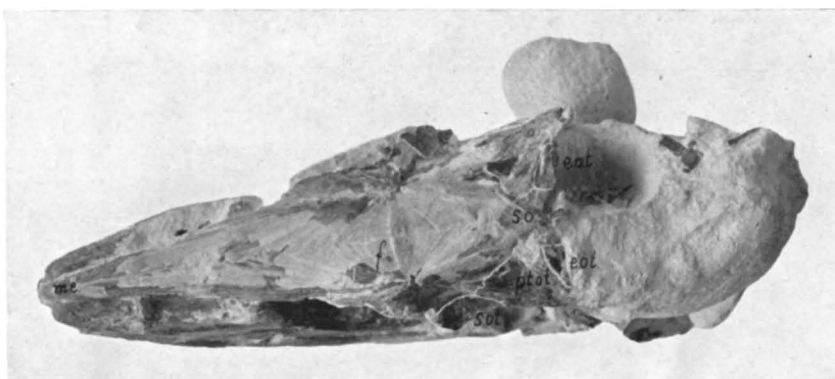


Fig. 3.

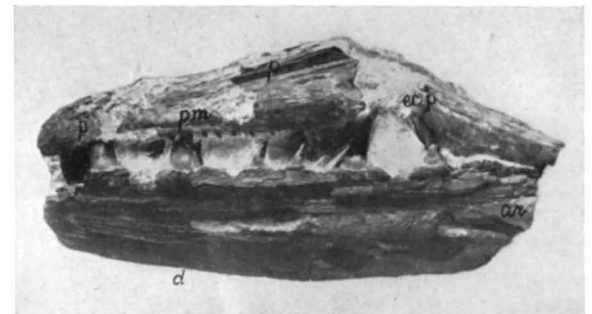


Fig. 7.

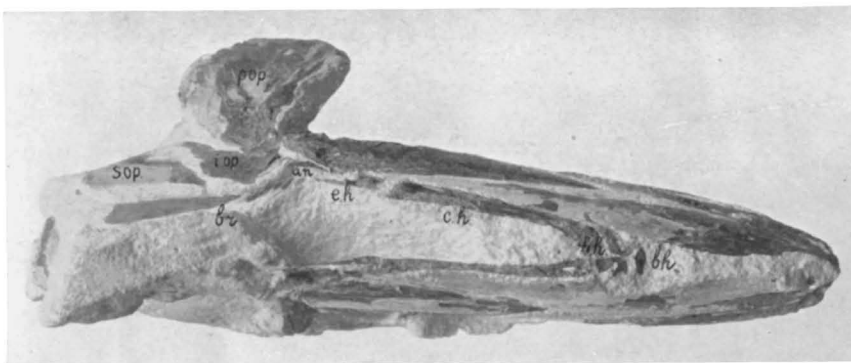


Fig. 4.



Fig. 8.

Apteodus Corneti (For.) KRUIZINGA 1923. Maestricht Chalk, Valkenburg, Limburg (Netherlands).

Upper Senonian, type spec. (fig. 1—4) length of the upperside of the skull 13,2 cM. $\frac{1}{2}$ nat. size; fig. 6 about 0,8 nat. size, fig. 5, 7 and 8 about nat. size.

Teleostei-Isospondyli-Stomiatoidei-Enchodontidae.

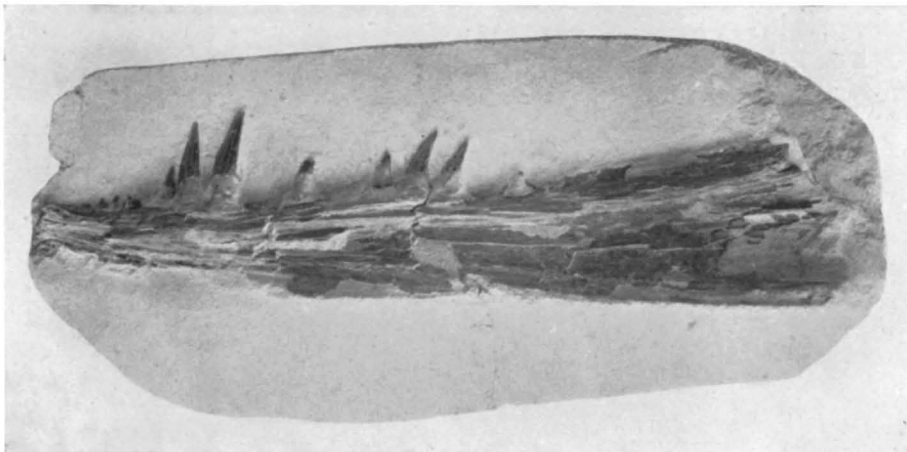


Fig. 9.

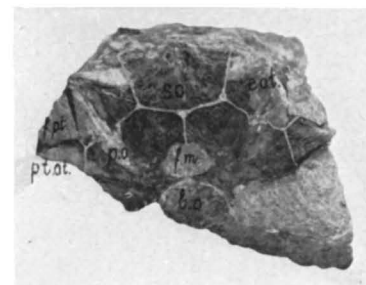


Fig. 12.

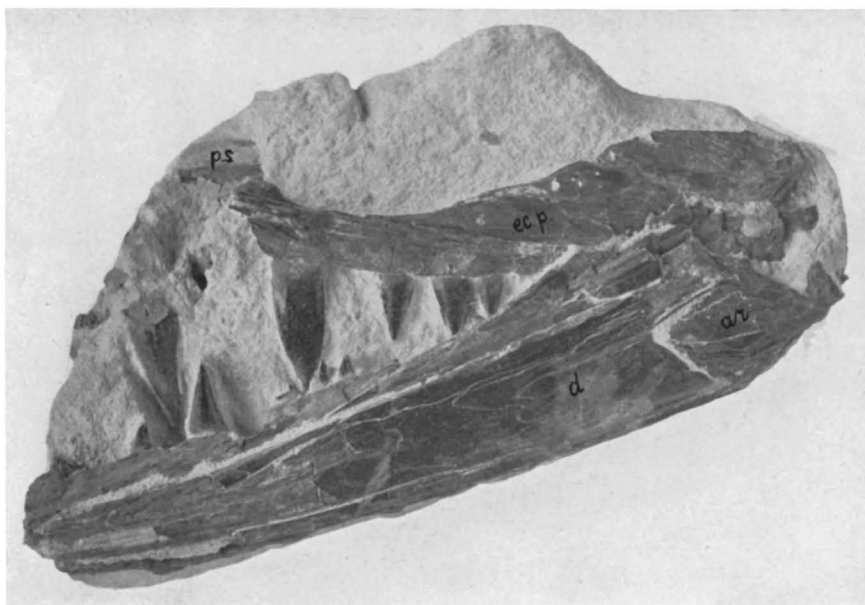


Fig. 10.

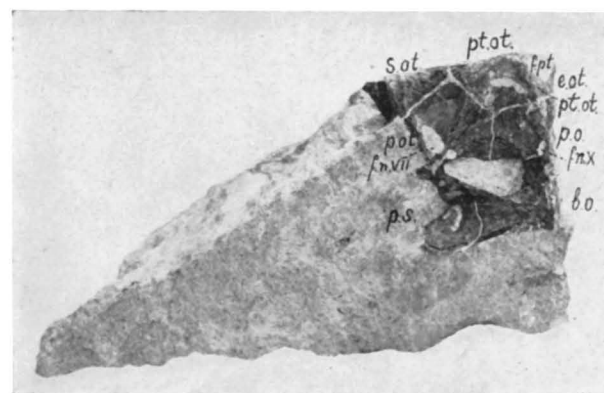


Fig. 13.

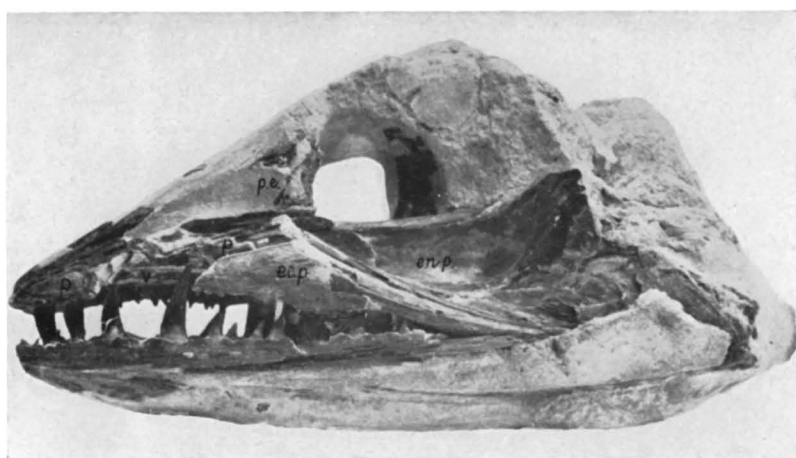


Fig. 11.



Fig. 14.

Apteodus Corneti (For.) KRUIZINGA 1923. Maestricht Chalk, Upper Senonian.

Fig. 9 about 0.9 nat. size, fig. 10 about 1.2 nat. size, fig. 12 and 13 about nat. size, fig. 11 about 0.8 nat. size, fig. 14 about nat. size.

Teleostei-Isospondyli-Stomiatoidei-Enchodontidae.

- Fig. 6. Left orbit of fig. 1, 0.8 nat. size, with orbitosphenoid, alisphenoid, basisphenoid, parasphenoid, prootic with foramina. myodome.
- Fig. 7. Left side of skull-fragment. Upper-Senonian found near Valkenburg, 0.8 nat. size, origin. described as *Enchodus Cornetic For.* = *Apateodus Corneti* (For.) with palatine with fang, remains of premaxillary, ectopterygoid and dentary with teeth. Coll. Liege.
- Fig. 8. Fragment of fig. 7, about nat. size, seen from above with vomer and the anterior end of the parasphenoid.
- Fig. 9. Internal aspect of a fragment of a jaw, origin the Upper Senonian of Southern part of Limburg, teeth, 0.9 nat. size. Coll. Delft.
- Fig. 10. Gaping mouth, found near Valkenburg, Upper Senonian, 1.2 nat. size, with the teeth in the ectopterygoid, and the hinder border of the dentary.
- Fig. 11. Fragment of a skull Upper Senonian, found near Valkenburg, Coll. Bosquet in the Brussels Museum N^o. I. G. 4289, 0.8 nat. size. Left lateral aspect of the skull with gape, the posterior end of the palatine, which overlaps part of the ectopterygoid, the fang in both palatines, the minute teeth in the premaxillary, the teeth in the left ectopterygoid and the teeth of the mandible (one series).
- Fig. 12. Fragment of a skull. Upper-Senonian, found near Kunrade. Coll. Ubaghs in the Mus. of Brussels. N^o. I. G. 6921. About nat. size. The bones of the occiput.
- Fig. 13. Fragment of Fig. 12, nat. size, inferior aspect, part of the left inferior angle of the basioccipital wanting.
- Fig. 14. Part of fig. 2 with the hyomandibular, metapterygoid and quadrate with articulation of the mandible, about nat. size.

LIST OF ABBREVIATIONS USED IN THE FIGURES.

<i>s.o.</i>	supraoccipital.	<i>f.</i>	frontal.	<i>an.</i>	angular.
<i>p.o.</i>	pleurooccipital.	<i>v.</i>	vomer.	<i>s.h.</i>	stylohyal.
<i>b.o.</i>	basioccipital.	<i>p.</i>	palatine.	<i>e.h.</i>	epihyal.
<i>e.ot.</i>	epiotic.	<i>ec.p.</i>	ectopterygoid.	<i>c.h.</i>	ceratohyal.
<i>pt.ot.</i>	pteric.	<i>en.p.</i>	entopterygoid.	<i>h.h.</i>	hypohyal.
<i>s.ot.</i>	sphenotic.	<i>m.p.</i>	metapterygoid.	<i>b.h.</i>	basihyal.
<i>p.ot.</i>	prootic.	<i>h.</i>	hyomandibular.	<i>p.op.</i>	preoperculum.
<i>a.s.</i>	alisphenoid.	<i>q.</i>	quadrate.	<i>op.</i>	operculum.
<i>b.s.</i>	basisphenoid.	<i>s.</i>	symplectic.	<i>s.op.</i>	suboperculum.
<i>p.s.</i>	parasphenoid.	<i>m.</i>	maxillary.	<i>i.op.</i>	interoperculum.
<i>o.s.</i>	orbitosphenoid.	<i>p.m.</i>	premaxillary.	<i>br.</i>	branchiostegals.
<i>p.e.</i>	pleuroethmoid.	<i>d.</i>	dentary.	<i>p.o.</i>	postorbitals.
<i>m.e.</i>	mesethmoid.	<i>ar.</i>	articulary.		