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Sankuchemys, a New Side-Necked Turtle (Pelomedusoides: Bothremydidae) from the Late Cretaceous of India

EUGENE S. GAFFNEY,[1] ASHOK SAHNI,[2] HERMAN SCHLEICH,[3]
SWARN DEEP SINGH,[4] AND RAHUL SRIVASTAVA[5]

ABSTRACT

The Maastrichtian Deccan Intertrappean beds of Amboli Quarry, Bombay, yielded the skull of a new genus of side-necked turtle. *Sankuchemys sethnai*, new genus and species, is a pelomedusoid pleurodire belonging to the family Bothremydidae Baur, 1891, based on these characters: (1) exoccipital-quadrate contact, and (2) foramen stapedio-temporale not visible in dorsal view. *Sankuchemys* is most closely related to *Kurmademys* from the Maastrichtian of Tamil Nadu, because among bothremydids they uniquely share a highly emarginated temporal roof and a small postorbital. *Sankuchemys* is unique among bothremydids in having an accessory ridge on the triturating surface.

INTRODUCTION

Singh et al. (1998) announced the discovery of a bothremydid skull in a fauna dated as Maastrichtian from the fossiliferous intertrappean tuff of the Bombay region. The purpose of this paper is to name and describe this specimen. Although the skull is

[1] Curator, Division of Paleontology, American Museum of Natural History. e-mail: esg@amnh.org
[2] Centre of Advanced Studies in Geology, Panjab University, Chandigarh, India. e-mail: ashok.sahni@usa.net
[3] Director, Fuhlrott-Museum and Forschungsinstitut, Auer Schulstrasse 20, D-42103 Wuppertal, Germany. e-mail: Schleich.hermann@T-online.de
[4] Institute of Petroleum Exploration, Oil and Natural Gas Corporation, 9, Kaulagarh Road, Dehra Dun 248001, India. e-mail: Swarndeep@yahoo.com
[5] Department of Geology, Lucknow University, Lucknow-226007, India. e-mail: rsrivastava@hotmail.com

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crushed nearly flat, it does retain enough morphology to diagnose it as a new taxon, and to make useful comparisons with related taxa.

Pleurodires are absent in the recent fauna of India, but they are known as fossils from the Late Cretaceous into the Neogene (Wood, 1970; Broin, 1987b, 1988; Jain, 1986). Nonetheless, fossil pleurodires in India are rare, and only two other Indian pleurodire taxa are known from skulls: a podocnemidid, *Shweboemys pisdurensis* (Jain, 1977, 1986), and a bothremydid, *Kurmademys kallamedensis* (Gaffney et al., 2001b).

The cranial morphology terms used here are described in Gaffney (1979), which also contains a literature review to that date. References to the higher categories used here are in Gaffney et al. (2001a, 2001b). Other recent papers on bothremydids are Lapparent de Broin and Werner (1998), Gaffney et al. (2001c), and Tong and Gaffney (2000).

Institutional Abbreviations

SDS/VPL	Vertebrate Paleontology Laboratory, Centre of Advanced Studies in Geology, Panjab University, Chandigarh, India

Anatomical Abbreviations

bo	basioccipital
bs	basisphenoid
ex	exoccipital
fnt	foramen nervi trigemini
fpcci	foramen posterius canalis carotici interni
fr	frontal
fst	foramen stapedio-temporale
ju	jugal
mx	maxilla
op	opisthotic
pa	parietal
pal	palatine
pf	prefrontal
pm	premaxilla
po	postorbital
pr	prootic
pt	pterygoid
qj	quadratojugal
qu	quadrate
so	supraoccipital
sq	squamosal

SYSTEMATICS

ORDER TESTUDINES LINNAEUS, 1758

MEGAORDER PLEURODIRA COPE, 1864

(FIDE GAFFNEY AND MEYLAN, 1988)

HYPERFAMILY PELOMEDUSOIDES COPE, 1868

FAMILY BOTHREMYDIDAE BAUR, 1891

Sankuchemys, new genus

TYPE SPECIES: *Sankuchemys sethnai*, new genus and species.

DISTRIBUTION: Maastrichtian of Bombay, India.

ETYMOLOGY: *Sankuch*, ''compressed'' in Sanskrit, in allusion to the remarkably crushed type specimen.

DIAGNOSIS: A genus of bothremydid pleurodire with triangular skull, orbits dorsolaterally placed; extensive temporal emargination and small postorbital as in *Kurmademys* (Gaffney et al., 2001b) and in contrast to all other bothremydids; triturating surfaces roughly parallel and without pits, but with accessory ridge parallel to labial ridge unique among bothremydids; foramen posterius canalis carotici interni formed by pterygoid and basisphenoid in contrast to basisphenoid only in *Kurmademys*; foramen stapedio-temporale not visible in dorsal view as in other bothremydids, but in contrast to *Kurmademys*; prootic and foramen nervi facialis exposed in ventral view as in *Kurmademys*.

DISCUSSION: Although many characters are visible in the type skull of *Sankuchemys*, one important area completely wrecked in SDS/VPL 1125 is the cavum tympani. This region has many characters important in bothremydid systematics (Gaffney et al., 2001a, 2001b) that are not determinable for this taxon. The occiput is also reduced to two dimensions completely obscuring foramina and features in that area. Nonetheless, SDS/VPL 1125 does preserve enough characters to show its distinctness from all other taxa and to test its relationships using currently available hypotheses.

Sankuchemys sethnai, new species

TYPE SPECIMEN: SDS/VPL 1125, a complete skull completely smashed flat.

TYPE LOCALITY: Amboli Quarry, Jogesh-

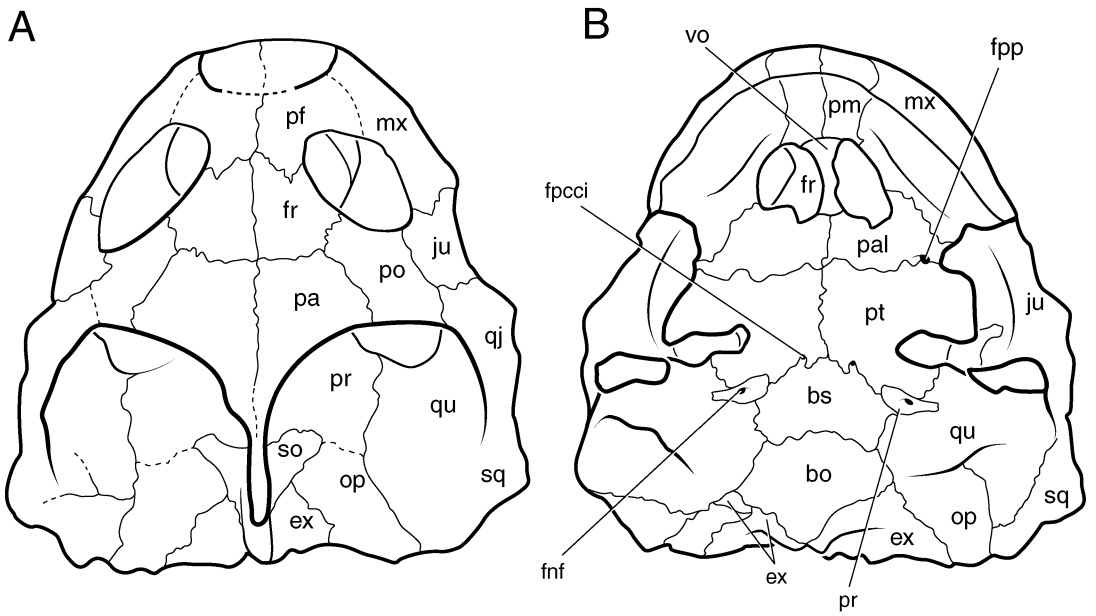

Fig. 1. *Sankuchemys sethnai*, n. gen. and sp. SDS/VPL 1125. Maastrichtian green tuff of Amboli Quarry, Bombay. Partially restored views. **A,** Dorsal; **B,** ventral.

wari, Bombay, India (map and faunal discussion in Singh et al., 1998).

HORIZON: Green tuff bed of Amboli, Intertrappean beds, late Maastrichtian (discussion in Singh et al., 1998).

DIAGNOSIS: As for genus.

ETYMOLOGY: In honor of the discoverer of the holotype skull, Prof. S.F. Sethna, known for his pioneering work on the geology of the Mumbai region.

DESCRIPTION

PREFRONTAL

Both prefrontals are present but crushed ventrally, disarticulated and overlain by the dorsal processes of the maxillae. There is no anterior projection as preserved.

FRONTAL

Both frontals are present, slightly fractured but complete. The frontal in *Sankuchemys* has the usual bothremydid contacts seen in *Kurmademys* (Gaffney et al., 2001b) and *Cearachelys* (Gaffney et al., 2001a).

PARIETAL

Both parietals are present, but they are cracked and crushed ventrally. Only the dorsal surface is visible. There is an anterior contact with the frontal and anterolateral contact with the postorbital as in *Kurmademys* and *Galianemys* (Gaffney et al., 2002b). In contrast to all other Bothremydidae except *Kurmademys*, the parietal of *Sankuchemys* shows an extreme condition of the temporal emargination. The parietal in these two taxa has very little overhang onto the fossa temporalis, and its posterolateral portion is largely missing in comparison to other Bothremydidae.

JUGAL

Both jugals are present in *Sankuchemys*, but they are cracked and displaced from their original articulations so that the relations of the medial process are ambiguous. The jugal in *Sankuchemys* contacts the maxilla anteriorly, the postorbital dorsomedially, and the quadratojugal posteriorly. It enters the posteroventral edge of the orbital margin. As preserved, it is very similar to the jugal in

Kurmademys, and differs from *Cearachelys* in its orbital exposure.

The triturating surfaces and palate are well enough preserved to show that the jugal does not form a significant part of the palate as in bothremydids like *Bothremys* (Gaffney and Zangerl, 1968).

Quadratojugal

At least portions of both quadratojugals are present in *Sankuchemys*, although they are badly broken due to crushing and their relations are unclear in some areas. The quadratojugal contacts the jugal anteriorly and the postorbital anteromedially. As preserved, the jugal, on both sides, completely prevents a maxilla-quadratojugal or maxilla-quadrate contact. The absence of a good quadratojugal (and good quadrate as well) makes it difficult to be sure that this was the case originally. Quadrate and squamosal contacts with the quadratojugal are obscured by preservational breakage. The formation of at least part of the lateral margin of the fossa temporalis by the quadratojugal is clear and appears to be similar to the condition in *Kurmademys* and *Cearachelys*.

Squamosal

At least part of both squamosals are present, but the bones are poorly preserved. As preserved, the squamosal in *Sankuchemys* shows the anteromedial quadrate contact on the ventral surface, and the medial opisthotic contact, both found in all other pelomedusoides. The complete obliteration of the cavum tympani prevents any information being available about the antrum postoticum and its formation by the squamosal.

Postorbital

The postorbital is preserved on both sides of *Sankuchemys*; both are badly fractured, but the relations and contacts on its external surface can be determined. The postorbital in *Sankuchemys* contacts the frontal anteromedially, the parietal posteromedially, the jugal anterolaterally, and the quadratojugal posterolaterally. The postorbital widely enters the orbit on its posterior margin, and it enters the margin of the temporal emargination posteriorly. The size and relations of the postorbital in *Sankuchemys* are very similar to the postorbital in *Kurmademys*. Among Bothremydidae, the postorbital in *Sankuchemys* and *Kurmademys* is shortest, being close to the small size in Pelomedusidae. This is related to the extent of temporal emargination.

The presence of a medial postorbital process is not determinable in *Sankuchemys* due to crushing; however, the skull is thicker in this area and there are bone fragments in the correct place.

Premaxilla

Both premaxillae are present and relatively well preserved. The contacts of the premaxilla in *Sankuchemys* in ventral view are with the maxilla laterally, the other premaxilla medially, and the vomer posteromedially. Contacts on the dorsal surface are not visible. The labial ridge is acute with a sharp ridge as in *Kurmademys*, but it is thicker dorsally. The size of the premaxillary posterior shelf bearing the triturating surface is nearly the same in both genera, but *Kurmademys* has a deep median concavity that is absent in *Sankuchemys*.

Maxilla

Most of both maxillae are preserved in *Sankuchemys*, but there is considerable damage due to crushing. The dorsal surface contacts are the premaxilla anteriorly, the prefrontal anterodorsally, and the jugal posteriorly. The posterior limits of the maxilla are damaged, and it is possible that a quadratojugal contact was present beneath the jugal. The ventral contacts are the premaxilla anteromedially, the palatine posteromedially, and the jugal posteriorly. As preserved, the maxilla does not contact the vomer and this seems to be original. The region of the palatine-pterygoid-jugal contact is a mush on both sides, so these relations are unclear.

The maxilla of *Sankuchemys* differs from *Kurmademys*, *Cearachelys*, and *Bothremys* in having a more parallel-sided triturating surface rather than a triangular one, expanded posteriorly. The labial ridge is acute and sharp as in *Kurmademys* and *Cearachelys*, but may be thicker dorsally, although this

may have been caused by crushing. The medial edge of the triturating surface is not particularly well preserved, but the posterior expansion seen in *Kurmademys* and *Cearachelys* seems to be absent. It is possible that this is a consequence of the poor preservation, as the lingual ridge marking the triturating surface edge is very low. However, *Sankuchemys* does have a more expanded anterior part of the triturating surface than do other bothremydids, and this is not preservational. The triturating surface of *Sankuchemys* is unique among bothremydids in having an accessory ridge parallel to the labial ridge and extending the complete length of the maxilla. This ridge is much lower than the labial ridge, and its height is constant along its length. It seems to begin on the premaxilla in a rugose area, and runs to the maxillajugal suture. No other bothremydid has an accessory ridge on the triturating surface, although such ridges do occur in podocnemidids (*Dacquemys*, Gaffney et al., 2002a).

VOMER

Sankuchemys has a well-preserved, although fractured, vomer. It contacts the premaxillae anteriorly and the palatines posteriorly. In available *Kurmademys* specimens the vomer is not preserved. In *Cearachelys* it has the same contacts and is similar to the vomer in *Sankuchemys*. The vomer separates the paired apertura narium interna, which, in *Sankuchemys* is oval and about the same size as in *Kurmademys* and *Cearachelys*.

PALATINE

At least some of both palatines are preserved in *Sankuchemys*, but these thin bones are badly fractured due to crushing. The palatine in *Sankuchemys* has the usual bothremydid contacts: vomer anteromedially, palatine medially, pterygoid posteriorly, and maxilla anterolaterally.

As preserved, the palatine in *Sankuchemys* agrees with that bone in *Kurmademys* except for one feature. The palatine in *Sankuchemys* does not extend anterolaterally to form part of the triturating surface as in *Kurmademys* and *Cearachelys*.

Only a small part of the dorsal surface of the palatine is visible in the orbital opening in *Sankuchemys*. The complete crushing of the skull precludes information on the sulcus palatinopterygoideus and foramen orbito-nasale.

A small part of the foramen palatinum posterius is present on the left palatine. It is consistent in size and position with that in *Kurmademys*.

QUADRATE

Both quadrates are present, but they are so crushed dorsoventrally that the presence of a cavum tympani can only be inferred, not observed. The ventral surface of the quadrate is better preserved than the dorsal surface, which is badly fractured.

In dorsal view the quadrate of *Sankuchemys* contacts the prootic anteromedially and the opisthotic posteromedially. Many of the sutures in this area are obscured by breakage, but it seems that there is no quadrate-supraoccipital contact as in *Kurmademys* and *Cearachelys*; however, one could be present (see Supraoccipital). As preserved, the quadrate lacks an anterior process contacting the maxilla, and the size of the jugal suggests that this was the case originally.

In ventral view, the quadrate contacts the pterygoid anteromedially, the basisphenoid and prootic medially, and the basioccipital posteromedially, with all contacts being found in *Kurmademys* and *Galianemys emringeri* as well. The quadrate also contacts the exoccipital as in all other bothremydids. The opisthotic contact is visible but is badly obscured by crushing. Posterolaterally the squamosal contact is also visible but badly damaged.

On the left side in lateral view there is a thin layer of matrix representing the crushed cavum tympani. All its associated features—incisura columellae auris, antrum postoticum and such—are not determinable. On the dorsal surface, the position of the foramen stapedio-temporale in the prootic suture is also not determinable. Some of the quadrate-prootic suture is visible, enough to determine that the foramen stapedio-temporale is not present dorsally. The condylus mandibularis has been crushed, but it does not seem to have been moved significantly from its original position. The condylus mandibularis is

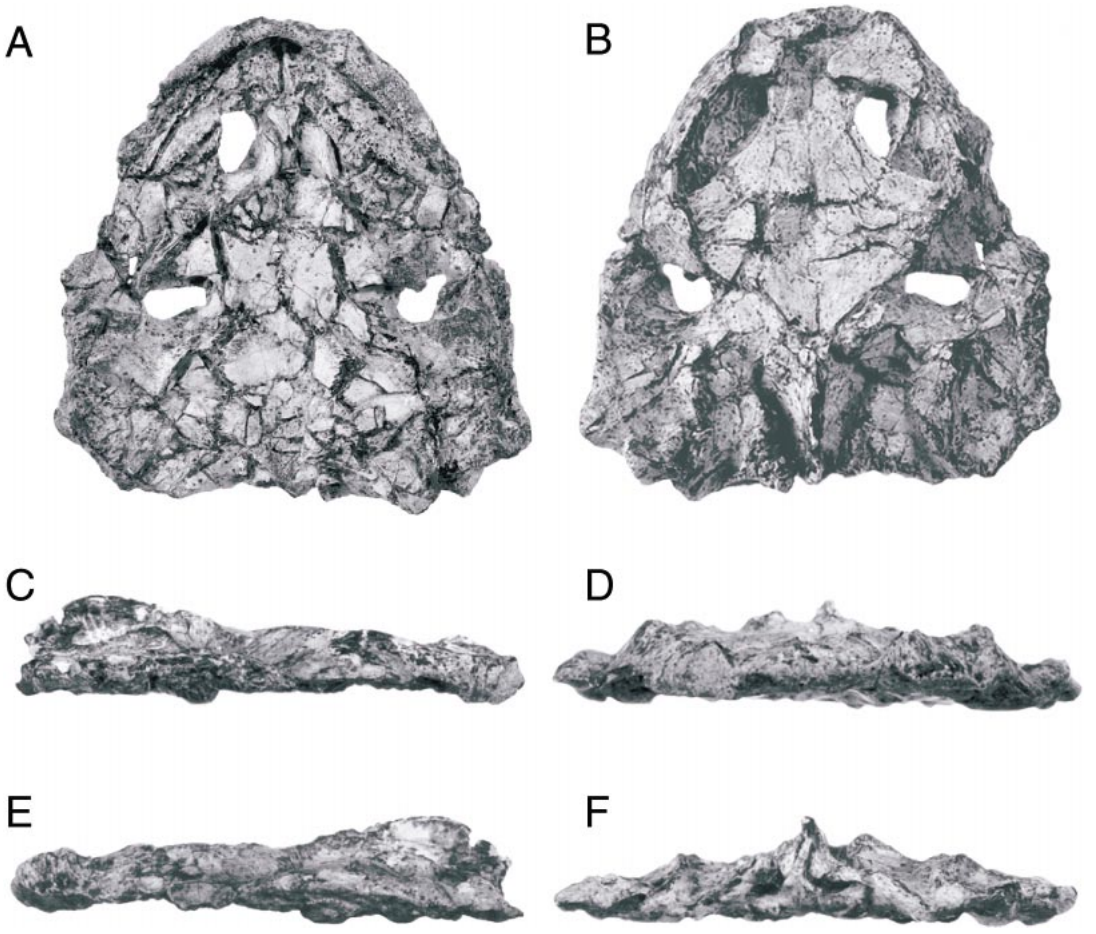

Fig. 2. *Sankuchemys sethnai*, n. gen. and sp. SDS/VPL 1125. Maastrichtian green tuff of Amboli Quarry, Bombay. **A,** Ventral; **B,** dorsal; **C,** right lateral; **D,** anterior; **E,** left lateral; **F,** posterior.

well anterior to the condylus occipitalis as in *Kurmademys,* and it is not as far posterior as in *Cearachelys*.

Pterygoid

Both pterygoids are present but badly fractured. Only the ventral surface is visible. The pterygoid in *Sankuchemys* contacts the palatine anteriorly, the quadrate posterolaterally, the other pterygoid medially, and the basisphenoid posteromedially, as in both *Kurmademys* and *Cearachelys*. There is also contact with the prootic posteriorly between the quadrate and basisphenoid (see Prootic) as in *Kurmademys*.

The processus trochlearis pterygoidei is partially preserved on both sides and appears to be directed laterally at nearly right angles to the midline, much as in *Kurmademys* and *Cearachelys*. The quadrate ramus is defined by sutures on both pterygoids but is badly fractured. The question of a deep M. pterygoideus attachment concavity as found in *Kurmademys* cannot be answered definitely for *Sankuchemys* due to poor preservation; however, there is some evidence that one was present. The prootic surface on the right side (see Prootic) is crushed, and the quadrate ramus of the pterygoid that is continuous with the prootic here forms a curved surface that, if restored, seems to be the lateral wall of a depression similar in depth to that in *Kurmademys*. Even though in its present condition, there is no M. pterygoideus concavity

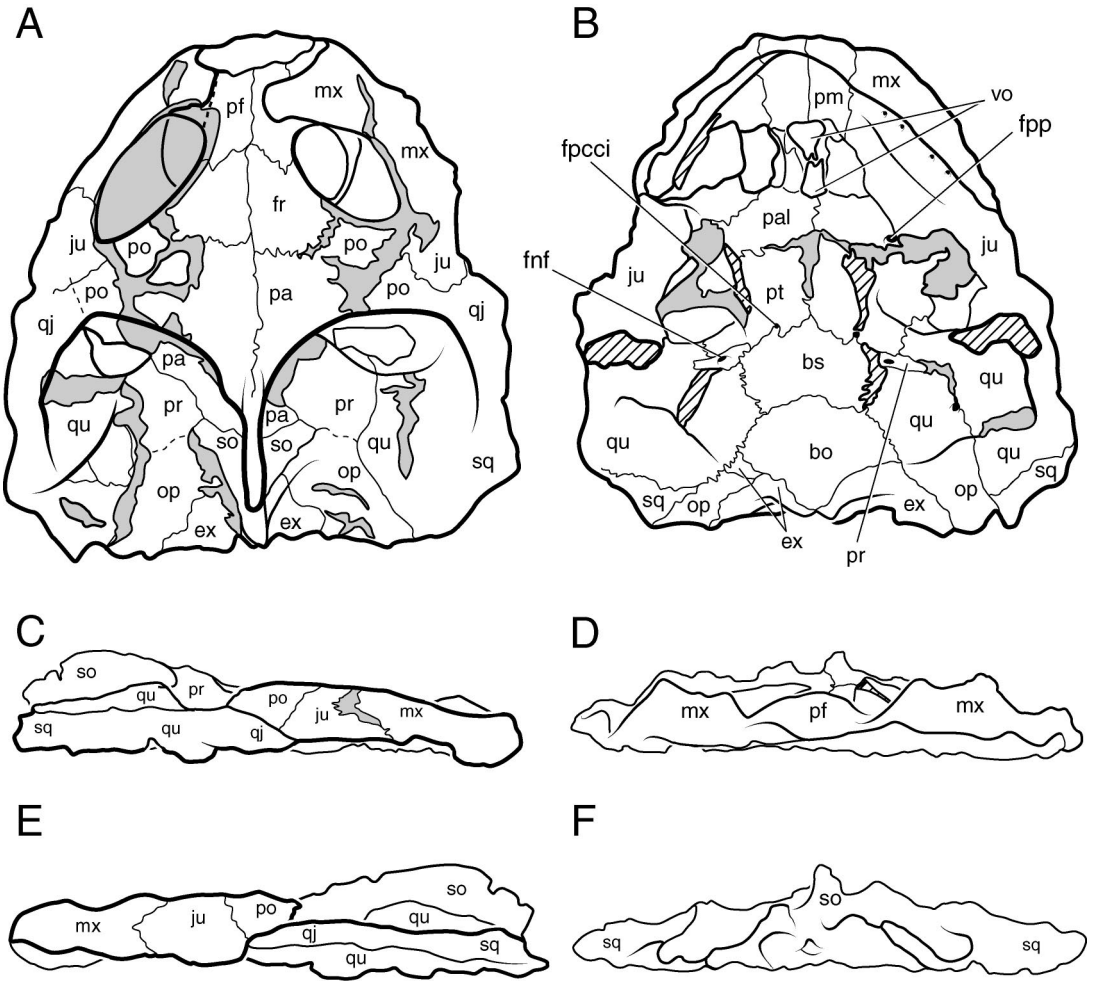

Fig. 3. Key to figure 2.

in *Sankuchemys*, it is likely that one was present.

The position of the foramen posterius canalis carotici interni is also not definite in *Sankuchemys*, although the damaged remnants of both can be seen. The foramen appears to be formed by pterygoid anteriorly and basisphenoid posteriorly. On the better preserved right side, the foramen posterius canalis carotici interni lies at the edge of a distinct dorsally curved surface of the pterygoid, further evidence of an M. pterygoideus depression with the foramen in its anterior wall. On the right side the posterior or dorsal margin of the foramen seems to be formed by the basisphenoid, but the area is badly fractured and it could be prootic. However, on the left side, there seems to be a posterodorsal margin for the foramen that is basisphenoid. The pterygoid portion of the foramen posterius canalis carotici interni is more damaged here, unfortunately. Due to crushing, the left pterygoid has little evidence of a depression, and the pterygoid margin of the foramen posterius canalis carotici interni is damaged.

The area where the foramen palatinum posterius would be expected is badly broken on both sides; however, a margin of the foramen is present on the right palatine, and the pterygoid margin as preserved is consistent with this.

SUPRAOCCIPITAL

The supraoccipital is present in *Sankuchemys* and relatively well preserved compared with the rest of the awful mess. The crista supraoccipitalis is partially preserved with its main surface still vertical. Its dorsal and posterior edges are broken. The laterally expanded base of the supraoccipital shows a clear anterior suture with the parietal on both sides. Posterolaterally the exoccipital suture is present on the left side. Laterally on both sides the more anterior prootic and more posterior opisthotic sutures are discernable but not definitive. There are a number of broken areas that could represent these sutures. The systematically important lateral lappet of the supraoccipital that contacts the quadrate is questionable. Given the state of preservation it could be present or absent. There are enough cracks that could be sutures to support either interpretation.

EXOCCIPITAL

Both exoccipitals are present but crushed, although they retain enough three-dimensionality to allow some definition of the foramen magnum. On the dorsal surface the exoccipital has the usual contacts: supraoccipital dorsally, opisthotic laterally, quadrate ventrolaterally, and basioccipital ventromedially.

The foramen magnum margins are visible and, although broken, the base of the condylus occipitalis is present on both sides. The condylus occipitalis is formed only by the exoccipitals. Parts of the medial margins of the foramen jugulare posterius are identifiable, but whether it was closed is not determinable. No foramen nervi hypoglossi is visible.

BASIOCCIPITAL

The basioccipital in *Sankuchemys* contacts the basisphenoid anteriorly, the quadrate laterally, and the exoccipitals posterolaterally, all as in *Kurmademys* and other bothremydids. The condylus occipitalis is not well preserved, but the posterior end of the basioccipital pinches out before entering what seems to be the articular surface of the condylus occipitalis. There is evidence of a low tuberculum basioccipitale, possibly developed to the extent seen in *Kurmademys*. There is no evidence of a median concavity, but one could have been present. As preserved, the basioccipital in *Sankuchemys* is slightly longer relative to its width than in *Kurmademys*.

PROOTIC

The exposure of the prootic in *Sankuchemys* is in an area of broken bone, but sutures and sutural surfaces are visible on both sides. As exposed in ventral view the prootic in *Sankuchemys* is a narrow, oval bone contacting the pterygoid anterolaterally, the basisphenoid medially, and the quadrate posterolaterally. The prootic exposure in *Sankuchemys* is similar to that in *Kurmademys* in its position, shape, and amount of exposure. In *Kurmademys* this exposure seems to be related to the development of a deep fossa pterygoideus, but there is no evidence of a fossa in *Sankuchemys*. The extensive crushing has probably obscured this depression.

In the center of the prootic in *Sankuchemys* is a foramen, the foramen nervi facialis, for the facial nerve (VII). This foramen is also exposed in the center of the prootic in *Kurmademys* and *Galianemys emringeri*.

On the dorsal surface both prootics are poorly preserved, but they are well enough preserved to show that a foramen stapediotemporale is not visible. The anterior surface of the prootic where this foramen and the foramen nervi trigemini would be expected is not preserved. On the dorsal surface the prootic contacts the supraoccipital posteromedially and the quadrate laterally. The question of a prootic-opisthotic contact cannot be determined confidently, but it is likely that one was present.

OPISTHOTIC

Although both opisthotics are present in *Sankuchemys*, transforming a complex three-dimensional element into two dimensions was not very kind to its morphology. On the ventral surface of both sides these contacts are visible: quadrate anterolaterally, squamosal posterolaterally, and exoccipital posteromedially. The opisthotic contacts the supraoccipital anteriorly and the quadrate lat-

TABLE 1
Measurements of *Sankuchemys sethnai* SDS/VPL 1125 (in millimeters)

A. Midline length as preserved	48.8
B. Maximum width	49.3
C. Width between orbits	9.0
D1. Width of left orbit	13.1
D2. Width of right orbit	11.5
E. Width of external nares	11.2
F. Width of internal nares	11.9[a]
G. Maximum height at quadrate	9.7[a]
H. Width of skull at middle of orbits	30.3[a]
I. Length from anterior margin of prefrontals to posterior margin of supraoccipital	44.5[a]
J1. Height of left orbit	5.5[a]
J2. Height of right orbit	6.7[a]
K. Skull height at occipital condyle	9.4[a]
L. Anterior width of triturating surface	5.5
M. Posterior width of triturating surface	7.0
N. Width of palate across foramina palatinum posterius	14.1[a]
O. Length from front of skull to posterior edge of condylus articularis	33.2[a]

[a] Damaged.

erally in dorsal view. The probable prootic contact is discussed under Prootic and Supraoccipital.

Few of the occipital structures and foramina can be made out in *Sankuchemys*. On the left side there is an opening that could be interpreted as what is left of the fenestra postotica.

Basisphenoid

The basisphenoid is present in *Sankuchemys* but it is fractured. It has the usual bothremydid contacts: pterygoid anterolaterally, quadrate posterolaterally, and basioccipital posteriorly. In addition there is the short, lateral contact with the prootic, also found in *Kurmademys* and *Galianemys emringeri*. The pterygoid contact includes a short anterolateral projection, presumed to be basioccipital, forming the posterior margin of the foramen posterius canalis carotici interni (see Pterygoid).

RELATIONSHIPS

Sankuchemys is missing some important morphologic areas, particularly the cavum tympani, that would help test its relationships. However, enough characters are present to provide some idea of its systematic position. It is a bothremydid because it has an exoccipital-quadrate contact and a foramen stapedio-temporale not visible in dorsal view. The foramen stapedio-temporale is not visible at all, but the dorsal surface of the prootic-quadrate suture is well enough preserved to show that it is not present there and was most likely on the anterior surface, as in other bothremydids.

Within the Bothremydidae, *Sankuchemys* has unique characters in common with the only other Indian bothremydid known from skulls, *Kurmademys*. Both taxa have an extensively emarginated temporal roof with very similarly shaped postorbitals, parietals, and squamosals, a condition so far unknown among other bothremydids. At present, *Sankuchemys* can best be hypothesized as a sister taxon to *Kurmademys* within the Bothremydidae.

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