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Middle and Late Eocene Ostracoda from Gebel El Mereir, Nile Valley, Egypt

ABSTRACT

Middle and Late Eocene deposits assigned to the El Mereir, El Fashn and Qarara Formations, middle Egypt, yielded 26 species of marine Ostracoda of which the following are new: *Loxoconcha pseudopunctatella*, *Schizocythere fadlensis*, *Digmocythere omarai*, *Bythocypris ? mereirensis*, *Anticythereis saidi*, *A. seylingi*, *Costa bassiounii* and *C. nilensis*. Smaller and larger foraminifera indicate a late Lutetian age for the El Fashn and Qarara rock-units, whereas the El Mereir Formation appears to be Late Eocene in age.

INTRODUCTION

In the region of Gebel El Mereir, on the eastern side of the Nile River, Middle Egypt, Middle and Late Eocene deposits are exposed. Previous micropaleontological investigation (Said, 1951; Krasheninnikov and Ponikarov, 1964; Hume, 1965) of these sections has emphasized the larger foraminiferal assemblages, and the ostracode faunas have not been described. Moreover, except for the series of studies by Bassiouni (1969, 1970, 1971) of middle and upper Eocene ostracodes from the lower Nile Valley, there is little published information on Eocene ostracodes from this part of the world. Hence a study of the ostracodes from Gebel El Mereir was undertaken.

MATERIAL AND METHODS

Because of their friable nature, bulk samples required no mechanical disintegration but were simply washed, fractions were decanted and then dried, and ostracode valves and carapaces were picked from the residue using a fine brush. Following examination with a light microscope, scanning electron photomicrographs were taken of type specimens at the Museum of Comparative Zoology, Harvard University.

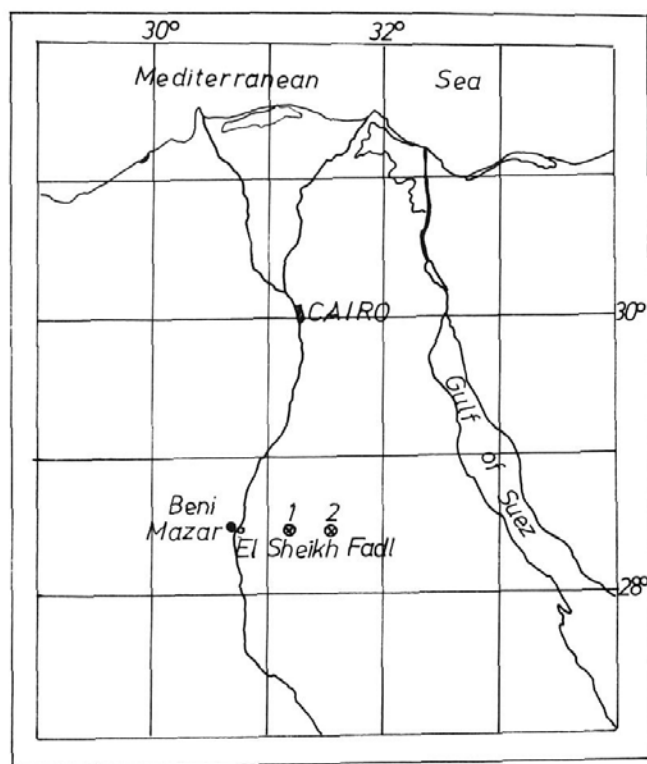
Unfortunately, many specimens consisted of the entire carapace, and the 2 valves could not be separated without damaging the shell. Thus, examination of internal features such as hingement, duplicature and muscle scars was sometimes impossible. Nevertheless, preservation of the external surface of carapaces was generally good and generic assignments could be made with confidence for most taxa. Others, requiring examination of internal features, were given questionable generic assignments.

STRATIGRAPHY

The two studied sections are situated 45 and 80 km. east of El Sheikh Fadl, Beni Mazar, Egypt (text-fig. 1). Lithologically the first section (45 km. east of El Sheikh Fadl) consists of 115 m. of shales, calcareous sandstones, arenaceous marls and limestones (text-fig. 2). In the second section (80 km. east of El Sheikh Fadl) 95 m. of limestones, arenaceous marls, marly limestones and shales are exposed.

Section 1 was studied by Bishay (1966) who placed most of it into the Qarara Formation assigning to the El Fashn Formation the top few meters of limestone. Subsequently Omara et al. (in press) introduced the term El Mereir Formation for the deposits at section 2.

The ages of the 2 sections are based on foraminiferal assemblages, according to studies of Middle and Late Eocene foraminifers from Egypt by Krasheninnikov and Ponikarov (1964), Bishay (1966) and Beckmann



TEXT-FIGURE 1
Location map. 1, section 45 km east of El Sheikh Fadl; 2, section 80 km east of El Sheikh Fadl.

et al. (1967). Other pertinent studies describing Middle and Late Eocene foraminifera found in the Gebel El Mereir sections are those of Berggren (1969) for Libya and Bolli (1957) for Trinidad.

The lower units (Qarara and El Fashn Formations) have yielded a foraminiferal assemblage that indicates a late Lutetian age: *Truncorotaloides rohri* Brönniman and Bermúdez, *T. topilensis* (Cushman), *Globigerina linaperta* Finlay, *G. parva* Bolli, *G. yeguaensis* Weinzierl and Applin, and *Globorotalia centralis* Cushman and Bermúdez.

Section 2 (the El Mereir Formation) yielded a planktonic foraminiferal assemblage that suggests a Late Eocene age: *Globigerina ciproensis angustumbilicata* Bolli, *G. parva* Bolli, *G. rohri* Bolli, *G. ampliapertura* Bolli, *Globorotalia opima nana* Bolli, *G. cocoaensis* Cushman, and *Hantkenina alabamensis* Cushman. In addition, several biostratigraphically diagnostic nummulites also suggest a Late Eocene age: *Nummulites striatus* Bruguère, *N. lucasi* d'Archiac and *N. discorbinus* (Schlotheim).

SYSTEMATIC PALEONTOLOGY

Without detailed examination of taxonomically diagnostic internal features, the generic assignment of several taxa is questionable. For several other taxa (*Krithe* sp.,

Bairdia sp., *Paracypris* sp., *Cytherella* spp.) the erection of new species was delayed until more abundant, better preserved material becomes available. Furthermore, several species represented by few specimens (*Trachyleberis*? sp., *Pterygocythereis* sp., *Carinocythereis*? sp.) are also left in open nomenclature. Nevertheless, many species appear to be new.

The ostracode fauna from Gebel El Mereir shows marked affinities to middle and upper Eocene faunas from the lower Nile Valley (Bassiouni, 1969, 1970, 1971). Species common to both regions include *Leguminocythereis africana*, *Martinicythere samalutensis*, *Asymetricythere yousefi*, *Costa praetricosta*, *C. qurnensis* and *Trachyleberis nodosa*. All these were first described by Bassiouni. Several other taxa such as *Hermanites* cf. *H. pajenborchianus*, *Quadracythere* cf. *Q. macropora* and *Schizocythere fadlensis* n. sp. strongly resemble European Eocene forms (Keij, 1957). In general, the assemblage is typical of Eocene marine faunas in which thick-shelled, highly ornamented trachyleberids and hemicytherids are abundant.

For several species common to both the Gebel El Mereir and lower Egyptian regions, Bassiouni recognized distinct subspecies that were restricted to certain stratigraphic intervals. For example, he found that surface reticulation of *Trachyleberis nodosa* Bassiouni gradually increased throughout the upper Eocene, whereas tubercle development became less prominent with time. In the present material, however, specimens referable to all 3 of Bassiouni's subspecies were found in samples from the same level, making the stratigraphic value of these forms questionable. For *Costa praetricosta* Bassiouni, on the other hand, only the lower upper Eocene subspecies, *C. praetricosta praetricosta* was present in the Gebel El Mereir material. We believe more extensive analyses of surface ornament such as that of Benson (1977) are necessary to determine evolutionary trends within an ostracode species and to assess the stratigraphical value of ostracode subspecies. The present material was not adequate for such analysis.

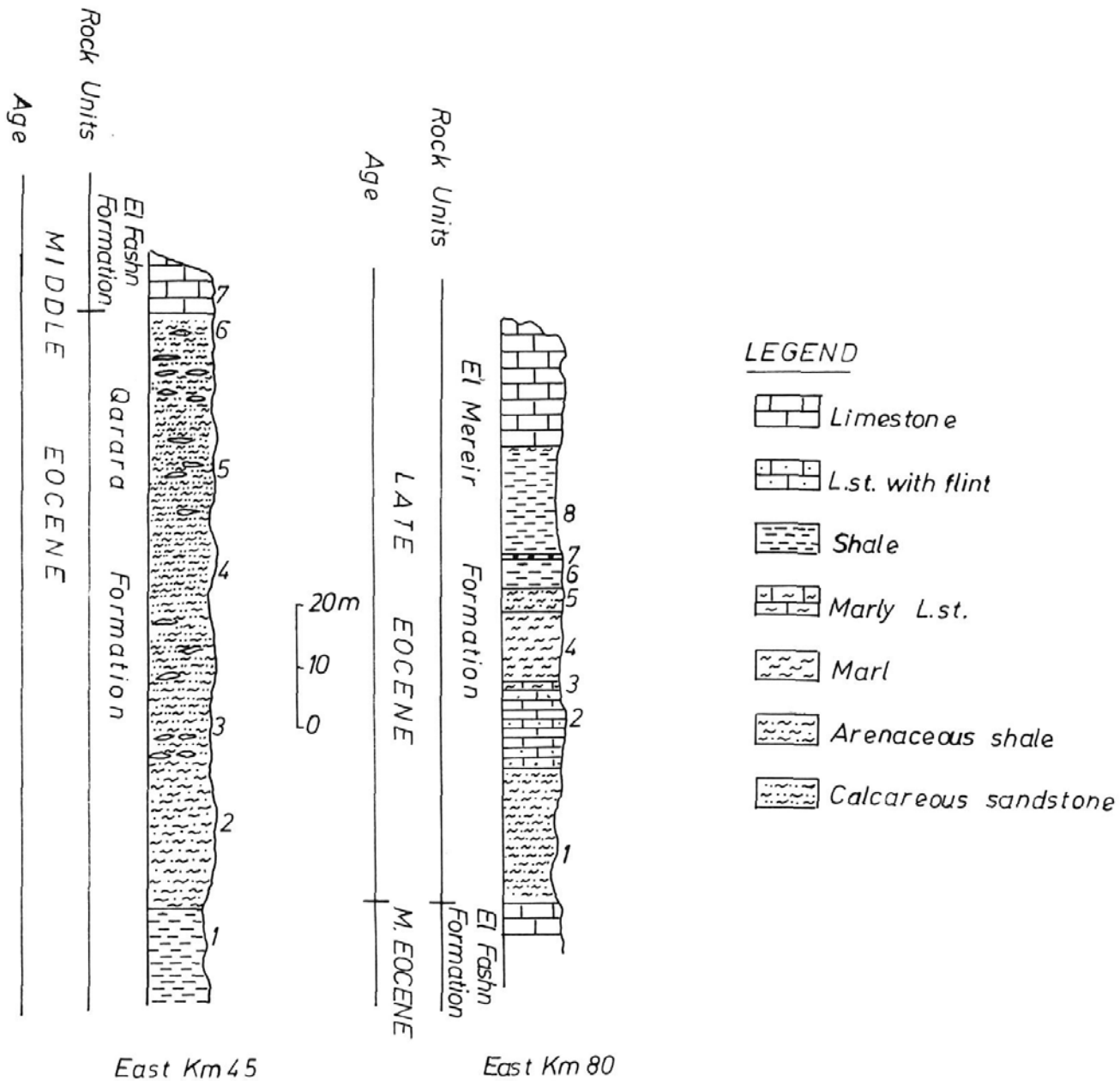
The Geological Museum, Department of Geology, Assuit University (AUGD) is the repository for type specimens of the ostracodes described below.

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

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

Material: 14 carapaces.

Description: Carapace subquadrate in lateral view;



TEXT-FIGURE 2

Stratigraphic columns, position of samples and lithology of Gebel El Merier, east of Beni Mazar, Egypt.

dorsal and ventral margins nearly straight, parallel; anterior margin obliquely rounded. In dorsal view widest about 2/3 length, tapering gradually toward anterior end. Surface smooth to variably pitted, pits more numerous on swollen posterior region. Weak marginal rim present along anterior and posterior borders. Eye tubercle weakly developed. Overlap strong, right valve larger than left. Sexual dimorphism present, females wider posteriorly.

Remarks: This species resembles *C. beyrichi* (Jones) from the Eocene of Belgium (Keij, 1957), but the present

species has a marginal rim and the pits are not as numerous.

Dimensions: Length .55 mm, width .20 mm, height .32 mm.

Type locality: Gebel El Mereir, 45 km east of El Sheikh Fadl, Beni Mazar, Upper Egypt.

Type level: Qarara Formation, Sample 1, Middle Eocene.

Repository: AUGD F50.

***Cytherella* sp. 2**

Plate 1, figures 2–3

Material: 7 carapaces.

Description: Carapace subquadrate in lateral view, dorsal and ventral margins nearly parallel; anterior and posterior end obliquely rounded. Greatest height at posterior. In dorsal view elongate, subtriangular, widest posteriorly, tapering gradually toward anterior. Surface of valves smooth except for weak anteromarginal rim. Right valve overlapping left around entire margin. Other features not observed.

Remarks: *Cytherella* sp. 2 is smaller than *Cytherella* sp. 1, lacks pitting, and has a different shape in dorsal view. It resembles *C. compressa* (Von Munster) from the Rupelian of Belgium (Keij, 1957) but is much smaller. It is similar to *C. cuneata* Deltel but lacks striations (Deltel, 1962–1963).

Dimensions: Length .60 mm, width .23 mm, height .32 mm.

Type locality: Gebel El Mereir, 45 km east of El Sheikh Fadl.

Type level: Qarara Formation, Sample 4, Middle Eocene.

Repository: AUGD F51–52.

Suborder PODOCOPINA Sars, 1866
Superfamily BAIRDIACEA Sars, 1888
Family BAIRDIIDAE Sars, 1888
Genus BAIRDIA McCoy, 1844

***Bairdia* sp.**

Plate 1, figures 4–5

Material: 35 carapaces, 3 valves.

Description: Right valve in lateral view typical “bairdioid” shape; dorsal margin nearly straight, horizontal; anterodorsal margin straight, diagonal, becoming broadly rounded ventrally. Ventral margin slightly concave anteriorly; posterior margin ventrally rounded, upturned at middle, dorsally straight, diagonal. Left valve subovoid in lateral view; dorsal margin arched, strongly convex; posterior margin acutely rounded, slightly upturned. Greatest height about middle. In dorsal view elliptical, greatest width anterior to center. Surface smooth, valve with a few small anterior and posterior marginal denticles. Hinge simple, straight groove in left valve accommodating dorsal margin of right valve. Flange strongly developed, especially anteriorly.

Remarks: This species resembles *B. ocalana* Puri from the Tertiary of Florida (Puri, 1957), but is more evenly rounded anteriorly.

Dimensions: Length .86 mm, width .46 mm, height .54 mm.

Occurrence: Gebel El Mereir, 80 km east of El Sheikh Fadl, El Mereir Formation, Sample 1, Late Eocene.

Repository: AUGD F53–54.

Superfamily CYPRIDACEA Baird, 1845
Family PARACYPRIDAE Sars, 1923
Genus PARACYPRIS Sars, 1866

***Paracypris* sp.**

Plate 1, figure 23

Material: 8 carapaces.

Description: Carapace subtriangular in lateral view, dorsal margin obtusely angular, posterior half nearly straight, anterior half convex; anterior end broadly rounded; posterior end pointed; ventral margin nearly straight in left valve, slightly concave in right. Greatest height anterior to middle. In dorsal view elliptical, widest just anterior to middle, tapering to compressed extremities. Carapace surface smooth. Left valve slightly larger than right. Other features not observed.

Remarks: *Paracypris* sp. is not as drawn out postero-ventrally as most Eocene congeners. It most closely resembles *P. chipolensis* Puri from the Miocene of Florida (Puri, 1953).

Dimensions: Length .63 mm, width .21 mm, height .28 mm.

Occurrence: Gebel El Mereir, 45 km east of El Sheikh Fadl, Qarara Formation, Sample 6, Middle Eocene.

Repository: AUGD F55.

Genus BYTHOCYPRIS Brady, 1880

***Bythocypris? mereirensis* Cronin and Khalifa, n. sp.**

Plate 1, figures 6–7

Etymology: From type locality, Gebel El Mereir, Egypt.

Holotype: Carapace.

Paratypes: 6 carapaces.

Diagnosis: Large species of *Bythocypris?* with evenly arched dorsal margin, and evenly rounded anterior and posterior ends.

Description: Carapace large, bean-shaped in lateral view; dorsal margin evenly arched, convex; anterior margin rounded, posterior margin more acutely rounded; ventral margin very slightly concave. Greatest height about middle. In dorsal view elongate ovoid, extremities acuminate; widest about middle. Surface smooth throughout. Left valve overlapping right, more strongly anteriorly. Other features not observed.

Remarks: *Bythocypris? mereirensis* is more elongate and not so high as *B. cuisensis* Keij from the Tertiary of Belgium. The dorsal margin is more evenly rounded and

not so angular as *B. ? gibsonensis* Howe and Chambers from the Tertiary of Florida (Puri, 1957).

Dimensions: Holotype: length .97 mm, width .35 mm, height .42 mm.

Type locality: Gebel El Mereir, 54 km east of El Sheikh Fadl.

Type level: Qarara Formation, Sample 2, Middle Eocene.

Repository: Holotype, AUGD F56; paratype, AUGD F57.

Superfamily CYTHERACEA Baird, 1850

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948

Genus TRACHYLEBERIS Brady, 1898

Trachyleberis nodosa Bassiouni

Plate 2, figures 9–10

Trachyleberis nodosus BASSIOUNI, 1969, p. 385, pl. 24, figs. 1–10.

Material: 7 carapaces, 8 valves.

Diagnosis: *Trachyleberis* with large rounded tubercles, largest in upper half of valve. Strong tubercle development obscuring weak reticulation. Sexual dimorphism pronounced.

Remarks: Bassiouni (1969) named 3 subspecies of *T. nodosa*, distinguished from one another by the degree of reticulation and tubercle development. Reticulation became more prominent as *T. nodosa* evolved during the upper Eocene. The specimens in the present study are variable in ornamentation, showing similarities to all of Bassiouni's subspecies. Although most specimens resemble *T. nodosa nodosa*, with heavy tubercles, we feel that more study is required before the interrelationships among these different forms are understood.

Dimensions: Males, length 1.05 mm, width .45 mm, height .52 mm; females, length .88 mm, width .43 mm, height .49 mm.

Occurrence: 45 km east of El Sheikh Fadl, Qarara Formation, Sample 2.

Repository: Male, AUGD F58; female, AUGD F59.

***Trachyleberis?* sp.**

Plate 2, figure 11

Material: 1 carapace.

Description: Carapace elongate, subtriangular in lateral view; dorsal margin straight, but outline irregular due to raised posterodorsal longitudinal ridge, ventral margin slightly concave; dorsal and ventral margins converging toward triangular posterior end, pointed about middle; anterior end broadly rounded. Greatest

height at anterior cardinal angle. In dorsal view ovoid with compressed posterior. Widest about 2/3 length.

Surface ornamented with tubercles of various sizes, subconcentrically arranged in anterior region. Dorsal longitudinal ridge curved posteriorly, forming posterior cardinal angle, at midlength consisting of only a few isolated tubercles. Carapace surface depressed subcentrally and behind eye tubercle. Posterior margin denticulate, anterior margin with double row of denticles. Eye tubercle prominent, raised.

Remarks: Although a posterodorsal ridge is not characteristic of the genus, the shape and tuberculate surface of this specimen are typical of *Trachyleberis*. Further material is required to ascertain the true affinities of this species.

Dimensions: Length .72 mm, width .34 mm, height .38 mm.

Occurrence: 45 km east of El Sheikh Fadl, Qarara Formation, Middle Eocene.

Repository: AUGD F60.

Genus ACANTHOCYTHEREIS Howe, 1963

***Acanthocythereis?* sp.**

Plate 2, figures 1–3

Material: 5 carapaces.

Description: Carapace elongate, subovoid in lateral view; dorsal margin straight, ventral margin straight to slightly concave in anterior half, both converging toward obtusely subtriangular posterior end. Posterior end nearly straight in dorsal half, rounded ventrally; anterior end broadly rounded. Greatest height at anterior cardinal angle. In dorsal view oblong, greatest width at 2/3 length, tapering gradually anteriorly, more rapidly toward compressed posterior.

Surface ornamented with fine reticulation, pits generally same size throughout surface, but varying in shape from angular to circular. Anteriorly reticulum concentrically arranged parallel to margin. Weak spinose ridge posteriorly forming posterodorsal cardinal angle. Spines superimposed on reticulum, more strongly developed anteriorly. Marginal denticles present around anterior and posteroventral margins. Eye tubercle clear.

Remarks: Specimens are tentatively assigned to *Acanthocythereis* on the basis of shape, weblike pattern of reticulation, marginal denticles and lack of a subcentral swelling. However, without internal views it could not be determined whether specimens were adults or juveniles and they appear to be small compared with other species of *Acanthocythereis*. The present material resembles *A. salahii* Bassiouni from the Eocene of Lower Egypt, but *A. salahii* is more spinose and has a finer pattern of reticulation.

Dimensions: Length .52 mm, width .23 mm, height .23 mm.

Occurrence: 45 km east of El Sheikh Fadl, Egypt, Qarara Formation, Sample 2, Middle Eocene.

Repository: AUGD F61–62.

Genus COSTA Neviani, 1928

Costa praetricosta Bassiouni
Plate 1, figure 24

Costa praetricosta praetricosta BASSIOUNI, 1969, p. 405, pl. 25, figs. 7–9 (not figs. 10–11).

Material: 10 carapaces, 1 valve.

Diagnosis: *Costa* with coarse reticulation, weakly developed longitudinal ridges, and deep pits in muscle scar region.

Remarks: Bassiouni (1969) named two subspecies of *C. praetricosta* and the present specimens are clearly the lower upper Eocene form *C. praetricosta praetricosta*.

Dimensions: Length .66 mm, width .35 mm, height .28 mm.

Occurrence: 45 km east of El Sheikh Fadl, Egypt, Qarara Formation, Samples 3 and 4.

Repository: AUGD F63.

Costa nilensis, Cronin and Khalifa, n. sp.
Plate 1, figures 17–19

Etymology: From the Nile River Valley.

Holotype: Carapace.

Paratypes: 2 carapaces.

Diagnosis: Small species of *Costa* with 3 weak longitudinal ridges, median and ventral ridges raised posteriorly into rounded tubercles. Surface reticulate.

Description: Carapace small, subquadrate in females, subrectangular in males in lateral view; dorsal and ventral margins nearly straight, anterior margin broadly rounded; posterior obliquely subtriangular. Greatest height at anterior cardinal angle. In dorsal view widest posteriorly, extremities compressed.

Surface with 3 poorly defined longitudinal ridges and reticulation. Dorsal ridge sharp posteriorly, bending downward to form a tubercle. Anterior marginal rim extending anteriorly from eye tubercle. Ventral longitudinal ridge paralleling ventral margin and turning upward anteriorly. At 3/4 length from anterior end this ridge rises into a tubercle, forming widest part of carapace. Reticulation subconcentrically arranged around muscle scar region; rest of surface also reticulate. Anterior margin with small denticles. Eye tubercle present. Males more elongate than females.

Remarks: This species resembles *C. edwardsi* (Roemer), but is not so long, and the reticulation is not so prominent.

Dimensions: Male, length .49 mm, width .22 mm, height .25 mm; female, length .46 mm, width .23 mm, height .28 mm.

Type locality: 80 km east of El Sheikh Fadl.

Type level: El Mereir Formation, Sample 2, Late Eocene.

Repository: Holotype, AUGD F64; paratype, AUGD F65.

Costa bassiounii Cronin and Khalifa, n. sp.
Plate 2, figures 16–18

Etymology: Named to honor M. A. Bassiouni, for his earlier studies of Eocene Egyptian ostracodes.

Holotype: Female carapace.

Paratypes: 3 carapaces.

Diagnosis: *Costa* with subtriangular posterior end, coarse reticulation and 3 longitudinal ridges, and anterior marginal rim with tubercles at intersections with reticulum.

Description: Male carapace elongate subrectangular in lateral view; dorsal and ventral margins nearly straight, ventral margin convex in females; anterior end rounded; posterior end subtriangular with slightly concave dorsal half and convex, denticulate ventral half. Greatest height at anterior cardinal angle. In dorsal view widest just posterior to middle; extremities compressed.

Surface ornamented with weak anterior and posterior marginal rims having rounded tubercles at intersections with reticulum. Three longitudinal ridges only slightly more strongly developed than reticulation. Reticulation coarse, longitudinally arranged ventrally, forming spokelike arrangement with anterior marginal rim. Anterior and posterior margins denticulate. Sexual dimorphism present, males longer and lower than females.

Remarks: This species is larger and has coarser reticulation than *C. nilensis*, n. sp. and *C. edwardsi* (Roemer).

Dimensions: Male, length .85 mm, width .38 mm, height .35 mm; female, length .80 mm, width .42 mm, height .38 mm.

Type locality: 45 km east of El Sheikh Fadl.

Type level: Qarara Formation, Sample 3, Middle Eocene.

Repository: Holotype, female AUGD F66; paratypes, male AUGD F67–68.

Costa qurnensis (Bassiouni)

Plate 1, figures 20–21

Cativella qurnensis BASSIOUNI, 1969, p. 398, pl. 27, fig. 8a–c.

Material: 8 carapaces.

Diagnosis: *Costa* with two strong median longitudinal ridges, the more dorsal having 2 depressions in muscle scar region. Surface nearly smooth throughout.

Remarks: Specimens are virtually identical with those described by Bassiouni (1969). However this species is placed in the genus *Costa*, rather than *Cativella* because it lacks the typical drawn-out posterior end.

Dimensions: Length .69 mm, width .34 mm, height .38 mm.

Occurrence: 80 km east of El Sheikh Fadl, Egypt, El Fashn Formation.

Repository: AUGD F69–70.

Subfamily PTERYGOCYHEREINAE Puri, 1957

Genus PTERYGOCYHEREIS Blake, 1933

***Pterygocythereis* sp.**

Plate 1, figure 8

Material: 1 carapace.

Description: Carapace elongate, subrectangular; dorsal margin gently convex; ventral margin convex due to ventrolateral swelling of carapace; posterior margin produced, obtusely rounded, ventrally posterior margin angular. Anterior end rounded and denticulate. In dorsal view arrow-shaped, widest behind middle, between alar projection. Extremities compressed, periphery of valves swollen; anterior and posterior margins denticulate. Valve surface smooth. Ventrolateral region with pyramid-shaped alar projection, more weakly developed than typical of genus.

Remarks: This specimen resembles *P. minor* Bassiouni in the general lack of spines and other ornamentation, but it is more elongate and the alar projection is not so strongly keeled. More material is required to determine the affinities of this species.

Dimensions: Length .63 mm, width .38 mm, height .32 mm.

Occurrence: 45 km east of El Sheikh Fadl, Qarara Formation, Sample 3.

Repository: AUGD F79.

Subfamily BRACHYCYTHERINAE Puri, 1954

Genus DIGMOCYTHERE Mandelstam, 1958

Digmocythere omarai Cronin and Khalifa, n. sp.

Plate 1, figures 9–10

Etymology: Named to honor Prof. S. M. Omara, Sohag University.

Holotype: Carapace.

Paratypes: 9 carapaces.

Diagnosis: *Digmocythere* with posterior end pointed slightly downward, and keel-like ventrolateral swelling.

Description: Carapace ovoid in lateral view, subtriangular in anterior view; dorsal margin straight in males to slightly convex in females; ventral outline convex due to ventrolateral swelling; anterior margin broadly rounded; posterior margin acutely subtriangular, pointed downward about middle; lower half straight, upper half convex. Greatest height about middle. In dorsal view arrow-shaped, widest just behind middle; anterior and posterior ends compressed.

Lateral and ventral surfaces smooth, ventrolateral swelling variably developed, occasionally keel-like. Eye spot weakly developed. Anterior and posterior margins with small denticles. Marginal areas inflated around periphery. Left valve slightly larger than right.

Remarks: Variation in development of ventrolateral swelling may simply be due to poor preservation in some specimens.

Dimensions: Male, length .66 mm, width .31 mm, height .37 mm; female, length .71 mm, width .35 mm, height .40 mm.

Type locality: 54 km east of El Sheikh Fadl, Egypt.

Type level: Qarara Formation, Sample 3, Middle Eocene.

Repository: Holotype, AUGD F80; paratypes, AUGD F81.

Family HEMICYTHERIDAE Puri, 1953

Subfamily THAEROCYTHERINAE Hazel, 1967

Genus HERMANITES Puri, 1955

Hermanites* cf. *H. paijenborchianus Keij

Plate 1, figure 16

Material: 5 carapaces.

Description: Carapace subrectangular in lateral view; dorsal and ventral outlines straight, converging toward produced posterior margin. Posterodorsal margin straight to slightly concave, posteroventral margin curved, with large denticles on marginal rim; anterior margin broadly rounded. Greatest height at anterior cardinal angle. Ventrolateral ridge keel-like, ending at 3/4 length; dorsal longitudinal ridge turning downward at about the same point. Reticulation obscure but seemingly coarse where visible. Subcentral tubercle swollen, eye tubercle present.

Remarks: Specimens are similar to those described by Keij (1957) from the Tertiary of Belgium, although specimens are worn and spines that project into the reti-

culum are not visible. *Hermanites* of Bassiouni (1970, pl. 20, fig. 8) is not so produced posteroventrally and the ornamentation appears to be different.

Dimensions: Length .65 mm, width .31 mm, height .34 mm.

Occurrence: 45 km east of El Sheikh Fadl, Qarara Formation, Egypt.

Repository: AUGD F82.

Genus QUADRACYTHERE Hornibrook, 1953

Quadracythere cf. *Q. macropora* (Bosquet)
Plate 1, figure 22

Material: 2 carapaces.

Description: Carapace small, subquadrate in lateral view; dorsal and ventral margins nearly straight; anterior margin broadly rounded; dorsal half of posterior margin nearly straight in left valve, acutely rounded ventrally; upper part of posterior end slightly concave in right valve. Maximum height at anterior cardinal angle. In dorsal view carapace ovoid, extremities compressed; widest at subcentral tubercle. Right valve slightly overlapped by left.

Surface ornamented with dorsal and ventral ridges, and reticulation. Dorsal ridge strongest in posterior region, where turning downward. Ventral ridge weakly developed, nearly parallel to ventral margin. Marginal rim weakly denticulate anteriorly. Subcentral tubercle smooth except for a few shallow pits. Entire lateral, ventral and dorsal surfaces reticulate, with near concentric pattern around tubercle, especially anteriorly. Eye tubercle large, glossy.

Remarks: Specimens resemble *Q. macropora* (Bosquet) from the Eocene of Belgium (see Keij, 1957), differing in their smaller size and finer reticulum.

Dimensions: Length .49 mm, width .28 mm, height .31 mm.

Occurrence: 80 km east of El Sheikh Fadl, El Fashn Formation, Sample 6.

Repository: AUGD F 83.

Genus MARTINICYTHERE Bassiouni, 1970

Martinicythere samalutensis Bassiouni
Plate 1, figures 11–12

Martinicythere samalutensis BASSIOUNI, 1970, p. 217, pl. 18, figs. 8–11; pl. 19, figs. 8–10.

Material: 1 carapace, 2 valves.

Diagnosis: *Martinicythere* with rounded tubercles superimposed on reticulation. Dorsally tubercles aligned in a row.

Remarks: The present specimens appear to belong to Bassiouni's subspecies *M. samalutensis samalutensis* on the basis of the dorsal longitudinal row of isolated spines.

Dimensions: Length .46 mm, width .25 mm, height .29 mm.

Occurrence: 45 km east of El Sheikh Fadl, Qarara Formation, Sample 1.

Repository: AUGD F84–85.

Subfamily CAMPYLOCYTHERINAE Puri, 1960

Genus LEGUMINOCYTHEREIS Howe and Law, 1936

Leguminocythereis africana Bassiouni
Plate 1, figure 25

Leguminocythereis africana BASSIOUNI, 1970, p. 223, pl. 21, fig. 4–6.

Material: 10 carapaces, 4 valves.

Diagnosis: Ovoid *Leguminocythereis* with longitudinally aligned rows of pits ventrally and laterally, vertically aligned anteriorly and posteriorly.

Remarks: Specimens similar to those described by Bassiouni (1970). In the present material the pits vary in shape from ovoid to subrectangular.

Dimensions: Male, length .74 mm, width .35 mm, height .37 mm.

Occurrence: 45 km east of El Sheikh Fadl, El Mereir Formation, Sample 6.

Repository: AUGD F86.

Genus ANTICYTHEREIS van den Bold, 1946

Anticythereis saidi Cronin and Khalifa, n. sp.
Plate 2, figures 4–8

Etymology: Named to honor Prof. Rushdi Said, of Cairo, Egypt.

Holotype: Female carapace.

Paratypes: 74 carapaces, 2 valves.

Diagnosis: *Anticythereis* with regular pattern of reticulation, and rounded tubercles at intersections of reticulum. Anterior and posterior margins with multiple rows of denticles.

Description: Carapace subrectangular in lateral view; dorsal and ventral margins straight to slightly sinuous, subparallel to each other, converging only slightly toward obliquely subtriangular posterior end; anterior margin broadly rounded. Greatest height at anterior cardinal angle. In dorsal view carapace ovoid, compressed posteriorly, maximum width 1/4 length from posterior margin.

Surface of valves reticulate and tuberculate. Tubercles most strongly developed anteriorly and posteriorly, with longitudinal row at about midheight. Reticulation longitudinally arranged ventrolaterally, curving upward and paralleling anterior margin of carapace. Two to three rows of anterior marginal denticles present, and ventral margin with small denticles.

Inner lamella moderately broad, small vestibule present; prominent flange with small denticles at anterior end. Marginal pore canals straight to slightly sinuous, sparse posteroventrally, numerous anteriorly, some extending into denticles.

Hinge typical for genus. Adductor muscle scars a nearly vertical row of four, the dorsomedian scar longest, and a U-shaped frontal scar. Sexual dimorphism pronounced, males longer than females.

Remarks: This species is highly tuberculate compared with other species of *Anticythereis*, yet tubercle development is variable.

Dimensions: Males, length .80 mm, width .33 mm, height .38 mm; females, length .66 mm, width .31 mm, height .37 mm.

Type locality: 80 km east of El Sheikh Fadl, Egypt.

Type level: El Fashn Formation, Sample 3, Late Eocene.

Repository: Holotype, female AUGD F71; paratypes, male, AUGD F72-73.

***Anticythereis seylingi* Cronin and Khalifa, n. sp.**
Plate 2, figures 19-21

Etymology: Named to honor Mr. Edward Seyling, of the Scanning Electron Microscope Laboratory, Museum of Comparative Zoology, Harvard University.

Holotype: Female carapace.

Paratypes: 11 carapaces, 1 valve.

Diagnosis: *Anticythereis* with gently curved, convex posteroventral outline, and regular longitudinal arrangement of reticulation.

Description: Carapace subrectangular to subrhomboidal in lateral view; dorsal margin straight; ventral margin convex, more curved toward upturned posterior end. Anterior margin broadly rounded. Carapace ovoid in dorsal view, tapering anteriorly and posteriorly from widest point at midlength.

Surface with reticulation and 3 weakly developed longitudinal ribs. A dorsal rib affecting dorsal margin slightly, then bifurcating with branches running to eye tubercle and below it. Median and ventral ribs essentially part of reticulum, being only slightly better developed. Reticulum coarse, made of angular pits, more or

less longitudinally arranged. Subcentrally, carapace depressed. Weak anterior and posterior marginal denticles present. Marginal zone moderately broad, small vestibule present anteriorly; marginal pore canals straight, numerous in anterior end. Hinge typical of genus. Sexual dimorphism pronounced, males more rectangular and longer than females.

Dimensions: Males, length .80 mm, width .31 mm, height .38 mm; females, length .74 mm, width .34 mm, height .40 mm.

Type locality: 80 km east of El Sheikh Fadl.

Type level: El Mereir Formation, Sample 3, Late Eocene.

Repository: Holotype, female AUGD F74; paratypes, male, AUGD F75-76.

***Anticythereis?* cf. *A. heluanensis* (Bassiouni)**
Plate 2, figure 13

Material: 2 carapaces.

Remarks: Two specimens resembling *Carinocythereis heluanensis* Bassiouni from the Upper Eocene of northern Egypt in shape, size ridge development and marginal spines, lack the longitudinal alignment of reticulation and have a more strongly developed dorsal ridge. However, they are questionably assigned to *Anticythereis* because *Carinocythereis* is a Pliocene-Recent genus. Additional material is required to better understand these forms.

Dimensions: Length .81 mm, width .32 mm, height .40 mm.

Occurrence: 80 km east of El Sheikh Fadl, El Mereir Formation, Samples 3 and 4.

Repository: AUGD F77.

***Anticythereis?* sp.**
Plate 2, figure 12

Material: 1 carapace.

Description: Carapace subrectangular; dorsal margin nearly straight; ventral margin concave, anterior margin broadly rounded, posterior margin subtriangular. Surface with coarse reticulation, longitudinally aligned ventrolaterally. Vertical rib extending from eye tubercle to midlength; dorsal rib bending downward at midlength, posteriorly paralleling margin. Anterior and posterior margins denticulate. Eye tubercle raised above margin. Other features not observed.

Remarks: This single, poorly preserved specimen shows similarity to *Carinocythereis scitula* Bassiouni.

Dimensions: Length .89 mm, width .32 mm, height .49 mm.

Occurrence: 80 km east of El Sheikh Fadl, Egypt, El Fashn Formation.

Repository: AUGD F78.

Family CYTHERIDAE Baird, 1850
Subfamily BUNTONIINAE Apostolescu, 1961
Genus ASYMMETRICYTHERE Bassiouni, 1971

Asymmetrythere yousefi Bassiouni
Plate 1, figures 13–15

Asymmetrythere yousefi BASSIOUNI, 1971, p. 180, pl. 8, figs. 1–5.

Material: 42 carapaces, 10 valves.

Diagnosis: Elongate *Asymmetrythere* with 3–6 longitudinal ridges, with pitted furrows between. Pit and ridge development variable.

Remarks: The present specimens show variability in the development of longitudinal ridges and the pitting

between them, as do those figured by Bassiouni (1971). Usually 3 to 5 ridges are present with pitting more prominent between the ventral ones. There is also variability in the degree of asymmetry, depending on the size of the large ventral ridge on the right valve.

Dimensions: Males, length .74 mm, width .34 mm, height .38 mm; females, length .72 mm, width .37 mm, height .42 mm.

Occurrence: 80 km east of El Sheikh Fadl, Egypt, El Mereir Formation.

Repository: Female, AUGD F87.

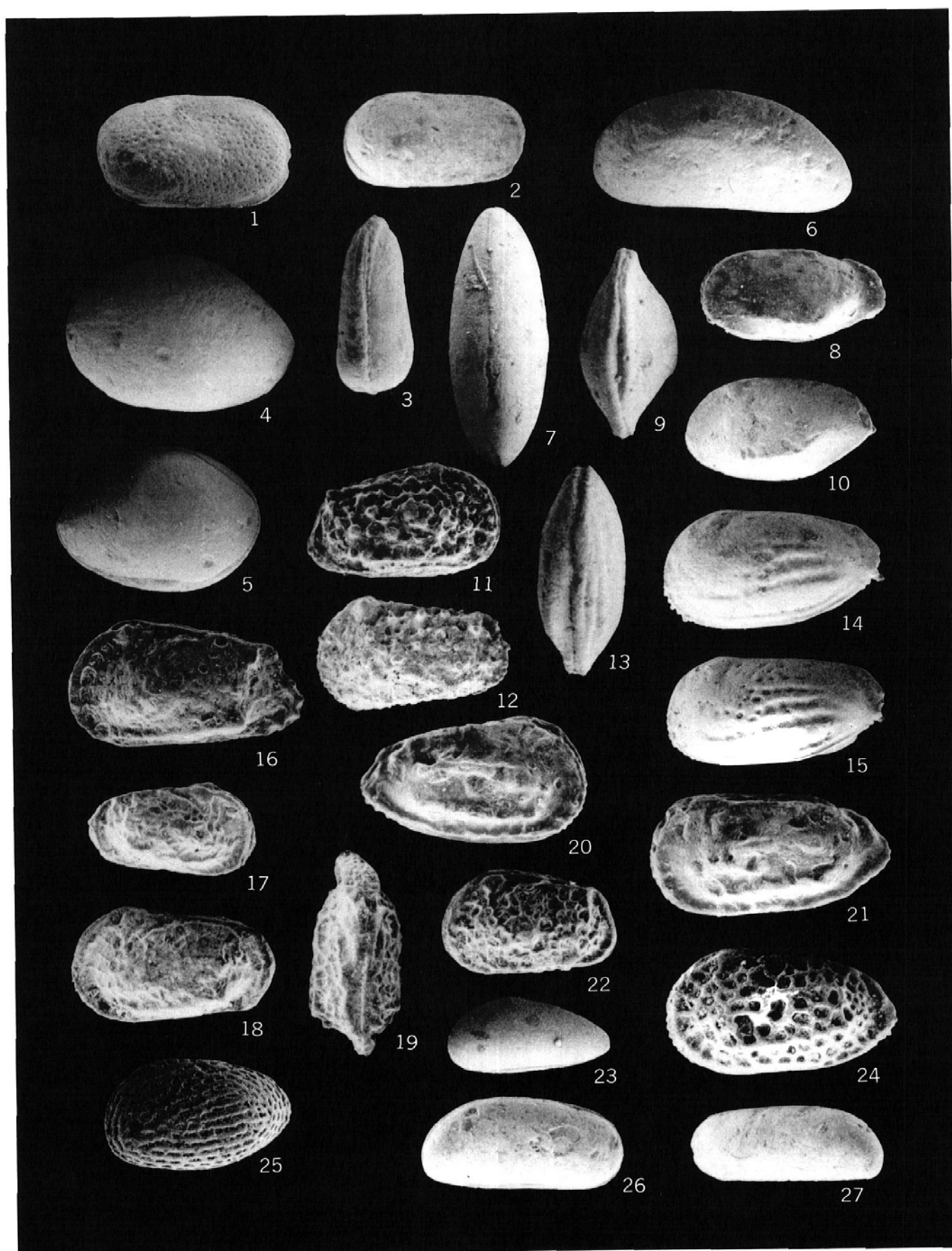
Family SCHIZOCYTHERIDAE Howe, 1961
Genus SCHIZOCYTHERE Triebel, 1950

Schizocythere fadlensis Cronin and Khalifa, n. sp.
Plate 2, figures 14–15

Etymology: From the village of El Sheikh Fadl, Egypt.

PLATE 1

- 1 *Cytherella* sp. 1.
Carapace, right lateral view, AUGD F50, × 67.
- 2–3 *Cytherella* sp. 2.
2, carapace, right lateral view, AUGD F51, × 67. 3, carapace, dorsal view, AUGD F52, × 67.
- 4–5 *Bairdia* sp.
4, carapace, left lateral view, AUGD F54, × 52; 5, carapace, right lateral view, AUGD F53, × 52.
- 6–7 *Bythocypris*? *mereirensis*, n. sp.
6, carapace, left lateral view, holotype, AUGD F56, × 52. 7, carapace, dorsal view, paratype, AUGD F57, × 52.
- 8 *Pterygocythereis* sp.
Carapace, left lateral view, AUGD F79, × 50.
- 9–10 *Digmocythere omarai*, n. sp.
9, carapace, dorsal view, paratype, AUGD F81, × 52. 10, carapace, left lateral view, holotype, AUGD F80, × 52.
- 11–12 *Martinocythere samalutensis* Bassiouni
11, carapace, right lateral view, AUGD F84, × 67. 12, left valve, lateral view, AUGD F85, × 67.
- 13–15 *Asymmetrythere yousefi* Bassiouni
13, male carapace, ventral view; × 52. 14, female carapace, left lateral view, AUGD F87, × 52. 15, Male carapace, left lateral view, × 52.
- 16 *Hermanites* cf. *H. pajenborchianus* Keij
Carapace, left lateral view, AUGD F82, × 67.
- 17–19 *Costa nilensis* Cronin and Khalifa, n. sp.
17, carapace, right lateral view, holotype, AUGD F64, × 52. 18, carapace, left lateral view, holotype, AUGD F64, × 75. 19, carapace, dorsal view, paratype, AUGD F65, × 75.
- 20–21 *Costa qurnensis* (Bassiouni)
20, carapace, right lateral view, AUGD F70, × 67. 21, carapace, left lateral view, AUGD F69, × 67.
- 22 *Quadracythere* cf. *Q. macropora* (Bosquet)
Carapace, left lateral view, AUGD F83, × 67.
- 23 *Paracypris* sp.
Carapace, left lateral view, AUGD F55, × 50.
- 24 *Costa praetricosta* Bassiouni
Carapace, left lateral view, AUGD F63, × 67.
- 25 *Leguminocythereis africana* Bassiouni
Carapace, left lateral view, AUGD F86, × 50.
- 26–27 *Krithe* sp.
26, carapace, right lateral view, AUGD F93, × 67. 27, carapace, left lateral view, AUGD F94, × 67.



Holotype: Carapace.

Paratypes: 14 carapaces, 2 valves.

Diagnosis: *Schizocythere* with intricate pattern of longitudinal and vertical ribs on lateral surface, and fine ribs on posterior caudal process.

Description: Carapace small, subquadrate in lateral view; dorsal and ventral margins nearly parallel and straight, anterior margin broadly rounded but drawn out ventrally; posterior margin with short, rounded caudal process above mid-height. Posteroventral margin affected by overhang of longitudinal ridge. In dorsal view males widest in middle, females widest about 2/3 length, tapering more rapidly toward posterior. Surface with strongly developed reticulum forming large, variably shaped pits. Anteroventrally, ornamentation longitudinally arranged. Caudal process with weak ribs. Ventral "notch" formed posteroventrally by reticulum. Eye tubercle present. Left valve larger than right. Hinge schizodont, left valve with anterior hinge element having proximal split tooth and distal socket; posterior element a crenulate socket; median hinge element a crenulate bar. Right valve hinge complementary.

Remarks: *Schizocythere fadlensis* shows marked affinity to *S. tessellata* (Bosquet) from the Tertiary of Belgium, differing primarily in having ribs on the caudal process and a slightly different pattern of reticulation. Both species have a posteroventral "notch" formed by the reticulum.

Dimensions: Length .38 mm, width .22 mm, height .29 mm.

Type locality: 54 km east of El Sheikh Fadl, Egypt.

Type level: Qarara Formation, Sample 3, Middle Eocene.

Repository: Holotype, AUGD F88; paratype AUGD F89.

Family LOXOCONCHIDAE Sars, 1925

Genus LOXOCONCHA Sars, 1866

***Loxoconcha pseudopunctatella* Cronin and Khalifa, n. sp.**

Plate 2, figures 22–24

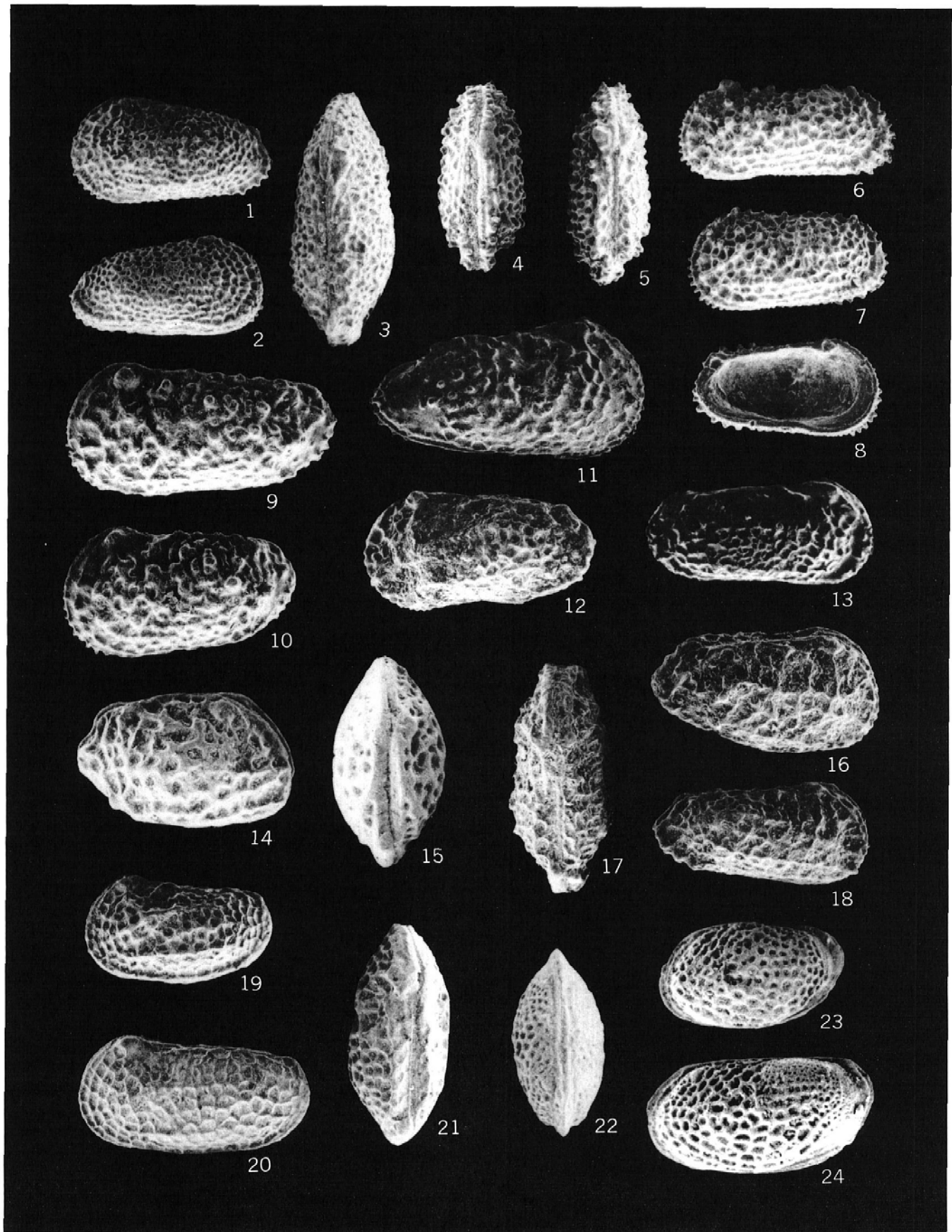
Etymology: *pseudopunctatella* (false *punctatella*) due to its close resemblance to *L. punctatella* (Reuss).

Holotype: Female carapace.

Paratypes: 19 carapaces.

PLATE 2

- 1–3 *Acanthocythereis*? sp.
1, carapace, left lateral view, AUGD F61, × 67.
2, carapace, right lateral view, AUGD F62, × 67. 3, carapace, dorsal view, AUGD F62, × 80.
- 4–8 *Anticythereis saidi* Cronin and Khalifa, n. sp.
4, female carapace, ventral view, × 50. 5, male carapace, dorsal view, paratype, × 50. 6, male carapace, left lateral view, AUGD F72, × 50. 7, female carapace, left lateral view, holotype, AUGD F71, × 50. 8, female left valve, internal view, AUGD F73, × 50.
- 9–10 *Trachyleberis nodosa* Bassiouni
9, male left valve, lateral view, AUGD F58, × 50. 10, female left valve, lateral view, AUGD F59, × 50.
- 11 *Trachyleberis*? sp.
Carapace, right lateral view, AUGD F60, × 60.
- 12 *Anticythereis*? sp.
Carapace, left lateral view, AUGD F78, × 50.
- 13 *Anticythereis* cf. *A. heluanensis* (Bassiouni)
Carapace, right lateral view, AUGD F77, × 50.
- 14–15 *Schizocythere fadlensis* Cronin and Khalifa, n. sp.
14, carapace, right lateral view, holotype, AUGD F88, × 100. 15, carapace, dorsal view, paratype, AUGD F89, × 100.
- 16–18 *Costa bassiounii* Cronin and Khalifa, n. sp.
16, female carapace, right lateral view, holotype, AUGD F66, × 55. 17, male carapace, dorsal view, paratype, AUGD F67, × 50. 18, male carapace, right lateral view, paratype, AUGD F68, × 50.
- 19–21 *Anticythereis seylingi* Cronin and Khalifa, n. sp.
19, female carapace, left lateral view, holotype, AUGD F74, × 50. 20, male carapace, left lateral view, paratype, AUGD F75, × 50. 21, male carapace, dorsal view, paratype, AUGD F76, × 50.
- 22–24 *Loxoconcha pseudopunctatella*, n. sp.
22, female carapace, dorsal view, holotype, AUGD F90, × 100. 23, female carapace, left lateral view, paratype, AUGD F91, × 100. 24, male carapace, left lateral view, AUGD F92, × 100.



Diagnosis: *Loxoconcha* with reticulation arranged concentrically on ventrolateral inflated region. Posterodorsal pits small, largest pits in middle.

Description: Carapace subrhomboidal in lateral view; dorsal margin straight, ventral margin convex, anterior end broadly and evenly rounded; posterior end upwardly rounded into short caudal process, more acute in females. In dorsal view ovoid, compressed posteriorly.

Ventrolateral region inflated, with concentric rows of subrectangular pits. Remainder of surface generally with longitudinally arranged rows of pits, with largest pits in middle, becoming smaller toward either end. Pits smallest posterodorsally. Males with deep depression in valve surface posteroventrally. Left valve slightly overlapping right valve. Eye spot not visible. Sexual dimorphism pronounced, males longer than females.

Remarks: *Loxoconcha pseudopunctatella* resembles *L. punctatella* (Reuss) (see Keij, 1957) in having a posteroventral depression, but differs in pattern of reticulation, the lack of an eyespot, and a different posterior outline.

Dimensions: Males, length .34 mm, width .17 mm, height .18 mm; females, length .31 mm, width .15 mm, height .17 mm.

Type locality: 80 km east of El Sheikh Fadl, Egypt.

Type level: El Mereir Formation, Sample 4, Late Eocene.

Repository: Holotype, female AUGD F90; paratype, male AUGD F91; paratype, female AUGD F92.

Family CYTHERIDEIDAE Sars, 1925
Subfamily KRITHINAE Mandelstam, 1958
Genus KRITHE Brady, Crosskey and Robertson, 1874

Krithe sp.
Plate 1, figures 26–27

Material: 60 carapaces.

Description: Carapace elongate, ovoid, length/width ratio from 2.0 to 2.5; dorsal margin convex to nearly straight; ventral margin slightly concave in right valve to almost straight in left; anterior end evenly rounded; posterior end weakly convex dorsally, more acutely rounded ventrally. Greatest height end with posterior to middle. In dorsal view anterior end more pointed, posterior to middle. In dorsal view anterior end more pointed, posterior end more inflated and rounded. Surface smooth, left valve overlapping right valve slightly, particularly ventrally. Adductor muscle scars consist of nearly vertical row of 4 muscle scars.

Remarks: This species is not as high as *K. saundersi* van den Bold from the Eocene of Trinidad (van den Bold, 1960). It strongly resembles *K. bartonensis* (Jones) in

having nearly parallel dorsal and ventral margins and a high length/width ratio.

Dimensions: Male, length .62 mm, width .25 mm, height .28 mm; female, length .57 mm, width .20 mm, height .25 mm.

Occurrence: 45 km east of El Sheikh Fadl, Qarara Formation, Sample 4.

Repository: AUGD F93–94.

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