ON SOME NEW CYNOGNATHUS ZONE SPECIMENS

By A. S. Brink and J. W. Kitching

Abstract

This paper describes a number of new specimens recently collected in *Cynognathus* zone beds, now in the collection of the Bernard Price Institute for Palaeontological Research. These specimens include two new genera and species, *Cistecynodon parvus* and *Inusitatodon smithi*. The former is related to the Galesauridae, but it may perhaps represent a new family of Cynodonts. The latter is a Gomphodont Cynodont. In addition a very perfect specimen of *Bauria cynops* is described and descriptions based on two other specimens affirm the validity of Broom's genus *Cyclogomphodon*. The paper also includes a short description of a specimen of *Diademodon broomi*.

On a fossil-collecting expedition to localities in the *Cynognathus* zone (October, 1952), Kitching collected 98 specimens, of which the tiny skull which we describe first is perhaps the most interesting. It was discovered on the farm Luiperdskop in the Aliwal North district, within a grey horizon which appears to be in the middle of the *Cynognathus* zone. It also appears as though this grey horizon is continuous with similar horizons on Winnaarsbaken, Vaalbank and Matyantya (see our description of *Bauria cynops* below). The specimen is numbered 318 in our collection.

Cistecynodon parvus gen. et sp. nov. (figs. 28-31)

For its size the type skull of this new genus and species is well preserved and remarkably well cleaned. Without removing the lower jaw, the palate was completely cleaned. The cleaning of the skull was not carried as far as is suggested in figures 28 and 29; in the preparation of the two figures they were superimposed to bring information from the one to the other so that, for instance, the relative positions of the postorbital bars and pterygoid processes could be illustrated. The specimen is also not as perfect as illustrated in figure 29. Certain detailed structural information is revealed only on the one side and in the case of the quadrates and the bones in the posterior parts of the lower jaw only the outlines could be ascertained. In general the sutures are remarkably well displayed for a specimen of this size although, judging not only from the sutures but also from the dentition, the skull is certainly that of a fully adult individual.

The skull is 55 mm. long, measured from the occipital condyles to the premaxillaries, and 50 mm. broad across the zygomatic arches. The snout is very short and broad for a Cynodont. It measures 21 mm. across the canines and 23 mm. from the premaxillaries to the anterior borders of the orbits. The orbits are perfectly round, with a cross section of 12 mm. The interorbital width is 15 mm.

The base and posterior palatal region of the skull is quite different from the average Cynodont condition. Superficially the skull may be considered as belonging to the family Galesauridae, especially as far as the dentition is concerned, but there are some peculiarities about the skull which induce us to consider this specimen as perhaps representing a new family of Cynodonts. These peculiarities are the absence of a pineal foramen, a fully developed secondary palate to which the palatines do not contribute, the short, broad and blunt snout, the two perfect and well separated occipital condyles, the peculiar pterygoids, and the alisphenoid prolongations to the quadrates.

The *basioccipital* does not take part in the occipital condyles. It contributes

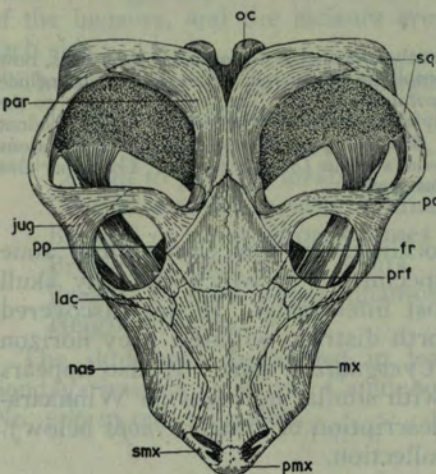

Fig. 28.—Dorsal view of the skull of *Cistecynodon parvus* gen. et sp. nov. natural size.

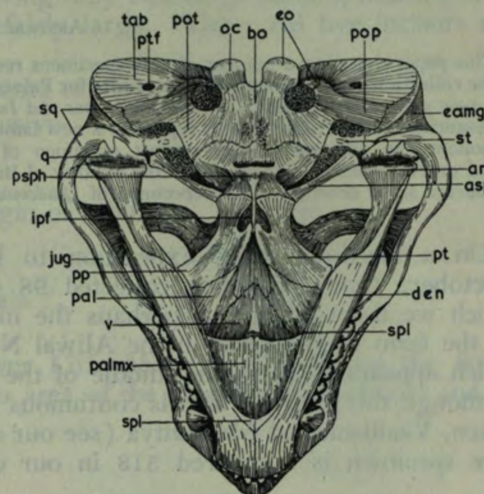

Fig. 29.—Ventral view of the skull of *Cistecynodon parvus* gen. et sp. nov. natural size. For abbreviations see page 31.

to the ventral margin of the foramen magnum. The bridge between the two occipital condyles is much reduced so that the condyles are well defined. The basioccipital does not contribute to the margins of the jugular foramina. It articulates with the parasphenoid relatively far forward. There are two longitudinal depressions immediately behind this suture.

The *exoccipitals* form the two large and well defined occipital condyles and the postero-medial halves of the margins of the large jugular foramina. They also form for short distances part of the margin of the foramen magnum, dorsally to the occipital condyles. Each exoccipital articulates with the prootic on the medial margin of the jugular foramen, laterally to the basioccipital, and with the opisthotic on the posterior margin of the jugular foramen.

The *supraoccipital* is relatively large and reaches fairly high. It articulates with the exoccipitals on the lateral margins of the foramen magnum and extends sidewards almost as far as these bones.

The *opisthotic* forms the paroccipital process, which is inclined forward. The paroccipital process appears to be a rather flat bone. Along the whole of its dorsal margin the opisthotic articulates with the tabular, and antero-medially it articulates with the prootic. Laterally it merely rests against the squamosal. It is not clear to what extent the opisthotic contributes to the fenestra ovalis.

The *prootics* are not well preserved on either side, but their ventral surfaces could not have been much different from our interpretation as figured in fig. 29. They articulate medially with the basioccipital, anteriorly with the parasphenoid, while their lateral margins are free. The base of the skull is very broad across the prootics. The fenestrae ovales are evidently situated immediately above the lateral margins of the prootics.

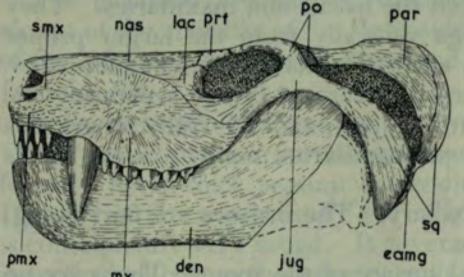

Fig. 30.—Lateral view of the skull of *Cistecynodon parvus* gen. et sp. nov. natural size.

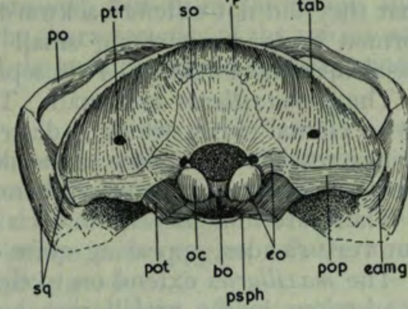

Fig. 31.—Posterior view of the skull of *Cistecynodon parvus* gen. et sp. nov. natural size.

Abbreviations: art, articular; asph, alisphenoid; bo, basioccipital; den, dentary; eamg, external auditory meatus groove; eo, exoccipital; fr. frontal; ip, interparietal; ipf, inter pterygoid fossa; jug, jugular; lac, lachrymal; mx, maxillary; nas, nasal; oc, occipital condyle; pal, palatine; palmx, palatal plate of the maxillary; par, parietal; pmx, premaxillary; po, postorbital; pop, paroccipital process; pot, prootic; pp, pterygoid process; prf, prefrontal; psph, parasphenoid; pt, pterygoid; ptf, post temporal fossa; q, quadrate; smx, septomaxillary; so, supraoccipital; spl, splenial; sq, squamosal; st, stapes; tab, tabular; v, vomer.

The *tabulars* are relatively large and cover the posterior faces of the squamosals completely. They do not overlap the paroccipital processes. The posttemporal fossae are situated well within the tabulars.

The *interparietal* is relatively small.

The *parietals* form the parietal crest, but contribute very little to the occipital crests. They diverge posteriorly in front of the margins of the occipital crests and extend far laterally, articulating throughout with the squamosals. Anteriorly they diverge and extend forward on each side of the frontals as tapering processes. These anterior processes are overlapped laterally by the postorbitals. There is no parietal foramen and the preparietal is missing. The parietal region is fairly broad.

The *postorbitals* are typical. Their posterior prolongations are very short and do not extend farther back than the frontals. It is not clear where exactly they meet the jugals on the postorbital bars. They form half of the dorsal margins of the orbits.

The *frontals* are large and broad. They extend up to the margins of the orbits without actually forming part of the latter. At the level of the anterior borders of the orbits they articulate with the nasals, forming a very broad suture.

The *prefrontals* are very small.

The *lachrymals* are relatively large and form the whole of the anterior borders of the orbits.

The *nasals* are very broad posteriorly, where they are flanked laterally by the lachrymals. Forward of the middle of their lengths they grow extremely narrow, but broaden out again very sharply farther forward. Even where they form the dorsal margins of the external nares, they are still very narrow compared with the breadth of the snout.

The *septomaxillaries* are not well preserved. It is however quite definite that they did not extend backward between the nasals and maxillaries. They formed bridges separating small openings ventrally from the larger proper nasal opening dorsally. This separation appears to have been complete.

The *premaxillaries* are small. They formed a vertical bridge separating the two external nares, which is destroyed in the specimen. Dorsally where this bridge reaches the surface of the skull the premaxillaries merely join the nasals without penetrating between them.

There are four incisors in each premaxillary. The incisors are fairly long, but very slender, appearing quite delicate.

The *maxillaries* extend on to the dorsal surface of the snout. There are no depressions in the maxillaries dorsally. Posteriorly the maxillaries overlap the jugals and extend to the level of the middle of the orbits. There are two tiny foramina on each side, relatively far forward.

Ventrally the maxillaries slope very little inward to the alveolar borders, with the result that the maxillary teeth of the two sides are well separated. There is a broad, fully developed secondary palate.

The canines are large and very long. The postcanine teeth are well cusped. There are six postcanine teeth, measuring 14 mm.. in length. The first follows immediately on the canine. It has a simple cone-shaped crown. The second has a trace of an additional cusp posteriorly. These two teeth could possibly be premolars. The following four teeth are much larger, each with a main cusp with a smaller cusp in front and a similar cusp behind, and may be considered as molars.

The last tooth is almost level with the anterior border of the orbit and the posterior border of the palate is level with the penultimate tooth. Immediately behind the ultimate tooth the dentary passes so close to the alveolar border and the maxillary passes so sharply outward that there is no room for an additional tooth, even to develop at a more advanced age. The dentition can therefore be considered as complete.

The dentition is typically Cynodont. The upper jaw molars bite outside of the lower jaw molars.

The *transverse* bone could not be displayed.

The *jugals* are much damaged on both sides, but their outlines could be determined from their impressions on the matrix. They form the suborbital bars which extend sharply upward posteriorly. After evidently contributing to a portion of each postorbital bar each extends downward again farther posteriorly. There is no trace of a jugal process. The zygomatic arch is indeed most peculiarly shaped.

The *squamosals* form the posterior portions of the zygomatic arches, which now descend practically vertically down to almost level with the ventral margins of the dentaries. At this level the quadrates articulate with the squamosals and immediately behind this articulation the external auditory meatus groove extends medially and anteriorly to level with the medial end of each quadrate. Here the squamosal perhaps articulates with the posterior prolongation of the alisphenoid. From the meatus grooves the squamosals rise directly in a postero-dorsal and later medial direction, posteriorly to the occipital wings of the parietals to form the anterior faces of the occipital crests.

The *quadrates* are almost completely destroyed, but from the shape and extent of the articular of the right side, and the characteristics of the squamosal of the left side, the general shape and size of the quadrate could be ascertained (see fig. 29).

Both *stapes* are missing.

The *vomer* divides the internal nares from each other. In this region it forms a fairly thick septum descending from the roof of the internal nares. Dorsally it forms practically the whole of the roof of each internal naris and is consequently very broad. It covers the palatines in this region. Posteriorly it tapers and covers the anterior ends of the pterygoids.

The *palatines* do not contribute to the secondary palate. They extend for short distances backward along ridges running across the pterygoids to the lateral walls of the internal nares.

The *pterygoids* form delicate pterygoid processes descending medially to the dentaries to a level 3 mm. short of the ventral margins of the latter. They are situated very far forward. It appears as though ridges extended from these processes to the posterior border of the secondary palate. Each pterygoid forms a descending process near the midline, at a level well behind the pterygoid processes, curving over towards its fellow of the opposite side. Both these processes then curve backward to clasp a plate-like extension of the parasphenoid between their ends. Immediately behind this structure, on each side of the parasphenoid plate, there are two cavities filled with matrix. Together they represent the interpterygoid fossa, but we could not establish how far they pass upward or whether they join above the parasphenoid plate.

The pterygoids articulate with the main parasphenoid bone immediately behind the interpterygoid fossa and at this level, but laterally, with the alisphenoids.

There is no suborbital fossa.

The *alisphenoids* could not be exposed, but the extensions of these bones to the quadrates, from the points where they articulate with the pterygoids, could be laid bare. These extensions are very delicate and were somewhat damaged, but enough is preserved to establish that they definitely belong to the alisphenoids.

The *parasphenoid* is most peculiar. It grows fairly narrow posteriorly to its articulation with the pterygoids and from this region it sends a plate-like process ventrally and anteriorly, dividing the interpterygoid fossa in two. The internal carotid foramina evidently passed into the brain cavity immediately above the anterior end of the parasphenoid, where the bone is narrowest. Farther back the bone grows extremely broad very suddenly, from above the internal carotid foramina backward and downward to the prootics. Medially, behind the plate-like process, the parasphenoid descends into a transverse crest with an almost vertical posterior face rising towards the basioccipital suture.

The *dentary* has a very distinct angular process and a well developed coronoid process, the posterior margin of which extends very close to the squamosal. The symphysial region is broad and low, with a well rounded "chin." There are three incisors on each side, smaller and more delicate than those of the upper jaw. The lower jaw canines are not exposed. The post-canine teeth of the lower jaw could barely be reached from the palatal side. There are four large molars exactly opposite the four of the upper jaw, and slight indications of two small pointed teeth in front, also opposing the upper jaw premolars. Unless there are more premolars farther forward in the lower jaw, which we strongly doubt, there should be a diasteme behind the canine.

The dental formula for this specimen is therefore:

$i\frac{4}{3}$, $c\frac{1}{1}$, $pm\frac{2}{2}$, $m\frac{4}{4}$.

The rest of the lower jaw bones are very badly preserved. The splenials can only be traced anteriorly and the articular on the right posteriorly. In figure 29 merely a general outline is given of the bones posteriorly in the lower jaw.

Bauria cynops Broom (figs. 32-35)

The following description is based on a complete skull and lower jaw,

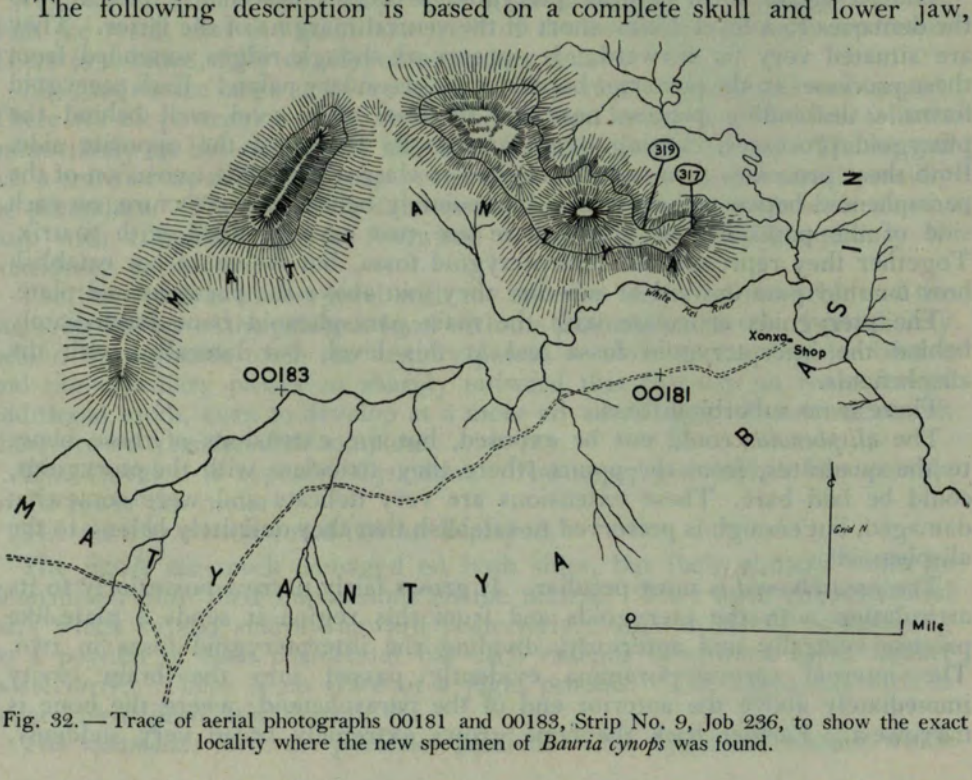

Fig. 32.—Trace of aerial photographs 00181 and 00183, Strip No. 9, Job 236, to show the exact locality where the new specimen of *Bauria cynops* was found.

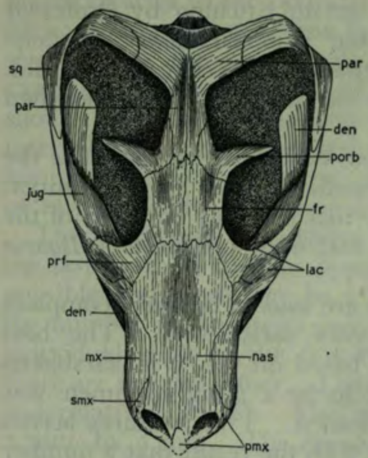

Fig. 33.—Dorsal view of the skull of *Bauria cynops* (½ natural size).

Abbreviations; ang, angular; art, articular; bo, basioccipital; den, dentary; eo, exoccipital; fr, frontal; ipf, inter pterygoid fossa; jug, jugular; lac, lachrymal; mx, maxilla; nas, nasal; pal, palatine; palmx, palatal plate of the maxilla; par, parietal; pmx, premaxilla; poc, paroccipital process; porb, postorbital; pp, process of parasphenoid; prf, prefrontal; psph, parasphenoid; pt, pterygoid; q, quadrate; smx, septomaxilla; sof, suborbital fossa; sq, squamosum; st, stapes; tr, transverse bone; v, vomer.

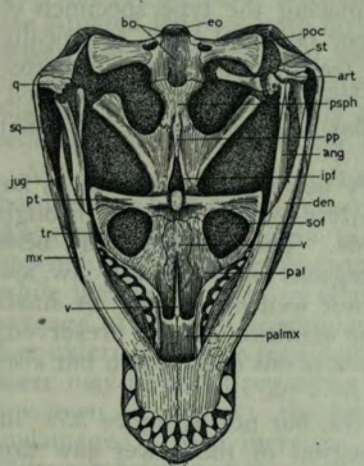

Fig. 34.—Ventral view of the skull of *Bauria cynops* (½ natural size). For abbreviations see fig. 33.

discovered by Kitching in *Cynognathus* zone beds in the Matyantya basin south-west of Lady Frere. The specimen also includes a portion of the skeleton; an isolated left dentary of another individual, with fairly well preserved teeth, was found about four feet away. These specimens come from a horizon consisting of coarse grained grey shale, about four feet in thickness. This horizon is exposed on the slopes of the Matyantya feature itself, in the middle of the basin, about half way up. The latter feature is 1,678 ft. high, measured from the level of the river south of it. All the strata above and below this horizon, excluding the sandstone horizons at regular intervals, consist of reddish brown shale and the fossils occurring in these layers are characterized by the typical dark red brown oxidation coating, which is not found over fossils of the grey horizon.

Figure 32 is a trace of the aerial photographs on which the exact locality of the specimen is registered (Air Force: job 235/6, Sept. 1949 16035-7; Trigonometrical Survey: Job 236, Strip 9, No. 00181-3).

The new specimen is slightly smaller than the type in the South African Museum and the second specimen in the American Museum of Natural History. The latter comes from Winnaarsbaken, where the grey horizon forms the topmost layer, with the reddish shales below it well exposed. The farm Vaalbank, where the type was found, derives its name from this grey horizon, which is the only layer exposed. The exact

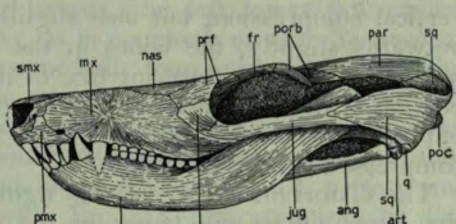

Fig. 35.—Side view of the skull of *Bauria cynops* (½ natural size). For abbreviations see fig. 33.

locality where the type was found was pointed out to Kitching by Professor Watson in 1948. We do not know whether the Winnaarsbaken specimen comes from the grey horizon, but we are prepared to accept that it did. Although the type was not in situ, there can be no doubt that this specimen is from the grey horizon.

The grey horizon is one of the lowest layers on Vaalbank, whereas it is the topmost layer on Winnaarsbaken and an intermediate layer in Matyantya. If there may have been doubt over the possibility that the grey horizons of the three different localities are identical, the fact that each produced a *Bauria cynops* now settles the question.

Although the two already described specimens are said to be fairly complete and well preserved, the descriptions are not very satisfactory. The best description was published by Boonstra in 1938, based on the Winnaarsbaken specimen, but he acknowledged that what used to be a good specimen was ruined by Broom in a very hurried attempt to clean it. Two fractures across the skull were ground down to produce sections, with the result that a number of points of evidence were destroyed. Even then the specimen was apparently not even half cleaned, and after Boonstra prepared it properly for a description, Broom intervened and published a hurried description which appeared before Boonstra's (1937).

Broom's description of the type (1909) is so unsatisfactory that we can hardly compare our new specimen with it. Our comparisons are largely based on Boonstra's descriptions of the Winnaarsbaken specimen. There are some points of difference, at first sight of enough importance to warrant the recognition of our specimen as a separate genus, but we consider these differences to be artificial, perhaps as a result of distortion or bad preservation, but more likely bad preparation, and in this respect we do not blame Boonstra for any misinterpretations.

We would like to thank Dr. Barnard, the Director of the South African Museum, and Dr. Boonstra very sincerely for placing the type specimen of *Bauria cynops* at our disposal. The type is a very beautiful skull, practically complete and not distorted at all. We certainly feel that it warrants a better description than Broom's of 1909, but the specimen is so poorly developed, largely with the aid of grinding instruments, that any attempt at additional development appears to be futile.

Our specimen is a very perfect one. It is very beautifully prepared, as far as the hard matrix would allow. It is only slightly distorted, largely through vertical compression, but also slightly rightwards. The mandibles are bent outwards slightly, the bones in the posterior regions of the lower jaw are imperfect, and the posterior face of the skull is not well preserved. A small portion of the internarial bridge is missing. The dentition is well preserved, but could not be cleaned properly, as the lower jaw is not only in situ but also compressed against the palate.

The distortion is corrected in figures 33 and 34, but not in figure 35. In the latter figure the bones in the posterior region of the lower jaw are reconstructed from the right side, while in figure 34 these bones are drawn as they appear on the specimen.

The new specimen is 117 mm. long, measured from the reconstructed premaxillaries to the occipital condyle. The squamosals do not extend farther back; they reach the same level as the occipital condyle. The breadth of the skull across the squamosals is 76 mm., but this breadth may have been exaggerated a millimeter or two as a result of vertical compression. The snout is 27 mm. broad and does not expand anteriorly. The parietal and interorbital widths are 8 and 18 mm. respectively. The zygomatic arch has a minimum vertical thickness of 3 mm. and the dentary has a vertical thickness of 11 mm. in the middle of the row of post-canine teeth.

There are nine postcanine teeth on the left side in the lower jaw, but as the last tooth in the row opposes the penultimate tooth in the upper jaw, it is possible that there may be a tenth tooth in the lower jaw. We cannot count the number in the upper jaw, but taking the total distance (30 mm.) and the individual sizes of the few teeth that are exposed, we could establish that there are ten altogether. The teeth are short (vertically and antero-posteriorly) and relatively broad. The largest tooth in the isolated lower jaw measures 3 mm. by 5 mm. The crowns have flat tops, showing wear, but there is no evidence that cusps were present. The ten post-canine teeth in the isolated lower jaw measure 32 mm.

We disagree with Broom's interpretation of the molars in the type (1909) as well as with Boonstra's interpretation (1938) as figured in their side views. According to Broom's figure the molars are not flat crowned and they are well spaced. According to Boonstra the molars are flat crowned, but we disagree with his spacing. His interpretation of the size and spacing in his palatal view (figure 4) agrees perfectly with our interpretation. The molars are spaced to some extent at the level of their necks, but the crowns expand so that they come in contact with each other. If the crowns are considerably worn with old age, it is possible that the impression may be created that they are well spaced.

The canines are not very powerful; they are only slightly larger than the incisors, but the latter are indeed relatively very large. The upper jaw canines are situated far back with no diastemes between them and the molars. In the lower jaw it appears from the specimen as though there is a diasteme behind the canines, but in the isolated lower jaw this is not the case. The reason is that the lower jaw canine is inclined forward so that although the crowns are well spaced, the necks of the canine and first molar are close together.

Where the maxillary joins the premaxillary on the alveolar border, this border is so reduced that the canine is visible in side view for its whole length. As a result of the slight distortion rightwards, the left lower jaw canine appears to close externally to the maxillary, as in mammals or as in *Sesamodon*, while the right lower jaw canine lies more medially than normal. Taking the average of the two conditions, it is clear that the lower jaw canines did not bite externally to the maxillaries, but exactly on the alveolar border. Whereas there may be doubt regarding the condition in *Sesamodon*, the condition in this specimen is genuine; the maxillaries and lower jaw canines are perfect and undamaged. We therefore disagree with Broom's interpretation of the Winnaarsbaken specimen, as illustrated in his figure 1 of his 1937 publication, where he demonstrates two excavations in the palate medially to the alveolar border. Boonstra (1938) described the condition as though there is still a thin maxillary edge laterally to the lower jaw canines, but he states that it is clear that this condition is developing into that found in *Sesamodon*. We are not prepared to doubt Boonstra's interpretation; there is actually no reason why both conditions cannot occur within the same species. If the canines of our specimen were placed slightly more laterally in life than in the Winnaarsbaken specimen, they could have worn the maxillary edges away.

There are four incisors in the upper jaw, and only three in the lower jaw, on each side. The number of incisors in the lower jaw is confirmed by the isolated dentary. We are not prepared to accept this as a difference between the new specimen and the two already described specimens; we consider that the latter two specimens were misinterpreted.

The most important difference between our specimen and the two already described lies in the region of the pterygoids. The pterygoids do not extend as far forward as both Broom and Boonstra illustrated, and the vomer extends much farther back. In our specimen the vomer extends to a level well behind the middle of the suborbital fossae and the sutures between the pterygoids and palatines, on each side of the vomer, extend even farther back. According to Boonstra, Broom destroyed this region in the Winnaarsbaken specimen.

Immediately behind the vomer the pterygoids form a bulge on the midline. The vomer extends into two small depressions on each side of the midline. These depressions pass practically underneath the median bulge, which towers 7 mm. above their level (considering the ventral aspect of the skull upside down). Immediately behind the bulge the interpterygoid fossa forms a narrow slit, tapering posteriorly. Anteriorly this fossa passes upward over the bulge. The interpterygoid fossa is exactly like Boonstra's interpretation (1938), but unlike Broom's interpretation (1937) of the same specimen.

The ventrally directed plate of the parasphenoid is broken off in our specimen.

According to both Broom and Boonstra (1937 and 1938), the pterygoid processes incline posteriorly much more than in our specimen. The difference can largely be due to distortion.

The pterygoid prolongations to the quadrates are also different. According to Broom and Boonstra they taper posteriorly. In our specimen they are not quite so delicate, and according to the condition on the left side they expand posteriorly. The lateral margins of these prolongations are stronger and more outstanding than the delicate dorso-medially projecting inner plates, and it is possible that these inner plates were destroyed, or perhaps not properly uncovered, in the Winnaarsbaken specimen. This plate was destroyed on the right side in our specimen.

We could not trace the posterior limits of these pterygoid prolongations, the posterior bones of the lower jaw being in the way.

In the new specimen the parietals penetrate the frontals and small posteriorly projecting processes of the frontals pass back on each side of the anterior ends of the parietals. The postorbitals flank the parietals laterally for a longer distance than illustrated by Boonstra. The laterally extending portions of the postorbitals, forming the posterior borders of the orbits, are at a level some 10 mm. behind the pterygoid processes; Boonstra illustrates them at the same level.

The nasals are well expanded behind, contrary to Broom's definition (1932) of the Bauriidae ("Bauriamorpha").

The lower jaw is 21 mm. broad in the region of the symphysis. The rami diverge suddenly behind the symphysis and progressively less posteriorly. The coronoid process of the dentary is well developed and passes through the temporal opening to the dorsal surface of the skull. The dentary measures 11 mm. across the coronoid process, the same as in the region of the molars, but it has a slight angle postero-ventrally.

The medial surface of the dentary, in the region of the molars, forms a prominent bulge. The maximum thickness of the dentary is 10 mm. in this region. This feature makes the lower jaw of *Bauria* quite unlike that of any Therocephalian or Cynodont. The ventral margin of the dentary folds medially over this bulge, leaving a very restricted crevice into which the splenial fits. Over this portion of its length the splenial is a thin plate-like bone, but anteriorly it could have had more vertical thickness, judging from its impression on the dentary.

All the thin plate-like portions of the angular have been destroyed, leaving only the solid axis. The nature of the rest of the lower jaw bones is somewhat confusing. The articular is recognisable as a bone extending down from the coronoid process and forming the condyle articulating with the quadrate. The lateral surface of this bone was evidently covered by a plate of the angular. What appears to be the retroarticular extends intimately along the inner face of the angular and at its posterior end, antero-medially of the articular condyle, it forms a structure extending medially. The stapes evidently slipped forward so that it appears now as if it extended from this structure to the fenestra ovalis.

The rest of the skull conforms perfectly with Boonstra's description (1938). We are inclined to consider Boonstra's interpretation of the interparietal as correct, and Broom's interpretation as incorrect.

The skeleton is rather good. The first vertebra preserved is well within the thoracic region. There are thirteen vertebrae of which the thirteenth is the first sacral with a transverse process extending 25 mm. from the midline. The vertebra in front has a rib 33 mm. long and a millimeter broader than the thoracic ribs. The next vertebra in front is missing. The two vertebrae farther forward have lost their ribs. The longest thoracic rib measures 96 mm. along the shaft. The capitula and tubercula of all the thoracic ribs form one articulation unit some 15 mm. in length.

All the vertebrae appear to be very similar. The centra are 15 mm. long and 12 mm. broad. Across the transverse processes the vertebrae measure 20 mm. in breadth. These transverse processes are at the level of the middle of the centra of all the vertebrae of the thoracic region, but in the lumbar region they are placed more forward. The distance between the lateral margins of the postzygapophyses is 6 mm. throughout. There was apparently no sudden change in characteristics between the lumbar and thoracic ribs.

The specimen further includes the left half of the pelvic girdle, so badly preserved that little can be deduced from it. The shafts of the femur, tibia and fibula are also included. The radius and ulna of one side are complete, but dislocated.

The Genus *Cyclogomphodon* Broom (figs. 36-38)

In 1913 Broom described a specimen in the Albany Museum as ***Diademodon platyrhinus***, the specimen consisting of "most of the skull and lower jaws of a small species." He figured only the lower jaw and paid much attention to dental succession, but he gave no reason why he considered the specimen as belonging to a new species. He also analysed the dental formula in detail, but he did not emphasise its significance or the possible difference between this specimen and other specimens belonging to the genus *Diademodon*. The dental formula is given as i4, c1, pm4, m8 for both the upper and lower jaws. We disagree with the number of incisors in the lower jaw and although we do not doubt that there may actually have been eight molars in both upper and lower jaws, we would have liked to know how Broom arrived at this number. Nevertheless, the presence of only eight molars should make no difference, as the number increased even after full maturity.

In 1919 Broom referred the specimen to a new genus *Cyclogomphodon*, on the strength of the following differences between it and the genus *Diademodon* (*Gomphognathus*): (1) The molars are said to be much narrower than in "*Gomphognathus*." (2) The dental formula (i4, c1, pm4, m8 for the upper jaw) differs from that of "*Gomphognathus*" (i4, c1, pm5, m9 for the upper jaw). Three incisors in the lower jaws of both genera are acknowledged. (3) The posterior molars are more "molariform."

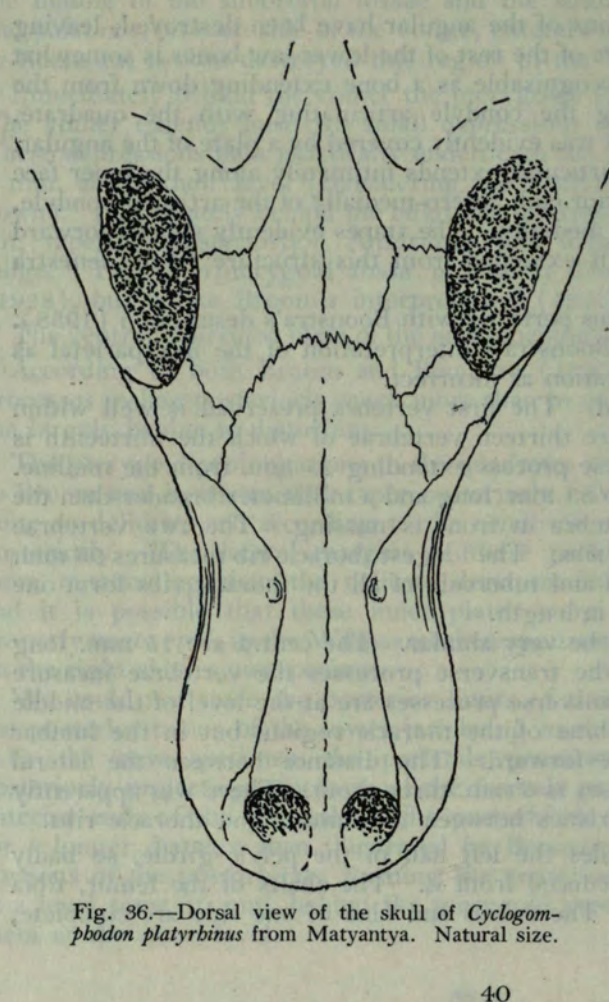

Fig. 36.—Dorsal view of the skull of *Cyclogomphodon platyrhinus* from Matyantya. Natural size.

Broom arrived at this dental formula for "*Gomphognathus*" by guessing that the first premolar on the left side in the type specimen of "*Gomphognathus*" *kannemeyeri* corresponds with the second on the right. The four premolars on the left side were then counted as the second, third, fourth and fifth. To make the right side cor-

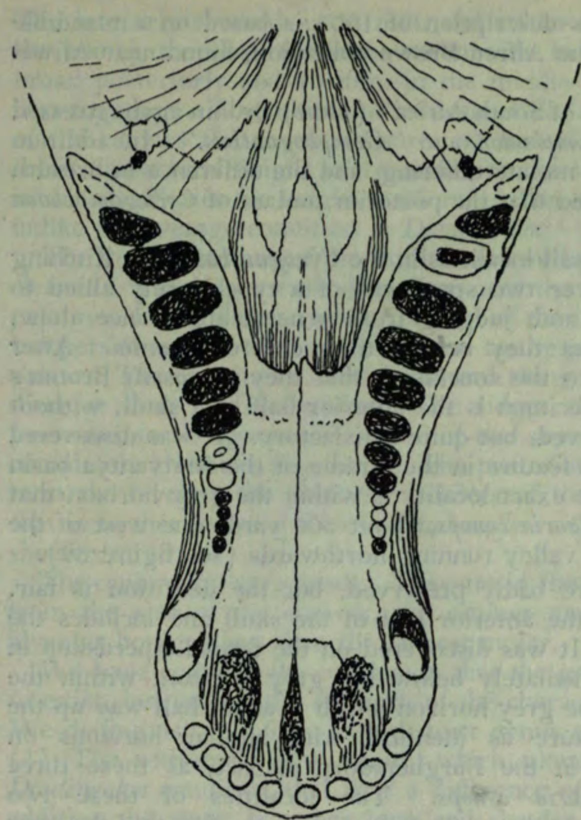

Fig. 37.—Palatal view of the skull of *Cyclogomphodon platyrhinus* from Matyantya. Natural size.

respond, he counted the first molar as the fifth premolar, leaving only eight molars, so he assumed the presence of a ninth molar on the right side. Many times we have been surprised by the remarkable correctness of Broom's assumptions but in this case we are inclined to doubt his interpretation, not of the particular specimen, but of the dental formula in general. If his illustration of the dentition of the type specimen of *"Gomphognathus" kannemeyeri* is absolutely correct, as far as the shapes and sizes of the individual teeth are concerned, it is quite feasible that the ultimate molar of the left side does not correspond with the last molar of the right side, and the first premolar of the right side is actually situated at a level farther forward than the first of the left side. Nevertheless, all the specimens of *Diademodon* which we have investigated show very clearly only 4 premolars, so that if the first tooth on the right side in *"G" kannemeyeri* is not a "milk" molar being replaced by the one behind, it may still be a freak.

In the same publication of 1919 Broom also transferred a specimen which he had described as *Diademodon mastacus* in 1905 to the new genus and species

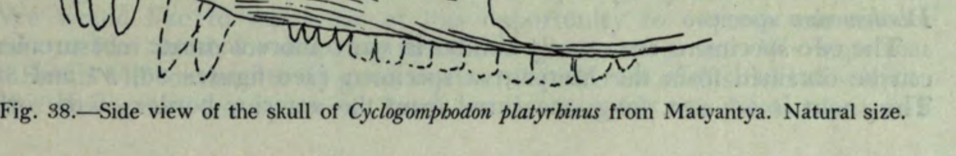

Fig. 38.—Side view of the skull of *Cyclogomphodon platyrhinus* from Matyantya. Natural size.

Cyclogomphodon platyrhinus. His description of 1905 is based on a mandible and some postcranial bones in the Alfred Brown collection, found near Aliwal North.

In his "Mammal-like Reptiles of South Africa" (1932) Broom again stressed the differences between *Cyclogomphodon* and "*Gomphognathus.*" In addition to the number of premolars and molars differing, and the difference in breadth of the molars, Broom again stated that the posterior molars of *Cyclogomphodon* are more "molariform."

On his recent expedition to fossil localities in the *Cynognathus* zone, Kitching was fortunate enough to discover two specimens of a type closely allied to *Diademodon*, but much smaller and, judging from general appearance alone, we immediately established that they belong to a different genus. After careful consideration we came to the conclusion that they represent Broom's genus *Cyclogomphodon.* One specimen is the anterior half of a skull, without lower jaw, not very well preserved, but quite satisfactory. It was discovered on the slopes of the Matyantya feature in the middle of the Matyantya basin south west of Lady Frere. The exact locality is within the grey horizon that yielded our new specimen of *Bauria cynops*, about 300 yards due west of the latter's locality, and within the valley running northwards (see figure 32).

The second specimen is more badly preserved, but the dentition is fair. The specimen also consists of the anterior half of the skull and includes the anterior half of the mandible. It was discovered on the farm Luiperdskop in the Burghersdorp district, immediately below the grey horizon, within the reddish shales. We consider the grey horizon which is about half way up the slopes of the Matyantya feature as identical with similar horizons on Winnaarsbaken and Vaalbank in the Burghersdorp district, as these three localities each yielded a *Bauria cynops.* The localities of these two *Cyclogomphodon* specimens support this view and point to the fact that the grey horizon also extends over the farm Luiperdskop. The three farms Luiperdskop, Winnaarsbaken and Vaalbank are situated in a triangle with equilateral sides approximately 15 miles long, Luiperdskop pointing north, Winnaarsbaken south-west, and Vaalbank south-east.

The Matyantya specimen is numbered 319 in our collection, and the Luiperdskop specimen 320.

The dental formula of the Matyantya specimen is i4, c1, pm4, m9, the ninth molars being unerupted on both sides. The row of molars in the Luiperdskop specimen is incomplete, and their structure cannot be ascertained, as the lower jaw is in situ. In the former, roots of only the seventh molar on the right and the first two molars of the left are preserved. The socket of the largest molar measures 5 mm. by 10 mm. There is therefore no difference between *Cyclogomphodon* and *Diademodon* as far as the dental formula and the size of the molars are concerned. We can also not establish any difference in the posterior molars between these two genera. The row of molars measure 43 mm. in the Matyantya specimen, that is well within the range of the *Diademodon* species.

The two specimens are exactly similar in size; more accurate measurements can be obtained from the Matyantya specimen (see figures 36, 37 and 38). The snout is 65 mm. long, measured from the anterior border of the orbit.

The interorbital width is 33 mm. and at the same level, across the middle of the orbits, the skull measures 68 mm. in breadth. The nasals are 28 mm. broad posteriorly and 10 mm. in the middle of their lengths, measuring the two together. The minimum breadth of the snout is 30 mm.; in the region of the canines the snout measures 37 mm. At the level of the canines the snout has a total height of 16 mm.; at the level of the depressions dorsally in the maxillaries the height is 25 mm. The latter depressions are very small, unlike the average condition in *Diademodon.*

The ventral surface of the skull is not well preserved, but nevertheless well cleaned. The ridges extending from near the midline over the pterygoids and palatines do not flatten out on the roof of the internal nares, as in *Diademodon,* but persist around the lateral margins to the posterior border of the secondary palate. The palatines extend backward along these ridges for rather a longer distance than in *Diademodon.* The ridges that extend from the pterygoid processes to the posterior border of the secondary palate in *Diademodon* are completely absent in this form. The posterior border of the secondary palate is at the level of the posterior borders of the fourth molars from the front, that is farther forward than in *Diademodon.* On the whole the palate appears shorter.

The canines are very small. They are in the act of being replaced. Judging from the size of the sockets, the canines measure in cross section (on the alveolar border) less than the largest molar.

We have come to the conclusion that the genus *Cyclogomphodon* has a right to exist, but not on the strength of the characteristics pointed out by Broom. We distinguish this form as a distinct genus on the following characteristics: (1) The extremely low snout, which alone contrasts so to the general *Diademodon* condition that it is a difference of more than specific nature. In addition the snout is rather long and slender. (2) The size of the canines. (3) The short secondary palate. (4) The absence of ridges joining the pterygoid processes with the posterior border of the secondary palate.

Inusitatodon smithi gen. et sp. nov. (Fig. 40)

Mr. M. D. S. Smith, Principal of the Lady Frere school, recently donated two specimens to our Institute, a fragmentary skull of *Diademodon broomi* (*Gomphognathus broomi,* Broili and Schröder) and the anterior two-thirds of the skull of a new type, which we describe in this paper as *Inusitatodon smithi.*

The exact localities of the two specimens are marked on an aerial photograph, a trace of which is shown in fig. 39 (aerial photograph Job 236 Strip No. 6 Print No. 399 — Trigonometrical Survey). These localities are immediately north of the river running in a westerly direction north of the town, on the slope of a koppie. The koppie itself is immediately north-east of the town. Both specimens are from the same grey horizon, and this horizon is not unlikely the same as the one that yielded *Bauria cynops* in the Matyantya basin.

We would like to make use of this opportunity to express our sincere thanks to Mr. Smith for donating these two specimens to us. We hope that Mr. Smith will continue to do good work in the interest of this field of science.

The new genus and species is based on the anterior two-thirds of a small skull of a gomphodont Cynodont, undoubtedly a member of the family Diademodontidae. The skull has suffered considerable lateral compression, but otherwise it is beautifully preserved and prepared. Under the circumstances, the dentition is perfect. It is numbered 312 in our collection.

The dentary of the left side is complete; only the posterior edge of the bone is slightly damaged. On the right side this posterior edge is broken away for about half the antero-posterior breadth of the coronoid process. The two dentaries are pressed towards each other so that the palate could not be cleaned without damaging the perfectly preserved teeth.

The parietal crest is preserved for perhaps the greater part of its length, so that it includes the parietal foramen. The whole occipital region and both temporal arches are missing. The orbital region on the left side is as shown in the figure, but on the right side badly preserved fragments of bone and impressions on the matrix made it possible to reconstruct the postorbital arch and the jugal bar below the orbit.

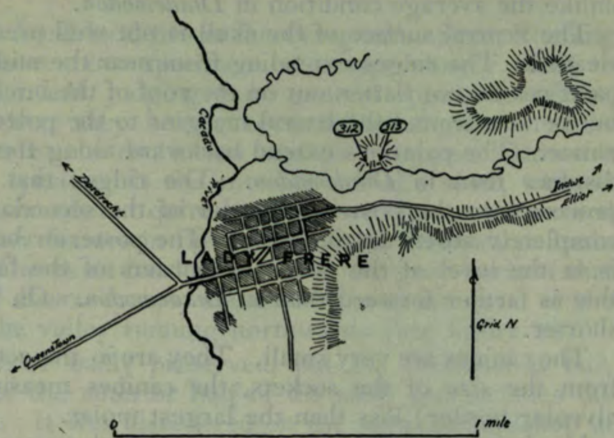

Fig. 39.—Trace of aerial photograph: Trigonometrical Survey, Job 236, Strip No. 6, Print No. 399, showing the exact localities of *Inusitatodon smithi* and *Diademodon broomi* (Nos. 312 and 313 respectively).

The region of the external nares is poorly preserved, largely on account of the lateral compression, and for the same reason very little can be deduced from the dorsal surface of the skull, least of all any transverse measurements.

A striking feature of the lower jaw is its powerful coronoid process and the distinct angular process. It is not clear from the specimen, but it appears as though the rest of the lower jaw bones extended back not far above the general line of the ventral margin of the dentary, so that the articular region could not have been much above this level. If this was the case the posterior region of the skull must have been comparatively high, as the height of the coronoid processes also suggests. It also appears as though the zygomatic arches extended upward initially immediately behind the orbits, so that their descent to the articular region farther back must have been quite conspicuous. The height of the arches cannot be ascertained and it is not clear whether the jugal developed a process as in all the other members of the family Diademodontidae.

The postorbital, frontal, prefrontal and lachrymal are much the same as in *Diademodon*. The maxilla differs only in one feature, the apparent absence of the peculiar depression dorsally.

There is a longitudinal ridge in the region of the frontals which became exaggerated through lateral compression into a prominent crest. Each frontal occupied a depressed area. The portion of the parietal crest included in the specimen suggests that this region, including the characteristics of the parietal foramen, was similar to that of *Diademodon*.

The skull is that of a mature individual. There is no trace of tooth replacement. The sutures suggest full maturity. Although the anterior face of the symphysial region of the lower jaw has been ground, no trace of a suture could be displayed.

The snout measures 36 mm. from the premaxillaries to the anterior border of the orbit. The orbit has an antero-posterior diameter of 19 mm. The dentary is 12 mm. high in the region of the molars; it has a total height of 41 mm. over the coronoid process, and a total length of 72 mm. The distance from the premaxillaries to the parietal foramen measures 55 mm. The total length of the skull may have been perhaps not more than 90 mm.

Judging from the characteristics of the coronoid process, the temporal region of the skull must have been relatively short. The anterior margin of the coronoid process extends into the orbital cavity. In the higher Cynodonts the posterior end of the dentary usually reaches very close to the squamosal and since this new specimen is evidently a higher Cynodont, with a well developed posterior extension of the dentary, it may be deduced that the latter also reached very close to the squamosal. The squamosal and quadrate region of the skull could therefore not have extended much farther back than as suggested in fig. 40.

The dentition of this specimen is peculiar. There are three fairly small and slender incisors on each side in the upper jaw, and two on each side in the lower jaw. The three of the upper jaw cover a distance of 8 mm. and the two of the lower jaw a distance of 4 mm. There is a diasteme of 4 mm. on each side between the incisors and canines of the upper jaw, and no diasteme in the lower jaw. There is, however, a diasteme of at least 5 mm. on each side behind the canine in the lower jaw, while in the upper jaw this diasteme is only 2 mm.

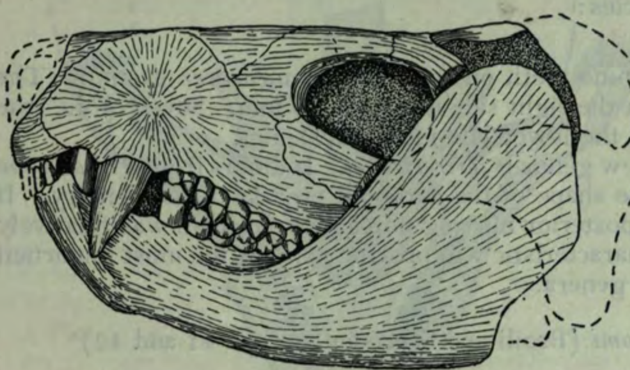

Fig. 40.—Side view of the skull of *Inusitatodon smithi* (natural size).

The canines are powerful. That of the upper jaw measures 8.5 mm. antero-posteriorly at the alveolar border and has a length of 13 mm.

The post-canine teeth are beautifully preserved, but unfortunately we cannot establish their full number, as they are covered posteriorly by the dentary. It is also impossible to establish the structure of the crowns and their breadths.

In the upper jaw the anterior two teeth are much smaller than those following and it is almost certain that they have simple conical crowns. They may be premolars. These two premolars are missing on the right side.

The next tooth has a flat crown and is apparently not very broad. This is apparently the first molar tooth. On the right side we count eight molars, but on the left only seven. The eighth molar on the right is so small that we assume it is the ultimate tooth. It is quite evident that the molars of the upper jaw, as well as of the lower jaw, have one major cusp in the middle of their outer margins.

The two upper jaw premolars are opposed by a large flat crowned tooth in the lower jaw, which is evidently the first true molar of the lower jaw. There may have been two premolars in the lower jaw, but they have been lost and we could not uncover their sockets. There are six molars exposed on the left side and seven on the right. The second has fallen out before fossilization. The seventh tooth opposes the sixth of the upper jaw, leaving the penultimate and ultimate teeth of the upper jaw unopposed. It is almost certain that there must be another tooth in the lower jaw opposing the posterior two of the upper jaw, bringing the total of the lower jaw also to eight. It is unlikely that there could have been a ninth molar in the lower jaw, judging from the size of the available space.

The lower jaw molars are larger than the upper jaw molars. Anteriorly they bite between the molars of the upper jaw, but posteriorly they gain on the upper jaw molars until they oppose them individually. This condition is illustrated on the right side; on the left side it appears as though the posterior molars also bite between the molars of the upper jaw.

We are quite confident in suggesting the following as the dental formula for this new genus and species:

$i\frac{3}{2}$, $c\frac{1}{1}$, $pm\frac{2}{2}$, $m\frac{8}{8}$.

The row of nine post-canine teeth on the left side measures 21 mm. The row of eight true molars on the right side measures 19 mm. Seven of the true molars on the right side in the lower jaw measure 21 mm.

The nearest ally of this new genus is *Trirachodon*. It differs from *Trirachodon* in dental formula and in the shape of the coronoid process of the dentary. If our interpretation that the posterior missing portion of our skull was relatively short is correct, then this characteristic will provide perhaps the most important difference between the two genera.

Diademodon broomi (Broili and Schröder) (Figs. 41 and 42)

The type of this species, described by Broili and Schröder in 1935, is a more complete skull than the specimen which Mr. Smith donated to us, but the latter shows some additional details.

In 1935 Broili and Schröder described specimens of two known species of *Diademodon* (*D. browni*, *D. mastacus*) and introduced three additional species (*D. grossarthi*, *D. broomi* and *D. haughtoni*). These species they described under the generic name *Gomphognathus*, but Brink pointed out in his thesis (unpublished) on the *Diademodon* material in the Watson Collection in the University College of the University of London that the generic name

Gomphognathus has no right to exist. The *Diademodon* material in the Watson Collection includes a specimen each of *D. grossarthi* and *D. haughtoni* and with the specimen described here as *D. broomi* we have now not only a second specimen of each of the three new species introduced by Broili and Schröder, but we also know that their species are genuine. As far as general proportions are concerned, including size, our specimen agrees perfectly with the type.

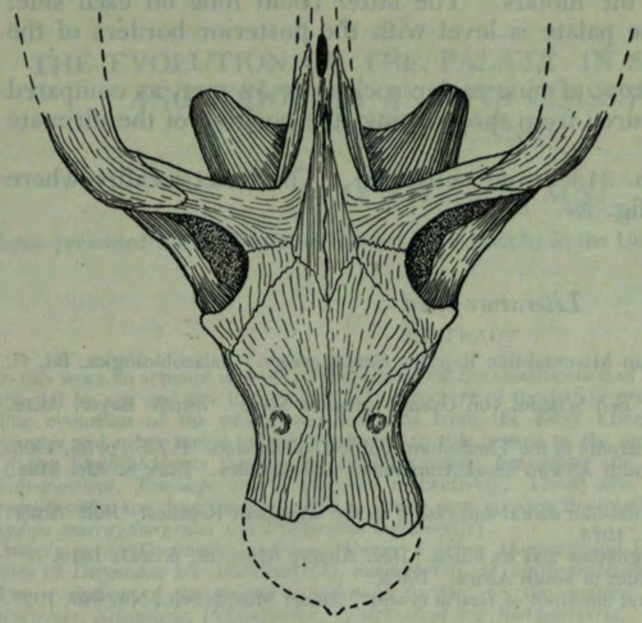

Fig. 41.—Dorsal view of the skull of *Diademodon broomi* (½ natural size).

In figs. 41 and 42 we illustrate the sutures on the skull, which are easily traceable, in contrast with the type where, according to Broili and Schröder, few sutures are distinguishable. As in the type the postorbitals extend far back before the two ridges join to form the parietal crest. The parietal foramen is situated level with the posterior ends of the postorbitals.

The orbits face more anteriorly than laterally and very little upward.

The transverse bones extend medially over the ridges running from the pterygoid processes to the posterior margin of the secondary palate. The suborbital foramen lies between the transverse bone, palatine and jugal, but there is an additional foramen within the transverse bone.

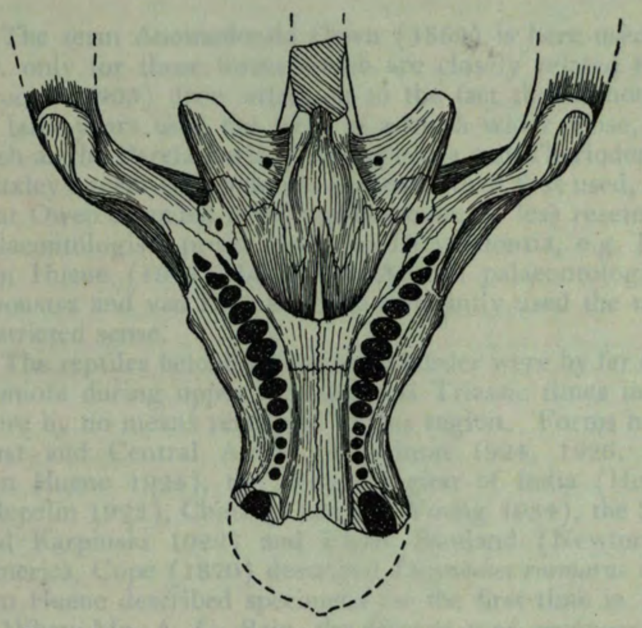

Fig. 42.—Ventral view of the skull of *Diademodon broomi* (½ natural size).

There are sockets for four premolars on each side, much smaller and more round than the sockets of the molars. The latter count nine on each side. The posterior border of the palate is level with the posterior borders of the fifth molars from the front.

The total length of the row of nine molar sockets is 52 mm. as compared with 47.5 in the type, measured from the drawing, the position of the ultimate molars being estimated.

The new specimen is No. 313 in our collection. The exact locality where it was found is marked in fig. 39.

Literature cited

Boonstra, L. D., On a South African Mammal-like Reptile, ***Bauria cynops***. Palaeobiologica, Bd. vi, 1938.

Broili, F. and Schröder, J., Ueber den Schädel von Gomphognathus Seeley. Sitzb. Bayer. Akad. Wiss., IX, 1935.

Broom, R., On some points in the anatomy of the Theriodont reptile Diademodon. P.Z.S., p. 95, 1905.

Broom, R., Notice of some new South African fossil Amphibians and Reptiles. Ann. S. Afr. Mus., vol. vii, pt. iii, p. 270, 1909.

Broom, R., On evidence of a mammal-like dental succession in the Cynodont Reptiles. Bull. Amer. Mus. Nat. Hist., xxxii, p. 467, 1913.

Broom, R., On the genus Gomphognathus and its allies. Rec. Albany Mus., iii, p. 227, 1919.

Broom, R., The Mammal-like Reptiles of South Africa. 1932.

Broom, R., On the palate, occiput and hind foot of ***Bauria cynops***. Amer. Mus. Novit., No. 946, 1937.