A NEW SPECIES OF *PROTOCETUS* (CETACEA) FROM THE MIDDLE EOCENE OF KUTCH, WESTERN INDIA

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ABSTRACT. The recent discovery of a cetacean from the Middle Eocene (Lutetian) beds of south-western Kutch is the earliest record of mammals from India. The Archaeoceti are represented in India by a new species of *Protocetus*, *Protocetus sloani* sp. nov., based on a partial skull and two mandibular fragments. The age of the bone-bearing horizon is Lutetian on the basis of an associated foraminiferal assemblage.

STUDIES of Tertiary vertebrates in India have mainly centred on the Neogene Siwalik beds of the Himalayan foothills, but recent finds of fossil cetaceans and other vertebrates in the Babia Stage (Lutetian) of the Berwali Series of Kutch have opened up new areas of palaeontological interest, having a significant bearing on the Palaeogene palaeobiogeography of the subcontinent.

The vertebrates were collected *in situ* in a dry stream section, about 3 km south-east of Baranda (lat. 23° 34′ 20″ N., long. 68° 43′ 10″ E.) in south-western Kutch. The beds are highly fossiliferous shallow-water marine deposits with abundant gastropods and pelecypods. On the basis of a rich foraminiferal assemblage, a Lutetian age has been determined for the sequence which is given below:

Oligocene (Lattorfian)	Glauconitic limestone
	—Unconformity—
	Cream limestone
	White marl
	Calcareous sandstone
	Grey marl
Middle	—Local unconformity—
Eocene (Lutetian)	Gritty sandstone
	Gypsiferous clay
	Chocolate limestone
	Green clay
	Variegated clay
	Ferruginous shale
	—Unconformity—
Lower	
Eocene (Ypresian)	Yellow marl

Bones are obtained from three main horizons. The oldest producing horizon is the chocolate limestone which contains well-preserved bones and vertebrae. The main horizon, however, appears to be the overlying Gypsiferous clay from which the poorly preserved cranial and mandibular fragments were collected. The third bone bed is the slightly younger Grey marl overlying a local unconformity. Associated with the cetacean material are some turtle plastron fragments, and an isolated tooth, probably of a fish.

The Tertiaries are particularly well developed in south-western Kutch and have been studied in considerable detail by Biswas (1965) and Biswas and Deshpande (1970). The

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sequence ranges from Upper Cretaceous to Recent. The Deccan basalts are overlain by lateritic conglomerates and tuffaceous shales with dicotyledonous leaf impressions and other plant remains of Palaeocene age (Madh Series). Unconformably overlying these beds are shales, marls, and limestones of Eocene age.

The Eocene in Kutch has been divided on the basis of foraminifera into a lower and upper division, corresponding to the Laki and Kirthar Series of the type-section of Sind-Baluchistan, respectively. The foraminiferal assemblage from the Middle Eocene rocks south-east of Baranda, has been described by Tandon (unpub. thesis, Lucknow, 1966) and includes *Nummulites acutus*, *N. stamineus*, *N. beaumonti*, *Discocyclina dispansa*, *D. javana*, *D. sowerbyi*, *Dictyoconoides cooki*, *Halkyardia minima*, and *Alveolina elliptica*.

Nuttall (1926), Tewari (1957), and Biswas and Deshpande (1970) have clearly demonstrated that the Middle Eocene beds of south-western Kutch are of Lutetian age. The Eocene beds are overlain successively by a thin band of Oligocene arenaceous marls, a thick sequence of Mio-Pliocene sandstones and carbonates, and a thin bed of Miliolitic Limestone of Pleistocene age. Recent and subrecent alluvium and wind-blown sand blanket parts of the Tertiary sequence.

There is no previous record of a Palaeogene mammal from India. Of the countries adjacent to India, Palaeogene mammal localities are so far known only from West Pakistan and Central Burma, two widely separated regions. In the north-western region of West Pakistan a mammalian fauna has been described from the Chharat Series of Middle Eocene age, and includes taeniodonts, creodonts, condylarths, brontotheres, anthracotheres, and other Artiodactyla (Pilgrim 1940, Dehm and Oettingen Spielberg 1958). The Creodonta are represented by at least four genera, of which two belong to the family Mesonychidae. The presence of mesonychids is significant in the context of Van Valen's (1966, p. 93) suggestion that this group is ancestral to the Archaeoceti.

In Central Burma, Primates, Artiodactyla, and Perissodactyla have been reported from the Pondaung Sandstones of Upper Eocene (Auversian) age (Pilgrim and Cotter 1916, Pilgrim 1925, 1928).

Other records of Protocetidae from the Eocene are: a partial scapula of *Anglocetus* from the London Clay (Lower Eocene) of England (Tarlo 1964), *Protocetus* from the Lower Lutetian of Egypt and Texas, and *Pappocetus* from the Lutetian of Southern Nigeria, and *Eocetus* from the Upper Eocene of Egypt. The other two families of Eocene whales are the shorter-skulled Dorudontidae and the gigantic Basilosauridae.

SYSTEMATIC DESCRIPTION

Order CETACEA Brisson 1762
Suborder ARCHAEOCETI Flower 1883
Family PROTOCETIDAE Stromer 1908
Genus PROTOCETUS Fraas 1904
Protocetus sloani sp. nov.

Plate 97, figs. 1–7; text-fig. 1A, B, C

Etymology. The species is named after Dr. Robert E. Sloan, Department of Geology, University of Minnesota, U.S.A.

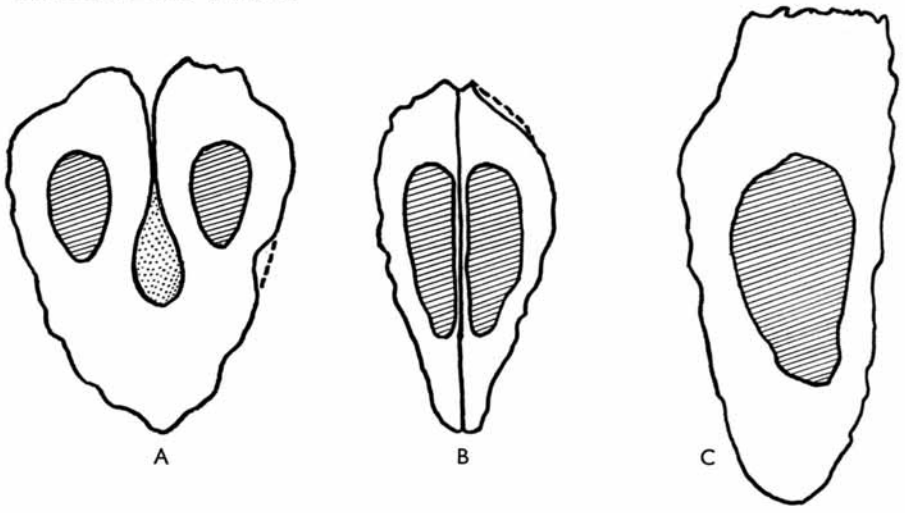
Diagnosis. Skull with a low sagittal crest, and a small lambdoidal crest; parietal narrow and elongated; temporal fossa large. Teeth extending far behind the anterior part of the orbits. Skull similar to that

of *Protocetus atavus* (Fraas 1904) but shorter in length with a larger foramen magnum and tympanic bullae. Lower dentition differing from that of *Pappocetus lugardi* (Andrews 1920); canine small, no diastema between C and P_1; and the symphysis extends posterior to P_2. Posterior part of lower jaw massive. P_4 longer than M_1, outer surface of jaw strongly curved, inner surface concave particularly near the ventral side.

Holotype. Anterior mandibular fragment, Specimen Lucknow University Vertebrate Palaeontology (L.U.V.P.) No. 11002 (Pl. 97, figs. 4, 5; text-fig. 1A, B), Museum, Geology Department, Lucknow University, Lucknow.

Locality. Stream section approximately 3 km south-east of Baranda (23° 34′ 20″ N., 68° 43′ 10″ E.) in the Gypsiferous clays of the Berwali Series, south-western Kutch, India (Toposheet No. 41 A/10).

Age. Middle Eocene (Lutetian).



TEXT-FIG. 1. *Protocetus sloani* sp. nov. A, posterior cross-sectional profile (Specimen 11002) ×1; B, anterior cross-sectional profile (Specimen 11002) ×1; C, posterior cross-sectional profile (Specimen 11003) ×1.

DESCRIPTION

The material of *Protocetus sloani* sp. nov. consists of a partial skull and two edentulous jaw fragments. The skull (L.U.V.P. 11001), which was found some distance away from the lower jaws, is in a highly gypsified and friable condition and lacks the portion anterior to the frontals (Pl. 97, figs. 1, 2, 3). The skull closely resembles that of *Protocetus atavus* (Fraas 1904) in dimensions and morphological features and is regarded as congeneric with it. Both the condyles are present in the specimen and the foramen magnum is large. As in *P. atavus*, the supraoccipital forms an almost vertical wall supporting the posterior part of the brain case. Although some of the postero-dorsal bones of the cranium are broken, it is apparent that neither the lambdoidal nor the sagittal crests were well developed, a condition

EXPLANATION OF PLATE 97

Figs. 1–7, *Protocetus sloani* sp. nov. 1–3 ×⅔; 4–7 ×approx. ⅔; 1–3, Right lateral, dorsal, and posterior views of L.U.V.P. 11001. 4–5, Left lateral, and occlusal views of L.U.V.P. 11002 (Holotype). 6–7, Left lateral, and occlusal views of L.U.V.P. 11003.

characteristic of the Protocetidae but differing from other Archaeoceti, such as Dorudontidae and Basilosauridae, where both the crests become very prominent. The highly altered and gypsified nature of the skull has obliterated many details, but on the right side, the contact of the parietal with the squamosal and frontal can be made out. These bones occupy the same position as in other members of the Protocetidae. The brain case is narrow and elongated, and the temporal fossa is large. The post-orbital process of the frontal is broken.

The bulla is well developed, and there appears to be a wide area between the petrosal and the basioccipital bone, a condition characteristic of mesonychids (Van Valen 1966, p. 92). The basioccipitals are covered by matrix. The palatine is narrow and elongated, and its contact with the maxilla is not clear. The maxilla bears a three-rooted molar series, spaced together and extending posteriorly behind the anterior rim of the orbits. The crowns of the teeth have been eroded away, only the roots and alveoli are visible.

The lower dentition consists of two mandibular fragments, which were found close together, but not in definite association with each other. They probably represent two different individuals of the same species. Of these L.U.V.P. 11002 contains the symphysis and alveoli for C, P_1, P_2, and P_3, while L.U.V.P. 11003 is more robust, with alveoli for P_4 and M_1 and the anterior alveolus for M_2. Though the length and depth of these jaws are almost identical to those of *Pappocetus lugardi* (Andrews 1920), the dimensions of the teeth are consistently smaller.

L.U.V.P. 11002 is an anterior mandibular fragment with right and left rami (Pl. 97, figs. 4, 5; text-fig. 1A, B). The symphysis is strong and is marked by a deep groove which becomes more pronounced posteriorly up to the posterior alveolus for P_2 whence the right and left rami begin to diverge. The outer sides of the rami on the dorsal surface are convex at the symphysial region, a condition that was noted in *Pappocetus lugardi* by Andrews (1920). In general, the jaw is laterally compressed, and the cross-sectional profiles are given in text-fig. 1A and B. Near the ventral side of each ramus, there is a deep groove which becomes shallower posteriorly, fading out completely at the point of divergence of the two rami.

As the jaw is edentulous, only tentative views can be expressed concerning the teeth that occupied the alveoli in the jaws. The assessment has been made on the basis of the following assumptions. Firstly, that C, P_1 are single-rooted and the teeth posterior to P_1 are two-rooted; and, secondly, that a condition similar to that in other protocetids, where the point of divergence of the two rami is either at the posterior end of P_2 or the anterior root of P_3, prevails.

The alveolus for the left canine is incomplete and there is no diastema between it and P_1. Judging from the shape of the alveolus for P_1, the first premolar was directed forward and slightly upwards. P_2 is separated from P_1 by a diastema of 16 mm. P_2 appears to be two-rooted and the posterior alveolus is larger. P_3 is separated from P_2 by a diastema of 8 mm and, as in P_2, the anterior alevolus is much smaller than the posterior.

Measurements (in cm) of L.U.V.P. 11002

Length of right mandibular fragment	9·2	Estimated length of C alveolus	0·65
Length of left mandibular fragment	7·5	Length of P_1 alveolus	1·0
Depth of right mandibular fragment at P_1	4·5	Length of P_2 alveoli	2·65
Depth of right mandibular fragment at P_3	5·2	Estimated length of P_3 alveoli	2·1

The only other mandibular fragment in the collection is a robust left jaw (L.U.V.P. 11003) with an asymmetrical cross-sectional profile (Pl. 97, figs. 6, 7; text-fig. 1C). The outer side is strongly convex near the dorsal surface of the jaw, while the inner is only slightly convex and becomes concave near the ventral border. The anterior tooth is probably P_4. The anterior root of P_4 which is exposed, is marked by longitudinal ridges. The alveoli of the M_1 are unequal, the anterior alveolus being larger. The anterior alveolus for M_2 is larger.

Measurements (in cm) of L.U.V.P. 11003

Length	7·3	Length of P_4	3·7
Depth at P_4	6·0	Width of P_4	1·5
Depth at M_1	6·3	Length of M_1	2·5
Width of anterior alveolus of M_1			1·5

REMARKS. *Protocetus* is based on a complete skull from Egypt, while *Pappocetus* is based on two mandibular fragments from Nigeria. The possibility that these genera are not distinct was suggested by Van Valen (1966, p. 92). Judging from the present material, however, it appears that the genera *Protocetus* and *Pappocetus* are independent but related. The skull from south-western Kutch closely resembles that of *Protocetus*, while the lower jaw fragments are clearly different to those of *Pappocetus*. As the association of the mandibular fragments and the skull from Kutch is uncertain, the distinction between the two genera still remains tentative.

From the chocolate-coloured limestones underlying the Gypsiferous clays, some vertebrae, turtle carapace fragments, and an isolated tooth were collected. The vertebrae, which are four in number, closely resemble the vertebrae described by Andrews (1920) and others, and are cetacean. The turtle carapace fragments have a characteristic surface texture of closely spaced, rounded tubercules, similar to the texture of some species of *Aspideretes*. The isolated tooth is laterally compressed and acutely pointed, about 9 mm in length and probably belongs to a teleost. The grey coloured marls overlying the local unconformity have yielded only broken rib pieces and unidentified bones.

CONCLUSIONS

The significance of the discovery of a fossil cetacean from the Middle Eocene beds of south-western Kutch is five-fold. First, evidence in hand seems to suggest that the genera *Protocetus* and *Pappocetus* are distinct. Secondly, the new species represents one of the older records of the group, from beds that have with certainty been dated as Lutetian. Thirdly, its occurrence in western India extends the geographical distribution of Middle Eocene Archaeoceti to southern Asia. At present primitive archaeocetes have been described from the Lower Eocene of England (Tarlo 1964) as well as the Lutetian of Nigeria, Egypt, and Texas, U.S.A. Upper Eocene finds are confined to North America, North Africa, and Europe. Fourthly, the occurrence of protocetids in widely separated areas indicates that the forms could freely migrate across interconnecting seaways. One such route could have been a seaway extending continuously from Africa to its eastern limit in western India. Fifthly, in view of the fact that the new species *Protocetus sloani* is the oldest mammal (Middle Eocene) to be reported from India, its bearing on the Palaeogene palaeobiogeography of southern Asia becomes significant.

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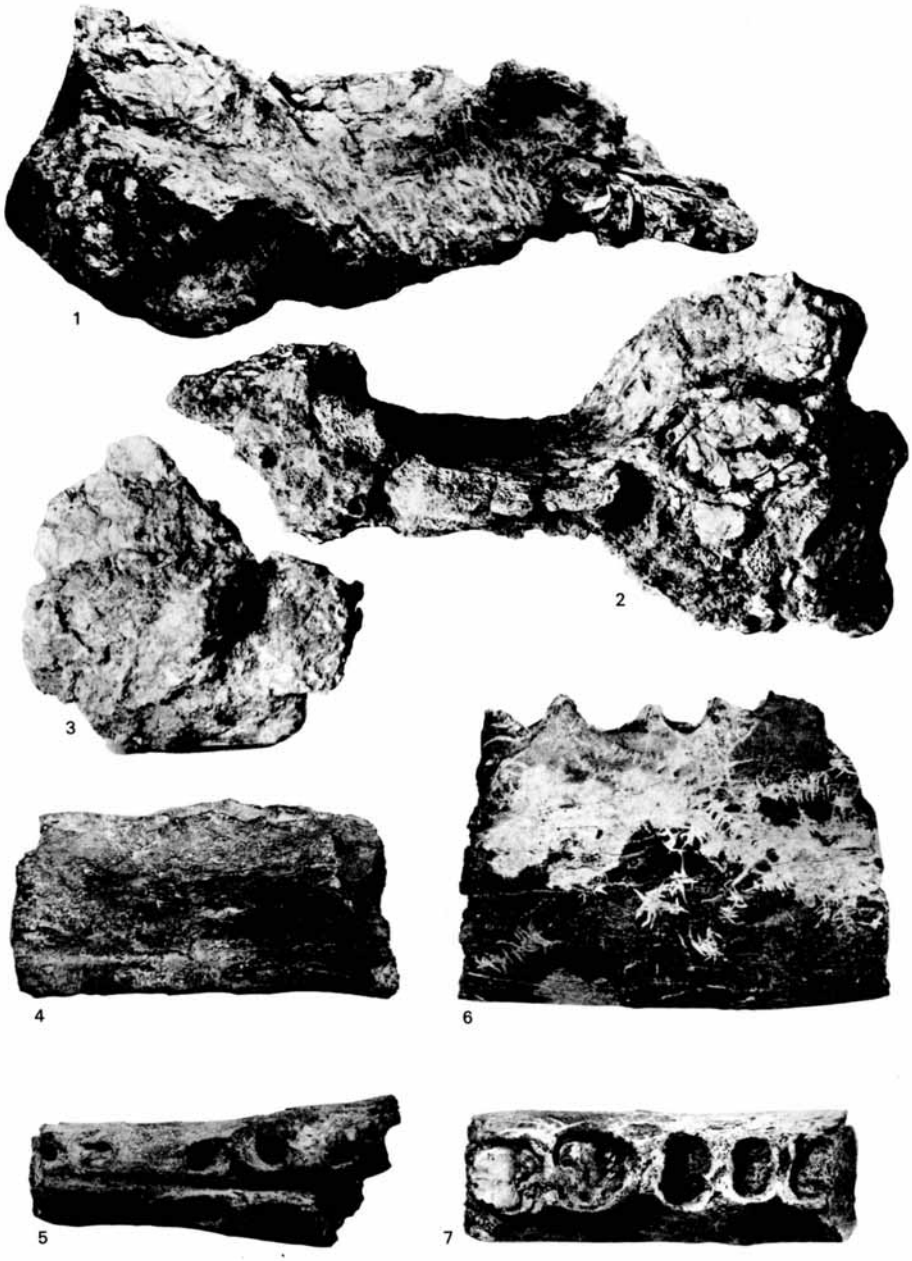

SAHNI and MISHRA, Eocene cetacean from India