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ORIGINAL ARTICLES.

I.—On the Exhumation and Development of a large Reptile (*Omosaurus armatus*, Owen), from the Kimmeridge Clay, Swindon, Wilts.

By William Davies, of the British Museum.

(PLATES VII. and VIII.)

COMPARATIVELY few of the many persons who visit our larger Museums, and stop to examine the fossils exhibited in the cases, have any idea of the time, labour, care, and mechanical skill which many of them require ere they are ready for the palæontologist to interpret and describe, the artist to delineate, or made sufficiently intelligible for public exhibition. The first operation, and one requiring considerable care, is the exhumation of the fossil remains from the stratum of gravel or clay, or from the siliceous or calcareous rocks of various degrees of hardness, in which they may have been imbedded and preserved. Then the hardening of the bones—for these remarks apply more especially to the remains of the larger Vertebrata—which are generally found much broken, and, unless thoroughly mineralized, in a more or less friable and brittle condition. Next there is the fitting and cementing together of the pieces, which are frequently numerous, and of such as have been imbedded in a rocky matrix, the careful development by hammer and chisel from their incasement of stone: all of which operations necessarily involve a large amount of skilled labour.

The late Prof. Phillips wrote a graphic description of the discovery, mode of exhumation and restoration of the remains of the huge *Cetiosaurus* discovered in 1869, in a quarry in the Great Oolite at Elmslow Bridge,[1] and now preserved in the University Museum at Oxford.

The discovery in 1874 at Swindon, Wilts, in the upper beds of the Kimmeridge Clay, of another huge Dragon, somewhat smaller in dimensions than the Elmslow giant, yet of scientific value and importance equally as great to the Palæontologist, being the subject of an important monograph by Prof. Owen, F.R.S.,[2] and also as it has been recently placed for exhibition in the Geological Gallery of

[1] See *Athenæum*, April 2nd, 1870.

[2] In the Palæontographical Society's volume for 1875. Monograph of a Fossil Dinosaur (*Omosaurus armatus*, Owen), from the Kimmeridge Clay, pp. 45–93, plates xi.–xxii.

the British Museum, may possibly render a short record of its occurrence and the method adopted for exhuming and developing it acceptable to the readers of the GEOLOGICAL MAGAZINE.

The Directors of the Swindon Brick and Tile Company having in May, 1874, informed Prof. Owen that many large bones had been discovered and laid bare in their Brick-pit by the workmen, I was instructed to proceed thither to examine and report if they were desirable objects for the National Collection. On arriving at the works, which are situated at the foot of Old Swindon Hill and adjoining the Wilts and Berks Canal, I found exposed on the floor of a newly-worked portion of the pit and at a depth of about nine feet from the surface of the clay six large nodules of septaria, one being more remarkable than the others, not only on account of its superior size, but also that it showed here and there small portions of bone protruding from its upper surface (see Plate VII.). In one portion of this mass, although deeply imbedded in the stone, the outline of a limb-bone could be traced, fully four feet in length, which I concluded to be a femur, and in addition, either projecting from its margin or in close proximity to it, and lying undisturbed in the clay, were two large pelvic bones (ischium and pubis), and six caudal vertebræ having centra six inches in diameter; processes of some of these were imbedded in the septarium, as was also one end of the pubic bone (see Plate VIII. Fig. 3). These bones ranged along a third of the marginal circumference of the nodule, which was of a flattened irregular elliptical form, measuring eight feet in its longest, and six feet in its shortest diameter; the margin was thin in places, but the general thickness of the nodule ranged from 12 to about 20 inches. About four feet from this group of bones and upon the same level was another group, which consisted of an entire humerus (Plate VIII. Fig. 2), ulna and radius. The distal ends of the humerus and ulna were enclosed and cemented together in a small block of septarium, which had to be broken before they could be removed. Subsequently, on further digging, carpal and metacarpal bones were found in proximity to this group, all being parts of the same fore-limb. These remains, and the vertebræ more especially, I supposed to have belonged to a reptile allied to *Cetiosaurus*, but new to science, and reported accordingly, making preparations at the same time for their removal.

The exhumation of the bones which were lying in the clay was readily effected by the method already described in the pages of this MAGAZINE (see GEOL. MAG., 1865, Vol. II. p. 93). But how to remove from the pit this large block of stone without injuring and destroying the enclosed bones was a problem, for to raise it entire with such appliances as we had was impossible. Yet its safe removal was imperative in the interests of science, as I believed it contained a large portion of the posterior part of the skeleton of the animal. Before deciding upon any special plan of operation, and to ascertain if the nodule was really compact and firm, a trench about a foot deep and several feet in length was dug along its margin; a workman was then instructed to insert his pick beneath and try slightly to raise the

mass, which was then found to be cracked in many places, although no cracks were before visible. Matters now looked promising, for it seemed possible to remove this concretionary mass in large blocks which could be afterwards reunited. When, however, after some further trenching around and digging beneath, we attempted to lift the first block—a nearly square mass about eighteen inches across—from the clay on which it was first formed, and where it had reposed for ages, it fell from our hands in many pieces by its own weight, and its enclosed bone was found to be wet, rotten and crumbling. Thus all the sanguine expectations of success which the fissures had raised were cast down, for should the whole nodule fall into small pieces as this portion had, the prospect of preserving the imbedded bone seemed hopeless. However, after careful examination it was found that no other method than taking it up in blocks was practicable, and preparations were made for removing it accordingly. Each block as it was taken up was numbered, and each piece into which it fell was marked with the same number, the smaller pieces being wrapped in paper, also numbered, and then ranged in separate heaps in an unused kiln. Every block when first lifted from the clay broke into many pieces, and every subsequent removal, in their transit from the pit to their final deposition in the National Collection, added greatly to the number. The contraction caused by the rapid drying of the mass in the sun, whilst lying in the pit, was also a source of disintegration; for the calcareous particles of which the septarium was composed, although hard, had but little cohesion, and broke readily into small cuboidal fragments with a short and clean fracture; whilst the quantity of bone it contained, which was all in a more or less crumbling condition, and the veins of crystalline calcite that traversed it in several directions were also sources of weakness.

The exhumation being completed, the whole mass, packed in many cases (stone, clay, plaster and bones, weighing nearly three tons), was forwarded to the British Museum. When unpacked, the pieces—which now amounted to many hundreds—were ranged in groups, and had more the appearance of heaps of worthless rock debris, rather than of fragments to be united, and from which was to be extracted the symmetrical bones of a huge reptile. The work of reconstruction was at once commenced; the bones imbedded in the clay were divested of their plaster casing, gelatinized and mended, for they were much decayed and broken. Piece by piece the septarium was fitted and cemented together, until the pieces were formed into great blocks, but not too big for convenient handling; these again were fitted and placed together so as to restore the nodule as nearly as possible to its original shape; but its surface, owing to its numerous joints, bore some resemblance to a very irregular piece of tessellated pavement, or to a curious Chinese puzzle. These large blocks were then united and firmly cemented, so as to form three masses of nearly equal proportions. This was readily effected, for fortunately I had discovered, in the course of removing it, that the nodule had two parallel cracks running across its short diameter

which divided it into three nearly equal parts;[1] these again, when the work of development was far advanced, were fixed and joined together in a frame, and now present the appearance of an entire slab.

And now commenced the principal work, that of cutting away the upper surface of the block, and tracing the imbedded bones, for as yet, with the exception of the femur already mentioned, and some centra of vertebræ, it was not certainly known what parts of the skeleton the stone enclosed. This was a work of much labour, patience and skill, for the matrix was hard and adhered firmly to the bone, which, being much softer, rendered it almost impossible to remove the former, without also taking away the surface of the latter. However, slowly but satisfactorily the work progressed, and bone after bone was brought to light, until a grand group, comprising the iliac bones of either side with the sacrum entire and retaining their normal form and position, an ischium, femur, dorsal, and caudal vertebræ, were projected in bold relief from a background of grey stone: forming a magnificent fossil group unique of its kind (Plate VIII. Fig. 1). This work was skilfully executed by Mr. Barlow, the mason attached to the Geological Department, and occupied him several months. But happily the labour has added much to palæontological knowledge, as witnessed by Prof. Owen's Monograph already referred to, and the results have been a source of gratification to those who took part in its reconstruction.

In addition to the bones above mentioned, a large dermal spine, several centra and processes of many vertebræ, chevron-bones, portions of ribs, and numerous fragments of other bones, had been found and taken up by the workmen, before the larger bones were exposed, and these fragments unquestionably prove that many, if not most of the vertebræ were lying around the central mass, and also lead to the inference that, had some competent person been present at the moment of its first discovery, a much larger portion of the skeleton would have been secured; for undoubtedly many a fine fossil is lost to science through the general ignorance and carelessness of the workmen, and the strong propensity on the part of the public to carry off *portions* of any *curiosity* for the mantel-shelf!

In the same workings have also been found remains of *Pliosaurus*, *Plesiosaurus* and vertebræ of a new species of *Bothriospondylus* (*B. suffossus*, Owen), the latter of which are described in the Monograph

[1] The surfaces of these cracks were completely covered with a felting of the rootlets of plants, which had penetrated through some eight or nine feet of compact clay to this nodule, and had long fed upon and derived nourishment from the decayed bones of the old monster within it. At least I assumed this much from the fact, that I had all the other nodules broken up to see if they contained any bones, and although they were much cracked, in none were there any traces of rootlets; nor did I find in one of them any organic remain which could have served as a nucleus of concretion. The form of each was elliptical, more or less elongated, and they were large, measuring several feet in their long diameter, and were traversed by veins of crystalline calcite, having also large cavities and fissures lined with crystals of the same mineral. The nucleus of all these nodules of septaria was probably organic, but may have consisted of more perishable organisms than bones, and so have been slowly dissolved and removed, leaving the cavities lined with spar to mark their former presence.

referred to; and also the defensive spines of a fish, *Asteracanthus*, Shells of Ammonites, numerous small Oysters, and other Mollusca abound in the clay, but they are all compressed and too friable for removal.

EXPLANATION OF PLATES.

PLATE VII.

FIG. 1. Rough diagram of principal mass of septarium in which the greater part of the remains of *Omosaurus armatus*, Owen, were enclosed.
f. the right femur in situ. *pu.* the right pubic bone projecting from the nodule into the surrounding clay-bed. *is.* the left ischium. Six caudal vertebræ (*c*) are also seen lying near the septarium in the clay.

,, 2. General view of the pit at Swindon, showing the relative position of the large septarium (*a*) and the five adjacent septaria *b*, *b*, *b* (from a rough sketch by the author).

PLATE VIII.

FIG. 1. *Omosaurus armatus*, Owen, as it appeared after development from the septarium.
sa. the sacrum. *il.* the iliac bones. *a.* the acetabulum into which the femur (*f*) was articulated. *is.* the ischium, nearly in situ. *d.* the dorsal vertebræ. *c.* the caudal vertebræ.

,, 2. The left humerus.

,, 3. The right pubic bone.

II.—Some Notes on Glaciers.

By the Rev. T. G. Bonney, M.A., F.G.S.

As missiles are falling thick like hail upon Mr. Judd since his challenge to the Glacialists, I take the opportunity of putting together a few notes, made during an Alpine journey last summer, which would have been published sooner, had more time been at my disposal. The lower parts of the Gorner, Arolla, Des Bossons, Des Bois, and Argentière Glaciers were carefully studied, but others received passing attention.

1. *Ground Moraine.* — The Glaciers of the Swiss and Savoy Alps have been retreating for several years; hence if anything like ground moraine existed, this would be a very favourable time for observing it. In no case have I been able to find signs of any deposit resembling Till or Boulder-clay; the detrital matter which is scattered, generally sparsely, over the slope left bare by the retreating glacier, has fallen from its surface, like ordinary terminal moraine. Further, by availing myself of crevasses, etc., I have made my way occasionally for some little distance beneath the ice. Nothing has been seen but bare rock, with now and then a film of mud or a passing stone. In short, the result of an experience of some years has convinced me, that if anything like the Till or Ground Moraine of recent glacialists exists in the Alps, it is a very local and exceptional phenomenon. It had sometimes occurred to me, as I believe it has to others, that much till-like matter might be produced from a residuum of stones and mud which had been once involved in the ice of the glacier. My more careful observations during the present year have shown me that these cases of included materials are more exceptional and less abundant than I had anticipated.

2. *The Erosive Power of Glaciers.*—As I have already several