

## **The Mesosauria of South Africa / by H.G. Seeley.**

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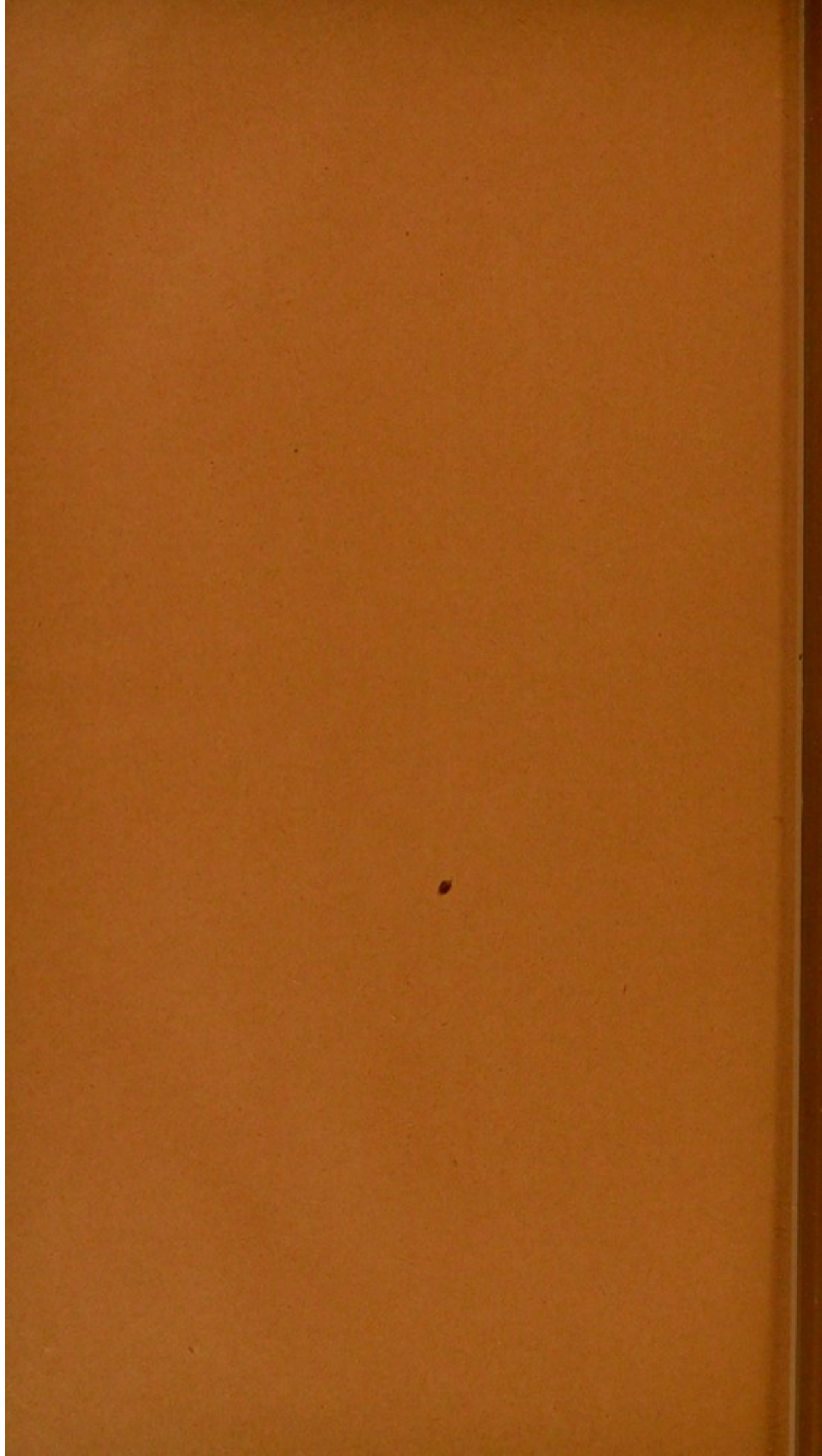
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THE MESOSAURIA OF SOUTH AFRICA.

*The MESOSAURIA of SOUTH AFRICA.* By H. G. SEELEY, Esq.,  
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## § 1. INTRODUCTION.

PROF. GERVAIS in 1865 described under the name *Mesosaurus tenuidens* the remains of a small reptile from Griqualand, South Africa, which had been brought to France more than thirty years before. It is preserved in a slab which shows the skull and anterior portion of the skeleton. As with other vertebrate remains from South Africa, its exact geological age is unknown. The author states<sup>1</sup> that the animal was a little larger than the Ocellated Lizard, and has many affinities; resembling in some characters terrestrial types of reptiles, while in other characters it approaches Simosaurians and Plesiosaurians. Its cervical vertebræ have some resemblance to those of Crocodiles. The lower jaw recalls in a general way Crocodiles and Plesiosaurs. The dorsal vertebræ are rather elongated and comparable to those of Homæosaurians and of Teleosaurs. The ribs are stronger than in any known reptile except *Pachypleura*, and are arranged as in that genus. They have much the same relation to the ribs of other reptiles that the ribs of Sirenians have to those of other mammals. The sternal ribs, identified by Cope, were regarded as annelid tracks. The scapular arch is compared to those of Crocodiles and Plesiosaurs; but the scapula and coracoid are ankylosed. The humerus is that of a Plesiosaur or Simosaur, with an ent-epicondylar perforation, like that seen in *Varanus* and certain mammals. The forearm and hand are of less aquatic type than in Plesiosaurs, and approach the terrestrial type; but the ulna, unlike that of terrestrial reptiles, has no olecranon. The animal is compared to *Lariosaurus*, *Machrimosaurus*, and *Pachypleura*, but is distinguished from them by the form of the head, the teeth (which are exceptionally long), and the number of cervical vertebræ, which were stated to be seven, with two which are intermediate in character between the cervical and dorsal.

<sup>1</sup> Gervais, 'Zoologie et Paléontologie Générales,' 1867-69, p. 223, pl. xlii.



§ 2. THE KIMBERLEY SPECIMENS OF *MESOSAURUS PLEUROGASTER*.

Many years passed without further evidence of *Mesosaurus*. But about 1878 Mr. G. H. Lee, F.R.M.S., of Kimberley, obtained from the shale at the margin of the Kimberley Diamond Mine some specimens, which were partially figured by Mr. J. W. Matthews in his 'Incwadi Yami' in 1887. In 1878 these four specimens, which were all that were collected, were deposited in the British Museum. Two display the characters of the lower dorsal and lumbar vertebræ, the dorsal ribs and abdominal ribs; the third fragment shows some characters of early caudal vertebræ, and the hind foot, which lies towards them; the fourth specimen belongs to the middle region of the tail. There are slight differences in the relative sizes of the bones in the several slabs, and differences in the colour and hardness of the marly matrix, so that the remains may be portions of more than one individual, but I have no doubt that they are all referable to one species.

They show that *Mesosaurus* was a long-tailed reptile, with hind limbs well developed. The remains are not easily compared with the type in Paris, which is in a very dark hard matrix; but they add materially to our knowledge of the genus, and are now described under the numbers in the British Museum Catalogue.

No. 1.—49972. Presented by Wm. Benstead Smith, Esq., Registrar of Kimberley Mine. This specimen, found  $\frac{1}{4}$  mile S.E. of Market Square, Kimberley, in January 1878, is a natural mould in pale whitish calcareous shale, from which the bones have disappeared. The late Mr. Wm. Davies placed with it a plaster-of-Paris impression which exhibits the forms of the bones in natural relief. It shows the ventral aspect of the bodies of eleven vertebræ, eight of which carry ribs; the last three show no trace of ribs, and may therefore be lumbar.

The bodies of the vertebræ are not in close contact, but separated by narrow intervertebral spaces. Each centrum is 6 millimetres long. Its form is semicylindrical, being convex from side to side, without the slightest concavity in length. On the contrary, the articular faces are a little contracted, and, on the evidence of one displaced centrum, are characterized by a subconical articular cavity penetrating into the centrum for fully a third of its length. The neural canal is wide, concave below, and angular above. The intervertebral perforations for the nerves are inferior in position to the transverse tubercles from the neural arch. These tubercles increase the width of the vertebræ, as exposed, to about 1 centimetre.

The ribs, 4 centimetres long, are strongly curved in the proximal part, and less curved distally, where they become cylindrical and thicker, being fully 3 millimetres wide. In the proximal third the rib is less than 2 millimetres thick, so that it is there flattened from below upward; and its small articular extremity bends a little forward. The measurement over the two extremities of the dorsal ribs is 3 centimetres. The length of the posterior ribs diminishes, so that the last is only 1.5 centimetre long, and the distal ends of



the last four terminate in the same transverse line, showing that the vertebræ behind them are lumbar. The massive cylindrical character and small head are the most distinctive features of the rib.

Delicate, curved, flattened, fusiform ossifications extend transversely over the ventral interspaces between the ribs, as well as beneath some of the ribs, and beneath the centrams of some vertebræ. These are the abdominal ribs. They are five or six times as numerous as the costal ribs, and are composite, joining each other by squamous overlap or contact, so as to form a ventral armour like that seen in the abdominal ribs of certain Plesiosaurs, with a median riblet and two lateral elements on each side. The middle bones are 7 millim. long.

No. 2.—49971. Presented by Maurice Marcus, Esq., from Mining Board Cutting, 50 feet deep; 100 feet from the eastern margin of Kimberley Mine, March 1878.

This is a natural mould of the dorsal region which exposes the dorsal aspect of the corresponding portion of a similar but slightly larger animal; for while seven vertebræ in No. 1 measure 4·7 centimetres, seven vertebræ in this specimen measure 5·5 centimetres. But there is no difference in the character of the vertebræ and ribs.

Eight vertebræ with their ribs are exposed in sequence, and the flattened filamentous abdominal ribs are seen between the costal ribs, admirably preserved. This armour is quite unlike that attributed to *Mesosaurus tenuidens*, and may indicate another species.

The neural arch, seen from above, has a wide subquadrate form; it is 6 millimetres long and 1 centimetre wide, but the width becomes less in the hinder vertebræ. It is slightly wider in front than behind. The dorsal surface is divided into two lateral subhorizontal areas, which are convex from back to front, by a very thin neural spine, which was vertical, compressed to a sharp edge anteriorly and posteriorly, and appears to have been low.

Laterally the neural arch of each vertebra gives off a strong tubercle. It is subconical, compressed from above downward, placed well below the level of the neural platform, towards the anterior end rather than in the middle of the side of the vertebra. These tubercles extend the width of the arch for 2 or 3 millimetres on each side in the earlier vertebræ, but they appear to be slightly shorter and slightly lower in position in the last vertebræ preserved.

The dorsal ribs lie in natural sequence. At first sight they appear to be wider proximally than in the other specimen, because they are exposed so as to show the superior convex dorsal curvature; but enough of the margin is exposed to show that the proximal end was compressed from above downward, so that there is no difference of condition, though these ribs are uniformly wide from the proximal to the distal end.

At the hinder extremity of this slab are two early caudal vertebræ, isolated, and partly exposed; one showing the anterior, the other showing the posterior articular face.

The anterior aspect displays the relatively small size of the face of the centrum as compared with the neural arch, the width of the



former being apparently about 5 millimetres, and of the latter about 11 mm. The prezygapophyses extend in advance of the face of the centrum, but are rather short, and look upward and inward. The sides of the neural arch are inclined obliquely outward, are convex from above downward, and look outward and upward. The transverse processes or caudal ribs are strong, subconical, almost horizontal processes, 9 millimetres long, compressed from above downward into a wedge-shape at the outer extremity; while they are flattened vertically in front at the base, which is 4 millimetres deep, where the process is given off from the conjoined centrum and neural arch. The processes are directed outward and a little downward. The neural spine is short, and in front it is sharp; the height from the base of the centrum to its summit is 1.5 centimetre.

The posterior aspect shows similar characters in the neural arch, except that the lateral convexity is rather greater, and the height is rather less. The posterior zygapophyses are compressed from above downward, and look obliquely downward and outward; the transverse width over them is about 7 millimetres, being apparently rather less than the anterior measurement. The neurapophyses do not extend to the hinder face of the centrum, but are notched out in the usual way to form the intervertebral foramen. The centrum is convex on the under side, as in the dorsal region, but its dimensions contract markedly towards the concave posterior articulation. The transverse process or caudal rib appears to be flattened on its under side; it is about 1.2 centimetre long.

No. 3.—49974. Presented by Captain Scott Helps; from the cutting at the east of Kimberley Mine, facing Claim .018, 40 feet from the margin and 50 feet deep; January 1878. This specimen shows an impression of a few early caudal vertebræ, very imperfectly preserved; and an impression of the hind foot with the distal row of the tarsus, the metatarsus, and digits having the formula 2·3·4·5·4.

The inflated sides of the neural arches are shown in five vertebræ, and the stout, subconical, transverse caudal ribs attached to them diminish from a length of 1.5 centimetre in the earliest to about 4 millimetres. These processes are rounded; their shortening in these five vertebræ may be taken to indicate that they are speedily lost, and that the sides of the caudal vertebræ then become flattened.

The evidence concerning the hind limb, though fragmentary, is instructive. The distal row of the tarsus is preserved and consists of five subovate cuneiform bones, of which the fifth is very small.<sup>1</sup> One of these bones articulates with the proximal end of each metatarsal (as in *Cryptobranchus* and *Salamandra*). On the external side of the slab, above the small fifth cuneiform bone, is the large broadly wedge-shaped cuboid, and above the other bones a part only is preserved of a larger bone which the evidence does not enable me to identify.

The metatarsal bones progressively increase in length, and there

<sup>1</sup> This fifth bone is much smaller than in *Stereosternum*.



is a corresponding elongation of the phalanges of the digits, so that curves might be drawn through the articular ends of the bones which would diverge as they extend outward and forward. The first digit is the shortest and strongest; the two outer digits appear to be slightly the more slender. All the metatarsals and phalangeal bones are more or less contracted in the shaft and expanded at the ends, and the digits terminate in conical claws.

The first digit measures 1.7 centimetre in length, of which the metatarsal forms one centimetre; it is a stout bone with the extremities fully 4 millimetres wide. The first phalange is less than 4 millimetres long and the conical claw-phalange 3 millimetres long. The interspaces between the bones are small, showing that their extremities were well ossified.

The second digit is 2.6 centimetres long. The metatarsal bone measures 14 millimetres. The first phalange is 5 millimetres long, the second scarcely 4 mm., and the third 2 mm.

The third digit has a length of 3.2 centimetres. The metatarsal bone is 15 millimetres long. The first phalange is 7 mm., the second 4 mm., the third 3 mm., and the fourth 2 mm.

The fourth digit has a length of 4.8 centimetres. The metatarsal bone has a length of 1.7 centimetre. The first phalange measures 8 millimetres, the second 5 mm., the third 4 mm., the fourth 3 mm., and the fifth phalange has a length of 1 millimetre.

The fifth digit has a length of 4.1 centimetres. The metatarsal bone is 2 centimetres long. The first phalange is nearly 11 millimetres, the second fully 5 mm., the third 3 mm., and the fourth, which is very small, is about 1 millimetre long.

No. 4.—49973, was found at the same time and place as the specimen just described, and presented to the British Museum by the same gentleman. It may therefore be a portion of the same individual. It is a similar slab in soft shale exhibiting some characters of the middle caudal region. It includes 18 vertebræ. In the early vertebræ the length of a centrum is 9 millimetres, and as the series measures 15.5 centimetres, it is manifest that the decrease of the vertebræ in length, as they extend posteriorly, is slight. The subquadrate vertebral bodies are flat at the side, with the centrum scarcely defined from the neural arch, which contracts anteriorly and laterally, so as to form a sharp, strong, pointed neural spine, which is directed upward and backward. In the later vertebræ, the neural spine becomes at first more slender, and afterwards, in the hindermost vertebræ preserved, it is more depressed. Chevron bones are present in all the vertebræ which are sufficiently well preserved to show them. They appear to be attached in the usual way at the posterior angles of the centrams, are more slender than the neural spines, rather shorter, and directed backward at a sharper angle. They are 9 mm. long, 2 mm. wide, and terminate at first in a horizontally truncated surface, but afterwards they are more compressed distally. (See fig. 1, p. 591.)

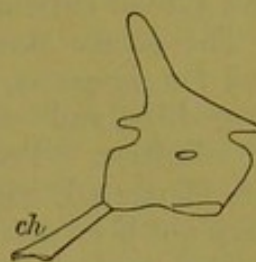
This completes the evidence from the Kimberley specimens. It is impossible to say that they belong to *M. tenuidens*. The well-



developed abdominal ribs, formed of flattened plates, give its most distinctive feature, and it is probable that the species is different from the slender delicate type-species, with elongated teeth. It makes known the remainder of the skeleton, with the exception of the pelvis and sacrum, the femur, tibia, and fibula, and the extremity of the tail.

There are some points in which it appears to me that the Mesosaurian shoulder-girdle figured by Gervais may be given a different contour, but the evidence in favour of this change in interpretation will be better appreciated after the discussion of a new specimen which is preserved in the South African Museum, Cape Town.

Fig. 1.



ch = chevron bone.

### § 3. THE MESOSAURUS TENUIDENS (GERVAIS) FROM ALBANIA.

The Cape Town fossil was collected by David Arnott in the district of Albania in Griqualand West. It is in white fissile marl, and, as in all other similar specimens, the bones have disappeared and left an internal mould of the skeleton. The slab unfortunately only shows the ventral aspect of the anterior part of the skeleton. It appeared at first as though the skull had a short triangular form, but by careful development from the matrix it is proved to have had the same elongated form of head which characterizes the Paris type; and, indeed, it extended beyond the limit of the slab.

As preserved, the lower jaw is 5 centimetres long. The rami are narrow in the articular region, beyond which they are prolonged backward in a heel. The transverse width over the articular region is about 1.5 centimetre. The rami widen as they extend forward, though this condition may be, in part at least, the effect of compression, since a median channel extends along the symphysis, of which not more than 1 centimetre is preserved. The transverse width at the anterior fracture exceeds  $\frac{1}{2}$  centimetre. The external surface of the bone is somewhat uneven and marked with longitudinal striations. Behind the acute anterior convergence of the rami the palate is exposed. It is completely closed, without indication of any vacuity. Two elevated ridges nearly parallel to each other and close together extend along its length and converge backward. There is a possibility that these ridges carried single rows of teeth like the teeth on the ridges on the palate of *Pareiasaurus*, as the impression from the cast shows at regular intervals a few white dots along each ridge. The ridges become more elevated at the back of the palate and diverge outward and backward in a V-shape to the articular region, which is strongly suggestive of the pterygoid bones abutting against the basi-sphenoid. It is possible that the palatenaes may be in the depression behind the posterior divergence of the pterygoid bones. On the hinder part of the pterygoid region are short slender rods which appear to be part of the hyoid.



The articulation with the vertebral column is not clearly shown, because the atlas is in close apposition with the back of the head. The teeth are few and imperfectly displayed; they are long, slender, and extend outwards at right angles to the jaw.

The palate closed in the median line is common to *Nothosaurus* and *Pareiasaurus*, and is seen in certain Amphibians, Chelonians, Crocodiles, and other orders, so that it gives no clear indication of affinities. Prof. Cope finds that the head of *Stereosternum* is also elongated, with slender teeth; but the details of the structure have not been determined.

The cervical vertebræ are short, narrow, wider in front than behind, in close contact, with a median ridge moderately elevated on the base of the centrum. On each side of the ridge the base of the centrum is concave, owing mainly to the development of a strong tubercle at the anterior angle of the side of the centrum. These tubercles are compressed from above downward, and each apparently gave attachment to a rib by a facet which is less than half as long as the centrum. Eight cervical vertebræ have a length of 3.25 centimetres. The first three are very short, the atlas shortest. It appears to terminate in front in a concave articular cup. The other centrams are rather less than  $\frac{1}{2}$  centimetre long.

The cervical ribs have large heads, which articulate with the lateral tubercles, but appear otherwise to be slender rods which lie near to the sides of the vertebræ and are about 1 centimetre long, which is unlike both the figure of the type of *Mesosaurus*, which has transversely expanded cervical ribs according to Gervais,<sup>1</sup> and the cast of the specimen, though these may be only the expanded heads of the ribs.

In the lateral aspect the cervical vertebræ are concave from above downward. The zygapophyses are well developed and strong; they lean a little forward. The foramen for the intervertebral nerve is developed vertically, and chiefly excavated at the posterior borders of the vertebræ.

Beyond the eighth centrum the vertebræ have a different form. The median ridge gives place to a convex base to the centrum, from the sides of which strong transverse processes are given off. No divisions can be seen between the centrams of the vertebræ 9-11, and they look as though ankylosed. But, since they are curved, that is impossible; and I suggest that the aspect is a delusive appearance which not improbably results from the presence of a thin osseous film which extends over the sutures. The position is that which would be occupied by the stalk of the interclavicle or forward prolongation of the precoracoid. Extending transversely outward from the suture between the eighth and ninth vertebræ are fragments of a transversely extended median bone. On the left side it extends outward and backward to the scapula, so that the bone has the relations of the clavicular mass in Plesiosaurs. The preservation is such that its nature cannot be determined with cer-

<sup>1</sup> The cast and the figure differ materially, especially in the structure of the skull; and I suppose the figure to be more accurate, since it corresponds better with this fossil.



tainty. On the right side are two bones a little displaced, which may be the remainder of the right clavicle and the transverse bar of the interclavicle. Both bones are wider than cervical ribs. There is nothing to show whether the clavicular arch resembled that of *Lariosaurus* and *Nothosaurus*, or that of *Pareiasaurus* and Anomodonts, but that it existed seems probable.

A pair of bony plates make the ventral part of the shoulder-girdle, and cover much of the two succeeding vertebræ so that their transverse processes are not seen. On both sides these bones are fissured and broken by pressure. On the left side a suture extends inward from near the acetabulum, which appears to have divided the mass into a posterior coracoid part and an anterior scapular part. On the right side the suture is not seen. There is a coracoid foramen, which is presumably in advance of the acetabulum. In some Anomodonts the coracoid foramen is situate at the junction of the scapula and precoracoid, in others at the meeting of the scapula, coracoid, and precoracoid; while it is entirely in the coracoid in Crocodiles and Dinosaurs. Hence it may be inferred that the part of the bone which thickens behind the foramen is the coracoid. The thinner plate in front is the scapula. The part of the bone which extends inward from the scapula towards the clavicle corresponds to the precoracoid region, though there is no suture to define it as a separate bone. The contour of the scapula is apparently not unlike that of the Muschelkalk fossil *Dactylosaurus gracilis*, but the coracoid is dissimilar.<sup>1</sup> The correspondence is close with the type *Mesosaurus tenuidens*. In that fossil the coracoids overlap, while in this specimen they are separated, probably by *post-mortem* pressure. On each side towards the median line there is a lunate plate. Its inner border is convex, very thin, and apparently adapted for squamous overlap. As it extends outward towards the coracoid foramen it contracts. There is a deep semi-ovate emargination of the posterior margin of the bone, external to which the posterior border of the coracoid terminates in a transverse line. In front of the emargination the bone thickens to an elevated band, which has the aspect of connecting the lunate mass with the external part of the coracoid and scapula, though there is no anterior emargination, but only a depression in which the coracoid foramen is placed. The external border of the scapula and coracoid is straight, with a tendency to concavity behind the humeri, which extend transversely outward from the middle of the border. In the impression from the natural mould the anterior border of the scapula appears to be rounded, but this may result from conditions of preservation.

A thin plate of bone, of which the outlines are imperfectly defined, extends laterally between the front of the scapula and the clavicle. It appears to be continuous with the inner lunate mass which rests on the 12th and 13th vertebræ, though it is not continuous with the anterior border of the scapula, but above it. It is obviously displaced, since the transverse process of the 10th vertebra extends

<sup>1</sup> Gürich, Zeitschr. d. Deutsch. geol. Gesellsch. vol. xxxvi. (1884) p. 125, pl. ii.



in front of it. Its external border appears to be straight and directed forward. It cannot be determined with certainty, and may be part of the scapula or the epiclavicle or clavicle; most likely the latter, for it is improbable that the epiclavicle has a separate existence as a large bone in *Mesosaurus*, seeing that no trace of it is known in European allies of the type. There is every reason to look for the epiclavicle in such a position in animals of this type, but no specimen shows it. In 1865<sup>1</sup> I suggested that the lateral plate of the Plesiosaurian scapula was the clavicle. This was corrected in 1874<sup>2</sup> by finding the clavicles in association with the interclavicle. Mr. Hulke suggested in 1883,<sup>3</sup> that the antero-internal part of the bone which articulates with the coracoid to form the glenoid cavity, is the precoracoid; and that the thin lateral ascending plate which extends above the head of the humerus is a part of the scapula. While the body of this bone both in *Plesiosaurus* and *Mesosaurus* appears to me to be the scapula, there is some evidence to suggest that the ascending plate of that bone in *Plesiosaurus* is the epiclavicle. There is no evidence of any such structure in *Mesosaurus*, though the bone identified as a clavicle in *Dactylosaurus* and in *Stereosternum* is in a not dissimilar position with regard to the head of the humerus.

After the eleventh vertebra, dorsal ribs are developed. Seventeen dorsal vertebræ thus characterized are more or less perfectly preserved. The bodies of the vertebræ increase a little in depth as they extend backward, owing to the transverse process being inclined rather more upward.

The attachment of the rib is by a transversely ovate facet, which is placed *below the zygapophysis on the anterior face of the neuropophysis*, so as to look forward and slightly outward and downward. I am not aware of a similar mode of attachment for ribs in any other animal. When the ribs are *in situ*, their proximal ends, which are compressed, have the appearance of being wedged into the interspaces between the ascending processes of the vertebræ. The articular faces of the contiguous centrums are seen between the twenty-second and twenty-third vertebræ. The centrum contracts a little to its articular ends, which are small and circular, and conically cupped as in the Kimberley specimens. The ribs are cylindrical, strongly curved in a bow, a little compressed proximally, truncate distally, and stout like the ribs of *Lariosaurus*. The first pair, partly covered by the shoulder-girdle, is short and conspicuously slender. The others are of approximately uniform size, the earlier measuring 2.5 centimetres in length, and in the middle of the specimen 3 centimetres; they are about 0.375 centimetre in diameter, but the antero-posterior width rather exceeds the thickness. The interspaces between the ribs are wider than the ribs. This specimen shows no trace of abdominal ribs, unless one or two hair-like rods at the distal end of the right humerus should be of that nature.

<sup>1</sup> Ann. & Mag. Nat. Hist. ser. 3, vol. xvi. p. 358, pl. xv.

<sup>2</sup> Quart. Journ. Geol. Soc. vol. xxx. p. 444.

<sup>3</sup> *Ibid.*, vol. xxxix. (Presid. Address), *Proc.* p. 46.



The anterior limbs are well preserved, and extended transversely. The measurement over them exceeds 15 centimetres, and each limb is  $6\frac{1}{4}$  centimetres long.

The humerus is 2.625 centimetres long. It has the form of the bone in *Pliosaurus*, being deep at the proximal end, elongated, nearly straight on the anterior border, and concave on the posterior border in consequence of the distal expansion. In no way except as a genus does it differ in form from the humerus of the Edentate mammal *Megalonyx*, where that bone has lost its terminal epiphyses, thus showing a new example of evolution in ossification which is associated with transition from one vertebrate type to another. The bone is  $\frac{1}{4}$  centimetre wide at the proximal end, and nearly 1 centimetre wide at the distal end. The anterior border is flattened proximally, but becomes compressed distally to a sharp edge; the posterior border is modified in the same way. The under side of the bone is concave in length. The distal end is truncated, slightly convex from front to back. Its inferior margin is slightly thickened, and its articular surface shows two concavities which correspond in position with the heads of the ulna and radius, though those bones on both sides appear to be separated from the humerus by an interval of about  $\frac{1}{8}$  centimetre. The bone has a comparatively large ent-epicondylar foramen which passes from the internal or posterior border obliquely downward and forward so as to open on the under side of the bone near to the posterior margin, above the ulnar articulation. It is vertically ovate and has not the narrow, elongate form figured by Gervais in the type of *Mesosaurus tenuidens*. This, with the slenderness of the humerus, supports the indication of the cervical ribs that the species may be distinct.

The ulna and radius are exceptionally slender in proportion to the size of the humerus. The radius is  $1\frac{3}{8}$  centimetre long, straight, slightly enlarged at both extremities, with the distal end compressed so as to carry a median ridge on the under side, which may make the distal end triangular.

The ulna is a little shorter. It is very slightly curved, the proximal end being a little developed on its radial side, where the two bones of the forearm are in contact. And distally there is a corresponding development towards the carpal element which is wedged between the radius and ulna so as to separate their distal ends. The posterior outline of the ulna is very slightly convex, and its radial border is concave. In slender form it is the counterpart of the radius. The transverse measurement over the proximal ends of the two bones as they lie together is  $\frac{1}{2}$  centimetre; the transverse measurement over the distal ends as they lie is  $\frac{3}{4}$  centimetre.

The carpus is remarkable for the large size and triangular arrangement of the three bones which form the proximal row, as compared with the small size and linear arrangement of the four bones in the distal row.

The proximal carpal, which alone gives attachment to the radius and ulna, may be regarded as the lunar bone. It is flattened, of irregular subquadrate outline, and has the border towards the



ulna thickened; it is in close contact with the other two bones which are placed distally. On the ulnar side there is a foramen between this bone and the element which is above the fifth digit, and separated from it by a cartilaginous interspace. On the radial side there is a close sutural union with the bone, beneath which are placed the four carpals of the distal row. There is an interspace, which was presumably occupied by cartilage, between the distal end of the radius and the carpal above the first digit. The bone on the ulnar side is obviously the cuneiform. But that on the radial side may be either the scaphoid or centrale. From its holding a corresponding position to the naviculare of the tarsus in relation to the bones of the distal row, there is some evidence in support of its identification as the centrale, in which case the scaphoid is unossified, but the evidence is insufficient to determine the point, especially as there is an interspace between the distal carpal bones and this element. If the bone were identified as the scaphoid it would approximate the carpus towards such a mammalian type as *Cheiromys*; and the resemblance would be not less interesting if the scaphoid were supposed to be unossified on the radial side, and the pisiform unossified on the ulnar side. In any case the condition is unlike that of Plesiosaurs, in which the carpal bones of the proximal row have a transverse linear arrangement. *Lariosaurus* is figured by Zittel with two bones in the proximal row and two in the distal row, but the carpus is imperfectly known in *Neusticosaurus* and unknown in *Anarosaurus*.

The distal row of the carpus in *Mesosaurus* consists of four bones,<sup>1</sup> arranged like the corresponding bones in a mammal. They are identified as trapezium, trapezoid magnum, and unciform. The first of these is the smallest, and the unciform is the largest.

The metacarpus consists of five divergent bones which vary in length. The first is strong and short,  $\frac{1}{2}$  centimetre long. The third, fourth, and fifth are about  $\frac{5}{8}$  centimetre long, and the fifth (which is most slender) is only a little longer than the first. The transverse measurement over the distal ends of the metacarpal bones is fully  $1\frac{3}{8}$  centimetre. The digits are moderately developed, the middle digit being the longest; and in every case the first phalange is the longest and strongest. The digits terminate in short conical claws. The number of phalangeal bones is 2·3·4·3+·3+. The fourth digit is imperfect; the fifth has three well-developed phalanges without a terminal claw, and a small ossification lies near its extremity which may represent the rudiment of a terminal phalange. The first digit, including the metatarsal, measures fully  $\frac{3}{4}$  centimetre, and the third measures  $1\frac{1}{4}$  centimetre in length.

There are obvious differences between this specimen and the type, but it is difficult to judge of their importance. In the Paris fossil the teeth appear to be more numerous, but in both they have

<sup>1</sup> Attention is subsequently drawn to the specimen of *Stereosternum* which may possibly show five bones in the distal row of the carpus.



an elongated slender cylindrical form. The cervical ribs in the Cape Town fossil are long and slender, and directed backward, close to the vertebræ; in the Paris specimen the cervical ribs have been figured with a considerable lateral expansion, which, however, is not present.<sup>1</sup> The shoulder-girdle is at first sight very dissimilar, but a mass of matrix appears to cover the hinder part of the coracoid plate in the Paris fossil and to hide the posterior emargination of the bone. The lateral pre-acetabular expansion seen in the Paris fossil is absent from the Cape Town specimen, but it may possibly be lost upon the upper slab. The humerus in the Paris specimen is more compressed distally and the foramen is longer. The evidence is insufficient to prove specific distinction.

#### § 4. THE MESOSAURUS IN THE ALBANY MUSEUM.

Another specimen of apparently the same genus, from near Burghersdorp, is contained in the Albany Museum at Grahamstown. It shows the dorsal aspect of dorsal vertebræ and ribs. The vertebræ are no wider than in the Cape Town fossil, but relatively longer. While in the latter seven vertebræ occupy a length of  $4\frac{1}{4}$  centimetres, in this only five vertebræ are contained in that length, but the vertebræ are less closely articulated. The ribs are fully  $\frac{1}{2}$  centimetre in diameter, so that the interspaces between them are only half as wide as the ribs. As they are preserved, inclined backward at an angle of  $45^\circ$ , they lie in close contact distally on the right side and overlap on the left side. They appear to be a little ovate in section, being wider than deep, so that this character is not peculiar to *Ditrochosaurus*. The proximal ends are compressed and recurved. They have a length of about  $4\frac{1}{4}$  centimetres; and the transverse measurement over the body as preserved is 7 centimetres. They lie in natural connexion with the vertebræ. On the left side of the sixth vertebra, the cast shows an impress as of a flat transverse process. Apparently the anterior edge of the rib is in close contact with the concave posterior margin of the process. The contact is as close as though this relation were articular.

Thirteen vertebræ are preserved in the cast, with indications of one more at each end, imperfectly preserved, and on the left side there are thirteen ribs in sequence. The vertebræ seen from above are transversely oblong. They are narrowest in front, widest in the middle, and narrow again posteriorly. The greatest transverse measurement is  $1\frac{1}{8}$  centimetre. The antero-posterior measurement increases a little from front to back, being less than  $\frac{3}{4}$  centimetre anteriorly, and more posteriorly. The neural spines are compressed from side to side, moderately elevated, higher than in the impression from the cast, stronger behind than in front, and stronger in the later than in the earlier vertebræ. On each side of the neural spine the surface is convex from front to back and concave from side to side,

<sup>1</sup> I am indebted to Prof. Gaudry for evidence that the cervical ribs in the type of *Mesosaurus tenuidens* are essentially the same as in this fossil. The tenth vertebra of the type appears to have ribs with two distinct articular surfaces, and such ribs may be present in the ninth vertebra.



being margined by a longitudinal ridge, chiefly developed above the posterior zygapophyses. In the anterior half of the vertebræ these ridges converge forward above the pre-zygapophyses. The lateral contour of the neural arch is concave in length. The pre-zygapophysial facets are horizontal, transversely ovate facets, above which the neural arch rises abruptly.<sup>1</sup>

The entire length of the fragment of this skeleton preserved is  $12\frac{1}{2}$  centimetres. I have no doubt that it indicates a new species, but there is no character available for its definition except the unsatisfactory one of relatively stout ribs.

#### § 5. THE RELATIONS OF MESOSAURUS WITH STEREOSTERNUM.

In 1886 Prof. Cope published his well-known description of *Stereosternum tumidum*.<sup>2</sup> He recognized the close general resemblance of that type to *Mesosaurus*; but since the Brazilian fossil which he figures represents the hinder half of the body, and the Paris specimen only shows the anterior half, no very close comparison could be made. The author observes, "As the dorsal vertebræ [of *Mesosaurus*] are obscured by matrix, the only point in which actual comparison can be made is the ribs. These are quite identical in the two types. . . The humerus is almost identical, and the carpus is nearly what one would expect to find in the Brazilian form." Shortly afterwards the British Museum acquired two skeletons of this animal from São Paulo, one of which is better preserved than that figured by Cope, in showing the entire dorsal region with the fore and hind limbs, as well as some indications of the shoulder-girdle, and important pelvic characters. Dr. Henry Woodward, F.R.S., had a cast taken from the better of the two slabs, and I studied the remains and found that comparison of the Kimberley and Brazilian specimens suggested the conclusion that *Stereosternum* was generically indistinguishable from *Mesosaurus*, unless the clavicular arch should be found to separate them. Mr. Lydekker, in his Catalogue of the Fossil Reptilia in the British Museum, Part ii. p. 302, referred the specimens to *Mesosaurus*, remarking that "there appear to be no characters by which *Stereosternum* can be specifically distinguished from the type-species [*Mesosaurus tenuidens*]." There are important regions of the skeleton which have not been compared, such as the pelvis, the shoulder-girdle, and the skull. The coracoid figured by Cope amply justifies specific separation, and makes generic distinction not improbable, though Mr. Lydekker would refer the coracoid to some other type of animal; but it has enough in common with the coracoid of *Mesosaurus* as now

<sup>1</sup> There are imperfectly preserved doubtful indications of transverse processes. In the Cape Town fossil these possible plates (if they are not division-planes in the matrix) are hidden beneath the ribs, but appear to be triangular and directed outward and backward for nearly half the length of the ribs. A similar appearance is seen in the Grahamstown specimen, where the transverse process appears to be broken. It is more slender than in the other example. These indications are imperfectly displayed, and better specimens must be obtained to show how far the indications may be relied upon.

<sup>2</sup> Proc. Am. Phil. Soc. vol. xxiii. p. 7.



known to indicate that it is a fragment of the coracoid of an allied genus, in which there was no squamous overlap of the bones. The British Museum examples of *Stereosternum* show that the cervical vertebræ are very short. They are exposed laterally. The centrum is badly preserved. The neural spine is long, thin, flat; with the anterior and posterior borders sub-parallel, slightly converging superiorly. The extremity of the spine is truncated. The neural spines are inclined backward, and increase in length towards the dorsal region. The neurapophyses are constricted from back to front, so as to cause the anterior angle to extend forward as a pre-zygapophysis, and there is a strong post-zygapophysis with a semi-circular excavation beneath it for the intervertebral nerve. There are six vertebræ preserved anterior to the humerus. In the Cape Town *Mesosaurus* these would extend forward to the middle of the cervical region.<sup>1</sup>

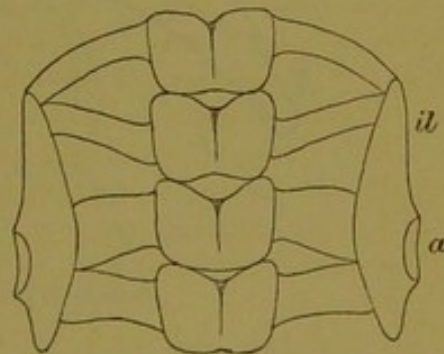
The measurement from the humerus to the femur is 13.5 centimetres, and in this length are twenty vertebræ. The transverse measurement over the middle of the dorsal ribs is 4.2 centimetres. There are twenty pre-sacral vertebræ which bear dorsal ribs. The early vertebræ of the dorsal series have the centrum short, measuring  $\frac{1}{2}$  centimetre. The under side of the centrum is wide anteriorly, convex from side to side, and less convex from back to front. In the specimen R. 537, twenty dorsal vertebræ measure 16.2 centimetres; that example is therefore somewhat larger. There are no lumbar vertebræ in *Stereosternum*.

The early dorsal ribs are slender proximally, and, enlarged, they are club-shaped distally. In R. 537 the ribs appear to be flatter, but this may be the effect of compression.

In the specimen R. 536 there are four sacral vertebræ characterized by their sacral ribs, supporting the ilium. Probably only the last two are rightly accounted sacral, and the anterior, which have the ribs converging outward, may be sacro-lumbar. There is no reason for believing that any of the sacral vertebræ are anchylosed. In Gürich's *Ditrochosaurus* from Hope Town the sacral vertebræ appear to be scattered. The width of the stronger transverse processes which are opposite the acetabulum in *Stereosternum* is about  $\frac{3}{4}$  centimetre.

The early caudal vertebræ of *Stereosternum* seen from above show the lateral notching behind the transverse processes, which defines the post-zygapophyses. The transverse processes of the caudal vertebræ

Fig. 2.—*Sacrum and ilium of Stereosternum.*



Restored.

*il*, ilium; *a*, acetabulum.

<sup>1</sup> Prof. Cope records nine cervical vertebræ besides the atlas, 'Am. Nat.' vol. xxi. p. 1109.



are somewhat similar to those in the Kimberley *Mesosaurus*, in which they decrease in length very rapidly and are thicker, so as to have a dissimilar aspect. Seventeen caudal vertebræ are preserved. In the first twelve the form is flattened, and they differ only by decreasing in size. In the later caudal vertebræ there may be a large intercentral ossicle, almost as large as the exposed part of the centrum. The chevron bones are attached to these ossifications.

This suggests that chevron bones are the transverse processes or caudal ribs of the intercentrum. The chevron bones are a little longer than the centrum, and lie parallel to its base.

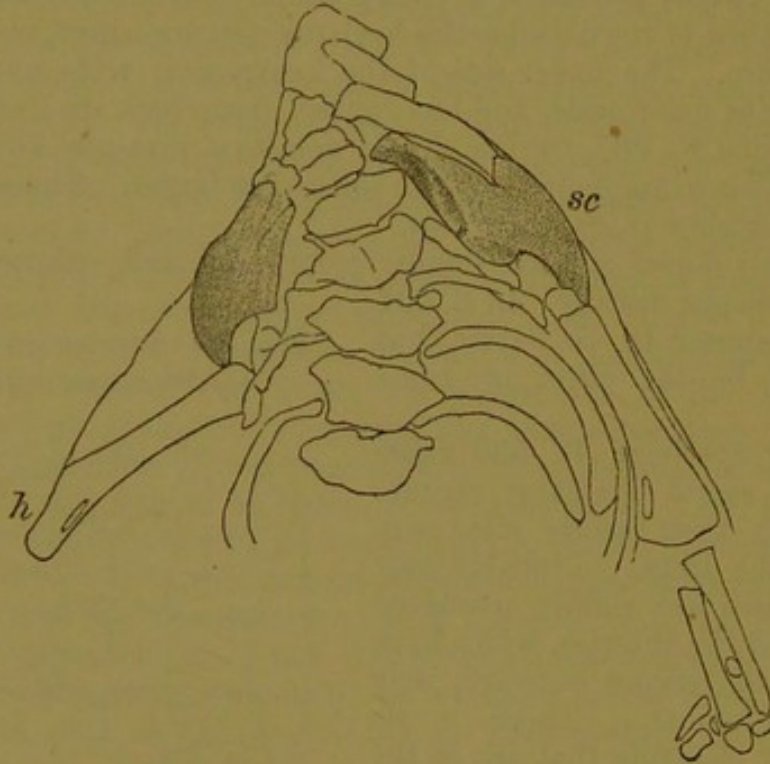
The shoulder-girdle is imperfectly preserved. The coracoid in

Fig. 3.—*Early caudal vertebra of Stereosternum.*



Natural size.

Fig. 4.—*Part of the shoulder-girdle of Stereosternum tumidum.*



Natural size.

*sc*, scapula; *h*, humerus.

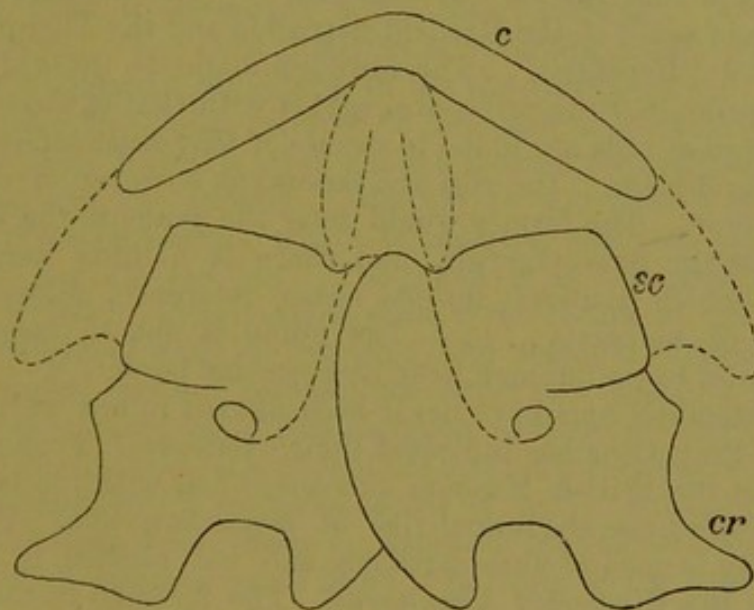
R. 537 is evidenced by an impression and some bone tissue, but its form is not defined. In R. 536, Brit. Mus., there are indications of a pair of wide, thin, crescentic bones in advance of the shoulder-girdle. In extending above the humeral articulation they correspond in position with the lateral plates of the Plesiosaurian scapula, and are of not dissimilar form. I cannot regard them as scapulæ because they do not enter into the glenoid cavity. Prof. Cope only records a



large coracoid, and a transverse element anterior to it which he regards as either clavicle or interclavicle.<sup>1</sup> I regard the bone as either the episcapula if it is blended with the scapula, or clavicle if it is a distinct element (as appears more probable).

If the transverse expansion seen in the Paris type of *Mesosaurus* is the same bone, its form is imperfect, but it is in the same position as the lateral crescentic bone of *Stereosternum*. There is nothing in the Cape Town *Mesosaurus* which corresponds in form with these bones in *Stereosternum*. And the shoulder-girdle in the two types seems to be unlike, because the coracoids in the Brazilian genus met (as shown by the thickened margin) in the median line, while in *Mesosaurus* there seems to have been a squamous overlap as in Monotreme Mammals, and as the coracoid cartilages overlap in *Triton* and *Salamandra*. This condition, so far as I am aware, is not otherwise suggested by remains of fossil reptiles. There is also a possible resemblance to Salamanders in the fact that the scapula and coracoid are not separable, though the Cape Town *Mesosaurus* appears to indicate a suture.

Fig. 5.—Restored outline of shoulder-girdle of *Mesosaurus*.



c, clavicles; sc, scapula; cr, coracoid.

The British Museum specimen of *Stereosternum* (R. 536) has the humerus 2.6 centimetres long. In R. 537 it is 3.6 centimetres long. It is very like the humerus of *Mesosaurus*. In all these types the bone would be separable only by generic characters from the humerus of the Edentate Mammal *Megalonyx*, if the epiphyses in that genus were removed. The ulna is  $1\frac{7}{8}$  centimetre long, and the radius a little shorter. The carpus is badly preserved. Prof. Cope states that it includes a radiale, a large intermedium, a small ulnare, a large centrale, and four distal carpals. The distal

<sup>1</sup> *Op. et loc. supra cit.*



row of the carpus is isolated in the British Museum specimen, but appears to include five small bones in linear series.

The femur is compressed in opposite directions at the two extremities, but the expansion in either direction is inconsiderable.

In the specimen R. 536 the tibia measures under 1·6 centimetre and the fibula over 1·8 centimetre long. Hence the bones of the hind limb are very little longer than those of the fore limb.

The Kimberley specimen of *Mesosaurus* has shown that in both genera the distal row of the tarsus includes five bones; but the fifth bone in *Mesosaurus* is a minute ossification compared with that in *Stereosternum*.

The presence of the fifth distal tarsal in *Stereosternum* induced Prof. George Baur to place the genus in a new order of reptiles under the name 'Proganosauria.' It seems to me probable that in most animals in which there are four distal tarsals the fourth is formed by blending of the fourth and fifth, since the fourth tarsal in them gives attachment to the fourth and fifth metatarsals. And if so, this tarsus is not necessarily so far removed from the mammalian type as might appear. Nor does the persistence of the fifth distal tarsal necessarily assume the importance assigned to it by Baur.

Prof. Cope remarks on *Stereosternum*:—"Its characters are only like those of some of the Urodele Batrachia and the Theromorphous [Anomodont] Reptilia. . . . The vertebræ might be those of a Theromorph reptile, and the pelvis also agrees with that of those animals. The abdominal rods are found in species of that order referred to the genus *Theropleura*. The ribs and tarsus are, however, of an entirely different type. The former would refer the genus to the Rhynchocephalia or the Sauropterygia, and there is nothing known in its structure which positively forbids either reference, unless it be the character of the pelvis. . . . The pubis is not so large as the ischium, and has a foramen near its posterior border."<sup>1</sup>

The abdominal rods have never been figured in any of the genera in which Prof. Cope has indicated their existence. They are dimly marked on the British Museum *Stereosternum*, with the same want of definition as the abdominal ribs of *Hyperodapedon*. They were presumably formed of fibro-cartilage, and not ossified in the same way as in the Kimberley *Mesosaurus*. The foramen in the pubis is interesting, as it approximates in position to the notch in the hinder border of the pubis, which characterizes Nothosaurians.

From the sum of the characters it may be legitimate to include the group within the Anomodontia. But it differs in some remarkable characters which appear to be of sub-ordinal value. The most important of these are the mode of articulation of the dorsal ribs, seen in *Mesosaurus*; the Edentate form of the larger limb-bones; and the structure of the shoulder-girdle. For this small group thus defined the name 'Mesosauria' would be convenient, because distinctive.

These African Sauromorpha closely resemble some genera from the Trias of Europe in general form and in characters of the humerus.

<sup>1</sup> Proc. Am. Phil. Soc. vol. xxiii. (1886) p. 9.



The most remarkable of these is *Neusticosaurus*. When describing that type<sup>1</sup> I inferred from the shoulder-girdle that it should be affiliated to the Nothosauria. Now, however, I believe<sup>2</sup> that too little importance was then given to the mode of attachment of the dorsal ribs. This character entirely separates *Neusticosaurus* from the Nothosauria, and approximates it to the Mesosauria. In all Nothosaurians the dorsal ribs are carried upon exceptionally stout transverse processes, which only differ from those of *Plesiosaurus* in being more massive and deeper; while in the Mesosauria there is no trace of this relation. In *Mesosaurus*, *Stereosternum*, and *Neusticosaurus* there is the same barrel-like contraction of the ends of each dorsal centrum, though this is but a family character. The articular faces of the centrum are conically cupped in the African and Brazilian types, but in *Neusticosaurus* this surface is flat, as in associated genera, although the neural arch is not ankylosed to the centrum. Indeed, the European Neusticosauridæ fall into a family which has the tail short and the neck long, and shows points of affinity to the Nothosauria; while the African Mesosauria have the neck short and the tail long, and show points of affinity to the Anomodontia. The Nothosauria are nearer in affinity to the Anomodontia than is consistent with their inclusion in the order Sauropterygia. The chief difficulty in recognizing this relation has been in the apparent differences of the shoulder-girdle.

In the shoulder-girdle referred to *Nothosaurus mirabilis* (Münster) figured by Von Meyer, a small notch is seen in the coracoid, between that bone and the scapula. Internal to the notch the coracoid develops a strong process which terminates abruptly forward in a transverse but oblique line. The notch is in the position of the foramen which in certain Anomodont types occurs at the junction of the precoracoid with the coracoid and scapula. Since an open angle stretches forward between the latter two bones, it is possible that it was occupied by a cartilaginous precoracoid during life, in contact with the internal border of the scapula and the anterior border of the coracoid, which have the aspect of being articular surfaces. Such a condition would make an approach towards the Anomodont type. But in *Neusticosaurus* there is no trace of the coracoid notch or foramen, and there are no internal articular surfaces in the scapular arch, like those seen in *Nothosaurus*.

The Lariosauridæ, according to Deecke,<sup>2</sup> have the vertebral characters of the Nothosauria. And although there is similarity in form in the humerus to that of the Mesosauria, there is no such entepicondylar foramen as characterizes the bone in the genera so grouped. It seems to be transitional between the Nothosauria and the Sauropterygia, and to have no near affinity with the Mesosauria, in so far as detailed comparison can be made. But the development of a sacrum of many vertebræ in *Lariosaurus*, as figured by Zittel,<sup>3</sup>

<sup>1</sup> Quart. Journ. Geol. Soc. vol. xxxviii. (1882) p. 350.

<sup>2</sup> Zeitschr. d. Deutsch. geol. Gesellsch. vol. xxxviii. (1886) p. 170.

<sup>3</sup> 'Handbuch der Palæontologie,' Bd. iii. p. 485.



makes a resemblance to *Stereosternum*. It is possible that the suborder Mesosauria may be enlarged hereafter, but at present it seems to me convenient to include in it two divisions, the Proganosauria of Baur and the Neusticosauria. These groups may be defined in the following classification:—

### § 6. CLASSIFICATION OF THE MESOSAURIA.

General Characters:—Palate closed in the median line. Teeth slender, prehensile. Cervical ribs with a single articulation. Dorsal ribs articulated to the anterior face of the neural arch. The shoulder-girdle formed of scapular and clavicular arches. Humerus expanded distally with an ent-epicondylar foramen. Digits terminating in claws.

#### Division I. Proganosauria.

Articular faces of centrum conically cupped. Coracoid and scapula ankylosed. A large clavicle [or separate episcapulæ]. A sacrum of four vertebræ. A foramen in the pubis. Five bones in the distal row of the tarsus. Neck short; tail long.

South Africa; South America.

#### Division II. Neusticosauria.

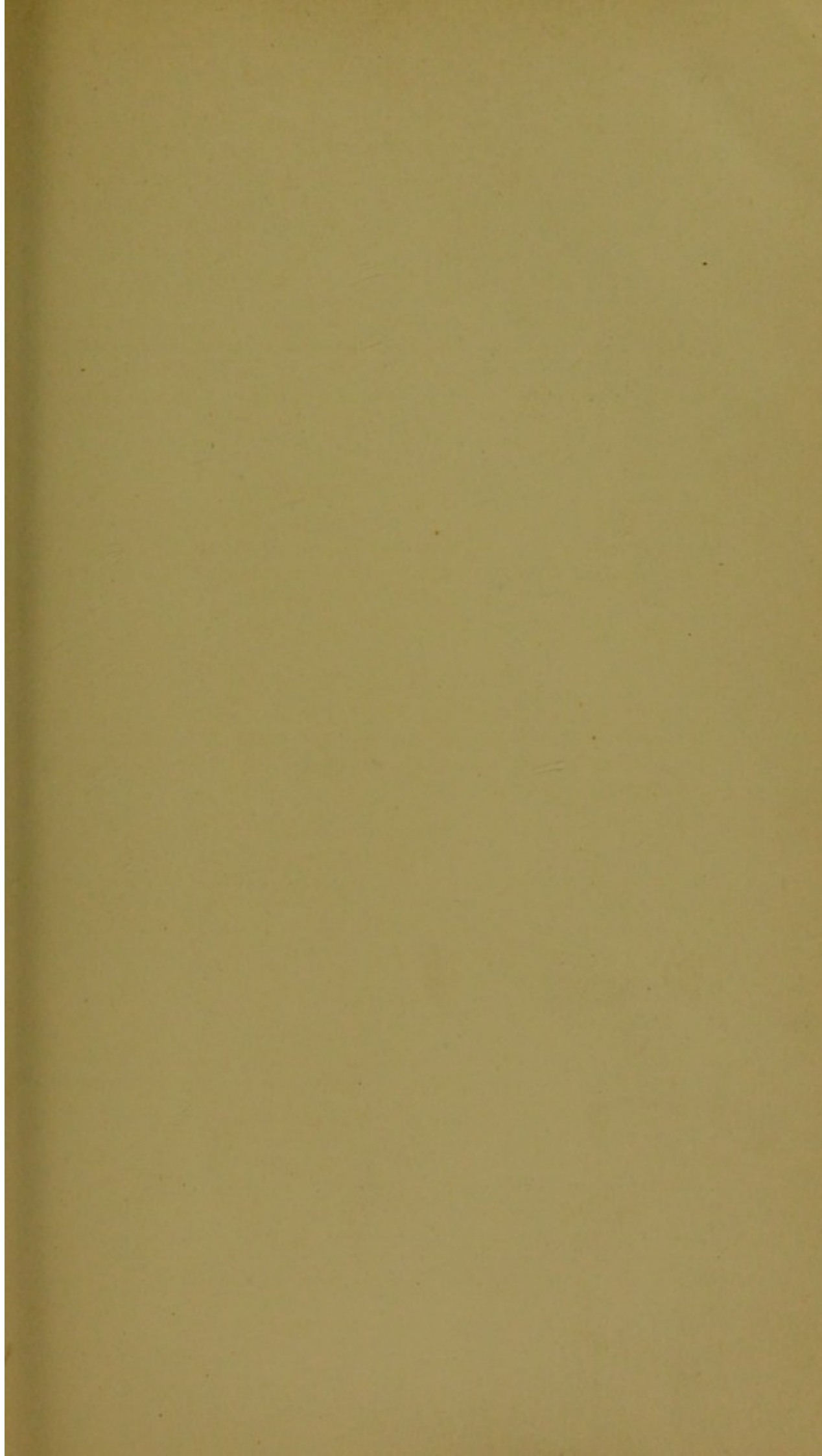
Articular faces of centrum flat. Coracoid and scapula separate. Clavicles relatively small [no separate episcapula]. Sacrum unknown. A notch instead of a foramen in the pubis. Neck long; tail short. Europe.

I wish in conclusion to express my thanks, for the loan of specimens and for facilities in making these observations, to the Trustees of the South African Museum, Cape Town; to the Committee of the Albany Museum, Grahamstown; to Dr. Henry Woodward, F.R.S., and the Officers of the Geological Department of the British Museum (Natural History); and to the Government Grant Committee of the Royal Society for assistance.

#### EXPLANATION OF PLATE XVIII.

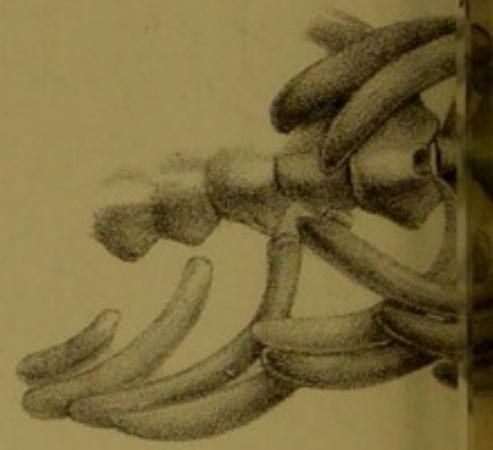
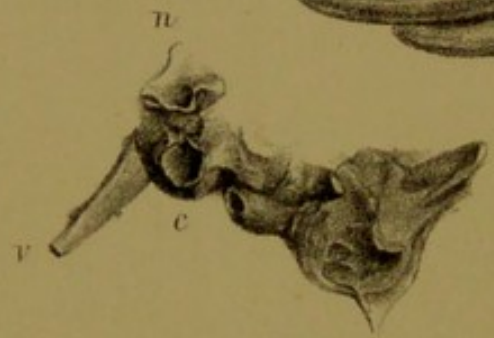
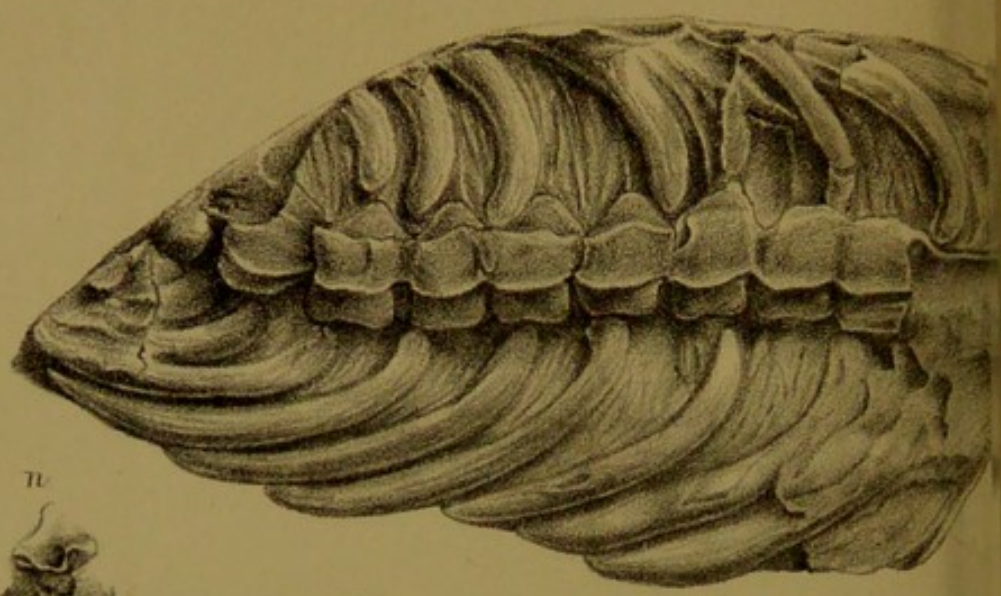
- Fig. 1. Dorsal aspect of dorsal vertebræ and ribs of *Mesosaurus pleurogaster* (Brit. Mus., Nat. Hist.); *n* = neural arch; *v* = transverse process; *c* = centrum.
2. Portion of ventral armour of the same specimen. †.
  3. Ventral aspect of a specimen showing abdominal ribs.
  4. Impressions of early caudal vertebræ; and hind foot of the same animal.
  5. Ventral aspect of the anterior part of the skeleton of *Mesosaurus tenuidens* (South Afr. Mus., Cape Town).



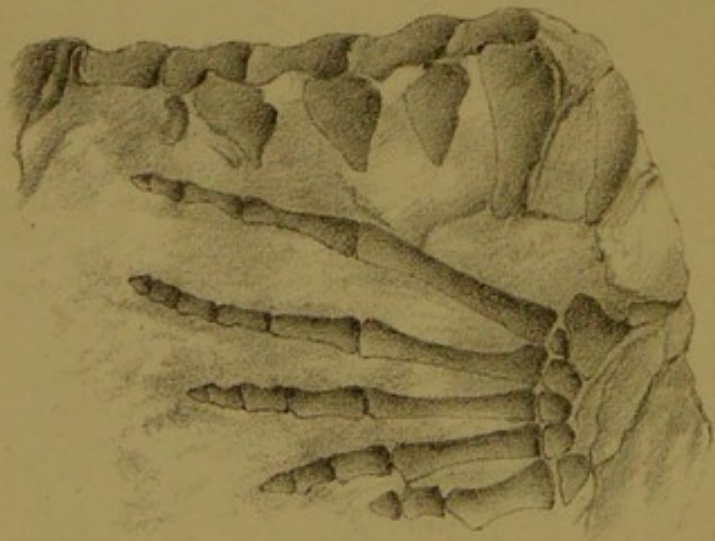




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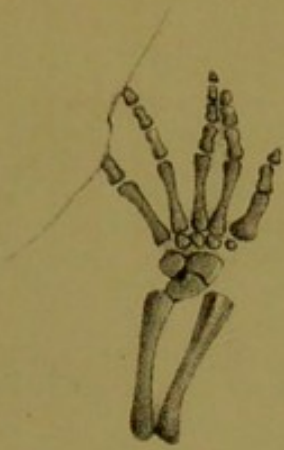


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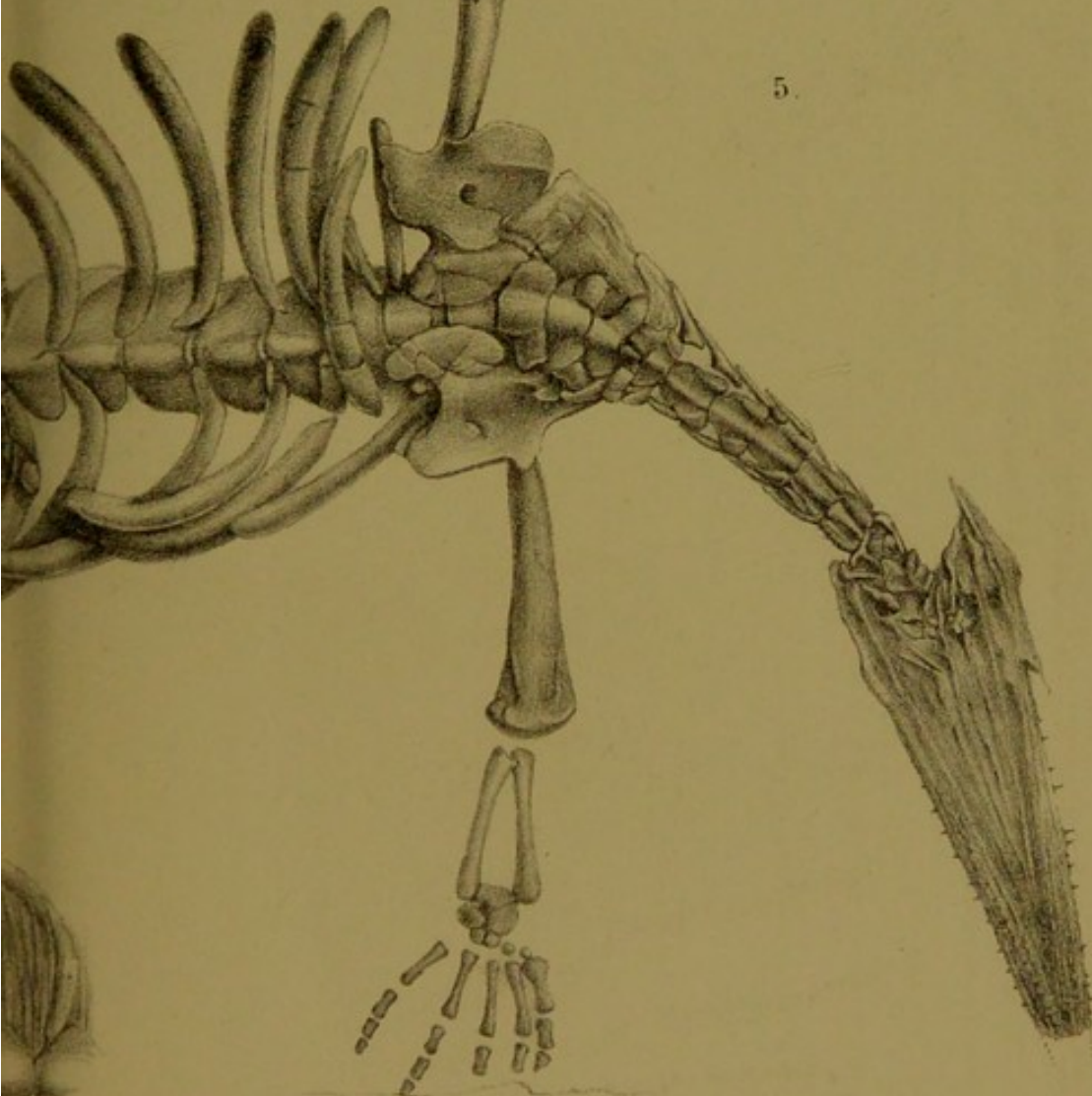




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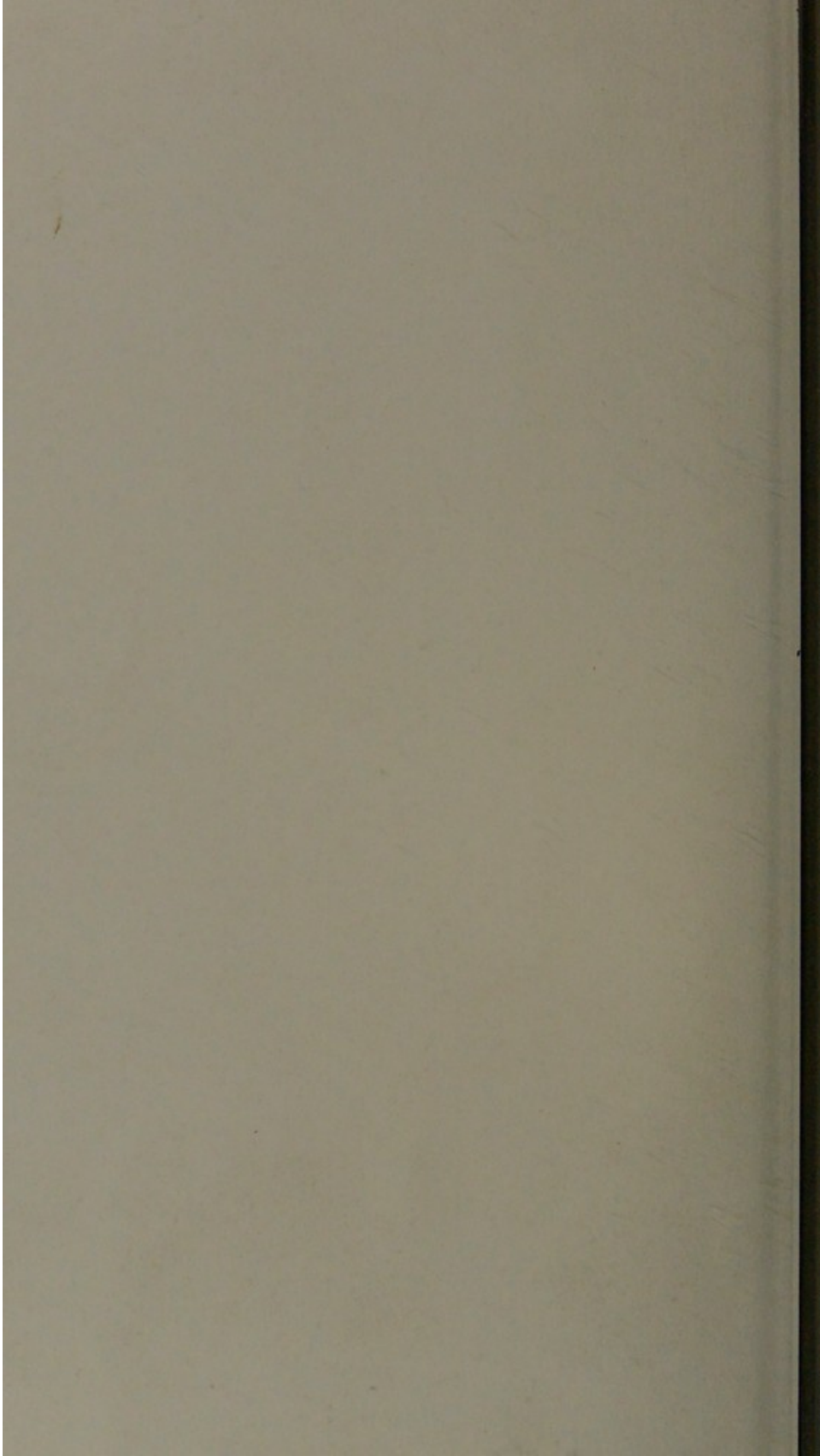
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