SIRENIAN-MOERITHERE DICHOTOMY: SOME EVIDENCE FROM THE MIDDLE EOCENE OF KACHCHH, WESTERN INDIA

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THE present note deals with additional material of a definite sirenian and a possible moeritheré (Proboscidea) from the Harudi Formation of Western Kachchh, throwing fresh light on the origin of these presently well-differentiated mammalian orders. The Kachchh finds comprise cranial and dental fragments of a genus close to *Protosiren* as well as a partial skull which has distinct moerithere-like affinities. In the light of recent work on the occurrence of a moerithere[1] from the Middle Eocene of NW India and Pakistan, the problem of sirenian-moerithere dichotomy assumes significance.

Prior to the present work the sirenian remains collected from the Middle Eocene of Kachchh were known only by a pelvis and a vertebra[2,3]. The present material comprises an edentulous jaw fragment bearing symphysis, along with isolated teeth and skull fragments. These were collected from the Rato Nala about 3 km south of Baranda (23°30'20"N, 68°41'15"E) and the Babia Hill (23°42'30"N, 68°46'E) sections (figure 1). The ossiferous horizon consists of grey to brown gypsified clays, about 4 m thick, representing a coastal lagoonal environment. These shales constitute the lower part of the Middle Eocene Babia Stage (Berwali Series)[4]. An early Middle Eocene age has been indicated for these beds on the basis of associated foraminifers and ostracodes[5]. Besides sirenians, vertebrates recovered from this horizon also include archaeocetes, crocodiles and fish[2,6].

The possibility of the presence of moeritheriids in the Middle Eocene of Kachchh was first suggested in 1975[2] with the description of a sacrum from the Rato Nala section. Later, however, this specimen was thought to represent *Anthracobune* or a closely related genus rather than *Moeritherium* itself[7]. The present find from the Babia Hill section of the posterior part of a skull which is clearly differentiable from associated marine mammals (sirenians and cetaceans) again raises the possibility of its assignment to Moeritheriidae. Such an assignment is based not only on its similarity to previously described specimens from Africa but also on the basis of its own cranial morphology.

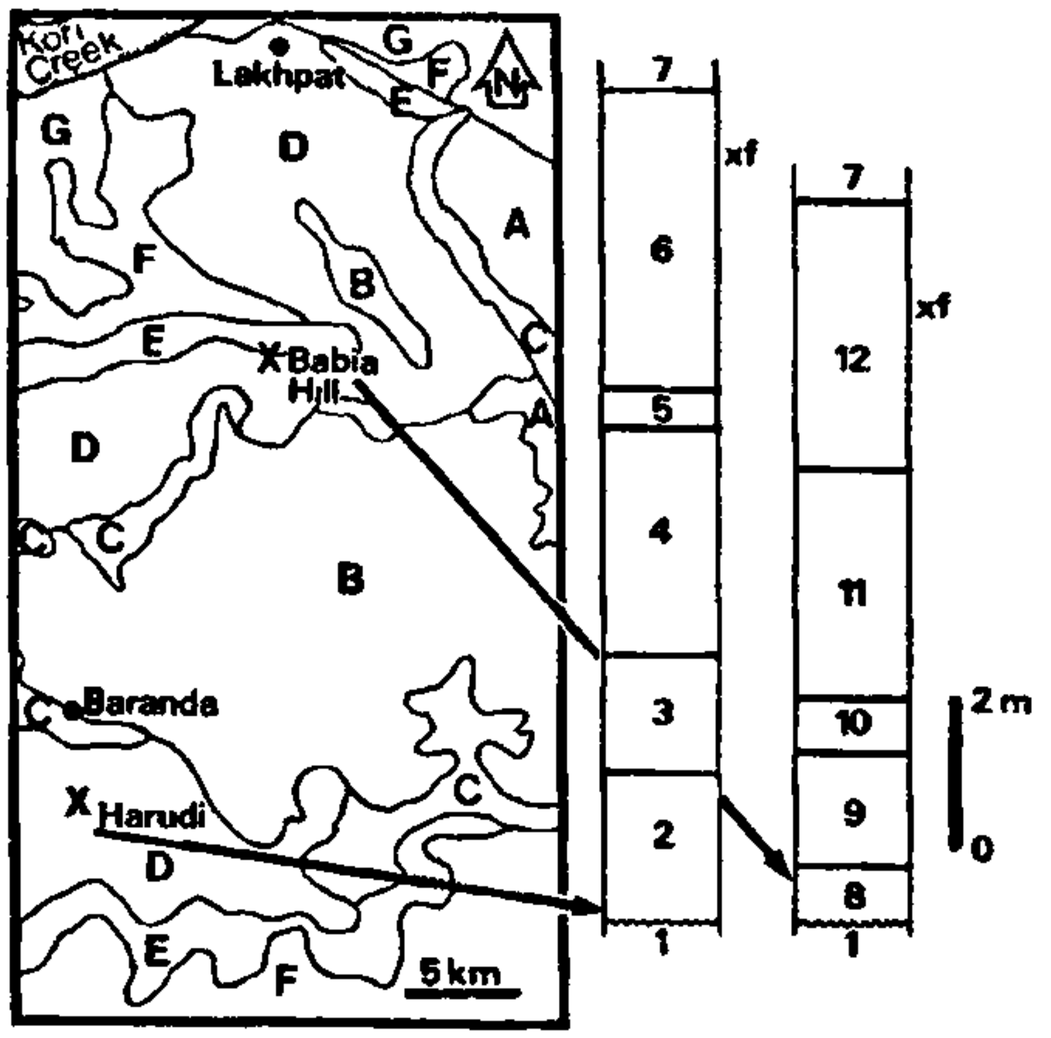
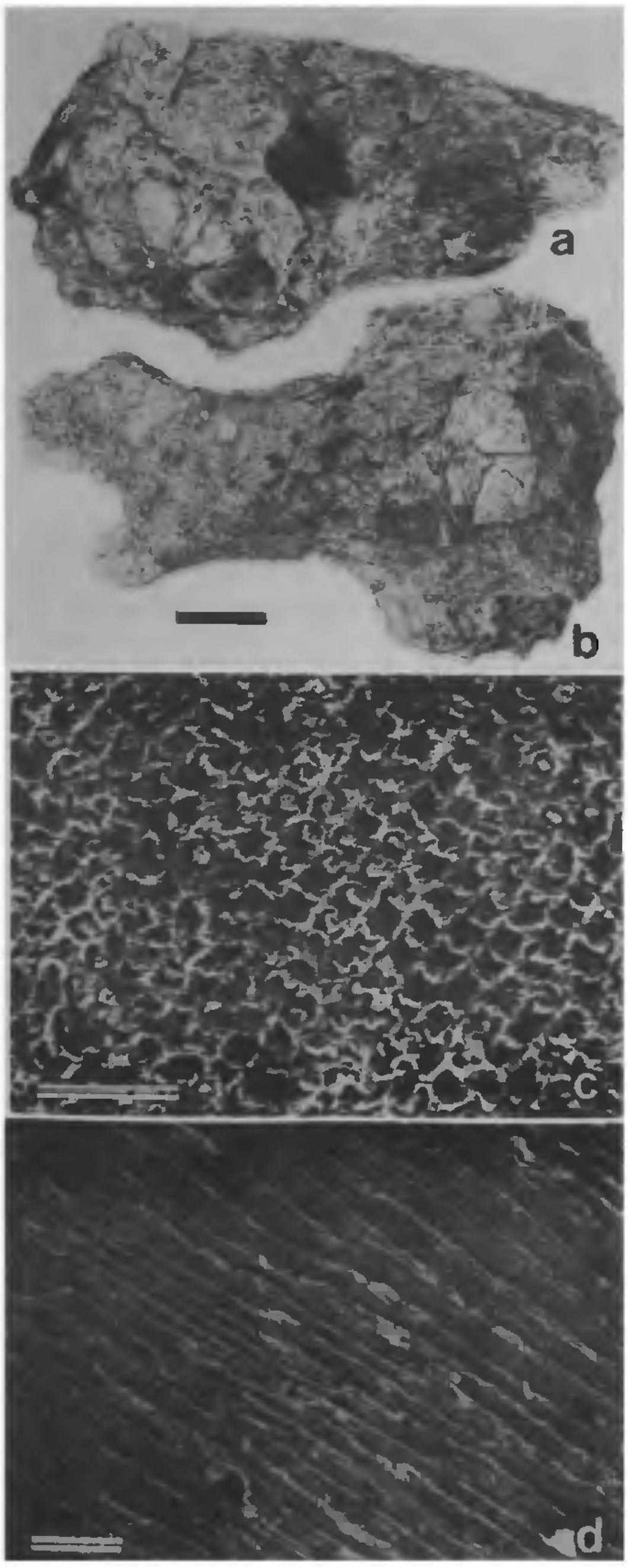


Figure 1. Geological map of a part of southwestern Kachchh. X, stratigraphic section (Harudi Formation, lower Middle Eocene) exposed at Babia Hill and Rato Nala; A, Mesozoics; B, Deccan Trap (Upper Cretaceous–?Palaeocene); C, Madh Series (Palaeocene); D, Berwali Series (Eocene); E, Bermoti Series (Oligocene); F, Khari Series (Miocene); G, Recent and Pleistocene sediments. 1, Laterite, lateritic clay and bauxite; 2, Reddish brown shale; 3, Grey shale; 4, Olive green shale; 5, Shelly limestone; 6, Ossiferous gypseous shale; 7, White foraminiferal limestone; 8, Yellowish white shale; 9, Greyish shale with lignite; 10, Light brown shale with plant remains; 11, Yellowish brown clay; 12, Ossiferous chocolate and yellowish brown clays; xf, Vertebrate-bearing horizon.

Order: Proboscidea
Family: Moeritheriidae

Preserved length 15.5 cm, width across squamosals 10 cm; skull roof moderately convex, slightly flattened anteriorly, exhibiting a characteristic cylindrical shape as seen in all moeritheres known from Africa, distinguishable in this feature from known Eocene sirenians and cetaceans; also, a prominent, posterolaterally extended lamboidal crest characterizing early sirenians not developed in the present specimen; similarly, differentiable from archaeocetes by the absence of a prominent nuchal crest, which is present in the latter; supraoccipital



Figures 2a–d. **a–b.** Moerithere skull (bar = 2.2 cm), right lateral and dorsal views; **c–d.** scanning electron micrographs of sirenian molar enamel; **c.** occlusal surface showing pattern 1 prisms (bar = 20 μ); **d.** transverse section (bar = 20 μ), note absence of Hunter–Schreger bands, (Enamel-dentine junction towards left margin).

oriented at an angle of about 115° with parietals; presence of dorsal triangular process as in *M. lyonsi* not discernible; upper border of supraoccipital fairly similar to that in *Moeritherium* sp. described (Tassy[8], figure 8) from Libya; squamosals well developed with their dorsal margin moderately elevated as in the specimen from Libya (Tassy[8], pl. 111); condition in Eocene sirenians somewhat different, with squamosals almost reaching the level of the cranial roof; possible alveoli for M^3 only 2 cm apart, in contrast to condition in archaeocetes showing prominently diverging tooth rows.

On gross dental morphology alone, it may not be possible to distinguish sirenian teeth from those of moeritheres. Therefore, an attempt was made to differentiate dental fragments from the Kachchh Eocene on the basis of enamel ultrastructure. The study indicates that the enamel characteristics of teeth that superficially resemble those of *Moeritherium* are in fact those of a sirenian. Important among these differentiating features are the predominance of pattern 1 prisms, complete absence of zones (figure 2c, d) and similarities to the enamel of both fossil and recent sirenians. Information provided by P. Bertrand (personel communication) shows that *Halitherium*, an Upper Oligocene–Lower Miocene sirenian also possesses the same enamel characteristics as the Kachchh sirenian, in contrast to *Moeritherium* known from Algeria in which the enamel is much thicker, predominantly composed of pattern 3 prisms with conspicuous zones and other subangulate features well developed.

In conclusion, the present investigation suggests the possibility of the presence of moeritheriids in the Middle Eocene of Kachchh. However, the assignment is tentative and must await confirmation till the recovery of additional cranial material not only from Kachchh but also from NW India and Pakistan, where a number of other slightly less derived moeritheriids are already known by dental remains[1]. Furthermore, the Kachchh specimens again reflect the fact that teeth of early sirenians and moeritheres bear close resemblance. This is also borne out by the recent reinterpretations of West[4], who transferred *Ishatherium subathuensis*, a lower Eocene Himalayan form described as sirenian[9], to the family Moeritheriidae. In spite of this dental similarity the two are differentiable on the basis of enamel ultrastructure characteristics as indicated by the present findings. It follows, therefore, that the sirenian–moerithere dichotomy had taken place prior to their occurrence in the early Middle Eocene

sediments of Kachchh. Furthermore, the record of moeritheres in Kachchh as well as in the Himalayas (NW India, Pakistan) indicates that the centre of their origin and early evolution was probably located in the Indo–Pak tethyan belt.

Recently, based on cladistic analysis, the ancestry of proboscideans and sirenians has been traced to Palaeocene times[10], which is in conformity with the conclusions reached herein. However, the sirenian–moerithere differentiation attempted in the present study is based on the assumption that the early moeritheres possessed the same enamel ultrastructure characteristics as the genus *Moeritherium*, which is so far known only from the African late Eocene–early Oligocene deposits[8, 11, 12]. This is a valid assumption in view of the striking similarity in their dental remains as well as in the habitat in which the Kachchh and the African forms are found to occur. However, further studies are needed to gain better insight into the evolutionary relationships of enamel ultrastructure patterns in these problematic primitive tethytheres.

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RADIOCARBON DATING OF CHARCOAL FROM PRE-INDUS CIVILIZATION FIREPLACE, UPPER INDUS VALLEY, LADAKH

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DURING geological studies in the remote areas of the Leh district of Jammu and Kashmir in 1979, two of the present authors (KKS and VMC) discovered a thin layer of charcoal embedded in clay and sand of the Indus terrace near Gaik, about 100 km east of Leh. The manner in which this charcoal layer was embedded with the sediments, initially suggested that the charcoal was possibly transported from a site of natural fire in some nearby forest by water and deposited on the river terrace along with other sediments. A small quantity of charcoal was sampled and subsequently analysed in the Radiocarbon Laboratory of the Birbal Sahni Institute of Palaeobotany, Lucknow.

Encouraged by these results two of us (KKS and VMC) did further excavation on this site during the summer of 1980 and discovered a fire place "Chullah" made by the pre-Indus civilization man on the terrace of the Indus River using three boulders (figure 1). The fire was put up by the pre-historic man to roast meat since a few pieces of thick bone, possibly of some goat-like animal, were also collected from the ash and the charcoal from this fire place (figure 2a–c).

The procedure followed for the dating of samples by C-14 method in the BSIP Radiocarbon Laboratory was earlier described[1]. The charcoal sample was cleaned off all the surface contaminants and was then given chemical pre-treatment to remove contamination due to dead carbon and modern carbon.

Approximately 5 g of pre-treated charcoal in large