JOURNAL OF THE PALAEONTOLOGICAL SOCIETY OF INDIA
VOL. 32, 1987, P P. 20 — 25

A NEW SIRENIAN FROM THE MIOCENE OF KACHCHH, WESTERN INDIA.

SUNIL BAJPAI, M.P. SINGH AND PRATAP SINGH.

1. CENTRE OF ADVANCED STUDY IN GEOLOGY, PUNJAB UNIVERSITY, CHANDIGARH-160014.
2. GEOLOGY DEPARTMENT, LUCKNOW UNIVERSITY, LUCKNOW.
3. KDMIPE, OIL & NATURAL GAS COMMISSION, DEHRADUN.

ABSTRACT

A new fossil sirenian *metaxytherium kachchhnesis* sp. nov. is recorded from the sediments belonging to the Khari series (Lower Miocene) exposed in the Khari River section near Aida in Southwestern Kachchh. On the basis of foraminiferal biostraitigraphy and the associated molluses these sediments have been inferred to be Aquitanian in Age. *M. Kachchhensis* n - sp. can be differentiated from other species of the genus in several minor features. The species has well developed tusks and temporal crests and a massive, elongated snout without boss. Environments reconstructed for the beds yielding this species indicate littoral to shallow marine conditions.

INTRODUCTION

During the course of field investigations undertaken in 1979 in the Khari River Section near Aida (68° 48' : 23° 24' 10''), SW Kachchh (inset, Fig. 1), a large number of vertebrates were collected by two of us

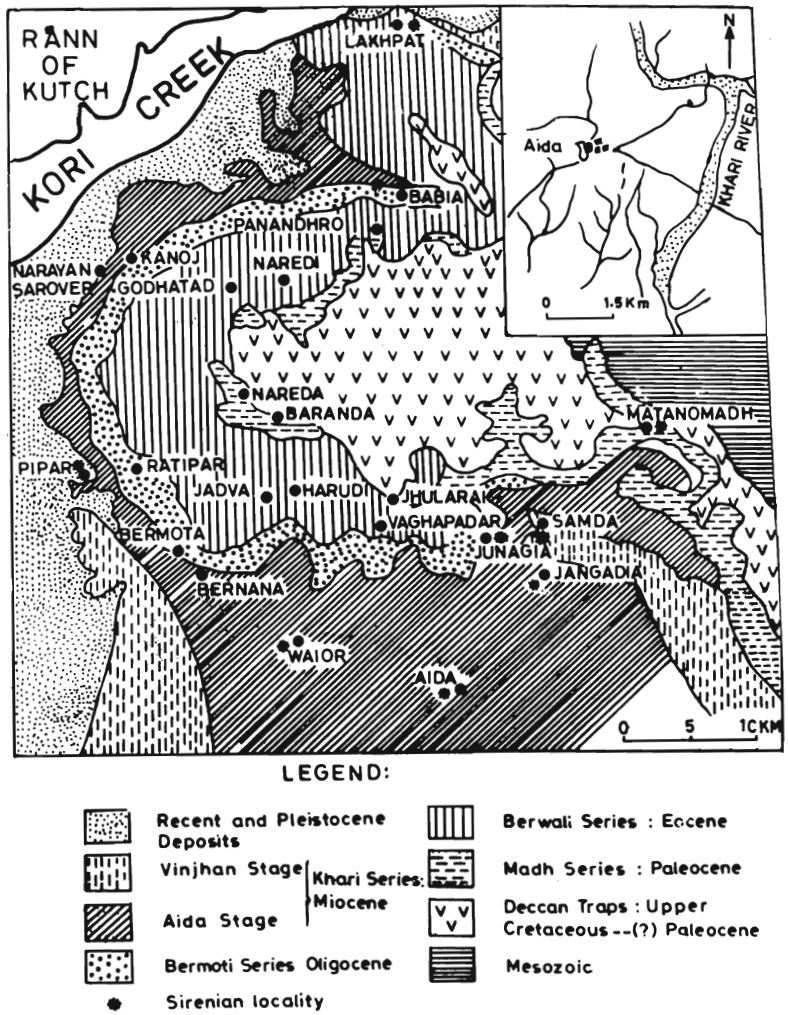


Fig. 1. Geological map of a part of southwestern Kachchh showing Oligo-Miocene sirenian localities. Inset shows the location of sirenian yielding horizon (modified after Biswas and Deshpande, 1970).

(MPS and PS) from the Miocene beds. The collection included a complete skull of a sirenian recovered from a 6 m thick horizon of grey gypseous shales. These sirenian yielding beds belong to the Aida Stage (Biswas and Deshpande, 1970); Later, they were included in the 'Khari Nadi Formation' proposed by Biswas and Raju (1971). A geological map of a part of southwestern Kachchh, also showing the Oligo-Miocene sirenian localities is given in Fig. 1.

The last decade has been significant for the discovery and documentation of Tertiary marine mammals from the Indian Subcontiment. Apart from the archaeocetes reported from Western India (Sahni and Mishra, 1972, 1975; Satsangi and Mukhopadhyay, 1975, Sahni; 1979 and Kumar and Sahni, 1986), the bulk of the marine mammals is represented by fossil sirenians ranging in age from the Ypresian (Lower Eocene) to Burdigalian (Lower Miocene). Sahni and Kumar (1980) described the taxon *Ishatherium subathuensis*, on the basis of dental and post cranial material from the basal Subathu Formation (Ypresian). The form had well developed tusks and the molars were in the process of becoming bilophodont. Doubts have been cast on the sirenian affinity of *I. subathuensis* and the species has been included in the family Anthracobunidae (Wells and Gingerich, 1983). The precise taxonomic assignment of *Ishatherium* awaits confirmation when additional material is forthcoming. It is noteworthy that the basal suite of rocks which has yielded *Ishatherium* also bear one of the most primitive centageans known (R.S. Rana, pers. comm.). Middle Eocene sirenians close to *Protosiren* have been recovered from bioclastic shell limestones and gypseous shales of Babia state (Lutetian) of Kachchh (Sahni and Mishra, 1975, S. Bajpai, in preparation). Record of sirenians from younger horizons (Oligo-Miocene) date back to Grant's report (1840) of rib bones from the so called 'Nummulitic Limestone and Marl unit' exposed near Aida. This unit is now considered to represent a Chattian Aquitanian sequence, represented by the Waior Stage (Bermoti Series) and the Aida Stage (Khari Series). Wynne (1872) also reported the occurrence of vertebrae and large rib bones from sediments which are now regarded as representing the Aida and Vinjhan Stage (Lower Miocene).

The Kachchh sirenians include *Halitherium* from the grey coloured shales of Aquitanian age, both at Matanomadh (68° 57' : 23° 32' 37''). The latter species is also known by a premaxillae recovered from the ferruginous conglomerates (Burdigalian) at Samda (68° 52' : 23° 28' 40'') (Sahni and Mishra, 1975). Other reports include those of Satsangi and Trivedy (1978) and Savage and Tewari (1977). The latter have recorded *Metaxytherium* sp. (listed as *Halitherium* in text figs.) from sediments outcropping between Vinjhan (69° 01' : 30'' : 23°06') and Waior (68° 41' 45'' : 23° 25') and probably of Burdigalian age.

All the above mentioned reports were based on fragmentary material. The present paper describes, for the first time, a complete sirenian skull, found together with a broken humerus. Unfortunately, however, subsequent breakage of the specimen during preparation renders it difficult to make a detailed study, and consequently, only a broad description and comparison have been given in the present paper.

Fossils associated with the present species of *Metaxytherium* namely *M. kachchhensis* n. sp. include *Miogypsina (Miogypasinoides)* cf. *dehaarti, Miogypsina (Miogypsina) complanata* and *Heterostegina* sp. and molluscs like *Ostrea angulata, Turritella* and *Cypraea* sp. The fauna is indicative of an Aquitanian age for the sirenian yielding sediments.

A shallow marine environment with a slowly transgressing sea has been inferred for the sediments yielding the above fauna.

Repository: The material described in this paper is stored in the Laboratory of Vertebrate Palaeontology, Geology Department, Lucknow University, Lucknow (LUVP/MP 1032).

SYSTEMATIC DESCRIPTION

Order Sirenia
Family Dugongidae GRAY
Genus. Metaxytherium CHRISTOL, 1840

In view of the rather complex problems connected with Euamerican (Palaearctic) Miocene-Pliocene sirenians, it is necessary to define the characteristics of the genus *Meaxytherium*. In doing so, the authors have followed observations of Reinhart (1976) with some slight modifications related mainly to the taxonomic value of the temporal crests.

Metaxytheres are characterised (along with some European felsinotheres) chiefly by nasals which are not united in the midline i.e., with frontals separating the nasals; tusks well developed in European and Indian taxa in contrast to the conditions in North American forms; rostrum considerably deflected but less than that in *Halitherium* and *Ducong;* an anteroposterior elongate boss present on the frontals; the supraoccipital not necessarily forming part of the foramen magnum but close to its dorsal border, M^3 elongate obovate to subquadrate, with a forwardly displaced metaconule, blocking the transverse median valley.

Mataxytherium kachchhensis n. sp.
(Plate I — a-f)

Holotype : LUVP/MP 1032, Complete skull
Diagnosis : Skull robust, nearly equal in length to *M. cuvieri*.but narrower; greatest width in a section which includes the greatest width of the mesorostral fossa; jugal squamosal arches nearly parallel; skull width across parietals only slightly smaller than the greatest

width; upper tusks well developed, oriented downwards and outwards; premaxillaries robust with considerable anterior width, gently downcurved (32°); rostral boss lacking; fronto-parietal regions fairly wide, limited laterally by well developed temporal crests which converge towards each other moderately near the fronto-parietal suture; frontal boss weakly developed; supraoccipital not in contact with the foramen magnum and oriented more or less normal to the parietals; M^3 obovate, divided by a pominent lingual re-entrant into a slightly larger posterior and a smaller anterior portion; M^2 and M^1 transverse, subquadrate and subtriangular in outline respectively and smaller in size than those in *M. ossivalense*, *M. floridanum* and *M. calvertense*.

Description : The skull of *Metaxytherium kachchhensis* n.sp. is about as long as that of *M. cuvieri* but is narrower than it. Posteriorly the height of the cranium is about 160 mm, as is the case in *Dusisiren jordani* (Dmning, 1978, p. 24). The premaxillaries are long and massive, forming slightly less than half the total length of the skull. They gradually widen posteriorly and are somewhat convex on sides. In contrast to *Dusiren ,hesperosiren* and North American metaxytheres which have a narrow wedge shaped rostrum, the present species shows considerably anterior rostal width. The rostrum is rather weakly deflected (32°) being intermediate to those seen in *Dusiren jordani* and *Hydrodamalis cuestae* (Domning, 1978, pls. 1B and 16B). The rostral boss which is present in varying degree of development in all sirenians, is lacking in *M. kachchhensis* n.sp. The palatal surface of the premaxillaries although crushed, is seen to be somewhat concave. The tusks are well developed having a more or less cylindrical anterior cross section as in *Indosiren koenigswaldi* (Sahni and Mishra, 1975). They are downwardly directed and show much stronger lateral diversion, as compared to those in *Halitherium olseni* (Reinhart, 1976).

The mersorostral fossa is oval in outline with its estimated length only slightly greater than that in *Dugong* (Dechaseaux, 1958, p. 335). However, the posterior end is widened in *Ducong* unlike the present species. The greatest width of the fossa which occurs nearly at the centre, also represents the greatest width of the skull. The maximum width across the parietals is, however, only slightly smaller. There is a faint suggestion of a modertely developed anterior arch, in contrast to the well developed arches exhibited by *M. ossivalense* and *Dugong*.

The naso-frontal suture, though not well preserved, suggests a separations of the nasals by the frontals. The frontals are elongate, probably more than in *M. ossivalense* and are markedly concave dorsally. They are limited laterally by well developed, thick temporal crests which are widely separated. The frontal boss which characterises all species of *Metaxytherium* and referred felsinotheres is seen in the pesence of a very gentle, low convexity, similar to that seen in *M. cuvieri*. This becomes virtually non-existsent anteriorly. The supraorbital processes appear well developed and possess a distinct posterolateral extremity. The lachrymals are obscure.

The partietals are massive and gently slope posteriorly. Widely separated, thick tempoal crests follow the dorsolateral borders of the parietals becoming rather weak posteriorly. These crests converge towards each other moderately. The minimum separation (33 mm) is seen slightly posterior to the fronto-parietal junction. This is quite comparable to that in *Hesperosiren* (41 mm) (Reinhart, 1976, p. 231), and is less than half the corresponding figure in *M. curvieri* (Flot, 1986). In comparision to the conditions in all other metaxytheres, the temporal crests in *M. kachchhensis* n.sp. extend to the lateral edges of the supraoccipital. The contact of the parietals with the supraoccipital is not discernible since, as in all sirenians, they are fused into a single bony unit. The two are, however, seen to meet in a more or less normal plane unlike the case in *Halitherium olseni* in which this juncture is at 115° (Reinhart, 1976, p. 248). The external occipital protuberance is broken. The supraoccipital appears to approach the foramen magnum but does not form part of it. The estimated separation is 14 mm, in comparison to 18 mm in *M. krahuletzi* (Abel, 1904), 10 mm in *M. iordani* (Reinhart, 1959) and 5 mm in *M. reinharti*. In contrast to this, the supraoccipital is in contact with the foramen magnum in *M. cuvieri*, *M. calvertense* and *M. ossivalense*. The exoccipitals meet the supraoccipital at an angle of about 140° which is comparable to 136° in *M. reinharti*. The occipital condyles are ovate in shape. As in *Halitherium olseni,* the lateral borders of the condyles are parallel to the outermost borders of the exoccipitals. A rather deep supracondylar fossa separates these two parts. The paraoccipital processes are strong and as in all metaxytheres and referred felsinotheres, extend slightly below the level of the condyles. The sutures between the basioccipital and exoccipitals are not clear. There is a prominent median keel in the basioccipital region, similar to that seen in *Hesperosiren* (Simpson, 1932). The pterygoid processes are well developed and begin about 2 cm lateral to the anterior end of this median keel. They are inclined laterally and possess a deep posterior groove. The medial margin of this groove has a moderately rounded crest whereas the lateral margin has no crest. This condition is similar to that seen in *Dugong*.

The jugal is strongly directed ventrally, the ventral most point being below the centre of the orbit. The zygomatic arches are almost parallel as seen in *Felsinotherium foresti*(Dachaseaux, 1958). The squamosal forms a prominent arc above the posttympanic proces-

ses, a feature exhibited by all sirenians.

Although M^{1-3} series occurs on both left and right sides, coronal details of none of the teeth are preserved except LM^2 in which paracone and metacone are seen. M^3 is elongate, obovate in shape. Both the anterior and the posterior margins are rounded. The length, as measured on the basal section, is less than those in *M. ossivalense, M. calvertense, M. floridanum* (Reinhart, 1976) and *Indosiren koenigswaldi* (Sahni and Mishra, 1975). The 1/w ratio (W-maximum width) ratio is less than in *M. calvertense* but greater than in *M. ossivalense, M. krahuletni, M. cuvieri* (Simpson, 1932) and *I. koenigswaldi* (Sahni and Mishra, 1975). The North American metaxytheres also have a much more squared-up M^3 in comparison to *M. kachchhensis* n. sp. A prominent lingual re-entrant divides the M^3 in the present species into a slightly larger posterior and a smaller anterior portion. This is in contrast to the conditions in *M. ossivalense* and *M. floridanum* in which the median valley separates the tooth into a larger anterior and a smaller prosterior portion. In *M. calvertense*, M^3 is divided by the median valley into nearly equal parts. M^2 is a transverse tooth, subquadrate in shape. As opposed to this, M^2 in *M. ossivalense, M. calvertense* and *M. floridanum* is longer than wide. Paracone and metacone are preserved with the former situated slightly more labially. They are closely appressed to each other and are of the same height. The lingual side of the tooth is missing. M^1 is also transverse, but is slightly smaller than M^2 and approaches a subtriangular shape.

Table 1 : Cranial measurements (in mm) of *Metaxytherium kachchhensis* n.sp. (LUVP/MP 1032)

Condylobasal length	512
Maximum height of the skull	158
Greatest width across perietals	218
Anterior width of rostrum	74
Length of mesorostral fossa	107
Maximum width of mesorostral fossa	64
Maximum height of rostrum	85
Distance between posterolateral extremities of supraorbital processes	164
Estimated length of the frontals (from anterior end of supraorbital processes to fronto-parietal suture)	152
Estimated length of the parietals	95
Minimum separation of temporal crests on parietals	33
Maximum separation of temporal crests on parietals	61
Length of the cranium from the posterior end of mesorostral fossa to the posterior border of parietals	214
Width across squamosals	185
Breadth across occipital condyles	111
Width of foramen magnum	35
Maximum width between left and right series of upper dentition (between lingual borders)	32

Measurements of the basal sections of the upper dentition (in mm)

		M^3	M^{2-}	M^1
Length		26	15	14
Width	Ant.	16		
	Post.	19	19	17

Remarks: *Metaxytherium* was a geographically widespread genus, found during the Lower Miocene to Early Pliocene from North America, South America and Europe. the first record from the Indian Subcontinent was by Savage and Tewari (1977) who described *Metaxytherium* sp. from the Lower Miocene sediments of Southeastern Kachchh. While it is obviously closely related to *M. kachchhensis* n.sp., there are certain essential differences between the reconstructed skull as illustrated by them and the present species. Firstly the skull in the latter is longer by about 70% of that in the former. Secondly, the premaxillaries in the former are strongly deflected, as is common in *Halitherium,* and possess a distinct rostral boss. In contrast to this, the rostrum of LUVP/MP 1032 forms a gentle arc and lacks the boss. Thirdly, in the former specimen, unlike the latter, the zygomatic arch is not strongly directed ventrally. Fourthly, the inclination of the supraoccipital to the parietals is oblique in the former specimen while it is nearly normal in LUVP/MP 1032.

The present species differs from *Metaxytherium ossivalense* principally in possessing tusks, lacking a swollen rostral boss and in the absence of contact between the supraoccipital and the foramen magnum. From *M. calvertense* it can be distinguished by lesser deflection of rostrum, absence of contact of supraoccipital with foramen magnum and by the presence of tusks. Also, M^3 in *M. calvertense* has a small cuspule appressed to the paracone which partially closes the median velley; this cuspule is lacking in the present species.

Domning (1978) has transfeerd *Metaxytherium jordani* Kellog to genus *Dusisiren* and has described its four species namely, *D. reinharti, Dusisiren* sp. B, *D. jordani* and *Dusisiren* sp. D. Discussing the relationships, he has regarded the Lower Miocene Austrian form *Metaxytherium krahuletzi* as the ancestor for *D. reinharti* which in turn has been regarded as the Middle Miocene ancestor for *D. jordani.* The present species differs from *Dusiren* as follows: The former has well developed tusks, unlike the latter; the supraoccipital does not touch the foramen magnum unlike the latter; the rostral deflection in the former is less (about 32°) than that

in the latter which is about 40°

The record of Indian fossil sirenians throughout the Tertiary indicate similar palaeoecological and palaeoenvironmental conditions. These are represented by coastal strand line deposits (bioclastic limestones, coquinas and oyster bearing sandstones) of the Tethyan basin in the northern part of the Indian Subcontinent (Subathu Formation, Himachal Pradesh of Ypresian age). Middle to Upper Eocene deposits are missing from the north Indian Himalayas and consequently the next younger record of sirenians comes from the Middle Eocene of Kachchh, Western India, where shallow marine sedimentation exists in a continuous succession upto atleast the Miocene (Sahni and Mishra, 1975). In both Himalayan and Kachchh Eocene occurrences, sirenians are associated with nummulitics. The Oilgocene occurrences again are represented by bioclastic shell limestones and ferruginous marls whereas the Lower Miocene sirenians are found in grey gypseous shales and ferruginous conglomerates (associated with the remains of *Deinotherum* in the latter, Sahni and Mishra, 1975,p.40)

As the record of fossil sirenians from India becomes better documented, it becomes more apparent that the early evolutionary history (and possibly origin) was lcoated in South Asia though by the Middle Eocene times sirenians had spread circumglobally.

ACKNOWLEDGEMENTS

The authors are grateful to Prof. Ashok Sahni, Centre of Advanced Study in Geology, Punjab University, Chandigarh, for his help in various ways in the preparation of the manuscript. One of us (SB) should also like to thank Dr. Roy H. Reinhart of Miami University, Ohio for providing literature.

REFERENCES

ABEL, O. 1904. Die sirenen der Mediterranean Tertiarbildungen Osterreichs. *Abh. K. K. Geol. Reichsanstalt Wein.* **19**(2): 1-223.

BISWAS, S. K. DESHPANDE, S.V. 1970. Geological and tectonic maps of Kutch. *Bull. Oil. at. Gas. Comm.* **7**(2): 115-120.

BISWAS, S. K. RAJU, D.S.N. 1971. Note on the rock stratigraphic classification of the Tertiary rocks of Kutch. *Bull. Geol. Min. Met. Soc. India.* **43**: 177-180.

DECHASEAUX, C. 1958. Sirenia. In *Traite de Paleontologie*, J. Piveteau, ed. Masson et Cie, Editeurs, Paris. **6**(2): 333-363.

DOMNING, D.P. 1978. Sirenian evolution in the North pacific Ocean. *Univ. Calif. Publ. Geol. Scien.* **118**: 1-176.

DOMNING, D.P., MORGAN, G.S. RAY, C.E. 1982. North American Eocene sea cows (Mammalia : sirenia). *Smith. Contri. Paleobiol.* **52**: 1-69.

FLOT, L. 1886. Description de Halitherium fossile Gervais. *Bull. Soc. Geol. Fr.* **3**(14): 483-518.

GRANT, C.W. 1840. Memoir to illustrate a geological map of Cutch. *Trans. Geol. Soc. London.* **5**(2): 289-326.

KUMAR. K. SAHNI, A. 1986. *Reminotonocetus harudiensis*, New combination, A Middle Eocene archaeocete (Mammalia, cetacea) from Western Kutch, India. *Jour. Verte. Paleont.* **6**(4): 326-349

REINHART, R.H. 1959. A review of the Sirenia and Desmostyla. *Univ. Calif. Publ. Geol. Sci.* **36**(1): 1-146

REINHART, R.H. 1976. Fossil Sirenians and desmostylids from florida and elsewhere. *Bull. Florida State Mus., Biol. Scien.* **4**(20): 187-300.

SAHNI, A. 1979. Miocene vertebrates from the coastal Tertiary rocks of Peninsular India and Sri Lanka. *Geol. Sury. India Mics. Publ.* **45**: 197-205

SAHNI, A., KUMAR, K. 1980. Lower Eocene Sirenia, *Ishatherium subathuensis*, gen. et sp. nov. from the Type Area, Subathu Formation, Subathu, Simla Himalayas, H.P. *Jour. Pal. Soc. India.* **23 24**: 132-135.

SAHNI. A. MISHRA. V.P. 1972. A new species of *Protocetus* (Cetacea) from the Middle Eocene of Kutch, Western India. *Palaeontology.* **15**(3): 490-495.

SAHNI, A. MISHRA, V.P. 1975. Lower Tertiary vertebrates from Western India. *Monogr. Pal. Soc. India.* **3**: 1-48.

SATSANGI, P.P. MUKHOPADHYAY, P.K. 1975. New marine Eocene vertebrates from Kutch. *Jour. Geol. Soc. India.* **16**: 84-86

SATSANGI. P.P. TRIVEDY. A.N. 1978. Fossil sea cow from the Tertiary of Kutch. *Jour. Geol. Soc. India.* **12**(19): 571-576.

SAVAGE, R.J. G. TEWARI, B.S. 1977. A new Sirenian from Kutch. India. *Jour. Pal. Soc. India.* **20**: 216-218.

SIMPSON, G.G. 1932. Fossil Sirenia of Florida and the evolution of the Sirenia. *Bull. Amer. Mus. Nat. Hist.* **59**: 419-503.

WELLS, N.A. & GINGERICH, P.D. 1983. Review of Eocene Anthracobunidae (Mammalia: Proboscidea) with a new genus and species, *Jozaria palustris* from the Kuldana Formation of Kohat (Pakistan). *Contri. Mus. Pal. Univ. Michi.* **26**(7): 117-139.

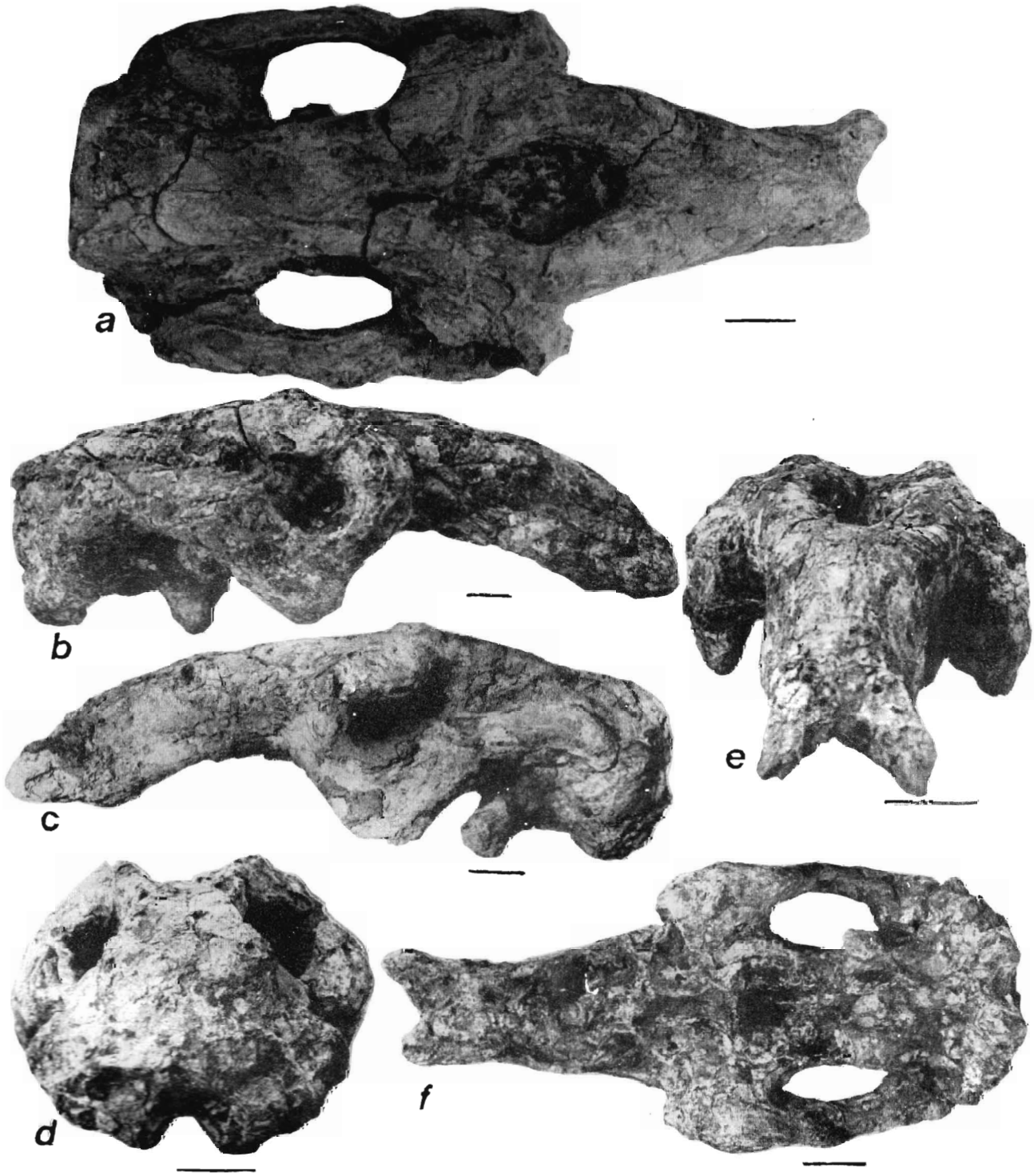
WYNNE, A.B. 1872. Memoir on the Geology of Kutch. *Mem. Geol. Surv. India.* **9**(1): 1-293.

EXPLANATION OF PLATE

PLATE I

Metaxytherium kachchhensis n. sp.

a. Dorsal view of skull, LUVP/MP1032(Holotype) X 0.26
b. Right lateral view X 0.21
c. Left leteral view X 0.21
d. Posterior view X 0.28
e. Anterior view X 0.33
f. Ventral view X 0.21



Bar = 5 cm