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Owen, R., 1861 Monograph on the fossil Reptilia of the Cretaceous Formations. Supplement III. Pterosauria (Pterodactylus). The Palaeontographical Society, London. (volume for 1858; pp. 1–19 & plates 1–4)

This monograph was written in 1858 and issued in 1861. Owen has a peculiarity of measuring things in inches and lines. A line is 1/16 of an inch when his measurements are compared to the original specimens.

SUPPLEMENT (No. III)

TO THE

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF

THE CRETACEOUS FORMATIONS.

Order – **PTEROSAURIA**, Owen.

Genus – PTERODACTYLUS, Cuvier.

In former monographs on the fossil reptilia of the Upper Green-sand of Cambridgeshire,[1] I have described, figured, or referred to, parts of a Pterodactyle, from an individual surpassing in size that to which the portions of upper and lower jaw[2] belonged on which the species dedicated to Professor Sedgwick was found. Such fossil evidences of mare gigantic flying reptiles, showing no better distinctive characters, were deemed, probably, to belong to the *Pterodactylus Sedgwickii*,[3] the then largest known species of the genus.

I am now, however, enabled to adduce, from the more recently acquired additions to the Woodwardian Museum at Cambridge, supplied to me by the same unfailing liberality of the eloquent Professor, evidences of a much larger Pterodactyle, distinct, in regard to the form of the skull, from any previously known, and one which, assuming that the portion of upper jaw of *Pterodactylus Sedgwickii* (Tab. I, fig. 1, 'Monograph' of 1857) belonged to a fully-grown specimen, must have acquired at least double the dimensions of that species.

PTERODACTYLUS SIMUS, Owen.

Jaws and teeth (Tab. I, figs. 1-10).

The first evidence I have to offer of this truly gigantic flying reptile consists of the corresponding part of the upper jaw with that on which the *Pterodactylus Sedgwickii* was found, viz., the anterior extremity forming the muzzle (Tab. I, figs. 1-5), including the first four (*a*,*b*,*c*,*d*) and part of the fifth (*e*) sockets of the teeth. The comparison and appreciation of the specific distinctions of the two large Pterodactyles are thus rendered easy and satisfactory.

In the specimen of *Pterodactylus simus* (Tab. I, figs. 1-5), the first tooth (*a*) on the left side remains in the socket; it is not larger than the corresponding tooth in *Pterodactylus Sedgwickii*, and, consequently, is relatively much smaller than in that species. Its socket and that of its fellow, moreover, are differently situated, opening downwards, like the succeeding sockets, and the position of the exserted (sic) foremost tooth is accordingly vertical and nearly parallel with the lower half of the anterior contour of the muzzle. In *Pterodactylus sedgwickii*, the sockets of the first pair of teeth open upon the forepart of the muzzle, and look almost directly forward,[4] and their teeth had, consequently, a nearly similar direction; the same, viz., which they appear to have had in *Pterodactylus suevicus*, Qnst.[5]

The contour of the muzzle in *Pterodactylus Sedgwickii* rises at first vertically above these sockets before curving back into the upper part of the skull's profile, and gives an obtuse termination to the upper jaw;[6] but this character is much exaggerated in the present specimen (Tab. I, figs. 1 and 3), not only by the greater relative extent of the vertical part above the front sockets, but by the greater breadth of that part, which is flattened anteriorly, forming a surface (fig.3) of nearly 2 inches in length, about 10 lines in breadth below, and contracting gradually above to a point, where the blunt ridge begins that forms the upper part of the profile of this portion of the skull. The name proposed for the species refers to this peculiarly obtuse and flattened forepart of the cranium. In *Pterodactylus Sedgwickii*, the upper ridge of the forepart of the cranium is continued down to between the first pair of sockets,[7] the muzzle being only obtuse vertically, and not transversely, as in *Pterodactylus simus*.

The flattened anterior surface, in the specimen figured (Tab. I, fig. 3), is impressed by a very shallow and wide, longitudinal or vertical channel; but this is scarcely marked in a second specimen of the same species. In both specimens the outer surface of the flattened part is less smooth than at the sides of the muzzle, being impressed by numerous irregular, linear grooves, seemingly vascular, affecting the vertical direction at the upper part, and the transverse direction at the rest of the surface.

The ridge where the two sides of the muzzle meet, above and beyond the flattened surface, is more obtuse and is relatively thicker than in *Pterodactylus sedgwickii*. Were the same curve to be continued from the part of the ridge preserved until it became horizontal, the vertical diameter of the skull at this part would be not less than three inches; It may, however, have risen to a greater height, for the contour is not regularly curved, but sub-angular, as shown in figs. 1 and 2.

The facial part of the skull must have been narrow in proportion to its height, and, no doubt, also to its length. The broadest part of the present fragment does not exceed one inch and a quarter at the fourth pair of sockets; the adherent matrix (*m,m*, figs. 4 and 5) gives a seemingly greater breadth to this part of the skull.

The sockets of the first pair of teeth (*a*) are three lines apart, the interspace equalling the largest diameter of the socket; the bone forming this anterior termination of the palate projects as a convexity below the level of the alveolar openings, the plane of which is a little inclined outwards. This inclination is increased in those of the second pair of sockets, which are nearly double the size of the first, and are five lines apart. The second is separated from the first socket by an interval of two lines; its outlet has a full, oval form. The third socket is four lines distant from the second, and exhibits the same ratio of increase in size; there is a shallow, vertical depression on the outer alveolar wall, between the second and third tooth, the socket of the latter appearing to have made a slight prominence on that part of the jaw. The palate between the second and third pair of sockets is flat, showing no trace of the median ridge characterising that part of the upper jaw, or of the groove at the corresponding part of the lower jaw, in the *Pterodactylus Sedgwickii*.

The upper jaw of the *Pterodactylus simus*, in the present specimen, has been partially fractured across the third pair of sockets (figs. *1*, *2*, *5*, *c*), of which only the forepart of the left one is here preserved, showing well-marked vascular grooves. Its outlet, from this fracture, appears to be of a larger oval or ellipse than in the second socket.

The fourth socket (*d*) is preserved only in the right side, with about the right half of the corresponding part of the bony palate. The outlet of this socket resembles in shape and size that of the second; it is three lines distant from the third socket.

The fifth socket (*e*), the forepart of which is preserved on the right side, is four lines distant from the fourth.

The thinness of the compact outer wall of this fragment of the upper jaw, and the large size of the cancelli, concur with the dental characters in demonstrating the Pterosaurian nature of the fossil. So far as the outer wall is preserved, it shows no trace of the external nostril at a distance, viz., of three inches from the forepart of the upper jaw.

The tooth in place is sub-compressed, conical, long, and slightly curved, with a convexity forward. The portion of enamel preserved on the crown accords with the Pterosaurian type of tooth in its thinness, in the very delicate, irregularly wavy, sometimes branching, longitudinal ridges, on its outer surface; the dentine is compact, and is coated by cement at the base of the tooth.

PTERODACTYLUS **W**OODWARDI. Tab. II, figs. 3, *a, b, c*.

The specimen from Professor Sedgwick's collection, represented of the natural size in Tab. II, fig. 3, *a, b*, is a transverse fragment of the jaw of a Pterodactyle, from the Upper Green-sand of Cambridgeshire, showing a greater divergence of the side walls towards the alveolar or oral surface, and consequently, greater breadth of that surface in proportion to the height or vertical extent of the part. Of the oral surface too small a portion is preserved to indicate whether it be a palatal or mandibular. By the character of the median ridge or groove pointed out in my former monograph, I incline to regard it as part of the upper jaw, corresponding in the proportions of height and palatal breadth with that of the *Pterodactylus Fittoni* (Tab. I, fig. 3, *c*, 'Monograph' for 1857), but coming from a part of the jaw further from the anterior extremity.

The fractured ends show the characteristic thinness of the compact, bony wall, and the large (air-?) cells occupying its substance.

The side wall, which is most entire, has been abraded (Tab. II, fig. 3, *b*), but the small portions of the preserved surface exhibit the smooth character of Pterosaurian bone. The fragment includes a pair of sockets, with the base of their teeth. The latter show the usual elliptical, transverse section (fig. 3, *c*). The implanted base of the tooth extends three fourths of the way to the upper border of the jaw; it has a coat of cement half a line thick, with the outer surface longitudinally ridged, corresponding with the grooves of the socket. The direction of the socket shows that the tooth extended obliquely forwards and outwards as well as downwards.

Tab. IV, fig. 4, shows the part of the base and baseal half of the crown of a tooth of a Pterodactyle, from the Upper Green-sand of Cambridgeshire, a little surpassing in size that of which the base is shown implanted in the socket of the portion of jaw (Tab. II, fig. 3), and of that figured in Tab. I, fig. 6, *a, b, c*, of my former 'Supplement' (1857). The total length of the tooth (fig. 4) cannot have been less than 4 inches.

If the present fragment has belonged to an individual of the same species as that on the upper jaw of which the *Pterodactylus Fittoni* is found, it shows such species to have attained more than double the dimensions indicated by the original specimen figured in Tab. I, figs. 3 and 4, of the 'Monograph' for 1857. Should the present fragment prove to belong to a distinct species, with the side of the jaw meeting above, at a less acute angle, and with the wall of the outlet of the socket less prominent externally, such species may be indicated as the *Pterodactylus Woodwardi*, in honour of the founder of the Geological Collection of the University of Cambridge.

*The **M**andible* (Tab. I, figs 6-10).

The portion of the right ramus of a lower jaw, or mandible, figured in the above-cited plate, may have belonged, by its size, to either of the gigantic Pterodactyles above specified as *Pt. Simus and Pt. Woodwardi*. Its texture and configuration show it to have formed part of a Pterosaurian skeleton. It is the part of the ramus which answers to the angular, sur-angular, (sic) and articular elements in the Pterodactylus suevicus,[8] but with only a part of the sutures between the angular and sur-angular remaining on the inner side of the bone. The angle is partially fractured, but seems to have been not much produced beyond the articular concavity.

The ramus, as it extends forward from the articular part, at first diminishes slightly in breadth and depth, then increases in vertical, whilst continuing to decrease in transverse, extent.

The outer surface (fig. 7) presents, near the articular cavity, a shallow, longitudinal depression, bounded below by a rather sharp border; a broader and more shallow depression, the lower boundary of which is well defined, marks the more advanced part of the ramus. These depressions indicate the insertions of muscles.

Both the upper (fig. 9) and lower (fig. 8) borders are obtusely rounded, the latter being the thickest. Along the inner side of the fragment a longitudinal channel (fig. 6, *e*) extends near the lower border, the upper boundary of the channel being produced inwards, especially posteriorly (*b*); above this boundary there is a deep, longitudinal (*d*) partly filled with matrix, and probably communicating with the (pneumatic ?) cavity of this part of the jaw-bone.

The longitudinal depression (fig. 6, *d*) is bounded below by the angular element, or part answering to that marked 2 in *Pterodactylus suevicus*, and above by the sur-angular (*c*). This element appears to have coalesced with the articular one; but between the bones (*a*, *c*) and that marked *b* a true harmonia or toothless suture remains. The line below the letter *e*, in fig. 6, appears to be an accidental crack. The fractured anterior end of the fragment (fig. 10) indicates the extreme thinness of the wall of the bone, which consists of compact osseous substance. A part of the concave, articular, surface is shown at *a*, fig. 7.

A similar longitudinal depression on the inner side of the back part of the ramus, with its lower boundary as a ridge, and formed by the angular element (2), is indicated in the figure of the lower jaw of the *Pterodactylus suevicus* in Professor Quenstedt's memoir; according to the proportions of which jaw, the present comparatively enormous fragment would answer to almost the hinder half of that part of the ramus which has not united with its fellow to form the long symphysis, and it may be estimated as including one fourth of the entire length of the lower jaw, which would give the Pterodactyle, yielding the present mandibular fragment, a head exceeding sixteen inches in length. It is probable, however, that the head of *Pterodactylus simus* as relatively shorter and thicker than in the smaller species of Pterodactyle.

*The **B**asi-occipital* (Tab. I, figs. 11, 12, 13)

A skull of the size above indicated would require an occipital condyle at least as large as that on the basi-occipital element figured in the above-cited plate. This condyle projects backwards on a well-marked base too broad to be called a peduncle; the convexity is only hemispheric, with the transverse diameter predominating; its shape and position indicating great freedom of movement of the head upon the spine. There is no mark of a suture surface for the exoccipitals on the expanded part of the bone (*b*); they were probably confluent, as in birds, with the basi-occipital, and have been broken away; the fracture surface (fig. 12, *b*) shows the large cancelli of this part of the occipital bone. The upper surface (*a*) indicates a wider foramen magnum, or neural canal, than that of the combined atlas and axis (fig. 14, *n*), and such a structure accords with the free and extensive movements of the head upon the spine indicated by the form and prominence of the condyle and its occipital cup (*c*).

***A**tlas and **A**xis* (Tab. I, figs. 14, 15, and 16).

The anchylosed atlas and axis (figs. 14, 15, and 16) correspond in size with the above-described basi-occipital; they were obtained at the same time from the same pit of the Upper Green-sand deposit near Cambridge. The condyloid ball (fig. 12, *c*) neatly fits the cup *c* of fig. 14, and most probably belonged to the same individual. All the characters described and figured in my paper on the 'Vertebrae of Pterodauria,'[9] and in a preceding monograph,[10] are repeated in the present larger specimens of the first and second neck-vertebrae. In the more transverse extension of the posterior articular ball of the axis (fig. 16, b) the present specimen agrees with the smaller of the two previously figured specimens of this part of the vertebral column.[11]

***C**ervical **V**ertebrae* (Tab. II, figs. 1, 2, and 4)

The middle (fourth or fifth ?) cervical vertebra of a Pterodactyle, corresponding in bulk with that indicated by the fossil above described and figured (Tab. I, figs. 1-16; Tab. II, fig. 3), agrees in proportions of length and breadth more with the smaller vertebrae (tab. II, figs. 14-17, vol. For 1857) than with the vertebrae (ib., figs, 7-11) described in my former monograph of that date. It shows the same posterior extension of the centrum (fig. 2, *b, p*) beyond the neural arch (*n*), but with somewhat greater divarication of the hinder process (*p*) than in figs. 18 or 11 of Tab. II of the above-cited monograph. The present specimen very strikingly illustrates the characteristic breadth and depression of the centrum of the middle cervicals of the large Green-sand Pterodactyles. The neural canal (fig. 2, *n*) appears to be proportionally more contracted than in the smaller cervical vertebrae; it is relatively much smaller than in any bird, marking well the reptilian nature of the extinct flying air-breather. The anterior surface of the diapophysial productions of the forepart of the base of the neural arch is marked by a groove extending from above and within outwards and downwards. The whole base of the arch has coalesced with the centrum; the major part, with the neural spine and zygapophyses, has been broken away.

An oblique side view of the last cervical vertebra of a similar-sized Pterodactyle is given in Tab. II, fig. 4, showing the more produced diapophysis (*d*), perforated by the vertebrarterial (sic) foramen (*f*), indicative of the development in this vertebral segment of a rudimentary rib, and of its coalescence with the other elements, the whole extending below the level of the under part of the centrum. Above and behind this foramen is that for the admission of air into the bone; it is of a similar size, and of a narrow, elliptical form. The posterior zygapophysis (*z*) is now raised to a higher level than the anterior one, indicating the sudden bend of the neck at this part. The posterior processes (*p*) are smaller and less produced; the body of the vertebra is narrower, but deeper, than in the more advanced vertebra (fig. 1). The posterior zygapophysis is surmounted by a tubercle.

***C**audal **V**ertebrae* (Tab. II, figs. 13-16).

The caudal vertebra, from the anterior half of the tail (figs. 14 and 14), presents a size corresponding with the proportions of the Pterodactyle given by the above-described neck-vertebrae; the neural arch and zygapophyses continue to be distinctly developed at this region of the tail. There is a foramen (*o*), leading into the substance of the neural arch, on each side of the back part of that arch, and near the corresponding outlet of the neural canal. In the more distal vertebra (figs. 15 and 16) the neural arch has sunk, and seems almost blended indistinguishably with the centrum, which is much longer than in the vertebrae nearer the trunk. The zygapophyses cease to be developed; but the articular, shallow cup and ball at the ends of the vertebra show that the tail retained its mobility, and was not stiffened or anchylosed as at the corresponding part in *Rhamphorhynchus*.

It should be noted that these vertebrae have since been found to be worn cervicals from the derived deposits of the Cambridge Greensand. Hence, the non-conformance with known caudal vertebrae of pterosaurs.

The Sternum (Tab. II, figs. 7-12).

According to the very able and instructive summary, by M. V. Mayer, of the osteology of the best-preserved examples of the skeletons of Pterodactyles, those, viz., from the lithographic slates of the Jurassic (Mid-oolitic) series of rocks, the sternum is a compound bone, consisting chiefly of a symmetrical, keelless, broad plate,[12] having an anterior process answering to the episternal process in the crocodile,[13] and with distinct side parts, having articulations for a few bony, sternal ribs.[14] A to its resemblance, otherwise, to the sternum of mammals, birds or reptiles, in regard to the articular surfaces for the scapular arch, nothing has been, hitherto, determined.

The rich repository of remains of gigantic Pterosauria in the Upper Green-sand of Cambridgeshire have added valuable evidence on these important points, and demonstrated a nearer approach to the keeled character of the breast-bone of flying birds than the specimens of the smaller species described in the under-cited works appear to demonstrate. By the kindness of Professor Sedgwick, I am enabled to compare the specimens of portions of the sternum acquired by the Woodwardian Museum with that which has recently been purchased by the British Museum. The best of these specimens consists of little more than the thicker and stronger, contracted forepart of the breast-bone (Tab. II figs. 7, 8, and 9), broken away from the thin, expanded, fragile plate (*h*), of which it principally consists, and of which remains or impressions have been preserved in a few slabs of fine-grained stone of the Oolitic series, such as the lithographic slate; that of Pterodactylus suevicus[15] showing the posterior border of the symmetrical plate to be convex and entire, not notched or perforated, as in many birds. The forepart of the sternum of the gigantic Pterodactyle from the Cambridge Green-sand includes the major part of the anterior process, and also the pair of articular facets for the coracoids. The keel-like process in the specimen (Tab. II, figs. 7, 8, 9, *b, e, f*) is continued forward from that articular region (*d, c*), for and extent equal to the depth of the bone at the same part; but the process is not entire. Its base is greatly convex at the sides, from the middle and thickest part of which it gradually narrows to a ridge, of about a line or less in thickness at both the upper and under margins; the extreme forepart being broken away, prevents the determination of the precise extent or contour of that end, but the convergence of the preserved parts of the upper and under margins indicate a convexly rounded termination (fig. 7, *e*). There is a gentle depression on each side of the beginning of the upper part of the ridge, which ridge is continued from a thickening or tubercle (figs. 7, 8, *b*), bounding anteriorly a small, deep, transversely oval depression (*d*) between the two articular surfaces for the coracoids (*c*). This tubercle answers to what I have termed the "manubrial process" in the sternum of birds,[16] and the above pre-coracoid part of the sternum answers to that process, confluent below, as in *Aptenodytes*, with the produced "keel." This, however, in *Pterodactylus*, quickly loses depth as it extends backwards along the mid-line of the under part of the sternum, some way behind the articular region, and has not quite subsided at the forepart of the expanded body of the breast-bone (fig. 9, *f*), from which the rest of the shield-like plate has been broken away. The sides of the post-coracoid part of the keel are gently concave; the lower border of the keel is first convex, then concave to near its posterior termination, both in a very feeble degree (fig. 7, *e, f*). Each of the articular surfaces for the coracoid (figs. 7 and 8, *c, d*) is sub-triangular, convex transversely, concave in the opposite direction, with the lower angle continued down the side of the thickest part of this anterior portion of the sternum.

The back part of the articular surface rises higher than the front, so that the general aspect of the surface is obliquely upward, forward and outward. The two surfaces are separated by a non-articular depression (*d*), of the breadth of one coracoid surface; this depression is bounded, like the sella turcica of the human sphenoid, by a transverse rising or ridge of bone (fig. 7, *a*), continued between the hinder angles of the two articular surfaces, and in front by the manubrial tubercle (*b*), from which the upper border of the produced keel is continued. The sternum contracts behind the articular region at *g*, figs. 8 and 9, and then expands rapidly in a horizontal direction, to form the broad, lamelliform body of the bone (*h*), which, in Pterodactylus suevicus,[17] appears to have been almost semicircular in shape, and to have extended backwards beneath about one half of the thoracic abdominal cavity. The upper surface of the forepart of the sternal plate is concave, and it becomes flatter as it expands. The lateral and lower surfaces are also concave vertically, with linear markings, showing the implantation of the pectoral muscles that filled those concavities on each side the keel. Sufficient thickness of the bone remains at the fractured posterior part (f), where the keel has not subsided, to show the widely cancellous, and seemingly pneumatic, texture of the bone.

The similar, but smaller and more mutilated, portion of a sternum of a Pterodactyle (Tab. II, figs. 10-12) shows the same form and position of the coracoid articular surfaces, the non-articular intermediate depression, the lateral emarginations or contraction of the sternum behind the part supporting the coracoids, and the backward extension of the keel beneath a certain proportion of the expanded body of the sternum, forming the hollows for the lodgement of the pectoral muscles.

A sternum of the shape and proportions above described plainly indicates pectoral muscles of great bulk and strength, by the extent of origin it afforded to them, and by the depth of the depressions they filled on each side of the keel; but to what purpose the limbs moved by those muscles were put is best inferred from the characters of the bone into which they were inserted. If, however, the peculiar development of the fore limbs of the Pterodactyle had not been known, the evidence of the pneumatic or widely cancellous structure in the thicker forepart of the breast-bone would have suggested a power of locomotion in its original possessor akin to that of the class to the sternum of which that of the Pterodactyle makes, upon the whole, the nearest approach.

It is true that the sternum is broad and shield-shaped in the Apteryx and other land-birds devoid of the power of flight; but this form, together with the strong coracoids and their articulation with the sternum, relates, in them, to the mechanism of respiration. The ossified sternal ribs, with their articulations to the sides of a broad sternum, indicate a like function of the breast-bone in the Pterodactyle, viz., to expand the thoracic abdominal cavity, when such plate of bone, with attached but jointed sternal ribs, was pressed down by the coracoids.[18] The superadded keel, co-extended anteriorly with the connate manubrial process of the sternum of the Pterodactyle, plainly bepeaks, however, additional functions; but these might have been, as M. Von Meyer suggests, the same as in the penguin, or even in the mole. And, at this point, the physiologist in quest of the locomotive relations of the sternum, would pass to the comparison of the humerus and other bones of the fore limb; or, failing those, to a more minute scrutiny of the texture of the breast-bone of the Pterodactyle. It is almost superfluous to remark that the evidence of the fore limbs had shown the Pterodactyle to have been a flying animal long before anything was precisely known as to its sternum.

The development of the interpectoral process or keel of the sternum in the Pterodactyle exceeds that in any of the bat tribe; and it may be confidently concluded that the flight of the winged reptile might have been, at least, as swift and of as long continuance as in the *Pteropi*. But, viewing the pneumaticity of the bones of the Pterodactyle, and the relatively greater and more continuous development of the interpectoral crest of its sternum, I an led to believe it to have been a creature of more extensive, continuous, and powerful flight than is now enjoyed by any bat; and the Pterodactyles may at least have been as capable of migration as the great frugivorous *Chiroptera*. The structural affinities, however, of the Pterodactyles to the cold-blooded air-breathers, and their analogy, in wing-structure, to the bats, indicate that they might have possessed the faculty of becoming torpid, and of so existing during a period when their food in a given locality was not attainable.[19]

In no other reptile does the sternum present coracoid articulations so shaped and placed as in the Pterodactyle. The Crocodilia, in which, as in Pterosauria, the clavicles are wanting, show the broad sternal margins of the coracoids ligamentarily attached to the middle of the lateral border of the sternum.

In bats the obtuse, sternal ends of the clavicles are applied to protuberances of the manubrium above the articulations of the first pair of ribs. Only in birds are distinct synovial articular cavities provided for the coracoids, which, in the main, are situated and shaped as in the Pterodactyle. The differences are these: the concavity and the convexity being (as, e.g., in *Aptenodytes*), the same, the bent grooves so formed are much longer than in the Pterodactyle, with a concomitant greater expansion of the ends of the bones they firmly lodge. The coracoid grooves are divided by a non-articular, median depression in *Aptenodytes*, but this, in some other birds, is wanting, the coracoid grooves decussating across the middle line, e.g., in the Heron.[20] There are various minor modifications of the coracoid grooves in the breast-bone of birds.

The marked distinction in the breast-bone of the Pterodactyle is its compression behind the coracoid articulations, and the distinct commencement of the shield-like expansion behind that articular part.

In most birds the “manubrium” projects from the mid-space between the coracoid grooves, and is distinct from the “keel;” in some it is bifurcated; in the penguins it is as little developed as in the Pterodactyle, and is as directly continuous or connate with the forward production of the keel. In this production *Aptenodytes patachonica (Jackass penguin)* most resembles, amongst birds, the Pterodactyle. The parts are homologous, and if we name that production the forepart of the keel of the breast-bone in the aquatic bird, we must apply the same name to the Pterodactyle; only in the latter the keel subsides sooner beneath the expanded part of the sternum.

In the Crocodilia the broad, thin, sternal borders of the coracoids are attached by fibrous substance to the fibro-cartilaginous, or, in old animals, partially ossified, plate, representing the sternum of struthious birds. The bony sternum, or “episternum,” is long, narrow, and depressed; it is considerably produced in advance of the coracoids, but this produced part is flattened horizontally. If it be compared with the pre-coracoid part of the sternum in the Pterodactyle or penguin, it is not more like the one than the other. In the main, the Pterosaurian breast-bone, like the scapular-arch, is formed on the ornithic type, but the post-coracoid, lateral emarginations are distinctive Pterosaurian characters.

*The **H**umerus of **P**terodactylus* (Tab. III).

The fragile texture of the bones of the Pterodactyles, and the consequently crushed or broken state in which those of the wings more especially have hitherto been usually found, have precluded any precise description or figures of the articular surfaces, or of the configuration of the extremities of these bones. And yet such particulars are absolutely requisite for defining the resemblance of the Pterosaurian humerus to that of the bird and reptile, and for acquiring this element in the determination of the degree of affinity or relationship of the Pterosaurian to those classes respectively.

The remains of the very large species of Pterodactyle from the Cretaceous formations of Kent and Cambridgeshire have furnished materials for advancing this desirable knowledge in regard to the structure of the vertebrae,[21] and I have now similar means of contributing more precise information respecting the structure of the proximal end of the humerus than has hitherto been possessed. For the subjects of this study and comparison I am chiefly indebted to Professor Sedgwick. But, in preceding to impart the results, I must premise some notice of the character of the humerus in Birds, in which I shall avail myself of the terms indicative of aspect and position proposed by Dr. Barclay, in his 'Anatomical Nomenclature.'

Proximal signifies the upper, *distal* the lower, ends of the bone, as it hangs in man; *ancona*l is the posterior, *palmar* the anterior, surface, as when the palm of the hand is directed forward; *radial* is the outer, *ulnar* is the inner, side, according to the same position of the human arm and hand. *Proximad*, *palmad*, &c., are adverbial inflections, meaning towards the proximal (upper) end, and towards the palmar (anterior) side.

In the bird, then, the humerus has a smooth shaft, sub-elliptic in transverse section, with expanded ends, the proximal one being the broadest. Lengthwise the bone is gently sigmoid, the proximal half being convex palmad, the distal half concave, with the plane of the terminal expansion vertical, as the bone extends along the side of the trunk from its scapulo-coracoid articulation backwards, in its position at rest.

The head of the humerus is an elongate, semi-oval convexity (Tab. III, fig. 8 *a*), with the long axis transverse from the radial to the ulnar sides (vertical, as naturally articulated), and with the ends continued into the upper (*b*) and lower (*c*) crests. Of these, the upper one (*b*, figs. 6-8), in the natural position of the bone, is on the same side as the radius, the lower, more tuberous one (*c*), in on the same side as the ulna; the one marked the "radial" side, the other the "ulnar" side, of the bone. The side of the humerus next the trunk answers to that called "anconal" (fig. 7), the opposite side to that called "palmar" (fig. 6)

The expanded, proximal part of the shaft of the palmar side (fig. 6) is concave across, convex lengthwise; on the anconal side (fig. 7) it is convex across to where the ulnar ridge (*c*) bends anconad near the pneumatic orifice (*p*).

The radial crest (*b*) answers to the "greater tuberosity" and to the "pectoral" and "deltoid ridges" in mammals; the "ulnar" crest (*c*) to the "lesser tuberosity," and the ridge for the "latissimus dorsi," in mammals.

In a few exceptions the shaft of the humerus is almost cylindrical, in still fewer (e. g., *Aptenodites*) it is flat.

The vulture (*V. monchus*), the ulnar crest forms a thick tuberosity at its proximal end (fig. 7, *c*), projecting anconad, and overarching the "pneumatic" foramen (*p*); it descends a short way obliquely palmad, decreasing in breadth, but still thick, convex, and terminating obtusely (fig. 6, *c'*). The radial crest (fig. 6, *b*) better merits the name; it extends twice the length of the ulnar one, down the shaft, to the palmar side, towards which the whole crest is slightly bent; its margin describes a very open or low, obtuse, angle at its middle part. A ridge (*r*) upon the palmar side of its distal half indicates the boundary of the insertion of the pectoralis major into the crest. At the middle of the anconal surface of the proximal part of the shaft there is a low, longitudinal ridge (*l*).

At the distal part of the humerus a ridge on the radial side of the palmar surface, and a rising of the bone on the ulnar side of the same surface, diverge to the opposite angles or tuberosities of the expanded end of the bone; they include a shallow, sub-triangular concavity above the articular surface. These are two, and are convex.

The radial surface is a narrower, sub-elongated convexity, extending from near the middle of the palmar surface obliquely to the lower part of the radial tuberosity, where the convexity subsides; it is very prominent at its palmar end, with a groove on each side, the deeper one dividing it from the ulnar, articular convexity. This is of a transversely oval or elliptical shape, most prominent palmad; all the part of the end of the humerus forming the two articular convexities is as if bent towards the palmar aspect. The ulnar end of the ulnar convexity is bent, and continued anconad to that end of the ulnar tuberosity. An oblique, longitudinal channel divides the anconal end of the radial tuberosity from an almost longitudinal ridge, which is nearer the middle of the anconal side of the distal end of the humerus; a similar; but shorter, longitudinal ridge or rising of bone, terminates in the anconal part of the ulnar tuberosity. Between the above almost parallel ridges the anconal surface is nearly flat transversely; it is traversed along the middle by a low, narrow, longitudinal ridge. Lengthwise the bone is here convex.

The differences in the humerus of different birds are seen chiefly in the forms and proportions of the proximal crests; the radial one in the *Columbidae*, e.g., is shorter and more produced than in most birds of flight. The humerus in the swift and humming-bird is distinguished by special modifications.

In the crocodile (Tab. III, figs. 9-12), the articular head of the humerus (fig. 12, *a*) is a transversely elongated, sub-oval convexity; it is continued upon the short, obtuse, angular prominence (*c*) answering to the ulnar crest or tuberosity in the bird. The radial crest (fig. 9, *b*) begins to project from the shaft at some distance from the head of the bone; it is shorter, thicker, more prominent, and projects more directly palmad than in the bird. The humerus presents a similar sigmoid flexure lengthwise to that in the bird, but the ulnar contour of the shaft, as it descends from the ulnar end of the head of the bone, describes a concave line to the ulnar condyle; the radial contour is sigmoid, and not affected by the radial crest, as in the bird. There is a longitudinal ridge (fig. 10, *d*) on the anconal surface close to the radial border.

The humerus of the Pterodactyle (ib., figs. 1-5) is shorter in proportion to the expanse of its proximal end than in either the bird or crocodile, and it appears to have a straighter shaft. It conforms at its proximal end more with the crocodile than the Avian type. The ulnar crest, or tuberosity (*c*), is rather more prominent and better defined than in the crocodile, but the radial crest (*b*) is much more developed than in either the crocodile or the bird. It resembles that of the crocodile in being more directly bent palmad, or what would be outward in relation to the side of the trunk, in the natural position of the bone at rest.

The crest begins, above, at the radial and palmar end or angle of the articular head of the bone, and rapidly expands, bending palmad, with a base co-extensive with one fifth of the length of the humerus, inclined, as it descends (fig. 3), to the palmar side, and ending below by a rough tuberosity projecting at right angle from the shaft of the bone; the lower sharp margin (fig. 1, *b'*) of the tuberosity passes by a quack curve, and subsides upon the cylindrical shaft. The palmar surface of the proximal part of the humerus, by the production in that direction of the ulnar tuberosity, but more especially by the direction of the large, radial crest (*b*), is more concave across than in birds. Between *b* and *c'*, *e*, *g*, in fig.1, it is gently convex lengthwise, and is very smooth.

A longitudinal ridge (fig. 1, *r*), along the distal half and palmar side of the base of the radial crest, indicates, as in birds, the insertion of the strong and large pectoral muscle.

The articular head of the bone is reniform, not uniformly convex, as in birds, but slightly concave between the beginnings of the radial and ulnar crests or processes on that moiety of the head next the palmar side (fig. 3, *a*). At the opposite (anconal) side (fig. 2, *a*), the head projects beyond or overhangs the shaft, the upper part of which, on the anconal side, is slightly concave lengthwise, very convex across, more so than in birds, and without trace of the median longitudinal ridge (*l*, fig.7). It is equally devoid of the ridge which, in the crocodile (fig. 18, *d*), runs to the radial side of the anconal surface.

The shaft is more cylindrical than in birds. The pneumatic foramen (figs. 3, 5, *p*) is situated a little below the radial end of the head of the bone, on the palmar side of the bone; in the vulture, and most birds of flight, it is situated on the opposite side (fig. 7, *p*). The pneumatic texture of the shaft is as well marked as in any bird of flight.

In looking directly upon the palmar side of the humerus in the bird one has an oblique, foreshortened view of the radial crest, the base of which lies wholly along the radial margin. Taking the same view of the humerus of a pterodactyle as in Tab. III, fig. 3, w look almost directly upon the edge of the radial crest (*b*, *b'*), the base of which has inclined below from the radial upon the palmar surface. A corresponding view of the humerus of the crocodile (fig. 11) shows the whole base of the radial crest on the palmar surface, clear of the radial border, and the opposite side of the crest to that in the bird is obliquely brought to view. (In the figure 11 the radial side of the shaft is rather too much turned towards the eye.)
In the position and shape of the radial crest of the Pterodactyle is between the bird and the crocodile; in the transverse extent of the crest it exceeds both. The crest differs in extent and shape in different species of the Pterodactyle. In fig. 1 the ulnar side of the shaft is turned so far towards the eye as to permit the whole breadth of the radial crest (*b*) to be seen. The degree to which the radial crest projects in the humerus of the large Cretaceous Pterodactyle (Tab. III, fig. 1) is only shown at its lower part, the upper, thinner portion being broken away. Relative to the size of the head of the bone, the extent of the base is greater than in the smaller species of Pterodactyle, a corresponding portion of the humerus of which is represented in fig. 5, from the same aspect as fig. 1. The extent of the base of the radial crest in fig. 5 corresponds with that of *Pterodactylus suevicus*.[22]

In *Rhamphorhynchus Gemmingi* the radial crest, with a similar short origin, has a remarkable transverse extent, and expands at its termination so that both upper and lower margins are very concave.[23] The latter is of much greater relative extent than in the larger Cretaceous Pterodactyle (Tab. III, fig. 1). The Wealden Pterodactyle (Pter. ornis) resembles Rhamphorhynchus in the proportions of the radial or outer process (*g*, fig. 5, 'Quart. Journal of the Geol. Soc.,' 1845, p. 99).

The determination of the homologies of the processes from the proximal end of the humerus of the pterodactyle with those in the bird and crocodile enables one to recognise the specimen (figs. 1-3 and fig. 5) as part of the right humerus.

Fig. 4 is part of the left humerus, from the Upper Green-sand of Cambridgeshire, but was drawn upon the stone without reversing, to facilitate its comparison with fig. 1, from the Middle or White Chalk of Kent, which it resembles in the extent of origin of the radial ridge (*b*).

***C**arpal **B**ones* (Tab. II, fig. 6; Tab. IV, figs. 5-9).

The two bones (Tab. IV, figs. 5, 6, and figs. 7-10) correspond in size so much more with that of the distal extremities of the radius and ulna than with that of the same part of the tibia, as to leave a conviction that they are carpal bones, and they afford instructive evidence of the characters of those bones in the Pterodactyle. Specimens of more or less entire, but dislocated, skeletons of the smaller kinds of Pterodactyle from the Oolitic strata, especially that of *Pterodactylus suevicus* from the lithographic slates of Wirtemburg,[24] and that of *Rhamphorhynchus Gemmingi* from the same formation at Eichstadt,[25] have demonstrated the presence of at least two large carpal bones, with one or two smaller ones, the two carpals forming a first and second row; but the figures are too small and indefinite to permit the matching with them of either of the larger and probably better-preserved carpal bones from the Cambridge Green-sand.

The first to be described is subdepressed, subtriangular in shape, with a general tendency to convexity on one articular surface (Tab. IV, fig. 8), and to concavity on the opposite surface (fig. 7); but both are irregularly undulated, as shown in the figures; the more concave surface being also impresses by a deep hemispheric pit. I conjecture that this bone formed the proximal part of the carpus and that the pit may have received a process of the distal end of one or the antibrachial bones. The opposite, probably distal, and more convex surface (fig. 8) is divided into two slight convexities, by a shallow, wide channel, crossing the bone obliquely. The convexity (*a*) meets the concave surface on the other side of the bone (*e, f*) by their convergence to the basal border of margin, which presents a slight notch. The opposite end of the bone forms the obtuse apex (*d*), which is a little bent towards the concave side. On this side (fig. 7) the notch is continued into an angular channel, which divides the two shallow, concave surfaces (*e* and *f*) occupying the basal half of this surface; a little nearer the apex than the middle of the bone comes the hemispheric pit, with a small depression on one side if it.

Fig.9 shows the thickest or deepest, non-articular side of the bone, sloping to the end of the facet (*f*), and with the apical tuberosity (*d*) at the opposite end.

Fig. 10 is taken looking upon the convex surface from the notched base (*a*).

Fig. 8 may correspond with the surface of the carpal bone in Pterodactylus suevicus, marked **1**, in the bones of the left wing in Professor Quenstedt's plate; and the side view of the same bone in the carpus of the right wing gives an indication of the produced apex. The outline of the large proximal carpal in Pterodactylus (Rhamphorhynchus) Gemmingi, in M. v. Mayer's Plate, accords in a general way with the profile of the narrower side of the present bone, which, for the convenience of indication and description, might be called the "scapho-cuniform." I have no proof, however, from knowledge of its precise connections, of the accuracy of this determination; but strongly suspect that the bone may represent more than one of the proximal carpals in the mammalian wrist, and probably the two proximal bones in the carpus of the crocodile.

In Tab. II, fig. 6, a scapho-cuniform bone is figured, which, from its size, might belong to *Pterodactylus simus*; it differs from that in Tab. IV, fig. 7, not merely in size, but, apparently, in a greater relative breadth of the surfaces (*e* and *f*); their margins forming the base of the triangle have been, however, abraded.

The second large wrist-bone (Tab. IV, figs 5 and 6), if the foregoing be rightly compared, will match with the carpal bone articulating with the proximal end of the metacarpal of the fifth or wing-finger in the plates of *Pterodactylus suevicus*, and of *Rhamphorhynchus Gemmingi*, above cited; and it will consequently answer to or include the "unciforme," by which name it will be here described and figured.

Both proximal and distal surfaces show well defined, concave articulations. On the more concave surface (fig. 5) there is an oblong, articular depression (*g*), continuous at the margin (*h*) with a surface on the opposite side of the bone; a more irregular undulated channel, deepest at the middle part (*i*), occupies the rest of the surface, but the end of the bone opposite (*h*) has been broken away. Fig. 6 shows two shallow articular channels (*k* and *l*), partly divided near the end (*h*) by a tract of non-articular surface.

In birds the base of the metacarpal of the digitus medius has the "os magnum" connate therewith, it also becomes confluent with the base of the second and fourth metacarpals. Between this compound bone and the antibrachium two distinct carpal bones partially intervene, being wedged between the metacarpus and antibrachium, one on each side. The Pterodactyle, in the complete separation of the metacarpus from the antibrachium, by two successive carpals, answering to the two rows, adheres more closely to the Reptilian type; but differs in the much greater expanse and complexity of the carpals, and in their minor length.

Ungual Phalanx (Tab. IV, figs. 11 and 12)

The ungula phalanx (Tab. IV, figs. 11 and 12), accords in size with that of the limb indicated by the carpal bones (figs. 5-10). The articular surface presents two trochlear concavities, extended vertically, narrow transversely, divided by a median ridge; the upper angle is rather produced; below the trochlea is a small depression, and below this the bone projects in the form of a rough protuberance for the flexor tendon. On each side of the phalanx is the curved vascular groove, beneath which, in some specimens, the bone slightly expands. In one specimen a second, more shallow groove is shown on one side, nearer the upper margin of the bone.

Footnotes

1. ‘Monograph on Fossil Reptilia of the Cretaceous Formations’ (1857), tab. i, p. 6; tab. iv, figs. 1, 2, and 3.
2. Ibid., t. i, figs. 1 and 2.
3. Ibid., p. 5.
4. Ibid., tab. i, fig. 1, c.
5. ‘Ueber *Pterodactylus suevicus*,’ &c., 4to, 1855, tab. i.
6. ‘Monograph’ for 1857, p. 2, tab. i, fig. 1.
7. Ib., tab. i, fig. 2.
8. Quenstedt, ‘Ueber Pterodactylus suevicus,’ 4to, 1855, tab. i, figs. 2, 4, 5.
9. ‘Phylosophical Transactions,’ 1859, p. 165, pl. 10, figs. 28-34.
10. ‘Palaeontographical Society,’ vol. For 1857, pp. 7, 8.
11. Compare Tab. I, fig. 16, with Tab. II, fig. 14, and Tab. IV, fig. 2, of the ‘Monograph’ of 1857.
12. “das Brustbein ist ein schwach gewölbes knöchernes Schild, das breiter al slang, und daher eher dem Brüstbein der nur kümmerlich mit *Flügel* versehenen Strauss-artigen Thiere beider Erdhälften, als dem in der Flug-begabten Vogeln zu vergleichen ist. Es zeigt keinen Kiel oder Gräth, und Man könnte daher glauben das die Stelle zum Ansatz eines kräftigen Flugmuskels fehlt, die Pterodactyln keine gute Flieger gewesen wären.” (‘Reptilien aus dem Lithographischen Schiefer,’ fol., 1859, p. 17.)
13. “Am Brustbein der Pterodactyln wird ein vorderer Forsatz wahrgenommen, der den Kiel ersetzt und den Brustmuskeln als Anheftungsstelle gedient haben wird. Dieser Theil erinnert an den Forsatz am Brustbein des Crocodils.” (Ibid., p. 18.)
14. “Bei Rhamphorhynchus gemmingi fand ich ausser den gewohnlichen Brustbein nach eine Platte mit Brustrippe welche die Verbindung mit den Kückenrippen unterhalten haben warden und wie in den Vogeln knöchern waren.” (Ibid., p. 18, tab. x, fig. 1.)
15. Quenstedt, ‘Ueber Pterodactylus suevicus, im Lithographischen Schiefer Würtembergs,’ 4to, 1855.
16. Art. “Aves,” ‘Cyclopedia of Anatomy and Physiology,’ vol. I, 1836, p. 282, fig. 129.
17. Quenstedt, op. cit.
18. From the appearances presented by the crushed specimen of *Pterodactylus Gemmingi*, imbedded in a slab of lithographic slate, I believe that the part of the sternum showing those articulations has been accidentally separated from the rest of the fractured bone. (see Von Meyer, Tab. x, op. cit.) The estimable author concludes that the marginal portion of sternum, with articulations with ossified sternal ribs, was originally distinct from the body or main plate of the sternum: but the plate of the specimen he describes shows fractures and some mutilation of the bones.
19. The inferences from what was previously known as to the structure of the sternum of the Pterodactyle are thus expressed by M. H. v. Mayer, in his summary of the knowledge of the Pterodsauria, in 1859: “Ez zeigt keinen Kiel oder Gräthe, und man könnte daher glauben, dass, da die Stelle zum Ansatz eines kräftigen Flugmuskels fehlt, die Pterodactyln keine guten Flieger gawesen wären. In dem mangel eines Kieles scheint indess nur eine Andeutung zu liegen, dass die Thiere keine Vögel waren. Eben so wenig warden sie Wanderthiere geweses seyn, und bedurften daher auch keines so starken Brustmuskels. Das Brustbein der Fledermäuse gleicht durch die Gegenwart eines Kiels mehr dem in den Vögeln (footnote carried over 2 pages) Es besitzen aber auch die Maulwürfe am brustbein diesen Kiel, der daher nicht unbedingt als ein Zeichen des Flugerrmögens gelten kann; er setzt engentlich nur starke Brustmuskeln voraus, die daran befestigt waren. Selbst in den Schwimmvögeln die nicht zu fliegen vermögen ist der Kiel verhanden für starke Brustmuskeln, die hier zum Schwimmen eben so nothing sind wie dem Maulwürf zum Graben. . . . . . . Aus diesen Betrachtungen ergiebt sich, dass der Pterodactylus nach der Beschaffenheit seines Brustbeins weder ein eigenliches Wasserthier, noch ein Gräger war, vielmehr ein Their der Luft.” (‘Reptilien aus dem Lithographischen Schiefer,’ &c., fol., p. 17.) Professor Quenstedt, however, seems to me to have fightly appreciated the homology of the forepart of the sternum and the physiological deductions from it: “Der Kamm springt vor einen halben Zoll weit über die Fläche des Knochens hinaus, gibt daher Beweis genung, das das Their fliegen konnte.” (Op. cit., p. 44.)
20. ‘History of British Fossil Mammals and Birds,’ 8vo, 1846, p. 556, fig. 236.
21. Phil. Trans., tom. cit.
22. Quenstedt, op. cit., tab. I, *cr*, *cl*.
23. H. v. Meyer, op. cit., tab. ix. A. Wagner, ‘Fauna des Lithogr. Schiefers,’ 4to, 1858, taf. xvi.

24. Well described and figured by Professor Quenstedt, in his treatise 'Ueber Pterodactylus suevicus,' 4to Tubingen, 1855.
25. H. v. Meyer, op. cit., tab. ix, fig.1.

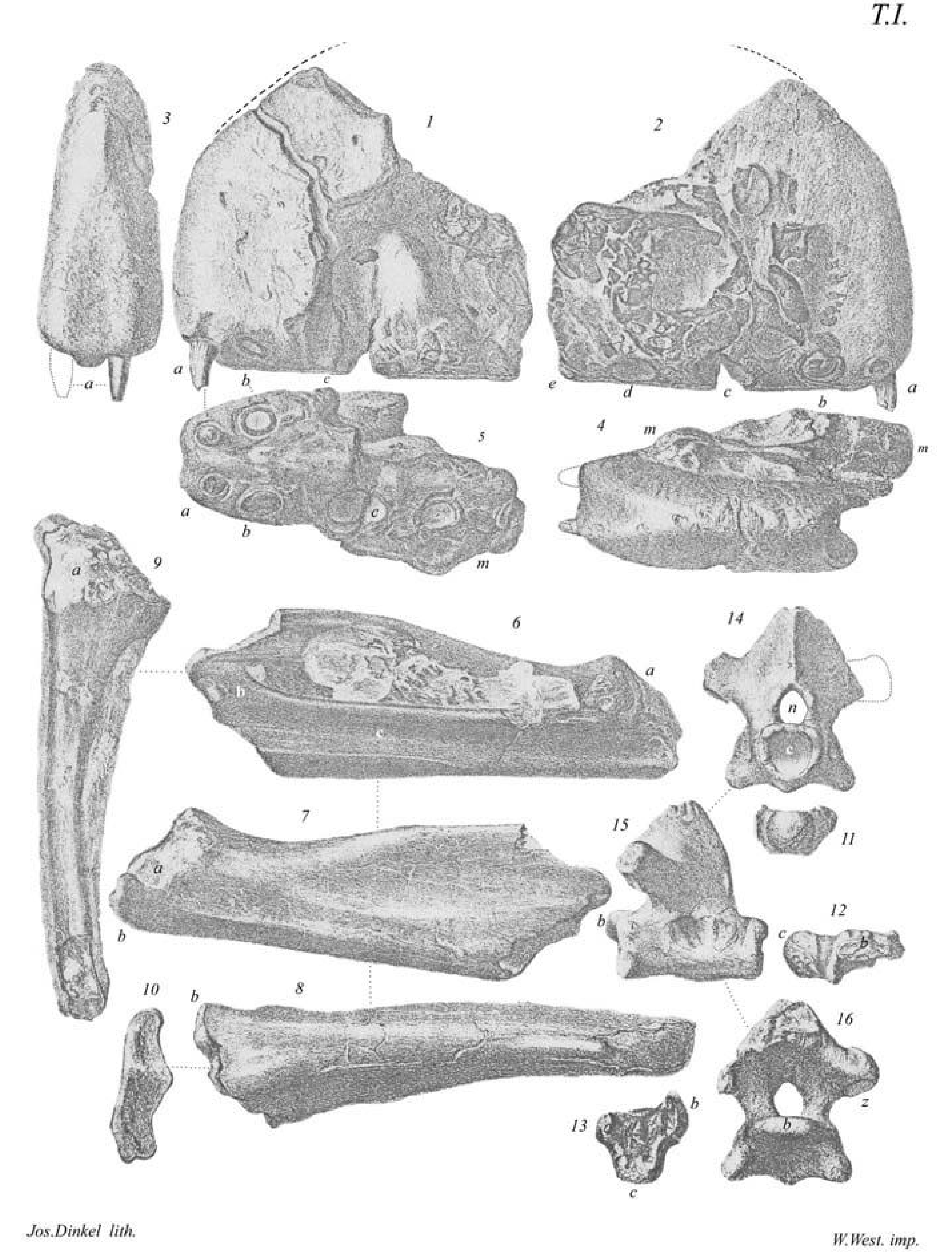
TAB. I.

***P**terodactylus **S**imus.*

Fig.

1. Fore part of the upper jaw, left side.
2. Ditto, right side.
3. Ditto, front view.
4. Ditto, upper view.
5. Ditto, under view.
6. Hinder part of the fight ramus of the lower jaw, inner side.
7. Ditto, outer side.
8. Ditto, under side.
9. Ditto, upper side.
10. Ditto, section.
11. Occipital condyle.
12. Basi-occipital, side view.
13. Ditto, upper view.
14. Atlas and axis vertebrae, front view.
15. Ditto, side view.
16. Ditto, back view.

The foregoing figures are of the natural size, and from specimens in the Woodwardian Museum of the University of Cambridge; they were obtained from the Upper Green-sand formation near that town.



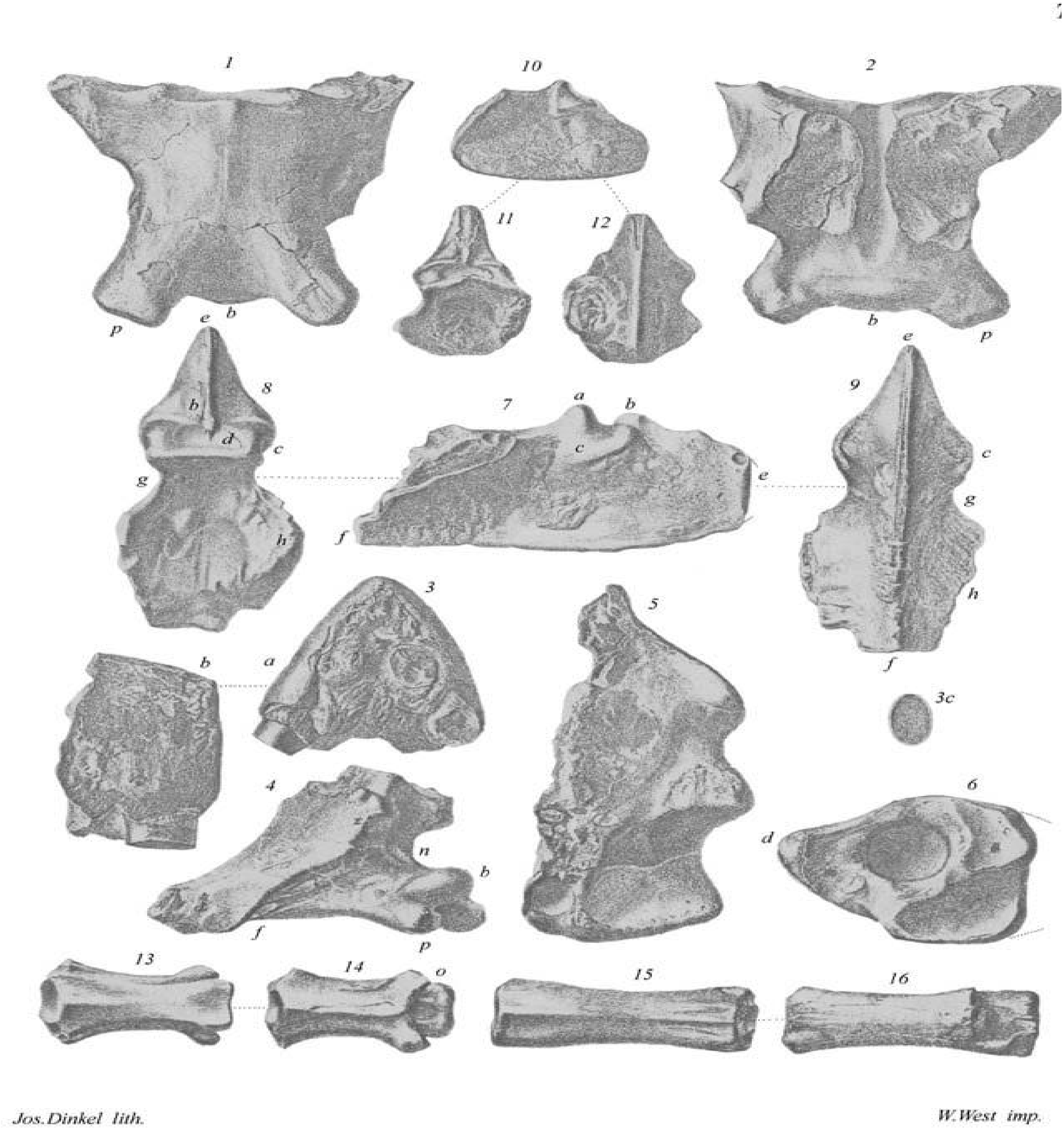
TAB. II.

***P**terodactylus **S**imus and **P**ter. **W**oodwardi.*

Fig.

1. Middle cervical vertebra, under view.
2. Ditto, upper view.
3. a) Fragment of jaw, section.
   b) Ditto, side view.
   c) Ditto, section of tooth.
4. Lower cervical vertebra, oblique view.
5. Glenoid articular cavity formed by the anchylosed ends of the scapula and coracoid.
6. Scapho-cuneiform (?) carpal bone.
7. Fore part of sternum, side view.
8. Ditto, upper view.
9. Ditto, under view.
10. Fore part of a smaller sternum, side view.
11. Ditto, upper view.
12. Ditto, under view.
13. Anterior caudal vertebra, under view.
14. Ditto, upper view.
15. Middle caudal vertebra, under view.
16. Ditto, upper view.

All the figures are of the natural size, and from specimens in the Woodwardian Museum of the University of Cambridge; they were found in the Upper Green-sand formation near that town.



TAB. III.

***H**umerus of **P**terodactyle.*

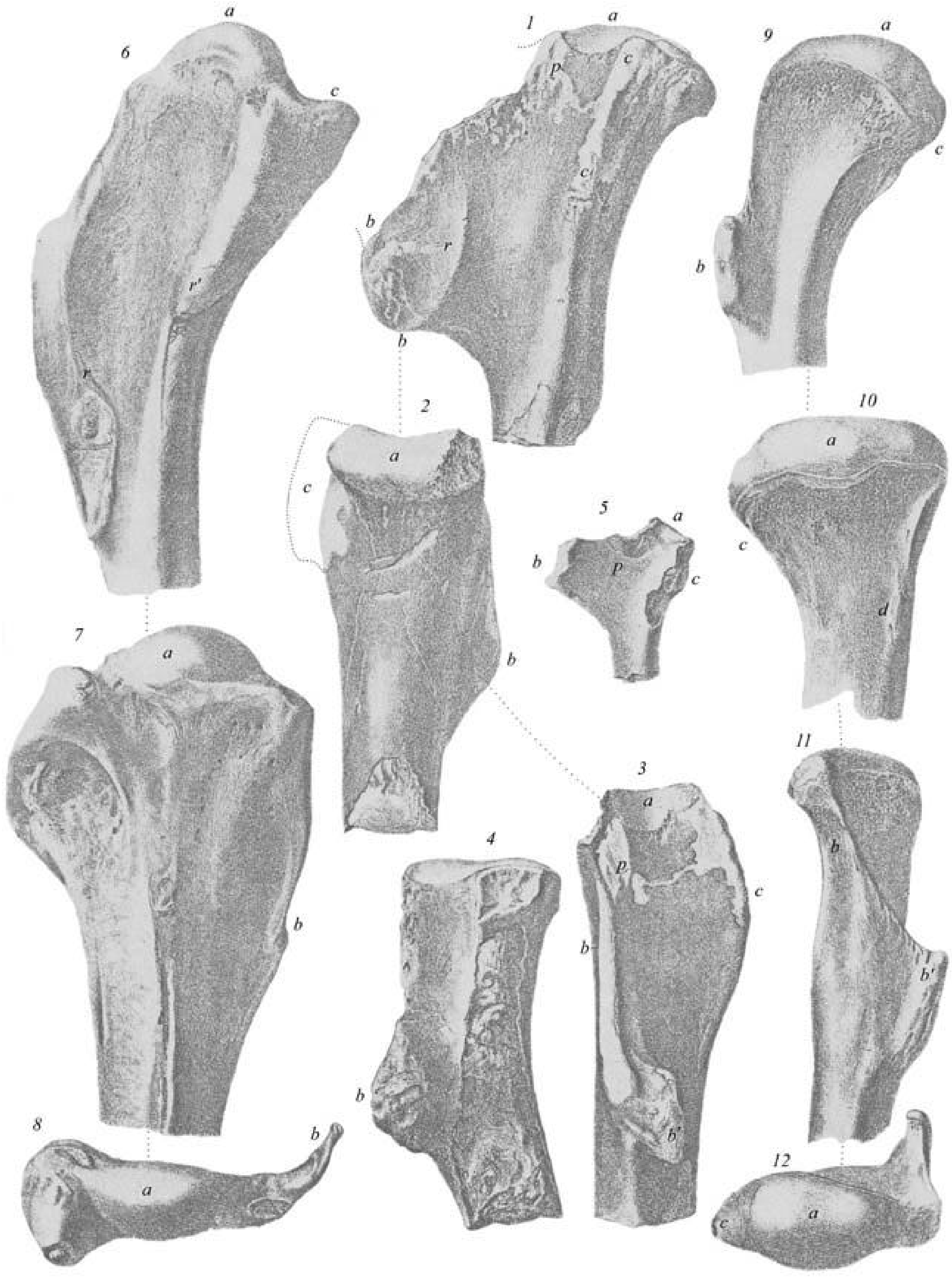
Fig.

1. Proximal or upper end of right humerus, oblique view of palmar and ulnar surfaces.
2. Ditto, anconal surface.
3. Ditto, palmar surface.
4. Proximal end of a left humerus, drawn without reversing, oblique view as in Fig. 1.
5. Proximal end of a right humerus of a smaller species of *Pterodactyle*, oblique view of palmar and ulnar surfaces.
6. Proximal end of the right humerus of a bird (*Vulture monachus*), oblique view of palmar and ulnar surfaces.

7. Ditto, anconal surface.
8. Ditto, upper surface, or head.
9. Proximal end of the right humerus of a crocodile (*Crocodilus biporcatus*), oblique view of palmar and ulnar surfaces.
10. Ditto, anconal surface.
11. Ditto, oblique view of the palmar and radial surfaces.
12. Ditto, upper surface, or head.

All the foregoing figures are of the natural size; 1 and 3, probably of *Pterodactylus Cuvieri*, are from the White Chalk of Kent; 4, probably of *Pter. Sedgwickii*, and fig. 5, are from the Upper Green-sand formation, near Cambridge. The foregoing specimens are in the Woodwardian Museum of the University of Cambridge.

T.III.



Jos. Dinkel. lith. W.West. imp.

TAB. IV.

Fig.

1. Upper view of a part of the cranium of *Polyptychodon interruptus*; one fourth the nat. size.
2. Fragment of the alveolar part of the same cranium; nat. size.
3. A tooth of the same specimen, side view, nat. size; a, ditto, opposite side; b, ditto, section of fang, showing pulp-cavity.
4. Basal half of a tooth of *Pterodactylus simus*; nat. size.
5. Unciform? carpal bone of *Pterodactylus Sedgwickii*, proximal? surface.
6. Ditto, distal? surface.
7. Scapho-cuniform? Carpal bone of Pterodactylus sedgwickii, proximal? surface.
8. Ditto, distal? surface.
9. Ditto, side view.
10. Ditto, end view.
11. Ungal phalanx of *Pterodactylus Sedgwickii*, side view.
12. Ditto, upper view.

T.IV.

Jos.Dinkel. lith.

W.West. imp.