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epoch, removes one of the chief difficulties attending the determination of the true vertebral characters of the *Iguanodon*. For if gigantic vertebrae, agreeing in the important character of their articular surfaces with the existing *Iguana*, had actually been discovered, though of rare occurrence, associated with teeth of corresponding dimensions, but similar in form to those of the *Iguana*, there would have been strong ground for suspicion, that such vertebrae and teeth might be parts of the same species.

The elimination of these, otherwise perplexing, ball and socket-jointed vertebrae, and their identification with the peculiar Crocodilian genus of Hontefleur, on which M. H. von Meyer has imposed the name of *Streptospondylus*, forms, therefore, an essential step in the appropriation to the *Iguanodon* of its true vertebral characters.

# CETIOSAURUS.

*Cetiosaurus brevis*, nob.—The attempt to reduce to order the various forms and types of vertebrae, which the Wealden strata have yielded to test the sagacity of the interpreters of its organized treasures, was one of Dr. Mantell's earliest labours, and he states † that his first step was, with the able assistance of the Rev. W. D. Conybeare, to separate those that belonged to the Crocodile, *Plesiosaurus* and *Megalosaurus*, or rather which resembled those from Stonesfield. Many enormous vertebrae then remained, from which those belonging to the *Iguanodon* were to be chosen; from these residuary specimens the characteristic ones of the *Poikilopleuron* and *Streptospondylus* have already been eliminated, and I next proceed to remove from them the vertebrae which characterize the genus *Cetiosaurus*.

Of the existence of vertebrae of this genus in the Wealden strata, I first became acquainted by the examination of Mr. Saull's collection of sea-rolled fossils washed out of the submerged Wealden beds, and deposited on the shores of the Isle of Wight, at Sandover Bay.

The vertebrae in question present the well-marked generic characters of those of the dorsal region in the *Cetiosaurus*, as the breadth of the centrum, its subcircular contour, its median contraction and unequal concavity of the articular extremities; as, also, the short antero-posterior extent of the neuropophysis, and their anchylosis to the anterior part of the upper surface of the centrum: but they differ from the vertebrae on which the characters of the present genus were first founded ‡ by the shortness of their antero-posterior diameters as compared with their breadth and depth, whence I propose to designate the species by the name of *Cetiosaurus brevis*.

The centrum of a dorsal vertebra of this species from Culver Cliff measures,

|                                        | In. Lines. |
|----------------------------------------|------------|
| in antero-posterior diameter . . . . . | 3 6        |
| transverse diameter . . . . .          | 6 4        |
| vertical diameter . . . . .            | 6 0        |

\* This suspicion is expressed, but with due caution, by Dr. Mantell in his 'Geology of the South-east of England.' "The somewhat angular vertebrae, described as appearing to constitute a Second System, I should be disposed, from their number, and from their so commonly occurring in the localities where the teeth of the *Iguanodon* most abound, to refer to that animal; it must, however, be mentioned, that the concavo-convex vertebrae which correspond so entirely with those of the *Iguana* and Monitor, would seem to offer a more probable approximation; yet the extreme rarity of the latter renders it questionable, since there appears no reason why the vertebrae should not have been preserved in as considerable numbers as the teeth."—p. 306. The vertebrae of the *Iguanodon* discovered by Mr. Bonstead in the greensand quarries near Maidstone, are so crushed or so imbedded, as to prevent a satisfactory determination of both articular extremities.

† Illustrations of the Geology of Sussex, 4to, 1827, p. 76. Geology of the South-east of England, 8vo, 1833, p. 278.

‡ See Proceedings of the Geological Society for June 1841.

One of the articular ends \* is rather more concave than the other, which, from the wearing away of the margins, appears slightly and unevenly convex. The contracted middle part of the vertebra is concave lengthwise, and pretty regularly convex in the direction transverse to the axis of the vertebra: the free surface is finely striated, and perforated here and there by vascular foramina: there is no lateral depression. The neuropophyses were broken off; their bases, instead of having their long diameter corresponding with the axis of the vertebra, as in *Iguanodon*, present it in the direction transverse to that axis, as in *Plesiosaurus*: they do not quite meet at the middle of the upper or neural surface of the centrum, but are there divided by a narrow longitudinal tract forming the lower part of the spinal canal.

The antero-posterior extent of the anchylosed base of the neural arch is 2 inches 6 lines: the transverse diameter, 5 inches.

Two caudal vertebrae of the same species, also from Culver Cliff, present the same length and unequal concavity of the articular extremities; the anterior one, here determinable by the anterior position of the narrower hæmapophyses, being the deepest: the sides of the body are more compressed, and more convergent towards the under surface; so that, as the expanded margins of the articular ends are worn away, the centrum presents rather a triangular than a subcircular contour. The disproportion of its antero-posterior with its transverse and vertical diameters, distinguishes it from the caudal vertebrae of the *Iguanodon*. The neuropophysis rises from the anterior three-fourths of the centrum, and sends forwards a subprismatic anterior oblique process, but does not develop a posterior one: it then contracts, and inclines to the base of the spine, which is much shorter than in the *Iguanodon*. The spinous process inclines backwards from the vertical axis of the centrum at an angle of 45°. A short transverse process is developed from the junction of the neuropophysis with the centrum. The hæmapophyseal surfaces appear single on both the anterior and posterior parts of the lower surface; they are nearly flat, and slope towards each other.

|                                                   | In. Lin. |
|---------------------------------------------------|----------|
| Antero-posterior diameter . . . . .               | 3 0      |
| Transverse diameter . . . . .                     | 5 0      |
| Vertical diameter . . . . .                       | 5 0      |
| Height of vertebra to summit of spine † . . . . . | 12 9     |
| Antero-posterior diameter of spine . . . . .      | 2 10     |
| Thickness at posterior part of base . . . . .     | 1 0      |
| Height of spine, 1st caudal . . . . .             | 5 0      |
| Height of spine, 2nd caudal ‡ . . . . .           | 4 0      |

The characters and dimensions of these rolled vertebrae of *Cetiosaurus* from the submarine beds of the Wealden formation, although somewhat obscured by the circumstances under which they are brought to light, are sufficiently satisfactory to establish their generic character, and to give an useful approximate idea of their size and proportions. The corresponding bones from the Wealden of Tilgate Forest supply, by their more perfect state of preservation, the deficiencies of the Isle of Wight specimens, and further establish the co-existence of the *Cetiosaurus* with the *Iguanodon*, *Streptospondylus*, *Megalosaurus* and other extraordinary reptiles of that period. The vertebrae of the *Cetiosaurus brevis* in the Mantellian Collection are the

\* Subsequently determined by more perfect specimens to be the posterior surface.

† This is rounded off, but seems not to have been broken.

‡ The 1st and 2nd do not here refer to the place of these vertebrae in the tail; but if the vertebrae were contiguous in the entire animal, the tail must be much shorter than in the *Iguanodon*.



most gigantic specimens of Saurian remains that enrich it. They include the bodies of two dorsal vertebrae and four entire caudal vertebrae, which, if not consecutive, seem to have come not from distant parts of the basal portion of the tail of the same individual; there are also the bodies of several of the smaller posterior caudal vertebrae.

No. 2133 ("Gigantic vertebra of *Iguanodon*," MS. Catalogue of Mantellian Collection,) is a posterior dorsal vertebra of the *Cetiosaurus brevis*, and exhibits in a striking manner the peculiar characters of this species, viz. the great depth and breadth, especially the latter dimension, as compared with the length or antero-posterior diameter of the centrum or body of the vertebra.

The posterior articular facet is, in this region of the spine, more concave than the anterior surface, a structure which approximates to that peculiar one which characterizes the *Streptospondylus*\*. The contour of the articular ends is a full transverse oval: the middle of the centrum is strongly concave, slightly concave in the longitudinal direction at the upper part of the side of the centrum, but deeply concave below, and with a slight indication of a broad, obtuse longitudinal ridge along the middle of the concave under surface. In the *Iguanodon* the sides of the vertebral body are nearly flat in the vertical direction; in the *Cetiosaurus* they are strongly convex. The surface at the middle of the vertebra is longitudinally striated with very fine, subparallel, short impressions: these grow deeper and more irregular at the thick, rugged and everted margins of the articular ends.

The neuropophyses are firmly ankylosed here, as in the caudal region, and the line of the primitive suture is hardly discernible: their base is shorter than the short centrum, and is attached nearer its anterior part: in the *Iguanodon* the neural arch is very nearly coextensive in antero-posterior diameter with the centrum supporting it: in a dorsal vertebra, of an *Iguanodon* 4½ inches in breadth, the antero-posterior extent of the base of the neural arch is 4 inches: in the present vertebra, which exceeds 7 inches in breadth, the antero-posterior extent of the base of the neural arch is 2½ inches, and only 2 inches a little above the base. The outer side of the neuropophysis is convex in the axis of the vertebra, and concave in the opposite direction as it ascends to the base of the transverse process, without exhibiting a trace of the ridges and hollows that so singularly characterize the same part in the dorsal vertebrae of the *Streptospondylus Cuvieri*. The antero-posterior diameter of the base of the transverse process is 2 inches; its vertical diameter 1 inch. The diameter of the spinal canal is 1 inch 9 lines. The articular surfaces of the anterior oblique processes are flat, and look upwards and slightly inwards. In the *Iguanodon* their under margins, in the dorsal vertebrae, converge at an nearly a right angle: in the present vertebra they incline to each other at an angle of 40°. The spinous process begins to rise immediately behind the anterior oblique processes by a narrow vertical plate, which seems as if it

\* Since the vertebrae of the *Streptospondylus* lose their peculiar convexo-concave character by the gradual subsidence of the anterior ball, as they approach the tail, the cervical vertebrae of the *Cetiosaurus* may approach, more nearly than do the dorsal ones, to the convexo-concave structure of the *Streptospondylus* vertebra. The fact that, hitherto, only cervical vertebrae of the great *Streptospondylus*, and only dorsal and caudal vertebrae of the *Cetiosaurus*, have been discovered in the Wealden formations, has induced me well to consider the grounds for assigning them to Saurians of distinct genera. But the general constancy of the vertebrae of the same Saurian in their antero-posterior diameter, forbids the supposition of a vertebra of six inches in length in the neck being associated with one of three inches in length in the back. Additional evidence of a very decisive character must at least be obtained before the great *Cetiosaurus* can be admitted to have resembled the *Pterodactyle* in such disproportionate length of the cervical vertebrae.

were nipped in between two shallow depressions; its base ascends obliquely, and grows thicker to the posterior part of the neural arch. The summit is not entire.

The height of this dorsal vertebra to the posterior origin of the spinous process is 9½ inches: from the base of the neuropophysis to the upper part of the transverse process, measures 3 inches.

No. "115" in the Mantellian Collection, ("Vertebra of *Iguanodon*, 8 inches in diameter," MS. Catalogue), may have actually presented that dimension when entire, for even now, not allowing for the margin of the posterior articular surface which has been broken away, it measures 7 inches across that surface. This remarkable specimen, which may probably have afforded the type of the 'third or plano-concave' vertebral system, in the summary of the vertebral characters of the Wealden reptiles given by Dr. Mantell in his 'Geology of the South-east of England', and which accords best with the characters assigned by M. H. von Meyer to the vertebrae of the *Iguanodon*†, presents, in fact, in a striking degree, those of the vertebrae of the *Cetiosaurus*, and belongs to a more posterior part of the dorsal region, perhaps to the loins, of the same individual, certainly to one of the same species, as the vertebra (No. 2133) last described.

The anterior articular extremity makes the same approach to a plane surface, being slightly concave below and very slightly convex above: the depth of the posterior concave surface at the centre is 9 lines. The general contour of the centrum has begun to change from the circular to the subquadrate, which latter figure is more decidedly expressed in the anterior caudal vertebrae of the *Cetiosaurus brevis*.

The upper half of the sides of the centrum are more concave in the axis of the vertebra than in No. 2133. The free surface presents the same degree of smoothness, and is pierced here and there by moderate-sized vascular foramina. The spinal canal makes a slight depression in the upper part of the centrum: in the *Iguanodon* it is encompassed by the bases of the neuropophyses. The transverse diameter of the spinal canal is 1 inch, which small dimension satisfactorily distinguishes the present enormous vertebra from those of the mammiferous class, viz. the Cetacea, to which in other respects it has the greatest similitude. The antero-posterior diameter of the base of the neuropophysis is 2 inches.

The four anterior caudal vertebrae in the Mantellian Collection, which are here assigned to the *Cetiosaurus brevis*, slightly increase in antero-posterior diameter, as is the case in the *Cetiosaurus medius*, as they recede from the trunk, which seems to indicate that the present gigantic marine Saurian must have had a capacious and bulky trunk, but propelled by a longer and more Crocodilian tail than in the modern whales. It is sufficiently evident, however, that, even in the present short segment of the tail, with the slight increase of length, there is a diminution of height and breadth of the centrum, and a still more obvious subsidence of the neural arch, as the vertebrae recede from the trunk. As compared with the dorsal vertebrae, the chief change of form is the subquadrate contour produced by a lateral extension and flattening of the lower surface of the centrum, which is more essentially distinguished by four hemaphysial articular surfaces, two at the anterior and two at the posterior margins of this inferior surface. The articular surfaces at both ends of the centrum are now concave; and the anterior one, which was nearly flat in the dorsals, is here the deepest; it is one inch deep at the upper third of

\* *Svo*, 1833, p. 296, fig. 3.

† *Paleogeologia*, p. 212.



the surface\*. The sides of the centrum at the upper half are concave both lengthwise and vertically, forming a wide depression below the transverse process; the middle part of the side begins to stand out and divide the upper from the lower lateral concavity, which character, being more strongly developed in the hinder caudal vertebrae, gives the rhomboidal or hexagonal form†. The lower half of the side of the centrum is less concave than in the dorsal vertebrae. The broad inferior surface is also less concave antero-posteriorly than in the dorsal vertebrae, and is nearly flat transversely: it gradually continues, in the transverse direction, in the posterior caudals, so as to take on the form of a longitudinal sulcus. The two anterior hæmapophysial surfaces are separated from each other by an interval of two inches; the two posterior surfaces, which are larger than the anterior ones, are similarly distinct.

In the *Iguanodon* the hæmapophysial surfaces are confluent on both the anterior and posterior parts of the under surface of the centrum, and the chevrons bones accordingly present modifications by which they may, when detached, be distinguished from those of the *Cetiosaurus*.

The transverse processes have descended, as usual, from the summit to the base of the neural arch in the present anterior caudal vertebrae. They are short, compressed vertically, diminishing, and as if slightly twisted, so that the upper margin is turned forwards, at their extremity. The vertical diameter of the base of the transverse process in the largest of the present caudal vertebrae is three inches; its antero-posterior diameter one inch six lines; its length two inches seven lines: the extremity terminates obtusely. The upper ridge-like termination of the transverse process is continued to the base of the anterior oblique processes. These processes are alone developed in the present vertebrae, the posterior articular surfaces being impressed upon the sides of the posterior part of the base of the spine. The anterior oblique processes project almost horizontally forwards, diminishing, chiefly in vertical diameter, to an obtuse apex; convex externally, flattened internally by the oblong articular surface, and separated by a fissure nearly one inch wide: the length of these processes, from the bottom of the intervening fissure in the second of the four caudals, where they are most entire, is two inches. When the vertebrae are placed in juxtaposition, these processes reach beyond the middle of the vertebrae next in front, and pinch, as it were, the back part of the base of the spine so as to impress upon it the surfaces representing the posterior articular processes. These processes are well developed, on the contrary, in the corresponding vertebrae of the *Iguanodon*, and overhang the posterior surface of the body of the vertebra to which they belong. The spinous process, which appears to be nearly perfect in the second caudal, is short, strong, and truncated at the summit. Its height from the anterior oblique processes is four inches: the total height of the vertebra is thirteen inches. The antero-posterior diameter of the side of the neural arch is two inches. The spinal canal is wider in these caudal than in the dorsal vertebrae, indicating the greater muscularity of the part deriving its nervous power from the corresponding part of the spinal chord: its transverse diameter is one inch ten lines; its vertical diameter is two inches. The neural arch is, as usual in the present genus, ankylosed to the anterior part of the upper surface of the centrum: one inch and a half of this surface is left free behind the attachment

\* The same modification of the articular extremities occurs in the caudal region of the vertebral column of the *Plesiosaurus*. See 'Report on Brit. Foss. Reptiles,' part i. Trans. Brit. Assoc. 1839, p. 58.

† It is one of these posterior caudals of the *Cetiosaurus*, which is figured as the type of the "second vertebral system" in the 'Geology of the South-east of England,' p. 296, fig. 2.

of the arch. The finely wrinkled or fibrous character of the free surface is more strongly marked in these caudal than in the dorsal vertebrae.

In the three succeeding vertebrae the neural arch diminishes in height, the anterior articular processes diminish in length, and the posterior articular impressions in depth. The upper and lower parts of the sides of the body become somewhat more concave; the posterior articular surface grows flatter.

A detached chevron bone, eight inches in length, consisting of two hæmapophyses, ankylosed only at their distal or inferior extremities, and with their distinct proximal ends more divaricated than are the confluent ones in the *Iguanodon*, corresponds with the caudal vertebrae here described, and doubtless belongs to the *Cetiosaurus brevis*.

The following are dimensions taken from the four caudal vertebrae above described:—

|                                        | 1st. | 2nd. | 3rd. | 4th. |
|----------------------------------------|------|------|------|------|
| Antero-posterior diameter of centrum . | 3    | 9    | 4    | 2    |
| Transverse diameter of centrum .       | 7    | 2    | 7    | 1    |
| Vertical diameter of centrum .         | 6    | 10   | 6    | 8    |
|                                        | 0    | 0    | 0    | 6    |

Of the present species of *Cetiosaurus*, I have examined specimens of the bodies of one dorsal and three posterior caudal vertebrae in the collection of Gilpin Gorst, Esq., which were obtained from the central strata of the Wealden, near Battle Abbey, commonly called the 'Hastings beds.'

The dorsal centrum closely agrees with those in the Mantellian Collection: its anterior surface is, as in them, nearly flat, or slightly convex; the posterior surface is concave.

|                                                           | In. Lines. |
|-----------------------------------------------------------|------------|
| The antero-posterior diameter . . . . .                   | 3 2        |
| The transverse diameter of the anterior surface . . . . . | 5 3        |
| The vertical diameter of the anterior surface . . . . .   | 5 2        |

A fracture of this centrum through its middle shows it to consist throughout of a coarse cellular texture. The neuropophyses, with an antero-posterior extent of base of two inches three lines, are continuously ankylosed with the centrum, as in Mammalia, and leave about three quarters of an inch of the posterior part of the centrum free. The lower part of the spinal canal is horizontal; its transverse diameter one inch three lines.

The posterior caudal vertebrae present an antero-posterior diameter of nearly four inches, with a breadth of three and a half inches, and a depth of four inches, measuring to the lower part of the base of the posterior hæmapophysial surface. The antero-posterior length of the base of the neuropophysis is two inches two lines; and it does not begin so close to the anterior part of the centrum as in the dorsal vertebrae. The upper and lower portions of the side of the centrum are more distinctly separated by the comparative projection of the middle part, which gives the obscurely hexagonal form to these vertebrae. The inferior parts are most concave, and converge to form the sides of the longitudinal sulcus, to which the inferior surface of the centrum is reduced at this part of the tail. It is plain, from these modifications of the vertebrae, that the tail must here have presented the compressed Crocodilian type; and it is satisfactory to have these indications of the Saurian affinities of the present gigantic fossil, in consequence of the very close approximation of the larger vertebrae to the Cetaceous type. The vertical extent of the osseous basis of the tail was here augmented by strong hæmapophyses, which have left more prominent articular facets on the under part of the centrum than in the larger anterior caudal vertebrae: these facets, instead of being in pairs, are confluent at the anterior, and at the posterior ends of the lower sur-



face: the posterior confluent pair, forming a triangular prominent surface, inclining obliquely forwards, and with its apex notched by the termination of the inferior sulcus.

There are several posterior caudal vertebrae of the *Cetiosaurus brevis* in the Mantellian Collection, which closely correspond with those just described from the Hastings beds; four of these vertebrae give the following dimensions:—

|                                                  | Nos. 2112. |      | 2142. |      | 2153. |      |
|--------------------------------------------------|------------|------|-------|------|-------|------|
|                                                  | In.        | Lin. | In.   | Lin. | In.   | Lin. |
| Antero-posterior diameter of centrum . . .       | 4          | 3    | 3     | 10   | 3     | 7    |
| Transverse diameter of its articular end . . .   | 3          | 10   | 3     | 0    | 2     | 8    |
| Vertical diameter of its articular end . . .     | 4          | 0    | 3     | 3    | 3     | 0    |
| Vertical diameter at middle of the centrum . . . | 4          | 6    | 3     | 11   | 3     | 10   |

The vertebrae figured in the 'Illustrations of the Geology of Sussex,' pl. ix. fig. 8, and pl. x. fig. 1, are posterior caudal vertebrae of the *Cetiosaurus brevis*. *Cetiosaurus brachyrus*.—A dorsal and a caudal vertebra from the Wealden formation at Tatham, which agree in essential characters with the *Cetiosaurus*, and differ from those of *Streptospondylus*, *Megalosaurus*, *Iguanodon*, *Hylaeosaurus*, *Poikilopleuron*, and the Crocodilian vertebrae of the Wealden, offer at the same time proportions which forbid their reference to the *Cetiosauri brevis*, *medius* and *longus*, and indicate a species distinguished by a shorter tail.

The dorsal vertebra (No. <sup>109</sup><sub>2107</sub> Mantellian Collection) presents a subcircular centrum, with the neuropophyses anchylosed, but broken off; they are shorter than the centrum, and leave eight lines of its hind part uncovered. The anterior articular surface of the body is slightly convex at the upper, and concave at the under half: the posterior surface is uniformly concave: the body is constricted at the middle, but in a less degree than in the *Cetiosaurus brevis*, so that it is less deeply concave lengthwise: it is as convex transversely: a slightly-raised obtuse ridge separates two shallow sulci at the under surface of the vertebra.

The caudal vertebra (No. <sup>101</sup><sub>2101</sub> Mantellian Collection) presents a shallow and rather oblique sulcus along the lower surface. The hemapophysal articulations are most marked at the posterior part of this surface. The sides of the centrum are less concave longitudinally than in the dorsal vertebra; there is a vascular perforation on each: the articular ends of the body agree with those of the dorsal vertebrae. The following are dimensions of the preceding vertebrae:—

|                                            | Dorsal. |      | Caudal. |      |
|--------------------------------------------|---------|------|---------|------|
|                                            | In.     | Lin. | In.     | Lin. |
| Antero-posterior diameter of body . . .    | 3       | 0    | 2       | 9    |
| Vertical diameter of articular end . . .   | 4       | 3    | 3       | 10   |
| Transverse diameter of articular end . . . | 4       | 6    | 3       | 7    |

These vertebrae closely corresponded in texture and character of the external surface.

*Cetiosaurus medius*.—The remains of this Reptile have hitherto been discovered only in the oolitic strata below the Wealden. They appear to have been first noticed in a letter from John Kingdon, Esq., read at the meeting of the Geological Society held June 3rd, 1825, in which "he mentions the situation in which certain bones of a very large size, appearing to have belonged to a whale and a crocodile, were lately found completely imbedded in the oolite quarries (lower oolite), about a mile from Chipping Norton, near Chapel House." It is principally on these bones, with others subse-

\* They are probably the bones alluded to in the Note at p. 221 of Dr. Mantell's 'Geology of the South-east of England.'

quently discovered and in the collection of Mr. Kingdon, that the characters of the *Cetiosaurus* were first determined\*. They include a portion of the tail consisting of ten vertebrae; the anterior and larger ones were five inches and a half in length, seven inches across the articular surface at each end of the body, and not less than two feet in vertical diameter, including the neural (superior) and haemal (inferior) spines. Both articular extremities are concave, the anterior one being rather the deepest; but the difference is less than in the *Cetiosaurus brevis*. The articular cavities become shallower in the posterior caudal vertebrae; these gradually diminish in transverse and vertical diameter, but retain the same length, even when they are reduced to two inches and one inch and a half in breadth. The body of the vertebra has no central cavity, in which respect the present, like the preceding species of *Cetiosaurus*, may be distinguished from the *Poikilopleuron*, where such a cavity exists. The neuropophysis does not equal in antero-posterior extent the centrum or body of the vertebra, the disparity increasing in the posterior caudal vertebrae: the arch is placed towards the anterior end of the vertebra. The hemapophysal arch has a less contracted base than in the *Iguanodon*, and the proximal extremities of the hamapophyses are free, as in the *Cetiosaurus brevis*.

One of the ungual phalanges, which is conical, subcompressed, and slightly curved, is traversed on each side by the usual vascular groove, curved with the convexity upwards, measuring five inches in length, and three and a half across its articular base. The bone alluded to in Buckland's 'Bridgewater Treatise,' vol. i. p. 115, and figured in Mr. Lyell's 'Elements of Geology' (1838), p. 384, is a metatarsal of the *Cetiosaurus*. This fossil was found in the great oolite of Enstone, near Woodstock.

A few large caudal vertebrae, and other bones of the *Cetiosaurus*, have been discovered in the oolite of the neighbourhood of the town of Buckingham, and form part of Dr. Buckland's museum.

Some vertebrae, an entosternal bone, a coracoid, scapula, and fragments of long bones, belonging apparently to the same skeleton, were disinterred from the middle oolite during the railway cuttings near Blisworth, and are preserved in the collection of Miss Baker at Northampton. The anterior transverse branch of the entosternum measures upwards of four feet across. The posterior caudal vertebrae, which, like those from Chipping Norton, measure five inches and a half in length, have a more hexagonal form, resembling, in this respect, the terminal caudal vertebrae of the *Cetiosaurus brevis* of the Wealden; they are, however, like the Chipping Norton specimens, of greater length.

In the museum of Professor Sedgwick, there is a caudal vertebra of the *Cetiosaurus* from the neighbourhood of Stratford-on-Avon. The size of the fossils hitherto obtained of the *Cetiosaurus medius*, especially the vertebrae, if calculated according to the numbers and proportions of those of the Crocodiles, gives a length of forty feet to this species.

*Cetiosaurus longus*.—In Professor Buckland's museum are preserved some fossil remains, principally vertebrae, of another enormous Saurian, which the form and texture of the vertebrae prove to belong to the genus *Cetiosaurus*, but which differ in the proportions of the vertebrae. One of these—a caudal vertebra—from the Portland stone at Garsington, near Oxford, measures in antero-posterior diameter of the centrum seven inches; in transverse diameter, seven inches nine lines; in vertical diameter of the centrum, six inches. Both articular extremities of the vertebra are slightly concave; the body is slightly compressed laterally; its middle part gives a subquadrate

\* See Proceedings of the Geological Society, June 1841.

TYPE OF  
C-LONGUS



vertical section, with the angles slightly rounded; the expanded articular ends are subcircular. A fractured dorsal or lumbar vertebra, from the same locality, with transverse processes extending obliquely backwards from the upper part of the sides of the body, measures one foot across the nearly flat articular surface. The body of a caudal vertebra of the same species, from the Portland stone at Thame, measures seven inches four lines in antero-posterior diameter; six inches six lines in transverse diameter; and seven inches eight lines in vertical diameter. The under surface is concave lengthwise, and nearly flat from side to side; it is perforated by many large vascular canals. A third caudal vertebra is somewhat shorter in antero-posterior diameter, but exceeds the preceding in vertical diameter, which is eight inches. In all these vertebrae the neuropophyses are ankylosed to the centrum, and have a smaller antero-posterior extent at their base than the centrum, as in the preceding species of *Cetiosaurus*. In all the species the hemipophyses are articulated to the interspaces of two vertebrae. To the *Cetiosaurus longus* is referable a vertebra, eight inches in length of body, and nine inches in transverse diameter, from the Yorkshire white at White Nab, which, together with some metatarsal bones, are deposited in the museum at Scarborough. No teeth, or fragments of jaws or cranium, have hitherto been discovered, which can, with certainty, be referred to any of the preceding species.

The names which I propose to give to these species refer to the relative length of their vertebrae, and from what we know of the constancy and regularity of this dimension in the back bone of individuals of the same species of Saurian, these specific names would, if we had the entire animals, be found to be as appropriate in reference to the relative length of their whole bodies.

At present the *Cetiosaurus brevis* is known to me only by specimens from the Wealden strata; the *Cetiosaurus medius* by fossils from the lower oolite, and the *Cetiosaurus longus* by a few vertebrae from both the upper and the lower oolite; but how far these species should actually characterize these divisions of the great oolitic system, will depend on the results of ulterior researches and a longer experience. It is certain, however, that we have in these remains ample proof of the existence, at that period of the earth's history which has been aptly termed the 'Age of Reptiles,' of another gigantic genus in addition to the *Pliosaurus*, *Poikilopleuron*, *Streptospondylus*, *Iguanodon*, *Megalosaurus* and *Hylaeosaurus*.

The enormous *Cetiosauri*, some of which must have rivalled the modern whales in bulk, may be presumed to have been of strictly aquatic and most probably of marine habits, on the evidence of the sub-biconcave structure of the vertebrae, and of the coarse cancellous tissue of the long bones, which show no trace of medullary cavity. In the great expanse of the coracoid and pubic bones, as compared with the *Telosaurus* and *Crocodyles*, the gigantic *Saurians* in question manifested their closer affinity to the *Enaliosauria*: their essential adherence to the Crocodilian type is marked by the form of the long bones of the extremities, especially the metatarsals; and, above all, by the toes being terminated by strong claws. The main organ of swimming is shown, by the strength and texture, and vertical compression of the posterior caudal vertebrae, to have been a broad vertical tail: and the webbed feet, probably, were used only partially in regulating the course of the swimmer, as in the puny *Amblyrhynchus* of the Gallipagos Islands, the sole known example of a Saurian of marine habits at the present period.

#### DINOSAURIANS.

This group, which includes at least three well-established genera of *Saurians*, is characterized by a large sacrum composed of five ankylosed ver-

tebrae of unusual construction, by the height and breadth and outward sculpturing of the neural arch of the dorsal vertebrae, by the twofold articulation of the ribs to the vertebrae, viz. at the anterior part of the spine by a head and tubercle, and along the rest of the trunk by a tubercle attached to the transverse process only; by broad and sometimes complicated coracoids and long and slender clavicles, whereby Crocodilian characters of the vertebral column are combined with a Lacertian type of the pectoral arch; the dental organs also exhibit the same transitional or annectant characters in a greater or less degree. The bones of the extremities are of large proportional size, for *Saurians*; they are provided with large medullary cavities, and with well developed and unusual processes, and are terminated by metacarpal, metatarsal and phalangeal bones, which, with the exception of the ungual phalanges, more or less resemble those of the heavy pachydermal Mammals, and attest, with the hollow long-bones, the terrestrial habits of the species.

The combination of such characters, some, as the sacral ones, altogether peculiar among Reptiles, others borrowed, as it were, from groups now distinct from each other, and all manifested by creatures far surpassing in size the largest of existing reptiles, will, it is presumed, be deemed sufficient ground for establishing a distinct tribe or sub-order of Saurian Reptiles, for which I would propose the name of *Dinosauria*\*.

Of this tribe the principal and best established genera are the *Megalosaurus*, the *Hylaeosaurus*, and the *Iguanodon*; the gigantic Crocodile-lizards of the dry land, the peculiarities of the osteological structure of which distinguish them as clearly from the modern terrestrial and amphibious *Sauria*, as the opposite modifications for an aquatic life characterize the extinct *Enaliosauria*, or Marine Lizards.

#### MEGALOSAURUS.

Of the gigantic Lacertians in question, the most remarkable are the *Megalosaurus*, *Iguanodon*, and *Hylaeosaurus*, the worthy fruits of the laborious researches of Prof. Buckland and Dr. Mantell. With respect to the *Megalosaurus*, the great carnivorous terrestrial Lizard of the Wealden and Oolitic period, the lucid descriptions of its discoverer in his original Memoir and the 'Bridgewater Treatise,' and the judicious remarks of Cuvier on its natural affinities, leave little to be added, save the observations on the sacrum, to the present brief record of the strata and localities in which the remains of the *Megalosaurus* have been found.

The most complete collection of the bones of this genus has been derived from the oolite of Stonesfield, where the original specimens were first discovered. Dr. Buckland now possesses in his valuable collection portions of a lower jaw, the principal fragment containing a tooth fully developed, and the germs of several others; detached dorsal, caudal, and a series of five sacral vertebrae, ribs, two coracoid bones, a clavicle, humerus, radius, an ilium, an ischium, a femur, fibula, metacarpal and metatarsal bones.

These parts have not been discovered so associated together as to prove them to belong to the same animal; but the peculiar characters of some of the bones, which distinguish them from the other oviparous reptiles of the same strata, and the agreement in texture and proportionate size of the others, render their reference to the *Megalosaurus* highly probable.

\* Gr. *deinos*, fearfully great; *saurops*, a lizard. In the tabular arrangement of extinct *Saurians* founded by M. Herm. v. Meyer on the development of their organs of motion, the *Megalosaurus* and *Iguanodon* are grouped together in Section B, with the following character:—*Saurians* with locomotive extremities like those of the bulky terrestrial Mammals: (*Saurier* mit Gliedmassen ähnlich denen der schweren Landsäugthiere).—*Palaeologia*, p. 201. No other grounds are assigned for their separation from other *Saurians*.