24. *On* Bones *of a* Sauropodous Dinosaur *from* Madagascar. By R. Lydekker, Esq., B.A., F.R.S., V.P.G.S. (Read February 6th, 1895.)

Originally described from the Lower Cretaceous and Jurassic rocks of England and other parts of Europe, the gigantic dinosaurs commonly known as sauropods have been subsequently discovered in great abundance in North America, while they have been recorded by myself some years ago from Southern India, and quite recently from Patagonia. We have thus evidence that the group had a very wide geographical distribution; and it is noteworthy that, while several of its North American representatives appear inseparable from their European allies, the Indian and Argentine forms are likewise referable to one and the same genus. Hitherto we have had no evidence of the occurrence of the group in Africa or Madagascar; and it is therefore a matter of considerable interest to be able to bring before the Society the fact that these gigantic dinosaurs were represented in the island last named.

Before proceeding to the consideration of the specimens themselves, it is important to mention that remains of a Mesozoic reptile of a Jurassic type have already been recorded from the island, and referred to the European genus *Steneosaurus*.[1] The presumption thus afforded of the occurrence of Jurassic strata in Madagascar is converted into a certainty by the discovery of a large series of molluscan remains belonging to forms characteristic of that period.[2]

The specimens that I have the opportunity of now bringing under the notice of the Society comprise a large series of reptilian bones collected by Mr. J. L. Last, at a spot about 20 miles to the eastward of the bay of Narinda, on the north-western coast. These bones, which have been purchased by the British Museum, include vertebræ, limb-bones, and portions of the pectoral and pelvic girdles of gigantic land-reptiles; and although the long bones are represented only by their extremities or fragments of the shafts, while the vertebræ are all more or less broken, yet many of the specimens are sufficiently well preserved to afford characters amply sufficient for defining the nature and affinities of the animals to which they belonged.

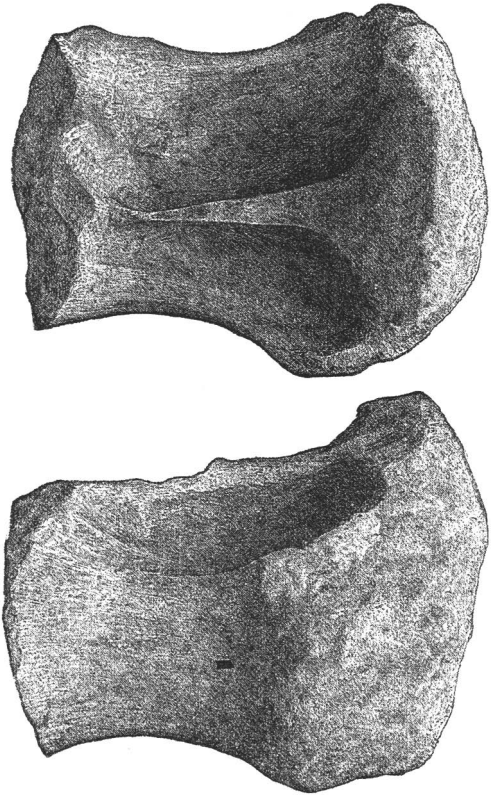
That the bones are those of dinosaurs is rendered certain by their huge size; while the same feature is likewise sufficient to indicate that they belong to the sauropodous section of that great group. If further evidence were required as to their sauropodous affinities, it is seen in the structure of the cervical and dorsal vertebræ described and figured below, which show the pits on the sides of the centra distinctive of the group in question.

The vertebræ are represented by specimens from the cervical, dorsal, lumbar, sacral, and caudal regions. Both the cervicals and dorsals are strongly opisthocœlous, and carry large lateral cavities; these cavities being apparently devoid of any channel of communication with the interior of the centrum, which seems to be solid;

[1] R. B. Newton, Geol. Mag. 1893, p. 193.
[2] *Id.* Quart. Journ. Geol. Soc. vol. li. p. 78.

and the bone between those of opposite sides being reduced to an exceedingly thin septum, extending upwards to form the floor of the neural canal. Whereas the best-preserved dorsal indicates an animal of the approximate dimensions of *Hoplosaurus armatus* of the English Wealden, a lumbar and first caudal are fully as large as the corresponding vertebra of the Oxfordian *Pelorosaurus Leedsi*.

Fig. 1.—*Superior and right lateral aspects of centrum of anterior cervical vertebra of* Bothriospondylus madagascariensis. (*About* $\frac{1}{3}$ *nat. size.*)



Of the three anterior caudal vertebræ preserved, one is also much larger than either of the other two, although it appears to have occupied a nearly similar position in the series. These facts seem to indicate that we have remains of more than a single individual to deal with, although I cannot satisfy myself that there is any evidence of a specific difference between the specimens.

Of anterior cervicals there are, as already mentioned, three examples of the centrum, one of which is much larger than the other two. In all the terminal extremities are imperfect. One of the smaller examples is represented in the accompanying illustration (fig. 1).

In all three specimens the centrum is somewhat narrow and

Fig. 2.—*Right lateral aspect of an imperfect late cervical vertebra of* Bothriospondylus madagascariensis. (*About* $\frac{1}{3}$ *nat. size.*)

elongated, while the inferior surface is rounded. The lateral cavities are large and rounded: their outer inferior margin not being raised above the general level to form a pocket. The narrow septum between them is, as in the figure, well exhibited. In the figured example the length is $6\frac{3}{4}$, and the posterior width $5\frac{1}{2}$ inches; the corresponding dimensions in the larger example being, severally, 9 and $6\frac{3}{4}$ inches.

The specimen represented in fig. 2 is an imperfect vertebra from the hinder part of the cervical region, exhibiting the contour of the entire lateral cavity. Although shorter than the anterior cervicals, it is still narrow, and rounded inferiorly. The septum between the two lateral cavities is so thin that in 'developing' it has been broken through. The cavity is irregularly pear-shaped, with the longer diameter directed upwards and backwards. The lower boundary of the lateral is raised up as wall for a considerable distance above the floor, so as to convert the lower portion of the cavity into a pocket. The length of the centrum of this specimen is $6\frac{1}{2}$ inches, and its proximal width is $5\frac{3}{4}$ inches.

Fig. 3.—*Left lateral aspect of centrum of dorsal vertebra of* Bothriospondylus madagascariensis. (*About* $\frac{1}{3}$ *nat. size.*)

The dorsal vertebræ are represented by the specimen shown in fig. 3,

which probably belongs to the anterior part of the series, and is broken off along the line of the floor of the neural canal. The lateral cavity, although incomplete, appears to be oval in form, with its longer axis longitudinal; and its lower outer margin is not produced upwards to form a pocket. The centrum is shorter and wider than in the cervicals, with its lower surface broad and flat; in all of which respects it agrees exactly with the corresponding vertebræ of *Hoplosaurus*. The anterior terminal convexity is also less strongly marked than in the cervicals. In length this specimen measures $7\frac{3}{4}$ inches, while its distal width is about $7\frac{1}{2}$ inches.

The centrum and base of the neural arch of the very large vertebra shown in fig. 4, from the presence of a small lateral immediately beneath the base of the transverse process, I take to be the last lumbar rather than the first caudal. The centrum is very short and wide, with its anterior terminal face somewhat saddle-shaped from above downwards, and the posterior extremity flat. The length of the centrum is 5 inches, and its posterior width upwards of 10 inches.

The sacrum is represented by two fragments, showing the anterior and posterior terminal surfaces, and probably belonging to a single individual. From these specimens it is probable that there were at least four segments in this portion of the vertebral column. The terminal faces are quite flat, and there are no lateral pits to the centra.

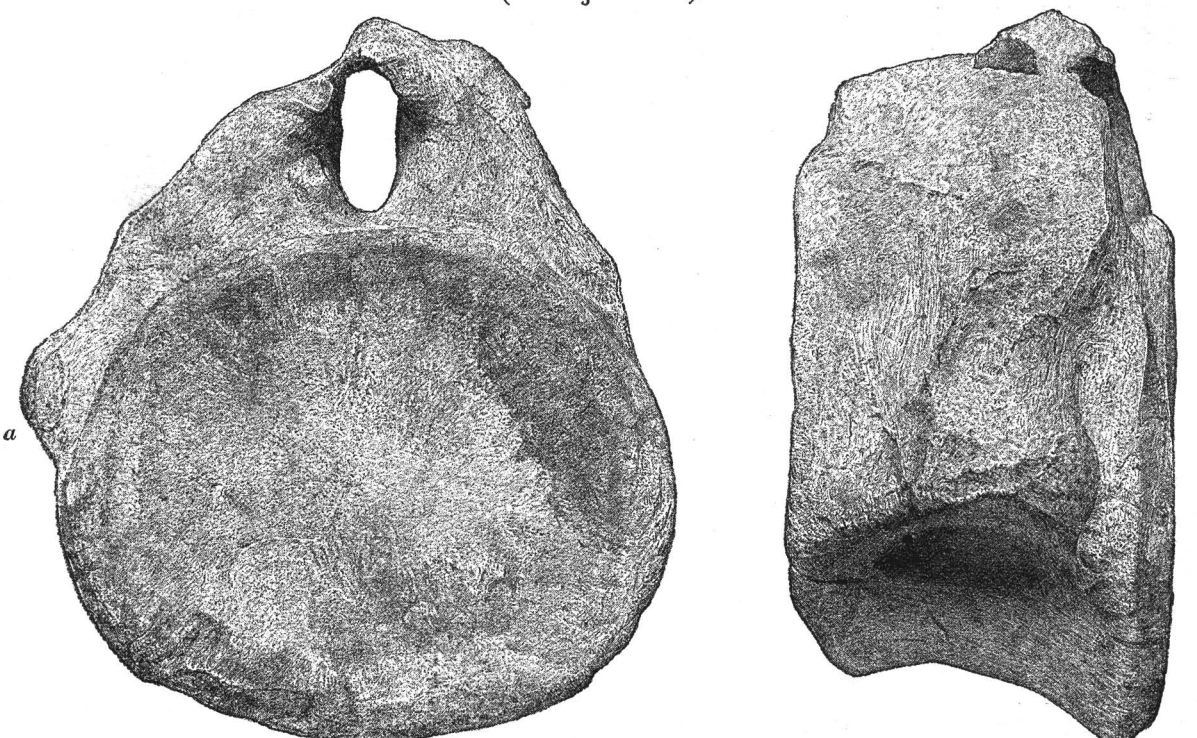
The centrum of a first caudal vertebra of large size is characterized by its extreme shortness and width: the anterior face being saddle-shaped from above downwards, and the posterior cupped. The length is $4\frac{3}{4}$, and the width 10 inches.

Both in form and size this vertebra closely resembles the anterior caudals of *Pelorosaurus Leedsi*, from the Oxford Clay of Peterborough, although the latter are abnormally shortened from the effects of pressure. In this, as well as in the more posterior caudals, there are no lateral pits.

From among several examples of vertebræ occupying a more posterior position in the caudal series, the one represented in fig. 5 (p. 334) is selected for illustration. Relatively longer than the last, this specimen has its anterior face flat and heart-shaped, while the hinder face is somewhat cupped. Chevron-facets are shown on both the front and hind borders of the inferior surface, indicating that the chevrons articulated with two adjacent vertebræ. The posterior caudals, of which there are several more or less imperfect examples, have the general form common to sauropodous dinosaurs, with flat terminal faces.

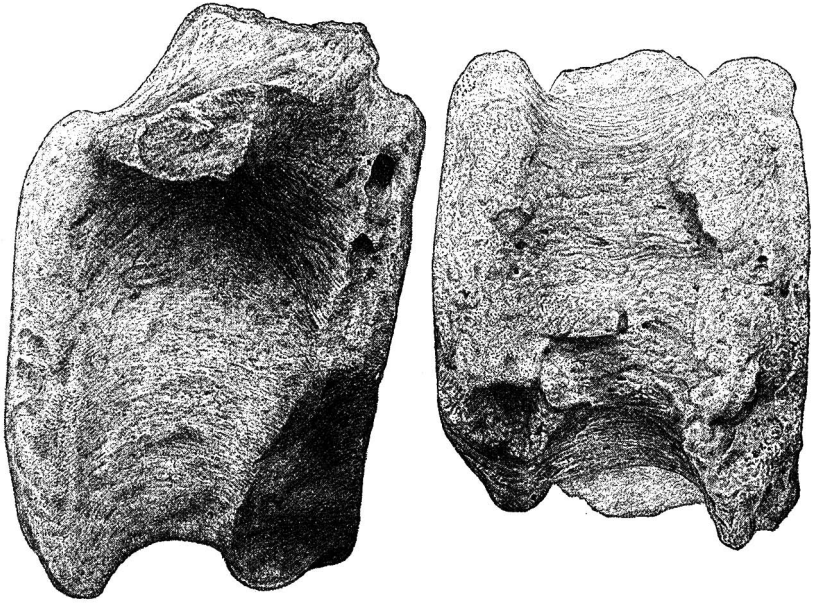
Since the remains of the pectoral and pelvic girdles, as well as the limb-bones, are very imperfect and broken, it seems unnecessary to describe them, more especially as bones like the femur do not generally afford any very well-marked generic characters. It may be mentioned, however, that the two extremities of a femur indicate a bone apparently closely resembling in size and form the femur of *Cetiosaurus oxoniensis*.

Fig. 4.—*Terminal and left lateral aspects of imperfect last lumbar vertebra of* Bothriospondylus madagascariensis. (*About* $\frac{1}{3}$ *nat. size.*)



Regarding the affinities of the gigantic dinosaur represented by the above-described vertebræ, the flat terminal faces of the posterior caudal vertebræ indicate that it cannot be identified with *Titanosaurus* of the Cretaceous of India, England, and Patagonia. From *Hoplosaurus* (*Ornithopsis*) it is at once distinguished by the narrow septum between the lateral cavities of the centra, the septum of the latter being of great thickness, and, like the rest of the centrum, much cancellated. Moreover, there is no communication between

Fig. 5.—*Left lateral and inferior aspects of the centrum of an early caudal vertebra of* Bothriospondylus madagascariensis. (*About* $\frac{1}{3}$ *nat. size.*)



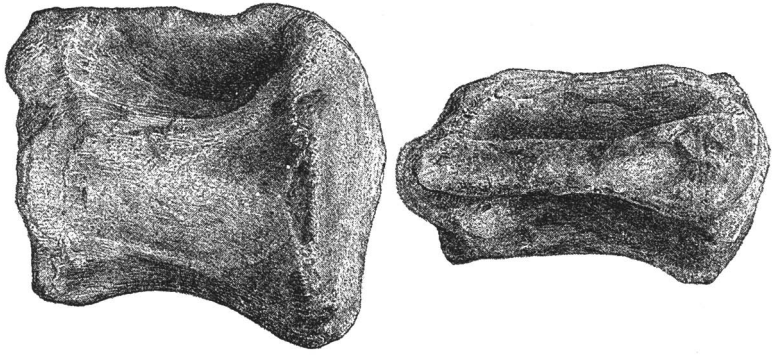
the lateral cavities of the centrum and the interior, as is the case in *Hoplosaurus*. Similar differences serve to distinguish the vertebræ from those of *Morosaurus*.[1]

Unfortunately the dorsal vertebræ of *Cetiosaurus oxoniensis* are so badly preserved, and so imperfectly figured, that I am unable to say anything regarding their lateral cavities; and I am unacquainted with any specimens of those of *Pelorosaurus*. From the resemblance of the other remains of these genera to those of *Atlantosaurus*, *Brontosaurus*, etc., it is, however, quite probable that at least in the typical Wealden representative of the latter the vertebræ were of the *Hoplosaurus*-type, as are those of the American genera.

[1] See Lydekker, Quart. Journ. Geol. Soc. vol. xlix. (1893) p. 277, fig. 1.

There are, however, in the British Museum certain dorsal vertebræ which, although of much smaller dimensions, agree precisely with those of the form under consideration in structure. The first of these are from the Kimeridge Clay, and were described by Owen under the name of *Bothriospondylus suffossus*, of which genus they constitute the type. They indicate a very immature dinosaur, and from their immaturity I have thought that they might belong to the young of one of the other genera.[1] These specimens have the lateral pits precisely similar to those in the dorsal vertebra of the Malagasy form, while a comparison with the latter shows that the dividing septum was of the narrow type. The whole bone, moreover, appears to be devoid of cancellation. Formerly I thought it possible that these features might be those of the immature state of forms like *Hoplosaurus*, but the specimens before us clearly demonstrate that this is not the case. Another dorsal vertebra of similar type, from the Forest Marble of Wiltshire, was likewise referred by Owen to *Bothriospondylus*, under the name of *B. robustus*. This specimen, represented in fig. 6, likewise agrees in all respects

Fig. 6.—*Lateral and superior aspects of centrum of dorsal vertebra of* Bothriospondylus robustus. (*About* $\frac{1}{3}$ *nat. size.*)



with the dorsal vertebra from Madagascar; and it is quite clear that, with the materials at present available, it is impossible to separate generically the two forms. I accordingly propose to refer the Malagasy dinosaur to the genus *Bothriospondylus* (which is now for the first time susceptible of definition) under the name of *B. madagascariensis*, taking the dorsal vertebra represented in fig. 3 (p. 331) as the type: the species being sufficiently characterized by its large size.

We have thus evidence that *Bothriospondylus* indicates a type of sauropodous dinosaur quite distinct from, and apparently much less specialized than, the Atlantosauridæ (in which *Hoplosaurus* and

[1] See Cat. Foss. Rept. Brit. Mus. pt. iv. (1890) p. 242.

probably *Pelorosaurus* may be provisionally included). Unfortunately, as already said, I cannot be sure as to *Cetiosaurus*, although I am inclined to think that the vertebræ had pits of a different type from those occurring in *Bothriospondylus*. If this be so, the latter genus cannot be included in the Cetiosauridæ; and as it certainly indicates a family-type distinct from the Atlantosauridæ, the name Bothriospondylidæ may be provisionally suggested.

There is, unfortunately, a considerable degree of doubt as to whether the generic name *Bothriospondylus* is entitled to stand, since, as I have shown elsewhere,[1] it is highly probable that *B. robustus*, which cannot be generically separated from the type-species, is really identical with *Cardiodon*, described at a much earlier date upon the evidence of a tooth. If this supposition is eventually verified, the name *Bothriospondylus* will have to yield to *Cardiodon*, and Bothriospondylidæ to Cardiodontidæ.

The identification of the Malagasy dinosaur with a type occurring in the Upper and Lower Jurassic of England, but unknown in the Cretaceous, harmonizes with the reference of some of the fossiliferous strata of Madagascar to the former period.

Discussion.

The President remarked upon the great interest attaching to the discovery of an *Ornithopsis*-like dinosaur in Madagascar, in rocks of supposed Jurassic age, and referred to the recent paper by the Rev. Richard Baron, in which he described Jurassic beds as occurring in the North-west of Madagascar, where these remains were reported to have been obtained.

Prof. Hull, Prof. Seeley, and Mr. E. T. Newton also spoke, and the Author replied.

[1] Cat. Foss. Rept. Brit. Mus. pt. iv. (1890) p. 236.