# CRUSTACEAN GUIDE FOR PREDATOR STUDIES IN THE SOUTHERN OCEAN

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Published by the Scientific Committee on Antarctic Research
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Design Agency: botodacruz.com
Art Director: Bruno Cruz

Cite book as following:
Xavier, J. C., Cherel, Y., Boxshall, G., Brandt, A., Coffer, T., Forman, J., Havermans, C., Jażdżewska, A. M., Kouwenberg, K., Schiaparelli, S., Schnabel, K., Siegel, V., Tarling, G. A., Thatje, S., Ward, P., Gutt, J. (2020) Crustacean guide for predator studies in the Southern Ocean. Scientific Committee on Antarctic Research, Cambridge, UK. 253 pp.

ISBN 978-0-948277-58-0

Recycled paper

Cover: the crustacean *Bovallia gigantea* (Photo from Eugenia Moreira).

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## ABSTRACT

Crustaceans are an important component in the diet of numerous predators of the Southern Ocean (water masses located south of the Subtropical Front). As identifying crustaceans from food samples using conventional methods is not easy, a crustacean guide is complied here to aid scientists working on trophic relationships within the Southern Ocean. Having the needs of the scientists in mind, we gathered information from > 100 species from 53 families of the most relevant crustaceans in the diet of subantarctic and Antarctic meso- and top predators, including information on distribution, their relevance in predator diets, sizes, availability of allometric equations and practical procedures to differentiate crustacean species within each family. Additional information of bibliography is added if families possess more that the species mentioned in this book. It is noted that a large number of species still has no allometric equations and the taxonomic status has (remains) to be clarified for some species (one or various species).

## ACKNOWLEDGEMENTS

This work is an international effort under the Scientific Committee on Antarctic Research (SCAR) programs, expert and action groups, namely SCAR AnT-ERA, SCAR AntEco, SCAR EGBAMM and ICED. Support was also provided by the Portuguese Polar Program PROPOLAR, University of Coimbra, British Antarctic Survey, Centre d´Etudes Biologiques de Chizé du Centre Nationale de la Recherche Scientifique, the Italian National Antarctic Museum (MNA) and the Alfred Wegener Institute. JX was supported by the FCT program (IF/00616/2013) and this study benefited from the strategic program of MARE, financed by FCT (MARE-UIDB/04292/2020). Shane T. Ahyong, Francoise Antonutti, Federico Betti, Charles Oliver Coleman, Martin Collins, Dave Conway, Cédric d´Udekem d´Acoz, Claude de Broyer, Miram Gleiber, Hugo Guímaro, Joana Fragão, Eugenia Moreira, Jens Thorvald Høeg, Todd O´Brien, Jamie Oliver, Evgeny A. Pakhomov, Claude Razouls, José Seco, Meike Seefeldt, Anita Slotwinski, Rod Stewart, Sven Tränkner, Jon Waters, Marianne Wootton, Renuka Badhe, Mike Sparrow, Eoghan Griffin, Chandrika Nath, Yan Ropert-Coudert, Eugene Murphy, Rachel Cavanaugh, Nadine Johnston, Huw Griffiths, Jan Strugnell, Carolina Mexias and Bruno Cruz are acknowledged for their help in providing comments, photographs and/or permissions. A very special thanks to Nicolas Raymond (www.boldfrontiers.com) for the brilliant work with the photographs taken in the Smithsonian Institution.

# INDEX

# INTRODUCTION

Crustaceans play a key role in the Antarctic marine ecosystems, being a main energy link between primary production and meso- and top predators (Laws 1984 , Everson 2000, Knox 2007, Murphy et al. 2012). They are consumed by a wide range of predators including squid, fish, seabirds and marine mammals (Nemoto 1970, Croxall et al. 1985b, Cherel & Klages 1998, La Mesa et al. 2004b, Collins & Rodhouse 2006).

A considerable effort has been put into providing information on the taxonomy of Antarctic crustaceans on a morphological base (Kirkwood 1984, Fischer & Hureau 1985, Boltovskoy 1999, De Broyer et al. 2007, De Broyer et al. 2014). However, there is a need to have a crustacean guide for the Southern Ocean (defined here as south of the Subtropical Front) focused particularly on aiding marine ecologists who work on feeding ecology of Antarctic and subantarctic predators. This is particularly relevant, as more information on several crustaceans has become available and an up-to-date Antarctic guide is highly desirable. Furthermore, access to taxonomists is often the limiting factor in prey species identification; worldwide there has been a decline in the number of trained taxonomists (Pearson et al. 2011).

Here, we specifically aim to describe the main crustacean taxa (see below) preyed upon by key top predators of the Southern Ocean in order to assist scientists and students interested in identifying crustaceans. Special emphasis was placed on the identification of digested prey from some key features because, in most cases, digestion precludes identification from whole intact specimens. However, crustacean exoskeleton is relatively resistant to digestive processes, thus generally allowing identification at the species level of almost all the main swarming crustaceans that form the bulk of the food of consumers in the Southern Ocean. Indeed, as durophagous predators are almost entirely absent in the Southern Ocean, crustaceans are generally swallowed without being chewed which helps their morphological recognition in stomach contents (Aronson & Blake 2001). A review of the available allometric regressions is also provided in order to relate crustacean body parts to total length or mass as well as a review of the predators feeding on those crustacean species.

# PROCEDURE FOR SORTING AND IDENTIFYING CRUSTACEANS IN SOUTHERN OCEAN FEEDING ECOLOGY STUDIES

The methods applied to feeding ecology studies that include crustaceans vary widely according to the predator studied. Stomach contents or scat analyses continue to provide a valuable source of information on predator - crustacean relationships, where crustaceans are found still in identifiable condition. Although these analyses are hamstrung by differential identification difficulties of prey items (e.g. rapid digestion/disintegration of soft-bodied and small crustaceans, and the short-term dietary snapshot provided due to short digestion times), high quality analysis of stomach contents is an essential part of food-web understanding. This is because such analyses provide a high level of taxonomic context to predator-prey relationships not yet duplicated by other methods (Young et al. 2015). Moreover, identification of prey provides the ground-truthing for many of the more contemporary methodologies that follow.

Crustaceans are more easily digestible in comparison with organisms that possess harder parts (e.g. squid beaks, fish bones and otoliths). Therefore it is important to be informed about potential biases according to the objectives of the study (e.g. how different types of food are digested at different rates, how these biases may affect the quantification and interpretation of your results, what can be done to compensate such biases) (Imber 1973, Croxall et al. 1985a, Brown & Klages 1987). Ideally, samples should be processed in as much detail as possible as soon after collection as practicable (Brown & Klages 1987). This is especially critical for crustaceans to avoid further degradation. Indeed, crustaceans from frozen samples are usually in much worse conditions than fresh material. If considering keeping the sample in ethanol, do so after separating the components of the sample (see below). One positive aspect of frozen material is that colour of the crustaceans can be used to help differentiate closely related species (e.g. the mostly red cephalothorax of *Euphausia triacantha*).

Using a complete food sample (avoid subsamples if possible, to avoid biases if your sample is not homogeneous) from a penguin as an example, the stomach sample should be analysed after having been weighed and the overall mass recorded. Empty it into a large tray, rinse thoroughly and re-weigh it (without the liquid). All components should be sorted into categories (e.g. crustaceans, cephalopods, fish) and weighed separately.

These remains can be sorted into digestive states (e.g. for Antarctic predator fish diet studies, the states of digestion used are: fresh, slightly digested, moderately digested and digested [Stevens et al. 2014]). The most highly digested state is eliminated from detailed analyses (e.g. only very rarely, exoskeleton fragments of crustacean species [e.g. *Eurythenes gryllu*s, *Pasiphaea* sp. or *Gnathophausia* sp.] may accumulate [Ridoux 1994]) although it can still provide useful information. Fresh prey items may also be eliminated if they have been deemed to be consumed whilst being caught (e.g. feeding in the net or eating prey already caught on the longline). Also, be aware that some crustaceans (secondary prey) might have been consumed by other larger prey, also caught by the predator (e.g. fresh scavenging amphipods found in the diet of an icefish that was eaten by a toothfish *Dissostichus* spp.). Depending on the objectives of the study, those old/ secondarily ingested crustaceans may not be included in the results (e.g. for studies aimed at assessing the targeted daily prey consumed by a predator) (Plötz 1986, Skinner & Klages 1994, Cherel et al. 2002c). To retrieve very small prey remains such as crustacean eyes, small squid beaks, and fish otoliths, either they should be searched initially in a tray (e.g. for very small prey, such as copepods, or small prey items [e.g. crustacean eyes]) and/or use sieves (e.g. 5.6 mm, 1.0 mm and/or 0.55 mesh diameter, to remove fluids). If a plastic bag was used to keep the food sample, please pay attention to the material in the bottom of the bag, as otoliths and beaks are regularly found there. If needed, subsampling is a time-effective way to estimate the number of the commonest crustacean prey in stomach contents containing large numbers of small prey (e.g. 130,000 copepods in a single stomach content of Salvin's prion; Ridoux 1994). Counts often rely on the number of eyes for euphausiid numbers, and of anterior (including eyes) or posterior (including telson and uropods) body parts for hyperiid amphipods.

The key aspect of identifying crustaceans is to be able to differentiate each individual crustacean and to find their potential diagnostic parts (e.g. carapaces, antennae, mandibles, eyes). Digested material is often identifiable by reference to intact material in the same sample. Having a good reference collection of crustaceans for your study area is vital. Identifying crustaceans from stomach contents of predators can be an arduous task that requires spending considerable time analyzing the material at hand, comparing it with reference collections and using guides. Be aware that even using this guide, it is extremely important to get expert advice, before attributing a name to a crustacean. Indeed, it is common to send material to experts to check crustacean identifications. Do please cite the sources of your identifications (e.g. books, identification guides, research papers, collections for research institutes, private collections) in your publications. Indeed, it is recommended in keeping a voucher collection in a permanent collection so that identifications can be verified (and related to other studies) in the future.

The following indices are usually measured to assess the importance of crustaceans in diet studies: Frequency of occurrence, as well as Number and Mass (Croxall 1993, Ridoux 1994, Cortés 1997, Xavier et al. 2002, Barrett et al. 2007, Ratcliffe & Trathan 2011, Karnovsky et al. 2012) [The frequency of occurrence (%) of crustaceans in the diet (number of stomach samples with a certain crustacean species present divided by the total number of stomach samples analyzed), the proportion (%) of individuals of a species (number of individuals of a certain species divided by the total number of individuals) and the contribution to the diet by estimated mass (%) (estimated mass, M, of all individuals of a certain crustacean species divided by the total estimated mass for all crustaceans)]. It is also desirable to obtain as much information as possible about the prey, such as size (e.g. through the measurement of total length, carapace length or eyes [and use allometric equations to estimate total length]), sex and reproductive status (e.g. juvenile, sub-adult or adult). As numerous Antarctic top predators feed on Antarctic krill *Euphausia superba*, it is important to have this information from randomly selected individuals, from each sample. In digested samples (especially in scats), in order to obtain an adequate sample of individuals measured, the length of the removed carapace can be used (Hill 1990, Reid & Measures 1998). In extreme cases, the only undigested crustacean material remaining may be the eyes or other appendages, and their diameters can be measured to provide an estimate of total length (but check prior to the study if allometric equations are available for the crustaceans found in your samples) (Ridoux 1994, Reid et al. 1997b, Green et al. 1998b, Everson 2000, Bocher et al. 2001, Marschoff et al. 2008). The taxonomy follows WoRMS (World Register of Marine Species; http://www.marinespecies.org/ [WoRMS Editorial Board 2016]) and must be checked for updated taxonomy.

# GENERAL ABREVIATIONS

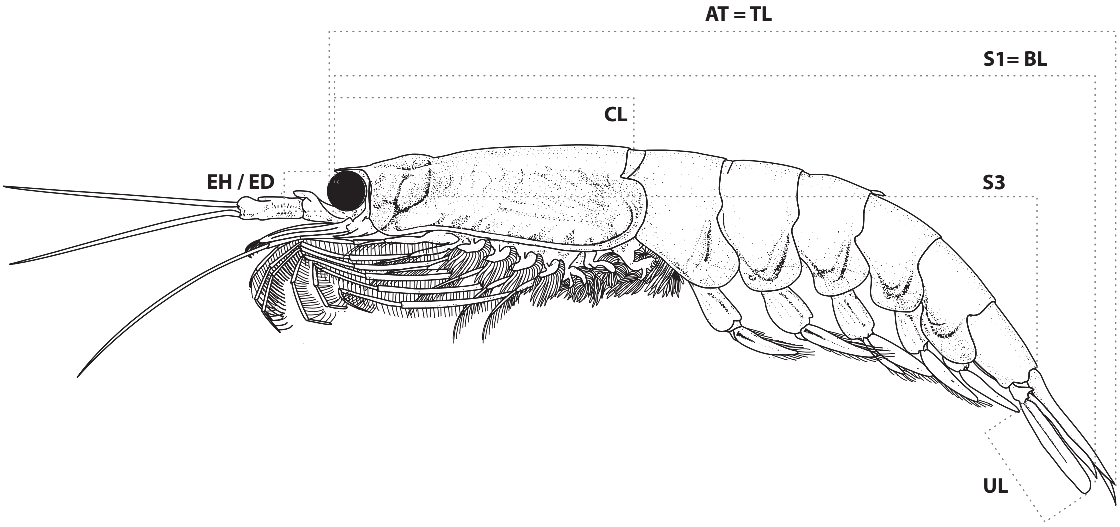



Figure 1. Abbreviated terminology of the main measurements in crustaceans (Siegel 2016) (Copyright permission from Springer). See details in list below.

AT = Total Body Length (mm); total body length is from the anterior margin of the eye to the tip of the telson excluding the terminal spine (usually applied to *Euphausia superba*) (Everson 2000, Siegel 2016).

BM = Body Mass wet weight (g),

BMs = Body Mass wet weight (mg),

BMdw = Body Mass dry weight (mg),

BL = Body Length (also known as Total length [TL]) (in cm or mm); body length is from the anterior tip of the rostrum to the posterior end of the telson, excluding setae,

ThL = Thoracic length (in cm or mm); Thoracic length is from the base of the rostrum to the midline dorsal posterior limit of the carapace of the cephalothorax,

CL = Carapace Length (mm); carapace length is from the tip of the rostrum to the mid-dorsal posterior edge of carapace; for decapod research, the post-orbital carapace length (PCL) is also used, from the anterior margin of the eye orbit to the mid-dorsal posterior edge of the carapace; both the CL of larvae and adults as well as TL are often measured from the base of the rostrum/rostral spine to the posterolateral margin of the carapace (as in decapods the rostral spines in specimens, found in the diet of predators, are often damaged).

DW = Dry Weight (mg)

ED = Eye Diameter (mm)

EH = Eye Height (mm) (EH = ED;

For crustaceans species with round eyes [e.g. *E. superba*], the used term by scientists is "Eye Diameter" [ED]. For other euphausiids with elongated eyes, such as in *Thysanoessa* sp., some scientists also used the term "Eye Height" [EH])

RCL = Removed Carapace Length (mm); carapace is dissected off, placed dorsal side down on the microscope stage, and measured (providing that the dorsal midline had not been torn)

S1 = Standard Length 1 (mm) for Euphausiacea; S1 length is the lateral or dorsal distance between the anterior tip of the rostrum and the posterior end of the uropods, excluding their terminal setae (Mauchline 1980, Siegel 2016); considering the accuracy of measurements, for euphausiids S1 length can probably be regarded as identical to BL length;

S3 = Standard Length 3 (mm) for Euphausiacea; S3 length is the lateral distance between the anterior lateral edge of the carapace and the posterior margin of the 6th abdominal segment (Mauchline 1980)

TLt = Telson Length (cm)

UL = Uropod Length (mm); total length of uropods, excluding setae.

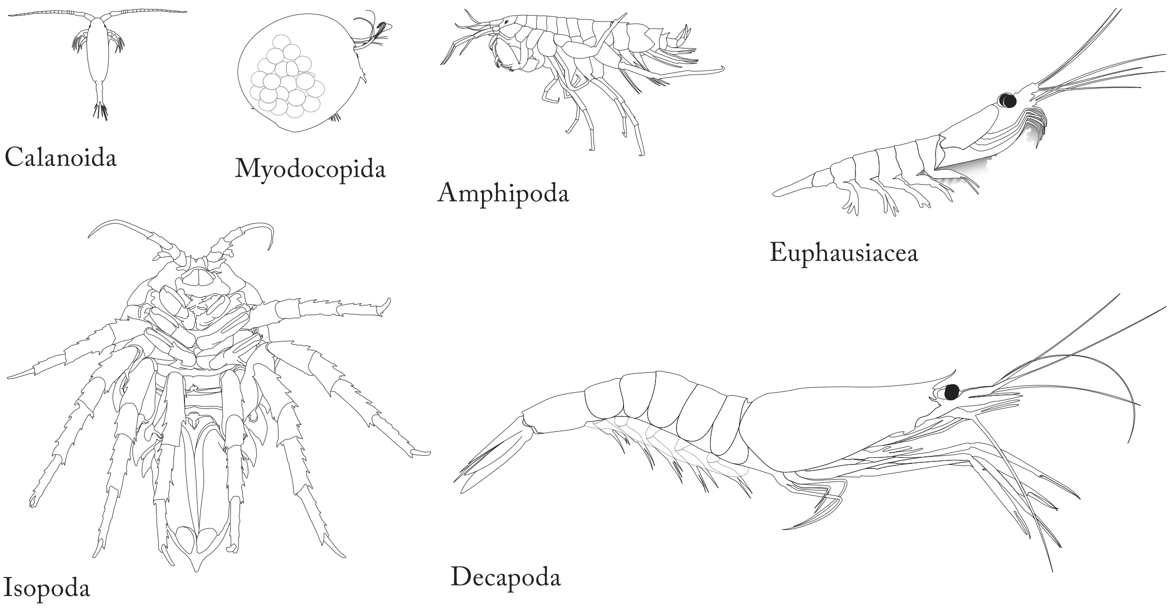
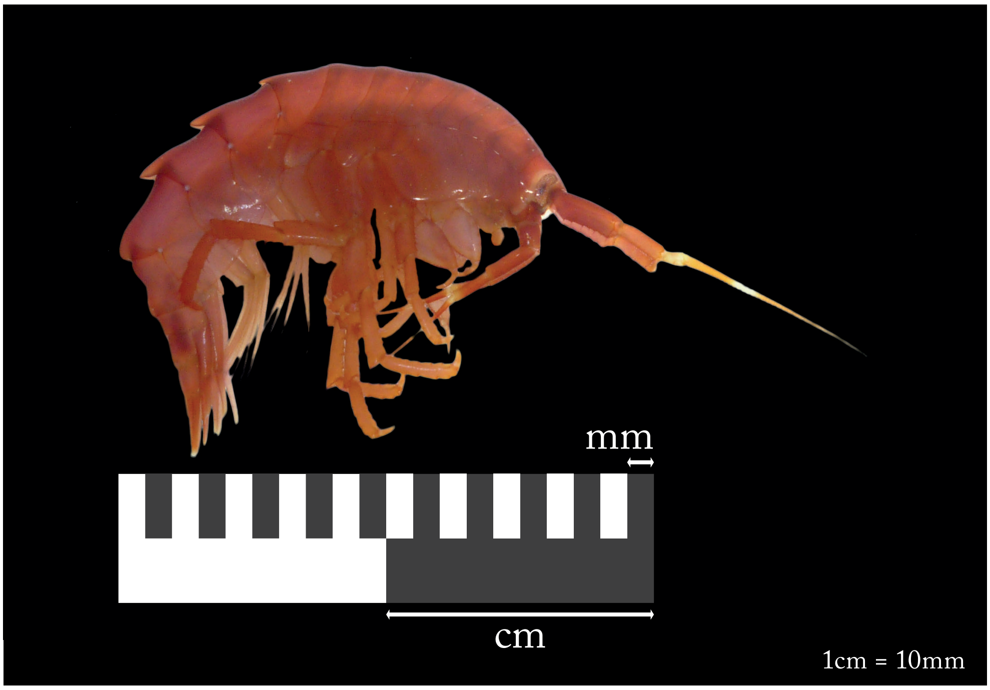



Figure 1.1. A schematic diagram to illustrate the average sizes of some of crustaceans found in the Southern Ocean, from Calanoida (smaller organisms) to Decapoda (larger organisms).

# THE STRUCTURE OF THE BOOK

Crustaceans are separated by superclasses, subclasses, orders, suborders and alphabetically by their respective families. The scale was put in the photographs, when possible, as below:



ANIMALIA (= METAZOA)

PHYLUM ARTHROPODA
Van Siebold, 1848

SUBPHYLUM CRUSTACEA
Brünnich, 1772

# CRUSTACEAN TAXONOMY

# SUPERCLASS MULTICRUSTACEA

Regier, Shultz, Zwick, Hussey, Ball, Wetzer, Martin & Cunningham, 2010

## SUBCLASS COPEPODA

Milne-Edwards, 1840

Pelagic copepods are a key component of the zooplankton fauna in the Southern Ocean, being numerically the dominant group with huge biomass (Kouwenberg et al. 2014). The below list of species encountered in the stomach contents of Southern Ocean predators is not exhaustive. Taking into account that there are 388 species in the Antarctic and Subantarctic regions, others are likely to be found in new studies concerning predators' diets. Indeed, some species are rare endemics, others living at depths below 1000 m are not encountered by visual predators. However, squid and fish may forage at greater depths that allow these copepods to be part of their food. Some large meso-bathypelagic species (prosome length 4-6 mm), making up more than 40% of total copepod biomass together with the species below include: *Heterostylites nigrotinctus* (Brady, 1918); *Mixtocalanus vervoorti* (Park, 1980); *Onchocalanus paratrigoniceps* Park, 1983; *Onchocalanus wolfendeni* Vervoort, 1950; *Scaphocalanus antarcticus* Park, 1982; *Scaphocalanus parantarcticus* Park, 1982. Other species than those listed, showing fair abundance during productive periods include epipelagic *Clausocalanus brevipes* (Frost & Fleminger 1968), and other Clausocalanidae occuring in the Subantarctic region, the widespread *Oithona atlantica* (Farran,1908), *O. similis*-group (Claus 1866), and other epipelagic Oithonidae, and more species from the widespread families Euchaetidae, Heterorhabdidae and Oncaeidae.

These are very likely to be encountered by visual predators. A list of all described Antarctic copepods can be found at: http://copepodes.obs-banyuls.fr/loc.php?loc=4, and of the Subantarctic at: http://copepodes.obs-banyuls.fr/loc.php?loc=3.

# ORDER CALANOIDA

Sars G. O., 1903

» FAMILY CALANIDAE DANA, 1849

» FAMILY CANDACIIDAE GIESBRECHT, 1893

» FAMILY CLAUSOCALANIDAE GIESBRECHT, 1893

» FAMILY EUCHAETIDAE GIESBRECHT, 1893

» FAMILY HETERORHABDIDAE SARS G.O., 1902

» FAMILY METRIDINIDAE SARS G.O., 1902

» FAMILY RHINCALANIDAE GELETIN, 1976

## FAMILY CALANIDAE DANA, 1849

### Existing species that can be found are:

***Calanoides acutus*** **(Giesbrecht, 1902)**
***Calanus propinquus*** **Brady, 1883** Figure 2 | page 139
***Calanus simillimus*** **Giesbrecht, 1902** Figure 3 | page 139

*Calanoides acutus* has a circumpolar distribution in Antarctic waters, from the Antarctic continent ice-edge to the Subtropical Front (Kouwenberg et al. 2014). As a dominant herbivore in the Southern Ocean, *C. acutus* is present in the diet of numerous predators, including fish, snow petrels, blue petrels, cape pigeons, fairy prions, Antarctic prions, common diving petrels and South Georgian diving petrels (Hubold 1985, Foster et al. 1987, Kellermann 1987, Croxall et al. 1988, Montgomery et al. 1989, Hubold & Ekau 1990, Prince & Copestake 1990, Foster & Montgomery 1993, Ridoux 1994, Pakhomov & Pankratov 1995b, Pakhomov et al. 1996b, Croxall et al. 1997, Reid et al. 1997a, Reid et al. 1997b, Bocher et al. 2000a, La Mesa et al. 2000, Bocher et al. 2001, Cherel et al. 2002a, La Mesa et al. 2004b, Barrera-Oro & Piacentino 2007, Collins et al. 2008, Shreeve et al. 2009, Fijn et al. 2012, Saunders et al. 2014).

*Calanus propinquus* has a circumpolar distribution in Antarctic waters, from the Antarctic continent ice-edge to the Subtropical Front (Kouwenberg et al. 2014). Similarly to *C. acutus*, *C. propinquus* is a dominant herbivore in the Southern Ocean, and is present in the diet of numerous predators, including fish, squid, Antarctic prions, fairy prions, Wilson's storm petrels, common diving petrels and South Georgian diving petrels (Hubold 1985, Foster et al. 1987, Kellermann 1987, Croxall et al. 1988, Montgomery et al. 1989, Hubold & Ekau 1990, Kellermann 1990, Prince & Copestake 1990, Foster & Montgomery 1993, Ivanovic & Brunetti 1994, Pakhomov & Pankratov 1995b, Pakhomov et al. 1996b, Croxall et al. 1997, Reid et al. 1997a, Reid et al. 1997b, La Mesa et al. 2000, La Mesa et al. 2004b, Pusch et al. 2004, Barrera-Oro & Piacentino 2007, Collins et al. 2008, Shreeve et al. 2009, Pinkerton et al. 2013, Saunders et al. 2014).

*Calanus simillimus* has a circumpolar distribution in Antarctic waters, from the Antarctic continent ice-edge to the Subtropical Front (Kouwenberg et al. 2014). Similarly to *C. acutus* and *C. propinquus*, *C. simillimus* is a dominant herbivore in the Southern Ocean, and is present in the diet of numerous predators, including fish, white-chinned petrels, blue petrels, Antarctic prions, fairy prions, Salvin's prions, thin billed prions, Wilson's storm petrels, common diving petrels, South Georgian diving petrels, fin whales and Sei whales (Nemoto 1962, Nemoto 1970, Mizroch et al. 1984, Croxall et al. 1988, North & Ward 1990, Prince & Copestake 1990, Ridoux 1994, Pakhomov et al. 1996b, Croxall et al. 1997, Reid et al. 1997a, Reid et al. 1997b, Bocher et al. 2000a, Cherel et al. 2002a, Cherel et al. 2002b, Bushula et al. 2005, Knox 2007, Collins et al. 2008, Shreeve et al. 2009, Quillfeldt et al. 2010, Saunders et al. 2014).

## Practical procedures to differentiate the species within this family

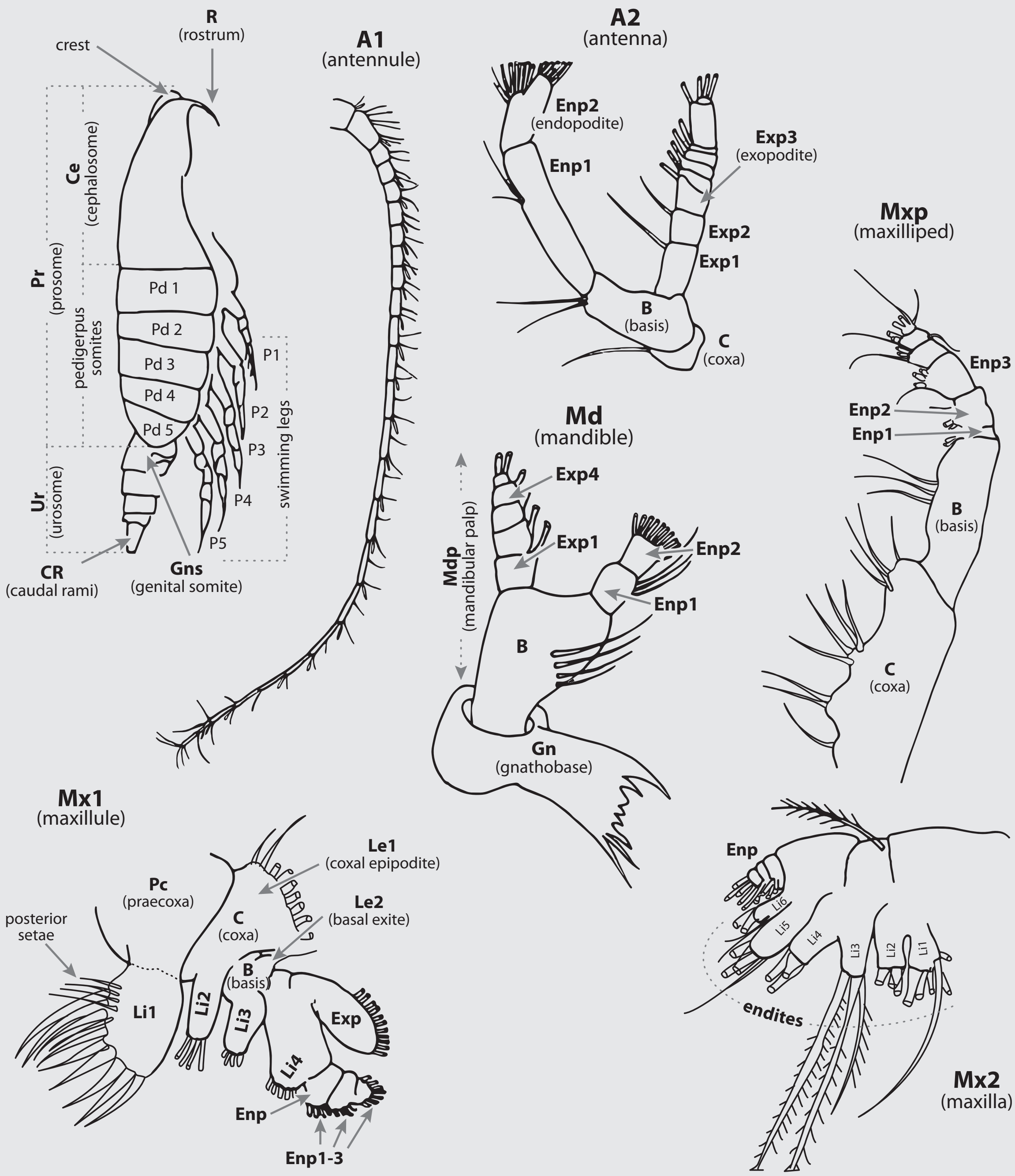
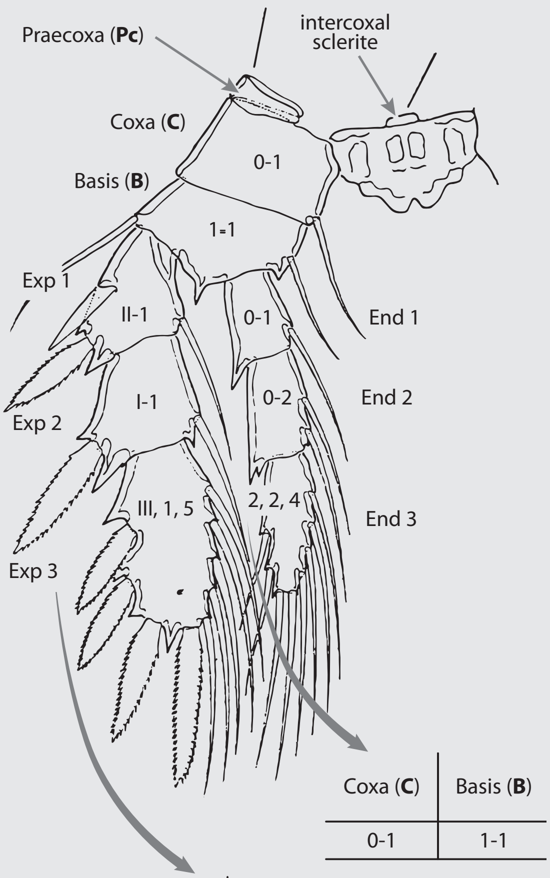



Figure 4 A. The general structures of a calanoid copepod and mouthparts.

**Structure of calanoid swimming leg**




| Coxa (**C**) | Basis (**B**) |
|---|---|
| 0-1 | 1-1 |

| Exopod (**Exp**) | | | Endopod (**End**) | | |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 1 | 2 | 3 |
| II-1 | I-1 | III, 1, 5 | 0-1 | 0-2 | 2, 2, 4 |

Figure 4 B. The details are provided of the structure of calanoid swimming leg, showing the maximum setation of a second leg. System of spine and setal description, used in the family descriptions, is given in the box (Boltovskoy 1999) (Copyright permission from Backhuys Publishers, Leiden, The Netherlands).

Identification keys for adult males and females in Razouls (1994) and Bradford-Grieve et al. (1999). *Calanoides acutus* females (total length range: 4.0-6.2 mm [Bradford-Grieve et al. 1999] and 3.5-5.7 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=493]) have an Antenna 1 that extends beyond caudal rami (Bradford-Grieve et al. 1999) while in males (very rarely to be encountered and the only known size reported for males is 4.6 mm total length [Giesbrecht 1902]), the right Leg 5 Endopod 1 and Endopod 2 have 1 inner seta each (Bradford-Grieve et al. 1999). Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=493. *Calanus propinquus* females (total length: 4.2-6.5 mm [Bradford-Grieve et al. 1999] and 4.8-6.0 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=509]) have the seta of Antenna 1 segment 23 longer than the last 8 segments while in males (total length: 4.75-5.3 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=509]), the right Leg 5

Exopod extends less than half way along the left Exopod 2; the right Leg 5 is about half the length of the left (Bradford-Grieve et al. 1999). This species is sometimes confused with *Calanus simillimus* but it can be recognised by its larger size. The mean female size is 5.26 mm (n = 15; SD = 0.3200), and the mean male size is 5.10 mm (n = 5; SD = 0.2424) (Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=509). Leg 5, compared with *C. simillimus*, has differently arranged teeth along the inner edge of the 1st basal segment; each segment has a curved row of 15 small teeth and a basal group of 3 much bigger teeth; the outer edge spine on the 3rd exopodal segment divides the margin in proportions of 5:3. Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=509. *Calanus simillimus* females (total length: 2.5-3.8 mm [Bradford-Grieve et al. 1999] and 2.5-3.97 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=510]) have the seta of Antenna 1 segment 23 shorter than the last 7 segments while in males (total length: 2.62-3.42 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=510]), the right Leg 5 Exopod extends less than half way along left Exopod 2; right Leg 5 is about half as long as the left (Bradford-Grieve et al. 1999). This species is sometimes confused with *Calanus propinquus*. It can be recognised, however, by its smaller size. The mean female size is 3.28 mm (n = 22; SD = 0.4063) and the mean male size is 3.23 mm (n = 11; SD = 0.2642. Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=510.

# FAMILY CANDACIIDAE GIESBRECHT, 1893

## Existing species that can be found is:

***Candacia maxima* Vervoort, 1957** Figure 5 | page 140

*Candacia maxima* is a mesopelagic species, distributed in Antarctic and subantarctic waters, extending north of the Subtropical Front (Kouwenberg et al. 2014), but preferentially thought to be subantarctic (Vervoort 1957). It was identified once in the diet of blue petrels (Cherel et al. 2002b).

## Practical procedures to differentiate the species within this family

Identification keys for adult males and females in Razouls (1994). It is a medium-sized species (total length for adult females: 3.5-4.0 mm). Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=544.

# FAMILY CLAUSOCALANIDAE GIESBRECHT, 1893

## Existing species that can be found are:

***Drepanopus pectinatus* Brady, 1883** Figure 6 | page 140
***Drepanopus forcipatus* Giesbrecht, 1888** Figure 7 | page 141

*Drepanopus pectinatus* has a circumpolar distribution in Antarctic and subantarctic waters, from the Antarctic continent ice-edge to the Subtropical Front (Kouwenberg et al. 2014), particularly in the inshore waters of Crozet, Kerguelen and Heard Islands (Bayly 1982, Hulsemann 1985). *D. pectinatus* is an endemic of the Kerguelen Province in the subantarctic Region. Its absence from Prince Edward and Marion Islands supports Brigg's supposition that these islands constitute a separate province (Briggs 1974). Similarly to *C. acutus*, *C. propinquus* and *C. simillimus*, *D. pectinatus* is a dominant herbivore in the Southern Ocean, and is present in the diet of blue petrels, Salvin's prions, thin billed prions, common diving petrels, South Georgian diving petrels and Sei whales (Nemoto 1970, Mizroch et al. 1984, Ridoux 1994, Bocher et al. 2000a, Cherel et al. 2002a, Cherel et al. 2002b).

*Drepanopus forcipatus* is distributed in Antarctic (at South Georgia) and subantarctic waters, in the Magellanic/Tierra del Fuego region (including Falkland Islands) and in Pacific waters (Bayly 1982, Hulsemann 1985) but extends considerably further north along the west coast of the continent (Razouls et al., 2005-2020). This species is particularly important in the diet of larval fish from *Champsocephalus gunnari*, *Chaenocephalus aceratus*, *Notothenia nudifrons* and *N. gibberifrons* (North & Ward 1990).

## Practical procedures to differentiate the species within this family

Identification keys for adult males and females are available (Razouls 1994, Bradford-Grieve et al. 1999). *Drepanopus pectinatus* can be confused with *D. forcipatus* (Hulsemann 1985), but their biogeographical distributions do not overlap. Both are small species (*D. pectinatus* females: 1.5-2.7 mm [Hulsemann 1985] and 1.78-3.00 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=613]; *D. forcipatus* females: 1.8-2.7 mm [Hulsemann 1985] and 1.39-2.74 mm [https://copepodes.obs-banyuls.fr/en/

fichesp.php?sp=612]). The forehead of males and females of *D. pectinatus*, in lateral view, is smooth and vaulted whereas for *D. forcipatus* it is flat and has a prominent, knob-like rostrum (Hulsemann 1985). Also, the base of the second antenna is naked in *D. pectinatus* whereas in *D. forcipatus*, it carries proximally a row of curved, presumably sensory, spines on its posterior side (Hulsemann 1985). *D. forcipatus* can be readily distinguished from *D. pectinatus* by the curve of the P5 female. Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list for *D. pectinatus* are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=613, and for *D. forcipatus* at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=612.

# FAMILY EUCHAETIDAE GIESBRECHT, 1893

## Existing species that can be found are:

***Euchaeta* spp.**
***Paraeuchaeta antarctica* Giesbrecht, 1902** Figure 8 | page 141

*Paraeuchaeta antarctica* (= *Euchaeta antarctica* Giesbrecht, 1902 [WoRMS 2014b]) has a circumpolar distribution in Antarctic, subantarctic and subtropical waters, with its distribution extending from the Antarctic continent ice-edge to the Subtropical Front (Kouwenberg et al. 2014). The species is abundant in some coastal areas. It is a large carnivorous copepod, moving rapidly towards the surface at sunset, and is capable of covering considerable vertical distances in a short time; during daytime it is completely absent from the surface. *P. antarctica* is present in the diet of fish, squid, macaroni penguins, rockhopper penguins, blue petrels, Antarctic prions, thin billed prions, common diving petrels and South Georgian diving petrels (Hubold 1985, Williams 1985, Montgomery et al. 1989, Foster & Montgomery 1993, Pakhomov et al. 1996b, Bocher et al. 2000a, Bocher et al. 2000b, La Mesa et al. 2000, Tremblay & Cherel 2000, Bocher et al. 2001, Bocher et al. 2002, Cherel et al. 2002a, Cherel et al. 2002b, Cherel & Duhamel 2003, Tremblay & Cherel 2003, Collins et al. 2008, Waluda et al. 2012, Pinkerton et al. 2013). It is noticeably a significant prey of the inshore foragers rockhopper penguins and common diving petrels at Kerguelen Islands, with the two predators feeding on different developmental stages (Bocher et al. 2002).

## Practical procedures to differentiate the species within this family

Identification keys for adult males and females are available (Razouls 1994, Bradford-Grieve et al. 1999). *Paraeuchaeta* spp. can be easily identified by the presence of a pair of strong raptorial maxillipeds, but species identification within the genus is notoriously difficult. Adult female *Paraeuchaeta antarctica* reach a large size (females: 7.5-9.8 mm [Bradford-Grieve et al. 1999] and 6.51-10.40 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=742]); they have an orange colour and, if present blue ovigerous sacs, A1, A2 and mouthparts are deep red (with colour often preserved after fixation). Description: serrate lamella of Leg 5 Exopod 2 not short, hair tubercle not rounded but tapering into long spiniform process (Bradford-Grieve et al. 1999). Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=742.

# FAMILY HETERORHABDIDAE SARS G.O., 1902

## Existing species that can be found is:

***Heterorhabdus austrinus* Giesbrecht, 1902** Figure 9 | page 142

*Heterorhabdus austrinus* is distributed in Antarctic and subantarctic waters, extending its distribution to subtropical waters and potentially further north (Bradford-Grieve et al. 1999, Kouwenberg et al. 2014). *H. austrinus* is present in the diet of squid, fish and blue petrels (Pakhomov & Pankratov 1995b, Cherel et al. 2002b, Cherel & Duhamel 2003). It is a meso-bathypelagic species and a member of the so-called "*abyssalis*" group (Park 2000).

## Practical procedures to differentiate the species within this family

Identification keys for adult males and females in Razouls (1994) and Bradford-Grieve et al. (1999). *Heterorhabdus austrinus* females (total length: 3.0-3.9 mm [Bradford-Grieve et al. 1999] and 2.40-4.05 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=835]) have the genital somite, in dorsal view, with both lateral borders undulating, more pronounced on left (Bradford-Grieve et al. 1999). *H. austrinus* males (total length: 2.5-3.6 mm [https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=835]) have right Leg 5 inner lobe arising from proximal part of segment by narrow stalk (Bradford-Grieve et al. 1999). Vervoort (1957) suggested that this species could be identical to *H. pustulifer* but this was contested (Bradford 1971). It has been suggested that *H. austrinus* is very close in habitus and details of the appendages to *H. abyssalis* (Park 2000) but can be distinguished from it by the genital somite, of which the posterior edge of the left genital flange meets the ventral wall of the somite in a characteristic notch in the *H. abyssalis* female, and in the male by the Leg 5 of which the right 3rd exopodal segment has a long terminal spine and the outer spine of the left 2nd exopodal segment is not borne on a conical process in *H. abyssalis*. Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=835.

# FAMILY METRIDINIDAE SARS G.O., 1902

## Existing species that can be found are:

***Metridia gerlachei* Giesbrecht, 1902** Figure 10 | page 142
***Metridia lucens* Boeck, 1865**

*Metridia gerlachei* is distributed in Antarctic and subantarctic waters, with its distribution extending from the Antarctic continent ice-edge to the Subtropical Front (Kouwenberg et al. 2014). *M. gerlachei* is present in the diet of fish (Hubold 1985, Foster et al. 1987, Kellermann 1987, Montgomery et al. 1989, Hubold & Ekau 1990, Kellermann 1990, Foster & Montgomery 1993, Pakhomov & Pankratov 1995b, Pakhomov et al. 1996a, Hubold & Hagen 1997, La Mesa et al. 2000, La Mesa et al. 2004b, Pusch et al. 2004, Barrera-Oro & Piacentino 2007, Collins et al. 2008, Pinkerton et al. 2013). This typical cold-water species differs from *Calanus propinquus* and *Calanoides acutus* in several respects. Schnack-Schiel & Hagen (1994) found that *M. gerlachei* did not inhabit the upper 50 m in the summer, while the other species concentrated there. The species is found preferentially in deeper waters (Ottestad, 1936; Michels et al., 2012). Its distribution is patchy, while the two *Calanidae* are more evenly distributed. Vertical migrations of *M. gerlachei* are considerable (epi- to bathypelagic). *C. acutus* is epi-mesopelagic and also a less pronounced cold water species. Its highest densities are found between the isotherms for -1° and -2°C, but high concentrations are also found up to +3°C water (Ottestad, 1936; Mackintosh, 1934). *C. propinquus* is mainly epipelagic. Both *C. acutus* and *C. propinquus* are usually found south of the Antarctic Polar Front (Tanaka, 1960; Bradford-Grieve, 1994), only occasionally north of this boundary. Schnack-Schiel & Hagen (1994) described seasonal variations in distribution and population structure for these three species in the Eastern Weddell Sea. *M. gerlachei* and *C. acutus* were most abundant in April, while highest concentrations for *C. propinquus* were reached in February. Younger stages (CI and CII) of *M. gerlachei* prevailed in autumn, while those of *C. acutus* and *C. propinquus* prevailed in summer.

*Metridia lucens* is a cosmopolitan species common in warm waters (subantarctic and subtropical waters, particularly in the Atlantic and Pacific Oceans), penetrating far South into Antarctic waters. Widely distributed in the World Oceans, it is also present in the northern hemisphere (Atkinson et al. 1996, Errhif et al. 1997, Hays et al. 1998, Bradford-

Grieve et al. 1999, Visser et al. 2001). *M. lucens* is present in the diet of squid and fish (Young & Blaber 1986, Pakhomov et al. 1996b, Williams et al. 2001, Cherel & Duhamel 2003, Bushula et al. 2005).

## Practical procedures to differentiate the species within this family

Identification keys for adult males and females in Razouls (1994) and Bradford-Grieve et al. (1999). *Metridia gerlachei* females (total length: 2.2-3.2 mm [Bradford-Grieve et al. 1999] and 3.25-4.30 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=980]) have rounded posterior prosome corners; caudal rami about 3.5 times as long as wide, whereas males (total length: 2.16-2.70 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=980]) have the Leg 5 with 3 inner spines on penultimate segment (Bradford-Grieve et al. 1999). Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=980. *Metridia lucens* females (total length: 1.9-4.0 m [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=984]) have pointed posterior prosome corners; caudal rami twice as long as wide. The males (total length: 1.5-3.0 mm [Razouls et al., 2005-2020, https://copepodes.obs-banyuls.fr/en/fichesp.php?sp=984]) also have pointed posterior corners of the prosome (Bradford-Grieve et al. 1999). There is confusion between this species and *M. pacifica*. However, the latter does not occur in the subantarctic and Antarctic regions. Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=984.

# FAMILY RHINCALANIDAE GELENTIN, 1976

## Existing species that can be found are:

***Rhincalanus gigas*** **Brady, 1883** Figure 11 | page 143
$BM/BL^3$ = 0.18 (n=20) (0.70-0.85 cm) (Ridoux 1994)

Any other calanoids
$BM/BL^3$ = 0.024 (n=168) (0.22-0.36 cm) (Ridoux 1994)

*Rhincalanus gigas* is distributed in Antarctic, subantarctic and subtropical waters, with its distribution extending from the Antarctic continent ice-edge to the Subtropical Front (Bradford-Grieve et al. 1999, Kouwenberg et al. 2014). *R. gigas* is present in the diet of fish, macaroni penguins, blue petrels, white-chinned petrels, cape pigeons, Antarctic prions, Salvin's prions, fairy prions, Wilson's storm petrels, common diving petrels and South Georgian diving petrels (Hubold 1985, Williams 1985, Kellermann 1987, Croxall et al. 1988, North & Ward 1990, Prince & Copestake 1990, Ridoux 1994, Pakhomov & Pankratov 1995b, Pakhomov et al. 1996b, Croxall et al. 1997, Hubold & Hagen 1997, Reid et al. 1997a, Reid et al. 1997b, Bocher et al. 2000a, Cherel et al. 2002a, Cherel et al. 2002b, Pusch et al. 2004, Bushula et al. 2005, Barrera-Oro & Piacentino 2007, Collins et al. 2008, Main et al. 2009, Shreeve et al. 2009, Waluda et al. 2012, Saunders et al. 2014). This species is subject to a seasonal vertical migration (Ommanney 1936), so that the winter months are passed in the relatively warm intermediate water layer. It is likely that the developmental stages are carried northwards in Antarctic surface waters. At the approach of sexual maturity and near the northern limit of its area of distribution it sinks to the warmer, southerly flowing intermediate water layers.

## Practical procedures to differentiate the species within this family

Identification keys for adult males and females in Razouls (1994) and Bradford-Grieve et al. (1999). *Rhincalanus gigas* are easy to identify due to their large size and the possession of Antenna 1 much longer than the body. Females (total length: 7.5-10.0 mm) lack dorsal spines on pedigerous somites 3 and 4 (Bradford-Grieve et al. 1999). *R. gigas* males are larger than 6.5 mm (Bradford-Grieve et al. 1999). Full species details including taxonomic identification plates, photographs, dimensions, biogeography, ecology and reference list are available at: http://copepodes.obs-banyuls.fr/en/fichesp.php?sp=706.

# ORDER SIPHONOSTOMATOIDA

Thorell, 1859

A group of parasitic copepods that are found in prey of top predators, particularly fish.

» FAMILY PENNELLIDAE BURMEISTER, 1835

» FAMILY SPHYRIIDAE WILSON C.B., 1919

# FAMILY PENNELLIDAE BURMEISTER, 1835

## Existing species that can be found are:

***Phrixocephalus carcellesi*** **Brian, 1944**
***Sarcotretes eristaliformis*** **Brian, 1908**
***Sarcotretes scopeli*** **Jungersen, 1911** Figure 12 | page 145

*Phrixocephalus carcellesi* (a parasitic copepod of fish) is distributed in subantarctic waters, around the southern tip of South America (Brian 1944, Boxshall 1989). It is present in the diet of king shag *Phalacrocorax albiventer* (Boxshall 1989). The only known host of *P. carcellesi* is the southern hake *Merluccius gayi* (Brian 1944).

*Sarcotretes eristaliformis* (a parasitic copepod of fish) is distributed in subantarctic, subtropical and tropical waters, extending its distribution worldwide in the Atlantic, Indian and Pacific oceans, particularly in the Atlantic (Kazachenko & Titar 1985, Hogans 1988, Boxshall 1998, Cherel & Boxshall 2004). Female *S. eristaliformis* is present in the diet of king penguins and white chinned petrels (Cherel & Boxshall 2004, Delord et al. 2010).

*Sarcotretes scopeli* (a parasitic copepod of fish) is distributed in subantarctic, subtropical and tropical waters, extending its distribution worldwide in the Atlantic, Indian and Pacific oceans, particularly in the north Atlantic and Pacific oceans (Boxshall 1989, Boxshall 1998, Cherel & Boxshall 2004). *S. scopeli* is present in the diet of king penguins (Cherel et al. 2002c, Cherel & Boxshall 2004). *S. scopeli* parasitizes myctophid fishes of the genus *Protomyctophum* (Cherel & Boxshall 2004).

## Practical procedures to differentiate the species within this family

Pennellids typically live with their cephalic holdfast embedded in their fish hosts: in *Phrixocephalus* the holdfast is complex with branching processes set at an angle to the trunk, whereas in *Sarcotretes* the holdfast lies on the same axis as the elongate trunk and comprises 2 or 3 simple processes. *Sarcotretes eristaliformis* (for females) body is up to approximately 45 mm or longer (about twice the length of *S. scopeli*), the neck is about as long as trunk and finally, a vestige of leg 4 (intercoxal sclerite) is present (Cherel & Boxshall 2004, Uyeno et al. 2012). *Sarcotretes scopeli* (for females) body is up to approximately 25 mm long, the neck is shorter than trunk and the leg 4 is absent (Cherel & Boxshall 2004, Uyeno et al. 2012). Other pennellid genera have been found, e.g. in scats of elephant seals (Geoff Boxshall, pers. comm.).

# FAMILY SPHYRIIDAE WILSON C.B., 1919

## Existing species that can be found is:

***Sphyrion lumpi* (Krøyer, 1845)** Figure 13 | page 145

*Sphyrion lumpi* (a parasitic copepod of fish) lives with its head and neck embedded in its host and is most likely to have been ingested with the host. It is widely distributed in the North and South Atlantic, and into the Antarctic (Ho 1992, Moran & Piasecki 1994, Ridoux 1994, Rohde et al. 1998, Walter et al. 2002). *S. lumpi* has been found in the diets of wandering albatrosses, northern giant petrels, great winged petrels and grey petrels (Ridoux & Offredo 1989, Cherel & Klages 1998).

## Practical procedures to differentiate the species within this family

Females of *Sphyrion* spp. reach large sizes (up to 60 mm) and their morphology is characteristic, precluding misidentification with the other genera of the family, such as *Lophoura*. The Genus *Sphyrion* is in need of revision.

# CLASS MALACOSTRACA

Latreille, 1802

# ORDER DECAPODA

Latreille, 1802

This order comprises mostly benthic species (e.g. crabs, lobsters, most shrimps) but also species (e.g. some shrimps) that occur in the water column and in symbiotic relationships (Basher & Costello 2014, Griffiths et al. 2014). Indeed, crabs and lobsters are very rarely found south of 60 °S and so far not in waters colder than 0 °C, which has been related to physiological constraints (Griffiths et al. 2014, Aronson et al. 2015a).

# FAMILY ACANTHEPHYRIDAE SPENCE BATE, 1888

## Existing species that can be found are:

***Acanthephyra pelagica* (Risso, 1816)** Figure 14 | page 147
***Notostomus auriculatus* Barnard, 1950** Figure 15 | page 147

*Acanthephyra pelagica* has a circumpolar distribution in the Southern Ocean (Basher & Costello 2014), and in warmer waters into the northern hemisphere close to the Arctic (Kirkwood 1984, Iwasaki & Nemoto 1987, Gorny 1999), being one of the various species of this family present in the Southern Ocean waters (Iwasaki & Nemoto 1987, Gorny 1999). However, these species are not common in food samples from top predators of the Southern Ocean (Klages et al. 1988, Arkhipkin et al. 2003), with *A. pelagica* present in the diet of fish (Clark 1985, Rosecchi et al. 1988, Arkhipkin et al. 2003, Laptikhovsky 2005, Forman et al. 2016). Total length up to 140 mm (Webber et al. 1990).

*Notostomus auriculatus* is distributed in subantarctic waters, extending its distribution to subtropical and tropical waters (including in northern hemisphere, off Canary Islands) (Iwasaki & Nemoto 1987, Gorny 1999). It was identified only as a rare prey in the diet of yellow-nosed albatrosses and pygmy sperm whales *Kogia breviceps* (Cherel et al. 2002d, Poore 2004) and in deep water fish (Forman et al. 2016). Total length up to 150 mm (Webber et al. 1990).

## Practical procedures to differentiate the species within this family

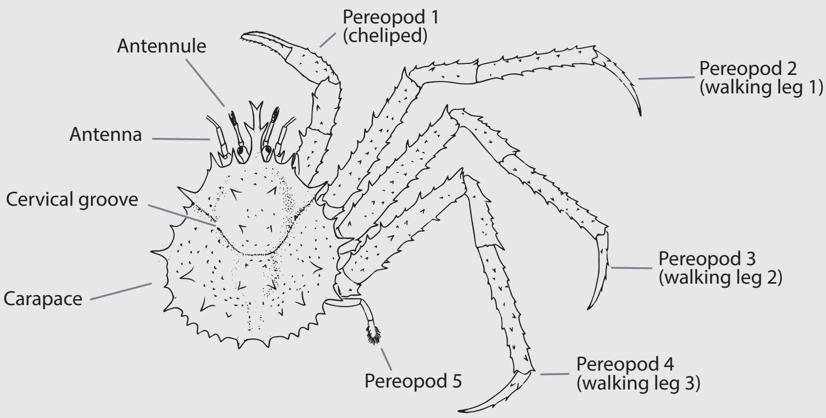



Figure 16 A. Diagram of the general structures in crab decapods (Ahyong 2010) with permission from NIWA.

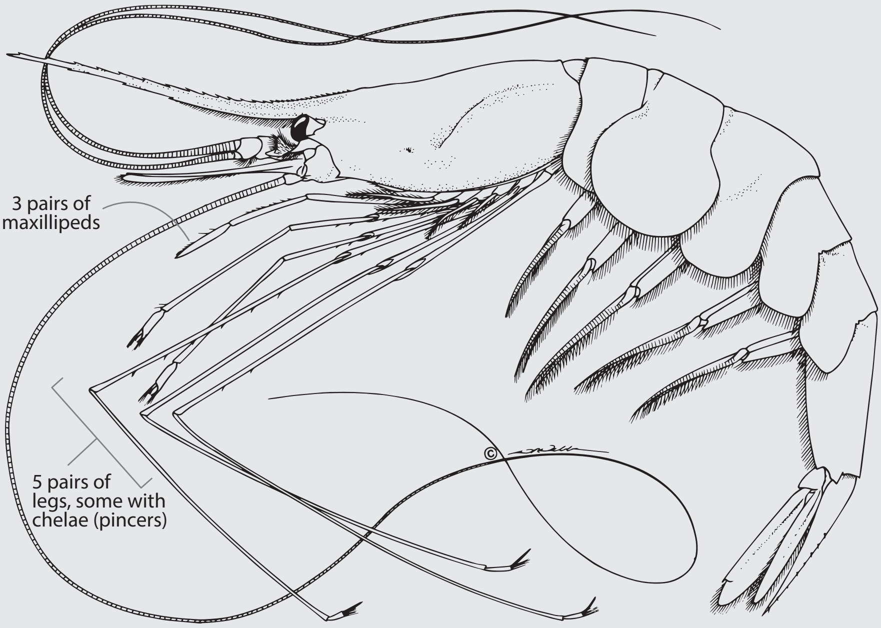



Figure 16 B. Diagram of the general structures in shrimp decapods (Webber et al. 1990) with permission from Fisheries New Zealand, Ministry for Primary Industries (formerly Ministry of Agriculture and Fisheries).

*Acanthephyra pelagica* has a long and slender rostrum, equal in length to its carapace, with 9 or 10 dorsal teeth being more widely separated distally (Kirkwood 1984). Also, their 3rd to 6th abdominal segments have posterior mid-dorsal spines and a telson with 6-11 pairs of lateral spines (Kirkwood 1984, Iwasaki & Nemoto 1987). The rostrum of *Notostomus auriculatus* reaches beyond the antennal scale and with the dorsal carina of carapace strongly arched and serrated (Iwasaki & Nemoto 1987). Other species of this family in the Southern Ocean include *Hymenodora gracilis* and *Hymenodora glacialis* (Basher & Costello 2014). The rostrum of both these species is short and sharp with about 4 short sharp dorsal spines (Kirkwood 1984). For detailed comparisons, see Basher et al. (2014), Basher and Castello (2014) and De Broyer et al. (2014).

# FAMILY CRANGONIDAE HAWORTH, 1825

## Existing species that can be found is:

***Notocrangon antarcticus*** **(Pfeffer, 1887)** Figure 17 | page 148
BL = 6.898 + 4.503 CL (n=122) (in mm) (Arntz & Gorny 1991a)

*Notocrangon antarcticus* has a circumpolar distribution; it is the only crangonid in Antarctic waters and can also be encountered in subantarctic waters, with reports from the South Atlantic (Tierra del Fuego shelf) (Kirkwood 1984, Arntz & Gorny 1991a, Basher et al. 2014, Basher & Costello 2014). A unique record of *N. antarcticus* was obtained north of the Subtropical Front in Pacific tropical waters (Basher & Costello 2014). *N. antarcticus* is present in the diet of fish, gentoo penguins, grey-headed albatrosses, white-chinned petrels and Weddell seals (Dearborn 1965, Targett 1981, Green & Burton 1987, Williams 1990, Kato et al. 1991, Williams 1991, Kock et al. 1994, Pakhomov & Pankratov 1995a, Croxall et al. 1997, Pakhomov 1998b, La Mesa et al. 2000, Lake et al. 2003, Xavier et al. 2003a, La Mesa et al. 2004b, Clarke et al. 2008, Main et al. 2009, Xavier et al. 2017, Xavier et al. 2018a).

## Practical procedures to differentiate the species within this family

*Notocrangon antarcticus* has a dorsoventrally compressed carapace which is characteristic, with surface very uneven, covered with ridges and mid-dorsal spines. Rostrum extends beyond anterior edge of eye, laterally compressed, acute and unarmed (Kirkwood 1984). The subchelate Pereopod 1, characteristic of crangonids, will help distinguish this species from other decapods. A very good re-description of *N. antarcticus* is available in Komai et al. (1996).

# FAMILY HIPPOLYTIDAE SPENCE BATE, 1888

## Existing species that can be found are:

***Chorismus antarcticus* (Pfeffer, 1887)** Figure 18 | page 149
BL = 8.436 + 4.739 CL (n=120) (in mm) (Arntz & Gorny 1991b)
BM = 0.000943 $CL^{2.976}$ (n=35) (Lake et al. 2003)

***Nauticaris marionis* Spence Bate, 1888** Figure 19 | page 149
BM = 0.0053 $BL^{3.54}$ (n=30) (0.3-2.2 cm) (Ridoux 1994)
BM = 0.001013 $CL^{3}$ (Kuun 1998)
CL = -1.0512 + 0.2814 BL (n=187) (2.11-4.81 mm) (Kuun et al. 1999)
LnBM = -6.3465 + 3.2870 ED (n=457) (0.08-0.22) (Kuun et al. 1999)

*Chorismus antarcticus* is circumpolarly distributed in Antarctic waters, mostly in inshore waters (most common in < 300 m deep (Zarenkov 1968, Kirkwood & Burton 1988) up to 20 m deep (Stefano Schiaparelli, unpubl. data) and can also be encountered in subantarctic waters (Falkland/Malvinas Islands and in Tierra del Fuego shelf) (Kirkwood 1984, Kirkwood & Burton 1988, Arntz & Gorny 1991a, Gorny 1999, Basher et al. 2014, Basher & Costello 2014), generally in shallower waters than *Notocrangon antarcticus* (Basher et al. 2014). *C. antarcticus* is present in the diet of fish, gentoo penguins, macaroni penguins, black bellied storm petrels and Weddell seals (Dearborn 1965, Green & Burton 1987, Williams 1990, Kato et al. 1991, Williams 1991, Kock et al. 1994, Green et al. 1995, Hahn 1998, Croxall et al. 1999, La Mesa et al. 2000, Lake et al. 2003, La Mesa et al. 2004a, La Mesa et al. 2004b, Xavier et al. 2018a).

*Nauticaris marionis* is distributed in subantarctic and subtropical waters, from southern New Zealand to the Prince Edward Islands, virtually restricted to the shelf regions (< 100 meters) but occurring up to 550 m deep between Cook Strait and Stewart island, New Zealand (Fenwick 1978, Perissinotto & McQuaid 1990, Branch et al. 1993, Pakhomov et al. 1999, Pakhomov et al. 2000, Poore 2004, de Cook, unpubl. data), reaching total lengths of up to 50-60 mm (Poore 2004) (de Cook, unpubl. data). *N. marionis* is present in the diet of fish, gentoo penguins, king penguins, macaroni penguins, rockhopper penguins, Crozet shags and subantarctic fur seals (Blankley 1982, LaCock et al. 1984, Clark 1985, Adams

& Klages 1987, Brown & Klages 1987, Espitalier-Noel et al. 1988, Ridoux 1994, Bushula et al. 2005, Tremblay et al. 2005, Cherel et al. 2007, Luque et al. 2007).

## Practical procedures to differentiate the species within this family

*Chorismus antarcticus* has a rostrum that is elongate and deep, as long as carapace, with 7-9 dorsal teeth and 6-9 ventral teeth. Carpus of Pereopod 2 with 11 articles (Kirkwood 1984). The carapace has a well-developed antennal spine, a rather small pterygostomian spine and no supraorbital spines (Komai et al. 1996). *Nauticaris marionis* has a rostrum shorter than the remaining carapace and with more than 8 dorsal teeth and 1 to 4 ventral teeth; eye small; Pereopod 1 short with a large stout chela; Pereopod 2 long with a long slender chela (Branch et al. 1991). The deep, blade-like, rostrum, with 6-11 dorsal teeth running back onto the carapace and 2-3 ventral teeth, is diagnostic (Poore 2004). The last (sixth) segment of the abdomen has a small, moveable, sharp plate posteriorly on each side, which is difficult to see without a microscope, but unique to *Nauticaris marionis* in the Hippolytidae (de Cook, unpubl. data). The shrimp is transparent in life with irregular diagonal bands of red on the carapace and transverse bands of red on the abdomen. The carapace and abdomen are also tinged with blue and the egg mass is blue-green (de Cook, unpubl. data). Carpus of Pereopod 2 with about 15 articles (Poore 2004). *N. marionis* should be compared with *Nauticaris magellanica* from the South Atlantic (Boschi et al. 1992). An additional note for the deepwater benthic species *Lebbeus antarcticus* (Hale, 1941) that has been found (in low numbers) in Weddell seal stomachs from the Antarctic peninsula (Ward 1985a) and recently Nye et al. (2013) have found it near the South Shetlands. Its description is well illustrated in both papers: *L. antarcticus* has a short, narrow rostrum with 5-6 dorsal and 1-2 ventral teeth (Ward 1985a, Nye et al. 2013); the carapace has supraorbital, antennal, and pterygostomian spines; carpus of Pereopod 2 with 6-9 articles (Nye et al. 2013).

# FAMILY HYMENOSOMATIDAE MACLAEY, 1838

## Existing species that can be found is:

***Halicarcinus planatus* (Fabricius, 1775)**

*Halicarcinus planatus* has a circumpolar distribution in subantarctic waters, in temperate and temperate - cold waters, including around New Zealand, Australian and South American waters (Lucas & Hodgkin 1970, Melrose 1975, Richer de Forges 1977, Gorny 1999, Pohle et al. 1999, Diez & Lovrich 2010), with carapace length reaching 19 mm (females; Auckland Is. and Campbell Is.) and 23.5 mm (males; Campbell Is.) (Garth 1958, Melrose 1975). Its distribution in Antarctic waters is still controversial (Thatje & Arntz 2004). Adults of *H. planatus* are present in the diet of fish, black-browed albatrosses, Kerguelen shags, brown skuas and kelp gulls, while zoeal larvae occur in food samples of thin-billed prions and common diving petrels (Richer de Forges 1977, Bocher et al. 2000a, Bocher et al. 2000b, Cherel et al. 2000, Cherel et al. 2002a, Bushula et al. 2005, Cook et al. 2013).

## Practical procedures to differentiate the species within this family

*Halicarcinus planatus* is a true crab; it is a small species with a round, smooth and convex carapace, a tri-dentate rostrum and lateral carapace wall with acute spine. For details on adults and on zoeal larvae, see Richer de Forges (1977). So far, *H. planatus* was found only in food samples from seabirds at Kerguelen Islands and from fish samples from Marion Island (see above), where it is the only Brachyura, thus allowing an easy identification.

# FAMILY LITHODIDAE SAMOUELLE, 1819

## Existing species that can be found are:

***Neolithodes yaldwyni*** Figure 20 | page 150
***Paralomis birsteini*** Figure 21 | page 150
***Paralomis stevensi*** Figure 22 | page 151

*Neolithodes yaldwyni* is a large king crab that is only found in the Antarctic Ocean, primarily in the Ross Sea but with records from the Amundsen Sea and the Antarctic Peninsula, with carapace length up to 183 mm (Ahyong 2010, Griffiths et al. 2014). It has not been found in Antarctic toothfish stomachs (Forman and Stevens, unpubl. data) but it is regularly caught during Antarctic toothfish surveys in the Ross Sea and is likely to be a prey item (Ahyong 2010).

*Paralomis birsteini* has a near circum-Antarctic distribution, with records from the Ross Sea in the vicinity of Scott and Balleny Islands, the Crozet and Kerguelen Islands, the Bellingshausen Sea and central Macquarie Ridge with carapace length of up to 89.9 mm (Ahyong 2010, Griffiths et al. 2014, Aronson et al. 2015a). This species has been reported from Antarctic toothfish stomachs (Stevens 2004).

*Paralomis stevensi* is only known from the Ross Sea with one record to date from the Amundsen Sea, with carapace length of up to 96.7 mm (Ahyong 2010). It was originally described from a specimen found in an Antarctic toothfish stomach (Ahyong 2010).

## Practical procedures to differentiate the species within this family

King crabs are typically distributed in deeper waters off continental shelf depths and they mostly inhabit the seamounts north of the Antarctic continent (with very few records from the Antarctic continental slope) (Thatje & Arntz 2004, Thatje et al. 2008, Aronson et al. 2015b). The three genera that may be encountered in the Southern Ocean are *Lithodes*, *Neolithodes* and *Paralomis*. They can be distinguished e.g. by the overall shape of the carapace, pear-shaped in *Lithodes* and *Neolithodes* and subpentagonal in *Paralomis*, the presence (*Lithodes* and *Neolithodes*) or absence (*Paralomis*) of a deep, longitudinal, medial fissure on the Sternite 5 (sternite between the first pair of walking legs) and the segmentation of abdominal somites, the second somite being composed of 3 plates or fused to a single plate in *Lithodes*, composed of 5 plates in *Neolithodes* and entire (undivided) in *Paralomis* (Ahyong 2010). Two other species of *Neolithodes* are found in the Southern Ocean, *N. capensis* (most likely just at Kerguelen Plateau; see above) and *N. diomedeae* (South America and South Georgia Island) but they both have to be considered rare. *Neolithodes yaldwyni* and *N. capensis* appear to be closely related with only slight differences between them. Ahyong (2010) differentiates them according to the proportion of the walking leg (Pereopods 2-4) propodi compared to the dactyli, the dactyli of *N. capensis* being half the propodus length in adult males versus ≥ 0.6 in *N. yaldwyni*. *Neolithodes diomedeae* has distinctly long cheliped fingers (twice as long as the palm), which are triangular in cross-section, they are shorter than the palm and rounded in cross-section in *N. yaldwyni*. The two species of *Paralomis*, *P. stevensi* and *P. birsteini*, appear to be closely related in size and morphology. They may also be distinguished by the proportion of the dactyli compared to the propodi of the walking legs (in *P. stevensi* the dactyli are shorter than the extensor, outside, margin of the propodi while in *P. birsteini* they are slightly longer), and the right cheliped of large males is more strongly inflated than the left in *P. stevensi* compared to *P. birsteini*. However, distinguishing features overlap considerably depending on size and sex so the reader is referred to the in-depth discussion provided by Ahyong (2010). Eleven other king crab species are found around the subantarctic islands, ridges, New Zealand and South American continental shelves but nearly all of the records remain north of the Polar Front (Griffiths et al. 2014). These belong to the genera *Paralomis*, *Neolithodes* and *Lithodes* that occur around the Antarctic Peninsula, South Georgia, the Scotia Arc and Bellingshausen Sea (Thatje & Arntz 2004, García Raso et al. 2005) and Kerguelen Islands (Macpherson 2004). Repeated exploratory fisheries for two species of *Paralomis* (*P. spinosissima* and *P. formosa*) around South Georgia since the early 1990s were largely unsuccessful (Belchier et al. 2012). The Bellingshausen Sea record for *Neolithodes capensis* is most likely referable to *N. yaldwyni* (Ahyong & Dawson 2006), other records remain as single sightings (for *L. murrayi* and *P. elongata*) and no records of occurrences in predator stomachs are provided. However, recent findings of movement of crabs into higher-latitude areas following warmer water incursions might result in a higher number of species in the Southern Ocean than at present (Smith et al. 2012).

# FAMILY MUNIDIDAE AHYONG, BABA, MACPHERSON & POORE, 2010

## Existing species that can be found is:

***Munida gregaria* (Fabricius, 1793)** Figure 23 | page 152
LogBM = -3.052 + 2.911 LogCL (n=47) (Tapella & Lovrich 2006)

The squat lobster *Munida gregaria* (= *M. subrugosa* Dana, 1852) (Tapella & Lovrich 2006, Vinuesa 2007, Pérez-Barros et al. 2008) is distributed in subantarctic and subtropical waters, in shallow waters (< 200 meters deep) in New Zealand, off Tasmania, southern South America, in southwestern Pacific (south Chile), south Atlantic (Patagonian shelf, including in Falkland/Malvinas waters, Argentina and Uruguay) (Henderson & Britain 1888, Matthews 1932, Zeldis 1985, Gorny 1999, Tapella & Lovrich 2006). The carapace length of 'pelagic' morph is 20.74 ± 0.91 mm (mean ± SD; n = 17) and 'benthic' form is 19.92 ± 1.74 mm (n = 18) (Zeldis 1983). It can produce high-density pelagic swarms (off Otago, New Zealand and off the southern tip of South America) that can be 0.1-5 km long and with an average density of 2700 individuals $m^{-3}$ and (Zeldis & Jillett 1982), once settled, can have high benthic densities (up to 30 individuals $m^{-2}$) (Zeldis 1985). *M. gregaria* occurs in the diet of squid, fish, yellow-eyed penguins, gentoo penguins, rockhopper penguins, magellanic penguins, Buller's albatrosses, royal albatrosses, wandering albatrosses, grey-headed albatrosses, and sooty shearwaters, thin billed prions and south American sea lions (Clark 1985, West & Imber 1986, McClatchie et al. 1989, Moore & Wakelin 1997, Alonso et al. 2000, Cruz et al. 2001, Pütz et al. 2001, Clausen & Pütz 2003, Xavier et al. 2003a, Xavier et al. 2003b, Nyegaard et al. 2004, Quillfeldt et al. 2010, Rosas-Luis et al. 2014), being the most important crustacean prey in gentoo penguins, rockhopper penguins, magellanic penguins and sooty shearwaters.

## Practical procedures to differentiate the species within this family

*Munida gregaria* is a squat lobster belonging to the Anomura. It has a long and slender rostrum, laterally compressed, with a well-developed supra-orbital spine on either side of its base. Second abdominal segment with 2 pairs of very short, sharp dorsal spines on anterior ridge, the inner pair stronger, the outer pair or both pairs sometimes obsolete to reduced to blunt tubercles, the third and fourth abdominal segments bear a median pair of spines each (Hendrickx 2003, Baba 2005). The carapace is almost rectangular in dorsal view and the eyestalks are elongated and the Maxilliped 3 endopod foliaceous in the pelagic 'subrugosa' form while short and non-foliaceous in the benthic form (Retamal 1981, Kirkwood 1984).

# FAMILY NEMATOCARCINIDAE SMITH, 1884

## Existing species that can be found are:

***Nematocarcinus lanceopes* Spence Bate, 1888** Figure 24 | page 153
***Nematocarcinus longirostris* Spence Bate, 1888**

*Nematocarcinus lanceopes* has an Antarctic circumpolar distribution, being also present in subantarctic, in southern Pacific Ocean waters (close to Chile shelf), southern Indian Ocean waters (Crozet and Kerguelen Islands), southern Atlantic Ocean and off South Africa (Basher & Costello 2014). They have been recorded in the diets of Antarctic toothfish from the Ross Sea (Stevens, unpubl. data).

*Nematocarcinus longirostris* has an Antarctic circumpolar distribution, being also present in subantarctic, subtropical and tropical waters, and in the South Pacific waters (close to Chile shelf), South Indian Ocean (Crozet and Kerguelen Islands), and the South Atlantic (off South Africa) (Kirkwood 1984, Gorny 1999, Basher & Costello 2014). *N. longirostris* occurs in the diet of macaroni penguins and white-chinned petrels (Brown & Klages 1987, Cooper et al. 1992). As *N. longirostris* are deep-water epibenthic species, and only bathypelagic during reproduction, the occurrence of this species in petrels could be secondary ingestion (see introduction).

## Practical procedures to differentiate the species within this family

The nematocarcinid shrimp are large epibenthic shrimp. *N. lanceopes* has a long and slender rostrum, similar or just longer than the carapace length. The rostrum has between 25-35 dorsal spines (mean = 29 spines), 4-10 ventral spines (mean = 5.6 spines), and a maximum carapace length of 34.5 mm (n=35 Ross Sea specimens [Forman, unpubl. data]). The rostrum can either be curved or straight. The number of post-orbital dorsal spines ranges from 3-6 (Macpherson 1984, Tiefenbacher 1990, Komai et al. 1996). *N. longirostris* has a long and slender rostrum, approximately one and a half times the carapace length. The rostrum has at least 38 dorsal spines (grading from minute closely packed, articulated spines at the proximal end), and 5-7 ventral spines (Kirkwood 1984). The number of post orbital dorsal spines range from 8-9 (Macpherson 1984, Tiefenbacher 1990, Komai et al. 1996). Because the rostrum is often broken the number of postorbital spines is a useful diagnostic feature. *Nematocarcinus* spp. could be confused with *Acanthephyra* spp. as they are similar in size and colour. However, the rostrum on *Acanthephyra* spp. have fixed teeth that tend to be spaced evenly and further apart compared to Nematocarcinidae which have both fixed teeth and articulating spines. The legs on *Nematocarcinus* spp. are also characteristically longer and thinner Figure 24 | page 153.

# FAMILY NEPHROPIDAE DANA, 1852

## Existing species that can be found is:

***Thymops birsteini*** **(Zarenkov & Semenov, 1972)**

*Thymops birsteini* is distributed in Antarctic (occurring at South Georgia) and subantarctic waters, in the south Atlantic (Patagonian shelf; up to Argentina and Uruguay region) and southwestern Pacific (one position in south Chile, Beagle Channel, with larvae/juveniles in deeper troughs) waters (Gorny 1999, Thatje et al. 2003, Laptikhovsky & Reyes 2009, Griffiths et al. 2014). *T. birsteini* is present in the diet of fish (Pilling et al. 2001, Arkhipkin et al. 2003, Brickle et al. 2003, Laptikhovsky 2005, Roberts et al. 2011).

## Practical procedures to differentiate the species within this family

*Thymops birsteini* resembles a typical lobster with 2 large claws, 4 pairs of walking legs and a long pleon (tail). It has parabranchial grooves and a different arrangement of the branchiocardiac and sellar grooves, the abdominal pleura are broadly overlapping and poorly developed exopods of the second and third maxillipeds. It also possesses spines on the lateral margin of the telson and in the uropodal exopods, and 3 spines on the posterior margin of the sixth abdominal somite (Zarenkov & Semenov 1972). The exopods are present, although somewhat reduced in size (Zarenkov & Semenov 1972).

# FAMILY PASIPHAEIDAE DANA, 1852

## Existing species that can be found are:

***Pasiphaea acutifrons* Spence Bate, 1888**
***Pasiphaea scotiae* (Stebbing, 1914)** Figure 25 | page 153

BL/TL = 2.63 (n=2) (8.0-8.7 cm) (Ridoux 1994)
BL/ED = 4.18 (n=2) (8.0-8.7 cm) (Ridoux 1994)
$BM/BL^3$ = 0.007 (n=2) (4.0-4.1 cm) (Ridoux 1994)

*Pasiphaea acutifrons* is distributed in subantarctic waters and in more northern waters, being found off southern South America, in the Pacific coast (off Peru and Chile), off Japan and in the Atlantic coast (Argentina and off Falkland/Malvinas Islands) (Iwasaki & Nemoto 1987, Gorny 1999). *P. acutifrons* is present in the diet of fish (Laptikhovsky 2005, Vidal et al. 2011).

*Pasiphaea scotiae* (also previously identified as *P. longispina* Lenz & Strunk, 1914) (Clarke & Holmes 1987, Iwasaki & Nemoto 1987) is a common and widespread species in the midwater and deep-sea Antarctic waters (Kirkwood 1984, Clarke & Holmes 1987, Arntz & Gorny 1991a, Gorny 1999, Basher & Costello 2014), including in abyssal depths (Basher et al. 2014), but can occur at the surface (Ainley et al. 1986). *P. scotiae* is generally distributed further south than *P. acutifrons* (Iwasaki & Nemoto 1987, Gorny 1999). *P. scotiae* is the commonest 'Natantia' prey of seabirds in the Southern Ocean, being present in the diet of wandering albatrosses, grey-headed albatrosses, black-browed albatrosses, sooty albatrosses, light-mantled sooty albatrosses, white-chinned petrels, blue petrels, Kerguelen petrels, Antarctic petrels, great winged petrels, snow petrels, soft-plumaged petrels, grey petrels, Antarctic prions and thin billed prions (Klages et al. 1990, Cooper et al. 1992, Ridoux 1994, Lorentsen et al. 1998, Catard et al. 2000, Cherel et al. 2000, Cherel et al. 2002a, Cherel et al. 2002b, Cherel et al. 2002d, Xavier et al. 2003a, Xavier et al. 2003b, Xavier et al. 2004, Connan et al. 2007a, Connan et al. 2007b, Delord et al. 2010, Richoux et al. 2010, Fijn et al. 2012, Connan et al. 2014).

## Practical procedures to differentiate the species within this family

*Pasiphaea scotiae* has a number of distinctive characters, notably the strikingly long, pointed and upturned rostrum tip (Clarke & Holmes 1987) which extends beyond the anterior edge of the eye (Kirkwood 1984). *P. scotiae* is often found in bad condition in food samples and identification then relies on a combination of loose remains including stalked eyes, anterior parts of the cephalothorax and (often broken) rostrum. But successful identifications can often be made using the cutting edge of all chelae which is pectinate, telson bifurcate with 7 or 8 spines and, importantly, the diagnostic merus of Pereopod 2 armed with 6 or 7 strong spines. In *P. acutifrons*, the rostrum overreaches the frontal margin of carapace but generally does not reach the posterior margin of the cornea in most cases (Iwasaki & Nemoto 1987); the rostrum of the largest specimen in Iwasaki and Nemoto (1987) (carapace length of 295 mm) overreaches the posterior margin of the cornea. Merus of second pereopod armoured with 10-19 spines.

# ORDER EUPHAUSIACEA

Dana, 1852

Within this order, the family Euphausiidae has more species (all pelagic) than any other family, being morphologically similar to Mysida. It contains *Euphausia superba*, which plays a key role in Antarctic food webs (Knox 2007). If not stated otherwise, all length measurements are given in mm.

» FAMILY EUPHAUSIACEA DANA, 1852

# FAMILY EUPHAUSIIDAE DANA, 1852

## Existing species that can be found are:

***Euphausia crystallorophias* Holt & Tattersall, 1906** Figure 26 | page 155
BL = 1.512 * CL + 13.28 (Puddicombe & Johnstone 1988)
All: BMs = 0.0017 * $S1^{3.373}$, size range 17-37 mm, number of krill measured n=150 (Siegel 1993)

**Males:** BMs = 0.0113 * $S1^{2.79}$ (n=118) (Rakusa-Suszczewski & Stepnik 1980)
**Females:** BMs = 0.0055 * $S1^{3.04}$ (n=118) (Rakusa-Suszczewski & Stepnik 1980)

***Euphausia frigida* Hansen, 1911** Figure 27 | page 155
BMs = 0.040 * $S1^{2.339}$ (8-23 mm, n=80) (Siegel 1993)

***Euphausia superba* Dana, 1850** Figure 28 | page 156, Tables 1, 2 and 3 | page 206, 207 and 208

The BIOMASS Handbook presented a variety of alternative length measurements for Antarctic krill (Mauchline 1980). For practical reasons the Antarctic krill science community has limited itself to two methods, the "standard 1 measurement" (S1) and the "Discovery measurement" (AT); for their definitions see abbreviations section. In some older literature related to *E. superba* we also find the reference to BL measurements from the tip of the rostrum to the tip of the telson. The 'Discovery' method (AT) was not mentioned in Mauchline's handbook, but is one of the most widely used measurements for total length of Antarctic krill. It was applied since the "Discovery Investigations" and is currently used by many research institutions. The question of length measurements was reviewed by CCAMLR to establish standard methods for the scientific observer programme on commercial krill vessels. The current Scientific Observers Manual of CCAMLR requires measurements according to the 'Discovery' standard of total length (AT) to the nearest millimeter below. This was thought to be most appropriate to be undertaken at sea on commercial vessels (Siegel 2016).

**For all stages**

AT = 0.133 + 1.030 S1 (n=151) (Siegel 1982)
AT = 0.971 + 1.001 S1 (Miller 1983)
S1 = 0.024 + 0.967 AT (n=151) (Siegel 1982)
S1 = 2.322 + 2.843 CL (Miller 1983)
S1 = 8.192 + 5.233 UL (Miller 1983)
BL = 3.466 + 2.763 CL (n=1599) (18-58 mm) (Ichii & Kato 1991)
BL = 2.861 + 6.948 UL (n=606) (19-57 mm) (Ichii & Kato 1991)
BL = 1.378 + 6.626 UL (n=101) (Nicol 1993)

A detailed study on the reliability of linear functions related to uropod length was carried out (Marschoff et al. 2008), because this parameter is usually used during growth rate (IGR) or stomach analysis studies. The authors modeled the relationship between uropod length and various estimates of krill length to understand whether any biases could impact the estimates of growth rate in krill. They showed that there was considerable variability in some measures of length, with some relationships performing better than others. This suggests that accounting for variability between body length measurements needs to be considered when examining growth rate using the IGR technique. It also suggests that a linear equation does not capture the relation between total and uropod length.

S1 = 6.77419 * $UL^{1.0387}$ from stomach samples (Marschoff et al. 2008) **or**
S1 = 7.17847 * $UL^{0.99209}$ from net samples (Marschoff et al. 2008)
BL = 11.56 + 2.44 RCL (n=269) (28-63 mm) (Hill 1990)
BL = 22.7 + 1.29 RCL (n=209) (20-45 mm) (Reid & Measures 1998)
BL = 10.43+2.26 RCL (n=154) (Goebel et al. 2007)
$BM/BL^3$ = 0.0074 (n=4) (0.32-0.46 cm) (Ridoux 1994)
BL = 1.93 ED + 0.60 (n=10) (3.3-5.0 cm) (Ridoux 1994)
ED = $0.574e^{0.0292BL}$ (Sun & Wang 1996)
ED = 0.2395 + 0.1573 CL (Shin & Nicol 2002) (based on experiments; see Shin & Nicol 2002)

ED = 0.3781 + 0.1218CL (Shin & Nicol 2002)
ED = 0.3403 + 0.1321CL (Shin & Nicol 2002)

**For Juveniles**

BL = -1.59 + 3.28RCL (n=50) (28-48 mm) (Hill 1990)

**For Males**

BL = 13.9 + 2.29 RCL (n=350) (38-57 mm) (Reid & Measures 1998)
BL = 0.62 + 3.13 RCL (n=541) (25-57 mm) (Goebel et al. 2007)
S3 = 6.753 + 2.131 CL (n=120) (Färber-Lorda 1990)
S3 = 1.869 + 2.748 CL (n=60) (older males?) (Färber-Lorda 1990)
S1 = 3.759 + 2.813 CL (fresh males n=236) (Miller 1983)
S1 = 2.823 + 2.770 CL (preserved males) (Miller 1983)
CL = 1.657 + 0.263 AT (males n = 539) (Siegel 1982)

**For Females**

BL = 15.3 + 2.09 RCL (n=292) (36-63 mm) (Reid & Measures 1998)
BL = 11.6 + 2.13 RCL (n= 436) (28-58 mm) (Goebel et al. 2007)
S3 = 9.139 + 1.836 CL (n=112) (Färber-Lorda 1990)
S1 = 6.901 + 2.490 CL (females n=264) (Miller 1983)
CL = -1.592 + 0.367 AT (females n=293) (Siegel 1982)

In sexually mature animals, the relationship of standard length (S1) to carapace length (CL) is significantly different for males and females. For females, it can be concluded that a swelling of the cephalothorax due to a ripening of the ovaries would account for the observed increase of the carapace length in gravid specimens. For males, the observed differences in the regression functions might be explained by a difference in the rate of carapace growth of mature animals opposed to more immature specimens. It was quite obvious from the data that a linear regression function for males does not properly fit the smaller length groups. In addition, larger size groups of males show a far greater variation of data within each length class. Consequently, the use of carapace length as an index of standard length must be viewed with great reservation (Mauchline 1980, Siegel 1982). Using a different type of total length *versus* carapace length, it was also found a significant difference between males and females, suggesting that mature males have slower carapace growth than females (Färber-Lorda 1990). Furthermore, he found evidence that males might reduce carapace length growth relative to total length with increasing age and therefore presented two different equations for males (see above). His results confirm that carapace length is not a reliable size measurement.

Numerous length-weight relationships have been provided for *E. superba* in the published literature and have been (at least, partly) summarized (Siegel 1993, 2016). To facilitate the use of the different relationships, the regression parameters are listed in Tables 1, 2 and 3. Some data were published as the linearized logarithmic version of the regression function; these results have been re-calculated to facilitate direct comparison with other published coefficient values.

***Euphausia triacantha* Holt & Tattersall, 1906** Figure 29 | page 156

BMs = 0.0383 * $S1^{2.495}$, size range 13-38 mm, number krill measured n=115 (Siegel 1993)

BMs = 0.007 * $AT^{2.9891}$, size range 20-35 mm in south-west Atlantic sector of Southern Ocean (Liszka, unpubl. data)

BMdw = 0.0007 * $AT^{3.2243}$, size range 20-35 mm in south-west Atlantic sector of Southern Ocean n = 69 (Liszka, unpubl. data)

***Euphausia vallentini* Stebbing, 1900** Figure 30 | page 157

BL = 6.6295 + 2.6048 CL (in mm) (Graham Hosie & Mareli Stolp pers. comm.) (Green et al. 1998b)

BL = 1.74 ED + 0.07 (n=151) (0.8-2.7 cm) (Ridoux 1994)

BMs = 0.00884 $BL^{2.904}$ (in mm) (Graham Hosie & Mareli Stolp pers. comm.) (Green et al. 1998b)

BM = 0.00316 $BL^{3.8}$ (n=25) (0.01-0.11 cm) (Ridoux 1994)

$Log_{10}BM_{dw}$ = -4.007 + (3.754 * $Log_{10}$BL), samples from south-west Atlantic including immature, female and male specimens. Specimens ranged from 12 to 21 mm BL (Tarling 1995)

***Nematoscelis megalops* G. O. Sars, 1883** Figure 31 | page 157
***Stylocheiron abbreviatum* G. O. Sars, 1883** Figure 32 | page 158
BL = 1.42 ED - 0.50 (n=13) (1.5-2.2 cm) (Ridoux 1994)

***Thysanoessa gregaria* G. O. Sars, 1883** Figure 33 | page 158
$Log_{10}BM_{dw}$ = -4.294 + (4.089 * $Log_{10}$BL), samples from south-west Atlantic including immature, female and male specimens. Specimens ranged from 8 to 18 mm BL (Tarling 1995)

***Thysanoessa macrura* G. O. Sars, 1883** Figure 34 | page 159
ED = 0.4361 $S3^{0.5411}$ (n=41) (Färber-Lorda & Mayzaud 2010)
S3 = 4.221 $CL^{0.812}$ (all, n=249),
S3 = 5.602 + 2.060 CL (males, n= 33)
S3 = 4.607 + 2.132 CL (females, n=41), there are significant differences in carapace length versus standard S3 length between juvenile and older stages and between males and females, with a greater carapace length increase relative to standard S3 length in adult specimens (Färber-Lorda 1990).
BMs = 0.00482 * $S1^{3.063}$, size range 11-28 mm, number of krill measured n=68 (Rakusa-Suszczewski & Stepnik 1980)
BMs = 0.00157 * $S3^{3.721}$ (n=106), data from February (Färber-Lorda 1994)
BMs = 0.002098 * $S3^{3.6446}$ (n=60), data from February (Färber-Lorda & Mayzaud 2010)

***Thysanoessa vicina* Hansen, 1911**
BL = 1.56 ED - 0.42 (n=15) (0.5-2.1 cm) (Ridoux 1994)
BM = 0.00251 $BL^{4.4}$ (n=10) (0.01-0.05 cm) (Ridoux 1994)

*Euphausia crystallorophias* has a circumpolar distribution in neritic Antarctic waters, around the Antarctic continent (John 1936, Fischer & Hureau 1985, Cuzin-Roudy et al. 2014). It is present in the diet of many neritic predators, including fish (being particularly important in the diet of the dusky rockcod *Trematomus newnesi*, Adélie penguins, chinstrap penguins, emperor penguins, Antarctic fulmars, snow petrels, cape pigeons, Wilson's storm petrels, Weddell seals, crabeater seals, southern elephant seals and minke whales (Marr 1962, Nemoto 1962, Nemoto 1970, Tarverdiyeva & Pinskaya 1980, Volkman et al. 1980, Jażdżewski 1981, Targett 1981, Linkowski et al. 1983, Takahashi & Nemoto 1984, Hubold 1985, Williams 1985, Plötz 1986, Foster et al. 1987, Puddicombe & Johnstone 1988, Montgomery et al. 1989, Ridoux & Offredo 1989, Hubold & Ekau 1990, Foster & Montgomery 1993, Ridoux 1994, Robertson et al. 1994, Watanuki et al. 1994, Pakhomov & Pankratov 1995b, Vacchi & La Mesa 1995, Cherel & Kooyman 1998, Ichii et al. 1998, Kent et al. 1998, Pakhomov 1998a, Pakhomov 1998b, La Mesa et al. 2000, Van Franeker et al. 2001, Burton & van den Hoff 2002, Clarke et al. 2002, Ainley et al. 2003, Hoff et al. 2003, La Mesa et al. 2004a, La Mesa et al. 2004b, Pusch et al. 2004, Knox 2007, Cherel 2008, Tamura & Konishi 2009, Tierney et al. 2009, Pinkerton et al. 2012, Delord et al. 2013, Pinkerton et al. 2013).

*Euphausia frigida* is mainly distributed in Antarctic waters, but can extend their distribution into subantarctic waters (up to the Subantarctic Front region) in much smaller numbers (John 1936, Fischer & Hureau 1985, Cuzin-Roudy et al. 2014). *E. frigida* is present in the diet of fish, Adélie penguins, gentoo penguins, macaroni penguins, Antarctic prions, Wilson's storm petrels and minke whales (Targett 1981, Croxall et al. 1988, North & Ward 1990, Kock et al. 1994, Vacchi et al. 1994, Watanuki et al. 1994, Pakhomov et al. 1996a, Croxall et al. 1997, Reid et al. 1997a, Croxall et al. 1999, Flores et al. 2004, La Mesa et al. 2004a, Pusch et al. 2004, Clarke et al. 2008, Collins et al. 2008, Main et al. 2009, Shreeve et al. 2009, Tamura & Konishi 2009, Waluda et al. 2012, Saunders et al. 2014, Xavier et al. 2017, Xavier et al. 2018a).

*Euphausia superba* has a circumpolar distribution in Antarctic waters, extending its distribution from the Antarctic continent to the Antarctic Polar Front (Siegel & Watkins 2016), being one of the most numerous species of macrozooplankton and a key element of the Antarctic marine food web (Marr 1962, Laws 1984 , Fischer & Hureau 1985, Everson 2000, Knox 2007). Being so abundant, it is present in the diet of a wide range of predators, including fish, squid, penguins, albatrosses, fulmars, petrels, prions, shags, skuas, seals and whales, being particularly important in the diet of, for example, the nototheniid fish *Notothenia neglecta*, the myctophid fish *Electrona antarctica*, the dragonfish *Cygnodraco* *mawsoni*, the icefish *Champsocephalus gunnari*, Adélie penguins, chinstrap penguins, emperor penguins, gentoo penguins, macaroni penguins, black-browed albatrosses, grey-headed albatrosses, light-mantled sooty albatrosses, Antarctic fulmars, white-chinned petrels, Kerguelen petrels, Antarctic petrels, snow petrels, blue petrels, white chinned petrels, cape pigeons, Antarctic prions, thin-billed prions, fairy prions, South Georgia diving petrels, Antarctic fur seals, crabeater seals and leopard seals, blue whales, fin whales, humpback whales, minke whales and Sei whales (Nemoto 1962, Solyanik 1965, Nemoto 1970, Laws 1977, Moreno & Osorio 1977, Øritsland 1977, Croxall & Furse 1980, Prince 1980, Tarverdiyeva & Pinskaya 1980, Volkman et al. 1980, Jażdżewski 1981, Targett 1981, Thomas 1982, Linkowski et al. 1983, Brown & Lockyer 1984, Croxall & Pilcher 1984, Mizroch et al. 1984, Laws 1984 , Goodall & Galeazzi 1985, Hubold 1985, Nemoto et al. 1985, Siniff & Stone 1985, Williams 1985, Offredo & Ridoux 1986, Croxall & Prince 1987, Kellermann 1987, Croxall et al. 1988, Nemoto et al. 1988, Puddicombe & Johnstone 1988, Klages 1989, Ridoux & Offredo 1989, Barrera-Oro & Casaux 1990, Hubold & Ekau 1990, Kellermann 1990, Klages et al. 1990, Prince & Copestake 1990, Williams 1990, Ichii & Kato 1991, Kato et al. 1991, Williams 1991, Rodhouse et al. 1992, Nicol 1993, Creet et al. 1994, Kock et al. 1994, Lu & Williams 1994, Ridoux 1994, Robertson et al. 1994, Watanuki et al. 1994, Pakhomov & Pankratov 1995b, Pütz 1995, Pakhomov & Perissinotto 1996, Reid & Arnould 1996, Croxall et al. 1997, Garcia de la Rosa et al. 1997, González et al. 1997, Reid et al. 1997a, Reid et al. 1997b, Casaux 1998, Cherel & Klages 1998, Cherel & Kooyman 1998, Favero et al. 1998, Ichii et al. 1998, Kent et al. 1998, Lorentsen et al. 1998, Pakhomov 1998a, Pakhomov 1998b, Croxall et al. 1999, Weimerskirch et al. 1999, Catard et al. 2000, Reinhardt et al. 2000, Cruz et al. 2001, Van Franeker et al. 2001, Barlow et al. 2002, Berón et al. 2002, Bocher et al. 2002, Cherel et al. 2002a, Cherel et al. 2002b, Cherel et al. 2002d, Clarke et al. 2002, Kock & Jones 2002, Quillfeldt 2002, Casaux et al. 2003, Libertelli et al. 2003, Xavier et al. 2003a, Xavier et al. 2003b, Collins et al. 2004, Flores et al. 2004, Hall-Aspland & Rogers 2004, La Mesa et al. 2004b, Lancraft et al. 2004, Lynnes et al. 2004, Pusch et al. 2004, Barrera-Oro & Piacentino 2007, Collins et al. 2007, Connan et al. 2007a, Connan et al. 2007b, Knox 2007, La Mesa et al. 2007, Casaux et al. 2008, Cherel 2008, Clarke et al. 2008, Collins et al. 2008, Connan et al. 2008, Main et al. 2009, Montalti et al. 2009, Shreeve et al. 2009, Tamura & Konishi 2009, Tierney et al. 2009, Delord et al. 2010, Richoux et al. 2010, Fijn et al. 2012, Pinkerton et al. 2012, Casaux & Barrera-Oro 2013, Delord et al. 2013, Pinkerton et al. 2013, Xavier et al. 2013, Cherel et al. 2014, Connan et al. 2014, Moreira et al. 2014, Saunders et al. 2014, Xavier et al. 2017, Dimitrijević et al. 2018, Xavier et al. 2018a).

*Euphausia triacantha* has a circumpolar distribution in Antarctic and subantarctic waters, distributed as far north as the Subantarctic Front (Baker 1959, Siegel 1987, Tarling 1995, Cuzin-Roudy et al. 2014) *E. triacantha* is not an important prey for predators. It is present in the diet of fish, squid, gentoo penguins, blue petrels, cape pigeons and Wilson's storm petrels (Williams 1983, Croxall et al. 1988, Williams 1990, 1991, Kock et al. 1994, Ridoux 1994, Pakhomov et al. 1996b, Cherel et al. 2002b, Cherel & Duhamel 2003, Pusch et al. 2004, Collins et al. 2007, Collins et al. 2008, Main et al. 2009, Shreeve et al. 2009, Pinkerton et al. 2013, Saunders et al. 2014, Xavier et al. 2017, Xavier et al. 2018a).

*Euphausia vallentini* has a circumpolar distribution in subantarctic waters, across the northern limit of the Antarctic Polar front (i.e. seldom found in Antarctic waters) and further north, such as the Patagonian shelf (Fischer & Hureau 1985, Tarling 1995, Gibbons et al. 1999) where it co-occurs with the smaller euphausiid species *E. lucens* and *Thysanoessa gregaria*. It is present in the diet of squid, fish, penguins, albatrosses, petrels, shearwaters, prions and whales but it is particularly important in the diet of, for example, the icefish *Champsocephalus gunnari*, gentoo penguins, macaroni penguins, rockhopper penguins, blue petrels, white chinned petrels, cape pigeons, short-tailed shearwaters, Antarctic prions, Wilson's storm petrels, black-bellied storm petrels, common diving petrels and South Georgian diving petrels (Nemoto 1962, Nemoto 1970, Laws 1977, Williams 1983, LaCock et al. 1984, Mizroch et al. 1984, Clark 1985, Croxall et al. 1985a, Duhamel & Hureau 1985, Horne 1985, Steele & Klages 1986, Brown & Klages 1987, Hindell 1988, Klages et al. 1989, Hindell 1989 , Cooper et al. 1992, Green & Wong 1992, Ridoux 1994, Bost et al. 1994 , González et al. 1997, Green et al. 1998b, Weimerskirch & Cherel 1998, Hull 1999, Weimerskirch et al. 1999, Bocher et al. 2000b, Cherel et al. 2000, Tremblay & Cherel 2000, Cruz et al. 2001, Mouat et al. 2001, Van Franeker et al. 2001, Bocher et al. 2002, Cherel et al. 2002a, Cherel et al. 2002b, Cherel et al. 2002d, Tremblay & Cherel 2003, Lescroël et al. 2004, Raya Rey & Schiavini 2005, Cherel et al. 2007, Connan et al. 2007a, Connan et al. 2007b, Knox 2007, Connan et al. 2008, Main et al. 2009, Connan et al. 2010, Quillfeldt et al. 2010, Delord et al. 2013, Cherel et al. 2014, Connan et al. 2014).

Two other *Euphausia* species, namely *E. longirostris* and *E. similis* were identified in the diet of gentoo penguins at Crozet islands, north of the Antarctic Polar Front (Ridoux 1994).

*Nematoscelis megalops* is distributed in subantarctic waters, at the Subantarctic Front region, being distributed northwards widely in both hemispheres (Cuzin-Roudy et al. 2014) and is present in the diet of squid, fish, gentoo penguins, rockhopper penguins, sooty albatrosses, cook petrels and short tailed shearwaters (Clark 1985, Montague et al. 1986, Young & Blaber 1986, Klages et al. 1988, Ivanovic & Brunetti 1994, Ridoux 1994, Imber 1996, Pakhomov et al. 1996b, Tremblay et al. 1997, Rojas et al. 1998, Weimerskirch & Cherel 1998, Williams et al. 2001, Brickle et al. 2003, Cherel et al. 2005, Connan et al. 2010, Delord et al. 2013, Temperoni et al. 2013).

*Stylocheiron abbreviatum* is distributed in subtropical and tropical waters (from 0-40 °S/N), being distributed widely in both hemispheres (Mauchline & Fisher 1969, Gibbons et al. 1999). *S. abbreviatum* is present in the diet of gentoo penguins, macaroni penguins and cape pigeons (Ridoux 1994).

*Thysanoessa gregaria* is distributed in subantarctic waters, subtropical waters and further north (Bary 1956, Pakhomov & Froneman 2000, Cuzin-Roudy et al. 2014), including the northern hemisphere (Lindley 1977, Gibbons et al. 1999, Taki 2011). *T. gregaria* is present in the diet of squid, fish, penguins and shearwaters, being particularly important in the diet of rockhopper penguins (Clark 1985, Croxall et al. 1985a, Horne 1985, Montague et al. 1986, Hindell 1988, Klages et al. 1988, Ivanovic & Brunetti 1994, Ridoux 1994, Pakhomov et al. 1996b, Tremblay et al. 1997, Freeman 1998, Weimerskirch & Cherel 1998, Cherel et al. 1999, Hull 1999, Tremblay & Cherel 1999, Cruz et al. 2001, Mouat et al. 2001, Tremblay & Cherel 2003, Schiavini & Raya Rey 2004, Raya Rey & Schiavini 2005, Connan et al. 2007b, Brickle et al. 2009, Connan et al. 2010, Stevens 2012b, Delord et al. 2013).

*Thysanoessa macrura* has a circumpolar distribution in Antarctic, subantarctic and subtropical waters, extending its distribution from the Antarctic continent shelves to the north of the Subantarctic Front (Haraldsson & Siegel 2014, Driscoll et al. 2015) . *T. macrura* is considered one of the most common, abundant and widespread species of euphausiids in the Southern Ocean (Cuzin-Roudy et al. 2014) and, despite the difficulties of differentiating *T. macrura* from *T. vicina* (see below) in numerous studies (Kock et al. 1994, Ridoux 1994, Reid et al. 1997b, Bocher et al. 2000a, Bocher et al. 2000b, Bocher et al. 2001, Cherel et al. 2002a, Cherel et al. 2002b, Tremblay & Cherel 2003, Lescroël et al. 2004, Cherel et al. 2007, Connan et al. 2007b, Connan et al. 2008, Cherel et al. 2014), *T. macrura* has been identified to species level as present in the diet of squid, fish, Adélie penguins, macaroni penguins, rockhopper penguins, gentoo penguins, blue petrels, Antarctic prions, Wilson's storm petrels and minke whales (Croxall & Furse 1980, Prince 1980, Tarverdiyeva & Pinskaya 1980, Linkowski et al. 1983, Williams 1983, Nemoto et al. 1985, Williams 1985, Croxall et al. 1988, Klages et al. 1989, Hubold & Ekau 1990, Prince & Copestake 1990, Williams 1990, 1991, Ridoux 1994, Pakhomov & Pankratov 1995a, Pakhomov et al. 1996a, Libertelli et al. 2003, Flores et al. 2004, Pusch et al. 2004, Tamura & Konishi 2009, La Mesa et al. 2011).

*Thysanoessa vicina* is distributed in Antarctic and subantarctic waters, in the Atlantic and Indian Oceans (Cuzin-Roudy et al. 2014) and is present in the diet of fish, macaroni penguins and rockhopper penguins (Brown & Klages 1987, Ridoux 1994, Pakhomov et al. 1996a). Most small unidentifiable specimens of *Thysanoessa* found in the diet of Kerguelen birds probably refer to that species (Bocher et al. 2000a, Bocher et al. 2000b, Cherel et al. 2002a, Cherel et al. 2002b, Connan et al. 2007b, Connan et al. 2008).

## Practical procedures to differentiate the species within this family

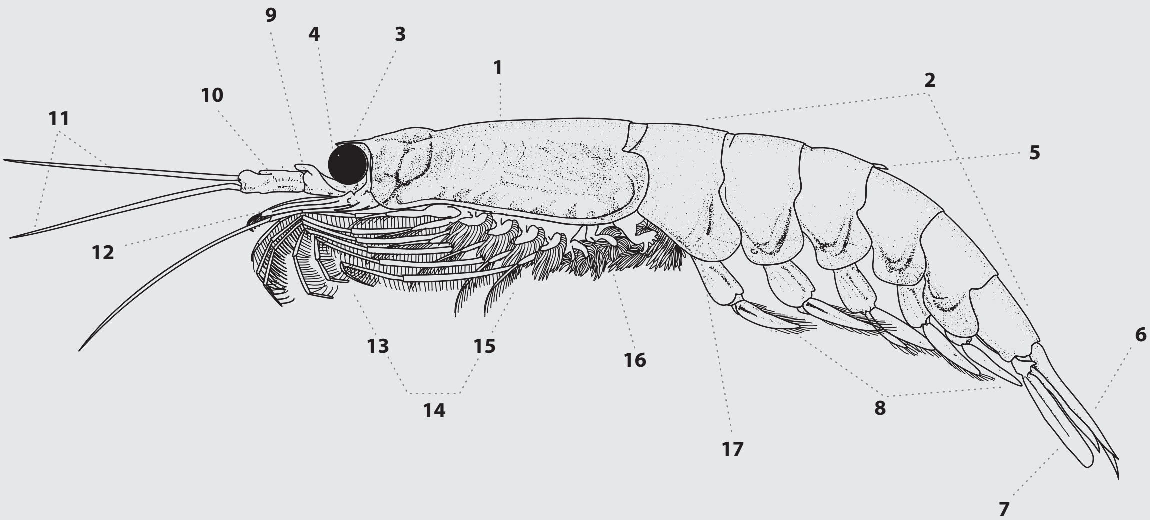



Figure 35 A. The general structures in euphausiids. Legend: 1. Carapace, 2. Abdomen, 3. Rostrum, 4. Compound eye, 5. Mid-dorsal Spine, 6. Telson, 7. Uropods, 8. Pleopods, 9. Antennule lappet, 10. Antennule, 11. Flagellae, 12. Antenna, 13. Endopods, 14. Pereiopods, 15. Exopods, 16. Gills, 17. Photophore. (modified from Siegel [2016]).

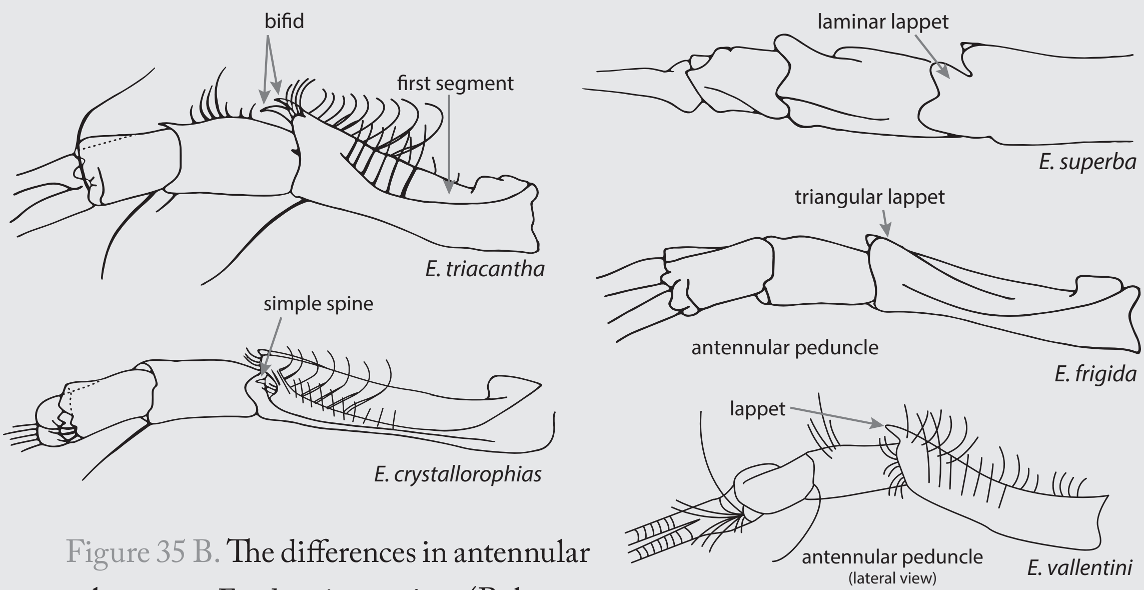



Figure 35 B. The differences in antennular lappets between *Euphausia* species. (Baker et al. 1990) (Copyright permissions from Springer, FAO and British Museum).

Euphausiids have first to be distinguished from Natantia (shrimps and prawns) and mysids. Indeed, mysids and euphausiids share a superficially similar shrimp like appearance and were at one time grouped together in the order Schizopoda. Morphological differences between adults of both groups have been summarized (Murano 1999). Even in much digested stomach contents two features are helpful: (i) gill shape and (ii) eye shape. Unlike Natantia, euphausiid gills are branched and feathery, being thus similar to those of the few mysids that have gills. Unlike Natantia and large mysids, the eyes of euphausiids have no large peduncles. Second, genus and species identification of digested euphausiids relies on a combination of various features, including antennular lappet morphology, rostrum size, eye shape, pereiopod size and setae, and number of abdominal spines, together with species biogeography. At the genus level (Baker et al. 1990), *Euphausia* species have always round eyes and pereiopods of almost equal lengths bearing well-developed setae, while *Thysanoessa* (and *Nematoscelis*) species of the Southern Ocean have bi-lobed eyes, a pair of long predatory legs and no well-developed setae on pereiopods. Note that *Thysanoessa* species are fragile euphausiids and, in most cases, loose predatory legs have to be searched for in food samples to confirm identification of the genus. The morphology of the tip of the predatory legs allows differentiating *Thysanoessa* from *Nematoscelis* species.

Among *Euphausia* species, *E. superba* is by far the largest one (up to 65 mm) (Baker et al. 1990). Hence, fully-grown adult *E. superba* present a unique combination of larger round eyes, larger pereopods with very well-developed setae and larger gills than any other euphausiids. Consequently, large specimens (> 40 mm total length) of that species can be identified with confidence from only a very few much-digested remains, even in the absence of the species-specific antennular lappets. In the analysis of many food samples (Cherel et al. 2002a, Cherel et al. 2002b), large eyes, pereopods and gills were always associated with loose antennular lappets if present, and never with distinctive remains of other crustacean species. Conversely, medium- and small-sized round eyes cannot be confidently identified as belonging to *E. superba*, but to *Euphausia* sp. (undetermined) only.

In high-Antarctic waters, two *Euphausia* species are very important in the diet of consumers, namely *E. crystallorophias* (up to 41.5 mm) (Kirkwood 1982, Siegel 1987) and *E. superba* (up to 65 mm) (Daly & Zimmerman 2004). Identification relies on antennular lappets and rostrum. *E. crystallorophias* rostrum is long and acute, reaching beyond the eyes; first antennular segment with a short sharp spine or denticle on its outer distal corner (Fischer & Hureau 1985); and antennular lappet absent (Baker et al. 1990, Gibbons et al. 1999). *E. superba* has a first segment of the antennular peduncle bearing a wide lappet that extends over one quarter to one half the length of the second segment and is nearly as wide as the base of the second segment (Kirkwood 1984, Fischer & Hureau 1985, Baker et al. 1990, Gibbons et al. 1999). Also the abdominal segments are without mid-dorsal spines (Fischer & Hureau 1985), with the sixth segment nearly as long as it is high. In numerous studies, maturity stages of *E. superba* have been identified following Makarov and Denys (1981).

*Euphausia frigida* (up to 24 mm) (Siegel 1987, Baker et al. 1990) has a short rostrum; Its first antennular segment has a very small, triangular lobe (antennular lappet), which is inconspicuous from lateral view and somewhat rounded (Fischer & Hureau 1985, Gibbons et al. 1999); the abdominal segments are without mid-dorsal spines and the sixth segment is almost twice as long as high in lateral view (Fischer & Hureau 1985). Early records of *Euphausia triacantha* reported a total length of up to 32 mm (Baker 1959) but it has been found a maximum size of 41.5 mm for the species in winter (Siegel 1987). *E. triacantha* is easily recognisable by 3 prominent abdominal dorsal spines on segments 3 to 5, and by the distinctive red colour of the anterior end of the cephalothorax of fresh specimens (Kirkwood 1982). It has a first segment of the antennular peduncle with a bifid lappet, with the inner process stouter and more curved outward than the outer (Fischer & Hureau 1985). Also, *E. triacantha* has a carapace without a post-ocular spine (Baker et al. 1990), and the posterior margin of the pleurae is entire (Gibbons et al. 1999). *Euphausia vallentini* (up to 28 mm) has a medium-sized rostrum, and a first segment of antennular peduncle with a large, round, broad, laminar lappet on its distal margin (Fischer & Hureau 1985, Baker et al. 1990, Gibbons et al. 1999). Also, the third abdominal segment has a short, thin, mid-dorsal spine which may be broken or absent occasionally (Fischer & Hureau 1985). In order to avoid misidentification with other euphausiid species (not as abundant in the diet of top predators), *Euphausia lucens* (up to 18 mm) it can be considered that this species has a very acute, small, dentate process on the first segment of the antennular penduncle which projects anteriorly over the proximal part of the second segment. The third segment has a strong dorsal keel. It does not possess a rostrum and there is a pair of lateral denticles on the carapace (Baker et al. 1990).

*Nematoscelis megalops* (up to 26 mm) (Baker et al. 1990) has a second thoracic (predatory) leg with terminal setae on both dactylus and propodus, and 3 segments beyond the knee of thoracic legs 3-6 (Gibbons et al. 1999).

*Stylocheiron abbreviatum* has dorsal keels on the fourth and fifth, or third, fourth and fifth abdominal segments (Baker et al. 1990). Also the terminal segment of the second thoracic leg has a sharply downward curved and overlapping setae on anterior margin (Baker et al. 1990).

*Thysanoessa* specimens are difficult to identify down to the species level in food samples, because they have similar morphologies and the pereiopods, which contain the most distinguishing features, are fragile and hence often missing. *Thysanoessa gregaria* has setae on their thoracic legs with small but clearly visible setulae (Baker et al. 1990, Gibbons et al. 1999). *Thysanoessa macrura* has an upper flagellum of antennule shorter than the sum of the lengths of 2$^{nd}$ and 3$^{rd}$ segments of peduncle (Fischer & Hureau 1985, Gibbons et al. 1999). *Thysanoessa vicina* has an upper flagellum of antennule somewhat, or considerably, longer than the sum of lengths of second and third segments of peduncle (Baker et al. 1990, Gibbons et al. 1999). *Thysanoessa macrura* and *T. vicina* are difficult to distinguish even when only slightly digested (Ward et al. 1990, Ichii & Kato 1991, Kock et al. 1994), and when caught in nets (in which specimens are also frequently damaged during sampling) the flagella of the antennules are frequently damaged or missing altogether [Baker et al. 1990]), both species are often pooled into a single *Thysanoessa* spp. category (Ward et al. 1990). However, for separating adults, *T. macrura* is a much larger species (with females reaching sometimes 31 mm) than *T. vicina* (grows to 20 mm at most) (Baker et al. 1990). Only recently, it has been observed that *T. macrura* from late autumn samples can grow much bigger up to 42 mm total length (Haraldsson & Siegel 2014).

# ORDER AMPHIPODA

Latreille, 1816

Amphipod crustaceans are well represented in all three macrohabitats of the Southern Ocean: benthic, pelagic and bentho-pelagic waters (e.g. Gammaridea, Hyperiidae) (De Broyer & Jażdżewska 2014). It is considered the second most speciose macrobenthic group, after Gastropoda, in Antarctic and subantarctic waters (Linse et al. 2006, De Broyer & Jażdżewska 2014). This order comprises species from far more than 20 families; the Antarctic and subantarctic amphipod fauna is mostly dominated by representatives from the Lysianassoidea, Eusiroidea, Stenothoidea, Ischyroceridae, Iphimediidae, Phoxocephalidae and Epimeriidae (De Broyer & Jażdżewska 2014). More than 170 Antarctic amphipod species are recorded as prey for top predators. The most diverse amongst them belong to the Lysianassoidea, Pontogeneiidae and Hyperiidae (Dauby et al. 2003).

# SUBORDER GAMMARIDAE

Latreille, 1802

# FAMILY AMATHILLOPSIDAE PIRLOT, 1934

## Existing species that can be found is:

***Parepimeria bidentata* Schellenberg, 1931** Figure 36 | page 161

*Parepimeria bidentata* is distributed in the Atlantic sector of the Southern Ocean (Weddell Sea, along Antarctic Peninsula, and South Shetland Islands), extending north up to around South Georgia (De Broyer et al. 2007), with total length ranging between 3.8-14.0 mm (Schellenberg 1931, Andres 1985). The species was found in the diet of fish (Wakabara et al. 1990).

## Practical procedures to differentiate the species within this family

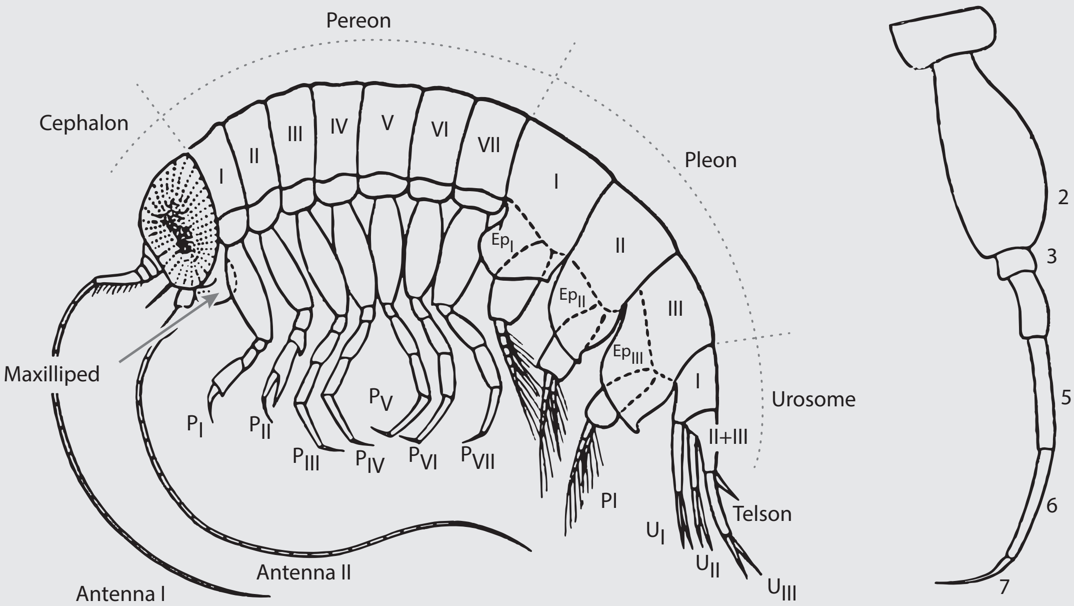



Figure 37 - left. The general structures of an amphipod, Figure 37 - right. with typical pereopod with articles numbered (Vinogradov 1999) (Copyright permission from Backhuys Publishers, Leiden, The Netherlands).

The family Amathillopsidae is represented in the Southern Ocean by two genera: *Amathillopsis* and *Parepimeria*. The latter genus can be recognized by having both pairs of simple gnathopods (Coleman 2007). Five species of *Parepimeria* are hitherto described from the Southern Ocean: *P. bidentata*, *P. crenulata*, *P. irregularis*, *P. major*, and *P. minor*. The list of literature and distribution information can be found in the literature (De Broyer et al. 2007). The morphological description is available (Schellenberg 1931) as well as the key for all known species of *Parepimeria* (Watling & Holman 1980). *P. bidentata* can be distinguished from its congeners by the combination of a long rostrum and the lack of mid-dorsal carina on pereon segments 5-7 (Watling & Holman 1980).

# FAMILY AMPELISCIDAE KRØYER, 1842

## Existing species that can be found is:

***Byblis securiger*** **(K.H. Barnard, 1931)** Figure 38 | page 161

*Byblis securiger* is distributed in the Atlantic sector of the Southern Ocean (along Antarctic Peninsula and South Shetland Islands), extending north up to around South Georgia (Loerz & Brandt 2003, De Broyer et al. 2007), with total length ranging between 9.5 and 37.0 mm (Barnard 1932). It is present in the diet of gentoo penguins (Williams 1990, Kato et al. 1991, Williams 1991, Xavier et al. 2017, Xavier et al. 2018a).

## Practical procedures to differentiate the species within this family

Four genera of Ampeliscidae (*Ampelisca*, *Byblis*, *Byblisoides*, and *Haploops*) were hitherto recored south of Subtropical Front. Amphipods belonging to the genus *Byblis* have well developed flagella on both antennae. The basis of pereopod 7 bears a ventrally expanding lobe (somewhat triangular) which is setose along its ventral as well as anterior edge (Barnard & Karaman 1991). Three species from genus *Byblis* are recorded in the Southern Ocean: *B. antarctica*, *B. securiger*, and *B. subantarctica*. The extensive list of literature and distribution information is available (De Broyer et al. 2007). Similarly, the detailed morphological description can also be found (Barnard 1932) where it is presented under its former genus name - *Haploops*. A key for World species identification is available (Barnard 1966). *B. securiger* is characterized by the rostrum reaching the middle of the first article of peduncle of antenna 1, which is much shorter in the other Antarctic representatives of this genus. Additionally, one pair of the corneal lenses is situated on the ventral side of the head. This feature separates this species from *B. antarctica* (lacking corneal lenses) but not from *B. subantarctica* (Barnard 1966).

# FAMILY CYPHOCARIDIDAE LOWRY & STODDART, 1997

## Existing species that can be found are:

***Cyphocaris anonyx* Boeck, 1871** Figure 39 | page 162
***Cyphocaris challengeri* Stebbing, 1888** Figure 40 | page 162
***Cyphocaris richardi* Chevreux, 1905 (Chevreux 1905a)** Figure 41 | page 163
$BM/BL^3 = 0.025$ (n=1) (0.32 cm) (Ridoux 1994)
$BL = 85.8\ TL_t^{0.063}$ ($r = 0.995$, $N = 90$, $p < 0.001$) (in cm) (Yamada & Ikeda 2000)

*Cyphocaris anonyx* is distributed in Antarctic waters, in the Pacific sector of the Southern Ocean (De Broyer et al. 2007), in subantarctic waters, subtropical waters and tropical waters off South Africa (Milne & Griffiths 2013) and in the north hemisphere (Gislason & Astthorsson 1992). *C. anonyx* is present in the diet of fish (Clark 1985).

*Cyphocaris challengeri* is distributed worldwide, including tropical waters off South Africa (Milne & Griffiths 2013) and in the north hemisphere (Yamada & Ikeda 2006). *C. challengeri* is present in the diet of great winged petrels (Ridoux 1994).

*Cyphocaris richardi* has a circumpolar distribution in Antarctic and subantarctic waters, being also found further north (De Broyer et al. 2007, Milne & Griffiths 2013). *C. richardi* is present in the diet of Adélie penguins, blue petrels, Kerguelen petrels and Antarctic prions (Volkman et al. 1980, Jażdżewski 1981, Ridoux 1994, Cherel et al. 2002a, Cherel et al. 2002b).

## Practical procedures to differentiate the species within this family

*Cyphocaris anonyx* is characterized by a sword-like tooth on the basis of pereopod 5, both margins of this tooth are deeply dentate. The tooth is relatively short and not longer than the ischium, merus and carpus of the pereopod 5 combined (Vinogradov 1999). The posterior margins of the pereopods 5-7 are dentate. *C. challengeri* has a sword-like tooth almost as long as articles 3-7 (ischium to dactyl) of pereopod 5 combined and a large fourth and fifth coxal plate, the former covering coxal plate 1-3 and the latter covering part of the sixth coxal plate (Vinogradov 1999). *Cyphocaris richardi* has the posterior margin of article 2 of pereopod 5 without sword-like tooth but with posterodistal serrate lobe (Vinogradov 1999). Both *C. richardi* (length to 56 mm) and *C. anonyx* (total length to 15 mm) are recognizable by their orange-red colour; most specimens of *C. richardi* present a narrow horn-like process anteriorly over the head (Vinogradov 1999). *C. faurei* K.H.Barnard, 1916, a fourth described species (total length to 30 mm) from the Southern Ocean (Andres 1983), which may also be found in predators' diets, has a less inflated process not covering the entire dorsal surface of the head, and similar to *C. challengeri*, a posterodistal sword-like tooth on the basis of pereopod 5, which is - apart from the tooth - completely smooth. The tooth is clearly shorter than the articles 3-7 (ischium to dactyl) of pereopod 5 combined and does not even reach the posterior margin of the fifth coxal plate. Alive specimens have a red-rose colour. Whilst in *C. anonyx*, the eyes are absent, in *C. richardi* they are small and oval, in *C. challengeri* large and reniform, and in *C. faurei* they are pear-like and broadened ventrally (Vinogradov 1999).

# FAMILY DEXAMINIDAE LEACH, 1814

## Existing species that can be found is:

***Polycheria kergueleni* (Stebbing, 1888)** Figure 42 | page 163

*Polycheria kergueleni* is distributed in subantarctic waters, around Kerguelen islands and total length can reach *ca* 5 mm (Stebbing 1888). It is commonly found in the diet of blue petrels, Antarctic prions and thin-billed prions from Kerguelen Islands (Cherel et al. 2002a, Cherel et al. 2002b, Connan et al. 2008).

## Practical procedures to differentiate the species within this family

The family Dexaminidae is represented by two genera in the Southern Ocean: *Paradexamine* and *Polycheria*. The representatives of the latter have all pereopods fully prehensile. There are eleven species in genus *Polycheria* reported from the Southern Ocean. The identification key can be found in the literature (Thurston 1974a), where they are treated as forms of *Polycheria antarctica sensu lato*. The detailed morphological description and drawings of *P. kergueleni* are available in the original description by Stebbing (1888) under its former genus name *Tritaeta*. The identification characters are: the coxa 1 (which is produced antero-ventrally), coxa 4 (having postero-ventral angle rounded but antero-ventral angle with strong tooth) and pereopods 3-4 (being stout with merus much longer than propodus) (Thurston 1974a).

# FAMILY EPIMERIIDAE BOECK, 1871

## Existing species that can be found are:

***Epimeria (Epimeriella) macronyx* (Walker, 1906)** Figure 43 | page 164
***Epimeria (Laevepimeria) walkeri (*K.H. Barnard, 1930)**

*Epimeria macronyx* (= *Epimeriella macronyx* [Lörz et al. 2009]) has a circum-Antarctic distribution extending as far north as the South Orkney Islands (De Broyer et al. 2007, Lörz et al. 2009), with the total length ranging between 14 and 28 mm (Coleman 2007). *E. macronyx* is present in the diet of fish, Adélie penguins and emperor penguins (Paulin 1975, Offredo & Ridoux 1986, Foster et al. 1987, Puddicombe & Johnstone 1988, Ridoux & Offredo 1989, Foster & Montgomery 1993, Watanuki et al. 1994, Cherel & Kooyman 1998).

*Epimeria walkeri* (= *Epimeriella walkeri* K. H. Barnard, 1930 [Lörz et al. 2009]) is distributed in Antarctic waters around continental Antarctica as well as around the Antarctic Peninsula and South Shetland Islands (De Broyer et al. 2007, Lörz et al. 2009), with its total length ranging between 11 and 29 mm (Coleman 2007). It is present in the diet of Adélie penguins (Puddicombe & Johnstone 1988).

## Practical procedures to differentiate the species within this family

*Epimeria* is one of four epimeriid genera recorded in the Southern Ocean. It has weakly subchelate gnathopods with a well-developed palm (the carpus is subequal in size to the propodus) and a 4-articulated palp of maxilliped (Coleman 2007). There are 27 species of *Epimeria* recorded from the Southern Ocean. The extensive list of literature and distribution information can be found in the literature (De Broyer et al. 2007) where both species are listed under the former genus name (*Epimeriella*). *E. macronyx* has been described and illustrated (Walker 1907, Coleman 2007). The description and drawings of *E. walkeri* are available (Barnard 1930, Barnard 1932, Coleman 2007). Both *E. macronyx* and *E. walkeri* have smooth dorsal side of pereonites and pleonites 1-2; the pleonite 3 has only a shallow keel. The species can be distinguished by the shape of the coxa 4, which is tapering and acute in the first species, while in the latter is truncate and ventrally rounded (Coleman 2007). An interactive key for World Epimeriidae can be found on the web (http://www.marinespecies.org/amphipoda/idkeys.php) (Horton et al. 2013). However, it is important to underline that recent investigations of the Antarctic *Epimeria* spp. based on both molecular and morphological characters doubled the actual number of *Epimeria* species by uncovering 25 new lineages (Verheye et al. 2016). A description of these new species supplemented by the key to the Antarctic and subantarctic Epimeriidae has recently been published (d'Udekem d'Acoz & Verheye 2017).

# FAMILY EURYTHENEIDAE STODDART & LOWRY, 2004

## Existing species that can be found are:

***Eurythenes gryllus* (Lichtenstein in Mandt, 1822) (probably E. *gryllus sensu stricto*)** Figure 44 | page 165
BM/BL$^3$ = 0.025 (n=1) (14.3 cm) (Ridoux 1994)

***Eurythenes obesus* (Chevreux, 1905)** Figure 45 | page 165
BM/BL$^3$ = 0.03 (n=3) (0.2-2.1 cm) (Ridoux 1994)

The complex of species *Eurythenes gryllus sensu lato* has a circumpolar distribution in the Southern Ocean, being also distributed across the World Oceans, except for the Red and the Mediterranean seas (Stoddart & Lowry 2004, De Broyer et al. 2007, Havermans et al. 2013, Milne & Griffiths 2013). However, recently it has been shown to consist of at least 15 different species-level lineages that can be recognized morphologically (Havermans 2016). So far, five of these have been (re)described (d'Udekem d'Acoz & Havermans 2015). Of these, four species have been found to co-occur throughout the Southern Ocean: i) *E. maldoror* d'Udekem d'Acoz & Havermans 2015, ii) *E. gryllus s.s.* (Lichtenstein in Mandt, 1822), iii) *E. gryllus sensu* d'Udekem d'Acoz & Havermans 2015, iv) *E. andhakarae* d'Udekem d'Acoz & Havermans 2015, and v) an undescribed species (d'Udekem d'Acoz & Havermans 2015). Specimens identified as *E. gryllus* have been found in the diet of a wide range of top predators, including fish, gentoo penguins, grey-headed albatrosses, black-browed albatrosses, sooty albatrosses, great winged petrels, blue petrels, white-chinned petrels, Kerguelen petrels, Antarctic prions, black bellied storm petrels and brown skuas (Croxall et al. 1988, Wakabara et al. 1990, Cooper et al. 1992, Ridoux 1994, Hahn 1998, Catard et al. 2000, Reinhardt et al. 2000, Cherel et al. 2002a, Cherel et al. 2002b, Xavier et al. 2003a, Pinkerton et al. 2012, Stevens et al. 2014, Xavier et al. 2017). However, in-depth molecular or morphological studies should reveal to which species these specimens found as prey belong. *Eurythenes* species in the Southern Ocean seem to be restricted geographically and bathymetrically. Species found from shallow waters to 3000 m depth are *E. gryllus s.s.* and *E.* sp. 1 whilst the other two species were so far only sampled at depths below 3000 m (Havermans 2016). Furthermore, *E. gryllus s.s.* seems to be the only species found around the subantarctic islands (e.g. Kerguelen), however, this cannot be certified without a more extensive sampling coverage. Hence, DNA barcodes and/or a detailed morphological examination will allow identifying these species.

*Eurythenes obesus* has a circumpolar distribution in Antarctic and subantarctic waters found at the surface to 1600 m depth, and can be distributed further north in deeper waters (Stoddart & Lowry 2004, De Broyer et al. 2007, Milne & Griffiths 2013). *E. obesus* is present in the diet of red cod (*Salilota australis*), light-mantled sooty albatrosses, grey-headed albatrosses, great winged petrels, soft-plumaged petrels, blue petrels, white-chinned petrels, Kerguelen petrels, Antarctic prions, thin billed prions and black-bellied storm petrels (Bellan-Santini & Ledoyer 1974, Ridoux 1994, Catard et al. 2000, Arkhipkin et al. 2001, Cherel et al. 2002a, Cherel et al. 2002b, Xavier et al. 2003a, Connan et al. 2014).

## Practical procedures to differentiate the species within this family

A key for identification of *Eurythenes* species can be found in the literature (d'Udekem d'Acoz & Havermans 2015). Species belonging to the complex *Eurythenes gryllus sensu lato* can reach much larger sizes than *E. obesus*, the latter has been found with a total length only to 80 mm, however, smaller species and juvenile specimens of the former can be found as well (e.g. *E. sigmiferus* [d'Udekem d'Acoz & Havermans 2015]). Hence, size is not a valid criterion to differentiate the two species, difficult to assess in food samples, mainly because they are often much digested and in pieces of various sizes. A key and easy feature however is the length of the dactyls in pereopods 3-7, which are extremely long in *E. obesus* (more than 0.6 of propodus) compared to all other *Eurythenes* species (less than 0.3 of propodus). Hence, as only one loose dactyl is sufficient for species identification, hence dactyls have to be carefully searched in the samples. Furthermore, the eye of *E. obesus* is narrowly linear in contrast with the broad and L-shaped eyes observed in the different species of the *E. gryllus* complex (d'Udekem d'Acoz & Havermans 2015). For further identification of *E. gryllus sensu lato* is available in d'Udekem d'Acoz & Havermans (2015).

# FAMILY EUSIRIDAE STEBBING, 1888

## Existing species that can be found are:

***Eusirus antarcticus* Thompson, 1880** Figure 46 | page 166
***Eusirus microps* Walker, 1906** Figure 47 | page 166
***Eusirus perdentatus* Chevreux, 1912** Figure 48 | page 167
***Eusirus propeperdentatus* Andres, 1979** Figure 49 | page 167

*Eusirus antarcticus* has a circumpolar distribution in Antarctic waters, extending to subantarctic waters (e.g. Patagonian shelf, off Argentina, Kerguelen Islands and New Zealand) (De Broyer et al. 2007), with total length ranging between 13 and 36 mm (Barnard 1930, Vinogradov 1999). *E. antarcticus* is present in the diet of fish, Adélie penguins, Antarctic prions and thin billed prions (Paulin 1975, Foster et al. 1987, Foster & Montgomery 1993, Vacchi & La Mesa 1995, Cherel et al. 2002a, La Mesa et al. 2004b, La Mesa et al. 2007).

*Eusirus microps* has a circumpolar distribution in Antarctic waters extending north to Bouvet Island (De Broyer et al. 2007), with total length ranging between 25 and 48 mm (Walker 1907). This species is present in the diet of emperor penguins and Weddell seals (Dearborn 1965, Cherel & Kooyman 1998).

*Eusirus perdentatus* has a circumpolar distribution in Antarctic waters, up to South Shetland and South Orkneys islands (De Broyer et al. 2007), with total length ranging between 30 and 75 mm (Vinogradov 1999, Andres et al. 2002). It is present in the diet of fish, Adélie penguins and emperor penguins (Offredo & Ridoux 1986, Puddicombe & Johnstone 1988, Ridoux & Offredo 1989, Emison 2000, Main et al. 2009).

*Eusirus propeperdentatus* has a circum-Antarctic distribution, including in the Scotia Sea (De Broyer et al. 2007), with total length ranging between 4 and 63 mm (Andres 1979, Andres et al. 2002). This species is present in the diet of emperor penguins and gentoo penguins (Jażdżewski 1981, Cherel & Kooyman 1998).

## Practical procedures to differentiate the species within this family

Five genera of Eusiridae are reported from the Southern Ocean, from which the genus *Eusirus* can be distinguished by the presence of gnathopods of the typical eusirid form (Barnard & Karaman 1991). There are eight species of *Eusirus* recorded in the Southern Ocean. The taxonomic status of *Eusirus antarcticus* is currently under revision (initiated by Claude de Broyer and Krzysztof Jażdżewski), and *E. antarcticus* is most likely more than one species (De Broyer et al. 2007). The detailed literature citation and distribution records are available (De Broyer et al. 2007). The thorough description and drawings of *E. antarcticus* can be found (Stebbing 1888) (under the name *E. longipes*). Additional drawings of this species are available (Bellan-Santini & Ledoyer 1974). The description of *E. microps* is available (Walker 1907) and additional drawings of this species can be found (Bellan-Santini 1972b). *E. perdentatus* was thoroughly described and illustrated (Chevreux 1913) as well as *E. propeperdentatus* (Andres 1979). The identification key for known Antarctic *Eusirus* species can be found in Andres et al. (2002). The representatives of this genus are known to have fragile body and very often their appendages are broken. The species-specific characters are sometimes difficult to observe and may also vary with size/age of the animal, hence it is highly recommended to use the original literature for species identification (possibly with the aid of molecular tools when available) or limit it to the genus level.

# FAMILY LILJEBORGIIDAE STEBBING, 1899

## Existing species that can be found is:

***Liljeborgia georgiana*** **Schellenberg, 1931** Figure 50 | page 168

*Liljeborgia georgiana* has a circum-Antarctic distribution and extends as far north as South Georgia and Bouvet Island, with total length up to 27 mm (d'Udekem d'Acoz 2008). This species is present in the diet of fish (Bellan-Santini 1972a, La Mesa et al. 2007, Collins et al. 2008, d'Udekem d'Acoz 2008).

## Practical procedures to differentiate the species within this family

There are only two known genera of Liljeborgiidae of which only *Liljeborgia* is present south of Subtropical Front. The representatives of this genus are characterized by the powerful, subchelate gnathopods with carpus produced along propodus (Barnard & Karaman 1991). There are 25 species in genus *Liljeborgia* reported from the Southern Ocean. The extensive citation list and distribution information of the Antarctic and subantarctic *Liljeborgia* species can be found in the literature (d'Udekem d'Acoz 2008, 2009). The detailed description and drawings as well as the identification key are available (d'Udekem d'Acoz 2008). *L. georgiana* is the only one species of this family reported from the fish stomach, however, one has to expect finding also other representatives of this genus as a prey. Therefore, while identifying specimens from Liljeborgiidae a thorough comparison with the other species, other than *Liljeborgia georgiana*, should be made using the available literature (d'Udekem d'Acoz 2008).

# FAMILY LYSIANASSIDAE DANA, 1849

## Existing species that can be found are:

***Charcotia obesa* Chevreux, 1906** Figure 51 | page 168
***Cheirimedon femoratus* (Pfeffer, 1888)** Figure 52 | page 169
***Debroyerella fougneri* (Walker, 1903)** Figure 53 | page 169
***Hippomedon kergueleni* (Miers, 1875)** Figure 54 | page 170
***Lepidepecreum urometacarinatum* Andres, 1985** Figure 55 | page 170
***Orchomenella franklini* Walker, 1903** Figure 56 | page 171
***Parawaldeckia kidderi* (Smith, 1876)** Figure 57 | page 171
***Tryphosella macropareia* (Schellenberg, 1926)** Figure 58 | page 172

*Charcotia obesa* (formely *Waldeckia* obesa [Chevreux, 1905]) has a circumpolar distribution in Antarctic waters (De Broyer et al. 2007, De Broyer & Jażdżewska 2014) and is present in the diet of fish, Adélie penguins, gentoo penguins, Antarctic terns and leopard seals (Moreno & Osorio 1977, Volkman et al. 1980, Jażdżewski 1981, Linkowski et al. 1983, Puddicombe & Johnstone 1988, Ridoux & Offredo 1989, Jażdżewski & Konopacka 1999, Hall-Aspland & Rogers 2004, Casaux & Barrera-Oro 2013, Dimitrijević et al. 2018).

*Cheirimedon femoratus* has a circumpolar distribution in Antarctic waters, extending its distribution to subantarctic waters (De Broyer & Jażdżewski 1993, De Broyer et al. 2007) and it is present in the diet of fish, Adélie penguins, black bellied storm petrels and Antarctic terns (Barnard 1932, Bellan-Santini 1972a, Bellan-Santini & Ledoyer 1974, Richardson 1975, Volkman et al. 1980, Jażdżewski 1981, Linkowski et al. 1983, Wakabara et al. 1990, Hahn 1998, Jażdżewski & Konopacka 1999).

*Debroyerella fougneri* (formely *Cheirimedon fougneri* Walker, 1903) is distributed in Antarctic waters (De Broyer et al. 2007) and it is present in the diet of fish, Adélie penguins and leopard seals (Bellan-Santini 1972a, Green & Williams 1986, Puddicombe & Johnstone 1988, Vacchi & La Mesa 1995, La Mesa et al. 2000, La Mesa et al. 2004a, La Mesa et al. 2004b).

*Hippomedon kergueleni* is distributed in Antarctic (e.g. Bouvet island [Arntz et al. 2006]) and subantarctic waters, extending to Prince Edward Islands (Branch et al. 1993, De Broyer et al. 2007), Snares Islands (Lowry & Stoddart 1983b), and the Magellanic/Tierra Del Fuego region (De Broyer & Jażdżewska 2014). *H. kergueleni* is present in the diet of fish, Adélie penguins, Antarctic terns and southern elephant seals (Bellan-Santini 1972a, Thurston 1974a, Volkman et al. 1980, Jażdżewski 1981, Linkowski et al. 1983, Kiest 1993, Jażdżewski & Konopacka 1999, La Mesa et al. 2007).

*Lepidepecreum urometacarinatum* is distributed in Antarctic waters, being found as north as the South Shetland Islands (De Broyer et al. 2007) and is present in the diets of fish (La Mesa et al. 2007, Collins et al. 2008).

*Orchomenella franklini* is distributed in Antarctic waters (De Broyer et al. 2007), often dominating Antarctic shallow communities (Stark 2000, Baird et al. 2012, Havermans 2012) and is present in the diet of fish (La Mesa et al. 2007).

*Parawaldeckia kidderi* has a circumpolar distribution in subantarctic waters (Lowry & Stoddart 1983b, De Broyer et al. 2007, De Broyer & Jażdżewska 2014) and is present in the diet of cape pigeons (Ridoux 1994).

*Tryphosella macropareia* is distributed in Antarctic waters (De Broyer et al. 2007) and present in the diet of fish (La Mesa et al. 2007).

## Practical procedures to differentiate the species within this family

*Debroyerella fougneri* has been recently revised (Lowry & Kilgallen 2015). This species has a rather compressed body and the head is characterized by rounded cephalic lobes with irregular, dark, reniform eyes. Its first gnathopod is very robust with a prominent propodus expanding slightly distally, bearing a slightly oblique and sinuous palm that is densely fringed with short spines and setae (Walker 1903). Its telson reaches a little beyond the end of the peduncles of the third uropods and is cleft with a wide sinus for nearly half its length with a small terminal spine on each division. *D. fougneri* can be differentiated from its formerly congeneric species *Cheirimedon femoratus* by the presence of a teeth on the posterior margin of the third epimeral plate, the long slender setae on the rami of uropod 3 and the comparatively longer coxal plates (Walker 1903, Siqueira & Serejo 2014). *C. fermoratus* has a telson with two robust setae on the medioapical surface (Siqueira & Serejo 2014). A description of *Debroyerella* species is available in Lowry & Kilgallen (2015) as well as a key to all *Cheirimedon* species (Siqueira & Serejo 2014).

*Lepidepecreum* species can be recognized by their robust bodies that are laterally bulged (species identifications is available [Lowry & Stoddart 2002]), but distinguished from *Charcotia obesa* (although it has recently noted that is a mixture of two species, according to bathymetric ranges [d'Udekem d'Acoz et al. 2018]) - also laterally bulged and very robust with thick coxal plates - by the presence of an acute, triangular cephalic lobe and the absence of the very large posteroventral lobe of the fourth coxal plate, that is so typical of *C. obesa* (Chevreux 1905b). It is important to mention that *C. obesa* is a complex of two separate species: *C. obesa s.s.* and *C. amundseni*. These two taxa has similar geographic distribution but differ in their depth ranges, the former found mainly up to 200 m (d'Udekem d'Acoz et al. 2018). It is highly probable that both species were reported as a prey for other animals, so when studying the stomach content of Antarctic predators it is highly recommended to refer to d'Udekem d'Acoz (2018) publication. However, in *L. umbo*, the fourth coxal plate is enlarged as well, but to a lesser extent as in *C. obesa* in which the lobe is prolonged alongside the border of the following coxal plate.

*Charcotia* species can also be recognized by the parachelate first gnathopod, almost unique amongst the lysianassids; *L. urometacarinatum* has a subchelate first gnathopod (Andres 1983). Whilst the telson of *Charcotia* species is deeply cleft, *L. urometacarinatum* has a telson cleft only over one fifth of its length. Species descriptions of *Charcotia* can be found in a genus revision (Lowry & Kilgallen 2014).

*Parawaldeckia kidderi* also bears a well-developed posteroventral lobe of the fourth coxal plate, however, can be differentiated from *Charcotia* species by the long plumose setae along the inner margins of the rami of the third uropods as well as long setae on the rami of the first and second uropods. The description of the different *Parawaldeckia* species is available (Lowry & Stoddart 1983a, Lowry & Stoddart 1983b). In contrast with the *Charcotia* and *Lepidepecreum* species, *Hippomedon* and *Tryphosella* species are not laterally bulged but rather compressed; a revision of the genus *Tryphosella* has been done (Lowry

& Stoddart 2011). Keys for the genus *Hippomedon* are available (Gurjanova 1962, Barnard 1964); *H. kergueleni* has been illustrated (Bellan-Santini 1972a) and can be distinguished by a very prominent tooth on the posterodistal corner of the third epimeral plate.

The identification of orchomenid species can be difficult due to the large number of species often separated by minute morphological differences. Moreover, in several cases, species complexes have been detected and therefore, species identification may be eased by the use of DNA barcoding (Havermans et al. 2011). For morphological identification, a number of works can be consulted (Walker 1903, Hurley 1965, Barnard & Karaman 1991, De Broyer et al. 2007).

# FAMILY OEDICEROTIDAE LILLJEBORG, 1865

## Existing species that can be found is:

***Oediceroides lahillei*** **Chevreux, 1911** Figure 59 | page 172

*Oediceroides lahillei* is distributed in Antarctic waters of the islands along Scotia Arc (South Shetland Islands, South Orkney Islands, South Sandwich Islands, South Georgia) extending north up to South Georgia and into subantarctic waters in the Magellanic/Tierra del Fuego region (De Broyer & Rauschert 1999, De Broyer et al. 2007), with total length ranging between 15 and 22 mm (Chevreux 1911). *O. lahillei* is present in the diet of fish (Collins et al. 2008) and gentoo penguins (Xavier et al. 2017).

## Practical procedures to differentiate the species within this family

Seven genera of Oedicerotidae are known from the Southern Ocean. The genus *Oediceroides* is characterized by triturative molar, robust gnathopods of similar size, multicarinate dorsal surface of the pereon segments and single eye which occupies the entire rostrum (Barnard & Karaman 1991). Eight species of *Oediceroides* are hitherto recorded south of Subtropical Front. The detailed literature list and distribution summary is available (De Broyer et al. 2007). No identification key exist for species belonging to this genus. *O. lahillei* has been described and illustrated (Chevreux 1911). The species is quite characteristic by its pereonites bearing tubercule processes on their dorsal surface. This feature can also be found in some other oedicerotid species, however, in the case of *O. lahillei* there is also a similar process on its head. Additionally it possesses a long (reaching the end of 1st peduncular article of antenna 1) convex rostrum, bearing the single eye (Chevreux 1911).

# FAMILY PHOXOCEPHALIDAE G.O. SARS, 1981

## Existing species that can be found is:

***Heterophoxus videns* K.H. Barnard, 1930** Figure 60 | page 173

*Heterophoxus videns* has a circum-Antarctic distribution and extends north up to South Georgia as well as Falkland Islands and Magellan region in the subantarctic, with total length ranging between 4 and 10 mm (Barnard 1930, Bellan-Santini 1972b). The species has also been recorded from outside the Southern Ocean (Brazil on the Atlantic Ocean coast and Valparaiso on the Pacific coast) (Alonso de Pina et al. 2008). The species has been reported from fish stomach contents (Bellan-Santini 1972a, Wakabara et al. 1990).

## Practical procedures to differentiate the species within this family

The genus *Heterophoxus* belongs to the phoxocephalid subfamily Harpiniinae which is recognizable by the narrow character of basis of pereopod 5. Within this subfamily five genera are represented in the Southern Ocean. Among them *Heterophoxus* is characterized by the presence of ommatidian eyes (sometimes fading away after fixation but preserving the ommatidia) and the ensiform process on the 2nd article of peduncle of antenna 2 (Barnard & Karaman 1991). There are three species of *Heterophoxus* described from the Southern Ocean (*H. pellusidus*, *H. trichosus*, and *H. videns*). The description and drawings of the species are available (Barnard 1930, Bellan-Santini 1972b). Taxonomic remarks are also available (Alonso de Pina et al. 2008). Among the species of *Heterophoxus* the present species can be recognized by the presence of a small tooth at the posterodistal corner on third epimeral plate (the other two species have a very large tooth) and small serrations on the posterior margin of the lobe of basis of pereopod 7. It is worth noting that the sexual dimorphism in *Heterophoxus* species is reflected in the size of the eyes which are large in males (having the height larger than 3/4 of the height of the head) and clearly smaller in females (height ca. 1/2 height of the head) (Barnard 1930).

# FAMILY SCOPELOCHEIRIDAE LOWRY & STODDART, 1997

## Existing species that can be found is:

***Paracallisoma* sp. Chevreux, 1903** Figure 61 | page 173

*Paracallisoma* sp. (also previously identified as *P. alberti* Schellenberg, 1926). It has been considered that *Paracallisoma alberti* Chevreux, 1903 (Chevreux, 1903) and *Scopelocheirus coecus* (Holmes, 1909) were erroneously synonymized by Schellenberg, 1926a, on the basis of a single specimen from Antarctic waters (Thurston, 1990); the former species is restricted to the northeast Atlantic Ocean and the latter one occurs in the Pacific Ocean (De Broyer et al. 2007). Vinogradov (1999) considered *Paracallisoma alberti* to be distributed worldwide, in both hemispheres, with a circumpolar distribution. The Southern Ocean material of *Paracallisoma alberti* has been revised (Horton & Thurston 2015, Lowry & Kilgallen 2015) and is no longer comprised under *P. alberti*, which is restricted to the Atlantic (Kilgallen & Lowry, 2015). This undescribed species is distributed in Antarctic waters (Schellenberg 1926, Brandt et al. 2007, De Broyer et al. 2007) seems to be closely related to *P. platepistomum* Andres, 1977 (Thurston 1990, Kilgallen & Lowry 2015), and has been identified in the diet of Kerguelen petrels (Ridoux 1994).

## Practical procedures to differentiate the species within this family

*Paracallisoma* sp. can be differentiated from other scopelocheirid amphipods by the pyriform basis of pereopod 5 and the subrectangular propodus of the first gnathopod (Horton & Thurston 2015). The telson is cleft and the disterolateral, subapical notch with robust setae on each telson lobe is also typical (Vinogradov 1999, Horton & Thurston 2015).

# FAMILY STEGOCEPHALIDAE DANA, 1855

## Existing species that can be found is:

***Parandania boecki* (Stebbing, 1888)** Figure 62 | page 174

*Parandania boecki* has a circumpolar distribution in Antarctic waters, being also distributed in subantarctic and more northern waters, including the Northern Hemisphere (Berge & Vader 2001, De Broyer et al. 2007, Milne & Griffiths 2013), with total length ranging between 3 and 26 mm (Stebbing 1888, Birstein & Vinogradov 1955). It is present in the diet of blue petrels (Cherel et al. 2002b).

## Practical procedures to differentiate the species within this family

The genus *Parandania* belongs to the Parandaniinae subfamily which can be distinguished by a long flagellum on antenna 1 and a triangular telson (Berge & Vader 2001). There are three species from the genus recorded in the Southern Ocean (*P. boecki*, *P. gigantea*, and *P. nonhiata*). The detailed description and drawings of *P. boecki* are available (Stebbing, 1888). The remarks on the morphological differences between the three *Parandania* species have been described (Berge & Vader 2001), as well as the key for Southern Ocean representatives of the family Stegocephalidae (Berge et al. 2000). It is important to note that, in this key, *P. gigantea* and *P. nonhiata* are listed under the former genus name - *Euandania*.

# FAMILY STENOTHOIDAE BOECK, 1871

## Existing species that can be found are:

***Antatelson walkeri*** **(Chilton, 1912)**
***Mesoproboloides spinosa*** **Bellan-Santini and Ledoyer, 1974**

*Antatelson walkeri* has been recorded from the Antarctic Peninsula waters, as well as Weddell Sea, South Shetland Islands, South Orkney Islands, South Georgia and Bouvet Island (De Broyer et al. 2007), with total length ranging between 1.0-3.5 mm (Schellenberg 1931, Thurston 1974b). The species was found in the diet of fish (Wakabara et al. 1990).

*Mesoproboloides spinosa* has been described from subantarctic (Kerguelen Islands) and later it was also reported from the area of Antarctic Peninsula (De Broyer et al. 2007). The species was found in the diet of fish (Wakabara et al. 1990).

## Practical procedures to differentiate the species within this family

The genus *Antatelson* belong to the Thaumatelsoninae subfamily which representatives have dorso-ventrally thickened telson and rectolinear basis of pereopods 5-7. There are seven species in the genus *Antatelson* known worldwide, six of which were reported from the Southern Ocean. The list of literature citation and detailed distribution records are available (De Broyer et al. 2007). The description and drawings of *A. walkeri* are also available (Chilton 1912) (under the former generic name *Thaumatelson*), as well as the key for all known species of this genus (Krapp-Schickel 2011). The species can be recognized by the sharp dorsal projection on the epimeron 3 which is directed backwards.

Three species of *Mesoproboloides* are known from the Southern Ocean. Only the original description and drawings of *M. spinosa* are available (Bellan-Santini & Ledoyer 1974). The species can be distinguished from its congeners by the combination of lack of the nasiform process on antenna 1, rectolinear basis of pereopod 6 as well as lack of the dorsal process on third pleonite.

# FAMILY URISTIDAE HURLEY, 1963

## Existing species that can be found are:

***Cicadosa cicadoides* (Stebbing, 1888)**
***Pseudorchomene plebs* (Hurley, 1965)** Figure 63 | page 174
***Pseudorchomene rossi* (Walker 1903)** Figure 64 | page 175
**Tryphosinae *incertae sedis intermedia* (Schellenberg, 1926)** Figure 65 | page 175
***Uristes gigas* Dana, 1852** Figure 66 | page 176
***Uristes georgianus* (Schellenberg, 1931)**
***Uristes murrayi* (Walker, 1903)** Figure 67 | page 176

*Cicadosa cicadoides* is distributed in subantarctic waters (Kerguelen island region) (De Broyer et al. 2007) and is present in the diet of Antarctic prions and thin billed prions (Cherel et al. 2002a).

*Pseudorchomene plebs* (= *Abyssorchomene* plebs [Hurley, 1965] and *Orchomene plebs* [Hurley, 1965] [d'Udekem d'Acoz & Havermans 2012]) has a circumpolar distribution in Antarctic waters (e.g. South Orkneys), and subantarctic waters, around Macquarie island (De Broyer et al. 2007, Havermans et al. 2011, d'Udekem d'Acoz & Havermans 2012). It is present in the diet of fish, emperor penguins, gentoo penguins and Antarctic terns (Linkowski et al. 1983, Montgomery et al. 1989, Cherel & Kooyman 1998, Jażdżewski & Konopacka 1999, Berón et al. 2002, La Mesa et al. 2004a).

*Pseudorchomene rossi* (= *Abyssorchomene rossi* (Walker, 1903) and *Orchomene rossi* [Walker, 1903], see d'Udekem d'Acoz & Havermans [2012]) has a circumpolar distribution in Antarctic waters, extending its distribution as far north as South Georgia (De Broyer et al. 2007) and is present in the diet of fish, Adélie penguins and emperor penguins (Bellan-Santini 1972a, Targett 1981, Foster et al. 1987, Puddicombe & Johnstone 1988, Montgomery et al. 1989, Cherel & Kooyman 1998).

Tryphosinae *incertae sedis intermedia* (= *Tryphosella intermedia* (Schellenberg, 1926); this species is being reviewed, and cannot be ascribed to the genus in which it was originally placed (i.e. *Thryphosella*) but it undoubtedly belongs to the Family Tryphosidae (De Broyer et al. 2007, Lowry & Stoddart 2011, Horton et al. 2014, Horton et al. 2019). It is distributed in Antarctic waters (De Broyer et al. 2007) and present in the diet of fish (La Mesa et al. 2007).

*Uristes gigas* has a circumpolar distribution in Antarctic waters, extending its distribution to subantarctic waters and Magellanic/Tierra Del Fuego region (De Broyer & Rauschert 1999, Chiesa & Alonso de Pina 2007, De Broyer & Jażdżewska 2014) and is present in the diet of fish, Adélie penguins, emperor penguins, black-browed albatrosses, blue petrels, Antarctic prions and thin billed prions (Offredo & Ridoux 1986, Ridoux & Offredo 1989, Cherel & Kooyman 1998, Cherel et al. 2000, Cherel et al. 2002a, Cherel et al. 2002b, Collins et al. 2008, Connan et al. 2008).

*Uristes georgianus* has a distribution encompassing the Adélie Coast as well as the South Shetland Islands to as far north as South Georgia (De Broyer et al. 2007). It was reported in large numbers from fish stomachs (Wakabara et al. 1990).

*Uristes murrayi* (also previously identified as *Tryphosella murrayi* (Lowry & Stoddart 2011) has a circumpolar distribution in Antarctic waters, extending north as much as South Shetland Islands (De Broyer et al. 2007). *U. murrayi* is present in the diet of Adélie penguins, fairy prions and Salvin's prions (Puddicombe & Johnstone 1988, Prince & Copestake 1990, Ridoux 1994).

## Practical procedures to differentiate the species within this family

*Pseudorchomene* species can be differentiated from other 'orchomenid' amphipod by the triangular or adze-shaped first coxal plate. Within this genus, the different species are separated based on the shape of the first gnathopod which is stocky for *P. plebs* and *P. rossi*, but elongated for *P. debroyeri* and *P. lophorachis* (d'Udekem d'Acoz & Havermans 2012). Visually, when freshly caught, specimens of *P. plebs* can be easily separated from *P. rossi* on the basis of the eye colour: the former have dark brown/reddish eyes whereas the latter have black eyes (d'Udekem d'Acoz & Havermans 2012). An identification key for the genus is available (d'Udekem d'Acoz & Havermans 2012). *P. plebs* and *P. rossi* can also be differentiated based on the uropod 3: in *P. plebs* the inner ramus is shorter than the first article of the outer ramus and the medial border of the outer ramus bears plumose setae whilst in *P. rossi* the inner ramus reaches at least the base of article 2 of the outer ramus and its medial border bears no setae (but sometimes spines) (d'Udekem d'Acoz & Havermans 2012).

*Cicadosa cicadoides* has a simple or poorly subchelate first gnathopod with a slightly elongated article 3, an oblique palm and a large dactyl and the second gnathopod with a minutely subchelate propodus (Bellan-Santini & Ledoyer 1974, Barnard & Karaman 1991). Some other characters defining the species are the separate labrum and epistome, of which the former is dominant and subsharp (Barnard & Karaman 1991). The coxa 1 is expanded and clearly visible, not tapering (Barnard & Karaman 1991). *Cicadosa* differs from *Tryphosella/Uristes* species in the length of the articles 5 and 6 of the first gnathopod, for the former, the article 5 is shorter than 6, in some of the latter species, the article 6 is distinctly longer than the article 5 (Barnard & Karaman 1991). Moreover, in *Tryphosella* species, the labrum and epistome are also differentially produced but the epistome is slightly to strongly dominant in size and projection (Barnard & Karaman 1991). From *Tmetonyx* species it can be distinguished by the notched inner ramus of the second uropod.

Concerning the *Uristes* species, the taxonomy is complex and several diagnostic characters for distinguishing *Tryphosella* and *Uristes* species have been pointed out in various works but subsequently rejected (Barnard & Karaman 1991). Currently accepted characters are the mouthparts, more precisely the length of the plates and setal teeth of the maxilla and the mandibular molars (Lowry & Stoddart 2011), which renders identification difficult especially for specimens from stomach contents. Moreover, within the major species of *Uristes* (e.g. *U. murrayi*) species complexes were detected which can be differentiated with very detailed morphometric analyses or DNA only (Feldkamp 2010, Seefeldt 2012). Keys to differentiate the different genera (e.g. *Uristes*, *Tryphosella*) are available, however they are only partly valid (Barnard & Karaman 1991).

# SUBORDER HYPERIIDEA

Milne Edwards, 1830

# FAMILY CYLLOPODIDAE BOVALLIUS, 1887

## Existing species that can be found are:

This is the only family of Hyperiidea endemic to the Southern Ocean (Zeidler & De Broyer 2014). It includes the genus *Cyllopus*, with two species that looks very similar. *Cyllopus* are common prey of seabirds (see below).

***Cyllopus lucasii* Bate, 1862** Figure 68 | page 178
BL = 0.56 ED - 0.08 (n=13) (0.9-1.3 cm) (Ridoux 1994)
BM/BL$^3$ = 0.034 (n=2) (0.04-0.07 cm) (Ridoux 1994)

***Cyllopus magellanicus* Dana, 1853**

*Cyllopus lucasii* has a circumpolar distribution in Antarctic and subantarctic waters, from the continent up to the Subantarctic Front (Weigmann-Haass 1983, Vinogradov 1999, Zeidler & De Broyer 2014). *C. lucasii* is a common species near the surface, being sometimes abundant enough to provide a substantial food source for predators (Zeidler & De Broyer 2014). It is present in the diet of fish, Adélie penguins, chinstrap penguins, gentoo penguins, macaroni penguins, emperor penguins, royal penguins, Antarctic fulmars, Kerguelen petrels, Antarctic petrels, blue petrels, cape pigeons, Salvin's prions, Antarctic prions, fairy prions, black-bellied storm petrels and grey-backed storm petrels (Barnard 1930, Prince 1980, Volkman et al. 1980, Jażdżewski 1981, Croxall et al. 1988, Hindell 1988, Ridoux & Offredo 1989, Pütz 1995, Kent et al. 1998, Hull 1999, Van Franeker et al. 2001, Berón et al. 2002, Cherel et al. 2002b, Pinkerton et al. 2012, Saunders et al. 2014).

*Cyllopus magellanicus* also has a circumpolar distribution in Antarctic and subantarctic waters, but is less common near the continent and can extent their distribution to the Subtropical Front and beyond (Weigmann-Haass 1983, Zeidler & De Broyer 2014). *C. magellanicus* is present in the diet of squid, fish, Adélie penguins, emperor penguins, wandering albatrosses, grey-headed albatrosses, black-browed albatrosses, Antarctic fulmars, blue petrels, short-tailed shearwaters, Antarctic prions, broad billed prions, thin billed prions and Wilson's storm petrels (Imber 1981, Clark 1985, Puddicombe & Johnstone

1988, Ivanovic & Brunetti 1994, Pütz 1995, Weimerskirch & Cherel 1998, Cherel et al. 2000, Van Franeker et al. 2001, Cherel et al. 2002a, Cherel et al. 2002b, Cherel et al. 2002d, Quillfeldt 2002, Xavier et al. 2003a, Xavier et al. 2003b, Connan et al. 2007b, Connan et al. 2008, Horn et al. 2013, Cherel et al. 2014, Connan et al. 2014).

## Practical procedures to differentiate the species within this family

For description of the two species, see Weigmann-Haass (1983) and Vinogradov (1999). The two species can be easily confused and thus misidentified (e.g. the surprising lack of *C. magellanicus* in Ridoux 1994). *C. lucasii* reaches a larger total length than *C. magellanicus* (23 versus 17 mm, respectively). Females are by far more numerous than males in birds' stomach contents, with males easily differentiated from females by their longer antennae. Some key features to distinguish both species (including in damaged specimens, typically found in predators diets) are (i) the tip of antenna 1 & antenna 2 in females that presents either a small segment bearing setae (*magellanicus*) or not (*lucasii*), and (ii) gnathopods 1 and P2 (weakly) chelate (*lucasii*) or simple (*magellanicus*) (Weigmann-Haass 1983). For *Cyllopus lucasii*, the head is longer than pereonites 1-3 combined whilst for *C. magellanicus*, the head is as long as pereonites 1-3 combined (Vinogradov 1999).

# FAMILY HYPERIIDAE DANA, 1852

## Existing species that can be found are:

***Hyperia macrocephala*** **(Dana, 1853)** Figure 69 | page 178
***Hyperia gaudichaudii*** **Milne Edwards, 1840** Figure 70 | page 179
For ***Hyperia*** spp.
BL = 0.36 ED + 0.12 (n=6) (0.7-1.9 cm) (Ridoux 1994)

***Hyperiella antarctica*** **Bovallius, 1887** Figure 71 | page 179
***Hyperiella dilatata*** **Stebbing, 1888** Figure 72 | page 180
***Hyperiella macronyx*** **(Walker, 1906)** Figure 73 | page 180
***Hyperoche luetkenides*** **Walker, 1906** Figure 74 | page 181
***Hyperoche capucinus*** **H. Barnard, 1930** Figure 75 | page 181

For ***Hyperoche*** spp.
BL = 0.36 ED + 0.12 (n=6) (0.7-1.9 cm) (Ridoux 1994)

***Themisto gaudichaudii*** **Guérin, 1825** Figure 76 | page 182
BL = (6.61 × EH) - 0.71 (n = 1005) (0.04-0.30 mm) (Bocher et al. 2001)
BL = 0.56 ED - 0.15 (n=118) (0.3-2.1 cm) (Ridoux 1994)
BMs = 0.025 $BL^{2.83}$ (n=69) (in mm) (Pakhomov & Perissinotto 1996)
BM = 0.0224 $BL^{2.6}$ (n=34) (0.01-0.09 cm) (Ridoux 1994)
Ln BMs = -5.31 + 2.4 LnTL (in mm) (Alvarez Colombo & Viñas 1994)
BM = 0.0002 $BL^{2.08}$ (n=69) (in mm) (Watts & Tarling 2012)

*Hyperia macrocephala* is distributed in Antarctic waters, between the Antarctic continent and the Antarctic Polar Front (in the Atlantic sector, as far north as South Georgia) (Bowman 1973, Zeidler & De Broyer 2014), with total length up to 29 mm (Vinogradov 1999). It is present in the diet of a wide range of top predators, including fish, Adélie penguins, chinstrap penguins, emperor penguins, gentoo penguins, grey-headed albatrosses, Antarctic fulmars, blue petrels and Antarctic prions (Paulin 1975, Prince 1980, Volkman et al. 1980, Jażdżewski 1981, Croxall et al. 1988, Puddicombe & Johnstone 1988, Ridoux & Offredo 1989, Williams 1990, 1991, Foster & Montgomery 1993, Robertson et al. 1994, Cherel & Kooyman 1998, Kent et al. 1998, Van Franeker et al. 2001, Xavier et al. 2003a, Xavier et al. 2003b).

*Hyperia gaudichaudii* is distributed in subantarctic and subtropical waters, including along the southern coasts of South Africa, South America and Australia (Bowman 1973, Zeidler & De Broyer 2009), with total length ranging between 10-14 mm (Bowman 1973) (> 20 mm further south) (Vinogradov 1999). It is present in the diet of grey-headed albatrosses, sooty shearwaters and Antarctic prions (Kitson et al. 2000, Cruz et al. 2001, Cherel et al. 2002a, Cherel et al. 2002d).

*Hyperiella* is the only genus of the family Hyperiidae that is endemic to the Southern Ocean. It includes three species.

*Hyperiella antarctica* is distributed in Antarctic and subantarctic waters, between the Antarctic continent and the Subtropical Front (preferably associated to shallow waters) (Bowman 1973, Zeidler & De Broyer 2014), with total length ranging between 6-8 mm (Vinogradov 1999). *H. antarctica* is present in the diet of fish, macaroni penguins, gentoo penguins, grey-headed albatrosses, blue petrels, Kerguelen petrels, cape pigeons, sooty shearwaters, Antarctic prions, fairy prions, thin billed prions, Salvin's prions, black-bellied storm petrels and Wilson's storm petrels (Prince 1980, Williams 1983, Croxall et al. 1988, Ridoux 1994, Cruz et al. 2001, Cherel et al. 2002a, Cherel et al. 2002b, Connan et al. 2008, Connan et al. 2014).

*Hyperiella dilatata* has a circumpolar distribution in Antarctic and subantarctic waters, extending its distribution up to the Subantarctic Front (Vinogradov 1999, Zeidler & De Broyer 2014), with total length ranging between 6-8 mm (Vinogradov 1999). *H. dilatata* is present in the diet of fish, royal penguins, light mantled sooty albatrosses and southern elephant seals (Foster et al. 1987, Hindell 1988, Jażdżewski & Presler 1988, Montgomery et al. 1989, Foster & Montgomery 1993, Green & Burton 1993, Pakhomov & Pankratov 1995a, Vacchi & La Mesa 1995, Pakhomov et al. 1996a, Green et al. 1998a, Hull 1999, La Mesa et al. 2000).

*Hyperiella macronyx* is distributed in Antarctic waters, extending its distribution from the continent up to the Antarctic Polar Front (Vinogradov 1999, Zeidler & De Broyer 2014), with total length up to 13 mm (Vinogradov 1999). *H. macronyx* is present in the diet of fish, Adélie penguins, emperor penguins and southern elephant seals (Ridoux & Offredo 1989, Foster & Montgomery 1993, Green & Burton 1993, Kiest 1993, Pakhomov & Pankratov 1995b, Vacchi & La Mesa 1995, Cherel & Kooyman 1998, La Mesa et al. 2000).

*Hyperoche luetkenides* is distributed in Antarctic waters, between the continent and the Antarctic Polar Front, but also a few records north of it, near Macquarie Island and near the Falkland Islands/Islas Malvinas (Zeidler & De Broyer 2014, Zeidler 2015), with total length ranging between 14-20 mm (adults) (Vinogradov 1999, Zeidler 2015). *H. luetkenides* is present in the diet of blue petrels, Antarctic prions, thin billed prions and South Georgian diving petrels (Bocher et al. 2000a, Cherel et al. 2002a, Cherel et al. 2002b).

*Hyperoche capucinus* is another large *Hyperoche* species from the Southern Ocean, distributed between the Antarctic continent and the Antarctic Polar Front, with total length ranging between 14-20 mm (Zeidler 2015). *Hyperoche* species (representing either *H. capucinus* or *H. luetkenides*) have been found in the diet of fish, blue petrels, Antarctic prions and fairy prions (Prince 1980, Jażdżewski & Presler 1988, Prince & Copestake 1990).

*Themisto gaudichaudii* is characterized by a circumpolar distribution in Antarctic and subantarctic waters, found mainly between the Antarctic continent and the Subtropical Front (less common near the pack ice) (Zeidler & De Broyer 2014). It is the most abundant hyperiid amphipod in the Southern Ocean, being one of the most numerous species of macrozooplaknton in the epipelagic zone. Total length ranges between 4 and 28 mm (Vinogradov 1999). Highest abundances have been observed in shelf areas around subantarctic and Antarctic islands, the Scotia Sea, the Patagonian shelf and the waters off Namibia in the Benguela Upwelling System but also offshore in the Antarctic Polar Frontal Zone (Kane 1966, Auel & Ekau 2009, Mackey et al. 2012, Zeidler & De Broyer 2014). In these regions, *T. gaudichaudii* is the main amphipod in the diet of many consumers in the Southern Ocean and hence forming the main stay of the pelagic ecosystems (Bocher et al. 2001). It has been found in stomachs of fish, squid, penguins, albatrosses, fulmars, petrels, prions, skuas, seals and whales, in particular in myctophid fish (e.g. *Electrona carlsbergi*), Adélie penguins, chinstrap penguins, gentoo penguins, macaroni penguins, rockhopper penguins, royal penguins, white-chinned petrels, blue petrels, sooty shearwaters, Antarctic prions, thin billed prions, fairy prions, Salvin's prions and common diving petrels (Nemoto 1962, Nemoto 1970, Prince 1980, Volkman et al. 1980, Imber 1981, Jażdżewski 1981, Targett 1981, Williams 1983, Takahashi & Nemoto 1984, Clark 1985, Croxall et al. 1985a, Duhamel & Hureau 1985, Horne 1985, Nemoto et al. 1985, Williams 1985, Steele & Klages 1986, Brown & Klages 1987, Duhamel 1987, Croxall et al. 1988, Hindell 1988, Puddicombe & Johnstone 1988, Klages 1989, Klages et al. 1989, Ridoux & Offredo 1989, Prince & Copestake 1990, Wakabara et al. 1990, Williams 1990, Kato et al. 1991, Williams 1991, Cherel & Ridoux 1992, Cooper et al. 1992, Green & Wong 1992, Rodhouse et al. 1992, Green & Burton 1993, Ivanovic & Brunetti 1994, Lu & Williams 1994, Ridoux 1994, Bost et al. 1994 , Cooper & Klages 1995, Pakhomov et al. 1996b, Cherel et al. 1997, Croxall et al. 1997, González et al. 1997, Reid et al. 1997a, Reid et al. 1997b, Green et al. 1998a, Green et al. 1998b, Weimerskirch & Cherel 1998, Croxall et al. 1999, Hull 1999, Weimerskirch et al. 1999, Bocher et al. 2000a, Bocher et al. 2000b, Catard et al. 2000, Cherel et al. 2000, Reinhardt et al. 2000, Tremblay & Cherel 2000, Bocher et al. 2001, Cruz et al. 2001, Mouat et al. 2001, Van Franeker et al. 2001, Bocher et al. 2002, Burton & van den Hoff 2002, Cherel et al. 2002a, Cherel et al. 2002b, Cherel et al. 2002d, Lea et al. 2002, Brickle et al. 2003, Cherel & Duhamel 2003, Clausen & Pütz 2003, Libertelli et al. 2003, Tremblay & Cherel 2003, Xavier et al. 2003a, Xavier et al. 2003b, Flores et al. 2004, La Mesa et al. 2004b, Lescroël et al. 2004, Lynnes et al. 2004, Nyegaard et al. 2004, Schiavini & Raya Rey 2004, Xavier et al. 2004, Cherel et al. 2005, Raya Rey & Schiavini 2005, Cherel et al. 2007, Collins et al. 2007, Connan et al. 2007a, Connan et al. 2007b, Knox 2007, Clarke et al. 2008, Collins et al. 2008, Connan et al. 2008, Lea et al. 2008, Brickle et al. 2009, Main et al. 2009, Montalti et al. 2009, Shreeve et al. 2009, Tamura & Konishi 2009, Connan et al. 2010, Delord et al. 2010, Quillfeldt et al. 2010, Fijn et al. 2012, Waluda et al. 2012, Delord et al. 2013, Horn et al. 2013, Temperoni et al. 2013, Cherel et al. 2014, Connan et al. 2014, Saunders et al. 2014, Xavier et al. 2017, Xavier et al. 2018a, Xavier et al. 2018b).

## Practical procedures to differentiate the species within this family

A key for the hyperiids in general, and in particular the genus *Hyperia* is available with illustrations (Bowman 1973). An additional key to the genus *Hyperia* is also available (Vinogradov 1999). The genus *Hyperia* is restricted to large species with no fusion of pereonites and the coxal plates not fused with the pereonites (Bowman 1973). Their body is strong, with a broadened pereon, especially in females. The head is large, spherical and without rostrum; the eyes occupy almost the entire surface of the head (Vinogradov et al. 1996). Pereopods 3-4 are longer than 5-7 (Vinogradov et al. 1996). *H. antarctica* Spandl, 1927, (= *H. spinigera* Bovallius, 1889 [Zeidler 1992]) is found in Antarctic and sub-Antarctic waters and has a worldwide distribution (Zeidler 2009, Zeidler & De Broyer 2009). A key feature to easily identify *Hyperia macrocephala* (total length up to 29 mm) is the shape of the coxa 4 that is pointed and projects laterally in adults (Vinogradov et al. 1996, Vinogradov 1999). The species has a head about as long as pereonites 1-2 combined; pereopods 3-4 bear numerous short setae that are not uniformly long on carpus and propodus. (Bowman 1973). *H. antarctica* can be distinguished from *H. macrocephala* by setation of the posterior margins of the carpus and propodus of pereopods 3-4 that are uniformly short in the former. *Hyperia gaudichaudii* is very similar to *H. medusarum* (Vinogradov 1999), however, this species is found in the southern hemisphere whilst *H. medusarum* restricted to the northern hemisphere (Bowman 1973). *H. gaudichaudii* can be differentiated by the head length that, in lateral view, is subequal to the length of pereonites 1 and 2 combined. The propodus of the first and second gnathopod bears many spines on the medial and lateral surfaces and a long dactyl, of which the spines do not reach the apex (Bowman 1973).

The genus *Hyperiella* can be recognized by the non-fused (free) coxal plates and pereonites, like *Hyperia* species. The head is also large, globular but with a flat anterior surface, without rostrum and lateral lobes. The first and second antennae of the females are 4-articulated (Vinogradov 1999). It can be differentiated from *Hyperia* species by the pereopods 5 or 5 and 6 that are longer than pereopods 3 and 4 whilst in *Hyperia* species the pereopods 3-7 are approximately equal in length, or 3-4 slightly longer than 5 and 6 (Vinogradov 1999). Further detailed identification features of the genus *Hyperiella* are available (Bowman 1973, Weigmann-Haass 1989b, Vinogradov et al. 1996, Vinogradov

1999). *H. macronyx* can be differentiated by the subequal pereopods 5-6 that are longer than all other pereopods and the basipodite (or peduncle) of the third uropod that is about twice as long as the telson. In *H. dilatata* and *H. antarctica*, the fifth pereopod is much longer than the sixth, and the basipodite (or peduncle) of the third uropod is distinctly more than twice as long as the telson (Vinogradov 1999). *H. dilatata* can be differentiated from *H. antarctica* by the anterodistal corners of the basis, ischium and merus of pereopods 6 and 7 that bear sharp triangular processes in the former and blunt processes in the latter, as well as by the epimeral plates, bearing sharp posterodistal corners in *H. dilatata* whilst in *H. antarctica* only the epimeral plates 2 and 3 bear sharp corners (Vinogradov 1999).

Identification features of the genus *Hyperoche* are available (Weigmann-Haass 1990, Vinogradov et al. 1996, Vinogradov 1999, Zeidler 2015). Two species occurred in the Southern Ocean, but only one was found in the diet of predators (see above). *Hyperoche luetkenides* is a large species (total length up to 20 mm). *Hyperoche* species can be identified by the first pereonites, which are partially or wholly fused dorsally and by the coxa 7 that is fused with the pereonite (Zeidler 2015). *Hyperoche* species also bear a knife-shaped carpus (vs. a spoon-shaped one in the other species) of the gnathopods, a laminate mandibular molar and often but not always retractile dactyls on the gnathopods (Zeidler 2015). *H. luetkenides* can be confused with *Hyperoche medusarum* but the later species is restricted to the colder waters of the northern hemisphere (Zeidler 2015); therefore *Hyperoche medusarum* identified in the diet of squid, blue petrels and Antarctic prions (Croxall et al. 1988, Ivanovic & Brunetti 1994) are most likely to be *H. luetkenides*. Another species, *Hyperoche capucinus*, also occurs in the Southern Ocean and can be differentiated from *H. luetkenides* by the small, pointed rostrum of pereonite 1 reaching over the head and the structure of the gathopods with the propodus projected anteriorly over the dactylus. An exhaustive description is available (Zeidler 2015).

*Themisto gaudichaudii* is the only species of its genus in the Southern Ocean. Its body is slender in both sexes, somewhat compressed laterally. Key features comprise the presence of an expanded carpus on pereopod 3 and pereopod 4 with its posterior margins bearing strong setae and a fifth pereopod that is much longer than pereopod 6 and pereopod 7 (the two latter being nearly subequal in length). The seven pereopods of the pereon are free (Schneppenheim & Weigmann-Haass 1986). Head is large, approximately globular, without rostrum and lateral lobes but with large compound eyes, occupying most of the surface. The first gnathopod is simple, the second chelate bearing a spoon-shaped distal process of the carpus. Often, the fifth pereopod is very long with an extended carpus and an even longer (much longer than the carpus) straight and narrow propodus (as in the forma *bispinosa sensu* Schneppenheim & Weigmann-Haass 1986; description [Vinogradov 1999]). *T. gaudichaudii* can be determined to sex based on secondary sexual characters: males are identified based on the flagellum of the second antennae, which become divided into many segments and filaments, whereas these remain short and unsegmented in the females (Kane 1963, Kane 1966, Schneppenheim & Weigmann-Haass 1986). Noticeably, the sex ratio is highly female-biased in most samples (Bocher et al. 2001). The degree of dorsal spination on pereon-pleon segments (as described by Vinogradov 1999 to differentiate the species) seems to vary with age within *T. gaudichaudii* populations (Havermans, pers. comm.). Two different morphs exist: the *bispinosa* form (with the pereopod 5 much longer as the pereopod 6), and the *compressa* form (with pereopod 5 and 6 being subequal in size), occurring in sympatry (Havermans et al. 2019). Currently only one species is described for the Southern Ocean, but the existence of several undescribed species is suspected (Zeidler & De Broyer 2014), which may be corroborated by molecular methods.

# FAMILY PHROSINIDAE DANA, 1853

## Existing species that can be found is:

***Primno macropa* Guérin-Méneville, 1836** Figure 77 | page 182
BL = 0.76 ED - 0.13 (n=56) (0.2-1.3 cm) (Ridoux 1994)
$BM/BL^3$ = 0.03 (n=1) (0.04 cm) (Ridoux 1994)

*Primno macropa* has a circumpolar distribution in Antarctic, subantarctic and subtropical waters, occurring between the Antarctic continent and the Subtropical Front, with very occasional excursions further north (Bowman 1978, Zeidler & De Broyer 2014), with total length up to 21 mm (Vinogradov 1999). As the second most common species of Hyperiidea from the Southern Ocean (second to *T. gaudichaudii*), *P. macropa* is present in the diet of numerous predators, including fish, squid, emperor penguins, gentoo penguins, macaroni penguins, royal penguins, rockhopper penguins, blue petrels, cape pigeons, sooty shearwaters, Antarctic prions, thin billed prions, fairy prions, black-bellied storm petrels, Wilson's storm petrels, common diving petrels and South Georgian diving petrels (Clark 1985, Williams 1985, Hindell 1988, Jażdżewski & Presler 1988, Ivanovic & Brunetti 1994, Ridoux 1994, Pütz 1995, Pakhomov et al. 1996b, Reid et al. 1997a, Reid et al. 1997b, Hull 1999, Bocher et al. 2000a, Cruz et al. 2001, Mouat et al. 2001, Cherel et al. 2002a, Cherel et al. 2007, Connan et al. 2007b, Collins et al. 2008, Main et al. 2009, Waluda et al. 2012, Saunders et al. 2014).

## Practical procedures to differentiate the species within this family

A key feature to identify species of the genus *Primno* is the expanded carpus of pereopod 5 with a strong anterior dentation including several long teeth separated by groups of short teeth (Bowman 1978, Vinogradov 1999). These spiny articles typical of the species are often found loose in stomach samples and are an easy indicator of the presence of *Primno* in the diet. Furthermore, *Primno* species bear longer first antennae but the second antennae are reduced to a tubercule. Pereopods 3, 4 and 6 are simple (Vinogradov 1999). *Primno macropa* has a relatively slender body and a head produced into a single very short rostrum; rostrum truncate in dorsal view. Mid-dorsal spines and posteroventral spine of pleonite 3 sharper and more pronounced than in other species of this genus found elsewhere (Bowman 1978).

# FAMILY VIBILIIDAE DANA, 1852

## Existing species that can be found is:

***Vibilia antarctica* Stebbing, 1888** Figure 78 | page 183
BL = 0.94 ED + 0.44 (n=37) (0.6-1.3 cm) (Ridoux 1994)
$BM/BL^3$ = 0.03 (n=1) (in cm) (Ridoux 1994)

*Vibilia antarctica* has a circumpolar distribution in Antarctic, subantarctic and subtropical waters, commonly found up to the Subtropical Front (Zeidler & De Broyer 2014) and even further north (Milne & Griffiths 2013), with total length up to 14 mm (Vinogradov 1999). *V. antarctica* is present in the diet of fish, gentoo penguins, grey-headed albatrosses, black-browed albatrosses, Antarctic fulmars, Antarctic petrels, blue petrels, cape pigeons, Antarctic prions, fairy prions, thin billed prions, black bellied storm petrels and Wilson's storm petrels (Prince 1980, Croxall et al. 1988, Jażdżewski & Presler 1988, Ridoux 1994, Pakhomov et al. 1996b, Croxall et al. 1997, Weimerskirch et al. 1999, Cherel et al. 2000, Van Franeker et al. 2001, Berón et al. 2002, Cherel et al. 2002a, Cherel et al. 2002c, Collins et al. 2007, Connan et al. 2007b, Collins et al. 2008, Connan et al. 2008, Main et al. 2009, Cherel et al. 2014, Xavier et al. 2017, Xavier et al. 2018a).

*Vibilia australis* Stebbing, 1888 is found near the Falkland Islands/Islas Malvinas and *V. viatrix* Bovallius, 1887 north of these islands (Zeidler & De Broyer 2014). *Vibilia* sp., corresponding to either *V. australis* or *V. viatrix*, has been found in the diet of fish (Arkhipkin et al. 2001).

## Practical procedures to differentiate the species within this family

*Vibilia antarctica* is the only species of *Vibilia* inhabiting truly Antarctic waters (Weigmann-Haass 1989a, Zeidler & De Broyer 2014). Unlike many other hyperiids, *Vibilia* species have small and separate eyes and their first antennae are short and broad with a laterally flattened flagellum, facilitating their identification (Vinogradov 1999). For *V. antarctica*, the second gnathopods bear a posterodistal process of the carpus reaching the distal end of the propodus and a strong dactyl that is equal to half or third of the propodus (Vinogradov 1999). A key to the genus is available (Vinogradov 1999).

# SUBORDER SENTICAUDATA

Lowry & Myers, 2013

# FAMILY CALLIOPIIDAE G.O. SARS, 1893

## Existing species that can be found are:

***Oradarea walkeri* Shoemaker, 1930** Figure 79 | page 185
***Stenopleura atlantica* Stebbing, 1888** Figure 80 | page 185

*Oradarea walkeri* is a species with a circum-Antarctic distribution, extending north to South Orkney Islands and Bouvet Island (De Broyer et al. 2007), with total length ranging between 5 and 12 mm (Bellan-Santini 1972b, Thurston 1974b). The species was found in the diet of fish (Bellan-Santini 1972a).

*Stenopleura atlantica* is widely distributed in the world, including Antarctic waters (where it was recorded from Davis Sea), South Atlantic waters (e.g. Patagonian shelf), North Atlantic and Indian Ocean, having a circumpolar distribution in tropical waters (Vinogradov 1999, Vinogradov et al. 2004, De Broyer et al. 2007, Miloslavich et al. 2010), with total length ranging between 3.5 and 7 mm (Stebbing 1888, Barnard 1962b). *S. atlantica* is present in the diet of squid (Rosas-Luis et al. 2014).

## Practical procedures to differentiate the species within this family

The genus *Oradarea* can be recognized from other genera of the Calliopiidae by having the second gnathopod subchelate and elongated with long carpus and propodus (the first gnathopod is also subchelate but carpus and propodus is not elongated). Additionally, the accessory flagellum on antenna 1 is 1-articulated, while telson is entire (Barnard & Karaman 1991). There are 14 species in the genus *Oradarea* reporded from the Southern Ocean. The list of literature and detailed distribution records is available (De Broyer et al. 2007). The detailed drawings of *O. walkeri* are also available (Bellan-Santini 1972b), as well as the key and additional drawings for Southern Ocean *Oradarea* (Thurston 1974b). It is important to note that after the revision of the genus *Oradarea* (Thurston 1974b) one additional species (*O. crenelata*) has been described (Alonso de Pina 1995). The species of this genus are distinguished on the basis of combination of the length of rostrum, shape and length of inter-antennal and post-antennal lobes, the presence of dorsal spines on pereonites and pleonites as well as the shape of the telson. Taking this into account and also the number of the Antarctic species, it is highly recommended to refer to specialist literature when identifying the amphipod material.

*Stenopleura atlantica* is the only species in the genus known worldwide. The detailed description and drawings of the species are available (Stebbing 1888) as well as additional figures (Barnard 1962b). The species has smooth body, very short coxa 1-7 and entire telson (trifid). Its gnathopods are similar in shape and size, subchelate with oblique palm longer than hind margin and carpi much shorter than propodi (Barnard & Karaman 1991).

# FAMILY ISCHYROCERIDAE G.O. SARS, 1893

## Existing species that can be found are:

***Jassa* spp.**
***Pseudischyrocerus distichon* K.H. Barnard K.H., 1930**

Species belonging to genus *Jassa* are widely distributed in both Antarctic and subantarctic waters (De Broyer et al. 2007), with total length ranging between 2 and 24 mm (Conlan 1990) and have often been found in the diet of fish and Antarctic shags (Bellan-Santini 1972a, Bellan-Santini & Ledoyer 1974, Wakabara et al. 1990).

*Pseudischyrocerus distichon* is a circum-Antarctic species that extends its distribution as far north as South Georgia, Bouvet Island as well as Prince Edward and Marion Islands in the subantarctic (De Broyer et al. 2007). The species was found in the diet of fish (Wakabara et al. 1990).

## Practical procedures to differentiate the species within this family

The authors who found representatives of the genus *Jassa* in the stomach content of Antarctic vertebrates identified them as *J. falcata* (Bellan-Santini 1972a, Bellan-Santini & Ledoyer 1974, Wakabara et al. 1990). However, a revision of the genus stated that *J. falcata* is northern hemisphere species and the Southern Ocean records of this taxon should be checked as they possibly belong to other species (Conlan 1990). The key and several illustrations of the *Jassa* species can be found in the above cited revision (Conlan 1990). The distribution records of known Antarctic and subantarctic species are also available (De Broyer et al. 2007). The genus *Jassa* is recognized by the enlarged gnathopod 2 which possess large process ("thumb") on the palm. However, it is important to note that this feature is well developed only in adult males but not always present in females and weakly developed in juvenile males. The available keys to genera are often produced only for males and while identifying the amphipods from stomach content it is better to refer to original descriptions and specialist literature.

The representatives of the genus *Pseudischyrocerus* have 1-articulated accessory flagellum on antenna 1 and their gnathopod 1 is smaller than gnathopod 2. The first gnathopod is weakly subchelate and has an unlobed, elongated carpus; the second gnathopod is weakly to strongly subchelate (Barnard & Karaman 1991). There are three species in the genus *Pseudischyrocerus* reported from the Southern Ocean (*P. crenatipes*, *P. denticauda*, and *P. distichon*). The distribution records are available (De Broyer et al. 2007), but there is no identification key for these species. The description and drawings are available (Schellenberg 1931), some under the name *Eurystheus distichon* (Barnard 1930). The differences between the species are on the palm of male gnathopod 2, as well as on the pereopods 5-7. However, the species are subject to a large sexual dimorphism which is expressed in the shape of gnathopod 2; additionally, the pereopods 5-7 are very fragile and very often missing, so it is highly recommended to check the original descriptions and drawings of all species while identifying the material.

# FAMILY PHOTIDAE BOECK, 1871

## Existing species that can be found is:

***Gammaropsis (Gammaropsis) longicornis* Walker, 1906**

*Gammaropsis longicornis* has been reported from localities all around the Antarctic as well as from the Scotia Arc islands (South Shetland, South Orkney Islands and, South Georgia), with total length ranging between 3 and 6 mm (Walker 1907, Schellenberg 1931). It was also found in subantarctic (Magellan/Tierra del Fuego region, and Falkland Islands/ Islas Malvinas and Kerguelen Islands) (De Broyer et al. 2007). The species was found in the diet of fish (Wakabara et al. 1990).

## Practical procedures to differentiate the species within this family

The genus *Gammaropsis* is characterized by the article 3 of the first antenna being equal or longer than article 1, by the normally developed coxal plates 1-4, and by gnathopod 2 being larger than gnathopod 1 (both weakly to strongly subchelate). The uropod 3 has both rami long and straight (Barnard & Karaman 1991). There are 18 species in the genus *Gammaropsis* reporded from the Southern Ocean of which 14 belong to the subgenus *Gammaropsis*. The representatives of this subgenus can be distinguished by the uniform size and shape of anterior coxae, the short carpus of gnathopod 2 and the long (more than 1-articulated) acessory flagellum of antenna 1 (Barnard & Karaman 1991). The list of literature citations and detailed distribution records are available (De Broyer et al. 2007). The description and drawings of *G. longicornis* are also available (Walker 1907), as well as additional figures (Bellan-Santini & Ledoyer 1974). The key for the species of *Gammaropsis* in the world is available, but it is based only on adult males (Thurston 1974b). It is important to note that one additional Antarctic species (*G. deseadensis*) was described after preparation of that key (Alonso 1981). Similarly to the representatives of the family Ischyroceridae, the genus *Gammaropsis* also displays a significant sexual dimorphism with differences in the gnathopd morphology and size. However, the shape of this appendage was used as a main character when describing the species. Hence, also in this case it is needed to refer to the original publications while identifying the material, especially when dealing with female specimens.

# FAMILY PODOCERIDAE LEACH, 1814

## Existing species that can be found is:

***Podocerus capillimanus*** **Nicholls, 1938**

*Podocerus capillimanus* is distributed in the Antarctic Peninsula area as well as South Orkney Islands, South Shetland Islands and Bouvet Island, with total length ranging between 3.5 and 8.5 mm (Thurston 1974b, De Broyer et al. 2007). It has also been found in the subantarctic in Magellan/Tierra del Fuego region as well as around the Prince Edward, Marion Islands and Kerguelen Islands (De Broyer et al. 2007). The species was found in the diet of cape pigeons (Ridoux 1994).

## Practical procedures to differentiate the species within this family

The genus *Podocerus* has antenna 1 shorter than antenna 2. The accessory flagellum on the first antenna is 1-articulated, the pereopods 3-7 have similar size, urosomite 1 is not longer than urosomites 2 and 3 combined while uropod 2 is biramous (Barnard & Karaman 1991). There are six species of *Podocerus* reported from the Southern Ocean. The record of one of them (*P. brasiliensis*) needs confirmation as this species is generally found in warm waters. The key for all species of *Podocerus* is available (Barnard 1962a). The description and drawings of *P. capillimanus* are also available (Nicholls 1938, Thurston 1974b). Among the Antarctic *Podocerus* species, *P. capillimanus* can be recognized by the smooth dorsal side of the pereon and pleon segments. However, when studying stomach content materials it is recommended to refer to the specialist literature.

# FAMILY PONTOGENEIIDAE STEBBING, 1906

## Existing species that can be found are:

***Bovallia gigantea* Pfeffer, 1888** Figure 81 | page 186
***Djerboa furcipes* Chevreux, 1906** Figure 82 | page 186
***Gondogeneia antarctica* (Chevreux, 1906)** Figure 83 | page 187
***Gondogeneia georgiana* (Pfeffer, 1888)**
***Gondogeneia spinicoxa* Bellan-Santini & Ledoyer, 1974**
BM = 0.02 $BL^{3.01}$ (n=8) (0.8-0.34 cm) (Ridoux 1994)

***Gondogeneia subantarctica* (Stephensen, 1938)**
***Liouvillea oculata* Chevreux, 1912** Figure 84 | page 187
***Paramoera fissicauda* (Dana, 1852)** Figure 85 | page 188
***Paramoera walkeri* (Stebbing, 1906)** Figure 86 | page 188
***Prostebbingia brevicornis* (Chevreux, 1906)** Figure 87 | page 189
***Prostebbingia longicornis* (Chevreux, 1906)**
***Prostebbingia serrata* Schellenberg, 1926** Figure 88 | page 189
***Schraderia gracilis* Pfeffer, 1888** Figure 89 | page 190

*Bovallia gigantea* is distributed in Antarctic waters, in Antarctic Peninsula region as well as along the Scotia Arc as far North as South Georgia (De Broyer & Jażdżewska 2014), with total length ranging between 10 and 45 mm (Barnard 1932). This species is present in the diet of fish, Antarctic shags and Weddell seals (Richardson 1975, Moreno & Osorio 1977, Duarte & Moreno 1981, Linkowski et al. 1983, Barrera-Oro & Casaux 1990, Wakabara et al. 1990, Casaux et al. 1997a, Casaux et al. 1997b, Favero et al. 1998, Casaux et al. 2001, Casaux et al. 2008, Zamzow et al. 2011, Casaux & Barrera-Oro 2013).

*Djerboa furcipes* is distributed in Antarctic waters in the Antarctic Peninsula region as well as around South Orkney Islands and South Georgia. It is also distributed in subantarctic waters in Prince Edward and Marion, Crozet and Kerguelen Islands (De Broyer et al. 2007), with total length ranging between 3 and 22 mm (Barnard 1932). This species is present in the diet of fish (Bellan-Santini & Ledoyer 1974, Richardson 1975, Casaux 1998, Zamzow et al. 2011) and gentoo penguins (Xavier et al. 2017).

*Gondogeneia antarctica* is distributed in Antarctic waters in the Antarctic Peninsula region, along the Scotia Arc and in subantarctic waters, in Falkland Islands/Islas Malvinas extending up to the Magellanic/Tierra Del Fuego region (De Broyer et al. 2007, De Broyer & Jażdżewska 2014), with total length ranging between 3 and 21 mm (Thurston 1974b). *G. antarctica* is present in the diet of fish, gentoo penguins, cape pigeons and skuas (Moreno & Osorio 1977, Duarte & Moreno 1981, Williams 1990, 1991, Creet et al. 1994, Barrera-Oro & Piacentino 2007, Barrera-Oro & Winter 2008, Montalti et al. 2009, Zamzow et al. 2011, Moreira et al. 2014, Xavier et al. 2017).

*Gondogeneia georgiana* is distributed in Antarctic waters, in Antarctic Peninsula region, South Shetland Islands up to South Georgia region (De Broyer et al. 2007), with total length ranging between 7 and 16 mm (Schellenberg 1931, Andres 1982). This species is present in the diet of gentoo penguins (Williams 1990, 1991, Xavier et al. 2017, Xavier et al. 2018a).

*Gondogeneia spinicoxa* is distributed in Antarctic (South Shetland Islands) and subantarctic (Crozet and Kerguelen Islands) waters (De Broyer et al. 2007), with total length ranging between 13 and 15 mm (Bellan-Santini & Ledoyer 1974). This species is present in the diet of gentoo penguins, Antarctic shags and Kerguelen terns (Bellan-Santini & Ledoyer 1974, Ridoux 1994).

*Gondogeneia subantarctica* was recorded from the Antarctic Peninsula area, South Shetland Islands as well as Campbell and Auckland Islands (De Broyer et al. 2007), with total length ranging between 7 and 11 mm (Stephensen 1927). This species is present in diet of fish (Wakabara et al. 1990).

*Liouvillea oculata* is distributed in Weddell Sea, Antarctic Peninsula area as well as South Shetland Islands and South Orkney Islands (De Broyer et al. 2007), with total length ranging between 9 and 19 mm (Chevreux 1912, Thurston 1974b). The species was found in the diet of fish (Wakabara et al. 1990).

*Paramoera fissicauda* has a circumpolar distribution in Antarctic, subantarctic and subtropical waters, extending its distribution up to the Magellanic/Tierra Del Fuego region and Chatham Islands (New Zealand) (De Broyer et al. 2007), with total length ranging between 5 and 22 mm (Schellenberg 1931). This species is present in the diet of fish, Antarctic prions and thin billed prions (Bellan-Santini & Ledoyer 1974, Cherel et al. 2002a).

*Paramoera walkeri* has a circumpolar distribution in Antarctic waters, extending its distribution up to South Georgia (De Broyer et al. 2007, De Broyer & Jażdżewska 2014), with total length ranging between 9.5 and 17 mm (Thurston 1974a). This species is present in the diet of fish, Adélie penguins, gentoo penguins and cape pigeons (Bellan-Santini 1972a, Paulin 1975, Puddicombe & Johnstone 1988, Kiest 1993, Watanuki et al. 1994, La Mesa et al. 2000, Van Franeker et al. 2001, La Mesa et al. 2004b, Xavier et al. 2017).

*Prostebbingia brevicornis* (= *Pontogeneiella brevicornis* [De Broyer & Jażdżewski 1993, De Broyer et al. 2007, Kim et al. 2014]) is distributed in Antarctic and subantarctic waters (De Broyer et al. 2007), with total length ranging between 5 and 22 mm (Thurston 1974b). It is present in the diet of fish, gentoo penguins, cape pigeons and Antarctic shags (Bellan-Santini & Ledoyer 1974, Richardson 1975, Jażdżewski 1981, Ridoux 1994, Zamzow et al. 2011).

*Prostebbingia longicornis* is distributed in Antarctic Peninsula area and along the Scotia Arc extending north up to South Georgia (De Broyer et al. 2007), with total length ranging between 6 and 22 mm (Thurston 1974b). This species is present in the diet of fish (Wakabara et al. 1990).

*Prostebbingia serrata* has a circum-Antarctic distribution with the most northern record at the South Orkney Islands (De Broyer et al. 2007), with total length ranging between 9 and 12 mm (Bellan-Santini 1972b). This species is present in the diet of fish (Wakabara et al. 1990).

*Schraderia gracilis* is widely distributed in the Antarctic and subantarctic waters, with sizes ranging between 3 and 16 mm (Thurston 1974b). This species is present in the diet of fish (Bellan-Santini 1972a).

## Practical procedures to differentiate the species within this family

*Bovallia gigantea*, *Djerboa furcipes*, and *Liouvillea oculata* are the sole species belonging to their genera. The literature citations and detailed distribution records are available (De Broyer et al. 2007) as well as the identification key for these genera (Barnard & Karaman 1991). *Bovallia gigantea* is characterized by dorsal teeth on the last pereon and two first pleon segments, by a short rostrum, a first article of antenna 1 longer than the head and the third one weakly produced. The accessory flagellum is absent. Both pairs of gnathopods are subchelate with the carpus distinctly shorter than the propodus, but possessing a distal lobe. Rami of uropod 3 are subequal and the telson is cleft to its half. *Djerboa furcipes* is characterized by dorsal spines on pleon segments 1 and 2, thin, long, subchelate gnathopods 1, 2 which carpus has similar length as propodus. The inner ramus of uropod 3 is short and the telson is deeply cleft. *Liouvillea oculata* has dorsal spines on the first two pleon segments, a long rostrum (reaching the end of the first article of peduncle of antenna 1) and very large eyes which occupy almost the whole surface of the head. The gnathopods are subchelate, while telson is cleft 1/4 (Barnard & Karaman 1991).

The genera *Gondogeneia*, *Paramoera* and *Prostebbingia* group amphipods which generally look very similar. There are just a few characters which can be used by non-specialists to discriminate them. The genus *Gondogeneia* is characterized by the lack of an accessory flagellum on antenna 1 (if it is present it is scale-like), the lack of an oblique setal row on the inner plate of maxilla 2 and by the telson lacking apical armaments. Amphipods belonging to the genus *Paramoera* possess a very short accessory flagellum, an oblique setal row on inner plate of maxilla 2 as well as apical armaments on the telson. The genus *Prostebbingia* groups animals lacking an accessory flagellum, possessing an oblique setal row on inner plate of second maxilla and lacking apical setae on the telson (Barnard & Karaman 1991).

There are 15 species in the genus *Gondogeneia* reported from the Southern Ocean. Ten of them, including *G. antarctica*, *G. georgiana*, and *G. subantarctica*, can be found in the identification key produced (Thurston 1974b), where they are presented under the former genus name *Pontogeneia*. It is important to note, however, that *G. spinicoxa* and four other species are omitted in that key. The extensive literature citations and distribution records of *Gondogeneia* species are available (De Broyer et al. 2007) as well as the most detailed illustration of *G. antarctica* (Chevreux 1906). Equally, *G. spinicoxa* has been also best described by Bellan-Santini and Ledoyer (1974) while *G. georgiana* has been drawn in detail by Andres (1982). The most detailed description and drawings of *G. subantarctica* are available (Stephensen 1927), where the species is mentioned as *Pontogeneia antarctica*. The differences between species within this genus are very minute, based partly on the appearance of flagellum of the first antenna, which is often broken. When studying the amphipod material it is necessary to refer to the original descriptions and drawings to avoid mistakes.

There are 22 species belonging to the genus *Paramoera* recorded from the Southern Ocean. There is no overall identification key for this genus, but the extensive literature citations and distribution records are available (De Broyer et al. 2007). *P. fissicauda* is the best drawn and described by Stebbing (under the name *Atyloides australis*) as well as by Bellan-Santini and Ledoyer (Stebbing 1888, Bellan-Santini & Ledoyer 1974). The most detailed description and drawings of *P. walkeri* are also available (Chevreux 1913) under the name *Bovallia walkeri*. Similarly to *Gondogeneia* the differences between species within *Paramoera* are small and specialist literature is required to identify the amphipod material.

There are six species of *Prostebbingia* reported from the Southern Ocean (one of which - *P. laevis* - is *nomen dubium*). There is no identification key available, but the literature citation and distribution records are available (De Broyer et al. 2007). *P. brevicornis* and *P. longicornis* are thoroughly described and illustrated (Chevreux 1906) under the former genus name - *Atyloides*. Additional drawings of *P. brevicornis* are also available (Bellan-Santini & Ledoyer 1974, Kim et al. 2014). Thurston has discussed the differences between the two species cited above (Thurston 1974b). *P. serrata* is best described and drawn in original description (Schellenberg 1926); additional drawings are also available (Bellan-Santini 1972b). The species within genus *Prostebbingia* can be divided into two groups: one assembling species having interantennal lobe of head rectangularly rounded and the second where this part of the head is triangularly acute. *P. serrata* belong to the first group. The species can also be recognized by large tooth on the posterodistal corner of epimeral plate 3 combined with serrate and not very expanded posterior margin of basis of pereopod 5 (Schellenberg 1926).

Both *P. brevicornis* and *P. longicornis* belong to the group with an acute interantennal lobe of head. However, the differences between these two species are very difficult to observe, so it is recommended to use the specific literature when identifying the material.

The genus *Schraderia* can be recognized by the elongated subchelate gnathopods of both pairs (carpus is usually shorter than propodus). Accessory flagellum on antenna 1 is present, the dorsal side of the body is smooth and the rami of uropod 3 are subequal (Barnard & Karaman 1991). There are five species of *Schraderia* reported from the Antarctic and subantarctic waters. *S. gracilis* was thoroughly described and illustrated (under the name *Stebbingia gracilis*) (Chevreux 1913). Additional drawings and discussion on the morphological forms of this species is available (Thurston 1974b). There is also an identification key for *Schraderia* species (Bellan-Santini & Ledoyer 1974), however, it does not include two species described the same year by Thurston (Thurston 1974b). *Schraderia gracilis* has distinct serrations on the postantennal lobe of head, ventral margin of coxae 1-3 as well as posterior margin of epimeral plate 3. The posterior margin of pereopods 5-7 and apices of the deeply cleft telson are also serrated. It is important to note, however, that there are two recognized forms or subspecies of *S. gracilis* recorded from the Antarctic waters. The typical form (*S. gracilis gracilis*) have all the aforementioned features, while they are not so pronounced in the second one (*S. gracilis calceolata*) (Thurston 1974b). Taking this into account it is highly recommended to use the specific literature while identifying the material.

# ORDER ISOPODA

Latreille, 1817

Antarctic and subantarctic marine isopods are represented in 50 families, with most isopod species being benthic; only few taxa have secondarily regained the ability to swim (Kaiser 2014). The geographic distribution of all Southern Ocean Isopoda described until 1991, including biogeographic maps, was already summarized (Brandt 1991).

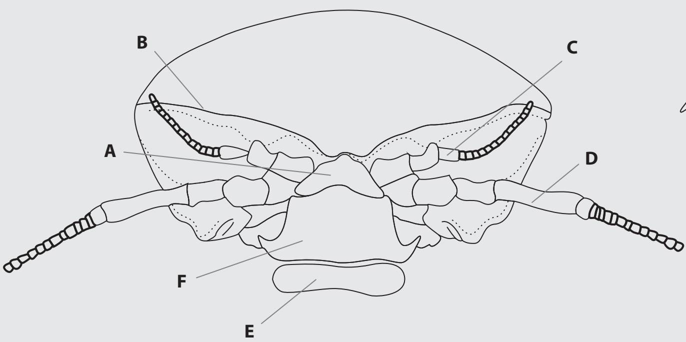
# FAMILY AEGIDAE WHITE, 1850

## Existing species that can be found is:

***Aega semicarinata*** **Miers, 1875** Figure 90 | page 192

*Aega semicarinata* is a temporary parasite (as adults; maximum total length: 58.00 mm) of fish with a circumpolar distribution in subantarctic waters, including around subantarctic islands (e.g. Prince Edward Islands, Kerguelen Islands, Macquarie Island, Falkland Islands), Magellanic region /Tierra del Fuego and coast of Chile (Kensley 1980). It was found twice in the diet of black-browed albatrosses, expected to be from fish parasitized with *A. semicarinata* (Cherel et al. 2000). This species has also been found at Cape Hoorn and at Cape Point, South Africa. This species has been recorded from littoral depths to 334 m (Niersteasz 1931).

## Practical procedures to differentiate the species within this family



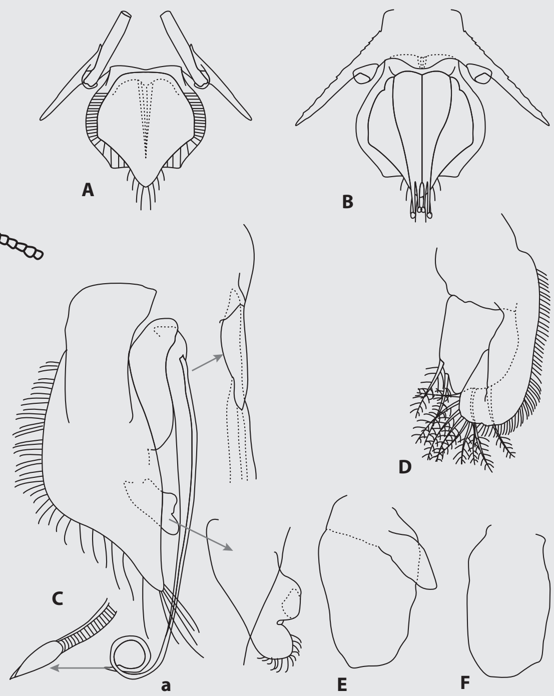




Figure 91 A. The general structures of Isopoda. Legend of an isopod cephalon: A. Front Lamina; B. Frontal margin; C. Antennule; D. Antenna; E. Labrum; F. Clypeus.

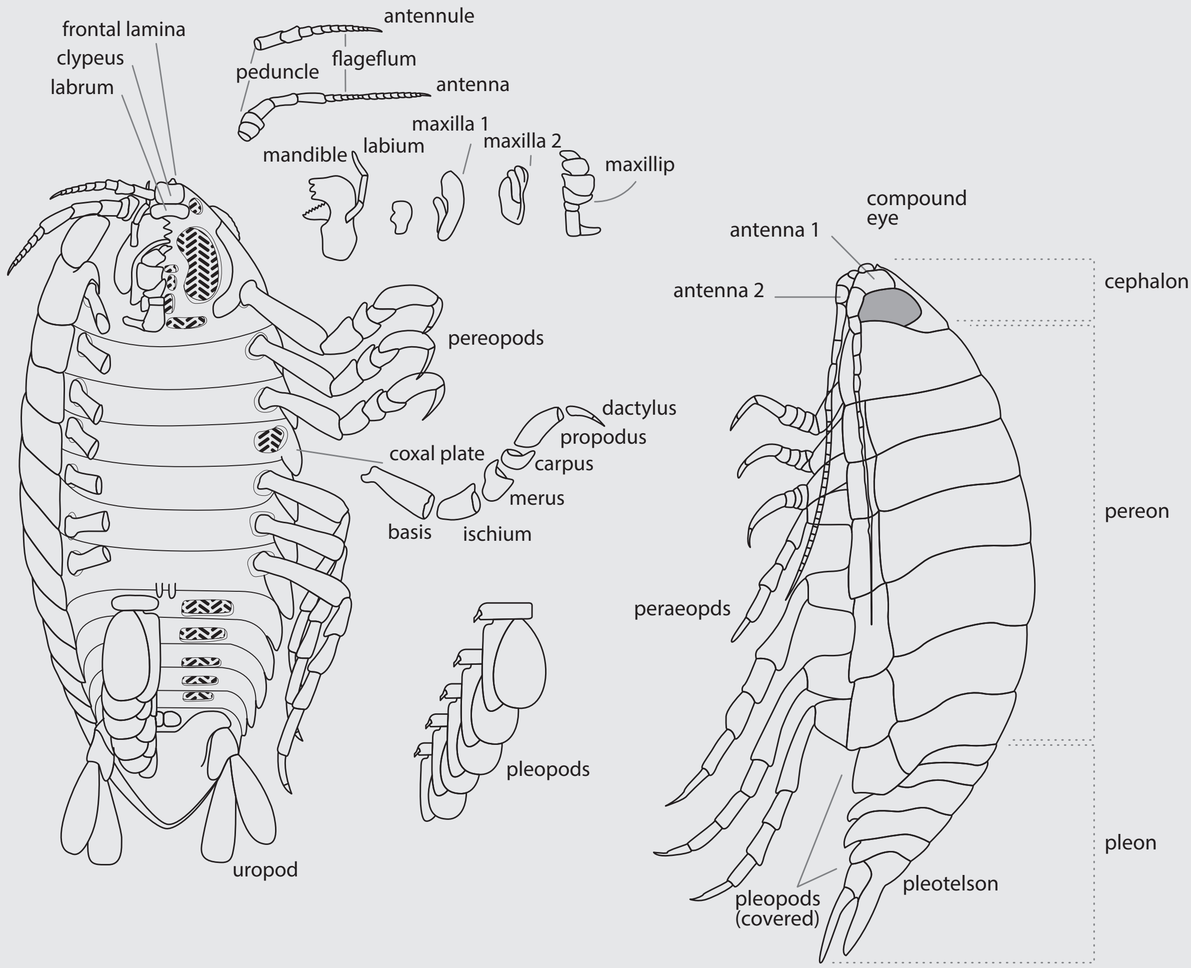



Figure 91 B. Illustration of sexual differences between pleopods 1 and 2 in the Asellota (Janiroidea). Legend: A. Female operculum (pleopod 2) in ventral view; B. Male pleopods 1 and 2 in ventral view; C. Male pleopod 2 with details of appendix masculina (upper arrow) and tip (a) as well as exopod (lower longer arrow); D. Male pleopod 3; E. Male pleopod 4; F. Male pleopod 5. (Naylor & Brandt, 2015) (Copyright permission from Linnean Society of London).

*Aega semicarinata* has a pleotelson with a concave terminal margin forming two blunt points; surface pocked with a pair of large circular depressions on dorsal surface (Branch et al. 1991).

# FAMILY ARCTURIDIDAE POORE, 2001

## Existing species that can be found is:

***Arcturides cornutus* Studer, 1882** Figure 92 | page 192

The valviferan isopod *Arcturides cornutus* (= *A. tribulis* Hale, 1946, *A. acuminatus* Sheppard, 1957 and *A. cornutus* Studer, 1884 [Park 1996]) reaches 20 mm total length. It is a subantarctic species distributed in the Indian and Pacific Oceans, particularly in the region of Kerguelen, Crozet and Prince Edward Islands (Kensley 1980, Park 1996), Marion Island (Beddard 1886, Nierstrasz 1941) and Heard Island (Kussakin 1982) at depths between 90-650 m. *A. cornutus* was found once in the diet of black-browed albatrosses (Cherel et al. 2000).

## Practical procedures to differentiate the species within this family

Only one species in the family, illustrated in Branch et al. (1993). Strong frontally directed supraocular spines, not surpassing the small frontal eye, body surface smooth, without spines or ornamentation. Original description has been already done (Studer 1882).

# FAMILY CHAETILIIDAE DANA, 1849

## Existing species that can be found is:

***Glyptonotus antarcticus* Eights, 1852** Figure 93 | page 193

*Glyptonotus antarcticus* (which comprise several undescribed species (Agrawal et al. 2013); total length ~ 100 mm but possibly reaching bigger sizes) may have a circumpolar distribution in Antarctic waters (considered a high Antarctic shelf organism), around some Antarctic islands, such as South Georgia and South Sandwich islands, in subantarctic waters (Castelló 2004, Held & Wägele 2005), at the South Shetland Islands(Miers 1883), Montagu Island (Kussakin 1967), Anvers Island (Schultz 1978), Wiencke Island and Palmer Archipelago (Sheppard 1957), Enderby Land (Haie 1946), Terre Adelie, Curie, Bernard and Lamarck Islands (Amar & M. L. Roman 1973), Ross Sea and from Gauss Station (Monod 1931) and from Scott base (Meyer-Rochow 1980). *G. antarcticus* is present in the diet of fish and Weddell seals (Moreno & Osorio 1977, Barrera-Oro & Casaux 1990, Foster & Montgomery 1993, Casaux et al. 1997a, Zamzow et al. 2011, Casaux & Barrera-Oro 2013). However, one has to keep in mind that this species is not one and therefore most likely not to have a circumpolar distribution in Antarctic waters; genetic analysis revealed four groups of haplotypes representing cryptic, but reproductively isolated species rather than a single species (Held & Wägele 2005).

## Practical procedures to differentiate the species within this family

*Glyptonotus antarcticus* is a large endemic Antarctic species (total length up to 90 mm). It is the only chaetiliid isopod recorded from Antarctic waters (Kaiser 2014) and easily identifiable by its large size.

# FAMILY SEROLIDAE DANA, 1852

## Existing species that can be found are:

***Ceratoserolis trilobitoides* (Eights, 1833)** Figure 94 | page 194
***Septemserolis septemcarinata* Miers, 1875** Figure 95 | page 194
***Spinoserolis latifrons* (White, 1847)** Figure 96 | page 195

*Ceratoserolis trilobitoides* (Eights, 1833) (= *Serolis cornuta* Studer, 1879 (Wägele 1986, Boyko 2016), *Ceratoserolis cornuta* (Studer, 1879), *Serolis trilobitoides* Eights, 1933) is a species being distributed circumantarctically (maximum total length ~ 50 mm) in Antarctic (i.e. Indian and Atlantic sectors of the Southern Ocean, including South Georgia, South Shetland Islands and South Sandwich Islands) and subantarctic and subtropical waters (Marion Island, Prince Edward Islands, Crozet Islands and Kerguelen Islands) waters(Kussakin 1967, Kensley 1980, Luxmoore 1982). However, it is cryptic, as the molecular data strongly suggest that *Ceratoserolis trilobitoides sensu lato* contains at least one, perhaps more, previously overlooked species (Held 2003). *C. trilobitoides* is present in the diet of black-browed albatrosses (Cherel et al. 2000).

*Septemserolis septemcarinata* (= *Serolis septemcarinata* Miers, 1875 (Schotte 2014a); maximum total length: 28 mm but most records are smaller, Brandt, unpubl. data) is distributed in Antarctic (e.g. around South Georgia, South Sandwich Islands), subantarctic (e.g. Marion Island, Prince Edward Islands, Crozet Islands and Kerguelen Islands), Patagonia and the Falkland Islands (Nordenstam 1933) and subtropical waters (Kensley 1980, Luxmoore 1982, Brandt 1991, Leese et al. 2010). It was found once in the diet of black-browed albatrosses (Cherel et al. 2000) .

*Spinoserolis latifrons* (= *Serolis latifrons* White, 1847 (Schotte 2014b); maximum total length ~ 25 mm) is distributed in Antarctic waters, Subantarctic (e.g. Marion Island, Prince Edward Islands, Crozet Islands and Kerguelen Islands) and subtropical waters (White 1847, Kensley 1980, Castelló 2004). It is present in the diet of rockhopper penguins and black-browed albatrosses (Ridoux 1994, Cherel et al. 2000).

## Practical procedures to differentiate the species within this family

All specimens of the Serolidae can easily be identified by their largely flattened body shape (dorsoventrally), thus they look like a coin and many species are round in shape. *Septemserolis septemcarinata*: eyes large, paired; pleotelson bears seven longitudinal ridges, terminal margin broadly notched. *Serolis cornuta*: eyes present; pleotelson, margin coarsely serrated, four middorsal spines. *Spinoserolis latifrons*: eyes absent; pleotelson not ridged, terminal margin notched (Branch et al. 1991). It is surprising that another species, *Serolella bouvieri* (Richardson, 1906), is not very common in the stomachs of predators (Xavier et al. 2017), as this is the most heavily cuticularized species of the Serolidae from which it would occur in the diet of top predators much more than the other species, like *Ceratorserolis*, as *S. bouvieri* has no acute lateral epimers while *Ceratoserolis* has (Angelika Brandt, pers. comm.); *Serolella bouvieri*, originally described as *Serolis bouvieri* Richardson, 1906 as a length of up to 35 mm and has a distribution in Antarctic waters from the South Orkney and South Shetland Islands down the West Antarctic Peninsula to the area of the Palmer Peninsula, at Paulet Island, and the western and eastern Weddell Sea (Richardson 1906, 1908, Nordenstam 1933, Sheppard 1933, Stephensen 1947, Sheppard 1957, Kussakin 1967, Brandt 1991).

# FAMILY SPHAEROMATIDAE LATREILLE, 1825

## Existing species that can be found is:

***Cassidinopsis emarginata* (Guérin-Méneville, 1843)** Figure 97 | page 195

*Cassidinopsis emarginata* is distributed in Antarctic (e.g. South Georgia, South Sandwich Islands, South Orkney Islands) and Subantarctic waters (e.g. Marion Island, Prince Edward Islands, Crozet Islands, Kerguelen Islands, Heard Island, Macquarie Island, Falkland Islands, South American coast (Chile and Argentina) and Auckland Islands and Campbell Island) having a circumpolar distribution in Subantarctic waters (Kensley 1980, Brandt 1991, Edgar & Burton 2000) (Maximum total length: 24 mm). *C. emarginata* is present in the diet of fish and of black-browed albatrosses (Williams 1983, Cherel et al. 2000).

## Practical procedures to differentiate the species within this family

*Cassidinopsis emarginata*: pleotelson smooth, rounded terminally, tip feebly emarginate; uropod, exopod stylet-shaped, attached to endopod at midpoint of lateral border (Branch et al. 1991).

# ORDER LOPHOGASTRIDA

Boas, 1883

In the Southern Ocean, the Order Lophogastrida is represented by 3 families (Gnathophausiidae, Eucopiidae and Lophogastridae) (Petryashov 2014b) of which the family Gnathophausiidae are noted to have pelagic or benthopelagic species that are commonly found in predators diets.

» FAMILY GNATHOPHAUSIIDAE UDRESCU, 1984

# FAMILY GNATHOPHAUSIIDAE UDRESCU, 1984

## Existing species that can be found are:

***Neognathophausia gigas* (Willemoes-Suhm, 1873)** Figure 98 | page 197
BL/ThL = 2.45 (n=4) (4.2-11.8 cm) (Ridoux 1994)
BM/$BL^3$ = 0.012 (n=4) (1.5-15.0 cm) (Ridoux 1994)

***Neognathophausia ingens* (Dohrn, 1870)** Figure 99 | page 197

*Neognathophausia gigas* (= *Gnatophausia gigas* Willemoes-Suhm, 1873 (Meland & Aas 2013, Mees & Meland 2014), *Gnathophausia drepanephora* Holt & Tattersall, 1905) is circumpolarly distributed in Antarctic waters (as far south as the Antarctic coastal regions) as well as widely distributed in the North Atlantic and North Pacific (with the exception of the Arctic) (Ledoyer 1995, Petryashov 2014a, Petryashov 2014b). *G. gigas* is present in the diet of grey-headed albatrosses, black-browed albatrosses, light-mantled sooty albatrosses, sooty albatrosses, yellow nosed albatrosses, grey faced petrels, great winged petrels, soft plumaged petrels, blue petrels, white-chinned petrels, grey petrels and Kerguelen petrels, Salvin's prions, Antarctic prions and thin-billed prions (Imber 1973, Ridoux 1994, Cherel et al. 2000, 2002d, Connan et al. 2007a, Delord et al. 2010, Richoux et al. 2010, Connan et al. 2014).

*Neognathophausia ingens* (= *Gnatophausia ingens* [Dohrn, 1970] [Mees & Meland 2015], *Gnathophausia bengalensis* Wood-Mason & Alcock, 1891, *Gnathophausia calcarata* G. O. Sars, 1883, *Gnathophausia doryphora* Illig, 1906, *Gnathophasia inflata* Willemoes-Suhm, 1873, *Lophogaster ingens* Dohrn, 1870) is similarly distributed as *G. gigas* in the World Ocean but present as far south as the Southern Circumpolar Current Front (SACCF) (Petryashov 2014b). *G. ingens* is present in the diet of fish, black-browed albatrosses, yellow nosed albatrosses, grey-faced petrels and southern giant petrels (Imber 1973, Clark 1985, Rosecchi et al. 1988, Ridoux 1994, Young et al. 1997, Catard et al. 2000, Cherel et al. 2000, Pinaud et al. 2005, Delord et al. 2013).

## Practical procedures to differentiate the species within this family

Within the genus *Neognathophausia*, *N. gigas* and *N. ingens* have antennal scales without articulation; outer margin ending in small spine (Murano 1999). These large to very large mysids have a crimson red colour; they are often found in pieces in food samples. Two diagnostic features are the shapes of pleural plates and of antennal scales. *N. gigas* (up to 160 mm body length [Haithcock Pequegnat 1965]) has a slender rostrum (rostrum shorter than carapace), distinctly denticulate (Murano 1999, Meland & Aas 2013). Supra-orbital spines are distinct but small. Antennal scale somewhat tapering toward apex, outer margin with 4 strong teeth (Murano 1999, Meland & Aas 2013). Anterior lappet of the epimera of the first to the fifth abdominal segments small, rounded (Haithcock Pequegnat 1965). *N. ingens* is the largest mysid species (up to 350 mm (Haithcock Pequegnat 1965); it has a rostrum rather short, broad at base, indistinctly denticulate (in young specimens, rostrum as long as carapace whereas in mature specimens the rostrum is short triangular and less denticulate) (Murano 1999, Meland & Aas 2013). Supra-orbital spines are wanting. Antennal scale subovate, apex truncate, distal half of its outer edge minutely serrate (Murano 1999). Both lappets of the epimera of the second to fifth abdominal segments pointed and spiniform (Haithcock Pequegnat 1965). Compare both species with other *Neognathophausia* spp., particularly if working with the feeding ecology of predators that forage into warmer waters (see Meland and Aas 2013).

# ORDER MYSIDA

Latreille, 1817

The order Mysida comprises pelagic species from 2 families in the Southern Ocean, both caught by predators (Petryashov 2014b).

» FAMILY MYSIDAE HAWORTH, 1825

» FAMILY PETALOPHTHALMIDAE CZERNIAVSKY, 1882

# FAMILY MYSIDAE HAWORTH, 1825

## Existing species that can be found are:

***Antarctomysis maxima* (Holt & Tattersall, 1906)** Figure 100 | page 199
$Log_{10}DW = 2.876 * Log10BL - 2.724$ (n=65) (using frozen specimens, in mm) (Ward 1984)
$Log_{10}DW = 2.992 * Log10BL - 2.935$ (n=65) (using formalin preserved specimens, in mm) (Ward 1984)
$BMs = 0.00328 * BL^{3.236}$ (11-52 mm, n=187) (Siegel & Mühlenhardt-Siegel 1988)
$BMdw = 0.00017 * BL^{3.592}$ (11-52 mm, n=187) (Siegel & Mühlenhardt-Siegel 1988)

***Antarctomysis ohlinii* Hansen, 1908** Figure 101 | page 199
$BMs = 0.00373 * BL^{3.194}$ (12-61 mm, n=151) (Siegel & Mühlenhardt-Siegel 1988)
$BMdw = 0.00057 * BL^{3.241}$ (12-61 mm, n=151) (Siegel & Mühlenhardt-Siegel 1988)
$Log_{10}BM_{dw}=3.191*Log_{10}BL - 3.409$ (n=52) (in mm) (using formalin preserved specimens from Moraine Fjord South Georgia October [Ward 1985b])
$Log_{10}BM_{dw}=3.528*Log_{10}BL-3.918$ (n=22) (in mm) (using formalin preserved specimens from Cumberland Bay South Georgia January [Ward 1985b])

***Mysidetes morbihanensis* Ledoyer, 1995 (specific equations available for *M. posthon*:**
$BMs = 0.01018 * BL^{2.911}$ (8-23 mm, n=113) (Siegel & Mühlenhardt-Siegel 1988)
$BMdw = 0.00051 * BL^{3.253}$ (8-23 mm, n=113) (Siegel & Mühlenhardt-Siegel 1988)

*Antarctomysis maxima* has a circumpolar distribution in Antarctic waters (found from coastal waters). But also in subantarctic and subtropical waters, generally up to the Subtropical Front (Siegel & Mühlenhardt-Siegel 1988, Petryashov 2014b). A. *maxima* is present in the diet of fish, gentoo penguins, macaroni penguins, blue petrels, Antarctic prions, Wilson's storm petrels, Weddell seals and crabeater seals (Dearborn 1965, Targett 1981, Green & Williams 1986, Croxall et al. 1988, Williams 1990, Kato et al. 1991, Williams 1991, Kock et al. 1994, Pakhomov et al. 1996a, Croxall et al. 1997, Pakhomov 1998a, b, Kock & Jones 2002, Flores et al. 2004, Xavier et al. 2017, Xavier et al. 2018a).

*Antarctomysis ohlinii* has a circumpolar distribution in Antarctic waters (found from coastal waters up to South Georgia) (Siegel & Mühlenhardt-Siegel 1988, Crescenti et al.

1994, Petryashov 2014b), occurring in the diet of fish, emperor penguins, gentoo penguins and Weddell seals (Dearborn 1965, Croxall et al. 1997, Cherel & Kooyman 1998, La Mesa et al. 2004b).

*Mysidetes morbihanensis* is distributed in subantarctic and subtropical waters, in south Indian Ocean waters (Ledoyer 1995) and it is found in the diet of rockhopper penguins and common diving petrels (Bocher et al. 2000a, Tremblay & Cherel 2000, 2003).

## Practical procedures to differentiate the species within this family

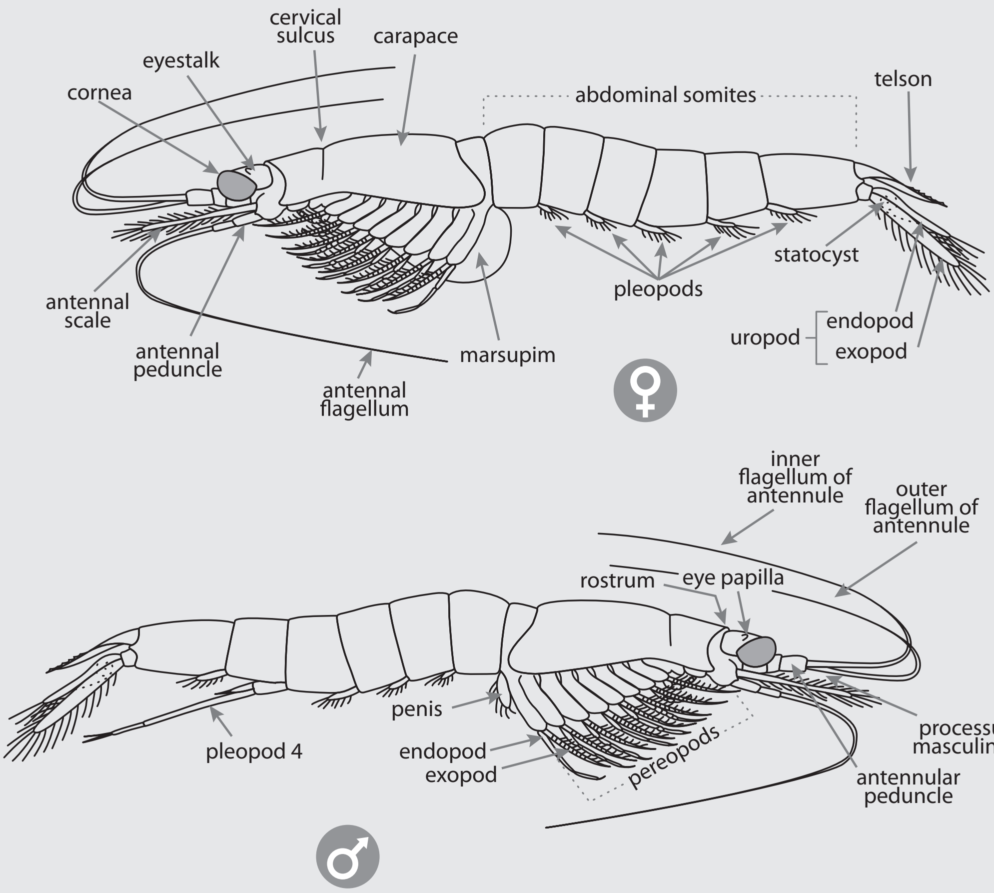



Figure 102. The general structures of a Mysidae. (Murano, 1999) (Copyright permission from Backhuys Publishers, Leiden, The Netherlands).

Features allowing identification of *Antarctomysis maxima* and *A. ohlinii* are described in Tattersall (1961) and Ledoyer (1995). The best features for their identification are the form of the eyes and the armature of the sympod of the Antenna 2. *A. maxima* have a larger cornea than *A. ohlinii*; the sympod of Antenna 2 of *A. maxima* bears 2 acute spines (only 1 for *A. ohlinii*). Of the two species, *A. ohlinii* is generally the larger of the two in South Georgia (up to ~ 65 mm body length vs ~ 50 mm for *A. maxima*) although at some locations *A. maxima* may be considerably larger (~ 96 mm found in a trawl carried out in Maxwell Bay South Shetlands; Ward, unpubl. data) (Siegel & Mühlenhardt-Siegel 1988). In size, both species are comparable to *E. superba* and also share its habit of forming aggregations, thus increasing its attraction to predators. *Mysidetes morbihanensis* is described in Ledoyer (1995). A key identification feature is the number and size of spines all along the telson, with medium-sized spines interspersed with small spines on the lateral borders (for a total of ~40 spines) and one large spine on each side of the telson at its two posterior ends. For less experienced ecologists, do compare mysids with euphausiids (and they key identification characters) as they can be easily mistaken. Note there are other species in *Mysidetes* spp. which although abundant in benthic and hyperbenthic net hauls (e.g. *M. posthon* around South Georgia), they have not, as yet, been reported in predator food remains.

# FAMILY PETALOPHTHALMIDAE CZERNIAVSKY, 1882

## Existing species that can be found is:

***Petalophthalmus armiger* Willemoes-Suhm, 1875** Figure 103 | page 200

*Petalophthalmus armiger* is distributed in subantarctic, subtropical and tropical waters off New Zealand and in the south Indian Ocean, and widely distributed in tropical and temperate waters (including in the North Atlantic) in the Indian and Pacific Oceans (Ledoyer 1995, Stevens 2012a, Petryashov 2014a). *P. armiger* is found in the diet of fish and great winged petrels (Ridoux 1994, Stevens 2012a).

## Practical procedures to differentiate the species within this family

The combination of flattened leaf-like eyes without visual elements, and a short, sharp, subtriangular rostrum, differentiates *P. armiger* from other members of this genus (Hendrickx & Hernandez-Payan, 2018).

# SUBCLASS THECOSTRACA
Gruvel, 1905

# ORDER LEPADIFORMES
Buckeridge & Newman, 2006

Goose barnacles, as commonly known, are pelagic and have been found attached to all types of floating structures (biotic or abiotic) (Darwin 1854, Hinojosa et al. 2006) and are sometimes ingested by seabirds (see below).

» FAMILY LEPADIDAE DARWIN, 1852

# FAMILY LEPADIDAE DARWIN, 1852

## Existing species that can be found is:

***Lepas (Anatifa) australis*** **Darwin, 1851** Figure 104 | page 202
Cypris larvae: BM/BL$^3$ = 0.011 (n=11) (0.21-0.28 cm) (Ridoux 1994)

*Lepas (Anatifa) australis* (= *Lepas australis* [Clarke & Johnston 2003, WoRMS 2014a]) has a circumpolar distribution in Antarctic, subantarctic and subtropical waters, between 30°S and 60°S) (Nilsson-Cantell 1930, 1939, Foster 1978, Hinojosa et al. 2006). It is present in the diet of rockhopper penguins, black-browed albatrosses, Buller's albatrosses, grey-headed albatrosses, blue petrels, cape pigeons, short tailed shearwaters, Antarctic prions, Salvin's prions, fairy prions, fulmar prions, thin billed prions, broad billed prions, Wilson's storm petrels, black bellied storm petrels, grey backed storm petrels, common diving petrels, South Georgian diving petrels, Crozet shags and brown skuas (Imber 1981, West & Imber 1986, Prince & Copestake 1990, Ridoux 1994, Weimerskirch et al. 1999, Bocher et al. 2000a, Reinhardt et al. 2000, Cherel et al. 2002a, Cherel et al. 2002b, Cherel et al. 2002d, Xavier et al. 2003a, Connan et al. 2007b, Richoux et al. 2010, Cherel et al. 2014, Connan et al. 2014). Adult specimens are found in food samples from large seabirds (e.g. albatrosses), while cypris larvae (and stalked juveniles) occur sometimes in significant numbers in the diet of small planktonophageous seabirds, (e.g. storm petrels, prions).

## Practical procedures to differentiate the species within this family

The species is by far the commonest species of pelagic barnacles from the Southern Ocean. Adults are generally in bad conditions precluding differentiating *Lepas (Anatifa) australis* from *Lepas (Anatifa) anatifera*. Biogeography also indicates that cypris larvae are likely to be *Lepas (Anatifa) australis* (Imber 1981).

# CLASS OSTRACODA

Gruvel, 1905

# ORDER MYODOCOPIDA

Sars, 1866

As Ostracoda, the Antarctic Myodocopida (i.e. *Gigantocypris*) are easily distinguished by its size and shape of a cherry; once seen, it would not be mistaken for any other pelagic form (Tibbs 1965).

» FAMILY CYPRIDINIDAE BAIRD, 1850

# FAMILY CYPRIDINIDAE BAIRD, 1850

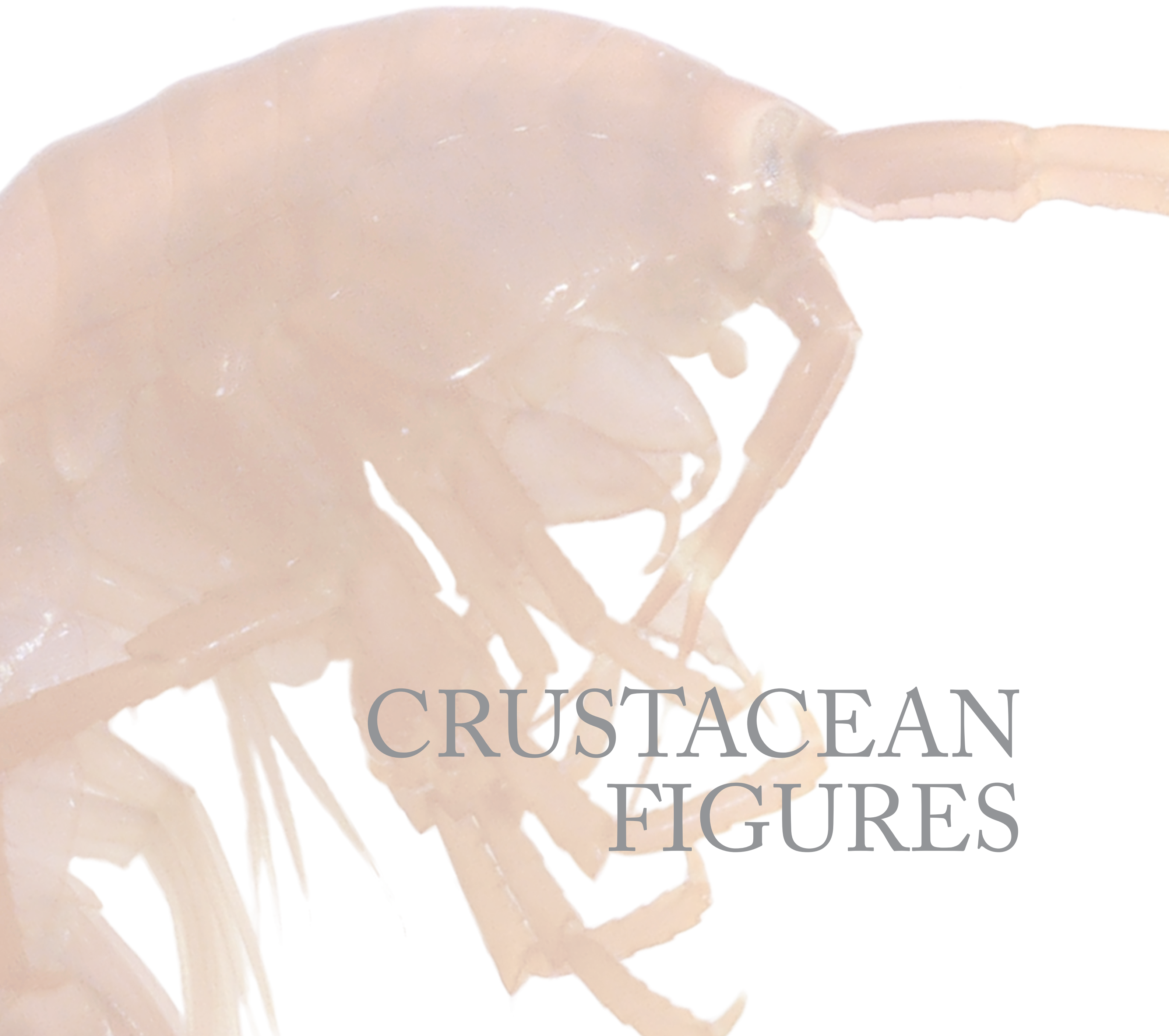
## Existing species that can be found is:

***Gigantocypris muelleri*** **Skogsberg, 1920** Figure 105 | page 204

*Gigantocypris muelleri* has a circumpolar distribution in Antarctic waters, and widely reported in the warmer waters of the Atlantic (including in the northern hemisphere [Angel et al. 2007]) and Indian Oceans (Tibbs 1965, Moguilevsky & Gooday 1977, Benassi et al. 1994, McKenzie et al. 2000, Kruk & Chavtur 2003, Mazdygan & Chavtur 2011). *G. muelleri* occurs in the diet of blue and Kerguelen petrels (Ridoux 1994). The specimens of *Gigantocypris* found in food samples of Antarctic prions and thin-billed prions probably refer to that species (Cherel et al. 2002a).

## Practical procedures to differentiate the species within this family

*Gigantocypris* species are immediately recognisable by their "large" size and rotundity. In *G. muelleri*, the ventral gape of the carapace does not extend its full length. It is well-coloured, appearing like a translucent orange-red ball (Angel 1999).



# CRUSTACEAN FIGURES

## SUPERCLASS MULTICRUSTACEA

Regier, Shultz, Zwick, Hussey, Ball, Wetzer, Martin & Cunningham, 2010

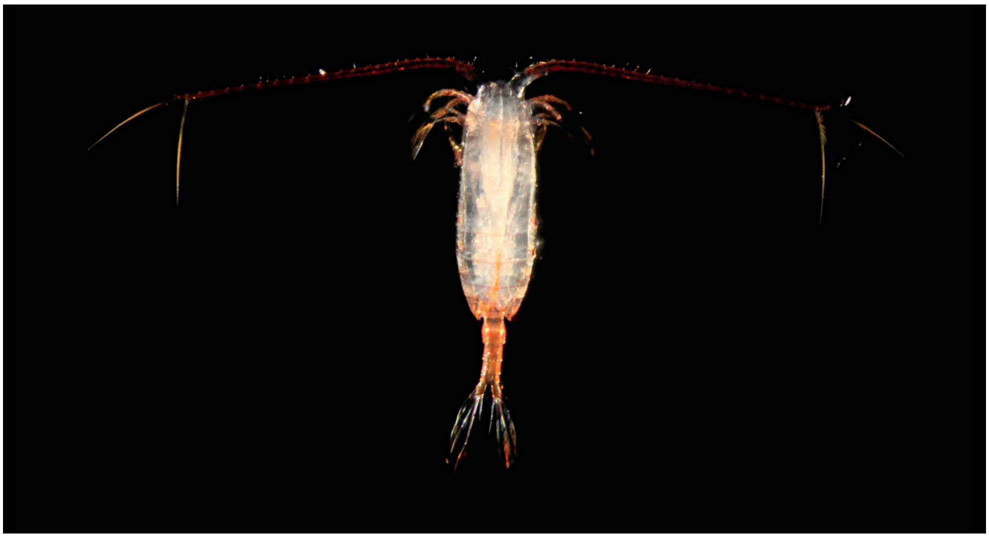
## SUBCLASS COPEPODA

Milne-Edwards, 1840

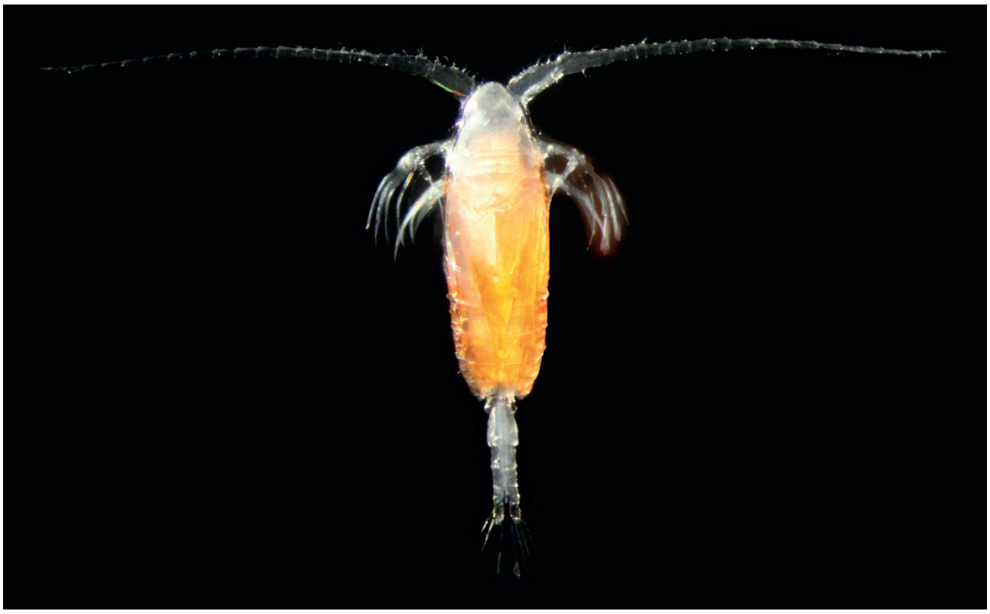
# ORDER CALANOIDA

Sars G. O., 1903

# FAMILY CALANIDAE DANA, 1849



*Calanus propinquus* Brady, 1883 Figure 2 | page 15
(Photo and copyright permission from Miram Gleiber).



*Calanus simillimus* Giesbrecht, 1902 Figure 3 | page 15
(Photo and copyright permission from Miram Gleiber).

## FAMILY CANDACIIDAE GIESBRECHT, 1893

*Candacia maxima* Vervoort, 1957 Figure 5 | page 20
(Photo by Nicolas Raymond (USNM 269180); Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

## FAMILY CLAUSOCALANIDAE GIESBRECHT, 1893

*Drepanopus pectinatus* Brady, 1883 Figure 6 | page 21
(Photo and copyright permission from Claude Razouls [https://copepodes.obs-banyuls.fr/en/index.php]).

*Drepanopus forcipatus* Giesbrecht, 1888 Figure 7 | page 21
(Photo and copryright permission from Marianne Wootton and Sir Alister Hardy Foundation for Ocean Science [SAHFOS]).

## FAMILY EUCHAETIDAE GIESBRECHT, 1893

*Paraeuchaeta antarctica* Giesbrecht, 1902 Figure 8 | page 23
(Photo and copyright permission from Marianne Wootton and Sir Alister Hardy Foundation for Ocean Science [SAHFOS]).

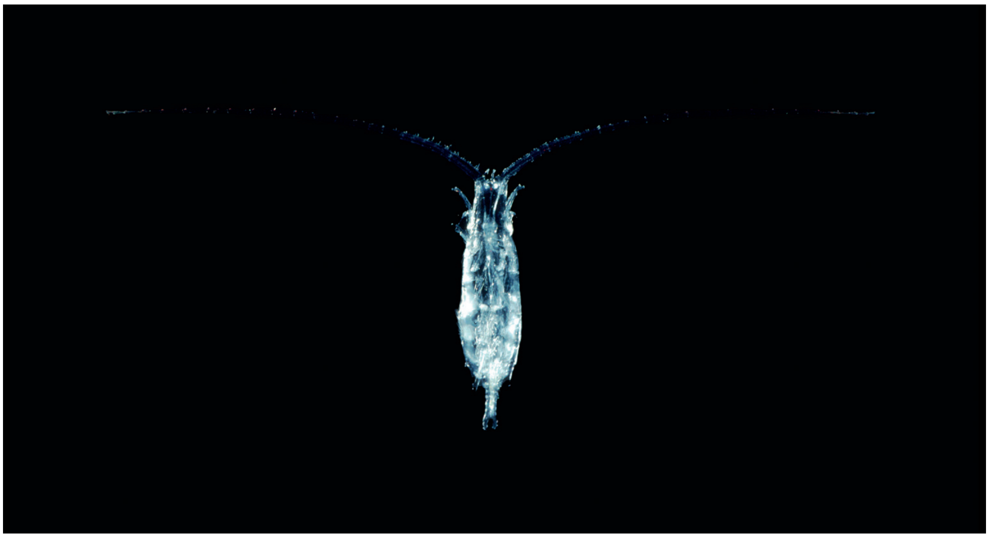
# FAMILY HETERORHABDIDAE SARS G.O., 1902

*Heterorhabdus austrinus* Giesbrecht, 1902 Figure 9 | page 25
(Photo by Nicolas Raymond [USNM 1009514]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

# FAMILY METRIDINIDAE SARS G.O., 1902

*Metridia gerlachei* Giesbrecht, 1902 Figure 10 | page 26
(Photo and copyright permission from Miram Gleiber).

# FAMILY RHINCALANIDAE GELENTIN, 1976

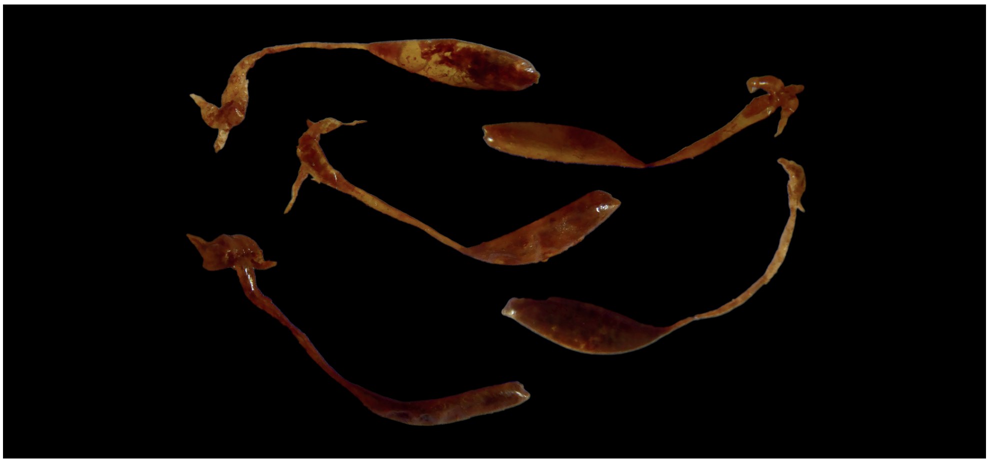


*Rhincalanus gigas* Brady, 1883 Figure 11 | page 28
(Copyright permission from the British Antarctic Survey [ID 10001066]).

# ORDER SIPHONOSTOMATOIDA

Thorell, 1859

# FAMILY PENNELLIDAE BURMEISTER, 1835



*Sarcotretes scopeli* Jungersen, 1911 Figure 12 | page 31
(Photo and copyright permission from Yves Cherel). Photo from preserved (adult female) specimens from the stomach contents of king penguins breeding in the Falkland Islands (note: Only females are found as parasites. Males are quite small and die young).

# FAMILY SPHYRIIDAE WILSON C.B., 1919

*Sphyrion lumpi* Krøyer, 1845 Figure 13 | page 33
(Photo and copyright permission from Geoff Boxshall).

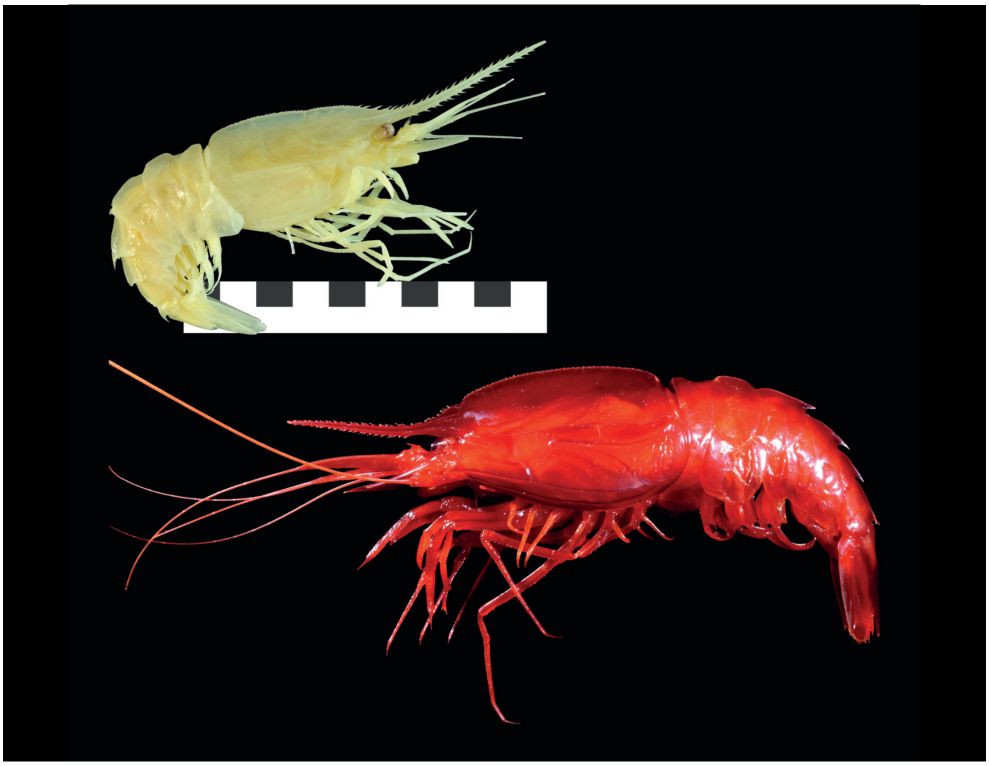
# CLASS MALACOSTRACA
Latreille, 1802

# ORDER DECAPODA
Latreille, 1802

» FAMILY ACANTHEPHYRIDAE SPENCE BATE, 1888
» FAMILY CRANGONIDAE HAWORTH, 1825
» FAMILY HIPPOLYTIDAE SPENCE BATE, 1888
» FAMILY HYMENOSOMATIDAE MACLEAY, 1838
» FAMILY LITHODIDAE SAMOUELLE, 1819
» FAMILY MUNIDIDAE AHYONG, BABA, MACPHERSON & POORE, 2010
» FAMILY NEMATOCARCINIDAE SMITH, 1884
» FAMILY NEPHROPIDAE DANA, 1852
» FAMILY PASIPHAEIDAE DANA, 1852

# FAMILY ACANTHEPHYRIDAE SPENCE BATE, 1888

*Acanthephyra pelagica* (Risso, 1816) Figure 14 | page 35
(Photo by Nicolas Raymond [USNM 1123161]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen with broken rostrum.

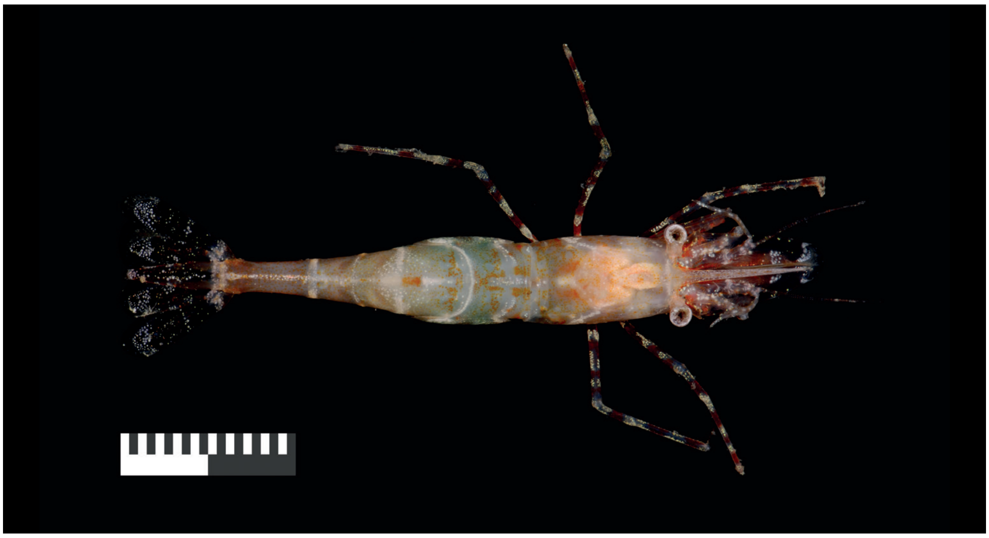


*Notostomus auriculatus* Barnard, 1950 Figure 15 | page 35
(Left image: Photo by Nicolas Raymond [USNM 256287]; Copyright permission from Smithsonian Institution, US National Museum of Natural History [Photo from preserved specimen]. Right image: Copyright permission from the National Institute of Water and Atmospheric Research [NIWA 118826]).

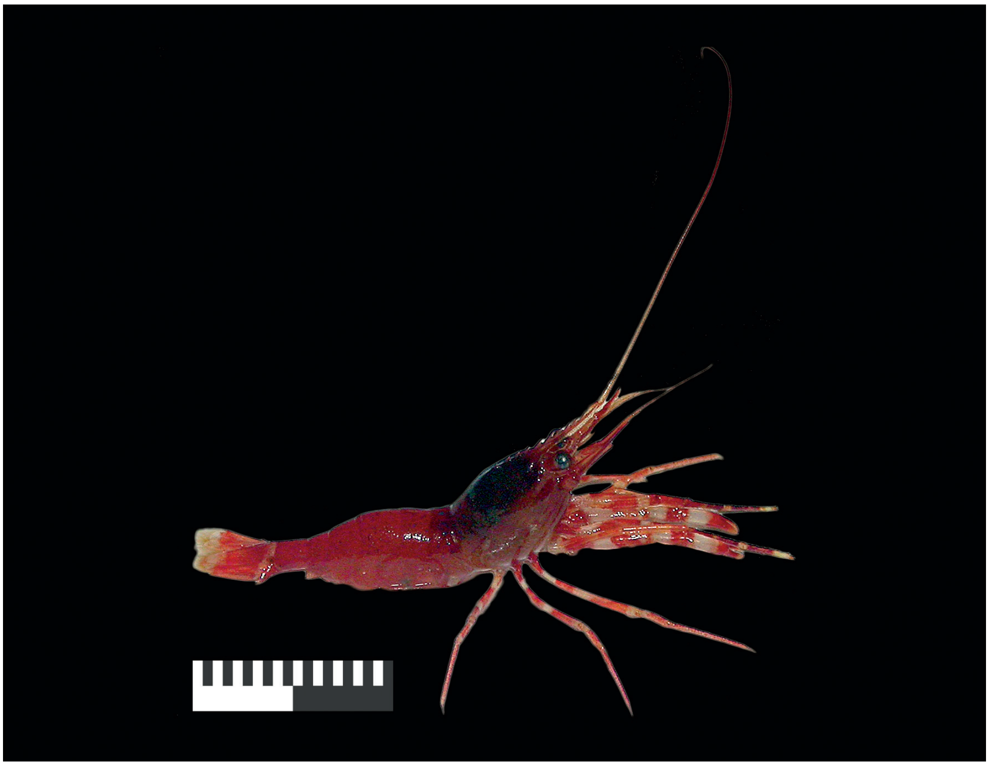
# FAMILY CRANGONIDAE HAWORTH, 1825

*Notocrangon antarcticus* (Pfeffer, 1887) Figure 17 | page 37
(Copyright permission from the British Antarctic Survey [ID 10009564]).

# FAMILY HIPPOLYTIDAE SPENCE BATE, 1888



*Chorismus antarcticus* (Pfeffer, 1887) Figure 18 | page 38
(Copyright permission from the National Institute of Water and Atmospheric Research [NIWA 35767]).



*Nauticaris marionis* Spence Bate, 1888 Figure 19 | page 38
(Photo and copyright permission from Evgeny A. Pakhomov).

# FAMILY LITHODIDAE SAMOUELLE, 1819

*Neolithodes yaldwyni* Figure 20 | page 41
(Copyright permission from the National Institute of Water and Atmospheric Research [NIWA 38209]).

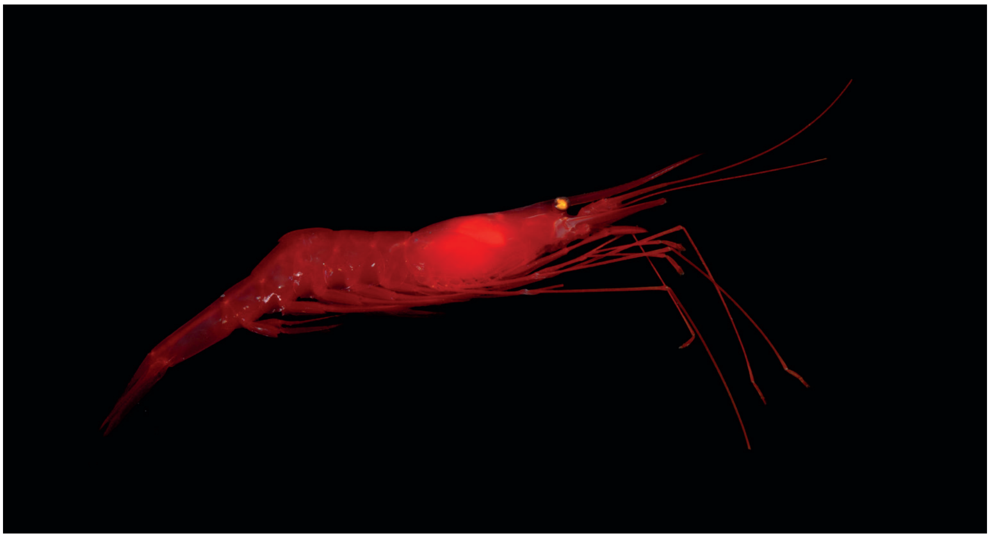
*Paralomis birsteini* Figure 21 | page 41
(Photo by Diane Pitassy [USNM 228830]; Copyright permission from Smithsonian Institution, US National Museum of Natural History; dorsal view [top] and ventral view [bottom]).

*Paralomis stevensi* Figure 22 | page 41
(Photo by Shane T. Ahyong; Copyright permission from the National Institute of Water and Atmospheric Research [NIWA 27835]).

# FAMILY MUNIDIDAE AHYONG, BABA, MACPHERSON & POORE, 2010

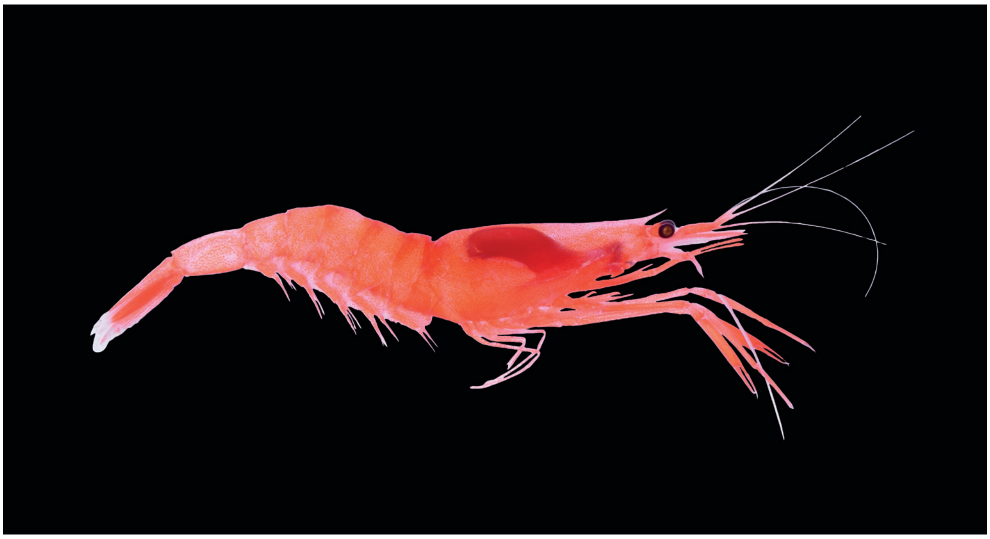
*Munida gregaria* (Fabricius, 1793) Figure 23 | page 43
(Left image: Photo and copyright permission from Stefano Schiaparelli [Photo from preserved specimen]; Right image: Photo and copyright permission from Federico Betti).

## FAMILY NEMATOCARCINIDAE SMITH, 1884



*Nematocarcinus lanceopes* Spence Bate, 1888 Figure 24 | page 45 and 46
(Copyright permission from the National Institute of Water and Atmospheric Research [NIWA 37046]).

## FAMILY PASIPHAEIDAE DANA, 1852



*Pasiphaea scotiae* (Stebbing, 1914) Figure 25 | page 48
(Photo and copyright permission from José Seco & José Xavier).

# ORDER EUPHAUSIACEA

Dana, 1852

» FAMILY EUPHAUSIACEA DANA, 1852

# FAMILY EUPHAUSIIDAE DANA, 1852

*Euphausia crystallorophias* Holt & Tattersall, 1906 Figure 26 | page 51
(Photo and copyright permission from Volker Siegel).

*Euphausia frigida* Hansen, 1911 Figure 27 | page 51
(Photo and copyright permission from Volker Siegel).

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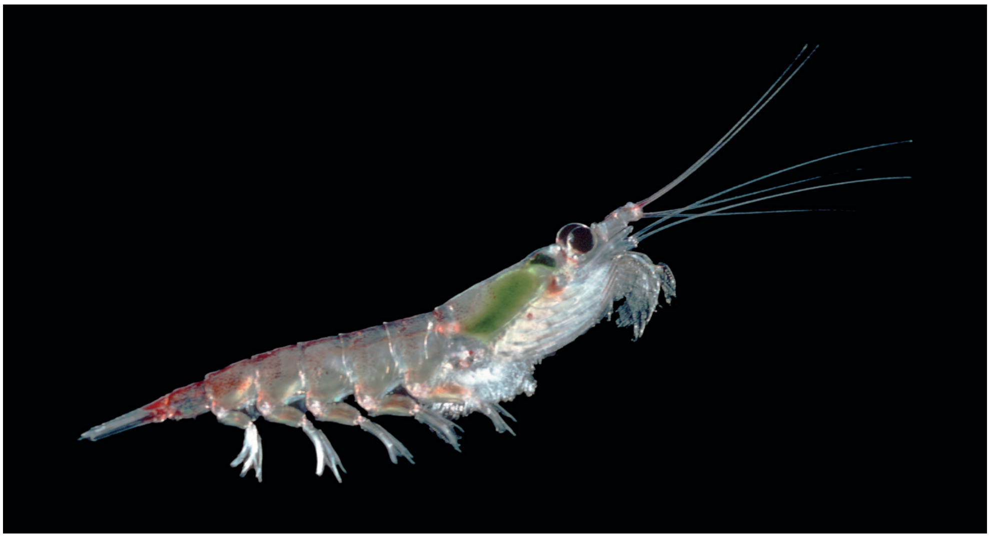


*Euphausia superba* Dana, 1850 Figure 28 | page 51, Tables 1, 2 and 3 | page 206, 207 and 208
(Copyright permission from the British Antarctic Survey [ID 10001031]).

*Euphausia triacantha* Holt & Tattersall, 1906 Figure 29 | page 54
(Photo and copyright permission from Volker Siegel).

*Euphausia vallentini* Stebbing, 1900 Figure 30 | page 54
(Photo and copyright permission from Stefano Schiaparelli). Photo from preserved specimen.

*Nematoscelis megalops* G. O. Sars, 1883 Figure 31 | page 55
(Photo from Rob Stewart; Copyright permission from the National Institute of Water and Atmospheric Research [NIWA]).

continue...

*Stylocheiron abbreviatum* G. O. Sars, 1883 Figure 32 | page 55
(Photo by Nicolas Raymond [USNM 45373]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

*Thysanoessa gregaria* G. O. Sars, 1883 Figure 33 | page 55
(Photo by Nicolas Raymond [USNM 59133]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Dried specimen in poor condition. Photo from preserved specimen.

*Thysanoessa macrura* G. O. Sars, 1883 (bottom) and *Thysanoessa* spp. (top) Figure 34 | page 55
(Photo of *Thysanoessa Macrura* by Nicolas Raymond [USNM 98577]. Dried specimen in poor condition. Photo from preserved specimen [Copyright permission from Smithsonian Institution, US National Museum of Natural History]); Photo of *Thysanoessa* spp. by José Seco and José Xavier.

# ORDER AMPHIPODA

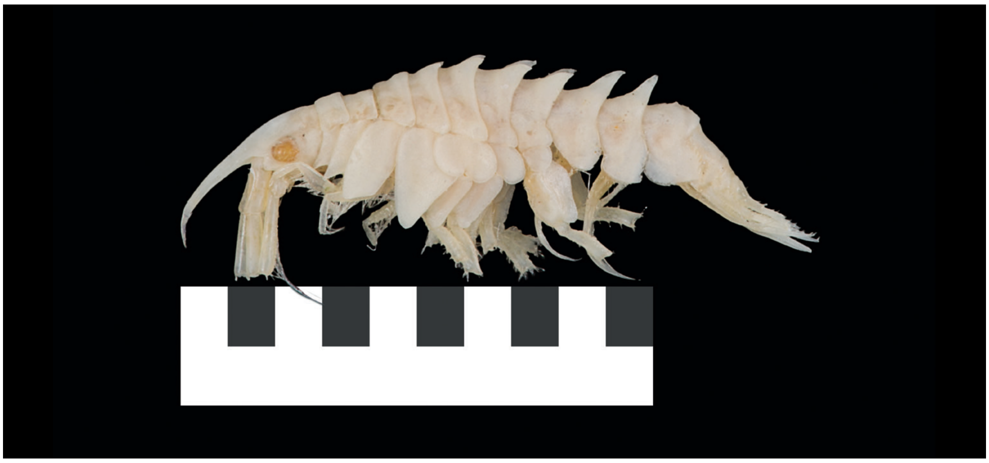
Latreille, 1816

# SUBORDER GAMMARIDAE

Latreille, 1802

- » FAMILY AMATHILLOPSIDAE PIRLOT, 1934
- » FAMILY AMPELISCIDAE KRØYER, 1842
- » FAMILY CYPHOCARIDIDAE LOWRY & STODDART, 1997
- » FAMILY DEXAMINIDAE LEACH, 1814
- » FAMILY EPIMERIIDAE BOECK, 1871
- » FAMILY EURYTHENEIDAE STODDART & LOWRY, 2004
- » FAMILY EUSIRIDAE STEBBING, 1888
- » FAMILY LILJEBORGIIDAE STEBBING, 1899
- » FAMILY LYSIANASSIDAE DANA, 1849
- » FAMILY OEDICEROTIDAE LILJEBORG, 1865
- » FAMILY PHOXOCEPHALIDAE G.O. SARS, 1891
- » FAMILY SCOPELOCHEIRIDAE LOWRY & STODDART, 1997
- » FAMILY STEGOCEPHALIDAE DANA, 1852
- » FAMILY STENOTHOIDAE BOECK, 1871
- » FAMILY URISTIDAE HURLEY, 1963

## FAMILY AMATHILLOPSIDAE PIRLOT, 1934



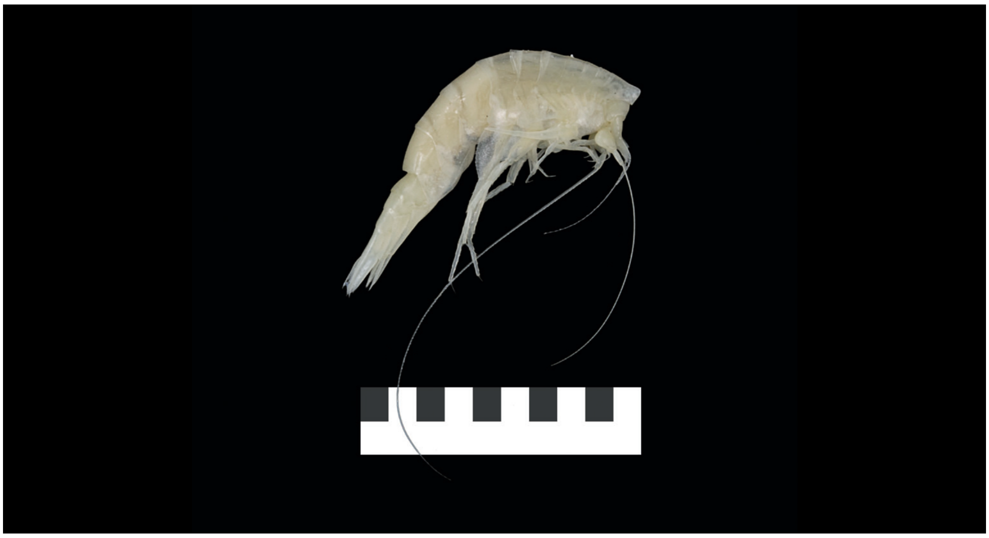
*Parepimeria bidentata* Schellenberg, 1931 Figure 36 | page 67
(Photo by Nicolas Raymond [USNM 1136676]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

## FAMILY AMPELISCIDAE KRØYER, 1842

*Byblis securiger* (K.H. Barnard, 1931) Figure 38 | page 69
(Copyright permission from the British Antarctic Survey [ID 10009526]).

# FAMILY CYPHOCARIDIDAE LOWRY & STODDART, 1997

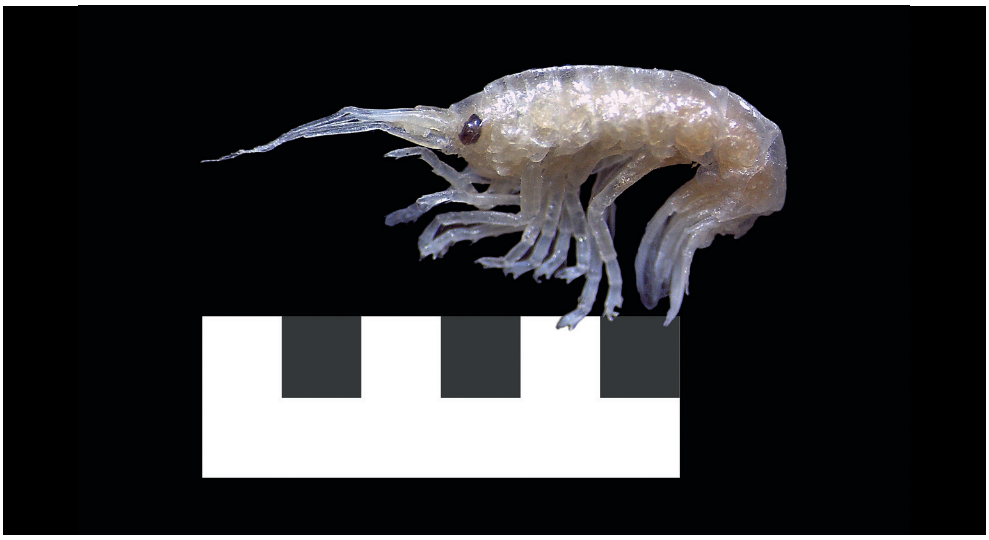
*Cyphocaris anonyx* Boeck, 1871 Figure 39 | page 70
(Photo by Nicolas Raymond [USNM 31795]; Copyright permission from Smithsonian Institution, US National Museum of Natural History; and from Martin Collins [right photo]). Photo from preserved specimen.



*Cyphocaris challengeri* Stebbing, 1888 Figure 40 | page 70
(Photo by Nicolas Raymond [USNM 103555]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

*Cyphocaris richardi* Chevreux, 1905 Figure 41 | page 70
(Photo and copyright permission from Volker Siegel).

## FAMILY DEXAMINIDAE LEACH, 1814



*Polycheria kergueleni* (Stebbing, 1888) Figure 42 | page 72
(Photo and copyright permission from Hugo Guímaro/Yves Cherel). Photo from preserved specimen.

# FAMILY EPIMERIIDAE BOECK, 1871

*Epimeria (Epimeriella) macronyx* (Walker, 1906) Figure 43 | page 73
(Copyright permission from the Royal Belgium Institute of Natural Sciences, Brussels [Belgium]).

# FAMILY EURYTHENEIDAE STODDART & LOWRY, 2004

*Eurythenes gryllus* (Lichtenstein in Mandt, 1822) (probably E. *gryllus sensu stricto*) Figure 44 | page 75
(Photo and copyright permission from Volker Siegel).

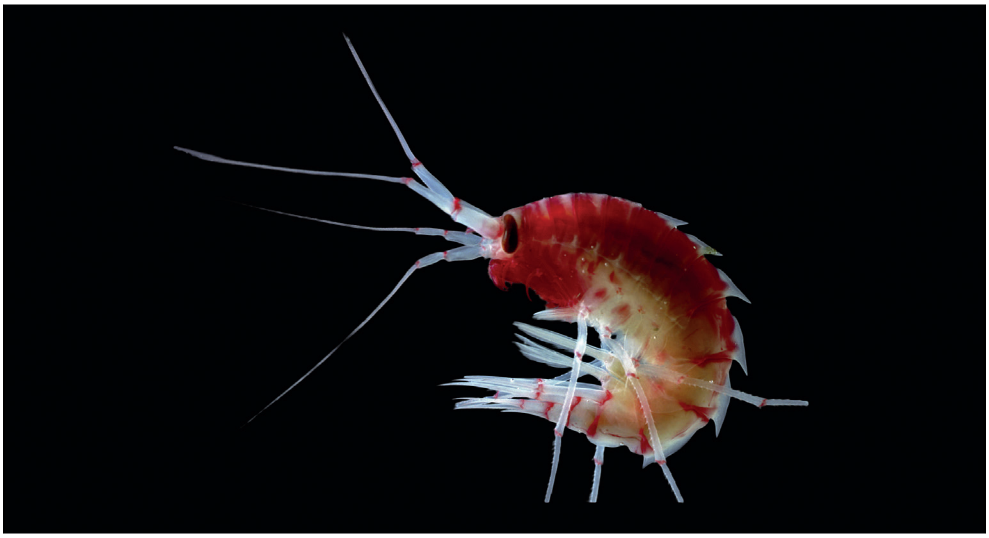
*Eurythenes obesus* (Chevreux, 1905) Figure 45 | page 75
(Photo by Nicolas Raymond [USNM 1157042]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

# FAMILY EUSIRIDAE STEBBING, 1888

*Eusirus antarcticus* Thompson, 1880 Figure 46 | page 77
(Photo and copyright permission from Stefano Schiaparelli).

*Eusirus microps* Walker, 1906 Figure 47 | page 77
(Photo and copyright permission from Volker Siegel).

*Eusirus perdentatus* Chevreux, 1912 Figure 48 | page 77
(Photo and copyright permission from Stefano Schiaparelli).



*Eusirus propeperdentatus* Andres, 1979 Figure 49 | page 77
(Photo and copyright permission from Volker Siegel).

## FAMILY LILJEBORGIIDAE STEBBING, 1899

*Liljeborgia* sp. Schellenberg, 1931 Figure 50 | page 79
(Photo and copyright permission from Anna M. Jażdżewska).

## FAMILY LYSIANASSIDAE DANA, 1849

*Charcotia obesa* Chevreux, 1906 Figure 51 | page 80
(Photo by Cédric d´Udekem d´Acoz; Copyright from Royal Belgian Institute of Natural Sciences).

*Cheirimedon femoratus* (Pfeffer, 1888) Figure 52 | page 80
(Photo and copyright permission from Meike Seefeldt).

*Debroyerella fougneri* (Walker, 1903) Figure 53 | page 80
(Photo by Nicolas Raymond [USNM 1113983]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

continue...


*Hippomedon kergueleni* (Miers, 1875) with a close up of posterolateral corner of epimerit 3. Figure 54 | page 80
(Photo and copyright permission from Meike Seefeldt).

*Lepidepecreum urometacarinatum* Andres, 1985 Figure 55 | page 80
(Photo by Nicolas Raymond [USNM 306583]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen with broken pereiopods.

*Orchomenella* sp. Walker, 1903 Figure 56 | page 80
(Photo and copyright permission from Stefano Schiaparelli).

*Parawaldeckia kidderi* (Smith, 1876) Figure 57 | page 80
(Photo by Nicolas Raymond [USNM 1115507]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

continue...

*Tryphosella macropareia* (Schellenberg, 1926) Figure 58 | page 80
(Photo by Cédric d´Udekem d´Acoz; Copyright from Royal Belgian Institute of Natural Sciences).

## FAMILY OEDICEROTIDAE LILLJEBORG, 1865

*Oediceroides* sp. Chevreux, 1911 Figure 59 | page 84
(Photo and copyright permission from Stefano Schiaparelli).

## FAMILY PHOXOCEPHALIDAE G.O. SARS, 1981

*Heterophoxus videns* K.H. Barnard, 1930 Figure 60 | page 85
(Photo by Nicolas Raymond [USNM 1088960]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

## FAMILY SCOPELOCHEIRIDAE LOWRY & STODDART, 1997

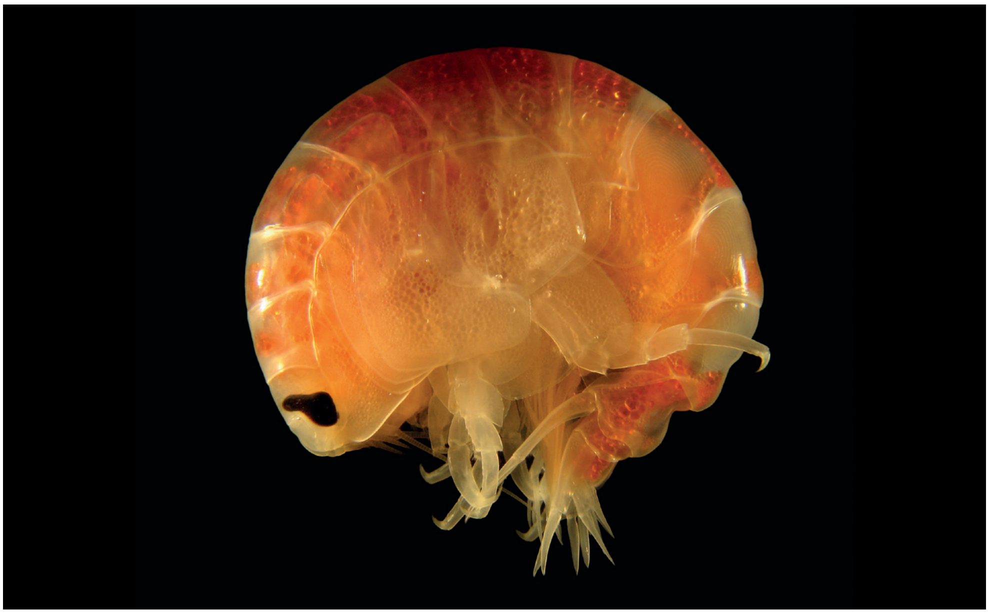
*Paracallisoma* sp. Chevreux, 1903 Figure 61 | page 86
(Photo by Nicolas Raymond [USNM 1157031]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

## FAMILY STEGOCEPHALIDAE DANA, 1855

*Parandania boecki* (Stebbing, 1888) Figure 62 | page 87
(Photo and copyright permission from José Seco & José Xavier).

## FAMILY URISTIDAE HURLEY, 1963

*Pseudorchomene plebs* (Hurley, 1965) Figure 63 | page 89
(Photo by Cédric d´Udekem d´Acoz; Copyright from Royal Belgian Institute of Natural Sciences).



*Pseudorchomene* rossi (Walker 1903) Figure 64 | page 89
(Photo by Cédric d´Udekem d´Acoz; Copyright from Royal Belgian Institute of Natural Sciences).

Tryphosinae *incertae sedis intermedia* (Schellenberg, 1926) Figure 65 | page 89
(Photo by Cédric d´Udekem d´Acoz; Copyright from Royal Belgian Institute of Natural Sciences).

continue...

*Uristes gigas* Dana, 1852 Figure 66 | page 89
(Photo by Cédric d´Udekem d´Acoz; Copyright from Royal Belgian Institute of Natural Sciences).

*Uristes murrayi* (Walker, 1903) Figure 67 | page 89
(Photo by Cédric d´Udekem d´Acoz; Copyright from Royal Belgian Institute of Natural Sciences).

# SUBORDER HYPERIIDEA

Milne Edwards, 1830

# FAMILY CYLLOPODIDAE BOVALLIUS, 1887

*Cyllopus lucasii* Bate, 1862 Figure 68 | page 93
(Copyright permission from the National Institute of Water and Atmospheric Research [NIWA 380046] and from Martin Collins [right photo]).

# FAMILY HYPERIIDAE DANA, 1852

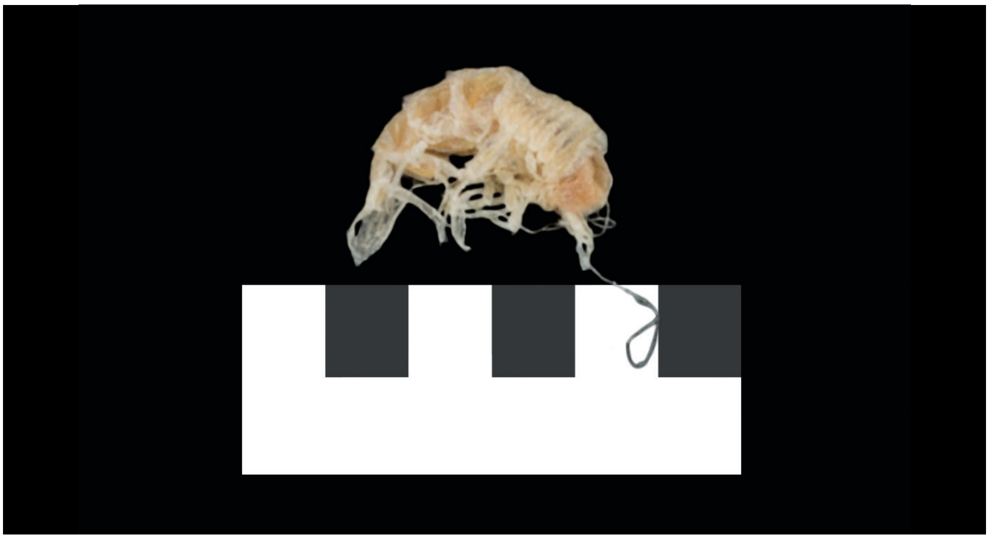
*Hyperia macrocephala* (Dana, 1853) Figure 69 | page 95
(Photo by Nicolas Raymond [USNM 1196375]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

*Hyperia gaudichaudii* Milne Edwards, 1840 Figure 70 | page 95
(Photo by Nicolas Raymond [USNM 101020]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

*Hyperiella antarctica* Bovallius, 1887 Figure 71 | page 95
(Photo by Nicolas Raymond [USNM 301638]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

continue...

*Hyperiella dilatata* Stebbing, 1888 Figure 72 | page 95
(Photo by Nicolas Raymond [USNM 250633]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.



*Hyperiella macronyx* (Walker, 1906) Figure 73 | page 95
(Photo by Nicolas Raymond [USNM 1154663]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Dried specimen. Photo from preserved specimen.

*Hyperoche luetkenides* Walker, 1906 Figure 74 | page 95
(Photo by Nicolas Raymond [USNM 1090279]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

*Hyperoche capucinus* H. Barnard, 1930 Figure 75 | page 95
(Photo by Nicolas Raymond [USNM 1090280]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

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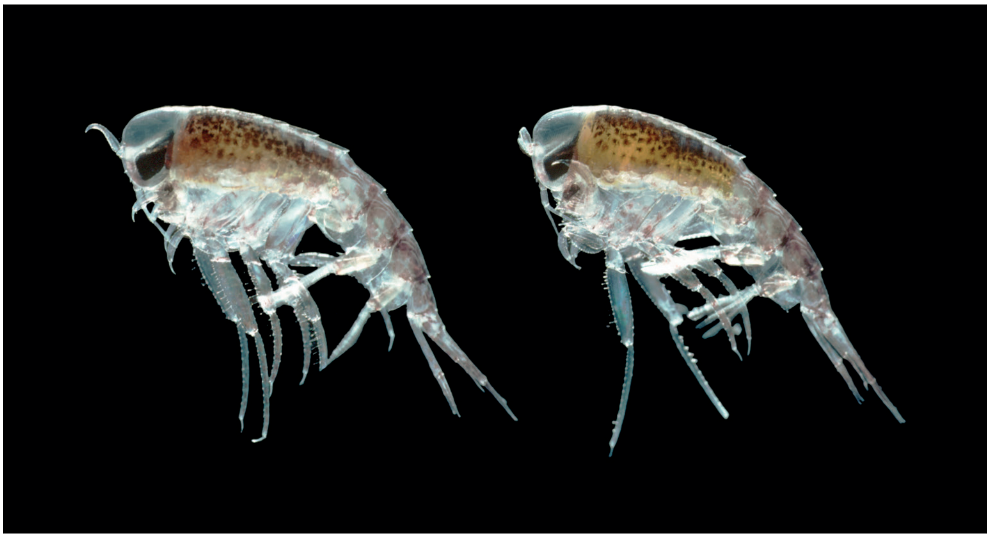


*Themisto gaudichaudii* Guérin, 1825 Figure 76 | page 95
(Copyright permission from the British Antarctic Survey [ID 10001055]).

## FAMILY PHROSINIDAE DANA, 1853

*Primno macropa* Guérin-Méneville, 1836 Figure 77 | page 102
(Photo and copyright permission from José Seco & José Xavier).

# FAMILY VIBILIIDAE DANA, 1852

*Vibilia* sp. Stebbing, 1888 Figure 78 | page 103
(Right image: Photo by Cédric d´Udekem d´Acoz; Copyright from Royal Belgian Institute of Natural Sciences) and *Vibilia* sp. (Left image: Photo and copyright permission from José Seco & José Xavier).

# SUBORDER SENTICAUDATA

Lowry & Myers, 2013

» FAMILY CALLIOPIIDAE G.O. SARS, 1893

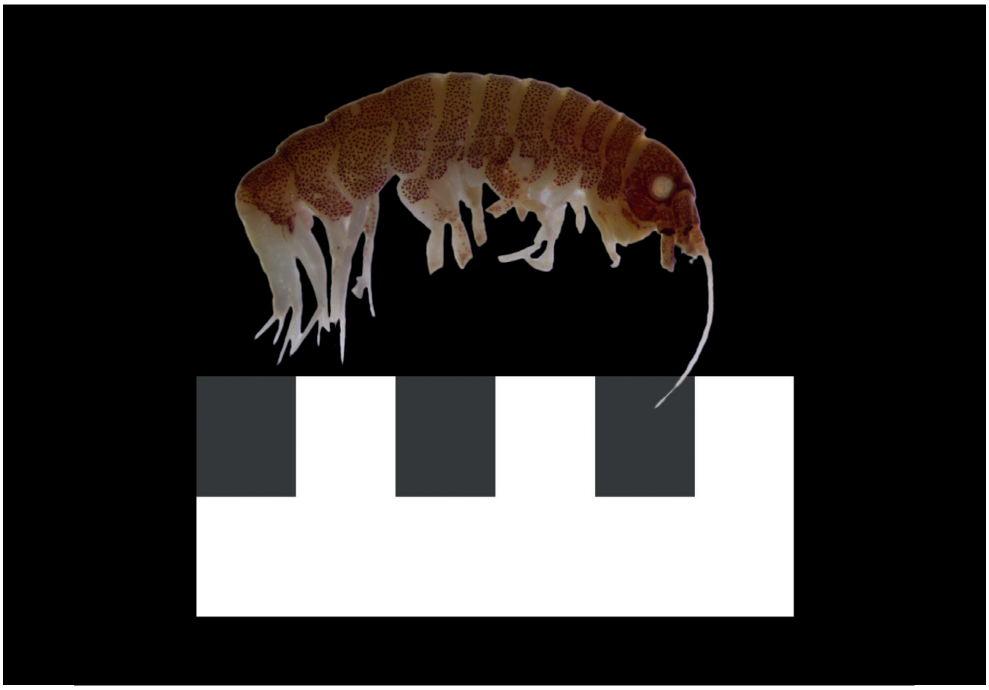
» FAMILY ISCHYROCERIDAE STEBBING, 1899

» FAMILY PHOTIDAE BOECK, 1871

» FAMILY PODOCERIDAE LEACH, 1814

» FAMILY PONTOGENEIIDAE STEBBING, 1906

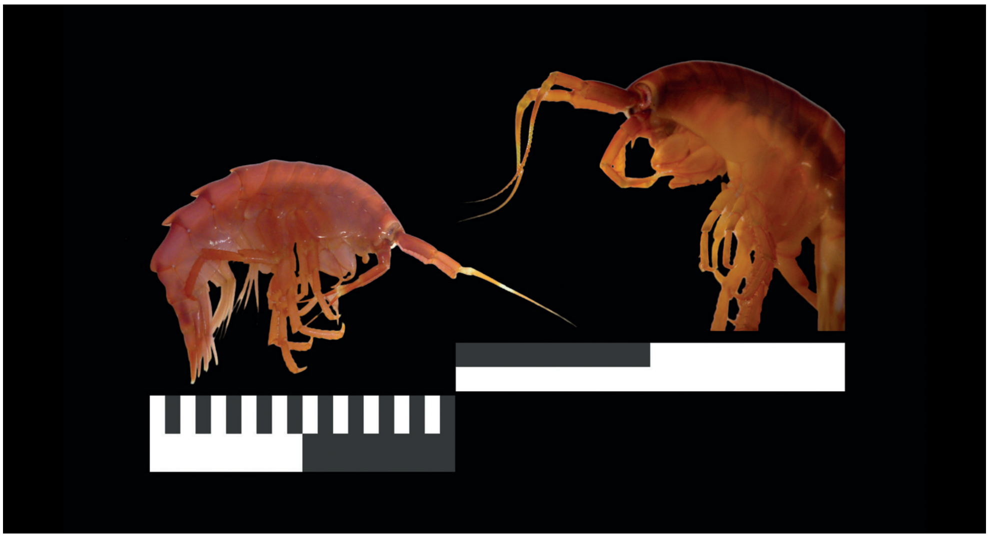
# FAMILY CALLIOPIIDAE G.O. SARS, 1893



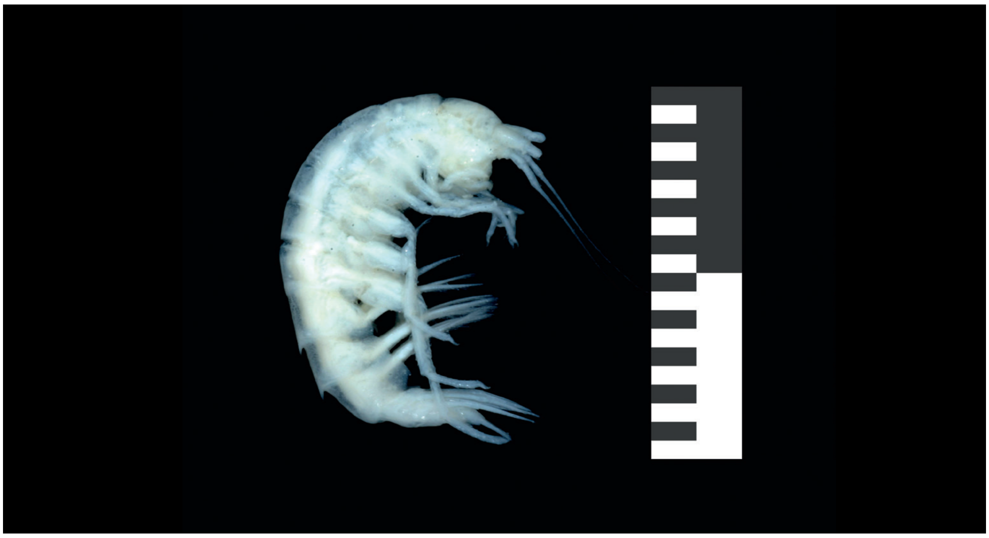
*Oradarea* sp. Shoemaker, 1930 Figure 79 | page 105
(Photos and copyright permission from Eugenia Moreira).

*Stenopleura atlantica* Stebbing, 1888 Figure 80 | page 105
(Photo by Nicolas Raymond [USNM 143470]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

# FAMILY PONTOGENEIIDAE STEBBING, 1906



*Bovallia gigantea* Pfeffer, 1888 Figure 81 | page 111
(Photos and copyright permission from Eugenia Moreira).



*Djerboa furcipes* Chevreux, 1906 Figure 82 | page 111
(Photo by Nicolas Raymond [USNM 143470]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

*Gondogeneia antarctica* (Chevreux, 1906) Figure 83 | page 111
(Photo and copyright permission from Eugenia Moreira).

*Liouvillea oculata* Chevreux, 1912 Figure 84 | page 111
(Photo by Nicolas Raymond [USNM 143517]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

continue...

*Paramoera fissicauda* (Dana, 1852) Figure 85 | page 111
(Photo and copyright permission from Hugo Guímaro/Yves Cherel). Photo from preserved specimen.

*Paramoera walkeri* (Stebbing, 1906) Figure 86 | page 111
(Photo and copyright permission from Stefano Schiaparelli).

*Prostebbingia brevicornis* (Chevreux, 1906) Figure 87 | page 111
(Photo by Nicolas Raymond [USNM 1080432]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

*Prostebbingia serrata* Schellenberg, 1926 Figure 88 | page 111
(Photo by Nicolas Raymond [USNM 143489]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

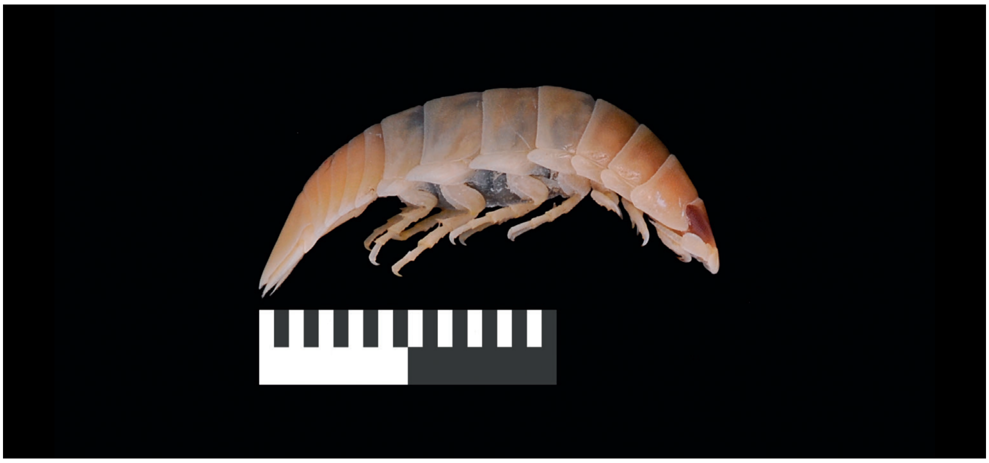
continue...

*Schraderia gracilis* Pfeffer, 1888 Figure 89 | page 111
(Photo by Cédric d´Udekem d´Acoz; Copyright from Royal Belgian Institute of Natural Sciences).

# ORDER ISOPODA

Latreille, 1817

# FAMILY AEGIDAE WHITE, 1850



*Aega semicarinata* Miers, 1875 Figure 90 | page 118
(Photo by Nicolas Raymond [USNM 235091]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

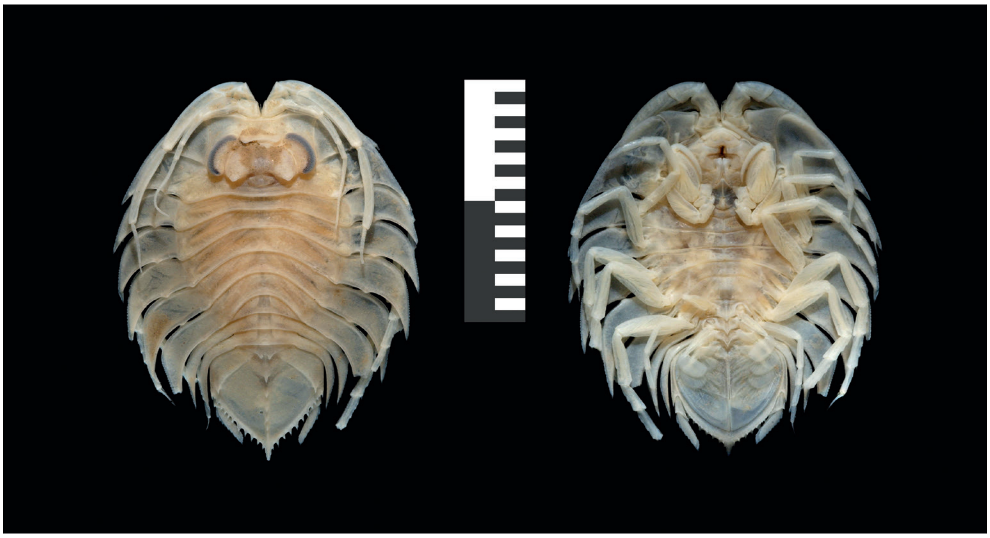
# FAMILY ARCTURIDIDAE POORE, 2001

*Arcturides cornutus* Studer, 1882 Figure 92 | page 120
(Photo and copyright permission from Charles O. Coleman [ZMB 5502]).

# FAMILY CHAETILIIDAE DANA, 1849

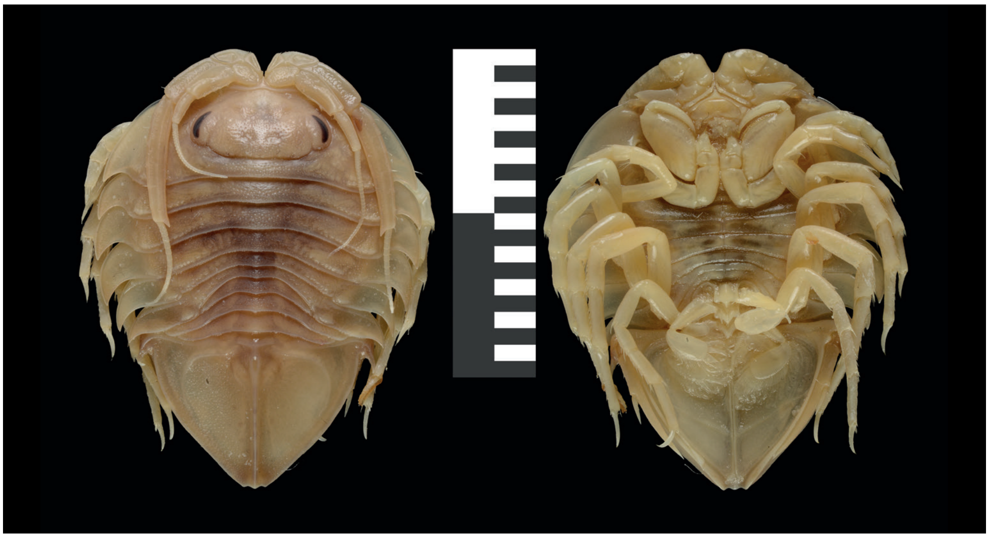
*Glyptonotus antarcticus* Eights, 1852 Figure 93 | page 121
(Photo and copyright permission from Stefano Schiaparelli). Photo from preserved specimen

# FAMILY SEROLIDAE DANA, 1852



*Ceratoserolis trilobitoides* (Eights, 1833) Figure 94 | page 122
(Photo by Nicolas Raymond [USNM 123946]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Dorsal view (left) and ventral view (right). Photo from preserved specimen.

*Septemserolis septemcarinata* Miers, 1875 Figure 95 | page 122
(Photo by Sven Tränkner and copyright permission from Angelika Brandt). Dorsal view (left) and ventral view (right). Photo from preserved specimen.



*Spinoserolis latifrons* (White, 1847) Figure 96 | page 122
(Dorsal side [left] and ventral side [right]; Photo by Sven Tränkner and copyright permission from Angelika Brandt). Dorsal view (left) and ventral view (right). Photo from preserved specimen.

## FAMILY SPHAEROMATIDAE LATREILLE, 1825

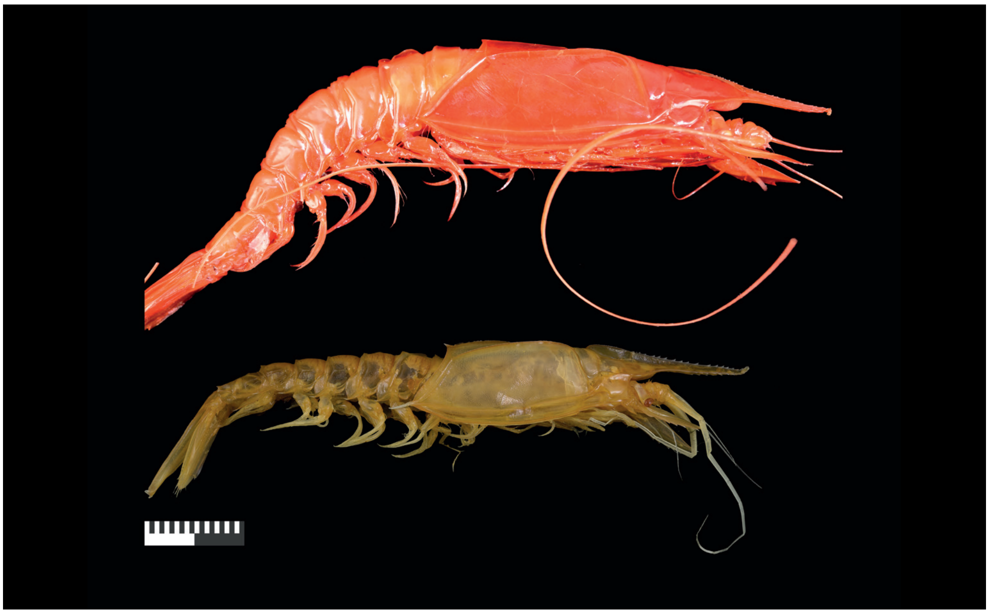
*Cassidinopsis emarginata* (Guérin-Méneville, 1843) Figure 97 | page 124
(Photo by Nicolas Raymond [USNM 280468]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

# ORDER LOPHOGASTRIDA

Boas, 1883

» FAMILY GNATHOPHAUSIIDAE UDRESCU, 1984

# FAMILY GNATHOPHAUSIIDAE UDRESCU, 1984



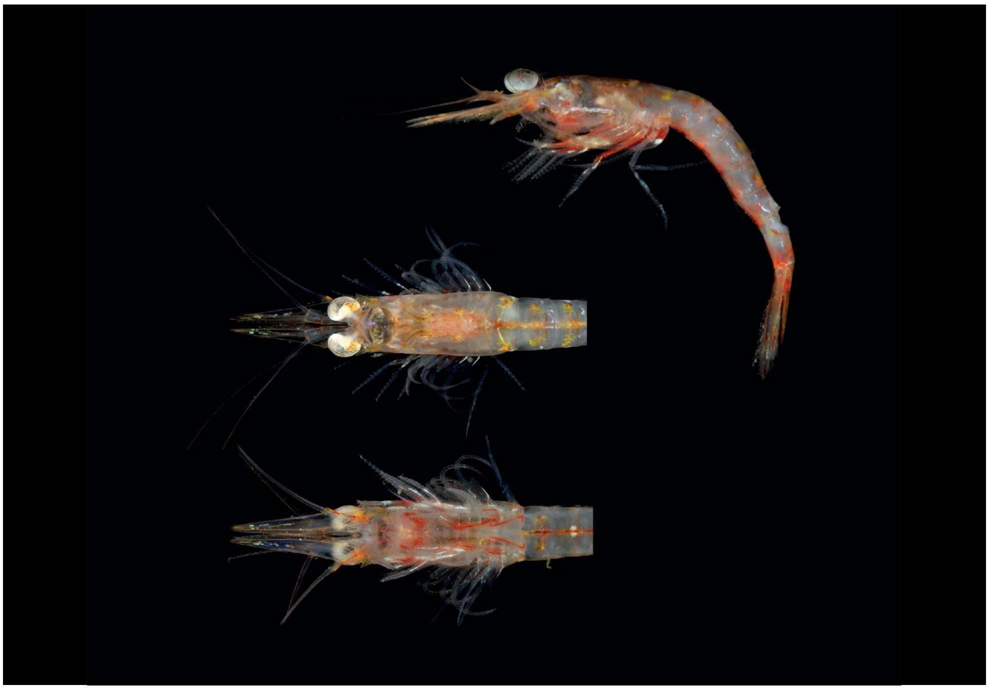
*Neognathophausia gigas* (Willemoes-Suhm, 1873) Figure 98 | page 126
(Top image: Photo by Diana Macpherson and copyright permission from the National Institute of Water and Atmospheric Research [NIWA140051]; Bottom image: Photo by Nicolas Raymond [USNM 283802]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Photo from preserved specimen.

*Neognathophausia ingens* (Dohrn, 1870) Figure 99 | page 126
(Top image: Copyright permission from the National Institute of Water and Atmospheric Research [NIWA]; Bottom image: Photo by Nicolas Raymond [USNM 235177]; Copyright permission from Smithsonian Institution, US National Museum of Natural History). Latter photo from preserved specimen.

# ORDER MYSIDA

Latreille, 1817

# FAMILY MYSIDAE HAWORTH, 1825



*Antarctomysis maxima* (Holt & Tattersall, 1906) Figure 100 | page 129
(Photo and copyright permission from Stefano Schiaparelli).

*Antarctomysis ohlinii* Hansen, 1908 Figure 101 | page 129
(Copyright permission from the British Antarctic Survey). Photo from preserved specimen.

# FAMILY PETALOPHTHALMIDAE CZERNIAVSKY, 1882

*Petalophthalmus armiger* (Willemoes-Suhm, 1875) Figure 103 | page 132
(Photo by Jeff Forman and copyright permission from the National Institute of Water and Atmospheric Research [NIWA]). Photo from preserved specimen.

## SUBCLASS THECOSTRACA

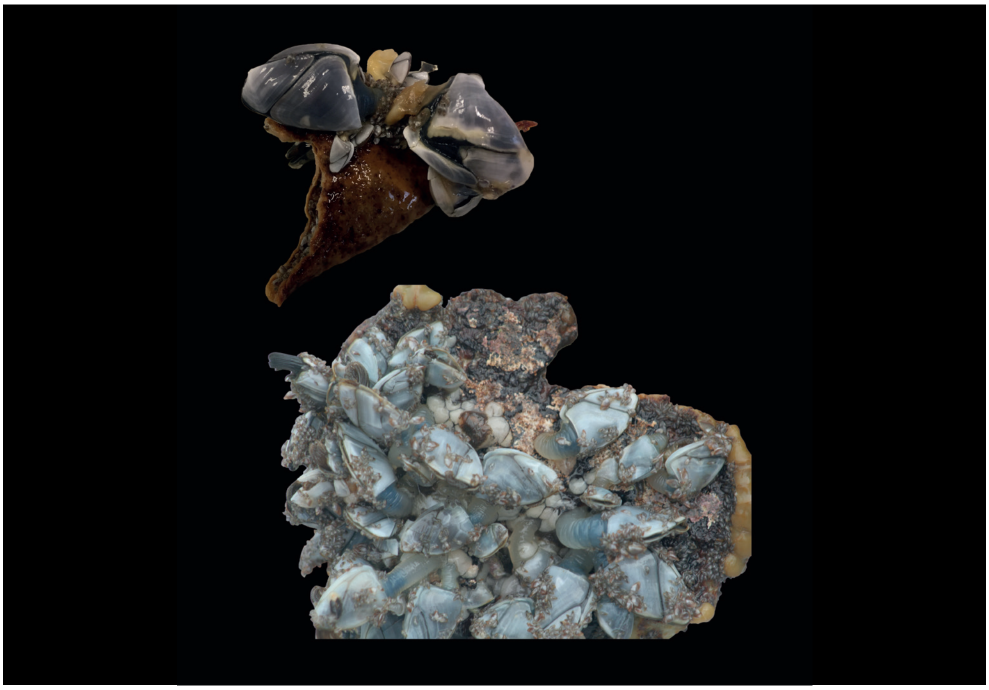
Gruvel, 1905

# ORDER LEPADIFORMES

Buckeridge & Newman, 2006

» FAMILY LEPADIDAE DARWIN, 1852

# FAMILY LEPADIDAE DARWIN, 1852



*Lepas (Anatifa) australis* (Darwin, 1851) Figure 104 | page 134
(Photo and copyright permission from Jonathan Waters).

# CLASS OSTRACODA
Gruvel, 1905

# ORDER MYODOCOPIDA
Sars, 1866

» FAMILY CYPRIDINIDAE BAIRD, 1850

## FAMILY CYPRIDINIDAE BAIRD, 1850

*Gigantocypris muelleri* (Skogsberg, 1920) Figure 105 | page 136
(Copyright permission from the National Institute of Water and Atmospheric Research [NIWA 37979]).

# TABLES

# TABLE 1. Length-weight relationships for krill *Euphausia superba* not segregated by sex

| Month | Regression A | Coefficient B | Size range (mm) | n Krill | Dominant adult maturity stage | Reference |
|---|---|---|---|---|---|---|
| Several combined | 0.00056 | 3.62 | 24-58 | 30/mm | n.a. | (Chekunova & Rynkova 1974) |
| October | 0.00236 | 3.251 | 13-58 | 279 | resting | (Siegel 1993) |
| December | 0.00086 | 3.551 | 15-59 | 250 | gravid | (Siegel 1993) |
| January | 0.00205 | 3.325 | 23-60 | 228 | gravid-spent | (Siegel 1993) |
| February | 0.00083 | 3.561 | 13-60 | 228 | gravid | (Siegel 1993) |
| February | 0.00165 | 3.380 | 16-59 | 261 | spent | (Siegel 1993) |
| February | 0.00503 | 3.283 | | 343 | | (Färber-Lorda 1994) |
| March | 0.00193 | 3.325 | 30-62 | 143 | spent | (Siegel 1993) |
| April | 0.0018 | 3.3436 | 20-61 | 1085 | spent | (Sahrhage 1978) |
| April | 0.0017 | 3.4327 | 20-60 | 708 | spent | (Miller 1986) |
| June | 0.00353 | 3.151 | 21-59 | 339 | resting | (Siegel 1993) |
| January - February | 0.00158 | 3.40 | 25-58 | 114 | prespawning-gravid | |
| January - March | 0.00229 | 3.35 | 22-42 | 49 | adolescent | (Clarke 1976) |
| February - March | 0.0018 | 3.3831 | | 145 | n.a. | (Jażdżewski et al. 1978) |
| February - March | 0.00298 | 3.432 | 23-47 | 5082 | n.a. | (Rojas et al. 1981) |
| February - March | 0.00385 | 3.20 | 26-59 | 3299 | gravid-spent | (Morris et al. 1988) |

$BMs = a^*AT^b$ (wet weight in mg, length in mm), [1)] refers to BL in mm, [2)] refers to Standard 3 length S3

# TABLE 2. Length-weight relationships for krill *Euphausia superba* separated by males and females

| Month | Sex | Regression A | Coefficient B | Size range (mm) | n Krill | Dominant adult maturity stage | Reference |
|---|---|---|---|---|---|---|---|
| Several years | M | 0.0034 | 3.1761 | 3-61 | | all | (Lockyer 1973) |
| | F | 0.0009 | 3.5792 | | | | |
| Several years | M | 0.00128 | 3.428 | | | all | (Nemoto et al. 1981) |
| | F | 0.00352 | 3.144 | | | | |
| October | M | 0.00236 | 3.251 | 13-58 | 138 | resting | (Siegel 1993) |
| | F | 0.00242 | 3.247 | 13-59 | 141 | resting | |
| November | M | 0.00315 | 3.207 | 10-57 | 406 | resting | (Siegel 1993) |
| | F | 0.00430 | 3.102 | 10-57 | 458 | resting | |
| December | M | 0.00083 | 3.561 | 15-59 | 114 | gravid | (Siegel 1993) |
| | F | 0.00115 | 3.457 | 15-59 | 114 | gravid | |
| January | M | 0.00156 | 3.403 | 23-60 | 114 | gravid-spent | (Siegel 1993) |
| | F | 0.00282 | 3.234 | 23-60 | 114 | gravid-spent | |
| February | M | 0.00111 | 3.507 | 16-58 | 129 | spent | (Siegel 1993) |
| | F | 0.00211 | 3.302 | 16-59 | 132 | spent | |
| June | M | 0.00193 | 3.176 | 21-59 | 380 | resting | (Siegel 1993) |
| | F | | 3.084 | 21-55 | 340 | resting | |
| December - February | M | 0.0019 | 3.36 | | | | (Strelnikova 1985) |
| | F | 0.0009 | 3.56 | | | | |
| January - February | M | 0.00423 | 3.170 | 23-47 3) | 92 | gravid | (Retamal & Quintana 1982) |
| | F | 0.00573 | 3.080 | 23-46 3) | 58 | pre-spawning | |
| February - March | M | 0.00265 | 3.464 | 23-47 3) | 2325 | | (Rojas et al. 1981) |
| | F | 0.00531 | 3.256 | 23-46 3) | 2757 | | |
| February - March | M | 0.00613 | 3.0776 | 34-57 | 1882 | gravid | (Morris et al. 1988) |
| | F | 0.00289 | 3.270 | 31-58 | 1417 | gravid-spent | |
| | F | 0.01088 | 2.9077 | 31-58 | 940 | nly non-gravid | |
| | F | 0.00975 | 2.9809 | 41-58 | 477 | only gravid | |
| | F | 0.03548 | 2.590 | 39-56 | 65 | only spent | |

BMs = a*AT$^b$ (wet weight in mg, length in mm), M males, F females, 3) refers to "Standard 2 Length" from tip of the rostrum to posterior margin of the 6$^{th}$ abdominal segment

# TABLE 3. Length-weight relationships for krill *Euphausia superba*

| Month | Sex | Regression A | Coefficient B | Size range (mm) | n Krill | Dominant adult maturity stage | Reference |
|---|---|---|---|---|---|---|---|
| October | M | 0.00060 | 3.030 | 13-58 | 138 | resting | (Siegel 1993) |
| | F | 0.00080 | 2.971 | 13-59 | 141 | | |
| November | M | 0.00076 | 3.071 | 10-57 | 406 | resting | (Siegel 1993) |
| | F | 0.00105 | 2.965 | 10-57 | 458 | | |
| December | M | 0.00019 | 3.435 | 23-60 | 114 | gravid | (Siegel 1993) |
| | F | 0.00025 | 3.357 | 23-60 | 114 | | |
| January | M | 0.00036 | 3.277 | 23-60 | 114 | gravid-spent | (Siegel 1993) |
| | F | 0.00075 | 3.066 | 23-60 | 114 | | |
| February | M | 0.00009 | 3.694 | 16-58 | 129 | spent | (Siegel 1993) |
| | F | 0.00031 | 3.306 | 16-59 | 132 | | |
| January - February | all | 0.00007 | 3.760 | 28-58 | 114 | prespawning-gravid | (Retamal & Quintana 1982) |
| February - March | all | 0.00010 | 3.799 | | 145 | | (Rojas et al. 1981) |
| February - March | M | 0.00238 | 2.93 | 34-57 | 1861 | gravid | (Morris et al. 1988) |
| | F | 0.00024 | 3.55 | 37-58 | 1404 | gravid-spent | |
| | F | 0.00139 | 3.0737 | 37-58 | 933 | only non-gravid | |
| | F | 0.00199 | 3.0438 | 41-58 | 471 | only gravid | |
| | all | 0.00106 | 3.15 | 31-58 | 3265 | gravid-spent | |

BMdw= $a*AT^b$ (Body Mass dry weight in mg, total length (AT) in mm, M = males, F = females)

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