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Ostracodes from the Eocene beds of Rajasthan, India

ABSTRACT

Fifty-three ostracode taxa from the Eocene beds of Rajasthan are described. Sixteen species and two subspecies are new. One species is renamed. The identifications of 21 taxa, previously described from Rajasthan and other areas, and also recorded in this work, are revised and brought up to date.

INTRODUCTION

The Eocene beds of Rajasthan occur in the Districts of Bikaner, Jaisalmer and Barmer. These beds contain a prolific microfauna consisting predominantly of foraminifers and ostracodes. A survey of the literature shows that, although some work has been done on the foraminifers, the ostracodes have not received much attention from micropaleontologists. Perhaps the first report of the occurrence of ostracodes in Rajasthan was published by Borooah (1946), who recorded the genus *Cythereis* from the Fuller's Earth beds (Lower Eocene) of Kapurdi, Barmer District. This was followed in 1950 by a short paper by Jacob and Sastri, who, besides describing smaller foraminifers, also recorded *Bairdia* sp., *Cythereis* spp., and *Cytheropteron* sp. from the Fuller's Earth beds of Mudh, Bikaner District. Thereafter, nothing was published until 1968, when Singh and Misra described 15 taxa, including a new genus, 12 new species, and a new variety, from the Fuller's Earth beds of the Kolayatji area, Bikaner District. The new taxa recorded by them were *Bairdoppilata jaswanti*, *Cythereis avadheshi*, *C. satyendri*, *C. spinellosa* var. *valdiyai*, *Cytherura rameshi*, *Quadracythere gautami*, *Schizocythere bikanerensis*, *S. vimali*, *Schuleridea bhupendri* (generic name misspelled *Shulredia*), *Trachyleberis deshbandi*, and *T. mathuri*. The other two recorded taxa were *Cytherella protuberantis* Lubimova and Guha (species name misspelled *protuberentis*), and *Paracypris* sp.

The ostracodes from the Eocene beds of other parts of India and Pakistan are, however, known in considerable detail, mainly through the works of Latham (1938), Tewari and Tandon (1960), Lubimova, Guha and Mohan (1960), Rajagopalan (1962), Sastri (1963), Guha (1965, 1967, 1968), Guha *et al.* (1965), Bhalla (1965), Tewari and Singh (1966), Srivastava (1968) and Sohn (1970).

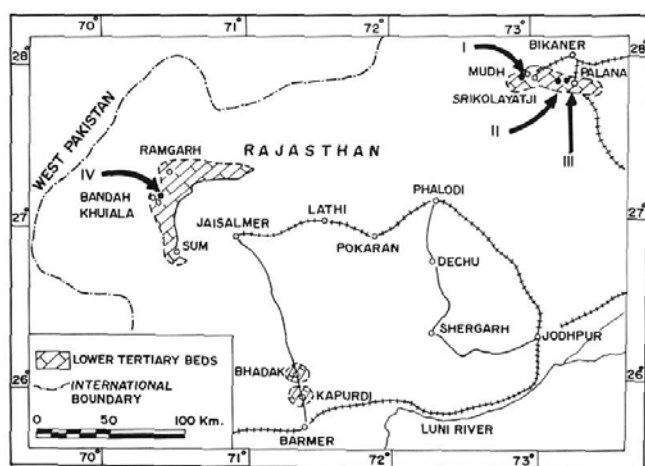
With the intention of investigating the little-known ostracode fauna of the Eocene beds of Rajasthan, the present author made a systematic collection of samples from four different sections, three in Bikaner District and one in Jaisalmer District, during 1965 and 1966. The locations of these sections are given below and in text-figure 1.

Bikaner District

Section I: Near Mudh Village (latitude 27°51'30"N.; longitude 72°56'E.), 52 kilometers west-southwest of Bikaner and 3 kilometers west-northwest of Srikolayatji (samples M/1 to M/64).

Section II: Lignite mine, 5 kilometers west of Palana (latitude 27°50'N.; longitude 73°15'E.), which is 22 kilometers south of Bikaner (samples P/B1 to P/B38).

Section III: One kilometer west of colliery office, Palana (samples P/A1 to P/A11).



TEXT-FIGURE 1

Index map of part of Rajasthan showing locations of the sections studied.

Jaisalmer District

Section IV: Near Bandah Village (latitude $27^{\circ}11'N$; longitude $70^{\circ}22'E$), 72 kilometers west-northwest of Jaisalmer (samples B/1 to B/17).

All of the sections yielded a rich and well-preserved ostracode fauna, sufficiently interesting and important to warrant publishing its systematic account. A preliminary note giving the check list of these ostracodes has already been published by the author (Khosla, 1968b). The new taxa were at that time left under open nomenclature.

STRATIGRAPHY

The stratigraphy of the Lower Tertiary beds of Rajasthan has been dealt with by Blanford (1877), Oldham (1886), La Touche (1902), Fox (1931), Bhola (1940), Singh (1953, 1955, 1969), Chatterji (1960), Poddar (1963), Mathur and Evans (1964), Siddiquie and Bahl (1965), Khosla (1967, 1968a), Metre (1968) and others.

The classification of these beds has recently been revised by the author (Khosla, MS.), and the revised classification has been followed in the present paper. The broad subdivisions and their brief lithological descriptions are summarized in table 1.

Of the four formations, only the Khuiala and the Bandah are rich in both microfauna and megafauna. On the basis of the larger foraminifers and pelecypods, which are the dominant fossils, it is possible to subdivide the Eocene formations further into various assemblage zones. The stratigraphy, as worked out by the author at sections I to IV, and the sample numbers are given in text-figures 2-5.

TABLE 1
Stratigraphy

Age	Formation	Lithology
?Post-Eocene	Jogira	Greyish-white grits, friable sandstones, lime-kankars, and ferruginous nodules
Middle Eocene	Bandah	White and yellow limestone
Lower Eocene	Khuiala	Calcareous shales, limestones, Fuller's Earth, red shales, and sandstones
Paleocene	Palana	Sandstones, clays, and lignite

COMPOSITION, AGE AND AFFINITY OF THE OSTRACODE FAUNA

The ostracode fauna of the Eocene beds of Rajasthan comprises 53 taxa. These belong to four families, five taxa to the family Cytherellidae, seven taxa to the family Bairdiidae, one taxon to the family Cyprididae, and 40 taxa to the family Cytheridae. Sixteen species and two subspecies are considered new. One species is re-named. Twenty-nine taxa are assigned to taxa already known. Seven taxa are left under open nomenclature.

Although some of the ostracodes are confined either to the Khuiala Formation or to the Bandah Formation, others occur in both. A total of 43 taxa were found in the Khuiala Formation, and 15 taxa in the Bandah Formation. An analysis of these is given below.

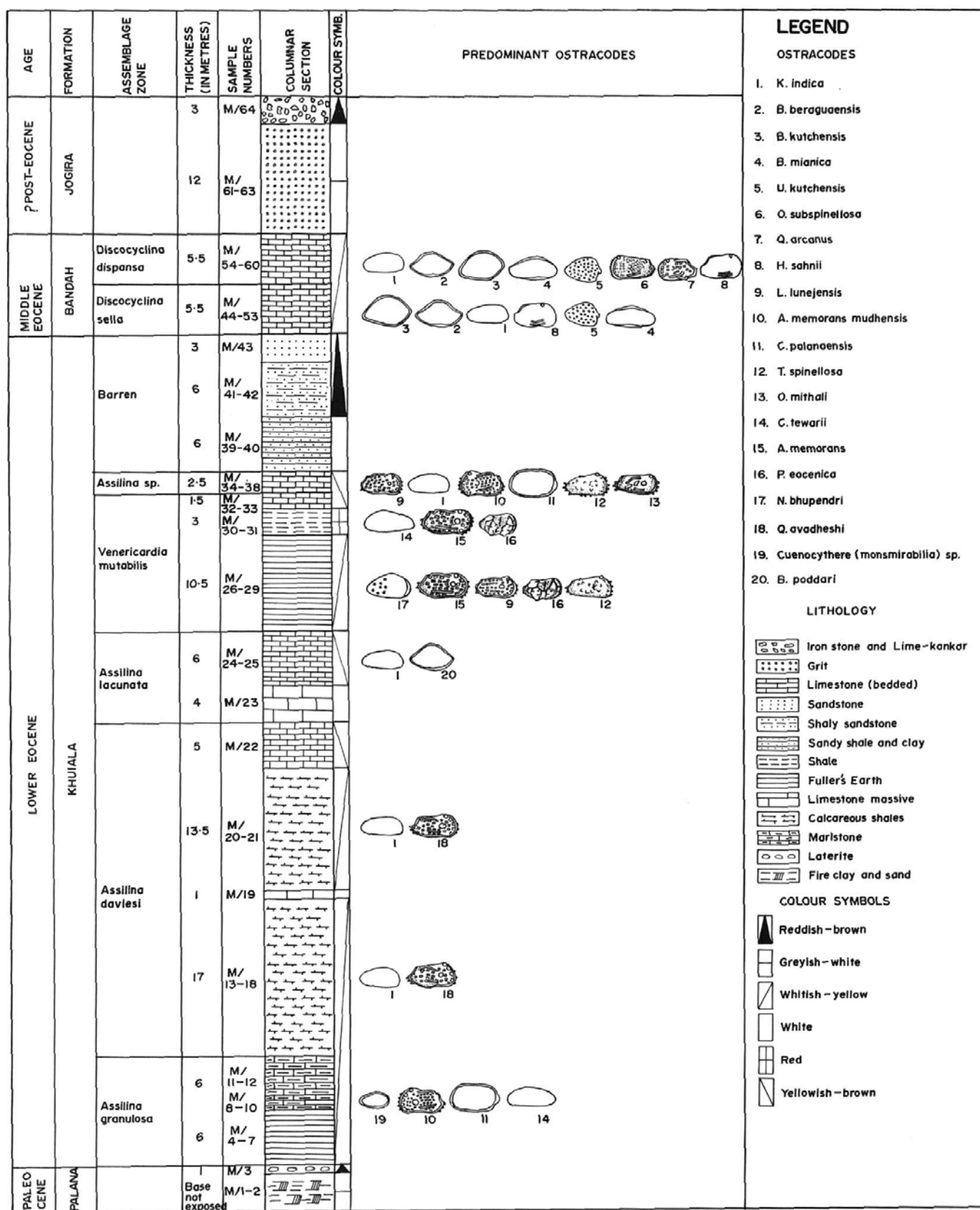
Khuiala Formation

1. Seven taxa are indeterminate, 17 are new, and two are compared with previously known taxa.

2. Five taxa are long-ranging. One taxon, *Legumino-cythereis lunejensis* Guha, extends from the Eocene to the Oligocene. Four taxa—*Bairdia poddari* (Lubimova and Mohan), *Cytherella protuberantis* Lubimova and Guha, *Paracypris meridionalis* Lubimova and Mohan, and *Trachyleberis spinellosa* (Lubimova and Guha)—range from the Eocene to the Miocene. All of these taxa were originally described from the Tertiary beds of Kutch. *Cytherella protuberantis* and *Trachyleberis spinellosa* have also been recorded from the Tertiary beds of Karikal in Tanjore District (south India).

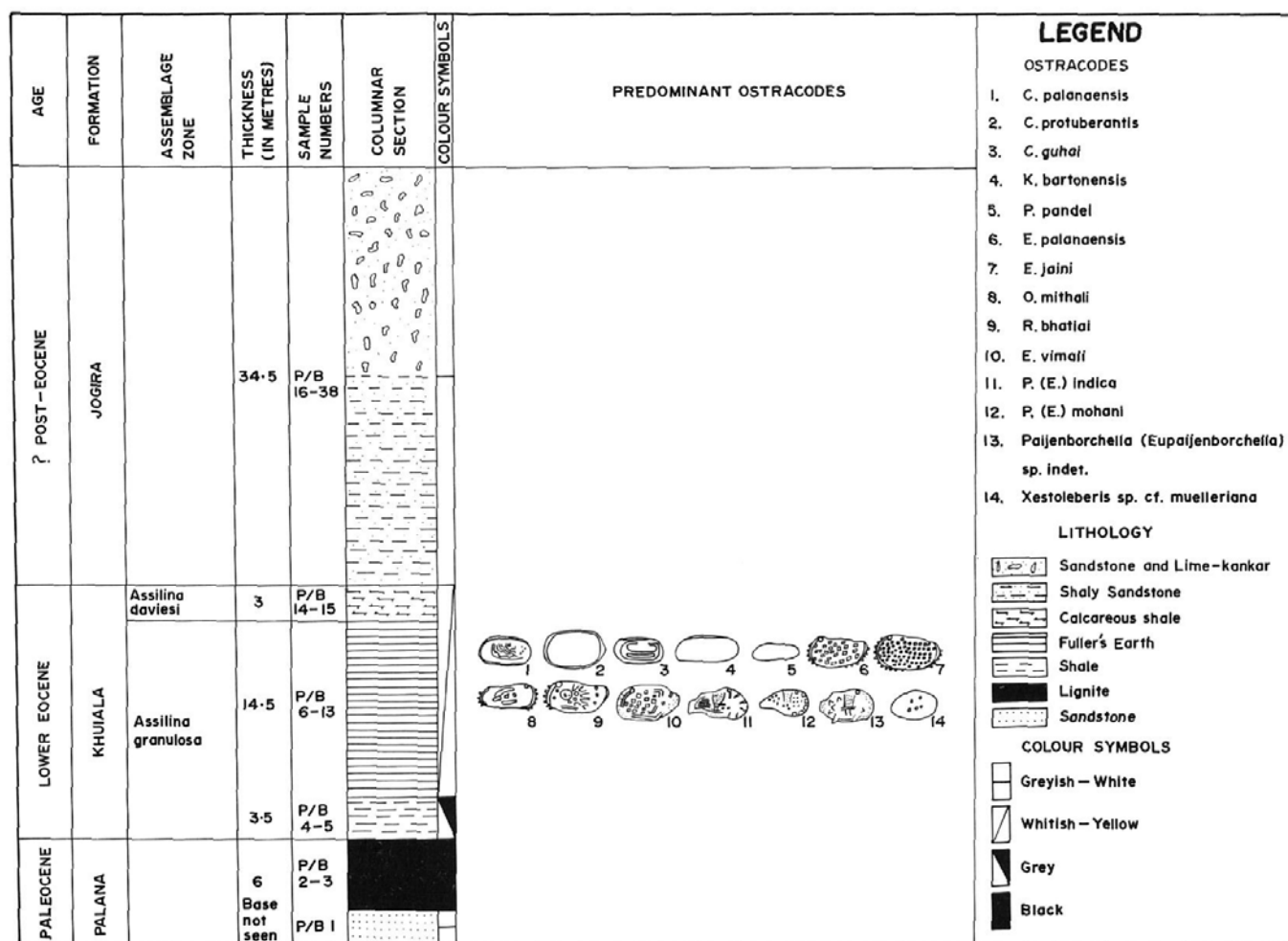
3. Five taxa—*Bairdia gliberti* (Keij), *Krithe bartonensis* (Jones), *K. indica* Tewari and Tandon, *Schizocythere appendiculata* Triebel and *Xestoleberis subglobosa* (Bosquet)—occur commonly in the Khuiala Formation and, except for *K. bartonensis*, also in the Bandah Formation. All of these taxa are characteristic of the Eocene. Although *K. indica* has been reported from the Middle Eocene beds of Kutch and the Lower Eocene beds of Jammu, the remaining four taxa have been reported only from the Eocene beds of Europe.

4. Five taxa—*Eucytherura vimali* (Singh and Misra), *Neocyprideis bhupendri* (Singh and Misra), *Quadra-cythere avadheshi* (Singh and Misra), *Schizocythere bikanerensis* (Singh and Misra), and *Semicytherura*



TEXT-FIGURE 2

Section I west of Mudh, Bikaner District. Constructed from surface exposures.



TEXT-FIGURE 3

Section II between Palana and Srikolayati, Bikaner District. Constructed from subsurface exposures in lignite mine.

rameshi (Singh and Misra)—are so far known only from Rajasthan. The first four taxa occur in the Khuiala Formation, and the fifth occurs in both the Khuiala and Bandah Formations.

5. Two taxa—*Anticythereis memorans* (Lubimova and Guha), and *Cytherella tawaica* Singh and Tewari—previously recorded from the Lower Eocene beds of Kutch and Jammu, respectively, occur in the equivalent horizons in Rajasthan and appear to be characteristic of the Lower Eocene.

Although the majority of the taxa are either long-ranging or are not morphologically distinct, no form renders inconsistent a Lower Eocene age for the beds of the Khuiala Formation.

Bandah Formation

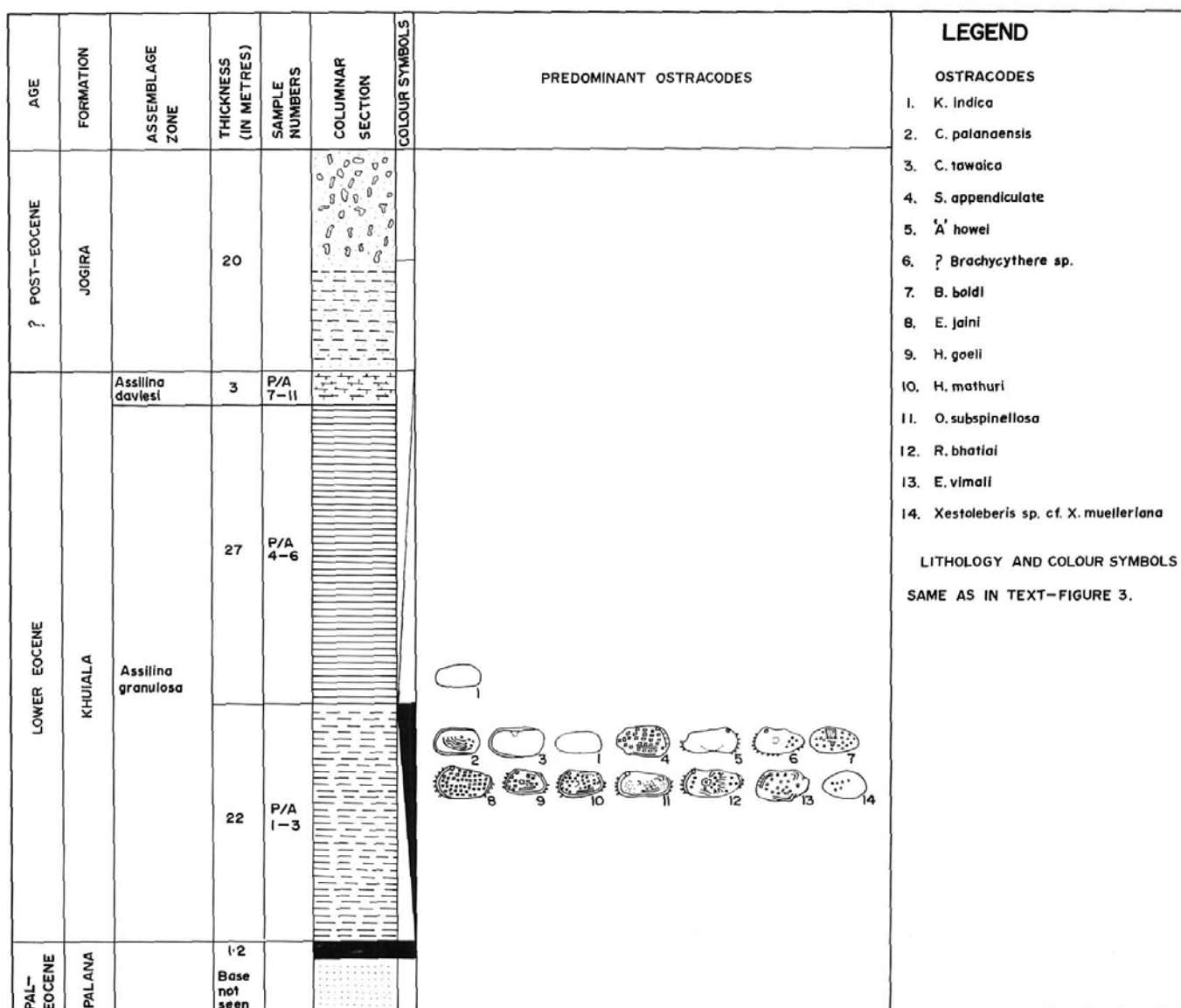
1. Two taxa are new, two taxa are compared with previously known taxa, and one taxon, *Cytherella protuberantis* Lubimova and Guha, is long-ranging.

2. One taxon, *Bairdia beraguaensis* Singh and Tewari, so far recorded only from the Lower Eocene beds of Jammu, occurs in the Bandah Formation of Rajasthan.

3. Three taxa—*Bairdia gliberti* (Keij), *Krithe indica* Tewari and Tandon, and *Xestoleberis subglobosa* (Bosquet)—are characteristic of the Eocene. In Rajasthan, they occur in both the Khuiala and Bandah Formations.

4. Six taxa—*Bairdia kirtharensis* Tewari and Tandon, *B. kutchensis* Khosla, new name, *Bythocypris mianica* Tewari and Tandon, *Hemicythere sahnii* Tewari and Tandon, *Quadracythere arcanus* (Lubimova and Guha), and *Uroleberis kutchensis* Guha—have so far been recorded only from the Middle Eocene beds of Kutch and Rajasthan.

The over-all evidence of the ostracode fauna confirms a Middle Eocene age for the beds of the Bandah Formation.



TEXT-FIGURE 4

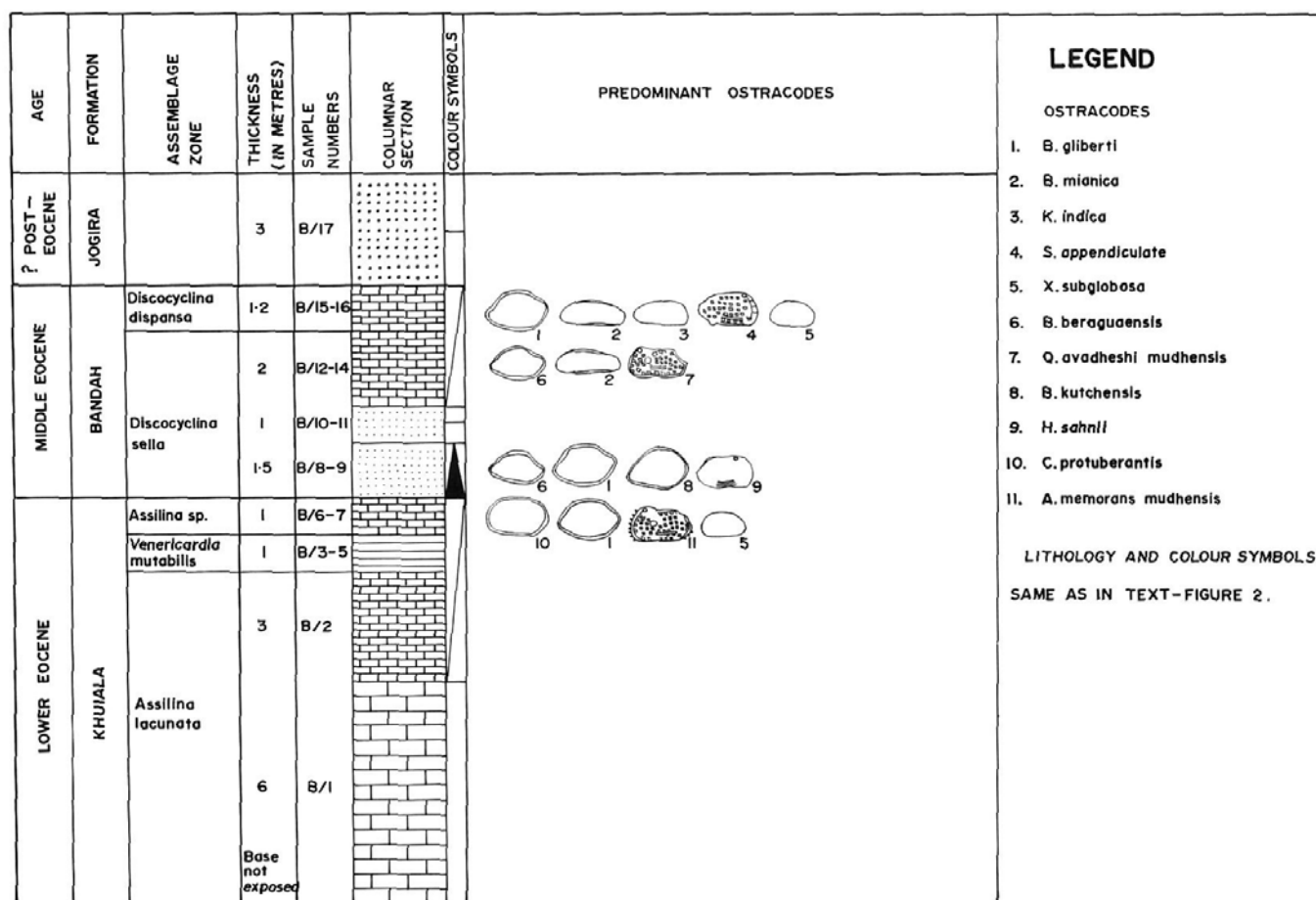
Section III west of Palana, Bikaner District. Constructed from core samples and data made available by the Department of Mines and Geology, Rajasthan.

SYSTEMATICS

A check list of the ostracode taxa discussed in this paper follows:

Cytherella palanaensis Khosla, n. sp.
C. protuberantis Lubimova and Guha
C. tawaica Singh and Tewari
Cytherella sp.
Cytherelloidea guhai Khosla, n. sp.
Bairdia beraguaensis Singh and Tewari
B. gliberti (Keij)
B. kirtharensis Tewari and Tandon
B. kutchensis Khosla, new name

B. poddari (Lubimova and Mohan)
Bythocypris sp. cf. *B. ? cancanaensis* (van den Bold)
B. mianica Tewari and Tandon
Paracypris meridionalis Lubimova and Mohan
Cushmanidea tewarii Khosla, n. sp.
Krithe bartonensis (Jones)
K. sp. cf. K. cancuensis van den Bold
K. indica Tewari and Tandon
Parakrithe pandei Khosla, n. sp.
Neocyprideis bhupendri (Singh and Misra)
Cuneocythere (Monsmirabilia) sp.
Schizocythere appendiculata Triebel



TEXT-FIGURE 5

Section IV northeast of Bandah, Jaisalmer District. Constructed from surface exposures.

S. bikanerensis Singh and Misra
Anticythereis memorans (Lubimova and Guha)
A. memorans mudhensis Khosla, n. subsp.
 "Archicythereis" howei Khosla, n. sp.
 ?*Brachycythere* sp.
Buntonia boldi Khosla, n. sp.
Echinocythereis jaini Khosla, n. sp.
E. palanaensis Khosla, n. sp.
Hermanites goeli Khosla, n. sp.
H. mathuri Khosla, n. sp.
Leguminocythereis lunejensis Guha
Occultocythereis mithali Khosla, n. sp.
O. subspinelliosa Khosla, n. sp.
Quadracythere arcanus (Lubimova and Guha)
Q. avadheshi (Singh and Misra)
Q. avadheshi mudhensis Khosla, n. subsp.
Ruggieria bhatiai Khosla, n. sp.
Trachyleberis spinellosa (Lubimova and Guha)
Hemicythere sahnii Tewari and Tandon
Paracytheridea eocenica Khosla, n. sp.
Cytherura sp.
Cytheropteron sp.

Eucytherura vimali (Singh and Misra)
Paijenborchella (*Eupaijenborchella*) sp. cf. *P. eocaenica* Triebel
P. (E.) indica Khosla, n. sp.
P. (E.) mohani Khosla, n. sp.
Paijenborchella (*Eupaijenborchella*) sp.
Semicytherura rameshi (Singh and Misra)
 ?*Nigeroloxoconcha* sp.
Xestoleberis sp. cf. *X. muelleriana* Lienenklaus
X. subglobosa (Bosquet)
Uroleberis kutchensis Guha

The classification followed is that of Hartmann (1964), with slight modification. The genus *Bairdopillata* Coryell, Sample and Jennings, 1935, is considered to be a junior synonym of *Bairdia* M'Coy, 1844, following Van Morkhoven (1958). For morphological terminology, including the hinge structures, the author has followed Van Morkhoven (1963). Only the new taxa are described in detail. Routine descriptions of already known and well-established taxa have been omitted for the sake of brevity. Wherever it is desirable and necessary,

however, morphologic and taxonomic comments and other features of significance are given under the heading "Remarks".

Holotypes, one paratype of each of the new taxa, and one specimen of each of the other taxa have been deposited in the museum of the Centre of Advance Study in Geology, Panjab University, Chandigarh, India, and references to them are designated by CASGMF catalogue numbers in the text and plate explanations.

Subclass OSTRACODA Latreille, 1806
Order PODOCOPIDA Müller, 1894
Suborder PLATYCOPA Sars, 1866
Family CYTHERELLIDAE Sars, 1866
Genus CYTHERELLA Jones, 1849

***Cytherella palanaensis* Khosla, n. sp.**

Plate 1, figures 1–2; plate 5, figure 1

Diagnosis: Carapace subquadrate in lateral outline; anterior and posterior margins equally rounded; dorsal and ventral margins straight; overlap distinct, right valve overlapping left valve at anterodorsal and anterior margins. Carapace wedge-shaped in dorsal view. Surface of each valve marked with a muscle-scar pit in dorsocentral area and with ornamentation consisting of closely spaced concentric striations, small pustules in posterior region, and a faint marginal ridge parallel to anterior, ventral and posterior margins.

Dimensions: Holotype (CASGMF No. 1), a complete carapace, length 0.48 mm., height 0.28 mm., width 0.18 mm.; paratype (CASGMF No. 2), a complete carapace, length 0.50 mm., height 0.30 mm., width 0.18 mm.

Discussion: The present species resembles *Cytherella pustulosa* Keij, 1957, an Eocene species, in the type of striations and pustules, but it differs in being much smaller, in lacking denticulations along the anterior margin, and in having a faint marginal ridge. The present species also resembles *Cytherella jonesiana* Bosquet, 1852, in general appearance, but the latter species, unlike the present one, has a surface ornamented by pits and a distinct vertical ridge at the posterior end.

Occurrence: In all, 50 specimens of this species were found in the Khuiala Formation of sections II and III.

Type level and locality: Grey shales of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section III.

Name: This species is named after the village of Palana, where it occurs abundantly.

***Cytherella protuberantis* Lubimova and Guha**
Plate 1, figure 3

Cytherella protuberantis LUBIMOVA and GUHA, in Lubimova, Guha and Mohan, 1960, pp. 17–18, pl. 1, fig. 3. – GUHA, 1965, p. 144, pl. 11, fig. 1. – GUHA *et al.*, 1965, p. 13, pl. 3, fig. 1. *Cytherella protuberantis* Lubimova and Guha. – SINGH and MISRA, 1968, pp. 36–37, pl. 11, figs. 5–7.

Remarks: *Cytherella protuberantis* Lubimova and Guha was originally described from the Lower Miocene beds of Kutch. The species also occurs in the Eocene beds. Incidentally, it should be mentioned that Lubimova and Guha (*supra cit.*) inadvertently gave a wrong orientation to the species, with the result that they considered the left valve to be larger than the right valve. The error is apparent from the description and illustration given by these authors. The right valve in this species, as is characteristic of the genus, is larger than the left. The presence of the species in the Eocene beds of Rajasthan has already been noted by Singh and Misra (*supra cit.*).

Dimensions: Hypotype (CASGMF No. 3), a complete female carapace, length 0.68 mm., height 0.42 mm., width 0.31 mm.

Occurrence: This species occurs abundantly in the Eocene beds of Rajasthan.

***Cytherella tawaica* Singh and Tewari**
Plate 1, figure 4

Cytherella tawaica SINGH and TEWARI, in Tewari and Singh, 1966, p. 127, pl. 2, fig. 3a–d.

Remarks: The present specimens from Rajasthan are identical with *Cytherella tawaica* described by Singh and Tewari (*supra cit.*) from the Eocene beds of Kalakot, Jammu (Dr. Tewari, personal communication). Similar forms from the Meting Limestone (Lower Eocene) of Pakistan have been described as *Cytherella* sp. aff. *C. lebanonensis* Howe by Sohn (1970).

Dimensions: Hypotype (CASGMF No. 4), a complete carapace, length 0.57 mm., height 0.33 mm., width 0.25 mm.

Occurrence: This species occurs commonly in the Khuiala Formation of sections I, II and III.

***Cytherella* sp.**
Plate 1, figure 5

Remarks: This species is characterized by an elongate-subquadrate carapace in lateral view, dorsal and ventral margins straight and parallel, anterior margin regularly rounded, and posterior margin truncate. In dorsal view, the carapace tapers anteriorly and is rounded posteriorly. The valve surface is smooth.

The species somewhat resembles *Cytherella vario-punctata* Lienenklaus, 1900, described from the Lower Oligocene beds of north Germany, in outline and length/

height ratio. The present species differs, however, from the latter in the absence of surface punctuation.

Dimensions: A right valve (CASGMF No. 5), length 0.70 mm., height 0.30 mm., width 0.18 mm.

Occurrence: One complete and a few broken valves of this species were found in sample P/B13 of section II.

Genus CYTHERELLOIDEA Alexander, 1929

Cytherelloidea guhai Khosla, n. sp.

Plate 1, figures 6–7; plate 5, figure 2

Diagnosis: Carapace subquadrate in outline in lateral view; anterior end broadly rounded; posterior end slightly truncate; dorsal and ventral margins nearly straight and subparallel in right valve, slightly concave in left. In dorsal view, carapace wedge-shaped, with maximum width at posterior end. Surface of each valve ornamented with two pronounced horizontal ridges in lower half and a third discontinuous one in upper half, the three horizontal ones being connected with a vertical marginal ridge at each end.

Dimensions: Holotype (CASGMF No. 6), a complete carapace, length 0.48 mm., height 0.28 mm., width 0.18 mm.; paratype (CASGMF No. 7), a complete carapace, length 0.48 mm., height 0.28 mm., width 0.20 mm.

Discussion: This species resembles *Cytherelloidea dameriacensis* Apostolescu, 1955, an Eocene species, in the number of ridges but differs in outline and ridge pattern. The dorsal ridge in *C. dameriacensis* is continuous; in the present species it is discontinuous. This species also somewhat resembles *Cytherelloidea panagensis* Keij, 1964, a Recent species, but differs in having a discontinuous dorsal ridge and a less truncate posterior margin.

Occurrence: This species is rare; only 15 specimens were found in the Khuiala Formation of sections I, II and III.

Type level and locality: Fuller's Earth beds of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section II.

Name: This species is named in honour of Mr. D. K. Guha, Geologist, Oil and Natural Gas Commission, Dehradun, India.

Suborder PODOCOPA Sars, 1866

Family BAIRDIIDAE Sars, 1866

Genus BAIRDIA M'Coy, 1844

Bairdia beraguaensis Singh and Tewari

Plate 1, figure 8

Bairdia beraguaensis SINGH and TEWARI, in Tewari and Singh, 1966, pp. 119–120, pl. 1, fig. 4a–d.

Bairdoppilata ? sp. SOHN, 1970, p. 60, pl. 1, figs. 5–6.

Remarks: The species was originally described from the Lower Eocene beds of Kalakot, Jammu. Specimens from Rajasthan agree with the types *fide* Dr. Tewari (personal communication), to whom the specimens were presented for comparison. The form described as *Bairdoppilata* ? sp. by Sohn (1970) from the Meting Limestone (Lower Eocene) of Pakistan apparently is the same as *B. beraguaensis*.

Dimensions: Hypotype (CASGMF No. 8), a complete carapace, length 0.96 mm., height 0.62 mm., width 0.51 mm.

Occurrence: The species occurs commonly in the Bandah Formation of sections I and IV.

Bairdia gliberti (Keij)

Plate 1, figure 9

Bairdia subdeltoidea BOSQUET, 1852, p. 29, pl. 1, fig. 13 (not *Cythere subdeltoidea* von Münster, 1830). — JONES and SHERBORN, 1889, p. 16, pl. 1, fig. 15. — LATHAM, 1938, p. 139, fig. 1. — APOSTOLESU, 1955, p. 245, pl. 1, figs. 9–10.

Bairdoppilata gliberti KEIJ, 1957, pp. 53–54, pl. 1, figs. 18–21.

Bairdoppilata kalakotensis SINGH and TEWARI, in Tewari and Singh, 1966, pp. 120–121, pl. 1, fig. 1a–d.

Remarks: The present specimens come within the range of variation of *Bairdia gliberti* (Keij) described from the Lutetian of Grignon, France, and other parts of Europe. *Bairdia subdeltoidea*, described by Latham (*supra cit.*) from the Eocene beds of the Salt Range, is here considered identical with *B. gliberti*. *Bairdoppilata kalakotensis* Singh and Tewari is also similar to *B. gliberti* in shape, size and other characters, and hence is considered to be a junior synonym.

Dimensions: Hypotype (CASGMF No. 9), a complete carapace, length 1.18 mm., height 0.80 mm., width 0.64 mm.

Occurrence: The species occurs commonly in sections I, III and IV.

Bairdia kutchensis Khosla, new name

Plate 1, figure 10

Bairdia indica TEWARI and TANDON, 1960, pp. 148–149, text-fig. 1, fig. 1a–b (not *Nesidea indica* Doeglas, 1931).

Remarks: This species was described as *Bairdia indica* by Tewari and Tandon (1960) from the Middle Eocene beds of Kutch. Dr. W. A. van den Bold has brought to the present author's attention the fact that the name is pre-occupied by *Nesidea* (= *Bairdia*) *indica* (Doeglas, 1931), described from the Tertiary beds of northeast Borneo. A new name, *Bairdia kutchensis*, is therefore proposed here for *Bairdia indica* Tewari and Tandon. The new name is after Kutch, the region from which it was first described.

Dimensions: Hypotype (CASGMF No. 10), a complete carapace, length 0.82 mm., height 0.51 mm., width 0.41 mm.

Occurrence: This species occurs commonly in the Bandah Formation of sections I and IV. In all, seventy specimens were found.

***Bairdia kirtharensis* Tewari and Tandon**

Plate 1, figure 11

Bairdia ? kirtharensis TEWARI and TANDON, 1960, pp. 149–150, text-fig. 1, fig. 4a–b.

Remarks: The specimens recorded herein are identical with the types of *Bairdia ? kirtharensis* Tewari and Tandon, described from the Middle Eocene beds of Kutch (Dr. Tewari, personal communication).

Dimensions: Hypotype (CASGMF No. 11), a complete carapace, length 1.13 mm., height 0.61 mm., width 0.47 mm.

Occurrence: This species is rare. A few specimens were found in samples M/46 and M/49 from section I.

***Bairdia poddari* (Lubimova and Mohan)**

Plate 1, figure 12

Bairdoppilata poddari LUBIMOVA and MOHAN, in Lubimova et al., 1960, pp. 21–23, pl. 2, fig. 1a–b. – GUHA et al., 1965, p. 13, pl. 3, fig. 9.

Bairdoppilata jaswanti SINGH and MISRA, 1968, p. 36, pl. 10, figs. 9–10, pl. 11, fig. 1.

Remarks: *Bairdia poddari* (Lubimova and Mohan) was originally described from the Middle Eocene beds of Kutch. It is also known to occur in the Lower Miocene beds of Karikal (Guha et al., *supra cit.*). The present specimens from Rajasthan have been compared with the types deposited in the Palaeontological Laboratory, Oil and Natural Gas Commission, Dehradun, and, except for a slight difference in size, the specimens are identical.

Dimensions: Hypotype (CASGMF No. 12), a complete carapace, length 0.77 mm., height 0.51 mm., width 0.39 mm.

Occurrence: In all, eight specimens of this species were found in sample M/25 from the Khuiala Formation of section I.

Genus BYTHOCYPRIS Brady, 1880

***Bythocypris* sp. cf. *B. ? cancanaensis* (van den Bold)**

Plate 1, figure 14

Cf. *Bairdia cancanaensis* VAN DEN BOLD, 1946, p. 73, pl. 4, fig. 8.

Cf. *Bythocypris ? cancanaensis* (van den Bold). – VAN DEN BOLD, 1960, pl. 2, fig. 10.

Remarks: The specimens recorded herein resemble closely *Bythocypris ? cancanaensis* (van den Bold), described from the Eocene beds of Trinidad, in size and length/height ratio, but differ in minor details of outline (*vide* Dr. van den Bold, personal communication).

Dimensions: Hypotype (CASGMF No. 13), a complete carapace, length 1.20 mm., height 0.75 mm., width 0.56 mm.

Occurrence: In all, 12 specimens of this species were found in the Bandah Formation of section I.

***Bythocypris mianica* Tewari and Tandon**

Plate 1, figure 13

Bythocypris mianica TEWARI and TANDON, 1960, pp. 150–151, text-fig. 2, fig. 1a–b.

Remarks: The present specimens from Rajasthan agree in all details with the types of *Bythocypris mianica* described by Tewari and Tandon (*supra cit.*) from the Middle Eocene beds of Kutch (Dr. Tewari, personal communication).

Dimensions: Hypotype (CASGMF No. 14), a complete carapace, length 1.07 mm., height 0.48 mm., width 0.40 mm.

Occurrence: This species is rare. Only five specimens were found in the Bandah Formation (samples M/57, B/12, B/16) of sections I and IV.

Family CYPRIDIDAE Baird, 1845

Subfamily PARACYPRIDINAE Sars, 1923

Genus PARACYPRIS Sars, 1866

***Paracypris meridionalis* Lubimova and Mohan**

Plate 2, figure 23

Paracypris meridionalis LUBIMOVA and MOHAN, in Lubimova, Guha and Mohan, 1960, pp. 23–24, pl. 2, fig. 3.

Remarks: The present specimens come within the range of variation of *Paracypris meridionalis* Lubimova and Mohan, described from the Eocene and Lower Miocene beds of Kutch.

Dimensions: Hypotype (CASGMF No. 15), a right valve, length 0.76 mm., height 0.36 mm., width 0.15 mm.

Occurrence: The species occurs commonly in the *Venericardia mutabilis* and *Assilina* sp. Zones of section I.

Family CYTHERIDAE Baird, 1850

Subfamily NEOCYTHERIDEIDINAE Puri, 1957

Genus CUSHMANIDEA Blake, 1933

***Cushmanidea tewarii* Khosla, n. sp.**

Plate 1, figures 17–18; plate 4, figure 1

Diagnosis: Carapace elongate in lateral view; maximum height less than half of length, posterior to middle; left

valve slightly larger than right valve; dorsal margin convex; ventral margin slightly convex in left valve but concave in right valve; anterior margin narrowly rounded; posterior margin sloping down from postero-dorsal part and rounded at posteroventral corner. In dorsal view, carapace with maximum width posteriorly; anterior end narrow. Surface of each valve smooth. Inner lamella of moderate width, maximum width at anterior margin. Hinge of lophodont type, in left valve with two terminal sockets and a median bar, complementary in right valve.

Dimensions: Holotype (CASGMF No. 16), a right valve, length 0.76 mm., height 0.35 mm., width 0.15 mm.; paratype (CASGMF No. 17), complete carapace, length 0.72 mm., height 0.35 mm., width 0.30 mm.

Discussion: The species described above resembles the type species, *Cushmanidea seminuda* (Cushman, 1906), in general appearance and type of hinge, but differs in the details of the outline. It also resembles *Cushmanidea kayserensis* Krutak, 1961, an Eocene species of Alabama, but the latter has faint ridges near the ventral margin and a slightly different outline. Another species close to the present one is *Cushmanidea sagena* Benson and Kaesler, 1963, but in this species the ventral margin in the left valve is concave, whereas in the present species it is slightly convex. *Cushmanidea panciradialis* Swain and Gilby, 1967, a Recent species, also resembles the present species in appearance but differs in the length/height ratio.

Occurrence: This species occurs in the Khuiala Formation of section I. In all, 20 specimens were found.

Type level and locality: Red shales of the *Venericardia mutabilis* Zone, Khuiala Formation (Lower Eocene), section I.

Name: This species is named in honour of Dr. B. S. Tewari, Professor of Geology, Panjab University, Chandigarh, India.

Subfamily KRITHINAE Mandelstam, 1960
Genus KRITHE Brady, Crosskey and Robertson, 1874

Krithe bartonensis (Jones)
Plate 1, figure 19

Cythere (*Cytherideis*) *bartonensis* JONES, 1857, p. 50, pl. 5, figs. 2-3.
Krithe bartonensis (Jones). — KEIJ, 1957, p. 85, pl. 8, figs. 11-17.

Remarks: This is a well-known Eocene species. The present specimens show various degrees of distortion due to compression. Some of the specimens are completely compressed.

Dimensions: Hypotype (CASGMF No. 18), a complete male carapace, length 0.70 mm., height 0.32 mm., width 0.30 mm.

Occurrence: The species occurs commonly in the Khuiala Formation of section II.

Krithe* sp. cf. *K. cancuenensis van den Bold
Plate 1, figure 20

Cf. *Krithe cancuenensis* VAN DEN BOLD, 1946, p. 77, pl. 17, fig. 6a-b. — VAN DEN BOLD, 1960, p. 157, pl. 3, fig. 2a-b.
Cf. *Krithe guatemalensis* VAN DEN BOLD, 1957, p. 7, pl. 1, fig. 5c-e.

Remarks: The present specimen may be compared with *Krithe cancuenensis* van den Bold, described from the Lower Eocene beds of Trinidad. Exact identification is not possible owing to insufficient material.

Dimensions: Hypotype (CASGMF No. 19), a right valve, length 0.84 mm., height 0.44 mm.

Occurrence: A single right valve of the species was found in sample P/B11 of section II.

Krithe indica Tewari and Tandon
Plate 1, figure 21

Krithe indica TEWARI and TANDON, 1960, pp. 152-153, text-fig. 2, fig. 5a-b. — TEWARI and SINGH, 1966, pp. 122-123, pl. 2, fig. 6a-d.

Remarks: *Krithe indica* was originally described from the Kirthar beds (Eocene) of Kutch. It has also been recorded from the Eocene beds of Kalakot, Jammu, by Tewari and Singh (*supra cit.*). The present specimens from Rajasthan are identical with the types (Dr. Tewari, personal communication). Tewari and Singh (1966) considered *Krithe autochthona* Lubimova and Guha, 1960, described from the Lower Miocene of Kutch, to be a junior synonym of *K. indica*. *Krithe autochthona* differs from *K. indica* in having a straight dorsal margin, a centrally concave ventral margin, and a much larger size. *Krithe autochthona* is therefore considered to be a separate species.

Dimensions: Hypotype (CASGMF No. 20), a complete female carapace, length 0.52 mm., height 0.28 mm., width 0.25 mm.

Occurrence: This species occurs commonly throughout the Eocene beds of Rajasthan, and specimens were found in almost all of the assemblage zones.

Genus PARAKRITHE van den Bold, 1958

Parakrithe pandei Khosla, n. sp.
Plate 2, figures 24-25

Diagnosis: Carapace elongate in lateral view, with maximum height posterior to middle; left valve slightly

larger than right, with a distinct overlap at ventral and posterior margins; dorsal margin convex for most of its length, but slightly concave in anterodorsal part; ventral margin concave in anteroventral part and straight for rest of length; anterior margin broadly rounded; posterior margin downwardly rounded. In dorsal view, carapace compressed anteriorly; maximum width posterior to middle. Valve surface smooth.

Dimensions: Holotype (CASGMF No. 21), a complete carapace, length 0.46 mm., height 0.18 mm., width 0.15 mm.

Discussion: This species shows some variation in the degree of concavity of the anterodorsal margin. It resembles the type species *Parakrithe vermunti* (van den Bold, 1946), described from the Lower Oligocene beds of Trinidad, in over-all shape and in the concavity at the anteroventral margin, but the latter species has comparatively more height and thus differs in length/height ratio. The present species in general appearance resembles also *Parakrithe elongata* van den Bold, 1960, described from the Middle Eocene and Lower Oligocene beds of Trinidad, but the latter species, unlike the present one, has a straight dorsal margin.

Occurrence: This species occurs commonly in the Khuiala Formation (samples P/B10, 11 and 13) of section II.

Type level and locality: Fuller's Earth beds of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section II.

Name: This species is named in honour of Dr. I. C. Pande, Director, Centre of Advanced Studies in Geology, Panjab University, Chandigarh, India.

Subfamily CYTHERIDEINAE Sars, 1925
Genus NEOCYPRIDEIS Apostolescu, 1956

Neocyprideis bhupendri (Singh and Misra)
Plate 1, figure 15; plate 4, figure 2

Shulredia bhupendri SINGH and MISRA, 1968, p. 32, pl. 8, figs. 7–9.

Remarks: The species recorded herein was described as *Schuleridea bhupendri* (generic name misspelled as *Shulredia*) by Singh and Misra (*supra cit.*) from the Fuller's Earth beds of Mudh. According to van Morkhoven (1963), the genus *Schuleridea* is characterized by a very pronounced overlap, the hinge in the right valve consisting of all projecting elements and that in the left valve all negative elements, and by numerous, closely spaced, marginal pore canals. As against this pattern, the present species has a different hinge (in the right valve consisting of anterior and posterior crenulated teeth connected by a groove, and complementary

elements in the left valve), a slight overlap, and a few straight, marginal pore canals. On the basis of these characters, the species is transferred to the genus *Neocyprideis*.

Dimensions: Topotype I (CASGMF No. 23), a complete female carapace, length 0.70 mm., height 0.45 mm., width 0.36 mm.; topotype II, a male right valve, length 0.66 mm., height 0.38 mm., width 0.18 mm.

Occurrence: The species occurs abundantly in the *Venericardia mutabilis* Zone, section I.

Genus CUNEOCYTHERE Lienenklaus, 1894
Subgenus MONSMIRABILIA Apostolescu, 1955

Cuneocythere (Monsmirabilia) sp.
Plate 1, figure 16

Remarks: This species is characterized by an elongate-ovate outline in lateral view; a strong overlap, the left valve being considerably larger than the right and overlapping it all around; a smooth valve surface; and a simple hinge, with a distinct accommodation groove in the left valve. Most of the specimens in the present material are badly preserved.

The present species shows some resemblance to *Cuneocythere (Monsmirabilia) subovata* Apostolescu, 1955, an Eocene species, in the strong overlap and the outline in dorsal view. However, the latter species has its maximum height slightly behind the middle and a different outline of the posterior margin in the left valve. No specific name is given to the present species for want of better-preserved material.

Dimensions: A complete female carapace (CASGMF No. 24), length 0.71 mm., height 0.44 mm., width 0.38 mm.

Occurrence: This species occurs abundantly in samples M/8–10 from the *Assilina granulosa* Zone of the Khuiala Formation, section I.

Subfamily CYTHERINAE Baird, 1850
Genus SCHIZOCYTHERE Triebel, 1950

Schizocythere appendiculata Triebel
Plate 2, figure 1

Cythere tessellata BOSQUET, 1852 (part), p. 84.
Schizocythere appendiculata TRIEBEL, 1950, p. 324, pl. 3, figs. 23–27. — APOSTOLESCU, 1955, p. 257, pl. 4, figs. 58–59. — KEIJ, 1957, p. 154, pl. 20, fig. 19.

Remarks: *Schizocythere appendiculata* Triebel was originally described from the Eocene beds of France. It has also been recorded from Belgium and the Netherlands. The Rajasthan specimens are identical with *S. appendiculata* except for a minor difference in outline.

Dimensions: Hypotype (CASGMF No. 25), a complete carapace, length 0.46 mm., height 0.27 mm., width 0.22 mm.

Occurrence: This species occurs commonly at sections III and IV.

Schizocythere bikanerensis Singh and Misra
Plate 2, figure 2

Schizocythere bikanerensis SINGH and MISRA, 1968, p. 29, pl. 7, figs. 8–10.

Remarks: The present specimens are identical with the types of *Schizocythere bikanerensis* described by Singh and Misra (*supra cit.*).

Dimensions: Topotype (CASGMF No. 26), a complete carapace, length 0.47 mm., height 0.28 mm., width 0.22 mm.

Occurrence: The species occurs commonly in the *Venericardia mutabilis* Zone of the Khuiala Formation, section I.

Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948
Genus ANTICYTHEREIS van den Bold, 1946

Anticythereis memorans (Lubimova and Guha)
Plate 2, figure 4; plate 4, figure 4

Trachyleberis memorans LUBIMOVA and GUHA, in Lubimova, Guha and Mohan, 1960, pp. 38–39, pl. 3, fig. 5.

? *Quadracythere gautami* SINGH and MISRA, 1968, pp. 30–31, pl. 8, figs. 1–3.

? *Trachyleberis deshbandi* SINGH and MISRA, 1968, p. 33, pl. 9, figs. 1–3.

? *Trachyleberis mathuri* SINGH and MISRA, 1968, pp. 33–34, pl. 9, figs. 4–6.

Quadracythere ? aspinosa SOHN, 1970, p. 64, pl. 3, figs. 15–18.

Remarks: This species has been previously described from the Eocene beds of Kutch as *Trachyleberis memorans* by Lubimova and Guha (*supra cit.*). However, it has surface ornamentation and hinge structure unlike those of the genus *Trachyleberis*. The surface of each valve is coarsely reticulate and has a dorsal ridge slightly protruding above the margin, a ventral ridge sloping upwards posteriorly, a prominent subcentral tubercle, and a crescent-shaped depression posterior to it. The hinge is of amphidont/heterodont type. In the right valve it consists of a pointed anterior tooth, a post-jacent socket which continues into a long groove, and a large, smooth, posterior tooth. The hinge in the left valve is complementary. On the basis of these characters the species is transferred to the genus *Anticythereis*. Singh and Misra (*supra cit.*) created three new species: *Quadracythere gautami*, *Trachyleberis deshbandi*, and *T. mathuri*. These appear to be conspecific and are here questionably considered as junior synonyms of *A. memorans*. *Quadracythere ? aspinosa* Sohn, 1970, de-

scribed from the Meting Limestone of Pakistan, is definitely a junior synonym of *A. memorans*.

Dimensions: Hypotype (CASGMF No. 27), a female right valve, length 0.83 mm., height 0.46 mm., width 0.26 mm.

Occurrence: This species occurs in the *Venericardia mutabilis* Zone of section I, and the *Assilina granulosa* Zone of section II.

Anticythereis memorans mudhensis Khosla, n. subsp.
Plate 2, figures 5–6; plate 4, figure 5; plate 5, figure 4

Diagnosis: Carapace subquadrate in lateral view; left valve slightly larger than right; dorsal margin in left valve with a distinct anterior hinge ear; central dorsal and posterodorsal margin obscured owing to protruding ridge; ventral margin slightly convex; anterior margin broadly rounded; posterior margin narrow and rounded. In right valve, dorsal and ventral margins nearly straight; posterior margin subangular, concave in upper part and convex in lower part. Carapace spindle-shaped in dorsal view. Anterior and posterior margins with prominent rim and denticulations. Valve surface with a subcentral tubercle, ornamentation composed of fine, closely spaced reticulations, and two distinct ridges, one dorsal and the other ventral. Eye tubercle distinct. Inner lamella of moderate width; selvage strong and near outer margin. Hinge of amphidont/heterodont type. Sexual dimorphism distinct; male carapace comparatively more elongate than female carapace.

Dimensions: Holotype (CASGMF No. 28), a female left valve, length 0.74 mm., height 0.44 mm., width 0.25 mm.; paratype I (CASGMF No. 29), a female right valve, length 0.74 mm., height 0.40 mm., width 0.22 mm.; paratype II, a complete female carapace, length 0.80 mm., height 0.47 mm., width 0.44 mm.

Discussion: This subspecies differs from *Anticythereis memorans* (Lubimova and Guha, 1960), described from the Eocene beds of Kutch, in having a finely reticulate ornamentation.

Occurrence: This subspecies occurs commonly in the Khuiala Formation of sections I and IV.

Type level and locality: Marlstone beds of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section I.

Name: This subspecies is named after the village of Mudh, near which it occurs commonly.

Genus "ARCHICYTHEREIS" Howe, 1936

"Archicythereis" howei Khosla, n. sp.
Plate 2, figures 7–8; plate 4, figure 3

Diagnosis: Carapace subquadrate-elongate, with maximum height at anterodorsal angle; dorsal margin straight and converging posteriorly towards ventral margin; ventral margin nearly straight in left valve and slightly concave in right valve; anterior margin broadly rounded; posterior margin subangular, concave in upper half and convex in lower; each valve produced in a strong alar prolongation in ventral half; margins, except for dorsal, fringed with long, thick spines. Carapace biconvex in dorsal view. Surface of each valve smooth. Eye tubercle distinct. Inner lamella of moderate width, broad along anterior and posterior margins, narrower along ventral margin; marginal pore canals straight and simple, some bifurcating. Hinge poorly developed. Sexual dimorphism distinct; female carapace higher and wider than male carapace.

Dimensions: Holotype (CASGMF No. 30), a female left valve, length 0.65 mm., height 0.40 mm., width 0.12 mm.; paratype I (CASGMF No. 31), a female left valve, length 0.60 mm., height 0.34 mm., width 0.12 mm.; paratype II, a complete female carapace, length 0.62 mm., height 0.36 mm., width 0.22 mm.

Discussion: The species shows considerable variation in the number of spines. The ventral margin varies in concavity, depending on the alar prolongation of the valves. The present species closely resembles the type species "*Archicythereis*" *yazooensis* (Howe and Chambers, 1935), an Eocene species, in general shape, long marginal spines, and alar prolongation in the ventral half, but differs in details of the outline and in the lack of T-shaped marginal spines.

Occurrence: The species occurs in the Khuiala Formation (sample P/A3) of section III. In all, 20 specimens were found.

Type level and locality: Grey shales of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section III.

Name: This species is named in honour of Dr. H. V. Howe, Director Emeritus, Department of Geology, Louisiana State University, Baton Rouge, Louisiana.

Genus BRACHYCYTHERE Alexander, 1933

?*Brachycythere* sp.

Plate 2, figure 3; plate 4, figure 6

Remarks: This species has the following characteristics. Carapace subovate in lateral view; each valve with ventrolateral swelling; margins fringed with spines. Surface ornamented by pits concentrated in posterior half. Hinge and other internal characters poorly preserved, but in right valve hinge apparently consisting of a distinct posterior crenulate tooth, a long continuous

groove, and an anterior hinge element which is not distinct. Left valve with an accommodation groove.

The species is questionably assigned to the genus *Brachycythere* Alexander on the basis of the above-mentioned characters. The posterior margin, unlike that of the type species *Brachycythere sphenoides* (Reuss, 1854), in which it is angular, is narrowly rounded. More and better-preserved specimens are required for precise identification.

Dimensions: A female left valve (CASGMF No. 32), length 0.46 mm., height 0.30 mm., width 0.15 mm.; a female right valve, length 0.48 mm., height 0.28 mm., width 0.13 mm.

Occurrence: In all, 10 specimens of this species were found in the Fuller's Earth (sample P/B11) of section II and the grey shales (sample P/A3) of section III.

Genus BUNTONIA Howe, 1935

Buntonia boldi Khosla, n. sp.

Plate 2, figures 13–14; plate 5, figure 3

Diagnosis: Carapace oval in lateral view, with maximum height anterior to middle; left valve slightly overlapping right valve; dorsal margin weakly arched; ventral margin convex; anterior end broadly rounded; posterior end less so. Carapace biconvex in dorsal view; maximum width posterior to middle. Surface of each valve covered with closely spaced pits. A vertical sulcus extends from the central dorsal margin downwards to two-thirds of the height, a short but distinct ridge traversing the sulcus near the centre. Sexual dimorphism distinct; male carapace more elongate than female carapace.

Dimensions: Holotype (CASGMF No. 33), a complete female carapace, length 0.50 mm., height 0.32 mm., width 0.23 mm.; paratype (CASGMF No. 34), a complete female carapace, length 0.50 mm., height 0.32 mm., width 0.23 mm.

Discussion: The internal features of the species are not well preserved. According to Dr. H. V. Howe, to whom the present specimens from Rajasthan were sent, the external characters are quite distinctive enough for the species to be assigned to the genus *Buntonia*. The species resembles *Buntonia shubutaensis* Howe, 1935 (in Howe and Chambers, 1935), the type species described from the Upper Eocene Jackson beds, in over-all shape and in some other characters. The present species differs distinctly, however, from *B. shubutaensis* and many other species of the genus *Buntonia* in the presence of a vertical sulcus, traversed by a short ridge near the centre. In *B. shubutaensis* the surface is ornamented by ridges and furrows in the posterior half. *Buntonia* (*Protobuntonia*) *punctata* Reyment, 1963, a

Paleocene species, somewhat resembles the present species in general shape and surface ornamentation, but differs in the absence of a vertical sulcus and in minor details of the outline.

Occurrence: This species was found only in sample P/A3, section III, in which it occurs abundantly.

Type level and locality: Grey shales of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section III.

Name: This species is named in honour of Dr. W. A. van den Bold, Professor of Geology, Louisiana State University, Baton Rouge, Louisiana.

Genus ECHINOCYHEREIS Puri, 1953

***Echinocythereis palanaensis* Khosla, n. sp.**

Plate 3, figures 1–2; plate 4, figure 9

Diagnosis: Carapace subquadrate in lateral view, with greatest height at anterodorsal angle; in left valve dorsal margin undulating, slightly concave at posterodorsal and anterodorsal margins; ventral margin straight; anterior margin broadly rounded; posterior rounded, with upturned end; in right valve anteroventral margin slightly concave; posterior margin subangular, gently concave in upper part and convex in lower; carapace biconvex in dorsal view, maximum width posterior to middle. Surface of each valve covered with coarse, concentrically arranged, reticulate ornamentation and a few surface spines. Margins with a narrow rim and spines. Eye tubercle distinct. Inner lamella of moderate width; selvage in right valve distinct and near outer margin; marginal pore canals closely spaced and simple. Hinge of amphidont/heterodont type. Sexual dimorphism distinct; male carapace more elongate than female carapace.

Dimensions: Holotype (CASGMF No. 35), a male left valve, length 0.81 mm., height 0.45 mm., width 0.20 mm.; paratype I, a female right valve, length 0.72 mm., height 0.40 mm., width 0.20 mm.; paratype II, a complete male carapace, length 0.83 mm., height 0.44 mm., width 0.40 mm.

Discussion: This species resembles *Echinocythereis cheropadiensis* (Tewari and Tandon, 1960), described from the Lower Miocene beds of Kutch, but differs in the outline of the dorsal margin.

Occurrence: The species occurs commonly in the Fuller's Earth beds of section II.

Type level and locality: Fuller's Earth beds of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section II.

Name: This species is named after the village of Palana, where it occurs commonly.

***Echinocythereis jaini* Khosla, n. sp.**

Plate 3, figures 3–4; plate 4, figure 8

Diagnosis: Carapace subquadrate in lateral view, with greatest height at anterodorsal angle; in left valve, dorsal margin nearly straight, posterodorsal margin slightly concave; ventral margin straight; anterior margin broadly rounded; posterior margin rounded, with upturned end; in right valve, anteroventral margin slightly concave; posterior margin subangular above mid-height. Carapace spindle-shaped in dorsal view. Marginal rim narrow, occurring along anterior and posterior margins; margins fringed with spines. Surface ornamented with spines superimposed on fine reticulations arranged in concentric manner. Eye tubercle distinct. Inner lamella of moderate width. Hinge of amphidont/heterodont type. Sexual dimorphism distinct; male carapace more elongate than female carapace.

Dimensions: Holotype (CASGMF No. 36), a male left valve, length 0.70 mm., height 0.38 mm., width 0.19 mm.; paratype I (CASGMF No. 37), a female right valve, length 0.62 mm., height 0.37 mm., width 0.23 mm.; paratype II, a complete female carapace, length 0.62 mm., height 0.40 mm., width 0.32 mm.

Discussion: The species described herein resembles *Echinocythereis garretti* (Howe and McGuirt) (in Howe *et al.*, 1935), a Miocene species, in general appearance, ornamentation, and hinge structure, but differs in details of the outline. The present species also resembles *Echinocythereis palanaensis* Khosla, n. sp., but differs from it in surface ornamentation.

Occurrence: This species occurs commonly in the Khuiala Formation of sections I (only in the *Assilina granulosa* Zone), II and III.

Type level and locality: Grey shales of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section III.

Name: This species is named in honour of Mr. S. P. Jain, Lecturer in Geology, Panjab University, Chandigarh, India.

Genus HERMANITES Puri, 1955

***Hermanites goeli* Khosla, n. sp.**

Plate 2, figures 15–16; plate 4, figure 14; plate 5, figure 5

Diagnosis: Carapace small and subquadrate in lateral view; greatest height anterior to middle; dorsal margin straight; posterodorsal margin obscured by protruding dorsal ridge; ventral margin straight in left valve and slightly concave in right valve; anterior margin broadly rounded; posterior margin subangular, slightly concave

in upper part and convex in lower part. In dorsal view carapace biconvex, with narrow ends. Marginal rim narrow, anterior and posterior margins denticulate. Valve surface coarsely reticulate, the edges giving a rough appearance, and having a dorsal ridge turning downwards at posterodorsal margin, a slightly convex ventral ridge, and a subcentral tubercle. Eye tubercle distinct. Inner lamella of moderate width; selvage strong near inner margin; marginal pore canals numerous, mostly simple, some bifurcating. Hinge of amphidont/heterodont type. Sexual dimorphism distinct; male carapace comparatively lower than female carapace.

Dimensions: Holotype (CASGMF No. 38), a complete female carapace, length 0.45 mm., height 0.30 mm., width 0.25 mm.; paratype (CASGMF No. 39), a male right valve, length 0.47 mm., height 0.27 mm., width 0.12 mm.

Discussion: This species somewhat resembles *Hermanites hutchisoni* van den Bold, 1957, described from the Lower Miocene beds of Trinidad, in surface ornamentation, size, and other characters, but differs in finer details of the outline in lateral view as well as in dorsal view.

Occurrence: The species occurs abundantly in section III. More than 50 specimens were found.

Type level and locality: Grey shales of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section III.

Name: This species is named in honour of Dr. R. K. Goel, Reader in Geology, University of Roorkee, Roorkee, India.

***Hermanites mathuri* Khosla, n. sp.**

Plate 2, figures 17–18; plate 4, figure 13; plate 5, figure 6

Diagnosis: Carapace subquadrate in lateral view, with greatest height anterior to middle; left valve slightly larger than right valve; dorsal margin weakly convex; ventral margin slightly concave; anterior margin broadly rounded; posterior margin subangular, concave in upper part and convex in lower part. Carapace biconvex in dorsal view, maximum width posterior to middle. Anterior and posterior margins with a narrow rim and denticulations. Valve surface marked by a faint subcentral tubercle, and ornamentation consisting of fine reticulations, a weakly developed dorsal ridge, and a ventral ridge. Eye tubercle distinct. Inner lamella of moderate width; selvage strong near inner margin; marginal pore canals few and straight. Hinge of amphidont/heterodont type. Sexual dimorphism distinct.

Dimensions: Holotype (CASGMF No. 40), a complete male carapace, length 0.57 mm., height 0.30 mm., width 0.25 mm.; paratype (CASGMF No. 41), a female

right valve, length 0.57 mm., height 0.32 mm., width 0.15 mm.

Discussion: The present species resembles *Hermanites memorans memorans* Moose, 1966, and *Hermanites memorans vitreus* Moose, 1966, described from the Lower Oligocene beds of northwestern Germany, in general appearance but differs in the details of the outline and ornamentation. The present species also resembles *Hermanites goeli* Khosla, n. sp., in outline, but differs from it in the length/height ratio and the degree of fineness of the reticulations.

Occurrence: The species occurs in the grey shales (sample P/A3) of section III. In all, 15 specimens were found.

Type level and locality: Grey shales of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section III.

Name: This species is named in honour of Dr. N. S. Mathur, formerly Research Fellow in the Department of Geology, Panjab University, Chandigarh, India.

Genus LEGUMINOCYTHEREIS Howe, 1936

***Leguminocythereis lunejensis* Guha**

Plate 2, figure 9; plate 4, figure 7

Leguminocythereis lunejensis GUHA, 1967, p. 21, pl. 1, figs. 3, 6, 8.

Jawaharia indica SINGH and MISRA, 1968, pp. 27–28, pl. 7, figs. 1–4.

Leguminocythereis brahmi SINGH and MISRA, 1968, pp. 28–29, pl. 7, figs. 5–7.

Genus and species indet. 5. SOHN, 1970, p. 68, pl. 4, figs. 23–24, 27–29.

Remarks: The present specimens are identical with *Leguminocythereis lunejensis* Guha, 1967, described from the Eocene and Oligocene beds of Cambay. The forms described as *Jawaharia indica* by Singh and Misra (*supra cit.*), are females of *L. lunejensis*. The genus *Jawaharia* is here considered to be a junior synonym of the genus *Leguminocythereis*. *Leguminocythereis brahmi* Singh and Misra, 1968, is also not a valid species, as it is a dimorphic form of *L. lunejensis*. The form described as genus and species indet. 5 by Sohn (*supra cit.*), from the Upper Chocolate Clay of west Pakistan, belongs to *L. lunejensis*.

Dimensions: Hypotype I (CASGMF No. 43), a female left valve, length 0.52 mm., height 0.34 mm., width 0.17 mm.; hypotype II, a male right valve, length 0.65 mm., height 0.36 mm., width 0.18 mm.

Occurrence: The species occurs commonly in the *Venericardia mutabilis* Zone of the Khuiala Formation in section I, and also in the *Assilina granulosa* Zone of section III.

Genus OCCULTOCYHEREIS Howe, 1951

***Occultocythereis mithali* Khosla, n. sp.**

Plate 2, figures 19–20; plate 5, figure 7

Diagnosis: Carapace compressed subquadrate-elongate in lateral view; greatest height at anterodorsal angle; dorsal and ventral margins nearly straight, converging posteriorly; anterior margin broadly rounded; posterior margin subangular. In dorsal view, maximum width near middle. Anterior and posterior margins fringed with about 12 and six spines, respectively; marginal rim present. Valve surface with a subcentral tubercle, three pronounced ridges, one near the dorsal margin turning downwards posteriorly, the second central, and the third near the ventral margin, and a small crescent-shaped ridge slightly posterior to the subcentral tubercle. Eye tubercle distinct. Sexual dimorphism pronounced; male carapace more elongate than female carapace.

Dimensions: Holotype (CASGMF No. 44), a complete male carapace, length 0.55 mm., height 0.26 mm., width 0.17 mm.

Discussion: The present species resembles the type species *Occultocythereis delumbata* Howe, 1951, an Eocene species, in general shape, but differs in its distinct ornamentation, as described above.

Occurrence: This species occurs in the Khuiala Formation of sections I, II and III. The specimens from section I are comparatively smaller. In all, 20 specimens were found.

Type level and locality: Fuller's Earth beds of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section II.

Name: The species is named in honour of Dr. R. S. Mithal, Consultant, Indian National Science Academy, Delhi.

***Occultocythereis subspinellosa* Khosla, n. sp.**

Plate 2, figures 21–22; plate 4, figure 11; plate 5, figure 8

Diagnosis: Carapace compressed, elongate in lateral view; greatest height at anterodorsal angle; dorsal and ventral margins straight, converging posteriorly; anterior margin broadly rounded; posterior margin subangular. In dorsal view, maximum width near middle. Anterior rim bearing 15 to 18 small, rectangular tubercles; margins fringed with small spines. Surface of each valve ornamented by closely spaced minute spines superimposed on reticulations arranged in rows inclined in posterior half and horizontal in anterior half, a dorsal ridge bearing a tubercle in posterodorsal part, and a lobelike ventral ridge turning upwards posteriorly;

subcentral tubercle faint. Eye tubercle distinct. Inner lamella of moderate width; selvage strong near outer margin. Hinge of amphidont/heterodont type. Sexual dimorphism distinct; male carapace more elongate than female carapace.

Dimensions: Holotype (CASGMF No. 46), a complete male carapace, length 0.60 mm., height 0.30 mm., width 0.18 mm.; paratype I (CASGMF No. 47), a female left valve, length 0.50 mm., height 0.30 mm., width 0.10 mm.; paratype II, a complete male carapace, length 0.60 mm., height 0.28 mm., width 0.17 mm.

Discussion: The present species resembles *Occultocythereis angusta* van den Bold, 1963, in over-all shape and the presence of dorsal and ventral ridges, but differs in having closely spaced spines and reticulations.

Occurrence: This species occurs in the Khuiala Formation of section III, and the Khuiala and Bandah Formations of sections I and IV. In all, 30 specimens were found.

Type level and locality: Grey shales of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section III.

Genus QUADRACYTHERE Hornibrook, 1952

***Quadracythere arcanus* (Lubimova and Guha)**

Plate 2, figure 12

Cythereis arcanus LUBIMOVA and GUHA, in Lubimova, Guha and Mohan, 1960, p. 33, pl. 3, fig. 1a–b.

Quadracythere arcanus (Lubimova and Guha). – GUHA, 1968, p. 91, pl. 1, fig. 24.

Remarks: The present specimens from Rajasthan are identical with the types of *Quadracythere arcanus* (Lubimova and Guha), described from the Eocene beds of Kutch.

Dimensions: Hypotype (CASGMF No. 48), a complete carapace, length 0.53 mm., height 0.28 mm., width 0.30 mm.

Occurrence: This species occurs commonly in the Bandah Formation of sections I and IV.

***Quadracythere avadheshi* (Singh and Misra)**

Plate 2, figure 11; plate 4, figure 15

Cythereis avadheshi SINGH and MISRA, 1968, p. 35, pl. 10, figs. 6–8.

Remarks: This species was described as *Cythereis avadheshi* by Singh and Misra (*supra cit.*) from the Fuller's Earth beds of Mudh. Unlike the genus *Cythereis*, however, the species is characterized by an acuminate posterior margin; surface ornamentation consisting of coarse reticulations, a dorsal and a ventral ridge, and a

faint subcentral tubercle; and an amphidont/heterodont hinge. On the basis of these characters, the species is transferred to the genus *Quadracythere*.

Dimensions: Hypotype I (CASGMF No. 49), a complete female carapace, length 0.58 mm., height 0.34 mm., width 0.32 mm.; hypotype II, a male left valve, length 0.64 mm., height 0.34 mm., width 0.15 mm.

Occurrence: This species occurs commonly in the Khuiala Formation of sections I and III.

***Quadracythere avadheshi mudhensis* Khosla, n. subsp.**

Plate 3, figures 5–6

Diagnosis: Carapace subquadrate in lateral view; posterior margin bluntly acuminate below mid-height; maximum height at anterodorsal angle; dorsal margin straight in anterior half and obscured in posterior half owing to protruding ridge; posterodorsal angle distinct; ventral margin slightly concave anteriorly; anterior margin broadly rounded. In dorsal view, carapace spindle-shaped; maximum width posterior to middle. Marginal rim narrow. Surface of each valve marked by a subcentral tubercle, pronounced reticulations arranged in a concentric manner around the subcentral tubercle, and dorsal and ventral longitudinal ridges. Eye tubercle distinct. Sexual dimorphism distinct; male carapace more elongate and less inflated than female carapace.

Dimensions: Holotype (CASGMF No. 50), a complete male carapace, length 0.72 mm., height 0.41 mm., width 0.34 mm.

Discussion: The present subspecies is closely related to *Quadracythere avadheshi* (Singh and Misra, 1968) in general outline and ornamentation, but differs in the outlines of the dorsal and posterior margins, and in the prominence of the surface ornamentation.

Occurrence: This subspecies is rare. In all, 10 specimens were collected from the Bandah Formation of sections I and IV.

Type level and locality: Whitish to yellow limestone, *Discocyclus sella* Zone, Bandah Formation (Middle Eocene), section I.

Name: This subspecies is named after the village of Mudh.

Genus RUGGIERIA Keij, 1957

***Ruggieria bhatiai* Khosla, n. sp.**

Plate 3, figures 7–8; plate 4, figure 10; plate 5, figure 9

Diagnosis: Carapace elongate-ovate in lateral view; maximum height at anterodorsal angle; left valve slightly overlapping right valve along dorsal and poster-

ior margins. In left valve dorsal margin slightly convex centrally, with a distinct anterior hinge ear; ventral margin straight for two-thirds of its length but sloping up posteriorly; anterior margin broadly rounded; posterior margin narrow, with upturned end. In right valve dorsal margin convex, without anterior hinge ear; anteroventral margin slightly concave; posterior margin subangular. Carapace spindle-shaped in dorsal view. Margin fringed with spines. Surface of each valve ornamented with seven ridges radiating from subcentral tubercle towards dorsal, posterior and ventral margins, and with reticulations disposed in areas between these ridges. Eye tubercle distinct. Inner lamella of moderate width; marginal pore canals straight, simple, closely spaced. Hinge of amphidont/heterodont type, in right valve consisting of a conical anterior tooth, a postjacent socket, which continues into a long groove, and then a large, faintly lobed posterior tooth; hinge in left valve complementary; a distinct eye sinus present behind anterior tooth in right valve. Sexual dimorphism distinct; male carapace more elongate and lower than female carapace.

Dimensions: Holotype (CASGMF No. 52), a complete male carapace, length 0.64 mm., height 0.34 mm., width 0.31 mm.; paratype I (CASGMF No. 53), a male right valve, length 0.64 mm., height 0.32 mm., width 0.15 mm.; paratype II, a female right valve, length 0.57 mm., height 0.32 mm., width 0.15 mm.

Discussion: The present species shows some variation in the degree of convexity of the dorsal margin. The species resembles *Ruggieria micheliniana* (Bosquet, 1852), a Miocene species, in the posterior up-turned end in the left valve, marginal spines, hinge and marginal pore canals, but differs in details of the outline and the pattern of surface ornamentation. It also resembles *Ruggieria tattami* Reyment, 1963, described from the Paleocene and Eocene beds of Nigeria, in overall shape but differs in the pattern of ornamentation.

Occurrence: The species occurs abundantly in the Khuiala Formation of sections II and III. More than 80 specimens were found.

Type level and locality: Grey shales of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section III.

Name: The species is named in honour of Dr. S. B. Bhatia, Reader in Geology, Panjab University, Chandigarh.

Genus TRACHYLEBERIS Brady, 1898

***Trachyleberis spinellosa* (Lubimova and Guha)**

Plate 2, figure 10; plate 4, figure 12

Cythereis spinellosa LUBIMOVA and GUHA in Lubimova, Guha and Mohan, 1960, pp. 31–32, pl. 2, fig. 10.

Trachyleberis spinellosa (Lubimova and Guha). – GUHA *et al.*, 1965, p. 13, pl. 3, fig. 15.

Cythereis spinellosa var. *valdiyai* SINGH and MISRA, 1968, p. 34 pl. 10, figs. 1–3.

Cythereis satyendri SINGH and MISRA, 1968, pp. 34–35, pl. 10, figs. 4–5.

Remarks: Except for the slightly smaller size, the specimens recorded herein are identical with the types of *Trachyleberis spinellosa* (Lubimova and Guha) deposited in the Palaeontological Laboratory, Oil and Natural Gas Commission, Dehradun. The species was originally described from the Eocene beds of Kutch and has also been described from the Lower Miocene beds of Karikal, south India (Guha *et al.*, *supra cit.*). *Cythereis spinellosa valdiyai* and *Cythereis satyendri*, described by Singh and Misra (*supra cit.*), are considered to be junior synonyms of *T. spinellosa*.

Dimensions: Hypotype (CASGMF No. 54), a female right valve, length 0.54 mm., height 0.33 mm., width 0.16 mm.

Occurrence: The species occurs commonly in the *Venericardia mutabilis* and *Assilina* sp. Zones of the Khuiala Formation in section I.

Subfamily HEMICYTHERINAE Puri, 1953

Genus HEMICYTHERE Sars, 1925

Hemicythere sahnii Tewari and Tandon

Plate 2, figure 26

Hemicythere sahnii TEWARI and TANDON, 1960, p. 157, text-fig. 4, fig. 1a–d.

Remarks: The present specimens from Rajasthan are identical with the types of *Hemicythere sahnii* Tewari and Tandon, described from the Middle Eocene beds of Kutch (Dr. Tewari, personal communication).

Dimensions: Hypotype (CASGMF No. 55), a complete carapace, length 0.72 mm., height 0.46 mm., width 0.41 mm.

Occurrence: The species occurs commonly in the Bandah Formation of sections I and IV.

Subfamily PARACYTHERIDEINAE Puri, 1957

Genus PARACYTHERIDEA Müller, 1894

Paracytheridea eocenica Khosla, n. sp.

Plate 3, figures 9–10; plate 4, figure 17; plate 5, figure 10

Diagnosis: Carapace subquadrate in lateral view; valves distinctly alate; posterior margin produced into a caudal process near mid-height; greatest height at antero-dorsal angle; left valve larger than right; dorsal margin straight; ventral margin weakly convex, sloping upwards posteriorly; anterior margin broadly rounded.

Carapace with arrowhead-shaped outline in dorsal view. Valve surface with a shallow, vertical sulcus extending from dorsal margin to a little below mid-height, coarse reticulations the edges of which resemble distinct ridges, and a ventral horizontal ridge bearing a backwardly directed spine. Eye tubercle large and glassy. Inner lamella of moderate width. Hinge in left valve consisting of two terminal sockets, connected by a crenulated bar; hinge in right valve complementary. Sexual dimorphism distinct; male carapace slightly more elongate and lower than female carapace.

Dimensions: Holotype (CASGMF No. 56), a female left valve, length 0.49 mm., height 0.32 mm., width 0.17 mm.; paratype I (CASGMF No. 57), a female right valve, length 0.49 mm., height 0.33 mm., width 0.17 mm.; paratype II, a male left valve, length 0.50 mm., height 0.30 mm., width 0.17 mm.

Discussion: The species described above resembles *Paracytheridea gradata* (Bosquet, 1852) and *Paracytheridea brusselensis* Keij, 1957, both Eocene species, in the type of strong reticulate ornamentation, but the present species differs in the arrangement of ridges and in details of the outline.

Occurrence: This species occurs commonly in the Khuiala Formation of sections I, II and III. More than 60 specimens were found.

Type level and locality: Red shales of the *Venericardia mutabilis* Zone, Khuiala Formation (Lower Eocene), section I.

Subfamily CYTHERURINAE Müller, 1895

Genus CYTHERURA Sars, 1866

Cytherura sp.

Plate 2, figure 27

Remarks: This species has the following characteristics: Carapace oblong, inflated ventrally; posterior margin drawn out into a distinct caudal process at mid-height; surface ornamented by one or two weakly developed ridges near ventral margin.

Specific identification is not possible because of insufficient material and poor preservation.

Dimensions: A complete carapace (CASGMF No. 59), length 0.36 mm., height 0.16 mm., width 0.16 mm.

Occurrence: Only two specimens were found in the Khuiala Formation (sample M/34), section I.

Genus CYTHEROPTERON Sars, 1866

Cytheropteron sp.

Plate 3, figure 13; plate 4, figure 18

Remarks: This species is characterized by the following: ventrally inflated carapace; posterior margin produced into an upturned caudal process; valve surface ornamented by reticulations arranged in rows, and a distinct ventral ridge produced into a backwardly directed spine; and a merodont/entomodont type of hinge. More specimens are required before any specific name can be assigned.

Dimensions: A right valve (CASGMF No. 60), length 0.35 mm., height 0.20 mm., width 0.11 mm.

Occurrence: A few specimens of this species were found in the Fuller's Earth beds (*Venericardia mutabilis* Zone) of section I.

Genus EUCYTHERURA Müller, 1894

Eucytherura vimali (Singh and Misra)
Plate 3, figure 12; plate 4, figure 16

Schizocythere vimali SINGH and MISRA, 1968, pp. 29–30, pl. 7, figs. 8–10.

Remarks: This species has been previously described as *Schizocythere vimali* by Singh and Misra (*supra cit.*) from the Fuller's Earth beds of Mudh. The present species has, however, a hinge structure different from that of the genus *Schizocythere*. In the right valve it consists of two terminal smooth teeth connected by a long groove. The hinge is complementary in the left valve. On the basis of this hinge structure and other characters, such as shape and ornamentation, the species is transferred to the genus *Eucytherura*.

Dimensions: Topotype I (CASGMF No. 61), a left valve, length 0.38 mm., height 0.23 mm., width 0.10 mm.; topotype II, a right valve, length 0.37 mm., height 0.22 mm., width 0.10 mm.

Occurrence: The species occurs in the Fuller's Earth beds (*Venericardia mutabilis* Zone) of the Khuiala Formation in section I. Few specimens were found.

Genus PAIJENBORCHELLA Kingma, 1948
Subgenus EUPAIJENBORCHELLA Keij, 1967

Paijenborchella (Eupaijenborchella) sp. cf. *P. eocaenica* Triebel
Plate 3, figure 18

Cf. *Paijenborchella eocaenica* TRIEBEL, 1949, p. 196, pl. 1, figs. 1–7; pl. 2, fig. 8. — KEIJ, 1957, pl. 2, fig. 6.

Remarks: The specimens from Rajasthan resemble closely *Paijenborchella eocaenica* Triebel, 1949, an Eocene species, in outline and other characters. The present specimens, however, lack reticulations, possibly owing to poor preservation.

Dimensions: Hypotype (CASGMF No. 62), a complete carapace, length 0.42 mm., height 0.23 mm., width 0.25 mm.

Occurrence: This species is rare; only three specimens have been found in the Bandah Formation (sample B/9) of section IV.

Paijenborchella (Eupaijenborchella) indica Khosla, n. sp.
Plate 3, figures 14–15; plate 5, figure 11

Diagnosis: Carapace subtriangular in lateral view; height greatest anteriorly; posterior margin drawn out into a downwardly directed caudal process; dorsal margin slightly convex and sloping down backwards; ventral margin concave, slightly convex in central part; anterior margin broadly rounded. In dorsal view, anterior end narrow; maximum width posterior to middle; anterior margin compressed. Surface of each valve depressed by a vertical sulcus extending from central dorsal margin to below mid-height, and covered by ornamentation consisting of ridges and reticulations; two ridges horizontal, one near the ventral margin and the other near the centre, traversing the sulcus; a third inclined ridge in the central dorsal and posterodorsal areas joining the two horizontal ridges; six short ridges near anterior margin; reticulation between two horizontal ridges comparatively finer than that of rest of surface.

Dimensions: Holotype (CASGMF No. 63), a complete carapace, length 0.56 mm., height 0.31 mm., width 0.21 mm.

Discussion: The species shows variation in the outline of the ventral margin, which ranges from concave to nearly straight, and in the curvature of the caudal process. The present species closely resembles *Paijenborchella caudata* (Lienenklaus, 1894) in over-all shape in lateral view, but differs from it in surface ornamentation. The species also resembles *Paijenborchella boldi* Tewari and Tandon, 1960, in shape but differs in ornamentation.

Occurrence: The species occurs commonly in the Khuiala Formation of sections I, II and III.

Type level and locality: Fuller's Earth beds of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section II.

Paijenborchella (Eupaijenborchella) mohani Khosla, n. sp.
Plate 3, figures 16–17; plate 5, figure 12

Diagnosis: Carapace elongate, pear-shaped in lateral view; posterior margin produced into a long, downwardly directed, caudal process; dorsal margin convex, sloping down posteriorly; ventral margin concave;

anterior margin broadly rounded. In dorsal view, carapace narrow at anterior end, with maximum width posterior to middle. Anterior margin with four to five minute spines. Surface of each valve with a shallow vertical sulcus, fine, closely spaced reticulations, and seven coarse pits along the anterior margin. Eye tubercle distinct.

Dimensions: Holotype (CASGMF No. 65), a complete carapace, length 0.51 mm., height 0.23 mm., width 0.15 mm.; paratype (CASGMF No. 66), a complete carapace, length 0.46 mm., height 0.26 mm., width 0.13 mm.

Discussion: The present species shows some variation in the curvature of the caudal process. It closely resembles *Paijenborchella prona* Lubimova and Guha, 1960, described from the Lower Miocene beds of Kutch, in outline, but differs in surface ornamentation. The present species also resembles *Paijenborchella* (*Eupaijenborchella*) *indica* Khosla, n. sp., *Paijenborchella caudata* (Lienenklaus, 1894), and *Paijenborchella boldi* Tewari and Tandon, 1960, in over-all shape, but differs from them in details of the outline and ornamentation.

Occurrence: The species occurs commonly in the Khuiala Formation of section II. More than 20 specimens were collected.

Type level and locality: Fuller's Earth beds of the *Assilina granulosa* Zone, Khuiala Formation (Lower Eocene), section II.

Name: This species is named in honour of Mr. P. C. Mohan, Lecturer in Geology, University of Roorkee, Roorkee, India.

***Paijenborchella* (*Eupaijenborchella*) sp.**

Plate 3, figure 19

Remarks: This species has a pear-shaped outline in lateral view, a posterior margin drawn into an upwardly directed caudal process, a vertical sulcus, two horizontal ridges, two prominent spines projecting from the ventral margin, and small spines disposed over the rest of the surface. The species somewhat resembles *Paijenborchella lomata* Triebel, 1949, and *Paijenborchella eocae-nica* Triebel, 1949, in outline and general appearance, but differs in details of the surface ornamentation. Precise identification is not possible because of poor preservation.

Dimensions: A complete carapace (CASGMF No. 67), length 0.36 mm., height 0.20 mm., width 0.18 mm.

Occurrence: This species is rare. In all, 10 specimens were found in the Khuiala Formation of sections II and III.

Genus SEMICYTHERURA Wagner, 1957

***Semicytherura rameshi* (Singh and Misra)**

Plate 3, figure 11

Cytherura rameshi SINGH and MISRA, 1968, pp. 31–32, pl. 8, figs. 4–6.

Remarks: This species was assigned to the genus *Cytherura* by Singh and Misra (*supra cit.*), but, on the basis of such characters as the subovate outline in lateral view, the winglike lateral prolongation of each valve, and the broad inner lamella at both the anterior and posterior ends, it is here transferred to the genus *Semicytherura*.

Dimensions: Topotype (CASGMF No. 68), a complete carapace, length 0.40 mm., height 0.25 mm., width 0.23 mm.

Occurrence: This species occurs commonly in the Eocene beds of Rajasthan.

Subfamily LOXOCOONCHINAE Sars, 1925

Genus NIGEROLOXOCONCHA Reymont, 1963

?*Nigeroloxoconcha* sp.

Plate 3, figure 20

Remarks: This species is characterized by a sub-quadrate outline in lateral view; a posterior margin produced into a short, blunt, caudal process in the dorsal half; each valve with an anteroventral prolongation which partially protrudes over the ventral margin, two small sulci in the anterodorsal and anteroventral areas, and fine reticulations. The species resembles *Nigeroloxoconcha oyesessei* Reymont, 1963, a Paleocene and Eocene species, in outline in dorsal view and in ornamentation, but it differs in details of the outline in lateral view.

Dimensions: A complete carapace (CASGMF No. 69), length 0.38 mm., height 0.21 mm., width 0.15 mm.

Occurrence: The species occurs in the *Assilina* sp. Zone of the Khuiala Formation of section I.

Subfamily XESTOLEBERIDINAE Sars, 1928

Genus XESTOLEBERIS Sars, 1866

***Xestoleberis* sp. cf. *X. muelleriana* Lienenklaus**

Plate 3, figure 21

Cf. *Xestoleberis muelleriana* LIENENKLAUS, 1900, p. 531, pl. 21, fig. 5. — KEIJ, 1957, p. 166, pl. 11, fig. 11.

Remarks: This species closely resembles *Xestoleberis muelleriana* Lienenklaus, originally described from the Oligocene beds of western Germany, in shape and other characters. The exact identification, however, could not be confirmed for want of topotype material.

Dimensions: Hypotype (CASGMF No. 70), a complete carapace, length 0.50 mm., height 0.35 mm., width 0.30 mm.

Occurrence: The species occurs commonly in the Khuiala Formation of sections II and III.

***Xestoleberis subglobosa* (Bosquet)**

Plate 3, figure 22

Bairdia subglobosa Bosquet, 1852, p. 23, pl. 1, fig. 7.

Xestoleberis subglobosa (Bosquet).—APOSTOLESCU, 1955, p. 260, pl. 4, figs. 70–71.—KEIJ, 1957, p. 166, pl. 8, fig. 21.—GUHA, 1968, p. 88, pl. 1, fig. 3.

Remarks: This species was originally described from the Eocene beds of France. It also occurs in the Eocene beds of Belgium and the Netherlands (*vide* Keij, *supra cit.*). In India the species has been recorded by Guha (*supra cit.*) from the Middle Eocene beds of Kutch.

Dimensions: Hypotype (CASGMF No. 71), a complete female carapace, length 0.43 mm., height 0.27 mm., width 0.25 mm.

Occurrence: The species occurs commonly in the Khuiala Formation of section I.

Genus *UROLEBERIS* Triebel, 1958

***Uroleberis kutchensis* Guha**

Plate 3, figure 23

Uroleberis kutchensis GUHA, 1968, p. 88, pl. 1, figs. 4, 8, 12.

Remarks: The species was originally described by Guha (*supra cit.*) from the Middle Eocene beds of Kutch.

Dimensions: Hypotype (CASGMF No. 72), a complete female carapace, length 0.47 mm., height 0.35 mm., width 0.36 mm.

Occurrence: The species occurs commonly in the Bandah Formation of section I.

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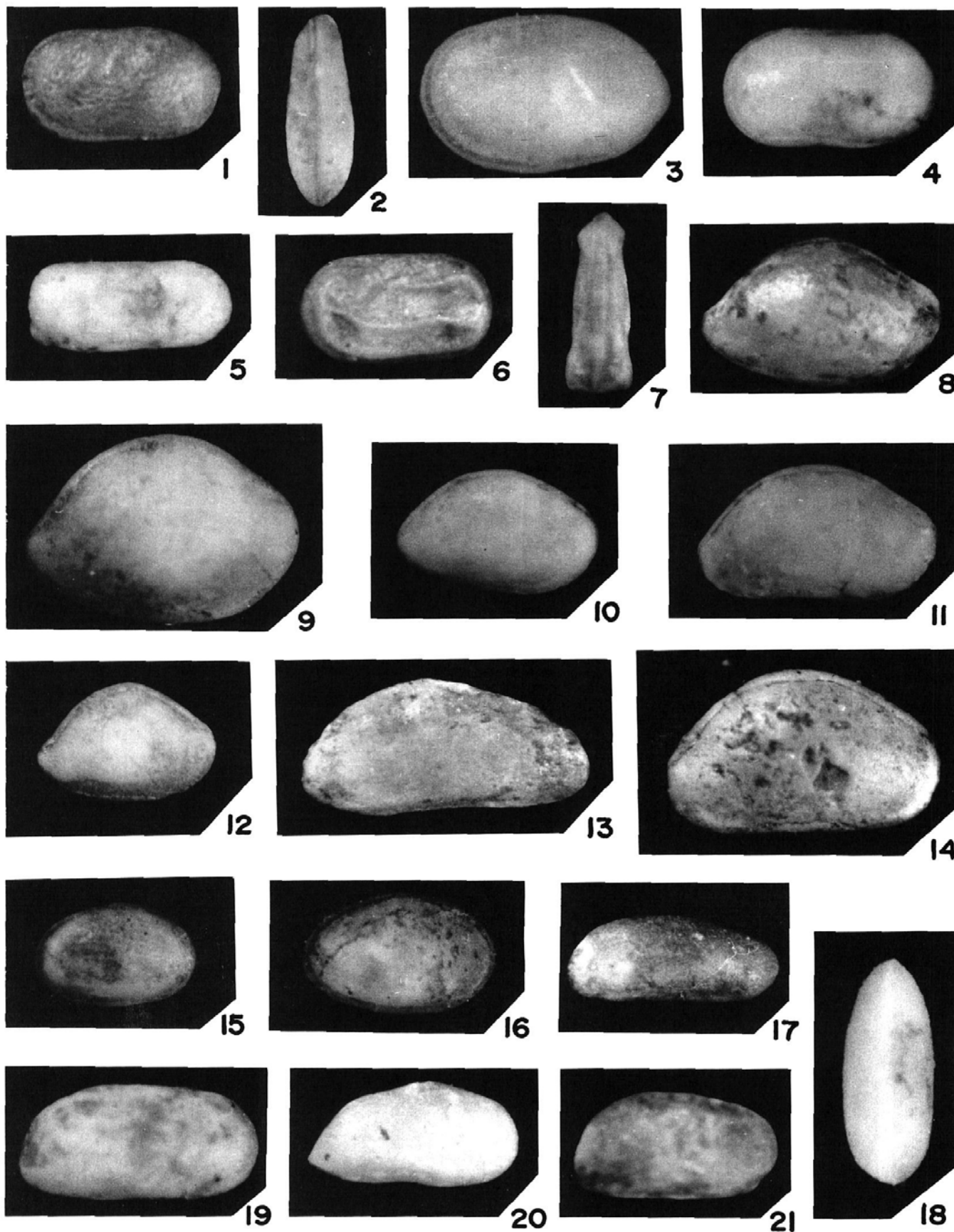
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PLATE 1

All external views

- 1-2 *Cytherella palanaensis* Khosla, n. sp.
Holotype (CASGMF No. 1), a complete carapace; 1, left valve view, $\times 77$; 2, dorsal view, $\times 75$.
- 3 *Cytherella protuberantis* Lubimova and Guha
Hypotype (CASGMF No. 3), a complete female carapace, left valve view, $\times 67.6$.
- 4 *Cytherella tawaica* Singh and Tewari
Hypotype (CASGMF No. 4), a complete carapace, left valve view, $\times 69.3$.
- 5 *Cytherella* sp.
A right valve (CASGMF No. 5), lateral view, $\times 54.3$.
- 6-7 *Cytherelloidea guhai* Khosla, n. sp.
Holotype (CASGMF No. 6), a complete carapace; 6, left valve view, $\times 75$; 7, dorsal view, $\times 70.8$.
- 8 *Bairdia beraguaensis* Singh and Tewari
Hypotype (CASGMF No. 8), a complete carapace, right valve view, $\times 45.8$.
- 9 *Bairdia gliberti* (Keij)
Hypotype (CASGMF No. 9), a complete carapace, right valve view, $\times 43.2$.
- 10 *Bairdia kutchensis* Khosla, new name
Hypotype (CASGMF No. 10), a complete carapace, right valve view, $\times 45.7$.
- 11 *Bairdia kirtharensis* Tewari and Tandon
Hypotype (CASGMF No. 11), a complete carapace, right valve view, $\times 38.9$.
- 12 *Bairdia poddari* (Lubimova and Mohan)
Hypotype (CASGMF No. 12), a complete carapace, right valve view, $\times 42.8$.
- 13 *Bythocypris mianica* Tewari and Tandon
Hypotype (CASGMF No. 14), a complete carapace, right valve view, $\times 50.5$.
- 14 *Bythocypris* sp. cf. *B. ? cancanaensis* (van den Bold)
Hypotype (CASGMF No. 13), a complete carapace, right valve view, $\times 42.5$.
- 15 *Neocyprideis bhupendri* (Singh and Misra)
Topotype I (CASGMF No. 23), a complete female carapace, right valve view, $\times 42.8$.
- 16 *Cuneocythere (Monsmirabilia) sp.*
A complete female carapace (CASGMF No. 24), right valve view, $\times 50.7$.
- 17-18 *Cushmanidea tewarii* Khosla, n. sp.
17, holotype (CASGMF No. 16), a right valve, lateral view, $\times 51.3$; 18, paratype (CASGMF No. 17), a complete carapace, dorsal view, $\times 58.3$.
- 19 *Krithe bartonensis* (Jones)
Hypotype (CASGMF No. 18), a complete male carapace, right valve view, $\times 64.3$.
- 20 *Krithe* sp. cf. *K. cancuenensis* van den Bold
Hypotype (CASGMF No. 19), a right valve, lateral view, $\times 46.4$.
- 21 *Krithe indica* Tewari and Tandon
Hypotype (CASGMF No. 20), a complete female carapace, right valve view, $\times 73$.



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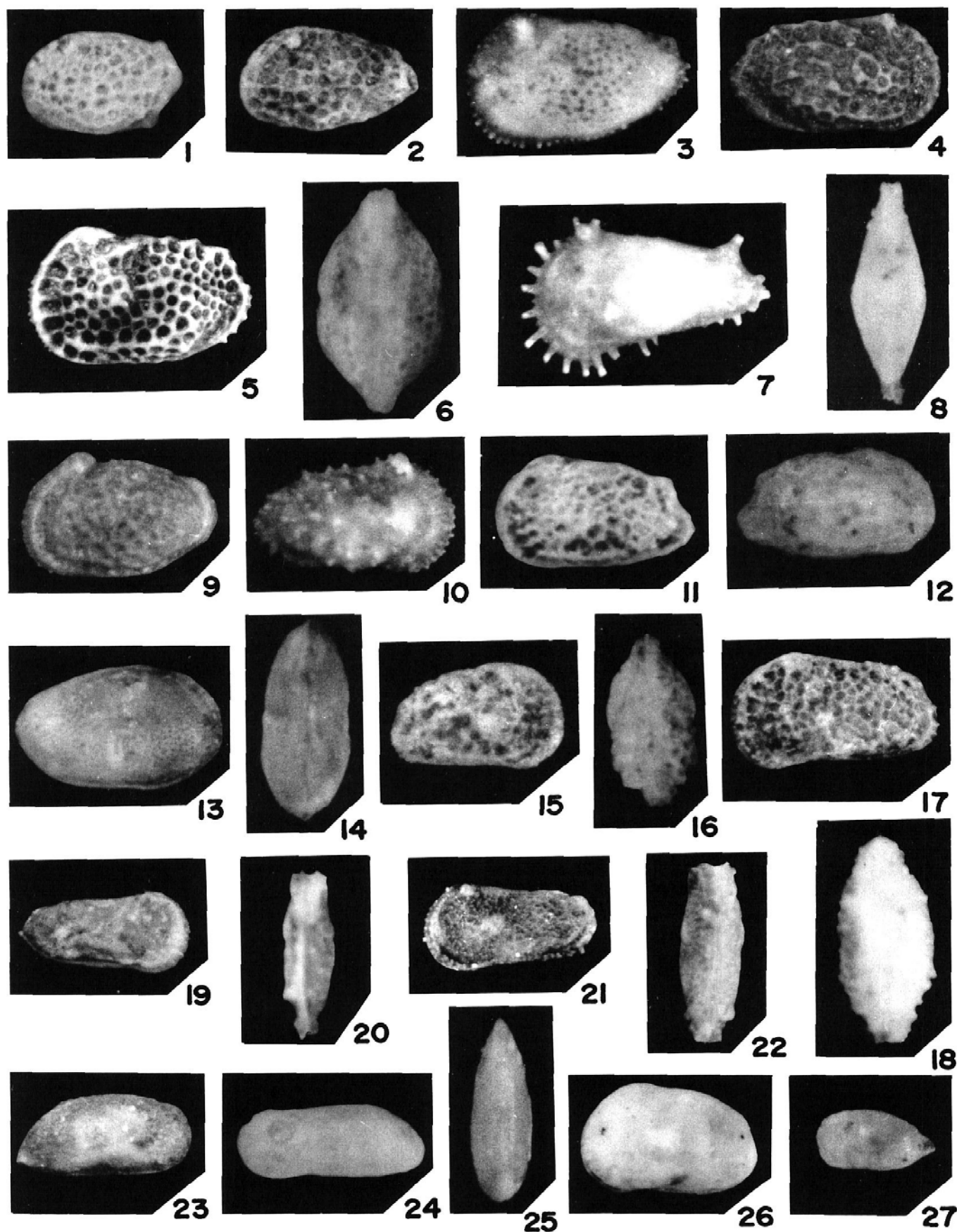
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PLATE 2

All external views

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| <p>1 <i>Schizocythere appendiculata</i> Triebel
Hypotype (CASGMF No. 25), a complete carapace, left valve view, $\times 66.3$.</p> <p>2 <i>Schizocythere bikanerensis</i> Singh and Misra
Topotype (CASGMF No. 26), a complete carapace, left valve view, $\times 69.1$.</p> <p>3 ?<i>Brachycythere</i> sp.
A female left valve (CASGMF No. 32), lateral view, $\times 91.3$.</p> <p>4 <i>Anticythereis memorans</i> (Lubimova and Guha)
Hypotype (CASGMF No. 27), a female right valve, lateral view, $\times 47.6$.</p> <p>5–6 <i>Anticythereis memorans mudhensis</i> Khosla, n. subsp.
5, holotype (CASGMF No. 28), a female left valve, lateral view, $\times 57.4$; 6, paratype II, a complete female carapace, dorsal view, $\times 52.5$.</p> <p>7–8 "<i>Archicythereis</i>" <i>howei</i> Khosla, n. sp.
7, holotype (CASGMF No. 30), a female left valve, lateral view, $\times 72.3$; 8, paratype II, a complete female carapace, dorsal view, $\times 67$.</p> <p>9 <i>Leguminocythereis lunejensis</i> Guha
Hypotype I (CASGMF No. 43), a female left valve, lateral view, $\times 71.1$.</p> <p>10 <i>Trachyleberis spinellosa</i> (Lubimova and Guha)
Hypotype I (CASGMF No. 54), a female right valve, lateral view, $\times 70.4$.</p> <p>11 <i>Quadracythere avadheshi</i> (Singh and Misra)
Hypotype I (CASGMF No. 49), a complete female carapace, left valve view, $\times 64.7$.</p> <p>12 <i>Quadracythere arcanus</i> (Lubimova and Guha)
Hypotype (CASGMF No. 48), a complete carapace, right valve view, $\times 70$.</p> | <p>13–14 <i>Buntonia boldi</i> Khosla, n. sp.
Holotype (CASGMF No. 33), a complete female carapace; 13, right valve view, $\times 78$; 14, dorsal view, $\times 76$.</p> <p>15–16 <i>Hermanites goeli</i> Khosla, n. sp.
Holotype (CASGMF No. 38), a complete female carapace; 15, right valve view, $\times 71.1$; 16, dorsal view, $\times 73.3$.</p> <p>17–18 <i>Hermanites mathuri</i> Khosla, n. sp.
Holotype (CASGMF No. 40), a complete male carapace; 17, left valve view, $\times 68.4$; 18, dorsal view, $\times 68.4$.</p> <p>19–20 <i>Occultocythereis mithali</i> Khosla, n. sp.
Holotype (CASGMF No. 44), a complete male carapace; 19, right valve view, $\times 58.2$; 20, dorsal view, $\times 58.2$.</p> <p>21–22 <i>Occultocythereis subspinellosa</i> Khosla, n. sp.
Holotype (CASGMF No. 46), a complete male carapace; 21, left valve view, $\times 56.6$; 22, dorsal view, $\times 56.6$.</p> <p>23 <i>Paracypris meridionalis</i> Lubimova and Mohan
Hypotype (CASGMF No. 15), a right valve, lateral view, $\times 44.7$.</p> <p>24–25 <i>Parakrithe pandei</i> Khosla, n. sp.
Holotype (CASGMF No. 21), a complete carapace; 24, left valve view, $\times 78.4$; 25, dorsal view, $\times 78.4$.</p> <p>26 <i>Hemicythere sahnii</i> Tewari and Tandon
Hypotype (CASGMF No. 55), a complete carapace, left valve view, $\times 45.8$.</p> <p>27 <i>Cytherura</i> sp.
A complete carapace (CASGMF No. 59), left valve view, $\times 61.1$.</p> |
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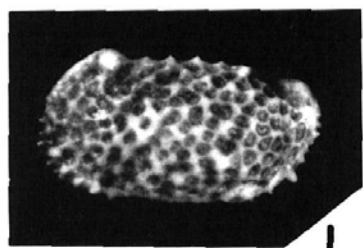
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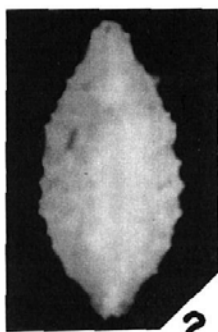
PLATE 3

All external views

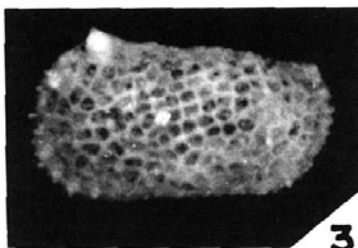
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|---|---|
| <p>1–2 <i>Echinocythereis palanaensis</i> Khosla, n. sp.
1, holotype (CASGMF No. 35), a male left valve, lateral view, $\times 45.7$; 2, paratype II, a complete male carapace, dorsal view, $\times 49$.</p> <p>3–4 <i>Echinocythereis jaini</i> Khosla, n. sp.
3, holotype (CASGMF No. 36), a male left valve, lateral view, $\times 57.1$; paratype II, a complete female carapace, dorsal view, $\times 65.3$.</p> <p>5–6 <i>Quadracythere avadheshi mudhensis</i> Khosla, n. subsp.
Holotype (CASGMF No. 50), a complete male carapace; 5, left valve view, $\times 55.5$; 6, dorsal view, $\times 58.3$.</p> <p>7–8 <i>Ruggieria bhatiai</i> Khosla, n. sp.
Holotype (CASGMF No. 52), a complete male carapace; 7, left valve view, $\times 71.9$; 8, dorsal view, $\times 68.4$.</p> <p>9–10 <i>Paracytheridea eocenica</i> Khosla, n. sp.
Holotype (CASGMF No. 56), a female left valve; 9, lateral view, $\times 75.5$; 10, dorsal view, $\times 75.5$.</p> <p>11 <i>Semicytherura rameshi</i> (Singh and Misra)
Topotype (CASGMF No. 68), a complete carapace, left valve view, $\times 67.5$.</p> <p>12 <i>Eucytherura vimali</i> (Singh and Misra)
Topotype I (CASGMF No. 61), a left valve, lateral view, $\times 66$.</p> <p>13 <i>Cytheropteron</i> sp.
A right valve (CASGMF No. 60), lateral view, $\times 87.1$.</p> | <p>14–15 <i>Paijenborchella</i> (<i>Eupaijenborchella</i>) <i>indica</i> Khosla, n. sp.
Holotype (CASGMF No. 63), a complete carapace; 14, left valve view, $\times 52.5$; 15, dorsal view, $\times 54.5$.</p> <p>16–17 <i>Paijenborchella</i> (<i>Eupaijenborchella</i>) <i>mohani</i> Khosla, n. sp.
Holotype (CASGMF No. 65), a complete carapace; 16, right valve view, $\times 64.7$; 17, dorsal view, $\times 68.6$.</p> <p>18 <i>Paijenborchella</i> (<i>Eupaijenborchella</i>) sp. cf. <i>P. eocaenica</i> Triebel
Hypotype (CASGMF No. 62), a complete carapace, right valve view, $\times 65.5$.</p> <p>19 <i>Paijenborchella</i> (<i>Eupaijenborchella</i>) sp.
A complete carapace (CASGMF No. 67), left valve view, $\times 65.2$.</p> <p>20 <i>?Nigeroloxoconcha</i> sp.
A complete carapace (CASGMF No. 69), right valve view, $\times 64.5$.</p> <p>21 <i>Xestoleberis</i> sp. cf. <i>X. muelleriana</i> Lienenklaus
Hypotype (CASGMF No. 70), a complete carapace, right valve view, $\times 48.7$.</p> <p>22 <i>Xestoleberis subglobosa</i> (Bosquet)
Hypotype (CASGMF No. 71), a complete female carapace, right valve view, $\times 66.3$.</p> <p>23 <i>Uroleberis kutchensis</i> Guha
Hypotype (CASGMF No. 72), a complete female carapace, right valve view, $\times 71.2$.</p> |
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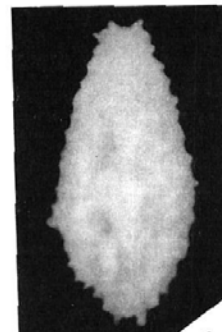
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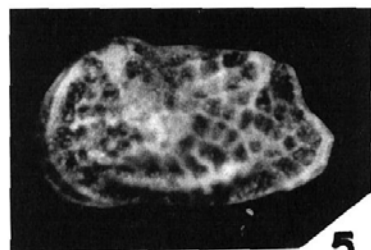
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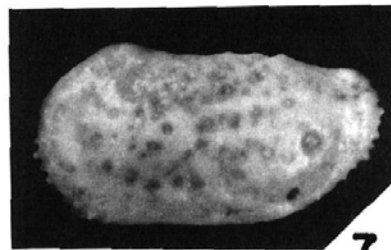
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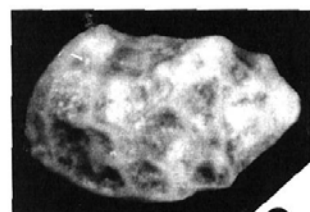
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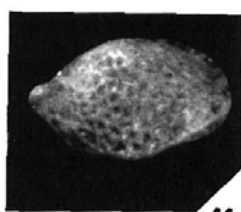
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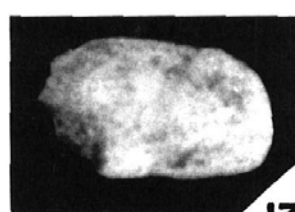
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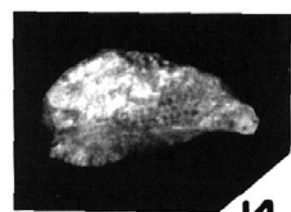
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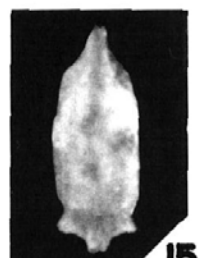
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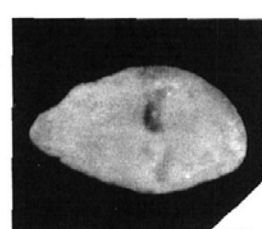
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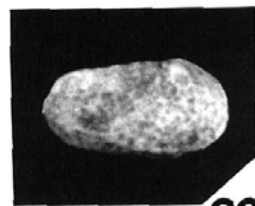
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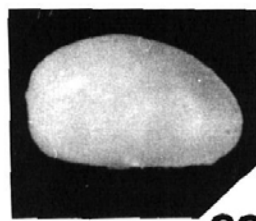
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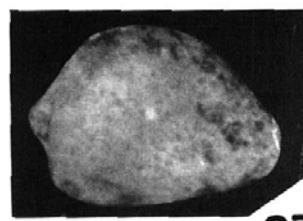
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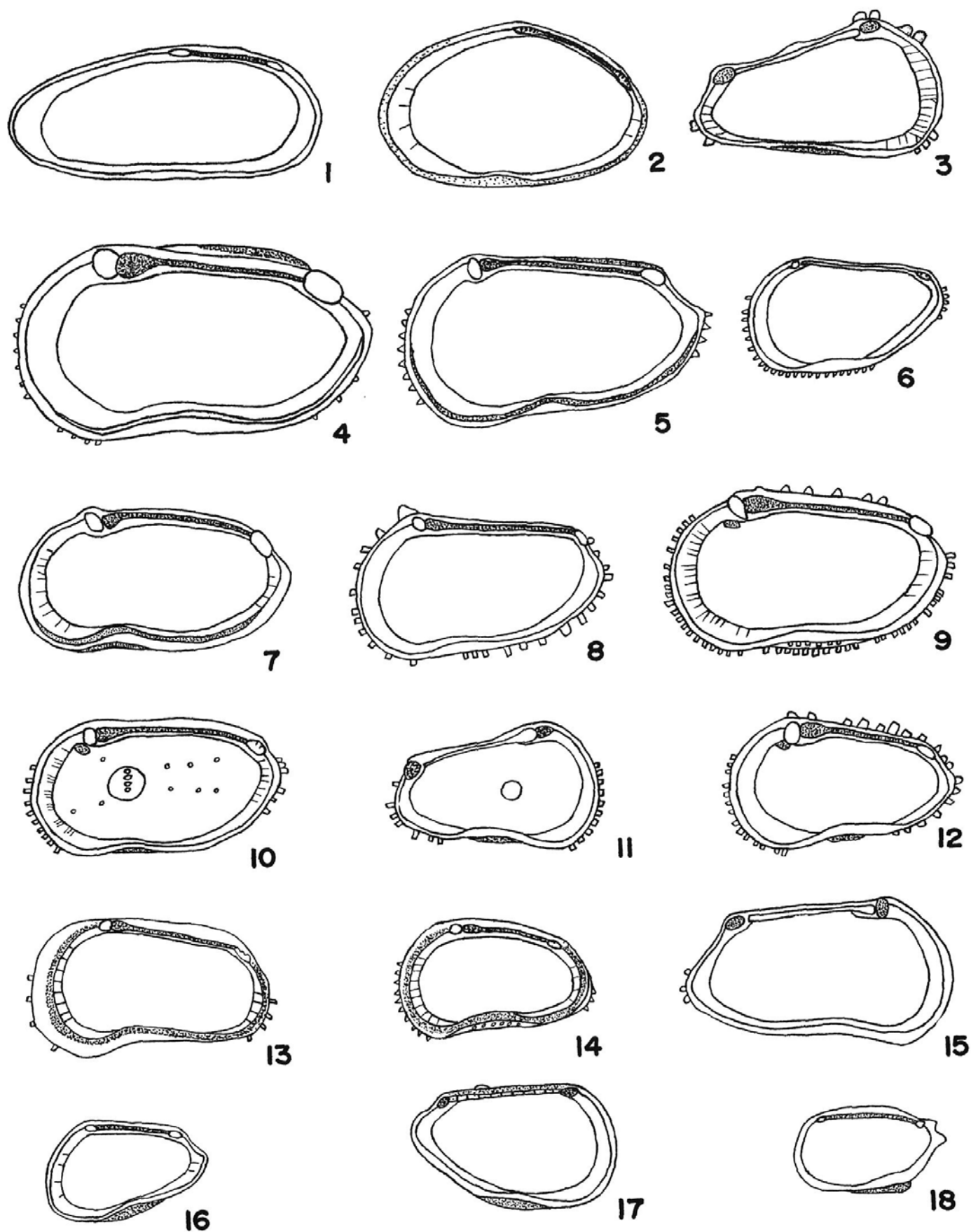


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PLATE 4
All internal views, $\times 80$

- | | |
|--|---|
| 1 <i>Cushmanidea tewarii</i> Khosla, n. sp.
Holotype (CASGMF No. 16), a right valve. | 10 <i>Ruggieria bhatiai</i> Khosla, n. sp.
Paratype I (CASGMF No. 53), a male right valve. |
| 2 <i>Neocyprideis bhupendri</i> (Singh and Misra)
Topotype II, a male right valve. | 11 <i>Occultocythereis subspinelloso</i> Khosla, n. sp.
Paratype I (CASGMF No. 47), a female left valve. |
| 3 " <i>Archicythereis</i> " <i>howei</i> Khosla, n. sp.
Paratype (CASGMF No. 31), a female left valve. | 12 <i>Trachyleberis spinelloso</i> (Lubimova and Guha)
Hypotype (CASGMF No. 54), a female right valve. |
| 4 <i>Anticythereis memorans</i> (Lubimova and Guha)
Hypotype (CASGMF No. 27), a female right valve. | 13 <i>Hermanites mathuri</i> Khosla, n. sp.
Paratype (CASGMF No. 41), a female right valve. |
| 5 <i>Anticythereis memorans mudhensis</i> Khosla, n. subsp.
Paratype I (CASGMF No. 29), a female right valve. | 14 <i>Hermanites goeli</i> Khosla, n. sp.
Paratype (CASGMF No. 39), a male right valve. |
| 6 ? <i>Brachycythere</i> sp.
A female right valve. | 15 <i>Quadracythere avadheshi</i> (Singh and Misra)
Hypotype II, a male left valve. |
| 7 <i>Leguminocythereis lunejensis</i> Guha
Hypotype II, a male right valve. | 16 <i>Eucytherura vimali</i> (Singh and Misra)
Topotype II, a right valve. |
| 8 <i>Echinocythereis jaini</i> Khosla, n. sp.
Paratype I (CASGMF No. 37), a female right valve. | 17 <i>Paracytheridea eocenica</i> Khosla, n. sp.
Paratype II, a male left valve. |
| 9 <i>Echinocythereis palanaensis</i> Khosla, n. sp.
Paratype I, a female right valve. | 18 <i>Cytheropteron</i> sp.
A right valve (CASGMF No. 60). |



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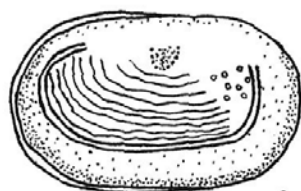
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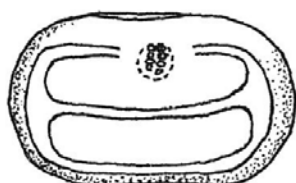
PLATE 5

All external, lateral views, $\times 80$

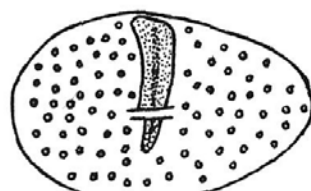
- | | |
|---|--|
| <p>1 <i>Cytherella palanaensis</i> Khosla, n. sp.
Paratype (CASGMF No. 2), a complete carapace, right valve view.</p> <p>2 <i>Cytherelloidea guhai</i> Khosla, n. sp.
Paratype (CASGMF No. 7), a complete carapace, right valve view.</p> <p>3 <i>Buntonia boldi</i> Khosla, n. sp.
Paratype (CASGMF No. 34), a complete female carapace, left valve view.</p> <p>4 <i>Anticythereis memorans mudhensis</i> Khosla, n. subsp.
Paratype I (CASGMF No. 29), a female right valve.</p> <p>5 <i>Hermanites goeli</i> Khosla, n. sp.
Paratype (CASGMF No. 39), a male right valve.</p> <p>6 <i>Hermanites mathuri</i> Khosla, n. sp.
Paratype (CASGMF No. 41), a female right valve.</p> | <p>7 <i>Occultocythereis mithali</i> Khosla, n. sp.
Holotype (CASGMF No. 44), a complete male carapace, right valve view.</p> <p>8 <i>Occultocythereis subspinellousa</i> Khosla, n. sp.
Paratype II, a complete male carapace, left valve view.</p> <p>9 <i>Ruggieria bhatiai</i> Khosla, n. sp.
Paratype II, a female right valve.</p> <p>10 <i>Paracytheridea eocenica</i> Khosla, n. sp.
Paratype I (CASGMF No. 57), a female right valve.</p> <p>11 <i>Paijenborchella (Eupaijenborchella) indica</i> Khosla, n. sp.
Holotype (CASGMF No. 63), a complete carapace, right valve view.</p> <p>12 <i>Paijenborchella (Eupaijenborchella) mohani</i> Khosla, n. sp.
Paratype (CASGMF No. 66), a complete carapace, right valve view.</p> |
|---|--|



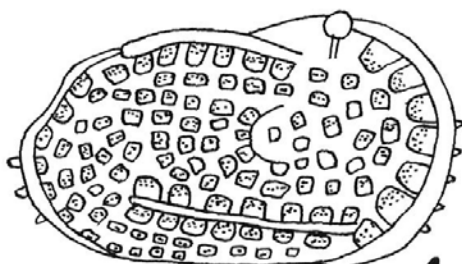
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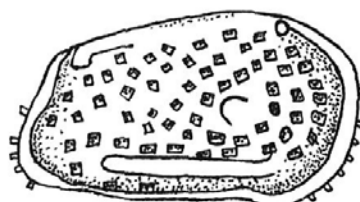
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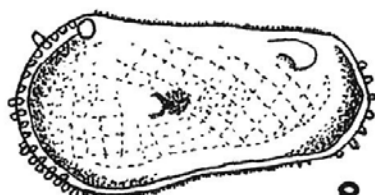
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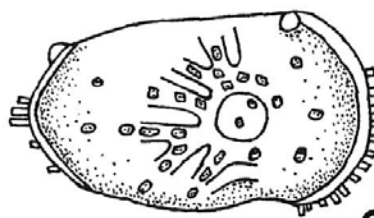
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7



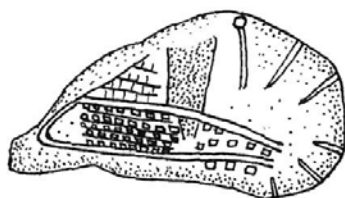
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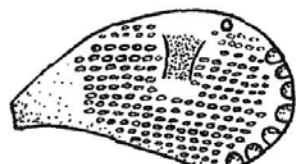
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