

OBSERVATIONS ON *LOXOCY THERE* (*LOXOCY THERE*)
OUYENENSIS (CHAPMAN, 1914) (OSTRACODA) FROM THE
CENOZOIC OF S.E. AUSTRALIA WITH COMMENTS ON SPECIES
ATTRIBUTED TO *MICROCY THERURA* MÜLLER, 1894 AND
HEMIPARVOCY THERE HARTMANN, 1982 FROM AUSTRALIAN
AND NEW ZEALAND MARINE WATERS.

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The type material of *Loxocythere* (*Loxocythere*) *ouyenensis* (Chapman, 1914) from mid Cenozoic strata of the Mallee Bore No. 11 in the Murray Basin, S.E. Australia is partially redescribed and refigured. This species belongs to a discrete group of large elongate Cenozoic fossil and living *Loxocythere* species, the carapaces of which possess sub-rectangular inner margin outlines, and broadly rounded posterior extremities. Some much smaller but otherwise very similarly shaped species, that have previously been placed under the genus *Microcytherura* (i.e. *Microcytherura?* *peterroyi* Yassini and Jones, 1995) or the genus *Hemiparvocyt here* Hartmann, 1982 (i.e. *Hemiparvocyt here lagunicola* Hartmann, 1982), are also known from marine Cenozoic strata and modern seas of the Australasian region. There is a marked difference in the shape of the inner margin between this group of small Australasian forms and European species of *Microcytherura* s.s.. The former have broadly rounded posterior inner margins, whilst the latter have acutely rounded posterior inner margins. The latter also usually present posterior extremities located well below mid carapace height. It is here argued that this difference in inner margin shape between smaller Australasian species such as *Microcytherura?* *peterroyi*, and European species of *Microcytherura* s. s., suggests that there is not a direct phylogenetic relationship between these two species groups.

Key words: Ostracoda, *Loxocythere* (*Loxocythere*) *ouyenensis*, *Microcytherura*, *Hemiparvocyt here*, Cenozoic, Australia, New Zealand

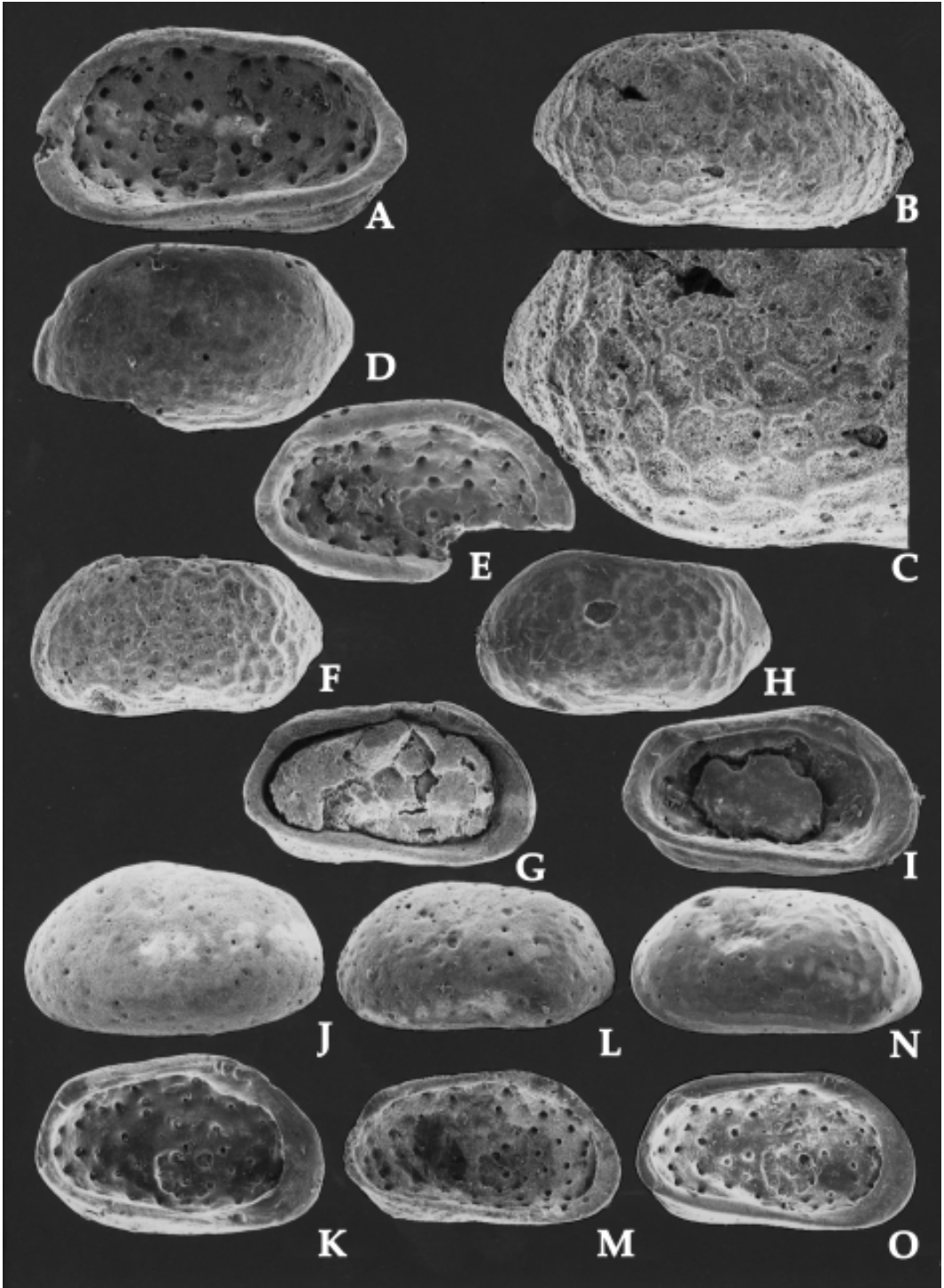
A VARIETY of species groups attributed to the genera *Loxocythere* Hornibrook, 1952 or *Microcytherura* Müller, 1894 have existed in Australasian marine waters throughout the Cenozoic and into the modern day. Previously, larger species have generally been assigned to the genus *Loxocythere* and smaller species to the genus *Microcytherura* (see also discussion in Warne, 2004). This paper will firstly describe the various species groups of the genus / subgenus *Loxocythere* (*Loxocythere*). Secondly, the phylogenetic relationship between some elongate *Loxocythere* (*Loxocythere*) species and some similarly shaped but smaller Australasian species, variously attributed to the genera *Microcytherura* and *Hemiparvocyt here* Hartmann, 1982, will be discussed. Thirdly, the type material of species *Loxocythere* (*Loxocythere*) *ouyenensis* (Chapman,

1914) will be reviewed. Specimens illustrated herein are housed in Museum Victoria and have the registration numbers, P12529, P122297, P311646 - P311652.

COMPARATIVE MORPHOLOGY

Loxocythere (*Loxocythere*) Hornibrook, 1952

There are three types or groups of species here recognised under the genus / subgenus *Loxocythere* (*Loxocythere*). The first, is the *Loxocythere* type species *L. (L.) crassa* Hornibrook, 1952, which has a thick shell, rugged reticulate ornament, subquadrate shaped inner margin and posterior extremity below mid height. The second group, which includes *L. (L.) kingi* Hornibrook, 1952 and *L. (L.) variaculpta*



Whatley *et. al.*, 1997, have subdued ornament, relatively elongate subrectangular carapaces / inner margins, and acutely rounded posterior outlines with valve posterior extremities well below mid height. The third group includes the species *L. (L.) hornibrooki* McKenzie, 1967, *L. (L.) ouyenensis* (Chapman, 1914), *L. (L.) inflata* Hanai, 1959 and *L. (L.)* sp. (this study), which also have relatively elongate subrectangular carapaces and inner margin outlines, but differ from other groups of *Loxocythere* (*Loxocythere*) species by possessing broadly rounded posterior extremities. This group of species is transitional in carapace morphology between *Loxocythere* (*L.*) *crassa* and species of the genus *Cythere* O. F. Müller, 1785 (see Hanai, 1959, p. 414-415; plate 28). Thus, *Loxocythere* (*Loxocythere*) species in groups two and three can be distinguished from *L. (L.) crassa* by possessing relatively elongate carapaces. Further, *Loxocythere* (*Loxocythere*) species in groups two and three can be distinguished from each other by differences in the shape of the posterior inner margin. These species groups are not designated as separate subgenera because the carapace shape differences that are used here to delineate species groups are rather gradational in nature. Species of *Loxocythere* (*Novoloxocythere*) Warne, 2004 can be clearly distinguished from *Loxocythere* (*Loxocythere*) spp. as the former possesses posterior extremities well above mid height (i.e. adjacent to the dorsal margin).

The species *L. (L.) crassa* is only known from the New Zealand region. Species in *Loxocythere* (*Loxocythere*) group two have been variously recorded from shallow marine waters or sedimentary facies of the New Zealand and Antarctic regions, and from the south-west Atlantic continental shelf. Species in *Loxocythere* (*Loxocythere*) group three are known from the western Pacific region, current records being from coastal Australasia and Japan.

Microcytherura G. W. Müller, 1894

The genus *Microcytherura* was originally established to accommodate European ostracod specimens with *Microcytherura nigrescens* G. W. Müller, 1894 being designated as the type species. A distinctive carapace characteristic of this species and other European species of *Microcytherura* such as *M. fulva* (Brady and Robertson, 1874) and *M. angulosa* (Seguenza 1880), is a strong oblique dorsal truncation of the posterior margin (see fig 2 A-D). These delicately ornamented species possess posterior extremities near or below mid carapace height and possess an acutely rounded and elongated posterior margin with a relatively small angle between a short posteroventral margin and longer posterodorsal margin. Species with this type of posterior carapace shape and delicate carapace surface ornament occur in European and nearby seas, and can be considered as one distinctive species group within the genus *Microcytherura*. One Australian species, *Microcytherura sulcata* Yassini and Jones, 1995, is similar in general shape to European *Microcytherura* spp., although differs by possessing a strongly ornamented carapace. In general shape and ornament *M. sulcata* resembles various west African species such as *Microcytherura reticulata* Hartmann, 1974 and *Microcytherura ornata* Jellinek, 1993. These three Australian / west African species make up a second, very distinctive group of species, within the genus *Microcytherura*. On the basis of similarities in carapace shape (in particular the presence of acutely rounded posteriors) these two *Microcytherura* species groups as outlined above are here considered to have a close phylogenetic relationship.

Within Australian shallow marine environments there is a diversity of cytherid "species groups" that have been attributed to the genus *Microcytherura*. Aside from *M. sulcata*, few of the species in these groups

Fig. 1. A–C. *Loxocythere* (*Loxocythere*) *ouyenensis* (Chapman, 1914). Holotype, right valve, adult, male(?), P12529, from Mallee No.11 bore (267–270 feet), mid Cenozoic. A. Internal view, x 100. B. External view, x 100. C. External view of ornament in posteroventral region of carapace, x 200. D–E. *Loxocythere* (*Loxocythere*) sp. Left valve, adult, female(?), P311652, from Nepean 1 borehole (178.3 m), late Late Miocene. D. External view, x 100. E. Internal view, x 100. F–G. *Loxocythere* (*Loxocythere*) *ouyenensis* (Chapman, 1914). Left valve, juvenile, male, P311646, nodule bed at base of Sandringham Sand (Black Rock Sandstone) outcropping on sea bed 30 metres offshore from a point on the beach at the base of coastal cliffs between the Beaumaris Motor Yacht Squadron and the old Keefer's Boathouse, Beaumaris, Victoria, latest Miocene or earliest Pliocene. F. External view, x 100. G. Internal view, x 100. H–I. *Loxocythere* (*Loxocythere*) *ouyenensis* (Chapman, 1914). Left valve, juvenile, female, P122297, from Koo-wee-rup 14 (87–113 m), early Middle Miocene. H. External view, x 100. I. Internal view, x 100. J–K. *Microcytherura*? sp. Left valve, adult, female, P311647, from Sherwood 18 (20m–22 m), late Late Miocene. J. External view, x 100. K. Internal view, x 100. L–M. *Microcytherura*? sp. Left valve, adult, male, P311648, from Sherwood 18 (20m–22 m), late Late Miocene. L. External view, x 100. M. Internal view, x 100. N–O. *Microcytherura*? sp. Left valve, adult, male, P311649, from Nepean 1 (178.3m), late Late Miocene. N. External view, x 100. O. Internal view, x 100.

have posterior carapace or inner margin shapes akin to those of European (or west African) *Microcytherura* species. One of these species groups, which includes the species *Microcytherura? peterroyi* Yassini and Jones, 1995, *Microcytherura? aestuaricola* Hartmann, 1980, *Microcytherura? triebeli* McKenzie, 1967 and *Microcytherura? sp.* (this study, Figs. 1J-O), possess broadly rounded posteriors with posterior extremities around (or slightly above / below) mid height. These posterior carapace shape characteristics are in contrast to those of European *Microcytherura* species, but are very similar to the posterior outlines of some (larger) species belonging to the genus *Loxocythere* (*Loxocythere*) such as *L. (L.) ouyenensis* (see Plates 1 & 2). It is here argued that the difference in inner margin shape between this group of Australasian "*Microcytherura*" species (with broadly rounded posterior margins), and species of *Microcytherura s.s.*, (i.e. European forms), suggests that there is not a direct phylogenetic relationship between these two species groups. Australasian species, such as *Microcytherura? peterroyi*, are herein thought to have evolved from ancestral stock allied to elongate *Loxocythere* (*Loxocythere*) species such as *L. (L.) ouyenensis* and as a result, considered examples of evolutionary modifications related to changes in carapace size. As a consequence, the genus *Microcytherura*, as it is generally and broadly applied to both European and Australian ostracod faunas, appears to be a polyphyletic taxon. However, if only applied to the European species (i.e. *M. nigrescens*,

M. fulva and *M. angulosa*), as well as perhaps Australian and west African species such as *M. sulcata*, this genus may represent a monophyletic cluster of species. The latter taxonomic framework is here considered preferable, although a full taxonomic review of Australian "*Microcytherura*" species is beyond the scope of this paper.

As illustrated here, particularly significant morphological similarities occur between juvenile valves of *Loxocythere* (*Loxocythere*) *ouyenensis* (i.e. Figs. 1 F - I) and adult specimens of the Australian taxon *Microcytherura? sp.* (Figs. 1J - O), although the latter tend to have slightly lower and less conspicuously caudate posterior extremities (just below mid-height). This observation suggests that pedomorphic processes, initially operating in *Loxocythere* "ancestral stock", may have contributed to the radiation and diversification of some smaller Australian Cenozoic groups of so-called *Microcytherura* species.

Hemiparvocythere Hartmann, 1980

Some very small Australasian species belonging to the family Parvocytheridae Hartmann, 1959 (for example *Hemiparvocythere lagunicola* Hartmann, 1982), are also similar in carapace morphology to larger Australian Cenozoic *Loxocythere* (*Loxocythere*) species, although there are marked differences in the soft part anatomy. In the Parvocytheridae, there is a reduction from three walking appendages (maxilla and two thoracic legs) to

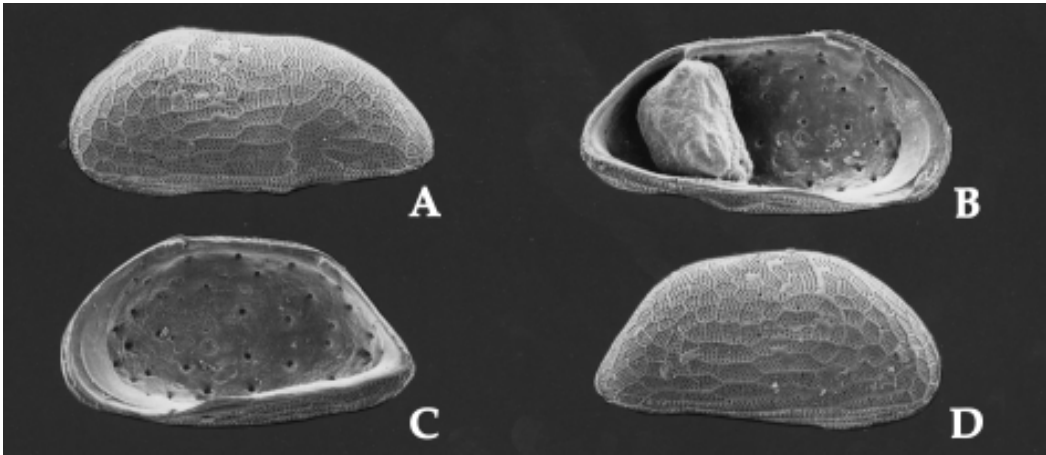


Fig. 2. *Microcytherura angulosa* (Seguenza, 1880) Specimens are from the seabed of the Adriatic Sea, Recent. A. Left valve, male, external view, P311650, x 100. B. Left valve, male, internal view, P311650, x100. C. Right valve, female, internal view, P311651, x 100. D. Right valve, female, external view, P311651, x 100.

only two (maxilla and one thoracic leg) reflecting adaptation to an interstitial environment (Hartmann and Puri, 1974). Despite this substantial difference in soft part anatomy, Hartmann and Puri (1974) commented that there is a close phylogenetic relationship between the Cytheridae Baird, 1850 and Parvocytheridae, the latter probably being derived from the former. The implication from this analysis by Hartmann and Puri (1974) is that close phylogenetic relationships are not always completely reflected in soft part anatomy, but rather may be more obvious in morphologically conservative carapace characters.

SYSTEMATIC PALAEOONTOLOGY

Subclass Ostracoda Latreille, 1806
Order Podocopida G.W. Müller, 1894
Suborder Podocopina Sars, 1866
Superfamily Cytheracea Baird, 1850
Family Cytheridae Baird, 1850
Subfamily Cytherinae Baird, 1850

Remarks: Most authors place the genus *Microcytherura* s.s. (European species') within the Cytheridae Baird (i.e. Jellinek, 1993), although as discussed by van Morkhoven, 1963, there is good evidence for the genus being placed within the Cytheruridae Müller, 1894. The latter view brings into question the often assumed close taxonomic relationship between *Loxocythere* and *Microcytherura* (i.e. Howe and McKenzie, 1989; Hartmann, 1982; McKenzie *et al.*, 1993; Yassini and Jones, 1995). This controversy is not here resolved. However it is the view of the present author that European species

of *Microcytherura* are congeneric with the more robustly ornamented west African species *M. reticulata* and *M. ornata*, and one Australian species, *M. sulcata*. Members of this ornate group of *Microcytherura* species, and the European species *Microcytherura angulosa*, (Seguenza, 1880) bear a close resemblance in inner margin outline to the New Zealand species *Loxocythere (Loxocythere) kingi*. All these species have a relatively elongated carapace posterior that is acutely rounded, the extremity of which is positioned adjacent to, or near, the ventral margin. This observation suggests that a common family level taxonomic association is warranted for the genera *Microcytherura* and *Loxocythere*.

Whilst most Cytherinae species possess a relatively simple merodont (hemimerodont or antimero-dont) hinge, some species such as *Loxocythere (L.) crassa* Hornibrook, 1952 have pentodont – like terminal thickenings of the medium hinge element (pseudopentodont hinge sensu Warne, 1996; see Hartmann 1982, Pl. 1, figs. 7 & 8). A pseudopentodont hinge is also apparent in the species *Microcytherura angulosa* (figs. 2B and 2C herein; see also Bonaduce *et al.*, 1975, Pl. 46, figs 4 -6). However, for these two species, this medium hinge feature is associated with typically crenulated or lobed, and overall subrectangular shaped cytherine posterior hinge elements, and not with the generally smooth, rounded or arched posterior hinge elements characteristic of the true pentodont hinges; the latter as usually found in leptocytherid species belonging to the subfamily Pectocytherinae Hanai, 1957. Similarly, the parvocytherid *Hemiparvocythere lagunicola* Hartmann, 1982 also displays terminal thickening of the medium hinge element (Hartmann, 1982; Plate 5, figures, 4 & 5).

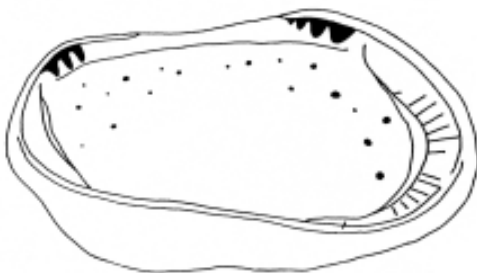


Fig. 3 *Loxocythere (Loxocythere) ouyensis* Chapman, 1914; line drawing, left valve, juvenile, female(?), internal view, P122297, from Koo-wee-rup 14 (87–113 m), early Middle Miocene, x 150.

Genus *Loxocythere* Hornibrook, 1952

Subgenus *Loxocythere* Hornibrook, 1952

Type species, *Loxocythere crassa* Hornibrook, 1952

Remarks: Prior to the present study, a number of taxonomic schemes had been proposed for the genera *Microcytherura* Müller, 1894, *Tetracytherura* Ruggieri, 1952 and *Loxocythere* Hornibrook, 1952. Ruggieri (1959) and Hanai (1957) regarded *Tetracytherura* [type species = *M. angulosa* (Seguenza, 1880)] as a junior synonym of *Loxocythere* while van Morkhoven (1963) and Hartmann (1979) regarded *Tetracytherura* as a junior synonym of

Microcytherura. McKenzie (1967) and Bonaduce *et. al.* (1975) maintained it as a separate genus. Whilst the type species of the genus *Tetracytherura* is much less elongate than the type species of *Microcytherura*, it is here considered that this morphology difference is insufficient in extent to recognise two separate genera. Hartmann (1980) considered *Loxocythere* a subgenus of *Microcytherura*, with *Microcytherura* (*Microcytherura*) being smaller and possessing only one type of normal pore canal, and *Microcytherura* (*Loxocythere*) being relatively large and possessing three types of normal pore canal. However, given the problematic family level taxonomic relationship between *Microcytherura* and *Loxocythere* (see above discussion) it would seem appropriate for the present to regard both as discrete genera. Some European loxoconchid species, such as *Elofsonia baltica* (Hirschmann), are convergent in carapace morphology towards some elongate *Loxocythere* species, although the former are generally thin shelled and less ventrally inflated.

Loxocythere (Loxocythere) ouyenensis

(Chapman, 1914)
Figs. 1A-C, F-I; 3.

1914 *Cytherura ouyenensis* Chapman, p. 44 -45, pl.8, figs. 35a,b

1916 *Cytherura ouyenensis* Chapman, p. 379, pl. 74, figs. 35a & b

1981 *Loxocythere ouyenensis* Chapman, McKenzie, p. 106.

1987 *Loxocythere* sp.6 Warne, p.441.

Holotype: Adult, right valve, P12529

Type Locality: Mallee Bore 11 at 267 -270 feet (see Chapman 1914 for further details)

Material. The type specimen is from subsurface mid Cenozoic marls of the Murray Basin, Victoria, Australia (Fig. 1 A-C). Additional, mostly juvenile specimens examined for this study come from mid Miocene and Late Miocene shallow marine sand facies of the Port Phillip and Western Port Basins (Figs. 1F-I;3). Details of localities in the Port Phillip Basin and the Western Port Basin that are listed in the figure captions can be found in Warne, 1993 and 2002.

Additional description: The following comments are modifications or expansions of descriptive comments provided by Chapman, 1914 (p. 44 - 45). Carapace large, elongate, subrectangular and thick shelled with a faint, reticulate ornament (varies in strength between specimens). Carapace with posteroventral inflation that slightly overhangs the posteroventral margin. Posterior extremity of RV at about mid-height and slightly caudate; anterior extremity slightly below mid height. In RV maximum height anterior of mid length. Adductor muscle scar pattern consisting of a vertical row of four individual oblong scars. Inner margin well calcified in both adult and juvenile specimens. Normal pore canals numerous and very large, particularly as viewed from an internal perspective. Hinge is merodont with a smooth median element and laterally elongate and strongly crenulated terminal hinge elements.

Dimensions: Holotype, right valve, adult, P12529, length = 0.55 mm, height = 0.29 mm

Remarks: The dimensions of the holotype of *Loxocythere* (*Loxocythere*) *ouyenensis* recorded here are less than those recorded by Chapman, 1914. The Pleistocene S. E. Australian species *Loxocythere* (*L.*) *posteventrobullata* McKenzie, *et. al.*, 1990 differs from *L.* (*L.*) *ouyenensis* only by possessing a slightly more inflated posteroventral margin; the former being a closely related descendant, or junior synonym of the latter. The latest Miocene S.E. Australian species *Loxocythere* (*Loxocythere*) sp. (Fig. 1 D - E) differs by possessing a smooth carapace (except for very faint reticulation in posterior third of carapace) and a greater height to length ratio.

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