

Versión española



CLASS MAXILLOPODA:

SUBCLASS COPEPODA:

Order Harpacticoida

Maria José Caramujo

CE3C – Centre for Ecology, Evolution and Environmental Changes, Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisboa, Portugal. mj.caramujo@fc.ul.pt

1. Brief definition of the group and main diagnosing characters

The Harpacticoida is one of the orders of the subclass Copepoda, and includes mainly free-living epibenthic aquatic organisms, although many species have successfully exploited other habitats, including semi-terrestrial habitats and have established symbiotic relationships with other metazoans. Harpacticoids have a size range between 0.2 and 2.5 mm and have a podoplean morphology. This morphology is characterized by a body formed by several articulated segments, metameres or somites that form two separate regions; the anterior prosome and the posterior urosome. The division between the urosome and prosome may be present as a constriction in the more cylindrical shaped harpacticoid families (e.g. Ectinosomatidae) or may be very pronounced in other families (e.g. Tisbidae). The adults retain the central eye of the larval stages, with the exception of some underground species that lack visual organs. The harpacticoids have shorter first antennae, and relatively wider urosome than the copepods from other orders. The basic body plan of harpacticoids is more adapted to life in the benthic environment than in the pelagic environment i.e. they are more vermiform in shape than other copepods.

Harpacticoida is a very diverse group of copepods both in terms of morphological diversity and in the species-richness of some of the families. Harpacticoids are extremely abundant yet, as a result of their small size and fragility, they fossilize poorly. Nevertheless, fragments of harpacticoids have been found in a single bitumen clast in a glacial diamictite of late Carboniferous age (c. 303 Ma) from eastern Oman (Selden *et al.*, 2010).

1.1. Morphology - the terms in **bold** indicate structures represented in Figures 1 and 2.

Harpacticoid copepods, as members of the sub-phyllum Crustacea, have biramous appendages, with the exception of the first pair of antennae. The **prosome** is formed by the **cephalothorax** plus three or four free thoracic somites bearing the first to fourth pair of swimming appendages. The **urosome** generally has five somites in the females and six somites in the males. In the females, the last segment of the thorax is fused with the first abdominal segment forming the large genital segment.

The cephalothorax primitively comprises the head plus the first thoracic segment which bears the maxilliped (Mxp), and in most families, also the second thoracic segment bearing the first pair of **swimming appendages** (P1). The cephalothorax thus bears: one pair of uniramous antennae, or **antennules** (A1), a pair of **second antennae** (A2), the mandible (Md), the first maxilla or maxillule (Mx1), the second maxilla (Mx2), the Mxp and P1. The antennules have 3-9 segments in females and 14 in males. Both antennules are geniculated in the male. The biramous appendages have an outer ramus named **exopod** and an inner ramus or **endopod**. In some species, the basis of A2 is fused with the first endopod segment

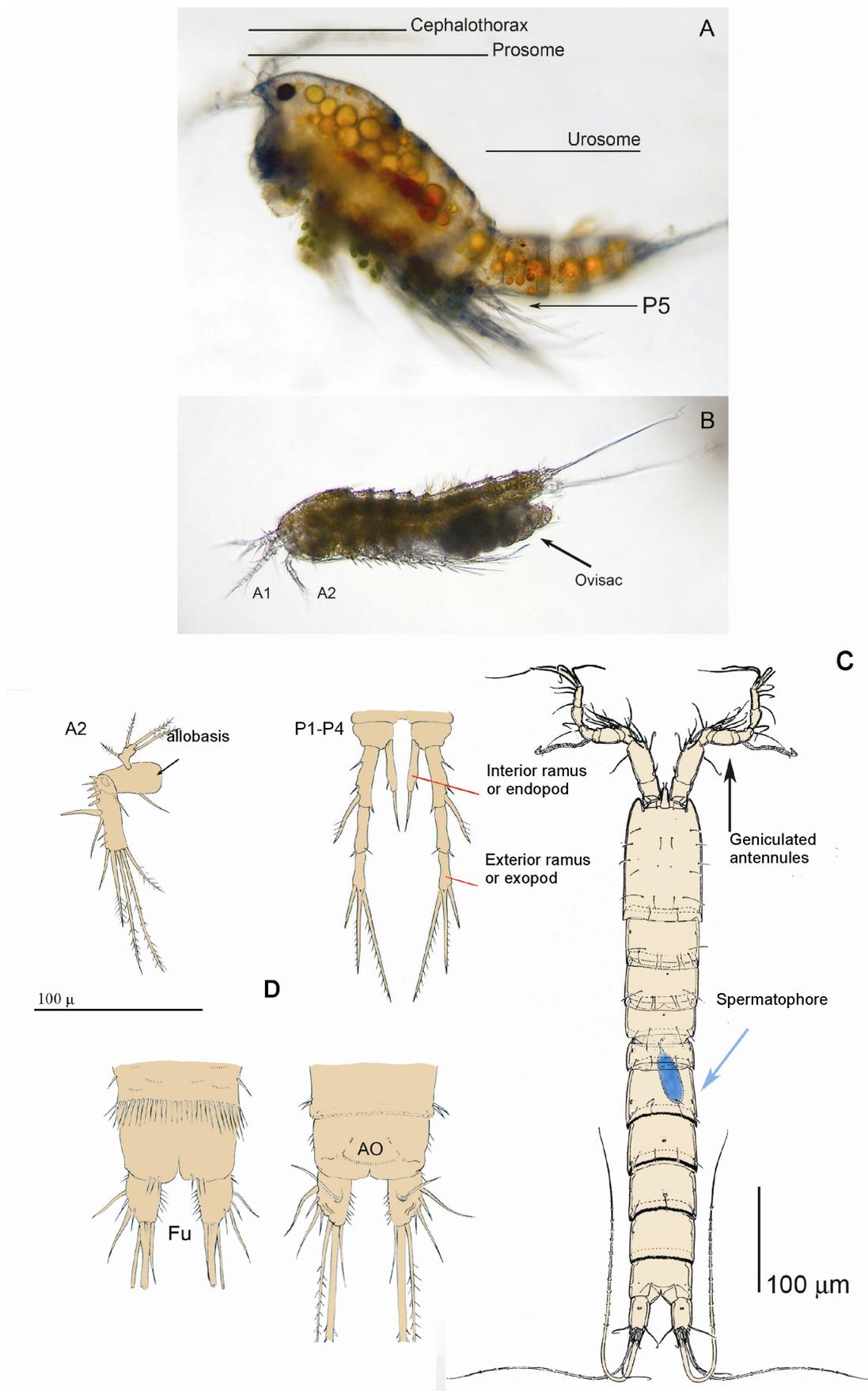


Figure 1. Body organization in harpacticoid copepods: **A**- female Canthocamptidae, Brady 1880; **B** – female Ameiridae, Monard 1927 carrying the single ovisac; **C** – male Ameiridae with geniculated pair of antennules (A1) and internal spermatophore (redrawn from Conroy-Dalton & Huys, 1998); and **D**- some morphological characters used in harpacticoid taxonomy: second antenna (A2) with allobasis; pair of swimming appendages (P1-P4); ventral view of the last abdominal segment bearing the furca (Fu) and dorsal view of the same segment bearing the dorsal anal operculum (AO). Photographs kindly provided by C.C.C.R. de Carvalho.

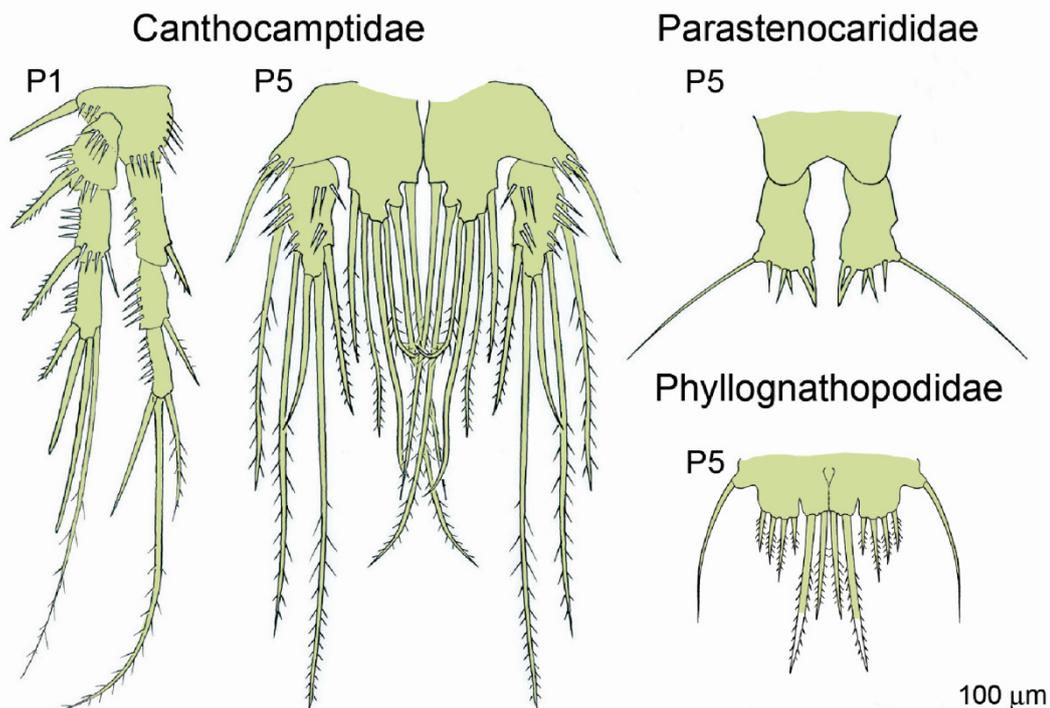


Figure 2. Basic scheme of swimming appendages: First swimming appendage (P1) and pairs of fifth swimming appendages (P5) of the families Canthocamptidae, Brady 1880, Parastenocarididae Chappuis 1933 and Phyllognathopodidae, Gurney 1932 (redrawn from Caramujo & Boavida 2009).

forming the **allobasis**. The Mx2 may possess accessory segments of the syncoxa named endites. The basic morphology of the first four pairs of swimming appendages is similar although some variations are present, while the fifth swimming appendage is modified and differs from the first four pairs. The sixth pair of swimming appendages is often rudimentary. The last abdominal somites bears a dorsal **anal operculum** that may be ornamented and a pair or caudal rami that are collectively named **furca**. The appendages and caudal rami are ornamented with hollow projections of the cuticle enclosing an epidermal cell or part of a cell. The slender of these projections are named setae, and are distinguished from spines and setulae because of their generally larger size and by possessing an articulation with the cuticle.

The males of harpacticoids are often poorly described and numerous identification keys rely on female morphology for species identification.

1.2. Natural History

Harpacticoid copepods have sexual reproduction and develop by a series of metamorphoses. The existence of asexual reproduction has been reported for one species, *Canthocamptus staphylinus* (Sarvala, 1979). Harpacticoids hatch from eggs carried by the female in the single ventral egg sac and undergo six naupliar larval stages and five copepodid stages before molting into the adult. The successive naupliar stages acquire a new pair of mouth appendages with each molt, and in the more complete sixth molt reach the copepodid stage that has a segmented body and two pairs of swimming appendages. The copepodids acquire one additional somite with each molt until the adult stage is reached. The duration of the development stages is depended on water temperature and photoperiod (Dussart, 1967) and is modulated by the availability and quality of available food. In general, harpacticoids growing at 20 °C take 3-4 weeks to reach the adult stage, and the adults may live for several months. Certain species undergo diapause in the adult stage which permits the survival of organisms during periods of adverse environmental conditions e.g. dissection or unfavourable temperatures (Dahms, 1995). Harpacticoids that undergo diapause may therefore live for more than one year. The organisms may reproduce several times during their adult life. During copulation, the males deposit the sperm cells into a spermatophore that is cemented on the genital opening of the female that stores the sperm in the seminal receptacle. The mature oocytes are fertilized during the passage in the genital duct and are deposited in a single ovisac.

The first naupliar stage, with only three pairs of appendages, does not feed and rapidly molts into the second naupliar stage. The other development stages generally feed on small particles that include particulate organic material, bacteria, flagellates, protozoans and algae. The diversity of harpacticoids is reflected in the life style adopted, and they are versatile feeders on many food types including bacteria (Rieper, 1978), microalgae (Carman & Thistle, 1985), metazoan tissue (Seifried & Dürbaum, 2000) and may resort to parasitism (Boxshall & Halsey, 2004). Chance encounter appears to be a primary mechanism in finding food for the mostly planktonic copepods (Fryer, 1957), yet chemoreceptors may help them to distinguish edible from inedible food items, and in locating food.

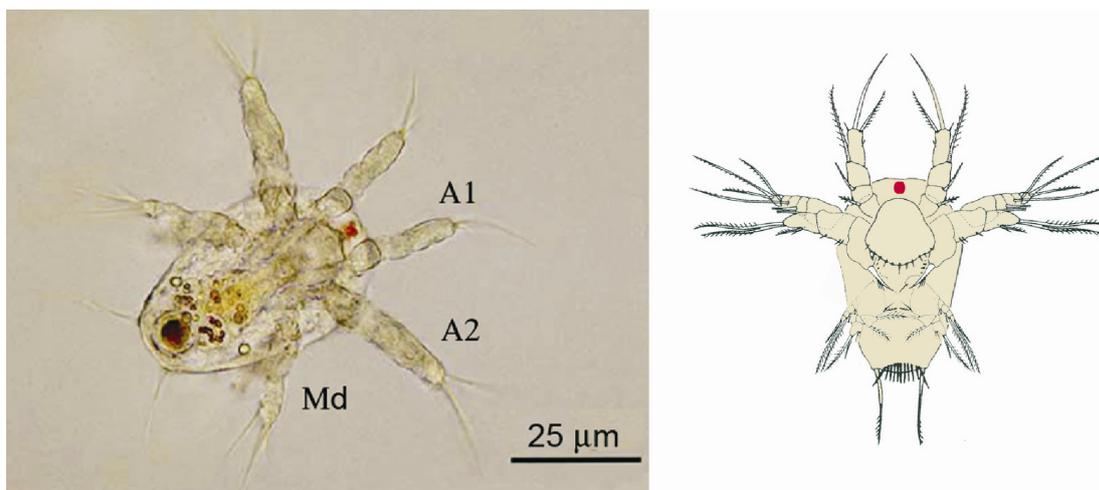


Figure 3. Body layout of the first naupliar stage as it hatches from the egg: A1 – first pair of antennae; A2 – second pair of antennae; Md – mandible.

Most of harpacticoids are free living organisms although a number are symbiotic species with different degrees of parasitism, living with various metazoan phyla, including sponges, cephalopods, crustaceans invertebrates, fish and mammals, sponges, hydroids and medusae, scleractinian corals, parasitic flatworms, polychaetes, bivalves, cephalopods, bryozoans, echinoderms, crustaceans fish and cetaceans (see Boxshall & Halsey, 2004; Huys *et al.*, 2009).

1.3. Distribution

Harpacticoids are considered primarily as marine epibenthic organisms inhabiting the surface sediment layers of marine environments. They have successfully exploited a wide variety of habitats that include open sea, deep-sea regions, brackish and freshwater environments (Huys & Boxshall, 1991). Some species are also present in semi-terrestrial habitats (Dumont & Mass, 1988), bryophytes (Bottazzi *et al.*, 2001) and small pools in leaf-pits of Bromeliaceae (Chappuis, 1928), and have entered into symbiotic relationships with a wide range of invertebrate hosts (e.g. Boxshall & Jaume, 2000; Gotto, 2004). The distribution patterns of different life forms vary with their dispersal abilities. As noted by Chertoprud *et al.* (2010) for marine forms, “at both inter- and intraregional scales, benthic-pelagic marine forms are the most widely distributed, followed by phytal species, whereas benthic species, especially interstitial, have a more restricted distribution.” The level of endemism in freshwater taxa is considered remarkable, especially that of groundwater species (Galassi, 2001; Boxshall & Defaye, 2008).

Harpacticoids have been recorded in all aquatic Iberian ecosystems and Macaronesian marine waters.

1.4. Scientific and applied relevance

The scientific relevance of this order is mainly the result of the (1) high diversity of the group, (2) their abundance in various ecosystems and (3) the high degree of endemism in various genera, especially as a consequence of habitat fragmentation (e.g. in karstic massifs).

Harpacticoida represents the second-largest meiofaunal group in the marine sediment habitats and in the deep-sea benthos, after nematodes. In the deep sea, harpacticoids may even exceed nematodes in terms of biomass. In marine ecosystems, harpacticoids form thus an integral link in food webs by coupling nutrients with higher trophic levels (e.g. fish), and also structure benthic and pelagic links (Gregg & Fleeger, 1998). In freshwater ecosystems, harpacticoids are important consumers of microbial carbon production and may provide a pathway for energy transfer to higher trophic levels (Hudson *et al.*, 1998). Thus, changes in the harpacticoid community may cause drastic shifts in ecosystem processes, especially the processes originating in or involving the benthic zone.

The marine and freshwater harpacticoid fauna of Iberia and Macaronesia has not been studied in detail. Nevertheless, the few surveys of harpacticoid fauna revealed highly diverse communities, new occurrence for known species, and new endemic species. Springs and groundwaters are generally rich in endemics, and future surveys in Iberia and Macaronesia, may reveal important new additions to subterranean harpacticoid fauna.

There is little information regarding symbiotic harpacticoids in the Iberian Peninsula, surrounding marine waters and Macaronesia. It is however noted that harpacticoid copepods may cause loss in commercially valuable species by acting as hosts to parasites of other species. The marine harpacticoid, *Euterpina acutifrons* has been proposed as potential host species for *Martellia refringens* (Paramyxia) that parasites the economically valuable mussel *Mytilus galloprovincialis* in the coast of Catalonia, causing loss of mussel condition and negative effects on reproduction in parasitized individuals (Carrasco *et al.*, 2007).

Harpacticoids living in association with other organisms should be considered as commensal or parasitic organisms, according to the degree of harm they cause on the host. It appears that *Balaenophilus*

unisetus living on whales, *Balaenoptera physalus*, captured off the NW coast of Spain cause a small or non-existent harm on the whales and should be considered commensals (Badillo *et al.*, 2007). Conversely, it appears that *Balaenophilus umigamecolus*, that lives associated with turtles in the Mediterranean, ingest turtle's tissue to benefit from its associated epibiota, and this may cause harm to turtles and the harpacticoid should be considered an ectoparasite (Huys *et al.*, 2009). The existence of harpacticoid parasitism on fish is unlikely since the only fish known to host a harpacticoid parasite species (Tisbidae) doesn't occur in our waters. It is however possible that symbiotic relationships with invertebrates do take place with potential to cause commercial losses. The potential parasites include (Huys *et al.*, 2009): *Nitocra divaricata divaricata* Chappuis, 1924 (Ameiridae) that has been recorded in the gill chamber of freshwater decapoda in Central Europe; the atlantic harpacticoid *Sunaristes paguri* Hesse, 1867 (Canuellidae) that is associated with crabs from the family Paguridae and Diogenidae; harpacticoids from the family Laophontidae that live associated with the crab *Maja squinado* Herbst, 1788 that occurs in the Atlantic and Mediterranean; *Paramphiascopsis paromolae* Soyer, 1973 (Miraciidae) that is hosted by the decapod *Paromola cuvieri* in French Mediterranean; species of the family Tisbidae that are hosted by lobsters.

1.5. Species in danger or vulnerable

There are no references for endangered harpacticoid species from the Iberian Peninsula neither from the surrounding marine waters. IUCN reports 22 harpacticoid species as vulnerable in its Red List of Threatened Species™, although it is recognized that information needs updating (IUCN, 2014). The species in the red list originate from hypogean waters that are especially vulnerable to chemical pollution from the surface and anthropogenic alteration of water regimes (e.g. the widespread practice of spring water exploitation). In practice, all human activities that imply disturbance of the habitat may threaten the inhabiting species, and rare and endemic species may be endangered by physical or chemical alterations of their habitats. While no conservation problems generally exist for the euryhaline species and most of the surface freshwater species, subterranean endemic species with short-range distribution are especially threatened by human activities (Karanovic *et al.*, 2013). It is recognized that it is difficult to define the situation of rare species that are represented by only few individuals and endemic species with "spot" distributions, and they should be considered as vulnerable or at high risk of extinction.

1.6. Exotic species

Introduced harpacticoid species have not been recorded for the Iberian Peninsula thus far, yet the presence of introduced species from other copepod orders indicates that such introduction may take place. The estuarine calanoid *Acartia tonsa*, originally from North America has been recorded in the the Tagus estuary (Sobral, 1985) and in five artificial brackish ponds situated in Doñana Natural Park (Frisch *et al.*, 2005). A cyclopoid ectoparasite of fish, *Lernaea cyprinacea* Linnaeus, native to Asia is widespread in the Iberian Peninsula (Moreno *et al.*, 2005; Gutiérrez-Galindo & Lacasa-Milán, 2005) while the copepods *Caligus fugu* Yamaguti, 1936 (Siphonostomatoid) and *Taeniacanthus lagocephali* Pearse, 1952 (Poecilostomatoida) have been recorded in fish arriving in the Mediterranean through the Suez Canal (Özak *et al.*, 2012).

Global movement may favour the establishment of introduced species, either through ballast water of ships, through the aquarium trade or aquaculture (Streftaris *et al.*, 2005). Harpacticoid species appear to be easily transported on ship hulls or in ballast water, and have been detected in the ballast water of ships entering the Great Lakes (Duggan *et al.*, 2005). In an assessment of non-indigenous species transported by international ship traffic to German waters (Gollasch *et al.*, 2000), it was found that opportunistic semiplanktonic species such as *Tisbe* are apparently able to thrive and propagate in ballast water tanks. Nevertheless, copepods albeit being the most abundant group in ballast waters, have been contributing little (e.g. 12 species) to the number of marine non-indigenous species in the Mediterranean Sea (Zenetos *et al.*, 2012).

The establishment of exotic species may be a profound disruptor of the ecology of local ecosystems, and biological, physical and chemical control methods of exotic species are either not known or of doubtful efficiency (GLMRIS, 2012).

1.6. Main diagnosing characters for the identification of families

- Body compression; body compressed laterally, dorso-ventrally compressed or compression absent.
- Presence or absence of rostrum.
- Cuticular lenses; present or absent.
- First antennae (A1) of the female; number of segments.
- Second antennae (A2); presence or absence or reduction the exopod (Exp) and the number of its segments when present (less than 4 or more than 6 segments); A2 with basis or allobasis.
- Thorax somite bearing the first pair of swimming appendages (P1) is free, fused or partially fused with the cephalothorax.
- Second maxilla (Mx2); the presence or absence of endites, morphology of syncoxa and basis.
- Maxilliped (Mxp) shape; lamelliform or not, prehensile or not; End with 1 segment or more than 2.
- Number of segments in the exopod (Exp) and endopod (End) of P1.
- Length of the End of the second pair of swimming appendages (P2); longer or shorter than the Exp.

- Third pair of swimming appendages (P3); Exp modified (or not) in the male.
- Fourth pair of swimming appendages (P4); number of segments in the End.
- Fifth pair of swimming appendages (P5); End and Exp distinct or fused forming a single plate; number of setae in the End.

2. Systematics

It is recognized that the taxonomy of the order Harpacticoida as a whole is in state of flux and a polyphyletic nature is hypothesized for many families and genera (Huys *et al.*, 1996; Galassi *et al.*, 2002; Seifried 2003, 2004). Additionally, many cryptic species are suspected to be hidden under some species, which are therefore in need of critical revision. Lang (1944) divided the order in two sub-orders: Polyarthra and Oligarthra. The Polyarthra had only two families, Longipediidae (in sediment or macroalgae) and Canuellidae that live at great depth (>2000 m) or are parasites of invertebrates, while Oligarthra had all the other families. In 2003, Seifried & Schminke made a filogenetic analysis of the suborder Oligarthra and arrived to the conclusion that this taxon only included 4 families among which Aegisthidae and Rometidae. The remaining families were then grouped in the new suborder Syngnatharthra. When Wells (2007) presented a checklist of approximately 4300 species of harpacticoid copepods, he adopted the phylogenetic system of Seifried (2003) recognising 56 families. Here, we follow their classification and note the following differences regarding the systematics reported in the World Register of Marine Species (WoRMS; Boxshall, 2014), and a new family addition:

1. The species *Euterpina acutifrons* Dana, 1848 is often classified under Euterpinidae Brian, 1921 (e.g. in WoRMS), however this monotypic family has been synonymized with Tachidiidae Sars 1909 by Seifried (2003);
2. We list the families Rometidae Seifried & Schminke 2003 and Rotundiclipeidae Huys 1988 (Huys, 1988) present in Seifried (2003) and in WoRMS;
3. We list Huntmaniidae Por 1986 although it is considered a synonym of Nannopodidae Brady 1880 in WoRMS;
4. A new family, not represented in our waters, was added after the publication of Wells' work (2007) – Parameiropsidae Corgosinho & Martínez Arbizu, 2010 (Corgosinho & Martínez Arbizu, 2010).

Typically, the members of the family Tegastidae have a laterally compressed body. The families Phyllognathopodidae and Chappuisiidae present the segment bearing the P1 not fused to the cephalothorax while the members of Darcythompsoniidae present the segment bearing the P1 only partially fused with the cephalothorax. The members of the other families present the segment bearing the P1 completely fused with the cephalothorax.

3. Diversity of Iberian harpacticoids

The harpacticoid families throughout Europe are very diverse, with species that inhabit various types of aquatic habitats. At the moment, the world harpacticoid fauna reaches ca. 5000 species distributed in 57 families and only a small proportion of this fauna (i.e. 126 species) has been recorded for the Iberian Peninsula. There are, however, indications that the small number of species here recorded is mainly a result of the lack of high intensity surveys.

Surveys of the harpacticoid fauna of the Iberian Peninsula are scarce, although intensive sampling programs of underground fauna revealed a diverse fauna with a high degree of endemism (Rouch, 1986b). The scope of the studies identifying harpacticoid species range from identification in multi-taxa samples (Sabater, 1986; Boix *et al.*, 2005) to surveys specifically directed to harpacticoid taxa (Jaume, 1997; Arroyo *et al.*, 2006). These studies often revealed new records of Palearctic fauna in the Iberian Peninsula or added new species to harpacticoid fauna. In a survey of harpacticoid copepods in a North Atlantic bed of *Laminaria ochroleuca*, Arroyo *et al.* (2006) recorded harpacticoids belonging to 17 different families, with 20 species of the family Thalestridae alone. This indicates a very diverse fauna and points to a high general diversity of harpacticoids in Iberian marine waters, yet unsuitably surveyed.

Considering the freshwater harpacticoid fauna, the families Ameiridae, Parastenocarididae and Canthocamptidae present the highest diversity. However, considering the pattern observed in other European fauna more intensively surveyed (e.g. Italy, see Berera *et al.*, 2006; Minelli *et al.*, 2006), it is expected that more species will be found when more comprehensive surveys of Iberian and Macaronesian fauna take place.

So far, members of the family Cancrincolidae that typically inhabit the gill chambers of grapsoid land crabs (Huys *et al.*, 2009) have not been recorded, yet the current amphi-Atlantic distribution of this family suggests its possible presence in the Atlantic shores of the Iberian Peninsula.

4. Present knowledge of the group

In terms of the world fauna, the period from the comprehensive treatment of the group by Lang in 1948 to the publication of the checklist of harpacticoids of the world by Wells in 2007, there was a five-fold increase in the number of species. Two years after the publication of Well's work, 28 genera were added (see Huys 2009), and since then, a steady addition of new taxa shows the dynamism of harpacticoid taxonomy.

Table I. Families of harpacticoids with recorded species in the Iberian and Canary Islands regions: Atl-antic, Atlantic; Atl. Can, Atlantic in the vicinity of Canary Islands; Mediter., Mediterranean sea; Iberian, Iberian Peninsula and Balearic Islands. Species in the last region include both freshwater and euryhaline species; the same species may occur in more than one region.

No.	Family	Atlantic	Atl. Can	Mediter.	Iberian
1	Aegisthidae Giesbrecht 1892 (includes Cerviniidae Sars 1903)	3	–	2	–
2	Ameiridae Monard 1927	5	–	2	15
3	Ancorabolidae Sars 1909	1	–	–	–
4	Arenopontiidae Martínez Arbizu & Moura 1994	–	–	–	–
5	Argestidae Por 1986	1	–	–	–
6	Balaenophilidae Sars 1910	1	–	1	–
7	Canthocamptidae Brady 1880	2	–	2	13
8	Canuellidae Lang 1944	–	–	–	1
9	Cylindropsyllidae Sars 1909 *	1	–	–	–
10	Ectinosomatidae Sars 1903	5	–	2	–
11	Harpacticidae Dana 1846	3	1	1	1
12	Huntemanniidae Por 1986	1	–	–	–
13	Laophontidae T. Scott 1904	–	–	–	1
14	Leptastacidae Lang 1948	2	–	–	–
15	Leptopontiidae Lang, 1948 sensu Martínez Arbizu & Moura, 1994	3	–	–	–
16	Miraciidae Dana 1846	8	–	2	2
17	Paramesochridae Lang 1944	3	–	–	–
18	Parastenocarididae Chappuis 1933	–	–	–	9
19	Peltidiidae Claus 1860	4	1	3	–
20	Phyllognathopodidae Gurney 1932	–	–	–	1
21	Psammopsyllidae synonym of Leptopontiidae Lang, 1948 (WoRMS)	1	–	–	–
22	Rhizothricidae Por 1986	2	–	–	–
23	Rometidae Seifried & Schminke 2003	–	1	–	–
24	Rotundiclipeidae Huys 1988	–	1	–	–
25	Superornatiremidae Huys, 1998	–	1	3	–
26	Tachidiidae Boeck 1864	2	–	1	–
27	Tegastidae Sars, 1904	1	–	–	–
28	Thalestridae Sars, 1905	20	–	–	–
29	Tisbidae Stebbing, 1910	1	1	–	1
	TOTAL	70	6	19	44

DATA SOURCE: Marine species: Petkovski (1964), Enckell (1965), Wells & Clark (1965), Noodt & Galhano (1969), Galhano (1970), Becker (1979), Sabater (1986), Huys & Willems (1993), Arroyo *et al.* (2003, 2006), Viatcheslav *et al.* (2004), Camacho & Valdecasas (2006), Badillo *et al.* (2007), Vives & Shmeleva (2010), Handschumacher *et al.* (2010), Candás *et al.* (2013), Boxshall (2014). Freshwater and euryhaline species of the Iberian Peninsula: Chappuis (1937), Margalef (1953), Dussart (1967), Noodt & Galhano (1969), Galhano (1970), Rouch (1985, 1986a, 1986b, 1990), Alonso & Miracle (1987), Esteban & Sanchiz (1997), Martínez Arbizu (1997), Boix *et al.* (2005), Camacho & Valdecasas (2006), Caramujo & Boavida (2009), Gaviria-Melo (2014).

However, this dynamism is not reflected in harpacticoid taxonomic research in the Iberian Peninsula. The sampling of the Iberian harpacticoid fauna is at best fragmentary, and the low number of species recorded most certainly results from the low number of studies devoted to the group. A particular case is that of the freshwater fauna of both Macaronesian and Balearic islands which has not been surveyed.

After the earlier surveys of Chappuis (1937) Margalef (1953) and Galhano (1970), only during the 1980's there was a renewed interest in the taxonomy of the Iberian fauna (Rouch, 1985, 1986a, 1986b, 1990). Since the 1990's sporadic works have been dedicated to species taxonomy (Jaume, 1997) yet recently, a high diversity has been recorded for marine harpacticoids (e.g. Arroyo *et al.*, 2006) with potential endemisms (Candas *et al.*, 2013). Vives and Shmeleva in 2010 listed 21 species of marine harpacticoids from the Iberian, Balearic and Canary regions. Here, we were able to list the recorded presence of a total of 82 marine species from numerous publications, which indicates that the knowledge on marine harpacticoids is extremely fragmented.

The knowledge of freshwater fauna is also fragmentary and the 44 species recorded is low relative to records for central Europe and neighbouring countries like France and Italy. As an example, numerous speciation phenomena is known to occur among subterranean Harpacticoida, and the genus *Parastenocaris* is represent in Italy with 26 species, of which more than 90% are endemic (Minelli, 2006). In our literature survey we found records for 8 harpacticoid species, of which 7 are endemic suggesting a similar degree of endemism in the Iberian Peninsula. The low number of species recorded in a territory twice as large as Italy suggests that more intensive surveys should be made to improve the knowledge of the group.

All available data suggests that the knowledge of the group can be improved by an increased research effort.

5. Main sources of information available

Information on the identification and ecology of harpacticoida is scattered and information on Spanish fauna is scarce. Information on harpacticoid fauna is restricted to scientific journal publications and a catalogue of marine species (Vives & Shmeleva, 2010). Here, we present a set of resources that may assist in the identification of Iberian and Macaronesian harpacticoid copepods.

5.1. General information resources relative to taxonomy and identification of harpacticoids

Regarding the identification of harpacticoids, the only identification key available in Spanish is that of Vives & Shmeleva (2010) for marine harpacticoids.

Resources available to identify species recorded in the Iberian and Macaronesian regions are restricted to published description of recorded new species. These include Martínez Arbizu (1997), Arroyo *et al.* (2003) and Jaume (1997).

Several keys for European fauna may be used for harpacticoid identification although some care should be taken to confirm the identification of Iberian specimens:

For freshwater harpacticoida, Dussart (1967) supplies a key that may need to be updated with revisions of genera and species published after 1967;

Boxshall & Halsey (2004) offers taxonomic keys related either to the systematic hierarchy or to habitat type; Wells (2007) offers an annotated checklist and keys to the species.

The identification of symbiotic species may be accomplished following Boxshall & Halsey (2004), and Boxhall Huys *et al.* (2009) who supply identifying characters of Cancrincolidae associated with land crabs.

5.2. Family keys of Harpacticoida

Families may be identified following Dussart (1967), Boxshall & Halsey (2004) and Wells (2007). Marine families may be identified following the work of Vives & Shmeleva (2010) published in Spanish by the Consejo Superior de Investigaciones Científicas (CSIC).

A family key (amended from Lang, 1948) is available online at
http://nzetc.victoria.ac.nz/tm/scholarly/tei-Vic68_70Zool-t1-g1-t3.html

5.3. Catalogues

For the region of Madrid, a list of stygal harpacticoids is supplied by Camacho & Valdecasas (2006), a list of 21 species of marine harpacticoids are supplied by Vives & Shmeleva (2010) and Esteban & Sanchiz (1997) list some freshwaters species recorded in the Iberian Peninsula.

Catalogues of marine fauna are supplied by Dussart & Defaye (1990) and by Huys (2001). Gotto (2004) supplies a synopsis of British fauna that may assist in the identification of symbiotic species in our waters.

5.4. Other resources available online include:

Integrated Taxonomic Information System (ITIS)

http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=86110

World Register of Marine Species (WoRMS) that includes Freshwater and symbiotic Species -

<http://www.marinespecies.org/copepoda/aphia.php?p=taxdetails&id=1102>

Copepod Portal – Lucio Pesce web Portal <http://www.luciopesce.net/copepods/arpa.htm>

Species registered for Europe can be found at The European Register of Marine Species (MARBEF) -

<http://www.marbef.org/data/erms.php>

Species 2000 – Catalogue of Life - <http://www.catalogueoflife.org/col/> (available in Spanish).

Major Books on Copepods can be found at

<http://archive.org/search.php?query=subject%3A%22copepoda%22>

6. References

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Annex 1. Associations and journals with information on Harpacticoidea

Websites:

- World Association of Copepodologists - <http://www.monoculus.org/>
Copepod portal by Lucio Pesce - <http://www.luciopesce.net/copepods/arpa.htm>

Journals

- Ann. Limnol. - Int. J. Limnol., published by EDP Sciences, available at www.limnology-journal.org
Aquatic Conservation: Marine and Freshwater Ecosystems, published by Wiley InterScience
www.interscience.wiley.com
Bull Nat Hist Mus Lond (Zool), published by The Natural History Museum
Cah. Biol. Mar.
Contributions to Zoology
Crustaceana, published by Koninklijke Brill NV Leiden, available online at www.brill.nl/cr
Graellsia, Museo Nacional de Ciencias Naturales, published by CSIC, Madrid
Hydrobiologia, Kluwer Academic Publishers
Journal of Natural History, Taylor & Francis Group, available at <http://www.tandfonline.com>
Journal of Plankton Research, Oxford University Press, <http://plankt.oxfordjournals.org>
Limnetica - Asociación Ibérica de Limnología, Madrid. Spain. ISSN: 0213-8409

Marine Biology, published by Springer
Marine Biodiversity, published by Springer,
Mediterranean Marine Science, available on line at <http://www.medit-mar-sc.net>
Molecular Phylogenetics and Evolution, available at www.elsevier.com/locate/ympev
Scientia Marina
TRANS. AM. MICROSC. Soc., published by the American Microscopical Society, Inc.
Vie et milieu - Life and environment
ZooKeys, available at www.zookeys.org
Zoological Journal of the Linnean Society, published by The Linnean Society of London, available at
www.idealibrary.com
Zoologica Scripta, published by Elsevier Science Ltd, The Norwegian Academy of Science and Letters
Zoological Studies
Zoology Publications from Victoria University of Wellington
Zootaxa, Magnolia Press, available at www.mapress.com/zootaxa/
Hydrobiologia, published by Kluwer Academic Publishers