SOME EARLY TERTIARY OSTRACODS
FROM WEST PAKISTAN

Thesis submitted for the
Degree of Doctor of Philosophy
University of Leicester

by

Qadeer Ahmad Siddiqui

1967
III SYSTEMATIC DESCRIPTIONS (Cont'd.)

Genus "Anommatocythere" Sohn
  'Anommatocythere' laqueta sp. nov. 29
  'Anommatocythere' confirmata sp. nov. 31
Genus Bradleya Hornibrook
  Bradleya? voraginosa sp. nov. 34
Genus Buntonia Howe
  Buntonia devexa sp. nov. 37
  Buntonia sp.A 38
Genus Costa Neviani
  Subgenus Paracosta nov.
    Costa (Paracosta) declivis sp. nov. 40
    Costa (Paracosta) compitalis sp. nov. 42
    Costa (Paracosta) disintegrata sp. nov. 44
Genus Echinocythereis Puri
  Subgenus Echinocythereis sensu stricto
    Echinocythereis (Echinocythereis)
      contexta sp. nov. 47
    Echinocythereis (Echinocythereis)
      elongata sp. nov. 49
  Subgenus Scelidocythereis nov.
    Echinocythereis (Scelidocythereis)
      multibullata sp. nov. 51
    Echinocythereis (Scelidocythereis) sp.A 54
    Echinocythereis (Scelidocythereis)
      rasilis sp. nov. 55
    Echinocythereis (Scelidocythereis)
      sparsa sp. nov. 57
<table>
<thead>
<tr>
<th>Genus</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Genus Gyrocythere nov.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gyrocythere exaggerata sp. nov.</td>
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<tr>
<td>Gyrocythere parvicarinata sp. nov.</td>
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<tr>
<td>Gyrocythere grandilaevia sp. nov.</td>
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<td>Gyrocythere mitigata sp. nov.</td>
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<tr>
<td>Gyrocythere perfecta sp. nov.</td>
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<td>68</td>
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<tr>
<td><strong>Genus Hermanites Puri</strong></td>
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<tr>
<td>Hermanites cracens sp. nov.</td>
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<td>Hermanites scopus sp. nov.</td>
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<tr>
<td>Hermanites palmatus sp. nov.</td>
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<tr>
<td>Occultocythereis interrupta sp. nov.</td>
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<td>Occultocythereis sp.A</td>
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<tr>
<td>Occultocythereis spilota sp. nov.</td>
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<td>Occultocythereis peristicta sp. nov.</td>
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<tr>
<td>Occultocythereis indistincta sp. nov.</td>
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<td><strong>Genus Patagonacythere Hartmann</strong></td>
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<td>Patagonacythere nidulus sp. nov.</td>
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<td><strong>Genus Phalcocythere nov.</strong></td>
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<tr>
<td>Phalcocythere horrescens (Bosquet)</td>
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<td>92</td>
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<tr>
<td>Phalcocythere improcera sp. nov.</td>
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<tr>
<td>Phalcocythere rete sp. nov.</td>
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<td>98</td>
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<tr>
<td>Phalcocythere retispinata sp. nov.</td>
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<tr>
<td>Phalcocythere sentosa sp. nov.</td>
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<td>102</td>
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<tr>
<td>Phalcocythere dissenta sp. nov.</td>
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<td>107</td>
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</table>
III SYSTEMATIC DESCRIPTIONS (Cont'd.)

Genus Phalcocythere nov. (Cont'd.)

Phalcocythere spinosa sp. nov. 112
Phalcocythere sp. cf. P. spinosa 113

Genus Quadracythere Hornibrook

Subgenus Hornibrookella Moos

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Subgenus Trachyleberis sensu stricto

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III SYSTEMATIC DESCRIPTIONS (Cont'd.)

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PART I

PALAEOCENE AND EOCENE

TRACHYLEBRIDIDAE

FROM WEST PAKISTAN
INTRODUCTION

The most comprehensive work so far published on the area is that of Eames (1951; 1952a,b,c). Most of his lithological subdivisions for the Eocene succession of the Rakhi Nala and Zinda Pir areas occur in the northern Sulaiman Range, i.e. in the Zao River and Shpalai Khwara sections. These can easily be distinguished on the basis of lithology and microfauna, particularly ostracoda. Eames' terminology of the rock units is therefore adopted here. Bayliss (1962) and Latif (1961 and 1964) are other recent workers who have contributed to our knowledge of the Palaeocene and Eocene in the Rakhi Nala section. However, they used a different terminology for the rock units to that used by Eames. Fig. 2 shows the correlation between these workers along the Rakhi Nala section.

The samples from the Rakhi Nala section examined for ostracods were the same as used by Bayliss and Latif, who worked on larger and pelagic foraminifera respectively. These samples were collected by Bayliss. The sample numbers as given by the collector are used in this paper. Latif altered the sample numbers after 3200 by subtracting two hundred, i.e. his sample no.3201 is the same as collector's no.3401, and so on.

Samples from the Zao River and Shpalai Khwara sections were taken by S. M. Ahmed and W. A. Zuberi and those from the Sor Range section by J. A. Reinemund.
Outcrops of Eocene rocks of part of West Pakistan.
(After Eames 1952.) Sections described are indexed.
### Correlation between Eames, Bayliss and Latif along the Rakhi Nala

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Succession</strong></td>
<td><strong>Thickness in feet</strong></td>
<td><strong>Thickness in feet &amp; sample nos.</strong></td>
</tr>
<tr>
<td><strong>Upper Eocene</strong></td>
<td><strong>Sample nos used in present paper</strong></td>
<td></td>
</tr>
<tr>
<td>Pelatispira Beds</td>
<td>60</td>
<td>959</td>
</tr>
<tr>
<td><strong>Middle Eocene</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Chocolate Clays</td>
<td>425-495</td>
<td></td>
</tr>
<tr>
<td>(Upper part)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White Marl Band</td>
<td>40</td>
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</tr>
<tr>
<td>Lower Chocolate Clays</td>
<td>930</td>
<td>1253</td>
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<tr>
<td>Platy Limestone</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td><strong>Lower Eocene</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shales with Alabaster</td>
<td>750</td>
<td>1600</td>
</tr>
<tr>
<td>Rubbly Limestones</td>
<td>410</td>
<td></td>
</tr>
<tr>
<td>Green and Nodular Shales</td>
<td>850</td>
<td>1650</td>
</tr>
<tr>
<td><strong>Lakh (Ghazij)</strong></td>
<td></td>
<td>3607</td>
</tr>
<tr>
<td>Upper Lakh Shales</td>
<td>1620</td>
<td>1840</td>
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<tr>
<td>Lower Lakh Shales (Max. part)</td>
<td>775</td>
<td>3000</td>
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<tr>
<td>Rover Beds</td>
<td>470</td>
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</tr>
<tr>
<td>Venerocardia Shales</td>
<td>95</td>
<td>850</td>
</tr>
<tr>
<td>Pab Sandstones</td>
<td></td>
<td>Pab</td>
</tr>
</tbody>
</table>

* Probable equivalents of Eames, 1952.
**Eames, personal communication.
† Darijan according to Nagappa, 1959, which he regards as basal Paleocene.
*? Paleocene.
Map of the Zao River and Shpalai Khwara sections.
Numbers in brackets refer to samples. (After Ahmed & Zuberi)
LITHOLOGICAL UNITS

Sulaiman Range. The lithological units of the Rakhi Nala section have been described in detail by Eames (1952, pp.162-165), Bayliss (1962) and Latif (1961, p.32). Fig. 2 shows the succession, and the formation names give some idea of the lithology; for a fuller description, see the authors mentioned above. The Eocene succession in the Zao River and Shpalai Khwara sections is very similar to that of the Rakhi Nala section. A detailed lithological description of rocks exposed along the Rakhi Nala, Zao River and Shpalai Khwara sections is given by means of two charts.

Sor Range. Samples were collected from the "Claystones" which are overlain by fifty feet of conglomerates. The Ghazij Shales overlie the conglomerates. A chart showing these lithological units is given (Fig. 5), and a detailed succession is given in the Appendix. "The locality is in Lease 58 on the north slope of the Sor Range, about 8 miles by road east of Quetta (Survey of Pakistan Topo. Sheet no.34 N/4, coordinates 30°11'20" N., 67°10' E, grid reference P 125210). Samples were collected from a road cut along the main access road that crosses the lease approximately parallel with the outcrop and along the contour of the slope; structurally the locality is near the northern end of the Sor Range syncline, which is the major structural feature of the Sor
SOR RANGE SECTION
Measured by John A. Reinemund

Kirthar formation

Ghazij formation

1600' (approx)

Middle Eocene

Lower Eocene

50 Ft.

Limestone
Claystone
Conglomerate
Sandstone

± Menardii zone (high Palaeocene)

Upper Palaeocene

Base not exposed

FIG. 5

Dr. F. T. Banner of the British Petroleum Co. Ltd. was kind enough to examine smaller foraminifera from sample 460-i. He has dated this horizon as the Upper Palaeocene (+ *menardii* zone).
SYSTEMATIC DESCRIPTIONS

Subclass OSTRACODA Latreille 1806
Order PODOCOPIDA Müller 1896
Suborder PODOCOPINA Sars 1866
Superfamily CYTHERACEA Baird 1850

Family TRACHYLEBERIDIDAE Sylvester-Bradley 1948

DIAGNOSIS. Cytheracea with heavily calcified carapace, often highly ornamented with more or less conspicuous eye-tubercle. Muscle scar pattern basically consisting of four adductor scars (some of which are vertically divided in some genera) with a frontal scar which may be simple, V-shaped, U-shaped or multiple. Posterior characteristically sub-triangular or auricular, but in some genera rounded; in a few genera produced to form a caudal process. Subcentral-tubercle present or absent.

Subfamily TRACHYLEBERIDINAE Sylvester-Bradley 1948

DIAGNOSIS. Trachyleberididae with more or less conspicuous subcentral-tubercle, muscle scar pattern mostly with single frontal scar (mostly V-shaped or U-shaped) and usually with four undivided adductor scars. Posterior sub-triangular or rounded, not auricular. Commonly heavily ornamented with spines, tubercles or reticulae. Anterior and posterior rims frequent. Carinae commonly developed. Normal pore canals mostly simple.

REMARKS. None of the species here described falls into the other subfamily of Trachyleberididae, the Hemicytherinae, which
is characterised by genera mostly with auricular posterior, no subcentral-tubercle, and divided muscle scars. Sieve type normal pore canals have been reported as characteristic of the Hemicytherinae (Van Morkhoven 1962, Vol.1, p.127).

Genus ACTINOCYHEREIS Puri 1953

TYPE SPECIES. Cythere exanthemata Ulrich and Bassler 1904

Actinocythereis? quasibathonica sp. nov.

(Plate 1, figs.1-3,6,7,10-13)

HOLOTYPE. GSP BM 2506, a female carapace (Pl.1, figs.2,3,11,12).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Upper Chocolate Clays, sample no.3611.

OTHER MATERIAL. 28 specimens from the Rakhi Nala section from 8 horizons (sample nos.3610, 3611, 3613, 3614, 3615, 3617, 3618 and 3620). 10 specimens from the Zao River section from two horizons (sample nos.24150 and 24154).

FIGURED SPECIMENS. GSP BM 2507 - GSP BM 2509.

DERIVATION OF NAME. Latin, quasibathonica, "simulating Bathonian", with reference to strong resemblance to Middle Jurassic (Bathonian) genus Oligocythereis.

DESCRIPTION. Sexual dimorphy moderate, the females are higher and wider than the males. Carapace sub-rectangular, medium size and thick shelled. Anterior margin broadly rounded, postero-dorsal margin slightly concave, posterior extremity and postero-ventral margin somewhat rounded. Dorsal and ventral margins almost straight, slightly tapering towards the posterior. In lateral view dorsal ornament over-reaches dorsal margin. Valves almost equal. In dorsal view greatest width at sub-central node. Eye-tubercle rounded, prominent and lies below and slightly anterior to a well-developed anterior cardinal angle. Anterior marginal rim high. Ventral and posterior marginal rims less high. Sub-central tubercle prominent, rounded and distinct. Surface sparsely punctate (punctuation is not distinct in some specimens), with an alate ventral ridge which slightly slopes upwards towards the posterior. The postero-dorsal process is a blade-like projecting ridge over-reaching the dorsal margin and extending vertically below to a short distance. A prominent mid-dorsal tubercle and a small tubercle in front present. There is also a small tubercle posterior and at some distance from the sub-central node. About 12 short spines anteriorly, partly concealed in external lateral view by the anterior marginal rim, and 5-6 spines posteriorly. Radial pore canals few, simple and straight. Inner margin and line of concrescence coincide. Duplicature moderately wide. Selvage well marked lying sub-peripheral in left valve, but at some distance from the outer
margin in right valve. There is a fairly well-developed flange groove in right valve. Muscle scars unknown. Hinge holamphidont with the details given below:

<table>
<thead>
<tr>
<th>Hinge element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Socket</td>
<td>Conical projecting tooth</td>
</tr>
<tr>
<td>Antero-median</td>
<td>Subconical tooth</td>
<td>Deep socket</td>
</tr>
<tr>
<td></td>
<td>having a straight</td>
<td></td>
</tr>
<tr>
<td></td>
<td>anterior and a convex</td>
<td></td>
</tr>
<tr>
<td></td>
<td>posterior in dorsal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>view</td>
<td></td>
</tr>
<tr>
<td>Postero-median</td>
<td>Denticulate bar</td>
<td>Shallow locellate groove</td>
</tr>
<tr>
<td>Posterior</td>
<td>Slightly elongate</td>
<td>Pessular tooth</td>
</tr>
<tr>
<td></td>
<td>socket, open on venter.</td>
<td></td>
</tr>
</tbody>
</table>

DIMENSIONS, (mm.):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2507 Carapace male</td>
<td>0.51</td>
<td>0.29</td>
<td>0.27</td>
</tr>
<tr>
<td>GSP BM 2506 Carapace female (holotype)</td>
<td>0.52</td>
<td>0.32</td>
<td>0.29</td>
</tr>
<tr>
<td>GSP BM 2508 Left valve male</td>
<td>0.51</td>
<td>0.29</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2509 Right valve male</td>
<td>0.51</td>
<td>0.29</td>
<td>-</td>
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</table>

REMARKS. This species is tentatively assigned to the genus Achinocythereis. It differs from the type species of the genus in having a continuous rather than broken ventral ridge. In addition, the present species is much smaller, has a pitted surface and fewer radial pore canals.
Genus ALOCOPOCYHERE nov.

TYPE SPECIES. *Alocopocythere transcedens* sp. nov.

DERIVATION OF NAME. Greek *aloκoς* = furrow, *οπός* = eye, with reference to the furrow behind the eye-tubercle + genus *Cythere*.

DIAGNOSIS. Trachyleberididae in which the eye-tubercle is confluent with both the elevated marginal rim and a short almost vertical ridge, delimited posteriorly by a deep furrow.

DESCRIPTION. Dimorphic, the males are proportionally longer than the females. Carapace sub-rectangular to sub-quadrate in shape. Dorsal margin in lateral view sinuous, dominated by protruding anterior and posterior cardinal angles, with a hump between, ventral margin evenly curved or almost straight. Anterior margin broadly rounded, posterior straight or very slightly concave in postero-dorsal margin (between posterior cardinal angle and posterior extremity); posterior extremity rounded, postero-ventral region rounded or straight. Valves almost equal. Sub-central tubercle and eye-tubercle more or less distinct. Surface ornament either reticulate (with or without superimposed lineations or with superimposed papillae) or papillose. A marginal rim always present, usually high in anterior, less high along venter and posterior. Anterior and posterior margins ornamented with small spines or denticles. Normal pores simple, widely spaced. Radial pore canals simple, almost straight, often slightly inflated towards the middle,
tending to occur in groups of two or three, often crossing one another, about 32-35 anteriorly and 18-20 posteriorly. Inner margin and line of concrescence coincide. Duplicature of moderate width. Selvage well marked - sub-peripheral in left valve but at some distance from the outer margin in right valve. Right valve with a deep flange groove on the venter and anterior. Muscle scar pattern consisting of four adductors in a vertical row on the posterior margin of the muscle scar pit and an oval frontal scar with two more or less rounded mandibular scars below. Hinge holamphidont. Right valve hinge with highly projecting, stirpate anterior tooth, postjacent socket, postero-median locellate groove and a pessular posterior tooth; left valve with anterior socket, antero-median sub-conical tooth, postero-median denticulate bar and a deep posterior socket.

COMPARISON. This genus differs from the genus *Echinocythereis* in having a short vertical ridge below and a furrow behind the eye-tubercle. There are two frontal scars in *Echinocythereis*, while *Alocopocythere* has only one frontal scar. *Stigmatocythere* has a curved ridge joining the eye-tubercle and the sub-central tubercle, whereas in *Alocopocythere* a short, almost vertical ridge joins the eye-tubercle and is delimited posteriorly by a furrow. *Henryhowella* has three longitudinal plications in the posterior half of the valve and an anterior vestibule, not present in *Alocopocythere*. Moreover, the frontal scar in *Henryhowella* is V-shaped, while *Alocopocythere* has an oval frontal scar.
REMARKS. In addition to the species described here, the Miocene species *Trachyleberis fossularis* Lubimova and Guha (1960, p. 40, pl. 3, fig. 7), which Guha in 1961 (p. 4, figs. 5-9) transferred to the genus *Echinocythereis* should be ascribed to *Alocopocythere*.

*Alocopocythere transcendentens* sp. nov.

(Plate 1, figs. 4, 5, 8, 9; Plate 2, figs. 1-4, 6, 7)

**HOLOTYPE.** GSP EM 2510, a female left valve (Pl. 2, figs. 1, 6).

**TYPE LOCALITY.** Zao River section.

**TYPE HORIZON.** Upper Chocolate Clays, sample no. 24148.

**OTHER MATERIAL.** 170 specimens from the Zao River section from 7 horizons (sample nos. 24127, 24131, 24132, 24145, 24147, 24148 and 24151). Approximately 600 specimens from the Rakhi Nala section from 46 horizons (sample nos. 3168, 3198, 3199, 3200, 3401, 3402, 3403, 3404, 3405, 3407, 3409, 3410, 3418, 3419, 3420, 3421, 3422, 3424, 3426, 3428, 3429, 3432, 3434, 3435, 3438, 3457, 3458, 3459, 3498, 3499, 3607, 3608, 3610, 3614, 3615, 3617 and 3618).

**FIGURED SPECIMENS.** GSP EM 2511 - GSP EM 2514.

**DERIVATION OF NAME.** Latin, transcendentens, rising above, with reference to stratigraphic position in relation to *A. abstracta*.

**DIAGNOSIS.** Strongly reticulate. *Alocopocythere* with rounded postero-ventral margin, sub-central tubercle more or less distinct, eye-tubercle distinct, marginal rim well marked.
DESCRIPTION. Carapace sub-rectangular to sub-quadrate in lateral outline. Sexual dimorphism rather marked, the females are shorter, higher and wider than the males. Dorsal margin sinuous with protruding anterior and posterior cardinal angles, ventral margin almost straight in the right valve but evenly curved in the left valve. Anterior margin broadly rounded, postero-dorsal margin very slightly concave particularly in right valve, posterior extremity rounded, postero-ventral margin rounded. Valves almost equal. Eye-tubercle distinct, rounded and polished. Sub-central tubercle more or less distinct. Surface strongly reticulate. Antero-dorsal furrow deep, bounded anteriorly by a short almost vertical ridge joining the eye-tubercle. Anterior marginal rim high, continuing as a less high rim round the venter and posterior. Anterior margin ornamented with 8-10 short spines, posterior with a postero-ventral spine, although these are preserved in a few specimens only. Duplicature moderately wide, 0.073mm, anteriorly in right valve female. Selvage prominent in both valves and is situated in the outer third of the duplicature in right valve but sub-peripheral in left valve. It is markedly concave anteriorly to the middle on the venter. Right valve has well-developed ventral and anterior flange grooves. Normal pore canals simple, small. Radial pore canals more or less straight, simple, some in groups of two or three, frequently crossing each other. There are approximately 35 radial pore canals in the anterior and 20 in the posterior. Line of concrescence and inner margin coincide
throughout. Muscle scars consist of a vertical row of four adductors, situated on the posterior margin of the muscle scar pit, with an oval frontal scar and two somewhat rounded mandibular scars below. Hinge holamphidont with the following details:

<table>
<thead>
<tr>
<th>Element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Deep socket confluent with ocular sinus, bounded on all sides.</td>
<td>Highly projecting stirpate tooth, ocular sinus lies below it.</td>
</tr>
<tr>
<td>Antero-median</td>
<td>Subconical tooth with straight anterior and convex posterior in dorsal outline.</td>
<td>Deep rounded socket opening into postero-median groove.</td>
</tr>
<tr>
<td>Postero-median</td>
<td>Denticulate bar</td>
<td>Locellate groove</td>
</tr>
<tr>
<td>Posterior</td>
<td>Deep slightly elongate socket opening on ventral side.</td>
<td>Pessular tooth, high on posterior tending towards reniform.</td>
</tr>
</tbody>
</table>

**DIMENSIONS (mm.):**

<table>
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<tr>
<th></th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
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<td>GSP BM 2511</td>
<td>0.72</td>
<td>0.43</td>
<td>0.42</td>
</tr>
<tr>
<td>GSP BM 2510</td>
<td>0.63</td>
<td>0.44</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2512</td>
<td>0.64</td>
<td>0.39</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2513</td>
<td>0.59</td>
<td>0.39</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2514</td>
<td>0.63</td>
<td>0.38</td>
<td>-</td>
</tr>
</tbody>
</table>

**COMPARISON.** *Alocopocythere abstracta* sp. nov. (Pl. 3, figs. 5-11) (Pl. 4, fig. 1) is a very closely related species, but is more elongate, has a straight rather than rounded posteroventral margin and less deep
reticulations. *Alocopocythere transcendens* is perhaps ancestral to *Alocopocythere transversa* sp. nov. (Pl.5-9 figs. ), but is smaller, and lacks the posterior concentric ridges and a short ridge in the anteroventral area. *Alocopocythere fossularis* (Lubimova and Guha) (1960, p.40, pl.3, fig.7) from the Miocene of Kutch is a similar species but differs in lateral outline of the carapace.

**REMARKS.** Specimens of *A. fossularis* (Lubimova and Guha) from the type locality in Kutch were not available for comparison.

*Alocopocythere rupina* sp. nov.

>({Plate 2, figs.5,8-10; Plate 3, figs.1-4}

**HOLOTYPE.** GSP BM 2515, a male carapace (Pl. 2, figs.5,8-10)

**TYPE LOCALITY.** Rakhi Nala section.

**TYPE HORIZON.** Gorge Beds, sample no.3111.

**OTHER MATERIAL.** 40 specimens from the locality above from one horizon (sample no.3111).

**FIGURED SPECIMEN.** GSP BM 2516

**DERIVATION OF NAME.** Latin, rupina, "chasm", with reference to anterodorsal furrow and associated ridges.

**DIAGNOSIS.** *Alocopocythere* in which anterodorsal furrow is delimited anteriorly by a short almost vertical ridge and posteriorly by the anterior part of the dorsal ridge. Surface reticulate with seven longitudinal ridges. Anterior and
posterior plains almost smooth.

DESCRIPTION. Sexual dimorphism strong, the males are longer than the females. Carapace subrectangular in lateral view. Dorsal margin sinuous, ventral margin slightly concave before the middle, anterior margin broadly rounded, posterior narrowly rounded. Anterior cardinal angle protruding particularly in right valve, posterior cardinal angle less well-developed. Left valve slightly over-reaches right valve at anterior cardinal angle and in the region of posterodorsal corner. Eye-tubercle rounded and distinct. Subcentral-tubercle well-developed. Surface ornament consists of reticulations and seven longitudinal ridges; the dorsal ridge begins above and very slightly to the anterior of the subcentral-tubercle and is convex in the middle culminating in the posterior quarter. The four ridges below the dorsal ridge are almost confined posterior to the subcentral-tubercle, the second ridge from the venter is the longest and is slightly curved; it commences above the anteroventral corner and slopes obliquely upwards towards the posterior ending in the posterior quarter. The ventral ridge is confined in the posterior part of the carapace and is intercalated between the ventral margin and the second ventral ridge, to which it is almost parallel. Anterodorsal furrow well-developed, delimited on the anterior by a short almost vertical ridge, and on the posterior by the anterior portion of the dorsal ridge. Anterior and posterior platforms almost smooth, compressed. Anterior marginal rim elevated, ventral and posterior marginal rims less high.
Radial pore canals not detectable. Duplicature moderate.
Selvage well-marked; it is submarginal in left valve but in the
outer third of the duplicature in right valve, which also has
well-developed anterior and ventral flange grooves. Hinge
holamphidont with diripate anterior tooth in right valve.

DIMENSIONS (mm.):

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<tbody>
<tr>
<td>GSP BM 2515</td>
<td>0.68</td>
<td>0.37</td>
<td>0.34</td>
</tr>
<tr>
<td>GSP BM 2516</td>
<td>0.59</td>
<td>0.37</td>
<td>0.34</td>
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</table>

COMPARISON. A. rupina can easily be differentiated from other
known species of Alocopocythere by its anterodorsal groove, which
is not only delimited by an anterior ridge but by a posterior
ridge as well.

REMARKS. This is so far the oldest known species of the genus
Alocopocythere. It occurs abundantly in one horizon (sample
no.3111) of the Gorge Beds of the Rakhi Nala section, the male
to female ratio being 1:3.

Alocopocythere abstracta sp. nov.
(Plate 3, figs.5-11; Plate 4, fig.1)

HOLOTYPE. GSP BM 2518, a female carapace (Pl. 3, figs.9-11 )
(Pl. 4, fig.1)

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Upper Rakhi Gaj Shales, sample no.3163.
OTHER MATERIAL. Over 2600 specimens (including adults and juveniles) from the Rakhi Nala section from 69 horizons (sample nos. 3147, 3152, 3153, 3157, 3158, 3159, 3160, 3161, 3162, 3163, 3164, 3165, 3166, 3167, 3168, 3169, 3170, 3171, 3172, 3173, 3174, 3175, 3176, 3177, 3178, 3179, 3180, 3183, 3184, 3186, 3187, 3188, 3189, 3190, 3191, 3193, 3194, 3195, 3197, 3198, 3199, 3200, 3401, 3402, 3403, 3404, 3405, 3407, 3409, 3410, 3415, 3416, 3417, 3418, 3419, 3420, 3421, 3422, 3423, 3424, 3426, 3428, 3429, 3432, 3434, 3435, 3438, 3443, and 3445). 5 specimens from the Zao River section from one horizon (sample no. 24127).

FIGURED SPECIMEN. GSP BM 2517

DERIVATION OF NAME. Latin abstractus, separated - referring to the difficulty in separating this species from A. transcendens because of the many intermediate forms.

DIAGNOSIS. A reticulate Alocopocythere with straight postero-ventral margin in lateral outline. Subcentral-tubercle present but not prominent.

DESCRIPTION. Carapace subrectangular in side view. Sexual dimorphism rather pronounced; the males are longer than the females. Dorsal margin sinuous, ventral margin nearly straight. Anterior margin broadly and evenly rounded, posterodorsal margin very slightly concave; posterior extremity rounded; postero-ventral margin straight. Anterior and posterior cardinal angles protruding. Valves more or less equal. Eye-tubercle distinct. Subcentral-tubercle present but not pronounced. Surface reticulate.
Anterodorsal furrow deep, bounded anteriorly by a short almost vertical ridge diagnostic of the genus. Anterior and posterior margins denticulate, although the denticles are only present in a few specimens. Internal details not known.

DIMENSIONS. (mm.):

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<tbody>
<tr>
<td>GSP BM 2517 Carapace male</td>
<td>0.66</td>
<td>0.38</td>
<td>0.34</td>
</tr>
<tr>
<td>GSP BM 2518 Carapace female (holotype)</td>
<td>0.63</td>
<td>0.39</td>
<td>0.35</td>
</tr>
</tbody>
</table>

COMPARISON. *Alocopocythere coarctata* sp. nov. (Pl. 4, figs. 2-9) is smaller, has a combination of reticulations and weak ridges and more sinuous dorsal margin. *Alocopocythere radiata* sp. nov. (Pl. 9, figs. 6-9) is larger, has deeper reticulations and a better developed subcentral-tubercle with the posterior radial ridges.

*A. abstracta* has already been compared with *Alocopocythere transcendens* sp. nov.

*Alocopocythere coarctata* sp. nov. (Plate 4, figs. 2-9)

HOLOTYPE. GSP BM 2520, a female carapace (Pl. 4, figs. 6-9).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Shales with Alabaster, sample no. 3458.

OTHER MATERIAL. 44 specimens from the above locality from three horizons (sample nos. 3435, 3458 and 3459).

FIGURED SPECIMEN. GSP BM 2519.
DERIVATION OF NAME. Latin coarctatus, "pressed together", with reference to carapace.

DIAGNOSIS. *Alocopocythere* in which carapace in lateral outline appears to be compressed; dorsal and ventral margins tapering towards the posterior, subcentral-tubercle distinct, anterior marginal rim high, surface finely reticulate (with superimposed weak longitudinal ridges).

DESCRIPTION. Carapace subrectangular to subquadrate in lateral view. Sexual dimorphism strong; the females are shorter than the males. Anterior margin broadly and evenly rounded, posterodorsal margin straight, particularly in left valve, posterior extremity rounded, posteroventral margin rounded. Dorsal margin sinuous with a hump between the protruding anterior and posterior cardinal angles, ventral margin slightly concave in the middle. Both dorsal and ventral margins taper towards the posterior. Valves almost equal. Surface finely reticulate with superimposed weak longitudinal ridges. Subcentral-tubercle distinct, eye-tubercle more or less distinct. Marginal rim present, elevated in the anterior, less elevated round the venter and posterior. Antero-dorsal furrow fairly distinct and is bounded anteriorly by a short almost vertical ridge. Anterior and posterior margins denticulate. Internal characters not known.

DIMENSIONS (mm.):

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<tbody>
<tr>
<td>GSP BM 2519 Carapace male</td>
<td>0.51</td>
<td>0.27</td>
<td>0.27</td>
</tr>
<tr>
<td>GSP BM 2520 Carapace female (holotype)</td>
<td>0.50</td>
<td>0.32</td>
<td>0.29</td>
</tr>
</tbody>
</table>
COMPARISON. *Alocopocythere rupina* sp. nov. (Pl. 2, figs.5,8-10) (Pl.3, figs.1-4)
has better developed longitudinal ridges and coarser reticulation.

In addition, these two species differ in lateral outline, particu­larly the male dimorphs. *Alocopocythere transcendens* sp. nov.

(Pl. 1, figs.4,5,8,9) is larger, has a less well-developed hump
(Pl. 2, figs.1-4,6,7) between the protruding anterior and posterior cardinal angles and
lacks longitudinal ridges.

*Alocopocythere longilinea* sp. nov.

(Plate 4, figs.10-13; Plate 5, figs.1-3,6)

**HOLOTYPE.** GSP BM 2521, a male carapace (Pl. 4, figs.10-13).

**TYPE LOCALITY.** Rakhi Nala section.

**TYPE HORIZON.** Shales with Alabaster, sample no.3443.

**OTHER MATERIAL.** Nearly 670 specimens (including adults and juveniles) from the Rakhi Nala section from 10 horizons (sample nos.3438, 3440, 3443, 3444, 3445, 3448, 3450, 3451, 3457 and 3458). One specimen from the Shpalai Ksawara section from one horizon (sample no.24683).

**FIGURED SPECIMEN.** GSP BM 2522.

**DERIVATION OF NAME.** Latin longi, longitudinal + linea, line.

**DIAGNOSIS.** A small *Alocopocythere* in which surface ornament is reticulate, the reticulae being arranged in longitudinal lines with weak ridges in between, subcentral-tubercle indistinct, marginal rim low, anterior marginal area compressed.
DESCRIPTION. Carapace ovate in lateral outline and slightly tapering towards the posterior. Sexual dimorphism marked; the males are longer in proportion than the females. Anterior margin broadly and obliquely rounded, somewhat compressed, posterior almost straight, posteroventral margin slightly curved. Dorsal margin sinuous, ventral margin evenly curved. Valves nearly equal. Subcentral-tubercle indistinct. Eye-tubercle low. Surface ornament consists of combination of reticulations and weak longitudinal ridges. Anterodorsal furrow deep with a short more or less vertical anterior ridge characteristic of the genus. Marginal rim low. Internal characters unknown.

DIMENSIONS (mm.):

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<tbody>
<tr>
<td>GSP EM 2521 Carapace male (holotype)</td>
<td>0.54</td>
<td>0.32</td>
<td>0.25</td>
</tr>
<tr>
<td>GSP EM 2522 Carapace female</td>
<td>0.46</td>
<td>0.30</td>
<td>0.24</td>
</tr>
</tbody>
</table>

COMPARISON. The present species differs from *Alocopocythere abstracta* sp. nov. (Pl. 3, figs. 5-11) and *Alocopocythere transcendens* sp. nov. (Pl. 1, figs. 4, 5, 8, 9) in being smaller and having weak longitudinal ridges. Moreover, *A. longilinea* has a low marginal rim and an indistinct subcentral-tubercle. *Alocopocythere coarctata* sp. nov. (Pl. 4, figs. 2-9) is about the same size but has a high marginal rim, well-developed subcentral-tubercle and more sinuous dorsal margin.

REMARKS. *A. longilinea* occurs in the lower part of the Shales with Alabaster of the Rakhi Nala section and at several horizons
it is very abundant. It is very rare in the Shpalai Khwara section.

Alocopocythere transversa sp. nov.

(Plate 5, figs. 4, 5, 7-10; Pls. 6-8; Pl. 9, figs. 1-5)

HOLOTYPE. GSP BM 2523, a female carapace (Pl. 5, figs. 8, 10). (Pl. 6, figs. 1, 2)

TYPE LOCALITY. Zao River section.

TYPE HORIZON. Upper Chocolate Clays, sample no. 24155.

OTHER MATERIAL. Over 800 specimens from the Zao River section from 20 horizons (sample nos. 24131, 24155, 24157, 24159, 24170, 24173, 24174, 24175, 24176, 24177, 24178, 24180, 24181, 24183, 24184, 24185, 24186, 24187, 24188 and 24195). Approximately 300 specimens from the Rakhi Nala section from 20 horizons (sample nos. 3624, 3625, 3626, 3630, 3631, 3634, 3640, 3641, 3642, 3645, 3646, 3648, 3649, 3650, 3651, 3652, 3653, 3658 and 3660).

FIGURED SPECIMENS. GSP BM 2524 - GSP BM 2533.

DERIVATION OF NAME. Latin transversus, transverse, with reference to posterior ridges.

DIAGNOSIS. A species of the genus Alocopocythere with three posterior transverse, concentric ridges. A short ridge in the anteroventral area runs obliquely from the anterior towards the venter, a shallow groove on the dorsal side of the ridge. Surface reticulate (with or without superimposed papillae) or papillose.
DESCRIPTION. Sexual dimorphism rather marked, the males are more elongate than the females. Carapace subrectangular in lateral view. Dorsal margin sinuous, ventral margin straight or evenly curved. Anterior margin broadly rounded, posterodorsal margin very slightly concave, posterior extremity rounded, posteroventral margin rounded or almost straight. Anterior and posterior cardinal angles well-developed and protruding. Valves nearly equal. Eye-tubercle distinct, polished and rounded. Subcentral-tubercle distinct. Surface either reticulate (with or without superimposed papillae) or papillose. There are three posterior transverse concentric ridges approximately parallel to the posterior margin with grooves in between. There is a short ridge in the anteroventral area running obliquely from the anterior towards the venter, with a groove on the dorsal side. Antero-dorsal groove fairly deep and bounded on the anterior by a short almost vertical ridge running from the eye-tubercle. The marginal rim is high in the anterior but less high on the venter and posterior. Anterior and posterior margins ornamented with short spines, only present in some specimens and approximately 20 anteriorly and 10 posteriorly. Normal pore canals simple, small and numerous. Radial pore canals numerous, simple, nearly straight, some in groups of two or three, often crossing one another. Duplicature moderately wide. Selvage pronounced in the outer third of the duplicature in the right valve but submarginal in the left valve. Right valve with deep ventral and anterior flange grooves. Line of concrescence and inner margin
coincide. Muscle scars consist of four adductors in a vertical row with an oval frontal scar and two almost rounded mandibular scars below. Hinge holamphidont:

<table>
<thead>
<tr>
<th>Element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Deep rounded socket bounded on all sides, confluent with ocular sinus.</td>
<td>Strongly projecting stirpate tooth (ocular sinus situated below and slightly anterior to it).</td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Subconical projecting tooth with a straight anterior and convex posterior in dorsal view.</td>
<td>Deep socket.</td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Denticulate bar</td>
<td>Locellate groove</td>
</tr>
<tr>
<td>Posterior</td>
<td>Deep elongate socket unbounded on venter</td>
<td>Pessular tooth with a tendency towards reniform, higher on posterior.</td>
</tr>
</tbody>
</table>

COMPARISON. *Alocopocythere radiata* sp. nov. (Pl. 9, figs.6-9) (Pl. 10, figs.1-4) is similar and perhaps related but lacks the posterior concentric ridges. Moreover, *A. radiata* has a ventral inflation culminating in a ventral ridge and the longitudinal ridges radiate from the posterior of a subcentral-tubercle.

The present species has already been compared with

*Alocopocythere transcendent* sp. nov.

REMARKS. This species is divided into the following morphotypes:
Morphotype A

(Pl. 5, figs. 4, 5, 7-10; Pl. 6, figs. 1-4)

This has a reticulate surface. The reticulae are usually without any superimposed papillae but in some specimens a few small papillae at the junction of reticulae are present. The posteroventral margin in lateral outline is curved in the male but straight in the female.

DIMENSIONS (mm.):

<table>
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<th>Specimen</th>
<th>Type</th>
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<td>Carapace male</td>
<td>0.76</td>
<td>0.44</td>
<td>0.44</td>
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<tr>
<td>GSP BM 2523</td>
<td>Carapace female (holotype)</td>
<td>0.71</td>
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<td>0.44</td>
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<tr>
<td>GSP BM 2525</td>
<td>Right valve male</td>
<td>0.85</td>
<td>0.46</td>
<td>-</td>
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</table>

Morphotype B

This comprises the transitional forms which fall between Morphotype A and Morphotype C. It has slightly papillose reticulae.

Morphotype C

(Pl. 6, figs. 5-8; Plate 7, figs. 1-4; Pl. 8, fig. 4)

This is similar to Morphotype B but has a combination of reticulations and papillae and a curved posteroventral margin in both male and female.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th>Specimen</th>
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<td>GSP BM 2526</td>
<td>Carapace male</td>
<td>0.78</td>
<td>0.46</td>
<td>0.44</td>
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<tr>
<td>GSP BM 2527</td>
<td>Carapace female</td>
<td>0.76</td>
<td>0.46</td>
<td>0.44</td>
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<tr>
<td>GSP BM 2528</td>
<td>Right valve male (broken)</td>
<td>0.80</td>
<td>-</td>
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Morphotype D

This includes the intermediate forms between Morphotype C and Morphotype E.

Morphotype E

(Pl. 7, figs. 5-8; Plate 8, figs.1-3,5)

This is similar in all characters to Morphotype A and Morphotype C but has a papillose surface. It has a curved posteroventral margin in the male and female dimorphs as in Morphotype C. There is a smooth, shallow groove on the dorsal side of the ventral ridge.

DIMENSIONS (mm.):

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<td>GSP BM 2529 Carapace male</td>
<td>0.80</td>
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<tr>
<td>GSP BM 2530 Carapace female</td>
<td>0.74</td>
<td>0.46</td>
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</table>

Morphotype F

(Pl. 8, figs. 6-9; Plate 9, figs.1-5)

This has a small carapace. The surface is ornamented with slightly papillose reticulae. There is a rim behind the anterior marginal rim and almost parallel to it with reticulations in between. It originates from the eye-tubercle and culminates in a short, oblique ventral ridge. It is likely that these forms may be juveniles of Morphotype A or Morphotype C or may even belong to a distinct species.
DIMENSIONS (mm.):

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<td>Left valve female</td>
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<tr>
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<td>-</td>
</tr>
<tr>
<td>Right valve female</td>
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<td></td>
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</tr>
</tbody>
</table>

**Alocopocythere radiata** sp. nov.

(Plate 9 figs. 6-9; Plate 10, figs. 1-4)

**HOLOTYPE.** GSP BM 2534, amale carapace (Pl. 9, figs. 6, 8).

(Pl.10, figs. 1, 2)

**TYPE LOCALITY.** Rakhi Nala section.

**TYPE HORIZON.** Upper Chocolate Clays, sample no. 3652.

**OTHER MATERIAL.** 13 specimens from the locality above from one horizon (samples no. 3652). 8 specimens from the Zao River section from one horizon (sample no. 24173).

**FIGURED SPECIMEN.** GSP BM 2535.

**DERIVATION OF NAME.** Latin, radiatus, rayed, refers to ridges radiating from subcentral-tubercle.

**DIAGNOSIS.** A coarsely reticulate Alocopocythere with longitudinal ridges radiating from the posterior of a well-developed subcentral-tubercle. Eye-tubercle distinct, marginal rim high, ventral inflation ends in a marked ridge, almost parallel to the ventral marginal rim.
DESCRIPTION. Sexual dimorphism distinct; the females are shorter than the males. Carapace subrectangular in lateral view. Dorsal margin sinuous with protruding anterior and posterior cardinal angles; ventral margin almost straight. Anterior margin broadly and evenly rounded, posterior extremity rounded, posterodorsal margin very slightly concave, posteroventral margin curved in the male dimorph but almost straight in the female. Valves more or less equal. Eye-tubercle rounded and distinct. Surface ornament consists of coarse reticulations with superimposed ridges radiating from the posterior of a well-developed subcentral-tubercle. The ventral inflation culminates in a marked ventral ridge almost parallel to the ventral marginal rim. There are two ridges which join the eye-tubercle, one a short more or less vertical ridge bounded posteriorly by a deep anterodorsal furrow which is better seen in dorsal view, and the other a high anterior marginal rim which continues on the venter and posterior as a less high rim. Anterior and posterior margins decorated with numerous very short and delicate spines.

DIMENSIONS (mm.):

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<td>0.72</td>
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<td>0.42</td>
</tr>
<tr>
<td>GSP BM 2535 Carapace female</td>
<td>0.68</td>
<td>0.42</td>
<td>0.40</td>
</tr>
</tbody>
</table>

COMPARISON. Alocopocythere transcendens sp. nov. (Pl. 1, figs.4,5,8,9) (Pl. 2, figs.1-4,6,7) shows some resemblance and is perhaps ancestral to the present species; but A. transcendens has a less well-developed subcentral-tubercle without radial ridges and lacks a ventral inflation.
ending in a ridge. *Alocopocythere coarctata* sp. nov. (Pl. 4, figs. 2-9) is much smaller, has a carapace which tapers towards the posterior and less deep reticulation.
Genus "ANOMMATOCYHERE" Sohn

TYPE SPECIES. "Anommatocythere microreticulata" Sohn.

REMARKS. This is a new genus erected by Sohn whose paper is in press. The two species described below are provisionally assigned to the genus but their final designation will depend on the publication of Sohn's paper.

"Anommatocythere" laqueata sp. nov.

(Plate 10, figs.5-10)

HOLOTYPE. GSP BM 2537, a female carapace (Pl. 10, figs. 8-10).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Green and Nodular Shales, sample no.3403.

OTHER MATERIAL. 31 specimens from the locality above from three horizons (sample nos.3403, 3465 and 3466). Two specimens from the Zao River section from one horizon (sample no.24107).

FIGURED SPECIMEN. GSP BM 2536

DERIVATION OF NAME. Latin laqueatus, fluted - with reference to ornament of anterior rim.

DIAGNOSIS. Anterior rim ornamented with seven small more or less rectangular depressions. Carapace subtriangular with a gently convex dorsal margin.

DESCRIPTION. Sexual dimorphy rather apparent; the males are longer in proportion than the females. Carapace subtriangular
in lateral view. Dorsal margin gently convex, ventral margin almost straight, anterior margin broadly rounded, posterior with a caudal process. Greatest length lies below mid-point, greatest height at anterior cardinal angle. Anterior and posterior cardinal angles more or less rounded, somewhat better developed in left valve. Left valve very slightly larger than right valve, over-reaching it in anterodorsal corner and postero-dorsal slope. Subcentral-tubercle indistinct. Eye-tubercle distinct but low. Surface reticulate, the reticulae are arranged in lines. The lines of reticulae are separated by longitudinal ribs. Anterior marginal rim ornamented with seven almost rectangular small depressions like a scallop or bivalve mollusc. Internal characters not observed.

DIMENSIONS (mm.): L H W

<table>
<thead>
<tr>
<th>Carapace male</th>
<th>0.66</th>
<th>0.37</th>
<th>0.32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carapace female (holotype)</td>
<td>0.66</td>
<td>0.39</td>
<td>0.34</td>
</tr>
</tbody>
</table>

COMPARISON. "Anommatocythere" confirmata sp. nov. (Pl. 10, figs.11,12) has a thick-shelled and ventrally inflated carapace. It has a convex rather than straight ventral margin in lateral view and lacks the anterior rim ornament of the present species.

REMARKS. Specimens from the Shales with Alabaster show fainter longitudinal ribs. This is perhaps due to the form of preservation.
"Anommatocythere" confirmata sp. nov.

(Holotype, Figs. 11, 12; Pl. 11, Pl. 12, Figs. 1, 2)

Holotype. GSP BM 2538, a male carapace (Pl. 10, Figs. 11, 12).

Type Locality. Rakhi Nala section.

Type Horizon. Upper Chocolate Clays, sample no. 3611.

Other Material. 69 specimens from the Rakhi Nala section from five horizons (sample nos. 3499, 3611, 3613, 3614 and 3615).

53 specimens from the Zao River section from six horizons (sample nos. 24145, 24147, 24148, 24150, 24151 and 24152).

Figured Specimen. GSP BM 2539 - GSP BM 2541.

Derivation of Name. Latin confirmatus, "strengthened", with reference to variation in strength of longitudinal ribs.

Diagnosis. Carapace ventrally inflated and with a short caudal process. Ventral longitudinal ribs are curved and better developed. Anterior and posterior cardinal angles well-marked.

Description. Sexual dimorphism rather marked, the females are shorter and wider in proportion than the males. Carapace plump, thick-shelled and with ventral inflation. Dorsal margin slightly convex particularly in right valve, ventral margin concave before the middle but in lateral outline it is convex due to ventral inflation, anterior margin broadly rounded, posterior with a short caudal process. Anterior and posterior cardinal angles well-developed particularly in left valve. Left valve slightly over-reaches right valve at anterodorsal and posterodorsal corners.
Subcentral-tubercle present but not distinct. Eye-tubercle rounded, shiny and distinct and lies below and slightly anterior to cardinal angle. Surface ornament consists of reticulations and longitudinal ribs. There is a variation in the strength of longitudinal ribs, those on the ventral surface are stronger and curved convexly downwards in the middle. Marginal rim narrow and low. Anterior and posterior margins denticulate. Valves are deep in internal view. Normal pore canals fairly numerous and perhaps each reticule has one normal pore canal. Radial pore canals simple, straight, sparse, irregularly spaced, few crossing one another, approximately 20 anteriorly and 8 posteriorly. Line of concrescence and inner margin coincide - no vestibule. Duplicature fairly wide - 0.073mm. anteriorly, 0.055mm. on the posterior extremity. Selvage distinct and subperipheral; it is in the outer sixth of the anterior of the right valve. Right valve with a ventral flange groove between selvage and flange. Muscle scar pattern with four adductor scars in an almost vertical superposition at the posterior margin of the muscle scar pit and two more or less rounded frontal scars. Hinge holamphidont with the following details of the hinge elements:

<table>
<thead>
<tr>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Deep socket bounded on</td>
<td>Strongly projecting</td>
</tr>
<tr>
<td>all sides. Eye-socket stirpate tooth.</td>
<td></td>
</tr>
<tr>
<td>lies almost in the</td>
<td></td>
</tr>
<tr>
<td>middle of it.</td>
<td></td>
</tr>
</tbody>
</table>

Continued........
Left valve  
Anteromedian  
Conical tooth, projecting slightly towards anterior.
Posteromedian  
Denticulate bar  
Posterior  
Deep and elongate socket unbounded on ventral side.

Right valve  
Deep socket narrowing posteriorly into a long groove.
Locellate groove, the anterior part deeper than posterior.
Large bilobate tooth, the anterior lobe lower than the posterior.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th>GSP BM 2538</th>
<th>Carapace male (holotype)</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.66</td>
<td>0.39</td>
<td>0.39</td>
</tr>
<tr>
<td>GSP BM 2539</td>
<td>Carapace female</td>
<td>0.63</td>
<td>0.42</td>
<td>0.44</td>
</tr>
<tr>
<td>GSP BM 2540</td>
<td>Left valve male</td>
<td>0.64</td>
<td>0.39</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2541</td>
<td>Right valve male</td>
<td>0.63</td>
<td>0.37</td>
<td>-</td>
</tr>
</tbody>
</table>

COMPARISON. This species has already been compared with "Anommatocythere" laqueata sp. nov.

REMARKS. The vertical range of the present species in the Rakhi Nala and Zao River sections is 286ft. and 378ft. respectively. Hence, it is a very useful species as an horizon marker in the region.

Adult specimens in the two sections vary in size and in the strength of ornament.
Genus BRADLEYA Hornibrook 1952

TYPE SPECIES. **Cythere arata** Brady 1880

**Bradleya? voraginosa** sp. nov.

(Plate 12, figs. 3-9)

**HOLOTYPE.** GSP BM 2542, a male carapace (Pl. 12, figs. 3, 5, 7, 8)

**TYPE LOCALITY.** Zao River section.

**TYPE HORIZON.** Upper Chocolate Clays, sample no. 24161.

**OTHER MATERIAL.** 9 specimens from the locality above from two horizons (sample nos. 24159 and 24161).

**FIGURED SPECIMEN.** GSP BM 2543

**DERIVATION OF NAME.** Latin voraginosus, full of pits.

**DIAGNOSIS.** A species provisionally placed in the genus Bradleya with subparallel dorsal and ventral margins, projecting anterior cardinal angle, truncated posterior, coarsely and deeply reticulate surface.

**DESCRIPTION.** Carapace subrectangular in lateral outline. Valves ventrally inflated. Dorsal and ventral margins almost straight and subparallel, anterior margin broadly rounded, posterior truncated, posterodorsal slope very slightly concave particularly in right valve. Anterior cardinal angle projecting, posterior cardinal angle rather well-marked (approximately 110°). Valves almost equal. Eye-tubercle rounded and distinct and situated
just below anterior cardinal angle. Subcentral-tubercle more or
less distinct. A marginal rim runs on anterior, ventral and poste-ior margins. It is fairly well-developed on anterior and posterior but less high along venter. Surface ornament consists of coarse and deep reticulations and dorsal and ventral ridges. The dorsal ridge is ill-defined in the anterior half, slightly arched upward in the posterior third and culminates in a short horn-like posterodorsal process. The ventral ridge is better developed and slightly alate posteriorly. Anterior margin finely denticulate, posteroventral margin ornamented with 4-5 short spines. Internal details not very well displayed. Duplicature fairly wide. Selvage in left valve is subperipheral and less well-developed than in the right valve where it is at some distance from the outer margin. It has a deep flange groove, particularly in the venter. Hinge holamphidont: left valve with a deep almost rounded anterior socket which is bounded on all sides, a conical projecting anteromedian tooth, an apparently denticulate bar and a deep elongate posterior socket which is bounded on the venter. Hinge of right valve not clearly seen.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th></th>
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<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP EM 2542</td>
<td>Carapace male (holotype)</td>
<td>0.76</td>
<td>0.42</td>
</tr>
<tr>
<td>GSP EM 2543</td>
<td>Carapace female</td>
<td>0.73</td>
<td>0.40</td>
</tr>
</tbody>
</table>

COMPARISON. *Bradleya? cornuelina* (Bosquet) Keij (1957, p.98, pl.15, figs.16-17; pl.17, figs.3-5) is similar in lateral view but has three rather than two longitudinal ridges. Further,
it has a less well-developed anterior cardinal angle. *Bradleya approximata* (Bpsquet) Keij (1957, p.97, pl.15, fig.18; pl.17, figs.1-2) has a different posterior and larger posteroventral spines.

REMARKS. The reticulae in most of the specimens are filled in with matrix.
Genus BUNTONIA Howe 1935

TYPE SPECIES. Buntonia shubutaensis Howe 1935

Buntonia devexa sp. nov.
(Plate 13, figs. 1-5)

HOLOTYPE. GSP BM 2545, a female carapace (Pl. 13, figs. 2, 4, 5)

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Gorge Beds, sample no. 3111.

OTHER MATERIAL. 10 specimens from the locality above from three horizons (sample nos. 3111, 3133 and 3135).

FIGURED SPECIMEN. GSP BM 2544

DERIVATION OF NAME. Latin devexus, sloping, with reference to tapering lateral outline.

DIAGNOSIS. A species of Buntonia in which carapace is elongate, subrectangular in lateral view; surface ornamented with 9-11 longitudinal ribs in posterior three-fifths of carapace.

DESCRIPTION. Sexual dimorphism rather pronounced; the males are longer and less wide than the females. Carapace subtriangular in lateral view, tapering towards the posterior. Anterior margin broadly and obliquely rounded, posterior narrowly rounded, dorsal and ventral margins almost straight, dorsal margin slopes downwards towards posterior. Greatest length passes through midpoint, greatest height in anterior third and greatest width in posterior two-fifths. Anterior cardinal angle rounded.
Left valve slightly larger than right valve. Surface ornament consists of 9-11 longitudinal ridges, which are more or less confined in the posterior three-fifths. Anterior marginal rim distinct.

DIMENSIONS (mm.)

<table>
<thead>
<tr>
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<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2544 Carapace male</td>
<td>0.80</td>
<td>0.39</td>
<td>0.24</td>
</tr>
<tr>
<td>GSP BM 2545 Carapace female (holotype)</td>
<td>0.73</td>
<td>0.35</td>
<td>0.27</td>
</tr>
</tbody>
</table>

COMPARISON. *Buntonia virgulata* Apostolescu (1961, p.805, pl.4, figs.74-76) has punctae between longitudinal ridges and a less elongate carapace. *Cythere cf. costellata* (Roemer) Latham (1938, p.41, fig.3) is similar and may even be conspecific. However, this figure, which appears to be drawn upside down, shows longitudinal ridges continuing in the anterior part of the carapace.

REMARKS. *Cythere costellata* (Roemer) is now regarded as a species of the genus *Cytheretta*. Because of the imperfect preservation, it has not been possible to observe whether the present species has any eye-tubercles.

*Buntonia sp.A*

Plate 13, figs. 6,7,9

LOCALITY. Rakhi Nala section.

HORIZON. Lower Rakhi Gaj Shales, sample no.3133.

MATERIAL. Two specimens from the locality and horizon above.

FIGURED SPECIMEN. GSP BM 3076
DESCRIPTION. Carapace small, almost triangular in lateral outline. Greatest length lies below mid-point, greatest height in anterior third. In dorsal view carapace widest just posterior to the middle and tapers towards anterior and posterior ends; posterior pointed. Anterior broadly and obliquely rounded, posterior narrow and somewhat rounded; dorsal and ventral margins taper towards the posterior. Anterior cardinal angle rounded and well-developed. Left valve larger than right valve. Surface ornamented with some ten longitudinal ridges.

DIMENSIONS (mm.)

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP EM 3076 Carapace</td>
<td>0.50</td>
<td>0.27</td>
<td>0.32</td>
</tr>
</tbody>
</table>

COMPARISON. *Buntonia devexa* sp. nov. (Pl. 13, figs. 1-5) is much larger, has a less triangular carapace with a gentle slope on the dorsal margin. Further, *B. devexa* has a rounded rather than pointed posterior in dorsal view and has longitudinal ridges which do not continue towards the anterior.
Genus COSTA Neviani 1928

TYPE SPECIES. *Cytherina edwardsii* Roemer 1838

DIAGNOSIS. Trachyleberididae in which ornament is dominated by three or four longitudinal ridges, the median or second ridge running back from the subcentral-tubercle towards posterodorsal corner in anterior two-thirds of length, then curving sharply down towards posteroventral corner in posterior third of length.

Subgenus COSTA sensu stricto

DIAGNOSIS. *Costa* with three longitudinal ridges.

Subgenus PARACOSTA nov.

TYPE SPECIES. *Costa (Paracosta) declivis* sp. nov.

DERIVATION OF NAME. Greek *para*, near; with reference to strong resemblance to subgenus *Costa*.

DIAGNOSIS. *Costa* with a fourth ventral ridge intercalated between third ridge and ventral margin.

REMARKS. The subgenus *Paracosta* is so far only known from the Rakhi Nala section. It is represented by two species in the Upper Chocolate Clays and one species in the Pellatispira Beds.

*Costa (Paracosta) declivis* sp. nov.

(Plate 13, figs.8,10-14)
(Plate 14, figs.1,2)

HOLOTYPE. GSP BM 2546, a male carapace.
TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Pellatispira Beds, sample no. 3662.

OTHER MATERIAL. 33 specimens from the Rakhi Nala section from four horizons (sample nos. 3661, 3662, 3663 and 3664).

FIGURED SPECIMENS. GSP BM 2547 - GSP BM 2548.

DERIVATION OF NAME. Latin declivis, sloping downward, referring to direction of ridge running anteroventrally from subcentral-tubercle.

DIAGNOSIS. A small species of Paracosta in which longitudinal ridges are well developed, median or second ridge runs anteroventrally from subcentral-tubercle.

DESCRIPTION. Sexual dimorphism marked, the males are longer than the females. Carapace elongate, subrectangular in lateral view with greatest height at anterior cardinal angle. Dorsal and ventral margins almost straight, subparallel, anterior broadly rounded, posterior subtrangular. Valves almost equal. Anterior cardinal angle rounded, posterior cardinal angle obtuse. Greatest width in posterior third. Subcentral-tubercle distinct. Eyetubercle rounded and distinct. Ornament consists of reticulations dominated by four longitudinal ridges. The dorsal ridge commences just above the subcentral-tubercle and is slightly arched upward (in lateral view over-reaching dorsal margin), the median or second ridge runs almost diagonally - from anteroventral margin towards posterodorsal corner, then bending down towards posteroventral
margin; the ventral or fourth ridge (better seen in ventral view) lies between the third ridge and the ventral margin and is not as well-developed as the other three. Anterior and posterior marginal rims high. Anterior margin ornamented with 15-18 small spines, posteroventral margin with 5-6 relatively large spines. Internal characters unknown.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Character</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2546</td>
<td>Carapace male</td>
<td>0.83</td>
<td>0.39</td>
<td>0.37</td>
</tr>
<tr>
<td>GSP BM 2547</td>
<td>Carapace female</td>
<td>0.77</td>
<td>0.39</td>
<td>0.37</td>
</tr>
<tr>
<td>GSP BM 2548</td>
<td>Carapace female</td>
<td>0.77</td>
<td>0.39</td>
<td>0.37</td>
</tr>
</tbody>
</table>

COMPARISON. This species differs from Costa (Paracosta) *disintegrata* sp. nov. (Pl. 14, figs. 11) in having well-developed (Pl. 15, figs. 1-6) longitudinal ridges and a different outline. Costa (Paracosta) *compitalis* sp. nov. (Pl. 14, figs. 3-10) is larger, lacks well-developed longitudinal ridges and has a ridge running from the eye-tubercle to the subcentral-tubercle.

**Costa (Paracosta) compitalis** sp. nov.

(Plate 14, figs. 3-10)

HOLOTYPE. GSP BM 2550, a female carapace (Pl. 14, figs. 56, 310).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Upper Chocolate Clays, sample no. 3604.

OTHER MATERIAL. 13 specimens from the locality above from one horizon (sample no. 3604).
FIGURED SPECIMEN. GSP BM 2549.

DERIVATION OF NAME. Latin compitalis, pertaining to cross-roads; referring to nexus of ridges running from subcentral-tubercle.

DIAGNOSIS. A large, strongly reticulate species of the subgenus Paracosta in which longitudinal ridges are moderately developed, subcentral tubercle prominent and is joined by three ridges – dorsal, median and a ridge running from eye-tubercle.

DESCRIPTION. Carapace subrectangular in lateral outline. Sexual dimorphism rather pronounced; the females are shorter and higher than the males. Dorsal margin slightly curved in lateral view because of over-reaching of the dorsal ridge, ventral margin straight, anterior broadly and evenly rounded, posterodorsal margin very slightly concave, posterior extremity slightly subtriangular, posteroventral margin rounded. Greatest height at anterior cardinal angle, greatest length at mid-point and greatest width in posterior third. Anterior cardinal angle well-developed with a concavity behind. Left valve slightly larger than right valve, over-reaching at posterodorsal margin and in the region of anterior cardinal angle. Eye-tubercle rounded and distinct and is confluent with anterior marginal rim and a ridge running from subcentral-tubercle. Subcentral-tubercle lies more or less in anterior third and is prominent. Surface coarsely reticulate. There are four longitudinal ridges: the dorsal ridge commences from subcentral-tubercle and is curved convexly upward, the median or second ridge stretches back from subcentral-tubercle towards
posteroventral margin, the third ridge slightly slopes upward towards posterior and the ventral ridge is almost parallel to ventral margin and is intercalated between the third ridge and the ventral margin. Anterior and posterior marginal rims distinct. Anterior and posterior margins ornamented with numerous small spines. Internal details not known.

**DIMENSIONS (mm.):**

<table>
<thead>
<tr>
<th>Carapace</th>
<th>GSP BM 2549 Carapace male</th>
<th>GSP BM 2550 Carapace female (holotype)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>0.98</td>
<td>0.93</td>
</tr>
<tr>
<td>H</td>
<td>0.51</td>
<td>0.51</td>
</tr>
<tr>
<td>W</td>
<td>0.46</td>
<td>0.44</td>
</tr>
</tbody>
</table>

**COMPARISON.** *Costa (Paracosta) disintegrata* sp. nov. (Pl. 14, figs. 1-6) is smaller, has ill-defined longitudinal ridges and the carapace tapers towards the posterior.

**HOLOTYPE.** GSP BM 2552, a male carapace (Pl. 14, figs. 11) (Pl. 15, figs. 3, 4)

**TYPE LOCALITY.** Rakhi Nala section.

**TYPE HORIZON.** Upper Chocolate Clays, sample no. 3622.

**OTHER MATERIAL.** Two specimens from the locality above from one horizon (sample no. 3621).

**FIGURED SPECIMEN.** GSP BM 2551.

**DERIVATION OF NAME.** Latin, "broken down"; referring to relict nature of ridges characteristic of *Costa*. 
DIAGNOSIS. *Paracosta* of medium size with weakly developed longitudinal ridges. Carapace tapering towards posterior in lateral view.

DESCRIPTION. Sexual dimorphism moderate; the males are longer in proportion than females. Carapace subrectangular, tapering to posterior in side view. Dorsal and ventral margins almost straight, anterior margin broadly and evenly rounded, posterior subtriangular. Anterior cardinal angle rounded, posterior cardinal angle obtuse—well-developed in left valve. Left valve over-reaches the right slightly at anterior cardinal angle and in the region of posterodorsal slope. A distinct eye-tubercle lies just below anterior cardinal angle. Subcentral-tubercle well-developed. Anterior and posterior marginal rims high. Surface coarsely reticulate (some reticulae being slightly papillose). There are four ill-defined longitudinal ridges: the dorsal ridge commences just behind the subcentral tubercle and is curved convexly upward; the second ridge stretching back from subcentral-tubercle towards posterodorsal corner in anterior two-thirds and then bending sharply round towards posteroventral corner; the third ridge commences below subcentral-tubercle sloping upward towards posterior; the fourth ridge (better seen in ventral view) is more or less parallel to the third ridge and lies between the ventral margin and the third ridge. Anterior and posterior margins spinose.
DIMENSIONS (mm.): 

<table>
<thead>
<tr>
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<th>L</th>
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</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2551</td>
<td>0.83</td>
<td>0.42</td>
<td>0.32</td>
</tr>
<tr>
<td>GSP BM 2552</td>
<td>0.85</td>
<td>0.44</td>
<td>0.37</td>
</tr>
</tbody>
</table>

COMPARISON. This species falls between *Costa (Paracosta) compitalis* sp. nov. and *Costa (Paracosta) declivis* sp. nov. in size and stratigraphical position and has already been compared with these species.
Genus ECHINOCYTHEREIS Puri 1954

TYPE SPECIES. Cythereis garretti Howe and McGuirt 1935.

DIAGNOSIS. Trachyleberididae with or without ventral ridges. Carapace often inflated and with curved posteroventral margin, particularly in right valve. Surface ornamented with papillae, nodes, reticulations (or combination of these - concentrically arranged in some species) or almost smooth. Muscle scars are in a vertical column of four adductors with two frontal scars.

Subgenus ECHINOCYTHEREIS sensu stricto

DIAGNOSIS. Echinocythereis without ventral ridges.

Echinocythereis (Echinocythereis) contexta sp. nov.

(Plate 13, figs.7,8,10,13)

HOLOTYPE. GSP BM 2534, a female carapace (Pl. 13, figs.8,13)

TYPE LOCALITY. Sor Range section.

TYPE HORIZON. Upper Palaeocene, sample no.460-i.

OTHER MATERIAL. Four specimens from the Sor Range section from four horizons (sample nos.460-f, 460-i, 460-j and 460-o).

FIGURED SPECIMEN. GSP BM 2553.

DERIVATION OF NAME. Latin contextus, joined together; from ornament of papillae joined by walls of reticulae.

DIAGNOSIS. A species of the subgenus Echinocythereis in which posterior is obliquely rounded towards posterodorsal corner,
eye-tubercle prominent, surface reticulate with superimposed papillae.

DESCRIPTION. Sexual dimorphism rather strong; the carapace is subrectangular in the male and subquadrate in the female. Dorsal margin in lateral outline undulating because of ornament, ventral margin almost straight, anterior broadly and evenly rounded, posterior obliquely rounded towards posterodorsal corner. Greatest length passes through above mid-point, greatest height in the anterior fourth and greatest width behind the middle. Anterior and posterior cardinal angles well-developed. Left valve larger than the right, over-reaching it at anterior, ventral and posterodorsal margins. Eye-tubercle rounded and prominent, standing out from the shell surface in lateral and dorsal views. Subcentral-tubercle more or less distinct. Surface ornament consists of slightly papillose reticulae which are concentrically arranged near margins. Anterior and posterior margins are set with a double row of papillae; those on the posterior are larger, and in some specimens become short spines. Internal details not seen.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th>Carapace</th>
<th>L</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Carapace male</td>
<td>0.78</td>
<td>0.44</td>
<td>0.37</td>
</tr>
<tr>
<td>Carapace female (holotype)</td>
<td>0.71</td>
<td>0.46</td>
<td>0.42</td>
</tr>
</tbody>
</table>

COMPARISON. Echinocythereis (Scelidocythereis) sp.A (Pl. 17, figs.3,4,8,9) has a straight rather than curved posterodorsal margin and less prominent eye-tubercle. Moreover, it has a weak ventral
ridge and a short horn-like posterodorsal process. *Echinocythereis*
(Echinocythereis) elongata sp. nov. (Pl.15, figs.9,11,) has a very
(Pl.16, figs.1,2) 12,14)
elongate carapace and a better developed subcentral-tubercle.

*Echinocythereis* (Echinocythereis) elongata sp. nov.

(Plate 15, figs.9,11,12,14; Pl.16, figs.1,2)

HOLOTYPE. GSP BM 2556, a female carapace (Pl.15, figs.12,14).
(Pl.16, fig.1)

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Rubbly Limestones, sample no.3416.

OTHER MATERIAL. Eight specimens from the Rakhi Nala section from
three horizons (sample nos.3404, 3409 and 3416).

FIGURED SPECIMEN. GSP BM 2555.

DERIVATION OF NAME. Latin elongatus, elongate; with reference
to carapace.

DIAGNOSIS. An elongate species of the subgenus *Echinocythereis*
in which posterior is rounded towards posterodorsal corner,
subcentral-tubercle distinct, surface ornamented with reticulae
and papillae.

DESCRIPTION. Carapace elongate, subrectangular in lateral outline.
Sexual dimorphism rather prominent in dorsal view; the males are
longer and less wide than the females. Anterior margin broadly
rounded, posterior narrowly rounded towards posterodorsal corner
particularly in the left valve, dorsal margin irregular due to
ornamentation, ventral margin more or less straight. Greatest
length lies above the middle, greatest height at anterior cardinal angle and greatest width before the middle. Valves almost equal. Subcentral-tubercle distinct. Eye-tubercle fairly distinct, but is worn in some specimens. Surface ornament consists of a combination of reticulations and papillae. The reticulae are in the anterior and ventral regions and the papillae in the middle and posterior. The papillae are perhaps shown by the removal of an upper layer of reticulae. The decoated papillae show normal pore canals and nexus of reticulae, which are smaller than the anterior and ventral ones. Normal pore canals are situated between papillae and presumably each papilla has one normal pore canal. Anterior and posterior margins denticulate, although the denticles are not preserved in some specimens. Internal characters unknown.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th></th>
<th>Carapace male</th>
<th>Carapace female (holotype)</th>
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<tbody>
<tr>
<td>GSP BM 2555</td>
<td>0.73</td>
<td>0.71</td>
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<tr>
<td>GSP BM 2556</td>
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<td>0.38</td>
</tr>
<tr>
<td></td>
<td>0.29</td>
<td>0.34</td>
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</tbody>
</table>

COMPARISON. This species can easily be separated from the other known species of the subgenus *Echinocythereis* by its much more elongate carapace.

REMARKS. Most of the specimens studied are slightly worn.
Subgenus SCELIDOCYTHEIS nov.

TYPE SPECIES.  Echinocythereis (Scelidocythereis) multibullata sp. nov.

DERIVATION OF NAME. Greek σκελίδος, rib (with reference to development of ventral ridges).

DIAGNOSIS.  Echinocythereis with ventral ridges.

Echinocythereis (Scelidocythereis) multibullata sp. nov.

(Plate 16, figs.3-9)
(Plate 17, figs.1,2,7)

HOLOTYPE.  GSP BM 2557, a male carapace (Pl. 16, figs.3,5,6).
            (Pl.17, fig.7)

TYPE LOCALITY.  Zao River section.

TYPE HORIZON.  Upper Chocolate Clays, sample no.24161.

OTHER MATERIAL.  75 specimens from the Zao River section from five horizons (sample nos.24154, 24156, 24159, 24161 and 24183).
28 specimens from the Rakhi Nala section from three horizons (sample nos.3621, 3624, and 3625).

FIGURED SPECIMENS.  GSP BM 2558 - GSP BM 2560.

DERIVATION OF NAME. Latin multus, much + bullatus, knobbed, from the ornament.

DIAGNOSIS.  A species of the subgenus Scelidocythereis in which subcentral-tubercle is prominent consisting of 4-5 small nodes. Surface nodose or tuberculate. Right valve over-reaches left valve in anterior margin but is over-reached by the latter at anterior and posterior cardinal angles.
DESCRIPTION. Sexual dimorphism rather marked; the presumed females are shorter, higher and wider than the males. Carapace subrectangular in lateral view. Anterior margin broadly and evenly rounded in both valves. In right valve posterodorsal corner very slightly concave, posterior extremity and postero-ventral margins rounded; in left valve posterior is truncated. Dorsal margin intricate in lateral view because of ornamentation, ventral margin slightly incurved before the middle in right valve but curved convexly downward in left valve. Greatest length lies in the middle, greatest height at the anterior cardinal angle and greatest width in front of the middle (i.e. at the subcentral-tubercle). Anterior cardinal angle protruding. Right valve over-reaches the left at the anterior margin and posteroventral margin; but left valve over-reaches the right in the region of anterior and posterior cardinal angles. Subcentral-tubercle prominent and is composed of 4-5 small nodes. Eye-tubercle rounded and distinct. Surface ornamented with nodes or tubercles, the ones near the ventral margin being larger. There are three small ventral ridges, the two near the ventral margin are smaller and almost confined to anteroventral and mid-ventral regions. Anterior and posterior margins are denticulate. Viewed internally the valves are deep. Duplicature fairly wide, 0.11mm. at the posterior extremity (Pl. 16, fig. 9). Selvage well-developed, subperipheral in the left valve but almost at the outer third in the right valve. A deep flange groove, better developed at the venter, lies between the selvage and flange in right valve.
Radial pore canals fairly numerous, simple, almost straight, few occurring in groups of two or three. Inner margin and line of concrescence coincide. Muscle scars (best seen in weathered specimens from the outside) are in an almost vertical column of four adductors and two more or less rounded frontal scars. Hinge holamphidont:

<table>
<thead>
<tr>
<th>Element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Deep, almost rounded socket bounded on all sides.</td>
<td>Highly projecting pessular tooth.</td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Projecting subconical tooth</td>
<td>Socket opening into posteromedian groove.</td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Slightly projecting denticulate ridge (denticles are seen only in nicely preserved specimens).</td>
<td>Locellate groove</td>
</tr>
<tr>
<td>Posterior</td>
<td>Deep elongate socket unbounded on venter.</td>
<td>Large subpessular tooth, less high on anterior.</td>
</tr>
</tbody>
</table>

**DIMENSIONS (mm.):**

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Carapace male (holotype)</th>
<th>Carapace female</th>
<th>Left valve female</th>
<th>Right valve female</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2557</td>
<td>0.85</td>
<td>0.83</td>
<td>0.84</td>
<td>0.83</td>
</tr>
<tr>
<td>GSP BM 2558</td>
<td>0.50</td>
<td>0.51</td>
<td>0.54</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**COMPARISON.** *Echinocythereis (Scelidocythereis) sparsa* sp. nov. (Pl. 18, figs. 4, 6, 8, 9) is smaller, has a different lateral outline, distinct marginal rims and scattered tubercles as surface ornament.
In addition to this, it has an indistinct rather than prominent subcentral-tubercle.

REMARKS. This species occurs in the Upper Chocolate Clays of the Zao River and Rakhi Nala sections. It has a short vertical range and hence can be used as an index marker.

**Echinocythereis (Scelidocythereis) sp. A**

(Plate 17, figs.3,4,8,9)

**LOCALITY.** Sor Range section.

**HORIZON.** Upper Palaeocene, sample no.460-1.

**MATERIAL.** Two specimens from the locality and horizon above.

**FIGURED SPECIMEN.** GSP BM 2561.

**DESCRIPTION.** Carapace short, subquadrate in lateral view. Dorsal margin slightly irregular due to surface ornament, ventral margin almost straight, anterior broadly and evenly rounded, posterodorsal margin straight, posterior extremity somewhat rounded, posteroventral margin curved. Greatest length lies below mid-point, greatest height in the anterior third and greatest width behind the middle. Anterior and posterior cardinal angles well-developed. Valves almost equal. Eye-tubercle rounded, polished and distinct. Subcentral-tubercle present but not well-developed. Surface reticulate with superimposed papillae. A weak ventral ridge at some distance from the ventral margin slopes obliquely upwards towards the posterior. The posterodorsal process
is a short horn-like ridge slightly anterior to the posterior cardinal angle. A margin runs along anterior, venter and posterior.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2561 Carapace</td>
<td>0.59</td>
<td>0.39</td>
<td>0.34</td>
</tr>
</tbody>
</table>

COMPARISON. This species has already been compared with *Echinocythereis (Echinocythereis) contexta* sp. nov.

**Echinocythereis (Scelidocythereis) rasilis** sp. nov.

(Plate 17, figs. 5, 6, 10)
(Plate 18, figs. 1-3, 5, 7)

HOLOTYPE. GSP BM 2563, a female carapace (Pl. 17, figs. 6). (Pl. 18, figs. 2, 3)

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Lower Chocolate Clays, sample no. 3499.

OTHER MATERIAL. 16 specimens from the Rakhi Nala section from three horizons (sample nos. 3499, 3614 and 3617). 41 specimens from the Zao River section from seven horizons (sample nos. 24145, 24147, 24148, 24150, 24152, 24153 and 24157).

FIGURED SPECIMENS GSP BM 2562, GSP BM 3077, GSP BM 3078.

DERIVATION OF NAME. Latin *rasilis*, smoothed.

DIAGNOSIS. Carapace subreniform. Dorsal margin arched with a slight concavity behind the protruding anterior cardinal angle. Surface smooth with two ventral ridges.
DESCRIPTION. Carapace subreniform in lateral outline, with
greatest height at the anterior cardinal angle. Dorsal margin
arched with a slight concavity behind the anterior cardinal angle,
ventral margin incurved before the middle, particularly in right
valve, anterior margin broadly rounded, posterodorsal slope very
slightly concave, posterior extremity rounded, posteroventral
margin curved or straight. In dorsal view greatest width lies
almost in the middle. Anterior and posterior marginal areas
compressed. Anterior cardinal protruding. Right valve over-
reaches left valve along the anterior and posteroventral margins.
Left valve over-reaches right valve slightly in the regions of
anterior cardinal angle and posterodorsal slope. Surface smooth.
There are two ventral ridges, the one near the ventral margin
being smaller. Eye-tubercle more or less distinct and lies below
the anterior cardinal angle. Anterior margin finely denticulate
(20-25 small denticles), posterior with 6-8 larger denticles.
Duplicature fairly wide, 0.073 mm. anteriorly. In right valve
the selvage and flange groove are well-developed particularly in
anteroventral and ventral regions. In left valve selvage is well-
marked but flange groove is somewhat less well-developed. Radial
pore canals not clearly visible but would seem to be simple,
straight and numerous. No vestibule. Hinge not determinable.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th>Carapace</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>0.59</td>
<td>0.46</td>
<td>0.37</td>
</tr>
<tr>
<td>female</td>
<td>0.56</td>
<td>0.45</td>
<td>0.37</td>
</tr>
<tr>
<td>male (holotype)</td>
<td>0.76</td>
<td>0.49</td>
<td>0.37</td>
</tr>
<tr>
<td>female</td>
<td>0.75</td>
<td>0.49</td>
<td>0.42</td>
</tr>
</tbody>
</table>
COMPARISON. Hemicythere sahnii Tewari and Tandon (1960, p.157, pl.4, fig.1a-d) seems to be a closely related species. Specimens of this were not available for comparison but from the description and figures given by these authors it does not seem to have a concavity behind the anterior cardinal angle.

REMARKS. The marginal denticles are not preserved in all specimens.

_Echinocythereis (Scelidocythereis) sparsa_ sp. nov.

(Plate 18, figs.4,6,8,9)

HOLOTYPE. GSP BM 2565, a female carapace (Pl. 18, figs.8,9).

TYPE LOCALITY. Zao River section.

TYPE HORIZON. Upper Chocolate Clays, sample no.24159.

OTHER MATERIAL. 42 specimens from the locality above from three horizons (sample nos.24159, 24181 and 24183).

FIGURED SPECIMEN. GSP BM 2564.

DERIVATION OF NAME. Latin sparsus, scattered; with reference to papillae.

DIAGNOSIS. A species of _Scelidocythereis_ with subrectangular carapace, dorsal margin slightly arched, ventral margin incurved in front of the middle. Surface ornamented with scattered papillae and two ventral ridges. Anterior and posterior marginal rims distinct. Left valve larger than right.
DESCRIPTION. Sexual dimorphism moderate, the males are longer in proportion than the females. Carapace subrectangular in side view with greatest height at anterior cardinal angle. Dorsal margin slightly arched, ventral sinuated anterior to the middle. Anterior margin broadly rounded, posterior somewhat rounded. Right valve larger than left valve, which it over-reaches along anterior and ventral margins. Anterior cardinal angle rounded. Subcentral-tubercle indistinct, eye-tubercle rounded and distinct. Surface ornament consists of sparsely distributed papillae. There are two ventral ridges: the top ridge bifurcates posteriorly, the bottom ridge being shorter. Anterior and posterior marginal rims fairly well-developed. Anterior margin ornamented with small and numerous denticles, posterior with 6-8 larger denticles. Duplicature moderately wide with a prominent selvage and flange groove in right valve particularly in ventral and anteroventral regions. Radial pore canals simple, almost straight, irregularly spaced, 25-30 anteriorly and 12-15 posteriorly. Hinge holamphidont: right valve with anterior tooth - conical and projecting, followed by postjacent socket, shallow posteromedian groove and posterior reniform tooth. Muscle scar pattern consists of four adductors in a vertical superposition and two more or less rounded frontal scars.

DIMENSIONS.

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2564 Carapace male</td>
<td>0.78</td>
<td>0.45</td>
<td>0.37</td>
</tr>
<tr>
<td>GSP BM 2565 Carapace female (holotype)</td>
<td>0.76</td>
<td>0.49</td>
<td>0.39</td>
</tr>
</tbody>
</table>
COMPARISON.  *Echinocythereis (Scelidocythereis) rasilis* sp. nov.  
(Pl. 17, figs.5,6,10) is smaller and may even be ancestral but has  
(Pl. 18, figs.1-3,5,7)  
a smooth rather than papillose surface.  Moreover, it has a con-  
cavity behind the anterior cardinal angle and lacks distinct  
marginal rims.

REMARKS.  *Echinocythereis (Scelidocythereis) sparsa* has so far only  
been found in the Upper Chocolate Clays of the Zao River area.
Genus GYROCYTHERE nov.

TYPE SPECIES. *Gyrocythere exaggerata* sp. nov.

DERIVATION OF NAME. Greek "γύρος" gyros, circle; with reference to concentric arrangement of ornament + genus *Cythere*.

DIAGNOSIS. Reticulate Trachyleberididae with three or four longitudinal ridges, the dorsal ridge distinct from the eye-tubercle, arcuate, sloping down towards anterior and terminating below the eye-tubercle; the second ridge running posteriorly from the subcentral-tubercle; the third ridge more or less distinct in different species.

DESCRIPTION. Sexual dimorphism rather pronounced; the females are shorter, higher and wider than the males. Carapace sub-rectangular to subquadrate in lateral view. Valves almost equal. Eye-tubercle and subcentral-tubercle present, more or less pronounced. Surface reticulate. Three to four longitudinal ridges present: the dorsal ridge commences anteriorly below the eye-tubercle and is arched convexly upwards; the second ridge stretches backwards from the subcentral-tubercle and is arched convexly upwards, its continuation in front of the subcentral-tubercle being less pronounced; the third ridge slopes obliquely upwards towards the posterior and is curved convexly downward towards the anterior; the ventral ridge is confined to the posterior two-thirds of the carapace and culminates in a slight alar expansion in the posterior, almost obsolete or absent in some species. Normal pores simple, fairly numerous. Radial pore canals simple,
irregularly spaced, more or less straight, few seem to bifurcate, approximately 25 anteriorly. Inner margin and line of concrescence coincide. Duplicature moderately wide. Selvage well-marked, submarginal in left valve but at some distance from the outer margin in right valve. Ventral and anterior flange grooves well-developed in right valve. Hinge holamphidont with stirpate anterior tooth in right valve. Muscle scar pattern consists of four adductor scars in an almost vertical row and a U-shaped frontal scar, which opens to the anterodorsal angle.

COMPARISON. This genus differs from the genus Costa in having an arcuate dorsal ridge and in the less evident anterior marginal rim. Further, the subcentral-tubercle in Costa lies more towards the anterior. Hermanites has only two longitudinal ridges and has a concave posterodorsal slope. Gyrocythere lacks the very wide duplicature seen in Paracytheretta.

Gyrocythere exaggerata sp. nov.

(Plate 18, figs.10-14)
(Plate 19; Plate 20, fig.5)

HOLOTYPE. GSP BM 2566, a female carapace (Pl. 19, figs. 1-4).

TYPE LOCALITY. Zao River section.

TYPE HORIZON. Upper Chocolate Clays, sample no.24151.

OTHER MATERIAL. 38 specimens from the Zao River section (sample nos.24145, 24147, 24148, 24150, 24151 and 24152). Eight specimens from the Rakhi Nala section (sample nos.3613 and 3614).
FIGURED SPECIMENS. GSP BM 2567 - GSP BM 2572, GSP BM 3079, GSP BM 3080.

DERIVATION OF NAME. Latin exaggeratus, exaggerate; with reference to well-developed longitudinal ridges.

DIAGNOSIS. A species of the genus Gyrocythere with prominent eye-tubercle, bilobate subcentral-tubercle and well-developed longitudinal ridges.

DESCRIPTION. Carapace subrectangular in the male dimorph and subquadrate in the female. Anterior margin broadly and evenly rounded, posterior narrow, almost rounded in left valve but slightly subangular in right valve. Dorsal and ventral margins almost concealed in lateral outline by the dorsal and ventral ridges. Greatest height in the ocular region; greatest length passes through mid-point. Anterior cardinal angle prominent with a concavity behind in lateral view. Valves almost equal. Eye-tubercle prominent, stands out in lateral view. It is rounded and polished. Subcentral-tubercle distinct and bilobate. Surface coarsely reticulate. Reticulae are slightly papillose in some specimens. There are four well-developed longitudinal ridges. Dorsal ridge begins below the eye-tubercle anteriorly and is convex upwards. Median or second ridge runs from the subcentral-tubercle posteriorly and is convex upwards. Its extension anterior to the subcentral-tubercle is less well-marked. Third ridge is intercalated between the median and ventral ridges. It slopes obliquely upwards towards the posterior and is convex downwards in its anterior part. Ventral ridge is restricted
in the posterior two-thirds of the carapace. It ends in a slight
alar expansion in the posterior third of the carapace. Anterior
margin denticulate, posteroventral margin with short spines present
in some specimens. Normal pore canals simple, numerous (Pl. 19,
figs. 6, 7). Radial pore canals not very well-displayed due to
form of preservation, but appear to be simple, almost straight,
irregularly spaced (few seem to bifurcate), with some 25 in the
anterior margin. Line of concrescence and inner margin coincide.
Duplicature of moderate width, 0.07 mm. anteriorly. Selvage
pronounced in both valves; it is in the outer third of the
duplicature in right valve but submarginal in left valve. Right
valve with well-developed flange groove, particularly on the
venter. Muscle scars are in a vertical row of four adductors and
a U-shaped frontal scar opening towards the anterodorsal corner.
Hinge holamphidont:

<table>
<thead>
<tr>
<th>Element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Rounded socket, confluent with ocular sinus, seen</td>
<td>Projecting stirpate tooth.</td>
</tr>
<tr>
<td></td>
<td>in a few specimens.</td>
<td></td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Subconical tooth which has straight anterior but</td>
<td>Deep rounded socket opening into postero-</td>
</tr>
<tr>
<td></td>
<td>convex posterior in dorsal median groove.</td>
<td>median groove.</td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Denticulate bar</td>
<td>Locellate groove</td>
</tr>
<tr>
<td>Posterior</td>
<td>Deep, slightly elongate socket.</td>
<td>Pessular tooth, but subrectangular in lateral</td>
</tr>
<tr>
<td></td>
<td></td>
<td>view.</td>
</tr>
</tbody>
</table>
DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th>Specimen ID</th>
<th>Description</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2567</td>
<td>Left valve male</td>
<td>0.81</td>
<td>0.49</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2568</td>
<td>Right valve male</td>
<td>0.83</td>
<td>0.49</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2566</td>
<td>Carapace female (holotype)</td>
<td>0.78</td>
<td>0.49</td>
<td>0.46</td>
</tr>
<tr>
<td>GSP BM 2569</td>
<td>Left valve male</td>
<td>0.76</td>
<td>0.46</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2570</td>
<td>Right valve female</td>
<td>0.71</td>
<td>0.44</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2571</td>
<td>Right valve female</td>
<td>0.71</td>
<td>0.44</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3079</td>
<td>Left valve male</td>
<td>0.72</td>
<td>0.44</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 2572</td>
<td>Right valve female</td>
<td>0.72</td>
<td>0.44</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3080</td>
<td>Right valve male</td>
<td>0.72</td>
<td>0.44</td>
<td>-</td>
</tr>
</tbody>
</table>

COMPARISON. This species resembles *Gyrocythere perfecta* sp. nov. (Pl. 22, figs. 1-10) but differs from it in being larger and having more prominent longitudinal ridges and eye-tubercle. Moreover, the subcentral-tubercle in *G. exaggerata* is distinctly bilobate.

REMARKS. The occurrence of this species is restricted to 390ft. in the Zao River section and 15ft. in the Rakhi Nala section, so it seems likely that it will prove a useful horizon marker.

*Gyrocythere parvicarinata* sp. nov.
Plate 20, figs. 1-4, 6-8, 12.

HOLOTYPE. GSP BM 2573, a male carapace (Pl. 20, figs. 1, 2, 6-7).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Green and Nodular Shales, sample no. 3407.

OTHER MATERIAL. Over 100 specimens from the Rakhi Nala section from 23 horizons (sample nos. 3153, 3168, 3169, 3170, 3171, 3172, 3179, 3180, 3185, 3192, 3193, 3199, 3200, 3401, 3402, 3403, 3404, 3405, 3407, 3409, 3410, 3415 and 3417).
FIGURED SPECIMEN. GSP BM 2574.

DERIVATION OF NAME. Latin parvus, little - carinatus, ridged; with reference to longitudinal ridges.

DIAGNOSIS. A strongly reticulate species of the genus Gyrocythere with three longitudinal ridges, (the median ridge is ill-defined in most specimens), posterior subtriangular, eye-tubercle distinct, subcentral-tubercle well-developed.

DESCRIPTION. Sexual dimorphism distinct; the males are more elongate than the females. Carapace subrectangular in side view. Anterior margin broadly rounded, posterior subtriangular. Dorsal margin straight but appears slightly convex in lateral view due to the over-reaching of the dorsal ridge, ventral margin slightly concave in front of the middle. Anterior cardinal angle distinct with a concavity behind in lateral view. Left valve slightly over-reaches right valve at anterior cardinal angle and postero-dorsal slope. In dorsal view greatest width lies in anterior two-fifths. Subcentral-tubercle well-developed. Eye-tubercle distinct. Surface strongly reticulate with three longitudinal ridges: the dorsal ridge is curved convexly upwards; the median is more or less ill-defined in many specimens; the third or ventral ridge is curved convexly downward anteriorly. Anterior and posterior marginal rims present but not high. Both anterior and posterior margins are denticulate. Duplicature of medium width. Selvage distinct and at some distance from the outer margin in right valve. Anterior and ventral flange grooves well-developed.
in right valve. Radial pore canals not clearly seen due to mineralisation. Hinge as for the genus.

DIMENSIONS (mm.): L H W

<table>
<thead>
<tr>
<th></th>
<th>Carapace male (holotype)</th>
<th>Carapace female</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2573</td>
<td>0.68 0.37 0.34</td>
<td>0.67 0.42 0.37</td>
</tr>
</tbody>
</table>

COMPARISON. This species is smaller than *Gyrocythere grandilaevia* sp. nov. (Pl. 20, figs. 9-11, 13). Although the longitudinal ridges (Pl. 21, figs. 1-4) are no better developed than *G. grandilaevia* the eye-tubercle and subcentral-tubercle are more prominent, the reticulation is deeper and wider in proportion.

**Gyrocythere grandilaevia** sp. nov.

Plate 20, figs. 9-11, 13
Plate 21, figs. 1-4.

HOLOTYPE. GSP BM 2573, a female carapace (Pl. 20, figs. 11, 13). (Pl. 21, figs. 3, 4)

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Shales with Alabaster, sample no. 3463.

OTHER MATERIAL. 15 specimens from the locality above from four horizons (sample nos. 3463, 3464, 3465 and 3466). Two specimens from the Shpalai Khwara section from one horizon (sample no. 24692).

FIGURED SPECIMEN. GSP BM 2576.

DERIVATION OF NAME. Latin grandis, large - laevis, smooth.

DIAGNOSIS. A species of *Gyrocythere* with large, reticulate, smooth carapace. Three longitudinal ridges including median ridge
which is not well-developed. Anterior and posterior marginal rims distinct.

DESCRIPTION. Sexual dimorphism moderate; the males are proportionally longer than the females. Carapace subrectangular in lateral outline. Anterior margin broadly rounded, posterior margin almost rounded in left valve but with a slight concavity in posterodorsal slope of right valve. Dorsal margin almost straight but appears slightly convex in lateral view due to the dorsal ridge, which slightly over-reaches it; ventral margin slightly concave in front of the middle. Valves almost equal. Subcentral-tubercle and eye-tubercle present but not pronounced. Surface reticulate. Reticulae are concentrically arranged around the subcentral-tubercle. There are three longitudinal ridges. Dorsal ridge is curved convexly upward. Median or second ridge is less well-developed. Ventral or third ridge runs obliquely from above the anteroventral corner towards the posterior and is curved convexly downward in its anterior portion. Anterior and posterior marginal rims distinct. Anterior and posterior margins denticulate. Internal features not seen.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th></th>
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<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2575</td>
<td>Carapace male (holotype)</td>
<td>0.85</td>
<td>0.46</td>
</tr>
<tr>
<td>GSP BM 2576</td>
<td>Carapace female</td>
<td>0.83</td>
<td>0.46</td>
</tr>
</tbody>
</table>

COMPARISON. This species resembles *Gyrocythere parvicarinata* sp. nov. (Pl. 20, figs.1-4, ) but differs from it in being larger. 6-8,12.
Moreover, the posterior in *G. parvicarinata* is subacuminate. *G. grandilaevis* is perhaps ancestral to *Gyrocythere perfecta* sp. nov. (Pl. 22, figs. 1-10), which is smaller and has stronger ornament.

**Gyrocythere mitigata** sp. nov.

**Plate 21, figs. 5-11**

**HOLOTYPE.** GSP BM 2577, a male carapace (Pl. 21, figs. 5-8).

**TYPE LOCALITY.** Zao River section.

**TYPE HORIZON.** Lower Chocolate Clays, sample no. 24131.

**OTHER MATERIAL.** 8 specimens from the locality above from two horizons (sample nos. 24131 and 24132).

**FIGURED SPECIMENS.** GSP BM 2578 - GSP BM 2579.

**DERIVATION OF NAME.** Latin mitigatus, mellowed; with reference to less emphatic ornament than typical species of *G. exaggerata*.

**DIAGNOSIS.** A large, strongly reticulate species of the genus *Gyrocythere* with three longitudinal ridges, the median ridge almost ill-defined.

**DESCRIPTION.** Sexually dimorphic; the males are longer than the females. Carapace subrectangular in lateral view. Anterior margin broadly and evenly rounded, dorsal margin almost straight in reality but appears slightly convex in lateral view because of the over-reaching of the dorsal ridge; posterodorsal slope very slightly concave particularly in right valve, posterior extremity
rounded, posteroventral margin curved, ventral margin almost straight. Greatest height in the anterior quarter, greatest length almost in the middle. Anterior and posterior cardinal angles well-marked, particularly in left valve. Left valve slightly over-reaches the right valve in the anterodorsal corner and at the posterodorsal slope. Greatest width in dorsal or ventral view lies in the posterior third. Subcentral-tubercle prominent, eye-tubercle rounded and distinct. Surface strongly reticulate with three longitudinal ridges: the dorsal ridge is curved convexly upwards in the middle and starts anteriorly below the eye-tubercle; the median ridge is less well-developed, almost ill-defined in most specimens; it runs posteriorly from the subcentral-tubercle and is curved convexly upwards. The ventral ridge commences anteriorly above the anteroventral corner and runs obliquely upwards towards the posterior and culminates in the posterior third. Marginal rim is distinct at the anterior and posterior but less distinct along the venter. Anterior margin denticulate, posterior extremity and posteroventral margin ornamented with about six short spines or papillae. Duplicature of moderate width. Selvage well-developed. In left valve it is subperipheral but in right valve it is situated at some distance from the outer margin. Right valve has fairly deep flange groove on the venter and anterior. Hinge as for the genus.

DIMENSIONS:

See next page.
DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>Carapace male (holotype)</th>
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<th>Left valve female</th>
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COMPARISON. *Gyrocythere grandilaevis* sp. nov. (Pl. 20, figs.9-11) (Pl. 21, figs.1-4) is somewhat similar and might even be ancestral to the present species. These two, however, can be separated. *G. grandilaevis* is smaller and has a less well-developed subcentral-tubercle. Moreover, the dorsal and ventral ridges in *G. grandilaevis* are less well-marked. *G. mitigata* differs from *Gyrocythere exaggerata* sp. nov. (Pl. 18, figs.10-14) in being larger, having a different lateral outline and less emphatic ornament. Further, *G. mitigata* has three, rather than four, longitudinal ridges and lacks a bilobate subcentral-tubercle.

REMARKS. *G. mitigata* has so far only been found in the Zao River section, where it occurs at two horizons.

---

**Gyrocythere perfecta** sp. nov.

Plate 22, figs. 1-10

HOLOTYPE. GSP BM 2580, a female carapace (Pl. 22, figs.3,4,7,8).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Lower Chocolate Clays, sample no.3499.

OTHER MATERIAL. 17 specimens from the locality above from two horizons (sample nos.3498 and 3499).
FIGURED SPECIMENS.  GSP BM 2581 - GSP BM 2583

DERIVATION OF NAME.  Latin perfectus, perfect; with reference to the beauty of the material.

DIAGNOSIS.  Gyrocythere with strongly reticulate, concentrically arranged ornament.  Eye-tubercle, subcentral-tubercle and longitudinal ridges distinct.

DESCRIPTION.  Carapace subrectangular in lateral view, arrow-shaped in ventral view.  Sexual dimorphism rather pronounced; the females are higher and wider than the males.  Anterior margin broadly rounded, posterior slightly subangular, particularly in right valve.  Dorsal margin straight but appears to be convex due to the over-reaching of the dorsal ridge; ventral margin slightly concave before the middle.  Anterior cardinal angle distinct and rounded.  Valves almost equal.  Eye-tubercle distinct but not high.  Subcentral-tubercle distinct, slightly lobate.  Surface strongly and deeply reticulate, the reticulation being concentric around the subcentral-tubercle.  Four longitudinal ridges occur: the dorsal ridge is convex upwards; it commences below the eye-tubercle and culminates in the posterodorsal region; the median or second ridge is also convex upwards; it runs from the subcentral-tubercle towards the posterior but its continuation anterior to the subcentral-tubercle is not distinct; the third ridge is convex downwards in its anterior half and slopes obliquely upwards towards the posterior; the ventral ridge is better seen in ventral view; it is confined in the posterior three-quarters.
Anterior margin denticulate. There is a short posteroventral spine present in most specimens. Radial pore canals simple, more or less straight, irregularly spaced, few seem to bifurcate, about 25-28 in the anterior. Inner margin and line of concrescence coincide throughout. Duplicature moderately wide with a distinct selvage. In right valve the selvage lies at some distance from the outer margin. Right valve has well-marked anterior and ventral flange grooves. Adductor scars in vertical column of four and a U-shaped frontal scar. Hinge holamphidont.

DIMENSIONS (mm.):  

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<td>GSP BM 2583</td>
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<td>Right valve female</td>
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COMPARISON. The present species is similar in all characters to *Gyrocythere exaggerata* sp. nov. (Pl. 18, figs.10-14) but is smaller (Pl. 19; Pl. 20, figs.5) and with less well-marked ornamentation. On the other hand, the ornament is stronger than *Gyrocythere grandilaevis* sp. nov. (Pl.20, figs.9-11,13) or *Gyrocythere parvicarinata* sp. nov. (Pl. 20, Pl.21, figs.1-4) (figs.1-4, ). In both morphological development and stratigraphical position, *G. perfecta* falls between *G. grandilaevis* and *G. exaggerata*.

REMARKS. *G. perfecta* has so far only been found in the type locality.
Genus HERMANITES Puri 1955

TYPE SPECIES. Hermania reticulata Puri 1954.

Hermanites cracens sp. nov.
Plate 22, figs.11; Plate 23, figs.1-3.

HOLOTYPE. GSP EM 2584, a carapace.

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. George Beds, sample no.3111.

DERIVATION OF NAME. Latin, cracens, graceful; with reference to pleasing curve of ridges.

DIAGNOSIS. A large Hermanites with well-developed slightly curved dorsal and ventral ridges. Subcentral-tubercle prominent with three small curved longitudinal ridges behind.

DESCRIPTION. Carapace large, massive, subrectangular in lateral view. Greatest length mid-point, greatest height an anterior cardinal angle and greatest width in the posterior third. Dorsal and ventral margins almost straight, anterior broadly and evenly rounded, posterodorsal margin very slightly concave, posteroventral margin and posterior extremity rounded. Anterior cardinal angle well-developed particularly in the left valve. Left valve slightly over-reaches the right at anterior cardinal angle and posterodorsal slope. Subcentral-tubercle prominent. Eye-tubercle rounded and distinct and with a rounded groove in front particularly in the left valve. Marginal rim high in the anterior
but somewhat less high in the posterior and venter. Surface coarsely reticulate with well-marked, dorsal and ventral ridges: the dorsal ridge commences above the subcentral-tubercle and is slightly curved convexly upward; the ventral ridge slopes obliquely upward towards posterior and then curves sharply round towards posteroventral margin in posterior quarter. There are three short curved longitudinal ridges behind the subcentral-tubercle, the bottom one being the shortest. Anterior and posterior margins spinose – anterior with numerous small spines but posterior with few larger spines.

DIMENSIONS (mm.):

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COMPARISON. Hermanites palmatus sp. nov. (Pl. 24, figs.1-9, 11,12) is much smaller, has the dorsal and ventral ridges joined posteriorly by a transverse ridge and the ridges in front of the subcentral-tubercle has a palmate appearance.

REMARKS. So far only one specimen of this species has been recovered from the George Beds of the Rakhi Nala section, where it occurs in association with Alocopocythere rupina sp. nov. and Buntonia (Protobuntonia) devexa sp. nov.

Hermanites scopus sp. nov.
Plate 23, figs.4-10

HOLOTYPE. GSP BM 2585, a male carapace. (Pl.23, figs.4-7)

TYPE LOCALITY. Zao River section.
TYPE HORIZON. Upper Chocolate Clays, sample no. 24148.

OTHER MATERIAL. 13 specimens from the Rakhi Nala section from six horizons (sample nos. 3499, 3610, 3613, 3614, 3615 and 3618). Two specimens (including holotype) from the Zao River section from two horizons (sample nos. 24148 and 24150).

FIGURED SPECIMEN. GSP EM 2586.

DERIVATION OF NAME. Latin scopus, target; in allusion to fancied resemblance of ornament to a bull's-eye.

DIAGNOSIS. A species of the genus Hermanites in which ventral ridge curves downward in the middle and is joined by a short vertical ridge at its posterior end; surface coarsely reticulate, prominent subcentral-tubercle from which a ridge runs towards anterior margin.

DESCRIPTION. Sexual dimorphy observed; the males are longer in proportion than the females. Carapace thick-shelled, sub-rectangular in lateral view. Anterior margin broadly and evenly rounded, posterior slightly subtriangular. Dorsal and ventral margins almost straight. Valves more or less equal. Anterior cardinal angle well-developed. In dorsal view, greatest width lies in the posterior third. Eye-tubercle rounded and prominent with rounded deep groove in front (better seen in dorsal view). Subcentral-tubercle prominent with a ridge running towards the anterior margin. Surface strongly reticulate (occasionally with superimposed rounded spines particularly at the junction where two reticulae meet). Dorsal and ventral ridges well-developed:
the dorsal ridge is almost straight while the ventral ridge is curved convexly downward in the middle culminating in a short vertical ridge in the posterior third. Anterior and posterior marginal rims elevated, ventral marginal rim somewhat less elevated. Anterior and posterior margins ornamented with double row of spines (not preserved in all specimens) – one row of spines lies on the anterior and posterior marginal rims and the second row below these rims. Duplicature of moderate width with subperipheral selvage. Radial pore canals and muscle scars not known. Hinge holamphidont: left valve hinge consists of two terminal sockets, median element subdivided into anteromedian subconical projecting tooth and denticulate bar; right valve hinge (seen only in a broken valve) consists of stirpate, projecting anterior tooth, deep anteromedian socket, locellate posteromedian groove and posterior tooth (broken).

**DIMENSIONS (mm.):**

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**COMPARISON.** This species shows some resemblance to *Hermanites cracens* sp. nov. (Pl. 22, figs. 11) but is smaller, has more (Pl. 23, figs.1-3) curved ventral ridge culminating into a short vertical ridge in the posterior third and lacks the three small, curved longitudinal ridges behind the subcentral-tubercle.

**REMARKS.** *Hermanites scopus* rarely occurs in the Lower and Upper Chocolate Clays of the Rakhi Nala and Zao River sections and can easily be recognised by its characteristic ventral ridge.
Hermanites palmatus sp. nov.

Plate 24, figs. 1-9, 11, 12.

HOLOTYPE. GSP BM 2587, a female left valve (Pl. 24, figs. 6, 8, 9, 11).

TYPE LOCALITY. Zao River section.

TYPE HORIZON. Upper Chocolate Clays, sample no. 24152.

OTHER MATERIAL. 9 specimens from the Rakhi Nala section from five horizons (sample nos. 3613, 3614, 3615, 3617 and 3618).
16 specimens from the Zao River section from four horizons (sample nos. 24131, 24150, 24152 and 24156).

FIGURED SPECIMENS. GSP BM 2588 - GSP BM 2590.

DERIVATION OF NAME. Latin palmatus, palmate; with reference to palmate appearance of ridges in front of subcentral-tubercle.

DIAGNOSIS. Hermanites in which dorsal and ventral ridges are alate and joined posteriorly by a transverse ridge which is slightly concave towards posterior. Subcentral-tubercle prominent with palmate appearance of ridges in front.

DESCRIPTION. Sexual dimorphism rather apparent; the females are shorter than the males. Carapace subrectangular in lateral outline with greatest height in the region of anterior cardinal angle.
Dorsal and ventral margins almost straight, anterior margin broadly rounded, posterodorsal corner very slightly concave, posterior extremity and posteroventral margin rounded. Valves almost equal. Subcentral-tubercle prominent. Eye-tubercle rounded and distinct. Surface reticulate with alate dorsal and ventral ridges which are
joined posteriorly by a transverse ridge which is slightly concave towards the posterior. Anterior and posterior marginal platforms compressed. Anterior and posterior marginal rims distinct. Anterior margin ornamented with 20-25 small spines, posterior with 6-8 larger spines. Duplicature of moderate width, 0.050mm. anteriorly. Both valves have a distinct selvage. Hinge holamphidont: left valve hinge with fairly deep anterior socket, anteromedian rounded, subconical tooth (slightly projecting towards the anterior in dorsal view), posteromedian denticulate ridge and deep, slight elongate posterior socket; right valve hinge with anterior subconical, projecting tooth followed by deep postjacent socket, posteromedian shallow groove and an almost rounded, posterior tooth.

DIMENSIONS (mm.):

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<td>Left valve female (holotype)</td>
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<tr>
<td>Left valve female</td>
<td>0.73</td>
<td>0.44</td>
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COMPARISON. **Hermanites scopus** sp. nov. (Pl.23, figs.4-10) is larger, has a curved ventral ridge and the subtriangular posterior **Hermanites indicus** Tewari and Tandon (1960, p.158, text-fig.4, figs.3a-c) has a subtriangular posterior and lacks a transverse ridge joining the dorsal and ventral ridges posteriorly. The Miocene species **Hermanites purii** Tewari and Tandon (1960, p.158, text-fig.5, figs.1a-b) has somewhat similar lateral outline, but
lacks a transverse ridge joining the dorsal and ventral ridges posteriorly and the palmate appearance of ridges in front of the subcentral-tubercle. Moreover, the greatest width in *Hermanites palmatus* is in the posterior third, but in *Hermanites purii* a little anterior to the middle (see Tewari and Tandon, p.158).

REMARKS. The true relationship of the present species with *Hermanites indicus* and *Hermanites purii* cannot be determined until topotype material from Kutch is available for comparison.
Genus OCCULTOCYHEREIS Howe 1951

TYPE SPECIES. Occultocythereis delumbata Howe 1951.

Occultocythereis interrupta sp. nov.

Plate 24, figs.10,13-18.

HOLOTYPE. GSP BM 2592, a female carapace (Pl.24, figs.14,17,18).

TYPE LOCALITY. Sor Range section.

TYPE HORIZON. Upper Palaeocene, sample no.460-i.

OTHER MATERIAL. 27 specimens from the locality above from three horizons (sample nos.460-f, 460-i and 460-j).

FIGURED SPECIMEN. GSP BM 2591.

DERIVATION OF NAME. Latin interruptus, "broken apart", from break in dorsal ridge.

DIAGNOSIS. A small Occultocythereis with a well-marked subangular posterodorsal process which is confluent with four ridges including an oblique ridge running towards posteroventral region and then extending towards anteroventral corner as an oblique ventral ridge.

DESCRIPTION. Sexual dimorphism marked; the females are shorter and wider than the males. Carapace subrectangular in side view, tapering towards the posterior. Dorsal and ventral margins almost straight; the dorsal margin appears slightly irregular in lateral outline because of the over-reaching of the dorsal ridge; anterior margin broadly and obliquely rounded, posterior narrow,
slightly concave in posterodorsal slope but more or less rounded in posteroventral margin. Greatest length lies in the middle and greatest height at anterior cardinal angle. Anterior and posterior cardinal angles well-marked particularly in right valve. Valves almost equal. Eye-tubercle distinct, lies on the anterior marginal rim. Surface undulating with compressed anterior and posterior platforms. A well-marked, subangular posterodorsal process is confluent with four ridges: a short ridge running vertically up towards the posterodorsal corner; the dorsal ridge runs towards the anterior, culminating in the anterior third of the dorsal margin - it is slightly convex upwards; a short ridge extends vertically below, terminating before reaching the mid-line; the fourth ridge runs obliquely towards posteroventral region where it is joined by an oblique ventral ridge running towards the anteroventral corner. Anteromedian swelling well-developed. A marginal rim runs on the anterior, ventral and posterior margins. It is elevated on the anterior margin but less elevated along the venter and posterior. Small ridges run between the anterior marginal rim and anterior margin (these are better seen in ventral view). Four to five short spines ornament posteroventral margin. Internal details not known.

DIMENSIONS (mm.):

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COMPARISON. *Occultocythereis indistincta* sp. nov. (Pl. 27, figs. 13-15) is much larger, has a continuous rather than broken dorsal ridge and lacks an oblique posterior ridge joining the postero-dorsal process and the ventral ridge.

REMARKS. *O. interrupta* is so far only known from the Early Eocene of the Sor Range section.

Several specimens were completely broken while being cleaned in the ultrasonic vibrator. These specimens are not included in the list of other material.

*Occultocythereis* sp.A
Plate 25, figs.1,2,5,12.

LOCALITY. Rakhi Nala section.

HORIZON. Lower Rakhi Gaj Shales, sample no.3672.

MATERIAL. Only one specimen from the locality and horizon above.

FIGURED SPECIMEN. GSP BM 2593.

DESCRIPTION. Carapace subrectangular with ventral inflation. Dorsal and ventral margins almost straight, tapering towards the posterior; anterior margin broadly and obliquely rounded, posterior narrowly rounded with a slight concavity in the posterodorsal corner. Greatest length lies in the middle, greatest height in the anterior two-fifths and greatest width in the posterior third. Anterior and posterior cardinal angles rounded. Valves almost equal. Eye-tubercle distinct but low. Subcentral-tubercle weak. Surface
reticulate. Posterodorsal process consists of a more or less rounded tubercle which extends anteriorly in a weak dorsal ridge. Anterior marginal rim well-marked, ventral and posterior marginal rims less elevated. Posterior ornamented with 4-5 short spines.

DIMENSIONS (mm.):

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REMARKS. It differs from other known species of the genus *Occultocythereis* in its obliquely rounded anterior margin.

*Occultocythereis spilota* sp. nov.

Plate 25, figs. 3, 4, 6-11.

HOLOTYPE. GSP BM 2595, a female carapace (Pl. 25, figs. 6, 7, 10, 11)

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Green and Nodular Shales, sample no. 3177.

OTHER MATERIAL. Three additional specimens from the locality above from three horizons (sample nos. 3173, 3174 and 3177).

FIGURED SPECIMEN. GSP BM 2594.

DERIVATION OF NAME. Greek spilotos, "spotted"; with reference to largish puncta.

DIAGNOSIS. A species of *Occultocythereis* in which surface is ornamented with largish puncta, posteroventral margin rounded, posteroventral process a short slightly oblique ridge well-developed in female, ill-defined in male, anteroventral swelling small.
DESCRIPTION. Dimorphic; the females are higher and wider than the males. Carapace subrectangular in lateral view with greatest length in the middle and greatest height in the anterior third. Anterior margin broadly rounded, posterodorsal slope very slightly concave, posteroventral margin rounded, dorsal and ventral margins almost straight, very slightly converging towards the posterior. Anterior cardinal angle rounded, posterior cardinal angle distinct about 110°. Valves almost equal. In dorsal view greatest width lies in the posterior third. Eye-tubercle more or less distinct. Subcentral-tubercle present but not pronounced with a small swelling below and slightly anterior to it. Surface ornamented with large puncta. Posterodorsal process is a short projecting ridge extending vertically below towards the mid-line but not reaching it. It extends anteriorly in a short dorsal ridge terminating in the anterior third of the dorsal margin. Posteroventral process is a short slightly oblique ridge lying in the posteroventral swelling. In the male dimorph the posteroventral swelling is less well-developed and the posteroventral ridge ill-defined. Anterior marginal rim prominent, ventral and posterior marginal rims less prominent. Anterior marginal area ornamented with numerous, short ridges lying between the rim and the margin. Posteroventral margin decorated with four to five short spines.

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<td>Carapace female (holotype)</td>
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COMPARISON.  Occultocythereis peristicta sp. nov. Morphotype C
(Pl. 26, figs.10-15) is larger, has a vertical rather than oblique
posteroventral ridge joining the second posterior tubercle and the
ventral ridge. Further, it lacks a dorsal ridge and the short
ridges between the anterior rim and the anterior margin.

Occultocythereis peristicta sp. nov.
Plate 25, figs.13-17; Plate 26;
Plate 27, figs.1-12.

HOLOTYPE.  GSP BM 2596, a female carapace (Pl. 25, figs.15,1G.
(Pl.26, figs.2,3)

TYPE LOCALITY.  Rakhi Nala section.

TYPE HORIZON.  Upper Rakhi Gaj Shales, sample no.3167.

OTHER MATERIAL.  Approximately 800 specimens from the Rakhi Nala
section from 42 horizons (sample nos.3160, 3163, 3167, 3170, 3171,
3173, 3174, 3177, 3179, 3180, 3186, 3187, 3188, 3189, 3190, 3191,
3192, 3193, 3194, 3197, 3198, 3199, 3200, 3401, 3402, 3403, 3404,
3405, 3407, 3409, 3410, 3415, 3418, 3419, 3420, 3421, 3422, 3423,
3428, 3432, 3434 and 3435).

FIGURED SPECIMENS.  GSP BM 2597 - GSP BM 2605.

DERIVATION OF NAME.  Greek peristiktos, "punctate or dappled".

DIAGNOSIS.  A punctate group of morphotypes of the genus Occulto-
cythereis without a dorsal ridge, ventral ridge well-marked,
anteromedian swelling distinct, posterodorsal tubercle present.

DESCRIPTION.  Sexual dimorphism rather pronounced, the males are
longer in proportion than the females.  Carapace subrectangular
or wedge-shaped in lateral outline. Dorsal and ventral margins almost straight, tapering towards the posterior, anterior margin broadly and evenly rounded, posterior narrow, slightly subangular in the middle or almost rounded. Greatest length passes through the middle, greatest height lies at the anterior cardinal angle which is fairly well-developed. Left valve slightly over-reaches right valve at anterior cardinal angle and in the region of posterodorsal slope. Eye-tubercle rounded and distinct, lying on the anterior marginal rim. Subcentral or anteromedian swelling distinct. It is either elongate or almost rounded (elongate in most morphotypes). There is no dorsal ridge. Ventral ridge fairly well-developed, short in most morphotypes. It is either almost straight or runs slightly obliquely towards the posterior where it may be connected to the second posterior tubercle or to the posterodorsal tubercle by means of a short vertical ridge. A dorsal ridge runs between the second posterior tubercle and the anteromedianswelling in some morphotypes. Anterior marginal rim high, ventral marginal rim less distinct, posterior marginal rim distinct. Short spines decorate anterior and posterior margins.

Trends of variants:-

1. Become sparsely punctate.

2. Gain second posterior tubercle, which may join either posterodorsal tubercle or ventral ridge.

REMARKS. *O. peristicta* commonly occurs in the Upper Rakhi Gaj Shales, Green and Nodular Shales and Rubbly Limestones of the Rakhi Nala section.

This species may be divided into the following morphotypes:

**Morphotype A**

(Pl. 25, figs. 13-17)
(Pl. 26, figs. 1-3)

This has a well-delimited vertical posterodorsal tubercle. There is no second posterior tubercle. The anteromedian swelling is less well-developed. The ventral ridge is almost straight, short, confined in the mid-ventral region. The surface is densely punctate.

**DIMENSIONS (mm.):**

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<tbody>
<tr>
<td>M 2597</td>
<td>0.43</td>
<td>0.22</td>
<td>0.11</td>
</tr>
<tr>
<td>M 2596</td>
<td>0.42</td>
<td>0.23</td>
<td>0.16</td>
</tr>
</tbody>
</table>

**Morphotype B**

(Pl. 26, figs. 4-9)

This is close to Morphotype A but has a more sparsely punctate surface and a second posterior tubercle. In addition, the present morphotype has a well-developed, somewhat elongate anteromedian swelling.

**DIMENSIONS (mm.):**

<table>
<thead>
<tr>
<th>Carapace</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 2598</td>
<td>0.44</td>
<td>0.22</td>
<td>0.15</td>
</tr>
<tr>
<td>M 2599</td>
<td>0.40</td>
<td>0.22</td>
<td>0.16</td>
</tr>
</tbody>
</table>
Morphotype C
(Pl. 26, figs.10-15)

This has a higher carapace than the other morphotypes. The ventral ridge runs slightly obliquely towards the posterior. It is joined posteriorly to the second posterior tubercle by a short vertical ridge. The anteromedian swelling and the second posterior tubercle form a broken diagonal ridge.

DIMENSIONS (mm.): 

<table>
<thead>
<tr>
<th></th>
<th>L</th>
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<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2600</td>
<td>0.45</td>
<td>0.26</td>
<td>0.17</td>
</tr>
<tr>
<td>GSP BM 2601</td>
<td>0.44</td>
<td>0.25</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Morphotype D
(Pl. 27, figs.1-6)

The carapace is much more elongate than Morphotype A, B, C and E. The dorsal and ventral margins taper very slightly towards the posterior. An oblique posterior ridge joins the posterodorsal tubercle, the second posterior tubercle and the posterior end of the ventral ridge. The ventral ridge commences above the anteroventral corner, slopes obliquely upwards towards the posterior and meets the oblique posterior ridge in the posterior quarter. A diagonal ridge which may or may not be continuous passes through the second posterior tubercle and the anteromedian swelling.

DIMENSIONS (mm.): 

<table>
<thead>
<tr>
<th></th>
<th>L</th>
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<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2602</td>
<td>0.51</td>
<td>0.24</td>
<td>0.16</td>
</tr>
<tr>
<td>GSP BM 2603</td>
<td>0.51</td>
<td>0.24</td>
<td>0.17</td>
</tr>
</tbody>
</table>
Morphotype E
(Pl. 27, figs.7-12)

This is very similar to Morphotype B, but has a wedge-shaped carapace.

**DIMENSIONS (mm.):**

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 2604 Carapace male</td>
<td>0.39</td>
<td>0.20</td>
<td>0.13</td>
</tr>
<tr>
<td>GSP BM 2605 Carapace female</td>
<td>0.37</td>
<td>0.20</td>
<td>0.13</td>
</tr>
</tbody>
</table>

**Occultocythereis indistincta** sp. nov.
Plate 27, figs.13-15; Plate 28, figs.1-4.

**HOLOTYPE.** GSP BM 3003, a female carapace (Pl. 27, figs. 15).
(Pl. 28, figs.1,3,4)

**TYPE LOCALITY.** Rakhi Nala section.

**TYPE HORIZON.** Lower Chocolate Clays, sample no.3499.

**OTHER MATERIAL.** 43 specimens from the locality above from seven horizons (sample nos.3499, 3614, 3615, 3621, 3625, 3648 and 3649).

**FIGURED SPECIMENS.** GSP BM 3001 - GSP BM 3002.

**DERIVATION OF NAME.** Latin indistinctus, "dim or obscure"; named from absence of well-marked diagnostic characters.

**DIAGNOSIS.** A species of the genus *Occultocythereis* with a well-developed dorsal ridge ending posteriorly in a large subangular posterodorsal process, ventral ridge oblique running from antero-ventral corner towards posterior, surface ornament consists of indistinct puncta.
DESCRIPTION. Sexual dimorphism apparent; the males are more elongate, less high and less wide than the females. Carapace subrectangular, slightly tapering towards the posterior. Dorsal margin straight but appears irregular in side view due to the over-reaching of the dorsal ridge, ventral margin almost straight, anterior margin broadly and evenly rounded, posterior narrow, sub-angular in the middle with slightly concave posterodorsal slope. Greatest length lies in the middle, greatest height in the anterior third. Anterior cardinal angle well-developed particularly in left valve, posterior cardinal angle rounded in right valve but pointed in left valve. Left valve over-reaches right valve in the region of anterior cardinal angle and posterodorsal slope. Eye-tubercle distinct. Surface ornamented with small, indistinct puncta. Anteromedian swelling (which perhaps represents a sub-central-tubercle) distinct. A well-marked dorsal ridge commences behind the eye-tubercle and is slightly convex upward in the middle terminating in a large subangular posterodorsal process. In most specimens it is ornamented with three small tubercles which lie at some distance from one another. Ventral ridge runs obliquely from the anteroventral corner towards the posterior, culminating in the posterior third. (In some specimens it is not well-developed.) A small tubercle is present in the posteromedian part of the carapace (halfway between the dorsal and ventral ridges) in a few specimens. A high marginal rim runs round the anterior extending along the venter and posterior as a less high rim. Anterior and posterior margins ornamented with short spines. Duplicature wide
in anterior and posteroventral regions. Selvage distinct and lies at some distance from the outer margin. Radial pore-canals and muscle scars not determinable. Hinge as for the genus.

COMPARISON. Occultocythereis mutabalis abducta (Triebel 1961, p.209, pl.2, figs.6-13) is very similar, but is larger, has a different posterior, less well-developed subcentral-swelling and posterodorsal tubercle. Occultocythereis mutabalis mutabalis (Triebel 1961, p.208, pl.1, figs.1-5) has a vertical posteroventral ridge in the right valve of the male and in both valves of the female.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3001 Right valve male</td>
<td>0.47</td>
<td>0.24</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3002 Carapace male</td>
<td>0.43</td>
<td>0.22</td>
<td>0.13</td>
</tr>
<tr>
<td>GSP BM 3003 Carapace female (holotype)</td>
<td>0.43</td>
<td>0.24</td>
<td>0.16</td>
</tr>
</tbody>
</table>

REMARKS. O. indistincta has so far been found in the Lower and Upper Chocolate Clays of the Rakhi Nala section.
Genus PATAGONACYTHERE Hartmann 1962

TYPE SPECIES. *Patagonacythere tricostata* Hartmann 1962.

REMARKS. The species here assigned to *Patagonacythere* differs in details of muscle scar pattern both from the type species described by Hartmann and from the two species described by Benson (1964) from the Antarctic. In common with the described species it shows the three longitudinal ridges in which a characteristic posterodorsal loop joins the upper two.

*Patagonacythere?nidulus* sp. nov.

Plate 28, figs. 5-12.
Plate 29, figs. 1-4.

HOLOTYPE. GSP BM 3005, a female carapace (Pl. 28, figs. 9-12).

TYPE LOCALITY. Zao River section.

TYPE HORIZON. Upper Chocolate Clays, sample no. 24173.

OTHER MATERIAL. Over 400 specimens from the Zao River section from 16 horizons (sample nos. 24155, 24156, 24157, 24159, 24166, 24170, 24173, 24175, 24176, 24177, 24178, 24180, 24183, 24185, 24187 and 24193). Approximately 60 specimens from the Rakhi Nala section from 13 horizons (sample nos. 3624, 3625, 3628, 3631, 3634, 3640, 3641, 3642, 3645, 3646, 3649, 3658 and 3662).

FIGURED SPECIMENS. GSP BM 3004, GSP BM 3006 - GSP BM 3008.

DERIVATION OF NAME. Latin nidulus, small bird's nest; with reference to reticulate complex of subcentral node.
DIAGNOSIS. Highly reticulate *Patagonacythere* in which ventral ridge culminates abruptly in posterior third, subcentral-tubercle prominent.

DESCRIPTION. Carapace subrectangular in side view with dorsal and ventral margins almost straight, subparallel; anterior broadly rounded, posterodorsal margin very slightly concave (particularly in right valve), posterior extremity and posteroventral margin rounded. Anterior cardinal angle well-developed in both valves, posterior cardinal angle in left valve obtuse and well-marked but in right valve it is not very well-developed. Left valve over-reaches right valve slightly at anterior cardinal angle and posterodorsal slope, otherwise the two valves are equal. In dorsal view greatest width at subcentral-tubercle; posterior third with a sulcus in between. Eye-tubercle rounded, polished and distinct; subcentral-tubercle prominent, composed of reticulate complex. Surface strongly reticulate with three longitudinal ridges: the ventral ridge slopes obliquely upward towards posterior, ending abruptly just before reaching the compressed posterior platform; the median ridge springs from the subcentral node, stretching backward to join the ventral ridge and forms a posterodorsal loop. (In some specimens at certain horizons longitudinal ridges are not well-developed.) A marginal rim runs round anterior, venter and posterior - it is high on anterior. Anterior margin ornamented with approximately 20 small spines, posterior with 6-8 spines. Normal pore canals fairly numerous. (These become exaggerated in specimens cleaned in ultrasonic vibrator.) Radial pore canals simple, nearly straight,
irregularly spaced; few cross one another. There are approximately 40 radial pore canals in anterior and about 20 in posterior. Inner margin and line of concrescence coincide. Duplicature of moderate width (0.073 mm. at anterior, 0.061 mm. at posterior extremity).

Selvage prominent, submarginal in left valve, at some distance in right valve. Flange groove well-developed (particularly in right valve) on venter and anterior. Adductor muscle scars are in a vertical column of four elongate scars, the second from the top being longest and the bottom one shortest. There are two frontal scars, the top one is smaller and almost rounded, but the bottom one is ovate. Hinge holamphidont:

<table>
<thead>
<tr>
<th>Hinge element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Deep socket bounded on venter, confluent with ocular sinus.</td>
<td>Strongly projecting slightly stirpate tooth with a concavity on anterior in dorsal view. Ocular sinus opens below and slightly anterior to it.</td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Conical tooth with straight anterior and convex posterior in dorsal outline.</td>
<td>Deep rounded socket.</td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Denticulate bar.</td>
<td>Locellate groove.</td>
</tr>
</tbody>
</table>

Continued......
Hinge element  Left valve  Right valve
Posterior  Deep socket bounded on  Tooth which in dorsal view
           venter.  appears pessular but in
                           reality is semicircular or
                           slightly trilobate. In
oblique view it can be seen
that line of concrescence
deviates in the neighbourhood
of posterior tooth so that
only the outside of the semi-
circular tooth is bilamellar
and thus enclosing a mono-
lamellar core formed by the
invagination of the line of
concrescence.

DIMENSIONS (mm.).

<table>
<thead>
<tr>
<th></th>
<th>L</th>
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<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3004 Carapace male</td>
<td>0.80</td>
<td>0.44</td>
<td>0.41</td>
</tr>
<tr>
<td>GSP BM 3005 Carapace female (holotype)</td>
<td>0.74</td>
<td>0.44</td>
<td>0.39</td>
</tr>
<tr>
<td>GSP BM 3006 Left valve female</td>
<td>0.75</td>
<td>0.45</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3007 Right valve female</td>
<td>0.76</td>
<td>0.44</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3008 Right valve male</td>
<td>0.80</td>
<td>0.45</td>
<td>-</td>
</tr>
</tbody>
</table>

COMPARISON. The presence of a reduced ventral ridge, which does not reach the posterior marginal rim, separates this species from

*Patagonacythere tricostata* Hartmann, *Patagonacythere deveixa* (Muller)
and Patagonacythere longiducta antarctica Benson. Patagonacythere tricostata Hartmann (1962, p.250, figs.200-204) has a smaller and more elongate carapace and three rather than two frontal scars. Patagonacythere devexa (Muller) Benson (1964, p.27, pl.2, fig.11; pl.3, figs.4,5,7-11, text-figs.18-20) is larger, has narrow anterior and posterior vestibules, split adductor scars and ill-defined median and dorsal ridges including the posterodorsal loop. (Comparative material of this species from the British Antarctic region was obtained through the courtesy of Dr. R. C. Whatley of Aberystwyth.) Patagonacythere longiducta antarctica Benson (1964, p.30, pl.2, figs.7-9; text-figs.21-22) is about the same size, has a more concave posterodorsal slope and the two median adductor scars are split.

REMARKS. The present species commonly occurs in the Zao River and Rakhi Nala sections. It is abundant in certain horizons in the Zao River section. It has a short vertical range in the two sections and is thus a very useful species for correlation in this region.
Genus PHAI\_OCYTHERE nov.

TYPE SPECIES. Cythere horrescens Bosquet 1852.

DERIVATION OF NAME. Greek φάλχης phalkes, beam or rib of a ship; with reference to ventral ridge.

DIAGNOSIS. Reticulate Trachyleberididae with a ventral ridge; with or without spines or papillae; mostly with pronounced postero-dorsal process.

DESCRIPTION. Sexual dimorphism present in most of the species. Carapace subrectangular to subquadrate in lateral outline. Anterior margin broadly rounded, posterodorsal margin very slightly concave, posterodorsal margin either curved or almost straight, dorsal margin almost straight or slightly convex (but appears irregular in lateral outline in many species due to surface ornament), ventral margin slightly concave in front of the middle or nearly straight (over-reached by a ventral ridge in lateral view in some species). Valves almost equal or right valve over-reaches left valve in anterior margin. Subcentral-tubercle more or less well-developed. Eyetubercle distinct, standing out in some. Surface reticulate with or without superimposed papillae or spines; or papillose or spinose. A posterodorsal process is generally present. A ventral ridge more or less prominent is always present; it is either straight or slightly curved convexly downward in the middle culminating in the posterior fourth usually in a spine or an ala. Anterior and posterior marginal rims always present, more or less distinct.
Radial pore canals simple, almost straight, irregularly spaced, sometimes crossing one another, fairly numerous (approximately 30 anteriorly in the type species). Line of concrescence and inner margin coincide. Duplicature fairly wide. Selvage more or less pronounced, submarginal in left valve but at some distance in right valve. Right valve with a deep and well-developed anterior and ventral flange groove. Adductor scars in a vertical column of four elongate scars with two almost rounded frontal scars (see description of P. horrescens). Hinge holamphidont.

COMPARISON. Hirsutocythere Howe 1951 has a wider duplicature and lacks a ventral ridge. Australicythere Benson 1964 is much larger, has fine pittings within the reticulae and the two median adductors split into two. Moreover, Australicythere has a posterior vertical ridge and a less prominent ventral ridge not ending in a spine posteriorly.

REMARKS. This genus is so far known from the Eocene of the Paris Basin, West Pakistan, Tanganyika and an undescribed species from the Aquitaine Basin.

Phalcocythere horrescens gm. nov. (Bosquet) 1852

Plate 29, figs. 5; Plate 30, figs. 1-6; Plate 33, figs. 12, 13.

Cythere horrescens Bosquet, p. 119, pl. 6, fig. 5.

Cythere thierensiana Bosquet (pars), p. 98.

Cythere nebulosa Bosquet, p. 105, pl. 5, fig. 8.
1955  **Trachyleberis horrescens** (Bosquet), Apostolescu, p.272, pl.8, figs.125-126.

1957  **Hirsutocythere horrescens** (Bosquet), Keij, p.101, pl.15, fig.4; pl.17, figs.6-7.

**TYPE LOCALITY.** Grignon, Paris Basin.

**TYPE HORIZON.** Lutetian.

**MATERIAL.** 8 specimens from Grignon, Paris Basin, from the Lutetian IV (sample no.CAB 1002, Keij 1957, p.19). 5 specimens from Villiers-St.-Frederic, Paris Basin, from the same horizon.

**FIGURED SPECIMENS.** GSP BM 3009 - GSP BM 3011, GSP BM 3081, GSP BM 3082.

**DIAGNOSIS.** Phalcocrythere in which posteroventral margin is straight in left valve but curved in the right and ornamented with five or six large spines, the whole surface ornamented with well-developed spines superimposed on reticulations; ventral ridge and posterodorsal process well-marked.

**DESCRIPTION.** Sexual dimorphy has not been observed. Carapace subrectangular in lateral view. Dorsal margin straight but appears to be irregular in lateral outline due to ornament; ventral margin over-reached by ventral ridge; anterior margin broadly rounded; posterior different in opposite valves. In right valve postero-dorsal slope slightly concave, posteroventral margin straight (better seen in specimens with worn off marginal spines). In left valve posterodorsal margin very slightly concave, posteroventral margin more or less rounded. Greatest length passes through mid-point,
greatest height at anterior cardinal angle and greatest width in posterior third. In right valve anterior and posterior cardinal angles almost rounded. In left valve anterior cardinal angle variable - rounded in some but protruding in others; posterior cardinal angle well-developed and armed with one or two spines. Eye-tubercle distinct, polished and rounded and lies below and slightly posterior to cardinal angle. Subcentral-tubercle distinct. Anterior and posterior marginal rims more or less distinct. The entire shell surface, including subcentral-tubercle and marginal rims, ornamented with well-developed spines superimposed on reticulations. The spines vary in size. A well-developed blade-like posterodorsal process present. The ventral ridge is prominent and culminates in posterior third with a pointed end. Anterior margin decorated with some 25 short spines, posteroventral margin with 5-6 larger spines. Radial pore canals not very well displayed in the specimens examined but they appear to be simple, more or less straight, approximately 30 anteriorly. Line of concrescence and inner margin coincide. Duplicature wide. Selvage strong, submarginal in left valve but in the outer two-fifths of the duplicature in right valve. There is a deep flange groove on anterior and venter in right valve. Adductor scars are in an almost vertical column of four, the second from the bottom is slightly convex upwards. Frontal scars have not been clearly seen in the material available for study but Keij (1957 p.102, pl.15, fig.4) observed two rounded frontal scars.

Continued........
Hinge holamphidont:

<table>
<thead>
<tr>
<th>Element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Deep rounded socket bounded on all sides with ocular sinus opening into it and below and slightly anterior to it.</td>
<td>Conical projecting tooth. Ocular sinus situated below and just anterior to it.</td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Conical tooth.</td>
<td>Deep socket.</td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Denticulate bar.</td>
<td>Locellate groove connecting anteromedian socket and posterior tooth, narrow at the posterior end.</td>
</tr>
<tr>
<td>Posterior</td>
<td>Socket slightly elongate, open on venter.</td>
<td>Tooth, subpessular in dorsal view with the anterior side lower than the posterior.</td>
</tr>
</tbody>
</table>

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3009 Left valve</td>
<td>0.60</td>
<td>0.33</td>
</tr>
<tr>
<td>GSP BM 3010 Left valve</td>
<td>0.59</td>
<td>0.33</td>
</tr>
<tr>
<td>GSP BM 3021 Left valve</td>
<td>0.72</td>
<td>0.37</td>
</tr>
<tr>
<td>GSP BM 3011 Right valve</td>
<td>0.59</td>
<td>0.33</td>
</tr>
<tr>
<td>GSP BM 3022 Right valve</td>
<td>0.63</td>
<td>0.37</td>
</tr>
</tbody>
</table>

COMPARISON. This species shows some affinity to *Phalcocythere retispinata* sp. nov. (Pl. 31, figs. 13-17) but has a more spinose surface, less tapering carapace and a better developed subcentral-tubercle. Further, *P. horrescens* has a straight posteroventral margin in the right valve, different posterodorsal process and less prominent eye-tubercle which lies below and slightly posterior to the anterior cardinal angle.
REMARKS. The present species has been redescribed by Keij (1957) in detail. Although he ascribed it to the genus *Hirsutocythere*, he noted that it lacks the very wide duplicature of that genus. He remarked, "This species is assigned to the genus *Hirsutocythere* Howe. Outline, ornamentation and hinge pattern are in full agreement with the description given by Howe. The marginal area, however, is not so extremely broad as with *Hirsutocythere hornotina* Howe (Florida Geol. Surv., Geol. Bull., no.34, 1951, p.22, pl.4, figs.3,6,9,12). Howe gave no details about the muscle scar."

Adult specimens vary in size. According to Apostolescu (1955, p.272), they range from 0.32mm. to 0.70mm. in length.

*Phalcocythere improcera* sp. nov.

Plate 30, figs.7-12.
Plate 31, figs.1-4

HOLOTYPE. GSP EM 3012, a male carapace (Pl. 31, figs. 1,2 ).
(Pl. 30, figs.8,9)

TYPE LOCALITY. Sor Range section.

TYPE HORIZON. Upper Palaeocene, sample no.460-i.

OTHER MATERIAL. 67 specimens from the Sor Range section from four horizons (sample nos.460-i, 460-j, 460-l and 460-n).

FIGURED SPECIMENS. GSP EM 3013 - GSP EM 3015.

DERIVATION OF NAME. Latin improcrerus, short; with reference to carapace.

DIAGNOSIS. A small *Phalcocythere* in which ventral ridge is prominent and with alar expansion, posteroventral margin slightly protracted towards the venter, subcentral-tubercle prominent.
DESCRIPTION. Carapace subrectangular in the male dimorph and subquadrate in the female. Sexual dimorphism is rather marked; the males are longer in proportion than the females. Anterior margin broadly rounded, posterodorsal margin very slightly concave, postero-ventral margin rounded and slightly protracted towards the venter. Dorsal margin straight but appears irregular in lateral view because of surface ornamentation; ventral margin nearly straight (concealed in side view by ventral ridge). Anterior and posterior cardinal angles well-developed in right valve but more or less rounded in left valve. Right valve slightly over-reaches the left in the anterior margin but left valve over-reaches the right in the region of posterodorsal slope. Subcentral-tubercle prominent. Eye-tubercle distinct, rounded and glassy. Surface deeply reticulate with superimposed papillae or spines. A prominent ventral ridge (over-reaching the ventral margin in lateral view) with alar expansion present. This ridge is slightly curved convexly downward in the middle and the surface ornament extends up to it. The posterodorsal process is variable - it is a short curved horn-like ridge in specimens with papillose ornament but specimens with spinose surface have a projecting and blade-like posterodorsal process. Anterior and posterior marginal rims distinct. Anterior margin finely denticulate with 20-22 denticles, posteroventral margin with 7-8 short spines. Normal pore canals fairly numerous and presumably each reticule has one normal pore canal. (These become exaggerated in specimens cleaned in the ultrasonic vibrator.) Radial pore
canals not very well preserved but appear to be simple, more or less straight, irregularly spaced, some crossing one another, approximately 35 anteriorly. Line of concrescence and inner margin coincide. 

Duplicature moderately wide. Selvage prominent - it is submarginal in left valve but in the outer two-fifths of the duplicature in right valve which also has a deep and well marked anterior and ventral flange groove. Hinge not clearly seen but appears to be holamphidont.

DIMENSIONS (mm.):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
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<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3012</td>
<td>Carapace male (holotype)</td>
<td>0.49</td>
<td>0.29</td>
</tr>
<tr>
<td>GSP BM 3013</td>
<td>Carapace female</td>
<td>0.49</td>
<td>0.30</td>
</tr>
<tr>
<td>GSP BM 3014</td>
<td>Left valve female</td>
<td>0.46</td>
<td>0.28</td>
</tr>
<tr>
<td>GSP BM 3015</td>
<td>Right valve female</td>
<td>0.46</td>
<td>0.27</td>
</tr>
</tbody>
</table>

COMPARISON. Distinguished from the other known species of the genus Phalcocythere by its small size and the posteroventral margin slightly drawn out towards the venter particularly in the right valve.

REMARKS. The surface ornament is variable. Most of the specimens examined have a combination of reticulations and papillae but in a few specimens spines are superimposed on reticulations.

Phalcocythere rete sp. nov.

Plate 31, figs.5-12.

HOLOTYPE. GSP BM 3019, a female right valve (Pl.31, figs.11).

TYPE LOCALITY. Sor Range section.
TYPE HORIZON. Upper Palaeocene, sample no.460-i.

OTHER MATERIAL. 13 specimens including the holotype from the Sor Range section from one horizon (sample no.460-i).

FIGURED SPECIMENS. GSP BM 3016 - GSP BM 3018.

DERIVATION OF NAME. Latin rete, net; with reference to ornament.

DIAGNOSIS. Reticulate Phalcocythere in which eye-tubercle is prominent, ventral ridge present but not prominent, dorsal margin slightly convex particularly in female.

DESCRIPTION. Sexual dimorphy rather strong; the males are longer, less high and less wide than the females. Carapace subrectangular to subquadrate in lateral view with a slight taper towards the posterior. Dorsal margin slightly convex particularly in the female, ventral margin almost straight, anterior broadly and evenly rounded, posterodorsal slope very slightly concave, posteroventral margin rounded. Left valve slightly over-reaches the right at the anterior margin. Subcentral-tubercle distinct, eye-tubercle prominent, rounded and polished. Surface reticulate, the reticulae are slightly papillose. The ventral ridge present but not prominent. It slopes obliquely upward towards the posterior and culminates in the posterior third. Marginal rim distinct. Anterior and posterior margins denticulate. Radial pore canals simple, straight, slightly thicker on the proximal end, irregularly spaced, about 30 anteriorly. Inner margin and line of concrescence coincide. Duplicature fairly wide, 0.060mm. anteroventrally. Selvage well-developed -
submarginal in left valve but almost in the middle in right valve. There is a deep anterior and ventral groove in right valve. Hinge not clearly distinguished due to mineralization but presumably holamphidont.

DIMENSIONS (mm.):

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<tr>
<td>GSP EM 3016</td>
<td>0.65</td>
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<td>GSP EM 3018</td>
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<td></td>
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<tr>
<td>GSP EM 3019</td>
<td>0.46</td>
<td>0.35</td>
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</table>

COMPARISON. Phalcocythere retispinata sp. nov. (Pl. 31, figs. 13-17) (Pl. 32, figs. 1-3) is a closely related species but has a reticulate and spinose surface, more elevated ventral ridge and a well-developed posterodorsal process.

Phalcocythere retispinata sp. nov.

Plate 31, figs. 13-17
Plate 32, figs. 1-3.

HOLOTYPE. GSP EM 3021, a female carapace (Pl. 31, figs. 15, 16). (Pl. 32, figs. 2, 3)

TYPE LOCALITY. Sor Range section.

TYPE HORIZON. Upper Palaeocene, sample no. 460-i.

OTHER MATERIAL. 5 additional specimens from the above locality from three horizons (sample nos. 460-i, 460-j and 460-o).

FIGURED SPECIMEN. GSP EM 3020.

DERIVATION OF NAME. Latin rete, "net" + spinatus, "spined".
DIAGNOSIS. Phalcocystere with a prominent ventral ridge with alar expansion, surface ornament combination of reticulations and spines, subcentral-tubercle present but not pronounced, eye-tubercle more or less prominent, posterodorsal process usually well-marked.

DESCRIPTION. Sexual dimorphism rather pronounced; the females are higher and wider than the males. Carapace tapering towards the posterior, subrectangular in side view. Dorsal margin nearly straight in the male dimorph but very slightly convex in the female (appears to be irregular in dorsal view due to ornament); ventral margin almost straight but concealed by the ventral ridge in side view; anterior broadly rounded, posterodorsal margin very slightly concave; posteroventral margin rounded. Greatest length lies below mid-point, greatest height in the anterior third. Anterior and posterior cardinal angles well-developed. Right valve very slightly over-reaches the left at the anterior margin. Subcentral-tubercle present but not pronounced. Eye-tubercle more or less prominent, rounded and polished. Ornament consists of reticulations and spines. The spines are of variable size. A posterodorsal process consists usually of a large spine, which stands out in lateral view. The ventral ridge is high and with alar expansion, slightly concave in the middle culminating in the posterior third with a pointed end. Anterior and posterior marginal rims more or less distinct and decorated with a row of spines. Anterior and posterior margins denticulate. Internal characters not seen.
DIMENSIONS (mm):

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<tbody>
<tr>
<td>GSP BM 3020 Carapace male</td>
<td>0.64</td>
<td>0.37</td>
<td>0.27</td>
</tr>
<tr>
<td>GSP BM 3021 Carapace female (holotype)</td>
<td>0.64</td>
<td>0.39</td>
<td>0.32</td>
</tr>
</tbody>
</table>

COMPARISON. Phalcocythere improcera sp. nov. (Pl.30, figs.7-12) (Pl.31, figs.1-4) is much smaller, has deeper reticulations and a posteroventral margin slightly drawn out towards the venter.

Phalcocythere sentosa sp. nov.
Plate 32, figs.4-10.

HOLOTYPE. GSP BM 3022, a male carapace (Pl. 32, figs.4,5,8,10).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Upper Rakhi Gaj Shales, sample no.3167.

OTHER MATERIAL. 68 specimens from the Rakhi Nala section from 11 horizons (sample nos.3153, 3165, 3167, 3169, 3170, 3173, 3174, 3175, 3176, 3177 and 3180).

FIGURED SPECIMEN. GSP BM 3023.

DERIVATION OF NAME. Latin sentosus, "rough".

DIAGNOSIS. A species of the genus Phalcocythere in which ventral ridge is present but not high; surface ornament consists of combination of reticulations and papillae; posterodorsal process a small tubercle or short spine. Subcentral-tubercle distinct, eyetubercle prominent.
DESCRIPTION. Strongly dimorphic, the females are less elongate than the males. Carapace subrectangular in lateral view. Anterior broadly rounded, posterodorsal slope very slightly concave, posteroventral margin rounded, dorsal margin almost straight, appearing irregular in lateral view, ventral margin slightly concave anterior to the middle. Right valve slightly over-reaches left valve in anterior margin but is over-reached by the latter in the region of posterodorsal slope. Anterior and posterior cardinal angles welldeveloped, particularly in right valve. Eye-tubercle rounded and prominent, projecting out from eye-socket. Subcentral-tubercle distinct. Surface reticulate with superimposed papillae, posterodorsal process consists of a small more or less rounded tubercle or short spines; ventral ridge present but not elevated. Anterior and posterior marginal rims distinct. Anterior margin denticulate, posteroventral margin papillose. Internal details not observed.

DIMENSIONS (mm.):

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<tr>
<td>GSP EM 3022 Carapace male (holotype)</td>
<td>0.56</td>
<td>0.32</td>
<td>0.25</td>
</tr>
<tr>
<td>GSP EM 3023 Carapace female</td>
<td>0.55</td>
<td>0.32</td>
<td>0.29</td>
</tr>
</tbody>
</table>

COMPARISON. *Phalcocythere rete* sp. nov. (Pl. 31, figs.5-12) is larger, has less papillose surface and slightly convex dorsal margin in the female.

REMARKS. So far only known from the Rakhi Nala section. The posterodorsal process varies; in some specimens it is almost a rounded tubercle but in others it is a short spine.
Phalcocythere dissenta sp. nov.

Plate 32, figs.11-18

HOLOTYPE. GSP BM 3024, a male carapace (Pl. 32, figs.11-14, 18).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Shales with Alabaster, sample no. 3456.

OTHER MATERIAL. Approximately 400 specimens from the locality above from six horizons (sample nos. 3454, 3456, 3460, 3461, 3462 and 3464) and 6 specimens from the Zao River section from one horizon (sample no. 24107).

FIGURED SPECIMEN. GSP BM 3025.

DERIVATION OF NAME. Latin dis, "not" + sentus, "spiny".

DIAGNOSIS. A reticulate species of the genus Phalcocythere with dorsal and ventral margins sub-parallel, anterior rim ornamented like a scallop or flute, subcentral-tubercle prominent, eye-tubercle and ventral ridge distinct.

DESCRIPTION. Sexual dimorphism marked, the presumed males are more elongate, less high and less wide than females. Carapace sub-rectangular in lateral outline with sub-parallel dorsal and ventral margins. Anterior margin broadly rounded; posterodorsal slope more or less straight; posteroventral margin rounded; dorsal margin slightly convex particularly in female; ventral margin almost straight, although partly hidden by ventral ridge in lateral view. Greatest length passes through mid-point, greatest height in anterior
third and greatest width in anterior two-fifths. Anterior and posterior cardinal angles protruding. Valves almost equal. Subcentral-tubercle prominent, eye-tubercle distinct and lies below the cardinal angle. Anterior marginal rim distinct, and ornamented with seven very short ridges with small depressions in between (like flute or scallops), posterior rim more or less distinct. Surface reticulate with a distinct ventral ridge which slopes obliquely upwards towards the posterior ending in the posterior third. In many specimens the posterior ending is pointed or spinose. Internal details not determinable because all the specimens recovered are complete carapaces.

**DIMENSIONS (mm.):**

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<tr>
<td>GSP BM 3024 Carapace male (holotype)</td>
<td>0.60</td>
<td>0.44</td>
<td>0.32</td>
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<tr>
<td>GSP BM 3025 Carapace female</td>
<td>0.56</td>
<td>0.44</td>
<td>0.44</td>
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</table>

**COMPARISON.** This species shows some resemblance to *Phalcocythere reta* sp. nov. (Pl. 31, figs. 5-12) but is smaller and has sub-parallel rather than tapering dorsal and ventral margins. It differs from *Phalcocythere improcera* sp. nov. (Pl. 30, figs. 7-12) (Pl. 31, figs. 1-4) and *Phalcocythere sentosa* sp. nov. (Pl. 32, figs. 4-10) in shape and surface ornament.

**REMARKS.** *P. dissenta* seems to be restricted to the Shales with Alabaster only and has been found in the Rakhi Nala and Zao River sections. It is abundant in the Rakhi Nala section but rare in the Zao River area.
Phalcocythere spinosa sp. nov.

Plate 33, figs.1,2,7,8.

HOLOTYPE. GSP BM 3026, a carapace.

TYPE LOCALITY. Zao River section.

TYPE HORIZON. Upper Chocolate Clays, sample no.24161.

OTHER MATERIAL. 15 specimens from the Zao River section from one horizon (sample no.24161).

DERIVATION OF NAME. Latin spinosus, spiny.

DIAGNOSIS. A species belonging to the genus Phalcocythere with short spines and/or papillae superimposed on reticulations; ventral ridge distinct and terminating in a spine in posterior third; posterodorsal process well-marked and blade-like.

DESCRIPTION. Carapace subrectangular in side view. Dorsal margin almost straight, appearing to be irregular in lateral view due to ornament; ventral margin more or less straight but hidden by ventral ridge in side view; anterior margin broadly rounded; posterodorsal margin slightly concave; posteroventral margin rounded. Greatest length lies in the middle and is greatest at anterior cardinal angle. Valves nearly equal. Subcentral-tubercle well-developed, eye-tubercle rounded, distinct and lies below the anterior cardinal angle. Surface ornament consists of short spines and/or papillae superimposed on reticulations. A distinct ventral ridge, diagnostic of the genus, is present, and over-reaches ventral margin in lateral view and is spinose posteriorly. It commences above the anteroventral corner.
and culminates in posterior third. The posterodorsal process is projecting and blade-like (present in most specimens). Anterior and posterior marginal rims distinct. Anterior margin finely denticulate, posteroventral margin ornamented with 6-7 short spines or papillae. Internal features not seen.

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<tbody>
<tr>
<td>GSP EM 3026 Carapace (holotype)</td>
<td>0.54</td>
<td>0.33</td>
<td>0.44</td>
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</tbody>
</table>

COMPARISON. Phalcocythere sentosa sp. nov. (Pl.32, figs.4-10) is similar and perhaps ancestral to the present species. These two, however, can be separated easily due to the fact that P. sentosa is strongly dimorphic and has less well-developed ventral ridge and posterodorsal process.

REMARKS. This species has so far only been recorded from one horizon of the Upper Chocolate Clays of the Zao River section. Sexual dimorphism has not been observed in this species.

Phalcocythere sp., cf. P. spinosa.

Plate 33, figs.3-6,9-11.

LOCALITY. Lindi survey, 10-50ft. above shore at Kitunga, Tanganyika.

HORIZON. Upper Eocene.

MATERIAL. Five specimens from the locality and horizon above (other specimens in the collections of the British Petroleum Co. Ltd. under registration no.FORM 1648).
DESCRIPTION. Sexual dimorphism rather marked; the females are higher and wider than the males. Carapace subrectangular to subquadrate in lateral outline. Dorsal margin irregular in lateral view due to ornament; ventral margin almost straight; anterior margin broadly rounded; posterodorsal margin very slightly concave; posterior extremity rounded. Right valve over-reaches the left slightly at the anterior margin. Anterior and posterior cardinal angles well-developed particularly in right valve. Greatest length below mid-point, greatest height at anterior cardinal angle and greatest width in the posterior third. Subcentral-tubercle distinct. Eye-tubercle rounded and prominent. Anterior and posterior marginal rims distinct. Surface ornament consists of reticulations with superimposed spines; ventral ridge prominent, posteriormolate, ending abruptly in the posterior third; posterodorsal process prominent and blade-like, standing out in lateral and dorsal views. Anterior margin ornamented with numerous very short spines; posterior with six larger spines. Radial pore canals not discernible. Duplicature moderately wide. Selvage strong - marginal in left valve but in right valve it is in the outer third. Right valve with a deep flange groove. Muscle scars are in a vertical row of four adductors and presumably two frontal scars. Hinge holamphidont with the details of each element as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Deep rounded socket</td>
<td>Projecting conical tooth. Eyeocket opens below and slightly anterior to this tooth.</td>
</tr>
</tbody>
</table>
Element Left valve Right valve
Anteromedian Conical projecting tooth. Socket opening into groove.
Posteromedian Denticulate bar. Shallow locellate groove narrowing towards posterior.
Posterior Elongate groove, presumably deep (filled in with matrix). Subpessular tooth, higher on the posterior side.

DIMENSIONS (mm.):

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<tr>
<td>Carapace male</td>
<td>0.55</td>
<td>0.32</td>
<td>0.30</td>
</tr>
<tr>
<td>Carapace female</td>
<td>0.56</td>
<td>0.34</td>
<td>0.34</td>
</tr>
<tr>
<td>Right valve female (broken)</td>
<td>( \frac{3}{4} W ), 0.17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COMPARISON. Phalocythere spinosa sp. nov. (Pl. 33, figs. 1, 2, 7, 8) closely approaches the present forms but is smaller, has a less reticulate and spinose surface and a more concave posterodorsal slope. Phalocythere retispinata sp. nov. (Pl. 31, figs. 13-17) (Pl. 32, figs. 1-3) is much larger, has a slightly convex dorsal margin particularly in the female dimorph, and the carapace tapers towards the posterior.

REMARKS. The specimens studied were made available through the kindness of Dr. F. E. Eames, Chief Palaeontologist of the British Petroleum Co. Ltd. These specimens may represent a distinct subspecies of P. spinosa.
Genus QUADRACYTHERE Hornibrook 1952

TYPE SPECIES. Cythere truncula Brady 1898

Subgenus HORNIBROCKELLA Moos 1965

TYPE SPECIES. Cythere anna Lienenklaus 1894

Quadracythere (Hornibrookella) platybomus sp. nov.

Plate 33, figs.14,15,18,19.

HOLOTYPE. GSP BM 3027, a male carapace (Pl.33, figs.14,18).

TYPE LOCALITY. Sor Range section.

TYPE HORIZON. Upper Palaeocene, sample no.460-i.

OTHER MATERIAL. 8 specimens from the locality above from two horizons (sample nos.460-i and 460-o).

FIGURED SPECIMEN. GSP BM 3028.

DERIVATION OF NAME. Greek platys, broad + bomos, bottom; with reference to expanded venter.

DIAGNOSIS. Carapace with expanded venter, subrectangular to sub-quadrate in lateral outline.

DESCRIPTION. Carapace subrectangular in the male dimorph and subquadrate in the female. Sexual dimorphism rather apparent; the females are higher and wider than the males. Carapace compressed in posterior region. Anterior margin broadly rounded, posterodorsal slope very slightly curved, posterior almost rounded, posteroventral margin slightly curved. The ornamentation over-
reaches the dorsal margin giving a jagged appearance, ventral margin almost straight in male but slightly curved in female. Left valve very slightly over-reaches right valve at posterodorsal slope and anterior cardinal angle. In dorsal view greatest width before the middle. Subcentral-tubercle prominent, eye-tubercle distinct. A marginal rim runs round anterior, ventral and posterior. It is high on the anterior but less elevated on venter and posterior. Surface reticulate with a well-marked ventral ridge giving rise to an expanded venter. At the posterodorsal corner a small horn-like projecting ridge present. Anterior margin ornamented with small, numerous denticles (20-25 in number) but posterior with few denticles.

DIMENSIONS (mm.):

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<td>0.24</td>
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<tr>
<td>GSP BM 3028 Carapace female</td>
<td>0.57</td>
<td>0.34</td>
<td>0.29</td>
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</table>

COMPARISON. Quadracythere (Hornibrockella) directa sp. nov. (Pl.33, figs.16,17) is larger, has a less well-developed subcentral-tubercle and lacks an expanded venter.

REMARKS. The preservation of the material prevents a description of the internal characters. So far this species is only known from the Upper Palaeocene of the Sor Range section.

Quadracythere (Hornibrockella) directa sp. nov.

Plate 33, figs.16,17
Plate 34, figs.1,2.

HOLOTYPE. GSP BM 3030, a female carapace (Pl.33, figs.17). (Pl.34, fig.2)

TYPE LOCALITY. Rakhi Nala section.
TYPE HORIZON. Green and Nodular Shales, sample no.3403.

OTHER MATERIAL. 95 specimens from the type locality from four horizons (sample nos.3184, 3192, 3402 and 3403).

FIGURED SPECIMENS. GSP BM 3029.

DERIVATION OF NAME. Latin directus, rectangular; with reference to outline in lateral view.

DIAGNOSIS. In lateral view carapace subrectangular with protruding anterior and posterior cardinal angles. Surface ornament consists of reticulation with an oblique ventral ridge sloping upward towards posterior and a short horn-like ridge at posterodorsal corner. Sexual dimorphism pronounced.

DESCRIPTION. Sexual dimorphy rather apparent; the females are shorter, high and wider than the males. Carapace subrectangular in side view with greatest height at anterior cardinal angle and greatest length below the middle. Anterior margin broadly and evenly rounded and posterodorsal slope very slightly concave, posterior extremity subtriangular, posteroventral margin almost straight. Dorsal margin very slightly undulating, venter slightly incurved before the middle. Posterior portion of carapace compressed. Anterior marginal rim high continuing on the venter and posterior as somewhat less elevated rim. Anterior margin set with numerous small and delicate denticles, posterior with few denticles. Anterior and posterior cardinal angles protruding. Left valve over-reaches right valve slightly at the anterior
cardinal and posterodorsal slope. In dorsal view greatest width almost in the middle. Eye-tubercle distinct. Subcentral-tubercle more or less distinct. Surface reticulate with a ventral ridge, which slopes slightly upward towards posterior. A short curved, hornlike ridge at posterodorsal corner present (better seen in dorsal view). Internal details not known.

**DIMENSIONS (mm.):**

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<tbody>
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<td>0.68</td>
<td>0.35</td>
<td>0.27</td>
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<tr>
<td>GSP BM 3030 Carapace female (holotype)</td>
<td>0.63</td>
<td>0.37</td>
<td>0.29</td>
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</tbody>
</table>

**COMPARISON.** Quadracythere (Hornibrookella) subquadra sp. nov. (Pl. 34, figs. 6-11) is subquadrate in lateral outline, has deeper reticulations and better developed subcentral-tubercle.

Quadracythere (Hornibrookella) arcana (Lubimova and Guha)

Plate 34, figs. 3-5

1960 Cythereis arcanus (Sic., recte Cythereis arcana) Lubimova and Guha, p. 33, pl. 3, fig. 1a-b.

**LOCALITY.** Rakhi Nala section.

**HORIZON.** Lower Chocolate Clays, sample no. 3499.

**MATERIAL.** Two specimens from the locality and horizon above.

**FIGURED SPECIMEN.** GSP BM 3031.

**DIAGNOSIS.** Carapace with distinct caudal process. Surface coarsely reticulate with superimposed longitudinal lineations in posterior half of carapace.
DESCRIPTION. Carapace thick-shelled, subquadrate in lateral view. Anterior margin broadly rounded, posterior with a pronounced caudal process. Dorsal margin slightly concave behind the round and protruding anterior cardinal angle, particularly in right valve. Ventral margin almost straight. Greatest height at anterior cardinal angle and greatest length below the middle. Left valve slightly over-reaches right valve in the region of anterior cardinal angle and posterodorsal slope. Eye-tubercle rounded and distinct, subcentral-tubercle well-developed. Surface ornament consists of coarse reticulations with superimposed longitudinal lineations in the posterior half of the carapace. The ventral ridge is slightly concave downwards culminating into an ala posteriorly. A short ridge at posterodorsal corner which meets dorsal margin at an angle (better seen in dorsal view) and ends into an ala at the posterior. A marginal rim runs round anterior, venter and posterior.

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<tr>
<td>GSP BM 3031</td>
<td>0.54</td>
<td>0.32</td>
<td>0.32</td>
</tr>
</tbody>
</table>

REMARKS. Topotype material was not available for study, and it is, therefore, difficult to determine whether or not the Rakhi Nala specimens are conspecific with those from the type locality in Kutch.
Quadracythere (Hornibrookella) subquadra sp. nov.

Plate 34, figs. 6-11

HOLOTYPE. GSP BM 3023, a female carapace (Pl. 34, figs. 7, 10, 11).

TYPE LOCALITY. Zao River section.

TYPE HORIZON. Upper Chocolate Clays, sample no. 24161.

OTHER MATERIAL. 40 additional specimens from the locality above from one horizon (sample no. 24161).

FIGURED SPECIMEN. GSP BM 3032.

DERIVATION OF NAME. Latin subquadrus, almost square; with reference to outline in lateral view.

DIAGNOSIS. Carapace subquadrate with dorsal and ventral margins almost straight and subparallel. Surface strongly and coarsely reticulate. Sexual dimorphism moderate.

DESCRIPTION. Carapace subquadrate in lateral outline with a short caudal process. Anterior margin broadly rounded, posterodorsal slope slightly concave, posterior extremity almost straight, postero-ventral margin curved. Dorsal and ventral margins nearly straight and subparallel. Greatest height at anterior cardinal angle, greatest length below the middle. In dorsal view greatest width in front of the middle. Anterior cardinal angle rounded, posterior cardinal well-developed. Left valve over-reaches right valve slightly in the region of posterodorsal slope and anterior cardinal angle. Subcentral-tubercle prominent, eye-tubercle rounded and
distinct. Surface coarsely and deeply reticulate. There is a distinct ventral ridge at some distance from the venter and a short curved hornlike ridge at the posterodorsal corner. Anterior marginal rim prominent continuing on venter and posterior as less prominent rim. Anterior margin ornamented with numerous denticles.

Sexual dimorphism moderate; the presumed females are wider than the males.

DIMENSIONS (mm.): 

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<tbody>
<tr>
<td>GSP BM 3032 Carapace male</td>
<td>0.66</td>
<td>0.40</td>
<td>0.32</td>
</tr>
<tr>
<td>GSP BM 3033 Carapace female (holotype)</td>
<td>0.67</td>
<td>0.42</td>
<td>0.34</td>
</tr>
</tbody>
</table>

COMPARISON. Quadracythere (Hornibrookella) arcana (1960, Lubimova and Guha, Pl. 34, figs.3-5 ) is smaller, has a well-developed caudal process, superimposed longitudinal lineations and a ventral ridge slightly curved downward. Quadracythere (Hornibrookella) platybomus sp. nov. (Pl.33, figs.14,15) is also smaller, has a different lateral outline, less deep reticulations and an expanded venter.

REMARKS. Quadracythere (Hornibrookella) subquadra sp. nov commonly occurs at one horizon (sample no.24161) of the Upper Chocolate Clays in the Zao River section associated with Echinocythereis multibullata sp. nov. and Phalcocythere spinosa sp. nov.
Quadracythere (Hornibrookella) sp.A

Plate 34, figs.12-14

LOCALITY. Zao River section.

HORIZON. Upper Chocolate Clays, sample no.24148.

MATERIAL. Only one specimen from the locality and horizon above.

FIGURE SPECIMEN. GSP BM 3034.

DESCRIPTION. Carapace subquadrate in side view. Dorsal and ventral margins almost straight, anterior margin broadly and obliquely rounded, posterodorsal margin slightly concave, posteroventral margin rounded. Greatest length lies below the middle, greatest height at the anterior cardinal angle. In dorsal view greatest width lies anterior to the middle. Valves almost equal. Eye-tubercle distinct, rounded. Subcentral-tubercle distinct. Surface coarsely and deeply reticulate. Reticulae are somewhat concentrically arranged around the subcentral-tubercle. Dorsal ridge present but not well-defined, ventral ridge more or less distinct. A low marginal rim runs round the anterior and posterior margins. Anterior and posteroventral margins denticulate. Internal characters not observed.

DIMENSIONS (mm.):

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<tbody>
<tr>
<td>GSP BM 3034 Carapace</td>
<td>0.93</td>
<td>0.54</td>
<td>0.56</td>
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</tbody>
</table>

COMPARISON. This is similar to Quadracythere (Hornibrookella) subquadra sp. nov. (Pl.34, figs.6-11) but is much larger, has coarser and
deeper reticulations more or less arrange in a concentric pattern around the sub-central-tubercle. In addition, these two species differ markedly in posterior outline.
Genus STIGMATOCYHERE nov.

TYPE SPECIES. Stigmatocythere obliqua sp. nov.

DERIVATION OF NAME. Greek stigma, mark; with reference to ornament + genus Cythere.

DIAGNOSIS. Highly ornamented Trachyleberididae in which two ridges spring from the eye-tubercle, one to form a high anterior marginal rim, the other curving sharply round to join the subcentral-tubercle.

DESCRIPTION. Carapace subrectangular in lateral outline. Sexual dimorphy apparent; the males are longer, less high and less wide than the females. Left valve slightly over-reaches the right in the region of the anterior cardinal angle and at the posterodorsal slope. Subcentral node and eye-tubercle distinct. Surface reticulate, spiny or combination of reticulations and spines or with only longitudinal ridges or lines of ornament. One to three longitudinal ridges or lines of ornament occur. The dorsal ridge or line when developed may be straight or arched convexly upwards. A strongly curved ridge, diagnostic of the genus, runs from the eye-tubercle to the anterodorsal corner of the subcentral complex and this may be continued posteriorly either as a ridge of a line of tubercles. The anterior marginal rim also springs from the eye-tubercle and is more or less elevated in the anterior region, continuing as a less elevated rim round the venter and posterior. A ventral ridge or line of tubercles diverges posteriorly from the ventral marginal rim. Anterior and posterior margins spinose.
Normal pore canals simple, medium, some 60 in female left valve. Radial pore canals simple, straight, irregularly spaced, some crossing one another, 24-26 anteriorly. Inner margin and line of concrescence coincide. Anterior duplicature moderately wide. Selvage well-marked in both valves. It is submarginal in left valve but almost in the outer third of the duplicature in right valve. In right valve a well-developed flange groove is present on venter and anterior. Muscle scars consist of four adductor scars in an almost vertical column with an oval frontal scar. Hinge holamphidont: right valve hinge with a strongly projecting anterior tooth followed by anteromedian socket, posteromedian locellate groove present or reduced to a narrow shelf, a posterior tooth, projecting reniform or pessular; left valve hinge with anterior and posterior sockets, a conical anteromedian tooth and a posteromedian denticulate or almost smooth bar.

COMPARISON. **Stigmatocythere** differs from the genus **Gyrocythere** in the arrangement of the longitudinal ridges and having a strongly curved ridge connecting the eye-tubercle and the subcentral-tubercle. The anterior marginal rim is less evident in **Gyrocythere** while it is well developed in **Stigmatocythere**. **Costa** has three or four continuous longitudinal ridges, the median or second of which has a characteristic posterior termination absent in **Stigmatocythere** and lacks the anterior connection to the eye-tubercle present in **Stigmatocythere**. **Bradleya** has only dorsal and ventral ridges.
REMARKS. Stigmatocythere is so far only known from the Middle
and Upper Eocene of the Sulaiman Range.

Stigmatocythere obliqua sp. nov.

Plate 35, figs.1-10
Plate 36, figs.1-2

HOLOTYPE. GSP BM 3036, a female carapace (Pl.35, figs.2,5,6).
(Pl.36, fig.2)

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Shales with Alabaster, sample no.24173.

OTHER MATERIAL. Over 1400 specimens from the Rakhi Nala section
from 18 horizons (sample nos.3448, 3451, 3452, 3453, 3454, 3456,
3457, 3460, 3461, 3462, 3463, 3464, 3465, 3466, 3467, 3470 and
3473). 470 specimens from the Zao River section from two horizons
(sample nos.24107 and 24110). Approximately 600 specimens from
the Shpalai Khwara section from three horizons (sample nos.24681,
24683 and 24686).

FIGURED SPECIMENS. GSP BM 3035, GSP BM 3037 - GSP BM 3040.

DERIVATION OF NAME. Latin obliqua, oblique; with reference to
ventral ridge.

DIAGNOSIS. A strongly reticulate species of Stigmatocythere with
three well-developed longitudinal ridges including an oblique
ventral ridge.

DESCRIPTION. Carapace subrectangular in lateral view. Sexual
dimorphism rather pronounced; the females are shorter, higher and
wider than the males. Anterior margin broadly and obliquely
rounded, posterior nearly straight. Dorsal margin almost intricate because of the over-reaching of the dorsal ridge, venter slightly incurved in front of the middle. Valves almost equal except that the left valve over-reaches the right in the region of the anterior cardinal angle and along the posterodorsal corner. Eye-tubercle and subcentral-tubercle distinct. Shell surface strongly reticulate. Three longitudinal ridges present: the dorsal ridge starts almost above the subcentral node and is arched convexly upwards; the median ridge commences from the eye-tubercle, curves sharply round to join the anterodorsal corner of the subcentral complex and continues posteriorly; the ventral ridge slopes obliquely upwards towards the posterior. The reticulations in the mid-posterior region of the carapace show a concentric pattern, although it is not always present. A high anterior marginal rim commences from the eye-tubercle continuing as a less high rim round the venter and posterior. Anterior and posterior short marginal spines present, 18-20 anteriorly. Normal pore canals simple, some 60 in female left valve. Radial pore canals, simple, straight, irregularly spaced, few crossing one another, mostly terminating into the marginal spines, 24-25 in the anterior. Inner margin and line of concrescence coincide. Anterior duplicature 0.050mm. wide in the female left valve. Selvage strong in both valves, subperipheral in left valve but in right valve it lies in the outer third of the duplicature. Right valve with deep anterior and ventral flange grooves. Muscle scar pattern consists of four adductor scars in a vertical row with an oval frontal scar. Hinge holamphidont,
the details are as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Socket confluent with</td>
<td>Strongly projecting sub-</td>
</tr>
<tr>
<td></td>
<td>occular sinus.</td>
<td>conical or subpessular tooth with a tendency for the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>anterior profile in dorsal view to appear concave.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The ocular sinus lies distally beyond this and opens to the interior below</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and in front of it.</td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Conical tooth with straight</td>
<td>Deep socket.</td>
</tr>
<tr>
<td></td>
<td>anterior in dorsal view.</td>
<td></td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Denticulate bar.</td>
<td>Locellate shelf, only detectable in best preserved specimens.</td>
</tr>
<tr>
<td>Posterior</td>
<td>Deep socket, slightly</td>
<td>Pessular tooth, tending towards reniform in some specimens.</td>
</tr>
<tr>
<td></td>
<td>elongate, open in venter.</td>
<td></td>
</tr>
</tbody>
</table>

**DIMENSIONS (mm.)**

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
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</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3035</td>
<td>0.61</td>
<td>0.30</td>
<td>0.29</td>
</tr>
<tr>
<td>GSP BM 3036</td>
<td>0.54</td>
<td>0.33</td>
<td>0.29</td>
</tr>
<tr>
<td>GSP BM 3037</td>
<td>0.52</td>
<td>0.34</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3038</td>
<td>0.54</td>
<td>0.32</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3039</td>
<td>0.54</td>
<td>0.34</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3040</td>
<td>0.51</td>
<td>0.29</td>
<td>-</td>
</tr>
</tbody>
</table>
COMPARISON. This species is perhaps ancestral to Stigmatocythere portentum sp. nov. (Pl. 36, figs. 3-6,10) which it resembles very closely, but differs in being smaller, having deeper reticulations and less prominent subcentral-tubercle.

REMARKS. The present species occurs abundantly in the Shales with Alabaster of the Rakhi Nala, Zao River and Shpalai Khwara sections and seems to be restricted to this formation. It is very likely that this species will prove to be a valuable horizon marker in the region.

The longitudinal ridges in some of the specimens from the upper few horizons of the Rakhi Nala section are exaggerated and in some the dorsal and ventral ridges terminate into spines posteriorly. These are perhaps variations within the species.

Stigmatocythere portentum sp. nov.

Plate 36, figs.3-6,10.

HOLOTYPE. GSP BM 3041, a male carapace (Pl.36, figs.3-6).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Lower Chocolate Clays, sample no.3498.

OTHER MATERIAL. Seven specimens from the locality above from one horizon (sample no.3499).

FIGURED SPECIMENS. GSP BM 3042 - GSP BM 3043.

DERIVATION OF NAME. Latin portentum, omen or sign; from the diagnostic ornament.
DIAGNOSIS. A large, reticulate species of the genus *Stigmatocythere* with three distinct longitudinal ridges, prominent subcentral-tubercle.

DESCRIPTION. Carapace subrectangular in side view with greatest height at anterior cardinal angle and greatest length above mid-point. Anterior margin broadly rounded, posterior truncated. Dorsal margin straight, but looks irregular in lateral view because of over-reaching of the dorsal ridge; ventral margin almost straight. Anterior and posterior cardinal angles well-developed particularly in left valve. Left valve slightly over-reaches the right valve at the anterior cardinal angle and along the posterodorsal slope. Eye-tubercle distinct and rounded. Subcentral-tubercle prominent. Surface reticulate with three longitudinal ridges. Dorsal ridge is wavy and convex upwards. It begins above the subcentral-tubercle and in the posterodorsal region it curves sharply down to meet the median ridge. A strongly curved ridge runs from the eye-tubercle to the subcentral-tubercle, continuing posteriorly as a median ridge. Ventral ridge commences above the anteroventral corner and is slightly convex downward. There is a short, curved ridge on the ventral side of the subcentral-tubercle running towards the anterior. A marginal rim runs on the anterior, ventral and posterior margins. It is high on the anterior but less high along the venter and posterior. Anterior ornamented with short, numerous spines. There is a large posteroventral spine. Radial pore canals simple, more or less straight,
some crossing one another, few seem to bifurcate, some 25 anteriorly. Inner margin and line of concrescence coincide; no vestibule. Duplicature of moderate width with a well-marked selvage. Hinge holamphidont with a projecting conical anterior tooth in right valve.

**DIMENSIONS (mm.).**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3041</td>
<td>Carapace male (holotype)</td>
<td>0.71</td>
<td>0.37</td>
<td>0.32</td>
</tr>
<tr>
<td>GSP BM 3042</td>
<td>Right valve (broken)</td>
<td>-</td>
<td>0.37</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3043</td>
<td>Carapace (juvenile)</td>
<td>0.59</td>
<td>0.35</td>
<td>0.29</td>
</tr>
</tbody>
</table>

**COMPARISON.** This species has already been compared with *Stigmatocythere obliqua* sp. nov.

**REMARKS.** *S. portentum* is a very rare ostracod and has so far only been found in the uppermost beds of the Lower Chocolate Clays of the Rakhi Nala section.

**Stigmatocythere calia** sp. nov.

Plate 36, figs. 7-9
Plate 37, figs. 1, 3.

**HOLOTYPE.** GSP BM 3045, a female carapace (Pl. 36, figs. 8, 9).
(Pl. 37, figs. 1, 3)

**TYPE LOCALITY.** Zao River section.

**TYPE HORIZON.** Upper Chocolate Clays, sample no. 24151.

**OTHER MATERIAL.** 14 specimens from the locality above from five horizons (sample nos. 24148, 24150, 24151, 24152 and 24153).

**FIGURED SPECIMEN.** GSP BM 3044.
DERIVATION OF NAME. Greek, calia, bird's nest; from a fancied appearance of the ornament in lateral view.

DIAGNOSIS. A non-reticulate *Stigmatocythere* with straight posterior, high anterior marginal rim, prominent and projecting subcentral-tubercle, dorsal and ventral lines of ornament, posteroventral ridge, almost straight.

DESCRIPTION. Sexual dimorphism distinct; the males are more elongate than the females. Carapace subrectangular in lateral outline. Dorsal margin almost straight but appears undulating in side view due to the over-reaching of the dorsal line of ornament, ventral margin nearly straight. Anterior margin broadly and evenly rounded, posterior straight, posterodorsal slope almost straight. Left valve slightly over-reaches the right valve in the anterodorsal and posterodorsal corners; otherwise the two valves are equal. Eye-tubercle distinct, rounded and polished. Subcentral-tubercle prominent and projecting particularly in dorsal and ventral views. Dorsal line of ornament consists of three nodes including a large subangular posterodorsal node which extends vertically below to a short distance. Ventral line of ornament consists of two nodes and in some specimens it is just a short ridge. A projecting, almost vertical posteroventral ridge runs from the posterior of the ventral line of ornament to a point which is slightly above mid-line. A curved ridge diagnostic of the genus runs from the eye-tubercle to the subcentral-tubercle; it is not well-marked. The subcentral-tubercle has two faint, short, curved ridges on its
ventral side, one to the anterior and one to the posterior.

Anterior marginal rim high, extending along the venter and posterior as less high rim. Anterior margin set with numerous short spines, concealed in lateral view by the elevated anterior marginal rim. There is one short posterodorsal marginal spine and one short posteroventral marginal spine. Internal details not determinable.

DIMENSIONS (mm.).

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>GSP BM 3044</td>
<td>0.61</td>
<td>0.34</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3045</td>
<td>0.56</td>
<td>0.36</td>
<td>0.32</td>
</tr>
</tbody>
</table>

*Stigmatocythere delineata* sp. nov.

Plate 37, figs. 2, 4-10.

HOLOTYPE. GSP BM 3047, a female carapace (Pl 37, figs. 7-10).

TYPE LOCALITY. Zao River section.

TYPE HORIZON. Upper Chocolate Clays, sample no. 24154.

OTHER MATERIAL. Five additional specimens from the type locality from two horizons (sample nos. 24154 and 24155).

FIGURED SPECIMEN. GSP BM 3046.

DERIVATION OF NAME. Latin delineata, outlined; from the resemblance of the ornament to a sketch map.

DIAGNOSIS. A species of the genus *Stigmatocythere* with a large hexagon formed of ridges in the posteromedian region, dorsal ridge broken in the middle and extending vertically below in the posterodorsal region.
DESCRIPTION. Sexual dimorphism apparent; the males are proportionally longer than the females. Carapace subrectangular in side view. Dorsal margin slightly concave, ventral margin almost straight, anterior margin broadly and evenly rounded, posterodorsal slope and posteroventral margin nearly straight. Greatest height lies at the anterior cardinal angle, greatest length above mid-point and greatest width in the posterior third. Anterior and posterior cardinal angles projecting particularly in left valve. Left valve slightly over-reaches right valve in the region of anterodorsal corner and posterodorsal slope. Subcentral-tubercle and eye-tubercle distinct. The most prominent part of the ornament is a large, slightly irregular hexagon formed of ridges just to the posterior of centre. Other short ridges join this hexagon on its corners mostly running outward. A sharply curved ridge characteristic of the genus connects the eye-tubercle and the subcentral-tubercle. Dorsal ridge is broken in the middle and in the posterodorsal region it extends vertically below to a point slightly above mid-line. Ventral ridge runs slightly obliquely upwards towards the posterior and its posterior portion forms the ventral part of the hexagon. There are two short, curved ridges on the ventral side of the subcentral-tubercle; one runs towards the anterior and the other towards the posterior to join the hexagon. A high marginal rim runs on the anterior and continues along the venter and posterior as a less high rim. Anterior margin denticulate, posteroventral corner ornamented with a short spine. Duplicature of moderate width with a strong selvage. Hinge holamphidont.
DIMENSIONS (mm.).

<table>
<thead>
<tr>
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<th>L</th>
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<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3046 Carapace male</td>
<td>0.61</td>
<td>0.34</td>
<td>0.29</td>
</tr>
<tr>
<td>GSP BM 3047 Carapace female (holotype)</td>
<td>0.56</td>
<td>0.34</td>
<td>0.29</td>
</tr>
</tbody>
</table>

COMPARISON. It is easy to separate S. delineata from other described species of the genus Stigmatocythere due to its characteristic surface ornament, particularly the large hexagon formed of ridges just to the posterior of centre.

**Stigmatocythere lumaria** sp. nov.

Plate 37, figs.11
Plate 38, figs.1-10; Plate 39, figs.1-8,11.

HOLOTYPE. GSP BM 3048, a male carapace (Pl.38, figs.1,5,8).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Upper Chocolate Clays, sample no.3642.

OTHER MATERIAL. Approximately 340 specimens from the Rakhi Nala section from 21 horizons (sample nos.3621, 3624, 3625, 3626, 3627, 3628, 3630, 3640, 3641, 3642, 3645, 3646, 3647, 3648, 3649, 3650, 3651, 3652, 3658, 3662 and 3663). 86 specimens from the Zao River section from 11 horizons (sample nos.24156, 24157, 24159, 24170, 24173, 24174, 24175, 24176, 24180, 24187 and 24193).

FIGURED SPECIMENS. GSP BM 3049 - GSP BM 3055.

DERIVATION OF NAME. Latin lumarius, thorny.

DIAGNOSIS. A species of Stigmatocythere with a prominent and bilobate subcentral-tubercle. Surface tuberculate or combination of reticulations and tubercles. Three large, projecting tubercles in the mid-dorsal region.
DESCRIPTION. Sexual dimorphism rather pronounced; the females are shorter and higher than the males. Carapace subrectangular in lateral view. Anterior margin broadly rounded, posteroverentral margin and posterior extremity more or less rounded, posterodorsal slope very slightly concave. Dorsal margin straight but appears intricate due to surface ornament; ventral margin slightly concave before the middle, particularly in right valve. Greatest height lies in the anterior third, greatest length passes above mid-line. Anterior and posterior cardinal angles well-marked. Valves almost equal. Eye-tubercle distinct and rounded. Subcentral-tubercle prominent and bilobate. Surface ornament consists of either tubercles or combination of reticulations and tubercles. In some cases tubercles become almost spinose. There are three tubercles in the mid-dorsal region and in most specimens these project beyond the dorsal margin in lateral outline. The eye-tubercle is joined to the subcentral-tubercle by a sharply curved ridge, diagnostic of the genus. The ventral side of the subcentral-tubercle has two weak, short, curved ridges; one extends towards the anterior and the other towards the posterior. Anterior marginal rim well-marked, ventral and posterior marginal rims less well-marked. Anterior and posterior margins decorated with short, numerous spines. Posterior has several short spines and has two large, somewhat blunt spines, one in the posteroverentral corner and the other in the posterodorsal corner. Radial pore canals simple, almost straight, irregularly spaced, some crossing one another, 25-26 anteriorly. Line of concrescence and inner margin coincide.
Anterior duplicature moderately wide, one-twelfth of the entire length of the valve. Selvage pronounced. In right valve it lies in the outer third of the duplicature but in left valve it is sub-marginal. Right valve with deep ventral and anterior flange grooves. Adductor scars in a vertical column of four. Frontal scar not clearly seen but appears to be oval in shape. Hinge holamphidont with the following details:

<table>
<thead>
<tr>
<th>Element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Socket bounded on all sides, ocular sinus opening into it.</td>
<td>Strongly projecting conical tooth. Ocular sinus lies below and slightly anterior to it.</td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Subconical tooth with straight anterior and convex posterior in dorsal view.</td>
<td>Deep socket bounded on venter and opening into posteromedian groove.</td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Denticulate bar</td>
<td>Locellate groove</td>
</tr>
<tr>
<td>Posterior</td>
<td>Deep socket open in venter.</td>
<td>Tooth more or less rounded in lateral view but pessular in dorsal view.</td>
</tr>
</tbody>
</table>

COMPARISON. *Stigmatocythere portentum* sp. nov. (Pl.36, figs.3-6,10) is larger, has three distinct longitudinal ridges, lacks a tuberculate surface and bilobate subcentral-tubercle. *Stigmatocythere calia* sp. nov. (Pl.36, figs.7-9 ) is probably (Pl.37, figs.1,3) ancestral to *S. lumaria* but has a vertical posteroventral ridge and more elevated anterior marginal rim. Further, it lacks
a tuberculate surface and bilobate subcentral-tubercle.

This species can be separated into two morphotypes, although it is rather difficult to maintain a distinction between them because of many intermediate forms:

**Morphotype A**

Plate 37, figs.11
Plate 38, figs.1-10; Plate 39, fig.11.

This has a tuberculate surface. Tubercles vary in size and in number. Some have few large tubercles with a tendency to become spinose and in others tubercles are small and rounded.

**DIMENSIONS (mm.).**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Type</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3048</td>
<td>Carapace male (holotype)</td>
<td>0.67</td>
<td>0.37</td>
<td>0.34</td>
</tr>
<tr>
<td>GSP BM 3049</td>
<td>Right valve female</td>
<td>0.63</td>
<td>0.37</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3050</td>
<td>Left valve male (juvenile)</td>
<td>0.59</td>
<td>0.32</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3051</td>
<td>Right valve male</td>
<td>0.68</td>
<td>0.37</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3052</td>
<td>Left valve female</td>
<td>0.59</td>
<td>0.40</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3053</td>
<td>Right valve female</td>
<td>0.60</td>
<td>0.37</td>
<td>-</td>
</tr>
</tbody>
</table>

**Morphotype B**

Plate 39, figs.1-8

This is very similar to Morphotype A, but has a surface ornament which is a combination of reticulations and tubercles.

**DIMENSIONS (mm.).**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Type</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3054</td>
<td>Carapace male</td>
<td>0.66</td>
<td>0.37</td>
<td>0.32</td>
</tr>
<tr>
<td>GSP BM 3055</td>
<td>Carapace female</td>
<td>0.62</td>
<td>0.37</td>
<td>0.31</td>
</tr>
</tbody>
</table>
REMARKS. This species has been described as Genus and sp. indet. G. by I. G. Sohn in his paper on Lower Tertiary ostracods from Western Pakistan, still in press.
Genus TRACHYLEBERIS Brady 1898

TYPE SPECIES. *Cythere scalpellocuneata* Brady 1880

Subgenus TRACHYLEBERIS sensu stricto

Trachyleberis (Trachyleberis) lobculus sp. nov.

Plate 39, figs. 9, 10
Plate 40, figs. 1, 3

HOLOTYPE. GSP BM 3057, a female carapace (Pl. 40, figs. 1, 3).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Upper Rakhi Gaj Shales, sample no. 3166.

OTHER MATERIAL. 286 specimens from the locality above from 49 horizons (sample nos. 3147, 3160, 3162, 3163, 3166, 3167, 3169, 3170, 3171, 3173, 3174, 3175, 3177, 3178, 3179, 3180, 3183, 3184, 3185, 3186, 3187, 3188, 3189, 3190, 3191, 3192, 3193, 3197, 3198, 3199, 3200, 3401, 3402, 3403, 3404, 3407, 3409, 3410, 3415, 3417, 3418, 3419, 3420, 3421, 3422, 3428, 3429, 3434, and 3435).

FIGURED SPECIMENS. GSP BM 3056.

DERIVATION OF NAME. Latin lobus, lobe + oculus, eye (with reference to lobate eye-tubercle).

DIAGNOSIS. A species of the subgenus *Trachyleberis* in which eye-tubercle is lobate, surface ornamented with tubercles, posterior cardinal angle well-marked in left valve.

DESCRIPTION. Carapace subrectangular in the male dimorph and subquadrate in the female. Sexual dimorphism apparent, the males being larger in proportion to the females. Dorsal and ventral margins
subparallel (undulating in lateral view because of surface ornamentation). Anterior margin broadly rounded, posterodorsal margin almost straight, posterior extremity somewhat rounded, posterodorsal margin curved. Greatest height at anterior cardinal angle and greatest length in the middle. Valves more or less equal. Eye-tubercle lobate and prominent and lies just below a well-developed anterior cardinal angle. Posterior cardinal angle well-marked in the left valve and armed with a node or short spine pointing upward. Subcentral-tubercle distinct. Both anterior and posterior margins ornamented with a double row of tubercles or very short spines. Surface tuberculate or nodose (occasionally tubercles or nodes develop into spines). Anterior and posterior marginal rim more or less distinct. Hinge holamphidont: left valve with terminal sockets, postjacent conical tooth and median denticulate bar; right valve hinge complimentary (anterior tooth being conical). Duplicature of moderate width with a submarginal selvage. Other internal details not determinable.

**DIMENSIONS (mm.)**

<table>
<thead>
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<tbody>
<tr>
<td>GSP BM 3056 Carapace male</td>
<td>0.61</td>
<td>0.34</td>
<td>0.24</td>
</tr>
<tr>
<td>GSP BM 3057 Carapace female (holotype)</td>
<td>0.59</td>
<td>0.35</td>
<td>0.28</td>
</tr>
</tbody>
</table>

**COMPARISON.** *T. lobeculus* is probably related to *Cythereis spinelloso* Lubimova and Guha (1960, p.31, pl.2, fig.10), but differs in having a lobate eye-tubercle and a different lateral outline and surface ornament.
REMARKS. Specimens of *Cythereis spinellosa* Lubimova and Guha were not available for comparison, but from the description and figure given by these authors it appears that the eye-tubercle in that particular species is not lobate.

*Trachyleberis* (*Trachyleberis*) bimammillata sp. nov.

Plate 40, figs. 2, 4-11.

**HOLOTYPE.** GSP BM 3058, a male carapace (Pl. 40, figs. 2, 8, 10).

**TYPE LOCALITY.** Rakhi Nala section.

**TYPE HORIZON.** Upper Chocolate Clays, sample no. 3613.

**OTHER MATERIAL.** 41 specimens from the Rakhi Nala section from 5 horizons (sample nos. 3610, 3613, 3614, 3615 and 3617).
7 specimens from the Zao River section from two horizons (sample nos. 24150 and 24152).

**FIGURED SPECIMENS.** GSP BM 3059 - GSP BM 3062 and GSP BM 3074 - GSP BM 3075.

**DERIVATION OF NAME.** Latin bimammillata, two-breasted (with reference to split subcentral-tubercle).

**DIAGNOSIS.** A small species of the subgenus *Trachyleberis* in which subcentral-tubercle is divided into two horizontally disposed nodes and posterodorsal process consisting of two vertically arranged nodes.

**DESCRIPTION.** Carapace subrectangular to subquadrate in lateral outline. Sexual dimorphism moderate; the presumed males are
longer and less high than the females. Dorsal and ventral margins straight and tapering towards the posterior. Anterior margin broadly rounded, posterodorsal slope very slightly concave, posterior extremity rounded, posterodorsal margin somewhat rounded. Anterior, posterior and ventral margins decorated with a double row of short spines, but dorsal margin with only one row of very short spines (these in some specimens almost look-like pustules). Greatest height at the anterior cardinal angle (which is obtuse and angular) and greatest length in the middle. In dorsal view greatest width lies at the anterior node of the subcentral-tubercle. Valves almost equal. Eye-tubercle rounded and distinct. Subcentral-tubercle divided into two nodes, horizontally arranged, the anterior one being larger (spinose in some specimens). The posterodorsal process consists of two nodes (spines in some specimens), which are vertically disposed. In a few specimens a posteroven- tral node is also present. Surface ornamented with scattered tubercles and spines. Duplicature fairly wide. The selvage is subperipheral and well-developed in both valves. Radial pore canals not seen because of mineralisation. The adductor muscle scars are in an oblique row of four at the posterior margin of the subcentral pit. The frontal scar is large and U-shaped and opens towards the anterodorsal corner. Hinge holamphidont with the following details:-
<table>
<thead>
<tr>
<th>Element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Socket</td>
<td>Projecting subconical tooth.</td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Subconical tooth</td>
<td>Socket</td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Denticulate ridge</td>
<td>Locellate groove.</td>
</tr>
<tr>
<td>Posterior</td>
<td>Fairly deep socket.</td>
<td>Tooth, subpessular in dorsal view.</td>
</tr>
</tbody>
</table>

**DIMENSIONS (mm.)**

<table>
<thead>
<tr>
<th>Specimen Number</th>
<th>Type Description</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3058</td>
<td>Carapace male (holotype)</td>
<td>0.52</td>
<td>0.29</td>
<td>0.22</td>
</tr>
<tr>
<td>GSP BM 3059</td>
<td>Carapace female</td>
<td>0.50</td>
<td>0.29</td>
<td>0.24</td>
</tr>
<tr>
<td>GSP BM 3060</td>
<td>Left valve male (broken)</td>
<td>-</td>
<td>0.29</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3061</td>
<td>Left valve female</td>
<td>0.50</td>
<td>0.29</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3061₂</td>
<td>Right valve female</td>
<td>0.49</td>
<td>0.29</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3074</td>
<td>Carapace male</td>
<td>0.54</td>
<td>0.29</td>
<td>0.22</td>
</tr>
<tr>
<td>GSP BM 3075</td>
<td>Carapace female</td>
<td>0.49</td>
<td>0.29</td>
<td>0.24</td>
</tr>
</tbody>
</table>

**COMPARISON.** This species can easily be distinguished from *Trachyleberis (Trachyleberis) lobculus* sp. nov. (Pl. 39, figs. 9, 10) (Pl. 40, figs. 1, 3) by its smaller size, slightly concave posterodorsal margin and split subcentra-tubercle. Further, *Trachyleberis (Trachyleberis) bimammillata* has a posterodorsal process consisting of two nodes in a vertical row and lacks a lobate eye-tubercle.
Subgenus ACANTHOCYHEREIS Howe 1963

TYPE SPECIES. Acanthocythereis araneosa Howe 1963

Trachyleberis (Acanthocythereis) procapsus sp. nov.

Plate 40, figs. 12, 13.
Plate 41, figs. 1, 3, 4.

HOLOTYPE. GSP BM 3063, a male carapace (Pl. 40, figs. 12).
(Pl. 41, figs. 1, 3)

TYPE LOCALITY. Sor Range section.

TYPE HORIZON. Upper Palaeocene, sample no. 460-j.

OTHER MATERIAL. 5 specimens from the locality above from two horizons (sample nos. 460-j and 460-l).

FIGURED SPECIMEN. GSP BM 3064.

DERIVATION OF NAME. Latin procapsus, "anterior cage"; with reference to smooth walled area enclosed behind anterior marginal rim.

DIAGNOSIS. Acanthocythereis in which a smooth walled area lies behind the anterior marginal rim, anterior and posterior platforms compressed.

DESCRIPTION. Sexual dimorphism apparent; the males are longer in proportion to the females. Carapace elongate, subrectangular in lateral outline with dorsal and ventral margins almost straight, tapering towards the posterior. Anterior margin broadly rounded, posterior subtriangular. Anterior cardinal angle rounded. Left valve over-reaches the right very slightly at the posterodorsal margin. Greatest height at the anterior cardinal angle and
greatest length in the middle. In dorsal view greatest width at
the anterior third. Subcentral-tubercle distinct. Eye-tubercle
rounded and distinct and lies at the anterior cardinal angle.
Surface reticulate (reticulae joined by walls of pustules or
papillae). Posterodorsal process consists of small more or less
rounded protuberances. Anterior and posterior margins ornamented
with a double row of short spines. Anterior and posterior
marginal rims high with a smooth walled area behind. Internal
details not known.

DIMENSIONS (mm.).

<table>
<thead>
<tr>
<th>Carapace</th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>0.68</td>
<td>0.32</td>
<td>0.20</td>
</tr>
<tr>
<td>female</td>
<td>0.59</td>
<td>0.30</td>
<td>0.20</td>
</tr>
</tbody>
</table>

COMPARISON. This species is distinguishable from Trachyleberis
(Acanthocythereis) usitata sp. nov. (Pl. 41, figs.2,5,7) by its
deeper reticulation, more elevated marginal rims and spinose
anterior and posterior margins.

The present species has already been compared with
Trachyleberis (Acanthocythereis) postcornis sp. nov. and
Trachyleberis (Acanthocythereis) decoris sp. nov.

REMARKS. T. (A.) procapsue has so far only been recovered from
the Upper Palaeocene of the Sor Range section.
Trachyleberis (Acanthocythereis) usitata sp. nov.

Plate 41, figs. 2, 5, 7.

HOLOTYPE. GSP BM 3065, a male carapace (Pl. 41, figs. 2).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Gorge Beds, sample no. 3111.

OTHER MATERIAL. 4 specimens from the Rakhi Nala section from four horizons (sample nos. 3111, 3130, 3132 and 3133).

FIGURED SPECIMEN. GSP BM 3066.

DERIVATION OF NAME. Latin usitatus, usual.

DIAGNOSIS. Carapace tapering towards posterior. Subcentral-tubercle distinct. Surface reticulate with superimposed pustules and a posterodorsal process.

DESCRIPTION. Sexual dimorphy present; the males are longer in proportion to the females. Carapace elongate, subrectangular, tapering towards posterior. Anterior margin broadly rounded, posterior narrowly rounded. Dorsal and ventral margins almost straight. Greatest height at the anterior cardinal angle which is well-developed in the left valve. Greatest length passes through mid-point. Valves almost equal. In dorsal view greatest width lies in the anterior third (in the region of the subcentral-tubercle). Eye-tubercle rounded and distinct. Subcentral-tubercle fairly distinct. Anterior and posterior marginal rims sharply defined. Surface reticulate with pustules at reticulae
intersections. A posterodorsal process in the form of more or less rounded tubercle of medium size present. A double row of pustules decorates anterior and posterior margins. Internal characters not known.

DIMENSIONS (mm.).

<table>
<thead>
<tr>
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<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3065 Carapace male (holotype)</td>
<td>0.63</td>
<td>0.32</td>
<td>-</td>
</tr>
<tr>
<td>GSP BM 3066 Carapace female</td>
<td>0.59</td>
<td>0.32</td>
<td>0.22</td>
</tr>
</tbody>
</table>

COMPARISON. This species shows some resemblance to *Trachyleberis (Acanthocythereis) decoris* sp. nov. (Pl. 42, figs.3-6,8,9) but is smaller, has marginal pustules rather than spines and carapace more tapering towards the posterior. *Trachyleberis (Acanthocythereis) postcornis* (Pl. 41, figs.9,10) has a characteristic posterodorsal process, more high marginal rims and spinose anterior and posterior margins.

REMARKS. In some specimens the posterodorsal process is not well-developed.

*Trachyleberis (Acanthocythereis) pedigaster* sp. nov.

Plate 41, figs.6,8.

HOLOTYPE. GSP BM 3067, a carapace.

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Lower Rakhi Gaj Shales, sample no.3671.

DERIVATION OF NAME. Greek for "flat belly" - with reference to ventral inflation.
DIAGNOSIS. A large species of the subgenus Acanthocythereis with ventral inflation. Carapace tapering towards posterior. Posterior margin subtriangular.

DESCRIPTION. Carapace large, elongate, tapering towards posterior and with ventral inflation. Anterior and posterior marginal platforms compressed. Dorsal and ventral margins almost straight, anterior margin broadly rounded, posterior subtriangular. Anterior and posterior cardinal angles well-developed particularly in the left valve. Left valve slightly larger than the right, which it over-reaches in the region of the anterodorsal corner and postero-dorsal slope. Eye-tubercle rounded and distinct and lies just below the anterior cardinal angle. Subcentral-tubercle more or less distinct. Greatest height at anterior cardinal angle, greatest length below mid-point and greatest width a little posterior to the middle. Surface ornament consists of reticulations with superimposed papillae. The posterodorsal process consists of two almost rounded small tubercles (or papillae) joined together in the left valve and one small rounded tubercle in the right. Anterior and posterior marginal rims fairly distinct. Anterior and posterior margins ornamented with a double row of papillae. Internal details unknown.

DIMENSIONS (mm.).

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3067 Carapace (holotype)</td>
<td>1.02</td>
<td>0.51</td>
<td>-</td>
</tr>
</tbody>
</table>

COMPARISON. There is no difficulty in separating T. (A.) pedigaster sp. nov. from other described species of the subgenus Acanthocythereis by its large carapace and subtriangular posterior.
Trachyleberis (Acanthocythereis) postcornis sp. nov.

Plate 41, figs. 9,10.

HOLOTYPE. GSP BM 3068, a male carapace (Pl. 42, figs. 1,2,7,10).

TYPE LOCALITY. Rakhi Nala section.

TYPE HORIZON. Lower Chocolate Clays, sample no. 3499.

OTHER MATERIAL. 44 specimens from the locality above from two horizons (sample nos. 3498 and 3499) and 3 specimens from the Zao River section from two horizons (sample nos. 24131 and 24148).

FIGURED SPECIMENS. GSP BM 3069 - GSP BM 3071.

DERIVATION OF NAME. Latin post, posterior + cornis, horned; with reference to posterodorsal process.

DIAGNOSIS. A species of the subgenus Acanthocythereis with distinct subcentral-tubercle and eye-tubercle. Surface reticulate with small superimposed spines. Posterodorsal process divided into two spines.

DESCRIPTION. Carapace elongate, subrectangular in lateral outline with dorsal and ventral margins straight, tapering towards the posterior. Anterior margin broadly and evenly rounded, posterior slightly sub-triangular in right valve but almost rounded in the left, posterodorsal margin very slightly concave. Anterior and posterior cardinal angles well-developed. Sexual dimorphism rather strong; the presumed males are longer, less high and less wide than the females. Valves almost equal. In dorsal view greatest width lies at the anterior third (in the region of the
subcentral-tubercle). Eye-tubercle rounded, polished and prominent (standing out of the carapace). Subcentral-tubercle distinct. Surface ornament consists of combination of reticulations and small spines. The posterodorsal process is divided into two spines (although in some specimens this division is not detectable). In a few specimens a posteromedian process also develops. The anterior and posterior margins are decorated with a double row of spines; the second row lies on high anterior and posterior marginal rims. The posterior marginal spines are larger and less in number. Duplicature fairly wide. Selvage prominent and submarginal. Radial pore canals not clearly displayed because of mineralisation, but appear to be simple, more or less straight with median swellings, 30-35 anteriorly. Hinge holamphidont:

<table>
<thead>
<tr>
<th>Hinge element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Socket</td>
<td>Stirpate tooth</td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Subconical tooth</td>
<td>Deep socket</td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Locellate shallow groove</td>
<td>Denticulate bar</td>
</tr>
<tr>
<td>Posterior</td>
<td>Deep socket</td>
<td>Tooth, almost rounded in lateral view</td>
</tr>
</tbody>
</table>

DIMENSIONS (mm.)

| GSP BM 3068  | Carapace male (holotype) | 0.62 | 0.30 | 0.22 |
| GSP BM 3069  | Carapace female          | 0.52 | 0.29 | 0.21 |
| GSP BM 3070  | Right valve male         | 0.61 | 0.29 | -    |
| GSP BM 3071  | Right valve female       | 0.50 | 0.28 | -    |
COMPARISON. The present species shows some affinity to
Trachyleberis (Acanthocythereis) decoris sp. nov. (Pl.42, figs.3-6, 8,9)
but is shorter, less high and less wide. These two species also
differ in surface ornamentation. T. (A.) postcornis has a
combination of reticulations and small spines, while T. (A.)
decoris is reticulate with superimposed pustules. Further,
T. (A.) postcornis has a well-developed posterodorsal process
divided into two spines and a distinct subcentral-tubercle.
This species may also be distinguished from T. (A.) procapsus
sp. nov. (Pl.40, figs.12,13) in being smaller and lacking a smooth
(Pl.41, figs.1,3,4) walled area behind the anterior marginal rim. These two species
also differ in dorsal outline.

Trachyleberis (Acanthocythereis) decoris sp. nov.
Plate 42, figs.3-6, 8,9.

HOLOTYPE. GSP BM 3072, a male carapace (Pl. 42, figs.3,4,5).

TYPE SECTION. Rakhi Nala section.

TYPE HORIZON. Upper Chocolate Clays, sample no.364 e.

OTHER MATERIAL. Over 250 specimens from the type locality from
18 horizons (sample nos.3604, 3607, 3609, 3610, 3613, 3614, 3615,
3629, 3640, 3642, 3645, 3648, 3649, 3650, 3661, 3662, 3663 and
3664). 8 specimens from the Zao River section from 3 horizons
(sample nos.24154, 24173 and 24193).

FIGURED SPECIMEN. GSP BM 3073.
DERIVATION OF NAME. Latin decoris, beautiful, adorned; from bejewelled appearance of pustules and reticulae.

DIAGNOSIS. Acanthocythereis in which surface ornament consists of reticulations with superimposed pustules. Carapace sub-rectangular with dorsal and ventral margins almost straight and subparallel.

DESCRIPTION. Sexual dimorphism rather marked; the males are longer in proportion than the females. Carapace subrectangular in lateral view with dorsal and ventral margins almost straight and subparallel. Anterior margin broadly and evenly rounded, posterior slightly subtriangular. Both anterior and posterior margins ornamented with a double row of short spines, the posterior ones being larger. Anterior cardinal angle rounded, posterior cardinal angle well marked. Greatest height at the anterior cardinal angle and greatest length in the middle. In dorsal view greatest width lies in the anterior third. Valves almost equal. Surface reticulate with superimposed pustules. Eye-tubercle rounded and distinct. Subcentral-tubercle more or less distinct (better seen in slightly worn specimens). A large number of specimens (particularly the females) show development of postero-ventral prominence. In a few specimens a small posterodorsal process also develops - but these characters here are regarded as variations within the species. Duplicature fairly wide with a submarginal selvage. Radial pore canals not seen. Muscle scar pattern consists of four adductors in a vertical superposition at
the posterior margin of the muscle scar pit with a W-shaped frontal scar opening towards the anterodorsal corner. Hinge holamphidont:

<table>
<thead>
<tr>
<th>Hinge element</th>
<th>Left valve</th>
<th>Right valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>Socket</td>
<td>Slightly stirpate tooth</td>
</tr>
<tr>
<td>Anteromedian</td>
<td>Subconical tooth</td>
<td>Socket</td>
</tr>
<tr>
<td>Posteromedian</td>
<td>Locellate groove</td>
<td>Denticulate ridge</td>
</tr>
<tr>
<td>Posterior</td>
<td>Deep socket</td>
<td>Somewhat rounded tooth in lateral view</td>
</tr>
</tbody>
</table>

DIMENSIONS (mm.)

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSP BM 3072</td>
<td>0.67</td>
<td>0.32</td>
<td>0.24</td>
</tr>
<tr>
<td>GSP BM 3073</td>
<td>0.59</td>
<td>0.32</td>
<td>0.23</td>
</tr>
</tbody>
</table>

COMPARISON. In some respects this species resembles *Trachyleberis* (Acanthocythereis) procapsus sp. nov. (Pl. 40, figs. 12,13), but (Pl. 41, figs.1,3,4) differs in the lack of a smooth walled area enclosed by the anterior marginal rim and compressed anterior and posterior marginal platforms. These two species also differ in size. *T. (A.) decoris* is smaller, higher and wider in proportion than *T. (A.) procapsus*.

REMARKS. This species commonly occurs in the Upper Chocolate Clays of the Rakhi Nala section but it is very rare in the Zao River section.
PART II

OSTRACODA

AND

EARLY TERTIARY CORRELATION

IN THE

SULAIMAN RANGE
The ostracods show uniform facies and fairly shallow-water marine environments. They give no evidence or suggestion of any non-marine conditions throughout the succession. There is, however, an indication of a brackish-water environment in the Shales with Alabaster because of the presence of a typical *Neocyprideis*. This genus lives predominantly in brackish (meso-polyhaline) environments (Van Morkhoven 1963, p.294). Eames has recorded small freshwater gastropods in the lower part of the Lower Chocolate Clays (in his local zones 8 and 9) of the Rakhi Nala section. He believes that these were carried down from a closely neighbouring source and deposited under estuarine conditions (Eames 1952, p.178).

Except for a few gaps, ostracods occur throughout almost the whole succession. At many horizons, particularly in the Eocene, samples are completely crowded with ostracods. They usually occur in association with larger and smaller benthonic foraminifera, but are very rare or almost absent in samples with rich pelagic foraminifera. The most conspicuous gap in the Eocene succession of the Rakhi Nala and Zao River sections which has not yielded any ostracods is the Platy Limestone and the lower part of the Lower Chocolate Clays. In the Zao River section the top 600ft. of the Upper Chocolate Clays are devoid of any recognisable ostracods, although at a few horizons some *Nummulites* have been found.
Rakhi Nala section.

The following ostracod biostratigraphic units in the Rakhi Nala section have been recognised (see Appendix 2).

Ostracod Biostratigraphic Unit I, Palaeocene (lower part)

The first Tertiary ostracod assemblage is encountered in the lower part of the Gorge Beds (samples from the Venericardia Shales were not available for study). Seven out of the eight species recorded are restricted to the unit. The species which ranges up into Unit II is *Trachyleberis (Acanthocythereis)* usitata sp. nov. *Alocopocythere rupina* sp. nov., *Neocyprideis?* sp.A and *Bairdia* sp.A are abundant and make up over 80% of the ostracod fauna.

Ostracod Biostratigraphic Unit II, Palaeocene (upper part)

This Unit is formed of the Lower Rakhi Gaj Shales. Ostracods are very rare and have only been found in the upper part which is very rich in pelagic foraminifera. The ostracods, although very rare, are easily distinguishable from the assemblages below and above. Eight species have been found. All the species except *Trachyleberis (Acanthocythereis)* usitata sp. nov. which is in common with the underlying Unit are restricted to the present Unit.

Ostracod Biostratigraphic Unit III, Lower Eocene (lower part)

This includes the Upper Rakhi Gaj Shales, Green and Nodular Shales and Rubbly Limestones. Eames' local zones 3, 4, 5 and 6 lie in this Unit.
This is the first Eocene ostracod assemblage. It is fairly rich and at several horizons the ostracods are very abundant. None of the Palaeocene species survive and a completely new fauna evolves. The ostracod fauna is of changing suite; species appear and disappear in the unit, but there seems to be no major break of any kind in the fauna. *Trachyleberis* (*Trachyleberis*) loboculus sp. nov., *Gyrocythere parvicarinata* sp. nov., *Occultocythereis peristicta* sp. nov. (with five morphotypes), *Schizocythere* sp.A and *Pontocythere* sp.A are the most important members restricted to the unit. Approximately 50% of the species range up into the overlying unit IV.

Ostracod Biostratigraphic Unit IV, Lower Eocene (upper part)

This consists of the Shales with Alabaster and includes Eames' local zone 7. It has a very rich ostracod faunal assemblage. Most of the samples studied were extremely rich in ostracods, which are mostly complete carapaces. The most typical species confined to the unit are *Stigmatocythere obliqua* sp. nov., *Phalcocythere dissenta* sp. nov., "Cythere" sp. A and "Cythere" sp.B. More than 50% of the species are restricted to the unit, approximately 44% are in common with Unit III, and only one species ranges up into Unit V.

Ostracod Biostratigraphic Unit V, Middle - Upper Eocene.

This comprises the Platy Limestone, Lower Chocolate Clays, Upper Chocolate Clays and *Pellatispira* Beds. Eames' local zones 8 to 15 and Latif's top six pelagic foraminiferal zones occur in
this unit. The lowest 730ft., which form the Platy Limestone and most of the Lower Chocolate Clays, excluding the top 30ft., are devoid of any recognisable ostracods and are provisionally included in the unit. There are 200ft. of covered sediments in the Lower Chocolate Clays below sample 3494.

The Unit is very rich in very well-preserved ostracods. It differs markedly from the underlying Unit. All the species except Aloycopocythere transcendentis sp. nov., which survives from the Unit below, appear for the first time, although few have their ancestors in Unit IV. The first appearance of ostracods in the Unit is in the uppermost part of the Lower Chocolate Clays (sample nos. 3498 and 3499), which lies at the base of the Globigerina veguaensis zone of Latif. The ostracod fauna is varied and of changing suite. 12% of the species are restricted to the Lower Chocolate Clays (topmost portion); 25% are confined to the Upper Chocolate Clays (lower part); and only 8% have been recorded from the Pellatispira Beds. 33% of the species are shared between the Lower Chocolate Clays (topmost portion) and Upper Chocolate Clays (lower part); 17% range from the Lower Chocolate Clays (uppermost part) to the Upper Chocolate Clays (upper part); 37% are shared between the Upper Chocolate Clays (lower part) and Upper Chocolate Clays (upper part); 8% range from the Upper Chocolate Clays (lower part) to the Pellatispira Beds; and 12% are found in both the Upper Chocolate Clays (upper part) and Pellatispira Beds. (The percentages are approximate and are based on the entire ostracod fauna of the Unit.)
The genus _Alocopocythere_ nov. occurs abundantly almost throughout the Unit. _Alocopocythere transcedens_ sp. nov., which ranges up from the underlying Units III and IV, is replaced by _A. transversa_ sp. nov. just above the middle of the lower part of the Upper Chocolate Clays. This last species has several morphotypes; in the upper part of the Upper Chocolate Clays the papillose form becomes more common and in the _Pellatispira_ Beds this is the only morphotype present. _Stigmatocythere obligna_ sp. nov., which was very abundant in the underlying biostratigraphic Unit IV, is replaced by the larger _Stigmatocythere portentum_ sp. nov., which has only been found in the uppermost part of the Lower Chocolate Clays. Higher up in the succession, i.e. in the lower part of the Upper Chocolate Clays the place of _S. portentum_ is taken by _Stigmatocythere lumaria_ sp. nov. which ranges up into the _Pellatispira_ Beds. The genera _Cytherella, Cytherelloidea, Krithe, and Paijenborchella_ are represented by several species. The genus _Gyrocythere_ nov. has two species in the Unit. _Gyrocythere perfecta_ sp. nov. occurs in the uppermost part of the Lower Chocolate Clays but in the lower part of the Upper Chocolate Clays it is replaced by the larger _Gyrocythere exaggerata_ sp. nov. The subgenera _Scelidocythereis_ nov. and _Paracosta_ nov. are represented by two and three species respectively and are known so far only from this Unit. The following are some of the most important species of the Unit: _Bairdoppilata_ sp. A, _Cytherelloidea cf. C. costatruncata_ Lubimova and Mohan, _Cytheromorpha_ sp. A,
Cytheropteron sp. D, Alocopocythere transversa sp. nov. (with six morphotypes), Patagonacythere nidulus sp. nov., Stigmatocythere lumaria sp. nov. (with two morphotypes) and Trachyleberis (Acanthocythereis) decoris sp. nov.

Zao River section

The two biostratigraphic Units IV and V of the Rakhi Nala section are found in the Zao River section (see Appendix 3).

Ostracod Biostratigraphic Unit IV, Lower Eocene (upper part)

This is very similar to biostratigraphic Unit IV of the Rakhi Nala section. The base of the Unit has been taken arbitrarily at the base of four foot of limestone, which lies 332ft. below the base of the Platy Limestone. The actual base of the Unit, or the Shales with Alabaster, probably lies much lower in the succession, but sediments below the 4ft. limestone have not been analysed. These have been recorded as the undifferentiated Ghazij by the collectors. No megafossils have so far been recorded from these sediments. It is unlikely that these would yield any smaller foraminifera or ostracods because of their lithology - mostly silty or maroon shales.

Ostracods have been found in the upper part of the Unit at two horizons (samples 24107 and 24110). They are extremely abundant in 24107. Approximately half of the Rakhi Nala species of the Unit are found in the Zao River section. None of the species range up into Unit V. Stigmatocythere obliqua sp. nov.
is the most dominant species and makes about one-third of the
ostracod fauna. Neocyprideis? sp.B, Neocyprideis sp.C,
Pontocyprilla sp.B, Pontocyprilla sp.B, Xestoleberis sp.C,
Xestoleberis sp.D, Xestoleberis sp.E, "Cythere" sp.A and "Cythere"
sp.B are some other important species.

Ostracod Biostratigraphic Unit V, Middle-Upper Eocene.

The biostratigraphic Unit V of the Rakhi Nala section
occurs in the Zao River and is 3743ft. thick. The Unit includes
the Platy Limestone, Lower Chocolate Clays and both lower and
upper parts of the Upper Chocolate Clays. The Pellatispira Beds
have not been recorded in the Zao River section. The bottom
460ft. of the Unit comprising the Platy Limestone and the lower
part of the Lower Chocolate Clays and the top 600ft. of the upper
part of the Upper Chocolate Clays have not yielded any ostracods
and are only provisionally included in the Unit.

The Unit is very rich in well-preserved ostracods. The
ostracod fauna is completely new since none of the species from
the Unit below survive. There are 7% of the species which are
restricted to the upper part of the Lower Chocolate Clays; 26%
have only been found in the lower part of the Upper Chocolate
Clays; and 17% have been recorded from the upper part of the
Upper Chocolate Clays only. 24% of the species occur in the
upper part of the Lower Chocolate Clays and the lower part of the
Upper Chocolate Clays; 13% range from the upper part of the
Lower Chocolate Clays to the upper part of the Upper Chocolate
Clays and 41% are shared between the lower and upper parts of the Upper Chocolate Clays.

The ostracod fauna of the Unit in the Zao River section is very similar to that of the Rakhi Nala section. It has about 74% of its species in common with the Rakhi Nala. These are shown in Appendix 5. As in the Rakhi Nala, Alocopocythere is one of the commonest genera and it occurs in great abundance at several horizons. It is represented by three related species: A. transcendens sp. nov., A. transversa sp. nov. (with six morphotypes), and A. radiata sp. nov. Stigmatocythere is another common genus and has three species in the Unit: S. calia sp. nov., S. delineata sp. nov. and S. lumaria sp. nov. (with two morphotypes). Among these, S. lumaria is the commonest, occurring in the lower and upper parts of the Upper Chocolate Clays. S. calia and S. delineata have so far not been found in the Rakhi Nala section. Bairdzonepilata sp.A, Pterygocythereis(Pterygocythere) sp.A are more common in the Zao River section. Trachyleberis (Acanthocythereis) decoris sp. nov. and Cytheromorpha sp.A which were very common in the Rakhi Nala are rare in the Zao River.

The subgenus Paracosta nov. which is represented by three species in the Rakhi Nala has not so far been recorded from the Zao River. Phalcocythere spinosa sp. nov. and Quadracythere (Hornibrookella) subquadra sp. nov. have only been found in sample 24161 of the Zao River section, where they occur in association with the larger foraminifer Pellatispira orbitoidea. Some of the more important members of the unit are: Alocopocythere transcendens sp. nov.,
Alocopocythere transversa sp. nov., Bairdiopilata sp. A, Cytherelloidea cf. C. costatruncata Lubimova and Mohan, Patagonacythere? nidulus sp. nov. and Stimatocythere lumaria sp. nov.

Shpalai Khwara section

The ostracod biostratigraphic Unit IV of the Rakhi Nala and Zao River sections is also represented in the Shpalai Khwara section (see Appendix 4).

Ostracod Biostratigraphic Unit IV, Lower Eocene (upper part)

Like the Zao River section, the base of the Unit is taken arbitrarily at the base of the 4ft. cf limestone, which is 320ft. below the base of the Platy Limestone. The Platy Limestone is only 40ft. thick in this section. The 12,450ft. thick sediments below the 4ft. limestone are barren except for a few horizons which contain poorly preserved pelagic foraminifera. These probably represent the following lithological units in ascending order: Upper Rakhi Gaj Shales, Green and Nodular Shales, Rubbly Limestones and lower part of the Shales with Alabaster.

Only the upper part of the Unit has yielded ostracods and the fauna is similar to that of the Zao River and Rakhi Nala sections. About 70% of its species are in common with the Zao River section. Over 40% of the species of the Unit in the Rakhi Nala have been recorded from the Shpalai Khwara section. Stigmatocythere obliqua sp. nov. is very abundant, particularly
in sample 24686, which is absolutely crowded with this species. Some other common species are: Neocyprideis? sp. B, Pontocyprella sp. B, Cytherella sp. B, Cytherella sp. and "Cythere" sp. B.
STATISTICAL CORRELATION OF RANGES OF OSTRACOD SPECIES COMMON TO THE
RAKHI NALA AND ZAO RIVER SECTIONS

The tops and bases of ostracod species common to the Rakhi Nala and Zao River sections have been plotted on a graph (Fig. 4). These fall into two rectilinear patterns, one in biostratigraphic Unit IV and the other in biostratigraphic Unit V.

The tops and bases of ostracod species in biostratigraphic Unit IV (i.e. in the Shales with Alabaster) lie almost in a straight line on the graph; this, however, is because ostracods have only been found at two horizons in the Zao River section. The Equations of Correlation for the array of biostratigraphic Unit V (i.e. above the Platy Limestone) can be computed from the data given in Appendix 5. This method has been discussed in detail by A. B. Shaw in his book 'Time in Stratigraphy', published in 1964. The points marked '+' have been omitted because they fall outside the main array. Eighty-one points have been considered. The Equations of Correlation between the Rakhi Nala and Zao River sections can be calculated as follows:

\[ R^2 = R^2 + \frac{\sum (\text{RN} - \text{RM})(\text{ZR} - \text{ZR})}{\sum (\text{ZR} - \text{ZR})^2} \]

\[ = \frac{66.38 + 21.6752.28}{6.4512 + 56.35} \]

\[ = 0.4451 \text{ZR} + 56.35 \]

\[ \text{and} \]

\[ Z^2 = Z^2 + \frac{\sum (\text{RN} - \text{RM})(\text{ZR} - \text{ZR})}{\sum (\text{RN} - \text{RN})^2} \]

\[ = \frac{22.53 + 21.6752.28}{11.75941} \]

\[ = 1.9433 \text{RN} - 106.46 \]
Graphic representation of ranges of Ostracod species common to the Rakhi Nala and Zao River sections. Regression and standard error of Rakhi Nala on Zao River indicated by lines.

INDEX

- Top of range
- Base of range
- Coincident base and top
- Point not used
- G & N.S. Green and nodular shales
- R. Lst. Rubby limestones
- S. W. A. Shales with alabaster
- P. L. Platy limestone
- L. C. Lower chocolate clays
- U. C. Upper chocolate clays
- W. M. B. White marl band
- P. B. Palaeontop beds

Feet above the base of the Venetianella Shales

FIG. 6
Any point in the Zao River section in biostratigraphic Unit V can be correlated with the corresponding point in the Rakhi Nala section by means of Equation (1). Similarly any point in the Rakhi Nala section can be correlated with the corresponding point in the Zao River section by using Equation (2).

The Coefficient of Correlation is expressed by the formula:

\[ r = \sqrt{b_1 \times b_2} \]

By substituting the values \( b_1 \) and \( b_2 \), we get

\[ r = \sqrt{0.4451 \times 1.9433} \]
\[ = \sqrt{0.8649} \]
\[ = 0.930 \]

This high value of \( r \) is above the 99% confidence level.

The standard error of estimate for \( R^N \) (\( S^\hat{N} \))

\[ S^\hat{N} = \sqrt{\frac{\sum (R^N - \hat{R^N})^2}{N}} \]

where \( R^N - \hat{R^N} \) is the difference between each observed point and its computed equivalent and \( N \) is the number of entries.

Hence,

\[ S^\hat{N} = \sqrt{1484288.91} \]
\[ = \sqrt{18324.554} \]
\[ = 135.4 \text{ ft} \]
The standard error of estimate for $Z^R (S^R)$

\[
\begin{align*}
&= \sqrt{\frac{\sum (Z^R - \hat{Z}^R)^2}{n}} \\
&= \sqrt{\frac{6464244.21}{81}} \\
&= \sqrt{79805.49} \\
&= 282.5 \text{ ft.}
\end{align*}
\]

When the two straight lines given by Equations (1) and (2) are drawn on a graph, they intersect one another at an angle of 30°. Since the Rakhi Nala section has been regarded as the standard section, therefore, for practical purposes only one straight line (i.e. $Z^R = 0.4431Z^G + 5635.2$) has been drawn on the graph. This is the Correlation or Regression Line of the Rakhi Nala on the Zao River with parallel dotted lines showing the standard error of estimate.
CONCLUSIONS

It is clear from the preceding discussions that the Palaeocene and Eocene of the Rakhi Nala section can be divided into five distinct biostratigraphic units on the basis of Ostracoda. Two of these Units, I and II, occur in the Palaeocene and three, III, IV and V, in the Eocene. Biostratigraphic Unit IV of the Rakhi Nala section is represented in the Zao River section by at least 332ft., and Unit V by 3743ft. The Units in the two sections have almost identical ostracod faunas. Biostratigraphic Unit IV of the Rakhi Nala is also represented in the Shpalai Khwara section by at least 320ft.

The Equations of Correlation of biostratigraphic Unit V between the Rakhi Nala and Zao River sections have been calculated by means of ostracod species common to the two sections. From these two equations any point in one section can easily be correlated with the corresponding point in the other section or vice versa. (see Fig. C ). The standard error of estimate for the two equations has also been calculated. Since only the upper part of biostratigraphic Unit IV in the Zao River section has yielded ostracods, only this part of the unit can be correlated with any certainty.

Eames' lithological units of the southern Sulaiman Range (Rakhi Nala and Zinda Pir) extend into the northern part of the Sulaiman Range (Zao River and Shpalai Khwara). This is
particularly true for sediments from the Shales with Alabaster (upper Lower Eocene) to the upper part of the Upper Chocolate Clays (upper Eocene). Sediments below the upper part of the Shales with Alabaster of the Shpalai Khwara section are unfossiliferous except for a few horizons containing poorly preserved pelagic foraminifera. These are 12,450ft. thick and are probably equivalent to Eames' Upper Rakhi Gaj Shales, Green and Nodular Shales, Rubbly Limestones and lower part of the Shales with Alabaster. In the Zao River section sediments below the upper part of the Shales with Alabaster are undifferentiated and are probably unfossiliferous. This suggests that environmental conditions in the northern Sulaiman Range during most of the Early Eocene were not suitable for life abundant marine life.

The faunal breaks in the sections studied do not always coincide with Eames' lithological subdivisions. For example, the Upper Rakhi Gaj Shales, Green and Nodular Shales and Rubbly Limestones have a similar ostracod fauna and are regarded as one ostracod biostratigraphic unit. Another example is in the Kirthar Formation where a new fauna appears before a change in lithology. This occurs in the uppermost part of the Lower Chocolate Clays (i.e. just below the White Marl Band). Most of the species range from the uppermost part of the Lower Chocolate Clays to the lower part of the Upper Chocolate Clays, although the White Marl Band lies in between.
The Palaeocene/Lower Eocene boundary in the Rakhi Nala section has been drawn at the base of the Nummulites irregularis Limestone of Eames and Nagappa. (Bayliss, however, identified this as Nummulites crasseornata (Henriei) form B.) This is in agreement with Eames, Bayliss and Latif. The ostracod faunal assemblages below and above the irregularis Limestone are completely different and have no species in common. These assemblages have been included in ostracod biostratigraphic Units II and III respectively. The Palaeocene and Lower Eocene boundary in fact has been placed between these two biostratigraphic units. The ranges of ostracod species found in the two biostratigraphic units are shown in Appendix A.

The Shales below the irregularis Limestone have a very rich assemblage of pelagic foraminifera and have been assigned to the Globorotalia rex Zone by Latif. Dr. Banner of the British Petroleum Co. Ltd., who very kindly examined these samples, considers them to be of the high Globorotalia rex Zone with derived Lower/Middle Palaeocene pelagic foraminifera.

The Lower/Middle Eocene boundary in the Rakhi Nala, Zao River and Shpalai Khwara sections has been placed at the base of the Platy Limestone. This is in conformity with Eames, who examined the Rakhi Nala and Zinda Pir sections of the Sulaiman Range. Bayliss and Latif, who worked on the Rakhi Nala section, however, have drawn the boundary in the uppermost part of the Lower Chocolate Clays (i.e. below sample 3498). The Platy Limestone serves as an important horizon marker in the region.
The Lower/Middle Eocene boundary lies between ostracod biostratigraphic Units IV and V, which have very different ostracod assemblages. Except for *Alocopocythere transcendens* sp. nov., none of the Lower Eocene ostracod species survive into the Middle Eocene.

The Middle/Upper Eocene boundary in the Rakhi Nala and Zao River sections has been placed between the lower and upper parts of the Upper Chocolate Clays. The upper part of the Upper Chocolate Clays contains the genus *Pellatispira*, which is of Upper Eocene age. In the Rakhi Nala section the boundary is taken arbitrarily between samples 3627 and 3628. This is approximately the same level as drawn by Eames (1952), who recorded the first appearance of *Pellatispira* just above this horizon in the section. Bayliss, however, recorded *Pellatispira* only from one horizon (sample 3657) in the *Pellatispira* Beds. Latif has placed the boundary in the middle of his *Chiloguemnitina aff. martini* Zone (i.e. above sample 3618). In the Zao River section sample 24161 contains specimens of *Pellatispira* in abundance. These have been assigned to *Pellatispira orbitoidea* (Provale) *sensu* Rao 1941 by Dr. C. G. Adams of the British Museum (personal communication), who very kindly examined these specimens. According to Dr. Adams these fall midway between *P. orbitoidea* and *P. madaraszi* var. *indica*. The Middle/Upper Eocene boundary in the Zao River section can, therefore, safely be placed below sample 24161.

The Middle and Upper Eocene ostracod fauna of the Rakhi Nala and Zao River sections is of changing suite and has been
included in ostracod biostratigraphic Unit V. It does not show any sharp break between the Middle and the Upper Eocene. Some species are restricted to the Middle Eocene, but others range from the Middle to the Upper Eocene. Some of the important species restricted to the Middle Eocene are: *Actinocythereis? quasi-bathonica* sp. nov., *"Anommatocythere" confirmata* sp. nov., *Echinocythereis (Scelidocythereis) rasilis* sp. nov., *Cytheropteron sp.C*, *Gyrocythere exaggerata* sp. nov., *Trachyleberis (Trachyleberis) bimammillata* sp. nov. Some of the common species which range from the Middle to the Upper Eocene are: *Alocopocythere transversa* sp. nov., *Bairdiopillata* sp.A, *Cytherelloidea* cf. *C. costatruncata* Lubimova and Mohan, *Cytheromorpha* sp.A, *Cytheropteron* sp.D, *Paijenborchella* sp.C, *Patagonacythere?nidulus* sp. nov., *Pterygo- cythereis (Pterygocythere)* sp.A and *Stigmatocythere lumaria* sp. nov. (A complete list of these species is given in Appendix 2.)
## APPENDIX 1

**Sor Range Lease 58**

Measured section at locality 460

Measured by John Reinemund

<table>
<thead>
<tr>
<th>Thickness (feet)</th>
<th>Description of Unit</th>
<th>Sample No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10+</td>
<td>Claystone, gray</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Conglomerate containing limestone and chert pebbles, cobbles, boulders as much as 8in. across; matrix of medium grained, yellowish brown sandstone forms about 20% of rock.</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Concealed by talus</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Claystone, medium gray, not fissile, semifluid, containing scattered fossils. Calcareous nodules at top; silty and carbonaceous in lower part.</td>
<td>460a (near top)</td>
</tr>
<tr>
<td>2-3</td>
<td>Sandstone, very fine grained to silty brownish-gray, imperfect and irregular bedding, contains carbonised plant fragments and vertical root molds.</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Claystone, dark olive gray, not fissile, silty in upper few feet and lower few feet; contains irregular coal layers as much as 4in. thick in lower 2 ins.</td>
<td>460b (6-8 above bottom) 460c (3-4 feet above bottom)</td>
</tr>
</tbody>
</table>

Continued......
<table>
<thead>
<tr>
<th>Thickness (feet)</th>
<th>Description of Unit</th>
<th>Sample No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 1/2</td>
<td>Sandstone, fine to very fine grained, light brownish gray, mostly even beds 2-8in. thick, locally cross-bedded.</td>
<td>460d</td>
</tr>
<tr>
<td>2</td>
<td>Siltstone, poorly bedded, carbonaceous, containing very carbonaceous layers as much as 1/8 in. thick in top 2in.</td>
<td></td>
</tr>
<tr>
<td>1 1/2</td>
<td>Claystone, silty, olive gray, not fissile, containing carbonized plant chips.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Siltstone, brownish gray, imperfect beds, cross laminated.</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Claystone, silty at top, olive gray, not fissile.</td>
<td>460e (5-6feet above bottom)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>460f (1-2feet above bottom)</td>
</tr>
<tr>
<td>8</td>
<td>Claystone, containing profuse white calcareous concretions.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Claystone, olive gray, fissile, grading down into siltstone, yellowish-brown, hard, fossiliferous.</td>
<td>460g (Channel sample)</td>
</tr>
<tr>
<td>50+</td>
<td>Claystone, slightly fissile, olive gray.</td>
<td>460h-o</td>
</tr>
</tbody>
</table>
APPENDIX 2 - Distribution of ostracod species in the Rakhi Nala section.

Key to numbers: 1, Gorge Beds; 2, Lower Rakhi Nala Shales; 3, Upper Rakhi Gaj Shales; 4, Green and Nodular Shales; 5, Rubbly Limestones; 6, Shales with Alabaster; 7, Platy Limestone and Lower Chocolate Clays (lower part); 8, Lower Chocolate Clays (upper part); 9, Upper Chocolate Clays (lower part); 10, Upper Chocolate Clays (upper part); 11, Pellatispira Beds. I - VI, Ostracod biostratigraphic units.

<table>
<thead>
<tr>
<th></th>
<th>Palaeocene</th>
<th>Lower Eocene</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I  II III</td>
<td>IV</td>
</tr>
<tr>
<td>Alocococythere ruadina sp. nov.</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Bairdia sp. A</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Buntonia devexa sp. nov.</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Cytherella sp. A</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Hermanites cracena sp. nov.</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Neocyprideis? sp. A</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Genus and sp. indet. 1</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Trachyleberis (Acanthocythereis)</td>
<td>usitata sp. nov.</td>
<td>x x</td>
</tr>
<tr>
<td>Brachycythere sp. A</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Buntonia sp. A</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Bythocypris sp. A</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Krithe sp. A</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

Continued...
### Occultocythereis sp. A

<table>
<thead>
<tr>
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<th>Lower Eocene</th>
</tr>
</thead>
<tbody>
<tr>
<td>I 1</td>
<td>II 2</td>
</tr>
</tbody>
</table>

### Trachyleberis (Acanthocythereis)

- **pedigaster** sp. nov. $x$

### Genus and sp. indet. 2

- $x$

### Cytherelloidea sp. A

### Cytherelloidea sp. B

- $x$

### Cytheropteron sp. B

- $x$, $x$

### Echinocythereis (Echinocythereis)

- **elongata** sp. nov. $x$

### Eucytherura sp. A

- $?, x$, $x$

### Gyrocythere parvicarinata sp. nov.

- $x$, $x$, $x$

### Krithe sp. B

- $x$, $x$, $x$

### Occultocythereis spilota sp. nov.

### Occultocythereis peristicta sp.

- nov. Morphotype A $x$, $x$

### O. peristicta sp. nov.

- Morphotype B $x$, $x$

### O. peristicta sp. nov.

- Morphotype C $x$, $x$

### O. peristicta sp. nov.

- Morphotype D $x$, $x$

### O. peristicta sp. nov.

- Morphotype E $x$, $x$

Continued........
<table>
<thead>
<tr>
<th></th>
<th>Lower Eocene</th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>III</td>
<td>IV</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Paracypris sp.B</td>
<td>X</td>
<td>X</td>
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Lubimova and Mohan

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Mid. Eocene Up. Eocene

7  8  9  10  11

Aloconocythere transversa sp. nov.
   Morphotype A
   A. transversa sp. nov. Morphotype B
   Cytherella sp.F
   Paracypris sp.D
   Paracypris sp.E
   Polycope sp.A
   Pteryocythereis (Pteryocythere) sp.A
   Krithe sp.D
   Paijenborchella sp.D
   Paijenborchella sp.E
   Patagonocythere?nidulus sp. nov.
   Stigmatocythere lumaria sp. nov.
      Morphotype A
      Trachyleberis (Acanthocythereis)
         decoris
      Aloconocythere transversa sp. nov.
         Morphotype C
         A. transversa sp. nov. Morphotype D
         A. transversa sp. nov. Morphotype F
         A. radia sp. nov.
         Stigmatocythere lumaria sp. nov.
            Morphotype B

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APPENDIX 3 - DISTRIBUTION OF OSTRACOD SPECIES IN THE ZAO RIVER SECTION.

Key to numbers: 6, Shales with Alabaster; 7, Platy Limestone and Lower Chocolate Clays (lower part); 8, Lower Chocolate Clays (upper part); 9, Upper Chocolate Clays (lower part); 10, Upper Chocolate Clays (upper part). IV - VI, ostracod biostratigraphic units.

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"Anommatocythere" laqueta sp. nov. x

Bairdia sp.C x

Bairdia sp.D x

Cytherella sp.B x

Cytherella sp.C x

Neocyprideis sp.B x

Neocyprideis sp.C x

Paracypris sp. x

Phalcocythere dissenta sp. nov. x

Pontocyprella sp.B x

Pontocyprella sp.C x

Stigmatocythere obliqua sp. nov. x

Xestoleberis sp.C x

Xestoleberis sp.D x

Xestoleberis sp.E x

"Cythere" sp.A x

"Cythere" sp.B x

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Alocopocythere transversa sp. nov.
  Morphotype A
"Anommatocythere" confirmata sp. nov.
"Apterygocythere" sp. B
Cytherelloidea cf. Cytherelloidea sp. C
Echinocythereis (Scelidocythereis)
  rasilis sp. nov.
Gyrocythere exaggerata sp. nov.
Hermanites scapus sp. nov.
Paracypris sp. G
Pontocythere sp. C
Quadracythere (Hornibrookella) sp. A
Stigmatocythere calia sp. nov.
Stigmatocythere delineata sp. nov.
Trachyleberis (Trachyleberis)
  bimammillata sp. nov.
Agalaicypris sp. B
Alocopocythere transversa sp. nov.
  Morphotype C
A. transversa sp. nov. Morphotype D
A. transversa sp. nov. Morphotype E
Bairdia sp. D
Bradleya? voraginosa sp. nov.

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### Middle Eocene

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<td>Morphotype A</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Trachyleberis (Acanthocythereis)</strong></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>decoris sp. nov.</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Xestoleberis</strong> sp. G</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Alcocopocythere transversa</strong> sp. nov.</td>
<td></td>
<td></td>
<td>x</td>
<td>?</td>
</tr>
<tr>
<td>Morphotype B</td>
<td></td>
<td></td>
<td>x</td>
<td>?</td>
</tr>
<tr>
<td><strong>A. transversa</strong> sp. nov. Morphotype F</td>
<td></td>
<td></td>
<td>x</td>
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</tr>
<tr>
<td><strong>A. radiata</strong> sp. nov.</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Cytherelloidea</strong> sp. E</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Krithe</strong> sp. F</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Neocyprideis?</strong> sp. D</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Neocyprideis?</strong> sp. E</td>
<td></td>
<td></td>
<td>x</td>
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</tr>
</tbody>
</table>

Continued...
Middle Eocene  Upper Eocene

7  8  9  10

*Paijenborchella* sp.F  x

*Paracypris* sp.F  x

*Phalocycythere spinosa* sp. nov.  x

*Quadracythere (Hornibrookella)*

    *subquadra* sp. nov.  x

*Stigmatocythere lumaria* sp. nov.

    Morphotype B  x
**APPENDIX 4** - Distribution of ostracod species in the Shpalai Khwara section.

Key to numbers: 6, Shales with Alabaster; IV, ostracod biostratigraphic unit.

<table>
<thead>
<tr>
<th>Lower Eocene</th>
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<tbody>
<tr>
<td>IV</td>
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<tr>
<td>6</td>
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</tr>
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</table>

- *Alocopocythere longilinea* sp. nov. x
- *A. transcendens* sp. nov. x
- "*Anommatocythere* laqueta" sp. nov. x
- *Bairdia* sp.C x
- *Bairdia* sp.D x
- *Cytherella* sp.B x
- *Cytherella* sp. x
- *Cytheropteron* sp.A x
- *Gyrocycythea grandilaevia* sp. nov. x
- *Krithe* sp. x
- *Neocyprideis?* sp.B x
- *Pontocyprella* sp.B x
- *Pontocyprella* sp.C x
- *Schizocythere* sp. x
- *Stigmatocythere obliqua* sp. nov. x
- *Xestoleberis* sp.C x
- *Xestoleberis* sp.D x
- "*Cythere*" sp.B x
### APPENDIX 5 - LIST OF OSTRACOD SPECIES COMMON TO THE RAKHI NALA AND ZAO RIVER SECTIONS.

<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
<th>Rakhi Nala Base</th>
<th>Rakhi Nala Top</th>
<th>Zao River Base</th>
<th>Zao River Top</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>&quot;Anommatocythere&quot; laqueta sp. nov.</td>
<td>4045</td>
<td>5223</td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Phalcocythere dissenta sp. nov.</td>
<td>4968</td>
<td>5195</td>
<td>252</td>
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</tr>
<tr>
<td>14</td>
<td>Stigmatocythere obliqua sp. nov.</td>
<td>4815</td>
<td>5373</td>
<td>252</td>
<td>294</td>
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<tr>
<td>21</td>
<td>Cytherella sp.C</td>
<td>5112</td>
<td>5195</td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Neocyprideis? sp.G</td>
<td>4815</td>
<td>5373</td>
<td>252</td>
<td>294</td>
</tr>
<tr>
<td>36</td>
<td>Neocyprideis sp.C</td>
<td>5373</td>
<td>252</td>
<td>294</td>
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<tr>
<td>44</td>
<td>Xestoleberis sp.C</td>
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<td>5208</td>
<td>252</td>
<td>294</td>
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<tr>
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<td>5112</td>
<td>5195</td>
<td>252</td>
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<tr>
<td>46</td>
<td>Xestoleberis sp.E</td>
<td>4815</td>
<td>5208</td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>&quot;Cythere&quot; sp.A</td>
<td>4687</td>
<td>5304</td>
<td>252</td>
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</tr>
<tr>
<td>49</td>
<td>&quot;Cythere&quot; sp.B</td>
<td>4687</td>
<td>5373</td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Bairdia sp.C</td>
<td>3682+</td>
<td>4815</td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>Bairdia sp.D</td>
<td>3995</td>
<td>5195</td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>Cytherella sp.B</td>
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<td>5223</td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>Pontocyarella sp.B</td>
<td>5023</td>
<td>5304</td>
<td>252</td>
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</tr>
<tr>
<td>54</td>
<td>Pontocyarella sp.C</td>
<td>4687</td>
<td>5208</td>
<td>252</td>
<td></td>
</tr>
</tbody>
</table>

1. Actinocythereis? quasibathonica sp. nov. | 6369 | 6524 | 1872 | 1994 |
2. Alocopocythere transcendens sp. nov. | 3215+ | 6488 | 650+ | 1948 |
3a. A. transversa sp. nov. Morphotype A | 6575 | 6706 | 2032 | 2190 |
3b. A. transversa sp. nov. Morphotype B | 6589+ | 6690 | 3384+ | |

Continued........
<table>
<thead>
<tr>
<th>No.</th>
<th>Species</th>
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<th>Zao River</th>
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<tbody>
<tr>
<td>3c</td>
<td><em>A. transversa</em> sp. nov. Morphotype C</td>
<td>6764</td>
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<tr>
<td>3d</td>
<td><em>A. transversa</em> sp. nov. Morphotype D</td>
<td>6839</td>
<td>2504</td>
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<tr>
<td>3e</td>
<td><em>A. transversa</em> sp. nov. Morphotype E</td>
<td>6839</td>
<td>2086</td>
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<tr>
<td>3f</td>
<td><em>A. transversa</em> sp. nov. Morphotype F</td>
<td>6943</td>
<td>2504</td>
</tr>
<tr>
<td>4</td>
<td><em>A. radiata</em> sp. nov.</td>
<td>7029</td>
<td>2712</td>
</tr>
<tr>
<td>6</td>
<td>&quot;Anommatocythere&quot; confirmata sp. nov.</td>
<td>6138</td>
<td>1570</td>
</tr>
<tr>
<td>7</td>
<td><em>Echinocythereis (Scelidocythereis) rasilis</em> sp. nov.</td>
<td>6138</td>
<td>1986</td>
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<tr>
<td>8</td>
<td><em>E. (S.) multibullata</em> sp. nov.</td>
<td>6531</td>
<td>1994</td>
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<tr>
<td>9</td>
<td><em>Gyrocythere exaggerata</em> sp. nov.</td>
<td>6401</td>
<td>1570</td>
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<tr>
<td>10</td>
<td><em>Hermanites palmatus</em> sp. nov.</td>
<td>6401</td>
<td>994</td>
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<tr>
<td>11</td>
<td><em>Hermanites scopus</em> sp. nov.</td>
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<td>1766</td>
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<tr>
<td>12</td>
<td><em>Patagonacythere, nidulus</em> sp. nov.</td>
<td>6575</td>
<td>2032</td>
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<tr>
<td>15a</td>
<td><em>Stigmatocythere lumaria</em> sp. nov. Morphotype A</td>
<td>6531</td>
<td>2060</td>
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<tr>
<td>15b</td>
<td><em>S. lumaria</em> sp. nov. Morphotype B</td>
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<td>2712</td>
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<tr>
<td>16</td>
<td><em>Trachyleberis (Trachyleberis) bimammillata</em> sp. nov.</td>
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<td>1872</td>
</tr>
<tr>
<td>17</td>
<td><em>T. (Acanthocythereis) postcornis</em> sp. nov.</td>
<td>6121</td>
<td>994</td>
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<tr>
<td>18</td>
<td><em>T. (Acanthocythereis) decoris</em> sp. nov.</td>
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<td>1766</td>
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<td>994</td>
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<td>Continued</td>
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<tr>
<td>No.</td>
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<td>Rakhi Nala Top</td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------</td>
<td>-----------------</td>
<td>----------------</td>
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<tr>
<td>23</td>
<td>Cytherella sp.F</td>
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<td>6985</td>
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<tr>
<td>24</td>
<td>Cytherella sp.G</td>
<td>6121</td>
<td>6985</td>
</tr>
<tr>
<td>25</td>
<td>Cytherelloidea cf. C. costatruncata</td>
<td>6121</td>
<td>7001</td>
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<td>7096</td>
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<tr>
<td>43</td>
<td>Schizocythere sp.B</td>
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<td>6524</td>
</tr>
<tr>
<td>47</td>
<td>Xestoleberis sp.G</td>
<td>6138</td>
<td>6931</td>
</tr>
</tbody>
</table>

+ Points omitted from computation.
I would like to express my sincere gratitude to Professor P. C. Sylvester-Bradley for his supervision, encouragement, constant help throughout this work, and for the use of the departmental facilities at Leicester. I am greatly indebted to Dr. F. E. Eames, lately Chief Palaeontologist of the British Petroleum Company Ltd., for his help and advice on the stratigraphy, particularly that of the Sulaiman Range, and for allowing me to examine East African Eocene ostracod collections at the BP Research Centre. Thanks are due especially to Dr. E. Triebel of the Senckenberg Museum, Frankfurt, G. M., for his instructions in photomicrography and for kindly permitting me to study the ostracod collection at the Museum. During my several visits to the British Museum (Natural History), I have been received with courtesy by Dr. J. P. Harding and Dr. R. H. Bate, who gave me free access to the ostracod collections under their care. I have profited from useful discussions with Professor R. A. Reyment which I had while on a study tour to Stockholm. He kindly allowed me to see his West African ostracod collection. Dr. P. Marks helped me during my stay at Utrecht and gave me free access to the van den Bold, Kingma and Keij Collections housed in the Geologisch Instituut.
I should like to thank Dr. F. T. Banner (British Petroleum) for examining some of the smaller foraminifera from the Rakhi Nala and Sor Range sections; Dr. C. G. Adams (British Museum, Natural History) for his help in identifying the genus *Pellatispira* from the Zao River; and Mr. J. A. Reinemund (U.S. Geological Survey) for the information on the Sor Range locality.

For the loan of samples, I am indebted to the following:
Standard Vacuum Oil Company, Karachi; The Director, Geological Survey of Pakistan, Quetta; Dr. I. Strachan, Birmingham University; Mr. D. J. Carter, Imperial College, London. I would like to acknowledge the following persons for comparative material: Mr. E. S. Pinfold, Geological Adviser of the Attock Oil Co. Ltd.; Dr. F. E. Eames, lately Chief Palaeontologist of the British Petroleum Co. Ltd.; Mr. I. G. Sohn, U.S.A.; Professor A. Wood, Aberystwyth; The Director, Oil and Gas Commission, India; Dr. R. H. Bate, British Museum (Natural History), London; Dr. W. A. van den Bold, U.S.A.; Dr. W. D. I. Rolfe, lately of the Hunterian Museum, Glasgow; Dr. N. Grekoff, France; Dr. R. C. Whatley, Aberystwyth; Dr. J. E. van Hinte, Holland; and Professor G. Ruggieri, Italy.

I would like to thank the departmental technical staff at Leicester, particularly Mr. M. Barker and Mr. G. McTurk for their assistance in photography. I am very grateful to Mrs. N. Farquharson for her patience in making the diagrams and charts and to Miss S. Austing who typed the thesis.
This work has been done during the tenure of a Leicester University Research Scholarship. The study tours to Frankfurt, Utrecht and Stockholm were made possible by two travelling grants from the Leicester University Research Board.
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PLATES
All specimens with the prefix GSP BM are to be sent to the Museum of the Geological Survey of Pakistan, Quetta. Those with the prefix Io. are to be sent to the British Museum (Natural History), London.
PLATE 1

Actinocythereis? quasibathonica sp. nov.

Figs.1-3,6,7,10-13.

Figs.1,10. Dorsal and right views, carapace male, x 70.
GSP BM 2507. Upper Chocolate Clays (lower part), sample 3613, Rakhi Nala.

Figs.2,3,11,12. Dorsal, ventral, left and right views, carapace female (holotype), x 70. GSP BM 2506. Upper Chocolate Clays (lower part), sample 3611, Rakhi Nala.

Fig.6. Dorsal view of hinge, left valve male, x 220.
GSP BM 2508. Upper Chocolate Clays (lower part), sample 3613, Rakhi Nala.

Figs.7,13. 7, dorsal view of hinge (x 230); 13, anterior radial pore canals (x 230). Right valve male. GSP BM 2509. Upper Chocolate Clays, sample 3611, Rakhi Nala.

Alocopocythere transcendens sp. nov.

Figs.4,5,8,9.

Figs.4,5,8,9. Dorsal, ventral, right and left views, carapace male, x 90. GSP BM 2511. Upper Chocolate Clays (lower part), sample 3607, Rakhi Nala.
Alocopocythere transcendens gen. et sp. nov.

Figs. 1-4, 6, 7.

Figs. 1, 6. External and dorsal views, left valve female (holotype), x 90. GSP BM 2510. Upper Chocolate Clays (lower part), sample 24148, Zao River.

Fig. 2. Muscle scars (x 200) showing four adductors and an oval frontal scar. Right valve male (broken), x 90. GSP BM 2514. Upper Chocolate Clays, sample 24151, Zao River.

Fig. 3. Anterior radial pore canals (x 128). Left valve female. GSP BM 2513. Upper Chocolate Clays (lower part), sample 24148, Zao River.

Figs. 4, 7. External and dorsal views, right valve female, x 90. GSP BM 2512. Upper Chocolate Clays (lower part), sample 24148, Zao River.

Alocopocythere rupina sp. nov.

Figs. 5, 8-10.

Figs. 5, 8-10. Right, left, dorsal and ventral views, carapace male (holotype), x 90. GSP BM 2515. Gorge Beds, sample 3111, Rakhi Nala.
PLATE 3

**Alocopocythere rupina** sp. nov.

Figs. 1-4. Left, right, dorsal and ventral views, carapace female, x 90. GSP BM 2516. Gorge Beds, sample 3111, Rakhi Nala.

**Alocopocythere abstracta** sp. nov.

Figs. 5-8. Left, dorsal, ventral and right views, carapace male, x 90. GSP BM 2517. Upper Rakhi Gaj Shales, sample 3163, Rakhi Nala.

Figs. 9-11. Right, dorsal and ventral views, carapace female (holotype), x 90. GSP BM 2518. Upper Rakhi Gaj Shales, sample 3163, Rakhi Nala.
Alocopocythere abstracta sp. nov.

Fig. 1. Left view, carapace female (holotype), x 90.
GSP EM 2518. Upper Rakhi Gaj Shales, sample 3163, Rakhi Nala.

Alocopocythere coarctata sp. nov.

Figs. 2-5. Dorsal, ventral, left and right views, carapace male, x 90. GSP EM 2519. Shales with Alabaster, sample 3448, Rakhi Nala.

Figs. 6-9. Dorsal, ventral, left and right views, carapace female (holotype), x 90. GSP EM 2520. Shales with Alabaster, sample 3448, Rakhi Nala.

Alocopocythere longilinea sp. nov.

Figs. 10-13. Dorsal, right, ventral and left views, carapace male (holotype), x 90. GSP EM 2521. Shales with Alabaster, sample 3443, Rakhi Nala.
PLATE 5

**Alocopocythere longilinea** sp. nov.

Figs.1-3,6. Left, right, dorsal and ventral views, carapace female, x 90. GSP BM 2522. Shales with Alabaster, sample 3443, Rakhi Nala.

**Alocopocythere transversa** sp. nov.

Morphotype A

Figs.4,5,7,9. Dorsal, ventral, left and right views, carapace male, x 90. GSP BM 2524. Upper Chocolate Clays (lower part), sample 24155, Zao River.

Figs.8,10. Left and right views, carapace female (holotype), x 90. GSP BM 2523. Upper Chocolate Clays (lower part), sample 24155, Zao River.
Alocopocythere transversa sp. nov.

**Morphotype A**

Figs. 1, 2. Dorsal and ventral views, carapace female (holotype), x 90. GSP BM 2523. Upper Chocolate Clays (lower part), sample 24155, Zao River.

Figs. 3, 4. Dorsal and internal views, right valve male, x 90. GSP BM 2525. Upper Chocolate Clays (lower part), sample 3625, Rakhi Nala.

**Morphotype C**

Figs. 5, 7. Left and right views, carapace male, x 90. GSP BM 2526. Upper Chocolate Clays (upper part), sample 24183, Zao River.

Figs. 6, 8. Left and right views, carapace female, x 90. GSP BM 2527. Upper Chocolate Clays (upper part), sample 24183, Zao River.
PLATE 7

Alocopocythere transversa sp. nov.

Morphotype C

Figs.1,2. Dorsal and ventral views, carapace male, x 90.
GSP EM 2526, Upper Chocolate Clays (upper part), sample 24183, Zao River.

Figs.3,4. Dorsal and ventral views, carapace female, x 90.
GSP EM 2527. Upper Chocolate Clays (upper part), sample 24183, Zao River.

Morphotype E

Figs.5-7. Dorsal, ventral and left views, carapace male, x 90. GSP EM 2529. Upper Chocolate Clays (upper part), sample 24175, Zao River.

Fig.8. Left view, carapace female, x 90. GSP EM 2530. Upper Chocolate Clays (upper part), sample 24175, Zao River.
PLATE 8

Alocopocythere transversa sp. nov.

Morphotype E

Fig.1. Right view, carapace male, x 90. GSP EM 2529.
Upper Chocolate Clays (upper part), sample 24175, Zao River.

Figs.2,3,5. Right, dorsal and ventral views, carapace female, x 90. GSP EM 2530. Upper Chocolate Clays (upper part),
sample 24175, Zao River.

Morphotype C

Fig.4. Muscle scars (x 200) showing four adducts, an oval
frontal and two mandibular scars. Right valve male (broken),
GSP EM 2528. Upper Chocolate Clays (upper part), sample 24174,
Zao River.

Morphotype F

Figs.6,8. Left and right views, carapace male, x 90.
GSP EM 2531. Upper Chocolate Clays (upper part), sample 3652,
Rakhi Nala.

Figs.7,9. Left and right views, carapace female, x 90.
GSP EM 2532. Upper Chocolate Clays (upper part), sample 3652,
Rakhi Nala.
PLATE 9

**Alocopocythere transversa** sp. nov.

Morphotype F

Figs. 1, 2. Dorsal and ventral views, carapace male, x 90.
GSP BM 2531. Upper Chocolate Clays (upper part), sample 3652, Rakhi Nala.

Figs. 3, 5. Dorsal and ventral views, carapace female, x 90.
GSP BM 2532. Upper Chocolate Clays (upper part), sample 3652, Rakhi Nala.

Fig. 4. Internal view to show radial pore canals, right valve female, x 108. GSP BM 2533. Upper Chocolate Clays (upper part), sample 24174, Zao River.

**Alocopocythere radiata** sp. nov.

Figs. 6, 8. Left and right views, carapace male (holotype), x 90. GSP BM 2534. Upper Chocolate Clays (upper part), sample 3652, Rakhi Nala.

Figs. 7, 9. Left and right views, carapace female, x 90.
GSP BM 2535. Upper Chocolate Clays (upper part), sample 3652, Rakhi Nala.
PLATE 10

**Alocopocythere radiata** sp. nov.

Figs. 1, 2. Dorsal and ventral views, carapace male (holotype), x 90. GSP BM 2534. Upper Chocolate Clays (upper part), sample 3652, Rakhi Nala.

Figs. 3, 4. Ventral and dorsal views, carapace female, x 90. GSP BM 2535. Upper Chocolate Clays (upper part), sample 3652, Rakhi Nala.

**“Anommatocythere” laqueta** sp. nov.

Figs. 5-7. Right, left and dorsal views, carapace male, x 70. GSP BM 2536. Green and Nodular Shales, sample 3403, Rakhi Nala.

Figs. 8-10. Left, right and dorsal views, carapace female (holotype), x 70. GSP BM 2537. Green and Nodular Shales, sample 3403, Rakhi Nala.

**“Anommatocythere” confirmata** sp. nov.

Figs. 11, 12. Right and left views, carapace male (holotype), x 70. GSP BM 2538. Upper Chocolate Clays (lower part), sample 3611, Rakhi Nala.
"Anommatocythere" confirmata sp. nov.

Figs. 1, 2. Dorsal and ventral views, carapace male (holotype), x 70. GSP BM 2538. Upper Chocolate Clays (lower part), sample 3611, Rakhi Nala.

Figs. 3. Anterior radial pore canals (x 232), left valve, GSP BM 2540. Upper Chocolate Clays (lower part), sample 24151, Zao River.

Figs. 4, 5, 8, 9. Dorsal, ventral, right and left views, carapace female, x 70. GSP BM 2539. Upper Chocolate Clays (lower part), sample 24148, Zao River.

Figs. 6, 7. Anterior and posterior radial pore canals (x 232), right valve male. GSP BM 2541. Upper Chocolate Clays (lower part), sample 24151, Zao River.
"Anommatocythere" confirmata sp. nov.

Fig. 1. Dorsal view of hinge (x 183), left valve male.
GSP BM 2540. Upper Chocolate Clays (lower part), sample 24151, Zao River.

Fig. 2. Dorsal view of hinge (x 183), right valve male.
GSP BM 2541. Upper Chocolate Clays (lower part), sample 24151, Zao River.

Bradleya? voraginosa sp. nov.

Figs. 3, 5, 7, 8. Dorsal, left, right and ventral views, carapace male (holotype), x 70. GSP BM 2542. Upper Chocolate Clays (upper part), sample 24161, Zao River.

Figs. 4, 6, 9. Dorsal, right and left views, carapace female, x 70. GSP BM 2543. Upper Chocolate Clays (upper part), sample 24161, Zao River.
**Buntonia de vexa** sp. nov.

Figs.1,3. Left and right views, carapace male, x 70.

GSP BM 2544. Gorge Beds, sample 3111, Rakhi Nala.

Figs.2,4,5. Left, dorsal and right views, carapace female (holotype), x 70. GSP BM 2545. Gorge Beds, sample 3111, Rakhi Nala.

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**Buntonia sp. A**

Figs.6,7,9. Left, right and dorsal views, carapace, x 70.

GSP BM 3076. Lower Rakhi Gaj Shales, sample 3133, Rakhi Nala.

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**Costa (Paracosta) declivis** subgen. et sp. nov.

Figs.8,10-12. Left, right, dorsal and ventral views, carapace male (holotype), x 68. GSP BM 2546. *Pellatispira* Beds, sample 3662, Rakhi Nala.

Fig.13. Right view, carapace female, x 68. GSP BM 2547. *Pellatispira* Beds, sample 3662, Rakhi Nala.

Fig.14. Left view, carapace female, x 68. GSP BM 2548. *Pellatispira* Beds, sample 3662, Rakhi Nala.
PLATE 14

Costa (Paracosta) declivis subgen. et sp. nov.

Fig.1. Dorsal view, carapace female, x 68. GSP BM 2547.

Pellatispira Beds, sample 3662, Rakhi Nala.

Fig.2. Ventral view, carapace female, x 68. GSP BM 2548.

Pellatispira Beds, sample 3662, Rakhi Nala.

Costa (Paracosta) compitalis sp. nov.

Figs.3,4,7,8. Dorsal, ventral, right and left views, carapace male, x 68. GSP BM 2549. Upper Chocolate Clays (lower part), sample 3604, Rakhi Nala.

Figs.5,6,9,10. Dorsal, ventral, right and left views, carapace female (holotype), x 68. Upper Chocolate Clays (lower part), sample 3604, Rakhi Nala.

Costa (Paracosta) disintegra sp. nov.

Fig.11. Left view, carapace male, x 68. GSP BM 2551.

Upper Chocolate Clays (lower part), sample 3622, Rakhi Nala.
PLATE 15

Costa (Paracosta) disintegrata sp. nov.

Figs.1,2,5,6. Left, right, dorsal and ventral views, carapace female (holotype), x 68. GSP BM 2552. Upper Chocolate Clays (lower part), sample 3621, Rakhi Nala.

Figs.3,4. Dorsal and ventral views, carapace male, x 68. GSP BM 2551. Upper Chocolate Clays (lower part), sample 3622, Rakhi Nala.

Echinocythereis (Echinocythereis) contexta sp. nov.

Figs.7,10. Left and dorsal views, carapace male, x 68. GSP BM 2553. Upper Palaeocene, sample 460-j, Sor Range, 8 miles east of Quetta.

Figs.8,13. Left and dorsal views, carapace female (holotype), x 68. GSP BM 2554. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Echinocythereis (Echinocythereis) elongata sp. nov.

Figs.9,11. Left and right views, carapace male, x 68. GSP BM 2555. Rubbly Limestones, sample 3416, Rakhi Nala.

Figs.12,14. Left and right views, carapace female (holotype), x 68. Rubbly Limestones, sample 3416, Rakhi Nala.
PLATE 16

Echinocythereis (Echinocythereis) elongata sp. nov.

Fig.1. Dorsal view, carapace female (holotype), x 68.
GSP BM 2556. Rubbly Limestones, sample 3416, Rakhi Nala.

Fig.2. Dorsal view, carapace male, x 68. GSP BM 2555.
Rubbly Limestones, sample 3416, Rakhi Nala.

Echinocythereis (Scelidocythereis) multibullata
subgen. et sp. nov.

Figs.5,6. Left and right views, carapace male (holotype), x 68. GSP BM 2557. Upper Chocolate Clays (upper part), sample 24161, Zao River.

Figs.7,8. Right and left views, carapace female, x 68. GSP BM 2558. Upper Chocolate Clays (upper part), sample 24161, Zao River.

Fig.9. Internal view to show radial pore canals, right valve female, x 132. GSP BM 2560. Upper Chocolate Clays (lower part), sample 24159, Zao River.
Echinocythereis (Scelidocythereis) multibullata sp. nov.

Fig.1. Dorsal view of hinge, left valve female, x 146.
GSP BM 2559. Upper Chocolate Clays (lower part), sample 24159, Zao River.

Fig.2. Dorsal view of hinge, right valve female, x 146.
GSP BM 2560. Upper Chocolate Clays (lower part), sample 24159, Zao River.

Fig.7. Ventral view, carapace male (holotype), x 68.
GSP BM 2557. Upper Chocolate Clays (upper part), sample 24161, Zao River.

Echinocythereis (Scelidocythereis) sp. A

Figs.3,4,8,9. Left, right, dorsal and ventral views, carapace, x 68. GSP BM 2561. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Echinocythereis (Scelidocythereis) rasilia sp. nov.

Figs.5,10. Left and ventral views, carapace male, x 68.
GSP BM 2562. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Fig.6. Left view, carapace female (holotype), x 68.
GSP BM 2563. Lower Chocolate Clays, sample 3499, Rakhi Nala.
PLATE 18

Echinocythereis (Scelidocythereis) rasilis sp. nov.

Fig.1. Dorsal view, carapace male, x 68. GSP BM 2562.
Lower Chocolate Clays, sample 3499, Rakhi Nala.

Figs.2,3. Dorsal and ventral views, carapace female (holotype), x 68. GSP BM 2563. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Fig.5. Right view, carapace male, x 68. GSP BM 3077.
Upper Chocolate Clays (lower part), sample 24157, Zao River.

Fig.7. Right view, carapace female, x 68. GSP BM 3078.
Upper Chocolate Clays (lower part), sample 24145, Zao River.

Echinocythereis (Scelidocythereis) sparsa sp. nov.

Figs.4,6. Dorsal and left views, carapace male, x 68.
GSP BM 2564. Upper Chocolate Clays (lower part), sample 24159, Zao River.

Figs.8,9. Dorsal and left views, carapace female (holotype), x 68. GSP BM 2565. Upper Chocolate Clays (lower part), sample 24159, Zao River.

Gyrocythere exaggerata gen. et sp. nov.

Figs.10,12. External and internal views, left valve male, x 68. GSP BM 2567. Upper Chocolate Clays (lower part), sample 24151, Zao River.

Figs.11,14. External and internal views, right valve male, x 68. GSP BM 2568. Upper Chocolate Clays (lower part), sample 24151, Zao River.

Fig.13. Dorsal view, carapace male (Specimen now split giving separate valves - GSP BM 2567-8 above.)
Gyrocythere exagerata gen. et sp. nov.

Figs.1-4. Left, right, dorsal and ventral views, carapace female (holotype), x 68. GSP BM 2566. Upper Chocolate Clays (lower part), sample 24151, Zao River.

Fig.5. Muscle scars (x 120) showing four adductors and a U-shaped frontal scar, right valve female. GSP BM 2572. Upper Chocolate Clays (lower part), sample 24148, Zao River.

Fig.6. Internal view to show radial pore canals, left valve male, x 134. GSP BM 2569. Upper Chocolate Clays (lower part), sample 24151, Zao River.

Fig.7. Internal view to show radial pore canals, right valve female, x 134. GSP BM 2570. Upper Chocolate Clays (lower part), sample 24148, Zao River.

Fig.8. Dorsal view of hinge (x 145), left valve male. GSP BM 3079. Upper Chocolate Clays (lower part), sample 24151, Zao River.

Fig.9. Dorsal view of hinge (x 145), right valve male. GSP BM 3080. Upper Chocolate Clays (lower part), sample 24151, Zao River.
PLATE 20

Gyrocythere exaegerata gen. et sp. nov.

Fig. 5. Dorsal view of hinge, right valve female, x 150.
GSP BM 2571. Upper Chocolate Clays (lower part), sample 24148, Zao River.

Gyrocythere parvicarinata sp. nov.

Figs. 1, 2, 6, 7. Right, left, dorsal and ventral views, carapace male (holotype), x 68. GSP BM 2573. Green and Nodular Shales, sample 3407, Rakhi Nala.

Figs. 3, 4, 8, 12. Right, left, dorsal and ventral views, carapace female, x 68. GSP BM 2574. Green and Nodular Shales, sample 3407, Rakhi Nala.

Gyrocythere grandilaevis sp. nov.

Figs. 9, 10. Left and right views, carapace male (holotype), x 68. GSP BM 2575. Shales with Alabaster, sample 3463, Rakhi Nala.

Figs. 11, 12. Left and right views, carapace female, x 68. GSP BM 2576. Shales with Alabaster, sample 3463, Rakhi Nala.
PLATE 21

**Gyrocythere grandilaevia** sp. nov.

Figs.1,2. Dorsal and ventral views, carapace male (holotype), x 68. GSP BM 2575. Shales with Alabaster, sample 3463, Rakhi Nala.

Figs.3,4. Dorsal and ventral views, carapace female, x 68. GSP BM 2576. Shales with Alabaster, sample 3463, Rakhi Nala.

**Gyrocythere mitigata** sp. nov.

Figs.5-8. Left, right, dorsal and ventral views, carapace male (holotype), x 70. GSP BM 2577. Lower Chocolate Clays, sample 24131, Zao River.

Figs.9,11. Dorsal and external views, left valve female, x 70. GSP BM 2579. Lower Chocolate Clays, sample 24131, Zao River.

Fig.10. Right view, carapace female, x 70. GSP BM 2578. Lower Chocolate Clays, sample 34131, Zao River.
PLATE 22

**Gyrocythere perfecta** sp. nov.

Figs. 1, 2, 5, 9. Left, right, dorsal and ventral views, carapace male, x 68. GSP BM 2581. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Figs. 3, 4, 7, 8. Left, right, dorsal and ventral views, carapace female (holotype), x 68. GSP BM 2580. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Fig. 6. Muscle scars (x 140), right valve male. GSP BM 2582. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Fig. 10. Internal view to show radial pore canals, right valve female, x 134. GSP BM 2583. Lower Chocolate Clays, sample 3498, Rakhi Nala.

**Hermanites cracens** sp. nov.

Fig. 11. Ventral view, carapace (holotype), x 70. GSP BM 2578. Gorge Beds, sample 3111, Rakhi Nala.
Hermanites cracens sp. nov.

Figs.1-3. Left, right and dorsal views, carapace (holotype), x 70. GSP BM 2584. Gorge Beds, Rakhi Nala.

Hermanites sconus sp. nov.

Figs.4-7. Left, dorsal, ventral and right views, carapace male (holotype), x 70. GSP BM 2585. Upper Chocolate Clays (lower part), sample 24148, Zao River.

Figs.8-10. Right, dorsal and ventral views, carapace female, x 70. Lower Chocolate Clays, sample 3499, Rakhi Nala.
Hermanites palmatus sp. nov.

Figs.1,2,5. Dorsal, ventral and left views, carapace male, x 70. GSP BM 2588. Upper Chocolate Clays (lower part), sample 24156, Zao River.

Figs.3,4,7. Dorsal, ventral and right views, carapace female, x 70. GSP BM 2589. Upper Chocolate Clays (lower part), sample 24156, Zao River.

Figs.6,8,9,11. Dorsal, external, internal and ventral views, left valve female (holotype), x 70. GSP BM 2587. Upper Chocolate Clays (lower part), sample 24152, Zao River.

Fig.12. External view, left valve female, x 70. GSP BM 2590. Upper Chocolate Clays (lower part), sample 3613, Rakhi Nala.

Occultocythereis interrupta sp. nov.

Figs.10,13,15,16. Left, right, dorsal and ventral views, carapace male, x 116. GSP BM 2591. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Figs.14,17,18. Right, dorsal and ventral views, carapace female (holotype), x 116. GSP BM 2592. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.
Occultocythereis sp. A

Figs. 1, 2, 5. Left, right and ventral views, carapace, x 116. GSP BM 2593. Lower Rakhi Gaj Shales, sample 3672, Rakhi Nala.

Occultocythereis spilota sp. nov.

Figs. 3, 4, 8, 9. Left, right, dorsal and ventral views, carapace male, x 120. GSP BM 2594. Green and Nodular Shales, sample 3177, Rakhi Nala.

Figs. 6, 7, 10, 11. Left, right, dorsal and ventral views, carapace female (holotype), x 120. GSP BM 2595. Green and Nodular Shales, sample 3177, Rakhi Nala.

Occultocythereis peristicta sp. nov.

Morphotype A

Figs. 13, 14, 17. Left, right and ventral views, carapace male, x 118. GSP BM 2597. Upper Rakhi Gaj Shales, sample 3167, Rakhi Nala.

Figs. 15, 16. Left and right views, carapace female (holotype), x 118. GSP BM 2596. Upper Rakhi Gaj Shales, sample 3167, Rakhi Nala.
Occultocythereis peristicta sp. nov.

Morphotype A

Fig. 1. Dorsal view, carapace male, x 118. GSP BM 2597. Upper Rakhi Gaj Shales, sample 3167, Rakhi Nala.

Figs. 2, 3. Dorsal and ventral views, carapace female (holotype), x 118. GSP BM 2596. Upper Rakhi Gaj Shales, sample 3167, Rakhi Nala.

Morphotype B

Figs. 4, 6, 7. Ventral, left and right views, carapace male, x 118. GSP BM 2598. Green and Nodular Shales, sample 3193, Rakhi Nala.

Figs. 5, 8, 9. Ventral, left and right views, carapace female, x 118. GSP BM 2599. Green and Nodular Shales, sample 3193, Rakhi Nala.

Morphotype C

Figs. 10-12. Ventral, left and right views, carapace male, x 118. GSP BM 2600. Green and Nodular Shales, sample 3191, Rakhi Nala.

Figs. 13-15. Left, right and ventral views, carapace female, x 118. GSP BM 2601. Green and Nodular Shales, sample 3191, Rakhi Nala.
Occultocythereis peristicta sp. nov.

Morphotype D

Figs. 1, 2, 5. Left, right and ventral views, carapace male, x 118. GSP BM 2602. Green and Nodular Shales, sample 3191, Rakhi Nala.

Figs. 3, 4, 6. Left, right and ventral views, carapace female, x 118. GSP BM 2603. Green and Nodular Shales, sample 3191, Rakhi Nala.

Morphotype E

Figs. 7, 9, 10. Ventral, right and left views, carapace male, x 118. GSP BM 2604. Rubbly Limestones, sample 3418, Rakhi Nala.

Figs. 8, 11, 12. Ventral, left and right views, carapace female, x 118. GSP BM 2605. Rubbly Limestones, sample 3418, Rakhi Nala.

Occultocythereis indistincta sp. nov.

Figs. 13, 14. Ventral and right views, carapace male, x 120. GSP BM 3002. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Fig. 15. Right view, carapace female (holotype), x 120. GSP BM 3003. Lower Chocolate Clays, sample 3499, Rakhi Nala.
Occultocythereis indistincta sp. nov.

Figs. 1, 3, 4. Left, dorsal and ventral views, carapace female, (holotype), x 120. GSP BM 3003. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Fig. 2. Dorsal view, carapace male, x 120. GSP BM 3002. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Patagonacythere? nidulus sp. nov.

Figs. 5-8. Left, right, dorsal and ventral views, carapace male, x 70. GSP BM 3004. Upper Chocolate Clays (upper part), sample 24173, Zao River.

Figs. 9-12. Left, right, dorsal and ventral views, carapace female (holotype), x 70. GSP BM 3005. Upper Chocolate Clays (lower part), sample 24173, Zao River.
Patagonacythere nidulus sp. nov.

Specimens showing exaggerated normal pores after being cleaned in the ultrasonic vibrator.

Figs. 1, 2. 1, Internal view to show radial pore canals, x 160; 2, Dorsal view of hinge, x 150. Left valve female, GSP BM 3006. Upper Chocolate Clays (upper part), sample 24170, Zao River.

Fig. 3. Dorsal view of hinge, right valve female, x 150. GSP BM 3007. Upper Chocolate Clays (upper part), sample 24170, Zao River.

Fig. 4. Muscle scars (x 260). Right valve male. GSP BM 3008. Upper Chocolate Clays (upper part), sample 24170, Zao River.

Phalcocythere horrescens (Bosquet) gen. nov.

Fig. 5. Anterior radial pore canals (x 212). Left valve. GSP BM 3010. Lutetian IV (sample CA B 1002, Keij 1957, p.19), Grignon, Paris Basin.
Phalcocythere horrescens (Bosquet) gen nov.

Figs. 1, 2. External and internal views, left valve, x 68. GSP BM 3081. Lutetian IV (sample CAB 1002, Keij 1957, p.19), Grignon, Paris Basin.

Figs. 3, 4. Dorsal and external views, left valve, x 68. GSP BM 3009. Lutetian IV (sample CAB 1002, Keij 1957, p.19), Grignon, Paris.

Fig. 5. Muscle scars (x 195). Right valve. GSP BM 3011. Lutetian IV (sample CAB 1002, Keij 1957, p.19), Grignon, Paris Basin.

Fig. 6. Internal view, right valve, x 132. GSP BM 3082. Lutetian, Villiers-St.-Frederic, Paris Basin.

Fig. 7. Anterior radial pore canals (x 224). Left valve female. GSP BM 3014. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Fig. 12. Anterior radial pore canals (x 224). Right valve female. GSP BM 3015. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.
PLATE 31

Phalcocythere improcera sp. nov.

Figs.1,2. Dorsal and ventral views, carapace male (holotype), x 68. GSP BM 3012. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Figs.3,4. Dorsal and ventral views, carapace female, x 68. GSP BM 3013. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Phalcocythere retispinata sp. nov.

Figs.5-8. Left, right, dorsal and ventral views, carapace male, x 68. GSP BM 3016. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Figs.9-10. Dorsal and left views, carapace female, x 68. GSP BM 3017. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Fig.11. External view, right valve female (holotype), x 68. GSP BM 3019. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Fig.12. External view, left valve female, x 68. GSP BM 3018. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Phalcocythere retispinata sp. nov.

Figs.13,14,17. Left, right and dorsal views, carapace male, x 68. GSP BM 3020. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Figs.15,16. Left and right views, carapace female (holotype), x 68. GSP BM 3021. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.
PLATE 32

**Phalcocythere retispinata** sp. nov.

Fig.1. Ventral view, carapace male, x 68. GSP BM 3020. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Figs.2,3. Ventral and dorsal views, carapace female (holotype), x 68. GSP BM 3021. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

**Phalcocythere sentosa** sp. nov.

Figs.4,5,8,10. Dorsal, left, right and ventral views, carapace male (holotype), x 68. GSP BM 3022. Upper Gaj Shales, sample 3167, Rakhi Nala.

Figs.6,7,9. Left, dorsal and right views, carapace female, x 68. GSP BM 3023. Upper Rakhi Gaj Shales, sample 3167, Rakhi Nala.

**Phalcocythere dissenta** sp. nov.

Figs.11,13,14,18. Left, right, dorsal and ventral views, carapace male (holotype), x 68. GSP BM 3024. Shales with Alabaster, sample 3456, Rakhi Nala.

Figs.12,15-17. Left, right, dorsal and ventral views, carapace female, x 68. GSP BM 3025. Shales with Alabaster, sample 3456, Rakhi Nala.
Phalcocythere spinosa sp. nov.

Figs.1,2,7,8. Left, right, dorsal and ventral views, carapace (holotype), x 68. GSP BM 3026. Upper Chocolate Clays (upper part), sample 24161, Zao River.

Phalcocythere sp., cf. P. spinosa

Figs.3,4,9. Left, right and ventral views, carapace male, x 68. Io.4230 Upper Eocene, Lindi survey, 10-50ft. above shore at Kitunga, Tanganyika.

Figs.5,6,10. Left, right and dorsal views, carapace female, x 68. Io.4231 Upper Eocene, Lindi survey, 10-50ft. above shore at Kitunga, Tanganyika.

Fig.11. Muscle scars (x 210), fragment of right valve female. Io.4232 Upper Eocene, Lindi survey, 10-50ft. above shore at Kitunga, Tanganyika.

Phalcocythere horrescens (Bosquet) gen. nov.

Fig.12. Dorsal view of hinge (x 183), left valve. GSP BM 3010. Lutetian IV (sample CAB 1002, Keij 1957, p.19), Grignon, Paris Basin.

Fig.13. Dorsal view of hinge (x 183), right valve. GSP BM 3011. Lutetian IV (sample CAB 1002, Keij 1957, p.19), Grignon, Paris Basin.

Quadracythere (Hornibrookella) platybomus sp. nov.

Figs.14,15. Right and dorsal view, carapace male (holotype), x 70. GSP BM 3027. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Figs.15,19. Right and dorsal views, carapace female, x 70. GSP BM 3028. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Quadracythere (Hornibrookella) directa sp. nov.

Fig.16. Left view, carapace male, x 70. GSP BM 3029. Green and Nodular Shales, sample 3403, Rakhi Nala.

Fig.17. Left view, carapace female (holotype), x 70. GSP BM 3030. Green and Nodular Shales, sample 3403, Rakhi Nala.
Plates 34

Quadracythere (Hornibrookella) directa sp. nov.
Fig. 1. Dorsal view, carapace male, x 70. GSP EM 3029. Green and Nodular Shales, sample 3403, Rakhi Nala.
Fig. 2. Dorsal view, carapace female, x 70. GSP EM 3030. Green and Nodular Shales, sample 3403, Rakhi Nala.

Quadracythere (Hornibrookella) arcana (Lubimova and Guha)
Figs. 3-5. Right, left and dorsal views, carapace, x 70. GSP EM 3031. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Quadracythere (Hornibrookella) subquadra sp. nov.
Figs. 6, 8, 9. Left, dorsal and ventral views, carapace male, x 70. GSP EM 3032. Upper Chocolate Clays (upper part), sample 24161, Zao River.
Figs. 7, 10, 11. Left, right and dorsal views, carapace female (holotype), x 70. GSP EM 3033. Upper Chocolate Clays (upper part), sample 24161, Zao River.

Quadracythere (Hornibrookella) sp. A
Figs. 12-14. Left, right and dorsal views, carapace, x 70. GSP EM 3034. Upper Chocolate Clays (lower part), sample 24148, Zao River.
Plate 33

Stigmatocythere obliqua gen. et sp. nov.

Fig. 1. Dorsal view, carapace male, x 92. Specimen lost.
Shales with Alabaster, sample 24173, Rakhi Nala.

Figs. 3, 4. Left and right views, carapace male, x 92.
GSP BM 3035. Shales with Alabaster, sample 24173, Rakhi Nala.

Figs. 2, 5, 6. Dorsal, left and right views, carapace female (holotype), x 92. GSP BM 3036. Shales with Alabaster, sample 24173, Rakhi Nala.

Fig. 7. Dorsal view, left valve female, x 92. GSP BM 3037.
Shales with Alabaster, sample 24173, Rakhi Nala.

Fig. 8. Dorsal view, right valve female, x 92. GSP BM 3038.
Shales with Alabaster, sample 24173, Rakhi Nala.

Fig. 9. Internal view to show radial pore canals, right valve female, x 160. GSP BM 3040. Shales with Alabaster, sample 24173, Rakhi Nala.

Fig. 10. Internal view to show radial pore canals, left valve female, x 160. GSP BM 3039. Shales with Alabaster, sample 24173, Rakhi Nala.
PLATE 36

Stigmatocythere obliqua gen. et sp. nov.

Fig. 1. Ventral view, carapace male, x 92. GSP HM 3035.
Shales with Alabaster, sample 24173, Rakhi Nala.

Fig. 2. Ventral view, carapace female (holotype), x 92.
Shales with Alabaster, sample 24173, Rakhi Nala.

Stigmatocythere portentum sp. nov.

Figs. 3-6. Dorsal, ventral, left and right views, carapace male (holotype), x 92. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Fig. 10. Anterior radial pore canals (x 216), fragment of right valve. GSP HM 3042.

Stigmatocythere calia sp. nov.

Fig. 7. External view, right valve male, x 92. GSP HM 3044.
Upper Chocolate Clays (lower part), sample 24152, Zao River.

Figs. 8, 9. Right and dorsal views, carapace female (holotype), x 92. GSP HM 3045. Upper Chocolate Clays (lower part), sample 24151, Zao River.
PLATE 37

**Stigmatocythere calia** sp. nov.

Figs. 1, 3. Left and ventral views, carapace female (holotype), x 92. GSP BM 3045. Upper Chocolate Clays (lower part), sample 24151, Zao River.

**Stigmatocythere delineata** sp. nov.

Figs. 2, 4, 5, 6. Left, dorsal, right and ventral views, carapace male, x 92. GSP BM 3046. Upper Chocolate Clays (lower part), sample 24154, Zao River.

Figs. 7-10. Dorsal, left, right and ventral views, carapace female (holotype), x 92. GSP BM 3047. Upper Chocolate Clays (lower part), sample 24154, Zao River.

**Stigmatocythere lumaria** sp. nov.

Fig. 11. Anterior radial pore canals (x 150), right valve female. GSP BM 3053. Upper Chocolate Clays (upper part), sample 24174, Zao River.
PLATE 38

_Stigmatocythere lumaria_ sp. nov.

Morphotype A

Figs.1,5,6. Left, dorsal and ventral views, carapace male (holotype), x 92. GSP EM 3048. Upper Chocolate Clays (upper part), sample 3642, Rakhi Nala.

Figs.2,4,7. External, internal and dorsal views, right valve male, x 92. GSP EM 3051. Upper Chocolate Clays (upper part), sample 3630, Rakhi Nala.

Figs.3,8. External and dorsal views, right valve female, x 92. GSP EM 3049. Upper Chocolate Clays (upper part), sample 3630, Rakhi Nala.

Fig.9. Dorsal view of hinge (x 240), left valve female. GSP EM 3052. Upper Chocolate Clays (upper part), sample 24174, Zao River.

Fig.10. Dorsal view of hinge (x 240), right valve female, GSP EM 3053. Upper Chocolate Clays (upper part), sample 24174, Zao River.
Stigmatocythere lumaria sp. nov.

Morphotype B

Figs. 1-4. Left, right, dorsal and ventral views, carapace male, x 92. GSP BM 3054. Upper Chocolate Clays (upper part), sample 3649, Rakhi Nala.

Figs. 5-8. Left, dorsal, ventral and right views, carapace female, x 92. GSP BM 3055. Upper Chocolate Clays (upper part), sample 3649, Rakhi Nala.

Morphotype A

Fig. 11. Anterior radial pore canals (x 232), left valve male (juv.). GSP BM 3050. Upper Chocolate Clays (upper part), sample 24174, Zao River.

Trachyleberis (Trachyleberis) lobulus sp. nov.

Figs. 9, 10. Left and dorsal views, carapace male, x 94. GSP BM 3056. Upper Rakhi Gaj Shales, sample 3163, Rakhi Nala.
PLATE 40

Trachyleberis (Trachyleberis) lobuculus sp. nov.
Figs.1,3. Left and dorsal views, carapace female (holotype), x 94. GSP BM 3057. Upper Rakhi Gaj Shales, sample 3166, Rakhi Nala.

Trachyleberis (Trachyleberis) bimammillata sp. nov.
Figs.2,8,10. Left, right and dorsal views, carapace male (holotype), x 94. GSP BM 3058. Upper Chocolate Clays (lower part), sample 3613, Rakhi Nala.

Fig.4. Dorsal view, left valve female, x 94. GSP BM 3061. Upper Chocolate Clays (lower part), sample 3613, Rakhi Nala.

Fig.5. Dorsal view, right valve female, x 94. GSP BM 3062. Upper Chocolate Clays (lower part), sample 3614, Rakhi Nala.

Fig.6. Dorsal view, carapace male, x 94. GSP BM 3074. Upper Chocolate Clays (lower part), sample 3613, Rakhi Nala.

Fig.7. Dorsal view, carapace female, x 94. GSP BM 3075. Upper Chocolate Clays (lower part), sample 3613, Rakhi Nala.

Fig.9. Left view, carapace female, x 94. GSP BM 3059. Upper Chocolate Clays (lower part), sample 3613, Rakhi Nala.

Fig.11. Muscle scars (x 172), fragment of left valve male. GSP BM 3060. Upper Chocolate Clays (lower part), sample 3613, Rakhi Nala.

Trachyleberis (Acanthocythereis) procansus sp. nov.
Fig.12. Left view, carapace male (holotype), x 94. GSP BM 3063. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Fig.13. Left view, carapace female, x 94. GSP BM 3094. Upper Palaeocene, sample 460-j, Sor Range, 8 miles east of Quetta.
PLATE 41

Trachyleberis (Acanthocythereis) procapsus sp. nov.
Figs. 1, 3. Right and dorsal views, carapace male (holotype), x 94. GSP BM 3063. Upper Palaeocene, sample 460-i, Sor Range, 8 miles east of Quetta.

Fig. 4. Dorsal view, carapace female, x 94. GSP BM 3064. Upper Palaeocene, sample 460-j, Sor Range, 8 miles east of Quetta.

Trachyleberis (Acanthocythereis) usitata sp. nov.
Fig. 2. Right view, carapace male (holotype), x 94. GSP BM 3065. Gorge Beds, sample 3111, Rakhi Nala.

Figs. 5, 7. Left and right views, carapace female, x 94. GSP BM 3066. Gorge Beds, sample 3111, Rakhi Nala.

Trachyleberis (Acanthocythereis) pedigaster sp. nov.
Figs. 6, 8. Right and left views, carapace (holotype), x 70. GSP BM 3067. Lower Rakhi Gaj Shales, sample 3671, Rakhi Nala.

Trachyleberis (Acanthocythereis) postcornis sp. nov.
Fig. 9. Left view, carapace male (holotype), x 94. GSP BM 3068. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Fig. 10. Left view, carapace female, x 94. GSP BM 3069.
PLATE 42

Trachyleberis (Acanthocythereis) postcornis sp. nov.

Fig.1. Dorsal view, carapace male (holotype), x 94. GSP BM 3068. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Fig.2. Dorsal view, carapace female, x 94. GSP BM 3069. Lower Chocolate Clays, sample 3499, Rakhi Nala.

Figs.7, 10. 7, Dorsal view of hinge, x 232. 10, Internal view to show radial pore canals, x 178. Right valve female. GSP BM 3071. Lower Chocolate Clays, sample 3498, Rakhi Nala.

Trachyleberis (Acanthocythereis) decoris sp. nov.

Figs. 3-5. Dorsal, left and right views, carapace male (holotype), x 94. GSP BM 3072. Upper Chocolate Clays (upper part), sample 3640, Rakhi Nala.

Figs. 6, 8, 9. Dorsal, left and right views, carapace female, x 94. GSP BM 3073. Upper Chocolate Clays (upper part), sample 3640, Rakhi Nala.
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<td>Anommatocythere laqueta sp. nov.</td>
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<td>Alocopocythere radiata sp. nov.</td>
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W. M. B. = White Marl Band
L. C. C. = Lower Chocolate Clays
P. L. = Platy Limestone
S. W. A. = Shales with Alabaster

Stratigraphic frequency of the ostracod family, Trachyleberididae

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W. M. B. = White Marl Band
L. C. C. = Lower Chocolate Clays
P. L. = Platy Limestone
S. W. A. = Shales with Alabaster


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**Chocolate Clays, Lower part**

**Upper Chocolate Clays Upper part**

**THAR**

**EOCENE**

**“TAPTI”**

**UPPER EOCENE**

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*Steberididae, in the Eocene of the Zao River.*
SOME EARLY TERTIARY OSTRACODS FROM WEST PAKISTAN

by Q. A. Siddiqui

ABSTRACT

Ostracoda from the Palaeocene of the Sor Range and from the Palaeocene and Eocene of the Rakhi Nala, Zao River and Shpalai Khwara sections, Sulaiman Range, West Pakistan, have been examined. The family TRACHYLEBERIDIDAE has been studied in detail. It is represented by fourteen genera, 4 subgenera and sixty-one species. Four new genera (Alocopocythere, Gyrocythere, Phalcocythere and Stigmatocythere) and two new subgenera (Paracosta and Scelidocytheres) are proposed. Out of the sixty-one species described, fifty-two are new.

The Palaeocene and Eocene of the Rakhi Nala section is divided into five ostracod biostratigraphic units. The biostratigraphic units IV and V of the Rakhi Nala are represented in the Zao River section and have almost identical ostracod faunas. The biostratigraphic unit IV of the Rakhi Nala is also represented in the Shpalai Khwara section. The Equations of Correlation between the Rakhi Nala and Zao River sections for biostratigraphic unit V (i.e. Middle - Upper Eocene) have been calculated by means of ranges of ostracod species common to the two sections. The standard errors of estimate for the Equations of Correlation have also been calculated. The boundaries between the Palaeocene - Lower Eocene, Lower - Middle Eocene and Middle - Upper Eocene in the Sulaiman Range are discussed.