

TAXONOMY AND ZOOGEOGRAPHY OF THE MESOZOIC CYTHERURID OSTRACODA FROM WEST-CENTRAL ARGENTINA

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Typescript received 28 September 2007; accepted in revised form 4 June 2008

Abstract: The status of thirty four species of the cytheroidean ostracod family Cytheruridae from the Neuquén Basin, west-central Argentina is reviewed. These species belong to the following nine genera: *Eucytherura* Müller, ranging in this study from Pliensbachian to Valanginian and represented by fourteen species; *Kangarina* Coryell and Fields, Aalenian–Bajocian, with a single species; *Acrocythere* Neale, Hauterivian, one species; *Paranotacythere* Bassiouni, Berriasian, two species; *Procytherura* Whatley, Pliensbachian to Hauterivian, twelve species; *Cytheropteron* Sars, Aalenian–Bajocian, one species; *Eocytheropteron* Alexander, Hauterivian, one species; *Paradoxorhyncha* Chapman, Aalenian–Bajocian, one species; and *Paracytheridea* Müller, Berriasian, one species. Of the three subfamilies of the Cytheruridae, the Cytherurinae, with thirty species are by far the most numerous and abundant throughout the study. The other two subfamilies, the Cytheropterinae are represented by three species and the Paracytherideinae by a single

species of the nominative genus. Several of the species are very widely distributed geographically and have, for example, also been recorded from Europe; others indicate close links with South Africa and Australia. The stratigraphical ranges of certain genera have been extended as a result of this study. For example, *Kangarina* has not previously been recorded below the Cretaceous. The Cytheruridae are clearly the most diverse cytheroidean ostracodes in the Mesozoic of the Neuquén Basin and are more diverse than all other groups of ostracodes combined. Four new species, *Eucytherura tessae*, *Eucytherura yunga*, *Procytherura amygdala* and *Eocytheropteron immodicus* are described. *Eucytherura guillaumeae* nom. nov. for *Eucytherura tuberculata* Brenner and Oertli and *Eucytherura paramuda* nom. nov. for *Eucytherura nuda* (Brand) are proposed.

Key words: Ostracoda, Cytheruridae, Mesozoic, Argentina, systematics.

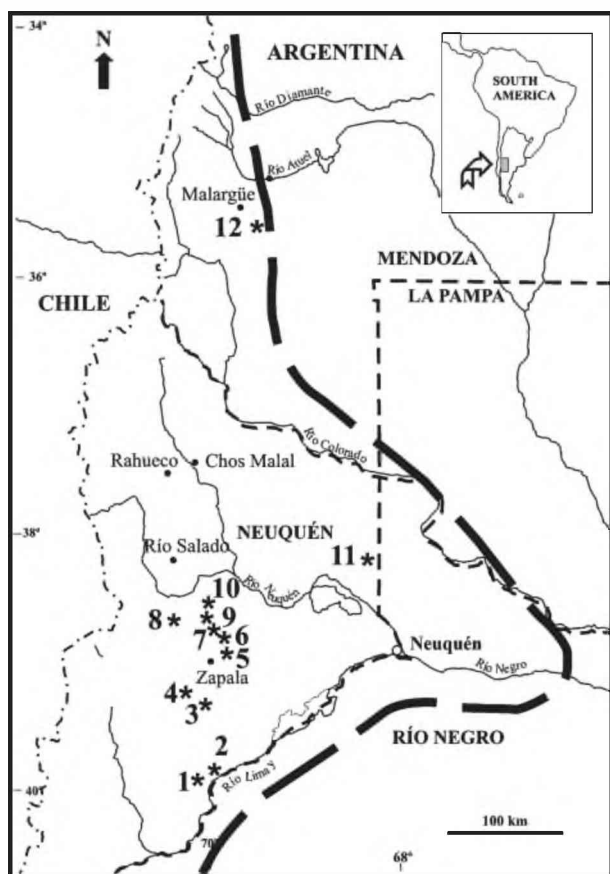
THE Family Cytheruridae Müller, 1894 is one of the most diverse extant families of cytheroidean ostracodes with a fossil record extending back to the early Mesozoic or possibly the latest Permian (Whatley and Boomer 2000). During the Cenozoic the family was almost equally diverse in shelf and deep-sea environments whereas Mesozoic cytherurids seem to have been confined to shelf depths, with many species also in marginal marine habitats. They are and were small crawling forms dwelling on and in soft relatively fine-grained substrates (silt and fine sand). Their typical carapace with flattened ventral surface may have acted to facilitate locomotion and prevent them from sinking into the sediment.

This paper constitutes the first work on cytherurids from the entire Jurassic and Lower Cretaceous of the Neuquén Basin, in west-central Argentina. It comprises a systematic review of thirty four species, including the description of four new species.

In Argentina, particularly around the Aalenian–Bajocian boundary, Cytheruridae are dominant representing almost 95 per cent of the total species (Ballent and Whatley 2000a). Their carapaces are small, delicate and preserved white opaque. They indicate essentially shallow marine conditions with clear and well oxygenated waters. Some species of the family are very widespread geographically and Boomer and Ballent (1996) and Ballent and Whatley (2000b) have demonstrated their usefulness in palaeogeographical reconstruction.

LOCATION OF THE NEUQUÉN BASIN

The Neuquén Basin is located in west-central Argentina and eastern Chile, between latitudes 34°S and 41°S. It is developed in Argentine territory in the provinces of Neuquén (from which takes its name), Mendoza, Río Negro



TEXT-FIG. 1. Base map showing Argentinian part of the Neuquén Basin outline (thick dashed line, after Legarreta and Uliana 1996) and position of sampling fossiliferous localities (*). 1: Cerrito Roth sur, 2: 8 km south of Estancia Santa Isabel, 3: Barda Cerro Marucho (Puesto Jara), 4: Cerro Birrete, 5: Northern slope of Cerro Trapial Mahuida, 6: Picún Leufú, 7: María Rosa Curicó, 8: Manzano Guacho, Sierra de la Vaca Muerta area, 9: Cerro Negro de Covun-có, 10: Bajada del Agrio, 11: Entre Lomas area, 12: Cuesta del Chihuido.

and La Pampa (Text-fig. 1). The succession exceeds 5000 m of marine and continental sedimentary rocks which range from late Triassic to Palaeocene in age. The nature of its lithology, exposure and fossil content, its microfaunas associated with well-known ammonite zones, and the eventual discovery of oil in the region are strong incentives for the further development of research and hydrocarbon exploration.

Sampling localities. Text-figure 1 shows the position of fossiliferous localities and the onshore boreholes which have been drilled in the course of hydrocarbon exploration. Greenish, greyish and brownish siltstones and grey calcareous siltstones and shales are the most common lithologies, and many of these yield microfossils.

Brief comments on the fossiliferous localities (from south to north) are as follows:

Neuquén Province

1: *Cerrito Roth sur* ($40^{\circ}08'S$, $70^{\circ}16'W$) section. It is situated directly to the south of Cerro Roth, about 500 m from it. It is a classical early Jurassic locality. The section consists of almost 100 m of grey fine-medium sandstones interbedded with limestones and shales. Bivalves, brachiopods and corals are frequent. Contemporary ammonoids indicate a late Pliensbachian age (cf. Riccardi *et al.* 1999). A detailed description of this section is given in Ballent (1987).

2: 8 km south of *Estancia Santa Isabel* ($39^{\circ}58'S$, $70^{\circ}28'W$). This locality comprises isolated outcrops of grey and yellowish brown tuffaceous siltstones. Fossil invertebrates are abundant. Contemporary ammonoids indicate a late Pliensbachian age.

3: *Barda Cerro Marucho (Puesto Jara)* ($39^{\circ}26'S$, $70^{\circ}13'W$) and 4: *Cerro Birrete* ($39^{\circ}16'S$, $70^{\circ}05'W$) sections. These are exposed about 60 km south of the town of Zapala and comprise Valanginian–Hauterivian marls and calcareous shales with intercalated coquinas. Lithological description, sampling and a detailed nannofossil biostratigraphy are given in Bown and Concheyro (2004).

5: *Northern slope of Cerro Trapial Mahuida* ($39^{\circ}00'S$, $69^{\circ}50'W$). This comprises grey and brown limestones of late Pliensbachian age.

6: *Picún Leufú* ($39^{\circ}10'S$, $69^{\circ}50'W$). This section comprises some 80 m of brown and yellowish grey siltstones with ammonoids of late Pliensbachian age, overlain by about 220 m of greenish and greyish siltstones with sporadic intercalated sandstones whose ammonoids indicate a late Aalenian to early Bajocian age (Riccardi *et al.* 1999). A detailed description and a palaeoenvironmental analysis have been made by Ballent (2004). Samples of mid Callovian and probable Berriasian age from this locality are also referred to in the present paper.

7: *María Rosa Curicó* ($38^{\circ}40'S$, $70^{\circ}00'W$). This section comprises some 40 m of greenish and brownish siltstones with sporadic intercalated sandstones. Contemporary ammonoids indicate a mid Callovian age (Riccardi *et al.* 1999). Stratigraphical profile and sampling details are described in Ballent (2004).

8: *Manzano Guacho, Sierra de la Vaca Muerta area* ($38^{\circ}40'S$, $70^{\circ}10'W$) and 9: *Cerro Negro de Covun-có* ($38^{\circ}46'S$, $69^{\circ}59'W$). These localities are situated about 20 km north of Zapala, on the flanks of the Sierra de la Vaca Muerta. The exposed succession encompasses the Callovian–Neocomian interval. The samples with ostracodes were from greenish grey limestones and intercalated sandstones, whose ammonoids indicate a Hauterivian age.

10: *Bajada del Agrio section* ($38^{\circ}25'S$, $70^{\circ}00'W$). This is located about 60 km north of Zapala. The exposed succession consists of shales, sandstones and limestones which encompasses the late Valanginian–late Hauterivian interval. A micropalaeontological study of this locality is

in progress. Samples with ostracodes are of late Hauterivian age.

11: *Entre Lomas area*. This is a petroleum exploration area located between 37°50', 38°15'S and 68°00', 68°30'W, in the eastern Neuquén Basin.

Mendoza Province

12: *Cuesta del Chihuido section (35°45'S, 69°34'W), southern Mendoza Province*. This section consists of 205 m of black mudstones, marls and micritic limestones. A biostratigraphical and palaeoenvironmental analysis was carried out by Ballent *et al.* (2006). Nannofossils association indicates a late Valanginian–Hauterivian age.

SYSTEMATIC PALAEOLOGY

The suprageneric classification adopted is that proposed by Moore and Pitrat (1961); for genera within the family, we follow the systematic review of early Cytheruridae by Whatley and Boomer (2000). In the systematic descriptions, synonymies used follow the symbols listed in Matthews (1973), and the following conventions are employed: L = length, H = height, W = width; very small (<0.400 mm), small (0.400–0.500 mm), medium (0.510–0.700 mm), large (0.710–0.900 mm), very large (>0.900 mm). Within each genus, new species are described first. Type and figured specimens are deposited in the collections of the Museo de Ciencias Naturales de La Plata, Argentina–Sección Micropaleontología (MLP-Mi) under their respective catalogue numbers.

PODOCOPIDA Müller, 1894

PODOCOPINA Sars, 1866

CYTHEROIDEA Baird, 1850

CYTHERURIDAE Müller, 1894

CYTHERURINAE Sars, 1925

Genus EUCYTHERURA Müller, 1894

Type species. *Cythere complanata* Brady, 1867 (by subsequent designation: Alexander, 1936) from the Recent sediments in the Gulf of Naples, Italy.

Diagnosis. A genus with a small carapace of subrectangular, quadrate or subtriangular lateral outline. Eye tubercle present or absent. Surface very ornate with reticulation, tubercles or ridges. For other characteristics see emended diagnosis in Ayress *et al.* (1995).

Eucytherura tessae sp. nov.

Plate 1, figures 1–4

v.1987 *Rutlandella?* sp. B Ballent, p. 109, pl. 6, figs 2, 3.

v.1991 *Rutlandella?* sp. B Ballent, p. 40, pl. 3, figs 5a, b.

Repository. MLP-Mi 581, 582, 583, 1593, 1594, 1595, 1596.

Studied material. Ten carapaces.

Derivation of name. (Latin) Named in honour of Tessa Briggs neé Evershed, a great friend of the second author, in recognition of all her help and her exceptional editorial skills.

Type specimens. Holotype MLP-Mi 582, male carapace illustrated in Plate 1, figure 1, from Cerrito Roth sur section, level 101b, Neuquén Basin, west-central Argentina.

Paratypes. MLP-Mi 581, female carapace; MLP-Mi 1593, female carapace; MLP-Mi 1594, juvenile carapace; MLP-Mi 1595, female carapace; MLP-Mi 1596, juvenile carapace; all from Cerrito Roth sur section, Neuquén Basin, west-central Argentina.

Type locality and type level. Cerrito Roth sur section (40°08'S, 70°16'W), Neuquén Basin, west-central Argentina, level 101b, late Pliensbachian.

Diagnosis. A very small, elegant, subrectangular species of *Eucytherura*, acuminate posteriorly at mid-height and with three longitudinal ribs. Dorsal and median ribs convex upwards, ventral rib shorter and concave; intercostal areas smooth. Normal pores with circular conuli, ranging in size from very small to large and bulbous.

Description. Carapace very small, but rather robust. Subrectangular in lateral view, acuminate posteriorly with dorsal and ventral margins slightly convergent posteriorly. Anterior margin obliquely rounded with apex below mid-height. Posterior margin angular with a short, posteriorly pointing caudal process at mid-height. Distinct rounded eye tubercle, with short ocular rib extending towards mid anterior margin. Valves subequal. Greatest length at mid-height; greatest height at anterior third of valve length. In dorsal view the carapace is ovate with greatest width at mid-length. Lateral surface with three longitudinal ribs. The dorsal rib is convex upwards and extends along the homonymous margin from the posterior margin to the mid-anterior area, close to the edge of the dorsal margin and, in both valves, dorsal to the eye tubercle. Median rib also convex, slightly sinuous and extending from the posterior apex to the anterior margin at mid-height. Ventral rib concave, shorter than the others and extends from the postero-ventral margin to the mid antero-ventral area. Intercostal areas smooth. Normal pores with circular conuli, ranging in size from very small to large and bulbous. Internal features not seen.

Dimensions (mm). Figured specimens:

MLP-Mi 582, Holotype, L = 0.370, H = 0.190, W = 0.150 (Pl.1, fig.1), MLP-Mi 1593, Paratype, L = 0.370, H = 0.170, W = 0.150 (Pl.1, fig.2), MLP-Mi 581, Paratype, L = 0.350, H = 0.180, W = 0.150 (Pl.1, fig.3), MLP-Mi 1594, Paratype, L = 0.345, H = 0.160, W = 0.140 (Pl.1, fig.4).

Age and distribution. Late Pliensbachian, Cerrito Roth sur and 8 km south of Estancia Santa Isabel sections; this new species is

also possibly represented by juvenile and fragmentary carapaces in the late Aalenian-early Bajocian (Picún Leufú section), Neuquén Basin, west-central Argentina.

Remarks. The lateral outline of the carapace and the pattern of the longitudinal ribs of this elegant species are somewhat similar to those of *Eucytherura fissicostata* (Herrig, 1969, p. 1088, text-fig. 11; pl. III, figs 5–6) from the Upper Pliensbachian of Germany; however, the new species lacks the rhomboid figure at the posterior end of the median rib which characterizes the German species. This new species also resembles *Eucytherura yunga* sp. nov. of this study from the late Aalenian-early Bajocian of the Picún Leufú section (see below), but is distinguishable by its somewhat more robust carapace, different rib features and the possession of a caudal process at mid-height. *Eucytherura tessae* is a little similar to *Eucytherura* sp. A of Boomer and Ballent (1996, pl. I, fig. 6) from the Sinemurian and Pliensbachian of the Mochras Borehole (Wales).

Eucytherura yunga sp. nov.

Plate 1, figures 5–9

v.1991 Ostrácodo A Ballent, p. 44, pl. 4, figs 6, 7, 8.

Repository. MLP-Mi 690, 694, 695, 696, 1597, 1598, 1599.

Studied material. Five carapaces, five left valves, two right valves.

Derivation of name. From the aboriginal Mapuche word *yung* meaning sharp. With reference to the sharp ribs on the lateral surface that characterizes this species.

Type specimens. Holotype MLP-Mi 694, male left valve, illustrated in Plate 1, figures 5–6, from Picún Leufú section, level 1685, Neuquén Basin, west-central Argentina.

Paratypes. MLP-Mi 690, female left valve; MLP-Mi 695, juvenile right valve; MLP-Mi 696, juvenile right valve; MLP-Mi 1597, juvenile left valve; MLP-Mi 1598, juvenile left valve; MLP-Mi 1599, female left valve; all from Picún Leufú section, Neuquén Basin, west-central Argentina.

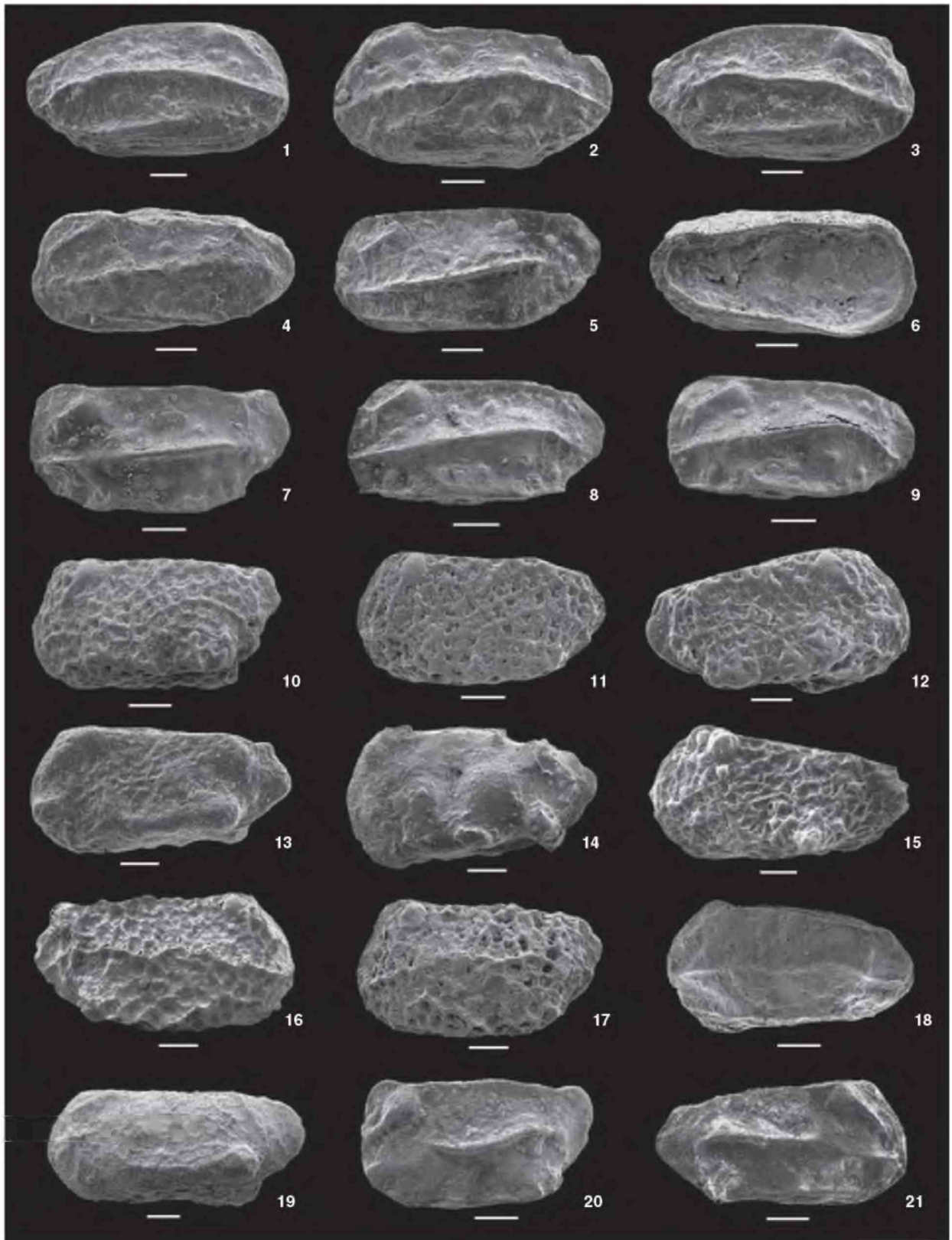
Type locality and type level. Picún Leufú section (39°10'S-69°50'W), Neuquén Basin, west-central Argentina, level 1685, late Aalenian-early Bajocian.

Diagnosis. Very small, subrectangular species of *Eucytherura*, acuminate posteriorly with subdorsal caudal process, prominent round eye tubercle and three sharp longitudinal ribs on the lateral surface. Intercostal areas smooth medianly but with rather weak, open reticulation anteriorly.

EXPLANATION OF PLATE 1

- Figs 1–4. *Eucytherura tessae* sp. nov. 1, MLP-Mi 582, holotype, male carapace, right lateral view. 2, 3, 4, paratypes. 2, MLP-Mi 1593, female carapace, left lateral view. 3, MLP-Mi 581, female carapace, right lateral view. 4, MLP-Mi 1594, juvenile carapace, left lateral view, late Pliensbachian, Cerrito Roth sur section, level 101b.
- Figs 5–9. *Eucytherura yunga* sp. nov. 5, 6, MLP-Mi 694, holotype, male left valve. 5, external lateral view, and 6, internal lateral view, Picún Leufú section, level 1685. 7, 8, 9, paratypes. 7, MLP-Mi 690, female left valve. 8, MLP-Mi 1597, juvenile left valve. 9, MLP-Mi 1598, juvenile left valve, all external lateral views, late Aalenian-early Bajocian, Picún Leufú section, level 1676.
- Figs 10–11. *Eucytherura argentina* Ballent, 1991. 10, MLP-Mi 654, carapace, left lateral view. 11, MLP-Mi 1600, left valve, external lateral view, late Aalenian-early Bajocian, Picún Leufú section, levels 1681 and 1684, respectively.
- Figs 12–13. *Eucytherura gassumensis* (Michelsen, 1975). 12, MLP-Mi 691, juvenile carapace, right lateral view, late Aalenian-early Bajocian, Picún Leufú section, level 1683. 13, MLP-Mi 1602, carapace, left lateral view, late Pliensbachian, Cerrito Roth sur section, level 101b.
- Fig. 14. *Eucytherura isabelensis* Ballent, 1987, MLP-Mi 576/1, carapace, left lateral view, late Pliensbachian, locality 8 km south of Estancia Santa Isabel.
- Fig. 15. *Eucytherura leufuensis* Musacchio, 1979b, MLP-Mi 727, carapace, left lateral view, mid-late Callovian, Picún Leufú section, level 2.
- Figs 16–17. *Eucytherura michelseni* (Finger, 1983). 16, MLP-Mi 666, female right valve, external lateral view. 17, MLP-Mi 665, female, left valve, external lateral view, late Aalenian-early Bajocian, Picún Leufú section, level 1680.
- Fig. 18. *Eucytherura paranuda* nom. nov., MLP-Mi 1073, carapace, left lateral view, mid Callovian, Maria Rosa Curicó section, level 1159.
- Fig. 19. *Eucytherura oeresundensis* (Michelsen, 1975), MLP-Mi 1603, carapace, left lateral view, late Pliensbachian, Cerrito Roth sur section, level 101b.
- Figs 20–21. *Eucytherura pichia* (Ballent, 1991). 20, MLP-Mi 645/1, female left valve, external lateral view. 21, MLP-Mi 645/8, male carapace, right lateral view, late Aalenian-early Bajocian, Picún Leufú section, levels 1153 and 1686, respectively.

All scale bars represent 0.050 mm.



BALLENT and WHATLEY, Mesozoic ostracods

orly and posteriorly. Normal pore canals either emerging with a smooth lip or as bulbous pore conuli.

Description. Carapace very small, subrectangular, acuminate posteriorly in lateral view. Strongly dimorphic. Males more subrectangular and more elongate in lateral view. Anterior margin bluntly rounded; posterior margin compressed, obliquely truncated below and with asymmetrical caudal process in the upper half of the valve. Dorsal margin straight with distinct cardinal angles. Ventral margin, slightly concave medianly and well developed postero-ventral keel. Females, less subrectangular in lateral view, shorter than males. Anterior margin squarely truncated, posterior margin with a blunt subdorsal caudal process. Dorsal margin straight to slightly sinuous medianly; ventral margin convex and obliquely compressed posteroventrally. In both sexes, left valve larger than right. The greatest length is above mid-height, coincident with the extremity of caudal process. Greatest height at mid-length. In dorsal view the carapace is subovate with the greatest width at mid-length. The lateral surface with three sharp longitudinal ribs. The dorsal rib extends in a gentle arc directly adjacent to the dorsal margin, passing above the eye tubercle. The median rib extends posteriorly from the mid-anterior area, but terminates short of the caudal process and being concave in its anterior and convex in its posterior halves. The ventral rib is convex and extends along the homonymous margin. In males this rib forms a postero-ventral keel. Prominent round eye tubercle with a short oblique ocular rib that bifurcates anteriorly. Intercostal areas smooth centrally but with a weak, open reticulum towards anterior and posterior margins. Normal pore canals either emergent as large open normal pores, surrounded by a lip or as rather bulbous pore conuli. Internal characters as for genus with small vestibula at either free margin.

Dimensions (mm). Figured specimens:

MLP-Mi 694, Holotype, L = 0.340, H = 0.160 (Pl.1, figs 5–6), MLP-Mi 690, Paratype, L = 0.300, H = 0.165 (Pl.1, fig. 7), MLP-Mi 1597, Paratype, L = 0.280, H = 0.130 (Pl.1, fig. 8), MLP-Mi 1598, Paratype, L = 0.280, H = 0.140 (Pl.1, fig. 9).

Age and distribution. Late Aalenian–early Bajocian, Picùn Leufú section, Neuquén Basin, west-central Argentina.

Remarks. *Eucytherura yunga* in lateral outline and pattern of ornamentation resembles *Movschovitschia schulzi* (Kozur) (*in* Gründel 1980, fig. 4). This Triassic genus, however, is regarded as a junior synonym of *Eucytherura* by Whatley and Boomer (2000). The new species is similar to *Eucytherura tessae* described in the present study, but differs in the possession of a subdorsal caudal process, sharper ribs and a well developed postero-ventral keel in males. *Eucytherura pichia* (Ballent) from the same levels, is also similar, but is more delicate, subquadrate (females) and subrectangular (males) in lateral outline and with the median rib interrupted (or weakened) at subcentral tubercle region.

Eucytherura argentina Ballent, 1991

Plate 1, figures 10–11

v*1991 *Eucytherura argentina* Ballent, p. 34, pl. 2, only fig. 1.

Repository. MLP-Mi 654, 1600.

Studied material. Five carapaces, one left valve.

Complementary description. A very small, delicate species, subquadrate to subrectangular in lateral view. Dorsal and ventral margins nearly straight, almost parallel; anterior margin bluntly rounded to truncate and posterior margin compressed with a short caudal process in the upper half of the valve pointing posteriorly. Ornament fairly coarsely reticulate in two generations. Primary reticulae generally subquadrate, radiating from the subcentral tubercle area and showing some cellation, coarsest dorsally and ventrolaterally on sub-alar protuberance. Some intermural nodes developed. Secondary reticulation more subrounded. Prominent eye-tubercle below anterior cardinal angle, having a short ocular rib extending antero-ventrally. An ill-defined, blunt antero-ventral rib enhances junction between the lateral and ventral surfaces. Hinge lophodont. Narrow vestibula occur at the end margins.

Dimensions (mm). Figured specimens: MLP-Mi 654, carapace, L = 0.300, H = 0.150, W = 0.180 (Pl.1, fig. 10); MLP-Mi 1600, left valve, L = 0.290, H = 0.150 (Pl.1, fig.11).

Age and distribution. Late Aalenian–early Bajocian, Picùn Leufú section, Neuquén Basin, west-central Argentina.

Remarks. *Eucytherura batei* (Ainsworth, 1986) from the late Toarcian–Aalenian offshore south-west Ireland is a similar species, but can be distinguished by its subrectangular outline in lateral view and in details of the reticulate ornamentation. The specimen MLP-Mi 666, assigned to *Eucytherura argentina* (see Ballent 1991, pl. 2, figs 2, 3), now is accommodated in *E. michelseni* (Finger, 1983) (see below) due to the presence of a distinct irregular median rib.

Eucytherura gassumensis (Michelsen, 1975)

Plate 1, figures 12–13

*1975 *Acrocythere gassumensis* Michelsen, p. 153, pl. 7, figs 97–100; pl. 8, figs 117–119.

v.1991 *Acrocythere* sp.; Ballent, p. 43, pl. 4, figs 1–2.

Repository. MLP-Mi 691, 692, 1601, 1602.

Studied material. Four carapaces.

Dimensions (mm). Figured specimens: MLP-Mi 691, juvenile carapace, L = 0.325, H = 0.170, W = 0.140, Pl. 1, fig. 12); MLP-Mi 1602, carapace, L = 0.370, H = 0.180 (Pl. 1, fig. 13).

Age and distribution. Late Sinemurian–early Pliensbachian, Danish Embayment (Michelsen 1975) and Skåne, Sweden (Sivhed 1980); early Sinemurian, offshore southwest Ireland (Ainsworth 1989); late Pliensbachian, Cerrito Roth sur section and late Aalenian–early Bajocian, Picùn Leufú section, Neuquén Basin, west-central Argentina.

Brief description. This is a very small species, subrectangular in lateral view, with the greatest height at the anterior cardinal angle. It is characterized by a very strong, broad ventro-lateral rib with terminal elevations and two distinct sub-alar protuberances postero-ventrolaterally. The entire surface is rough and irregular, comprising many structural elements, including a coarse and imperfect reticulation.

Eucytherura isabelensis Ballent, 1987

Plate 1, figure 14

v*1987 *Eucytherura? isabelensis* Ballent, p. 105, pl. 6, figs 4–8.

Repository. MLP-Mi 576/1-576/11, 722.

Studied material. Eleven carapaces.

Dimensions (mm). Figured specimen: MLP-Mi 576/1, female carapace, L = 0.320, H = 0.175, W = 0.170 (Pl. 1, fig. 14).

Age and distribution: Late Pliensbachian, locality 8 km south of Estancia Santa Isabel, Neuquén Basin, west-central Argentina.

Brief description. Very small with subquadrate carapace, strongly dimorphic, with a moderately depressed subcentral-anterior area. Surface of tubercles and a secondary ornament of delicate reticular and occasional small papillae. Generally there are five large tubercles: one, on the eye tubercle; another postero-dorsal and three rather smaller tubercles along the ventro-lateral margin.

Remarks. These above mentioned characteristics distinguish *E. isabelensis* from all other Jurassic species of the genus. Arias (2006, p. 20) considered that some of the specimens of this species illustrated by Ballent (1987, pl. 5, figs 4–8) could possibly be reassigned to *Trachycythere tubulosa* (Triebel and Klingler, 1959), which is considered to be indicative of the Upper Pliensbachian–Toarcian of Central Europe. The very small size of the carapace and its external features suggest that this species is clearly accommodated within *Eucytherura*.

Eucytherura leufuensis Musacchio, 1979b

Plate 1, figure 15

v*1979b *Eucytherura? leufuensis* Musacchio, p. 502, pl. 2, figs 8–12.

v. 2004 *Eucytherura leufuensis* Musacchio; Ballent, fig. 6.O.

Repository. MLP-Mi 727.

Studied material. Five carapaces.

Dimensions (mm). Figured specimen: MLP-Mi 727, carapace, L = 0.360, H = 0.190, W = 0.180 (Pl. 1, fig. 15).

Age and distribution. Mid–late Callovian, Picùn Leufú section, Neuquén Basin, west-central Argentina.

Brief description. Very small, elongate subtriangular to subrectangular in lateral view, with distinct ocular, postero-dorsal and postero-ventral nodes; entire surface ornamented with a subpolygonal reticulum.

Eucytherura michelseni (Finger, 1983)

Plate 1, figures 16–17

1975 *Acrocythere tricostata* Michelsen, p. 158, pl. 9, figs 131–142; pl. 11, figs 157–158; text-fig. 26 (pre-occupied binomius).

*1983 *Acrocythere michelseni* Finger, p. 110. (nom. nov. for *A. tricostata*)

v.1991 *Eucytherura argentina* Ballent, p. 34, pl. 2, figs 2–3.

Repository. MLP-Mi 665, 666, 667.

Studied material. Four carapaces, four valves.

Dimensions (mm). Figured specimens: MLP-Mi 666, female right valve, L = 0.345, H = 0.175 (Pl. 1, fig. 16); MLP-Mi 665, female, left valve, L = 0.330, H = 0.175 (Pl. 1, fig. 17).

Age and distribution. Late Pliensbachian, Danish Embayment (Michelsen 1975); also, Pliensbachian, southern Sweden (Sivhed 1980) and southwest Germany (Harloff 1993); late Aalenian–early Bajocian, Picùn Leufú section, Neuquén Basin, west-central Argentina. It is possible that this species occurs (as *Renicytherura* sp. A and sp. B) in the lower Jurassic/Aalenian of Australia (Lord *et al.* 1993) but further study is required to determine this.

Brief description. This is a very small species, subquadrate to subrectangular in lateral view, with distinct eye tubercle and the posteroventral part of the lateral surface inflated with a weak alate extension. It is ornamented with three distinct longitudinal ribs and the intercostal areas have a polygonal pattern of low ribs. Hinge antimerodont which, in the right valve, consists of small but prominent ovate anterior and posterior teeth with a very narrow and delicately locellate median groove.

Remarks. The specimen MLP-Mi 666 (see Ballent 1991, pl. 2, figs 2, 3) there assigned to *E. argentina*, is herein accommodated in *E. michelseni*, because of its delicate dorsal and ventral ribs and distinct irregular median

ridge. *Eucytherura oxfordiana* Rosenfeld and Honigstein (in Rosenfeld *et al.* 1987, p. 239), a minute species from the Oxfordian of the Golan Heights, Israel, could be conspecific with the present species.

Eucytherura paranuda nom. nov. for *Eucytherura nuda*
(Brand, 1990)

Plate 1, figure 18

*1990 *Tethysia nuda* Brand, p.169, pl. 5, figs 3–7.

v.2004 *Eucytherura* sp. Ballent, fig. 6.M.

Repository. MLP-Mi 1073.

Studied material. One carapace.

Derivation of name. With reference to its similarity to *Eucytherura nuda* (Brand).

Dimensions (mm). Figured specimen: MLP-Mi 1073, carapace, L = 0.290, H = 0.160, W = 0.120 (Pl. 1, fig. 18).

Age and distribution. Late Bathonian, northwest Germany (Brand 1990); mid Callovian, María Rosa Curicó section, Neuquén Basin, west-central Argentina.

Brief description. Species with very small and delicate carapace, subrectangular, slightly acuminate posteriorly with a blunt caudal process at mid-height and ornamented with three distinct but rather fine longitudinal ribs. Distinct eye tubercle with a short oblique ocular rib produced anteriorly. Lateral surface smooth, except for primary polygonal reticulation and second-order punctae anteroventrally and on the caudal process area.

Remarks. Brand (1990) included this species in *Tethysia* Donze, but we have no doubts in including it within *Eucytherura*. *Eucytherura nuda* (Brand) is a junior secondary homonym of *Eucytherura nuda* Kaye, 1964 (p. 99, pl. IV, figs 13–15) from the Lower Barremian at Speeton (UK) and should be renamed. It is proposed herein that the new name *Eucytherura paranuda* replace the preoccupied binomius *Eucytherura nuda* (Brand).

Eucytherura oeresundensis (Michelsen, 1975)

Plate 1, figure 19

*1975 *Acrocythere oeresundensis* Michelsen, p. 155, pl. 7, figs 101–104; pl. 8, figs 120–124.

Repository. MLP-Mi 1603.

Studied material. Three carapaces.

Dimensions (mm). Figured specimen: MLP-Mi 1603, carapace, L = 0.400, H = 0.170, W = 0.180 (Pl. 1, fig. 19).

Age and distribution. Late Sinemurian–early Pliensbachian, Danish Embayment (Michelsen 1975), late Sinemurian–early Toarcian, southwest Germany (Herrig 1981; Harloff 1993); late Pliensbachian, Cerrito Roth sur section, Neuquén Basin, west-central Argentina.

Brief description. Small, elongate subrectangular and subulate in lateral view, with a ‘wrinkled’ carapace surface brought about by an irregular, rather weak reticulation and with a strong longitudinal rib ventrolaterally terminating in an alar boss and a short rib below posterior cardinal angle.

Remarks. The small size and external features suggest that this species is better accommodated within *Eucytherura*.

Eucytherura pichia (Ballent, 1991)

Plate 1, figures 20–21

v*1991 *Acrocythere pichia* Ballent, p. 41, pl. 3, figs 7–11.

v.2000a *Eucytherura pichia* (Ballent); Ballent and Whatley, fig. 15.5.

Repository. MLP-Mi 645/1–645/8.

Studied material. Four carapaces, twenty valves.

Dimensions (in mm). Figured specimens: MLP-Mi 645/1, female left valve, L = 0.265, H = 0.145 (Pl. 1, fig. 20); MLP-Mi 645/8, male carapace, L = 0.310, H = 0.150, W = 0.150 (Pl. 1, fig. 21).

Age and distribution. Late Aalenian–early Bajocian, Picún Leufú section, Neuquén Basin, west-central Argentina.

Brief description. A very small, strongly dimorphic species with subquadrate (females) to subrectangular (males) carapace in lateral view. Characteristic features are the very distinct longitudinal ventro-lateral, median and dorsal ribs. The median rib is interrupted (or subdued) in the subcentral tubercle region and a prominent eye tubercle with a short, oblique ocular rib produced anteriorly. Intercostal regions smooth or weakly punctate.

Remarks. *Eucytherura* sp. A of Boomer and Ballent (1996, pl. I, only fig. 4) from the Sinemurian and Pliensbachian of the Mochras Borehole (Wales) is possibly conspecific with the Argentinian species.

Eucytherura transversiplicata (Bate and Coleman, 1975)

Plate 2, figures 1–2

*1975 *Rutlandella transversiplicata* Bate and Coleman, p. 34, pl. 13.7, 13.10, 13.12; figs 14a, b, 15, 16.

- v.1987 *Rutlandella?* sp. A Ballent, p. 108, pl. 5, fig. 11; pl. 6, fig. 1.
 v.1991 *Rutlandella* cf. *transversiplicata* Bate and Coleman; Ballent, p. 38, pl.2, figs 1, 2.
 v.1991 *Rutlandella* sp. A Ballent, p. 39, pl. 3, figs 3, 4.
 v. 1996b *Eucytherura transversiplicata* (Bate and Coleman); Ballent and Whatley, p. 148, pl. 1, fig. 15.

Repository. MLP-Mi 579, 580, 586, 622, 656, 687.

Studied material. Twelve carapaces, three valves.

Dimensions (mm). Figured specimens: MLP-Mi 579, female carapace, L = 0.330, H = 0.155, W = 0.150 (Pl. 2; fig. 1); MLP-Mi 687, female carapace, L = 0.370, H = 0.175, W = 0.170 (Pl. 2, fig. 2).

Age and distribution. Lower and Middle Toarcian of Leicestershire and Cambridgeshire (Bate and Coleman 1975). Also, Toarcian and Aalenian, west-central Europe (see Ainsworth 1986); Pliensbachian from D.S.D.P. (Deep Sea Drilling Project) Site 547 off North Africa (Bate *et al.* 1984); Bajocian, Sinai, Egypt (Rosenfeld *et al.* 1987); late Pliensbachian, Picún Leufú and Cerrito Roth sur, sections and late Aalenian-early Bajocian, Picún Leufú section, Neuquén Basin, west-central Argentina.

Brief description. Very small, dimorphic, subrectangular to subtriangular in lateral outline, tapering posteriorly, with prominent eye tubercle. Valve surface coarsely reticulate and with three ribs; the dorsal rib is largely eroded by the reticulation resulting in an irregular dorsal margin; the median rib is very strong and traverses the valve obliquely from a complex postero-dorsal loop to the anterior margin at about mid-height; the ventro-lateral rib is complex being subulate postero-ventrally, with an overlap at mid-length and as inverted chevron in its anterior third. The eye tubercle is hemispherical, very prominent and bearing an ocular rib that extends vertically downwards to the median rib. Argentinian specimens possess a polygonal (mainly pentagonal) reticulum; second-order reticulation occurs in the solum of primary reticula, but is best developed towards the central area of the valve.

Remarks. Whatley and Boomer (2000, p. 140) consider *Rutlandella* as one of the many junior synonyms of *Eucytherura*. Arias and Lord (1999) considered *E. transversiplicata* as a junior synonym of *E. michelseni* (Finger). However, while the two species are similar, the latter possess three distinct longitudinal ribs and is subquadrate in lateral outline (the dorsal and ventral margins only converge slightly posteriorly) rather than subrectangular as in *E. transversiplicata*. Arias (2006, table 3b) considered *Rutlandella?* sp. A of Ballent, 1987 as a junior synonym of *E. oeresundensis* (Michelsen, 1975), from the Lower Pliensbachian of Denmark. We dispute this as the two species differ considerably in the nature of their costae.

Eucytherura guillaumeae nom. nov. for *Eucytherura tuberculata* Brenner and Oertli, 1976
 Plate 2, figure 3

- *1976 *Eucytherura* (*Vesticytherura*) *tuberculata* Brenner and Oertli, p. 511, pl. 7, figs 11–14; pl. 8, fig. 10.

Repository. MLP-Mi 1604.

Studied material. Three carapaces.

Derivation of name. In honour of the late Dr. Marie-Claude Guillaume, in recognition of her important studies on the genus *Leptocythere*.

Dimensions (mm). Figured specimen: MLP-Mi 1604, carapace, L = 0.250, H = 0.125, W = 0.120 (Pl. 2, fig. 3).

Age and distribution. Late Valanginian–late Hauterivian, Algoa Basin, South Africa (Brenner and Oertli 1976; Valicenti and Stephens 1984); late Valanginian, Barda Cerro Marucho (Puesto Jara) section, Neuquén Basin, west-central Argentina.

Brief description. A very small species with a tapering subrectangular outline. Ornament essentially of tubercles, and a network of first and second-order reticula. Smooth semiglobular eye tubercle, situated just behind the anterior cardinal angle. The dorsal margin is overreached by two tubercles: the most anterior is in the lowest third of the valve and the most posterior lies close to the postero-ventral border, directly beneath the postero-dorsal cardinal angle. The ventro-lateral ridge is substituted by five tubercles.

Remarks. *Eucytherura tuberculata* Brenner and Oertli, 1976 is a junior primary homonym of *Eucytherura tuberculata* Bonnema, 1941 (p. 21, pl.5, figs 52–57, in Howe and Laurencich 1958, p. 341) from the subsurface Senonian of the northeastern Netherlands. Since the two species are distinct in the arrangement and shape of the tubercles, a replacement name is required for Brenner and Oertli species. It is proposed herein that the new name *Eucytherura guillaumeae* replace the preoccupied binomial *Eucytherura tuberculata* Brenner and Oertli, 1976.

Eucytherura sp. B Boomer and Ballent, 1996
 Plate 2, figure 4

- v.1991 *Hemiparacytheridea* sp.; Ballent, p. 335, pl. 2, fig. 4.
 v.1996 *Eucytherura* sp. B; Boomer and Ballent, pl. I, fig. 14.

Repository. MLP-Mi 655.

Studied material. One right valve.

Dimensions (mm). Figured specimen: MLP-Mi 655, right valve, L = 0.330, H = 0.160 (Pl. 2, fig. 4).

Age and distribution. Late Pliensbachian–early Toarcian, British Isles (Mochras Borehole, Boomer and Ballent 1996); late Aalenian–early Bajocian, Picún Leufú section, Neuquén Basin, west-central Argentina.

Brief description. Very small, subrectangular to subtriangular, with notably cribose intercostal ornament and with very strong subdorsal caudal process and further distinguished by strong ocular, postero-dorsal and postero-ventral nodes. The latter forming the termination of a ventrolaterally alar inflated rib.

Remarks. The specimen figured by Ballent (1991, pl. 2, fig. 4) and by Boomer and Ballent (1996, pl. I, fig. 14) are certainly conspecific and they have been referred to Group 9, which is recorded in the British Isles and Argentina (Boomer and Ballent 1996).

Eucytherura sp.

Plate 2, figure 5

v.1991 *Rutlandella* sp. C Ballent, p. 41, pl. 3, fig. 6.

Repository. MLP-Mi 688.

Studied material. One carapace.

Dimensions (mm). Figured specimen: MLP-Mi 688, L = 0.370, H = 0.175, W = 0.160 (Pl. 2, fig. 5).

Age and distribution. Late Aalenian–early Bajocian, Picún Leufú section, Neuquén Basin, west-central Argentina.

Remarks. In this species, the intercostal areas are coarsely punctate, which separates it from *Eucytherura transversiplicata* (Bate and Coleman) in which the intercostal areas are coarsely reticulate.

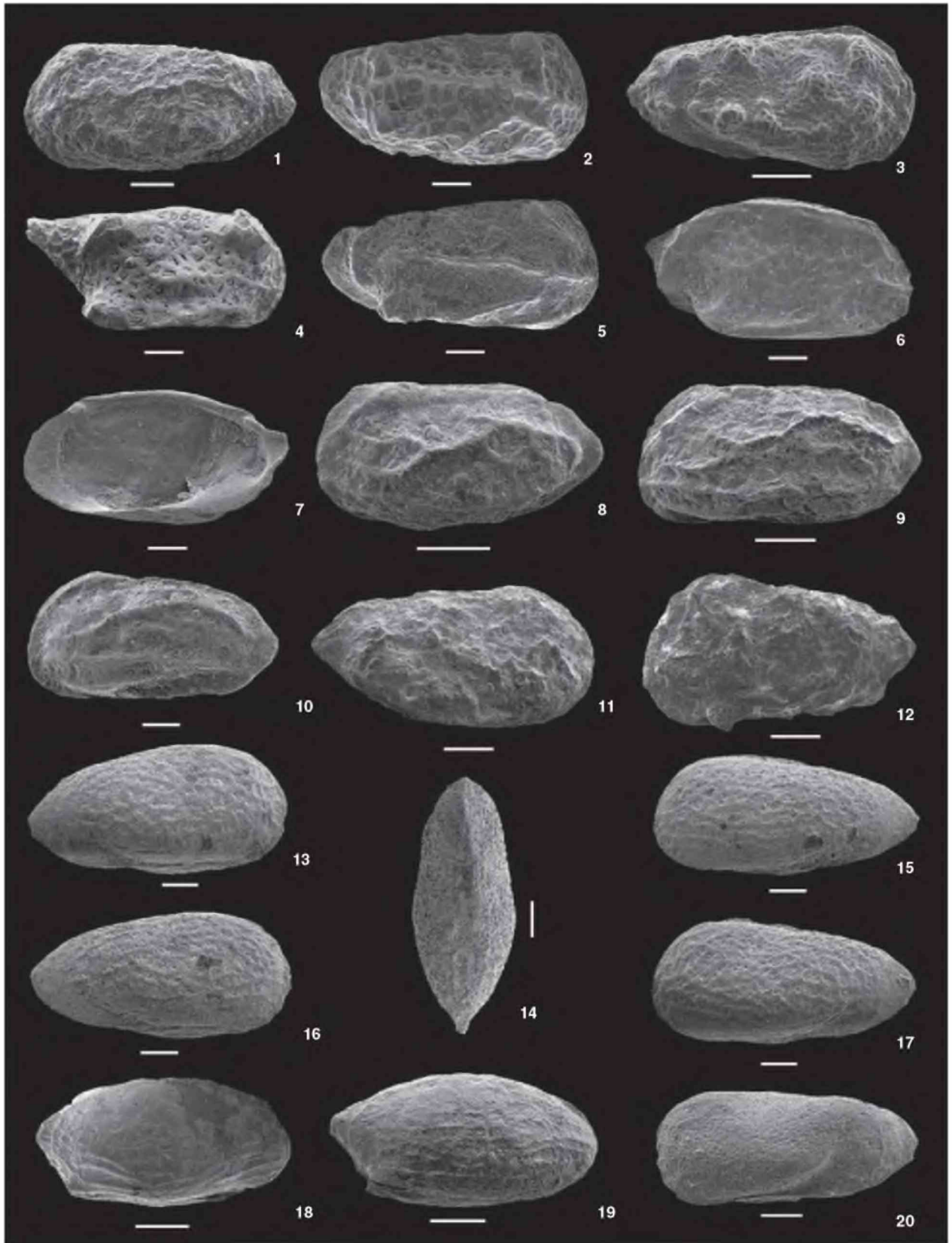
Genus KANGARINA Coryell and Fields, 1937

Type species. *Kangarina quellita* Coryell and Fields, 1937 from the Miocene of Panama.

Diagnosis. A very small to small, strongly, thick-shelled, ornate cytherurid genus with strong ribs, deep intercostal reticulae, a rather narrow and often marginally denticulate anterior margin, pronounced caudal process above

EXPLANATION OF PLATE 2

- Figs 1–2. *Eucytherura transversiplicata* (Bate and Coleman, 1975). 1, MLP-Mi 579, female carapace, left lateral view, late Pliensbachian, Picún Leufú, level 1145. 2, MLP-Mi 687, female carapace, right lateral view, late Aalenian–early Bajocian, Picún Leufú section, level 1676.
- Fig. 3. *Eucytherura guillaumeae* nom. nov., 1976, MLP-Mi 1604, carapace, right lateral view, late Valanginian, Barda Cerro Marucho (Puesto Jara) section, level MARJ11, Bco 15.
- Fig. 4. *Eucytherura* sp. B Boomer and Ballent, 1996, MLP-Mi 655, right valve, external view, late Aalenian–early Bajocian, Picún Leufú section, level 1681.
- Fig. 5. *Eucytherura* sp., MLP-Mi 688, carapace, right lateral view, late Aalenian–early Bajocian, Picún Leufú section, level 1676.
- Figs 6–7. *Kangarina* sp., MLP-Mi 1605, right valve. 6, external view. 7, internal view, late Aalenian–early Bajocian, Picún Leufú section, level 1676.
- Figs 8–10. *Acrocythere* sp. 8, MLP-Mi 1606, male carapace, left lateral view. 9, MLP-Mi 1607, male carapace, left lateral view. 10, MLP-Mi 1608, juvenile carapace, left lateral view, late Hauterivian, Bajada del Agrio section, level AG 18a.
- Fig. 11. *Paranotacythere* sp., MLP-Mi 1609, carapace, right lateral view, late Tithonian, Entre Lomas area (YPF.PC.Nq.EL-10, 1870 m below surface).
- Fig. 12. *Paranotacythere?* sp., MLP-Mi 1610, carapace, left lateral view, Berriasian?, Entre Lomas area (YPF.PC.Nq.EC-24, 1930–1940 m below surface).
- Figs 13–17. *Procytherura amygdala* sp. nov. 13, MLP-Mi 1434, holotype, carapace, right lateral view. 14, 15, 16, 17, paratypes. 14, MLP-Mi 1437, carapace, dorsal view. 15, MLP-Mi 1435, carapace, left lateral view. 16, MLP-Mi 1436, carapace, right lateral view. 17, MLP-Mi 1439, carapace, left lateral view, late Valanginian, Cuesta del Chihuido section, level CH6.
- Figs 18–19. *Procytherura bispinata* Ballent, 1991. 18, MLP-Mi 1611, carapace, right lateral view. 19, MLP-Mi 678/2, carapace, right lateral view, late Aalenian–early Bajocian, Picún Leufú section, levels 1675 and 1676, respectively.
- Fig. 20. *Procytherura bremeri* Valicenti and Stephens, 1984, MLP-Mi 1612, carapace, left lateral view, late Valanginian, Barda Cerro Marucho (Puesto Jara) section, level MARJ11, Bco 15.
- Scale bars represent 0.050 mm in figs 1, 2, 3, 4, 5, 6, 7, 10, 13, 14, 15, 16, 17, 18, 19, 20 and 0.100 mm in figs 8, 9, 11, 12.



BALLENT and WHATLEY, Mesozoic ostracods

mid-height, and particularly strong dorsal and ventro-lateral ribs, the latter being alate. Eye tubercle prominent; hinge antimerodont.

The genus is worldwide in both deep and shallow marine environments and usually ranges from the mid Cretaceous to the Recent.

Kangarina sp.

Plate 2, figures 6–7

Repository. MLP-Mi 1605.

Studied material. A single right valve.

Description. Very small, thick-shelled, subrhomboidal. Dorsal margin very slightly convex and partly obscured posteriorly by dorsal rib; anterior cardinal angle more strongly marked than posterior. Ventral margin with slight median incurvature but overhung in lateral view by strong ventro-lateral alar rib. Anterior margin only rounded medianly and with straight antero-dorsal and antero-ventral slopes; medianly denticulate and with extremity near mid-height. Posterior margin with a compressed, slightly upturned caudal process in the upper half of the valve. Eye tubercle and internal ocular sinus present but not strongly developed. Valve surface costate and coarsely reticulate, especially centrally. A dorsal rib bearing a number of excavations and isolated pits, parallels the dorsal and posterior margins. A strong alar rib extends across the ventro-lateral surface. At 1/3 length of the valve, it bifurcates with a short ramus continuing along the ventro-lateral surface and another, broader and somewhat interrupted by coarse, deep puncta bearing large solate normal pores, extends to an antero-median complex and then extends to the anterior margin at mid-height and is responsible for the marginal denticulation. Another, weaker rib also extends from the alar process, obliquely anteriorly at 45° to an elevated complex of strongly reticulate anastomosing ribs that extend horizontally forwards to the previously-mentioned antero-median complex. Smaller ribs extend down towards this complex from the area of the eye tubercle. All intercostal areas and many of the ribs are coarsely reticulate. Internal features as for genus. Hinge well developed and antimerodont, with the posterior terminal hinge element bearing six small teeth and the anterior three and separated by a deep, locellate median groove. Adductors an oblique row of four oval scars with a flattened u-shaped frontal scar antero-dorsally.

Dimensions (mm). Figured specimen: MLP-Mi 1605, right valve, L = 0.360, H = 0.185 (Pl. 2, figs 5–6).

Age and distribution. Late Aalenian–early Bajocian, Picún Leufu section, Neuquén Basin, west-central Argentina.

Remarks. It is possible that this specimen from the late Aalenian–early Bajocian represents the earliest record of the genus. In the general outline of its costation, it resembles most species of the genus and can, for example, be compared in this respect with *Kangarina abyssicola* (Müller, 1894).

The ORTHONOTACYTHERE Group

Three genera, *Orthonotacythere* Alexander, *Paranotacythere* Bassiouni and *Acrocythere* Neale form a distinct group of costate, reticulate and tuberculate, with antimerodont hinge ostracodes within the Cytherurinae, of which the former is late Cretaceous and Tertiary, while the latter two are Jurassic and Cretaceous. *Paranotacythere* and *Acrocythere* both occur in this study but are neither diverse nor numerous; *Orthonotacythere* does not occur.

Genus ACROCYTHERE Neale, 1960

Type species. *Orthonotacythere haueriviana* Bartenstein, 1956 from the Upper Hauterivian of Lincolnshire, England.

Diagnosis. Medium; subrectangular to elongate-triangular, with eye tubercle and ornamented by sharp longitudinal ribs, converging towards end margins with remainder of valve surface generally reticulate. Hinge and other internal features as in *Orthonotacythere* Alexander, 1933.

The genus was first described as a subgenus of *Orthonotacythere*; both have similar hinge and internal features but differ in shape and ornamentation. The posterior termination of the carapace is bluntly pointed at about mid-height and not markedly subdorsally as in *Orthonotacythere*. The ornamentation is dominantly costate and/or reticulate, whereas tubercles (reflected as pits in the inner surface of the valve) are typically present in *Orthonotacythere*.

Acrocythere sp.

Plate 2, figures 8–10

Repository. MLP-Mi 1606, 1607, 1608.

Studied material. Fifteen carapaces, mainly juveniles.

Description. Small; subrectangular in lateral view, somewhat inflated ventrally and with caudal process at mid-height. Subdorsal anterior area depressed. Dorsal margin straight, slightly sinuose medianly; ventral margin regularly convex. Anterior margin regularly rounded; posterior margin subangular with posteriorly pointing caudal process at mid-height. Greatest length at mid-height; greatest height anteriorly, at anterior cardinal angle area, in front of the eye tubercle. Subrectangular in dorsal view and somewhat inflated, with maximum width at mid-length. Ornament of three main sharp ribs. The dorso-marginal, keel-like rib extends from the posterior margin to the anterior area, where it extends distal to the eye tubercle before becoming an antero-marginal fringe-like rib. Median rib sinuous, extending from the posterior area and bifurcating anterior of mid-point; both rami reach the anterior margin. The ventral rib extends parallel to that homonymous margin and bifurcates at about two third of

length. Eye tubercle conspicuous. A short anterodorsal rib extends ventrally from the eye tubercle. Intercostal surface punctate. Large pore openings, few in number, occur widely scattered over the lateral surface of the valve. Sexual dimorphism present; males more elongate than females. Juveniles are more acuminate posteriorly, with more subtriangular outline in lateral view, and with the mid-rib strongly arched in the posterior two-thirds of its length. Internal features not seen.

Dimensions (mm). Figured specimens: MLP-Mi 1606, male carapace, L = 0.410, H = 0.210, W = 0.170 (Pl. 2, fig. 8); MLP-Mi 1607, male carapace, L = 0.500, H = 0.230, W = 0.170 (Pl. 2, fig. 9); MLP-Mi 1608, juvenile carapace, L = 0.360, H = 0.175, W = 0.150 (Pl. 2, fig. 10).

Age and distribution. Early Hauterivian, Barda Cerro Marucho (Puesto Jara) and Cerro Birrete sections; late Hauterivian, Bajada del Agrio section, Neuquén Basin, west-central Argentina.

Remarks. Its rib pattern distinguishes this species from other *Acrocythere* species. The diagnostic character of the type species *A. hauteriviana* Bartenstein is the interrupted mid-rib which is broken abruptly about one third of its length. *A. costata* Brenner and Oertli, 1976 (pl. 4, figs 1–6) from the Hauterivian of the Algoa Basin in South Africa, possesses a distinct longitudinal ribbing with the upper lateral rib interrupted at mid-length. In *A. cf. ashqelonensis* (Rosenfeld and Raab) of Bassiouni (2002, pl. 8, figs 12, 13) from the Albian–Cenomanian of Sinai, Egypt, the mid-rib bifurcates in front of the centre of the carapace; from these branches the upper one gives rise to a short dorsal vertical branch.

Genus PARANOTACYTHERE Bassiouni, 1974

Type species. *Orthonotacythere diplypta* Triebel, 1941 from the Hauterivian of Germany.

Diagnosis. Medium size. Subrectangular to subtrapezoidal in lateral view with a subdorsal caudal process. Prominent eye tubercle and pronounced subcentral vertical subcentral sulcus. Lateral surface with a number of well developed tubercles disposed along dorsal and ventral margins. These latter generally form a more or less distinct ventral ridge. Remainder of surface variously costate, reticulate or punctate.

Paranotacythere sp. Plate 2, figure 11

Repository. MLP-Mi 1609.

Studied material. Five carapaces.

Dimensions (mm). Figured specimen: carapace, MLP-Mi 1609, L = 0.580, H = 0.290, W = 0.250 (Pl. 2, fig. 11).

Age and distribution. Late Tithonian–Berriasian from boreholes, Entre Lomas area, Neuquén Basin, west-central Argentina. Possibly also Berriasian, outcrops Picún Leufú area, in the Neuquén Basin.

Brief description. Medium, subrectangular, posteriorly acuminate with caudal process above mid-height, depressed subdorsally and inflated ventrolaterally. Lateral surface rough with irregular ribs and irregularly reticulate intercostal areas with scattered mamillae. Eye tubercle hemispherical.

Remarks. Only few specimens have been recovered. The species is very similar in shape and ornament to a number of European late Jurassic and early Cretaceous species and is possibly conspecific with *Paracytheridea* sp. 1 of Musacchio (1979a, pl. 2, figs 13, 14, not described) from the Berriasian at Picún Leufú area.

Paranotacythere? sp. Plate 2, figure 12

Repository. MLP-Mi 1610.

Studied material. Three carapaces.

Dimensions (mm). Figured specimen: carapace, MLP-Mi 1610, L = 0.520, H = 0.290, W = 0.160 (Pl. 2, fig. 12).

Age and distribution. Berriasian? from boreholes of the Entre Lomas area, Neuquén Basin, west-central, Argentina.

Brief description. The carapace is of medium size and subtrapezoidal in lateral view. Anterior margin high, obliquely rounded to truncated with extremity just below mid height and posterior margin with a moderately well-developed, posteriorly directed caudal process just above mid height. Dorsal and ventral margins straight, converging posteriorly. Subvertical subcentral sulcus fairly well-defined. Distinct rounded, glassy eye tubercle. The lateral surface of the valves is rough and chaotic with interaction of numerous short ribs and tubercles and with an anterior, ventral and posterior submarginal rib. In dorsal view the carapace is compressed and flattened (deformed?).

Remarks. A few, reasonably preserved specimens have been studied, that are accommodated tentatively within *Paranotacythere*.

Genus PROCYTHERURA Whatley, 1970

Type species. *Procytherura tenuicostata* Whatley, 1970 described from the top of the Nothe Clay (*plicatilis* Zone), Corallian of

the Dorset Coast; widespread throughout the English Oxfordian.

Diagnosis. Small, subtriangular to subovate carapace, with variable ornamentation from almost smooth to reticulate or striate/costate. Lophodont hinge and narrow anterior and posterior vestibula.

Procytherura amygdala sp. nov.

Plate 2, figures 13–17

- .1998 *Procytherura* cf. *maculata* Brenner and Oertli; Simeoni and Musacchio, p. 1412, pl. 2.
 v.2006 *Procytherura* sp. nov.? Ballent (*in* Ballent *et al.*), p. 65, pl. 4, fig. H.
 .2008 *Procytherura* cf. *maculata* Brenner and Oertli; Musacchio and Simeoni, pl. 1, fig. 7.

Repository. MLP-Mi 1434–1442.

Studied material. Eleven carapaces.

Derivation of name. (Greek ἀμυγδαλή) *amygdalē* almond. With reference to the almond-like shape and outline of this species.

Type specimens. Holotype MLP-Mi 1434, carapace illustrated in pl. 2 fig. 13, from Cuesta del Chihuido section level CH6, Neuquén Basin, west-central Argentina.

Paratypes. MLP-Mi 1435, MLP-Mi 1436, MLP-Mi 1437, MLP-Mi 1438, MLP-Mi 1439, MLP-Mi 1440, MLP-Mi 1441, MLP-Mi 1442, carapaces, all from Cuesta del Chihuido section (level Ch6), Neuquén Basin, west-central Argentina.

Type locality and type level. Cuesta del Chihuido section (35°45'S–69°34'W), Neuquén Basin, west-central Argentina, level CH6, late Valanginian.

Diagnosis. Very small and elongate subrectangular species of *Procytherura* characterized by an almond-like appearance with well defined ventro-lateral rib, faintly developed reticulation and fine punctae on the surface of the valves.

Description. Carapace very small, delicate. Elongate subrectangular in lateral view, acuminate and compressed posteriorly with a caudal process at mid-height. Greatest length at mid-height; greatest height in the anterior third of the valve. Dorsal margin straight and sloping posteriorly. Ventral margin feebly convex with a well-developed posteroventral keel. Anterior margin broadly and symmetrically rounded. Posterior margin with a compressed and symmetrical posteriorly pointed caudal process. Mid-dorsal area somewhat depressed in both valves. In dorsal view the carapace is subovate in

outline with the greatest width behind mid-length. Ornament with a faint regular reticulation that is best developed in ventral area parallel to that margin. Fine puncta and normal pore canals occur in the solum of the reticula. A well defined ventro-lateral rib is present. Eye tubercle absent. Lateral outline and ornamentation of this species is almond-like. Internal features not seen.

Dimensions (mm). Figured specimens: MLP-Mi 1434, Holotype, L = 0.375, H = 0.180, W = 0.150 (Pl. 2, fig.13), MLP-Mi 1435, Paratype, L = 0.380, H = 0.160, W = 0.180 (Pl. 2, fig. 15), MLP-Mi 1436, Paratype, L = 0.360, H = 0.170, W = 0.180 (Pl. 2, fig. 16), MLP-Mi 1437, Paratype, L = 0.375, H = 0.200, W = 0.150 (Pl. 2, fig. 14), MLP-Mi 1439, Paratype, L = 0.375, H = 0.170, W = 0.160 (Pl. 2, fig. 17).

Age and distribution. Late Valanginian–late Hauterivian: Cuesta del Chihuido section; late Valanginian–early Hauterivian: Barda Cerro Marucho (Puesto Jara) and Cerro Birrete sections, Neuquén Basin, west-central Argentina.

Remarks. *P. amygdala* is closest to *P. maculata* Brenner and Oertli, 1976 (see below) from the Hauterivian of South Africa and Neuquén Basin in Argentina which is distinguished by a ventro-lateral node present on each valve at 2/3 length. *P. batei* Dingle, 1984 (p. 129, fig. 12 B–C, E) from the early–middle Albian of boreholes on the Falkland Plateau is ovate in lateral outline, lanceolate in dorsal view and coarsely punctate with a prominent ventrolateral swelling.

Procytherura bispinata Ballent, 1991

Plate 2, figures 18–19

- v* 1991 *Procytherura bispinata* Ballent, p. 37, pl. 2, figs 8–11.

Repository. MLP-Mi 1611, 578/2.

Studied material. Fifteen carapaces.

Dimensions (mm). Figured specimens: MLP-Mi 1611, carapace, L = 0.250, H = 0.120, W = 0.100 (Pl. 2, fig. 18); MLP-Mi 678/2, carapace, L = 0.260, H = 0.125, W = 0.100 (Pl. 2, fig. 19).

Age and distribution. Late Aalenian–early Bajocian, Picūn Leufū section, Neuquén Basin, west-central Argentina.

Brief description. Very small, ovate with a short subdorsal caudal process in lateral view; punctate surface and with two posteroventral spines.

Remarks. Its delicate costate ornament and two posteroventral spines distinguish this species from others of the genus.

Procytherura brenneri Valicenti and Stephens, 1984
Plate 2, figure 20

- *1984 *Procytherura brenneri* Valicenti and Stephens, p. 192, pl. 7, figs 9–11; pl. 8, figs 1–2.
.1998 *Procytherura* cf. *brenneri* Valicenti and Stephens; Simeoni and Musacchio, p. 1412, pl. 2.

Repository. MLP-Mi 1612.

Studied material. Two carapaces.

Dimensions (mm). Figured specimen MLP-Mi 1612, carapace, L = 0.325, H = 0.140, W = 0.150 (Pl. 2, fig. 20).

Age and distribution. Late Valanginian and Hauterivian, Sundays River Formation, Algoa Basin, South Africa; late Valanginian, Cerro Birrete and Barda Cerro Marucho (Puesto Jara) sections, Neuquén Basin, west-central Argentina.

Brief description. Very small, subrectangular to subovate in lateral view with angular posterior margin with caudal process at or above mid-height and well-developed postero-ventral keel. Postero-ventral alar process developed; surface ornamented with large puncta.

Remarks. Argentinian specimens have more numerous and smaller puncta than the types. *P. brenneri* appears to be intermediate in shape and ornament between *P. aerodynamica* Bate, 1975 (pl. 11, figs 7–15) from the Middle and Upper Kimmeridgian of Tanzania, with fewer puncta) and the reticulate *P. maculata* Brenner and Oertli (see below).

Procytherura celtica Ainsworth, 1986
Plate 3, figure 1

- *1986 *Procytherura celtica* Ainsworth, p. 303, pl. 4, figs 8–11.
v.1991 *Procytherura* cf. *celtica* Ainsworth; Ballent, p. 36, pl. 2, figs 7.

Repository. MLP-Mi 1613.

Studied material. Forty carapaces.

Dimensions (mm). Figured specimen: MLP-Mi 1613, carapace, L = 0.270, H = 0.135, W = 0.120 (Pl. 3, fig. 1).

Age and distribution. Late Toarcian–Aalenian, off southwestern Ireland (Ainsworth 1986); late Aalenian–early Bajocian, Picún Leufú section, Neuquén Basin, west-central Argentina.

Brief description. Very small, subtriangular in lateral view, with a nearly straight dorsal margin, a very subdued costate ornament with fine secondary punctation.

Remarks. Argentinian specimens are somewhat more posteriorly acuminate than those from offshore Ireland.

Procytherura euglyphea Ainsworth, 1986
Plate 3, figure 2

- *1986 *Procytherura euglyphea* Ainsworth, p. 303, pl. 4, figs 12–15.
v.1991 *Procytherura* cf. *euglyphea* Ainsworth; Ballent, p. 35, pl. 2, fig. 6.

Repository. MLP-Mi 670.

Studied material. Twelve carapaces, three valves.

Dimensions (mm). Figured specimen: MLP-Mi 670, carapace, L = 0.310, H = 0.150, W = 0.150 (Pl. 3, fig. 2).

Age and distribution. Mid to late Toarcian to Aalenian, British Isles (Ainsworth 1986; Boomer 1989); late Aalenian–early Bajocian, Picún Leufú section, Neuquén Basin, west-central Argentina.

Brief description. Very small and subtriangular, ornamented with a strongly developed, slightly oblique longitudinal rib. Antero-ventrally, weak ribs extend to and beneath ventral inflation. Valve surface with irregular open polygonal reticulation medially and posteriorly, with punctation anteriorly.

Remarks. The specimens from Argentina are less ventrally inflated and less prominently costate than the type material from Ireland, though this may be related to preservational differences. *Procytherura* sp. A of Ballent and Whatley (2000b, p. 234, fig. 2. N, MLP-Mi 1082) from the late Pliensbachian (Cerrito Roth sur section, Neuquén Basin), which is a very small species with an oblique, somewhat inflated, lateral rib and an indistinct postero-ventral spine, is possibly a juvenile of *E. euglyphaea* Ainsworth.

Procytherura kroemmelbeini Musacchio, 1979a
Plate 3, figure 3

- v* 1979a *Procytherura kroemmelbeini* Musacchio, p. 467, pl. 2, figs 10–12.
v.2000b *Procytherura kroemmelbeini* Musacchio; Ballent and Whatley, p. 233, fig. 2J.

Repository. MLP-Mi 1077.

Studied material. Five carapaces.

Dimensions (mm). Figured specimen: MLP-Mi 1077, carapace, L = 0.410, H = 0.200, W = 0.170 (Pl. 3, fig. 3).

Age and distribution. Hauterivian, Cerro Negro de Covun-có section, Neuquén Basin, west-central Argentina.

Brief description. Small, with a slim elongate-triangular outline and ornamentation of sinuous and anastomosing longitudinal ribs subparallel to margins and a ventro-lateral spine on each valve.

Remarks. This species is closest to *P. beerae* Brenner and Oertli, 1976 (pp. 507–508, pl. 8, fig. 9) from the Hauterivian of the Algoa Basin, South Africa. However, they can be easily distinguished because the South African species lacks a ventro-lateral spine.

Procytherura maculata Brenner and Oertli, 1976

Plate 3, figures 4–5

*1976 *Procytherura maculata* Brenner and Oertli, p. 507, only pl. 8, fig. 8.

v.1979a *Procytherura* aff. *maculata* Brenner and Oertli; Musacchio, pl. 6, fig. 6.

v.2000b *Procytherura maculata* Brenner and Oertli; Ballent and Whatley, p. 234, figs 2K–M.

Repository. MLP-Mi 1078, 1614.

Studied material. Ten carapaces.

Dimensions (mm). Figured specimens: MLP-Mi 1078, male carapace, L = 0.350, H = 0.185, W = 0.150 (Pl. 3, fig. 4); MLP-Mi 1614, juvenile, L = 0.280, H = 0.135, W = 0.100 (Pl. 3, fig. 5).

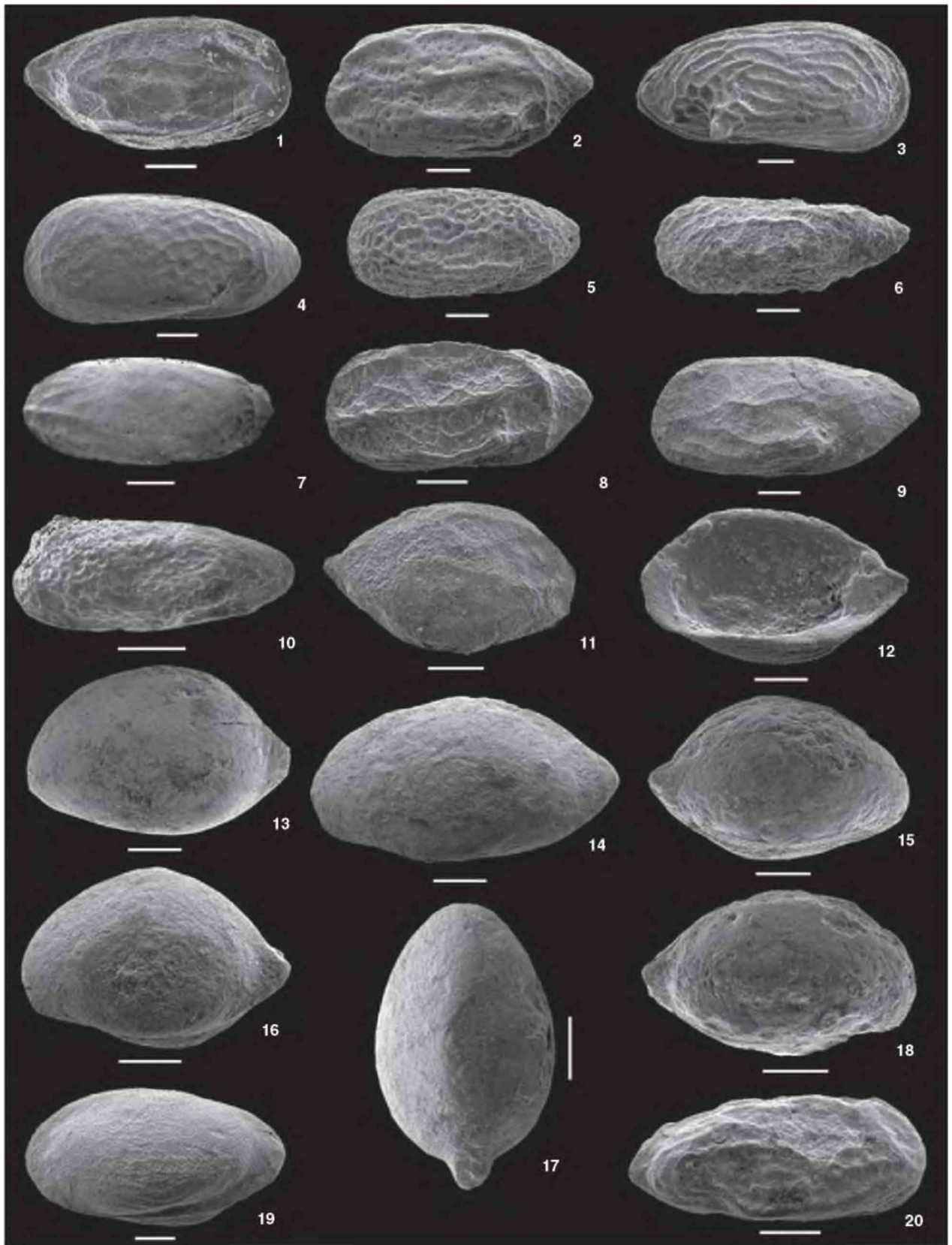
Age and distribution. Hauterivian, Algoa Basin, South Africa (Brenner and Oertli 1976); Hauterivian, Manzano Guacho section, Sierra de la Vaca Muerta area and late Valanginian, Barda Cerro Marucho (Puesto Jara) section, Neuquén Basin, west-central Argentina.

Brief description. Small to very small, elongate subtriangular in lateral view and with dorsal and ventral margins nearly straight,

EXPLANATION OF PLATE 3

- Fig. 1. *Procytherura celtica* Ainsworth, 1986, MLP-Mi 1613, carapace, right lateral view, late Aalenian–early Bajocian, Picún Leufú section, level 1676.
- Fig. 2. *Procytherura euplyphea* Ainsworth, 1986, MLP-Mi 670, carapace, left lateral view, late Aalenian–early Bajocian, Picún Leufú section, level 1676.
- Fig. 3. *Procytherura kroemmelbeini* Musacchio 1979a, MLP-Mi 1077, carapace, right lateral view, Hauterivian, Cerro Negro de Covun-có section.
- Figs 4–5. *Procytherura maculata* Brenner and Oertli, 1976. 4, MLP-Mi 1078, male carapace, left lateral view, Manzano Guacho section, Sierra de la Vaca Muerta area. 5, MLP-Mi 1614, juvenile carapace, left lateral view, late Valanginian, Barda Cerro Marucho (Puesto Jara) section, level MARJ3, Bco 5.
- Fig. 6. *Procytherura mediocostata* Bate and Coleman, 1975, MLP-Mi 1615, carapace, left lateral view, late Pliensbachian (Northern slope of Cerro Trapial Mahuida), level 1186.
- Fig. 7. *Procytherura* sp. B Ballent and Whatley, 2000b, MLP-Mi 1083, carapace, left lateral view, mid Callovian, María Rosa Curicó section, level 1159.
- Fig. 8. *Procytherura* sp. 1, MLP-Mi 1616, carapace, left lateral view, late Aalenian–early Bajocian, Picún Leufú section, level 1685.
- Fig. 9. *Procytherura* sp. 2, MLP-Mi 1617, carapace, left lateral view, late Aalenian–early Bajocian, Picún Leufú section, level 1685.
- Fig. 10. *Procytherura?* sp. Ballent and Whatley, 2000b, MLP-Mi 1084, carapace, left lateral view, late Pliensbachian, Cerrito Roth sur section, level 101b.
- Figs 11–12. *Cytheropteron* sp., MLP-Mi 1618, right valve. 11, external lateral view. 12, internal lateral view, late Aalenian–early Bajocian, Picún Leufú section, level 1677.
- Figs 13–18. *Eocytheropteron immodicus* sp. nov. 13, MLP-Mi 1619, holotype, female carapace, left lateral view, ?early Hauterivian, Entre Lomas area (YPF.PC.Nq.EL. a-9, 1740 m below surface). 14, 15, 16, 17, 18, paratypes. 14, MLP-Mi 1620, male carapace, left lateral view, ?early Hauterivian, Entre Lomas area (YPF.PC.Nq.EL. a-9, 1740 m below surface). 15, MLP-Mi 1621, female carapace, right lateral view, ?early Hauterivian, Entre Lomas area (YPF.PC.Nq. PB. a-9, 1754 m below surface). 16, 17, MLP-Mi 1622, juvenile carapace, left lateral and dorsal views, ?early Hauterivian, Entre Lomas area (YPF.PC.Nq. PB. a-9, 1754 m below surface). 18, MLP-Mi 1623, juvenile carapace, right lateral view, ?early Hauterivian, Entre Lomas area (YPF.PC.Nq. PB. a-9, 1745 m below surface).
- Fig. 19. *Paradoxorhyncha neuquenensis* (Ballent, 1991), MLP-Mi 664/2, male carapace, left lateral view, late Aalenian–early Bajocian, Picún Leufú section, level 1676.
- Fig. 20. *Paracytheridea* sp. 2 Musacchio, 1979a, MLP-Mi 360, male carapace, right lateral view, ?Berriasian, Picún Leufú section, level 138.

Scale bars represent 0.050 mm in figs 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 19 and 0.100 mm in figs 10, 13, 14, 15, 16, 17, 18, 20.



BALLENT and WHATLEY, Mesozoic ostracods

and well-developed posteroventral keel. A ventro-lateral node is present on each valve at 2/3 length and a shallow, vertical sulcus extends across the lateral surface from the dorsal margin. Ornamentation by a distinctive regular reticulum, disposed concentrically and parallel to margins.

Remarks. Ballent and Whatley (2000b, p. 234) have provided a complementary description of this species in order to clarify its confused status (also see *P. brenneri* Valicenti and Stephens, this study).

Procytherura mediocostata Bate and Coleman, 1975
Plate 3, figure 6

*1975 *Procytherura mediocostata* Bate and Coleman,
p. 40, pl. 14.1–14.9, 14.11, 14.12, 14.15; fig. 18a–c.

Repository. MLP-Mi 1615.

Studied material. One carapace.

Dimensions (mm). Figured specimen: MLP-Mi 1615, male carapace, L = 0.310, H = 0.115, W = 0.150 (Pl. 3, fig. 6).

Age and distribution. Lower Toarcian of England; late Pliensbachian, northern slope of Cerro Trapial Mahuida, Neuquén Basin, west-central Argentina.

Brief description. Very small, narrow, elongate carapace tapering posteriorly with distinct sub-dorsal caudal process. Well-marked diagonal rib crosses a dorso-median sulcus, surface with irregular reticulation. The only specimen recovered seems to be male.

Procytherura sp. B Ballent and Whatley, 2000b
Plate 3, figure 7

v.2000b *Procytherura* sp. B Ballent and Whatley, p. 235,
fig. 20.

Repository. MLP-Mi 1083.

Studied material. One carapace.

Dimensions (mm). Figured specimen: MLP-Mi 1083, carapace, L = 0.275, H = 0.130; W = 0.140 (Pl. 3, fig. 7).

Age and distribution. Mid Callovian, María Rosa Curicó section, Neuquén Basin, west-central Argentina.

Brief description. Very small and very elongate ovate in lateral view, with a small postero-ventral keel. Surface smooth except for feeble anterior ribs and a strong reticulum at the base of the caudal process. Although probably a new species, with

only a single specimen, it is retained under open nomenclature.

Remarks. *Procytherura* sp. B is closest to *Procytherura* sp. of Dépêche (1985, pl. 31, fig. 29) from the Middle Bathonian of the Paris Basin, France, but the latter species has a more pronounced ventral expansion.

Procytherura sp. 1
Plate 3, figure 8

Repository. MLP-Mi 1616.

Studied material. One carapace.

Description. Very small and delicate species, subrectangular tapering posteriorly in lateral view. Anterior margin regularly rounded; posterior margin acute, with a symmetric caudal process nearly mid-height. Dorsal margin convex, with well formed dorsal flange. Ventral margin slightly concave medianly. Greatest length above mid-height; greatest height at mid-length. In dorsal view, very compressed, subrhomboidal, with greatest width behind mid-length at posterior termination of ventro-lateral rib. Three longitudinal ribs are disposed over the lateral surface of the valves. The sharp dorsal rib, extends from the antero-dorsal angle parallel to the dorsal margin; at the postero-dorsal region turns vertically terminating at postero-ventral angle. The median rib, somewhat sinuous extends from the mid-anterior margin terminating against the vertical part of the dorsal rib in a prominent postero-dorsal node. Round, small mid-anterior node is present. The ventral rib, concave and somewhat sinuous, extends along a weakly alar inflation terminating in a distinct postero-ventral node. Round eye tubercle with a fine ocular rib produced anteriorly. Inter-rib regions with delicate irregular polygonal reticulation; fine secondary pitting within reticulae. Internal features not seen.

Dimensions (mm). Figured specimen: MLP-Mi 1616, carapace, L = 0.270, H = 0.150; W = 0.100 (Pl. 3, fig. 8).

Age and distribution. Late Aalenian–early Bajocian, Picùn Leufú section, Neuquén Basin, west-central Argentina.

Remarks. The ornamentation distinguishes it from others of the genus. Although surely a new species, with only a single specimen, it is retained under open nomenclature.

Procytherura sp. 2
Plate 3, figure 9

Repository. MLP-Mi 1617.

Studied material. One carapace.

Description. Very small, subrectangular tapering posteriorly and ventrally inflated. Anterior margin slightly asymmetrically rounded, extremity below mid-height. Posterior margin subtriangular, extremity above mid-height. Dorsal margin straight, tapers towards posterior. Ventral margin slightly convex, tapers towards posterior. Greatest length above mid-height; greatest height at mid-length. Valves subequal. In dorsal view, lanceolate with greatest width in the posterior third at termination of ventro-lateral rim. Weak eye swelling is present. Valve surface punctate and with weak ribs situated mainly in anterior region of the valve and two irregular ribs extending back from anterior margin; they fuse at the moderately developed ala to form a single rib extending back along alar rim and terminating in a postero-ventral node.

Dimensions (mm). Figured specimen: MLP-Mi 1617, carapace, L = 0.335, H = 0.150; W = 0.150 (Pl. 3, fig. 9).

Age and distribution. Late Aalenian–early Bajocian, Picún Leufú section, Neuquén Basin, west-central Argentina.

Remarks. The two irregular ribs extending back from the anterior margin which then fuse to form a single rib running along the ala, diagnoses *Cytheropteron pulchellum* Bate and Coleman, 1975 (p. 30, pl. 12, figs 10–14) from the early Toarcian of England, which is, however, more acuminate posteriorly and has more distinct lateral expansions.

Procytherura? sp. Ballent and Whatley, 2000b
Plate 3, figure 10

v.2000b *Procytherura?* sp. Ballent and Whatley, p. 235, fig. 2P.

Repository. MLP-Mi 1084.

Studied material. One carapace.

Dimensions (in mm). Figured specimen: carapace MLP-Mi 1084 L = 0.420, H = 0.180; W = 0.200 (Pl. 3, fig. 10).

Age and distribution. Late Pliensbachian, Cerrito Roth sur section, Neuquén Basin, west-central Argentina.

Brief description. Small, elongate subrectangular, tapering posteriorly. Anterior margin rounded; posterior produced into a caudal process with blunt apex almost coincident with mid-height. The surface of the valves is finely reticulate with muri preferentially aligned parallel to margins.

Remarks. This species is only tentatively assigned to *Procytherura* due to differences in lateral outline and lack of internal details.

CYTHEROPTERINAE Hanai, 1957

Genus CYTHEROPTERON Sars, 1866

Type species. *Cytheropteron latissimum* (Norman) (by subsequent designation: Alexander, 1933) from the Recent sediments in the North Atlantic.

Diagnosis. A genus with a small carapace of subcircular, subovate or subrhomboidal lateral outline. With or without caudal process. Alate or, alternatively, very tumid ventrolaterally. Smooth, punctate, rarely reticulate or delicately ribbed. Blind. Median element of hinge crenulate. Radial pores relatively few, well spaced, straight and simple.

Cytheropteron sp.
Plate 3, figures 11–12

Repository. MLP-Mi 1618.

Studied material. One right valve.

Dimensions (mm). Figured specimen: right valve MLP-Mi 1618 L = 0.235, H = 0.140 (Pl. 3, figs 11–12).

Age and distribution. Late Aalenian–early Bajocian, Picún Leufú section, Neuquén Basin, west-central Argentina.

Brief description. Very small, delicate species, subovate in lateral view with dorsally directed caudal process at mid-height. Moderately alate ventrolaterally and with weak dorsal and median ribs and delicate intercostal punctation. Hinge merodont, inner lamella of moderate width; vestibula not seen.

Remarks. *Cytheropteron* sp. A of Boomer and Ballent 1996 from the Late Pliensbachian–Toarcian at Mochras (British Isles) and North Africa is more elongate in lateral view and more strongly alate than the present species.

Genus EOCYTHEROPTERON Alexander, 1933

Type species. *Cytheropteron bilobatum* Alexander, 1929 from the Lower Cretaceous of Texas.

Diagnosis. Carapace subtrapezoidal in lateral view, egg-shaped in dorsal view, short caudal process, without trace of wing-like lateral expansions. Left valve overhanging right valve conspicuously along the dorsal margin. The right valve bears small teeth on short, ridge-like elevations at each end of the hinge margin, with corresponding notched sockets in the left valve. The hinge margin of each valve,

between the terminal series of teeth of the right, and the terminal sockets of the left valve, is finely denticulate.

Eocytheropteron immodicus sp. nov.

Plate 3, figures 13–18

Repository. MLP-Mi 1619, 1620, 1621, 1622, 1623, 1624, 1625, 1626, 1627.

Studied material. Fifteen carapaces.

Derivation of name. Latin *immodicus* = excessive, extravagant. With reference to the very strongly expressed sexual dimorphism of this species.

Type specimens. Holotype MLP-Mi 1619, female carapace illustrated in pl. 3 fig. 13, from borehole YPF.PC.Nq.EL.a-9 (Entre Lomas), Neuquén Basin, west-central Argentina, 1740 m below surface.

Paratypes. MLP-Mi 1620, male carapace, YPF.PC.Nq.EL.a-9 (Entre Lomas), 1740 m below surface; MLP-Mi 1621, female carapace, YPF.PC.Nq.PB.a-99 (Piedras Blancas), 1754 m below surface; MLP-Mi 1622, juvenile carapace, YPF.PC.Nq.PB.a-99 (Piedras Blancas), 1754 m below surface; MLP-Mi 1623, juvenile carapace, YPF.PC.Nq.PB.a-99 (Piedras Blancas), 1745 m below surface; MLP-Mi 1624, female carapace, YPF.PC.Nq.PB.a-99 (Piedras Blancas), 1772 m below surface; MLP-Mi 1625, juvenile carapace, YPF.PC.Nq.PB.a-99 (Piedras Blancas), 1772 m below surface; MLP-Mi 1626, male carapace, YPF.PC.Nq.EL.a-9 (Entre Lomas), 1740 m below surface; MLP-Mi 1627, male carapace, YPF.PC.Nq.PB.a-99 (Piedras Blancas), 1871 m below surface, all from the Entre Lomas area, Neuquén Basin, west-central Argentina.

Type locality and type level. Borehole YPF.PC.Nq.EL.a-9 (Entre Lomas), Entre Lomas area (between 37°50'–38°15'S and 68°00'–68°30'W) Neuquén Basin, west-central Argentina, 1740 m below surface, ?early Hauterivian.

Diagnosis. A medium, very strongly inflated species of *Eocytheropteron*, with marked sexual dimorphism.

Description. Medium, strongly dimorphic. Female, ovate and strongly inflated in lateral view, with a short upturned caudal process below mid-height. Dorsal margin regularly and strongly convex; ventral margin markedly convex in lateral view with apex at mid-length. Anterior margin obliquely rounded; posterior margin, with a short, narrow, upturned caudal process below mid-height. Greatest length below mid-height; greatest height at about mid-length. The H/L ratio is nearly 2/3. Males, subovate, more elongate than females in lateral view with the short caudal process at mid-height. In both sexes, in dorsal view the carapace is subovate with maximum width at mid-length and the left valve, larger than right, overlaps along the dorsal margin. Lateral surface finely punctate. Ventral surface with weak ribs beneath and parallel to the line of the prominent ventro-lateral tumidity. Internal features not seen.

Dimensions (mm). Figured specimens: MLP-Mi 1619, Holotype, L = 0.510, H = 0.320, W = 0.320 (Pl. 3, fig. 13), MLP-Mi 1620, Paratype, L = 0.590, H = 0.310, W = 0.300 (Pl. 3, fig. 14), MLP-Mi 1621, Paratype, L = 0.480, H = 0.300, W = 0.250 (Pl. 3, fig. 15), MLP-Mi 1622, Paratype, L = 0.450, H = 0.280, W = 0.310 (Pl. 3, figs 16–17), MLP-Mi 1623, Paratype, L = 0.430, H = 0.260, W = 0.250 (Pl. 3, fig. 18).

Age and distribution. ?Early Hauterivian from boreholes of the Entre Lomas area, Neuquén Basin, west-central Argentina.

Remarks. This new species differs from others with similar lateral outline, such as *E. tumidum* (Alexander) and *E. delrioense* (Alexander) from the Lower Cretaceous of Texas (Alexander 1933, pl. 27, figs 13a, b and pl. 25, fig. 12; pl. 26, fig. 9, respectively) in the strength of its sexual dimorphism and punctate ornament.

Genus PARADOXORHYNCHA Chapman, 1904

Type species. *Paradoxorhyncha foveolata* Chapman, 1904 from the Middle Jurassic (Lower Oolite) strata, near Geraldton, in Western Australia.

Diagnosis. The type species is medium-sized, thick-shelled and very coarsely ornamented, whereas other species included in this genus are smaller, thinner-shelled and much more delicately ornamented, with puncta rather than reticulae. Hinge hemimerodont.

Paradoxorhyncha neuquenensis (Ballent, 1991)

Plate 3, figure 19

v.1991 *Praeschuleridea? neuquenensis* Ballent, p. 331, pl. 1, figs 5–11.

v.1996a *Paradoxorhyncha neuquenensis* (Ballent); Ballent and Whatley, Fig. 1: 4–6.

Repository. MLP-Mi 627, 664/1-664/14.

Studied material. Thirty carapaces, twelve valves.

Dimensions (mm). Figured specimen: MLP-Mi 664/2, male carapace, L = 0.360, H = 0.180, W = 0.160 (Pl. 3, fig. 19).

Age and distribution. Late Aalenian–early Bajocian, Picùn Leufú section, Neuquén Basin, west-central Argentina.

Brief description. *Paradoxorhyncha neuquenensis* is small, subtriangular to subovate in lateral view, moderately alate and with a densely and coarsely punctate ornament. It has a poorly preserved hinge, imperfectly described originally because it is only observed in juveniles (Ballent 1991), which could be interpreted as lophodont. Lophodont hinges occur in the ontogeny of

merodont types (for example in species of *Galliaecytheridea* Oerthli); the present species could represent a similar case with juveniles bearing lophodont, but adults hemimerodont hingement.

Remarks. Ballent and Whatley (1996a) included in the genus *Paradoxorhyncha* five early Middle Jurassic species: *P. foveolata* Chapman (the type species), *P. jurassica* (Chapman), *P. australiense* (Chapman) and *Paradoxorhyncha* sp. (Chapman) from Australia and *Paradoxorhyncha neuquenensis* (Ballent) from west-central Argentina. Mette (*in* Mette and Geiger 2004) recorded the genus with four species from the Bajocian and middle-Upper Bathonian of the Morondova Basin, Madagascar. The systematic status of Australian species of this genus has been recently discussed by Lord *et al.* 2006.

P. neuquenensis is extremely similar in shape, outline and ornamentation to *P. australiense*, which is, however, medium in size. Ballent and Whatley (1996a) considered that the two species shared a common ancestor.

Gen. indet. B of Bate *et al.* 1984 (pl. 5, figs 12, 14, 15) from the Pliensbachian of Leg 79, Site 547 (offshore Morocco) strongly resembles species of *Paradoxorhyncha*.

PARACYTHERIDEINAE Mandelstam *in* Orlov, 1960

Genus PARACYTHERIDEA Müller, 1894

Type species. *Paracytheridea depressa* Müller, 1894 from the Recent sediments in the Gulf of Naples, Italy.

Diagnosis. Subrectangular elongate, moderately to strongly alate, flattened ventrally and with posterior end drawn out into a distinct caudal process. In dorsal view the carapace is arrowhead-shaped. Surface heavily ornamented with ridges and/or tubercles. Ventral rib in posterior end, often terminating in a prominent spine. Hinge weak and variably crenulate, with faint indications of sockets in left valve; hinge margin or crenulate bar between them.

Paracytheridea sp. 2 Musacchio, 1979a

Plate 3, figure 20

v. 1979a *Paracytheridea?* sp. 2 Musacchio, p. 467, pl. II, figs 23–25.

Repository. MLP-Mi 360, 361.

Studied material. Two carapaces.

Dimensions (mm). Figured specimen: MLP-Mi 360, male carapace L = 0.500, H = 0.200, W = 0.185 (Pl. 3, fig. 20).

Age and distribution. Berriasian?, Picún Leufú section, Neuquén Basin, west central Argentina.

Brief description. The studied material consists of two carapaces; one of them apparently an adult male and the another probably an A-1 juvenile. The species is of medium length, elongate subrectangular in lateral view, with a distinct, backward pointing, symmetrical caudal process at mid-height. Moderately alate mid ventrolaterally. Eye tubercle at some distance from the margin. Longitudinal ribs and coarse punctations ornament the lateral surface of the valves. The dorsal rib, weak and discontinuous, extends along the dorsal margin, cuts through the eye node and joins the anterior margin in the lower half of the valve. The median rib extends obliquely across the valve, and posteriorly, in front of the caudal process area, it bends ventrally and continues as a ventro-lateral rib. The median rib is markedly concave below the position of the adductor scars.

Remarks. Valicenti and Stephens (1984, p. 189) suggested that the present species, together with *Orthonotacythere* (*Acrocythere*) 129 of Grékoff 1963 (Portlandian of Madagascar), *Paracytheridea mandawaensis* Bate, 1975 (Middle to Upper Kimmeridgian of Tanzania) and *Paracytheridea? aranea* Valicenti and Stephens, 1984 (Upper Valanginian of South Africa), all of very small size, may belong to a new genus of the family Cytheruridae. We consider that while the three African species, which are very similar, both in size and general morphology, might constitute a new taxon, the present species is considerably different and we prefer to consider it as *Paracytheridea*.

ZOOGEOGRAPHY

During the Cenozoic the Cytheruridae was almost equally diverse in shelf and deep-sea environments. During the Mesozoic, members of the family seem to have been confined to shelf depths, with many species also in marginal marine habitats.

The distribution of Recent cytherurids from the coast of northern Río de Janeiro (Brazil) shows that most of the species have a preference for finer sands and greater depths offshore, where influence of wave action on the bottom is diminished. The results show that ostracods are most abundant between 51 and 70 m, where 88 per cent of the total number of the specimens occurs. Fine sand predominates in this depth range (Feijo Ramos *et al.* 1999). Similarly, Coimbra *et al.* (1999) concluded that cytherurids from the Brazilian continental shelf inhabit on a substrate of fine-grained bioclastic sands between 75 and 100 m depth.

In the present study, early and Middle Jurassic cytherurids occur in association with abundant and diverse lagenid foraminifers, with floods of polymorphinids, spirillinids and involutinids, which indicate shallow-marginal marine restricted environments, with clear and well

oxygenated waters (Ballent 1987, 2004). Cytherurids from the late Valanginian–early Hauterivian of the Barda Cerro Marucho (Puesto Jara) and Cerro Birrete and from the Hauterivian of the Cerro Negro de Covun-có sections, all close to the southern border of the Neuquén Basin, occur associated with species of Platycopina, with a relatively high ostracod/foraminiferal ratio with the latter dominated by polymorphinids and spirillinids (Concheyro *et al.* 2005). The environment of deposition corresponds to restricted marginal marine conditions with warm waters. In both Jurassic and early Cretaceous microfaunas, the presence of *Cytherelloidea*, a well-known warm water indicator (Sohn 1962) militates in favour of inner rather than outer shelf in a subtropical or warmer environment.

Mesozoic Cytheruridae were marine podocopid ostracods, which, in common with all contemporary (and modern) cytheroideans, were incapable of free swimming and also lacked pelagic larvae. Therefore, their active migration is confined to the distance where they could ‘walk’ or be transported by marine agencies. The dispersion of ostracods in shallow water marine environments is much more constrained by physical factors than it is for deep water forms. Only where continuity of continental shelf occurs latitudinally are conditions likely to be ideal for the successful migration of such shallow water faunas (Whatley 1986, 1988). Ostracodes can migrate latitudinally when temperature and other ecological parameters, such as the bathymetry, remain stable within certain limits and continental margins can function as migration pathways (Babinot and Colin 1992).

The Tethys, a largely east–west, latitudinally oriented thermospheric ocean, was a major oceanographic feature throughout the late Palaeozoic, entire Mesozoic and the pre-Miocene Cainozoic. It was a major route adopted by migrant ostracodes during all this time (McKenzie 1967, 1982; Whatley 1988). Given the absence of polar ice during the Mesozoic, the depth of Tethys was not a barrier to migration from one shore to the other (Whatley 1988; Whatley and Ballent 1994).

The presence in the Neuquén Basin of *Eucytherura gassumensis*, *E. michelseni*, *E. paranuda* [ex *Eucytherura nuda* (Brand)], *E. oeresundensis*, *E. transversiplicata*, *Procytherura celtica* and *P. mediocostata* as well as several cyprid-oids (Ballent and Whatley 2000a; Arias 2006) all species known from the well-documented shelf deposits of the North West European Lias, supports the idea that an initial migration route may have taken place from European epicontinental seas, around the southern margin of Tethys, around western Australia and southern Antarctica and northwards to the western Argentina. The same route is known to have been adopted by foraminifers (Ballent 1987) and invertebrates (Riccardi 1991; Damborenea and Manceñido 1992).

The contemporaneous presence of *Paradoxorhyncha* in the early Bajocian of Western Australia (Malz and Oertli 1993; Lord *et al.* 2006), late Aalenian–early Bajocian of Western Argentina (Ballent and Whatley 1996a) and Bajocian of southwest Madagascar (Mette and Geiger 2004) indicates the genus to be apparently restricted to the Southern Hemisphere. Since it has not been found in the northern parts of Gondwana and southern Europe, it is probable that it migrated along the southern shores of Gondwana from Australia to South America and Madagascar during the early Bajocian (Mette 2004). This allows us to explain the close similarities between early–mid Jurassic foraminifers from Australia and Argentina (Bartenstein and Malz 2001).

Species such as *Eucytherura* sp. B of Boomer and Ballent and *Procytherura euglyphea*, recognized from sites to the southwest of the British Isles, off Northwest Africa and in the Neuquén Basin, although not known from other parts of Britain and Europe (Boomer and Ballent 1996), support the existence of a central Atlantic seaway which connected the western part of the Tethys with the eastern Pacific (‘the Hispanic Corridor’) as a migration route during the early–Middle Jurassic (see discussion in Ballent and Whatley 2000b).

During the latest Jurassic (Berriasian) the opening of a shallow intermittent epicontinental seaway between southern South Africa and southern Argentinian Patagonia favoured faunal interchange. This seaway corresponds to the commencement of the continental separation between Africa and South America (124 Ma), which created the South Atlantic and a small ocean basin off south-east Africa (Natal Valley, see Dingle 1988) producing a Valanginian–Hauterivian influx of new species and an increase in population diversity. The coeval records of *Procytherura brenneri*, *P. maculata* and *Eucytherura guillaumeae* (ex *E. tuberculata* Brenner and Oertli), as well as several species of *Majungaella* and *Rostroclytheridea* (Ballent *et al.* 1998; Ballent and Whatley 2007) and foraminifers (McMillan 2003) in the Algoa Basin in South Africa and in the Neuquén Basin, western Argentina strongly support the existence of a southern Gondwana seaway.

CONCLUSIONS

The Cytheruridae were clearly the most abundant and diverse ostracod family during the studied interval in the Neuquén Basin, west-central Argentina. No other family of ostracods can even approach them in these respects. Table 1 demonstrates the diversity of podocopinid families within the Pliensbachian to Tithonian interval in the Neuquén Basin.

TABLE 1. Diversity of Podocopina throughout the stages of late early Jurassic and late Jurassic of the Neuquén Basin, west-central Argentina.

Stages	Number of species		
	Cypridoidea	Bairdioidea	Cytheroidea
Tithonian	0	1	6 (1 Cytheruridae)
Mid-Late Callovian	2	0	16 (5 Bythocytheridae, 3 Cytheruridae)
Bajocian	0	0	1
Aalenian-Bajocian	1	2	23 (17 Cytheruridae)
Late Pliensbachian	4	5	10 (7 Cytheruridae, 3 Bythocytheridae)

The Late Pliensbachian is represented by a mixed fauna of Metacopida, Platycopida and Podocopida with marine Cypridoidea (four species), Bairdioidea (five species) and Cytheroidea with ten species, of which the Cytheruridae are the most abundant family with seven species.

Around the Aalenian–Bajocian boundary, the fauna is strongly dominated by Cytheroidea, with the Platycopina, Cypridoidea and Bairdioidea comprising together only 4.5 per cent of the total number of individuals. The Cytheroidea comprise twenty three species with the Cytheruridae again being clearly the most abundant group with seventeen species. Of these, the three most abundant species (*Procytherura celtica*, *Eucytherura pichia* and *Paradoxorhyncha neuquenensis*) make up almost 50 per cent of the total of specimens.

In the mid–Late Callovian, the dominant Cytheroidea (84.5 per cent) are mainly represented by the Bythocytheridae followed by the cytherurids. Throughout the Tithonian–early Cretaceous interval the Cytheroidea retain their dominance; however, data on relative abundance of each family are not yet comprehensive available. Nine species of Cytheruridae have been recorded in this paper and five species of *Rostrocytheridea* (Cytherideidae) have been described by Ballent and Whatley (2007); studies on other genera, such as ‘*Sondagella*’ and allies by the authors are in progress.

In numerical terms the Cytheruridae are distributed throughout the strata available for study in the basin as indicated in Table 2. It demonstrates, as shown by Whatley and Stephens (1976) and Whatley (1988), the great expansion of the Cytheroidea, and the Cytheruridae in particular in the Middle Jurassic, with a further increase in the marine early Cretaceous.

The most abundant genus, with fourteen species is *Eucytherura*, followed closely by *Procytherura* with twelve species; these two accounting for 77 per cent of the fauna. The Cytherurinae are by far the most important of the three subfamilies of the Cytheruridae. With thirty species belonging to four genera, they make up 44.4 per cent of

the genera but 86 per cent of the species, while the Cytheropterinae comprise three genera and three species (11 per cent) and the Paracytherideinae with a single genus and species are very poorly represented.

The fact that several of the species are also known as far away as Europe, demonstrates the very important migratory links that existed between the two areas during the Mesozoic. Examples are particularly common among *Eucytherura* and *Procytherura* species (*Eucytherura gassumensis*, *E. michelseni*, *E. paranuda* [ex *Eucytherura nuda* (Brand)], *E. oeresundensis*, *E. transversiplicata*, *Procytherura celtica*, *P. mediocostata*). Others, such as *Eucytherura* sp. B of Boomer and Ballent and *Procytherura euglyphea*, recognized from sites to the southwest of the British Isles, off Northwest Africa and the Neuquén Basin (although not known from other parts of Britain and Europe), support the existence of the Hispanic Corridor as a migration route during the early–Middle Jurassic. The coeval occurrence of the genus *Paradoxorhyncha* in western Australia, southwest Madagascar and western Argentina indicates that it migrated along the southern shores of Gondwana during the early Bajocian. In the early Cretaceous, some species indicate close links with South Africa (*Procytherura brenneri*,

TABLE 2. Distribution of Cytheruridae throughout the Jurassic and early Cretaceous of the Neuquén Basin, west-central Argentina.

	Stage	Number of genera	Number of species
Cretaceous	Hauterivian	3	5
	Valanginian	2	3
	Berriasian	2	3
Jurassic	Tithonian	1	1
	Callovian	2	3
	Bajocian	1	1
	Aalenian-Bajocian	5	17
	Pliensbachian	2	7

P. maculata, *Eucytherura guillaumeae* [ex *E. tuberculata* Brenner and Oertli]) supporting the existence of a southern Gondwana seaway.

The fact that certain genera, such as *Kangarina*, hitherto not recorded below the Cretaceous, have been encountered in the late Aalenian–early Bajocian suggests that southern South America should be considered more seriously as an important locus of evolution for cytheroid ostracodes.

With respect to palaeoenvironmental preferences, Jurassic and early Cretaceous cytherurids seem to typify a marginal marine environment, with warm-temperate waters, normal salinity levels and low energy regime.

Acknowledgements. S. Fontana (Liverpool) and A. Benialgo (La Plata) helped us in many ways. An anonymous referee informed us about homonym names. Thanks also to the editor Professor Paul Smith for his many helpful suggestions. Funding for this study was provided by Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET) and Agencia Nacional de Promoción Científica y Tecnológica (PIP 5613 and ANPCYT 14143/03, respectively).

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