Limnetica, 44(2): 000-000 (2025). DOI: 10.23818/limn.44.18

Ostracods (Crustacea, Ostracoda) from Doñana (SW Spain): an updated checklist, including new records, of Recent and Quaternary non-marine, marine and brackish species in the area

Ángel Baltanás[1,2,*], Miguel Ángel Bravo-Utrera[3], María Luz González-Regalado[4], Stephani Tasso[4] & Francisco Ruiz[4]

[1]Departamento de Ecología, Facultad de Ciencias, Universidad Autónoma de Madrid, c / Darwin, 2, 28049 Madrid, Spain
[2]Centro de Investigación en Biodiversidad y Cambio Global (CIBC-UAM). Universidad Autónoma de Madrid, c / Darwin, 2, 28049 Madrid, Spain
[3]Área de Monitorización Ambiental de la ICTS-Doñana (CSIC). Current address: Espacio Natural de Doñana. Centro Administrativo "El Acebuche", 21760 Matalascañas, Spain
[4]Departamento de Ciencias de la Tierra, Universidad de Huelva. Avda. Fuerzas Armadas, s/n., 21071 Huelva, Spain

* Corresponding author: angel.baltanas@uam.es

Received: 28/05/24 Accepted: 07/11/24

ABSTRACT

Ostracods (Crustacea, Ostracoda) from Doñana (SW Spain): an updated checklist, including new records, of Recent and Quaternary non-marine, marine and brackish species in the area.

Here we provide an updated list of ostracod taxa (Crustacea, Ostracoda) identified from freshwater, brackish and marine (infralittoral) environments in the 'Doñana Natural Area' and alongside its adjacent shores. This list, based on both published and new records, encompasses a total of 101 species spanning a stratigraphic sequence from the Lower Pliocene to the present. Sixty-five marine species have been found to occur in the area (11 of which also thrive in brackish waters); of which just over 50% (34 spp.) are present both in Recent samples collected in the infralittoral zone, and as fossils/subfossils found in sediment cores. Nineteen other marine species have been found solely in the infralittoral zone whereas other twelve species occurred exclusively as fossils or subfossils in sediment cores. Conversely, the total number of non-marine species recorded amounts to thirty-seven, eight of which are new records for 'Doñana Natural Area'. All the non-marine species recorded have been found as living organisms in Recent samples although seven of them have been found as subfossils in sediment cores as well. In agreement with the diversity of aquatic habitats in the area and the sampling effort carried out over more than six decades, the non-marine ostracofauna of Doñana constitutes a significant portion (~33%) of the overall known species richness across the Iberian Peninsula.

KEY WORDS: Ostracoda, Doñana, species catalogue, taxonomic diversity.

RESUMEN

Ostrácodos (Crustacea, Ostracoda) de Doñana (SO España): una lista actualizada, incluyendo nuevas citas, de las especies Actuales y Cuaternarias de ostrácodos no-marinos, salobres y marinos de la zona.

Presentamos aquí una lista actualizada de las especies de ostrácodos (Crustacea, Ostracoda) que se encuentran en los sistemas acuáticos continentales y marinos (infralitorales) del 'Espacio Natural Doñana' y su costa limítrofe. Esta lista, basada tanto en registros publicados como nuevos, incluye un total de 101 especies de un rango estratigráfico que comprende desde el Plioceno *inferior hasta la actualidad. En la zona se han encontrado hasta sesenta y cinco especies marinas (11 de ellas presentes también en ambientes salobres); de las cuales algo más del 50% (34 spp.) están presentes tanto en muestras recientes de la zona infralitoral como en forma de fósiles/subfósiles hallados en testigos de sedimento. De las restantes especies marinas, diecinueve corresponden a organismos vivos encontrados exclusivamente en muestras del infralitoral, y doce fueron halladas únicamente como fósiles o subfósiles en testigos de sedimento. Por otra parte, el número total de especies no-marinas registradas asciende a treinta y siete, ocho de las cuales son nuevas citas para el 'Espacio Natural Doñana'. De todas las especies no-marinas hay registros actuales, y de siete de ellas también material subfósil. En correspondencia con la diversidad de ambientes acuáticos que contiene y con el esfuerzo de muestreo realizado en la zona a lo largo de más de seis décadas, la riqueza de especies no-marinas en Doñana representa una fracción significativa (~33%) de la riqueza total de especies conocida de la península Ibérica.*

PALABRAS CLAVE: *Ostracoda, Doñana, catálogo de especies, diversidad taxonómica.*

INTRODUCTION

The 'Doñana Natural Area' (hereafter 'Doñana'), located in the coastal plain between the estuaries of the Tinto and the Guadalquivir rivers in SW Spain, is considered one of the most important wetlands in Europe and has therefore been recognised with multiple protection figures: National Park (1969) and its protection zones, Natural Park (1989), UNESCO Biosphere Reserve (1980), Ramsar Site (1982), Special Protection Area for birds-SPA (1989), World Heritage Site (1994), Special Conservation Area (SAC) and IUCN Green List of Protected and Conserved Areas (2014) (Green et al., 2018). In addition, a large marine extension in the Gulf of Cádiz (Atlantic Ocean) that includes the entire area located off the coast of Doñana was designated Marine Protected Area (OSPAR) in 2014.

It is not an easy task to provide a comprehensive summary of the main features of the aquatic systems occurring in Doñana since they are extremely diverse: estuarine and tidal ecosystems linked to the mouth of the river Guadalquivir; a seasonal marsh mainly fed by the rain and the water entering the area through some small streams, and a plethora shallow water bodies located in the sandy floodplain of aeolian origin. The system evolved from shallow marine palaeoenvironments (Lower Pliocene), and through an intermediate phase of alluvial character during the Pleistocene, to a brackish lagoon (Upper Pleistocene-Holocene) and the establishment of aeolian sediments (<1900 yr BP) (Ruiz et al., 2013a) leading to a rather flat area where small topographic variations translate into important ecological differences resulting in abundant and varied water bodies ranging from ephemeral to permanent, and from subsaline to hypersaline (Bravo-Utrera, 2010). Due to its relevance and uniqueness, Doñana has attracted the attention of many scientists and numerous research projects have been developed there. Montes et al. (1998) listed 1624 scientific works published between 1854 and 1996 that deal specifically with Doñana, and a search recently conducted (January 2024) on Clarivate Analytics Web of Science (WoS; Science Citation Index Expanded) returned a total of 890 references of papers published from 1997 to 2023 with the term Doñana in 'Topic'. In summary, a significant amount of scientific information exists for the area. Quite paradoxically, however, the effort devoted to the study of its aquatic systems and to the aquatic organisms that inhabit them do not match, to say the least, the importance, abundance, and diversity of such systems in the area (Serrano et al., 2006); and our knowledge of the ostracod fauna of Doñana is no stranger to that fact.

Ostracods are small crustaceans that live in almost every type of aquatic habitat including the ocean (from abyssal depths to surface and from open waters to coastal areas), inland waters (fresh and saline; flowing and standing; permanent and temporary), the subterranean realm, and even in phytotelmata (Jocque et al., 2013) and hot springs (Wickstrom & Castenholz, 1973; Castenholz, 2015). Their body is totally enclosed within a carapace that consists of two calcified valves, a characteristic that facilitates the fossilization process once the animal has died and explains why the group is, second to molluscs, the one with the largest fossil record (Park & Cohen, 2011). Such taxonomic and ecological diversity and the existence of a large fossil record make the group an excellent candidate for ecological, evolutionary, biogeographical, and/or paleoenvironmental investigations (e.g. Sánchez-González et al., 2004; Martins et al., 2008; Brandao et al., 2010; Horne et al., 2012a; Baltanás & Danielopol, 2013; Ruiz et al., 2013b; Lorenschat & Schwalb, 2013, von Grafenstein & Labuhn, 2021).

As far as Doñana is concerned, the information on its ostracod fauna is significant but far from comprehensive. It is stored in 18 published papers (see Table 1) with the first of them (Bigot & Marazanof, 1965) listing records corresponding to samples collected in 1962, a time in which there was no conservation status for Doñana yet, but a period in which big efforts were developed by an international group of prominent scientists (led by José Antonio Valverde) to achieve that goal (see the section 'Account of previously published records' below). That paper and thirteen others (Group 1 in Table 1) offer detailed information of the specific localities where the ostracod species were found, whereas the remaining four publications (Group 2 in Table 1) either provide a list of the species collected and the sites sampled but without relating one to the other (Fahd et al., 2000; Serrano & Fahd, 2005, Fahd et al., 2007), or simply refer their collections to Doñana without providing further details (Aguilar-Alberola et al., 2012).

That number of studies—in an area where so much scientific work has been done—suggests that the group has received attention that is as scarce as it is undeserved; especially given its significant contribution to unravel the genesis and the evolution of this unique ecological system (see Ruiz et al. 2013a, and references therein), and its great potential as tracer of the environmental changes that already threatens the whole circum-Mediterranean region (Pozo et al., 2010; Horne et al., 2012a; Ruiz et al., 2013b; Marco-Barba et al., 2019). A recent paper (Green et al., 2018) aimed at offering broad insights into Doñana Wetlands exemplifies the scant role given to the study of this group in the area: it mentions ostracods just once, incorrectly labels them

Table 1.- List of the publications that include information on ostracod species occurring within the Doñana area. *Listado de las publicaciones que incluyen información sobre especies de ostrácodos presentes en Doñana.*

Group	Reference	Age	Observations
1	Bigot & Marazanof, 1965	Recent	Sampling date — 1962
	Marazanof, 1967	Recent	Sampling date — 1965
	Armengol, 1976	Recent	Sampling date — not specified
	Ruiz et al., 1996	Recent	Sampling date — 1989/92
	Ruiz et al., 1997	Recent	Sampling date — 1992/93
	Ruiz et al., 2004a	Holocene	Short sediment cores
	Ruiz et al., 2004b	Holocene	Short sediment cores
	Ruiz et al., 2005	Holocene	Short sediment cores
	Rodríguez-Pérez & Baltanás, 2008	Recent	Sampling date — 1998/99
	Ruiz et al., 2008	Holocene	Short sediment core
	Ruiz et al., 2010	Holocene	Short sediment cores (see Ruiz et al., 2004a, 2005)
	Pozo et al., 2010	Pleistocene to Holocene	Long sediment core
	Ruiz et al., 2013	Pliocene to Holocene	Long sediment core
	Alcorlo et al., 2014	Recent	Sampling date — May, 2007
2	Fahd et al., 2000	Recent	Sampling date — 1997 (18 ponds)
	Serrano & Fahd, 2005	Recent	Sampling date — 1996/97/98 (19 ponds)
	Fahd et al., 2007	Recent	Sampling date — 1997 / 98 (9 ponds) and May '98 (36 ponds)
	Aguilar-Alberola et al., 2012	Recent	Sampling date — July 2003

as 'zooplanktonic organisms' and cites 20 as the species richness in the area, a figure significantly lower than the real number.

Considering that this lack of appreciation could be caused, at least partially, by the scattered and/or specialized nature of the bibliographic sources, the goal of this paper is to offer an updated checklist of the ostracod fauna of the area including already published records as well as many unpublished ones, together with geographical references and comments on selected species. Hence, the aim of this paper is purely faunistic with some biogeographical and palaeoenvironmental tones (see further arguments in support of this approach in the 'Conclusions' section). For an exploration of the environmental factors related with the distribution of the ostracod fauna in the area the papers by Fahd et al. (2000, 2007), Serrano & Fahd (2005), and Alcorlo et al. (2014) are recommended.

MATERIALS AND METHODS

Study area

This study strictly refers to the area included within the limits of the so-called 'Doñana Natural Area' ('Espacio Natural Doñana', in Spanish), a management figure (BOE, 1999) which groups Doñana National and Natural Parks (and the associated protection zones) and covers a surface of 128 384 ha. (see Fig. 1). A detailed description of this area, including a typology of its main ecological units, can be found in Montes et al., (1998); additionally, two inventories of the water bodies occurring on the aeolian sands sector of the National Park are available in Bravo-Utrera & Montes (1993) and Gómez-Rodríguez et al. (2011).

There is a widely accepted qualitative model that defines a salinity gradient in the marsh that runs from north-west —where the main streams flow into the marsh— to south-east —where the marsh communicates with the estuary and the ocean— (Bernués, 1990) (Fig. 2). This gradient, and the existing micro-relief in an otherwise apparently flat terrain, determine the characteristics and dynamics of the many different water bodies that can occur in the area throughout an

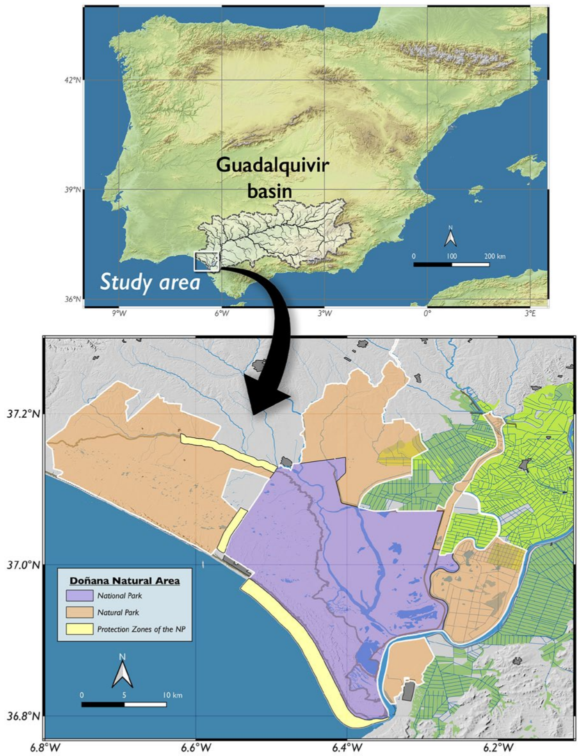

Figure 1. Limits of 'Doñana Natural Area' and its location within the Guadalquivir Basin and the Iberian Peninsula. *Límites del 'Espacio Natural Doñana' y su ubicación en la cuenca del Guadalquivir y la península Ibérica.*

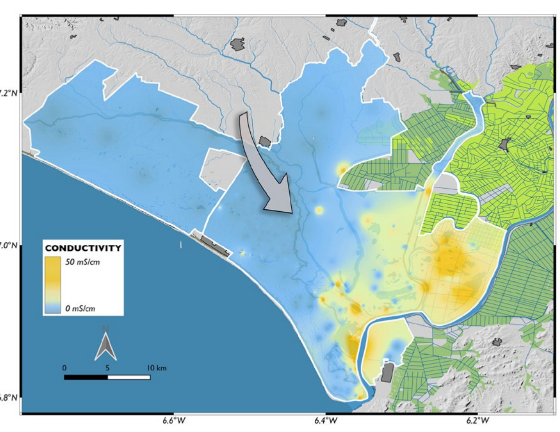

Figure 2. Map of the study area displaying the NW-SE conductivity gradient. Based on average data values from various sources (Bernués, 1980; Bodelón et al., 1994; ICTS-Doñana), it does not depict the specific value of this variable at any specific moment or location but its wide scale pattern. *Mapa del área de estudio mostrando el gradiente de conductividad NO-SE. Elaborado con datos promedio a partir de diversas fuentes (Bernués, 1980; Bodelón et al., 1994; ICTS-Doñana) no refleja la condición particular de esta variable en un momento y lugar determinados sino su comportamiento a escala amplia.*

annual cycle. Regarding the ponds on sandy substrate — ponds that are tightly linked to the underlying detritic aquifer—, the most recent and detailed models establish various hydrological types (from ponds with extraordinarily short hydroperiods to permanent shallow lakes) which are ultimately determined by the amount and the timing of water inputs into the ponds (Borja, 2011). Such types are far from being constant on an inter-annual basis as water inputs themselves vary from year to year depending on the prevailing weather conditions. Pond hydrological variability eventually affects water chemistry, which ranges from oligohaline to polyhaline, as well as the biocenoses that inhabit them (Serrano et al., 2006; Díaz-Paniagua et al., 2016). Figure 2, based on water electrical conductivity data mainly gathered from Bernués (1990) and Bodelón et al. (1994), summarizes the NW-SE salinity gradients that are so important in determining ostracod species distribution.

Data sources

In addition to the papers previously published, samples gathered in the area during the 1977-2022 interval and stored in the archives of the Department of Ecology (UAM) became available. The state of preservation of these samples was diverse, yet it was still possible to obtain whole specimens or, at least, valves and carapaces in adequate conditions from a significant number of them. The 'Natural Processes Monitoring Team-EBD' provided an additional batch of ostracod samples from 30 different sites in the area. The set was completed with samples collected within the scope of a postgraduate work carried out by our colleagues at the University of Huelva.

Equivalences between species names used in earlier publications and those currently accepted are summarized in Table 2. Only the latter are used throughout the entire text.

RESULTS AND DISCUSSION

Account of previously published records

The first publication with information on (non-marine) ostracods from the area of Doñana is that of Bigot & Marazanof (1965). Samples were collected between November 19th and 22th, 1962 during an excursion organized within the IUCN Project "MAR" (Conservation and management of temperate marshes, bogs and other wetlands), a project led by the co-founder of WWF Hans Lukas "Luc" Hoffmann. Different specialists were committed to identify different groups of organisms and Prof. Ramón Margalef (at that time at the 'Instituto de Investigaciones Pesqueras'-CSIC, Barcelona, Spain) was in charge of studying the ostracods that happened to occur in 11 (out of 15) sampling sites. A total of 8 ostracod taxa were identified to the species level.

Francis Marazanof visited the area again from April 30th to May 17th 1965 in a CNRS Mission (Marazanof, 1967). That expedition sampled 36 sites, all inside the then called "Réserve du Coto de Doñana" (now Doñana Biological Reserve-CSIC); most of the sampling sites differed from those visited in 1962. On that occasion, ostracod identifications were entrusted to Prof. Gerd Hartmann (Zoologisches lnstitut und Zoologisches Museum der Universität Hamburg, Germany). The final species list consisted in nine taxa identified to the species level, with four new records for the area.

It would take a decade until Joan Armengol (University of Barcelona) published new data on the ostracods and other crustaceans occurring in the area (including Branchiopoda, Copepoda, Ostracoda and Isopoda). Armengol (1976) summarised previously published information on crustaceans from Doñana and added new, personal observations. Those new records are referred to specific water bodies in the area but lacked information about the corresponding sampling dates. Concerning ostracods, he recorded four new species for the area.

Next in the timeline is the paper by Ruiz et al. (1996) which includes data for 7 ostracod species, four of them new records for the area, found in four temporary ponds located on the aeolian sands of Doñana (Santa Olalla, Dulce, Taraje and Jabata) in the period 1989-1992. Few years after, between March 1996 and May 1998, a research group lead by Laura Serrano (Department of Plant Biology and Ecology at the University of Seville) addressed a series of studies aimed

Table 2.-List of species scientific names as they appeared in the publications and their corresponding currently accepted names. *Listado de los nombres científicos de las especies tal y como fueron citadas en las publicaciones y sus correspondencias con los nombres aceptados en la actualidad.*

Reference	Name in publication	Accepted name
Serrano & Fahd, 2005; Fahd et al., 2007	*Candona neglecta*	*Neglecandona neglecta*
Ruiz et al., 1996	*Notodromas monachus*	*Notodromas monacha*
Marazanof ,1967	*Cypricercus obliquus*	*Bradleycypris obliqua*
Armengol, 1976	*Cypricercus affinis*	*Bradelystrandesia reticulata*
Serrano & Fahd, 2005	*Cypricercus reticulatus*	*Bradleystrandesia reticulata*
Ruiz et al., 1996; Ruiz et al., 2004a; Ruiz et al., 2004b; Fahd et al., 2000; Serrano & Fahd, 2005; Fahd et al., 2007	*Cyprinotus salinus*	*Heterocypris salina*
Armengol, 1976	*Cypridopsis newtoni*	*Plesiocypridopsis newtoni*
Bigot & Marazanof, 1965; Armengol, 1976	*Cypridopsis aculeata*	*Sarscypridopsis aculeata*
Ruiz et al., (2004a; 2004b; 2008; 2013); Pozo et al., 2010	*Pontocythere elongata*	*Cushmanidea elongata*
Ruiz et al., 1997	*Cytheropteron depressum*	*Microxestoleberis depressa*
Ruiz et al., 2005	*Phlyctocythere pellucida*	*Loxocauda pellucida*
Ruiz et al., 1997	*Paradoxostoma simile*	*Pseudopsammocythere similis*
Ruiz et al., 2008	*Hiltermannicythere emaciata*	*Celtia emaciata*
Ruiz et al., 1997	*Costa punctatissima*	*Rectotrachyleberis punctatissima*
Ruiz et al., 2004a, 2004b, 2005, 2010, 2013; Pozo et al., 2010	*Urocythereis oblonga*	*Urocythereis britannica*
Ruiz et al., 2013	*Neocytherideis subspiralis*	*Procytherideis subspiralis*

to identify the factors controlling the species composition and diversity of zooplankton communities in up to 36 temporary ponds in Doñana (Fahd et al., 2000, 2007; Serrano & Fahd, 2005). Although non-marine ostracods are not planktonic but benthic organisms, low water depth and the sampling methodology they used made it possible to also collect, partially at least, the ostracod fauna inhabiting those ponds. As a result, they have recorded the presence of 10 ostracod species, three of them new records to the area. Unfortunately, no detailed information is provided concerning which ostracod species occur in which specific water bodies.

Two papers with a narrower, more specific focus are those by Rodríguez-Pérez & Baltanás (2008) and Aguilar-Alberola et al. (2012). The first one dealt with aspects of the life cycle and population dynamics of a couple of ostracod species (*Heterocypris exigua* and *Plesiocypridopsis newtoni*) inhabiting 'Santa Olalla', a hypertrophic shallow lake where five ostracod species were recorded in total. The paper by Aguilar-Alberola et al. (2012) is the output of a wide survey throughout the Eastern Iberian Peninsula in search of entocytherid ostracods, a group of species known to be commensals of different species of crustaceans. As a result, the authors recorded the alien species *Ankylocythere sinuosa* (Ostracoda, Entocytheridae), comensal of the alien red swamp crayfish (*Procambarus clarkii*) for the first time in Doñana (and the Iberian Peninsula). Although the original paper (Aguilar-Alberola et al., op. cit.) includes no detail about the site where the species was found, the exact location is now available in the IMOST database (see Castillo-Escrivà et al., 2023). Given the abundance of this alien crayfish in Doñana, this ostracod species could be widely spread in the area too; however, further studies should be undertaken to evaluate its incidence and impacts.

The most recent publication that includes data on non-marine ostracods from Doñana is Alcorlo et al., (2014), a paper that focused on the invertebrate communities occurring in the marshland and their relationships with some environmental factors. It includes a list of 17 ostracod taxa identified to the species level. After re-examining the samples, there is a correction to be made: specimens in sample M08, initially assigned to *Fabaeformiscandona fragilis*, must be referred to *F. fabaeformis* instead.

Concern about the ostracod fauna in the area has not been restricted to non-marine species, especially because the genesis and evolution of this complex ecological system have been (and still is) tightly linked to marine and brackish —tidal and estuarine— environments. Accordingly, an active group from the University of Huelva led by Francisco Ruiz carried out intense work in the study of ostracod marine communities inhabiting shallow waters (3-18m deep) along the North Cádiz Gulf Coast, where they identified the presence of 75 ostracod species; 50 of which are found in the waters located in front of Doñana (Ruiz et al., 1997). But as interesting as that information is, their most remarkable contribution is, without a doubt, the study of several short and long sediment cores extracted at different locations in the marshlands and surrounding areas (Ruiz et al., 2004a, 2004b, 2005, 2008; 2010, 2013a; Pozo et al., 2010). Those cores yield a total of 52 ostracod species; and that information, together with mineralogical and geochemical data, were used to track the evolution of the area at a geological scale.

Updated checklist

This paper compiles information on ostracod species occurring in 152 sites; 135 of them located within the administrative limits of 'Doñana Natural Area' and the remaining 17 located in the coastal area (Fig. 3 and Table S1 (supplementary information, available at https://www.limnetica.net/en/limnetica)). Previously published ostracod records come from 84 of those sampling sites. In this paper, we contribute with ostracod records from 68 new sites as well as additional records from 15 of the previously sampled sites.

Three comprehensive lists that summarise the most relevant information regarding ostracod records in the area have been included as 'Supplementary Material' due to their size (available at https://www.limnetica.net/en/limnetica).

Table S1 lists all the sites within the study area where ostracod presence has been recorded and includes the geographic coordinates for all sites; information on whether the records from those sites have been published or not; the total number of visits rendered to each site; and the cumulative species richness for each site.

Table S2 (supplementary information, available at https://www.limnetica.net/en/limnetica) is the taxonomic list of all ostracod species recorded in the area with data on their incidence (i.e. number of sites where they have been recorded) and information on their corresponding habitat and age.

The list of ostracod species currently known to occur in Doñana includes 101 taxa belonging to 66 genera, in 22 families and 4 superfamilies (see Table S2 for a detailed account). Sixty-five species were sampled in the marine realm —eleven of them also found in brackish environments— whereas the total number of non-marine species recorded is thirty-eight. Data concerning the sites where each species have been recorded can be found in Table S3 (available at https://www.limnetica.net/en/limnetica) and a map showing ostracod species richness per sampling site is displayed in figure 4.

Eight non-marine species are recorded here for the first time within the limits of the study area: *Cyclocypris ovum* (Jurine, 1820), *Fabaeformiscandona fabaeformis* (Fischer, 1851), *Neglecandona angulata* (G.W. Müller, 1900), *Neglecandona meerfeldiana* (Scharf, 1983), *Trajancypris clavata* (Baird, 1838), *Herpetocypris brevidaudata* Kaufmann, 1900, *Hemicypris reticulata* (Klie, 1930) and *Cypridopsis concolor* Daday, 1900. However, it must be mentioned that *H. reticulata* has been previously found by Lovas-Kiss et al. (2018) in a rice-field very close to the limits of study area.

Within the non-marine species Cypridoidean ostracod species are majority (32 spp.) with the family Cyprididae representing 50% (22 species) of the fauna in the area (see Table S3). *Plesiocypridopsis newtoni*, *Herpetocypris chevreuxi*, *Cypris bispinosa* and *Eucypris virens* are the most frequently found ostracod species in the area; namely, they are present in 46, 44, 38 and 36 sampling sites, respectively (Figs. 5 and 6). Scanning Electron Microscope (SEM) photographs of some of the more representative non-marine species in the area are also included (Plates I to III). Given the heterogeneous nature of the samples used —remember that some samples differed in the date of sampling by decades, and that collection and preservation methods also vary widely— we made no attempt to explore any kind of association among species.

The fossil (>13 kyr) and subfossil (<13 kyr) ostracod faunas of Doñana also remain poorly known, as they are based on the analysis of a small number of cores, most of them consisting of sediments deposited during the last 5000

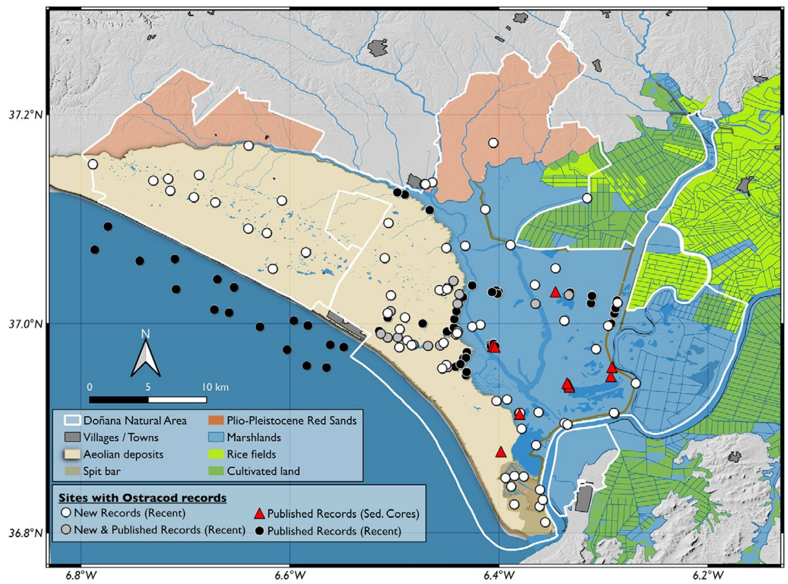

Figure 3. Sampling sites with published and/or new ostracod records (see Table S2 for a comprehensive list). *Puntos de muestreo con registros de ostrácodos publicados y/o nuevos (ver Tabla S2 para una lista detallada).*

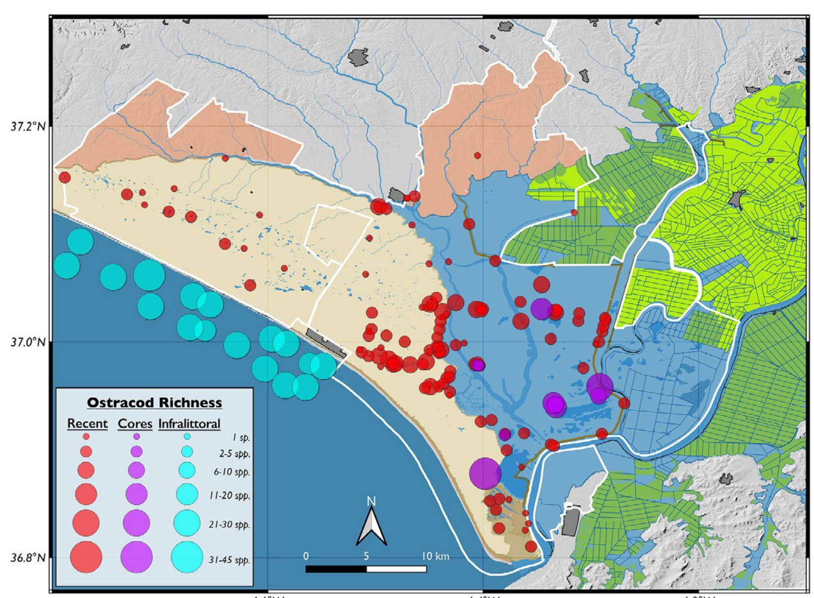

Figure 4. Ostracod species richness per sampling site. *Riqueza específica de ostrácodos por punto de muestreo*

years. To date, the oldest ostracods were identified in a long core (289m depth) extracted near the Guadalquivir mouth from the Huelva Sand Formation (Civis et al., 1987). This formation consists of Pliocene bioclastic sands and silts deposited in an infralittoral palaeoenvironment around 5.3-4.5 Ma ago, when Doñana was part of an extensive bay that extended along the present-day Guadalquivir Basin. Only six species have been identified at depths between 237m and 289m: *Carinocythereis carinata*, *Hiltermannicythere retifastigata*, *Loxoconcha* sp., *Nonurocythereis seminulum*, *Falunia costata* and *Ruggieria tetraptera* (Ruiz et al., 2013a).

During the Upper Pliocene and most of the Pleistocene, the geological record of Doñana is dominated by alluvial sands, freshwater silty marshes, and dune systems in most of which no ostracods have been recorded. Only two long cores from Lucio del Lobo and Las Nuevas include several silty-clayey levels deposited on freshwater/brackish marshes during the Upper Pleistocene with an ostracod fauna dominated by the brackish species *Cyprideis torosa*, *Loxoconcha elliptica* and some species of *Leptocythere*, although marine species (especially *Urocythereis britannica*) also appear (Zazo et al., 1999, Pozo et al., 2010).

From about 20 kyr BP to 4-5 kyr BP there was a rise in sea level due to the MIS-1 transgression resulting from the last deglaciation. Doñana was progressively flooded by the sea and formed part

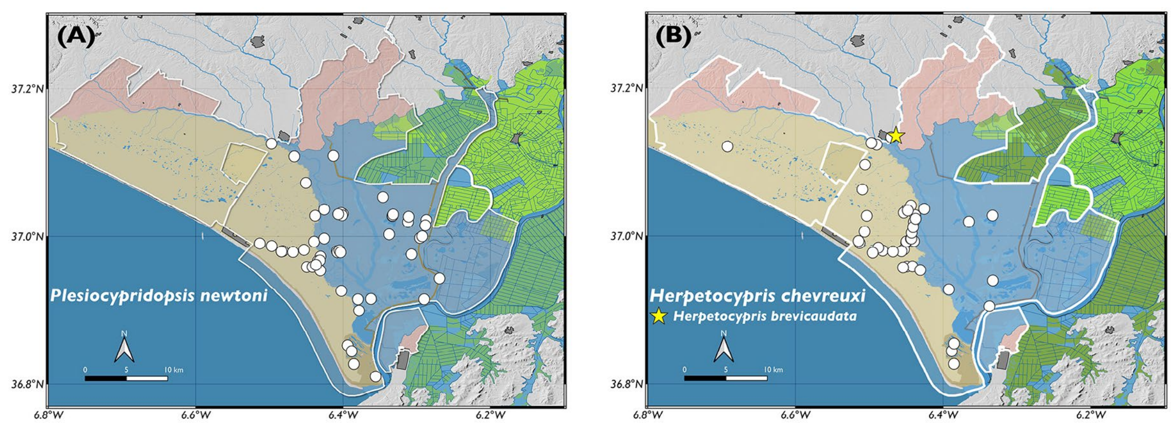

Figure 5. Records of *Plesiocypridopsis newtoni* (A) and *Herpetocypris chevreuxi* (B) in the study area, also including a single record of *Herpetocypris brevicaudata* (yellow star in B). *Registros de* Plesiocypridopsis newtoni *(A) y* Herpetocypris chevreuxi *(B) en el área de estudio, se incluye también el único registro existente de* Herpetocypris brevicaudata *(estrella amarilla en B).*

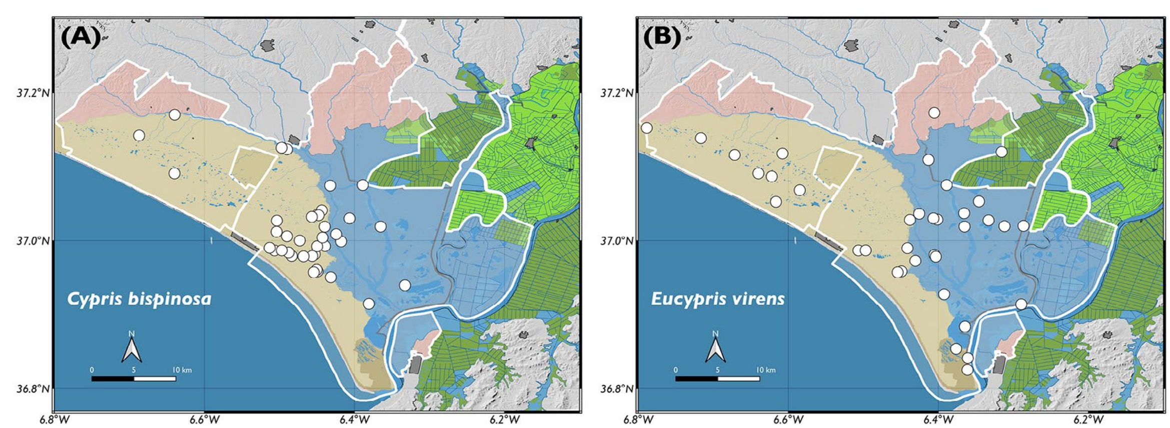

Figure 6. *Cypris bispinosa* (A) and *Eucypris virens* (B) records in the study area. *Registros de* Cypris bispinosa *(A) y* Eucypris virens *(B) en el área de studio.*

of a large brackish lagoon that extended to the vicinity of Seville, known as Lacus Ligustinus during the Roman period. In this scenario, the previously mentioned brackish ostracods were extremely abundant, accompanied by marine species still present today on the marine areas adjacent to the park, such as *Aurila convexa*, *Loxoconcha rhomboidea*, *Palmoconcha turbida* or *Urocythereis britannica*. The frequent presence of these reworked species, together with the multidisciplinary analysis of short cores, has made it possible to differentiate the sediments deposited during the Holocene transgressive maximum (~6.5 kyr) and different tsunamigenic layers (~5.3 kyr BP, 4.2 kyr BP, 3.6 kyr BP or 3.3 kyr BP, among others) (Ruiz et al., 2005, Pozo et al., 2010).

The present-day sandy infralittoral (3-18m deep) sediments near Doñana have a diversified ostracod fauna with 50 identified species (Ruiz et al., 1997). However, seven species make up more than 60% of the total ostracod fauna: *Callistocythere rastrifera*, *Cytheretta adriatica*, *Neocytherideis subulata*, *Palmoconcha guttata*, *Pontocythere elongata* and *Urocythereis britannica*. These species, together with *Paracypris polita*, are also abundant in the Guadalquivir riverbed near its mouth.

Scanning Electron Microscope (SEM) photographs of some of the most representative brackish and marine species in the area are included in Plates IV to V.

Notes on selected species

Ilyocypris getica Masi, 1906

This species can be easily identified based on the short natatory setae on A2, the 5-segmented walking leg and the presence of an aesthetasc-like seta in the penultimate segment of the cleaning leg. It has a scattered occurrence in the Palaearctic with a strong presence in the circum-mediterranean region region (Gauthier, 1928, 1933, 1938, Ramdani, 1982, Thiery, 1987, Meisch, 2000, Ramdani et al., 2001, Külköylüoğlu et al., 2010, Marrone et al., 2019, Pieri et al., 2020, Menail et al., 2023). However, evidence of its presence in the Iberian Peninsula is still scarce. Escrivà et al. (2014) claimed to have recorded the species for the first time in Spain after finding some specimens in three reservoirs in the Valencian Community (E Spain); but a previous record of the species living in a shallow hypersaline lake in Almenar (Lleida, NE Spain) can be found in a technical report elaborated by Boix et al. (2004) for the Catalan Water Agency.

The records from Doñana in this study significantly increase the range of distribution of the species in the Iberian Peninsula and suggest that it is likely to occur in many other areas.

Bradleycypris obliqua (Brady, 1868) McKenzie 1982a

The species seems to be widely but loosely distributed over an area that comprises Western and Central Europe, North Africa, North America, and the Macaronesia as well (see Meisch, 2000; Scharf and Hollwedel, 2009; Scharf and Meisch, 2014). Such distribution range has recently expanded to include Taiwan in the far East (Yu et al., 2009). In the circum-Mediterranean region, the species is known to occur in Algeria (Gauthier, 1928; Klie, 1935), Tunisia (Gauthier, 1928, Marrone et al. 2020), Morocco (Klie, 1943), Croatia (Petkovski, 1964), Slovenia (Griffiths & Brancelj, 1996, Mori & Meisch, 2012), Serbia (Karan-ŽnidaršIč & Petrov, 2007), Italy (Pieri et al., 2015) and Turkey (Dalgakiran, 2018). In the Iberian Peninsula it was recorded for the first time —bisexual populations included— in Doñana (11 sites) by Marazanof (1967); a fact that, nevertheless, has gone completely unnoticed by later authors, including Meisch (2000), Roca et al. (2000) and Martins et al. (2010). Additional records of this species in the Iberian peninsula can be found in Baltanás (1992) [a pond in Extremadura, W Spain], Roca et al. (2000) [a bisexual population at Ojos de Villaverde, Albacete, SE Spain), Boix et al. (2005) [a temporary pond in Alt Empordá, NE Spain), Poquet et al. (2008) [a pond nearby Xeresa, Valencia, E Spain], Martins et al. (2010) [bisexual populations in 3 ponds in Baixo Alentejo, SW Portugal], Mezquita et al. (2011) [springs in Castelló, E Spain], and Escrivà et al. (2015) [lotic habitats within the Guadalquivir basin; exact coordinates available in IMOST database hosted in GBIF (see Castillo-Escrivà et al., 2023)].

In the area of Doñana it is known to occur in 27 sites with males present in most samples. Given that the absence of males happened to occur either in poorly preserved samples or in samples with few individuals, it can be assumed that syngamic reproduction is the norm throughout the entire area. See figure 7 for a map of the species distribution within Doñana and the existing records for bisexual populations in the circum-Mediterranean region.

Herpetocypris reptans (Baird, 1835)

The species was cited in the area by Serrano & Fahd (2005) and Fahd et al. (2007) but without providing specific information of the locations where it was found or details of the morphological features that support such identification. Such backup evidence is especially relevant in the case of this species as there are serious concerns about the validity of the existing records of this species in the Iberian Peninsula. Such concerns were first raised by one of us (Baltanás, 1992) mainly based on the size measurements provided in some, but not all, of the publications containing those records (Margalef, 1953a; Armengol, 1972) as those measurements were closer to the values expected for *H. brevicaudata* than for *H. reptans*. Baltanás (op. cit.) concluded that “the taxonomic identity of those records remains an

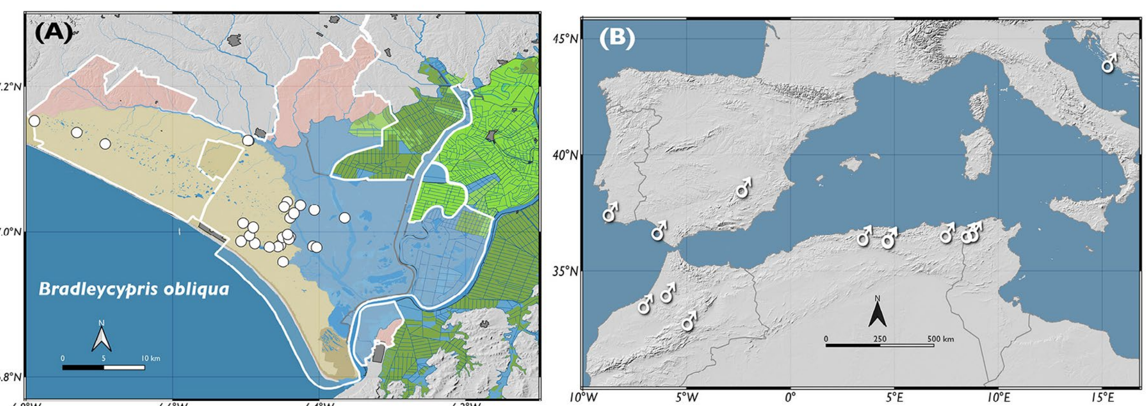

Figure 7. (A) Records of *Bradleycypris obliqua* in Doñana and (B) sites with syngamic populations (males present) in the circum-Mediterranean area. *(A) Registros de* Bradleycypris obliqua *en Doñana y (B) localidades con presencia de poblaciones singámicas (machos presentes) en la región circum-Mediterránea.*

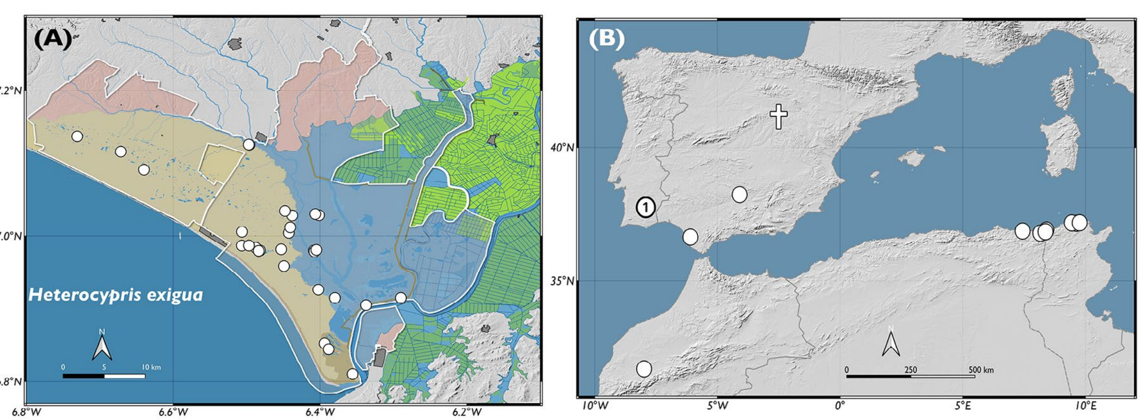

Figure 8. Records of *Heterocypris exigua* in Doñana (A) and in the circum-Mediterranean region (B): ┼ — Pleistocene record (Baltanás et al., 2005); ① — determination not fully confirmed because of the lack of males (Martins et al., 2010). *Registros de* Heterocypris exigua *en Doñana (A) y en la region circum-Mediterránea (B): ┼ — registro del Pleistoceno (Baltanás et al., 2005); ① — determinación no plenamente confirmada debido a la ausencia de machos (Martins et al., 2010).*

open question because neither the original material has been checked nor the argument of the size is conclusive". Since then, and despite the significant sampling effort displayed, the species have not been recorded again in the Iberian Peninsula and, accordingly, Castillo-Escrivá et al. (2023) recently transferred those historical records into *Herpetocypris* sp. Such a level of caution is perfectly justified but may lead to overlook some interesting issues as there seems to be no objective reasons for the non-presence of the species in the Iberian Peninsula given that its ecological requirements are not very demanding (Meisch, 2000; Horne et al., 2012b) and it has a wide geographical distribution (Meisch, 2000) which includes circum-Mediterranean areas close to the Iberian Peninsula: Italy (Pieri et al, 2012, 2015, 2020; Rosati et al, 2017); southern France (Salel et al, 2016); Greece (Marrone et al, 2019), and Turkey (Külköylüoğlu et al, 2018; Özulug et al, 2018; Çelen et al, 2019; Dalgakiran et al, 2020).

In summary, the resemblance between Herpetocypris species with short natatory setae on A2 has probably caused mix-ups and could have led to incorrect citations in many studies; however, correcting this problem is difficult since often neither the initial specimens are kept, nor do the details provided with species inventories offer sufficient data on the specimen's morphology for a precise reassessment of the identifications.

Heterocypris exigua (Gauthier & Brehm, 1928) Klie 1938

Originally described by Gauthier & Brehm (1928) as *Cyprinotus exiguus* from individuals collected from ponds in El Kala (Algeria), and Tindja and Sejnane (Tunisia), the species has been recorded only from just few sites in the Western circum-Mediterranean region, including Algeria & Tunisia (Gauthier & Brehm, 1928, Gauthier, 1928), Morocco (Masi, 1932), and the Iberian peninsula (Marazanof, 1967, Martins et al., 2010, Escrivà et al., 2015), including a fossil record from the Pleistocene deposit of Ambrona (Soria, Central Spain) (Baltanás et al., 2005) [see figure 8 for the species distribution and Karan–Žnidaršič et al. (2018) for an updated description of the species].

In Doñana, *H. exigua* has been recorded in 30 sites (see Table S3), and bisexual populations seem to be the rule, not the exception; a feature that might explain its restricted geographic distribution. Anyway, the prevalence of sexual reproduction in a species so closely related with the cosmopolitan *Heterocypris incongruens*, a species that mainly reproduces asexually, deserves further attention as it is likely to offer some hints into the mechanisms behind reproduction modes in ostracods (Martens, 1998; Rossi et al., 2007; Schmit et al., 2013).

Cypridopsis concolor Daday, 1900; C. parva GW Müller, 1900 and C. vidua (O.F. Müller, 1776)

Since long time ago, there has been some controversy about the taxonomic identity of these *Cypridopsis* species. Already in 1915, Gunnar Alm had assigned *Cypridopsis concolor* to *C. parva*, probably mainly because of its small size, and Klie (1938) followed suit (see Fuhrmann & Goth, 2011). In the most important and recent compendium on the non-marine ostracod fauna of Western and Central Europe (Meisch, 2000) both *C. parva* and *C. concolor* are listed as synonyms of *C. vidua*. However, different carapace characteristics between all three species have been described (Fuhrmann & Goth, 2011; Fuhrmann, 2012), thus increasing the evidence backing their existence as valid species. Additionally, there are various studies carried out by the research group of the University of Valencia led by F. Mesquita —studies not yet published at the time of writing this paper— which add support to this conclusion. Accordingly, we list here records corresponding to both species, *C. vidua* and *C. concolor*. Regarding the only available record of the presence of *C. parva* in Doñana (Marazanof, 1967), an additional comment is necessary. The paper of Marazanof (op. cit.) includes no description of the specimens collected or information about their size, carapace features or soft parts morphology. Therefore, although that of Marazanof is the only record of *C. parva* in a region where *C. concolor* has been gathered at multiple other sites; and although Castillo-Escrivà et al (2023) considered that all the records of *Cypridopsis parva* in the Iberian Peninsula belong to *Cypridopsis concolor*, we cannot unequivocally assign that record to any other species but *C. parva*.

Notodromas monacha (OF Müller, 1776)

Since certain historical records of this otherwise rare species in Spain have been recently reviewed and attributed to its sibling species *N. persica* (Castillo-Escrivá et al., 2023), every record of the prior species must undergo examination before it is confirmed. In the present case, Ruiz et al. (1996) documented the presence of a single specimen of *N. monacha* from a single site (Laguna del Alcornoque de la Jabata) and included a draft drawing of the carapace (lateral view) and information on its size. Although the illustration is closer to a freehand sketch than to a technical line drawing it allows us to appreciate the presence of a postero-ventral spur-shaped expansion that points posteriorly; a feature characteristic of *N. monacha* as compared to *N. persica* whose spur points either anteriorly or downwards (Meisch, 2000). Furthermore, the carapace length value provided (1.00 mm), while not a definitive morphological feature, matches the measurements for *N. monacha* reported by Meisch (2000).

FINAL REMARKS

This review of the ostracod fauna recorded in Doñana configures it as a rich-species area for the non-marine section of these crustacean group as it harbours a third of the species known so far in the Iberian Peninsula (see Castillo-Escrivá et al., 2023 for a recent account). Because of the predominance of temporary inland water bodies in the area, its non-marine ostracod fauna is dominated by Cyprididae species (22 spp.); and given that most ostracod species are widely distributed at a regional or a continental scale with local endemics restricted to speciation-prone habitats like ancient lakes and groundwater (Martens et al., 2008), it is not surprise that there are no local endemics to this area. Nevertheless, there are some species that deserve special attention; particularly, *Heterocypris exigua* a species with a restricted geographic distribution and a prevalence —if not an obligation— of syngamic reproduction. Marine species diversity is also high with fifty species that have been found in Recent infralittoral environments. Meanwhile, Pleistocene and Holocene records display less diverse communities dominated by otherwise very abundant brackish species.

All the information collected can be organised in a species presence/absence data matrix to be submitted to come kind of numerical analysis in order to identify patterns in species associations and explore other features of ostracod community composition. This data matrix, though, is not technically fit for this kind of inquiry and using this method would lead to clearly misleading results. And that is due to the extreme heterogeneity of the observational units [ostracod species x site] as they were gathered (a) across a period exceeding six decades, (b) in sites characterized by significant variability on seasonal, yearly, and multi-annual levels, and (c) by researchers with diverse goals and techniques. This makes information regarding the presence/absence of species difficult to interpret because the presence of varied species at the same location does not necessarily imply co-occurrence (unless they were recorded on the same date) nor does their absence necessarily suggest adverse biotic-abiotic conditions at the spot. Within this context it becomes especially difficult to ascertain if the nonappearance of specific species at locations where they were once present is due to ecological factors (for instance, lack of necessary environmental conditions or extinction due to shifts in the environmental state of the aquatic system) or arises from problems associated with the sampling (such as inappropriate sampling periods or inadequate sampling methods).

Information gathered from 'Laguna del Sopetón', the shallow lake with most sampling events (9 sampling events, ranging from 1962 to 2022) might illustrate this point. A total of 10 species have been recorded in this lake, yet none were present in all samples. *Cypris bispinosa*, which is easily recognizable and whose populations reach high densities, was observed in this lake on 7 instances: excluding samplings in 1965 and 1990. Other species also showed up intermittently in the time series of samples. Did those species vanish from the lake in the years they were not recorded, only to return and populate the lake again? It is highly unlikely; instead, the shortcomings of the sampling method are the more plausible explanations for these discrepancies, especially in a relatively large (almost 2.3Ha) shallow lake like this.

Another fact that precludes a meaningful overall analysis of the ostracod community patterns in Doñana is the uneven distribution of the sampling effort (see Table S1). Whereas some sites have been visited on several occasions, many others have been visited only once and, most frequently, to satisfy objectives very different to those specific to a faunal study. Concerning this point, let's consider the samples gathered, sorted, and kindly supplied to us by the 'Natural Processes Monitoring Team-EBD'. Most of these samples showed very low species diversity (1-2 spp.), with *Cypris bispinosa* being the sole species found in most of the sites (15 out of 28). Given that *C. bispinosa* is a large and conspicuous species, the theory of a sampling bias, where smaller species were missed during collection and/or sorting, seems more plausible than the notion that these ponds and shallow lakes are

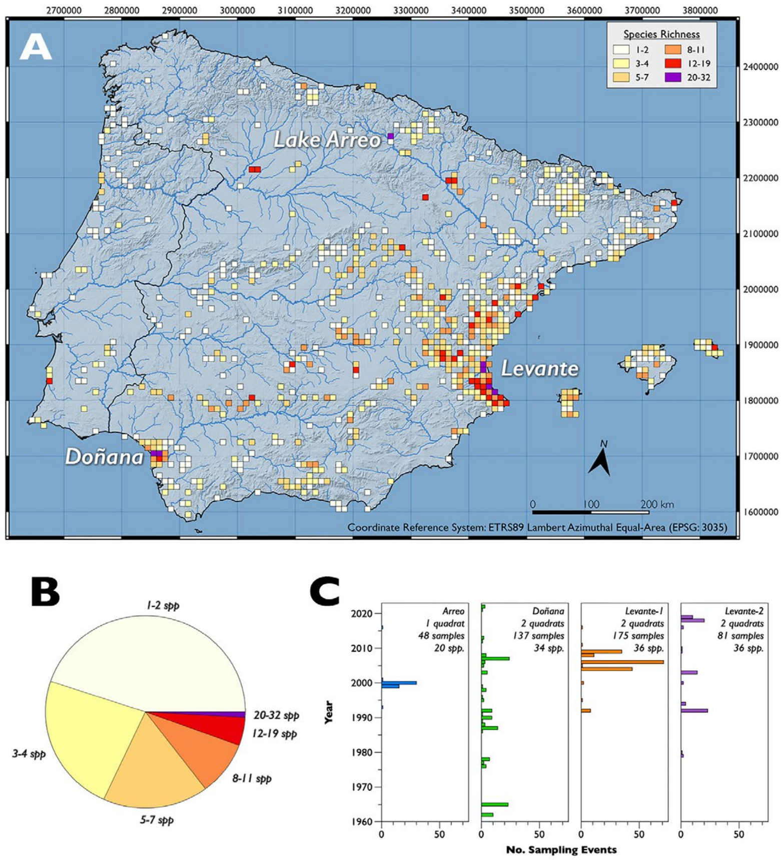

Figure 9. (A) Non-marine ostracod species richness for each 10x10 km quadrat covering the Iberian Peninsula and the Balearic Islands [grid provided by the Geographic Information System of the (European) Commission-GISCO] as estimated from data available in the database IMOST (see text for further details) (B) Proportion of quadrats with different ostracod species richness. (C) Sampling effort (number of sampling events on a yearly basis) in those areas with quadrats with species richness equal to or greater than 20 spp. *(A) Riqueza específica de ostrácodos no-marinos para cada cuadrícula de 10x10 km que cubre la Península Ibérica y las Islas Baleares [cuadrícula proporcionada por el Sistema de Información Geográfica de la Comisión (Europea)-GISCO]. La riqueza fue estimada a partir de los datos disponibles en la base de datos IMOST (ver texto para más detalles) (B) Proporción de cuadrantes con diferente riqueza-específica de ostrácodos no-marinos. (C) Esfuerzo de muestreo (número de eventos de muestreo por año) correspondiente a las zonas que contienen cuadrículas con riqueza específica igual o superior a 20 spp.*

inherently species-scarce.

A final comment is devoted to non-marine ostracod richness in the area and how it compares to ostracofauna in other areas of the Iberian Peninsula. To do that we made extensive use of IMOST, a non-marine ostracod database for the Iberian Peninsula and the Balearic and Macaronesian islands recently presented by Castillo-Escrivà et al. (2023) and whose database is publicly accessible at https://github.com/andreucastillo/imost. Using data from that database we have calculated non-marine ostracod richness, and the number of sampling events carried out in each of the 10x10 km quadrats covering the Iberian Peninsula and the Balearic Islands [grid provided by the Geographic Information System of the (European) Commission-GISCO] (see Fig. 9A). The number of such quadrats is 6363; yet ostracods have been recorded in a scant 12% of the total. Furthermore, within many of these, the species richness observed is quite small (1-2 spp. in 45% of the quadrats; and 3-4 spp. in another 23%) (see Fig. 9B). These numbers alone suggest the sampling effort that yet need to be accomplished to reach an acceptable degree of knowledge across the Iberian Peninsula.

Next step was to identified quadrats rich in species by applying the reasonable yet arbitrary threshold of ≥20 spp per quadrat as the dividing rule. We identified quadrats (or groups of contiguous quadrats) with such characteristics in three regions (Fig. 9A):

(a) Doñana (this study): two contiguous 10x10km quadrats, with 137 sampling events recorded in 136 localities and a total of 34 non-marine ostracod species.

(b) Levante (Eastern coast of the Iberian Peninsula) where we recognised two areas, here labelled 'Levante-1' and 'Levante-2', made of two contiguous quadrats each. Concerning Levante-1, the database includes data from 175 samples obtained in 86 sampling sites for a total of 36 non-marine ostracod species. The Albufera, one of the largest oligohaline coastal lagoons in Spain, is located within the limits of Levante-1. Slightly further south, Levante-2, which includes ponds in the vicinity of Xeresa and the Pego-Oliva coastal wetland, has been sampled on 81 occasions (32 sampling sites) for a total of 36 spp as well.

(c) Lake Arreo constitutes a unique body of water, the deepest lake (24.8 m) on evaporite rocks of the Iberian Peninsula (Gonzalez-Mozo et al., 2000). Its ostracod fauna was approached through a systematic and intensive programme that run on a monthly basis from February 1999 to January 2001, rendering a total of 20 ostracod species after 46 sampling events (Martín-Rubio et al., 2005).

Our goal now is to demonstrate how challenging, if not unsuitable, is the quantitative comparison among these species-rich areas due to significant variations in the timing and methodology of sample collection that underpin this data. Therefore, while the sampling effort in Lake Arreo have comprehensively spanned the various seasons of the year (Martín-Rubio et al., 2005), these efforts have been somewhat less systematic yet still quite concentrated temporally in Levante-1 and -2 (nearly 70% of all sampling events in this region were carried out by the same research group in a relatively short period of time, 2000 and 2003-2009). On the other end of the spectrum, as previously mentioned, ostracod database of Doñana encompasses records obtained by very diverse people, with different aims and methodologies, spanning over six decades; thus, it lacks a stringent framework that could have ensured a reliable depiction of the ostracod community occurring at the most representative aquatic habitats in the area across seasonal and yearly intervals (Fig. 9C).

Despite this, the number of species recorded so far is remarkable, and given the abundance and diversity of aquatic systems existing in Doñana, we must expect such number to increase significantly as far as systematic surveys in the area are supported. Further efforts to enrich our knowledge of the ostracofauna of the area and to better understand its relationships with environmental factors will help us to track changes that are likely to happen in this valuable ecosystem due to expected global changes ahead.

ACKNOWLEDGEMENTS

Samples stored at the Department of Ecology (UAM) and used in this study were collected by

Prof. Carlos Montes (10 samples, 1977-78) and Dr. Magdalena Bernués (32 samples, 1987-88). Samples collected within the 'Natural Resources Monitoring Program' between 2003 and 2012 were kindly provided by ICTS-Doñana for this study; we especially acknowledge the contribution of Hughes Lefranc and Arantxa Arrechederra in the collection and sorting of those samples. Two anonymous referees helped to improve the manuscript. This work has been partly funded by the research group RNM-238 (Palaeontology and Applied Ecology) of the Andalusian Government. This is a contribution to the Research Center in Historical, Cultural and Natural Heritage (CIPHCN) of the University of Huelva.

AUTHOR CONTRIBUTIONS

ÁB: Conceptualization; Validation; Resources; Data Curation; Writing — original draft; Writing — review & editing; Visualization. MÁBU: Conceptualization; Resources; Data Curation; Writing — review & editing. MLGR: Resources; Data Curation. ST: Resources; Data Curation. FR: Conceptualization; Validation; Resources; Data Curation; Writing — review & editing

REFERENCES

Aguilar-Alberola, J. A., Mesquita-Joanes, F., López, S., Mestre, A., Casanova, J. C., Rueda, J. & Ribas, A. (2012). An invaded invader: high prevalence of entocytherid ostracods on the red swamp crayfish *Procambarus clarkii* (Girard, 1852) in the Eastern Iberian Peninsula. *Hydrobiologia*, 688, 63-73. DOI: 10.1007/s10750-011-0660-1

Alcorlo, P., Jiménez, S., Baltanás, Á. & Rico, E. (2014). Assessing the patterns of the invertebrate community in the marshes of Donana National Park (SW Spain) in relation to environmental factors. *Limnetica*, 33, 189-204. DOI: 10.23818/limn.33.15

Alm, G. (1916). Monographie der Schwedischen Süsswasser-Ostracoden nebst systematischen besprechungen der tribus Podocopa. *Zoologiska Bidrag fran Uppsala*, 4(1), 1-247.

BOE (1999). LEY 8/1999, de 27 de octubre, del Espacio Natural de Doñana. BOE, 295, 42569-81.

Armengol, J. (1972). Ostracodes de la Vall de Bigues. *Treballs de la Societat Catalana de Biologia*, 32, 121-125.

Armengol, J. (1976). Crustáceos acuáticos del Coto de Doñana. *Oecologia Aquatica*, 2, 93-97.

Baltanás, Á. (1992). A contribution to the knowledge of the cypridid ostracode fauna (Crustacea, Ostracoda, Cyprididae) on the Iberian Peninsula, and a comparison with adjacent areas. *Archiv für Hydrobiologie/Supplementband Monographische Beiträge*, 90, 419-52.

Baltanás, Á. & Danielopol, D. L. (2013). Body-size distribution and biogeographical patterns in non-marine ostracods (Crustacea: Ostracoda). *Biological Journal of the Linnean Society*, 109, 409-23.

Baltanás, Á., Alcorlo, P. & Namiotko, T. (2005). Ostrácodos (Crustacea, Ostracoda) del yacimiento Pleistoceno de Ambrona. *Zona Arqueológica*, 5, 221-231.

Bernués, M. (1990). Limnologia de los ecosistemas acuáticos del Parque Nacional de Doñana. Doctoral Thesis, 242 p. (+Appendices); Universidad Autonoma de Madrid.

Bigot, L. & Marazanof, F. (1965). Considèrations sur l'ecologie des invertèbrès terrestres et aquatiques des marismas du Guadalquivir (Andalucia). *Vie et Milieu*, 16, 441-473.

Bodelón, O. G., Bernués, M., Baltanás, Á. & Montes, C. (1994). Conductividad y salinidad en los ecosistemas acuaticos del parque nacional de Doñana (SO, España). *Limnetica*, 10, 27-31.

Boix, D., Gascón, S., Gifre, J., Moreno-Amich, R., Martinoy, M., Quintana, X. & Sala, J. (2004). *Caracterització, regionalització i elaboració d'eines d'establiment de l'estat ecològic de les zones humides de Catalunya*, 185pp. Agència Catalana de l'Aigua, Departament de Medi Ambient i Habitatge, Generalitat de Catalunya.

Boix, D., Gascón, S., Sala, J., Martinoy, M., Gifre, J. & Quintana, X. D. (2005). A new index of water quality assessment in Mediterranean wetlands based on crustacean and insect assemblages: the case of Catalunya (NE Iberian peninsula). *Aquatic Conservation: Marine and Freshwater Ecosystems*, 15, 635-51. DOI: 10.1002/aqc.750

Brandao, S. N., Sauer, J. & Schön, I. (2010). Circumantarctic distribution in Southern Ocean benthos? A genetic test using the genus *Macroscapha* (Crustacea, Ostracoda) as a model. *Molecular Phylogenetics and Evolution*, 55, 1055-1069. DOI: 10.1016/j.ympev.2010.01.014

Bravo-Utrera, M. Á. (2010). Monitoring Aquatic Ecosystems at Doñana Natural Space., p. 339-355. In: Hurdford, C., Schneider, M. & Cowx, I. (eds.), *Conservation monitoring in freshwater habitats: A practical guide and case studies*, Springer Netherlands, Dordrecht

Bravo-Utrera, M. Á. & Montes, C. (1993). Inventario de las formaciones palustres del manto eólico del Parque Nacional de Doñana (SW España). *Actas VI Congreso Español de Limnología*, 31-43.

Castenholz, R. W. (2015). Portrait of a Geothermal Spring, Hunter's Hot Springs, Oregon. *Life*, 5, 332-347. DOI: 10.3390/life5010332

Castillo-Escrivà, A., Baltanás, Á., Camacho, A., Horne, D. J., Pretus, J. L., & Mesquita-Joanes, F. (2023). IMOST: a database for non-marine ostracods in the Iberian Peninsula, the Balearic Islands and Macaronesia. *Journal of Limmnology*, 82, 2115. DOI: 10.4081/jlimnol.2023.2115

Çelen, E., Külköylüoğlu, O., Yavuzatmaca, M., Akdemir, D., & Yilmaz, O. (2019). First evidence of *Cardinium* (Sphingobacteria) in non-marine ostracods from Turkey. *Journal of Crustacean Biology*, 39(5), 547-551.

Civis, J., Sierro, F. J., González Delgado, J. A., Flores, J. A., Andrés, I., Porta, J., Valle, M. F., (1987). El Neógeno marino de la Provincia de Huelva: Antecedentes y definición de sus unidades litoestratigráficas, p. 5–16. In: Civis, J. (Ed.), *Paleontología del Neógeno de Huelva (W Cuenca del Guadalquivir)*. Universidad de Salamanca

Dalgakıran, E. (2018). Determination of the relationship between ostracoda (Crustacea) carapace size and geographic and ecological factors in different aquatic habitats of Mersin (Turkey). MSc dissertation, 89 pp. Department of Biology, Bolu Abant Izzet Baysal Univerity, Bolu, Turkey

Dalgakıran, E., Külköylüoğlu, O., Yavuzatmaca, M., & Akdemir, D. (2020). Correlational analyses of the relationships between altitude and carapace size of Ostracoda (Crustacea). *Annales de Limnologie - International Journal of Limnology*, 56, 2.

Díaz-Paniagua, C., Fernández Zamudio, R., Serrano, L., Florencio, M., Sousa Martín, A., García Murillo, P. & Siljeström, P. (2016). El sistema de lagunas temporales del Parque Nacional de Doñana: aplicación a la gestión y conservación de hábitats acuáticos singulares. *Proyectos de investigación en parques nacionales*, 37-59.

Escrivà, A., Poquet, J. & Mesquita-Joanes, F. (2015). Effects of environmental and spatial variables on lotic ostracod metacommunity structure in the Iberian Peninsula. *Inland Waters*, 5, 283-294. DOI: 10.5268/IW-5.3.771

Escrivà, A., Rueda, J., Armengol, X. & Mesquita-Joanes, F. (2014). Artificial dam lakes as suitable habitats for exotic invertebrates: Ostracoda ecology and distribution in reservoirs of the Eastern Iberian Peninsula. *Knowledge and Management of Aquatic Ecosystems*, 412, (09) 12p. DOI: 10.1051/kmae/2013091

Fahd, K., Florencio, M., Keller, C. & Serrano, L. (2007). The effect of the sampling scale on zooplankton community assessment and its implications for the conservation of temporary ponds in south-west Spain. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 17, 175-193. DOI: 10.1002/aqc.781

Fahd, K., Serrano, L. & Toja, J. (2000). Crustacean and rotifer composition of temporary ponds in the Doñana National Park (SW Spain) during floods. *Hydrobiologia*, 436, 41-49.

Fuhrmann, R., & Goth, K. (2011). Neue und weitere bemerkenswerte Ostrakoden aus dem Quartär Mitteldeutschlands. Palaeontographica, Abt. *A: Palaeozoology - Stratigraphy*, 4-6, 95-201.

Fuhrmann, R. (2012). Atlas quartärer und rezenter Ostrakoden Mitteldeutschlands. *Altenburger Naturwissenschaftliche Forschungen*, 15, 330 pp

Gauthier, H. (1928). Recherches sur la faune des eaux continentales de l'Algérie et de la Tunisie. (PhD Thesis. Université de Paris, France)

Gauthier, H. (1933). Nouvelles recherches sur la faune des eaux continentales del'Algerie et de la Tunisie (1er note). *Bulletin de la Société d'Histoire Naturelle de l'Afrique du Nord*, 25, 121-126.

Gauthier, H. (1938). Ostracodes continentaux récoltés par M. Monod au Sahara occidental et en Mauretanie. *Bull. Soc. Sc. Nat. du Maroc*, 18, 39-61.

Gauthier, H. & Brehm, V. (1928). Ostracodes et Cladocères de l'Algèrie et de la Tunisie (3 note). *Proceedings of the Biological Society of Washington*, 19, 114-121.

Gómez-Rodríguez, C., Díaz-Paniagua, C. & Bustamante, J. (2011). *Cartografía de lagunas temporales del Parque Nacional de Doñana*. Agencia Andaluza del Agua, Consejería Medio Ambiente. Junta de Andalucía, Sevilla.

González-Mozo, M., Chicote, A., Rico, E., & Montes, C. (2000). Limnological characterization of an evaporite karstic lake in Spain (Lake Arreo). *Limnetica*, 18, 91-98.

Green, A. J., Bustamante, J., Janss, G. F. E., Fernández-Zamudio, R. & Díaz-Paniagua, C. (2018). Doñana Wetlands (Spain)., p. 1123-36. In: Finlayson, C. M., Milton, R. M., Prentice, R. C. & Davidson, N. C. (eds.), *The Wetland Book II: Distribution, Description, and Conservation*, Springer Netherlands, Dordrecht

Griffiths, H. I. & Brancelj, A. (1996). Preliminary list of freshwater Ostracoda (Crustacea) from Slovenia. *Annales Series Historia Naturalis*, 9, 201-210.

Horne, D. J., Holmes, J. A., Rodríguez-Lázaro, J. & Viehberg, F. A., eds. (2012a). Ostracoda as Proxies for Quaternary Climate Change, Developments in Quaternary Science, 17, Elsevier, Amsterdam, The Netherlands. DOI: 10.1016/b978-0-444-53636-5.00008-1

Horne, D. J., Curry, B. B., & Mesquita-Joanes, F. (2012b). Mutual climatic range methods for Quaternary ostracods. In D. J. Horne, J. A. Holmes, J. Rodriguez-Lazaro, & F. A. Viehberg (Eds.), Ostracoda as Proxies for Quaternary Climate Change, 65-84. Elsevier, Amsterdam.

Jocque, M., Fiers, F., Romero, M. & Martens, K. (2013). Crustacea in phytotelmata: a global overview. *Journal of Crustacean Biology*, 33, 451-460. DOI: 10.1163/1937240x-00002161

Karan-Žnidaršič, T. & Petrov, B. (2007). Non-marine Ostracoda (Crustacea) of Banat district in Serbia. *Hydrobiologia*, 585, 57-66. DOI: 10.1007/s10750-007-0628-3

Karan-Žnidaršič, T., Vujić, V. & Baltanás, Á. (2018). Analysing morphological variation of appendages and labrum in 10 species of *Heterocypris* Claus, 1893 (Podocopida: Cyprididae) with additional description of *Heterocypris exigua*. *Invertebrate Systematics*, 32, 1448-1464. DOI: 10.1071/IS18031

Klie, W. (1935). Ostracoda aus dem tropischen Westafrika. *Archiv für Hydrobiologie*, 29, 282-295.

Klie, W. (1938). Ostracoda, Muschelkrebse. - In Dahl, F. (ed.): *Die Tierwelt Deutschlands und der angrenzenden Meeresteile nach ihren Merkmalen und ihrer Lebensweise,* 34(3), 1-230.

Klie, W. (1943). Ostracoden aus Marokko und Mauretanien. *Zoologischer Anzeiger*, 143, 49-62.

Külköylüoğlu, O., Dügel, M. & Balcı, M. (2010). Limnoecological relationships between water level fluctuations and Ostracoda (Crustacea) species composition in Lake Sünnet (Bolu, Turkey). *Turkish Journal of Zoology*, 34, 429-442. DOI: 10.3906/zoo-0904-17

Külköylüoğlu, O., Yavuzatmaca, M., Akdemir, D., Çelen, E., & Dalkıran, N. (2018). Ecological classification of the freshwater Ostracoda (Crustacea) based on physicochemical properties of waters and habitat preferences. *International Journal of Limnology*, 54, 26. DOI: 10.1051/limn/2018017

Laprida, C., Massaferro, J., Mercau, J. R. & Cusminsky, G. (2014). Paleobioindicadores del fin del mundo: ostrácodos y quironómidos del extremo sur de Sudamérica en ambientes lacustres cuaternarios. *Latin American Journal of Sedimentology and Basin Analysis*, 21, 97-117.

Lorenschat, J. & Schwalb, A. (2013). Autecology of the extant ostracod fauna of Lake Ohrid and adjacent waters-a key to paleoenvironmental reconstruction. *Belgian Journal of Zoology*, 143, 42-68.

Lovas-Kiss, Á., Sánchez, M. I., Molnár V., A., Valls, L., Armengol, X., Mesquita-Joanes, F. & Green, A. J. (2018). Crayfish invasion facilitates dispersal of plants and invertebrates by gulls. *Freshwater Biology*, 63, 392-404. DOI: 10.1111/fwb.13080

Marazanof, F. (1967). Ostracodes, cladocères, hétéroptères et hydracariens nouveaux pour les marismas du guadalquivir (Andalousie) données écologiques. *Annales de Limnologie*, 3, 47-64. DOI: 10.1051/limn/1967005

Marco-Barba, J., Burjachs, F., Reed, J., Santisteban, C., Usera, J., Alberola, C. … Miracle, M. R. (2019). Mid-Holocene and historical palaeoecology of the Albufera de València coastal lagoon. *Limnetica*, 38(1), 353-389. DOI: 10.23818/limn.38.22

Marrone, F., Alfonso, G., Stoch, F., Pieri, V., Alonso, M., Dretakis, M. & Naselli-Flores, L. (2019). An account on the non-malacostracan crustacean fauna from the inland waters of Crete, Greece, with the synonymization of *Arctodiaptomus piliger* Brehm, 1955 with *Arctodiaptomus alpinus* (Imhof, 1885)(Copepoda: Calanoida). *Limnetica*, 38, 167-187. DOI: 10.23818/limn.38.01

Marrone, F., Pieri, V., Turki, S. & Rossetti, G. (2020). The Recent non-marine ostracods of Tunisia: an updated checklist with remarks on their regional distribution patterns and ecological preferences. Non-marine ostracods of Tunisia. *Journal of Limnology*, 79(3), 293-307. DOI: 10.4081/jlimnol.2020.1982

Martens, K (ed.) (1998). *Sex and Parthenogenesis: Evolutionary Ecology of Reproductive Modes in Non-Marine Ostracods*, 334 pp. Backhuys Publishers, Leiden.

Martens, K., Schön, I., Meisch, C. & Horne, D. J. (2008). Global diversity of ostracods (Ostracoda, Crustacea) in freshwater. *Hydrobiologia*, 595, 185-93. DOI: 10.1007/s10750-007-9245-4

Martín-Rubio, M., Rodríguez-Lázaro, J., Anadon, P., Robles, F., Utrilla, R., & Vázquez, A. (2005). Factors affecting the distribution of recent lacustrine ostracoda from the Caicedo de Yuso-Arreo Lake (Western Ebro Basin, Spain). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 225(1-4), 118-133. DOI: 10.1016/j.palaeo.2003.10.021

Martins, M. J. F., Joao, M., Vandekerkhove, J. & Namiotko, T. (2008). Environmental stability and the distribution of the sexes: insights from life history experiments with the geographic parthenogen *Eucypris virens* (Crustacea: Ostracoda). *Oikos*, 117, 829-836. DOI: 10.1111/j.0030-1299.2008.16557.x

Martins, M. J. F., Namiotko, T., Cabral, M. C. & Fatela, F. (2010). Contribution to the knowledge of the freshwater Ostracoda fauna in continental Portugal, with an updated checklist of Recent and Quaternary species. *Journal of Limnology*, 69, 160-173. DOI: 10.3274/JL10-69-1-15

Masi, L. (1932). Escursione Zoologica All'Oasi di Marrakesch nell' Aprile 1930: Ostracodi. *Italian Journal of Zoology*, 3, 213-223.

Meisch, C. (2000). *Freshwater Ostracoda of Western and Central Europe (Süßwasserfauna von Mitteleuropa 8/3)*. Spektrum Akademischer Verlag GmbH, Heidelberg, Germany.

Menail, A., Scharf, B. & Amarouayache, M. (2023). Living ostracods (Crustacea) from Algerian Sahara and High Plains: ecological data and new records. *Zootaxa*, 5227, 501-530. DOI: 10.11646/zootaxa.5227.5.1

Mezquita, F., Aguilar-Alberola, J. A., Carbonell, E., Escrivà, A., Rueda, J., Schmit, O. & Zamora, L. (2011). Introducció als ostracodes (Crustacea: Ostracoda) castellonencs. Actes del 1er Congrés sobre Fauna Castellonenca, 37-46.

Montes, C., Borja-Barrera, F., Bravo-Utrera, M. A. & Moreira, J. M. (1998). Reconocimiento biofísico de espacios naturales protegidos. Doñana: una aproximación ecosistémica, 526 pp. Consejería de Medio Ambiente, Junta de Andalucía, Sevilla

Mori, N., & Meisch, C. (2012). Contribution to the knowledge on the distribution of Recent free-living freshwater ostracods (Podocopida, Ostracoda, Crustacea) in Slovenia. *Natura Sloveniae*, 14(2), 5-22.

Özuluğ, O., Kubanç, S. N., Kubanç, C., & Demirci, G. İ. (2018). Checklist of Quaternary and Recent Ostracoda (Crustacea) species from Turkey with information on habitat preferences. *Global and Planetary Change*, 2(1), 51-100.

Park, L. E. & Cohen, A. S. (2011). Paleoecological response of ostracods to early Late Pleistocene lake-level changes in Lake Malawi, East Africa. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 303, 71-80. DOI: 10.1016/j.palaeo.2010.02.038

Petkovski, T. K. (1964). Bemerkenswerte entomostraken aus Jugoslavien. *Acta Musei Macedonici Scientiarum Naturalium*, 9, 147-181.

Pieri, V., Marrone, F., Martens, K. & Rossetti, G. (2020). An updated checklist of Recent ostracods (Crustacea: Ostracoda) from inland waters of Sicily and adjacent small islands with notes on their distribution and ecology. *The European Zoological Journal*, 87, 714-740. DOI: 10.1080/24750263.2020.1839581

Pieri, V., Martens, K., Meisch, C. & Rossetti, G. (2015). An annotated checklist of the Recent non-marine ostracods (Ostracoda: Crustacea) from Italy. *Zootaxa*, 3919, 271-305. DOI: 10.11646/zootaxa.3919.2.3

Pieri, V., Vandekerkhove, J., & Goi, D. (2012). Ostracoda (Crustacea) as indicators for surface water quality: a case study from the Ledra River basin (NE Italy). *Hydrobiologia*, 688(1), 25-35. DOI: 10.1007/s10750-010-0568-1

Poquet, J. M., F. Mesquita-Joanes, J. Rueda & M. R. Miracle, 2008. Loss of Ostracoda biodiversity in Western Mediterranean wetlands. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 18: 280-296. DOI: 10.1002/aqc.831

Pozo, M., Ruiz, F., Carretero, M. I., Vidal, J. R., Cáceres, L. M., Abad, M. & González-Regalado, M. L. (2010). Mineralogical assemblages, geochemistry and fossil associations of Pleistocene–Holocene complex siliciclastic deposits from the Southwestern Doñana National Park (SW Spain): A palaeoenvironmental approach. *Sedimentary Geology*, 225, 1-18. DOI: 10.1016/j.sedgeo.2010.01.002

Ramdani, M. (1982) Les entomostraces de la Merja SIdi Bou Ghaba. *Bulletin de 1'Institut Scientifique, Rabat*, 6, 105-117.

Ramdani, M., Flower, R., Elkhiati, N., Birks, H. J. B., Kraïem, M. M. & Fathi, A. (2001). Zooplankton (Cladocera, Ostracoda), Chironomidae and other benthic faunal remains in sediment cores from nine North African wetland lakes: the CASSARINA Project. *Aquatic Ecology*, 35, 389-403.

Roca, J. R., Mezquita, F., Rueda, J., Camacho, A. & Miracle, M. R. (2000). Endorheic versus karstic lakes: patterns of ostracod distributions and lake typology in a Mediterranean landscape (Castilla-La Mancha, Spain). *Marine and Freshwater Research*, 51, 311-319. DOI: 10.1071/MF99103

Rodríguez-Pérez, H. & Baltanás, Á. (2008). Ecology and production of *Heterocypris exigua* and *Plesiocypridopsis newtoni* (Crustacea, Ostracoda) in an oligohaline hypertrophic shallow lake. *Fundamental and Applied Limnology / Archiv für Hydrobiologie*, 172, 13-26. DOI: 10.1127/1863-9135/2008/0172-0013

Rosati, M., Rossetti, G., Cantonati, M., Pieri, V., Roca, J. R., & Mesquita-Joanes, F. (2017). Are aquatic assemblages from small water bodies more stochastic in dryer climates? An analysis of ostracod spring metacommunities. *Hydrobiologia*, 793(1), 199-212. DOI: 10.1007/s10750-016-2938-9

Rossi, V., Gandolfi, A., Baraldi, F., Bellavere, C. & Menozzi, P. (2007). Phylogenetic relationships of coexisting *Heterocypris* (Crustacea, Ostracoda) lineages with different reproductive modes from Lampedusa Island (Italy). *Molecular Phylogenetics and Evolution*, 44, 1273-1283. DOI: 10.1016/j.ympev.2007.04.013

Rueda, J., Aguilar-Alberola, J. A. & Mesquita-Joanes, F. (2006). Contribución al conocimiento de los crustáceos (Arthropoda, Crustacea) de las Malladas de la Devesa del Parque Natural de la Albufera (Valencia). *Boletín de la Asociación Española de Entomología*, 30: 9-29.

Ruiz, F., Abad, M. & Rodríguez-Ramírez, A. (2004a). Aportaciones del análisis poblacional de Ostrácodos: la Evolución Paleoambiental del Sector Sudoccidental del Parque

Nacional de Doñana durante dl Holoceno Superior. *Revista Española de Micropaleontología*, 36, 485-492.

Ruiz, F., Abad, M., Bodergat, A.-M., Carbonel, P., Rodríguez-Lázaro, J., González-Regalado, M. L., …. Prenda, J. (2013b). Freshwater ostracods as environmental tracers. *International Journal of Environmental Science and Technology*, 10, 1115-1128. DOI: 10.1007/s13762-013-0249-5

Ruiz, F., Abad, M., González-Regalado, M. L., Toscano, A., Vidal, J. R., Cáceres, L. M., Pozo, M., Carretero, M. I. & García, E. X. (2010). Evidencias de depredación en ostrácodos holocenos del Parque Nacional de Doñana (SO de España). *Revista Española de Micropaleontología*, 42, 267-273.

Ruiz, F., Abad, M., Pozo, M., Carretero, M. I., Rodríguez-Vidal, J., Cáceres, L. M., … García, E. X. (2013a). Evolución paleoambiental del sector meridional del Parque Nacional de Doñana desde el Plioceno Inferior a la actualidad. *Estudios Geológicos*, 69, 173-177. DOI: 10.3989/egeol.41072.234

Ruiz, F., Abad, M., Rodríguez Vidal, J., Caceres, L. M., Gonzalez-Regalado, M., Carretero, M. I., …. Gómez Toscano, F. (2008). The geological record of the oldest historical tsunamis in southwestern Spain. *Rivista Italiana di Paleontologia e Stratigrafia*, 114, 145-154.

Ruiz, F., González-Regalado, M. L. & Muñoz, J. M. (1997). Multivariate analysis applied to total and living fauna: seasonal ecology of recent benthic Ostracoda off the North Cadiz Gulf coast (southwestern Spain). *Marine Micropaleontology*, 31, 183-203.

Ruiz, F., González-Regalado, M. L., Serrano, L. & Toja, J. (1996). Ostrácodos de las lagunas temporales del Parque Nacional de Doñana. *Aestuaria*, 4, 125-140.

Ruiz, F., Rodríguez-Ramírez, A., Cáceres, L. M., Vidal, J. R., Carretero, M. I., Abad, M., … Pozo, M. (2005). Evidence of high-energy events in the geological record: Mid-holocene evolution of the southwestern Doñana National Park (SW Spain). *Palaeogeography, Palaeoclimatology, Palaeoecology*, 229, 212-229. DOI: 10.1016/j.palaeo.2005.06.023

Ruiz, F., Rodriguez-Ramírez, A., Caceres, L., Rodriguez-Vidal, J., Carretero, M. D., Luis, C., …. Abad, M. (2004b). Late Holocene evolution of the southwestern Doñana National Park (Guadalquivir Estuary, SW Spain): a multivariate approach. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 204, 47-64. DOI: 10.1016/S0031-0182(03)00721-1

Salel, T., Bruneton, H., & Lefèvre, D. (2016). Ostracods and environmental variability in lagoons and deltas along the north-western Mediterranean coast (Gulf of Lions, France and Ebro delta, Spain). *Revue de micropaleontologie*, 59(4), 425-444. DOI: 10.1016/j.revmic.2016.09.001

Sánchez-González, J. R., Baltanás, Á. & Danielopol, D. L. (2004). Patterns of morphospace occupation in recent Cypridoidea (Crustacea, Ostracoda). *Revista Española de Micropaleontología*, 36, 13-27.

Scharf, B. W. & Hollwedel, W. (2009). Ostracoda und Cladocera (Crustacea) van der lnsel Terschelling, Niederlande. *Drosera*, 127-141.

Scharf, B. W. & Meisch, C. (2014). New records of nonmarine Ostracoda (Crustacea) from Gran Canaria (Canary Islands), with an updated checklist of the nonmarine Ostracoda of the Canary Islands. *Bulletin de la Société des Naturalistes Luxembourgeois*, 115, 259-270.

Schmit, O., Bode, S. N. S., Camacho, A., Horne, D. J., Lamatsch, D. K., Martens, K., …. Mezquita, F. (2013). Linking present environment and the segregation of reproductive modes (geographical parthenogenesis) in *Eucypris virens* (Crustacea: Ostracoda). *Journal of Biogeography*, 40, 2396-2408. DOI: 10.1111/jbi.12174

Serrano, L. & Fahd, K. (2005). Zooplankton communities across a hydroperiod gradient of temporary ponds in the Doñana National Park (SW Spain). *Wetlands*, 25, 101-11.

Serrano, L., Reina, M., Martín, G., Reyes, I., Arechederra, A., León, D. & Toja, J. (2006). The aquatic systems of Doñana (SW Spain): watersheds and frontiers. *Limnetica*, 25, 11-32.

Thiery, A. (1987). Les Crustaces Branchiopodes Anostraca, Notostraca & Conchostraca des milieux limniques temporaires (Dayas) au Maroc: Taxonomie, Biogeographie, Ecologie, 403 pp, PhD Dissertation, Faculté des Sciences et Techniques de St Jerome, Université de Dorit d'Economie et des Sciences d'Aix-Marseille

Valls, L., Rueda, J. & Mesquita-Joanes, F. (2014). Rice fields as facilitators of freshwater invasions in protected wetlands: the case of Ostracoda (Crustacea) in the Albufera Natural Park (E Spain). *Zoological Studies*, 53: 68. DOI: 10.1186/s40555-014-0068-5

von Grafenstein, U. & Labuhn, I. (2021). Air-Interface: δ18O Records of Past Meteoric Water Using Benthic Ostracods from Deep Lakes., p. 179-195. In: Ramstein, G., Landais, A., Bouttes, N., Sepulchre, P. & Govin, A. (eds.), *Paleoclimatology, Frontiers in Earth Sciences*, Springer International Publishing, Cham. DOI: 10.1007/978-3-030-24982-3-15

Wickstrom, C. E. & Castenholz, R. W. (1973). Thermophilic ostracod: aquatic metazoan with the highest known temperature tolerance. *Science*, 181, 1063-1064. DOI: 10.1126/science.181.4104.1063

Yu, N., Quanhong, Z., Li, E., Chen, S. & Chen, L. (2009). An updated and annotated checklist of recent nonmarine ostracods from China. *Zootaxa*, 2067, 29-50. DOI: 10.11646/zootaxa.2067.1.2

Zamora, L., Mezquita, F. & Rueda, J. (2005). *Biodiversitat I ecologia del invertebrats aquatics continentals de la Marina Alta I el seu valor com a indicadors de la qualitat de les aigues de la comarca*. 92 pp. Instituto Alicantino de Cultura "Juan Gil-Albert', Alacant.

Zazo, C., Dabrio, C. J., Borja, F., Goy, J. L., Lezine, A. M., Lario, J., … Boersma, J. R. (1999). Pleistocene and Holocene aeolian facies along the Huelva coast (southern Spain): climatic and neotectonic implications. *Geologie en Mijnbouw*, 77, 209-124. DOI: 10.1023/A:1003689518310

SCANNING ELECTRON MICROSCOPE (SEM) PHOTOGRAPHS OF SOME OF THE MORE REPRESENTATIVE SPECIES IN THE AREA

Captions of plates: [RV-right valve; LV-left valve; ext.-exterior; int.-interior]. *[RV-valva derecha; LV-valva izquierda; ext.-exterior; int.-interior]*

Plate I. - A-D, *Bradleycypris obliqua*: A, female, RV, ext.; B, male, RV, ext.; C, female, LV, ext.; D, male, LV, int. (with visible remains of the seminiferous tubules). E-F, *Heterocypris exigua*: E, female, LV, ext., F, female, RV, ext. G-H, *Heterocypris barbara*: G, female, LV, ext., H, female, RV, ext. I-J, *Heterocypris incongruens*: I, female, LV, ext.; H, female, RV, ext.; insert: detail of the row of pustules in the posterior part of the RV. Scales: 200µm. *A-D,* Bradleycypris obliqua*: A, hembra, RV, ext.; B, macho, RV, ext.; C, hembra, LV, ext.; D, macho, LV, int. (con restos visibles de los túbulos seminíferos). E-F,* Heterocypris exigua*: E, female, LV, ext., F, hembra, RV, ext. G-H,* Heterocypris barbara*: G, hembra, LV, ext., H, hembra, RV, ext. I-J,* Heterocypris incongruens*: I, hembra, LV, ext.; H, hembra, RV, ext.; inserto: detalle de la fila de tuberculillos en la parte posterior de la RV. Escalas: 200µm.*

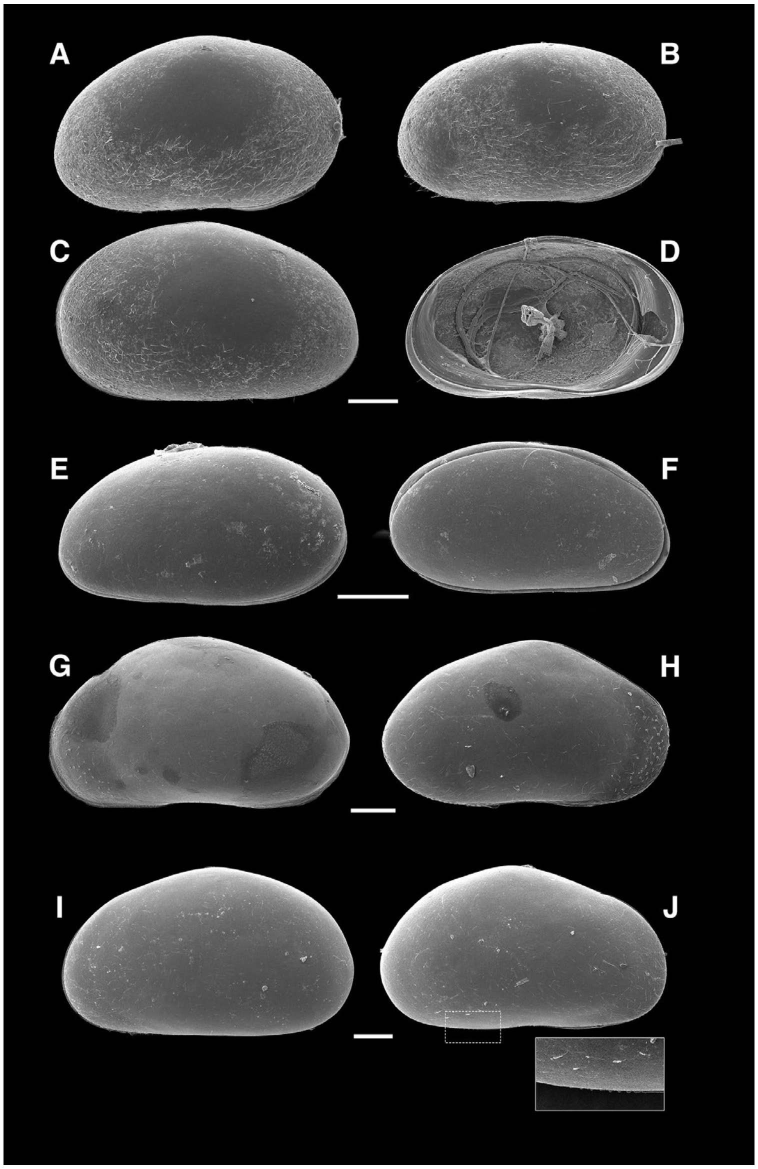

Plate II. - A-B, *Cypris bispinosa*: A, female, LV, ext.; B, female, RV, ext. C-D, *Herpetocypris chevreuxi*: C, female, LV, ext.; D, female, LV, int.. E-F, *Herpetocypris brevicaudata*: E, female, LV, ext.; F, female, LV, int.. G-H, *Tonnacypris lutaria*: G, female, LV, ext., H, female, RV, ext. I-J, *Neglecandona* cf. *angulata*: I, female, LV, ext.; H, female, RV, ext. Scales: 500µm. - *A-B,* Cypris bispinosa*: A, hembra, LV, ext.; B, hembra, RV, ext. C-D,* Herpetocypris chevreuxi*: C, hembra, LV, ext.; D, hembra, LV, int.. E-F,* Herpetocypris brevicaudata*: E, hembra, LV, ext.; F, hembra, LV, int. G-H,* Tonnacypris lutaria*: G, hembra, LV, ext., H, hembra, RV, ext. I-J,* Neglecandona *cf*. angulata*: I, hembra, LV, ext.; H, hembra, RV, ext. Escalas: 500µm*

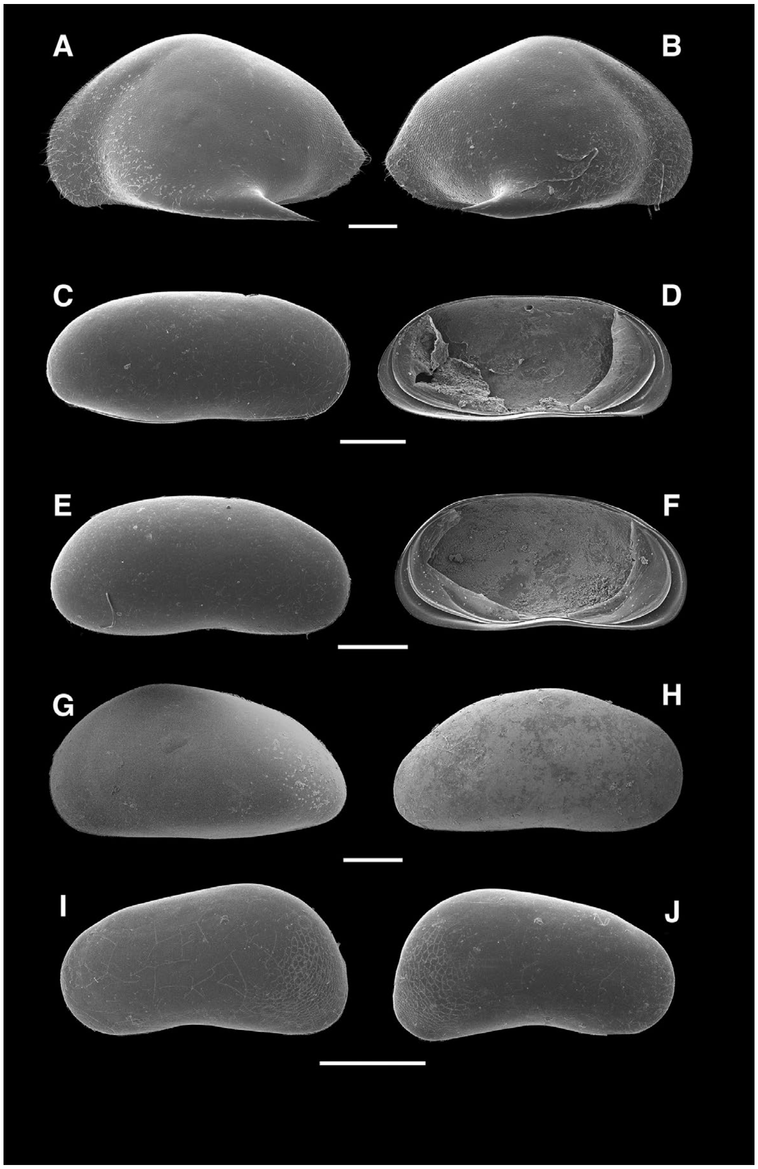

Plate III. - A-B, *Ilyocypris gibba*: A, female, LV, ext.; B, female, RV, ext. C-D, *Plesiocypridopsis newtoni*: C, female, LV, ext.; D, female, RV, ext. E, *Eucypris virens*: female, RV, ext. F, *Cypridopsis concolor*: females, dorsal view. G, *Trajancypris clavata*: female, RV, int. H, *Isocypris beauchampi*: female, RV, ext. Scales: 200µm. - *A-B,* Ilyocypris gibba*: A, hembra, LV, ext.; B, hembra, RV, ext. C-D,* Plesiocypridopsis newtoni*: C, hembra, LV, ext.; D, hembra, RV, ext. E,* Eucypris virens*: hembra, RV, ext. F,* Cypridopsis concolor*: hembras, dorsal view. G,* Trajancypris clavata*: hembra, RV, int. H,* Isocypris beauchampi*: hembra, RV, ext. Escalas: 200µm.*

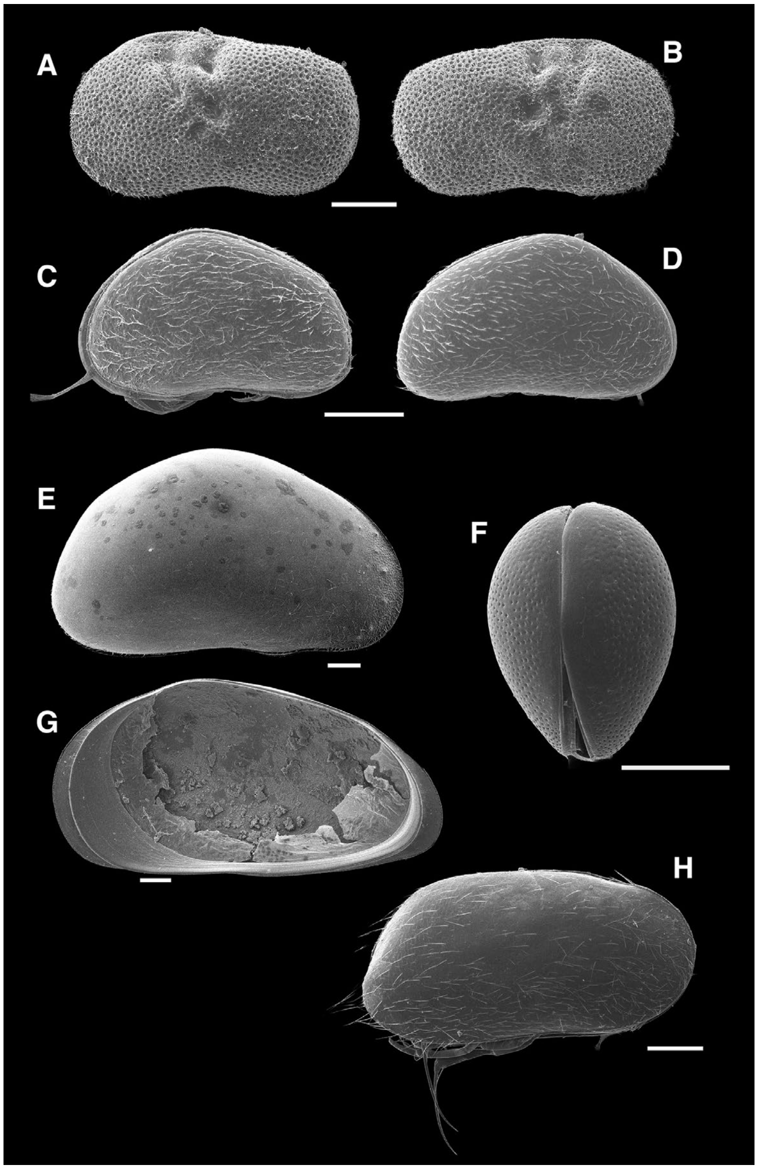

Plate IV. - Marine ostracods. A, *Carinocythereis whitei*, LV, ext.; B, *Cytheretta adriática*, LV, ext.; C, *Hiltermannicythere rubra*, LV, ext.; D, *Neocytherideis subulata*, LV, ext.; E, *Palmoconcha guttata*, RV, ext.; F, *Palmoconcha turbida*, RV, ext.; G, *Pontocythere elongata*, LV, ext.; H, *Semicytherura acuticostata*, RV, ext.; I, *Semicytherura incongruens*, RV, ext.; J, *Urocythereis britannica*, RV, ext. Scales: 100 µm. - *Marine ostracods. A,* Carinocythereis whitei*, LV, ext.; B,* Cytheretta adriática*, LV, ext.; C,* Hiltermannicythere rubra*, LV, ext.; D,* Neocytherideis subulata*, LV, ext.; E,* Palmoconcha guttata*, RV, ext.; F,* Palmoconcha turbida*, RV, ext.; G,* Pontocythere elongata*, LV, ext.; H,* Semicytherura acuticostata*, RV, ext.; I,* Semicytherura incongruens*, RV, ext.; J,* Urocythereis britannica*, RV, ext. Escalas: 100 µm.*

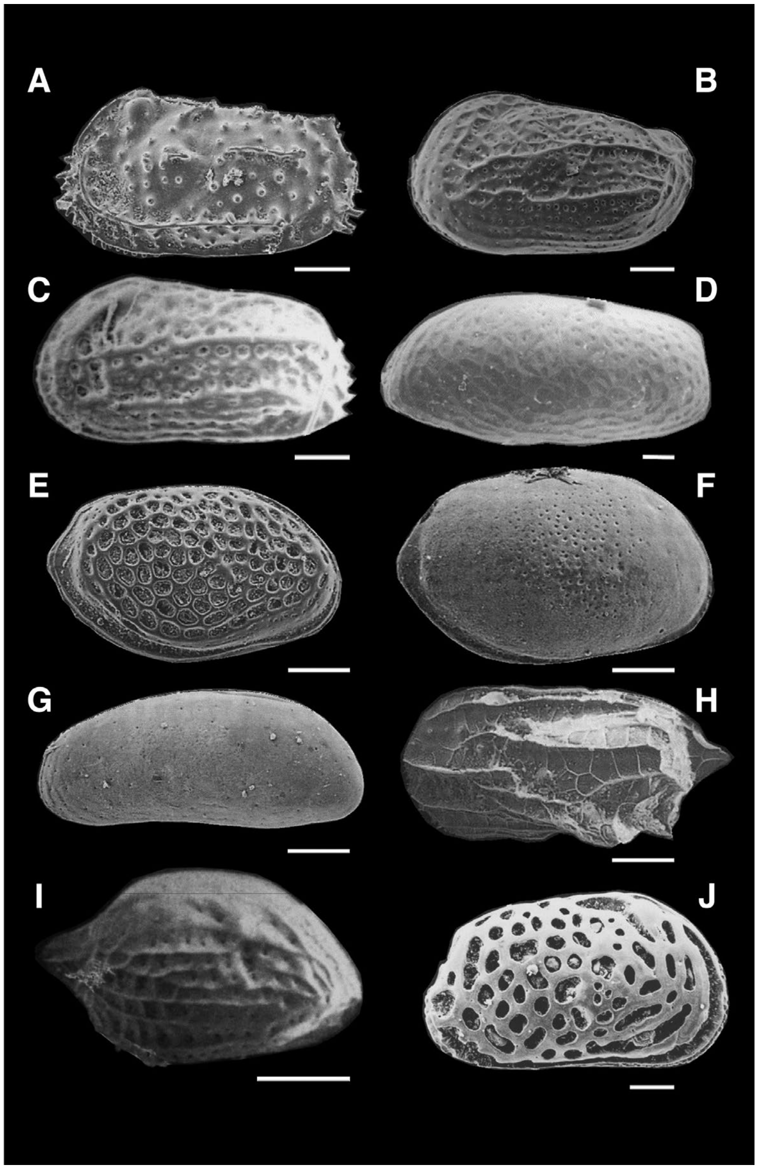

Plate V. - Brackish ostracods. A, *Cyprideis torosa*, RV, ext.; B, *Cytherois fischeri*, LV, ext.; C, *Leptocythere castanea*, RV, ext.; D, *Loxoconcha elliptica*, RV, ext. Scales: 100 µm. - *Brackish ostracods. A,* Cyprideis torosa*, RV, ext.; B,* Cytherois fischeri*, LV, ext.; C,* Leptocythere castanea*, RV, ext.; D,* Loxoconcha elliptica*, RV, ext. Escalas: 100 µm.*