

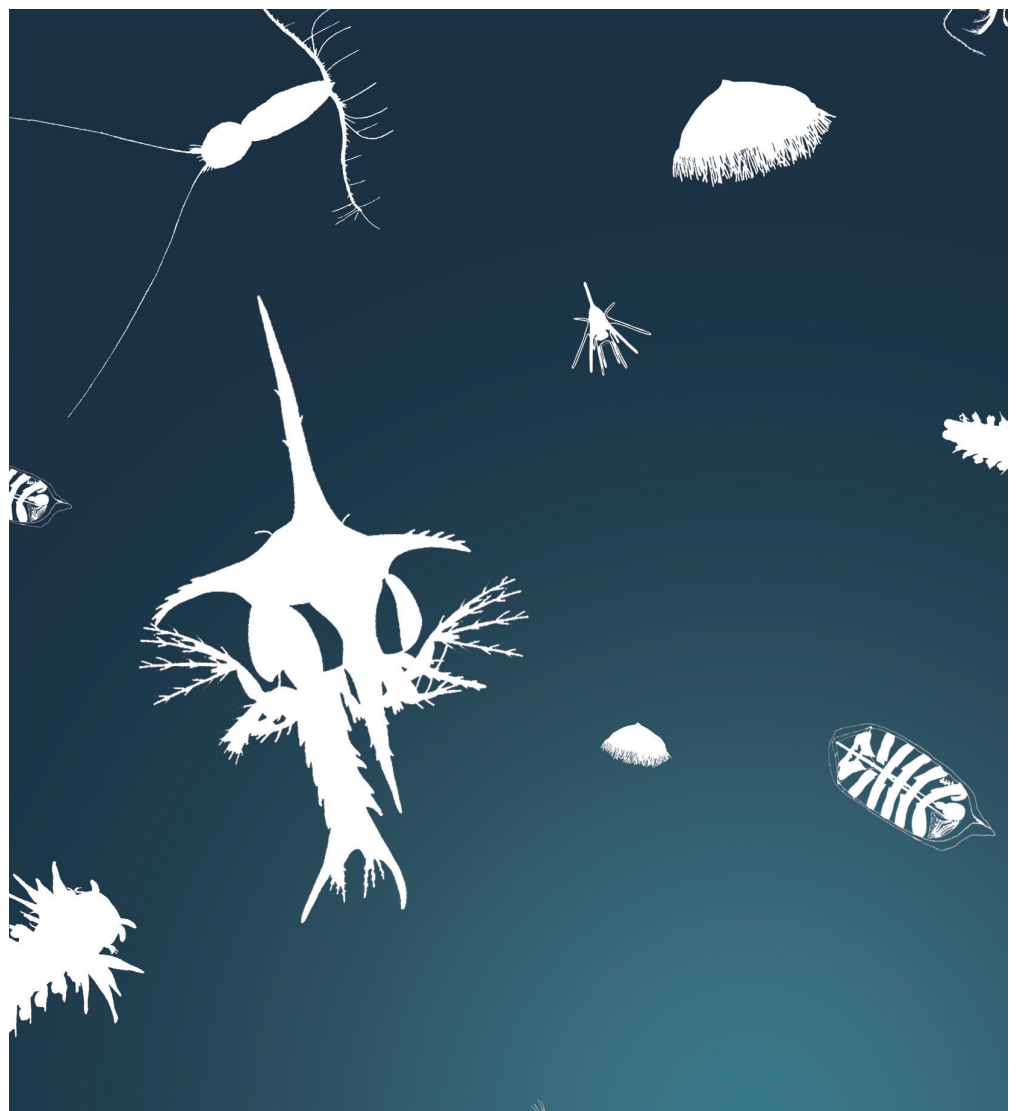
# Centropages Krøyer, 1849

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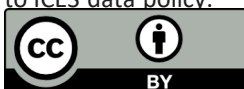
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# Contents

1	Summary .....	1
2	Introduction .....	1
	Main characteristics of <i>Centropages</i> .....	1
	Main morphological features .....	3
	Diagnostic features of Family Centropagidae and dominant marine genera.....	3
	Main Female characteristics.....	4
	Main Male characteristics.....	4
	Remarks on dimensions and sex ratio .....	4
3	Distribution .....	4
4	Taxonomic Key .....	7
	Taxonomic key for the identification of adult females.....	7
	Taxonomic key for the identification of adult males .....	9
	Centropages groups .....	10
5	Figures.....	11
6	Links to further information .....	17
	WoRMS.....	17
	Molecular information.....	17
	Other useful links.....	17
7	Terminology .....	18
8	Acknowledgments.....	18
9	References.....	18
10	Author contact details .....	26

# Copepoda

Order..... Calanoida

Family ..... Centropagidae Geisbrecht, 1893

Genus..... *Centropages* Krøyer, 1849

## 1 Summary

The genus *Centropages* is a member of the family Centropagidae within the order Calanoida. This planktonic copepod family is common and widespread globally, inhabiting all oceans, in coastal, neritic and offshore waters. They are predominantly found in the epipelagic zone, spanning a wide latitudinal range in both hemispheres, but they can also be found in the mesopelagic zone. The genus *Centropages* is characterized by medium sized individuals, with females typically averaging 1.5 mm in length and males slightly smaller. Of the 35 species identified worldwide, 17 species of *Centropages* have been documented in the ICES area, the Mediterranean and Black Seas. Their geographical distributions are detailed accordingly.

This Leaflet is an update of Plankton Identification Leaflet 11 (G.P. Farran, 1948) in which 5 species were included. This new leaflet includes 17 species and is based on the Vervoort (1964) classification and the key taxonomic diagnosis based in Bradford-Grieve *et al.* (1999), Vives and Shmeleva (2007), Gubanov *et al.* (2014) and the website on marine planktonic copepods by Razouls *et al.* (2002–2025).

## 2 Introduction

The family Centropagidae is a well-recognized taxonomic group of Calanoid copepod (Giesbrecht, 1892; Tanaka, 1963; Bradford-Grieve, 1999). This family comprises two dominant marine genera: *Centropages* Kroyer, 1848 and *Isias* Boeck, 1845 (Bradford-Grieve *et al.*, 1999; Vives and Shmeleva, 2007).

*Centropages* is the most speciose genus in the family Centropagidae, with 35 species currently identified worldwide (Bradford-Grieve *et al.*, 1999), of which 17 are reported in ICES area. It is the most abundant and often dominant taxon in marine zooplankton communities, widely distributed in all oceans, and occurring over a wide latitudinal range of diverse ecosystems from the epipelagic to mesopelagic zones. Individuals have a small to medium body size, usually between 1 and 2.5 mm, with two species smaller than 1 mm. Female mean length size is 1.5 mm; males are slightly smaller.

### Main characteristics of *Centropages*

Many of the *Centropages* species are restricted to the epipelagic zone, usually affiliated with neritic environments (Siokou-Frangou *et al.*, 2010). Some are also found in low numbers in oceanic regions near continental slopes, probably resulting from seasonal expatriation of individuals from populations living over the shelf edge (Beaugrand *et al.*, 2007). Species of

*Centropages* are omnivorous, but phytoplankton can become an important component of their diet (Benedetti *et al.*, 2016). They usually can exhibit mixed feeding strategies, depending on the available food items. Several studies are focused on their feeding habitat (Wiadnyana and Rassoulzadegan, 1989; Saiz *et al.*, 1997; Caparroy *et al.*, 1998; Calbet *et al.*, 1999, 2007). For instance, the feeding appendages of *Centropages hamatus* can filter and grasp small particles (Anraku and Omori, 1963); at natural food concentrations, this species ingests more plant than animal material (Conley and Turner, 1985; Tiselius, 1989).

*Centropages typicus* is one of the most abundant and comprehensively studied calanoid copepod in the ICES area (Beaugrand *et al.*, 2007; Bonnet *et al.*, 2007; Carlotti and Harris, 2007). It is a temperate copepod with a wide distribution range in the North Atlantic and adjacent seas. In shelf areas, it may account for 10–50% of total copepod abundance, depending on the time of year; and it is often dominant in the Mediterranean Sea (Mazzocchi *et al.*, 2007). Population dynamics of *C. typicus* have been studied and modelled (Stegert *et al.*, 2012; Carlotti *et al.*, 2014). Though many studies were focused on *C. typicus*, the species *C. hamatus*, *C. chierchiae* and *C. ponticus* were also well studied (Conley and Turner, 1985; Cruz *et al.*, 2013; Krsinic, 2017). The behaviour of *C. typicus* was studied by Alcaraz *et al.* (2007) and more recently by Uttieri *et al.* (2021) and Carotenuto *et al.* (2023).

The development time of the different *Centropages* is almost the same for all species (Björnberg, 1972). At temperatures around 17°C, it takes about 20 days for them to develop from egg to adult, although the development time of *C. typicus* is longer than other species (Smith and Lane, 1987). The annual cycle of *C. typicus* in the north western Mediterranean, the North Sea, and the English Channel consists of a succession of five to seven generations (Bonnet *et al.*, 2007; Mazzocchi *et al.*, 2007). The instantaneous growth rate of *C. abdominalis* is similar to that of other *Centropages* species (Chen and Zhang, 1965). However, the growth rate of *C. abdominalis* is high compared to those of other calanoid species occurring in low temperature periods (Chen and Zhang, 1965). Nevertheless, this rate is constant over all developmental stages in the case of *C. typicus* and *C. hamatus* (Fryd *et al.*, 1991).

*C. typicus* metabolism was studied by Gaudy and Thibault-Botha (2007), and its respiration was investigated by Cruz *et al.* (2013). A lot of studies were also performed on *C. typicus* reproduction (Miralto *et al.*, 1995; Carlotti *et al.*, 1997; Halsband-Lenk *et al.*, 2001; Bagøien and Kjørboe, 2005; Ianora *et al.*, 2007; Carotenuto *et al.*, 2023). Studies on fecundity and egg hatching were also performed (Dagg, 1978; Ianora *et al.*, 1992; Bonnet and Carlotti, 2001). The reproduction traits of *C. ponticus* were investigated by Souissi *et al.* (2008), while Neffati *et al.* (2013) focused on *C. kroyeri*. In order to overcome unfavourable conditions, some *Centropages* species can diapause or produce resting eggs (Sazhina, 1968; Nival *et al.*, 1990; Marcus and Lutz 1998; Rubino *et al.*, 2002; Castellani and Lucas, 2003; Engel and Hirche, 2004; Jo and Marcus, 2004).

Molecular phylogenies demonstrated a complex biogeography history in the family *Centropagidae*, involving five independent invasions of continental waters from the sea (Adamowicz *et al.*, 2010). Within *Centropages*, there are a large number of cryptic species that are now considered recognized species, especially for geographically widespread taxa. Castellani *et al.* (2012) observed morphological differences in the male P5 of *C. typicus* which reflected genetic differentiation between the NW Atlantic, NE Atlantic and Mediterranean Sea (Bucklin *et al.*, 2011; Blanco-Bercial *et al.*, 2014). A further analysis by Blanco-Bercial and Bucklin (2016) revealed genetic population structure of same species in the North Atlantic. There is still sometimes a significant doubt about the validity of the distinction between a few species (e.g. between *C. chierchiae* and *C. typicus*) owing to their similar morphological features. A genetic analysis of several species (e.g. *C. hamatus*, *C. kroyeri* and *C. ponticus*, or *C. longicornis*, *C. calaninus* and *C. violaceus* among others) would help clarify and verify the species distinctions.

## Main morphological features

Morphological differences of the chela of the P5 prevent breeding between individuals belonging to different populations and species. The chela of the male fifth leg (P5) of *Centropages* is thus the most useful feature to distinguish the different species (Goetze, 2008). The shape of their bodies, the A1 and P5 of the female, are also essential for the different species distinction. It is even suggested that morphological variation among the chela of the male P5 of *C. typicus* could be used as an indicator to reflect differentiation among specimen from different sides of the Atlantic and the Mediterranean Sea (Lee, 1972).

## Diagnostic features of Family Centropagidae and dominant marine genera

The followed diagnosis is based on Bradford-Grieve *et al.* (1999) and Vives and Shmeleva (2007).

**Centropagidae** is a worldwide community that mainly has a narrow head towards the front and posterior corners of the prosome (Pr), often prolonged into points. The urosome (Ur) presents with separate segments, 3 in the female and 4 or 5 in the male. Oral parts are not reduced. In males, the antennule (A1) is prehensile.

**In females:** the first four legs of the female (P1 to P4) usually have three knuckles on both branches. The fifth leg (P5) of the female is biramea with a spinous process, exopodal (Exp) segment 2 with finger-like projection instead of internal seta.

**In males:** the P5 is asymmetrical and biramea with a clamp in the third joint of the Exp of the right branch. The endopodite (End) is composed of two segments. In addition, the distal seta of Maxilliped (Mxp) is without small shield-shaped appendages (Bradford-Grieve *et al.*, 1999).

As mentioned, this family comprises two marine genera: *Centropages* and *Isias*. The other genera are brackish-or freshwater (Bradford-Grieve *et al.*, 1999; Boxshall and Halsey, 2004; Vives and Shmeleva, 2007).

*Centropages*.....Ur of female 3 segmented; P1 with 2- or 3- segmented End; P2 to P4 with 3-segmented End. P5 without tooth in the second basipod. End of P5 typically 2 or 3 segmented in both sexes; sometimes 1 segmented or vestigial in males. First and second Exp segments of P1 each with outer spine. End2 segment of P1 typically with two inner setae. The Exp3 segment of swimming leg 2 to leg 4 (P2 to P4) with III, 1, 5 setation; Right P5 chelate with distal segment opposing inner process on 2nd Exp segment (Boxshall and Halsey, 2004).

*Isias*.....Ur of female 3 segmented. P1 with 2- or 3- segmented End; P2 to P4 with 3-segmented Ends. End1 of P5 segmented. P5 with strong tooth in the second basipod. End1 of P5 segmented or vestigial in both sexes. Male P4 asymmetric without clamp.

The main morphological characteristics of *Centropages* are summarized below, again based on Bradford-Grieve *et al.* (1999) and Vives and Shmeleva (2007).

- Genital segment usually asymmetrical
- Mx1 inner lobe 1 with 15 spines and setae; inner lobe 2 with 3 setae; inner lobe 3 with 3 setae; basipod 1 with 5 setae; End with 4+5 setae, segments 1 and 2 fused to basis; Exp with 9 setae, outer lobe 2 with 1 small seta, outer lobe 1 with 9 setae, 7 of them long.
- Exp3 of P2 to P4 with three outer-edge spines

### Main Female characteristics

- Ur with 3 segments
- P5 basipod 2 not ornamented
- Exp2 with a large, straight inner edge spine

### Main Male characteristics

- Ur with 5 segments
- P4 with a conspicuous clamp
- P5 with basipod 2 unornamented; left Exp2-segmented, segment 1 with 1 outer-edge spine; segment 2 with 3 outer-edge spines and 1 small terminal spine; both Ends as in female; right Exp3 segmented, in the form of a chela.

### Remarks on dimensions and sex ratio

The mean female size is 1.536 mm (n = 68; SD = 0.4478), and the mean male size is 1.472 mm (n = 64; SD = 0.4405). The size ratio (Male: Female) is 0.958. The sex ratio (F: M) is 1.03 (Bradford-Grieve, 1999).

## 3 Distribution

The previous ICES identification leaflet n° 11 of *Centropages* (Farran, 1948) provided information and description of five species in the ICES area: *C. typicus*, *C. chierchiae*, *C. hamatus*, *C. bradyi*, and *C. violaceus*.

Presently, 17 species are accepted in the ICES area, and only 10 are present in the North Atlantic, namely *C. brachiatus* (Dana, 1849–1852); *C. bradyi* Wheeler, 1900; *C. caribbeanensis* Park, 1970; *C. chierchiae* Giesbrecht, 1889; *C. furcatus* (Dana, 1849–1852); *C. hamatus* (Lilljeborg, 1853); *C. kroyeri* Giesbrecht, 1892–1893; *C. longicornis* Mori, 1932; *C. typicus* Krøyer, 1849; *C. violaceus* (Claus, 1863). Among these species, *C. longicornis* is the only one not found in the Mediterranean and Black Seas.

The following species were reported in the Mediterranean Sea:

*C. abdominalis* Sato, 1913; *C. brachiatus* (Dana, 1849–1852); *C. bradyi* Wheeler, 1900; *C. calaninus* (Dana, 1849–1852); *C. caribbeanensis* Park, 1970; *C. chierchiae* Giesbrecht, 1889; *C. elongatus* Giesbrecht, 1896; *C. furcatus* (Dana, 1849–1852); *C. gracilis* (Dana, 1849); *C. hamatus* (Lilljeborg, 1853); *C. krøyeri* Giesbrecht, 1892; *C. ponticus* Karavaev, 1895; *C. tenuiremis* I. C. Thompson & A. Scott, 1903; *C. typicus* Krøyer, 1849; *C. violaceus* (Claus, 1863).

Only *C. ponticus* Karavaev, 1895 is clearly present in the Black sea, whereas the presence of *C. bradyi* Wheeler, 1900; *C. furcatus* (Dana, 1849–1852); *C. krøyeri* Giesbrecht, 1892; and *C. spinosus* (Krichagin, 1873) are uncertain (Gubanov *et al.*, 2014).

It is important to note that among the 17 species found in the ICES area, two of them were very rare. *C. tenuiremis*, usually found in the Pacific and Indian Oceans, was cited in the coastal Egyptian area (Zakaria *et al.*, 2016) and *C. spinosus* in the coastal waters of the Black Sea (Shmeleva, 2005).

The following distribution data and size measurements were collected from Björnberg (1981), Bradford-Grieve *et al.* (1999), Vives and Shmeleva (2007), and Razouls *et al.* (2002–2025).

**1. *Centropages abdominalis*** Sato, 1913. F: 1.30–2.10; M: 1.20–1.60. This species is allied to *C. calaninus* and *C. violaceus* (Mori, 1964). It was found in coastal and brackish waters in the Pacific

and in the Seto Inland Sea of Japan (Chen and Zhang, 1965). However, it was also observed in the Eastern Mediterranean Sea (Zakaria *et al.*, 2016).

**2. *Centropages bradyi*** Wheeler, 1900. F: 1.30–2.50; M: 1.52–2.40. Epi-meso-bathypelagic, widely distributed in the temperate Atlantic and, Pacific Oceans, as well as in the Mediterranean Sea (Brodsky, 1962; Brodsky, 1967).

**3. *Centropages brachiatus*** (Dana, 1849–1852). Epipelagic, neritic, littoral and cryophilic species (Björnberg, 1981) with no apparent vertical migration (Timonin, 1977). F: 1.50–3.00; M: 1.30–2.90. Although it shows a worldwide distribution, it is a cold-living species (Tanaka, 1964) which occurs more frequently in the southern rather than in the northern hemisphere (Razouls, 1995).

**4. *Centropages calaninus*** (Dana, 1849–1852). Epipelagic, cosmopolitan (Timonin, 1971). F: 1.72–2.18; M: 1.68–2.11. It is similar to *C. violaceus* (Zheng and Chen, 1982), it is distinguished by the proportions of the anal segment, CR and A1 in the female and by the form of the right P5 Exp segment 3 in the male.

**5. *Centropages caribbeanensis*** Park, 1970. Epipelagic. F: 1.90–2.00; M: 1.82–2.14. This species was mainly found in the Caribbean Sea, and its description was revised by Roe (1975). In the Mediterranean Sea it was cited for first time by Uysal *et al.* (2002).

**6. *Centropages chierchiae*** Giesbrecht, 1889. Epipelagic with geographic distribution similar to *C. typicus* (Vives and Shmeleva, 2007). F: 1.48–2.10; M: 1.48–2.26. For several authors, this species is close to *C. typicus* but different in their urosome and P5 (Lee, 1972; Razouls, 1973).

**7. *Centropages elongatus*** Giesbrecht, 1896. Epipelagic. It is mostly present in the Indian and in the Pacific oceans (Chihara and Murano, 1997). F: 1.50–1.91; M: 1.50–2.00.

**8. *Centropages furcatus*** (Dana, 1849–1852). Epipelagic. F: 1.38–1.92; M: 1.40–1.92. Two forms were cited (Lee, 1972): in the Atlantic (*C. velificatus*; Oliveira, 1947 already described it as a different species) and in the Pacific-Indian (*C. furcatus* s.s.; Fleminger and Hulsemann, 1973). There is a form observed in the Eastern Mediterranean which has lessepsian origin (Siokou *et al.*, 2013), but the form found in the western Mediterranean probably needs confirmation (Razouls *et al.*, 2002–2025), as does the form in the Black Sea (Gubanova *et al.*, 2014).

**9. *Centropages gracilis*** (Dana, 1849). Epipelagic and mainly coastal (Brodsky, 1962; Timonin, 1971) F: 1.70–2.16; M: 1.70–2.04. The presence of this species in the Mediterranean Sea was recorded in the Algerian coastal waters (Khelifi-Touhami *et al.*, 2007).

**10. *Centropages hamatus*** (Lilljeborg, 1853) Epipelagic and neritic, abundant in the Atlantic Ocean (Lee, 1972). F: 0.94–1.42; M: 0.90–1.30. The size ratio (male: female) is 0.93 (n = 7; SD = 0.28). The vertical range is down to 400 m. The occurrence of this rare species is confirmed in the NW Mediterranean Sea over the year (Gaudy, 1962). This species is uncommon so far north of Norway (69°30'N), where it is found mainly during summer and disappears in winter (Norrbin, 1992).

**11. *Centropages longicornis*** Mori, 1932 Epipelagic. Only the female is described. Size: 1.88–2.00. It was found in the Atlantic and in the Pacific Oceans (Tanaka, 1963) and not yet found in the Mediterranean. According to Mori (1964), this species is also morphologically allied to *C. calaninus* and *C. violaceus*.

**12. *Centropages kröyeri*** Giesbrecht, 1892–1893. Epipelagic and cosmopolitan (Razouls, 1972). F: 1.25–1.52; M: 1.20–1.41. It can appear in the Northwest Mediterranean mainly in autumn (Gaudy, 1962), but all along the year in the rest of the Mediterranean (Razouls, 1993). It resembles *C. ponticus* (Greeze and Baldina, 1964; Kovalev, 1967).

**13. *Centropages ponticus*** Karavaev, 1895. Epipelagic and neritic, it is found also in lagoons and ports of the Mediterranean and the Black Sea (Razouls, 1983). F: 0.70–1.04; M: 0.54–1.10. It is probably original from the Mediterranean Sea and successively penetrated the Red Sea (Krsinic, 2017; Prusova *et al.*, 2019).

**14. *Centropages spinosus*** (Krichagin, 1873) F: 0.85–0.90; M: 0.80. According to Shmeleva (2005), this species, found in the Black Sea, is euryhaline (7 to 39 psu) and lives in temperatures from 14°C to 31°C. This species resembles *C. ponticus*.

**15. *Centropages tenuiremis*** I. C. Thompson. and A. Scott, 1903. Epipelagic, neritic and estuarine (Mulyadi, 1998). F: 1.35–2.00; M: 1.20–1.80. It was found in the eastern coast of India (Rakhesh *et al.*, 2013). The first citation in the Mediterranean was done in the west Egyptian coast by Zakaria *et al.* (2016).

**16. *Centropages typicus*** Krøyer, 1849. Epipelagic and very abundant in the Atlantic (Boxshall and Hasley, 2004), particularly in spring (Vives and Shmeleva, 2007). In the Mediterranean, it is one of the most studied calanoid copepods (Mazzocchi *et al.*, 2007; Molinero *et al.*, 2009; Carotenuto *et al.*, 2023). F: 0.79–2.00 mm (mean  $1.59 \pm 0.27$  mm,  $n = 21$ ); M: 1.00–1.90 mm (mean  $1.55 \pm 0.20$  mm,  $n = 19$ ). The size ratio (male: female) is 0.95 ( $n = 11$ ; SD = 0.05).

**17. *Centropages violaceus*** (Claus, 1863). Epipelagic and oceanic. F: 1.76–2.24; M: 1.77–2.17. The mean female size is 1.99 mm ( $n = 24$ ; SD = 0.15), and the mean male size is 1.96 mm ( $n = 23$ ; SD = 0.13). The size ratio (male: female) is 0.98 ( $n = 13$ ; SD = 0.05). This epipelagic species has been mainly observed in tropical and subtropical waters of all oceans (Razouls, 1995).

Below are summarized the preference habitats, waters and depths of the different *Centropages* species found in the ICES area according to Razouls *et al.* (2002–2025).

<u>Species</u>	<u>Localization</u>	<u>Depth</u>
<i>C. abdominalis</i>	Warm temperate, sub-Arctic (Arct), Arct ± brackish	L
<i>C. brachiatus</i>	Cosmopolitan, cold waters, sub-Antartic (Ant), sub-Tropical	E
<i>C. bradyi</i>	Cosmopolitan, sub-Ant, cold temperate	E-B
<i>C. calaninus</i>	Cosmopolitan, Tropic, cold temperate	E
<i>C. caribbeannensis</i>	sub-Tropic	E
<i>C. chierchiae</i>	sub -Tropic	E
<i>C. elongatus</i>	Cosmopolitan	E
<i>C. furcatus</i>	Cosmopolitan (equatorial-subtropical), rare in Ant	E
<i>C. gracilis</i>	Tropic	E
<i>C. hamatus</i>	Cold temperate	E-N
<i>C. krøyeri</i>	Tropic, warm temperate	E
<i>C. longicornis</i>	Tropic, sub-Tropic	E
<i>C. ponticus</i>	Warm temperate	L
<i>C. spinosus</i>	Insufficient Information	L
<i>C. tenuiremis</i>	Tropic, cold waters, Pacific NW	N
<i>C. typicus</i>	Cold temperate, sub-Tropic	E, N, B
<i>C. violaceus</i>	Cosmopolitan, Tropic, and sub-Tropic	E, Oc

Abbreviations: Epipelagic (E); Neritic (N); Bathypelagic (B); Littoral (L); Oceanic (Oc).

## 4 Taxonomic Key

Taxonomic information of *Centropages* has been widely provided in many publications and books: Sars, 1902; Esterly, 1905; Van Breemen, 1908; Scott, 1911; Wilson, 1932; Rose, 1933; Grize, 1962; Kasturirangan, 1963; Tanaka, 1963; Boltovskoy, 1981; Mauchline, 1988; Chihara and Murano, 1997; Mauchline, 1998; Mulyadi, 1998; Bradford-Grieve *et al.*, 1999; Mulyadi, 2004; Vives and Shmeleva, 2007.

Considering *Centropages* species present in ICES area, the following taxonomic key was issued using the keys by Bradford Grieve *et al.* (1999), by Shmeleva (2005), and by Vives and Shmeleva (2007). For the species *C. abdominalis*, *C. tenuiremis*, and *C. spinosus*, the key integrated the information provided by Razouls *et al.* (2002–2025).

*Centropages typicus* Krøyer, 1849 is the type species of the genus.

### Taxonomic key for the identification of adult females

- 1 Posterior corners of Pr rounded.....2  
Posterior corners of Pr pointed...../.....7
- 2 CR with peg-like projection on posterior border: .....*C. bradyi* (Wheeler, 1900)  
CR without such projection.....3
- 3 Ur2  
ornamented.....4  
Ur2 unornamented .....5
- 4 Ur2 with spinous lateral knob on each side. Gns with naked lateral borders:  
.....*C. gracilis* (Dana, 1849–1852)  
Ur2 with conspicuous ventral process, centrally placed; Gns with a patch of spinules on  
right side and probably few spinules on the left side:  
.....*C. violaceus* (Claus, 1863)
- 5 P5 Exp2 inner spine does not extend as far as distal border of Exp3:  
.....*C. longicornis* (Mori, 1932)  
P5 Exp2 inner spine is shorter than distal border of Exp3:  
.....*C. caribbeanensis* (Park, 1970)  
P5 Exp2 inner spine extends to or well beyond distal border of  
Exp3.....6
- 6 P5 Exp2 inner spine extends as far as or slightly beyond distal border of Exp3:  
.....*C. elongatus* (Giesbrecht, 1896)  
P5 Exp2 inner spine extends well beyond distal border of Exp3:  
.....*C. calaninus* (Dana, 1849–1852)
- 7 Segments 1, 2 and 5 of A1 with conspicuous anterior spine.....8  
Proximal A1 segments without large spines .....11

- 8 Gns without setae; posterior corners of Pr with 2 points on each side: .....*C. furcatus* (Dana, 1849–1852)  
Gns with setae: posterior corners of Pr with 1 point on each side .....9
- 9 Ur2 in dorsal view with convex right lateral border and straight left border bearing small ventro-lateral spine just posterior to midlength; Ur2 twice longer than anal segment; posterior Pr corners and Gns very asymmetrical: .....*C. brachiatus* (Dana, 1849–1852)  
Ur2 in dorsal view with left border without ornamentation; posterior Pr corners and Gns not very asymmetrical in shape.....10
- 10 Ur2 in dorsal view with slight, wide, right side antero-lateral swelling; A1 extends to posterior border of CR:.....*C. typicus* (Krøyer, 1849)  
Ur2 in dorsal view with conspicuous, narrow right side process just posterior to mid-length, plus more antero-ventrally placed swelling; A1 does not extend to posterior border of the CR:..... *C. chierchiae* (Giesbrecht, 1889)
- 11 Posterior Pr points directed straight.....12  
Posterior Pr points divergent.....13
- 12 Posterior Pr point with strong straight spines. Not symmetric Gns with hairs and a ventral spine. P5 with a curve internal spine in Exp2 segment: .....*C. tenuiremis* (Thompson, I.C. & Scott, A., 1903)  
Posterior Pr pointed with small spines .....16
- 13 Posterior Pr divergent pointed out, similarly in both sides. Gns with spinous, asymmetrical, antero-lateral swelling on each side and patch of dorsal spinules with hairs; A1 extends to posterior border of CR: .....*C. kroyeri* (Giesbrecht, 1892–1893)  
Posterior Pr divergent with small spines pointed out .....14
- 14 Posterior Pr with spine pointed out, different in size and trajectory. Gns slightly asymmetric and swelled in both sides with great hairs. Head in frontal view quadrangular: .....*C. hamatus* (Lilljeborg, 1853)  
Gns asymmetric differently swelled .....15
- 15 Gns asymmetric more convex on the right side, bearing hairs on both lateral borders and in front of the genital pore there is a posterior pointed spine which does not reach midlength of Gns; projections of the posterior Pr directed postero-laterally in one side and divergent in the other:.....*C. abdominalis* (Sato, 1913)  
Gns asymmetric more swelled on right side than left side in dorsal view bearing hairs. Similarly projections of the posterior Pr. Head round in frontal view: .....*C. ponticus* (Karavaev, 1895)
- 16 Gns symmetric ventrally ornamented without hair. P5 with slight straight spine in Exp2:..... *C. spinosus* (Krichagin, 1873)

## Taxonomic key for the identification of adult males

- 1 Posterior corners of Pr rounded .....2  
Posterior corners of Pr pointed .....7
- 2 Right P5 Exp3 terminated by 2 thick spine-like extensions:  
.....*C. elongatus* (Giesbrecht, 1896)  
Right P5 Exp3 tapering to single point.....3
- 3 Right P5 Exp3 sharply curved at an acute angle about 1/3 of its length from proximal-  
end, left P5 with two different long spines.....  
..... *C. calaninus* (Dana, 1849–1852)  
Right P5, Exp 3 not acutely bent .....4
- 4 Right P5 Exp3 very broadly thickened proximally, with pointed triangular projection  
on inner border, left P5 with several spines:  
.....*C. gracilis* (Dana, 1849–1852)  
Right P5 Exp3 only slightly thickened proximally without pointed projection on inner  
border.....5
- 5 Right P5 Exp2 inner process arising narrowly at about middle length from its bulbous  
segment.....6  
Right P5 Exp2 inner process, which is truncate distally, arises broadly from about  
middle length; Exp 3 curved in and S-shape and is just greater than length of Exp 2  
inner process. Left P5 is with several and curved spines. CR with distal peg-like  
processes: .....*C. bradyi* (Wheeler, 1900)
- 6 Right P5 Exp3 curved in an S-shape and is at least 3 times longer than Exp 2 inner  
process. CR without distal peg-like process: .....*C. violaceus* (Claus, 1863)  
Right P5 Exp2 inner process curved. Left P5 End2 and End3 not completely separated  
and the 3 with two long spines.....*C. caribbeanensis* (Park, 1970)
- 7 Posterior corners of Pr with pair of points on each side:  
.....*C. furcatus* (Dana, 1849–1852)  
Posterior corners of Pr with single point on each side.....8
- 8 Posterior corners of Pr with distinct points. Left P5 Exp 2+3 oblong. Right geniculated  
A1 segment 16 with large spine, segment 15 without spine:  
.....*C. typicus* (Krøyer, 1849)  
Right geniculated A1, segment 15 and 16 both with large spine.....9
- 9 Right P5 Exp2 inner process abruptly curved at right angles .....10  
Right P5 Exp2 inner process gently curved .....11
- 10 Right P5 Exp2 inner process abruptly curved at distal 1/3, without teeth along distal  
part, spines on segments 15 and 16 of A1, with their bases about 1/3 length of segments:  
.....*C. brachiatus* (Dana, 1849–1852)  
Right P5 Exp2 inner process abruptly curved at about middle length and bearing teeth  
along distal part, spines on A1 segments 15 and 16 with their bases about 1/2 length of  
segments: .....*C. chierchiaie* (Giesbrecht, 1889)
- 11 Right P5 Exp2 with almost straight clamp and short. Posterior Pr ending at small  
spines.....*C. hamatus* (Lilljeborg, 1853)

- Right P5 Exp2 with straight clamp or slightly curved one of them and the other with angle.....12
- 12 Right P5 Exp long and curved in right angle forming the grasping organ. End1 and End2 of left P5 with marginal swellings. Posterior Pr ending in small hardly curved tooth:.....*C. ponticus* (Karavaev, 1895)  
Clamp of the P5 gently curved and posterior Pr ending with small spines.....13
- 13 Similar Posterior Pr at both sides. Right P5 Exp2 inner process gently curved at less than right angle: .....*C. kroyeri* (Giesbrecht, 1892)  
Right P5 Exp2 inner process gently curved and almost equal to Exp3.....14
- 14 Posterior Pr ending with different spines on each side. Right P5 Exp2 inner process gently curved as a grasping organ but differing on the fact that thumb is shorter than the terminal claw .....*C. tenuiremis* (I. C. Thompson & A. Scott, 1903)  
Posterior Pr with spines, similarly pointed out on either side .....15
- 15 Right P5 Exp2 claw like extension and slightly shorter as compared to Exp3. Left P5 End2 outer distal corner with small swelling:.....*C. abdominalis* (Sato, 1913)  
Right P5 slightly curved with short grasping organ and two spines .....*C. spinosus* (Krichagin, 1873)

## Centropages groups

According to Vervoort (1964), *Centropages* species were grouped by considering the dominant morphological characteristic of the genus, i.e. the shape of the last thoracic somite, shape of abdomen, morphology of P5, and the male A1. He pointed out the need for a thorough revision of *Centropages* as a preliminary step, arranging the species provisionally into five groups with some suggested synonyms: "*typicus*", "*furcatus*", "*hamatus*", "*violaceus*" and "*orsinii*".

Group of *typicus* with *C. typicus*, *C. chierchiae*, and *C. brachiatus*, as well as *C. auklandicus* and *C. australensis*, also included in this group but both living in the Pacific Ocean. The presence of the former is uncertain in the Mediterranean Sea (Razouls *et al.*, 2005–2025), and the latter is absent in ICES area.

Group of *furcatus* with *C. furcatus* and *C. velificatus*. However, this last species, which lives in the Caribbean Sea, has never been found in ICES area.

Group of *hamatus* with *C. hamatus*, *C. abdominalis*, *C. kroyeri*, *C. tenuiremis*, *C. ponticus*, and *C. spinosus*. Subsequently, two other species, *C. trispinosus* and *C. alcocki*—never found in ICES area—were removed from Vervoort's "*hamatus*" group.

Group of *violaceus* with *C. violaceus*, *C. bradyi*, *C. calaninus*, *C. caribbeanensis*, *C. elongatus*, *C. gracilis*, and *C. longicornis*.

Finally, the *orsinii* group, which is found in the South Atlantic and in the Pacific oceans, has been never observed in ICES area.

Species absent from ICES area are not presented in this leaflet.

## 5 Figures

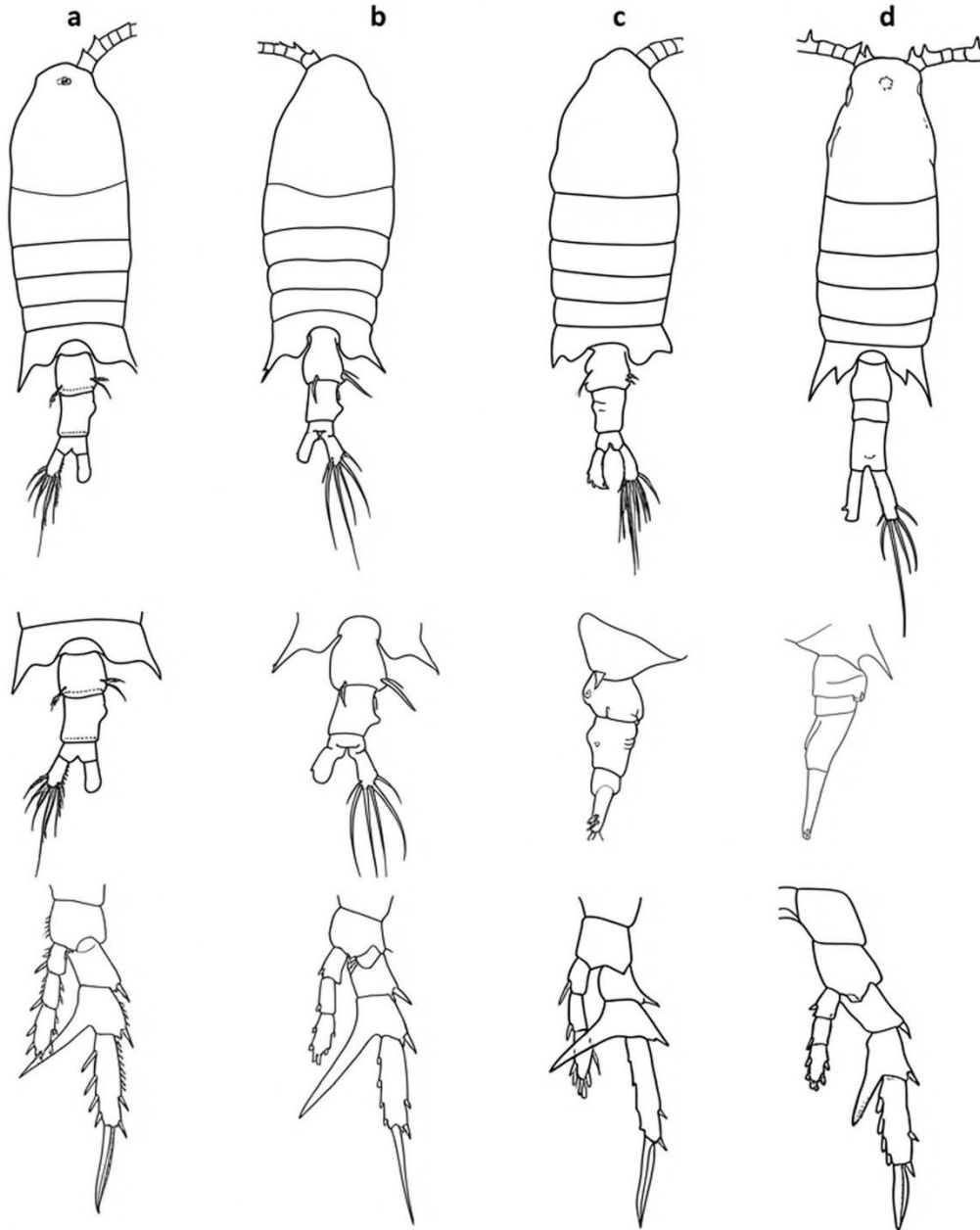


Figure 1: Females of Group I (not to scale), body dorsal view of *C. typicus* (a), *C. chierchiae* (b), *C. brachiatus* (c); of Group II, *C. furcatus* (d) with their Ur details (middle part) and Right P5 (lower part). Figures from Rose, 1933 (a); from Tanaka, 1960 (b); modified from Tanaka, 1964 (c); and from Chen and Zhang, 1965 (d).

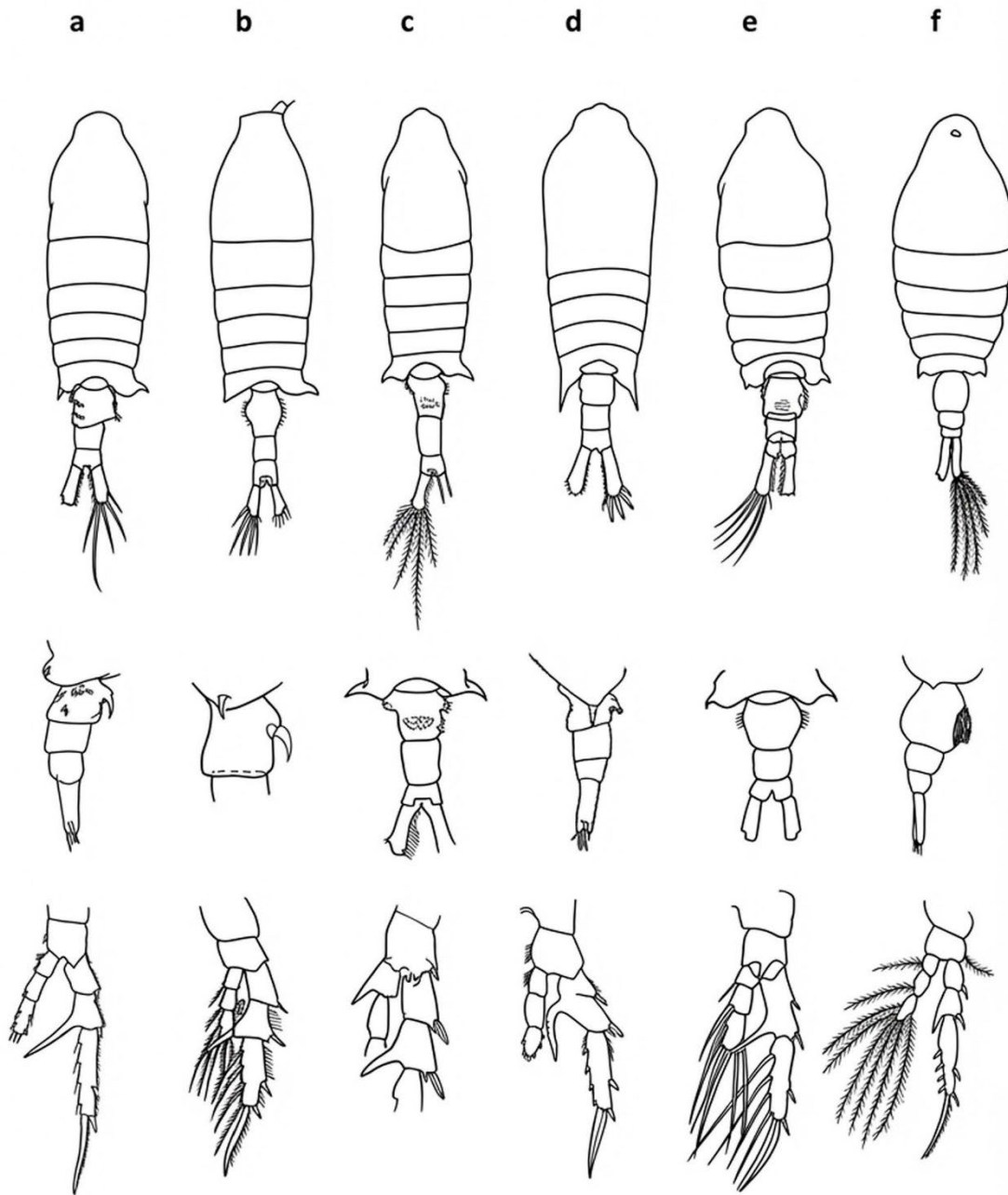


Figure 2. Females of Group III (not to scale): *C. abdominalis* (a), *C. hamatus* (b), *C. kroyeri* (c), *C. tenuiremis* (d), *C. ponticus* (e), *C. spinosus* (f). Details of Ur ventral or lateral (middle part) and Right P5 (lower part). Figures from Sars, 1902 (b); and modified from Cheng and Zhan, 1965 (a and d); Giesbrecht, 1893 and Kovalev, 1967 (c); Prusova *et al.*, 2019 (e); and Shmeleva, 2005 (f).

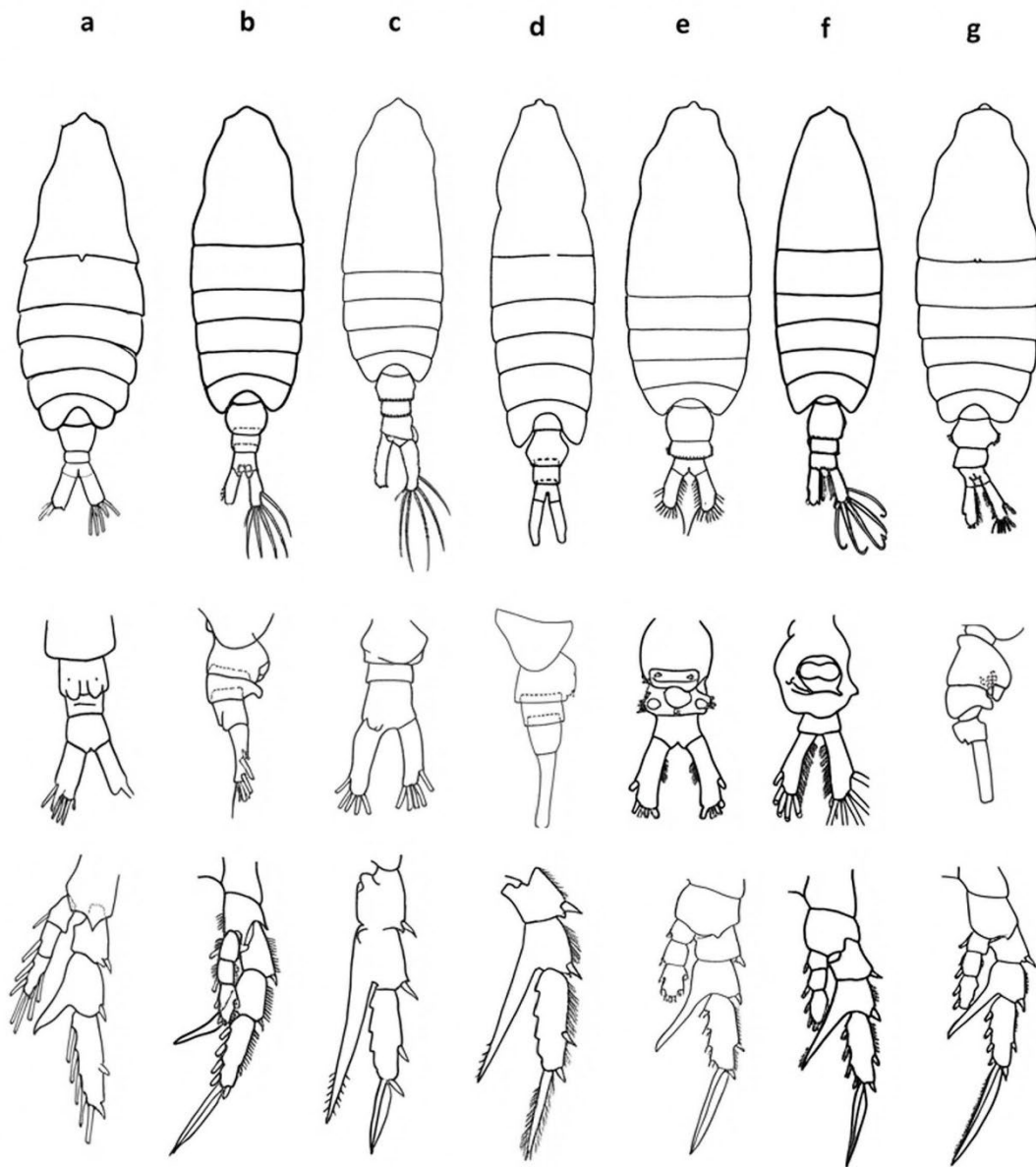


Figure 3. Females of Group IV (not to scale): *C. bradyi* (a); *C. caribbeanensis* (b), *C. calaninus* (c), *C. elongatus* (d), *C. gracilis* (e), *C. longicornis* (f), *C. violaceus* (g). Their Ur ventral or lateral view (middle part) and P5 (lower part). Figures from Park, 1970 (b); Grize, 1962 (d); Park, 1968 (g) and modified from Brodsky, 1962 (a); Zheng and Chen, 1982 (c); Chen and Zhang, 1965 (e); Chihara and Murano, 1997 (f).

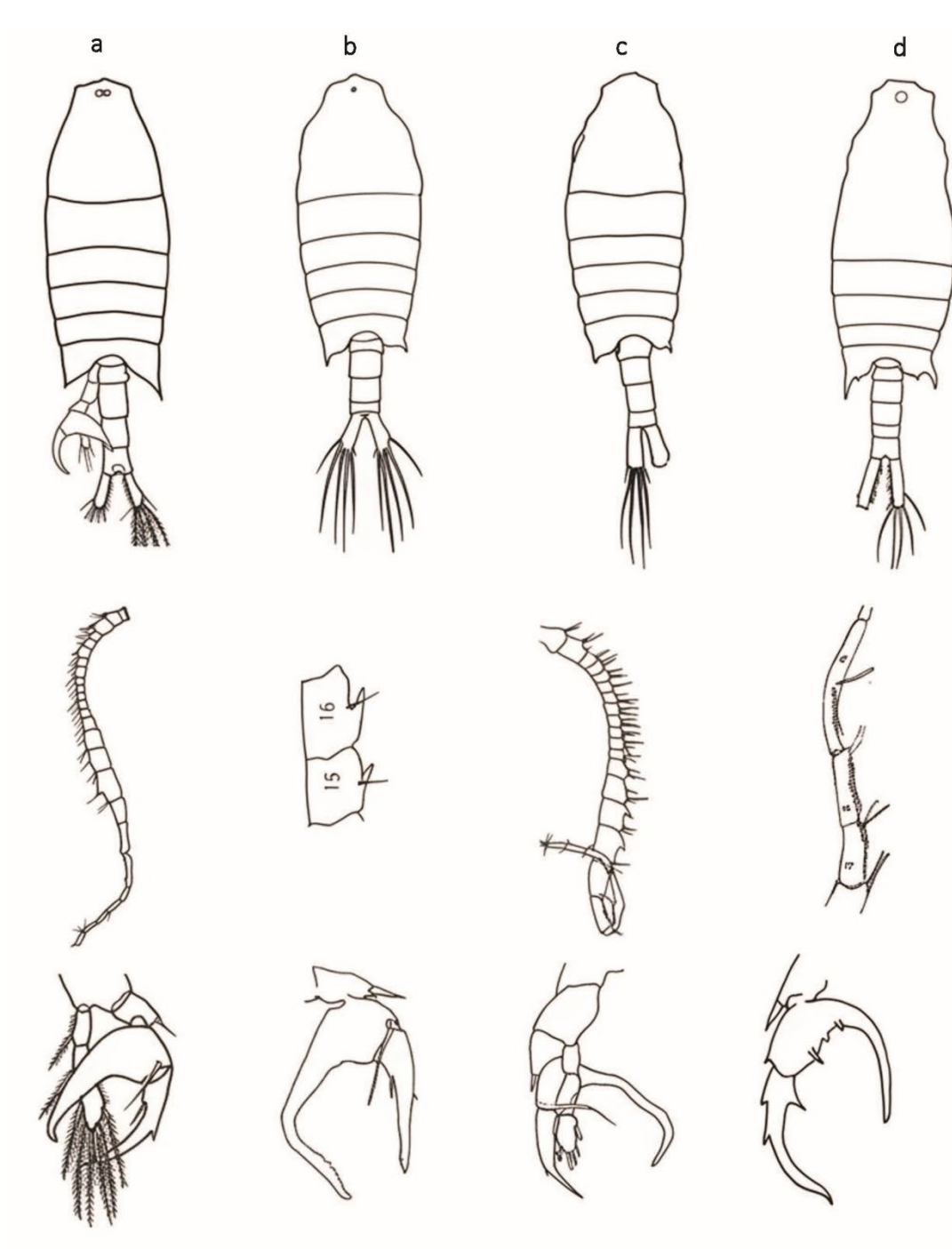


Figure 4. Males of Group I (not to scale): Body of *C. typicus* (a), *C. chierchiae* (b), *C. brachiatus* (c) and male of Group II: *C. furcatus* (d). Their A1 (middle part) and their Right Exp P5 (lower part). Figures from Rose, 1933 (a); Tanaka, 1960 (b); and modified from Tanaka, 1964 (c); and Chen and Zhang, 1965 (d).

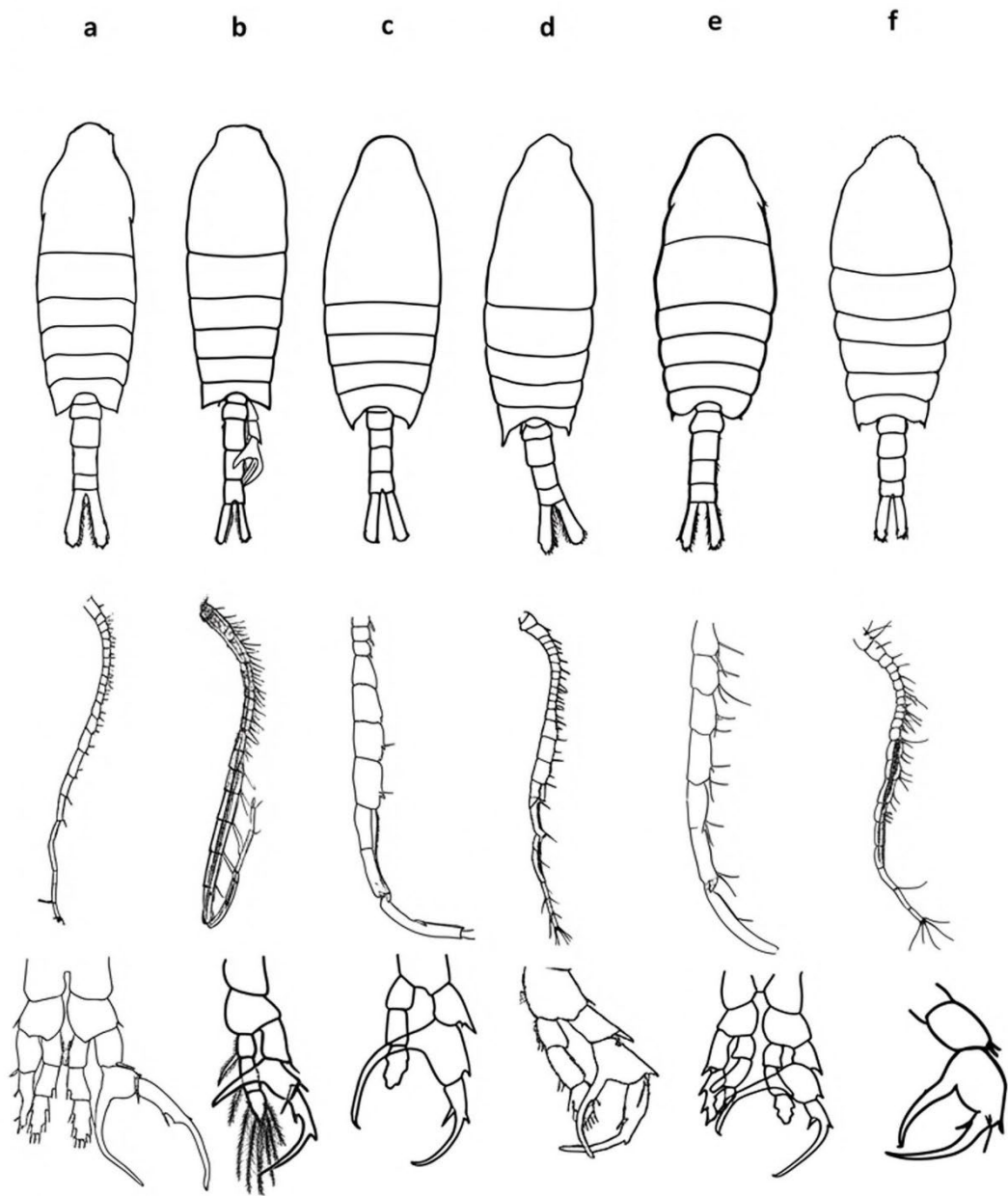


Figure 5. Males of Group III (not to scale): Dorsal bodies of *C. abdominalis* (a), *C. hamatus* (b), *C. kroyeri* (c), *C. tenuiremis* (d), *C. ponticus* (e) and *C. spinosus* (f). Their A1 (middle part) and Right Exp P5 in b) c) d) f), and entire P5 in a) and e) (lower part). Figures from Sars, 1902 (b); and modified from Cheng and Zhan, 1965 and Shen and Bai, 1956 (a and d); Giesbrecht, 1893 and Kovalev, 1967(c); Prusova *et al.*, 2019 (e); and Shmeleva, 2005 (f).

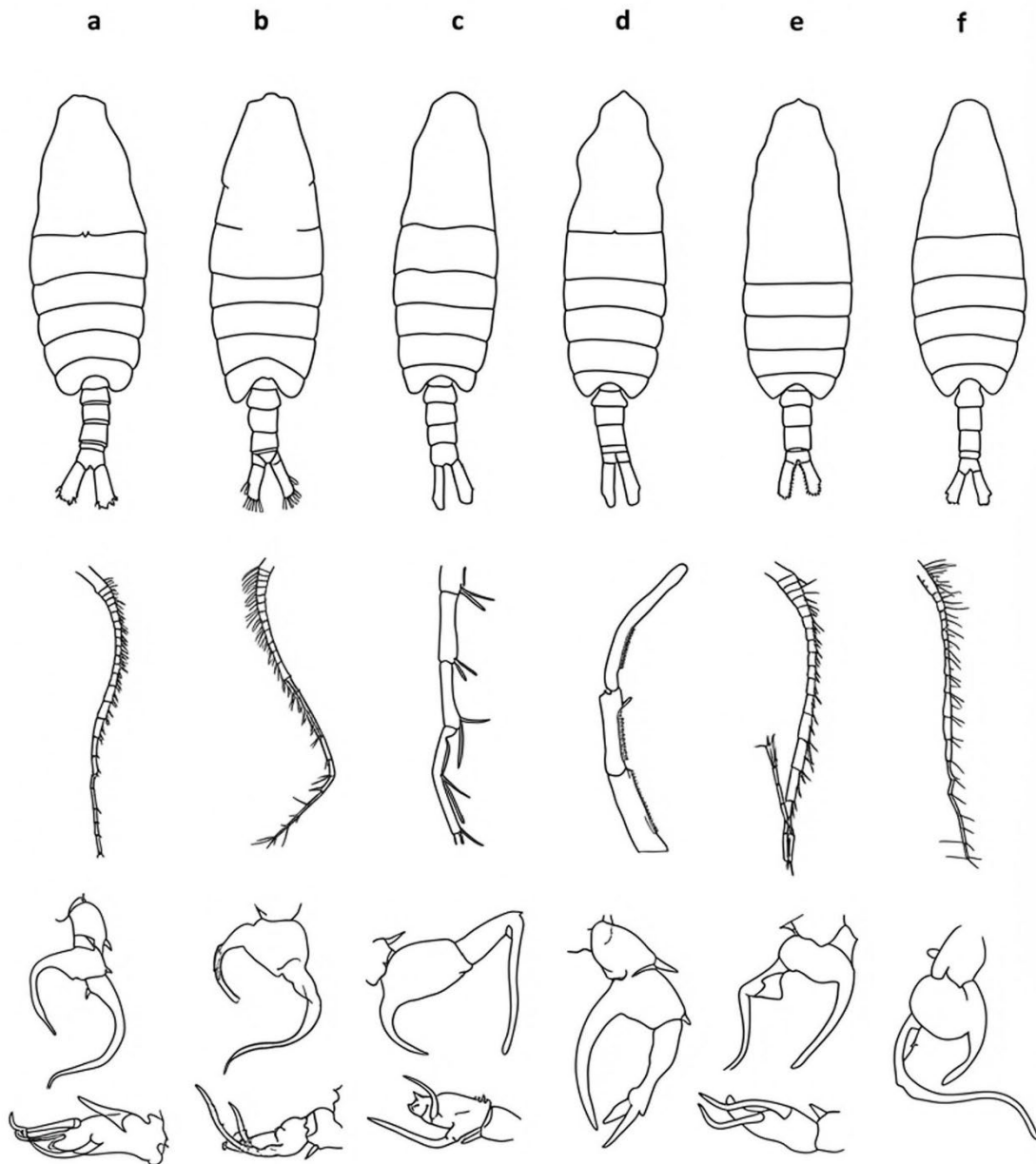


Figure 6.-Males of Group IV: *C. bradyi* (a), *C. caribbeanensis* (b), *C. calaninus* (c), *C. elongatus* (d), *C. gracilis* (e), *C. violaceus* (f). Their A1 (middle part) and their right and left P5 (lower part). Figures from Minello, 1976 (b); Grize, 1962 (d); and Park, 1968 (f); and modified from Brodsky, 1962 (a); Zheng and Chen, 1982 (c); and Chen and Zhang, 1965 (e).

## 6 Links to further information

### WoRMS

- C. abdominalis*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=196774>
- C. brachiatus*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104490>
- C. bradyi*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104491>
- C. calaninus*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104492>
- C. caribbeanensis*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104493>
- C. chierchiae*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104494>
- C. elongatus*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=220902>
- C. furcatus*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104495>
- C. gracilis*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=220903>
- C. hamatus*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104496>
- C. kroyeri*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104497>
- C. longicornis*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=346258>
- C. ponticus*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104498>
- C. spinosus*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=357746>
- C. tenuiremis*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=346261>
- C. typicus*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104499>
- C. violaceus*: <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104500>

### Molecular information

<https://www.ncbi.nlm.nih.gov/nuccore/?term=Centropages>

[https://metazoogene.org/mzgdb/atlas/html-src/full\\_T4001179\\_o02.html](https://metazoogene.org/mzgdb/atlas/html-src/full_T4001179_o02.html)

### Other useful links

Razouls, C., Desreumaux, N., Kouwenberg, J., and Bovée F. 2002–2025. Biodiversity of Marine Planktonic Copepods (morphology, geographical distribution and biological data). Sorbonne University, CNRS. <https://www.copepodes.obs-banyuls.fr/en>

World of Copepods Database. 2025. World Register of Marine Species, Flanders Marine Institute, VLIZ, Belgium. <https://www.marinespecies.org/aphia.php?p=taxdetails&id=104159>

Copepedia: Centropages. 2025. NOAA. <https://www.st.nmfs.noaa.gov/copepedia/taxa/T4000260>

## 7 Terminology

- A1 Antennule (first antenna)
- A2 Antennae (second antenna)
- Md Mandible
- Mx1 Maxillules
- Mx2 Maxilla
- Mxp Maxilliped
- P1–P5 Swimming legs 1 to 5
- Pr Prosome
- Ur Urosome
- Exp Exopod
- End Endopod
- CR Caudal Rami

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