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Researches on the Structure, Organization, and Classification of the Fossil Reptilia. Part IX., Section 6. Associated Remains of Two Small Skeletons from Klipfontein, Fraserburg

H. G. Seeley

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III. *Researches on the Structure, Organization, and Classification of the Fossil Reptilia.*—Part IX., Section 6. *Associated Remains of two small Skeletons from Klipfontein, Fraserburg.*

By H. G. Seeley, *F.R.S.*

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In 1888, in the 'Phil. Trans.,' B, vol. 179, I described some parts of the skeleton of *Theriodesmus phylarchus*. Its geological horizon was then unknown. In the following year I visited the locality where it was found, at Klipfontein, near Fraserburg, in Cape Colony, on the summit of the volcanic series of rocks the escarpment of which forms the Neiuwveldt range. As the base of the Karroo rocks at Prince Albert is fully sixty miles south, and the same strata dip towards the north, over all that distance, with some minor undulations in the southern part of the area, while the elevation of the surface of the country augments northward, Klipfontein holds a high position in the deposits of Permian age which are comprised in the Karroo formation. I had the advantage of the company of the late Mr. Thomas Bain, who conducted me to the farm of two brothers, E. and O. Erasmus, where the *Theriodesmus* was collected. But after an interval of more than twelve years, the effects of atmospheric forces in breaking and removing the surface rocks made it impossible to discover additional remains of that animal. We carefully explored the banks and bed of a dried stream which drains into the Orange River, where I met with fragments of two species of the ganoid fish, *Atherstonia*, which have been regarded by Mr. A. Smith Woodward as new species, but found nothing resembling *Theriodesmus*.

Along that stream I found and collected fragments of two skeletons which appear to me to be referable to Theriodonts, though their position in the group is not certain. These fossils show the association of limb bones and vertebræ; and with them I found fragments of skulls, which may have belonged to the same animals; but the association should be made with caution, since it is unsafe to put together disconnected fragments of skeletons which may have been associated by transport, unless there is corroborative evidence that they belong to the same type of organization. These small animals in the character of the humerus are Marsupial in type. This character being associated with carnivorous dentition among existing animals, led me to anticipate the discovery of a skull showing canine teeth. Such dentition,

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though poorly preserved, I found near by, in the bed of the river, associated with the back of the skull.

A second fossil, found at some distance from the other remains, shows the middle part of the vertebral column, the fore-limb, femur, and some other bones. It indicates another genus, and although a second fragment of a skull was met with which appears to be different from the first example, I have preserved no record of its association with the second skeleton. This was the first time that any connected bones of a Theriodont reptile had been discovered in Africa (for my other types were found subsequently); and although fragmentary, the specimens are not unimportant in illustrating the relative dimensions of parts of the skeleton, and as showing that the limbs were short, as compared with existing Marsupials.

Theromus leptonotus. (Seeley.)

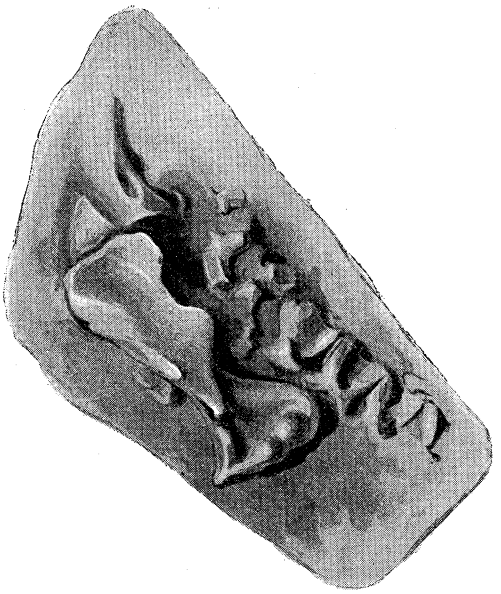
The Humerus and Vertebræ.

The first specimen shows in partial side exposure six early vertebræ, the left humerus, and a bone with which it articulates proximally, apparently the scapula. The humerus is exposed on its infero-anterior aspect. It is concave on the long triangular proximal portion, and concave from side to side, with the concavity deepest below the proximal articular surface. The proximal end is $\frac{1}{2}$ inch wide, transversely truncated, compressed on the external border to a sharp edge, below which the border of the deltoid or radial crest is emarginate, and then strongly developed as among Phalangers and animals of that type. There is a remarkable difference from such Mammals in the relatively greater width of the proximal end of the bone, in the limitation of the muscular ridge to its lateral border, and in the transverse width of the proximal articulation, which was evidently compressed from above downward, as shown by the proximal concavity, and was not hemispherical as in Mammals. The least transverse width of the shaft is below the termination of the radial crest where the bone is $\frac{2}{10}$ inch wide, at $\frac{8}{10}$ inch from the proximal end. The entire bone is fully $1\frac{4}{10}$ inch long. In its lower third it expands transversely, reaching its greatest width of nearly $\frac{7}{10}$ inch, just above the distal articulation.

The distal end of the bone follows the configuration of such Mammals as the Lion and the Phalangers. There is an ent-epi-condylar foramen, similarly placed to that of the Lion which is vertical, and that of the Marsupial which is horizontal. In this fossil it is horizontal; and the bridge which covers the foramen, is less than $\frac{1}{10}$ inch wide, and arched convexly, parallel to the inner margin of the bone, but so placed as not to cover it as in the Marsupials. This ridge prolonged distally inward, terminates in a small lateral tuberosity, below which the distal surface is concavely emarginate as among Marsupials, but the tuberosity is relatively smaller, being hardly more than $\frac{1}{10}$ inch in diameter. This diminution in size is brought about by diminished development of

this part of the bone distally. The distal articulation consists of two well-rounded hemispherical condyles placed close together (fig. 1), which have a transverse width of $\frac{7}{20}$ inch, and are directed downward. As among Marsupials, the outer condyle is somewhat the larger, but the concave channel which divides the condyles is much smaller, narrower, and has more the aspect of a median groove than among Mammals. Above the condyles, and especially the outer condyle, there is a distinct supra-condylar pit, or depression which helps to make the condyle much more prominent

Fig. 1.



Humerus, part of the scapular arch, and vertebræ of *Theromus leptonotus*.

and gives it a well-defined convexity, $\frac{2}{10}$ inch deep. External to the condyle is a compressed area which extends the distal end of the bone laterally outward. This is rather more evident in placental Carnivora, like the Lion, than among Marsupials, but in neither type is it anything like so strongly developed as in this humerus, where its width exceeds $\frac{2}{20}$ and is less than $\frac{3}{20}$ inch. Its lateral contour is convex in length, and its distal part appears to be a portion of the distal articulation. The lateral border of the bone is well rounded from above downward. It may be remarked that, as among Marsupials, the radial crest prolonged distally would be continuous with the bridge over the ent-epi-condylar foramen, so that the radial crest is lifted above this external distal margin, which shows no indication, as preserved, of the sharp lateral compression seen in marsupial Mammals. In proportion to the length of the bone, the ent-epi-condylar foramen is nearer to its distal end than in the South African reptiles hitherto known, but it is not so near to the distal extremity as in those Marsupials which the bone most resembles in form. In the humerus of a Phalanger $2\frac{6}{10}$ inches long, it is $\frac{7}{20}$ inch from the distal end; in this fossil $1\frac{4}{10}$ inch long, it is $\frac{4}{10}$ inch from the distal end.

No trace is preserved of the ulna and radius; but scattered carpal bones and phalanges are seen on both sides of the humerus. Two phalanges, adjacent to its inner proximal extremity, slightly obscure its margin. A strong bone belonging to the shoulder girdle is in articular contact with the proximal radial side of the head of the humerus. It is very imperfectly preserved, but appears to show a strong, thick, obliquely truncated articular surface; and there is a large ovate depression, piercing or penetrating the bone obliquely, which I have not previously seen in any example of a scapula in a South African fossil. The depression may be only a muscular or ligamentous attachment, since the corresponding position on the posterior margin of the scapula of *Cynognathus* appears to show a muscular tuberosity. But there appears to be a similar foramen in the scapula of *Ptychosiagum orientale*. The fragment of the scapula indicated is $\frac{8}{10}$ inch long and about $\frac{3}{10}$ inch thick.

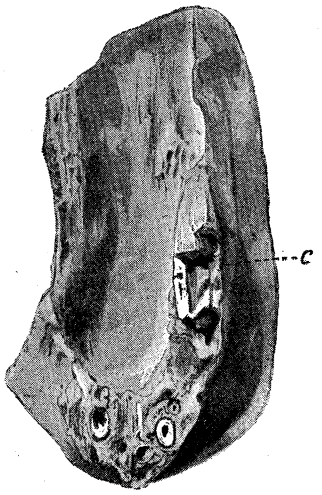
The vertebræ are exposed upon the left side, in sequence, though the first two are separated from the four which follow. Each vertebra is $\frac{3}{10}$ of an inch long. They are probably cervical. A transverse suture marks the close union of the neural arch with the centrum. The base of the centrum is not seen. The sides appear to approximate inferiorly; each is margined by a posterior border to the articular face of the centrum; which is prolonged upward to the base of the slight transverse process upon the neural arch. The anterior border is much thicker and forms the articulation for the rib, which consists of a vertically ovate part upon the centrum, which in the later vertebræ is prolonged obliquely upward and backward to the front of the slight transverse process, converging towards the hinder ridge, so as to define a triangular lateral area between the ridges and the base of the centrum. The apex of the triangle arches outward in a slight hood, beneath which there appear to be two small vascular foramina.

The anterior ridge is much the stronger, and in the last vertebra preserved it appears to be more obliquely inclined. In front of it the neural arch retreats inward and develops the pre-zygapophysis. There is no indication of a neural spine, but a nearly horizontal superior ridge, $\frac{9}{20}$ inch long, extends horizontally backward, and its posterior extremity forms the post-zygapophysis, which in succeeding vertebræ are observed to lie within the pre-zygapophyses, so that the articular facets look inward, and, apparently, there would be a vertical movement in this part of the column, which I regard as probably cervical. The lateral inter-vertebral foramen is large and about equally contributed to by both contiguous vertebræ. It is entirely in the neural arch. What I have termed the second vertebra has the neural arch slightly displaced from the centrum, and what I have termed the first vertebra appears to have a stouter neural arch with stronger posterior zygapophysial area, but no anterior zygapophyses. There is, however, a bone in front of that vertebra, which appears to be symmetrical and may be the arch of the atlas, indicating a very short vertebra like that seen in *Tropidostoma*.

The skull fragments next described are also from the dried bed of the stream, and were found on the same level, within a foot of the specimen just described. There is, therefore, a possibility that they belong to the same animal. They are in similar preservation, the bones being more or less dissolved away, so that the matrix remains as a mould.

The anterior part of a skull, very imperfectly preserved, indicates a depressed lanceolate snout, with the nares divided in the usual way and lateral, placed above the incisor teeth. Three incisor teeth are indicated on each side, the middle tooth being larger than the other two. A diastema succeeds, on the inner side of which, in an ovate vacuity, is the small summit of the mandibular canine, longitudinally ovate

Fig. 2.



Anterior fragment of a skull showing incisor (*i*), and canine teeth (*c*), possibly referable to *Theromus*.

in section, and not much larger than the base of the middle incisor. It shows no trace of cutting edges. The root of the maxillary canine is relatively large (fig. 2, *c*), compressed laterally, ovate in section, and extending obliquely upward and backward. It has a pulp-cavity; its base contracts; its extremity is not preserved.

The length of this anterior fragment of the snout is under $2\frac{1}{2}$ inches. The alveolar region beyond the canine is lost, and there is, therefore, no evidence of molar teeth. The roof bones of the snout appear to be flattened, rounding into maxillary bones at the sides, and there appears, on the right side, to be an indication of the pre-frontal bone at the posterior fracture. In advance of the canines the width does not appear to have exceeded $\frac{9}{10}$ inch, but the preservation is imperfect.

A posterior fragment of a skull shows the palate and base of the brain case by means of a natural mould, and above this, by a fracture, there is partial exposure of the roof of the skull, including the narrow frontal bones with the orbital cavity external and somewhat lateral, separated by post-frontal bones, which extend trans-

versely outward from the long, oblong temporal vacuity, which is bounded externally by the zygoma which is longitudinally parallel to the cranial wall.

The zygomatic cavity is about $\frac{1}{2}$ inch wide, and upwards of 1 inch long, since it extends backward with the squamosal bones, beyond the back of the supra-occipital region. The transverse measurement of the brain-case behind the post-frontal bars is about $\frac{7}{10}$ inch, and, as the sides of the brain-case are slightly concave, it widens a little behind. There is no trace of a median crest, though there may be a slight median depression posteriorly. The surface is gently rounded from side to side. In this character it is unlike known Theriodonts. The back of the skull is concave transversely, and, although the occipital plate is not exposed, it was manifestly inclined and concave, as in Cynodont Theriodontia.

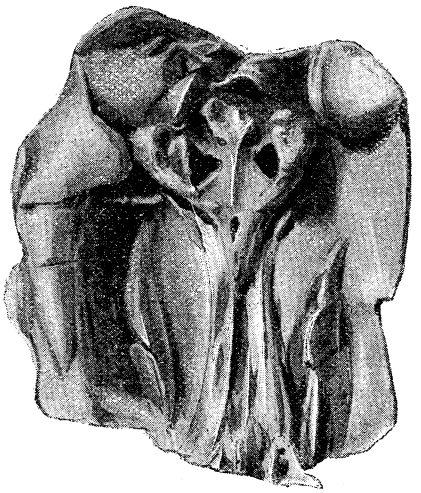
The palatal aspect of the skull is only intelligible from an impression. It shows the zygomatic arch of the right side on its superior surface, and the posterior extremity of the zygoma on the left side (fig. 3). This superior surface is flattened, rather more horizontal than vertical, and expands posteriorly as it approaches the back of the skull, terminating almost on a level with the base of the brain-case. It appears to be formed by the squamosal bone, which, on the inner side, is in contact with another bone, regarded as the postfrontal. The malar bone is inferred to have been external and inferior, but is not seen. The transverse width of the zygoma is about $\frac{2}{10}$ inch in front, augmenting as it extends backward. Its hinder termination is saddle-shaped, and its position is so low as to preclude the possibility of any descending pedicle having existed in the articular region for the lower jaw.

Between the posterior lateral expansions of the squamosal bones is an impression of the base of the brain-case, including the lateral wall of the brain-case on the right side, and the bones on which the brain rested between the auditory walls. From this it is manifest that the brain-case is not closed in front, but that there is a slight ridge in the median line, and lateral anterior ridges which converge forward in the pre-sphenoid region. This region is vertically perforated, presumably by the carotid canal, in front of which a triangular mass of the sphenoid appears to terminate in a sharp ridge. The sphenoid is flanked laterally by the pterygoids. Those bones send slender processes backward towards the articular region of the skull. These posterior processes are behind the carotid canal, and parallel to the lateral sphenoidal wall. Anteriorly, what I regard as the pterygoids are parallel to each other, widening a little as they extend forward, and there is a longitudinal median concavity, or vacuity, between them in advance of the extremity of the sphenoid. Where this vacuity ends in front there appear to be indications of a suture, but it is uncertain whether the widened mass which now unites in the median line, and which ascends towards the pre-frontal region, is the palatine bone, or whether the transverse bone is also included. There is no evidence from the nature of the case of inferior descending processes of these bones, such as characterize the Theriodontia, and it is manifest that there is no development of a pre-sphenoid keel below and above the pterygoid bones, as in

typical Theriodonts, so that the specimen manifestly differs from the known representatives of that group, and apparently possesses a palate which approaches more nearly to the Dicynodont type.

On each side of the pterygoid region of the palate, about midway between it and the zygoma, a portion of the lower jaw is preserved on each side. It appears to be composite, the dentary bone lying in front, and showing a shallow groove on its superior border on the right side. Its inner side is overlapped by a distinct bone, which does not appear to form the inner side of the groove, which I suppose to be the only representative of a coronoid process, which is developed and is therefore probably formed by the dentary bone. On the right side, the articulation of the lower jaw appears to be imperfectly preserved. The impression is remarkable for its transverse width, and for being at a higher level than the adjacent part of the lower jaw.

Fig. 3.



Showing the base of the brain-case, the hinder part of the palate bones, the zygoma, and mandible of a small animal, possibly referable to *Theromus*. Natural size.

If the base of this skull belongs to the same individual as the snout, it shows the skull to be nearly $4\frac{1}{2}$ inches long.

Herpetochirus brachycnemus (Seeley).

A small slab of hard grey sandstone which I found on the west bank of the dried-up river-bed at Klipfontein, shows a portion of a small skeleton, without evidence of the skull, which I infer to be Theriodont from the forms of the larger limb-bones. The remains preserved comprised impressions of fourteen dorsal vertebræ which extend in a curve, with the ribs on both sides; all the bones of the fore-limb, though some of the bones of the carpus are badly defined, and the phalanges are not preserved in all the digits; and there are impressions of the femur and a small ilium (?),

which are displaced from natural continuity with the vertebral column. The value of the specimen is in the evidence it gives concerning the ribs, and the proportions of the limb-bones as compared with each other, and with the length of the vertebræ. The remains indicate a small animal with somewhat slender limbs.

The Vertebræ (fig. 4).

Fourteen dorsal vertebræ are indicated in the longitudinal fracture through the remains, arranged in a curve which measures $5\frac{1}{4}$ inches in length, and 4 inches between its extremities. In front, the centrums only show the basal impression; but further back they are exposed laterally. Each slightly exceeds $\frac{3}{10}$ inch in length. The fracture having passed through the middle of the centrum in the middle region, its articular ends are shown to be deeply excavated by concavities, which are as well developed as in most fishes, being only separated from each other by a very slight median partition. Something like this condition has been indicated by Sir Richard Owen in his section of the cervical vertebræ of *Anthodon;* but in no other specimen am I aware of these notochordal concavities being relatively so large, or such perfect cones. Only a few vertebræ show the external surface. In front, the base of the centrum is somewhat flattened, but rounded from side to side; in which direction it is moderately compressed. The lateral view of the centrum in the hinder vertebræ is concave in length, and the centrum appears to be deeper than wide and quite free from longitudinal ridges, having the centrum rather longer and deeper than in Plesiosaurs. The anterior and posterior borders are somewhat thickened laterally; the anterior border is possibly the more prominent. The neuro-central suture is not distinctly defined, but the centrum appears to be pinched in below the base of the neural arch which is very imperfectly indicated, though the neural spine is short, compressed, triangular, and inclined backward. The transverse processes appear to be small, but are not clearly defined. There is no distinct indication of a capitular articulation for the ribs, and as most of the ribs show large, deep undivided heads, it appears probable that the capitular articulation was on the inter-central margin.

From the character of the convex, superior, proximal ends of the ribs, it appears probable that the tubercular articulation was upon the under side of such transverse processes as existed. Several ribs appear to be in contact with the hinder border of the parts of the neural arches which are preserved. The greatest depth of a centrum is about $\frac{3}{10}$ inch, while the width of its base in the middle hardly exceeds $\frac{1}{10}$ inch.

The ribs are well developed, they extend in advance of the impressions of the vertebræ and appear to indicate seven or eight vertebræ at least more than are preserved. No indications of ribs are shown in the last vertebra, though there appears to be a rib attachment at the base of the last but one, which, as preserved, resembles a chevron bone. Hence I infer that the number of dorsal vertebræ indicated by ribs

well developed exceeded twenty, without any indication that the series is complete. All these ribs are of uniform character, long, slender, becoming smaller towards the extremities, longitudinally grooved in the lower part, and not terminating in points but in thin narrow blades. The longest anterior ribs measure 2 inches between their extremities, and $2\frac{6}{10}$ inches round the curve, so that those ribs are fully eight times as long as the centrum. The articular head is truncated in a slightly oblique way, as though the ribs were directed at first outward rather than downward. The head is $\frac{2}{10}$ inch deep, but not so wide. Its articular margin is elevated, and external to the articular margin there is often on the superior border a slight notch or concavity.

The Anterior Limb (Fig. 4).

The bones of the left fore-limb are exposed on their superior aspect. The humerus is a moderately stout bone, stouter than in small Mammals of similar size. It is nearly $1\frac{6}{10}$ inch long, with the proximal end $\frac{6}{10}$ inch wide, as exposed, and the shaft contracts below the middle to little more than $\frac{2}{10}$ inch, and the distal end again widens to $\frac{3}{4}$ inch, and, as in Mammals, the expansion is rather greater on the inner border than on the external border. The distal end is not quite in the same plane with the proximal end, being rotated a little downward on the inner side. The epi-condylar foramen is not seen, because the bridge which defines it in Theriodonts is so placed as not to be visible on the superior aspect of the humerus.

The head of the bone has the transverse form which characterizes the humerus in *Ornithocheirus* and other Ornithosaurs, being wider than deep and somewhat crescentic in width. It is well inflated and is more like the articular surface in a Monotreme than that in a placental Mammal, though the rest of the bone rather resembles the marsupial type. On the inner side there is a compressed muscular ridge, rather more developed than in Mammals, rather thicker at its proximal end than in Marsupials, with a slight reflection upward. It is this ridge which gives its width to the proximal end of the bone. There is a slight ridge on the external proximal border of the articulation. Below the articulation the shaft may be regarded as contracting towards its external basal border. It is compressed from above downward, slightly concave in length, slightly convex transversely, with the convexity increasing towards the external border as the shaft narrows in transverse diameter. The distal half of the bone is somewhat concave tranversely owing to a wide, shallow impression of the surface which affects the inner half of the distal end above the articular surface. Both lateral borders of the bone are concave. The external border is somewhat thickened and rounded, in harmony with the convexity of the external side of the shaft. The inner margin is less perfectly exposed but appears to be more compressed. The distal end appears to consist of a median articular portion about $\frac{1}{4}$ inch wide which is convex from above downward, concave from side to side, well rounded into a small pulley, with the trochlear surface sharply defined superiorly by a small impression in

the bone which, however, is less developed than the olecranon pit in the humerus of Phalangers, but is otherwise suggestive of the marsupial type. The extension of the distal end of the bone on the inner side of the articulation exceeds its extension on the external side, but the inner side shows no indication of the tuberosity commonly seen in Mammals, while the external border, which is transversely convex, is more

Fig. 4.

Part of the vertebral column, ribs, fore-limb, and femur of *Herpetochirus brachycnemus*.

developed than in Mammals which may be compared in form of the bone. Both these margins are produced distally quite as far as the borders of the distal articulation. This humerus is but very slightly larger than the specimen or *Theromus*, already described from this locality, but the absence of the tuberosity on its inner border

and the convexly rounded contour of that border appear to indicate that the specimens are referable to distinct genera.

Radius and Ulna.

The bones of the forearm are slightly displaced, the radius, which is the stronger bone, being separated at its proximal end from the slender ulna, which is thrown backward, and it appears to extend further proximally than is manifest. There is no clear indication of an olecranon process to the ulna, though it appears to be partly hidden in the matrix. The radius is 1 inch in length, expanded at both extremities, which are truncated. The shaft is rounded; it contracts evenly to its middle region, as in *Pareiasaurus* and *Theriodesmus*. The distal end, which is about $\frac{1}{20}$ inch wider than the proximal end, is more than $\frac{1}{4}$ inch in width. It becomes slightly angular on the distal end, but the angle is rounded, and there is a trifling contraction to the distal articulation with the large proximal carpal bone. The ulna is slender, and no stouter than a rib; the preservation does not show its complete proximal or distal extremity, though the proximal end indicates a small articulation, which appears to be transversely truncated proximally. The shaft of the bone towards the distal end has the aspect of being triangular.

Carpus.

The carpus is imperfectly displayed; there is one large bone below the radius, which corresponds with it in size, and has much the same general aspect as the proximal carpal bone in *Pareiasaurus*. This is one of the characters which appears to be distinctive of these animals. This carpal bone is convex transversely, with a sharp superior margin, and a less well-defined inferior margin; is more than $\frac{3}{20}$ inch deep and $\frac{5}{20}$ inch wide. There is a smaller bone on its outer side, which corresponds to the distal end of the ulna, but the specimen does not show with certainty any trace of a third bone in the proximal row of the carpus. Beneath the ulnar carpal is a bone with a convex surface, which may be regarded as a central bone. Of the distal carpals only two are indicated with certainty: one below the radial carpal, which is the larger, and the other below the central bone. But this is possibly attributable to the disturbed state of preservation of the bones, since the carpus is not so wide as the metacarpus.

The Foot.

Only four metacarpals are clearly exposed; they are stout, about $\frac{3}{10}$ inch long, expanded at the articular ends, which appear to slightly overlap each other proximally, and are without distinct trochlear distal ends. The first metacarpal appears to be shorter and stouter than the others, and to give attachment to not fewer than three phalanges. The other digits are slightly displaced, and only two are preserved. There

are three phalanges in each of these, the bones being constricted in the middle, moderately long, with a long terminal claw phalange, which is compressed to a sharp ridge. The length of the three phalanges, as preserved, is about $\frac{1}{2}$ inch, the first being longer than the second and the third longer than the first. This evidence of the structure of the foot is incomplete.

Midway between the proximal end of the humerus and the proximal end of the femur, in almost equally close contiguity to both bones, is an imperfect impression, which might correspond very well in form with the ilium, but which I am rather disposed to believe to be part of the shoulder-girdle indicating the coracoid and part of the pre-coracoid bones. The impression is comparatively flat, with a portion of an acetabular surface, opposite which the bone is $\frac{4}{10}$ inch deep. Its length, or antero-posterior extent, is $\frac{17}{20}$ inch. On the hypothesis that it is part of the shoulder-girdle, the scapula is lost, and a slight transverse ridge indicates the suture with the pre-coracoid in front. The acetabular border of what would then be the coracoid is thickened, and in advance of its sharp margin the slab appears to show indications of a coracoid foramen passing towards the scapula and just below the supposed line of transverse suture. The posterior margin is thickened and concave. The inner margin, which would correspond to the superior crest of an ilium, has the aspect of being cartilaginous and slightly convex, so that it terminates in a point posteriorly, and decreases in width or depth after its supposed junction with the pre-coracoid. The specimen is as likely to be an ilium exposed on the internal aspect; the vertical ridges seen in the ilium of *Cynognathus* parallel the condition of this specimen. There are imperfect impressions of part of a thin plate adjoining this fossil impression, but too imperfect for determination, though it resembles the inter-clavicle and clavicle.

The Femur (fig. 4).

The right femur is exposed so as to show its internal aspect. It is $1\frac{9}{20}$ inch long. The articular head is hemispherical, about $\frac{3}{20}$ inch deep as exposed. The bone then contracts to a short neck, about as long as the head of the bone is deep. This neck may be compared with that in the femur of *Tribolodon*. The neck descends obliquely, and is limited by a slight vertical ridge which descends the shaft. This appears to be the characteristic ridge on the inner side of the proximal end of the femur, which is seen in the Gomphodont and Cynodont Theriodontia, which I regard as homologous with the similarly placed ridge in Megalosauria and other Saurischia, and as corresponding to the trochanter minor in Mammals. The ridge itself is very slightly developed in this fossil, and descends longitudinally on the inner side of the shaft; but external to it and behind it the bone expands transversely in a lamellar plate-like trochanter minor, so as to measure $\frac{8}{10}$ inch from the articular ball to the posterior margin. It may be compared with the internal aspect of the femur of *Tribolodon*, § 5, fig. 33. As preserved, the bone retreats on its superior

contour, descending obliquely in a line with the superior contour of the neck; distal to this border there is a posterior truncated margin, which connects the superior contour, about $\frac{1}{2}$ inch long, with the inferior concave contour of the shaft, which measures about $\frac{17}{20}$ inch in a straight line to the distal articulation. This posterior inferior surface is smooth and gently concave both from side to side and from above downward, and more than $\frac{7}{20}$ inch wide where the posterior emargination excavates it. The expansion of this plate gives the bone the aspect of being twisted so that its head is directed forward instead of inward in the way which is usual in Mammals and Birds, thus making a nearer approximation to the conditions in Ornithosaurs and Saurischian reptiles, which the fossil further appears to resemble in having the head and neck of the bone produced proximally beyond the compressed proximal termination of the shaft, as in *Ornithocheirus nasutus* ('Ornithosauria,' 1870, plate 8, figs. 5, 6). In that and other Cretaceous Ornithosaurs there is a posterior truncation, such as this femur shows at its proximal end, only it is smaller, but the articular head is dissimilar in form. The shaft contracts to a width of little more than $\frac{1}{10}$ inch from front to back below the middle, and then it expands transversely, developing a strong rounded border which is concave from above downward on the inner side. This border stops short above the articulation, where the bone appears to become compressed a little on the anterior border.

The posterior side of the distal end shows a well-rounded trochlear surface which is imperfectly exposed, $\frac{2}{10}$ inch deep, and thickens the distal end to more than $\frac{2}{10}$ inch, and by its backward development gives the bone a somewhat sigmoid curve in its lateral exposure. Although the femur in Plesiosaurs is never specialized in the ways which characterize these fossils, it also often has a slight sigmoid curvature when seen laterally, and the character is in harmony with many resemblances in the skull and skeleton between Theriodonts and Plesiosaurs.

Not far from the position where this skeleton was found I met with a fragment of jaw, which there is no reason for supposing to belong to the same individual. It is too imperfect for description, and in a matrix which is too hard for development of the specimen. Anteriorly on the right side there is indication of the base of a single large incisor tooth and a part of the socket of the corresponding incisor seen on the opposite side. In advance of this on the left side, the bases of two, or possibly three incisors appear to be indicated, but they are upon the margin of the jaw, whereas the large incisor which is cylindrical diverges outward from near the middle line of the palate. Behind this tooth on the right side is a portion of the large canine, which is about $\frac{4}{10}$ inch wide. There is no trace of teeth behind the canine. The fragment has some appearance of being coprolitic, since small fragments of bone are included in the earthy mass which is continuous with it.

The two animals now described make known connected parts of the skeleton and differ in notable ways from all other Theriodonts. There is, unfortunately, no

absolute association of the skull fragments with the limb-bones and vertebræ. In *Theromus* there is probability of association, but the skull, while possessing incisor and canine teeth, is so unlike the Lycosaurian type of skull as to give probability to the suggestion that other types of Theriodonts with distinctive structures may occur in those rocks. The maxillary dentition being unknown, there is no proof that the type is Lycosaurian. The humerus has a very thin and expanded radial crest, which is inclined at an angle of 45° to the distal end of the bone, and is much more developed than in any Marsupial, but if the crest were absorbed, and the proximal articulation deepened so as to become hemispherical, there would be very little to separate the humerus from that of a marsupial Mammal. It is the mammalian character of the humerus, especially as seen in its distal end, upon which the genus *Theromus* is founded. The vertebræ appear to be as distinct as the limb-bone from those of *Herpetocheirus*.

The humerus of *Herpetocheirus* shows no trace of the distal tuberosity on the inner side. Its distal end is relatively more expanded, and its proximal end does not appear to be so convex. It is very similar in size. The interest of *Herpetocheirus* is chiefly in the fore-limbs. The large size of the radius and small size of the ulna is a remarkable distinctive character. The ulna is displaced downward, and its distal termination appears to be brought on to a level with the inner side of the principal carpal, though there is no proof that the distinct ossification in that position is the ulna, other than that the length of the radius would require the ulna to end there, if both bones were of the same length. There is on the radial side a distinct bone between the proximal carpal, which is under the radius, and the distal carpal, which is above the first and second metacarpal bones. There is no question but that a central bone exists upon the radial side, but the carpus is not sufficiently preserved to show more details of its structure than have been described. The small size of the ulna, partly imbedded in matrix, does not imply the absence of an olecranon process, such as is seen in *Theriodesmus* and *Pareiasaurus*, which would be remarkable in view of the well-rounded trochlear articulation of which the humerus gives evidence on its superior aspect. There is some indication that the olecranon is preserved. The extraordinary length of the ribs and their slenderness are a character which has not hitherto been evidenced in an Anomodont.

Fig. 1

umerus, part of the scapular arch, and vertebræ of *Theromus leptonotus*.

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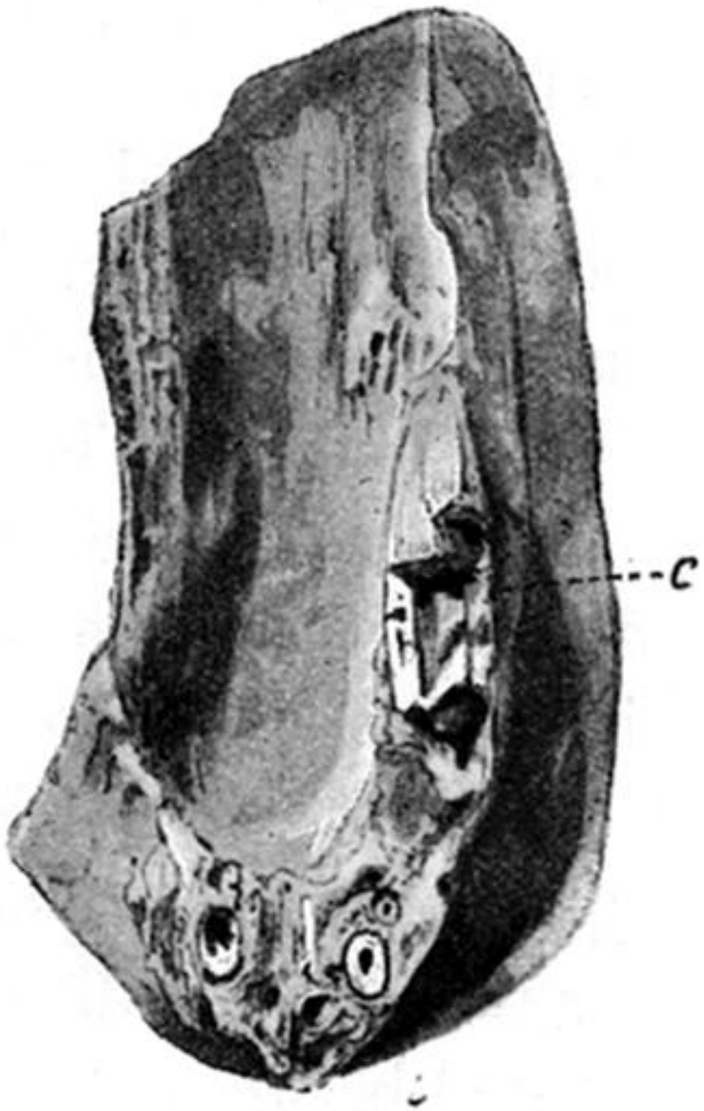
Fig. 2.



nterior fragment of a skull showing incisor (*i*), and canine teeth (*c*), possibly referable to *Theromus*.

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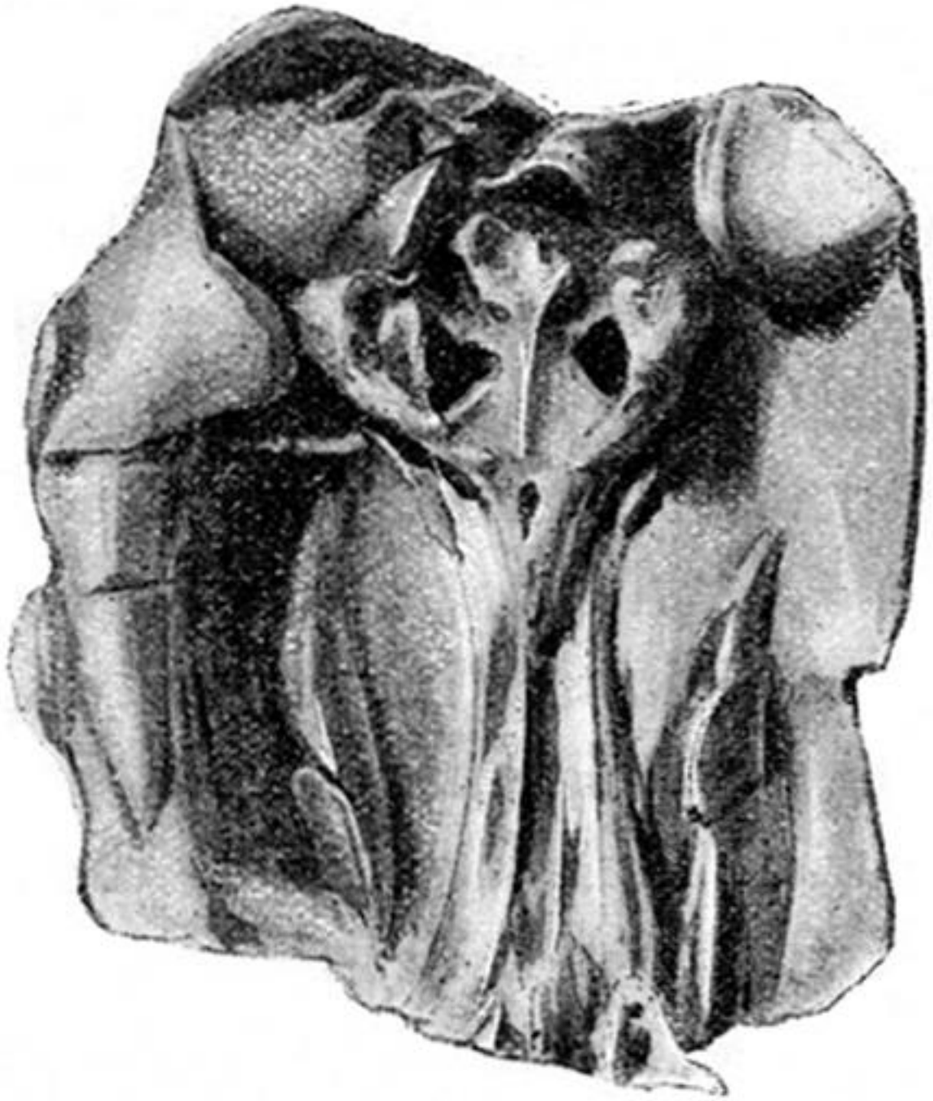
Fig. 3.



howing the base of the brain-case, the hinder part of the palate bones, the zygoma, and mandible of a small animal, possibly referable to *Theromus*. Natural size.

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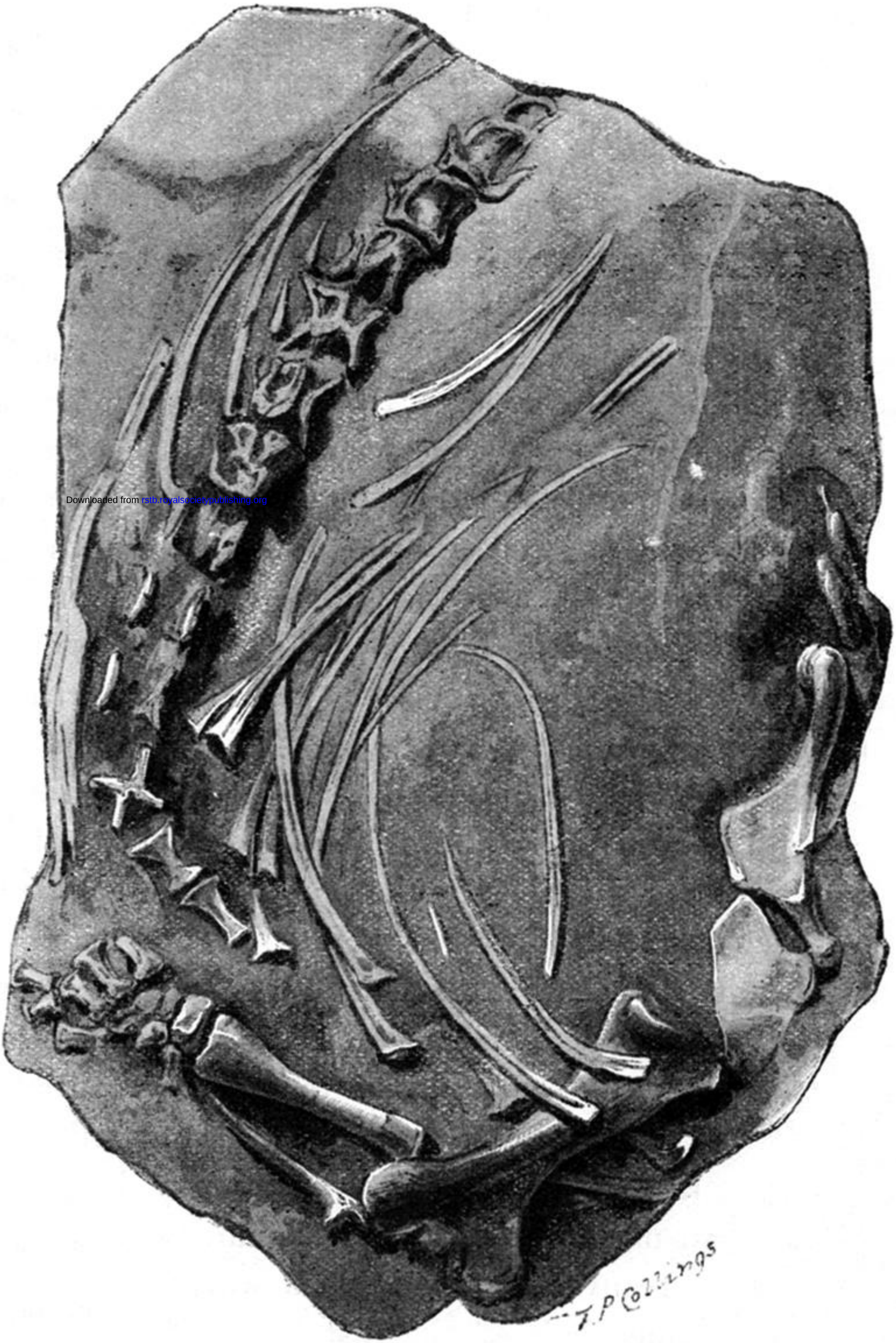
Fig. 4.



art of the vertebral column, ribs, fore-limb, and femur of *Herpetochirus brachycnemus*.