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SAUROPOD DINOSAUR HUMERI FROM LAMETA GROUP (UPPER CRETACEOUS—? PALAEOCENE) OF KHEDA DISTRICT, GUJARAT

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ABSTRACT

Five well preserved humeri of sauropod dinosaur from the conglomerate/grit beds of Lameta Group (Upper Cretaceous—? Palaeocene) from near Rahioli village in Balasinor Taluka, Kheda district, Gujarat are described. They are close to *Antarctosaurus septentrionalis* Huene from Lameta Group of Jabalpur (M.P.) in the shape and proportion of the head and size of the humerus.

INTRODUCTION

During the excavation at a recently discovered site of dinosaur remains in Rahioli area, Balasinor Taluka of Kheda district, Gujarat (Western India) (Fig. 1), different parts of dinosaur skeletons were recovered in a disarticulated state. These bones were extracted from shallow pits dug on the slopes of a high ground formed of Lameta beds. Before removal of the fossil bones from the pits, their original disposition after removing the overburdon was recorded, so that a permanent and reliable record of their relative position is at hand. The five humerii described here were collected from the conglomerate and grit beds of Lameta Group (Upper Cretaceous—? Palaeocene) from a locality 1 km west of Rahioli village on Rahioli-Bhanthala road.

Since the matrix adhering to the fossils is very hard and extremely difficult to be freed, it may take considerable time before all the material is carefully cleaned and prepared for illustration and description, and also for the possible restoration of the skeleton. It was, therefore, considered desirable to publish the accounts of the interesting materials which need no further development. This paper is the second in such series; the first being on dinosaur teeth (Mathur and Srivastava, in press). Five, well preserved humeri, four of which presumably belong to two individuals, are being described here and their affinity discussed. The ensuing discussions discount the first impression gained by examining the collection of assorted bones of varied forms and sizes, that no single individual is likely to be present in the collection. It can, therefore, now be hoped that when further material is developed and described, more and more parts of a single individual/species will come to light, thereby making it possible to restore the complete skeleton of a Kheda dinosaur.

The Cretaceous sauropod dinosaurs from India are known by only four species assigned to three genera.

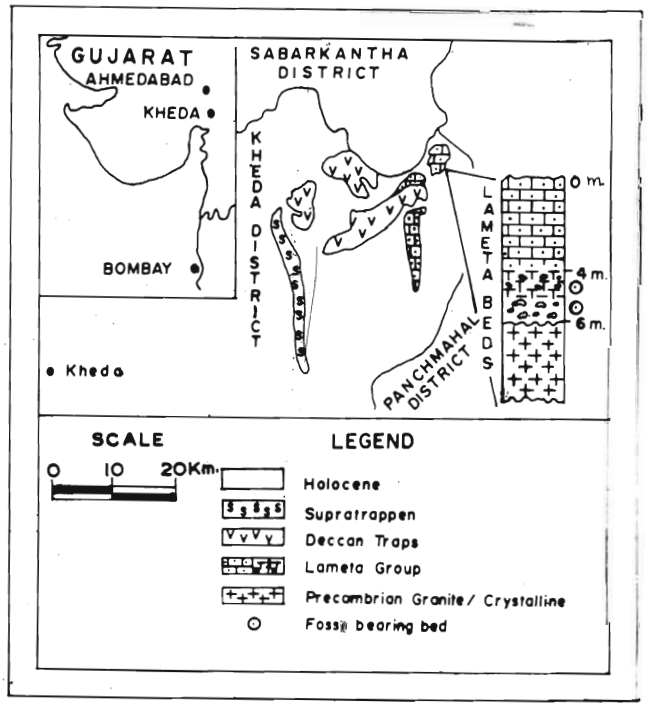


Fig. 1 Geology of Kheda district and stratigraphic succession of dinosaur bearing locality.

They are *Titanosaurus indicus* Lydekker, *T. blanfordi* Lydekker, *Antarctosaurus septentrionalis* Huene and *Laplatosaurus madagascariensis* (Deperet). They are known from Jabalpur, Pisdura, Doongargaon and Umrer in Central India (Huene and Matley 1933, Prasad and Verma 1967, Berman and Jain 1982). Out of these, the only species whose humeri are described is *Antarctosaurus septentrionalis* from the Sauropod Bed as well as from Carnosaur Bed (Lameta Group) of Bara Simla, Jabalpur (Huene and Matley 1933, pp. 21, 29-30). Since the knowledge of the humerus of dinosaur imparts a good deal of information on the animal's posture, movement, body weight, habitat, etc., the data presented here

on Kheda dinosaur humeri may be of immense value in not only assigning them to proper taxon but in the reconstruction of the environments in which the reptilian life existed in the area during the Late Cretaceous.

GEOLOGICAL SETTING

The dinosaur fossils described here were collected from the eastern slope of a north-south trending hillock, about 1 km west of Rahioli village in Balasinor Taluka (sub-division), Kheda district. In this area, the sedimentary succession, comprising conglomerate, grits, calcareous sandstone and arenaceous limestone, in ascending order, belongs to Lameta Group. The sedimentaries overlie the Precambrian Godhra Granite. The Deccan Traps which overlie the Lameta sediments elsewhere have been eroded away in the study area, but their effect in the form of extensive chertification of Lameta sediments can be noted.

While the material was collected from the conglomerate and grit beds at the base of the Lameta succession, the upper fine grained arenaceous limestone of the adjacent areas have yielded a number of dinosaur eggs and their clutches (Mohabey, 1983, 1984). But for the dinosaurian remains and a few crocodilian teeth, no other mega fossils have been found in the sediments of the area. However, on the basis of angiospermic seeds recovered from the dinosaur egg bearing beds of Balasinor area it has been inferred that they are Upper Cretaceous—? Palaeocene in age.

DESCRIPTION

The specimen Nos. 20008, 20010 and 20012 are the right humeri (Plate I—1, 3, 4), while the other two bearing Nos. 20009 (Plate I—2) and 20011 are the left ones. The humeri Nos. 20008 and 20009 form one pair with a length of 70 cm and the humeri Nos. 20010 and 20011 with a length of 78 cm form another pair. The specimen no. 20012 is largest of all having a length of about 85 cm when reconstructed (Table 1). These solid but slender humeri with both the extremities a little expanded, have a Gracility Index** varying from 73 to 78. The deltopectoral ridge is quite prominent in all the specimens. It lies a little away from the head and rises to its apex some distance down the shaft where it makes a prominent point at the lower end of the crest and then immediately slopes down to merge with the shaft. The ratio of deltopectoral crest to the length of humerus is about 1:3. On reconstruction, the articular head appears to be posteriorly placed and is slightly curved. In the Type No. 20008 the radial and ulnar areas are clearly seen as rounded convexities separated by a groove (Plate I—3b).

Repository: A right humerus, GSI Type No. 20008; two left and two right humeri, GSI Type Nos. 20009-20012. The specimens are deposited in the Type collection of the Geological Survey of India, Calcutta.

REMARKS

There is no doubt that the long humeri under consideration belong to sauroped dinosaur and not to the theropods or ornithischians. This is because in the latter, the forelimbs are much reduced in size. They do not belong to even stegosaurian dinosaurs in which the forelimbs are small, being about 35 cm long in the *Stegosaurus* from Jabalpur (Chakravarti 1934).

From the Cretaceous sediments of India,, the humerus of only one sauroped dinosaur species viz., *Antarctosaurus septentrionalis* Huene is known (Huene and Matley 1933, p. 21, 29-30) with which the Kheda material is compared below:—

	Antarctosaurus septentrionalis Huene	Present material
Length of humerus	134 cm	70-85 cm
Gracility Index of humerus	80	77-78
Ratio of deltopectoral ridge to the length of humerus	2.8	2.8-3.0
Shape of Deltopectoral ridge	Lower end with prominent point	Lower end with a prominent point
Shape of proximal end of humerus	Straight	Curved

From the above comparison, it is evident that the material under discussion shows some characters in

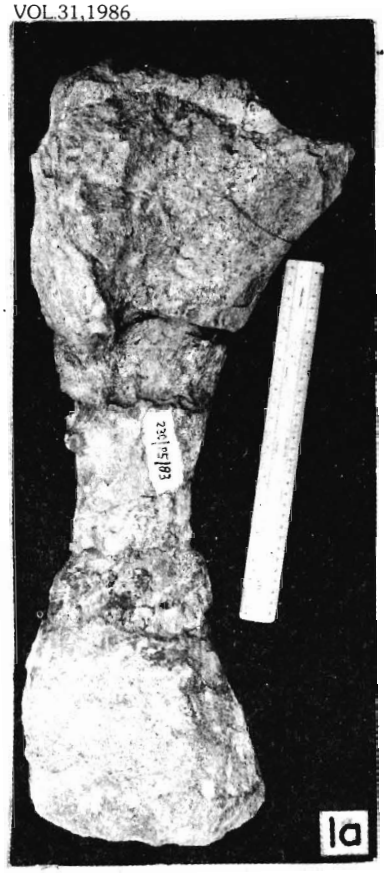
Table 1. Dimensions (in cm) of humeri. The length of reconstructed humeri are given in parantheses.

Sl. No.	GSI Type No.	Position of the humerus	Greatest length	Delto-pectoral ridge length	Transverse Diameter Proximal	Distal	Medial	Gracility** Index
1.	20008	Right	67 (70)	25	24	20	10.0	77
2.	20009	Left	61 (70)	25	24	20	10.5	78
3.	20010	Right	78	28	26	20	11.5	74
4.	20011	Left	78	28	25	21	11.0	73
5.	20012	Right	52 (85)	28	31	—	11.0	—

Gracility Index (GI) is a measure of the robustness of the humerus and is calculated by the formula given below:-

$$GI = \frac{Dp+Dm+Dd}{L} \times 100$$

Where Dp, Dm, Dd are the proxinal, medial and distal diameters of the humerus and L is the total length of the bone.


1a


3a


3b


1b


2


4

common with the humerus of *A. septentrionalis*, particularly in the shape and size-proportion of the deltopectoral ridge. In both, the lower end of the deltopectoral crest has a prominent point instead of being a plate as in some other sauropods. Besides, the ratio of the length of the humerus to that of the deltopectoral ridge is about 1:3 in Kheda as well as in Jabalpur species. Even the Gracility Index of 73 to 78 in the Kheda species is closer to that of *A. septentrionalis* in which it is 80. The main point of divergence between the Jabalpur species and Kheda species lie in the shape of the proximal end of the humerus, which is straight in the former and curved in the latter. Although this character along with the much smaller length of the Kheda species (being 70 to 85 cm as compared to 134 cm in Jabalpur species) seem to be sufficient to put the material under a new species but the authors at this stage do not propose to do so till more skeletal elements from the collection are studied and described.

The Gracility Index of humerus in some of the sauropod dinosaur species is given below (Table 2).

Table 2. Gracility Index (GI) of humerus in Sauropod Dinosaur (modified after Santafe *et al.*, 1982)

Family Brachiosauridae	
Subfamily Brachiosaurinae	
Brachiosaurus brancai	63
Bothriospondylus madagascariensis	71
Brachiosaurinae indet	72
Family Camarasauridae	
Subfamily Cetiosaurinae	
Cetiosaurus oxoniensis	84
Subfamily Camarasaurinae	
Camarasaurus (Morosaurus) grandis	88
Family Titanosauridae	
Subfamily Titanosaurinae	
Antarctosaurus septentrionalis	80
Argyrosaurus superbus	94
Titanosaurus australis	97
Subfamily Apatosaurinae	
Apatosaurus excelus	110
Present material	73-78

From the above it has been inferred that the Kheda species was perhaps relatively more agile species (GI-73-78) than the patagonian sauropod dinosaurs of the family Titanosauridae viz:, *Titanosaurus australis* (GI-97) and *Argyrosaurus superbus* (GSI-94). Curiously, the GI of Kheda species is quite low as that of the bulkiest of all sauropod dinosaurs of the family Brachiosauridae (63-72). Its implications will be better understood when more skeletal elements from Kheda are described and habitat interpreted.

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REFERENCES

BERMAN, D.S. & JAIN, S.L. 1982. The braincase of a small sauropod dinosaur (Reptilia: Saurischia) from the Upper Cretaceous Lameta Group, Central India, with review of Lameta Group Localities. *Ann. Carnegie Mus.* **51**: 405-422.

CHAKRAVARTI, D.K. 1934. On a stegosaurian humerus from the Lameta beds of Jabalpur. *Quart. Jour. Min. Met. Soc. India.* **3**: 75-79.

HUENE, F. VON., & MATLEY, C.A. 1933. The Cretceous Saurischia and Ornithischia of the Central Provinces of India. *Mem. Geol. Surv. India, Palaeont. Indica, n. sr.* **21**: 1-74.

MATHUR, A.K. & MATHUR, U.B. 1985. Boraginaceae (Angiosperm) seeds and their bearing on the age of Lameta beds of Gujarat. *Curr. Sci.* (in press).

MATHUR, U.B. & SRIVASTAVA, S. 1985. Dinosaur teeth from Lameta Group (Upper Cretaceous), Kheda district, Gujarat. *Jour. Geol. Soc. India* (in press).

MOHABEY, D.M. 1983. Note on the occurrence of Dinosaur fossil eggs from Infratrappean limestone of Kheda district, Gujarat. *Curr. Sci.* **53**, (24): 1194.

MOHABEY, D.M. 1984. The study of Dinosaurian eggs from Infratrappean Limestone in Kheda district, Gujarat. *Jour. Geol. Soc. India.* **25**(6): 1-9.

PRASAD, K.N. & VERMA, K.K. 1967. Occurrence of dinosaurian remains from the Lameta beds of Umrer, Nagpur district, Maharashtra. *Curr. Sci.* **36**(2): 547-548.

SANTAFE, J. VTE., CASANOVAS, M.L., SANZ, J.L. & CALZADA, Y.S. 1982. Geologia and Paleontologia (Dinosaurios) de la capas rojas de Morella (Castellon, Espana). *Diputacion Provincial de Castellon Y Diputacion de Barcelona, Castellon, Barcelona.*

EXPLANATION OF PLATE

PLATE I

(All figures are about 1/6, 5th natural size)

1. *Right humerus of a sauropod dinosaur, GSI Type No. 20010 (Reg. No. GSI/PAL/WR/230); a. ventral view, b. dorsal view.*
2. *Left humerus of a sauropod dinosaur, GSI Type No. 20009 (Regd. No GSI/PAL/WR/153); ventral view.*
3. *Right humerus of a sauropod dinosaur, GSI Type No. 20008 (Reg. No. GSI/PAL/WR/9); a ventral view; b. dorsal view.*
4. *Right humerus of a sauropod dinosaur, GSI Type No. 20012 (Reg. No. GSI/PAL/WR/155); ventral view.*