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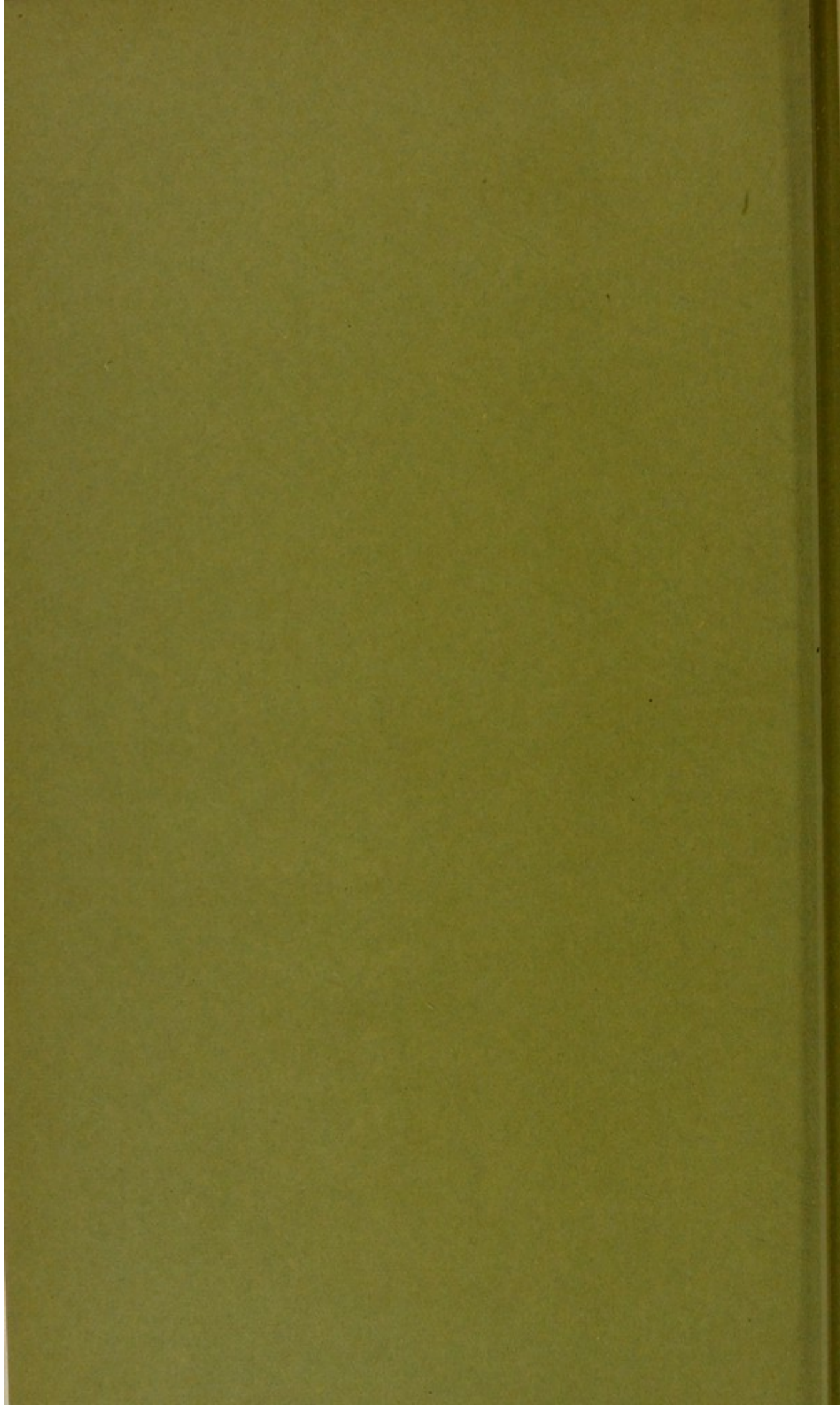
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ON A PYRITIOUS CONCRETION FROM THE LIAS
OF WHITBY,

BY

H. G. SEELEY, F.R.S.

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ON A PYRITIOUS CONCRETION FROM THE LIAS
of Whitby, which appears to show the external form of the
body of embryos of a species of *Plesiosaurus*.

By H. G. SEELEY, F.R.S.

In 1887 I received a fossil from J. F. Walker, Esq., M.A., F.G.S., which he had obtained from a dealer at Whitby. It appeared at first to be mineralized with phosphate of lime, but has since proved to consist of iron pyrites, which has obliterated whatever evidence there may have been of internal structure. Upon the surface of the concretion are several elongated forms in high relief, almost as well rounded and well defined as though they were artificially modelled, which I regarded as embryos of a *Plesiosaurus*. As such the specimen was exhibited and briefly described at the meeting of the British Association in 1887, at Manchester—Report, page 697. I am still unable to interpret the specimen in any other way; it therefore seems desirable to record its essential characters.

The specimen is a central concretionary mass of compact iron pyrites with microcrystalline texture. The surface of this iron pyrites was covered, and is in part still covered, with a smooth film of hard clay. This film has much the aspect of a defining membrane of a placenta-like character, upon which the embryos are clustered and elevated, so as to exhibit curved forms of well-rounded bodies, which correspond to the main contours of the concretion, above which they are for the most part prominently elevated. There are four principal masses, each of which may be regarded as an embryonic plesiosaur; and in addition to these there are indications of three or four others. They partly overlap each other, are in various stages of preservation and of development, and are chiefly interesting for showing the external form of the body as it may be presumed to have been at the time when the parent animal died.

There are many examples of preservation, for a time at least, of the soft parts of animals in various geological deposits. The Solenhofen slate has yielded specimens which demonstrate the forms and structures of *Pterodactyle*'s wings, of bird's feathers, of jelly-fish, and cuttle-fish. These remains prove that there is no *a priori* improbability of the external form of the soft parts

of an animal being preserved. The Lias itself has yielded from many localities evidences of the skin in Ichthyosaurs, and the beautiful example of a Wurtemberg Ichthyosaur, figured by Dr. Eberhard Fraas, demonstrates that the skin need not follow the contours of the bones, since the high dorsal and caudal fins are preserved. All that appears to be required for the preservation of such soft parts is the absence of bacteria, by which decomposition is brought about; and it may be a reasonable inference that there is a greater probability of an embryo being free from the influence of agencies which cause decomposition than most vertebrate structures.

In this specimen decomposition appears however to have taken place after a time. After the external form may have been moulded, the internal tissue appears to have been replaced by iron pyrites; for vertical sections of the neck of one of these supposed foetal plesiosaurs have been prepared from one of the fragmentary specimens, without giving any evidence of internal structure beyond a small central canal. After carefully comparing these slices with corresponding sections from the neck of embryos of reptiles, which Adam Sedgwick, Esq., F.R.S., has had the kindness to have prepared at my request, in his laboratory in the University of Cambridge, I am unable to affirm that even the central canal in the fossil is manifestly identical with any structure in existing animals. The longitudinal section of the neck, when seen under the microscope, is equally devoid of evidence of segmentation, such as might have been expected, though the longitudinal canal shows a uniform width, and presumably has some relation, if not to original structures, at least to mineralization. This evidence of internal structure, having failed, I have not thought it necessary to slice up the specimen in the way originally contemplated.

The evidence for the organic origin of the specimens is essentially that contributed by their external forms; but not one example is sufficiently perfect to show all the details. Each of the four principal specimens is characterized by a median longitudinal ridge or blunt angle which extends down the neck, body, and tail, upon what I regard as the dorsal surface; corresponding in position to the neural spines of the vertebræ. In the example numbered 1, in which the head is

preserved, this ridge commences immediately behind the head, and is traced down the length of the neck, but the back is so far worn that it is not clearly seen in the dorsal region. In the specimen numbered 2, in which only a small part of the neck is exposed, the median ridge is traced down about two-thirds of the back, but the sacral region and tail are more flattened. In the specimen numbered 3, it similarly extends down the median line of the back. And in number 4 the ridge is indicated apparently in the tail, where there appears to be evidence of a median longitudinal division beneath the angle of the ridge, owing to the existence of some more durable substance in that position. The fragmentary remains also give some evidence of this median longitudinal structure. Such an angle along the neck and back would be expected in the body of a Plesiosaur.

The head in the specimen numbered 1 is bent at an angle to the neck in a way which is commonly seen in the embryos of reptiles.

On the middle of the side of the head there was present when the specimen was found a scale with a radiated structure, which had the appearance of being a sclerotic circle of bones about the eye, which, although unknown in Plesiosaurs, is a character of some fossil reptiles, like *Rhopalodon*. The neck contracts behind the head, and then steadily widens along its length down to the position in which the fore limbs are given off. The neck does not appear to increase in depth so rapidly as in width, as though cervical ribs were well developed. It is nearly straight in the specimen (No. 1), but makes a small angular bend with the back, a character which is somewhat obscured by abrasion which the back has undergone.

Limbs are given off where the body widens transversely behind the neck, but in this specimen (1) the fore limb is only partially exposed on the left side, so as to show its edge. It appears to be narrow, but is evidently small and short, like a limb imperfectly developed.

In the same way the hind limb, which is imperfectly preserved on the left side, appears to be shown laterally. The neck of another individual is seen passing under the middle of the abdomen of this specimen, and this apparently causes

a ridge on the external side of the skin of the animal, as though the neural spines already existed in the neck, and sharply elevated the soft tissues of the animal which covered them.

In the specimen No. 2 the forelimbs are also shown. On the right side they are short, flattened, lateral expansions, nearly as wide apparently as long, covered by two films super-imposed on each other. On the left side there is an obvious fracture, and what I suppose to be the limb seems to be nearly as deep as wide on its fractured surface, which is not mineralized with pyrites, but consists of clay. Behind the fracture the dorsal aspect of the limb appears to include a surface bone in the position of the ascending process of the plesiosaurian scapula.

In this specimen, which rests upon No. 4, there is no clear indication of hind limbs, and the tail as exposed is exceedingly short, being shorter than in the specimen No. 1. The specimen No. 3, which is smaller, has not apparently any indication of the budding of limbs except a slight convexity at the base of the neck on the left side; and in No. 4 the form of the body is distorted and cannot be regarded as giving conclusive proof of the existence of limbs.

Hence the evidence for the interpretation of the specimen as embryos of plesiosaurs consists in the present state of preservation of the fossil, in the form and proportions of specimen 1, which appears to indicate the head, neck, body, tail, and limbs of such a shape as a plesiosaur would show. Secondly, in the less perfect definition of the parts in the other specimens, which is such as might be expected in a group of embryos in various stages of development. Thirdly, in the community of character of the external structures, like the dorsal longitudinal ridge, seen in all the examples.

Further, there appear to be some faint indications of transverse segmentation like that of muscles, in the region of the neck in the specimen No. 1, and in the dorsal region in specimen No. 2.

The deficiencies of the evidence are the following :—The head in the specimen No. 1 terminates transversely in a truncated surface, rather like the nose in an Emydian Chelonian, instead of such a rounded nose as might have been expected. Secondly,

the pre-orbital region curves downward, and there does not appear to be any demonstrable indication of a mandible. An injury crosses the head from behind the right orbit forward, so as to break the continuity of the front of the head with its hinder part in such a way that, taken by itself, the identification of the head is not quite conclusive in the present state of preservation, notwithstanding some longitudinal markings like definition of the nasal and other skull bones. It is possible that the extremity of the snout is broken and lost, and that the lower jaw may be indicated in the film of clay, which is imperfectly preserved beneath the head, and that some small badly preserved white spots arranged in linear succession are indications of teeth. By the side of this head there is the anterior termination of another imperfect specimen which is possibly a head also. If so it terminates in a sharp point, compressed laterally and flattened above, and is manifestly much less developed; but I am unable to recognise indications of any parts of the head or its organs. The curvature of the head upon the neck is however similar in the two specimens.

These defects in the preservation of the specimens do not appear to me to be conclusive against the organic nature of these supposed embryonic Plesiosaurs; and I have stated them as fully as possible that there might be no acceptance of the interpretation which I have placed upon the specimen, without consideration of the grounds on which that interpretation may be questioned.

The following descriptions record the dimensions of the several specimens:—

I.

The extreme length of the specimen No. 1 measured along the middle line is 5 inches. The head measures $\frac{11}{20}$ of an inch, the neck is $1\frac{8}{10}$ of an inch long, the body is about $1\frac{6}{10}$ of an inch, and the tail as exposed is $\frac{6}{10}$ of an inch long.

The head appears to be long, narrow, contracting in front of the orbit, about a quarter of an inch deep posteriorly, and half that depth at the anterior termination of the snout. The two sides of the head are inclined to each other, and its summit is rounded much as in many plesiosaur skulls. Its lateral aspect is a good deal modified by the loss of the radiated circle

of sclerotic plates from the orbit. But the impression remains from which the circle came away, and although delicate, it appears to show some evidence of a radiating structure. The pit which has held it is not now circular, but deeper than wide. The eye was rather behind the middle length of the head, was relatively large, extending between the crown of the head and the inferior angle of the palate. There appears to be some matrix in the middle of this depression. At some distance in front of the orbit on the side of the head, in the position occupied by the right anterior nostril of a plesiosaur, is a circular area very slightly raised, with a small central spot, which I regard as being situate as the nostril would have been in the living animal. Extending between the nostrils towards the orbit, there are parallel longitudinal ridges such as might margin two slender nasal bones, and these surfaces appear to be truncated posteriorly in a line with the middle of the orbit, as though the frontal bones there joined the nasal bones. There is some appearance of the parietal foramen, though in the present state of preservation it is not possible to identify it. The side of the head has a nearly straight palatal margin behind the orbit, and as this is inclined a little outward and downward, it gives the head the appearance of being deeper as well as wider than the neck behind it.

The neck is a quarter of an inch wide at its inferior border behind the head, but it is not more than $\frac{2}{10}$ ths of an inch deep. Its two sides are inclined to each other, and convex, meeting superiorly in the median ridge already described, which is sharper in the front of the neck than where the neck joins the body. The neck is convex on the sides, and on the left side, on which the preservation is better, there appears to be a lateral angle such as might result from the position of the cervical ribs. The width of the neck towards its junction with the transversely expanded body is $\frac{1}{2}$ an inch, but its depth appears to be somewhat less. The external surface is smooth. There are many transverse delicate lines upon its surface. The neck is nearly straight, showing a slight convexity at its lower third such as in a plesiosaur might result from a group of neural spines in that position being slightly elongated.

The transverse expansion at the base of the neck is most marked on the left side in which the preservation is most distinct, and is such as would correspond with the width of the bones of the shoulder girdle and the attachment of the limbs.

The body in its relative shortness as compared with the neck, in the convexity of its sides, and in transverse breadth, has such proportions as might be anticipated in a young plesiosaur. It measures rather less than an inch where widest in the middle, and $\frac{3}{4}$ of an inch in front of the hind limbs. The preservation of the external surface is unfortunately somewhat imperfect.

The limbs are imperfectly displayed, those on the left side are most distinct. Both the hind limbs appear to be indicated, but the form is not shown, and is so different from that indicated in another specimen, as to suggest the idea that their lateral edges only are seen. The measurement between the limbs on the left side is about $\frac{17}{20}$ ths of an inch. The form of the body appears to be depressed as though it were not more than half as deep as wide.

Behind the hind limbs the body curves downward rapidly and rapidly contracts from side to side, terminating in a tail which is not more than $\frac{8}{10}$ ths of an inch long, and is therefore shorter in proportion than the tail in an adult plesiosaur.

There is a manifest angular ridge in the median line upon the tail, although its external surface is lost. The form of the tail as exposed is a triangle, which is longer than wide, with its lateral contours continuous with those of the sides of the body behind the hind limbs.

II.

The specimen numbered 2 is apparently somewhat larger than the example just described, and appears to measure 6 inches in length. This is the individual over the neck of which, the specimen numbered 1 appears to extend, so that the neck of No. 2 passes under the middle of the abdomen of No. 1, and extends on its opposite side. It must however be stated that there is no definition of the head in this individual; and that the anterior part of the neck does not so manifestly pass continuously under the body, though this may result from the way in which that side of the specimen has suffered

from surface abrasion. Measured in length, the neck is about $2\frac{1}{10}$ ths of an inch long, and the body and tail are together about $\frac{2}{10}$ ths of an inch longer.

As preserved they extend in a semi-ovate curve, which embraces more than half the circumference of the concretion. The neck appears to be proportionately about as long as in the specimen No. 1, but its base does not seem to be so wide, nor is there any sharp definition of its substance from the body of the individual which is supposed to overlap it. This however might be due to conditions of preservation; and the curvature between the neck and the limb at the shoulder on the left side, is a similar concavity. As already remarked the median longitudinal ridge is manifest down the back, which is convex in length, and convex from side to side. Its inferior lateral margin is rounded as in the specimen No. 1, and the under surface appears to be similarly flattened, so that the depth of the body is not more than $\frac{13}{20}$ ths in its wide hinder part, where the width is $\frac{19}{20}$ ths of an inch. The tail is similarly short, a median ridge extends down it like that on the back, it has a triangular form, and terminates in a point. It is bent towards the right side, and the body of the specimen rests upon and partly covers the left side of the body of the specimen No. 4. The hinder limb on that side is not seen; and on the right side it appears to be imperfectly developed, or broken away, although there is a distinct lateral prominence at the side of the tail, which may indicate the budding base of the limb. It is not so distinct as in the specimen No. 1, appears to be somewhat further backward, and rather smaller. The fore limbs are at the sides where the neck joins the body. That on the left side is imperfect at its extremity, but is extended outward and a little downward, and as preserved is about $\frac{1}{2}$ inch long, as wide at the base, flattened above, and somewhat rounded. It appears to consist of a clayey material. The other limb on the opposite side is similarly extended. It also consists of hardened clay in the centre, of which there are some indications by means of difference of colour of two connected bodies, with corrugated outlines. The depth of this limb is greater, but its width is much less than that of its fellow on the opposite side. A concave curve of distinctly defined skin-

like surface connects it with the lateral contour of the body. Compared with the fore-limbs of the specimen No. 1, the differences are greater than would have been anticipated, but they may result from the different aspect which the limb has when exposed horizontally, as compared with the depressed condition at the side of the body in the specimen No. 1.

III.

The third example is the smallest and most unsatisfactory. The head is not seen, and the greater part of the neck is hidden under the specimen No. 1, and only about $\frac{1}{4}$ inch of a neck remarkable for its singular compression is exposed. The body has the usual antero-posterior curvature; the tail being bent downward rather more sharply than in the examples described; and although the specimen has been fractured in this region, the tail appears to be relatively smaller and shorter than in the other specimens. The body is convex from side to side, with a characteristic median dorsal ridge, and increases in width from the neck to about the sacral region. At the base of the neck there is a slight transverse expansion on the left side. It is similar in kind to the right fore limb in the individual No. 2, but is relatively much smaller. There is no corresponding process on the opposite side, so that if this represents the budding of the fore limbs they are in a very rudimentary condition. Behind this lateral anterior expansion, the body contracts and its transverse measurement does not greatly exceed $\frac{3}{10}$ ths of an inch. There is no clearly defined lateral border to the hinder part of the body, but as in the specimens described it appears to be nearly twice as wide as deep. There is no clear evidence of the hind limbs.

IV.

The fourth individual is remarkable for its distorted form. The head, if it exists, is buried in the matrix, and the neck is bent almost at a right angle to the body. It is partly overlapped on the left side by the individual numbered 2. The supposed neck is $1\frac{7}{10}$ ths inch long as exposed: and this appears to be equal to, or longer than the body and tail. The neck is exceedingly narrow in front, and widens transversely to about $\frac{6}{10}$ ths inch at the shoulder. The shoulder however has

manifestly no indication of a limb, but is convex as though the limb were budding. There is no recognisable trace of a hind limb. The body has the usual width relative to depth, and the usual angle in the median line of the neck, but it cannot be traced over the distorted form of the body.

These are the more important details of aspect of this remarkable specimen. At present I am unaware of any evidence concerning the mode of reproduction of any plesiosaurs, other than the inference which such specimens suggests that some species were viviparous. It were to be desired that the specimen gave more conclusive demonstration of its organic nature; but the characters described have seemed to me to be of sufficient interest to be put on record, and they may draw attention to possibilities of further evidence being found by examining adult specimens.