42. *The* Reptile Fauna *of the* Gosau formation *preserved in the* Geological Museum *of the* University *of* Vienna. By Prof. H. G. Seeley, F.R.S., F.G.S., &c., Professor of Geography in King's College, London. *With a* Note *on the* Geological Horizon *of the* Fossils *at* Neue Welt, *west of* Wiener Neustadt, by Edw. Suess, Ph.D., F.M.G.S., &c., Professor of Geology in the University of Vienna, &c. (Read June 8, 1881.)

[Plates XXVII.–XXXI.]

Contents.

Introduction.

Historical Review.

The Gosau formation, nearly corresponding in age to the Upper Greensand of this country, is represented at Neue Welt, near Wiener Neustadt, by freshwater deposits full of such freshwater shells as *Melania* and *Unio*, and land-plants such as *Banksia* and *Pecopteris*. The formation and its fauna have been described by Profs. Suess, Zittel, and many others; but, although the late Dr. Stoliczka detected a tooth imbedded in the coal of the formation, no important knowledge was obtained of the vertebrate fauna of the Gosau beds until Prof. Suess

was so fortunate as to obtain the assistance of Bergverwalter Pawlowitsch in conducting excavations. These were carried on with admirable skill; timber drift-ways were driven into the rocks, with the result that they penetrated into a perfect cemetery of the remains of Cretaceous reptiles. The remarkable collection thus obtained was intrusted for description to Dr. Emanuel Bünzel, whose memoir upon it was published in 1871 in the 'Transactions of the Imperial-Royal Geological Institution.' Subsequently more specimens were discovered; and in Easter 1879 my honoured friend, Prof. Suess, invited me to visit Vienna to examine these specimens, with the object of making them available for the advancement of knowledge by publication. With the assistance of the Royal Society I gladly undertook this work, and spent a month in Vienna studying the thousands of fragments which had been obtained. The great mass of these, mere comminuted bones, proved of but little value; or, rather, the time that I could give to their study enabled me to piece together but few specimens that were likely to prove interesting. There were, however, other important remains, which Prof. Suess had already reconstructed and pieced together with great patience and perseverance, that had produced many indications of lost animal forms out of a chaos of débris. I soon found that Bünzel's views and my own presented certain differences. His memoir, which extends to eighteen quarto pages, and is illustrated by eight plates, describes the following species—*Crocodilus carcharidens, Iguanodon Suessii, Struthiosaurus austriacus,* and *Danubiosaurus anceps.* Other remains are referred to the genera *Hylæosaurus, Scelidosaurus,* and *Lacerta*; while certain specimens are classed as "Crocodili ambigui," Chelonians, and indeterminate remains. All the specimens which he described are figured; but the artist has so imperfectly appreciated the details of character of the fossils represented in Bünzel's plates, that it is impossible to form from them a just opinion of these fossil reptiles. After examining the specimens, I have come to the conclusion that some of Bünzel's identifications may be modified. I am unable to recognize *Scelidosaurus*, of which Bünzel figures a claw-phalange, tail-vertebræ, and dermal armour. *Hylæosaurus* is another genus doubtfully cited, resting upon a single scute, which it may be well to discard. *Lacerta* is a genus that certainly cannot be recognized, although the author refers to it parietal and postfrontal bones, the articular element of the lower jaw, and the right side of the lower jaw, vertebræ, fragments of ribs, humerus, radius, and femora. But the genus *Lacerta* could here only be used in the sense of animals of the Lizard group.

For reasons that will be adduced, the *Crocodilus carcharidens*, founded upon a fragment of the lower jaw, cannot be referred to the genus *Crocodilus*; while the *Danubiosaurus anceps* was founded in error, and the remains, instead of being lacertilian, belong to other orders and other parts of the skeleton than those identified. *Struthiosaurus* being founded on a single specimen, remains an interesting type; but I feel constrained to refer the *Iguanodon Suessii* to a distinct genus.

The vertebræ, plate i. figs. 24–26, regarded as crocodilian, pertain to a small Dinosaur; figure 27 in the same plate, regarded as the dorsal rib of a Crocodile, I interpret as the cervical rib of a Dinosaur. The vertebræ, regarded as crocodilian, which are figured in pl. ii. give evidence of a second and larger species of Dinosaur, and exemplify its cervical, caudal, and dorsal vertebræ.

On plate iii. fig. 1, the specimen regarded as the right side of a hinder dorsal rib of a Teleosaur I regard as the shaft of the femur of a new Dinosaurian genus. Figures 2–4, described as a crocodilian femur, is the femur of the larger Dinosaur. Figures 5, 6, called fragment of lower jaw of a Lizard, is certainly neither a fragment of jaw nor a Lizard-bone, but the proximal end of a large rib of a Dinosaur. Figures 12, 13, called the upper half of a crocodilian humerus, I regard as the proximal part of a Dinosaurian fibula.

In plate iv. figs. 1, 2, classed as dermal bones of a Crocodile, I refer to one of the large new Dinosaurs. Figure 3, described as the right ilium of *Iguanodon Mantelli*, is certainly a coracoid of a large Dinosaur. The tail-vertebræ on the same plate, referred to *Scelidosaurus*, are caudals of the same Dinosaurian genus already referred to. The figures 11, 12, called phalange of crocodilian, is a Dinosaurian metacarpal or metatarsal; and the claw-phalange (figs. 4, 5), referred to *Scelidosaurus*, probably belongs to the same animal.

The figures of the remarkable skull of *Struthiosaurus*, represented on plate v., are all unsatisfactory, since they give but a vague idea of its structure. Figures 7–9, described as the rib of a lacertilian (*Danubiosaurus anceps*), represent the scapula of the larger Dinosaur. Figure 10, termed claw-phalange of *Danubiosaurus*, was shown by Prof. Suess to be a piece of Dinosaurian armour, since he fitted it to a remarkable horn-like scute of the larger new Dinosaur.

On plate vi. figs. 1–3, is represented another example of the large Dinosaurian scapula, there interpreted as the rib of *Danubiosaurus anceps*. Figures 4, 5 are said to represent the left ilium of this imaginary animal; but they are really the costal plate and blended rib of a large and remarkable new Chelonian type. Figures 8–10, termed bodies of vertebræ of Lizard, are vertebræ of the same species of Crocodile represented on plate i. Figures 6, 7, described as the articular part of the lower jaw of a Lizard, are really the articular end of the lower jaw of a Pterodactyle of the genus *Ornithocheirus*. I concur with the identification of fig. 11, as vertebra of a Lizard. The bone represented in figures 12, 13, termed dorsal rib of Lizard, is the fibula of a Crocodile. I am unable to recognize satisfactory Lizard-characters either in the humerus figured in this plate or in any of the bones represented in plate vii., while that represented in figs. 22 and 23, termed a rib, seems to me to be a femur of a new Dinosaurian genus. The Dinosaurian dermal armour in this plate, referred to *Scelidosaurus*, must be associated with the bones of one or the other of the large Dinosaurs already referred to.

All the specimens on plate viii. are Dinosaurian; and I should only differ from Dr. Bünzel in referring them, together with fig. 1 (which he terms tail-vertebræ of a crocodilian) to the principal Dinosaur.

Figures 2–4 are termed by the author vertebra of a fœtal Dinosaur; but I am not aware of any evidence which enables us to determine a matter of that kind, and I refer it to the same animal as the so-called Lizard-bones (pl. vi. figs. 14, 15, pl. vii. figs. 1–4).

Indicating these and some other differences of opinion from Prof. Suess, and arranging the material, old and new, into species according to my interpretation, I was invited to deal with the remains in such a manner as my conclusions made necessary. As the time available did not suffice for description of the whole collection, I was generously permitted to borrow, from the museum of the University of Vienna, the more important specimens, which required further study or to be figured. The results I now offer to the Geological Society. The subject confessedly presents great difficulties; and in the following memoir I have dealt with it to the best of my ability. As already stated, the bulk of Dinosaurian vertebræ, scutes, and limb-bones are referable to two species of the same genus differing in size and other characters. This genus is certainly new. But when we come to examine the corresponding skull-fragments, there are two species indicated (by lower jaws) which are both of about the same size. There is also the somewhat smaller Dinosaur indicated by Bünzel as *Iguanodon Suessi*; and there are teeth that appear to be referable to two other Dinosaurs, one resembling *Lælaps* or *Megalosaurus*, and the other somewhat approaching the Scelidosaurian pattern. Hence there is great difficulty in referring the right jaws to the skeletons; and there is absolutely no evidence to show whether the hinder skull-fragment, called *Struthiosaurus austriacus*, belonged to one of these species, or is the only specimen of the animal hitherto discovered. I have therefore some doubt whether, in the endeavour to make the subject clear, a synonym or two may not be introduced, which can only be got rid of by the discovery of additional materials; and I put my views forward with some diffidence.

Of the new Chelonian indicated by costal plates which were separate from each other at the lateral margins, I find no other evidence except postfrontal bones indicating a skull covered with an elaborate pattern of minute scutes, and a strong but imperfect coracoid bone. Both these latter remains, however, are so typically Chelonian, although the skull-bones joined by squamose overlap instead of by suture, that I have no doubt of the propriety of including the costal plates in the Chelonian order, singular as is their form. This remarkable animal is associated with Emydian types which differ in no important respect from existing genera. The Pterodactyles are very imperfectly represented, and badly preserved, and require but brief notice. The Crocodilians, however, are more curious, partly from their remarkable resemblances to types previously known in the Greensand of New Jersey and Cambridge, and partly from displaying new characters in the vertebræ.

All the species hitherto discovered are peculiar to the deposit, and, with the exception of those temporally referred to *Crocodilus*, *Emys*, *Ornithocheirus*, and *Megalosaurus*, must, as it seems to me, be located in new genera. The most important new type is the Dinosaur *Cra-*

tæomus, represented by two species; the other Dinosaurian genera are *Doratodon*, *Rhadinosaurus*, *Mochlodon*, *Ornithomerus*, *Oligosaurus*, and *Hoplosaurus*.

Condition of the Specimens.

Almost all the bones are in fragmentary condition, and somewhat distorted by the effects of pressure. Being hollow, they have sometimes become greatly crushed; and were it not that both right and left bones are usually preserved, it would often be difficult to avoid being misled by appearances which result from conditions of fossilization. Unfortunately almost all the long bones have lost their articular extremities, and although in some instances this may perhaps be the result of fracture, yet in most cases it is certainly a consequence of decay of the bones before they were covered up in the deposit. I do not speculate as to whether the articular ends may have been eaten off by large carnivorous contemporaries; for there are no indications of tooth-marks or other evidences of animals which might thus have mutilated the specimens. No doubt to some this condition would be proof that the remains were derived from an older deposit; but since the Wealden and Cambridge Greensand and Stonesfield Slate all have a number of bones in a not dissimilar condition, it seems to me less hypothetical to find an explanation of their condition in prolonged maceration, coupled with the lithological and petrological modifications which the deposit has since undergone. There is, however, no record of natural association of any of the remains; yet, as they have mostly come from the same locality, it is probable that remains which agree in size and anatomical characters may, in most cases, with certainty be referred to the skeleton of the same individual, since duplicate parts of the skeleton are almost unknown in each species. There may perhaps be a certain amount of doubt as to the correct association of the remains which I have ventured to put together; but this is a doubt which the anatomist will best appreciate who can realize the nature of the studies which have led me to group the bones as here set forth.

Mochlodon Suessii (Bünzel). (Pl. XXVII. fig. 1.)
See Bünzel, *l. c.* p. 8, pl. iii. figs. 7–11.

One of the most beautifully preserved specimens is a right dentary bone of a small Dinosaur which at first sight exactly reproduces in miniature the characters of the *Iguanodon* of the Weald; but it differs in a character so remarkable that, had it occurred in a living animal, no hesitation would have been felt in relegating the jaw to a distinct genus. Anterior to the teeth, the symphysial extremity of every *Iguanodon*-jaw bends round so that the rami form a U-shaped curve; but this specimen is straight, and the anterior inward inflexion is scarcely appreciable, so that the snout was evidently sharply pointed, and therefore indicative of a new form of head. The fragment is little more than $7\frac{1}{2}$ centimetres long, and the tooth-bearing part of the jaw 17 or 18 millimetres; the height at the

posterior end to the top of the coronoid process, which is imperfectly preserved, is $3\frac{1}{2}$ centim. The external surface is smooth, rounded at the base, with a strong rounded ridge descending from the anterior margin of the coronoid process, and extending downward and forward along the jaw, dying away in front, and placed well above the middle of the side. Above this ridge the area of the jaw, extending inward to the alveoli, is flattened almost horizontally at the back; but the area becomes more oblique anteriorly, and undistinguishable as the ridge subsides. Along its upper and outer margin towards this ridge is a series of foramina which are elongated or ovate—four of them larger, and half-a-dozen smaller. The area below the ridge is flattened towards the posterior limit of the dentary bone; anteriorly it is flattened and pointed, being bevelled on the inferior border for its union with the other ramus, and on the superior border terminating in an oblique area, which is compressed from side to side and channelled by a somewhat deep groove. Whether this groove is merely vascular, or whether it may have contained a few premaxillary teeth, is a matter upon which I have no evidence. It is about 16 millim. long, wider and deeper behind than in front, and, as in the Wealden *Iguanodon*, has the inner border more elevated than the outer border. Below it are three or four vascular foramina. Both the inner and outer extremities of the jaw below are roughened, and indicate that the symphysis was loose, but held together by ligamentous union. As usual, the external outline of the bone, when viewed from above, is moderately convex, and its thickness from within outward continues to increase from before backward almost to the coronoid process. The inner side, which is slightly crushed, displays ten alveoli. Portions of five or more teeth are seen in the jaw; and there are impressions of others and empty sockets, indicating ten in all. The first tooth, which is unfortunately imperfect (wanting the extremity of the crown), is remarkable for the smoothness of its inner surface, which, however, is elevated into a very strong median ridge, leaving the sides slightly concave. The serrations visible on the anterior margin are slight, and do not extend down the tooth. It is not sufficiently elevated to have come into wear. All the succeeding sockets are empty, owing to the teeth having dropped out; but most of them show successional teeth coming up, which have not yet reached the level of the outer alveolar margin. The second and third teeth are broken away on their external part, and not recognizable. The fourth tooth, also wanting the extremity of the crown, still shows the same enormously developed median ridge; but external to it are, on each side, about half-a-dozen fine parallel ridges which have sulcations behind them of about their own width. The fifth tooth only just shows the top of its crown coming up low down in the alveolus. The sixth tooth is the best developed, was apparently the largest, and occurs near the thickest part of the jaw. Its pattern is like that of the last described; only the strong median ridge or keel is much sharper, and the lateral concavities deeper, in accordance with the width of the tooth. The lateral ridges run up and terminate in the sharp rounded lanceolate

margin, and give it a crenulate appearance, which is due to their elevation. The median ridge terminates in a point, which is rounded and does not project beyond the tooth-margin. The tooth is slightly displaced, and leans backward towards the seventh socket. Low down in the seventh socket the crown of another tooth is seen. The eighth socket is empty. The ninth socket has lost the successional tooth, but displays the external impression, and shows it to have been marked with a median ridge and lateral finer ridges somewhat radiating upward. The tenth socket appears to have been small; it is imperfectly preserved, and there is no evidence as to its form or character; but a groove, which is smooth, is placed behind the last socket mentioned, and just in advance of the coronoid process. Hence these teeth appear to differ from those of *Iguanodon* in the persistent development of a powerful median ridge and in the striation of the external surface. Behind the alveolar border the bone becomes squamous and thin, having overlapped the surangular bone, though there is no trace of a separate coronoid element, from the suture entering into the coronoid process. An opercular bone, or its representative ossification, appears to have extended along the broad subdentary groove at the base of the bone margining its upper part, while the angular bone, if it were distinct from the surangular, would appear to have reached far forward along the base of this groove, and to have rested on a thin ledge of the dentary. The submaxillary groove, in its anterior third, becomes shallow, but persists to the symphysis. The region of the symphysis has no definite outline.

Two separate teeth, both such as may belong to this species, have been found. They are of small size, and may have belonged to this individual specimen. One belongs to the lower jaw, and might be the eighth tooth of the specimen described. The other is an upper-jaw tooth. The tooth from the lower jaw (Pl. XXVII. fig. 2) shows that the crown curves outward at a considerable angle to the fang; its outer margin is worn, showing that the teeth worked together with a scissors-like action, the lower-jaw teeth being, as usual, internal to those of the upper jaw. The external surface is marked with about half-a-dozen primary ridges; between these, in the middle of the tooth, are finer ridges; and across them run transverse lines of growth. There is no median external ridge. The internal aspect of the crown is essentially the same as in the specimens described in the jaw itself. The median ridge, however, is not prolonged down the fang; and hence there is a slight constriction at the base of this ridge; and the elevated lateral ridges sharply define this side of the crown from the smooth lateral areas.

The upper-jaw tooth (Pl. XXVII. figs. 3, 4) has the crown similarly curving inward from the fang. The fang is compressed from side to side, so as to give a subquadrate section. There is a slight constriction between the crown and the fang on the outer or cutting edge, but no constriction on the inner edge. The fang is imperfect at the base; but the total length of fang and crown, as preserved, is 18 millim. The worn surface (fig. 4), like that aspect of the tooth

itself, is convex from side to side. The unworn part of the crown below is vertically striated; but the ribs are fainter than on the lower-jaw tooth. The inner surface of the crown is subquadrate, marked with eight vertical ridges, which are moderately elevated, stronger and wider apart on one side of the tooth than on the other. The height of the crown is about 8 millim., and its width about 7 millim. Its thickness at the base is about 4 millim.

Parietal bone of a small Dinosaur (*probably* Mochlodon).
(See Bünzel, pl. v. fig. 11, p. 14.)

The parietal bone of a small Dinosaur (Pl. XXX. fig. 1), which was regarded by Bünzel as a Lizard, shows, as I take it, the parieto-frontal suture in front, and an indication that the postfrontal bone was given off from the expanded anterior outer corner, much as in *Iguanodon*. The under and interior surface of the bone, however, is much more lizard-like in some respects, seeing that it did not enclose a brain-case after the pattern demonstrated in *Iguanodon*, *Hypsilophodon*, *Struthiosaurus*, and other genera. The bone was relatively thin, but appears to have been united by a not very intimate suture to bone below, which formed the lateral wall of the brain-case. The bone is imperfect posteriorly, being fractured; superiorly it is divided into three areas:—a median triangular area with concave sides, which becomes narrower posteriorly till it disappears at about the line of fracture (this surface is slightly convex from side to side in front); and two lateral areas for the attachment of muscles working the lower jaw, which converge posteriorly, and in converging are more highly inclined to each other. Their superior limit is sharply defined by a ridge, which becomes elevated posteriorly, and is apparently passing into a median crest, and is also elevated anteriorly at the point where the postfrontal suture is visible. The length of the fragment is 2 centim.; its width in front, as preserved, is 2 or 3 millim. more; its width posteriorly is $1\frac{1}{2}$ centim. There is no foramen parietale. The characters are certainly such that the bone might well be referable to the skull of a Lacertilian; but it would be hazardous to determine absolutely on such evidence whether the bone really pertained to *Mochlodon Suessii*, as is rendered probable by its Iguanodont form.

Scapula (*probably of* Mochlodon).

The imperfect proximal end of a small scapula (Pl. XXVIII. fig. 1) presents somewhat Crocodilian characters. The fragment is only 4 centim. long. It shows the humeral articular surface and part of the sutural surface for the coracoid. The character which especially distinguishes it from Crocodiles is the extraordinary lateral position of the humeral articulation, in consequence of the sutural surface for the coracoid being prolonged beyond it. This articular surface is $2\frac{1}{2}$ centim. long, $1\frac{1}{2}$ centim. wide proximally, and narrower towards the sutural surface. The bone is a little crushed, but was concave from above downward, and flattened in the antero-posterior direc-

tion. Hence the surface is narrower, more vertical, and more elongated, and especially more concave than in the Crocodile; but there is a slight angle rising as a short ridge from the hinder exterior corner of the articulation, directed upward and forward, represented in Crocodiles by a similar fainter ridge. Only the posterior part of the coracoid suture is preserved. It makes an angle of 45° with the humeral surface when seen from the front, and an angle of 90° when seen from the side. The bone is narrower in front and behind than in the middle, where it is 12 millim. thick. So much as is preserved is $2\frac{1}{2}$ centim. long. Its external margin is convex; the internal margin appears to have been straighter. At the angle above its union with the humeral surface there is a small depression. Owing to the fact that the bone thickens externally with the humeral surface, the area anterior to that surface is concave and smooth. The concavity is directed obliquely downward and forward. There are indications that the anterior margin of the bone was developed into an angular ridge, which may have corresponded with that of the Crocodile. The visceral surface of the bone was concave from above downward, and, though crushed, appears to have been flatter from side to side, more rounded on the anterior margin, and more compressed on the posterior margin about the humeral articulation than in Crocodiles. The blade of the bone, however, was similarly constricted at the fracture, where it is less than 2 centim. wide and about 1 centim. thick as preserved, convex in front and flattened behind. Though this bone is on the whole Crocodilian in its characters, it is also Dinosaurian, and perhaps makes the nearest approximation to the scapula figured by Prof. Marsh in the fore limb of his five-toed Dinosaurian *Camptonotus dispar*.

STRUTHIOSAURUS AUSTRIACUS, Bünzel.
(See Bünzel, pl. v. figs. 1–6, p. 11.)

The hinder part of the skull of a Dinosaur figured by Bünzel is somewhat difficult to describe, on account of the obliteration or obscurity of the sutures; and yet the anterior surface of the roof of the brain-case is margined by a well-marked transverse suture limiting the front of the parietal bone—a suture similar to that which persists in the skull of the Fowl long after other sutures have become obliterated in the hinder part of the cranium. The specimen certainly presents a remarkable resemblance to the back of the skull of a bird; but I believe that Bünzel has attached more than due importance to this similitude, owing to the circumstance that the true nature of the Dinosaurian skull was even less perfectly known when he wrote than it is now. He has supposed his specimen to be more complete than, in truth, it is, being unaware, or unmindful, of the evidence that, external to the parietal bone, the Dinosaurian skull has an upper arch or bar, like that so common in reptiles and unknown in birds, and that, as a rule, there is also a lower malar arch, more or less developed, behind the orbit; and therefore it happens that the bone which he regarded as tympanic or quadrate, and interpreted as Crocodilian, is the paroccipital or opisthotic of modern anatomists, as, indeed,

was long since appreciated by Mr. Hulke in describing his skull of *Iguanodon**. Therefore Bünzel's Avian and Crocodilian affinities of the skull both fall to the ground, owing to this fundamental misconception of its characters. Hence it appears to me desirable to describe the specimen anew, in order to render its structure clearer. The specimen exhibits superior, lateral, inferior, posterior, anterior, and cerebral aspects; and on each of these I propose to offer a few remarks. The fossil, as preserved, is 63 millim. broad behind, and 5 centim. high, owing to the downward direction of the occipital condyle; for, although the skull obviously increases in height as it passes forward, the height from the base to the fronto-parietal suture is only $4\frac{1}{2}$ centim. The presphenoid bone is broken away; but the length from the fracture or suture to the back of the occipital condyle is $4\frac{1}{2}$ centim., and to the back of the supraoccipital bone is $5\frac{3}{4}$ centim. Superiorly and externally the cranial region is moderately convex from side to side, and also exhibits a slight convexity from front to back (Pl. XXVII. fig. 6), especially towards the outer borders, indicative, I think, of the parietal bone just reaching the margin of the temporal fosse on the right side. The surface of the bone is rough, with slight and irregular close-set elevations, not so distinct as those of a *Trionyx*, but certainly suggesting the surface that is sometimes seen when the scutes are removed from a Chelonian carapace. There is also a transverse furrow running across the bone, rather behind its middle, nearly parallel to the convex posterior border, and therefore curving backward. The width of this superior surface, as preserved, is nearly $5\frac{1}{2}$ centim.; but then the bone is broken on both sides, though it has become thin and separated laterally from the brain-case. Its antero-posterior extent in the middle line where greatest is just over 3 centim. I have no doubt that the transverse groove (Pl. XXVII. fig. 5) indicates the limit of the parietal bone; for the suture defining it is seen on the left side of the cerebral surface and on the external lateral surface; but I cannot trace it across the upper surface, and it may be that the suture is obliterated by ossification, consequent upon a scutal covering. The groove recalls those which occur on the skulls of Lizards such as *Trachydosaurus*, while the texture of the bone is not dissimilar; and hence it is also possible that we have here an explanation of the absence of sutures, in the circumstance that they are covered up by a layer of dermal ossifications. The parietal bone at the frontal suture (Pl. XXVII. fig. 6) is 9 millim. thick; but at the transverse groove the thickness is reduced to 7 millim., owing to cerebral excavation beneath it. The area behind the groove terminates posteriorly in a margin which is rounded, but suggests the idea that a plate 4 millim. thick in the middle, and becoming thinner laterally, was superimposed upon the cranial bones. This region posterior to the groove I suppose to be occupied by the supraoccipital bone.

The posterior aspect of the skull is chiefly remarkable for the elevated border above the foramen magnum, which was evidently

* Hulke, Quart. Journ. Geol. Soc. vol. xxvii. p. 206.

in somewhat close contact with the neural arch of the atlas, and for the transverse grooves and muscular rugosities, which run between this border and the slight groove defining the supposed cranial scute. Hence the back of the skull is not vertical, like that of some Crocodiles, and its superior margin is far from being as well rounded as in very young Crocodiles; and on the whole there is nothing to call for remark as affiliating this region to what is seen in either Crocodiles or Lizards. The surface ascends somewhat obliquely, but in two terraces; that immediately above the ridge bordering the foramen magnum is divided by it into two lateral portions. These lateral portions are channels extending outward and downward, and widening as they go. There are, on each side of the median vertical dividing ridge in these channels, three large tubercles. Above the channels, and as nearly as may be of corresponding size, is a pair of convex surfaces, which are undistinguishable in the middle from the median bar just referred to. They are margined above by the supposed cranial scute, and, as they extend outward, widen and curve obliquely upward; and a muscular ridge appears dividing the outer part of this wedge longitudinally into two nearly equal parts. Hence the pattern of the back of the skull as preserved is very like a capital letter K placed transversely, so that the two diverging limbs correspond to the ridges above the foramen magnum. The height from the top of the foramen magnum to the summit of the back of the skull is 2 centim. The transverse width over the supraneural ridges is 4 centim. The width of each ridge at its outer third, before its upper border becomes concave, is 9 millim., the upper margin extending over the concave channel above it; higher up its width is little more than half. The median connecting ridge between the two transverse ridges at the back of the head is about 12 millim. wide. Though the back of the head as a whole is convex from side to side, it is concave from above downward in the median line. The foramen magnum is slightly elliptical, being 17 millim. wide and about 15 millim. high. The skull presents the unusual condition that the basioccipital condyle retreats below and in front of the upper border of the foramen magnum, so that, placing the back of the skull vertically, which puts the base of the skull horizontal, the back of the brain-case projects for a centimetre behind the basioccipital condyle. The areas at the outer and upper corners of the occipital condyle are concavely notched, and at first convex from side to side, but more flattened as they pass outward and upward. The depth from the back of the skull to the base of the occipital condyle is 4 centim.

The base of the skull, as preserved, is triangular, $5\frac{1}{2}$ centim. from the hinder border of the foramen magnum to the front of the basisphenoid, or a fracture in front of the sella turcica. The hinder border of the triangle is convex, and the lateral border is concave, though all the borders are irregular. There is no sutural distinction between the basioccipital and basisphenoid, any more than between the basioccipital, exoccipitals, and supraoccipital bones. The basioccipital condyle probably is formed to some extent by the exoccipital bones, much as in the Crocodile, since foramina occur

some little distance in advance of the basioccipital, which may be presumed to penetrate the exoccipital bones and give passage to the pneumogastric and hypoglossal nerves. The occipital condyle is well rounded; but its outline is subtrapezoidal; its greatest width in the upper third is 2 centim., its greatest depth 16 millim. The under surface is deeply channelled, so that the thickness of the bone behind the articular surface is one millim. The region in front of the occipital condyle is about $3\frac{1}{4}$ centim. long, fairly smooth, but concavely excavated in the middle, both in length and breadth, rising, however, to a rounded margin at the sides internal to the lateral foramina. The width across the pneumogastric foramina is 3 centim. The lateral margin of the triangle is divided by a median convexity into two concavities: the shorter, in front, is about 2 centim. long; and the longer, behind, is a little more; while posterior to this, on the left side, is a surface which appears to have been laterally sutural and nearly vertical, while a suture on the opposite side shows that the upper part of this mass consists of a small bone, which readily comes away. Hence I interpret the lateral masses of bone external to the foramen magnum as being the exoccipital bones, as in Crocodiles, while the small bone above the outer border of the exoccipital is the paroccipital of Owen; and I suppose the exoccipital to extend forward so as to form the side of the wall of the brain-case; so that no portion of the posterior lateral structure preserved can be the quadrate bone, as supposed by Bünzel, and hence the analogy attempted to be made out in this region of the skull with the Crocodile can have no foundation.

I would next note the characters of the lateral aspect of the skull. (Pl. XXVII. fig. 5). Here all the bones which are connected with the roof of the brain-case are more or less broken, and the bones have disappeared which formed the external suspensory arch for the lower jaw, so that nothing remains but the internal part of the head, which may be likened, perhaps, to that of a Crocodilian type in which neither were the quadrate bones blended with its lateral walls nor the pterygoid bones connected with its base. I fail altogether to recognize a Lizard-like type, although, as at present used, the term Lizard is almost large enough to include any thing. Forms like *Amphisbæna*, which have the quadrate bone firmly wedged into the skull and no trace of either of the postorbital arches, might well be regarded as a distinct ordinal type; and there are some Dinosaurs towards which the structures of the hinder part of such a brain-case somewhat approximates; but the cranial bones in ordinary Lizards, like *Iguana*, form a part of the skull that is very imperfectly connected with its roof, and very different from the structure seen in Crocodiles and Dinosaurs, though other Lizards, like *Cnemidophorus* for instance, have a better union between the brain-case and the surrounding bones; but I do not recall any type of Lizard that so far corresponds in the characters of the bones covering the brain with what is seen in Dinosaurs as to justify us in affirming that this skull is lacertilian. Turning our attention first to the basal part of the brain-case, it will be seen that the articular head of the basiocci-

pital is directed almost vertically downward, showing, I think, that the head must have been carried upon the neck as in Deer, Kangaroos, and other animals in which the position of the neck is vertical. The part of the basioccipital posterior to the sella turcica is flattened on its cranial surface, gently concave from side to side, with a slight median ridge. Then at a distance forward of about 3 centim. from the occipital condyle, the brain-case thickens from below upward, but does not present the cup-shaped depression seen in Crocodiles and many birds, though its edge is obviously destroyed by fracture, and must have extended some millimetres higher than the 13 millimetres preserved. At the border of this ridge, on each side, is a large perforation for the second nerve. The inner and anterior wall of the perforation is broken away; and the transverse width between the outer walls of these foramina is 2 centim. Below these foramina, and extending forward, are several others. First, on the right side is a large foramen that runs obliquely outward and forward, penetrating into the brain-case. On the opposite side, instead of one large foramen, there appear to be two, divided by a considerable intervening piece of bone. I have no doubt that this foramen gives passage to the fifth nerve. On the left side it is prolonged backward and outward in a horizontal groove; and although there is a groove on the right side, and though it is smaller and shallower, it does not impress the margin of the bone. In advance of this foramen, and below the sella turcica, in the anterior concavity of the bone, are two other foramina, which appear to be vascular. The anterior one, owing to fracture, is seen on the left side to curve obliquely downward and forward, and open upon the base of the skull. Between the outlets of these foramina, in the median line, is a portion of a conical foramen, the anterior wall of which is removed by the fracture.

The vertical fracture of the sphenoid (Pl. XXVII. fig. 6), where it terminates, is triangular, 2 centim. wide, and about as high, the sides being compressed so as to meet superiorly in a crest which rises in front of the pituitary fosse, as in some birds, and not at all as in Crocodiles. Its walls are concave at the sides; and posteriorly a slight longitudinal ridge rises, which becomes directed at an angle inward and upward to the ridge bordering the pituitary region behind. The pit for the pituitary body is about 12 millim. long and 9 millim. wide, is concave from side to side, and margined by a sharp elevated ridge. Its anterior part is overhung by the process of the sphenoid, which rises above it. The posterior portion of the lateral aspect of the skull consists of a small superior area, subtriangular, formed apparently partly of the parietal and partly of the supraoccipital bones. It is a smooth internal surface below the fractured roof of the brain-case, directed obliquely outward, downward, and forward, and traversed by a groove which probably indicates a suture between the two bones. The posterior border is a sharp knife-edge, concave from before backward. Under this edge a deep excavation extends, penetrating to within half a centimetre of the brain-case. The excavation is smoothly concave, extends longitudinally, and is pro-

longed backward and outward above the otic bones; but the surface is prolonged obliquely outward and downward, so as to form a smooth quadrate area, which rounds towards the base of the skull, and terminates backward on the left side, where best preserved, in a vertical lunate surface, convex behind and concave in front, formed by the exoccipital and otic bones. In front these spaces slightly converge, especially below and above; and behind the middle there is a foramen a millimetre or two in diameter, apparently largest on the left side, but smaller than might have been expected if it is the entrance to the auditory chamber, which probably lies in the depression above it. From the lateral lunate surface to the inner wall of the brain-case above the occipital condyle is $2\frac{1}{4}$ centim.

Finally there remains the interior cavity of the skull which held the brain (Pl. XXVII. fig. 6). This does not present any great contraction in the auditory region. Its extreme width behind is 17 millim., where the auditory bones bulge inward after the manner of Crocodiles. The transverse width of the brain-case is thus reduced to 13 millim.; but at the same time its height increases from 14 millim. behind to about $2\frac{1}{2}$ centim. in the region of the auditory prominences, though the extreme height of the brain-case is somewhat in advance of this point, where it becomes 3 centim. The width continues to increase from behind forward to the parieto-frontal suture. It is greatest in the upper third of the outline of the brain, where it amounts to 22 millim. A bone which in a bird might be regarded as the alisphenoid, which lies above the sphenoid, appears to meet the parietal and exoccipital by a well-defined suture, visible externally and internally, and running obliquely downward and backward. It is difficult to speak with confidence of the limit of this bone on the external surface, since as it extends backwards it is only preserved on the left side. The suture from which it has come away is well defined on the right side. Its anterior border is sharp; and the external surface is concave from within and outward. This sharp border appears to show that in this Dinosaur the brain-case was not completely closed in front in the middle line. Anterior to the highest point of the upper wall of the brain-case, which lies under the transverse scute-like groove crossing the external surface, the bone makes an angular bend forward; but though there are many little irregularities of outline in the internal surface, there is nothing so important as the bending inward and downward of the lower part of the alisphenoids, which must have made the transverse section of the cerebrum nearly circular at the parieto-frontal sutures.

Imperfect as this description is, it will suffice to show that we have here a Dinosaur of a type so different from that indicated by the skull referred by Mr. Hulke to *Iguanodon*, as only to be classed in a separate suborder; and if the base of a skull figured by myself under the name *Craterosaurus* be, as I believe, also Dinosaurian, that also indicates a subordinal type, and is totally distinct from either of the others. These great differences of skull-structure lead me to suspect that the Dinosauria are a far more important group

than has hitherto been suspected *; and it may well be that different genera present modifications which affiliate representatives of the group towards Crocodiles on the one hand and birds on the other. But I cannot believe that any order, however homogeneous, could have spanned the interval between the Crocodile and the bird, though there can be no doubt that this skull of *Struthiosaurus* makes a nearer approach towards the bird than does the skull of any living reptile; its differences from the bird-skull are precisely those which distinguish it from the Crocodile, little as we know or can infer concerning the suspensory arches for the lower jaw. In the base of the skull not being covered with pterygoids there is a notable difference from Crocodiles of the surviving type; but then the base of the skull is not bird-like, any more than it is like that of any other animal. It is one of the most distinctive points of the Dinosaurian skeleton.

It would be desirable to compare this specimen with other Cretaceous genera; but, with the exception of *Acanthopholis*, none of these have, as yet, yielded any evidence of the brain-case. One fragment, found at Folkestone at the base of the Chalk with the remains of the *Acanthopholis horridus*, is briefly referred to by Prof. Huxley; and on inspection it proves, though clearly allied, to belong to a different genus, a fact that will be best demonstrated by a description of the specimen and comparison of the figures (Pl. XXVII. figs. 6 & 8 and 5 & 7).

NOTE ON THE BASE OF THE SKULL OF *Acanthopholis horridus*, Huxley.

Professor Huxley's account of the skull of *Acanthopholis* is so brief that it would be difficult to be sure from it of the identity of the specimen, especially since Prof. Huxley describes characters which we are now unable to recognize, though it is, of course, possible that the specimen is in a less perfect condition than when originally noticed. I therefore reproduce Prof. Huxley's original remarks (Geol. Mag. 1867, vol. iv., Huxley on *Acanthopholis horridus*, p. 66).

"Of the skull I possess only a very much mutilated fragment, showing the basioccipital and basisphenoid. The occipital condyle measures 1·4 transversely, or has about the same diameter as that of the skull of a *Crocodilus biporcatus* which measures 16 inches in length from snout to occiput. But it is more elongated transversely and excavated above than in the Crocodile, and the exoccipitals enter more largely into its composition. The Crocodilian disposition of the Eustachian tubes is absent; and the carotids run up the side of the basisphenoid in Lacertilian fashion. The sella turcica has a well-developed posterior plate."

This fragment (Pl. XXVII. figs. 7 & 8) comprises the base of the skull, and includes the basioccipital and basisphenoid, which are completely ankylosed, and give no indication whatever of suture. I am similarly unable to detect any sutural evidence of the exoccipital; nor can I recognize the basioccipital condyle, which I believe to have been directed

* Professor Marsh, since this was written, has published a classification of American Dinosaurs (Amer. Journ. Sc. vol. xxi. p. 423).

downward, and to have been largely removed by attrition, so that no idea can now be formed of its relative depth. The presphenoidal part of the specimen is broken away and terminates anteriorly in a triangular transverse fracture (fig. 8). The base of the skull, as preserved, is $5\frac{1}{2}$ centim. long. In the middle it is 4 centim. wide, but narrows posteriorly to the region of the condyle, where the bone is 33 millim. wide. Anteriorly it also appears to contract a little; but at both ends the external white film of bone has scaled off, leaving the dark phosphatic substance below—a condition reminding one curiously of the pale and dark mineralization of bones in the Cambridge Greensand. This inferior region is concave in length, with a rounded median ridge, and lateral concavities on each side of it in the middle. Posterior to the middle area the bone is fractured inferiorly for a length of $2\frac{1}{2}$ centim.; and this fracture I suppose to have removed the lower half and characteristic form of the occipital condyle.

The basioccipital bone (Pl. XXVII. fig. 7) terminates posteriorly in a mass which, as preserved, is convex below and concave above, so as to have a crescent outline, and is also moderately convex from side to side. Above it is the brain-case, which certainly extended somewhat further backward than the present limits of the occipital condyle, as is shown by the form and character of the lateral walls. The superior surface, however, of the occipital bone appears to curve convexly downward as it extends backward; and, as preserved, the bone is little over 1 centim. deep, and about 3 centim. wide at the origin of the condyle, which is, as usual, defined by a lateral constriction that can only be detected by careful examination, and is some distance posterior to the lateral notches on each side of the base of the brain-case.

The cranial cavity (fig. 8) is imperfectly defined, because there is no portion of the roof of the brain-case preserved, and its lateral walls are imperfect. It is evident, however, that it is higher than wide; the posterior width in the region of the foramina for the hypoglossal nerves is 28 millim., while the height appears to have been not less than about 4 centim. On the right side a part of the inner wall of the brain-case is exposed, showing that it is smooth, bulges inward a little in the auditory region, and is inclined a little inward as it extends upward. On the left side the bone is fractured, so as to show that the hinder wall of the brain in the auditory region is 2 centim. thick, and extends outward transversely at a little higher level than the base of the skull. It shows a horizontal semicircular canal, which extends from the wall of the brain-case outward and forward for a length of about $1\frac{1}{2}$ centim., as exposed, and is about $\frac{1}{2}$ centim. wide. The curve cannot be followed round; nor can its relations to the other semicircular canals be definitely made out.

Along each side of the floor of the brain-case, and under the transverse jutting of its lateral walls, which extend out horizontally behind, is a row of foramina which extends in a curve, just separated from each other by bony interspaces. Six are visible on the left side; on the right side there were certainly five, and may have

been six (fig. 7). These foramina are different from those of *Struthiosaurus* or *Iguanodon*, and furnish a marked character, defining *Acanthopholis*. It may be difficult to correlate them with the foramina in the back of the skull of a Crocodile; but since those perforations are, for the most part, in the exoccipital bones, and extend downward at the back of the skull, it is obvious that we have here in the longitudinal arrangement something more nearly paralleled by Lizards, where the twelfth, eleventh, tenth, eighth, fifth, and second nerves are given off in more or less longitudinal series. The hindermost foramen may be referred to the hypoglossal nerve, the next, perhaps, to the pneumogastric nerve, then perhaps a vascular foramen. The two hinder foramina are much smaller than the third: and the third foramen may probably be for the eighth nerve; the fourth is small; the fifth is so large that it might well correspond to the fifth nerve. The anterior direction of the sixth makes it probable that we have here the foramen for the optic nerve; for though it is somewhat smaller than might have been expected, it is given off from the most anterior part of the side of the brain-case behind the sella turcica.

The anterior extremity of the basisphenoid is massive and wedge-shaped, broken away on the compressed inferior lateral margins, as well as in the front. A strong vertical plate rises in the middle, so as to form the anterior border of the brain-case (fig. 8). The upper margin is $3\frac{1}{2}$ centim. above the base of the skull, and it is nearly 2 centim. behind the anterior fragment of the basisphenoid preserved. This plate therefore seems to me to be exactly in the position of the posterior border of the sella turcica; but if so, the anterior border, such as is seen in *Struthiosaurus* (figs. 6, 5), is entirely broken away. What remains of the sella turcica is a concave base in front of the plate, terminating anteriorly in two diverging concave streaks of bone-surface, which probably represent the channels of the carotids (fig. 8). They extend downward and outward, making an angle of 90° with each other, and do not appear to reach forward. On each side of the posterior plate of the sella turcica there is a concave notch in the skull-wall.

The skull diverges so far from both the Crocodilian and Lacertian types that it may be as well to recognize it as equally distinct from both. It resembles *Struthiosaurus* in the downward direction of the occipital condyle, in the extension of the lateral wall of the brain-case posterior to the condyle, in the transverse horizontal expansion of the exoccipital region in front of the occipital condyle, in the massiveness of the bone in the auditory region, and in the grouping of the foramina, so that the posterior three are inferior, while the anterior three have a more anterior and lateral position; but the convex form of the base of the occipital bone, the immense thickness of the basisphenoid bone, are matter for distinction, as is the form of the alisphenoid in *Acanthopholis*. The resemblances, however, are so remarkable as to show that these two genera are near allies; and though we cannot infer with certainty the roof of the brain-case of *Acanthopholis* from that of *Struthiosaurus*, or the teeth of *Struthiosaurus* from those of *Acanthopholis*, yet they seem to

me to show that *Struthiosaurus* was probably a Scelidosaurian, and to open up a suggestive possibility of its claim to the jaws and teeth which have a Scelidosaurian character. Future researches may possibly demonstrate it to be the skull of *Cratæomus*; but as the back of the skull of *Struthiosaurus* is so different from that of *Scelidosaurus*, I have not felt justified in adopting such a view.

Cratæomus.

The dermal armour of this genus presents a remarkable resemblance to that of the Scelidosaurian Dinosaurs. The large supravertebral scutes of the caudal region are compressed, and terminate upward in a sharp knife-like edge. They are, perhaps, more like the similar scutes of *Scelidosaurus* than those of *Acanthopholis*. The flat dorsal scutes which were carried on the ribs were also keeled; but the keel was relatively lower, and the plates were more or less ovate. This, too, is a character paralleled in *Scelidosaurus*; but there are also scutes without any ridge at all, and marked with deep vascular grooves. These I regard as probably ventral. Coming probably from the region of the shoulders are two remarkable scutes which are quite unlike any thing at present figured. These plates, which are excavated on the underside, terminated in a sharp spine at each end; and the middle of the scute bore upon its surface a number of conical ossifications, which have much the appearance of a group of limpets packed close together. These ossifications have exactly the appearance of the scutes of *Hylæosaurus*, so much so as to suggest a doubt whether the armour hitherto referred to *Hylæosaurus* may not be unankylosed scutes separated from the plate which carried them, and really referable to *Polacanthus*, in which Mr. Hulke has found an armour closely approximating to that seen in this genus. Finally, there is a scute bearing a bone exactly like the horn-core of an ox; this I am also disposed to refer to the fore quarters. The distinctive features of this armour are the sharpness of the caudal scutes and the form and patelloid incrusting of the cervical scutes; but in other characters it approximates to the genera already named.

The vertebral column is remarkable for the forward extension of the neural arch in the neck and the deep gap between the anterior and posterior zygapophyses, the shortness of the neural spine, and the biconcave form of the vertebræ, while the dorsal vertebræ are remarkable for the great strength of the ridge below the transverse processes, the distinctness of the facets to which the ribs were articulated, and the broad rounded base to the vertebræ. The caudal vertebræ have somewhat the form characteristic of *Acanthopholis*, having a groove in the middle line of the base; but the single lateral ridge is a point of distinction, though the vertebræ were obviously nearly allied to those of that genus. The ribs, in having the superior margin flattened and widened to a greater extent than the depth of the bone, present a character that is found in all reptiles which carried heavy armour, but is especially characteristic of this form, though, according to Mr. Hulke, met with also in *Polacanthus*. The

fragments of jaw with the teeth, if rightly referred to this genus, present a character similar to that of *Priodontognathus*, *Scelidosaurus*, and *Acanthopholis*; but while nearly resembling *Scelidosaurus*, the tooth-structure is distinctive in the character of the serrations, just as the lower jaw is distinctive in its angularity and vascular foramina. But it is the limb-bones which best define *Cratæomus*. The scimitar-shaped scapula, with its powerful acromion process, is altogether distinctive, while what remains of the coracoid appears to indicate an equally unusual form. The humeri are remarkably powerful, and indicate an animal strong in its fore limbs, evidently a quadruped, and therefore presumably carnivorous, since the herbivorous forms have the fore limbs feebly developed. The humerus, with a general resemblance to that of *Anoplosaurus*, is far more robust, and indicates a heavier animal: no bone anterior to the humerus is known. The femur is distinguished from that of the Iguanodonts by wanting the separate external trochanter at the proximal end. It has the articular ends powerfully developed, and, perhaps, most closely resembles in general form that of *Cryptosaurus eumerus* of the Oxford clay. The tibia is remarkable for the extremely compressed form and forward development of the cnemial crest. The fibula, so far as preserved, is very like the fibula of a bird, and bears a similar relation of size to the tibia. The metatarsal and phalangial bones, if belonging to this genus, rather indicate a flattened foot, terminating in claws which were broad rather than sharp. Taken as a whole, far more difference from *Cratæomus* is found in described genera in the structure of the internal skeleton than would have been inferred from either the armour or the teeth; and it is quite possible that the armour, especially in Dinosaurs, may have undergone as little change as the feathers of birds or scales of lizards, so as to be common to several families.

Mandibles and Teeth probably referable to Cratæomus.

Three fragments of the anterior extremities of Dinosaurian lower jaws have been found which indicate two species, though the remains are so fragmentary that they cannot be defined with the detailed accuracy which is desirable. Both specimens are of about the same size, and belong to a genus which is closely related to *Priodontognathus*. I will describe the more perfect specimen first.

This species is represented by a dentary bone (Pl. XXVII. figs. 9, 10), the anterior extremity of which is unfortunately not preserved; nor is the fragment complete on the hinder or lower border, though it probably gives indications of the whole of the teeth. The alveolar border is bent in a sigmoid flexure (fig. 9); and the bone itself is bent so as to present a flattened lower part at right angles to the upper part of the side behind, but sloping more and more outward in front. The lateral contour of the alveolar border is convex, rising higher in the middle and descending to near the level of the base; it has a width of about 6 centimetres. As usual with Dinosaurs, it is higher on the external than on the internal margin. The teeth were placed in sockets defined and separated by narrow bony inter-

spaces. The sockets were circular, and indicate larger teeth in the fore part of the jaw than in the hind part. The alveoli for twenty teeth are shown (fig. 9); they did not reach to the extremity of the jaw; nor apparently was there any bony union between the rami; but the small fragment anterior to the termination of the alveolar margin is broken away. The length of the alveolar margin is about 8 centimetres; and the extreme length of the fragment is under 9 centimetres. The internal aspect of the jaw has at its base a deep groove, which widens from before backward, and passes close to the base of the jaw (fig. 9), though it appears to slightly ascend, and no doubt lodged the opercular bone. The basal margin below this groove is rounded; the surface above the groove is smooth, and forms an obliquely twisted area, which maintains a depth of about $1\frac{1}{2}$ centimetre, so far as it is preserved. It is very slightly convex in length, but concave from above downwards, the concavity increasing forward owing to the increasing twist in the bone. The depth of the jaw at the first alveolus is 18 millimetres. At the tenth alveolus it is nearly 2 centimetres; but the depth cannot be given further back, as the base of the jaw is broken away. The hinder part of the inner alveolar border shows indications of a squamous bone having come awey. This would presumably be part of the opercular bone.

The external surface (fig. 10), as already remarked, is traversed, at least in part, by a strongly elevated ridge, which inclines a little downwards as it extends forward, and dies away towards the anterior end. The surface below this ridge is flattened, but very slightly convex from above downwards, and, so far as preserved, is straight. It shows a few deep narrow vascular grooves and markings for vessels. The superior part of the side is obliquely twisted, becoming more and more horizontal behind, and more and more vertical in front. In the middle of the side, both in length and depth, are four large foramina (fig. 10), placed close together in a line, seven millimetres below the alveolar border, and 7 millimetres above the longitudinal angle in the middle of the bone. These foramina and their interspaces extend over a length of about 28 millimetres. The anterior one descends vertically; the three posterior ones enter the bone obliquely, being directed downwards, forwards, and inwards. From the hinder and inferior corner of the last foramen a slight ridge is prolonged backwards, which makes an angle in the upper margin of the jaw. The surface anterior to these foramina rounds convexly from above downwards; and below the third to sixth alveoli there are about four minute foramina, and below the seventh and eighth, only much nearer to the alveolar margin, two others. It would thus appear as though a series of foramina had extended along the bone, of which the middle four had become greatly developed. The thickness of the jaw from within outwards augments along the line of the median lateral ridge; in front it is about six millimetres, in the middle 12 or 13 millimetres, and obviously increases as it extends further backwards. What remains of the inferior margin, the anterior 4 centimetres, is concave; and the

margin curves downwards and inwards as it extends forward. The fourth alveolus is the only one which displays an indication of tooth-structure. It is the extremity of a compressed arrow-shaped successional tooth with serrated border, more after the pattern of that seen in *Priodontognathus* than in any other genus, but too imperfect to demonstrate the generic characters. It appears to be more elongated than the teeth of any genus hitherto described. It may pertain to one species of *Crateomus*.

The other fragmentary pieces of lower jaws may or may not belong to one individual. A terminal fragment pertains to the anterior end of the right ramus. Two other and smaller fragments belong to the left ramus; but they are so imperfectly preserved as to be scarcely worth notice, although they are apparently quite distinct from the species just described, if I may judge from the flatness of the inferior surface of the jaw and the flatness of the lower part of the side which was vertical.

The anterior extremity of the right ramus was loosely attached, by a rough lunate surface about 17 millimetres deep and 8 millimetres wide, to the ramus on the opposite side. Its extremity is bent a little inwards and downwards—the basal margin being concave from in front backward, and the prolongation of the alveolar margin convex. The fragment is 4 centimetres long; and though upwards of 3 centimetres of the alveolar margin are preserved, I do not recognize with certainty any tooth-sockets. If such exist, they are three in number, and are indicated by small round sockets placed just behind the symphysis; but as the whole anterior end of the bone is covered with vascular foramina, and there are corresponding foramina external to these possible sockets, it is not improbable that they are foramina also, since they present no distinctive alveolar characteristics. The jaw thickens a little in front here; it is bevelled, looks obliquely forward, upward, and, perhaps, outward, and has the appearance of having utilized the foramina in the nutrition of a pad. This surface is about $3\frac{1}{2}$ centimetres long, and above the symphysis is 13 millimetres wide, but becomes narrower posteriorly, where it terminates on the inner edge of the jaw in a sharp margin, external to which two large oblique foramina appear at intervals, the second of which seems to be external to the first tooth-socket, which is compressed from side to side, if it really be a socket, of which there is some doubt. At this point the depth of the jaw is about $2\frac{1}{2}$ centimetres. Below the anterior area described, the upper portion of the side which is smooth begins to be concave from above downwards; and the lower part of the side which is rugose is here convex, though it may, perhaps, as indicated by a fragment already referred to from the other side of the jaw, become flattened in its posterior extension. The specimen shows no trace of the groove on the inferior margin of the inner side seen in the specimen already described; and the appearance of a groove in the upper part probably results from fracture. The internal surface is smooth and concave in length. The thickness of the jaw at the posterior fracture is about 11 millimetres; the base,

which is flattened, is nearly at right angles to the internal and external surfaces, and altogether unlike the narrow rounded base which characterizes the species previously described. This, with the less extension of the alveolar margin forward and greater thickening of the extremity of the jaw to form the parrot-like terminal surface, constitute specific distinctions.

Teeth.

The teeth have very much the aspect of having been eaten (Pl. XXVII. figs. 11–16), or at least exposed to some solvent which may have slightly dissolved their surfaces; but the contours are sharp and well preserved; and though the fangs are in some cases broken, the teeth do not exhibit the indications of ordinary wear. It is very difficult, since they only number nine, to judge whether the differences which are to be detected result from relative position in the jaw, or whether one modification at least is not, as I am inclined to believe, of specific importance.

These teeth have a triangular crown and a compressed fang. There is a cingulum at the base on the outer side only; but it merely serves to give a compressed aspect to the base of the crown and to thicken the top of the fang. Even these teeth exhibit certain modifications. First, there is one with the fang perfect; and this shows that it is closed; and on the inner side at the base it curves a little and shows an impressed area, as though a successional germ had rested there; the fang in its upper part is slightly concave from side to side. The tooth is bevelled off obliquely on each side by the cutting-edge of the crown (Pl. XXVII. fig. 13). The other side has a transverse cinguloid ridge, considerably lower in position than the bevellings (fig. 14). It extends up towards the bevelled corners at the sides. The crown is convex from side to side; but the median longitudinal ridge is not distinctly defined. Below the cinguloid ridge the tooth contracts from side to side. The extreme length of the tooth is over 9 millimetres, the extreme width of crown is about $5\frac{1}{2}$ millimetres, and its length down to the base 5 millimetres. The width of the fang becomes reduced to between 3 and 4 millimetres. In a second specimen the crown presents the same characters, only that it is flatter on the cinguloid side. A third specimen has the bevellings on the attached side of larger extent, so as to reach further down the tooth; but all have the crown perfectly smooth, without the slightest trace of serrations on either side. It is quite possible that the bevellings may be produced by wear, though there is nothing to indicate such an explanation.

Then there are two teeth very similar in character, only rather broader in the crown, being fully 8 millimetres wide. These specimens want the bevellings, but have the inner side of the tooth marked, with a narrow middle surface which may be flat or concave, external to which the tooth is bevelled vertically on one side and has a thickening at the base of the crown on the other. The

base of the cinguloid thickening on the opposite side is convex in the middle and concave at the sides. Both these teeth are marked with slight rough ridges (Pl. XXVII. figs. 15, 16), which are not continuous to the cutting-edge, and are vertical, and much more marked on one tooth than on the other. Of the two other specimens which have the attached side of the crown flat, one, though but badly preserved, is remarkable for showing a few faint and vertical serrations, which are equally marked on both sides (fig. 12). They did not exceed five in number on each of the cutting-edges, though only one of these is preserved. All these teeth, I suppose, may belong to one species.

There remain two other teeth, which, perhaps, may belong to a second species or may be worn down. They are characterized by the same general features as those already described, but had the crown remarkably low, relatively broad, and hardly making any approach to a triangular form. The tooth is very thick at the base of the crown; and the cinguloid thickening extends along both sides. The crown is smooth, and shows no trace of serration.

I am inclined to refer these teeth to *Cratæomus*; they probably belong to the species described.

Cratæomus Pawlowitschii, Seeley.

Vertebral Column.

The vertebral column which I refer to *Cratæomus* is chiefly represented by the tail, of which there are about eighteen vertebræ preserved; and the series is very imperfect. There are slight differences of mineralization in these specimens, some being red, others brownish, and some nearly black; and there are slight differences in preservation, since some have the articular margins of the vertebræ rubbed away, and the processes more or less broken, and others are better preserved but somewhat crushed. Still, when the series is arranged in sequence there is a perfect continuity of character and no evidence to suggest that the remains belong to more than one species, or indeed that they may not all have pertained to a single individual. A curious feature, also observed in some of the English Cretaceous Dinosaurs, is the circumstance that these caudal vertebræ scarcely vary in absolute length, though the centrums diminish in size. Hitherto no trace of the sacrum has been found. The dorsal region is represented by two vertebræ, which show the forms of the processes; while the cervical region is represented by a vertebra from the hinder part of the neck. In the absence of evidence of another vertebral column, it may be legitimate to refer these vertebræ to the same species as the tail; and from the similarity of size it is not unlikly that the whole of these vertebral remains are the spoils of a single animal, the *Cratæomus Pawlowitschii*.

Cervical Vertebra.

(See Bünzel, pl. ii. figs. 9, 10.)

The centrum and neural arch are both preserved; but the neural

spine and transverse processes are broken away. The centrum has the articular faces somewhat oblique; but though this may be to some extent natural, it is probably augmented by crushing, since the form of the centrum has become in this way a good deal distorted. Its length along the base is $2\frac{2}{10}$ inches, while the measurement along the neural canal is about $\frac{3}{20}$ inch less. The posterior articular face, as preserved, is subquadrate, $1\frac{1}{2}$ inch deep, and about $1\frac{7}{10}$ inch wide. It is considerably excavated by a saucer-shaped depression. The anterior articulation was probably as deep, and $1\frac{8}{10}$ inch wide; but it does not appear to have been so deeply excavated as the posterior face. The base appears to have been flattened, and margined on each side by an angular ridge. In the middle these ridges are about $\frac{8}{10}$ inch apart; and they diverge towards both anterior and posterior faces. The sides of the centrum are distinctly defined from the neural arch by the deeply marked horizontal suture, below which in front is the oblong articular face for the rib, which is about $\frac{7}{10}$ inch long and $\frac{1}{2}$ inch deep. It is about $\frac{4}{10}$ inch behind the articular face. It rises as a slight pedicle; and the transverse measurement over these parapophyses is $2\frac{1}{20}$ inches. The centrum is compressed from side to side below these processes, so that a median cavity divides the side into a highly convex upper portion and a comparatively flat lower portion. The articular margin of the centrum is moderately sharp, thickened, and rounded. The neural arch has an aspect of leaning forward obliquely, which is more marked than that of the centrum, and may probably be taken as evidence that the neck of the animal was carried in a somewhat raised position. The pedicles lean forward at an angle of nearly 45°, have their anterior margins concave, and are compressed from side to side, but especially pinched in the middle. The greatest width of the arch in front at its union with the centrum is $1\frac{6}{10}$ inch, while behind and above the middle of the centrum its width is reduced to $\frac{19}{20}$ inch, again to become expanded to $1\frac{1}{2}$ inch near the posterior articulation. This median depression extends up to the side of the neural arch, being margined above and behind by a sharp buttress, which widens laterally and extends outward so as to underprop the transverse process, and form with it the upper head for the rib. Where fractured this process is 1 inch above the capitular articulation, and has a triangular outline pointed in front and about $\frac{4}{10}$ inch deep. There is a triangular area which is concavely excavated behind these transverse processes and in front of the posterior zygapophyses. The posterior zygapophyses are divided from each other throughout their length of an inch by a notch $\frac{3}{10}$ inch wide behind and rather wider in front, where it terminates in the vertical wall of the neural spine, which in the middle has a slight sharp ridge. These processes have their inner sides subparallel, are placed obliquely, and are convex superiorly from below outward. The articular facets are large, subovate, flat, and look downward and outward so as to make with each other an angle which is more than a right angle. The anterior zygapophyses extend entirely in front of the articular face of the centrum. They are similarly divided anteriorly

to a level with the centrum, and are thick strong processes which have the articular faces somewhat rounded and convex, as though to allow of considerable play. Behind the facets the bone is a good deal compressed, so as to be concave in length and concave from side to side. The base of the neural spine, as preserved, is a square pillar, rather more than $\frac{1}{2}$ inch in diameter, which appears to rise vertically. In front of this and between the transverse processes is a deep excavation about $\frac{3}{4}$ inch long and wide. The neural canal is large, and formed almost entirely by the neural arch, the neurapophyses converging so as to almost unite in the middle line of the base of the neural canal. The width of the neural canal is greatest in front, where it is $\frac{8}{10}$ inch; and its height is greatest behind, where it is about the same, or a little more, the canal being depressed in front and compressed posteriorly, the width of the canal behind being $\frac{1}{2}\frac{3}{0}$ inch. The height from the base of the centrum to the upper surface of the posterior zygapophyses is $3\frac{1}{10}$ inch; the width over the outer margins of the posterior zygapophyses is $1\frac{7}{10}$ inch; the length, from posterior to anterior zygapophyses is $3\frac{3}{20}$ inch; the width over the anterior zygapophyses was about $2\frac{4}{10}$ inch.

Dorsal Vertebræ.

(See Bünzel, pl. ii. figs. 1–3, pl. vii. fig. 24.)

Of the two dorsal vertebræ the more anterior has the lower half of the centrum badly preserved, but shows the anterior zygapophysis, transverse process, and neural spine completely. In this the transverse processes extend more horizontally outward, while in the later vertebra they are directed more obliquely upward. To begin with the latter (Pl. XXX. fig. 3), the centrum is $2\frac{1}{2}\frac{1}{0}$ inches long, and has the anterior face subquadrate, $2\frac{1}{2}\frac{1}{0}$ inches deep, and $2\frac{1}{10}$ wide. It is moderately concave. The posterior face is badly preserved at the margin, but appears to have been much smaller, since it is $1\frac{1}{2}\frac{7}{0}$ inch deep, and, as preserved, is rather wider. It has a deep pit just below the neural canal, while the remainder of the face is convex from above downward, slightly convex from side to side, and smooth. The neural canal is 2 inches long. The base of the centrum is flattened, margined by rounded lateral ridges. The upper parts of the sides of the centrum are concavely compressed, as though squeezed with the finger and thumb; and here, in the middle of the centrum, the transverse measurement is 1 inch a little below the neural canal. The neural arch is lofty, the height to the origin of the transverse process from the base of the centrum being $3\frac{8}{10}$ inches, and from its base $2\frac{2}{10}$ inches. The buttress which supports the transverse process is flattened at the side, since it is formed by pillars which arise from the anterior and posterior margins of the centrum, and converge as they ascend so as to form a sharp angular ridge beneath the transverse process, which is flattened and expanded above. There is a deep excavation in front of the vertical A-shaped masses which support the transverse processes; and these were placed behind the anterior zygapophyses. There are much larger but similar posterior excavations, which are subtriangular and in front of the posterior zygapophyses,

which were divided from each other, and looked obliquely outward and downward so as to form with each other an angle which was much less than a right angle. The neural spine is compressed from side to side, and originates from a base about $1\frac{1}{10}$ inch long. The angle enclosed superiorly by the diverging transverse processes is more than a right angle. The neural canal is subquadrate in front, and about $\frac{17}{20}$ inch wide. Posteriorly its height becomes $1\frac{2}{10}$, and its width about $\frac{6}{10}$ inch. The neural arch has the aspect of being placed vertically on the centrum rather towards its anterior part.

In the other dorsal vertebra the height from the base of the neural arch to the top of the neural spine is $3\frac{7}{10}$ inches. The neural spine is greatly compressed from side to side, rises about $1\frac{1}{2}$ inch above the platform of the transverse processes, is $\frac{2}{10}$ inch in its greatest posterior thickness, has an antero-posterior measurement of $1\frac{2}{10}$ inch, and swells out at its free end to a width of more than $\frac{1}{2}$ inch. This inflated mass is convex from side to side, and tapers forward in a wedge. The platforms of the transverse processes, which are flat above and triangular in section, are given out horizontally; the one preserved measures $2\frac{13}{20}$ inches from the median line to its free end, which is compressed from above downward, and is rounded from back to front. The base of this process occupied the whole space between the posterior and anterior zygapophyses. Its anterior margin is slightly concave, and terminates in a sharp thin edge. The posterior side is similarly thin; but its hinder part is somewhat broken. The width towards the free end is $1\frac{1}{4}$ inch. On the underside is the usual strong median buttress compressed from side to side, and terminating forward in an ovate articular facet for the rib, which is 1 inch long, looks downward and is placed towards the anterior margin; while it terminates inward abruptly on the neural arch above in a nearly circular facet, which is large, vertical, slightly concave, and gave attachment to the head of the rib; half the facet is above the neural canal. There is the usual superior concave excavation in front, behind the zygapophyses, while posteriorly the concavity which runs along the posterior side of the transverse process below terminates in an enlarged excavation; and these excavations approximate so as to be separated only by a sharp vertical ridge which is placed above the neural canal, with which its outline helps to form an S-shaped curve on the right posterior aspect. The zygapophyses present no peculiarities, the facets being flat and oblique; the anterior excavation between the transverse processes in front is small; and the interspace between the two facets for the rib on the sides of the neural arch is about $1\frac{1}{4}$ inch. What remains of the posterior face of the centrum appears to be slightly concave from side to side, and slightly convex from above downward, though this condition has probably resulted from compression. There is here no sharp line dividing the neural arch from the centrum, though the separation can be easily traced, and it is at the middle point of the suture that the compression is greatest; there the transverse measurement is less than 1 inch. The lower portion

of Bünzel's figure of this vertebra is the centrum; the transverse process is lettered *d*.

Caudal Vertebræ.

(See Bünzel, pl. ii. figs. 4–8, pl. iv. figs. 6–9, pl. viii. figs. 1, 7, 8, 16.)

There are eighteen caudal vertebræ preserved. The earlier ones have strong transverse processes, which, however, are more or less broken away, are compressed from above downward, and appear to have been short; and the vertebræ differ from each other in passing backward in the suppression of these transverse processes, which become represented by sharp ridges in the middle part of the series, while towards the end of the tail all trace of their existence is lost, and the centrum, which has become gradually reduced in vertical and transverse measurements, assumes a constricted or dicebox-like outline. None of the caudal vertebræ, except the earliest, appear to have possessed a prominent neural spine; for the neural arch has well-developed zygapophyses and a concave outline from front to back. The arch, however, soon becomes reduced in size, and in the middle of the series is greatly compressed from side to side, and the articular zygapophysial facets are lost, while towards the end of the tail the neural arch is a mere rudiment. The chevron bones were at first apparently large, and articulated with large oblique facets at the hinder margin of the base of the centrum; but these facets do not appear to have been quite distinct from each other, though they were partly divided by the median groove on the base of the centrum. They soon become relatively small, and near the end of the tail are quite separated from each other, though (it may be by an injury received during life) they appear to have become united to the centrum. Two of the hinder caudal vertebræ are fractured through the centrum, and show the bones to have contained central hollow spaces, which, however, were not clearly defined by a smooth bony lining, but are rather like the medullary cavities of the long bones of mammals. The articular edges, where preserved, are at first somewnat rounded, but terminate in a sharp outer margin. They are very slightly concave, and later on in the series become almost flat, showing that the tail possessed but little flexibility.

The earliest vertebra preserved has the centrum leaning slightly forward. It is fully $1\frac{7}{10}$ inch long, and the same depth to the chevron facets on the hinder basal margin, which, however, is badly preserved. The width of the centrum in front, at the base of the transverse processes, is $1\frac{7}{20}$ inch. The corresponding width behind is a trifle less. The anterior articular face is nearly flat, but had the margin rounded. The posterior articular face is more concave, and the rounding of the margin is less marked. The upper borders of the transverse processes are on a level with the base of the neural canal. They are placed nearer to the anterior than to the posterior articular face, are transversely oblong where broken close to the centrum, and measure $\frac{8}{10}$ inch in length, $\frac{4}{10}$ in depth. Below them the centrum is compressed; the base is broad, ill defined, 1 inch in width, rounds into the sides, and is divided longitudinally by a shallow groove about $\frac{3}{10}$ inch in width, which is most marked

posteriorly. The neural canal is high and narrow: the sides of the neural arch converge upward; and the anterior zygapophyses have the facets looking inward; they are concave in depth.

The second and third vertebræ of the series only differ in having slight tubercles adjoining the anterior and posterior articular margins on the middle of the sides, and in the decreasing dimensions of the centrum and processes, though the length still remains the same. The fourth vertebra is distorted by vertical compression, and the fifth by lateral compression. It, however, has the neural arch well preserved, and shows the length from the anterior to the posterior zygapophyses to be $2\frac{13}{20}$ inches. There is also an indication of a slight neural spine broken away, which rose above the posterior zygapophyses. The greater part of both anterior and posterior facets projects beyond the centrum. The anterior pair of facets is divided from each other; but there is only a slight notch at the hinder extremity of the posterior pair. In the sixth vertebra the neural arch is seen to taper posteriorly, when seen from above, in a triangular outline slightly compressed in the middle; and in the seventh, in which the centrum is $1\frac{8}{10}$ inch long, $1\frac{4}{10}$ inch deep posteriorly, and slightly wider, the neural arch is $2\frac{4}{10}$ inches long. There is a distinct concave compression below the anterior zygapophyses, from which faint ridges extend backward longitudinally towards the posterior zygapophyses. The facet from which the transverse process has come away is still ovate, about $\frac{7}{10}$ inch long, and is placed in the middle of the side of the centrum, just below the neural arch. The neural spine is seen to be a slight sharp ridge. The anterior zygapophyses are $\frac{11}{20}$ inch apart, while the posterior zygapophyses, which have smaller facets, are $\frac{4}{10}$ inch long. The groove on the base of the centrum has become somewhat narrower and more sharply defined. Here several vertebræ appear to be missing; and in the next of the series the transverse process has become much smaller, is placed lower on the side of the centrum, is margined by a vascular groove in front, and is prolonged backward by a sharp ridge towards the articular margin. The vertebræ now begin to elongate a little; and the ninth of the caudal series is $1\frac{9}{10}$ inch long; the transverse processes have disappeared, and are only marked by a sharp median ridge in the middle of the centrum, margined in front by an oblique vascular groove. Above these lateral ridges the centrum is compressed from side to side; the basal groove has become much shallower and best marked towards the extremities. The tenth and eleventh show the neural arch to be greatly compressed from side to side, and to rise very much higher behind than in front, owing to the greatly diminished size of the anterior zygapophyses. The posterior zygapophyses have disappeared; and the centrum is a good deal constricted in the middle. The twelfth centrum shows a much greater reduction in size of the neural arch, which leaves the posterior third of the centrum free. The underside of the centrum is similarly compressed to the upper part, though the median basal ridges become rounded. The facets for the zygapophyses are distinctly marked at both ends, and divided by a groove, of which there is no trace in the middle of

the base. In the thirteenth and fourteenth vertebræ the centrum is $1\frac{7}{10}$ inch long, with the articular face $1\frac{3}{20}$ inch wide in front and rather less behind, while the depth in front is 1 inch. The neural arch is small, and its superior outline horizontal. The measurement from the middle of the base of the centrum to its upper border is $1\frac{3}{20}$ inch. The neural canal indents the centrum concavely at both back and front articulations; and from the hinder limit of the neural arch a vascular groove impresses the sides, descending slightly forward to the middle of the base. The centrum here is most constricted, and measures $\frac{8}{10}$ inch from side to side, and has a rather less depth. The chevron bones are preserved in the thirteenth vertebra, with the posterior margin of which they appear to be blended; they unite below in a V-shape, and have facets for the succeeding vertebra. They are $\frac{13}{20}$ inch wide, $\frac{11}{20}$ inch deep, and, with the groove at the terminal end of the centrum, enclose the vascular canal. Of the fifteenth vertebra only half the centrum is preserved. The sixteenth and seventeenth are blended together, and the chevron may not have united in the median line. The vertebræ now become roughened with many slight longitudinal muscular ridges, indicative of the near approach of the end of the series; and the articular faces of the centrum appear to have central concavities.

Ribs.

(See Bünzel, pl. iii. figs. 5, 6, pl. viii. figs. 14, 15, pl. i. fig. 27.)

One cervical rib is preserved; there are about half a dozen tolerably perfect dorsal ribs, and a multitude of fragments of dorsal ribs. The majority of these obviously belong to one animal; and I refer them to the smaller of the two large Dinosaurs, *Cratæomus lepidophorus*; but there are a few slightly larger fragments which possibly pertain to the larger Dinosaur. They are, however, too imperfect to yield any characters for description; and as they are doubtful remains, I prefer to leave their elucidation to future discoveries. They are larger and stouter than the bulk of the specimens. The only example which shows the proximal end is represented in Pl. XXXI. fig. 12, and may be compared with the corresponding part of the smaller rib, fig. 17, Pl. XXVII. This proximal end is the specimen figured by Bünzel as the lower jaw of a lizard, a determination which is presumably due to its imperfect condition and the circumstance that the transverse platform is only developed on one side. I owe its identification to Mr. Hulke, who recognized its resemblance to the smaller specimens when examining the collection.

The cervical rib wants the articular head of the lower tubercle. The interspace between these two heads was nearly $1\frac{1}{2}$ inch, the outline between them being deeply concave; the ventral outline is flat, the dorsal outline concave. The length of the rib, as preserved, is $3\frac{2}{10}$ inches. After being directed outward for half its length, it curves concavely backward and tapers at the same time. There is in front, in the middle of the rib, a slight ridge. The articular head which is preserved is $\frac{6}{10}$ inch long and $\frac{9}{20}$ inch wide. When perfect

the rib must have had a Y-shaped form; and just below the fork of the Y on the posterior side is a moderately large vascular foramen.

The dorsal ribs are all imperfect at the distal end; and some of them have a much greater curve than others. The longest fragments are imperfect, proximally and distally, and measure round the outside curve about 11 inches, and across the chord a little over 10 inches. But all the ribs agree in distinctive character, which is seen in side-to-side compression along the proximal half of the visceral surface and lateral expansion on the dorsal surface (Pl. XXVII. fig. 17), so that in this half of the rib the transverse section is shaped like a T (Pl. XXVII. fig. 18); but distally the rib expands on the visceral surface, and the elevated ridge on the anterior border disappears, the direction of the rib becomes somewhat oblique, and its section has a compressed ovate outline. One consequence of this remarkable dorsal expansion is to form an expanded table-like external surface which is convex in the direction of the length of the rib, and nearly flat in the antero-posterior direction; so that the ribs closely resemble the combined rib and costal plate of a Chelonian, and in the living animal the interspaces between the ribs must have been as small as in many mammals, such as the Buffalo and the Lesser Anteater. It is, of course, possible that this expansion of the dorsal margin of the rib may be homologous with the costal plates of Chelonians, since representatives of the structure are also met with in Crocodiles, *Hatteria*, and birds. I have no doubt that this table structure carried the heavy dermal armour with which these animals were weighted. One specimen (fig. 17), which has the articular head preserved, has an interspace of $1\frac{3}{10}$ inch between the capitulum and tuberculum. The capitulum curves slightly forward, is $\frac{1}{2}\frac{1}{0}$ inch in depth, and gradually widens on the ventral surface towards the articulation, where it is $\frac{1}{2}$ inch in diameter. The tuberculum is relatively small, $\frac{1}{2}$ inch from back to front, and about $\frac{1}{4}$ inch in width. It is somewhat reniform and rounded, like the outside of a kidney. Immediately beyond the tubercle the bone begins to widen; and the anterior ridge extends in the specimen 4 inches, while in other ribs it extends 6 inches, and in some only 3. Its antero-posterior width is also variable, but, where widest, in no specimen measures more than 1 inch, and is usually about $\frac{3}{4}$ inch. The compression of the rib just below the tubercle gives a measurement of less than $\frac{2}{10}$ inch, though in some specimens it may be a little more and in others less; while the depth of the rib from dorsal to ventral surface is at first $\frac{9}{10}$ inch, and becomes gradually reduced as the rib extends and loses its T-shaped section. The side-to-side compression extends close under the external platform, so that both sides of the rib are concavely channelled. Several specimens show some amount of muscular roughness on the transverse platform and a part of the rib distad to its termination; and this is probably correlated with the muscular attachment of dermal armour. The longest ribs preserved do not indicate a greater length when complete than 14 inches. When they become obliquely

flattened they maintain a remarkable uniformity of width, and taper almost imperceptibly towards the distal extremity.

Dermal Armour.

(See Bünzel, pl. iv. figs. 1, 2, pl. vii. figs. 20, 21, pl. viii. figs. 9–12.)

The Dinosaurian dermal armour which I refer to the genus *Cratæomus* presents many remarkable modifications, such as have not been met with in any genus hitherto described. Some of the plates are remarkably similar to those of *Scelidosaurus* and *Acanthopholis*; others are large scutes with a median longitudinal ridge and numerous vascular impressions on the carinate surface, as though they were imbedded in the skin. These plates are all thin and may have been abdominal, while the more elevated plates may have been dorsal and caudal. A third type of plate appears to be greatly compressed from side to side with a sharp cutting surface in front, terminating in a spike superiorly, and with a rounded posterior margin. The articular bases of these plates are not preserved. A fourth kind of plate of large size appears to have terminated at each end in a great triangular spike, while across the intermediate space there extended rows of conical tubercles somewhat resembling in outline those attributed to *Hylæosaurus*. A fifth kind of armour is represented by an immense conical spine, like the horn-core of an ox, which rises from a bony base.

None of these pieces of armour are symmetrical, hardly any of them can be grouped in pairs; altogether there are fully fifty well-defined plates, besides a large number of fragments. It is quite possible that the remains may have belonged to more than one species. But seeing that the vertebral column of one species is well preserved in its hinder portion, and that to this species the bulk of the limb bones may reasonably be relegated, and that in many points of osteology there is an approximation of the animal towards *Scelidosaurus*, we may be justified in considering that the larger Austrian Dinosaur possessed armour as varied in character as that seen in its English prototype; and in the absence of a second and larger vertebral column, I am unwilling to attempt to divide the scutes between the two different animals, merely on the ground of their contours. Yet it may be acknowledged that the horncore-like scute is larger than would have been expected, and that the whole armour is heavy even for an animal with such strongly marked muscular development as is shown on the bones of the limbs of both the species.

I proceed to describe the armour according to the varieties it presents. As Prof. Suess had noticed, there is, besides the horn-like scute, a second base, from which the horn-like spine has been broken away. There thus appear to have been at least a pair. The base from which the horn rises (Pl. XXVIII. fig. 4) is $5\frac{1}{4}$ inches long, of irregular oblong shape with roughened edge, a little broken at one end. It is nearly $3\frac{1}{2}$ inches wide where widest, and narrows to about $2\frac{1}{2}$ inches. It is concave in length on the under surface in the middle, convex at the sides. The margin is full of vascular perforations, and appears to have had strong union

with the skin. On the broad side this bony base is $1\frac{6}{10}$ inch thick; on the narrow side the greatest thickness is $1\frac{3}{10}$ inch. The horn-like spine is placed obliquely upon it, and rises vertically, curving a little backward or outward. It is $5\frac{1}{2}$ inches high. Its base is rather more than $2\frac{1}{2}$ inches long, and $2\frac{1}{10}$ inches wide. The spine is slightly flattened on the convex and concave sides. The right and left sides are nearly straight. The bone is covered with close-set irregular vascular perforations similar to those on a horn-core. (See Bünzel, pl. v. fig. 10.)

Two other plates of quite as remarkable character are dissimilar in form, one being twice the width of the other; but both had smooth bases for attachment to the skin. The base is rounded at its lateral margins, as though it were a bone distinct from the extraordinary dermal ornament which rises from it. The larger specimen (Pl. XXVIII. fig. 2) is 8 inches long and imperfect at one end. The articular base appears to have been about $4\frac{1}{2}$ inches long and 2 inches wide, while the greatest width of the plate is $3\frac{1}{4}$ inches towards each end of the articular space, and in the intermediate area it becomes contracted to about $2\frac{1}{2}$ inches. The spine which existed at the other end of this contracted area has been almost entirely broken away; so that the plate was originally probably a central oblong mass with constricted sides terminating at each end in a large triangular spine, which was directed upward from the body of the plate. The one spine which is preserved is on its upper surface about 4 inches long, and at the base $3\frac{1}{4}$ inches wide. It is slightly convex from side to side, and terminates in a sharp cutting-edge on each side, which is longer and more convex on one side than on the other; and the longer edge is reflected a little upward. There are a few longitudinal subparallel vascular grooves in the middle of this part of the plate. On the under surface of this region the bone is flattened on the two sides, which converge towards a rounded ridge in the middle line, which helps to give strength to the sharp dagger-like extremity in which the bone terminates. The greatest thickness of this part of the plate in the middle is $\frac{17}{20}$ inch. Its base terminates abruptly, perhaps owing to some crushing on the underside. The middle oblong portion of the plate is studded over with conical tubercles, the bases of which are pretty clearly defined, and the cones are low. They are arranged across the bone in three rows with four low conical tubercles in each of the two outer rows and two larger tubercles in the middle, 1 inch in diameter, with three on the external margin of each, making in all 6 in the middle. These tubercles make an elevated border abutting against the triangular spine. Their surfaces are roughened with close-set irregular vascular punctures. The smaller plate (Pl. XXVIII. fig. 3), of similar character, is rather better preserved, its total length $6\frac{1}{2}$ inches, length of the articular base $5\frac{1}{4}$ inches. It carries a vertically elevated spine, and the base beneath this is deeply concave. The margins of the base are smooth and well rounded as already described in the larger specimen. The width of the base is $1\frac{3}{20}$ inch. At one end the compressed spine rises at an angle

from the part of the plate on which it is situate; it is somewhat fractured; but its height as preserved is nearly $2\frac{1}{2}$ inches, and the length of its base rather less; it terminates towards the free extremity in a sharp cutting-edge. Its thickness in the middle of the base is $\frac{9}{10}$ inch; and it tapers upward and outward towards both margins. It is defined at the base by a constriction which appears to separate it from the plate from which it rises. It is scored with somewhat irregular vertical vascular furrows. The corresponding plate at the other end is much smaller, and is defined from the under articular surface by a furrow; and a similar furrow appears to mark its limit on the upper surface, as though it did not completely cover the bone upon which it rests. It is of ovate outline, $2\frac{2}{10}$ inches long and $1\frac{1}{4}$ inch wide in the middle. Its surface is undulating, as though the free extremity, growing against another plate, had been forced up into an elevation. It has the aspect of projecting on one side beyond the bone on which it rests, and is then sharply compressed, and terminates in a cutting-margin which is convex in length. The interspace between these terminal plates is rhomboidal, about $1\frac{9}{10}$ inch in length, and is covered with conical tubercles, the largest of which is $\frac{7}{10}$ inch long and about $\frac{1}{2}$ inch high. These tubercles are about 5 in number, the 3 largest being on one side.

The next series of dermal bones are all longitudinally carinate. They may, perhaps, be divided into such as have the base angularly excavated, as though they were median bones of the dorsal or caudal region, and such as have the base comparatively flattened; and in these latter the keel becomes greatly reduced in height: these bones are probably lateral. Judging from the example of *Stagonolepis*, I am inclined to believe that most of these plates pertain to the tail. There are four plates, each about $2\frac{9}{10}$ inches long, with an ovate base having a rough margin, rising into a sharp cutting median keel about 2 inches in height, which has a vertical sharp margin behind and a convex margin over the length of the plate (Pl. XXX. fig. 2). The sides of these plates are concave from above downward, and convex in length; but they are all somewhat distorted by pressure. They thin away at the free margin to about $\frac{1}{10}$ inch in thickness. Four other plates, also angular on the underside, are much more elongated, and clearly overlap each other at one end, which may be presumed to be posterior. The largest of these plates is $6\frac{3}{4}$ inches long, $1\frac{13}{20}$ inch wide where widest behind, and $2\frac{1}{2}$ inches high in the highest part of the sharp compressed keel. One side of this plate is moderately concave from above downward; the other side is plano-convex; and posteriorly the underpart of the bone has the aspect of being obliquely truncated—a character which results from the posterior $2\frac{1}{2}$ inches rising free from the basal attachment so as to terminate in an upward and backwardly directed spine, which overlapped the next succeeding plate. The crest of the median ridge has a very slight sigmoid flexure. Attached to this bone on one side is a small fragment which appears to be a broken portion of the proximal end of the dorsal rib. Other plates are somewhat flatter and relatively broader;

one which measures nearly 5 inches in length has a subrhomboidal outline, two long sides converging in front, and a short pair of sides converging behind. The greatest width of the plate is $2\frac{1}{2}$ inches. The greatest length of the flat part of the base is $3\frac{1}{2}$ inches; and the posterior $1\frac{1}{2}$ inch rises into a strong spine, which terminates the median crest, is $1\frac{9}{10}$ inch high, compressed behind and above. The crest gradually diminishes in height from this spine forward till it dies away at the anterior end. The outline of the crest is very slightly sigmoid. The crest has a compressed aspect, as though it had been naturally squeezed from side to side in its upper half.

There are numerous smaller sharply carinate plates of a somewhat ovate outline, with the keel placed nearer towards one margin than the other, and always becoming a little more elevated towards one end, where it is truncated. And these plates, though mostly flat on the underside, always have the end on which the ridge is highest bent a little upward, as though to overlap the next succeeding plate. These plates vary in size: one is $2\frac{8}{10}$ inches long, $1\frac{6}{10}$ inch wide, and has the keel $\frac{13}{20}$ inch high; another is $2\frac{3}{10}$ inches long, $1\frac{7}{10}$ inch wide, and has the keel $\frac{8}{10}$ inch high posteriorly.

Another remarkable series of plates is distinguished by extreme thinness. They appear all to have been subrhomboidal and to have had the keel scarcely elevated.

The largest is about $2\frac{7}{10}$ inches long, and more than $2\frac{3}{10}$ inches wide. The under surface is smooth and slightly convex. The superior and inferior margins converge to a sharp but irregular edge; the thickness of the body of the plate is about $\frac{3}{20}$ inch, though many of the plates are much thinner; and the thickness in the line of the median ridge is about $\frac{3}{10}$ inch. This slight keel does not extend to either extremity of the plate: but the margin of each plate is turned up towards one of the posterior sides, as though they still obliquely overlapped (Pl. XXXI. fig. 3). The surface of these plates is slightly concave on each side of the median ridge, and there scored with vascular markings which ascend towards the ridge and ramify and interlace. Their prevailing direction in the plates with more elevated keels is towards the posterior spine. There are a few slightly thicker plates which have no trace of keel, but are flat below and gently convex above (Pl. XXVIII. fig. 5), with a deep Y-shaped vascular groove on each, and a sharp margin. The smallest and best-preserved is $1\frac{4}{10}$ inch long, and $1\frac{1}{10}$ inch wide.

Some fragments of crest-spines, broken away from the bases, indicate plates of a larger size than any thing here described. The plates appear to have been remarkable for their great side-to-side compression, the posterior elevation of the crest, and the sharpness of the spine, which, in fragments preserved, extended to a height of 5 inches where the antero-posterior measurement is only about 3 inches, and the greatest thickness of the spine from side to side is only $\frac{13}{20}$ inch (at the inferior fracture).

There is also a fragment indicating that the plates in which the keel is almost suppressed, in some regions attained a larger size than has here been described.

One such fragment as preserved is about 5 inches long and rather wider, with apparently two slight keel-like ridges parallel to each other. The greatest height of the crest in this specimen is about $\frac{1}{2}\frac{5}{0}$ inch.

If all this armour is correctly referred to the genus *Cratæomus*, it furnishes one of the most distinctive generic characters of this type. I do not remember any described genus in which large tubercled plates such as are here figured have been found, though an isolated plate was described from the Wealden of the Isle of Wight many years ago* as showing a not dissimilar ornament. Other plates are so similar to armour of *Scelidosaurus*, especially the median-keeled caudal plates, as to enable us to concur with Bünzel in recognizing a strong affinity to that genus, which, however, does not amount to identity. *Cratæomus* was more heavily armoured. It is difficult to say whether its armour has more in common with the bony tubercles which occur on the limbs and tail of many Chelonians, or approximates better to the bony scutes of certain lizards and crocodiles; for it is so distinct that no near parallel can be drawn between the armour of Dinosaurs and that of living reptiles; nor if the comparison were possible would it have much weight as a mark of organic affinity.

Scapulæ.

Three specimens of Dinosaurian scapulæ have been obtained; two are larger than the other, and belong to a distinct species. The two larger specimens were figured by Bünzel, and regarded by him as left ribs of his imaginary Lacertilian genus *Danubiosaurus* and the type of his species *D. anceps*. They are left scapulæ. The smaller specimen obtained subsequently is a right scapula. I refer the larger bones to the animal indicated by the larger limb-bones (*Cratæomus Pawlowitschii*), though, as the smaller specimen is little more than half the size, the disproportion in the scapulæ is much greater than would have been anticipated in the two species.

Left Scapula.

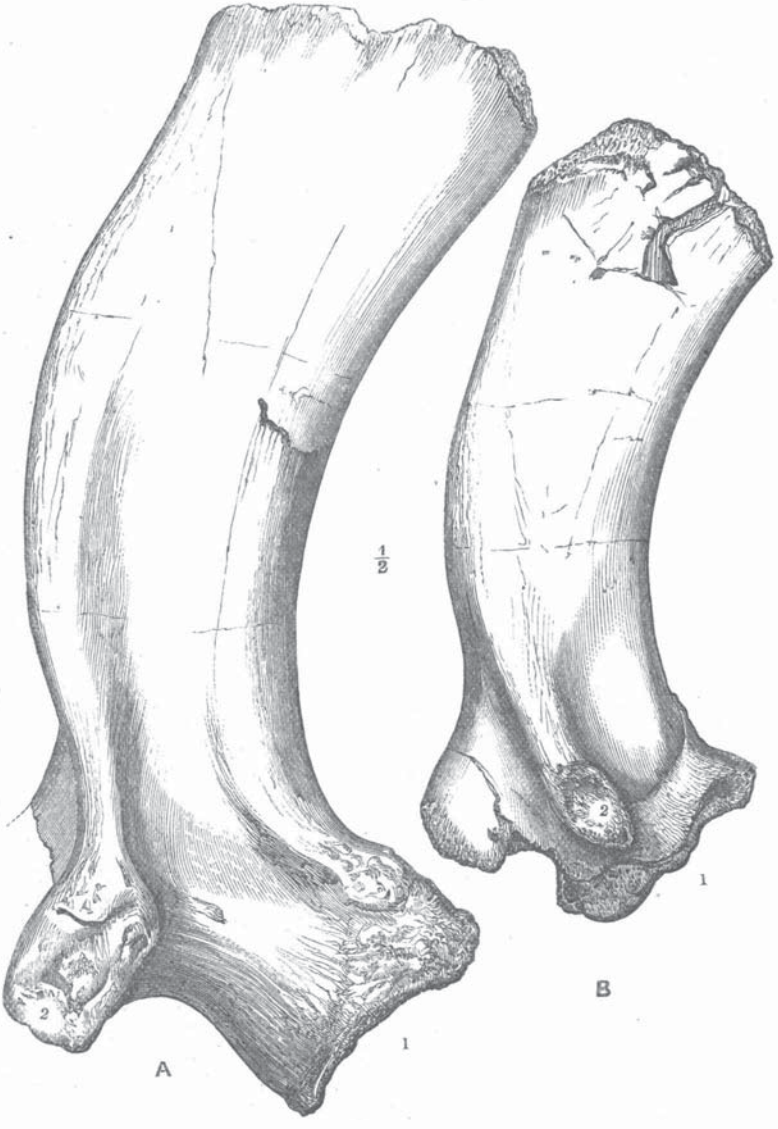
(See Bünzel, pl. v. figs. 7–9, pl. vi. figs. 1–3.)

The scapula (fig. A, p. 656) is remarkable for its great breadth, its curved form, its compressed aspect, and the remarkable acromial process in which its slight spine terminates. The specimen has been a little crushed, and is not quite perfect at its distal end; the whole surface for union with the coracoid is destroyed by decomposition, and slightly injured by fracture. What remains of the articular surface for the humerus is a semiovate surface $5\frac{1}{2}$ centim. wide and rather longer. It is margined by an elevated ridge, has the usual roughness of cartilaginous surfaces, and is more concave than usual, both in length and breadth. The inner or visceral margin of the bone appears to have been more convex than the external margin. Both are somewhat inflated; and the external surface and posterior margin

* J. E. Lee, Ann. & Mag. Nat. Hist. vol. xi. p. 5, reprinted in his 'Note Book of a Geologist.'

especially are roughened with ligamentous attachments and muscular rugosities. The thickness of the bone rapidly diminishes above the articulation; and it continues to become thinner towards the free end, where the thickness does not exceed a centimetre and a half. The posterior margin is compressed and rounded, the rounding becoming more conspicuous as the surface approaches the humeral articulation, owing to the increasing thickness of the bone. The length of the posterior side of the bone is about 25 centim.; its outline is concave; the concavity, as preserved, may be indicated by the fact that the chord joining its two extremities is 21 centim. long, and the abscissa 6 centim. high. The corresponding anterior margin is not quite parallel, since the bone is wider in its upper third than in its lower third; and hence the anterior margin is more convex. The least transverse measurement above what may be termed the spine of the scapula is $6\frac{1}{2}$ centim. In the upper third of the bone the width has increased to upwards of 8 centim.; it then contracts a little to less than 8 centim., so as to make the anterior termination of the superior margin concave; for the bone widens once more, so as to become broader than ever at its free end. The posterior corner of the free end appears to be curved a little outward. The external surface is smooth, convex in length, and more convex in breadth at the distal end than proximally. The visceral surface exhibits corresponding characters. The anterior margin of the bone is thicker, better rounded than the posterior margin, and rougher with muscular attachments. As preserved, the measurement from acromion to the anterior distal margin is 23 centim. in a straight line. In about the middle of the anterior margin the bone becomes appreciably thickened on the inner side with muscular attachments, and the thickness increases until a vertical anterior shoulder is formed almost at right angles to the spine of the scapula, extending downward and inward towards the coracoid area. Only a small portion of this triangular space is preserved; but so much of it as is seen below the acromion is 4 centim. deep. The spine of the scapula only runs for a short distance along the proximal part of its surface, and is difficult to define, because the bone is obviously compressed so as to make the surface posterior to the spine appear more concave than it really was; but the spine may be considered to originate in the thickening of the anterior margin of the bone already alluded to; and it becomes most distinct a centimetre or two above the acromion, where it is $1\frac{1}{2}$ centim. wide, flat above, and margined at the sides by rounded ridges. It is prolonged into a free process or acromion, which was directed forward and outward. This process is a little crushed, is nearly 5 centim. long, 33 millim. broad, and, as preserved, about 2 centim. thick, though before crushing it was thicker; the corners and angles of its free end are rounded; and the inferior or internal surface is concave, since it rises from the anterior coracoid border of the bone. The plane of the acromion is parallel to that of the blade of the scapula, and makes an angle of 45° with the direction of the humeral articular surface. The distance

Scapulæ of Cratæomus Pawlowitschii *and* C. lepidophorus.



A. Left scapula of *Cratæomus Pawlowitschii.*
B. Right scapula (drawn reversed for comparison) of *Cratæomus lepidophorus.*
1. Humeral articulation. 2. Acromion process.

of its inferior border from the humeral articular surface is between 6 and 7 centim. From the inferior margin of the acromion descends a strong rounded ridge which divides the part of the bone above the humeral articulation into anterior and posterior areas, and, but for the intervening acromion process, would look like a continuation of the spine. This ridge dies away before reaching the humeral articulation. Posterior to the acromion the surface of the scapula is broadly channelled. In its singular curvature and development of the acromion it is unlike the scapula of any other Dinosaur.

The second specimen, though evidently belonging to the same species, is a little smaller; it has been reconstructed out of even a larger number of fragments than the specimen described. The proximal part of the bone is wanting, the fracture having removed the articular region and acromion process; but this portion was compressed from side to side; the anterior margin of the bone, however, appears to be thicker, and the cavity in front of the acromion is more marked, than in the specimen here figured. Distally a portion of the terminal free margin of the bone is preserved, showing that it was obliquely truncated and somewhat thickened and roughened with muscular attachments, especially towards the posterior border; the specimen, as preserved, is 27 centim. long and about 76 millim. wide in the blade, where it is widest. The details of the two bones otherwise present the closest agreement.

Distal End of Humerus.

A large humerus is unfortunately only known from its distal end (Pl. XXIX. fig. 4), which has decayed in the manner so frequent with these fossils, and as though indicating that the terminal end had been a distal epiphysis similar to that which characterizes the long bones in the order Sauropterygia, which may have separated from the shaft absolutely or decayed in consequence of the less perfect ossification of its cartilaginous substance.

This fragment is little more than 4 inches long. It exhibits at the proximal end a natural fracture, made during extraction from the rock; and here the bone is $1\frac{9}{20}$ inch thick, $1\frac{8}{10}$ inch wide, ovate in outline, with an angular bulge towards the middle of the superior surface—a bulge which indicates a ridge similar to that referred to in the more perfect specimens of the other species (Pl. XXIX. fig. 1). I regard this specimen as the distal half of a left humerus of *Cratæomus Pawlowitschii*.

The fracture is somewhat interesting as showing the existence of a central medullary cavity (Pl. XXIX. fig. 5). This cavity is $\frac{7}{10}$ inch long and more than $\frac{1}{2}$ inch wide; so that the bone round it is about half an inch thick; and this contrasts remarkably with the thinness of the terminal and irregular edges of the distal margin of the shaft, which is nowhere much more than $\frac{1}{10}$ inch thick, though becoming somewhat thicker as it extends proximally. The cavity is relatively smaller in the second species. The superior surface is unfortunately somewhat crushed; and the whole specimen has been pieced together, like so many of these remains, with great patience,

skill, and success. The shaft does not widen quite so rapidly towards the distal end as in the smaller species, since the bone is $2\frac{1}{2}$ inches wide only at $2\frac{1}{2}$ inches further towards the distal extremity. The surface is remarkably smooth and free from muscular markings, except on what I regard as the outer side. This is roughened; and rather above its middle there is a chain of strong muscular eminences (which appear to be much in the position of the inner straight ridge described in *Cratæomus lepidophorus*, in which, however, the ridge was only developed proximally). Here it is strong distally, and would seem to have extended to the terminal articulation. The middle of the inferior aspect is marked by a straight vascular groove about an inch long in the upper half of the fragment; and at the extreme distal margin towards the inner side there is a vertically ovate muscular pit about 1 inch long. The distal extremity appears to be curved downward and outward rather more than usual, while the surface is more than usually convex. The sides, which are slightly concave in length, are comparatively straight. The extreme width, as preserved distally is 3 inches; but this is fully 1 inch short of what must have been the end of the specimen.

Femur.

(See Bünzel, pl. iii. figs. 2–4.)

The shaft of the right femur which I refer to this species is very well preserved; but there is no trace of the articular extremities, which disappeared before the bone was imbedded in the matrix; and towards the articular ends the bone is crushed, on the posterior aspect proximally, and at the distal end in front. There is, however, quite enough preserved to indicate a very distinct animal from that referred to *Cratæomus lepidophorus* (Pl. XXXI. fig. 5), to which, however, it was nearly related in femoral character. The fragment (Pl. XXXI. fig. 1) is 11 inches long and $1\frac{7}{10}$ inch wide in the lower third of the shaft, is remarkably cylindrical, has the muscular ridges on the anterior surface strongly developed, while the inner middle trochanter of the shaft would not be recognized as such, so feebly is it developed, were it not for the characters of the other species. As preserved, the appearance of the bone is remarkably mammalian. When perfect, it may have been 15 inches long.

The fragment of the corresponding left femur is scarcely at all compressed, but was so far destroyed before mineralization that only 7 inches of its length now remain, showing the lower half of the shaft to be subtriangular in section, being flattened behind and somewhat compressed towards the median muscular ridge in front.

The following description is drawn from the representative of the right limb (Pl. XXXI. fig. 1). The bone, which is most constricted in the lower third, widens in the usual way towards both proximal and distal ends; and its most remarkable feature is the inflation of the proximal half of the dorsal or anterior half of the shaft in the line of the median longitudinal muscular ridge. This ridge is strong; and its crest is broken into short lengths of from half to three quarters

of an inch; it originates distally in the part of the shaft which is most constricted, runs rather nearer to the external than to the internal margin, and increases in strength proximally till it becomes $\frac{2}{10}$ inch wide, where the shaft is 3 inches in diameter. All that part of the shaft which is external to the ridge is obliquely flattened, with a slight increase of inflation towards the proximal end, but without the slightest indication of the formation of a proximal trochanter, which presumably was not developed, though the absence of this structure may be due to mutilation. The inner side of the shaft is rather more convex than the outer side; but on its upper side there curves round from where the lateral trochanter should be, a muscular ridge, which is rather stronger but less well defined than the principal median ridge, towards which it very slowly converges proximally. At first the width between the ridges is nearly $1\frac{1}{2}$ inch: but at 3 inches nearer to the proximal end it is narrowed to $1\frac{1}{10}$ inch; and as it narrows, the area thus defined between the muscular ridges, which is at first flat, becomes very markedly concave. Proximally the bone curves inward as though approaching the terminal articular head, and the space external to the inner ridge is fairly well rounded. The proximal half of the posterior aspect of the bone is somewhat crushed, and appears to have been more convex than usual. It may have terminated towards the outer side in a slight ridge, and shows but very slight or uncertain indications of the posterior muscular ridge seen in the second species. The lateral trochanteroid muscular indication is placed a little higher up than is usual with the lateral trochanter: it is about $1\frac{1}{2}$ inch long, slightly elevated and rounded; its proximal end inclines slightly towards the anterior face of the bone. The lateral outline of the bone is here markedly convex.

The distal end of the bone gives no indication of the widening on the outer side of the articulation which is so often met with, since it is flattened and straight externally. Posteriorly there is a moderately deep broad channel inclined a little outward; it was evidently prolonged between the condyles, and shows the outer condyle, as usual, to have been small, while the inner condyle was large. The bone appears to have been quite as much thickened as usual at the distal end, though only the backward curve of the shaft and no part of the articulation itself is preserved. The whole surface of the shaft is remarkable for the longitudinal muscular roughnesses, which are more marked than in any reptile bone that I have ever seen.

Tibia.

A pair of large limb-bones, both 8 inches long, as preserved, but mutilated before fossilization, so that no trace is shown of either proximal or distal articulations, present, however, characters which unmistakably show them to be the tibial bones (Pl. XXXI. fig. 2). The fragments are straight on the inner side. The shaft bends inward a little at the distal end, has a long anterior crest immensely developed forward at the proximal end, and sends out a compressed process on the outer

side. The bone measures from back to front at the proximal end $3\frac{6}{8}$ inches, while the middle of the shaft measures $1\frac{6}{8}$ inch, and the distal end $1\frac{1}{4}$ inch. The whole inner surface is remarkably flattened, and, except for the usual distal widening, shows no character that calls for remark. The posterior aspect is badly defined, somewhat flattened towards the distal end, where the bone is rough with muscular markings, and $1\frac{1}{4}$ inch from side to side. The thickness in the middle of the shaft is apparently less, though the bone may be somewhat compressed; and the thickness varies in the two specimens. In length, the posterior outline is slightly concave in the middle of the shaft, and slightly convex in its upper portion, where it is well rounded from side to side. The outer surface of the bone is convex from back to front, and slightly concave in length. It becomes compressed proximally; so that it is divided by an elevated median ridge into two portions—the posterior somewhat flattened and looking obliquely outward and backward, while the anterior half is deeply concave, the concavity resulting from the natural compression of the shaft anteriorly, so as to form an immense patelloid crest something after the pattern of that figured by Leidy as characterizing *Cœlosaurus*. The anterior margin is somewhat sharp, and is defined at the distal end by a slight angular ridge, which above the middle of the shaft extends inward; so that the proximal portion of the anterior outline becomes convex from side to side, though the side-to-side compression increases, and the bone, where fractured, is again increasing in width from side to side, and measures $\frac{1}{2}$ inch. The upper part of the shaft has a subtriangular section, owing to the elevation of the external or fibular ridge. Fibulæ of two sizes occur; but the larger specimen is so small that I have noticed it under the next species.

Cratæomus lepidophorus, Seeley.

In grouping together the remains which are now to be described I have been influenced partly by their anatomical characters, partly by size, and partly by the fact that I have no evidence of the limb-bones of a third species of the same genus to which any of the bones might be referred. The specific distinctness of this smaller Dinosaur will be found well indicated by the characters of the scapula, humerus, femur, and vertebra. The armour is probably undistinguishable from that of the larger species; and at present there is no sufficient ground for saying how much of that already described belonged to *Cratæomus lepidophorus*.

Left Coracoid.

(See Bünzel, pl. iv. fig. 3.)

The left coracoid is very imperfectly preserved, giving no indication of the outline of the bone, no trace, or even indication of direction, of its union with the scapula, and showing the articular surface for the humerus but imperfectly. The bone, however, is perfectly recognizable; it has been figured by Bünzel as the right side of the ilium of *Iguanodon Mantelli*. Since no other example of a

Dinosaurian coracoid occurs in this formation, it may be useful to record the few indications and characters which it displays. The length of the fragment is about $11\frac{1}{2}$ centim.; its breadth is $4\frac{1}{2}$ centim. I infer it to have been a bone, however, fashioned on the plan of the coracoid of *Hylæosaurus* or *Scelidosaurus*. The bone thickened considerably towards the articular surface for the humerus, where the greatest transverse measurement is 36 millim., though, being eroded, this may not have been its widest point. The length of the articulation is about 65 millim.; but, from the state of preservation of the specimen, this can only be given approximately. There are some irregularities on the surface which would suggest cartilaginous covering, such as is indicated by the articular end of the scapula. In length, the surface is slightly concave. Below the articular surface the bone is excavated concavely in length, though the excavation is not very deep. This inferior surface is obliquely compressed on the inner side, so that a slight and rounded ridge extends downward from the articular surface on the outer margin of the bone. The excavation extends slightly under the articular surface. The visceral surface is so eroded as to be almost unrecognizable, only one or two patches of unworn bony surface being preserved. The external aspect towards the scapular articulation is roughened with longitudinal ridges. The middle part of the bone appears to be smooth, but carries a row of seven or eight vascular pits close to the elevated and compressed margin of the humeral articular surface, in front of which is a broad shallow furrow, as though the thumb had been drawn over a plastic substance. This furrow becomes wider as it extends downward, and at its distal termination is margined by slight muscular rugosities. Distant 3 centim. from the upper part of the humeral articulation, and rather more, apparently, from the margin of the scapula, was the coracoid foramen, which was about 15 millim. in length and probably ovate or pear-shaped, though its outline is imperfectly preserved. The external surface of the bone appears to have been convex both in length and breadth. The size of the bone can only be inferred from comparison with allied genera. From its imperfect condition I do not feel assured that this bone may not belong to the larger species.

Right Scapula.

This comparatively small bone, though corresponding in a general way with the larger specimens described (see fig. B, p. 656), presents remarkable differences, which enforce the conviction that it belongs to a very distinct species. The blade of the bone is flat, and presents no curvature of plane; its anterior margin is relatively straighter: the acromion was smaller and differently placed, and approached almost to the margin of the humeral articulation. As in the other species, the surface for union with the coracoid is eroded, though apparently to no great extent: and though the bone is imperfect at the opposite free end, there is no reason to suppose that it extended appreciably beyond the part preserved. The extreme length of the spe-

cimen is 18½ centim. The length of the posterior margin to the humeral articulation is about 15 centim., the length of the chord of the arc of the posterior curvature is 13½ centim., and the abscissa is about 28 millim.; so that the curvature is much less than in the large species. The posterior margin is also more inflated; it is similarly sharp at its distal end; but the bone thickens steadily towards the humeral end, where it rapidly expands, chiefly on the inner side, to form the humeral articular surface. The posterior margin is more rounded on the external than on the internal surface, giving the effect of an obscure ridge along the visceral border of this outline of the bone. The anterior border is also well rounded and thicker than the posterior border, the thickness in the middle of the blade being about 12 millim. The outline divides itself into a proximal part, which is concave, and a distal part, which is straight. The middle convexity of the outline is much less pronounced than in the larger species. The concavity towards the proximal end is due to the prolongation forward of the comparatively thin process for union with the coracoid. The middle part of the anterior margin is marked with fine parallel muscular ridges; and from this region the spine of the scapula is prolonged downward obliquely across the bone, so that it terminates at about the middle of the proximal end of the bone, which is 9 centim. wide. The least width of the blade in the middle of the concavity on the anterior side of the margin is less than 5 centim. The width at the origin of the spine of the scapula is about 53 millim.; and the width at the distal end, as preserved, is 6½ centim. The spine is remarkably straight; and even the length to its acromial termination is nearly 10 centim.; it does not so much suggest the form of spine in a mammalian scapula as that of *Hatteria*, existing as a broad rounded ridge, which divides the proximal end of the external surface of the bone into two areas, which are both concave in length, though the outer subtriangular area is rather wider and shallower. The acromial process is imperfectly preserved proximally; and hence the spine appears to terminate in a rounded ridge which is about 2 centim. high and approaches to within a centim. and a half of the humeral articulation. The thickness of the bone from the internal to the external surface at the worn or eroded termination of the spine of the scapula is 4 centim. The width of the process is less than 1½ centim.; and the measurement from its outer border to the anterior coracoid margin is about 5 centim., or over 4 centim. from its inner margin to the posterior humeral articulation. The visceral surface is remarkably flat; but beneath the region occupied by the spine the base was somewhat concave. The humeral articular surface obliquely truncates the inner half of the proximal end. It is much roughened and grooved with the marks of a cartilaginous epiphysis, and was broader in proportion to its length than in the larger species. It shows some sign of crushing, and is fully 4 centim. wide and 47 millim. long. Its posterior outline is much broader than in the larger species; and the axis of the articular surface was not materially different from the plane of the blade. The thickness of the anterior coracoid

process was but little more than $1\frac{1}{2}$ centim. where widest, and became somewhat narrower as it extended outward.

Humerus.

Both the right and left humeri are strong bones (Pl. XXIX. figs. 1-3) which, previously to fossilization, had lost both proximal and distal articular ends. They are of exactly the same length as preserved, and are mutilated in almost the same manner, the distal ends especially being obliquely truncated from behind forward; and they show a subquadrate section. The right humerus is slightly the more perfect; and neither bone is distorted by pressure.

The fragments are 8 inches long; and, as preserved, the right humerus is $4\frac{1}{4}$ inches wide at the proximal end; the left humerus is 4 inches wide; the shaft is most constricted in the middle, where it measures $1\frac{7}{10}$ inch from side to side; there is no corresponding constriction from back to front; but in this position the antero-posterior measurement is $1\frac{1}{2}$ inch. The bone widens distally; but, as preserved, the distal measurement from side to side is only $2\frac{3}{10}$ inches. The proximal articular head was nearly in the same plane as the distal end. The inner lateral outline is gently concave; the external outline is deeply concave, owing to the expansion outwards of the large thick deltoid process, which is bent at a considerable angle with the shaft. The antero-inferior and postero-superior outlines are both nearly straight, though very slightly concave; and they converge slightly from behind forward, owing to the slight distal twist giving to the bone an appearance of thickening to that end. At the distal end the shaft becomes flattened both in front and behind; and these surfaces are nearly parallel; and, where fractured, the bone is here $1\frac{6}{10}$ inch thick on the outer side, and somewhat thinner on the inner side. The remainder of the inferior surface is anterior to, and makes a slight angle with, the subtriangular flattened distal area. It also may be said to be a long triangle extending from the inner corner of the distal articulation forward to the divergent elements of the proximal end (fig. 2). Nearly its whole length is straight; and its middle portion is more rugose with muscular attachments than the rest of the bone: the markings have the appearance of slightly impressed ovate pits, which extend for a length of nearly 3 inches. This inferior area is defined by faint lateral ridges, and proximally, beyond the muscular markings, becomes somewhat deeply concave from side to side, and compressed towards the superior aspect, so that in length it is convex. This area is a little inflated on the inner portion, and terminates laterally in a slight sharp ridge. The outer expanded wing has a well-rounded margin.

Superiorly the bone is highly convex from side to side (fig. 1), though somewhat flattened on the inner and posterior side, and also on the expanded external process, which is smooth and slightly concave in length, and slightly convex from within outwards. The upper aspect of the bone is divided into two portions by an

oblique moderately elevated muscular ridge, which extends for about $3\frac{1}{2}$ inches across the middle of the shaft from near the inner side proximally towards the outer side distally; and though the whole superior surface, except the expanded crest, is roughened with muscular lines, another fainter ridge may be traced running straight distally from the proximal termination of the oblique ridge. Immediately below the proximal articulation in the middle of the shaft is an elevated muscular boss about $1\frac{1}{10}$ inch in diameter, which, as preserved, is subcircular. The thickness of the shaft at its inner margin is $1\frac{6}{10}$ inch, and at its outer margin $1\frac{3}{10}$ inch. The radial crest thickens towards the proximal surface, and curves a little upward. The outline of the fractured proximal end is somewhat boat-shaped and compressed (fig. 3). This humerus is quite distinct in character from any form of which I have any knowledge.

Femur.

The right femur (Pl. XXXI. fig. 5), found in 1876, is $10\frac{2}{10}$ inches long. The left femur (Pl. XXXI. fig. 4), found in 1877, is hardly more than 10 inches long. This difference is apparently due to the different ways in which the bones are compressed. They are both in the same state of mineralization, of a rich chocolate-brown colour, and quite free from matrix, which has been removed by Professor Suess. The bones belong to a somewhat distinct type; they offer many resemblances, as Professor Suess pointed out to me, to *Cryptosaurus* of the Oxford Clay, but are more slender. They therefore show the typical characters of Dinosaurs, though there is a difference from all English genera in the proximal anterior trochanter not being separated from the shaft; and there is a remarkable development of muscular ridges on the bone, one of which extends on the proximal posterior face (fig. 4) in a curve upward and outward from the small middle trochanter on the inner margin of the shaft to the outer and external margin of the proximal articulation. It is impossible not to recognize the similarity of this strong muscular ridge to the ridge seen on the corresponding aspect of the mammalian femur; and if this coincidence be admitted, it goes far to prove that the middle trochanter, which is the most distinctive mark of the femur of a Dinosaur, is homologous with the inner or lesser trochanter of man; and so far it would seem rather to imply a foreshadowing of a mammalian plan of muscle-arrangement. A similar muscular attachment to this may be observed in Crocodiles above the middle of the shaft. From it an intertrochanteric muscular ridge extends to the position in which the proximal trochanter of Dinosaurs is seen when it is developed. The shaft is most constricted in its distal third, where there is a slight flexure bending the distal articulation backward; both articular ends appear to have been highly cartilaginous, since they are marked with ramifying furrows and occasional pits. As is usual with cartilaginous surfaces, the articular margin is sharply defined.

The proximal articular surface is best preserved in the right femur,

and, as usual, consists of a subcircular head (fig. 5), which is directed inward and forward, and a narrower external area. The posterior border of the articulation is nearly straight; but the anterior outline is deeply excavated between the head of the bone and the external trochanter. The globose head measures $1\frac{7}{10}$ inch from front to back; and may be considered to be $1\frac{9}{10}$ inch from within outward; but the entire length of the proximal articular surface was about $3\frac{2}{10}$ inch. The articular surface beyond the head contracts to less than 1 inch from front to back, but widens again to fully $1\frac{3}{10}$ inch at the border of the external trochanter; as in *Cryptosaurus eumerus*, the narrower external part of the articulation is concave from within outward, and does not extend so far proximally as the convex head by half an inch. The length of the bone to the distal border of the head on its inner margin is not more than 9 inches.

The anterior proximal trochanter (fig. 5) is about $1\frac{1}{2}$ inch long, and convex in length; so that it dies away both distally and proximally, where it merges in the articular surface. It is rough with oblique muscular markings, and rounds into the flattened but slightly convex external surface, which is also roughened, with a triangular area of muscle-marking $2\frac{1}{2}$ inches long, which tapers distally. Below this area the external side loses its flattened aspect, and becomes rounded from front to back.

The proximal half of the shaft is considerably compressed from above downward, and is flattened on both aspects: its width from within outward in a line with the distal limit of the proximal trochanter is about $2\frac{4}{10}$ inches, and just above the lateral inner trochanter about $1\frac{7}{10}$ inch, while just below the lateral trochanter the width is about $1\frac{3}{10}$ inch; and there, as the shaft becomes narrower, it grows more convex from side to side. The superior or anterior aspect of the bone is marked with a strong longitudinal muscular ridge, which originates towards the hinder part of the articular ball, curves a little outward and then inward, and extends as nearly as possible in the middle line of the shaft for a length of $6\frac{1}{2}$ inches; it is moderately elevated, strongest proximally, and dies away where a distal flattening of the bone gives an aspect of flexure to the lower part of the shaft. There is also a second muscular ridge, which originates at the same point, below the outer limit of the proximal head, and, running obliquely inward, curves round the convex inner side of the bone and becomes merged in the proximal limit of the trochanter. Both these ridges are less marked than in the larger species.

The posterior aspect of the shaft (fig. 4) is much more flattened. The strong muscular ridge to which I have already referred as defining an area homologous with the obturator-region of mammals, extends distally for nearly 3 inches, and then curves more sharply inward to merge in the inner trochanter. From this ridge extend obliquely inward, so as to cross each other, two series of narrow straight linear muscular markings. Parallel to the sigmoid curve of the proximal articular margin, and about a quarter of an inch below it, is a line of about six or eight circular vascular perforations.

The lateral trochanter is placed, as usual, at the angle between the internal and posterior aspects of the bone (fig. 4). It is moderately elevated, about $1\frac{1}{2}$ inch long, $\frac{6}{10}$ inch wide proximally, and tapers distally; it is placed exactly midway between the proximal and distal articular ends. Below the trochanter the section of the shaft becomes subtriangular, being flattened on the internal aspect and posteriorly, and rounded on the external and anterior aspect.

The distal articulation is chiefly noticeable for the inflated expansion of the bone at the external margin, and for the relatively large size of the condyles (fig. 4). The articular surface is 3 inches long in the left femur, which has this region best preserved; it is very moderately convex from behind forward, and very slightly concave from within outward, and rounds gently into the anterior surface of the bone, where a concave natural impression divides the anterior margin into a larger internal area and a smaller area which is external. There is the usual ill-defined gently concave pit for ligamentous attachment just above the articulation on the flattened internal surface of the bone, which looks obliquely upward, much as in *Cryptosaurus*. The internal condyle is the larger of the two; it is about an inch wide, and curves round considerably on the posterior aspect of the bone, so as to cause the articulation to measure $2\frac{2}{10}$ inches from front to back. The interspace between the condyles is about $\frac{5}{10}$ inch; and in this region the articulation measures, from front to back, $1\frac{1}{2}$ inch. This depression becomes prolonged up the middle of the posterior side of the shaft towards the inner part for about $1\frac{1}{2}$ inch. The smaller condyle is more compressed, about $\frac{6}{10}$ inch wide, and gives an antero-posterior measurement to the articular end of 2 inches; and external to this condyle is a concave area or groove, $\frac{1}{2}$ an inch wide, which defines it from the well-rounded broad external margin. The small part of the articulation external to this condyle makes a considerable angle with the major part of the surface. The anterior half of the articular surface is nearly smooth; but the posterior half is deeply scored with about eight comparatively straight grooves, six of which lie between the condyles. These grooves appear, from their corresponding development at the anterior part of the proximal articulation, to be in the positions of greatest pressure and greatest condylar growth, and may be regarded as evidence that the bone was carried in an oblique position, as among mammals.

Tibia.

A smaller pair of tibial bones are much less perfectly preserved than those of the large species, only exhibiting about $6\frac{1}{4}$ inches of the middle of the shaft (Pl. XXVII. fig. 19). Their ends are decayed in the usual way: and distally the fractured outline was subtriangular, but formed a triangle in which the anterior and two converging posterior elements rounded into each other, and were subequal. Here the extreme antero-posterior measurement is about $1\frac{2}{10}$ inch, and the extreme width from side to side at the distal end is the same. In the middle of the shaft the antero-posterior

measurement remains unaltered, but the side-to-side measurement is reduced to $\frac{19}{20}$ inch; where the specimen is fractured proximally, the antero-posterior measurement is $\frac{17}{20}$ inch, while the measurement from side to side in the middle of the shaft is $1\frac{1}{10}$ inch. The right tibia (fig. 19) does not appear to be crushed; but the left specimen is somewhat fractured at its distal end. The inner side in both is flattened, though not quite so flat as in the larger species. The outer side is convex, but divided into two portions by a median ridge, which in its upper $3\frac{1}{2}$ inches is strongly muscular, though the markings appear to be stronger on the left tibia than on the right—a condition the reverse of that which obtains in the larger species. The muscular ridge is made up of three or four close parallel ridges. The posterior half of this side of the bone appears to be more flattened than in the larger species, while the anterior half shows indications of a similar longitudinal concavity, though the specimens are fractured too low down for more than the beginning of it to be detected. The proximal fracture displays a triangular outline with a long straight base formed by the inner side and two shorter converging sides which form the outer side. Here the bone is less than twice as deep as it is wide. On the posterior side, as compared with the larger species, the side-to-side compression is greater towards both the proximal and distal ends, while anteriorly the bone is rather more rounded from side to side. There is about as much difference in size between the two types of tibiæ as there is between the two kinds of femora, though, so far as can be judged from the fragments preserved, the differences in essential characters in the tibiæ were less important than those of the femora.

There have also been found fragments of patelloid ridges of tibiæ which appear to belong to a species slightly larger than either of these; but the materials are too imperfect for description, or even for absolutely certain osteological identification.

Fibula.

The specimen which Bünzel (pl. iii. f. 12, 13) regarded as the upper half of the left humerus of a Crocodile is undoubtedly a somewhat obscure fossil. It, however, presents nothing in common with any crocodilian humerus with which I am acquainted, especially differing in its remarkable compression, in wanting all trace of a radial crest, in the lateral compression of the shaft at right angles to the supposed head of the bone, and in the inflation of the inferior side of the head. While, therefore, I have no hesitation in affirming that the specimen is not crocodilian and not a humerus, the loss of the terminal articular end and the evidence of a certain amount of crushing makes any other determination a matter requiring some caution. The contour, however, of the bone is so similar to that of the tibia of *Cratæomus*, and one aspect, and especially the posterior margin, is so roughened with muscular attachments, that I have little hesitation in affirming that we have here the fibula of one of the Dinosaurs—a view which is further sup-

ported by the circumstance that the tibia has a strong ligamentous ridge that would correspond to the rough side of the fibula. Moreover I have found a further small portion of the supposed shaft, not absolutely continuous, but showing that the bone retained the same characters for some length further, and did not expand at its distal end. It therefore may be well to state that this specimen (Pl. XXVII. fig. 20) is to be regarded as a right fibula imperfect at the proximal end, but, as preserved, $4\frac{1}{2}$ centim. wide. As preserved, the main piece of bone is over 10 centim. long, and, with the additional fragment and the lost interspace, would indicate a length of about 14 centim. The distal end is imperfect, having decomposed before fossilization. The anterior margin is concave, the posterior margin straight and rugose. The thickness of the proximal end, as preserved, is about a centimetre, while the fractured distal end is 7 millim. thick and about 17 millim. wide. As remarked by Bünzel, the distal fracture is semiovate, but the flattened side is towards the transversely convex head of the bone, while the convex distal outline is towards the transversely concave or external surface of the head. Other fragments of similar character, also presumably fibular, but too imperfect for detailed description, may be referred, one to a larger and one to a smaller Dinosaur.

Metatarsal Bone.

(See Bünzel, pl. iv. figs. 11, 12.)

The specimen regarded by Bünzel (t. iv. f. 11, 12) as the phalange of a Crocodile is almost too imperfect for accurate determination; but since it is certainly either the second or third metatarsal of a Dinosaur, probably the former, it requires a slight notice. As preserved, it is little more than $6\frac{1}{2}$ centim. long and about 3 centim. wide in front. What I take to be the inferior surface is the best preserved; only a small portion remains of the anterior articular end, which was unusually convex from above downward. The lateral outlines are concave; and the bone measures only 2 centim. from side to side in the middle, where most constricted. The superior surface was compressed, so as to form an obscure broad rounded ridge on the outer side, with a very slight broad channel below it on the inner side. The depth of the bone in the middle of the shaft is $2\frac{1}{2}$ centim. The under surface is concave in length, flattened from side to side, with a slight twist in the plane, which is directed a little inward as it extends forward. The posterior fractured end is subtriangular, owing to the flattening of the base.

Claw-Phalange.

(See Bünzel, pl. iv. figs. 4, 5.)

A claw-phalange (Pl. XXIX. fig. 6), probably pertaining to the second or third digit of the left hind limb, as indicated by Bünzel, is ascribed by that writer to a species of *Scelidosaurus*, but may be referred to *Cratæomus lepidophorus*. It is 33 millim. long, 25 millim. wide behind, and 22 millim. wide in front, is compressed

from above downward, and, though blunt anteriorly, is most compressed on the right border. The articular surface is imperfectly preserved, but was concave from above downward, straight transversely, and inclined obliquely to both superior and inferior aspects. The superior surface, which is slightly convex from side to side, is margined on each side by a strong groove, which is not very deep, and extends forward for more than half the length of the bone. Between these grooves are a number of slight parallel ridges. At the sides the bone is excavated for the attachment of powerful ligaments, more so on the left side than on the right; and on the left side the irregular excavations extend further forward. The under surface is comparatively flat, but concave in length, convex from side to side, and marked in the middle with two irregular longitudinal grooves, which have a tendency to branch as they pass forward. These grooves are very imperfectly indicated in Bünzel's figure, which gives no indication of their dendroid character. The posterior outline of the bone is ovate, and less than 2 centim. deep.

Dorsal Vertebra.

(See Bünzel, pl. i. figs. 24, 25.)

A dorsal vertebra with the neural arch fairly well preserved is the best vertebral evidence of this species (Pl. XXX. fig. 5). The centrum is 4 centim. long, flattened on the under side, where it is $1\frac{1}{2}$ centim. broad in the middle, where most constricted; it is concave from front to back. The sides are compressed and somewhat concavely excavated below the neural arch, where the least transverse width is $1\frac{1}{2}$ centim. Thus the body of the vertebra in section would be subquadrate. The anterior articular surface of the centrum is concave, 32 millim. broad, and 27 millim. deep. The posterior end is not concave, but somewhat flattened and convex from above downward. The margin is a little worn; the greatest transverse width is less than 3 centim., the greatest depth $2\frac{1}{2}$ centim. The neural arch is high, though not unusually so for a Dinosaur. Its base is nearly as wide as the anterior face of the centrum. It extends the whole length of the centrum, and has the aspect of being compressed from side to side below the transverse processes. The borders of the neural arch are excavated (fig. 5), moderately in front, and more deeply behind, to form the intervertebral passage for the nerves. The least length of the neural arch from front to back, in the middle of the neural canal, is 23 millim. The length from the anterior to the posterior zygapophyses is about $5\frac{1}{2}$ centim.; and the upper border of those facets is fully that height from the base of the centrum. The anterior zygapophyses are directed upward, forward, and inward. Their external surface is rounded. There is a V-shaped notch between them in front; and they form the anterior border of a transverse cup-shaped depression in front of the neural spine, the hinder borders of which cup are contributed to by the transverse processes, which are directed upward and outward, and placed between the zygapophyses in the middle region of the vertebra. The neural

spine is narrow and short, and placed on the hinder half of the neural arch; only its base is preserved. The posterior zygapophyses are circular facets placed below and somewhat beyond its hinder termination. They converge downward, but are separated by a broad groove. The height of the vertebra to the base of the neural spine, as preserved, is $6\frac{1}{4}$ centim. The extreme width over the posterior zygapophyses is $2\frac{1}{4}$ centim. The width of the groove between them is about $\frac{1}{2}$ centim. The side of the neural arch is of the usual character, with ridges ascending from the anterior and posterior ends of the arch which converge upward; and the posterior ridge, which is the better marked, passes into the strong ridge which extends under the base of the transverse process (broken away on the left side) The area between these two lateral ridges, which is unusually deep and narrow and ill-defined, appears to be the capitular articulation for the rib. The space posterior to the lateral ridges is concavely excavated. The transverse process is broken off short. I infer this to have been an early dorsal vertebra. The posterior convexity of the centrum shows it to have been full-grown. This, no less than the long narrow articulation at the side, and the other characters of the neural arch described, show it to indicate a distinct species from the vertebræ referred to *Crateomus Pawlowitschii*.

Megalosaurus pannoniensis, Seeley.

There are two teeth of a carnivorous Dinosaur (Pl. XXVII. figs. 21–23) which present some resemblance to the teeth of *Megalosaurus* and *Lælaps*, differing in no character of importance except size, the fineness of the serrations, and shortness and breadth of the crown. One specimen is a crown tolerably perfect, fractured just above the base and before the commencement of the fang (fig. 21). The other is the lower half of the crown of a somewhat larger but similar tooth. The more perfect specimen is 21 millim. long, curved backwards, quite straight, convex on both sides, though rather more so on the inner side, and with the inflation towards the convex anterior margin of the tooth. The posterior margin is relatively straight, but is concave. The surface of the tooth is marked with microscopic longitudinal wrinkling and faint parallel transverse lines of growth, only to be detected by the way in which they reflect light. The posterior margin throughout its length is marked with perfectly regular transverse serrations, which extend along the tooth like a fringe. Towards the extremity of the crown the serrations become slightly shorter. On the anterior border (fig. 22) the serrations are of a similar character, but only reach down the tooth for 13 millimetres, becoming smaller as they disappear. There are about forty-five of these minute chisel-like serrations in all this margin. Where they terminate, the tooth is just appreciably narrower and the anterior margin is rounded, so that the transverse section (fig. 23) is exactly the same as in *Megalosaurus*. The serrations of the posterior margin are larger than those of the anterior margin: so that there are only about forty in the entire length of the tooth. The antero-posterior

measurement is over a centimetre, and the thickness 6 millimetres. There are no bones that I could refer to this species; and when they are discovered the teeth may prove to belong to an animal as different from *Megalosaurus* as is *Lælaps*.

Ornithomerus gracilis, Seeley.

The specimen figured by Bünzel, pl. vii. figs. 22, 23, and regarded (p. 15) as the middle of the dorsal rib of a lizard, is the distal half of the shaft of the femur of a remarkable new Dinosaurian. From the circumstance that Bünzel has figured the external instead of the internal aspect of the bone, it would have been difficult to make this interpretation without examination of the specimen. The fragment (Pl. XXVIII. figs. 6, 7) is only $5\frac{1}{2}$ centim. long, has a nearly circular shaft 13 millim. in diameter at the proximal fracture, becoming a little more compressed distally from above downwards and slightly more expanded from side to side. The specimen shows no trace of the distal articular end; but distally the bone is a little flattened on the inferior and posterior surface, and slightly compressed towards the outer border. There is a distal curve in the bone, rather more marked, perhaps, than in the crocodilian femur. Towards the proximal end of the fragment the transverse fracture passes through a longitudinal muscular pit, margined below by an elevated muscular ridge, which is prolonged further distally than the muscular pit, and appears to have terminated in a free process, though the extremity of this is broken away. This is the internal trochanter of the Dinosaurian femur (figs. 6, 7). What remains of the muscular impression is about 12 millim. long and half a centimetre wide. What remains of the sharp ridge bordering it is 17 millim. long. I am not acquainted with any Dinosaur in which the femur has this cylindrical bird-like form. The shaft is formed of dense bone with a large medullary cavity about 7 millimetres in diameter (fig. 7), and has, at first sight, rather the aspect of the bone of a bird than of a Dinosaur. Though the fragment is so imperfect, it is so characteristic that I have ventured to refer it to a new genus.

Doratodon carcharidens (Bünzel).

The sculpturing of the outer surface of the jaw, no less than its general form, would seem to have weighed with Bünzel in referring the specimen represented in his plate i. figs. 29–32 to the genus *Crocodilus*. I find myself unable, however, to accept this generic determination, partly because the teeth are such as indicate a different genus, and partly because I am led to refer the maxillary bone represented in the same plate, figs. 3–5, to the same genus and probably the same species as the lower jaw: and this shows, though the fragment is very imperfect, characters which are not met with in the genus *Crocodilus*. But whether its affinities are stronger with Crocodiles or with Dinosaurs is a matter far from easy to determine. The lower jaw consists of slender rami, having a length, as preserved, of about $13\frac{1}{4}$ centim. with-

out reaching back to the articular region. The jaws converge forward to the symphysis, where the contraction ceases, and there is a slight anterior expansion before the lanceolate anterior termination. The greatest width of this slight expansion is $2\frac{1}{2}$ centim.; and the width of the diverging rami at 10 or 11 centim. from the anterior termination is over 5 centim.; thus the jaw is remarkably pointed. The lateral contour of the alveolar margin is convex from before backwards in the region of the symphysis and concave in length behind the symphysis. The symphysis is 3 centimetres long, and is made up in the anterior and inferior part by the dentary bone, and in the posterior and superior part by the opercular bone, which, on the alveolar aspect, forms half the symphysis, while inferiorly it only constitutes the hinder fifth. In Crocodiles the opercular bone does not enter into the symphysis. The anterior part of the jaw in the symphysial region is excavated in a spoon-shape, owing to the remarkable and vertical elevation of the alveolar margin, an elevation which appears to have relation to the straightness and vertical position of the teeth; so that the fangs could not have made an angle with the crown. The whole inner side of the ramus is formed, as in crocodiles, by the opercular bone, which, as Bünzel remarks, is smooth and slightly rounded at its inferior and superior margins, and extends back beyond the alveoli, only showing in its anterior part two or three nutritive foramina. The external surface of the bone is formed of the dentary element, except, it may be, towards the hinder superior border, where a suture appears to indicate on the inner side a coronoid bone. On the under surface the jaw is flattened at the symphysis, but the flattened area rounds up anteriorly to the alveolar margin; but where the rami begin to diverge, there is a distinct sharp angle between the base of the jaw and its side, and this ridge is prolonged backwards for a large part of the region through which the teeth extend: and here the base of the ramus is slightly convex from side to side till, with the fading of the angle into the upper surface, it becomes more rounded and narrower. The suture for the opercular bone runs along the inner third of the base. In ornament, the anterior expanded end of the snout is pitted much after the pattern of crocodiles, and evidently with similar relation to a vascular condition; but inferiorly the ramus is marked with rough, short, irregular longitudinal ridges, which extend round onto the side but do not rise to the alveolar region, which is comparatively smooth and marked with a row of relatively large foramina, about seven or eight in number, and placed above the middle of the lateral margin in a concave line or groove. As they extend backwards they rise nearer to the alveolar margin, and form the basis of a slight compression of the bone above them. Posterior to the symphysis the depth of the jaw increases: it is about 9 millim. in front, 17 millim. at the last tooth-socket, and 3 centim. in the coronoid region; so that it increases in depth more rapidly behind the teeth. It is difficult to count the exact number of sockets; for some of the fangs are preserved, and in other cases the teeth have fallen

out: but there were not fewer than fifteen; and as the alveolar groove is carried back and becomes very shallow beyond this point, it is possible there may have been five teeth more, of small size, in the hinder part of the jaw, making a total of twenty. The teeth are largest in the middle of the jaw; but only the tenth on the right side has the crown preserved *in situ*. The crown is 8 millim. high, and nearly 6 millim. wide at its base. It is triangular in lateral outline, is curved inwards and directed upwards, inwards, and backwards. Its base is rather less than 3 millim. thick. Each surface is convex, terminating in a sharp cutting-edge, which is very finely serrated along the margin. In front and behind there is a constriction, so as to separate the sides of the crown from the elliptical fang; but this constriction is not appreciable on the interior or the exterior aspect of the tooth. This form of tooth is entirely Dinosaurian. Four teeth have been found separately which show the same character. Two of these are crowns broken off directly from the fang, and show the constricted oval base of the crown where the lateral ridges become pinched in. These teeth are sharply pointed, and have the surface smooth to the naked eye. There are also two teeth which have the same general form, except that the crown is broader and shorter; and, owing to this circumstance, the serrations, which are transverse to the cutting-edge, have an appearance of being directed obliquely upward. These, however, are probably successional teeth, it may be from another part of the jaw, or from the upper jaw. A certain amount of variation is obvious, because the fang of the eleventh tooth on the left side shows that the base of the crown was marked with blunt parallel ridges.

There is a fragment of the anterior end of a right dentary bone from which the opercular element has come away, and which clearly belongs to the same genus. It may indicate another and smaller species, since the rami appear to diverge more rapidly, to have contained more numerous teeth, with smaller and more circular fangs, to want the anterior elevation of the jaw in its presymphysial region, to be devoid of the ridge between the base of the jaw and the side, and to have the side convexly inflated instead of flattened, especially external to the alveolar margin. The ornament also appears to be slightly different; but as no teeth are preserved I have not thought it necessary to give a name to this fragment. The length of the dentary symphysis is $1\frac{1}{2}$ centimetre, and the length of the fragment $4\frac{1}{2}$ centimetres. The corresponding length of the dentary symphysis in the larger specimen exceeds $2\frac{1}{2}$ centimetres.

The fragment of upper jaw briefly described by Bünzel, p. 6, pl. i. figs. 3–5, I have, as already mentioned, identified with the lower jaw of the large species just described. Notwithstanding the circumstance that Bünzel remarks on its close resemblance to existing crocodiles, he places the nasal aperture immediately in front of the orbit, which alone would suffice to show that the type differed from crocodiles fundamentally. In fact, the perforation of orbit and nares in the maxillary bone would be a modification of old-fashioned

anatomy of no ordinary kind, since the maxillary bone does not enter into either the orbit or the anterior nares of the crocodile, and it certainly does not enter in any known Dinosaur into the external wall of either of these vacuities. Agreeing with Bünzel, that the margin which he regards as the anterior border of the orbit is correctly identified, I regard the perforation which he terms nasal as the preorbital vacuity characteristic of Teleosaurs, and more or less developed in various Dinosaurs. The bone between the orbit and the preorbital vacuity is always the lachrymal; and I therefore identify the lachrymal bone as united by suture with the maxillary. The length of its base is 2 centim.; but it is fractured superiorly, and therefore its outline cannot be stated, further than that it appears to have been triangular. The posterior margin is concave, rounded and thickened, with an indication of a groove, which may have had relation to the lachrymal canal. The surface is sculptured with somewhat oblique ridges, which are short and irregular, and deeper than the sculpturing on the maxillary. The suture with the maxillary is straight but slightly oblique, so that it laps a little further down on the inner than on the external surface. The preorbital vacuity only shows a small portion of its basal margin, which is rounded. The lachrymal bone in front of it is thin, and gives the aspect of the vacuity having penetrated obliquely inwards and forwards. A small portion is preserved of a suture on the superior surface, which is straight and parallel to the alveolar surface, or but slightly inclined forwards. Hence it may reasonably be identified as the suture for the nasal bone. The depth of the bone from the nasal suture to the alveolar border is 22 millim. Anteriorly the bone is fractured, so that there is no indication either of its length or of the length of the nasal suture, or of the nature of its relation to the premaxillary bone. The posterior end is also fractured; but just below the orbital border there is a minute indication of a suture, evidently indicating the malar bone, and showing that its relations were the same as in Dinosaurs. The surface of the maxillary bone is marked with an indefinite rough sculpturing, which, in the upper part, has a tendency to assume a linear character; and the hinder part is somewhat lightly pitted. The internal surface is necessarily irregular; and its appearances may be passed over in so far as they relate to the region above the palate; but above the alveoli the bone evidently developed a horizontal palatal plate, which has been almost entirely broken away. It appears to have been notched out posteriorly into a postmaxillary vacuity, such as is seen in the crocodile, since the hindermost $1\frac{1}{2}$ centimetre is a smooth, sharp, somewhat concave margin bordering the alveoli.

It is very difficult to understand the alveolar structure from an inspection of Bünzel's plate, since it gives the appearance of a double row of tooth-sockets: this is due to the circumstance that while the tooth-sockets (in which most of the teeth still remain) are placed close to the outermost alveolar border, there is, internal to them, a parallel series of pits which are broad and shallow, and are, I think,

produced by the circumstance that the teeth of the lower jaw were received scissor-like between the teeth of the upper jaw; and these pits I regard as excavations which have resulted from the pressure of their crowns—a view which is especially supported by the circumstance that they are deeper posteriorly, where the palatal border is but little above the outer alveolar border, and are less marked anteriorly, where the palatal border rises about 8 millim. above the alveolar border. The teeth extend along the whole alveolar length, which is $4\frac{1}{2}$ centim., and were eight in number in the fragment. They are larger in front than behind, and mostly appear to have been successional teeth not fully cut. The first, where broken, is 7 millim. long and 4 millim. thick. The second is less than 4 millim. long, and is clearly a section of the fang; but one of the later teeth shows the sharp serrated cutting-edge, compressed form, and smooth enamel characteristic of the teeth of the lower jaw; and it is on this evidence that I have felt justified in referring it to the same species. Both fang and crown appear to have been hollow; but as the cavities are filled with iron pyrites, I have not been able to excavate them.

There are a few other unimportant fragments, chiefly of the lower jaw, which exhibit similar sculpture, and presumably belong to this genus, but too imperfect to be worthy of description.

There is a small claw-phalange (Pl. XXVII. fig. 26) which, perhaps, for the present may be noticed here, seeing that it is quite impossible to say with certainty to which of the animals it belonged. It is 17 millim. long, curved downward and to the right. It tapers to a point, and is subtriangular, being flattened on the under side, on the left side, and obliquely on the right side, which is large. But these three surfaces round into each other, except where they are divided by the sharp lateral ridges which margin the base. The articulation is 7 millim. deep, a little narrower, concave from above downwards, and convex from side to side.

Rhadinosaurus alcimus, Seeley.

I found this genus upon the femora, which are quite distinct from any thing hitherto discovered. The humeri are such as would be associated with those bones, though there is no proof beyond similarity of character that they belong to the same species. The same remark applies to the vertebræ, which are such as might be expected in an animal of this kind; but there is no evidence of natural association. I have placed this genus next in succession to *Doratodon*, because that genus is founded upon a head, while this is formed for limb-bones; and though there is no evidence to justify their being thrown together, there is a possibility that *Doratodon* belongs to one of the animals of which the head cannot be identified.

Humerus.

Two specimens of humeral bones (Pl. XXXI. figs. 8–10) exhibit characters indicative of an animal in many respects unlike any other

in the deposit, especially in the slenderness of the shaft and relatively small size of the articular ends, as well as in the circumstance that the articular extremities were at right angles to each other. Unfortunately both proximal and distal ends are lost by decomposition. The left humerus is best preserved proximally, while the right humerus extends further distally. The length indicated by the two bones without reaching the articular ends is 14 centim.; so that the entire length of the bone, when perfect, was at least 2 centim. more. The left fragment (fig. 8) is fully 12 centim. long, and, when placed with the distal end uppermost, shows a slight convexity on one lateral margin and a corresponding concavity on the other, the concavity facing the anterior and inferior aspect of the bone, the convexity being superior. Owing to the circumstance that the proximal end is absolutely at right angles to the distal end, it happens that the shaft of the bone widens distally. The transverse measurement at the base of the radial crest (fig. 9) is $1\frac{1}{2}$ centim., and at the distal fracture 23 millim. (fig. 10); and it is still widening.

The superior distal surface is convex from side to side, with a slight ridge towards the radial side of the bone, which is really a prolongation of the muscular ridge of the radial crest, which in crocodiles never extends along the superior aspect of the bone. This ridge produces a flattened radial aspect, a slight approximation to which may be observed at the distal articular end of the crocodilian humerus; but here it gives a somewhat compressed and sharp aspect to the inferior radial margin of the bone along the distal half of the shaft, while the ulnar side is relatively flattened or rounded. The bone is marked, on the superior aspect especially, with strong longitudinal striæ or slightly elevated ridges. Its thickness at the distal end, as preserved, is about 13 millim.; but the right bone is a trifle stouter. The inferior aspect is flattened distally with a slight longitudinal depression. The proximal end of the bone necessarily widens, while the shaft remains comparatively uniform. The superior surface is smooth, and convex from side to side, but slightly channelled towards the expanded radial process, which is necessarily placed on the middle of the aspect which, when viewing the distal end, would be regarded as superior. The width of the proximal end appears to have been small. The lower part of the radial crest gives a transverse width, as preserved, of less than $2\frac{1}{2}$ centim. The inferior aspect of the proximal end is longitudinally channelled, and thus divided into a compressed anterior process and a rounded and somewhat inflated inferior and posterior part. The thickness of the bone here at the fracture is just over a centimetre. The whole inferior surface, not only of the radial crest but of the adjacent region of the bone, is roughened with powerful muscular attachments. The right fragment substantially repeats these characters; only the bone is appreciably stronger, with its muscular ridges more marked, and in length shows a decided sigmoid curve, like that which marks the humerus of a crocodile. I am led to refer these bones to the same species as is indicated by the femora next described. In this case they would indicate an

animal with remarkably small anterior limbs, suggesting the proportions of a Teleosaur. I may state that this identification is founded chiefly on similarity of general aspect, superficial texture, condition of preservation, and colour.

Femur.

(See Bünzel, pl. iii. fig. 1.)

A pair of remarkable slender bones, somewhat crushed, and without trace of an articular end, which, at first sight, have the aspect of being portions of ribs, I am disposed to regard as the femora of a small Dinosaur, having probably Teleosaurian affinities. Yet such an identification is necessarily somewhat conjectural; and I would therefore state that I am led to the conclusion that the bones are femora (Pl. XXXI. figs. 6, 7) by their slightly curved form, by the widening of what I take to be the proximal end, by the slightly smaller size of what would be the distal end, but chiefly by a large somewhat oblique muscular scar with an elevated border in its lower part, which is situate in the same position as the middle trochanter on the femur of a Dinosaur, which also looks inwards, backwards, and downwards. And I do not recognize so many probabilities in favour of any other interpretation, especially as only two bones have been found, which are right and left, while nearly all the other limb-bones are similarly represented by pairs. The longer specimen measures about 6 inches; it is $1\frac{3}{10}$ inch wide proximally; and the trochanteroid scar reaches to within $1\frac{1}{2}$ inch of the proximal end. At its upper limit the bone is $1\frac{1}{8}$ inch wide. The scar is $1\frac{7}{10}$ inch long, and about $\frac{8}{10}$ inch wide in its greatest width in the middle (fig. 6). It causes the bone to swell out in thickness, so that the internal border is much thicker than the external border, which appears to be somewhat compressed, and which is slightly convex in length; while the inner border of the bone, but for the trochanteroid bulge in its lower part, would be slightly concave. As it is, it is divided into two concavities. The widening of the bone at the proximal end I take to indicate the base of the proximal articulation. The specimen is there slightly incrusted with pyrites; but no trace is preserved of either articular head or external trochanter. The long oval of the lateral trochanter is defined by a ring, which is slightly elevated in its proximal and internal part, and much more elevated on its distal and anterior portion, which gives a width to the bone of $1\frac{3}{20}$ inch, while the width at the distal end is $\frac{19}{20}$ inch. The thickness of the bone at the distal end may be slightly diminished by accidental compression. It is $\frac{11}{20}$ inch on the inner side, which is less than the thickness at the proximal end (fig. 7), where, in a corresponding position, the bone measures $\frac{13}{20}$ inch. The inner border, both proximally and distally, is convexly rounded; the external border appears to be flattened obliquely externally in the distal half, and compressed and rounded proximally. But as the specimen is crushed, this point remains obscure. These femora are among the most remarkable bones that the Gosau formation has yielded.

Dorsal Vertebra.

There are two dorsal vertebræ, both a little crushed and without the neural arches, which belong to such a Dinosaur. From the more perfect of these I draw the following characters. The centrum is $4\frac{1}{2}$ centim. long, with the articular ends flat, and about $2\frac{1}{4}$ centim. wide. The anterior face appears to be rather the flatter and larger; but both articular margins are a little injured by fracture. Their edges are defined by a narrow bevelled area; the body of the centrum is smooth, regularly constricted, so as to be concave from back to front in every position below the neural arch, and devoid of ridges. It is more constricted at the base of the neural arch than elsewhere, and, except in being much more slender and less deep, recalls the dorsal vertebræ of *Anoplosaurus*. The neural canal is similarly narrow.

OLIGOSAURUS ADELUS, Seeley.
(See Bünzel, pl. vi. figs. 14, 15, pl. vii. figs. 1–4.)

The bone which Bünzel figures (pl. vi. figs. 14, 15) and regards as the right humerus of a lizard, I regard as the right scapula probably of a Dinosaur; while the specimens (pl. vii. figs. 1, 2, and 3, 4) regarded as right femur and fragment of humerus of lizard, I regard, from their correspondence in character and size, as probably referable to the same animal, though the femur entirely wants the trochanter which is usually seen in Dinosaurs. Taken by themselves, these two bones have enough in common with lizards to account for Bünzel's determination; but if the scapula is rightly associated with them, there can, I think, be no doubt concerning their Dinosaurian affinities.

Scapula.

The scapula is a slender compressed bone $4\frac{1}{3}$ centim. long, and imperfect at both ends, but not so much injured as materially to affect its characters. The inner or visceral side is slightly concave in length, and makes no approximation to the concave form the bone has in the crocodile. This inner surface is gently convex from side to side. The posterior margin is nearly straight, becoming slightly concave towards the proximal end. In adopting this nomenclature I have followed the crocodilian analogies rather than those of certain Dinosaurs. This posterior margin, as preserved, is 33 millim. long; it is rounded, rather compressed towards the free end, and somewhat obliquely flattened towards the proximal end, where a slight ridge becomes developed, which extends towards the articulation, giving the bone a thickness of about $\frac{1}{2}$ centim. The blade of the scapula is moderately concave on its anterior border, which, as preserved, is 3 centim. long. The width of the distal end is 11 or 12 millim; in the middle the blade becomes constricted to a width of 1 centim., and then expands proximally. The proximal width cannot be given, on account of fracture; but the specimen, as preserved, is 17 millim. wide. The anterior margin is more com-

pressed than the posterior margin. There is an indication of a ridge towards the proximal end, similar to that on the opposite side of the bone; and between these ridges, which are 13 millim. apart, the proximal end of the bone is concave from side to side. The bone does not greatly thicken at the proximal end, the greatest thickness towards the anterior border is 6 millim. There is a general resemblance in character to the scapula attributed by Professor Owen to *Iguanodon Mantelli* (Pal. Soc. 1854, pl. xiv. fig. 1); but in this form the blade is not so constricted, and it may be doubted whether the anterior process there so marked attained any corresponding development in this fossil; nor is the resemblance closer to *Scelidosaurus*; and, indeed, in the straightness of its posterior margin the bone rather suggests the scapula of an *Ichthyosaurus*, in which, however, the straight margin is anterior.

Humerus.

The bone which Bünzel identifies as belonging to the right side of the body seems to me to be referable to the left side. The reason for this determination is that the articular head of the bone is on the right side, as proved by the thickening, and the radial crest on the left side. Like most of the other specimens, this is imperfect at both the articular ends, though enough remains to convey an idea of the form and length of the bone before it was mutilated. The shaft, which is greatly expanded proximally, is 5 centim. long. The distal end has the superior and inferior surfaces parallel; and the bone is 8 millim. thick and nearly 12 millim. wide, more rounded on the anterior than on the posterior border. From the superior outer border a faint rounded ridge extends up the shaft towards the middle of the articular head; and an impression occurs in its upper half which appears to be muscular. The width of the bone at the proximal end, just above this ridge, is 22 millim. Internal to the ridge the bone is compressed, so as to contribute to form the articular head. External to the ridge it is transversely expanded, somewhat flattened, and marked with strong longitudinal grooves at the outer extremity of the radial border. The radial border is more concave than the ulnar border. The thickness of the radial expansion is about 6 millim., but diminishes proximally. The thickness of the base of the proximal articulation where fractured is about 9 millim. The inferior surface is regularly concave from side to side at the proximal end, and convex in length, corresponding to the transverse convexity and longitudinal concavity of the superior surface. The shaft where most constricted, in its lower third, is less than 1 centim. wide, while its thickness steadily diminishes from the distal end to the radial margin at the proximal end. This bone possesses none of the typical characters of a lizard-humerus, but all those which are usually found in Dinosaurs, though I am unable to name any genus in which the form of this bone is so closely paralleled as to suggest generic identity or even affinity. The distal fracture, which is transverse, is so irregular as to suggest an epiphysial surface from which the epiphysis has come away.

Femur.

Bünzel, though referring this specimen to the right side of the body, has given no indication as to its proximal and distal ends. These determinations are a matter of some difficulty; but it is well known that, as a rule, a Dinosaurian femur is thicker on the inner than on the external margin, which is commonly compressed: and there is usually a certain compression of the bone on the posterior surface. I have hence been led to regard this specimen as probably the shaft of a left femur which has lost both the proximal and distal ends. The fragment is 6 centim. long; the shaft is curved more after the crocodilian than the Dinosaurian pattern; only it is a simple convex curve, without any trace of a sigmoid flexure. The shaft is nearly cylindrical, 1 centim. in diameter in the middle, where most constricted; and there it is about 9 millim. thick. What I take to be the distal end expands transversely to 13 millim., is flattened on the superior and inner borders, flat or concave on the inferior border, somewhat compressed towards the external side. The bone is 9 millim. thick on the inner margin, and 6 millim. thick on the outer margin. Proximally there is a nearly similar expansion of the bone; only the inner border is directed well inwards, the external border is more flattened, and the inferior surface is flattened. The width of the proximal end, as preserved, is $1\frac{1}{2}$ centim. It is impossible, in the absence of more distinctive characters, to form any opinion as to the affinities of this specimen. A curious circumstance concerning it is that, while indubitably a left femur, either end could be regarded as proximal.

Vertebræ.

Two vertebræ are figured by Bünzel, pl. viii. figs. 2–4, which he regarded as indicating a fœtal Dinosaur. It is difficult to discover any evidences that would enable one to confirm this remarkable speculation. The vertebræ are beyond all doubt Dinosaurian; but except in the fact that the neural arch is lost, there is no sign of immaturity. The articular ends are perfectly ossified and almost flat; and though the specimens are a trifle worn from rolling, I have no doubt that they must be referred to a fairly well-developed animal. The larger and better-preserved vertebra has the centrum $1\frac{1}{2}$ centim. long, with the sides somewhat converging, but well rounded below. There is the base of a transverse process, seen in the middle of the side, just below the pit for the neural arch. This circumstance determines the vertebra as an early caudal. The transverse measurement over the bases of these processes is 14 millim. The anterior articular surface is nearly circular, $1\frac{1}{2}$ centim. deep, and nearly as wide, with the margin rounded and the articular surface nearly flat. The posterior articular end appears to have been rather small and rather more concave. The neural arch did not extend the whole length of the centrum. The neural canal is concave from front to back. There are no signs of facets for chevron bones.

The second vertebra is about $1\frac{1}{4}$ centim. long, but had a keel on the base of the centrum. It appears to have been smaller than the other; but, as the dorsal half of the centrum is not preserved, it may be that this is a similar caudal vertebra.

There is no evidence that these vertebræ belong to the animal which possessed the limb-bones; and I have noticed them here because they are not obviously referable to any of the other species described.

Hoplosaurus ischyrus, Seeley.

In June 1880 I received word from Prof. Suess that another collection of Cretaceous reptile remains from the Gosau beds existed, which was discovered long before the publication of Dr. Bünzel's paper. Eventually this small series was secured by Prof. Suess, and forwarded to me. The specimens are imbedded in a hard calcareous clay, and are in a bad state of preservation, having been fractured in the contortion of the rocks to an extent that often makes identification of the fragments extremely difficult. Prof. Suess remarks of the collection, "It is not very much—a few broken articular ends of limbs, a number of those thick roof-shaped dermal plates well known to you, and a few fragments of vertebræ—the whole imbedded in a number of hard fragments of calcareous clay evidently once united together, and clearly belonging to the same individual; so they may be of some interest as showing to which limb-bones the dermal plates belong." They are certainly the most unpromising set of fragments that I ever examined with a view to the study of a new type of life; and yet they certainly indicate a different species from any of which the other collections give evidence. I have removed the matrix, and offer a few notes on some of the more characteristic fragments.

Proximal end of right Humerus.

This fragment indicates a humerus very different from any thing with which I am acquainted, but perhaps makes a near approximation to that reptilian humerus described by Mr. Hulke as probably referable to *Hylæosaurus*. It has lost the radial crest, which appears to have been reflected downward more conspicuously than in Mr. Hulke's specimen, and to have presented more of the Crocodilian conformation, though it extended up to the articular head of the bone, as is usual in Dinosaurs. The superior surface has been fractured, so that the entire thickness of the humeral articulation is not demonstrated; but it was evidently oblong, and measures $6\frac{1}{2}$ centim. in width, and, as preserved, is 4 centim. thick just internal to the radial crest, and over 3 centim. thick above the ulnar tuberosity. It appears to have been comparatively flat, and is remarkably pitted with the evidences of a cartilaginous epiphysis. It appears to be inclined at a considerable angle towards the radial side of the bone. Towards the ulnar side it is rounded. On the ulnar margin it is constricted; and a portion of a tuberosity remains on the inferior surface which is 2 or 3 centim. below the articular head, and increases

the transverse width of the bone to about 8 centim., thus giving to the head of the bone a blunt wedge-shaped aspect; a concavity completely separates the tuberosity on the inferior surface from the articular head. Unfortunately I have not found it possible to clear away the matrix from the inferior surface, except so far as was necessary to show that there was a concavity behind the radial crest. The radial side of the bone is flattened, but a little concave from side to side on its external aspect. It forms a considerable angle with the superior face of the bone, from which it is divided by the ridge or tuberosity which formed the ball-like part of the articulation; though this ball is fractured, it was placed conspicuously towards the radial side; and beyond it is a longitudinal concavity. The fragment is only about $7\frac{1}{2}$ centim. long, and the fracture is not sharp; but it shows that the shaft was becoming remarkably flattened and compressed, especially towards the ulnar side.

The specimen thus presents a very marked difference from the humerus of *Anoplosaurus*, and is unlike that of any other genus, especially in the constriction which defines the ulnar tuberosity and in the angle which it makes with the head of the bone.

There is a small fragment which might well be a part of the middle of the shaft of this specimen, too imperfect for description; but if it really pertained to this bone, it may be interesting as showing a thickness of nearly $2\frac{1}{2}$ centim.

A third fragment, very imperfectly preserved, I am disposed to regard as the distal end of the right humerus, though it is so imperfect that I cannot speak confidently on the matter. It only shows one condyle, which is almost globular, with the flattened lateral margin of the bone and a small adjacent part of the superior surface of the shaft. This condyle, however, is remarkably massive, is rounded, less than 4 centim. thick, and $4\frac{1}{2}$ centim. wide, with a rugous articular surface extending internally parallel to the external lateral surface of the bone, and indicating, if I have correctly guessed the nature of the fragment, that the ulna developed a process received between the condyles in an unusual manner. The bone was evidently concave from side to side in front and greatly compressed between the condyles, very much as Mr. Hulke has represented in *Hylæosaurus*; it was thick on the ulnar side, and evidently more compressed on the radial side.

Articular ends of Scapulæ.

The scapulæ are fractured so that the entire blade of the bone is lost as well as the articular surface for the coracoid; so that nothing remains but the articular region. The left scapula is rather more perfect than the right. The specimens have, at first sight, rather the appearance of articular ends of caudal vertebræ than of scapulæ. The left specimen shows the articulation to have been an elongate ovoid with the internal margin of the articulation convex and the external margin more flattened. The extreme width is $4\frac{1}{2}$ centim., and the length about $6\frac{1}{2}$ centim., as preserved. The articular sur-

face was moderately rough, with the margin slightly rounded; and it was concave from front to back. Just above the posterior rounded termination of the articulation the bone is thickened so as to form a very slight tuberosity, most conspicuous on the internal surface, where a groove divides it from the articular head. This inferior surface of the bone is convex from side to side, but soon becomes compressed, so that the blade, where fractured, at 4 centim. from the articulation, is less than 2 centim. thick. On the external surface the specimen is concave above the articulation, partly because there is a slight rounded ridge on the posterior edge, not, however, separable from the rounded posterior border, and partly because the bone is becoming thickened anteriorly, evidently in relation to the development of a strong spine or crest at about 2 or 3 centim. above the articular surface. The articular margin is marked with longitudinal lines of ligamentous attachment. It is of course impossible to speak of the affinities presented by this form of scapula; but the bone appears to me to be distinct from the scapula of *Cratæomus*, *Anoplosaurus*, *Iguanodon*, *Scelidosaurus*, and other types with which it might be supposed to be allied.

A flat expanded bone, very imperfectly preserved, appears to be a portion of a coracoid. It has but one margin remaining, which is straight for a length of upwards of 5 centim. and indicates an articular surface at right angles to the bone, such as may have adjoined the scapula. The specimen is upwards of 7 centim. broad and 10 centim. wide, as preserved, but is too imperfect for description.

Vertebræ.

The vertebral fragments have shared in the general fracturing. There are two portions of sacrum which had thoroughly decomposed before fossilization. One fragment indicates two vertebræ ankylosed together; the other fragment I regard as showing the base of the centrum of another vertebra, and on this evidence should infer that there were at least three, and probably four, sacral vertebræ, though the second specimen is imperfect in every direction, so that it has to be regarded carefully to be accepted as a vertebra at all. This fragment, as preserved, is 5 centim. long, broad, rounded on the under side and somewhat flattened, with a shallow median depression which is fully 1 centim. wide.

The same characters are shown in one of the ankylosed vertebræ. These also are imperfect at both ends, so that it is impossible to judge what the length of each centrum may have been; but, as preserved, the length of the two together is a little over 5 centim.; and 3 centim. of this belong to what I regard as the more anterior of the two. This vertebra is very slightly concave from front to back, and convex from side to side, with the aspect of being flattened on the under side and with a very slight median depression, which becomes more marked in the second vertebra. The sides are rounded and concavely impressed between the transverse processes. This appears to have been given off at the suture between the two vertebræ, which is somewhat ele-

vated and expands laterally—though, from the fractured state of the specimen, it is impossible to state the width across the vertebra, which, as preserved, is only 5 centim., but may perhaps have been somewhat more. The centrum appears to have been depressed, as usual in the sacral region, but there is no fracture showing its exact thickness. This form of vertebra is very different from that referred to *Iguanodon* by Prof. Owen (Pal. Soc. 1854, pl. 3), in which the base of the centrum is a sharp ridge. It is also unlike, but nearer to, the centrum represented by the same author, pl. 7, and referred to a young *Iguanodon*, in which the base of the centrum is flat, with a sharp ridge margining each side.

There are two vertebræ which appear to be caudal—one from the early part of the tail, the other from the later part of the tail. Both appear to have been equally long; and both are crushed. The earlier caudal vertebra, as preserved, has the centrum about $4\frac{1}{2}$ centim. long, and 22 millim. wide in the middle of the base. The anterior face appears to have been concave, and, as preserved, is $4\frac{1}{2}$ centim. deep; the depth of the posterior end of the bone is somewhat less. The base is flattened, though concave in length, and separated from the sides by a sharp angular ridge. The sides of the bone are concave. The transverse process appears to have been placed on the hinder part of the centrum, below the neural arch, and to have had an antero-posterior extent of no more than 17 millim. The neural arch is compressed from side to side and constricted from back to front, with a rounded ridge margining the straight outer border of the neural arch, which is inclined obliquely backward. The zygapophyses are imperfectly preserved. The posterior zygapophyses extend beyond the centrum; of the anterior zygapophyses no trace is preserved. The later caudal vertebra has a constricted dicebox-like form. Its contour appears to have been five-sided at the articular ends, with a median ridge on the base and lateral ridges at the middle of the sides. The length of the centrum is about 5 centim. Its depth appears to be about 3 centim., and its width $3\frac{1}{2}$ centim. This I take to be at the posterior end of the bone. Only an indication of the neural arch is preserved; the width of the canal increases posteriorly as usual. Another vertebra, apparently dorsal, is imbedded in the matrix; but I have not felt justified in excavating it so as fully to display its characteristics.

Dermal Armour.

The dermal armour comprises plates of two patterns:—first, more or less circular plates of moderate thickness; and angular plates which are thick at one margin, thin at the opposite margin, and have the surface concave in one direction and convex in the other. They are flat on the under side. One or two of the small biscuit-like plates present that curious angular combination of fibres that is characteristic of the armour referred to *Hylæosaurus*, a character which rather suggests the etched surface of a meteorite than the structure of ivory. I have been led to think that this armour of Hylæosaurian

character is probably abdominal, or at least was not placed in a position so exposed on the sides of the body as the larger and thicker scutes. One of the plates, as preserved, is 6 centim. long, less than 5 centim. wide, has the margin rounded, and not more than $\frac{1}{2}$ centim. thick (Pl. XXXI. fig. 11). It shows the fibres crossing somewhat obliquely, so as to define slightly rhombic areas. This structure is suggestive of the transverse crossing of the fibres in ivory; but I have no evidence whether it extends into the substance of the bone.

Another plate of about the same size appears to be rather thicker, and, though retaining traces of the cross angular markings, has the surface of the scute a good deal pitted and marked in lines with fine vascular perforations. The larger scutes appear to have lost the cross striping and to show a more porous texture. They are remarkable for having the angle on the scute placed so near towards one margin as sometimes to make that side all but vertical to the base. The other side covers nearly the whole superior surface of the scute, and presents the curious saddle-shaped form to which attention has already been drawn. One of these scutes is $6\frac{1}{2}$ centim. long, and has the angular crest $2\frac{1}{2}$ centim. high, while the average thickness of the plate is not much over 1 centim. In another specimen the crest appears to rise considerably higher, and gives evidence of median compression and oblique overlapping; the base is slightly concave.

Besides these remains there are portions of ribs, which are slender, straight, flattened, or slightly grooved on one side and convex on the other, with the anterior margin of the bone rounded and the posterior margin compressed to a sharp ridge. These fragments are all short enough to appear straight, and have a width of about $1\frac{1}{2}$ centim. There are a few fragments which give some information about the characters of the articular ends of some of the larger limb-bones; but they are so obscure that I have not felt justified in attempting to describe them; and there is a fragment which may be a portion of an ilium, of unusual shape.

Crocodilus proavus, Seeley.

The remains of a procœlous Crocodile, some of which were figured by Bünzel (pl. i.) comprise 2 cervical vertebræ, 8 dorsal, one lumbar, one sacral, an early and a late caudal, portions of two iliac bones (which unfortunately exhibit no characters of value), the proximal end of a femur showing the typical Crocodilian characters in a very pronounced manner, and the ulna and radius. There are Crocodilian teeth which have lateral ridges and striated crowns, and small successional teeth, and a parietal bone.

There is also evidence of a minute Crocodile in the articular head of a femur. The fragment is too small for description; but it obviously indicates a distinct species from the larger remains, as shown by the greater forward curvature of the head, its relatively greater width, and the stronger development of the median crest on the under side of the articular surface.

Femur.

The proximal fragment of the femur (Pl. XXIX. figs. 7, 8), which may have belonged to the same animal as the vertebræ, is $6\frac{1}{2}$ centim. long, exhibits the usual sigmoid flexure, and is compressed on the external or superior surface as in living Crocodiles. Unfortunately the posterior margin of the head is not quite complete; but from the region of the great trochanter a powerful muscular ridge, defined by a groove on its anterior side, runs obliquely downward, outward, and forward, exactly as in the living Alligator; only the muscular power appears here to have been greater. The shaft of the bone is similarly subcylindrical; and the ridges are distributed in exactly the same way. The inferior surface of the bone shows the articular head to have been rather better developed than in the Alligator, apparently a little broader, and curving a little more inward. The median process is more developed, and extends as a distinct ridge for a short distance down the shaft. The muscular tuberosity which represents the lesser trochanter in Mammals and the trochanter of Dinosaurs generally, seen in the middle of the shaft, is better developed than in the recent type. There is an oblique oval depression with an elevated ridge behind it, and another ridge extending above it proximally. The posterior ridge runs proximally towards the articular head, and is separated from the ridge above the muscle by a groove. Every thing which distinguishes the living Crocodile is here intensified.

Proximal end of Right Fibula.

The specimen which Bünzel regarded (pl. vi. figs. 12, 13) as the rib of a lizard presents all the characters of a small crocodilian fibula, in which, as compared with living forms, the crocodilian attributes are somewhat intensified. But the bone-tissue is so dense and brilliant that it has more the aspect of the bone of a bird, Ornithosaur, or Lacertilian. The fragment (Pl. XXVIII. figs. 10, 11) is about $3\frac{1}{2}$ centim. long, and has been obliquely fractured below the expanded head, with a minute displacement which slightly augments the curvature of the bone.

The articular head is relatively thicker than in the Mississippi Alligator, measuring fully 11 millim. from front to back, and 7 millim. from side to side. The articular surface is somewhat saddle-shaped as in the living animal, being concave in length and convex in width. It is widened a little posteriorly, owing to the development of an oblique muscular ridge, which in the existing crocodile does not approach so near to the articulation and is less internal. The internal aspect of the bone is less flattened than in the Alligator, is similarly marked below the articulation with short muscular ridges; but they are not defined by a V-shaped area, and hence the longitudinal tibial ridge, which is well marked proximally, does not originate in a Y-shaped form. The anterior margin of the bone is convex from above downwards; and there is a corresponding concavity in the length of the posterior outline. The external sur-

face was presumably convex from side to side, though (owing, I think, to crushing) it has a longitudinal groove. There is a small muscular tuberosity on the outer anterior margin, as in the Alligator, just where the compressed and curved proximal end merges into the straight and nearly cylindrical shaft. The shaft at the fracture is 7 millim. long by 6 millim. wide, and has a medullary cavity which is over 2 millim. in diameter (fig. 11).

Ulna.

With the radius figured by Bünzel, pl. vii. figs. 7, 8, occurs an ulna. The radius was regarded as that of a lizard. The ulna, which is slender and compressed, with a somewhat expanded proximal end, is exactly paralleled by some of the living short-snouted Crocodiles. The ulna (Pl. XXIX. figs. 9, 10) is $6\frac{1}{2}$ centim. long, and referable to the left side of the body; it has the shaft smooth, compressed from side to side, and contracting and curving as it descends from the humeral to the carpal surface. The articular head of the bone (fig. 10) is remarkably large, being in antero-posterior measurement over 17 millim., while the width is 11 millim. towards the radial border, and about 1 centim. at the posterior border. This surface is somewhat concave from front to back. Immediately below the articulation at the proximal end is a deep impression, which may possibly be due to pressure, but may also indicate the entrance of a large vessel into the bone. On the superior aspect there are natural impressions in the middle of the side and below the inner margin of the articular surface. The thickness of the shaft just below the articular head is 5 centim.; and though this thickness becomes reduced a little in the middle of the shaft, there is a slight thickening again towards the distal end. The width of the shaft just below the articulation is 1 centim.; and this width diminishes to about 6 millim. just above the distal articulation. On the superior surface of the distal end of the shaft a ridge appears at the hinder margin, which extends obliquely across the bone. The distal end is a little crushed and twisted, subreniform, more than 1 centim. wide, and 6 millim. thick, and makes an angle of about 45° in the plane of its direction with the proximal end. The form of the articulation appears to include three regions—first a deep middle groove, external to which is a small spherical ball, while internal to it is a concavity. The median groove and the compression of the bone on the inferior margin give to the articulation somewhat of a broad V-shape.

Radius.

The radius is represented by both right and left bones. The specimen figured by Bünzel (pl. vii. figs. 7, 8) appears to me to be left. It is a straight bone, 6·2 centim. long, corresponding in length with the ulna. The proximal end (Pl. XXIX. fig. 13) of the bone is expanded transversely, with a thickened margin on the inferior border. This end of the bone is fully 1 centim. wide, but, as preserved, is only $\frac{1}{2}$ centim. thick, probably owing to crushing of the superior articular border.

The shaft (fig. 11) rapidly contracts, so that at a little below the articulation it is hardly more than $\frac{1}{2}$ centim. wide; but it gradually expands distally to 1 centim. The bone is compressed from above downward; its thickness in the upper half of the shaft is 4 millim.; but it increases in the lower half of the shaft to over 5 millim., owing to the development of a median ridge which divides this part of the bone nearly equally into internal and external areas, which are margined laterally by ridges. The inferior surface is also marked towards the distal end by a slight longitudinal median ridge; and the articular end of the bone is subreniform, convex from side to side. The width of the distal end (fig. 12) is 1 centim.; and its thickness in the middle is about $\frac{1}{2}$ centim. The distal ridges are an important distinctive character not found in living Crocodiles.

Cervical Vertebræ.

The cervical vertebræ are probably about the third and fourth. What I take to be the third is only the centrum, and, except in less development of the tubercle for the ribs, differs in no essential point from the better-preserved bone. The fourth vertebra (Pl. XXX. figs. 6, 7) might, indeed, be the fifth, sixth, or seventh, since it presents all the characters seen in the vertebræ of the Alligator in the middle of the neck. It is about the size of the vertebra figured by myself as that of *Crocodilus cantabrigiensis*, but is shown to belong to a distinct species by the less antero-posterior length of the neural arch, its greater inclination forward, the stronger development of the hypapophysial spine, and minor characters.

The centrum is 17 millim. long, terminates posteriorly in a well-rounded articular ball which is about 4 millim. long, and is margined below by a sharp ridge and above by an equally sharp incised groove (which may perhaps indicate a certain incompleteness of ossification). The ball is circular and as nearly as may be a centimetre in diameter. The cup in front is of corresponding size and form. The hypapophysis is a strong compressed process which rises just in front of the ridge bounding the posterior articulation, and is directed forward and downward in front of the anterior cup, much as in the fifth cervical of the Mississippi Alligator. On each side of this process and below the middle of the side of the centrum, but rather higher than the corresponding process in the Alligator, is situate the parapophysis or articulation for the rib. It blends with the margin of the anterior cup, and is a strong, compressed, triangular process with a flattened facet which looks obliquely outward and forward. It is separated from the hypapophysis by the usual concave channel (fig. 6); and a similar channel divides it from the diapophysial process on the neural arch; but in the middle of this channel, or, rather, towards its upper part, is a slight ridge which extends from the upper margin of the anterior cup backward towards the ball. The diapophysis, as usual, extends further outward than the parapophysis, and is a smaller facet supported on a process of which the hinder margin is no more free than in the third vertebra of the Alligator; but the process is

broad, and defined below and in front by an oblique groove. The vertical measurement across the two facets for the cervical rib is 1 centim. The neural arch has a decided aspect of being inclined forward, owing to the way in which the slight rounded ridge from the diapophysis ascends obliquely forward towards the præzygapophysis, coupled with the fact that the posterior border of the neural canal is straight and parallel to it. The antero-posterior measurement of the neural arch below the zygapophyses is less than a centimetre. The sides of the neural arch are concave from above downward, and obliquely channelled. The præzygapophyses are strong processes compressed into a wedge-shape in the usual way (fig. 7), directed upward, forward, and outward, with circular facets, which are divided from each other by a broad V-shaped notch. The processes are united by a thin platform above the neural canal, the anterior half of which is excavated by a longitudinal pit which almost, or quite, perforates the forked depression between the zygapophyses. From the hinder half of the neural platform, which has a remarkably four-cornered appearance owing to the lateral constrictions, rises the neural spine. It is triangular, being compressed in front and wider behind, where it is vertically channelled; and the channel descends so as to divide the posterior zygapophyses from each other. The antero-posterior measurement of the base of the spine is $\frac{1}{2}$ centim. Its height, as preserved, from the base of the zygapophysial facet is $1\frac{1}{2}$ centim. A slight ridge extends from its anterior border to the posterior border of the præzygapophysial facet, while in the Alligator the corresponding ridge, when it exists, is carried forward; behind this ridge the platform at the base of the neural arch rounds convexly on the side of the centrum. The posterior zygapophyses (fig. 6) are strong wedge-like processes directed outward, only slightly extending behind the neural spine, and not entirely behind it as in the Alligator. They are remarkable for the well-defined notch below them, something like that seen in the third and fourth vertebræ of the Alligator, and for the tubercle above the posterior margin of the ovate facets, which gives the back of the zygapophyses a somewhat channelled appearance, to which the Alligator offers no parallel. The measurement from back to front over the zygapophyses is 2 centim. The transverse measurement over the præzygapophyses is about 18 millim. The side-to-side measurement of the constriction between the anterior and posterior zygapophyses is 12 millim. The posterior zygapophyses were evidently narrower than those in front by a millimetre or two. The neural canal is transversely ovate behind, but in front appears wider and more depressed (fig. 7), with a flat wall; the floor of the centrum is concave, and shows the usual pair of nutritive foramina.

Dorsal Vertebræ.

There are 8 dorsal vertebræ, which mostly belong to the hinder part of the series. Reckoning as the first dorsal that vertebra in which the rib is for the first time entirely carried on the transverse process, I should regard the earliest vertebra preserved of this

series as probably not later than the 6th dorsal, while it might have been as early as the second, which is likely to have been its true position. Then succeeds a centrum which may have belonged to about the fifth dorsal. The remaining six vertebræ appear to be in sequence, and belong to the hinder part of the vertebral column; and if the number of vertebræ was the same in this animal as in the Alligator, they might be the 7th to 12th dorsal vertebræ. The 13th, or last dorsal or lumbar vertebra, if found separately, might have been referred to another genus, and perhaps to a Dinosaur. The first sacral vertebra is imperfectly preserved.

The early dorsal vertebra is distinguished, as in existing Crocodiles, by the slight development of the ridge, which ascends from the hinder border of the præzygapophysis inward and backward towards the neural spine. The centrum has a length of from 18 to 19 millim.; so that there is but little increase of length as compared with the cervical region. The transverse process is compressed and directed outward horizontally or a trifle upward. It is thickened on the inferior posterior border by a ridge which extends downward towards the centrum and constitutes a marked specific character, especially as there is a deep conical pit behind it immediately below the notch which separates the transverse process from the postzygapophysis. The antero-posterior width of the transverse process is 11 millim. Resting upon it in front, rather more horizontally than in existing Crocodiles, so far as regards its lateral direction, is the præzygapophysial facet (fig. 8), which is about 11 millim. long and 6 millim. wide. The transverse process is perhaps a little lower in position than the transverse process in the early dorsal vertebræ of the Alligator, being on a level with the upper part of the neural canal. The ridges on the posterior zygapophyses are rather narrow, so as to give a somewhat pinched aspect to the concave area on each side at the base of the neural spine (fig. 8). The neural spine extended backward a little between the diverging ridges of the posterior zygapophyses; and at its base there is a pit. The centrum is evenly rounded (fig. 9), and both cup and ball well developed. As in the cervical region, the ball is marked on its upper margin by an incised groove (fig. 8) similar to that seen in the vertebræ of the Alligator.

The later dorsal vertebræ, as in existing Crocodiles, are characterized by the deeper depression between the anterior and posterior zygapophyses, and by the increased elevation of the zygapophyses above the transverse process, consequent upon this process acquiring a somewhat lower position relatively to the neural canal. The præzygapophyses come to extend a little further forward and to look a little more upward and inward. The centrums increase in length so that what I regard as the tenth is 23 millim. long. The articular cup in front, perhaps, becomes a little wider: and the base of the centrum is rather more flattened. The compressed appearance at the base of the transverse process gives place to a regular concavity from above downward: and the antero-posterior extent of the neural arch is increased, while the size of the neural canal is diminished and its height lessened. There also comes to be a less development

of the inferior margin of the cup of the centrum, which gives a slight appearance of leaning forward to the bodies of the vertebræ. The twelfth centrum is 22 millim. long, and has the cup 13 millim. wide in front, showing an increase in the depression of the centrum similar to that which is observed in the later dorsal vertebræ of existing Crocodiles.

Lumbar Vertebra.

The lumbar vertebra (Pl. XXX. figs. 10, 11) may not have been the only one of its kind; it certainly did not immediately succeed the last dorsal, if it is supposed to have pertained to the same animal; for it has the centrum much more depressed, with the zygapophysial facets perceptibly higher, but still retaining a much less inclined position than is seen in the Alligator. The cup in front of the centrum (fig. 10) is $1\frac{1}{2}$ centim. wide, and, as preserved, 1 centim. in vertical diameter; so that it has a transversely oval form, which gives a broad aspect to the base of the centrum. The posterior ball has a similar pterodactyle-like transverse extension, but, as in the earlier vertebræ of the series, is margined above by the characteristic groove. The transverse process is only 7 millim. wide at the base, and was therefore small, like the corresponding process in the Alligator. In transverse section (fig. 11) it is somewhat T-shaped, owing to the development of an inferior sharp vertical ridge which descends to the base of the neural arch, widening as it comes downward. This ridge curiously resembles that which is so characteristic in the neural arch of a Dinosaur; but it is clearly comparable to that which I have referred to in the early dorsal vertebra, and constitutes one of the distinctive characters of the species. The neural canal here enlarges again as though in anticipation of the sacral expansion. The notch between the posterior zygapophyses is wider in this vertebra than in the dorsal series; and the zygapophyses appear to be somewhat stronger and broader.

Sacral Vertebra.

The first sacral vertebra is only a fragment, the greater part of the neural arch being broken away, only a portion of it remaining at the anterior end of the left side. The centrum is remarkably oblique; it is 2 centim. long, and flattened on the under side, with a small median groove in the anterior part. The sides are rounded; the anterior cup is imperfectly preserved, but appears to have been more depressed than in the lumbar vertebra. The posterior end of the centrum is oblique, flattened, with a depression below the neural surface. It is narrower than the anterior end, being about 11 millim. wide, as preserved, and semicircular in outline. The basal surface of the neural canal is smooth, straight, and concave from side to side. The neural arch enters into the anterior cup as in the Alligator, and gives off at the anterior end of the side a massive transverse process, the fractured base of which is 13 millim. deep and 1 centim. wide, and has a somewhat reniform outline owing to the anterior concavity. Only the base of the anterior zygapophysis is preserved.

Caudal Vertebræ.

The early caudal vertebra was probably about the fifth or sixth. The late caudal vertebra would correspond with about the 23rd or 24th in the Alligator, though the form of the centrum might be taken to indicate that the tail was relatively short, and probably contained fewer vertebræ, while, from the absence of any continued series, its identification as belonging to this species is open to some doubt. The early caudal vertebra (Pl. XXX. figs. 12–14) is of elongated form, compressed at the sides, narrow and somewhat flattened on the underside. The length of the centrum is 31 millim. The cup in front (fig. 14) is circular and 11 millim. in diameter; below it is an oblique hypapophysial facet. The cup is slightly oblique; and the length of the base of the centrum is 22 millim. Posteriorly the outline is subquadrate, owing to the flatness of the sides and to the development of two facets divided by a groove below the articular ball (fig. 13). Unlike the Alligator, the centrum is widest over these facets. There is the incised margin on the upper surface of the ball which characterizes all the vertebræ. The width of the posterior end of the centrum is 1 centim., its extreme depth 13 millim. The centrum has a pinched-in appearance (fig. 13) below the transverse process (fig. 12), which, as usual, was given off about the middle of the side, was horizontal, compressed from above downward, and, though convex on the underside, shows no indication of a ridge. The antero-posterior extent of its base is about 12 millim. The neural arch appears to have had a very short neural spine; and the ridges from the zygapophyses, instead of being directed downward to join the transverse process as in the Alligator, converge inward and backward to form the base of the neural spine in front. The anterior zygapophyses projected in front of the centrum; the facets (fig. 12) looked more upward and less inward than in the Alligator; and there was no notch between them exposing part of the neural surface of the centrum.

The late caudal vertebra, supposing it to belong to this species, concerning which I feel some doubt, is about 17 millim. long, has a ridge in place of the transverse process, has the narrow base margined by two sharp parallel ridges, and the posterior cup deeper than the anterior cup.

Teeth.

There are 5 Crocodilian teeth. The most important of these (Pl. XXVII. fig. 25) is fractured, but appears to indicate an ovate crown curved slightly inward, terminating on each side in a strong ridge, and having the exterior face marked with a number of faintly elevated blunt striæ, with finer striæ on the inner face; the crown, which is a little worn, is 1 centim. high, and gives indication of the beginning of the fang. There are two successional teeth: one of these has a circular base, the other an oval base; both are short and blunt, marked with lateral ridges and covered with numerous fine parallel striæ. The largest is nearly $\frac{1}{2}$ centim. in diameter (fig. 24).

Another tooth has the same general character; but the crown appears more curved, with sharper lateral ridges and finer and more numerous striations.

In the possession of lateral ridges, as well as in the striated surface of the crown, the teeth of this species approximate to those referred by Leidy to *Hyposaurus*; but there is no correspondence in vertebral characters. The vertebræ referred by the same author to *Thoracosaurus* correspond in being procœlous, but differ in the position and character of the tubercles for the articulation of the ribs, as well as in the form and direction of the neural spine in the cervical region. It is difficult to determine accurately the relation of the species to *Holops*; but the absence of the hypapophysis from the early dorsal vertebræ will exclude comparison with that form, equally with the contour of the neural canal. *Holops*, however, appears to have had the sharp ridge margining the parietal bone which is seen in the specimen figured by Bünzel.

It is impossible to determine whether the parietal bone of Crocodilian character (figured by Bünzel, pl. i. figs. 1–2), is referable to this species or to some other animal. Its distinctive features are the sharp lateral ridges margining the temporal fossæ, the fineness of the circular pits on the bone, and the remarkable thinness of the bony substance.

That this species can remain in the genus *Crocodilus* is improbable; but at present I see no grounds on which to separate it.

Pleuropeltus Suessii, Seeley.

Postfrontal Bones of a Chelonian Skull.

Two fragmentary bones (Pl. XXVIII. figs. 8, 9), right and left, present on their external surface impressions of scutes, and on their under surface portions of a large cavity which I believe to be orbital; therefore I interpret these fragments as being postfrontal bones of a large Chelonian of Emydian affinities; and as the skull, when complete, was obviously of large size, it may well have belonged to the animal indicated by the large costal plates presently to be described. The remarkable feature about this bone is the character of its sutures: for while a groove runs round the thin margin in which the edge of the bone terminates, and evidently received a sharp ridge from the adjacent bone, the margin on the under side is bevelled, and thus demonstrates a union of the bones by squamous overlap. The under surface of the bone (fig. 9) is crossed by an oblique ridge, which divides it, as preserved, into two nearly equal portions. This ridge helps to form a part of the posterior boundary for the eye-ball, and is characteristic of *Chelydra* and allied genera. The orbital surface is concave, and more resembles that of *Chelydra serpentina* than that of *Trachydoglossus*; and the resemblance extends even to the position of the vascular foramen at the back of the orbit, though there may, perhaps, in the fossil be several small foramina in a line. This surface, as preserved, mea-

sures about 4 centim. in its greatest length, and upwards of 3 centim. in its greatest width. The bone probably extended forward no further than the middle of the orbit; and in that case but a small portion is lost. The area posterior to this ridge bounding the back of the orbit is excavated, 4 centim. long and 2 centim. wide. It consists of an inner oblong area, truncated externally by the suture for the malar bone, and margined by the bevelled edge referred to, which is about 6 millim. wide behind and 8 millim. on the inner side. The superior surface of this subquadrate fragment (fig. 8) is convex from within outward, showing that the top of the head was flattened, but that it rounded into the lateral area. It is divided into seven areas by unusually wide and well-marked scutal grooves. The bone between these grooves has a roughened, somewhat pitted appearance, indicative of vascular structure. The scutes are especially remarkable from their number and small size; that over the orbit is largest, being about 3 centim. long and more than $1\frac{1}{2}$ centim. wide. The other scutes will be best understood from the figure. They are irregular, subquadrate or subtriangular figures, varying in measurement from 1 centim. to about $1\frac{1}{2}$ centim. The grooves which define the scutes are from 2 to 3 millim. wide. The articular surface for the malar bone (fig. 9) is $2\frac{1}{4}$ centim. long, and over a centimetre deep. It is a concave shallow groove, which involves the termination of the postorbital ridge. There is every reason to suppose that the squamosal articulation was a small area just behind the malar articulation, and that it did not extend for more than a centimetre. Hence the inner and posterior bevelled articular surface, which becomes very thin behind, is related to union with the parietal bone. The posterior portion is oblique, and makes an angle of 45° with the interior portion, which is straight and parallel to the orbital margin. Three scutes are crossed by the parietal suture, which, indeed, is the case in the skull of the Common Turtle. In front of the parietal suture, commencing with the most anterior inner scute, is a distinct suture, which prolongs the line of the parietal, and therefore gave attachment to the frontal. The portion of the right postfrontal bone includes four scutes and a fragment of the inner part of the postorbital ridge, extending as far forward as the termination of the parietal suture.

Costal Plates.

Dr. Bünzel figured a remarkable specimen, which he regarded as the left ilium of an animal named *Danubiosaurus anceps*, the supposed rib of which proved to be a Dinosaurian scapula. I find a second specimen of this supposed ilium, less perfect, but similar in character, evidently coming from the opposite side of the body. For reasons to be mentioned, I have no hesitation in interpreting these specimens as ribs to which dermal plates are ankylosed. But there is something very different here from what is observed in ordinary Chelonians; and though I have no doubt that we have to do with a pair of Chelonian costal plates, the type indicated by these remains is new. It would, indeed, have been less startling to refer the specimens to any part of the skeleton of a Dinosaur or lizard than

to the Chelonia; for these fossils, if rightly interpreted, indicate an animal with a relatively larger vertebral column than any Chelonians now known, or at least with a vertebral column constructed upon a different plan. The ribs were wide, as in the marine Chelonia, and extended distally far beyond the limits of the plates which covered them. The superimposed plate is developed chiefly behind the rib; its anterior margin is smooth and rounded; the posterior margin is not preserved, but obviously became thin. The free articular end of the rib was massive; and the superimposed plate extended beyond it proximally for an unusual distance, indicating great width for the intervening vertebra. This portion of the dermal plate, which extends mesially beyond the rib, has the external surface well preserved, but wants the smooth ossified internal surface; and as this is absent in both specimens, it is possible that in the living animal this internal part of the plate may have been cartilaginous or united to other bones. Neither of the specimens gives the slightest indication either of external scutes or ornament, or of union to adjacent bones; and the external surface is such as would suggest that the bones were probably contained, if not beneath a muscular covering, at least beneath a skin which had not become specialized; so that we have here an animal that in some respects recalls the *Protostega* of Prof. Cope, but differs essentially in the dermal plates being blended with the ribs. An allied but undescribed type from the Cambridge Greensand also has the costal plates separate from each other, but differs in having them marked with scutes.

A short description of each of these specimens appears necessary. First, the less perfect of the two (Pl. XXX. fig. 15) shows a smooth external surface gently convex in length and somewhat convex from side to side. It consists of a thick dense dermal plate superimposed upon a rib, this plate probably being a representative of the supracostal cartilages and ossifications found in birds, crocodiles, and *Hatteria*. Immediately above the articular expansion of the rib, at the proximal end, the plate is a centimetre thick, and is defined by the density of its texture from the osseous matter of the rib beneath. This bone on the interior surface is much eroded, but presumably extended much further towards the median line of the animal's body, since the dermal plate is prolonged with a rough under surface, due to this bone having adhered to the bone with which it is blended; and as the plate is prolonged mesially, its thickness becomes reduced to one half, though the fractured specimen is imperfect at its margin. The transverse width of the plate, as preserved above the expanded head of the rib, is about $9\frac{1}{2}$ centim. About 9 centim. further away from the middle line of the animal, a length of about 4 or 5 centim. of the margin of the plate is rounded; and here its union with the thin underlapping, transversely expanded margin of the rib is distinctly seen. On the opposite or posterior margin there are some faint indications of a lateral rounding of the margin of the dermal plate. At 18 centim. from the proximal end of the rib the dermal plate comes to an end, being broken away, and allows the rib to project freely from under it, showing, I think, that although there was

bony union between these two parts of the skeleton, it was a union established somewhat late in the animal's life. At this point the bony plate is somewhat thinner than at its proximal fracture; the plate tapers apparently outwards, and is somewhat broken away from the anterior proximal margin of the rib. The plate is hence, as preserved, of a lanceolate form; but its outline cannot be accurately stated.

The rib in this specimen differs from the ribs attached to the costal plates of living Chelonians in being coextensive with the plate —that is, as wide as the plate, and, as shown by the other specimen, as long; hence its limits are not defined distinctly in any part of its extent, least so in the proximal part of the bone, where the surface is convex from side to side. This convexity becomes narrower and relatively more elevated as the bone proceeds outward, and is confined to its anterior border: where the rib terminates it is over 3 centim. wide, over 1 centim. thick, and, though compressed on the anterior border, is more compressed on the posterior border. The thickness of the combined rib and plate is about $2\frac{1}{4}$ centim.; but even as preserved, the thickness at the fractured articular end is 7 centim. The underpart of the bone, which is slightly displaced by a fracture consequent upon a minute dislocation, is convexly rounded from side to side, and concave from within outwards, so as to present a saddle-shape. The transverse width of the fragment preserved is about $6\frac{1}{2}$ centim. The anterior border is notched, as though for the passage of an intervertebral nerve, or from the head of the rib being free, as in ordinary Chelonia, though the conformation would rather suggest the former interpretation. There is one curious character in evidence that the expanded lateral part of the rib extended further towards the middle line than the articular head, showing that the ribs had attained an unusual transverse development consequent upon the expansion of the superimposed plates. The transverse width of the head of the rib is 4 centim.; and here the fracture gives it an almost semicircular outline.

The second specimen, already figured by Bünzel, pl. vi. figs. 4, 5, has a length, as preserved, of 48 centim.; of this 39 centim. is occupied by the blended rib and its superimposed dermal plate, the remaining 9 centim. consists of the extension of the plate alone beyond the head of the rib towards the middle line of the body. The plate, where it is presumed to have extended over the vertebra, is thin, and becomes thinner the further it extends, both mesially and laterally. Its margins are imperfectly preserved, but have a wedge-shape. The costal region wants a small portion in the middle of the plate in front; but throughout it has the anterior margin preserved rounded from below upwards, and roughened in the proximal half, as though with ligamentous attachment to the adjacent plate. On the upper surface these lines at first run in a transverse direction, and then run forwards and inwards, just as on the under side they run downward and outward. This oblique direction is strongly suggestive of the oblique crossing of ordinary intercostal muscles. In length the anterior margin of the bone is gently concave. The posterior margin

is, unfortunately, not preserved; and the plate is remarkably convex from before backwards above, though this convexity is more marked on what I take to be the posterior side than on the anterior side. The extreme width of the plate below the articular head of the rib is about $13\frac{1}{2}$ centim.; and it gradually tapers as it extends outwards. Distally the thickness of plate and rib diminish; and at the extreme distal end, where the transverse measurement, as preserved, is under 3 centim., the thickness of the combined plate and rib is less than a centimetre. The posterior half of the plate, while smoother externally than the anterior half, is marked with several short, parallel, straight, vascular grooves, which are very narrow; each is about 2 centim. long. This condition leads me to suspect that the anterior part of the rib may have been imbedded in muscle, while, owing to its curvature, the middle of the plate may have had only a dermal covering.

The interior or under side of the specimen has the expanded head of the rib broken away; and while it was placed in the middle of the width of the plate as in the other specimen, the rib soon becomes developed on the anterior border, being limited by a concavity which runs down the length of the bone, dying away with the elevation of the rib at the distal end. This principal part of the rib becomes narrower as it extends further outward; but the fractured condition of the posterior margin appears to indicate that the margin of the rib was prolonged as a thin film towards the adjacent plate.

No similar remains which are referable to an animal of this kind have been discovered.

Scapula of large Chelonian.

The fragment which I identify as a portion of a right Chelonian scapula, indicates an animal of somewhat large size. It shows no trace either of the præcoracoid or the articular end of the bone, which had decomposed prior to fossilization, or of the distal end; so that it is not a fragment giving valuable information concerning the affinities of the animal. The fragment is 9 centim. long, 4 centim. wide at the proximal end, as preserved, and 2 centim. wide at the distal end. The surface which I take to be posterior is smooth, convex from side to side, but more flattened at the distal end than at the wider proximal end. In length the surface is almost straight. The internal margin is concave and sharp, and looks as though it might have been produced into a præcoracoid. The external margin is slightly convex, except towards the proximal end, where it is modified, owing to the bone bending outwards and downwards, as though for the formation of the articular surface. The anterior aspect of the bone is much rougher; and there is a ridge which becomes stronger towards the proximal end, thickening the bone on its outer part, and making it concave in length, and dividing the anterior aspect into a broad, flattened, inner area and a narrower external area. The thickness of the bone towards the proximal end, where fractured, is 2 centim., and the thickness towards the distal

fracture 13 millim. This is not an identification in which I feel absolute confidence, on account of the smoothness of one side of the bone and the roughness of the other, which I had not noticed in any Chelonian scapula.

Emys Neumayri, Seeley.

There occur many remains of several Chelonians of moderate size. I only brought to this country a selection of some of the more characteristic fragments, which all belong to the carapace and plastron. It does not seem to me desirable to determine the genera from these specimens; but from their general character rather than from any distinctive characteristics, I regard them as being Emydian. The specimens are as imperfect as any of the other reptile remains, and, as they do not differ much in size or character, are difficult to deal with. There are, however, certain differences of texture and form which justify me in indicating the existence of several species. These are all referred provisionally to the genus *Emys*, pending better evidence of their generic characters. The species are best distinguished by the characters of the plastron; for the hyo- and hypoplastral bones preserved may indicate, even in their fragmentary condition, four species. The bulk of the remains I refer to the largest species, which was fully 25 centim. across the carapace. This species is marked by the depth of the grooves which define the areas of the scutes, and frequently by their elevated borders. Another marked feature is the exceedingly fine subgranular condition of the bone on its external surface—a character difficult to define, but altogether peculiar. Of this species the plastron is represented by portions of the hyoplastral and hypoplastral bones, though from their fragmentary condition, it is not always easy to distinguish between these. One fragment (Pl. XXX. fig. 16) is only $7\frac{1}{2}$ centim. broad and $5\frac{1}{2}$ centim. long; it does not show a single sutural surface, but exhibits the axillary region crossed in its lower part by an oblique scutal impression which runs forwards and a little inwards till it reaches the inner margin of the præaxillary scute, which is prolonged forwards on the superior edge as a strongly marked groove. The usual transverse scutal impression on the basal part of the hyoplastral plate runs a little in advance of the axilla, and, as it nears the lateral margin, is directed angularly forwards in the last centimetre of its length. This scutal impression is strongly elevated; the ascending axillary process was compressed and directed obliquely upwards, forwards, and apparently a little outwards. The thickness of the plate varies from $\frac{1}{2}$ centim. in the inner part to 1 centim in front of the axillary notch.

A second specimen, showing the anterior part of a similar right hyoplastral plate, may, perhaps, belong to the same species though to another individual: the thickness of the scute is the same; the elevated ridge at the scutal suture is the same; though fractured in front, it measures upwards of $4\frac{1}{2}$ centim. anterior to the transverse suture. The lateral margin of the plate is sharp, being be-

velled above, with the bevelled area also defined internally by a sharp ridge, interior to which runs a slightly impressed broad prolongation of the supraaxillary impression. In the carapace no neural plate is preserved. The first costal plate (Pl. XXXI. fig. 13) on the left side is nearly perfect; it is slightly arched, rather less than 10 centim. long, and more than $3\frac{1}{2}$ centim. wide at the lateral impression of the first vertebral scute. It shows the oblique sutural surface for the nuchal plate, which has a concave border about $3\frac{1}{2}$ centim. long; the width of the union with the first neural plate is $2\frac{1}{2}$ centim., but was probably more, as the posterior border of the scute is imperfect. The rib is not visibly distinct from the plate upon which it is supported, as it is in some species of *Testudo*; it has a well-elevated compressed head, 7 millim. deep and 4 millim. wide; it is placed obliquely, so as to look forward and outward. In the middle of the plate the rib has become so depressed as to be only just recognizable; it is there 1 centim. wide; but at the outer part of the plate its extremity is prolonged beyond the plate, to unite apparently with the marginal plate. Anterior to it, on the under side, the plate is excavated (Pl. XXVII. fig. 27), and the side of the rib roughly striated, owing to attachment of the supraaxillary process from the hyoplastron. This excavation extends inwards from the extremity of the rib for $4\frac{1}{2}$ centim. A fragment of the right plate shows its depth where it joins the first neural plate to be $3\frac{1}{4}$ centim., and the greatest depth of the bone to be about 4 centim. There are several fragments of costal plates; but they can only be identified by the scutal markings. What appears to be a third costal plate of the left side is impressed with the transverse border dividing the second and third vertebral scutes for a length of $3\frac{3}{4}$ centim.; and since at this point the antero-posterior measurement of the plate is only 3 centim., it shows that the vertebral scutes were extremely broad relatively to their length, since the length could not have exceeded 6 centim., while the breadth could hardly have been less than 10 centim. The plate is arched, showing that the carapace was as much elevated as in a testudinate Chelonian. Its extreme length, without reckoning the curve, is upwards of 11 centim.; following the curve, the length is nearly 13 centim. The breadth of the plate, towards the outer margin, is about $3\frac{1}{2}$ centim. Its thickness at the proximal part is 4 millim., and at the distal end 3 millim. On the under side the head of the rib is moderately elevated; but its course down the plate is only just perceptible, and marked by a smoother condition. It does not appear to have been prolonged at the distal margin. A plate from the hinder part of the carapace, which is imperfect, also shows the arched character strikingly. It is remarkable for its antero-posterior extent of nearly $3\frac{1}{2}$ centim., and appears to be the last costal plate. If so, it is impressed on its outer part with a vertebral scute. Hence I infer this animal to have had a nearly circular outline, and to have had the shield greatly elevated. It may be distinguished as *Emys Neumayri*.

Other Species of Emys.

Another species, represented by the remains of more than one example, is, however, known chiefly from the hypoplastral plates. It appears to have been a smaller species than the last, though it is not easy to estimate its size from the distance between the axillæ, or from the breadth of the abdominal scutes. The hypoplastron shows some indication of the median and anterior sutural margins, which would indicate a broad species, after the pattern of the foregoing. The length of the fragment is $6\frac{1}{2}$ centim., and its breadth about 6 centim. The transverse scutal impression is from $2\frac{1}{2}$ to 3 centim. behind the anterior suture. The bone is compressed to a sharp margin, which is prolonged as an elevated ridge for about 1 centim. beyond the inguinal notch. The margin is nearly straight. I regard this ridge as indicative of a well-marked species.

A third species is distinguished by the way in which the axillary and inguinal processes are obliquely overlapped. A fourth species, of small size, is represented by many parts of the carapace and plastron.

Aræosaurus gracilis, Seeley.

Vertebra.

The vertebra of a lizard, figured by Bünzel, pl. vi. fig. 11, is very imperfect, and so badly drawn as to give no just idea of its characters. It is remarkable for the perfectly globular form of the posterior articular ball, which is nearly 6 millim. in transverse measurement, and nearly 5 in vertical measurement. It is margined by an impressed groove, which extends further forward on the neural margin than on the visceral margin. The length of the centrum in the middle line is 13 millim. What remains of the anterior cup is deeply excavated to correspond with the articular ball, with a sharp margin conspicuous on the inferior border. The inferior interarticular surface of the centrum is 1 centim. long; on its base run two parallel blunt ridges, divided by a median groove; external to these ridges are two oblique impressed concave lateral areas, which are broad in front and narrow behind, margined superiorly by an oblique rounded ridge, which ascends from the upper margin of the articular ball towards the middle of the articulation for the rib on the anterior part of the vertebra. This articulation for the rib is a strong process, extending laterally further than the width of the articular cup of the centrum, is concave from above downwards in front, looking obliquely downward and outward, long and narrow, rounded from fore to back, and most elevated proximally. It carries superiorly the prærygapophysis, which was a large oval surface, looking upwards and a little inwards, placed just above the articulation for the rib, and considerably above the intervertebral articulation. The zygapophysis is only preserved on the left side, the portion which had existed on the right side

having disappeared before the bone came into my possession. It is impossible from this slender evidence to determine the affinities of this animal.

Ornithocheirus Bünzeli, Seeley.

The remains of Ornithosaurians are unsatisfactory, being, for the most part, either small portions of shafts of bones, or else bones which have been greatly crushed. The fragments of phalangeal bones throw no light on the structure of the animals to which they belong, and give no clue to specific characters. The bone-tissue, however, is somewhat thicker than in English specimens; and I have no doubt the fragments belong to a peculiar species. There is an interesting crushed proximal end of a humerus, showing the form of the head, the immense radial crest, and the ulnar expansion of the bone at the humeral articulation: and this, with some other fragments, characterized by thin texture of the bone, may, perhaps, indicate a second species. But although of great local interest as demonstrating the presence of these animals in a period of time in which they were so plentiful in England, these fragments are of no importance to the anatomist. The only specimen of importance is the articular end of the lower jaw, already described by Bünzel (pl. vi. figs. 6, 7). This bone is obliquely fractured just in front of the articular end, and shows the articular surface and the characteristic keel beyond it. The length of the fragment is 34 millim. The bone is compressed from side to side; and the sides converge downward into a narrow rounded ridge. The external surface is flattened like the internal surface, which latter shows a suture with very irregular margin, nearly parallel to the base, and near to it, indicating that the articular bone was received into the angular bone. The area in front of the articulation contracts from side to side, and is rounded; but on the inner margin there is a large pit partly fractured through, indicating a pneumatic foramen. The articular surface is transversely ovate in area, with a median ridge running obliquely backwards and outwards from the hind margin of this foramen. This divides the articular surface into a triangular concave area in front and towards the outer side, and a posterior groove which is best developed towards the inner side of the jaw. This articulation perceptibly widens the bone at each side. Its width is 13 millim., its length 8 millim. Behind the articulation there is no defining border, like the sharp elevated ridge in front, but the surface is flattened, with the sides slightly converging till they terminate in the rounded extremity. This posterior area is directed obliquely downwards to the base of the bone. The inner half of its surface consists of a pneumatic foramen, which is 13 millim. long, and reaches forwards to the posterior articular groove. This jaw seems to be well distinguished from the species already described.

Conclusion.

From this survey it appears that Dinosaurs were well represented in the Gosau beds. Most of the remains belong to two species of a quadrupedal carnivorous genus *Cratæomus*, which in many respects resembles *Scelidosaurus*. It is just possible that *Struthiosaurus* may prove to be the same genus, or may have possessed the teeth referred to *Cratæomus*. The genera *Hoplosaurus*, *Oligosaurus*, *Rhadinosaurus*, and *Ornithomerus* are only known from a few bones each; *Megalosaurus* merely from teeth. It is just within the limits of possibility that *Doratodon* may prove to be the jaw of *Rhadinosaurus*; but it is not likely to belong to the Crocodile, because true Crocodilian teeth occur. Hence there are certainly, with the *Mochlodon*, seven Dinosaurian genera, while there may be as many as ten genera. Of Crocodiles, Lizards, and Pterodactyles there are certainly at least one each. The Chelonians are represented by two genera and five species, two only of which are described. Thus the Gosau fauna includes in all fourteen genera and eighteen species of reptiles; and there is every reason to suppose that these formed but a part of the Reptilia living when the deposits were formed.

I can scarcely hope that my efforts have been in every case successful in determining the species to which these disjointed and often fragmentary bones should be referred; but I have throughout worked on the basis of anatomical structure, and indicated only such species and genera as the organization of the animals made inevitable.

I have now only to express my gratitude to Professor Suess for his kindness in allowing me to study this collection and retain the specimens so long in this country; and I would also express my thanks to Prof. Ramsay for permission to figure the skull of *Acanthopholis*; and to the Council of the Royal Society for assistance in carrying on this research.

APPENDIX.

Note *on the* Gosau Beds *of the* Neue Welt, West *of* Wiener Neustadt. By Prof. Edward Suess, F.M.G.S.

The Gosau beds have been deposited in *preexisting* valleys of the Triassic and Rhætic portion of our North-eastern Alps, and have suffered so much subsequent folding and dislocation that in the valley of the "Neue Welt," the spot where the bones were gathered which I sent to you, several shafts pass twice through one and the same seam of coal. The Gosau beds usually form green slopes at the foot of the great mural precipices of Triassic and Rhætic limestone. In the Gosau valley, near Halstatt, exposures are offered by a series

of ravines; in the "Neue Welt" (south of Vienna, west of Wiener Neustadt) a number of coal-mines give the opportunity of following the succession of beds, although they are highly disturbed here; and I believe that the succession is not very different in the two valleys, notwithstanding their distance apart.

The base of the Gosau beds is formed by a calcareous breccia of variable thickness, evidently the consolidated débris of the surrounding mountains.

Then follows a series of freshwater beds, sandstones, marls and a few seams of coal, accompanied by freshwater Mollusca such as *Melanopsis*, *Dejanira*, *Boysia*, *Tanalia*, *Cyclas*, and *Unio*, and the remains of a highly heterogeneous flora, comprising a true Palm, together with *Pecopteris Zippi*, *Microzamia*, *Cunninghamites*, and leaves of a dicotyledonous tree resembling *Magnolia*, &c., evidently the mingling of the younger dicotyledonous type with a number of surviving older types. It is this horizon which has yielded the reptilian bones.

Deposits of a brackish character, with *Cerithium*, *Omphalia*, and *Actæonella*, begin to appear above the freshwater beds, sometimes apparently intercalated with them and accompanied by gravel beds and conglomerate, sometimes also by the first true marine strata, usually characterized by *Hippurites organisans* and *Nerinæa bicincta*.

The next group is formed by a loose marly limestone or a calcareous marl crammed with reef-building corals and with masses of *Hippurites cornu-vaccinum*, *Hipp. sulcatus*, *Caprina Aguilloni*, *Sphærulites organisans*, and a good number of highly ornamented Gasteropoda. This is the true French Turonian zone of *Hippurites cornu-vaccinum*.

This zone is succeeded by a series of loose grey and marly sandstones, likewise very fossiliferous. The reef-building corals and Rudistæ have disappeared or are very rare, corals being represented by a few species of *Cyclolites*, by *Diplochenium lunatum* and especially by *Trochosmilia complanata*. Here the first Ammonites appear. *Natica bulbiformis*, *Cardium productum*, *Protocardia Hillana*, *Trigonia limbata*, and *Janira quadricostata* are some of the most characteristic fossils.

In some places rose-coloured limestone beds with *Orbitoides* and the remains of a small Decapod are seen, which seem to succeed directly to this zone, which I have sometimes named the zone of *Trochosmilia complanata*.

The last and highest member of the Gosau beds is a series of sandy loose sandstone beds, containing no fossil except great numbers of *Inoceramus Crispii*.

I cannot, therefore, say positively that the age of the reptiles which you have had the kindness to study is quite exactly that of your Cambridge phosphate-beds; but it is certain that they are older than the true Turonian deposits, and especially older than the zone of *Hippurites cornu-vaccinum*.

EXPLANATION OF PLATES XXVII.–XXXI.

(All the figures are of the natural size, unless an enlargement is mentioned.)

PLATE XXVII.

Fig. 1. Dentary bone of right ramus of lower jaw of *Mochlodon Suessii* (Bünzel) seen from above, showing tooth-sockets, symphysial curvature, and ascending coronoid process.
2. Separate tooth of *Mochlodon Suessii* from the lower jaw, showing the internal aspect; enlarged twice.
3. Tooth referred to the upper jaw of *Mochlodon Suessii*, showing the ribbed external face of the crown; enlarged twice.
4. Side view of the same tooth, showing the worn internal edge of the crown and curved fang.
5. Left side of hinder portion of skull of *Struthiosaurus austriacus* (drawn reversed for comparison with fig. 7), showing downward direction of occipital condyle, foramina at base of skull, plate in front of the sella turcica, transverse groove on roof of skull, &c.
6. The same skull seen from the front, showing the parieto-frontal suture, form of the parietal bone, cerebral cavity, form of the basisphenoid and sella turcica, &c.
7. Right side of hinder part of base of skull of *Acanthopholis horridus*, Huxley, showing the united basioccipital and basisphenoid bones, with the line of large nerve-foramina. (Original in Museum of Practical Geology.)
8. Anterior aspect of same specimen, showing posterior plate of sella turcica.
9. Dentary bone of right ramus of lower jaw referred to *Cratæomus*. The specimen is seen from above, and shows tooth-sockets along the alveolar margin.
10. External aspect of same specimen, showing the large foramina below the alveolar margin and above the longitudinal angle.
11. Tooth referred to *Cratæomus*, probably from the lower jaw, showing cinguloid ridge at the base of the crown; enlarged twice.
12. Similar tooth, less worn, showing serrations on the right margin; enlarged twice.
13. Tooth referred to the upper jaw of *Cratæomus*, showing bevelled edges, probably due to wear; enlarged twice.
14. External aspect of same specimen; enlarged twice.
15. Tooth probably of the larger species of *Cratæomus*.
16. Anterior aspect of same tooth, showing cinguloid thickening on both sides of the crown; enlarged twice.
17. Dorsal rib from the right side, referred to *Cratæomus lepidophorus*, showing articular surfaces.
18. Transverse section from the proximal third of the same rib, showing transverse expansion of the superior plate and lateral compression of the body of the rib.
19. Middle of shaft of left tibia referred to *Cratæomus lepidophorus*, showing muscular ridges on the fibular aspect and commencement of proximal expansion.
20. Proximal portion of right fibula of *Cratæomus*, showing convex tibial aspect.
21. Tooth referred to *Megalosaurus pannoniensis*; one and a half times natural size. [The serrations are not directed upward so much as in the figure.]
22. Anterior aspect of the same tooth, showing limit of the serrations.
23. Transverse section of base of same tooth, showing posterior compression.
24. Tooth of a Crocodile, with slight lateral ridges and worn crown; enlarged twice.
25. A smaller more compressed and curved Crocodilian tooth, showing one of the lateral ridges; enlarged twice.
26. Claw phalange, probably of *Rhadinosaurus*.
27. Internal surface of first left costal plate of *Emys Neumayri*.

Plate XXVIII.

Fig. 1. Proximal portion of left scapula, showing humeral articulation, probably referable to *Mochlodon Suessii*. [The articular surface is longer than in the figure.]
2. Dermal plate referred to *Cratæomus*, terminating at each end in a free spine.
3. Another dermal plate, with free spines at the ends and similar tubercles in the middle portion.
4. A dermal plate bearing a horn-like spine, also referred to *Cratæomus*.
5. A small scute referred to *Cratæomus*, probably from the ventral region.
6. Distal portion of right femur of *Ornithomerus gracilis*, showing part of the lateral trochanter on the inner side of the shaft.
7. Transverse section of the same bone at the proximal fracture, showing medullary cavity.
8. Right postfrontal bone of a Chelonian, seen from above, showing the cranial scutes, referred to *Pleuropeltus Suessii*.
9. Internal aspect of the same specimen, showing postorbital ridge and surfaces for union with adjacent bones.
10. Proximal end of right fibula of *Crocodilus proavus*.
11. Transverse section of the same bone at the distal fracture.

Plate XXIX.

Fig. 1. Superior aspect of left humerus of *Cratæomus lepidophorus*.
2. Inferior aspect of right humerus of the same species.
3. Proximal surface of left humerus, showing expansion of the radial crest.
4. Inferior aspect of distal end of a humerus referred to *Cratæomus Pawlowitschii*.
5. Transverse fracture of proximal end of the same specimen, showing medullary cavity.
6. Side view of claw-phalange of *Cratæomus*.
7. Internal aspect of proximal end of left femur of *Crocodilus proavus*.
8. Outline of proximal articular surface of the same specimen.
9. Ulna of *Crocodilus proavus*.
10. Proximal articular surface of the same specimen.
11. Radius of *Crocodilus proavus*.
12. Distal end of the same bone.
13. Proximal end of the same bone.

Plate XXX.

Fig. 1. Superior surface of parietal bone of a small Dinosaur, probably *Mochlodon Suessii*.
2. Side view of an angular truncated dorsal piece of dermal armour of *Cratæomus*.
3. Posterior aspect of dorsal vertebra of *Cratæomus Pawlowitschii*, showing transverse processes and fractured base of the neural spine.
4. Left side of early caudal vertebra of *Cratæomus Pawlowitschii*. [An earlier caudal exists with the short caudal rib unankylosed.]
5. Left side of dorsal vertebra of a Dinosaur, referred to *Cratæomus lepidophorus*.
6. Right side of mid cervical vertebra of *Crocodilus proavus*.
7. Anterior aspect of the same vertebra.
8. Posterior aspect of dorsal vertebra of *Crocodilus proavus*.
9. Left side of dorsal vertebra of *Crocodilus proavus*.
10. Anterior aspect of lumbar vertebra of *Crocodilus proavus*.
11. Left side of the same vertebra.
12. Left side of an early caudal vertebra of *Crocodilus proavus*.
13. Inferior aspect of the same vertebra.
14. Anterior aspect of the same vertebra.

Fig. 15. Side view of rib and part of superimposed plate, showing the rib free from the plate at the number 15, and the great expansion of the costal articulation at the other end. *Pleuropeltus Suessii.*
16. Right hyoplastral element of *Emys Neumayri.*

PLATE XXXI.

Fig. 1. Anterior aspect of shaft of right femur of *Cratæomus Pawlowitschii*, showing the muscular ridges.
2. Antero-external aspect of right tibia of *Cratæomus Pawlowitschii.*
3. Thin slightly keeled dermal plate, probably lateral, of *Cratæomus lepidophorus.*
4. Posterior and inferior aspect of left femur of *Cratæomus lepidophorus.* The figure 4 is placed opposite the small lateral trochanter.
5. Anterior and superior aspect of right femur of *Cratæomus lepidophorus.*
6. Posterior and inferior aspect of shaft of left femur of *Rhadinosaurus alcimus.* The figure 6 is placed against the lateral trochanter.
7. Outline of the proximal fracture of the same bone.
8. Antero-inferior aspect of shaft of left humerus referred to *Rhadinosaurus alcimus.*
9. Outline of proximal fracture of the same bone.
10. Outline of distal fracture of the same bone.
11. One of the flat dermal plates of *Hoplosaurus ischyrus*, showing the cross-fibre structure.
12. Proximal end of a rib of *Cratæomus Pawlowitschii*, for comparison with fig. 17, Pl. XXVII. Compare Bünzel, pl. iii. fig. 5.
13. Superior aspect of first costal plate of carapace of a Chelonian, *Emys Neumayri.*

Synopsis of the Bones figured in these Plates, arranged under the Species to which they are referred.

MOCHLODON SUESSII (Bünzel).

Dentary bone, Pl. XXVII. fig. 1; teeth, figs. 2–4; scapula, Pl. XXVIII. fig. 1; parietal bone, Pl. XXX. fig. 1.

STRUTHIOSAURUS AUSTRIACUS, Bünzel.

Hinder portion of skull, Pl. XXVII. figs. 5, 6.

ACANTHOPHOLIS HORRIDUS, Huxley.

Hinder portion of base of skull, Pl. XXVII. figs. 7, 8.

CRATÆOMUS (species uncertain).

Dentary bone, Pl. XXVII. figs. 9, 10; teeth, figs. 11–16.

CRATÆOMUS PAWLOWITSCHII, Seeley.

Femur, Pl. XXXI. fig. 1; tibia, fig. 2; fibula, Pl. XXVII. fig. 20; humerus, Pl. XXIX. figs. 4, 5; dorsal vertebra, Pl. XXX. fig. 3; caudal vertebra, fig. 4; dorsal rib, Pl. XXXI. fig. 12; dermal armour, Pl. XXVIII. figs. 2–4.

CRATÆOMUS LEPIDOPHORUS, Seeley.

Femur, Pl. XXXI. figs. 4, 5; tibia, Pl. XXVII. fig. 19; humerus, Pl. XXIX. figs. 1–3; dorsal vertebra, Pl. XXX. fig. 5; dorsal rib, Pl. XXVII. figs. 17, 18; claw-phalange, Pl. XXIX. fig. 6; dermal armour, Pl. XXX. fig. 2, Pl. XXXI. fig. 3, Pl. XXVIII. fig. 5.

HOPLOSAURUS ISCHYRUS, Seeley.

Dermal scute, Pl. XXXI. fig. 11.

MEGALOSAURUS PANNONIENSIS, Seeley.

Tooth, Pl. XXVII. figs. 21–23.

ORNITHOMERUS GRACILIS, Seeley.

Femur, Pl. XXVIII. figs. 6, 7.

RHADINOSAURUS ALCIMUS, Seeley.

Femur, Pl. XXXI. figs. 6, 7; humerus, figs. 8–10; claw-phalange, Pl. XXVII. fig. 26.

CROCODILUS PROAVUS, Seeley.

Vertebræ, Pl. XXX. figs. 6–14; femur, Pl. XXIX. figs. 7, 8; fibula, Pl. XXVIII. figs. 10, 11; ulna, Pl. XXIX. figs. 9, 10; radius, figs. 11–13; teeth, figs. 24, 25.

PLEUROPELTUS SUESSII, Seeley.

Postfrontal bone, Pl. XXVIII. figs. 8, 9; rib, Pl. XXX. fig. 15.

EMYS NEUMAYRI, Seeley.

Costal plate, Pl. XXVII. fig. 27; Pl. XXXI. fig. 13; hyoplastral plate, Pl. XXX. fig. 16.

The species described which are not figured are *Doratodon carcharidens*, Bünzel, *Oligosaurus adelus*, Seeley, *Arœosaurus gracilis*, Seeley, and *Ornithocheirus Bünzeli*, Seeley.

DISCUSSION.

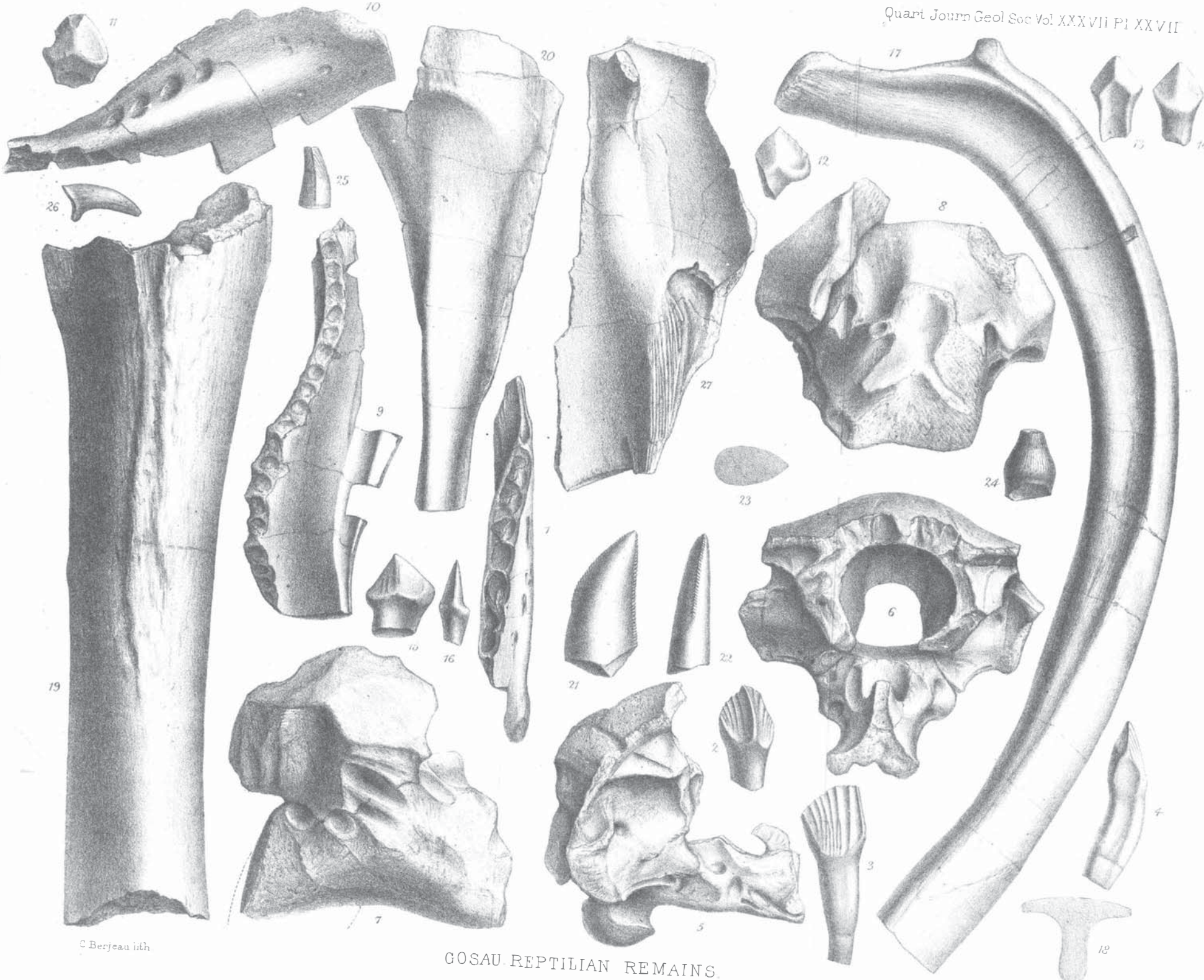
Mr. HULKE considered Prof. Seeley's paper a very valuable communication, throwing, as it did, fresh light upon an important group of fossils the true nature of which had before been but imperfectly apprehended. So far as he had been able to judge from a cursory inspection of the fossils, he did not doubt the accuracy of Prof. Seeley's interpretations. He called attention to the anterior extremity of the mandible of *Mochlodon*, which had sutural indications of a prædentary ossification, such as he thought he had seen in *Hypsilophodon*; and he mentioned the difficulty which the downward extension of the Dinosaurian inner trochanter appeared to him to offer to the hypothesis of its homology with the human trochanter minor, an extension which suggested that it might rather be homologous with an outgrowth of the middle part of the linea aspera to which the short head of the biceps is attached.

Mr. CHARLESWORTH remarked on the difference between the teeth in the upper and lower jaw of *Mochlodon*.

Dr. MURIE pointed out that the work of Prof. Seeley showed that much caution must be exercised in accepting hurried descriptions of genera and species from fragments.

Prof. BOYD DAWKINS stated that his examination of the American collections of Secondary Saurians proved that the so-called Megalosaurian type of teeth was exhibited by forms belonging to very different genera.

The AUTHOR agreed with Prof. Dawkins's views concerning the Megalosaurian teeth, and agreed that teeth were not sufficient alone for generic determinations.



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GOSAU REPTILIAN REMAINS

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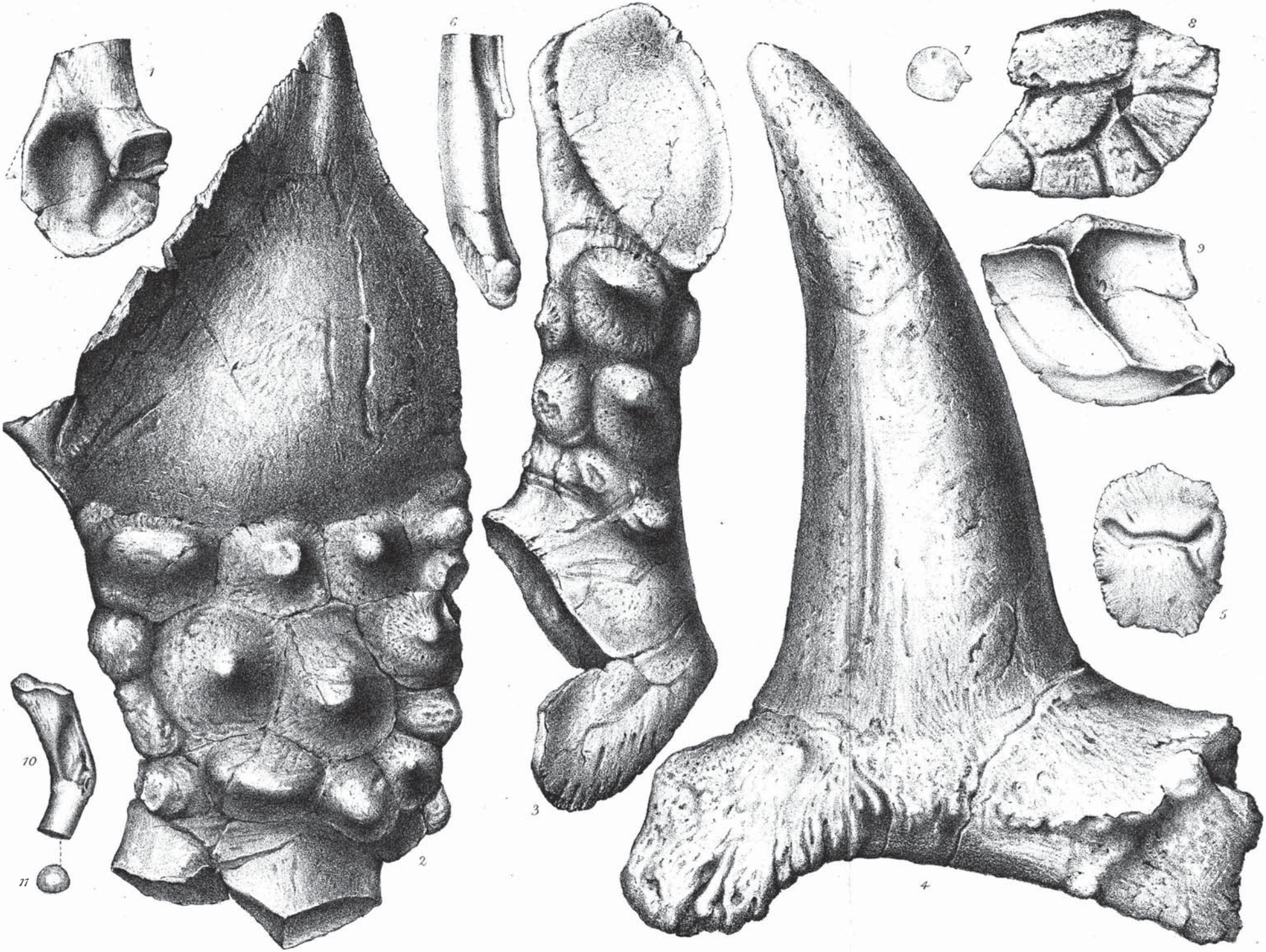

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GOSAU REPTILIAN REMAINS.

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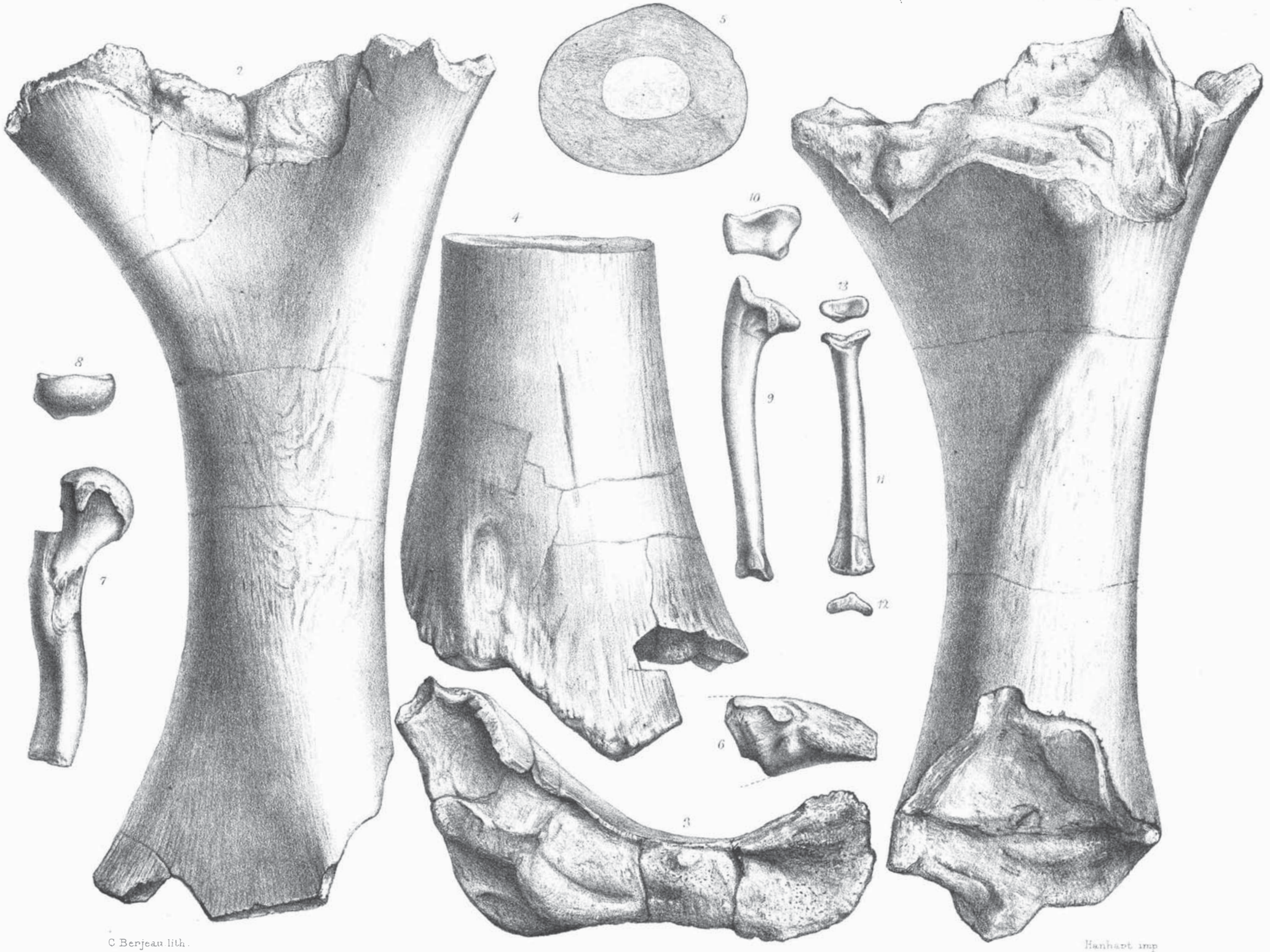

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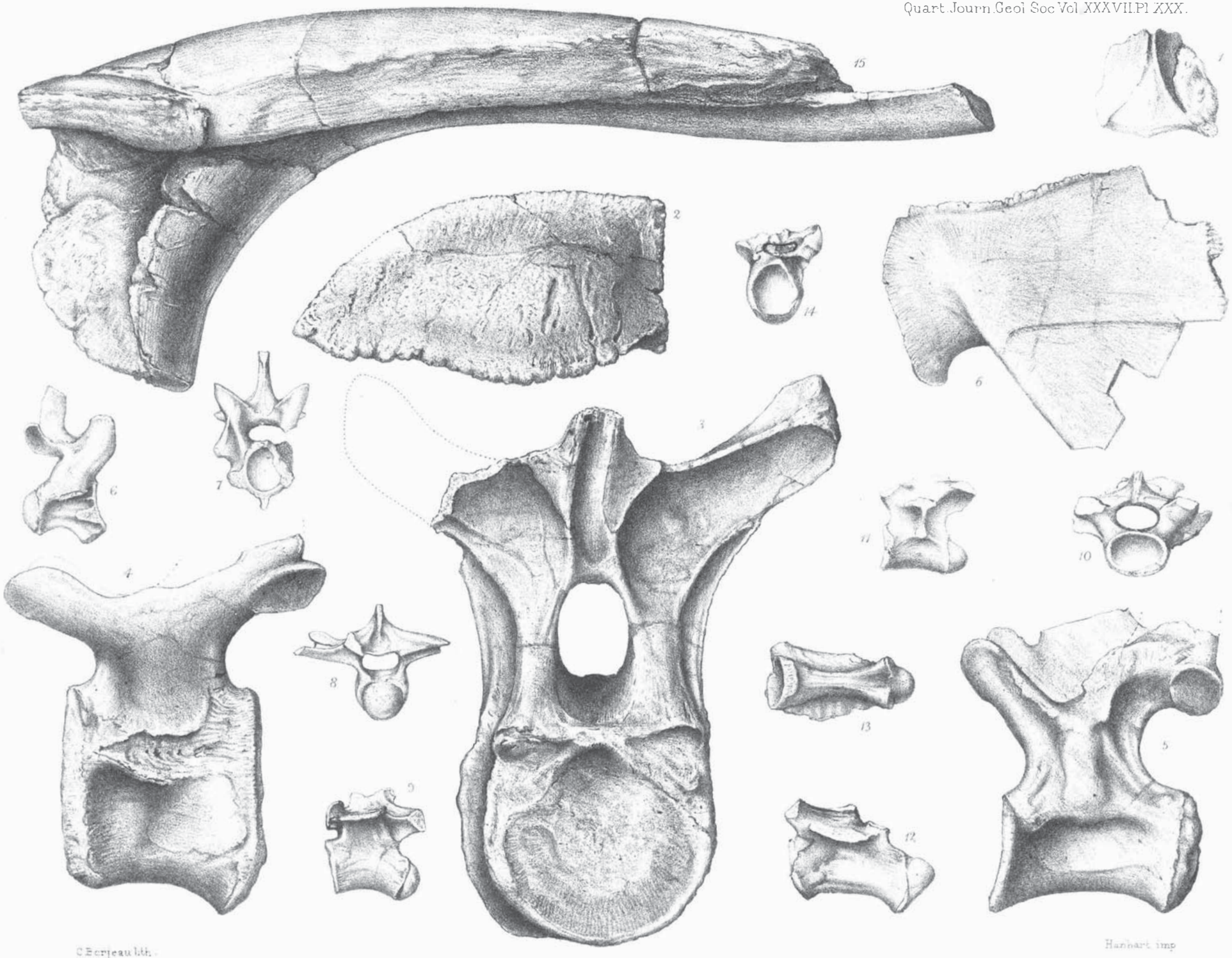

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