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PALEOCENE AND LOWER EOCENE OSTRACODA FROM THE UMM ER RADHUMA FORMATION OF SAUDI ARABIA[1]

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Abstract.—Six species and one subspecies of trachyleberidid ostracodes are described and illustrated from the Umm er Radhuma Formation (Paleocene-Lower Eocene). Of these, four are new species, *Gyrocythere celata*, *Hermanites straba*, *Anommatocythere porata*, and *Hornibrookella abdulrazzaqi*; and one is a new subspecies, *Hornibrookella quinquecellulosa irregularis*.

THE UMM ER RADHUMA Formation is divided into two major units, an upper dolomitic limestone of early Eocene age and a lower limestone-shale unit of Paleocene age. These units, designated "upper Umm er Radhuma" and "lower Umm er Radhuma" respectively, are separated by an unconformity that causes loss of section locally in crested areas.

The upper Umm er Radhuma is more porous than the lower unit, consisting of tan to brown, crystalline, granular dolomite with subordinate amounts of cream to tan, fine- to medium-grained, porous limestone. Thickness of the upper Umm er Radhuma ranges from about 100 feet in crestal Ghawar wells to 330 feet at Abu Hadriya. Lithology of the lower Umm er Radhuma is quite variable but commonly contains more limestone and shale than dolomite. Chert occurs at several levels in the upper half of this unit, but it is hazardous to base correlation on such occurrences. Thickness of the lower Umm er Radhuma ranges from 800 feet in the crestal area of the Ghawar oil field to about 1,300 feet at Abu Hadriya and in the central Rub'al-Khali (see Powers and others, 1966; Powers, 1968, for more stratigraphic details).

Thicknesses measured in several wells (Table 1) show that the Umm er Radhuma Formation in the subsurface thickens to the north, east, and south of the reference section (lat 27°38'03" N., long 44°53'24" E. to lat 27°59' N., long 45°27'48" E.). The rate of deposition was greater to the north of the reference section, shown by the thickness in Safaniya W-3.

The upper contact of the Umm er Rad-

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Table 1. *Thicknesses (in feet) of the Umm er Radhuma Formation based on Well Measurements.*

Well	Lat.	Long.	Thickness
ST-23	23°36′	51°17′	1,105
S-1132	23°44′	48°53′	1,130
G. Uthmaniyah W-4	25°113′	49°00′	880
S-710 WW	25°13′	48°21′	680
Ain Dar W-1	25°55′	49°14′	1,150
S-877 WW	26°32′	47°14′	880
Abqaiq W-69	26°22′	49°50′	1,250
El-Alat W-1	26°28′	49°50′	1,265
S-111	26°36′	46°55′	740
Abu Hadriya W-1	27°22′	48°59′	1,620
S-474	27°50′	45°58′	1,090
Safaniya W-3	28°01′	48°43′	1,900
S-468	28°38′	45°39′	1,265

huma is not exposed at the reference section because of overlapping Miocene and Pliocene rocks, but Powers and others (1966) reported that the top is present a short distance downdip in trial holes and in water wells where Umm er Radhuma dolomite containing *Lockhartia hunti pustulosa* Smout is overlain by soft chalky Rus Limestone. The base of the Umm er Radhuma is placed below dolomite and limestone with *Rotalia jacobi* Sander, and above dark-gray or black lignitic shale of the Aruma Formation, which contains *Fissoelphidium operculiferum* Smout and *Omphalocyclus macroporus* (Lamarck).

Apart from my previous work (1975, 1977, 1980) and my work with Siddiqui (Al-Furaih and Siddiqui, 1981; Siddiqui and Al-Furaih, 1981), the Paleocene and Eocene ostracodes of Saudi Arabia and nearby areas are virtually undescribed. Therefore, most of the species described here are new. The Paleocene ostracodes appear to be of greater stratigraphical value than those of the Eocene, the latter being rare and less well known. As a matter of fact, petroleum geologists there use ostracodes more than foraminifera to correlate Paleocene rocks. There remains, however, much work to be done.

The fact that the Arabian Paleocene and Eocene ostracodes differ from those described from rocks of the same age in North Africa, Europe, and North America suggests that there was no direct marine connection between these areas at that time. Those from the Indian subcontinent and from east Africa, however, are more closely comparable and suggest a marine connection.

Materials for this investigation are subsurface cutting samples from test well ST-23 drilled by the Arabian American Oil Company (Fig. 1). Ostracode terminology used in this paper follows that of Moore (1961), Sylvester-Bradley and Benson (1971), and Van Morkhoven (1962, 1963). Figured specimens are deposited with collections of the Geology Department, King Saud University, Riyadh, Saudi Arabia.

Fig. 1. Outcrops map of Umm er Radhuma Formation (Paleocene-Lower Eocene) and location of well from which ostracodes were obtained.

Acknowledgments.—Roger L. Kaesler critically read the typescript of this paper and placed his collection at my disposal. Abdullah Al-Shamlan arranged for the samples used in this study, and Ibrahim A. Al-Zaid of King Saud University and Lorraine Hammer of the University of Kansas gave technical assistance. The Deputy Ministry of Petroleum for Technical Affairs and Companies of Saudi Arabia provided the samples. King Saud University provided financial support.

SYSTEMATIC PALEONTOLOGY

Order PODOCOPIDA Müller, 1894
Suborder PODOCOPINA Sars, 1866
Superfamily CYTHERACEA Baird, 1850
Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948
Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948

Genus GYROCYTHERE Siddiqui, 1971

Gyrocythere celata sp. nov.

Plate 3, figures 1, 2

Derivation of name.—Latin, for the celate reticulation.

Diagnosis.—A species with celate reticulation. Dorsal and ventral ridges distinct. Median ridge behind subcentral tubercle, curved upward, less well developed.

Holotype.—Male carapace (Pl. 3, fig. 2), KSU.G.OS. 144.

Material.—Eighteen specimens from ST-23 (depth 1,395-1,500 ft).

Type locality and horizon.—ST-23, sample 1,495-1,500 feet below surface, Umm er Radhuma Formation, Lower Eocene.

Dimensions (mm).—Paratype, male right valve (KSU.G.OS. 143): length, 0.91; height, 0.46. Holotype, male carapace (KSU.G.OS. 144): length, 0.91; height, 0.46; width, 0.39.

Description.—Carapace subrectangular in lateral view with posterodorsal slope concave, particularly in right valve. Greatest length through midpoint; greatest height through anterior cardinal angle. Posterior cardinal process prominent, especially in left valve. Left valve slightly overreaching right in anterodorsal area and at posterodorsal slope. Subcentral tubercle distinct. Eye tubercle rounded and prominent. Shell surface ornamented with celate reticulation to form a trefoil pattern. Three longitudinal ridges: dorsal ridge starting below and behind eye tubercle, curving upward in middle; median ridge behind subcentral tubercle, curving upward, less well developed (very poorly defined in some specimens); ventrolateral ridge well marked, starting anteriorly above anteroventral corner, running slightly upward toward posterior, disappearing in posterior third. Small marginal denticles often apparent on anterior and posterior margins. Denticles may be absent, depending on state of preservation. Duplicature of moderate width. Hinge holamphidont. Other internal details not observed.

Remarks.—*Gyrocythere celata* sp. nov. is similar to *G. mitigata* Siddiqui (1971) from the middle Eocene in Pakistan, but has celate reticulation, less well-developed dorsal and ventrolateral ridges, and a less prominent anterior hinge ear.

Genus HERMANITES Puri, 1955

Hermanites straba sp. nov.

Plate 2, figures 3-5

Derivation of name.—Latin, oblique; with reference to oblique ribs in the posterior half of the valves.

Diagnosis.—Coarsely reticulated shell surface. Areas between rows of reticula upraised to form ribs in posterior half of carapace. Eye and subcentral tubercles distinct.

Holotype.—Male right valve (Pl. 2, fig. 3), KSU.G.OS. 151.

Material.—Nineteen specimens from ST-23 (depth 2,145-2,500 ft).

Type locality and horizon.—ST-23, sample 2,345-2,350 feet below surface, Umm er Radhuma Formation, Paleocene.

Dimensions (mm).—Holotype, male right valve (KSU.G.OS. 151): length, 0.89; height, 0.45. Paratype, female carapace (KSU.G.OS. 152): length, 0.88; height, 0.50. Paratype, male left valve (KSU.G.OS. 153): length, 0.89; height, 0.49.

Description.—Sexual dimorphism rather marked; females more quadrate than males. Carapace subrectangular with distinct caudal process. Shell surface reticulate with tendency toward development of ribs, especially in posterior half of valve. Small marginal denticles common on posterior and anterior margins. Denticles may be absent, depending on preservation. Ventrolateral and dorsal ridges prominent. Subcentral and eye tubercles well developed. Normal pore canals of two kinds: intramural (poorly preserved and difficult to observe) and those opening into solum of each reticulum. Duplicature of moderate width, selvage peripheral in left valve, bordered by flange in right valve. Hinge holamphidont.

Remarks.—*Hermanites straba* sp. nov. resembles *H. tranquillis* Al-Furaih (1980) but differs in having ribs in the posterior half of the carapace. Furthermore, the posterior end of the dorsal ridge in *H. straba* is heavier and the subcentral tubercle is more distinct.

Tribe ECHINOCYTHEREIDINI Hazel, 1967
Genus ALOCOPOCYTHERE Siddiqui, 1971

Alocopocythere immodica Al-Furaih, 1980

Plate 1, figures 1, 2

Alocopocythere immodica Al-Furaih, 1980, p. 24-25, pl. 16, fig. 1-4.

Material.—Eleven specimens from ST-23 (depth 2,345-2,350 ft).

Locality and horizon.—ST-23, sample 2,345-2,350 feet below surface, Umm er Radhuma Formation, Paleocene.

Dimensions (mm).—Male carapace (KSU.G.OS. 141): length, 0.66; height, 0.38; width, 0.44. Female right valve (KSU.G.OS. 142): length, 0.64; height, 0.39.

Genus ANOMMATOCYTHERE Sohn, 1970

Anommatocythere porata sp. nov.

Plate 3, figures 3, 4, 6

Derivation of name.—Latin, *porus*.

Diagnosis.—Coarsely pitted shell surface. Carapace subovate in lateral view, ventrally inflated. Posterior end with distinct causal process.

Holotype.—Male right valve (Pl. 3, fig. 3), KSU.G.OS. 157.

Material.—Seventeen specimens from ST-23 (depth 2,345-2,350 ft).

Type locality and horizon.—ST-23, sample 2,345-2,350 feet below surface, Umm er Radhuma Formation, Paleocene.

Dimensions (mm).—Holotype, male right valve (KSU.G.OS. 157): length, 0.93; height, 0.50. Paratype, female left valve (KSU.G.OS. 158): length, 0.88; height, 0.54. Paratype, male right valve (KSU.G.OS. 159): length, 1.08; height, 0.53.

Description.—Carapace subovate in lateral view, ventrally inflated. Anterior margin rounded, posterior end with caudal process, posterodorsal slope concave. Dorsal margin convex, ventral margin appearing convex in lateral view due to ventral inflation. Posterior cardinal angle distinct. Line of greatest length passing below mid-height. Shell surface strongly pitted. Pits rounded, normal pore in each pit. Duplicature of moderate width with a well-marked selvage. Muscle scars consisting of four elongate adductor scars in a subcrescentic row and two more or less rounded frontal scars. Hinge holamphidont. Sexual dimorphism distinct; males more elongate than females.

Remarks.—*Anommatocythere porata* sp. nov. resembles *A. canistrum* Al-Furaih and Siddiqui (1981) but *A. porata* has a less distinct posterior cardinal angle and the fossae are smaller and rounded. *A. porata* also resembles *A. microreticulata* Sohn (1970) but *A. porata* is less inflated ventrally and its surface has widely spaced and rounded pits.

Tribe THAEROCYTHERINI Hazel, 1967
Genus HORNIBROOKELLA Moos, 1965

Hornibrookella abdulrazzaqi sp. nov.

Plate 1, figures 3-6

Derivation of name.—In honor of Dr. Sabeeka Al-Abdul-Razzaq for her important contributions to Arabian Gulf micropaleontology.

Diagnosis.—Shell surface coarsely and beautifully reticulate. Fossae rounded with thick muri. Carapace subrectangular with distinct caudal process.

Holotype.—Female left valve (Pl. 1, fig. 4), KSU.G.OS. 146.

Material.—Thirty-two specimens from ST-23 (depth 2,145-2,500 ft).

Type locality and horizon.—ST-23, sample 2,345-2,350 feet below surface, Umm er Radhuma Formation, Paleocene.

Dimensions (mm).—Holotype, female left valve (KSU.G.OS. 146): length, 0.84; height, 0.45. Paratype, female right valve (KSU.G.OS. 145): length, 0.84; height, 0.45. Paratype, female left valve (KSU.G.OS. 147): length, 0.84; height, 0.48. Paratype, male right valve (KSU.G.OS. 148): length, 0.85; height, 0.45.

Description.—Sexual dimorphism rather strong; males longer and less high than females. Carapace subrectangular in lateral view with a distinct caudal process. Anterior and posterior cardinal angles distinct. Left valve overreaching right slightly in region of posterodorsal slope and at anterior cardinal angle. Subcentral

tubercle present, covered by reticula. Eye tubercle rounded and distinct. Shell surface coarsely and deeply reticulate. Ventrolateral ridge well developed; dorsal ridge distinct and convex upward. A third ridge intercalated between ventrolateral ridge and ventral margin, extending obliquely downward from posterior end of ventrolateral ridge to end in mid-ventral area. Anterior margin finely denticulate, posterior margin with large denticles. Duplicature of moderate width. Selvage prominent in both valves, submarginal in left valve, in outer third of duplicature in right valve. Muscle scars in a vertical row of four elongate adductor and two frontal scars. Hinge holamphidont.

Remarks.—*Hornibrookella abdulrazzaqi* sp. nov. resembles *H. posterisella* Al-Furaih (1977) but differs in having a well-developed caudal process and well-marked posterodorsal slope. *Hornibrookella subquadra* (Siddiqui, 1971) has a more rounded anterior cardinal angle (especially in the left valve) and higher eye tubercle. *Bradleya lagaghiroboensis* Apostolescu (1961) from the Paleocene of the Ivory Coast compares closely in side view but lacks the anterior hinge ear in the left valve, and the eye tubercle is situated at a higher position.

Hornibrookella cyclopea Al-Furaih, 1977

Plate 2, figures 1, 2, 7

Hornibrookella cyclopea Al-Furaih, 1977, p. 486-488, pl. 54, fig. 1-4, text-fig. 4; 1980, p. 42, pl. 35, fig. 1.

Material.—Seven specimens from ST-23 (depth 2,345-2,350 ft).

Locality and horizon.—ST-23, sample 2,345-2,350 feet below surface, Umm er Radhuma Formation, Paleocene.

Dimensions (mm).—Female, right valve (KSU.G.OS. 149): length, 0.98; height, 0.56. Female, left valve (KSU.G.OS. 150): length, 0.96; height, 0.58.

Remarks.—Muscle scars are in a vertical row of four elongate adductors and two rounded frontal scars.

Hornibrookella quinquecellulosa irregularis subsp. nov.

Plate 2, figures 6, 8; Plate 3, figure 5

Derivation of name.—Latin, irregular, with reference to shape of fossae.

Diagnosis.—A subspecies of *Hornibrookella quinquecellulosa* with spongy reticulation. Muscle scars in vertical row of four elongate adductor and two rounded frontal scars.

Holotype.—Female right valve (Pl. 2, fig. 8), KSU.G.OS. 154.

Material.—Fourteen specimens from ST-23 (depth 2,345-2,500 ft).

Type locality and horizon.—ST-23, sample 2,345-2,350 feet below surface, Umm er Radhuma Formation, Paleocene.

Dimensions (mm).—Holotype, female right valve (KSU.G.OS. 154): length, 0.90; height, 0.55. Paratype, male left valve (KSU.G.OS. 155): length, 0.91; height, 0.53. Paratype, male right valve (KSU.G.OS. 156): length, 0.91; height, 0.53.

Remarks.—This subspecies is almost identical to *Hornibrookella quinquecellulosa s.s.* except in its spongy reticulation. The muscle scars are clearly seen in this form. For other details, see Al-Furaih (1977 and 1980).

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EXPLANATION OF PLATE 1

FIGURE

1,2. *Alocopobythere immodica* Al-Furaih, 1980., Paleocene. ——*1.* Male carapace, right-lateral view, ×94, KSU.G.OS. 141.——*2.* Female right valve, internal lateral view, ×96, KSU.G.OS. 142.

3-6. *Hornibrookella abdulrazzaqi* sp. nov., Paleocene. ——*3.* Female right valve, paratype, external lateral view, ×74, KSU.G.OS. 145.——*4.* Female left valve, holotype, external lateral view, ×75, KSU.G.OS. 146.——*5.* Stereopair, female left valve, paratype, internal lateral view, ×74, KSU.G.OS. 147.——*6.* Stereopair, male right valve, paratype, internal lateral view, ×73, KSU.G.OS. 148.

EXPLANATION OF PLATE 2

FIGURE

1,2,7. *Hornibrookella cyclopea* Al-Furaih, 1977, Paleocene. ——*1,7.* Female right valve, KSU.G.OS. 149; *1*, external lateral view, ×63; *7*, internal lateral view, ×65.——*2.* Female left valve, external lateral view, ×65, KSU.G.OS. 150.

3-5. *Hermanites straba* sp. nov., Paleocene.——*3.* Male right valve, holotype, external lateral view, ×69, KSU.G.OS. 151.——*4.* Female carapace, paratype, left-lateral view, ×70, KSU.G.OS. 152. ——*5.* Male left valve, paratype, internal lateral view, ×69, KSU.G.OS. 153.

6,8. *Hornibrookella quinquecellulosa irregularis* subsp. nov., Paleocene.——*6.* Male left valve, paratype, external lateral view, ×68, KSU.G.OS. 155.—— *8.* Female right valve, holotype, external lateral view, ×69, KSU.G.OS. 154.

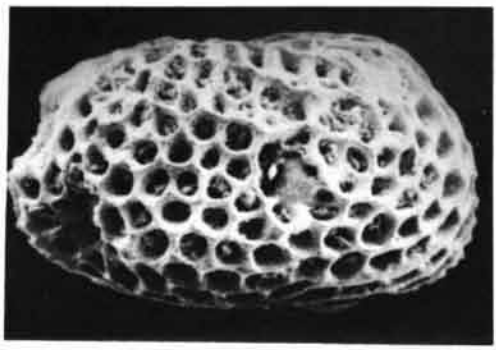
EXPLANATION OF PLATE 3

FIGURE

1,2. *Gyrocythere celata* sp. nov., Lower Eocene.——*1.* Male right valve, paratype, external lateral view, ×68, KSU.G.OS. 143.——*2.* Male carapace, holotype, left-lateral view, ×69, KSU.G.OS. 144.

3,4,6. *Anommatocythere porata* sp. nov., Paleocene.——*3.* Male right valve, holotype, external lateral view, ×66, KSU.G.OS. 157.——*4.* Female left valve, paratype, external lateral view, ×70, KSU.G.OS. 158.——*6.* Stereopair, male right valve, paratype, internal lateral view, ×57, KSU.G.OS. 159.

5. *Hornibrookella quinquecellulosa irregularis* subsp. nov., Paleocene. Stereopair, male right valve, paratype, internal lateral view, ×68, KSU.G.OS. 156.



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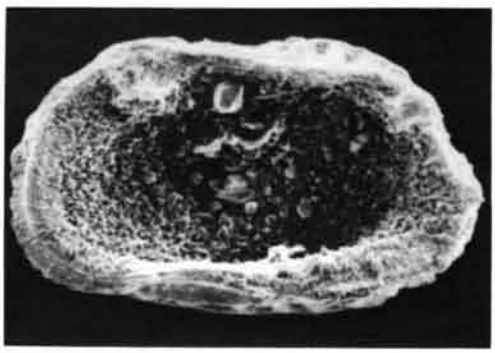

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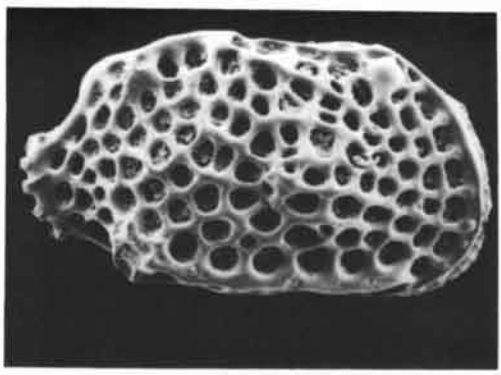

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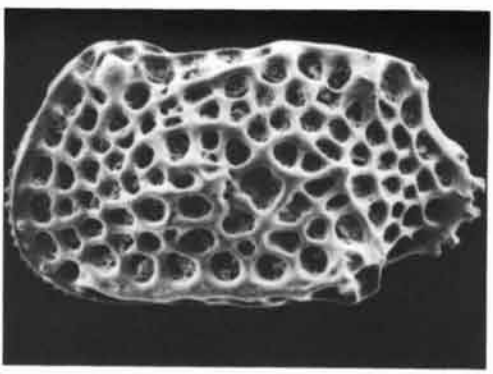

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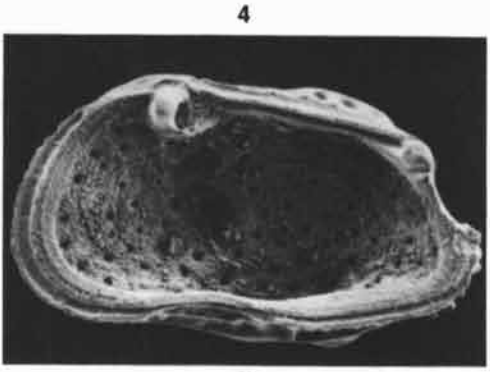

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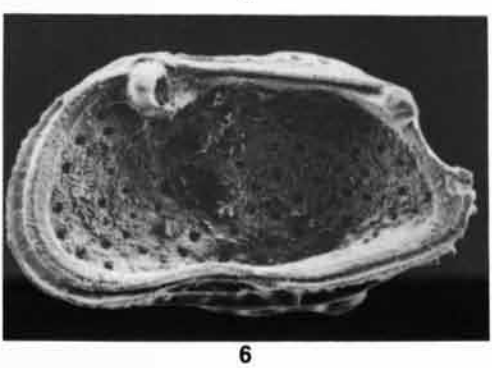

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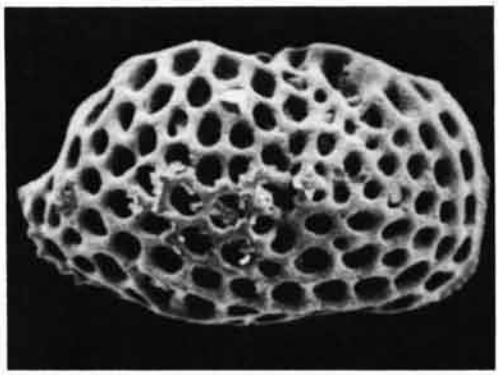

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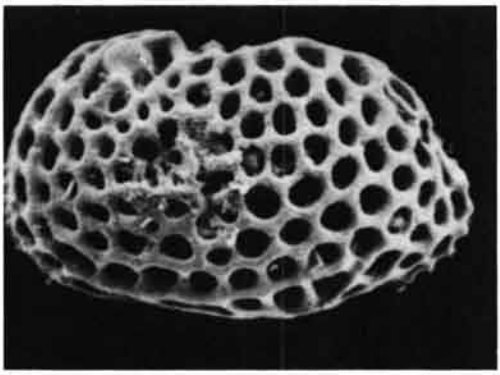

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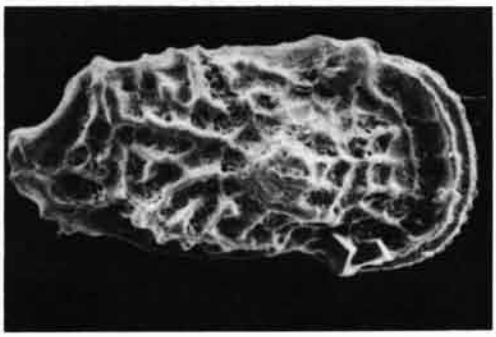

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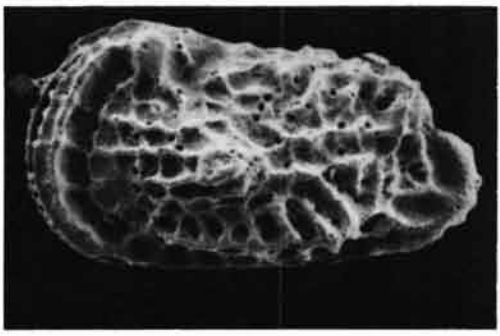

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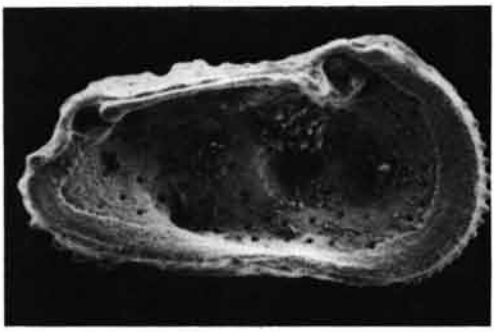

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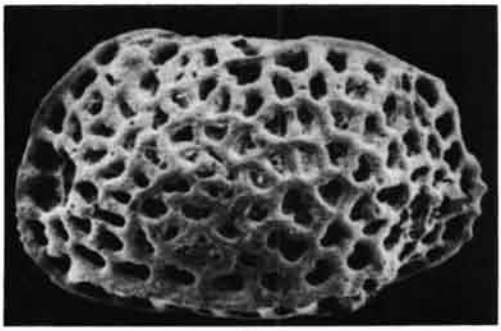

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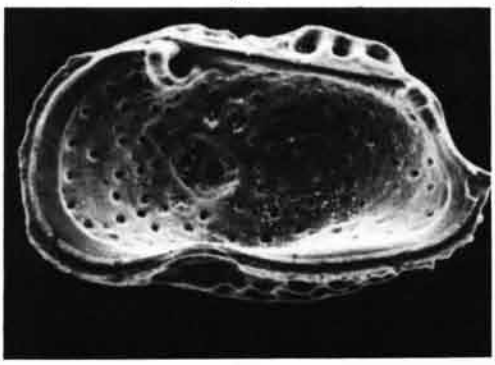

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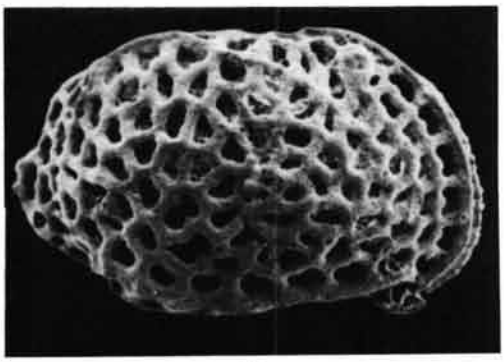

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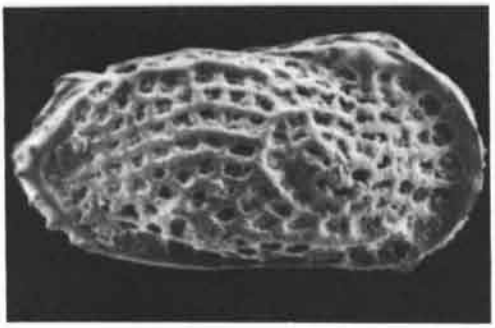

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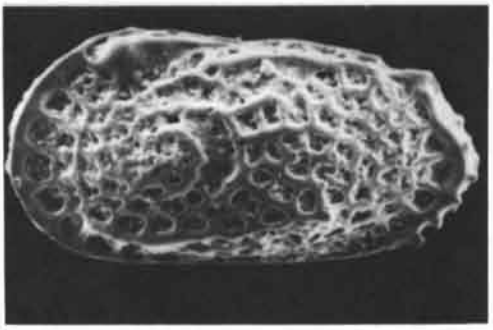

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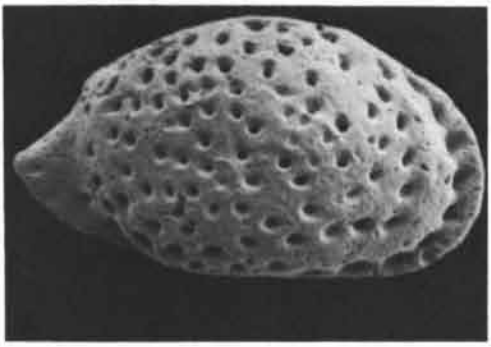

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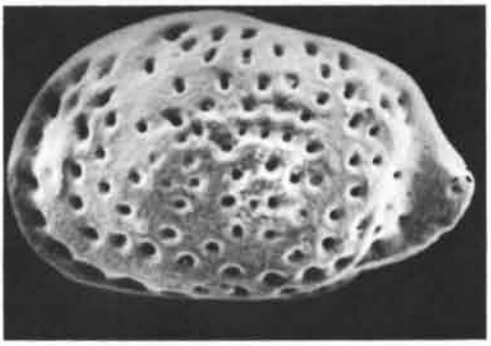

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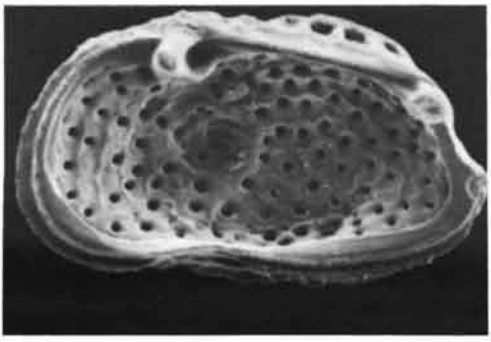

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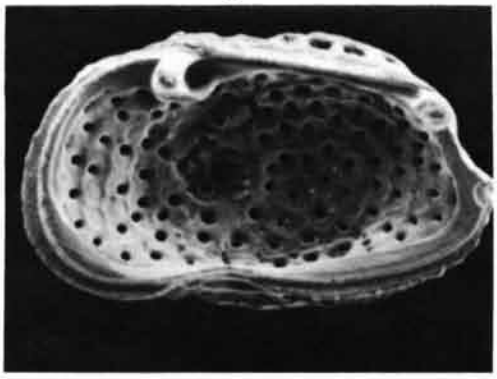

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