Overview of Recent and Holocene ostracods (Crustacea) from brackish and marine environments of Portugal

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ABSTRACT – An extensive overview of Recent and Holocene ostracods from brackish and marine environments of Portugal is presented for the first time. 178 species belonging to 75 genera have been found all are listed and illustrated with SEM images. From those species only 30 were found alive, most of them living in marginal-marine environments. Some comments on the 30 species found alive and a summary of main results are also presented. The data come from unpublished notes, reports of several research projects, observations on Recent ostracods in sediments from different estuaries of the western coast of Portugal and from the western Algarve continental shelf and slope, Masters theses and published papers. J. Micropalaeontol. 32(2): 135–159, July 2013.

KEYWORDS: Ostracoda list, marginal-marine, continental shelf, Quaternary, Portugal

INTRODUCTION
There are very few papers about the Recent marine and brackish ostracods of mainland Portugal. The first contribution was published by Paulo (1969), where only five species (1 brackish, 4 freshwater) from Castelo do Queio, Porto were described. Later, Paulo & Moutinho (1983) listed 33 species, most of them from freshwater habitats. More recently, in Loureiro et al. (2009), ostracods of the Mira estuary were studied, both alive (autoclonous) and transported by tidal currents. Cabral et al. (2011b) is the first reference to the ostracods from the Portuguese continental shelf. In these two latter works some species are figured.

Information about Holocene ostracods has started appearing more recently, with several papers published since 1999: Hindson & Andrade (1999), Hindson et al. (1999), Cearreta et al. (2003), Cabral et al. (2006, 2011a), Hilbich et al. (2008), van der Schriek et al. (2008), Almeida et al. (2009) and Lord et al. (2011). In all these papers ostracods come from long boreholes taken from marginal-marine sediments; the ostracods are figured only in Cabral et al. (2006) and Lord et al. (2011).

In spite of their specific merits, most of these works lack scanning electron microscope (SEM) illustrations, which would have rendered them much more useful for comparison with ostracods from other Atlantic and Mediterranean coastal regions. In this work we present, for the first time, an overview of the distribution of Recent and Holocene brackish and marine ostracods in Portugal, with full SEM photographic documentation. In addition, gathering a broad dataset in a single survey allows us to make well-supported conclusions on palaeoenvironmental, palaeoecological and stratigraphical issues. Freshwater ostracods are not considered in this work, though some of the known species live in slightly saline inland and coastal environments. Recently, an overview of these freshwater Portuguese species was published by Martins et al. (2010).

MATERIAL AND METHODS
The list presented here is based on unpublished notes (MCC), reports of several research projects (MCC), observations of one of the authors (MCC) on Recent ostracods in sediments from different estuaries of western Portugal and from the Algarve continental shelf and slope. The data come from unpublished notes, reports of several research projects, observations on Recent ostracods in sediments from different estuaries of the western coast of Portugal and from the western Algarve continental shelf and slope, Masters theses and published papers. J. Micropalaeontol. 32(2): 135–159, July 2013.

The taxa have been identified only on the basis of carapaces without soft parts. Most of the Recent marine taxa, from the continental shelf or slope and from the tidal flats of the lower part of the estuaries, were found in fine-grained sediments, as separate valves, therefore limiting knowledge of where they really live today in the areas where they have been found. The material from the continental shelf and slope was frequently abundant, well preserved and represented by several ontogenic stages suggesting, in this case, that it was in situ. The material from the tidal flats was generally represented by rare valves of each species, frequently worn.

The brackish forms from the tidal marshes were generally collected in muddy sediment, and most of them were found alive, as indicated in the list. Only a few brackish forms from the tidal marshes were collected in fine sand or silty sand substrates. The brackish marine forms from rock tidal pools and from the transect along the Laje River were collected both on algae and on sandy substrate. The marine forms from the continental shelf and slope were collected with a Smith-McIntyre (SMT) grab, in fine sediment patches (sand fraction generally <50%). Forms were identified as alive when containing the soft parts (appendages) and pink staining due to Rose Bengal. The material from the tidal marshes was collected in two different seasons, generally in autumn and spring, very rarely at the beginning of winter and of summer; the material from the continental shelf and slope was collected during winter (January 2008) and spring (June 2008). Salinity and temperature values from tidal flat, low and high marsh sampling points were measured at low tide in the interstitial sediment water. The records were collected up to May 2012.

The taxonomy follows Horne et al. (2002). For the identification of most of the species, Athersuch et al. (1989) and Bonaduce
et al. (1976) were used. For some genera or species, several other works were also used: Aiello et al. (1996), Athersuch (1976b), Athersuch & Horne (1987), Barbeito-González (1971), Breman (1975), Ciampo (1976), Colalongo & Pasini (1980), Coles et al. (1994, 1996), Horne & Whittaker (1985), Horne et al. (2004), Lachenal (1989), Schornikov & Keyser (2004), Whatley & Masson (1980) and Yassini (1969, 1979) and many Stereo-Atlas of Ostracod Shells papers, e.g. Athersuch (1976a, 1981), Athersuch & Horne (1983), Athersuch & Whittaker (1982a, b, 1976), Doruk (1974), Guillaume (1988), Horne (1989), Horne & Robinson (1982, 1985) and Whittaker (1978a, b).

All the studied specimens are deposited in the Cabral Collection of the Department of Geology, Faculty of Sciences, University of Lisbon.

STUDY AREA
Recent material comes from several different estuaries of the western Portuguese coast, two in the NW, three in the SW (Fig. 1) – transects of tidal marsh zones, across the tidal flat, low marsh (Spartina) and high marsh (Salicornia) – and from the Algarve continental shelf and slope (Fig. 2):

Minho River and its Coura tributary – 2 transects, 1 in the Coura confluence with the Minho River (CP), 1 in the lower Minho estuary (PR).

Lima River – 1 transect in the lower estuary (NSR), 2 transects in the mid-estuary (DAR and BPR).

Tejo River and its Trancão and Laje tributaries – 2 transects in the lower Tejo estuary (ALF and ROS), 1 transect in the lower Trancão estuary (TRA), 100 m from the confluence with Tejo (mid Tejo estuary), 1 transect along the lower Laje River estuary (LAJ), from the mouth to 350 m upriver (lowest part of Tejo estuary/Atlantic ocean) and 2 rock intertidal pools nearby, in Santo Amaro de Oeiras beach.

Sado River – 3 transects in the lower estuary (FAR, CAR, TRO), 1 transect in the mid-estuary (ALC).

Fig. 1. Location map of the transects in the Portuguese estuaries: A – Minho estuary (CP and PR) and Lima estuary (NSR, DAR, BPR). B – Tejo estuary (LAJ, TRA, ALF and ROS) and Sado estuary (FAR, CAR, TRO and ALC). C – Mira estuary (PMF, MAS, CBR and FLP).
Recent and Holocene ostracods from Portugal

Mira River – 2 transects in the lower estuary (PMF and MAS), 2 transects in the mid-estuary (CBR and FLP).

Material also comes from the continental shelf and slope of western Algarve (south Portugal), between Sagres and Faro – 9 sites in the continental shelf (1, 3, 5, 6, 8, 9, 12, 13 and 14) ranging in depth from –58 to –125 m and 2 sites in the continental slope (11 and 23), respectively at c. –220 m and c. –500 m deep.

Holocene material comes from several boreholes located in coastal lagoons or estuaries (Fig. 3). From north to south: Pederneira lagoon, west Portugal – 2 long boreholes, both in the Recent alluvial plain of Alcoa River, 1 in the inner ancient lagoon (S2), another in the middle ancient lagoon (S3). Sizandro estuary/lagoon, west Portugal – 1 long borehole in the alluvial plain of Sizandro River, around 10 km from coast (RS06_1). Tejo estuary – 1 long borehole in Lisboa central urban area (esteiro da Baixa), Praça do Comércio (PC), and a 4 m core from a marsh area in Seixal bay (DWK2).

Melides lagoon, SW Portugal – 2 long boreholes, one in the alluvial plain of the Recent lagoon (MIGM), another in the sand barrier (MB). Santo André lagoon, SW Portugal – 1 long borehole in the alluvial plain of the Recent lagoon (LSA).

List of Brackish and Marine Ostracoda Found in Portugal

Systematics according to Horne et al. (2002). Identifications based primarily on Athersuch et al. (1989) and Bonaduce et al. (1976). Note that primary author sources for individual species have been consulted but, for brevity, are not all listed in the References.

Note: Includes all records, both live forms and dead carapaces/vales. The localities (generally estuaries) where the Recent forms occurred are ordered from north to south; the localities where the Holocene forms occurred are ordered alphabetically. Species which are referred as cf. compare fairly closely with known species (they present almost all the characteristics of the species, but differ in one or two details, frequently because they are either worn or juveniles); species referred as aff. are probably new, but present some similarities with existing species.

Class Ostracoda Latreille, 1806
Subclass Myodocopa Sars, 1866
Order Halocyprida Dana, 1853
Suborder Cladocopina Sars, 1866
Superfamily Cladocopioidea Sars, 1866
Family Polycopidae Sars, 1866
Genus Polycop Sars, 1866
Polycop reticulata G. W. Müller, 1894 – Mira (Pl. 1, fig. 1)

Subclass Podocopa Sars, 1866
Order Platycopida Sars, 1866
Suborder Platycopina Sars, 1866
Superfamily Cytherelloidea Sars, 1866
Family Cytherellidae Sars, 1866
Genus Cytherella Jones, 1849
Cytherella alvearium Bonaduce, Ciampo & Masoli, 1976 – continental shelf and slope (Pl. 1, fig. 2)
Cytherella robusta Colalongo & Pasini, 1980 – continental shelf and slope (Pl. 1, fig. 3)
Cytherella thrakiensis Stambolidis, 1980 – Mira (Pl. 1, fig. 4)
Cytherella cf. vulgata Ruggieri, 1962 – continental shelf (Pl. 1, fig. 5)
Genus Cytherelloidea Alexander, 1929
Cytherelloidea cf. sordida (G. W. Müller, 1894) – Holocene Lisboa (Pl. 1, fig. 6)

Order Podocopida Sars, 1866
Suborder Cytherocopina Gründel, 1967
Superfamily Cytheroidea Baird, 1850
Family Bythocytheridae Sars, 1866

Fig. 2. Location of the studied sites on the western continental shelf and slope of Algarve.
Genus *Bythocythere* Sars, 1866

*Bythocythere bradyi* Sars, 1926 – Mira (Pl. 1, fig. 7)

*Bythocythere intermedia* Elofson, 1938 – Mira, Holocene Lisboa (Pl. 1, fig. 8)

Genus *Pseudocythere* Sars, 1866

*Pseudocythere caudata* Sars, 1866 – continental shelf, Mira (Pl. 1, fig. 9)

*Pseudocythere cf. abbreviatus* Brady & Robertson, 1869 – Mira, Holocene Lisboa (Pl. 1, fig. 10)

*Sclerochilus gewemuelleri* Dubowsky, 1939 – Lima, Mira (Pl. 1, fig. 11)

Genus *Sclerochilus* Sars, 1866

*Sclerochilus cf. abbreviatus* Brady & Robertson, 1869 – Mira, Holocene Lisboa (Pl. 1, fig. 10)

Family *Cuneocytheridae* Mandelstam, 1959

**Explanation of Plate 1**

| Plate Number | Image Description |
|--------------|-------------------|
| 1            | *Polycope reticulata* G. W. Müller, 1894, LV, external; Mira-PMF, P2 (aut.). |
| 2            | *Cytherella alvearium* Bonaduce, Ciampo & Masoli, 1976, LV, external; site 12 (POP 0108). |
| 3            | *Cytherella robusta* Colalongo & Pasini, 1980, LV, external; site 11 (POP 0108). |
| 4            | *Cytherella thrakiensis* Stambolidis, 1980, RV, external; Mira-MAS, P1 (spr.). |
| 5            | *Cytherella cf. vulgata* Ruggieri, 1962, RV, external; site 12 (POP 0608). |
| 6            | *Cytherelloidea cf. sordida* (G. W. Müller, 1894), LV, external; Lisboa, PC-10.66-10.67. |
| 7            | *Bythocythere bradyi* Sars, 1926, RV, external; Mira-MAS, P1 (aut.). |
| 8            | *Bythocythere intermedia* Elofson, 1938, LV, external, m; Mira-MAS, P2 (spr.). |
| 9            | *Pseudocythere caudata* Sars, 1866, RV, external, f; Mira-MAS, P1 (spr.). |
| 10           | *Sclerochilus cf. abbreviatus* Brady & Robertson, 1869, RV, external, f; Mira-MAS, P1 (aut.). |
| 11           | *Sclerochilus gewemuelleri* Dubowsky, 1939, LV, external, ?m; Mira-MAS, P1 (spr.). |
| 12           | *Cuneocythere semipunctata* (Brady, 1868), RV, external; Mira-MAS, P2 (aut.). |
| 13           | *Pontocythere elongata* (Brady, 1868), RV, external; Mira-MAS, P2 (aut.). |
| 14           | *Cyprideis torosa* (Jones, 1850), RV, external; Mira-MAS, P2 (aut.). |
| 15           | *Cytheroma variabilis* G. W. Müller, 1894, C, right view; Mira-MAS, P1 (spr.). |
| 16           | *Cytheropteron depressum* Brady & Norman, 1889, LV, external; Mira-MAS, P1 (aut.). |
| 17           | *Cytheropteron dorso-costatum* Whatley & Masson, 1980, LV, external; Mira-MAS, P1 (spr.). |
| 18           | *Cytheropteron latum* G. W. Müller, 1894, RV, external, m; Mira-MAS, P2 (spr.). |
| 19           | *Cytheropteron monoceros* Bonaduce, Ciampo & Masoli, 1976, LV, external; site 12 (POP 0108). |
| 20           | *Cytheropteron punctatum* Brady, 1868, LV, external; site 11 (POP 0608). |
| 21           | *Cytheropteron aff. punctatum* Brady, 1868, LV, external; site 11 (POP 0608). |
Genus *Cuneocythere* Lienklaus, 1894
*Cuneocythere semipunctata* (Brady, 1868) – continental shelf, Mira, Holocene Lisboa, Pederneira (Pl. 1, fig. 12)

Family *Cushmaniidae* Puri, 1974
Genus *Pontocythere* Dubowsky, 1939
*Pontocythere elongata* (Brady, 1868) – Lima, Mira, Holocene Lisboa, Melides, Pederneira, Santo André (Pl. 1, fig. 13)

Family *Cytherideidae* Sars, 1925
Genus *Cyprideis* Jones, 1857
*Cyprideis torosa* (Jones, 1850) – Lima, Tejo (alive), Laje, Sado (alive), Mira, Holocene Lisboa, Melides, Pederneira, Santo André, Seixal, Sizandro (Pl. 1, fig. 14)

Family *Cytheromatidae* Elofson, 1939
Genus *Cytheroma* G. W. Müller, 1894
*Cytheroma variabilis* G. W. Müller, 1894 – continental shelf, Mira, Holocene Lisboa (Pl. 1, fig. 15)

Family *Cytheruridae* G. W. Müller, 1894
Genus *Cytheropteron* Sars, 1866
*Cytheropteron depressum* Brady & Norman, 1889 – Mira, Holocene Lisboa, Melides, Pederneira (Pl. 1, fig. 16)
*Cytheropteron dorosocatum* Whatley & Masson, 1980 – continental shelf, Lima, Mira, Holocene Lisboa, Pederneira (Pl. 1, fig. 17)
*Cytheropteron latum* G. W. Müller, 1894 – continental shelf and slope, Mira, Holocene Lisboa (Pl. 1, fig. 18)
*Cytheropteron monoceros* Bonaduce, Ciampo & Masoli, 1976 – continental shelf and slope (Pl. 1, fig. 19)
*Cytheropteron punctatum* Brady, 1868 – continental slope (Pl. 1, fig. 20)
*Cytheropteron aff. punctatum* Brady, 1868 – continental slope (Pl. 1, fig. 21)
*Cytheropteron cf. ruggeri Pucci, 1956 sensu Bonaduce, Ciampo & Masoli, 1976 – continental shelf and slope (Pl. 2, fig. 1)
*Cytheropteron sulcatum* Bonaduce, Ciampo & Masoli, 1976 – continental shelf (Pl. 2, fig. 2)
*Cytheropteron testudo* Sars, 1869 – continental slope (Pl. 2, fig. 3)
*Cytheropteron vespertilio* (Reuss, 1850) – continental shelf, Mira (Pl. 2, fig. 4)
*Cytheropteron volantium* Whatley & Masson, 1980 – continental shelf (Pl. 2, fig. 5)
*Cytheropteron zinzulusae* Bonaduce, Ciampo & Masoli, 1976 – continental shelf (Pl. 2, fig. 6)
*Genus Eucytherura* G. W. Müller, 1894
*Eucytherura complexa* (Brady, 1866) – continental shelf, Mira, Holocene Lisboa (Pl. 2, fig. 7)
*Eucytherura mistrettai* Sissingh, 1972 – continental shelf, Mira, Holocene Lisboa (Pl. 2, figs 8–9)
*Genus Hemicytherura* Elofson, 1941
*Hemicytherura cellulosa* (Norman, 1865) – continental shelf, Lima, Holocene Lisboa (Pl. 2, figs 10–11)
*Hemicytherura defiorei* Ruggieri, 1953 – continental shelf, Mira (Pl. 2, fig. 12)
*Hemicytherura aff. defiorei* Ruggieri, 1953 – Mira, Holocene Melides, Pederneira (Pl. 2, fig. 13)
*Hemicytherura hoskini* Horne, 1981 – continental shelf, Lima, Mira, Holocene Pederneira (Pl. 2, fig. 14)
*Hemicytherura videns* (G. W. Müller, 1894) – continental shelf, Lima, Mira, Holocene Pederneira (Pl. 2, fig. 15)
*Genus Microcytherura* G. W. Müller, 1894
*Microcytherura fulva* (Brady & Robertson, 1874) – continental shelf and slope, Lima, Mira, Holocene Lisboa, Melides, Pederneira (Pl. 2, fig. 16)
*Microcytherura cf. nigrescens* G. W. Müller, 1894 – Mira (Pl. 2, fig. 17)
*Genus Pseudocytherura* Dubowsky, 1939
*Pseudocytherura calcarata* (Seguenza, 1880) – Mira, Holocene Lisboa (Pl. 2, fig. 18)
*Genus Semicytherura* Wagner, 1957
*Semicytherura acuminata* (G. W. Müller, 1894) – continental shelf, Mira, Holocene Lisboa (Pl. 2, fig. 19)
*Semicytherura acuta* (G. W. Müller, 1912) – continental shelf, Mira, Holocene Lisboa, Melides (Pl. 2, fig. 20)
*Semicytherura acuticostata* (Sars, 1866) – Mira, Holocene Lisboa (Pl. 2, fig. 21)
*Semicytherura acuticostata ventricosa* (Sars, 1866) – continental slope, Mira, Holocene Lisboa, Melides, Pederneira (Pl. 3, fig. 1)
*Semicytherura aff. alifera* Ruggieri, 1959 – Mira (Pl. 3, fig. 2)
*Semicytherura angulata* (Brady, 1868) – Lima, Holocene Lisboa, Pederneira (Pl. 3, fig. 3)
*Semicytherura aff. angulata* (Brady, 1868) – continental shelf and slope, Mira, Holocene Lisboa, Melides (Pl. 3, fig. 4)
*Semicytherura arcachonensis* Yassini, 1969 – Lima, Mira, Holocene Lisboa, Pederneira (Pl. 3, fig. 5)
*Semicytherura cornuta* (Brady, 1868) – Mira, Holocene Lisboa (Pl. 3, fig. 6)

**Explanation of Plate 2.** LV, left valve; RV, right valve; C, carapace; f, female; m, male; j, juvenile; aut., autumn; spr., spring. Scale bar 100 µm.
**fig. 1.** *Cytheropteron cf. ruggeri Pucci, 1956 sensu Bonaduce, Ciampo & Masoli, 1976, RV, external; site 1 (POP 00108).* **fig. 2.** *Cytheropteron sulcatum Bonaduce, Ciampo & Masoli, 1976, RV, external; site 12 (POP 00108).* **fig. 3.** *Cytheropteron testudo Sars, 1869, LV, external; site 23 (POP 00108).* **fig. 4.** *Cytheropteron vespertilio* (Reuss, 1850), LV, external; site 12 (POP 00608).* **fig. 5.** *Cytheropteron volantium Whatley & Masson, 1980, LV, external; site 12 (POP 01008).* **fig. 6.** *Cytheropteron zinzulusae* Bonaduce, Ciampo & Masoli, 1976, LV, external; site 11 (POP 00108).* **fig. 7.** *Eucytherura complexa* (Brady, 1866), RV, external; site 13 (POP 00608).* **figs 8, 9.** *Eucytherura mistrettai* Sissingh, 1972, site 13 (POP 00608).* **figs 10, 11.** *Hemicytherura cellulosa* (Norman, 1865): **10.** RV, external; Lima-NSR, P1 (spr.); **11.** C, right view, m; Mira-PMF, P1 (aut.). **fig. 12.** *Hemicytherura defiorei* Ruggieri, 1953, RV, external; Mira-PMF, P1 (spr.). **fig. 13.** *Hemicytherura aff. defiorei* Ruggieri, 1953, LV, external; Mira-MAS, P1 (aut.). **fig. 14.** *Hemicytherura hoskini* Horne, 1981, RV, external; Mira-PMF, P1 (aut.). **fig. 15.** *Hemicytherura videns* (G. W. Müller, 1894), RV, external; Mira-CBR, P2 (spr.). **fig. 16.** *Microcytherura fulva* (Brady & Robertson, 1874). C, right view; Mira-MAS, P1 (aut.). **fig. 17.** *Microcytherura cf. nigrescens* G. W. Müller, 1894, C, left view; Mira-PMF, P5 (aut.). **fig. 18.** *Pseudocytherura calcarata* (Seguenza, 1880), LV, external; Mira-MAS, P1 (spr.). **fig. 19.** *Semicytherura acuminata* (G. W. Müller, 1894), RV, external; Mira-MAS, P1 (spr.). **fig. 20.** *Semicytherura acuta* (G. W. Müller, 1912), RV, external; Mira-MAS, P1 (spr.). **fig. 21.** *Semicytherura acuticostata* (Sars, 1866), RV, external, 20 µm; Mira-MAS, P1 (spr.).
Recent and Holocene ostracods from Portugal
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*Semicytherura occulta* Bonaduce, Ciampo & Masoli, 1976 – continental shelf, Holocene Lisboa (Pl. 3, fig. 7)

*Semicytherura cf. producta* (Brady, 1868) – Lima, Mira, Holocene Lisboa (Pl. 3, fig. 8)

*Semicytherura quadridentata* (Hartmann, 1953) – Mira (Pl. 3, fig. 9)

*Semicytherura robertsi* Whittaker & Horne, 2009 – Holocene Lisboa, Melides, Pederneira (Pl. 3, fig. 10)

*Semicytherura robusta* Bonaduce, Ciampo & Masoli, 1976 – continental shelf, Holocene Lisboa (Pl. 3, fig. 11)

*Semicytherura sella* (Sars, 1866) – Lima, Mira, Holocene Lisboa, Melides, Pederneira (Pl. 3, fig. 12)

*Semicytherura simplex* (Brady & Norman, 1889) – Mira, Holocene Lisboa, Melides (Pl. 3, fig. 13)

*Semicytherura cf. stillifera* Bonaduce, Ciampo & Masoli, 1976 – continental shelf, Mira, Holocene Lisboa (Pl. 3, fig. 14)

*Semicytherura striata* (Sars, 1866) – continental shelf, Lima, Mira, Holocene Lisboa, Melides, Pederneira (Pl. 3, fig. 15)

*Semicytherura cf. sulcata* (G. W. Müller, 1894) – Mira, Holocene Lisboa, Melides, Pederneira (Pl. 3, fig. 16)

*Semicytherura tela* Horne & Whittaker, 1980 – Santo Amaro de Oeiras (rockpool, alive), Sado, Mira, Holocene Lisboa (Pl. 3, fig. 17)

*Semicytherura undata* (Sars, 1866) – Holocene Lisboa (Pl. 3, fig. 18)

Genus *Tetracytherura* Ruggieri, 1952

*Tetracytherura angulosa* (Seguenza, 1880) – continental shelf, Mira, Holocene Lisboa (Pl. 3, fig. 19)

Genus *Typhlocythere* Bonaduce, Ciampo & Masoli, 1976

*Typhlocythere ruggieri* Bonaduce, Ciampo & Masoli, 1976 – continental slope (Pl. 3, fig. 20)

Family *Eucytheridae* Puri, 1954

Genus *Eucythere* Brady, 1868

*Eucythere anglica* Brady, 1868 – continental shelf and slope (Pl. 3, fig. 21)

*Eucythere argus* (Sars, 1866) – Holocene Pederneira (Pl. 4, fig. 1)

*Eucythere prava* Brady & Robertson, 1869 – Mira, Holocene Lisboa, Pederneira (Pl. 4, fig. 2)

Family *Hemicytheridae* Puri, 1953

Genus *Aurila* Pokorny, 1955

*Aurila arborescens* (Brady, 1865) – Holocene Lisboa, Melides, Pederneira, Santo André (Pl. 4, fig. 3)

*Aurila convexa* (Baird, 1850) – continental shelf and slope, Lima, Santo Amaro de Oeiras (rockpool), Laje, Mira, Holocene Lisboa, Melides, Pederneira, Santo André (Pl. 4, fig. 4)

*Aurila woutersi* Horne, 1986 – Lima, Mira, Holocene Lisboa, Pederneira (Pl. 4, fig. 5)

Genus *Caudites* Coryell & Fields, 1937

*Caudites calceolatus* (O. G. Costa, 1853) – continental shelf, Lima, Mira, Holocene Lisboa, Pederneira (Pl. 4, fig. 6)

Genus *Finnmarchinella* Swain, 1963

*Finnmarchinella angulata* (Sars, 1866) – Holocene Lisboa (Pl. 4, fig. 7)

Genus *Hemicythere* Sars, 1925

*Hemicythere robusta* (Brady, 1868) – Holocene Lisboa (Pl. 4, fig. 8)

*Hemicythere villosa* (Sars, 1866) – Lima, Holocene Lisboa (Pl. 4, fig. 9)

Genus *Heterocythereis* Elocson, 1941

*Heterocythereis albomaculata* (Baird, 1838) – continental shelf, Minho, Lima, Santo Amaro de Oeiras (rockpool, alive), Laje (alive), Mira, Holocene Lisboa, Melides, Pederneira, Santo André (Pl. 4, fig. 10)

Genus *Urocythereis* Ruggieri, 1950

*Urocythereis britannica* Athersuch, 1977 – continental shelf and slope, Lima, Sado, Mira, Holocene Lisboa, Melides, Pederneira, Santo André, Seixal (Pl. 4, fig. 11)

Family *Kritididae* Mandelstam, 1960

Genus *Krithe* Brady, Crosskey & Robertson, 1874

*Krithe keyi* Breman, 1978 – continental slope (Pl. 4, fig. 12)

Genus *Parakrithe* Van den Bold, 1958

*Parakrithe dimorpha* Bonaduce, Ciampo & Masoli, 1976 – continental slope (Pl. 4, fig. 14)

Genus *Pseudopsammocythere* Carbonnel, 1966

*Pseudopsammocythere similis* (G. W. Müller, 1894) – continental shelf and slope (Pl. 4, fig. 15)

Family *Leptocytheridae* Hanai, 1957

*Callistocythere* Ruggieri, 1953

*Callistocythere badia* (Norman, 1862) – Santo Amaro de Oeiras (rockpool, alive), Laje, Mira, Holocene Lisboa, Melides, Pederneira, Santo André (Pl. 4, fig. 16)

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**Explanation of Plate 3**

- **LV.** Left valve; **RV.** Right valve; **C.** Carapace; **f.** Female; **m.** Male; **j.** Juvenile; **aut.** Autogenous; **spr.** Spring. Scale bar 100 µm.
- **fig. 1.** *Semicytherura acutocosta* ventricosa (Sars, 1866) – Limousin, m; Mira-MAS, P1 (aut.).
- **fig. 2.** *Semicytherura aff. aliformis* Ruggieri, 1959 – Limousin, m; Mira-MAS, P1 (spr.).
- **fig. 3.** *Semicytherura angulata* (Brady, 1868), C; Limousin, f; Mira-NSR, P1 (spr.).
- **fig. 4.** *Semicytherura aff. angulata* (Brady, 1868), C; Limousin, f; Mira-NSR, P1 (spr.).
- **fig. 5.** *Semicytherura arachchonelus* Yassini, 1969 – continental shelf, Mira, Holocene Lisboa, Melides, Pederneira (Pl. 4, fig. 2).
Callistocythere curryi Horne, Lord, Robinson & Whittaker, 1990 – continental shelf and slope, Lima, Mira, Holocene Lisboa, Melides, Pederneira (Pl. 4, fig. 17)

Callistocythere diffusa (G. W. Müller, 1894) – Mira (Pl. 4, fig. 18)

Callistocythere donovani Horne, Lord, Robinson & Whittaker, 1990 – continental shelf and slope, Holocene Lisboa (Pl. 4, fig. 19)

Callistocythere aff. gilva Bonaduce, Ciampo & Masoli, 1976 – Holocene Lisboa (Pl. 4, fig. 20)

Callistocythere littoralis (G. W. Müller, 1894) – continental shelf, Callistocythere littoralis

Callistocythere murrayi Whitaker, 1978 – Minho (alive), Lima (alive), Tejo (alive), Sado, Mira, Holocene Lisboa, Seixal, Sizandro (Pl. 5, fig. 2)

Genus Clathia Neale, 1973

Clathria keiji Neale, 1975 – continental shelf, Mira (Pl. 5, fig. 3)

Genus Leptocythere Sars, 1928

Leptocythere baltica Klie, 1929 – Minho (alive), Lima (alive) (Pl. 5, fig. 4)

Leptocythere castanea (Sars, 1866) – Holocene Seixal (Pl. 5, fig. 5)

Leptocythere ciliata Hartmann, 1957 – Minho (alive), Lima (alive), Tejo (alive), Sado, Mira (Pl. 5, fig. 6)

Leptocythere cribrosa (Brady, Crosskey & Robertson, 1874) – Holocene Lisboa (Pl. 5, fig. 7)

Leptocythere fabaeformis (G. W. Müller, 1894) – Lima, Tejo, Mira (alive), Holocene Lisboa, Melides, Pederneira, Santo André, Seixal (Pl. 5, fig. 8)

Leptocythere lacertosa (Hirschmann, 1912) – Minho (alive), Tejo (alive), Sado, Lima, Mira (alive), Holocene Lisboa, Melides, Pederneira, Santo André, Seixal (Pl. 5, figs. 9–10)

Leptocythere macallana (Brady & Robertson, 1869) – Lima, Holocene Lisboa, Melides, Pederneira, Seixal (Pl. 5, fig. 11)

Leptocythere pellicuda (Baird, 1850) – Holocene Lisboa, Pederneira, Santo André (Pl. 5, fig. 12)

Leptocythere porcellanea (Brady, 1869) – Minho (alive), Lima (alive), Tejo (alive), Sado, Mira (alive), Holocene Lisboa, Pederneira, Santo André, Seixal, Sizandro (Pl. 5, figs. 13–14)

Leptocythere psammophila Guillaume, 1976 – Minho (alive) (Pl. 5, fig. 15)

Leptocythere tenera (Brady, 1868) – continental shelf and slope, Mira, Holocene Lisboa, Pederneira, (Pl. 5, fig. 16)

Leptocythere sp. A – Minho (alive) (Pl. 5, figs. 17–18)

Leptocythere sp. B – Minho (alive), Lima (alive), Holocene Melides (Pl. 5, fig. 19)

Family Loxoconchidae Sars, 1925

Genus Elofonia Wagner, 1957

Elofonia pusilla (Brady & Robertson, 1870) – Mira, Holocene Lisboa, Melides, Pederneira (Pl. 5, fig. 20)

Genus Hirschmannia Elofon, 1941

Hirschmannia viridis (O. F. Müller, 1785) – Holocene Lisboa (Pl. 5, fig. 21)

Genus Loxoconcha Schornikov, 1969

Loxoconcha decipiens (G. W. Müller, 1894) – Mira (Pl. 6, fig. 1)

Genus Loxoconcha Sars, 1866

Loxoconcha concentrica Bonaduce, Ciampo & Masoli, 1976 – continental shelf (Pl. 6, fig. 2)

Loxoconcha ellipitica Brady, 1868 – continental shelf, Minho (alive), Tejo (alive), Sado (alive), Mira (alive), Holocene Lisboa, Melides, Pederneira, Santo André, Seixal, Sizandro (Pl. 6, fig. 3)

Genus Nannocythere Schäfer, 1953

Nannocythere nana (Bonaduce, Ciampo & Masoli, 1976) – Mira (Pl. 6, fig. 6)

Nannocythere pavo (Malcomson, 1886) – continental shelf, Mira (Pl. 6, fig. 7)

Genus Palmoconcha Swain & Gilby, 1974

Palmoconcha guttata (Norman, 1865) – continental shelf and slope, Mira, Holocene Lisboa (Pl. 6, fig. 8)

Palmoconcha laevata (Norman, 1865) – continental shelf, Lima, Holocene Lisboa (Pl. 6, fig. 9)

Genus Phlyctocythere Keij, 1958

Phlyctocythere pellucida (G. W. Müller, 1894) – continental shelf (Pl. 6, fig. 10)

Genus Roundstonia Neale, 1973

Roundstonia robertsoni (Brady, 1868) – Lima, Holocene Lisboa, Pederneira (Pl. 6, fig. 11)

Genus Sagmatocythere Atherson, 1976

Sagmatocythere caelata (Ciampo, 1976) – continental shelf, Mira (Pl. 6, fig. 12)
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Sagmatocythere multiforma (Norman, 1865) – continental shelf and slope, Holocene Lisboa (Pl. 6, fig. 13)
Sagmatocythere napolitana (Puri, 1963) – Holocene Lisboa (Pl. 6, fig. 14)
Sagmatocythere aff. scuprea Aiello & Szczechura, 2004 – Mira, Holocene Lisboa (Pl. 6, figs 15–16)
Sagmatocythere varieculpta (Ruggieri, 1962) – Mira, Holocene Pederneira (Pl. 6, fig. 17)
Genus Tuberoxoconcha Hartmann, 1973
Tuberoloxoconcha cf. atlantica Horne, 1989 – Tejo (alive), Mira (alive) (Pl. 6, figs 18–19)
Tuberoloxoconcha sp. 1 – Minho (alive) (Pl. 6, figs 20–21)

Family Neocytherideidae Puri, 1957
Neocytherideis subulata (Brady, 1868) – continental shelf, Lima, Mira, Holocene Lisboa, Pederneira (Pl. 7, fig. 1)
Genus Procystheridea Ruggieri, 1978
Procystheridea cf. foveolata (G. W. Müller, 1894) – Holocene Pederneira (Pl. 7, fig 2)
Procystheridea aff. subspiralis (Brady, Crosskey & Robertson, 1874) – continental shelf, Mira, Holocene Melides (Pl. 7, fig. 3)
Genus Sahnicythere Athersuch, 1982
Sahnicythere retroflexa (Klie, 1936) – Lima, Mira, Holocene Lisboa, Pederneira (Pl. 7, fig. 4)

Family Paracytherideidae Puri, 1957
Genus Paracytheridea G. W. Müller, 1894
Paracytheridea depressa G. W. Müller, 1894 – continental shelf, Sado, Mira, Holocene Lisboa, Melides (Pl. 7, fig. 5)
Paracytheridea triquetrata (Reuss, 1850) – continental shelf, Mira, Holocene Lisboa (Pl. 7, fig. 6)
Genus Tuberculocythere Colalongo & Pasini, 1980
Tuberculocythere infelix (Bonaduce, Ciampo & Masoli, 1976) – continental shelf (Pl. 7, fig. 7)

Family Paradoxostomatidae Brady & Norman, 1889
Genus Bradystroma Schornikov & Keyser, 2004
Bradystroma bradyi (Sars, 1928) – Lima, Mira, Holocene Lisboa (Pl. 7, fig. 8)
Genus Brunneostoma Schornikov, 1993
Brunneostoma aff. cuneatum Schornikov & Keyser, 2004 – Mira (Pl. 7, fig. 9)
Genus Cytherois G. W. Müller, 1884
Cytherois fischeri (Sars, 1866) – Minho (alive), Lima, Tejo (alive), Sado (alive), Mira (alive), Holocene Lisboa, Melides, Pederneira, Santo André, Seixal (Pl. 7, fig. 10)

Cytherois cf. stephanidesi Klie, 1938 – Minho (alive), Lima (alive), Tejo (alive), Holocene Melides, Pederneira (Pl. 7, fig. 11)
Genus Lanceostoma Schornikov & Keyser, 2004
Lanceostoma aff. tenerifense Schornikov & Keyser, 2004 – Mira (Pl. 7, fig. 12)
Genus Paradoxostoma Fischer, 1855
Paradoxostoma aff. abbreviatum Sars, 1866 – Lima, Mira, Holocene Lisboa (Pl. 7, fig. 13)
Paradoxostoma cf. atrum G. W. Müller, 1894 – Mira (Pl. 7, fig. 14)
Paradoxostoma ensiforme Brady, 1868 – Lima, Mira, Holocene Lisboa, Pederneira (Pl. 7, fig. 15)
Paradoxostoma incongruens G. W. Müller, 1894 – Mira (Pl. 7, fig. 16)
Paradoxostoma robinhoodi Horne & Whittaker, 1985 – Mira, Holocene Lisboa, Pederneira (Pl. 7, fig. 17)
Paradoxostoma sp. 1 – Minho (alive), Sado (alive), Mira (alive) (Pl. 7, fig. 18)
Paradoxostoma tenuissimum (Norman, 1869) – continental shelf (Pl. 7, fig. 19)
Paradoxostoma trieri Horne & Whittaker, 1985 – Santo Amaro de Oeiras (rockpool, alive), Sado (alive), Mira (alive) (Pl. 7, fig. 20)
Paradoxostoma cf. versicolor G. W. Müller, 1894 – Mira (Pl. 7, fig. 21)
Genus Paracytherois G. W. Müller, 1894
Paracytherois acuminata G. W. Müller, 1894 – Lima, Mira (Pl. 8, fig. 1)
Paracytherois flexuosa (Brady, 1867) sensu Bonaduce, Ciampo & Masoli, 1976 – Mira (Pl. 8, figs 2–3)
Paracytherois cf. mediterranea Bonaduce, Ciampo & Masoli, 1976 – Mira (Pl. 8, fig. 4)

Family Thaerocytheridae Hazel, 1967
Genus Thaerocythere Hazel, 1967
Thaerocythere hoptonensis (Brady, Crosskey & Robertson, 1874) – continental shelf, Lima, Santo Amaro de Oeiras (rockpool), Mira, Holocene Lisboa, Pederneira (Pl. 8, fig. 5)

Family Trachyleberidae Sylvester-Bradley, 1948
Genus Basslerites Teichert, 1937
Basslerites teres (Brady, 1869) – continental shelf (alive), Mira (alive), Holocene Lisboa, Melides, Pederneira, Santo André (Pl. 8, fig. 6)
Genus Bosquetina Keij, 1957
Bosquetina tarentina (Baird, 1850) – continental shelf (alive) (Pl. 8, fig. 7)
Genus Bantonia Howe, 1935

Explanation of Plate 5. LV, left valve; RV, right valve; C, carapace; f, female; m, male; j, juvenile; aut., autumn; spr., spring. Scale bar 100µm. fig. 1. Callistocythere lobiancoi (G. W. Müller, 1894), LV, external, f; Pederneira, S3-10.84–10.85. fig. 2. Callistocythere murrayi Whittaker, 1978, C, right view, m; Mira-CBR, P1 (spr.). fig. 3. Clathria keiji Neale, 1975, LV, external; site 1 (POP 0108). fig. 4. Leptocythere baltica Klie, 1929, C, left view, f; Lima-NSR, P1 (spr.). fig. 5. Leptocythere castanea (Sars, 1866), C, left view, f; Seixal, DWK2 285. fig. 6. Leptocythere ciliata Hartmann, 1957, C, right view, m; Lima-NSR, P6 (spr.). fig. 7. Leptocythere cibrosa (Brady, Crosskey & Robertson, 1874), LV, external, f; Lisboa, PC-23.40-23.41. fig. 8. Leptocythere fabaerformis (G. W. Müller, 1894), C, left view, m; Mira-PMF, P1 (aut.). fig. 9. Leptocythere lacertosia (Hirschmann, 1912), LV, external, f; Pederneira, S2-3.92, fig. 10. Leptocythere lacertosia (Hirschmann, 1912), C, right view, f; Minho, Camarido-2 (spr.). fig. 11. Leptocythere macallana (Brady & Robertson, 1889), C, left view, f; Pederneira, S2-3.92, fig. 12. Leptocythere pellucida (Baird, 1850), RV, external, f; Pederneira, S2-8.26. figs 13, 14. Leptocythere porcellanea (Brady, 1869), 13, LV, external, f; Mira-CBR, P3 (aut.); 14, C, left view, f; Minho, Camarido-2 (spr.). fig. 15. Leptocythere psammophila Guillaume, 1976, C, right view, f; Minho, Camarido-2 (spr.). fig. 16. Leptocythere tenera (Brady, 1868), C, right view, f; site 1 (POP 0108). figs 17, 18. Leptocythere sp. A, Minho-CP, P1 (spr.); 17, C, left view, f; 18, C, dorsal view, f; fig. 19. Leptocythere sp. B, C, left view, f; Minho-CP, P2 (aut.). fig. 20. Elofsonia pusilla (Brady & Robertson, 1870), RV, external, ?m; Melides, MI-9.095. fig. 21. Hirschmannia viridis (O. F. Müller, 1785), LV, external, f; Lisboa, PC-8.15-8.16.
Buntonia textilis Bonaduce, Ciampo & Masoli, 1976 – continental Recent and Holocene ostracods from Portugal

Genus Carinocythereis Ruggieri, 1956

Carinocythereis carinata (Roemer, 1838) – continental shelf and slope (Pl. 8, fig. 10)

Carinocythereis whitei (Baird, 1850) – continental shelf and slope, Lima, Mira, Holocene Lisboa, Melides, Pederreira, Santo André (Pl. 8, fig. 11)

Genus Celtia Neale, 1973

Celtia quadridentata (Baird, 1850) – continental shelf and slope, Mira, Holocene Pederreira (Pl. 8, fig. 12)

Costa runcinata (Baird, 1850) – continental shelf and slope, Mira, Holocene Lisboa, Pederreira (Pl. 8, fig. 13)

Genus Falunia Grekoff & Moyes, 1955

Falunia cf. sphaerulolineata (Jones, 1857) – Mira (Pl. 8, fig. 14)

Genus Henryhowella Puri, 1957

Henryhowella sarsi (G. W. Müller, 1894) – continental shelf and slope (Pl. 8, fig. 15)

Genus Hiltermannicythere Bassioni, 1970

Hiltermannicythere emaciata (Brady, 1867) – Lima, Mira, Holocene Lisboa, Melides (Pl. 8, fig. 16)

Genus Occultocythereis Howe, 1951

Occultocythereis dohrni (Puri, 1963) – Mira (Pl. 8, fig. 17)

Genus Pterygocythereis Blake, 1933

Pterygocythereis ceratorpera (Bosquet, 1852) – continental shelf (Pl. 8, fig. 18)

Pterygocythereis jonesii (Baird, 1850) – continental shelf and slope, Mira, Holocene Lisboa (Pl. 8, fig. 19)

Genus Rectobuntonia Sissingh, 1972

Rectobuntonia miranda Bonaduce, Ciampo & Masoli, 1976 – continental shelf and slope (Pl. 8, fig. 20)

Rectobuntonia rectangularis (Ruggieri, 1954) – continental shelf (alive) (Pl. 8, fig. 21)

Family Xestoleberididae Sars, 1928

Genus Microxestoleberis G. W. Müller, 1894

Microxestoleberis nana G. W. Müller, 1894 – continental shelf, Lima, Mira (Pl. 9, fig. 1)

Microxestoleberis cf. pustulosa Ciampo, 1986 – Lima, Mira (Pl. 9, fig. 2)

Genus Xestoleberis Sars, 1866

Xestoleberis labiata Brady & Robertson, 1874 – Santo Amaro de Oeiras (rockpool, alive), Mira (alive), Holocene Lisboa, Melides, Pederreira, Santo André, Seixal (Pl. 9, fig. 3)

Xestoleberis cf. nitida (Liljeborg, 1853) – Mira (Pl. 9, figs 4–5)

Xestoleberis aff. parva G. W. Müller, 1894 – continental shelf, Lima, Mira (Pl. 9, fig. 6)

Xestoleberis rubens Whittaker, 1978 – continental shelf, Lima, Sado, Mira, Holocene Lisboa, Melides, Seixal (Pl. 9, fig. 7)

Superfamily Terrestreicytheroidea Schornikov, 1969

Family Terrestreicytheridae Schornikov, 1969

Genus Terrestreicythere Schornikov, 1969

Terrestreicythere aff. elisabethae Home, Smith, Whittaker & Murray, 2004 – Tejo (alive), Sado (alive), Mira (alive) (Pl. 9, figs 8–9)

Suborder Bairdiocopina Gründel, 1967

Superfamily Bairdioidoidea Sars, 1888

Family Bairdiidae Sars, 1888

Genus Bairdia McCoy, 1844

‘Bairdia’ subcircinata (Brady & Norman, 1869) – continental shelf, Lima, Mira, Holocene Lisboa (Pl. 9, fig. 10)

Genus Neonesidea Maddocks, 1969

Neonesidea cf. corpulenta (G. W. Müller, 1894) – Lima (Pl. 9, fig. 11)

Neonesidea longevaginata (G. W. Müller, 1894) – Holocene Lisboa, Pederreira (Pl. 9, fig. 12)

Neonesidea sp. 2 (Bonaduce, Ciampo & Masoli, 1976) – continental shelf, Lima, Mira, Holocene Lisboa, Pederreira (Pl. 9, fig. 13)

Genus Triebelina Van den Bold, 1946

Triebelina raripila (G. W. Müller, 1894) – Holocene Melides (Pl. 9, fig. 14)

Suborder Cypridocopina Jones, 1901

Superfamily Pontocypridoidea G. W. Müller, 1894

Family Pontocyprididae G. W. Müller, 1894

Genus Argilloecia Sars, 1866

Argilloecia aff. conoidea Sars, 1923 – continental slope (Pl. 9, fig. 15)

Argilloecia minor (G. W. Müller, 1894) – continental shelf (Pl. 9, fig. 16)

Genus Pontocypris Sars, 1866

Pontocypris cf. acuminata (G. W. Müller, 1894) – continental shelf, Lima, Mira (Pl. 9, fig. 17)
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*Pontocypris mytiloides* (Norman, 1862) – Mira (Pl. 9, fig. 18)

Genus *Propontocypris* Sylvester-Bradley, 1947

*Propontocypris cf. intermedia* (Brady, 1868) – Mira, Holocene Lisboa, Melides, Pederneira, Santo André (Pl. 9, fig. 19)

*Propontocypris pirifer* (G. W. Müller, 1894) – Mira, Holocene Lisboa, Pederneira (Pl. 9, fig. 20)

Superfamily Cypridoidea Baird, 1845

Family Candonidae Kaufmann, 1900

Genus *Paracypris* Sars, 1866

*Paracypris polita* Sars, 1866 – continental shelf and slope, Lima, Mira (Pl. 9, fig. 21)

**COMMENTS ON RECENT OSTRACODA FOUND ALIVE IN PORTUGAL**

Note that taxa found only as empty carapaces or valves are not discussed below. In addition, no mention is made of fossil records of the Recent species.

*Bassleriida teres* (Brady, 1869)

A marine/marine to slightly brackish littoral species known from the Mediterranean to western Europe, found in France (Yassini, 1969, as *Bassleriites berchoni* (Brady, 1870)) and England (J. Whittaker, pers. comm.). In France, Arcachon Bay, it lives at depths of 2–8 m and salinity of 27% (Yassini, 1969). In Portugal found alive in the tidal flat of low and mid-Mira estuary, in autumn and spring conditions (approximate salinity range of 32.1–33.8‰ and temperature 16.3–16.8°C, in sediment interstitial water); also found alive in site 3 (96.5 m depth) and 5 (94.0 m depth), in western Algarve continental shelf, in spring conditions.

*Bosquetina tarentina* (Baird, 1850)

A marine sublittoral species, known from the Mediterranean to western Europe, in France (Guillaume et al., 1985, pl. 103, figs 9–10, as *Bosquetina dentata* (G. W. Müller, 1894)); found living in the Mediterranean, in Bay of Bou-Ismail, Algeria, on mud and sandy mud substrates at depths of 75–220 m (Yassini, 1979, Pl. 5, figs 5–6, as *Bosquetina carinella* (Reuss, 1850)). In Portugal found alive in site 12 (105.3 m depth), on western Algarve continental shelf, in winter conditions.

Callistocythere badia (Norman, 1862)

A marine littoral species known from the Mediterranean to western Europe (Athersuch et al., 1989). In Portugal found alive on green and red algae, in an intertidal rockpool near Laje River mouth, Santo Amaro de Oeiras beach, in spring conditions (approximate salinity 36.2‰ and temperature 29.4°C, at low tide).

*Callistocythere murrayi* Whittaker, 1978

A brackish species (1–8% at the type locality – Athersuch et al., 1989) known in western Europe, in British Isles and France (Chait et al., 1998). In Portugal found alive from the tidal flat to the low marsh in the lower Minho, mid Lima and lower Tejo estuaries, in autumn and spring conditions (approximate salinity range of 21.0–33.1‰ and temperature 12.4–18.5°C, in sediment interstitial water).

*Cyprideis torosa* (Jones, 1850)

A common and widespread highly euryhaline species, from almost freshwater to over 60‰, known in Europe (as far north as Iceland), Asia, Mediterranean region, Central Africa (Athersuch et al., 1989). In Portugal found alive from the tidal flat to the high marsh in the lower Tejo and lower Sado estuaries, in autumn/winter and spring/summer conditions (approximate salinity range of 19.0–34.1‰ and temperature 13.8–21.7°C, in sediment interstitial water). It seems to prefer very large estuaries, with almost lagoon dynamics. No noded forms have been found until now.

*Cytherois fischeri* (Sars, 1866)

A common and widespread brackish species, tolerating salinities from 4–35‰, known in the Mediterranean, western Europe, to Scandinavia in the north (Athersuch et al., 1989) and Morocco in the south (Nachtigal et al., 2010). In Portugal found alive from the tidal flat to the lower part of the low marsh (much more abundant on the tidal flat) in the lower Minho, lower Tejo, lower Sado and lower Mira estuaries, in autumn/winter and spring conditions (approximate salinity range of 10.3–37.0‰ and temperature 13.7–19.7°C, in sediment interstitial water).

*Cytherois cf. stephanodes* Klie, 1938

A brackish species found associated with algae and fine sediment, in salinities of 0–20‰, known in the Mediterranean and western Europe (Athersuch et al., 1989). In Portugal found alive in the lower Minho and mid Lima estuaries, from the tidal flat to the low marsh (where it is much more abundant), in autumn and spring conditions (approximate salinity range of 1.1–22.9‰ and temperature 12.4–21.4°C, in sediment interstitial water).

*Hemicytherura videns* (G. W. Müller, 1894)

A marine, littoral, phytal species, known from the Mediterranean to western Europe (northern limit of its distribution appears to be in France – Yassini, 1969) and NW Morocco (Nachtigal et al., 2010). The Portuguese specimens which present small variation in fossil patterns, particularly in the central part,

*Explanation of Plate 7. LV, left valve; RV, right valve; C, carapace; f, female; m, male; j, juvenile; aut., autumn; spr., spring. Scale bar 100 µm.*

fig. 1. *Neocytherideis subulata* (Brady, 1868), LV, external; Lima-NSR, Pl. 6 (spr.).

fig. 2. *Proocytherideis cf. joveolata* (G. W. Müller, 1894), RV, external; Pederneira, S2-3.98.

fig. 3. *Proocytherideis aff. subspiralis* (Brady, Crosskey & Robertson, 1874), RV, external; m; Mira-MAS, Pl. 1 (spr.).

fig. 4. *Sahicytheride retroflexa* (Klie, 1936), C, left view; f; Mira-MAS, Pl. 1 (spr.).

fig. 5. *Paracytherideis depressa* G. W. Müller, 1894, LV, external; m; Mira-MAS, Pl. 1 (aut.).

fig. 6. *Paracytherideis triqueta* (Reuss, 1850), LV, external; Mira-MAS, Pl. 1 (aut.).

fig. 7. *Tuberulocytheride infelix* (Bonaduce, Ciampo & Masoli, 1976), LV, external; site 13 (POP 0108).

fig. 8. *Bradydostoma bradyi* (Sars, 1845), RV, external; m; Lima-MAS, Pl. 1 (spr.).

fig. 9. *Cytherois fischeri* (Sars, 1866), C, right view; f; Mira-MAS, Pl. 1 (aut.).

fig. 10. *Cytherois fischeri* (Sars, 1866), C, right view; f; Mira-MAS, Pl. 1 (aut.).

fig. 11. *Cytherois cf. stephanodes* Klie, 1938, C, right view; m; Minho-PR, Pl. 3 (aut.).

fig. 12. *Lanceostoma aff. tenerifense* Schormik & Keyser, 2004, RV, external; Mira-MAS, Pl. 1 (spr.).

fig. 13. *Paradoxostoma aff. abbreviatum* Sars, 1866, RV, external; m; Mira-MAS, Pl. 1 (spr.).

fig. 14. *Paradoxostoma triternatum* (Norman, 1869), LV, external; f; Lima-MAS, Pl. 1 (spr.).

fig. 15. *Paradoxostoma ensiforme* Brady, 1868, LV, external; m; Mira-MAS, Pl. 1 (spr.).

fig. 16. *Paradoxostoma incomnus* G. W. Müller, 1895, LV, external; Mira-MAS, Pl. 1 (aut.).

fig. 17. *Paradoxostoma rorbii* Horn & Whittaker, 1985, LV, external; m; Mira-MAS, Pl. 1 (spr.).

fig. 18. *Paradoxostoma sanriense* Brady, 1868 C, right view; f; Oeiras, rock pool PP2’Avn.

fig. 19. *Paradoxostoma tenuisstum* (Norman, 1869), broken LV, external; Pl. 14 (POP 0060).

fig. 20. *Paradoxostoma trieri* Horn & Whittaker, 1985; C, left view; f; Oeiras, rock pool PP2’Avn.

fig. 21. *Paradoxostoma cf. versicolor* G. W. Müller, 1894, RV, external; Mira-MAS, Pl. 1 (aut.).
were rarely found alive in the lower and mid Mira estuary, from the tidal flat to the low marsh, in autumn and spring conditions (approximate salinity range of 23.2–42.0‰ and temperature 15.1–17.2°C, in sediment interstitial water).

*Heterocythereis albomaculata* (Baird, 1838)

A common phytal, littoral and sublittoral marine species, often abundant in rock pools, known from the Mediterranean to northern Norway (Athersuch et al., 1989) and NW Morocco (Nachite et al., 2010). In France, Yassini (1969) reports the euryhaline nature of the species, with a salinity range of 26–34‰. In Portugal found alive in the lowest part of Laje River estuary (Tejo’s tributary), associated with green algae, in spring conditions (approximate salinity 28.9‰ and temperature 15.8°C, at low tide) and in the sediment of an intertidal rock pool, in Santo Amaro de Oeiras beach (near Laje River mouth), in spring conditions (approximate salinity 36.2‰ and temperature 29.4°C, at low tide).

*Krithe aff. praetexta* (Sars, 1866)

A marine sublittoral species, living on sand and mud at depths of 50–500 m, from the British Isles to Sweden and Norway (Athersuch et al., 1989). The Portuguese species, closely related but with a less rounded posterior margin, was found alive in sites 5 (94.0 m depth) and 6 (100.0 m depth), western Algarve continental shelf, in spring conditions.

*Leptocythere baltica* Klie, 1929

A marine/brackish NW European species, occurring from the Bay of Biscay to the Baltic, usually on sand substrates, but also in British low marsh, within an approximate salinity of 25‰ (Horne & Boomer, 2000). In Portugal found alive in the lower Minho and lower Lima estuaries, on sand to silty sand substrates of the tidal flat and low marsh, in autumn and spring conditions (approximate salinity range of 12.6–19.7‰ and temperature 11.7–19.3°C, in sediment interstitial water).

*Leptocythere ciliata* Hartmann, 1957

A brackish species known from Germany (North Sea), also recorded in the British Isles by Horne (1980 – unpublished PhD thesis) and probably in NW Morocco (Nachite et al., 2010, Pl. 2, fig. 15). In Portugal found alive in the lower Minho, lower and mid Lima, lower and mid (Trancão) Tejo, lower Sado and lower and mid Mira estuaries, from the tidal flat to the high marsh (more abundant on the low and high marsh), in autumn/winter and spring/summer conditions (approximate salinity range of 2.5–47.5‰ and temperature 10.2–23.0°C, in sediment interstitial water).

*Leptocythere fabeformis* (G. W. Müller, 1894)

A brachych (highly euryhaline – 13–33‰), phytal/littoral marine species, known from the Mediterranean to western Europe, whose northern limit of distribution is apparently in France (Yassini, 1969). In Portugal found alive only in the tidal flat of the lower Mira estuary, as subordinate species, in autumn and spring conditions (approximate salinity 33.6‰ and temperature 16.3°C, in sediment interstitial water).

*Leptocythere lacertos* (Hirschmann, 1912)

A common NW European brackish species usually inhabiting estuaries on mud or fine sand substrate; its geographical distribution spans from the Baltic Sea to the NW Morocco coast (Nachite et al., 2010). In Portugal found alive from the tidal flat to the high marsh (more abundantly on the tidal flat and low marsh) of the lowest part of Minho (very rarely), lower Tejo, lower Sado and lower and mid Mira estuaries, in autumn/winter and spring/summer conditions (approximate salinity range of 22.9–47.5‰ and temperature 13.6–21.7°C, in sediment interstitial water).

*Leptocythere psammophila* Guillaume, 1976

An outer estuarine species inhabiting sandy substrates from the Atlantic coasts of France to Iceland and the Baltic (Athersuch et al., 1989) and NW Morocco (Nachite et al., 2010); in the British Isles it was found in a low salt marsh, within a salinity range of 25–29‰ (Horne & Boomer, 2000). In Portugal found alive on sandy to silty sand substrates of the tidal flat of the lower Minho estuary, in autumn and spring conditions (approximate salinity range of 1.1–18.6‰ and temperature 18.5–21.4°C, in sediment interstitial water).

*Leptocythere sp.* A

Although showing affinities to some *L. lacertos* in NW Europe it is best to leave this species in open nomenclature, pending further study; it is a brackish species found alive only in the lower Minho estuary, from the tidal flat to the low marsh, in autumn and spring conditions (approximate salinity range of 1.1–22.3‰ and temperature 13.8–21.4°C, in sediment interstitial water).
Leptocythere sp. B

Like Leptocythere sp. A, this species shows affinities to some L. lacertosa in NW Europe, but until further study it is best to leave it in open nomenclature; it is a rare brackish species found alive in the lower Minho and lower and mid Lima estuaries, from the tidal flat to the low marsh (particularly on the tidal flat), in autumn and spring conditions (approximate salinity range of 3.1–24.8‰ and temperature 11.6–20.2°C, in sediment interstitial water).

Loxoconcha elliptica Brady, 1868

A common brackish species usually associated with algae and mud, known from the Mediterranean to NW Europe (Horne & Boomer, 2000) and NW Morocco (Nachit et al., 2010). In Portugal found alive in lower Minho, lower and mid Lima, lower and mid (Trancão) Tejo, lower Sado and lower and mid Mira estuaries, from the tidal flat to the high marsh, in autumn/winter and spring/summer conditions (approximate salinity range of 1.1–34.3‰ and temperature 10.9–21.7°C, in sediment interstitial water).

Loxoconcha malcomsoni Horne & Robinson, 1985

A rare brackish species, until now only known from the British Isles, living in salt marshes close to the tidal flat/low marsh limit, near marine salinity conditions (Horne & Boomer, 2000). In Portugal found alive in the lowest part of Mira and lower Sado estuaries, from the low to the high marsh, in autumn and spring conditions (approximate salinity range of 23.2–47.5‰ and temperature 14.4–17.2°C, in sediment interstitial water).

Loxoconcha rhomboidea (Fischer, 1855)

A common phytal, littoral/shallow sublittoral marine, NW European species (from Norway to Madeira and Canary Islands – Athersuch et al., 1989), also found in salt marshes in slightly reduced salinities near the mouth of estuaries (Horne & Boomer, 2000); most Mediterranean records are doubtful, but some species from Cyprus and from the western part of the Mediterranean do appear to be L. rhomboidea (Athersuch & Whittaker, 1976). In Portugal very rarely found alive in the tidal flat of the lower Lima and lower Mira estuaries, in autumn and spring conditions (approximate salinity range of 24.8–33.8‰ and temperature 16.3–20.2°C, in sediment interstitial water).

Paradoxostoma sarsi Nemi Brady, 1868

A phytal, marine/brackish species (tolerant to salinities as low as 25%) apparently only known previously from the British Isles and France (Athersuch et al., 1989). In Portugal found alive on sandy substrate and red algae, in an intertidal rock pool near Laje River mouth, Santo Amaro de Oeiras beach, in spring conditions (approximate salinity range of 35.5–36.2‰ and temperature 26–29.4°C, at low tide). Also found alive in the tidal flat of the lower Sado estuary, in autumn and spring conditions (approximate salinity range of 31.6–34.1‰ and temperature 13.8–18.7°C, in sediment interstitial water).

Paradoxostoma trieri Horne & Whittaker, 1985

A phytal, littoral marine species, apparently only known previously from the British Isles and France (Horne & Boomer, 2000); in the British Isles it also lives in salt marshes at the limit tidal flat/low marsh (Horne & Boomer, 2000). In Portugal found alive on sandy substrate, green and red algae, in an intertidal rock pool near Laje River mouth, Santo Amaro de Oeiras beach, in spring conditions (approximate salinity range of 35.5–36.2‰ and temperature 26–29.4°C, at low tide). Also found alive in the tidal flat of lower Sado and lower Mira estuaries, in autumn and spring conditions (approximate salinity range of 33.4–34.6‰ and temperature 15.9–17.6°C, in sediment interstitial water).

Rectobuntonia rectangularis (Ruggieri, 1954)

A marine sublittoral species known from the Mediterranean, found living at depths of 54–112m, essentially on mud (Yassini, 1979, Pl. 4, figs 7 and 15, as Buntonia subula Ruggieri, 1954). In Portugal found alive in sites 3 (96.5m depth) and 5 (94.0m depth), on western Algarve continental shelf, in spring conditions.

Semicytherura sella (Sars, 1866)

A shallow-marine/outer estuarine species, living on silty and sandy substrates, in NW Europe, including Norway and the Baltic Sea (Whittaker, 1974; Athersuch et al., 1989). In Portugal rarely found alive on muddy substrate in the tidal flat of the lowest part of Mira estuary, in spring conditions (approximate salinity range 32.8–35.8‰ and temperature 17.7–18.9°C, in sediment interstitial water).

Semicytherura tela Horne & Whittaker, 1980

A littoral marine/brackish species found on algae in rock pools, in British Isles and France (Athersuch et al., 1989). In Portugal, found alive (only one specimen) on sandy substrate in an intertidal rock pool near Laje River mouth, Santo Amaro de Oeiras beach, in a salinity of 35.5‰ and a temperature of 26°C, at low tide, in spring conditions.

Terrestricythere aff. elisabethae Horne, Smith, Whittaker & Murray, 2004

T. elisabethae was described in the British Isles from the high intertidal zone of a brackish creek with reeds and overhanging trees providing leaf litter (Horne et al., 2004). The Portuguese species is possibly new and was found alive only in the high marsh of lower Tejo, lower Sado and mid Mira estuaries, in

Explanation of Plate 9. LV, left valve; RV, right valve; C, carapace; f, female; m, male; j, juvenile; aut., autumn; spr., spring. Scale bar 100µm.

fig. 1. Microxestoleberis nana G. W. Müller, 1894, LV, external; Mira-MAS, P1 (aut.). fig. 2. Microxestoleberis cf. pustulosa Ciampo, 1986, RV, external; Mira-MAS, P1 (spr.). fig. 3. Xestoleberis labiata Brady & Robertson, 1874, C, right view, f; Mira-MAS, P1 (aut.). figs 4, 5. Xestoleberis cf. nitida (Ljøeberg, 1853); 4, C, right view; J; Mira-PMF, P1 (aut.); 5, LV, internal, f; Mira-MAS, P1 (spr.). fig. 6. Xestoleberis aff. parva G. W. Müller, 1894, LV, external; Mira-MAS, P1 (spr.). fig. 7. Xestoleberis rubens Whittaker, 1978, RV, external, f; Mira-MAS, P1 (spr.). figs 8, 9. Terrestricythere aff. elisabethae Horne, Smith, Whittaker & Murray, 2004, C; Sado-TRO, P6 (aut.): 8, right view; 9, dorsal view. fig. 10. ‘Bairdia’ subcircinata (Brady & Norman, 1869), RV, external; J; Lima-NSR, P1 (spr.). fig. 11. Neonesidea cf. corporlenta (G. W. Müller, 1894), RV, external; Lima-NSR, P3 (aut.). fig. 12. Neonesidea longevaginata (G. W. Müller, 1894), LV, external; J; Pederneira, S2-3.98. fig. 13. Neonesidea sp. 2 (Bonaduce, Ciampo & Masoli, 1976), LV, external; Pederneira, S2-3.98. fig. 14. Triebelina raripila (G. W. Müller, 1894), RV, external; J; Melides, MB-16.915. fig. 15. Agilloecia aff. conoidea Sars, 1923, LV, external, f; site 23 (POP 0108). fig. 16. Agilloecia minor (G. W. Müller, 1894), RV, external; site 14 (POP 0108). fig. 17. Propontocypris cf. acuminata (G. W. Müller, 1894), C, left view; Mira-PMF, P1 (spr.). fig. 18. Propontocypris mytiloides (Norman, 1862), LV, external; Mira-PMF, P1 (aut.). fig. 19. Propontocypris cf. intermedia (Brady, 1868), C, right view; Pederneira, S2-6.70. fig. 20. Propontocypris piriforma (G. W. Müller, 1894), LV, external; Lisboa, PC-18.80-18.81. fig. 21. Paracypris polita Sars, 1866, RV, external; site 23 (POP 0108).
autumn/winter and spring/summer conditions (approximate salinity range of 18.5–25.9‰ and temperature of 13.4–14.4°C, in sediment interstitial water).

*Tuberoloxoconcha* cf. *atlantica* Horne, 1989

*T. atlantica* is a marine, littoral, interstitial, western (Massachusetts, USA) and eastern (west Scotland) North Atlantic species (Horne, 1989). The Portuguese species, very similar but almost without ornamentation, was found alive only in the high marsh of lower Tejo and lower Mira estuaries, in autumn/winter and spring/summer conditions (approximate salinity range of 18.5–30.6‰ and temperature of 14.4–16.3°C, in sediment interstitial water).

*Tuberoloxoconcha* sp. 1

A new brackish species found alive only in the transition zone between low and high marsh of lower Minho estuary (Coura confluence), in autumn and spring conditions, within an approximate salinity range of 10.1–22.9‰ and temperature of 12.9–15.4°C, in sediment interstitial water.

*Xestoleberis labiata* Brady & Robertson, 1874

A shallow-marine species recorded previously only from the British Isles and France (Athersuch *et al*., 1989). In Portugal found alive on sandy substrate, green and red algae, in an intertidal rock pool near Laje River mouth, Santo Amaro de Oeiras beach, in spring conditions (approximate salinity range of 35.5–36.2‰ and temperature 26–29.4°C, at low tide). Also found alive in the tidal flat of the lower Mira estuary, in autumn and spring conditions (approximate salinity range of 33.4–33.8‰ and temperature 16.0–16.3°C, in sediment interstitial water).

**SUMMARY**

A total of 178 brackish and marine ostracod species belonging to 75 genera has been found and identified in Portugal, most of them as empty valves. From those species, 17 are referred to as aff. or in open nomenclature; some of them are probably new. Eighteen species are recorded as fossil only and 73 have no fossil record in the area. Thirty species were found alive, most of them living in littoral areas; only 4 species were found alive in the western zone of the continental shelf of Algarve, and none was found alive in the continental slope.

**Autochthonous fauna**

The autochthonous fauna of the estuaries comprises 25 species, distributed in the high and low tidal marshes and in the tidal flat. Almost all the species are known in marginal-marine settings of the Atlantic coast of NW Europe – Spain, France, UK, Ireland, Belgium, The Netherlands and, for 10 of the species, even Norway, Sweden and the Baltic Sea (*Cyprideis torosa, Cythereis fischeri, Heterocythereis albomaculata, Leptocythere baltica, L. lacertosa, L. porcellana, L. psammophila, Loxoconcha elliptica, L. rhomboidea, Semicytherura sella*) and also in both the Atlantic and Mediterranean coasts (9 species: *Basslerites teres, Callistocythere badiya, Cyprideis torosa, Cythereis fischeri, C. cf. stephanidesi, Hemicytherura videns, Heterocythereis albomaculata, Leptocythere fabaeformis, Loxoconcha elliptica*). Two phylial species live in the lower estuaries, being found alive very rarely, but with very abundant empty valves in the tidal flat: *Hemicytherura videns* (also in the lower part of the low marsh) and *Loxoconcha rhomboidea*. The phylial *Paradoxostoma sarniense, P. trieri* and *Xestoleberis labiata* were found alive in the tidal flat of the SW Portuguese estuaries, in a near-marine salinity range (31.6–34.6‰). *Heterocythereis albomaculata*, also a phylial species, was found alive associated with green algae, always submerged (even at low tide), in the lowest part of Laje river estuary, in the confluence with Tejo, in a salinity of 28.9‰. Five brackish species, preferring a muddy substrate and with a wide salinity tolerance can be found in all the three environments, tidal flat, low and high marsh: *Cyprideis torosa, Leptocythere ciliata, L. lacertosa, L. porcellanae and Loxoconcha elliptica*.

In the tidal flat, generally muddy, where the emersion time (time of subaerial exposure between tides) ranges between 12% and 70% and the salinity is highly variable, but no higher than 35%, the number of species is high. Twenty species were found alive, from which eight are restricted to the tidal flat: *L. rhomboidea, P. sarniense, P. trieri, X. labiata, Basslerites teres, Leptocythere fabaeformis, L. psammophila and Semicytherura sella*. *Leptocythere psammophila* is associated with fine sand substrate. *Cytherois fischeri* is found both in the tidal flat and in the lower part of the low marsh, but it is much more abundant in the tidal flat. The most abundant species in the tidal flat are *L. elliptica, C. fischeri, L. porcellana* and *Leptocythere* sp. A in the NW estuaries and *C. fischeri, L. elliptica, C. torosa* and *L. lacertosa* in the SW ones. The dominant species differs from one estuary to another and according to the location of the transect inside the estuary. In the tidal flat of the lower Lima and the lower Mira estuaries, empty valves of over 25 and 80 marine species, respectively, which do not live in these estuaries, were transported in by tidal currents.

In the low marsh, generally muddy, with emersion time around 75–90% and variable salinity (always lower in the NW estuaries, higher in the SW ones, where frequently it exceeds 35‰), fourteen species were found alive, all of them also found in the tidal flat and/or in the high marsh. The most frequent species in the low marsh are *L. porcellana, L. ciliata* and *L. lacertosa*, present in almost all the estuaries and frequently dominant. In the NW estuaries, in addition to *L. porcellanae and L. ciliata*, *Cytherois cf. stephanidesi, Leptocythere* sp. A and *L. elliptica* are also well represented, particularly in the autumn. In the SW estuaries *L. porcellanae and L. lacertosa* are the dominant species, with *L. ciliata, L. elliptica* and *C. torosa* sometimes well represented. Among the other species also recorded alive in the low marsh are *L. baltica* and *Leptocythere* sp. B in the NW estuaries, *L. malcomsoni* in the SW ones, *C. murrayi* and *C. fischeri* in both; very rarely, *Tuberoloxoconcha* sp. 1 and *H. videns* occur, each one in one of the estuaries.

The high marsh, with a long emersion time (93–99.5%) and wide range of salinity values (frequently very low, reaching 2.5‰ in the NW estuaries and very high, reaching 45–50‰ in the SW estuaries), is often barren of ostracods. Besides the five very tolerant brackish species found in some high marshes (generally in the lower part), three other species have been recorded living there: *Tuberoloxoconcha* sp. 1 in the NW Minho estuary, characterized by low salinities at low tide and *Tuberoloxoconcha* cf. *atlantica* and *Terrestrychthera aff. elisabethae* in the SW estuaries. Though more abundant in the low marsh, *Loxoconcha malcomsoni* is also found inhabiting the lower part of the high marsh in two SW estuaries.

In the marine littoral settings, only two intertidal rock pools were studied, where six species were found living on algae or in sandy substrate, within a salinity around 35.5–36‰: *Callistocythere badiya, Heterocythereis albomaculata,*
Recent and Holocene ostracods from Portugal

Paradoxostoma sarniense, P. trieri, Semicytherura tela (only in the substrate) and X. labiata.

**Continental shelf and slope.** On the continental shelf and slope 86 species were recognized, from which 10 were found only in the continental slope. Over 30% of the species are known, until now, both in the Atlantic Ocean and in the Mediterranean Sea, with at least 27 recorded only in the Mediterranean Sea and 19 only in the Atlantic Ocean. On the continental shelf the most common species, represented by abundant and complete populations (with all or almost all ontogenetic stages, though all dead), are: Costa runcinata, Palmoconcha guttata, Krithe aff. praetexta, Ptyerygothyereus jonesii and Henryhowella sarsi (this species only abundant around or below –125 m depth). Rectobuntonia rectangularis, Celtia quadridentata and Cytheropteron cf. ruggieri are not abundant but are frequently present. Only four species have very few specimens found alive: Bassleriites teres, Bosquetina larentina, K. aff. praetexta and R. rectangularis. B. teres is found alive as deep as 96.5 m, but is more frequent in shallower water. In the continental slope no species were found alive. The assemblages are dominated by K. aff. praetexta and H. sarsi around –220 m depth and by Paracypris polita, K. aff. praetexta and K. keyi around –500 m depth.

**Holocene.** In the Holocene the ostracods characterize different environments and help to build a general evolutionary model of the studied marginal-marine regions since the Lateglacial (Cearreta et al., 2003; Freitas et al., 2003). This model includes several palaeoenvironmental stages, with the earliest and the latest being characterized by sediments barren in ostracods. The first stage (Lateglacial to Early Holocene), lacking ostracods, was interpreted as a high-energy fluvial environment, contemporaneous with a sea level significantly lower than present. In the second stage (Early Holocene), ostracods are present, at first represented by brackish forms (generally C. torosa and L. elliptica), progressively replaced by littoral and sublittoral marine species, the most abundant being: Urockythereis britannica, Pontocythere elongata, Bassleriites teres, Carnicytherides whitei, Semicytherura robertsi, S. sella, X. labiata, L. rhomboidea, Aurila convexa. The maximum signal of marine influence in the sedimentary record is represented by the highest diversity in ostracods, including some deeper-water marine species, such as Celtia quadridentata, Cytheropteron dorcostatum, C. depressum, Roundstonia robertsoni. This stage corresponds to the progressive development of an estuarine environment that further evolved to fully marine, due to the rapid sea-level rise during the Holocene transgression. A third stage (Middle and Late Holocene) is contemporaneous with a pronounced decrease in the rate of sea-level rise followed by stabilization of mean sea level. In this stage, brackish (and sometimes, rare freshwater) ostracods are once more present: C. torosa and L. elliptica if the marginal zone evolved to a barrier-lagoon system or C. torosa, L. elliptica, Cytherois fischeri, L. porcellanea, L. lacertosa (and many littoral marine/slightly brackish species) if the environment remained as an open estuary with marginal tidal marshes. The last stage (Late Holocene), lacking ostracods, corresponds to the terrestrialization of the former marginal marine systems, which became progressively shallower and smaller, due to significant input of terrestrial-sourced sediment settling in low energy depocentres and retained in alluvial fans and plains prograding and accreting over former intertidal space. In consequence, the environment resumed essentially freshwater and fluviatile conditions that persisted until present.

**CONCLUSIONS**
To assist both monitoring of contemporary environmental change and to assist reconstruction of Holocene palaeoenvironments, we list and figure 30 living ostracod species from a range of marginal to marine environments in Portugal. In addition, we list and figure 148 species for which we have only the calcareous carapaces or valves, some of which appear to be restricted to the Holocene and are not known living in the area.

Knowledge of Recent Portuguese ostracods is fair for the western estuarine zones, but very incomplete for the marine littoral and sublittoral zones, where only two intertidal rock pools near Lisbon and a very small area from the continental shelf and slope in south Portugal have been studied. Holocene ostracods are relatively well known in the marginal-marine settings, particularly in the lagoons.

With this work, ostracod biogeographical patterns between NW European waters and the Mediterranean Sea are clarified, with some NE Atlantic species whose southern distribution limit was set in northern Spain (Bay of Biscay) now shown to live further to the south in Portugal. Most of the listed species are typical NE Atlantic forms, especially the Recent ones, found living or accumulated in the western Portuguese estuaries, but in Algarve, in the continental shelf and slope faunas, a Mediterranean influence is clearly stronger than in the other studied environments. In future research it will be very interesting to check whether this influence is also that important in the marginal littoral Algarve assemblages.

**NOTE ADDED IN-PRESS**
After manuscript acceptance, further work on the western Algarve continental slope revealed 19 more Recent ostracod species and eight more genera not previously reported in the main list. All were found on the continental slope, between 230 and 513 m depth; only 2 species were found alive. The discoveries modify some of the manuscript data (total number of species and genera, number of live species, etc) particularly the Abstract, which are not possible to change at this stage.

Genus Monoceratina Roth, 1928 Monoceratina mediterranea Sissingh, 1971 – continental slope (alive). Genus Cytheropteron Sars, 1866 Cytheropteron aff. alatum Sars, 1866 – continental slope, Cytheropteron crassipinatum Brady & Norman, 1888 – continental slope, Cytheropteron rotundatum Müller, 1894 – continental slope (alive). Genus Eucythere Brady, 1868 Eucythere cf. curta Ruggieri, 1975 – continental slope, Eucythere pubera Bonaduce, Ciampo & Masoli, 1976 – continental slope. Genus Parakrithe Van den Bold, 1958 Parakrithe aff. robusta Van den Bold, 1966 – continental slope. Genus Pseudopsammocythere Carbone, 1966 Pseudopsammocythere aff. reniformis (Brady, 1868) – continental slope. Genus Loxoconchidea Bonaduce, Ciampo & Masoli, 1975 Loxoconchidea minima Bonaduce, Ciampo & Masoli, 1976 – continental slope. Genus Nipponocythere Ishizaki, 1971 Nipponocythere sp. 1 – continental slope. Genus Sagmatocythere Athersuch, 1976 Sagmatocythere aff. moncharmonti (Ciampo, 1971) – continental slope. Genus Echinocythereis Puri, 1953 Echinocythereis echiina (Sars, 1866) – continental slope. Genus Microxestoleberis G. W. Müller, 1894 Microxestoleberis aff. xenomys (Barbeito-González, 1971) – continental slope. Genus Platyleberis Bonaduce & Danielopol, 1988 Platyleberis profunda (Bremian, 1975) – continental slope. Genus Anchistrochelis Brady & Norman, 1889 Anchistrochelis cf. trena (Bremian, 1975) – continental slope. Genus Bythocypris Brady, 1880 Bythocypris obtusata (Sars,
1866) – continental slope. Genus *Macropyx* Maddocks, 1990. *Macropyx cf. adriatica* (Bremen, 1975) – continental slope. Genus *Argilloecia* Sars, 1866 *Argilloecia cf. acuminate* G. W. Müller, 1894 – continental slope, *Argilloecia cf. robusta* Bonaduce, Ciampo & Masoli, 1976 – continental slope.

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