

MICROPALAEONTOLOGIA

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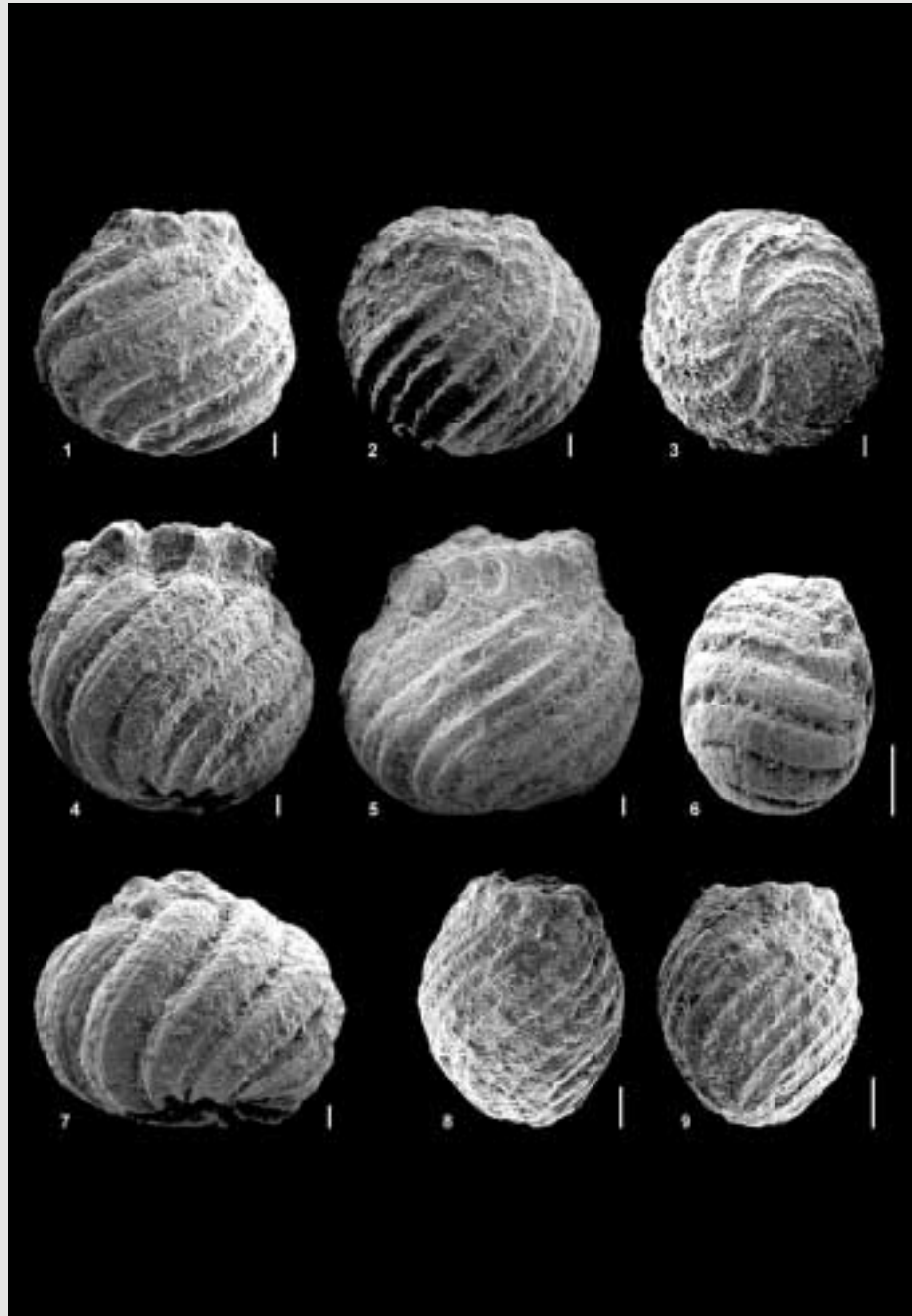
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Portada: Carofitas devónicas del oeste de Canadá. Microfotografías por M. D. Georgescu y W. K. Braun. Escala: 100 micras.

Cover: Devonian Charophyta of Western Canada. Microphotographies by M. D. Georgescu & W. K. Braun. Scale bar: 100 microns.

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Genus *Thomasinella* Schlumberger, 1893
Thomasinella punica Schlumberger, 1893

Use italics rather than underlining for genus/species names.

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DEVONIAN CHAROPHYTA OF WESTERN CANADA

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Abstract

Devonian Charophyta assemblages of Western Canada are compound of five species of which *Xinjiangochara burgessi*, *Moellerina greenei* and *Karpinskya laticostata* are recorded from across the North American continent. *Karpinskya aperta* n. sp., and the first Devonian record of Porocharaceae, *Stomochara moreyi*, are added as minor assemblage constituents. Two groups of species are recognized reflecting their different origins and paleoecological affinities. *Xinjiangochara burgessi* is the primary species encountered in freshwater shales in the vast majority of the assemblages from the late Givetian sequences in Western Canada. All of the other species were found associated with typical marine assemblages, suggesting that the earlier representatives of the Charophyta were adapted to a variety of sedimentary environments in contrast to the modern taxa which are fresh- and brackish-water inhabitants exclusively.

Key words: Charophyta, devonian, western Canada, new species.

Resumen

Las asociaciones de carofitas devónicas del oeste de Canadá están constituidas por cinco especies, de las cuales *Xinjiangochara burgessi*, *Moellerina greenei* y *Karpinskya laticostata* han sido descritas en Norteamérica. *Karpinskya aperta* n. sp. y el primer registro devónico de Porocharaceae, *Stomochara morey*, están presentes en una proporción menor. Dos grupos de especies descritas muestran diferentes orígenes y afinidades paleoecológicas. *Xinjiangochara burgessi* es la especie principal encontrada en la pizarras lacustres entre todas las asociaciones descritas en las secuencias del Givetiense superior del oeste del Canadá. El resto de las especies están asociadas con asociaciones marinas, sugiriendo que los primeros representantes de Charophyta estuvieron adaptados a una amplia variedad de ambientes sedimentarios en contraste con los representantes actuales, que habitan medios lagunares y salobres exclusivamente.

Palabras clave: Charophyta, devónico, oeste de Canadá, nueva especie.

INTRODUCTION

Charophyta are a rather small group of both fossil and modern, morphologically advanced algae. Its evolutionary history seemingly starts in the late Silurian,

and all the representatives of the group display the same complex morphological features ever since. They are mostly preserved in the fossil record as calcified oospheres or “egg cells”, the gyrogonites, which therefore provide the basis for the taxonomy and classification.

The history of the group shows several phases of adaptive radiations from Silurian to Quaternary. The early evolution of the group from the late Silurian to Permian, representing the first major radiation, is dominated by “primitive” forms with horizontally divided or undivided vertical cells (e. g., Sycidiaceae and Chovanellaceae respectively), cells arranged following a double-branch opposing system (e. g., Pinnoputamenaceae), and dextrorse coiled spiral cells around the gyrogonites (e. g., Trochiliscaceae and Moelleriaceae). They are combined in three distinct orders, Sycidiales, Chovanellales, and Moellerinales, differing by the shape of the vertical cells around the gyrogonite in vertical and dextrorse coiled fashion respectively (Mädler, 1952). Most of the Devonian species of Western Canada belong to these more “primitive” charophytes. The typical and morphologically advanced charophytes (Order Charales), in contrast, are characterized by sinistrorse spiral cells of which one rare Devonian species is now reported from Canada. The spiral cells are more numerous in the primitive representatives of the group (more than six in Eocharaceae, and six in the representatives of the Palaeocharaceae) of the Devonian throughout Permian. The other four families display various structures of the apical pore (Porocharaceae and Raskyellaceae), spiral cells joined at the apex (Characeae), and gyrogonites enclosed within an utricle (Clavatoraceae).

There are few records of late Silurian Charophyta. Their rapid evolution above the Silurian/Devonian boundary manifests itself in the appearance of new types of gyrogonite organization, which in turn resulted in a marked increase in the number of genera and species. This pattern developed as a result of the colonization of new geographical areas, and Devonian Charophyta are known from all over the world (e. g., North America, Africa, Asia, Australia, and Europe). North American Devonian Charophyta were extensively recorded and studied in the United States (Missouri, Ohio, North Dakota, Nevada), but rarely reported from Western Canada.

As a by-product of the exploration for hydrocarbons in Western Canada, in particular in Devonian sequences, a relatively clear picture about the distribution patterns of the charophytes emerged over decades of micropaleontological studies (Figure 1). Up-to-date and collectively, five species of Devonian Charophyta are recognized belonging to four genera. Except for one new species, they present close resemblances to those reported from the United States. A new species, *Karpinskya aperta* is added as a see-



FIGURE 1—Location of the provincial areas of Western Canada which yielded the fossil material for the present study. 1-northwestern Alberta, 2-northeastern Alberta, 3-Great Slave Lake region of the Northwest Territories, 4-central Saskatchewan.

mingly indigenous Western Canadian taxon. In addition, the listed species proved useful not only in understanding the general stratigraphic-geographic distribution of the Devonian taxa, but also in evaluation of the group's paleoecological affinities.

ORIGIN AND DISTRIBUTION OF THE DEVONIAN CHAROPHYTA IN WESTERN CANADA

Geologists engaged in the exploration for hydrocarbons in Western Canada commonly differentiate between two groups of Devonian utricles: younger “spiral” (i. e., *Karpinskya*, *Moellerina* and *Stomochara*) and older “ridged” (i. e., *Xinjiangochara*) types. The first group is more diverse and widespread both stratigraphically and geographically, yet also the least known and appreciated in contrast to the second and small group which became a household name by virtue of its mass concentrations used as stratigraphic marker. Most of the “spi-

ral” utricles occur in erratically distributed horizons and as minor components in ostracod-dominated, marine micropaleontological assemblages together with diverse echinoderm, brachiopod, and coral debris, conodonts, and foraminifera, all of them pointing to their origin in marine environments. In contrast, the “ridged” specimens are recorded from non-marine sediments, and most of them were recovered from freshwater shales pointing to paleoenvironmental settings close to that of the modern Charophyta.

The general state of preservation is also different in the two groups. Preservation of the “spiral” ones, as a rule, is adequate to excellent, and there is no evidence for large-scale transport, turbulence, and mechanical abrasion, which applies to the micropaleontological assemblages in the overall. The same *in situ* is considered for the “ridged” specimens although their preservation is distinctly poor when compared to the first group. Most likely this reflects secondary chemical-diagenetic alteration and corrosion rather than primary mechanical abrasion. Although the paleoecology of the Paleozoic charophytes is a long debated problem (Croft, 1952; Edgell, 2003), the Western Canadian Devonian evidence apparently points primarily towards marine, and to freshwater environments in only rare cases.

The most widely known of the Devonian Charophyta occurrences in Western Canada are the largely monotypic mass-concentrations in the Middle Givetian Watt Mountain Formation, a localized non-marine sequence of clastic sediments in the Peace River region of the northwestern Alberta. *Xinjiangochara burgessi* was described originally from this region by Peck and Eyer (1963a), and its presence is confirmed in freshwater shales of many wells north of the Peace River Arch. An identical mass concentration of *Xinjiangochara burgessi* occurs also from the “Pine Point Mining Concession” of the south-central Great Slave Lake area, which on basis of lithological identity is informally referred to as “Watt Mountain shale”. According to the ostracod evidence, however, this unit is younger, located and not connected with the developments in northwestern Alberta.

The “spiral” group is more diverse and consists of four species: *Moellerina greenei*, *Karpinskya laticostata*, *K. aperta* n. sp. and *Stomochara moreyi*. The most abundant species is, by far, *Karpinskya laticostata*, the other three being minor and rare constituents of the Charophyta assemblages. The “spirals” appear first in larger numbers in late Givetian sequences and became the exclusive type in the Frasnian of the surveyed area. The presence of *Stomochara moreyi* is of particular interest for its occurrence represents the

oldest of the representatives of Porocharaceae in the stratigraphic record.

BIOSTRATIGRAPHIC FRAMEWORK

Although the charophytes were collected initially as stratigraphically less important “background micropaleontological assemblage components”, their occurrences are nevertheless directly tied to the biostratigraphic framework established for the ostracods by Braun (1968, 1978). These zones were conceived and defined from the beginning in terms of “(bio)sequences” representing either assemblage zones, or Oppel zones, or any other of the standard zones used for the benthic fossil assemblages. They are based on the most fossiliferous and complete mid-Givetian to Frasnian subsurface and surface sequences of northwestern and northeastern Alberta, and adjoining Great Slave Lake region encountered during four decades of comprehensive studies. The charophyte occurrences are summarily tabulated in Figure 2 within the overall stratigraphic and detailed ostracod zonal framework, with a brief summary of decisive events which may have had some implication in the charophyte original distribution.

SYSTEMATIC PART

Genus *Xinjiangochara* Yang & Zhou, 1990

Type species: *Xinjiangochara kovalevi* Reitlinger & Yartseva, 1958

Xinjiangochara burgessi Peck & Eyer, 1963
(Pl. 1, Figs. 1-10)

- 1963a *Chovanella burgessi* Peck & Eyer, Pl. 1, Figs. 1-15.
- 1966 *Chovanella burgessi* Peck & Eyer – Peck & Morales, Pl. 2, Figs. 9-13.
- 1996 *Xinjiangochara burgessi* (Peck & Eyer) – Lu *et al.*, Pl. 2, Figs. 1-4.
- 2003 *Xinjiangochara burgessi* (Peck & Eyer) – Wang *et al.*, Pl. 1, Figs. 15-17.

Description.—Utricle subspherical to subcylindrical of variable height and resulting in a more or less elongate shape in lateral view. Basal end subrounded to fairly flattened. Apical edge always flattened and with a central circular opening, resulting in a truncated upper margin. Seven to twelve undivided vertical cells can be observed at the exterior part of the gyrogonite.

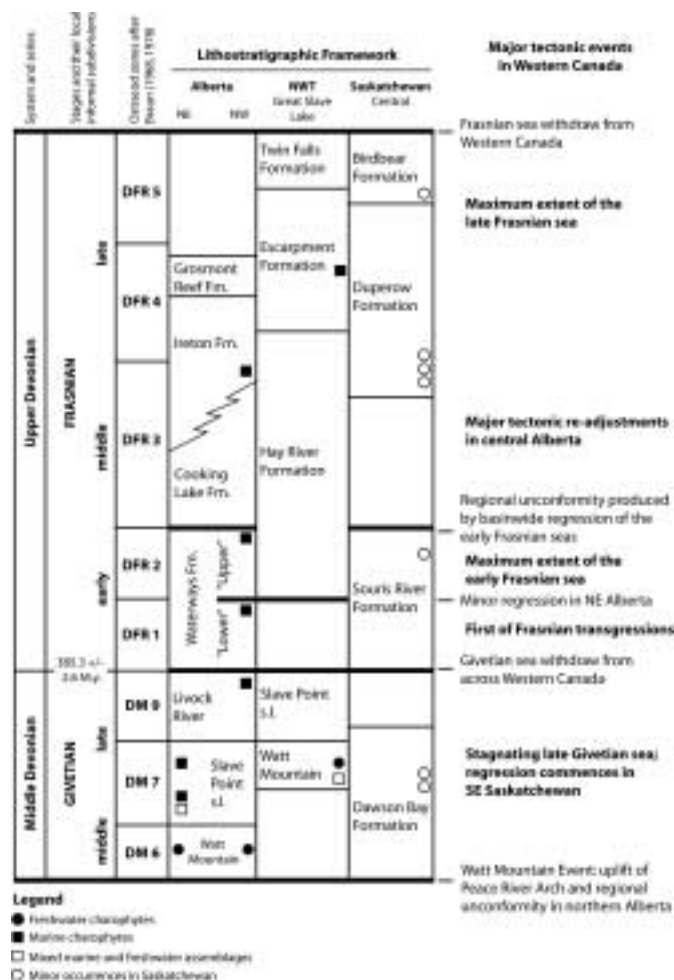


FIGURE 2—Major Charophyta occurrences, ostracod zones, lithostratigraphy and major events in the Givetian and Frasnian of the study area. Transgressive surfaces are given in thickened lines. Stratigraphic intervals without relevance for this study are left blank.

Some ridges bifurcate outside the basal and apical areas. No coronular cells have been observed in the specimens in the collections at hand.

Dimensions.—LPA (length of the polar axis) = 0.28 – 0.58 mm; MXD (maximum diameter) = 0.52 – 0.67 mm; ISI (isopolarity index) = 0.48 – 0.55.

Remarks.—*Xinjiangochara burgessi* displays high morphological variability mainly with respect to the height of the utricles and number of vertical cells observable at the exterior part. It is the dominant and often exclusive species in the charophyte mass concentrations of the middle and late Givetian Watt Mountain freshwater shales, and the only species in the vertically “ridged” group. The species has been primarily recorded from across northern Alberta and the southern Great Slave Lake area of the Northwest Territories.

Local occurrence.—Middle and late Givetian freshwater shales and part of DN6 and DN7 ostracode zones.

Genus *Moellerina* Ulrich, 1886

Type species: *Moellerina greenei* Ulrich, 1886

Moellerina greenei Ulrich, 1886

(Pl. 1, Figs. 11-13)

1886 *Moellerina greenei* Ulrich, p. 35, Pl. 3, Fig. 8.

1934a *Trochiliscus bellatulus* Peck, p. 115, Pl. 10, Figs. 21, 23-24.

1934a *Trochiliscus devonicus* (Wieland) – Peck, p. 108, Pl. 12, Figs. 14-21.

1934a *Trochiliscus rugulatus* Peck, p. 115, Pl. 13, Figs. 1-4.

1934a *Trochiliscus* sp. Peck, p. 116, Pl. 13, Figs. 8-11.

1946 *Trochiliscus greenei* (Ulrich) – Brown, p. 344.

1966 *Moellerina greenei* Ulrich – Peck & Morales, p. 315, Pl. 4, Figs. 1-14.

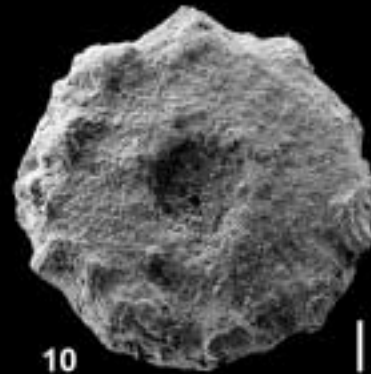
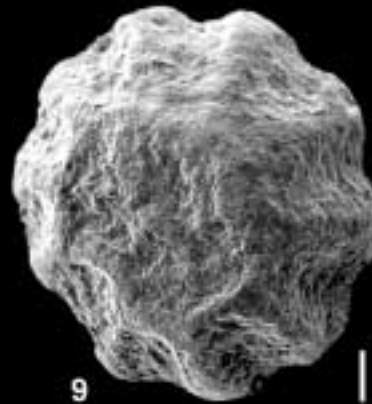
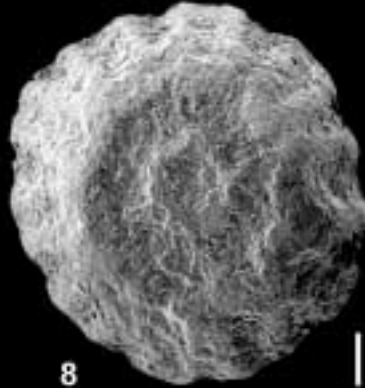
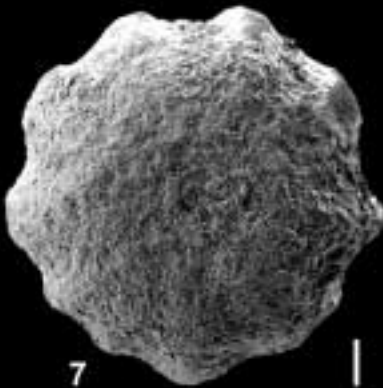
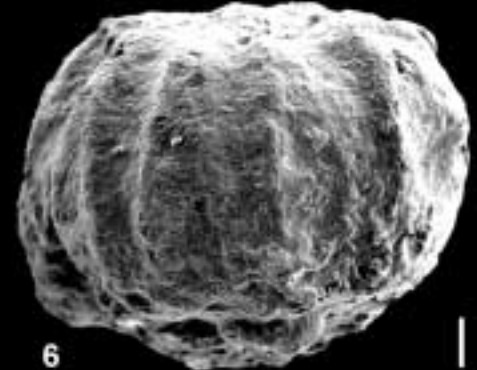
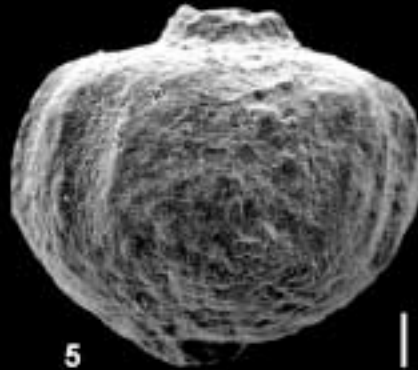
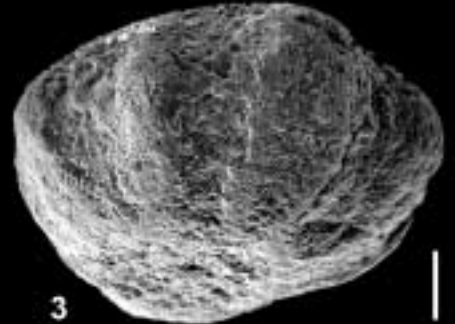
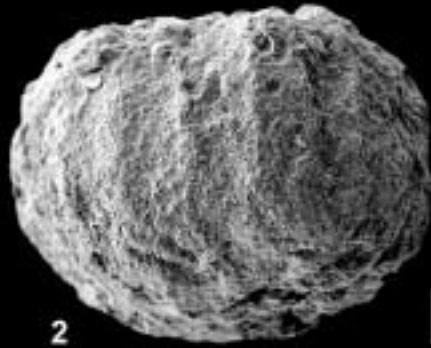
1970 *Moellerina greenei* Ulrich – Conkin et al, p. 403, Pl. 1, Figs. 5-52.

1980 *Moellerina greenei* Ulrich – Tappan, Fig. 11.24(1).

1996 *Moellerina greenei* Ulrich – Lu et al., Pl. 3, Figs. 1-3.

PLATE 1—Devonian Charophyta of Western Canada. Specimens reposit at the University of Saskatchewan micropaleontological collection. Scale bars represent 100 microns. 1-10. *Xinjiangochara burgessi*. Specimens from late Givetian Watt Mountain shales of the Pine Point Mining Concession area, wireline core sample 19.00-19.45 m, south central Great Slave Lake region, Northwest Territories. 11-13. *Moellerina greenei*. Specimens from the middle Frasnian Cooking Lake Formation of northeastern Alberta, Bear Biltmore core 7-11-87-17W4, sample 293.83-296.88 m.

PLATE 1



Description.—Subglobose to ellipsoidal gyrogonites, sometimes slightly asymmetrical, with seven to nine dextrorse coiled cells at the exterior. No coronular cells present. Cells form an angle of approximately 30° with the equatorial plane, the ridges lining them starting from a small basal ring. Apical margin obtuse, subtruncated to truncated.

Dimensions.—LPA (length of the polar axis) = 0.36 – 0.56 mm; MXD (maximum diameter) = 0.31 – 0.50 mm; ISI (isopolarity index) = 0.47 – 0.52.

Remarks.—This species is well-known from the Devonian sediments of the North American continent. In the Givetian and Frasnian assemblages of Western Canada it is only a minor element in the charophyte microflora representing the “spiral” informal group. *Moellerina greenei* has reduced morphological variability in contrast to *Moellerina convoluta* (Peck).

Local occurrence.—A minor and erratically distributed species in the late Givetian to mid-Frasnian assemblages of northeastern Alberta and adjoining Great Slave Lake region.

Genus *Karpinskya* Grambast, 1962

Type species: *Trochiliscus laticostatus* Peck, 1934a

Karpinskya aperta n. sp.
(Pl. 2, Figs. 8-9)

Holotype.—Specimen reposit in the micropaleontological collection of the University of Saskatchewan (B3-S2/5).

Dimensions of the holotype.—LPA (length of the polar axis) = 0.42 mm; MXD (maximum diameter) = 0.36 mm; AOD (apical opening diameter) = 0.14; ISI (isopolarity index) = 0.50; NSC (number of spiral cells) = 10.

Type locality.—Pine Point Mining Concession, Canadian Mining and Smelting, CMAS G#4 stratigraphic test, core 60° 54' N, 44° 46' W, 16,15-17.07 m.

Stratum typicum.—Freshwater shales assigned to the “Watt Mountain” on basis of lithological identity, but of late Givetian age based on ostracode assemblage (DN7).

Derivatio nominis.—The Latin name ‘aperta’ emphasizes the opened appearance of the apical edge.

Diagnosis.—Small-sized, cup-like utricles with numerous, eight to ten dextrorse coiled cells and small-sized coronular cells.

Description.—Cup-like utricles with rounded to sub-truncated basal edge. Eight to ten dextrorse coiled, undivided and narrow spiral cells at the exterior. Ridges narrow and thin, initiating at a slightly eccentrically positioned basal ring. Cell overgrowth not observed. Small-sized coronular cells resulting in a ring-like coronular structure at the distal edge of the utricle. Coronular structure diameter wide, its diameter representing 60 to 70% of the largest diameter of the utricle.

Remarks.—The combination between the cup-like shape and the large number of cells is unique among the representatives of the genus *Karpinskya*. This newly proposed species differs from *K. laticostata* (Peck) in the shape of the utricles, wider coronular structure, and smaller coronular cells.

Stratigraphical range.—Late Givetian to middle Frasnian.

Geographical distribution.—This species is only known from northeastern Alberta and adjoining Great Slave Lake region (Northwest Territories) of Western Canada. It is a rare component in the marine micropaleontological assemblages.

Karpinskya laticostata (Peck), 1934
(Pl. 2, Figs. 1-5, 7)

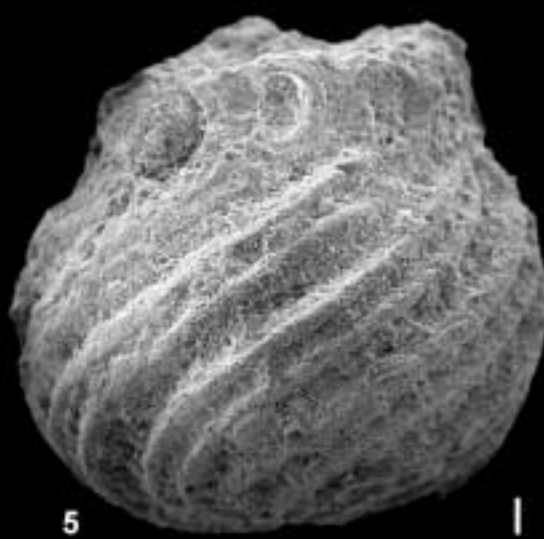
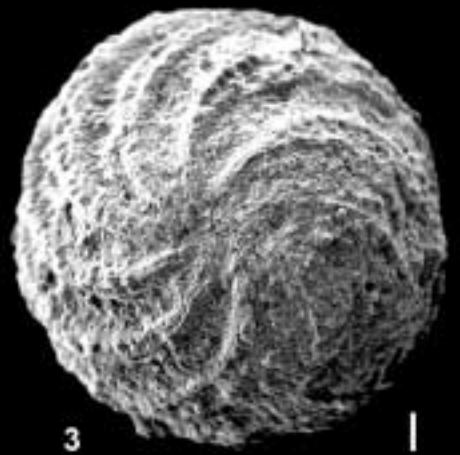
1934a *Trochiliscus laticostatus* Peck, p. 109, Pl. 11, Figs. 1-23.

1934a *Trochiliscus decacostatus* Peck, p. 109, Pl. 12, Figs. 4-9.

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PLATE 2—Devonian Charophyta of Western Canada. Specimens reposit at the University of Saskatchewan micropaleontological collection. Scale bars represent 100 microns. 1-5, 7. *Karpinskya laticostata*. 1-3: specimens from the lower part of the Waterways Formation (early Frasnian); Bear Biltmore core 7-11-87-17W4, sample 448.06-452.32 m. 4, 5 and 7: specimens from lower part of the Cooking Lake Formation (Middle Frasnian); Bear Biltmore core 7-11-87-17W4 (Sample 293.83-296.88 m). 6. *Stomochara moreyi*. Specimens from late Givetian Watt Mountain shales of the Pine Point Mining Concession area, wireline core sample 19.00-19.45 m, south central Great Slave Lake region, Northwest Territories. 8-9. *Karpinskya aperta* n. sp. Specimens from late Givetian Watt Mountain shales of the Pine Point Mining Concession area, wireline core sample 19.00-19.45 m, south central Great Slave Lake region, Northwest Territories. Type specimens: 8-holotype (B3-S2/5); 9-paratype (B3-S2/8).

PLATE 2



- 1934a *Trochiliscus octocostatus* Peck, p. 111, Pl. 10, Figs. 11-20, 22.
 1934a *Trochiliscus septemcostatus* Peck, p. 111, Pl. 12, Figs. 25-30.
 1966 *Karpinskya laticostata* (Peck) – Peck & Morales, p. 313, Pl. 3, Figs. 11-16.
 1980 *Karpinskya laticostata* (Peck) – Tappan, Fig. 11.24(2).

Description.—Large-sized subglobose to pyriform utricles, with seven to nine dextrorse spiral cells. Cells are lined by ridges which initiate in a basal ring and bifurcate just outside it. Well-developed seven to nine coronular cells typically forming a rampart-like structure at the apical part of the utricles.

Dimensions.—LPA (length of the polar axis) = 0.76 – 1.09 mm; MXD (maximum diameter) = 0.80 – 1.07 mm; ISI (isopolarity index) = 0.45 – 0.56.

Remarks.—This species is the only one in the Western Canada assemblages with well-developed coronular cells resulting in a rampart-like structure. It differs from *Karpinskya bilineata* (Peck) mainly by its larger size.

Local occurrence.—Middle Givetian throughout late Frasnian. It is the dominant trochiliscid species in Western Canada and was recovered from numerous cored sections and wells throughout northern Alberta and the Great Slave Lake region of the Northwest Territories.

Genus *Stomochara* Grambast, 1961

Type species: *Gyrogonites moreyi* Peck, 1934

Stomochara moreyi (Peck) 1934
 (Pl. 2, Fig. 6)

- 1934b *Gyrogonites moreyi* Peck, p. 54, Pl. 1, Figs. 1-3, 5-6.
 1934b *Gyrogonites robertsi* Peck, p. 54, Pl. 1, Figs. 10-12.
 1934b *Gyrogonites* sp. Peck, p. 55, Pl. 1, Fig. 4.
 1937 *Aclistochara moreyi* (Peck) – Peck, p. 87.
 1955 *Porochara moreyi* (Peck) – Mädler, p. 271.
 1963b *Catillochara moreyi* (Peck) – Peck & Eyer, p. 839, Pl. 100, Figs. 1-8; Pl. 101, Figs. 1, 6-8.

Description.—Small-sized, subellipsoidal gyrogonites constantly with five sinistrorse coiled, spiral cells. Furrows narrow and deep. Basal edge rounded to sub-truncated. Apical edge strongly flattened resulting in a well-truncated upper margin.

Dimensions.—LPA (length of the polar axis) = 0.21 – 0.26 mm; MXD (maximum diameter) = 0.17 – 0.21 mm; ISI (isopolarity index) = 0.47 – 0.57.

Remarks.—This is the only porocharacean in the assemblages now reported from the Devonian of Western Canada. Globally the first porocharaceans listed in the fossil record were considered to be of Pennsylvanian age by Tappan (1980), and Feist & Grambast-Fessard (1991). The Canadian record indicates that the Porocharaceae precede the Paleocharaceae in the fossil record and, accordingly, *Stomochara* appears to be more closely related to *Eochara*-like taxa, and not to *Palaeochara*.

Local occurrence.—A very rare species found so far only in the late Givetian “Watt Mountain shales” of the south-central Great Slave Lake region, and in association with mass concentrations of *Xinjiangochara burgessi*, the latter being a good freshwater indicator in Western Canada.

CONCLUSIONS

Five Charophyta species are reported from Givetian and Frasnian subsurface cores of northern Alberta, and the Great Slave Lake region of Western Canada. The fossil remains were encountered both in marine and freshwater shaly sediments. *Xinjiangochara burgessi* appears to be restricted to Givetian freshwater environments, whereas *Moellerina greeniei*, *Karpinskya laticostata*, *K. aperta* n. sp. and *Stomochara moreyi* are primarily encountered in marine Frasnian sediments. Mixed assemblages were rarely encountered.

Species of *Karpinskya*, *Xinjiangochara* and *Moellerina* are known from Devonian sediments across North American continent. In contrast, the record of *Stomochara moreyi* represents the oldest one of the genus, and the first report in the stratigraphic record of a taxon of the Porocharaceae below the Devonian/Mississippian boundary.

Karpinskya aperta n.sp. is described from the late Givetian to middle Frasnian sequences of Western Canada. This species is characterized by cup-like utricles presenting wide apical opening, well-developed coronular structure, eight to ten spiral cells, and smaller sizes when compared to *K. laticostata*, the dominant species of the genus recorded in the study.

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PLIOCENE OSTRACODA OF CEPHALONIA, GREECE. THE UNREVISED SPECIES OF ULICZNY (1969)

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Abstract

We present here the results of a revision of the ostracod species from Uliczny (1969) not previously revised. A detailed reappraisal of the Uliczny's original material preserved in Bayerische Staatssammlung für Paläontologie und Historische Geologie (Munich) revealed that *Aurila livathoensis* and the holotype of *A. maculosa* are conspecific and junior synonyms of *A. (A.) convexa* (Baird, 1850), whereas the paratype of *A. maculosa* displays distinct ornamental differences and thus can retain the specific position. *A. aspidoides* corresponds to *A. (A.) fornicata* (Terquem, 1878), *A. veniliae* to *A. (A.) bisinuata* (Terquem, 1878) and *A. skalae* to *A. (A.) nebianii* Ruggieri, 1953. *A. punctata plagia* and *A. (A.) nilensis* Bassiouni, 1965 should be consolidated as they have the same diagnosis and are evidently conspecific. *A. interpretis* and *A. convexa emathiae* are conspecific and represent *A. (A.) abscisa* (Terquem, 1878). *A. anguisfoveata simplex* and *A. lobooides*, both Uliczny, 1969, are conspecific and synonymous with *A. (A.) anguisfoveata* Uliczny, 1969. *Mutilus dohrni* is identified as being a junior synonym of *Mutilus (O.) retiformis* (Terquem, 1878). *Urocythereis margaritifera alba* is synonymous with *U. crenulosa*, and *U. labyrinthica labyrinthica* and *U. labyrinthica aperta* are conspecific. *Verrucocythereis bulbuspinata tuberculata* Ruggieri, 1973 is placed in the synonymy of *V. bulbuspinata* (Uliczny, 1969). Two new species, *Aurila (A.) cephalonica* and *Tegmenia terquemi*, are proposed for *A. speyeri nebianii* and *Falunia rogusa* (sensu Uliczny, 1969), respectively.

Key words: Uliczny's collection, Ostracoda, Taxonomy, Pliocene, Cephalonia, Greece.

Resumen

Se presentan los resultados de la revisión de las especies de Uliczny (1969) que no habían sido revisadas anteriormente. Un estudio detallado del material original de Uliczny, conservado en la Bayerische Staatssammlung für Paläontologie und Historische Geologie (Munich), ha puesto de manifiesto que *Aurila livathoensis* y el holotipo de *A. maculosa* son coespecíficos y son sinónimos anteriores de *A. (A.) convexa* (Baird, 1850), mientras que el paratipo de *A. maculosa* muestra diferencias de ornamentación por lo que mantiene su status específico. *A. aspidoides* corresponde a *A. (A.) fornicata* (Terquem, 1878) y *A. skalae* a *A. (A.) nebianii* Ruggieri, 1953. *A. punctata plagia* y *A. (A.) nilensis* Bassiouni, 1965 tienen los mismos caracteres diagnósticos y son, por tanto, coespecíficas. *A. interpretis* y *A. convexa emathiae* corresponden a una misma especie, *A. (A.) abscisa* (Terquem, 1878). *A. anguisfoveata simplex* y *A. lobooides*, ambas definidas por Uliczny (1969), son la misma especie, sinónimos a su vez de *A. (A.) anguisfoveata* Uliczny, 1969. *Mutilus dohrni* se considera como un sinónimo anterior de *Mutilus (O.) retiformis* (Terquem, 1878). *Urocythereis labyrinthica labyrinthica* y *U. labyrinthica aperta* son coespecíficas, y *Urocythereis margaritifera alba* es sinónimo de *U. crenulosa* (Terquem, 1878). *Verrucocythereis bulbuspinata tuberculata* Ruggieri, 1973 es considerada sinónimo de *V. bulbuspinata* (Uliczny, 1969). Se proponen dos nuevas especies, *Aurila (A.) cephalonica* y *Tegmenia terquemi*, para *A. speyeri nebianii* y *Falunia rogusa* (sensu Uliczny, 1969), respectivamente.

Palabras clave: Colección de Uliczny, Ostracoda, taxonomía, Plioceno, Cephalonia.

INTRODUCTION

Uliczny (1969) introduced 85 ostracod species and subspecies from the Pliocene of Cephalonia (Greece) including 32 new taxa. The taxonomical status of some of these species is suspicious (Sissingh, 1972; Doruk, 1974b, Bassiouni, 1979; Mostafawi, 1981, 1989; Malz & Jellinek, 1984) and they have been considered as being junior synonyms of previously known species, specially of those described by Terquem (1878) from the Upper Pliocene of the Rhodes Island. When Wouters re-examined the Terquem collection, the quite rightly drew attention to *Mutilus* (O.) *dohrni*, *Aurila aspidoides*, *Aurila interpretis*, *Aurila convexa emathiae* and *Urocythereis margaritifera alba* described by Uliczny (1969) from the Pliocene of Cephalonia, noting that they may be conspecific with Terquem's *Mutilus* (O.) *retiformis*, *Aurila* (A.) *bisinuata*, *A. (A.) abscisa*, *A. (A.) radiola* and *Urocythereis crenulosa* respectively. The revision of some selected species of Uliczny's collection by Mostafawi (2002) resulted in the following conclusions: 1) *Cistacythereis caelatura* and *Cistacythereis pokornyii hellenica* are conspecific and junior synonyms of *Cistacythereis cerenidos* Uliczny, 1969; 2) the subspecies *Costa punctatissima samiensis* represents *Costa punctatissima* Ruggieri, 1962; 3) *Falunia capsula* is a junior synonym of *Hiltermannicythere rubra* (G. W. Müller, 1894); 4) *Quadracythere prava salebrosa* is conspecific with *Tenedocythere exornata* (Terquem, 1878).

The present paper deals with the taxonomy and stratigraphy of the remaining Uliczny species deposited in the Bayerische Staatssammlung für Paläontologie und Historische Geologie (Munich, Germany), to clarify the existing taxonomical confusion especially surrounding aurilid and urocytherid species and to illustrate the taxa with scanning electron micrographs. Species not discussed in text are listed in Table 1 with old and modern names.

Genus *Carinocythereis* Ruggieri, 1956
Carinocythereis carinata (Roemer, 1838)
 Pl. 1, Fig. 1

- 1838 *Cytherina carinata* n. sp. Roemer, 518, Pl. 6, Fig. 28.
 1850 *Cythereis antiquata* n. sp. Baird, 176, Pl. 20, Fig. 2.
 1878 *Cythere lamelosa* n. sp. Terquem, 119, Pl. 14, Figs. 4a-c.
 1878 *Cythere tuberosa* n. sp. Terquem, 120, Pl. 14, Figs. 5a-c.

- 1969 *Carinocythereis antiquata* Baird; Uliczny, 73, Pl. 4, Figs. 9-10; Pl. 16, Fig. 5.
 1972 *Carinocythereis antiquata antiquata* Baird; Uffenorde, 70, Pl. 7, Fig. 7.
 1975 *Carinocythereis antiquata antiquata* Baird; Breman, 57, Pl. 7, Fig. 103 (q. v. for detailed synonymy).
 1980 *Carinocythereis carinata* Roemer; Ruggieri & Russo, Pl. 2; Fig. 8.
 1989 *Carinocythereis lamelosa* Terquem; Mostafawi, Figs. 6-9.
 1989 *Carinocythereis carinata* Roemer; Mostafawi, Pl. 5, Fig. 112.
 1987 *Carinocythereis carinata* Roemer; Athersuch & Whittaker, 97-102 [1987a].
 1989 *Carinocythereis carinata* Roemer; Athersuch *et al.*, 136, Pl. 4, Fig. 1; Text-Fig. 53 (q. v. for more synonymy).

Remarks.—The species is very similar to *C. whitei*, but differs clearly in the disposition of the ventro-lateral carina which is not produced anteriorly to run parallel to the anterior margin, but is restricted to the ventro-lateral region, the anterior part being replaced by a row of five cone-shaped tubercles. Wouters (1974) reported that *Cythere tuberosa* described by Terquem (1878) from the Upper Pliocene of Rhodes is conspecific with *Carinocythereis antiquata*, apparently with reference to Uliczny (1969), as he noted “The specimen in the collection corresponds with *Carinocythereis antiquata* (Baird, 1850) as it has been figured by Uliczny (1969, Pl. 16, Fig. 5)”.

Occurrence and stratigraphy.—A common marine littoral to sublittoral species widespread around the coasts of Britain (mostly in the south), Mediterranean and French Atlantic, found as deep as 71 m on fine sand and silt substrates (Carbonel & Moyes, 1971; Uffenorde, 1972; Breman, 1975; Athersuch *et al.*, 1989), and tends to occur more frequently in depths between 40 and 130 m (Athersuch & Whittaker, 1987b). Ruiz *et al.* (2000) found living specimens in south-western Spanish estuaries in depths between 6 and 18 m. The species appears in the Mediterranean during the Pliocene and is widely distributed in Pleistocene.

Carinocythereis whitei (Baird, 1850)
 Pl. 1, Figs. 2-3

- 1950 *Cythereis whitei* n. sp. Baird, 175, Pl. 20, Fig. 3.
 1969 *Carinocythereis bairdi* n. sp. Uliczny, 75, Pl. 5, Figs. 1-4; Pl. 18, Fig. 7.
 1969 *Carinocythereis cnistum* n. sp. Uliczny, 77, Pl. 5, Figs. 5-6; Pl. 18, Fig. 8.

- 1969 *Carinocythereis whitei* (Baird). Uliczny. 79, Pl. 5, Fig. 7; Pl. 16, Fig. 7.
 1971 *Carinocythereis bairdi* Uliczny; Bonaduce *et al.* Pl. 2, Fig. 9.
 1972 *Carinocythereis antiquata bairdi* Uliczny; Uffenorde, 70, Pl. 7, Fig. 8.
 1975 *Carinocythereis antiquata bairdi* Uliczny; Breman, 57, Pl. 7, Fig. 104.
 1977 *Carinocythereis bairdi* Uliczny; Bonaduce *et al.* Pl. 2, Fig. 8.
 1981 *Carinocythereis carinata* (Roemer); Mostafawi, 146, Pl. 5, Figs. 14-15.

Collection-number	Pl, Fig.	After Uliczny 1969	Present paper	Length (mm)	Height (mm)		Man.-fact
242	4/5	<i>Aurila anguisfoveata anguisfoveata</i>	<i>Aurila</i> (A.) <i>anguisfoveata</i>	0,98	0,63	U	65,6
243	4/6	<i>Aurila anguisfoveata simplex</i>	<i>Aurila</i> (A.) <i>anguisfoveata</i>	1,01	0,65	U	65,3
244	4/7	<i>Aurila anguisfoveata simplex</i>	<i>Aurila</i> (A.) <i>anguisfoveata</i>	0,99	0,65	U	66,7
245	5/7	<i>Aurila aspiodes</i>	<i>Aurila</i> (A.) <i>fornicata</i>	0,93	0,60	U	71,4
246	5/8	<i>Aurila aspiodes</i>	<i>Aurila</i> (A.) <i>fornicata</i>	0,98	0,61	U	67,3
248	5/4	<i>Aurila bullapunctata bullapunctata</i>	<i>Aurila</i> (A.) <i>bullapunctata</i>	0,65	0,44	U	96,9
250	5/5	<i>Aurila bullapunctata extumefacta</i>	<i>Aurila</i> (A.) <i>bullapunctata</i>	0,63	0,44	U	100,0
252	4/10	<i>Aurila calciplena</i>	<i>Aurila</i> (A.) <i>calciplena</i>	0,83	0,53	U	78,8
254	3/8	<i>Aurila cicatricosa cicatricosa</i>	<i>Aurila</i> (A.) <i>cf. hesperiae</i>	0,85	0,52	P	74,1
255	3/3	<i>Aurila convexa convexa</i>	<i>Aurila</i> (A.) <i>cf. punctata</i>	0,91	0,61	P	64,3
257	5/1	<i>Aurila convexa emathiae</i>	<i>Aurila</i> (A.) <i>abscisa</i>	0,94	0,64	U	65,2
260	4/9	<i>Aurila cruciata cruciata</i>	<i>Aurila</i> (A.) <i>anguisfoveata</i>	1,03	0,67	P	61,2
261	5/3	<i>Aurila cruciata minor</i>	<i>Aurila</i> (A.) <i>minor</i>	0,86	0,53	U	83,6
305	6/1	<i>Aurila fastigata</i>	<i>Aurila</i> (A.) <i>fastigata</i>	0,68	0,45	U	101,5
263	3/5	<i>Aurila fialodes</i>	<i>Aurila</i> (A.) <i>fialodes</i>	0,83	0,58	U	72,3
265	4/4	<i>Aurila hadra</i>	<i>Aurila</i> (A.) <i>hadra</i>	0,71	0,50	U	83,1
267	5/2	<i>Aurila interpretis</i>	<i>Aurila</i> (A.) <i>abscisa</i>	0,91	0,59	U	72,5
269	3/9	<i>Aurila ithacae</i>	<i>Aurila</i> (A.) <i>ithacae</i>	0,85	0,56	U	72,9
272	6/2	<i>Aurila lancaeformis</i>	<i>Aurila</i> (A.) <i>lancaeformis</i>	0,75	0,45	U	86,7
275	3/2	<i>Aurila livathoensis</i>	<i>Aurila</i> (A.) <i>convexa</i>	0,85	0,53	U	71,8
280	4/8	<i>Aurila loboides</i>	<i>Aurila</i> (A.)	0,85	0,51	U	77,6
281	3/1	<i>Aurila maculosa</i>	<i>Aurila</i> (A.) <i>convexa</i>	0,76	0,49	U	82,7
282	3/4	<i>Aurila maculosa</i>	<i>Aurila</i> (A.) <i>maculosa</i>	0,78	0,49	U	78,7
283	3/6	<i>Aurila praeacuta</i>	<i>Aurila</i> (A.) <i>praeacuta</i>	0,77	0,53	U	74,7

TABLE 1—List of the total ostracod species found in the Uliczny's collection deposited in Bayerische Staatssammlung für Paläontologie und Historische Geologie, München. The leftmost column gives the Uliczny's collection number, and the rightmost column shows magnification factors in plates of present paper. P = present authors, U = Uliczny in Uliczny 1969. ⚡ = Species not treated in text, but only illustrated.

Remark—The specimens of *Carinivalva marginata* (Terquem, 1878) are lacking in the Uliczny's collection. Uliczny (1969) determined the specimens from the Pliocene of Cephalonia as *Incongruellina* (*Lixourina*) *unicostulata* (Kuiper, 1918), but latter (1971) he described it as new species, *Incongruellina* (*Lixourina*) *patrasiensis* which is considered being conspecific with *Carinivalva marginata* (Terquem, 1878) from the Upper Pliocene of Rhodes (Malz & Jellinek, 1984; Mostafawi, 1989).

Collection-number	Pl, Fig.	After Uliczny 1969	Present paper	Length (mm)	Height (mm)		Man.-fact
284	3/7	<i>Aurila praeacuta</i>	<i>Aurila (A.) praeacuta</i>	0,81	0,51	U	79,0
290	4/1	<i>Aurila punctata nilensis</i>	<i>Aurila (A.) nilensis</i>	0,67	0,47	P	94,0
291	4/3	<i>Aurila punctata plagia</i>	<i>Aurila (A.) nilensis</i>	0,71	0,48	U	90,1
288	4/2	<i>Aurila punctata punctata</i>	<i>Aurila (A.) nilensis</i>	0,73	0,49	P	86,3
294	5/9	<i>Aurila skaliae</i>	<i>Aurila (A.) nevianii</i>	0,86	0,52	U	83,7
298	5/10	<i>Aurila speyeri nevianii</i>	<i>Aurila (A.) cephalonica</i>	0,91	0,57	P	72,5
295	3/10	<i>Aurila speyeri speyeri</i>	<i>Aurila (A.) ithacae</i>	0,96	0,57	U	67,7
303	5/6	<i>Aurila veniliae</i>	<i>Aurila (A.) bisinuata</i>	0,90	0,52	U	76,7
391	2/7	<i>Bosquetina carinella</i>	<i>Bosquetina tarentina</i>	1,29	0,73	P	38,8
400	2/13	<i>Buntonia giesbrechtii</i>	<i>Buntonia giesbrechtii</i> ^{xx}	0,57	0,36	P	87,7
401	2/15	<i>Buntonia robusta</i>	<i>Buntonia conularis</i>	0,53	0,34	P	94,3
402	2/12	<i>Buntonia sublatissima</i>	<i>Buntonia sublatissima</i> ^{xx}	0,49	0,34	P	98,0
403	2/14	<i>Buntonia subulata rectangularis</i>	<i>Rectobuntonia rectangularis</i> ^{xx}	0,57	0,32	P	91,2
344	1/1	<i>Carinocythereis antiquata</i>	<i>Carinocythereis carinata</i>	0,89	0,53	P	61,8
348	1/2	<i>Carinocythereis bairdi</i>	<i>Carinocythereis whitei</i>	0,80	0,51	U	70
346	1/4	<i>Carinocythereis carinata</i>	<i>Carinocythereis princeps</i>	0,89	0,54	P	67,4
347	1/5	<i>Carinocythereis carinata</i>	<i>Carinocythereis princeps</i>	0,89	///	P	83,1
353	1/3	<i>Carinocythereis cnistium</i>	<i>Carinocythereis whitei</i>	0,80	0,41	U	70,0
307	2/8	<i>Caudites calceolatus</i>	<i>Caudites calceolatus</i> ^{xx}	0,65	0,34	P	87,7
367	1/9	<i>Costa batei ahramensis</i>	<i>Costa batei</i> ^{xx}	0,75	0,38	P	85,3
366	1/8	<i>Costa batei batei</i>	<i>Costa batei</i> ^{xx}	0,89	0,48	P	69,7
368	1/6	<i>Costa edwardsii edwardsii</i>	<i>Costa edwardsii</i>	0,85	0,47	P	71,8
370	1/7	<i>Costa edwardsii runcinata</i>	<i>Costa edwardsii</i>	0,83	0,47	P	73,5
392	2/5	<i>Echinocythereis scabra</i>	<i>Echinocythereis scabra</i>	0,99	0,59	P	54,5
377	1/12	<i>Falunia cephalonica</i>	<i>Celtia quadridentata cephalonica</i> ^{xx}	0,76	0,39	U	76,3
379	2/1	<i>Falunia emaciata</i>	<i>Hiltermannicythere emaciata</i> ^{xx}	0,75	0,39	P	74,7
380	1/13	<i>Falunia quadridentata</i>	<i>Celtia biflexa</i>	0,73	0,37	P	87,7
381	1/10	<i>Falunia retifastigata</i>	<i>Hiltermannicythere turbida</i> ^{xx}	0,93	0,45	P	65,6
385	2/2	<i>Falunia rugosa</i>	<i>Tegmenia terquemi</i>	0,75	0,38	P	74,7
384	2/3	<i>Falunia rugosa</i>	<i>Tegmenia terquemi</i>	0,73	0,38	P	78,1
386	1/11	<i>Falunia turbida</i>	<i>Hiltermannicythere turbida</i> ^{xx}	0,79	0,43	P	75,9
388	2/9	<i>Henryhowella asperrima</i>	<i>Henryhowella hirta</i>	0,73	0,45	P	74,0
308	2/17	<i>Heterocythereis albomaculata</i>	<i>Heterocythereis albomaculata</i> ^{xx}	0,83	0,44	P	59,0
309	6/3	<i>Mutilus cimbaeformis</i>	<i>Cimbaurila cimbaeformis</i>	0,79	0,51	P	83,5
310	6/6	<i>Mutilus dohrni</i>	<i>Mutilus (O.) retiformis</i>	0,85	0,57	U	68,2
285	6/4	<i>Mutilus praeapulina</i>	<i>Cimbaurila praeapuliana</i>	0,75	0,53	U	80,0
312	6/7	<i>Mutilus retiformis</i>	<i>Mutilus (O.) elegantulus</i>	0,83	0,57	P	75,9
313	6/5	<i>Mutilus venetiensis</i>	<i>Cimbaurila venetiensis</i>	0,69	0,45	U	92,8
389	2/16	<i>Occultocythereis bituberculata</i>	<i>Occultocythereis dohrni</i>	0,63	0,36	P	84,1
318	2/10	<i>Pachycaudites h-scripta</i>	<i>Graptocythere intricata</i> ^{xx}	0,85	0,49	P	61,2
322	2/11	<i>Pachycaudites sp.</i>	<i>Graptocythere sp.</i> ^{xx}	0,79	0,47	P	67,1
319	7/9	<i>Pachycaudites ungeri</i>	<i>Pachycaudites attenuatus</i>	0,85	0,53	P	77,6

TABLE 1—Continue.

Collection-number	Pl, Fig.	After Uliczny 1969	Present paper	Length (mm)	Height (mm)		Man.-fact
395	7/8	<i>Pterygocythereis ceratoptera</i>	<i>Pterygocythereis coronata</i>	1,01	0,49	P	75,2
396	7/7	<i>Pterygocythereis fimbriata</i>	<i>Pterygocythereis jonesii</i>	0,97	0,55	P	73,2
397	2/6	<i>Ruggieria tetraptera</i>	<i>Ruggieria tetraptera</i> ²³	0,97	0,49	P	58,8
342	7/6	<i>Thaerocythere bulbusspinata</i>	<i>Verrucocythereis bulbusspinata</i>	0,76	0,48	U	92,1
321	7/10	<i>Thyrrhenocythere pignattii</i>	<i>Tyrrhenocythere amnicola</i>	0,83	0,48	P	78,3
390	2/4	<i>Trachyleberis hystrix</i>	<i>Acanthocythereis hystrix</i> ²³	0,87	0,50	P	65,5
326	6/10	<i>Urocythereis favosa exedata</i>	<i>Urocythereis exedata</i>	0,91	0,47	U	79,1
324	7/2	<i>Urocythereis favosa favosa</i>	<i>Urocythereis labyrinthica</i>	0,79	0,45	P	88,6
335	7/3	<i>Urocythereis labyrinthica aperta</i>	<i>Urocythereis labyrinthica</i>	1,00	0,52	U	76,0
332	7/1	<i>Urocythereis labyrinthica labyrinthica</i>	<i>Urocythereis labyrinthica</i>	0,94	0,52	U	79,8
329	6/9	<i>Urocythereis margaritifera alba</i>	<i>Urocythereis crenulosa</i>	0,97	0,49	U	76,3
330	7/4	<i>Urocythereis minoos</i>	<i>Urocythereis minoos</i>	0,83	0,44	U	90,4
331	7/5	<i>Urocythereis minoos</i>	<i>Urocythereis minoos</i>	0,90	0,44	U	85,6
336	6/8	<i>Urocythereis sororcula</i>	<i>Urocythereis favosa</i>	0,97	0,47	P	76,3

TABLE 1—Continue.

- 1986 *Carinocythereis bairdi* Uliczny; Mostafawi, Pl. 2, Fig. 28.
- 1989 *Carinocythereis whitei* (Baird); Athersuch *et al.*, 137, Pl. 4, Fig. 2; Text-Fig. 54 (q. v. for more synonymy).
- 1992 *Carinocythereis whitei* (Baird); Bonaduce *et al.*, 50, Pl. 14, Fig. 7.
- 1997 *Carinocythereis whitei* (Baird); Barra, 78, Pl. 2, Fig. 9.
- 2003 *Carinocythereis whitei* (Baird); Guernet *et al.*, 83, Pl. 2, Figs. 8-9 (q. v. for complete synonymy).

Remarks.—Athersuch *et al.* (1989) discussed the former confusion over the relationship between *C. whitei* and *C. bairdi* described by Uliczny (1969) from the Pliocene of Cephalonia and concluded that the two species were synonymous. Another species of the genus described by Uliczny (1969) is *C. cnistum*, which represents in fact poorly preserved or worn specimens of *C. whitei*, appearing more nodose because median and dorso-lateral carinae are abraded. Comparison of *C. bairdi* with *C. cnistum* and *C. whitei* from the Uliczny's collection leaves no doubt that all of these forms represent *C. whitei*

(Baird). However, McKenzie & Bonaduce (1993) consider *C. bairdi* as before being a separate species.

Occurrence and stratigraphy.—The species is distributed around the coasts of Britain (mostly in the south), the Atlantic coast of France and widespread throughout the Mediterranean. A littoral to sublittoral species living at depths of 2-170 m with maximum abundance at depths between 71-100 m, preferentially on sand or silt substrates (Uffenorde, 1972; Bonaduce *et al.*, 1976; Breman, 1975; Athersuch & Whittaker, 1987b; Athersuch *et al.*, 1989; Ruiz *et al.*, 2000). Fossil records are poorly known, mainly because of confusion with other species. It has a relatively wide stratigraphical range reported from the Upper Miocene to Pleistocene of the Mediterranean (Sissingh, 1972; Bonaduce *et al.*, 1992), and from Pleistocene of England, however, as *Cythere aspera* (see also Athersuch & Whittaker, 1987b).

Carinocythereis princeps (Terquem, 1878)
Pl. 1, Figs. 4-5

1878 *Cythere princeps* n. sp. Terquem, 113, Pl. 13, Figs. 9a-d.

- 1878 *Cythere senilis* n. sp. Terquem, 115, Pl. 13, Figs. 14a-c.
 1878 *Cythere affinis* n. sp. Terquem, 116, Pl. 13, Figs. 15a-b.
 1969 *Carinocythereis carinata* (Roemer); Uliczny, 76, Pl. 16, Fig. 6; Pl. 18, Fig. 6.
 1972 *Carinocythereis carinata* (Roemer); Sissingh, 98, Pl. 6, Fig. 12.
 1972 *Carinocythereis carinata* (Roemer); Uffenorde, 72, Pl. 7, Fig. 9.
 1975 *Carinocythereis carinata* (Roemer); Breman, 75, Pl. 7, Fig. 105.
 1981 *Carinocythereis carinata* (Roemer); Tsapralis, 92, Pl. 1, Fig. 3.
 1989 *Carinocythereis whitei* (Baird); Mostafawi, 147, Pl. 6, Figs. 4-5.

Remarks.—*C. princeps* is characterized by its large size ($L = 0.85\text{--}0.95$ mm) and relatively robust and clearly ponticulate carinae, giving the carapace a rectangular appearance in dorsal view. Dorsal margin is straight, obscured by a strongly projecting dorsal carina. Ventral carina is continuous with the anterior concentric carina. Dorsal and median carinae are posteriorly joined by an oblique riblet. Anterior and ventral margins are carinate and ponticulate throughout, being neither denticulate nor spinose.

The species is often referred to as either *C. carinata* or *C. whitei*. Wouters (1974) recognised that *Cythere affinis*, *Cythere princeps*, *Cythere senilis* and *Cythere monile* described by Terquem (1878) from the Upper Pliocene of Rhodes are conspecific, however, he assign-

ned them to *Carinocythereis carinata*. Apparently his determination based on specimens figured by Uliczny (1969) as *C. carinata*, which considered herein as being conspecific with *C. princeps*. The species differs from *C. whitei* mainly in the large size and in the disposition of the anterior marginal carina, which is ventrally disconnected in *C. whitei* to form a row of short marginal spines. The ventral and dorsal carinae in *C. carinata* are interrupted, and the ventral carina is not anteriorly produced to run concentric to the anterior margin.

Occurrence and stratigraphy.—A marine shallow water species reported from the Adriatic Sea, mainly on sandy bottom (Uffenorde, 1972; Breman, 1975). Fossil records are from the Upper Miocene of Crete and Pliocene to Pleistocene of the South Aegean Islands Arc and Cephalonia (Sissingh, 1972; Mostafawi, 1989; Uliczny, 1969).

Genus *Costa* Neviani, 1928

Costa edwardsii (Roemer, 1838)

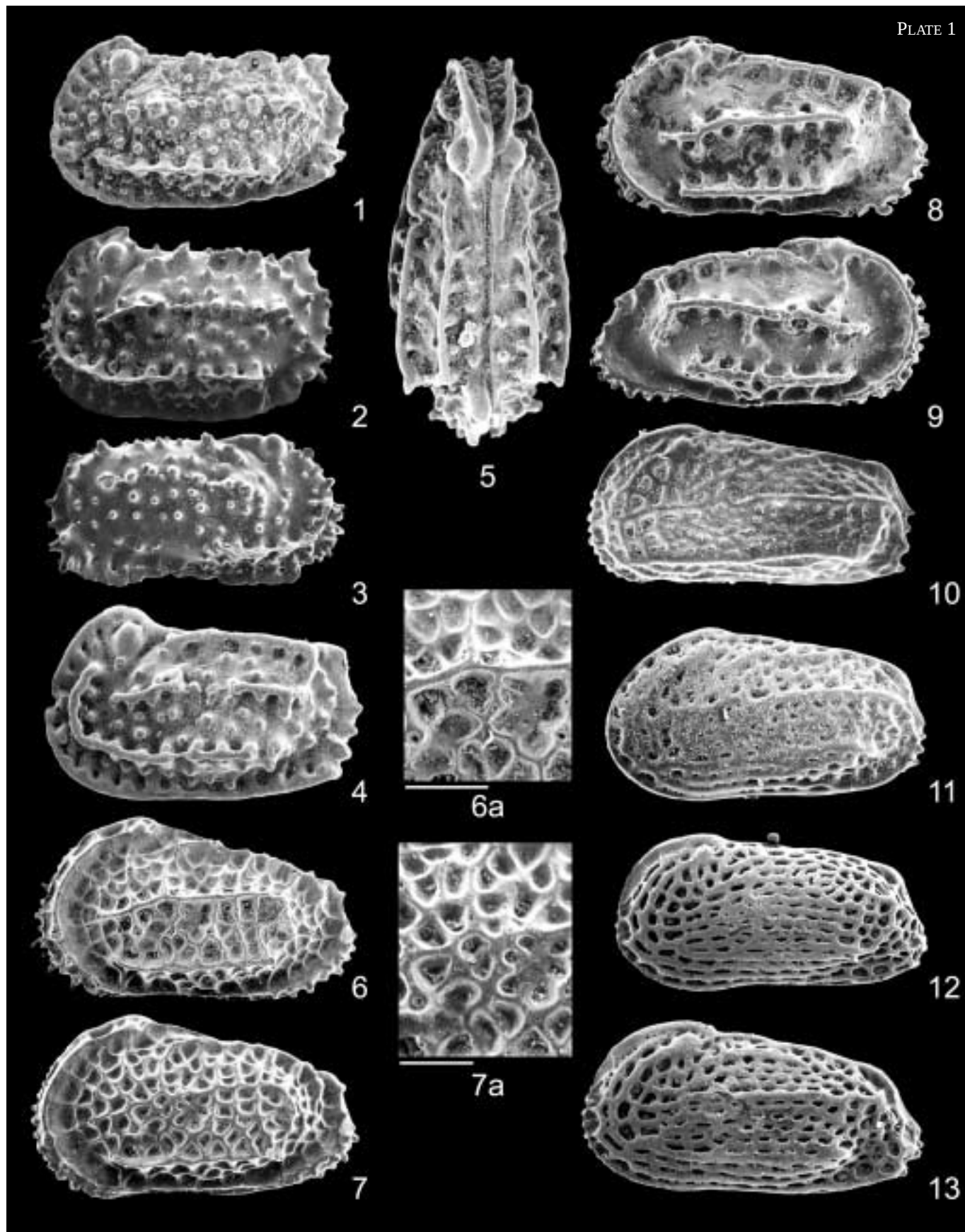
Pl. 1, Figs. 6-7

- 1838 *Cypridina edwardsii* n. sp. Roemer, 518, Pl. 6, Fig. 4.
 1969 *Costa edwardsii edwardsii* (Roemer); Uliczny, 87.
 1969 *Costa edwardsii runcinata* (Baird); Uliczny, 88.
 1973 *Costa edwardsii* (Roemer); Doruk, 245-248, Pl. 1: 44: 246, Figs. 1-2; Pl. 1: 44: 248, Figs. 1-3 [1973d].
 1981 *Costa edwardsii* (Roemer); Mostafawi, 146, Pl. 6, Figs. 1-3, 7 (q. v. for more synonymy).

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PLATE 1—All figures are external view, LV, if not otherwise stated; Uliczny's original specimens are deposited at the Bayerische Staatssammlung für Paläontologie und Historische Geologie, München (Sgl. Ostracoda). 1, *Carinocythereis carinata* (Roemer, 1838); Female, x 62, corresponding to "*Carinocythereis antiquata*", sensu Uliczny, 1969 (Sgl. Ostr. Nr. 344). 2-3, *Carinocythereis whitei* (Baird, 1850); 2, Female, x 70, corresponding to "*Carinocythereis bairdi*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 348); 3, Male, RV, x 70, corresponding to "*Carinocythereis cnistium*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 353). 4-5, *Carinocythereis princeps* (Terquem, 1878); 4, Female, x 67, corresponding to "*Carinocythereis carinata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 346); 5, Female, carapace, dorsal view, x 83, corresponding to "*Carinocythereis carinata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 347). 6-7, *Costa edwardsii* (Roemer, 1838); 6, Female, x 72, corresponding to "*Costa edwardsii edwardsii*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 368); 6a, Detail of Fig. 6, surface ornament of antero-central region, scale = 100 µm; 7, Female, x 74, corresponding to "*Costa edwardsii runcinata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 370); 7a, Detail of Fig. 7, surface ornament of antero-central region, scale = 100 µm. 8-9, *Costa batei* (Brady, 1866); 8, Female, x 70, corresponding to "*Costa batei batei*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 366); 9, Female, x 85, corresponding to "*Costa batei ahramensis*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 367). 10, *Hiltermannicythere rubra* (G. W. Müller, 1894), x 66, corresponding to "*Falunia retifastigata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 381). 11, *Hiltermannicythere turbida* (G. W. Müller, 1894), x 76, corresponding to "*Falunia turbida*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 386). 12, *Celtia quadridentata cephalonica* (Uliczny, 1969), Male, x 76, corresponding to "*Falunia cephalonica*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 377). 13, *Celtia biflexa* (Terquem, 1878), Female, x 88, corresponding to "*Falunia quadridentata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 377).

PLATE 1



- 1989 *Costa edwardsii* (Roemer); Zangger & Malz, Pl. 3, Fig. 7.
 1994 *Costa edwardsii* (Roemer); Danatsas, 120, Pl. 11, Figs. 14-16 (q. v. for more synonymy).
 1998 *Costa edwardsii* (Roemer); Hajjaji *et al.* Pl. 1, Figs. 1-2.

Remarks.—Ruggieri (1962a) considered *C. runcinata* (Baird) as a subspecies of *C. edwardsii* (Roemer). Subsequently, Doruk (1973b) included *C. runcinata* in the synonymy of *C. edwardsii*. However, Athersuch *et al.* (1989) maintained separation with the statement: “We consider that the neotype of *C. edwardsii* differs sufficiently from all the British and other NW European Recent specimens at our disposal for them to be regarded as distinct species.” On the other hand, the present authors could not recognise any distinct differences between British specimens illustrated by Athersuch *et al.* (1989) as *C. runcinata* and other specimens recorded as *C. edwardsii* from different sites of the Mediterranean, extant or fossil. Subtle differences stated by Athersuch *et al.* (*op. cit.*, p. 143) may be an environmentally controlled character. Further detailed examination is necessary before the British specimens can be attributed with certainty to this species.

There is some variation in the development of the costae in both Recent and fossil populations, a factor which appears to be related to calcification of the valves as the whole. This led Uliczny (1969) to ascribe part of the Pliocene material from Cephalonia to *C. edwardsii* and the other part to *C. runcinata*.

Occurrence and stratigraphy.—The species is widespread in the Mediterranean at water depths of 20 to 200 m, but it becomes dominant at depths between 50 and 100 m with a preference for silty to muddy substrates (Barbeito-González, 1971; Uffenorde, 1972; Bonaduce *et al.*, 1976; Yassini, 1979a). It has been also found on south-western coasts of Spain (Ruiz, *et al.*, 2003). A report of *C. edwardsii* from the Middle/Upper Miocene of Gavdos and Crete (Sissingh, 1972) suggests that the species existing in the Mediterranean before the Messinian Crisis. Apparently, it recurred to the area during the Pliocene transgression.

Genus *Celtia* Neale, 1973

Celtia quadridentata cephalonica (Uliczny, 1969)
 Pl. 1, Fig. 12

- 1969 *Falunia cephalonica* n. sp. Uliczny. 93, Pl. 8, Fig. 2; Pl. 17, Fig. 4.
 1972 *Falunia* (*Hiltermannicythere*) *cephalonica* Uliczny; Sissingh. 105, Pl. 7, Fig. 15.

- 1984 *Celtia cephalonica* (Uliczny); Malz & Jellinek, 137, Pl. 4, Fig. 30.
 1989 *Celtia cephalonica* (Uliczny); Mostafawi, Pl. 5, Fig. 95.
 1990 *Celtia cephalonica* (Uliczny); Mostafawi, Pl. 2, Fig. 25.
 2001b *Celtia cephalonica* (Uliczny); Dall’Antonia & Bossio, 416, Pl. 5, Figs. 13-15.

Remarks.—Ruggieri (1976) considered *C. quadridentata cephalonica* (Uliczny) from the Pliocene of Cephalonia as being synonymous with *C. quadridentata quadridentata* (Baird), whereas Malz & Jellinek (1984) decided on separation. *Celtia quadridentata cephalonica* appears to be a geographical variant of *Celtia quadridentata quadridentata* and considered herein as subspecies, as proposed by Wood (in press). Its outline and size are consistent with the nominate species, the only differential feature may be slit-shaped fossae in *C. quadridentata cephalonica*. The specimens from the Salentine Peninsula illustrated by Dall’Antonia & Bossio (2001b) display certain differences concerning the ornamentation. Their ornament is strongly developed as the whole, and the slit-like fossae are a little tegminate. *C. multicosata* Dall’Antonia & Bossio from the Middle Miocene of Salentine Peninsula is closely related to *C. quadridentata cephalonica*, but differs in having three distinct longitudinal fine ribs and a more rectangular outline in lateral view. Recently Wood (in press) discussed the former confusion over the relationship between *Cythere quadridentata*, and *Cythere retifastigata* Jones and concluded that they are conspecific, however, the identity of *Cythere quadridentata* var. *tenuis* described by Seguenza (1880) from the Pleistocene of Calabria (type material presumably lost, no illustrations) remains obscure.

Occurrence and stratigraphy.—*C. quadridentata cephalonica* first emerged in SE Italy during the Middle Miocene (Dall’Antonia & Bossio, 2001b) and subsequently migrated east to colonize the South Aegean Sea during the Upper Miocene (Sissingh, 1972), where it became a frequent littoral species until it disappeared in the Lower Pleistocene (Ruggieri, 1980; Malz & Jellinek, 1984; Mostafawi, 1989, 1990; Hastrup & Thomsen, in press; Wood, in press).

Celtia biflexa (Terquem, 1878)
 Pl. 1, Fig. 13

- 1878 *Cythere biflexa* n. sp. Terquem, 112, Pl. 13, Figs. 6a-c.
 1969 *Falunia quadridentata* (Baird); Uliczny, 97, Pl. 8, Fig. 5; Pl. 17, Fig. 6.

- 1973 *Celtia quadridentata ulicznyi* n. subsp. Neale, 437.
 1989 *Celtia biflexa* (Terquem); Mostafawi, 136, Pl. 5, Figs. 96-97.

Remarks.—Neale (1973) has rightly recognised that the specimens from the Pliocene of Cephalonia figured by Uliczny (1969) as *Falunia quadridentata* are smaller and differ in some respects from the true *C. quadridentata*, and proposed them as a new subspecies, *Celtia quadridentata ulicznyi*. One year later, when Wouters re-examined the type material of Terquem (1878) from the Upper Pliocene of Rhodes, he distinguished two species, *Falunia (Hiltermannicythere) quadridentata* and *Falunia* sp. Subsequently, Mostafawi (1989), assigned the smaller species to *Cythere biflexa* Terquem, 1878, which is characterized by conspicuous median and ventro-lateral costae being posteriorly inflated.

Occurrence and stratigraphy.—The species has only been reported from the Pliocene of Cephalonia (Uliczny, 1969) and Upper Pliocene to Lower Pleistocene of Rhodes (Terquem, 1878; Mostafawi, 1989).

Genus *Tegmenia* Bonaduce, Ruggieri & Russo, 1988
Tegmenia terquemi n. sp.
 Pl. 1, Figs. 2-3

- 1969 *Falunia rugosa* (Costa); Uliczny, 100, Pl. 8, Figs. 6-7; Pl. 17, Figs. 7-8.
 1972 *Falunia (Hiltermannicythere) rugosa* (Costa); Sissingh, 106, Pl. 7, Fig. 19.
 1979 *Hiltermannicythere rugosa* (Costa); Bassiouni, 136, Pl. 17, Figs. 13-15.
 1979 *Falunia rugosa* (Costa); Yassini, 100, Pl. 8, Figs. 3, 8, 10 [1979b].
 1989 *Celtia* (subgen?) *rugosa* (Costa); Mostafawi, 136, Pl. 5, Figs. 96-97.

Derivatio nominis.—In honour of initial Terquem, the pioneer ostracod worker in Greece.

Holotype.—LV; Slg. München Ostr. Nr. 383.

Paratype.—RV; Slg. München Ostr. Nr. 384.

Dimension.—0.70-0.72 mm length, 0.38-0.40 mm height (female); 0.74-0.77 mm length, 0.36-0.39 mm height (male).

Diagnosis.—Carapace elongate, tapering posteriorly. Postero-dorsal area concave, forming a triangular posterior elongation in lateral view. Median and ventro-lateral costae linked posteriorly by a short oblique riblet and extended without a break to the anterior margin. Intercostal areas reticulate by deep and polygonal foveolae, distinctly tegminate.

Remarks.—The new species resembles *Tegmenia rugosa*, but differs in details of outline and ornamentation, particularly the triangular posterior margin and the disposition of the longitudinal costae. *Tegmenia rugosa*, type species of the genus, illustrated by Bonaduce *et al.* (1988) is sub-rectangular with nearly parallel dorsal and ventral margins in lateral view. The posterior margin is not protruded. Median and ventro-lateral costae are interrupted or absent anteriorly.

Occurrence and stratigraphy.—The species is known from the Pliocene of Cephalonia, Crete, Rhodes, Mediterranean coast of Turkey and Algeria (Uliczny, 1969; Sissingh, 1972; Bassiouni, 1979; Yassini, 1979b; Mostafawi, 1989).

Genus *Pterygocythereis* Blake, 1933
Pterygocythereis jonesii (Baird, 1850)
 Pl. 7, Fig. 7

- 1850 *Cythereis jonesii* n. sp. Baird. 175, Pl. 20, Fig. 1.
 1969 *Pterygocythereis fimbriata* (von Münster); Uliczny. 109.
 1989 *Pterygocythereis jonesii* (Baird); Athersuch *et al.* 146, Pl. 4, Fig. 6; Text-Fig. 3B.
 2003 *Pterygocythereis jonesii* (Baird); Guernet *et al.* 84, Pl. 2, Fig. 7 (q. v. for more synonymy).

Occurrence and stratigraphy.—This species is extremely widespread along the coasts of the Mediterranean and Britain, tolerates a wide range of depths (80-270 m) and usually inhabits mud or fine sand (Uffenorde, 1972; Bonaduce *et al.*, 1976; Yassini, 1979a; Athersuch *et al.*, 1989). It has also been reported from the Atlantic coast of France and Spain; records from Kattegat, Skaggerak and Black Sea (Athersuch *et al.*, 1989) require detailed examination. Fossil records ranging from Pliocene to Pleistocene throughout the Mediterranean (Yassini, 1979b; Mostafawi, 1981; Aranki, 1987; Guernet *et al.*, 2003).

Pterygocythereis coronata (Roemer, 1838)
 Pl. 7, Fig. 8

- 1969 *Pterygocythereis ceratoptera* (Bosquet); Uliczny. 108.
 1978 *Pterygocythereis siveteri* n. sp. Athersuch. 1-8.
 1981 *Pterygocythereis siveteri* Athersuch; Mostafawi. 150, Pl. 7, Fig. 11.
 1984 *Pterygocythereis coronata* (Roemer); Malz & Jellinek. 132, Pl. 3, Fig. 20.

Remarks.—Mediterranean findings have been previously attributed without exception to *Pterygocythereis ceratoptera* from the Miocene of the Paris Basin. Athersuch (1978) proposed *Pterygocythereis siveteri* for the Recent and sub-Recent specimens from the Mediterranean and NW Scotland respectively, which was recognized by Malz & Jellinek (1984) to be a junior synonym of *Pterygocythereis coronata* from the Pliocene of Castell'arquato.

Occurrence and stratigraphy.—The species is widespread in the Mediterranean Sea, with a preference for fine sand and silt substrates at depths between 31 and 115 m (Bremner, 1975; Bonaduce *et al.*, 1976; Stambolides, 1985). British records of *P. coronata* are sub-Recent, however, reported as *P. siveteri* by Athersuch (1978). Fossil records from the Mediterranean region range from Pliocene to Pleistocene (Malz & Jellinek, 1984), it has been also reported from the Messinian of Huelva, S.W. Spain (Ruiz & González-Regalado, 1996).

Genus *Verrucocythereis* Ruggieri, 1962

Verrucocythereis bulbospinata (Uliczny, 1969)

Pl. 7, Fig. 6

1969 *Thaerocythere bulbospinata* n. sp. Uliczny. 71, Pl. 4, Fig. 2; Pl. 16, Fig. 4.

1972 *Verrucocythereis bulbospinata* Uliczny; Ruggieri. 99, Fig. 2.

1973 *Verrucocythereis bulbospinata tuberosa* n. subsp. Ruggieri. 229.

1976 *Verrucocythereis bulbospinata tuberosa* Ruggieri; Bonaduce *et al.* 47, Pl. 24, Pl. 1-6.

1981 *Verrucocythereis bulbospinata tuberosa* Ruggieri; Tsapralis. 99, Pl. 1, Fig. 6.

2005 *Verrucocythereis bulbospinata* Dall'Antonia *et al.* 78, Pl. 1, Fig. 7.

Remarks.—The surface of the species is densely covered by pin-shaped spines. Two prominent tubercles protrude through the reticulation in central posterior and central anterior regions of each valve, and these can vary to some extent. Ruggieri (1973) considers the Recent occurrences as a new subspecies, *Verrucocythereis bulbospinata tuberosa*. Comparison with Recent specimens from the Adriatic Sea provided by modern photographs (Bonaduce *et al.*, 1976) indicates that the degree of development of the tubercles is apparently ecologically controlled.

Occurrence and stratigraphy.—The species was originally known from the Pliocene of Cephalonia, and later found in Pleistocene sediments of Calabria, Italy and Zakynthos Island (Ruggieri, 1973; Tsapralis, 1981). It is a shallow water species inhabiting coastal regions of Sicily, the Ionian and Adriatic Seas at a water depth of 20-25 m (Bonaduce *et al.*, 1976).

Genus *Henryhowella* Puri, 1957

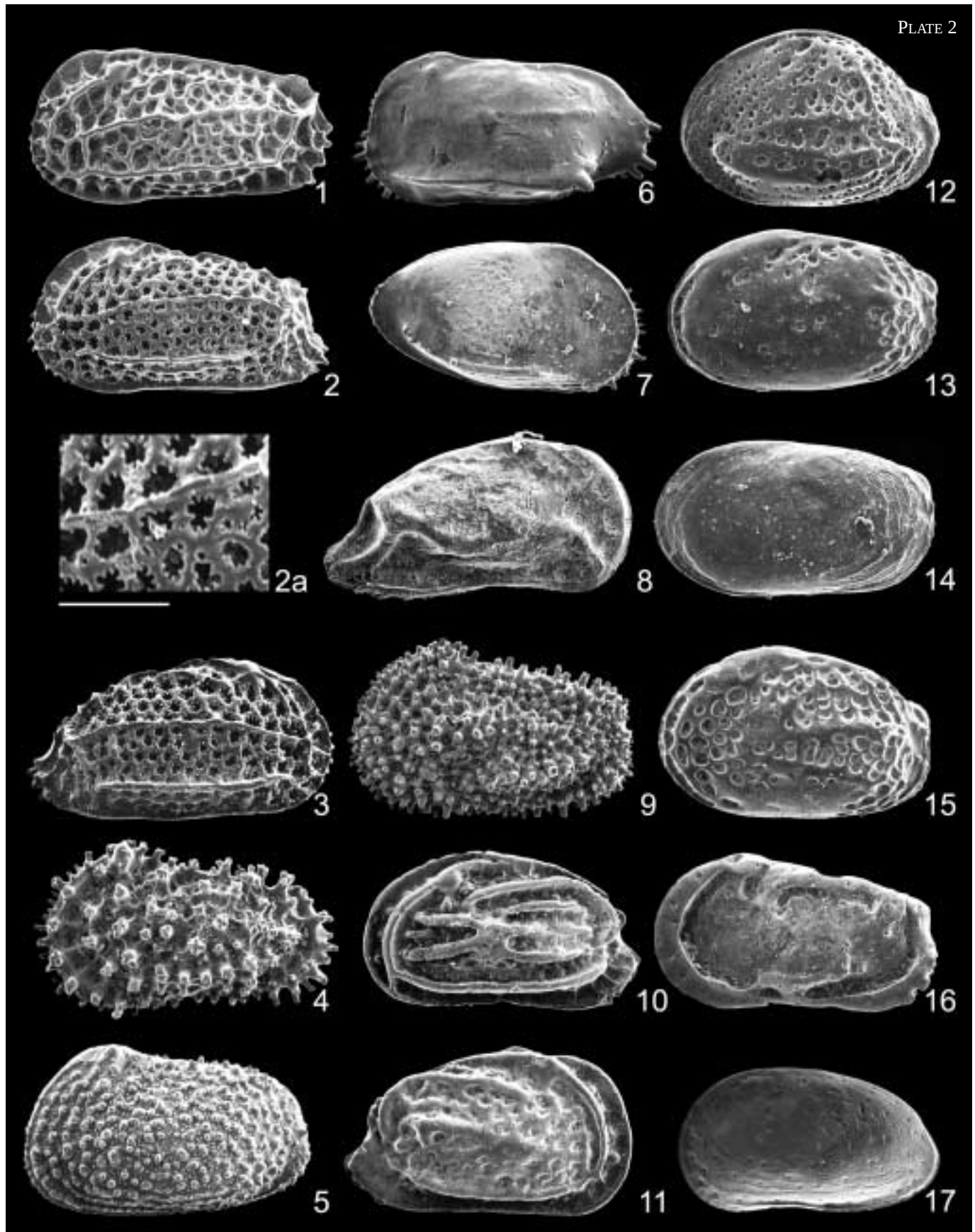
Henryhowella hirta (Costa, 1853)

Pl. 2, Fig. 9

→

PLATE 2—All figures are external view, LV, if not otherwise stated; Uliczny's original specimens are deposited at the Bayerische Staatssammlung für Paläontologie und Historische Geologie, München (Sgl. Ostracoda). 1, *Hiltermannicythere emaciata* (Brady, 1866), Female, x 75, corresponding to "*Falunia emaciata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 379). 2-3, *Tegmenia terquemi* n. sp.; 2, Holotype, x 75, corresponding to "*Falunia rugosa*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 385); 2a, Detail of Fig. 2, surface ornament showing tegminate fossae, scale = 100 µm; 3, RV, Paratype, x 78, corresponding to "*Falunia rugosa*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 384). 4, *Acantocythereis hystrix* (Reuss, 1850), Female, x 66, corresponding to "*Trachyleberis hystrix*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 390). 5, *Echinocythereis scabra* (von Münster, 1830), Female, x 55 (Sgl. Ostr. Nr. 392). 6, *Ruggieria tetraptera* (Seguenza, 1879), Female, x 59 (Sgl. Ostr. Nr. 397). 7, *Bosquetina tarentina* (Baird, 1850), RV, x 39, corresponding to "*Bosquetina carinella*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 391). 8, *Caudites calceolatus* (Costa, 1853), RV, x 88 (Sgl. Ostr. Nr. 307). 9, *Henryhowella hirta* (Costa, 1853), x 74, corresponding to "*Henryhowella asperrima*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 388). 10, *Graptocythere intricata* (Terquem, 1878), Female, x 61, corresponding to "*Pachycaudites h-scripta*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 318). 11, *Graptocythere* sp., RV, x 67, corresponding to "*Pachycaudites* sp." sensu Uliczny, 1969 (Sgl. Ostr. Nr. 322). 12, *Buntonia sublatissima* (Neviani, 1909), Female, x 98 (Sgl. Ostr. Nr. 402). 13, *Buntonia giesbrechtii* (G. W. Müller, 1894), Female, x 88, (Sgl. Ostr. Nr. 400). 14, *Rectobuntonia rectangularis* (Ruggieri, 1954), x 91, corresponding to "*Buntonia sublata rectangularis*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 403). 15, *Buntonia conularis* (Terquem, 1878), x 94, corresponding to "*Buntonia robusta*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 401). 16, *Occultocythereis dohrni* Howe, 1963, x 84, corresponding to "*Occultocythereis bituberculata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 389). 17, *Heterocythereis albomaculata* (Baird 1850), Female, x 59 (Sgl. Ostr. Nr. 308).

PLATE 2



- 1969 *Henryhowella asperrima* (Reuss); Uliczny, 102, Pl. 17, Fig. 10.
- 1979a *Henryhowella asperrima* (Reuss); Yassini, Pl. 7, Figs. 12-14.
- 1984 *Henryhowella hirta* (Costa); Malz & Jellinek, 140, Pl. 5, Fig. 37.
- 1996 *Henryhowella asperrima* (Reuss); Ruiz *et al.*, Pl. 2, Fig. 1.
- 1999 *Henryhowella parthenopea* n. sp. Bonaduce *et al.* 61, Pl. 3, Figs. 1-11, 13, 14; Pl. 4, Fig. 11-12; Pl. 5, Figs. 3-5, 9, 10, 12.
- 1999 *Henryhowella sarsii sarsii* (G. W. Müller); Bonaduce *et al.*, 64, Pl. 2, Figs. 1-10; Pl. 3, Fig. 12; Pl. 4, Figs. 9-10; Pl. 5, Figs. 1-2, 6-8, 11 (q. v. for long synonymy).

Remarks.—Costa (1853) described this species from the Pliocene of Castell'arquato as *Cypridina hirta*, but it was not recorded again until Malz & Jellinek (1984) recovered it again. So it appears in the literature either as *H. asperrima* (e. g. Aranki, 1987; Bonaduce *et al.*, 1992; Ruiz & González-Regalado, 1996) or as *H. sarsii* (Bonaduce *et al.*, 1976; Bonaduce *et al.*, 1999) and or as *H. parthenopea* (Bonaduce *et al.*, 1999). After re-examining the topotypic specimens, Malz & Jellinek (1984) concluded that 1) *H. asperrima* from the Miocene of the Vienna Basin differs in some respects from the Mediterranean Plio-Pleistocene species, and 2) *H. sarsii* from the Gulf of Naples is a junior synonym of *H. hirta*. Apparently, Bonaduce *et al.* (1999) were not aware of the paper of Malz & Jellinek (1984), when they re-studied *Henryhowella* species.

The differences between the species of *Henryhowella* are only minor, and variations in the development of spines or tubercles have been observed in several species, which could be attributed to environmental factors (Dall'Antonia & Bossio, 2001b). We consider that the smaller size and subtle variation in the ornament of *H. parthenopea* introduced by Bonaduce *et al.* (1999) not being sufficient criteria for species separation.

Occurrence and stratigraphy.—The species first appeared during the Upper Miocene of Morocco, Tunisia (Bonaduce *et al.*, 1992) and SW Spain (Ruiz *et al.*, 1996), and subsequently re-entered the post-Messinian Mediterranean associated with the Pliocene transgression, where it became widespread in Plio-Pleistocene. Reports from the Mio-Pliocene of Huelva (Ruiz *et al.*, 1996) and from Messinian to Early Pliocene of W Morocco (Bonaduce *et al.*, 1999) suggest that the species existed in the immediate vicinity

during the Mio-Pliocene. Recent specimens found in the Adriatic Sea, Gulf of Naples, and on Tunisian shelf at depths ranging from 40 to 440 m (Bonaduce *et al.*, 1999).

Genus *Echinocythereis* Puri, 1953

Echinocythereis scabra (von Münster, 1830)
Pl. 2, Fig. 5

- 1830 *Cythere scabra* n. sp. von Münster, 63.
- 1878 *Cythereis cribrata* n. sp. Terquem, 102, Pl. 11, Figs. 13a-c.
- 1878 *Cythereis squamosa* n. sp. Terquem, 102, Pl. 11, Figs. 14a-e.
- 1878 *Cythereis excavata* n. sp. Terquem, 104, Pl. 12, Figs. 3a-b.
- 1969 *Echinocythereis scabra* (von Münster); Uliczny, 105.
- 1972 *Echinocythereis scabra* (von Münster); Ciampo, Pl. 4, Figs. 5-6.
- 1972 *Echinocythereis* (*Rhodicythereis*) sp., Sissingh, 103, Pl. 7, Fig. 11.
- 1976 *Echinocythereis* sp., Bonaduce *et al.*, 52, Pl. 31, Fig. 8.
- 1979a *Echinocythereis scabra* (von Münster); Yassini, 379, Pl. 5, Fig. 11.
- 1979b *Echinocythereis scabra* (von Münster); Yassini, 101, Pl. 10, Figs. 6-7.
- 1981 *Echinocythereis scabra* (von Münster); Mostafawi, 150, Pl. 7, Figs. 12-13.
- 1981 *Echinocythereis scabra* (von Münster); Uffenorde, 155, Pl. 6, Figs. 2-5 (q. v. for more synonymy).
- 1984 *Echinocythereis pustulata* (Namias); Malz & Jellinek, 134, Pl. 3, Fig. 25.
- 1985 *Echinocythereis laticarina* (Brady); Guillaume *et al.*, Pl. 104, Figs. 7-8.
- 1989 *Echinocythereis* (*Rhodicythereis*) *cribrata* (Terquem); Mostafawi, 138, Pl. 5, Fig. 110.
- 1993 *Echinocythereis scabra* (von Münster); Nachite *et al.*, Pl. 4, Figs. 5-6.
- 2000 *Echinocythereis scabra* (von Münster); Barra & Bonaduce, 216, Pl. 3, Figs. 1-9 (q. v. for more synonymy).

Remarks.—As discussed previously (Mostafawi, 1981; Malz & Jellinek, 1984; Barra & Bonaduce, 2000) there are debates concerning the separation between *Echinocythereis scabra* described from the Upper Oligocene of Astrup (Germany) and the Mediterranean Plio-Pleistocene species. After re-examining the Terquem's material, Wouters (1974) con-

cluded that *Cythere cribrata*, *Cythere squamosa* and *Cythere excavata* described by Terquem (1878) from the Upper Pliocene of Rhodes are conspecific and belong to the genus *Echinocythereis* and in this has been followed by Mostafawi (1989). *Echinocythereis scabra* once was thought to be separated from the Mediterranean species, now regarded as conspecific. We consider that only the larger size of the specimens from the Upper Oligocene of Astrup (Germany) is not a sufficient distinctive feature to separate them from the Mediterranean species, as proposed by Malz & Jellinek (1984). Apparently, there are populations with specimens of intermediate size. As an example, Uffenorde (1981) reports lengths of 0.95 mm (female) and 1.02 mm (male) for specimens from the Upper Miocene of NW Germany which represent an intermediate size between smaller forms from the Upper Oligocene and larger ones from the Pliocene-Pleistocene of the Mediterranean. However, there is a certain development in size from the Upper Oligocene to Recent, which could have evolutionary significance.

Some of species of *Echinocythereis* are separated on the basis of papillose or reticulate ornamentation, but this may be an environmentally deduced character (Benson, 1981). Barra & Bonaduce (2000) describe the reticulate specimens from the Tortonian of Montebanzzone (N Apennines) as a new species, *Echinocythereis oertliana*, which appears to represent *E. scabra*. The differences between these two taxa are only slight, based on subtle ornamental variations (papillose or reticulate). One of us (N. M.) observed in material from the South Aegean Islands that the ornamental variation between individuals within one sample may be considerably, which might be controlled by ecological factors. The surface of the valves is usually covered by numerous papillae. If the papillae are worn or only weakly developed, then the surface appears reticulate.

Occurrence and stratigraphy.—This species has an extremely wide stratigraphical range from the Upper Oligocene to Recent. It first appears during the Upper Oligocene and becomes widespread in North Sea and Aquitaine Basins during the Miocene (Uffenorde, 1981; Barra & Bonaduce, 2000) and subsequently immigrated into the Mediterranean during the Pliocene transgression to spread throughout the area. This development is supported by numerous records ranging from the Pliocene to Lower Pleistocene. Recent records from the Mediterranean are only from the Adriatic Sea (Bonaduce *et al.*, 1976) and Bay of Bou-Ismaïl, where it lives at depths down

to 130 m (Yassini, 1979a). However, the specimens from the Adriatic Sea are uncertain and thought to be reworked (Bonaduce *et al.*, 1976). It has also been reported from the Bay of Biscay, where it lives in circalittoral to epibathyal zone (Guillaume *et al.*, 1985).

Genus *Occultocythereis* Howe, 1951

Occultocythereis dohrni Puri, 1963

Pl. 2, Fig. 16

- 1894 *Cythereis lineata* n. sp. G. W. Müller, 377, Pl. 29, Figs. 21, 26; Pl. 31, Figs. 25-30, 33.
- 1961 *Occultocythereis lineata* (G. W. Müller); Triebel, 214, Pl. 4, Fig. 29; Pl. 5, Figs. 30-32.
- 1963 *Occultocythereis dohrni* n. nom. Puri, 373.
- 1969 *Occultocythereis bituberculata* (Reuss); Uliczny, 103, Pl. 18, Fig. 1.
- 1976 *Occultocythereis dohrni* Howe, Bonaduce *et al.*, 50, Pl. 26, Figs. 1-5.
- 2001b *Occultocythereis bituberculata* (Reuss); Dall'Antonia & Bossio, 418, Pl. 6, Figs. 1-4 (q. v. for detailed synonymy).

Remarks.—This species was originally described as *Cythereis lineata* by G. W. Müller (1894) from the Gulf of Naples, but it was re-named by Puri (1963) since the original name was preoccupied by *Cythereis triplicata lineata*. The specific status of the specimens from the Mediterranean is still controversial. A comprehensive taxonomical study by Triebel (1961) revealed that *O. dohrni* closely resembles *O. bituberculata* from the Tortonian of Vienna Basin, but differs in details of ornament, particularly the disposition of the costae and a larger body size, being 0.62-0.66 mm length (female) and 0.65-0.69 mm length (male). *O. dohrni* is smaller in size (L = 0.58-0.64 mm; based on 14 specimens from the Uliczny's collection) and possesses an undulate dorso-marginal costa. The most characteristic feature is that the ventro-lateral costa is posteriorly divided into two branches. The longer branch is perpendicular and the shorter branch is parallel to the ventral margin. However, Dall'Antonia & Bossio (2001b) regarded, in accordance with Ruggieri (1992) *O. lineata* as junior synonym of *O. bituberculata*.

Occurrence and stratigraphy.—The species is known to occur in the Mediterranean from the Middle Miocene to Recent (Sissingh, 1972; Bonaduce *et al.*, 1976; Dall'Antonia & Bossio, 2001b, Hastrup & Thomsen, in press). Recent records are only from the Mediterranean, where it occurs at water depths between 20 and 100 m associated with sandy substrates.

Genus *Aurila* Pokorný 1955
 Subgenus *Aurila* Ruggieri, 1975
Aurila (*Aurila*) *convexa* (Baird, 1850)
 Pl. 3, Figs. 1-2

- 1850a *Cythere convexa* n. sp. Baird. 174, Pl. 21, Fig. 3.
 1878 *Cythere inflata* n. sp. Terquem. 108, Pl. 12, Figs. 13a-d.
 1969 *Aurila livathoensis* n. sp. Uliczny. 32, Pl. 12, Figs. 7-9.
 1969 *Aurila maculosa* n. sp. Uliczny. 35 (*partem*), Pl. 2, Fig. 10; Pl. 13, Fig. 1 (non Pl. 13, Fig. 2).
 1973b *Mutilus convexus* (Baird); Doruk, 129-136, Pl. 1: 24: 134, Figs. 1-2 (non Pl. 1: 24: 130, Figs. 1-2; Pl. 1: 24: 132, Figs. 1-3).
 1975 *Aurila* sp. aff. *cicatricosa* (Reuss); Ruggieri. 425, Fig. 1.
 1975 *Aurila convexa* (Baird); Liebau. Figs. 4a-d.
 1975 *Aurila convexa* (Baird); Breman. 62, Pl. 9, Fig. 120.
 1979 *Aurila convexa* (Baird); Bassiouni. 116, Pl. 18, Fig. 12.
 1979a *Aurila cicatricosa* (Reuss); Yassini. 379, Pl. 5, Figs. 7-9.
 1979b *Aurila convexa* (Baird); Yassini. 98, Pl. 5, Figs. 7-9.
 1981 *Aurila maculosa* Uliczny; Mostafawi. 153, Pl. 8, Figs. 10-11.
 1982 *Aurila convexa* (Baird); Horne, Pl. 1, Fig. 13.
 1983 *Aurila* (*A.*) *convexa* (Baird); Aruta & Ruggieri. 290, Pl. 1, Figs. 1-2; Text-Fig. 3.
 1987 *Aurila convexa* (Baird); Aranki, 68, (*partem*) Pl. 9, Figs. 1-4; Pl. 17, Fig. 8 (non Pl. 9, Fig. 5 = *A. nilensis*).

- 1989 *Aurila convexa* (Baird); Athersuch *et al.* 157, Pl. 5, Fig. 1; Text-Fig. 62.
 1989 *Aurila* (*A.*) *inflata* (Terquem); Mostafawi. 133, Pl. 4, Fig. 77.
 1998 *Aurila convexa* Pokorný; Hajjaji *et al.* Pl. 1, Figs. 4-9.

Remarks.—Modern illustrations have not only greatly extended our knowledge of the detailed ornamentation of *Aurila* (*A.*) *convexa*, but also of its geographical and palaeontological distribution. For a long time considerable confusion existed regarding the identification of this species, mainly due to inadequate illustrations lacking details. Uliczny (1969) described specimens from the Pliocene of Cephalonia as *Aurila maculosa*. The holotype of Uliczny's material is identical with the topotypic specimens of *Aurila* (*A.*) *convexa* illustrated by Athersuch *et al.* (1989), but the paratype displays some differences both in outline and in ornament and obviously belongs to a separate species. *A. (A.) convexa* has also been confused in the literature either with *Aurila* (*A.*) *punctata* (von Münster, 1830) or with *Aurila* (*A.*) *fialodes* Uliczny, 1969. The specimens determined by Uliczny (1969) as *Aurila convexa convexa* are in fact representatives of *Aurila* (*A.*) *punctata* (von Münster, 1830). Specimens figured by Doruk (1973b) as *Mutilus convexus* are not convincing. They comprise in fact three distinct species: 1) *A. (A.) fialodes* (Pl. 1: 24: 130, Figs. 1-2); 2) *A. (A.) convexa* (Pl. 1: 24: 134, Figs. 1-3); and 3) *A. (A.)* sp. (Pl. 1: 24: 130, Figs. 1-2). Harrison *et al.* (2000) refer specimens from the Pliocene of NW France to *A. (A.) convexa*, which show a certain similarity, but differ in having a symmetrically arched dorsal margin in the left valve and in

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PLATE 3—All figures are external view, LV, if not otherwise stated; Uliczny's original specimens are deposited at the Bayerische Staatssammlung für Paläontologie und Historische Geologie, München (Sgl. Ostracoda). 1-2, *Aurila* (*A.*) *convexa* (Baird, 1850); 1, Female, x 83, corresponding to holotype of "*Aurila maculosa*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 281); 2, Male, x 72, corresponding to paratype of "*Aurila livathoensis*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 275). 3, *Aurila* (*A.*) cf. *punctata* (von Münster, 1830); Female, x 64, corresponding to "*Aurila convexa convexa*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 255). 4, *Aurila* (*A.*) *maculosa*, x 79, corresponding to paratype of "*Aurila maculosa*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 282). 5, *Aurila* (*A.*) *fialodes* Uliczny, 1969, Female, x 72 (Sgl. Ostr. Nr. 263). 6-7, *Aurila* (*A.*) *praeacuta* Uliczny, 1969; 6, Female, x 75, corresponding to "*Aurila praeacuta praeacuta*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 283); 7, Male, x 79, corresponding to "*Aurila praeacuta praeacuta*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 284). 8, *Aurila* (*A.*) *hesperiae* Ruggieri, 1974, Female, x 74, corresponding to "*Aurila cicatricosa cicatricosa*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 254). 9-10, *Aurila* (*A.*) *ithacae* Uliczny, 1969; 9, Female, x 73 (Sgl. Ostr. Nr. 269); 10, Male, x 68, corresponding to "*Aurila speyeri speyeri*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 295).

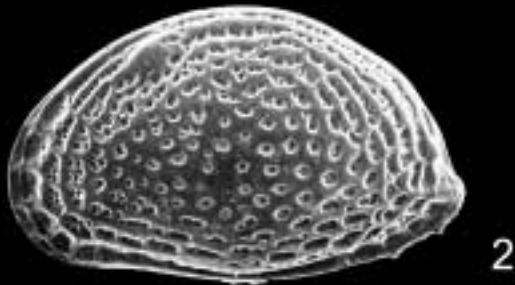
PLATE 3



1



6



2



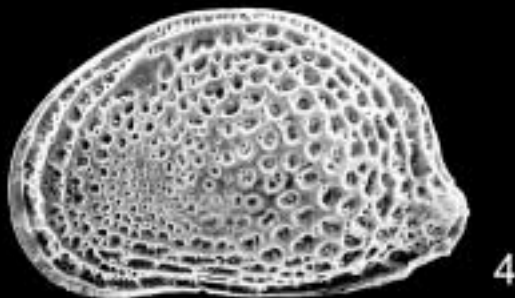
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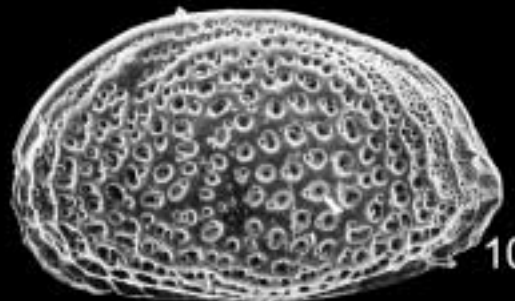
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5



10

possessing different ornamentation. Their surface is evenly covered by subovate to subcircular foveolae arranged concentrically to the margins. *A. (A.) redoniana redoniana* Harrison *et al.*, 2000 from the Pliocene of NW France exhibits, except for the small size, all characteristic features of *A. (A.) convexa*.

Occurrence and stratigraphy.—*A. (A.) convexa* is a littoral to sublittoral marine species in the Mediterranean region occurring certainly from the Pliocene to the present day. It has also been reported from southern Britain and Atlantic coasts of France and Portugal inhabiting algae, algal debris or sand (Whatley, 1976; Athersuch *et al.*, 1989) with different salinities ranging from 15 to 35‰ (Ruiz *et al.*, 2003) in extreme shallow waters (0.5–4.5 m) in south-western Spanish estuaries (Ruiz *et al.*, 2000). Southern British waters appear to be the northern limit of its geographical distribution.

Aurila (Aurila) cf. punctata (von Münster, 1830)
Pl. 3, Figs. 3

- 1830 *Cythere punctata* n. sp. von Münster. 62.
1969 *Aurila convexa convexa* (Baird); Uliczny. 21, Pl. 11, Figs. 1–2.
1973 *Aurila punctata* (von Münster); Wouters. Pl. 2, Figs. 3a–b.
1975 *Aurila (Euaurila) punctata* (von Münster); Ruggieri. 31, Fig. 4 (q. v. for detailed synonymy).

Remarks.—The carapace is characterized by an evenly arched dorsal margin without any prominent cardinal angles. The surface of the valves is covered by deep foveolae which are rounded and widely scattered in the centro-ventral region; around the margins the foveolae become elongate and arranged in rows divided by riblets and give the valves a reticulate ornament. The species has originally been described by von Münster (1830) from the Pliocene of Castell'arquato. However, it has often been misidentified by subsequent workers and referred to different species. The specimens recorded by Harrison *et al.* (2000) from the Pliocene of NW France show a rounded, but distinct posterior cardinal angle in the left valve and are more closely related to *A. (A.) bradleyana* Ruggieri, 1975 rather than to *A. (A.) punctata*. Specimens studied in the present paper appear to be very similar to *A. (A.) punctata*, but require detailed examination before they can be assigned with certainty to this species—so far, only one SEM photograph exists of the right valve of a topotype specimen of *A. (A.) punctata* provided by Ruggieri (1975).

Occurrence and stratigraphy.—*A. (A.) punctata* has apparently an extremely wide stratigraphical range, reported from the Tortonian to Pleistocene of the Mediterranean (Ruggieri, 1962, 1975; Uliczny, 1969) and from the Neogene of Gabon (van den Bold, 1966).

Aurila (Aurila) maculosa Uliczny, 1969
Pl. 3, Fig. 4

- 1969 *Aurila maculosa* n. sp. Uliczny. 35, Pl. 13, Fig. 2 (non Pl. 2, Fig. 10; Pl. 13, Fig. 1).
1968 1976 *Aurila convexa* (Bird); Masoli, 23, Pl. 7, Figs. 88–90.
1976 *Aurila convexa* (Bird); Bonaduce *et al.* 43, Pl. 21, Figs. 1–7.
1989 *Aurila convexa* (Baird); Zangger & Malz. Pl. 1, Figs. 13–14.
1993 *Aurila convexa* (Baird); Nachite *et al.* Pl. 5, Fig. 6.
1997 *Aurila convexa* (Baird); Barra. 81, Pl. 3, Fig. 3.
1999 *Aurila convexa* (Baird); Handle *et al.* Pl. 5, Fig. 1.
2003 *Aurila convexa* (Baird); Guernet *et al.* 85, Pl. 2, Fig. 1.

Remarks.—Aruta & Ruggieri (1983) drew attention to the illustrations of the specimens given by Uliczny (1969: Pl. 2, Fig. 10; Pl. 13, Figs. 1–2), of which the figure 10 (holotype) is not a good representation of the species. They removed it from the synonymy to include it in *A. (A.) convexa* (Baird, 1850). On the other hand, the paratype of *A. maculosa* figured by Uliczny (1969: Pl. 13, Fig. 2) differs in some respects from *A. (A.) convexa* and can easily be distinguished by its broadly arched dorsal margin. The surface of the valve is reticulate with foveolae, which are peripherally aligned parallel to the margins and become smaller in the antero-central region. Nevertheless, we maintain *A. (A.) maculosa* as an independent species. The species shows a superficial resemblance to *A. (A.) anterocostata* Harrison *et al.*, 2000 from the Pliocene of NW France. The latter species is characterized by a horizontal component of small ribs forming the reticulum, which radiates to the anterior and posterior margins. Some of the references cited in the synonymy list refer to a broader concept of ornamental variation within *A. (A.) maculosa* than indicated by the specimens examined in this study.

Occurrence and stratigraphy.—So far, the species occurs in the Pliocene of Cephalonia (Uliczny, 1969) and NW Morocco (Nachite *et al.*, 1993), Pleistocene

of Aigion, Greece (Guernet *et al.*, 2003); Holocene of Büyük Menderes delta plain, Western Turkey (Handle *et al.*, 1999) and Recent in the Mediterranean Sea (Bonaduce *et al.*, 1976), however, mostly under the name of *A. (A.) convexa*.

Aurila (Aurila) fialodes Uliczny, 1969
Pl. 3, Fig. 5

- 1969 *Aurila fialodes* n. sp. Uliczny. 26, Pl. 2, Figs. 2-3; Pl. 11, Figs. 7-8.
1973b *Mutilus convexus* (Baird); Doruk, 129-136, Pl. 1: 24: 130, Figs. 1-2; Pl. 1: 132, Figs. 1-3.
1981 *Aurila convexa* (Baird); Mostafawi. 153, Pl. 8, Figs. 1-3.
1994 *Aurila convexa* (Baird); Danatsas, 106, Pl. 5, Figs. 9-10.

Remarks.—Uliczny (1969) introduced this species from the Pliocene of Cephalonia, which differs from other similar species, such as *A. (A.) convexa* or *A. (A.) punctata* in having a strongly convex dorsal margin with the highest point just behind the anterior half of the left valve. The posterior cardinal angle in the left valve is present and is more strongly developed in males than females. Terquem (1878) described *Cythere maxima* from the Upper Pliocene of Rhodes, which displays great similarity to Uliczny's species. Unfortunately, the original specimens of Terquem's species have been lost (Wouters, 1974) and a direct comparison is impossible.

Occurrence and stratigraphy.—The species is known to occur in the Pliocene of Cephalonia (Uliczny, 1969) in the Plio-Pleistocene of Kos (Mostafawi, 1981), SW Turkey (Doruk, 1973b) and the Upper Pliocene of N Peloponnesos (Danatsas, 1994).

Aurila (Aurila) praeacuta Uliczny, 1969
Pl. 3, Fig. 6-7

- 1969 *Aurila praeacuta* n. sp. Uliczny. 36, Pl. 3, Fig. 1; Pl. 13, Fig. 3.

Remarks.—A subovate species with irregular reticulation and very distinct sexual dimorphism. Males are less high than females and the anterior margin is more sharply rounded. The surface of the valves is covered by irregular reticulae consisting of rounded to ovate and shallow foveolae which become larger and circular in shape around the region of the central muscle scars.

Occurrence and stratigraphy.—The species is only known from the Pliocene of Cephalonia.

Aurila (Aurila) hesperiae Ruggieri, 1974
Pl. 3, Fig. 8

- 1969 *Aurila cicatricosa* (Reuss); Uliczny. 20.
1974 *Aurila hesperiae* n. sp. Ruggieri. 427.
1975 *Aurila hesperiae* Ruggieri; Ruggieri. 36, Fig. 8.
1983 *Aurila hesperiae* Ruggieri; Aruta & Ruggieri. Pl. 1, Fig. 4.
1986 *Aurila* sp. 3 Hastrup, 28, Pl. 19, Figs. 1-2.
2001a *Aurila cicatricosa* (Reuss); Dall'Antonia & Bossio, 88, Pl. 1, Figs. 8-10.

Remarks.—This species has been assigned in the literature to *A. cicatricosa* (Reuss, 1850) from the middle Miocene of Vienna Basin. Compared with the neotypic specimens from Nussdorf figured by Kollmann (1971) and Wouters (1973), it becomes obvious that there is no close affinity between these two taxa and all records from the Mediterranean are dubious. The dorsal margin of *A. cicatricosa* is more convex and evenly curved without forming any prominent angles. The ventral margin is obscured in lateral view by the ventro-lateral inflation of the valves. There is some ornamental difference between specimens from the Pliocene of Cephalonia and those from the Pleistocene of Imola, Italy. The surfaces of the Italian population are more densely covered by punctae. The species closely resembles *A. convexa* with regard to outline and the size, but can easily be distinguished by its ornamentation, which consists of numerous simple punctae evenly distributed on the surface, except on the central area of the valves.

Occurrence and stratigraphy.—The species has been reported from the Lower Messinian of Lampedusa Island (Dall'Antonia & Bossio, 2001a), Lower Pleistocene of Imola (Ruggieri, 1974) and Pliocene of Cephalonia (Uliczny, 1969).

Aurila (Aurila) ithacae Uliczny, 1969
Pl. 3, Figs. 9-10

- 1894 *Cythereis speyeri* (Brady); G. W. Müller. 367, Pl. 32, Figs. 24, 25, 28.
1969 *Aurila ithacae* n. sp. Uliczny. 30, Pl. 2, Fig. 7; Pl. 12, Fig. 4.
1969 *Aurila speyeri speyeri* (Brady); Uliczny. 46, Pl. 13, Figs. 8-9.
1972 *Aurila speyeri* (Brady); Uffenorde. 77, Pl. 8, Fig. 6.

1986 *Aurila speyeri* (Brady); Hastrup, 27, Pl. 17, Figs. 5-7.

1997 *Aurila fallax* Ruggieri; Barra. 81, Pl. 3, Figs. 8, 10; Pl. 5, Fig. 6.

Remarks.—The species appears in the literature under different names, mostly as *Aurila speyeri*. Brady (1868) quasi contemporaneously introduced *Aurila speyeri* from two localities, Tenedos and Sira. When Brady (*op. cit.*) described the species from Tenedos, he noted that there are considerable morphological differences between the specimens. In a re-examination of Brady's material of Tenedos, Sissingh (1972) recognized that two different species were included: *Aurila speyeri* and a second species having different size, shape and ornamentation which may be similar to *A. punctata* (*sensu* Sissingh, 1972). On examination of Brady's specimens from both localities, Ruggieri (1983) found that the specimens from Sira are not conspecific with Brady's type specimens of Tenedos, and thus described them as a new species, *Aurila fallax*. We consider herein that *Aurila fallax* is a junior synonym of *A. (A.) bisinuata* (Terquem). In 1969, Uliczny ascribed part of the material from the Pliocene of Cephalonia to *A. speyeri* and the other part he described as a new species, *Aurila ithacae*. In our opinion, the morphological differences between these forms are not sufficient to consistently differentiate them at the species or subspecies levels.

Occurrence and stratigraphy.—The species is widely distributed in the Mediterranean area, with fossil records ranging from Pliocene to Recent (Doruk, 1973; Ruggieri, 1983; Barra, 1997).

Aurila (Aurila) nilensis Bassiouni, 1965
Pl. 4, Figs. 1-3

1965 *Aurila (punctata) nilensis* n. subsp. Bassiouni. 637, Pl. 42, Figs. 1a-c.

1969 *Aurila punctata punctata* (Münster); Uliczny. 39, Pl. 2, Fig. 9.

1969 *Aurila (punctata) nilensis* Bassioui; Uliczny. 41.

1969 *Aurila punctata plagia* n. subsp. Uliczny. 41, Pl. 3, Fig. 3; Pl. 13, Fig. 6.

1979a *Aurila bullapunctata* Uliczny; Yassini. 98, Pl. 4, Fig. 12; Pl. 5, Fig. 10 [1979a].

1981 *Aurila punctata punctata* von Münster; Mostafawi. 155, Pl. 8, Figs. 12-14.

1984 *Aurila (Euaurila) nilensis* Bassiouni; Malz & Jellinek. 148, Pl. 6, Fig. 52.

1984 *Aurila (Euaurila) plagia* Uliczny; Malz & Jellinek. 148, Pl. 6, Fig. 52.

Remarks.—*A. (A.) nilensis* was originally described from the Pliocene of Kom el Shelul near Cairo as a subspecies of *Aurila (A.) punctata*. However, Harrison *et al.* (2000) raised it to the status of a separate species. *A. (A.) nilensis* has been misidentified by some workers and wrongly attributed either to *A. (A.) punctata* e. g. by Uliczny (1969) and Mostafawi (1981) or to *A. (A.) bullapunctata* by Yassini (1979a).

Uliczny (1969) distinguished a second subspecies, *Aurila punctata plagia*, which is from the ornamental point of view identical with *A. (A.) nilensis*. There are also no great differences in respect to dimensions between the specimens from Cephalonia. The dimensions

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PLATE 4—All figures are external view, LV, if not otherwise stated; Uliczny's original specimens are deposited at the Bayerische Staatssammlung für Paläontologie und Historische Geologie, München (Sgl. Ostracoda). 1-3, *Aurila (A.) nilensis* Bassiouni, 1965; 1, Female, x 94, corresponding to "*Aurila punctata nilensis*" *sensu* Uliczny, 1969 (Sgl. Ostr. Nr. 290); 2, Female, x 86, corresponding to "*Aurila punctata punctata*" *sensu* Uliczny, 1969 (Sgl. Ostr. Nr. 288); 3, Male, x 90, corresponding to "*Aurila punctata plagia*" *sensu* Uliczny, 1969 (Sgl. Ostr. Nr. 291). 4, *Aurila (A.) hadra* Uliczny, 1969, x 83 (Sgl. Ostr. Nr. 265). 5-9, *Aurila (A.) anguisfoveata* Uliczny, 1969; 5, Female, x 66, corresponding to "*Aurila anguisfoveata anguisfoveata*" *sensu* Uliczny, 1969 (Sgl. Ostr. Nr. 242); 6, Female, x 67, corresponding to "*Aurila anguisfoveata simplex*" *sensu* Uliczny, 1969 (Sgl. Ostr. Nr. 243); 7, Male, x 67, corresponding to "*Aurila anguisfoveata*" *sensu* Uliczny, 1969 (Sgl. Ostr. Nr. 244); 8, Male, x 78, corresponding to "*Aurila loboides*" *sensu* Uliczny, 1969 (Sgl. Ostr. Nr. 280); 9, Female, x 61, corresponding to "*Aurila cruciata cruciata*" *sensu* Uliczny, 1969 (Sgl. Ostr. Nr. 260). 10, *Aurila (A.) calciplena* Uliczny, 1969, Female, x 79 (Sgl. Ostr. Nr. 252).

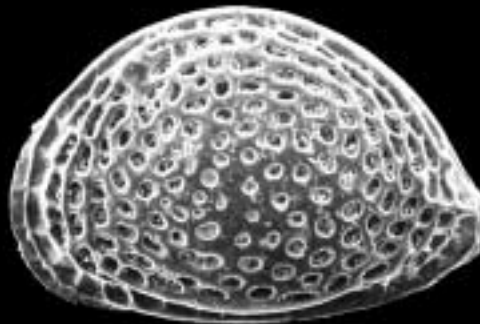
PLATE 4



1



6



2



7



3



8



4



9



5



10

stated by this author (0.68-0.75 mm length, 0.45-0.52 mm height for *A. punctata punctata* and 0.71-0.74 mm length, 0.475 mm height for *A. punctata plagia*) also overlap. However, Malz & Jellinek (1984) consider the difference in size sufficient to separate *Aurila* (*A.*) *nilensis* from "*Aurila plagia*". Specimens from the Pliocene of NW France figured by Harrison *et al.* (2000) have the same size as *A. (A.) nilensis*, but show differences in outline with the dorsal margin marked by rounded cardinal angles.

Occurrence and stratigraphy.—The species is widely distributed in the Mediterranean area, occurring from the Pliocene to Pleistocene (Uliczny, 1969; Yassini, 1979a; Ruggieri, 1980; Mostafawi, 1981; Malz & Jellinek, 1984).

Aurila (Aurila) hadra Uliczny, 1969
Pl. 4, Fig. 4

- 1969 *Aurila hadra* n. sp. Uliczny. 27, Pl. 2, Figs. 4-5; Pl. 12, Fig. 1.
2005 *Aurila lacryma* (Terquem); Dall'Antonia *et al.* Pl. 1, Fig. 16.

Remarks.—The ornamentation is composed of slits and foveolae; the slits are arranged in three rows to the posterior margin. The central part of the surface covered by a single foveolae, circular in shape, and the anterior part by irregular to V-shaped fossae. Sexual dimorphism is distinct, males being slightly more elongate, less high with more narrowly arched dorsal margin than females and marked by subtle anterior and posterior cardinal angles. *Aurila (A.) nana* Aruta & Ruggieri, 1983 from the Pleistocene of Olivella, Palermo is very similar in shape, but differs in having a different ornamentation consisting of deep and more circular fossae densely covering the surface of the valves and a small but distinct ventral costa. Males of *A. (A.) hadra* show certain similarities to *A. (A.) convexa*, but the left valve of the latter species is sub-triangular in lateral view and the dorsal margin is more narrowly arched and shows an obtuse angle at about mid-length of the valve.

Occurrence and stratigraphy.—The species has only been reported from the Pliocene of Cephalonia and of the lower-Middle Pliocene of Tuscany (Uliczny, 1969; Dall'Antonia *et al.*, 2005).

Aurila (Aurila) anguisfoveata Uliczny, 1969
Pl. 4, Figs. 5-9

- 1969 *Aurila anguisfoveata anguisfoveata* n. subsp. Uliczny. 13, Pl. 1, Fig. 1; Pl. 10, Fig. 10.

- 1969 *Aurila anguisfoveata simplex* n. subsp. Uliczny. 15, Pl. 1, Fig. 2; Pl. 10, Figs. 2-3.
1969 *Aurila cruciata cruciata* (Ruggieri); Uliczny. 20; non *Aurila cruciata* (Ruggieri, 1953).
1969 *Aurila loboides* n. sp. Uliczny. 34, Pl. 2, Fig. 9; Pl. 12, Fig. 10.
1981 *Aurila anguisfoveata simplex* Uliczny; Mostafawi. 154, Pl. 8, Figs. 8-9.
1984 *Aurila (Cruciaurila) simplex* Uliczny; Malz & Jellinek. 148, Pl. 6, Fig. 53.
1986 *Aurila anguisfoveata simplex* Uliczny; Mostafawi. 282-283.

Remarks.—Wouters (1974) noted that *Bairdia fornicata* Terquem, 1878 is very similar to *A. (A.) cruciata* (Ruggieri, 1953), and has been wrongly identified as such by Uliczny (1969) and Sissingh (1972). From comparison with the modern illustrations of *A. (A.) cruciata* provided by Ruggieri (1975), it becomes evident that there are two distinct species. *A. (A.) cruciata* is more convex, the highest point of the carapace situated in the middle of the dorsal margin, and the punctate ornament is focused more centrally. Uliczny (1969) distinguished two species and two subspecies (*Aurila anguisfoveata anguisfoveata*, *Aurila anguisfoveata simplex*, *Aurila cruciata cruciata* and *Aurila loboides*) on the basis of subtle differences in ornamentation. We find that ornamentation is variable and the variation is continuous. So we can not agree that there are specific or subspecific differentiations.

Occurrence and stratigraphy.—The species is recorded from Pliocene and Pleistocene of Cephalonia, Crete, Rhodes, Kos and Peloponnese (Uliczny, 1969; Sissingh, 1972; Mostafawi, 1981, 1986; Malz & Jellinek, 1984).

Aurila (Aurila) calciplena Uliczny, 1969
Pl. 4, Fig. 10

- 1969 *Aurila calciplena* n. sp. Uliczny. 19, Pl. 1, Fig. 9; Pl. 10, Fig. 8.
1994 *Aurila calciplena* Uliczny; Danatsas, 106, Pl. 5, Figs. 5-8, 17-18.

Remarks.—A suboval species with conspicuous posterior cardinal angle and weak ornamentation consisting of small, circular and single punctae. The species resembles to *A. (A.) bisinuata*, but the dorsal margin of the latter species is more convex and evenly arched without cardinal angles, and its surface is densely covered by small punctae.

Occurrence and stratigraphy.—The species is only known from the Pliocene of Cephalonia (Uliczny, 1969) and Upper Pliocene of N Peloponnesos (Danatsa, 1994).

Aurila (Aurila) abscisa (Terquem, 1878)

Pl. 5, Figs. 1-2; Pl. 8, Figs. 2-3

- 1878 *Cythere abscisa* n. sp. Terquem. 108, Pl. 12, Figs. 12a-c.
 1978 *Cythere radiola* n. sp. Terquem. 110, Pl. 13, figs. 2a-b.
 1878 *Cythere terebrata* n. sp. Terquem. 109, Pl. 12, Fig. 17.
 1969 *Aurila convexa emathiae* n. sp. Uliczny. 22, Pl. 1, Figs. 7-8; Pl. 11, Figs. 3-4.
 1969 *Aurila interpretis* n. sp. Uliczny. 28, Pl. 2, Fig. 6; Pl. 12, Figs. 2-3.
 1975 *Aurila bradleyana favorita* n. subsp. Ruggieri. 38, Figs. 11-12.
 1982 *Aurila (Aurila) convexa* (Baird); Aruta. 115, Pl. 1, Fig. 3.
 1983 *Aurila (Eaurila) favorita* Ruggieri; Aruta & Ruggieri. 290, Pl. 1, Figs. 5, 6, 13.
 1986 *Aurila interpretis* Uliczny; Mostafawi. Pl. 1, Fig. 14-15.
 1989 *Aurila (Aurila) terebrata* (Terquem); Mostafawi. 133, Pl. 4, Fig. 75.

Remarks.—*A. abscisa* is distinguished by coarse ornamentation consisting of ovate fossae arranged peripherally to the margins. The dorsal margin of the left valve is gently and evenly arched with a weak (in males) and distinct (in female) posterior cardinal angle. The species appears in the literature under diverse names. Terquem (1878) assigned the specimens from the Upper Pliocene of Rhodes to three species (*Cythere abscisa*, *Cythere radiola*, *Cythere terebrata*). Uliczny (1969) divided the material from the Pliocene of Cephalonia into two species, *Aurila interpretis* and *Aurila convexa emathiae*, on the basis of variation in the degree of ornamentation. To our opinion, the ornamentation is variable and the variation is continuous. Therefore, we cannot agree with the existing specific or subspecific differentiation. After the re-study of Terquem's collection, Wouters (1974) concluded that *Aurila interpretis* Uliczny is a junior synonym of *Cythere abscisa* Terquem, 1878 and *Aurila convexa emathiae* Uliczny, 1969 is conspecific with *Cythere radiola* Terquem, 1978. However, Mostafawi (1989) attributed the specimens from the Plio-Pleistocene of Rhodes to *Aurila terebrata* (Terquem, 1878) and included some junior synonyms.

The latter species is absent in Terquem's collection, presumed lost (Wouters, 1974). To sum up: *Aurila abscisa*, *A. radiola* and *A. terebrata* from the Upper Pliocene of Rhodes are conspecific. Apparently, this is no individual case, because Terquem (1878) often erroneously used two or three different names for a single species (Wouters, 1974; Mostafawi, 2002). Another synonymous species is *Aurila (A.) favorita* Ruggieri, 1975 from the Pleistocene of Olivella, Sicily, which is somewhat more strongly reticulated, but corresponds to *A. (A.) abscisa* in all details both in shape and in the pattern of the reticulation.

The Recent specimens from the Adriatic Sea figured by Breman (1975) and Bonaduce *et al.* (1976) as *A. interpretis* represent *A. gibba* (Terquem, 1878), according to Mostafawi (1989). Apparently, Ruggieri's identification of *A. interpretis* as a junior synonym of *A. speyeri* (Brady, 1868) is based on these Recent specimens from the Adriatic Sea (Ruggieri, 1983).

Occurrence and stratigraphy.—The species is known to occur in the Pliocene of Rhodes (Terquem, 1878; Mostafawi, 1989), Cephalonia (Uliczny, 1969), Sahelian of Bonfornello, Palermo (Aruta, 1982), Lower Pleistocene of Olivella, Sicily (Aruta & Ruggieri, 1983) and in Upper Pleistocene of Kos (Mostafawi, 1986).

Aurila (Aurila) minor Uliczny, 1969

Pl. 5, Fig. 3

- 1969 *Aurila cruciata minor* n. subsp. Uliczny. 24, Pl. Fig. 1; Pl. 11, Fig. 5.
 1972 *Aurila cruciata minor* Uliczny; Sissingh. 115, Pl. 8, Fig. 7.
 1974 *Aurila cruciata minor* Uliczny; Broekman. 40, Pl. 3, Fig. 12.
 1981 *Aurila cruciata minor* Uliczny; Mostafawi. 155, Pl. 8, Figs. 6-7.
 1998 *Aurila cruciata minor* Uliczny; Hajjaji *et al.* Pl. 1, Fig. 11-12.

Remarks.—The species closely resembles *A. (A.) hesperiae*, but can be easily distinguished by its relatively small and distinctive caudal process and by ornamentation. The surface is covered peripherally by fine punctae which centrally increase in size and decrease in number. The species depicts sufficient differences, both in ornament and outline, from *A. cruciata* and can be considered as an independent taxon.

Occurrence and stratigraphy.—The species is well known from the Pliocene to Pleistocene of Cephalonia, Crete, Carpathos, Kos and Rhodes.

Aurila (Aurila) bullapunctata Uliczny, 1969
Pl. 5, Figs. 4-5

1969 *Aurila bullapunctata bullapunctata* n. subsp.
Uliczny. 17, Pl. 1, Fig. 5; Pl. 10, Fig. 6.

1969 *Aurila bullapunctata extumefacta* n. subsp.
Uliczny. 18, Pl. 1, Fig. 6; Pl. 10, Fig. 7.

2005 *Aurila bullapunctata extumefacta* Uliczny;
Dall'Antonia *et al.* Pl. 1, Fig. 4.

Remarks.—The intraspecific variation with subtly differing ornament led Uliczny (1969) to describe two subspecies from the Pliocene of Cephalonia. According to this author, the dorsal margin in *A. bullapunctata extumefacta* is weakly convex and displays centro-dorsal and postero-dorsal angles. The central hyaline tubercle and ventral rib are less prominent. We could not recognize such a tubercle, but we can only note that the foveolae in the central muscle scars region are small or absent. This “smooth” part of the valve may mimic the appearance of a tubercle under transmitted light.

Occurrence and stratigraphy.—The species is only known from the Pliocene of Cephalonia and Lower-Middle Pleistocene of Tuscany (Dall'Antonia *et al.*, 2005).

Aurila (Aurila) bisinuata (Terquem, 1878)
Pl. 5, Fig. 6; Pl. 8, Figs. 5-6

1878 *Cythere bisinuata* n. sp. Terquem. 103, Pl. 11,
Figs. 15a-c.

1969 *Aurila veniliae* n. sp. Uliczny. 48, Pl. 3, Fig.
5; Pl. 14, Fig. 5.

1976 *Aurila* sp. 1. Bonaduce *et al.* 45, Pl. 19, Figs.
8-9.

1976 *Aurila veniliae* Uliczny; Ciampo. Pl. 3, Fig. 1.

1997 *A. aff. A. convexa* (Baird); Barra. 375, Pl. 3,
Fig. 4.

Remarks.—The species can easily be distinguished from other similar species by its subrectangular shape in lateral view and by its evenly and finely punctuate surface. The specimens from the Pliocene of Rhodes recorded by Mostafawi (1989) as *Aurila (A.) abscisa* are very similar to *A. (A.) veniliae*, but differ in having an almost straight dorsal margin and a symmetrically rounded anterior end. The specimens from the Pleistocene of the same island figured by Sissingh (1972) as *Aurila veniliae* may represent *A. (A.) hesperiae*. They have a subtriangular shape in lateral view and possess a more broadly rounded posterior end with a very short caudal process.

Occurrence and stratigraphy.—Fossil records are known from the Pliocene of Cephalonia (Uliczny, 1969), Pleistocene of Cala Bianca, Italy (Ciampo, 1976); Recent records are from the Adriatic Sea and Tripoli (Bonaduce *et al.*, 1976; Barra, 1997).

Aurila (Aurila) fornicata (Terquem, 1878)
Pl. 5, Figs. 7-8; Pl. 8, Fig. 4

1878 *Bairdia fornicata* n. sp. Terquem. 91, Pl. 10,
Figs. 13a-c.

1969 *Aurila aspidoides* n. sp. Uliczny. 16, Pl. 1,
Figs. 3-4; Pl. 10, Figs. 3, 5.

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PLATE 5—All figures are external view, LV, if not otherwise stated; Uliczny's original specimens are deposited at the Bayerische Staatssammlung für Paläontologie und Historische Geologie, München (Sgl. Ostracoda). 1-2, *Aurila (A.) abscisa* (Terquem, 1878); 1, Female, x 65, corresponding to “*Aurila convexa emathiae*” sensu Uliczny, 1969 (Sgl. Ostr. Nr. 257); 2, Male, x 73, corresponding to “*Aurila interpretis*” sensu Uliczny, 1969 (Sgl. Ostr. Nr. 267). 3, *Aurila (A.) minor* Uliczny, 1969, Male, x 84, corresponding to “*Aurila cruciata minor*” sensu Uliczny, 1969 (Sgl. Ostr. Nr. 261). 4-5, *Aurila bullapunctata* Uliczny, 1969; 4, Female, x 97, corresponding to “*Aurila bullapunctata bullapunctata*” sensu Uliczny, 1969 (Sgl. Ostr. Nr. 248); 5, Female, x 100, corresponding to “*Aurila bullapunctata extumefacta*” sensu Uliczny, 1969 (Sgl. Ostr. Nr. 250). 6, *Aurila (A.) bisinuata* (Terquem, 1878), Male, x 77 (Sgl. Ostr. Nr. 303). 7-8, *Aurila (A.) fornicata* (Terquem, 1878); 7, Female, x 71, corresponding to “*Aurila aspidoides*” sensu Uliczny, 1969 (Sgl. Ostr. Nr. 245); 8, Male, x 67, corresponding to “*Aurila aspidoides*” sensu Uliczny, 1969 (Sgl. Ostr. Nr. 246). 9, *Aurila (A.) nevianii* (Ruggieri, 1953), Male, x 84, corresponding to “*Aurila skalae*” sensu Uliczny, 1969 (Sgl. Ostr. Nr. 294). 10, *Aurila (A.) cephalonica* n. sp., Female, x 73, corresponding to “*Aurila speyeri nevianii*” sensu Uliczny, 1969 (Sgl. Ostr. Nr. 298).

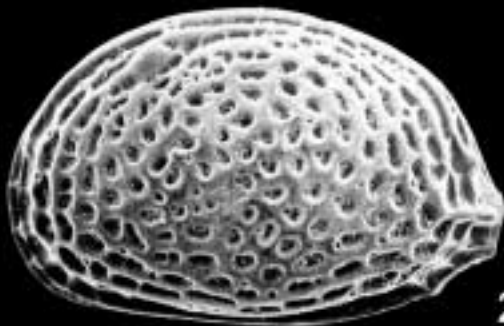
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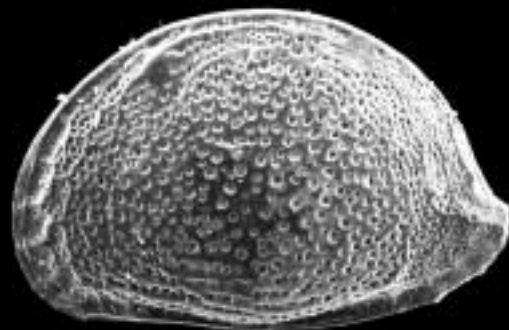
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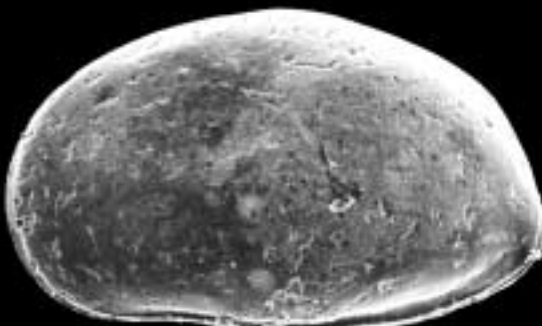
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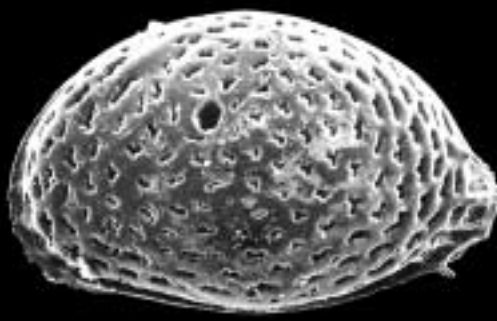
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- 1973 *Mutilus speyeri* (Brady); Doruk. 137-140, 1: 25: 138, Figs. 1-2; Pl. 1: 25: 140, Figs. 1-2 [1973c].
 1983 *Aurila fallax* n. sp. Ruggieri, 283.
 1986 *Aurila aspidoides* Uliczny; Hastrup; 24, Pl. 14, Fig. 4.3.
 1989 *Aurila bisinuata* (Terquem); Mostafawi, 132, Pl. 4, Fig. 73.

Remarks.—*Aurila* (*A.*) *forficata* was originally described by Terquem (1878) from the Upper Pliocene of Rhodes, but it has been confused by subsequent workers. Consequently, it appears in the literature under different names. Doruk (1973c) misidentified the Recent specimens from the Mediterranean coast of Turkey and referred them to *A. (A.) speyeri*, from which it can easily be separated by its more evenly arched dorsal margin and more gentle reticulation of the surface (Ruggieri, 1983). The re-study of Terquem's collection by Wouters (1974) revealed that *A. aspidoides* Uliczny is a junior synonym of *Cythere bisinuata* Terquem. Specimens from the Plio-Pleistocene of Rhodes illustrated by Mostafawi (1989) as *A. bisinuata* are very similar to *A. (A.) forficata*, but show some differences in both outline and ornament. The species shows conspicuous resemblance to *A. (A.) woutersi* Horne from Britain, from which it may be distinguished by its finely punctate ornament and by absence of the reticulation in the posterior marginal area.

Occurrence and stratigraphy.—The species has only been reported from the Plio-Pleistocene of Cephalonia, western Turkey and Rhodes (Uliczny, 1969; Doruk, 1973c; Mostafawi, 1989).

Aurila (Aurila) nebianii (Ruggieri, 1953)
 Pl. 5, Fig. 9

- 1953 *Hemicythere speyeri nebianii* n. subsp. Ruggieri. 89, Pl. 1, Fig. 7; Pl. 3, Fig. 18.
 1969 *Aurila skalae* n. sp. Uliczny. 42, Pl. 3, Fig. 4; Pl. 13, Fig. 7.
 1975 *Aurila (Ulicznina) nebianii* (Ruggieri); Ruggieri. 33, Pl. 1, Figs. 7-8; Text-Fig. 5.
 1979 *Aurila skalae* Uliczny; Bassiouni. 122, Pl. 15, Figs. 1-3.

Remarks.—The species is characterized by an elongate oval carapace in lateral view, both in males and females, with a smooth or only weakly ornamented surface. The ornament of the species varies little and is composed of punctae which are evenly dispersed on the

surface. The modern illustrations provided by Ruggieri (1975) show that the ornament, punctae, of the specimens from the Pliocene of S. Arcangelo (Rimini) is relatively coarser, but this subtle ornamental differences between different populations are here considered not to be sufficient to separate them at species level.

Occurrence and stratigraphy.—The species has only been reported from the Pliocene of S. Arcangelo, Cephalonia and Turkey (Ruggieri, 1953, 1975; Uliczny, 1969; Bassiouni, 1979).

Aurila (Aurila) cephalonica n. sp.
 Pl. 5, Fig. 10

- 1969 *Aurila speyeri nebianii* n. subsp. Uliczny. 47.

Derivatio nominis.—From the type locality.

Holotype.—Female LV; Slg. München Ostr. Nr. 298.

Paratype.—Male LV; Slg. München Ostr. Nr. 297.

Dimension.—0.86-0.88 mm length, 0.54-0.58 mm height (females); 0.90-0.94 mm length, 0.56-0.58 mm height (males).

Diagnosis.—A large species of the genus *Aurila* with T-shaped fossae. The fossae become narrow peripherally and run parallel to the margins. Sexual dimorphism is very distinct; males being more elongate and less high than females and the anterior margin much more sharply rounded.

Remarks.—The species has been confused with *Aurila nebianii* Ruggieri, 1953 from the Pliocene of S. Arcangelo, Rimini. The surface of the latter species is only scantily ornamented by simple punctae uniformly dispersed on the surface. The other characteristic feature is the elongate oval carapace in both males and females.

Occurrence and stratigraphy.—The species is only known from the Pliocene of Cephalonia.

Aurila (Aurila) fastigata Uliczny, 1969
 Pl. 6, Fig. 1

- 1969 *Aurila fastigata* n. sp. Uliczny. 25, Pl. 11, Fig. 6.

Remarks.—A medium size species of *Aurila* characterized by subrectangular shape in left valve with a conspicuous inflation at the ventral margin. The species exhibits a close affinity to *A. reversa* Harrison *et al.*, 2000 from the Pliocene of NW France. The surface of the latter species is coarsely reticulate with polygonal reticulae. The ventral margin is not inflated and there is a well-developed ventro-lateral rib across

which reticulæ do not extend. *A. fastigata* is also very similar to *A. longa* Ruggieri, 1962b from the Tortonian of Enna, Sicily in shape and ornament of the left valve, but its surface is covered more densely by circular to oval foveolæ, arranged in rows at the margins.

Occurrence and stratigraphy.—The species is only known from the Pliocene of the type locality in Cephalonia.

Aurila (Aurila) lanceaeformis Uliczny, 1969
Pl. 6, Fig. 2

1969 *Aurila lanceaeformis* n. sp. Uliczny. 31, Pl. 2, Fig. 8; Pl. 12, Figs. 5-6.

1976 *Aurila lanceaeformis* Uliczny; Ciampo. Pl. 2, Figs. 12-15.

Remarks.—A coarsely ornamented and oval species with prominent caudal process. The surface is coarsely reticulate with fossae varying from circular, through oval to subrectangular in shape and concentrically disposed around the central muscle scars region. Posteriorly the reticulæ are arranged in rows and the horizontal component of riblets enclosing the reticulæ become dominant to give a radiating pattern of ribs. Harrison *et al.* (2000) refer specimens from the Pliocene of NW France to *A. lanceaeformis* which display a superficial resemblance, but have some differences in detail. The French specimens are clearly smaller in size and their dorsal margin, especially of the females, is characterized by prominent mid-dorsal and postero-dorsal angles. *A. paratrigonula* Harrison *et al.*, 2000 from the Pliocene of NW France is similar in shape and ornamentation, but differs in having a conspicuous ventro-lateral rib from which the valve surface slopes towards the dorsal margin.

Occurrence and stratigraphy.—The species occurs in the Mediterranean from Pliocene to Emilian (Uliczny, 1969; Ciampo, 1976; Ruggieri, 1980).

Genus *Cimbourila* Ruggieri, 1975
Cimbourila cimbaeformis (Seguenza, 1883)
Pl. 6, Fig. 3

1883 *Cythere cimbaeformis* n. sp. Seguenza. 20 (*partim*), Pl. 1. Figs. 6a-c (non Fig. 6d).

1950 *Hemicythere cimbaeformis* (Seguenza); Ruggieri. 38, Pl. 1, Fig. 2; Text-Fig. 22.

1969 *Mutilus cimbaeformis* (Seguenza); Uliczny. 52, Pl. 14, Fig. 7.

1976 *Aurila cimbaeformis* (Seguenza); Bonaduce *et al.* 43, Pl. 17, Fig. 15.

1979b *Mutilus cimbaeformis cimbaeformis* (Seguenza); Yassini. 98, Pl. 4, Figs. 5-7.

1981 *Aurila cimbaeformis* (Seguenza); Tsapralis. 97 (*partem*), Pl. 2, Fig. 8.

1985 *Mutilus? labiatus* n. sp. Carbonel. Pl. 92, Fig. 6.

1986 *Mutilus cimbaeformis* (Seguenza); Mostafawi. Pl. 3, Fig. 47.

1987 *Cimbourila cimbaeformis* (Seguenza); Bonaduce *et al.* Pl. 1, Figs. 1-4.

Remarks.—*Cimbourila* was originally erected as a subgenus of *Aurila* and subsequently raised to genus status by Bonaduce *et al.* (1987). In 1975 Ruggieri had quite rightly drawn attention to figure 6d given by Seguenza (1883) —a lateral view of a specimen, obviously not being a good representation of the species— and therefore described it as a new species, *Aurila (Cimbourila) panormitana*. Specimens from Uliczny's collection correspond very well to the modern illustrations of the species given by Bonaduce *et al.* (1987), both in size and in distribution pattern of the fossae. In a re-evaluation of the genus, Bonaduce *et al.* (1987) referred *Mutilus? labiatus* figured by Carbonel (1985) from the Upper Pliocene of Forage Soustons, France into the synonymy list of *C. cimbaeformis*. The specimens from the Pliocene of Kato-Lakatamia (Cyprus) illustrated by Doruk (1973a) defer in having three fine longitudinal costae.

Occurrence and stratigraphy.—The species has been reported from a number of localities in the Mediterranean region, from Pliocene to Recent (Bonaduce *et al.*, 1987), and is represented in the Upper Pliocene of France, but under the name of *Mutilus? labiatus* by Carbonel (1985).

Cimbourila praeapuliana (Uliczny, 1969)
Pl. 6, Fig. 4

1969 *Aurila praeapuliana* n. sp. Uliczny. 38, Pl. 3, Fig. 2; Pl. 13, Fig. 4.

1972 *Aurila praeapuliana* Uliczny; Sissingh. 118, Pl. 9, Fig. 8.

1981 *Mutilus praeapuliana* Uliczny; Mostafawi. 156, Pl. 9, Figs. 11-13.

Remarks.—The ornament of the species consists of oval to triangular fossae arranged posteriorly in concentric rows parallel to the margins. The species is very similar in general appearance to *C. cimbaeformis* but differs chiefly in being very tumid; in *C. cimbaeformis* the fossae are arranged in longitudinal rows transversely to the dorsal margin and a dorso-lateral rib is present.

Occurrence and stratigraphy.—The species has been reported from the Plio-Pleistocene of Cephalonia (Uliczny, 1969), Crete, Karpathos (Sissingh, 1972), Kos and Rhodes (Mostafawi, 1981, 1989).

Cimbourila venetiensis (Uliczny, 1969)
Pl. 6, Fig. 5

- 1969 *Mutilus venetiensis* n. sp. Uliczny. 54, Pl. 3, Fig. 7; Pl. 14, Fig. 10; Pl. 15, Fig. 1.
1972 *Aurila venetiensis* (Uliczny); Sissingh. 121, Pl. 8, Figs. 11-12.
1981 *Mutilus venetiensis* Uliczny; Ducasse & Cirac. 89, Pl. 2, Figs. 1-4.
1981 *Aurila cimbaeformis* (Seguenza); Tsapralis. 97 (*partim*), Pl. 2, Figs. 5-6.
1987 *Aurila cimbaeformis* (Seguenza); Aranki. 68, Pl. 8, Figs. 10-13.
1992 *Cimbourila cimbaeformis* (Seguenza); Bonaduce *et al.*, 34, Pl. 8, Fig. 14.

Remarks.—A small species ornamented by deep fossae, which peripherally are elongated and separated by fine costae. Around the smooth central longitudinal tubercle, the fossae decrease in size and become circular in shape. The specimens from the Pliocene of Algiers recorded by Yassini (1979b) as *Mutilus venetiensis* differ in having a more convex dorsal margin without any conspicuous cardinal angles and in possessing a small median rib; it is possibly conspecific. Aranki (1987) erroneously determined the specimens from the Lower Pliocene of southern Spain as *Aurila cimbaeformis*. The species also has some characters in common with *C. vitrocincta* (Ruggieri, 1950) from the

Pleistocene of Imola, but there are obvious differences as well. In *C. vitrocincta* the fine costae between fossae are absent and the central longitudinal tubercle is more prominent.

Occurrence and stratigraphy.—The species has been reported from the Pliocene of Cephalonia, Crete, Karpathos, Sakynthos and southern Spain (Uliczny, 1969; Sissingh, 1972; Tsapralis, 1981; Aranki, 1987). It has also been reported from the Mio-Pliocene of NW Morocco (Ducasse & Cirac 1981) and Lower Pliocene of the Gulf of Gabès, Tunisia (Bonaduce *et al.*, 1992).

Genus *Mutilus* Neviani, 1928
Subgenus *Obtusomutilus* Ruggieri, 1980
Mutilus (*Obtusomutilus*) *retiformis* (Terquem, 1878)
Pl. 6, Fig. 6

- 1878 *Cythere retiformis* n. sp. Terquem. 116, Pl. 13, Figs. 16a-d.
1969 *Mutilus dohrni* n. sp. Uliczny. 52, Pl. 3, Fig. 6; Pl. 14, Fig. 8.
1972 *Mutilus dohrni* Uliczny; Sissingh, 124 (*partim*), Pl. 9, Fig. 11.
1979 *Mutilus retiformis* (Terquem); Bassiouni. 126 (*partim*), Pl. 21, Fig. 4.
1981 *Mutilus elegantulus* Ruggieri & Sylvester-Bradley; Tsapralis. 98, Pl. 3, Figs. 6-7.
1981 *Mutilus retiformis* (Terquem); Mostafawi. 156, Pl. 0. Figs. 7-10.
1984 *Mutilus* (*Obtusomutilus*) *retiformis* (Terquem); Malz & Jellinek. 133, Pl. 3, Figs. 22-23.
1987 *Mutilus* (*Obtusomutilus*) *retiformis* (Terquem); Bonaduce *et al.* 262, Pl. 2, Figs. 9-10 ; Text-Fig. 1/1.

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PLATE 6—All figures are external view, LV, if not otherwise stated; Uliczny's original specimens are deposited at the Bayerische Staatssammlung für Paläontologie und Historische Geologie, München (Sgl. Ostracoda). 1, *Aurila* (*A.*) *fastigata* Uliczny, 1969, Female, x 102 (Sgl. Ostr. Nr. 305). 2, *Aurila* (*A.*) *lanceaeformis* Uliczny, 1969, Male, x 87 (Sgl. Ostr. Nr. 272). 3, *Cimbourila cimbaeformis* (Seguenza, 1882), Female, x 84, corresponding to "*Mutilus cimbaeformis*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 309). 4, *Cimbourila praeapuliana* (Uliczny, 1969), Female, x 80, corresponding to "*Mutilus praeapuliana*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 285). 5, *Cimbourila venetiensis* (Uliczny, 1969), Female, x 93, corresponding to "*Mutilus venetiensis*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 313). 6, *Mutilus* (*O.*) *retiformis* (Terquem, 1878), x 68, corresponding to "*Mutilus dohrni*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 310). 7, *Mutilus* (*O.*) *elegantulus* Ruggieri & Sylvester-Bradley, 1975, x 76, corresponding to "*Mutilus retiformis*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 312). 8, *Urocythereis favosa* (Roemer, 1838), x 76, corresponding to "*Urocythereis sororcula*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 336). 9, *Urocythereis crenulosa* (Terquem, 1878), Female, x 76 (Sgl. Ostr. Nr. 329). 10, *Urocythereis exedata* Uliczny, 1969, RV, x 79, corresponding to "*Urocythereis favosa exedata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 326).

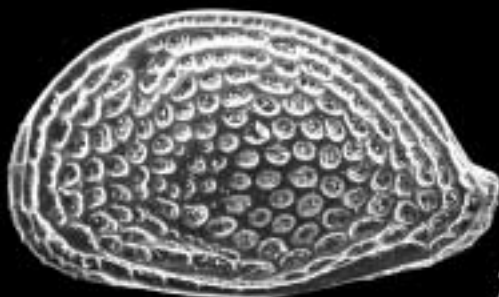
PLATE 6



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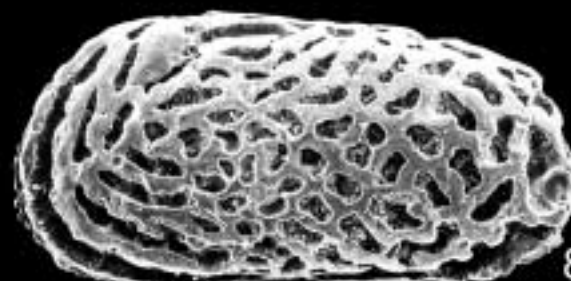
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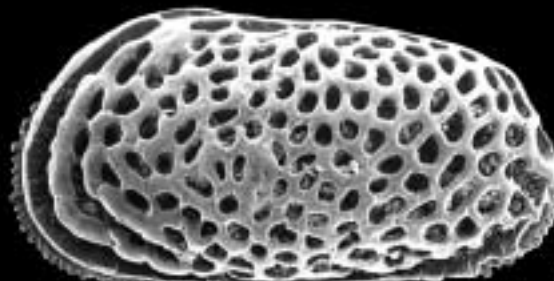
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Remarks.—Terquem (1878) described this species from the Upper Pliocene of Rhodes as *Cythere retiformis*, but it has been confused by subsequent workers. Uliczny (1969) introduced the specimens from the Pliocene of Cephalonia as a new species, *Mutilus dohrni*. In a preliminary revision of Terquem's original material, Wouters (1974) recognized that: 1) *Mutilus dohrni* is a junior synonym of *M. (O.) retiformis*. 2) specimens determined by Ruggieri (1956), Uliczny (1969), Sissingh (1972) and by Ruggieri & Sylvester-Bradley (1973) as *Mutilus retiformis* are not conspecific, but clearly represent another (perhaps even two) species. A part of these records was later ascribed to *M. (M.) laticancellatus* and the other part to *M. (M.) elegantulus* by Ruggieri (1980) and Ruggieri & Sylvester-Bradley (1975) respectively.

Occurrence and stratigraphy.—The species is widely distributed in the Eastern Mediterranean including South Aegean Islands (Sissingh, 1972; Mostafawi, 1981, 1986, 1989; Hastrup & Thomsen, in press), Cephalonia (Uliczny, 1969), Muğla, SW Turkey (Bassiouni, 1979) and SE Laconia (Malz & Jellinek, 1984) ranging from Pliocene to Middle Pleistocene. In contrast it is very rare in Italy, recorded by only one single valve from the Lower Pleistocene of Castelvetro, Trapani/Sicily (Bonaduce *et al.*, 1987).

Subgenus *Mutilus* Ruggieri, 1980

Mutilus (Mutilus) elegantulus Ruggieri & Sylvester-Bradley, 1975
Pl. 6, Fig. 7

- 1969 *Mutilus retiformis* (Terquem); Uliczny. 53, Pl. 14, Fig. 8.
- 1972 *Mutilus retiformis* (Terquem); Sissingh. 124, Pl. 9, Fig. 12.
- 1973 *Mutilus retiformis* (Terquem); Ruggieri & Sylvester-Bradley. 1091-116.
- 1984 *Mutilus (M.) elegantulus* (Neviani); Malz & Jellinek. 134, Pl. 4, Figs. 34-35.
- 1975 *Mutilus elegantulus* n. sp. Ruggieri & Sylvester-Bradley. 296.
- 1981 *Mutilus retiformis* (Terquem) forme "gaufree"; Ducasse & Cirac. 89, Pl. 1. Fig. 5-7.
- 1987 *Mutilus (M.) elegantulus* (Neviani); Ruggieri & Sylvester-Bradley; Bonaduce *et al.* 258, Pl. 2, Figs. 6-9; Text-Figs. 1/2, 2.

Remarks.—*Mutilus (M.) elegantulus* is similar to *M. (O.) retiformis* (Terquem, 1878) and these two species have often been confused in the past. The species can

easily be distinguished by the stronger relief of the muri as well as by the large size and small number of the fossae. Also conspicuously resembling *M. (M.) elegantulus* in having the same pattern of the reticulum is *M. (M.) laticancellatus* (Neviani, 1928). The main differentiating feature is that the fossae in the latter species are relatively smaller, but more abundant in the anterior region.

Occurrence and stratigraphy.—The species occurs in the Mediterranean area from the Pliocene to Lower Pleistocene.

Genus *Urocythereis* Ruggieri, 1950

Urocythereis favosa (Roemer, 1838)

Pl. 6, Fig. 8

- 1838 *Cytherina favosa* n. sp. Roemer. 516, Pl. 6, Fig. 7.
- 1950 *Urocythereis favosa* (Roemer); Ruggieri. 28, Pl. 1, Fig. 4; Text-Figs. 10, 14.
- 1965 *Urocythereis favosa* (Roemer); Bassiouni. 635 (*partim*), Pl. 40, Fig. 5.
- 1969 *Urocythereis sororcula* (Seguenza); Uliczny. 67, Pl. 4, Fig. 8; Pl. 16, Fig. 1.
- 1972 *Urocythereis sororcula* (Seguenza); Sissingh. 128, Pl. 10, Fig. 9.
- 1974a *Urocythereis favosa* (Roemer); Doruk. 33-44 (*partim*), Pl. 2: 6: 34, Figs. 2a-b (non Figs. 1a-b; Pl. 2: 6: 36, Figs. 1-2; Pl. 2: 6: 37, Figs. 1-3; Pl. 2: 6: 40, Figs. 1-3) [1974a].
- 1977 *Urocythereis favosa* (Roemer); Athersuch. 255, Pl. 1, Fig. 1, Text-Fig. 3g.

Remarks.—When Ruggieri (1950) erected the genus *Urocythereis*, he chose *Cytherina favosa* from the Pliocene of Castell'arquato as the type species and provided a relatively detailed illustration of a topotypic specimen, since no specimens attributable to *U. favosa* remain in the Roemer collection. In a re-examination of the species, Doruk (1974a) demonstrated the wide range of the intraspecific variation. However, the specimens from the type-locality have a relative consistent pattern as illustrated by different authors (Ruggieri, 1950; Bassiouni, 1965; Doruk, 1974a; Athersuch, 1977).

There are extreme differences between specimens from the Pliocene and Recent figured by Doruk (1974a), not only in outline and ornamentation but also in the posterior hinge element (Athersuch, 1977). Apparently, specimens figured by Doruk (*op. cit.*) represent two different taxa. There are also great morp-

hological differences between the Pliocene specimens illustrated by Doruk (1974a). The right valves from the Pliocene of Turkey display quite different ornamentation to those from Castell'arquato (type-locality) and may represent distinct species. The specimens from the Pliocene of Cephalonia, which have been attributed to *Cythere sororcula* Seguenza by Uliczny (1969) are identical with the topotypic specimens recorded by authors mentioned above. Furthermore, *Cythere sororcula* is regarded by Athersuch (1977) as a junior synonym of *U. favosa*.

Occurrence and stratigraphy.—The species occurs in the Pliocene of Castell'arquato (Doruk, 1974a; Athersuch, 1977), Cephalonia (herein) and in Pleistocene of Imola (Ruggieri, 1950). All reports of Recent *U. favosa* are suspicious as the species is presumed extinct (Athersuch, 1977).

Urocythereis crenulosa (Terquem, 1878)
Pl. 6, Fig. 9; Pl. 8, Fig. 1

- 1878 *Cythere crenulosa* n. sp. Terquem, 104, Pl. 11, Figs. 18a-c.
1969 *Urocythereis margaritifera margaritifera* (G. W. Müller); Uliczny. 65, Pl. 15, Fig. 8.
1969 *Urocythereis margaritifera alba* n. subsp. Uliczny. 65, Pl. 15, Fig. 9.
? 1972 *Urocythereis margaritifera margaritifera* (G. W. Müller); Sissingh. 128, Pl. 10, Fig. 8.

Remarks.—The species displays considerable intraspecific variability in ornamentation and size. The pattern of the ornament is relatively constant, but the size and complexity of the foveolae may vary considerably between populations or even between individuals. Uliczny (1969) failed to notice *U. crenulosa* which was originally described from the Upper Pliocene of Rhodes, and on the basis of differences in ornamentation he recognized two sub-species, *U. margaritifera margaritifera* and *U. margaritifera alba*. In our opinion, the variation in the ornamental patterns of this species is continuous and there is no evidence of sub-specific separation. Wouters (1974) noted that *U. margaritifera alba* displays a resemblance to *U. crenulosa* (Terquem) from the Upper Pliocene of Rhodes and it is not impossible that they are conspecific. The original specimen of *Cythere crenulosa* Terquem, 1978 figured in the present paper (see Pl. 8, Fig. 1) confirm this view. Thus, we consider *U. margaritifera alba* Uliczny, 1969 as a junior synonym of *U. crenulosa* (Terquem, 1878). Whereas, specimens from the Pliocene of Rhodes reported by Mostafawi (1989)

as *U. crenulosa* show some differences in ornamentation and they may represent distinct species. *U. margaritifera* (Müller, 1894) from the Gulf of Naples appears to be closely related to *U. crenulosa* but requires detailed examination before it can be assigned with certainty to this species.

Occurrence and stratigraphy.—The species has been reported from Pliocene to Recent of the Mediterranean, but some of these references are suspect.

Urocythereis exedata Uliczny, 1969
Pl. 6, Fig. 10

- 1969 *Urocythereis favosa exedata* n. subsp. Uliczny. 62, Pl. 4, Fig. 5; Pl. 15, Fig. 4.

Remarks.—The species is characterized by specific ornamentation composed of sinuous longitudinal costae and intercostal foveolae, which posteriorly increase in size and become triangular in shape. In posterior and ventral regions, the muri are reinforced and appear as a network of riblets. Specimens from the Pliocene of Kiligli, western Turkey, wrongly determined by Doruk (1974a) as *U. favosa* are very closely related to *U. exedata* and may represent the same species.

Occurrence and stratigraphy.—The species is known only from the Pliocene of the type locality in Cephalonia.

Urocythereis labyrinthica Uliczny, 1969
Pl. 7, Figs. 1-3

- 1969 *Urocythereis labyrinthica labyrinthica* n. sp. Uliczny. 63, Pl. 4, Fig. 6; Pl. 15, Fig. 5.
1969 *Urocythereis labyrinthica aperta* n. subsp. Uliczny. 64, Pl. 15, Figs. 6-7.
1969 *Urocythereis favosa favosa* (Roemer); Uliczny. 61.
1974b *Urocythereis labyrinthica* Uliczny; Doruk, 49-52 (*partim*), Pl. 21: 8: 50, Figs. 1a-b (non Figs. 2a-b) [1974b].

Remarks.—The ornament of this species varies greatly and the variation in the reticulation patterns is continuous. This ornamental variability led Uliczny (1969) to subdivide the material from the Pliocene of Cephalonia into one species and two subspecies (*U. labyrinthica labyrinthica*, *U. labyrinthica aperta*, *U. favosa*). The ornamental characteristics used by this author to justify the separation of these forms are of doubtful taxonomic significance, and are considered in

the present paper as morphological variations within one species.

Generally, *U. labyrinthica* has been variously treated in the past. Sissingh (1972) and Athersuch (1977) consider the species as a junior synonym of *U. lumbricularis* (Terquem, 1878) while Mostafawi (1981) and Malz & Jellinek (1984) regard it as a separate species. From comparison with the lectotype specimen of *U. lumbricularis* figured by Athersuch (1977), it becomes obvious that *U. lumbricularis* and *U. labyrinthica* are two different species. They are very closely related, but can be separated by their characteristic ornament. *U. lumbricularis* is characterized by a branched labyrinth complex of consistent pattern. Having been exposed, the labyrinths appear as parallel canals posteriorly flowing into the dorsal and ventral margins. However, in *U. labyrinthica* the labyrinths, except for the dorsal region, have been replaced by fossae of different shape and size. The specimens from the Pliocene of Brindisi figured by Doruk (*op. cit.*, Figs. 2a-b) and those from the Plio-Pleistocene of Peloponnesos illustrated by Malz & Jellinek (1984; Pl. 5, Fig. 45) are not conspecific with *U. labyrinthica*, but clearly represent *U. lumbricularis*; this also includes the Plio-Pleistocene material from Kos published by Mostafawi (1981).

Occurrence and stratigraphy.—The species is reported from the Pliocene and Pleistocene of Cephalonia (Uliczny, 1969; Doruk, 1974b; Athersuch, 1977). All other reports in the literature are dubious and may represent other distinct species.

Urocythereis minoos Uliczny, 1969

Pl. 7, Figs. 4-5

1969 *Urocythereis minoos* n. sp. Uliczny. 66, Pl. 4, Fig. 7; Pl. 15, Fig. 10.

Remarks.—The species is characterized by small circular to oval and widely separated fossae arranged parallel to the margins. Sexual dimorphism is very distinct. Females are shorter and slightly higher than males, and they are posteriorly enlarged and depressed, bearing large fossae. The species is similar in shape and ornament to *Urocythereis praelonga* (Terquem), described from the Upper Pliocene of Rhodes and re-illustrated by Mostafawi (1989), but the surface of the latter species is smooth and the antero-ventral depression and rib are lacking. *Urocythereis flexicaudata* Bonaduce *et al.* (1976) possesses three large fossae at the posterior end, both in males and females.

Occurrence and stratigraphy.—The species is only known from the Pliocene of Cephalonia.

Genus *Bosquetina* Keij, 1957

Bosquetina tarentina (Baird, 1850)

Pl. 2, Fig. 7

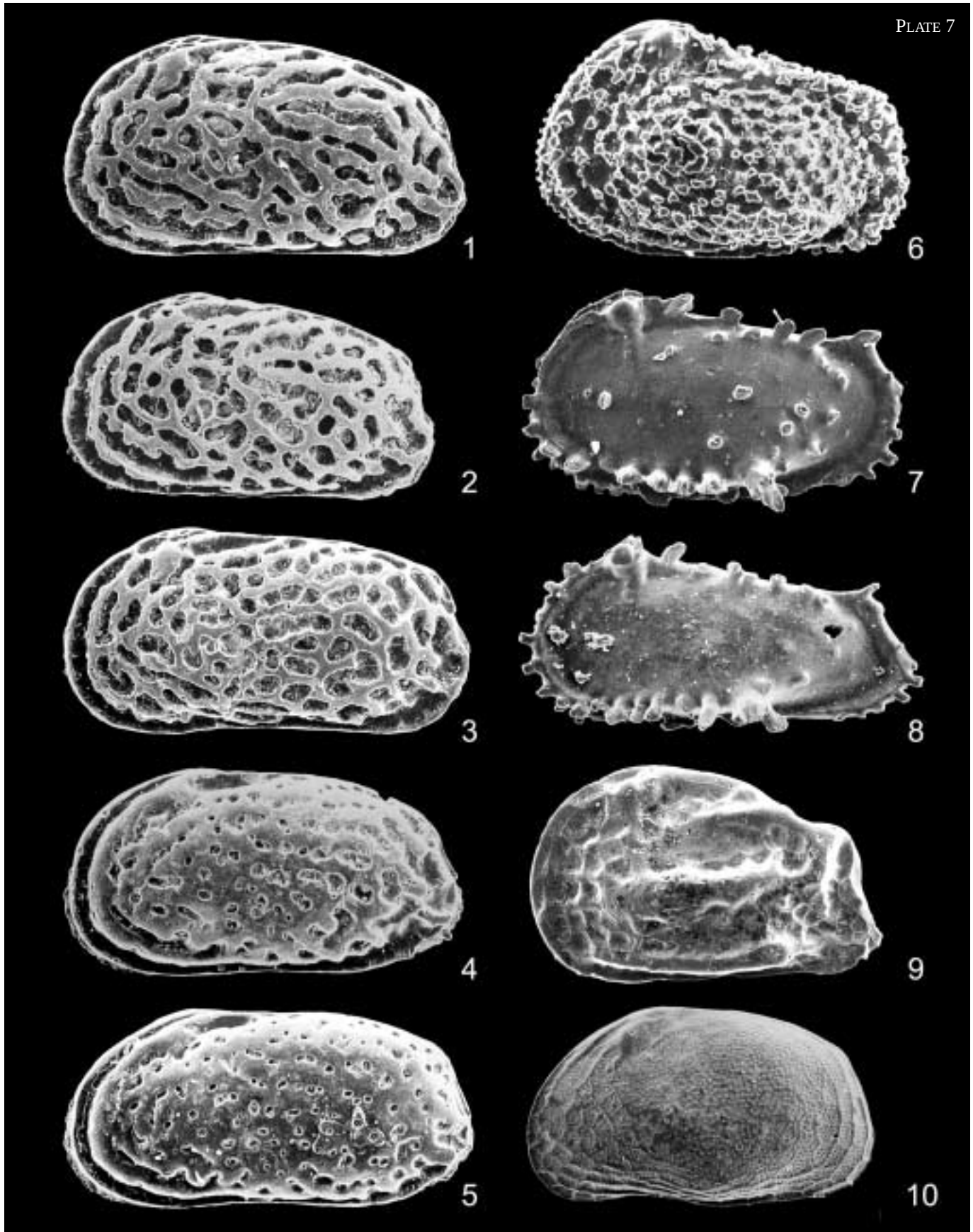
1850b *Cythere tarentina* n. sp. Baird, 355, Pl. 18, Figs. 31-33.

1894 *Cythereis dentata* n. sp. G. W. Müller, 379, Pl. 32, Figs. 23, 27, 31.

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PLATE 7—All figures are external view, LV, if not otherwise stated; Uliczny's original specimens are deposited at the Bayerische Staatssammlung für Paläontologie und Historische Geologie, München (Sgl. Ostracoda). 1-3, *Urocythereis labyrinthica* Uliczny, 1969; 1, Female, x 80, corresponding to "*Urocythereis labyrinthica labyrinthica*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 332); 2, Female, x 89, corresponding to "*Urocythereis favosa favosa*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 324); 3, Male, x 76, corresponding to "*Urocythereis labyrinthica aperta*" Uliczny, 1969 (Sgl. Ostr. Nr. 335). 4-5, *Urocythereis minoos* Uliczny, 1969; 4, Female, x 90 (Sgl. Ostr. Nr. 330); 5, Male, x 86 (Sgl. Ostr. Nr. 331). 6, *Verrucocythereis bulbusspinata* (Uliczny, 1969), Female, x 92, corresponding to "*Thaerocythere bulbusspinata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 342). 7, *Pterygocythereis jonesii* (Baird, 1850), Female, x 73, corresponding to "*Pterygocythereis fimbriata*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 396). 8, *Pterygocythereis coronata* (Roemer, 1838), x 75, corresponding to "*Pterygocythereis ceratoptera*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 395). 9, *Pachycaudites attenuatus* Ruggieri, 1980, Female, x 78, corresponding to "*Pachycaudites ungeri*" sensu Uliczny, 1969 (Sgl. Ostr. Nr. 319). 10, *Tyrrhenocythere amnicola* (Sars, 1888), Female, x 78, corresponding to *Tyrrhenocythere pignattii* sensu Uliczny, 1969 (Sgl. Ostr. Nr. 321).

PLATE 7



- 1969 *Bosquetina carinella* (Reuss); Uliczny, 105.
 1981 *Bosquetina dentata* (G. W. Müller); Mostafawi, 158, Pl. 10, Figs. 1-3 (q. v. for more synonymy).
 1984 *Bosquetina tarentina* (Baird); Malz & Jellinek, 145, Pl. 5, Fig. 45.
 1985 *Bosquetina dentata* (G. W. Müller); Guillaume *et al.*, Pl. 103, Figs. 9-10.
 1989 *Bosquetina tarentina* (Baird); Mostafawi, 139, Pl. 5, Fig. 114.

Remarks.—Ruggieri (1962b) suggested that *Cythere pectinata* Bosquet, *Cythere tarentina* Baird, *Cythere cordiformis*, *Cythere subtrigonica* Seguenza, *Cythere subtrigonica marginata* Seguenza and *Cythere dentata* are conspecific and junior synonyms of *Cypridina carinella* from the Tortonian of Nußdorf near Vienna. However, later (1967) he changed his identification to *Cythere pectinata* Bosquet and regarded *Cypridina carinella* as *nomen oblitum*. Uffenorde (1981) considered *B. carinella* part of a larger homeomorphic group comprising the above mentioned taxa and *B. curta*. However, after re-examining the topotypic specimens Malz & Jellinek (1984) maintained separation.

B. rhodiensis Sissingh from the Plio-Pleistocene of Karpatos and Rhodes is very similar, but can be easily distinguished by completely smooth surface, strongly developed postero-ventral alar protuberance and by subtrapezoid-shape of the right valve in lateral view.

Occurrence and stratigraphy.—The species has been reported as common throughout the Mediterranean, occurring at water depths between 16 and 260 m (Bonaduce *et al.*, 1976; Stambolides, 1985; Montenegro *et al.*, 1998),

predominantly in sandy biotopes (Athersuch, 1979). However, optimum water depths seem to be between 75 and 120 m (Yassini, 1979a). It is a typical circalittoral (100-200 m) species in the Bay of Biscay (Guillaume *et al.*, 1985). Most fossil records are of Plio-Pleistocene age (Malz & Jellinek, 1984; Mostafawi, 1989; Hastrup & Thomsen, in press). It has also been reported from the Middle/Upper Miocene of Gavdos and Crete (Sissingh, 1972).

Genus *Pachycaudites* Uliczny, 1969
Pachycaudites attenuatus Ruggieri, 1980
 Pl. 7, Fig. 9

- 1969 *Pachycaudites ungeri* (Reuss); Uliczny, 59, Pl. 15, Fig. 3.
 1976 *Pachycaudites ungeri* (Reuss); Ciampo, Pl. 3, Figs. 6-9.
 1980 *Pachycaudites attenuata* n. sp. Ruggieri, 133, Fig. 5 (q. v. for detail synonymy).
 1981 *Pachycaudites ungeri* (Reuss); Tsapralis, 100, Pl. 1, Fig. 4.
 1984 *Pachycaudites attenuatus* Ruggieri; Malz & Jellinek, 139, Pl. 4, Fig. 32.

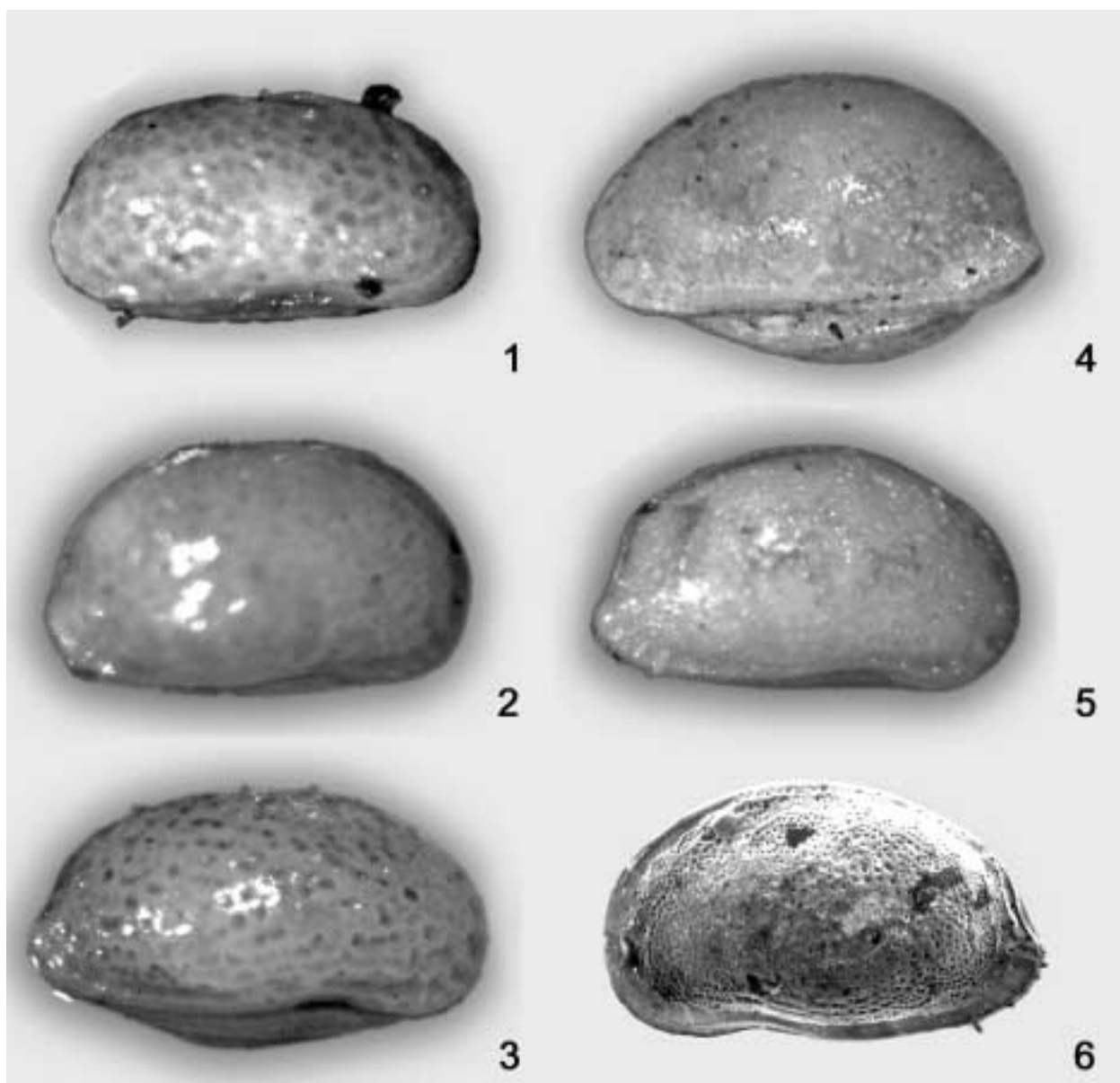
Remarks.—The species was long confused with *P. ungeri* from the Miocene of Vienna Basin. Ruggieri (1980) recognized that Mediterranean occurrences are superficially similar, but differ sufficiently from the Miocene species for them to be considered as a distinct species.

Occurrence and stratigraphy.—The species is well known from the Plio-Pleistocene of the Mediterranean

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PLATE 8—All figures represent Terquem's original specimens photographed by Dr. Marie-Thérèse Vénec Meyré (Muséum National d'Histoire Naturelle, Paris) under transmitted light, except for Fig. 9 which is the paratype of *Aurila veniliae* n. sp. sensu Uliczny, 1969, SEM. 1, *Urocythereis crenulosa* (Terquem, 1878), carapace from right view, x 70, corresponding to *Urocythereis margaritifera alba* n. subsp. sensu Uliczny, 1969 (T81, Muséum National d'Histoire Naturelle, Paris). 2-3, *Aurila* (*A.*) *abscessa* (Terquem, 1878); 2, carapace from right view, x 73, and to *Aurila emathiae* and *A. interpretis* n. sp. sensu Uliczny, 1969 (T85, Muséum National d'Histoire Naturelle, Paris); 3, carapace from right view, x 73, corresponding to *Cythere radiola* n. sp. sensu Terquem, 1878 (T78, Muséum National d'Histoire Naturelle, Paris). 4, *Aurila* (*A.*) *formica* (Terquem, 1878), carapace from left view, x 71, corresponding to *Aurila aspidoides* n. sp. sensu Uliczny, 1969 (T70, Muséum National d'Histoire naturelle, Paris). 5-6, *Aurila* (*A.*) *bisinuata* (Terquem, 1878). 5, carapace from right view, x 68 (T80, Muséum National d'Histoire Naturelle, Paris); 6, Male, LV, x 68, corresponding to the paratype of *Aurila veniliae* n. sp. sensu Uliczny, 1969 (Sgl. Ostr. Nr. 304, Bayerische Staatssammlung für Paläontologie und Historische Geologie, München).

PLATE 8



(Ciampo, 1976; Ruggieri, 1980; Malz & Jellinek, 1984; Hastrup & Thomsen, in press). Empty valves found in the Adriatic Sea are considering to be reworked material from the coastal area (Bonaduce *et al.*, 1976).

Genus *Tyrrhenocythere* Ruggieri, 1955
Tyrrhenocythere amnicola (Sars, 1887)
 Pl. 7, Fig. 10

1969 *Tyrrhenocythere pignattii* Ruggieri; Uliczny, 60, Pl. 16, Figs. 2-3.

1985 *Tyrrhenocythere amnicola* (Sars); Maness & Kaesler. 69-72 (q. v. for more synonymy).

1994 *Tyrrhenocythere amnicola* (Sars); Mostafawi. 107, Pl. 8, Fig. 14.

2003 *Tyrrhenocythere amnicola* (Sars); Guernet *et al.* 85, Pl. 2, Fig. (q. v. for detailed synonymy).

Remarks.—The species has long been misidentified and consequently it appears in the literature either as *T. sicula* Brady or as *T. pignattii* Ruggieri both of which are from the Recent of the Mediterranean. Subsequently, Maness & Kaesler (1985) have recognized that they are synonymous with *T. amnicola* (Sars). It has also been confused (Krstić, 1977) with *T. donetziensis* (Dubowsky) described from the Severny Donets River, Ukraine.

Occurrence and stratigraphy.—A fresh to brackish water species well known from the Pleistocene to Recent of the Mediterranean area. Pleistocene records are, in contrast to Recent records, widely distributed, notably from Italy (Ruggieri, 1955; Devoto, 1965) and from numerous places in Greece, *e. g.* from Cephalonia (Uliczny, 1969), the Gulf of Corinth (Maness & Kaesler, 1985, 1987), north and NW Peloponnese (Fernández-González *et al.*, 1994; Mostafawi, 1994), Lesvis (Galoukas *et al.*, 1995) and Pinarbaşı, south-central Turkey (Griffiths *et al.*, 2002). Boomer *et al.* (1996) rightly concluded that all the Recent specimens reported from Ponto-Caspian regions must be assigned to *T. donetziensis* (Dubowsky).

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OSTRÁCODOS DEL PLIOCENO DE LA SECCIÓN DE VILLARROYA (LA RIOJA, ESPAÑA): TAXONOMÍA Y PALEOECOLOGÍA

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Resumen

Se describen las asociaciones de ostrácodos del Plioceno medio de la sección de Villarroya (La Rioja, Cuenca del Ebro, España). Se han determinado 31 especies dentro del Orden Podocopida (24 de Cypridoidea, 6 de Cytheroidea, 1 de Darwinuloidea), proporcionando asimismo su descripción taxonómica y distribución biogeográfica y estratigráfica. El análisis de los tipos y diversidades de las distintas asociaciones ha permitido caracterizar la evolución paleoambiental de un sistema lacustre plioceno, que evoluciona a otro palustre a lo largo de una secuencia sedimentaria de colmatación. Finalmente se aportan nuevos datos de los registros más antiguos de especies no marinas, solamente conocidas hasta la fecha desde el Pleistoceno y/o Holoceno hasta el Reciente.

Palabras clave: Ostrácodos, Cuenca del Ebro, Taxonomía, Paleolimnología, Plioceno.

Abstract

Ostracod assemblages of the middle Pliocene Villarroya section (La Rioja, Ebro Basin, Spain) are described. A total of 31 species of the Order Podocopida (24 of Cypridoidea, 6 of Cytheroidea, 1 of Darwinuloidea) have been taxonomically determined. Detailed taxonomy as well as biogeographic and stratigraphic distributions of these species have been provided. The analyses of the type and diversity of the studied assemblages allowed us to interpret the palaeoenvironmental evolution of a Pliocene lacustrine system to a palustrine one, through a basin-fill sedimentary sequence. Finally new data on the oldest record of several nonmarine ostracod species are provided, particularly for those only known so far from the Pleistocene and/or Holocene to the Recent.

Key words: Ostracods, Ebro Basin, Taxonomy, Palaeolimnology, Pliocene.

INTRODUCCIÓN

El estudio de las asociaciones fósiles de ostrácodos límnicos resulta una eficaz herramienta paleoecológica, ya que permite obtener información sobre cambios ambientales en medios antiguos (Smith y Horne,

2002). El análisis de estos fósiles es una técnica muy extendida y utilizada por numerosos autores para realizar interpretaciones paleoecológicas (Delorme, 1971; Absolon, 1972) y recientes (Frogley *et al.*, 2002). En este trabajo se estudian las asociaciones de ostrácodos de la sección de Villarroya, a partir de las cuales se

pretende obtener un mejor conocimiento de la paleoecología de este sistema lacustre, así como su evolución durante parte del Plioceno.

La cuenca pliocena de Villarroya se sitúa en la comunidad autónoma de La Rioja, a unos 64 km de Logroño, en el borde noroeste de la Sierra de Los Cameros. La sección estudiada se encuentra próxima al pueblo de Villarroya, del cual toma su nombre (Fig. 1). La cubeta terciaria de Villarroya ha sido objeto de numerosos estudios, tanto por su interés estratigráfico como paleontológico. Los antecedentes de estudios sedimentológicos, paleontológicos, paleoclimáticos y de datación de estos materiales son sintetizados por Anadón *et al.* (2002), que proponen una evolución paleoambiental de los sedimentos lacustres pliocenos de la cuenca de Villarroya, a partir de la mineralogía de los sedimentos, así como el contenido en polen, ostrácos, moluscos y carofíceas. La presencia de ostrácos en estos materiales ha sido descrita por Rodríguez-Lázaro *et al.* (1997) y Rodríguez-Lázaro y Martín-Rubio (2005).

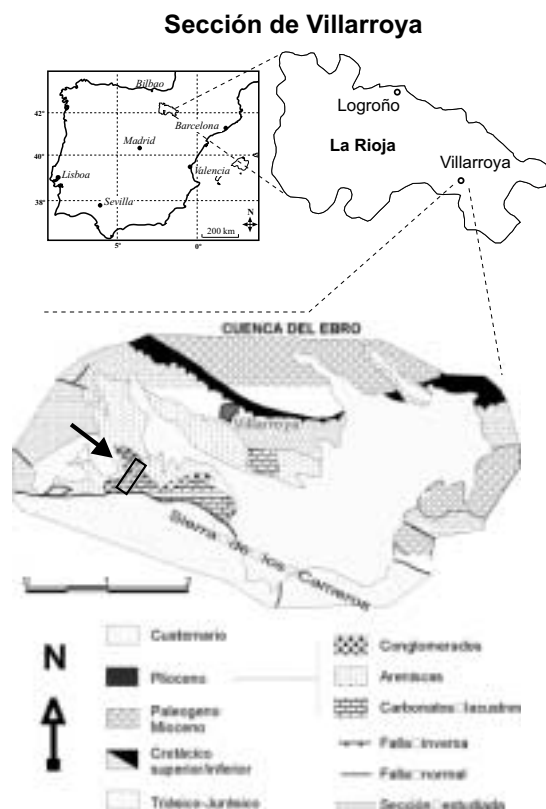


FIGURA 1—Situación geográfica y geológica de la sección de Villarroya.

FIGURE 1—Geographical and geological locations of the Villarroya section.

Sección de Villarroya

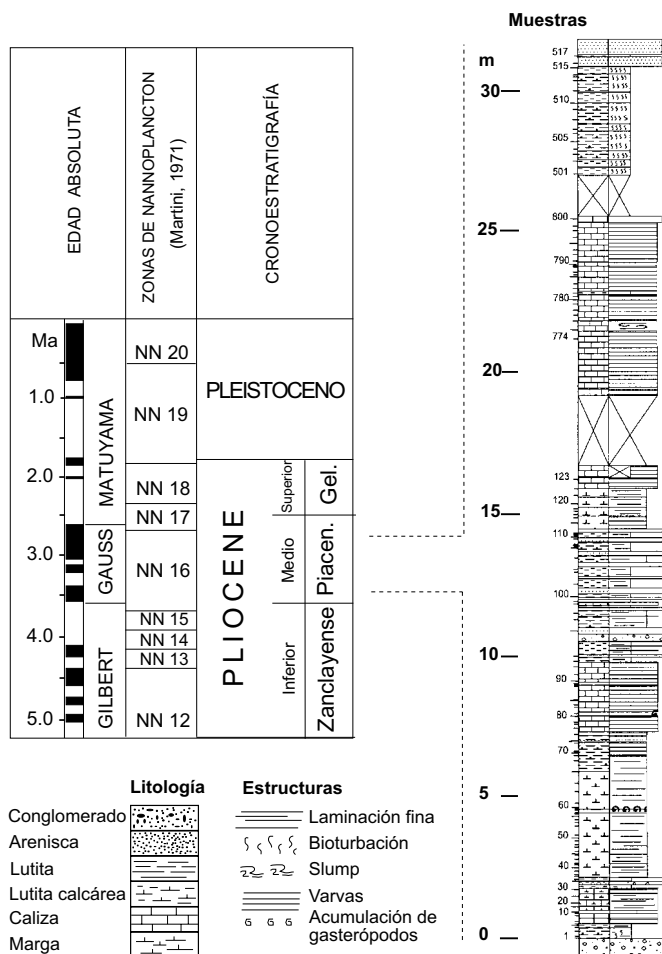


FIGURA 2—Columna estratigráfica de los sedimentos lacustres de la sección de Villarroya y situación de las muestras estudiadas (Anadón *et al.*, 2002).

FIGURE 2—Stratigraphical log of the lacustrine sediments of the Villarroya section with location of the samples (Anadón *et al.*, 2002).

Muñoz *et al.* (1989, 1994) y Anadón *et al.* (2002) describen una secuencia más de 100 m de relleno de la cuenca de Villarroya. En la base se desarrollan sedimentos aluviales, mayoritariamente facies conglomeráticas, con una potencia de 12 m. A estos depósitos se les superponen otros descritos como lacustres, de 30 m de potencia (los cuales serán objeto de estudio en este trabajo) y finalmente 60 m de depósitos aluviales (Fig. 2).

Pueyo *et al.* (2005) indican que el conjunto de la sección de Villarroya estaría representada casi en su totalidad por los crones Gauss y Matuyama. El intervalo de tiempo representado en los sedimentos lacus-

tres estudiados en este trabajo, se situaría entre la zona basal del cron Gauss (3,33-3,58 Ma) y la zona alta del mismo cron (3,04-2,58 Ma) dando una edad de Plioceno medio para esos materiales.

MATERIAL Y MÉTODOS

En el contexto de un proyecto de estudio paleolimnológico de lagos del Neógeno de la Cuenca del Ebro, llevado a cabo por los autores de este trabajo, se realizaron muestreos de alta resolución de la serie de Villarroya, en el tramo de la sucesión que corresponde a los sedimentos lacustres. Estos sedimentos contienen una rica representación de ostrácodos, charáceas y gasterópodos (Rodríguez-Lázaro *et al.*, 1997). En este trabajo se describen en detalle las asociaciones de ostrácodos de esta serie, considerando su taxonomía y su distribución paleogeográfica y paleoecológica.

Se recogieron un total de 157 muestras de una columna estratigráfica de más de 30 m (Fig. 2). Los especímenes de ostrácodos han sido separados de las muestras levigadas y cuarteadas, obteniéndose un mínimo de 300 valvas por muestra, para asegurar la representación de la mayoría de las especies. El peso del sedimento remanente se ha utilizado como estimación de la riqueza individual de cada muestra. En total se han estudiado y clasificado más de 43.000 valvas, reconociéndose 31 especies de ostrácodos pertenecientes a 15 géneros, cuyo análisis taxonómico detallado se muestra en el apartado correspondiente.

PALEOECOLOGÍA

A partir de un muestreo de alta resolución de la sección pliocena de Villarroya se ha estudiado la evolución temporal de las asociaciones de ostrácodos, poniendo de manifiesto la evolución paleoecológica de un sistema lacustre fósil.

De las 31 especies clasificadas, la más abundante en el conjunto de las muestras estudiadas es *Fabaeformiscandona brevicornis*, representando un 26,24% del total de la asociación y las de menor representación son *Heterocypris incongruens* y *Parakeijia* ? sp., ya que únicamente representan un 0,002% de la asociación total. En cuanto al grado de distribución, las especies con representación más regular a lo largo de la sección son *Candona angulata* y *Fabaeformiscandona* cf. *F. spelaea*, ya que aparecen en casi todas las muestras de la sec-

ción. En cambio, especies como *Heterocypris incongruens* y *Parakeijia* ? sp. están restringidas a una sola muestra.

La riqueza de las muestras (No = n.º valvas/g sedimento) presenta grandes variaciones a lo largo de la sección estudiada, oscilando entre 9.225 v./g en y 1 v./g (Fig. 3). En la parte inferior de la sección (tramos T1, T2; 0-8 m), la riqueza presenta fuertes variaciones, con pequeñas secuencias de ascenso y descenso en los valores de No, dándose los valores más altos registrados en toda la sección. A lo largo de los tramos T3 y T4 la riqueza individual es muy baja, con dos pequeños intervalos inferiores más favorables. En el tramo superior T5 se produce otro pico de esta riqueza. Analizando los valores de riqueza individual a lo largo de esta sección, se aprecia una tendencia general de disminución desde la base hasta el tramo T3 de la misma.

En cuanto a la evolución de los valores de la diversidad específica (diversidad simple, n.º de especies; Fig. 3), los valores más altos se registran en los primeros 6 metros de la serie y los valores más bajos, en las muestras situadas a techo. Por lo tanto, puede decirse que la diversidad específica simple marca una tendencia descendente hasta los 22 m, y a partir de este punto comienza una suave tendencia ascendente hasta los 27 m, donde desciende de nuevo gradualmente hasta el final de la serie.

La diversidad, medida según el índice de Shannon-Wiener [S(H)], oscila entre 0,09 y 2 (Fig. 3). En la zona basal de la sección se registran los valores máximos de diversidad, permaneciendo altos y relativamente estables hasta los 2 m. A partir de este punto los valores describen tendencias ascendentes y descendentes que oscilan entre 1 y 1,5 a lo largo de los tramos T2 y T3. El tramo T4 registra una tendencia ascendente de la diversidad, mientras que en el tramo superior T5, la tendencia es descendente hacia valores del índice S(H) de 0,5. Tal y como sucedía con los valores de riqueza, la diversidad también muestra una tendencia general descendente desde la base al techo de la sección.

Tomando en consideración la distribución vertical de los ostrácodos a lo largo de la sección estudiada, se pueden distinguir 5 tramos (T1 a T5). La asociación típica de cada tramo, así como las variaciones en los mismos aparecen representadas en la Fig. 3.

El primer tramo (T1) contiene como especies más importantes: *F. brevicornis*, *Qinghaicypris riojensis*, *C. angulata*, *F. aff. F. spelaea*, *Pseudocandona compressa*, *Cyclocypris taubachensis*, *Cypria ophtalmica* y cuatro especies del género *Amnicythère*.

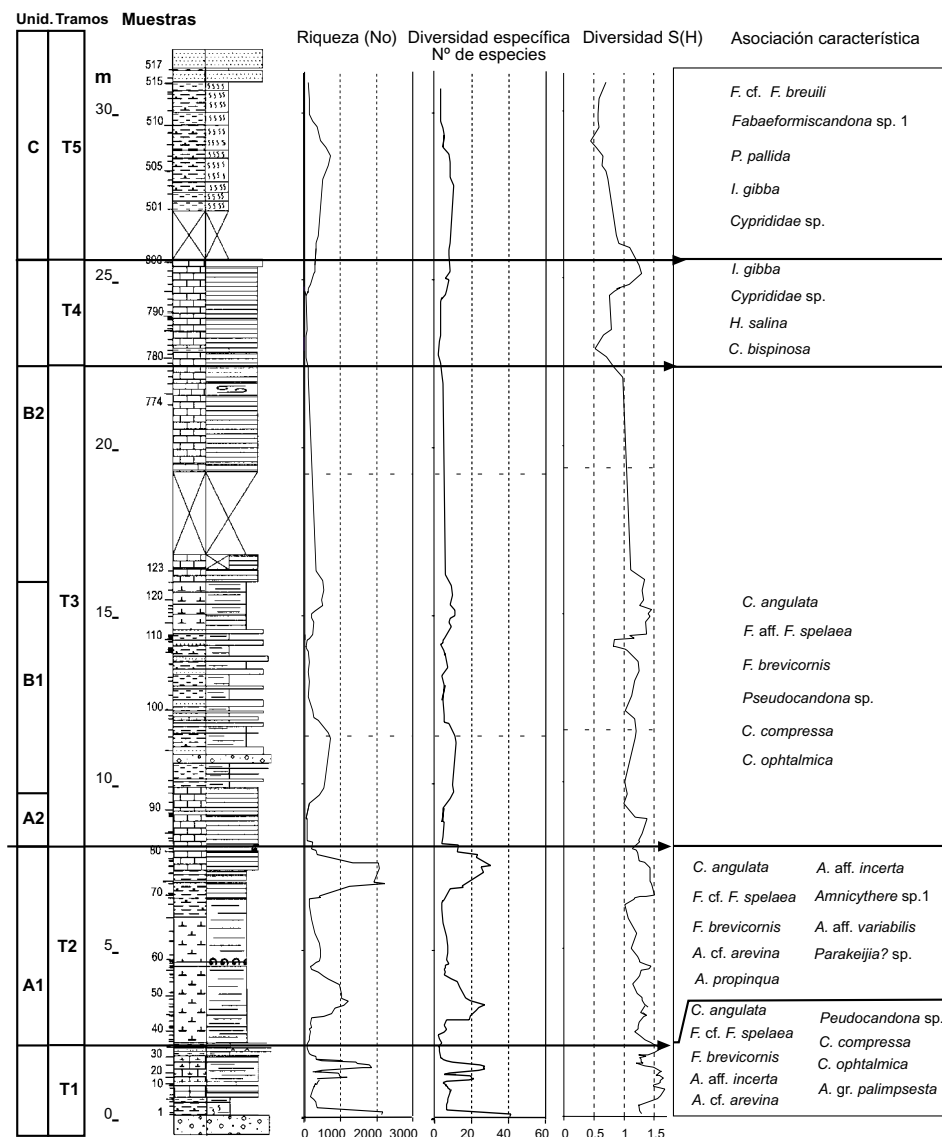


FIGURA 3—Evolución de los valores de riqueza, diversidad específica simple, índice de diversidad Shannon-Weaver y variación en la asociación de los ostrácodos, a lo largo de la sección lacustre de Villarroya.

FIGURE 3—Evolution of the richness, simple specific diversity, Shannon-Weaver diversity and ostracod-type assemblages through the Villarroya section.

En el segundo tramo (T2) desaparecen prácticamente algunas de las especies del T1, como *Eucypris* sp., *P. compressa*, *C. taubachensis*, *Pseudocandona* sp., *C. ophtalmica* y *Heterocypris salina*. El resto de las especies presentes en T1 continúan apareciendo en las mismas proporciones en T2.

En el tramo T3, nuevamente aparecen las especies ausentes en el tramo T2, pero a su vez desaparecen *Amnicythere* gr. *palimpsesta*, *A. aff. incerta*, *A. cf. arevina* y *Amnicythere* sp. 1. Las especies del género

Amnicythere desaparecen definitivamente en este tramo.

En el tramo T4 se observa un nuevo cambio en la asociación respecto a los tres tramos anteriores, ya que desaparecen especies como *Q. riojensis*, *P. compressa*, *C. taubachensis*, *Pseudocandona* sp. y *Cypridopsis hartwigi* y reaparece con un registro más continuo *H. salina*. En la zona superior de este tramo entran en este registro *Cypris bispinosa*, *Ilyocypris gibba* y *Cyprididae* sp.

En el último tramo (T5) se observa el cambio de asociación más brusco registrado en toda la sección. Desaparecen *F. brevicornis*, *Fabaeformiscandona* sp. 2 y *H. salina* y la presencia de *C. angulata* y *F. aff. F. spe-laea* queda restringida a dos y tres muestras, respectivamente. En este tramo también aparecen especies como *Fabaeformiscandona breuili*, *Fabaeformiscandona* sp. 1 y *Potamocypris pallida*, mientras que continúan *I. gibba* y *Cyprididae* sp.

Basándonos en el tipo de asociación de ostrácodos, en los cambios en la misma y en las variaciones de la riqueza y diversidad, es posible realizar una aproximación paleoecológica para cada uno de los tramos anteriormente descritos de la serie de Villarroya.

La asociación característica del primer tramo (T1) indicaría un ambiente lacustre, en el que la presencia de especies de los géneros *Amnicythere* y *Leptocythere* serían marcadores de un tipo de aguas oligosalinas a mesosalinas, con temperaturas relativamente cálidas (Rodríguez-Lázaro *et al.*, 1997).

Amnicythere Apalimpsesta, *A. incerta*, *A. arevina* y *A. variabilis* son especies que presentan afinidad con aguas salobres y/o estuarinas. Algunas de estas especies han sido encontradas en el Pleistoceno, en cuerpos de aguas considerados relictos del Paratethys (Schornikov, 1966; Gliozzi, 1999; Gliozzi *et al.*, 2005). Por su parte la presencia de especies como *C. taubachensis*, *C. ophtalmica*, *C. neglecta*, *C. angulata*, junto con otros candónidos no dejan lugar a dudas sobre el ambiente lacustre que dominaría en este primer intervalo, indicando por lo tanto la presencia de un lago con una profundidad moderada.

En el tramo T2 la asociación dominante es similar a la del tramo anterior, diferenciándose por la desaparición de algunas de las especies y el incremento en la presencia de otras (*A. gr. palimpsesta*, *A. aff. incerta*, *A. sp. cf. A. arevina* y *A. sp. aff. A. variabilis*). La proliferación de estas especies nos indicaría un cambio de salinidad de las aguas, probablemente hacia una mayor salinidad, ya que *A. palimpsesta* vive actualmente en el mar Caspio en salinidades entre 7,5 a 13,5‰, aunque las condiciones óptimas de salinidad para esta especie se sitúan entre el 12-12,5‰ (Gliozzi, 1999). Continúan apareciendo especies típicamente lacustres que indicarían que, al igual que en el tramo anterior, nos encontramos todavía en un sistema lacustre estable.

En el siguiente tramo (T3), desaparecen las especies representantes del género *Amnicythere* y entran nuevamente las ausentes del tramo 2: *P. compressa*, *C. taubachensis*, *Pseudocandona* sp. y *C. hartwigi*. Este cambio de asociación puede interpretarse como un

descenso en la salinidad de las aguas, quedando un sistema lacustre de tipo oligosalino.

En el tramo T4 desaparecen nuevamente las especies *P. compressa*, *C. taubachensis*, *Pseudocandona* sp. y *C. hartwigi* (aunque continúan otras especies típicamente lacustres). Esta desaparición, asociada a la presencia en la zona superior de este tramo, de especies como *C. bispinosa*, *I. gibba* y *Cyprididae* sp., podría indicar un descenso en el nivel del agua, ya que algunas de estas nuevas especies se encuentran asociadas a cuerpos de agua poco profundos, con abundante vegetación acuática (por ejemplo *C. bispinosa*, Martín-Rubio *et al.*, 2002). Por otra parte, la neta presencia en este tramo de *H. salina* podría indicar un relativo ascenso de la temperatura de las aguas y un ligero aumento de la salinidad (NaCl) (Anadón *et al.*, 2002) en relación a los tramos inferiores.

Por último, el tramo T5 supone un cambio sustancial respecto a los tramos anteriormente descritos. Por una parte desaparecen los representantes del género *Candona* que aparecían en el resto de los tramos. *Cyprididae* sp. e *I. gibba* refuerzan su presencia y aparecen las especies *F. breuili*, *Fabaeformiscandona* sp. 1 y *P. pallida*. Esta última especie vive actualmente asociada a arroyos y charcas (Meisch, 2000). *F. breuili*, otra de las especies que tiene representantes actuales, es básicamente hipogea, aunque sobrevive en aguas epigeas poco profundas conectadas a surgencias subterráneas (Meisch, 2000). A diferencia de los tramos anteriores, los sedimentos de este tramo superior se encuentran fuertemente bioturbados. Todas estas características, junto con el cambio de asociación en este tramo, estarían indicando un ambiente palustre (quizás conectado a algún arroyo), con vegetación acuática, aguas frías (presencia de *P. zchokkei*) y una ligera corriente.

Por tanto, la evolución del sistema lacustre plioceno de Villarroya indicaría un cambio en el medio, pasando de un sistema lacustre estable, con estadios de diferente salinidad, a un sistema palustre relativamente frío, mediante un descenso progresivo de los niveles de agua a lo largo de la serie (Martín-Rubio, 2003).

DESCRIPCIONES SISTEMÁTICAS

En el análisis taxonómico hemos seguido las clasificaciones de Hartmann y Puri (1974) y Horne *et al.* (2002), complementadas con las de Meisch (2000), Kempf (1980, y suplementos posteriores) y Bronshtein (1947). Para cada especie, se describe el material estudiado, las dimensiones, la descripción

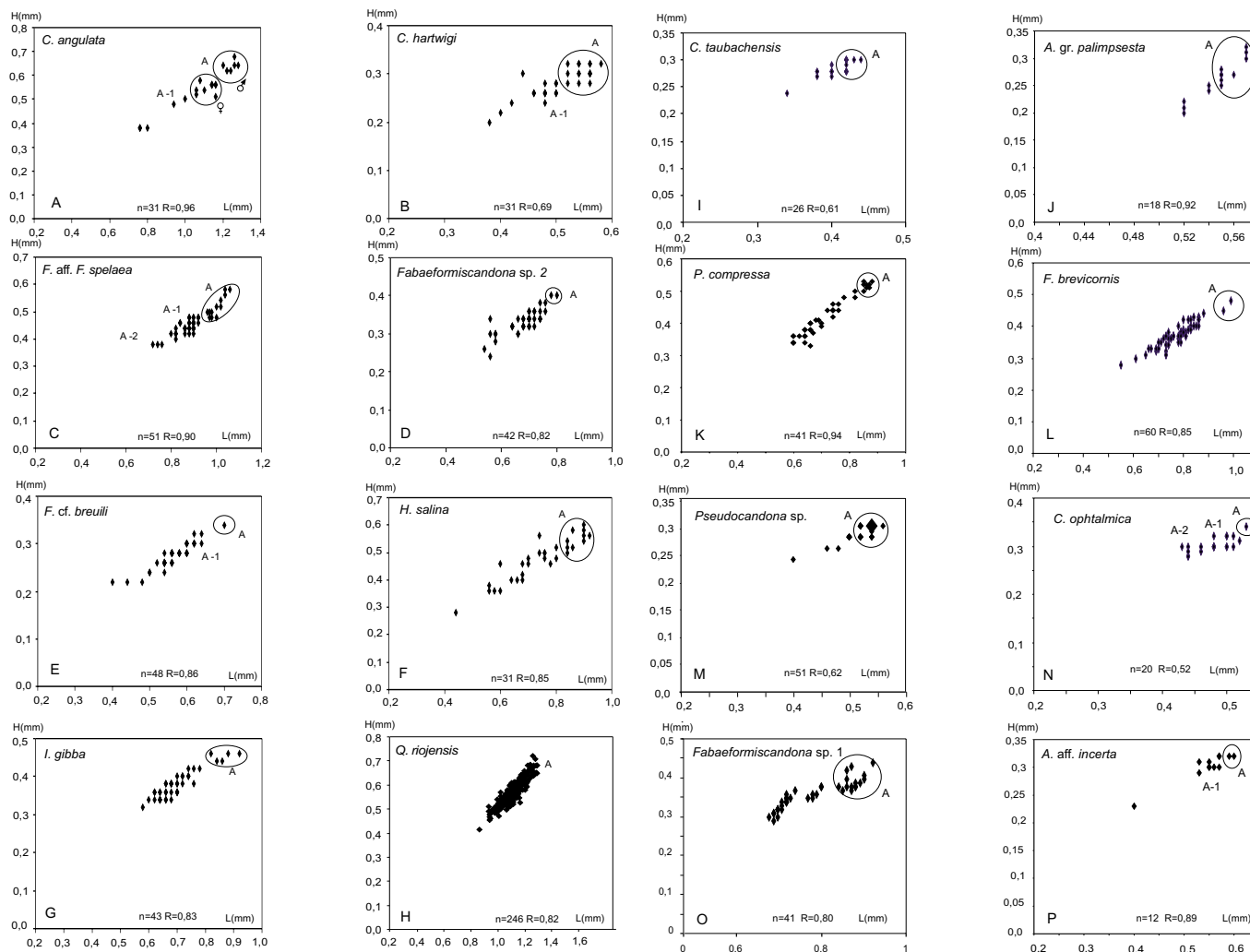


FIGURA 4—Gráficas de dispersión (LxH) de algunas de las especies de ostrácodos más abundantes de la sección de Villarroja.
FIGURE 4—Scatter plots (LxH) of the most representative species of the Villarroja section.

morfológica y las comparaciones con otras especies. Finalmente se proporciona la distribución geográfica y la edad de las especies consideradas, utilizando como referencias básicas, las de Baltanás *et al.*, (1996) para la distribución en la Península Ibérica, y Meisch (2000) para las distribuciones generales. Leyenda: L = longitud; H = altura, de los caparazones/valvas; VI = valva izquierda; VD = valva derecha. cpm = canales de poros marginales. Las dimensiones, si no se indica lo contrario, son de individuos adultos.

Subfillum CRUSTACEA Pennant, 1777
Clase OSTRACODA Latreille, 1806
Orden PODOCOPIDA Sars, 1866

Suborden CYPRIDOCOPINA Jones, 1901
Superfamilia CYPRIDOIDEA Baird, 1845
Familia CANDONIDAE Kaufmann, 1900
Subfamilia CANDONINAE Kaufmann, 1900
Género *Candona* s. str. Baird, 1845

Candona angulata G. W. Müller, 1900
(Lám. 1, Figs. 2-4)

- 1900 *Candona angulata* Müller, p. 18, Pl. 1, Figs. 1-17.
- 1978 *Candona angulata* G. W. Müller, Absolon, p. 29, Fig. 15.
- 2000 *Candona angulata* G. W. Müller, Meisch, p. 87-89, Fig. 31.

Material.—729 valvas de individuos mayoritariamente juveniles.

Dimensiones.—Machos: L = 1,18-1,28 mm; H = 0,62-0,68 mm. Hembras: L = 1,06-1,16; H = 0,52-0,58 mm (Fig. 4A).

Descripción.—Contorno subtrapezoidal, con el borde ventral sinuoso. El borde dorsal es rectilíneo. Bordes anterior y posterior redondeados, con una fuerte angulación posterior, característica de la valva izquierda. La altura máxima se sitúa en la zona centro-posterior y la mayor longitud es subventral. Superposición valvar normal (VI>VD), algo más acusada en el borde centroventral. Superficie aparentemente lisa, con finos poros normales distribuidos por la valva. Dimorfismo sexual presente, si bien apenas se han encontrado machos. Las poblaciones estarían representadas prácticamente por individuos hembras. Internamente presenta una amplia zona marginal anterior ocupada casi en su totalidad por un gran vestíbulo, apreciable tanto en individuos hembras como machos. Los cpm son numerosos y muy cortos en el borde anterior y más largos en los bordes ventral y posterior. La charnela es muy débil, con dos fosetas distales muy finas en la valva izquierda.

Observaciones.—*Candona (Candona) decimai* Freels (1980) del Mioceno superior de Turquía es morfológicamente muy próxima a *C. angulata*, de la que difiere (hembras) por presentar un borde ventral más cóncavo, la zona marginal anterior más ancha y una superposición valvar (VI>VD) más acusada a lo largo de toda la periferia. Además, los ejemplares de Turquía son de tamaños mayores que los de Villarroya.

Distribución.—*C. angulata* es conocida en el conjunto de Europa y el Norte de África. En la Península Ibérica ha sido descrita solamente como fósil, en el Pleistoceno de Gerona y Granada (en: Baltanás *et al.*, 1996) y en el Mioceno de la Cuenca del Duero (Civis *et al.*, 1990). En la sección de Villarroya presenta un registro continuo, siendo más escasa en el tramo superior T5.

Edad.—Se ha asignado a esta especie una edad de Pleistoceno inferior-Reciente (Meisch, 2000). Su presencia en Villarroya así como en el del Mioceno de la Cuenca del Duero permite ampliar su rango estratigráfico, que sería de Mioceno-Reciente.

Candona neglecta Sars, 1887
(Lám. 1, Figs. 5-6)

1887 *Candona neglecta* Sars, p. 279, Pl. 15, Figs. 5-7, Pl. 19.

1978 *Candona neglecta* Sars, Absolon pp. 23-25, Figs. 9-11.

2000 *Candona neglecta* Sars, Meisch, pp. 77-81, Figs. 26-27.

Material.—17 valvas de individuos adultos y juveniles.

Dimensiones.—L = 1,00-1,20 mm; H = 0,50-0,58 mm.

Descripción.—Contorno subreniforme, con bordes anterior y posterior redondeados. El borde posterior es ligeramente hinchado y caído hacia la zona ventral. El borde dorsal es ligeramente convexo y el ventral moderadamente cóncavo. La máxima altura se encuentra en la zona centroposterior y la máxima longitud es subventral. Dimorfismo sexual presente, siendo las hembras mucho más numerosas que los machos. En estos últimos se observa una zona posterior muy hinchada.

En vista interna se observa como, tanto en machos como en hembras, la zona marginal anterior se encuentra bien desarrollada y con vestíbulo, mientras que la posterior es más estrecha. La superficie de la valva es lisa.

Observaciones.—*C. neglecta* recuerda morfológicamente a *C. angulata*, aunque ésta difiere por la angulación posteroventral (VI) y su tamaño es algo más grande.

Distribución.—Especie Holártica. Ampliamente distribuida por la Península Ibérica (Baltanás *et al.*, 1996), y también descrita en el Mioceno de la Cuenca del Duero (Civis *et al.*, 1990). En la sección de Villarroya es muy escasa, apareciendo solamente en la parte alta del tramo T1 y en dos muestras aisladas de T2 y T3.

Edad.—Ha sido asignada una edad de Pleistoceno-Reciente (Meisch, 2000). Sin embargo, su presencia en Villarroya y en el Mioceno de la Cuenca del Duero permite ampliar su rango estratigráfico al Mioceno-Reciente.

Candona sp. 1
(Lám. 1, Figs. 9-10)

Material.—160 valvas de juveniles y adultos.

Dimensiones.—L = 0,75-0,80 mm; H = 0,30-0,38 mm.

Descripción.—Caparazón de contorno arriñonado muy elongado (L/H = 2,5), bordes anterior y posterior redondeados y una gran simetría entre estos dos márgenes. El borde dorsal es rectilíneo o sinuoso y el ventral presenta una amplia concavidad.

La superficie de la valva es lisa. En vista interna se observan una serie de poros distribuidos homogénea-

mente por toda la valva. Presenta zonas marginales anterior y posterior bien desarrolladas.

Distribución.—Aparece regularmente en los tramos T1 y T2 y en los niveles más altos de tramos T3 de la sección de Villarroya.

Edad.—Plioceno medio.

Candona sp. 2
(Lám. 1, Figs. 11-12)

Material.—6 valvas de ejemplares adultos.

Dimensiones.—L = 1,2 mm; H = 0,63-0,65 mm.

Descripción.—Contorno subtrapezoidal a subtriangular, con el borde anterior redondeado, el posterior más agudo y apuntando hacia el lado ventral. El borde dorsal es fuertemente convexo, marcando una clara angulación posterodorsal. El borde ventral presenta una neta concavidad media. La máxima altura del caparazón se sitúa en la zona centroposterior, mientras que la máxima longitud es subventral.

En vista interna se observa una zona marginal anterior muy ancha y con un amplio vestíbulo, y una zona marginal posterior muy estrecha, también con vestíbulo. La superficie de las valvas es lisa, con numerosos poros normales.

Observaciones.—El contorno subtriangular característico de *Candona* sp. 2 le diferencia del resto de las especies de candónidos estudiados en este trabajo. *Candona levanderi* Hirschmann, sensu Diebel y Pietrzeniuk (1984), del Pleistoceno medio-Reciente de centroeuropa, presenta un tamaño y contorno similares a los de *Candona* sp. 2, si bien se diferencia de ésta por un extremo posteroventral más agudo y un menor desarrollo de la zona marginal anterior.

Fabaeformiscandona balatonica (Daday), conocida desde el Mioceno y con una distribución Paleártica (cf. Meisch, 2000), es de tamaño similar, aunque su contorno es menos subtriangular y el trazado de la zona marginal más regular que *Candona* sp. 2.

Distribución.—Es una especie minoritaria en la sección de Villarroya, habiendo sido registrada exclusivamente en tres niveles concretos de los tramos T1 y T3.

Edad.—Plioceno medio.

Género *Fabaeformiscandona* Krstić, 1972
Fabaeformiscandona cf. *F. breuili* (Paris, 1920)
(Lám. 2, Figs. 1-2)

1920 *Candona breuili* Paris, p. 477, Pl. 18, Figs. 18, 1-16.

1984 *Candona breuili* Paris, Diebel y Pietrzeniuk, pp. 299-300, Pl. 4, Figs. 5-7.

2000 *Fabaeformiscandona breuili* (Paris), Meisch, pp. 135-140, Figs. 55-58.

Material.—3.003 valvas mayoritariamente de juveniles.

Dimensiones.—L = 0,60-0,64 mm; H = 0,28-0,32 mm (Fig. 4E).

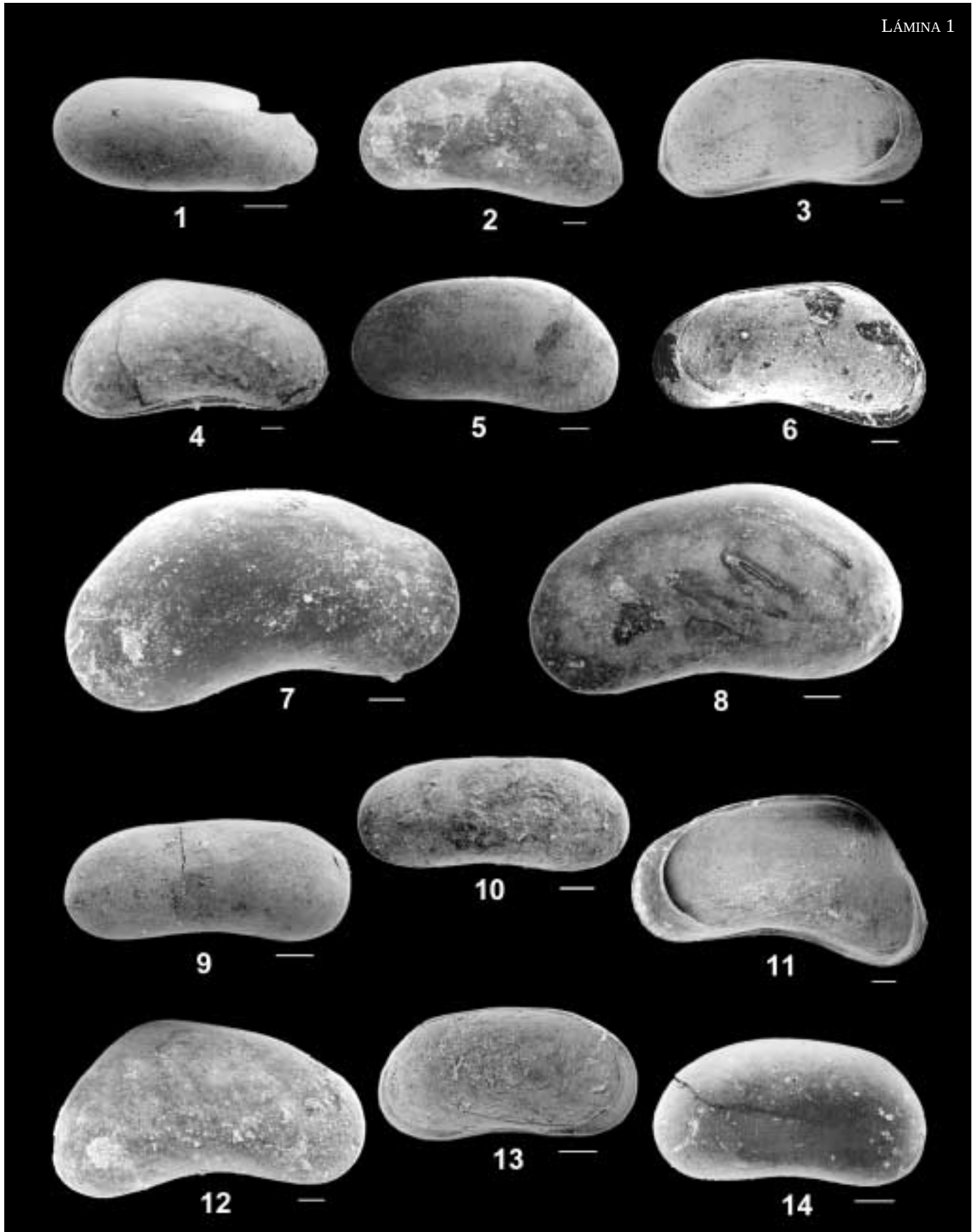
Descripción.—En vista lateral presenta una forma arriñonada, con los márgenes anterior y posterior redondeados. En la unión entre el margen anterior y la zona dorsal se observa un pequeño ángulo, encontrándose el margen anterior desplazado ligeramente hacia la zona ventral, donde se registra la máxima longitud. La altura máxima se reparte por la zona central. El margen dorsal es ligeramente convexo y el ventral presenta una suave concavidad media. En vista interna, se observan peque-

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LÁMINA 1–1, *Darwinula stevensoni*. VD fragmentada, vista externa. Vr25. 2, 3, 4, *Candona angulata* (hembras); 2, VI, vista externa. Vr59; 3, VI, vista interna. Vr59; 4, caparazón, vista lateral derecha. Vr107. 5, 6, *Candona neglecta*; 5, VI, vista externa. Vr38; 6, VD, vista interna. Vr38. 7, 8, *Fabaeformiscandona* aff. *F. spelaea*; 7, VD, vista externa. Vr2; 8, VI, vista externa. Vr22. 9-10, *Candona* sp. 1; 9, VI, vista externa. Vr2; 10, VI, vista externa. Vr2. 11, 12, *Candona* sp. 2; 11, VD, vista interna. Vr21; 12, VD, vista externa. Vr21. 13, 14, *Fabaeformiscandona* sp. 2; 13, VI, vista interna. Vr21; 14, VI, vista externa. Vr21.

PLATE 1–1, *Darwinula stevensoni*. Broken right valve, external view. Vr25. 2, 3, 4, *Candona angulata* (females); 2, left valve, external view. Vr59; 3, left valve, internal view. Vr59; 4, carapace, right lateral view. Vr107. 5, 6, *Candona neglecta*; 5, left valve, external view. Vr38; 6, right valve, internal view. Vr38. 7, 8, *Fabaeformiscandona* aff. *F. spelaea*; 7, right valve, external view. Vr2; 8, left valve, external view. Vr22. 9-10, *Candona* sp. 1; 9, left valve, external view. Vr2; 10, left valve, external view. Vr2. 11, 12, *Candona* sp. 2; 11, right valve, internal view. Vr21; 12, right valve, external view. Vr21. 13, 14, *Fabaeformiscandona* sp. 2; 13, left valve, internal view. Vr21; 14, left valve, external view. Vr21.

LÁMINA 1



ños poros repartidos homogéneamente por toda la valva. La zona marginal anterior es de mediano desarrollo y la posterior mucho más estrecha; ambas con vestíbulo. La charnela (VI) está bien calcificada definiendo un surco continuo a lo largo de la zona cardinal. El ajuste complementario (VD) se produce mediante un surco periférico, que continúa en el lado posterior con el borde externo de esta valva. En vista dorsal se observa como la valva izquierda es ligeramente mayor que la derecha. La superficie de la valva es lisa.

Comparaciones.—Por el tamaño y la configuración general del caparazón, este material se corresponde con los ejemplares vivos procedentes de Asturias, que son incluidos en *F. breuili* por Meisch (2000). Esta especie es morfológicamente muy próxima a *Fabaeformiscandona brevicornis* (Klie), de la que se diferencia por su menor tamaño (Fig. 5) y por un diferente contorno, con el borde dorsal ligeramente convexo, que en el caso de *F. brevicornis* es rectilíneo.

Distribución.—Ha sido descrita en diversas localidades del Sur y Centro de Europa. En la Península Ibérica, se ha encontrado en Asturias y Zamora (Baltanás *et al.*, 1996). En la sección de Villarroya aparece exclusivamente en los niveles más modernos (T5).

Edad.—El rango temporal reconocido hasta la fecha es de Pleistoceno-Reciente (Meisch, 2000). Su presencia en la sección de Villarroya permite ampliar dicho rango al Plioceno medio-Reciente.

Fabaeformiscandona brevicornis (Klie, 1925)
(Lám. 2, Figs. 3-4)

1925 *Candona brevicornis* Klie, pp. 58-59, Figs. 181-182.

1975 *Candona brevicornis* Klie, Diebel y Pietrzeniuk, 34, Pl. 3, Figs. 3-4.

1985 *Candona limnocrenica* Sywula, Pietrzeniuk, p. 214, Pl. 1, Figs. 7-8.

2000 *Fabaeformiscandona brevicornis* (Klie), Meisch, pp. 127-128, Fig. 51.

Material.—11.334 valvas, la mayor parte de juveniles y fragmentadas.

Dimensiones.—L = 0,96-0,99 mm; H = 0,45-0,48 mm (Fig. 4L). El tamaño de estos ejemplares es mayor que el descrito para esta especie en Europa central (Meisch, 2000).

Descripción.—Caparazón subtrapezoidal elongado. Borde dorsal rectilíneo, con una concavidad anterodorsal característica (VD) y borde ventral cóncavo en su parte media. Borde anterior redondeado y el posterior más agudo. La máxima longitud se da en la zona subventral, mientras que la altura máxima se reparte por la zona central de la valva. Internamente presenta una zona marginal anterior de mediano desarrollo y con vestíbulo. En la zona de charnela de la valva derecha, se observa una barra fuertemente calcificada con dos suaves expansiones distales. Superficie lisa con numerosos poros normales.

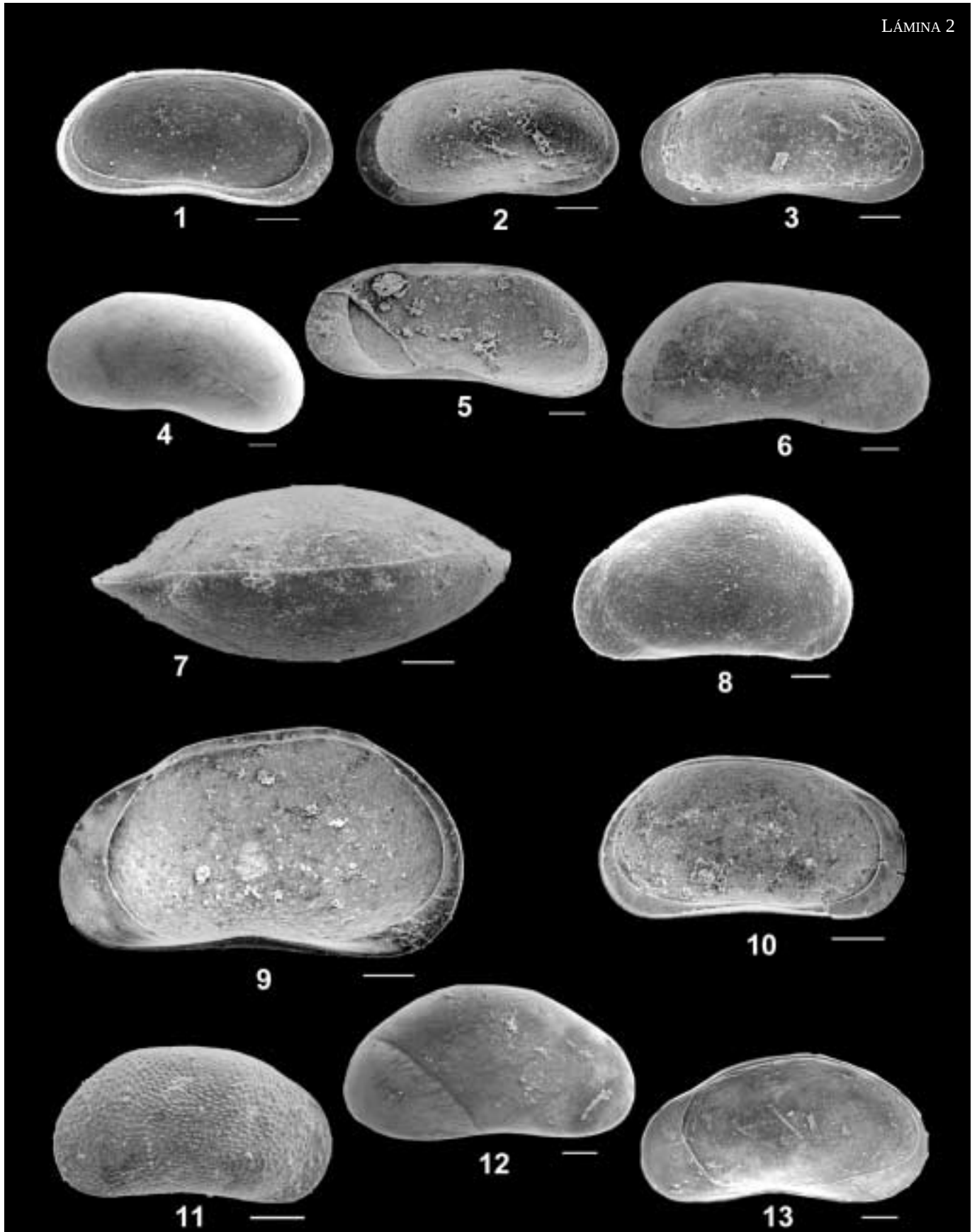
Distribución.—*Fabaeformiscandona brevicornis* ha sido descrita exclusivamente en el área centroeuropea (Meisch, 2000). En la sección de Villarroya se ha registrado de una forma continua a lo largo de los tramos T1 a T4.

Edad.—Se ha asignado a esta especie una edad de Holoceno-Reciente (Meisch, 2000). Su presencia en la sección de Villarroya, nos permite ampliar su intervalo temporal al Plioceno medio-Reciente.

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LÁMINA 2-1, 2, *Fabaeformiscandona* cf. *F. breuili*; 1, VI, vista interna. Vr504; 2, VD, vista interna. Vr504. 3, 4, *Fabaeformiscandona brevicornis*; 3, VD, vista interna. Vr792; 4, VI, vista externa. Vr792. 5, 6, *Fabaeformiscandona* sp. 1; 5, VD, vista interna. Vr505; 6, VD, vista externa. Vr505. 7-9, *Pseudocandona compressa*; 7, caparazón, vista dorsal. Vr12; 8, VI, vista externa. Vr13; 9, VD, vista interna. Vr13. 10-11, *Pseudocandona* sp.; 10, VI, vista interna. Vr23; 11, VD, vista externa. Vr23. 12, 13, *Candonopsis kingsleii*; 12, VD, vista externa. Vr506; 13, VD, vista interna. Vr27.

PLATE 2-1, 2, *Fabaeformiscandona* cf. *F. breuili*; 1, left valve, internal view. Vr504; 2, right valve, internal view. Vr504. 3, 4, *Fabaeformiscandona brevicornis*; 3, right valve, internal view. Vr792; 4, left valve, external view. Vr792. 5, 6, *Fabaeformiscandona* sp. 1; 5, right valve, internal view. Vr505; 6, right valve, external view. Vr505. 7-9, *Pseudocandona compressa*; 7, carapace, dorsal view. Vr12; 8, left valve, external view. Vr13; 9, right valve, internal view. Vr13. 10-11, *Pseudocandona* sp. 10; left valve, internal view. Vr23; 11, right valve, external view. Vr23. 12, 13, *Candonopsis kingsleii*; 12, right valve, external view. Vr506; 13, right valve, internal view. Vr27.



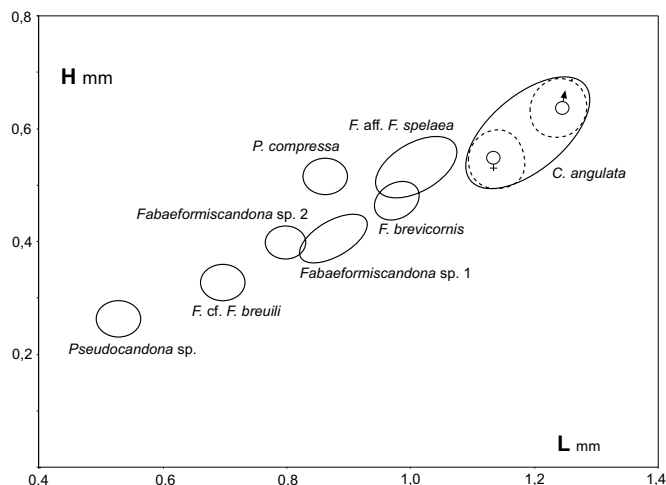


FIGURA 5—Campos de dispersión morfométrica (LxH) de las especies de candónidos más características de la sección de Villarroya.

FIGURE 5—Morphometric plots (LxH) of some of the most characteristic candonid species of the Villarroya section.

Fabaeformiscandona aff. *F. spelaea* (Klie, 1941)
(Lám. 1, Figs. 7-8)

1941 *Candona spelaea* Klie, p. 17, Figs. 10, 13.

1984 *Candona spelaea* Klie, Diebel y Pietrzeniuk, p. 302, Pl. 4, Figs. 3, 4.

Material.—3.677 valvas de adultos y juveniles.

Dimensiones.—L = 0,98-1,04 mm; H = 0,44-0,56 mm (Fig. 4C).

Descripción.—En vista lateral, el caparazón presenta un contorno arriñonado con los márgenes anterior y posterior redondeados. La valva derecha exhibe una fuerte convexidad en su lado dorsal y una neta concavidad medioventral. La máxima altura se encuentra en la zona centroposterior y la longitud máxima en la zona centroventral en ambas valvas. En vista dorsal la valva izquierda presenta un mayor tamaño que la derecha, a la cual se le superpone sobre todo dorsalmente. En vista interna, la VI presenta una fina charnela, con dos fosetas distales muy elongadas. El elemento complementario de la VD consiste en una barra periférica dorsal que encaja en la estructura cardinal de la VI. La zona marginal es muy estrecha, con un desarrollo similar en ambos extremos y con vestíbulo.

Observaciones.—Los individuos de Villarroya presentan una morfología comparable con *F. spelaea* Klie, descrita por Diebel y Pietrzeniuk (1984) en el

Pleistoceno de Alemania. Sin embargo, nuestros ejemplares son más grandes, diferenciándose en el contorno y más claramente en los campos morfométricos de los adultos de ambas especies. Por su parte, Meisch (2000) incluye a *F. spelaea* dentro de la variación morfológica de *F. breuili* (Paris), basándose en la fuerte similitud que presentan sus caparazones. Considerando lo anterior, optamos por mantener provisionalmente esta especie como afín de *F. spelaea*, a la espera de un estudio más pormenorizado basándonos en un mayor número de valvas de adultos con buena conservación.

Distribución.—La especie de referencia, *F. spelaea*, ha sido descrita en Grecia y en Alemania. En la sección de Villarroya, *F. aff. F. spelaea* aparece de forma regular a lo largo de los tramos T1 a T4 y en algunos niveles del tramo T5.

Edad.—*F. aff. F. spelaea* ha sido descrita exclusivamente en el Plioceno medio de Villarroya.

Fabaeformiscandona sp. 1
(Lám. 2, Figs. 5-6)

Material.—272 valvas mayoritariamente de individuos juveniles.

Dimensiones.—L = 0,80-0,92 mm; H = 0,38-0,44 mm (Fig. 4O).

Descripción.—Contorno subtrapezoidal muy elongado, el borde dorsal rectilíneo y el ventral fuertemente cóncavo en su tramo medio. Borde anterior subredondeado y el posterior más agudo; ambos apuntan hacia la zona ventral. En vista interna destaca una zona marginal anterior muy ancha, limitando un gran vestíbulo. La zona marginal posterior es de mediano desarrollo, con vestíbulo y un gran número de canales de poros marginales rectos, que definen una línea de concrescencia de trazado irregular. Superficie aparentemente lisa, con unos pocos poros normales de varios tamaños.

Observaciones.—Incluimos provisionalmente a esta especie en el género *Fabaeformiscandona*, considerando su morfología general. Se diferencia de *F. cf. breuili* por el tamaño mayor (ver Fig. 5), así como por el contorno más irregular y el mayor desarrollo de la zona marginal, sobre todo anteriormente. *F. brevicornis* es de tamaño ligeramente mayor que *Fabaeformiscandona* sp. 1, pero presenta las mismas diferencias respecto al contorno y la zona marginal, que *F. cf. breuili*.

Distribución.—Esta especie aparece en la unidad más moderna (tramo T5) de la sección de Villarroya.

Edad.—Plioceno medio.

Fabaeformiscandona sp. 2
(Lám. 1, Figs. 13-14)

Material.—9.136 valvas, mayoritariamente fragmentos de juveniles.

Dimensiones.—L = 0,78-0,80 mm; H = 0,40 mm (Fig. 4D).

Descripción.—En vista lateral presenta un contorno arriñonado muy simétrico (H/L media = 0,46), con los lados anterior y posterior redondeados, el posterior un poco más agudo. El borde dorsal es ligeramente convexo y el ventral presenta una suave inflexión media.

En vista interna se observa una charnela muy débil. Las zonas marginales son muy estrechas y contienen un pequeño vestíbulo. La superficie de la valva es lisa.

Observaciones.—Esta especie se diferencia de *F. breuili* en el contorno netamente más simétrico y su menor tamaño (Fig. 5). *F. aff. F. spelaea* es más grande y de contorno diferente, menos elongado (H/L media = 51,8) con el borde dorsal más convexo que *Fabaeformiscandona* sp. 2.

Distribución.—Esta especie aparece regularmente a lo largo de los tramos T1 a T5 de la sección de Villarroya.

Edad.—Plioceno medio.

Género *Pseudocandona* Kaufmann, 1900
Pseudocandona compressa (Koch, 1838)
(Lám. 2, Figs. 7-9)

1838 *Cypris compressa* Koch, p. 171, Pl. 17.

1975 *Candona compressa* (Koch), Diebel y Pietrzeniuk, p. 1211, Pl. 5, Figs. 3-4.

1978 *Candona compressa* (Koch), Absolon, pp. 43-44, Fig. 30.

2000 *Pseudocandona compressa* (Koch), Meisch, pp. 179-182, Fig. 76.

Material.—Más de 6.500 valvas mayoritariamente de individuos juveniles.

Dimensiones.—L = 0,85-0,88 mm; H = 0,50-0,53 mm (Fig. 4K).

Descripción.—El contorno de esta especie es subtrapezoidal, con el borde anterior redondeado y reducido a la mitad inferior del caparazón. El borde dorsal es fuertemente convexo, con los tramos central y anterior rectilíneos y el posterior redondeado y en continuidad con el borde posterior. El borde ventral es prácticamente rectilíneo (VI) o ligeramente cóncavo (VD). La máxima longitud es subventral y la altura máxima se sitúa en posición centroposterior. La superficie externa está ornamentada por un retículo muy somero y un fino punteado, con numerosos poros normales.

En vista interna destaca una zona marginal anterior muy ancha y con un amplio vestíbulo. La zona marginal posterior es mucho más reducida, y con vestíbulo más evidente en la valva izquierda. La charnela es débil, del mismo tipo que el descrito para el resto de los candónidos. La zona de fusión es muy estrecha y contienen numerosos cpm rectos y cortos.

En vista dorsal presenta un contorno subovoidal, con el lado anterior muy comprimido. La valva izquierda se superpone a la derecha ligeramente y a lo largo de todo el contorno. Los ejemplares que incluimos como juveniles de esta especie presentan un contorno más regular, con el borde dorsal menos convexo y con una reticulación más marcada que en el caso de los adultos.

Comparaciones.—Nuestro material es comparable al descrito por Diebel y Pietrzeniuk (1975, 1984) en el Pleistoceno-Holoceno de Alemania. *Pseudocandona marchica* (Hartwig) in Meisch, 2000, conocida en el ámbito paleártico desde el Pleistoceno al Reciente, es una especie morfológicamente muy próxima, aunque es de mayor tamaño, con el borde ventral cóncavo y la zona marginal anterior más desarrollada que nuestros ejemplares.

Distribución.—*Pseudocandona compressa* es una especie de distribución Paleártica (Meisch, 2000), si bien ha sido descrita también en el Pleistoceno-Reciente de Kashmir (India; Bhatia, 1968) y en el Plioceno de Turquía (Tonoglu *et al.*, 1995). En la sección de Villarroya aparece a lo largo de los tramos T1 y T3.

Edad.—Descrita previamente en el intervalo Pleistoceno-Reciente (Meisch, 2000). La presencia de esta especie en Villarroya confirma la edad más antigua descrita también en el Plioceno de Turquía.

Pseudocandona sp.
(Lám. 2, Figs. 10-11)

Material.—4.459 valvas de individuos adultos y subadultos.

Dimensiones.—L = 0,54-0,56 mm; H = 0,28-0,30 mm (Fig. 4M).

Descripción.—Forma subtrapezoidal elongada, con bordes anterior y posterior redondeados. El lado posterior tiene un aspecto más hinchado hacia la zona ventral. El borde dorsal es de recto a ligeramente convexo y el ventral, cóncavo. Externamente, presenta un retículo muy denso de celdillas redondeadas, homogéneamente distribuidas por toda la valva. La superficie está recubierta por unos pequeños poros normales. Zona marginal bien desarrollada, con un neto vestíbulo.

lo en el lado anterior. Se han reconocido machos y hembras, con un dimorfismo sexual muy poco acusado en la morfología del caparazón.

Observaciones.—Los individuos descritos en este trabajo presentan una morfología comparable a *Pseudocandona* sp., sensu Diebel y Pietrzeniuk (1984), considerada por Absolon (1978) y Meisch (2000), como juveniles (A-1) de *Pseudocandona albicans* (Müller). Sin embargo, nuestros ejemplares presentan diferencias morfológicas suficientes como para considerarlos una especie distinta de *P. albicans*. Así, en el lago Caicedo de Yuso (Martín-Rubio, 2003), encontramos ejemplares vivos, con la zona marginal y los órganos reproductores bien desarrollados, lo que implica que son individuos adultos perfectamente diferenciables en cuanto a su morfología, de los considerados como individuos A-1 de *P. albicans*. Tampoco parecen ser juveniles de *Pseudocandona compressa*, anteriormente descrita, ya que los campos morfológicos de los adultos de ambas especies están muy separados (ver Fig. 5), no pudiendo corresponder *Pseudocandona* sp. con individuos juveniles muy pequeños (A-5?) de *P. compressa*. Especímenes comparables con este material, han sido descritos en el Plioceno superior-Pleistoceno inferior de los Apeninos centrales (Barberi *et al.*, 1995). Los ejemplares figurados por Carbonnel (1969, Pl. 11, Figs. 15, 16) como juveniles de *P. marchica*, del Plioceno de la Cuenca del Rhone (Francia), presentan la misma morfología y tamaño que nuestro material, por lo que podría tratarse de la misma especie. Olteanu (1995) figura un espécimen comparable, del Plioceno de la Cuenca Dácica, al que incluye en *Pseudocandona albicans* (Brady). Las citas de esta especie en la Península Ibérica (Baltanás *et al.*, 1996) son incluidas en *Pseudocandona albicans*.

Distribución.—Cuenca del Rhone y Apeninos. En la sección de Villarroya aparece continuamente a lo largo de los tramos T1 y T3.

Edad.—Plioceno-Reciente.

Género *Candonopsis* Vávra, 1891

Candonopsis kingsleii (Brady y Robertson, 1870)
(Lám. 2, Figs. 12-13)

1870 *Candona kingsleii* Brady y Robertson, p. 17, Pl. 9, 11-12.

1947 *Candonopsis kingsleii* (Brady y Robertson), Bronshtein, pp. 340-341, Pl. 13, Fig. 5.

1990 *Candonopsis kingsleii* (Brady y Robertson), Diebel y Pietrzeniuk, p. 154, Pl. 2, Figs. 7-8, 10.

2000 *Candonopsis kingsleii* (Brady y Robertson), Meisch, pp. 209-211, Fig. 89.

Material.—13 valvas de ejemplares adultos y juveniles.

Dimensiones.—L = 0,82-0,86 mm; H = 0,44-0,46 mm.

Descripción.—Caparazón reniforme en vista lateral, con los bordes anterior y posterior redondeados. El margen anterior se encuentra ligeramente caído hacia la zona ventral. Borde dorsal convexo, con dos ángulos centrales. El borde ventral es ligeramente cóncavo. La máxima altura se sitúa en la zona central y la longitud máxima es subventral. En vista interna se observan amplias zonas marginales, especialmente desarrolladas en el margen anterior y posteroventral; ambas contienen sendos vestíbulos. La superficie de la valva es lisa.

Distribución.—Holártica. En la Península Ibérica ha sido descrita en el Pleistoceno de Granada (Anadón *et al.*, 1986). En la sección de Villarroya aparece puntualmente en muestras de los tramos T1, T2, T4 y T5.

Edad.—Mioceno-Reciente (Meisch, 2000).

Familia CYPRIDIDAE Baird, 1845

Subfamilia CYCLOCYPRIDINAE Kaufmann, 1900

Género *Cyclocypris* Brady y Norman, 1889

Cyclocypris taubachensis Diebel y Pietrzeniuk, 1977
(Lám. 4, Figs. 1-2)

1977 *Cyclocypris taubachensis* Diebel y Pietrzeniuk, p. 131, Pl. 6, 7-8, 10.

1984 *Cyclocypris taubachensis* Diebel y Pietrzeniuk, pp. 304-305, Pl. 5, Figs. 7-8.

Material.—234 valvas de adultos y juveniles.

Dimensiones.—L = 0,40-0,44 mm; H = 0,26-0,30 mm (Fig. 4I).

Descripción.—Contorno oval a subtriangular, con los bordes anterior y posterior redondeados. El borde dorsal es convexo y presenta un ángulo centrado (VI) o dos angulaciones en la zona cardinal (VD). El borde ventral es rectilíneo con un fuerte repliegue en su parte media (VI). Su máxima altura, así como la máxima longitud, se sitúa en la zona central. En vista interna se observa una zona marginal relativamente estrecha, con el repliegue fuertemente resaltado y con vestíbulos anterior y posterior. La charnela consta de una barra subperiférica (VI) que encaja en el surco complementario de la valva derecha. En vista dorsal se observa un contorno subovalado con una suave superposición inversa (VD>VI). La superficie de la valva es de lisa a

finamente granulada, observándose la presencia de poros normales, algunos de tipo “conuli”.

Observaciones.—*Cyclocypris taubachensis* presenta un contorno, sobre todo en la VD muy próximo a *Cyclocypris globosa*, del que se diferencia claramente por un tamaño mucho menor. Meisch (2000) incluye provisionalmente a *C. taubachensis* dentro de la variabilidad morfológica de *Cyclocypris ovum*, a la espera del análisis de las partes blandas de *C. taubachensis*. Sin embargo, la morfología de esta última especie, con un caparazón de contorno subtrapezoidal, es claramente diferente de la de *C. ovum*, con un contorno subovalado.

Distribución.—Alemania y Siberia (Diebel y Pietrzeniuk, 1984). En la sección de Villarroya aparece de forma continua a lo largo de los tramos T1 y T3 y en una muestra aislada del tramo superior T5.

Edad.—Esta especie ha sido descrita para el intervalo Pleistoceno medio al Reciente. Su presencia en Villarroya permite ampliar su edad al Plioceno medio-Reciente.

Género *Cypria* Zenker, 1854
Cypria ophtalmica (Jurine, 1820)
(Lám. 3, Figs. 9-10)

- 1820 *Monoculus ophtalmicus*, Jurine, p. 178, Pl. 19, Figs. 16-17.
1984 *Cypria ophtalmica* (Jurine), Diebel y Pietrzeniuk, p. 314, Pl. 5, Figs. 5-6.
1987 *Cypria ophtalmica* (Jurine), Meisch, pp. 100-104, Figs. 5-6.
1990 *Cypria ophtalmica* (Jurine), Henderson, p. 126, Fig. 127.
2000 *Cypria ophtalmica* (Jurine), Griffiths & Holmes, pp. 176-177, Pl. 2, Fig. 4.
2000 *Cypria ophtalmica* (Jurine), Meisch, pp. 217-221, Fig. 92.

Material.—310 valvas de individuos mayoritariamente subadultos.

Dimensiones.—L = 0,53 mm; H = 0,34 mm (Fig. 4N).

Descripción.—Caparazón de contorno subredondeado a subtriangular con un borde dorsal fuertemente convexo y el borde ventral rectilíneo (VI) o con una suave concavidad media (VD). La máxima longitud del caparazón es subventral y la altura máxima se sitúa en posición central. Superficie externa lisa. La superposición valvar (VI>VD) es continua a lo largo de toda la periferia, si bien algo mayor en los márgenes dorsal y ventral. Zona marginal estrecha con amplios vestíbulos en lados anterior y posterior.

Distribución.—Es una de las especies de distribución más general, siendo considerada como cosmopolita, excepto en Australia. Ha sido hallada en numerosas localidades de la Península Ibérica y Baleares (Baltanás *et al.*, 1996). Es la especie viva más abundante en el Lago Caicedo de Yuso/Arreo (Martín-Rubio *et al.*, 2002). En la sección de Villarroya aparece a lo largo del tramo T1 y la parte basal del T2.

Edad.—Mioceno (?) y Pleistoceno-Reciente (Meisch, 2000). Su presencia en Villarroya confirma el intervalo Plioceno-Reciente.

Subfamilia CYPRIDINAE Baird, 1845
Género *Cypris* O. F. Müller, 1776
Cypris bispinosa Lucas, 1849
(Lám. 3, Figs. 7-8)

- 1849 *Cypris bispinosa*, Lucas, p. 82, Pl. 8, Fig. 7.
1947 *Cypris bispinosa* Lucas, Bronshtein, Pl. 3, Figs. 1, 2.
1981 *Cypris bispinosa* Lucas, Pons, pp. 55-66, Pl. 1.
1990 *Cypris bispinosa* Lucas, Henderson, p. 180, Fig. 78.
2000 *Cypris bispinosa* Lucas, Meisch, p. 275-277, Fig. 115.

Material.—18 valvas fragmentadas de individuos juveniles.

Descripción.—Los ejemplares juveniles hallados presentan un contorno subtrapezoidal, con el borde dorsal fuertemente convexo, borde anterior redondeado y borde posterior triangular con espinas marginales en el lado posteroventral. La superficie de la valva exhibe un reticulado muy fino, dispuesto concéntricamente, que es típico de las formas juveniles de esta especie. Basándonos en estas características, incluimos estos ejemplares juveniles en *Cypris bispinosa*. El ejemplar de la lámina 3 (Fig. 7) podría corresponder a un estadio A-4, si comparamos sus medidas (L = 0,96 mm; H = 0,62 mm) con la de los ejemplares vivos de esta especie del lago Caicedo de Yuso (Martín-Rubio *et al.*, 2002).

Distribución.—*C. bispinosa* es una especie de distribución Paleártica meridional (Circum-mediterránea). En la Península Ibérica ha sido descrita en Barcelona, el área central y Andalucía occidental (Baltanás *et al.*, 1996). También se han encontrado ejemplares vivos en el lago Caicedo de Yuso/Arreo (Martín-Rubio, *et al.*, 2002). La mención más antigua conocida es la del Mioceno terminal de Granada (Bekkali y Nachite, *com. per.*, 2003). En la sección de Villarroya solamen-

te hemos encontrado ejemplares juveniles en el tránsito de los tramos T4 y T5.

Edad.—*C. bispinosa* era conocida como especie holocena. Su presencia en Villarroya y en Granada permite ampliar su registro estratigráfico al Mioceno terminal-Reciente.

Cypridinae sp.

Incluimos en esta denominación a restos fragmentarios de valvas de grandes ciprídidos, que no han podido ser asignados a ninguna especie concreta. Aparecen en muestras de la parte final del tramo T4 y a lo largo de todo el T5. A pesar de esta indefinición taxonómica, su presencia en la parte final de esta serie es interesante ya que está asociada al cambio de la asociación de tipo lacustre a otra de tipo palustre.

Subfamilia CYPRIDOPSINAE Kaufmann, 1900

Género *Cypridopsis* Brady, 1867

Cypridopsis hartwigi G. W. Müller, 1900
(Lám. 3, Figs. 11-12)

1900 *Cypridopsis hartwigi* G.W. Müller, p. 82, Pl. 18.

1947 *Cypridopsis orientalis* Bronshtein, pp. 206-207, Fig. 83.

2000 *Cypridopsis hartwigi* G.W. Müller, Meisch, pp. 378-380, Fig. 157.

Material.—430 valvas de adultos y juveniles.

Dimensiones.—L = 0,52-0,58 mm; H = 0,28-0,32 mm (Fig. 4B).

Descripción.—Caparazón elongado subovoidal a subtriangular, con el margen anterior redondeado, el posterior agudo, el dorsal convexo y el ventral sinuoso. La máxima altura se sitúa en la zona centroanterior y la longitud máxima es subventral. En vista dorsal se observa cómo la valva izquierda se superpone ligeramente a la derecha en la zona anterior, con una neta separación entre ambas. En vista interna se observa (VD) una barra que recorre toda la charnela. La zona marginal anterior es muy ancha, con gran vestíbulo y con una serie de tubérculos redondeados dispuestos a lo largo de dicho margen.

Distribución.—Es una especie circum-mediterránea poco abundante en Europa (Meisch, 2000). En la Península Ibérica se ha encontrado en Badajoz, Menorca y Ribatejo (Portugal) (Baltanás *et al.*, 1996). En la sección de Villarroya aparece de forma discontinua a lo largo de los tramos T1 a T3. Los ejemplares de Villarroya son de menor tamaño que los descritos por Meisch, 2000.

Edad.—Conocida previamente en el intervalo Pleistoceno-Reciente. Su presencia en Villarroya permite ampliar su rango al Plioceno medio-Reciente.

Género *Potamocypris* Brady, 1870

Potamocypris aff. *P. pallida* Alm, 1914
(Lám. 4, Figs. 4-5)

1914 *Potamocypris pallida* Alm, p. 470, Fig. 2.

1984 *Potamocypris pallida* Alm, Meisch pp. 20-27, Figs. 5-7.

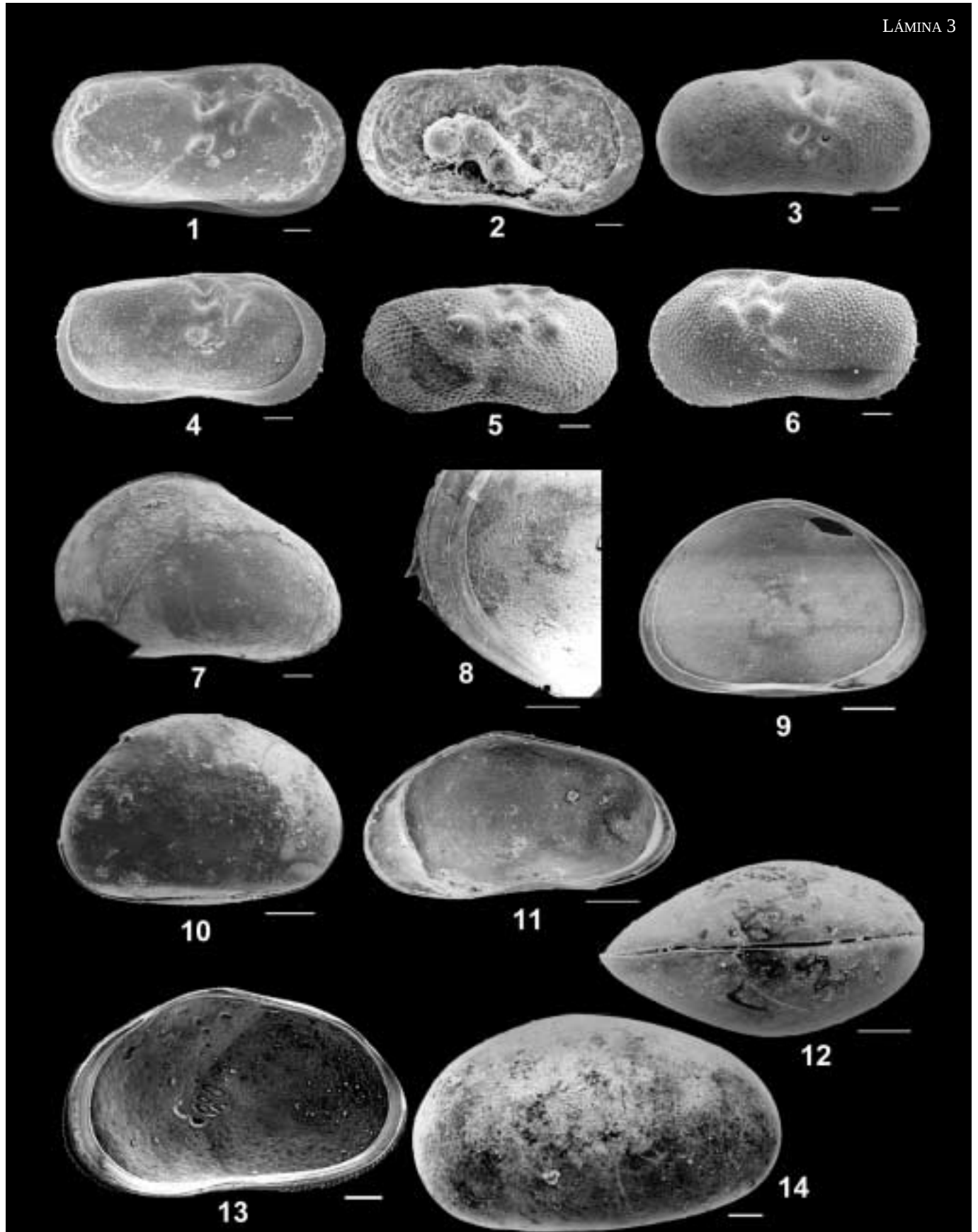
2000 *Potamocypris pallida* Alm, Meisch, pp. 400-402, Fig. 165.

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LÁMINA 3—1, 2, 3, *Qinghaicypris riojensis*; 1, VI, macho, vista interna. Vr9; 2, VI, vista interna. Hembra con huevos. Vr48; 3, VD, vista externa. Vr23. 4, 5, 6, *Ilyocypris gibba*; 4, VI, vista interna. Vr504; 5, VD, vista externa. Vr795; 6, VI, vista externa. Vr504. 7, 8, *Cypris bispinosa*; 7, VI, juvenil, vista externa. Vr502; 8, detalle de espinas posteroventrales en una VI, vista interna. Vr798. 9, 10, *Cypria ophtalmica*; 9, VI, vista interna. Vr24; 10, caparazón, vista lateral derecha. Vr14. 11, 12, *Cypridopsis hartwigi*; 11, VD, vista interna. Vr116; 12, caparazón, vista dorsal. Vr122. 13, *Heterocypris salina*, VD, vista interna. Vr778. 14, *Heterocypris incongruens*, VI, vista externa. Vr19.

PLATE 3—1, 2, 3, *Qinghaicypris riojensis*; 1, left valve, male, internal view. Vr9; 2, left valve, internal view. Female with eggs. Vr48; 3, right valve, external view. Vr23. 4, 5, 6, *Ilyocypris gibba*; 4, left valve, internal view. Vr504; 5, right valve, external view. Vr795; 6, left valve, external view. Vr504. 7, 8, *Cypris bispinosa*; 7, left valve, instar, external view. Vr502; 8, detail of posteroventral spines, left valve, internal view. Vr798. 9, 10, *Cypria ophtalmica*; 9, left valve, internal view. Vr24; 10, carapace, lateral right view. Vr14. 11, 12, *Cypridopsis hartwigi*; 11, right valve, internal view. Vr116; 12, carapace, dorsal view. Vr122. 13, *Heterocypris salina*, right valve, internal view. Vr778. 14, *Heterocypris incongruens*, left valve, external view. Vr19.

LÁMINA 3



Material.—126 valvas mayoritariamente fragmentadas de individuos juveniles y adultos.

Dimensiones.—L = 0,73-0,74 mm; H = 0,41-0,42 mm.

Descripción.—Contorno subtriangular a subtrapezoidal con el margen anterior redondeado y el posterior más agudo, apuntando ambos hacia la zona ventral. El borde ventral es cóncavo y el dorsal fuertemente convexo, dando la altura máxima del caparazón en posición centroanterior. La máxima longitud se da en posición ventral.

En vista dorsal se observa cómo la valva derecha se superpone a la izquierda a lo largo de toda la periferia, excepto en su extremo posteroventral, donde el recubrimiento es normal (VI>VD). Observando el interior de las valvas, se aprecia que la zona marginal es muy estrecha, con un repliegue en relieve y con pequeño vestíbulo. La zona de fusión es muy reducida y contiene numerosos canales de poros marginales simples y rectos. La charnela es de estructura muy simple. Las valvas presentan una superficie externa lisa, con poros normales repartidos homogéneamente.

Comparaciones.—*Potamocypris villosa* (Jurine) presenta un tamaño y morfología del caparazón comparables con la especie que describimos, si bien se diferencia de ésta por la superposición inversa (VD>VI) y en el extremo posteroventral. Nuestra especie también es muy próxima a *P. pallida*, en lo relativo al contorno, tamaño y tipo de superposición valvar. Sin embargo, la estructura de la zona marginal es más compleja que la observada en *P. pallida*. A falta de un estudio más minucioso basado en un material

más completo, optamos por dejar esta especie como denominación *affinis*.

Distribución.—*P. pallida* está en la actualidad ampliamente distribuida por Europa, Canarias y Madeira, si bien no se conocen registros fósiles confirmados de la misma (Meisch, 2000). En la sección de Villarroja, *P. aff. pallida* aparece exclusivamente en el tramo superior T5.

Edad.—Plioceno medio.

Potamocypris zschokkei (Kaufmann, 1900)
(Lámina 4, Figura 3)

1900 *Paracypridopsis zschokkei* Kaufmann, p. 317, Pl. 19, Figs. 18-20; Pl. 22, Figs. 26-30.

1984 *Potamocypris zschokkei* (Kaufmann), Meisch, pp. 28-34, Figs. 10, 11.

2000 *Potamocypris zschokkei* (Kaufmann), Meisch, pp. 402-406, Figs. 166-167.

Material.—10 valvas de ejemplares juveniles y adultos.

Dimensiones.—L = 0,68-0,70 mm; H = 0,35-0,37 mm.

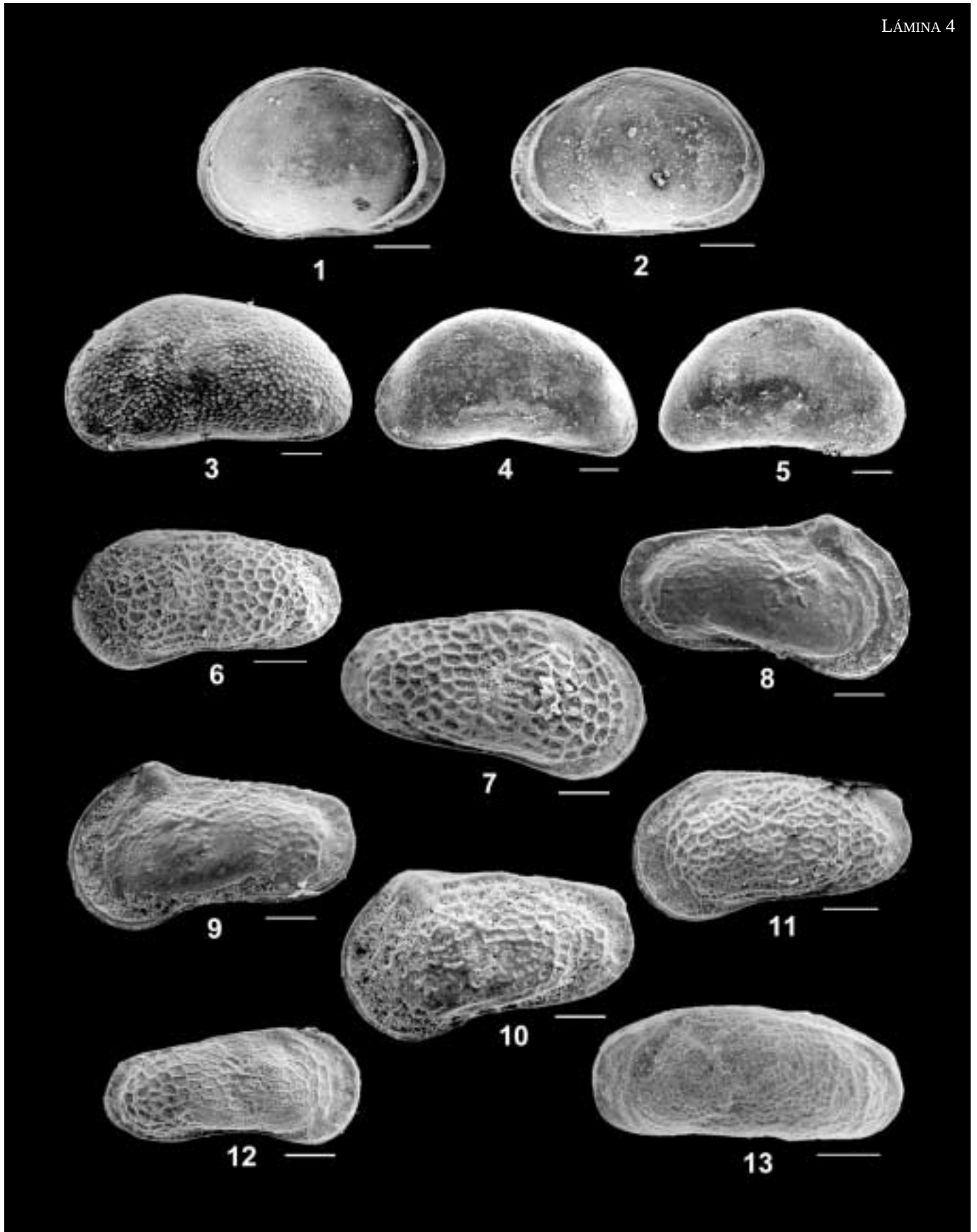
Descripción.—Contorno subtrapezoidal a subtriangular elongado (VI) y más alto en la VD. Lado anterior redondeado y el posterior más agudo, ambos desplazados hacia la zona ventral. El borde ventral es ligeramente cóncavo y el dorsal fuertemente convexo. La máxima altura se sitúa en la región centro-anterior y la longitud máxima es ventral. En vista dorsal se observa una ligera superposición dorsal de la valva

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LÁMINA 4—1, 2, *Cyclocypris taubachensis*; 1, VI, vista interna. Vr116; 2, VD, vista interna. Vr191. 3, *Potamocypris zschokkei*, VI, vista externa. Vr506. 4, 5, *Potamocypris aff. pallida*; 4, VI, vista externa. Vr517; 5, VD, vista externa. Vr517. 6, 7, *Amnicythere gr. palimpsesta*; 6, VI, vista externa. Vr35; 7, VD, vista externa. Vr16. 8, 9, *Amnicythere* sp. 1; 8, VD, vista externa. Vr77; 9, VI, vista externa. Vr77. 10, *Amnicythere* sp. cf. *A. arevina*, VI, vista externa. Vr74. 11, *Amnicythere aff. incerta*, VI, vista externa. Vr28. 12, *Amnicythere* sp. aff. *A. variabilis*, VD, vista externa. Vr16. 13, *Parakeijia? sp.*, caparazón, vista lateral izquierda. Vr50.

PLATE 4—1, 2, *Cyclocypris taubachensis*; 1, left valve, internal view. Vr116; 2, right valve, internal view. Vr191. 3, *Potamocypris zschokkei*, left valve, external view. Vr506. 4, 5, *Potamocypris aff. pallida*; 4, left valve, external view. Vr517; 5, right valve, external view. Vr517. 6, 7, *Amnicythere gr. palimpsesta*; 6, left valve, external view. Vr35; 7, right valve, external view. Vr16. 8, 9, *Amnicythere* sp. 1; 8, right valve, external view. Vr77; 9, left valve, external view. Vr77. 10, *Amnicythere* sp. cf. *A. arevina*, left valve, external view. Vr74. 11, *Amnicythere aff. incerta*, left valve, external view. Vr28. 12, *Amnicythere* sp. aff. *A. variabilis*, right valve, external view. Vr16. 13, *Parakeijia? sp.*, carapace, left lateral view. Vr50.

Escala = 100 µm. Bar = 100 µm.



derecha sobre la izquierda. En vista interna la zona marginal es estrecha, con el reborde en relieve y con vestíbulo. La superficie de las valvas está recubierta de perforaciones y poros normales de diversos tamaños, distribuidos homogéneamente. Se han encontrado dos morfologías, una ligeramente más alta y otra más comprimida, posiblemente asociadas al dimorfismo sexual.

Distribución.—*Potamocypris zschokkei* está ampliamente distribuida por Europa (Meisch, 2000). Asimismo está presente en la mitad septentrional de la Península Ibérica (Baltanás *et al.*, 1996). *P. zschokkei* es una especie minoritaria en la sección de Villarroya, apareciendo en una muestra de la parte más moderna de la serie (tramo T5).

Edad.—Conocida hasta la fecha desde el Pleistoceno hasta la actualidad, su presencia en Villarroya permite ampliar su rango al Plioceno medio-Reciente.

Subfamilia CYPRINOTINAE Bronshtein, 1947

Género *Heterocypris* Claus, 1892

Heterocypris incongruens (Ramdohr, 1808)

(Lám. 3, Fig. 14)

1808 *Cypris incongruens* Ramdohr, p. 86, Pl. 3 Figs. 1-12, 15, 18, 20.

2000 *Heterocypris incongruens* (Ramdohr), Meisch, pp. 346-351, Fig. 145.

Material.—1 valva de adulto, o juvenil A-1.

Dimensiones.—L = 1,08 mm; H = 0,6 mm.

Descripción.—Contorno subovalado, con los bordes anterior y posterior redondeados. El borde dorsal es convexo y el ventral presenta una convexidad mucho más suave. La máxima altura se sitúa en la zona centro anterior y la máxima longitud en la zona media del caparazón.

En vista interna se observa un escaso desarrollo de las zonas marginales, siendo la anterior más amplia que la posterior. La superficie de la valva presenta una serie de perforaciones muy tenues, que tienden a atenuarse hacia los márgenes de la valva.

Distribución.—*H. incongruens* es una especie muy común en los ambientes continentales, presentando una distribución cosmopolita (Meisch, 2000). En la Península Ibérica aparece asimismo ampliamente representada en materiales recientes (Baltanás *et al.*, 1996). También ha sido descrita en sedimentos del Mioceno inferior de Navarra (Murelaga *et al.*, 1997) y en el Mioceno terminal de Granada (Bekkali *et al.*, 2003). En la sección de Villarroya solamente ha sido registrada en una muestra de la parte media del tramo inferior T1.

Edad.—Conocida previamente desde el Plioceno medio, los nuevos datos nos permiten ampliar este rango hasta el Mioceno-Reciente.

Heterocypris salina (Brady, 1868)

(Lám. 3, Fig. 13)

1868 *Cypris salina* Brady, p. 368, Pl. 28, Figs. 8-13.

2000 *Heterocypris salina* (Brady), Meisch pp. 354-357, Fig. 148.

Material.—129 valvas de adultos y juveniles.

Dimensiones.—L = 0,80-0,92 mm; H = 0,48-0,56 mm (Fig. 4F).

Descripción.—Contorno subtriangular, sobre todo en valva derecha. El borde anterior es redondeado y el posterior más agudo. El borde ventral es rectilíneo y el dorsal presenta un contorno convexo con un ángulo anterior, que da el perfil subtriangular mencionado. La máxima altura es centroanterior y la longitud máxima se sitúa en la zona central.

En vista dorsal se observa cierta asimetría entre la valva derecha e izquierda, dándose una suave superposición dorsal (VI>VD). La valva derecha está comprimida ligeramente en la zona anterior. En ambas valvas se observa una serie de tubérculos restringidos a la zona anterior. En la superficie de las valvas se aprecia una serie de microperforaciones que se hacen más tenues hacia las zonas centrales de las mismas. En vista interna se observan zonas marginales relativamente estrechas y con vestíbulos. En los bordes anterior y posterior de la valva derecha se observa el borde denticulado, característico del género.

Distribución.—Aunque Meisch (2000) asigna una distribución Holártica a esta especie, menciona que aparece solamente en Europa, con introducciones en el hemisferio sur, por lo que debemos considerarla en realidad como especie Paleártica. Baltanás *et al.* (1996) le asignan una distribución Paleártica (Europa, región occidental de Asia y Norte de África). Estos mismos autores señalan la amplia distribución de *H. salina* en el reciente de la Península Ibérica. También ha sido descrita en diversas localidades del Mioceno de las cuencas del Duero, Ebro, Granada y Baleares (Civis *et al.*, 1979, 1989, 1990; Bekkali *et al.*, 2003; Rodríguez-Lázaro y Martín-Rubio, 2003; Rodríguez-Lázaro, *unp.*). En sedimentos pliocenos de la sección de Villarroya, *H. salina* aparece de forma discontinua en los tramos T1 y T2 y más regularmente en el T4.

Edad.—Considerando los datos mencionados, su rango sería de Mioceno-Reciente.

Subfamilia EUCYPRIDINAE Bronshtein, 1947

Género *Eucypris* Vávra, 1891

Eucypris sp. 1

Material.—Varios fragmentos de valvas. La escasez de material apropiado no permite una descripción más completa de esta especie.

Distribución.—En Villarroya solamente la hemos encontrado en algunas muestras de los tramos T1, T3 y T5.

Edad.—Plioceno medio.

Familia ILYOCYPRIDIDAE Kaufmann, 1900

Subfamilia ILYOCYPRIDINAE Kaufmann, 1900

Género *Ilyocypris* Brady y Norman, 1889

Ilyocypris gibba (Ramdohr, 1808)

(Lám. 3, Figs. 4-6)

1808 *Cypris gibba* Ramdohr, p. 91, Pl. 3, 13-14, 17.

2000 *Ilyocypris gibba* (Ramdohr), Meisch, pp. 245-248, Fig. 104.

Material.—90 valvas de ejemplares subadultos y adultos.

Dimensiones.—L = 0,82-0,92 mm; H = 0,44-0,46 mm (Fig. 4G).

Descripción.—Caparazón de contorno subrectangular en vista lateral. Los bordes anterior y posterior son redondeados, el borde dorsal es rectilíneo y con un ángulo posterior casi recto. El margen ventral presenta una concavidad media. La superficie externa de la valva se encuentra cubierta por un reticulado homogéneo, compuesto por celdas redondeadas, delimitadas por una estructura tipo *muri* fina, que dan al reticulado un aspecto marcado y nítido. En ambos bordes anterior y posterior, se observan unos dentículos marginales y unas pequeñas espinas dispuestas a lo largo del margen posterior. En la zona anterodorsal aparecen los dos surcos paralelos típicos del género, que se extienden desde la zona dorsal hasta la central. En ésta encontramos dos tubérculos situados a los lados de los surcos. Estas estructuras únicamente aparecen en algunos ejemplares (morfología *gibba*) mientras que otros carecen de estos tubérculos (morfología *gibba biplicata*, *sensu* Meisch, 2000). En vista interna se observa zonas marginales relativamente estrechas y con vestíbulo.

Distribución.—Especie muy repartida por Europa, Asia, África y América (Meisch, 2000). En el Reciente de la Península Ibérica ha sido descrita en 15 localidades, y además en las Islas Baleares y Canarias (Baltanás *et*

al., 1996). Como fósil, ha sido mencionada en el Mioceno de las cuencas del Duero, Ebro, Granada (Civis *et al.*, 1979, 1989, 1990; Bekkali *et al.*, 2003). En la sección de Villarroya aparece pobremente representada en los niveles superiores de la serie (T4 y T5).

Edad.—Considerando estos datos, el rango temporal de esta especie sería de Mioceno-Reciente.

Género *Qinghaicypris* Huang, 1979

Qinghaicypris riojensis Rodríguez y Martín, 2005

(Lám. 3, Figs. 1-3)

1987 *Ilyocypris bradyi* Sars, 1890. Anadón *et al.*, Pl. 1, Fig. 3.

2005 *Qinghaicypris riojensis* Rodríguez y Martín, Pl. 2, Figs. 1-10.

Material.—4.500 valvas de adultos y subadultos.

Dimensiones.—Adultos hembras: L = 1,09-1,28 mm; H = 0,53-0,71 mm. Adultos machos: L = 0,94-1,18 mm; H = 0,46-0,63 mm (Fig. 4H).

Descripción.—Las hembras presentan un contorno de subrectangular a subovoïdal (L/H = 1,79-2,08). El borde anterior es redondeado y en el posterior se reconoce un ligero ángulo posterodorsal. El borde dorsal es ligeramente sinuoso mientras que el ventral es subrectilíneo. Externamente, en la zona centroanterodorsal se observan dos surcos que se extienden hacia la zona central, por debajo de los cuales se sitúan tres profundas depresiones, dispuestas en forma triangular. La depresión posterior es más grande que el resto y estaría asociada a los músculos aductores centrales, mientras que las otras dos corresponderían a huellas de los músculos mandibulares.

Las valvas muestran un reticulado de celdillas subpoligonales distribuidas homogéneamente, que dan el aspecto de finas perforaciones. En el *muri* de estas celdillas se disponen numerosas microporaciones, solamente observables con grandes aumentos; además hay numerosos poros normales intramurales. En el borde anterior se puede observar una densa hilera de finos dentículos marginales, que se hacen más espaciados en los bordes ventral y posterior.

Los machos son más pequeños y elongados (L/H = 1,82-2,15) que las hembras y en vista externa se diferencian de ellas por la presencia de una zona plana en el área posterodorsal. En vista interna, esta zona plana está ocupada por tres huellas de los conductos seminíferos, visibles en algunos especímenes (ver Lám. 3, Fig. 1). En las muestras estudiadas los machos y las hembras aparecen en proporciones muy similares (ratio H/M = 1,04). La zona marginal es estrecha, con

un pequeño vestíbulo anterior. Los canales de poros marginales son estrechos y muy numerosos (48-56). La charnela es simple, de tipo adonta modificada.

Distribución.—Esta especie, descrita en esta sección por Rodríguez-Lázaro y Martín-Rubio (2005), presenta una distribución peri-Mediterránea septentrional. En la sección de Villarroya aparece abundantemente en la parte inferior de la serie, a lo largo de los tramos T1, T2 y T3.

Edad.—Plioceno medio-Pleistoceno inferior.

Superfamilia CYTHEROIDEA Baird, 1850

Familia LEPTOCYTHERIDAE Hanai, 1957

Subfamilia LEPTOCYTHERINAE Hanai, 1957

Género *Amnicythere* Devoto, 1965

Amnicythere sp. cf. *A. arevina* (Livental) sensu Olteanu, 1989
(Lám. 4, Fig. 10)

1989 *Amnicythere arevina* (Livental), Olteanu, p. 724, Pl. 4, Fig. 7.

No 1989 *Amnicythere arevina* (Livental), Stancheva, p. 20, Pl. 7, Fig. 1.

Material.—435 valvas fragmentadas de adultos y juveniles.

Dimensiones.—L = 0,53-0,55 mm; H = 0,30-0,32 mm.

Descripción.—Contorno de subtrapezoidal a subtriangular, con el borde anterior redondeado y el posterior rectilíneo. El borde posterior es más agudo que el anterior; en vista dorsal ambos bordes se encuentran ligeramente comprimidos. El borde dorsal es rectilíneo, limitado anteriormente por un prominente tubérculo ocular y posteriormente por una orejeta (VI). El borde ventral es cóncavo. La superficie de la valva está recubierta por celdillas poligonales, más elongadas en la zona centrodorsal (VI). La máxima longitud se sitúa en la zona central y la altura máxima en la zona anterior, a nivel del tubérculo ocular. Internamente se observa una charnela (VI) anfidonta con la barra mediana lisa. La zona marginal es muy ancha, sobre todo la anterior, y contiene un amplio vestíbulo. El tubérculo de cierre de las valvas “snap pit”, típico del género, se localiza en el borde centroventral. Se ha observado una cierta variabilidad en el desarrollo del tubérculo ocular así como en la reticulación, que en algunos individuos es más cerrada, presentando algunas zonas lisas.

Observaciones.—Esta especie de Villarroya es comparable a *Leptocythere arevina* (Livental) sensu Olteanu, 1989, del Pontiense superior (Mioceno termi-

nal) de la Cuenca Dácica. *Leptocythere* (*A.*) *servica* Krstić (in Olteanu, 1989), del mismo material, difiere de nuestra especie por la presencia de un retículo marginal anterior y posterior, así como en un tubérculo central más marcado. *Amnicythere arevina*, sensu Stancheva, 1989, del Pleistoceno del Mar Negro, es claramente diferente de nuestra especie, de la que se diferencia por un contorno más cuadrangular y una distinta reticulación.

Distribución.—Hasta el presente ha sido solamente descrita en el Mioceno terminal de la Cuenca Dácica (Rumania, Olteanu, 1989). En Villarroya aparece exclusivamente en niveles superiores de la unidad inferior A1.

Edad.—Messiniense-Plioceno medio.

Amnicythere aff. *A. incerta* Olteanu 1995
(Lám. 4, Fig. 11)

1995 *Amnicythere incerta* Olteanu, p. 354, Pl. 21, Figs. 1-10.

Material.—503 valvas adultos y juveniles.

Dimensiones.—L = 0,58-0,60 mm; H = 0,30-0,32 mm (Fig. 4P).

Descripción.—En vista lateral presenta un contorno subrectangular con los bordes anterior y posterior redondeados, si bien en este último se diferencia una clara orejeta posterodorsal (VI). El borde dorsal es rectilíneo y el ventral ligeramente cóncavo. La máxima longitud se sitúa en la zona media de la valva y la altura máxima en la anterior. En vista dorsal se observa que los bordes anterior y posterior están comprimidos. En vista interna se observan zonas marginales bien desarrolladas, sobre todo en el margen anterior. Externamente, las valvas presentan una reticulación compleja, que se atenúa en los bordes anterior y posterior. El retículo está compuesto por celdas poligonales irregulares que contienen otras celdillas redondeadas, con poros simples en su interior. En la zona central de la valva las celdas son más elongadas, formando una estructura compleja.

Observaciones.—Esta especie difiere de *Amnicythere incerta* Olteanu del Mioceno de la Cuenca Dácica (Olteanu, 1995), por presentar un borde dorsal más rectilíneo. *Leptocythere* (*L.*) aff. *ultima tuberculata*, del Mioceno superior de Rumanía (Olteanu, 1989) presenta una morfología externa totalmente comparable con nuestra especie, de la que difiere aparentemente solo en un menor tamaño (L = 0,40 mm). *A.* sp. cf. *A. arevina* difiere de esta especie por un contorno más subtrapezoidal y el fuerte tubérculo ocular.

Distribución.—En la sección de Villarroya esta especie aparece regularmente en las muestras de los tramos T1 y T2.

Edad.—Plioceno medio.

Amnocythere gr. *palimpsesta* (Livental, 1929)
(Lám. 4, Figs. 6-7)

1929 *Cythere palimpsesta* Livental, p. 15, Pl. 1, Figs. 3-4.

1961 *Leptocythere palimpsesta* (Livental), Agalarova *et al.*, Pl. 60, Fig. 3.

1989 *Amnocythere palimpsesta* (Livental), Krstić & Stancheva, Pl. 13, Figs. 6-7.

1989 *Leptocythere* (*Amnocythere*) *palimpsesta* (Livental), Olteanu, Pl. 7, Figs. 7-8.

1999 *Leptocythere* (*Amnocythere*) *palimpsesta* (Livental), Gliozzi, p. 197, Pl. 1, Fig. e.

Material.—657 valvas fragmentadas de adultos y juveniles.

Dimensiones.—L = 0,57 mm; H = 0,29-0,32 mm (Fig. 4J).

Descripción.—Contorno subrectangular con los bordes anterior y posterior redondeados y ligeramente comprimidos en vista dorsal. El borde ventral es marcadamente cóncavo y el dorsal, sinuoso. El tubérculo ocular no sobresale del perfil anterodorsal, si bien se reconoce por una zona lisa en esta posición. En el extremo posterodorsal se observa una pequeña orejeta. En vista interna presenta unas zonas marginales bien calcificadas y con máximo desarrollo en la zona anteroventral. Externamente, se aprecia un retículo poligonal regular de celdas profundas, algo más deformadas en la zona central, que corresponde a las huellas musculares.

Observaciones.—Nuestro material es similar al descrito por Agalarova *et al.* (1961) en el Plioceno de Azerbayán, si bien no es posible establecer una comparación estricta debido a la mala calidad de la reproducción del material azerbaiyano. Los ejemplares descritos por Olteanu (1989) en el Pontense (Mioceno Terminal) de Rumanía difieren de los nuestros por poseer un marcado tubérculo ocular. Por otro lado, los descritos por Gliozzi (1999; Messiniense, Italia) y por Krstić & Stancheva (1989; Pontense, Serbia) presentan un borde dorsal más rectilíneo que la especie de Villarroya. *A. sp. cf. A. arevina* y *A. aff. incerta* se diferencian de esta especie en el contorno y el tipo de reticulación.

Distribución.—*Amnocythere palimpsesta* es conocida fósil en el Messiniense terminal de diversas localidades de Italia y Francia y viva en el Mar Caspio

(Gliozzi, 1999). En Villarroya aparece regularmente en las muestras de los tramos T1 y T2.

Edad.—*Amnocythere* gr. *palimpsesta* aparece en el Plioceno medio.

Amnocythere sp. aff. *A. variabilis* Olteanu, 1989
(Lám. 4, Fig. 12)

1989 *Leptocythere* (*Amnocythere?*) *variabilis* Olteanu, pp. 141-142, Pl. 21, Figs. 5-6.

Material.—20 valvas de adultos y juveniles.

Dimensiones.—L = 0,49-0,51 mm; H = 0,20-0,23 mm.

Descripción.—Contorno subrectangular elongado. Bordes anterior redondeado y el posterior más agudo. El borde dorsal es rectilíneo y el ventral, con fuerte concavidad media. La máxima altura se mide en la zona anterior y la máxima longitud, en la zona central. El borde anterior se ve fuertemente comprimido en vista dorsal. La superficie de la valva está recubierta por una somera reticulación, con celdillas poligonales más marcadas hacia la zona posterior. En la zona anterior se observan celdillas poligonales muy difusas, con un micropunteado en su interior.

Observaciones.—Esta especie recuerda morfológicamente a *L. (A.?) variabilis* descrita por Olteanu (1989) en el Pontense superior de Rumanía. Sin embargo, se diferencia claramente de ella en un mayor tamaño, el contorno más elongado y detalles en la ornamentación. *Leptocythere* (*Amnocythere*) *sinegubi* Krstić, descrita por Olteanu (1989) en el Mioceno superior de Rumanía, presenta individuos juveniles muy parecidos morfológicamente a nuestra especie, aunque se pueden diferenciar por detalles de la ornamentación. *Leptocythere* (*Euxinocythere*) *palimpsesta* (Livental), del mismo material rumano, difiere de nuestra especie por un reticulado más regular. Las especies de *Amnocythere* descritas previamente en este trabajo, difieren de *A. aff. variabilis* en el contorno menos elongado y el tipo de reticulación.

Distribución.—En la sección de Villarroya, aparece en algunas muestras aisladas de los tramos T1 y T2.

Edad.—Plioceno medio.

Amnocythere sp. 1
(Lám. 4, Figs. 8-9)

Material.—53 valvas de individuos adultos y juveniles.

Dimensiones.—L = 0,52-0,55 mm; H = 0,34-0,35 mm.

Descripción.—En vista lateral posee un contorno subtriangular, con el borde anterior fuertemente redondeado, terminando superiormente en un abultado tubérculo ocular. El borde posterior es rectilíneo y subvertical. El borde dorsal es rectilíneo y el ventral fuertemente cóncavo. Es la zona anterior se registra la máxima altura, mientras la máxima longitud se sitúa en posición media del caparazón. En vista dorsal, los extremos anterior y posterior están fuertemente comprimidos. En vista interna se observan zonas marginales bien calcificadas y desarrolladas sobre todo en el lado anterior. En vista externa, esta especie muestra una superficie lisa, donde apenas se distingue una tenue reticulación en el área posterior, mientras que unas finas perforaciones recubren las zonas anterior y dorsal de las valvas.

Observaciones.—Esta especie recuerda morfológicamente al grupo *Amnocythere cymbula/propinqua* (Livental), conocida desde el Plioceno hasta la actualidad en el Paratethys, aunque pueden diferenciarse claramente por el contorno. *Amnocythere* sp. 1 se diferencia de las otras especies de *Amnocythere* descritas en este trabajo, en el perfil anterior y en la práctica ausencia de ornamentación externa de sus valvas.

Distribución.—Esta especie aparece exclusivamente en las muestras superiores de los tramos T1 y T2 de la sección de Villarroya.

Edad.—Plioceno medio.

Familia PECTOCYtheridae (Hanai, 1957)
 Género *Parakeijia* (Howe & McKenzie, 1989)
Parakeijia? sp.
 (Lám. 4, Fig. 13)

Material.—1 caparazón.

Dimensiones.—L = 0,46 mm; H = 0,20 mm.

Descripción.—Contorno arriñonado con los bordes anterior y posterior redondeados. Borde dorsal ligeramente convexo y el ventral ligeramente cóncavo. La superficie de la valva aparece cubierta por un retículo muy somero, con celdillas subredondeadas y con costillas concéntricas en los lados anterior y posterior. La máxima altura se sitúa en la zona central, y la máxima longitud en la zona media del caparazón.

Observaciones.—Debido al escaso material del que se dispone, no ha sido posible asignar esta morfología a una especie concreta. *Parakeijia* sp., descrita en una plataforma arrecifal somera actual de Bali (Indonesia; Mostafawi *et al.*, 2005), presenta una morfología externa similar a nuestra especie, de la que se diferencia por un mayor desarrollo de las costillas concéntricas anteriores y posteriores.

Distribución.—Solamente hemos encontrado un ejemplar en los tramos T1 y T2 de la sección de Villarroya.

Edad.—Plioceno medio.

Suborden DARWINULOCOPINA Sohn, 1988
 Superfamilia DARWINULOIDEA Brady y Norman, 1889
 Familia DARWINULIDAE Brady y Norman, 1889
 Género *Darwinula* Brady y Robertson, 1885
Darwinula stvensoni (Brady y Robertson, 1870)
 (Lám. 1, Fig. 1)

1938 *Darwinula stvensoni* (Brady y Robertson), Klie, p. 147, Figs. 492-493.

1968 *Darwinula stvensoni* (Brady y Robertson), Bhatia, p. 470, Pl. 3, Fig. 5; Pl. 5, Fig. 13.

1990 *Darwinula stvensoni* (Brady y Robertson), Henderson, pp. 46-47, Fig. 16.

2000 *Darwinula stvensoni* (Brady y Robertson), Meisch, pp. 49-52, Fig. 16.

Material.—2 valvas de individuos, adulto y subadulto.

Dimensiones.—L = 0,62 mm; H = 0,26 mm.

Descripción.—Caparazón de contorno ovalado con el lado posterior muy redondeado y el lado anterior más agudo. Los bordes dorsal y ventral son rectilíneos y subparalelos. La máxima altura se sitúa en la zona centroposterior y la máxima longitud es central. La superficie del caparazón es lisa.

Distribución.—*D. stvensoni* es una especie cosmopolita, con la excepción de la Antártida y el subcontinente Indio (Griffiths y Butlin, 1994). Ha sido descrita en varias localidades de la Península Ibérica e Islas Baleares (Baltanás *et al.*, 1996; Horne *et al.*, 1998) así como en el lago Caicedo de Yuso/Arreo (Martín Rubio *et al.*, 2002). En el Plioceno de Villarroya aparece en dos muestras aisladas de los tramos T1 y T2.

Edad.—*Darwinula* es uno de los géneros de ostrácos con registro temporal más amplio, habiendo sido descrito desde el Devónico superior hasta la actualidad. *D. stvensoni* se conoce desde el Oligoceno medio.

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ANÁLISIS PALINOFAICIAL DE SEDIMENTOS ACTUALES EN LA CUENCA INFERIOR DEL RÍO QUEQUÉN SALADO, PROVINCIA DE BUENOS AIRES. ARGENTINA. PRIMEROS RESULTADOS

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Resumen

Con la finalidad de realizar estudios comparativos con secuencias polínicas cuaternarias se efectuó el análisis palinofacial de muestras superficiales en la cuenca inferior del río Quequén Salado, provincia de Buenos Aires, Argentina (38°S/60°W). Dichas muestras fueron tomadas en siete ambientes caracterizados por sus comunidades vegetales: dunas móviles, dunas semi-fijas, dunas fijas, depresiones entre dunas, cuerpo lagunar, comunidades forestales y la llanura aluvial. El análisis palinofacial permitió determinar seis Palinofacies. Dentro del grupo palinomorfos, los espectros polínicos reflejaron principalmente las comunidades vegetales “locales” y “extra-locales”, registrándose en todas ellas la presencia de componentes “regionales” y “extra-regionales”. Las dunas móviles resultaron palinológicamente estériles. La Palinofacies 1 (dunas semi-fijas) consistió en materia orgánica muy oxidada y un espectro polínico dominado por *Tamarix gallica*. La Palinofacies 2 (dunas fijas) dominada por fitoclastos mostró evidencias de importante oxidación biológica y una asociación polínica caracterizada principalmente por *Poaceae* y *Asteraceae*, con influencia de árboles introducidos (*Pinaceae*). La Palinofacies 3 (depresión entre dunas) con predominio de fitoclastos sobre materia orgánica amorfa, registró mayor actividad biológica que la Palinofacies 2. El espectro polínico asociado reflejó la cobertura vegetal típica de estos ambientes *Asteraceae* y *Poaceae*. La Palinofacies 4 (cuerpo lagunar) consistió en materia orgánica amorfa (derivada de plantas terrestres y acuáticas) en igual proporción que los fitoclastos. El espectro polínico reflejó la vegetación que crece en las proximidades de la laguna (*Asteraceae* y *Poaceae*) y la que crece en/o dentro del agua (*Cyperaceae*, *Juncaceae*, *Thypha* sp., etc.). La Palinofacies 5 (comunidades forestales) con mayor proporción de fitoclastos en relación a la materia orgánica amorfa denota fuerte oxidación biológica y un espectro polínico dominado por *Myrtaceae*. La Palinofacies 6 (llanura aluvial) registró escasa proporción de granos de polen, asociada a un considerable deterioro del material. La acción antrópica (por cultivo y forestación) se refleja tanto en la vegetación como en los espectros polínicos.

Palabras clave: Palinofacies, Muestras de Superficie, Río Quequén Salado, Provincia de Buenos Aires, Argentina.

Abstract

With the purpose of obtaining modern analogous for Quaternary pollinic sequences the palynofacial analysis of surface samples was made in the low basin of Quequén Salado river, Buenos Aires province, Argentina (38°S/60°W). These samples were taken in seven environments characterized by their vegetable communities: mobile dunes, semi-fixed dunes, fixed dunes, interdune ponds, lacustrine body, forest wood and the alluvial plain. The palynofacial analysis allowed to determine six Palynofacies. Inside the palynomorph group, the pollinic spectrum reflected mainly the “local” and “extra-local” vegetable communities, registering in all them the presence of “regional” and “extra-regional” components. The mobile dunes were sterile palynologically. The Palynofacies 1 (semi-fixed dunes) consisted on oxidized organic matter and a pollinic spectrum dominated by *Tamarix gallica*. The

Palynofacies 2 (fixed dunes) dominated by phytoclasts showed evidences of important biological oxidation and a pollinic association characterized by Poaceae and Asteraceae, with influence of introduced forest (Pinaceae). The Palynofacies 3 (interdune ponds) dominated by phytoclasts, registered bigger biological activity than the Palynofacies 2. The associated pollinic spectrum reflected the typical vegetable covering of these environments Asteraceae and Poaceae. The Palynofacies 4 (lacustrine body) consisted on amorphous organic matter (derived of terrestrial and aquatic plants) in same proportion that the phytoclasts. The pollinic spectrum reflected the vegetation that grows next to the lagoon (Asteraceae and Poaceae) and the one that grows in its borders and/or inside the water (Cyperaceae, Juncaceae, *Thypha* sp., etc.). The Palynofacies 5 (forest wood) dominated by phytoclasts it has more than enough amorphous organic matter denotes strong biological oxidation and a pollinic spectrum dominated by Myrtaceae. The Palynofacies 6 (alluvial plain) registered scarce proportion of pollen grains, associated to a considerable deterioration of the material. The anthropic influence (agriculture/forestation) is reflected as much in the vegetation as in the pollinic spectrum.

Key words: Palynofacies, Surface Samples, Quequén Salado River, Buenos Aires Province, Argentina.

INTRODUCCIÓN

Perfiles estratigráficos del Pleistoceno tardío/Holoceno en las cuencas inferior (Grill, 2003) y media (Grill, en realización) del río Quequén Salado, provincia de Buenos Aires (Argentina), están siendo estudiados a partir de su contenido palinológico.

Es sabido que las reconstrucciones ambientales de las secuencias polínicas cuaternarias, pueden mejorar a medida que aumenta el conocimiento sobre las relaciones vegetación-polen actual (Birks y Birks, 1980). Diversos autores, entre ellos Prentice (1985), Moseholm *et al.* (1987), han elaborado modelos de dispersión polínica demostrando la alta relación entre un determinado espectro polínico con las fuentes locales de emisión del mismo y en menor medida su relación con fuentes regionales y extra regionales. Esto indica que en general los espectros polínicos reflejan la vegetación circundante.

No obstante, diversos factores inciden en la relación cuantitativa polen-vegetación (diferencias en la producción, floración, dispersión, distancia a la fuente emisora, abundancia y distribución espacial de las mismas, caracteres específicos incidentes en el transporte del polen, así como factores meteorológicos). En consecuencia, ello determina que la abundancia de las asociaciones polínicas actuales no se traslade directamente como abundancia de la vegetación en las secuencias fósiles (Prentice, 1988).

Con la finalidad de realizar estudios comparativos con las secuencias palinológicas cuaternarias mencionadas en la cuenca del río Quequén Salado, se ha inicia-

do el estudio palinofacial de sedimentos actuales en su cuenca inferior.

Según Traverse (1994), cuando una asociación de palinomorfos/restos asociados ("palynodebris") es considerada como un todo, provee información tanto de la biosfera que produce las partículas fósiles como del ambiente en el cual se originó la roca. El término "palinofacies" fue creado por Combaz (1964) para la materia orgánica contenida en las rocas sedimentarias, refiriéndose tanto a los ambientes sedimentarios de depósito como a los elementos de la biosfera producidos. Según Traverse (1994), cuando los estudios palinológicos se aplican a la determinación de las relaciones entre concentraciones de palinomorfos y asociaciones de la biosfera tales como tipos de vegetación, podría utilizarse el término "palinobiofacies". Del mismo modo, el término "palino-biolitofacies" alude al uso de las asociaciones polínicas para interpretar el origen de distintos tipos de rocas sedimentarias. Si bien lo antedicho corresponde a análisis palinofaciales fósiles, los conceptos pueden extrapolarse a estudios actuales, y particularmente, en el presente trabajo se aplican los términos "palinobiofacies" (cuando se alude a la relación polen-vegetación) y "palino-biolitofacies", cuando se analizan los espectros polínicos registrados en relación a los distintos ambientes o litologías involucradas.

El presente trabajo constituye la primer contribución al conocimiento de las palinofacies en sedimentos actuales de la cuenca del río Quequén Salado y representa una primer etapa dentro de un proyecto que involucra el estudio de mayor número de muestras.

En la provincia de Buenos Aires son limitadas las contribuciones sobre estudios palinológicos en sedimentos actuales. Las mismas corresponden a: Prieto (1992, 1996), Borromei y Quattrocchio (1990), Grill y Guerstein (1995). Por otra parte, trabajos en ambientes de dunas costeras corresponden a Fontana (2003 y 2005) y Stutz y Prieto (2003).

CARACTERÍSTICAS GENERALES DEL ÁREA DE ESTUDIO

La cuenca del río Quequén Salado está ubicada al suroeste de la provincia de Buenos Aires, entre las cuencas de los ríos Sauce Grande al oeste y Claromecó al es-

te (Fig. 1). Atraviesa una región agrícola-ganadera muy importante de la República Argentina: la región pampeana. Recibe aportes tanto de ríos y arroyos que provienen desde la Sierra Pillahuincó como desde el área comprendida entre los sistemas de Ventania y Tandilia. Después de recorrer 162 km desemboca en el océano Atlántico y forma un estuario.

El área de estudio se localiza en la cuenca inferior del río Quequén Salado, entre los $38^{\circ}50' - 38^{\circ}56' S$ y $60^{\circ}31' - 60^{\circ}32' W$. De las siete muestras estudiadas, cinco de ellas se tomaron en las proximidades del balneario Marisol. El mismo está emplazado en el área adyacente al estuario y sobre el margen derecho del río, a 22 km al sur de la localidad de Oriente y aproximadamente a 1,5 km de la desembocadura del río en el océano

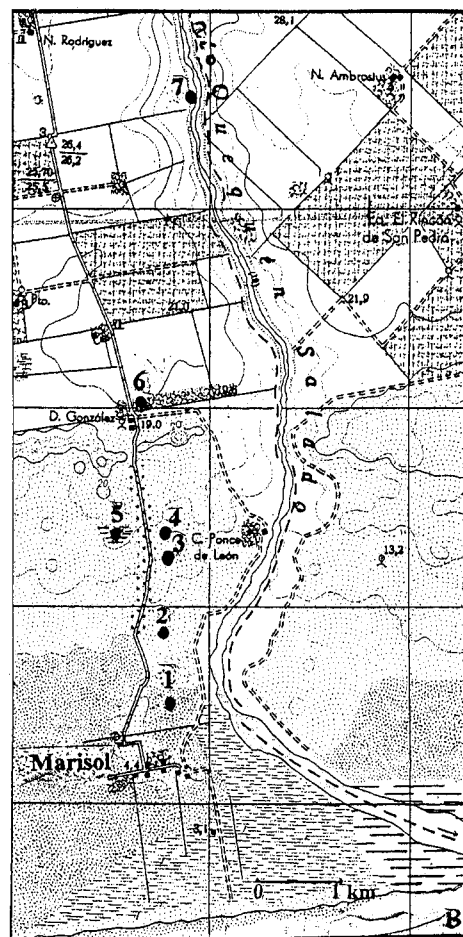
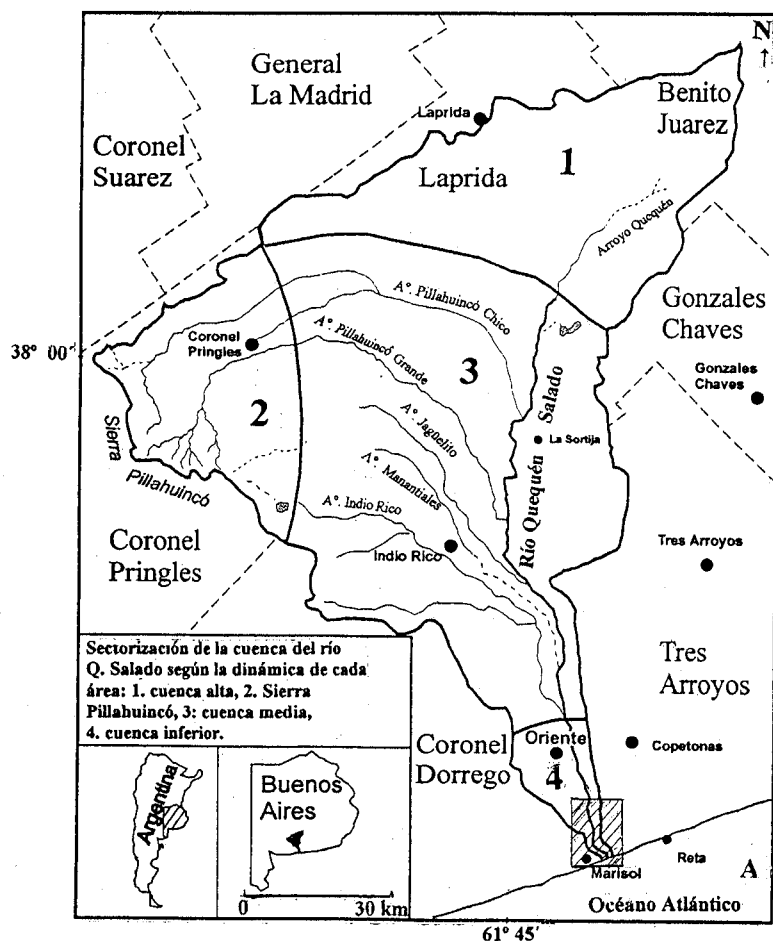


FIGURA 1—A: mapa de ubicación del área de muestreo (modificado de Marini, 2002). B: ubicación de muestras superficiales: 1, dunas vivas; 2, dunas semi-vegetadas; 3, dunas fijas; 4, depresión entre dunas; 5, cuerpo lagunar; 6, comunidades forestales; 7, llanura aluvial.

FIGURE 1—Falta traducción.

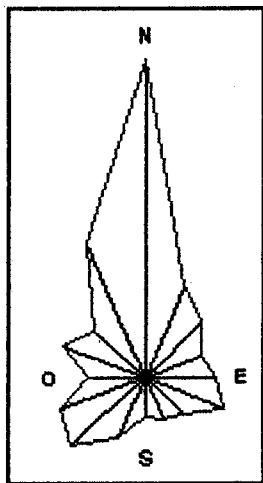


FIGURA 2—Rosa de los vientos —balneario Marisol— período 1995/1999 (extraída de Marini, 2002).

FIGURE 2—Falta traducción.

Atlántico (Fig. 1). Tres cordones de dunas cubren el sector costero: dunas móviles y semi-fijas, adyacentes a la playa y dunas fijas, asociadas a depresiones formadas entre las mismas. Cuerpos lagunares se registran hacia el continente.

Respecto a las condiciones climáticas, el área pertenece a la zona de los climas templados, caracterizados por registrar valores extremos de temperatura con una clara diferenciación de las cuatro estaciones durante el transcurso del año.

Con relación a la circulación general de los vientos, los de dirección NE-SW atraviesan la provincia de Buenos Aires durante todo el año. Ello es consecuencia de la actividad del anticiclón semi-permanente del Atlántico sur y el Anticiclón del Pacífico sur. Son vientos cálidos, originados por los retrocesos ocasionales del anticiclón del Pacífico (Burgos, 1968).

De acuerdo con la rosa de los vientos período 1995/1999 —Balneario Marisol— (Fig. 2), los predominantes son los del sector Norte (21,9%), con velocidades medias de 15,8 km/hora, seguidos por los del Norte-Noroeste (9,9%), con velocidades medias de 16,8 km/hora. Los del sector Sur y Oeste presentan menos frecuencia pero mayores velocidades medias: 23,3 km/hora (Oeste) y 26,5 km/hora (Oeste-Suroeste), registrándose máximas de hasta 133 km/hora. La consecuencia directa de la acción de los mismos, durante las décadas del 1980/1990, fue el avance de las dunas vivas y el abandono de viviendas, cubiertas por la arena, por parte de pobladores del balneario Marisol. Los vientos del sector Este son menos frecuentes y no presentan velocidades

altas. Aunque se han registrado ráfagas importantes durante el verano, el porcentaje total de calmas es muy bajo (1,1%), típico de zonas costeras (Marini, 2002)

La precipitación media para la cuenca del río Quequén Salado, de acuerdo al promedio matemático obtenido entre cuatro localidades circundantes, es de 819,2 mm (período 1981/1990) (Marini, 2002). Para el sector del Balneario Marisol (período 1995/1999) la media anual es de 668,6 mm, registrándose los valores máximos durante el mes de enero (promedio: 115,5 mm) y los mínimos durante el mes de agosto con 13,1 mm.

La temperatura media anual del sector del estuario y del balneario Marisol (período 1995/1999) es de 14,8 °C, las temperaturas máximas absolutas registradas para ese período fueron de 40,8 °C en verano y 22,3 °C en invierno y las mínimas absolutas de 3,9 °C y 10,6 °C para el invierno y verano respectivamente (Fig. 3).

Según Cabrera (1976), desde el punto de vista fitogeográfico, la provincia de Buenos Aires pertenece a la Región Neotropical, con un área pequeña ocupada por el Dominio Amazónico y el resto cubierto por el Dominio Chaqueño. Este último se halla representado por las provincias del Monte, del Espinal y Pampeana. El área de estudio corresponde a la Provincia Pampeana (Distrito Pampeano Austral).

MATERIALES Y MÉTODOS

La colección de las muestras de superficie fue realizada previa identificación en el terreno de los ambientes a caracterizar. El posicionamiento de cada una fue realizado mediante un GPS ETREX.

Los relevamientos de la vegetación actual consistieron en censos de las diferentes comunidades, registrán-

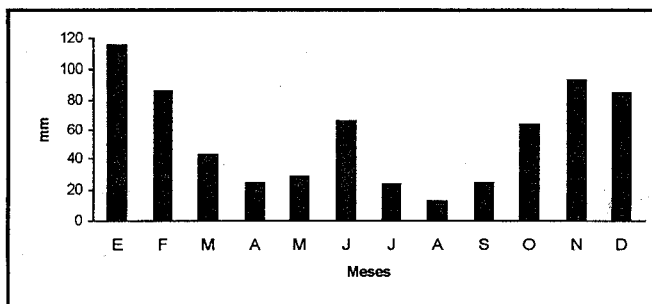


FIGURA 3—Distribución mensual de las precipitaciones —balneario Marisol— período 1995/1999 (extraída de Marini, 2002).

FIGURE 3—Falta traducción.

dose las especies con mayor frecuencia y abundancia (Braun-Blanquet, 1950). Las figuras 4 y 5 muestran la vegetación de dos ambientes: dunas móviles y el cuerpo lagunar.

Para efectuar el análisis palinofacial en cada unidad de vegetación se tomaron muestras de acuerdo con Adam y Merhinger (1975). Las mismas consistieron en 5 sub-muestras recogidas en los 0,5 cm superficiales del terreno. El área involucrada en cada caso fue de 10 x 10 cm. Previo secado y homogeneización en un mortero, 10 a 20 gramos de cada una de ellas, se utilizaron para el análisis polínico. La concentración de los palinomorfos fue realizada de acuerdo a la metodología de Heusser y Stock (1984). El análisis palinofacial fue realizado después del tratamiento con HCl y HF sobre residuos sin oxidar ni acetolizar, con la finalidad de no alterar la fluorescencia de las partículas ricas en hidrógeno. De acuerdo con Batten (1996), los residuos después del tratamiento con los ácidos contienen, comúnmente, importantes cantidades de materia orgánica amorfa, del tipo finamente dividido, cuyo tamaño no supera los 10 μm . El uso de filtros de 5 o 10 μm produce un preparado más limpio, sin embargo, cuando el finamente dividido constituye el único tipo de materia orgánica amorfa presente, la remoción de estos residuos puede conducir a la ausencia de este tipo de información. Siguiendo este criterio, las muestras estudiadas en el presente trabajo no fueron filtradas con mallas de 10 μm .

Los palinomorfos fueron examinados bajo luz transmitida y la materia orgánica palinológica total bajo luz transmitida y ultravioleta. En ambos casos, se utilizó un microscopio Olympus BH2 N.º 100786. La luz ultravioleta permitió analizar la intensidad de fluorescencia relativa de la materia orgánica palinológica.

Para la determinación de los palinomorfos, en parte se utilizó material de las plantas parentales recogidas durante el muestreo. En algunos casos, esto permitió llegar a asignaciones genéricas o a nivel de especie. También se utilizó el material de referencia de la Palinoteca del Laboratorio de Palinología (U.N.S) y las obras de Heusser (1971), Markgraf y D'Antoni (1978), Hooghiemstra (1984), entre otros, fueron utilizadas para completar las identificaciones. En el caso de las esporas de hongos y algas fueron consultados van Geel *et al.* (1982/1983), Hooghiemstra (1984) y Kalgutkar y Jansonius (2000).

Se contaron como mínimo 200 granos de polen por muestra. Las esporas de hongos y algas no fueron consideradas en el conteo. La muestra 7 (llanura aluvial) registró menos de 100 granos de polen, en consecuencia no se efectuaron cálculos porcentuales de los taxo-

nes registrados. En la Fig. 6 se ilustra el diagrama polínico porcentual de las muestras estudiadas.

Para efectuar el análisis palinofacial se siguió el trabajo de Tyson (1995). Batten (1996) fue utilizado para complementar el estudio de la materia orgánica amorfa. Según Tyson (1995) la materia orgánica palinológica comprende los grupos: materia orgánica amorfa, fitoclastos, zooclastos y palinomorfos. Los zooclastos (material derivado de animales) en este trabajo se caracterizaron por escasos e inidentificables restos, por ello no se mencionan. La materia orgánica amorfa y los fitoclastos fueron examinados visualmente en 5 puntos del preparado palinológico con el objetivo de 20x y estimadas sus frecuencias relativas independientemente del resto de los palinomorfos, de acuerdo con Batten (1996).

El estado de preservación de la materia orgánica palinológica fue determinado siguiendo el criterio propuesto por Delcourt y Delcourt (1980). De las 5 categorías establecidas por estos autores, en el presente trabajo fueron identificadas 3: corrosión, por actividad biológica, degradación, por actividad química y daño mecánico, granos rotos o con espinas gastadas. En la Lám. 1 se ilustran microfotografías de las palinofacies.

RESULTADOS

Vegetación

De acuerdo con los censos de vegetación efectuados en la cuenca inferior del río Quequén Salado, se determinaron 56 especies, de las cuales 37 son nativas y el resto introducidas (Tabla 2). Dichos censos permitieron reconocer la estepa herbácea psamófila definida por Verettoni (1965) para el área de Bahía Blanca. La misma está integrada por diversas especies nativas e introducidas que colonizan las dunas costeras. A medida que dichas dunas avanzan desde la costa marina hacia el continente, son fijadas progresivamente por la vegetación. La estepa de gramíneas desarrollada sobre suelos arenosos está constituida principalmente por diversas especies del género *Stipa*, junto a matorrales aislados de *Discaria americana* y *Lycium chilense*. También en dirección al continente son comunes comunidades forestales introducidas por el hombre hace algo más de medio siglo (comunicación personal de un poblador del lugar). Las comunidades presentes en la planicie de inundación actual del río Quequén Salado se hallan muy alteradas a causa del pastoreo y otros factores antrópicos, como el cultivo de cereales y forrajeras.

Dunas móviles

Constituyen el cordón más cercanos al mar. En ellas las especies pioneras son: *Calycera crassifolia*, *Sporobolus rigens* y *Cortaderia selloana*.

Dunas semi-fijas

En estos cordones de dunas fijados parcialmente por la vegetación, dominan la especie introducida *Tamarix gallica*, asociada a *Sporobolus rigens*, *Cortaderia selloana*, *Spartina coarctata*, *Poa lanuginosa*, *Senecio quequensis*, *Solidago chilensis*, *Oenothera mollissima* y *Parapholis incurva*, frecuente además en estepas halófilas.

Dunas fijas

Se destacan *Hyalis argentea*, *Solidago chilensis*, *Achyrocline satureioides*, *Poa lanuginosa* y *Pinus radiata* (especie arbórea introducida).

Depresiones entre dunas

Las comunidades vegetales de estas depresiones están representadas por *Juncus acutus*, *Sporobolus rigens*, *Panicum urvilleanum*, *Cortaderia selloana*, *Lagurus ovatus*, *Hydrocotyle bonariensis*, *Lactuca serriola*, *Melilotus albus* y *Sesuvium portulacastrum*, frecuente asimismo en estepas halófilas.

Cuerpos lagunares

Las comunidades vegetales que caracterizan a dichos cuerpos están integradas por *Juncus acutus*, *Cortaderia selloana*, *Thypha* sp. y *Zygnemataceae*. Los bordes de la laguna están colonizados por *Scyrpus olneyi*, *Hydrocotyle bonariensis*, *Melilotus albus*, *Ambrosia tenuifolia*, *Myoporum laetum*, *Populus* sp. y *Acacia longifolia*, las tres últimas especies son árboles introducidos.

Comunidades forestales

La cobertura vegetal en este caso está representada por árboles como: *Eucalyptus camaldulensis* y *Eucalyptus tereticornis*, *Cupressus macrocarpa*, *Pinus radiata* y *Pinus halepensis*, todos ellos exóticos en la zona. En el estrato herbáceo, habitan *Oxalis corniculata* y *Oxalis articulata*, *Geranium dissectum* y *Glandularia pulchella*. Completan la asociación diversas especies del género *Stipa*, junto a matorrales aislados de *Discaria americana* y *Lycium chilense*.

Llanura aluvial del río Quequén Salado

La vegetación natural de este ambiente ha evidenciado notables cambios por causa del pastoreo y cultivo. Entre las especies más difundidas están *Lolium mul-*

tiflorum, *Festuca arundinacea*, *Thinopyrum ponticum*, *Juncus microcephalus* y *Scyrpus olneyi*, junto a malezas adventicias como *Cynara cardunculus* y *Cirsium vulgare*.

ANÁLISIS PALINOFACIAL

La muestra 1 (dunas móviles) (Fig. 4), que resultó palinológicamente estéril, pertenece al cordón más próximo a la costa. Estas dunas constituyen ecosistemas deficientes en nutrientes y en capacidad de almacenamiento de agua, estando sujetas al constante “spray” salino, como consecuencia de los vientos procedentes del sector costero (Fontana, 2005). De allí su incapacidad de retener algún tipo de material orgánico. Esta muestra no resulta útil a los efectos de su caracterización palinológica. No obstante, constituye un referente para aquellos tramos de secuencias del Pleistoceno tardío, registradas en varios perfiles de la provincia de Buenos Aires (Borromei, 1995 y 1998; Grill, 1997, 2003; entre otros), donde facies eólicas han sido asociadas a condiciones climáticas áridas/extremadamente áridas.

PALINOFACIES 1 (muestra 2-dunas semi-fijas)

Palinomorfos: dominados por una de las especies que se halla entre las primeras fijadoras de dunas: *Tamarix gallica* (80%), asociada a Poaceae (*Poa lanuginosa*, *Spartina coarctata*, entre otras) (10%), Pinaceae (4%), Asteraceae (tipo *Senecio*) (1,5%), Chenopodiaceae-Amaranthaceae (1,5%), Myrtaceae (*Eucalyptus* sp.) y Mimosaceae (*Albizzia* sp.) (<1%). Completan la asociación escasas esporas de hongos (algunas totalmente oxidadas) entre ellas: *Dicellaesporites* sp., *Pluricellaesporites* sp. y *Monoporisporites* sp.



FIGURA 4—Dunas móviles con sus primeros colonizadores.
FIGURE 4—Falta traducción.

Materia orgánica amorfa (40%): constituida por masas irregulares, esponjosas, algunas asociadas a remanentes de fitoclastos muy oxidados y materia orgánica amorfa del tipo finamente dividido. Se registra también la presencia de masas totalmente ennegrecidas (de tamaño y forma variable) y de “pseudoamorfos” (Tyson, 1995), en ningún caso se observa fluorescencia bajo luz ultravioleta.

Fitoclastos (60%): translúcidos (bioestructurados): prevalecen las cutículas (algunas de ellas con estomas) sobre los tejidos (gradando desde el amarillo a ámbar, bajo luz transmitida), asociados algunos de ellos a remanentes de fitoclastos oxidados; presencia de hifas de hongos y material fibroso elongado (woody). El tamaño de los tejidos varía entre (126-252 x 210-560) μm .

Fitoclastos opacos (<5%): presentan tamaño muy variable, los más grandes (420 x 280) μm presentan formas muy irregulares y en general bordes corroídos y/o degradados, los medianos en su mayoría constituyen tablillas alargadas en una dirección y los pequeños son mayormente redondeados.

Alteración predominante: oxidación química, subordinada: oxidación biológica y daño mecánico.

La importante proporción de materia orgánica oscurecida (tanto fitoclastos como materia orgánica amorfa) sugiere ambientes oxigenados variablemente secos y húmedos, pero no saturado (Batten, 1996).

PALINOFAECIES 2 (muestra 3-dunas fijas)

Palinomorfos: caracterizados por Poaceae (38%), Pinaceae (23%), Asteraceae (*Hyalis argentea* y *Solidago chilensis*, entre otras) (16%), Chenopodiaceae-Amaranthaceae (4%), Brassicaceae (4%), Mimosaceae (cf. *Albizia*) (3%), Myrtaceae (*Eucalyptus* sp.) (3%), Cyperaceae (2%), cf Piperaceae (2%), Haloragaceae (*Myriophyllum* sp.) (1%). Menos del 1% para cada familia vegetal corresponde a: Thyphaceae, Solanaceae, Papilionaceae, Ulmaceae (*Celtis* sp.), Caryophyllaceae, Tamaricaceae, Aizoaceae y Apiaceae. Completan la asociación esporas de hongos: Corticiaceae, *Monoporisorites* sp. y *Pluricellaesporites* sp., esporas de algas, entre ellas: *Botryococcus* sp., Clorophyta (cf *Cosmarium* y *Zygnema* sp.), *Arcella catinus* (ameboide), esporas de Pteridophytas (*Cystopteris*) y tipo 337 (Hooghiemstra, 1984).

Materia orgánica amorfa (40%): asociada a masas irregulares de bordes difusos, tamaño pequeño a mediano, amarillento a ámbar, bajo luz transmitida y presencia de geles húmicos. Materia orgánica amorfa del tipo finamente dividido grisácea y ennegrecida (no fluorescente) y restos filamentosos/membranosos, de aspecto deshilachado, mal preservados, completan el grupo.

Fitoclastos (60%): fitoclastos translúcidos (bioestructurados): abundan los tejidos (degradados y corroídos) gradando su color desde hialinos a ambarinos (bajo luz transmitida), algunos de ellos superan los 400 μm , hifas de hongos y material fibroso elongado (“woody”), así como cutículas se hallan presentes en menor proporción.

Fitoclastos opacos (<5%): predominan las tablillas elongadas en una dirección, con bordes irregulares y tamaño mediano (variable entre 63 x 210 μm a 147 x 53 μm); los más pequeños presentan formas más redondeadas.

Alteración predominante: oxidación biológica, oxidación química y daño mecánico subordinados.

El material amorfo presente en esta palinofacies se relaciona parcialmente a la degradación de materia orgánica lignítica y celulósica por actividad bacterial y fúngica (presencia de geles húmicos) y a la degradación de tejidos y estructuras celulares de plantas terrestres. Ello es consecuencia de la importante actividad biológica registrada en la misma.

PALINOFAECIES 3 (muestra 4-depresión entre dunas)

Palinomorfos: caracterizados por Asteraceae (29%), Poaceae (22%), Chenopodiaceae-Amaranthaceae (15,50%), Pinaceae (14,50%), Urticaceae-Moraceae (4,50%), Brassicaceae (4%), Myrtaceae (*Eucalyptus* sp.) (1,50%), Mimosaceae (cf. *Albizia* y *Acacia* sp.) (1,50%), Caryophyllaceae (1%), Cyperaceae (1%), Apiaceae (*Hydrocotyle bonaerensis*) (1%), Portulacaceae (<1%), Ephedraceae (1%), Tamaricaceae (1%), Geraniaceae (<1%), Indet (3%). Completan la asociación: esporas de hongos, entre ellos: Corticiaceae, Microthyriaceae, *Glomus* sp., *Pluricellaesporites* sp., tipo 181 (Van Geel *et al.*, 1982/1983) y tipo 375 (Hooghiemstra, 1984); algas: Clorophyta (*Spirogyra* y cf *Cosmarium*), esporas de Pteridophytas (Polypodiaceae) y *Arcella catinus* (ameboide).

Materia orgánica amorfa (40%): constituida por masas esponjosas, color ámbar, tamaño variable, en algunos casos se observa la derivación de dichas masas de tejidos conformando geles húmicos. El amorfo descrito anteriormente se halla asociado a materia orgánica amorfa del tipo finamente dividido grisáceo a hialino a oscuro (bajo luz transmitida) y amarillo (bajo luz ultravioleta).

Fitoclastos (60%): fitoclastos translúcidos (bioestructurados): presencia de tejidos (42 x 273 μm a 95 x 420 μm) y cutículas (157 x 380 μm) con evidencia de corrosión y degradación color ámbar (fluorescentes bajo luz ultravioleta). Abundancia de hifas de hongos y

material fibroso elongado (“woody”) (ambos en mayor proporción que la palinofacies anterior).

Fitoclastos opacos (<2%): varían desde muy pequeños hasta grandes (105 x 170 µm), con evidencias de corrosión y/o degradación.

Alteración predominante: oxidación biológica, oxidación química y daño mecánico subordinados.

La materia orgánica amorfa puede relacionarse a cutículas degradadas, tejidos pobremente lignificados bacteriamente modificados bajo condiciones reductoras (Tyson, 1995).

PALINOFACIAS 4 (muestra 5-cuerpo lagunar)

(Fig. 5)

Palinomorfos: representados por Asteraceae (43%), Poaceae (21%), Chenopodiaceae-Amaranthaceae (7%), entre los forestales introducidos: *Myoporum laetum* (6%), Pinaceae (*Pinus radiata* y/o *halepensis*) (2,65%), *Eucalyptus* sp. (2,30%) y *Alnus* sp. (<1%), asociadas a *Tamarix* sp. (<1%), Mimosaceae (cf. *Albizia*) (2%), Aizoaceae (2%), Brassicaceae (2%). El polen de plantas acuáticas está representado por: Cyperaceae (5,7%), Juncaceae (1%), *Thypha* sp. (1%). Juncaginaceae (<1%) y Apiaceae (*Hydrocotyle bonariensis*) (<1%). Granos de *Celtis* sp. (<1%), Nothofagaceae (<1%) e indeterminados (1%), completan la asociación. Las esporas de hongos están representadas por Microthyriaceae, Corticiaceae, *Pluricellaesporites* sp., *Monoporisorites* sp. y *Glomus* sp., las de algas por Clorophyta (*Gelaniacysta* y *Zygnema*).

Materia orgánica amorfa (50%): fibrosa, filamentos, membranosa, color ámbar-amarillento (bajo luz transmitida), parcialmente fluorescente –amarillo claro– (bajo luz ultravioleta). Abundancia de restos de con-



FIGURA 5—Cuerpo lagunar (vegetación terrestre y acuática).
FIGURE 5—Falta traducción.

torno difuso a neto (redondeado) transicionales entre geles húmicos y pseudoamorfos color ámbar.

Fitoclastos (50%): fitoclastos translúcidos (bioestructurados): presencia de tejidos (105 x 180/580 µm), oxidados, en parte deshinchados, asociados a restos de fitoclastos ennegrecidos y cutículas degradadas. Abundancia de fitoclastos no bioestructurados, masivos de bordes angulares, bandeados (marrón oscuro y claro) y fitoclastos alargados oxidados, translúcidos sólo en sus bordes. Presencia de traqueidas corroídas y degradadas. Las hifas de hongos son muy abundantes.

Fitoclastos opacos (<2%): predominan los de menor tamaño, equidimensionales.

Alteración predominante: oxidación biológica, subordinada: oxidación química y daño mecánico.

La materia orgánica amorfa derivada de plantas terrestres y acuáticas y preservada en un ambiente álcuo y anóxico de baja energía, registra una importante oxidación bioquímica relacionada con la actividad de hongos y bacterias.

PALINOFACIAS 5 (muestra 6-comunidades forestales)

Palinomorfos: caracterizados por Myrtaceae (*Eucalyptus* sp., 56%), Pinaceae (*Pinus radiata* y/o *halepensis*, 18%) Asteraceae (7%), Poaceae (6%), Chenopodiaceae-Amaranthaceae (2%), Brassicaceae (2%), Oxalidaceae (1%) y Plantaginaceae (1%), Cyperaceae (1%), Piperaceae (1%). Con porcentajes inferiores al 1% se hallan Malvaceae, Juncaginaceae, Betulaceae (*Alnus* sp.) y Umbelliferae. Entre las esporas de hongos: Corticiaceae, Microthyriaceae, tipo 370 y 375 (Hooghiemstra, 1984); esporas de Bryophyta [*Bartramia*?, *Breutelia*? (Hooghiemstra, 1984) y *Phaceros* sp.] y *Arcella catinus* completan la asociación.

Materia orgánica amorfa (40%): representada por finamente dividido asociado a masas esponjosas, fibrosas y membranosas, de tamaño variable y color ámbar (bajo luz transmitida), parcialmente oxidadas y en parte gelificadas, con muy baja fluorescencia. Presencia de “pseudoamorfos”.

Fitoclastos (60%): fitoclastos translúcidos (bioestructurados): presencia de hifas de hongos y material fibroso elongado (“woody”) superando a los tejidos; estos últimos se presentan degradados, gelificados y en parte oxidados. Sus tamaños son variables: 38 x 170 µm, 42 x 150 µm, 75 x 130 µm. No se observan cutículas ni traqueidas. Presencia de fitoclastos no bioestructurados bandeados algunos de ellos con perforaciones circulares (“pits”).

Fitoclastos opacos (<5%): en general equidimensionales, tamaño pequeño a mediano.

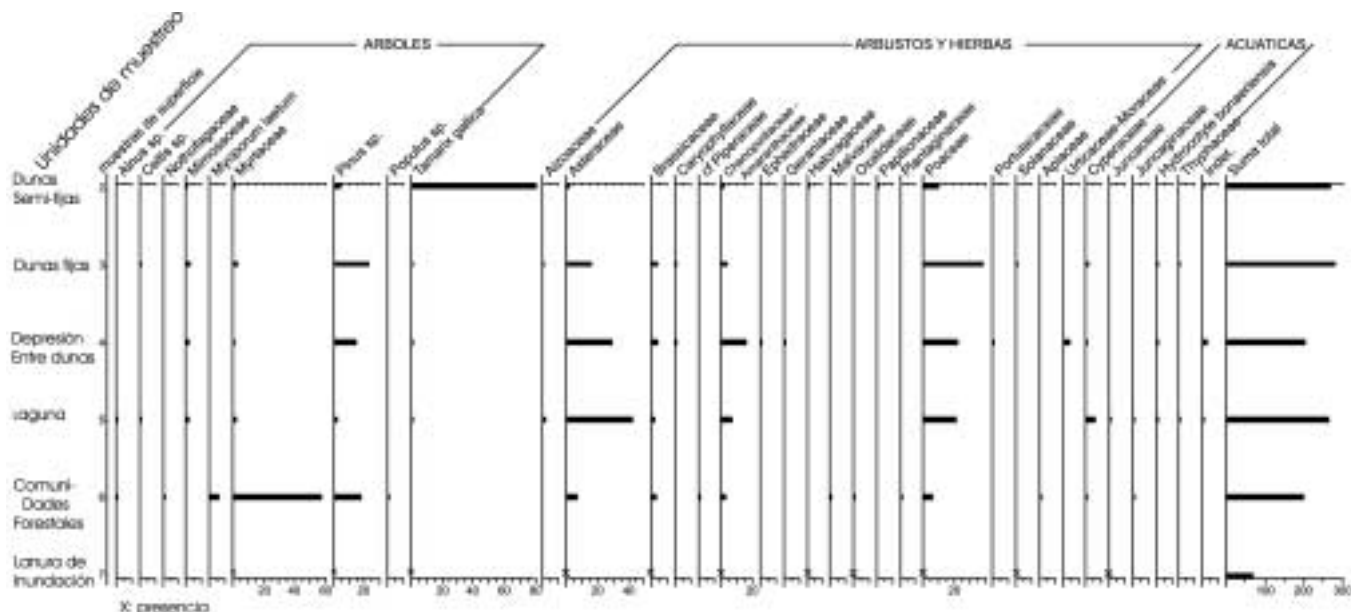


FIGURA 6—Diagrama polínico porcentual de las muestras superficiales.

FIGURE 6—Falta traducción.

Alteración predominante: oxidación biológica; subordinada: oxidación química y daño mecánico.

La materia orgánica amorfa sugiere principalmente origen de plantas terrestres y los fitoclastos y la degradación de los mismos se relaciona principalmente con la actividad biológica y en menor medida con la oxidación química.

PALINOFACIAS 6 (muestra 7-llanura aluvial)

Palinomorfos: presencia de: Asteraceae, Poaceae, Brassicaceae, Chenopodiaceae-Amaranthaceae, Oxalidaceae, Haloragaceae (*Miryophyllum*, entre otros), Solanaceae, Juncaginaceae, Pinaceae, Myrtaceae (*Eucalyptus* sp.), Tamaricaceae (*Tamarix gallica*) y algunos granos de polen indeterminados, completan la asociación. Las esporas de hongos están presentes con: Microthyriaceae, *Glomus* sp., *Monoporisorites* sp., *Pluricellaesporites* sp. y tipo 187 A (Van Geel *et al.* 1982/1983) y las esporas de Chlorophyta con *Zygnema*.

Materia orgánica amorfa (60%): constituida por masas de contornos irregulares asociadas en algunas de ellas a restos oscurecidos ('black debris' *sensu* Tyson, 1995); otras se presentan totalmente ennegrecidas. Se registra también la presencia de "pseudoamorfos" (Tyson, 1995). Materia orgánica amorfa del tipo finamente dividido completa este grupo.

Fitoclastos (40%): fitoclastos translúcidos bioestructurados: presentes como hifas de hongos y material

fibroso elongado ("woody") son muy abundantes, los tejidos y cutículas en algunos casos muestran evidencias de degradación y corrosión. Se registra también la presencia de fitoclastos bandeados, algunos de ellos con perforaciones circulares ("pits") y con evidencias de fuerte oxidación química.

Fitoclastos opacos: con bordes irregulares y algunos redondeados, representan menos del 5%, siendo de tamaño pequeño a mediano.

Alteración: tanto la oxidación biológica (por hongos y bacterias), como la química (asociada a la exposición del material por fluctuación del nivel de agua) son muy importantes; es muy notable también el daño mecánico que principalmente han sufrido los palinomorfos. En consecuencia, se asume una importancia similar para los 3 tipos de deterioro.

Los tejidos pobremente lignificados, cutículas degradadas, sugieren importante oxidación bioquímica relacionadas con actividad fúngica y bacterial bajo condiciones subácueas. La presencia de masas amorfas ennegrecidas sugiere ambientes oxigenados. Alternancia de condiciones aeróbicas y anaeróbicas propias de una planicie de inundación refleja esta palinofacies.

Relación espectros polínicos-vegetación

Diversos factores influyen en la relación cuantitativa polen-vegetación; entre los más importantes, merecen especial atención el tipo de polinización, la produc-

tividad, la distancia a la fuente emisora, así como los factores meteorológicos. Además debe tenerse en cuenta el deterioro que sufren los granos con posterioridad a su entierro en los sedimentos.

Respecto del tipo de polinización, en general existe una sub-representación del polen en relación con la vegetación cuando la polinización es entomófila, ya que la misma suele estar asociada a una menor producción polínica (Erdtman, 1969; Faegri y van der Pijl, 1979). No obstante, las características de polinización (anemofilia, entomofilia, etc.) no deben considerarse en términos absolutos, existen numerosas excepciones ligadas tanto a los distintos taxones polínicos como a las plantas (Lewis, 1986).

En relación con la distancia desde la fuente emisora de polen, se deben diferenciar aquellos palinomorfo depositados cercanos a las mismas, de los que proceden desde sitios alejados. La lluvia polínica en general reúne tres componentes cuyos límites son arbitrarios: “local” (esporomorfos depositados a unas pocas decenas de metros de sus plantas parentales), “extra-local” (depositados a unos pocos cientos de metros de la fuente emisora), “regional” (depositados más allá de cientos

de metros de la fuente). Estos límites son vagos y algunos autores además usan un cuarto término, “extra-regional”, para el transporte de esporomorfos de larga distancia (Holmes, P. L. en Traverse (1994), pág. 9).

En la Tabla 1 se registran las especies vegetales y los taxones polínicos presentes o ausentes en las muestras palinológicas estudiadas. De allí surge que los taxones polínicos (de origen “local” y “extra-local”) procedentes de los **árboles** censados en el área de estudio, se hallan presentes, exceptuando a *Cupressus macrocarpa*. En algunos casos la anemofilia, la proximidad de la fuente emisora y/o las características aerodinámicas, como es el caso de los bosques de Myrtaceae (*Eucalyptus camaldulensis* y *Eucalyptus tereticornis*) (56%) y Pinaceae (*Pinus radiata* y *Pinus halepensis*), influyen en la sobrerrepresentación de los primeros y las considerables proporciones de los segundos (18%).

En el caso de *Tamarix gallica*, su sobrerrepresentación (80%) (dunas semi-fijas) está asociada a la alta productividad polínica y a una excelente preservación de este taxón en dicho ambiente.

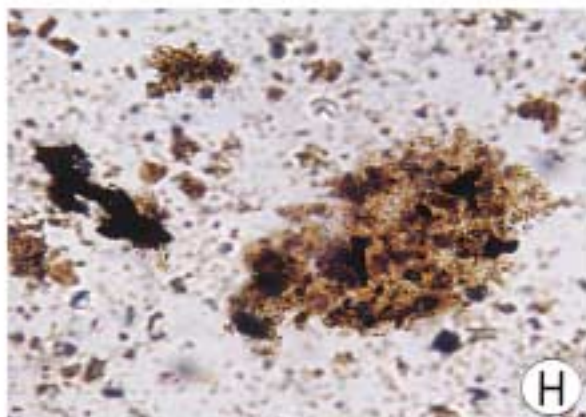
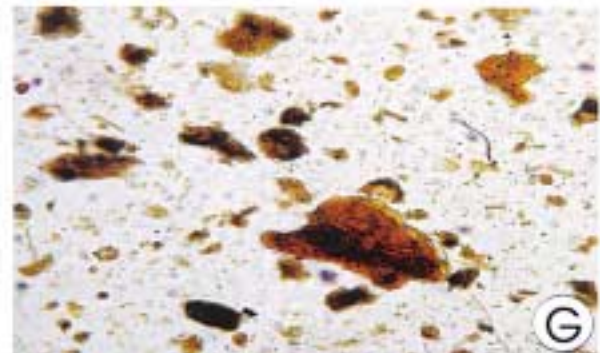
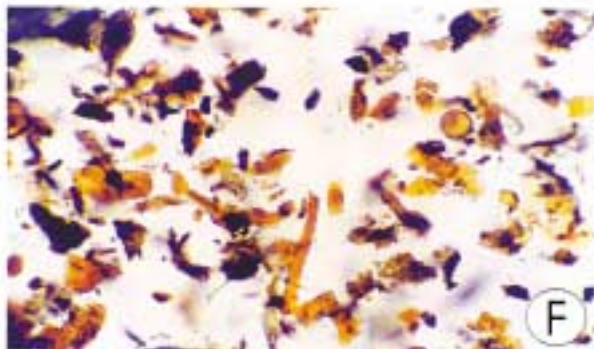
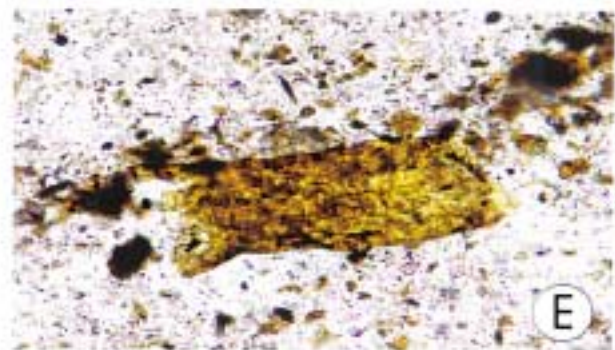
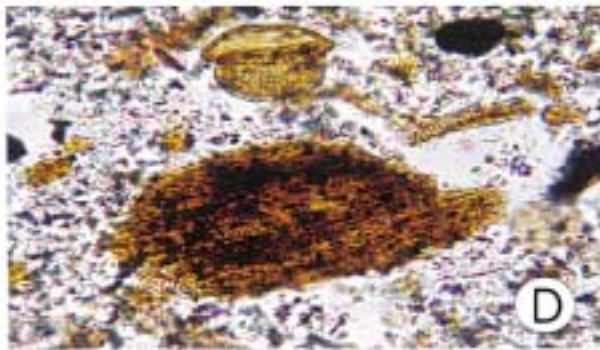
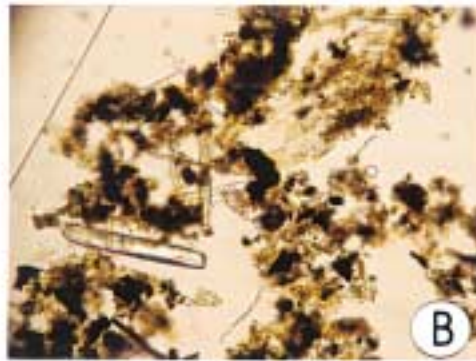
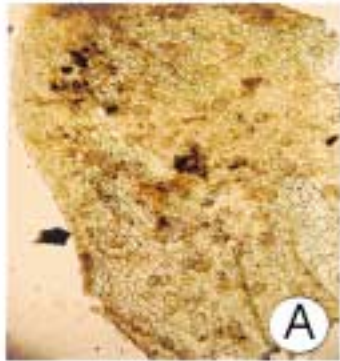
La presencia de la familia Nothofagaceae (<1%) procedente de los bosques subantárticos se relaciona

→

LÁMINA 1—Microfotografías de las palinofacies identificadas. Todas las palinofacies fueron fotografiadas con una magnificación de x 200. A, B y C: Palinofacies 1: A: Fitoclasto translúcido bioestructurado: cutícula, con celdas de contornos poligonales y rectangulares en cuyo interior se alojan granos de *Tamarix gallica*. B: materia orgánica amorfa con evidencias de fuerte oxidación química. C: Fitoclasto bioestructurado opaco. D: Palinofacies 2: “Pseudoamorfo” asociado a restos oxidados de materia orgánica, restos de tejidos y palinomorfo, inmersos en una matriz de materia orgánica amorfa finamente dividida. E: Palinofacies 3: Fitoclasto translúcido bioestructurado: cutícula con evidencias de importante corrosión y degradación, masas amorfas parcialmente oxidadas y finamente dividido. F: Palinofacies 4: materia orgánica amorfa fibrosa, filamentosa, membranosa, asociada a fitoclastos bioestructurados translúcidos (tejidos, hifas, “woody”) y algunos palinomorfos. G: Palinofacies 5: materia orgánica amorfa de distinto tamaño (esponjosa, membranosa), parcialmente oxidada asociada a restos de cutícula degradada y corroída y abundantes hifas y “woody”, en una matriz de finamente dividido. H e I: Palinofacies 6: H: materia orgánica amorfa de tamaño variable asociada a restos de materia orgánica oxidada inmersa en una matriz de finamente dividido. I: materia orgánica amorfa asociada a un vaso con evidencias de fuerte degradación y corrosión (“pits” deformados).

PLATE 1—Falta traducción.

LÁMINA 1



con las masas de aire frío que llegan desde el sudoeste de nuestro país y es considerado un componente “extra-regional”. Es sabido que la velocidad, dirección y turbulencia del viento ejercen un alto impacto en la dispersión polínica, afectando tanto la concentración (Mc Donald, 1980) como la dilución del polen en el aire (Richard, 1985). No obstante, la influencia más notable se registra a través del transporte de polen desde distancias muy largas (Cour y Duzer, 1980; Cambon *et al.*, 1992), decreciendo la concentración a medida que aumenta la distancia de la fuente emisora. Tanto en estudios polínicos actuales (Borromei y Quattrocchio, 1990; Grill y Guerstein, 1995; Fontana, 2005) como en secuencias polínicas fósiles de la provincia de Buenos Aires (Borromei, 1998; Grill, 2003, entre otros) ha sido registrada la presencia de este taxa.

El polen de Ulmaceae (*Celtis* sp.), Betulaceae (*Alnus* sp.) y Mimosaceae (*Acacia* sp., entre otras) es considerado “extra-regional” y procedente en el primer caso de la provincia del Espinal (bosque xerófilo) y en los restantes de la provincia de las Yungas, aunque en parte las acacias pueden ser de origen “local”. En todas las muestras, su representación es baja, inferior al 5%. La baja productividad de estas plantas, en general, está asociada a la presencia de pocos ejemplares. Al igual que las nothofagaceas, tanto en los registros actuales (Grill y Guerstein, 1995; Borromei y Quattrocchio, 1990) como en los fósiles (Borromei, 1998; Grill, 2003, entre otros) de la provincia de Buenos Aires siempre presentan bajas proporciones dentro de los espectros polínicos.

Dentro de los **arbustos y hierbas** se destacan las familias Poaceae y Asteraceae (de origen “local”, “extra-local” y “regional”) seguidas por Chenopodiaceae-Amaranthaceae y Brassicaceae (de origen “regional”).

El polen de Poaceae (anemófilo y fácilmente dispersable) tiene una alta correspondencia con la vegetación, reflejando en parte especies nativas y, particularmente en la llanura aluvial del Quequén Salado, especies introducidas por cultivo (*Thinopyrum ponticum* “agropiro” y *Lolium multiflorum*, entre otras). Se asume que la presencia de estos taxones en el ambiente mencionado obedece también al aporte pluvial desde áreas aledañas al cauce del río. La palinología no permite llegar a discernimientos genéricos dentro de esta familia, por lo tanto, las determinaciones botánicas son las que permiten, en los estudios actuales, discriminar entre especies nativas e introducidas. La sub-representación de esta familia tanto en las dunas semi-fijas (10%) como en las comunidades forestales (6%) está en relación directa con la sobrerrepresentación del polen de Tamarix en el primer caso y el de Eucalytus en el segundo.

El polen de Asteraceae, sub-representado en la duna semi-fija (1,5%) y con importantes proporciones en la interduna (29%) y el cuerpo lagunar (43%) está presente con diferentes géneros. Entre ellos, *Senecio quequensis* y *Ambrosia tenuifolia* (ambos de polinización anemófila) están presentes en todas las muestras palinológicas. En cambio, de *Hyalis argentea*, con alta cobertura vegetal en las dunas fijas, se registraron pocos granos de polen. El gran tamaño de esta especie sugiere polinización entomófila y por ende baja producción polínica y débil capacidad de dispersión (Naab, 2004). En dunas costeras del balneario de Monte Hermoso (55 km al sur del río Quequén Salado), Fontana (2005) registra una situación similar relacionada a esta especie.

El polen de Chenopodiaceae-Amaranthaceae está presente en todas las muestras palinológicas (1,5 a 15,5%), no en la cobertura vegetal. El registro de este tipo de polen se relaciona con sus características anemófilas, alta productividad y morfología aerodinámica (Subba Reddi y Reddi 1986, en Naab, 2004); dichas condiciones facilitan su dispersión y persistencia en la atmósfera, produciendo en general sobrerrepresentación dentro de los espectros. Esta familia, típica de la estepa halófila, según Verettoni (1961) y Verettoni y Aramayo (1976), ocupa terrenos próximos a la costa y suelos con alto contenido en sales. Los espectros polínicos registrados en muestras de superficie de tales comunidades alcanzan valores que oscilan entre 38% y 69% (Grill y Guerstein, 1995).

La familia Brassicaceae (de alto interés apícola) constituye una maleza típica de la región, estando su polen presente en bajas proporciones (2% a 4%) en todas las muestras analizadas. Ello puede deberse más a la lejanía de la fuente emisora que a su capacidad de dispersión y preservación, ya que es un taxón que en general es muy abundante en los horizontes superficiales y sub-superficiales de suelos de la provincia de Buenos Aires.

Los taxones polínicos pertenecientes a Ephedraceae, Papilionaceae, Solanaceae, Urticaceae-Moraceae, todos con porcentajes muy bajos (<1%), llegan al área procedentes en algunos casos del Distrito del Caldén y/o estepa patagónica (Ephedraceae). Su escasa representatividad se relaciona con la baja productividad, pobre cobertura vegetal y distancia de la fuente emisora (son componentes de origen “regional”).

El polen perteneciente a las familias Oxalidaceae y Geraniaceae (componentes “locales”) presenta porcentajes muy bajos (<1%), particularmente en comunidades forestales donde la sobrerrepresentación del polen de Myrtaceae influye en su baja representatividad.

	Vegetación	Taxón polínico
Árboles		
<i>Albizzia</i> sp.	-	+
<i>Acacia</i> sp.	+	+
<i>Alnus</i> sp.	-	+
<i>Celtis</i> sp.	-	+
<i>Nothofagus</i> sp.	-	+
<i>Cupressus macrocarpa</i>	+	-
<i>Eucalyptus camaldulensis/ tereticornis</i>	+	+
<i>Myoporum laetum</i>	+	+
<i>Pinus radiata / halapensis</i>	+	+
<i>Populus</i> sp.	-	+
<i>Tamarix gallica</i>	+	+
Arbustos y Hierbas		
Asteraceae	+	+
Brassicaceae	-	+
<i>Calycera crassifolia</i>	+	-
Caryophyllaceae	-	+
Chenopodiaceae–Amaranthaceae	-	+
<i>Discaria americana</i>	+	-
Ephedraceae	-	+
Geraniaceae	+	+
<i>Glandularia pulchella</i>	+	-
<i>Myriophyllum</i> sp.	-	+
Malvaceae	-	+
<i>Melilotus</i> sp.	+	-
<i>Oenothera mollissima</i>	+	-
Oxalidaceae	+	+
Papilionaceae	+	+
Piperaceae	-	+
Plantaginaceae	-	+
Poaceae	+	+
Portulacaceae	-	+
<i>Sesuvium portulacastrum</i>	+	+
Solanaceae	+	+
Umbelliferae	-	+
Urticaceae–Moraceae	-	+
Plantas Acuáticas		
Cyperaceae	+	+
Juncaceae	+	+
Juncaginaceae	+	+
<i>Hydrocotyle bonaerensis</i>	+	+
Thyphaceae	+	+

TABLA 1—Especies vegetales y taxones polínicos presentes o ausentes en las muestras superficiales +: presencia, -: ausencia.

TABLE 1—Falta traducción.

Respecto de las plantas **acuáticas** (Cyperaceae, Juncaceae, Juncaginaceae, Apiaceae (*Hydrocotyle bonaerensis* y *Thypha* sp.)), existe una importante relación entre la cobertura vegetal y el polen que las mismas producen, reflejando el depósito prácticamente “in situ” de estos taxones polínicos, además de las condiciones favorables de preservación otorgadas por el medio subacuático.

Relación vegetación nativa-vegetación introducida

Del análisis de la Tabla 2, surge que las comunidades vegetales presentes en la cuenca inferior del río

Quequén Salado están representadas por 66% de especies nativas. La mayor proporción de las mismas se registra en los tres cordones de dunas, depresión formada entre las dunas y el cuerpo lagunar, gradando desde un 100% (dunas móviles, más cercanas a la costa) hasta un 63% registrado en la laguna.

En las dunas móviles predominan: *Calycera crassifolia*, *Sporobolus rigens* y *Cortaderia selloana* (tres especies nativas). Las dunas semi-fijas están dominadas por *Tamarix gallica*, una especie arbórea introducida en América por los europeos, pero que actualmente crece en forma natural en lugares arenosos. Soporta bajas temperaturas, fuertes vientos, salinidad y es característica de los médanos costeros de la provincia de Buenos Aires. En las dunas fijas se destacan las nativas *Hyalis argentea*, *Solidago chilensis*, *Achyrocline satureioides* y *Poa lanuginosa* asociadas a un árbol introducido: *Pinus radiata*. En las depresiones formadas entre las dunas, las comunidades vegetales nativas representadas por *Juncus acutus*, *Sporobolus rigens*, *Panicum urvilleanum*, *Cortaderia selloana*, *Lagurus ovatus*, *Hydrocotyle bonariensis* y *Sesuvium portulacastrum* se asocian a las introducidas: *Lactuca serriola* y *Melilotus albus*. En los cuerpos lagunares, la vegetación natural desarrollada tanto en el agua (*Cortaderia selloana*, *Thypha* sp. y Zygnemataceae) como en los bordes de la laguna: *Scyrrpus olneyi*, *Hydrocotyle bonariensis* y *Ambrosia tenuifolia*, convive con la introducida: *Melilotus albus* y los árboles: *Myoporum laetum*, *Populus* sp. y *Acacia longifolia*.

El mayor número de especies introducidas se manifiesta en las comunidades forestales asociado a la estepa gramínea y en la llanura aluvial. En el primer caso las especies introducidas corresponden a: *Eucalyptus camaldulensis* y *Eucalyptus tereticornis*, *Cupressus macrocarpa*, *Pinus radiata* y *Pinus halepensis*. En el segundo, el alto impacto antrópico está relacionado con el cultivo (*Lolium multiflorum*, *Festuca arundinacea*, *Thinopyrum ponticum*) y con algunas herbáceas típicas del área estudiada como los cardos (*Cynara cardunculus*, *Cirsium vulgare*).

Otros componentes presentes dentro del grupo palinomorfos

Del análisis de la Tabla 3 surge que en todas las muestras palinológicas (a excepción de la muestra 1: dunas vivas) están presentes las esporas de hongos, registrando la duna semi-fija la asociación más pobre y la depresión entre dunas la mayor abundancia y diversidad. La ausencia total en las dunas vivas y la escasez en las semi-fijas, confirma la capacidad relativamente baja de dispersión que poseen las esporas de hongos. Esporas tales como el tipo

Unidades de muestreo	Especies Nativas (número de ejemplares)	Especies Introducidas (número de ejemplares)	Número total de especies (número de ejemplares)
Dunas móviles	3	-	3
Dunas semi-fijas	8	1	9
Dunas fijas	5	1	6
Depresión entre dunas	7	2	9
Cuerpo lagunar	7	4	11
Comunidades forestales	6	6	12
Llanura aluvial	2	5	7

TABLA 2—Número de especies vegetales nativas e introducidas en cada muestra superficial.

TABLE 2—Falta traducción.

181 (Van Geel *et al.*, 1982/1983), presentes en la depresión entre dunas, son típicas de aguas estancadas someras eu a mesotróficas (Van Geel *et al.*, *op. cit.*).

La mayor diversidad de esporas de algas se registra en la duna fija asociada a *Botryococcus* sp. y Clorophyta (cf *Cosmarium* y Zygnematacea: *Zygnema*). Esporas de bryophytas se registran solamente en las comunidades forestales, estando las pteridophytas presentes en la duna fija y en la depresión entre dunas. *Arcella catinus* (ameboide) fue registrada en la duna vegetada, depresión entre las dunas y en las comunidades forestales. El género *Arcella* está asociado tanto a aguas dulces como saladas y a distintos tipos de suelos (Curtis, 2001).

CONCLUSIONES

El análisis palinofacial de sedimentos actuales en la cuenca inferior del río Quequén Salado permitió llegar a las siguientes conclusiones:

– La muestra 1 (dunas fijas), palinológicamente estéril, evidencia ecosistemas costeros muy severos incapaces de retener algún tipo de material orgánico.

– La Palinofacies 1 (muestra 2-dunas semi-fijas) consiste en materia orgánica muy oxidada con predominio de fitoclastos (60%) sobre la materia orgánica amorfa. La asociación polínica dominada por *Tamarix gallica* (80%) refleja la adaptación de esta especie vegetal a los ecosistemas costeros. La importante oxidación química del material es asociada tanto a rigurosidad del ambiente como a la escasez o ausencia de microorganismos (hongos y algas).

– La Palinofacies 2 (muestra 3-dunas fijas) representada por fitoclastos (60%) (principalmente tejidos degradados y corroídos) y materia orgánica amorfa (40%) (masas de bordes irregulares, filamentosa/membranosa, geles húmicos) evidencia importante degradación por ac-

tividad fúngica y bacterial. La asociación polínica caracterizada principalmente por *Poaceae* (38%) y *Asteraceae* (16%) refleja la estabilidad del cuerpo medanoso con influencia de forestales introducidos *Pinaceae* (23%).

– La Palinofacies 3 (muestra 4-depresión entre dunas) dominada por fitoclastos (60%) [mayormente hifas de hongos y material fibroso elongado (“woody”)] sobre materia orgánica amorfa (masas esponjosas, geles húmicos) presenta evidencias de mayor actividad biológica que la Palinofacies 2. La asociación polínica refleja principalmente a la cobertura vegetal típica de estos ambientes: *Asteraceae* (29%) y *Poaceae* (22%).

Taxones	muestras					
	2	3	4	5	6	7
Hongos						
Corticiaceae	-	2	3	-	2	1
Microthyriaceae	-	-	3	-	1	-
<i>Dicellaesporites</i> sp.	1	-	-	-	-	-
<i>Glomus</i> sp	-	-	3	3	-	3
<i>Monoporisporites</i> sp.	1	1	-	-	-	1
<i>Pluricellaesporites</i> sp.	1	1	2	1	-	1
tipo 181 (Van Geel, 1982)	-	-	2	-	-	-
tipo 187 A (Van Geel, 1982)	-	-	-	-	-	1
tipo 370*	-	-	-	-	3	-
tipo 375*	1	-	3	-	1	-
Algas						
<i>Botryococcus</i> sp.	-	1	-	-	-	-
Clorophyta	-	1	-	-	-	-
cf <i>Cosmarium</i>	-	-	2	-	-	-
<i>Gelaniacysta</i>	-	-	-	1	-	-
<i>Nassauvia anillanis</i>	-	2	-	1	-	-
<i>Spirogyra</i>	-	-	2	-	-	-
<i>Zygnema</i>	-	1	-	1	-	2
Bryophyta						
<i>Bartramia</i> ? (Musci)	-	-	-	-	1	-
<i>Breutelia</i> ? (Musci)	-	-	-	-	3	-
<i>Phaceros</i> sp	-	-	-	-	1	-
Pteridophyta						
Polypodiaceae	-	-	1	-	-	-
<i>Cystopteris</i>	-	1	-	-	-	-
Ameboides						
<i>Arcella catinus</i>	-	3	3	-	3	-

TABLA 3—Otros palinomorfos: 1: 0-5 ejemplares; 2: 5-10 ejemplares; 3: > 10 ejemplares *(Hooghiemstra, 1984).

TABLE 3—Falta traducción.

Falta traducción.

– La Palinofacies 4 (muestra 5-cuerpo lagunar) representada por materia orgánica amorfa (fibrosa, filamentosa, membranosa, bien preservada), procedente de plantas terrestres y acuáticas, se halla presente en igual proporción que los fitoclastos. El espectro polínico refleja la vegetación que crece en las proximidades de la laguna [*Asteraceae* (43%), *Poaceae* (21%)] y la que coloniza sus bordes y/o se desarrolla dentro de la misma (*Cyperaceae*, *Juncaceae*, *Thypha* sp., etc.).

– La Palinofacies 5 (muestra 6-comunidades forestales) dominada por fitoclastos (60%) sobre materia orgánica amorfa (masas esponjosas, fibrosas, membranosas) denota fuerte oxidación biológica y un espectro polínico dominado por *Myrtaceae* (56%) (principal componente de este tipo de comunidades).

– La Palinofacies 6 (muestra 7-llanura aluvial del río) registra escasa proporción de granos de polen, asociada a un considerable deterioro del material, contribuyendo los tres grados de alteración en forma similar. En este ambiente, la disponibilidad de agua necesaria para generar actividad biológica se asocia a las características energéticas que contribuyen al daño mecánico de los palinomorfos y a la exposición del material por fluctuaciones del nivel del río.

– Dentro del grupo palinomorfos, los espectros polínicos de cada muestra superficial reflejan no sólo la comunidad que vive “in situ” (componentes “locales”), sino también aquellas comunidades que habitan los ambientes cercanos (componentes “extra-locales”) y aún los alejados del área de muestreo (componentes “regionales” y “extra-regionales”) cuyos taxones polínicos arriban por vientos, lavaje pluvial, etc.

– La influencia antrópica por cultivo/pastoreo y forestación es evidente en el área de estudio y se manifiesta en forma creciente a medida que aumenta la distancia desde la costa hacia el continente. Las dunas costeras y la depresión entre dunas son las que mantienen mayor número de especies nativas. Por el contrario, las comunidades forestales y la llanura de inundación del río, destacan por la fuerte influencia antrópica.

– El estudio de mayor número de muestras de superficie permitirá un mejor conocimiento de las relaciones entre los espectros polínicos actuales y fósiles y en consecuencia una mejor reconstrucción de las comunidades vegetales del pasado.

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PALYNOLOGICAL IMPLICATIONS OF THE PRESENCE OF TRIGLOCHIN IN HOLOCENE PALAEOENVIRONMENTAL RECONSTRUCTIONS IN THE COASTAL PLAIN OF RIO GRANDE DO SUL STATE, BRAZIL

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Abstract

The detailed morphological description of the recent *Triglochin striata* Ruiz & Pav. pollen, widespread in the salt and brackish-water marshes and interdunal depressions, was done using optical microscope and scanning electron microscopes. Pollen morphology analysis provided a possibility to distinguish dispersed *Triglochin* type pollen from the Holocene sediments. The dispersed *Triglochin* type pollen was registered in the surface sediments from eight locations in the salt marshes of the estuarine part of the Patos Lagoon, and eleven Holocene samples from core B-2. The obtained results provide the importance of this taxon as a reliable indicator of terrestrial environments with elevated salinity in the coastal plain of Rio Grande do Sul State.

Key words: *Triglochin striata*, pollen, salt marsh, Holocene, Coastal Plain of Rio Grande do Sul State, Brazil, palaeoenvironmental reconstructions.

Resumen

Se realiza una detallada descripción morfológica del polen de *Triglochin striata* Ruiz & Pav., planta distribuida en ambientes salinos, pantanos salobres y depresiones interdunas, utilizándose microscopía electrónica y de luz transmitida. El análisis de la morfología polínica posibilitó la distinción del polen disperso del tipo *Triglochin* en sedimentos holocenos. El polen disperso del tipo *Triglochin* fue registrado en los sedimentos superficiales de ocho localidades de los pantanos salinos localizados en la parte estuarina de la Laguna de los Patos. Así mismo muestras holocénicas fueron obtenidas del sondeo B-2. Los resultados obtenidos muestran la importancia de este taxon como indicador de ambientes terrestres con salinidad elevada en la planicie costera del Estado del Río Grande do Sul.

Palabras clave: *Triglochin striata*, polen, pantano salobre, Holoceno, Planicie Costera del Estado del Río Grande do Sul, Brasil, reconstrucciones paleoambientales.

INTRODUCTION

The Holocene palaeoenvironmental and palaeoclimatic reconstructions of the Coastal Plain of Rio

Grande do Sul State, Brazil, based on palynological data, were made by Lorscheitter (1983), Cordeiro & Lorscheitter (1994), Lorscheitter & Dillenburg (1998), Medeanic *et al.* (2001), and others. The palae-

oenvironmental reconstructions were based on palynomorphs, including pollen and spores of terrestrial and aquatic plants, zygospores, coenobiums and colonies of freshwater coccal algae (Chlorophyta), dinoflagellates and acritarch cysts.

At present, many taxonomic definitions of the pollen and spores of terrestrial and aquatic plants are made *sensu lato* (up to genus or family), and this only enables a general interpretation of palynological data. It is evident that more efficient use of the dispersed pollen and spores encountered in the samples depends on our knowledge on their detailed morphology and possibility to make detailed taxonomic definitions. A great contribution to the morphological studies of pollen of recent plants in Brazil was made by Barth (1976), Barth & Melhem (1988) and Melhem *et al.* (2003). In Rio Grande do Sul studies of pollen morphology of actual plants were initiated by Neves & Lorscheitter (1995) and Neves *et al.* (2001).

The correlation between the composition and frequency of pollen taxa in the surface sediments of different ecosystems and vegetation cover is important. The difference between buried pollen and spores and vegetation cover is caused by difference in the pollen productivity of plants, specific pollen morphology features, the possibility to be transported by wind, the pollen grains capacity to be preserved, and pollination mode (Gritchiuk & Zaklinskaya, 1948; D'Antoni & Markgraf, 1980; Traverse, 1988; Woo *et al.*, 1998). In Rio Grande do Sul State, the first comparison between pollen-and-spore assemblages from salt marsh surface sediments and vegetation cover in the estuarine part of the Patos Lagoon, was made by Medeanic (2003). The obtained results demonstrate close similarity between pollen and spore assemblages from the salt marsh surface sediments and vegetation cover.

The indicative pollen and spore definition from different environments (wetland, salt marsh, brackish-water marsh and freshwater marsh) based on ecological plant characteristics may be useful for palaeoenvironmental reconstructions. The Coastal Plain of Rio Grande do Sul is characterized by wide development of salt and brackish-water marshes, wetlands and dunes. The most frequent plants of salt marshes belong to the families: Amaryllidaceae, Asteraceae, Chenopodiaceae, Cyperaceae, Juncaceae, Juncaginaceae, Fabaceae, Malvaceae, Plumbaginaceae Poaceae, Polygonaceae and Typhaceae (Cordazzo & Seeliger, 1995). The families Asteraceae, Cyperaceae and Poaceae are composed of many genera and species which occur both in wetlands, brackish-water marshes, salt marshes and foredunes.

The family Juncaginaceae (*Triglochin striata*) has a limited spreading, confined to areas with high salinity. This specie of restricted occurrence makes it an important indicator for coastal environment palaeoreconstructions, whose development is connected to sea level changes. This species is anemophilous and has high pollen productivity (Bobrov *et al.*, 1983). The first records of dispersed Juncaginaceae (*Triglochin* type) pollen were obtained from two core samples from Middle Holocene sediments collected from the Coastal Plain of the State (Clerot, 2004). The studied sediments were deposited during the postglacial marine transgression when the salt and brackish-water marshes were widespread in this region (Lorscheitter, 1983; Cordeiro & Lorscheitter, 1994, and Medeanic *et al.*, 2001).

Aim of this study was to carry out a detailed morphological study of the *T. striata* pollen, so that it could be easily recognized in the buried Holocene sediments and point out pollen of this specie as indicative for the environments of high salinity whose increased in distribution during Holocene marine transgression.

MATERIAL AND METHODS

T. striata pollen was collected during field work at Cassino Beach, Rio Grande do Sul State (Fig. 1),

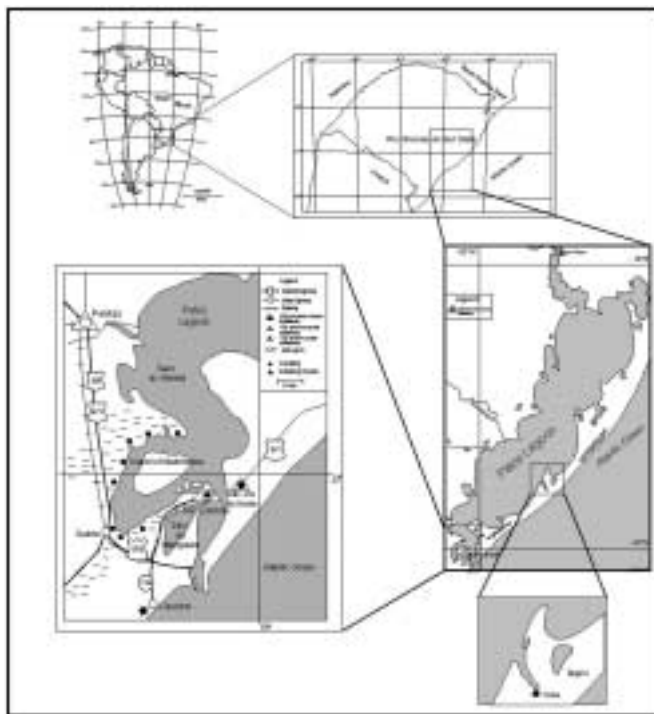


FIGURE 1—Map of locality of studied area.

during this plant flowering period in January, 2002. Flowers, anthers and pollen from two plants were collected and placed into paper envelopes. The material chemical treatment was made using the acetolysis method, proposed by Erdman (1969). Sample numbers are PC 165, PC 206.

Pollen morphology was studied using an optical microscope (X400-600). The pollen was photographed using an Olympus photomicroscope (Plate 1-A, C). One slide was prepared to study pollen grains through scanning electron microscopy (slide SM 165). A drop of mix was covered by Au (80 seconds, 40 mA). The photomicrographs were made by the SEM model JSM 5800 (Plate 1-B, D, E, F, G). The pollen morphology description was borrowed from Traverse (1988).

Eight locations were chosen in the salt marsh area on the margin of the Patos Lagoon estuary (Fig. 1). Samples of surface sediments with a weight of 50 g were collected from each location, from the surface to a depth of 3 cm. All collected samples were desiccated in a furnace at 60°. The samples underwent chemical treatment, following the usual procedure for

pollen analysis, as described by Faegri & Iversen (1989). Slide sample numbers are P 162, P 163, P 164, P 165, P 166, P 167, P 168 and P 169.

The Holocene sediments were studied in samples of core B-2 (31° 38' S, 51° 26' W) (Fig. 1). The lithologic characteristic of the studied sediments are shown in Fig. 3. The absolute ages of the two samples were established by the ^{14}C method at Beta Analytic Inc., Miami, FL, USA. Eleven samples of organic-rich clay were collected for the palynological study. Their chemical treatment was the same as for the surface sediment samples from salt marshes. Their collection numbers are PA 191, PA 192, PA 193, PA 194, PA 195, PA 196, PA 197, PA 198, PA 199, PA 201 and PA 204. All studied slides are stored in the Centro de Estudos de Geologia Costeira e Oceânica of Instituto de Geociências, Universidade Federal do Rio Grande do Sul, Brazil.

The organic remains examination obtained from the surface and core samples, includes taxonomic definition of palynomorphs, based on pollen and spores palynotheca of living plants growing on the Coastal Plain of the state. The most frequently recor-

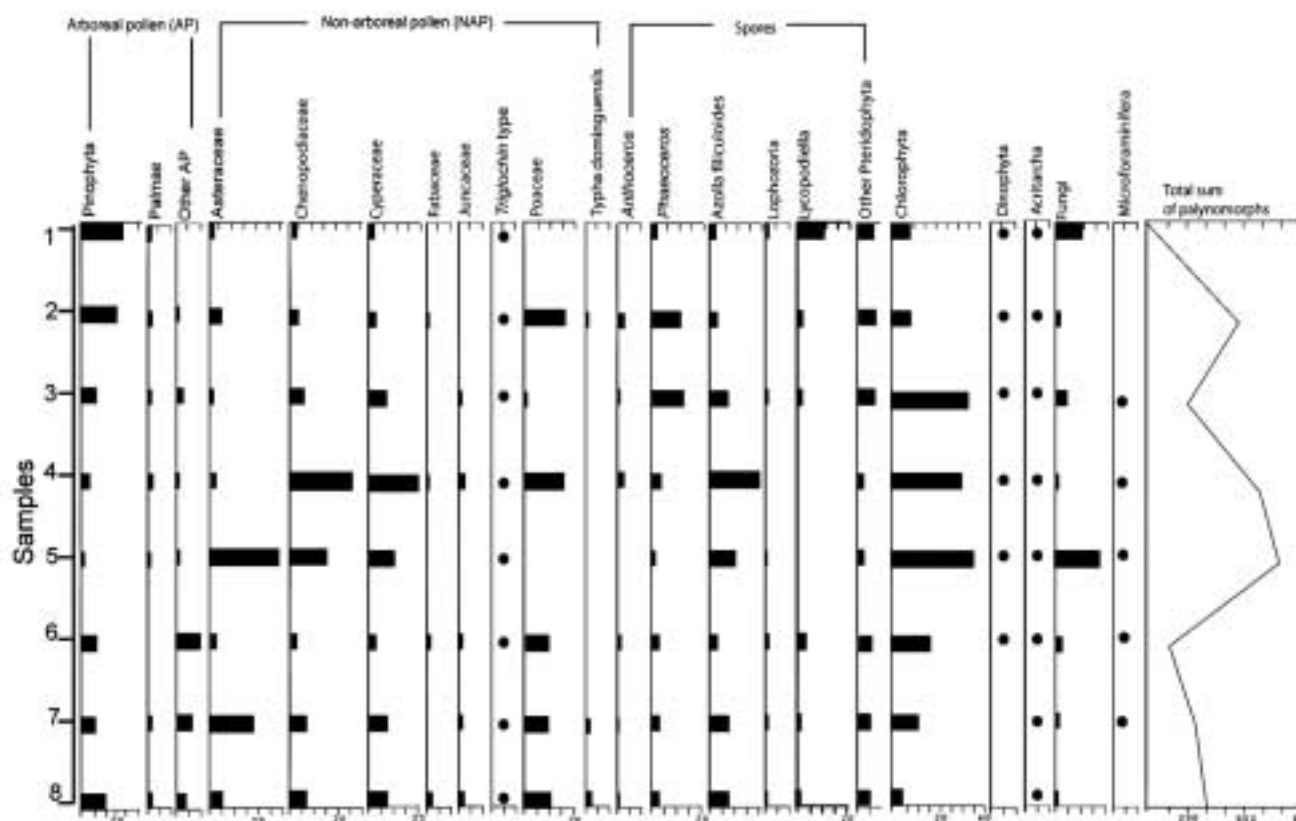


FIGURE 2—Pollen diagram (%) from surface sediments of the salt marshes < 1%.

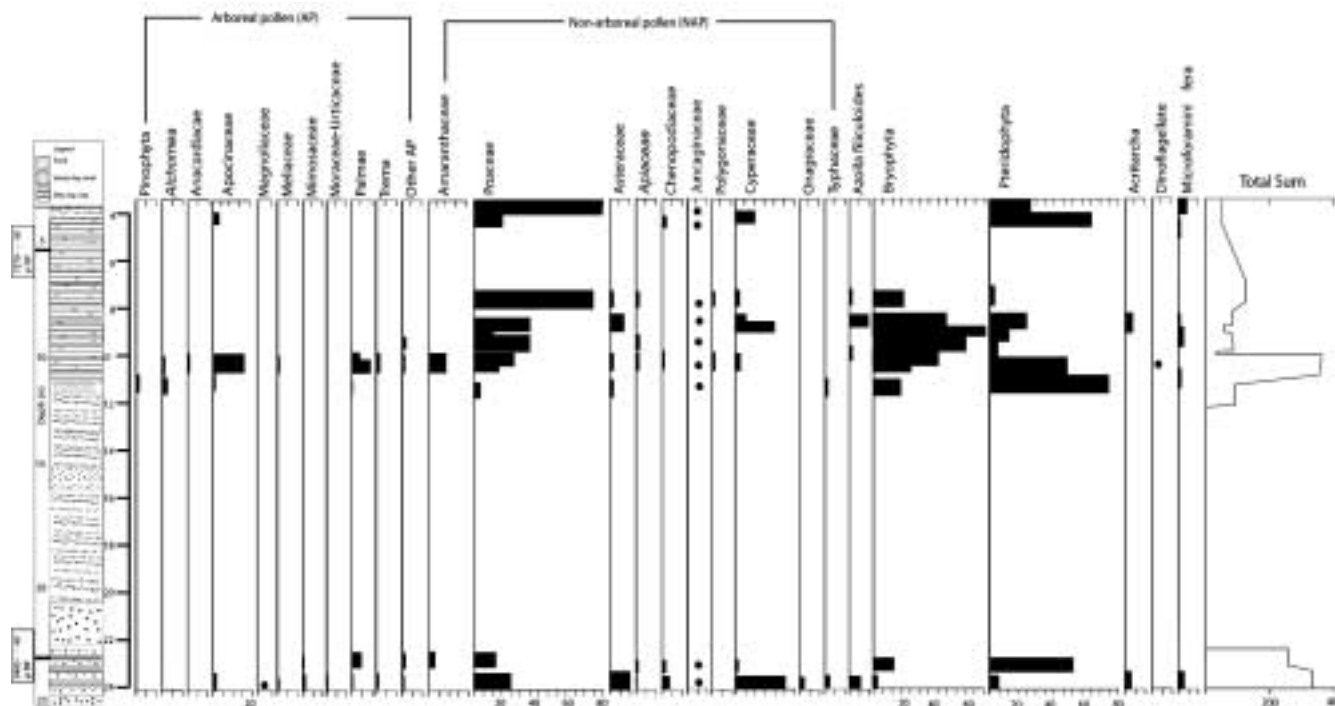


FIGURE 3—Lithological column of core B-2 and pollen diagram (%) of palynomorphs <1%.

ded palynomorphs and relationship (%) are represented in the palynodiagram using the Tilia Software (Grimm, 1987). All palynomorphs, including pollen, spores of vascular plants, Chlorophyta zygospores, fungal spores, dinoflagellates and acritarch cysts were counted together (“palynomorph sum”) (Figs. 2, 3). The comparison between pollen-and-spore assemblages from surface sediments and vegetation cover is shown in Table 1, and the full list of pollen and spores from core samples is given in Table 2.

RESULTS AND DISCUSSION

Actual pollen *Triglochin striata* Ruiz & Pav. morphology

The family Juncaginaceae is widely distributed in the world and consists of 5 genera and 20 species (Judd *et al.*, 1999). The most of species of this family

are distributed in environments with elevated salinity. In Latin America, the genus *Triglochin* is widespread in salty and brackish-water marshes and interdunal depressions. In the Coastal Plain of Rio Grande do Sul State, only one species *Triglochin striata* was identified (Cordazzo & Seeliger, 1995).

Russian palynologists (Bobrov *et al.*, 1983) described the morphology of the recent species *T. palustre* L., widespread in Europe, and the other, less frequent *T. maritimum* L. The morphology of the modern pollen of *T. striata* and *T. palustre* from Argentina was described by D’Antoni & Markgraf (1980).

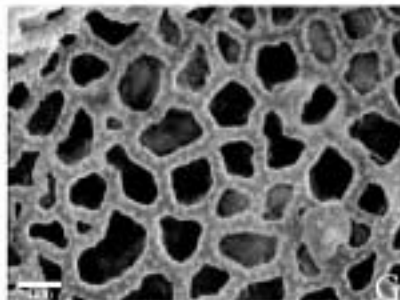
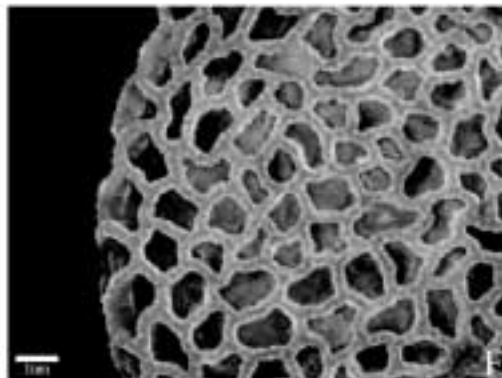
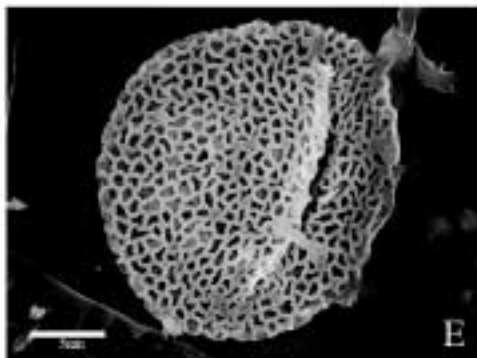
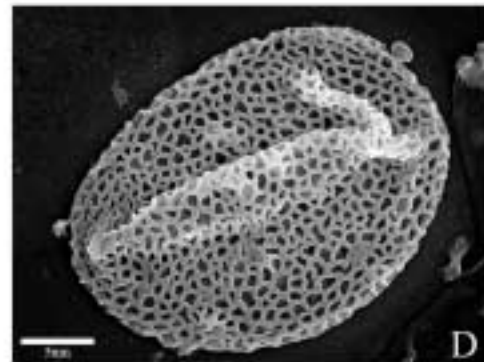
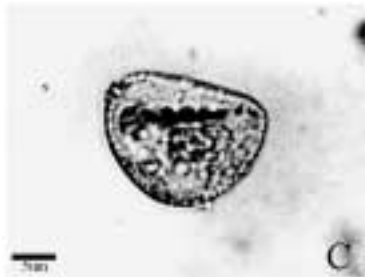
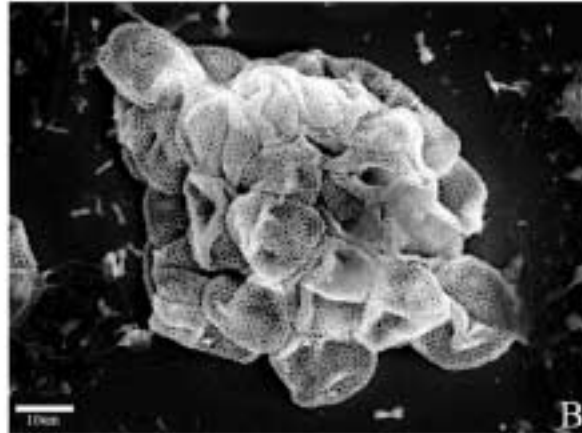
Triglochin striata Ruiz & Pav. Pl. 1, Figs. A-G

Pollen grains are spheroidal to ellipsoidal. The diameter of spheroidal grains is 18-20 µm. The major diameter of ellipsoidal grains varies –20-30 µm and minor

→

PLATE 1—Pollen grains in optical microscope (OM) and scanning electron microscopy (SEM); A-OM, B-SEM: pollen clusters; C-OM: ellipsoidal pollen grain, D, E-SEM: spheroidal pollen grains; F, G-SEM: detail of reticulate ectexine.

PLATE 1



Taxa	Pollen and Spores taxa	Vegetation cover
Pinophyta		
<i>Ephedra</i> L.	+	-
<i>Eucalyptus</i> L'Hér.	+	-
<i>Pinus maritima</i> Mill.	+	-
Magnoliophyta		
Trees and Shrubs		
<i>Alchornea</i>	+	-
Caprifoliaceae	+	-
<i>Ilex</i> L.	+	-
Lauraceae	+	-
Loranthaceae	+	-
Magnoliaceae	+	-
Melastomataceae	+	-
Moraceae-Urticaceae	+	-
Palmae	+	-
<i>Rapanea</i> Aubl.	+	-
Rubiaceae	+	-
<i>Salix</i> L.	+	-
<i>Smilax</i> L.	+	-
<i>Trema</i> Lour.	+	-
Herbs		
Amaranthaceae	+	+
Amaryllidaceae	+	+
Apiaceae	+	-
Asteraceae	+	+
Brassicaceae	+	+
Chenopodiaceae	+	+
Commelinaceae	+	-
Cyperaceae	+	+
Gunneraceae	+	+
Fabaceae	+	+
Juncaceae	+	+
Lamiaceae	+	-
Malvaceae	+	+
Onagraceae	+	-
Poaceae	+	+
Primulaceae	+	-
Scrophulariaceae	+	-
Solanaceae	+	+
Verbenaceae	+	+
<i>Myriophyllum</i> L.	+	-
<i>Triglochin</i> -type	+	+
Typhaceae	+	+
Utriculariaceae	+	-
Bryophyta		
<i>Anthoceros</i> L.	+	-
<i>Phaeoceros</i> L.	+	-
<i>Sphagnum</i> L.	+	-
Pteridophyta		
Monolete psilate	+	-
Monolete verrucate	+	-
Trilete psilate	+	-
Trilete echinate	+	-
<i>Azolla filiculoides</i> Lam.	+	+
<i>Anemia</i> Sw.	+	-
<i>Lophozoria</i> C. Presl.	+	-
<i>Lycopodiella</i> C. Presl.	+	-

TABLE 1—Pollen and spore taxa from surface sediments of the salt marsh and plant taxa from modern vegetation (described by Costa, 1992; Costa e Davy, 1992; Costa *et al.*, 1997).

diameter is 16-20 μm . Pollen is inaperturate. The thin exine frequently has one or two folds and consists of two distinct layers. Ectexine is reticulate positive, present by luminas, divided by solid walls. Contour of luminas is from circular-angular to angular, minor length –0.06-0.08 μm ; major length –0.4-0.6 μm . Exine of luminas is smooth. The luminas are divided by solid walls (muri). The width of solid walls are approximately equal (about 0.3 μm). The sculpture of solid walls is echinate. The diameter of every echinae is about 0.04-0.06 μm . The distance between echinae is about 0.2 μm . The color of pollen grains is light-yellow to colorless.

Comparison.—By size, contour and reticulate ornamentation, as observed in optical microscope, the *T. striata* pollen resembled *T. palustre* and *T. maritimum* (Bobrov *et al.*, 1983). The described *T. striata* pollen morphology differs from the morphology of the same species from Argentina (D'Antoni & Markgraf, 1980). These authors indicate one circular pore.

Note.—Our present knowledge on pollen morphology enables us to identify only one species of the genus *Triglochin* among the dispersed *Triglochin* type pollen. It seems it is not possible to differentiate the pollen of the species belong to the genus *Triglochin*. Probably, the difference between morphological features of the *Triglochin* species is not well observed in optical microscope in common palynological analyses. Dispersed subfossil *T. striata* pollen in Holocene sediments may be confused with *Typha* type pollen by reticulate sculpture of exina and is different due to the absence of pores, smaller grain size, thinner exine and lighter color.

Palynological study of the surface sediments

The palynomorph assemblage obtained from the salt marsh surface sediments are represented by pollen of arboreal plants, AP (2.2-22.8%), herbaceous pollen, NAP (16.6-60.9%), Bryophyta (1.1-24.0%) and Pteridophyta spores (2.9-13.8%), Chlorophyta zygospores (5.3-26.2%), dinoflagellate (0.2-5.3%), and acritarch cysts (0.2-1.4%) and fungal spores (0.5-5.7%). The most frequent pollen are *Pinus maritima* Miller, arboreous pollen, and herbaceous pollen—Asteraceae, Chenopodiaceae, Cyperaceae and Poaceae (Table 1). *Triglochin* type dispersed pollen was registered in all studied samples (<1%). The Bryophyta spores are relatively abundant and represented by *Anthoceros* L. and *Phaeoceros* L. The Pteridophyta spores are rare, represented by monolete psilate, monolete verrucate, trilete psilate and trilete echinate types. *Lophozoria* C. Presl. and *Lycopodiella* C. Presl. spores are present. The aquatic fern spores, *Azolla filiculoides* Lam., are frequent. Zygospores and colonies of coccal Chlorophyta (*Botryococcus* Kützinger, *Spirogyra* Link, *Debarya* Wittrock, *Mougeotia* (C. A. Agardh) Wittrock and *Zygnema* C.A. Agardh)] were identified. The marine palynomorphs were represented by dinoflagellates cysts and acritarchs, and rare microforaminifera linings. Fungal spores include *Tetraploa* type.

The obtained pollen and spore assemblage does not correspond completely to the salt marsh vegetation cover of the Coastal Plain, described by Costa (1992),

Pollen and spores taxa	3.5	3.9	7.8	8.8	9.1	9.5	10	10.3	11	23	24
Pinophyta											
<i>Ephedra</i> L.											+
<i>Podocarpus</i> L'Hér. Ex Pers										+	+
Magnoliophyta											
Arboreal pollen (AP) – Trees and shrubs											
<i>Alchornea</i> Sw.								+	+		
Anacardiaceae								+			
Apocynaceae							+	+			
Boraginaceae								+			
Magnoliaceae											+
Melastomataceae											+
Meliaceae								+			+
Mimosaceae										+	+
Moraceae-Urticaceae											+
Palmae							+	+	+	+	+
<i>Rapanea</i> Aubl.										+	
Rosaceae											+
Rubiaceae						+					+
Thymelaeaceae											+
<i>Trema</i> Lour.								+			+
Non-arboreal pollen (NAP)											
Amaranthaceae							+			+	+
Apiaceae				+		+		+	+	+	+
Asteraceae				+				+	+	+	+
Brassicaceae									+		
Chenopodiaceae		+						+		+	+
Cyperaceae		+	+	+	+			+		+	+
Ericaceae			+								+
Fabaceae											+
Liliaceae				+							
Malvaceae				+							
<i>Myriophyllum</i> L.											+
Onagraceae											+
Poaceae	+	+	+	+	+	+	+	+	+	+	+
Polygonaceae		+					+				+
Primulaceae		+							+		+
Scrophulariaceae								+	+		+
Solanaceae		+									+
<i>Triglochin</i> -type		+	+	+				+		+	+
Typhaceae											+
Bryophyta											
<i>Anthoceros</i> L.				+		+		+	+		+
<i>Phaeoceros</i> L.				+	+	+	+	+	+	+	+
Pteridophyta											
Monolete psilate		+	+	+		+	+	+	+	+	+
Monolete verrucate		+		+		+		+	+	+	+
Trilete psilate						+	+	+	+	+	+
Trilete verrucate				+			+	+	+	+	+
<i>Lophozoria</i> C. Presl.						+		+	+	+	+
<i>Lycopodiella</i> C. Presl.	+		+			+		+	+	+	+

TABLE 2—List of pollen and spores taxa from the samples of the core B-2.

Costa & Davy (1992), Costa *et al.* (1997), Seeliger (1992) and Azevedo (2000) (Table 1). The arboreal pollen presence in surface samples and the complete absence of arboreal plants and shrubs in salt marshes may be easily explained by wind or water current transport of pollen from the neighboring lands. The herbaceous pollen from surface sediments approximately coincide *sensu lato* with the composition of herbaceous terrestrial and aquatic plants, growing in the salt and brackish-water marshes. The dinoflagellate cysts, acritarchs and microforaminifera, together with the *Triglochin* type pollen can be used as indicative palynomorphs for salt marshes in the coastal plain. These palynomorphs are completely absent in the surface sediments of the adjacent wetland (Medeanic, 2004).

Palynological study of the Core B-2

The palynomorphs were identified in the three layers from depth intervals –23–24 m, 7.2–11.6 m, 3.5–7.2 m of core B-2, represented by clay and mud. The absolute age of the sample at the depth 23.2 m, established by ^{14}C dating is 9.400 ± 140 yrs BP and for the sample at the depth 5.0 m is 7.370 ± 150 yr BP

(Fig. 3). The palynomorphs recovered from these layers are similar and differ only in the frequency of some taxa, especially acritarch and dinoflagellate cysts, and microforaminifera linings portion (Fig. 3, Table 2). The recovered palynomorphs represented by terrestrial and aquatic plant pollen and spores, coccal algae Chlorophyta zygospores, rare acritarchs and fungal spores. Arboreous pollen is represented by Apocynaceae, Euphorbiaceae (*Alchornea* Swartz), Palmae and others. The herbaceous pollen (NAP) predominate. The most frequent are Poaceae, Asteraceae, Chenopodiaceae and Cyperaceae pollen. Halophyllous plant pollen, such as *Triglochin* type, are constantly present. The monolete psilate, monolete verrucate, trilete psilate and trilete verrucate fern spores are notable. Cysts of acritarchs and dinoflagellates and microforaminifera linings are constantly present. *Debarya*, *Mougeotia* and *Spirogyra* zygospores were found.

The difference between palynomorph taxa composition and their frequency is probably due to the sea-level oscillations and climatic changes. Relatively frequent *Azolla filiculoides* spores and xerophilous and halophilous plant pollen (Asteraceae, Chenopodiaceae, Cyperaceae, Juncaginaceae-*Triglochin* type, Juncaceae) are indicative for the brackish water and salt marshes. The palynomorph assemblages from these three intervals are comparable with the palynomorph assemblage from the surface sediments of the salt marsh and are indicators for salt marshes in the coastal plain of Rio Grande do Sul State during the Early and Middle Holocene.

CONCLUSIONS

A detailed pollen morphology description of *T. striata*, was carried out in Brazil for the first time. This description can be used for the identification of dispersed subfossil pollen *Triglochin* type and supplement the catalogue of the modern pollen, distributed in Rio Grande do Sul State, as well as the Pollen Database for Latin America.

The dispersed subfossil *Triglochin* type pollen was recognized in palynomorph assemblages from the surface sediments of salt marshes in the estuarine part of the Patos Lagoon. This pollen was recovered and identified from samples together with other pollen of Asteraceae, Chenopodiaceae, Cyperaceae, Poaceae, aquatic fern *Azolla filiculoides* spores, *Phaeoceros* mosses, dinoflagellate and acritarch cysts, *Tetraploa* fungal spores and microforaminifera linings.

The specific *Triglochin* type pollen morphology and the limited geographic distribution of this genus indicative of elevated saline environments together with the other taxa (cysts of acritarchs, dinoflagellates, microforaminifera linings, etc.).

The obtained pollen and spore assemblages generally correlate with to the vegetation cover of the salt marshes in the studied region. The occurrence of dispersed *Triglochin* type pollen in Holocene sediments provides additional evidence for the wide spreading of the salt and brackish water marshes in the past.

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OSTRACODA FROM LEE POINT ON SHOAL BAY, NORTHERN AUSTRALIA: PART 3. PODOCOPINA (CYTHERACEA)

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Abstract

Recent littoral environments within Shoal Bay, Northern Territory (Australia) contain a very high diversity of cytheracean Ostracoda (51 genera/subgenera and 97 species/subspecies). This diversity is probably a consequence of three factors: (1) warm, well oxygenated marine environments conducive to high rates of biological productivity; (2) shallow marine environments which are favourable to post mortem accumulation of shell material, and (3) a central location on the continental shelf dispersal route between the SW Pacific and SE Asian regions. A particular feature of this cytheracean fauna is that a number of genera, such as *Alocopocythere*, can be traced back through the fossil record to the Cretaceous when they first evolved in the shallow waters of Tethys. Overlain on this ancient taxonomic component of the fauna are those dominant modern Indo-Pacific taxa, which include genera such as *Keijia*. The Cytheracea dominate the overall ostracod fauna of the study area, although the other groups, particularly the marine Cypridacea, Bairdiacea and Platycopina are very well represented and quite diverse (see Whatley *et al.*, 1995, 1996). One new genus, *Paraxestoleberis*, is described and 15 species are new: *Dentibythere multituberosa*, *Dampiercythere papillolineata*, *Neocytheromorpha papilloporosa*, *Loxoconcha catasteros*, *Semicytherura gamma*, *Callistocythere cookei*, *Loxocorniculum koolpionyahensis*, *Keijia intermedia*, *K. profundosculpta*, *K. parademissa*, *Quasibradleya leepointensis*, *Actinocythereis gippsi*, *Henryhowella sinespinosa*, *Ponticocythereis spatulospinosa* and *Paraxestoleberis posteroacuminata*. Due to insufficiency of material, 16 species are left in open nomenclature: *Bythoceratina* sp., *Corallicythere* sp., *Venericythere* sp., *Tanella* sp., *Loxocorniculum* sp. 1, *L.* sp. 2, *Gambiella* sp., *Javanella* sp., *Paradoxostoma* sp., *Neomonoceratina* sp., *Bradleya* (s.l.) sp., *Echinocythereis* (s.l.) sp., *Platycythereis*? sp., *Alocopocythere* sp., *Xestoleberis* sp. and *Paraxestoleberis* sp. The remaining 66 species/subspecies have all been previously described or are compared with previously described species.

Key words: Ostracoda, Cytheracea, new species and genus, Recent, Shoal Bay, Northern Australia.

Resumen

Los ambientes litorales actuales en Shoal Bay, Northern Territory (Australia) muestran una alta diversidad de ostrácodos cytheráceos (51 géneros y 97 especies). Probablemente esta diversidad es debida a tres factores: (1) ambientes marinos cálidos y bien oxigenados que conducen a un alto nivel de productividad biológica; (2) ambientes someros marinos favorables para la acumulación *post mortem* de material conchífero, y (3) una ubicación central en el camino de dispersión sobre la plataforma continental, entre las regiones del Pacífico y de Asia suroriental. Una característica particular de esta fauna de Cytheracea es que algunos géneros, como por ejemplo *Alocopocythere*, pueden remontarse hasta el Cretácico cuando aparecieron por primera vez en las aguas someras del Tethys. En superposición a esta componente antigua de la fauna están los ostrácodos dominantes en las asociaciones modernas del Indo/Pacífico, como el género *Keijia*. Mientras los Cytheracea son los ostrácodos dominantes, otros grupos, especialmente los Cypridacea marinos, Bairdiacea y Platycopina, están bien representados y son bastante diversos (*vide* Whatley *et al.*, 1995, 1996). Se describe aquí un

género nuevo, *Paraxestoleberis*, y 15 especies nuevas: *Dentibythere multituberosa*, *Dampiercythere papillolineata*, *Neocytheromorpha papilloporosa*, *Loxoconcha catasteros*, *Semicytherura gamma*, *Callistocythere cookei*, *Loxocorniculum koolpionyahensis*, *Keijia intermedia*, *K. profundosculpta*, *K. parademissa*, *Quasibradleya leepointensis*, *Actinocythereis gippsi*, *Henryhowella sinespinosa*, *Ponticythereis spatulospinosa* y *Paraxestoleberis posteroacuminata*. Debido al escaso material obtenido, 16 especies se mantienen en nomenclatura abierta: *Bythoceratina* sp., *Corallicythere* sp., *Venericythere* sp., *Tanella* sp., *Loxocorniculum* sp. 1, *L.* sp. 2, *Gambiella* sp., *Javanella* sp., *Paradoxostoma* sp., *Neomonoceratina* sp., *Bradleya* (s.l.) sp., *Echinocythereis* (s.l.) sp., *Platycythereis?* sp., *Alocopocythere* sp., *Xestoleberis* sp. y *Paraxestoleberis* sp. Las restantes 66 especies han sido descritas previamente en otras áreas.

Palabras clave: Ostracoda, Cytheracea, nuevo género, nuevas especies, Reciente, Shoal Bay, Norte de Australia.

INTRODUCTION

Ostracods of the podocopid superfamily Cytheracea are very diverse in the warm shallow marine seas of northern Australia. Cytheraceans from Recent littoral environments of Shoal Bay within the Beagle Gulf, Northern Territory (Australia) include genera with ancient Cretaceous Tethyan origins, such as *Alocopocythere* as well as typical modern Indo-Pacific taxa such as *Keijia* (NB. *Keijia* also occurs in the Atlantic and Caribbean).

As a consequence of the large complexity of easily discernible carapace characters, ornate cytheraceans have commonly been finely subdivided into a large array of genera. This practice has probably led to ornate groups of ostracods having been split into more genera than non-ornate groups, relative to that which might be apparent from the examination of soft part anatomy. As our knowledge of modern and fossil ostracod faunas grows, it is becoming increasingly apparent that greater efforts towards understanding morphological associations between cytheracean genera are needed in order to gain better insights into phylogenetic relationships. Therefore, the taxonomic discussions presented here aim at extending taxonomic concepts and knowledge of taxonomic relationships for northern Australian cytheracean Ostracoda. Many of these have been previously considered in major works by Brady, 1880; Hartmann, 1978; Whatley & Zhao, 1987, 1988; Howe & McKenzie, 1989; Yassini *et al.*, 1993; Mostafawi, 1992; Dewi, 1997, and Titterton *et al.*, 2001.

Ostracods were collected from back beach to tidal flat sediment samples gathered from Lee Point on

the coast of Shoal Bay approximately 15 kilometres northeast of Port Darwin in the north of the Northern Territory of Australia. Details of the sites and the sample settings are given in Whatley *et al.*, 1995. Non-cytheracean ostracods obtained from the same samples were described and illustrated in two previous papers (Whatley *et al.*, 1995, 1996). The present paper, which is the third in this series on the ostracod faunas from these samples, deals exclusively with the dominant Cytheracea and concludes the documentation of this diverse and important fauna.

This paper is one of a series, with which the ostracod group at the University of Wales, Aberystwyth, has initiated or been associated with, designed to extend our knowledge of the benthonic Ostracoda of the Indo-Pacific, Australia, Indonesia and adjacent areas. This research programme concentrates on the systematics and taxonomy of the various faunas and on their zoogeography, particularly their migrational history. Whatley, 1986, and Titterton & Whatley, 1988b, began this endeavour based on a study of the fauna of the Solomon Islands and an analysis of the existing literature. Since this date, important studies by a number of authors in the region have provided much more detailed and comprehensive data, although the zoogeographical provincial structures outlined by Titterton & Whatley remain more or less intact. Among the important contributions of the last decades are Behrens, 1991a, b, 1992 (Great Barrier Reef); Cabiocch *et al.*, 1986 (New Caledonia); Dewi, 1997 (Java Sea); Howe & McKenzie, 1989 (NW Australia); Jellinek, 1993 (Kenya); Labutis, 1977 (southern Great Barrier Reef); Montenegro *et al.*,

2004 (Thailand); Mostafawi, 1992 (Malaysia); Mostafawi *et al.*, 2005 (Indonesia); Titterton & Whatley (1988a, 2005 & in press a, b, c, d & e Solomon Islands); Whatley *et al.*, 1995 & 1996 (Northern Australia); Whatley & Keeler, 1989 (Reunion Island); Whatley & Zhao, 1987 & 1988 (Malacca Straits); Whatley, 2000; Whatley & Jones, 1999; Whatley *et al.*, 2000 (Easter Island); Whatley & Roberts, 1995; Whatley *et al.*, 2004 (Pitcairn Group), Yassini *et al.*, 1993 (Eastern Australia), Yassini & Jones, 1995 (Eastern Australia), Zhao & Whatley, 1989 (Malaysia).

The high cytheracean diversity here reported from Lee Point on Shoal Bay, northern Australia probably relates to three factors. These are the presence of (1) warm, well oxygenated marine environments conducive to high rates of biological productivity; (2) shallow marine environments which are favourable to post mortem accumulation of shell material, and (3) a central location on the continental shelf dispersal route between the SW Pacific and S. E. Asian regions. The Cytheracea dominate the overall ostracod fauna of the study area, although the other groups, particularly the marine Cypridacea, Bairdiacea and Platycopina are very well represented and are also quite diverse (see Whatley *et al.*, 1995, 1996).

SYSTEMATIC DESCRIPTIONS

All specimens are deposited in the collections of the Palaeontology Department, The Natural History Museum (London) and are registered in the collection reference file under catalogue numbers prefixed BB/NA (or BB). The following conventions are employed: A: adult; juv.: juvenile; RV: right valve; LV: left valve; C: articulated carapace; A-1: penultimate instar; A-2: antepenultimate instar; rpc: radial pore canals; npc: normal pore canals; im: inner margin; om outer margin. Dimensions are quoted in millimetres. Size groupings are based on the following standards for length: less than 0.4 mm, very small; 0.4-0.5 mm, small; 0.5-0.7 mm, medium; 0.7-1.0 mm, large; greater than 1.0, very large. Qualitative references to the abundance of radial pore canals and normal pore canals are based on the following numerical framework: less than 30, few; 30-70, numerous; greater than 70, very numerous. Distribution data within the systematic palaeontology only pertains to the samples examined for this study (outlined in Fig. 2 of Whatley *et al.*, 1995).

Phylum CRUSTACEA Pennant, 1777
Class OSTRACODA Latreille, 1806
Order PODOCOPIDA Müller, 1894
Suborder PODOCOPINA Sars, 1866
Superfamily CYTHERACEA Baird, 1850
Family BYTHOCYTHERIDAE Sars, 1926
Genus *Bythoceratina* Hornibrook, 1952
Bythoceratina scabrocuneata (Yassini, Jones & Jones, 1993) comb. nov.
(Pl. 1, Fig. 15)

1993 *Dentibythere scabrocuneata* Yassini *et al.*, p. 394, Pl. 6, Figs. 109-114.

Material.—1 adult valve.

Distribution.—Sample A5.

Dimensions.

	Length	Height
ARV, BB/NA 011	0.40	0.20

Remarks.—A species of *Bythoceratina* characterised by its strongly reticulate ornament, strongly alate ventrolateral spine, ventral and dorsal ribs and a proximally plicate anteromarginal rim. *B. orientalis* (Brady, 1869), from Hong Kong, is similar in overall outline to the present species, as well as in possessing a ventral flange or frill, and medium sulcus, but can be distinguished by its lack of strong reticulate ornament.

Bythoceratina sp.
(Pl. 1, Figs. 8-10)

Material.—9 valves.

Distribution.—Samples A4, A5 and B 4.

Dimensions.

	Length	Height
ALV, BB/NA 002	0.50	0.24
ARV, BB/NA 003	0.50	0.24
ALV, BB/NA 004	0.50	0.26
ARV, BB/NA 005	0.48	0.24

Remarks.—The closest species to the present material is *B. bicornis* Mostafawi, 1992, but the latter has a delicate carapace reticulation and two small, short parallel ribs extending ventrally from the dorsal margin at 1/3 distance from the anterior margin. *Bythoceratina scabra* van den Bold, 1960, from the

Eocene and Oligocene of Trinidad is similar to the present species, but possesses a more strongly inflated dorsal region of the carapace. *B. monstruosa* Holden, 1967, from the Neogene of Hawaii also lacks the well developed dorsal rib and its alar process is less strongly bifurcate. Similarly the alar process in *Dentibythere schornikovi* Yassini & Jones, 1995, is less strongly bifurcate than for the species here illustrated. The present species also occurs in reef and reef associated environments of the Java Sea (Watson MS, 1988) and in the Solomon Islands (Titterton & Whatley, in press b).

Genus *Dentibythere* s.l. Schornikov, 1982

Remarks.—*Dentibythere* Schornikov is generally characterised by its coarse surface ornament and a strong denticulate hinge compared to *Bythoceratina* Hornibrook. However, one species illustrated in this study (Pl. 1, Figs. 11-14) possesses rugged ornament typical of *Dentibythere* but a simple lophodont hinge typical of *Bythoceratina*. The differential diagnosis of *Bythoceratina* and *Dentibythere* appears, therefore, to require clarification, although this is beyond the scope of the present study.

Dentibythere multituberosa sp. nov.
(Pl. 1, Figs. 11-14)

Derivatio nominis.—Latin. With reference to the multituberculate nature of the carapace.

Holotype.—ALV, BB/NA 006 (Pl. 1, Fig. 11).

Type locality and level.—Lee Point East, sample A5, Recent.

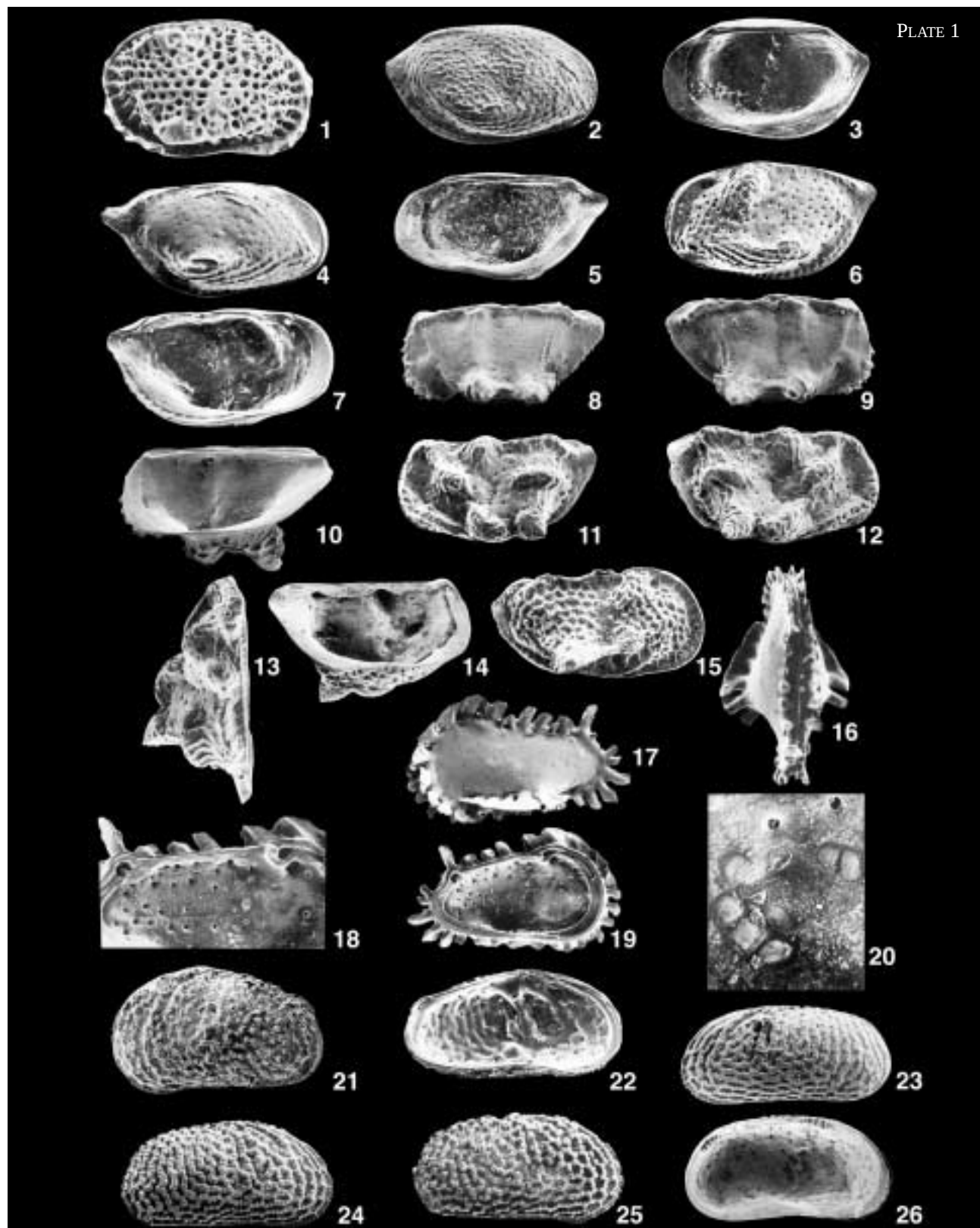
Material.—11 valves. Adult to A-1.

Diagnosis.—A species of *Dentibythere*, characterised by its subquadrate to subrectangular outline and multi-tuberculate surface. The tuberculae are ornamented by riblets and puncta.

Description.—Small, subtranslucent. Subquadrate to subrectangular in lateral view. Anterior margin broad but rather angular, with a weakly developed marginal ridge. Dorsal margin slightly concave, overhung by strong dorsal rib posteriorly and tubercle just anterior of mid-length. Anterior cardinal angle distinct. Posterior cardinal angle obtuse. Posterior margin subcaudate, acuminate; extremity subdorsal. Ventral margin straight, overhung ventromedianly, and posteroventrally by well developed tubercle and blunt alar spine respectively. Greatest length above mid-height. Greatest width through lateral extremity of posteroventral spines. Surface ornament of 5 irregularly spaced tubercles and reticulate meshwork made up of fine riblets, that cover both the tubercles and the inter-tuberculate areas, as do numerous, prominent npc openings that resemble puncta. Anteriorly a weakly developed marginal rib occurs, sub parallel to margin. This marginal rib, becomes divergent anteroventrally to form ventro-lateral rib, which merges with well developed ventromedian tubercle and the very strong, spine-like ala. Dorsal marginal rib extending from posterodorsal cardinal angle to well developed dorsal tubercle medianly. A sharp rib extends from the anterior cardinal angle ventrally, to a large subovate, antero-median tubercle. A pronounced and sinuous median sulcus extends from the dorsal margin to 1/3 the distance from the ventral margin. An elongate, rounded lateral tubercle extends from the posterior edge of the

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PLATE 1–1, *Saida herrigi* Keij, 1975. RV, ext., BB/NA 001, x 123. 2, 3. *Rhombobythere intertexta* Schornikov, 1982; 2, RV, ext., BB/NA 012, x 74; 3, RV, int., BB/NA 012, x 74. 4, 5. *Rhombobythere sulcata* Schornikov, 1982; 4, RV, ext., BB/NA 016, x 92; 5, RV, int., BB/NA 016, x 103. 6, 7. *Rhombobythere tuberculata* Schornikov, 1982; 6, LV, ext., BB/NA 019, x 84; 7, LV, int., BB/NA 021, x 84. 8–10, *Bythoceratina* sp.; 8, LV, ext., BB/NA 002, x 74; 9, RV, ext., BB/NA 003, x 74; 10, RV, int., BB/NA 003, x 74. 11–14, *Dentibythere multituberosa* sp. nov.; 11, Holotype, LV, ext., BB/NA 006, x 71; 12, Paratype, RV, ext., BB/NA 008, x 73; 13, Holotype, LV, dorsal, BB/NA 006, x 74; 14, Holotype, LV, int., BB/NA 006, x 73. 15, *Bythoceratina scabrocuneata* (Yassini et al., 1993). RV, ext., BB/NA 011, x 90. 16–20, *Pterygocythereis velivola* (Brady, 1880); 16, Female, carapace, dorsal, BB/NA 038, x 53; 17, Female, LV, ext., BB/NA 033, x 49; 18, LV, hinge detail, BB/NA 034, x 98; 19, Female, LV, int., BB/NA 034, x 49; 20, LV, central muscle scar detail, BB/NA 034, x 295. 21, 22. *Corallicythere* sp.; 21, Female, LV, ext., BB/NA 022, x 66; 22, Female, LV, int., BB/NA 022, x 66. 23–26, *Dampiercythere papillolineata* sp.; nov. 23, Holotype, Male, LV, ext., BB/NA 023, x 51; 24, Paratype, Female, RV, ext., BB/NA 026, x 52; 25, Paratype, Female, carapace, ext. view of RV, BB/NA 028, x 57; 26, Paratype, Female, LV, int., BB/NA 025, x 52.



median sulcus, to reach the posterior margin medianly. Inner lamella narrow, im subparallel to om. Small crescentic vestibulum anteriorly. Rpc rather few, simple, slightly sinuous. Central muscle scars; a subvertical row of 5 ovate adductors. Dorsal-most adductor largest; remainder decreasing in size towards ventral margin. Hinge; lophodont.

Distribution.—Samples A1-A5.

Dimensions.

	Length	Height
Holotype ALV, BB/NA 006	0.50	0.26
Paratype ALV, BB/NA 007	0.48	0.26
Paratype ARV, BB/NA 008	0.48	0.26
Paratype ALV, BB/NA 009	0.50	0.24
Paratype ARV, BB/NA 010	0.48	0.24

Remarks.—The present species is closest in external appearance to *Bythoceratina* sp. McKenzie, 1974, although the latter differs in not possessing an elongate posteromedian tubercle or posteroventral subalar process with broad, sharp spine. Furthermore the dorsal rib in McKenzie's species is less strongly developed. This species is superficially very similar to *Dentibothere dentata* Schornikov, 1982, but differs in lacking large marginal denticles and in its lophodont hinge. Very similar in external ornament to *Dentibothere dentata* Schornikov as illustrated by Yassini & Jones, 1987, and Yassini *et al.*, 1993, except that the present species has a much stronger mid-posterior node.

Genus *Rhombobothere* Schornikov, 1982
Rhombobothere intertexta Schornikov, 1982
 (Pl. 1, Figs. 2-3)

1982 *Rhombobothere intertexta* Schornikov, p. 70, Pl. 9, Figs. 1-2.

1995 *Rhombobothere intertexta* Schornikov. Yassini & Jones, p. 321, Figs. 125, 128, 130, 132, 134.

Material.—95 valves.

Distribution.—Sample A1-A5 and B1-B4.

Dimensions.

	Length	Height
ARV, BB/NA 012	0.50	0.30
ALV, BB/NA 013	0.48	0.30
ARV, BB/NA 014	0.50	0.28
ALV, BB/NA 015	0.52	0.30

Remarks.—*Rhombobothere foveolata*, *R. tuberculata* and *R. sulcata*, described by Schornikov, 1982 from Australian reef environments, all broadly resemble the present species in external appearance. *R. foveolata* and *R. tuberculata* differ in lacking a median sulcus, and in their more acuminate caudal processes. *R. sulcata* is larger, has a less acuminate posterodorsal caudal process and a less well developed posteroventral alar process. Howe & McKenzie (1989) record the also similar *R. alata* Schornikov, from Darwin but, since they do illustrate their single specimen, it is not possible to corroborate their identification. *Bythocythere arenicola* Behrens, 1991 from the Great Barrier Reef has very similar ornament but a quite different shape. *Rhombobothere kueneni* (Keij, 1953) is similarly ornamented to the present species, although the former is more rotund in shape.

Rhombobothere sulcata Schornikov, 1982
 (Pl. 1, Figs. 4-5)

1982 *Rhombobothere sulcata* Schornikov, p. 69, Pl. 8, Figs. 3-5.

1992 *Bythoceratina ventristriata* Mostafawi, p. 159, Pl. 7, Figs. 158-159.

Material.—5 valves.

Distribution.—Samples A4-A5.

Dimensions.

	Length	Height
ARV, BB/NA 016	0.44	0.22
ARV, BB/NA 017	0.44	0.24

Remarks.—The acuminate posterodorsal caudal process and weak alar-like tubercle posteroventrally, as well as its smaller size, distinguish the present species from *R. intertexta*, Schornikov 1982. Specimens of *R. tuberculata* Schornikov 1982 collected from samples examined for this study, can be readily distinguished from the present species by their prominent tubercle immediately behind and below the anterodorsal cardinal angle. Mostafawi's (1992) species *Bythoceratina ventristriata* from the Sunda Shelf, SE Asia appears conspecific with the present species.

Rhombobothere tuberculata Schornikov, 1982
 (Pl. 1, Figs. 6-7)

1982 *Rhombocythere tuberculata* Schornikov, p. 67, Pl. 8, Fig. 2.

1993 *Rhombocythere alata* Schornikov. Yassini *et al.*, p. 393, Pl. 6, Figs. 199, 120.

Material.—17 valves, 1 carapace.

Distribution.—Sample A3-A5, B2, B4.

Dimensions.

	Length	Height
ARV, BB/NA 018	0.40	0.24
ALV, BB/NA 019	0.36	0.20
ARV, BB/NA 020	0.40	0.22
ALV, BB/NA 021	0.36	0.20

Remarks.—The present species is closest to *R. sulcata* Schornikov in external appearance and size, the latter being distinguished by lack of a prominent tubercle immediately behind and below the anterior dorsal cardinal angle and in being more acuminate posterodorsally.

Family CYTHERIDEIDAE Sars, 1925
Subfamily CYTHERIDEINAE Sars, 1925
Genus *Corallicythere* Hartmann, 1974
Corallicythere sp.
(Pl. 1, Figs. 21, 22)

Material.—1 valve.

Distribution.—Sample A4.

Dimensions.

	Length	Height
ALVF, BB/NA 022	0.56	0.32

Remarks.—The present species resembles *Dampiercythere papillolineata* sp. nov. of the present study, but differs externally in being less elongate, and having its tubercles less regularly orientated. Internally the two can be distinguished by the difference in muscle scar pattern, 3 adductors in *Corallicythere* as opposed to 4 in *Dampiercythere*. The generic assignment of this species is uncertain because the one specimen to hand may be juvenile, in that its inner lamella is very narrow and poorly developed. Watson (MS, 1988) records a very similar species from reef environments in the Java Sea. *Corallicythere arcanis* Behrens, 1991, from the northern Great Barrier Reef differs in being only feebly ornamented peripherally and smooth medianly. *Corallicythere* sp. Mostafawi, 1992, from the Sunda Shelf (SE Asia) differs from the present species by

possessing a more concave ventral margin and coarser ornament.

Genus *Dampiercythere* Hartmann, 1978

Dampiercythere papillolineata sp. nov.

(Pl. 1, Figs. 23-26; Pl. 2, Figs. 1-2)

Derivatio nominis.—Latin. Referring to the ornament of papillae which are arranged in rows.

Holotype.—LVM, BB/NA 023 (Pl. 1, Fig. 23).

Type locality and level.—Lee Point East, sample A4. Recent.

Material.—31 valves, 10 carapaces. Adult to A-1.

Diagnosis.—A species of *Dampiercythere* characterised by its subrectangular outline and broadly rounded end margins. Surface ornament of papillae arranged in rows; vertically (posteriorly and medianly) and longitudinally (ventrally and anteriorly).

Description.—Medium to large, thick-shelled, elongate subrectangular, in lateral view. Anterior margin asymmetrically rounded, extremity below mid-height. Dorsal margin straight to very slightly convex. Cardinal angles obtuse. Posterior margin broadly rounded, extremity at mid-height. Ventral margin straight. Surface ornamentation of papillae arranged in rows; vertically (posteriorly and medianly) and horizontally (ventrally). Anteriorly papillae arranged in 3-4 rows, subparallel to anterior margin. Npc few. Inner margin narrow but robust. Rpc moderately numerous, simple, short. Avestibulate. Four adductors in a subvertical row; three dorsal-most scars equidimensional, ventral scar large and rounded. Frontal scar “L” shaped, opening anteriorly. Hinge antimerodont with strongly developed terminal elements, comprising in the RV, a dentate bar with 5 teeth anteriorly and 4 posteriorly separated by a uniformly locellate median groove. Sexual dimorphism not very pronounced.

Distribution.—Samples A3-A5 and B2, B4.

Dimensions.

	Length	Height
Holotype ALVM, BB/NA 023	0.72	0.34
Paratype ARVM, BB/NA 024	0.76	0.32
Paratype ALVF, BB/NA 025	0.70	0.32
Paratype ARVF, BB/NA 026	0.70	0.34
Paratype ALVF, BB/NA 027	0.68	0.34
Paratype ACF, BB/NA 028	0.64	0.32

Remarks.—The present species resembles *Dampiercythere tuberoreticulata* Hartmann, 1978,

from the west coast of Australia, but differs in its more regular arrangement of papillae. The form of the papillae within the present species ranges from low and smoothly rounded, to elevated with castellate distal endings. *Corallicythere* sp. (this study) is also superficially very similar but can be distinguished by differences in its muscle scars, less orderly arrangement of papillae and more flared anterior margin.

Dampiercythere tuberoreticulata Hartmann, 1978
(Pl. 2, Figs. 3-4)

1978 *Dampiercythere tuberoreticulata* Hartmann,
p. 74, Pl. 13, Figs. 13-30; Pl. 14, Figs. 1-3.

Material.—111 valves, 67 carapaces. Adult to A-1.

Distribution.—Samples A1, A3-A5 and B1-B4.

Dimensions.

	Length	Height
ARV, BB/NA 029	0.71	0.32
ALV, BB/NA 030	0.74	0.31
ARV, BB/NA, 031	0.78	0.31
ALV, BB/NA, 032	0.72	0.34

Remarks.—The present material, with its delicate reticulum and deeply lipped median sulcus is identical in all respects to that described by Hartmann, 1978, from the eulittoral of Western Australia, except that the development of papillae is not as marked as in Hartmann's specimens. Occasionally, presumably due

to abrasion, the papillae are absent altogether. The present species is similar to *Dampiercythere papillolineata* sp. nov., the latter differing in having a strongly developed lateral surface ornament of papillae arranged in horizontal and vertical rows, and a more rounded posterior margin. *Corallicythere verrucosa* Hartmann, 1974, can be distinguished from the present species by its smaller size, less elongate rectangular shape, and in the nature of its surface ornament.

Family CYTHERIDAE Baird, 1850

Genus *Saida* Hornibrook, 1952

Saida herrigi Keij, 1975

(Pl. 1, Fig. 1)

1975 *Saida herrigi* Keij, p. 238, Pl. 2, Figs. 5-8.

Material.—1 valve.

Distribution.—Sample A4.

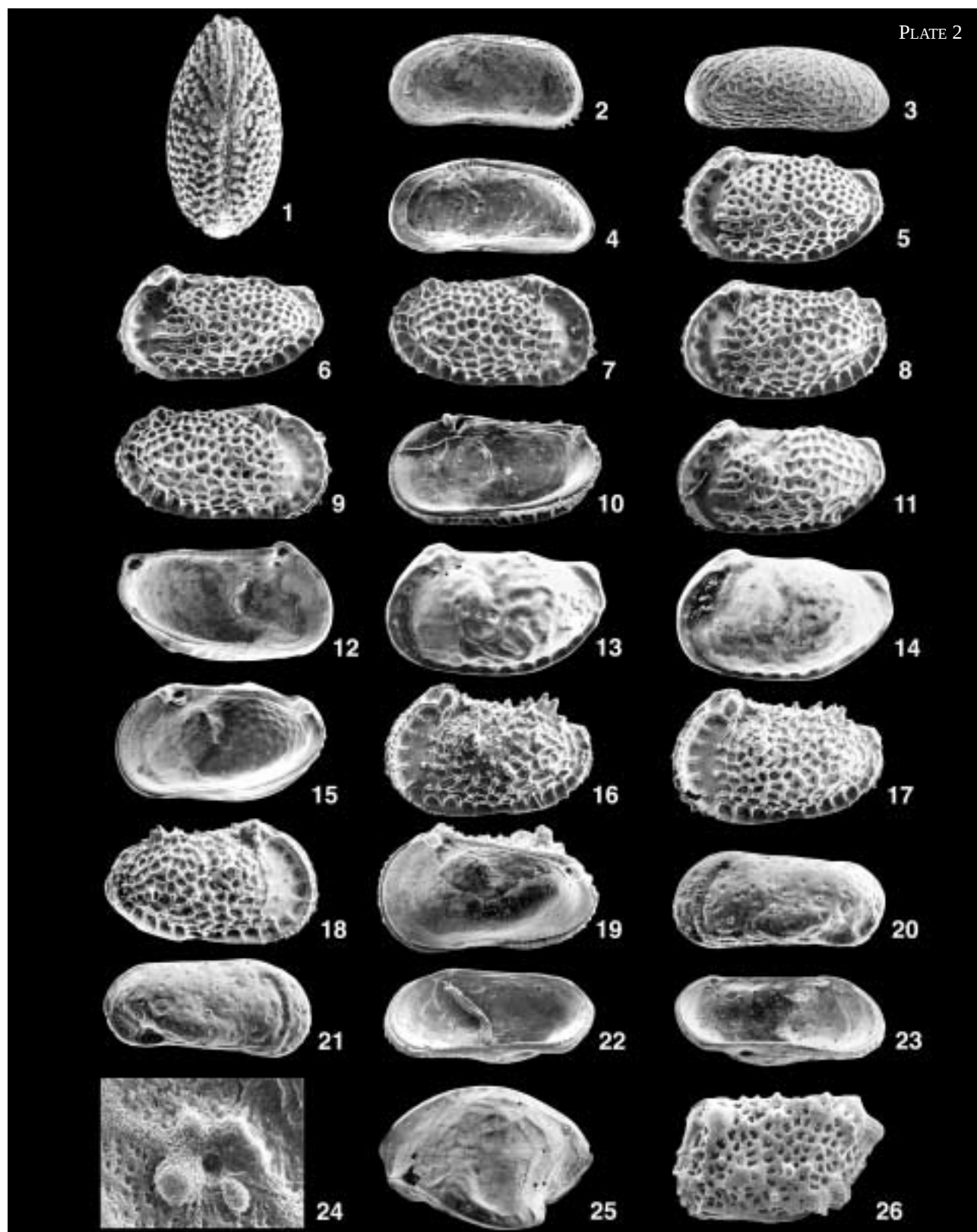
Dimensions.

	Length	Height
ARV BB/NA 001	0.30	0.20

Remarks.—*Saida herrigi* Keij, 1975, recorded from the Holocene of Indo-Malaysia is very similar to *S. torresi* (Brady, 1880) from the Torres Strait, off northern Australia. However, *S. herrigi* has a more triangular shaped ala on each valve and usually a more curved and thickened posterodorsal carina. As assessed from the illustrations presented in Hornibrook,

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PLATE 2—1, 2. *Dampiercythere papillolineata* sp. nov.; 1, Paratype, carapace, dorsal, BB/NA 028, x 61; 2, Paratype, Female, RV, int., BB/NA 024, x 56. 3, 4. *Dampiercythere tuberoreticulata* Hartmann, 1978; 3, Male, LV, ext., BB/NA 030, x 53; 4, Female, RV, int., BB/NA 029, x 53. 5-10, *Alocopocythere ventrocostata* (Howe & McKenzie, 1989); 5, Female, LV, ext., BB/NA 041, x 61; 6, Male, LV, ext., BB/NA 042, x 61; 7, Female, RV, ext., BB/NA 039, x 61; 8, Female, LV, ext., BB/NA 043, x 61; 9, Male, RV, ext., BB/NA 040, x 61; 10, Female, RV, int., x 61. 11, 12. *Alocopocythere* sp.; 11, Female, LV, ext., BB/NA 044, x 48; 12, Female, LV, int., BB/NA 044, x 48. 13-15, *Neocytheretta adunca horrida* (Mostafawi, 1992); 13, BB/NA 046, Female, LV, ext., x 53; 14, BB/NA 048, Female, LV, ext., x 54; 15, BB/NA 047, Female, RV, int., x 54. 16-19, *Neocytheretta spinobifurcata* Yassini et al., 1993; 16, Female, LV, ext., BB/NA 051, x 79. 17, Female, LV, ext., BB/NA 053, x 75; 18, Female, RV, ext., BB/NA 052, x 75; 19, Female, RV, int., BB/NA 052, x 75. 20-24, *Neocytheromorpha papilloporosa* sp. nov.; 20, Holotype, LV, ext., BB/NA 055, x 79; 21, Paratype, RV, ext., BB/NA 056, x 75; 22, Paratype, RV, int., BB/NA 056, x 79; 23, Holotype, LV, int., BB/NA 055, x 79; 24, Holotype, LV normal pore detail (external surface), BB/NA 055, x 754. 25, *Cytheropteron alabarda* Bonaduce et al., 1976. LV, ext., BB/NA 057, x 132. 26, *Eucytherura* sp. cf. *E. orientalis* Kingma, 1948. LV, ext., BB/NA 059, x 123.



1952, *S. truncula* Hornibrook from New Zealand differs from *S. herrigi* by virtue of its less conspicuous posterodorsal carina. *S. truncula* can be further distinguished from the present species by its straight, flat dorsal margin. Nevertheless, these three very similar species require further study to fully verify their taxonomic relationships. *S. herrigi* was also recorded from the Great Barrier Reef, Australia by Labutis (MS, 1977).

Genus *Loxocythere* Hornibrook, 1952
Subgenus *Novoloxocythere* Warne, 2004
Loxocythere (Novoloxocythere) kerrysoni
(Yassini & Jones, 1995)
(Pl. 3, Figs. 9-11)

- 1987 *Microcytherura* sp. Yassini & Jones, p. 819, Figs. 52–55.
1989 *Microcytherura* sp. Howe & McKenzie, p. 16, Fig. 66.
1995 *Microcytherura (Loxocythere) kerrysoni* Yassini & Jones, p. 348-349, Figs. 587-591.
2004 *Loxocythere (Novoloxocythere) kerrysoni* (Yassini & Jones). Warne, p. 250.

Material.—29 valves, 2 carapaces. Adults only.
Amended description.—Small, thick-shelled, subrhomboidal to subtriangular in lateral view. Anterior margin obliquely rounded, extremity subventral. Dorsal margin straight, cardinal angles rounded. Posterior margin obliquely rounded, subcaudate, extremity well above mid-height. Ventral margin nearly straight, slight incurvature orally. Eye spot large, glassy. Greatest length median, greatest height through anterior cardinal angle. Strong subalar inflation mid ventrolaterally. Sexual dimorphism not observed. Avestibulate, marginal zone narrow. Rpc few, short, simple. Central adductors muscle scars consist of an inclined vertical row of four subovate adductors.
Distribution.—Sample A1-A5, B1, B4.
Dimensions.

	Length	Height
ALV BB/NA 068	0.34	0.20
ARV BB/NA 069	0.32	0.18
ALV BB/NA 070	0.32	0.20
ARV BB/NA 071	0.32	0.18

Remarks.—A species of *Loxocythere (Novoloxocythere)* that is convergent in morphology towards

various cytheropterines such as a *Oculocytheropteron catasteros* sp. nov. (see also discussion in Warne, 2004).

Family CYTHERURIDAE G.W. Müller, 1894
Subfamily CYTHEROPTERINAE Hanai, 1957
Genus *Cytheropteron* Sars, 1866
Cytheropteron alabarda Bonaduce, Masoli & Pugliese, 1976
(Pl. 2, Fig. 25)

- 1976 *Cytheropteron alabarda* Bonaduce *et al.*, p. 392, Pl. 9, Figs. 7-8.
1988 *Cytheropteron alabarda* Bonaduce *et al.*, Whatley and Zhao, p. 43, Pl. 4, Figs. 15-17.
1993 *Cytheropteron* sp. 2 Yassini *et al.*, p. 404, Pl. 9, Fig. 163.

Material.—1 adult valve.
Distribution.—Sample A 4.
Dimensions.

	Length	Height
ALV BB/NA 057	0.30	0.16

Remarks.—This species is most similar to *Oculocytheropteron* sp. cf. *raybatei* McKenzie & Pickett of Whatley & Keeler, 1989, from Reunion Island but differs in having a more rounded anterior margin, which lacks anterodorsal marginal scalloping. The presence in the latter, of a small almost indistinct glassy eye tubercle also distinguishes the two species. *O. microfornix raybatei* McKenzie & Pickett, 1984 n. comb. (see below), can be distinguished from the present species by its larger size, subrectangular to subovate outline in lateral view, stronger, more pronounced alar development, presence of a small eye spot (expressed internally by a large ocular sinus below the anterior cardinal angle); and by differences in surface ornament. Unlike *C. alabarda*, which has a surface ornament of faint reticulae, *O. microfornix raybatei* has an ornament composed of numerous evenly spaced papillae. Other similar Australian species, which differ in details of their ornamentation, size and shape are *C. bermaguense* Yassini & Jones, 1995 and *C. wrighti*. Yassini & Jones, 1987. *Cytheropteron crassipinatum* Brady & Norman of Whatley & Masson, 1979, from Britain differs in being more elongate and having a less rounded alar process.

Genus *Oculocytheropteron* Bate, 1972

Oculocytheropteron microfornix raybatei (McKenzie, 1984) comb. nov.
(Pl. 3, Figs. 6-8)

1984 *Oculocytheropteron raybatei* McKenzie [in McKenzie & Pickett], Pl. 6, Figs. G, H.

1989 *Oculocytheropteron* sp. cf. *raybatei* McKenzie. Whatley & Keeler, Pl. 1, Fig. 16.

1993 *Cytheropteron wrighti* Yassini & Jones, 1987. Yassini *et al.*, p. 404, Pl. 9, Figs. 159-160.

Material.—51 valves. Adult to A-1.

Dimensions.

	Length	Height
ARV BB/NA064	0.36	0.20
ALV BB/NA065	0.40	0.20
ARV BB/NA066	0.38	0.22
ALV BB/NA067	0.28	0.22

Distribution.—Sample A3-A5, B4.

Remarks.—The present species is very similar to *O. microfornix* s.s. Whatley & Downing, 1983, from the Miocene of Victoria, Australia. However, *O. microfornix raybatei* possess a well developed series of ribs extending from the posterior of its alar process obliquely towards the posterior cardinal angle. *O. microfornix* s.s. lacks such clearly defined ribs. *Loxocythere* (N.) *kerry-swansoni* Yassini & Jones, 1995, and *Oculocytheropteron catasteros* sp. nov. can clearly be distinguished from the present species by their reticulate ornament (the ornament of *O. microfornix raybatei* consisting of numerous papillae covering the whole of the valve surface); more subrectangular outline in lateral view, less convex dorsal margin, and to a lesser extent ventral margin; and lack of a prominent medioventral alar process. Internally *O. microfornix raybatei* can be distinguished from *L. (N.) kerry-swansoni* and *O. catasteros* by its shorter, more strongly developed hinge. *Cytheropteron alabarda* Bonaduce *et al.*, 1976 (and herein) closely resembles the present species but differs in having a more subovate outline in lateral view, less pronounced alar process, lack of a papillose and ribbed surface ornament, and smaller size. This subspecies has been recorded by Whatley & Keeler, 1989, from the Island of Reunion in the S. W. Indian Ocean. Williams, MS 1980, illustrated specimens attributable to this species from the Quaternary of the Solomon Islands as did Watson, 1988, from Recent reef environments of the

Java Sea. *Oculocytheropteron microfornix amphora* (Yassini *et al.*, 1993) n. comb. has thicker posterior ribs extending from the alar to the posterior cardinal angle and less pronounced depressions along the upper surface of the alar process.

Oculocytheropteron catasteros sp. nov.
(Pl. 3, Figs. 12-15)

Derivatio nominis.—Gr. *katasteros*: set with stars. From the fanciful resemblance of the interreticulate punctate ornament of this species to dense star clusters as in the Milky Way galaxy.

Holotype.—ALV BB/NA 072 (Pl. 3, Fig. 12).

Type locality and level.—Lee Point on Shoal Bay, sample A4. Recent.

Material.—15 valves, 2 carapaces. Adults.

Diagnosis.—A species of *Oculocytheropteron* characterised by its delicate reticulate primary ornament and densely punctate secondary surface ornament and weakly developed alate extension.

Description.—Small, thick-shelled, subrhomboidal to subovate in lateral view. Anterior margin obliquely rounded, extremity at mid-height. Dorsal margin slightly convex, cardinal angles rounded. Posterior margin bluntly pointed, subcaudate, extremity at mid-height. Ventral margin nearly straight, slight incurvature orally; overhung by strong ventro-lateral tumidity. Eye spot glassy. Greatest length median, greatest height through anterior cardinal angle. Carapace with delicate primary reticulation and with dense secondary punctation in the fossae. Sexual dimorphism with females shorter and higher anteriorly than males. Avestibulate, marginal zone narrow. Rpc few, short, simple. Central muscle scars consist of an inclined vertical row of four subovate adductors. Frontal scars not observed.

Distribution.—Samples A3-A5, B4, B5.

Dimensions.

	Length	Height
Holotype ALVM BB/NA 072	0.34	0.18
Paratype ALVF BB/NA 073	0.32	0.20
Paratype ARVF BB/NA 074	0.32	0.20
Paratype ARVF BB/NA 075	0.32	0.20

Remarks.—The present species is most similar to *L. (N.) kerry-swansoni* but differs in the strength of its reticulation as well as in the nature and position of the posterior margin. In *L. (N.) kerry-swansoni* the apex of the posterior margin is subdorsal while in the present species it is at

mid height. The hinge line in *L. (N.) kerrywansoni* is straight while in the present species it is convex dorsally. The two species also differ in the size of the eyespot, and the ocular sinus, these features tending to be larger and more obvious in *L. (N.) kerrywansoni*. *O. catasteros* belongs to the same Australasian/S. E. Asian species group as *Oculocytheropteron? infrequens* (Mostafawi, 1992) n. comb., which includes carapace forms that are transitional in morphology towards some species of *Loxocythere (Novoloxocythere)* Warne and *Antarctiloxoconcha* Hartmann (see discussion in Warne, 2004).

Subfamily CYTHERURINAE G. W. Müller, 1894

Genus *Eucytherura* Müller, 1894

Eucytherura sp. cf. *E. orientalis* Kingma, 1948
(Pl. 2, Fig. 26; Pl. 3, Figs. 1-2)

1948 *Eucytherura orientalis* Kingma, p. 93.

1980 *Eucytherura orientalis* Kingma. Hanai *et al.*,
p. 181.

1989 *Eucytherura* cf. *orientalis* Kingma. Howe and
McKenzie, p. 47, Fig. 149.

Material.—1 valve, 2 carapaces. Adult to A-1.

Distribution.—Samples A4, B5.

Dimensions.

	Length	Height
ARV BB/NA 058	0.32	0.20
ALV BB/NA 059	0.32	0.22

Remarks.—The present species differs from *E. multituberculata* Ayress *et al.*, 1995; *E. sp.* 3 Whatley & Downing, 1983, and *E. horrida* McKenzie *et al.*, 1993 in the positions of its tubercles; reticulation pattern and more quadrate outline in lateral view. Watson (MS, 1988) also records this species in Recent reef and reef associated environments in the Java Sea. Howe & McKenzie, 1989, commented on the similarity that this species has with *Eucytherura orientalis* Kingma, 1948, but were uncertain whether their specimens and those of Kingma, 1948, were sufficiently comparable on available illustrations to attribute to the same species.

Genus *Kangarina* Coryell & Fields, 1937

Kangarina sp. cf. *K. macropus* Whatley & Downing,
1983
(Pl. 3, Figs. 3-5)

1974 *Kangarina* sp. McKenzie, p. 177, Pl. 3, Fig.
8.

1983 *Kangarina macropus* Whatley & Downing,
p. 375, Pl. 6, Figs. 20-21; Pl. 7, Figs. 1-2.

1987 *Kangarina macropus* Whatley & Downing,
Warne, p. 442, Pl. 4, Fig. F.

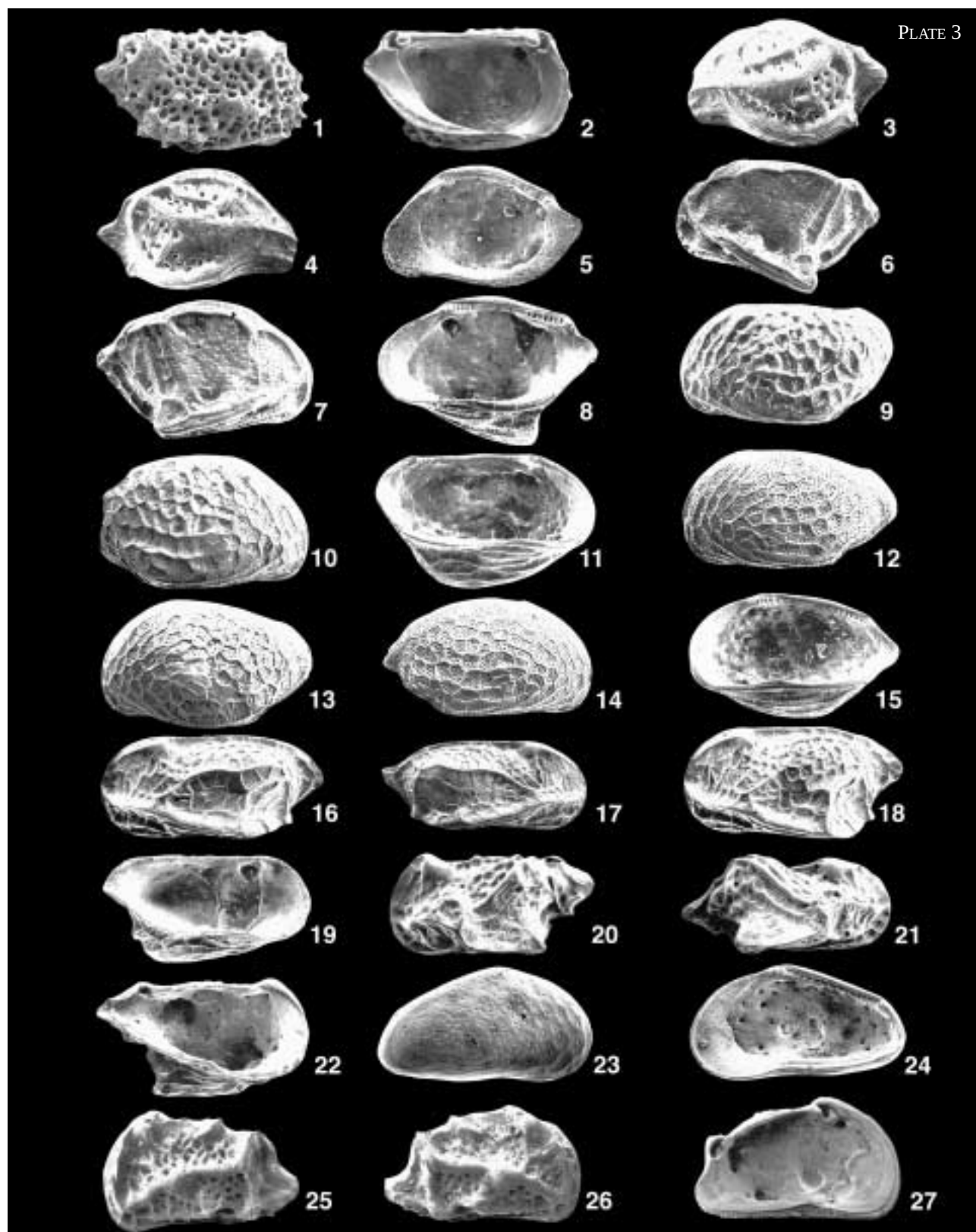
1989 *Kangarina* sp. Howe & McKenzie, p. 47,
Fig. 152.

Material.—14 valves, 4 carapaces. Adult to A-1.

Distribution.—Samples A1, A3-A5; B1, B2,
B4.

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PLATE 3—1, 2. *Eucytherura* sp. cf. *E. orientalis* Kingma, 1948; 1, RV, ext., BB/NA 058, x 118. 2, LV, int., BB/NA 059, x 118. 3-5, *Kangarina* sp. cf. *K. macropus* Whatley & Downing, 1983; 3, LV, ext., BB/NA 061, x 127; 4, RV, ext., BB/NA 060, x 127; 5, RV, int., BB/NA 062, x 127. 6-8, *Oculocytheropteron microforix raybatei* (McKenzie, 1984); 6, Male, LV, ext., BB/NA 065, x 106; 7, Female, RV, ext., BB/NA 064, x 97; 8, Female, RV, int., BB/NA 064, x 102. 9-11, *Loxocythere (Novoloxocythere) kerrywansoni* (Yassini *et al.*, 1993); 9, LV, ext., BB/NA 068, x 112; 10, RV, ext., BB/NA 069, x 110; 11, LV, int., BB/NA 068, x 110. 12-15, *Oculocytheropteron catasteros* sp. nov.; 12, Holotype, Male, LV, ext., BB/NA 072, x 118; 13, Paratype, Female, LV, ext., BB/NA 073, x 118; 14, Paratype, Female RV, ext., BB/NA 074, x 118; 15, Paratype, Female, RV, int., BB/NA 074, x 118. 16-19, *Semicytherura gamma* sp. nov.; 16, Holotype, Male, LV, ext., BB/NA 080, x 93; 17, Paratype, Male, RV, ext., BB/NA 083, x 85; 18, Paratype, Female, LV, ext., BB/NA 081, x 93; 19, Paratype, Female, LV, int., BB/NA 081, x 93. 20-22, *Paracytheridea remanei orientalis* subsp. nov.; 20, Paratype, LV, ext., BB/NA 077, x 68; 21, Holotype, RV, ext., BB/NA 076, x 68; 22, Paratype, LV, int., BB/NA 077, x 68. 23, 24, *Rotundracythere mytila* Hornibrook, 1952; 23, RV, ext., BB/NA 084, x 110; 24, RV, int., BB/NA 084, x 110. 25-27, *Caudites exmouthensis* Hartmann, 1978; 25, LV, ext., BB/NA 085, x 72; 26, RV, ext., BB/NA 086, x 68; 27, LV, int., BB/NA 085, x 72.



Dimensions.

	Length	Height
ARV BB/NA060	0.30	0.20
ALV BB/NA061	0.36	0.20
ARV BB/NA062	0.32	0.20
ALV BB/NA063	0.34	0.20

Remarks.—The present material accords well with Whatley & Downing's (1983) specimens from the Miocene of Victoria, Australia, although it differs in its less well developed posteroventral spine. The present species is also very similar in external appearance to *K. radiata* (Hornibrook, 1952) and further detailed study of both species is required to better document morphological differences. Unillustrated specimens recorded by McKenzie & Peypouquet, 1984, as *Kangarina* sp. come from the type locality for *Kangarina macropus* and may be the same as the later.

Genus *Semicytherura* Wagner, 1957

Semicytherura gamma sp. nov.

(Pl. 3, Figs. 16-19)

1993 *Semicytherura* sp. 2 Yassini *et al.*, p. 404, Pl. 9, Figs. 167, 168.

Derivatio nominis.—Gr. γαμμα. From the fanciful resemblance of the bifurcating median rib of this species to a reclined lower case Greek letter gammadion or gamma.

Material.—12 valves. Adult to A-1.

Holotype.—ALVM BB/NA 080 (Pl. 3, Fig. 16).

Type locality and level.—Lee Point on Shoal Bay, sample A 4. Recent.

Diagnosis.—A species of *Semicytherura* characterised by its subrectangular outline in lateral view, inflated carapace posteriorly, and strong smooth lateral rib extending from the anterior median margin; posteroventrally forming a strong, broad alar process, which bifurcates at quarter length, with a ramus extending diagonally to a postero-dorsal position and overall resembling a reclined Greek letter gamma. Mural walls of fossae with minute vertical striae.

Description.—Small, thick-shelled, opaque, subrectangular in lateral view. Anterior margin broadly rounded, extremity at mid-height. Dorsal margin nearly straight, slightly convex. Cardinal angles obtuse. Posterior margin; subcaudate, acuminate, extremity well above mid-height. Ventral margin concave orally. Greatest length medianly, greatest height through anterior cardinal angle. Eye tubercle prominent, glassy.

Surface ornament of irregular but delicate reticulae, weakly developed costate, and with a strongly developed alar process posteroventrally. Weakly developed ocular rib extending anteromedianly. Strongly developed median rib extending obliquely from anteromedian edge, towards posteroventral margin as an alar process and with a ramus, produced by an anterior bifurcation extending to a postero-dorsal position. Remainder of surface covered with a fine reticulate meshwork. Mural walls with minute vertical striae. Sexual dimorphism marked; males more elongate, and less high, inflated posteromedianly. Females shorter, taller, less obviously inflated posteriorly. Also, males tend to develop a median rib extending from the anterior margin of the alar process (below the eye tubercle) towards the posterodorsal cardinal angle. Inner margin extremely broad, broadest posteriorly. Rpc long, sinuous, simple. Muscle scar details not observed. Hinge modified antimeridont.

Distribution.—Samples A4, A5, B4.

Dimensions.

	Length	Height
Holotype ALVM BB/NA 080	0.42	0.22
Paratype ALVF BB/NA 081	0.40	0.22
Paratype ALVF BB/NA 082	0.40	0.18
Paratype ARVM BB/NA 083	0.40	0.18

Remarks.—The present species resembles *Semicytherura pasila* Barbeito-González, 1971, from the Recent Mediterranean, but the latter lacks the well developed alar process and well developed ocular rib. Both *S. boatswainensis* Hartmann, 1980, and *S. cryptifera* (Brady, 1880) closely resemble the present species but differ in shape and position of the caudal process as well as in the strength of their costae and reticulation. This species is unusual in that sexual dimorphism is manifested in ornamental variation with respect to strength of medium rib development. *S. cryptifera* (Brady) *sensu* Yassini *et al.*, 1993, differs from the present species by possessing an additional lateral rib above and parallel to the ala extending from the anterior margin for about two-thirds the length of the valves. This rib is present at about mid height at the anterior margin and is inclined downwards towards the posteroventral margin.

Subfamily PARACYTHERIDEIDAE Puri, 1957

Genus *Paracytheridea* Müller, 1894

Paracytheridea remanei Hartmann, 1964

Paracytheridea remanei orientalis subsp. nov.

(Pl. 3, Figs. 20-22)

1993 *Paracytheridea remanei* Hartmann. Yassini *et al.*, p. 393, Pl. 5, Fig. 99.

Derivatio nominis.—L. With reference to the fact that the two records of this subspecies are both from locations to the east of known occurrences for the nominative subspecies in the Red Sea and Western Australia.

Holotype.—ARV BB/NA 076 (Pl. 3, Fig. 21).

Type locality and level.—Lee Point on Shoal Bay, sample A 3. Recent.

Material.—360 valves. Adults to A-2.

Diagnosis.—A subspecies of *Paracytheridea remanei* characterised by the absence of a continuous median rib across the subcentral tubercle.

Description.—Medium, thick shelled, subquadrate in lateral outline. Anterior broadly rounded with extremity at mid height. Posterior with strong caudal process; extremity well above mid height. Dorsal margin gently arched. Ventral margin straight anterior of mid length and strongly inclined upwards to posterior extremity posterior of mid length. Surface of carapace with marked posterodorsal “hump-like” swelling and large ventral ala. Strong ribs extend from the posterodorsal margin across the “hump-like” swelling to subcentral tubercle. Internal features as for *P. remanei* s.s.

Distribution.—Samples A1-A5, B1-B4.

Dimensions.

	Length	Height
Holotype ARV BB/NA 076	0.60	0.28
Paratype ALV BB/NA 077	0.60	0.30
Paratype ARV BB/NA 078	0.58	0.28
Paratype ALV BB/NA 079	0.60	0.30

Remarks.—*P. remanei remanei* Hartmann, 1978, from the Red Sea and Western Australia differs in having a median rib that trifurcates at the subcentral tubercle, with the median branch continuous across the tubercle. This continuation of the median rib is absent in the present subspecies. The present subspecies is also more quadrate than *P. remanei* s.s. Sexual dimorphism was noticed in the inflation of the posterodorsal “hump-like” swelling, but females and males could not be consistently separated. A very similar species from the Solomon Islands (Titterton & Whatley, in press, b) differs in possessing 4 strong diagonal ribs extending from the posterodorsal loop to the subcentral tubercle. *Paracytheridea polyspinosa* Hu & Cheng, 1977, and *Paracytheridea echinata* Hu, 1981, are similar in gene-

ral carapace morphology to the present species, but differ in the detail of ridge patterns and reticulate ornament. See also discussion on sexual dimorphism in *P. remanei* and comparative morphology between various *Paracytheridea* spp. in Mostafawi *et al.* (2005).

Family EUCYTHERIDAE Puri, 1953

Genus *Rotundracythere* Mandelstam, 1958

Rotundracythere mytila Hornibrook, 1952
(Pl. 3, Figs. 23-24)

1952 *Eucythere (Rotundracythere) mytila* Hornibrook, p. 29, Pl. 2, Figs. 20-21.

Material.—1 adult RV.

Distribution.—Sample A2.

Dimensions.

	Length	Height
ARV BB/NA 084	0.34	0.20

Remarks.—The present material accords well with Hornibrook’s specimens from New Zealand, apart from lacking the faint reticulate ornament, although this may be due to abrasion. *Eucythere gibba* Edwards, 1944, differs in being shorter, having a more broadly rounded anterior, and a different muscle scar pattern. The present species, as illustrated here, is very similar to *Rotundracythere gracilis* (Yassini & Jones, 1995), although the latter has a greater length to height ratio.

Family HEMICYTHERIDAE Puri, 1953

Subfamily HEMICYTHERINAE Puri, 1953

Genus *Caudites* Coryell & Fields, 1937

Caudites exmouthensis Hartmann, 1978
(Pl. 3, Figs. 25-27)

1978 *Caudites exmouthensis* Hartmann, p. 102, Pl. 9, Figs. 10-11.

Material.—19 valves, 176 carapaces. Adults only.

Distribution.—Samples A1-A5; B1-B5.

Dimensions.

	Length	Height
ALV BB/NA 085	0.54	0.28
ARV BB/NA 086	0.58	0.30
ALV BB/NA 087	0.52	0.30
ARV BB/NA 088	0.50	0.26

Remarks.—The present species differs from *C. scopulicola territoriae* (Howe & McKenzie, 1989) n. comb. from the northern coast of Australia, in the shape and form of the surface ornamentation, i. e. the present species lacks the development of thick strong radial ribs. Whatley & Keeler, 1989, record this species from Reunion Island, SW Indian Ocean, while the type material is from Western Australia.

Caudites scopulicola territoriae (Howe & McKenzie, 1989) comb. nov.
(Pl. 4, Fig. 1)

1989 *Orionina territoriae* Howe & McKenzie, p. 39, Figs. 36, 108, 110.
1993 *Caudites territorii* (Howe & McKenzie). Yassini *et al.*, p. 402.

Material.—3 valves, 1 carapace. Adults only.

Distribution.—Samples A5, B4.

Dimensions.

	Length	Height
ALV BB/NA 089	0.52	0.30
ARV BB/NA 090	0.50	0.30

Remarks.—*C. scopulicola scopulicola* Hartmann, 1981, differs from *C. scopulicola territoriae* (Howe & McKenzie, 1989) by having weaker inter-rib reticulation. The subspecies *C. scopulicola japonensis* Zhao & Whatley, 1989, from Malaysia resembles the present material in all characteristics except for its more

strongly developed ornamentation. *C. exmouthensis* Hartmann, 1978, differs in having a less elongate carapace, fewer costae and weaker reticulation. It is less elongate than *C. longirostris* Yassini *et al.*, 1993 [= *Caudites* cf. *javana* Kingma *sensu* Howe & McKenzie, 1989] and with a different pattern of surface ribs and reticulate ornament.

Subfamily AURILINAE Puri, 1974

Genus *Mutilus* Neviani, 1928

Mutilus fungoides (Brady, 1866) comb. nov.
(Pl. 4, Figs. 2-3)

1866 *Cythere fungoides* Brady, p. 385, Pl. 61, Figs. 7a-d.
1880 *Cythere fungoides* Brady. Brady, p. 93, Pl. 19, Figs. 7a-d.
1989 *Jugocythereis henryhowei* Howe & McKenzie, p. 41, Figs. 12, 136, 137.

Material.—169 valves, 2 carapaces. Adults to A-4.

Distribution.—Samples A1-A5, B1, B3, B4.

Dimensions.

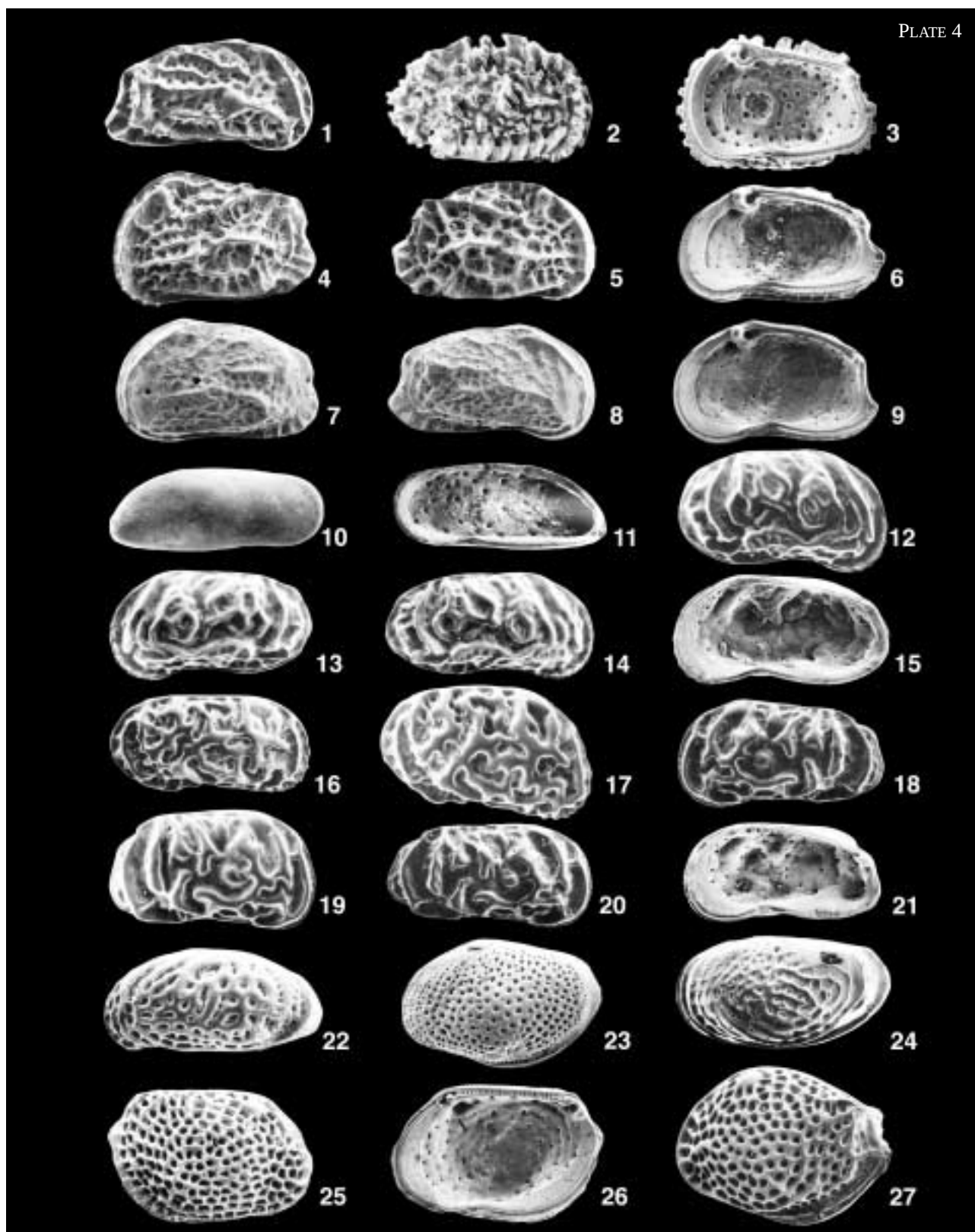
	Length	Height
ARV BB/NA 091	0.72	0.48
ARV BB/NA 092	0.70	0.44
ALV BB/NA 093	0.76	0.46
ALV BB/NA 094	0.74	0.44

Remarks.—The present species resembles *Pontocythereis spatulospinosa* sp. nov. of the present study. The latter differs in having a more elongate, sub-

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PLATE 4—1, *Caudites scopulicola territoriae* (Howe & McKenzie, 1989). RV, ext., BB/NA 090, x 75. 2, 3. *Mutilus fungoides* (Brady, 1866); 2, RV, ext., BB/NA 091, x 50; 3, RV, int., BB/NA 092, x 50. 4-6, *Mutilus splendideornatus australiensis* Hartmann, 1978; 4, LV, ext., BB/NA 095, x 58; 5, RV, ext., BB/NA 096, x 58; 6, RV, int., BB/NA 096, x 58. 7-9, *Mutilus varionatus* Hartmann, 1978; 7, LV, ext., BB/NA 100, x 69; 8, RV, ext., BB/NA 099, x 67; 9, RV, int., BB/NA 099, x 69. 10, 11. *Parakriothella placida* (Mostafawi, 1992); 10, RV, ext., BB/NA 103, x 81; 11, RV, int., BB/NA 103, x 83. 12-15, *Callistocythere cookei* sp. nov.; 12, Holotype, RV, ext., BB/NA 105, x 79; 13, Paratype, LV, ext., BB/NA 106, x 75; 14, Paratype, RV, ext., BB/NA 107, x 75; 15, Paratype, RV, int., BB/NA 107, x 75. 16, 17. *Callistocythere keiji* (Hartmann, 1978); 16, Male, RV, ext., BB/NA 110, x 75; 17, Female, RV, ext., BB/NA 108, x 85. 18-21, *Callistocythere neili* Howe & McKenzie, 1989; 18, Male, LV, ext., BB/NA 115, x 83; 19, Female, RV, ext., BB/NA 112, x 92; 20, Male, RV, ext., BB/NA 114, x 83; 21, Female, RV, int., BB/NA 112, x 83. 22, *Tanella* sp. LV, ext., BB/NA 116, x 100. 23, *Loxoconcha australis* Brady, 1880. Female, LV, ext., BB/NA 117, x 58. 24, *Loxoconcha dampierensis* Hartmann, 1978. LV, ext., BB/NA 121, x 63. 25, 26. *Loxoconcha heronislandensis* Hartmann, 1981; 25, RV, ext., BB/NA 125, x 63; 26, RV, int., BB/NA 125, x 63. 27, *Loxoconcha lilljeborgii* Brady, 1868, carapace, ext. view of LV, BB/NA 127, x 75.

PLATE 4



rectangular outline, less prominent alar process and less irregularly ornamented surface. Brady (1866, 1880) described this species from Australia (including Booby Island) and Bermuda. Howe & McKenzie, 1989, record that *Jugocythereis henryhowei* [= *Mutilus fungoides* (Brady)] has two frontal scars.

Mutilus splendideornatus australiensis Hartmann,
1978
(Pl. 4, Figs. 4-6)

- 1978 *Mutilus splendideornatus australiensis* Hartmann, pp. 99-100; Text-Figs. 223-230; Pl. 8, Fig. 10-16.
1989 *Mutilus splendideornatus australiensis* Hartmann. Howe & McKenzie, pp. 38-39, Figs. 111-113.
1989 *Mutilus curvicostatus* Howe & McKenzie, p. 39, Figs. 116, 161.
1990 *Robustaurila splendidornata australiensis* (Hartmann, 1978). Gou, p. 27, Pl. 2, Figs. 26, 27 (also see synonymy list therein).
1992 *Mutilus australiensis* Hartmann. Mostafawi, p. 143, Pl. 3, Fig. 54.
1995 *Auradilus australiensis* (Hartmann). Jellinek, p. 168, Figs. 1-8, Text-Fig. 4.
2005 *Auradilus australiensis* (Hartmann). Mostafawi et al., p. 132, Pl. 2, Figs. 4, 5 (also see synonymy list therein).

Material.—70 valves, 34 carapaces. Adults to A-3.

Distribution.—Samples A5, B4.

Dimensions.

	Length	Height
ALV BB/NA095	0.62	0.40
ARV BB/NA096	0.62	0.36
ALV BB/NA097	0.68	0.40
ARV BB/NA098	0.64	0.36

Remarks.—The present species can readily be distinguished from *Mutilus varionatus* Hartmann, 1978, and herein, by its well developed, strong lateral costae, particularly subdorsally and subventrally, and more strongly developed anterior marginal flange. The strongly reticulate ornament with deep fossae and sharp muri of *M. splendideornatus australiensis* also serves to differentiate this taxon from *Mutilus varionatus*. Subspecies of *M. splendideornatus*, which differ only in the strength and minor details of ribbing

and reticulation, are known from Africa (Hartmann, 1974), Australia (Hartmann, 1978; Howe & McKenzie, 1989) and Southeast Asia (Gou, 1990; Mostafawi, 1992). Some authors (i. e. Jellinek, 1995) raise this subspecies to species level. For discussion of the relationship between the present species and *Mutilus convolutes* (Brady, 1868) see Mostafawi et al. (2005).

Mutilus varionatus Hartmann, 1978
(Pl. 4, Figs. 7-9)

- 1978 *Mutilus varionatus* Hartmann, p. 98, Pl. 8, Figs. 1-9.
1989 *Mutilus varionatus* Hartmann. Whatley & Keeler; Pl. 3, Figs. 4-6.
1989 *Mutilus variolatus* Hartmann. Howe & McKenzie, p. 38, Figs. 114, 115.
1990 *Hemicythere variornata* (Hartmann, 1978), Gou, p. 27, Pl. 2, Figs. 19, 20.
?1992 *Mutilus* cf. *variornatus* Hartmann, Mostafawi, p. 143, Pl. 3, Fig. 55.

Material.—11 valves, 4 carapaces. Adults to A-2.

Distribution.—Samples A1, A4, A5, B3, B4.

Dimensions.

	Length	Height
ARV BB/NA 099	0.54	0.32
ALV BB/NA 100	0.56	0.30
ARV BB/NA 101	0.60	0.30
ALV BB/NA 102	0.58	0.28

Remarks.—*M. varionatus* Hartmann, 1978, can be distinguished from *M. splendideornatus* Hartmann 1978 (various subspecies), by its lack of strong costae extending laterally across the carapaces, and less strongly reticulate ornament. The shape and ornament of the present species can vary considerably. The ornament consists of a finely reticulate surface with weak radiating costae. It is the strength and position of these costae that are so variable within the species. Hartmann's original material was from the west coast of Australia. Whatley & Keeler, 1989, recorded this species from Reunion Island in the SW Indian Ocean.

Family CAMPYLOCYTHERIDAE Puri, 1960

Subfamily RUGGIERIANAE subfamily nov.

Remarks.—This subfamily is erected to accommodate such genera as *Ruggieria* Keij, *Keijella* Ruggieri,

Bicornucythere Schornikov & Saitarov, *Parakeijella* Jellineck, *Venericythere* Mostafawi, *Lankacythere* Bhatia & Kumar and *Pistocythereis* Gou. This subfamily is distinguished from the Campylocytherinae Puri, 1960 (i. e. *Leguminocythereis* Howe & Law, *Campylocythere* Edwards, etc.) on the basis of their generally less elongate carapace, usually more pointed posterior and (with the exception of *Lankacythere* and *Pistocythereis*) their much less subquadrate/subrectangular outline. All these genera (of the Campylocytherinae and Ruggierianae) are here removed from the Trachyleberidae, where they have commonly been previously placed, and are here listed separately under the family Campylocytheridae.

Genus *Keijella* Ruggieri, 1967

Keijella kloempitensis (Kingma, 1948)

- 1948 *Cythere kloempitensis* Kingma, p. 69, Pl. 7, Figs. 5a, b.
 1980 *Bicornucythere kloempitensis* (Kingma). Hanai *et al.*, p. 174.
 1982 *Leguminocythereis? hodgii* (Brady) (pars). Hou *et al.*, p. 182, Pl. 76, Figs. 10-12.
 1988 *Keijella kloempitensis* (Kingma). Zhao & Whatley, p. 76, Pl. 7, Figs. 13-14.
 1989 *Keijella kloempitensis* (Kingma). Zhao & Whatley; p. 241, Pl. 4, Figs. 6-8.

Material.—27 valves.

Distribution.—Sample A1-A5, B3, B4.

Dimensions.

	Length	Height
ALV BB/NA 229	0.64	0.42
ALV BB/NA 230	0.62	0.40
ARV BB/NA 231	0.60	0.36

Remarks.—The present species is very similar to *K. multisulcus* Whatley & Zhao, 1988, from the Malacca Straits, although the latter differs in its more convex dorsal margin, slightly smaller size, and less sharply defined posterolateral costae. The original material was described from coastal waters off Java.

Venericythere Mostafawi, 1992

Venericythere papuensis (Brady, 1880)
 (Pl. 8, Figs. 8-9)

- 1880 *Cythere papuensis* Brady, p. 95, Pl. 25, Figs. 5a-d.

- 1976 *Cythere papuensis* Brady. Puri & Hulings, p. 283, Pl. 16, Figs. 11-18, Fig. 7.

- 1978 *Leguminocythereis papuensis* (Brady). Jain, p. 118, Figs. 4 (1-3).

- 1980 *Bicornucythere papuensis* (Brady). Hanai *et al.*, p. 174.

- 1988 *Keijella papuensis* (Brady). Zhao & Whatley, p. 77, Pl. 8, Figs. 1-2.

- 1988 *Cythereis papuensis* Brady. Yassini & Kendrick, p. 112, Figs. 4M-N.

- 1992 *Venericythere papuensis* (Brady). Mostafawi, p. 146, Pl. 4, Figs. 71-72.

- 1993 *Venericythere papuensis* (Brady). Yassini *et al.*, p. 397, Pl. 7, Figs. 124-125.

- 1997 *Venericythere papuensis* (Brady). Dewi, p. 70-71, Figs. 170-171.

Material.—9 valves. Adults to A-2.

Distribution.—Samples A3, A4, A5.

Dimensions.

	Length	Height
LV BB-1 (?juv.)	0.52	0.32
RV BB-2 (?juv.)	0.51	0.31

Remarks.—The illustrated specimens for this species (BB-1 and BB-2) are from slide no. 76 of the Blagden Collection in the Natural History Museum (London). The present species differs from *Venericythere* sp. of the present study by its more quadrate outline and weaker longitudinally arranged costae.

Venericythere sp.
 (Pl. 9, Fig. 17)

- 1989 *Bicornucythere* cf. *darwini* (Brady). Howe & McKenzie, p. 42, Figs. 34, 120, 138.

Material.—4 valves. Adult to A-1.

Distribution.—Samples A4, A5.

Dimensions.

	Length	Height
ALV BB/NA 272	0.52	0.30
ARV BB/NA 273	0.52	0.30

Remarks.—The present species differs from *Venericythere papuensis* (Brady) of the present study by its less quadrate outline and more prominent longi-

tudinally arranged costae. This species differs from *Keijella gonia* Zhao and Whatley, 1989, in the pattern of the ornament in the central portion of the carapace surface.

Genus *Pistocythereis* Gou, 1983 [in Gou, Zheng & Huang, 1983]

Pistocythereis sp.

(Pl. 8, Figs. 10-12)

1976 *Cythere euplectella* Brady. Puri & Hullings, Pl. 25, Figs. 14-18.

1993 *Pistocythereis cribriformis* Brady. Yassini *et al.*, p. 398, Fig. 128.

Material.—121 valves, 6 carapaces. Adult to A-3.

Distribution.—Samples A2-A5, B2-B4.

Dimensions.

	Length	Height
ALVF BB-3	0.67	0.36
ARVM BB-4	0.67	0.36

Remarks.—The illustrated specimens for this species (BB-3 and BB-4) are from slide no. 81 of the Blagden Collection in the Natural History Museum (London). The present material is closest to *Pistocythereis cribriformis* (Brady, 1866) and *Pistocythereis bradyi* (Ishizaki, 1968), but differs by possessing prominent lateral (subhorizontal) carinae developed from the relatively heavy calcification of certain muri. The present species is also close to *Lankacythere coralloides* (Brady, 1886) and *Lankacythere elaborata* Whatley & Zhao, 1988, but differs in the form and shape of the reticulum.

Family KRITHIDAE Mandelstam, 1958

Genus *Parakrithella* Hanai, 1959

Parakrithella placida (Mostafawi, 1992) comb. nov.
(Pl. 4, Figs. 10-11)

1989 *Pseudopsammocythere* cf. *reniformis* (Brady).
Howe & McKenzie, p. 26, Fig. 27.

1992 *Parakrithella placida* Mostafawi, p. 142, Pl. 3,
Figs. 49-57.

1993 *Pseudopsammocythere* cf. *reniformis* (Brady).
Yassini *et al.*, p. 386, Figs. 40-42.

1997 *Parakrithella* sp. Dewi, p. 63, Figs. 37-38.

Material.—1 valve, 2 carapaces. Adults only.

Distribution.—Samples A4, A5.

Dimensions.

	Length	Height
ARV BB/NA 103	0.46	0.20
ALV BB/NA 104	0.46	0.20

Remarks.—A relatively large species with a straight dorsal margin and a narrowly rounded posterior margin. This species also occurs in the Solomon Islands. *Parakrithella placida* Mostafawi is significantly smaller than the very large species, *Parakrithella oblongata* Hu, 1978 (see also Hu & Yeh 1978).

Family LEPTOCYOTHERIDAE Hanai, 1957

Genus *Callistocythere* Ruggieri, 1953

Callistocythere cookei sp. nov.

(Pl. 4, Figs. 12-15)

1989 *Callistocythere* cf. *insolata* McKenzie
[1967]. Howe & McKenzie, p. 28, Fig. 86.

Derivatio nominis.—L. named for Peter Cooke, in recognition of his valuable contribution to our knowledge of the non-cytheracean ostracods of the Port Darwin area of northern Australia.

Holotype.—ARV BB/NA 105 (Pl. 4, Fig. 12).

Type Locality and Level.—Lee Point on Shoal Bay, Sample A4. Recent.

Material.—11 valves, 24 carapaces. Adults to A-1.

Diagnosis.—A species of *Callistocythere* with a surface ornament of weak, irregular, broadly rounded ribs, forming an open reticulate meshwork with shallow to moderately deep fossae. Distinguished by its prominent ocular rib, but particularly by the two circular reticulae joined by a rib across the median surface resembling *pinz nez* and imparting a binocular appearance to the two valves.

Description.—Small, thick-shelled, opaque, sexual dimorphism apparent; males longer and less high than females. Sub-rectangular to subovate in lateral view. Anterior margin broadly rounded with 6-7 short, blunt marginal denticles, extremity below mid-height. Posterior margin more narrowly rounded, extremity at mid-height. Dorsal margin almost straight, slightly convex; cardinal angles rounded, obtuse. Ventral margin concave orally. Greatest length at mid-height. Greatest height through anterior cardinal angle. Greatest width medianly. Eye spot obscured by ocular rib. Surface of valves weakly to moderately ornamented by irregular ribs forming an open reticulate meshwork. Prominent ocular rib

extends subparallel to anterior margin. Two circular reticulæ joined by a rib across the median surface resembling *pinz nez* and impart a binocular appearance to the two valves. Npc few, widely distributed. Inner lamella wide, line of concrescence and inner margin subparallel to outer margin, divergent anteriorly and posteriorly forming crescentic vestibula. Rpc few, wide, short, branching. Selvage moderately developed. Hinge pseudoentodont. Central muscle scars comprising 4 adductors in a vertical row of subovate to subrectangular scars. Frontal "V" shaped opening dorsally.

Distribution.—Samples A1-A5; B2-B4.

Dimensions.

	Length	Height
Holotype ARV BB/NA 105	0.49	0.26
Paratype ALV BB/NA 106	0.48	0.26
Paratype ARV BB/NA 107	0.48	0.24

Remarks.—The present species is similar to *Callistocythere neili* Howe & McKenzie, 1989, and *Callistocythere warnei* Howe & McKenzie, 1989, but differs in the nature of its surface ornament and hinge. *Callistocythere keiji* (Hartmann, 1978) from the eulittoral of Western Australia, differs from the present species predominantly in the shape of its ornament, and more elongate nature. *C. puri*, McKenzie, 1967, and *C. insolata* McKenzie, 1967, are also similar to the present species but differ in the shape and distribution of their reticulate ornament. The present species also differs from *C. puri* in not possessing the strong anterior marginal denticles.

Callistocythere keiji (Hartmann, 1978)
(Pl. 4, Figs. 16-17)

- 1978 *Leptocythere keiji* Hartmann, p. 77, Pl. 3, Figs. 9, 10, 13, 14.
 1979 *Leptocythere keiji* Hartmann. Hartmann, p. 226, Pl. 3, Figs. 1, 2.
 1981 *Leptocythere keiji* Hartmann. Hartmann, p. 102, Pl. 3, Figs. 1, 2.
 1989 *Callistocythere keiji* (Hartmann). Howe & McKenzie, p. 28, Figs. 4, 90, 91.
 1989 *Callistocythere rhine* Howe and McKenzie, p. 30, Fig. 156.

Material.—87 valves, 39 carapaces. Adult to A-2.

Distribution.—Samples A1-A5; B1, B2, B4, B5.

Dimensions.

	Length	Height
ARVF BB/NA108	0.46	0.26
ALVF BB/NA109	0.44	0.24
ARVM BB/NA110	0.50	0.24
ALVM BB/NA111	0.44	0.22

Remarks.—*C. cookei* sp. nov. can be distinguished from the present species by its more open, less prominent reticulation and strong ocular ridge extending to 1/3 the distance from the ventral margin; an ocular ridge being absent in the present species, and by its binocular structures on the lateral surface. *C. neili* Howe & McKenzie, 1989, can similarly be distinguished from the present species by its open reticulation and smaller size. The present species also differs from other Australian *Callistocythere* species in its numerous and large npc, which occur on the upper flanks of the ribs. The pattern of the surface ornament on specimens of *C. keiji* illustrated by Hartmann, 1978, is almost identical to that illustrated for *C. rhine* by Howe & McKenzie, 1989. Thus, the latter is here considered a junior synonym of the former.

Callistocythere neili Howe & McKenzie, 1989
(Pl. 4, Figs. 18-21)

1989 *Callistocythere neili* Howe & McKenzie, p. 30, Fig. 88.

Material.—15 valves, 9 carapaces. Adults to A-1.

Amended diagnosis.—A species of *Callistocythere* with a surface ornament of strong irregular, broad, rounded ribs forming an open reticulate meshwork, with moderately deep fossae. Particularly conspicuous is the almost "X"-shaped median, or posteromedian fossa.

Amended description.—Small, thick-shelled, opaque, sexually dimorphic, males longer and lower than females. Carapace subrectangular to subquadrate in lateral view. Anterior margin broadly rounded with 10-11, very small, short blunt marginal denticles, extremity at or slightly below mid-height. Posterior margin obliquely rounded, slightly truncated, extremity at mid-height; partially obscured by strong posterior marginal rib. Dorsal margin straight, cardinal angles obtuse, rounded. Ventral margin concave medianly. Greatest length at mid-height, greatest height through anterior cardinal angle, greatest width posteriorly. Large prominent, subspherical eye spot. Surface of valves strongly ornamented by irregular ribs forming an open reticulate meshwork of moderate

to deep broad fossae. A broad "X" shaped median to posteromedian fossae is characteristic. A strong ocular ridge extending anteroventrally towards its termination 1/2 distance from ventral margin is also present. Strong anterior marginal rib, and extremely broad posterior marginal rib, sub parallel to anterior and posterior margins respectively. Npc irregularly distributed. Line of concrescence and inner margin divergent anteriorly and posteriorly. Rpc short, branched distally. Hinge pseudoentodont. Central muscle scar pattern a subvertical row of four elongate oval scars. Frontal scar not clearly visible.

Distribution.—Samples A2-A5; B2, B4.

Dimensions.

	Length	Height
ARVF BB/NA 112	0.44	0.24
ALVF BB/NA 113	0.44	0.24
ARVM BB/NA 114	0.46	0.20
ALVM BB/NA 115	0.46	0.22

Remarks.—The present species is similar to *C. cookei* sp. nov. but differs in the lack of such a strong ocular rib and the binocular structure on the lateral surface and in its more strongly developed reticulation. *C. cookei* also lacks the "X" shaped median fossae, and has a more elongate, subovate outline than the present species. *C. keiji* Hartmann, 1978, from the eulittoral of Western Australia can be distinguished from the present species by its stronger, irregular, less open reticulation. This species has a less tapered posterior and different ornament pattern to *C. warnei* Howe & McKenzie, 1989.

Genus *Tanella* Kingma, 1948

Tanella sp.
(Pl. 4, Fig. 22)

Material.—1 adult left valve.

Description.—Small, moderately thick-shelled, subrectangular to subcylindrical in lateral view. Anterior margin broadly rounded, extremity slightly below mid-height. Dorsal margin convex, cardinal angles rounded. Posterior margin rounded, slightly acuminate, extremity below mid-height. Ventral margin biconvex, about anteriorly positioned oral concavity. Greatest length below mid-height, greatest height through anterior cardinal angle. Surface ornament of strong reticulae; muri broad, smooth. Indistinct anterior marginal rib. Internal details not observed.

Distribution.—Sample A4.

Dimensions.

	Length	Height
ALV BB/NA 116	0.36	0.16

Remarks.—The present species can be readily distinguished from *T. gracilis* Kingma, 1948, due to its more ovate shape in lateral view, more robust ornament and more rounded anterior margin. *T. africana* Hartmann, 1974, also differs in being more elongate, as well as in its pattern of reticulation. A similar species is described by Titterton & Whatley (in press, d) from the Solomon Islands. The absence of *T. gracilis* from the present study is remarkable as the species is very widespread in the Indo-Pacific region, but this absence may be due to its partial euryhaline habitat preference.

Family LOXOCONCHIDAE Sars, 1925

Subfamily LOXOCONCHINAE Sars, 1925

Genus *Loxoconcha* Sars, 1866

Loxoconcha australis Brady, 1880
(Pl. 4, Fig. 23)

1880 *Loxoconcha australis* Brady, p. 119, Pl. 28, Figs. 5a-f; Pl. 29, Figs. 3a-d.

1967 *Loxoconcha australis* Brady. McKenzie, p. 68, Pl. 12, Figs. 10-11.

1987 *Loxoconcha australis* Brady. Yassini & Jones, p. 828, Figs. 3.20-3.22.

1988 *Loxoconcha australis* Brady. Yassini & Kendrick, p. 112, Figs. 4H-L.

1990 *Loxoconcha australis* Brady. McKenzie, *et al.*, p. 15-16, Figs. 5-7.

1993 *Loxoconcha australis* Brady. Yassini *et al.*, p. 394.

Material.—14 valves, 1 carapace. Adults to A-1.

Distribution.—Samples A2, B2-B4.

Dimensions.

	Length	Height
ALVF BB/NA 117	0.64	0.40
ARVF BB/NA 118	0.60	0.42
ARVM BB/NA 119	0.66	0.40
ALVM BB/NA 120	0.66	0.40

Remarks.—*Loxoconcha australis* Brady, 1880, recorded from Port Jackson, Australia, and from Booby Island north of mainland Australia, is similar

to *L. pulchra* McKenzie, 1967, but differs in the form of the reticulation; the latter being more irregular than in the present species. The lectotype specimen of *Loxoconcha australis* Brady illustrated by Puri and Hullings has a more strongly upturned posterior than the present material. *Loxoconcha* cf. *australis* Hartmann, 1979, is similar to the present species but has a more strongly developed caudal process. *L. paiki* Whatley & Zhao, 1987, can be distinguished from the present species by its nearly oval outline in lateral view; as well as in its smaller size and more pronounced, larger and deeper reticulation. *Loxoconcha miniaustralis* Howe & McKenzie, 1989, is markedly smaller than the specimens of *L. australis* encountered in this study. The present material is very similar to *L. broomensis* Hartmann, 1978, except the former lack the conspicuous posterodorsal ornamental "notch" (short carina) of the latter.

Loxoconcha dampierensis Hartmann, 1978
(Pl. 4, Fig. 24)

- 1978 *Loxoconcha dampierensis* Hartmann, p. 106, Pl. 10, Fig. 8.
1989 *Loxoconcha dampierensis* Hartmann. Howe & McKenzie, p. 24.
1989 *Loxoconcha judithae* Howe & McKenzie, p. 28, Fig. 79.
1993 *Loxoconcha judithae* Howe & McKenzie. Yassini *et al.*, p. 394, Pl. 6, Figs. 105-108.

Material.—101 valves, 2 carapaces. Adult to A-2.
Distribution.—Sample A1-A5, B2-B4.
Dimensions.

	Length	Height
ALV BB/NA 121	0.60	0.32
ARV BB/NA 122	0.62	0.34
ALV BB/NA 123	0.60	0.30
ARV BB/NA 124	0.62	0.30

Remarks.—The present species, first recorded by Hartmann 1978, from eulittoral habitats in Western Australia, can be distinguished from other species of *Loxoconcha* by its subovate to subrectangular lateral outline, and muri of the reticulae that form a ventral series of arcuate, lateral costae. *L. paiki* Whatley & Zhao, 1987, resembles the present species but can be distinguished from it by virtue of its smaller size, less elongate subrectangular lateral outline, and more poorly developed ventrolateral

costae. *Loxoconcha violacea* Behrens, 1991a, is very similar to the present species except these two species differ slightly in shape and the strength of the ornament.

Loxoconcha heronislandensis Hartmann, 1981
(Pl. 4, Figs. 25-26)

- 1981 *Loxoconcha heronislandensis* Hartmann, p. 117, Pl. 9, Figs. 1-6, Text-Figs. 52-54.
1984 *Loxoconcha heronislandensis* Hartmann. Hartmann, p. 128, Text-Figs. 47, 48, Pl. 7, Figs. 1-7.
1984 *Loxoconcha heronislandensis* Hartmann. Titterton MS, p. 365, Pl. 11, Figs. 11, 12; Pl. 47, Figs. 1-10.
1988 *Loxoconcha heronislandensis* Hartmann. Watson MS, p. 178, Pl. 34, Figs. 1-3.
1988 *Loxoconcha heronislandensis* Hartmann. Whatley & Zhao, p. 350, Pl. 5, Fig. 12.
1991 *Loxoconcha heronislandensis* Hartmann. Behrens, p. 117-118, Pl. 5, Figs. 3-6.
2000 *Loxoconcha georgei* Hartmann. Hoibian *et al.*, p. 223, Pl. 1, Fig. 7.
2002 *Loxoconcha heronislandensis* Hartmann. Hoibian *et al.*, p. 191, Pl. 1, Fig. 4.

Material.—2 valves. Adult to A-1.

Distribution.—Samples A1, B4.

Dimensions.

	Length	Height
ARV BB/NA 125	0.56	0.36

Remarks.—The present species is most similar to *L. albaniensis* Hartmann, 1979, and to *L. trita* McKenzie, 1967 [*sensu* Hartmann, 1978], from eulittoral habitats in southwestern and western Australia respectively. All three species possess a prominent alar inflation and are reticulate, but can be seen to differ in their carapace outline, and strength of reticulation. Large numbers of the present species were collected from algae off Heron Island, eastern Australia by Hartmann (1981) where it was more numerous in the protected inner reef than in the outer reef. Dead shells were also found with coral detritus in pools within the reef. Williams (1980, MS, unpub.) found 29 valves in Quaternary brackish water sediments from the Indispensable Reefs off the Solomon Islands. Gou, 1990, regarded *L. heronislandensis* Hartmann as a junior synonym of *Loxoconcha tumu-*

losa Hu, 1979. Whilst these species are very similar, the specimens listed as *L. tumulosa* Hu in Gou, 1990, possess a less regularly concentric reticulation pattern in the posterodorsal region of the carapace than is apparent in *L. heronislandensis*. This difference may represent subspecies level morphological variation, although classification as such will require future study of the currently scantily illustrated type material of *L. tumulosa*.

Loxoconcha lilljeborgii Brady, 1868
(Pl. 4, Fig. 27; Pl. 5, Fig. 1)

- 1868 *Loxoconcha lilljeborgii* Brady, p. 183, Pl. 13, Figs. 11-15.
1954 *Loxoconcha lilljeborgii* Brady. Keij, p. 358, Pl. 3, Fig. 4.
1968 *Loxoconcha lilljeborgii* Brady. Guha, p. 61, Pl. 4, Fig. 2.
1975 *Loxoconcha lilljeborgii* Brady. Gramman, p. 29, Pl. 5, Figs. 6-8.
1985 *Loxoconcha lilljeborgii* Brady. Zhao *et al.*, p. 206, Pl. 20, Fig. 12.
1988 *Loxoconcha lilljeborgii* Brady. Whatley & Zhao, p. 351, Pl. 5, Fig. 13.
1989 *Loxoconcha lilljeborgii* Brady. Whatley & Keeler, p. 73, Pl. 4, Figs. 4-6, 9.
1992 *Loxoconcha lilljeborgii* Brady. Mostafawi, p. 151, Pl. 5, Fig. 102.

Material.—6 valves, 2 carapaces. Adults only.

Distribution.—Samples A3-A4, B2-B3

Dimensions.

	Length	Height
ARV BB/NA 126	0.50	0.30
AC BB/NA 127	0.48	0.30

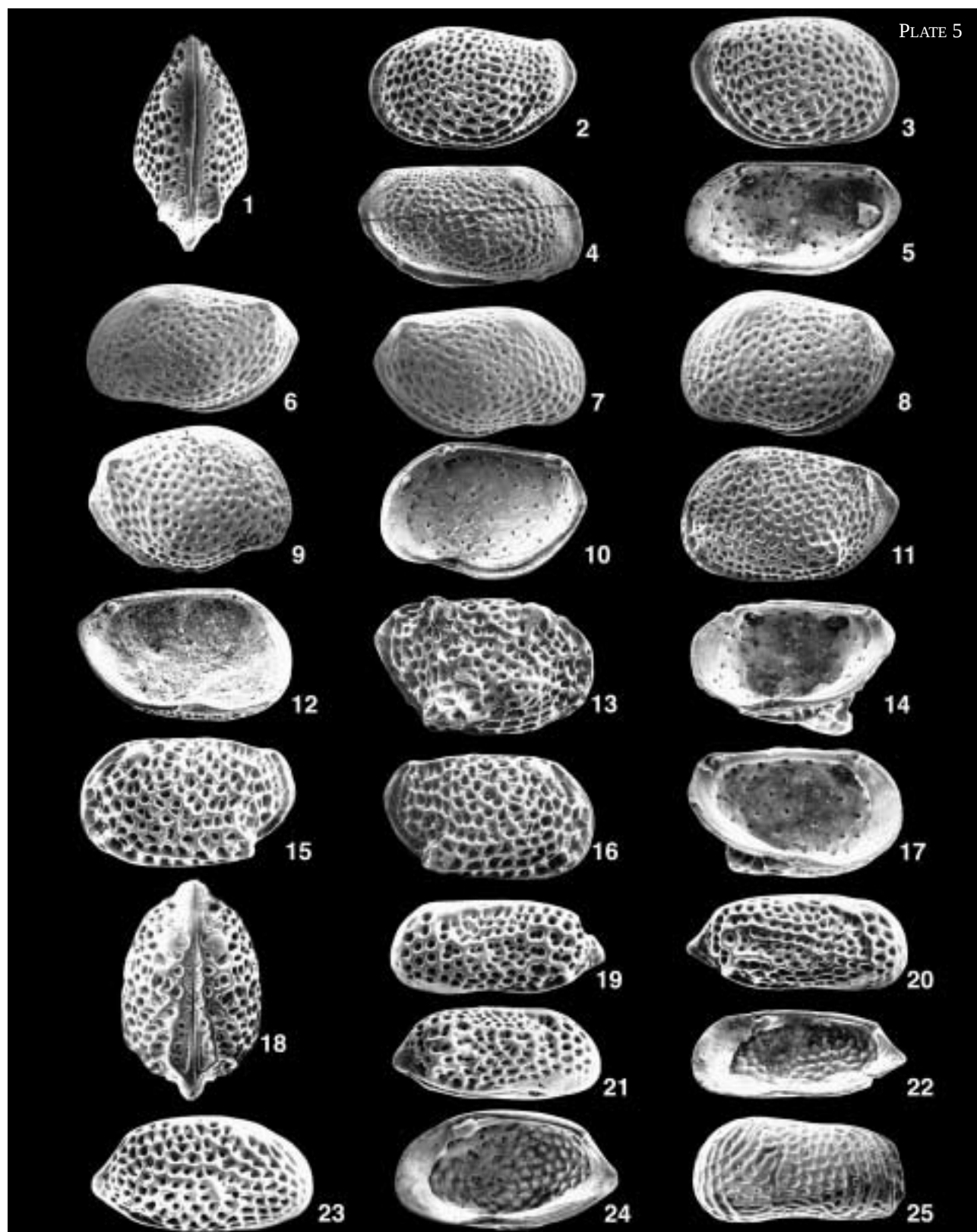
Remarks.—*L. lilljeborgii* Brady, 1868, was first described from the Recent of Mauritius in the Indian Ocean. Since then it has been reported from the Recent of the Philippines (Keij, 1954), Burma (Gramman, 1975) and Reunion Island (Whatley & Keeler, 1989) and also from the Malacca Straits (Whatley & Zhao, 1988) and Malaysia (Mostafawi, 1992). *L. georgei* Hartmann, 1978, is very similar to the present species but has a more narrowly rounded anterior margin and less strongly developed reticulation. Mostafawi *et al.*, 2005, regarded *Loxoconcha broomensis* Hartmann, 1978, as a junior synonym of *Loxoconcha lilljeborgii*, although it is here noted that specimens previously attributed to these two species vary in the extent of rib-like muri thickening in the anterior and posterior regions of the lateral carapace surface.

Loxoconcha paiki Whatley & Zhao, 1987
(Pl. 5, Figs. 2-3)

- 1977 *Loxoconcha* sp. A. Paik, Pl. 6, Figs. 112-115; Pl. 10, Fig. 170.
1987 *Loxoconcha paiki* Whatley & Zhao, Pl. 5, Fig. 14-16.
1988 *Loxoconcha paiki* Whatley & Zhao. Watson MS, p. 180, Pl. 34, Figs. 4-6.

→

PLATE 5—1, *Loxoconcha lilljeborgii* Brady, 1868, carapace, dorsal view, BB/NA 127, x 101. 2, 3. *Loxoconcha paiki* Whatley & Zhao, 1987; 2, Male, LV, ext., BB/NA 130, x 75; 3, Female, RV, ext., BB/NA 129, x 75. 4, 5. *Loxoconcha parvifoveolata* Hartmann, 1980; 4, RV, ext., BB/NA 132, x 75; 5, RV, int., BB/NA 132, x 75. 6-10, *Loxoconcha* sp. cf. *L. georgi* Hartmann, 1978; 6, Male, LV, ext., BB/NA 134, x 67; 7, Male, RV, ext., BB/NA 133, x 67; 8, Female, LV, ext., BB/NA 135, x 75; 9, Female, RV, ext., BB/NA 136, x 75; 10, Female, RV, int., BB/NA 136, x 71. 11, 12. *Loxocorniculum* sp. 1; 11, LV, ext., BB/NA 142, x 84; 12, LV, int., BB/NA 142, x 84. 13, 14. *Loxocorniculum* sp. 2; 13, RV, ext., BB/NA 143, x 101; 14, RV, int., BB/NA 143, x 101. 15-18, *Loxocorniculum koolpionyahensis* sp. nov.; 15, Paratype, LV, ext., BB/NA 138, x 84; 16, Holotype, RV, ext., BB/NA 137, x 84; 17, Paratype, LV, int., BB/NA 138, x 84; 18, Paratype, carapace, dorsal view, BB/NA 141, x 126. 19-22, *Gambiella pytta* Howe & McKenzie, 1989; 19, LV, ext., BB/NA 147, x 84; 20, RV, ext., BB/NA 146, x 84; 21, carapace, view of RV, ext., BB/NA 149, x 88; 22, RV, int., BB/NA 146, x 82. 23, 24. *Gambiella* sp.; 23, RV, ext., BB/NA 150, x 84; 24, RV, int., BB/NA 150, x 88. 25, *Keijia (Praemunita)* sp. cf. *K. (P.) broomensis* (Hartmann, 1978). LV, ext., BB/NA 151, x 75.



1992 *Loxoconcha paiki* Whatley & Zhao. Mostafawi, p. 151, Pl. 5, Fig. 105.

1997 *Loxoconcha paiki* Whatley & Zhao. Dewi, p. 64-65, Figs. 116-117.

Material.—156 valves, 33 carapaces. Adult to A-4.

Distribution.—Samples A1-A5, B1-B4.

Dimensions.

	Length	Height
ALVF BB/NA 128	0.48	0.32
ARVF BB/NA 129	0.50	0.32
ALVM BB/NA 130	0.48	0.32
ARVM BB/NA 131	0.50	0.32

Remarks.—The present species differs from other species of *Loxoconcha* in its nearly oval shape in lateral outline, especially, in the females, strongly oblique rounded anterior margin, strong close set reticulation and strongly inflated carapace. Whatley & Zhao, 1987, record this species from the Malacca Straits and Watson (MS 1988) from the Java Sea. *L. paiki* has a more evenly rounded anterior and posterior outline than *Loxoconcha miniaustralis* Howe & McKenzie, 1989. The present species is very similar to *Loxoconcha tata* Hu, 1978, although the latter displays a somewhat greater posteroventral inflation of the carapace.

Loxoconcha parvifoveolata Hartmann, 1980
(Pl. 5, Figs. 4-5)

1980 *Loxoconcha parvifoveolata* Hartmann, p. 139, Pl. 10, Fig. 10-13.

Material.—1 adult RV.

Distribution.—Sample A4.

Dimensions.

	Length	Height
ARV BB/NA 132	0.50	0.24

Remarks.—The present species is similar to *L. abditocostata parva* Hartmann, 1984, from the Society and Taumotu Islands; but differs in not possessing a dorsal costa or posterodorsal tubercle. *L. abditocostata* Hartmann, 1981, from the eulittoral of the east coast of Australia differs in not displaying the deep reticulate to punctate surface ornament of the present species. The present species is very similar in shape to

Loxoconcha ismailusnai Dewi, 1997 from Indonesian seas, but the latter possesses a more coarsely reticulate ornament.

Loxoconcha sp. cf. *L. georgi* Hartmann, 1978
(Pl. 5, Figs. 6-10)

1978 *Loxoconcha georgi* Hartmann, p. 105, Pl. 9, Figs. 13-16.

1989 *Loxoconcha georgi* Hartmann. Howe & McKenzie, p. 18, Fig. 84.

1990 *Loxocorniculum georgi* (Hartmann). Gou, p. 26, Figs. 43, 44.

1991 *Loxoconcha georgi* Hartmann. Behrens, p. 116-117, Pl. 4, Figs. 6-9.

Material.—50 valves, 17 carapaces. Adult to A-2.

Distribution.—Samples A3-A5, B3-B4.

Dimensions.

	Length	Height
AVRM BB/NA 133	0.54	0.34
ALVM BB/NA 134	0.52	0.34
ALVF BB/NA 135	0.50	0.34
ARVF BB/NA 136	0.50	0.32

Remarks.—The present species is similar to *L. australis* Brady, 1880, but differs in being inflated medianly, and in having a slightly different pattern of reticulation. Also the latter has a small opaque patch medianly. The specimens of the present study illustrated here are very similar to *L. georgi* s.s. Hartmann, 1978, although the latter tends to have a slightly more elongated and narrowly rounded anterior in both male and female specimens. The present species is very similar in shape to *L. wrighti* Dewi, 1997, from Indonesian seas, although the latter possesses a coarser reticulate ornament.

Genus *Loxocorniculum* Benson & Coleman, 1963

Loxocorniculum koolpionyahensis sp. nov.

(Pl. 5, Figs. 15-18)

Derivatio nominis.—Referring to the Aboriginal name for the area around Lee Point.

Holotype.—ARV BB/NA 137 (Pl. 5, Fig. 16).

Type Locality and level.—Lee Point East on Shoal Bay, sample A4. Recent.

Material.—17 valves, 28 carapaces. Adult to A-1.

Diagnosis.—A species of *Loxocorniculum* characterised by its small size, rather subquadrate shape in

lateral outline and strong deep reticulate ornamentation, with a very steeply inclined slope from the flanks of the muri to the floor of the solae.

Description.—Small, thick-shelled, rather subquadrate in lateral view. Anterior margin broadly rounded, extremity at mid-height. Dorsal margin nearly straight, slightly convex in anterior part. Cardinal angles rounded. Ventral margin nearly straight. Oral incurvature median. Posterior margin obliquely rounded, smooth, sloping anteriorly; extremity above mid-height. Large glassy eyespot present. Greatest length median. Greatest height through anterior cardinal angle. Surface ornament of strongly developed, deep, circular to pentagonal and hexagonal reticulae with a very steeply inclined slope from the flanks of the muri to the floor of the solae. Small sharply pointed posteroventral alate process extending postero-ventrally. Avestibulate, inner lamella narrow, im parallel to om. Rpc short, simple. Central muscle scars a subvertical row of four ovate adductors; dorsal-most, and ventral-most scars smallest. Frontal scar impression not clearly observed.

Distribution.—Samples A1-A5, B1-B4.

Dimensions.

	Length	Height
Holotype ARV BB/NA 137	0.44	0.26
Paratype ALV BB/NA 138	0.44	0.26
Paratype ARV BB/NA 139	0.42	0.24
Paratype ALV BB/NA 140	0.40	0.26
Paratype AC BB/NA 141	0.42	0.24

Remarks.—The present species is similar to *Loxocorniculum* sp. 2 (this study) but differs in having a less well developed alar process and lacking the tubercle below the posterior cardinal angle present in the latter. The present species is similar in shape to *Loxoconcha gilli* McKenzie, 1967; *Loxoconcha susanhayseae* Yassini & Jones, 1995; *Loxoconcha trita* McKenzie, 1967; *Loxoconcha variolata* Brady, 1878; *Loxoconcha cumulus* (Brady, 1880) and *Loxoconcha macgowrani* McKenzie *et al.*, 1991, although varying from all of these latter six species in the details of the reticulate ornament and/or extent of development of alate process.

Loxocorniculum sp. 1
(Pl. 5, Figs. 11-12)

Material.—4 valves. Adult to A-2.

Distribution.—Samples A4, A5, B2.

Dimensions.

	Length	Height
ALV BB/NA 142	0.42	0.28

Remarks.—The present species is similar to *L. koolpionyahensis* sp. nov. of this study but lacks the strong deep reticulae of the latter.

Loxocorniculum sp. 2
(Pl. 5, Figs. 13-14)

Material.—6 valves. Adult to A-1.

Distribution.—Sample A4.

Dimensions.

	Length	Height
ARV BB/NA 143	0.38	0.28
ALV BB/NA 144	0.40	0.24
ARV BB/NA 145	0.36	0.22

Remarks.—*Loxoconcha insulaecapricornensis* Hartmann, 1981, is similar to the present species but differs in being more elongate and possessing a weakly reticulate, and costate surface ornament. *Loxoconcha huahinensis* Hartmann, 1984, is also very similar to the present species but differs in the position and shape of the caudal process, as well as in lacking a posterodorsal 'tubercle'. This species is also known from the Recent of the Solomon Islands (Titterton & Whatley, in press, c).

Subfamily CYTHEROMORPHINAE Mandelstam, 1960
Genus *Gambiella* Witte, 1985

Remarks.—*Gambiella* is here placed in the Loxoconchidae and Cytheromorphinae because in terms of overall carapace structure, species of *Gambiella* are related to some species of *Cytheromorpha*. Interestingly, the shape of *Gambiella* is somewhat similar to that of the paradoxostomatid *Javenella* Kingma. Warne, 1996, suggested a possible affinity between *Gambiella* and *Hemicytheridea* Kingma, 1948, on the basis of similarities in hinge type, although there is little resemblance with respect to other carapace characters.

Gambiella pytta Howe & McKenzie, 1989
(Pl. 5, Figs. 19-22)

1989 *Gambiella pytta* Howe & McKenzie, p. 34,
Figs. 94-95.

1993 *Gambiella pytta* Howe & McKenzie. Yassini *et al.*, p. 392, Pl. 9, Figs. 173-175.

Material.—8 valves, 59 carapaces. Adult to A-1.

Distribution.—Samples A1-A5, B1, B2, B4, B5.

Dimensions.

	Length	Height
ARV BB/NA 146	0.46	0.20
ALV BB/NA 147	0.44	0.20
ALV BB/NA 148	0.42	0.20
AC BB/NA 149	0.42	0.22

Remarks.—The present species differs from *Gambiella caelata* Witte, 1985, from The Gambia, West Africa, in lacking the strongly developed posteroventral caudal process. The present species also has a stronger reticulation pattern than Witte's type species. The present species is closest in external appearance to *Cytherura interposita* Lyubimova and Guha, 1960, from the Miocene of India, but differs in having a more strongly developed reticulation, and less pronounced oral incurvature. *Gambiella* sp. of the present study is also very similar in having a strongly developed micro-reticulation, but differs in having a more elongate outline in lateral view. This species possesses a hemigonglyodont hinge (*sensu* Warne, 1996).

Gambiella sp.
(Pl. 5, Figs. 23-24)

Material.—2 valves, 1 carapace. Adults only.

Diagnosis.—A species of *Gambiella* characterised by its subovate shape in lateral view and strong deep reticulate surface ornament.

Description.—Small, moderately thick-shelled, subovate to subrectangular in lateral view. Anterior margin broadly rounded, extremity below mid-height. Dorsal margin convex, sloping posteriorly from anterior dorsal cardinal angle. Cardinal angles rounded, obtuse. Posterior margin subcaudate, truncated; extremity well below mid-height. Ventral margin convex. Greatest length below mid-height, greatest height approximately mid length. Surface ornament of strong, subequal reticulae. Small glassy eye spot present. Inner lamella broad, im subparallel to om. Avestibulate. NPC few. Radial pore canals few, long, simple. Four adductor scars in a subvertical row. Frontal scar impression not observed.

Distribution.—Samples A4, A5.

Dimensions.

	Length	Height
ARV BB/NA 150	0.44	0.22

Remarks.—The present species differs markedly from *Gambiella pytta* Howe & McKenzie, 1989, from the same locality, in its subovate outline in lateral view, and poster-ventral caudal process. Differences in reticulation pattern and lack of costae also distinguish the two species. The subovate outline in lateral view, and more strongly developed reticulation also serve to distinguish the present species from *G. caelata* Witte, 1985.

Family PARADOXOSTOMATIDAE Brady & Norman, 1889
Genus *Javanella* Kingma, 1948

Remarks.—Keij, 1957, commented that the difference between *Pellucistoma* Coryell & Fields, 1937, and *Javanella* Kingma is that the former has a higher more inflated carapace than the latter. There seems to be a shape continuum for species in these two genera with subrectangular forms being common in the Asian, Australasian and SW Pacific regions.

Javanella sp.
(Pl. 6, Figs. 1-3)

1978 *Paracytheroma caudata* Hartmann, p. 82, Figs. 114-126.

1988 *Paracytheroma caudata* Hartmann. Yassini & Kendrick, p. 114, Figs. 5L-M.

1989 *Javanella caudata* (Hartmann). Howe & McKenzie, p. 12.

1993 *Paracytheroma caudatum* (Hartmann). Yassini *et al.*, p. 384, Pl. 2, Figs. 27-30.

Material.—9 valves, 41 carapaces. Adult to A-1.

Distribution.—Samples A2-A5, B4.

Dimensions.

	Length	Height
ALV BB/NA 152	0.50	0.26
ARV BB/NA 153	0.60	0.28
ALV BB/NA 154	0.60	0.26

Remarks.—The present material is very similar to the original material of *Javanella kendengensis* Kingma, 1948, from the Upper Pliocene of East Java

but differs in the slightly greater length of the carapace and in its greater height to length ratio. The taxonomic relationships between, and taxonomic status of, *J. kendengensis*, *J. caudata* (Hartmann, 1978) and *J. aestaphila* Behrens, 1991, requires clarification through the further study of relevant populations of adult female and male specimens.

Genus *Paradoxostoma* Fisher, 1855
Paradoxostoma sp.
 (Pl. 6, Figs. 4-5)

1988 *Paradoxostoma* sp. 2. Whatley & Zhao, p. 108, Pl. 10, Figs. 24, 25.

Material.—2 valves, 2 carapaces. Adult to A-1.

Diagnosis.—A species of *Paradoxostoma* characterised by its subcylindrical lateral outline, rounded acuminate anterior margin and sharply acuminate posterior margin. Dorsal margin convex. Ventral margin straight, slightly convex. Greatest length at mid height. Greatest height at mid length. Vestibulum of similar extent both anteriorly and posteriorly.

Distribution.—Samples A3, A4, B4.

Dimensions.

	Length	Height
ALV BB/NA 155	0.70	0.22
ARV BB/NA 156	0.70	0.26

Remarks.—The present species resembles *P. cylindricum* Müller, 1894, from the Bay of Naples, Italy, but has a more acuminate anterior margin. *P. limbaughi* Allison & Holden, 1971, from Clipperton Island, is also similar has a less narrowly rounded anterior than the present species. The material of *Paradoxostoma* sp. 2 Whatley & Zhao, 1988, from the Malacca Straights differs only in being a little less high posteriorly. Typical of paradoxostomatids, this species possesses four adductor muscle scars. There are similar species that occur widely in the Australia/Indo/Pacific region, all of which differ in important details of size, shape and internal morphology from the present taxon. Among the species referred to are: *Paradoxostoma mimicus* (Whatley *et al.*, 2000) from Easter Island; *Paradoxostoma* sp. 3 Watson MS, 1988, from the Java Sea; *Machaerina* sp. A Titterton MS, 1984, Solomon Islands; *Paradoxostoma* sp. Mostafawi, 1992 [= *Paradoxostoma* sp. Dewi, 1997], SE Asia; *Paracytherois* sp. A Labutis MS, 1977,

Great Barrier Reef; *Paradoxostoma lizardensis* Behrens, 1991, Great Barrier Reef.

Family PECTOCYTHERIDAE Hanai, 1957

Remarks.—The Pectocytheridae are both abundant and diverse in the present study, as they are throughout the warm, shallow marine waters of the area. This diversity is greater than anywhere else within their modern geographical range. This is probably a reflection of the fact that the family originated in this region and from this locus have migrated out to other seas/oceans. In the main they have maintained themselves in warm shallow waters, but some species, especially in the subantarctic and adjacent South Atlantic, have become more cryophilic. The Australasian locus of origination dates back at least to the late Mesozoic as testified by the studies of Bate, 1972, and Neale, 1975, in the Upper Cretaceous of Western Australia. As a further distribution note, there is a particular large diversity of pectocytherid species in late Neogene shallow marine strata of SE Australia.

Genus *Keijia* Teeter, 1975

Remarks.—The genus *Keijia* is here regarded as a morphologically plastic taxon that includes a diversity of species groups including those previously assigned to the genera *Mckenziartia* Labutis & Bentley in Bentley, 1988; *Parakeijia* McKenzie in Howe & McKenzie, 1989, and *Labutisella* McKenzie in Howe & McKenzie, 1989.

Keijia demissa (Brady, 1868)
 (Pl. 6, Figs. 7-9)

1868 *Cythere demissa* Brady, Pl. 12, Figs. 1-2.

1880 *Cythere demissa* Brady. Brady; p. 66, Pl. xii, Figs. 1a-j.

1987 *Keijia demissa* (Brady). Whatley & Zhao; Pl. 5, Figs. 27, 28.

1989 *Keijia demissa* (Brady). Whatley & Keeler; Pl. 4, Figs. 12-14.

2001 *Keijia demissa* (Brady). Titterton *et al.*, p. 38, Pl. 2, Figs. 13-19 (plus synonymies therein).

2005 *Keijia demissa* (Brady). Mostafawi *et al.*, p. 130-131, Pl. 1, Fig. 15.

Material.—3 valves. Adults only.

Distribution.—Samples A4, A5.

Dimensions.

	Length	Height
ALV BB/NA 157	0.50	0.24
ARV BB/NA 158	0.50	0.22

Remarks.—The present material is most similar to *K. parademissa* sp. nov. of the present study, but differs in its less pronounced concentric reticulation pattern. *K. parademissa* also possesses a broad posterior marginal depression. *K. nordaustraliae* Howe & McKenzie, 1989, and *K. profundosculpta* sp. nov. also differ in their more open reticulation pattern, and strong ventral and posterior marginal depressions. This species is widespread in the Indo-Pacific and also in the Caribbean and Gulf of Mexico (see Witte, 1993, and Titterton *et al.*, 2001). *K. tjokrosapoetroi* Dewi, 1997, from central Indonesian marine waters differs from *K. demissa* in the fine detail of the carapace ornament and by having a less strongly tapering posterior half of the carapace.

Keijia intermedia sp. nov.
(Pl. 6, Figs. 10-13)

Derivatio nominis.—Latin, referring to the nature of the reticulation pattern and peripheral muri, which incorporate elements from both *K. nordaustraliae* Howe & McKenzie, 1989, and *K. parademissa* sp. nov., and to the apparently intermediate status of this species with respect to carapace morphology.

Holotype.—ARV BB/NA 159 (Pl. 6, Figs. 12, 13).

Type locality and level.—Lee Point on Shoal Bay. Sample A4.

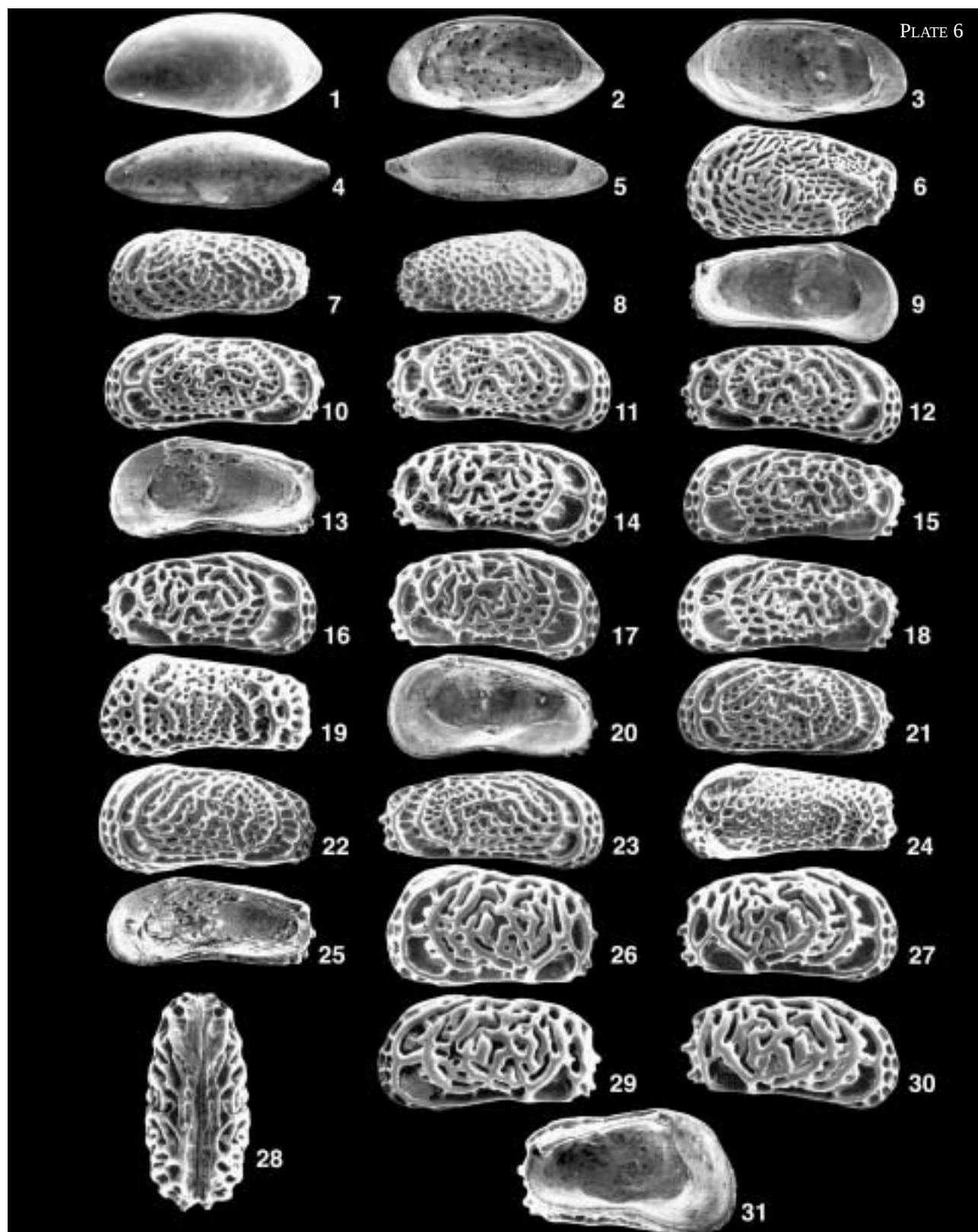
Material.—22 valves, 17 carapaces. Adults only.

Diagnosis.—Small, subrectangular, elongate *Keijia* species characterised by its ornamentation, which incorporates the pattern of reticulation displayed by *K. parademissa* sp. nov. together with the posterior peripheral depression subdivided into three, similar to *K. nordaustraliae* Howe & McKenzie.

Description.—Small, moderately thick-shelled, semi-translucent, subrectangular in lateral view. Anterior margin broadly rounded, extremity at mid-height and with straight antero-dorsal slope. Dorsal margin nearly straight, sloping posteriorly. Anterior cardinal angle rounded, posterior cardinal angle distinct. Posterior margin truncated, subquadrate, 4 short, blunt marginal denticles and extremity at mid-height. Ventral margin concave medianly. Greatest length at mid height. Greatest height through anterior cardinal angle. Surface ornament fairly strongly reticulate, formed by the intersection of weakly developed irregular costae concentric to mid-point of carapace with less strong radial costae. Intercostal areas reticulate. Reticulation deep subrectangular to subquadrate. Prominent deep subrectangular fossae around periphery. Two rows of moderately deep reticulae anterior and anteroventrally of marginal ridge. Posteriorly, peripheral depression divided into three subequal, large, deep, fossae. NPC few, simple. Inner lamella broad, subparallel to om. Line of concrescence and inner margin divergent to form crescentic vestibulum anteriorly. RPC moderate, long irregular. Central muscle scar pattern indistinct, subcentral. Hinge penta-

→

PLATE 6—1-3, *Javanella* sp.; 1, LV, ext., BB/NA 152, x 76; 2, RV, int., BB/NA 153, x 76; 3, LV, int., BB/NA 154, x 80. 4, 5, *Paradoxostoma* sp.; 4, LV, ext., BB/NA 155, x 55; 5, LV, int., BB/NA 155, x 51. 6, *Kotoracythere inconspicua* (Brady, 1880). LV, ext., BB/NA 184, x 93. 7-9, *Keijia demissa* (Brady, 1868); 7, LV, ext., BB/NA 157, x 76; 8, RV, ext., BB/NA 158, x 76; 9, LV, int., BB/NA 157, x 84. 10-13, *Keijia intermedia* sp. nov.; 10, Paratype, LV, ext., BB/NA 161, x 84; 11, Paratype, RV, ext., BB/NA 160, x 84; 12, Holotype, RV, ext., BB/NA 159, x 84; 13, Holotype, RV, int., BB/NA 159, x 80. 14-18, 20, *Keijia nordaustraliae* Howe & McKenzie, 1989; 14, Male, RV, ext., BB/NA 164, x 84; 15, Male, LV, ext., BB/NA 165, x 84; 16, Female, RV, ext., BB/NA 166, x 84; 17, Female, RV, ext., BB/NA 168, x 84; 18, Male, LV, ext., BB/NA 169, x 84; 20, Female, RV, int., BB/NA 166, x 76. 19, *Keijia darwinensis* (Howe & McKenzie, 1989). LV, ext., BB/NA 170, x 127. 21-23, 25, *Keijia parademissa* sp. nov.; 21, Holotype, Female, LV, ext., BB/NA 171, x 84; 22, Paratype, Female, LV, ext., BB/NA 175, x 84; 23, Paratype, Male, RV, ext., BB/NA 174, x 80; 25, Paratype, Male, RV, int., BB/NA 174, x 76. 24, *Keijia interrupta* (Howe & McKenzie, 1989). LV, ext., BB/NA 176, x 118. 26-31, *Keijia profundosculpta* sp. nov.; 26, Holotype, LV, ext., BB/NA 177, x 89; 27, Paratype, carapace, ext. view of RV, BB/NA 178, x 84; 28, Paratype, carapace, dorsal view, BB/NA 178, x 127; 29, Paratype, LV, ext., BB/NA 179, x 84; 30, Paratype, RV, ext., BB/NA 180, x 84; 31, Paratype, LV, int., BB/NA 181, x 89.



dont. Sexual dimorphism exhibited, males longer and lower than females.

Distribution.—Samples A4, A5.

Dimensions.

	Length	Height
Holotype ARV BB/NA 159	0.44	0.20
Paratype ARV BB/NA 160	0.46	0.20
Paratype ALV BB/NA 161	0.46	0.22
Paratype ALV BB/NA 162	0.46	0.22
Paratype ARV BB/NA 163	0.44	0.22

Remarks.—The present material is closest to *K. parademissa* sp. nov. in overall shape and ornamentation, although differences in reticulation do occur especially medianly and posteromedianly. Also, the present species differs in having its posterior marginal depression strongly subdivided into three subequal fossae. *K. nordaustaliae* Howe & McKenzie, 1989, is also similar, but lacks the reticulation pattern of the present species. *K. demissa* (Brady, 1868) differs in having a narrower posterior marginal depression, as well as in the pattern of its reticulation.

Keijia nordaustaliae Howe & McKenzie, 1989
(Pl. 6, Figs. 14-18, 20)

1989 *Keijia nordaustaliae* Howe & McKenzie, p. 32, Fig. 74.

In part 1989 *Keijia nordaustaliae* Howe & McKenzie. Yassini *et al.*, p. 392, Pl. 4, Figs. 79-80.

Material.—31 valves, 107 carapaces. Adults only.

Amended diagnosis.—Small, subrectangular, elongate species of *Keijia* characterised by its anterior depression being divided into three (two large and one very small) sub-depressions, irregular open reticulation posteriorly and prominent “X” shaped, or bird shaped muri medianly.

Amended description.—Small, moderately thick-shelled, semitranslucent, subrectangular in lateral view. Anterior margin broadly rounded, extremity at mid-height. Dorsal margin nearly straight, sloping posteriorly. Anterior cardinal angle rounded, posterior cardinal angle distinct. Posterior margin truncated, 4-5 blunt marginal denticles, posteroventrally. Ventral margin concave. Greatest length at mid height, greatest height through anterior cardinal angle. Surface ornament of strong irregular open reticulae posteriorly and dorsally; anteromedianly reticulae small, sube-

qual. Muri rounded, smooth. Large broad peripheral depression divided into three subdepressions (one very small and two large) anteriorly and anteroventrally, and two posteriorly and posteroventrally. Anteriorly, immediately bordering the margin, two rows of small deep fossae. Npc large, simple, few. Inner lamella broad, im subparallel to om. Line of concrescence and inner margin divergent to form crescentic vestibule anteriorly. Rpc medium in number, long irregular. Central muscle scar pattern indistinct, subcentral. Hinge pentadont.

Distribution.—Samples A1-A5, B1-B5.

Dimensions.

	Length	Height
ARVM BB/NA 164	0.46	0.20
ALVM BB/NA 165	0.44	0.20
ARVF BB/NA 166	0.44	0.20
ALVF BB/NA 167	0.40	0.22
ARVF BB/NA 168	0.44	0.20
ALVM BB/NA 169	0.44	0.22

Remarks.—The present species possesses a degree of variation in the form of the ornamentation, particularly in the posterior and posteroventral areas. Occasionally two large fossae are developed, the more ventral of the two being open to the ventromarginal peripheral depression. The present species can be distinguished from *K. demissa* (Brady, 1868), by its coarser reticulation medianly, and broad posteromarginal depression. *K. intermedia* sp. nov. is closest to the present species, but can be distinguished from it by its more compact reticulate ornament, concentric to the median area of the carapace. *K. parademissa* sp. nov. has a somewhat similar pattern of ornament, but in the present species, all the structural elements are much stronger.

Keijia parademissa sp. nov.
(Pl. 6, Figs. 21-23, 25)

Derivatio nominis.—Latin, with reference to the similarity of this species to *K. demissa* (Brady, 1868).

Holotype.—ALVF BB/NA 171 (Pl. 6, Fig. 21).

Type locality and level.—Lee Point on Shoal Bay. Sample A4. Recent.

Material.—10 valves, 31 carapaces. Adults only.

Diagnosis.—Small, subrectangular species of *Keijia* characterised by its small, closely spaced, subrectangular, moderately deep reticulum and numerous weak rounded costae arranged subconcentrically about the mid-point of the carapace.

Description.—Small, thick-shelled, semitranslucent, elongate subrectangular, in lateral view. Anterior margin broadly rounded to slightly truncated, extremity at mid-height. Dorsal margin nearly straight, slightly convex posteriorly. Anterior cardinal angle rounded, obtuse; posterior cardinal angle distinct. Posterior margin truncated, sub-quadrate, 5-6 blunt marginal denticles. Ventral margin concave medianly. Greatest length at mid height, greatest height through anterior cardinal angle. Surface ornamentation reticulate, formed by intersection of weakly developed irregular costae, concentric to mid-point of carapace and other, radial costae. Intercostal areas finely reticulate. Reticulation deep, subrectangular to subquadrate. Prominent deep, subrectangular fossae around periphery. Two rows of moderately deep reticulae anterior and anteroventrally of marginal ridge. NPC large, simple, rare, unevenly distributed. Inner lamella broad, line of concrescence and inner margin divergent, subparallel to outer margin. RPC moderate, long irregular. Central muscle scar pattern indistinct, large “V” shaped frontal opening dorsally. Hinge pentadont.

Distribution.—Samples A3-A5, B1, B3, B4.

Dimensions.

	Length	Height
Holotype ALVF BB/NA 171	0.46	0.22
Paratype ARVF BB/NA 172	0.48	0.22
Paratype ALVM BB/NA 173	0.44	0.20
Paratype ARVM BB/NA 174	0.44	0.20
Paratype ALVF BB/NA 175	0.46	0.22

Remarks.—Very similar to *K. demissa* (Brady, 1868), but differs in having a broad posterior marginal depression and different reticulation pattern medianly and posteriorly. The present species is also similar to *K. nordaustaliae* Howe & McKenzie, 1989, but differs in its weaker costae, as well as in the number of posterior peripheral fossae. This species is also quite similar to *Keijia australis* Yassini *et al.*, 1993, except it has a less narrowly rounded and tapering posterior and somewhat different pattern of surface ornament. The close similarity in surface ornament pattern between *K. intermedia* sp. nov. and *K. parademissa* sp. nov. perhaps reflects a close phylogenetic relationship (see also remarks for *K. intermedia* sp. nov.).

Keijia profundosculpta sp. nov.
(Pl. 6, Figs. 26-31)

1989 *Keijia nordaustaliae* Howe & McKenzie, p. 32, Fig. 74.

In part 1993 *Keijia nordaustaliae* Howe & McKenzie. Yassini *et al.*, p. 392, Pl. 4, Fig. 78.

Derivatio nominis.—Latin with reference to the deeply dissected nature of the ornament.

Holotype.—ALV BB/NA 177 (Pl. 6, Fig. 26).

Type locality and level.—Lee Point on Shoal Bay.

Material.—130 valves, 12 carapaces. Adults to A-1.

Diagnosis.—Small, subrectangular species of *Keijia* characterised by its long, strong irregular and labyrinthine ornament, in which the strongly elevated smooth muri enclose deep, narrow fissure-like fossae.

Description.—Small, thick-shelled, semi-translucent, subrectangular in lateral view. Anterior margin asymmetrically and irregularly rounded. Dorsal margin slightly concave medianly, cardinal angles indistinct, obtuse. Posterior margin subtruncated and bearing 4-5 short, blunt, marginal denticles. Ventral margin nearly straight, slight oral incurvature. Maximum length at mid height, greatest height through anterior cardinal angle. Maximum width posteromedianly. Surface ornament of strong irregular and labyrinthine ornament in which the strongly elevated, smooth, muri enclose deep, narrow, fissure-like fossae. Strong “ocular” ridge subparallel to anterior margin; merges dorsally into dorsal rib, parallel to dorsal margin. Dorsal margin merges with posterior marginal ridge and then via weakly developed ventral rib coalesces with anterior margin. Remainder of surface covered by irregular, strongly elevated, smooth muri enclosing deep narrow fossae. Rare large, simple npc, irregularly distributed. Large crescentic vestibulum anteriorly. Line of concrescence and inner margin subparallel to periphery. RPC long, irregular. Hinge pentadont. Central muscle scar pattern indistinct, vertical row of four elongate, subovate adductors and a “V” shaped frontal scar.

Distribution.—Samples A1-A5, B1, B3-B5.

Dimensions.

	Length	Height
Holotype ALV BB/NA 177	0.44	0.24
Paratype AC BB/NA 178	0.40	0.22
Paratype ALV BB/NA 179	0.42	0.22
Paratype ARV BB/NA 180	0.40	0.20
Paratype ALV BB/NA 181	0.42	0.22

Remarks.—The present species, although clearly belonging to *Keijia* on the basis of its internal features is, in respect of its ornament, reminiscent of certain species of the genus *Kotoracythere* Ishizaki, 1966. It also resem-

bles some species of *Callistocythere*. The ornament of this species is unusually strong for *Keijia* and differs from *K. nordaustriale* Howe & McKenzie, in its more massive ornament of fewer components. *K. parademissa* sp. nov., is much more delicately and regularly ornamented. It differs from all other members of the genus in the present study by being relatively more subquadrate.

Keijia bentleyi (Howe & McKenzie, 1989) comb. nov.
(Pl. 7, Figs. 1-2)

1989 *Mackenziartia bentleyi* Howe & McKenzie, p. 34, Figs. 32, 105.

1993 *Mckenziartia bentleyi* Howe & McKenzie. Yassini *et al.*, Pl. 4, Figs. 75-77.

Material.—4 adult valves.

Distribution.—Samples A3-A5.

Dimensions.

	Length	Height
ARV BB/NA 182	0.36	0.14
ARV BB/NA 183	0.34	0.18

Remarks.—In the present material details of the reticulation are difficult to observe, due to the relatively poorly preserved nature of the specimens. However, the material examined here is assigned to the species *K. bentleyi* on the basis of its broad scale external ornamental features. *Keijia portjacksonensis* (McKenzie, 1967) only differs from the present species in the fine detail of the surface ornament pattern

(very minor) and by possessing a very slightly inflated posterodorsal region of the carapace.

Keijia darwinensis (Howe & McKenzie, 1989) comb. nov.
(Pl. 6, Fig. 19)

1989 *Labutisella darwinensis* Howe & McKenzie, p. 37, Figs. 31, 99-101.

Material.—29 valves, 43 carapaces. Adults (?) & juveniles.

Distribution.—Samples A1-A5, B1-B.5.

Dimensions.

	Length	Height
LV BB/NA 170	0.32	0.16

Remarks.—The specimens here illustrated accord closely in external morphology to the type specimens of this species illustrated by Howe & McKenzie, 1989, except that the later appear to be slightly more elongate.

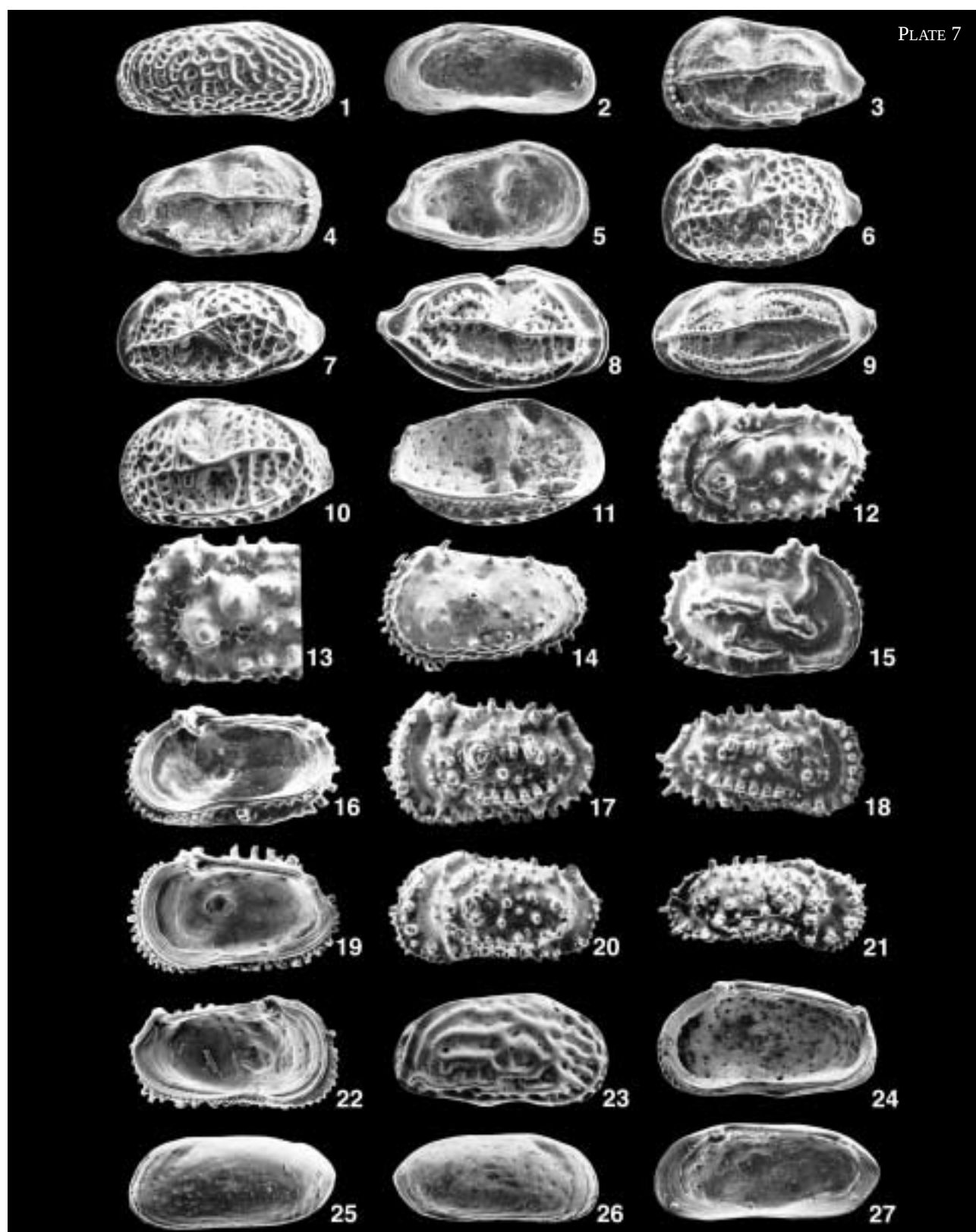
Keijia interrupta (Howe & McKenzie, 1989) comb. nov.
(Pl. 6, Fig. 24)

1989 *Labutisella interrupta* Howe & McKenzie, p. 38, Fig. 103.

Material.—2 valves, 16 carapaces. Adults (?) & juveniles.

→

PLATE 7–1-2, *Keijia bentleyi* (Howe & McKenzie, 1989); 1, RV, ext., BB/NA 182, x 106; 2, BB/NA 182, RV, int., BB/NA 182, x 110. 3-5, *Neomonoceratina indonesiana* Whatley & Zhao, 1987; 3, LV, ext., BB/NA 185, x 88; 4, RV, ext., BB/NA 186, x 88; 5, LV, int., BB/NA 185, x 88. 6, 7, *Neomonoceratina koenigswaldi* (Keij, 1954); 6, Female, LV, ext., BB/NA 189, x 57; 7, Male, LV, ext., BB/NA 187, x 53. 8, 9, *Neomonoceratina porocostata* Howe & McKenzie, 1989; 8, Female, RV, ext., BB/NA 192, x 88; 9, Male, LV, ext., BB/NA 193, x 84. 10, 11, *Neomonoceratina* sp.; 10, LV, ext., BB/NA 194, x 66; 11, LV, int., BB/NA 194, x 62. 12-14, *Actinocythereis scutigera* (Brady, 1868); 12, Female, LV, ext., BB/NA 195, x 49; 13, Female, LV, detail of ornament, BB/NA 195, x 97; 14, LV (juv.?), ext., BB/NA 196, x 106. 15, 16, *Actinocythereis costata* Hartmann, 1978; 15, Female, RV, ext., BB/NA 197, x 57; 16, Female, RV, int., BB/NA 197, x 53. 17-19, *Actinocythereis tetrica* (Brady, 1880); 17, Female, LV, ext., BB/NA 199, x 62; 18, Male, RV, ext., BB/NA 203, x 57; 19, Female, RV, int., BB/NA 200, x 62. 20-22, *Actinocythereis gippsi* sp. nov. 20, Holotype, Female, LV, ext., BB/NA 205, x 53. 21, Paratype, Male, RV, ext., BB/NA 210, x 49; 22, Paratype, Female, LV, int., BB/NA 207, x 53. 23, 24, *Australimoosella* sp. cf. *A. exmouthensis* Hartmann, 1978; 23, RV, ext., BB/NA 211, x 75; 24, RV, int., BB/NA 211, x 75. 25-27, *Australimoosella paenenuda* Howe & McKenzie, 1989; 25, LV, ext., BB/NA 212, x 71; 26, RV, ext., BB/NA 213, x 71; 27, RV, int., BB/NA 213, x 79.



Distribution.—Samples A1-A5, B1, B3, B4.

Dimensions.

	Length	Height
LV BB/NA 176	0.32	0.16

Remarks.—The specimen of this species illustrated here is similar in external ornament to the type specimens of this species illustrated by Howe and McKenzie, 1989. However the latter are significantly larger than the former.

Subgenus *Praemunita* Labutis, 1989 [in Howe & McKenzie, 1989]

The taxon *Praemunita* was established as a genus in Howe and McKenzie, 1989. Howe and McKenzie, 1989, assigned authorship of this genus name to Labutis. It had been previously referred to as a *nomen nudum* by Hartmann, 1978. Such establishment of a genus name, that has previously been a *nomen nudum*, appears permissible under the International Code of Zoological Nomenclature (4th edition), which states the following. “A *nomen nudum* is not an available name, and therefore the same name may be made available later for the same or a different concept; in such a case it would take authorship and date [Arts. 50, 21] from that act of establishment, not from any earlier publication as a *nomen nudum*.” (International Commission on Zoological Nomenclature 1999, p. 111). *Praemunita* is here regarded as a subgenus of *Keijia*. *Keijia* (*Praemunita*) is transitional in carapace morphology between the rather morphologically plastic genus *Keijia* (*Keijia*) (as here defined) and the morphologically conservative pectocytherine genus *Ameghinocythere* Whatley *et al.*, 1997.

Keijia (*Praemunita*) sp. cf. *K. (P.) broomensis*
(Hartmann, 1978) comb. nov.
(Pl. 5, Fig. 25)

1978 *Pectocythere* (?) *broomensis* Hartmann, p. 145, Text-Figs. 621-629, Pl. 14, Figs. 15-20.

1989 *Praemunita broomensis* (Hartmann). Howe & McKenzie, p. 36, Fig. 96.

1993 *Praemunita broomensis* (Hartmann). Yassini *et al.*, p. 390, Pl. 4, Figs. 72-74.

Material.—1 adult valve.

Description.—Small, thick-shelled, subrectangular in lateral view. Anterior margin rounded, slightly

truncated; extremity at mid-height. Dorsal margin concave medianly; sloping posteriorly. Cardinal angles rounded, obtuse. Posterior margin truncated, sub-quadrate, smooth. Extremity below mid-height. Ventral margin, concave medianly. Greatest length medianly, greatest height through anterior cardinal angle. Surface ornament of weakly defined costae and reticulae. Anterior margin with 3-4 subparallel smooth costae extending from the anterodorsal cardinal angle to their termination at the ventral margin. Posterior margin with 5-6 similar costae extending from the posterior cardinal angle, subparallel to the posterior margin, until their termination at the ventral margin. Three weakly defined costae, obliquely extending from the anterior cardinal angle, anteromedianly. Remainder of carapace covered with a fine meshwork of subequal reticulae. Internal details not observed.

Distribution.—Samples A4, A5.

Dimensions.

	Length	Height
ALV BB/NA 151	0.50	0.22

Remarks.—This species, as illustrated here, has a slightly greater height to length ratio than previously illustrated specimens of *P. broomensis* (i. e. Hartmann, 1978, Pl. 14, Figs. 15-20). The present material differs from *Hemicytheridea reticulata* Kingma, 1948, from Malaysia in its more subrectangular outline in lateral view, hinge structure and in the form of its ornamentation (in Kingma's species no vertical costae were developed). *P. broomensis* is extremely similar to *Keijia* (*P.*) *mowbrayi* (Yassini & Mikulandra, 1989) comb. nov., the latter possibly being a junior synonym or subspecies of the former. Topotypic populations of adult female and male specimens of both species will require comparison to determine the taxonomic status of *K. (P.) mowbrayi*. The species *K. (P.) broomensis* also bears comparison to the similarly shaped littoral pectocytherid species from Argentina, *Ameghinocythere reticulata* Whatley *et al.*, 1997. The latter differs by possessing a less rounded posterior and near vertical posterior margin.

Genus *Kotoracythere* Ishizaki, 1966
Kotoracythere inconspicua (Brady, 1880)
(Pl. 6, Fig. 6)

1880 *Cythere inconspicua* Brady, p. 70, Pl. 13, Fig. 1.

1954 *Leptocythere inconspicua* (Brady). Keij, p. 354, Pl. 1, Figs. 3a, b.

- 1975 *Morkhovenia inconspicua* (Brady). Teeter, p. 435, Figs. 70q, 8c.
 1981 *Morkhovenia* cf. *inconspicua* (Brady). Hartmann, p. 120, abb. 50-61b.
 1984 *Morkhovenia inconspicua* (Brady). Hartmann, p. 126, Pl. 4, Figs. 9-10.
 1989 *Kotoracythere inconspicua* (Brady). Whatley & Keeler, Pl. 5, Figs. 5-7.
 1990 *Morkhovenia kingstoni* McKenzie *et al.*, p. 11, Pl. 3, Fig. 1.
 1991 *Kotoracythere inconspicua* (Brady). Witte & Van Harten, p. 434, Figs. 3a-n, 4a-x, 5a-v.
 1993 *Kotoracythere inconspicua* (Brady). Jellinek, p. 121, Pl. 7, Figs. 157-165; Pl. 8, Figs. 166-170.
 1995 *Kotoracythere inconspicua* (Brady). Yassini & Jones, p. 338, Figs. 287-288.
 2001 *Kotoracythere inconspicua* (Brady). Titterton *et al.*, p. 39, Pl. 2, Figs. 11, 12 (also see synonymy list therein).
 2005 *Kotoracythere inconspicua* (Brady). Mostafawi *et al.*, p. 130, Pl. 1, Figs. 10-12 (also see synonymy list therein).

Material.—2 valves. Adult to A-1.

Distribution.—Samples A4, B2.

Dimensions.

	Length	Height
ALV BB/NA 184	0.40	0.24

Remarks.—The present species is placed in *Kotoracythere* because of its similarity to the type species *K. abnorma* Ishizaki, 1966, from the Miocene of Japan. The present species differs from the latter by the absence of lateral ribs and reticulate ornament. *Kotoracythere* has priority over *Morkhovenia* Teeter, 1975, with the latter is here considered to be a junior synonym of the former.

Family SCHIZOCYTHERIDAE Howe, 1961

Genus *Neomonoceratina* Kingma, 1948

Neomonoceratina indonesiana Whatley & Zhao, 1987
 (Pl. 7, Figs. 3-5)

- 1987 *Neomonoceratina indonesiana* Whatley & Zhao, p. 340, Pl. 2, Figs. 23-26.
 1997 *Neomonoceratina indonesiana* Whatley & Zhao. Dewi, p. 59-60, Figs. 51-53.

Material.—3 adult valves.

Distribution.—Sample A4.

Dimensions.

	Length	Height
ALV BB/NA 185	0.44	0.25
ARV BB/NA 186	0.44	0.24

Remarks.—The present species can be distinguished from *N. koenigswaldi* Keij, 1954, by its stronger ribs and the lack of intercostal reticulation. The present species is also smaller than *N. koenigswaldi*. Whatley and Zhao's original type material of the present species was from the Malacca Straits between Indonesia and Malaysia.

Neomonoceratina koenigswaldi (Keij, 1954)
 (Pl. 7, Figs. 6-7)

- 1954 *Paijenborchella (Neomonoceratina) koenigswaldi* Keij, p. 359, Pl. 3, Figs. 14-18.
 1975 *Neomonoceratina koenigswaldi* (Keij). Guha, p. 18, Pl. 1, Figs. 14-15.
 1978 *Neomonoceratina koenigswaldi* (Keij). Hartmann, p. 76, Pl. 111, Figs. 1-8.
 1981 *Neomonoceratina koenigswaldi* (Keij). Hartmann, p. 101, Pl. 11, Figs. 5-8.
 1984 *Neomonoceratina koenigswaldi* (Keij). Titterton MS, p. 447, Pl. 14, Fig. 14; Pl. 53, Figs. 8-9.
 1988 *Neomonoceratina koenigswaldi* (Keij). Zhao & Whatley, p. 570, Pl. 2, Figs. 20, 21.
 1988 *Jankeicythere koenigswaldi* (Keij). McKenzie, p. 31-32, Pl. 1, Figs. 1-18.
 1989 *Jankeicythere* cf. *koenigswaldi* (Keij). Howe and McKenzie, p. 14.
 1993 *Neomonoceratina iniqua* (Brady, 1868). Yassini *et al.*, p. 393, Pl. 5, Figs. 84-90.

Material.—41 valves, 3 carapaces. Adults to ?A-4.

Distribution.—Samples A1, A3-A5, B3-B4.

Dimensions.

	Length	Height
ALVM BB/NA 187	0.68	0.34
ARVM BB/NA 188	0.68	0.34
ALVF BB/NA 189	0.56	0.34
ARVF BB/NA 190	0.52	0.32

Remarks.—The present species closely resembles *Neomonoceratina* sp. of this study but differs in being

more elongate, and more subrectangular in lateral view. Also lacking in *N. koenigswaldi*, is the strong rib extending vertically from the ocular tubercle to join the median rib. *N. helvetica* Oertli, 1958, from the Miocene of Switzerland, also resembles the present species but differs in carapace shape, reticulation pattern, and position, and number of ribs. This species was originally recorded from Manila in the Philippines (see Keij, 1954) but is widespread in Australia and the Solomon Islands and occurs in reef environments of the Java Sea (Watson MS, 1988). Zhao and Whatley, 1988, illustrated both *N. iniqua* (Brady, 1868) [type material] and *N. koenigswaldi* Keij, 1954. Comparisons based on Zhao and Whatley's (1988) illustrations and those of Keij, 1954, indicate that the latter has a (relatively) much lower posterior extremity than the former. A consequence of this observation is that specimens illustrated as *N. iniqua* by Yassini *et al.*, 1993, are better placed under *N. koenigswaldi*.

Neomonoceratina porocostata Howe & McKenzie,
1989
(Pl. 7, Figs. 8, 9)

- 1984 *Neomonoceratina mediterranea* (Ruggieri).
McKenzie & Pickett, p. 237, Figs. 4Y, Z.
1989 *Neomonoceratina porocostata* Howe &
McKenzie, p. 12, 14, Figs. 60, 61.
1993 *Neomonoceratina porocostata* Howe &
McKenzie. Yassini *et al.*, p. 393, Pl. 5, Figs.
93-97.

Material.—1 valve, 5 carapaces. Adults only.

Distribution.—Sample A4, A5.

Dimensions.

	Length	Height
ALVM BB/NA 191	0.44	0.18
ARVF BB/NA 192	0.40	0.20
ALVM BB/NA 193	0.44	0.18

Remarks.—The present material differs slightly from the very similar types of *P. mediterranea* Ruggieri in possessing a stronger ocular ridge, and a short arcuate rib in an anteromedian position. For other differences with *P. mediterranea* see comments by Howe & McKenzie, 1989. While the specimens illustrated here are undoubtedly of the same species as those recorded as *N. porocostata* by Howe & McKenzie, 1989, and Yassini *et al.*, 1993, it is noted

that this name may be a junior synonymy of *P. mediterranea malayensis* Zhao & Whatley, 1988. However, the illustrations and descriptions of *P. mediterranea malayensis* in Zhao & Whatley, 1988, are currently of insufficient extent, for detailed comparisons to be made with *N. porocostata*. Similarly, the present species is very similar to *Neomonoceratina crispata* Hu, 1976, and *Neomonoceratina delicata* Ishizaki & Kato, 1976, although the latter two species have more complex ornament in the ventral half of the carapace and tend to display an inter-rib reticulate ornament. The present material displays strong sexual dimorphism with males being more elongate than females.

Neomonoceratina sp.
(Pl. 7, Figs. 10-11)

Material.—1 adult valve.

Diagnosis.—A species of *Neomonoceratina* characterised by its subovate outline in lateral view, finely reticulate surface ornament, with strong ocular, median and circumperipheral ribs.

Description.—Medium, thick-shelled, subovate in lateral view. Anterior margin broadly rounded, smooth; extremity at mid-height. Dorsal margin nearly straight, sloping posteriorly. Cardinal angles rounded, indistinct. Posterior margin, subcaudate, slightly truncated; extremity below mid-height. Ventral margin nearly straight, slightly convex posteriorly, slight oral incurvature anteriorly. Greatest length below mid-height. Greatest height through eye tubercle. Surface ornament of a strong mediolateral rib sloping obliquely anteriorly. A strongly developed circum-submarginal rib extending from the eye tubercle, anterodorsally around the entire free margin. This rib is deflected, mediodorsally, towards the centre of the carapace, its termination situated within the median sulcus. A strong ocular rib is also present, extending from the eye tubercle to merge with the mediolateral rib anteromedianly. Intercostal areas occupied by a fine mesh-work of deep reticulae. Internal details as for genus.

Distribution.—Sample A4.

Dimensions.

	Length	Height
ALV BB/NA 194	0.60	0.40

Remarks.—The present species closely resembles *N. koenigswaldi* Keij, 1954, but can be distinguished

from the latter by the presence of the ocular rib extending almost vertically down to merge with the medio-lateral costae. The ocular rib in *N. koenigswaldi* is less prominent and extends anteriorly to merge with the anterior marginal rib. The reticulation pattern of the present species also differs from that of the latter in being less open. *N. koenigswaldi* is also slightly larger and more elongate than the present species. While almost certainly a new species, this taxon is left in open nomenclature due to its rarity.

Family THAEROCYTHERIDAE Hazel, 1967
Bradleya s.l. Hornibrook, 1952

Remarks.—As with Hornibrook's (1952) original concept of the morphological range of this taxon, there are a large number of morphologically distinct species groups of *Bradleya s.l.* inhabiting shallow marine realms in Australasia. The greatest diversity of these shallow marine *Bradleya s.l.* groups probably occurs in southeast Australian coastal waters with *Bradleya s.l.* group taxa being relatively less diverse in tropical waters of northern Australia. *Quasibradleya* Benson, 1972, is one such group that has been separated out as a distinctly named species cluster (see below).

Bradleya sp.
(Pl. 8, Fig. 7)

Material.—1 adult valve.
Distribution.—Sample A4.
Dimensions.

	Length	Height
ALV BB/NA 228	0.54	0.30

Description.—Medium, moderately thick-shelled, subrectangular in lateral view. Anterior margin broadly rounded, denticulate. Dorsal margin straight. Cardinal angles rounded. Posterior margin sharply rounded, acuminate, extremity at mid-height. Ventral margin straight, slightly convex. Greatest length median; greatest height through anterior cardinal angle. Surface ornament of coarse reticulae and small, mainly circular and deep puncta. Internal details not clearly observed due to poorly preserved nature of specimen.

Remarks.—This species belongs to the same group of shallow marine *Bradleya s.l.* species as *Bradleya reticulata* Yassini & Jones, 1987. Both forms possess

an elongate rectangular carapace, and differ only in the details of their ornament. The present species is very similar to a species of *Bradleya s.l.* designated as *Hiltermannicythere* spec 124 by Hartmann, 1980.

Genus *Quasibradleya* Benson, 1972
Quasibradleya pitalia (Hu, 1981)
(Pl. 9, Figs. 7-10)

- 1972 *Bradleya* (*Quasibradleya*) species Benson, Pl. 2, Fig. 10.
1981 *Trachyleberidea pitalia* Hu, p. 86, Pl. 1, Figs. 12, 14, 20-22, Text-Fig. 6.
1990 *Bradleya pitalia* (Hu). Gou, p. 28, Pl. 2, Fig. 24.
1995 *Bradleya* (*Quasibradleya*) *pitalia* (Hu). Zhao, p. 75, Pl. 3, Fig. 15.

Material.—40 valves. Adults to A-1.
Distribution.—Samples A2-A5, B3-B4.
Dimensions.

	Length	Height
ARV BB/NA 260	0.72	0.34
ALV BB/NA 261	0.80	0.44
ARV BB/NA 262	0.72	0.34
ALV BB/NA 263	0.68	0.34

Remarks.—Only adults and juveniles to A-1, were found in the Recent material of Lee Point. The species is common in the Quaternary of the Solomon Islands. The species most closely resembles *Q. leepointensis* sp. nov. of the present study, but differs in having a more strongly developed alar process and in the form of a caudal process. The present species is similar in carapace morphology to *Bossella polyclada* (Hu, 1981) n. comb., *Bossella* (?) *macroloba* Hu, 1981 n. comb. and *Bossella elongata* (Hu, 1979), except the latter three species possess heavier ornament around the subcentral region of the carapace and also differ in the details of the ribbing and reticulate ornament.

Quasibradleya leepointensis sp. nov.
(Pl. 9, Figs. 11-13)

Derivatio nominis.—L. With reference to the type locality of the species.

Holotype.—ALVF BB/NA 264 (Pl. 9, Figs. 11, 13).

Type locality and level.—Lee Point on Shoal Bay. Lee Point East. Sample A4. Recent.

Material.—24 valves, 27 carapaces. Adults to A-2.

Diagnosis.—A species of *Quasibradleya* characterised by its coarsely reticulate surface and prominent ribs parallel to the periphery. Two strong ribs emerge from the posterodorsal cardinal angle; one parallel and over-reaching the dorsal margin, deflected towards the anterior, medianly, the other extending vertically down towards the ventral surface to meet and join with a weakly alate, medioventral rib. Subquadrate caudal process.

Description.—Large, subquadrate in female, subrectangular in male, thick-shelled, semitranslucent. Anterior margin, asymmetrically but broadly rounded, anterodorsally sloping up to meet nearly straight dorsal margin. Median to posterior portion of dorsal margin over-reached by dorsal rib. Posterodorsal margin short, straight, sloping posteroventrally to form a short subquadrate caudal process. Anterior cardinal angle rounded, obtuse. Posterior cardinal angle pronounced. Ventral margin nearly straight, slight ventral incurvature orally. Maximum length at mid height; maximum height through anterodorsal cardinal angle; maximum width through posterior extremity of slight alar process. Surface coarsely ornamented with strong ribs and large, deep, subequal intercostal reticulae. Strong ocular rib, extends from large spherical glassy eye tubercle, anterodorsally, towards the anterior margin. This rib continues parallel to ventral margin as the ventrolateral rib, becoming subalate posteriorly. Two strong ribs emerge from the posterodorsal cardinal angle, one parallels and over reaches the dorsal margin, and is deflected anteroventrally, medianly. The other extends vertically down towards the ventral margin to meet, first the median rib and then the ventrolateral rib at their posterior termination. Median rib subparallel to dorsal margin; extends from posterior vertical rib anteriorly through the subcentral tubercle to join anterior marginal rib. Intercostal surface of the valves coarsely reticulate. Costae with fine secondary reticulation. Npc's, along the flanks of the costae. Well developed broad inner lamella. Avestibulate. Short, straight radial pore canals, evenly distributed. Central muscle scar pattern not clearly visible. Hinge strongly holamphidont.

Distribution.—Samples A2-A5, B3-B4.

Dimensions.

	Length	Height
Holotype ALVF BB/NA 264	0.66	0.32
Paratype ARVF BB/NA 265	0.64	0.34
Paratype ALVM BB/NA 266	0.66	0.32
Paratype ARVM BB/NA 267	0.66	0.30

Remarks.—The present species is most similar to *Quasibradleya* sp. of the present study, but differs in being more quadrate, and in its weaker but denser reticulation. *Bradleya (Quasibradleya) plicocarinata* Benson, 1972, is also very similar to the present species, but differs in its reticulation pattern and, unlike the present species only has the median rib joined with the dorsal carina, forming a posterodorsal loop, whereas the present species has both a posterodorsal loop and a posteroventral loop developed. Specimens illustrated and described as *Bradleya mckenziei* by Yassini and Jones, 1995, are very similar to the specimens here designated *Quasibradleya leepointensis* sp. nov. However, the name *Bradleya mckenziei* designated for the Yassini & Jones, 1995, specimens is invalid as it had previously been designated for a different species —*Bradleya mckenziei* Benson, 1972 (see Benson, 1972; p. 42). As an additional note, Benson, 1972, later referred to this species in the same publication under a different spelling —*Bradleya mackenziei* (Pl. 7, Fig. 6). However, despite similarities, adult specimens of the present material from tropical northern Australian marine waters are much smaller than the Yassini & Jones, 1995 material from temperate marine waters of southeastern Australia. In addition, the present material has a slightly better developed posteroventral loop and some very minor differences in the reticulation pattern in the posterior of the carapace, compared to the Yassini & Jones, 1995 material.

Quasibradleya sp. cf. *Q. elongata* Howe & McKenzie, 1989
(Pl. 9, Figs. 14-16)

1989 *Quasibradleya elongata* Howe & McKenzie, pp. 40-41, Fig. 119.

Material.—420 valves, 15 carapaces. Adult to A-5.

Description.—Large, subovate to subrectangular, thick-shelled, semi-translucent. Anterior margin broadly rounded, with 14-16 very small marginal denticles. Dorsal margin nearly straight, interrupted by dorsal rib; medianly. Dorsal rib deflected anteroventrally towards its anterior termination. Posterior margin subcaudate, with 5-6 short, blunt, denticles, posteroventrally. Ventral margin nearly straight, convex posteriorly, with slight oral concavity. Anterior cardinal angle indistinct, rounded, obscured by hinge ear. Posterior cardinal angle obtuse. Greatest length at mid-height; greatest height through anterior cardinal angle. Surface ornamented by deep, strong reticula-

tion. Strong tricarinate ribs with the median rib joined to the dorsal rib, forming a posterodorsal loop. The median rib extends anteriorly to join a complex of muri over the sub-central tubercle, then continues to join the ocular rib. Dorsal rib extends above dorsal margin, diverted anteriorly towards the anteroventral margin. Ventrolateral rib subparallel to the ventral margin, extends to meet the ocular rib. Ocular rib extends parallel to the anterior margin to unite with the median and ventral ribs. Large, glassy subspherical eye tubercle present. Inner margin broad. Avestibulate. Numerous, long simple rpc's. Central muscle scars difficult to observe. Hinge holamphidont.

Distribution.—Samples A1-A5, B2-B5.

Dimensions.

	Length	Height
ALVF BB/NA 268	0.72	0.36
ARVF BB/NA 269	0.72	0.36
ALVM BB/NA 270	0.76	0.34
ARVM BB/NA 271	0.74	0.34

Remarks.—The present species is very similar to *B. (Quasibradleya) plicocarinata* Benson, 1972, but differs in its reticulation and size of the caudal process. *Q. leepointensis* sp. nov. from the same sample locality, differs in its more quadrate outline, smaller truncated posterior margin, well developed subquadrate caudal process and different reticulation pattern. The specimens illustrated here have very similar ornament to the holotype specimen of *Q. elongata* illustrated by Howe & McKenzie, 1989, except for minor differences in the posterior reticulation. Further the holotype specimen of *Q. elongata* is somewhat smaller than the specimens illustrated herein.

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

Subfamily TRACHYLEBERIDINAE Sylvester-Bradley, 1948

Genus *Actinocythereis* Puri, 1953

Actinocythereis scutigera (Brady, 1868)
(Pl. 7, Figs. 12-14)

- 1868 *Cythere scutigera* Brady, p. 70, Pl. 8, Figs. 15, 16.
1880 *Cythere scutigera* Brady. Brady, p. 109, Pl. 22, Figs. 5a, b.
1954 *Trachyleberis scutigera* (Brady). Keij, p. 356, Pl. 3, Figs. 5a, b.

1985 *Actinocythereis scutigera* (Brady). Zhao *et al.*; Pl. 19, Fig. 12.

1988 *Actinocythereis scutigera* (Brady). Whatley & Zhao, p. 63, Pl. 6, Fig. 14.

1992 *Actinocythereis scutigera* (Brady, 1868). Mostafawi, p. 143, Pl. 3, Fig. 61.

1997 *Actinocythereis scutigera* (Brady, 1868). Dewi, p. 68, Figs. 145-146.

Material.—8 valves, 1 carapace. Adults to A-1.

Distribution.—Samples A4, B3, B4.

Dimensions.

	Length	Height
ALVF BB/NA 195	0.80	0.48
LVF (juv.) BB/NA 196	0.80	0.50

Remarks.—The present species differs slightly from Brady's specimens in exhibiting an anteroventral, and median spines, as well as, well developed proximal rims of spines. These spines tend to be broken in most specimens. *Actinocythereis costata* Hartmann, 1978, from the west and north coast of Australia can clearly be distinguished from the present species by its general lack of tubercles on the lateral surface and by the development of a strong mediolateral rib. *Actinocythereis tetrica* (Brady, 1880), and *A. gippsi* sp. nov., can be distinguished from the present species by their smaller size; more elongate, subrectangular outline and different arrangement of spines and denticles.

Actinocythereis costata Hartmann, 1978
(Pl. 7, Figs. 15-16)

1978 *Actinocythereis scutigera costata* Hartmann, p. 87, Pl. iv, Figs. 6-9.

1979 *Actinocythereis scutigera costata* Hartmann. Hartmann; p. 231, Pl. v, Figs. 1-8.

1988 *Actinocythereis scutigera* (Brady). Yassini & Kendrick, p. 112, Figs. 4C-G.

1989 *Ponticocythereis costata* (Hartmann). Howe & McKenzie, p. 41, Figs. 127-130.

Material.—2 valves, 3 carapaces. Adult to A-1.

Distribution.—Samples A3, A4, B4.

Dimensions.

	Length	Height
ARVF BB/NA 197	0.70	0.40
ALVF BB/NA 198	0.72	0.38

Remarks.—The present species resembles *Ponticocythereis militaris* (Brady, 1868), externally, but the latter lacks the well developed marginal ridge and sub-ventral rib of the present species. Also, in *P. militaris* the median rib is not divided into two distinct elements. See also comments by Warne, 2001.

Actinocythereis tetrica (Brady, 1880)
(Pl. 7, Figs. 17-19)

- 1880 *Cythere tetrica* Brady, p. 104, Pl. 23, Figs. 5a-d.
 1976 *Cythere tetrica* Brady. Puri & Hulings, p. 293, Pl. 27, Figs. 4-6.
 1978 *Actinocythereis dampierensis* Hartmann, p. 89, Pl. 5, Figs. 10-11.
 1984 *Trachyleberis dampierensis* (Hartmann). McKenzie & Pickett, Figs. 4, 5.
 1993 *Actinocythereis tetrica* (Brady). Yassini *et al.*, p. 398, Figs. 131-137.
 1996 *Actinocythereis tetrica* (Brady). Warne & Whatley, p. 166.
 2000 *Actinocythereis tetrica* (Brady). Hoibian *et al.*, p. 223, Fig. 22.
 2002 *Actinocythereis tetrica* (Brady). Hoibian *et al.*, p. 191, Pl. 1, Fig. 10.

Material.—15 valves, 1 carapace. Adult to A-1.

Distribution.—Samples A3, A4, B3, B4.

Dimensions.

	Length	Height
ALVF BB/NA 199	0.64	0.36
ARVF BB/NA 200	0.62	0.34
ALVF BB/NA 201	0.64	0.36
ARVF BB/NA 202	0.64	0.32
ARVM BB/NA 203	0.64	0.30
ALVM BB/NA 204	0.66	0.34

Remarks.—The present species differs from *Actinocythereis indica* Rajagopalan, 1962, from the Eocene of southern India in having a line of tubercles mediolaterally, aligned subparallel to the dorsal and ventral margins and extending from the subcentral tubercle to the posterior margin, as well as an anteroventral cluster of 4-5 spines. Hartmann, 1978, described this taxon as a new species, *A. dampierensis*, from the west coast of Australia. From an examination of his plates and descriptions, it was concluded by Warne & Whatley, 1996, that

this species was synonymous with *A. tetrica* (Brady).

Actinocythereis gippsi sp. nov.
(Pl. 7, Figs. 20-22)

Derivatio nominis.—Named in honour of Sir George Gipps, who became Governor of New South Wales and its various dependencies in 1838.

Holotype.—ALV BB/NA 205 (Pl. 7, Fig. 20).

Type locality and level.—Lee Point on Shoal Bay. Sample A4. Recent.

Material.—36 valves, 8 carapaces. Adult to A-2.

Diagnosis.—A strongly dimorphic species of *Actinocythereis* characterised by its elongate, subrectangular outline, prominent marginal ridges and inflated carapace. Surface ornament of spines and papillae, distally flattened and castellate, and irregularly distributed.

Description.—Large, moderately thick-shelled, translucent, sexual dimorphism distinct (males longer and less tall than females). Carapaces subrectangular to sub-quadrate in lateral view. Anterior margin obliquely rounded, strongly denticulate, with a well developed marginal rim of 2-3 rows of short, blunt to slightly pointed, distally flattened and expanded denticles, parallel to anterior margin. Dorsal margin convex, broken by denticles of largely decayed dorsal rib. Cardinal angles indistinct. Posterior margin broadly rounded, with a well developed, denticulate marginal ridge. Ventral surface nearly straight, slight ventral incurvature orally. Greatest length at mid height; greatest height through anterior cardinal angle. Surface of carapace ornamented by evenly spaced, but randomly distributed, short, blunt, occasionally long, sharp spines, castellate distally. Anterior margin of 2-3 rows of denticles each successive row towards the posterior with fewer and larger, more strongly developed spines. Posterior marginal rib with two rows of similar spines. Dorsal marginal rib largely decayed but with 5-6 pointed, castellate, short, spines. Rib sloping slightly posteroventrally. Subcentral tubercle an aggregate of 5 long, sharp spines. Large glassy subspherical eye tubercle. Avestibulate, inner lamella broad. Numerous straight, simple evenly spaced radial pore canals. Central muscle scar pit deep, adductor muscle scars in subvertical row of four. Dorsal and dorsomedian scar largest, all scars elongate, subelliptical. “V” shaped frontal scar opening anterodorsally. Hinge strongly holamphidont.

Distribution.—Samples A1-A5, B2-B4.

Dimensions.

	Length	Height
Holotype ALVF BB/NA 205	0.74	0.30
Paratype ARVF BB/NA 206	0.74	0.31
Paratype ALVF BB/NA 207	0.72	0.40
Paratype ARVF BB/NA 208	0.71	0.38
Paratype ALVM BB/NA 209	0.80	0.34
Paratype ARVM BB/NA 210	0.80	0.30

Remarks.—The present species differs from *Actinocythereis tetrica* (Brady, 1880), in not possessing a clearly discernable ventral line of 5-7 spines extending from the ventral margin, and sloping towards the posterodorsal margin. The present species is also larger and more elongate than the latter. The present species is also similar to *Trachyleberis* cf. *probesiodes* Hornibrook of McKenzie *et al.*, 1991, and *Trachyleberis brevicosta major* McKenzie *et al.*, 1991, although varies from these two taxa in the pattern of spine positions on the carapace surface.

Genus *Actinoleberis* McKenzie in Howe & McKenzie, 1989

Remarks.—Publication of the genus name *Actinoleberis* McKenzie, 1989 predates publication of the genus name *Malaycythereis* Zhao & Whatley, 1989, by a few months.

Actinoleberis arafurae Howe & McKenzie, 1989
(Pl. 8, Fig. 13)

1989 *Actinoleberis arafurae* Howe & McKenzie, p. 43, Figs. 35, 131, 132.

1989 *Malaycythereis trachodes* Zhao & Whatley, Pl. 3, Figs. 17-19; Pl. 4, Figs. 1-3.

1997 *Malaycythereis trachodes* Zhao & Whatley. Dewi, p. 68, Fig. 150.

Material.—4 valves. Adult to A-1.

Distribution.—Samples A3, A4.

Dimensions.

	Length	Height
ALVF BB/NA 237	0.42	0.30
ALVM BB/NA 238	0.44	0.26

Remarks.—The present species and genus has been recorded from northern Australia (Howe & McKenzie,

1989; present study) and from the Sedili River, and the Jason Bay area of the south eastern Malay Peninsula (Zhao & Whatley, 1989). Dewi, 1997, records it from the Java Sea. Howe and McKenzie, 1989, noted that the frontal scars of this species were generally v-shaped, but that some specimens display divided frontal scars.

Genus *Henryhowella* Puri, 1957

Henryhowella sinespinosa sp. nov.

(Pl. 9, Figs. 18-21; Pl. 10, Fig. 1)

1993 *Venericythere* sp. Yassini *et al.*, p. 393, Pl. 7, Figs. 129, 130.

Derivatio nominis.—*L. sine* without, plus *spina* thorn, spine = *sinespinosa*. Referring to the fact that, although most species of *Henryhowella* are ornamented by spines superimposed on reticulation, the spines are lacking in this species.

Material.—67 valves. Adult to A-2.

Holotype.—ARVM BB/NA 274 (Pl. 9, Fig. 20).

Type locality.—Lee Point on Shoal Bay.

Dimensions.

	Length	Height
Holotype ARVM BB/NA 274	0.70	0.36
Paratype ALVM BB/NA 275	0.64	0.40
Paratype ALVF BB/NA 276	0.70	0.44
Paratype JLV BB/NA 277	0.58	0.32

Distribution.—Samples A1-A5, B2-B4.

Diagnosis.—A species of *Henryhowella* characterised by its subquadrate to subrectangular outline in lateral view, medium size, and reticulate ornamentation which forms a series of 2-3 rather poorly defined costae subparallel to the ventral margin; and two less distinct costae subparallel to the anterior margin. The strong reticulate ornament shows a tendency to be arranged concentrically about the median area of the carapace. Spines absent.

Description.—Medium to large, thick-shelled, opaque, subquadrate to subrectangular in lateral outline. Anterior margin broadly rounded, with 13-14 short, blunt marginal denticles. Extremity at mid-height. Dorsal margin almost straight to slightly convex. Cardinal angles rounded, indistinct. Ventral margin almost straight; very slight oral incurvature. Posterior margin bluntly rounded with 3-4 short blunt marginal denticles posterodorsally; extremity slightly above mid height. Greatest length at mid height, greatest height through anterior cardinal angle. Eye spot small

and glassy. Surface ornament strongly and densely reticulate. Reticulation centred about mid point of carapace. Muri forms 3 costae parallel to ventral margin. Npc's large, on flanks of muri. Inner lamella narrow, avestibulate, im parallel to om. Rpc's numerous, short, straight. Central muscle scars a vertical row of 4 elongate adductors with a prominent "V" shaped frontal scar. Hinge holamphidont. Sexual dimorphism marked; females shorter and higher than males.

Remarks.—The present species is similar to *Wichmanella meridionalis* Bertels, 1969, from the lower Tertiary of Argentina, but differs in the details of the reticulate ornament particularly in the median and posterodorsal areas of the carapace. Also, the 2 distinct anterior marginal ribs, and the 3 ribs that subparallel the ventral margin, formed by the muri of the reticulate ornament; are not present in the latter. The genus *Wichmanella* Bertels is here regarded as synonymous with *Henryhowella*.

Genus *Australimoosella* Hartmann, 1978

Australimoosella spp. all have a well-formed "v" shaped frontal scar, and are here considered to be members of the Trachyleberidinae. It is here argued that *Yassinicythere* McKenzie in Howe & McKenzie, 1989, was erected on specific rather than generic grounds and that it is scarcely necessary to expand the diagnosis of *Australimoosella* to subsume *Yassinicythere* within it. We concur with McKenzie (in Howe & McKenzie, 1989) that Hartmann, 1978, inappropriately placed species such as *Australimoosella*

bassiouni in *Hiltermannicythere*, a European genus belonging to a different subfamily.

Australimoosella sp. cf. *A. exmouthensis* Hartmann, 1978
(Pl. 7, Figs. 23-24)

1978 *Australimoosella exmouthensis* Hartmann, p. 95-97, Pl. 6, Figs. 6-14.

1984 *Australimoosella* sp. Hartmann. McKenzie & Pickett, p. 239, Fig. 5b.

Material.—1 adult valve.

Distribution.—Sample A4.

Dimensions.

	Length	Height
ARV BB/NA 211	0.52	0.28

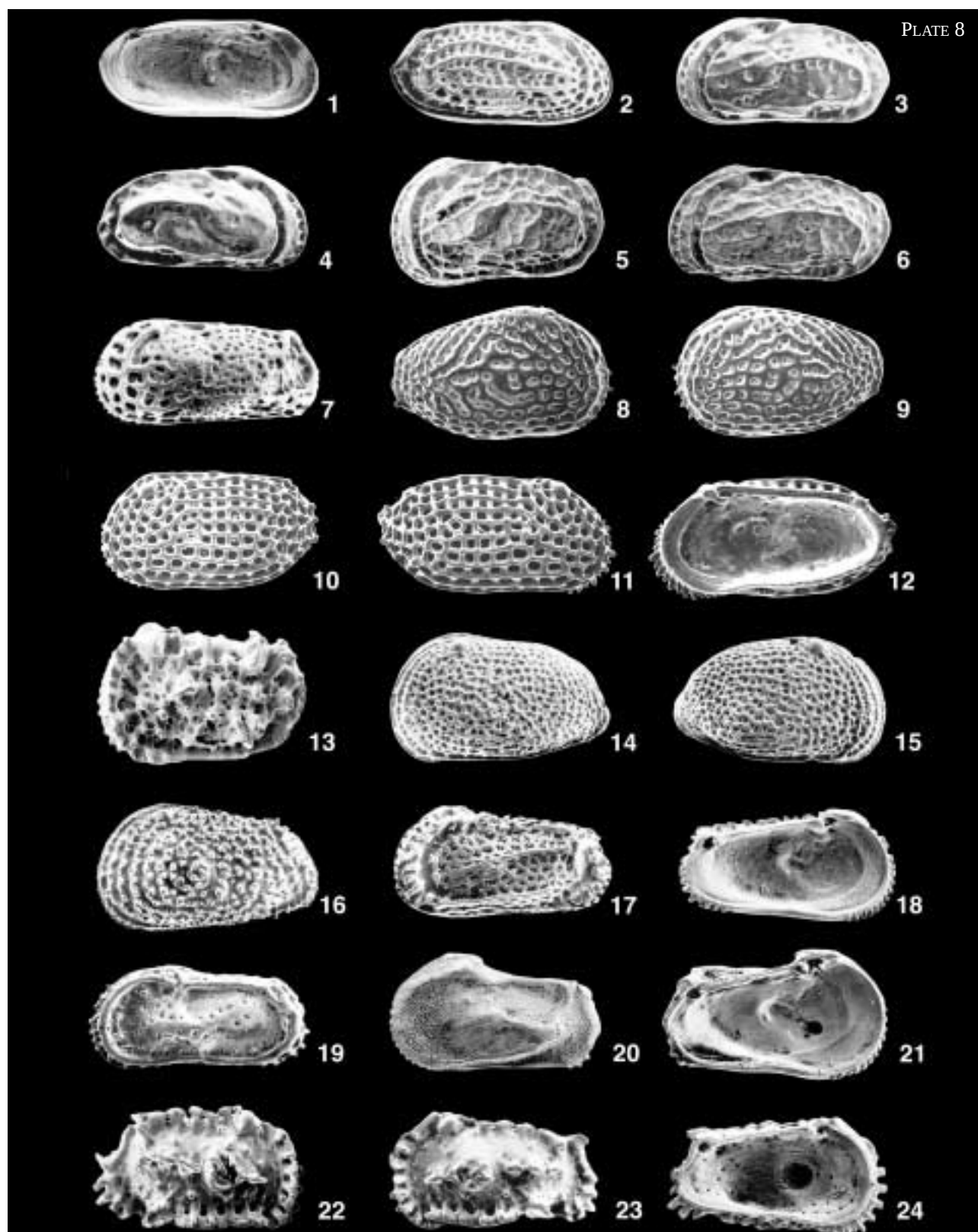
Remarks.—The present material is similar to Hartmann's type specimens of *A. exmouthensis* from the west coast of Australia, although there is slight variation in surface ornament. *Australimoosella liebau* Hartmann, 1978, resembles the present species, but differs in the strength, number and position of the longitudinal ribs, especially posteriorly.

Australimoosella rockinghamensis Hartmann, 1979
(Pl. 8, Fig. 2)

1979 *Australimoosella rockinghamensis* Hartmann, p. 233, Pl. 6, Figs. 1-4.

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PLATE 8—1, *Australimoosella paenenuda* Howe & McKenzie, 1989, LV, int., BB/NA 214, x 78. 2, *Australimoosella rockinghamensis* Hartmann, 1979, carapace, ext. view of RV, BB/NA 216, x 80. 3, 4, *Australimoosella bassiouni bassiouni* (Hartmann, 1978). 3, Female, LV, ext., BB/NA 220, x 76. 4, Male, RV, ext., BB/NA 223, x 76. 5, 6, *Australimoosella bassiouni triornata* (Yassini *et al.*, 1993); 5, Female, LV, ext., BB/NA 225, x 72; 6, Male, LV, ext., BB/NA 227, x 72. 7, *Bradleya* sp. LV, ext., BB/NA 228, x 72. 8, 9, *Venericythere papuensis* (Brady, 1880); 8, RV (juv.?), ext., BB-2, x 73; 9, LV (juv.?), ext., BB-1, x 70. 10-12, *Pistocythereis* sp.; 10, Female, LV, ext., BB-3, x 56; 11, Male, RV, ext., BB-4, x 61; 12, Male, RV, int., BB-4, x 62. 13, *Actinoleberis arafurae* Howe & McKenzie, 1989. LV, ext., BB/NA 237, x 98. 14, 15, *Neobuntonia* sp. cf. *N. sabulosa* (Brady, 1880); 14, LV, ext., BB/NA 240, x 85; 15, RV, ext., BB/NA 239, x 85. 16, *Echinocythereis* sp. LV, ext., BB/NA 241, x 80. 17, 18, *Dumontina lauta* (Brady, 1880); 17, LV, ext., BB/NA 234, x 67; 18, LV, int., BB/NA 243, x 67. 19, *Platocythereis*? sp. carapace, ext. view of LV, BB/NA 244, x 69. 20, 21, *Bradyleberis cristatella* (Brady, 1880); 20, LV, ext., BB/NA 246, x 63; 21, LV, int., BB/NA 247, x 67. 22-24, *Ponticocythereis spatulospinosa* sp. nov.; 22, Holotype, RV, ext., BB/NA 250, x 61; 23, Paratype, LV (juv.), ext., BB/NA 251, x 67; 24, Paratype, LV (juv.), int., BB/NA 253, x 67.



- 1980 *Australimoosella rockinghamensis* Hartmann. Hartmann, p. 133, Pl. 9, Figs. 1-3.
 1989 *Australimoosella liebauti* Hartmann. Howe & McKenzie, p. 43, Figs. 121-122.
 1990 *Australimoosella rockinghamensis* Hartmann. McKenzie *et al.*, p. 23, Pl. 7, Figs. 3-4.
 1993 *Australimoosella liebauti* Hartmann. Yassini *et al.*, p. 396, Pl. 6, Figs. 115-118.
 1995 *Australimoosella rockinghamensis* Hartmann. Yassini & Jones, p. 358, Fig. 365.

Material.—9 carapaces. Adults to A-1.

Distribution.—Samples A2-A5, B2-B4.

Dimensions.

	Length	Height
AC BB/NA 216	0.48	0.24
AC BB/NA 217	0.50	0.24
AC BB/NA 218	0.50	0.24
AC BB/NA 219	0.50	0.24

Remarks.—The present species is very similar in size, shape and ornamentation to *Australimoosella liebauti* Hartmann 1978, recorded from the eulittoral of Western Australia, but differs in the detail of the anterior and posterior ornament and in having more strongly developed lateral ribs than the present species. Externally, *Australimossella bassionii* s.s. (Hartmann, 1978) can be distinguished from the present species by its less elongate outline in lateral view, and fewer longitudinal ribs. Further, the surface ornamentation of the valves in *A. bassionii* is characteristically heavily celated, thus tending to obscure the reticulate and costate ornamentation. *Australimossella bassionii reticulata* (Hartmann, 1980) differs in its less elongate, more reniform outline, greater size, and less strongly costate ornamentation. *Australimoosella paenenuda* Howe & McKenzie, 1989, and *A. exmouthensis*, Hartmann, 1978, can be distinguished from the present species by lack of surface ornament in the first instance; and by a less elongate, more subrectangular outline and different orientation and strength of ribs in the second.

Australimoosella paenenuda Howe & McKenzie, 1989
 (Pl. 7, Figs. 25-27; Pl. 8, Fig. 1)

1981 *Australimoosella* spec. 117 Hartmann, p. 105, Pl. 5, Figs. 5, 6.

- 1989 *Australimoosella paenenuda* Howe & McKenzie, pp. 43-44, Fig. 139.

Material.—4 valves, 4 carapaces. Adults to A-1.

Amended description.—Medium, thin-shelled, subrectangular in lateral view. Anterior margin, broadly rounded, smooth, extremity at mid-height. Dorsal margin nearly straight, slightly convex. Cardinal angles obtuse. Posterior margin sharply rounded, acuminate, extremity at mid height. Ventral margin nearly straight with slight concavity medianly. Greatest length at mid height. Greatest height through anterior dorsal cardinal angle. Eye tubercle large. Surface ornamentation of fine reticulae, highlighted by marginal punctae. Inner margin narrow, parallel to outer margin, avestibulate. Rpc numerous, simple, straight. Central muscle scars in a vertical row of four, dorsal and ventral most scars smallest. “V” shaped frontal opening anterodorsally. Two other scars high in carapace towards anterior cardinal angle. Sexual dimorphism not observed.

Distribution.—Samples A3, A4, B1, B4.

Dimensions.

	Length	Height
ALV BB/NA 212	0.56	0.24
ARV BB/NA 213	0.52	0.24
ALV BB/NA 214	0.54	0.24
ARV BB/NA 215	0.56	0.26

Remarks.—The present species differs from *Australimoosella* sp. Hartmann 1981; in lacking the fine reticulate ornament of the latter, probably due to celation. *A. rockinghamensis* Hartmann, 1979, and *A. liebauti* Hartmann, 1978, are also very similar in external outline to the present species, but have a strong costae and reticulate ornament, as does *A. tomokoae* (Ishizaki, 1968).

Australimoosella bassionii bassionii (Hartmann, 1978) comb. nov.
 (Pl. 8, Figs. 3-4)

1978 *Hiltermanicythere bassionii* Hartmann, p. 91-93, Pl. 7, Figs. 6-14.

1979 *Hiltermanicythere bassionii* Hartmann. Hartmann, p. 232, Pl. 5, Figs. 10-20.

1988 *Makencythere venata* (Brady). Yassini & Kendrick, p. 114, Fig. 5A-D.

1989 *Yassinicythere bassionii* (Hartmann). Howe & McKenzie, p. 45, Fig. 126.

1989 *Makencythere* sp. Howe & McKenzie, p. 45, Fig. 124.

Material.—26 valves, 30 carapaces. Adults to A-1.

Distribution.—Samples A3-A5, B2-B4.

Dimensions.

	Length	Height
ALVF BB/NA 220	0.54	0.30
ALVF BB/NA 221	0.52	0.26
ARVF BB/NA 222	0.54	0.26
ARVM BB/NA 223	0.52	0.26
ALVM BB/NA 224	0.54	0.24

Remarks.—*Australimoosella bassionii reticulata* (Hartmann, 1980), differs from the present subspecies in its weaker ribs and strong secondary reticulation. The present specimens are slightly smaller than those illustrated by Hartmann, 1978, 1979. Yassini *et al.*, 1993, stated that *Australimoosella bassionii tricornata* [= *Yassinicythere tricornata* Yassini *et al.*, 1993] is distinguished from *A. bassionii* (s.s.) by the latter's smaller size and lack of numerous parallel ridges. However the type specimens of *A. bassionii* do not appear to show any difference in the number of parallel ridges to *A. bassionii triornata*. However, *A. bassionii triornata* tends to display greater complexity in the reticulation and as a consequence is regarded here (see below) as a subspecies of *A. bassionii*.

Australimoosella bassionii triornata (Yassini, Jones & Jones, 1993) comb. nov.
(Pl. 8, Figs. 5-6)

1988 "*Hiltermannicythere*" *bassionii* Hartmann. Yassini & Kendrick, p. 114, Fig. 5E-H.

1993 *Yassinicythere triornata* Yassini *et al.*, p. 396, Pl. 6, Figs. 109-114.

Material.—3 adult valves.

Distribution.—Sample A4.

Dimensions.

	Length	Height
ALVF BB/NA 225	0.56	0.30
ARVM BB/NA 226	0.64	0.30
ALVM BB/NA 227	0.62	0.30

Remarks.—This subspecies was originally designated as a new species of *Yassinicythere* by Yassini *et*

al., 1993. The major difference between *A. bassionii* s.s. and *A. bassionii triornata* is that the latter has a more prominent reticulate ornament. *A. bassionii triornata* differs from *A. bassionii reticulata* by possessing stronger lateral surface ribs.

Genus *Dumontina* Deroo, 1966

Remarks.—Australasian Cenozoic taxa belonging to the genus *Carvocythere* McKenzie *et al.*, 1990, are here referred to *Dumontina* Deroo, 1966, following Warne, 1987, 2000, and Neil, 1997.

Dumontina lauta (Brady, 1880) comb. nov.
(Pl. 8, Figs. 17-18)

1880 *Cythere lauta* Brady, p. 85, Pl. 21, Figs. 4a-d.

1976 *Cythere lauta* Brady. Puri & Hulings; p. 280, Pl. 14, Figs. 5-8.

1993 *Carvocythere lauta* (Brady). Yassini *et al.*, p. 396, Pl. 6, Fig. 121.

Material.—12 valves, 20 carapaces. Adults to A-2.

Distribution.—Samples A1-A4, B1-B4.

Dimensions.

	Length	Height
ALV BB/NA 243	0.58	0.30

Remarks.—First recorded by Brady, 1880, from the Booby Island dredging, Lat 10°36' S, Long 141°55' E at a depth of 6 to 8 fathoms. Brady described this species from only one station (station 187) and figures a complete carapace. The present material contains valves and carapaces from adult to A-2. *Dumontina lauta australiae* (McKenzie *et al.*, 1990) n. comb. differs from the present species by having slightly coarser ornament and being overall, slightly larger in size.

Genus *Platycythereis* Triebel, 1940
Platycythereis? sp.
(Pl. 8, Fig. 19)

Material.—1 adult carapace.

Description.—Medium in size. Elongate subrectangular, with almost equally well-rounded end margins. Dorsal and ventral margins slightly concave; not inclined to the posterior. Apart from a median area, which has a broad but ill-defined rib, the lateral surface is depressed and is completely surrounded by a strong,

mostly smooth sub-peripheral rib. Very large npc's occur on the inner flank of this rib anteriorly and on the lateral surface, which is minutely but very densely micropunctate. Internal features not seen.

Distribution.—Sample A4.

Dimensions.

	Length	Height
AC(LV) BB/NA 244	0.58	0.30

Remarks.—*Platycythereis* is a Cretaceous genus, common in the Valanginian to Campanian of Europe. The authors know of no *bona fide* post Mesozoic record but, equally, know of no other cytheracean genus with a rib that loops around the entire sub-periphery of the taxon. With only a single carapace it is impossible to be more exact and the taxon is, therefore, included here in *Platycythereis* only very tentatively.

Genus *Bradyleberis* McKenzie in Howe & McKenzie, 1989

Bradyleberis cristatella (Brady, 1880)
(Pl. 8, Figs. 20-21)

1880 *Cythere cristatella* Brady, p. 90, Pl. 19, Figs. 6a-d.

1976 *Cythere cristatella* Brady. Puri & Hulings, p. 271, Pl. 26, Figs. 5, 7

1989 *Bradyleberis cristatella* (Brady). Howe & McKenzie, p. 42, Figs. 33, 133.

Material.—63 valves, 36 carapaces. Adults to A-1.

Distribution.—Lee Point East, sample A4.

Dimensions.

	Length	Height
ALV BB/NA 246	0.64	0.36
ALV BB/NA 247	0.66	0.36
ARV BB/NA 248	0.62	0.34
ARV BB/NA 249	0.62	0.32

Remarks.—There is a considerable variation in the angle of the median rib in that it may be parallel to the dorsal margin or sloping posteroventrally at various angles. The median and ventral ribs may or may not be joined. Brady, 1880, recorded this species from Booby Island, Challenger station 187, at a depth of 6-8 fathoms. Howe & McKenzie, 1989, also previously recorded it from northern Australia.

Genus *Ponticythereis* McKenzie, 1967

Ponticythereis spatulospinosa sp. nov.

(Pl. 8, Figs. 22-24)

1978 *Pterygocythereis* spec. (Jurien 71) Hartmann, p. 91, Pl. vi, Fig. 15.

Derivatio nominis.—L. With reference to the spatulate tubercles which surround the margins of this species.

Holotype.—ARV BB/NA 250 (Pl. 8, Fig. 22).

Type locality and level.—Lee Point on Shoal Bay, sample A4. Recent.

Material.—127 valves, 18 carapaces. Adult to A-3.

Distribution.—Samples A2- A4, B2- B4.

Diagnosis.—A species of *Ponticythereis* characterised by its prominent subcentral tubercle, its medio-lateral line and periphery of distally expanded spatulate spines; and its elongate subrectangular outline in lateral view.

Description.—Medium, thick-shelled, translucent. Elongate subrectangular in lateral view. Anterior margin broadly rounded. Two rows of long distally expanded anterior marginal denticles, that coalesce at the antero-dorsal margin to form a short crest. Dorsal margin nearly straight, sloping slightly posteriorly, interrupted and overhung by five spines of the dorsal rib. Anterior cardinal angle, obscured by ornamentation, obtuse. Posterior cardinal angle, rounded, marked by prominent postero-dorally orientated spine. Posterior margin, subcaudate, with two rows of 4-5 long, sharp distally flattened marginal denticles posteromedianly and posteroventrally. Ventral margin denticulate in lateral view nearly straight, slight oral incurvature. Greatest length at mid height; greatest height through anterior cardinal angle; greatest width through subcentral tubercle. Surface ornamented by marginal ribs bearing irregular spatulate tubercles. Dorsal rib of 4-5 short, distally, expanded spatulate tubercles. Dorsal rib extends from eye tubercle to posterior cardinal angle. Termination at posterior cardinal angle deflected medianly. Ventrolateral rib with similar tubercles and united to posterior and anterior marginal ribs. Weakly developed tuberculate alar process ventrally. Tubercles expanded distally and laterally and coalescing to form a "velate" rim to leading edge of alar process. Prominent sub-central tubercle bearing 4-5 short, blunt spines. Median rib of five distally expanded tubercles extending across subcentral tubercle. Intercostal surface smooth. Npc's well spaced, inner lamella broad, avestibulate. Rpc's, numerous, straight, simple long, tendency to cluster. Central muscle scars; four adductors in a vertical row, distorted by well developed, deep subcentral pit. Large "V" shaped frontal scar. Hinge strongly holamphidont.

Distribution.—Samples A2-A4, B2-B4.

Dimensions.

	Length	Height
Holotype ARV BB/NA 250	0.70	0.34
Paratype A-1 LV BB/NA 251	0.60	0.30
Paratype A-1 RV BB/NA 252	0.54	0.30
Paratype A-1 LV BB/NA 253	0.54	0.30

Remarks.—The present species resembles *Mutilus fungoides* (Brady, 1880) externally and internally, except that *M. fungoides* has the whole of the lateral surface ornamented by short, strong tri-radiate spines and internally possesses two frontal scars. It differs from *P. militaris* (Brady) and from *P. manis* Whatley & Titterton in its smaller size, larger, more prominent subcentral tubercle, lack of an inclined ventral costa in the first instance and by a lack of denticles covering the entire lateral surface in the second. Note that Howe & McKenzie, 1989, included *Pterygocythereis* spec. (Jurien 71) Hartmann, 1978, under *Jugocythereis henryhowei* Howe and McKenzie [= *Mutilus fungoides* (Brady)] while here, *Pterygocythereis* spec. (Jurien 71) Hartmann, 1978, is regarded as a synonym of *Ponticocythereis spatulospinosa* sp. nov. *P. spatulospinosa* belongs to the same species group as *P. tricristata* (Brady, 1880) (see discussion in Warne, 2001). *P. spatulospinosa* differs from *P. tricristata* by being less elongate and possessing a more distinct spinose and ribbed ornament.

Genus *Puriana* Coryell & Fields, 1953 [in Puri 1953]

Puriana lubbockiana (Brady, 1880) comb. nov.

(Pl. 9, Figs. 1-6)

1880 *Cythere lubbockiana* (Brady), p. 68, Pl. 14, Figs. 6a-d.

1976 *Cythere lubbockiana* (Brady). Puri & Hulings, p. 281, Pl. 8, Figs. 13, 14.

Material.—384 valves, 10 carapaces. Adult to A-2.

Distribution.—Samples A1-A5, B1-B4.

Dimensions.

	Length	Height
ARVF BB/NA 254	0.70	0.34
ALVF BB/NA 255	0.72	0.32
ARVF BB/NA 256	0.70	0.32
ALVF BB/NA 257	0.70	0.32
ARVF BB/NA 258	0.70	0.32
JLV BB/NA 259	0.54	0.22

Remarks.—Brady, 1880, described this species from only one station, Booby Island, and figured a complete carapace. The present material contains adults to A-2. Juveniles of A-2 differ markedly in their ornamentation from the adult of the species. In the juveniles the surface of the valves are strongly ornamented by irregular ribs forming an open reticulate meshwork, which is absent in the adults. This is perhaps a function of the heavy calcification of adult specimens. Sexual dimorphism present; males longer and lower than females; females posteriorly inflated.

Subfamily PTERYGOCYOTHERINAE Puri, 1957

Genus *Pterygocythereis* s.l. Blake, 1933

Pterygocythereis velivola (Brady, 1880)

(Pl. 1, Figs. 16-20)

1880 *Cythere velivola* Brady, p. 111, Pl. 23, Figs. 4a-c.

1976 *Cythere velivola* Brady. Puri and Hulings, p. 293, Pl. 15, Figs. 9-16, Text-Fig. 13.

1993 *Pterygocythereis velivola* Brady. Yassini *et al.*, p. 398, Figs. 146-148.

Material.—61 valves, 18 carapaces. Adult to A-1.

Distribution.—Sample A1-A5 and B1, B3-B5. Previously recorded by Brady, 1880, from the vicinity of Booby Island. Station 189, Lat. 9° 59' S; Long. 137° 50' E. Labutis (MS 1977) has also recorded the species from the Great Barrier Reef and Yassini *et al.* (1993) from northern Australia.

Dimensions.

	Length	Height
ALVF, BB/NA 033	0.70	0.40
ALVF, BB/NA 034	0.66	0.40
ARVF, BB/NA 035	0.68	0.36
ALVM, BB/NA 036	0.72	0.30
ARVM, BB/NA 037	0.74	0.32
AC, BB/NA 038	0.68	0.40

Remarks.—The single species here recorded as belonging to *Pterygocythereis* s.l. Blake differs from other species of the genus in its divided frontal muscle scar. Also in *Pterygocythereis* s.s. the ventral and dorsal adductors tend to be the smallest. This is not the case in the present species, which also has some adductor muscle scar division (giving a total of 5 discrete adductor scar). Labutis, MS 1977, also noted these differences between this species and true *Pterygocythereis* species

and should other like species with similar morphological differences from true *Pterygocythereis* species be subsequently discovered, consideration should be given to erecting a new genus or subgenus for such forms.

Subfamily ECHINOCYTHEREIDINAE Hazel, 1967

Genus *Echinocythereis* s.l. Puri, 1953

Echinocythereis sp.

(Pl. 8, Fig. 16)

non 1890 *Cythere melobesoides* Brady, 1869.
Brady, p. 108, Pl. 18, Fig. 1

1984 "Cytherid" sp. A Titterton, p. 182, Pl. 30,
Figs. 1-6.

1987 *Echinocythereis melobesoides* (Brady).
Yassini & Jones, p. 823, Figs. 3.15, 3.16.

1988 *Echinocythereis melobesoides* (Brady).
Yassini & Wright, p. 169, Figs. 6A, B.

1989 *Echinocythereis melobesiodes* Brady, Howe
& McKenzie, p. 40, Figs. 134-135.

1995 *Echinocythereis* cf. *melobesoides* (Brady).
Yassini & Jones, p. 356, Figs. 412, 414.

Material.—3 adult left valves.

Distribution.—Samples A3, A4.

Dimensions.

	Length	Height
ALV BB/NA 241	0.46	0.26
ALV BB/NA 242	0.50	0.30

Remarks.—The present material possesses divided frontal muscles scars thus differentiating it from

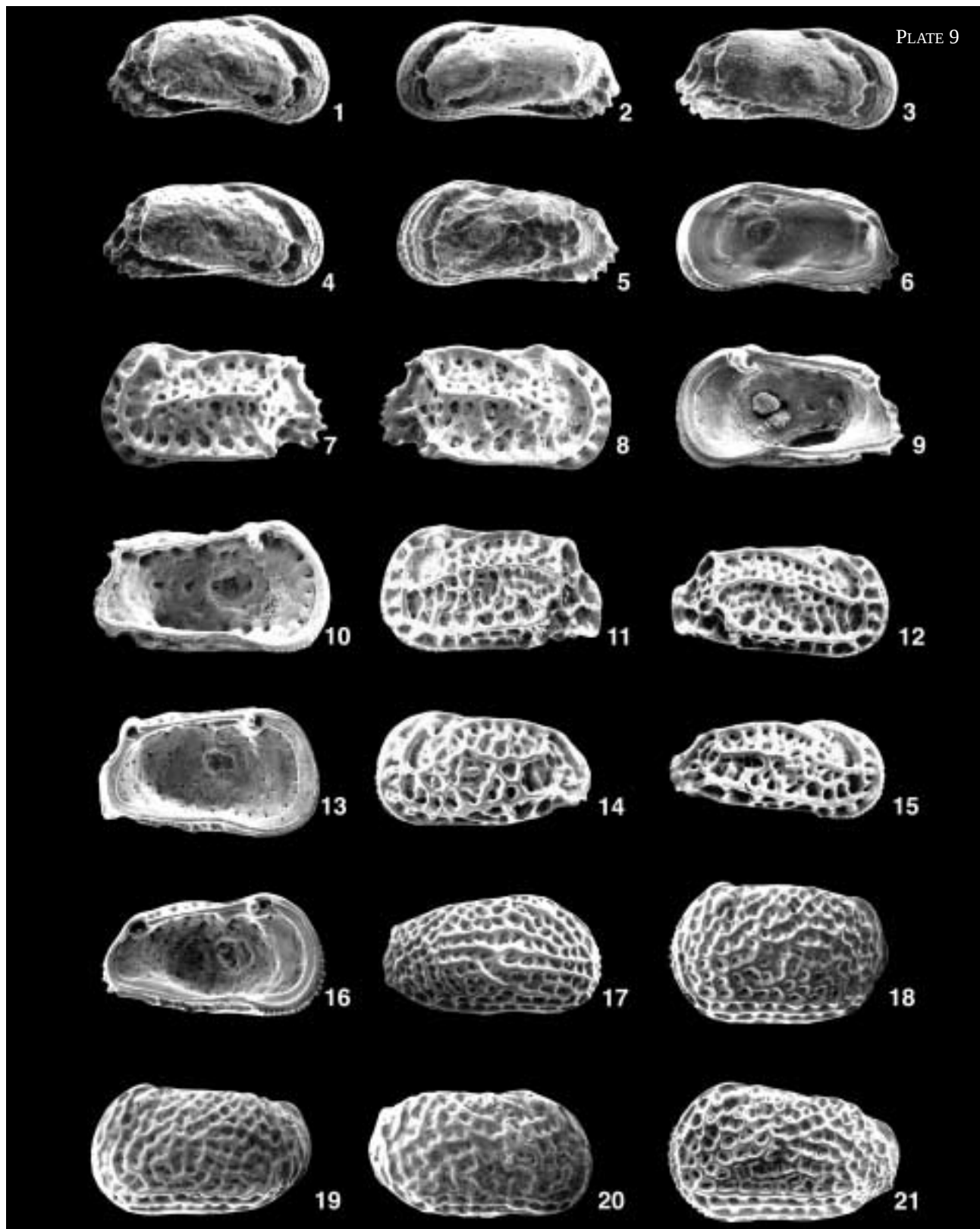
Henryhowella melobesiodes (Brady), which possesses a V-shaped frontal muscle scar. The present material, here assigned to *Echinocythereis* s.l., differs from *Echinocythereis* s.s. spp. by possessing a simpler (antimerodont) hinge structure. Externally the present species is somewhat similar to *Echinocythereis scabra* (Münster, 1830), but can be distinguished from it by its more subovate outline and by the orientation of the spinose ornament. *Neobuntonia sabulosa* (Brady, 1880) is also similar, but can be distinguished from the present species by its lack of a strongly spinose ornament; instead a fine reticulate ornament is developed. The present species perhaps belongs to the same evolutionary lineage of ostracods as the morphologically similar south-east Australian fossil Cenozoic species, *Echinocythereis karooma* McKenzie *et al.*, 1993, although the latter differs from the former in the details of spine numbers and positions. The present species also occurs in the Solomon Islands.

Genus *Neobuntonia* Hartmann, 1981

Remarks.—At present there is an inadequate differential diagnosis between the genera *Neobuntonia* Hartmann, 1981, and *Digmocythere* Mandelstam, 1958. The present material is placed in *Neobuntonia* pending clarification of the above taxonomic relationship. It is here considered that species of *Neobuntonia* described from Australian waters/strata have taxonomically significant similarities in carapace morphology to species of *Bosquetina* Keij, 1957, suggesting that *Neobuntonia* species are echinocythereiines.

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PLATE 9—1-6, *Puriana lubbockiana* (Brady, 1880); 1, Female, RV, ext., BB/NA 254, x 54; 2, Female, LV, ext., BB/NA 255, x 54; 3, Female, RV, ext., BB/NA 256, x 54; 4, Female, RV, ext., BB/NA 258, x 54; 5, LV (juv.), ext., BB/NA 259, x 75; 6, Female, RV, int., BB/NA 256, x 54. 7-10, *Quasibradleya pitalia* (Hu, 1981); 7, LV, ext., BB/NA 261, x 50; 8, RV, ext., BB/NA 260, x 50; 9, RV, int., BB/NA 260, x 50; 10, LV, int., BB/NA 261, x 52. 11-13, *Quasibradleya leepointensis* sp. nov.; 11, Holotype, Female, LV, ext., BB/NA 264, x 58; 12, Paratype, Male, RV, ext., BB/NA 267, x 57; 13, Holotype, Female, LV, int., BB/NA 264, x 58. 14-16, *Quasibradleya* sp. cf. *Q. elongata* Howe & McKenzie, 1989; 14, Female, LV, ext., BB/NA 268, x 54; 15, Male, RV, ext., BB/NA 271, x 54; 16, Female, LV, int., BB/NA 268, x 54. 17, *Venericythere* sp. RV, ext., BB/NA 273, x 75. 18-21, *Henryhowella sinespinosa* sp. nov.; 18, Paratype, Female, LV, ext., BB/NA 276, x 54; 19, Paratype, Male, LV, ext., BB/NA 275, x 54; 20, Holotype, Male, RV, ext., BB/NA 274, x 54; 21, Paratype, LV (juv.), ext., BB/NA 277, x 75.



Neobuntonia sp. cf. *N. sabulosa* (Brady, 1880) comb. nov.

(Pl. 8, Figs. 14-15)

1880 *Cythere sabulosa* Brady, p. 80, Pl. xix, Figs. 1a-h.

1976 *Cythere sabulosa* Brady. Puri & Hulings, p. 287, Pl. 12, Figs. 1-3.

Material.—6 valves. A-1 juveniles (?).

Distribution.—Samples A1, A4, B4.

Dimensions.

	Length	Height
RV BB/NA 239	0.50	0.30
LV BB/NA 240	0.48	0.28

Remarks.—A small to medium species of *Neobuntonia* with shape and outline typical of most species of this genus but with gentler ventro-lateral tumidity. Apart from a series of 4 weak ribs that parallel the anterior margin, carapace finely reticulate. This species is also known from the Solomon Islands (Titterton & Whatley, in press, a). The lectotype specimen of *Neobuntonia sabulosa* (Brady) chosen by Puri & Hulings, 1976, is very similar to the holotype specimen of *Neobuntonia foveata* McKenzie *et al.*, 1990, although the former is slightly larger than the latter. Specimens assigned to both these taxa are significantly larger and possess a more coarsely “pitted” carapace surface than the present material (which may be juveniles). Further study of relevant type material is required in order to clarify the taxonomic relationship between *N. sabulosa* (Brady), *N. foveata* McKenzie *et al.*, *Neobuntonia jonesi* (Yassini & Jones, 1987) and *Neobuntonia praemucronata* (Chapman & Crespín, 1928) n. comb. [in Chapman, Crespín & Keble, 1928].

Subfamily CYTHERETTINAE Triebel, 1952

Genus *Alocopocythere* Siddiqui, 1971

Alocopocythere ventrocostata (Howe & McKenzie, 1989) comb. nov.
(Pl. 2, Figs. 5-10)

1989 *Neocytheretta ventrocostata* Howe & McKenzie, p. 46, Figs. 117, 118.

1993 *Neocytheretta spongiosa* (Brady), Yassini *et al.*, p. 400, Pl. 7, Figs. 140-142; Pl. 8, Fig. 153.

Material.—290 valves, 65 carapaces.

Amended diagnosis.—A species of *Alocopocythere* characterised by: (1) its regular, strongly reticulate ornament (with many circular and oval fossae), which does not extend to the anterior margin, and (2) the presence of a postero-dorsal protuberance in females.

Amended description.—Medium, thick-shelled, male subrectangular in lateral view, female more subovate. Anterior margin broadly rounded bearing 7-8 short, blunt marginal denticles, extremity at mid-height. Posterior margin obliquely rounded, slightly acuminate, extremity at mid-height. Dorsal margin straight. Cardinal angles rounded, indistinct. Posterior cardinal angle in females marked by tubercle like extension of the postero-dorsal loop. Ventral margin nearly straight, slight oral incurvature. Eye tubercle small, glassy and prominent, and with a deep pit immediately antero-ventrally. Greatest length medianly; greatest height through anterior cardinal angle. Surface ornament of strong reticulae, not extending onto the anterior margin. Short ocular rib extending ventrally to coalesce with muri of the reticulation and a strong marginal rib extends from the eye tubercle, very peripherally around the anterior margin. Subcentral tubercle indistinct. Inner lamella broad, irregular, with considerable divergence, especially anteriorly, between im and om. Avestibulate. Rpc numerous, long, simple; occasionally branching and sinuous. Central muscle scars, a subvertical row of 4 adductors. Frontal “V” shape composed of two oval scars. Hinge, strongly holamphidont.

Distribution.—Samples A1-5 and B1-B5.

Dimensions.

	Length	Height
ARV, BB/NA 039	0.60	0.32
ARV, BB/NA 040	0.62	0.32
ALV, BB/NA 041	0.62	0.34
ALV, BB/NA 042	0.64	0.36
ALV, BB/NA 043	0.64	0.36

Remarks.—The present species is similar to *Neocytheretta spongiosa* (Brady) *sensu* Whatley & Zhao (1988) from the Malacca Straits, but differs in that it lacks the short subhorizontal costae in the posterior third of the carapace surface, characteristic of the latter. Also in the latter species, the surface ornament of reticulae extends to the anterior margin. Externally, the present species is closest to *Alocopocythere reticulata indoaustralis* Hartmann,

1978, from the eulittoral of Western Australia, but the latter species has a slight depression in the posteroventral region of the carapace surface. Two subspecies of a very similar species, that differs mainly in its lack of a postero-dorsal protuberance, occurs in the Solomon Islands (Titterton & Whatley, in press, a). Specimens illustrated by Mostafawi, 1992, as *Neocytheretta vandijki* (Kingma, 1948) only differ from the present species by possessing reticulate ornament that extends continuously across the carapace surface to the anterior margin. *Neocytheretta formosana* Hu, 1984, differs by possessing reticulate ornament that extends to the anterior margin and by possessing a faint posteroventral ridge.

Alocopocythere sp.
(Pl. 2, Figs. 11-12)

2001 *Neocytheretta spongiosa* (Brady), Clarke *et al.*, Fig. 8q.

Material.—103 valves, 19 carapaces. Adult to A-3.
Distribution.—Samples A1-A5, B1-B5.
Dimensions.

	Length	Height
ALV BB/NA 044	0.82	0.42
ALV BB/NA 045	0.88	0.42

Remarks.—The present species is similar to a yet undescribed species of *Alocopocythere* from the Recent of the Solomon Islands (Titterton & Whatley, in press, a), but differs in not having the reticulation extending completely to the anterior margin. The present species is distinguished from *Neocytheretta spongiosa* (Brady) *sensu* Whatley & Zhao, 1988, and *Alocopocythere goujoni* (Brady) and *Alocopocythere reticulata indoaustralis* Hartmann, 1978, by possessing a different pattern of the reticulate ornament. The present species lacks the posteroventral ridging of *Neocytheretta murilineata* Zhao and Whatley, 1989.

Genus *Neocytheretta* van Morkhoven, 1963
Neocytheretta adunca horrida (Mostafawi, 1992)
comb. nov.
(Pl. 2, Figs. 13-15)

1992 *Alocopocythere horrida* Mostafawi, p. 147, Figs. 79-82.

Material.—40 valves. Adults to A-1.

Distribution.—Samples A2-A5, B2-B4.

Dimensions.

	Length	Height
ALVF BB/NA 046	0.78	0.48
ARVF BBNA 047	0.74	0.44
ALVF BB/NA 048	0.80	0.46
ALVM BB/NA 049	0.84	0.44
ARVM BB/NA 050	0.80	0.46

Remarks.—The present subspecies can be distinguished from *N. inflata* Malz, 1980, from the Plio-Pleistocene of Taiwan in lacking three prominent longitudinal posterior ribs. It can be distinguished from other species of *Neocytheretta* by its lack of surface reticulation. Specimens of *N. adunca adunca* (Brady) illustrated by Yassini *et al.*, 1993, and Mostafawi, 1992, have more prominent ribbing than specimens of the present subspecies.

Neocytheretta spinobifurcata Yassini, Jones & Jones, 1993
(Pl. 2, Figs. 16-19)

1993 *Neocytheretta spinobifurcata* Yassini *et al.*, p. 398; Pl. 7, Figs. 126, 127.

Material.—7 valves. Adults only.

Amended description.—Small to medium, subquadrate to subrectangular in lateral view, with strong anterior hinge ear. Anterior margin broadly rounded with 12-14 small, blunt marginal denticles, extremity at mid-height. Dorsal margin nearly straight interrupted by 4-5 posterodorsal long, sharp spines. Cardinal angles indistinct. Ventral margin nearly straight, slight oral incurvature. Greatest length medianly, greatest height through anterior hinge ear. Large, subspherical glassy eye tubercle present. Surface ornament of weak reticulae bearing conjunctive spines. Ornament does not extend to anterior margin. Peripheral muri strong; 6 anteriorly, 9 ventrally, 4 posteriorly, radiating from mid-point of carapace. Subcentral tubercle prominent, bearing a single, short, sharp spine. Inner lamella extremely broad, irregular. Avestibulate. Rpc moderate, very long, simple, slightly curved. Adductors a row of 4. Frontal not clearly observed. Hinge strongly hemiamphidont. Sexual dimorphism marked, females shorter, higher, and more posteriorly inflated than males.

Distribution.—Samples A1, A3-A5; B2-B4.

Dimensions.

	Length	Height
ALVF BB/NA 051	0.50	0.34
ARVF BB/NA 052	0.52	0.30
ALVF BB/NA 053	0.50	0.32
ARVF BB/NA 054	0.50	0.30

Remarks.—The present species can clearly be distinguished from other species of *Neocytheretta* by its small size. Average length and height for the species is 0.50 mm and 0.32 mm respectively. The present species is closest to *N. spongiosa* (Brady, 1870) but differs in its internal features and in details of ornament. *Alocopocythere ventrocosta* (Howe & McKenzie, 1989) is a somewhat similar species which differs in possessing a distinctly arcuate posterodorsal rib rather than a series of tubercles.

Subfamily ARCULACYTHERINAE Hartmann, 1981
Genus *Neocytheromorpha* Guan, 1978

Remarks.—A small to median genus, characterised by its elongate, subrectangular shape in lateral outline. Broadly rounded anterior and posterior margins, weakly developed reticulate ornament, strong anterior and posterior marginal depressions. Adductors in a subvertical row of 4 scars. Frontal scar “V” shaped opening dorsally. Hinge lophodont. *Neocytheromorpha* s.s. differs from the very similar genus *Arculacythereis* Hartmann, 1981, by possessing strong anterior and posterior marginal depressions. These features are conspicuously absent in *Arculacythereis*. *Arculacythereis* species may have a heterochronic evolutionary relationship to *Neocytheromorpha* species. *Neocytheromorpha* also resembles *Bensonocythere* Hazel, 1967; *Cuneocythere* Lienenklaus, 1894, and *Triginglymus* Blake, 1950, although there is little possibility of confusion with *Bensonocythere*, which has a more advanced (complex) hinge structure than *Neocytheromorpha*. It differs from *Cuneocythere* in its more elongate, subrectangular outline and avestibulate nature, and from *Triginglymus* in lacking a distinctive subcentral tubercle, and in its lophodont hinge, as opposed to a holamphidont hinge in the latter.

Neocytheromorpha papilloporosa sp. nov.
(Pl. 2, Figs. 20-24)

Derivatio nominis.—Latin. Named for the clusters of 4-5 papillae that centre on the normal pore canals.

Material.—10 valves, 3 carapaces. Adults to A-1.

Holotype.—ALV BB/NA 055 (Pl. 2, Figs. 20, 23).

Type locality and level.—Lee Point on Shoal Bay. Recent.

Diagnosis.—A species of *Neocytheromorpha* characterised by its subrectangular to subcylindrical outline, smooth carapace and clusters of 4-5 bulbous protrusions around normal pore canals, and weakly developed reticulation with secondary punctation.

Description.—Small to medium, thin-shelled, translucent, subrectangular to subcylindrical in lateral view. Anterior margin broadly rounded, extremity slightly below mid-height. Posterior margin broadly rounded, extremity at mid-height. Dorsal margin straight sloping posteriorly. Cardinal angles rounded. Ventral margin nearly straight with slight incurvature medianly. Greatest length at mid height, greatest height through anterior cardinal angle. Surface ornamentation consists of very weakly developed, shallow microreticulation. Fossae secondarily punctate. A strong crescentic depression occurs anteriorly extending from below anterior cardinal angle to ventral margin. Remainder of carapace slightly tumid, strongly inflated posteroventrally with a marked posteroventral marginal depression and with groups (clusters) of 4-5 small bulbous tubercles, which surround npc. Inner lamella wide and irregular, widest anteriorly, approaching outer margin ventrally. Rpc numerous, mostly simple, long slightly sinuous, occasionally branching. Central muscle scars consist of 4 adductors in a subvertical row with central two scars set obliquely to other scars. Frontal scar “V” shaped, opening dorsally. Hinge lophodont composed of a weak bar in the left valve and with strong accommodation groove in RV.

Distribution.—Samples A4,A5; B1, B4.

Dimensions.

	Length	Height
Holotype ALV BB/NA 055	0.52	0.24
Paratype ARV BB/NA 056	0.52	0.22

Remarks.—At present this is the only known record of the genus in Australian waters.

Family XESTOLEBERIDIDAE Sars, 1928

Genus *Foveoleberis* Malz, 1980

Foveoleberis cypraeoides (Brady, 1868)
(Pl. 10, Figs. 2-3)

1868 *Cythere cypraeoides* Brady, p. 72, Pl. 8, Figs. 21, 22.

1880 *Xestoleberis foveolata* Brady. Brady, p. 130, Pl. 30, Figs. 1a-g.

- 1988 *Foveoleberis foveolata* (Brady). Whatley & Zhao, p. 26, Pl. 10, Figs. 18, 19 and synonymy.
 1989 *Foveoleberis foveolata* (Brady). Howe & McKenzie, p. 20.
 1992 *Foveoleberis cypraeoides* (Brady). Mostafawi, p. 158, Pl. 6, Fig. 139.
 1993 *Foveoleberis cypraeoides* (Brady). Yassini et al., p. 402, Pl. 9, Figs. 171, 172.
 1997 *Foveoleberis cypraeoides* (Brady). Dewi, pp. 75-76, Figs. 225, 228.

Material.—2006 valves, 103 carapaces. Adult to A-3.

Distribution.—Samples A1-A5, B1-B5.

Dimension.

	Length	Height
ALVF BB/NA 278	0.52	0.40
ALVF BB/NA 279	0.50	0.38
ARVF BB/NA 280	0.50	0.38
ALVM BB/NA 281	0.46	0.32

Remarks.—Whatley & Zhao (1988) have recently demonstrated that the two species *Foveoleberis cypraeoides* and *F. foveolata* (Brady) are conspecific. The present species is widely distributed throughout the Indo-Pacific. In the present study, this species was by far the most dominant.

Genus *Xestoleberis* Sars, 1866

Xestoleberis sp. cf. *X. broomensis* Hartmann, 1978 (Pl. 10, Fig. 4)

- 1978 *Xestoleberis broomensis* Hartmann, p. 117, Pl. 12, Figs. 8-10.
 1989 *Xestoleberis broomensis* Hartmann. Howe & McKenzie, p. 16.

Material.—1 valve, A-1?

Distribution.—Sample A4.

Dimensions.

	Length	Height
RV (A-1 juv.) BB/NA 282	0.32	0.28

Remarks.—The present species closely resembles *X. cauticola* Hartmann 1978 (and *Xestoberis* sp. cf. *X. cauticola* of the present study), but differs in having a more convex dorsal margin and more obliquely rounded ante-

rior margin. The illustrations of the original type material of this species (Hartmann, 1978) only include one SEM photograph of a whole valve (int. RV), which together with the juvenile aspect of the present material, makes the species level identification of the latter uncertain.

Xestoleberis sp. cf. *X. cauticola* Hartmann, 1978 (Pl. 10, Figs. 5-6)

- 1978 *Xestoleberis cauticola* Hartmann, p. 119, Pl. 12, Figs. 12-13.
 1989 *Xestoleberis cauticola* Hartmann. Howe & McKenzie, p. 18.

Material.—51 valves, 22 carapaces. Adult to A-3.

Distribution.—Samples A1-A5, B1-B4.

Dimensions.

	Length	Height
ALVF BB/NA 283	0.44	0.32
ARVM BB/NA 284	0.40	0.28

Remarks.—*Xestoleberis broomensis* Hartmann 1978, from the eulittoral of Western Australia resembles the present species, but differs in its more convex dorsal margin and obliquely rounded anterior. Differences in the hinge can also be observed, with *X. broomensis* having a shorter median element. *Xestoleberis cauticola* Hartmann, 1978, also resembles *Xestoleberis darwiniensis* Howe & McKenzie, 1989, and *Xestoleberis paramargaritea* Howe & McKenzie, 1989, but differs in having a carapace maximum height distinctly anterior of mid length. The specimens illustrated here are slightly smaller than those of *X. cauticola* recorded by Hartmann, 1978.

Xestoleberis paraporthedlandensis Hartmann, 1978 (Pl. 10, Fig. 7)

- ? 1966 *Xestoleberis* sp. XF Maddocks, p. 68, Fig. 58.
 1978 *Xestoleberis paraporthedlandensis* Hartmann, p. 122, Text-Figs. 409-422, Pl. 13, Figs. 1, 2.
 1984 *Xestoleberis paraporthedlandensis* Hartmann, 1978. Hartmann, p. 131, Text-Figs. 55-56, Pl. 9, Figs. 4-7.
 1988 *Xestoleberis paraporthedlandensis* Hartmann, 1978. Watson MS, p. 251, Pl. 11, Figs. 2, 3; Pl. 46, Figs. 8-14.
 1989 *Xestoleberis porthedlandensis* Hartmann. Howe & McKenzie, p. 16.

2005 *Xestoleberis porthedlandensis* Hartman. Titterton & Whatley, p. 302, Fig. 4, Nos. 14, 17; Pl. 3, Figs. 1-8.

Material.—18 valves. Adult to A-3.

Distribution.—Sample A1, A3-A5, B4-B5. Also, Hartmann, 1978 (Recent eulittoral, Western Australian coast); Hartmann, 1984 (Recent eulittoral, Huahine Island and Rangiroa Atoll); Recent, Pulau Seribu, Java Sea (Watson MS 1988). Solomon Islands, Guadalcanal and Shortland islands (Titterton & Whatley, 2005).

Dimensions.

	Length	Height
ARV BB/NA 285	0.42	0.26

Remarks.—Several species of *Xestoleberis* are similar to the present species. As indicated by Titterton & Whatley, 2005, *Xestoleberis capensis* Müller, 1908, illustrated by Benson & Maddocks, 1964, from the Recent of the Knysna Estuary, South Africa, is very similar but does not appear to have opaque patches. *Xestoleberis trimaculata* Hartmann, 1979, from the Recent eulittoral of southern Australia (and the present study), has a similar opaque patch but differs in the shape of the carapace, and central muscle scar pattern. *Xestoleberis* sp. (present study) varies slightly in carapace shape and in possessing a different opaque patch pattern.

Xestoleberis trimaculata Hartmann, 1979
(Pl. 10, Fig. 9)

1979 *Xestoleberis trimaculata* Hartmann, p. 252, Pl. 12, Figs. 1-4.

Material.—32 valves, 9 carapaces. Adult to A-3.

Distribution.—Samples A1-A5, B1-B3, B4.

Dimensions.

	Length	Height
ALV BB/NA 288	0.54	0.32
ARV BB/NA 289	0.54	0.30
ALV BB/NA 290	0.50	0.30

Remarks.—The present species resembles *X. broomensis* Hartmann, 1979, but differs in its slightly more elongate shape in lateral view and slightly different opaque patches on the lateral surface. *Xestoleberis* sp. (this study) can be distinguished from the present species by virtue of its quadrate, truncated posterior margin.

Xestoleberis sp.
(Pl. 10, Fig. 8)

Material.—20 valves, 5 carapaces. Adult to A-1.

Distribution.—Samples A1-A5, B1-B5.

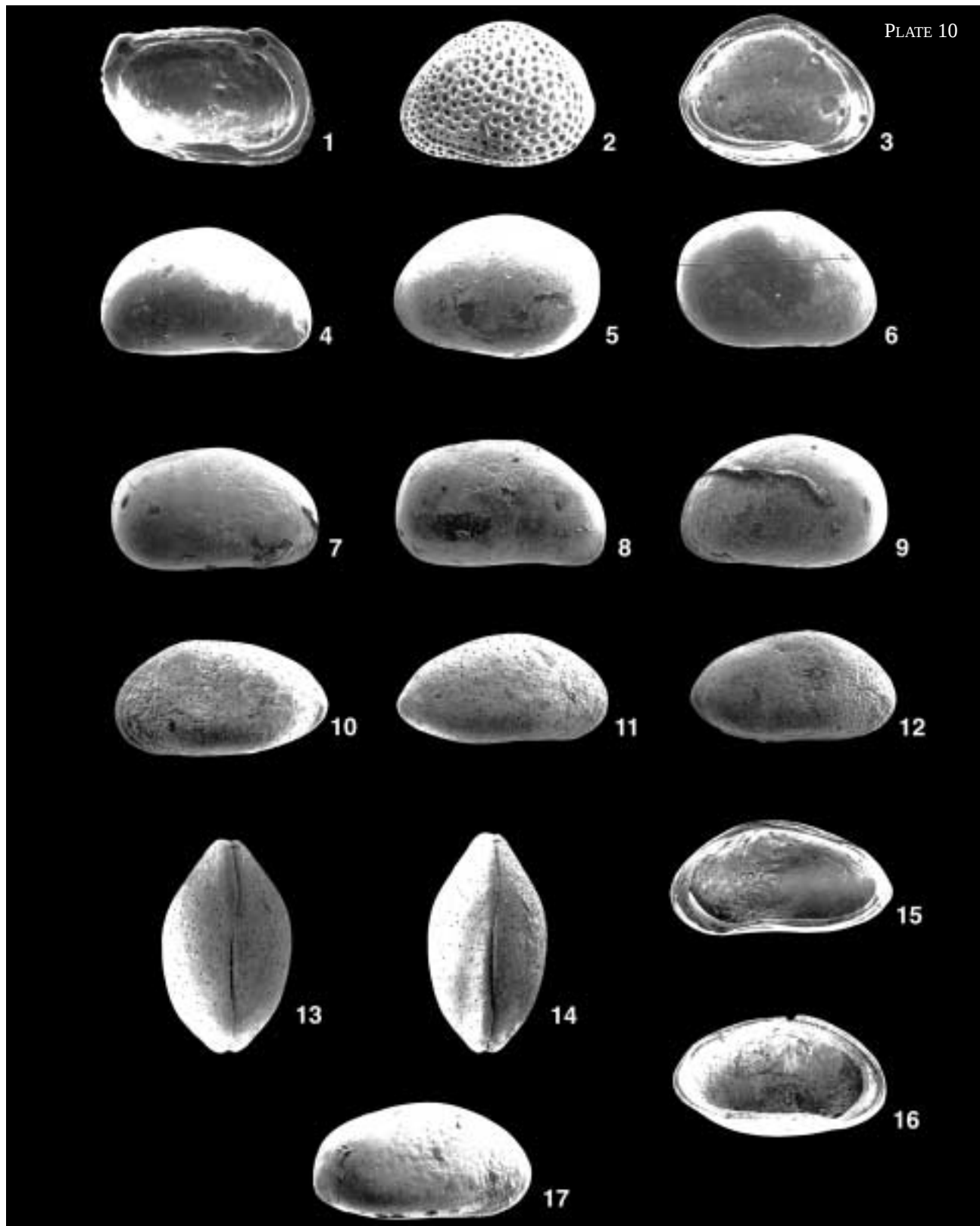
Dimensions.

	Length	Height
ARV BB/NA 286	0.52	0.30
ARV BB/NA 287	0.54	0.30

Remarks.—The present species can be distinguished from other species of the genus in the present study by its strongly truncated posterior margin, relatively inconspicuous *Xestoleberis* spot and relatively large size. This species has a close resemblance to a number of species known from the Solomon Islands,

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PLATE 10–1, *Henryhowella sinespinosa* sp. nov. Paratype, Female, LV, int., BB/NA 276, x 54. 2, 3. *Foveoleberis cypraeoides* (Brady, 1868); 2, Female, LV, ext., BB/NA 278, x 71; 3, Female, LV, int., BB/NA 278, x 71. 4. *Xestoleberis* sp. cf. *X. broomensis* Hartmann, 1978. RV (A-1 juv.), ext., BB/NA 282, x 107. 5, 6. *Xestoleberis* sp. cf. *X. cauticola* Hartmann, 1978; 5, Female, LV, ext., BB/NA 283, x 84; 6, Male, RV, ext., BB/NA 284, x 84. 7. *Xestoleberis paraporthedlandensis* Hartmann, 1978, RV, ext., BB/NA 285, x 88. 8. *Xestoleberis* sp. RV, ext., BB/NA 286, x 71. 9. *Xestoleberis trimaculata* Hartmann, 1979. LV, ext., BB/NA 288, x 69. 10–16. *Paraxestoleberis posteroacuminata* gen. et sp. nov.; 10, Holotype, Female, LV, ext., BB/NA 291, x 74; 11, Paratype, Male, RV, ext., BB/NA 293, x 74; 12, Paratype, Female, RV, ext., BB/NA 292, x 74; 13, Paratype, Female, carapace, dorsal view, BB/NA 294, x 116; 14, Paratype, Male, carapace, dorsal view, BB/NA 295, x 116; 15, Paratype, Male, RV, int., BB/NA 293, x 75; 16, Holotype, Female, LV, int., BB/NA 291, x 74. 17. *Paraxestoleberis* sp. Female, RV, ext., BB/NA 296, x 78.



including *X. maculanitida* Titterton & Whatley, 2005; *X. honiaraensis* Titterton & Whatley, 2005; *X. posterotruncata* Titterton & Whatley, 2005, and *X. whittakeri* Titterton & Whatley, 2005.

Genus *Paraxestoleberis* gen. nov.

Type species.—*Paraxestoleberis posteroaccuminata* gen. et sp. nov.

Diagnosis.—A xestoleberidid genus distinguished by its elongate, subrectangular shape in lateral view, and with well rounded anterior margin; pointed posterior margin, and overall strongly convex dorsal margin. *Xestoleberis* spot prominent, concave posteriorly, especially in RV. Surface smooth, translucent, numerous large, simple, regularly distributed normal pores. Hinge antimerodont, marginal areas narrow. Small crescentic vestibula anteriorly and posteriorly. Rpc's numerous, short, straight, simple; adductor scars in a vertical row of four, with "V" shaped frontal scar, two mandibular scars anteroventrally.

Remarks.—This genus is closest to *Xestoleberis*, Sars 1866, *Ornatoleberis*, Keij 1975, *Foveoleberis*, Malz 1980 and *Uroleberis*, Triebel 1958, although there is little possibility of confusion with either *Foveoleberis* or *Uroleberis* which have short carapaces with strongly arched dorsal margins and the posterior margin drawn out into a caudal processes. It differs from *Xestoleberis* in its more broadly rounded anterior margin and acuminate posterior. The "arrow head" shaped frontal scar typical of *Xestoleberis* is not present. *Ornatoleberis*, although with an outline more similar to the present genus, can also be distinguished by its surface ornament of spines, carinae or reticulae.

Paraxestoleberis posteroaccuminata sp. nov.

(Pl. 10, Figs. 10-16)

Derivatio nominis.—Latin, with reference to the acuminate posterior margin of this species.

Holotype.—ALVF BB/NA 291 (Pl. 10, Figs. 10, 16).

Type locality and level.—Lee Point on Shoal Bay, sample A4. Recent.

Material.—107 valves, 37 carapace. Adult to A-3.

Diagnosis.—A species of *Paraxestoleberis* characterised by its elongate subrectangular shape in lateral view. Anterior margin well rounded. Posterior margin acuminate and especially pointed in RV. Valve surface densely but minutely punctate; micropapillate anteriorly. Inner lamella narrow with numerous simple, straight rpc's. Muscle scars situated subcentrally.

Adductor scars in a vertical row of four, second scar from dorsal surface subdivided into two discrete sub-circular scars, other scars elongate. Frontal "V" shaped opening anterodorsally. Small mandibular also present. *Xestoleberis* spot prominent.

Description.—Small to medium, thin-shelled, translucent, shiny. Sexual dimorphism distinct with females shorter, higher and more inflated posteroventrally than males. Carapace elongate subovate in lateral view; ovate in dorsal view. Anterior margin well rounded in LV, more narrowly in RV. Posterior margin bluntly pointed at about mid-height in LV, sharply pointed in RV. Dorsal margin slightly arched. Cardinal angles rounded, obtuse. Ventral margin almost straight, with slight concavity slightly anterior of mid length. Greatest length below mid-height; greatest height 1/3 from anterior margin; greatest width antero-medianly. LV > RV, slight overlap around entire free margin. Surface of valves densely micropunctate, micropapillate in some parts, especially anteriorly. Npc's numerous. Eye spot inconspicuous. *Xestoleberis* spot distinctive, thin crescent-shaped; convex anteriorly extending 1/4 height. Inner lamella narrow. Narrow vestibula anteriorly and posteriorly, widest anteriorly. Rpc's numerous, straight, simple. Selvage strongly developed. Hinge antimerodont. Posterior and anterior terminal elements of RV comprise dentate bar with small ovate teeth, median element a fine locelate groove. Terminal elements of similar size, median element twice the length of terminal elements. Central muscle scars situated subcentrally, comprise a vertical row of four adductors, second scar from dorsal margin subdivided. Dorsal scar shows signs of subdivision. Other scars elongate. Frontal "V" shaped, opening anterodorsally. Small ovate mandibular scar also present.

Distribution.—Samples A1-A5, B1-B5.

Dimensions.

	Length	Height
Holotype ALVF BB/NA 291	0.50	0.26
Paratype ARVF BB/NA 292	0.49	0.28
Paratype ARVM BB/NA 293	0.52	0.26
Paratype ACF BB/NA 294	0.52	0.26
Paratype ACM BB/NA 295	0.52	0.26

Remarks.—The present species most closely resembles *Xestoleberis claroculata* Bate *et al.*, 1981, from Equador, but differs from it in its more broadly rounded anterior, smaller and less deep anterior vestibule, a greater number of radial pore canals, 30 in the pre-

sent species as opposed to 10 in *X. claroculata* and subdivided adductors, and larger, less recurved *Xestoleberis* spot.

Paraxestoleberis sp.
(Pl. 10, Fig. 17)

Material.—Two right valves, male and female.

Diagnosis.—A species of *Paraxestoleberis* characterised by its almost straight dorsal and truncated posterior margins.

Description.—Small to medium, thin-shelled, translucent, shiny. Sexual dimorphism distinct, males longer, with more acuminate posterior margin. Females with truncated posterior margin, and inflated posteriorly. Carapace subovate to subrectangular in lateral view, ovate in dorsal view. Anterior margin broadly rounded, extremity at mid-height. Posterior margin, truncated, extremity below mid-height. Ventral margin nearly straight, concave medianly. Dorsal margin convex. Posterodorsal margin nearly straight, obliquely sloping posteriorly. Cardinal angles indistinct. Small glassy eye spot below anterior cardinal angle, indistinct. Surface smooth, to slightly punctate. *Xestoleberis* spot distinctive, thin crescent shaped, concave posteriorly. Inner lamella narrow. Inner margin and line of concrescence divergent anteriorly and posteriorly to form thin crescentic vestibula. Rpc's short, simple, numerous. Details of central muscle scars obscured.

Distribution.—Samples A4, A5.

Dimensions.

	Length	Height
ARVF BB/NA 296	0.48	0.28
ARVM BB/NA 297	0.50	0.24

Remarks.—The present species differs from *Paraxestoleberis posteroacuminata* sp. nov., in its straighter dorsal margin and slightly truncated posterior margin.

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RECENT MARINE OSTRACODA FROM THE SOLOMON ISLANDS. PART 3. CYTHEROIDEA: BYTHOCYTHERIDAE, CYTHERIDEIDAE, KRITHIDAE, NEOCYTHERIDEIDAE, CYTHERURIDAE

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Abstract

Seventeen species of the cytheracean families Bythocytheridae, Cytherideidae, Krithidae, Neocytherideidae and Cytheruridae are described. Three species have been previously recorded elsewhere: *Neocyprideis spinulosa* (Brady), *N. timorensis* (Fyan) and *Copypus posterosulcus* Wang. Three new species are described: *Parakrithe cucumeris*, *P. cyrtonos* and *Paracytheridea dromedaria* ssp. nov. Two species are compared to known taxa, while 9 species belonging to the following genera are left in open nomenclature, due to rarity, juvenility or poor preservation: *Bythoceratina*, *Parakrithella*, *Cytherura*, *Kangarina*, *Oculocytheropteron* and *Paracytheridea*. While the three new species and probably most of the *nomina aperta* species are clear evidence of endemism, these contrast with the two previously described species of *Neocyprideis* which are very widely distributed, *N. spinulosa* being virtually pandemic in the Indo-West Pacific.

Key words: Recent, marine Ostracoda, Solomon Islands, Pacific.

Resumen

Se estudian diecisiete especies de cytheráceos de las familias Bythocytheridae, Cytherideidae, Krithidae, Neocytherideidae y Cytheruridae, de las cuales tres han sido descritas previamente en otras áreas: *Neocyprideis spinulosa* (Brady), *N. timorensis* (Fyan) y *Copypus posterosulcus* Wang. Tres especies son nuevas y se describen e ilustran aquí: *Parakrithe cyrtonos*, *P. cucumeris* y *Paracytheridea dromedaria* ssp. nov. Nueve especies de los siguientes géneros se encuentran descritas en *nomina aperta*: *Bythocytheratina*, *Parakrithella*, *Cytherura*, *Kangarina*, *Oculocytheropteron* y *Paracytheridea*. Mientras que las tres especies nuevas y probablemente la mayoría de las especies en *nomina aperta* presentan evidencias claras de endemismo, las dos especies previamente descritas de *Neocyprideis* presentan una amplia distribución, especialmente *N. spinulosa*, que es casi panéndemica en el Pacífico Indoccidental.

Palabras clave: Ostrácodos marinos, Reciente, Islas Salomón, Pacífico.

INTRODUCTION

The present work is part of a larger study of the Quaternary and Recent Ostracoda of the Solomon Islands. Apart from Harding's (1962) study of species

recovered from the gut of freshwater fishes, and two papers by the present authors on marine taxa (Whatley & Titterton, 1981; Titterton & Whatley, 1988), which dealt with two trachyleberidid genera and the large fauna (21 species) of Bairdiinae respec-

tively, the Ostracoda of the Solomon Islands have been sadly neglected. The authors are currently publishing the remainder of the Solomon Island ostracod fauna, and this is the third of a series of publications. The first two papers, on the Cypridoidea, Cladocopina and Platycopina (Titterton & Whatley, in press) and on the Xestoleberidae (Titterton & Whatley, 2005) and another, on the cytheracean family Leptocytheridae is currently under review. Two further papers on other cytheracean families, which will complete the series, are in preparation.

The Solomon Islands are situated to the NE of Australia and to the SE of New Guinea between Lat. 5°-12° S and Long. 155°-162° E and enjoy an oceanic tropical climate. The samples on which this study is based were collected off the islands of Guadalcanal and Shortland (Fig. 1). The location of the samples is given in Figs. 2 and 3. All of the samples are of largely biotrital sand, ranging from very fine to medium in grain size. Much of the medium sand originated from coral and were collected with a simple pipe dredge or by diving. Details of the individual samples can be found in Whatley & Titterton, 1981, and Titterton (1984 MS).

The total ostracod fauna comprises some 160 species belonging to 56 genera. The overwhelmingly dominant group are the Cytheracea (63%) the remainder are cyprids (15%), bairdiids (8%) and platycopids/cladocopids (13%). In this contribution, 17 species from 5 families of the Cytheracea (Bythocytheridae, Cytherideidae, Krithidae, Neocytherideidae and Cytheruridae) are treated and three

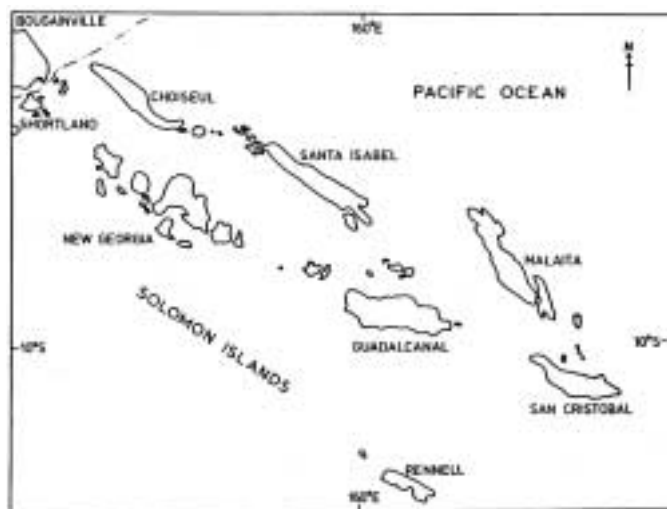


FIGURE 1—The Solomon Islands.

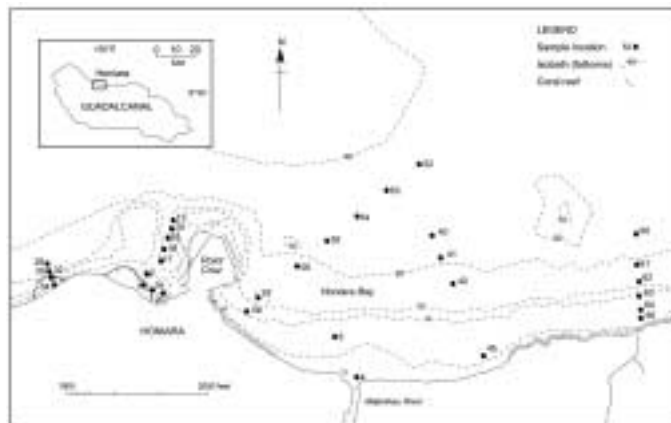


FIGURE 2—Location of sample stations, Honiara Bay, N. Guadalcanal, Solomon Islands.

new species (*Parakrithe cucumeris*, *P. cyrtonos* and *Paracytheridea dromedaria* ssp. nov.) are described. Only these 3 species and *Neocyprideis timorensis* (Fyan) 1916 occur in significant numbers, the remainder being rather poorly represented. Three species are known to occur outside the Solomon Islands. *Neocyprideis spinulosa* (Brady) 1868, of which only 2 specimens were found in the present fauna from Honiara Bay, is one of the most widely distributed shallow water species of the present day, occurring in the subtropical belt from as far west as the eastern coast of South Africa, across Indonesia to the Solomon Islands in the east. Fossil occurrences of this species are from the Upper Pliocene of Timor (Fyan, 1916), the Pliocene-Pleistocene of Southern India (Guha, 1968) and the Quaternary of the Solomon Islands (Williams, 1980 MS) and Fijian Islands (Malz & Ikeya, 1986). *Neocyprideis timorensis* (Fyan) 1916, is common in the present fauna from Honiara Bay and is also recorded from the Miocene of Honiara Bay, Guadalcanal (Hughes, 1977 MS), Pliocene of Timor (Fyan, 1916) and Quaternary of the Solomon Islands (Williams, 1980 MS). *Copysus posterosulcus* Wang, 1985 is widely distributed in the Recent from the east coast of Africa to the Solomon Islands and 4 specimens were recorded in the present fauna from Honiara Bay. It is possible that a fourth species, *Bythoceratina* sp. B, occurs also in the Recent of Madagascar.

There has been a renewed interest in the Ostracoda in the SW Pacific and Indian Ocean. Among the important contributions of the last decades are Behrens (1991a, b, 1992 Great Barrier Reef), Cabioch

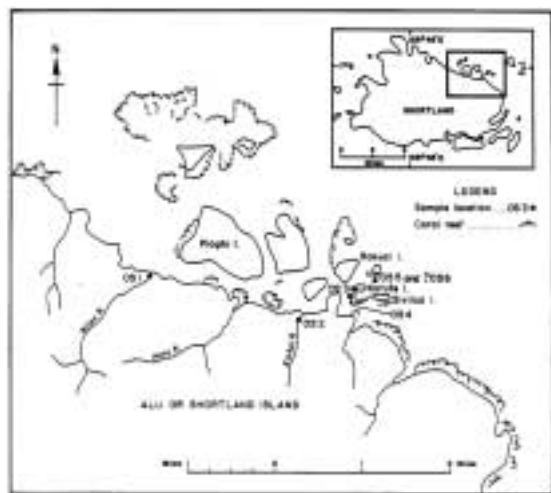


FIGURE 3—Location of sample stations, Shortland Island, Solomon Islands.

et al. (1986 New Caledonia), Dewi (1997 Java Sea), Howe & McKenzie (1989 NW Australia), Jellinek (1993 Kenya), Mostafawi (1992 Malasia); Titterton *et al.* (2001 Indo-Pacific); Whatley *et al.* (1995, 1996) and Warne *et al.* (in press Northern Australia), Whatley & Keeler (1989 Reunion Island), Whatley & Zhao (1987, 1988 Malacca Straits), Whatley *et al.* (2000 Easter Island), Whatley & Roberts, 1995 and Whatley *et al.* (in press, Pitcairn Group); Whatley *et al.* (in prep, Quaternary, Solomon Islands); Yassini *et al.* (1993 Eastern Australia), Yassini & Jones (1995 Eastern Australia), Zhao & Whatley (1989 Malaysia) and the three in press papers by the present authors referred to above.

SYSTEMATIC DESCRIPTIONS

The type specimens of all new taxa are housed in the collections of the Natural History Museum, London to which the catalogue numbers prefixed RT/SIR refer. In all cases, specimens are of adults unless otherwise stated. All dimensions are given in millimetres, and the size convention for adults, as used by the senior author over many years for podocopid ostracods is as follows: <0.40 very small, 0.40–0.50 small, 0.50–0.70 medium, 0.70–1.00 large, >1.0–very large. Other conventions used throughout are: LV = left valve, RV = right valve, C = carapace, A = adult, rpc = radial pore canal, npc = normal pore canal. All new taxa are fully described.

Class OSTRACODA Latreille, 1806
Order PODOCOPIDA Müller, 1894
Suborder PODOCOPINA Sars, 1866
Superfamily CYTHEROIDEA Baird, 1850
Family BYTHOCYTHERIDAE Sars, 1926
Genus *Bythoceratina* Hornibrook, 1952
Bythoceratina sp.
(Pl. 1, Figs. 8–10)

Material.—One juvenile RV.

Dimensions.

	Length	Height
juv. RV, RT/SIR/201	0.44	0.22

Distribution.—The present species occurs more abundantly in Quaternary, offshore marine sediments from Guadalcanal (Williams, 1980 MS). Present study, sample: 54, Guadalcanal.

Remarks.—The present specimen is a juvenile, probably A-1, of a new species which occurs abundantly in Quaternary offshore deposits from Guadalcanal (Williams, MS 1980) which will be described in a subsequent paper (Whatley *et al.*, in press b). The species is very similar to *B. powelli* and *B. edwardsoni*, both of Hornibrook, 1952, from the Tertiary to Recent of New Zealand, but is smaller, the caudal process is more pronounced and it lacks the marginal denticulations present in the latter two species.

Bythoceratina sp. A
(Pl. 1, Fig. 7)

Material.—One LV, probably juvenile.

Description.—Surface of valve deeply reticulate, anterior marginal region almost smooth with very faint reticulation. Median sulcus weak. Ventro-lateral ala well developed, terminating in a prominent, rod-like spine.

Dimensions.

	Length	Height
juv? LV, RT/SIR/200	0.41	0.23

Distribution.—Sample: 53, Guadalcanal.

Remarks.—The present species, although rather similar to *Bythoceratina* sp. above, differs in that the ventro-lateral ala terminates in a distinctive, rod-like spine.

Bythoceratina sp. B
(Fig. 4, No. 3; Pl. 1, Figs. 11-15)

1966 Genus Uncertain, species IB Maddocks, p. 62, Fig. 48.1.

Material.—2 adult LV.

Description.—Surface of valves smooth. Subdorsal caudal process. Prominent, vertical median sulcus. Strong irregular rib along dorsal margin. Ventro-lateral ala bilobate with swellings on either side of sulcus with bridge-like rib across sulcus linking the swellings. All ribs and swellings delicately ornamented with various frills, spines, ribs and tubercles. 5 adductor muscle scars in arcuate row with a 6th, ovate scar dorsal to adductors.

Dimensions.

	Length	Height
LV, RT/SIR/198	0.42	0.21
LV, RT/SIR/199	0.49	0.24

Distribution.—Soft clays at 10 metres in Baie d'Ampasindava, Northern Madagascar (all dead) (Maddocks, 1966). Present study, samples: 15, 30, Guadalcanal.

Remarks.—The two left valves placed in this species differ slightly from one other. The smaller specimen (RT/SIR/198) appears to be eroded so that the dorsal rib and ala are less elaborately ornamented and the caudal

process is broken. Maddocks (1966) briefly described and illustrated a species (species IB) of uncertain generic status from Recent sediments from Northern Madagascar. A specimen of this latter species was made available to the present authors. This specimen was intermediate between the two specimens from Guadalcanal in degree of ornament of the dorsal rib and ala. It is also slightly smaller than either specimen, although the caudal process is broken. We believe that all 5 specimens belong to a single species, but more material is needed to erect a new species. The species is, therefore, left with open nomenclature. Hornibrook (1952b) described one smooth species of *Bythoceratina*, *B. utilazea*, from the Recent off New Zealand. This species differs from the present species in that the dorsal marginal rib is less elaborately ornamented. *Bythoceratina monstruosa* Holden, 1967, from the Neogene of Hawaii, is also similar but possesses a slightly different ornament and a smooth median hinge element.

Family CYTHERIDEIDAE Baird, 1850

Subfamily CYTHERIDEINAE Sars, 1925

Genus *Cyprideis* Jones, 1857

Cyprideis sp. cf. *Cyprideis australiensis* Hartmann, 1978
(Pl. 1, Fig. 29)

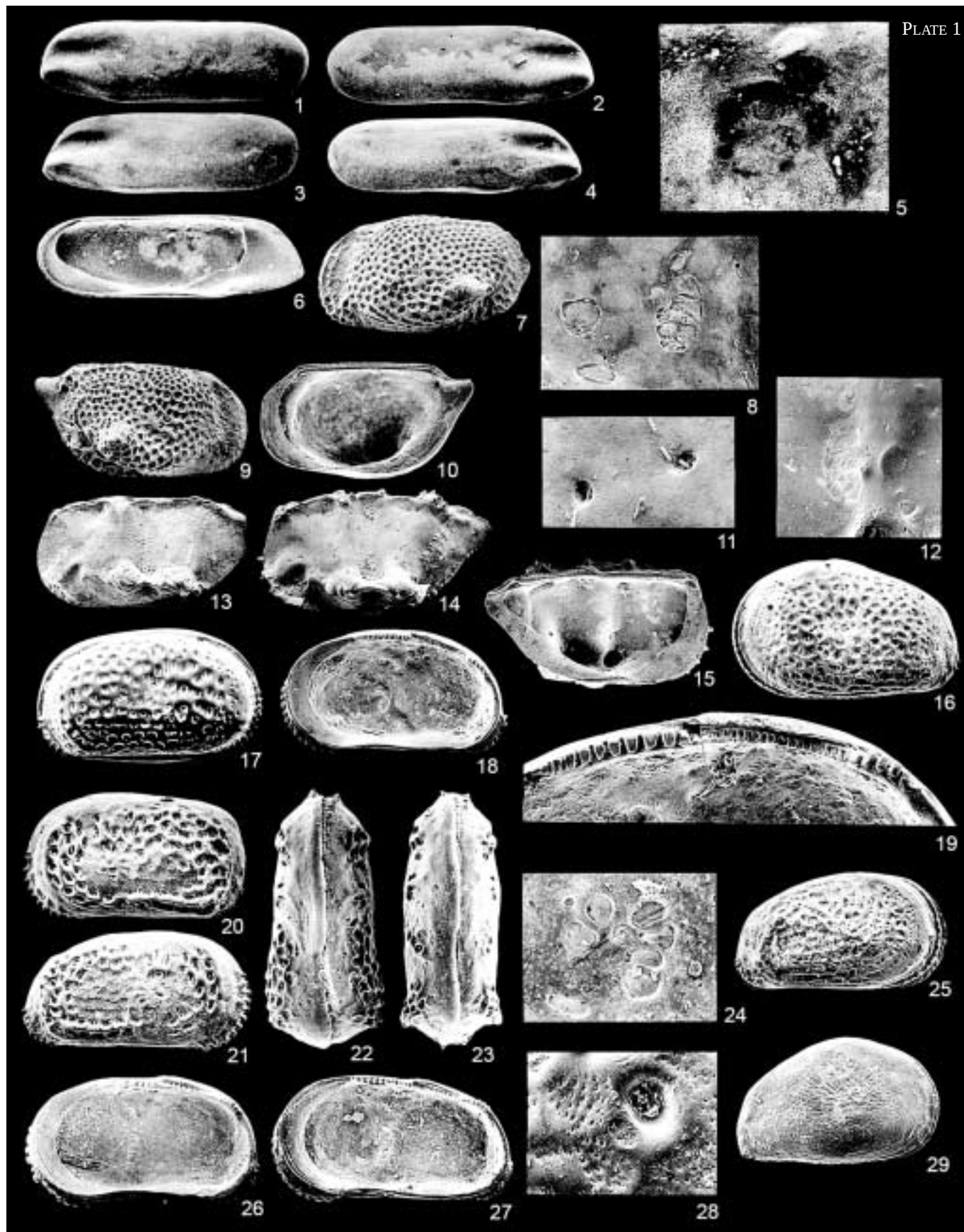
1978 *Cyprideis australiensis* Hartmann, p. 85, t-figs. 147-155, Pl. 5, Figs. 1-5.

Material.—One juvenile right valve, probably an A-1 instar.

→

PLATE 1–1-6, *Copytus posterosulcus* Wang (in Wang *et al.*), 1985. 1, Left valve, RT/SIR/247, external lateral view x 77.8. 2, Right valve, RT/SIR/248, external lateral view x 79.2. 3, 5-6, Left valve, RT/SIR/245. 3, external lateral view x 93.0. 5, detail of central muscle scars x 409.6. 6, internal view x 97.7. 7, *Bythoceratina* sp. A. Juvenile? left valve, RT/SIR/200, external lateral view x 80.5. 8-10, *Bythoceratina* sp. A-1 juvenile right valve, RT/SIR/201. 8, detail of central muscle scars x 343.1. 9, external lateral view x 77.3. 10, internal view x 76.1. 11-15, *Bythoceratina* sp. B. 11-12, 14-15, Left valve RT/SIR/199. 11, detail of normal pore x 641.7. 12, detail of central muscle scars x 246.0. 14, external lateral view x 72.4. 15, internal view x 71.4. 13, Left valve RT/SIR/198, external lateral view x 78.6. 16-19, *Neocyprideis spinulosa* (Brady, 1868). 16, A-1 juvenile left valve, RT/SIR/210, external lateral view x 72.4. 17, Female carapace, RT/SIR/208, external right lateral view x 58.3. 18-19, Female right valve, RT/SIR/209. 18, internal view x 58.6. 19, detail of central muscle scars x 167.8. 20-28, *Neocyprideis timorensis* (Fyan, 1916). 20, 28, female left valve, RT/SIR/216, 20, external lateral view x 65.1. 28, detail of normal pore x 379.9. 21, Male right valve, RT/SIR/217, internal view x 72.9. 22, Female carapace, RT/SIR/212, dorsal view x 74.5. 23, Male carapace, RT/SIR/211, dorsal view x 77.5. 24, 27, male right valve, RT/SIR/218, 24, detail of central muscle scars x 275.3. 27, internal view x 73.0. 25, A-1 juvenile right valve, RT/SIR/215, external lateral view x 76.2. 29, *Cyprideis* sp. cf. *Cyprideis australiensis* Hartmann, 1978. A-1 juvenile right valve, RT/SIR/207, external lateral view x 54.4.

PLATE 1



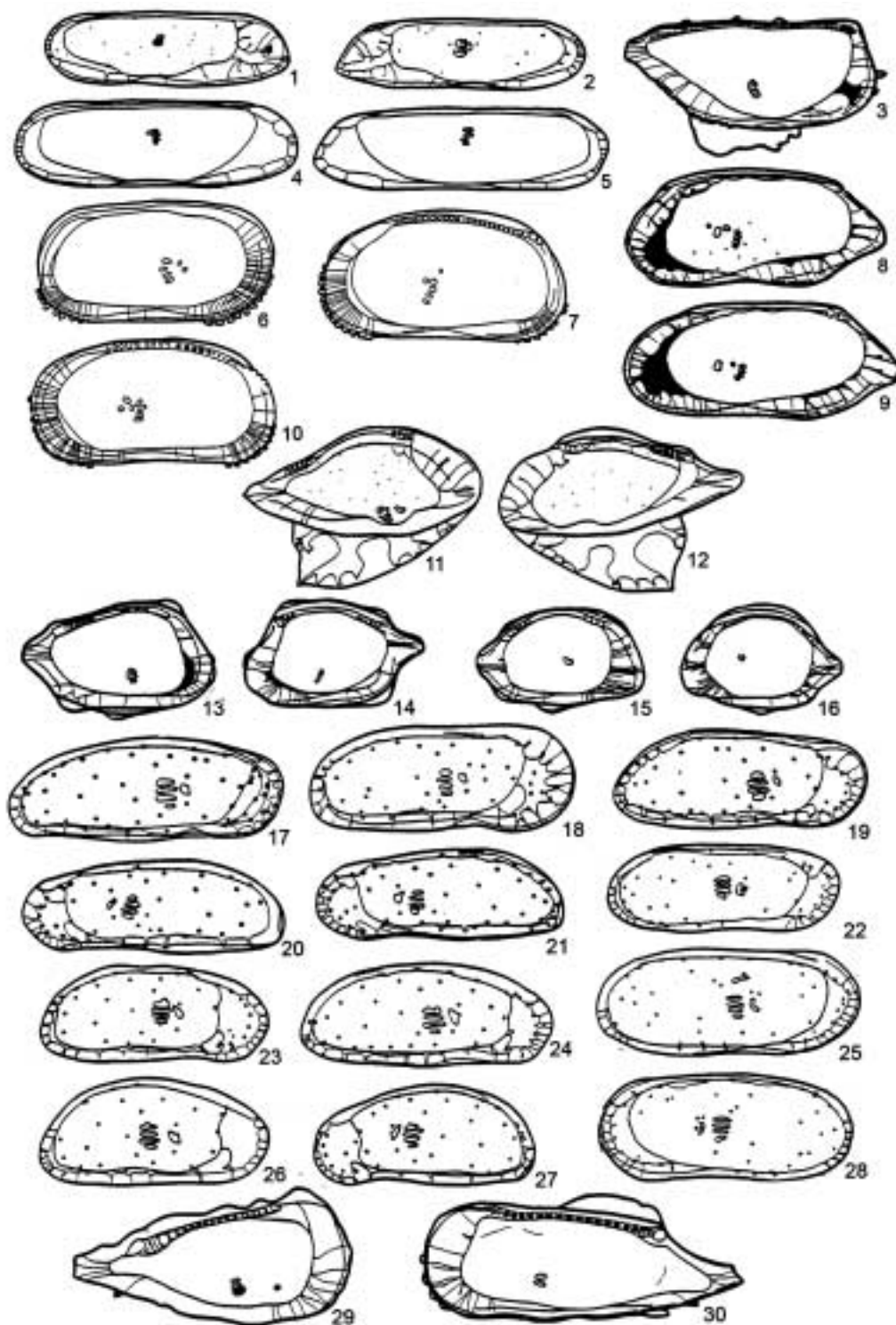


FIGURE 4—Internal lateral views. 1-2, 4-5, *Copytus posterosulcus* Wang (in Wang *et al.*), 1985. 1, Left valve, RT/SIR/245 x 84.9. 2, Right valve, RT/SIR/246 x 83.7. 4, Left valve, RT/SIR/247 x 77.8. 5, Right valve, RT/SIR/248 x 83.0. 3, *Bythoceratina* sp. B. Left valve, RT/SIR/199 x 77.6. 6, 10, *Neocyprideis timorensis* (Fyan, 1916). 6, Female left valve, RT/SIR/219 x 65.7. 10, Male right valve, RT/SIR/220 x 73.0. 7, *Neocyprideis spinulosa* (Brady, 1868). Female right valve, RT/SIR/209 x 60.3. 8-9, *Cytherura* sp. A. 8, Right valve, RT/SIR/257 x 81.3. 9, Right valve, RT/SIR/258 x 77.4. 11-12, *Oculocytheropteron* sp. A. 11, Left valve, RT/SIR/251 x 82.6. 12, Right valve, RT/SIR/252 x 81.1. 13-14, *Kangarina?* sp. A. 13, Left valve, RT/SIR/263 x 87.9. 14, Right valve, RT/SIR/261 x 79.4. 15-16, *Hemicytherura* sp. cf. *Hemicytherura mackenziei* Hartmann, 1978.

Dimensions.

	Length	Height
A-1 juv. RV, RT/SIR/207	0.57	0.36

Distribution.—*Cyprideis australiensis* occurs commonly in Quaternary brackish water sediments from the Indispensable Reefs and offshore Quaternary marine sediments from Guadalcanal (Williams, 1980 MS, Whatley et al., in press b) and was originally described as Recent. Hartmann's original description was from the eulittoral from the western coast of Australia (Hartmann, 1978). Present study, sample: 60, Guadalcanal.

Remarks.—The present species is represented by one juvenile RV in the present material. This specimen appears to be most closely related to *Cyprideis australiensis*, but has rather less reticulate ornament.

Genus *Neocyprideis* Apostolescu, 1956

1957 *Goelichia* Keij, p. 69.

1960 *Miocyprideis* Kollmann, p. 176.

1976 *Bishopina* Bonaduce, Masoli & Pugliese, p. 397.

Remarks.—*Neocyprideis* is very closely related to *Cyprideis* Jones, 1857, but differs mainly in the structure of the hinge, which in *Cyprideis* is pseudoentomodont. Kollmann (1960) erected *Miocyprideis*, which differs from *Neocyprideis* in possessing anterior and posterior marginal denticles, more numerous radial pore canals and a very strong ventral overlap of LV over the RV. The present authors agree with Van Morkhoven (1963: 295) that these differences are insufficient to afford *Miocyprideis* generic status. The diagnosis of *Neocyprideis*, therefore, should be expanded to accommodate those species assigned to *Miocyprideis* and the stratigraphical range of the genus extended to the Recent. Babinot & Colin (1976) dis-

agree and contend that the shape of the carapace and hinge are important features in separating *Miocyprideis* from *Neocyprideis*. We contend, however, that the degree of variation within these two characters alone in species they would place in two separate genera, is enough to demonstrate that they represent a single species. Babinot & Colin (*op. cit.*), in their interesting paper on the evolution of the Cytherideinae, also follow in essence the scheme of evolution of Kollmann (1960) from *Fabanella* via their genus *Sarlatina* to *Cyprideis*, with another branch evolving from *Fabanella* to *Neocyprideis* and *Miocyprideis*. However, we regard this phylogeny as too simplistic and regard *Neocyprideis* as a sibling (or even possible ancestral) genus of *Cyprideis*. Bonaduce *et al.* (1976) established the genus *Bishopina* on characters which, despite the arguments of Malz & Ikeya (1986) we consider to be of specific rather than generic ranking and, therefore, we place *Bishopina* in the synonymy of *Neocyprideis*.

Neocyprideis spinulosa (Brady, 1868)
(Fig. 4, No. 7; Pl. 1, Figs. 16-19)

1868 *Cytheridea spinulosa* Brady, p. 182, Pl. 13, Figs. 1-6.

2001 *Neocyprideis spinulosa* (Brady). Titterton, Whatley & Whittaker, p. 37, Pl. 2, Figs. 1-5.

2001 *Miocyprideis spinulosa* (Brady). Mohan, Ravi, Hussein & Rao, p. 8, Pl. 1, Figs. 20, 21.

Material.—2 adults, one juv.

Dimensions.

	Length	Height	Width
Female C, RT/SIR/208	0.60	0.35	0.30
Female RV, RT/SIR/209	0.58	0.31	
A-1 juv. LV, RT/SIR/210	0.49	0.30	

FIGURE 4 (continue)—15, Female left valve, RT/SIR/253 x 82.8. 16, Male right valve, RT/SIR/254 x 77.4. 17-21, *Parakrithella cucumeris* sp. nov. 17, Holotype, female left valve, RT/SIR/234 x 75.9. 18, Female left valve, RT/SIR/239 x 77.5. 19, Male left valve, RT/SIR/237 x 77.6. 20, Male right valve, RT/SIR/238 x 81.3. 21, Paratype, male right valve, RT/SIR/236 x 74.0. 22, 25, 28, *Parakrithella* sp. A. 22, Left valve, RT/SIR/243 x 84.1. 25, Left valve, RT/SIR/241 x 88.6. 28, Right valve, RT/SIR/242 x 86.4. 23-24, 26-27, *Parakrithella cyrtonos* sp. nov. 23, Holotype, left valve, RT/SIR/225 x 87.2. 24, Paratype, left valve, RT/SIR/230 x 87.2. 26, Left valve, RT/SIR/224 x 87.2. 27, Paratype, right valve, RT/SIR/226 x 84.6. 29-30, *Paracytheridea dromedaria* sp. nov. 29, Left valve, RT/SIR/272 x 84.2. 30, Right valve, RT/SIR/273 x 74.1.

Distribution.—*Neocyprideis spinulosa* is one of the most widely distributed shallow water species of the present day, occurring in the subtropical belt from as far west as the eastern coast of South Africa, across Indonesia to the Solomon Islands in the east. It does not occur in the Pitcairn group (Whatley *et al.*, in press a) nor at Easter Island (Whatley *et al.*, 2000). The earliest fossil occurrence of this species is from the Upper Pliocene sediments of Timor (Fyan, 1916). Other fossil records include the Pliocene-Pleistocene of Southern India (Guha, 1968) and the Quaternary of the Solomon Islands (Williams, 1980 MS) and Fijian Islands (Malz & Ikeya, 1986). Present study, samples: 15, 56, Guadalcanal.

Remarks.—*Neocyprideis spinulosa* differs from *N. timorensis* (Fyan, 1916) in that the punctate/reticulate ornament extends across the entire lateral surface and is coarsest and most irregular centrally. It is also consistently and conspicuously larger in size than the latter. The punctate ornament is variable, even within a single population, for example the specimens in Brady's original slide all vary. Some populations are particularly heavily ornamented, such as those described by Cabioch *et al.* (1986). The present specimens differ slightly in ornament from *N. spinulosa* as illustrated Brady (1868, 1880) and Keij (1954). In these illustrations *N. spinulosa* appears to possess a smooth marginal area, whereas the present material is finely punctate peripherally. *Neocyprideis spinulosa* is similar to *N. atjehensis* (Kingma) 1948, of Gramann 1975, from the Recent off the coast of Burma, but differs slightly in outline and in latter the puncta appear to be paired. *Neocyprideis atje-*

hensis of Hartmann 1981, from the Recent, eulittoral of the southwestern coast of Australia is closer *N. atjehensis* Kingma, 1948 than the present species in that the puncta of the ornament appear paired.

Neocyprideis timorensis (Fyan, 1916)
(Fig. 4 Nos. 6, 10; Pl. 1, Figs 20-28)

- 1916 *Cytheridea timorensis* Fyan, p. 1211, Fig. 9.
1986 *Bishopina timorensis* (Fyan). Malz & Ikeya, Pl. 3, Figs. 1-3.
2001 *Neocyprideis timorensis* (Fyan). Titterton, Whatley & Whittaker, p. 37, Pl. 2, Figs 6-10.

Material.—Approximately 500 valves and carapaces, A-3 to adult.

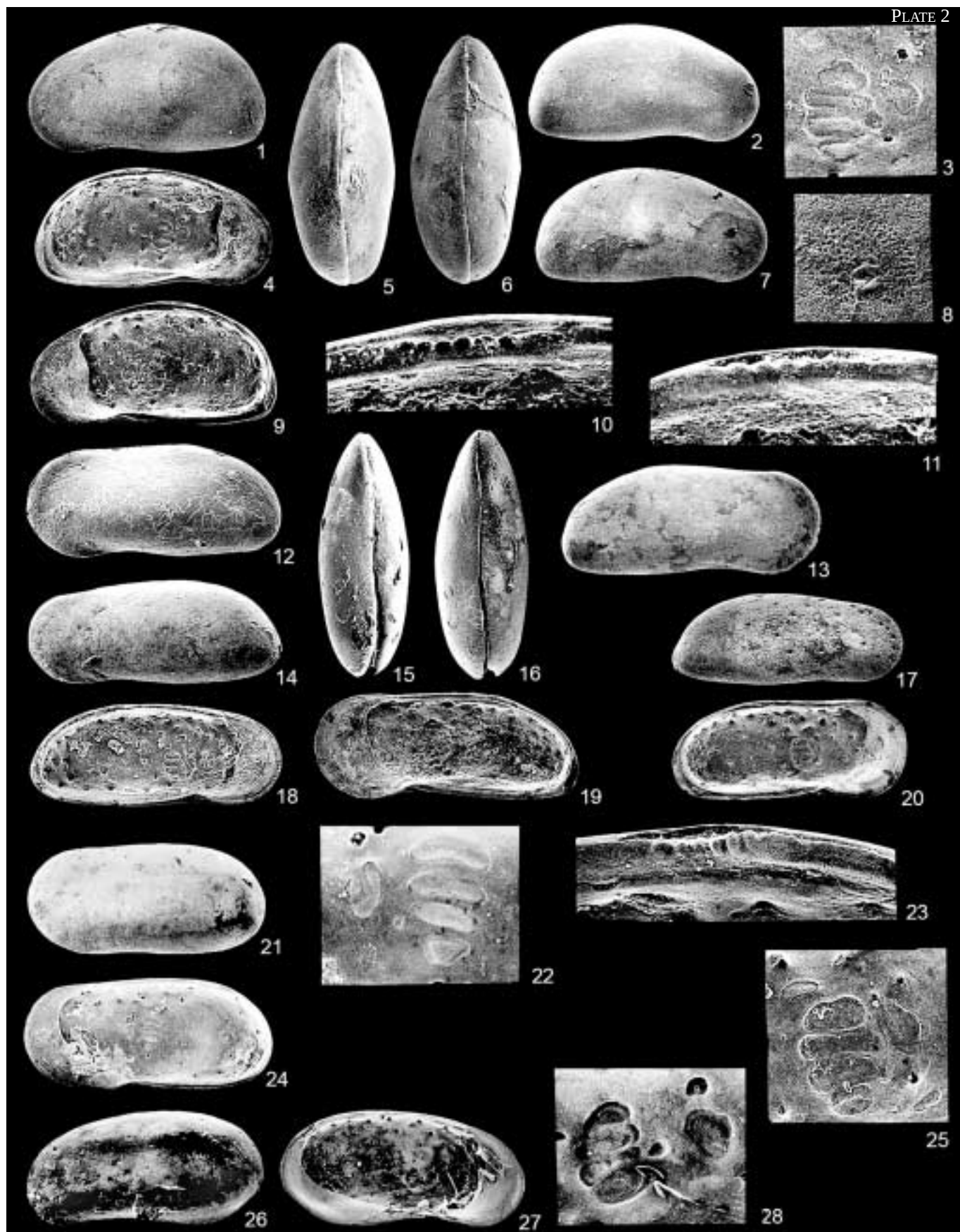
Dimensions.

	Length	Height	Width
Male C, RT/SIR 211	0.51	0.28	0.19
Female C, RT/SIR/212	0.53	0.30	0.25
Female RV, RT/SIR/213	0.54	0.29	
Male LV, RT/SIR/214	0.47	0.26	
A-1 RV, RT/SIR/215	0.42	0.24	
Female LV, RT/SIR/216	0.53	0.30	
Male RV, RT/SIR/217	0.48	0.25	
Male RV, RT/SIR/218	0.50	0.25	
Female LV, RT/SIR/219	0.54	0.29	
Male RV, RT/SIR/220	0.50	0.26	
Female RV, RT/SIR/221	0.53	0.29	

→

PLATE 2–11, *Parakrithella cyrtonos* sp. nov. 1, Holotype, left valve, RT/SIR/225, external lateral view x 96.2. 2, 8, Paratype, right valve, RT/SIR/227. 2, external lateral view x 93.6. 8, detail of normal pore x 2028.4. 3–4, 10, Paratype, left valve, RT/SIR/228. 3, detail of central muscle scar x 288.2. 4, internal view x 97.4. 10, detail of hinge x 610.4. 5, Paratype, carapace, RT/SIR/223, dorsal view x 97.4. 6, Paratype, carapace, RT/SIR/222, dorsal view x 100.0. 7, Paratype, right valve, RT/SIR/226, external lateral view x 96.1. 9, 11, Paratype, right valve, RT/SIR/229. 9, external lateral view x 102.6. 11, detail of hinge x 610.4. 12–20, 23, 25, *Parakrithella cucumeris* sp. nov. 12, Holotype, female left valve, RT/SIR/234, external lateral view x 74.1. 13, Female right valve, RT/SIR/233, external lateral view x 75.9. 14, Male left valve, RT/SIR/235, external lateral view x 83.3. 15, Paratype, male carapace, RT/SIR/232, dorsal view x 78.1. 16, Paratype, female carapace, RT/SIR/231, dorsal view x 73.1. 17, Paratype, male right valve, RT/SIR/236, external lateral view x 78.2. 18, Male left valve, RT/SIR/237, internal view x 80.6. 19, 23, Female right valve, RT/SIR/240. 19, internal lateral view x 79.8. 23, detail of hinge x 673.7. 20, 25, Female left valve, RT/SIR/239. 20, internal view x 80.1. 25, detail of central muscle scar x 291.9. 21–22, 24, *Parakrithella* sp. A. 21, Left valve, RT/SIR/241, external lateral view x 85.2. 22, 24, Right valve, RT/SIR/242. 22, detail of central muscle scar x 348.4. 24, internal view x 88.6. 26–28, *Parakrithella* sp. B. 26, Left valve, RT/SIR/244, external lateral view x 95.0. 27, internal view x 95.0. 28, detail of central muscle scars x 539.0.

PLATE 2



Mean Dimensions

	Length	Height	Width
15 Female C	0.52 (0.50-0.54)	0.48 (0.47-0.49)	0.25 (0.24-0.27)
10 Female LV	0.52 (0.50-0.54)	0.43 (0.41-0.44)	
10 Female RV	0.52 (0.50-0.55)	0.48 (0.47-0.49)	
8 Male C	0.49 (0.47-0.50)	0.43 (0.41-0.44)	0.19 (0.18-0.21)
10 Male LV	0.49 (0.47-0.50)	0.48 (0.47-0.49)	
10 Male RV	0.48 (0.47-0.50)	0.43 (0.41-0.44)	
12 A-1 LV	0.40 (0.37-0.43)	0.23 (0.22-0.25)	
14 A-1 RV	0.40 (0.39-0.42)	0.23 (0.21-0.24)	
13 A-2	0.33 (0.31-0.35)	0.20 (0.18-0.21)	
2 A-3	0.28	0.16, 0.17	

Distribution.—Fyan (1916) described *Neocyprideis timorensis* from the Pliocene of Timor. The species has also been recorded from the Solomon Islands from marine sediments of Miocene age from the Honiara Bay area, Guadalcanal (Hughes, 1977 MS). It also occurs in Quaternary brackish water sediments from the Indispensable Reefs and marine offshore sediments from Guadalcanal (Williams, 1980 MS, Whatley *et al.*, in press b). Present study, samples: 5, 13-17, 29, 30, 40-42, 53-58, 60, Guadalcanal.

Remarks.—The material described as *Bishopina mozarti* Bonaduce *et al.*, 1976, from the Recent of the Red Sea is clearly synonymous with the present species, but represents a form in which few puncta are developed and largely lacks the secondary reticulate and punctate ornament which is normally developed. *Neocyprideis spinulosa* Brady, 1868, differs from the present species in that the deep puncta extend across the entire lateral surface and the muri are not developed into ribs. Although sexual dimorphism is conspicuous in the adults, precocious sexual dimorphism was not observed in the juveniles. The relative larger size of the females can be clearly seen.

Family KRITHIDAE Mandelstam, 1958

Genus *Parakrithella* Hanai, 1959

1975 *Eukrithe* Schornikov, p. 4.

Parakrithella cucumeris sp. nov.

(Fig. 4, Nos. 17-21, 26-27; Pl. 2, Figs. 12-20, 23, 25)

Derivatio nominis.—*L. cucumeris*. From the subcylindrical shape of the carapace in lateral view with its fanciful resemblance to a cucumber.

Holotype.—Female LV, RT/SIR/234. Plate 2, Fig. 12.

Type locality.—Sample 29, 550 feet off shore, west of Point Cruz, Honiara Bay, Guadalcanal. 19 fathoms. Unconsolidated, fine-grained coral sand. Recent.

Material.—70 valves and carapaces, A-1 to adult.

Diagnosis.—A small to medium species of *Parakrithella*, subcylindrical in lateral view, elongate, subelliptical in dorsal view. Anterior margin very broadly rounded. Dorsal margin almost straight. Dorsal adductor muscle scar bilobate; frontal scar becoming trilobate. Inner margin gently curved anteriorly, parallel to margin.

Description.—Small to medium. Thin-shelled. Translucent. Sexual dimorphism conspicuous; female with broader anterior and posterior margins and slightly higher than male. Subcylindrical in lateral view; elongate, subelliptical in dorsal view. Anterior margin very broadly rounded; extremity at mid-height. Posterior margin narrower and somewhat downturned; more acuminate in male: extremity subventral. Dorsal margin almost straight, cardinal angles rounded, Ventral margin gently biconvex with slight oral concavity; more pronounced in female. Greatest length about mid-height; greatest height median in male, in anterior 1/4 in female; greatest width median. LV > RV with slight overlap on anterior margin. Surface of valves smooth. Npcs moderately numerous, large, sieve-type, regularly distributed. Inner lamella broad anteriorly; narrower posteriorly and ventrally. There is a narrow vestibulum posteriorly and ventrally. Anterior vestibulum large, semicircular or sometimes restricted to an anvil shape. There are 12 Rpcs at each end and some false canals posteroventrally. Hinge pseudodont: RV with a long, smooth hinge bar bearing a short rim of 6 small, rounded teeth at about the maximum convexity of the dorsal margin; LV complementary. Central muscle scars moderately large, comprising 4 adductor scars; dorsal scar bilobate and ventral scars subovate, median scars more elongate, frontal scar trilobate. Males may be readily distinguished from females by their shape, being less high anteriorly and posteriorly.

Dimensions.

	Length	Height	Width
Holotype			
Female LV, RT/SIR/234	0.54	0.22	
Paratype			
Female C, RT/SIR/231	0.54	0.25	0.19
Paratype			
Male C, RT/SIR/232	0.48	0.20	0.18
Paratype			
Male RV, RT/SIR/236	0.50	0.19	
Female RV, RT/SIR/233	0.54	0.22	
Male LV, RT/SIR/235	0.48	0.19	
Male LV, RT/SIR/237	0.49	0.20	
Male RV, RT/SIR/238	0.48	0.19	
Female LV, RT/SIR/239	0.51	0.20	
Female RV, RT/SIR/240	0.52	0.20	

Mean Dimensions

	Length	Height	Width
8 Female C	0.51 (0.48-0.54)	0.21 (0.18-0.24)	0.19 (0.15-0.20)
5 Female LV	0.49 (0.45-0.53)	0.22 (0.21-0.23)	
5 Female RV	0.52 (0.51-0.54)	0.22 (0.20-0.23)	
11 Male C	0.49 (0.44-0.52)	0.19 (0.18-0.22)	0.18 (0.16-0.20)
11 Male LV	0.48 (0.43-0.50)	0.20 (0.19-0.21)	
13 Male RV	0.46 (0.43-0.51)	0.19 (0.18-0.20)	
3 A-1 C	0.44 (0.42-0.46)	0.19 (0.18-0.21)	0.16 (0.15-0.18)
4 A-1 LV	0.44 (0.42-0.45)	0.19 (0.17-0.20)	

Distribution.—The species is of common occurrence in offshore Quaternary marine sediments from Guadalcanal (Williams, 1980 MS). Present study, samples: 13, 29, 30, 40-42, 53-58, 60, 61 Guadalcanal.

Remarks.—The present species is distinguished from *P. cyrtonos* sp. nov. by its larger size and almost straight dorsal margin and also the inner margin anteriorly is less sinuous than in *P. cyrtonos*. There are also differences in muscle-scar pattern and distribution of the normal and marginal pore canals. *Parakrithella*? sp. figured and described by Swain, 1967, from the Recent off California, although imma-

ture, is remarkably similar in shape to the present species. Unfortunately, the figure is poor, but the size of the species (0.43 mm long, 0.20 mm wide) is the same size as an A-1 juvenile of the present species. *Parakrithella* sp. EB Maddocks, 1966, from the Recent off Madagascar, is also similar in outline and distribution of the normal pore canals but differs from the present species in muscle-scar pattern and lacks the posterior indentation of the RV. *Parakrithella* sp. EA Maddocks, 1966, also from the Recent off Madagascar, differs in having more numerous normal pore canals and a different muscle-scar pattern from the present species. *Parakrithella cucumeris* sp. nov. has a similar dorsal margin to *P. australis* McKenzie, 1967, from the Recent off Southeastern Australia, but the former is proportionally less high and does not have a v-shaped frontal scar. *Parakrithella cucumeris* sp. nov. is less acuminate posteriorly, less arched dorsally and concave orally than *P. sp. cf. australis* McKenzie, 1967 of Hartmann, 1979, from the Recent of Southwestern Australia. Brady, 1890, figured a new species, *Cytheridea flavescens* from the Recent from Fiji and New Caledonia, the male being similar in shape to the present species but longer (0.8 mm). It is not certain from the description or the figure that *C. flavescens* is in fact a species of *Parakrithella*, but it seems likely. *P. placida* Mostafawi, 1992 from the Sunda Shelf is smaller (L= 0.43-0.46) and has a much less flared anterior margin.

Parakrithella cyrtonos sp. nov.

(Fig. 4, Nos. 23-24, 26-27; Pl. 2, Figs. 1-11)

?1993 *Parakrithella pseudadonta* Hanai. Dewi, p. 122, Figs. 94, 95.

Derivatio nominis.—Gr. κυρτωνοζ humpbacked. With reference to the overall humpbacked aspect of the species in lateral view due to its arched dorsal and concave ventral margins.

Holotype.—LV, RT/SIR/225. Plate 2, Fig. 1.

Type locality.—Sample 40, 3,100 feet offshore, east of the Matanikau River, Honiara Bay, Guadalcanal. 20 fathoms. Unconsolidated, medium-grained coral sand. Recent.

Material.—24 valves and carapaces, A-1 to adult.

Diagnosis.—A very small, thin-shelled species of *Parakrithella*. Characterised by a strongly and evenly arched dorsal margin and almost matchingly concave ventral margin. Inner margin gently sinuous anteriorly. Dorsal adductor muscle scar and frontal scar trilobate.

Description.—Very small. Thin-shelled. Translucent. Elongate, subovate in lateral view, with an overall arched aspect: subelliptical in dorsal view. Anterior margin rather narrowly rounded: extremity a little below mid-height. Posterior subtruncated in RV, bluntly rounded in LV; extremity well below mid-height. Dorsal margin strongly and regularly arched: cardinal angles rounded. Ventral margin with oral concavity. Greatest length below mid-height; greatest height and width medianly. LV slightly larger than RV, with overlap on anterior margin. Surface of valves smooth. Npcs moderately numerous, large, evenly distributed: sieve-type; sieve-plate flush with surface and with minute perforations. Inner lamella broad anteriorly, narrower posteriorly and ventrally. Inner and outer margins sub-parallel. Very narrow vestibulum posteriorly, much wider and semicircular anteriorly. There are some 10-12 true, simple, short, straight rpcs anteriorly and about 10-12 posterior and ventral canals, some of which are false. Hinge pseudodont: RV with a long, smooth hinge bar bearing a short row of about 7 small, rounded teeth at the maximum convexity of the dorsal margin; LV complementary. Central muscle scars moderately large, dorsal adductor scar trilobate, median two scars elongate and ventral scar subovate; frontal scar trilobate.

Dimensions.

	Length	Height	Width
Holotype LV, RT/SIR/225	0.39	0.20	
Paratype C, RT/SIR/222	0.38	0.19	0.17
Paratype C, RT/SIR/223	0.39	0.19	0.17
Paratype RV, RT/SIR/226	0.39	0.19	
Paratype LV, RT/SIR/230	0.43	0.20	
LV, RT/SIR/224	0.39	0.20	
RV, RT/SIR/227	0.38	0.19	
LV, RT/SIR/228	0.38	0.19	
RV, RT/SIR/229	0.38	0.19	

Mean Dimensions

	Length	Height	Width
5 AC	0.39 (0.38-0.39)	0.19 (0.18-0.20)	0.17 (0.16-0.17)
11 ALV	0.30 (0.37-0.43)	0.19 (0.17-0.21)	
5 ARV	0.38 (0.37-0.40)	0.19 (0.18-0.20)	

Distribution.—This species was encountered in samples 5, 14, 40-42, 54, 56-58, Honiara Bay.

Remarks.—The present species is very similar in overall morphology to *P. pseudadonta* Hanai, 1959, from the Neogene to Recent of Japan, but is considerably smaller. *Parakrithella pseudadonta* of Dewi (1993) is even smaller than the present material ($L = 0.33$) and possibly belongs to the present species. There are also differences in the muscle scar pattern. *Parakrithella hanai* Hartmann, 1962, from the Recent of Chile and Argentina, is also very similar, being strongly arched dorsally but is slightly larger and possesses an ovate dorsal adductor scar. *Parakrithella cyrtosus* sp. nov. is less acuminate posteriorly than *P. eopacifica* Holden, 1976, from the Miocene of Midway Island or *P. sp. cf. P. australis* McKenzie, 1967 of Hartmann, 1979, from the Recent eulittoral of the western coast of Australia. *Parakrithella* sp. Lizard 2 of Behrens (1991) from the Great Barrier Reef is smaller and less arched dorsally. *P. peregrinata* Whatley *et al.* (2000) from Easter Island is similar in shape and outline but is markedly larger ($L = 0.45-0.48$). Sexual dimorphism was inconspicuous; all the adults being of approximately the same size, one specimen (RT/SIR/230), however, was slightly longer than the others and is possibly a male.

***Parakrithella* sp. A**

(Fig. 4, Nos. 22, 25, 28; Pl. 2, Figs. 21-22, 24)

Material.—10 valves and carapaces, A-1 to adult.

Description.—Small. Thin-shelled. Translucent. Sexually dimorphic: female longer and wider than male. Subrectangular in lateral view, elliptical in dorsal view. Anterior margin bluntly and broadly rounded; extremity just above mid-height. Posterior margin well rounded, slightly oblique posterodorsally, extremity well below mid-height. Dorsal margin straight: cardinal angles rounded. Ventral margin straight, parallel to dorsal margin, with very slight oral concavity. Greatest length below mid-height; greatest height median; greatest width median. Valves subequal in size, LV slightly overlapping RV on anterior margin. Valves slightly broader anteriorly than posteriorly. Smooth. Internal features as for genus.

Dimensions.

	Length	Height
LV, RT/SIR/241	0.44	0.20
RV, RT/SIR/242	0.44	0.19
LV, RT/SIR/243	0.41	0.17
A-1 juv. LV,	0.37	0.16

Distribution.—Samples: 13, 41, 53, 54, 56, 58, 60 Guadalcanal.

Remarks.—The present species is distinctive in its small size and long, straight dorsal margin, parallel to the ventral margin. Because of the paucity of material the species is left with open nomenclature, although it is almost certainly new.

Parakrithella sp. B
(Pl. 2, Figs. 26-28)

Material.—Two adult valves.

Description.—Very small. Thin-shelled. Translucent. Subrectangular in shape in lateral view. Anterior and posterior margins well rounded; postero-ventral margin with slight concavity. Dorsal margin gently arched. Ventral margin biconvex. Smooth. Npcs moderately numerous, large, sieve-type. Inner lamella broad. Central muscle scars a compact, vertical row of 4 adductor scars with a trefoil frontal scar. Ovate fulcral point just anterior to third adductor scar.

Dimensions.

	Length	Height
LV, RT/SIR/244	0.40	0.19

Distribution.—Sample: OS5 Shortland Island.

Remarks.—The present species may be distinguished by its very small size, gently arched dorsal margin and the slight concavity of the postero-ventral margin.

ACKNOWLEDGEMENTS

Family NEOCYTHERIDEIDAE Puri, 1957

Genus *Copytus* Skogsberg, 1939

Copytus posterosulcus Wang (in Wang *et al.*), 1985
(Fig. 4, Nos. 1-2, 4-5; Pl. 1, Figs. 1-6)

1985 *Copytus posterosulcus* Wang. Zhao, Wang & Zhang, p. 211, Pl. 21, Figs. 9-13.

1987 *Copytus posterosulcus* Wang. Whatley & Zhao, p. 345, Pl. 4, Figs. 6-8.

1989 *Copytus posterosulcus* Wang. Zhao & Whatley, p. 186.

1993 *Copytus* cf. *posterosulcus* Wang. Jellinek, p. 122, Pl. 8, Figs. 184-185.

1993 *Copytus posterosulcus* Wang. Yassini, Jones & Jones, p. 402, Pl. 8, Figs. 151, 152.

1995 *Copytus posterosulcus* Wang Yassini & Jones, p. 365, Figs. 615, 617.

Material.—4 adult valves, 1 adult carapace and 1 A-1 instar.

Description.—Elongate, oblong in shape in lateral and dorsal views. Anterior margin obliquely rounded, becoming angularly rounded anteroventrally. Posterior margin bluntly rounded. A broad, lateral sulcus extends from anterior margin at about mid-height for a quarter of length. Surface of valves smooth.

Dimensions.

	Length	Height	Width
LV, RT/SIR/245	0.43	0.13	
RV, RT/SIR/246	0.43	0.13	
LV, RT/SIR/247	0.54	0.16	
RV, RT/SIR/248	0.53	0.16	
C, RT/SIR/249	0.49	0.16	0.14
A-1 JUV, RV RT/SIR/250	0.37	0.13	

Distribution.—*Copytus posterosulcus* is widely distributed from the east coast of Africa to the Solomon Islands. Present study, samples: 5, 45, 53, 56, Guadalcanal.

Remarks.—The present species is most similar to *Copytus rara* McKenzie, 1967, from the Recent of Port Phillip Bay, Southern Australia. The former may be distinguished, however, as it is more than 0.5 mm shorter, the dorsal margin is not arched posteriorly, the surface of the valves is smooth and the anterior marginal pore canals are more numerous. *Copytus* sp. aff. *C. rara* of Hartmann, 1978, from the Recent, eulittoral of the western coast of Australia, possesses a faint reticulate ornament. *Copytus caligula* Skogsberg, 1959, from the Recent of South Georgia, is 0.2 mm longer and the anterior margin is more rounded than in the present species. *Copytus elongatus* Benson, 1964, from the Recent of the Ross Sea, similarly differs from the present species in that the anterior margin is more regularly rounded. No internal characters of *Cytherideis baculoides* Brady, 1890, from Recent sediments from Fiji have been described or illustrated; therefore, it is uncertain if this species should be assigned to *Copytus*. It is, however, very similar in outline to the present species but is 0.5 mm longer.

Family CYTHERURIDAE G. W. Müller, 1894

Subfamily CYTHERURINAE G. W. Müller, 1894

Genus *Cytherura* Sars, 1866

Cytherura sp. A

(Fig. 4, Nos. 8-9; Pl. 3, Figs. 1-4)

Material.—2 adult right valves.

Description.—Small to medium. Moderately thin-shelled. Translucent. Elongate subrectangular to

subcylindrical in lateral view. Anterior margin asymmetrically and rather narrowly rounded, with long gently convex antero-dorsal slope and shorter, much more strongly convex: extremity well below mid-height. Posterior margin strongly caudate, extremity just below mid-height. Dorsal margin almost straight: anterior cardinal angle rounded; posterior angle obtusely rounded. Ventral margin almost straight. Surface of valves ornamented by a series of interlinking, longitudinal ribs with inter-costate reticula. Eye-spot not observed. Greatest length at mid-height; greatest width median. Npcs moderately numerous, evenly distributed. Inner lamella moderately wide. Large, crescentic anterior vestibulum; very narrow postero-ventral vestibulum. Rpcs moderately numerous; approximately 20 anteriorly and 15 posteriorly majority branching, some false. Hinge modified lophodont. RV with small tooth at anterior end of long, smooth hinge groove; hinge groove anteriorly bounded by strong, elongate anti-slip tooth; small ovate tooth at posterior end of hinge groove. Central muscle scars a compact, arcuate row of 4 ovate adductor scars and a subrectangular frontal scar; large, ovate fulcral point near dorsal 2 adductor scars.

Dimensions.

	Length	Height
RV, RT/SIR/257	0.48	0.21
RV, RT/SIR/258	0.53	0.23

Distribution.—Sample: OS6, Shortland Island.

Remarks.—The present species is unlike any other species described from the Pacific. Externally it resembles some European species of the genus, for example, *C. striata* Sars, 1866. It differs from other species of this genus in the structure of the hinge, which appears to be very simple, in its large anterior vestibulum branching marginal pore canals. It also resembles some European Jurassic species of *Procytherura* Whatley, 1970; such as the Liassic species, *P. mediocostata* Bate and Coleman, 1975. *Cytherura tenuifossulata* Hartmann, 1978, from the Recent eulittoral of the west coast of Australia, shows some similarities to the present species. The former differs, however, in possessing more numerous lateral ribs and conspicuous, intercostal puncta.

Genus *Kangarina* Coryell & Fields, 1937

Kangarina? sp. A

(Fig. 4, Nos. 13-14; Pl. 3, Figs. 15-20)

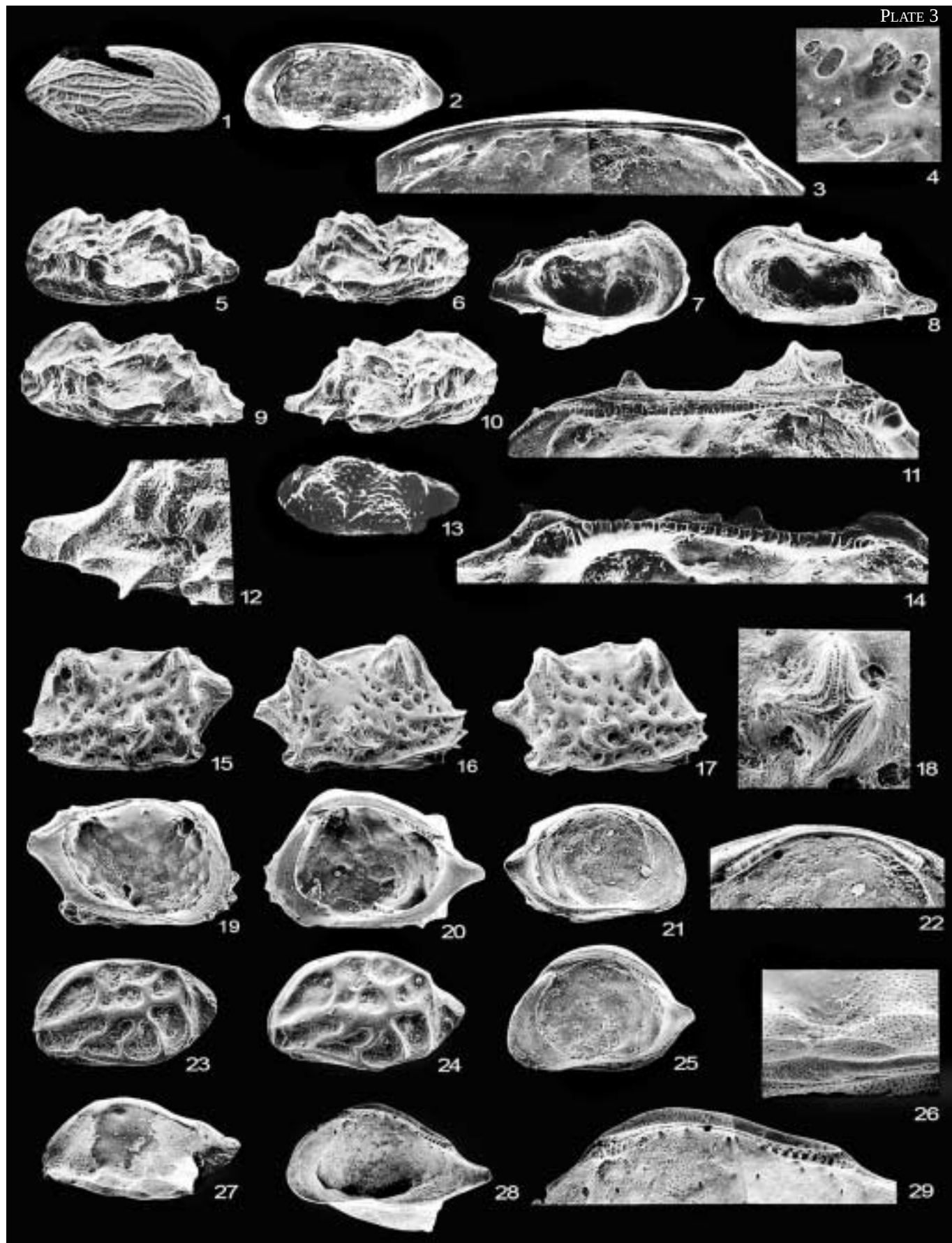
Material.—9 valves, A-1 to adult.

Description.—Subquadrate in lateral view. Anterior margin angular and strongly projected anteroventrally where two strong ribs project beyond the margin. Posterior margin strongly caudate, with sharp apex at mid-height. Dorsal margin straight between two tubercles at the cardinal angles that project strongly beyond the margin. Ventral margin largely obscured in lateral view by strong ventro-lateral rib. Valves coarsely reticulate with well developed, prominent tubercles. There is a large and very pronounced eye tubercle, a pyramid-

→

PLATE 3–1–4, *Cytherura* sp. A. 1, Right valve, RT/SIR/258, external lateral view x 58.5. 2–4, Right valve, RT/SIR/257. 2, internal view x 65.6. 3, detail of hinge x 189.9. 4, detail of central muscle scar x 301.7. 5–14 *Paracytheridea dromedaria* sp. nov. 5, Holotype, left valve, RT/SIR/264, external lateral view x 61.8. 6, Paratype, right valve, RT/SIR/268, external lateral view x 55.2. 7, 14, Left valve, RT/SIR/271. 7, internal view x 59.3. 14, detail of hinge x 167.8. 8, 11, Right valve, RT/SIR/270. 8, internal view x 64.8. 11, detail of hinge x 157.3. 9, Left valve, RT/SIR/267, external lateral view x 58.2. 10, 12, Paratype, right valve, RT/SIR/269. 10, external lateral view x 59.6. 12, detail of posterior lateral ornament x 157.3. 13, *Paracytheridea* sp. A. Juvenile left valve, RT/SIR/274, external lateral view x 69.0. 15–20, *Kangarina?* sp. A. 15, 18, 19, Left valve RT/SIR/260. 15, external lateral view x 91.4. 18, detail of central tubercle ornament x 296.5. 19, internal view x 91.4. 16, Right valve, RT/SIR/261, external lateral view, x 97.1. 17, Right valve, RT/SIR/262, external lateral view x 97.1. 20, Right valve, RT/SIR/259, internal view x 101.5. 21–25, *Hemicytherura* sp. cf. *Hemicytherura mackenziei* Hartmann, 1978. 21–22, 24, Female left valve, RT/SIR/253. 21, internal view x 89.1. 22, detail of hinge x 205.5. 24, external lateral view x 96.9. 23, Male left valve, RT/SIR/256, external lateral view x 93.5. 25, Female right valve, RT/SIR/254, internal view x 96.8. 26–29, *Oculocytheropteron* sp. A. 26–27, Left valve, RT/SIR/251. 26, detail of lateral ornament x 226.4. 27, external lateral view x 72.1. 28–29, Right valve, RT/SIR/252. 28, internal view x 72.2. 29, detail of hinge x 162.9.

PLATE 3



shaped tubercle at the posterior cardinal angle, overreaching the dorsal margin; an alate tubercle at the postero-ventral angle and a subcentrally situated, x-shaped tubercle with an inconspicuous subcentral tubercle situated anterior of it. The tubercles are ornamented with radiating ribs. Other ornament is very complex and varies in strength of development. The inter-tuberculate areas and the caudal process are coarsely reticulate, particularly the x-shaped tubercle. A strong ventro-lateral ridge extends from below the postero-ventral tubercle to beyond the anterior margin. The fossae are secondarily ornamented with fine papillae. Hinge modified antimerodont; median element arched and strongly denticulate. Central muscle scars comprise a vertical row of 4 ovate adductor scars and a heart-shaped frontal scar.

Dimensions.

	Length	Height
RV, RT/SIR/259	0.34	0.20
LV, RT/SIR/260	0.35	0.22
RV, RT/SIR/261	0.34	0.23
RV, RT/SIR/262	0.34	0.23
LV, RT/SIR/263	0.33	0.21

Distribution.—Samples: 1, 13-15, 17, Guadalcanal.

Remarks.—This species seems to present a mosaic of characters somewhat midway between the three genera *Eucytherura* Müller, *Hemicytherura* Elofson and *Kangarina* and we only tentatively include it within the latter, since its distinctive ornament distinguishes it from any other species of the genus known to the authors. *Eucythere binocula* Allison and Holden, 1971 from the Recent of Clipperton Island also possesses a strong, reticulate ornament but the tubercles are less well developed. The median element of the hinge of *E. binocula* is long, almost straight and finely denticulate.

Genus *Hemicytherura* Elofson, 1941

Hemicytherura sp. cf. *Hemicytherura mackenziei*
Hartmann, 1978

(Fig. 4, Nos. 15-16; Pl. 3, Figs. 21-25)

1978 *Hemicytherura mackenziei* Hartmann, p.
114, Text-Figs. 329-333, Pl. 11, Figs. 10-15.

Material.—3 adult valves.

Description.—Very small. Fairly thick-shelled. Translucent. Subpolygonal in lateral view. Strongly dimorphic, with male smaller and less strongly arched dorsally than female. Anterior margin asymmetrically subrounded, with long almost straight antero-dorsal slope

and much shorter, tightly rounded antero-ventral slope; apex almost sub-dorsal. Posterior margin strongly caudate: extremity at about mid-height in RV and above in LV. Dorsal margin very strongly arched in female; less so in male: cardinal angles rounded. Ventral margin almost straight, overhung by lateral ornament. Greatest length just below mid-height; greatest width median. Surface of valves strongly reticulate with strong, rather flat profiled, anastomosing ribs. A strong, short rib extends to the anterior margin from the eye tubercle, being itself an extension of the dorsal peripheral rib. A strong median rib crosses the lateral surface diagonally, from the posterodorsal loop to the anterior margin and thickening medianly. Just above the median rib, is an ovate fossa with a smaller fossa immediately anterior to it. A third, subalate ventro-lateral rib also extends to the anterior margin. Subvertical, usually curved ribs anastomosingly connect the major ribs. Npcs few, large, open, regularly distributed, some in small fossae. Inner lamella broad; avestibulate. Rpcs approximately 20 anteriorly and 10 posteriorly canals. Hinge modified antimerodont, strongly arched. Other internal features not seen.

Dimensions.

	Length	Height
Female LV, RT/SIR/253	0.32	0.19
Female RV, RT/SIR/254	0.31	0.21
Male LV, RT/SIR/256	0.28	0.16

Distribution.—Eulittoral sediments from Point Hedland, Exmouth, Western Australia (Hartmann, 1978). Present study, samples: 1, 58, Guadalcanal.

Remarks.—*Hemicytherura mackenziei* Hartmann, 1978, from the Recent of the western coast of Australia, differs somewhat in ornament from the present species, mainly in the strength of development of some of the muri, although the pattern of the reticulum is essentially the same. The most distinguishing feature of the reticulate pattern in the present species is the strong diagonal median rib. Almost at the centre of the valve, just above this rib, is an ovate fossa with a smaller fossa immediately anterior to it. In *H. mackenziei* these two fossae are fused to form a single, larger one. *Hemicytherura* sp. described by Jain (1978) from the Recent off Western India is very similar to the present species but differs in its reticulate pattern, particularly subcentrally. Similarly, *H. cranekeyensis* Puri, 1960, from the Recent off Florida, also differs in the sub-central reticulate pattern by possessing 4 subequal, ovate fossae.

Subfamily CYTHEROPTERINAE Hanai, 1957

Genus *Oculocytheropteron* Bate, 1972

Remarks.—*Oculocytheropteron* was erected to accommodate species previously assigned to *Cytheropteron* Sars, 1866, which possess, distinct eye-tubercles. *Cytheropteron*, which dates from the Lower Jurassic to Recent is blind, although it descends from sighted ancestors (Whatley & Boomer, 2000). *Oculocytheropteron*, with distinct eye tubercles, first appeared in the Upper Cretaceous, and because it is an invariable law of evolution that once an organ is lost it cannot be regained, *Oculocytheropteron*, therefore, cannot have descended from *Cytheropteron*. Notwithstanding the very great similarity between the two genera, they are not, therefore, closely related. There is, however, an associated enigma. Sighted ostracod species lose their eyes (at about 500-600 m) when they migrate down slope from the shelf (Benson, 1972). This has happened in the case of Cainozoic *Oculocytheropteron*, especially in Australian and New Zealand waters (Whatley *et al.*, 1983). The resultant sightless ostracods without eye tubercles are virtually indistinguishable from *Cytheropteron* species, which abound in the deep sea (Whatley, 1983).

Oculocytheropteron sp. A
(Fig. 4, Nos. 11-12; Pl. 3, Figs. 26-29)

Material.—2 adult valves.

Description.—Small. Subtrapezoidal in lateral view. Strongly sagittate in dorsal view. Anterior margin rounded with apex below mid-height. Posterior margin extended into a long, very acuminate caudal process, with apex above mid-height. Dorsal margin sinuous and sloping posteriorly. Ventral margin obscured in lateral view by alae. Surface of valves finely and densely punctate in a concentric pattern. Eye tubercle and internal ocular sinus distinct. Ala large and triangular, with leading edge extending from anterior margin to tubercular apex and embellished with a double rib along its crest. Trailing edge sinuous and dentate. Internal features as for genus. Hemimerodont hinge strongly developed.

Dimensions.

	Length	Height
LV, RT/SIR/251	0.43	0.25
RV, RT/SIR/252	0.45	0.23

Distribution.—Samples: 50, 55, Guadalcanal.

Remarks.—The present species is less strongly ornamented than those species of *Oculocytheropteron* described by Hornibrook (1952b) from the Tertiary and Recent of New Zealand. The present species similarly differs from *O. microformix* Whatley & Downing (1984) from the Miocene of Southeastern Australia.

Subfamily PARACYTHERINAE Puri, 1957

Genus *Paracytheridea* Müller, 1894

Paracytheridea dromedaria sp. nov.

(Fig. 4, Nos. 29-30; Pl. 3, Figs. 5-14)

Derivatio nominis.—L. With reference to the large postero-dorsal “hump-like” swelling.

Holotype.—LV, RT/SIR/264. Plate 3, Fig. 5.

Type locality.—Sample 14, 1,400 feet offshore, west of Point Cruz, Honiara Bay, Guadalcanal. 10 fathoms. Unconsolidated, medium-grained coral sand. Recent.

Material.—212 valves and carapaces, A-2 to adult.

Diagnosis.—A medium, subpyriform species of *Paracytheridea*. Strongly inflated posterodorsally and with a well developed dorsal tubercle immediately posterior to eye tubercle. Surface of valve strongly ornamented; a conspicuous lateral rib extends from anterior margin, bifurcates at subcentral tubercle, dorsal branch arches over the tubercle and ventral branch curves below. Hinge antimerodont with strongly crenulate median element. Selvage finely denticulate around anterior cardinal angle of right valve.

Description.—Medium. Thick-shelled. Opaque. Sexual dimorphism inconspicuous; male may be slightly larger with shallower median sulcus. Subpyriform in lateral view: bispinose in dorsal view. Anterior margin broadly rounded in RV; slightly more obliquely rounded in LV: extremity at mid-height. Posterior margin acuminate, well developed caudal process, slightly more pointed, extended and upturned in RV: extremity below mid-height. Dorsal margin straight, obliquely sloping towards posterior, overhung postero-dorsally by lateral swelling, particularly in RV. Cardinal angles accentuated by presence of hinge ears, particularly in LV. Ventral margin obliquely sloping posteriorly and almost straight; margin overhung posteroventrally by alar process. Greatest length through caudal process; greatest height at anterior cardinal angle in RV, at postero-dorsal lateral swe-

ling in LV; greatest width through ala. LV > RV with overlap at anterior cardinal angle and on caudal process. Surface of valve with strongly inflated postero-dorsal swelling and very well developed, sharply pointed ala postero-ventrally. A strong, inflated subcentral tubercle is separated from the dorsal swelling by a deep, vertical sulcus. Small, glassy eye tubercle. Surface strongly ornamented by a series of irregular ribs and tubercles: 3 short, irregular, subparallel ribs extend obliquely across the postero-dorsal swelling from the sulcus towards the posterior cardinal angle. Five irregular ribs extend posteriorly from the anterior margin; the first extends subperipherally along the ventral margin to edge of the ala; the second extends to the subcentral tubercle and then along the crest of ala; the third, a slightly sinuous rib, extends to subcentral tubercle. These ribs are united by less well-developed vertical riblets. A short rib, from the ala to the posteroventral margin, extends into a short, strong spine that overhangs that margin. A short rib extends vertically from the eye tubercle of LV; absent in RV. Secondary ornamentation of minute papillae, except on crests of primary ribs which are smooth. Npcs large, moderately numerous, evenly distributed, sieve-type. Inner lamella moderately wide; narrower posteriorly, avestibulate. Rpcs few: approximately 15 anteriorly and 4 posteriorly, simple, slightly sinuous; anterior canals in pairs around anteroventral angle. Hinge antimerodont. Anterior terminal element of RV hinge a short, dentate ridge of 4-5 quadrate teeth, median groove strongly locellate; posterior terminal element a strong lobate tooth. Auxiliary dentition developed only on RV selvage around anterodorsal angle, comprising a finely denticulate ridge accommodated within selvage of LV. Muscle scars not seen.

Dimensions.

	Length	Height
Holotype LV, RT/SIR/264	0.55	0.28
Paratype LV, RT/SIR/265	0.56	0.25
Paratype RV, RT/SIR/268	0.58	0.24
Paratype RV, RT/SIR/269	0.57	0.25
A-1 juv, RV RT/SIR/266	0.47	0.20
LV, RT/SIR/267	0.61	0.27
RV, RT/SIR/270	0.54	0.23
LV, RT/SIR/271	0.54	0.26
LV, RT/SIR/272	0.57	0.27
RV, RT/SIR/273	0.56	0.24

Mean Dimensions

	Length	Height
27 ALV	0.54 (0.50-0.60)	0.21 (0.25-0.30)
30 ARV	0.55 (0.50-0.59)	0.26 (0.23-0.28)
10 A-1 LV	0.45 (0.42-0.47)	0.22 (0.21-0.24)
21 A-1RV	0.45 (0.40-0.48)	0.21 (0.19-0.22)
11 A-2	0.38 (0.34-0.42)	0.16 (0.16-0.20)

Distribution.—Common in offshore Quaternary, marine sediments from Guadalcanal (Williams, 1980 MS). Present study, samples: 1, 2, 13-17, 19, 20, 30, 32, 52, 57, 61, OS5, OS6, Guadalcanal and Shortland islands.

Remarks.—The strength of development of the surface ornament varies within the species, but conforms in general to the pattern described. Although the ornament varies, there are constant features that distinguish the present species from *P. remanei* Hartmann, 1964, from the Recent of the Red Sea and off Western Australia (Hartmann, 1978). In the present species, an irregular rib extends from mid-height of the anterior margin to the subcentral tubercle where it bifurcates; the dorsal branch arches over the subcentral tubercle, the ventral branch curves around and below the tubercle and continues ventrally along the crest of the ala, becoming spinose at its extremity. In *P. remanei* this rib trifurcates at the subcentral tubercle, the median branch continues across the tubercle. The present species possesses a strong dorsal tubercle immediately posterior to the eye tubercle which overreaches the dorsal margin. This tubercle is absent in *P. remanei*. *Paracytheridea remanei* possesses a secondary ornament of fine puncta each surrounded by a rim, and very fine papillae. In the present species a more strongly developed papillate secondary ornament obscures similar puncta and papillae. *Paracytheridea tschoppi* Bold, 1946 is similar to the present species, but differs in its anterior ornament. *Paracytheridea longicaudata chilensis* Hartmann, 1962, from the Recent off Chile, is also similar, but differs in details of the hinge, less well developed caudal process and distribution of the marginal pore canals. *Paracytheridea longicaudata* (Brady) 1890, from the Recent off Fiji, is less strongly inflated posterodorsally than the present species. *P. gynaiokratina* Behrens (1991) from the Great Barrier Reef is rather smaller (0.51; 0.25), less rounded anteriorly and has a

much less prominent postero-dorsal tubercle. Males could not be consistently separated from females in the present species. It is thought that the male may be larger and its median sulcus less deep. Bate *et al.* (1981) illustrated males and females of *P. pinea* from Recent sediments in the Galapagos Islands. The females of this species were more deeply sulcate than the males. *Paracytheridea pinea* is very similar to the present species but may be distinguished by the anterior ornament. This species possesses only one median rib that extends to the anterior margin, whereas in *P. dromedaria* there are two.

Paracytheridea sp. A
(Pl. 3, Fig. 13)

Material.—2 juvenile valves, probably A-2 instars.
Dimensions.

	Length	Height
juv. LV, RT/SIR/274	0.42	0.19

Distribution.—Samples 17, 29 Guadalcanal.

Remarks.—The present species possesses a very strongly developed subcentral tubercle, ventrolateral ala and posterodorsal tubercle with a deep, median sulcus. The ornament is unusual in that strong spines that form rib-like rows cover the surface. The posterior caudal process is smooth. It is this ornament of spines that distinguishes the present species from both adults and juveniles of *P. dromedaria* and other described species of *Paracytheridea*.

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INTERNATIONAL SCHOOL ON PLANKTONIC FORAMINIFERA

6th COURSE

LATE MIOCENE TO PLEISTOCENE
PLANKTONIC FORAMINIFERA:
AN UPDATE OF TAXONOMY, BIOSTRATIGRAPHY
AND PHYLOGENETIC RELATIONSHIPS

Perugia, 19-23 February 2007

Prof. Silvia IACCARINO
University of Parma (Italy)

Prof. Isabella PREMOLI SILVA
University of Milano (Italy)

Max number of participants: 30

Registration and payment dead line: 30 November 2006

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