6. *Additions to our Knowledge of the South African Gorgonopsia, preserved in the British Museum (Natural History).*—By Lieuwe D. Boonstra, D.Sc., Palaeontologist to the South African Museum and Queen Victoria Scholar of the University of Stellenbosch.

(With 18 Text-figures.)

There is preserved in the British Museum (Natural History) a small, though historically important collection of South African Mammal-like Reptiles of the sub-order Gorgonopsia. In all there are thirty specimens. These have been studied by Owen, Lydekker, Seeley, Broom, and Watson, and have been referred to fifteen genera and sixteen species. As will become apparent in the sequel, some of these so-called species cannot be considered to have been founded on valid characters. There are included, one specimen which apparently comes from the *Tapinocephalus* zone, six species from the *Endothiodon* zone, and nine species from the *Cistecephalus* zone. Considered as a whole, this collection consists of very indifferently preserved material. Quite a number are of a very fragmentary and incomplete nature, and some show practically no structure at all; even the best preserved specimens leave much to be desired. A considerable amount of preparation has been necessary, and the following descriptions are, I believe, as full as the nature of the material warrants.

A. Forms from the *Tapinocephalus* zone.

Cyniscodon lydekkeri, Broom.

The type-specimen is the anterior portion of a small right dentary. It was found on the farm Palmietfontein by T. Bain in 1878; but as there are many farms in the Karroo with this name it is not certain that the specimen represents a form from the *Tapinocephalus* zone. It was found in association with some remains of a small Dicynodont, and was referred by Lydekker to *Cynosuchus suppostus*. Broom in 1915 showed that the dentary was apparently that of a Gorgonopsian. The roots of three incisors, one canine, and four small molars are preserved. Broom was of the opinion that in life four incisors were present; I can find no evidence for this supposition; as preserved,

the first incisor is practically on the anterior edge of the bone and there is no room for an additional tooth. There is no diastema anterior to the canine, which has an oval root and lies lateral to the last incisor. Posterior to the canine, there is a diastema of 7 mm.; the three incisors occupy 7 mm.; the canine measures 6 by 3 mm., and the four molars measure 9 mm. The mentum is deep and square; the depth being 19 mm., and the width 20 mm.

At the present time five types of Gorgonopsia from the *Tapinocephalus* zone are known, viz. *Eoarctops*, *Eriphostoma*, *Galesuchus*, *Hipposaurus*, and *Scylacognathus*. Of these *Eriphostoma* is the only one to which the fragment of *Cyniscodon* can be compared. The nature of the mentum is very similar, but the dentition is quite different. Broom compared it to *Aelurosaurus*, but in this form the mentum is sloping, whereas in *Cyniscodon* it is upright; in addition, there is a considerable difference in the nature of the teeth. The relations of this fragment thus remain unknown.

As this fragment throws practically no light on the nature of the Gorgonopsians of the *Tapinocephalus* zone, it seems a pity that a new genus should have been created for such an unimportant fragment with practically no diagnostic characters. An additional name does not increase our knowledge.

Type, B.M.N.H., 49404, Palmietfontein, Beaufort West?, Cape Province.

B. Forms from the *Endothiodon* zone.

From this zone there are in the collection six forms, viz. *Arctops*, *Aelurosaurus*, *Aelurosauroides*, *Gorgonops*, *Leptotrachelus*, and *Scymnognathus*. Most of these are represented by fairly complete skulls, from which a number of structural details has been determined.

Arctops willistoni, Watson.

(Figs. 1–3.)

This type was collected by A. G. Bain in 1857 at Howse Post, near Fort Beaufort, which locality Watson considered to be in the *Endothiodon* zone; the nature of the matrix suggests the older *Tapinocephalus* zone. In either case, *Arctops* is one of the earlier Gorgonopsians. It consists of the posterior two-thirds of a skull, from which the quadrates and quadratojugals have been lost. Watson in 1914 described and figured the occiput and part of the brain-case, with which account I am in agreement. In 1921 figures and a

description of the dorsal, lateral, and palatal surfaces were published. I have since etched all these surfaces with dilute hydrochloric acid

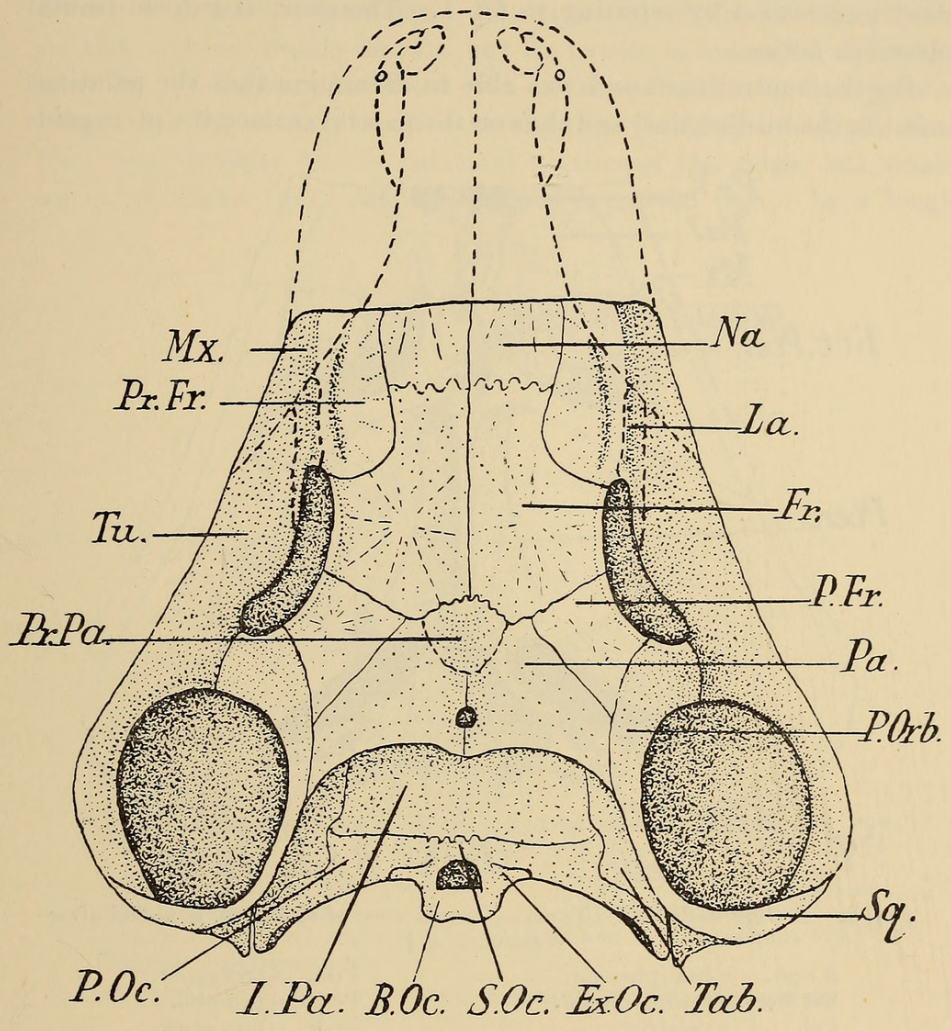

Fig. 1.—*Arctops willistoni*. Type, B.M.N.H., R4099. Dorsal view of the skull. × ½.

B.Oc. = basioccipital.
Ex.Oc. = exoccipital.
I.Pa. = interparietal.
Fr. = frontal.
Ju. = jugal.
La. = lacrimal.
Mx. = maxilla.
Na. = nasal.
Pa. = parietal.
P.Fr. = postfrontal.
P.Oc. = paroccipital.
P.Orb. = postorbital.
Pr.Fr. = prefrontal.
Pr.Pa. = preparietal.
S.Oc. = supraoccipital.
Sq. = squamosal.
Tab. = tabular.

and developed the brain-case, so that the skull now shows a number of points not determined by Watson. This account is thus purely supplementary.

On the dorsal surface the radiation of the bone-fibres assists materially in determining the limits of the various bones, which are best understood by referring to fig. 1. The short cruciform frontal deserves notice.

On the ventral surface I was able to determine that the palatines meet in the median line, and thus on the palatal surface the pterygoids

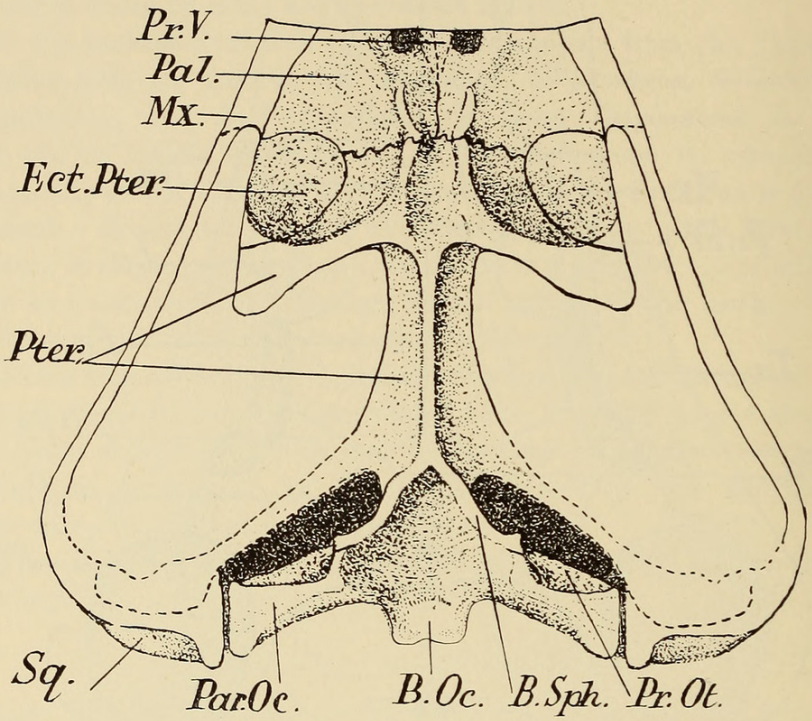

FIG. 2.—*Arctops willistoni*. Type. Ventral view of the skull, modified after Watson. × ½.

B.Sph. = basisphenoid.
Ect.Pter. = ectopterygoid.
Pal. = palatine.
Pter. = pterygoid.
Pr.Ot. = pro-otic.
Pr.V. = prevomer.

are prevented from meeting the prevomers; on either side of the median line there is a low ridge; enclosed between these ridges is a median groove; just behind the highest part of this ridge the transverse suture, between the anterior pterygoid ramus and the palatines, is clearly seen as a convoluted line lying anterior to a dark line of matrix in a crack, which runs parallel to it and with which it must not be confused; in a parasagittal section the pterygo-palatine suture can also be seen; the suture then continues in lateral direction to meet the ectopterygoidal suture (fig. 2). The ectopterygoid descends to form the anterior corner of the transverse pterygoidal

process, which is much shallower and situated somewhat further posteriorly than in later forms, but it has shifted somewhat forward from the primitive condition. The junction of the prevomers and palatines is not clearly shown, but its nature is indicated in broken lines in the figure. No teeth can be seen on the median palatal ridges, but in analogy with other known forms it is certain that they were present on the palatinal portion of the ridge, but would appear to have been absent on the pterygoidal part. In a longi-

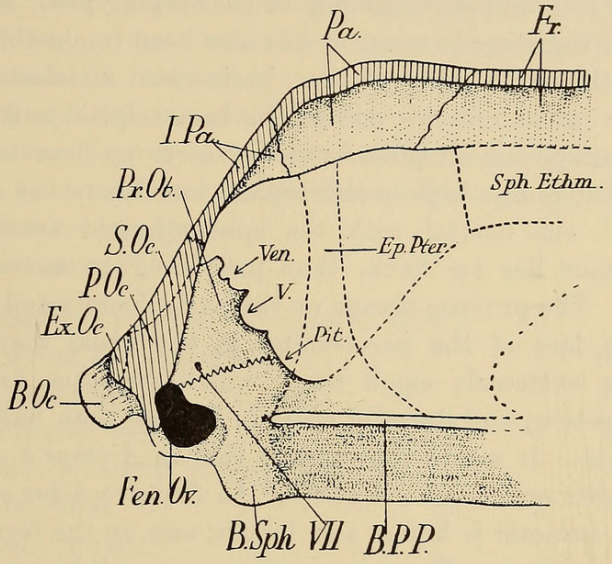

FIG. 3.—*Arctops willistoni*. Type. Lateral view of the right side of the brain-case. × ½.

B.P.P. = basipterygoid process.
Ep.Pter. = epipterygoid.
Fen.Ov. = fenestra ovalis.
P.Sph. = parasphenoid.
Pit. = pituitary fossa.
Sph.Ethm. = sphenethmoid.
Ven. = venous fossa.

Roman numerals refer to the foramina for the cranial nerves.

tudinal section, it is seen that the anterior pterygoidal ramus carries a high dorsal keel.

The palate of *Arctops* is thus seen to agree in the essential points of structure with all the forms in which the palate has hitherto been studied, viz. *Scylacops*, *Aelurognathus*, *Arctognathus*, *Lycosaurus*, *Cynariodes*, *Lycaenodon*, *Lycaenodontoides*, and *Arctognathoides*, and, as I hope to show later in this paper, with *Gorgonops*, *Aelurosaurus*, *Aelurosauroides*, and *Scymnognathus*. In all these forms there is no evidence whatsoever of a median unpaired bone in the anterior part of the palate.

The basicranial region is not very well shown; the basisphenoidal

tubera are present as high narrow ridges with a broad deep groove in between; posteriorly, it rests on ridge-like tubera of the basioccipital, and it forms the anterior border of the fenestra ovalis; anteriorly, the limits of the basisphenoidal portion of the median keel and the basipterygoidal processes cannot be determined. Although I have gone to considerable trouble to expose the lateral surface of the brain-case on the right side, the result is rather disappointing. The posterior part of the quadrate ramus of the pterygoid is lost, and portions only of the epipterygoid, which rested on it, can be indistinctly seen; it has also been impossible to expose the sphenethmoidal part of the brain-case satisfactorily. Posteriorly, the broad anterior end of the basioccipital and the widely diverging basisphenoidal tubera produce a roomy floor to the brain-case; the skull is also high in this region, but due to the shortness of the parietal, the frontal with the sphenethmoid attached to its ventral surface lies far back, thus producing an extremely short hind brain. The pro-otic stands on the basisphenoid and lies against the anterior face of the paroccipital in the usual manner; it is, however, an extremely small bone, which stretches very little in anterior direction, and dorsally extends for less than half the height of the occiput. It would thus appear that in *Arctops* a considerable part of the otic region did not ossify. In *Leptotrachelus* and *Scymnognathus* the pro-otic is higher and longer, and, in the forms from the *Cistecephalus* zone (e.g. *Cynariops*), it is very much higher and longer. The lateral opening into the pituitary fossa, the notch for the fifth nerve, and the venous notch above it are situated far back and low down; the latter two openings have no ossified anterior borders as have the later forms. In sagittal section it is seen that the spur of the basisphenoid, forming the posterior border of the pituitary fossa, is well developed. The fenestra ovalis is large and irregular, and is on the level of the basioccipital condyle. Posteriorly, neither the supraoccipital nor the interparietal send flanges to contribute to the walls of the brain-case, as they do in later forms. In the median line the occiput is extremely thin. The parietal sends down two lateral flanges, with which the rod-like epipterygoids presumably articulate. Lying ventral to the frontals, parts of the sphenethmoidal portion of the brain-case can be seen. Unfortunately the epipterygoid is not preserved; if it were rod-like, as in all known Gorgonopsians, the sides of the middle portion of the brain-case would be largely unenclosed by bone, *i.e.* the *cavum epiptericum* is not yet included within the cranial cavity.

The main morphological features are:

Primitive. Square section of the snout; laterally directed orbits; very small lateral temporal openings; sides straight; basioccipital large; strong paroccipital; fenestrae ovales far apart; basisphenoid massive, but with deep edge-like tubera; pro-otic small; pineal foramen situated far posteriorly; preorbital depression; frontal forms large part of the orbital border; little ossification of the side-walls of the brain-case; wide parietal region.

Advanced. Pterygoid flanges not far posteriorly; skull slightly wider than high; flat laterally-placed basipterygoid processes; maxilla apparently fairly deep; basisphenoidal tubera edge-like; occiput fairly upright, but not concave.

From this summary it is evident that *Arctops*, although advanced beyond the Pelycosaurian and Deinocephalian stage, is one of the more primitive Gorgonopsians.

Chief measurements:

Pineal foramen to edge of occipital plate . .	9 mm.
Width across the squamosals	185 ,,
Interorbital width	64 ,,
Intertemporal width	89 ,,
Width across lateral pterygoid flanges . .	100 ,,
Height of snout	60? ,,
Height of occiput	80 ,,

Type, B.M.N.H., R4099, Howse Post, Fort Beaufort, Cape Province.

Gorgonops torvus, Owen.

(Fig. 4.)

This is the type species, and was found by A. G. Bain in 1853 at Mildenhalls, near Fort Beaufort. This locality probably is in the *Endothiodon* zone; another specimen, in the American Museum, comes from an undoubted *Endothiodon* zone locality, and we may thus consider *Gorgonops* to be a form from that zone. The type is a good skull which lacks the temporal arches and the mandibles; the occiput and posterior half of the ventral surface are not clearly shown, and in general the surface has been somewhat stripped by former developers.

Owen's lithographs are beautiful illustrations of the outward appearance of the skull as preserved.

Watson's account (1921) of the dorsal and lateral surfaces is correct; anterior to the pineal foramen, a large preparietal, which was not

figured by Watson (fig. 4), is present; his interpretation of the relations of the septomaxilla, maxilla, and the premaxilla is correct.

With regard to the palate, I am in agreement with Watson as to his interpretation of the relations of the premaxilla and the prevomers, and also as to the posterior intercalation of the prevomers; but my interpretation of the relations of the palatines, pterygoids, and ectopterygoids is totally different. The posterior slip-like prolongation of the prevomers is clasped in the median line by the two palatines lying laterally; from the posterior tip of the prevomers a median suture proceeds in posterior direction for a short distance; it then bifurcates and each branch continues in postero-lateral direction, crossing the ridge, that borders the median groove at its lowest part, to meet the ectopterygoidal suture. According to this interpretation, the pterygoids are ventrally excluded from the posterior borders of the internal nares; whereas, according to Watson, the pterygoids stretch far forward and are intercalated between the palatines, which do then not meet in the median line. The limits of the ectopterygoids are not clearly visible, but I am inclined to think that they descend further down the pterygoid flanges than figured by Watson.

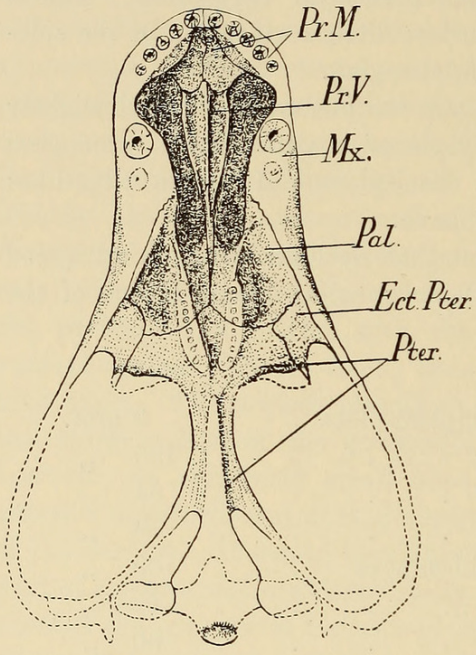

Fig. 4.—*Gorgonops torvus*. Type, B.M.N.H., R1647. Ventral view of the skull, modified after Watson. × ⅓.

Pr.Mx. = premaxilla.

The ridges bounding the median palatal groove are not well preserved; but although no teeth are visible, in life they were probably present on both the pterygoidal and palatinal portions of these ridges. Watson has maintained that the roof of the posterior part of the median groove is formed by a distinct element—the vomer—which is, of course, quite distinct from the prevomer. In *Gorgonops* there is no evidence of any posterior limit to this part of the roof of the median vault, which would definitely separate it from the rest of the pterygoid. My interpretation of the palate of *Gorgonops* is thus in agree-

ment with the condition found in the nine Gorgonopsian genera mentioned above.

The main morphological features of *Gorgonops* are:

Primitive. Square section of the snout; laterally directed orbits; slightly sloping occiput; tooth row straight and step in alveolar border; very small lateral temporal openings; basioccipital large; posterior position of the pineal foramen; preorbital depression; frontals form large part of orbital border; large postfrontals.

Advanced. Pterygoid flanges not far posteriorly; slightly cupped occiput; sides of skull not straight; snout wider than high; maxilla deep; flat basipterygoid processes laterally placed.

As far as the skull of *Gorgonops* is known, it is quite as primitive as *Arctops*, but as the region of the nostril is absent in the latter, and the brain-case is unknown in the former, further discussion would not be profitable.

Chief measurements:

Length from basioccipital to premaxilla	210 mm.
Length from premaxilla to pineal foramen	170 ,,
Length from pineal foramen to edge of occipital plate	14 ,,
Length from premaxilla to front of orbit	111 ,,
Width across squamosals	120? ,,
Interorbital width	60 ,,
Intertemporal width	68? ,,
Width across the canines	60 ,,
Width across pterygoid flanges	72? ,,
Height of snout	50 ,,
Height of occiput	45 ,,
Diastema	14 ,,
Incisor series	34 ,,

Type, B.M.N.H., R1647, Mildenhalls, Fort Beaufort, Cape Province.

Scymnognathus whaitsi, Broom.

(Fig. 5.)

There are in the collection three specimens of this species, which have been described by Watson. All come from the *Endothiodon* zone of Beaufort West.

In R4052 it is possible to determine from the weathered fragments the nature of the snout and the dental formula (i. 5, c. 1, m. 4 or 5), as fully described by Watson. The material is, however, not sufficiently well preserved to enable one to state with certainty what the relations

of the prevomers, palatines, and pterygoids are. Watson's figure of this part is based on inconclusive evidence, and I have no doubt that better preserved material will show that, in this region, *Scymnognathus* agrees with other Gorgonopsians, viz. that the palatines meet in the median line, that the pterygoids do not meet the prevomers, and that there is no unpaired median bone.

An imperfect weathered axis is the basis on which this element was

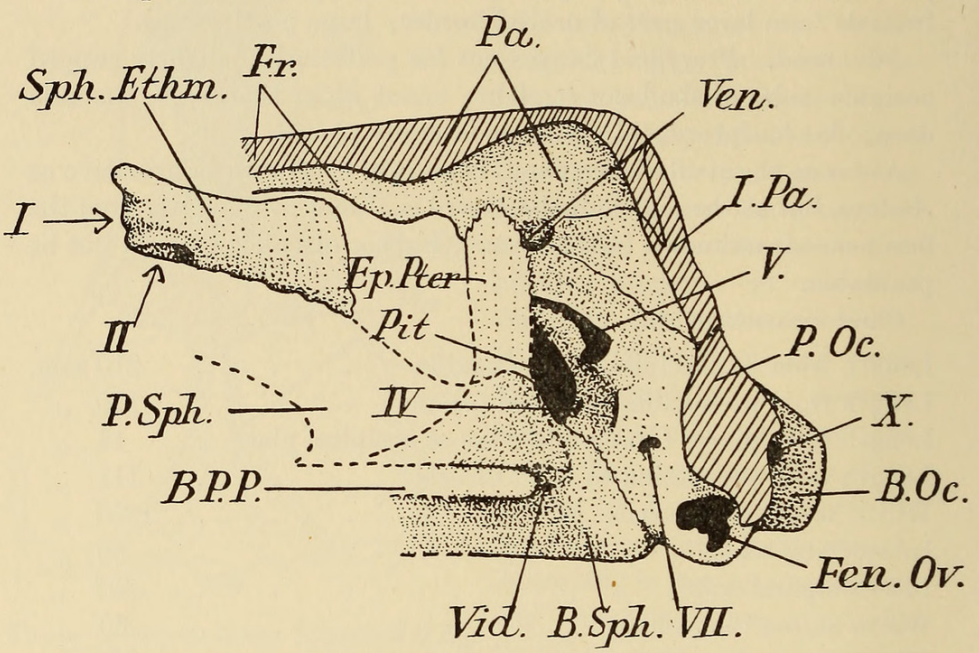

Fig. 5.—*Scymnognathus whaitsi*. B.M.N.H., R4053. Lateral view of the left side of the brain-case, modified after Watson. × $\frac{2}{3}$.

Vid. = Vidian foramen.

figured by Watson. The anterior cervicals are much better shown in *Hipposaurus*, *Aelurognathus*, and *Arctognathoides* recently described by me, and these show that Watson was correct in his restoration.

Watson's figures of the sectioned snout (49369) are correct. In fig. 12, No. 7, the inner pair of strips labelled "pterygoid" are open to discussion. There is no doubt as to their presence as separate strips of bone; what must be decided is whether they represent the anterior extremities of the pterygoids or not. If they do, it means that the palatines do not meet in the median line and that the pterygoids meet the prevomers, which would be contrary to the condition in at least nine other Gorgonopsia. I believe that the explanation is that they represent a dorsal pterygoidal girder which is not exposed in ventral view.

In R4053 the back portion of the skull is fairly well preserved; the proatlas and the axial centrum are well shown *in situ*; and the structure of the occiput and the greater part of the brain-case can be determined. From the material in the collection I have been fortunate enough to develop the brain-case in three different genera—*Cynariops*, "*Lycaenodon*," and *Arctognathus*—and comparing these to the figure of the brain-case of *Scymnognathus* published by Watson, some very disturbing differences were noticed. Re-examining the specimen in the light of this new knowledge, an interpretation different to that of Watson was arrived at. In the figure it is shown that the pro-otic is a much larger bone than Watson thought; its ventral limit is marked by a suture, which runs from behind the basisphenoidal tubera to the edge of the lateral opening into the pituitary fossa; dorsally, it extends right up to the parietal and interparietal and forms the ventral and dorsal borders of the notch (or foramen?) for the fifth nerve, and the ventral border of the venous fossa; it is this dorsal part that Watson, as I believe in error, considered to be supraoccipital. The foramen for the sixth nerve is extraordinarily large, and lies ventro-posteriorly of the notch for the fifth nerve; it has a depression below it. The foramen for the seventh nerve lies in advance of the fenestra ovalis, and below it is a depression for the geniculate ganglion. In the specimen the basipterygoid process has been forced upwards, and in the figure its normal horizontal position is restored; behind this process lies an opening—the Vidian foramen.

The chief morphological features are:

Primitive. Laterally directed orbits; sloping occiput; slender epipterygoid; large basioccipital; fenestrae ovales far apart; basisphenoidal tubera fairly large, but edge-like; step in maxillary border.

Advanced. Snout somewhat broader than high and not square in section; pterygoid flange has shifted forward; basipterygoid process laterally situated; parietal enters brain-case; pro-otic fairly large; pineal foramen not posteriorly situated; practically no preorbital depression; frontal forms only small part of orbital border; maxilla deep; paroccipital not massive; basisphenoidal tubera situated more anteriorly than in *Arctops*; squamosals widened, and thus increase in size of temporal openings; occiput concave.

A consideration of all these characters tends to show that *Scymnognathus*, although retaining some primitive characters in common with *Arctops* and *Gorgonops*, does show a definite advance over them.

Scymnognathus sps.

In the collection is a specimen found by Professor D. M. S. Watson in 1915; he did not think it worth describing, but Broom, in a paper, which consists of a number of specific descriptions based on absolutely impossible material, created a new species—*S. parvus*. The type is a weathered skull, very badly crushed; nothing can be made out of the palate, occiput, or lateral surface; on the dorsal surface a few sutures are visible. The dental formula is as for the genus—i. 5, c. 1, m. 4; the posterior edges of the incisors and canines have very definite fine serrations, whereas, on the last molar, which alone is fairly well preserved, there are some indefinite grooves which may be serrations.

I do not think that the specimen is sufficiently well preserved to warrant the creation of a new species; the few characters that can be determined are sufficient only to identify the genus, and there are no valid characters to differentiate it from the other species of *Scymnognathus*.

B.M.N.H., R4139, Kuilspoort, Beaufort West, Cape Province.

There is another specimen consisting of a fragment of a left maxilla, which shows the dental formula—i. 4 or 5, c. 1, m. 3, and has a distinct step anterior to the canine. This has, I believe, been correctly identified by Broom as *Scymnognathus sp.*

B.M.N.H., R3611, Karroo.

Leptotrachelus eupachygnathus, Watson.

(Figs. 6–7.)

Although somewhat distorted, the skull shows a considerable portion of its structure, and this has been fully described by Watson. The dental formula, which is the same as in *Scymnognathus whaitsi*, is i. 5?, c. 1, m. 4 or 5. There is no evidence as to the nature of the crowns, and no definite evidence of a step in the alveolar border as Watson's figure would imply. I have refigured the dorsal aspect of the skull, for, as Watson has admitted, the snout as reconstructed by him is too long and narrow. The position of the pineal foramen has also been determined.

I have refigured the brain-case in order to indicate the position of the basisphenoidal-pro-otic suture, the depression which apparently leads into a venous fossa, and the probable position of the foramen for the sixth nerve. Above the notch for the fifth nerve the bone has

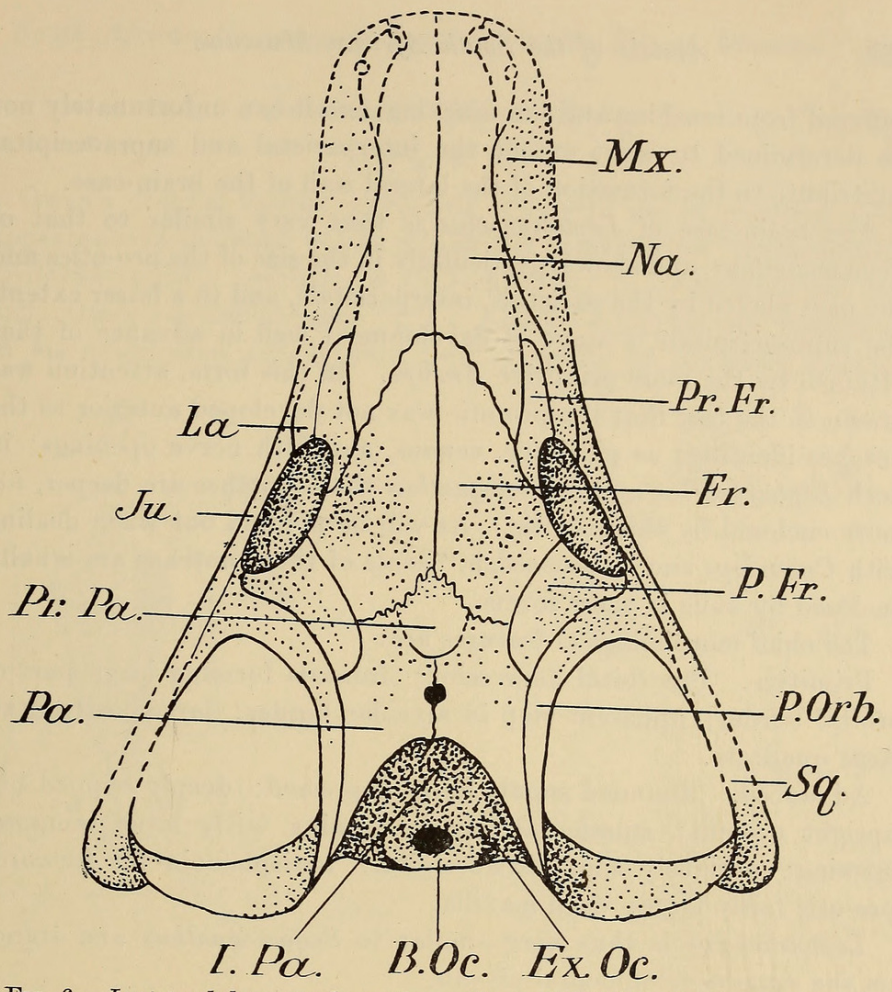

FIG. 6.—*Leptotrachelus eupachygnathus*. Type, B.M.N.H., R4051. Restored dorsal aspect of the skull. × ½.

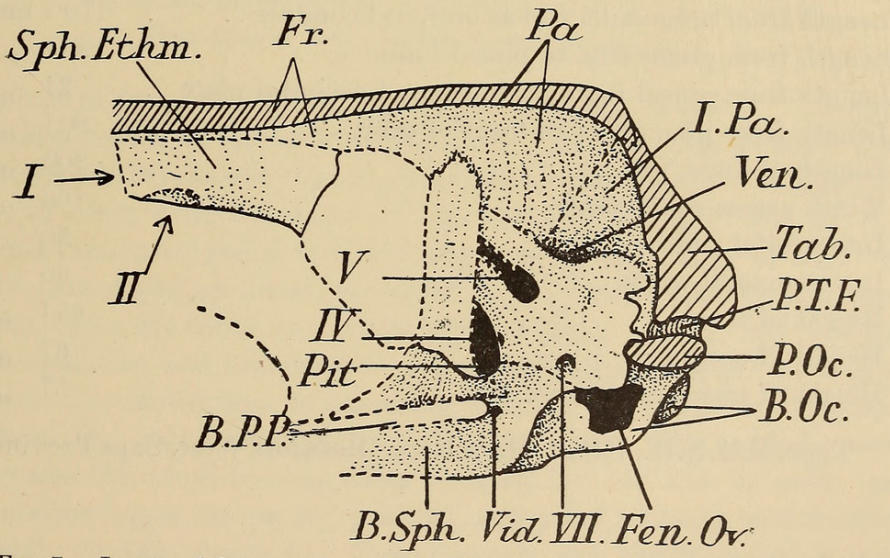

FIG. 7.—*Leptotrachelus eupachygnathus*. Type. Lateral view of the left side of the brain-case, modified after Watson. × ⅔.
P.T.F. = posttemporal fenestra.

suffered from crushing and sun-cracking, and it can unfortunately not be determined to what extent the interparietal and supraoccipital contribute to the formation of the lateral wall of the brain-case.

The brain-case of *Leptotrachelus* is thus very similar to that of *Scymnognathus*, and shows, particularly in the size of the pro-otics and the part played by the parietals, interparietals, and to a lesser extent, the supraoccipitals, a stage of development well in advance of that attained by the more primitive *Arctops*. In this form, attention was drawn to the fact that the pro-otic was not developed anterior to the notches identified as pituitary, venous, and fifth nerve openings; in both *Leptotrachelus* and *Scymnognathus* these notches are deeper, *i.e.* more enclosed by the pro-otic. As will be pointed out when dealing with *Cynariops* and "*Lycaenodon*," some of these notches are wholly enclosed by bone in these forms.

The chief morphological features are:

Primitive. Preorbital depression; frontals forming large part of orbital border; apparent step in alveolar border; large postfrontal; large quadrate.

Advanced. Rounded snout, fairly depressed; deeply cupped but upright occiput; squamosal bayed, forming fairly large temporal opening; curiously small basioccipital; basisphenoid far forward; pro-otic fairly large; deep maxilla.

Leptotrachelus is thus very similar to *Scymnognathus* and stands on the same developmental niveau.

Chief measurements:

Length from premaxilla to basioccipital condyle	170 ? mm.
Length from premaxilla to pineal foramen	120 ? ,,
Length from pineal foramen to edge of occipital plate	24 ,,
Length from premaxilla to front of orbit	80 ? ,,
Length of lower jaw	200 ,,
Width across squamosals	160 ,,
Interorbital width	50 ,,
Intertemporal width	60 ,,
Height of snout	65 ? ,,
Height of occiput	67 ,,
Height of mentum of lower jaw	57 ,,

Type, B.M.N.H., R4051, Hans River, Beaufort West, Cape Province.

Aelurosaurus felinus, Owen.

(Fig. 8, *A*.)

Owen's original figures excellently illustrate the form and general appearance of the skull, but he mistakenly considered it "mononarial." Lydekker rightly pointed out that in reality the internasal bar was lost. Owen's dental formula—i. 5, c. 1, m. 5—is correct, and Lydekker, in his description and figures, drew attention to the finely serrated

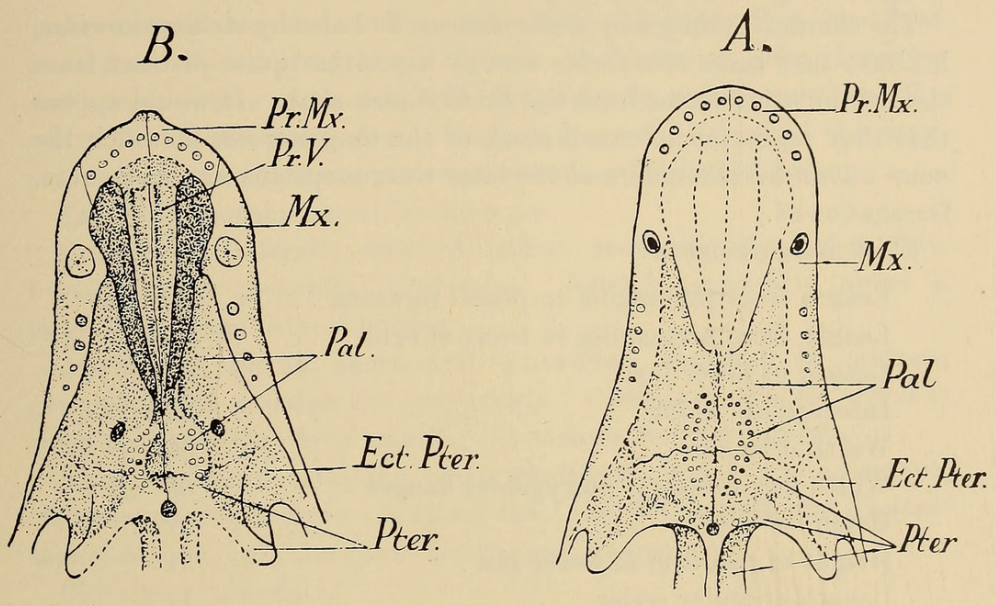

Fig. 8.

A.—Aelurosaurus felinus. Type, B.M.N.H., R339.
B.—Aelurosauroides watsoni. Gen. et sp. nov. B.M.N.H., R855.
Ventral views of the anterior part of the palate. × ½.

nature of the posterior borders of both incisors and molars. Seeley's interpretation of the articulation of the lower jaw was at fault, and Broom (1910) showed that in *Aelurosaurus* this structure is typically as in other Gorgonopsians. Seeley correctly noticed teeth on the transverse pterygoidal bar, and also noticed two groups of teeth on the pair of palatal ridges, but failed, as did Broom and Watson after him, to see the transverse suture between them. This suture between the palatine and pterygoid is plainly visible, on the left side, as a dark convoluted line demarcating the two lighter coloured bones. From the ectopterygoidal suture, this suture runs medially and crosses the tooth-bearing ridge between the two sets of teeth—an anterior larger set on the palatine, and a set of fewer and smaller teeth on the pterygoid. Unfortunately the ectopterygoid is not

sufficiently exposed, but it apparently stretched for a considerable distance down the transverse pterygoidal flange.

The main morphological features are:

Primitive. Snout higher than wide; laterally directed orbits; slight preorbital depression; frontals form large part of orbital border.

Advanced. Snout rounded; anterior position of pterygoidal flanges; deep maxilla; no step in alveolar border.

The characters shown by *Aelurosaurus*, and also by *Aelurosauroides*, indicate that these two forms occupy a position quite distinct from that of the other forms from the *Endothiodon* zone. It would appear that they represent a branch stock of the *Gorgonopsia*, in which the more advanced characters of the later Gorgonopsians are, as it were, foreshadowed.

Chief measurements :

Length from premaxilla to pineal foramen	80 mm.
Length from premaxilla to front of orbit	55 ,,
Length of lower jaw	85 ,,
Interorbital width	22 ,,
Width of snout	30 ,,
Width across lateral pterygoidal flanges	35 ,,
Height of snout	32 ,,
Height of mentum of lower jaw	31 ,,
Length of molar series	12 ,,
Diastema	6 ,,
Length of incisor series	16 ,,

Type, B.M.N.H., R339, Gouph, Beaufort West, Cape Province.

Aelurosauroides watsoni, gen. et sp. nov.

(Fig. 8, *B.*)

This specimen has been regarded by both Lydekker and Broom as *Aelurosaurus felinus*. It consists of the anterior two-thirds of a small skull, and lacks the lower jaw; the outer surfaces are well exposed, and Watson has had the palate developed. I concur in Watson's description and figures, except that, in dorsal view, the preparietal is oval and not squarish and, moreover, agree with him that it is generically distinct from *Aelurosaurus*. In addition to the points enumerated by him, I have been able to determine that the palatines meet in the median line, and thus the pterygoids do not meet the prevomers.

Aelurosauroides agrees with *Aelurosaurus felinus* in its dentition, size, and general shape, but differs in that the snout is rounder and less high. As Watson has already pointed out, the two forms differ very markedly in the relative size and shape of the palatal elements, although they agree in the essential morphological features. Watson's point, that great care must be taken before assigning specimens of Gorgonopsians, which have the same outward appearance, to the same species, without knowing the nature of the palate, therefore deserves full emphasis. The differences in proportion are best understood by referring to the figures; the main are—the shortness and raised nature of the tooth-bearing ridge in *Aelurosauroides*; the relatively shorter prevomers; the great ventral extent of the ectopterygoids, and the more posterior extent of the internal nares.

The main morphological features are:

Primitive. Laterally directed orbits; snout slightly higher than broad; slight preorbital depression; frontal apparently forms a large part of the orbital border.

Advanced. Snout short and somewhat rounded in section; pterygoid not situated far posteriorly; tooth row slightly curved; sides not straight; deep maxilla; no step in alveolar border.

Thus, although retaining some characters which are primitive, *Aelurosauroides* is more advanced than the forms from the *Tapinocephalus* zone, and also than *Arctops* and *Gorgonops*.

Chief measurements:

Length from premaxilla to front of orbit	60 mm.
Interorbital width	22 ,,
Width of snout	33 ,,
Height of snout	37 ,,
Width of pterygoid flanges	35 ,,
Length of molar series	12 ,,
Diastema	6 ,,
Length of incisor series	15 ,,

Type, B.M.N.H., R855, Gouph, Cape Province.

An Unidentified Specimen.

There is in the collection a specimen, labelled 855*a*, which lacks the external surface; but its palate can be exposed. Until this is done, it is not possible to state whether it must be referred to *Aelurosaurus* or to *Aelurosauroides*.

C. Forms from the *Cistecephalus* zone.

Eight species from this zone are represented, viz. *Arctognathus*, *Arctosuchus*, *Cerdognathus*, *Cynariops*, *Cynodraco*, *Lycaenodon*, *Lycosaurus*, and *Scylacops*. Careful preparation has produced two good palates and the lateral surfaces of three excellent brain-cases.

Lycaenodon longiceps, Broom.

(Fig. 9.)

The type-specimen consists of two-thirds of a skull; the whole parietal, occipital, and basicranial regions are lost; very little of the palate is present. A short original description was given by Broom in 1925, and in 1930 two figures were published. The dental formula is i. 5, c. 1, m. 6; the very long molar series, measuring 28 mm., is remarkable, as in the *Gorgonopsia* the tooth row is in general very short. A sagittal fracture reveals some points of structure, which were figured by Broom; the dorsal unperforated keel of the prevomers is very strongly developed; the sphenethmoid is a large element, and its shape is probably as figured by Broom; on its antero-lateral surface there is a large foramen for the exit of the second nerve; Broom's figure clearly shows that the palatines meet in the median line and thus prevent the pterygoids from meeting the prevomers. There can be no doubt that this is the usual Gorgonopsian condition, and that my interpretation of the palatal aspect of *Arctops*, *Gorgonops*, *Arctognathus*, etc., is correct, and that Watson misinterpreted these relations. Broom's reconstruction of the basicranial portion of the sagittal section, as figured, is based on another specimen, and this will be referred to later. The detailed structure of the anterior part of the palate cannot be determined. Its general shape is, however, of interest; although the skull is a long one, the prevomers appear to be relatively longer, and the palatines do not stretch so far anteriorly, as is usually the case—their anterior borders lie well posterior to the plane of the canines; the median groove is deep, but unfortunately the ridges bounding it are not shown.

The outer surface, although thoroughly cleaned and etched, shows few sutures, as the skull appears to be that of an old animal with closed sutures. The dorsal surface, with the posterior third reconstructed, is shown in the accompanying figure.

The main morphological features are:

Primitive. High, fairly narrow snout; extraordinarily long

straight tooth row, with a step anterior to the canine; preorbital depression; frontals apparently forming a large part of the orbital border; temporal openings apparently small, and parietal region probably very wide.

Advanced. Orbits slightly anteriorly directed; sides of snout not upright; deep maxilla.

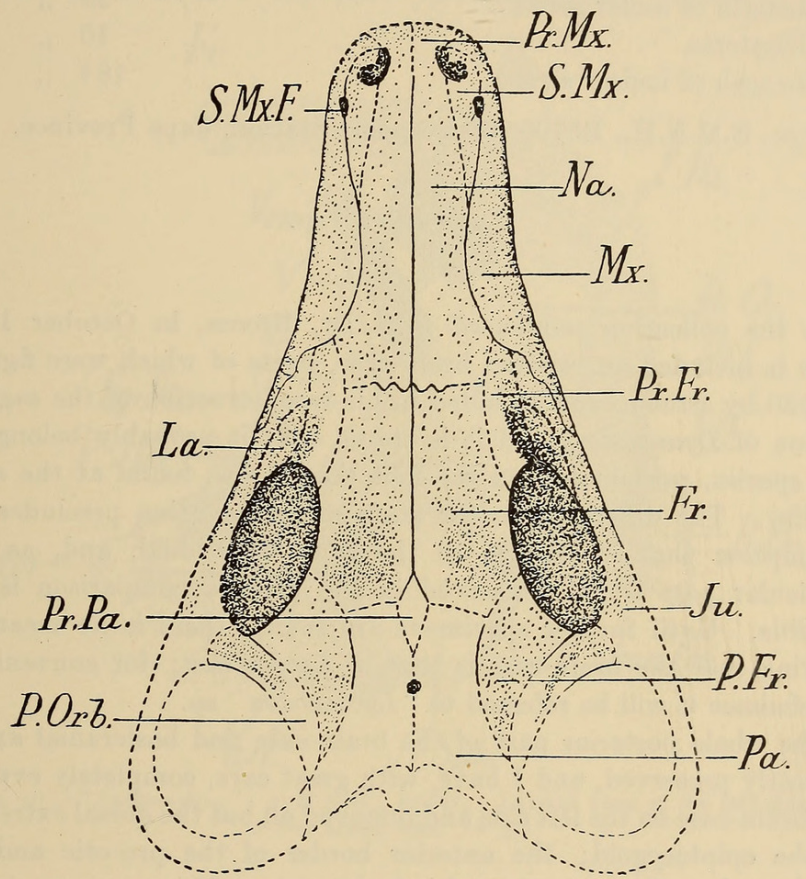

Fig. 9.—*Lycaenodon longiceps*. Type, B.M.N.H., R5700. Restored dorsal view of the skull. × ½.

As far as the skull of *Lycaenodon* is known, it appears to be very primitive for a form from the base of the *Cistecephalus* zone. The very long molar series is unique amongst all the known *Gorgonopsia*, and, if we are correct in considering this to be a primitive character, then *Lycaenodon* is in this respect the most primitive known Gorgonopsian. The general contour indicates a very broad parietal region, with very small laterally directed temporal openings, and if such is actually the case, then *Lycaenodon* would be less advanced in this region than either *Arctops* or *Gorgonops*.

Chief measurements:

Length from premaxilla to front or orbit	100? mm.
Interorbital width	47 ,,
Width of snout	38 ,,
Width across lateral pterygoidal flanges	85? ,,
Height of snout	46 ,,
Length of molar series	28 ,,
Diastema	10 ,,
Length of incisor series	18? ,,

Type, B.M.N.H., R5700, Biesjespoort Station, Cape Province.

"*Lycaenodon*" sp.

(Fig. 10.)

In the collection purchased from Dr. Broom, in October 1932, there is included an isolated brain-case, parts of which were figured in 1930 by Broom, and included in his reconstruction of the sagittal section of *Lycaenodon*, and it is stated that it probably belongs to this species, presumably on the fact that it was found at the same locality. The difference in the state of preservation precludes the assumption that it belongs to the same individual, and, as this particular part is not preserved in the type, a comparison is not possible. Until further specimens are found, there is no means of proving that the brain-case is that of *Lycaenodon*; for convenience of reference it will be referred to "*Lycaenodon*" sp.

The whole posterior part of the brain-case and basicranial axis is perfectly preserved, and I have, with great care, completely exposed the brain-case on the left side and removed all but the dorsal extremity of the epipterygoid; the anterior border of the pro-otic and the pituitary fossa have also been freed of matrix. This specimen, before adequate development, was the basis of Broom's (1930) figure showing the relations of the epipterygoid, pterygoid, and the two elements identified as "vomer" and "basisphenoid" respectively, and also of the reconstructed posterior part of his sagittal section of *Lycaenodon longiceps*.

The basisphenoid is a fair-sized bone with edge-like tubera, which underlie the processes sent downwards by the basioccipital, and which form the anterior border to the large irregular fenestra ovalis. From the dorso-anterior corner of the fenestra a slightly digitating suture runs anteriorly, in a plane practically horizontal, to enter the

lateral border of the pituitary fossa. From the tubera the basisphenoid extends, in anterior direction, in the form of a vertical sheet of bone, which laterally carries the horizontal basipterygoid processes; on the ventral surface this produces the median keel; dorsally, it forms the anterior border of the pituitary fossa. Here it is broken off, but, in life, it apparently stretched forwards and upwards as a median septum. In *Arctognathus curvimola* this

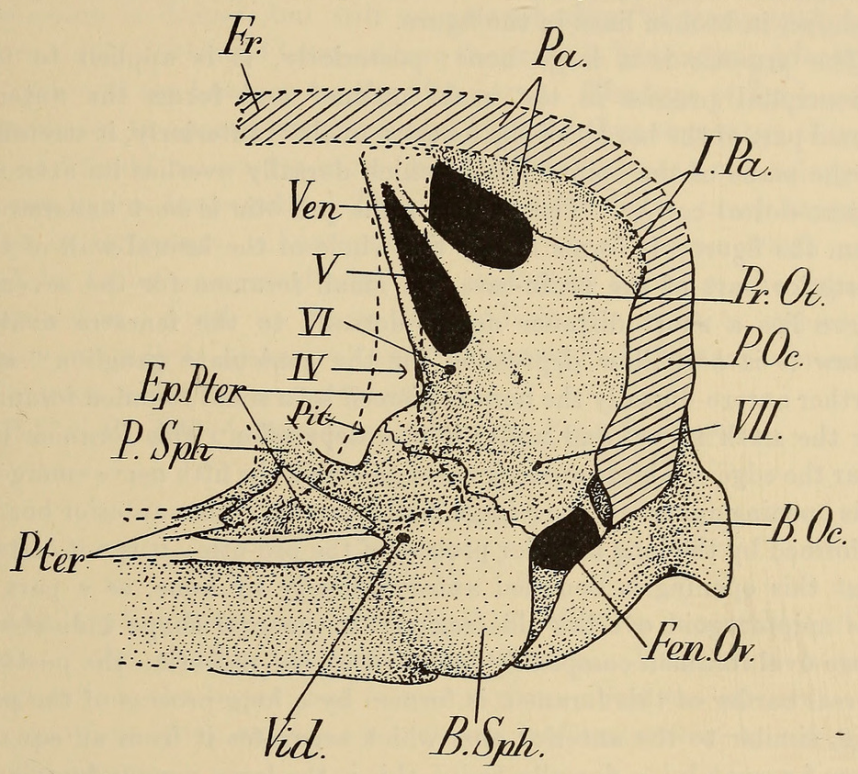

Fig. 10.—"*Lycaenodon*." B.M.N.H., R5746. Lateral view of the left side of the brain-case. × $\frac{4}{3}$.

structure is better shown, and this will be discussed further when describing that form. It is evident that this extent of bone cannot all be basisphenoid; the anterior part of the ventral keel, and the antero-dorsal vertical sheet of bone must, for its greater part, be the parasphenoid. The limits of the parasphenoid cannot, however, be determined; the parasphenoid—a membrane bone—appears to have become intimately connected with the basisphenoid, which is, of course, preformed in cartilage.

As indicated in the figure, the flattened, horizontally situated basipterygoid processes of the basisphenoid are clasped on their dorsal and ventral surfaces by the posterior end of the pterygoid

ramus, which has split into two thin horizontal plates—a long ventral one and a shorter dorsal one. Immediately behind the end of the basipterygoid process a Vidian foramen pierces the bone. It is on the latero-dorsal edge of the ventral pterygoidal plate that the epipterygoid stands; from this lateral edge a thin horizontal flange extends medially, and this acts as a base to the epipterygoid. From its base the epipterygoid stretches dorsally as a thin pillar, which is shown in broken lines in the figure.

The pro-otic is a large bone; posteriorly, it is applied to the paroccipital process in the usual manner and forms the antero-dorsal part of the border of the fenestra ovalis; anteriorly, it stretches to the plane of the epipterygoid, which dorsally overlies its extreme antero-dorsal corner. The shape of the pro-otic is best understood from the figure; it forms nearly the whole of the lateral wall of the posterior part of the brain-case. A small foramen for the seventh nerve lies a short distance antero-dorsally to the fenestra ovalis; below it is a shallow depression for the geniculate ganglion; still further antero-dorsally the bone is pierced by a small rounded foramen for the sixth nerve, and under it is a depression; this foramen lies near the edge of a large opening through which the fifth nerve emerged; this opening appears to be a large oval foramen, whose anterior border is formed by the long anterior process of the pro-otic; it is not certain that this opening is bounded antero-dorsally by bone, as a part of the epipterygoid overlies this region; its general shape indicates a large oval foramen completely bounded by the pro-otic; the postero-dorsal border of this foramen is formed by a long process of the pro-otic, similar to the anterior one, which separates it from an equally large foramen lying dorsally to it; this is the large venous foramen.

In anterior view, the edges of both pro-otics have been exposed and it is seen that, above the pituitary fossa, processes are sent inwards by both pro-otics, so as to form a bridge of bone over the pituitary fossa; ventrally, the bridge appears to be supported by a spur of the basisphenoid, which here forms the posterior border of the pituitary fossa; dorsally to this bridge, the pro-otics approach each other closely (3 mm.), so that the brain here emerged through a high and narrow slit. On the anterior face of the pro-otic, just above the bridge, is a small foramen facing directly forwards—this is for the exit of the fourth nerve.

The sphenethmoidal region is unfortunately not preserved.

The basioccipital has a well-developed condyle and has strong downwardly directed processes, on whose ventral surfaces the

basi-sphenoidal tubera are applied; it forms the postero-ventral border of the fenestra ovalis; on its ventral surface lie the two nutritive foramina in their usual position. The foramen for the tenth nerve is overhung by the exoccipitals in the usual manner.

If we are right in our interpretation that in *Arctops* the anterior part of the pro-otic is not ossified, and that the foramen for the fifth nerve is only represented as a shallow notch, and that in *Cynariops* the notch is deeper, but still unenclosed, then "*Lycaenodon*" is a more highly developed form, as here the pro-otic has extended forward to surround the foramen for the fifth nerve. The type of *Lycaenodon* was shown to appear primitive, and it would thus seem that there is an additional reason for regarding this brain-case as not belonging to the genus *Lycaenodon*. The strong basioccipital, much stronger than in *Cynariops*, is, however, a primitive character, which may well be found associated with the characters found in the type of *Lycaenodon*. Until we know more about the relative values of characters styled "primitive" and "advanced," any further expression of opinion will serve no useful purpose.

B.M.N.H., R5746, Biesjespoort Station, Cape Province.

Cynariops robustus, Broom.

(Figs. 11–14.)

The type consists of a good skull, lacking the temporal arches, part of the occiput, and the premaxillaries. After some further preparation, the lateral and dorsal surfaces show the sutures well; the relations of the various elements are best understood by referring to the figures.

The dental formula is i. 5, c. 1, m. 4; on the right side there are three, on the left four, the fourth being small; there is a diastema between the last incisor and the canine, whereas the first molar follows immediately on the canine.

Mr. L. E. Parsons, Technical Assistant in the Geological Department, has prepared the palate and the lateral surface of the brain-case for me, and after some further development and etching, a number of interesting features have become apparent. The structure of the palate is adequately exposed; ventrally, the prevomers have a strong median keel and two lateral flanges on their anterior part; the median palatal groove has deep overhanging ridges, and both the palatine and pterygoid portions bear teeth; the median convoluted interpalatine suture is beautifully shown, and so is the transverse

suture separating the palatine and pterygoid in ventral view; the latter crosses the ridge at its lowest part and then continues in postero-lateral direction to meet the ectopterygoid suture. The posterior limits of the prevomers are not clearly shown, but probably are as indicated in the figure.

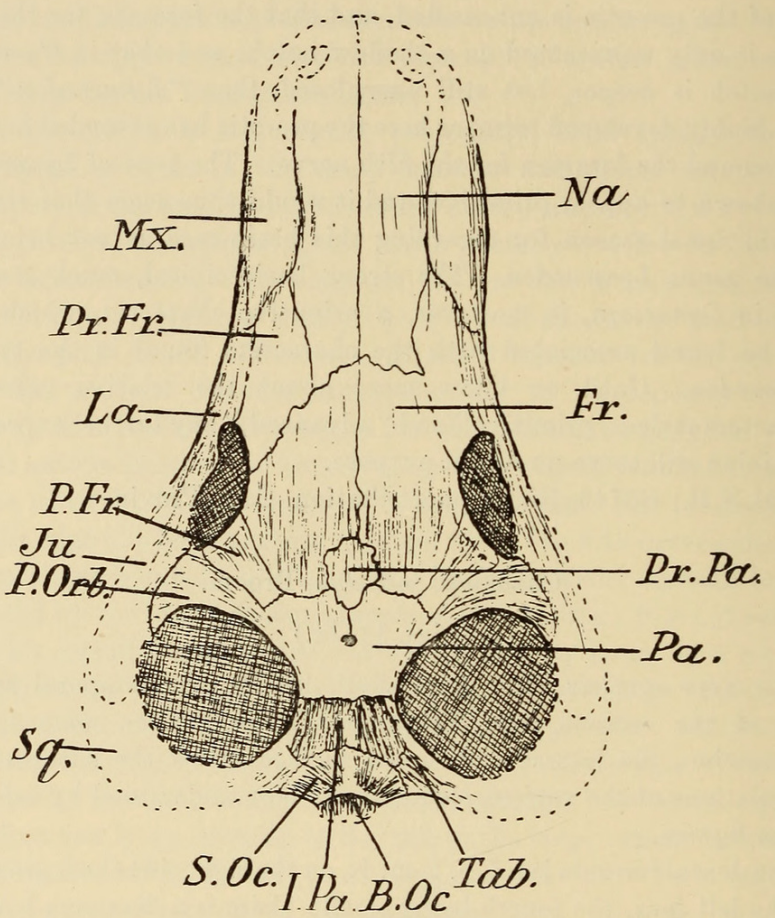

Fig. 11.—*Cynariops robustus*. Type, B.M.N.H., R5743. Dorsal view of the skull. × $\frac{5}{7}$.

On the left side, the outer surface of the brain-case has been partially exposed; on this side, the epipterygoid is not preserved, but, on the right side, it is practically complete. The epipterygoid has a long base resting on the quadrate ramus of the pterygoid; it then extends dorsally as a very high, narrow, and flattened pillar to meet the parietal; it thus forms the side wall of the *cavum epiptericum* anterior to the pro-otic, with the Gasserian ganglion lying immediately median to it; in lateral view, it lies in front of the lateral opening into the pituitary fossa and, further dorsally, overlies the anterior

border of the large irregular notch for the fifth cranial nerve. The pro-otic is a fairly large bone, whose shape will be better understood from the accompanying figure than from a verbal description. Ventrally, it meets the basisphenoid in a fairly open suture; antero-

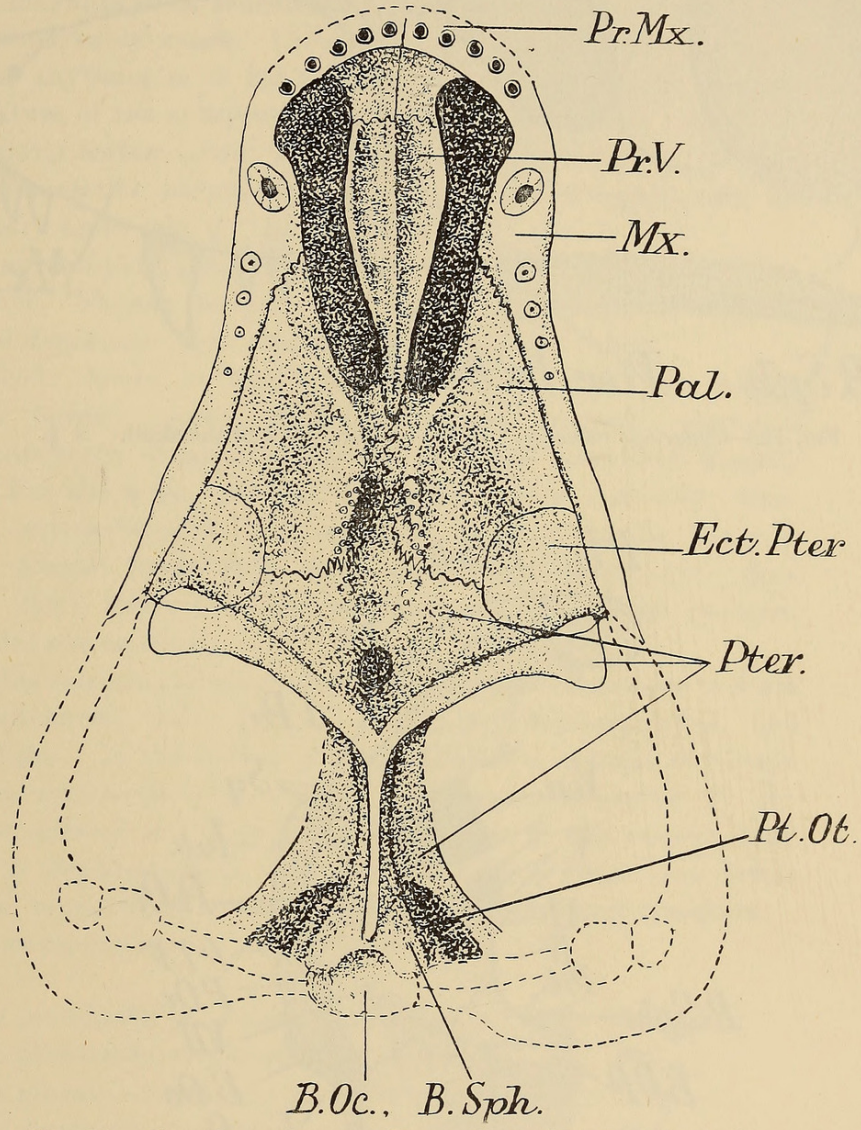

FIG. 13.—*Cynariops robustus*. Type. Ventral view of the skull. × $\frac{5}{6}$.

ventrally, it forms the posterior border of the fenestra leading into the pituitary fossa; dorsally, it forms the ventral and posterior borders of the notch for the fifth nerve; the anterior pro-otic process is apparently not strongly developed, so that the notch is not deep; further dorsally, the pro-otic forms the ventral border of the large

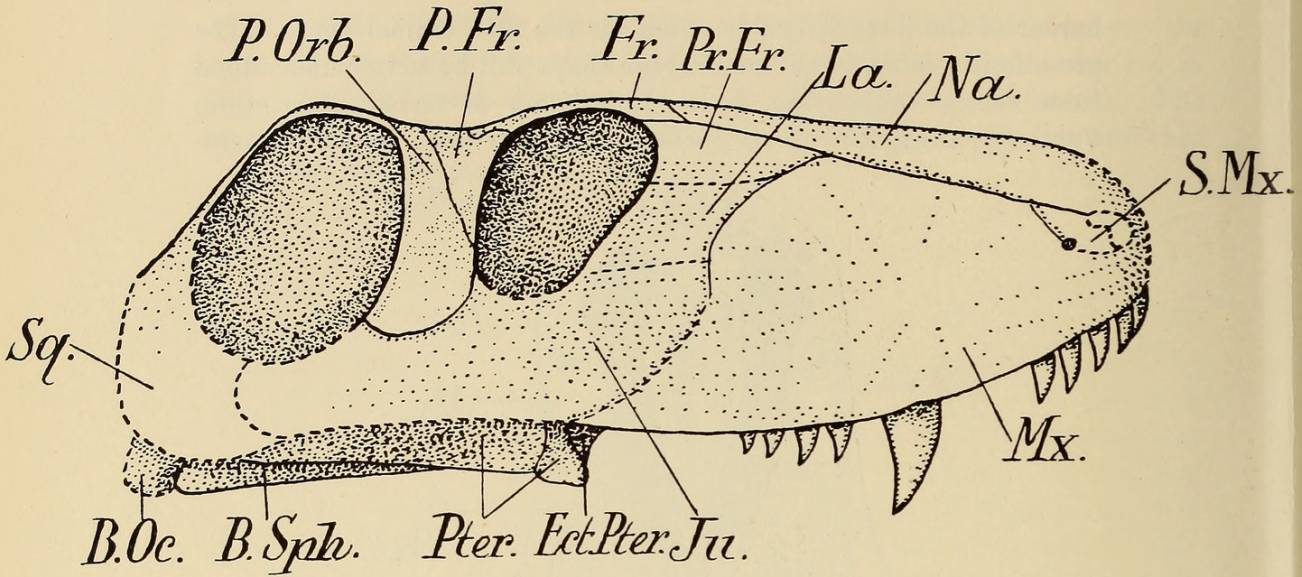

FIG. 12.—*Cynariops robustus*. Type. Lateral view of the skull. × $\frac{4}{5}$.

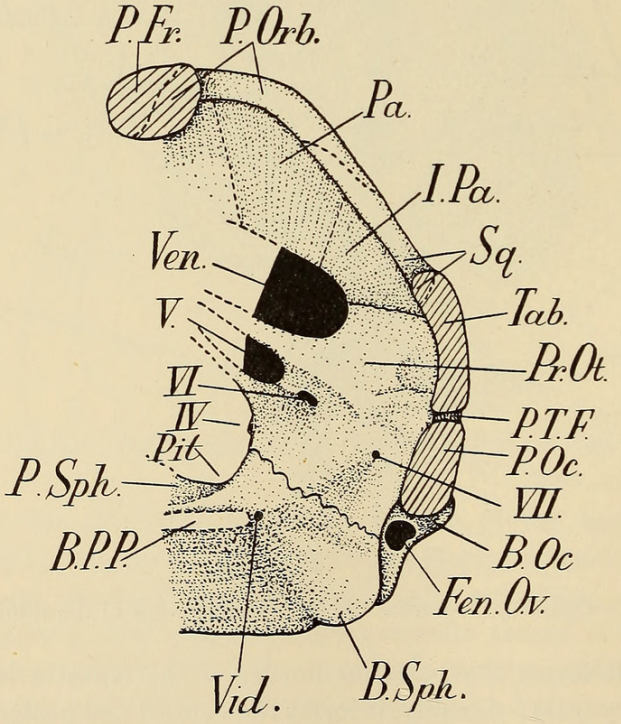

FIG. 14.—*Cynariops robustus*. Type. Lateral view of the left side of the brain-case. × $\frac{4}{3}$.

venous foramen; but, unfortunately, the extent to which the supra-occipital and interparietal enter the side wall of the brain-case cannot be determined. The fenestra ovalis is seen to lie above and behind the basisphenoidal tubera, and appears to be fairly large. The foramen magnum is extraordinarily large and the basioccipital condyle is remarkably small. Unfortunately I have not been able to determine anything as to the presence of a parasphenoidal rostrum or the nature of the sphenethmoidal portion of the brain-case. The most striking feature about the brain-case of *Cynariops* is its great height and relative narrowness. In this respect it agrees with the fragmentary brain-case of "*Lycaenodon.*"

The main morphological features are:

Primitive. Sloping occiput, not cupped; epipterygoid slender; preorbital depression; pro-otic of no great anterior extent.

Advanced. Snout as broad as high and rounded; no step in maxillary border; orbits slightly anteriorly directed; pterygoid flanges anteriorly situated; temporal openings somewhat dorsally directed, but not large; parietal apparently enters brain-case; basi-occipital extraordinarily undeveloped; pro-otic larger than in *Arctops*; frontal forms only small part of orbital border; deep maxilla; short tooth row, but straight; parietal width reduced; paroccipital not massive.

From this summary of characters, it is clear that *Cynariops* is much further advanced than *Arctops*, *Gorgonops*, *Scymnognathus*, and *Leptotrachelus*. In the nature of its brain-case it appears to occupy a position intermediate to *Arctops* and that represented by the brain-case referred to "*Lycaenodon*," and it is in this respect comparable to *Scymnognathus* and *Leptotrachelus*. These two latter genera are, however, in all other respects definitely more primitive.

Chief measurements:

From premaxilla to basisphenoidal tubera .	125? mm.
From premaxilla to pineal foramen . .	97? ,,
From pineal foramen to edge of occipital plate .	8 ,,
From premaxilla to front of orbit . . .	65? ,,
Interorbital width	35 ,,
Intertemporal width	22 ,,
Width of snout	53 ,,
Height of snout	45 ,,
Width across pterygoidal flanges . . .	50 ,,
Height of occiput	45 ,,

Length of molar series	19 mm.
Diastema	2 ,,
Length of incisor series	20 ,,

B.M.N.H., R5743, Biesjespoort Station, Cape Province.

Lycosaurus pardalis, Owen.

This form has been studied by Owen, Lydekker, Broom, and Watson. In Watson's 1921 account all the evidence is fully stated. The left side is best preserved, and Watson's figure is obviously a mirror image of this side. It is the left, and not the right, ramus of the mandible that is preserved. Although the difference in level between the pre-canine and post-canine edge is considerable, the step is not so abrupt as in *Gorgonops*. The dental formula is apparently i. 5, c. 1, m. 4?; the incisors are serrated, but as the teeth are badly preserved this is not well shown. The coronoid process of the dentary stretched far in dorso-posterior direction.

The main morphological features are:

Primitive. Orbits laterally directed; skull higher than wide; laterally situated nostril; slender epipterygoid.

Advanced. Snout short, rounded but high; section of snout not square; no abrupt step in dentigerous border; maxilla deep; small facial part of septomaxilla.

Although *Lycosaurus* is very inadequately known, it seems certain that it represents a stage somewhat in advance of that reached by the forms described above. As nothing is known of the basicranial axis and the posterior part of the skull, it would be best not to include this form in any morphological series.

Chief measurements:

From premaxilla to pineal foramen . .	120? mm.
From premaxilla to front of orbit . . .	80 ,,
Length of lower jaw	130? ,,
Interorbital width	30? ,,
Intertemporal width	25? ,,
Width of snout	43? ,,
Height of snout	43? ,,
Height of mentum	44 ,,
Length of molar series	15? ,,
Diastema	6 ,,
Length of incisor series	11 ,,

Type, B.M.N.H., R1717, Karroo, Cape Province.

1717*a*, ,, ,, ,,

A number of specimens have been referred to *Lycosaurus*, viz.:—

49407. A badly weathered snout, which shows the dental formula i. 5, c. 1, m. ?. Letjesbosch, Cape Province.

49410. A weathered fragment of snout, which shows the dental formula i. 5, c. 1, m. 3 + 1 ?.

R512. Weathered fragment of snout.

Arctognathus curvimola, Owen.

(Figs. 15–17.)

The type is a distorted and weathered skull; the occiput, roof of skull, and temporal arches are very much weathered; part of the palate had been developed, and the teeth of the upper jaw are well preserved on the right side. This type has been studied by Owen, Lydekker, Seeley, Broom, and Watson. Watson's 1921 account is a detailed one, and the sutures of the dorsal and palatal surfaces are indicated in his figures. I have refigured the dorsal surface in order to show the relations of the septomaxilla and its foramen, the maxillo-nasal and the jugo-lacrimal sutures. The septomaxilla is a fairly large bone and the foramen is a fair-sized narrow slit—both larger than described by Watson. The dental formula is i. 4, c. 1, m. 5; the posterior edges of the canine and molars are serrated.

The middle part of the palate was misinterpreted by Watson, who described the pterygoid as a large bone forming the roof of the median groove, carrying the two dentigerous ridges and reaching the prevomers and internal nares. The line of matrix lateral to the dentigerous ridges, taken by Watson to be the pterygo-palatine suture, is a crack. The real suture is plainly visible as a thin, digitating line of matrix, which commences at the antero-median corner of the epipterygoid and then runs medially to cross the dentigerous ridge at its lowest part, then runs obliquely forward and continues in the median line as a well-marked wavy line of matrix. Posterior to the median groove, which has an abrupt hinder edge, there lies a distinct small interpterygoid foramen.

The left side of the skull lacks the temporal arch, and I have succeeded in exposing the lateral surface of the brain-case from this side by removing the displaced portion of the lateral surface. This could have been done sixty years ago as it was a straightforward piece of development, which was accomplished by the use of a small chisel and

hammer only. As now developed, the skull shows all but the anterior quarter of the internal structure in parasagittal view.

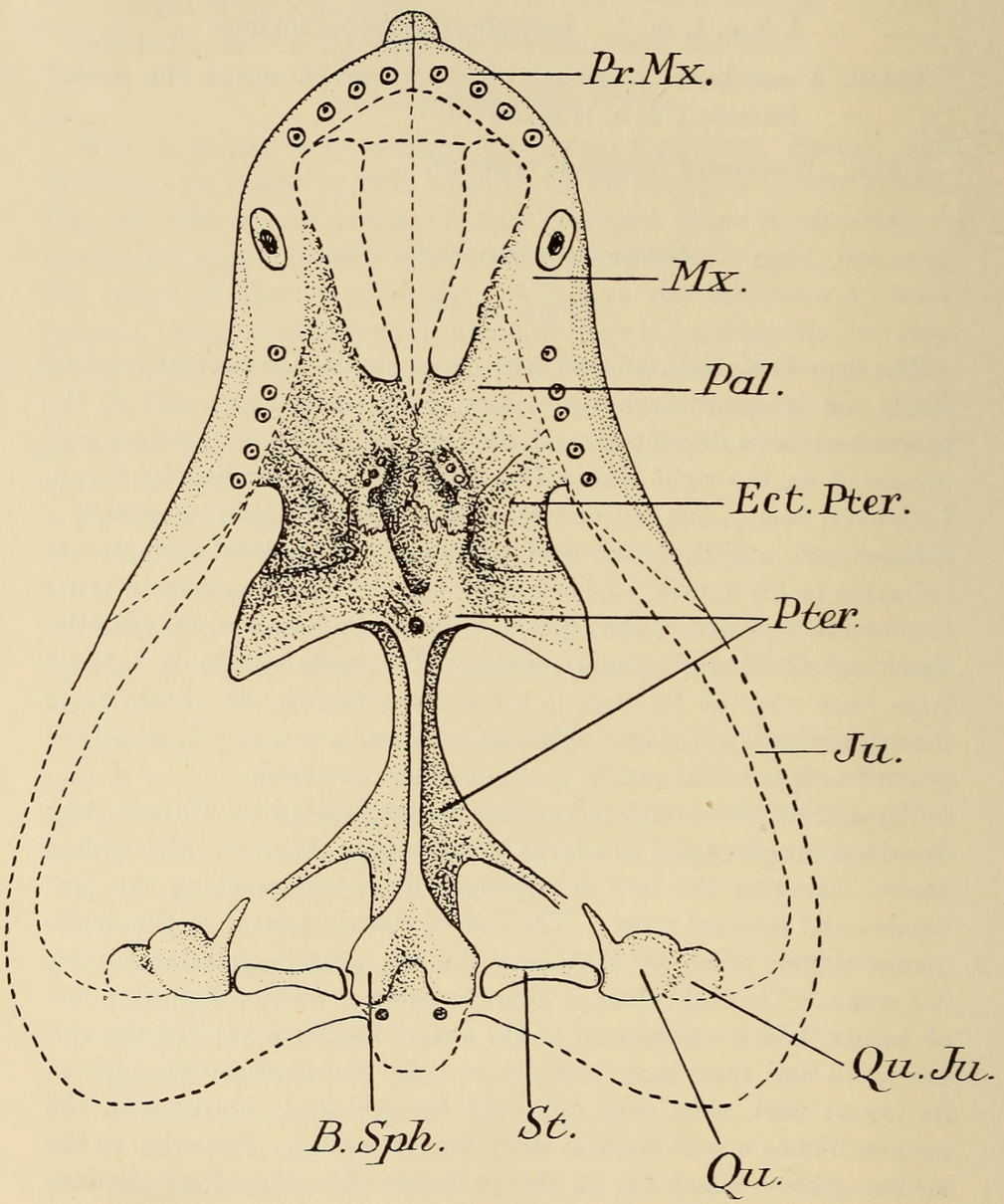

Fig. 15.—*Arctognathus curvimola*. Type, B.M.N.H., 47339. Ventral view of the skull, modified after Watson. × $\frac{3}{5}$.

St. = stapes. Qu. = quadrate. Qu.Ju. = quadratojugal.

The basioccipital condyle and the greater part of the paroccipital have been removed by a fracture; their nature is probably as indicated in broken lines in the figure.

The basisphenoid is present *in toto*. Ventro-posteriorly lie its tubera, which are thin and edge-like; they underlie the ventrally directed processes of the basioccipital and diverge in posterior direction, so that the floor of the hinder end of the brain-case (for the cerebellum) is wide, and the fenestrae ovales far apart. Anteriorly, the basisphenoid extends as a thin vertical sheet of bone, which laterally carries the horizontal basipterygoid processes; the ventral part of this sheet forms the posterior part of the keel, which must further anteriorly be formed by the parasphenoid flanked by the pterygoids, but the exact relations of these elements cannot be determined as the fusion appears to be very intimate; the dorsal part of the basisphenoid is anteriorly confluent with the parasphenoid; its free anterior edge lies in the plane of the posterior border of the pituitary fossa and, in life, this edge must have supported the infundibulum; dorsally, the basisphenoid meets the pro-otic along a line running from the fenestra ovalis to the open side of the pituitary fossa.

The outer surface of the pro-otic does not show up too well; posteriorly, it was apparently applied to the anterior face of the paroccipital in the usual manner; ventrally, it rests on the sides of the basisphenoid; anteriorly, its extent is not great; this is rather remarkable for a form otherwise showing many advanced characters; the anterior process of the pro-otic does not extend far, so that the exit for the fifth nerve appears to be only a shallow notch, whereas in "*Lycaenodon*" it is a large oval foramen; the outer surface of the anterior pro-otic process is deeply hollowed out, and this may have housed the Gasserian ganglion; dorsal to the opening for the fifth nerve, the hinder pro-otic process is also short, so that the venous notch has no extensive osseous ventral border. Dorso-anteriorly to the large fenestra ovalis lies a small foramen for the facial nerve, with a slight hollow under it for the geniculate ganglion. Anteriorly, the pro-otic forms the posterior border of the open side of the pituitary fossa and, posteriorly, forms part of the anterior border of the large and irregular fenestra ovalis.

Dorsally, there are indications that both the parietal and interparietal sent down flanges, which contributed to the formation of the side-wall; the anterior part of this parietal flange articulated with the posterior part of the sphenethmoid; it was this relation that apparently led Watson astray, since, what he interpreted as a broad epipterygoid on the right side is, in reality, the outer surface of the sphenethmoid; the posterior part of the parietal flange articulated with the ascending epipterygoid.

The epipterygoid is not preserved, but there is no reason to suppose it to be different from that of the other known Gorgonopsia; standing on the pterygoid, it would ascend as a thin bony rod in a plane lateral to the other bones of the brain-case, and acted as a lateral wall for the thalamencephalon, mid-brain, and Gasserian ganglion.

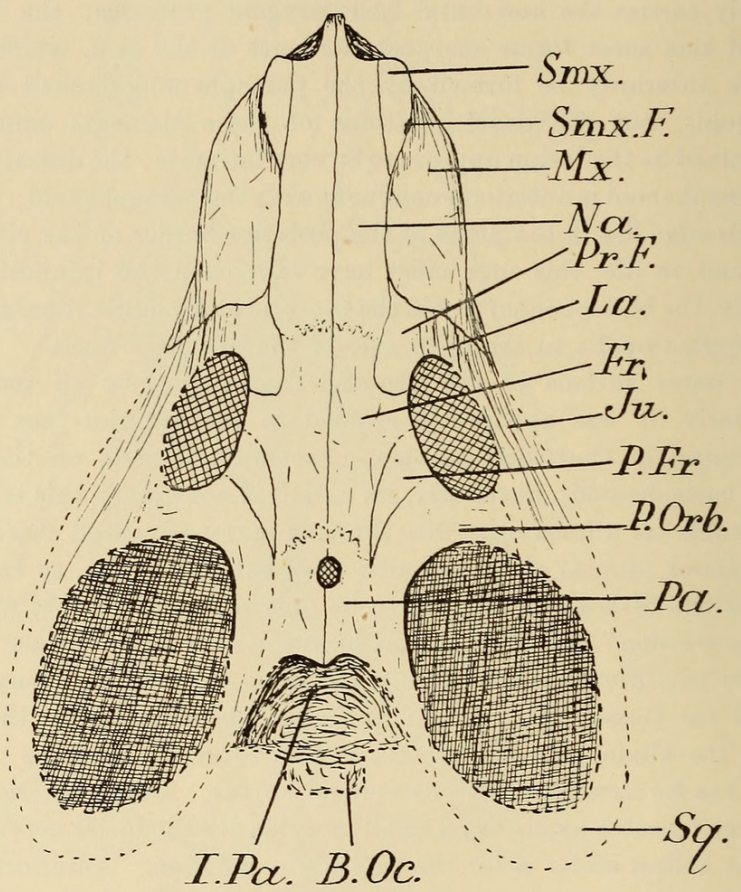

Fig. 16.—*Arctognathus curvimola.* Type. Dorsal view of the skull. × ½.

The parasphenoid, from where it is indistinguishably fused with the basisphenoid, stretches antero-dorsally as a vertical sheet of bone; at its dorsal edge it appears to split, and in this groove the ventral edge of the sphenethmoid rests; anteriorly, the parasphenoid tapers, and here appears as a vertical slip of bone applied to the lateral surface of the sphenethmoidal part of the interorbital septum.

The sphenethmoidal part of the brain-case is beautifully shown, and it is now evident that the "sphenethmoid" figured in *Scymnognathus*

and *Leptotrachelus* is only a part of that bone. The sphenethmoid in *Arctognathus* is a very large element; its ventral half represents a part of an ossified interorbital septum and rests on the parasphenoid, and, further forward, on the dorso-median keel of the pterygoid. Anteriorly, the interorbital septum is continued forward, but is separated by an unossified portion from the internasal septum. It is thus only the dorsal portion, which has split into two curved sheets of bone, that is preserved in *Scymnognathus* and *Leptotrachelus*. This housed the

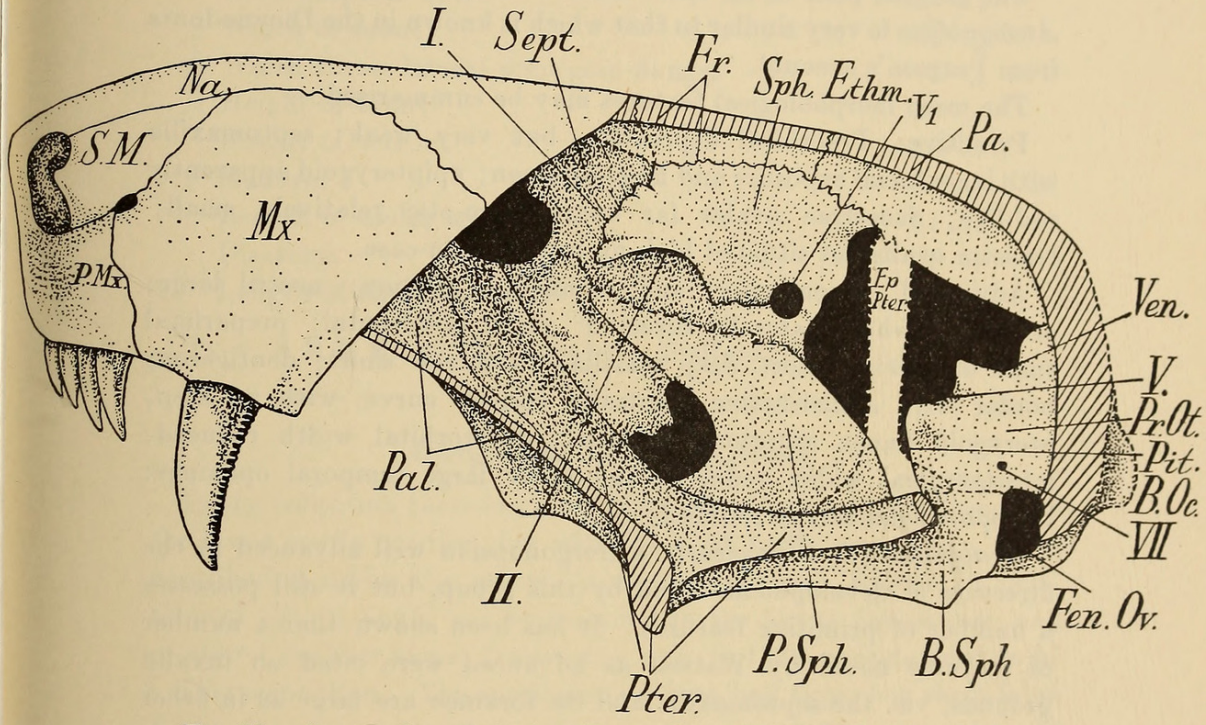

FIG. 17.—*Arctognathus curvimola*. Type. Lateral view of the left side of the brain-case. × $\frac{2}{3}$.

fore-brain. Dorsally, flanges from the frontal and parietal are sent downwards and these, meeting the dorsal edges of the sphenethmoid, complete the side-wall. Ventro-posteriorly, a large rounded foramen pierces the sphenethmoid; it is directed somewhat forward and outward, and from it may have emerged the ophthalmic branch of the fifth nerve, but the large size makes it more probable that it is really a venous foramen. Ventro-anteriorly, lies a downwardly-directed oval slit between the median septum and the side of the sphenethmoid, through which the second nerve emerged. Anteriorly, the sphenethmoid has a free edge, and anterior to this edge, the median septum

is visible. The olfactory lobes were probably situated in this position. Antero-ventrally to the tapering end of the parasphenoid, the sphenethmoidal part of the interorbital septum is extraordinarily thickened and, in this part, rests on the dorso-median keel of the anterior pterygoid ramus. The thickening is solid, and I can make no suggestion as to its probable function. Posterior to this structure there is a gap, which thus lies between the sphenethmoid, pterygoid, and parasphenoid.

The general plan of all these internal ossifications in the skull of *Arctognathus* is very similar to that which is known in the Dicynodonts from Pearson's account.

The main morphological features may be summarised:—

Primitive. Preorbital depression, but very weak; septomaxilla with large facial exposure and large foramen; epipterygoid apparently rod-like; fenestrae ovales far apart; pro-otic relatively small; fenestra ovalis not situated high up in the brain-case.

Advanced. Snout short and rounded in section; nostril large; orbits not wholly laterally directed; small postfrontal; preparietal small or absent; short, deep maxilla; tooth row short; dentigerous border with a distinctive, ventrally convex curve, with no step; pterygoid flange anteriorly situated; interorbital width reduced; intertemporal width reduced, and fairly large temporal openings; basisphenoidal tubera reduced.

Arctognathus is thus clearly a Gorgonopsian well advanced in the direction of development taken by this group, but it still possesses a number of primitive features. It has been shown that a number of features noted by Watson as advanced were cited on invalid grounds, viz. the septomaxilla and its foramen are large as in other Gorgonopsians and there is no evidence that the epipterygoid is broad. The pro-otic is certainly not very advanced, and stands on the same developmental niveau as do *Scymnognathus* and *Leptotrachelus*; in this respect "*Lycaenodon*" is much more advanced. The nature of the basisphenoid and its relations with the pterygoids and parasphenoid do not show very marked advances over the condition of the earlier Gorgonopsians that have been described above. In the attainment of a short rounded snout and the reduction of the interorbital and intertemporal width, however, *Arctognathus* shows definite advances. The great amount of ossification in the median septum appears to be primitive and will probably be found in the earlier forms when better preserved material is examined.

Chief measurements:

From premaxilla to basisphenoidal tubera	180 mm.
From premaxilla to pineal foramen	126 ,,
From pineal foramen to edge of occiput	32 ,,
From premaxilla to front of orbit	91 ,,
Length of lower jaw	153 ,,
Width across squamosals	146? ,,
Interorbital width	36 ,,
Intertemporal width	38? ,,
Width of snout	64 ,,
Width across lateral pterygoid flanges	72 ,,
Height of snout	56 ,,
Height of occiput	55? ,,
Mentum	67 ,,
Length of molar series	31 ,,
Diastema	7 ,,
Length of incisor series	23 ,,

Type, B.M.N.H., 47339, Kagaberg, Bedford, Cape Province.

Arctognathus ?curvimola, Owen.

In the collection there is a preorbital portion of a skull with part of the lower jaw in position, but with the teeth badly preserved. Owen described it under the name *Lycosaurus tigrinus*; Broom, in 1911, showed that it could not be included in the genus *Lycosaurus*, and proposed the new name *Arctosuchus*, and, in 1932, considered it to be a Therocephalian. The specimen is a very bad type, but there is no doubt that it represents a Gorgonopsian, probably very close to *Arctognathus*. In 1921 Watson maintained that it was specifically identical with *Arctognathus curvimola*. I have etched the right side of the snout, and the maxillo-premaxillary suture now shows clearly; the relations of maxilla, premaxilla, septomaxilla, and septomaxillary foramen and the nostrils are typically Gorgonopsian and do not differ much from the condition in *A. curvimola*. There appear to be four incisors, although the roots of only two are actually preserved; the molars are badly preserved, but probably number five. All the features shown by the fragment thus agree very well with *A. curvimola* and, as no differentiating features can be determined, there is no valid reason to distinguish it by name from *A. curvimola*.

B.M.N.H., R1719, Mildenhalls, Fort Beaufort, Cape Province.

Cynodraco serridens, Owen.

Owen described a number of fragmentary snouts under this name, and another fragment presumably associated with a good humerus under the name of *C. major*. There is no evidence to warrant the separation into two distinct species. Moreover, so little can be determined of the structure that, except for the deep mentum in one specimen, there is very little evidence that the fragments are Gorgonopsians at all. Owen's lithographs show the general appearance of these specimens very well. They are :

Type, B.M.N.H., 47084, Bovey's Farm, Fort Beaufort, Cape Province.

This is a bad piece of snout, which exhibits some features of the incisors; there are five upper incisors with fairly strong and coarse serrations, four lower incisors with similar serrations; the incisors are strong and protruding.

B.M.N.H., 47086, Fort Beaufort, Cape Province.

A mandibulary fragment showing the canine of both sides and also four incisors.

B.M.N.H., 47085, Stylkrantz, Graaff-Reinet, Cape Province.

Weathered and fragmentary snout; the fragmentary incisors show fairly coarse serrations on both anterior and posterior edges. The spur of the septomaxilla protruding into the nostril is shown on the right side.

B.M.N.H., 47309, Mildenhalls, Fort Beaufort, Cape Province.

This is Owen's type of *C. major*. It consists of a fragment of mandibulary symphysis with both upper canines attached. The roots of four large incisors are seen in section; the serrations on the posterior border of the very large canines are beautifully preserved. The symphysis is deep.

B.M.N.H., 47310, Mildenhalls, Fort Beaufort, Cape Province.

A very good left humerus showing both foramina, well illustrated in Owen's lithograph.

Chief measurements :

Length	260 mm.
Width across the epicondyles	110 ,,
Width across the proximal surface	105 by 36 mm.
Width across delto-pectoral crest	110 mm.
Maximum width of shaft	36 ,,
Minimum width of shaft	26 ,,
Length of delto-pectoral crest	149 ,,

Cerdognathus greyi, Broom.

The type is an imperfect dentary; the number of incisors cannot be ascertained, but four seems to be the most probable number; the canine and four molars are badly preserved as casts and, although no serrations can be seen, this evidence is simply negative; Broom is probably right in postulating a low coronoid process, as this would conform with the general contour. The very low, though upright, symphysis and the absence of a diastema stamps the dentary as a distinct type; but one wonders if such a fragment warrants the creation of a new generic name.

Chief measurements:

Probable length of dentary	100? mm.
Height of symphysis	21 ,,
Length of molar series	13 ,,
Depth of dentary behind last molar . .	14 ,,

Type, B.M.N.H., R2892, Klippoort, Cradock, Cape Province.

Scylacops capensis, Broom.

This specimen consists of the middle third of a skull, which shows the greater part of the structure of that region. Watson's description and figures appear to be correct in every detail. His attitude with regard to the specimen is to be highly commended. The snout is missing and the dentition is thus unknown and, as much of the classification of the Gorgonopsia rests on this character, Watson, although recognising the fact that he had before him a representative of a new genus, refrained from naming it. Instead, he gave a good morphological account, which is of far greater value than a new generic name. Subsequent finds have shown the wisdom of such a procedure. We now have an excellent skull as the type of *Scylacops capensis*, named by Broom, but to Watson must go the honour of the first morphological description.

B.M.N.H., 47098, ?Fort Beaufort, Cape Province.

A Fore-foot of an Unnamed Form.

(Fig. 18.)

Lying on a series of vertebrae, there is a partial right fore-foot of a Gorgonopsian. The fourth digit is fully preserved; the third lacks

only the point of the claw; the fifth has two phalanges preserved; parts of the third, fourth, and fifth metacarpals are present; the fourth and fifth distals are present as a single fused element, to which the distal half of the ulnare is articulated. The foot is typically Gorgonopsian (about two-thirds the size of that of *Aelurognathus tigriceps*), with the distinctive mammal-like epiphysial distal ends to the metacarpals, and with indications of an incipient reduction

FIG. 18.—An unnamed Gorgonopsian. B.M.N.H., R3768. Dorsal aspect of the partial manus. × ½.

U. = ulnare.
4+5 = fused fourth and fifth distal carpals.
III–V = the third, fourth, and fifth digits.

in the number of phalanges. The fourth and fifth metacarpals articulate with the fused fourth and fifth distals; the second phalanx of the fourth, and, in particular, of the third digit, is very much shortened; the third phalanx is robustly developed.

As preserved, the phalangeal formula is—?, ?, 4, 4, 3. If the first and second digits possessed two and three phalanges respectively, the structure of the digits would be exactly as in *Aelurognathus tigriceps* and, as in that form, dorso-ventral movement of the segments *inter se* is well developed with finely modelled articulatory faces.

B.M.N.H., R3768, Oude Klip, Cape Province.

Short Discussion.

In a series of papers on the Therocephalians, Gorgonopsians, Bauriamorphs, and Cynodonts, Watson has argued that one branch of the Therocephalians gave rise to the Bauriamorphs, and that the Gorgonopsians led on to the Cynodonts. With the first conclusion I can concur, but in this study of a limited number of Gorgonopsian skulls two important facts bearing on this question have been established, viz. the nature of the epipterygoid and the relations of the posterior end of the prevomers, and these seem to invalidate Watson's second conclusion. In all the Gorgonopsians I have studied there is no evidence, whatsoever, of a tendency for the original slender rod-like epipterygoid to become widened and intimately incorporated into the side-wall of the brain-case; and in all, where the palate is known, the prevomers have their posterior ends tapering and are here clasped by the palatines and do not meet the pterygoids on the ventral surface. In the Therocephalia, on the other hand, there is very definite evidence of the progressive widening of the epipterygoid and, in this group, the posterior end of the prevomers is expanded and underlies the pterygoid in ventral view. This is also the condition in the Cynodonts. With respect to the nature of the prevomers and the epipterygoid, it seems that the Gorgonopsians must be excluded from the direct ancestry of the Cynodonts; but at this stage it would be premature to maintain that these two characters indicate a Therocephalian ancestry. I am more inclined to think that no known Therocephalian indicates anything more than a parallel development in the two suborders, *Therocephalia* and *Cynodontia*. I do not intend to continue this discussion any further; this can be more profitably done when the various suborders of the Theriodontia are treated monographically, as I hope to be able to do in the near future.

My thanks are due to the officers of the British Museum (Natural History) for permission and facilities to study the material in their charge. I am particularly grateful to Dr. W. E. Swinton for his constant readiness to facilitate my work, and to Mr. Parsons for doing some of the developmental work. Professor D. M. S. Watson's interest was very encouraging, and his critical advice always welcome. To the University of Stellenbosch I am indebted for a small scholarship, which has enabled me to undertake the visit to London. All but three of the figures are by my wife.