XIII. *Reptiles from the Elgin Sandstone.—Description of Two New Genera.*

By E. T. Newton, *F.R.S.*

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[Plates 53–56.]

Contents.

I. Introduction.

Since the reading of my previous paper (68*), 'On some New Reptiles from the Elgin Sandstone,' several additional specimens have come to me for examination. They are all from the Elgin Sandstone, but, with possibly one exception, are from the quarry at Spynie, two miles north-east of Elgin. Two of these specimens are new forms, representing two new genera, and form the subject of the present communication. One of them, like all those in the earlier paper, is in the condition of hollow moulds, and a similar mode of investigation has been resorted to, namely, the preparation of gutta-percha casts from the cavities. In the second specimen the bones were present, but in a very friable condition; the skull, however, owing to the care with which it was uncovered by Mr. Richard Hall, of the British Museum, is now beautifully preserved, and most of the caudal vertebræ are still *in situ*; but the greater part of the rest of the skeleton had hopelessly crumbled away with the breaking open of the stone, and, for these parts, the casting process had again to be resorted to before the forms of the bones could be seen.

* These numbers refer to the List of Works, p. 603.

II. DESCRIPTION OF SPECIMENS.

1. Erpetosuchus Granti, *gen. et sp. nov.* (Plate 53.)

General Remarks.

The first specimen to be noticed is contained in a small block of sandstone, the property of Mr. James Grant, of Lossiemouth, who has been good enough to place it in my hands for development and description. The exact locality from which it came is uncertain, as it had been used for part of a breakwater before its value was discovered; but there is no doubt as to its being from the Elgin Sandstone, and in all probability it came originally from the quarry at Lossiemouth, or that at Spynie. When the block first came to me it had been broken across in two directions, and one piece was wanting. The two portions remaining formed an irregular cube, showing on one side some small cavities, which proved to be parts of the vertebral column that had been broken across. Another surface, exposed by the breaking open of the stone, exhibited several holes, the meaning of which could only be conjectured, and an outline which seemed to indicate a transverse section of a skull.

These remains, like those from Cuttie's Hillock, are, as already mentioned, only represented by hollow cavities; in the present instance, however, this is probably due to weathering since the stone was removed from the quarry.

In order to reproduce the forms of the bones, it was necessary, as in previous instances, to split open the cavities, and then, by chiselling away such parts as could be best spared, so to expose the hollow moulds that casts could be prepared from them. After carefully probing to find in which direction the bones lay, for at this time the nature of the specimen was very uncertain, it was decided to split the smaller block from end to end, so as, if possible, to open longitudinally a cavity which seemed to be part of a skull.

This operation was successful beyond expectation, for it displayed not only the impression of the hinder half of the skull divided nearly vertically and longitudinally, but also a good portion of the vertebral column, surmounted by a row of small pitted scutes. Moreover, it was now certain that the anterior part of the skull was in the larger block of stone, and its direction was shown by the position of the hinder part, so that, after partly sawing through this larger piece of stone, it also was split open vertically; and thus was displayed not only the front of the skull, but also part of a ramus of the lower jaw. Further development revealed the pectoral arch, with both the fore limbs as nearly as possible in their natural positions. It was now evident that the skeleton must have been entire when embedded in the sand, and the lost portion of the block of stone doubtless contained the greater part of the body, with the hind limbs and tail, of this exceedingly pretty little reptile, the skull of which is only three inches in length.

Description.

Skull.—In the descriptions which follow, it will be understood that, for convenience sake, the casts are alluded to as if they were the original bones.

There can be no doubt that the skull, and, indeed, all the parts of this skeleton which have been preserved, have a very crocodile-like appearance, although in certain points it differs widely from any living crocodile and can only be compared with the Triassic *Parasuchia*.

Seen from above (Plate 53, fig. 2), the skull is very regularly pear-shaped, being broad and rounded in the temporal region, somewhat narrowed posteriorly, more rapidly narrowed in front of the orbits, but enlarging again near the front, before terminating in a rather pointed anterior extremity.

In this view, eight distinct openings are seen, namely, a pair of proportionately large supra-temporal fossæ, the still larger and almost circular orbits, a pair of elongated pre-lachrymal fossæ, and, quite anteriorly, a pair of small nasal apertures. The infra-temporal fossa is also just visible on the side in this view, making in all ten openings. Very little can be seen of the sutures, but there is no doubt as to the general position of most of the bones, although their exact extent is uncertain.

The small anterior apertures, which are doubtless the external nares, are bounded in front, and partly separated from each other, by a small bone (or pair of bones) which is evidently the united premaxillæ. This bone has a somewhat greater extent on the oral aspect (fig. 3), and gives evidence of having supported three or four teeth on each side. How much of the dentary margin was formed by the premaxillæ is not certain, but the notch, seen most distinctly on the left side, although to some extent due to imperfection, apparently marks the division between it and the maxilla; the latter being expanded at its front part and carrying larger teeth. The median, upper process of the premaxillæ is pointed and wedged into a cleft in the anterior end of the large flat bone, which forms the posterior boundary of the nasal apertures and nearly the whole of the preorbital upper surface; no definite median suture can be seen, but this area is almost certainly formed by the two nasal bones. Towards the front a groove is seen passing downwards on each side just behind the nasal aperture, which is clearly part of the naso-maxillary suture, and the sharp thread-like line, passing backwards from this suture nearly to the orbit, divides the upper from the side walls of this part of the skull, and, apparently, also marks the division between the nasal and maxillary bones. While the nasal bones are nearly smooth, the frontal, or interorbital region is marked by irregular pittings, which anteriorly become ridges and grooves that terminate rather abruptly, and seemingly mark the junction of the frontal and nasal bones, but no suture is visible. Posteriorly the rugosities of the frontals also end abruptly; the inter-temporal, or parietal region being almost smooth, and a little below the level of the frontal bones; this region has a median longitudinal crest which posteriorly joins the transverse ridge that marks the hinder boundary of

the upper surface and the upper margin of the occiput. The transverse ridge extends outwards on each side to the squamosal region, and seems to be formed chiefly by the parietal bones, which form a comparatively broad band of bone on the upper surface behind the supra-temporal fossæ, and extend for a short distance on the occiput.

There is no trace of a pineal fossa.

A side view of the skull (fig. 1) shows the same five vacuities that were seen from above; but the infra-temporal and pre-lachrymal fossæ are here better shown, while the supra-temporal fossa is only just visible. As already mentioned the premaxilla is small, and seemingly is restricted to the anterior half of the narial opening, the thickened dentary margin which supports the larger teeth, apparently belonging to the maxilla. The whole of the side wall of the skull, between the anterior nares and the orbit, forms a deep and clearly-defined depression, marked off from the upper and lower surfaces by sharp ridges, which meet and form a rounded front a little behind the nasal opening. The upper part of this depression is occupied by a thin, wrinkled plate of bone, which partly separates it from the internal cavity; and the appearance of this, together with the sharply-defined margins, makes it probable that the space was occupied by some soft tissue, possibly a gland. A large vacuity at the lower part opens into the internal cavity of the skull. The front part of this fossa is doubtless formed by the maxilla, as well as much of the flattened surface, seen on the under parts; but how far it extends backwards is not seen, and probably the hinder portion of this depressed area and the front margin of the orbit are due to prefrontal and lachrymal elements, the sutures not being visible.

The upper and side aspects of this skull, behind and including the orbits, have so close a resemblance to the same parts in *Teleosaurus*, that it is in the highest degree probable that the bony elements, entering into its construction, occupy the same relative positions, but there are very few indications of sutures to mark their boundaries. Judging from the position of the post-palatine vacuity (fig. 3), the maxilla seems to extend backwards to about the middle of the orbit (fig. 1), from which it is probably excluded by the jugal. The sub-orbital bar divides posteriorly into two branches which form the upper and lower boundaries of the infra-temporal fossa. The lower branch becomes much attenuated, and its pointed end seems to be received into a socket of the bone which forms the lower and outer part of the pedicle supporting the lower jaw; the pointed bar is evidently the jugal bone, and the socket receiving it is as certainly formed by the quadrato-jugal; the latter bone probably forms the outer border of the pedicle, with the quadrate altogether on its inner aspect. The upper branch of the sub-orbital bar, passing backwards, unites first with the post-orbital bar, and then with the bones of the squamosal region to form the supra-temporal bar, to which is likewise attached the upper end of the pedicle for the lower jaw. The hinder end of the squamosal is pointed and free, and is not in close relation with the exoccipital process, as it generally is in crocodiles.

The occiput is broken, but something of its structure may still be deciphered.

There is a single bead-like occipital condyle, with a pit in its middle, and above this the foramen magnum is indistinctly seen. On each side a large process passes off from the exoccipital region, and that of the right side is seen to extend upwards and outwards, so as to overhang somewhat, and come into close relation with, the quadrate articulation. This right exoccipital is obscured by two projecting pieces of bone which, as there is nothing to correspond with them on the left side, are believed to be accidental, and probably are portions of the atlas vertebra pressed out of place against the exoccipital. Above the foramen magnum the bone is much broken, and there is a considerable space without bone below the upper or parietal margin of the occiput. It seems probable that the supraoccipital is wanting, and that the bone in place above the foramen is to be attributed to the exoccipitals, which most likely meet above the foramen magnum.

When clearing away the matrix, the impression of a bone was seen passing upwards from the side of the cranial cavity, somewhat in front of the exoccipital to join the inner and upper part of the quadrate and also the squamosal. The wide upper part of this bone, in a back view of the skull, is above and in front of the exoccipital process. On comparing these parts with the same region in a crocodile, it is clear that this widened part of the bone must have formed the front wall of the auditory passage through which the columella passed. In the fossil, however, in its present condition, the passage is not completed behind, as it is in the crocodile, by the meeting of the squamosal with the quadrate and exoccipital processes.

The Palate of this skull (fig. 3) differs widely from that of any recent crocodile, but approaches the condition found in the Triassic *Parasuchia*. The greatest peculiarity is found in the forward position of the posterior nares, and in the deep trough which occupies nearly the entire length of the middle region. The roof of the mouth near the premaxillæ and the thickened parts of the maxillæ, that is to say, the part surrounded by the teeth, is slightly arched; but nearly opposite the hindermost tooth, the palate is suddenly deepened and a sharply defined trough is formed, which extends to the hinder end of the palate, and may indeed be said to reach to the basioccipital condyle. This trough is a little wider in the middle than it is at either end; anteriorly, the sharp overhanging edges appear to be formed by the maxillæ, these bones probably extending back as far as the post-palatine vacuities (*pt. pl.*), which lie close to the sides of the hinder part of the trough. It is probable that both palatines and pterygoids help to form the inner boundaries of the post-palatine vacuities.

On each side of the trough and extending backwards from the hindermost tooth, there is an edentulous, flattened edge almost certainly formed by the maxilla, which looks a little inwards and widens at its hinder end, where it embraces the front of the post-palatine vacuity. On the outer sides of these edges the under surface of the skull forms a wide obliquely flattened area which slopes outwards and upwards

to constitute the sharp lower margins of the pre-lachrymal depressions, seen on the sides of the skull.

This oblique area is narrow just behind the teeth (5 millims.) where it is probably formed entirely by the maxilla, but widens as it passes backwards, its greatest width being opposite the post-palatine vacuity, and directly below the orbit, at which part it is probably formed chiefly by the jugal, but no suture between this bone and the maxilla is visible. The posterior nares are placed quite at the front part of the median trough and below the front half of the pre-lachrymal vacuity; each is about 13 millims. long and 3·5 millims. wide, and is partly hidden in figure 3 by the overhanging sides of the trough. There is no reason for doubting that the outer and front walls of the posterior nares are formed by the maxillæ, and it is probable, though not certain, that the premaxillæ are shut out by the meeting of the maxillæ in the middle line.

The median part of the trough is occupied by a narrow spindle-shaped area, with a thread-like border on each side, which extends backwards nearly to the hinder part of the pterygoids, where it ends in a point, and forwards, between the posterior nares, for at least two-thirds of their length. If this area is formed by a distinct bone it can only be the vomer, and it is uncertain whether it is separated from the posterior nares by forward processes of the palatines or pterygoids. It is by no means clear what share the two bones last-named take in the formation of this trough.

In both crocodiles and lizards the post-palatine vacuity is bounded behind and outwardly by the transverse bone, which unites by a T-shaped piece with the maxilla and jugal, while the stem is applied to the descending process of the pterygoid. A precisely similar bone, occupying a similar position, is seen in the present specimen, and is without doubt a transverse bone. Passing backwards from this the pterygoids are seen as strong ridges, extending to, and abutting upon the basisphenoid, where they are united in the middle line, leaving no indication of any inter-pterygoid foramen, such as may be seen in *Sphenodon* and *Phytosaurus* (*Belodon*). The pterygoids, passing forwards, probably form part of the post-palatine vacuity, and they seem to extend along the sides of the vomer, perhaps to the posterior nares, but it is most likely that the palatines form the posterior, and to some extent the inner, boundaries of these apertures. The palatines seem to form the side walls of the trough, and are, therefore, largely hidden in this view from below; they most likely form part of the inner wall of the post-palatine vacuity, and extend forwards to the posterior nares; but the absence of sutures leaves these points uncertain.

To return to the pterygoids, close to their junction with the basisphenoid, each gives off a large process, backwards, outwards, and upwards to the quadrate. This process, at its origin, is compressed from side to side, but is comparatively deep; this condition is speedily reversed and the process becomes a wide and depressed bone,

its broad outer end being applied to the under surface of the quadrate. In all probability much of the outer part of this bone is a process from the quadrate, but no suture is visible to divide it from the pterygoid. Each pterygoid, therefore, is seen to have the characteristic triradiate form, one short limb passing forwards and outwards to the transverse bone, a second large and broad process extending backwards to the quadrate, while a third process seemingly extends forwards along the trough of the palate.

The palatal surface of the vomer (?) is marked by irregular pits, similar to those which usually give attachment to cartilage, and it seems possible, therefore, that in the living animal there was a median cartilaginous septum; and this leads to the surmise, that possibly the sharp overhanging sides of the trough gave attachment to soft tissues, which may have separated this trough more or less completely from the general cavity of the mouth. If this were the case, the posterior nares, in the living animal, must have been thrown far back, as in recent crocodilia, but with the two nasal passages formed by soft tissues, and not by bone.

The *base of the cranium* between the occipital condyle and the pterygoid bones, gives no indication of its division into basioccipital and basisphenoid; it is concave both from before backwards and from side to side. A little in front of the condyle, and evidently formed by the basioccipital, there is a pair of rounded processes projecting almost directly downwards, and from each of these a ridge passes forwards and becomes a long laterally compressed and downwardly directed process at the front part of the basisphenoid. Just in front of these processes, the pterygoids are attached to the base of the cranium.

Lower Jaw.—Impressions of both the rami of the lower jaw are preserved, but to display either of them from end to end would endanger other parts of the head. Nearly the whole of the left ramus is seen, and this shows the form from the front to behind the lateral vacuity; while the hinder part of the right ramus is uncovered as far forward as the middle of the lateral vacuity. The form of the entire ramus, therefore, is known and is represented in the figure (Plate 53, fig. 1), the front part being drawn from the left side (fig. 4), and reversed. The entire ramus measures 87 millims. in length, and 10 millims. in height at its deepest part, that is near the hinder part of the lateral vacuity. The lower jaw, corresponding with the form of the skull, is narrow in front, but the rami diverge considerably as they pass backwards. The symphysis is comparatively long, and seems to extend for perhaps 23 millims. from the front. The teeth are restricted to the anterior third of the ramus, and eleven may be counted on the left side. The external lateral vacuity commences at 39 millims. from the front, and is 22 millims. long, while the articulation for the quadrate is 14 millims. behind this vacuity, and the hinder extremity extends for another 14 millims. backwards. Near the hindermost teeth the outer part of the dentary border begins to form a lateral ridge, which becomes better defined as it passes backwards, and overhanging the hinder part of the lateral vacuity, divides this region of

the outer surface into two oblique areas, an upper and a lower, which terminate a little in front of the articulation.

Although the sutures are not all very distinct there are sufficient to show that the usual elements are present. The articulare extends on the inner side quite down to the lower margin, and appears on the outer surface (fig. 1), where an impressed line, extending almost to the lateral vacuity, marks its union with the angulare; the latter bone occupying nearly all the triangular area seen, in a side view, below the articulation. The surangular extends from below the articulation to the lateral vacuity, and over this possibly to near its anterior extremity, being itself overlaid by the backward process of the dentary. The lower process of the dentary passes below the lateral vacuity, but at what point it meets the angulare is uncertain. There are indications of a splenial element extending forwards to within 15 millims. of the front of the jaw, but its hinder extremity is not shown.

Dentition.—The teeth are irregular and vary considerably in size; but they are all slender, conical, and recurved; their mode of implantation is not clearly shown, but the evidence, so far as it goes, is in favour of their being in distinct alveoli. The largest teeth are 5 or 6 millims. long and 2 millims. thick at their bases; they are found in the upper jaw in the thickened part of the bone which I have above referred to as the maxilla. Two of these large teeth are to be seen on each side; they are directed downwards, backwards, and but little if at all outwards. From the positions of these teeth, and from the appearance of the alveolar border, there seem to be spaces for four of these large teeth on each side, but possibly they were never all in place at one time. Two smaller teeth (about 2 millims. long) are preserved on the right side nearly at the anterior extremity, and evidently in the premaxilla; they are, perhaps, turned a little more outwards than the large teeth. On the left side the alveolar border of the premaxilla is best seen and this seems to show spaces for three or four teeth, all smaller than those of the maxilla. I have been unable to find traces of teeth or alveoli behind the large teeth of the maxilla, although the more extended dental series of the lower jaw led one to expect that corresponding teeth would be found in the upper jaw.

Eleven irregularly spaced teeth may be counted in the left mandibular ramus within 25 millims. of the anterior extremity. They differ much in size, but none are quite so long as the largest ones of the upper jaw, and some are very small.

Pectoral Arch.—The impressions of the greater part of both scapulæ, the two coracoids, and the upper surface of the interclavicle have been exposed; they occupy very nearly their natural relations to each other, but the scapulæ have possibly been pressed down into a more horizontal position than they naturally held.

The *scapula* (figs. 9, 9A) is an elongated slender bone, rod-like in the middle, flattened and expanded above, and curved much forwards at its lower end, where it widens so as to form an arched plate, the concavity of which looks downwards and outwards. The upper edge of this plate forms a strong ridge, and apparently corre-

sponds with the process found in a similar position in the scapula of the crocodile. The lower edge of this plate is thickened and rough, and is, in part, attached to the coracoid, but a space is left between the two bones which was evidently occupied by cartilage; posteriorly this space widens, and both the bones become thicker, thus forming the glenoid cavity. A little above the glenoid articulation (7 millims.), on the inner aspect of the scapula (fig. 9A), there is a distinct prominence which appears to be for the ligamentous attachment of a clavicle, and there is some evidence that such a bone existed.

The length of the scapula from the glenoid cavity to the upper extremity is 32 millims. From the same point to the anterior extremity 11 millims. Diameter of shaft 3 millims. Width at upper extremity 6·5 millims.

Each Coracoid (fig. 9) is a small quadrate bone about 10 millims. from front to back, and 7 millims. wide; it is deeply concave above and convex below, with a straight and thickened inner edge. The impressions of both coracoids are seen lying just above the inter-clavicle (fig. 14) and very nearly meeting in the middle line; but they are a little out of place, and the thickened edge of the right one looks more backwards than inwards, this, however, is partly due to displacement. It is tolerably evident that the inner edges of the coracoids were naturally placed at an angle to each other and were attached either to the oblique front edges of the inter-clavicle, or to a plate of cartilage in relation with the inter-clavicle. The coracoid (fig. 9) seems to be attached to the scapula at two points, with an opening between; but whether this is accidental, or represents the coracoid foramen, is uncertain.

The inter-clavicle (fig. 14) is attenuated at both extremities, it is about 35 millims. long, and anteriorly has the form of an arrow-head, the widest part of which is 9 millims. The front is curved a little upwards and its end is bead-like; for a short distance behind this there is a median raised line, and then follows a shallow depression extending nearly to the hinder end. The probable relation of this bone to the coracoids has been alluded to above.

On the left side, lying in close relation to the scapula, coracoid, and inter-clavicle, there is a curved bone which is very suggestive of a clavicle, but the evidence is insufficient for any definite interpretation.

Humerus.—The impressions of the greater part of both humeri are preserved (Plate 53, figs. 10, 10A, 12), and with the exception of the distal articular condyles, the form of the bone is well shown. The greatest length is 38 millims.; the width of the proximal end, including the pectoral crest, is 9 millims., and the distal extremity measures as nearly as possible the same; while the middle of the shaft has a diameter of scarcely 3 millims. The bone is somewhat twisted so that the expansions of the two extremities are not in the same plane. The proximal articulation is compressed, and seems to be continued by a ridge into the large pectoral crest, which extends down the shaft to about 16 millims. from the proximal end of the bone. The upper surface (fig. 12) in this region is convex from side to side, and the downward projection

of the pectoral crest makes the lower surface (fig. 10) deeply concave. The middle of the shaft is almost cylindrical. The upper aspect (fig. 12) of the expanded distal extremity is marked by a triangular depression, which is continued between the articular condyles, the latter appearing to be very definitely divided; but this part is somewhat obscured by the upper end of the tibia. The under surface (fig. 10) of the distal expansion is convex, but this gives place to the groove between the condyles; it is in this part that the humeri are most defective, both condyles being absent from the bone of the left side, and only one is shown on the right.

Radius and Ulna.—The right and left bones are both represented (figs. 11, 13), but on neither side are they quite perfect, the proximal end in all cases being defective. Sufficient, however, is preserved on the right side to show that both radius and ulna were about 30 millims. long and nearly straight, the latter being larger than the former. Proximally the ulna is flattened from before backwards, and the radius is rounded, while distally both bones seem to be laterally compressed.

Fore-feet.—Portions of both the fore-feet are present (figs. 11, 13), that of the left side being the more perfect. It is the plantar surface of the left foot (fig. 11) which is preserved, and five metacarpals may be seen very nearly in their natural positions, the middle one seeming to be the longest. Only a few of the phalanges could be traced, although it is probable they were all present, but the coarse matrix prevented their being successfully uncovered. It is the upper surface of the right foot (fig. 13) which is shown, and here also the five metacarpals are present, but they are somewhat displaced.

Carpal bones are preserved; but, in spite of numerous casts and very close examination of the impressions left in the stone, I am unable to satisfy myself as to their number. There seem to be four cavities in the stone, one or two of which may be the ends of the metacarpals. The cast taken from these cavities may be interpreted as two, or perhaps three, ossicles in a proximal row, and one between these and the middle metacarpals; but the number is uncertain, and the settlement of this point of structure must await the discovery of a more perfect specimen.

Vertebræ.—Immediately behind the head are the impressions of a series of vertebræ, which have been split open vertically and longitudinally. The twelve anterior vertebræ are present in a more or less perfect condition, and (excepting the first) the casts taken from their impressions give a very satisfactory knowledge of their structure; parts obscured on one side are shown on the other; for example, the centra and neural arches are well seen in several instances on the left side (fig. 5), but the neural spines are hidden by the scutes which have been pressed down upon them. On the right side, however (fig. 6), the neural spines and articulations of all the vertebræ, from the second to the sixth inclusive, are clearly seen. There are only fragments of the tenth, eleventh, and twelfth vertebræ.

When speaking of the occiput, p. 577, mention was made of some fragments, probably parts of a vertebra, pressed against the exoccipital; these are most likely parts

of the first or atlas vertebra, but they are too indistinct to give any idea of their form. All the succeeding vertebræ, so far as can be seen, are bi-concave. The second or axis vertebra (fig. 6) has the neural spine much elongated from before backwards (10 millims.), and it overlaps the greater part of the succeeding vertebra; the neural arch also extends a little in front of its own centrum, and was doubtless in close relation with an odontoid bone, not now in place. The centrum is slightly concave in front, for articulation with the odontoideum, and rather more concave behind. The sides of the centrum are pinched in so as to form a sharp and deep median keel, and this character is repeated in all the centra which are preserved. The third vertebra has the neural spine narrow from before backwards and almost pointed above, while those of the succeeding vertebræ gradually increase a little in antero-posterior extent. The neural arch presents, in a side view, a wide, flattened, trapezoidal area, the upper angles of which form the anterior and posterior zygapophyses, and these articulations are particularly well shown on the right side.

The union of the neural arches with the centra is best seen on the left side, where the sutures may still be traced. Similar neural arches are found as far back as the sixth vertebra, but with a slight increase in size. The sixth vertebra shows, just above the neuro-central suture and near the middle of the centrum, a tuberosity, which corresponds in position with the upper articular process for the cervical rib found on the sixth vertebra of a young alligator used for comparison, but it is proportionately smaller and does not form a distinct process.

The seventh and eighth vertebræ are broken and partly hidden, but the ninth (figs. 5 and 7) shows the upper articulation for the rib, well up on the side of the neural arch, while a lower articular surface is seen just below the neuro-central suture and near the front of the centrum; both these articular surfaces agree with those found in the corresponding ninth vertebra of the alligator.

The vertebræ behind the ninth are indistinct, but portions of two dorsal ribs are present, and they both have double heads. It is clear, therefore, that each of the anterior dorsal ribs had a double articulation with its vertebra, and that the positions of the articular surfaces of the ninth vertebra correspond with those of the ninth vertebra of the alligator. It is also evident that, passing forwards, the upper articulation descends to the neuro-central suture on the sixth vertebra; while this suture and the upper articulation encroach more and more upon the centrum from the fifth to the second vertebra. Near the front part of the centrum of each of the anterior three or four vertebræ a slight rugosity is seen, which may be an articular surface for the lower process of the cervical rib; but as the sixth vertebra does not show any such lower articulation, it is uncertain whether or not the cervical ribs had double articulations. I have been unable to trace any of the cervical ribs.

Scutes.—A continuous series of closely opposed scutes is seen extending, in the region of the neural spines, from the occiput as far backwards as the specimen is preserved. In no part can more than two scutes be certainly seen side by side, and

it seems probable, therefore, that there were only two longitudinal rows in the cervical and early dorsal regions; but as the scutes, which are seen, are all on the left side of the neural spines, and it is possible that others may be hidden in the matrix, one cannot speak with certainty. All the scutes are quadrate and longer than they are wide, the proportion being about three to two, one of the hinder ones measuring about 7·5 millims. by 5 millims.; each has a longitudinal ridge, which is rather nearer the outer than the inner margin; and the exposed surface is ornamented by distinct pits, which are rounded near the middle of each scute, but more or less elongated towards the edges. These pittings have a tendency to radiate from the middle of the scute.

On the outer side of the hindermost pair of scutes (that is the ninth pair counting from the front, and overlying the eleventh or twelfth vertebra) there is a fragment which looks like a piece of another scute, and this may possibly indicate an increase in the number of rows of scutes in the dorsal region.

Affinities.

The general form of the upper part of the skull of this specimen agrees so closely with the crocodilia generally and with *Teleosaurus* in particular, that there can be little question as to these parts being constructed upon the same plan. The form and position of the four cavities, so characteristic of the skulls of ordinary crocodiles, namely, the two supratemporal fossæ and the orbits, are well exhibited in this fossil, and there is a similar narrowness of the frontal and parietal regions. The small external nasal apertures are placed near the front extremity, but are divided by bone in our fossil, although usually undivided in recent crocodilia. In all these particulars, except the last, *Teleosaurus* approaches nearer to our fossil than do the recent forms. The infra-temporal fossa seen on the side of this skull is found also in the recent crocodiles, but in them it is not so distinctly divided from the orbit in front and from the auditory channel behind. In both these particulars, again, *Teleosaurus* more nearly resembles this fossil, as it does also in the position of the quadrate pedicle. The large pre-lachrymal vacuity finds no counterpart in the recent crocodilia; it is present in *Teleosaurus*, although much smaller; but the latter genus has no similar depression of the side walls in the vicinity of the vacuity.

If only the upper part of this little skull were known, the palate being hidden, there would have been but little hesitation in regarding it as a close ally of *Teleosaurus*; but the fortunate preservation of so many important features of the palate prevents any such reference. The forward position of the posterior nares gives the palate a very lizard-like character, and is quite unlike any form of *Eusuchia* or *Mesosuchia*, but resembles the condition found in that of the Triassic *Parasuchia*, as described by Professor HUXLEY in his memoir on the Elgin *Stagonolepis* (17, 18). Unfortunately, the skull of the latter genus is very imperfectly known, but still

sufficient is preserved (18, Plate 9) to show that there are important resemblances, as well as differences, between it and the present specimen. Professor HUXLEY's figures show a similar divergence from the living crocodilia in the forward position of the posterior nares, and absence of any inward growth of the palatines and pterygoids to form complete bony channels, such as are found in more recent forms, and which throw the posterior nares so far back. The possibility that, in the present specimen the nasal passages were carried further back by soft tissues, has been noticed on p. 579. Another important resemblance between this skull and that of *Stagonolepis* is the presence of the large pre-lachrymal vacuity. Professor HUXLEY pointed out the affinity with *Belodon* (*Phytosaurus*) which both these peculiarities indicate. *Stagonolepis* has two troughs along the palate, separated by a prominent median ridge, formed by the pterygoids and vomers, while in the present specimen there is but a single and much narrower median trough, the vomers and pterygoids not being prominent, but forming, apparently, the bottom of the trough. The relation of the orbit to the pre-lachrymal vacuity and to the infra-temporal fossa, as well as the width of the inter-orbital space, is very different in the two forms.

The teeth of *Stagonolepis* are short and stout, with inflated but somewhat compressed crowns, and differ, therefore, in a marked manner from the slender, tapering, recurved teeth of the present specimen.

If comparison be made with *Phytosaurus* (65, 66, 18), similar pre-lachrymal vacuities will be found, and the relation of these to the orbits and to the anterior nasal apertures will be seen to closely resemble the arrangement of the corresponding parts in our Elgin fossil. It is the enormous development of the premaxillary region in *Phytosaurus* which makes the two skulls so unlike in general appearance. The supra-temporal fossæ in the last-named genus, are not seen as distinctly circumscribed openings on the upper surface of the skull, and consequently the hinder part of this region has a different aspect in the two forms.

The palate of this Elgin skull bears a closer resemblance to that of *Phytosaurus* than to that of *Stagonolepis*, for *Phytosaurus* has a single median trough, and the vomers and pterygoids do not form a median ridge as they do in *Stagonolepis*. The pterygoids in *Phytosaurus* and in the present specimen have a similar relation to the basisphenoid; in both this bone has a backwardly-directed quadrate process, resembling more the lacertilian than the ordinary crocodilian type of structure. In the Elgin skull, however, the pterygoids have completely united in front of the basisphenoid, but in *Phytosaurus* there is an inter-pterygoid foramen, and this is important, as indicating a nearer approach to the lacertilian and rhynchocephalian condition of the pterygoids than is found in any ordinary crocodilian; indeed the resemblance between this part of the palate in *Phytosaurus* and in *Sphenodon* is remarkable.

The pectoral arch of this Elgin specimen differs from that of the ordinary crocodilian in its more elongated scapula and its shortened coracoid, but in these parti-

culars again it resembles *Stagonolepis* and *Phytosaurus*, and seemingly approaches the lizards, a shorter coracoid being generally characteristic of the latter group, and the elongated scapula is paralleled in the chamæleon. The fore limbs conform to the crocodilian pattern, but it is possible that the carpus may prove to be of a more generalized type. The vertebræ correspond in a striking manner with those of ordinary crocodiles, although it is not certain that there were doubly articulated cervical ribs, and the amphicœlous centra again link them on to the Parasuchia. The ornamented dorsal scutes also point to a similar relationship.

The above comparison shows most unmistakably that the specimen here described is more nearly related to the Parasuchia than to any group of living reptiles, but in the form of the upper part of the skull it approaches the mesosuchian genus *Teleosaurus*. And further, those points of its structure in which it differs from the Eusuchia and Mesosuchia, namely, the forward position of the posterior nares, the presence of a pre-lachrymal vacuity, the bi-concave vertebræ, the elongated scapula, and the short coracoid,—are just those points in which it resembles *Stagonolepis* and *Phytosaurus*. There seems no doubt, therefore, that our specimen is most nearly related to these two forms, and that its proper systematic position is with them in the Parasuchia, whether this group be retained as a division of the Crocodilia, or raised to a distinct order, as suggested by Mr. R. Lydekker (24, p. 235). It will be obvious, however, that the differences in the skulls prevent a reference of the present specimen to either of the above-named genera. It is separated from *Stagonolepis* by the structure of the palate, by the different arrangement of the openings on the upper surface, and by the form of the teeth. On the other hand, it is distinguished from *Phytosaurus* by its short premaxillary region, by the very different form of the temporal region and fossæ, by the proportionately large and differently placed orbit; also by the absence of an inter-pterygoid foramen, by the narrowly troughed palate, and by the restricted area occupied by its teeth.

I suggest for this reptile the name of *Erpetosuchus Granti*.

2. Ornithosuchus Woodwardi, *gen. et sp. nov.* (Plates 54, 55, 56.)

General Remarks.

The second specimen to be described is one that was discovered a few years ago by the Rev. Dr. Gordon, in the reptiliferous sandstone at Spynie, near Elgin—a locality rendered classical by the discovery, in the year 1851, of the celebrated *Telerpeton Elginense*. The present specimen was sent by Dr. Gordon to the British Museum, and at that time showed the greater part of a vertebral column, with parts of the hind limbs; also a series of small scutes, and a lower jaw broken through horizontally so as to show several teeth in cross-section. The bones themselves, although present, were in an exceedingly friable condition, and, where broken through

by the splitting open of the stone, had largely crumbled away. The skull, which now forms a conspicuous and important part of the specimen, was at that time wholly concealed, and was discovered in one of the slabs under the lower jaw by Mr. RICHARD HALL, of the British Museum, who, with his accustomed skill, disengaged the greater part of the cranium from the matrix, and has thus brought to light one of the most perfect skulls yet found in the Elgin Sandstone. Few, even among those experienced in developing fossils, can appreciate the difficulties overcome by Mr. HALL in the delicate task of clearing away the hard sandstone from the decayed and friable bone without destroying the specimen itself.

This reptile was to have been described by Mr. A. SMITH WOODWARD, of the British Museum, who, when exhibiting it at a Soirée of the Royal Society, remarked on its possible affinities with the Triassic *Aëtosaurus* of Dr. FRAAS (56); but a plethora of work in other directions prevented his accomplishing this task, and hearing that I was engaged upon some fresh material from the same locality, he most generously gave me the opportunity of describing this new and interesting specimen. It is with much pleasure that I acknowledge my indebtedness to Mr. SMITH WOODWARD for his disinterested courtesy.

The specimen is now contained in two slabs of sandstone, each broken across, and several smaller pieces, all portions of one block which, on being split open, revealed the parts above mentioned. When the animal was buried in the sand the head was turned over on the dorsal region, with the nose turned backwards (Plate 54). The parts of the skeleton preserved being so nearly in their natural relations to each other, it is almost certain that the cervical vertebræ and fore limbs were also in place, but no trace of them is seen, and as the stone has been broken across just at the front of the thorax, there is but little doubt that these parts were contained in a piece of stone which has not been preserved.

The palate was still covered by matrix when the specimen came into my hands, but the desirability of knowing the structure of this region led me to undertake the hazardous task of uncovering it, and this has now been safely accomplished; a small part, however, still remains covered by the symphysis of the lower jaw, but to expose this would mean the destruction of the symphysis with several of the teeth. Some other parts of the skeleton have likewise been further cleared of matrix. Most of the pre-caudal vertebræ and limb bones were so broken by the original splitting open of the stone that only fragments of the bone remained, and it was necessary to clear out these fragments and take casts from the cavities in order to ascertain the original forms of the bones. It is these casts, therefore, which, for the most part, have supplied the material for the following descriptions, but the account of the skull is taken from the specimen itself, the bone being well preserved.

Description.

Skull.—The general aspect of the skull, when seen from above (Plate 55, fig. 2), is very bird-like, being broad at the back and pointed and beak-like in front. In a side view (fig. 1), however, the premaxillary region is seen to have a considerable vertical extent, and the nasal apertures are large and close to the front; moreover, the parietal region (fig. 2) is narrow, and there are distinct and completely enclosed supra-temporal fossæ. The greatest length of the skull, from the front to the quadrate, is 115 millims., the width across the quadrates 54 millims. The bone, although broken at the edges, is sufficiently well preserved to show the natural form. The sutures are well shown in almost every instance, and consequently the elucidation of the structure is comparatively easy, although the arrangement of some of the parts is peculiar.

The upper surface (fig. 2) has the bones in distinct pairs from front to back, and the various bones are at once recognizable. The small backward processes of the premaxillæ are wedged in between the front points of the nasal bones, and the latter join the frontals by a transverse suture well in front of the orbits. The parietals form an obtuse angle anteriorly, which is received between the hinder ends of the frontals. A median suture extends throughout the length of the upper surface of the skull. There is no parietal foramen. On each side, extending outwards from the hinder part of each parietal, is a band of bone, the upper edge of which forms the boundary between the upper and hinder surfaces of the skull; it also forms the posterior walls of the supra-temporal fossæ, and joins the squamosal on each side at the hinder and outer angle. This band is evidently formed by the parietals, no suture being visible, and it overlaps on each side a post-temporal fossa. The outer boundary of the supra-temporal fossa is doubtless formed by the squamosal, which joins the parietal band posteriorly, and extends downwards on the outer side of the skull (fig. 1), but no suture can be traced between this bone and that, evidently the postfrontal, which forms the hinder angle of the orbit, and is internally united to both the frontal and the parietal. The anterior angle of the orbit is also formed by a distinct bone, the prefrontal. At first sight this bone seems to extend forwards on the outer side of the large nasal bone (fig. 2), but there is a suture near the anterior extremity of the frontal bone cutting off this anterior part, which in a side view (fig. 1) is seen to be a forward extension of the lachrymal bone above the great pre-lachrymal fossa.

A side view of the skull is rendered striking by the large size of the pre-lachrymal fossa, by the peculiar form of the infra-temporal fossa, and by the formidable predaceous teeth. The orbit is large and narrow inferiorly, reminding one of the orbit of *Scaphognathus*. The large nasal apertures are near the front, and each is enclosed by its nasal bone and premaxilla; the junction of the latter with the maxilla is probably hidden by the large tooth projecting upwards from the lower jaw. The two largest teeth are evidently planted in the maxilla, which is seen to extend backwards

as far as the orbit, and to bear teeth nearly to its hinder extremity. The maxilla is excluded from the orbit by the jugal, which itself sends upwards two slender processes, one before, the other behind, the orbit, and thus forms its lower boundary. The anterior process extends upwards in front of a slender bone occupying the position of a lachrymal, which forms the front wall of the orbit, and is continuous with that seen above the pre-lachrymal fossa and on the outer side of the nasal bone (fig. 2). The posterior upward process of the jugal unites in a similar manner with the bone forming the hinder boundary of the orbit, which can only be interpreted as a post-orbital; unless it be a long process of the postfrontal, by which its upper end is overlaid. The quadrato-jugal, which underlies the hinder process of the jugal, is one of the stoutest bones of the side of the skull; it forms the outer angle of the pedicle for the lower jaw, and, extending upwards on the outer side of the quadrate, joins the squamosal. The quadrato-jugal thus shuts off the quadrate from the side wall of the skull. The squamosal is T-shaped in this view, and seems to overlap the upper end of the quadrato-jugal; but there is a V-shaped suture a little above this, which may indicate a distinct bone. When viewed from behind, the quadrate is seen to form about half the width of the pedicle, being overlaid by the quadrato-jugal; the latter, however, is narrowed at its lower end, so that the articulation for the lower jaw is formed entirely by the quadrate, which, a little above its middle, is pierced by a large foramen. Extending upwards, the quadrate reaches the point where the parietal meets the squamosal, and expanding at its upper part seems to be in contact with the inner side of the downward process of the squamosal; but this part is somewhat hidden by the matrix. From the lower and front part of the quadrate a broad process passes forwards to join the pterygoid (fig. 3). The latter bone will be alluded to again, when describing the palate.

The Occiput (fig. 2) is much broken, but something of its structure may be seen. The upper part, as already noticed, is formed by the parietals, and immediately below this, in the middle line, is a four-sided plate occupying the position of a supra-occipital; but, from its lower part, on the left side, a process passes off to the point of the squamosal, and as there can be no question as to this corresponding with the ex-occipital process of the crocodile, it is probable that much of the four-sided plate is formed by the exoccipitals meeting above the foramen magnum; and it may be that the supraoccipital is represented by the small triangular area at the upper part, although the line of separation looks more like a breakage than a suture. On the left side, between the exoccipital process and the parietal band, there is a distinct post-temporal fossa. On the right side part of the exoccipital bar is broken away, revealing a more deeply-seated bone, probably the opisthotic. There are traces of bone in the position which would be occupied by the basioccipital, but its form is by no means clearly defined, and its rounded end may not represent an articular condyle.

The Palate (fig. 3) being partly covered by the lower jaw, could not be wholly displayed, and about an inch of it still remains hidden by the symphysis. It is also

unfortunate that very little of the sutures can be made out. The quadrate bone sends forwards and inwards a large bar, which joins what is clearly a backward process of the pterygoid; anteriorly this process is united with a broad plate of bone that, with its fellow of the opposite side, extends backwards in the middle line to join the base of the skull, and spreads outwards in a broad wing; these parts are, without doubt, the pterygoid, which closely resembles that bone in the crocodile. From the anterior and outer part of this wing, and seemingly separated from it by a suture, a small bone passes to the point of union of the maxilla and jugal bones, and there spreads out into a T-shape; this must be the transverse bone; and the aperture seen in front of it is evidently the post-palatine vacuity. How far the pterygoid extends forwards, and how much of this broad plate is formed by the palatine, is uncertain. Close to the middle line, and between the post-palatine vacuities, is a pair of elongated apertures, the interpretation of which is not so satisfactory as could be wished. These apertures are regarded as the primitive posterior nares thrown far back, but they may be secondary nares, brought back to this position by the meeting of palatal laminæ of the palatine bones; or they may possibly be merely inter-pterygoid vacuities, such as are present in Dicynodonts. The front of the palate being hidden by the lower jaw, it is not certain but that the posterior nares are further forwards, as in lizards and in the form above named *Erpetosuchus Granti*.

The palate is divided throughout its length, so far as exposed, by a median suture, and the bones of the left side are pressed downwards a little, making the division very distinct. This suture runs along the bar of bone which divides the posterior nares. That the hinder median part of the broad plate which joins the base of the skull, and that passing back to the quadrate, as well as that united to the transverse bone, are all three parts of the pterygoid there can be little question; but we are left in doubt as to how far this bone extends forwards. If the line seen on the right side (on the left, fig. 3), passing between the front parts of the post-palatine vacuity and posterior narial opening, is really a suture, then in all probability it marks the anterior boundary of the palatine bone, as in *Phytosaurus* (66, Plates 38, 42). These median apertures seem most nearly to agree with the pair seen in the genus just named, which are referred to by Professor Huxley as the posterior nares (18, Plate 9, fig. 6), although in that form they are in advance of the post-palatine vacuities, as they are in all lizards. Among reptiles it is only in the crocodiles, where the secondary posterior nares are formed by the meeting the palatines, that they are thrown as far back as they are in the present fossil, and occupy a more posterior position than the post-palatine vacuities; but, excepting this backward position, there are no indications that these apertures, in the present specimen, are anything but primitive posterior nares; it is only their relative position which raises any doubt, and this to some extent finds a counterpart among birds. The longitudinal double bar of bone separating these two apertures may be formed by the palatines or by the pterygoids, but more probably by the vomers. In front of these apertures this median bar con-

tinues as a narrow double rod, separated from the broad plates on each side, which are almost certainly parts of the maxillæ; and if it were quite certain that this separation were natural and not due to breakage, this pair of median elongated bones could scarcely be regarded otherwise than as vomers; and it would also be pretty well demonstrated that the pair of apertures were the primitive posterior nares, an interpretation which is here adopted as most probably the correct one.

The Lower Jaw having been broken through longitudinally, and the upper margin being hidden by the maxillæ, its form cannot be properly seen, but the accompanying figure has been restored from the parts remaining and by careful measurements, so that it represents as nearly as possible the true form (fig. 1). The greatest length is about 110 millims. It extends some 7 or 8 millims. behind the quadrate articulation, but does not reach the front of the muzzle by perhaps 12 millims. At about 25 millims. in front of the hinder extremity there is a large lateral vacuity 33 millims. long, extending a little in advance of the orbit. The anterior half of the ramus is comparatively deep, but when seen from below (fig. 3) the hinder part of the symphysial region is found to be very narrow, the alveolar margin of this and all the hinder parts of the jaw being received within the teeth of the upper jaw. Anteriorly the rami are enlarged to carry the prominent teeth, which bite outside the upper jaw at the hinder part of the compressed premaxillary region, and below the posterior end of the nasal orifices. At the front each ramus carries one or more smaller teeth, which are received into the deep palate on the inner sides of the premaxillary teeth. The alveolar margin being hidden, the number of these teeth is not known. The hinder half of each ramus is stouter than the front part, and widens to form the articular surface for the quadrate. No sutures can be certainly traced.

Dentition.—The teeth, although partly broken and hidden by matrix, supply much information as to their form and arrangement (figs. 1, 3). They vary in size, but are otherwise similar in form, the largest being about 22 millims. in length. Each tooth is set in a distinct socket, and the larger ones have quite half their length sunk in the jaw; but while the front ones seem to have been firmly fixed, the hinder ones appear to have been comparatively loose, some of the hinder maxillary teeth being more or less out of their sockets. Several of the teeth are still in place, as shown in the figures, and others have been broken across, showing spindle-shaped transverse sections. All the teeth, so far as can be seen, are recurved, pointed, and compressed, with acute anterior and posterior edges. Some of the larger teeth show the hinder edge of the crown to be serrated throughout its length, and the front edge for about half its length. The basal parts of the teeth are rounder than the crowns and are not serrated.

There appear to have been three moderate-sized teeth in each premaxilla, projecting about 3 or 4 millims. beyond the alveoli; but there may have been others which are now hidden by the lower jaw, from which at this part a large tooth projects upwards outside the premaxilla. At the front of the maxilla there is a small tooth directed much

outwards, and following this on each side two large sabre-like teeth, passing downwards and backwards, with only just room between the teeth of the two maxillæ to receive the narrow symphysis of the lower jaw. Much of the crowns of these teeth is broken away from the skull, but those of the left side are preserved in the opposite block of stone, and are shown restored in the figure. The roots of these two teeth are exposed by the breaking away of the outer lamina of the maxilla (fig. 1); the hinder one is the largest, its entire length being 22 millims., the crown projecting about 10 millims. from the alveolus (fig. 1A). The longest diameter at the base of the crown is 4 millims. Behind this largest tooth on the left side, six or eight alveoli may be seen, some containing broken teeth, and on the right side some of the teeth are present, but partly fallen from their sockets. The teeth decrease in size towards the back of the maxilla, and none of them was so large as the two preserved and figured.

At the front of the lower jaw there is evidence of two, perhaps three, forwardly directed teeth on each side, about equal in size to those of the premaxillæ, within which they bite, and they extend forwards to about the second premaxillary tooth. At the thickened part of each ramus there is the large tooth, which bites outside the premaxilla. One of these two teeth being further forwards than the other, it seems probable that there were alveoli for two of these large teeth in each ramus; but possibly the four teeth were not in place at the same time. Behind the large teeth there are traces of others, but nothing definite, the alveolar border being hidden.

Vertebral Column.—The cervical vertebræ are wanting; but thirteen pre-sacral, three sacral, and twenty-one caudal vertebræ are well preserved in an almost unbroken series, and supply all the important vertebral characters of these regions. The centra throughout are completely ossified, and the terminal faces of the centra are only slightly concave.

The *pre-sacral vertebræ* had been broken through in two or three directions, and so much of the bone had crumbled away that the small portions remaining were unintelligible, but, by clearing away the fragments and developing certain parts hidden by the matrix, it was possible to take casts which reproduce the greater part of both sides of the series, and the right side being the most perfect, is figured (Plate 56, fig. 1).

The centra are all as nearly as possible 11 millims. long, and 7 millims. high; they are pinched in at the middle, but expanded at their articular faces, the edges of which are somewhat thickened; inferiorly they all appear to be longitudinally keeled. The position of the neuro-central suture is shown in the first and fourth vertebræ from the sacrum, by the arches being raised from the centra, and in the thirteenth its place is marked by a depression. Throughout this series of pre-sacral vertebræ the rib articulations are both above the neuro-central suture. The neural spines of this region increase in antero-posterior extent from before backwards, the largest seen being about equal to the length of a centrum, 11 millims.; they are as nearly as possible the

same height throughout, 10 millims., and each vertebra, with its centrum and spine, has a total height of 24 millims. The pre- and post-zygapophyses are well shown. The transverse processes cannot all be seen, but by laying open some of them which were near the longitudinal break, we now know the form of the rib articulations of vertebræ Nos. 3, 5, 8, 11, and 13. All the costal articulations being above the neuro-central suture, these vertebræ agree, in this respect, with the corresponding vertebræ of living crocodiles; but they differ inasmuch as some of the anterior ones have distinct capitular and tubercular processes, while in crocodiles the corresponding thirteen presacral vertebræ have each a single long transverse process which carries both the costal articulations. The most anterior vertebra, in the present specimen, has the tubercular process nearly as long as the neural spine (8 millims.), it is directed upwards and perhaps a little forwards, and its anterior and posterior edges are thin and continuous with the pre- and post-zygapophyses; below and in front of it is seen the short capitular articulation quite at the front of the neural arch. Passing backwards, No. 11 vertebra has the tubercular process shorter (6 millims.) and directed outwards and a little backwards; the capitular articulation is still distinct. In No. 8 vertebra the two articular processes have united at their bases, and the tubercular process is shorter; both articular surfaces may be said to be on the short transverse process. No. 5 vertebra shows this character carried still further, and the transverse process is a little lower on the neural arch; but there are still two articular surfaces. In No. 3 vertebra the transverse process is as long as in No. 5, but narrower from before backwards, and, although the end still seems to be bifid, the two articulations are close together, if they do not join.

The Sacrum is composed of three vertebræ, the two hindermost of these are in their natural position, and seem to have been firmly united; but the third has been pushed out of its place and somewhat broken. Casts of the cavities from which the fragments of bone had been cleared away reproduce the forms of these vertebræ and their ribs (Plate 55, figs. 4, 5, 6). The centra of the two united vertebræ have a total length of 23 millims., they are flattened inferiorily, and the terminal faces are flat. The neural spines are about 10 millims. above the pre-zygapophyses and, with the centra, stand about 25 millims. high. The middle spine of the sacrum is the broadest, having an antero-posterior extent of 13 millims. The sacral ribs are strong quadrate processes, very similar to those of a crocodile, they are directed outwards and a little downwards, with expanded extremities, the hinder one being the largest and having its wide outer end oblique to the longitudinal axis of the vertebræ (fig. 4). This large rib, it is tolerably evident, was attached to the posterior extremity of the ilium, which is but little out of place.

The anterior sacral vertebra has been troublesome to interpret, as it is not only pushed out of place but is partly broken, and the centrum is not shown. At first it was uncertain whether this was part of the sacrum; and the fact that the centrum was not fixed to the other two, as they were to each other, seemed to militate against

this interpretation, but a close examination has convinced me that it is correct. In the pre-sacral vertebræ, as we have seen, the transverse processes become smaller as we pass backwards, and are very small in the vertebra immediately in front of the one now in question, which retains, on the right side, a long and strong process (or rib) with an expanded end, quite as long as that of the vertebra next behind it although not so stout (Plate 55, fig. 4, *sa.* 1). The corresponding process of the left side has been separated from the vertebra, and is seen in the stone just above the ribs of the two hinder sacral vertebræ. The rib of this anterior sacral vertebra must have been in close relation to the broad anterior part of the ilium (see fig. 5), which would otherwise have been without support.

Caudal Vertebræ (Plate 54) to the number of twenty-one are preserved in a continuous series, and much of the bone is present, although in a very friable condition. The centra of the more anterior of the caudal vertebræ are very little shorter than those of the sacrum, being, as nearly as possible, equal to those of the thorax (11 millims.), and they decrease so little in length in the hinder part of the tail that the twentieth of the series measures 10 millims. The height of the centra, however, decreases more rapidly, for while the first caudal centrum is about 9 millims. high the twentieth is only 5 millims. In form also these centra resemble those of the thorax, but the inferior part is rounded and not keeled, and their articular faces are oblique to the long axes. Neural spines are exposed at both ends of the series, and also in the middle, the front one being about the same height and width as those of the sacrum (11 millims.); but while they gradually decrease in width they rapidly increase in length to the fifth, which stands 16 millims. above the zygapophyses, and with the centrum has a total height of 30 millims. Passing backwards from this point, the spines gradually shorten, the eleventh being 13 millims. and, with the centrum, 26 millims. high, while the twentieth spine is 8 millims. and, with the centrum, 15 millims. high.

The *chevron bones* are long and slender, and about sixteen of them are exposed; the anterior one is not less than 40 millims. long, and its proximal end is near the junction of the first and second caudal centra, but it may be somewhat out of place, for it is the third caudal centrum which first shows a distinct articular surface for a chevron bone, and this is at its hinder end. The transverse process of the first caudal projects about 10 millims. from the centrum, it is flattened and has an antero-posterior width of about 5 millims. at the base, but expands to 7 or 8 millims., and is rounded distally. The transverse processes of the next three vertebræ are somewhat longer and the width is maintained if not exceeded; beyond this they become narrower, and apparently shorter towards the end of the tail, but they are not clearly shown. All the transverse processes, so far as they can be traced, have a ridge on the under surface from base to apex, and a corresponding groove on the upper surface. On the first caudal vertebra these processes arise from the lower part of the neural arch and from the centrum, and project directly outwards; but in the succeeding vertebræ

they ascend the arch, so that on the sixth vertebra they are nearly on a level with the base of the neural spine. From this point backwards they remain practically in this position, but are directed more and more upwards.

Close under the transverse process of the anterior caudal vertebra there is a distinct tubercle on the side of the centrum, and a similar tubercle may be seen on the two or three succeeding vertebræ, but gradually getting lower down on the centrum. These tubercles are distinct on the left side, but less so on the right.

The Ribs are represented by a few slender bones seen below the thoracic vertebræ (Plate 56, fig. 1), but they are too imperfect to supply any satisfactory information; close to the anterior vertebræ of this region, however, there are some fragments, one of which is clearly the proximal part of a rib with a distinct double head, such as would have articulated with the distinct capitular and tubercular processes of the thirteenth vertebra above described.

In front of the pubis and close to the edge of the block of stone (Plate 54) are a number of still more slender bones, which, from the manner of their meeting to form an acute angle, directed forwards, it is evident are abdominal ribs, but these also are too indefinite to allow very much of their structure or arrangement to be distinguished.

Pelvis.—The fragments which represented the bones of the pelvis and hind limbs were found to be insufficient to give any just idea of their form, and it was deemed best to clear them away and make casts from the cavities, as in other instances. The result has fully justified the attempt, the casts having reproduced the forms of the bones of the greater part of the pelvis, as well as those of the hind limb and foot, in greater detail than could have been anticipated.

The *ilium* (Plate 56, fig. 3) of the left side is shown, but it is thrown somewhat out of its natural relation to the other pelvic bones; and, as it is the ischium and pubis of the right side (Plate 56, fig. 4) which are best exposed, the precise mode of union of the three elements is not clear. The ilium is small compared with the other two bones; its greatest length being 46 millims., while that of the ischium is 52 millims., and that of the pubis 70 millims. The ilium extends for about half its length behind the acetabulum, and is at this extremity acutely pointed; anteriorly it is obtusely angulated, slightly inflected above, and extends but little in front of the articular cup. The concave outer surface is definitely marked off from the acetabulum, which is a deep excavation bounded internally by bone; but it is not certain whether it was completely closed or perforated. Both before and behind the acetabulum there is a short process, the ends of which were apparently articulated to the ischium and pubis; and it seems almost certain that both these bones combined with the ilium to form the acetabular cup.

The *ischia* are both preserved; the inner side of the left one is seen in close relation with the left ilium (fig. 4), but it is partly hidden by the corresponding bone of the right side, which is the one best preserved, and shows the external surface; its

greatest length is 52 millims. The proximal end of the ischium is wide (22 millims.), its upper part being thickened to form an articular surface for the ilium and part of the articular cup, while the lower part is thin, forming a broad plate which unites with a similar plate of the pubis. At about 18 millims. from the proximal end there is a distinct obturator process, behind which the bone is reduced to about 8 millims. in width and not more than 3 millims. in thickness. The narrowest part of the bone (6 millims.) is at about the middle of its length. Posteriorly the bone curves inwards and upwards, and widening again to about 8 or 9 millims., terminates by a rounded spatulate extremity.

The pubis (fig. 4) is 67 millims. long, it is broad proximally like the ischium, and has a similar width, with the upper part thickened for articulation with the ilium, and the lower part thin where it unites with the ischium. The upper thickened part is proximally about 14 millims. wide; but this is rapidly reduced, its distal half being only about 3 or 4 millims. thick as seen from the side. The inner parts of both pubes have been broken away by the splitting of the block of stone, but it seems probable that the distal half of each of them was flattened from above downwards. A distinct ridge separates the proximal thickened part from the thin plate below; this ridge, at first directed downwards, gradually turns outwards, and becomes the external edge of the distal half of the bone. The thin lower plate of this bone has a peculiar form; proximally where it evidently joined the corresponding plate of the ischium, it is directed downwards and a little inwards; passing forwards it widens, projects more inwards, and gets more towards the inner side of the thicker and upper part of the bone; this change continuing, the thin plate forms a scroll, which, at a distance of about 20 millims. from the proximal end, comes to be altogether on the inner side of the pubis, and seems to have been continued into a spatulate distal termination. In other words, as we trace the distal transversely flattened part of the pubis proximally, its inner part gradually turns downwards, so that its inner margin becomes the lower edge, where this plate joins the ischium. To what extent the inner edges of the pubes met in the middle line cannot be ascertained.

Hind Limb.—Parts of both hind limbs are preserved (Plate 56, fig. 2), and it is evident that the skeleton, even to the small bones of the toes, was still connected by ligaments when it was buried in the Elgin sand. The lower part of the right tibia and fibula, together with the right foot, are wanting, having been destroyed in the process of splitting open the block of stone. Casts from the cavities in the stone have been prepared which reproduce all the parts of the limb now to be described. But it should be noticed that although the cast which has been figured (fig. 2) shows nearly all the bones described, the continuations of some of them, as well as a few bones not shown by this cast, are present on the opposing block of stone, and all these are represented in their proper position in this figure, by unshaded outlines.

The femur of the left side shows the form of the proximal end, and the full length of the bone; that of the right side has the distal half exposed. In general form this

femur closely resembles that of the *Alligator Mississippiensis*, which I have for comparison; it is, however, more slender, the trochanter is not so well marked, and the preaxial roughened protuberance is more prominent than in the alligator. The greatest length is 87 millims., the width of both extremities is the same, 16 millims. On the under surface of the fibular condyle (fig. 5) there is a small prominence, which may be altogether accidental, but, seeing that it occupies the position of the crest found in birds and Dinosaurs, which articulates between the tibia and fibula, it deserves to be noticed, as it may prove to be of morphological importance.

The *tibia* and *fibula* of the right side are only represented by pieces of their proximal ends, which are seen close to the right femur. The left tibia and fibula are also present, but they want their proximal ends. Although neither of these bones are complete, yet it is clear that they were but little, if at all, shorter than the femur. Both ends of these two bones are enlarged, much as they are in the alligator, but they are too imperfect to speak about very definitely.

The *tarsus* is represented by two bones, one of which is in contact with the distal end of the bone referred to as the left tibia, and is, doubtless, the astragalus; it agrees better with the astragalus of a crocodile or lizard than with that of any Dinosaur. The second tarsal bone is merely a small ossicle which may have belonged to the distal row.

The *hind foot* of the left side is preserved in a most unexpected manner; but that of the right side, as well as the greater part of the right tibia and fibula, is wanting, and the position and direction of the pieces of the latter which are preserved make it very unlikely that any of the right foot-bones are mixed with those of the left; and further, the position and relations of the phalanges of each of the left toes show unmistakably that they belonged to one digit, and for the most part look as if they were still united by their decaying ligaments. There are five metatarsals, and these are numbered in the figure (Plate 56, fig. 2), in accordance with their gradually decreasing stoutness, but partly also on account of the number of phalanges in relation with them. Thus it will be seen that number 1 is the stoutest metatarsal, and number 5 the most slender. The second, third, and fourth metatarsals, however, are longer than the first or fifth. Metatarsal 1 has close to it two stout phalanges (*a* 1, *a* 2), the terminal one being ungual. Metatarsal 2 has three phalanges (*b* 1, *b* 2, *b* 3) close to its distal end, the last being ungual. Metatarsal 3 has no phalanges quite close to it, but it is evident from their size that the four rather smaller ones (*c* 1, *c* 2, *c* 3, *c* 4), which are close together, curled in a ring, belong to the third digit, the terminal phalanx of which was ungulate. Metatarsal 4 has near its extremity one phalange (*d* 1), while a little below this there are three small ones (*d* 2, *d* 3, *d* 4) in a series, and on the opposite block of stone, but continuing the series, is another very small one (*d* 5), making in all five phalanges to this fourth digit. In the cast figured metatarsal 5 has no phalanges near it, but, on the opposite block of stone, its counterpart is shown with two phalanges (*e* 1, *e* 2), in a

line with it, but somewhat separated, and these are indicated in the figure by unshaded outlines. The second phalange of this fifth digit has an articular surface at its distal extremity, and consequently there must have been at least one other phalange. This foot, it will be seen, agrees with that of modern lizards in having five digits, and also in the number of phalanges in the first four digits, and probably in the fifth also; namely, in the first 2 phalanges, in the second 3, in the third 4, in the fourth 5, and in the fifth certainly 3, and very likely 4 phalanges.

Scutes.—Upwards of forty scattered scutes may be counted above the vertebræ, between the two extremities of this specimen. The majority of these are more or less oval in outline, and several show signs of having been keeled. No definite markings can be seen on those of the caudal region, but two or three in the neighbourhood of the thorax and skull are ornamented with more or less distinct tubercles and radiating ridges (Plate 55, fig. 7). The oval outline of most of the scutes shows that they were not in close relation, but somewhat separated from each other; several, however, have one side straighter than the other, and this may indicate an arrangement in pairs although not united. In the front dorsal region there are several scutes having a more quadrate outline, and these may have been closer together; but there is no evidence of overlapping or of their having been definitely in contact with each other.

Affinities.

The pointed and beak-like extremity of the skull of this Elgin reptile, especially when seen from above, as well as the large pre-lachrymal fossas gives it a very bird-like appearance; but the similarity is only superficial, the details of its structure being more reptilian that avian. This skull has some resemblance to that of the Pterosaurian, *Scaphognathus*; both having a large pre-lachrymal fossa, and a similarly disposed jugal bone; the supra- and infra-temporal fossæ are likewise present in both, and the teeth are not very dissimilar; but in the form of the palate and other details the two differ widely, and still greater differences characterize other parts of the skeleton.

This Elgin fossil before it was fully freed from the matrix was referred to by Mr. Smith Woodward as a new genus of Aëtosaurian reptile, and the similarity, in many respects, between the two forms is obvious; but now that its structure is more clearly seen, important points of difference are observable, the significance of which will be best appreciated after a closer comparison. If the figures of *Aëtosaurus*, given by Dr. Oscar Fraas (56), be compared with ours (Plate 55, fig. 2) the two skulls will be found to agree in having paired frontals and parietals, as well as in the absence of a parietal foramen. In both also there are double and large anterior nasal openings, between which and the orbits are the large pre-lachrymal fossæ. The palate of *Aëtosaurus* is

not figured or described, which is the more to be regretted as it is an important point in the structure of these early forms of reptiles. Dr. FRAAS however says (56, p. 13) "Die 3 Knochen, Zwischenkiefer, Nasenbein und Oberkiefer, umschliessen die vordere ovale Höhle, Nasenhöhle, welche nach unten offen zugleich das grosse Foramen incisium bildet," and this apparently indicates an anterior position for the primitive posterior nares, as in lizards.

Aëtosaurus differs from the present specimen in having broad parietals instead of narrow ones, with the supra-temporal fossæ pushed outwards quite to the sides of the skull. Moreover the parietals do not, by a lateral process, bound the supra-temporal fossæ posteriorly. In the Elgin skull there is a distinct and peculiar infra-temporal fossa, but nothing of the kind is shown in the restored figure of *Aëtosaurus* (56, p. 12). If this restoration is correct, the absence of an infra-temporal fossa is a very distinctive feature; but both the skulls figured by Dr. FRAAS on plates 2 and 3 seem to show a part of such a fossa, and if this be so, then the two forms will prove to be more nearly related than they now appear to be, judging from the restored figure; and one of the chief characters excluding *Aëtosaurus* from the Parasuchia will vanish. The teeth of *Aëtosaurus* are uniform in size, with the crowns enlarged, somewhat as in *Stagonolepis*; in our specimen the teeth vary much in size and their crowns are not enlarged.

The vertebræ of *Aëtosaurus* are said to be concave anteriorly and convex posteriorly, but only a few of them are seen, and those figured do not clearly show this procœlous character. The pelvic bones are not alike in the two forms, which differ also in the number of the phalanges in each digit of the foot, so far as these can be made out. Although the ornamentation of the scutes in the two animals is very similar, yet their arrangement differs widely, for while *Aëtosaurus* has the body completely encased in its closely locked armour, there is only a double row of dorsal scutes in the present specimen, and these are separated from each other, except perhaps in the front part of the body.

If *Aëtosaurus* should be found to agree with the present specimen in the possession of an infra-temporal fossa and bi-concave vertebræ, yet the other differences between the two forms would suffice to separate them at least generically; but *Aëtosaurus* could hardly then be excluded from the Parasuchia.

The only forms from the British Trias, excepting the Parasuchia, which will be referred to later on, that need be noticed are the compressed and serrated teeth referred to *Teratosaurus* (= *Zanclodon*), *Cladyodon*, and *Palæosaurus* (60, 67); and even if the resemblance between these and the teeth of our specimen were greater than it is, one would scarcely be justified in referring the latter to any one of those genera, which have been founded upon teeth only, and all represent animals of much greater size. *Zanclodon*, besides being much larger, has both edges of the tooth-crown serrated throughout, while the teeth of the other two genera although agreeing with those of the Elgin fossil in the restriction of the serration on the

anterior edge to its distal half, differ, the one in being much larger, and the other in having a much rounder section. However, the similarity between these teeth suggests the possibility of the Elgin fossil belonging to the same group of reptiles, and certainly it presents many points of resemblance to some of the Theropodous Dinosauria. The skull of *Megalosaurus*, if it has been correctly restored, and that of the American *Ceratosaurus*, notwithstanding their much greater size, seem to be constructed upon the same plan. (Compare Plate 55, fig. 1, with MARSH, 'Am. Journ. Sci.,' 1884, vol. 27, Plate 8, fig. 1.) There are similar supra-temporal fossæ and the four lateral apertures, with the bones arranged on the same plan; the teeth are compressed and serrated, they also vary much in size, and the quadrate is similarly directed obliquely backwards. The palate of *Ceratosaurus* is not figured by Professor MARSH, and the description does not give the position of the posterior nares. Other parts of the skeleton of *Ceratosaurus* are less like the Elgin specimen than are those found in the much smaller Dinosaur *Anchisaurus*, more recently made known from the Trias of Connecticut (64), the skull of which is only slightly larger than that of our specimen, but although constructed upon essentially the same plan as that of *Ceratosaurus*, is less like the Elgin form inasmuch as the quadrate is set obliquely downwards and forwards, while the teeth are uniform in size, and of a different shape. The pelvis of the Elgin specimen makes, perhaps, a nearer approach to that of *Anchisaurus* than to that of any other Dinosaur; but the ilium, having but little pre-acetabular extension, retains more of the crocodilian character; while the ischium and pubis, in their large proportionate size, resemble those of *Anchisaurus*. The femur of the Elgin specimen, as we have seen, is crocodilian in form, and is not half the size proportionately of that of *Anchisaurus*. The astragalus of the latter genus is described as attached to the tibia in true Dinosaurian fashion, while in our specimen it is a separate bone and more like that of a crocodile or lizard.

The general resemblance which the skeleton of the little *Compsognathus* (79) bears to our specimen is very striking, especially as their position in the stone is so alike, and its affinity to the Dinosaurs above noticed leads one to expect similarities of structure. A close comparison, however, does not indicate a nearer relationship to our fossil than was found in *Anchisaurus*. The skull of *Compsognathus* is broken, but was probably formed on the same plan as that of our specimen; the teeth are slender and conical, not compressed and serrated. The greater proportionate length which the tibia bears to the femur, and the hind limb bears to the rest of the skeleton, is unlike our fossil; and then again the astragalus is said to be firmly attached to the tibia.

If we turn to the Parasuchia, we find that the obvious characters of our specimen prevent its reference to either of the known genera, namely, *Stagonolepis*, *Phytosaurus*, *Parasuchus*, and the above described *Erpetosuchus*; yet it presents many of the characters which distinguish that group of reptiles. The skull has a large pre-lachrymal vacuity and distinct supra- and infra-temporal fossæ; the primitive

posterior nares, if my interpretation of the palatal apertures be correct, are placed only a little further back than they are in *Phytosaurus*; the vertebral centra are slightly amphicœlous; the ilium is of crocodilian type, although not so high as in *Stagonolepis*, and projecting a little more forwards, while the ischium and pubis are elongated bones approaching in form those of certain Dinosaurs. The limb bones seem to be of crocodilian type, and there is a row of dorsal scutes apparently in a double series. These characters, it will be seen, are essentially those laid down as characteristic of the Parasuchia by Professor HUXLEY, who, at the same time, pointed out (18, p. 41) how the "Parasuchia, in those respects in which they differ from the Mesosuchia, approach the Ornithoscelida and the Lacertilia" (especially Sphenodon). The many points of resemblance between the Parasuchia and certain of the forms usually included among the Dinosauria, have also been noticed by other writers; and the difficulty of separating the two groups is increased by a study of this new Elgin reptile, which holds, as I think, a more intermediate position between the two series, than any form hitherto described, for although the characters of its skull and teeth find their nearest counterpart among the Dinosaurs, and the pelvis and limbs might belong to either a Theropodous Dinosaur, or a Parasuchian; the form of the free astragalus is more Crocodilian than Dinosaurian. While acknowledging the difficulty of assigning this new reptile to either of these groups, it seems most in accordance with the facts to place it provisionally with the Dinosaurs.

Whatever doubt there may be as to the precise affinities of this most interesting reptile from the Elgin Sandstone, there will be none as to its being generically distinct from any known form, and I propose therefore to name it *Ornithosuchus Woodwardi*.

3. NOTE ON SOME FRAGMENTARY SPECIMENS.

Besides the specimens above described, I have received four others, all obtained from the quarry at Spynie, which, although too imperfect to allow of precise determination, should not be altogether passed over, more especially as the quarry, I am told, is now closed, and new specimens from this locality are not likely to be discovered for some time to come.

1. The first of these specimens was obtained by Dr. GORDON. It is contained in the two halves of a block of stone, which, when it reached me, weighed somewhat more than half a ton. Obliquely across the broken surfaces of this stone, for a distance of about twenty-four inches, a series of vertebræ could be traced, each about three-quarters of an inch long, while lying across these were many slender bones, evidently abdominal ribs, together with a few other bones, apparently dorsal ribs At each end of this series, portions of bones could be seen on the sides of the block, and it was hoped that with patience the limbs and skull might be displayed, but these hopes have not been realized. The bones have been much crushed and partially

dissolved, while they are, for the most part, so nearly the same colour as the matrix, and so intimately incorporated with it, that their forms could not be deciphered. At one end, portions of the pelvis and of a femur may be seen; and, at the other, there is part of a skull, but these are so fragmentary and indistinct that I have been quite unable to satisfy myself as to the relationship of this fossil.

2. The second specimen was secured by Mr. H. H. Howell of the Geological Survey. It is in several pieces, and comprises a few portions of vertebræ with centra less than three-quarters of an inch long, fragments of pelvic bones, and, extending outwards from these on each side, a femur which may have been six inches long. A few slender bones are seen, which look like abdominal ribs. This fossil may be part of a *Stagonolepis*, but there are no scutes to be seen.

3. The third specimen was likewise obtained by Mr. H. H. Howell. It is part of a small reptile, the bones of which have been dissolved out; it shows part of the vertebral column, traces of the pelvis, and a very perfect hind limb, the bones of which were remarkably stout for their length. The femur, tibia, astragalus, five metatarsals, and one or two phalanges are very nearly in their natural positions, but the fibula is somewhat displaced. The cavities left by the vertebræ are too much broken to give a definite idea of their shape, but the deeply bi-concave character of their centra is well seen. Four vertebræ together measure 25 millims. The lengths of the other bones are: femur, 32 millims.; tibia, 22 millims.; metatarsals, 1 to 5, gradually increasing from 8 to 10 millims. This specimen must have been smaller than the *Erpetosuchus Granti*, from which it differs in having deeply bi-concave vertebræ; moreover, its short and stout hind limb would scarcely accord with a long and slender fore limb, such as that of *Erpetosuchus Granti*. The specimen probably represents a lizard of about the size of the living *Sphenodon*. It is much larger than *Telerpeton Elginense*, but may, perhaps, belong to another species of that genus.

4. The fourth specimen, sent to me by Mr. Taylor, of Elgin, is interesting as having been found at Spynie only a short time before the closing of the quarry; but it is in several disjointed pieces, and the bones are scattered, the most perfect part being a row of neural spines, which agree in size with, and are not unlike those of *Erpetosuchus Granti*, but it would be very hazardous to refer these remains to that genus.

III. LIST OF WORKS CONSULTED.

The reference numbers follow on from those given in the earlier paper (68), and any less number than 50 mentioned in the present paper refers to the previous list.

51. Baur, Georg. Der Tarsus der Vögel und Dinosaurier. Morpholog. Jahrb., vol. 8, p. 417, 1883.
52. ——. Phylogenetic Arrangement of the Sauropsida. Journ. Morphology, vol. 1, p. 93, 1887. See also Biolog. Centralblatt, vol. 7, p. 481, 1887.
53. Cope, E. D. On Dinosauria. Proc. Philad. Ac. Nat. Sci., 1866, pp. 275 and 316.
54. ——. Synopsis of the Extinct Batrachia, Reptilia, and Aves of North America. Trans. Am. Phil. Soc., N.S., vol. 14, 1871.
55. ——. On the Homologies of the Posterior Cranial Arches in the Reptilia. Trans. Am. Phil. Soc., vol. 17, p. 11, 1892.
56. Fraas, Anton. *Aëtosaurus ferratus*, Fr. Die gepanzerte Vögel-Echse aus dem Stubensandstein bei Stuttgart. 4to. Stuttgart, 1877.
57. Hulke, J. W. Osteology of *Hypsilophodon Foxii*. Phil. Trans., vol. 173, p. 1035, 1883.
58. Huxley, T. H. On the Upper Jaw of *Megalosaurus*. Quart. Journ. Geol. Soc., vol. 25, p. 311, 1869.
59. ——. Dinosauria and Birds. Quart. Journ. Geol. Soc., vol. 26, p. 12, 1870.
60. ——. Classification of the Dinosauria, with observations on the Dinosauria of the Trias. *Ibid.*, vol. 26, p. 32, 1870.
61. Jäger, G. F. Ueber die fossile Reptilien welche in Würtemberg aufgefunden worden sind. 4to. Stuttgart, 1828.
62. Lydekker, R. Synopsis of the Fossil Vertebrata of India. Rec. Geol. Surv. Ind., vol. 16, p. 65, 1883.
63. Marsh, O. C. Principal characters of American Jurassic Dinosaurs. Part 8. Theropoda. Am. Journ. Sci., vol. 27, p. 329, 1884, and earlier papers.
64. ——. Notes on Triassic Dinosaurs. *Ibid.*, vol. 43, p. 543, 1892, and vol. 45, p. 169, 1893.
65. Meyer, H. von. Reptilien aus dem Stubensandstein des oberen Keupers. Palæontographica, vol. 7, p. 253, 1861, and vol. 14, p. 99, 1865.
66. ——. Der Schädel des Belodon aus dem Stubensandstein des oberen Keupers. *Ibid.*, vol. 10, p. 227, 1863.
67. Murchison, R. I. and H. E. Strickland. On the Upper Formations of the New Red Sandstone System, &c. Trans. Geol. Soc., ser. 2, vol. 5, p. 344, Plate 28, figs. 6, 7, 1837.

68. Newton, E. T. On some new Reptiles from the Elgin Sandstone. Phil. Trans., vol. 184, B., p. 431, 1893.

69. Owen, R. Report on British Fossil Reptiles. Rep. Brit. Assoc., 1841, p. 60, 1842.

70. ——. Description of an Extinct Lacertian Reptile, *Rhynchosaurus articeps*, &c. Trans. Camb. Phil. Soc., vol. 7, p. 355, 1842.

71. ——. Fossil Reptiles of the Wealden and Purbeck. Part 3, Pal. Soc., 1856.

72. ——. Note on the Affinities of *Rhynchosaurus*. Ann. Mag. Nat. Hist., ser. 3, vol. 4, p. 237, 1859.

73. ——. Palæontology. 8vo. Edinburgh, edit. 2, 1861.

74. ——. On the Skull of *Megalosaurus*. Quart. Journ. Geol. Soc., vol. 39, p. 334, 1883.

75. Phillips, J. *Megalosaurus Bucklandi*. Geology of Oxford, &c. 8vo. Oxford, 1871, p. 196.

76. Pleininger, Th. Ueber ein neues Sauriergenus und die Einreihung der Saurier mit flachen, schneidenden Zähnen in eine Familie. Württ. Jahresheft, vol. 2, pp. 148 and 248, 1846.

77. Riley, H. and S. Stutchbury. A Description of various Fossil Remains of three distinct Saurian Animals, &c. Trans. Geol. Soc., ser. 2, vol. 5, p 349, 1836.

78. Seeley, H. G. Classification of the Dinosauria. Proc. Roy. Soc., vol. 43, p. 165, 1887, and numerous other papers.

79. Wagner, A. Neue Beiträge zur Kenntniss der urweltlichen Fauna des lithographischen Schiefers. Abh. Kön. Bayer. Akad. Wiss., vol. 9, p. 94, 1861–3. Munich.

IV. EXPLANATION OF PLATES.

PLATE 53.

Erpetosuchus Granti, gen. et sp. nov.

All the figures, except 7 and 8, are natural size, and have been drawn from gutta-percha casts taken from the cavities in a block of Elgin Sandstone, in the possession of Mr. JAMES GRANT of Lossiemouth. The exact locality of the specimen is uncertain.

Fig. 1. Skull and lower jaw seen from the right side. The anterior part of the right ramus being still hidden by the matrix, it has been completed by reversing the left side, fig. 4.

Fig. 2. Skull seen from above; a portion of the left side restored in outline.

Fig. 3. Skull seen from below.

Fig. 4. Lower jaw, left ramus, articular end hidden in matrix.

Fig. 5. Series of vertebræ and scutes immediately behind the skull, seen from left side.

Fig. 6. Part of same series seen from right side.

Fig. 7. Vertebra No. 9, enlarged and restored.

Fig. 8. Four scutes enlarged.

Fig. 9. Right scapula and coracoid seen from outside.

Fig. 9A. Same seen from inner side.

Fig. 10. Left humerus, under surface.

Fig. 10A. Same bone, front view.

Fig. 11. Left tibia and fibula seen from behind, with under surface of five metacarpals and some phalanges.

Fig. 12. Right humerus, upper surface.

Fig. 13. Right tibia and fibula seen from before, with upper surface of five metacarpals.

Fig. 14. Interclavicle, upper surface.

PLATE 54.

Ornithosuchus Woodwardi, gen. et sp. nov.

From a photograph about one-third natural size, by Messrs. WALKER and BOUTALL, of a specimen obtained by Dr. GORDON from the Elgin Sandstone of Spynie, to be preserved in the British Museum. The under surface of the skull with the lower jaw in place is seen on the left; the dorsal and caudal vertebræ extend obliquely across the stone; below them are the pelvis and limb bones, and above them are the

scattered scutes. At the lower part of the slab and towards the left the group of abdominal ribs are seen.

PLATE 55.

Ornithosuchus Woodwardi.

Same specimen as Plate 54. All the figures except 1A are drawn natural size.

Fig. 1. Skull and lower jaw, right side. Much of the front parts of the right side being hidden in the specimen, it has been completed in the figure from the left side, and the right ramus has been similarly restored by reference to both rami.

Fig. 1A. The largest tooth, twice its natural size.

Fig. 2. Skull from above.

Fig. 3. Skull from below.

The following figures are drawn from gutta-percha casts.

Fig. 4. Vertebræ seen from right side—5 caudal, 3 sacral, and 1 pre-sacral. The sacral ribs have been completed from the left side. This pre-sacral vertebra is shown also in the series on Plate 56, fig. 1.

Fig. 5. Sacrum and left ilium seen from above.

Fig. 6. Sacrum seen from below.

Fig. 7. One of the largest and most perfect scutes.

PLATE 56.

Ornithosuchus Woodwardi.

Same specimen as Plate 54. All the figures natural size, and drawn from gutta-percha casts.

Fig. 1. Series of pre-sacral vertebræ seen from the right side. The vertebræ are each numbered from the sacrum forwards. No. 1 vertebra is also shown in the series on Plate 55, in order that the relations of the two series may be understood.

Fig. 2. Parts of pelvis and limb bones seen from the left side. The unshaded outlines completing several parts are supplied from the opposite slab of stone. The various bones are indicated by letters, the right and left

sides being marked respectively *rt.* and *lt.* All the foot bones belong to the left side—*ast.*, astragalus; *mt.*, 1, 2, 3, 4, 5, metatarsals; *a*, 1, 2, phalanges of first digit; *b*, 1, 2, 3, phalanges of second digit; *c*, 1, 2, 3, 4, phalanges of third digit; *d*, 1, 2, 3, 4, 5, phalanges of fourth digit; *e*, 1, 2, phalanges of fifth digit.

Fig. 3. Left ilium, outer surface, nearly complete.

Fig. 4. Right pubis with right and left ischia seen from right side. The lower edge of left acetabulum is also seen.

Fig. 5. Right femur, under surface of distal half.

Fig. 6. Left femur, under surface of proximal half.

Lettering used in the Figures.

a, b, c, d, e. Phalanges of digits.
ang. Angulare.
art. Articulare.
ast. Astragalus.
bo. Basioccipital.
bs. Basisphenoid.
den. Dentary.
exo. Exoccipital.
fem. Femur.
fib. Fibula.
fr. Frontal.
il. Ilium.
is. Ischium.
i.tem. Infra-temporal fossa.
ju. Jugal.
la. Lachrymal.
lt. Left.
mt. Metatarsal.
mx. Maxilla.
n. Anterior narial aperture.
na. Nasal bone.
op.ot. Opisthotic.
orb. Orbit.
p. Pubis.
pa. Parietal
p.la. Pre-lachrymal fossa.
pmx. Premaxilla.
pr.fr. Prefrontal.
p.sa. Pre-sacral vertebra.
pt. Pterygoid.
p.tem. Post-temporal fossa.
pt.fr. Post-frontal.
pt.na. Posterior narial aperture.
pt.o. Post-orbital.
pt.pl. Post-palatine vacuity.
qu. Quadrate.
qu.ju. Quadratojugal.
rt. Right.
s.a. Sacral vertebra.
s.ang. Surangular.
sq. Squamosal.
s.tem. Supra-temporal fossa.
tib. Tibia.
tr. Transverse bone of palate.

t. Plate 55, fig. 2, tooth of lower jaw.

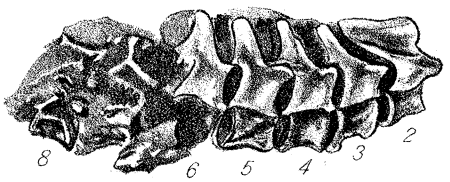


Fig. 6.

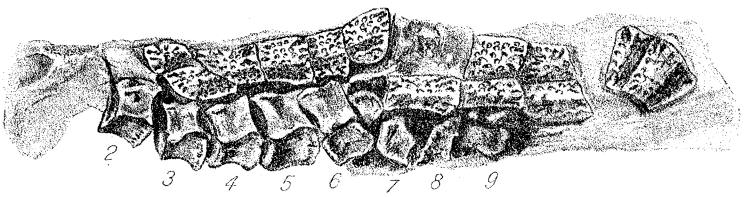


Fig. 5.

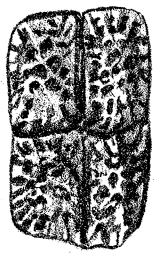
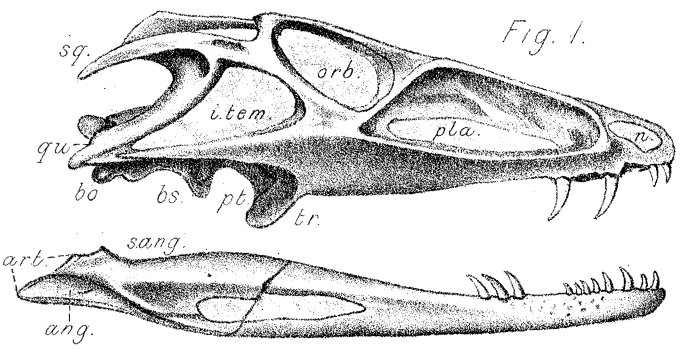


Fig. 8 x 2.

Fig. 1.



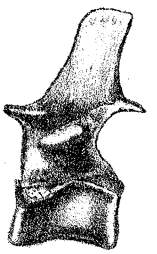


Fig. 7 x 2

Fig. 9.

Fig. 14.

Fig. 9a.

Fig. 3.

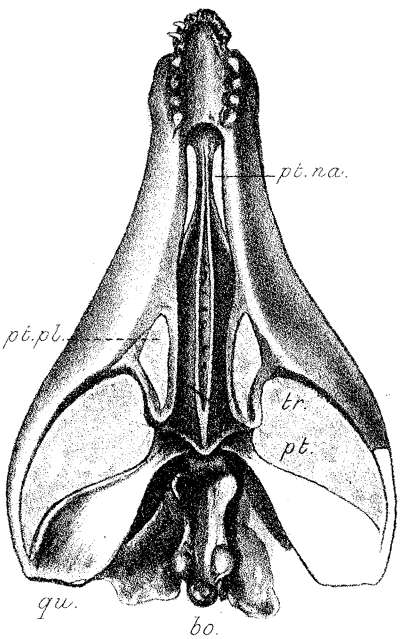
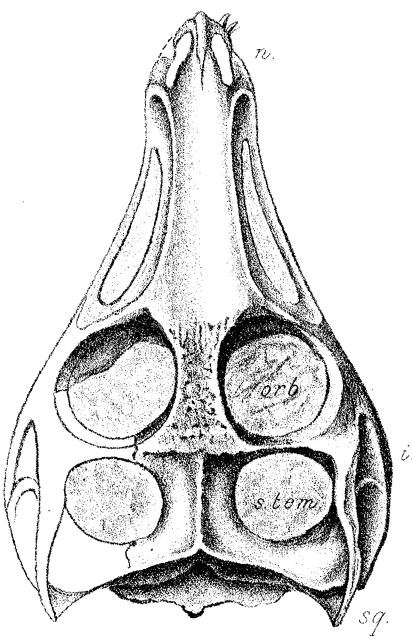


Fig. 2.



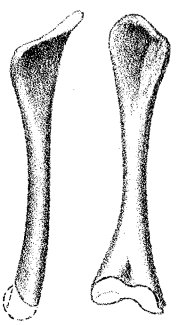


Fig 10a. Fig. 10.

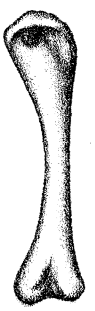


Fig. 12.

Fig. 11.

Fig. 4.

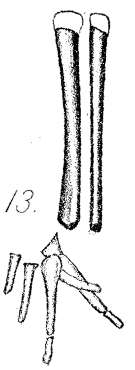


Fig. 13.

ERPETOSUCHUS GRANTI gen. et. sp. nov.

From a Photograph by Messrs. Walker & Boutall

ORNITHOSUCHUS WOODWARDI. GEN. ET SP. NOV.

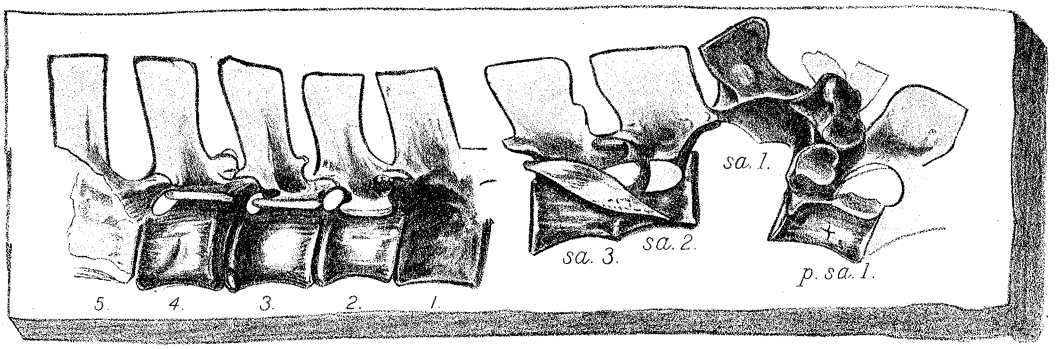


Fig. 4.

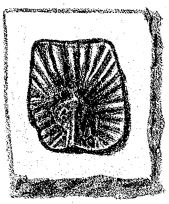


Fig 7.

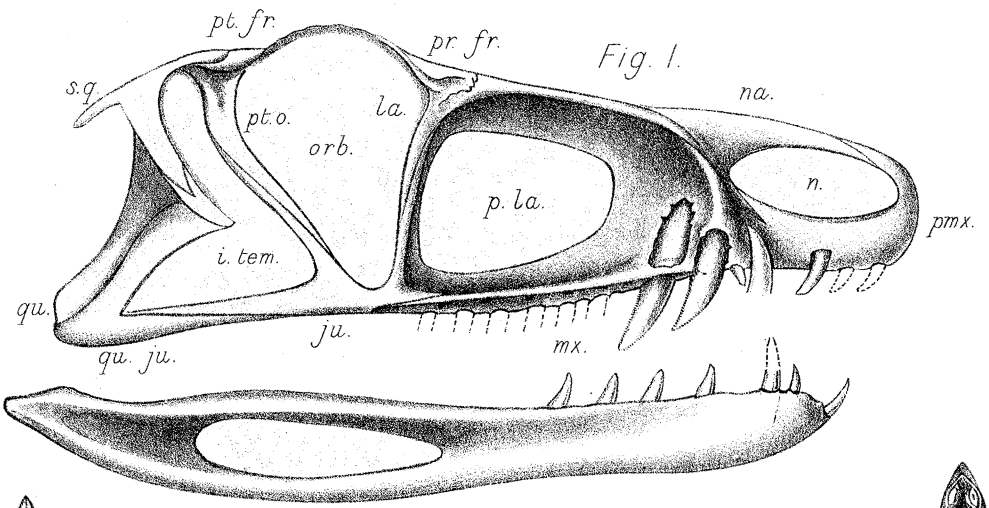


Fig. 1.

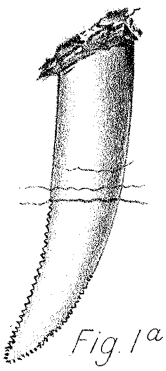


Fig. 1a

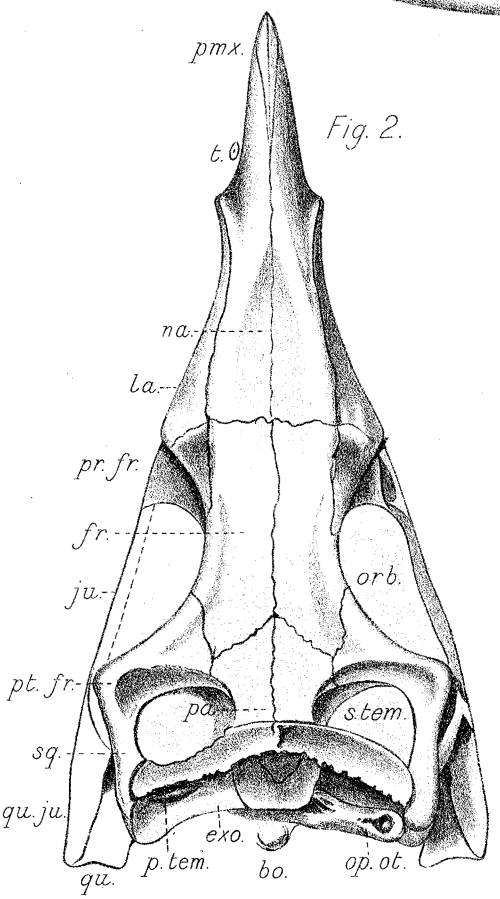


Fig. 2.

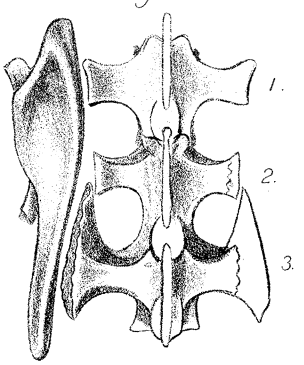


Fig. 5.

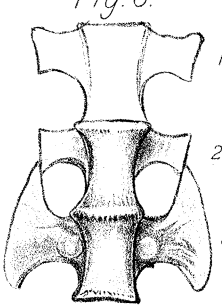


Fig. 6.

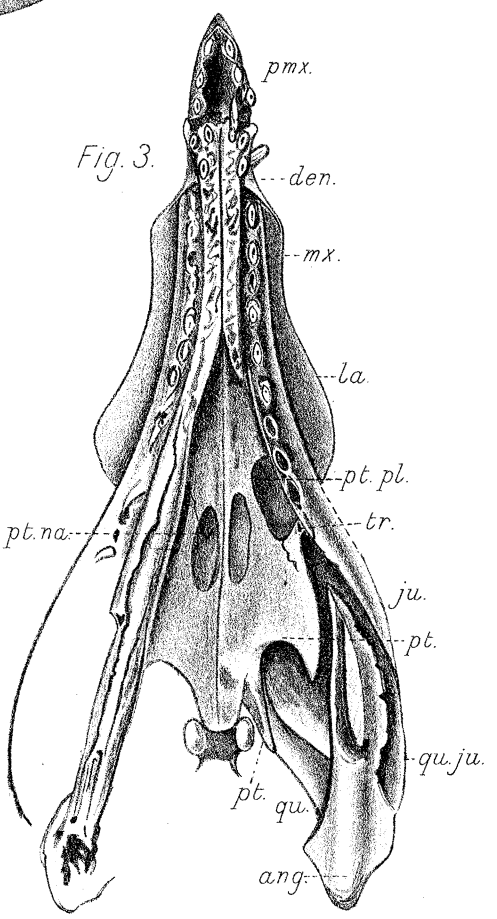


Fig. 3.

ORNITHOSUCHUS WOODWARDI. gen. et sp. nov.

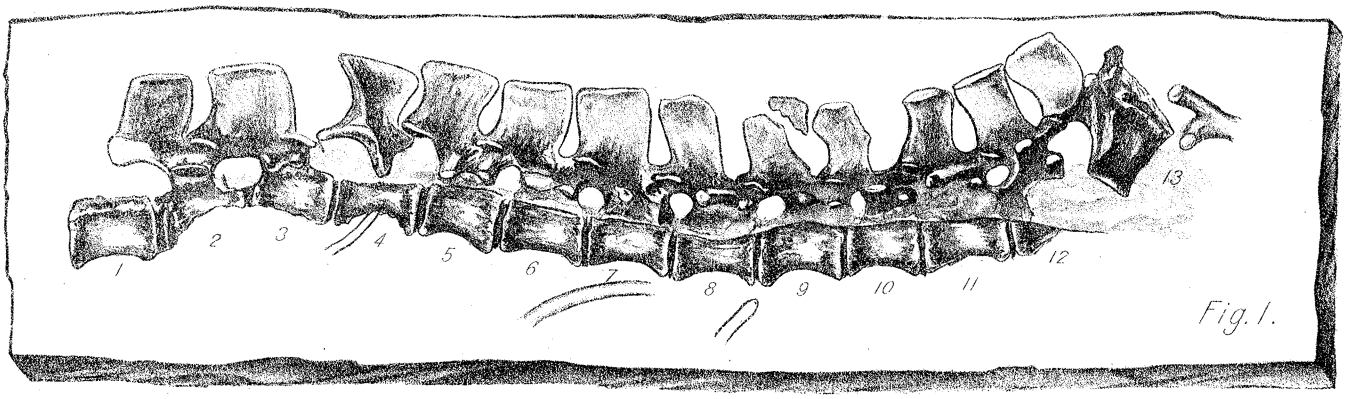


Fig. 1.

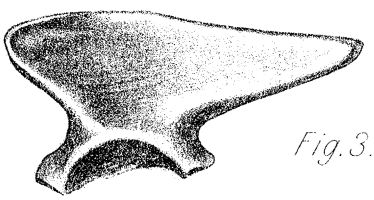


Fig. 3.

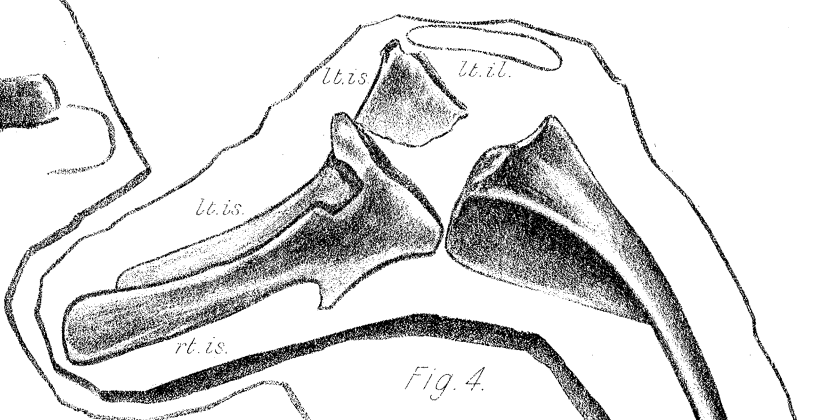


Fig. 4.

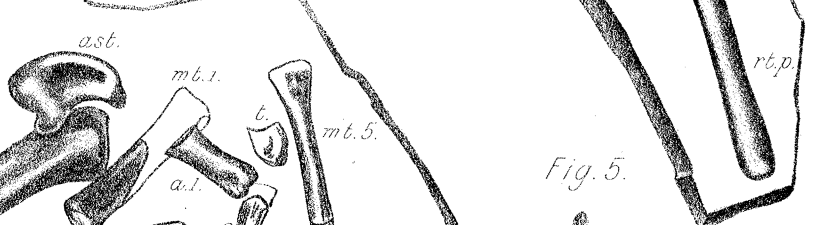


Fig. 5.

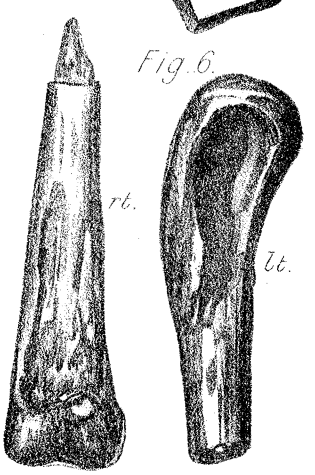


Fig. 6.

Fig. 2.

ORNITHOSUCHUS WOODWARDI. gen. et. sp. nov

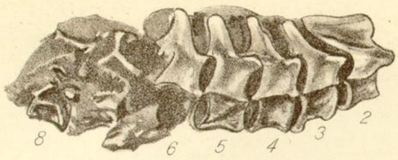


Fig. 6.

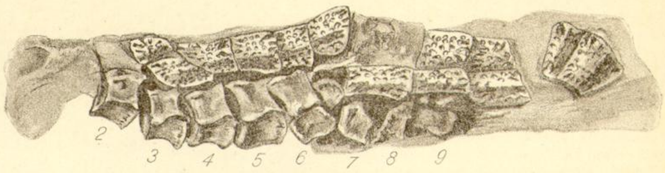


Fig. 5.

Fig. 8 x 2.

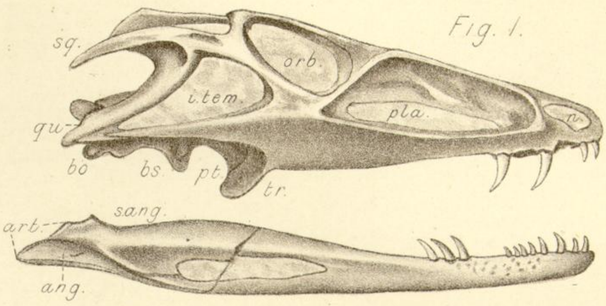


Fig. 1.

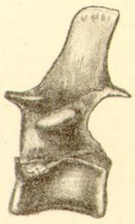


Fig. 7 x 2.

Fig. 9.

Fig. 9a.

Fig. 14.

Fig. 3.

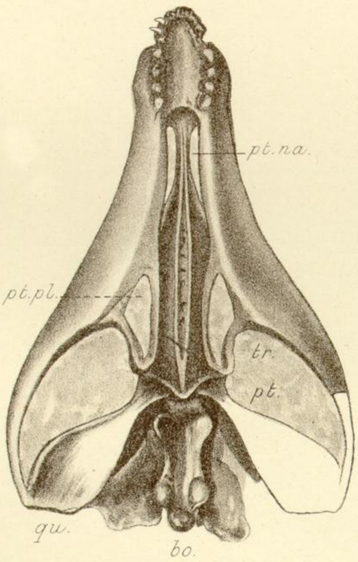
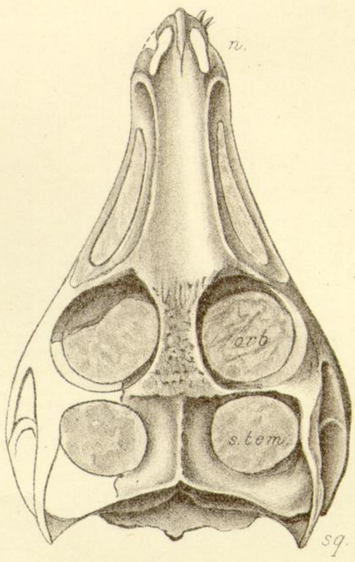


Fig. 2.



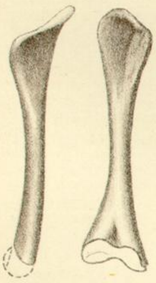


Fig. 10a. Fig. 10.

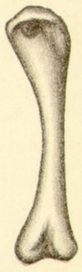


Fig. 12.

Fig. 11.

Fig. 4.

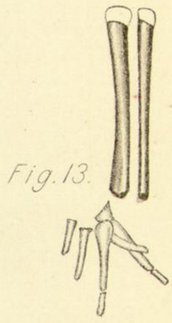


Fig. 13.

PLATE 53.

Erpetosuchus Granti, gen. et sp. nov.

All the figures, except 7 and 8, are natural size, and have been drawn from gutta-percha casts taken from the cavities in a block of Elgin Sandstone, in the possession of Mr. James Grant of Lossiemouth. The exact locality of the specimen is uncertain.

Fig. 1. Skull and lower jaw seen from the right side. The anterior part of the right ramus being still hidden by the matrix, it has been completed by reversing the left side, fig. 4.

Fig. 2. Skull seen from above ; a portion of the left side restored in outline.

Fig. 3. Skull seen from below.

Fig. 4. Lower jaw, left ramus, articular end hidden in matrix.

Fig. 5. Series of vertebræ and scutes immediately behind the skull, seen from left side.

Fig. 6. Part of same series seen from right side.

Fig. 7. Vertebra No. 9, enlarged and restored.

Fig. 8. Four scutes enlarged.

Fig. 9. Right scapula and coracoid seen from outside.

Fig. 9a. Same seen from inner side.

Fig. 10. Left humerus, under surface.

Fig. 10a. Same bone, front view.

Fig. 11. Left tibia and fibula seen from behind, with under surface of five metacarpals and some phalanges.

Fig. 12. Right humerus, upper surface.

Fig. 13. Right tibia and fibula seen from before, with upper surface of five metacarpals.

Fig. 14. Interclavicle, upper surface.

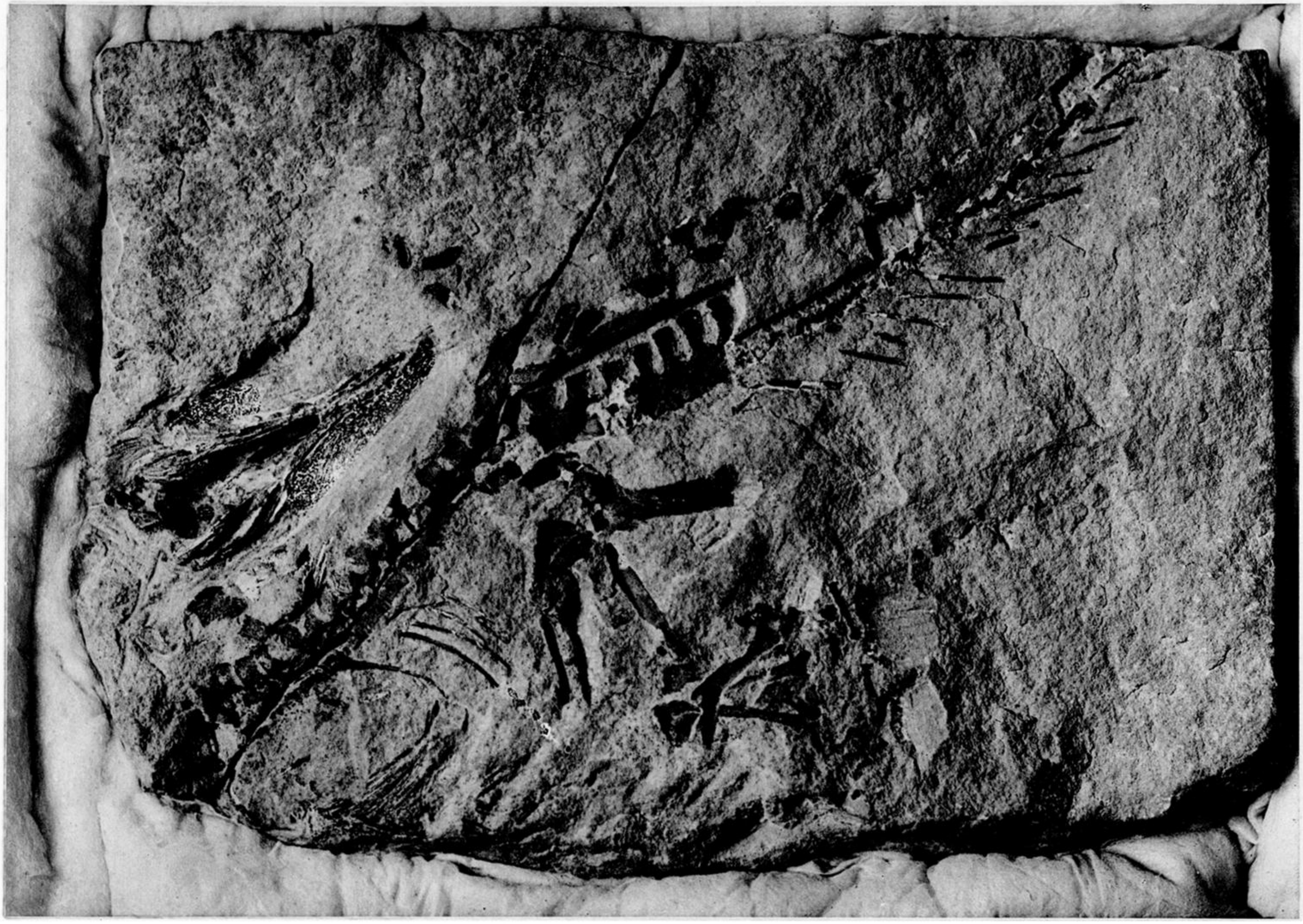


PLATE 54.

Ornithosuchus Woodwardi, gen. et sp. nov.

From a photograph about one-third natural size, by Messrs. WALKER and BOUTALL, of a specimen obtained by Dr. GORDON from the Elgin Sandstone of Spynie, to be preserved in the British Museum. The under surface of the skull with the lower jaw in place is seen on the left; the dorsal and caudal vertebræ extend obliquely across the stone; below them are the pelvis and limb bones, and above them are the scattered scutes. At the lower part of the slab and towards the left the group of abdominal ribs are seen.

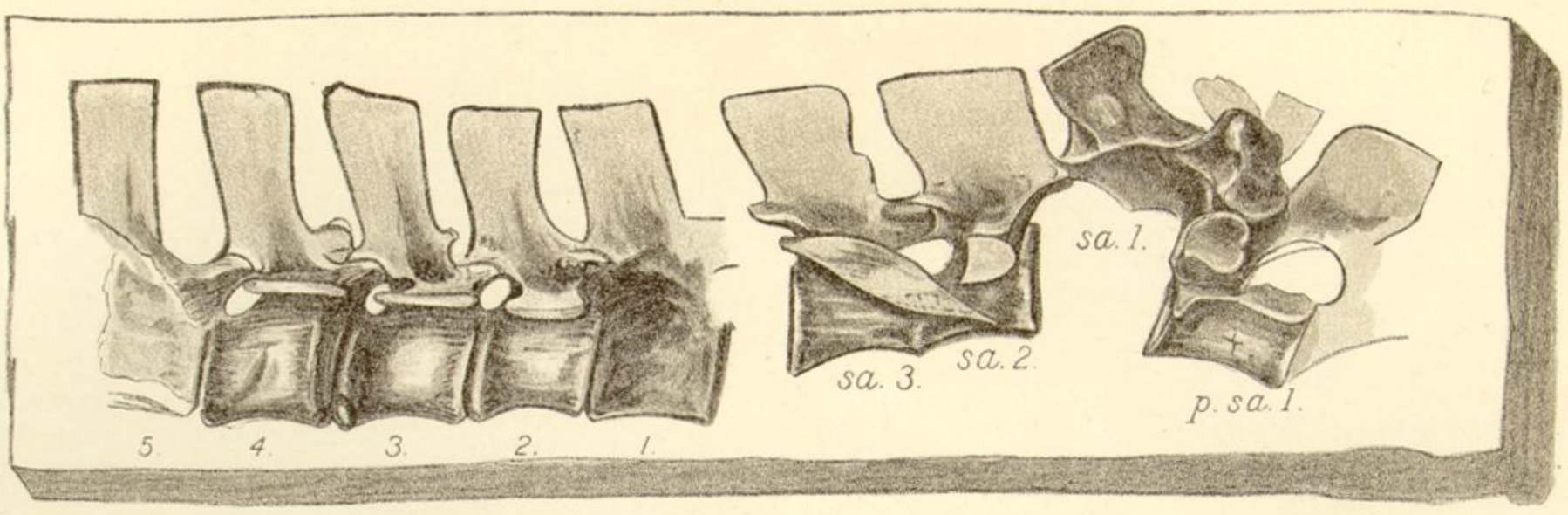


Fig. 4.

Fig 7.

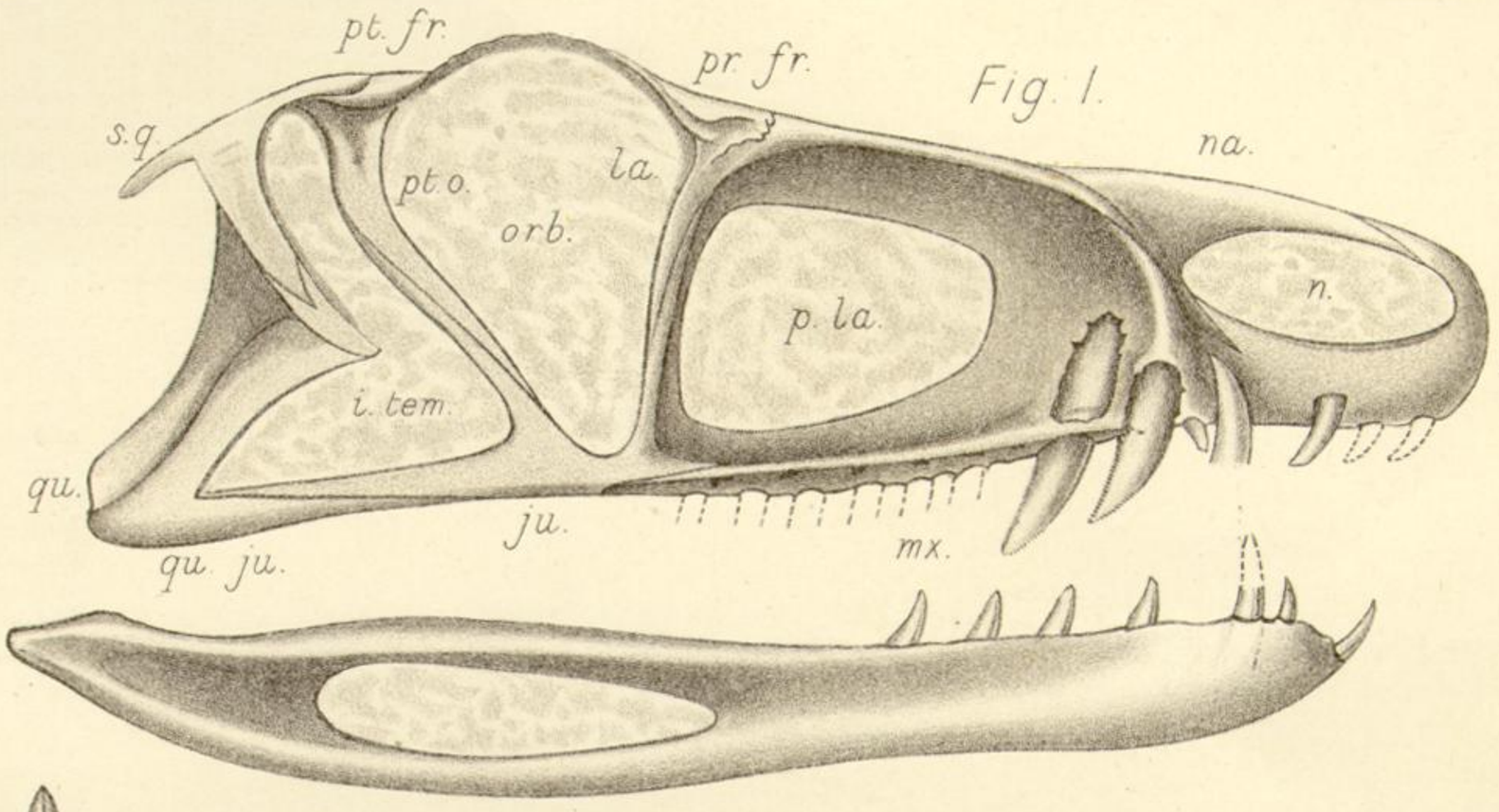


Fig. 1.

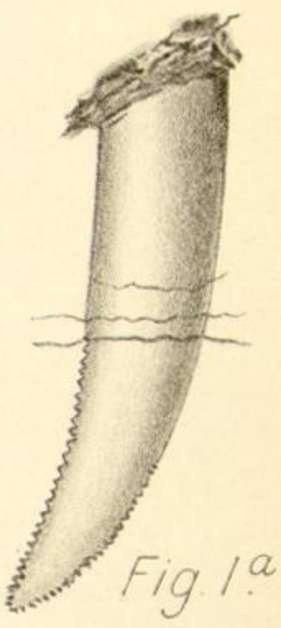


Fig. 1a

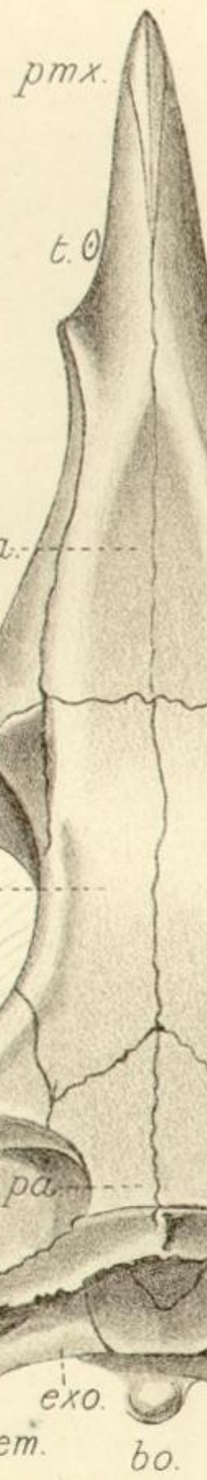


Fig. 2.

Fig. 5.

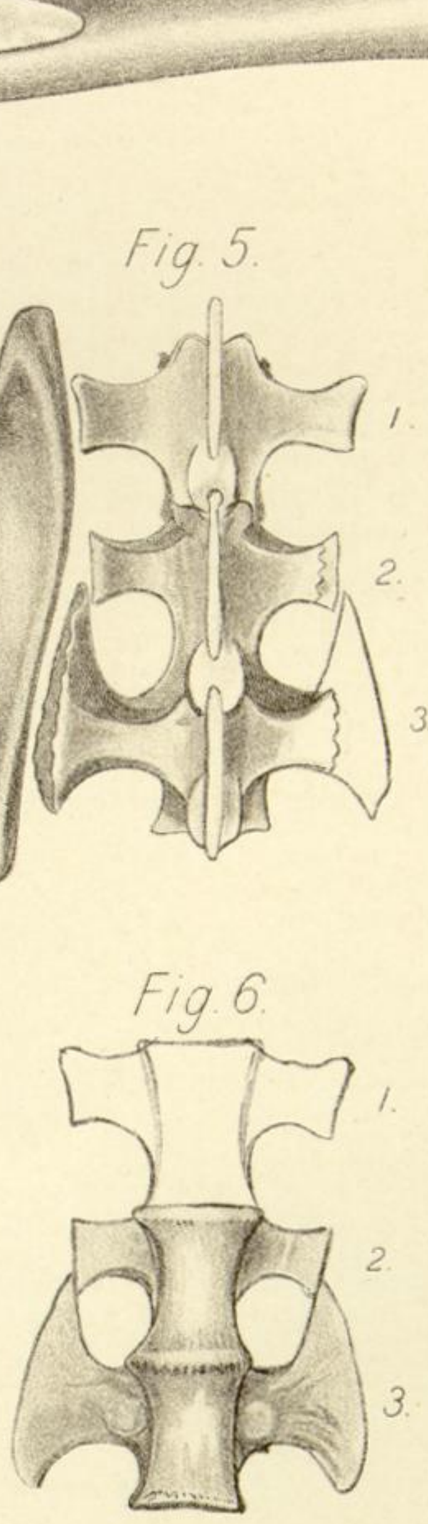


Fig. 6.

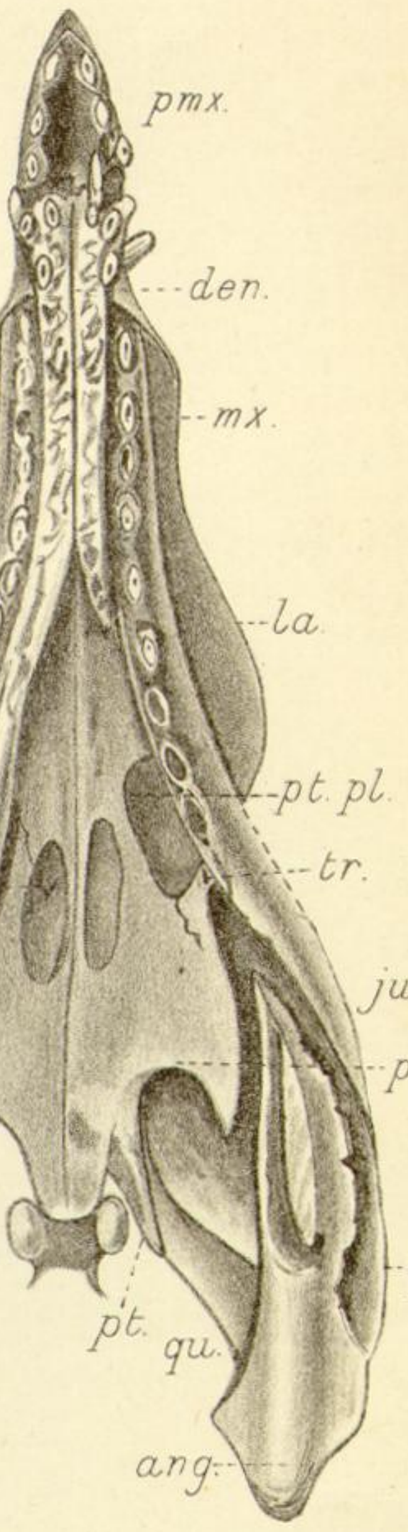


Fig. 3.

Fig. 2.

PLATE 55.

Ornithosuchus Woodwardi.

Same specimen as Plate 54. All the figures except 1A are drawn natural size.

Fig. 1. Skull and lower jaw, right side. Much of the front parts of the right side being hidden in the specimen, it has been completed in the figure from the left side, and the right ramus has been similarly restored by reference to both rami.

Fig. 1A. The largest tooth, twice its natural size.

Fig. 2. Skull from above.

Fig. 3. Skull from below.

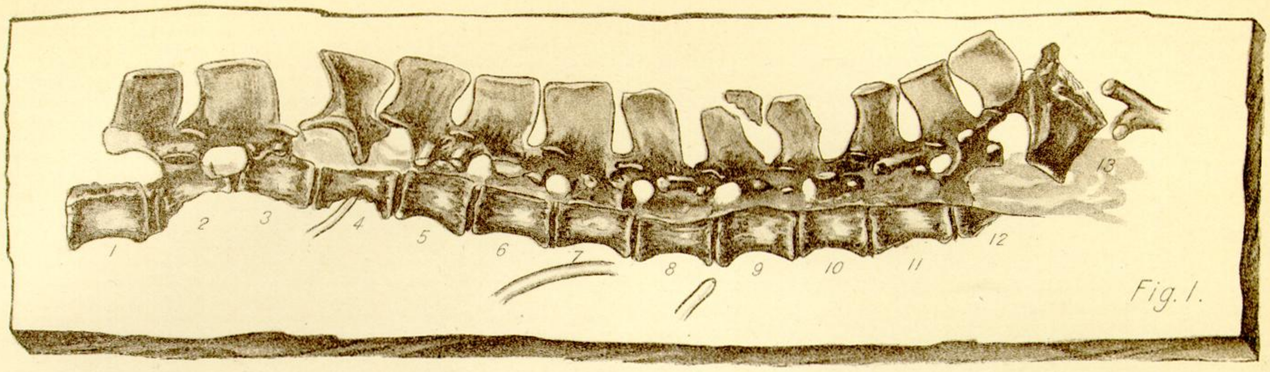
The following figures are drawn from gutta-percha casts.

Fig. 4. Vertebræ seen from right side—5 caudal, 3 sacral, and 1 pre-sacral. The sacral ribs have been completed from the left side. This pre-sacral vertebra is shown also in the series on Plate 56, fig. 1.

Fig. 5. Sacrum and left ilium seen from above.

Fig. 6. Sacrum seen from below.

Fig. 7. One of the largest and most perfect scutes.



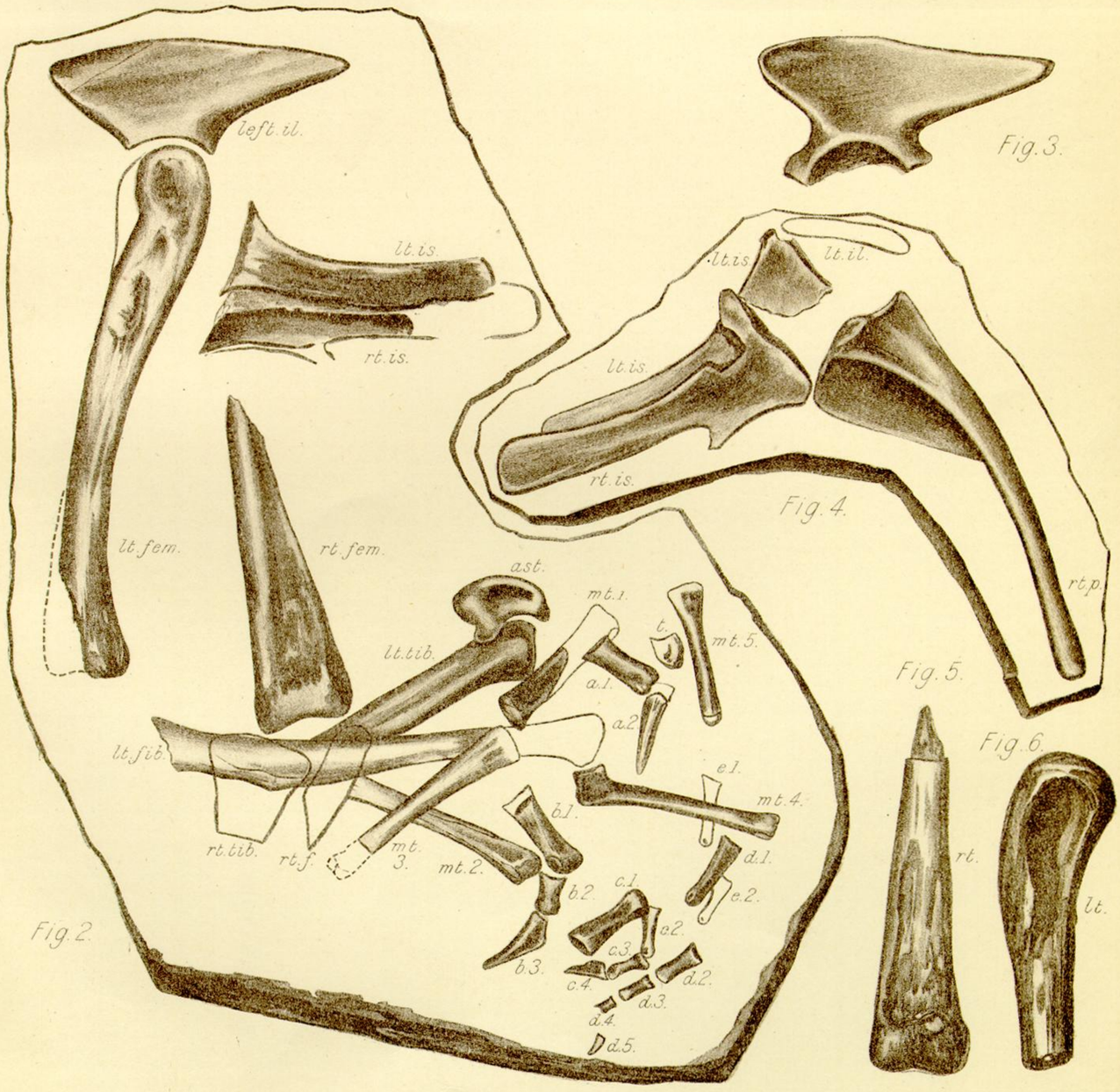


PLATE 56.

Ornithosuchus Woodwardi.

Same specimen as Plate 54. All the figures natural size, and drawn from gutta-percha casts.

Fig. 1. Series of pre-sacral vertebræ seen from the right side. The vertebræ are each numbered from the sacrum forwards. No. 1 vertebra is also shown in the series on Plate 55, in order that the relations of the two series may be understood.

Fig. 2. Parts of pelvis and limb bones seen from the left side. The unshaded outlines completing several parts are supplied from the opposite slab of stone. The various bones are indicated by letters, the right and left sides being marked respectively *rt.* and *lt.* All the foot bones belong to the left side—*ast.*, astragalus; *mt.*, 1, 2, 3, 4, 5, metatarsals; *a*, 1, 2, phalanges of first digit; *b*, 1, 2, 3, phalanges of second digit; *c*, 1, 2, 3, 4, phalanges of third digit; *d*, 1, 2, 3, 4, 5, phalanges of fourth digit; *e*, 1, 2, phalanges of fifth digit.

Fig. 3. Left ilium, outer surface, nearly complete.

Fig. 4. Right pubis with right and left ischia seen from right side. The lower edge of left acetabulum is also seen.

Fig. 5. Right femur, under surface of distal half.

Fig. 6. Left femur, under surface of proximal half.