

Trace fossils from the Ranipat sediments (Early Cretaceous), Saurashtra Basin, Gujarat, Western India

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Field investigation of the Ranipat Formation (Early Cretaceous) of the Dhrangadhra Group of Surendranagar district, Saurashtra basin (Gujarat) has led to the discovery of trace fossils *Ophiomorpha* (?), *Planolites*, *Skolithos* and *Thalassinoides* (ichnofossil, *Lebensspuren*) in crossbedded white to dirty-white sandstone, siltstone and clay. Preliminary investigations of well-preserved physical and biogenic structures of the Ranipat sediments reveal that the succession represents deposition in a nearshore-coastal, shallow-water or littoral-marginal marine setting. Indeed, the characteristic ichnofacies and lithofacies of the Ranipat Formation should provide a potentially useful model for reconstruction of nearshore to coastal marine sequences.

MOST trace fossils occur in characteristic, albeit intergradational lithofacies of nearshore-coastal to offshore sequences. Landward facies are typified by clean, well-sorted, well-stratified, sparsely burrowed sandstones¹. Seaward facies, except where interrupted by hummocky cross-stratified sandstones, exhibit successively less pure, less well-sorted and stratified, more intensely bioturbated, finer-grained sandstones, siltstones, and mudstones^{1,2}. Examination of Early Cretaceous (Upper Tithonian-Albian) deposits of the Saurashtra basin (Dhrangadhra Group), Surendranagar district, Gujarat, at sites near Chuli (23° 00' N 71° 21' E) and Sarla (22° 42' N 71° 23' E) of the Ranipat Formation led to the discovery of *Ophiomorpha* (?), *Planolites*, *Skolithos* and *Thalassinoides*. Trace fossils (ichnofossils, *Lebensspuren*), are being increasingly used in palaeoenvironmental interpretation of nearshore-coastal and marine deposits^{2,3}. In field applications, the relative abundance of dominant species is as important for local environmental reconstruction as the diversity and composition of the respective ichnofacies¹.

To my knowledge this is the first report of such fossils in the Early Cretaceous deposits of Saurashtra basin. The burrows discovered are assigned to ichnogenera but the identifications must remain tentative at present.

The Mesozoic rocks of Kutch (Jurassic-Early Cretaceous) are well known for the occurrence of fauna, ammonoides, plant fossils, as well as trace fossils, and have been extensively studied⁴⁻⁶. The Early Cretaceous rocks of Saurashtra peninsula lie mostly covered underneath the younger Deccan Trap, and only in the central part around Surendranagar do they occur as

inlier, occupying an outcrop area of about 1000 km² (refs. 7,8). The Mesozoic sequence of Dhrangadhra Group has been differentiated into four formations, viz. the Than at the base, succeeded by Surajdeval, Ranipat, and Wadhwan at the top^{7,8}. The Ranipat Formation¹ (~ 200 m) overlies the Surajdeval Formation conformably. The sedimentary sequence consists of recurring fining upward cycles comprising coarse, medium- to fine-grained sandstone, interbedded fine sandstone (Figure 1), siltstone and clay⁸. Coarse- to medium-grained sandstones occur as thick bodies (5-10 m), lenticular and channel-shaped, and display large- and small-scale planar and trough cross-bedding, including herringbone cross-bedding and hummocky cross-stratification (?) depending upon grain size. The cross-bedded sandstone bodies are white to dirty white in places, moderately sorted, locally containing thinner interbeds of white silty mud (5-10 cm thick), and occasionally ferruginous. Medium to fine sandstone occurs as laterally persistent bodies, interbedded with white siltstone and clay. The associated clay and mudstone beds are massive or show well-developed parallel laminations. The ichnofossils reported here are commonly associated with medium to fine sandstone and interbedded fine sandstone, siltstone, clay and mudstones. In the road cut, some 15 km west of Muli on the Sarla road, at least 4-8-m-thick sequence of interbedded fine sandstone, siltstone, clay and mudstone is exposed in various road cuts and excavations (quarries) in and around Chuli and Dhrangadhra towns. The following ichnofossils are recognized from Sarla and Chuli sections of the Ranipat Formation (species are listed alphabetically).



Figure 1. Successive sets of large- and small-scale trough cross-bedded coarse, medium to fine-grained sandstone, showing fining-upward cycles, Ranipat Formation, road-side section, 10 km north of Chotila on Than road.

Ichnogenus *Ophiomorpha annulata* (?) (Książkiewicz, 1977)

(Figure 2), size: diameter 0.6–2.5 cm.

Walls consisting of evenly spaced, transverse rows of elliptical pellets; more or less continuous rings or annulations around burrow segments. Horizontal segments more abundant than vertical segments. Vertical segments possibly connected the burrow system with the original surface, although true apertures of the burrow have not been observed owing to poor preservation. Scarcity of forms prevented a true identification. These burrows occur in fine to medium, parallel-laminated or associated hummocky cross-stratified (?) sand in the vicinity of Sarla. This specimen has also been reported from the Jurassic of Kutch^{6,9} and the Upper Cretaceous of east-central Utah (USA)¹.

Ichnogenus *Planolites* Nicholson, 1983

Planolites sp. (Figure 3), size: diameter 0.6–20 cm.

Unlined, simple non-branching, straight to slightly arcuate, mostly irregular on the outer surface, and subcircular in cross-section (1–2.5 cm). These burrows, occurring in fine to medium sandstone and associated

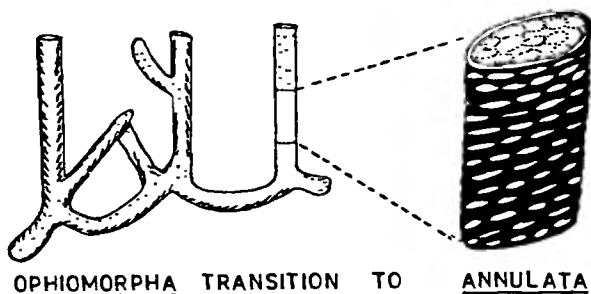


Figure 2. Sketch of *Ophiomorpha* (?) sp. showing probable transition to *Ophiomorpha annulata* (?) (Książkiewicz, 1977).

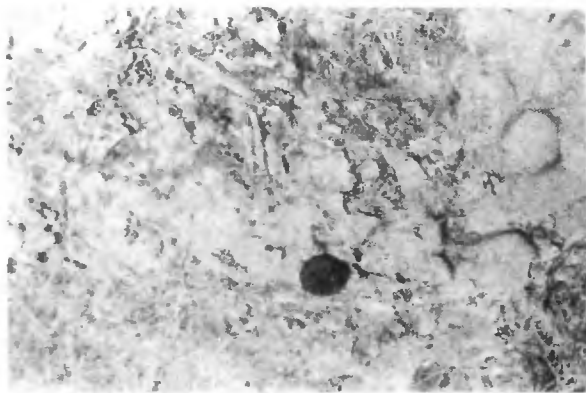


Figure 3. Typical occurrence of pipe-like tubes of *Planolites* species, occurring in fine to medium-grained sandstone and siltstone.

silt and clay exposed in the vicinity of Chuli and Nalkahmba (22° 38' 15" N, 71° 16' E), are ascribed to ichnogenus *Planolites* Nicholson. This form is known to range in age from Precambrian to Recent. It is reported from the Jurassic of Kutch^{6,9}, Bagh beds of Narmada Valley⁹, Cretaceous of Trichinopoly¹⁰, Cambrian of Spiti Valley¹¹, and Upper Cretaceous of east-central Utah¹.

Ichnogenus *Skolithos* Haldeman, 1840

Skolithos sp. (Figure 4), size: diameter, 0.5–1 cm.

Predominantly vertical, cylindrical to slightly sub-cylindrical about 0.5–1 cm, distinctly walled burrows were collected from white quartz-rich fine to medium sandstones in the vicinity of Chuli, Nalkahmba, and 2 km south of Palasan (22° 38' 30" N, 71° 20' E). It shows simple non-branching burrows. Vertical pipe-like sandy burrow tubes are more or less circular in cross-section, and occur in dense cluster colonial form (Figure 4). The pipe-like sandy burrow tubes are assigned to ichnogenus *Skolithos* Haldeman. The genus ranges from Precambrian to Cretaceous. The burrows described above have been widely reported from different geological records. Bhargava *et al.*¹¹ reported the occurrence of *Skolithos* Haldeman from the Cambrian sediments of Spiti Valley, Howard and Singh¹⁶ and Casshyap *et al.*⁶ from the Mesozoic sediments of Kutch, and Chiplonkar and Ghare¹⁰ from the Cretaceous sediments of Trichinopoly.

Ichnogenus *Thalassinoides* Ehrenberg, 1944

Thalassinoides sp. (Figure 4), size: diameter, 0.5–1.5 cm. *Thalassinoides* differs from *Ophiomorpha* in having ornamented walls. These burrows, of variable diameter (0.5–1.5 cm), and consisting of coarse to fine sandy material, circular to subcircular in cross-section, are



Figure 4. *Skolithos* Haldeman, 1840, and *Thalassinoides* Ehrenberg, 1944, occurring in dense cluster colonial form.

referred to ichnogenus *Thalassinoides* Ehrenberg. Large burrow smooth-walled, essentially cylindrical, oriented vertically, whereas small burrow inclined or oriented horizontally, mostly in Y-shaped branches, typically enlarged at points of bifurcation. They occur frequently around the quarries of Nalkahmba and Palasan. These burrows have been widely reported from the Cretaceous sediments of Bhuj^{6,16}, Upper Cretaceous of Germany (Sax)¹², and from east-central Utah¹.

The Ranipat Formation containing an assemblage of ichnofossil, including *Ophiomorpha*, *Planolites*, *Skolithos* and *Thalassinoides*, belongs to the *Skolithos*-*Cruziana* ichnofacies^{3,13,14}, which is characteristic of nearshore-coastal, shallow-water, littoral and intertidal environments. Howard and Frey^{1,14} attributed *Skolithos* to nearshore to offshore-marine environment. Seilacher¹⁵ reported the presence of *Skolithos* in both shallow-water non-marine and marginal-marine environments. Camberlain and Clark¹³ documented *Cruziana* ichnofacies in shallow marine environment. Thus the presence of ichnogenes, as described above, may indicate nearshore-marine or littoral-marginal-marine environment for the deposition of the Ranipat sediment. Coarse to medium sandstone bodies showing opposite to diagonally oriented cross-bedding (herringbone cross-bedding) may be attributed to sandy tidal-channel facies, and nearshore (barrier associated) facies¹⁵, whereas associated fine sandstone, clay and mudstone resemble intertidal mudflat facies. The locally associated hummocky cross-stratification may indicate occasional record of stormy conditions in the tidally influenced deposits.

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An articulated rhynchosaur fossil from Maleri Formation (Upper Gondwana), Andhra Pradesh, South India

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Rhynchosaurs were a widespread group of reptiles during the Triassic period. We report the finding of a nearly complete articulated skeleton of a rhynchosaur from a new locality, in the Upper Triassic Maleri Formation in the Pranhita-Godavari valley in Andhra Pradesh. The specimen preserves the postcranial skeleton but for the left forelimb down to the tail in a pose that is reminiscent of the living posture and suggests quick burial before scavengers could disrupt the carcass. The skull was fragmented but could be restored.

RHYNCHOSAURS have been recorded from all continents except Australia and Antarctica¹. The highly specialized Upper Triassic Rhynchosauridae comprise three inter-related¹ genera, *Paradapedon* from India²⁻⁶, *Hyperodapedon* from Scotland¹, and *Scaphonyx*^{7,8} from South America. These are known through partial skeletons, disarticulated bones, and restorations^{1,6,7} based on these. In India, early records of rhynchosaurs were on the basis of tooth plates from Upper Gondwana rocks belonging to the Upper Triassic Maleri Formation in the Pranhita-Godavari valley of Central India and Tiki Formation of the Sone-Mahanadi valley^{2,3}. Initially compared with *Hyperodapedon gordonii*², the Indian forms were renamed as *H. huxleyi* by Lydekker^{4,5}. Huene^{9,10} erected the genus *Paradapedon* for the species *huxleyi* and also provided a partial reconstruction from the fragmentary material⁹. An excellent collection of disarticulated skull and postcranial bones belonging to six skeletons allowed Chatterjee⁶ a more complete osteological description as well as restoration of the species *Paradapedon huxleyi*. The Elgin rhynchosaur *Hyperodapedon gordonii* from northeast Scotland has been restored on the basis of skulls and partial skeletons from a collection of 31-37 individuals¹. *Scaphonyx fischeri* from Santa Maria Formation of Brazil is also represented by a restoration⁷.

The rhynchosaur skeleton reported here was found in red clays which along with sandstone lenses and lime

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