

JURASSIC FRESHWATER OSTRACODS FROM THE KOTA LIMESTONE OF INDIA

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ABSTRACT. Three species of Jurassic freshwater ostracods representing the genera *Timiriasevia*, *Darwinula*, and (?)*Limnocythere* are described from the limestone of the Kota Formation of the Pranhita-Godavari Valley, India. Of these *Timiriasevia digitalis* sp. nov. is new, (?)*Limnocythere* sp. A is left under open nomenclature, and *Darwinula* cf. *D. sarytirmenensis* compared with the Middle Jurassic species of that name recorded from the Mangishlaka Peninsula, U.S.S.R.

A SMALL, well-preserved, ostracod faunule occurring in the limestone of the Kota Formation, a member of the continental Gondwana Group, in the Pranhita-Godavari Valley, provides our first knowledge of definite occurrence of non-marine Jurassic ostracods in India. The purpose of this paper is to describe and illustrate these ostracods and to interpret the palaeoecology of the fauna.

The Gondwana Group of rocks exposed in the Pranhita-Godavari Valley were first described by King in 1881. Since 1960 the geological and geophysical field parties of the Oil and Natural Gas Commission have been carrying out systematic surveys in this area as part of a programme of exploration for oil and gas in the Gondwana sediments. In recent years the Geological Studies Unit of the Indian Statistical Institute have also initiated a programme of study of the geology and palaeontology of this area (Sengupta 1966, 1970; Chatterjee 1967; Kutty 1969; Rudra 1973).

The Kota Formation of Upper Gondwana comprises a sequence of sandstones with conglomerates, red and green clays, and limestones. It overlies unconformably the Maleris. The basal member of the Kota Formation is made up of grey, coarse-grained, friable, poorly sorted, pebbly sandstone, grading in places to conglomerate. These are succeeded by a sequence of red and green clays interbedded with fine-grained sandstones. These, in turn, are followed by a band of grey to cream-coloured, hard, argillaceous, micritic, dolomitic limestone, with thin chert lenses, interstratified with soft clays. The limestone can be traced from south of Bobaram (79° 52' 35" N.; 18° 59' 40" E.) to north of Kadamba (79° 39' 20" N.; 19° 22' 50" E.). It is nearly 30–35 m thick and dips 5–10° NE. to ENE. It is dislocated by faults at many places and is overlain by a sequence of red clays and sandstones.

The Kota limestone is widely known for its rich and well-preserved fish remains. Sykes (1851), Bell (1853), and Egerton (1851, 1854, 1878) were the first ichthyologists to describe fossil fishes from it. Three genera are known, namely *Dapedium*, *Tetragonolepis*, and *Lepidotes*. Recently, Jain (1973), who carried out a detailed restudy of the Kota fish remains, has described a new genus *Paradepidium*. Tasch, Sastry, Shah, Rao, Rao and Ghosh (1973) have reported conchostracans, namely *Cyzicus* and *Paleolimnadia*, in these limestones and they have pointed out the close similarity of this fauna with the Antarctic non-marine Jurassic estheriids.

This paper, however, describes ostracod assemblages which were obtained from

Daroghapalli, Potepalli, Aklapalli, Kanchelli, and Metpalli in the Kota limestone at the north-eastern part of the Pranhita-Godavari Valley (text-fig. 1).

To the author's knowledge, the only known previous record of ostracods from the Kota limestone of the Pranhita-Godavari Valley was a species identified by Jones as *Candona* (in King 1881, p. 273). The present study deals with the ostracod assemblage which has not been previously reported from this area.

LOCALITIES AND SAMPLES

The localities from which samples were collected for this report are shown in text-fig. 1. The samples were collected from limestone and from interbedded clays and their details are given below.

Metpalli. A nearly complete section of the Kota limestone, probably the best-exposed in this area, 1 km south-west of Metpalli ($79^{\circ} 44' 00''$ N.; $19^{\circ} 11' 00''$ E.) on the south side of the lake near the overflow spill. Five samples were studied from the exposed thickness of 34.5 m. The limestone is underlain by calcareous silts and silty clays and overlain by red clays.

Kanchelli. Three samples were collected from the section 1.5 km north of Kanchelli ($79^{\circ} 49' 55''$ N.; $19^{\circ} 11' 18''$ E.). The exposed thickness of the limestone is 11.7 m. The limestone is overlain by red clays but the base could not be observed.

Daroghapalli. A comparatively well-exposed section north-east of Daroghapalli ($79^{\circ} 41' 14''$ N.; $19^{\circ} 19' 40''$ E.). Six samples were studied from the exposed thickness of 12.65 m. The limestone is underlain by crimson red clays.

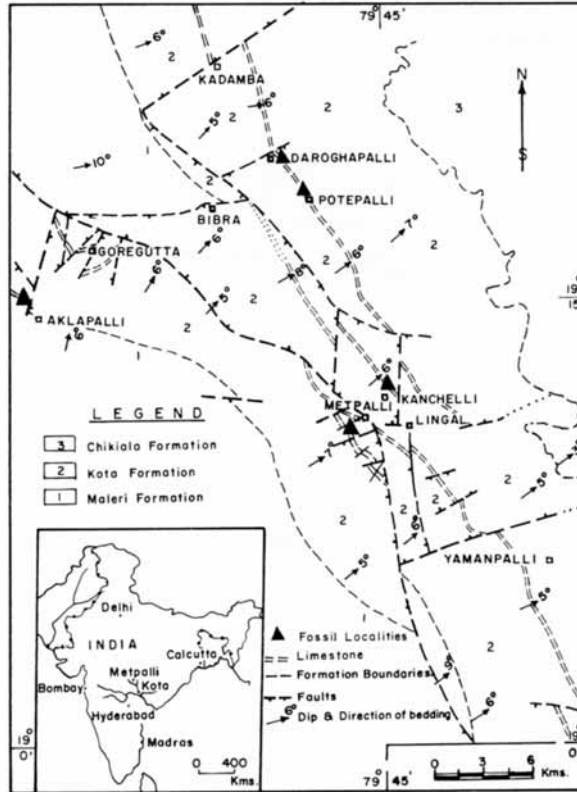
Aklapalli. Three samples were examined from the section exposed 1 km north of Aklapalli ($79^{\circ} 32' 40''$ N.; $19^{\circ} 14' 20''$ E.). The measured thickness of this band is 18 m.

Potepalli. The nearly 5 m thick limestone band is exposed 1 km NNW. of Potepalli ($79^{\circ} 42' 25''$ N.; $19^{\circ} 18' 10''$ E.). Two samples were collected.

In the laboratory, the limestone samples were treated with one part of glacial acetic acid in seven parts of water for three to four hours. The procedure was repeated several times to obtain matrix-free specimens. The clays were processed by treating them with hydrogen peroxide. The richest, well-preserved, material was obtained mainly from clays.

THE OSTRACOD FAUNA

The ostracods of the Kota limestone are moderately well preserved and some are silicified. They are abundant in some samples, mostly thin shelled, smooth, moderately large, and commonly filled with material making observation of internal features impossible. Separated valves are rare. Three genera were identified, each represented by a single species. Of these, one is now reported as a new species. One species is left under open nomenclature for want of sufficient study material. The genera identified are *Darwinula*, *Timiriasevia*, and (?)*Limnocythere*. *Darwinula* is well represented in most of the samples.



TEXT-FIG. 1. Map showing the fossil localities. Inset: outline map of India showing the villages Kota and Metpalli.

Perusal of the literature concerning the stratigraphic ranges of these ostracod genera shows that *Darwinula* ranges from Carboniferous to Recent, while *Limnocythere* extends from early Jurassic to Recent (vide Moore 1961). *Timiriasevia* is known to range from Middle Jurassic to Lower Cretaceous (vide Moore 1961, Q. 358). *Timiriasevia epidermiformis*, the type species of the genus *Timiriasevia*, was originally reported from the Middle Jurassic of U.S.S.R. Recently, Szczechura (1971) has recorded a few *Timiriasevia* species from the Palaeocene of Mongolia. The genus was also recorded earlier from the Bathonian beds of the Paris Basin (Oertli 1958) and from Oxfordshire (Bate 1965).

Darwinula cf. *D. sarytirmenensis*, a species comparable with the Middle Jurassic species of that name reported by Mandelstam (1947) from the Mangishlaka Peninsula, U.S.S.R., is represented abundantly in the Kota limestone. The occurrence of *Darwinula* cf. *D. sarytirmenensis* Sharapova together with *Timiriasevia digitalis*

sp. nov. and (?)*Limnocythere* species in the assemblage suggests that the Kota limestone is Middle Jurassic in age. In this context, it is pertinent to point out that the age of the Kota limestone has been determined as Liassic, based on the restudy of the fish fauna by Jain (1973).

ENVIRONMENT

The usefulness of ostracods for palaeoecological interpretations has long been recognized. Curtis (1960), Sandberg (1964), and others have used generic assemblages for precise determination of the various environments. The most striking feature of the Kota limestone ostracod assemblages is their complete domination by freshwater forms, of which the smooth-shelled *Darwinula* constitutes the largest part. *Darwinula* is essentially a freshwater form and occasionally is also encountered in oligomesohaline waters (*vide* Morkhoven 1963, p. 29). According to Bate (1967) at present day, *D. stephensoni* (Brady and Robertson), the type species of the genus *Darwinula*, lives in rivers and lakes in East Anglia, from where it was originally described. Moore (1961, Q. 358) gives the ecologic habitat of the genus *Timiriasevia* as freshwater.

In general, the freshwater Jurassic ostracod faunas are often dominated by the species of a small number of characteristic freshwater genera, particularly *Theriosynoecum*, *Darwinula*, *Cypridea*, *Bisulcoypris*, *Limnocythere*. Bate (1965) and Ljubimova (1956) reported on freshwater ostracods from Jurassic sediments in the U.K. and U.S.S.R. From the Kirtlington Quarry section of Oxfordshire, eight species of freshwater ostracod belonging to the genera *Theriosynoecum*, *Timiriasevia*, *Bisulcoypris*, *Darwinula*, and *Limnocythere* were described by Bate (1965). The fauna described by Ljubimova (1956) from the U.S.S.R. included species of *Darwinula*, *Timiriasevia*, *Theriosynoecum*, and other genera. These two freshwater Jurassic faunas correspond very closely to the Kota limestone ostracod fauna. Thus the limestone represents a freshwater facies deposited under lacustrine conditions.

Depository of types. The primary types are deposited at the Oil and Natural Gas Commission Regional Geological Laboratory, Baroda, and are designated here by the prefix ONGC:RGLB. A set of secondary types will be deposited at the British Museum (Natural History), London. Some types are in the author's collection, O.N.G.C. Geological Laboratory at Madras.

The photographic illustrations for this paper were taken by Dr. H. J. Oertli on a Stereoscan Scanning Electron Microscope while text-fig. 2 was drawn by the author using a Carl Zeiss camera lucida.

SYSTEMATIC PALAEOLOGY

Subclass OSTRACODA Latreille, 1806

Order PODOCOPIIDA Muller, 1894

Suborder PODOCOPINA Sars, 1866

Superfamily DARWINULACEA Brady and Norman, 1889

Family DARWINULIDAE Brady and Norman, 1889

Genus DARWINULA Brady and Robertson, 1885

Type species. *Polycheles stevensoni* Brady and Robertson, 1870, by original designation.

Darwinula cf. *D. sarytirmenensis* Sharapova, 1947

Plate 37, figs. 1-3; text-fig. 2a-h

1947 *Darwinula sarytirmenensis* Sharapova; Mandelstam, pl. 2, fig. 8.

Material. More than 200 carapaces and valves.

Occurrence. Metpalli, Daroghapalli, Potepalli, Kanchelli, and Aklapalli, Kota Formation, Pranhita-Godavari Valley, India.

Description. The carapace is elongate-oval in lateral view. The shell material is thin and the surface completely smooth. The greatest height of the carapace is situated in the posterior third and greatest length passing through or slightly below the mid-point. The anterior margin is narrowly rounded; the posterior margin is broadly and regularly rounded. The dorsal margin is nearly straight with convex anterodorsal and posterodorsal slopes. The ventral margin is broadly incurved anteromedially. The left valve is larger than the right which it overlaps along the entire margin and most strongly along the ventral margin. The hinge is adont, consisting in the right valve of a straight shallow groove.

Dimensions (in mm).

| Specimen | Length | Height | Width |
|------------------------|--------|--------|-------|
| ONGC:RGLB 380 (entire) | 0.890 | 0.450 | 0.395 |
| ONGC:RGLB 381 (entire) | 0.915 | 0.408 | 0.370 |
| ONGC:RGLB 382 (entire) | 0.925 | 0.407 | 0.370 |
| BMNH:IO 6016 (entire) | 0.915 | 0.408 | 0.335 |

Remarks. The Indian material closely resembles *Darwinula sarytirmenensis* Sharapova, described and illustrated by Mandelstam (1947, p. 254, pl. 2, fig. 8) from the Middle Jurassic of the Mangishlaka Peninsula. The specimens studied agree well with *D. sarytirmenensis* Sharapova figured by Mandelstam (op. cit.) and differ only by being slightly smaller in size. The Russian specimens attain a length of up to 1.14 mm and height up to 0.83 mm. The Indian material ranges in length from 0.80 to 0.90 mm and in height from 0.40 to 0.45 mm.

Superfamily CYTHERACEA Baird, 1850
Family LIMNOCYTHERIDAE Klie, 1938
Genus LIMNOCYTHERE Brady, 1868

Type species. *Cythere inopinata* Baird, 1843, by subsequent designation Brady and Norman, 1889.

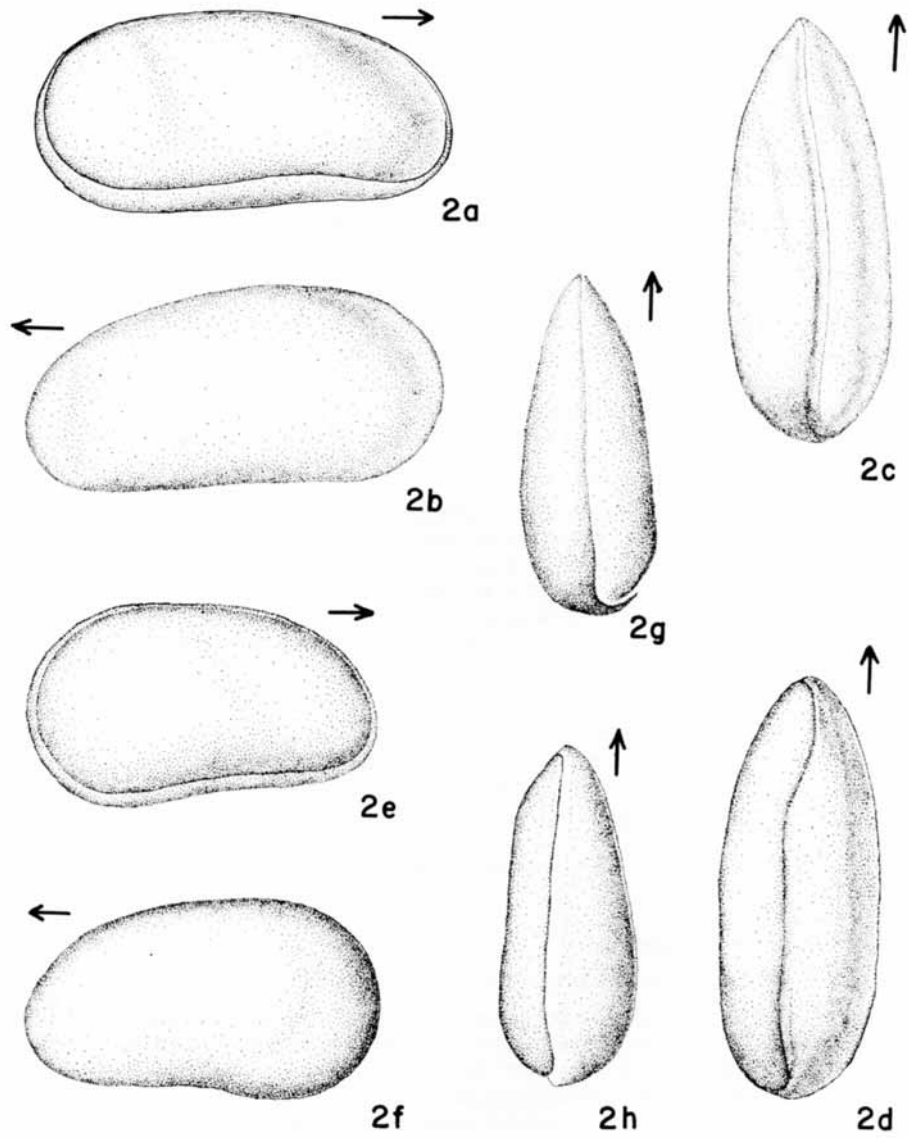
(?)LIMNOCYTHERE sp. A

Plate 37, fig. 6

Material. Three complete carapaces.

Occurrence. Daroghapalli, Kota Formation, Pranhita-Godavari Valley, India.

Description. The carapace is subrectangular in lateral view with the greatest height in the anterior third. The dorsal margin is nearly straight with prominent cardinal angles. The ventral margin is incurved medially. The anterior and posterior margins are regularly and broadly rounded, the posterior end being slightly more narrowly so. Anterior and posterior peripheral margins are compressed to form distinct marginal borders. A deep narrow sulcus is seen just anterior of mid-point. The greatest length of the carapace passes through the mid-point. The shell surface is faintly reticulated, the reticulae arranged in concentric rows close to and paralleling



TEXT-FIG. 2a-h, *Darwinula* cf. *D. sarytirmenensis* Sharapova. 2a-d, right, left, dorsal, and ventral views complete carapace, specimen ONGC:RGLB 382. 2e-h, right, left, dorsal, and ventral views, complete carapace, specimen BMNH:IO 6016 (all figures $\times 60$).

the margins. The internal characters could not be studied as the material yielded only carapaces.

Dimensions (in mm).

| Specimen | Length | Height | Width |
|-----------------|--------|--------|-------|
| ONGC:RGLB 383 ♀ | 0.520 | 0.340 | 0.295 |
| ONGC:RGLB 384 ♀ | 0.595 | 0.300 | 0.320 |
| BMNH:IO 6017 ♀ | 0.590 | 0.370 | 0.330 |

Remarks. Three poorly preserved forms in the material studied could belong to the genus *Limnocythere*. The characteristic deep anteromedian sulcus, the sinuate ventral margin, the broadly rounded ends, the compressed peripheral margins, and the reticulate surface ornamentation seem to fit well. Because there is insufficient material available, it is preferred to record it questionably under the genus *Limnocythere* until additional material becomes available for confirmation.

Genus TIMIRIASEVIA Mandelstam, 1947

Type species. *Timiriasevia epidermiformis* Mandelstam, 1947, by original designation.

Timiriasevia digitalis sp. nov.

Plate 37, figs. 4, 5, 7-11

Derivation of name. With reference to surface ornamentation of the carapace.

Material. Twenty complete carapaces and thirty-six partly broken carapaces.

Holotype. A complete female carapace, Plate 37, figs. 4-5.

Paratypes. Two complete female carapaces, Plate 37, figs. 9, 10, and 11 and a male carapace, Plate 37, figs. 7, 8.

Type locality. Daroghapalli, Kota Formation, Pranhita-Godavari Valley, India.

Diagnosis. A species of *Timiriasevia* with the following characteristics; carapace large, subrectangular in lateral view, slightly constricted mid-dorsally, greatly expanded posteriorly. Sexual dimorphism strongly evident, female dimorph heart-shaped in dorsal view with tapering anterior end, male lacks the posterior swellings of the female when viewed dorsally. Ornamentation consists of fine reticulations arranged somewhat concentrically in the middle of the posterior half and fine longitudinal ridges aligned roughly parallel to the outer margin; individual longitudinal ridges bifurcate and unite, forming a network pattern when viewed dorsally. Ventro-lateral margin thickened with a ridge. Left valve slightly larger than the right.

Description. The carapace is large, subrectangular in lateral view, slightly constricted mid-dorsally, just anterior of mid-point, and with the posterior highly inflated. In dorsal aspect, the carapace is heart-shaped tapering to the anterior with the greatest inflation at about the posterior third of the length. The dorsal margin is nearly straight to gently convex and the ventral margin is straight. The ventro-lateral margin is projected as a thinly developed ridge, particularly around the posterior margin. The anterior margin is broadly and evenly rounded. The anterior marginal zone is compressed to form a flattened marginal border. The posterior margin is broadly rounded. The ventral side of the carapace is flattened to produce a broad surface. The greatest

length of the carapace passes through the mid-point and the width is greatest at the posterior third. The lateral surface is ornamented with fine reticulations arranged somewhat concentrically in the middle of the posterior half of the shell. In addition, the ventral ornament consists of fine, closely spaced longitudinal ridges aligned roughly parallel to the outer margins. Individual longitudinal ridges bifurcate and coalesce resulting in a network pattern of ridges in dorsal view (Pl. 37, fig. 11). The left valve overlaps the right slightly along the ventral margin. The absence of single valves in the studied material precludes the possibility of ascertaining the details of the internal structures.

Dimensions (in mm).

| Specimen | Length | Height | Width |
|---------------------------|--------|--------|-------|
| Holotype, ONGC:RGLB 385 ♀ | 0.962 | 0.444 | 0.592 |
| Paratype, ONGC:RGLB 386 ♀ | 0.814 | 0.440 | 0.518 |
| Paratype, ONGC:RGLB 387 ♀ | 0.888 | 0.445 | 0.520 |
| Paratype, BMNH:IO 6018 ♀ | 0.960 | 0.445 | 0.519 |
| Paratype, BMNH:IO 6019 ♀ | 0.888 | 0.485 | 0.592 |

Remarks. *Timiriasevia digitalis* sp. nov. bears no affinities with known Russian Jurassic *Timiriasevia* species, differing from all by the larger, more elongate outline of the carapace, the presence of thickened postero-ventral marginal ridge, the flattened antero-marginal zone, and the distinct surface ornamentation. *T. mackerrowi* Bate, 1965, described from the Bathonian of Oxfordshire, differs considerably in the outline of the carapace and in the ornamentation. In the elongate outline of the carapace and in the type of the ridge pattern the present species also differs from *T. ulanbulakensis* Szczuchura, 1971, and *T. naranbulakensis* Szczuchura, 1971, described from the Palaeocene of Mongolia.

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EXPLANATION OF PLATE 37

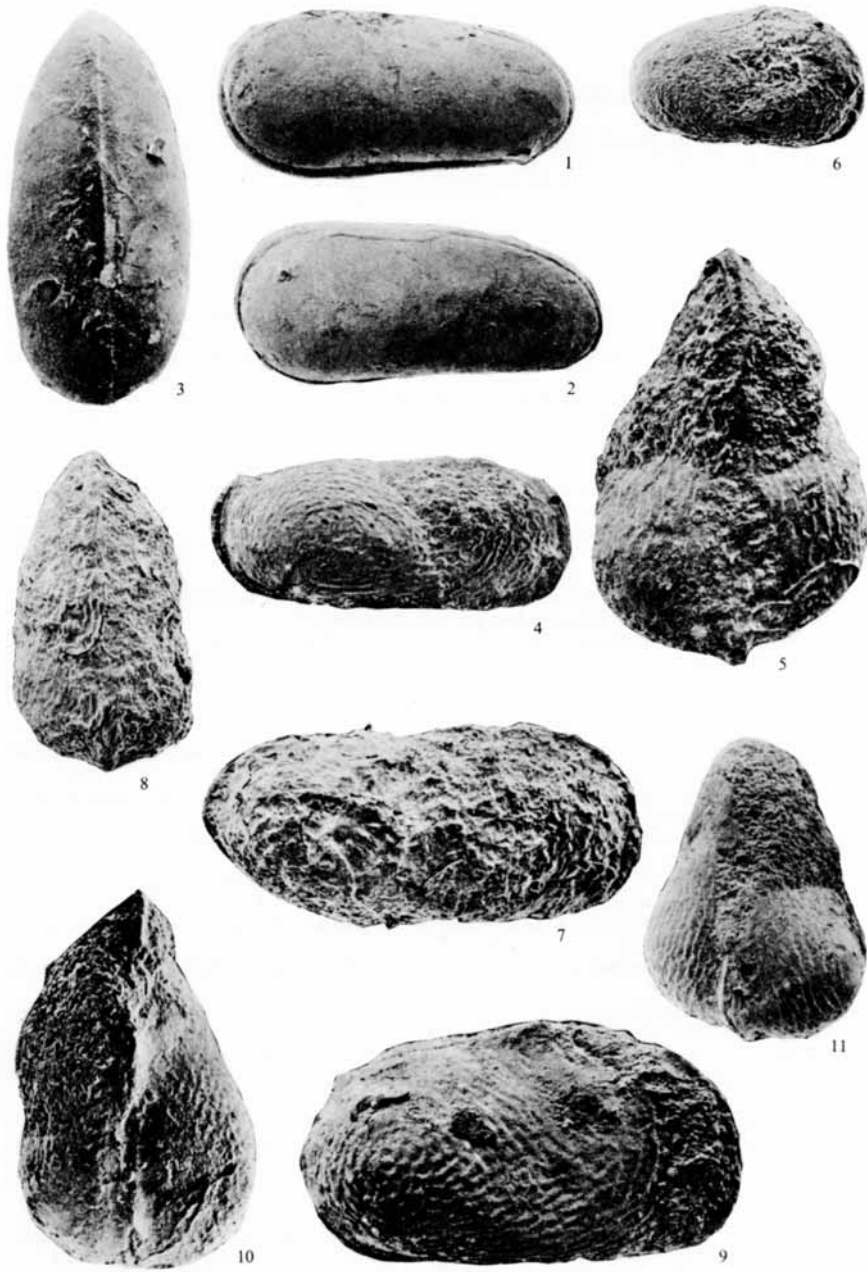
All figures are scanning micrographs.

Figs. 1-3. *Darwinula* cf. *D. sarytirmenensis* Sharapova. 1, right side of a complete carapace; ONGC:RGLB 380, $\times 66$. 2-3, right and dorsal views; complete carapace; ONGC:RGLB 381, 2, $\times 66$; 3, $\times 70$.

Figs. 4, 5. *Timiriasevia digitalis* sp. nov. 4, external view of right side of complete female carapace; holotype ONGC:RGLB 385, $\times 62$. 5, dorsal view of the same specimen, $\times 72$.

Fig. 6. (?) *Limnocythere* sp. A. External view of right side of complete carapace; holotype ONGC:RGLB 383, $\times 72$.

Figs. 7-11. *Timiriasevia digitalis* sp. nov. 7, external view of right side of complete male carapace; paratype ONGC:RGLB 386, $\times 78$. 8, dorsal view of the same specimen to show the absence of posterior swellings; $\times 58$. 9, external view of right side of complete female carapace showing characteristic surface ornamentation; paratype ONGC:RGLB 387, $\times 87$. 10, dorsal view of the same specimen showing prominent posterior swellings, $\times 74$. 11, dorsal view of another complete female carapace; paratype BMNH:IO 6018, $\times 60$.



GOVINDAN, Jurassic ostracods

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