MARCH 23, 1859.

Capt. James Hales Reid, 35 Weymouth Street; Robert Mallet, Esq., Dublin; John McLandsborough, Esq., M.I.C.E., Bradford, Yorkshire; Charles Ratcliff, Esq., F.L.S., F.A.S., Downing College, Cambridge; Archibald Geikie, Esq., Geological Surv. of Great Britain, Edinburgh; John Hamilton Clement, Esq., C. & M.E., 3 Gloucester Terrace, Kensington, were elected Fellows.

The following communications were read:—

1. *On some* AMPHIBIAN *and* REPTILIAN REMAINS *from* SOUTH AFRICA *and* AUSTRALIA. *By* THOMAS H. HUXLEY, F.R.S., Sec.G.S., Professor of Natural History, Government School of Mines.

[PLATES XXI. XXII. XXIII.]

At the Evening Meeting of this Society held on the 17th of November 1858, a paper by Mr. Stow "On some Fossils from South Africa" was read. In the course of the discussion which followed, my opinion as to the nature of one of those fossils was asked. With so much reserve as was due to the cursory character of my examination of the remains, I expressed my conviction that the organism in question was the skull of a Labyrinthodont Amphibian, and briefly stated the grounds upon which I based that conclusion. The Chairman of the Meeting then called upon me to undertake a thorough investigation of the matter; and I now report the results of my inquiries in the first of the following papers, in which I have embodied, incidentally, the description of an allied Australian Amphibian.

1. *On* Micropholis Stowii *and* Bothriceps Australis.

Micropholis Stowii.—The skull in question is $1\frac{5}{8}$ inch long, and has, when viewed from above, a parabolic outline (Pl. XXI. fig. 1), or it might be compared to the half of a long ellipse, half of the longer diameter of which is to its shorter diameter as 13 to 10. The bony plates which formed the roof of the skull (fig. 1) have entirely disappeared, as have those which constituted the greater part of its right lateral parietes; but on the left side (fig. 2), the lateral walls are in a tolerably good state of preservation.

The matrix has split in such a manner that that portion of it which is bounded by the contour of the skull has separated from the rest, leaving in its concave counterpart the outer bony crust of the mandible and a portion of the maxillary bones. I had hoped that the fossil might be relieved in such a manner as to show, not only the structure of the under part of the skull, but the character of the occipital articulation; but the matrix is so exceedingly hard, and the bony matter so soft and fragile, that even my experienced and skilful ally, Mr. Dew, was afraid of carrying on his excavations sufficiently far to attain these objects.

Sufficient has been done, however, to reveal the indistinct remainder of the anterior part of the vertebral column, and to prove, by its means, at what point the occipital region of the skull was situated. From this it appears that the postero-lateral angles of the cranium were produced for $\frac{3}{8}$ths of an inch behind the general plane of the occipital surface.

The most striking features in the skull are the large oval orbits, which occupy, as nearly as may be, the middle third of the space between the occiput and the end of the snout. Their long axes converge a little anteriorly; and the interorbital space (which is not equal to more than one-fourth of the diameter of the skull), opposite the middle of the orbits, is far narrower than the transverse diameter of the orbit.

The nostrils are rounded apertures, distant less than twice their own antero-posterior diameter from the anterior edge of the orbit; they are placed very near the anterior edges of the snout, and are separated transversely by an interval equal to the interorbital space. Their long axes are, like those of the orbits, directed obliquely inwards and forwards. Both orbits and nostrils look upwards and outwards, the former direction predominating. The vertical diameter of the skull (including the mandible) is greatest posteriorly; but even here the thickness does not attain one-fourth of the length; and the vertical diameter gradually diminishes anteriorly, until, at the end of the snout, the thickness does not exceed an eighteenth of the length.

The left premaxillary bone appears to be nearly entire. It is very short, its horizontal portion extending backwards only to the middle of the external nostril, the anterior part of whose inferior boundary it forms. At its inner end, the premaxilla gives off a broad but short, ascending, recurved process, which forms the anterior and internal boundary of the external nostril and ends superiorly in a point. Whether it is broken off here, or not, I cannot say.

The maxilla meets the posterior end of the premaxilla, and then extends backwards beneath the orbit to the posterior margin of the jugal bone, where its bony matter disappears. The maxilla is widest midway between the nostril and orbit, where it sends up a short obtuse process.

Immediately above this portion of the maxilla lies a broad flat bone (Pl. XXI. fig. 2), circumscribed on three sides by a zigzag suture, whose posterior free edge forms the anterior boundary of the orbit, while its anterior margin does not quite reach the posterior boundary of the external nostril. Its upper edge unites with a fragment of bone whose anterior end enters into the boundary of the nostril. Inferiorly and behind, it is in contact, for a small extent, with a bone (the jugal) which completes the boundary of the orbit below; and, in front of this point, it either comes into relation with the maxilla, or is separated from it by an elongated bone which completes the boundary of the nostril anteriorly. I put the alternative because I do not feel certain whether a particular line, which seems to be a suture, is one or not. If the elongated strip of osseous matter in question be a distinct bone, it corresponds with that termed by Von Meyer "lacrymal" in the Labyrinthodonts.

The bone bounded by the zigzag suture is in all probability the prefrontal, while the upper fragment connected with it is apparently all that remains of the nasal.

The jugal bone (Pl. XXI. fig. 2) narrows as it passes back from its connexion with the prefrontal, becoming very slender where it forms the lowest part of the orbital wall. Indeed it here exhibits a discontinuity; but I believe this to be the result of fracture. At the posterior part of the orbit it expands into a broad plate, whose anterior concave margin forms half of the posterior boundary of that cavity. Its inferior margin unites with the maxillary, and then with a small triangular plate of bone interposed between it and the end of the maxillary (quadrato-jugal?). Its superior margin is divided into two parts,—an anterior, nearly horizontal, which unites with a slender plate of bone whose anterior end forms part of the boundary of the orbit, and seems to be all that is left of the bone called "post-orbital" (Hinteraugenhöhlen-knochen) by Von Meyer; and a posterior moiety, which shelves downwards and backwards and articulates with another fragmentary bony plate, whose upper part occupies the superior and external angle of the skull, while its lower part becomes lost in the outer surface of the mass of matrix which has filled the cavity formed by the quadrate and other bones, and is the representative of the suspensorial apparatus of the lower jaw. This bone is obviously the squamosal.

On the left side, the bones which should constitute the lower end of the mandibular suspensorium have almost entirely disappeared, a small fragment only of the quadratum remaining. On the right side, however, a considerable proportion of the quadratum is preserved (Pl. XXI. fig. 4). Its articular end, $\frac{3}{16}$ths of an inch broad, and flattened from above downwards, exhibits a condyloid surface which is divided by a groove into a stronger internal, and a less prominent external portion. In front of the condyles the quadratum is very thin, but it rapidly expands, so as to cover all that remains of the flat lateral face of the suspensorium, and extends forward to about midway between the articular condyle for the mandible and the posterior margin of the orbit. At this point the bony matter disappears. On the top of the skull all the osseous matter has vanished except two white lines, one on each side of the interorbital space (representing the upper edges of the orbito-sphenoids?), and a sinuous transverse line faintly indicating the contour of the occiput (Pl. XXI. fig. 1).

The lower jaw (figs. 2, 4, 5) has the same general outline as the anterior and lateral contours of the skull. Its rami are slender in front, but deep and strong posteriorly, where there is a faint indication of a coronoid elevation, in correspondence with which the inferior margin of the suspensorial peduncle is slightly excavated. Behind this the ramus rapidly narrows to its posterior extremity, which extends very little beyond that of the quadrate bone. At the symphysis, the dentary element of the mandible is very distinct and is rather less than $\frac{1}{8}$th of an inch in width; it extends back, becoming more slender as it goes, along the upper edge of the mandible. Its posterior boundary cannot be exactly traced; but the backward continuation of the series of teeth with which it is beset testifies to its elongation beyond the level of the posterior margin of the orbit. The symphysial end of each dentary bone is concave and produced into a short process posteriorly, so that the union of the two rami would seem to have been somewhat lax (fig. 3).

The counterpart of the fossil (figs. 1, 2, 3) just described exhibits the dentary bone of the right ramus in transverse section. It is triangular, with a thin internal edge and a flat upper surface. The teeth are set in apparently distinct alveoli along its outer moiety; and beneath them runs a canal filled with matrix.

A second osseous element of the mandible, the angular bone, extends on the inner side of the jaw to within $\frac{3}{16}$ths of an inch of the symphysis. It is trough-like (fig. 5), consisting of an internal and an external lamella, united at an angle below, and it appears to extend back nearly to the posterior extremity of the ramus. The precise boundaries of the third distinguishable component of the mandible, the articular bone, are not to be made out; but on the left side, the matrix which fills the posterior end of the ramus extends forwards, becoming narrower until it ends by a slender rounded extremity, coated with a bony sheath, between the angular and the dentary, and near the anterior termination of the latter. On the right side, in the counterpart, the section of this style-like process of the matrix is seen, and seems to be connected with a narrow bony plate, which appears on the inner side of the ramus between the dentary and the angular.

The posterior end of the articular element is broad and somewhat produced internally, so as to afford sufficient space for the adjustment of the wide articular end of the suspensorial peduncle.

On the under surface of the skull (fig. 3), a whitish patch may be observed on the inner side of the anterior part of the right ramus of the mandible, and a much larger transverse band, of a similar aspect, stretches from the posterior part of the left ramus, two-thirds of the way across to the opposite one.

When these patches are minutely examined, they are seen to consist of a multitude of small, flat, polygonal scutes, of very various dimensions and forms, but none exceeding $\frac{1}{16}$th of an inch in diameter. These minute scutes are fitted together by their edges; and their surfaces are marked by irregular grooves and pits, which are so disposed as to leave a narrow, clear margin (fig. 7).

Between the posterior extremities of the rami, the same surface of the fossil exhibits on each side the indistinct impression, and part of the bony substance, of a broad, flat, triangular plate, whose base is turned inwards, and whose apex is produced and bent upwards. Two other fragmentary bones, of apparently a similar character, lie behind these; and still further back, on the counterpart, are the remains of what I take to be a portion of the pectoral arch and its appended member; but the parts are so indistinct and fragmentary that it would be vain to describe them particularly.

The teeth (fig. 6) are very numerous and close-set, slender, conical, sharply pointed, and either straight or concave inwards. They are stronger in the lower jaw than in the upper, and in the anterior than in the posterior part of the lower jaw. I could observe no distinct traces of those longitudinal grooves which characterize the teeth of the larger Labyrinthodonts; but they seem to have possessed a large pulp-cavity. While the teeth of the mandible appear (as I have said) to be lodged in distinct though shallow alveoli, those of the upper jaw seem to be completely anchylosed with the bony walls of the jaw, so as to look like mere processes of it. I would be understood to speak with considerable hesitation on these points, however, the parts being but very imperfectly preserved.

It is at once obvious that the skull which I have just described could have belonged to no true Reptile, but is either that of an Amphibian or that of a Fish.

The composition of the lower jaw, the characters of the teeth, the well-developed nasal apertures, and the arrangement of the bones in the temporal region leave no doubt in my mind as to which of the latter alternatives is to be preferred, and satisfactorily prove the amphibian affinities of the fossil.

Such being the case, there is but one order of the *Amphibia*, as they are at present arranged, to which it can be referred—the *Labyrinthodonta*,—with a knowledge of whose characteristic peculiarities, so much of the structure of the skull as can be made out becomes readily intelligible. Thus, in shape and in the position of its orbital and nasal apertures, the African fossil presents a certain resemblance to the German Labyrinthodont *Metopias*, and to the imperfectly known Russian *Rhinosaurus*. The arrangement of the cranial and facial bones, and their ornamentation, coincide very well, so far as they go, with the corresponding features of those Labyrinthodonts which have been best studied; and the peculiarities of the jugal, postorbital, and squamosal bones are especially characteristic. Again, I should hardly have ventured to interpret so confidently the appearances presented by the mandible, had I not recently had an opportunity of studying the composition of its articular moiety in some portions of very large mandibles of *Labyrinthodon*, or *Mastodonsaurus*, from Warwickshire. I find, from these fossils, that the articular element of the Labyrinthodont jaw (in these genera at any rate) sends a hollow bony prolongation (at first probably a mere osseous sheath around Meckel's cartilage) for a long distance towards the symphysial end of the jaw; and I suspect that the cone of matrix which I have described above is nothing but the cast of a similar prolongation. In the Warwickshire Labyrinthodont, a strong process, formed partly by the angular and partly by the articular bone, is given off inwards and forwards from the posterior part of the inner surface of the ramus; and this is perhaps represented by the inward production of the posterior part of the ramus of the mandible in the African fossil. On the other hand, the great Labyrinthodonts have a very distinct angular process prolonged backwards behind the articulare, and composed in great measure of a process of that element, as in the Crocodile—a structure of which I see no trace in the fossil under consideration*.

The large bony plates under the throat suggest a comparison with the similarly proportioned bony plates which occupy a like position in so many of the better-known Labyrinthodonts, such as *Mastodonsaurus*, *Archegosaurus*, &c. Of these plates, however, there are only three, a median (rhomboidal), and two antero-lateral (triangular and bent up at the sides); while the present fossil seems to exhibit the remains of four plates, in two pairs, all of which have the form of triangles with their bases inwards. I am inclined to think that these parts are, in fact, the remains of a hyoidean system, possibly indicating a long persistence of the branchial apparatus.

The teeth, in their even size, their very large pulp-cavities, and the apparent absence of folds of their dentine, are not much like those of the typical Labyrinthodonts; but it must not be forgotten that our own Red Sandstone series† contain a Labyrinthodont (the so-called *Labyrinthodon Bucklandi*) which is a totally distinct generic form‡ from any of the described Labyrinthodonts, and has close-set, conical, thin-walled teeth, so anchylosed with the upper jaw as to appear continuous with it.

But the Labyrinthodont remains to which the African skull presents the closest resemblance are the *Brachyops laticeps* of Central India, and the undescribed cranium of an animal (from Australia) in the British Museum, very closely allied to *Brachyops*.

Brachyops laticeps has been already so fully described by Professor Owen§, that I need merely refer to his paper and to the figures accompanying it: by studying these any person may convince himself of the general resemblance between the Indian and the African fossil, and, at the same time, of the clear differences which separate them generically.

The precise locality whence the Australian skull was obtained is unknown; and I should have remained ignorant of its existence except for the kindness of my friends Mr. Waterhouse and Mr. Woodward, the latter of whom, being present when I gave a short description of the African fossil to the Society, was struck with its resemblance to the skull in the British Museum.

Bothriceps Australis.—In the Australian fossil (Pl. XXII. fig. 1) the bony matter has almost wholly disappeared from the roof of the skull, except near the occiput, where a patch of it remains in the supraoccipital region, and is sculptured like the corresponding part

* Since this paper was read, I have published an account of the structure of the Labyrinthodont jaw to which reference is made, in Mr. Howell's "Memoir on the Warwickshire Coal-field": Memoirs of the Geological Survey, 1859.

† I learn from Professor Ramsay that the stratum in which *Dasyceps Bucklandi* occurs is of Permian, not of Triassic age.

‡ I therefore propose to change its name into *Dasyceps Bucklandi*, the generic appellation alluding to the singularly rough and prickly surface of the cranial bones, like that of some recent *Bratrachia*. (See Mr. Howell's Memoir cited above, in which the cranium of *Dasyceps* is described and figured.)

§ Quart. Journ. Geol. Soc. vol. x. p. 473; and vol. xi. p. 37.

of a Crocodile's skull, exhibiting irregular close-set, but separate, polygonal pits. The cranium measures four inches in length, from the extremity of the snout to the end of the occipital condyles, and its greatest breadth between the ends of the mandibular suspensoria is $3\frac{3}{4}$ inches; the greatest depth of the skull is at its posterior end, and does not exceed $1\frac{1}{2}$ inch, so that it is very flat (fig. 2). The margins of the left orbit are much broken; but those of the right orbit seem to be nearly entire. It is oval, with its long axis directed forwards, nearly parallel with that of the skull; it measures $\frac{7}{8}$ths of an inch in breadth, $\frac{5}{8}$ths of an inch in width, and it occupies as nearly as possible the middle of the space between the superior margin of the occiput and the anterior edge of the premaxilla. The interorbital space appears to have measured about an inch in width. The posterior margins of the large rounded nasal apertures are distant about $\frac{3}{4}$ths of an inch from the anterior margin of the orbits; and the interspace between the nostrils is about half an inch.

The surface of the matrix exhibits impressions of the sutures which separated the constituent bones of the skull. Two nasals, two large frontals, and a single or double parietal are clearly traceable in the middle line. The middle of the anterior half of the parietal region is marked by a strong longitudinal depression, which occupies nearly one-third of its width, and ends, posteriorly, in the parietal foramen, while anteriorly it is continued forwards, becoming shallower, on to the frontals. The postfrontal bounds most of the inner and a little of the posterior margin of the orbit, while almost the whole of the remaining posterior boundary is filled up by the postorbital bone. Posteriorly and externally, this joins the squamosal; while posteriorly and internally, a bent sutural line separates it from a bone which is called "squamosum" by Von Meyer, in *Archegosaurus*, and "second parietal" by Prof. Owen in *Brachyops*. This bone and the squamosal unite posteriorly with a pyramidal bone which resembles in form and position the bone called "occipital externe" in Fishes by Cuvier. The exoccipitals project for half an inch below the occipital foramen, to form the two stout occipital condyles, which have unfortunately been sawn through.

I can find no indication of a suture in the bony plate which covers the supraoccipital region. The quadratum is cut away on one side, and so imbedded in the matrix, on the other, that its form cannot be made out. The whole suspensorium, however, projects downwards and backwards. The lower jaw has the same parabolic outline as the skull; but some adherent matrix must be cleared away before its exact proportions and constituents can be made out. The teeth are very numerous, and close-set, not more than $\frac{1}{8}$th of an inch long. They are conical, straight, and sharp-pointed; and their bases are expanded, and marked by about twelve longitudinal folds, which extend to near the apex of the tooth.

On comparing this fossil with *Brachyops laticeps*, its proportions are seen to be widely different, though the two skulls have within half an inch of the same length; and therefore specific identity is out of the question. Indeed, considering the additional difference in the relative size, in the form, the position, and the direction of the orbits, I conceive that the Australian fossil may be safely regarded as the type of a new genus, for which I propose the name of *Bothriceps*, in allusion to the peculiarly pitted character of the sculpture of such of the cranial bones as are left. I should, indeed, have been disposed to bring forward this pitted sculpture more prominently in alluding to the difference between this genus and *Brachyops*, were it not that the character of the surface of that part of the skull of the latter fossil which corresponds with all that is left of the cranial bones of *Bothriceps* is not clearly discernible. The present species may be called *Bothriceps Australis*.

Whatever be the relations between the Australian and Indian fossils, the evidence, as it stands at present, justifies our regarding both as generically distinct from the African Labyrinthodont, whose dermal scutes alone separate it from all other members of the group, the scutes of *Archegosaurus* having perfectly different characters*.

I propose therefore to form a new genus, *Micropholis*, for this African fossil, and to call it *Micropholis Stowii*, after its discoverer†, who has the merit not only of finding the fossil, but recognizing its Batrachian affinities, sending home with it the skull of that African Frog which seemed to him most nearly to approach it.

The concurrence of Labyrinthodont remains with the beaked and few-toothed or toothless Dicynodont Reptiles‡ in the Karoo-beds of Africa presents so striking a resemblance with the assemblage of reptiles characteristic of the Fauna of the Trias in this country, that one is at first inclined to leap to the conclusion, that the discovery of this association settles the question of the age of the African formation. When I consider, however, that Labyrinthodont *Amphibia* range from the Lias down to the Carboniferous formations inclusive, and that *Micropholis* is not very closely allied to any of the more characteristic forms of the Trias, I am inclined to pause before drawing any very decided inference from the analogy of the Faunas.

2. *On a New Species of* Dicynodon (D. Murrayi), *from near Colesberg, South Africa; and on the Structure of the Skull in the Dicynodonts.*

In the spring of 1858 the Rev. H. M. White of Andover brought to the Museum of Practical Geology some fossils from South Africa, with whose nature he desired to be acquainted. Among them was a fragment of the skull of a *Dicynodon*, which, on comparison with the species already described, appeared to me to be new. On ap-

* There is no certainty that the *Anisopus scutulatus* (Owen) of the Warwickshire Trias is really a Labyrinthodont; and if it prove to be such, its scutes are very different from those of *Micropholis*.

† Quart. Journ. Geol. Soc. vol. xv. p. 193.

‡ Mr. Stow collected in the same locality (at the foot of the Rhenosterberg), together with the *Micropholis*, some Dicynodont remains, to which I hope to return on a future occasion.

plying to Mr. White for further information about the fossil, that gentleman was good enough to put me in communication with its discoverer, Mr. J. A. Murray, who, on learning what interest attached to the skull, very kindly undertook to procure a supply of more perfect remains of the same reptile from his father, who resides near Colesberg in South Africa, and not very far from the junction of the Orange and Caledon Rivers, where the fossil was found. Under these circumstances I thought it better to abstain from publishing the new species until the promised additional materials should have come to hand. They arrived at the end of the year; and in January 1859, Mr. Dew, of the British Museum, to whom I had entrusted the working out of one of the three (nearly entire) crania which Mr. Murray had sent, brought me the skull figured in Pl. XXIII., which, I had the satisfaction to find, fully bore out the view I had taken of the specific distinctness of the fragment which first came into my possession. I had then no hesitation in desiring to lay my results before this Society; and on the 2nd of February the President assigned me the evening of the 23rd of March for this and certain other communications.

In the meanwhile, the Society happening to be but scantily supplied with papers on the evening of the 23rd of February*, I exhibited the cranium of my new *Dicynodon*, defined its characters, and conferred upon it the name of *D. Murrayi*, after the gentleman to whose exertions I was indebted for my materials.

The cranium of *Dicynodon Murrayi* (Pl. XXIII. fig. 1) measures seven inches in a straight line from the extremity of the occipital condyle to the extremity of the snout, and six inches along a line drawn from the highest point of the roof of the skull to the articular extremity of the quadrate bone. From the extreme outer point of the left quadrate bone (the right is somewhat damaged) to the centre of the occipital condyle is a distance of four inches; so that the back of the skull is eight inches wide. The highest point, or vertex, of the skull lies a little in front of the posterior boundary of the orbit, and is situated, as nearly as may be, opposite the middle of the horizontal axis of the skull. The occipital condyle is a little broken at its extremity, but still projects half an inch beyond the plane of the occipital foramen.

The posterior part of the superior region of the skull, or that which lies between the temporal fossæ, looks backwards as well as upwards, so as to form an angle of about 30° with a line joining the snout and the occipital condyle. Between the orbits the contour of the cranial roof is rounded from before backwards, and so passes into the preorbital region, which slopes abruptly downwards and forwards, so as to form an angle of 90°–100° with the plane of the intertemporal region. As both the anterior and the posterior ends of the head are obliquely truncated, its entire lateral contour appears like a pentagon, whose apex, formed by the vertex, is directed upwards, and its base, formed by the mandibles, is turned down-

* See above, p. 555.

wards. On the other hand, viewed from in front or behind (Pl. XXIII. fig. 2), the skull has rather the form of a hexagon, whose superior side is constituted by the interorbital space, its supero-lateral sides by the edges of the postfrontal bones, its infero-lateral sides by the quadrate bones, and its base by the interval between the rami of the mandibles. The superior face of the skull is narrower in front than behind, where it presents a deep and wide median excavation, formed by the divergence of two strong processes, which expand at their ends and unite with a straight, strong, bony bar, which lies parallel with the longitudinal axis of the skull, and consequently nearly at right angles with them. Anteriorly this bony bar becomes connected with the process which forms the posterior boundary of the orbit. The upper wall of the cranium itself is very narrow, measuring only 1·3 inch across posteriorly, but it expands anteriorly, until, at the level of the posterior margins of the post-orbital processes, into which its margins gradually pass, it is 2 inches wide.

The supratemporal fossæ, circumscribed by these parts on each side, are 3 inches wide by 1½ inch long; and while their anterior, posterior, and external boundaries are nearly straight, the inner boundary, formed by the walls of the cranium proper, is concave. The narrow and flattened intertemporal region of the skull expands anteriorly into the interorbital region, which has a nearly square outline, 3½ inches wide by 3 inches long. It is convex from before backwards, and exhibits a slight median ridge, which is much more marked in the original fragmentary specimen than in that figured.

I have not been able to detect any clear evidence of the existence of a parietal foramen in this skull; but in another specimen it is situated in the middle of a line drawn from the anterior margin of one temporal fossa to that of the other.

Anteriorly the interorbital space is bounded by two strong converging ridges (less distinct in this specimen than in others), which pass forwards and inwards, to meet in the middle, rather behind a line uniting the anterior and inferior margins of the orbits. Here they are joined by the low longitudinal ridge which has been stated to traverse the interorbital region.

Each of the converging ridges exhibits a thickening rather internal to its middle, which is continued for a short distance obliquely inwards.

In front of the orbits the facial bones form a thick mass, produced downwards and forwards in the way already described, and which is so much wider on its oral than on its nasal side that it may be compared to a trihedral prism. Transverse sections, however (figs. 3–6, Pl. XXII.), show that its outline is not quite so simple as that of a trihedral prism would be, its surface being raised into seven longitudinal ridges, separated by as many slight excavations. Of these ridges one is in the middle line above, while the other three lie on each side. Of these the lowermost, situated in the lower and outer part of the maxilla, is very strong and thick, and corresponds with the alveolus of the tusk. The middle lateral ridge is thin and sharp, and is developed from the maxilla, close to its upper boundary. The supero-lateral ridge is situated on the sides, and the median ridge on the middle, of the premaxillary and nasal bones. The external bony nasal apertures are placed in the upper part of the snout, about $\frac{3}{4}$ths of an inch in front of the orbit; they are irregularly oval, and about an inch long by $\frac{6}{10}$ths of an inch wide. They are $1\frac{1}{2}$ inch apart, but appear to have communicated with one another above the thin bony ethmovomerine septum. In another specimen the bony plate which roofs them in above and in front is wider than in that figured; but in none does it seem to have formed an overhanging ledge.

The extreme termination of the snout is apparently wanting in all my specimens; it was probably curved downwards and convex forwards, but, I suspect, less so than in other Dicynodons. Below the infero-lateral or alveolar ridge, the sides of the maxilla slope abruptly inwards, and are then continued downwards to unite with the palatine bones.

The projecting ends of the tusks are broken off at about two inches from the ends of their fangs in the specimen figured. In the transverse sections (Pl. XXII. figs. 3–6), it is seen that no trace of the tusk is visible in that taken through the external nostrils (fig. 3); while in that taken $\frac{9}{10}$ths of an inch further forwards (fig. 4), the section of the walls of the tusk, which measures nearly $\frac{7}{10}$ths of an inch in diameter, and has a pulp-cavity $\frac{1}{5}$th of an inch less, is very visible. The pulp-cavity gradually diminishes anteriorly, so that close to where the tusk is broken off, in fig. 6, its diameter is not more than equal to that of its wall, and, as I observe in other specimens, it becomes still less further forwards. The tusks seem to have been nearly straight in this *Dicynodon*, or to have been but very slightly curved.

The occipital bones (Pl. XXIII. fig. 2) are united into a great vertical quadrate plate, $2\frac{1}{2}$ inches high by $4\frac{1}{2}$ inches broad. The upper edge of this plate exhibits a median notch, on each side of which it passes outwards, nearly horizontally, but with a slight upward convexity, for $1\frac{1}{2}$ inch. It then curves downwards until it joins the lateral face, which at a short distance below the junction presents a deep notch. Down to the level of this notch the occipital surface is nearly flat; but below the notch, it presents an oblique excavation on each side, succeeded by a very strong convexity, whose longitudinal axis is directed downwards and outwards, and which, by its truncated end, apparently abuts against the quadrate bone. The occipital foramen, which lies in the midst of the occipital face of the skull, is shaped like an Egyptian doorway, being high, straight-sided, and wider below than above. It is rather more than $\frac{8}{10}$ths of an inch in height, $\frac{6}{10}$ths of an inch broad at the base, and $\frac{4}{10}$ths of an inch at the summit, which is 1 inch distant from the upper edge of the occipital plate.

I have spoken of this great quadrate bony mass as the "occipital plate," because it appears to me to be formed by the combination of all the elements of the occipital bone. There are traces of the primitive sutures between the basi-occipital and the exoccipitals;

but those which should appear between the exoccipitals and supra-occipital are not clearly traceable. On the other hand, there is a very distinct line of separation, which externally becomes a space $\frac{1}{4}$th of an inch wide, between the upper margin of the occipital plate and the body and lateral processes of the parietal. This latter bone has a triangular outline when viewed from behind, measuring fully $1\frac{1}{3}$ inch from base to apex. The union of its lateral processes with the squamosals is distinctly traceable on one side. The parietal process, whose end is rather more than 2 inches from the centre of the bone, passes in front of, and overlaps the inward process of the squamosal.

A strong inferior process or "hypapophysis" is seen descending from the base of the skull on the right side. The quadrate bone is a broad, but comparatively thin, bony plate, $1\frac{1}{2}$ inch wide superiorly and 3 inches long. Its anterior face and its outer edge are convex. The posterior face, which is very concave from above downwards superiorly, and convex in the same direction below, is divided by a vertical ridge into a large outer portion, whose plane is nearly the same as that of the occiput, and a smaller inner division, bent forwards almost at a right angle with the foregoing. The lower moiety of this inner division of the posterior face of the bone is pretty closely applied to the end of the broad process of the exoccipital. The upper moiety forms, with the concave surface of the exoccipital above this process, the lateral walls of a deep fossa, roofed over, above and externally, by the recurved upper part of the quadratum, which is separated from the occipital plate by a small intercalary bone. This appears to me to correspond with that bone called "une espèce d'épiphyse, ou plutôt d'os interarticulaire pour le tympanique," in the Monitor, by Cuvier (Oss. Foss. ed. 2. vol. x. p. 16).

The mandible is imperfect posteriorly; and a considerable part of of its symphysial end has also disappeared. It measures about 4 inches as it is, but probably attained between 5 and 6 inches in length when perfect. The depth of the symphysial part of the mandible could hardly have been less than $2\frac{1}{2}$ inches; and, in the coronary region, the ramus attains about 2 inches in this direction.

The skull whose external characters have just been described is distinguished from those of all hitherto discovered Dicynodons by—

1. The great angle formed by the planes of the intertemporal and facial regions of the upper surface of the skull.
2. The excess of the transverse over the longitudinal diameter of the supratemporal fossæ.
3. The position of the nasal aperture altogether in front of the orbits.
4. The proportional length of the upper jaw in front of the nasal apertures.
5. The length and form of the os quadratum.
6. The circular section and straightness of the tusks*; the position

* Where the tusks are other than circular in section, their figure is clearly distorted by pressure. It is a curious circumstance, indeed, that no one of the skulls of *Dicynodon Murrayi* which I have seen is free from a certain amount of disfigurement from this cause.

of their posterior ends immediately below the nasal apertures; their extension downwards and forwards parallel with the plane of the nasal and premaxillary bones; and their not leaving their sockets till they have passed beyond the level of the posterior end of the symphysis of the mandible.

7. The longitudinal ridges on the prism-like snout.

The Structure of the Skull of Dicynodonts.—The general structure of the Dicynodont skull, so far as it is visible from the exterior, and without making sections, has been fully elucidated by Prof. Owen in his papers in the Transactions of this Society (vol. vii.); but no attempt has been made hitherto, so far as I am aware, to work out the anatomy of its deeper-seated parts.

The remarks I am about to offer are the results of my observations upon *Dicynodon Murrayi*, and upon a small skull from the Rhenosterberg, the species of which is not determinable with certainty.

The cranio-facial axis is more completely ossified in *Dicynodon* than in any reptile I am acquainted with, the presphenoid, the ethmoid, and the vomer being, so far as I can observe, entirely osseous.

The basi-occipital is extremely short, and the basi-sphenoid is a very strong cuboidal bone, whose posterior face projects freely, for half its extent, below the basi-occipital. This portion of the bone slopes downwards as well as backwards, and is concave from side to side. The inferior face, wide but short, is also concave from side to side, but is a little convex from before backwards. The pterygoids abut against the lateral and inferior parts of the basi-sphenoid.

The presphenoid is united with the basisphenoid by an oblique sutural face: posteriorly it is thick and solid; but anteriorly it thins off into a vertical plate, which extends continuously between the orbits and forms a bony interorbital septum.

The interorbital septum passes into the ethmovomerine plate or nasal septum, which, as far forwards as the front part of the external nasal apertures, is an exceedingly thin but deep plate of bone (fig. 3, Pl. XXII.). At the anterior boundary of this aperture, however, the upper portion of the nasal septum thickens and rapidly expands into a broad and thick spongy mass, consisting of a horizontal and a vertical portion. The former is $1\frac{1}{4}$ inch wide. Its flat summit articulates with the ascending process of the premaxillary bone; while its obliquely truncated lateral faces, half an inch wide, appear on the face, between the supero-lateral and median-lateral ridges, being interposed between the premaxillary and the maxillary bones, which are completely separated by this horizontal prolongation of the septum narium. The inferior sides of the mass slope downwards and inwards to join the vertical portion of the thickening, which is $\frac{7}{10}$ths of an inch long, by $\frac{6}{10}$ths wide. Its sides are convex, its inferior surface is concave, and from its centre proceeds the thin bony plate which constitutes the proper nasal septum. The maxillary bone unites suturally with the inferior face of the horizontal portion of the bony expansion, and with about the upper half of the outer surface of the vertical portion (Pl. XXII. fig. 4).

In a section taken nearly an inch further forwards (Pl. XXII. figs. 5 & 6) the bony expansion has enlarged and acquired a quadrate form, the vertical portion having expanded, so as to be nearly as wide as the horizontal, and uniting throughout the whole of its outer surface with the maxillary bone. Its lateral portions have extended downwards below the level of the alveoli, while the centre of its inferior surface has hardly altered its distance from the anterior, or superior, boundary of the snout. In consequence of this, the inferior surface of the spongy mass forms a deep arch, from whose centre depends the proper nasal or vomerine septum, which has attained a thickness of $\frac{1}{4}$th of an inch.

An inch further towards the end of the snout, no trace of these parts is seen in a transverse section; and I conclude, partly from these sections and partly from other evidence, that the ethmovomerine plate had a curved inferior margin which ended somewhat abruptly anteriorly, corresponding in all probability with the form of the middle symphysial ridge in the lower jaw. Superiorly it seems to have dilated into a thick bony mass, whose supero-lateral portions intervened between the premaxillary and the maxillary bones, while its infero-lateral parts extended down on the inner side of the maxillary bone, and, as I am inclined from some appearances to think, sent back a process along the maxillary wall, close to the palatine bones, to form a part of the boundary of the internal nares.

The palatine bones are attached to the presphenoid below the anterior boundary of the orbits; they pass, diverging, forwards and outwards, till they reach the lower walls of the maxillæ, into which their upper edges are wedged. Anteriorly, these bones incline inwards and join the lower edge of the ethmovomerine plate. The posterior nares are the two spaces enclosed between them, the palatine bones, and the ethmovomerine septum.

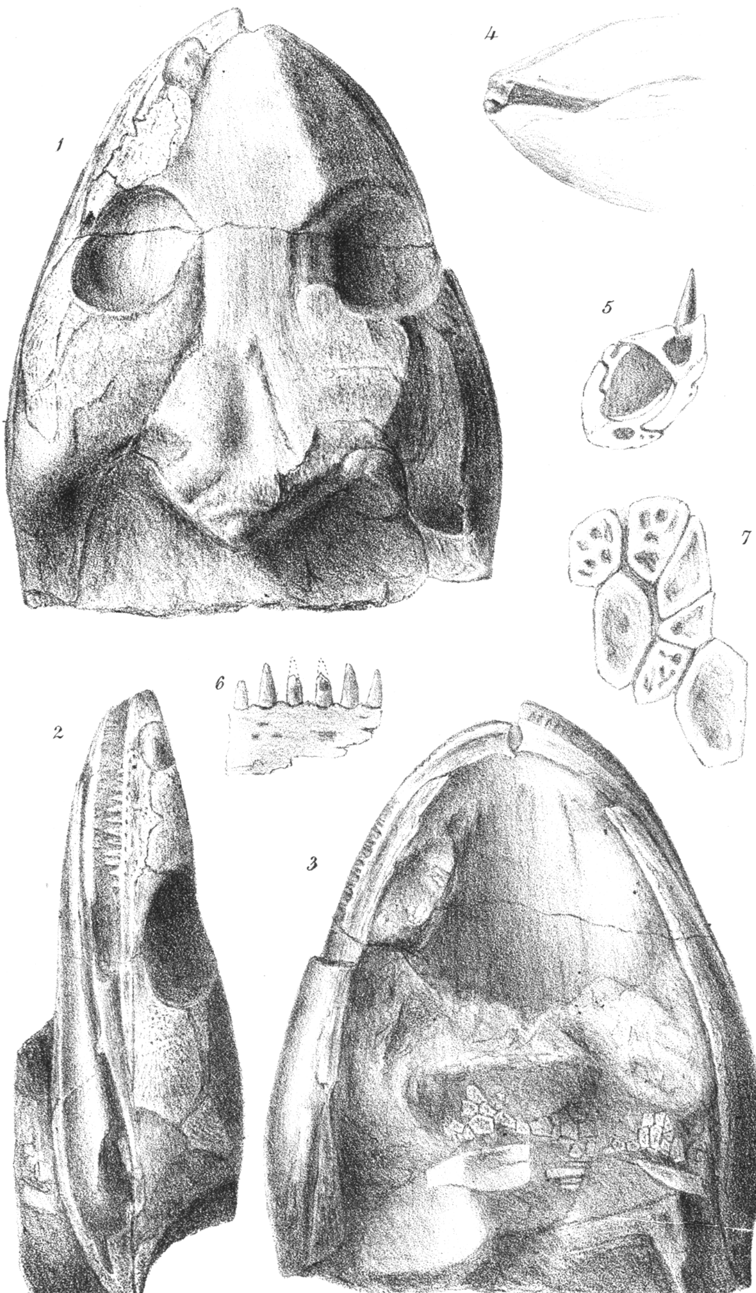
The structure which I have just described cannot, I think, be explained by the analogy of any recent reptile, nor am I acquainted with any fossil member of the class which presents a similar arrangement of the parts.

In all *Lacertilia*, *Ophidia*, *Chelonia*, and *Crocodilia*, the palatine bone has but a small share in the lateral osseous boundary of the posterior nares; while the vomers or vomer often present a broad inferior surface, and have little vertical expansion.

In the Monitors, however, there is a bony mass, commonly called the turbinal bone, which appears to me to represent very closely the superior expansion of the ethmovomerine plate of *Dicynodon*. Except in proportional size, in fact, it agrees very closely with the latter; for it appears on the upper surface of the skull, between the ascending process of the premaxilla, where it is joined by the descending part of the nasal, and occupies a broad space between the ascending process of the premaxilla and the maxilla, with whose inner and upper edge it articulates. Behind it, the maxilla reaches the prefrontal; in front, the "turbinal" extends inwards to the premaxilla; internally the "turbinal" is continuous with a vertical plate which passes inferiorly into the vomers; and if these bones, instead of being expanded horizontally below, were represented by their thin vertical plate only, the resemblance to *Dicynodon* would be close. But the nasal passages of Birds present a much nearer approximation to those of *Dicynodon*. In such a bird as a Vulture, for instance, the osseous, vertical vomerine septum expands inferiorly in front of the external nares into a mass of cancellated bone; and that mass bounds the nasal passages in front and above, and sends down a thin septum in the middle line, just as in *Dicynodon*. Furthermore, the posterior nares are bounded externally by the palatine bones to the same extent in the Bird as in *Dicynodon*; and the bone called "inferior turbinal" in birds occupies a position on the inner side of the palatine and maxillary precisely similar to that occupied by the bone to which I have referred above. Again, the manner in which the palatines and pterygoids are connected with one another and with the presphenoid in *Dicynodon* is extremely bird-like.

Many points in the structure of the mandible and premaxilla are very well shown by the skull of *D. Murrayi* figured in Pl. XXIII., which displays excellent transverse sections of both the maxillary and the mandibular bones, not only close to the extremity of the snout, where, as I have already mentioned, part of the bony matter is altogether broken away, but at $1\frac{1}{2}$ inch from it, where an accidental fracture has taken place. The inner surface of the premaxillary bones, in front of the septum, is produced into two longitudinal ridges, which have a triangular section, their sharp edges being directed downwards. The upper part of the symphysial region of the dentary element of the mandible is developed into three very strong processes which fit into the interspaces left between these ridges—at the sides, and in the middle between each ridge and the downwardly inclined sides of the premaxilla.

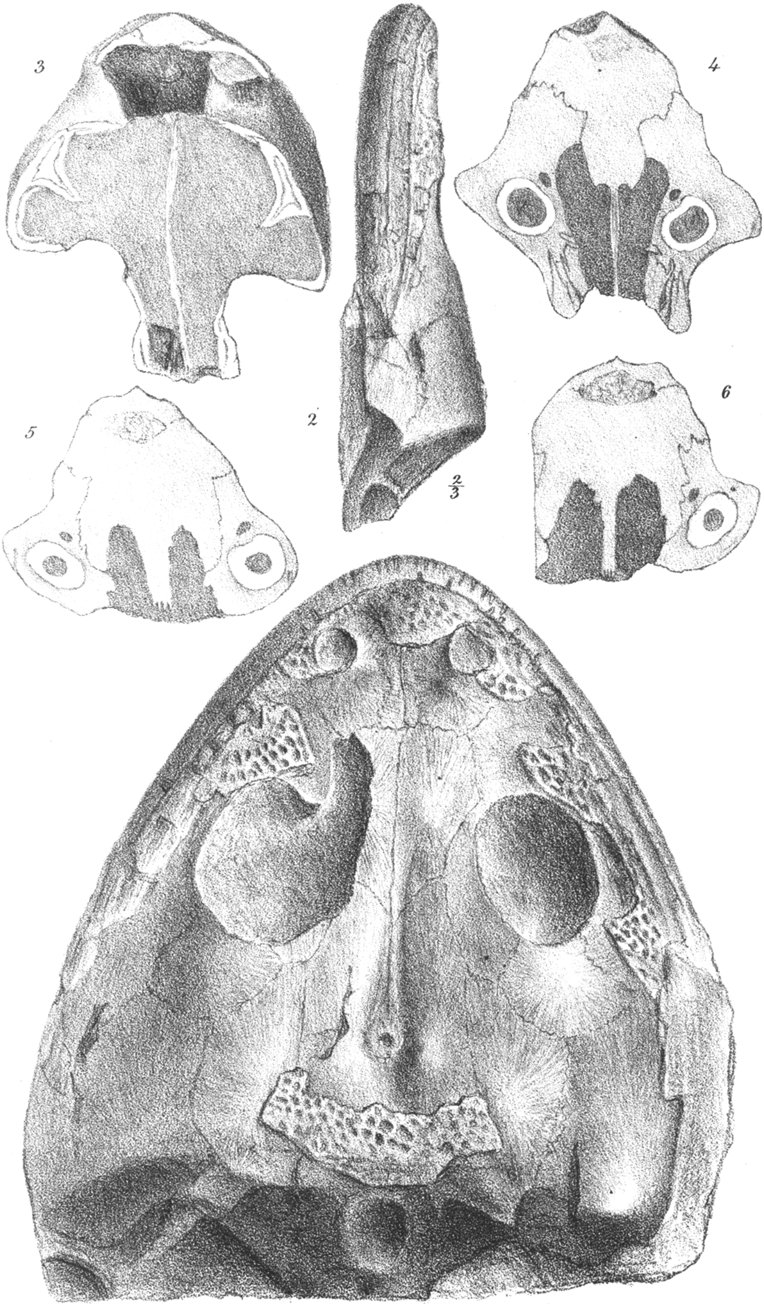
The median ridge is $\frac{3}{4}$ of an inch high and $\frac{1}{3}$rd of an inch thick at its base. It expands superiorly and ends in a sharp edge, so that its section is lancet-shaped. It is separated by a deep groove from the lateral plates, which are slightly curved, not so long as the median plate, and are obliquely bevelled off internally. A section of either ramus shows that the upper edge of the dentary bone in this region is broad and produced into a thick inner and a thin outer wall, separated by a deep groove, which, in consequence of the convexity of its walls, is much narrower below than above. Inferiorly the dentary bone sends down a broad plate on each side. The inner of these remains comparatively thin and comes into contact with the splenial element; the outer becomes very thick where it passes the longitudinal ridge which marks the outer surface of the dentary bone, and then, thinning, overlaps the supra-angular element. The dentary element extends back for more than half the length of the ramus. In almost all these respects the dentary bone of *Dicynodon* is very Chelonian, as will be obvious to any one who compares with these the corresponding sections of a Turtle's mandible. The splenial bone, however, appears to extend to the symphysis, where it unites with its fellow.



G. West del. & lith.

MICROPHOLIS STOWII.

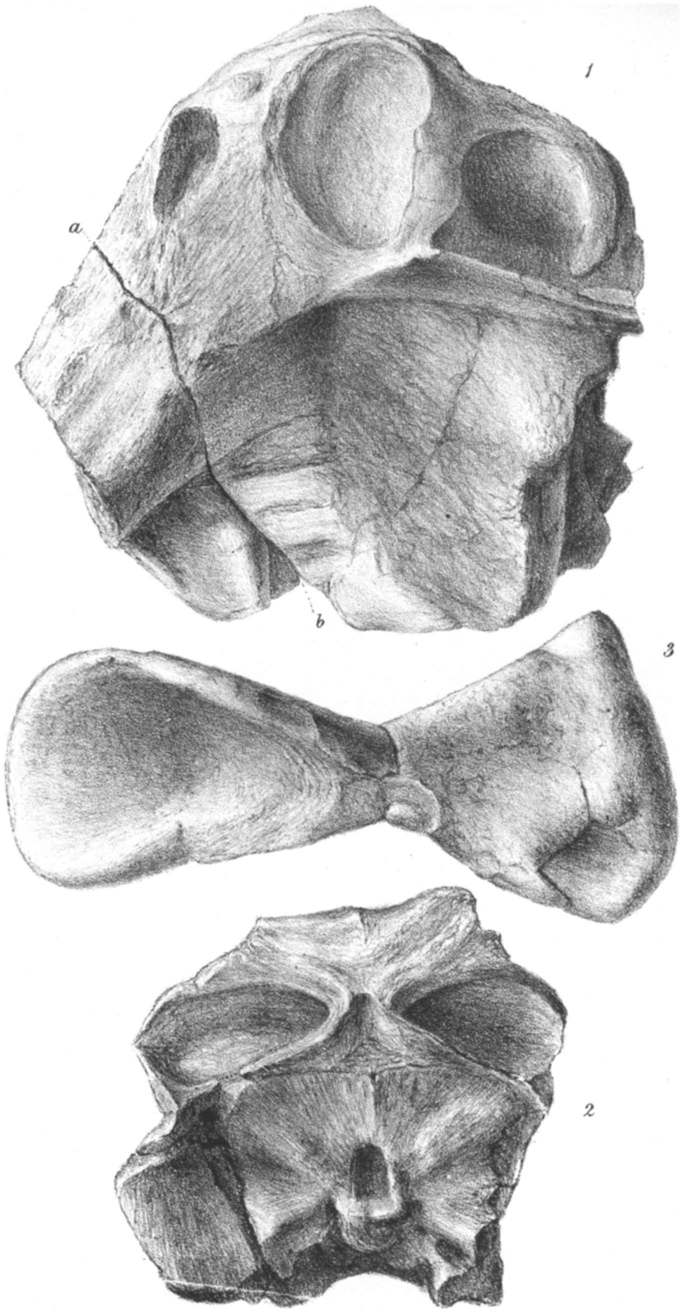
W. West imp.



G. West del. & lith.

W. West imp.

BOTHRICEPS AUSTRALIS & DICYNODON MURRAYI.



G. West del. & lith.

W. West imp

DICYNODON MURRAYI.

A fragmentary specimen of the skull of a small *Dicynodon Murrayi* exhibits very beautifully marked impressions of the sclerotic bones in their natural arrangement. They form a zone $1\frac{6}{10}$ inch in diameter and $\frac{1}{2}$ an inch broad, which closely adapts itself to the bony circumference of the orbit. The sclerotic ring does not seem to have consisted of more than four or five ossicles.

Bones of the Extremities of D. Murrayi.—The only complete bone of the extremities which I have met with is a left humerus (Pl. XXIII. fig. 3) $3\frac{6}{10}$ inches long, and not unlike that of a *Monitor*, except that it is proportionally wider at the articular ends and narrower in the middle. The deltoid crest is very large, with an almost semicircular free margin; and there is a deep posterior intercondyloid depression, as if for a large olecranon-process.

Among the other remains, I found an extremely interesting fragment, consisting of the anterior part of the sacrum and the last dorsal or lumbar vertebra of *Dicynodon Murrayi*.

The lumbar vertebra is biconcave; its centrum measures $\frac{7}{10}$ths of an inch antero-posteriorly and an inch transversely at its ends, while its centre is a little constricted. Superiorly it widens, and, uniting with the base of the neural arch, enters into a broad but short transverse process. The neural arch is broad, thick, and depressed,—the neural canal not exceeding $\frac{3}{10}$ths of an inch in diameter. A strong spinous process rises from it, and passes obliquely upwards and backwards for an inch, to end in a truncated extremity. The first sacral vertebra is like the last lumbar; but the lateral enlargement, or rudimentary process, into which the neural arch and the centrum enter, unites suturally with the smaller end of a broad fan-shaped pleurapophysis, $\frac{3}{4}$ths of an inch long, whose outer, vertically expanded, obliquely truncated end abuts against the inner surface of the ilium. The centrum of this vertebra is $\frac{4}{5}$ths of an inch long, and it is concave anteriorly, flat posteriorly. The anterior articular face of the centrum of the next sacral vertebra is also flat, and is closely applied to, if not partially anchylosed with, the flat hinder face of the first. The upper parts both of it and of the next vertebra are much mutilated, but their pleurapophyses, similar to, but smaller than, those of the first sacral, are well preserved. The anterior faces of these pleurapophyses look downwards as well as forwards. The fragment of the ilium shows that this bone was very broad and expanded, concave externally, slightly convex internally, and much thicker towards its ventral than at its dorsal edge.

DESCRIPTION OF PLATES XXI. XXII. XXIII.

Plate XXI.

Fig. 1. Skull of *Micropholis Stowii*, viewed from above. Magnified 2 diameters.
2. The same, seen from the left side. Magnified 2 diameters.
3. The same, seen from below. Magnified 2 diameters.
4. The posterior end of the right ramus of the mandible, and of the mandibular suspensorium of the same.
5. Transverse section of the mandibular ramus.
6. A portion of the mandible, with teeth *in situ*.
7. The dermal scutes represented in fig. 3, magnified 10 times.

PLATE XXII.

Fig. 1. Dorsal or superior view of the cranium of *Bothriceps Australis*. Nat. size.
2. Lateral view of the same, reduced to one-third diam.
3. Transverse section of the snout of *Dicynodon Murrayi*, taken perpendicularly to its axis, just in front of the internal nares. Reduced to one-half diam.
4, 5, 6. Similar sections, taken successively nearer the extremity of the snout. Reduced to one-half diam.

PLATE XXIII.

Fig. 1. Lateral view of the skull of *Dicynodon Murrayi*. Reduced to one-half diam. The fossil has been accidentally fractured in the direction *a b*.
2. The same skull, viewed from behind; reduced to one-third diam.
3. The left humerus (nat. size) of a *Dicynodon Murrayi*.

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2. *On* RHAMPHORHYNCHUS BUCKLANDI, *a* PTEROSAURIAN *from the* STONESFIELD SLATE. By THOMAS H. HUXLEY, F.R.S., Sec. G.S., Professor of Natural History, Government School of Mines.

(PLATE XXIV.)

SINCE the description of the fossils belonging to this species of Pterosaurian which originally came into my possession, I have met with so much additional material, that I have thought it better completely to remodel the present Memoir, than to add the subsequently acquired information in cumbrous notes.

Some time ago, the Earl of Ducie was good enough to place in my hands, for description, a portion of a lower jaw, about $3\frac{1}{2}$ inches in length, which was obtained from a quarry known by the name of "Smith's Quarry," at Sarsden, near Chipping Norton, in Oxfordshire. Bones of Pterosaurians abound in this locality, associated with remains of *Megalosaurus* and of Oolitic fishes; and Lord Ducie considers that the beds in which his fossil was discovered are the representative of the Stonesfield slate. In this conclusion, I find, my colleagues of the Geological Survey concur.

The symphysial part of the lower jaw in question, and the whole of what remains of the right ramus, are extremely well preserved (Pl. XXIV. figs. 1*a*, 1*b*.); but the inferior part of the left ramus is broken away at a distance of about an inch behind the symphysis. The latter measures $\frac{7}{8}$ths of an inch in length, and exhibits no suture. Its posterior boundary is nearly a quarter of an inch thick, and looks downwards as well as backwards.

The distance between the two edges of the rami opposite the posterior extremity of the symphysis is $\frac{15}{16}$ths of an inch, the depth of a ramus measured perpendicularly at the same point being $\frac{7}{16}$ths of an inch. The outer faces of the rami are here inclined at an angle of 45° to a vertical longitudinal plane; and they converge to a rounded edge, which forms the lower margin of the symphysis, and bends upwards anteriorly, so as to exhibit a slight downward convexity. In front, the symphysis ends in the base of a stout median process, whose continuation is unfortunately fractured. Its section is an elongated oval with rather sharp extremities, having its greater