

# Re-descriptions of *Caprella linearis* (Linnaeus, 1767) and *C. septentrionalis* Kröyer, 1838 (Crustacea: Amphipoda: Caprellidea) from Scotland, with an ontogenetic comparison between the species and a study of the clinging behaviour

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## SARSIA



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*Caprella linearis* (Linnaeus, 1767) and *C. septentrionalis* Kröyer, 1838 are re-described based on specimens collected from the coasts of Scotland. Mature males of *C. linearis* differ clearly from those of *C. septentrionalis* mainly in the features of antenna 1 and gnathopod 2. The pair of lateral projections present on pereonite 5 in females of *C. linearis* is lacking in females of *C. septentrionalis*. The gnathopod 2 propodus is wider and the genital openings more setose in females of *C. septentrionalis* than in *C. linearis*. The arrangement of the body projections and the abdomen during development is quite similar in *C. linearis* and *C. septentrionalis*. For both species the predominant mode of attachment to the substrate is the upright posture and feeding is by filtering, frequently using grooming behaviour. These species present basically the same geographical distribution, along the North Atlantic, Boreal and Arctic regions and they are not very specific in choosing their substrate.

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## INTRODUCTION

During a short stay at the Gatty Marine Laboratories, St Andrews, Scotland, several samples of the Caprellidea from the east and west coasts of Scotland (Fig. 1) were collected. The intertidal rocky areas of St Andrews, Boarhills and Kingsbarns (east coast) were exclusively inhabited by *Caprella septentrionalis* Kröyer, 1838. On the west coast (Clachan Seil, near Oban) an important population of *C. linearis* (Linnaeus, 1767) was found.

The nomenclature of *C. linearis* and *C. septentrionalis* has traditionally been one of the most confused in the Caprellidea literature. McCain & Steinberg (1970) pointed out that these species were easily confused and, therefore, many of the references could be questionable. Smaldon (1990) reported that no simple distinction could be made between the two species. For *C. septentrionalis*, a variety of body forms based mainly on the body projections have been recognized since its original description. Mayer (1890, 1903) considered the different forms as variants of the same species. Nevertheless, Stephensen (1940) treated several of these forms as distinct species or subspecies. McCain (1968) found numerous intergradations between the forms and suggested that they probably represented only infra-

subspecific variants. Although *C. linearis* and *C. septentrionalis* have been found frequently in North Atlantic waters, they have never been described in detail. Furthermore, from the extensive literature, only the descriptions of McCain (1968) as part of a general study of the Caprellidea of the western North Atlantic, are of most significance.

To differentiate *C. linearis* from *C. septentrionalis* complete descriptions with detailed figures of antennae, mouthparts, gnathopods, pereopods and abdomen are necessary. These descriptions, based on the material collected along the Scottish coasts, are included in the present paper. Furthermore, figures of the lateral view, gnathopod 2 and abdomen during the different stages of development and data on clinging behaviour are presented here with the purpose of comparison between the two species.

## MATERIAL AND METHODS

Samples of various types of substrata on which caprellids were expected to inhabit were carefully detached from rocks of intertidal areas along the east and west coasts of Scotland (Fig. 1). The intertidal zones at St Andrews, Boarhills and Kingsbarns (56°15'N

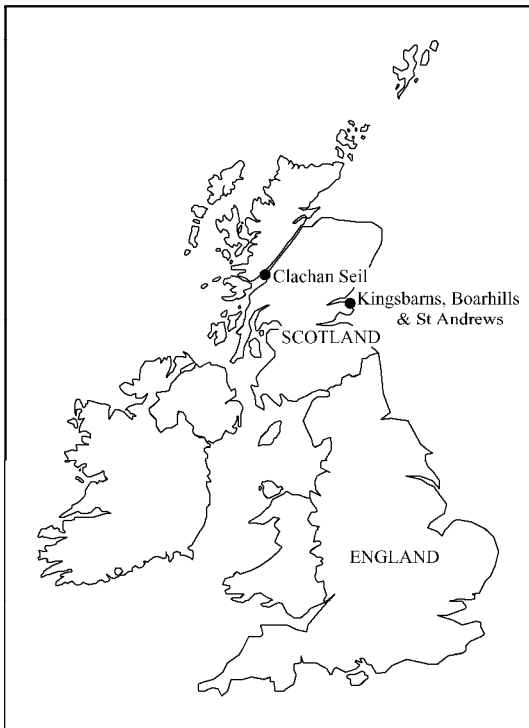


Fig. 1. Location of the sampling stations on the coasts of Scotland.

02°30'W) are areas exposed to wave action. The algae community is dominated by the brown seaweed *Fucus serratus* Linnaeus, 1753 and several species of the genera *Polysiphonia* and *Ceramium*. Clachan Seil, along the west coast, is a very sheltered tidal strait of approximately 30 m wide and 1 km long separating Seil Island (56°20'N 05°35'W) from the Argyll mainland. There are tidal sills at both ends of the narrows, and as a result, the spring tides ebb to the same level between the sills irrespective of the open coast fluctuations; hence, the enclosed narrows are never immersed. The dominant alga is also *F. serratus*; large amounts of bryozoans (principally *Electra pilosa* Linnaeus, 1767) and hydroids are attached to the surface of the seaweed and are considerably more abundant than at St Andrews, Boarhills and Kingsbarns.

The collected material was brought back to the Gatty Marine Laboratories and transferred into a shallow tray filled with seawater. The caprellids were hand picked and fixed in a 10% seawater-formalin solution and then preserved in 70% ethanol.

In an attempt to elucidate if the method of attachment to the substrate could differentiate these species, the

clinging behaviour was also studied. For the behavioural studies, 10 mature specimens (five males and five females) of each species were selected prior to preservation and individuals were placed in a Petri dish filled with seawater. The methods used for measuring the clinging behaviour in the present study are explained in detail in Takeuchi & Hirano (1995).

The figures were drawn using a binocular microscope with the aid of a camera lucida. Permanent preparations of the mouthparts were made using polyvinyl lactophenol. Fifty mature males and 50 mature females of each species were measured under the microscope. The body length was calculated as the sum of the head and pereonite lengths. Specimens of both species have been deposited in the Museo Nacional de Ciencias Naturales, Spain with the following catalogue numbers: MNCN 20.04/4660 for *C. septentrionalis* and 20.04/4661 for *C. linearis*. With the purpose of comparison, the type material (syntypes from Greenland) of *C. septentrionalis* from the Zoological Museum, University of Copenhagen (ZMUC-CRU-8059) was consulted. Type material does not exist for *C. linearis*. In this case, non-type material from Nordsøen, Ørsted, Denmark (ZMUC uncatalogued) was examined.

## RESULTS AND DISCUSSION

### SYSTEMATICS

*Caprella linearis* (Linnaeus, 1767)

*Cancer linearis* (Linnaeus 1767: 1056)

*Oniscus scolopendroides* (Pallas 1772: 80, plate 4, fig. 15 a–c)

*Squilla lobata* (Müller 1776: 197)

*Squilla quadrilobata* (Abildgaard 1788: 21–22, plate 56, figs 4–6)

*Gammarus quadrilobatus* (Abildgaard 1789: 58, plate 114, figs 11, 12)

*Cancer (Gammarellus) linearis* (Herbst 1793: 142–144, plates 99, 106)

*Cancer linnearis* (Linnaeus 1800: 761)

*Caprella linearis* (Mayer 1882: 58–62, figs 17–19, plate 4, fig. 32; Koehler 1885: 98–99, 117; Sokolowsky 1900: 162, plate 3, fig. 16; Chevreux & Fage 1925: 456–457, fig. 434; McCain 1968: 30–33, figs 14, 22, 51; Laubitz 1972: 35–37, plate 7; Smaldon 1990: 448, fig. 9.48; Larsen 1998: 82, fig. 2)

*Caprella laevis* (Goodsir 1842: 189–190, plate 3, figs 4, 5)

*Caprella lobata* (Bate 1856: 60; 1862: 354, plate 55, fig. 8)

*Caprella linearis* f. *gullmarensis* (Mayer 1903: 112, plate 8, fig. 20)

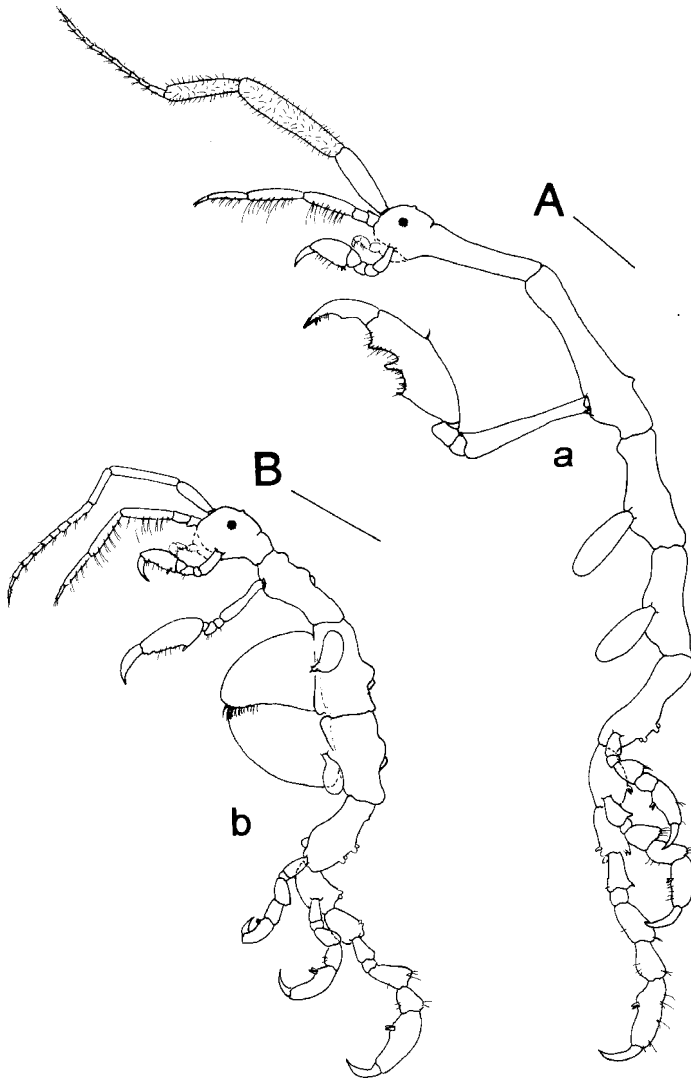


Fig. 2. *Caprella linearis* (Linnaeus, 1767) from Scotland. Lateral view. a. Male. b. Female. Scale bars: 1 mm.

*Caprella linearis f. distalis* (Mayer 1903: 113, plate 4, figs 27, 28)

*Type locality*

“Habitat in Oceano Europaeo” (Linnaeus 1767).

*Type material*

Not designed.

*Material examined*

Eight mature males, seven mature females, seven premature females and one juvenile collected from hydroids attached to the seaweed *F. serratus* at the intertidal area of Clachan Seil, west coast of Scotland, May 2000.

*Additional material examined*

Non-type material (12 mature males, three mature

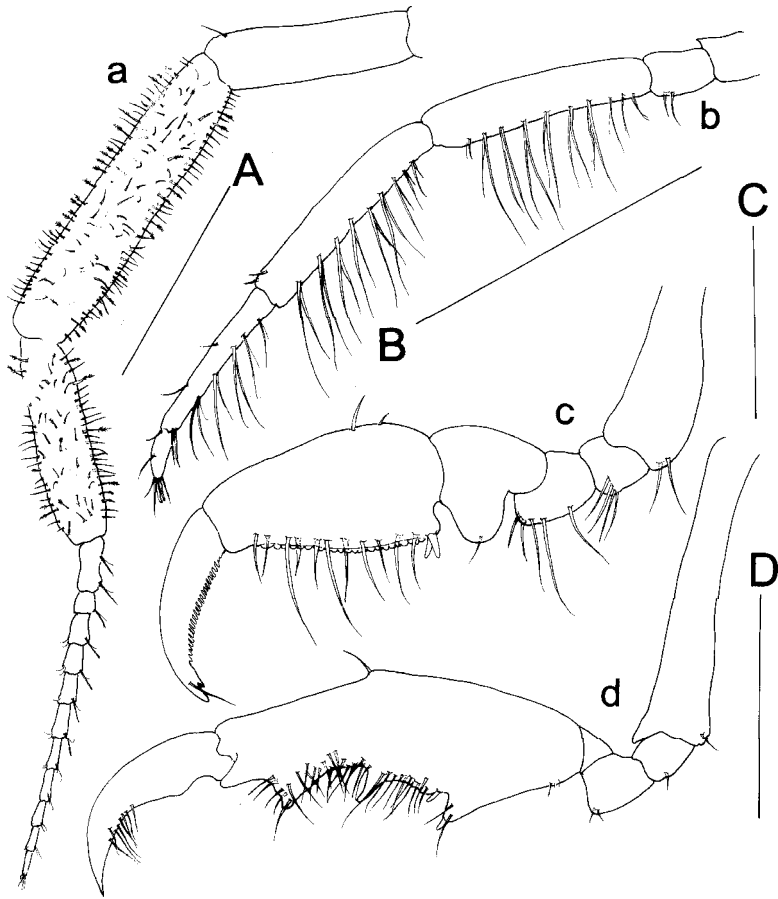


Fig. 3. *Caprella linearis* (Linnaeus, 1767) from Scotland. Male. a. Antenna 1. b. Antenna 2. c. Gnathopod 1. d. Gnathopod 2. Scale bars: A: 1 mm (a); B: 1 mm (b); C: 0.3 mm (c); D: 1 mm (d).

females, 14 premature females, 11 juveniles) from Nordsöen, Örsted, Denmark.

Description (mature male “a” from Clachan Seil, Scotland). Lateral view (Fig. 2a). Body length 10.1 mm. Head with a small mid-dorsal rounded projection. Pereonites 1 and 2 elongate. Pereonite 2 the longest. Pereonite 3 with a round tubercle posteriorly. Pereonite 5 with two pairs of small round projections. Pereonites 6 and 7 with one pair of small acute projections. Gills elongate, length about 3.3 times width.

Antenna 1 (Fig. 3a) nearly 0.5 the body length. Articles 2 and 3 of peduncle setose. Article 2 the longest, about 1.5 times longer than article 1. Articles 1 and 3 subequal. Flagellum composed of 11 articles.

Antenna 2 (Fig. 3b) equal in length to peduncular articles 1 and 2 of antenna 1. Ten pairs of swimming

setae on peduncular articles 3 and 4. Flagellum two-articulate. Proximal article with six pairs of swimming setae.

Gnathopod 1 (Fig. 3c) basis a little shorter than ischium to carpus combined. Carpus with a pair of proximal grasping spines. Grasping margin of palm propodus and dactylus serrated. Dactylus bifid distally carrying a simple seta.

Gnathopod 2 (Fig. 3d) basis inserted posteriorly on pereonite 2, about 0.7 times as long as pereonite 2 and 0.2 the body length. Basis with a distal acute projection. Propodus slender, length about 3.0 times width, bearing a mid-dorsal seta. Palm setose, with a proximal projection carrying a grasping spine, an accessory spine and two distal projections separated by a deep cleft. Dactylus curved and setose distally.

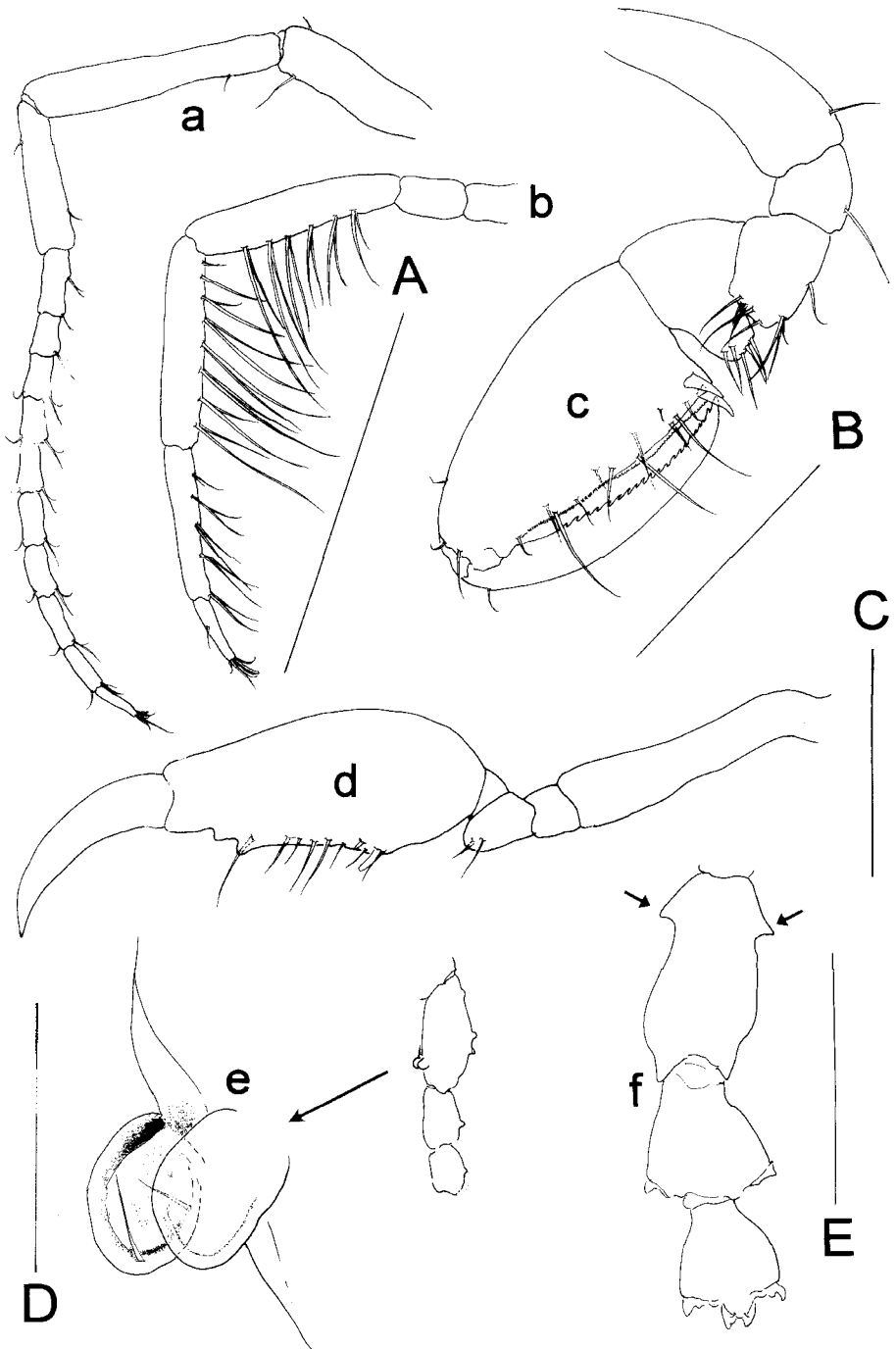


Fig. 4. *Caprella linearis* (Linneus, 1767) from Scotland. Female. a. Antenna 1. b. Antenna 2. c. Gnathopod 1. d. Gnathopod 2. e. Genital openings. f. Dorsal view of pereonites 5–7 showing lateral projections on pereonite 5. Scale bars: A: 1 mm (a, b); B: 0.3 mm (c); C: 0.5 mm (d); D: 0.3 mm (e); E: 1 mm (f).

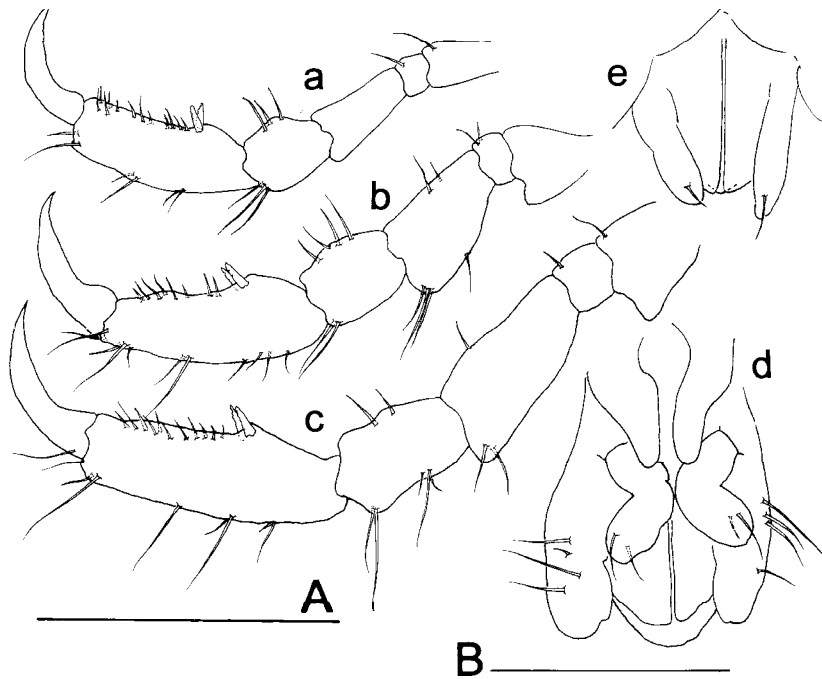


Fig. 5. *Caprella linearis* (Linnaeus, 1767) from Scotland. a–d. Male. a. Pereopod 5. b. Pereopod 6. c. Pereopod 7. d. Abdomen. e. Female abdomen. Scale bars: A: 1 mm (a, b, c); B: 0.2 mm (d, e).

Pereopods 5–7 (Fig. 5a–c) similar in feature but increasing in length. Palm of propodus with a pair of grasping spines.

Abdomen (Fig. 5d) with a pair of one-articulate appendages, a pair of lateral lobes and a single dorsal lobe. Appendages curved medially, length about 3.0 times width, carrying a pair of setae apically.

Upper lip of mouthparts (Fig. 6a) symmetrically bilobed, setose apically.

Mandibles (Fig. 6d, e) without palp. Molar process strong. Incisor and lacinia mobilis five-toothed. A row of three setae on the left mandible and two setae on the right. Molar flake small, present on the right mandible.

Lower lip of mouthparts (Fig. 6b) with well-marked inner lobes. Inner and outer lobes densely pubescent apically.

Maxilla 1 (Fig. 6f) outer lobe carrying six stout teeth apically. Palp two-articulate, distal article of the palp with nine distal marginal spines and a row of five setae medially.

Maxilla 2 (Fig. 6g) outer and inner lobe carrying 11 setae apically.

Maxilliped (Fig. 6c) inner plate with two simple and four plumose setae and two small teeth. Outer plate, a

little longer than the inner plate, bearing four setae apically, three teeth and two setae medially. Palp setose. Dactylus with two rows of fine setae in the inner margin.

Description (mature female “b” from Clachan Seil, Scotland). Lateral view (Fig. 2b). Body length 5.1 mm. Pereonites 1 and 2 not elongated. Pereonites 2–4 with a pair of tubercles dorsally. Pereonite 5 with two pairs of small dorsal round projections and a pair of acute lateral ones (Fig. 4f). Genital openings (Fig. 4e) scarcely setose. Pereonites 6–7 with a pair of round projections dorsally.

Antenna 1 (Fig. 4a) longer than 0.5 the body length. Peduncular articles 2 and 3 not setose, flagellum 10-articulate.

Antenna 2 (Fig. 4b) with six pairs of swimming setae on peduncular article 3 and eight pairs on peduncular article 4.

Gnathopod 1 (Fig. 4c) as in male.

Gnathopod 2 (Fig. 4d) inserted on the anterior half of pereonite 2. Palm without large distal projection followed by notch, sparsely setose. Dactylus not setose.

Abdomen (Fig. 5e) with a pair of lateral lobes with an apical setae and a single dorsal lobe.

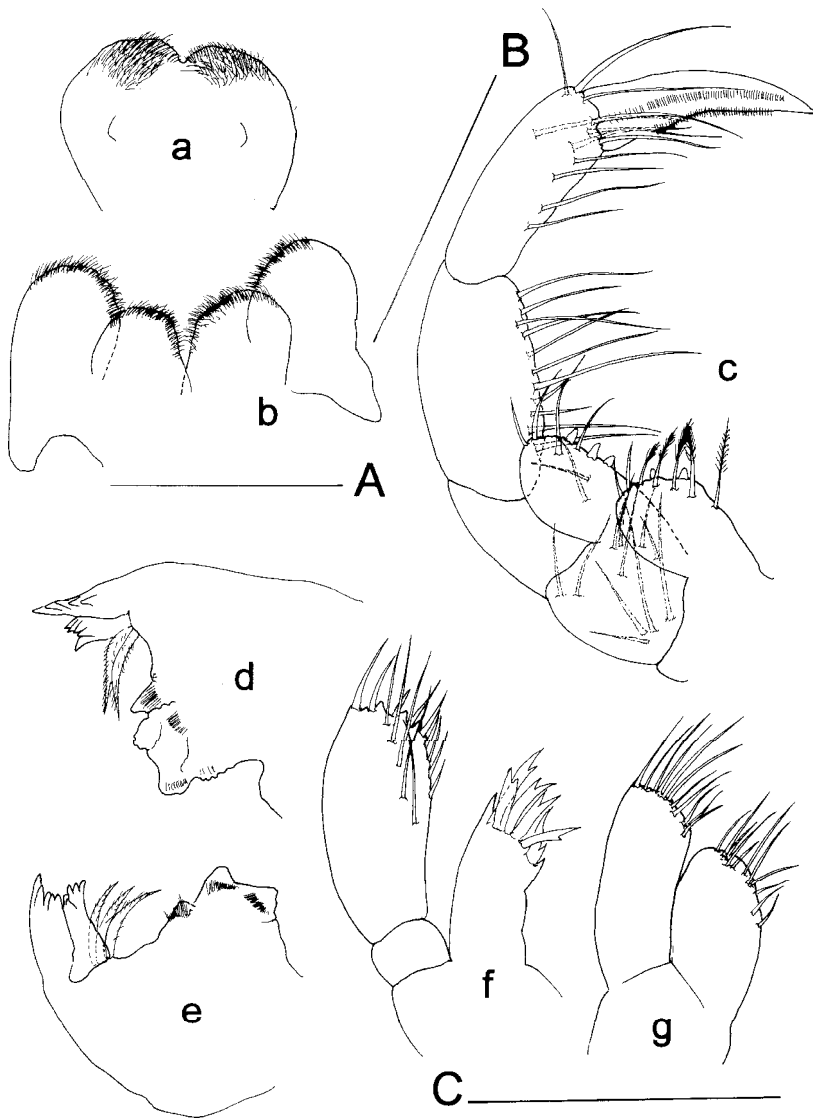


Fig. 6. *Caprella linearis* (Linnaeus, 1767) from Scotland. Male. a. Upper lip. b. Lower lip. c. Maxilliped. d. Right mandible. e. Left mandible. f. Maxilla 1. g. Maxilla 2. Scale bars: 0.2 mm. A(a, b), B(c, d, e), C(f, g).

Pereopods and mouthparts as in male.

*Caprella septentrionalis* Krøyer, 1838

*Caprella septentrionalis* (Krøyer 1838: 318; Herklots 1861: 43; Bate 1862: 355, plate 56, fig. 3; Mayer 1882: 62–64, figs 20–22; 1890: 65–68, plate 2, figs 26–33, plate 4, fig. 31, plate 6, fig. 38; Sars 1895: 659–660, 700, plate 237, fig. 1; Mayer 1903: 120–123, plate 5, figs 19–21, plate 8, fig. 24; Stephensen 1928: 384–386, fig. 92; Oldevig 1933: 266–269, figs 1–2 (p. 267), figs

1–3 (p. 268); McCain 1968: 44–49, figs 19–22, 51; Laubitz 1972: 48–53, plate 12; Smaldon 1990: 488, fig. 9.48; Larsen 1998: 84)

*Caprella cercopoides* (White 1852, fig. 1)

*Caprella robusta* (Stimpson 1854: 44; Mayer 1882: 66; 1890: 73)

*Caprella punctata* (Boeck 1861: 676–677; Stephensen 1928: 385, fig. 92)

*Caprella septentrionalis* (Herklots 1861: 43)

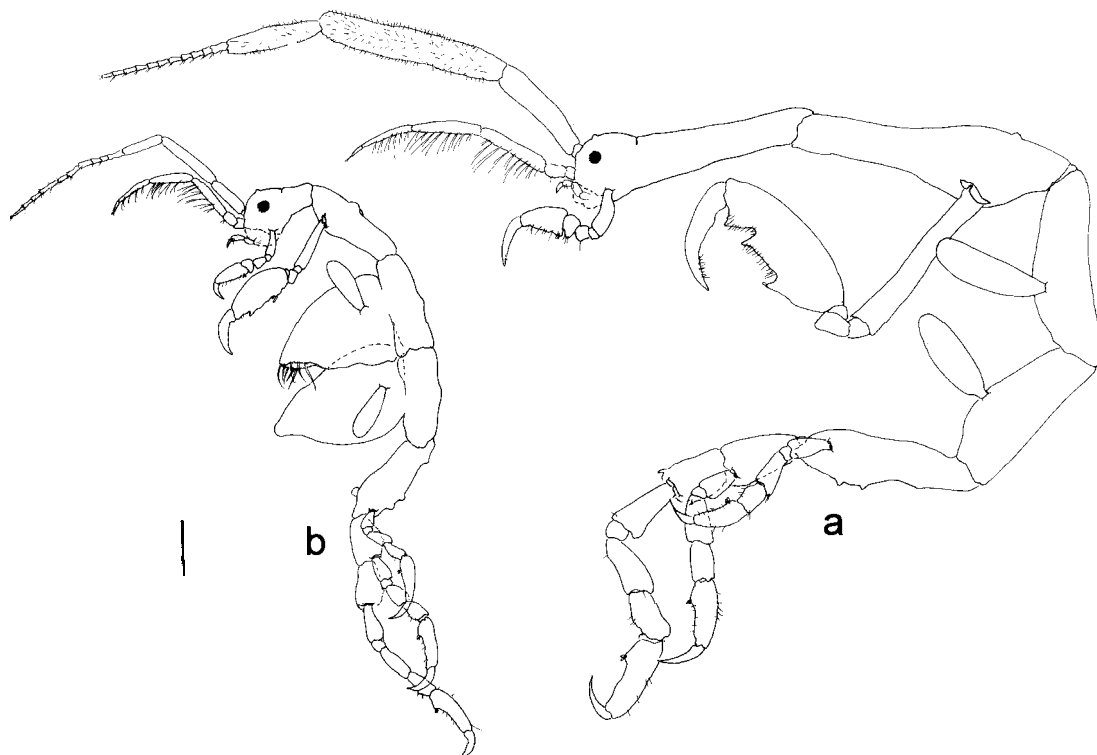


Fig. 7. *Caprella linearis* (Linnaeus, 1767) from Denmark (non-type material). Lateral view. a. Male. b. Female. Scale bar: 1 mm.

*Caprella stimpsoni* (Bate 1862: 361)

*Caprella longicornis* (Boeck 1871: 274–275)

*Caprella septentrionalis* f. *typica* (Mayer 1890: 66)

*Caprella septentrionalis* f. *longicornis* (Mayer 1890: 66, plate 2, figs 26, 27, 33, plate 4, fig. 31)

*Caprella septentrionalis* f. *nodigera* (Mayer 1890: 66)

*Caprella septentrionalis* f. *polyceros* (Mayer 1890: 66, plate 2, fig. 32)

*Caprella septentrionalis* f. *parva* (Mayer 1890: 66, plate 2, figs 28–31)

*Caprella septentrionalis* f. *spinigera* (Hansen 1895: 130)

#### Type locality

Greenland (Krøyer 1838).

#### Type material

Syntypes (ZMUC-CRU-8059).

#### Material examined

Seven mature males, four mature females, two premature

females from Boarhills, east coast of Scotland, May 2000; two mature males, one mature female, one juvenile from Kingsbarns, east coast of Scotland, June 2000; one mature male, one mature female, four premature females from St Andrews, east coast of Scotland, May 2000. All the specimens were collected from algae, especially *Polysiphonia* sp., at the intertidal zone.

#### Additional material examined

Syntypes (31 mature females, five young males).

Description (mature male “a” from Boarhills, Scotland). Lateral view (Fig. 8a). Body length 10.9 mm. Head with a patent mid-dorsal rounded projection. Pereonites 2 and 3 with a round tubercle dorsally. Pereonite 4 with a medial and a posterior tubercle. Pereonites 5–7 with two pairs of dorsal small round projections. Pereonites 2, 3 and 4 subequal in length. Gills oval-elongate, length 2.8 times width.

Antenna 1 (Fig. 9a) about 0.3 of body length. Peduncular articles not setose. Peduncular article 2 the longest. Peduncular article 3 the shortest, about 0.5 the length of article 2. Flagellum nine-articulate.



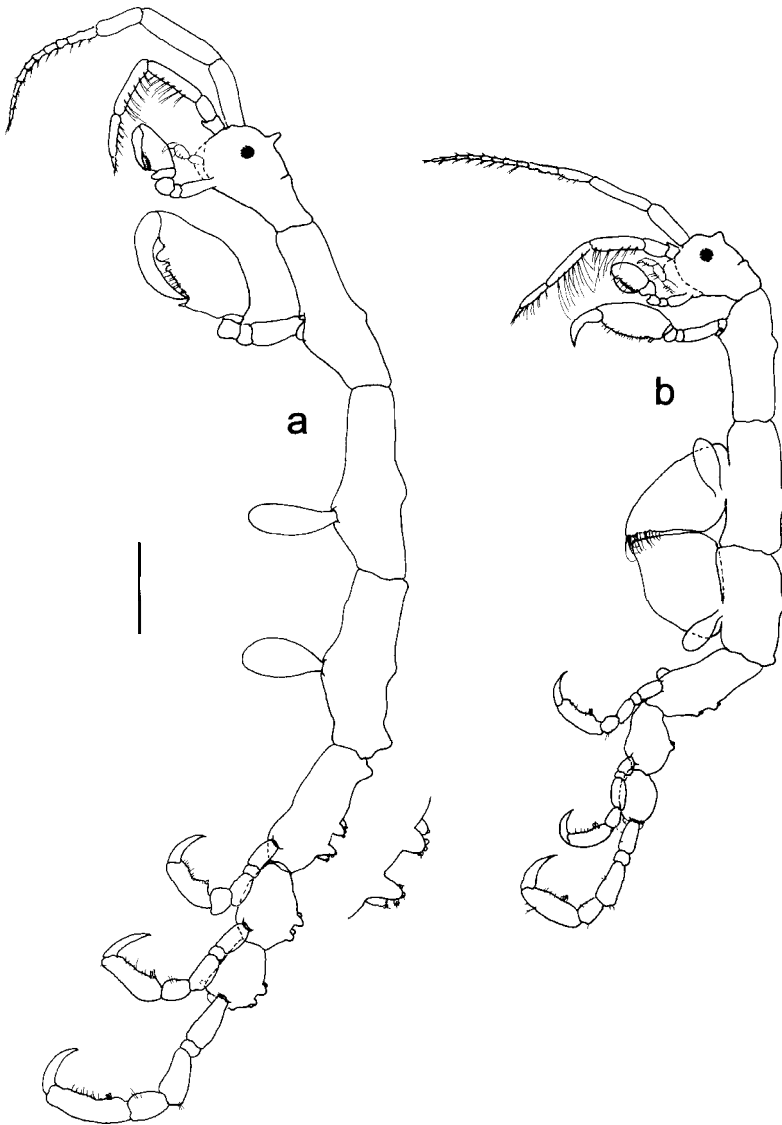


Fig. 8. *Caprella septentrionalis* Kröyer, 1838 from Scotland. Lateral view. a. Male. b. Female. Scale bar: 1 mm.

Antenna 2 (Fig. 9b) a little longer than peduncle of antenna 1. Ten pairs of swimming setae present on peduncular articles 3 and 4. Flagellum two-articulate. Proximal article with six pairs of swimming setae.

Gnathopod 1 (Fig. 9c) basis a little shorter than ischium to carpus combined. Carpus with a pair of proximal grasping spines. Grasping margin of palm propodus and dactylus serrated. Propodus wider and carpus more setose than in *C. linearis*.

Gnathopod 2 (Fig. 9d) basis inserted in the middle of pereonite 2, about 0.25 the length of pereonite 2 and 0.05 the body length. Basis with a distal acute projection. Propodus wide, length about 1.7 times width. Palm scarcely setose with a proximal projection carrying a grasping spine, an accessory spine and two small distal projections separated by a cleft. Dactylus curved without setae.

Pereopods 5–7 (Fig. 11a–c) increasing in length, less

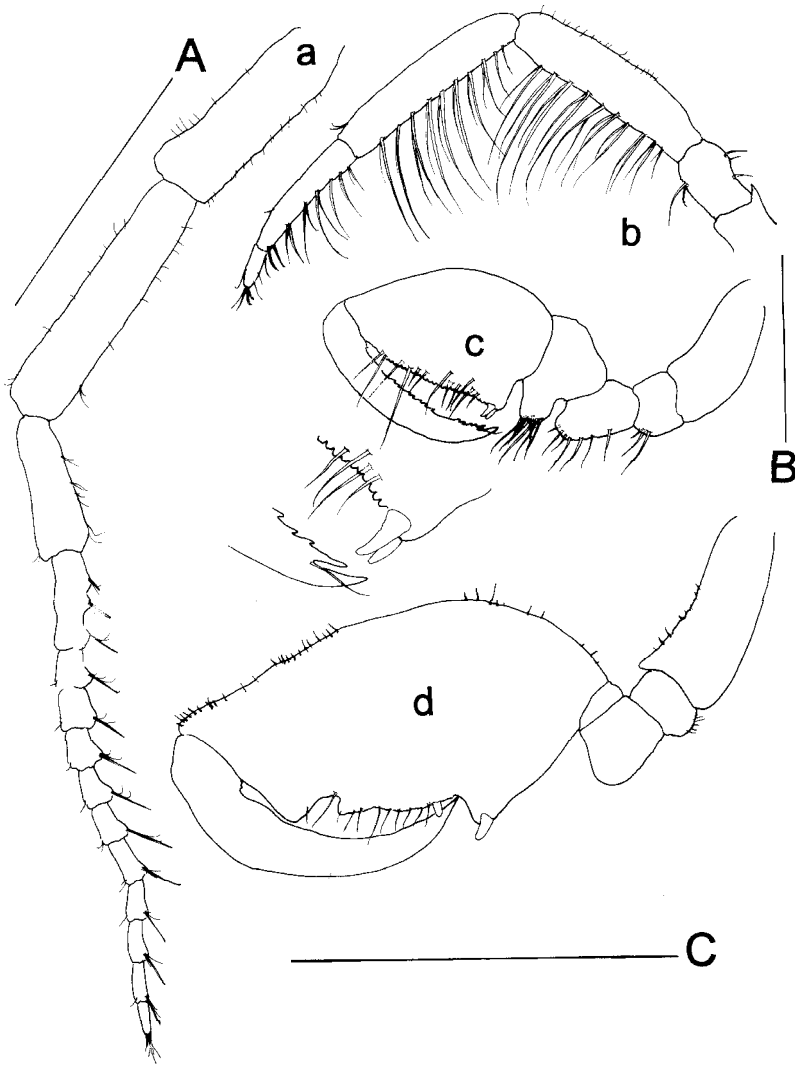


Fig. 9. *Caprella septentrionalis* Kröyer, 1838 from Scotland. Male. a. Antenna 1. b. Antenna 2. c. Gnathopod 1. d. Gnathopod 2. Scale bars: A: 1 mm (a, b); B: 0.5 mm (c); C: 1 mm (d).

setose than those in *C. linearis*. Palm of propodus with a pair of grasping spines.

Abdomen (Fig. 11d) with a pair of one-articulate appendages, a pair of lateral lobes and a single dorsal lobe.

Upper and lower lips of mouthparts (Fig. 12a, b) morphologically similar to those in *C. linearis* but less pubescent apically.

Mandibles (Fig. 12d, e) similar to those described for *C. linearis* except lacinia mobilis four-toothed.

Maxillae 1 (Fig. 12f) outer lobe carrying five stout

teeth apically. Distal article of the palp with six spines and a row of four setae medially.

Maxillae 2 (Fig. 12g) outer lobe with 11 setae distally, inner lobe shorter but wider than outer lobe, with 12 setae apically.

Maxilliped (Fig. 12c) inner plate carrying six simple setae and two small teeth distally. Outer plate bearing three teeth and several setae. Article 2 of the palp scarcely setose. Article 3 setose. Article 4 acute distally. Description (mature female “b” from Boarhills, Scotland). Lateral view (Fig. 8b). Body length 7.2 mm.

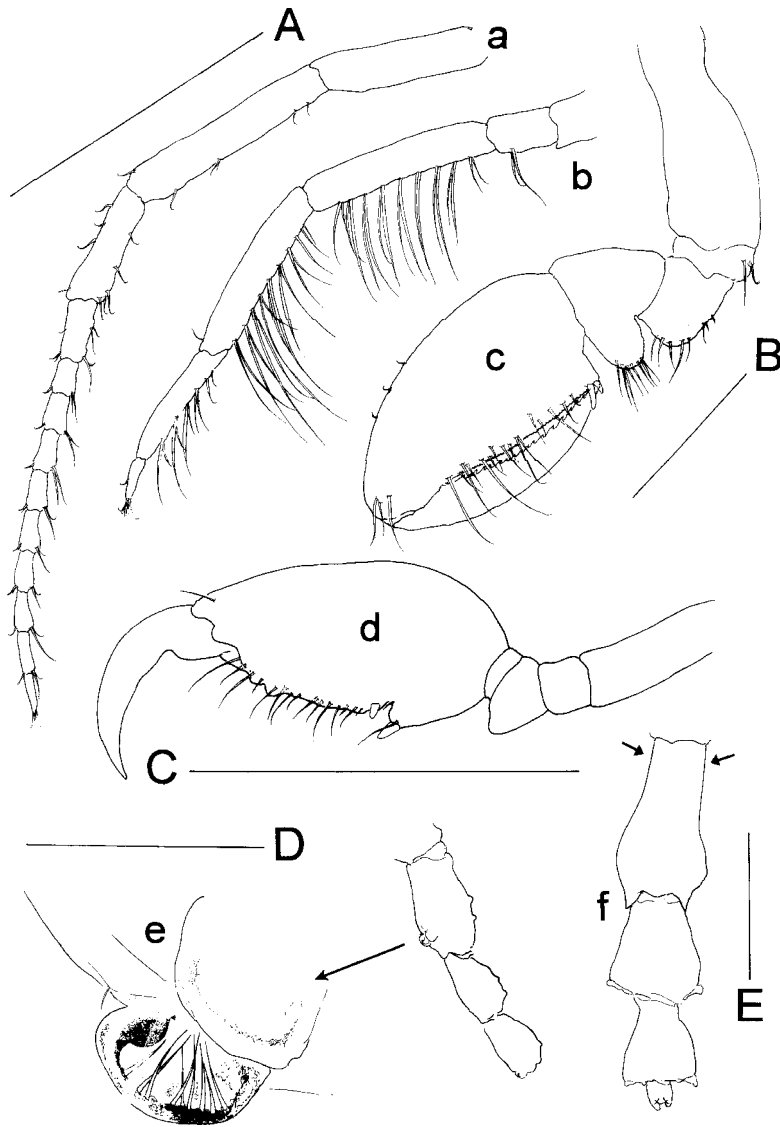


Fig. 10. *Caprella septentrionalis* Kröyer, 1838 from Scotland. Female. a. Antenna 1. b. Antenna 2. c. Gnathopod 1. d. Gnathopod 2. e. Genital openings. f. Dorsal view of pereonites 5–7. Scale bars: A: 1 mm (a, b); B: 0.3 mm (c); C: 1 mm (d); D: 0.2 mm (e); E: 1 mm (f).

Lateral projections on pereonite 5 absent (Fig. 10f). Pereonite 6 with only a pair of dorsal round projections. Pereonite 7 smooth. Genital openings (Fig. 10e) setose.

Antenna 1 (Fig. 10a) longer than 0.5 the body length. Flagellum 10-articulate.

Antenna 2 (Fig. 10b) with nine pairs of swimming setae on peduncular articles 3 and 4.

Gnathopod 1 (Fig. 10c) as in male.

Gnathopod 2 (Fig. 10d) slender; propodus palm almost straight.

Abdomen (Fig. 11e) with a pair of lateral lobes carrying three apical setae and a single dorsal lobe.

Pereopods and mouthparts as in male.

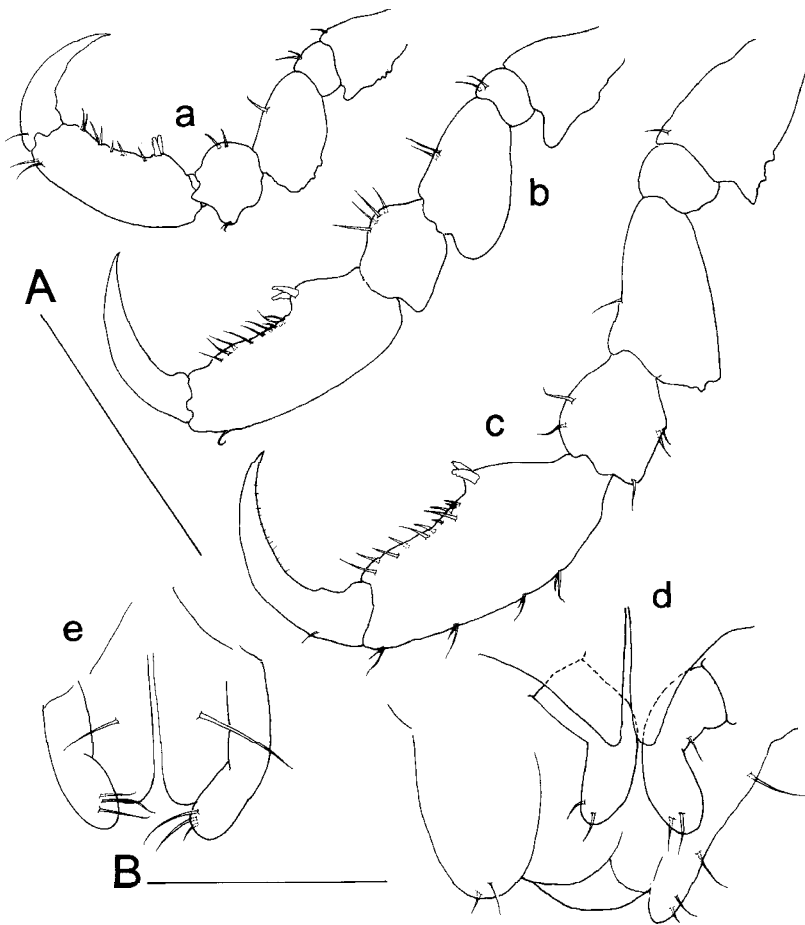


Fig. 11. *Caprella septentrionalis* Kröyer, 1838 from Scotland. a–d. Male. a. Pereopod 5. b. Pereopod 6. c. Pereopod 7. d. Abdomen. e. Female abdomen. Scale bars: A: 1 mm (a, b, c); B: 0.2 mm (d, e).

#### REMARKS

The body lengths of the males of both species are similar, while the females of *C. septentrionalis* are larger than the females of *C. linearis* (Table 1). Mature males of *C. linearis* differ from those of *C. septentrionalis* mainly in the features of antenna 1 and gnathopod 2. In adult males of *C. linearis*, the peduncular articles 2 and 3 of antenna 1 bear short setae. Regarding gnathopod 2, the basis is almost as long as pereonite 2 in *C. linearis* while being about one third in *C. septentrionalis*. Furthermore, the propodus is clearly slender in *C. linearis* (length about 3.0 times width) while in *C. septentrionalis* the propodus is wider (length about 1.7 times width). Moreover, the

dactylus in *C. linearis* is provided with setae in the inner margin. Other minor but constant differences have been found between the two species: pereonites 1 and 2 are elongate and the pereopods are more setose dorsally in adult males of *C. linearis*. The lacinia mobilis is five-toothed in *C. linearis* and four-toothed in *C. septentrionalis*. The upper and lower lips are more setose in *C. linearis*. Distal setae on the inner plate of the maxilliped are plumose in *C. linearis* and simple in *C. septentrionalis*. The propodus of gnathopod 2 is wider and the genital openings more setose in females of *C. septentrionalis* than in *C. linearis*. Furthermore, a pair of lateral projections in pereonite 5, present in *C. linearis*, are lacking in *C. septentrionalis*. The morphological differences between the

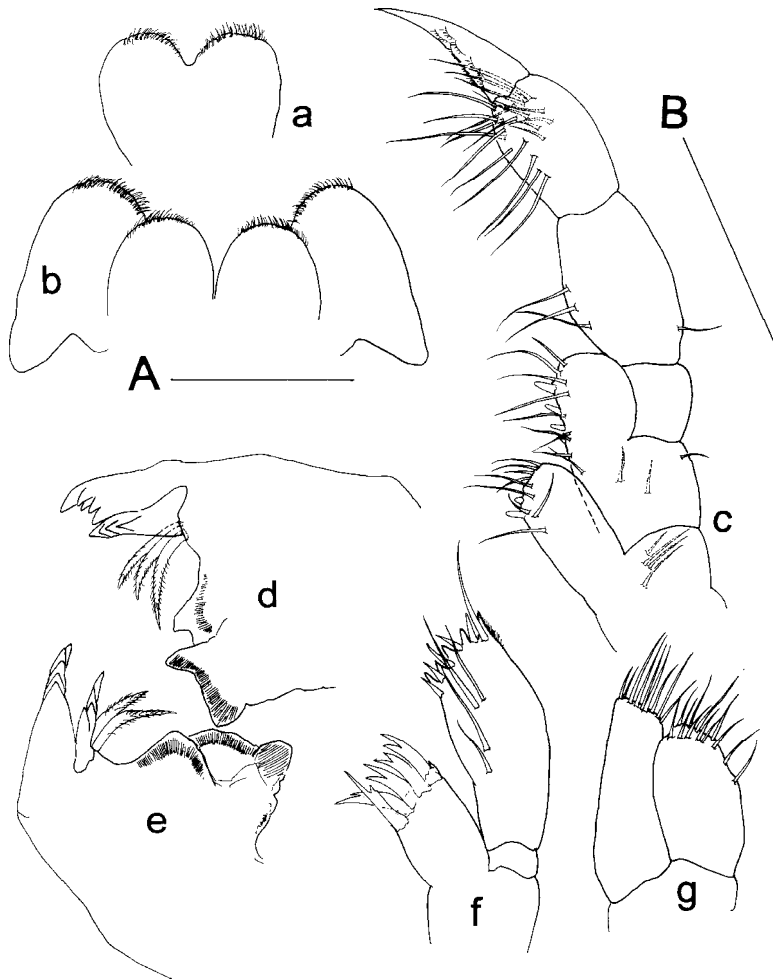


Fig. 12. *Caprella septentrionalis* Kröyer, 1838 from Scotland. Male. a. Upper lip. b. Lower lip. c. Maxilliped. d. Left mandible. e. Right mandible. f. Maxilla 1. g. Maxilla 2. Scale bars: 0.2 mm. A(a, b), B(c, d, e, f, g).

Table 1. Comparison of selected morphological characteristics in *Caprella linearis* and *C. septentrionalis*. Data of average length (mm) for mature males and females are also included. Fifty mature males and 50 mature females of each species were measured. Numbers in parentheses indicate the range. The results of the one-way ANOVA for males and females are included.

	<i>C. linearis</i>	<i>C. septentrionalis</i>	F
Body length (males)	8.2 (6.8–10.1)	8.3 (6.0–11.9)	0.01 ns
Body length (females)	5.1 (4.0–6.1)	8.1 (6.0–11.2)	7.01*
Peduncle of antenna 1 (males)	Setose	Not setose	
Basis of gnathopod 2 length (males)	About pereonite 2	One third of pereonite 2	
Length/width ratio of propodus of gnathopod 2 (males)	3:1	1.7:1	
Pereonites 1 and 2 (males)	Elongate	Non-elongate	
Lacinia mobilis (males and females)	Five-toothed	Four-toothed	
Genital openings (females)	Scarcely setose	Very setose	
Lateral projections on pereonite 5 (females)	Present	Absent	

ns, not significant.

\*  $p < 0.05$ .

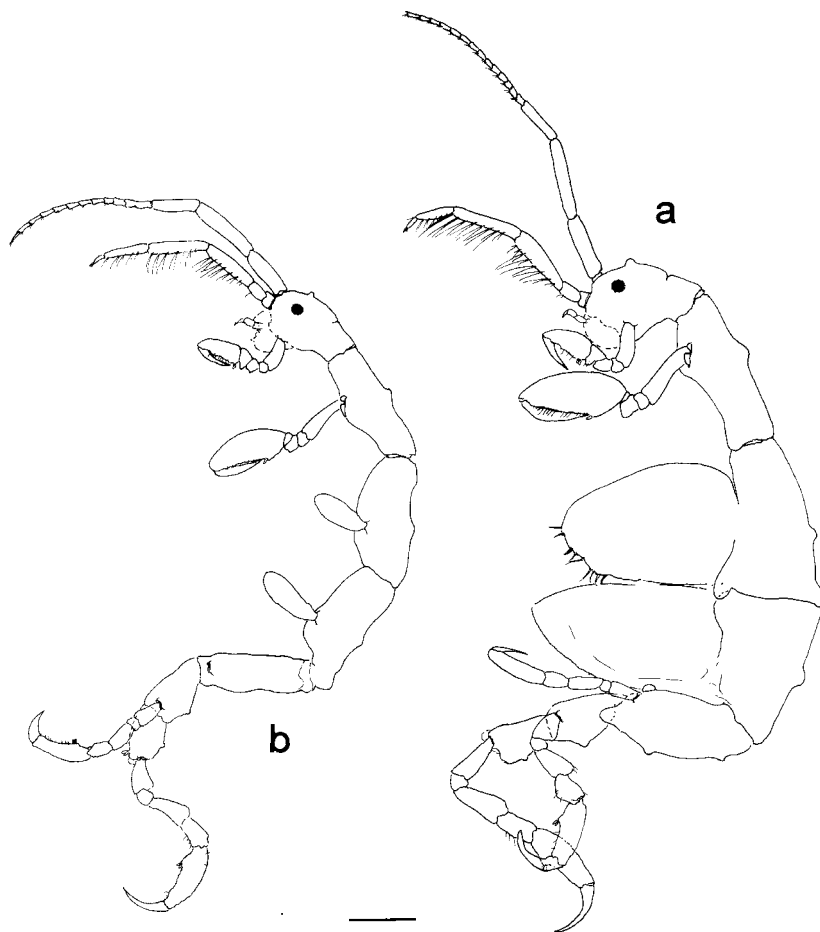


Fig. 13. *Caprella septentrionalis* Kröyer, 1838 from Greenland (ZMUC-CRU-8059, syntypes). Lateral view. a. Mature female. b. Young male. Scale bar: 1 mm.

species are also present in the specimens belonging to the type material of *C. septentrionalis* from Greenland (Fig. 13) and the non-type material of *C. linearis* from Denmark (Fig. 7). Consequently, the consistent and constant morphological differences existing between these two species (Table 1) support the idea of considering them as two valid species.

#### ONTOGENETIC DEVELOPMENT

The arrangement of the body projections during development is quite similar in both species (Figs 14, 15). Juvenile stages are indistinguishable between the two species. Nevertheless, it seems that the rounded projection on the head appears earlier during development in specimens of *C. septentrionalis*. Mature

females of *C. linearis* are also very similar to females of *C. septentrionalis*. Although the length/width ratio of the propodus of gnathopod 2 in males seems to be constant during development in *C. septentrionalis* (Fig. 17), it changes in *C. linearis*. In the more advanced stages of development, this length/width ratio increases, the palm becomes more setose and some setae appear on the dactylus (Fig. 16). No differences in the abdomen between the two species were found during ontogenetic development. The penes and the appendages increase in size during development for both species (Figs 16, 17).

In several species of *Caprella* the ontogeny of the abdominal appendages has been studied (see Mori 1999). Sakaguchi (1989) described the post-marsupial development of *C. scaura diceros* Mayer, 1890, reared

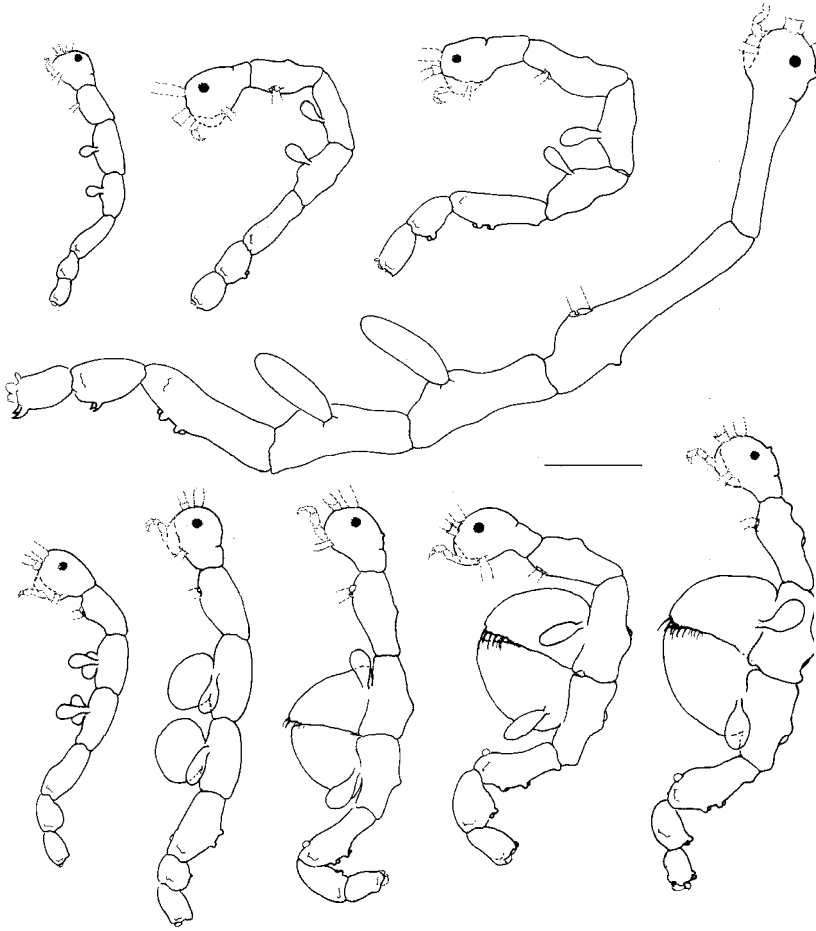


Fig. 14. *Caprella linearis* (Linnaeus, 1767) from Scotland. Different stages in the lateral view of males (above) and females (below) during development. Scale bar: 1 mm.

in the laboratory. All the hatchlings had paired abdominal appendages bearing a single seta, as shown here for *C. linearis* (Fig. 16). These appendages were at first one-articulate and small, becoming larger and two-articulate in the older specimens of *C. scaura*. Takeuchi (1989) described the post-marsupial development of the abdominal appendages of *C. danilevskii* Czerniavski, 1868, *C. okadai* Arimoto, 1930 and *C. generosa* Arimoto, 1977, reared in the laboratory. In these three species, all the early juveniles had paired abdominal appendages bearing a single apical seta. The appendages grew larger in the males, whereas they were reduced in the females, as in *C. scaura diceros*.

#### CLINGING BEHAVIOUR

The predominant mode of substrate attachment was the upright posture for both *C. linearis* and *C. septentrionalis* (Table 2). Both species grasp the substrate with pereopods 5–7 with the anterior somites held away from the substrate. Both of the second gnathopods are usually extended laterally. Grooming was frequent in both species in comparison with data reported by Takeuchi & Hirano (1995), using the same methodology as for other species of Caprellidea. Grooming behaviour has been traditionally associated with filtering suspended material (Patton 1966; Caine 1974). The rows of setae present ventrally on antenna 2 favour this type of feeding. Therefore, both species

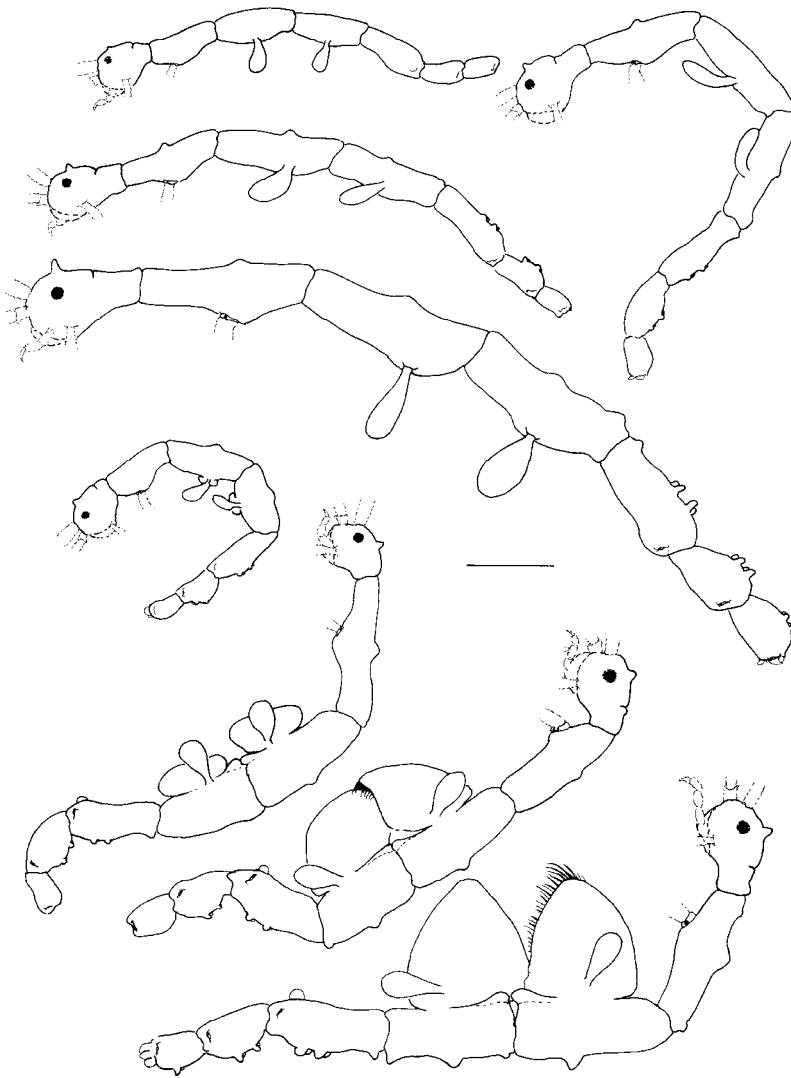


Fig. 15. *Caprella septentrionalis* Kröyer, 1838 from Scotland. Different stages in the lateral view of males (above) and females (below) during development. Scale bar: 1 mm.

seem to filter feed, standing in the upright posture. Although they have been found in areas exposed to wave action, especially *C. septentrionalis*, neither species has adopted the parallel posture as predominant behaviour and scraping as a feeding strategy. Some species of the genus *Caprella*, considered as one of the most apomorphic genera of the Caprellidea (Takeuchi 1993), such as *C. penantis* Leach, 1814 and *C. danilevskii*, present this parallel posture in association with feeding by scraping the substrate, and have developed characters that specifically enable them to

inhabit substrates subject to heavy wave exposure (Takeuchi & Hirano 1995). In the parallel posture the caprellid strongly grasps the substrate with both of the first gnathopods and pereopods 5–7, with the body somites straight and parallel to the substrate, thus avoiding displacement by the currents or the wave action.

#### ECOLOGY

The intertidal rocky areas of St Andrews, Boarhills



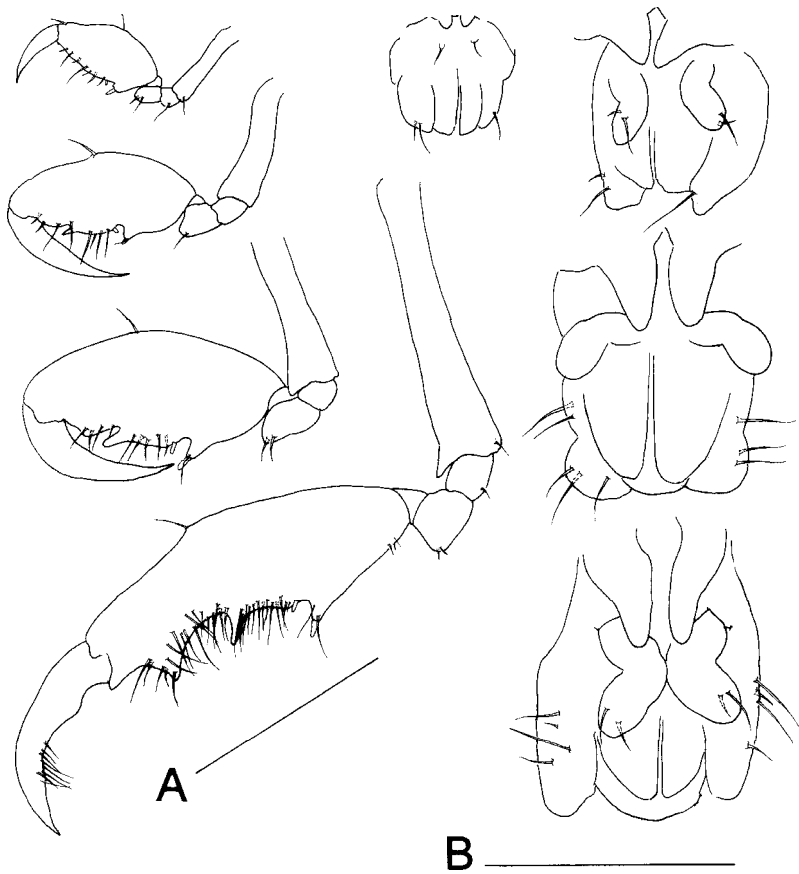


Fig. 16. *Caprella linearis* (Linnaeus, 1767) from Scotland. Different stages in A. gnathopod 2 and B. the abdomen in males. Scale bars: A: 1 mm; B: 0.2 mm.

and Kingsbarns (east coast) were exclusively inhabited by *C. septentrionalis*, attached mainly to the red algae *Polysiphonia* sp. On the west coast (Clachan Seil, near Oban) an important population of *C. linearis* was found clinging to the hydroids growing on *F. serratus*. Other caprellids found living on these substrate were *Phtisica marina* Slabber, 1719 and *C. acanthifera* Leach, 1814.

Both species, *C. septentrionalis* and *C. linearis*, do not appear to be very substrate specific, having been collected from brown, green and red algae, sea grass, sponges, hydroids, alcyonarians and tunicates (McCain 1968). Ohlin (1895) reported *C. linearis* from *Asterias* sp. collected off Newfoundland and Mayer (1903) also reported it from the asteroid *Solaster* sp. which was collected from Scotland. Harrison (1944) pointed out the presence of *C. linearis* on *Zostera* sp., *Laminaria* sp. and floating wreckage and buoys. Smaldon (1990) also

found it on Bryozoa and reported that *C. septentrionalis* sometimes inhabits among the seaweed *Corallina* sp. in rock pools. The temperature range for *C. linearis* is established between 7.1 and 8.2°C and for *C. septentrionalis* between 0 and 7.9°C (Larsen 1998). The depth range is 0–1000 m for *C. linearis* and 0–1026 m for *C. septentrionalis* (Larsen 1998).

#### DISTRIBUTION

The known distribution of *C. linearis* and *C. septentrionalis* is presented in Fig. 18. Both species share basically the same area of distribution which occurs mainly along the North Atlantic, Boreal and Arctic regions. The most occidental localities for *C. linearis* are in Alaska. In Greenland, *C. septentrionalis* is more abundant than *C. linearis* (Laubitz 1972). The presence of *C. linearis* has also been reported along the Atlantic

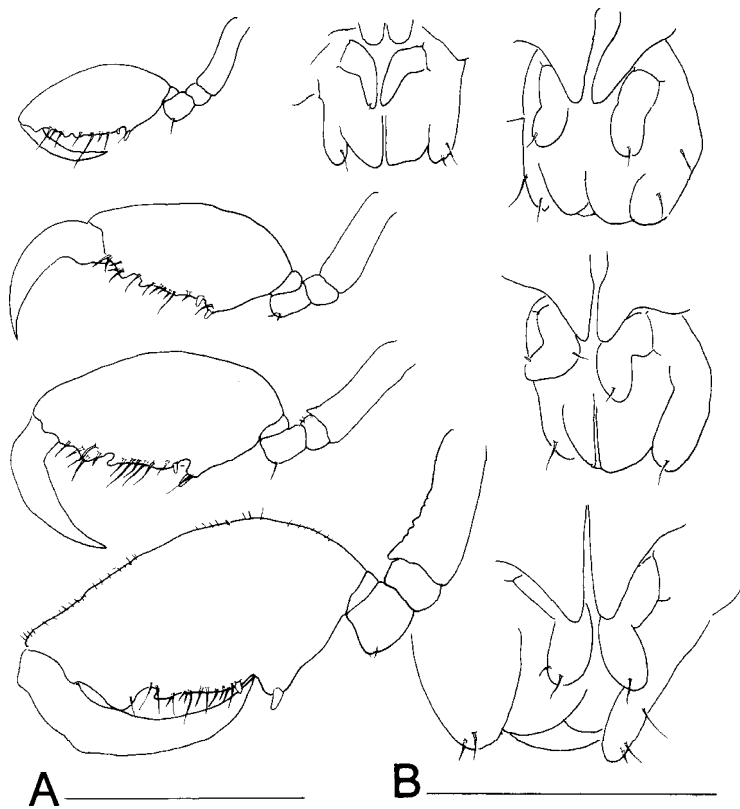


Fig. 17. *Caprella septentrionalis* Kröyer, 1838 from Scotland. Different stages in A. gnathopod 2 and B. the abdomen in males. Scale bars: A: 1 mm; B: 0.3 mm.

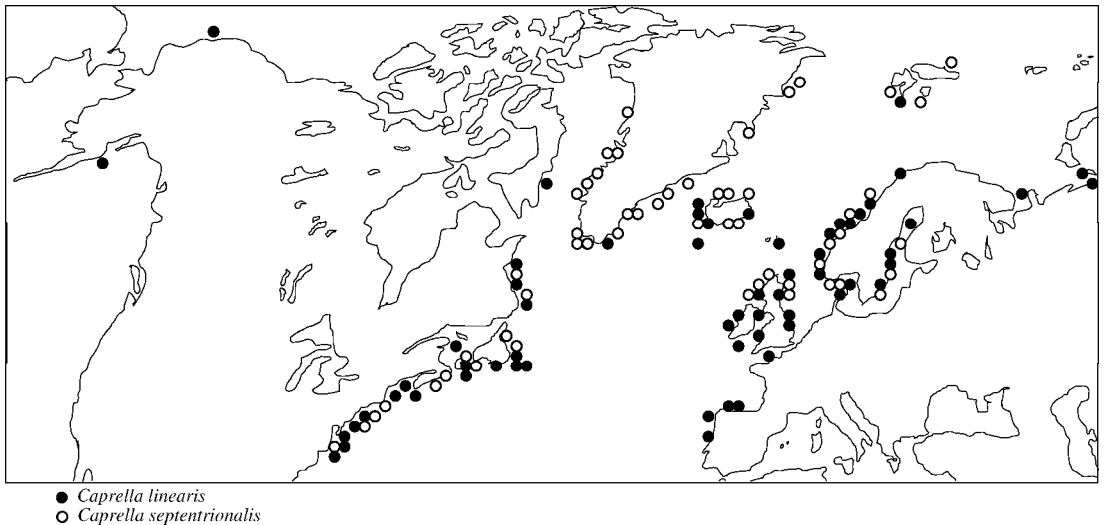


Fig. 18. Geographical distribution of *C. linearis* and *C. septentrionalis*. Data from McCain (1968), McCain & Steinberg (1970), Laubitz (1972), Larsen (1998), Smaldon (1990) and Guerra-García (unpublished data).



Table 2. Average time spent in each clinging type of behaviour, scraping and frequency of grooming. Data are given as a percentage of the total observation time (10 min), except for the grooming frequency which is given as the number of times per 10 min observation period. The numbers in parentheses indicate the range. Ten specimens of each species were observed.

	Clinging behaviour				Feeding	
	Moving (%)	Upright (%)	Bending (%)	Parallel (%)	Scraping (%)	Grooming (times)
<i>Caprella linearis</i>	1.1 (0.0–3.0)	96.5 (85.0–100.0)	1.9 (0.0–4.0)	0.5 (0.0–2.0)	0	20 (5.0–28.0)
<i>Caprella septentrionalis</i>	0.7 (0.0–5.0)	93.5 (76.0–100.0)	2.5 (0–10)	3.3 (0.0–7.0)	0	22.5 (2.0–32.0)

coast of the Iberian Peninsula. Inside the British Isles, *C. linearis* is common on all British coasts while *C. septentrionalis* is a northern distributed species, occurring in Scottish waters, but is not known further south (Smaldon 1990). Harrison (1944) pointed out the presence of *C. septentrionalis* on the east coast of Scotland, at Clyde and St Andrews, the locality where the present material was collected.

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