Owen R; Supplement (No.1) to the Monograph of the fossil Reptilia of the Cretaceous formations, Palaeontographical Society, London. 1859

This supplement, though containing a few inaccuracies at the time, and many specimens that have since been re-named, has four magnificent lithographic plates which depict the fossils superbly. They were drawn by William West and the Lithographs were produced by Jos. Dinkel. The whole document was dated 1857 and issued in 1859. The plates are a true work of art.

Additional notes in green have been added to the text to clarify such points as measurements and subsequent re-naming of specimens.

SUPPLEMENT (No. 1)

TO THE

MONOGRAPH

ON

THE FOSSIL REPTILIA

OF

THE CRETACEOUS FORMATIONS

- -

Order – PTEROSAURIA, Owen.

Genus – PTERODACTYLUS, Cuvier.

In the 'Monograph of Fossil Reptilia of the Chalk Formations,' p. 103,[1] the occurrence of remains of a large Pterodactyle in the Green-sand formation near Cambridge, was noticed, and portions of the wing-bones were figured in Tab. XXXII figs. 6-8.[2]

The Woodwardian Museum of the University of Cambridge has subsequently been enriched by successive acquisitions of fossils, obtained chiefly through the exertions of LUCAS BARRETT, Esq., F.G.S., from the same stratum of 'Upper Green-sand,' near Cambridge, where I had the opportunity of inspecting them last year. All those belonging to the *Pterosauria* have since been liberally transmitted to me by my friend PROFESSOR SEDGWICK for description and illustration in the Monographs of the Palaeontographical Society, and I have subsequently received a few highly interesting additional examples of Pterodactyle remains from sources which will be duly acknowledged in the sequel.

PTERODACTYLUS SEDGWICKII, Owen. Jaws and Teeth, Tabs. I and III.

The specimen (Tab. I, fig. 1, a, b, c, d) is the fore part of the upper jaw, containing the first seven sockets of the teeth, in a few of the anterior of which the base of the tooth is retained. The first two sockets open upon the obtuse extremity of the jaw (fig. 1,c), and have a direction showing that their teeth projected obliquely forward, so as to prolong the prehensile reach of the jaw (these sockets are now considered to be the ends of the palatines); the second and third sockets are the largest, and cause a slight transverse swelling (fig. 1,b); the fourth is suddenly smaller, and the three following retain nearly the same size, or show a slight increase as they pass backward. The apertures of the sockets are elliptic, with the long axis extending obliquely from before outward and backward, not parallel with the axis of the jaw; the plane of the outlet inclines slightly outwards (fig. 1, c). The interval between two sockets is about half the longer diameter of each. On one side of the figured specimen the fifth socket is obliterated. The anterior termination of the jaw is obtuse; the sides are smooth, flat, converging at an acute angle to what almost forms a ridge above (fig, I, c, d); the jaw gradually increases in vertical diameter as it proceeds backwards, the upper contour being straight as far as it can be traced in the fossil. The palatal surface is entire, narrowest between the second sockets, suddenly broader and flat between the third pair, retaining about the same breadth, but with a slight convexity and feeble indication of a median ridge in the rest of its extent, the ridge not being so strongly marked as it appears in fig. 1, b.

The Pterosaurian nature of this fossil is shown by the extreme thinness of the compact bony wall of the jaw; its relation to the genus *Pterodactylus*, as contradistinguished from the *Rhamphorhynchus*, V. Meyer, is proved by the terminal position of the sockets; and sufficient of the outer side wall of the jaw is preserved to show that the nostril did not advance so far forward as in *Dimorphodon* – the generic form of Pterodactyle from the Lower Lias.

By its size and true or proper Pterodactyle affinities the present specimen most resembles *Pterodactylus [Ornithocheirus] Cuvieri* of the Chalk, (Monog. Cit., Tab. XXVIII); but it offers the following well-marked differences: a greater proportional size of the anterior sockets, with a corresponding expansion of the fore part of the jaw; a greater number and closer arrangement of the sockets; a greater depth of the jaw, in proportion to the breadth of the palate. The extent of the jaw, e.g., containing the first seven sockets, in *Pterodactylus [Ornithocheirus] Sedgwickii*, is 2 inches 9 lines [66 mm, Owen is using the term line for 1/16 of an inch]; but in *Pterodactylus Cuvieri* it is 3 inches 6 lines [87 mm]: the depth of the jaw, above the third socket, in *Pter. Sedgwickii* is 14 lines [23 mm]; in *Pter. Cuvieri* it is 8 lines [13 mm]; whilst the breadth of the palate between the third pair of sockets is only 1 line less in *Pter. Cuvieri* than in *Pter. Sedgwickii.* It needs only to compare the fore part of the jaw of the Great Chalk Pterodactyle (Monog. Cit., Tab. XXVIII, figs. 1-4) with the same part of the still larger species from the Green-sand (Tab. I, figs. 1 and 2), to be convinced of their specific distinction.

The difference is still more marked between *Pterodactylus Sedgwickii* and *Pterodactylus [Ornithocheirus] compressirostris* (Tab. XXVII, figs. 8, 9, 10). The rapid increase of depth as the jaw extends backward, in *Pter. [Ornithocheirus] Giganteus*, Bk. (ib., Tab. XXXI, fig. 1), shows that that [Sic.] comparatively small species cannot be the young of the present truly gigantic Pterodactyle of the Upper Green-sand. I have no hesitation, therefore, in basing on the above-described fossil a new species, at present the largest known in the order of Flying Saurians, which I propose to dedicate to the Woodwardian Professor of Geology in the University of Cambridge, who for forty years has discharged the duties of that office with exemplary zeal and a rare eloquence, has almost created the museum still called (Woodwardian,) and has enriched geological science by original researches which have thrown light on its most obscure and difficult problems.

The next fossil selection from the Pterosaurian series of Green-sand fossils for present description is the fore part of the jaw figured in Tab. I, figs. 2, a, b, c, d. This contains about the same number of sockets in the same extent of jaw as fig. I; and the last four sockets present about the same extent of interspace, with the same diminution of size, as compared with the two preceding sockets. But the walls of these sockets form no lateral expansion, the depth of the jaw is less, and the flat sides converge to a sharper ridge, fig. c; the aspect of the sockets is also more obliquely outward, the interspace between the pairs is narrower, and this is traversed by a median groove 1/8th of an inch across, fig. b. Were this specimen a part of an upper jaw, it would indicate a distinct species from *Pterodactylus Sedgwickii*, as exemplified by fig. 1; but I regard fig. 2 as being the fore part of a lower jaw, and consequently as most probably belonging to the same species. The minor depth of the bone accords with the proportions of the lower jaw in *Pter. Giganteus* (Monog. Cit., Tab. XXXI, figs 1 and 2); and the sockets are directed more obliquely outward, as they likewise are in the lower jaw of *Pter. Giganteus*, as compared with the upper one of the specimen of that species, in which both jaws of the same head have been preserved. In the belief, therefore, that fig. 2, a, b, represents part of the under jaw of *Pterodactylus Sedgwickii*, the median groove on the upper or oral surface of the prolonged ‘symphysis mandibulae’ (fig. 2, b) suggests that it may have served to lodge a long filiform tongue, perhaps bifurcated at the end, as in Leptoglossal Lizards of the present day. The same thin outer wall, and capacious cavity filled matrix and probably in the living reptile by air, characterise the lower (fig. 2, c) as they do the upper, jaws of Pterodactylus Sedgwickii. In one of the sockets of the lower jaw part of the hollow base of an old tooth is preserved, with the sharp slender point of a new tooth projecting from the inner side of the socket (Tab. I, fig. 2, d), showing the same relative position of the matrix of the successional tooth, as may be observed in the existing Crocodile.

PTERODACTYLUS FITTONI, Owen. Jaws and teeth, Tab. I, figs. 3, 4, 5.

Figure 3, a, b, &c., shows the fore part of the upper jaw of a Pterodactyle, with the first and second pairs of alveoli. In the minor depth of the jaw, compared with its basal breadth, in its more obtuse rounded upper surface, and in the greater extent of space between the alveoli of the same size, this maxillary fragment indicates a very distinct species from the *Pterodactylus Sedgwickii*, but one probably not much inferior in size. I propose to dedicate it to my friend, Dr. Fitton, F.R.S., one of the founders of the Geological Society of London, and who may be regarded as the discoverer of the system now called "Neocomian," which includes the Green-sand matrix of the Flying Reptiles under consideration. The sockets in the fragment (fig. 3) may answer to the second and third in fig. 1, though there scarcely seems room for a pair in advance of the foremost in the specimen figured; be that as it may, the distance between the first and second socket in the specimen of *Pterodactylus [Ornithocheirus] Fittoni* is, relatively to the size of the socket, greater than the interval between the second and third sockets in *Pterodactylus Sedgwickii*, and much greater than that between the second and third socket. The outer wall of the largest anterior socket in *Pter. Fittoni* is much less prominent than in *Pter. Sedgwickii*, and the lateral expansion of the fore part of the upper jaw must have been relatively less; the form of the bony palate is different, there being a distinct though shallow longitudinal groove on each side a low obtuse median ridge. The diastema between the second and third tooth is shown to exceed the long diameter of the second socket, recalling the proportion of the interspace in *Pterodactylus Cuvieri* (Monog. Cit., Tab. XXVIII, fig. 4), but the jaw is broader in proportion to its height in *Pterodactylus Fittoni*.

Figure 4, a and b, is a fragment of one side of the fore part of the upper jaw, showing three alveoli, and agreeing in general proportions with *Pterodactylus Fittoni*.

Fig. 5 is the fragment of a jaw, showing a single elliptical socket, 5 lines [10 mm] in long diameter (a), and with the plane inclined a little outwards, as at b. The widely open cancellous structure of the bone is well shown on the inside of this fragment, as at c.

PTERODACTYLUS. Sp. Inc.

Tab. I, fig. 6, is a portion of an upper jaw, including a part of two sockets, in one of which the root of the tooth remains. Three views of this fragment are given, of the natural size: a showing the alveolar boarder, b the broken margin exposing the tooth, and c the outer wall of the jaw. This part of the wall is nearly flat, very slightly convex below, and as slightly concave above, vertically; the upper margin showing no indication of any bending or inclination to the upper boarder of the jaw, the height or vertical diameter of which remains conjectural; that it was, at least, one third more than the proportion preserved, may be estimated from the extent of the socket of the tooth being equal with the preserved part of the wall (fig. 6, b). A coat of roughish 'caementum,' one third of a line thick [1 mm], is preserved upon the upper half of the tooth-root; below this is seen the smooth dentine; and where it is broken, the pulp-cavity is exposed, filled by the Green-sand matrix. The length of the implanted part of the tooth is 1 inch 4 lines [32 mm], the long diameter of the transverse fracture at the base of the crown is ½ an inch [13 mm], the short diameter is 4½ lines [7 mm]. Estimating the length of the exserted [sic.] enamelled crown to equal that of the inserted cement base of the tooth of a Pterodactyle – and I have known it more in the long anterior laniariform teeth – we may assign a length of 2 inches 8 lines [64 mm] to the teeth implanted in the part of the upper jaw here described. The interspace between the two sockets is 3½ lines [6 mm], or half that of the long diameter of the socket; the plane of the opening of the socket, and the interspace, present the same obliquity as they do in *Pterodactylus Sedgwickii* (fig. 1); and as the proportion of the interspace to the socket is also the same, the present fragment has most probably belonged to a larger individual of the same species. Since the outer border of the socket does not swell out beyond the outer wall of the jaw, the fragment has been part of jaw behind the anterior swelling caused by the proportionally large prehensile teeth; and as, from the analogy of known Pterodactyles, the teeth succeeding those anterior ones are not of larger size, but are usually smaller, at any posterior part of the jaw, we may, with due moderation, frame an idea of the Pterodactyle to which the maxillary fragment (fig. 6) belonged, as surpassing in size that which the proportion of jaw (fig. 1) belonged, in the proportion in which the socket in fig. 6, a, exceeds the last socket in fig. 1, b. Such an idea impels to a close scrutiny of every character or indication of the true generic relationship of the present fragment in the Reptilian class; but the evidence of the large and obviously pneumatic vacuities, now filled by the matrix, and the demonstrable thin layer of compact bone forming their outer wall, permit no reasonable doubt as to the Pterosaurian nature of this most remarkable and suggestive fossil. All other parts of the Flying Reptile being in proportion, it must have appeared, with outstretched pinions, like the soaring Roc of Arabian romance, but with the demonical features of the leathern wings and crooked claws, and of the gaping mouth with threatening teeth, superinduced.

The last portion of jaw of Pterodactyle from the Cambridge Green-sand which will here be described, is that figured in Tab. I, fig. 7, a, b, c, d. It is part of the lower jaw, and indicates a smaller individual of *Pterodactylus Sedgwickii* than the specimens, figs. 1 and 2. In a longitudinal extent of 2½ inches [64 mm], six successive sockets are shown, but with only the two middle pairs perfect. Their orifices have the same obliquity as in fig. 2; and the surface of the bone between the right and left sockets shows the same median longitudinal groove. Opposite the middle sockets the sides of the jaw are preserved nearly to the median inferior ridge, as shown in fig. 7, c; these sides being flat and straight, and giving the transverse section shown at fig. 7, d. The intervals of the sockets are a little wider, proportionally, than in some of those in fig. 2, but not more than a hinder position in the jaw would account for, without having recourse to a distinction of species to explain it.

Two species, however, are satisfactorily established, both of them distinct from any of the known large Pterodactyles of the Chalk, by the portions of jaws from the Upper Green-sand near Cambridge, viz., *Pterodactylus Sedgwickii*, with more approximated alveoli (Tab. I, figs. 1 and 2, with probably 6 and 7); and *Pterodactylus Fittoni* (ib., figs. 3, 4, and 5).

To which of these large species the teeth and bones next to be described belong is not satisfactorily determinable, but indications of their appertaining to more than one such species now and then occur with more or less significancey.

Teeth.

Various teeth, but few quite entire, have been rescued by the care and perseverance of Mr. Lucas Barrett from the rubbish of fragmentary fossils accumulated during the diggings for phosphatic nodules in the Green-sand deposits near Cambridge. Guided by the proportions of the length to breadth, by the elliptical section, and the concordance of the minute markings on the crown and base with those on the portions of teeth, as in Tab. I, fig. 2, d, and 6, b, remaining in the jaws of *Pterodactylus Sedgwickii*, many of the above detached teeth can be satisfactorily referred to the genus, if not to that particular species.

The base or implanted part of one of the largest of these teeth is figured of the natural size in Tab. I, fig. 10. It has belonged to a Pterodactyle as large as that represented by the fragment of jaw (fig. 6), if not to the same individual; it presents the same elliptical transverse section as the implanted base of the tooth in fig. 6, b; shows a widely excavated pulp-cavity at the base, and gradually tapers to the crown; the cement, about 1/3d of a line [0.8 mm] in thickness, is roughened by longitudinal grooves, not continuous for any great length, but uniting, or bifurcating, in an irregular reticulate pattern, forming long and very narrow meshes, the raised interspaces being equal in breadth to the grooves. In a few teeth the base shows an oblique depression evidently due to the pressure of a successional tooth, as shown in Tab. I, fig. 8, o; in these the basal pulp-cavity is more or less filled up by ossification of the pulp. The enamel of the crown seems smooth and polished, and, under the lens, shows only extremely delicate, slightly and irregularly wavy, longitudinal, but often interrupted or confluent, ridges. The crown is straight in a few teeth, as at Tab. I, fig. 9, but more commonly it is bent, as it is in the tooth of the great Pterodactyle from the Chalk figured in the above-cited ‘Monograph on Cretaceous Reptilia,’ Tab. XXVIII, fig. 5. In general, the transverse section of the crown is less truly elliptical than that of the base, owing to its being a little flattened on one side. The smaller teeth, probably from the back part of the dental series, are rather more curved than the larger ones (Tab, III, figs. 16-20).

Vertebrae of Pterodactyls. Tab. I, figs. 11-14. Tab. II.

The most instructive specimens from the Cambridge Green-sand are those which have afforded the precise and hitherto unknown characters of certain vertebrae of *Pterodactylus*. Viewed as indicative of the generic character of these bones, they give the earliest known example of the "procoelian" type of vertebtae[3] in the reptilian class, being the first cup-and-ball vertebrae, with the "cup" at the fore part of the centrum, met with in ascending order of strata. It cannot be doubted that this structure prevails in the moveable vertebrae of the neck and back of all *Pterosauria*, and must be predicated of the *Dimorphodon*[4] of the Lias as well as of the *Pterodactylus* of the Green-sand, in which the structure is now clearly demonstrated. The chief difference which the Pterodactyle presents in this respect from modern Lizards is, that both the cup and ball are of a more transversely extended elliptical shape in most of the vertebrae of the flying Saurians.

Amongst the numerous vertebrae submitted to me were specimens of united, or partly united, "atlas and axis".

The atlas consists of a centrum (Tab. I, figs. 11 and 12, c), of two slender styliform neurapophyses (ib., n) and of a very small discoid neural spine. The centrum is so short as to be discoid; it is flat where it joins and becomes anchylosed to the axis (x), and is concave for the occipital tubercle: this cup is circular; its depth is shown in the section of the anchylosed atlas and axis, fig. 12. The neurapophyses (n), resting on each side of the upper half of the centrum of the atlas, converge and articulate above with two small tubercles, as shown in fig. 13, on the fore part of the neural arch of the axis; the neurapophyses almost meet, but do not unite above the neural canal.

The body of the axis is eight times longer than that of the atlas; it expands posteriorly, and terminates by a transversely elliptical ball (b) at the upper part of that end, and in a pair of thick, short, obtuse, diverging apophyses (p), at the lower part. There is a rudimental hypapophysial ridge, fig. 12, h, from the middle and towards the fore part of the under surface of the centrum; the extent to which this surface descends below the hinder ball, and between the apophyses (p), is shown at Tab. I, fig. 12, x.

The centrum of the axis vertebra is confluent with the neural arch, fig. 11, n, x; at the middle of the side, apparently crossing the line of junction, is a large subcircular aperture, which leads directly into the widely cancellous structure of the bone, below the neural canal. This vacuity (fig. 11, 0) answers to the "foramen pneumaticum" in the vertebrae of birds, and doubtless admitted a production from the air-cells extending along the neck of the Pterodactyle into the cancelli of the osseous tissue. The neural arch rests upon the three anterior fourths of the centrum; it expands as it passes backward; and there, also, as it rises, until it sends off from each posterior angle the zygapophysis (Tab. I fig. 11, z), which has a tubercle above, and a flat articular surface below, looking downward and a little outward and backward. The small tubercles at the fore part of the neural arch, shown in fig. 13, to which the neurapophyses of the atlas are ligamentously connected, may be the stunted homologues of anterior zygapophyses. The neural spine begins by a low ridge between those tubercles, increases rapidly in thickness behind; but it has not been preserved in its full height in any specimen.

In the small atlas and axis figured in Tab. II, figs. 1-4, the line of suture between the bodies of these two vertebrae is distinct. In a somewhat larger specimen, the centrum of the atlas was seperable by a smart blow, and showed the true anterior surface of that of the axis, as shown in Tab. I, fig. 13; this surface is very slightly concave, with a submedian prominence. The neural canal expands at its posterior outlet.

The small atlas and axis (Tab. II, figs. 1-4) not only differ in size from the specimen (fig. 5 and 6), but also in the smaller relative size of the articular surface of the zygapophysis, and the greater relative expansion of the back part of the centrum: the specimen belongs to another species of Pterodactyle. On comparing the atlas and axis of the Pterodactyle with that of the bird, the Ostrich for example, the atlas in the bird is represented by the neurapophyses, which have coalesced below with a hypapophysis, forming an irregular ring of bone. The centrum has coalesced with that of the axis, forming a small prominence, convex anteriorly, and filling up the vacuity at the upper part of the cup excavated in the fore part of the hypapophysis; the neurapophyses are broad in the bird, and overlap the anterior zygapophyses in the axis; they meet above the neural canal, but long retain the separating fissure there, in the Ostrich; the centrum of the axis is broader before than behind. A short process, like a connate pleurapophysis, from the fore part of the centrum, unites with a diapophysis from the neural arch to form an arterial canal. The pneumatic foramen is behind the diapophysis, and conducts to the cancellous tissue of the neural arch. The centrum is produced into a strong hypapophysis below the posterior articular surface; but not expanded laterally into transverse processes, answering to parapophyses, in the Pterodactyle. The hinder articular surface of the centrum of the axis in the bird is convex transversely, but concave vertically, not simply convex, as in the Pterodactyle; thus a portion of the vertebra of that reptile, notwithstanding its pneumatic structure, might be distinguished from the vertebra of a bird.

In the ordinary neck-vertebrae of the Pterodactyle the centrum in oblong, subdepressed, slightly compressed at the middle, subcarinate (Tab. II figs. 11, 12, h), or with a low obtuse hypapophysis (fig. 18) at the fore part of the under surface, which expands laterally to join the base of the anterior zygapophyses (ib. a). The back part of the centrum expands and bifurcates into the short, thick, obtuse parapophyses (figs. 11 and 18, b), the anterior concavity (fig. 10, c) is a long transverse oval, with the upper border somewhat produced: the hinder ball (fig. 8) has a similar transversely expanded elliptical figure, directed a little upwards; it appears to be tilted up by the curve of the under surface of the centrum, above the level of the terminal tuberous parapophyses (p). A large pneumatic foramen (figs. 7, 13, 15, 0) of an elliptical form, opens upon the middle of each side of the centrum, close to the anchylosed base of the neurapophyses. The texture of the centrum (fig.19) presents a few very large cancelli, which communicated by the pneumatic foramen with the cervical air-cells. The smooth outer wall of the centrum is a very thin but compact plate of bone; it becomes a little thicker where it forms the articular cup and ball.

The neural arch, between the notches of the nerve-outlets, is not quite two thirds the length of the centrum. The hinder notch is the deepest; the arch is low, broad exteriorly, less concave on each side than it is before and behind (Tab. II, fig. 17), with the four angles somewhat produced, and supporting the articular surfaces, of which the two anterior (fig. 18, a) look upward and inward, the two posterior (fig. 16, z) downward and backward. The sides of the neural arch extend outward so as to overhang those of the centrum (fig. 18). The posterior zygapophyses (z), do not extend so far back as the articular ball of the centrum.

Figs. 7 to 11 give five of the natural size of the middle cervical vertebra, which, according to the proportions of *Pterodactylus [Gallodactylus] suevicus, Qnstd*.,[5] may have belonged to a Pterodactyle with a first phalanx of the wing-finger of about one foot in length. In fig. 12 the under surface of the centrum is well preserved; it differs from that of the larger cervical vertebra (figs. 7-11) in being flatter from side to side, and in being concave instead of convex from before backward; the concave contour being due to the median production, gradually extending into the obtuse hypapophysis (h) at the fore part. This difference indicates that the present vertebra had a more advanced position in the cervical series than fig. 7, which may probably have been the sixth. The superior breadth of the neural arch over the centrum is well shown in fig. 12; and the relative positions of the zygapophysis (z), the articular ball (b), and the parapophysis (p), at the hinder end of the vertebra, are seen in fig. 13, which is a side view of the same vertebra.

Figs. 14, 15 and 16 show a smaller cervical vertebra, of a more depressed form, not due to crushing. The centrum is much depressed; the pneumatic foramen (fig. 15, 0) partakes of the same modification of form, and is a longer ellipse than in the vertebra (fig. 7); the neural canal retains its normal cylindrical shape, with slightly expanded outlets. The form of the posterior zygapophysis is perfectly preserved on one side, in fig. 11, z, and the articular surfaces on both sides in fig. 16, z,; they are relatively larger than in fig.11. In fig. 15 more of the base of the neural spine remains than in most other specimens.

Figs. 17 and 18 are of a rather shorter and probably more advanced cervical vertebra, but of very similar proportions; in it the neural arch (fig. 17) is more entire than in most specimens, the anterior (a) as well as the posterior (z) zygapophyses being preserved; the more frequent loss of the anterior pair is due to their being more slender and more produced. The under surface of the centrum (fig. 18) shows no rising in the middle part, the hypapophysis having a less extended base than in the vertebra, (fig. 12). The inner surface of the anterior zygapophysis (fig. 18, a), is divided by a notch from the border of the articular concavity of the centrum.

Fig. 19 gives a view of a section of a mutilated cervical vertebra, nearly equal in size with fig. 7, and similar in form. The shape of the neural canal, the large cancelli, and the thin superficial compact crust of the bone, are well shown in this section.

At then base of the neck, or beginning of the back, the vertebrae suddenly decrease in length; the hypapophysis disappears, or is represented only by a slight production of the lower border of the anterior cup; the parapophyses are less produced, the lower surface of the centrum is flattened, and presents the quadrate form shown in figure 20. There is now a considerable development from the fore part of each side of the neural arch and contiguous part of the centrum, and thereby the last cervical or first dorsal vertebra of the Pterodactyle more resembles the corresponding vertebra of the bird. The parapophysis, diapophysis, and rudimental rib coalesce around the vertebral foramen; an oblique ridge is continued from the upper border of the anterior articular cup upon the parapophysis; a parallel oblique ridge is continued from the anterior zygapophysis downwards and outwards upon the pleurapophysis; the diapophysis makes a low obtuse projection above the pleurapophysis and behind the zygapophysis. Above these developments the neural arch contracts from before backwards, to an extent of 5 lines [9 mm], as compared with a total vertebral breadth, anteriorly, of 1 inch 8 lines [38 mm]; it then rapidly expands, rising vertically at its fore part, and developing at its back part the posterior zygapophyses, the articular facets of which look more directly outward than in the long cervical vertebrae; the superincumbent tubercle (fig. 22 c) is more distinct from the facet (ib., z); the posterior zygapophyses are also much more approximated than in those vertebrae; they are separated behind by a semicircular concavity; the base of the neural spine in the vertebra here described measure 6 lines [10 mm] in length by 3 [5 mm] in breadth. The pneumatic foramina are at the back part of the base of the diapophysis, as I have seen them in the cervical vertebra of a *Dinornis*. The articular surfaces of the centrum retain the transversely extended form, and are simply concave before and convex behind, which at once distinguishes the Pterosaurian hind-cervical vertebra from that of the bird.

In the dorsal region the vertebral centrum (fig. 24), retaining its shortness, gains in depth, and presents the more usual proportions of cup-and-ball reptilian vertebrae. The under surface (fig. 20) is smooth and even, very slightly concave lengthwise, convex transversely. The parapophysis disappears, and the diapophysis, which alone supports the fib, after the first or second dorsal, is sent off from a higher position in the neural arch (fig. 25).

Sacrum.

Fig. 26, Tab. II, shows parts of the bodies of three anchylosed sacral vertebrae, the first being demonstrated by part of its anterior concave articular surface (a) for the last lumbar vertebra. The groove for the passage of the nerve notches the back part of the parapophysis, close to the line of suture with the second sacral. In this vertebra the corresponding nerve-notch is more advanced, leaving a short sutural surface behind, indicative of a position of the neural arch crossing for a short extent the line of junction of the second with the third sacral centrum. The parapophyses of the second and third are set off almost on a level with the lower surface of the centrum, which is flattened.

The fore part of then sacrum of a much larger Pterodactlye, from the Cambridge Green-sand, differing also in the less transverse convexity of the under part of the first centrum, measures 11 lines [18 mm] across the shallow anterior articular concavity, and 14 lines [24 mm] from the lower part of the centrum to the fore part of the base of the neural spine. The neural canal is circular and 2 lines [3 mm] in diameter; above it the neural arch rises like a vertical wall for 5 lines [8 mm], where the spine has been broken off.

Caudal Vertebrae.

From the number of elongated caudal vertebrae in the series of fossils from the Cambridge Green-sand submitted to me – not fewer than seven – I believe the large Pterodactyle from that formation to have had a long tail, but moveable, not stiff through anchylosis of the vertebrae, as in Pter. (Ramphorhynchus) Gemmingi, V. Meyer. [Sic.].

The largest of these caudal vertebrae measures 1½ inches [38 mm] in length; it is slightly contracted in the middle; the fore part of the under surface is a little produced; the back part almost flat between the rudimental parapophyses; the shallow anterior concavity has resumed its transversely elliptical shape, and the hinder concavity is defined below by a shallow groove connecting the parapophyses. There is no pneumatic foramen, unless a small hole on each side the hinder outlet of the neural canal have served as such; the neural arch is long and low, quite one piece with the centrum, which extends beyond it posteriorly. It sends off short, obtuse zygapophyses before and behind, those in front extending beyond the cup of the centrum; the surfaces on those behind look downward and backward. The base of the spine is coextensive with the summit of the arch, but is narrow. The neural canal is much contracted. There is no indication of a haemal arch, either by articular of fractured anchylosed surfaces. The diameter of the middle of this vertebra is 6 lines [9 mm].

The caudal vertebra next in size measures 1 inch 5 lines [34 mm]. The base of the neural spine begins 2 lines [3 mm] behind the fore part of the arch, but terminates nearer the hind part; the nerve-groove notch the hinder zygapophyses.

Three more slender caudal vertebrae present each a length of 1 inch 3 lines [4.5 mm]; the diameter at the middle is 5 lines [7.5 mm] in one, 4 lines [6 mm] in a second, 3½ lines [5 mm] in the third vertebra, showing that they become more slender without losing length. A caudal vertebra 3 lines [4.5 mm] across the middle appears to have been nearly an inch [25 mm] in length; but both extremities are injured.

[The caudal vertebrae that Richard Owen studied have since been identified as worn cervical vertebrae. *Howse S C B; On the cervical vertebrae of the Pterodactyloidea (Reptilia: Archosauria), Zoological Journal of the Linnaean Society, (1986) 88: 307-328 with 12 figures. 1985*]

***Frontal Bone* (?)**

[This has since been identified as a notarium]

As it is probable that the median symmetrical portion of bone (Tab. IV, figs. 6, 7 and 8) may belong to the cranium of one of the large Pterodactyles from the Upper Green-sand, its description follows that of the vertebrae.

It is 2 inches 4 lines long [57 mm]; 10 lines [17 mm] across its broadest part; 1 inch 2 lines [28 mm] in depth, to the surface where the piece has been broken away; the sides present a smooth concave plate of bone (fig. 6), as if the piece had been nipped between a finger and thumb, but quite symmetrically; the surface, which, on the supposition that those smooth concave facets were inner walls of the orbits, would be the upper one, and due to the frontal bone, is greatly convex in the direction of its length, and has a median longitudinal ridge, which expands and subsides near the end most produced beyond the lateral depressions. I have observed a similar median ridge or rising upon the single frontal bone of the *Aligator lucius*, between the orbits, and upon the double frontal, supporting the median suture, in the *Rhynchocephalus* lizard of New Zealand. There is also an indication of such a median ridge in the figure of the cranium of *Pterodactylus [Gallodactylus] suevicus*, in Professor Quenstedt's Memoir on that species (4to., Tübingen, 1855).

The most perfectly preserved of the lateral impressions (fig. 6) is of an oval form, 1 inch 3 lines [30 mm] in long diameter; it is well defined from the narrower upper surface (fig. 7) to which it stands at nearly a right angle; the curved border defining it is not produced. The whole of the substance of the bone between the lateral plates is occupied by a moderate open and apparently pneumatic cancellous texture (fig. 8); the outer wall of bone is compact, but extremely thin; the general structure is decidedly that of a Volant Vertebrate, and most resembles that of a Pterodactyle.

The parts of the skeleton of the Pterodactyle which would afford a symmetrical median piece of bone, comparable with the present fragment, are - the sternum, the fore part of the upper jaw, the sphenoid at the base of the skull, and the parietal and frontal bones at the upper part of the skull. The absence of any trace of cranial cavity at the lower fracture surface, more than an inch [25 mm] below the outer surface, opposes the choice of the parietal with lateral impressions of temporal fossae: there remains, therefore, the frontal with the interpretation of the lateral depressions as part of the orbits; but the depth of the smooth impressed plates, and their divergence as they descend, oppose this interpretation. I have no evidence of sternal ends of coracoids which would require articular depressions of such size and shape as the lateral ones on the fragment in question, on the hypothesis that it may be from the fore part of the sternum. Upon the whole, therefore, I have to acknowledge a degree of uncertainty as to the exact nature of the present fragment on the skeleton, most probably, of some large Pterodactyle.

Scapular Arch.

The mechanism of the framework of the wings in the Pterodactyle is much more bird-like than bat-like. The scapular arch is remarkably similar to that of a bird of flight. It consists of a scapula and coracoid, usually anchylosed where they combine to form the shoulder joint.

The cavity for the head of the humerus, in *Pterodactyle [Dimorphodon] macronyx*[6] (Tab. III, fig. 6), is oval with the great end formed by the scapula; it is concave vertically, or in the direction of its long diameter, convex transversely, but least so near the scapula. If these proportions hold good in other species, they would serve to determine the scapular or coracoid portion of a glenoid cavity, when, as in the case of the fossil here described, the rest of the scapular arch had been broken away.

The upper (scapular) border of the glenoid cavity is prominent and well defined; the bone is moderately constricted beyond it, from without inward, whence the scapula extends upwards and backwards, as a slightly bent sabre-shaped plate, a little twisted on itself. The coracoid is thicker, straighter, and shorter than the scapula; it is rather suddenly expanded at the sternal end, where it is most compressed: the scapular end develops a protuberance below the glenoid cavity.

The scapular arch in *Pterodactylus [Ornithocheirus] giganteus*, Bwk., from the Chalk of Kent ('Monog. Cretaceous Reptiles, ' 1851, p. 93, Tab. XXXI, fig. 7), was distinguished by a tuberous (acromial) process from the scapula, near the glenoid cavity, the corresponding anterior process from the coracoid being well marked.

The fossil fragment from the Cambridge Green-sand (Tab. III, figs. 1 and 2) consists of the coalesced extremities of the scapula (a) and coracoid (b), where they form the glenoid cavity for the humerus.

The margins of the cavity are in part abraded, but its long diameter cannot have been less than 1 inch 3 lines [30 mm]; it is concave vertically, rather convex transversely below, but plane, or a little concave, in that direction at the upper or scapular end. The cavity is transversed obliquely by a depression pretty equally dividing it, and indicating the respective shares of the scapula and coracoid in its formation prior to the anchylosis of those two bones. The end of the scapula, near the cavity, would present an unequally three-sided figure in transverse section, the side looking inward and that looking forward being concave, the side looking outward convex. Half an inch [13 mm] above the border of the glenoid cavity is the fractured base of the (acromial) process answering to that in *Pterodactylus [Ornithocheirus] giganteus*, but which is more feebly developed in *Pterodactyle [Dimorphodon] macronyx*, Bkd., and *Pterodactylus [Gallodactylus] suevicus*, Qnstd. Beyond this process the bone rapidly contracts in size, and presents an oval transverse section, as at a, fig. 2, Tab. III.

The surface of the coalesced extremities of the bones which is applied to the thorax is concave in every direction, and an inch in breadth, with a long narrow (pneumatic) aperture near its hinder border. The anterior production of the coracoid has been broken away at c (figs. 1 and 2), the coracoid quickly contracts as it recedes from the humeral articulation to a size and shape shown by section b (fig. 2). The size of the entire scapular arch, according to *Pterodactyle [Dimorphodon] macronyx*, is shown by the dotted outlines in fig.1.

Fig. 3 shows the articular surface of the scapular arch of a Pterodactyle of larger size than the preceding specimen; the oblique groove indicative of the portions contributed by the scapula and coracoid to the cavity is well marked, as it also is in the corresponding fragment of the scapular arch of the smaller Pterodactyle (fig. 4). In the still smaller but similar fragment of the scapular arch (fig. 5), the posterior concave surface shows a long (pneumatic?) foramen very distinctly, and also a trace of the primitive separation of the scapula and coracoid. If this specimen has belonged to a young individual of either of the two larger species, it shows that the union of the two bones takes place at an early age. In the bird, although the early and extensive coalescence of the originally distinct bones is a characteristic of the skeleton, the scapula remains distinct from the coracoid, and the persistent suture transverses the glenoid cavity. The coracoid is shorter and straighter in birds than in pterodactyls, but is commonly broader, and with a longer and stronger anterior process.

Humerus.

The portion of bone figured of the natural size in Tab. III. Fig. 7, shows an articular surface of a reniform figure, convex in its shorter diameter, less convex upon the more prominent half, lengthwise, and slightly concave lengthwise at the side which is hollowed out. The smaller end of the surface (a) has been produced into a process, here broken away, and the fracture is coextensive with the length, in the direction of the shaft of the bone, of the fragment, which is nearly 2 inches [51 mm]; the larger end of the articular surface (b) seems not to have sent off such a process; but the back part of this end is broken away. The Pterosaurian nature of the fragment is shown by the thinness of the compact wall of the shaft below the articular surface, and the wide cancelli. The general resemblance of the articular surface, in shape, to that of the humerus of the Wealden Pterodactyle (*Pt. Sylvestris*, Ow. [*Ornithocheirus clifti*]) figured in the 'Quarterly Journal of the Geological Society,' Dec., 1845, vol. Ii, p. 100, fig. 6; and to that of the more complete humerus of *Pterodactylus [Gallodactylus] suevicus*, Qnstd., loc. Cit., but especially to the articular surface of the portion of the bone of a smaller pterodactyle (Tab. III, figs. 14 and 15) which exhibits more distinctive characters of a humerus, have led me to refer to the fragments in question (fig. 7) to the proximal end or head of that bone in one of the large species above established by maxillary characters.

The end of the articular surface (a) answers to the outer plate or process (g) in *Pterodactylus sylvestris*, and the fractured surface behind the end (b) might well have been the base of a shorter and thicker process, like that marked f in *Pter. Sylvestris*. Determining, by these analogies, that a is the outer or radial, b the inner of ulnar, end of the transversely extended head of the humerus; that the convex side is the fore part, and the concave one is the back part, of the same bone; in may next be remarked that the inner half of the fore part of the articular surface is extended further and more convexly upon the shaft than the outer half, which meets the vertical plane of the shaft more abruptly; but the form of this part of the head of the humerus is better shown in the next specimen.

This fragment (fig. 8) is the head of the opposite humerus of a Pterodactyle of equal size with the preceding. The boundary of the articular surface near the outer process (a) is very slightly raised, with a few short ridges at right angles, indicative of the firm attachment of the capsular ligament; an oblique line divides the more abruptly defined outer half of the surface from the inner anteriorly more convex half. The anterior surface of the fore part of the shaft of the humerus, here preserved, is impressed by longitudinal reticulate markings. The total length of the humerus, according to the proportions of the length of that bone to the breadth of its proximal articular surface in *Pterodactylus [Gallodactylus] suevicus*,[7] would be 10½ inches [267 mm].

Fig. 9 shows well the minutely punctuate surface of the articular head of the humerus; the portion of the fore part of the shaft preserved with this shows that the fine reticulate markings are limited to a short distance below the head, and that the rest of the outer surface of the shaft here preserved is smooth. The extent of the base of the outer plate or process is 1 inch [25 mm], the long diameter of the articular surface of the head being 1 inch 3 lines [31 mm].

The fragment of the head of the humerus (Tab. III, fig. 10) is remarkable for the well-defined ridge bounding the anterior convex part of the articular surface.

The proximal end of the smaller humerus (fig. 11) includes nearly two inches [51 mm] of the shaft, of which a front view is given in fig. 12, and a back view in fig. 13. The base of the outer process (g) shows the same proportion to the long diameter of the head, as in fig. 9. The fractured surface along the opposite side of the shaft (f) seems to show that this border had been produced into a ridge or plate, as in *Pterodactylus sylvestris* [*Ornithocheirus clifti*]. The back part of the shaft between these plates is concave transversely, but rather convex lengthwise; the opposite conditions prevail on the fore part of the bone. Here, towards the base of the outer process, is a small, apparently pneumatic, oblong foramen.

The smaller proximal end of the humerus (figs. 14 and 15), shows a larger proportion of the process (f) which extends the bone in that direction beyond the articular head.

All these specimens show that, in the Pterodactyles from the Green-sand, there is a plate or process with a shorter base, extending close to the articular surface of the head of the bone, and that there is a plate, with a larger base, extending farther from the articular head at the opposite side of the bone.

The fragments (figs. 1, 2, and 3, Tab. IV) shows part of the articular extremity of one of the long bones of the wing. The articular surface has been partially divided into what might be called, were they entire, two condyles (a and b). The most perfect of these divisions shows a slightly convex surface (figs. 1, and 2. a, a,) occupying its major part, and a small well-defined flat surface (figs. 1, and 3, c,), placed obliquely. So much of the other division as is preserved likewise shows two facts - one, which we may call the anterior (d), is convex and of small extent, and behind it is a well-defined part of a concave surface (b). At the fore (?) part of the bone (fig. 2) the two convex surfaces extend a little upon the shaft (a), and are divided from each other by a moderate median depression; where the thin smooth outer crust of the bone has been worn away, the small superficial cancelli are exposed. At the back (?) part (fig. 3), where the major part of the bone is broken away, the larger cancelli are exposed.

Guided by considerations of size, the fragment (Tab. IV, figs. 1-3) might form the opposite end of the bone indicated by the articular ends (Tab. III, figs. 7, and 8). I am not acquainted with the precise configuration of the distal end of the humerus, in any Pterodactyle; indeed, the articular surfaces of very few of the bones of this remarkable reptile have been perfectly preserved, so as to be recognisably delineated and described. From general analogy, however, one should scarcely be prepared to find so feeble an indication of division into condyles, an absence of general convexity, and a presence of a well-defined concavity in one condyle, and as well-defined a flattened or feebly concave facet in the other condyle, of the distal end of a humerus. The form of articulation above described would seem rather to be that of the end of an antibrachial bone adapted to join the bones of a carpus. But, on the hypothesis of the fragment in question being either proximal or distal, and of a radius or ulna, it expands our ideas of the bulk of the Green-sand Pterodactyle even beyond those suggested by the manifestly head of the humerus (Tab. III, fig. 7). The present description and figures will at least help, it is hoped, to forward a precise knowledge of the osteological characters of the *Pterosaurians*.

Assuming that we have in figs. 1-3, Tab. IV, the articular end of an antibrachial bone, then, according to the proportions which the broadest end of one of these bones bears to its total length in the *Pterodactylus [Gallodactylus] suevicus*, the length of such antibrachial bone in the great pterodactyle of the Green-sand here indicated would be 16 inches [404 mm]. The total length of wing will be calculated on this basis at the conclusion of the present Monograph.

The fifth or wing-metacarpal.

The trochlear joint of the bone (Tab. IV, figs. 9-11) belongs to the distal end of the metacarpal of the fifth or wing-finger. The pulley is more complex, in the large Pterodactyles here described, than it is in similar trochlear joints of other animals; there are three convex ridges, a, b, c, which traverse the articular surface from behind forward, describing rather more than half a circle; the middle ridge, c, is less prominent, and of less extent than the lateral ones which form the sides of the pulley. The direction of the ridges is rather oblique, and one which, to help the description, may be called the outer ridge, is rather more pronounced and of a less regular curve than the inner ridge. The outer ridge, a, begins by a rising at the middle of the fore part of the distal end of the shaft, which bends obliquely outward and meets the outer angle of that part of the shaft where the outer trochlear ridge begins to be prominent; this ridge then extends with a feeble convex curve th the back part of the trochlea, where the convexity of the curve increases, and it terminates by projecting a little beyond the level of the outer almost flattened side of the trochlea (fig. 10). The articular surface, as it extends from the margin of this element of the trochlea inward, is first gently convex, then sinks to a concave channel by the side of the low median convexity. The inner ridge b, begins from the inner side of the fore part of the bone, and describes a pretty regular semicircular curve as it extends backward and a little outward, to terminate near the middle of the back part of the distal end of the shaft; thus owing to the termination of the inner ridge near the middle of the back part, and to the beginning of the outer ridge near the middle of the fore part, of the metacarpal bone, these principal ridges of the trochlear joint recede from each other at the middle of the joint, and approximate at the fore and back ends of the joint. As the back ends of the two lateral ridges are on the same transverse line, and the front end of the inner ridge rises higher upon the shaft than that of the outer ridge, this is by so much the shorter of the two. The low middle ridge c, is much shorter than either of the lateral ones, being confined to the lower and middle part of the trochlear, to which it gives an undulating transverse outline (fig. 11).

The figure of the metacarpal bone of the wing-finger, in *Pterodactylus [Gallodactylus] suevicus*, Qnstd., does not show any trace of the mid-rising of the distal trochlear joint. The back surface of that of the left wing shows a wide and moderately deep excavation along the upper three fourths of the shaft. A portion of a similarly shaped shaft of a long bone, in size matching that of the trochlear extremity (fig. 10), is represented in Tab. IV, figs. 4 and 5. Although both ends are broken away, yet the degree of expansion towards the upper end shows that this was not very far from the proximal articulation. The shaft is three-sided; two of the sides are nearly flat or very feebly convex; they meet anteriorly at an acute angle, but this is rounded off as shown in the transverse sections of figs. 4 and 5; the third and shorter side in concave in the degree shown in the same sections. The lower of these (fig. 5), indicates the extreme thinness of the compact wall of the bone, and the size of the cancelli occupying that part of the shaft.

The portion of the wing-bones of the Pterodactyle of the Cambridge Green-sand, here described and figured, show the same superior proportions over those of the great Pterodactyles from the Kentish Chalk, described and figured in a former Monograph, 4to., 1851, as do the portions of jaw bones and teeth.

The long diameter of the largest of the wing-bones, figured in Tab. XXX, fig. 1, 4to, 1851, *e.g.*, is 2 inches 2 lines [55 mm]; that of the wing-bone figured in Tab. IV, figs. 1-3 of the present Monograph, is 3 inches [76 mm]. The transverse diameter of the distal end of the humerus in *Pterodactylus grandis*, Cuv., the largest species hitherto obtained from the Lithographic Slates of Germany, is 1 inch 3 lines [31 mm]; neither the radius, ulna, or metacarpal of the wing-bone of the same species presents a diameter of its largest end equalling 1 inch[8] [25 mm].

The articular end of the long wing-bone, (Tab. IV, figs. 1-3, being most probably that of an antibrachial bone, and the total length of the bone, whether radius of ulna, being, according to proportions of either of those bones in *Pterodactylus [Gallodactylus] suevicus*, 16 inches [], the following would be the length of the other bones of the wing in the large Pterodactyle to which the above-cited specimen belonged, according to the proportions which those bones bear to the radius or ulna in *Pterodactylus [Gallodactylus] suevicus*. –

	Ft.	In.	Lines.	cm.
Humerus	1	0	0	30.5
Radius	1	4	0	40.8
Metacarpus of wing-finger	1	8	0	50.9
First phalanx of do.	2	3	0	68.7
Second do. do.	1	9	0	53.5
Third do. do.	1	5	0	43.2
Fourth do. do.	1	1	0	33.0
Total length of long-bones of one wing	10	6	0	230.25

Supposing the breadth of the Pterodactyle between the two shoulder-joints to be 8 inches [20.2 cm], and allowing 2 inches [2.1 cm] for the carpus and the cartilages of the joints of the different bones, in each wing, we may then calculate that a large *Pterodactylus [Ornithocheirus] Sedgwickii* would be upborne on an expanse of wing of not less than 22 feet [6.7 m] from tip to tip.

I look forward with confidence to future acquisitions of remains of a truly gigantic Pterodactyle of the cretaceous periods, more especially from the Green-sand locality near Cambridge, as a means of throwing more light on a peculiar osteology of the extinct flying reptiles.

For the opportunities at present afforded me, I have to express most grateful acknowledgements to my old and much esteemed friend the Rev. professor Sedgwick, F.R.S.; to the acute and active curator of the Woodwardian Museum, Mr Lucas Barrett, F.G.S.; to James Carter, Esq., M.R.C.S., Cambridge; to T. W. Beddome, Esq., of Trinity College, Cambridge; and to the Rev. G. D. Living, M.A., of St. John's College, Cambridge; to whom I am indebted for the lower jaw of *Pterodactylus [Ornithocheirus] Sedgwickii (Tab. I, figs. 2, a, b, c, d).*

Footnotes

1. Volume of the Palaeontographical Society, 4to, 1851.
2. Ib.
3. 'Monograph of Fossil Reptilia of the London Clay,' 4to, vol. For 1850, p. 11.
4. 'Reports of the British Association,' 1858.
5. Quenstedt, 'Ueber *Pterodactylus suevicus*,' 4to, 1855
6. Buckland, 'Geological transactions,' 2d series, vol. iii, pl. xxvii, x, 9.
7. See the plate in Quenstedt's 'Memoir,' above cited.
8. These admeasurements are derived from the excellent figures of a recently acquired specimen, well described by Professor Andres Wagner of Munich, in the "Abhandlungen der Kais. Bayer. Akademi der Wissenschaft," Band. iii, p. 663, taf. xix.

The estimates of measurement are to the nearest whole mm and to the first decimal point in cm. This gives a slight calculation error in final totals for the wingspan calculated here.

Extracted list of Richard Owens Monographs and works on the Pterosaurs,

Owen R; On the supposed fossil bones of birds from the Wealden, Quart. J. Geological Society, Vol.2 Pp.96-102, 1846

Owen R; Monograph of the fossil Reptilia of the Cretaceous Formations, Palaeontographical Society, London, 1851

Owen R; A Monograph on the fossil Reptilia of the Mesozoic formations. I. Pterosauria, Palaeontographical Society, London, 1851

Owen R; Supplement (No.1) to the Monograph of the fossil Reptilia of the Cretaceous formations, Palaeontographical Society, London, 1859

Owen R; A Monograph on the fossil Reptilia of the Liassic formations, Palaeontographical Society, London, 1865

Owen R; A monograph on the fossil Reptilia of the Liassic formations, Palaeontographical Society, London, 1870

Owen R; Monograph on the Order Pterosauria, Palaeontographical Society, London, 1870

Owen R; Supplement (No.3) to the Monograph on the fossil Reptilia of the Cretaceous formations, Palaeontographical Society, London, 1874

TAB. I.

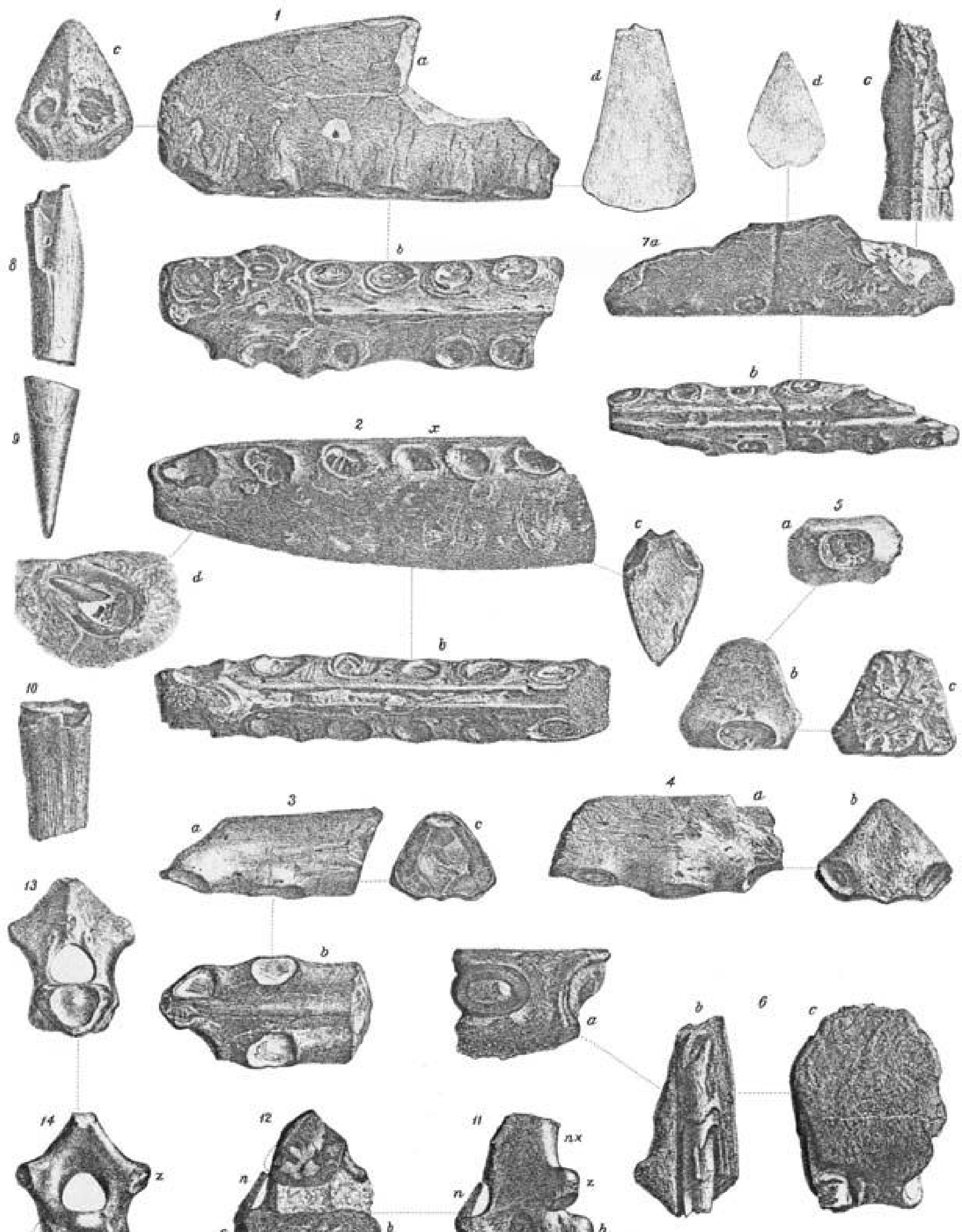
Genus *Pterodactylus*.

Fig.

1. Fore part of the upper jaw of *Pterodactylus Sedgwickii*: a, side view; b, under view, or palatal surface; c, front view or end; d, section of fractured opposite end.
2. Fore part of the lower jaw of *Pterodactylus Sedgwickii*; x, side view; b, upper view; c, section of fractured end; d, one of the sockets, magnified, showing the protruding apex of a young successional tooth.
3. Fore part of the upper jaw of *Pterodactylus Fittoni*: a, side view; b, under view; c, section of fractured end.
4. Another portion of the upper jaw of *Pterodactylus Fittoni*: a, side view; b, section.
5. A fragment of the upper jaw with one socket of *Pterodactylus Fittoni*: a, under view; b, outside view; c, inside view, showing the large cancelli.
6. A fragment of the upper jaw of a large *Pterodactylus Sedgwickii*: a, under view; b, end view, showing the deep implantation of the tooth; c, outside view.
7. Part of the under jaw of *Pterodactylus Sedgwickii*: a, side view; b, upper view, or that next the mouth; c, under view; d, section.
8. Base of a tooth, impressed by the apex of a successional tooth, at o.
9. Crown of a tooth.
10. Base of a large tooth, showing the longitudinally wrinkled cement.
11. Anchylosed atlas and axis: c, centrum; cx, centrum of axis; b, articular ball of axis; p, inferior process; o, pneumatic foramen; n, neurapophyses of atlas; nx, neural arch of axis; z, posterior zygapophysis and tubercle of axis.
12. Section of anchylosed atlas and axis: h, median hypapophysis.
13. Front view of the axis vertebra from which the atlas has been detached.
14. Back view of the same vertebra.

All the foregoing figures are of the natural size, and from specimens in the Woodwardian Museum of the University of Cambridge (with the exception of fig. 7 in the Private Collection of the Rev. G. D. Living, M.A., of St. John's College Cambridge); they were obtained from the Upper Green-sand (Neocomian), near the town.

T. I.



Jos. Dinkel. lith.

W.West. imp.

TAB. II.

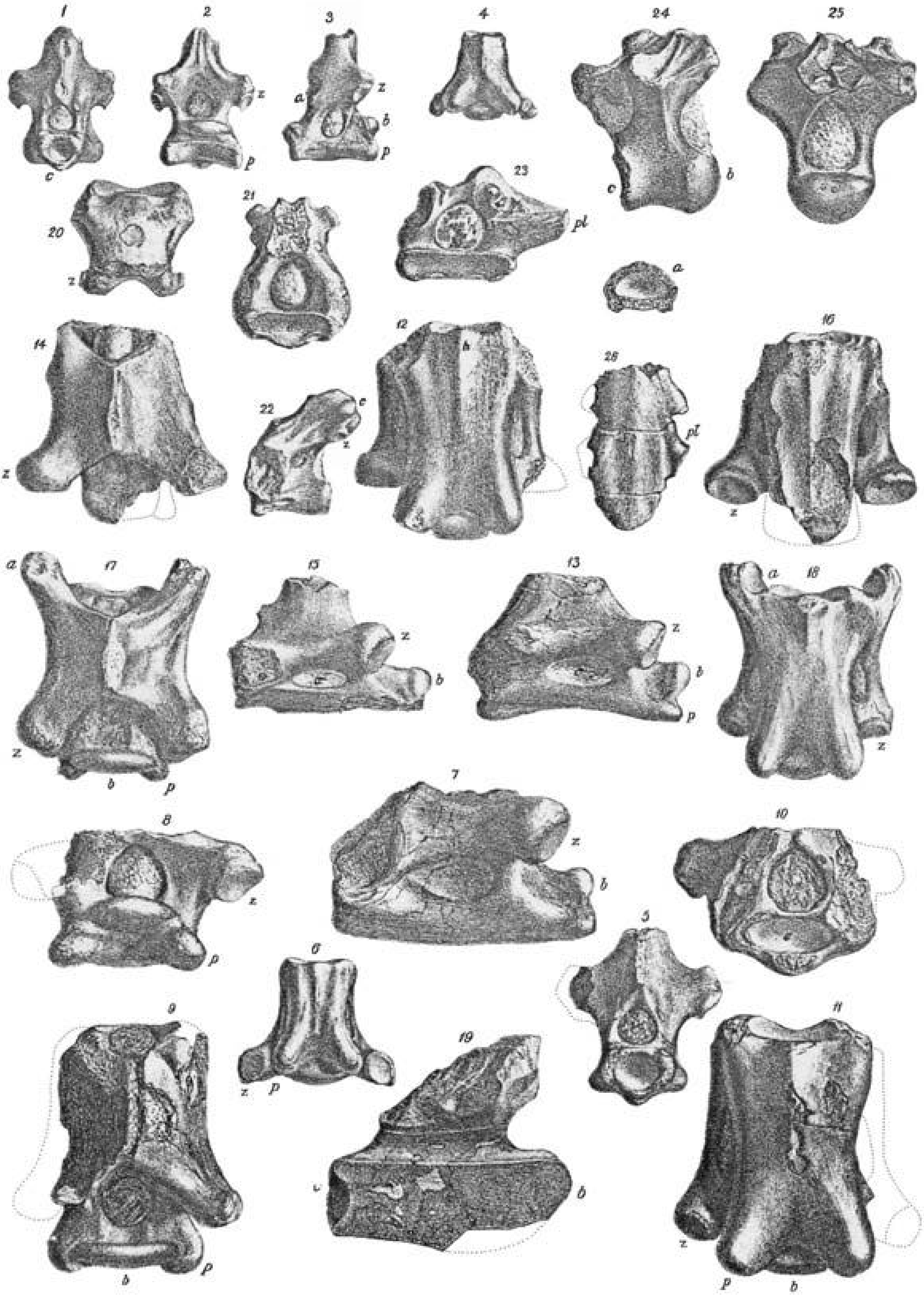
Vertebrae of *Pterodactylus Sedgwickii* and *Pter. Fittoni*.

Fig.

1. Front view of anchylosed atlas and axis.
2. Back view of same.
3. Side view of same.
4. Under view of the same: a, anterior tubercle, or rudiment of zygapophysis, of axis; z, posterior zygapophysis, of axis; c, centrum of atlas; p, inferio-posterior process of axis; b, articular ball of axis.
5. Front view of a larger specimen of atlas and axis.
6. Under view of the same, indicative of a species distinct from fig. 4.
7. Side view of a middle cervical vertebra.
8. Back view do.
9. Upper view do.
10. Front view do.
11. Under view do.
12. Under view of a cervical vertebra.
13. Side view do.
14. Upper view of a cervical vertebra.
15. Side view do.
16. Under view do.
17. Upper view of a more complete cervical vertebra.
18. Under view do.
19. Section of a large cervical vertebra.
20. Under view of an anterior dorsal vertebra.
21. Front view do.
22. Side view do.
23. Front view of a lumbar vertebra.
24. Side view od a dorsal vertebra.
25. Back view do.
26. Under view of three anchylosed sacral vertebrae.

All the figures are of the natural size, and from specimens in the Woodwardian Museum of the University of Cambridge, which were found in the Upper Green-sand (Neocomian) near that town.

T. II.



Jos. Dinkel. lith.

W.West. imp.

TAB. III.

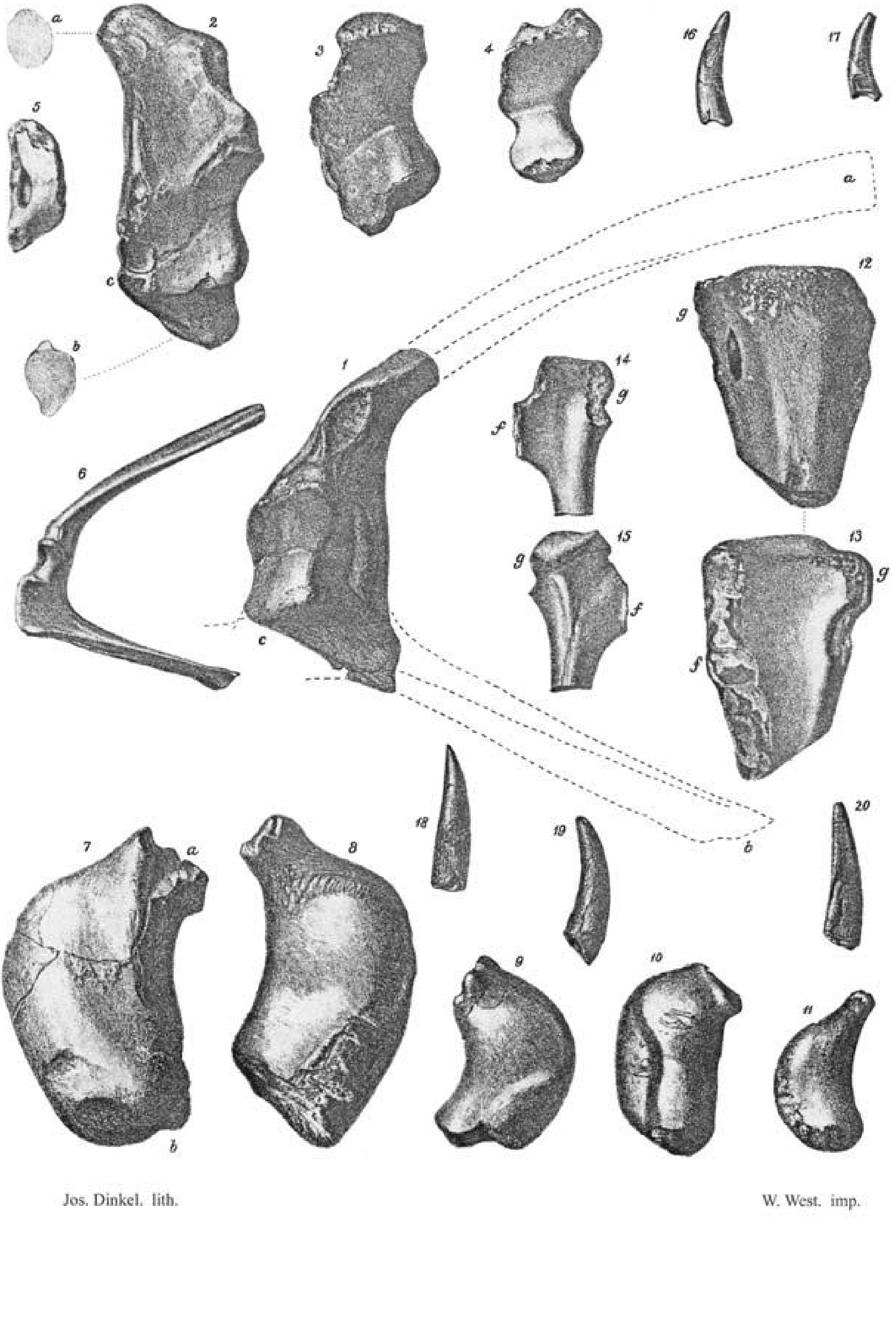
Pterodactylus Sedgwickii and *Pterodactylus Fittoni*.

Fig.

1. Humeral end of anchylosed scapula a, and coracoid b, with the glenoid articular cavity. The letter c indicates the base of the broken-off anterior or angular production of the coracoid.
2. Front view of the same specimen.
3. Similar view of the glenoid articular cavity of a similar sized Pterodactyle.
4. Glenoid articular cavity of a smaller specimen, and probably different species.
5. Inner surface of the anchylosed humeral end of the scapula and coracoid of a still smaller Pterodactyle.
6. The scapulo-coracoid arch of *Pterodactylus (Dimorphodon) macronyx*, Bkd.
7. The articular head of the right humerus of a large Pterodactyle.
8. The articular head of the left humerus of a large Pterodactyle.
9. The articular head of the left humerus of a smaller Pterodactyle.
10. The articular head of the right humerus of a similar sized Pterodactyle.
11. The articular head of the proximal end of the humerus of a Pterodactyle.
12. (The convex side) do.
13. (The concave side) do.
14. (The convex side) of the proximal end of the humerus of a smaller Pterodactyle.
15. (The concave side) do.
16. -20. Different teeth of Pterodactyles.

All the figures are of the natural size, and from specimens in the Woodwardian Museum of the University of Cambridge, which were found in the Upper Green-sand (Neocomian) near that town.

T. III.



Jos. Dinkel. lith.

W. West. imp.

TAB. IV.

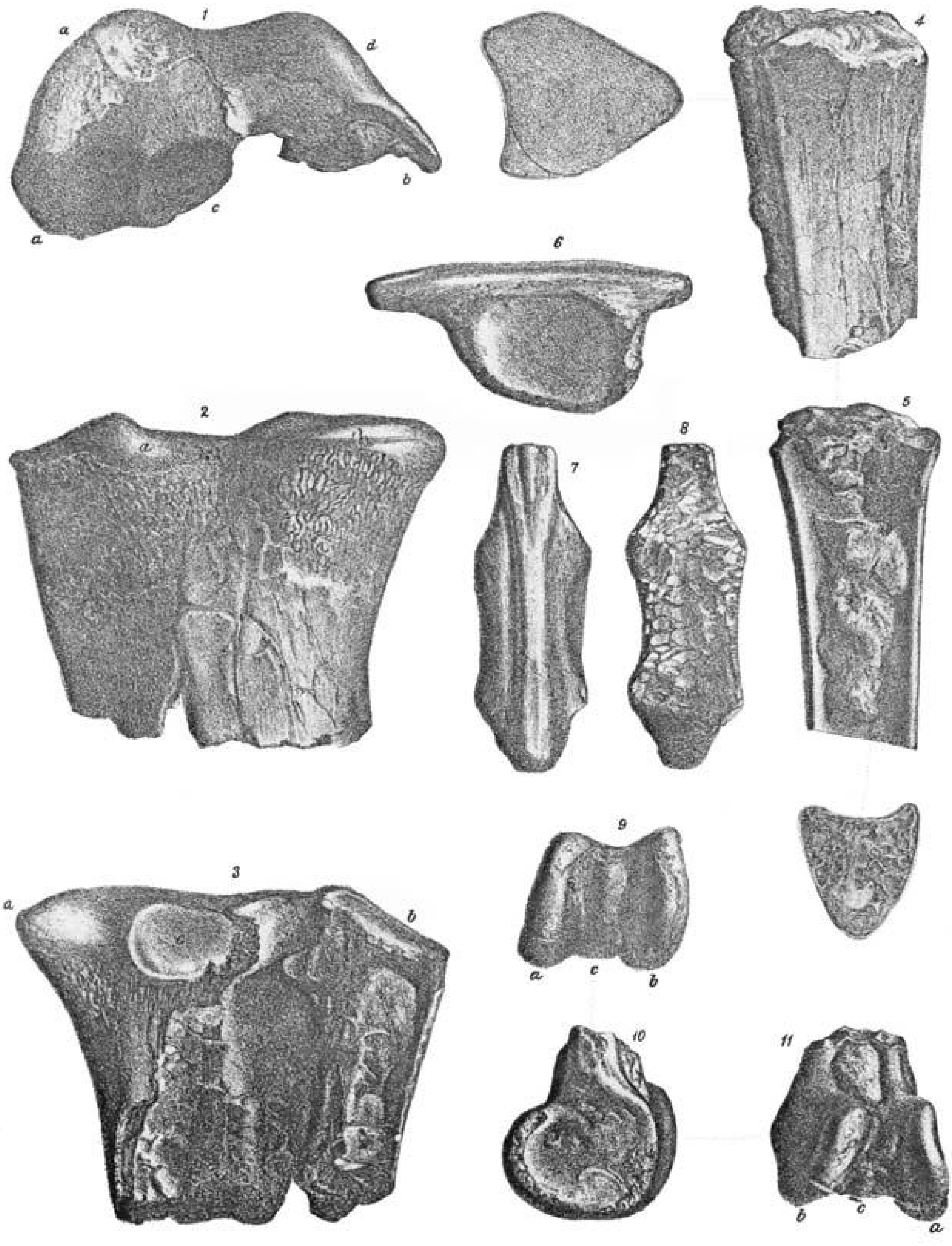
Pteodactylus Sedgwickii and *Pter. Fittoni*.

Fig.

1. Articular end,
2. Front (?) surface of a long bone of the wing.
3. Back (?) fractured) surface do.
4. Side view of part of the proximal end of the metacarpal of the 5th or wing-finger.
5. Back (?) view do.
6. Side view of a symmetrical (probably frontal) bone.
7. Upper (?) view do.
8. Opposite fracture durface do.
9. Articular end of the trochlear distal extremity of the metacarpal of the 5th or wing-finger.
10. Side view do.
11. Back view do.

All the figures are of the natural size, and from specimens in the Woodwardian Museum of the University of Cambridge, which were found in the Upper Green-sand (Neocomian) near that town.

T. IV.



Jos. Dinkel lith.

W.West. imp.