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On a new Species of *Plesiosaurus* (*P. Conybeari*) from the Lower Lias of Charmouth; with Observations on *P. megacephalus*, Stutchbury, and *P. brachycephalus*, Owen

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Notes

36. *On a new SPECIES of PLESIOSAURUS (P. Conybeari) from the LOWER LIAS of CHARMOUTH; with Observations on P. MEGACEPHALUS, Stutchbury, and P. BRACHYCEPHALUS, Owen.* By W. J. SOLLAS, M.A., F.R.S.E., F.G.S., &c., Professor of Geology in University College, Bristol. *Accompanied by a SUPPLEMENT on the GEOGRAPHICAL DISTRIBUTION of the GENUS PLESIOSAURUS, by G. F. WHIDBORNE, Esq., M.A., F.G.S.* (Read May 11, 1881.)

[PLATES XXIII. & XXIV.]

THE nearly complete and very fine specimen of *Plesiosaurus* (Pl. XXIII. fig. 1) which forms the subject of the present paper is the latest addition to the already large collection of fossil reptiles preserved in the Bristol Museum.

It was found over a year ago, by Samuel Clarke of Charmouth, on the north-west corner of Blackven Water, half a mile west of the river Char, where it lay in a "table-ledge" of the Lower Lias, some seven feet above the "boulder-bed." From its position and the species* of Ammonite still associated with it, we may conclude that its geological horizon is that of the zone of *Ammonites obtusus*.

From the pectoral to the pelvic girdle it is imbedded in a layer of hard impure limestone, thick enough to hold the parts securely together, but at the same time thin enough to let the skeleton be seen on both sides, dorsal as well as ventral. The head and neck were preserved chiefly in shale; so that, to ensure the safety of the neck, it has been found necessary to imbed it in plaster; but the head, being filled in and about with limestone, has been left free, and can be turned about, handled, and examined on all sides.

The ventral surface of the fossil (Pl. XXIII. fig. 1) is exposed on the upper surface of the imbedding limestone; the coracoids lie side by side nearly in the position they would have occupied in the dead animal lying on its back, except that they are slightly displaced towards the left side; the left pubis and ischium are also nearly in position; but the corresponding bones of the right side have been pushed to the left, so as to underlie them; the femora, which are all that is left of the hind limbs, remain on their proper sides, extended outwards and backwards. The fore limbs have been considerably displaced; for though that of the left remains on its own side, the palmar surface of its hand looking upwards, that of the right has been completely crossed over onto the left, so that its palmar surface would be directly superposed on that of its fellow were it not for a slight dislocation at the distal end of the humerus, which has carried the rest of the right limb backwards, and so left the left hand exposed. The scapulæ have turned on their axes, but have not shifted sides; and

* This, according to the determination of Mr. Whidborne, is *Ammonites planicosta*.

the "furculum," or combined clavicles, is tilted up from right to left.

So far as the appendicular skeleton is concerned, it has approximately the position it would have in an animal lying flat on its back with its limbs extended outwards, except that it has been skewed over as a whole a little to the left, and the right fore limb completely crossed over.

The axial skeleton is similarly disposed as far as the ribs are concerned; but the head and vertebral column have been turned round 90° , and lie on one side, the left. The neck and head are also curved backwards, in the manner so usual with *Plesiosaurus*, and which has been commented on by Professor Huxley as suggestive of death by opisthotonic contraction.

This disposition of the parts of the skeleton may be readily explained by supposing that the animal to which it belonged fell, after death, sideways through some depth of sea-water to an oozy bottom. The body, being broadest laterally, has settled on its back, the hind limbs sprawling outwards. The left shoulder touched the bottom first; and the right fore limb heeling over, fell across the one to the left. The neck and, in this species, the head being broadest dorso-ventrally, settled on one side, the left, and so communicated a twisting strain to the rest of the vertebral column, which, being but slightly attached to the ribs and appendicular skeleton, readily yielded to it, and turned on its side also; thus the whole of the vertebral column came to lie on its broadest face (that is to say, laterally). The twist to the left given by the crossing of the right fore limb, and the subsequent pressure of overlying strata, led to the various other minor dislocations and displacements.

That the specimen is undoubtedly the type of a new species is shown by the following summary of its chief characters:—

1. The length of the skull from the anterior extremity of the lower jaw to the posterior margin of its articulation with the quadrate bone is 19.75 inches, measured along the right side.

2. The number of vertebræ is 66, of which 59 are cervico-dorsal, 2 sacral, and 5 caudal. Of the cervico-dorsal vertebræ 38 appear to be cervical and 21 dorsal.

3. The length of the cervical region is 83 inches (6 feet 11 inches); so that the length of the head is to that of the neck as 24.1 : 100.

4. The length of the cervico-dorsal series is 136 inches (11 feet 4 inches); and the length of the head to this is as 14.6 : 100.

5. The length of the centrum of the anterior cervical vertebræ is equal to the height and greater than the breadth of the articular face. Thus in vertebra xv the measurements are:—Length 2 inches, breadth 1.5 inch, height 2 inches.

6. In the posterior cervical vertebræ the breadth of the articular face is greater than the length or height, but the latter two dimensions remain equal. Thus in vertebra xxxv we find—length 2.7 inches, breadth 3.5 inches, height 2.7 inches.

7. The neural spines increase in size up to the 40th to 44th vertebra, in which they measure 4.75 inches in length.

8. The neural spines are inclined backwards as far as the 55th vertebra; past this up to the 57th they are inclined somewhat forwards; but after this they again incline backwards to the end of the vertebral series.

9. The humerus and femur are nearly equal in length, the femur being slightly the shorter.

For the new species which these characters indicate, I propose the name of *Plesiosaurus Conybeari*, as a tribute to that classic authority who first made the existence and nature of *Plesiosaurus* known to us. This was sixty years ago; and it is singular that up to this date no one seems to have thought of calling some species of *Plesiosaurus* after the author of the genus.

Plesiosaurus Conybeari agrees closely with *P. Etheridgii* in the relative length of head and neck; but if the length of the head be compared in each with that of the whole cervico-dorsal series, a marked difference is apparent; thus in *P. Etheridgii* the ratio is 12·5 : 100, in *P. Conybeari* 14·6 : 100. *P. Conybeari* further differs from *P. Etheridgii* in absolute size, being nearly twice as long; it also possesses a larger number of cervico-dorsal vertebræ, *P. Etheridgii* having only 53, or 6 less than *P. Conybeari*. In this latter character the new species more nearly agrees with *P. homalospondylus*, each having 38 cervicals, while the latter has 22 and the former 21 dorsal vertebræ; but *P. Conybeari* has a larger head than *P. homalospondylus*. Both have the same length of neck; but *P. homalospondylus* has a longer dorsal series of vertebræ (81 inches in length). The length of its head relatively to that of the neck and cervico-dorsal series is also much less than in *P. Conybeari*, being to the neck as 10·6 : 100, and to the cervico-dorsal series as 5·4 : 100.

Detailed Description.

The Skull (Pl. XXIV, fig. 1).—This, which has been very thoroughly freed from matrix, and is in an excellent state of preservation, presents us with that very exceptional character amongst Plesiosaurs, a good profile. This is due to its having been compressed from side to side, and not, as is more usual, depressed from above downwards. Perhaps this indicates a difference in the original shape of the head. The right side of the skull has slipped a little upwards above the left; and some other displacements have occurred, but nothing like so great as one would have expected if the present greatly compressed head had originally been as broad from side to side as most Plesiosaur heads evidently were.

Posterior Aspect.—In the middle of the back of the skull is a confused mass of bone comprising the axis and atlas vertebræ, under which the *foramen magnum* lies concealed. Inferior to this are the posterior ends (*articulare*) of the rami of the lower jaws, bent towards the middle line; that on the right side is nearly perfect, clearly not needing more than a quarter of an inch to complete it. The *articulare* thins off rapidly behind its articulation with the qua-

drate, not extending more than 1·5 inch beyond the posterior edge of the condyle.

The quadrate appears to be directly continuous with the squamosal on each side; and the latter bones are prolonged upwards into a process which, viewed from behind, has a somewhat sabre-like outline, with the convexity outwards. Both these suprasquamosal processes are broken at the distal end, so that their junction over the parietal (a characteristic Chameleon feature seen in most Plesiosaurs) is not here observable.

Superior Aspect.—Most posterior is the previously mentioned axis and atlas vertebral mass; then succeed in front the approximated ends of the broken suprasquamosal processes. The parietal comes next, a pent-roof-like bone, 5·75 inches long, compressed for the anterior three quarters of its length into a strong median crest, along which the persistent sagittal suture extends, expanding anteriorly into the *foramen parietale* 0·3 inch wide, in front of which the parietal ends. Behind, the parietal is expanded into a form like the bowl of a spoon, the bowl being supposed turned with the convexity upwards.

The next bones in front are the frontals, longitudinally ridged in the middle, smooth at the sides, and separated by a median suture, which is slightly more open in the middle of its length than at the ends*. A splintery suture joins the frontals to the nasals, which are short longitudinally striated bones, not by any means clearly defined in front from the posterior prolongations of the præmaxillæ. The præmaxillæ, 9 or 10 inches long, are separated for their whole length by a simple suture; posteriorly they are smooth, or only faintly wrinkled, but in front much roughened, probably for attachment of integument.

From the parietals a process is given off on each side of the *foramen parietale*, and continues backwards as far as the middle of the lateral margin of the bone; in uncrushed skulls this process is a plate of bone standing out nearly at right angles to the body of the parietal; its parallelism in this case must be due to compression.

Lateral Aspect.—On the left side the upper jaw is 14·3 inches long; and the anterior 4·3 inches is furnished by the præmaxilla; this bone joins the maxilla along a line which runs obliquely upwards and backwards, to end just above the anterior nares. The maxilla is an irregularly triangular bone. Its base (10" long) furnishes the margin of the upper jaw; its anterior side bounds the præmaxilla; its posterior side, just behind the apex, furnishes the lower anterior boundary to the external nostril, and further down the lower anterior margin of the orbit (being excluded from the upper part of it by the lacrymal and prefrontal bones, here badly defined); still further downwards and backwards it meets the jugal, by which it is excluded from the posterior half of the lower boundary of the orbit; and along and beneath this bone it extends to its

* This appears to indicate a fossa corresponding to that on the frontal suture of the Lizard's skull, interpreted by Professor Parker as "the scarcely-closed anterior fontanelle" of *Clarias*.—Phil. Trans. clxx., 1879, p. 598.

termination, which takes place a considerable distance (over an inch) behind the orbit. This is a marked character in several of the Lacertilia, particularly the Agamidæ. The maxilla bears teeth at least up to within 1·8 inch of its termination.

The jugal is bounded below by the maxilla; in front it forms the posterior lower corner of the orbit; above it joins the postorbital (postfrontal), which bounds the upper posterior corner of the orbit; and behind it unites with the squamosal by a splintery suture, which is 1·4 inch long, and runs almost at right angles to the length of each bone. The jugal is convex outwards in front, and depressed behind; in the depression a vertical row of three oval pits (nutritive foramina) separated by intervening smooth ridges is situated. At the ends of the pits, which are elongated antero-posteriorly, striæ appear on the surface of the bone, and are continued forwards, diverging at the same time, over the otherwise smooth anterior convexity. The external form and surface-markings thus described give to the jugal such a characteristic appearance that it is easily identified by them alone.

The squamosal is a large and important bone, of which the general form and relations are not quite so clearly defined as could be wished. Its characteristic anterior or zygomatic process, however, is well displayed; it is a thin bar of bone 1 inch broad, about $2\frac{1}{2}$ inches long, and $\frac{1}{8}$ inch thick, finely striated longitudinally, the striæ sweeping somewhat obliquely forwards from above downwards.

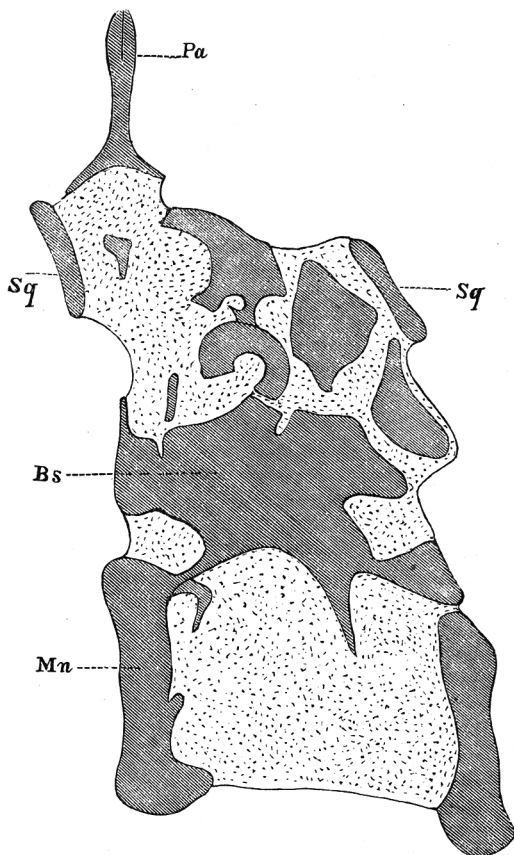
The postorbital continues backwards from the jugal over the upper edge of the zygoma for a distance of 0·8 inch. These three bones, jugal, postorbital, and squamosal, clearly meet in a T-shaped suture; and thus Professor Huxley is undoubtedly correct in asserting that, "contrary to what is usually stated, the postfrontal appears to articulate with a bone, the homologue of the squamosal of the Crocodile" (Quart. Journ. Geol. Soc. vol. xiv. p. 293).

A slight extension downwards of the lower margin of the anterior end of the squamosal bar, rendering its inferior outline curved concavely, while that above is rectilinear, brings it within half an inch of the posterior end of the maxilla. From that part of the jugal which is exposed between the squamosal and the maxilla no bony bar is produced towards the quadrate; nor is there the slightest evidence of one having ever existed, so far as this skull is concerned. I feel persuaded that an inferior bony temporal arcade has never been present, and that, if a quadrato-jugal occurs at all, it must be as what we have called the anterior process of the squamosal, while for such a view I see no evidence.

The quadrate is clearly enough identified at its articulation with the lower jaw; but on tracing it towards the squamosal it is impossible to say where it ends or the squamosal begins. The relations of the two bones are quite obscure; so that one cannot even tell in this specimen whether what we have already termed the suprasquamosal processes are the property of the bones to which we have assigned them, or whether they came off from the quadrate. They appear in

area, the transverse section of a bone which is continued backwards on the side of the skull to terminate on the inner side of the lower end of the quadrate. In all probability this bone is the pterygoid, or

Fig. 1.—*Transverse Section through the Skull in the Region of the Supratemporal Fossæ.* (Scale $\frac{2}{3}$.)



at all events a part of it; and the narrow neck from which it extends may be partially furnished by the basipterygoid process; but there is no evidence of the existence of a joint between it and the pterygoid. The lower process of the bifurcation may also be a part of the pterygoid; if not, I do not know what nature to suggest for it.

On the left side the pterygoid is crushed up against the basisphenoid, almost obliterating the space which separates them on the right; and the descending process below it is thrust and broken against the lower jaw.

On each side of the section above the basisphenoid the thin bar of bone which proceeds from the squamosal is seen, and at the summit the parietals with their median crest and persistent suture. The other bones appear to be undeterminable; some of them are probably parts of the periotic mass.

Dentition.—A fine series of teeth is well displayed on the left side of the head. They are slender, conical, slightly recurved, and finely striated from the apex for a considerable distance downwards, *i. e.* over the crown. They vary greatly in size, the largest being those in the neighbourhood of the maxillo-premaxillary suture; an inch or so behind this they begin to diminish in size, and beneath the orbit have less than one half the average length of those in front, while behind it they dwindle to mere pointed tubercles.

The largest tooth present is one in the right upper jaw, behind the maxillo-premaxillary suture; it is 2.45 inches long, the distal 1.5 inch, or crown, finely striated, its diameter at the point where the striæ begin being 0.6 inch. A smaller but more perfect tooth, the largest on the left side, measures 1.95 inches long; 1.35 inch is striated; and the diameter at the commencement of striation is 0.5 inch.

Those teeth which still remain exposed to view are distributed as follows:—on the left side in the præmaxilla 5, in the maxilla 15, in the lower jaw 13; on the right side in the præmaxilla 3, in the maxilla 11, in the lower jaw 8. The number of teeth in the left præmaxilla and maxilla make the nearest approximation to the numbers originally present.

The Vertebral Column.—There is a continuous series of 66 vertebræ, of which 38 are cervical, 21 dorsal, 2 sacral, and 5 caudal. The caudal series is evidently incomplete, a considerable number of vertebræ being missing from the distal end.

Cervical Vertebræ.—The first and second, as already mentioned, form a confused mass adherent to the back of the skull, but from the third onwards all are clearly defined and can be easily examined. III. The centrum of the third is 1.12 inch long* (a.p.), 0.75 broad (l.l.), and 1.4 high (d.v.), the breadth and height being measured along the articular face. It is much compressed in the middle, the edges of the articular ends projecting greatly, as though the more yielding cancellous interior had given way under heavy pressure, such as that of overlying strata; this feature is markedly present as far as the thirteenth cervical vertebra. The neuro-central suture is a nearly straight or slightly tricurvate line, with the central convexity downwards. A tricurvate ridge, with the central convexity upwards, runs along the whole length of the centrum between the articular edges or rims, at a level 0.4 inch below the neuro-central suture; it defines the upper edge of the nearly oval costal pit, which is 0.9 inch long, 0.45 inch broad (d.v.), and obscurely divided into two by a faint median longitudinal ridge or closed furrow. The rib has been displaced downwards; and its ovate-lanceolate posterior

* (a.p.) antero-posterior, (l.l.) from side to side, (d.v.) dorso-ventral.

prolongation extends with a downward direction as far back as the posterior edge of the centrum to which it belongs.

Near the articular ends the centrum is roughened by a few small irregularly scattered tubercles, which become larger and more numerous in succeeding vertebræ down to the twenty-fifth. The neural spine has been broken away; so that the total height of the vertebra cannot be determined. The line between the zygapophyses is 1·9 inch from the base, and 0·9 inch from the neuro-central suture.

VII. The seventh vertebra has a total height of 2·95 inches; the centrum is 1·375 inch long and 1·5 high. The well-marked neuro-central suture is 1·1 inch from the base. The tubercles near the articular ends have become larger and more numerous. The rib is distinctly hatchet-shaped, and consists of a blade-like upper part and a lower handle-like horizontal process; a deep incision separates the handle from the blade in front, and the front end of the handle does not reach the anterior edge of the centrum by about an inch. The posterior margin of the blade slopes gradually down, and curves gradually into the handle, the posterior prolongation of which extends a short distance beyond the posterior edge of the centrum, from which the rib proceeds.

The anterior zygapophysis is, as in the other anterior cervical vertebræ, turned inwards and upwards; below the line of the zygapophyses the neural arch is ridged in a direction crossing obliquely from the anterior edge of the anterior zygapophysial facet downwards to the posterior edge of the neuro-central suture, the ridges being most marked near their origin and termination. The distance from the anterior to the posterior zygapophysis is 2·3 inches. From the line of the zygapophyses to the base of the centrum is 2·0 inches, to the top of the spine 1·35 inch.

The neural spine has somewhat the outline of a Phrygian cap seen in profile; it has a gentle convex slope backwards in front, and a short sigmoid curve behind; it rises from the middle of the length of its centrum, and hangs over the anterior quarter of the centrum next behind. It is smooth below, but roughened towards the distal end.

The vertebræ increase in size and change in the relative size of their parts as they pass backwards: down to the fifteenth (xv), probably to the twenty-second (xxii), the articular face of the centrum is an ellipse, with the major axis vertical (d.v.); at the twenty-third (xxiii) the diameters are about equal, and continue so to about the twenty-fifth (xxv), beyond which the horizontal diameter (l.l.) becomes the larger, and continues to increase over the vertical down to and beyond the end of the cervical series. The neuro-central suture becomes more sharply inflected in the middle, so that in the fifteenth (xv) the middle curve of the tricurvate line becomes transformed into a right angle. The zygapophysial facets acquire by degrees an entirely horizontal position; they seem to have done so in the fifteenth vertebra.

The neural spines increase more rapidly in size than the centra, and considerably change their form; at the eighteenth (xviii) the

spine is broader at the distal end than in the preceding vertebræ. The anterior margin is short and straight, sloping backwards; the upper margin curved, rising obliquely backwards; the posterior margin is sigmoid, convex backwards above, and concave below, nearly vertical. In the thirty-second (xxxii) the outline is much simpler: both anterior and posterior margins are straight, not quite parallel with each other, since they are further apart below than above; the upper margin is an elliptical curve, through which the anterior and posterior margins pass into each other. The base of the anterior part of the spine between the anterior zygapophyses is much compressed; it broadens out immediately behind the origin of the anterior zygapophyses, and also over the posterior zygapophyses. The costal pits increase in size; but neither they nor the ribs show much sign of other change down to the twenty-sixth (xxvi) vertebra, when, however, preparations for change become evident.

In the twenty-sixth, the rib being displaced allows the costal pits to be seen; they are now quite separate oval depressions, 0·95 inch long and 0·9 inch distant from the anterior edge of the centrum, with which they are connected by a ridge which continues the anterior margin of each forwards.

In the twenty-seventh (xxvii) all trace of rugosity has disappeared from the surface of the centrum, and it is now quite smooth; this continues to be the case throughout the rest of the vertebral column. The neuro-central suture is marked by a swelling ridge, particularly prominent in the central part of its course.

In the twenty-ninth (xxix) the thickening of the lower end of the neural arch becomes more marked, and the margin of the costal pits is somewhat elevated.

In the thirtieth (xxx) faint signs appear of a ridge proceeding from the swollen end of the neural arch to the upper margin of the costal pit; in the thirty-first (xxxi) this and the ridge connecting the anterior margin of the costal pit with the anterior edge of the centrum have both become more marked. In the thirty-second and thirty-third (xxxii and xxxiii) the costal pits begin to rise higher on the centrum, and become more posterior; the upper edge of the pit swells into a marked ridge, and is connected by the previously mentioned ridge, which (now become very prominent) ascends from it to the swollen end of the neural arch.

In the thirty-fourth (xxxiv) the lower costal pit has almost disappeared, and the upper and anterior margins of the remaining pit are swollen into a strong crescentic ridge, which is joined in the middle by the ridge descending from the neuro-central suture.

In the thirty-fifth (xxxv) the thickened lower end of the neural arch and the ridge arising from the anterior margin of the costal pit form together a single vertically descending median ridge, which extends more than halfway down the side of the centrum. That part of the ridge contributed by the neural arch is more swollen than the other, and curves forwards as it descends, joining at an obtuse angle the part contributed by the centrum, which is sigmoid in outline; the general form of the united ridge is much like that

of a bracket (}), the middle point of the bracket standing for the point of junction of the two constituent ridges.

In the thirty-sixth (xxxvi) the lower end of the neural arch is still more swollen, and has retreated further up the centrum; it more abruptly joins the costal ridge, which has become almost straight, and more prominent; it extends down the middle of the centrum to within 0·65 inch of an oval nutritive foramen, which lies on one side of the concealed middle line of the base of the centrum.

(xxxvii) An abrupt change in the character of the costal ridge takes place in the thirty-seventh vertebra; it has become greatly enlarged, to form a simple transverse process, which, curving downwards and backwards from the neural arch, ends in an oval facet, looking obliquely backwards and downwards; the lower edge of the facet rests upon the centrum, the pedicel of the transverse process having as yet only an upper and not an inferior margin. The rib is no longer hatchet-shaped, but of the ordinary half-hoop form; it is nearly cylindrical down to 1·3 inch from the transverse process, and then expands laterally so as to become somewhat triangular in section; the line along which this change takes place is marked by a strong ridge, oblique to the axis of the rib. A transverse fracture across the front of this vertebra and the overhanging posterior zygapophyses of the preceding vertebra shows that the zygapophysial facets are not horizontal (as one might have conjectured), but much inclined, the posterior looking outwards and downwards, and the anterior inwards and upwards.

(xxxviii) The base of the transverse process of this vertebra extends a little more than halfway down the centrum; the facet is borne on a distinct pedicel, and looks a little less backwards than that of the preceding vertebra. This I take to be the last cervical vertebra, the transverse process of the next vertebra appearing to arise wholly from the neural arch. I use the word "appearing" definitely, since, in the absence of any well-defined neuro-central suture, it is difficult to say certainly what the exact constitution of the transverse process is. It is clear, however, that the process in this vertebra extends a little below the dorsal half of the centrum; and this is presumptive evidence* that it is cervical; while in the next vertebra it does not, but is wholly confined to the dorsal half, and thus should be the first dorsal. Moreover, owing to a difference in the colour of the substance of the centrum and that of the neural arch, the latter being black and the former brown, in this region of the vertebral column, it is possible to detect in the transverse process of the thirty-eighth vertebra bone contributed by the centrum; in the transverse process of the thirty-ninth no certain indication of bone so contributed is to be found. The possession of hatchet-shaped ribs was at one time included by Professor Huxley in the definition of a cervical vertebra; if this should be regarded as an essential character, then the vertebræ thirty-seven and thirty-eight would

* "There is reason to believe that the neurapophyses do not extend upon the bodies of the cervical vertebræ beyond their dorsal half."—HUXLEY, on *Plesiosaurus Etheridgii*, Quart. Journ. Geol. Soc. vol. xiv. p. 282 (footnote).

be excluded from the cervical series, and there would be only thirty-six cervical vertebræ. If it were desirable to make a natural grouping of the vertebræ of this skeleton without reference to those of other species, one would not hesitate to draw the line between cervical and dorsal at the end of the thirty-sixth vertebra; for all down to the thirty-sixth are without transverse processes, but possess hatchet-shaped ribs, while past the thirty-sixth the hatchet-shaped rib disappears and unmistakable transverse processes correspondingly arise. As, however, it is convenient to adhere as closely as possible to existing conventions, in order to facilitate the comparison of species, I have been governed in my determination of the last cervical by the fact that a part of the transverse process borne by it does clearly seem to be contributed by the centrum as far back as the thirty-eighth vertebra; and thus I have included as cervical two vertebræ which would certainly seem more in place in the dorsal series. Professor Seeley's plan of calling those vertebræ in which the transverse process is passing from the centrum onto the neural arch "pectoral" has much to recommend it, and might fairly be applied to the vertebræ thirty-seven and thirty-eight. Indeed there is just a shade of doubt in my mind whether vertebra thirty-nine should not also be called pectoral; for its transverse process appears to have a little brown bone like that of the centrum at its base, and the rib it bears is bifurcate near the head and short, while the succeeding vertebræ bear ribs with a simple proximal termination only.

The determination of the position of the last cervical vertebra is not only important as giving us the number of vertebræ in the neck, but also because it furnishes us with a necessary datum for the measurement of the length of the neck, and hence for ascertaining that important character, the ratio of the length of the head to that of the neck, or, as we may briefly term it, the cervico-cephalic index. Fortunately, in the case of the species under consideration the neck is so long that one or two vertebræ more or less can make very little difference to the value of this index, the thirty-seventh and thirty-eighth vertebræ measuring together not more than five inches. The thirty-eighth cervical vertebræ measure 83·25 inches, or 6 feet 11 inches; and the cervico-cephalic index is 24·1. A Table is here appended, giving the dimensions of the cervical vertebræ, so far as they are ascertainable: it will be seen that the constancy in length which Prof. Owen* regards as characteristic of the cervical vertebra of the Enaliosauria, and only exceptionally absent in *Pliosaurus*, has no real existence, and also that no single vertebra can well be taken as typical of the remainder. Hence the importance of such a Table as this as a help in the specific identification of separate vertebræ will be apparent. It may be worth while to call attention to the abrupt manner in which some of the changes in dimensions occur, as for instance in the length of the centrum in passing from the twenty-second to the twenty-third vertebra; and again, to the abnormal

* Report Brit. Assoc. 1841. Report on British Fossil Reptiles, p. 63.

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variations which occasionally appear, as, for instance, in the twenty-eighth vertebra, which is longer not only than its predecessor, but also than its successor; the same is also the case in the thirty-sixth vertebra: the difference is too large to be explained as an error of measurement, and can scarcely be the result of mechanical compression; it seems rather to be concomitant with that wide departure from the ordinary Reptilian type which the Plesiosaurian neck presents.

Table of Measurements of Cervical Vertebrae.

Number of the vertebra	Centrum.			Total height.	Zygapophys to base.	Zygapophys to end of spine.	Zygapophys to Zygapophys.	Neurocentral suture to base.	Neurocentral suture to costal pit.	Number of vertebra.	
	Length. (a.p.)	Breadth. (l.l.)	Height. (d.v.)								
1.											
2.											
3.	1.12	0.75	1.4	...	1.9	...	...	1.2	0.4	3.
4.	1.25	...	1.4	...	1.9	...	2.1	1.1	0.4		
5.	1.25	...	1.4	...	2.0	1.35	...	1.1	0.4	5.	
6.	1.375	...	1.4	2.9	2.0	...	2.3	1.1	0.5		
7.	1.375	...	1.5	2.95	2.0	...	2.3	1.1	0.5		
8.	1.375	...	1.5	2.95	2.0	1.45	...	2.3	1.1	0.5	
9.	1.375	...	1.5	3.2	2.0	...	2.3	1.1	0.5		
10.	1.7	...	1.5	...	2.25	...	2.45	1.05	0.5	10.	
11.	1.7	...	1.7	...	2.3	...	2.45	1.2	0.5		
12.	1.7	1.4	1.7	...	2.45	...	...	1.2	0.5	
13.	1.8	1.45	1.75	...	2.45	...	...	1.4	0.5	
14.	1.9	1.4	1.9	...	2.4	1.9	...	1.4	0.5		
15.	2.0	1.5	2.0	4.0	2.6	2.1	2.75	1.5	0.6	15.	
16.	2.1	...	2.1	4.6	2.6	2.2	2.85	1.55	0.7		
17.	2.2	...	2.1	4.8	2.6	2.45	3.05	1.55	0.7		
18.	2.2	...	2.2	5.1	2.8	2.45	3.05	1.5	0.7		
19.	2.2	..	2.2	5.2	2.8	2.65	3.2	1.7	0.7		
20.	2.2	...	2.2	5.4	2.8	2.8	3.2	1.7	0.8	20.	
21.	2.3	...	2.15	5.4	2.8	2.8	3.4	1.45	0.65		
22.	2.2	...	2.2	5.6	2.8	2.8	3.4	1.5	0.55		
23.	2.5	2.3	2.2	...	3.0	2.9	...	1.8	0.75		
24.	2.55	2.4	2.2	5.85	3.1	3.0	3.5	2.0	0.7		
25.	2.5	..	...	6.6	3.4	3.3	3.7	...	0.7	25.
26.	2.5	...	2.25	6.4	3.5	3.1	3.55	...	...
27.	2.65	...	2.35	6.55	3.55	3.45	3.7	2.2	0.8		
28.	2.75	2.45	2.5	6.8	3.5	3.65	...	2.0	0.8		
29.	2.6	...	2.6	6.8	3.5	3.85	3.7	2.3	0.75		
30.	2.6	...	2.65	6.8	3.6	3.6	3.7	2.3	0.7	30.	
31.	2.65	...	...	7.1	3.6	3.9	3.9	2.6	0.65	
32.	2.5	...	...	7.1	3.7	3.98	3.9	2.4	0.5	
33.	2.625	...	...	7.3	3.7	4.0	...	2.6	0.5	
34.	2.6	3.3	2.7	7.5	3.8	4.25	...	2.7	0.2		
35.	2.69	3.5	2.7	7.7	3.8	4.4	...	2.8	...	35.	
36.	2.75	3.5	2.75	...	3.8	...	...	2.8	...	
37.	2.6	...	...	...	3.55	...	...	...	...
38.	2.6	3.625	2.725	...	...	...	...	...	...	38.

Dorsal Series. (Plate XXIII. fig. 2.)

The dorsal vertebræ are well exposed in a fine and complete series on the underside of the specimen. They have the same general character as the last two cervicals—the centrum being smooth, not tuberculated, its height (d.v.) and length (a.p.) being about equal, and both shorter than the breadth (l.l.). The maximum dimensions of the centrum appear to be attained in the fortieth vertebra, in which the length and height are each 2·8 inches, and the breadth 4·8 inches; its total height, however, is only 7·6 inches, being less than that of the forty-third vertebra, which is 8·2 inches high; behind the fortieth the centra decrease in size, and a little more rapidly in breadth than in the other dimensions. The transverse processes rise upon the vertebræ from the thirty-ninth (xxxix) to the forty-second and forty-third (xlii and xliii) beyond which they spring from the neural arch along the zygapophysial line; they maintain this position down to the fifty-sixth (lvi), past which they begin to descend and also change in character. At first, as in the fortieth vertebra (xl) or second dorsal, the pedicel of the transverse process projects outwards at right angles to the vertical plane given by the flat side of the neural spine; passing backwards this angle is much diminished, so that in the forty-fourth (xliv) vertebra it is only 65°; behind this it begins to increase again, and at length becomes 90° at the fifty-fifth (lv) vertebra, or seventeenth dorsal.

The length of the transverse process increases slowly down to the forty-seventh (xlvii), in which it is 4·3 inches long; behind this it slowly shortens and becomes 1·5 inch at the fifty-eighth vertebra.

The dorso-ventral diameter of the base of the transverse process is at first, as in the fortieth vertebra, 2·1 inches; but it rapidly diminishes, so that at the forty-third it has become 1·2 inch; past the forty-third it remains pretty constant as far as the fifty-sixth vertebra. At the fifty-sixth important changes commence; the transverse process loses its straight boldly projecting form and droops, as it were, into a curve, assuming the character of the last cervical transverse process. In the fifty-eighth vertebra the facet is inclined downwards and backwards; but its form cannot be fully made out, as its lower half is concealed by the head of its rib.

The neural spines are parallel-sided, and truncated above by a straight or very gently curved distal margin. They attain their greatest length and breadth in the fortieth to forty-third vertebræ, past which they diminish in size slowly. In the early part of the dorsal region the spines are inclined backwards at a slight angle; thus in the fortieth to forty-second vertebræ the axis of the spine makes with the zygapophysial line an angle of 64°, *i.e.* it slopes backwards 36° from the vertical; posteriorly the backward inclination diminishes and the spine becomes at length vertical; this is the case at the fifty-fifth vertebra; still more posteriorly the inclination becomes reversed and the spine slopes forwards; thus in the fifty-seventh vertebra it makes an angle of 93° with the zygapophysial

line, *i. e.* it is inclined forwards at an angle of 3° from the vertical ; at the sixtieth (LX) vertebra (1st sacral) the spine has resumed its backward inclination.

The Ribs.

The early dorsal ribs for about two inches from the proximal end are almost straight ; they then somewhat rapidly bend into a curve, which is steeper near its origin and straighter towards the end. At the fifty-first vertebra the curvature of the rib has become less, in the fifty-third much less ; and at the fifty-fourth the rib is straight. The longest ribs are those of the forty-seventh to the fiftieth vertebrae ; behind the fifty-second they rapidly shorten, those of the fifty-sixth being only 5·4 inches, and of the fifty-ninth 2·7 inches long.

For a short distance from the head the ribs are roughened with irregular longitudinal ridges, which are most marked in the anterior, and absent in the last few posterior dorsal ribs. All possess simple proximal ends, except the first dorsal, which gives off a short process just below the head.

Sacral Vertebrae.

The two vertebrae regarded as sacral are the sixtieth and sixty-first (LX and LXI). In them the transverse process has become very short, little more than a raised facet, the surface of which, however, is larger than that of the preceding transverse process of the last dorsal. It obviously consists of two nearly equal parts—an upper contributed by the neural arch, the articular face of which is a plane surface, meeting along a horizontal line at an obtuse angle the similar plane surface of the inferior moiety contributed by the centrum. The ribs are short (1·9 inch long) and slightly expanded at the distal ends. The neural spines are inclined backwards, making in the sixtieth an angle of 80° , and in the sixty-first of 78° .

Caudal Vertebrae.

If the determination of the sacral vertebrae be correct, then there are five caudal vertebrae, the dimensions of which are given in the appended Table (page 455) of measurements for all vertebrae past the last cervical. The spines are broken away from them all except the first, in which it is suddenly inclined backwards at a much greater angle than that of the last sacral. The zygapophyses are nearly vertical.

The transverse processes are now represented merely by pits with raised margins, only the upper part of which is furnished by the swollen end of the neural arch. The ribs remain short ; but that of the first is longer than that of the last sacral.

Table of Measurements of Postcervical Vertebra.

No. of vertebra.	Centrum.			Total height.	Zygap. to base.	Zygap. to end of spine.	Zygap. to zygap.	Breadth of spine.	Length of anterior margin of spine.	Length of spine along middle line.	Inclination of spine to line of zygap.	Inclination of transverse process with spine.	Length of rib.	Length of transverse process.	Height of base of trans. process (d.v. diam.).	Height of facet of trans. process (d.v. diam.).	Breadth of transverse process.
	Length.	Breadth.	Height.														
39.	in. 2.6	in. 3.5	in. 2.8	in. 7.6	in. 4.2	in. 4.75	in. 2.4	in. 3.9	in. 4.0	in. 4.625	° 64	° 90	in.	in. 1.5	in. 2.1	in. 1.0	in. 1.0
40.	2.8	4.1	2.8	7.7	3.1	4.75	2.4	4.0	4.5	4.625	64	75	....	1.5	1.8	1.2	1.0
41.	2.76	.....	.....	8.0	3.5	4.75	2.5	4.25	4.5	4.5	64	76	....	1.4	1.3	1.25	1.15
42.	2.76	.....	.....	8.2	3.5	4.75	2.1	4.2	4.3	4.3	72	68	....	1.6	1.2	1.1	1.25
43.	2.76	.....	.....	8.0	3.5	4.75	.....	4.0	4.0	4.0	72	65	....	1.7	1.2	.....	1.25
44.	.....	3.2	2.85	8.1	3.5	4.4	.....	3.65	3.8	3.8	72	66.5	....	1.9	1.25	1.3	1.35
45.	2.65	3.15	2.85	7.8	.....	.....	2.1	3.65	4.0	3.8	72	66	....	2.2	1.15	1.2	1.35
46.	2.65	.....	2.6	.....	.....	.....	2.1	.....	.....	.....	72	72	....	2.3	1.2	1.2	1.5
47.	2.65	3.2	.....	.....	.....	.....	2.1	3.6	.....	.....	72	72	....	2.2	1.15	1.15	1.5
48.	2.65	.....	.....	.....	.....	.....	.....	.....	.....	.....	78	72	....	2.2	1.15	1.15	1.4
49.	2.4	.....	.....	.....	.....	.....	1.9	.....	.....	.....	80	76	....	2.1	1.15	1.0	1.4
50.	2.33	.....	.....	7.3	.....	.....	1.9	.....	.....	.....	83	76	....	2.0	1.15	0.9	1.25
51.	2.33	.....	.....	7.3	3.8	.....	2.05	.....	.....	.....	86	78	....	1.9	1.15	0.9	1.25
52.	2.33	.....	.....	.....	.....	.....	2.05	.....	.....	.....	86	85	....	1.9	1.15	0.9	1.2
53.	2.33	.....	.....	.....	.....	.....	.....	.....	.....	.....	86	84	....	1.8	.....	0.85	1.05
54.	2.33	.....	.....	.....	3.6	.....	1.85	.....	.....	.....	90	90	....	1.6	.....	0.85	1.1
55.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	1.7	.....	0.9	0.8
56.	2.3	2.9	2.3	6.7	.....	.....	.....	.....	.....	.....	93	.....	....	1.6	.....	0.8	0.8
57.	2.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	1.5	.....	0.9	0.9
58.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	1.5	.....	.....	0.9
59.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	1.1	.....	.....	0.9
60.	2.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	80	80	....	1.4	.....	1.5	1.0
61.	2.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	78	78	....	.....	.....	1.3	1.15
62.	2.0	2.6	2.2	.....	.....	.....	.....	.....	.....	.....	52	52	....	.....	.....	1.3	1.05
63.	2.0	2.6	2.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	.....	1.3	0.8
64.	2.0	2.5	2.175	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	.....	1.3	0.8
65.	2.0	2.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	.....	1.1	0.9
66.	.....	2.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	.....	.....	.....	.....

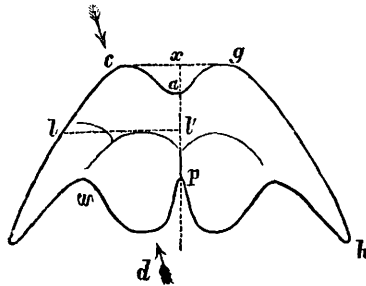
Pectoral Arch.

The bones of the pectoral arch are all present, though somewhat displaced from their original position. They consist of the furculum, coracoids, and scapulæ.

The Furculum.

This (fig. 2) is a large bilaterally symmetrical plate of bone, convex ventrally from side to side, with two long thin tapering lateral wings, one on each side, directed backwards and slightly dorsally; a tricurvate anterior margin, the central curve being a large semicircular excavation, which passes into a curve convex forwards on each side; and a gently curved posterior margin convex backwards, with a narrow deep incision running forwards along the median line, or axis of symmetry. The lateral curve of the anterior margin passes insensibly into the front margin of the lateral wing; the posterior margin meets the posterior margin of the wing in a rounded angle.

Fig. 2.—*Diagram of the Furculum.* (Scale $\frac{1}{8}$.)



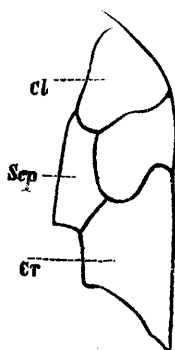
If one draws a line from the central point of the curve, which we have just called a "rounded angle," parallel approximately to the anterior margin of the bone, we shall divide the body into two parts, the anterior of which is much thicker than the posterior, being at least 1 inch across; it is of somewhat dense or close texture superficially, but loose and open in the middle: the posterior part is very thin, a mere lamella of bone. The anterior part may be distinguished as the "body" proper of the bone; the posterior, which is divided into two by its median longitudinal fissure, is a pair of "lapels;" and thus with the "wings" we have five distinct regions present, but of true sutures I cannot find a trace; the whole appears to be a single piece of bone, though having regard to the great difficulty there often is in discovering sutures which do really exist in fossilized bones, I should not wish to be thought too positive on this point.

The bilateral symmetry of the bone and its median longitudinal

notches, point to its connate nature; its position in front of the coracoids, between the prescapular processes of the scapulæ, points to its clavicular origin; I regard it therefore as representing a pair of fused clavicles, which repeating the behaviour of the coracoids, have expanded into extensive plates over the ventral surface. An interclavicular element appears to be absent; there is no room for it, except in the position conjecturally assigned to it by Professor Seeley, who has suggested that it forms the anterior middle part of the bone. This, however, is a position which it occupies in no other known reptile, as it is always more or less posterior instead of anterior to the clavicles. Since writing the first part of this paragraph I have been able to devote a few minutes to an examination (which I wish could have been less hasty) of a loose specimen of Plesiosaurian furculum, preserved in the British Museum, the same bone, I fancy, that is figured as a sternum in Hawkins's monograph. It certainly shows traces of sutures, and is marked on the surface by striæ, which appear to indicate a median and lateral elements. It has a suggestive resemblance to the clavicles and interclavicle of a Chelonian like, say, *Trionyx*. But it differs considerably in form and appearance from the furculum of our species; so that it is doubtful how far it can be used as a guide. Very possibly the furcula of different Plesiosaurs may differ in composition, as they do in Birds, an interclavicle being sometimes present and sometimes absent.

There is another difficulty attending the interpretation of the furculum; and that lies in its position beneath the prescapular ends of the scapulæ, which overlap its posterior lapels. In all recent reptiles the clavicles are superficial to the scapulæ, while here just the reverse is the case. This is proved by more than one well-preserved specimen in the British Museum, showing the scapular processes abutting on the body of the furculum, and also by Lord Enniskillen's specimen of *P. macrocephalus*, which affords us a dorsal view of the left clavicle overlapping the dorsal surface of the scapula (fig. 3).

Fig. 3.—Diagram showing the left side of the Pectoral Arch of *P. macrocephalus*, seen from behind. (The wing of the furculum conceals the termination of the scapula.)



This anomalous position I altogether fail to explain : if the lapels could be shown to be precoracoids, all would be clear; but this view is not without difficulties.

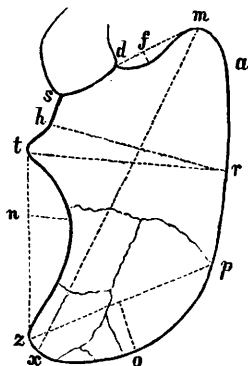
The dimensions of the bone are given below :—

	inches.
Antero-posterior diameter in the median line (fig. 2, <i>ap</i>)	3·65
Maximum antero-posterior diameter (ib. <i>cd</i>)	6·4
Antero-posterior diameter from <i>a</i> to <i>w</i>	5·25
Breadth (twice the line <i>ll'</i>)	8·6
Length of wing (<i>gh</i>)	8·4
Width of anterior excavation (<i>cg</i>)	2·55
Depth of anterior excavation (<i>ax</i>)	1·05
Depth of posterior incision	2·1

The Coracoids.

The coracoids (fig. 4) have the usual Plesiosaurian form, presenting together a close and almost ludicrous resemblance to the front of a short jacket.

Fig. 4.—*Diagram of the Right Coracoid.* (Scale $\frac{1}{8}$.)



The inner margins of the bones meet for half their length in a straight median harmonia, diverging gently outwards from each end of it. The outer margin has a simple concave sweep backwards behind the articulation for the humerus; the anterior margin projects in an elliptical curve in front, the outer edge of the curve sinking into a curve backwards, which joins the almost straight margin of the scapular articulation. The bone is thickest where it furnishes the articulations for the scapula and humerus. Thence it continues with only slightly diminished thickness along a ridge or keel, which extends transversely to its inner margin. This ridge, which rises from the ventral surface of the bone, and as shown by a transverse

fracture, is scarcely, if at all, marked on the dorsal surface, is defined in front by a curved line, which commences near the anterior end of the scapular articulation, curves backwards to the middle of its course, and then forwards till it ends against the inner margin of the bone; posteriorly it is defined by a line very slightly curved, convex backwards, which commences from the hinder end of the humeral articulation and passes very slightly backwards, also to end against the inner margin. From this ridge the bone thins rapidly away in front and behind, more rapidly in front, till it ends in a thin edge.

The posterior region of the right coracoid is traversed by several lines of fracture, on one side of which the surface of the bone remains higher than on the other, and thus forms little cliffs. A broken surface, dividing the bone across, reveals its internal structure, and shows between its dense outer layers a more cancellous open tissue in the middle; not only so, but in some places the middle of the bone is occupied by a layer of calcite; and this is thicker on that side of a fracture where the surface is higher, and thinner on that side where it is lower. This calcitic layer is probably due to the replacement of cartilage; and it is thinner where the bone is thinner on the side of a crack, because the cartilage had there been squeezed together by pressure of overlying strata.

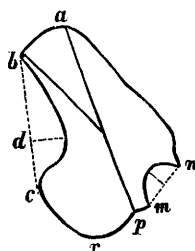
The measurements of the right coracoid are given below:—

	inches.
Maximum length (fig. 4, <i>m x</i>)	17·375
Length of harmonia (ib. <i>a p</i>)	10·5
Breadth (ib. <i>t r</i>)	8·6
Breadth along median ridge (ib. <i>h r</i>)	8·0
Distance from anterior end of coracoid to posterior edge of glenoid cavity (ib. <i>m t</i>) . .	10·0
Length of chord of anterior concave margin of coracoid (ib. <i>m d</i>)	2·75
Height of arc of anterior concave margin of coracoid (ib. <i>f</i>)	0·375
Length of articulation for the scapula (ib. <i>d s</i>)	3·3
Length of articulation for the humerus (ib. <i>s t</i>)	3·2
Thickness at articulation for the humerus . .	1·6
Length of chord of posterior and outer lateral curve (ib. <i>t z</i>)	8·3
Height of arc of posterior and outer lateral curve (ib. <i>n</i>)	2·3
Length of chord of posterior convex margin (ib. <i>z p</i>)	7·5
Height of arc of posterior convex margin (ib. <i>o</i>)	3·3
Thickness of median ridge where broken in middle of its course (left coracoid)	0·91
Thickness of anterior region of coracoid . . .	0·25
Thickness of posterior region of coracoid . .	0·6

The Scapula.

This (fig. 5) consists of a ventral plate, from the outer lateral margin of which a lateral plate arises and ascends towards the dorsal surface, its plane being inclined to that of the ventral plate at an angle of about 90°. The ventral plate is longer than broad, thicker behind than in front, truncated by a slightly convex edge anteriorly, bounded by a widely open V-shaped margin behind, the inner stroke (*cr*) of the "V" representing its articulation with the coracoid, the outer stroke (*rp*) its share in the glenoid cavity for the humerus. The

Fig. 5.—*Diagram of Right Scapula.* (Drawn reversed, scale $\frac{1}{8}$.)




inner lateral margin is concave, the outer straight; and from along its whole length the lateral plate arises. The latter is like a long scalene triangle in shape, the apex lying in front, the longest side being that common to it and the ventral plate, and the next longest its outer edge; the base of the triangle is not a straight line, but a deep concave curve arising from the anterior edge of the glenoid cavity, passing forwards and upwards and then backwards to the end of the outer edge. The lateral plate, when complete, is not bounded by a simple outer or upper margin, as here described, but is prolonged upwards along its posterior third into a thin narrow ascending process: this process is broken off both scapulæ in our specimen; and the posterior third of the outer edge of the lateral plate is consequently a surface of fracture.

Dimensions of the Scapula.

	inches.
Length of outer edge of ventral plate (fig. 5, <i>ap</i>)	8·1
Breadth at distal end (ib. <i>ab</i>)	2·4
Length of chord of concave inner margin (ib. <i>bc</i>)	5·05
Height of arc of concave inner margin (ib. <i>d</i>)	1·2
Length of articular surface for coracoid (ib. <i>cr</i>)	2·2
Length of articular surface for humerus (ib. <i>rp</i>)	1·9
Length of chord of posterior concavity of ascending plate (ib. <i>mn</i>)	2·1
Height of arc of posterior concavity of ascending plate (ib. <i>mn</i>)	1·0

Restoration of the Pectoral Girdle. (Plate XXIII. fig. 3.)

The displaced bones retain their original outline so perfectly, that if it were possible to move them relatively to each other into their original positions the pectoral girdle would be well restored; as, however, the stony matrix in which they are imbedded renders this impossible, I have made careful outline drawings of the several bones, and then cut these out and fitted them together, being guided in doing so by a direct study of the bones themselves. The result is given in the diagram (Plate XXIII. fig. 3).

The furculum lies in front in the middle line; and the prescapular processes of the scapulæ abut each on its own side upon the outer posterior border of the furcular body proper, covering its wings, which appear to lie in the angle between the ascending scapula and its prescapular process. The lapels face the anterior projecting convexities of the coracoids without touching them. There is thus produced a single continuous foramen, bounded laterally by the concave inner borders of the scapulæ, anteriorly by the furcular lapels, and posteriorly by the anterior margin of the coracoids; it is wide from side to side, narrow from before backwards, and roughly resembles in form two brackets joined face to face, thus:—

In the fact that the foramen is not subdivided into two by the overlapping of the furcular lapels by the coracoids, this species differs from some other species of Plesiosaurs; a corresponding difference is displayed in the pelvic arch, the foramen between the pubes and ischia, likewise double-bracket-shaped, being continuous from side to side, and not divided into two, as happens in most other Plesiosaurs.

The Humerus.

The right humerus is carried over to the left side, and lies with its flat posterior surface uppermost (Pl. XXIII. fig. 1). For the proximal third of its length it is a thick cylindrical bone, with an elliptical transverse section, the major axis being twice the length of the minor axis (4 inches and 2 inches respectively); it then widens out into a broad plate-like distal portion for the remaining two thirds of its length. The ulnar margin is almost straight, only slightly convex; the radial more curved and concave. It is covered superficially with irregular longitudinal ridges, more abundant on the radial than the ulnar side, which is almost smooth, and most marked near the ends of the bone; at the anterior end they become broken up into irregular tubercles.

The left humerus is similar to the right; but its surface is smoother, and its proximal half less elliptical or more circular in section; it begins to widen a little past the middle of its length, widens and flattens then rapidly, becoming very thin ($\frac{1}{4}$ inch) towards its distal edge. The more rapid expansion of the left than of the right humerus is almost certainly due to compression, though without the latter bone for comparison we should have nothing to

indicate this; hence a possibility to be borne in mind in making specific determinations of isolated bones.

The Radius.

The right radius is a straight, almost parallel-sided bone, elliptical in transverse section, truncated by slightly convex ends; it has a simpler outline than is usual in Plesiosaurs. The left radius, which has suffered more from compression, has more of the usual Plesiosaurian outlines: its outer edge is gently concave, its ulnar margin tricurvate, the middle curve being concave inwards; and its once cartilaginous articular surfaces have been squeezed beyond the edge of the flat surface of the bone. It is much ridged longitudinally, the ridges diverging a little from the middle towards the ends.

Representing the length of the humerus by 100, that of the radius will be 37; and this number may be called the humero-radial index. Its value for other species is found in the table on page 477. For *P. rostratus* it will be seen to be almost the same as for *P. Conybeari*.

Dimensions of Humeri, Radii, Ulnæ, and Femora.

	Diameter of head.		Diameter at middle of length.		Diameter of distal end.			Length	
	Ra. Ul.	A. P.	Ra. Ul.	A. P.	Ra. Ul.		A. P.	from end to end.	from cap- tular ridge to end.
					chord.	arc.			
Humerus:—									
Right.....	3.5	2.9	3.9	2.0	6.7	8.2	1.2 (?)	14.8	15 A. 14.25 P.
Left	(?) 3.6	3.2	3.9	2.0	...	.55	...	14.8	14.8 P.
Femur:—									
Right.....	3.5	3.6	3.4	2.0	6.7	...	1.2	14.25	12.75 M. 13.5 A.
Left	3.5	3.8	3.7	1.6	...	...	1.2	14.37	13.37
Radius:—									
Right.....	...	...	3.6	...	3.5	3.75	0.7	5.45	...
Left	3.9	0.8	3.15	0.55	3.5	3.5	0.55	5.0	4.75
Ulna:—									
Right.....	2.8	...	3.9	...	4.85	6.5	0.7	5.5	...
Left	2.8	0.7	3.7	...	4.7	6.0	...	5.6	...

Ra. Ul. means from radial to ulnar margin; A. P. means from anterior to posterior margin; Chord means measured along chord of curve; Arc means measured along curve itself. In the last column A., M., P. mean measured to anterior, median, and posterior edge of distal margin respectively.

The Ulna.

The right ulna, like the right radius, retains more of its original form than the corresponding bone on the left; for although its distal two thirds are much flattened, its proximal third still presents its original thickness.

This uncompressed portion has a smoother surface than the other,

which is distinctly ridged; the entirely compressed left ulna is ridged all over; and this leads one to suggest that the ridges on fossil bones may in some cases have been subsequently produced by mechanical pressure. Let the soft cancellous interior of a bone be crushed together, and the denser outer layers, in adapting themselves to a more circumscribed area under pressure, may possibly become finely wrinkled, and thus give rise to a spurious appearance of ridges.

The Carpus.

The carpus, 7·25 inches in breadth, consists of two rows of three bones each, which diminish in size from the ulnare to the radiale. They are polygonal bones, with the dimensions given in the table below. In the left manus the distal row of carpal bones alone bears the fingers, the radiale carrying one, the intermedium and ulnare two each. In the right manus the ulnare of the proximal row appears to bear one finger, the ulnare of the distal row two, the distal intermedium one (but it contributes a small facet for the adjoining digit of the ulnare), and the distal radiale, as in the left manus, one.

	Length.			Breadth.		
	Radial.	Inter- medium.	Ulnare.	Radial.	Inter- medium.	Ulnare.
Proximal series...	1·6	2·3	2·65	2·15	2·5	2·75
Distal series	1·8	1·4	2·9	2·1	1·8	2·1

The Manus.

The hand, where broadest, is 8·5 inches across. It consists of five digits; the first, with five phalanges, is incomplete in both hands; the rest are complete in the left manus—the second, third, and fourth having nine, and the fifth eight phalanges. The third and fourth fingers are the longest. The phalanges have the usual form, a compressed hour-glass outline,—except the most distal, which is triangular, and apparently equivalent to the proximal half of one of the other phalanges, the distal half being suppressed: it has much the appearance of an unguis phalanx, and may very well have borne a nail.

The measurements of the phalanges are averages of those of the right and left manus, and in the case of the breadth, of the distal and proximal ends of each phalanx.

	<i>Phalanges.</i>									
	Length.					Breadth.				
	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.
i.....	1.9	2.5	3.0	3.0	3.1	1.25	1.15	1.35	1.35	1.75
ii.....	1.8	2.5	2.5	2.6	2.45	...	1.35	1.4	1.25	1.1
iii.....	2.9	2.1	2.1	2.5	2.4	1.2	1.45	1.4	1.5	1.3
iv.....	1.8	1.75	1.95	1.95	2.0	...	...	1.25	1.25	1.0
v.....	1.75	2.05	1.7	1.65	1.65	1.15	1.15	1.1	0.9	0.8
vi.....	?	1.3	1.65	1.4	1.4	...	...	0.95	1.0	0.8
vii.....	?	1.3	1.2	1.2	1.15	...	0.72	0.72	0.7	0.55
viii.....		1.0	0.8	1.0	0.45	...	0.55	0.45	0.45	0.35
ix.....		0.8	0.7	0.6	...	...	0.44	0.3	0.3	...

Total length of } ? 17 18 18.25 16.8
 fingers }

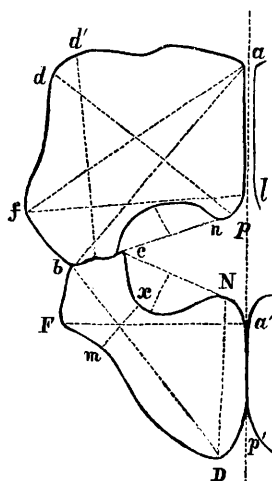
The Pelvis.

A restoration of the pelvic girdle, obtained in the same way as that of the pectoral arch, is given on Pl. XXIII. fig. 4.

The Pubes (fig. 6).

These are more or less quadrangular plates, which meet each other in a straight median symphysis along nearly their whole length. The anterior margin is an undulating curve, with a general direction at right angles to the symphyseal margin. The posterior margin, at first a little convex, becomes concave for half its length outwards from the symphysis, then almost straight and parallel to the ante-

Fig. 6.—*Diagram of the Right Pubis and Ischium.* (Scale $\frac{1}{8}$.)



rior margin as it articulates with the ischium; finally it curves forwards and outwards, to contribute its share to the acetabulum, and joins the outer margin, which has a slope obliquely outwards as it passes backwards from the anterior margin.

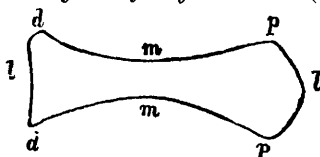
The Ischium (fig. 6).

This "shoulder-of-mutton" shaped bone meets its fellow for about half its length in the median symphysis. The ω -shaped anterior margins of the two ischia meet to form together a bracket-like outline (—); the similarly shaped posterior margins of the pubes do the same; and the brackets facing each other give rise to a foramen, which is continuous from the pubic ischial symphysis on one side to that on the other. In this character the pelvis resembles that of *Murcenosaurus*, Seeley, Q. J. G. S. vol. xxx. p. 206.

The Ilium (fig. 7).

The ilium has the usual Plesiosaurian form, a central shaft with expanded ends, compressed in different planes, which are inclined at about a right angle with each other.

Fig. 7.—Diagram of Right Ilium. (Scale $\frac{1}{8}$.)



Measurements of Pelvic Bones.

Pubis.

	inches.
Length of symphysis (fig. 6, <i>a p</i>).....	5.5
Breadth of bone from symphysis, and along a line at right angles to it, to anterior edge of acetabulum (ib. <i>f l</i>)	8.5
Maximum antero-posterior diameter, drawn from <i>d'</i>	8.1
Length of diagonal from inner anterior angle to anterior edge of acetabulum (<i>a f</i>).....	10.3
" " from inner anterior angle to posterior edge of its share of acetabulum (<i>a b</i>).....	10.3
" " from outer antero-posterior to inner posterior angle (<i>d p</i>)	9.0
" articular surface for acetabulum (<i>f b</i>)	2.9
" " " for ischium (<i>b c</i>).....	2.3
" " " chord of posterior concavity (<i>c N</i>).....	3.9
Height of arc " " " ".....	1.25

Ischium.

Length of symphysis (<i>a' p'</i> , fig. 6).....	5.5 to 6.0
Breadth along a line at right angles to symphysis to posterior edge of acetabulum (<i>a' F</i>)	7.8
Length from outer edge of its articulation with the pubis to its posterior angle (<i>b D</i>)	10.1
Length from anterior inner angle to posterior angle (<i>N D</i>)	7.725
Minimum diameter across "neck" (<i>m x</i>)	2.4
Length of symphyseal margin for pubis (<i>b c</i>).....	2.4
" acetabular margin (<i>b F</i>)	2.5
" " " chord of anterior concavity (<i>c N</i>)	3.85
Height of arc of anterior concavity (<i>x</i>)	1.8

Ilium.

	Right ilium.	Left ilium.
	inches.	inches.
Length (<i>ll</i> , fig. 7)	6·9	7·2
Breadth of proximal end (<i>pp</i>)	2·4 (?)	2·85
„ distal (<i>dd</i>).....	2·3	1·9
Minimum diameter of shaft (<i>mm</i>).....	...	1·0

Note.—The proximal end of the right ilium is slightly broken, and its distal end compressed, probably by subsequent pressure.

The Femora.

These bones, which are smaller than the humeri, have the articular head well defined by a sharp surrounding ridge; the articular surface itself is deeply pitted and tuberos, indicating the previous existence of a thick covering of cartilage which has since disappeared.

The cylindrical proximal end is slightly constricted below the capitular ridge before it begins to expand. The dorsal and ventral margins are almost straight lines, or only slightly concave curves, which diverge gently from the thick proximal to the broad and flattened distal end. The distal end is truncated by a simple gently convex curve.

The surface of the bone is roughened beneath the head, and strongly ridged at the distal end with longitudinal lines, which diverge in conformity with the curves of the lateral margins of the bone.

The Integuments.

Remains of what appears to be some dermal structure have been stated by previous writers to occur in connexion with *Ichthyosaurus*; and Charles Moore in particular has well described a thin layer having a wrinkled surface, which invests a large number of the Ichthyosaurs in the collection of the Bath Museum; but no one, so far as I know, has made mention of any similar investment in the case of *Plesiosaurus*. Great interest therefore attaches to the presence of a thin brownish film, with characteristic surface-markings, which coats a considerable portion of the specimen under consideration.

It is best displayed on the surface between the fortieth and sixtieth vertebræ, covering the bodies, transverse processes, and neural spines of the vertebræ, the ribs, and the surface of stony matrix intervening between them. It also extends in a band over an inch broad, along the distal ends of the neural spines, at a little distance from them as now exposed.

This band, which seems to restore the dorsal outline, ends in the pelvic region, where it covers the head of the right femur, and imbeds a small oblong bone, the smooth shining surface of which is raised into three parallel longitudinal ridges; other fragments of

similar bone are indicated near the same spot. Their presence can scarcely be accidental; and they may possibly be dermal plates. That they are not found elsewhere would simply point to the restricted distribution of dermal scutes in the species, they having originally been present in the pelvic region and nowhere else. The thin film, however, has nothing of the nature of scales and scutes, so far as we can see; it was a continuous membrane, not a collection of separate individual structures. It can easily be detached from the underlying surface, owing, it would seem, to the presence of a thin whitish layer, apparently calcite, which is more strongly adherent to the film than to the surface beneath.

The surface of this film is variously marked; but all the different markings may be described as essentially of the nature of wrinkles. In the film of the dorsal band they have the appearance of fine regular rounded ridges, giving the surface a resemblance in some degree to "corded silk;" elsewhere, as over the bases of some of the neural spines, the ridges lose to a great extent their straightness and regularity, take a tortuous course, though generally with one prevailing direction, and are more apparently mere wrinkles; but over the greater part of its extent an additional feature presents itself in the form of long, fine, parallel grooves, bordered by fine ridge-like margins, and looking as though they had been scored by a fine needle: they vary in distance from each other; but the best-marked are about $\frac{1}{20}$ inch apart. They maintain one general direction from before backwards on the bodies of the vertebræ, the exposed outer sides of the ribs, and on the stone between them, from the forty-second to the fiftieth vertebra. Between the grooves minute wrinkles are abundant, mostly undulating, sometimes straight, not always confined to the space between two grooves, but sometimes crossing them without changing their course; they are inclined at all angles to the grooves, but are chiefly transverse to them.

What the precise nature of this film may be is by no means clear. From its distribution one might infer that it originally formed a part of the integumentary investment. It closely resembles in character the structure which has been regarded by Mr. Moore as forming a part of the integument of *Ichthyosaurus*, and which this acute observer has compared to the wrinkled surface of the skin of the Porpoise*. The resemblance between this surface, as seen in our museum-specimens, and that of the investing film in *Plesiosaurus* is, indeed, great; and if such a skin were capable of fossilization, one might fairly allow that *Plesiosaurus* had been invested with it. It is very certain that the film in our fossil specimen was of a yielding flexible nature, or it could not have so neatly covered the exterior of the ribs and adapted itself to the ends of the transverse processes and the angles between the neural spines and the vertebral bodies as it has done.

* Som. Archæol. & Nat. Hist. Soc. Proc. 186-566, p. 179.

Classification.

The pectoral arch in its essential characters is truly Plesiosaurian, though it differs from most Plesiosaurs in the fact, if it be a fact, that the coracoids do not extend in front so as to overlap the "lapels" of the furculum.

To make plain its relations to other members of the genus *Plesiosaurus*, I have constructed the following Table, in the last four columns of which the distribution of the vertebræ amongst the various regions of the spine is given for each species.

In comparing the length of the head with that of the neck (or rather of the cervical series of vertebræ) I have uniformly made use of the proportion :—

$$\frac{\text{length of head}}{\text{length of neck}} = \frac{I}{100}$$

The value found for I may be conveniently called the cervico-cephalic index. This index is given, for each species in which it has been determined, in the first column of the Table.

In the second column I have similarly compared the length of the head and the dorsal series of vertebræ (excluding sacral vertebræ). The indices of this column are dorso-cephalic.

The total length has not been made use of in comparison, since it is seldom possible certainly to obtain it, and variations in the length of the caudal region are of secondary value; but in the third column values are given for the length of the head compared with the cervico-dorsal series (exclusive of sacral vertebræ). To the cervico-dorsal cephalic index great value may be attached, since it can frequently be obtained and is independent of any error in the method or the practice of determining the position of the last cervical vertebra. It is true it may be affected by a mistaken determination of the first sacral vertebra; the sacral vertebræ, however, are more easily determined than the last cervical; and an error with regard to them will not cause a deficiency or excess of more than one or two vertebræ to the cervico-dorsal series, while I am convinced much larger errors have been made with reference to the number of vertebræ in the cervical series; and, finally, in comparatively so great a length as that of the cervico-dorsal series one or two vertebræ more or less will have but a trifling effect on the value of the index obtained from them. Another index of some interest is the cervico-dorsal, obtained by referring the length of the neck to that of the trunk taken as 100.

The values now given for the various indices will certainly in many cases need revision, since the measurements on which they are founded are often extremely unsatisfactory. Sometimes they are unreliable or erroneous, sometimes vague (as when the length of the "trunk" is given without stating whether the sacral vertebræ are included or not, or when the length of one part is given in fractions

of another* ; and sometimes, finally, they are not comparable, as when in one place the length of the skull is given (as it too frequently is) as the length of the lower jaw, while in another it is taken as the length between the end of the snout and the basioccipital.

On reference to the Table it will be seen that *P. Conybeari* has the same number of cervical vertebræ as *P. homalospondylus*, but one less dorsal: its head, however, is much larger than that of the latter species; and hence there is a great difference in their respective cephalic indexes. In proportion of head to neck it agrees exactly with *P. Etheridgii*, but differs widely in the number of cervical vertebræ. It has also two dorsal vertebræ fewer; and its dorsal and cervico-dorsal cephalic indexes are distinctly different. Its cervico-dorsal index approaches nearest to that of *P. Hawkinsii*, in which species this index attains its maximum value.

Plesiosaurus.	Cephalic indexes.			Number of vertebræ.				Cervico-dorsal index.	Humero-rachal index.
	Cervico-cephalic.	Dorso-cephalic.	Cervico-dorsal cephalic.	Cerv.	Dors.	Sac.	Cau.		
Zetlandicus	87.6	58.3	33.9	...	...	...	...	72.2	
rostratus	63.9	51.1	28.4	24	24	2	34	92.3	37.4
propinquus	60.0	55.5	28.85	25	23	2	34	92.6	45.8
Cramptoni	55.5	41.6	24.0	27	30	2	32	75.0	28.5
megacephalus	53.3	49.3	26.5	30	26	2	34	92.6	33.5
macrocephalus ...	51.2	65.6	28.8	29	20	2		128.0	31.0
brachycephalus ...	35.3	40.3	18.8	31	24	2	21	114.0	33.3
longirostris	33.8	29.7	15.8	33	25		32	87.5	34.5
Hawkinsii	30.0	46.9	18.3	31	23	2		156.2	34.7
Etheridgii	24.3	26.0	12.5	30	23	2	34	106.0	
Conybeari	24.1	37.4	14.6	38	21	2	5+	153.0	37.0
dolichodeirus	17.7	23.6	10.1	41	21	2	30+	133.3	42.9
macropterus	12.8	17.0	7.3	39	24	1 ?	28	132.0	50.0
homalospondylus	10.6	11.1	5.4	38	22	2		105.0	46.0

There is a fine specimen of *Plesiosaurus* in the British Museum, with the MS. name *P. laticeps*, Owen, which bears a close resemblance to *P. Conybeari*. Its pectoral and pelvic girdles are well exposed on their ventral surface, and are strikingly similar in general form and arrangement to those parts in *P. Conybeari*; the dimensions of their component bones also show a general agreement, as will be seen from the following table. In each the humerus is longer than the femur; but these bones are each an inch shorter in *P. laticeps* than in *P. Conybeari*.

* Thus, in his Monograph on Liassic Reptiles, Professor Owen says of *P. rostratus* that the skull is $\frac{3}{4}$ the length of the neck. Now the skull is 1 foot 11 inches long; and thus the length of the neck should be 2 feet 6 inches 8 lines. But he also says that the length of the neck is rather less than $\frac{1}{4}$ the length of the spinal column; as the latter is 9 feet 9 inches long, the neck should be "rather less" than 3 feet 3 inches long. Whereabouts between these two quantities is the exact length? And would it not seem to have been easier to directly state it? Unfortunately the instance here given does not stand alone.

Table of Measurements of corresponding Parts in P. laticeps, Owen, M.S., and P. Conybeari.

	<i>P. laticeps.</i>	<i>P. Conybeari.</i>
	inches.	inches.
Furculum, length (a. p. dia.)	6·0	6·4
Coracoid, length (maximum).....	17·0	17·375
" breadth	8·0	8·0
Pubis, length of symphyseal margin (a. p. dia.)	6·5	5·5
" " parallel to outer margin (a. p. dia.)	8·0	8·1
" " oblique diameter from inner anterior to postero-exterior angle.....	10·0	9·0
Ischium, length (max. obl. dia.)	9·0	10·1
Humerus, length.....	13·5	14·5
Femur, length.....	12·5	13·5
Neck, from first cervical vertebra to anterior edge of furculum	56·0	78·0
Trunk, from anterior edge of furculum to posterior edge of pubis	48·0	53·0
Number of cervical vertebræ from first to anterior edge of furculum	27	38
Length of posterior cervical vertebra	2·25	2·5
Length of dorsal vertebra	2·375	2·65

The anterior end of the head is broken off and missing in *P. laticeps*; so that the cephalic indexes cannot be determined.

The regions of its vertebral column cannot be clearly defined, since the pectoral and pelvic girdles conceal to some extent the vertebræ beneath them. There is no great difference in the length of the dorsal region of the two species; as shown in the Table, in *P. Conybeari* it is 5 inches longer than in *P. laticeps*, a difference which may be accounted for by supposing the furcula of the former to be displaced a little forwards.

The widest departure is seen in the neck, its length being much less and the number of its vertebræ much fewer in *P. laticeps*; but there is an artificial look about the neck of this specimen which leads me to conjecture that some of the cervical vertebræ may be missing, so that, if those which remain were arranged as they were first found, several considerable lacunæ would appear between them.

The lengths of the centra of the cervical and dorsal vertebræ make a close approximation in the two species, *P. laticeps* in this, as in several other characters being a little the smaller. The anterior cervical vertebræ of *P. laticeps* are rugose or tubercular in the same fashion as those of *P. Conybeari*.

Finally, both species come from the same "gisement," the Lower Liás of Charmouth.

If my conjecture with regard to the identity of the two species should prove correct (and it will require a closer examination of Owen's species than I have been able to give it to decide this), then of course the name "*laticeps*" will have to be suppressed. It occurs in print in the 'Geological Magazine,' vol. iv. p. 144, but without accompanying diagnosis or specific description.

One other character of *P. Conybeari* alone remains for comparison; and that is the relative dimensions of its vertebral centra. If we find the proportion of the breadth and height of a centrum to its

length taken as 100, we shall obtain its latitudinal and altitudinal indices. These are given in the following Table for the cervical vertebræ of a number of species. To make their comparison of value, corresponding vertebræ should be selected for each species; and for this tables like that on p. 452 would have to be constructed and discussed. As it is, I have had to make the best use I could of the material ready to hand in published papers, and to trust to the chance of different describers having given measurements of an average cervical vertebra. Most of the indices in the table have been derived from the thirteenth to the fifteenth vertebræ, and probably are sufficiently comparable.

Plesiosaurus	Latitudinal index.	Altitudinal index.	Number of vertebra.
<i>Conybeari</i>	70	100	xv.
<i>homalospondylus</i>	92	72	xiii & xiv.
<i>rugosus</i>	107	100	
<i>ceolospondylus</i>	110	106	xv.
<i>plicatus</i>	112	84	xv.
<i>macrourus</i>	112	100	Middle.
<i>infraplanus</i>	113	101	} Average of middle and basal half of neck.
<i>dolichodeirus</i>	113	94	
<i>arcuatus</i>	116	116	
<i>carinatus</i>	120	98	
sp. from Aust	123	113	
<i>Hawkinsii</i>	125	112	
<i>validus</i>	127	102	
<i>eleutheraxon</i>	127	100	
<i>costatus</i>	134	119	
<i>subtrigonus</i>	140	109	
<i>oxoniensis</i>	140	116	
<i>pachyomus</i>	142	110	
<i>trigonus</i>	150	120	
<i>eleutheraxon</i>	169	100	
<i>rostratus</i>	170	155	xv.

It will be seen that the centrum of the fifteenth vertebra of *P. Conybeari* has a lower latitudinal index than any other known species, while its height remains about the average.

P. homalospondylus, which makes the nearest approach to it, is equally remarkable for its exceptionally low altitudinal index.

The compression which the cervical vertebræ of *P. Conybeari* have undergone may to some extent account for the narrowness of their centra; but it cannot be altogether explained in this way, since it persists in a marked manner down to the twenty-eighth vertebra. Moreover our measurements were taken from the articular ends of the centra; and these show no obvious signs of compression.

The Table shows a general tendency in the long-necked species towards a low latitudinal index, and in short-necked species towards a high one; but the rule is subject to exceptions, and we have not enough instances to reason from. The latitudinal has clearly a greater range of variation than the altitudinal index.

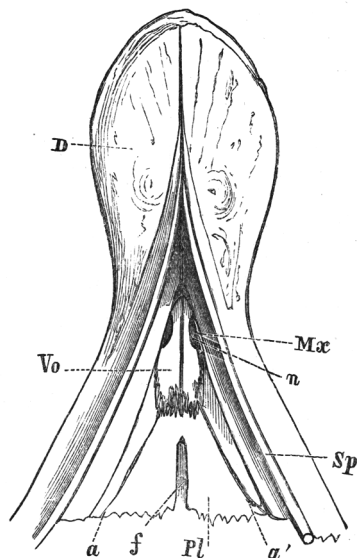
Notes on Plesiosaurus megacephalus, Stutchbury, and P. brachycephalus, Owen.

The type specimens of these two species are preserved in the Bristol Museum; so that I have had a good opportunity of making a close acquaintance with them, and have succeeded in elucidating some points in their anatomy which were hitherto obscure.

PLESIOSAURUS MEGACEPHALUS.

1. *The Roof of the Mouth.*—The skull of this specimen lies on its dorsal surface, separated from its matrix from the snout to a transverse fracture which traverses it across the orbits. The matrix has been carefully chiselled away from between the rami of the lower jaw, so as to clearly expose the roof of the mouth and the base of the skull for its entire length. The anterior part of the base (fig. 8), which lies in front of the fracture before mentioned, is by a most lucky chance much better-preserved than that behind, and thus affords us an opportunity which has long been desired of ascertaining more exactly the true nature of this part of the skull.

Fig. 8.—*Ventral View of the anterior Part of the Skull of P. megacephalus.* (Scale $\frac{1}{3}$.)

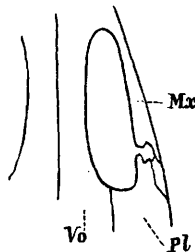


n, internal naris; *f*, palatal foramen.

It presents, about 2 inches behind the end of the mandibular symphysis, two oval foramina (fig. 8, *n*) longer than broad (1.45 inch in length) separated from each other by a bone which extends back-

wards in the middle line and unites by a splintery suture with the palatines behind. It shows traces of a straight sutural union along its median antero-posterior diameter, and consists, without doubt, of the connate vomers. On their outer margin the foramina are bounded (fig. 9) for the anterior three quarters of their extent by the maxillæ, for the remaining quarter and along their posterior margin by the palatines, and along the inner border (as before mentioned) by the concave outer margin of the conjoined vomers. The vomero-palatine

Fig. 9.—Diagram showing the left Internal Naris of *P. megacephalus*, bounded by the Maxilla, Vomers, and Palatine. (Scale $\frac{1}{2}$.)



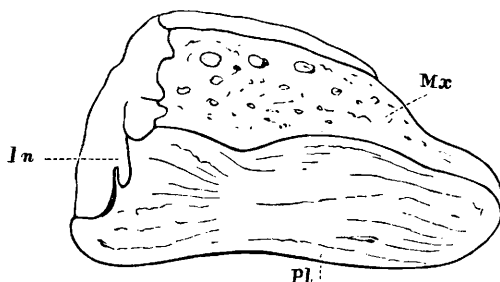
suture has more or less the shape of a W, as exposed on the floor of the skull, the apex of the W being on the median line, and the end of its lateral strokes cutting the inner posterior angles of the foramina.

The palatines extend backwards for some distance as flat, horizontal plates, suturally united in the middle line, and completely roofing over the front of the mouth. Their sutural union is interrupted for a part of its course by an elongated vacant space (fig. 8, *f*) which clearly corresponds to the palatal foramen of many Lizards (e. g. *Iguana*, in which it is well seen).

An oblique linear fissure starting from the middle of the outer stroke of the W of the vomero-palatine suture runs on each side outwards and backwards, to disappear against the matrix bounding the roof of the mouth. These fissures might easily be mistaken for sutures, in which case they would be regarded as indicating the line of junction of the palatines; they are, however, simply fractures which have broken the palatines along a line where they become flanged upwards and outwards to join the maxillæ. The fractures are, indeed, continued through the skull; so that the middle part of it, included between them, can be readily separated from the outer part on each side, and the form of the palatines and their union with the maxillæ clearly exposed (fig. 10).

Another fracture traverses the skull nearly vertically, but oblique to the axis, passing through one of the external nares, and one of the oval foramina, or nares, as we may venture to call them, before mentioned. This fracture shows (fig. 11) a large central chamber, now filled with the Lias limestone; it is bounded above by the

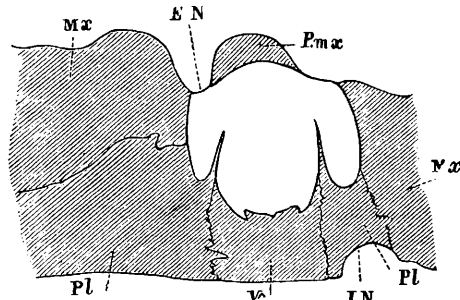
Fig. 10.—*Oblique Fracture through the Skull of P. megacephalus, showing the line of union of the maxilla and palatine.* (Scale $\frac{1}{2}$.)



In, Internal nasal passage.

præmaxillæ, below by the vomers and palatines, and on each side by the maxillæ, and also in some parts of its course by the palatines.

Fig. 11.—*Transverse Fracture through the Skull of P. megacephalus, crossing the nasal chambers.* (Scale $\frac{1}{2}$.)



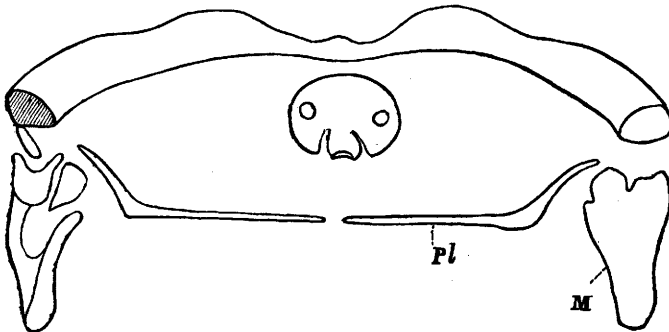
EN, external naris; *IN*, internal naris.

The vomers (fig. 11, *Vo*) form a trough-shaped bone of considerable thickness, flat below but concave above, with a low ridge on each side of the middle line; its sides extend upwards, together with a process from the palatines, as a curved wall for half the height of the central chamber, which is thus divided through its lower half into a middle and two lateral portions. The lateral portions have the appearance of tubes sloping downwards and forwards. On each side of the præmaxillæ the external nares open freely into the central chamber; while the foramina on each side of the vomers communicate with its lateral passages. These passages are bounded externally by the maxillæ, and internally, as well as inferiorly, by the palatines.

The oval foramina appear to represent the internal nares, since they are similarly situated with respect to the surrounding bones as the posterior nares of many Lacertilia; and it is with this order that *Plesiosaurus* stands in the closest connexion.

It must be borne in mind, however, though I doubt whether it is generally known, that the posterior nares by no means occupy a constant position in the Lacertilia; for though they are most usually bounded in the manner above stated, they sometimes shift their position backwards and open at the back of the palatines. In such cases, however, the palatines are produced towards the middle line, each along its outer edge, into an underlying plate, which roofs over the mouth and forms a floor to the nasal passages. A section across the Plesiosaurian skull might be expected, therefore, to give some signs of an inflection of the palatine bones, converting them into incomplete tubes, if such a backward extension of the nasal passage obtained in it. No such signs, however, are to be detected in the specimens under consideration. A diagrammatic sketch of a fracture passing transversely through is given below (fig. 12); it shows plainly the outward and upward bend of the palatines, but not a trace of an infolding.

Fig. 12.—*Transverse Section across the Skull of P. megacephalus, showing the palatal plates flanged upwards and outwards towards the Maxillæ, but not inflected to form a nasal passage.*

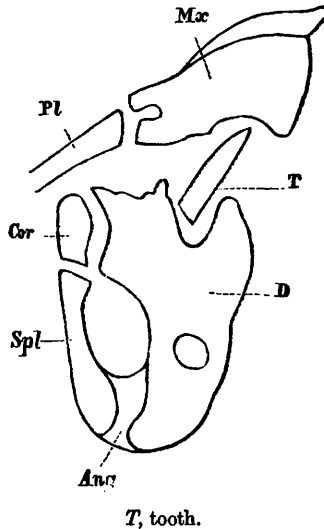


It is a fact too curious to be passed over, however, that the internal nares are situated in advance of the external nares of this Plesiosaur, the anterior margin of the latter being a trifle under 2·8 inches behind that of the former.

A transverse section through the upper and lower jaws is given in fig. 13: the upward flange of the palatine is seen meeting the maxilla; and the lower jaw has the usual reptilian composition.

2. *Redetermination of the Number and Distribution of the Vertebrae and of the Length of the Regions of the Spinal Column.*—Of cervical vertebrae, twenty-nine are visible up to the anterior edge of the furculum; in all probability one more lies beneath this bone; and the total number may therefore be taken as thirty. In consequence of the concealment of a large part of the spine beneath the pectoral and pelvic girdles, the number of dorsal

Fig. 13.—*Transverse Section through the Jaws of P. megacephalus.*
(Scale $\frac{1}{2}$.)



vertebræ can only be indirectly arrived at. The total length of that part of the vertebral column which lies between the anterior edge of the furculum and the posterior edge of the ischium is 70 inches; from this 2·3 inches must be deducted on account of the concealed last cervical vertebra, and 6·9 inches for three post-dorsal vertebrae supposed to be concealed beneath the ischium, two of them being sacral and one the first caudal. This leaves 60·8 inches ($70 - 2·3 - 6·9 = 60·8$), which is the length of the dorsal region. Divided by 2·3, the average length of a dorsal vertebra, this gives 26·43, or, neglecting the fraction, 26, which is the number of vertebrae in the dorsal series. These numbers are embodied in the annexed Table (page 477), in which the measurements of a number of specimens of different species are compared together.

PLESIOSAURUS BRACHYCEPHALUS, Owen. (Plate XXIV. fig. 2.)

This species has not been figured, and has been only partly described. I do not intend here to do more than offer a few observations upon it, and to correct the previously made measurements.

1. *The Skull.*—Although incomplete and broken, the skull is but slightly distorted, and presents several points of interest.

The snout is broken away from the rest of the skull, and shows the under surface perfectly. It is 5 inches long, and does not exhibit the internal nares; so that they must have been situated further back. Its broken surface extends at right angles to its long

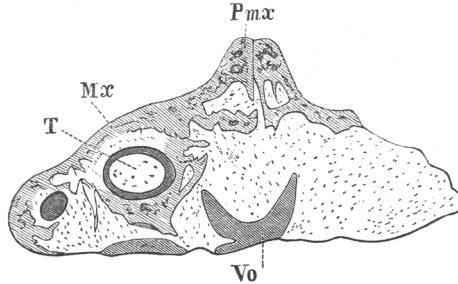
MEGACEPHALUS AND P. BRACHYCEPHALUS.

Species.	Total length.	Head.	Neck.	Trunk.	Se-crum.	Tail.	Fore limb.	Hind limb.	Humerus.	Femur.	Radius.	Tibia.	Ulna.	Fibula.	Manus.	Pes.
* Megacephalus	185	30	56.3	60.8	4.6	54.5	33+	.....	13.7	13.5	4.6	4.5	4.3	4.5	.....	.....
* Crampont	268	40	72	96	.....	66	60	.....	21	22	6	6.5	6.5	6	.....	.....
Macrocephalus	59+	10.5	20.5	16	1.5	11+	12.75	13.5	4	4.75	1.25	1.4	1.15	1.3	8	9
Brachycephalus	129	14.5	41	36	2.5	23	.....	.....	9	9.75	.....	3.25	.....	.....	.....	.....
Longirostris	170	23.75	70?	80	.....	50	44	.....	14.5	.....	5	.....	5	3	.....	.....
† Hawkinsi	69	7.5	25	16	.....	20.5	17	16.5	7.2	5.5	2.0	2.0	1.8	1.8	.....	9.5
* Eiberidgii	96.8	6.8	28	26.5	2.5	26	.....	.....	14.8	7.15	5.45	.....	5.5	.....	23.6	14
* Conybeari	171	20	83	53.5	4.25	10+	44.5	.....	7	14.25	.....	.....	.....	.....	12	12
† Dolichoderus	113	8.5	48	36	.....	24	42.5	46.5	.....	7	3	3	.....	.....	20	20
Macroperus	182	9	70	53	.....	48	42.5	46.5	14.8	.....	6	5	.....	.....	24	24
homalospandytus	198	9	85	81	.....	32	44	45	.....	11	5.5	.....	.....	.....	24	24
rostratus	140?	23	36	39	.....	39	24	28.5	12	13	3	3.1	3.3	.....	13	.....
propinquus	180	30	50	54	.....	52	44	.....	13	14	3.3	.....	3.3	.....	.....	.....
† zelandicus	228	42	52	72	.....	74	.....	.....	20	.....	5.5	.....	5.5	.....	.....	.....

The measurements are given in inches.
 In those marked * the length of the head is taken from the anterior edge of the premaxilla to the posterior edge of the quadrate; marked †, it is taken as the length of the lower jaw; thus, †, from anterior edge of the premaxilla to end of parietal.

axis, and since it has been polished reveals very clearly the arrangement of the bones in this region of the skull (fig. 14).

Fig. 14.—*Transverse Section through the Skull of P. brachycephalus.*
(Scale $\frac{3}{4}$.)



The upper and backwardly prolonged processes of the præmaxillæ are seen on each side of the middle line above, the maxillæ bearing teeth on each side, the vomers in the middle line below conjoined to form a single trough-shaped bone; a plate of bone forming the roof of the mouth on each side of the vomers is an extension inwards of the maxillæ.

The left orbit is complete and undistorted; it is bounded by the usual bones, the sutures between them being exceptionally plainly shown. An additional bone, which looks as though it had been segmented off from the jugal, appears, however, between the jugal and postorbital; its surface is marked in the same way as the jugal; and it bears a nutritive foramen, which completes the ascending series of these openings carried by the jugal. The suture between the two bones is distinct, however; and the striations on their surface are so directed as to indicate their separate nature. If a posterior supraorbital bone had worked its way in between the jugal and the postorbital, it would have the position here described; but simulation of the appearance of the jugal bone would remain unexplained. Hence it seems best to call it a suprajugal.

The jugal and the suprajugal bones are not the simple bony plates which they appear to be in a lateral view of the skull, and as the jugal really is in recent Lacertilia. Both extend inwards behind the orbit as a bony plate, which meets and joins externally with a similar expansion of the parietal. In this way the orbit is completely walled in behind. The maxilla similarly extends inwards in front, no doubt accompanied by the lacrymal; and, below, a continuous floor is afforded by the expanded palatine. The orbit is consequently very thoroughly walled round.

The right orbit is incomplete; and a horizontal fracture enables us to remove the jugal, the only outer boundary bone of it remaining, from the floor of the skull below. The jugal thus removed is a

triradiate bone—when looked at from below, something like the letter T. The crossbar of the T corresponds to the outer plate of the jugal, the stem to the process which extends from it inwards. The inner plate or process of the jugal does not join the outer bone abruptly, but curves outwards on each side into it. Thus a triangular space of considerable size is left at the junction of the two parts, or, in other words, at the origin of the inner plate. This space is occupied by coarsely cancellous bone, and lies immediately under the nutritive foramina, which occur on the outside of the proper jugal bone. The meaning of these foramina is thus made clear.

The floor exposed by the removal of the jugal is very difficult to interpret. Immediately behind the palatine is a narrow bone, transverse to the axis of the skull, and apparently joining the posterior edge of the palatine. Behind this, again, is a flat parallel-sided bar or lath of bone, projecting from the middle of the skull outwards at right angles to the axis; it is united by a splintery suture with the inner margin of a large and important bone, which extends backwards, prolonging the line of the maxillæ towards the quadrate. It consists of a vertical wall-sided outer plate, roughened on the external surface (which is a flat plane), and an interior horizontal plate, the inner angle formed by the divergence of the two plates being neatly rounded into a concave curve. The inner margin of the horizontal plate is a deeply concave curve.

The vertical plate of a bone having a similar position is shown in the right side of the ventral surface of a skull numbered 14550 in the British Museum. I do not know what to make of this bone; but it appears to be that which Prof. Huxley has spoken of as quadrato-jugal in his paper on *P. Etheridgii*.

The posterior part of the skull of *P. brachycephalus* covers over the axis and atlas vertebræ. It consists of the parietal and the ends of the two bones which have been called suprasquamosal. They join in a splintery suture over the middle of the parietal, and appear likewise to underlap it below; so that this bone appears to proceed from between the upper and lower tables of the suprasquamosal bones. This is a very singular feature; but as I have been able to examine this posterior fragment of the skull on all sides, and partly to take it to pieces, I entertain little doubt as to its existence.

2. *Redetermination of Measurements.*—Professor Owen says that the vertebræ, at least as far as the 28th, are cervical; but a careful examination leads me to include the 29th as an indubitable cervical vertebræ. The succeeding vertebræ have lost a slice from their exposed sides; but there is good reason to conclude that the 30th and 31st also belong to the neck. The length of the cervical series is, then, as follows:—

I and II concealed + III to XXIX undoubted cervicals + XXX and XXXI doubtful.
1.5 inch + 36 inches + 3.5 inches

= 41 inches or 3 feet 5 inches.

The remaining measurements are given in the appended Table (p. 477).

Geological Horizon.—Associated with this specimen, which came from the Lias of Bitton, are some Ammonites and *Rhynchonellæ*, which Mr. Whidborne regards as *A. Conybeari* and *R. variabilis*; hence he refers it to the *A.-Bucklandi* zone.

In concluding this paper, I have to offer my best thanks to Mr. Etheridge and Dr. Henry Woodward for the kind assistance they have given me in many ways; to Mr. Whidborne I am especially indebted for much useful help, and particularly for his care and assiduity in drawing up the appended list of species, with their geological positions, many of which have been determined by his own personal examination of the original types.

EXPLANATION OF PLATES XXIII. & XXIV.

PLATE XXIII.

Plesiosaurus Conybeari.

- Fig. 1. Ventral aspect of the skeleton. One twelfth nat. size.
2. Dorsal aspect, showing the vertebral column from the thirty-seventh (xxxvii) to the sixty-third (lxiii) vertebrae. About one eleventh nat. size.
3. Diagrammatic restoration of the pectoral girdle. One eighth nat. size.
4. Diagrammatic restoration of the pelvic girdle, the ilia not being represented. One eighth nat. size.

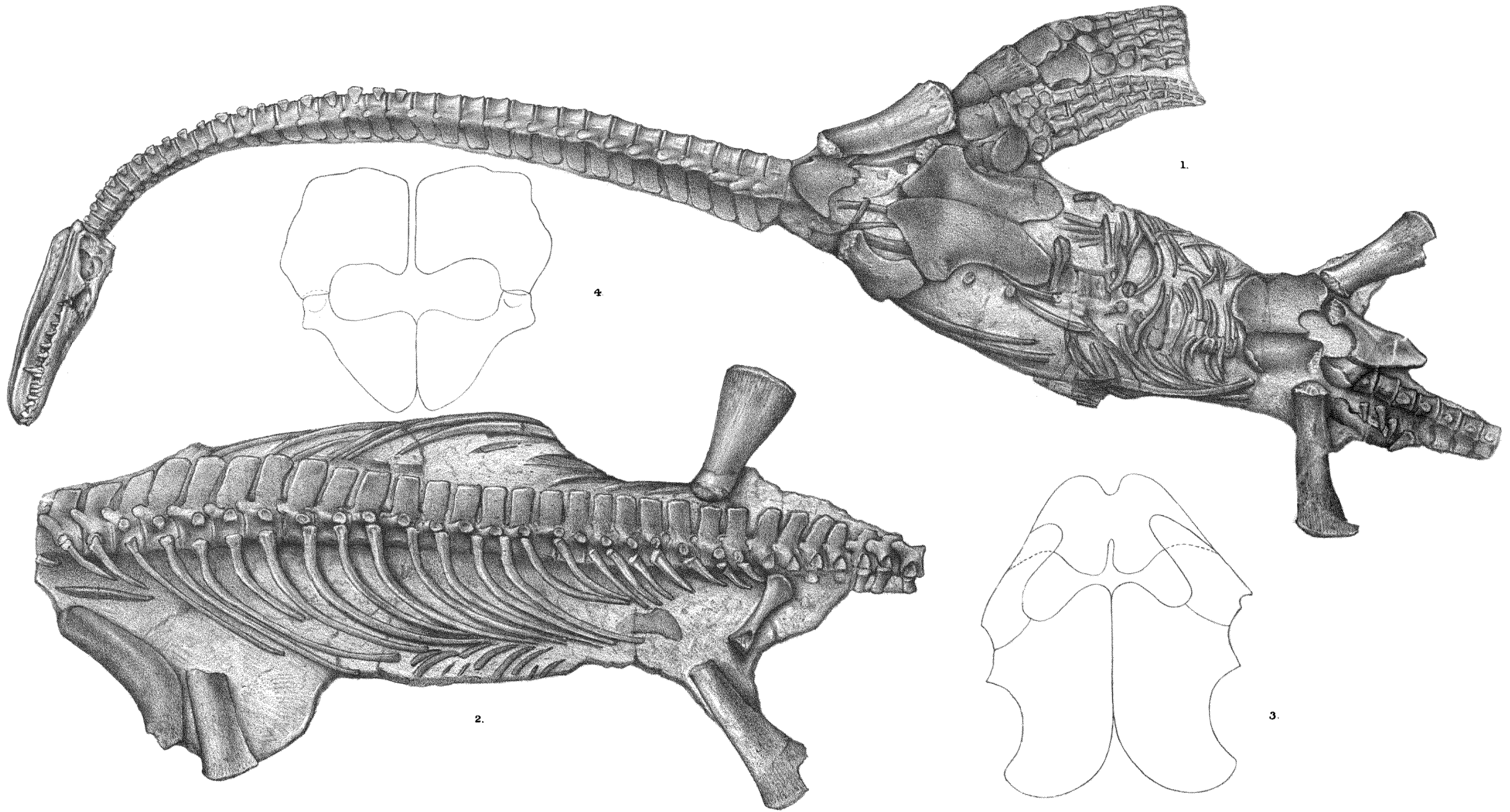
PLATE XXIV.

- Fig. 1. Skull of *P. Conybeari*, left side. About one fourth nat. size.
2. Skeleton of *P. brachycephalus*, Owen. About one twelfth nat. size.

DISCUSSION.

Prof. SEELEY said that without an inspection of the evidence he was not in a position to criticise this elaborate paper; but it gave evidence of painstaking research of no ordinary kind, and he congratulated the author upon what he had put forward. He thought, however, that a part of the information was not entirely new. Still the species, he fully believed, was a new one, as several of the characteristics are not found in any other described Plesiosaur. He had an impression that the palatal foramina described by Prof. Sollas were shown in the species described by Mr. Stutchbury fourteen years ago; and he believed they had been excavated after that description had been drawn up. As to the Lacertilian affinities of *Plesiosaurus*, he was unable himself, so far as he had seen, to recognize any of importance. In some respects it had affinities with Ichthyosaurs, Dinosaurs, and Crocodiles; so he thought the Lacertilian affinities could not be pressed. Though he differed in some details, he thought the paper, as a whole, was done extremely well.

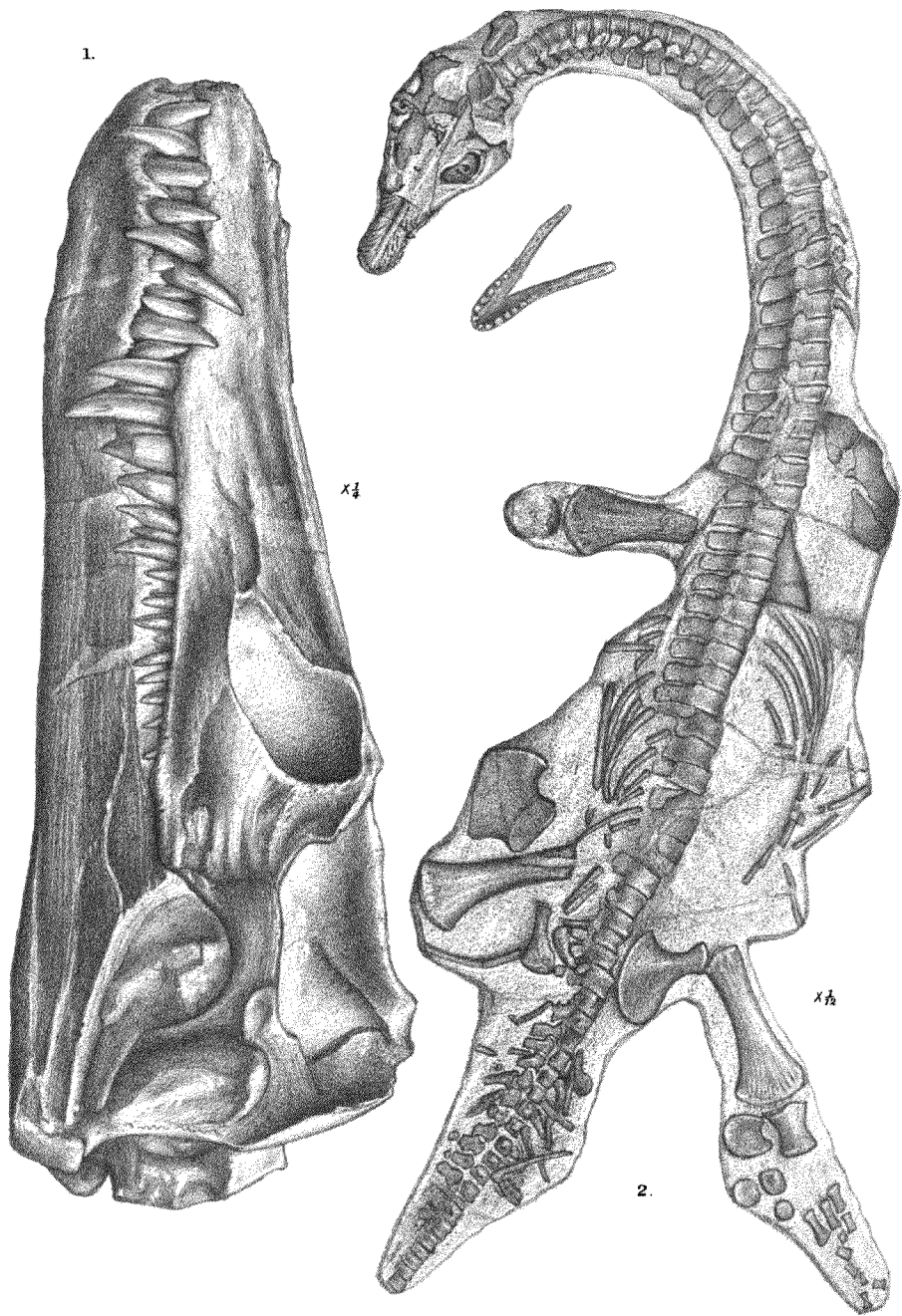
Prof. SOLLAS expressed his sense of the generous way in which Prof. Seeley had spoken of his paper. It was impossible to write a paper without making use of material already published; but he thought that there was but little put forward as new which was not really so in his paper. He thought the Lacertilian affinities were extremely well marked in the skull of *Plesiosaurus*. His determination of the structure of the anterior part of the roof of the mouth in *P. megacephalus* confirmed him in this opinion.



C. Berjeau del et lith.

PLESIOSAURUS CONYBEARI.

Mixter Bros imp.



C. Berjeau del et lith.

Mintern Bros. imp.

PLESIOSAURUS CONYBEARI AND BRACHYCEPHALUS