Journal of the Palaeontological Society of India
Volume, 54(2), December 2009: 225-227

ISSN 0522-9630

SHORT COMMUNICATIONS

AN UNUSUAL SPECIMEN OF THE EOCENE WHALE *REMINGTONOCETUS* (CETACEA, MAMMALIA) FROM KUTCH, INDIA

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ABSTRACT

An unusual specimen skull in tight occlusion with left and right mandibles of the middle Eocene whale *Remingtonocetus harudiensis* from Kutch, western India, is described. The specimen adds significantly to our knowledge of the skull and mandibular morphology of this important taxon.

Keywords: Cetacea, Eocene, mammal, Kutch, India

INTRODUCTION

Archaeocete diversity in the Indian subcontinent is well-known because of the excellent outcrops of Eocene sedimentary rocks in Kutch (India) and the Sulaiman Range (Pakistan). *Remingtonocetus* is the most common cetacean in the middle Eocene Harudi Formation of Kutch (Gujarat). The genus was first described by Kumar and Sahni (1986), partly based on fossils initially described by Sahni and Mishra (1975). Since then, the cranial anatomy of *Remingtonocetus* has been elucidated further by the recovery of a large number of new specimens, in the collections at the Indian Institute of Technology, Roorkee (Bajpai and Thewissen, 1998). Although this collection contains excellent cranial material, mandibular material is scarce. A collection of fossils from Kutch made by the Geological Survey of India (DPD) contains a very unusual specimen, a skull in tight occlusion with left and right mandibles. This specimen adds considerably to our understanding of *Remingtonocetus* mandibular morphology, and is described here. Several specimens in the IIT Roorkee collections have been used to supplement the description.

The specimen K60/996 described and figured here is housed in the Palaeontology Laboratory, Geological Survey of India, Kolkata, India. Additional specimens discussed in the paper are catalogued under the acronym IITR-SB at the Paleontology laboratory, Indian Institute of Technology, Roorkee, Sunil Bajpai Collections.

ABBREVIATIONS

IITR-SB- Palaeontology laboratory, Indian Institute of Technology, Roorkee, Sunil Bajpai Collections.

SYSTEMATIC PALAEONTOLOGY

Order Cetacea Brisson, 1762

Family Remingtonocetidae Kumar and Sahni, 1986

Remingtonocetus harudiensis Kumar and Sahni, 1986

(Pl. I, figs.A-D)

Referred specimens: K60/996, skull united with mandible; IITR-SB 2521 ; IITR-SB 3018,

Horizon and locality: Type Harudi Formation (middle Eocene), Rato Nala, District Kutch, Gujarat, India

Description: The specimen of *Remingtonocetus harudiensis* (K60/996) comprises a skull with both left and right lower jaws articulated. The specimen preserves the entire outline of the skull, and only the most anterior part, holding the roots for i1, is missing. As such, the specimen illustrates the mandibular morphology of *Remingtonocetus* better than any specimen described previously. The mandibular ramus is narrow in lateral view, and increases caudally in dorsoventral depth. Under p1, the ramus is 35 mm, and under m3, it is 10.5 mm. The gradual increase in jaw depth observed below the cheek teeth continues posteriorly behind the molars, and reaches the coronoid process. The ascending anterior edge of the coronoid process is gradual as in modern whales, not steep as in most mammals. The posterior edge of the coronoid process of the jaw descends to the mandibular condyle, which is placed approximately halfway down the jaw. Ventral to the mandibular condyle is the angular process, which is a small flat process projecting caudally. This process can be seen clearly in IITR-SB 2521, a specimen of *Dalanistes ahmedi,* closely related to *Remingtonocetus (*Thewissen and Bajpai, 2001).

The part of the mandible posterior to the molars is strongly convex buccally, matching a concavity on the medial side of the mandible. The mandibular condyle (IITR-SB 2521) faces posteriorly, and is more or less triangular in outline in posterior view, strongly convex dorso-ventrally and nearly flat medio-laterally. Its medial side is flush with the lingual side of the jaw, and continuous with a broad concavity on the medial part of the jaw that is continuous with the mandibular canal. The lateral side of the mandibular condyle projects well beyond the lateral side of the jaw. The lateral wall of the jaw is between 2 and 3 mm in thickness in this area. The mandibular canal is extremely high here, covering nearly the total height of the jaw. More anteriorly, where it accommodates the roots of m3, the mandibular canal makes up 70% of the cross-sectional height of the jaw.

The mandibular symphysis in K60/996 extends posteriorly to the area of the diastema between P/2 and P/3, and it reaches below P/3 in IITR-SB 3018. Anterior to this point the mandibles are straight and gracile (Fig. 2). Posterior to this point the mandibles diverge strongly and directly. The mandibular symphysis is unfused along its ventral aspect but, dorsally, the symphysis is fused in some specimens (K60/996, IITR-SB

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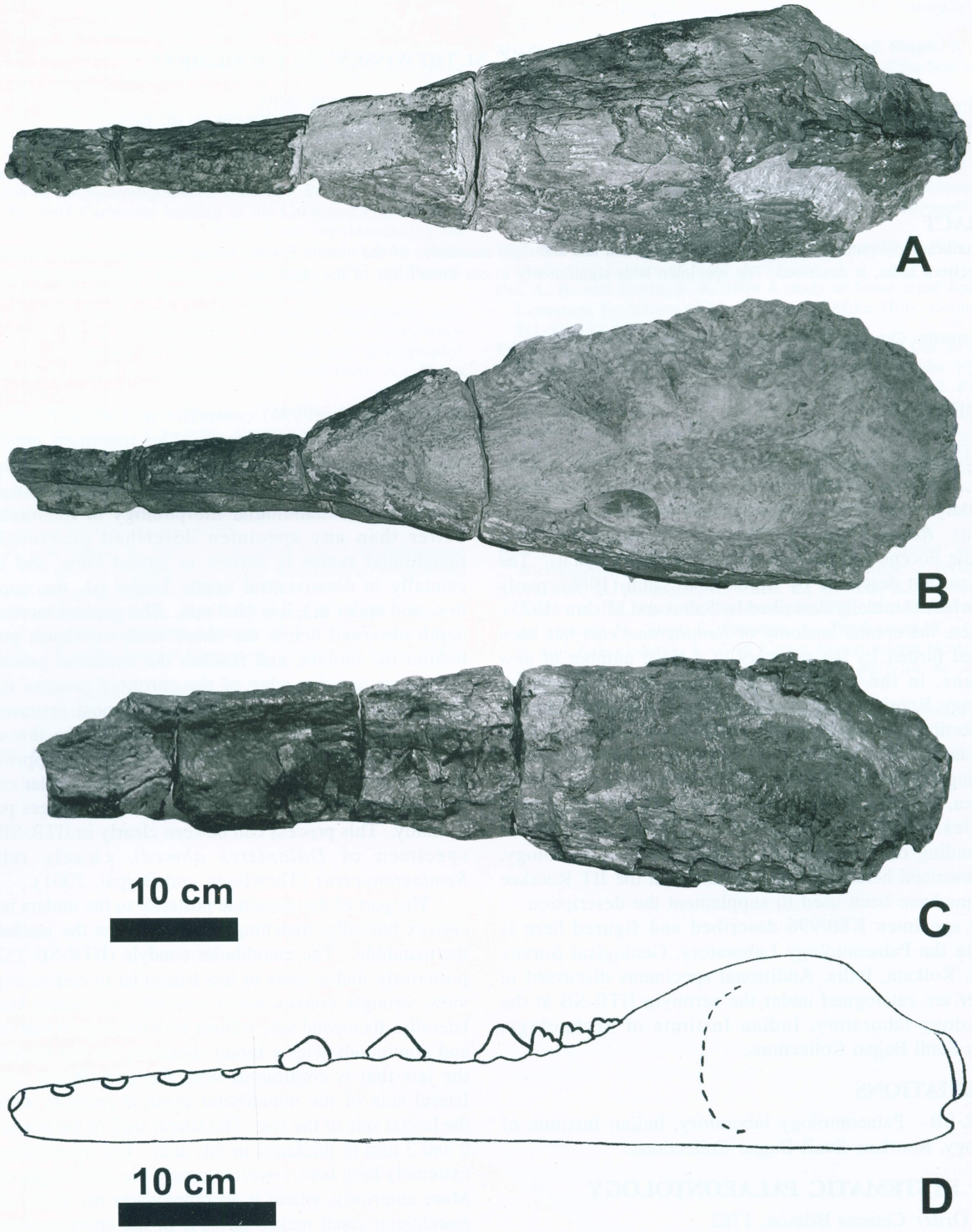
Journal of the Palaeontological Society of India
Volume, 54(2), December 2009

Plate I



EXPLANATION OF PLATE I

A-C ***Remingtonocetus harudiensis***, dorsal, inferior and left lateral view of skull with occluded mandible (K60/996)

D. ***Remingtonocetus harudiensis***, outline drawing of left mandible, reconstructed from several specimens (K60/996, IITR-SB 2521, IITR-SB 3018). Stippled line indicates extent of mandibular canal.

3018), but not in others (IITR-SB 2521).

DISCUSSION

The importance of the new morphological features studied for *Remingtonocetus* is two-fold. First, Thewissen *et al.* (2007) identified the lengthening of the postorbital-pretemporal region as one of the features that characterize cetaceans. Such an evolutionary change obviously also affects the morphology of the mandible, as the mandibular condyle articulates with the skull posterior to the area that was lengthened. In *Remingtonocetus*, it is clear that this process has progressed to the point where the jaw resembles that of many modern cetaceans, with a gradually ascending coronoid process, and a long postdental region. Importantly, there is confusion about the length of the postorbital-pretemporal region in *Remingtonocetus*. In the *Remingtonocetus* skull described by Kumar and Sahni (1986), this portion is missing, and shown stippled in their reconstruction. They significantly underestimated the length of this area, indicating that their estimated skull length is much shorter than it was in reality. Unfortunately, this incorrect reconstruction was not cautiously interpreted by later authors. Gingerich et al. (1998) redrew *Remingtonocetus'* skull showing it with a short postorbital-pretemporal region, thus exaggerating the difference with *Dalanistes*, and Gingerich et al. (2001) used the skull length estimate in describing a new species of *Remingtonocetus*.

Secondly, it has been pointed out by Nummela et al. (2007) that, functionally, remingtonocetids were among the first cetaceans to acquire the modern cetacean mode of hearing. The specimens described here indicate that the mandible was also adapted for this method. In modern cetaceans, sound is received by the lower jaw and transmitted to the ear. A morphological indicator of this is the large size of the mandibular canal. This canal is large in remingtonocetids, similar to that of modern cetaceans. However, the lateral wall of the mandible is relatively thick, and the thinning of this wall characteristic of odontocetes (so-called pan bone), is not present in remingtonocetids.

ACKNOWLEDGEMENTS

SB acknowledges financial support from the Department of Science & Technology, Government of India. Krishna Kumar's help with illustrations is also thankfully acknowledged.

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Manuscript Accepted January 2009