

Cumaceans (Crustacea: Peracarida) from the Persian Gulf

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Abstract

The study of a benthic macroinvertebrate collection from the Iranian coasts off Assaluyeh led to obtain the first data on the cumacean fauna of the Persian Gulf. During two sampling campaigns carried out in August 1998 and November 2002, eight species belonging to the families Bodotriidae and Nannastacidae were collected. Four of them are new to science, namely *Cyclaspis adiaستolos*, *Eocuma carinocurvum*, *Heterocuma inerme* and *Pseudosympodomma persicum*. All new species, and two rare ones (i.e. *Cumella* cf. *schieckei* and *Eocuma travancoricum*), are described and keys to the species of *Heterocuma* and *Pseudosympodomma* are provided. The local distribution of the cumacean assemblages off Assaluyeh is characterized by its homogeneity during the different sampling periods.

Key words: Cumacea, Bodotriidae, Nannastacidae, Persian Gulf.

Introduction

The Persian Gulf is a shallow (36 m mean depth), semi-enclosed basin with a low rate of water exchange (up to 5 years) (Sheppard, 1993). Higher than freshwater inputs (i.e. precipitation and river inflow) evaporation causes increase water density in surface layer. Dense, salty water sinks to the bottom and move out from the Persian Gulf through deeper portion of the Strait of Hormuz. The reverse estuary circulatory model is analogue to that observed in the Mediterranean Sea (Reynolds, 1993).

A relatively low biotic diversity has been reported for the area. It is often attributed to the natural stress induced in the ecosystem by the existing extreme environmental conditions

(Price *et al.* 1993). For instance, surface temperature varies from 15°C at the north coast during winter time to

Alternative explanation for the low diversity rely on the short existence of the Gulf in recent time due to its complete drying out in the late Pleistocene (Sheppard 1993).

However, scarcity of taxonomic or faunistic studies in the area could hide reliable data. Thus, recent studies on the polychaete fauna are revealing that all species of the family Chaetopteridae of the genera *Spiochaetopterus*, *Mesochaetopterus* and *Chaetopterus* found off Assaluyeh are new to science (Bhaud *et al.* 2003; D. Martin, unpublished results). Also it was proved that previously mentioned *Owenia fusiformis* represents a new valid species (Martin *et al.* in progress)

Although Cumacea are known from the Red Sea, SE coast of India and Maldives Islands (see Kurian 1951, 1954; Bacescu & Muradian 1975; Radhadevi & Kurian 1989, 1990; Mühlenhardt-Siegel 1996, 2000, among others) they have never been studied in the Persian Gulf. Therefore, the study of a benthic macroinvertebrate collection from the Iranian coast provides the first data on the cumaceans of the Persian Gulf and four new species are described

Material and Methods

Study area

Samples were collected along the Iranian shoreline, at the East coast of the Persian Gulf near Assaluyeh (north Nay Band Bay, 250 km south of Bandar Bousher,

outlet channel (opening between stations 11 and 16), always tending to remain close to the shore so that they do not affect the area inhabited by the cumaceans.

Sampling methods

Five transects of 3 km long were positioned perpendicular to the coast from North to South along the shoreline. On each transect, 3 stations were distributed from the deepest margin of the coral reef belt to the depth of about 30 m. Samples were collected in August 1998 and November 2002 using a van Veen grab (35 x 42 x 90 cm, about 0.1 m² per grab). One litre of sediment from one grab at each station was transferred into a wide-mouthed double-closing 500 ml polyethylene flasks and stored in the dark until used for physico-chemical analyses.

Laser granulometry (% volume) was performed on dry sediment after sifting through a 0.8 mm mesh sieve using a Malvern Mastersizer S laser granulometer. Sediments were characterized by the percentage of silt and clay (diameter < 63 µm) and sand (0.2 mm < diameter < 2 mm) and the median grain diameter. Sediment water content (%) was measured according to the European experimental AFNOR (standard X 31-102). Concentration of total organic matter (% dry weight) was calculated by steam-drying at 105°C, according to the AFNOR (standard NF U 44-160). Estimates of organic carbon have been made according to the European experimental standard NF ISO 14235 (oxidation method 0.1% m/m).

The density of cumaceans was estimated on the basis of a total sampling area of 0.3 m² (i.e., three grabs). The grab contents were gently mixed in a container and then sieved out on board by pouring the contents through a 1 mm mesh sieve. The retained sediment was transferred to a plastic bag, fixed with a 4% formaldehyde/seawater solution, stained with Rose Bengal and stored until sorted. After sorting, all specimens were preserved in 70% ethanol.

As for the morphological observations, the cumaceans were dissected in lactic acid and stained with black of Chlorazol. Material preserved in permanent slides mounted in Fauré medium sealed with nail varnish. Nomenclature follows Jones (1976). Drawings were prepared using a camera lucida on an Olympus microscope. The material is deposited in the cumacean collection of the Institut de Ciències del Mar (ICM), Barcelona.

Taxonomy

Family Bodotriidae Scott, 1901

Subfamily Bodotriinae Scott, 1901

Genus *Cyclaspis* Sars, 1865

Cyclaspis adiaستolos sp. nov. (Figs. 1-3)

Type material. *Holotype*: ov. female, Assaluyeh, North Nay Band Bay, Persian Gulf: stn 20, 52°33.763'N 27°20.193'E, 27 m, November 2002, (ICM CUM-0041). *Allotype*: 1 ad. male, stn 5, 52°32.959'N 27°30.292'E, 26 m, August 1998 (ICM CUM-0042). *Paratypes*: 2 ov. female (one dissected in two slides), 1 ad. male, stn 15, 52°33.344'N 27°29.421'E, 27 m depth, August 1998 (ICM CUM-0043); 1 ov. female, stn 15, 52°33.344'N 27°29.421'E, 27 m depth, November 2002 (ICM CUM-0044); 1 ov. female, stn 20, 52°33.763'N 27°20.193'E, 27 m depth, August 1998 (ICM CUM-0045).

Diagnosis. Carapace globose with a transversal ridge nearly encircling it and two semicircular dorsolateral tubercles on the hinder fourth. Uropod peduncle as long as pleonite 6, with finely serrated inner margin. Endopod longer than peduncle, with 4 acuminate setae in middle. Adult male without ridges or carinae on the carapace but with a small protuberance on each side. Uropod peduncle as long as pleonite 6, with finely serrated inner margin. Endopod longer than peduncle, sharply pointed, finely serrated on 1/3 of inner margin and with 4 acuminate setae in middle.

Description. Ovigerous female 4.15 mm total length. Carapace slightly longer than 1/3 of total length, globose, with a transversal ridge nearly encircling it; this ridge crosses the dorsal line a little behind the middle of carapace and slopes a little forward on each side, not reaching the lateral margin; with a pair of dorsolateral carinae on the hinder fourth not reaching the hinder margin, which is bumped backwards on the dorsal line. Eyelobe narrow, slightly longer than pseudorostral lobes, with corneal lenses. Pereonite 2 with three carinae, one median and two dorsolateral; pereonite 1 and 3 without carinae, pereonite 4 and 5 with a pair of dorsolateral carinae. Five first pleonites with a pair of dorsolateral carinae and a median carina that becomes faint in the pleonite 5.

Antennula peduncle 3-articulate; article 1 as long as articles 2 and 3 combined length; article 3 longer than article 2; main flagellum 2-articulate, with 2 aesthetascs, accessory flagellum rudimentary. Mandible with 4 teeth on the pars incisiva, 13 setae between pars incisiva and truncated pars molaris. Maxillula palp with two unequal filaments, inner endite with 5 setae, three simple, one trifid and one microsetulated. Maxilliped 1 basis produced distally and with 5 plumose setae on inner margin; carpus with 5 flattened setae on inner margin. Maxilliped 2 basis as long as the rest of appendage combined length, with a long plumose seta on inner distal corner; carpus longer than merus, with 4 plumose setae on inner margin. Maxilliped 3 basis expanded distally over mero-carpal articulation; ischium with 4 plumose setae on inner margin; merus produced distally reaching the carpo-propodial articulation with a plumose seta on its tip. Pereopod 1 basis longer than ischium, merus and carpus combined length; merus as long as $2/3$ of carpus; propodus longer than carpus; dactylus of the same length than carpus. Pereopod 2 basis shorter than the rest of appendage, with 3 long plumose setae; ischium short; merus twice as long as carpus; dactylus three times as long as propodus. Pereopod 3 basis slightly longer than the rest of appendage, with two plumose setae on distal half; ischium half length of merus; merus and carpus of same length; carpus and propodus with 2 and 1 long setae on distal corner respectively. Pereopod 4 and 5 basis shorter than rest of appendage; merus and carpus of the same length.

Uropod peduncle as long as pleonite 6, with finely serrated inner margin. Endopod longer than peduncle, sharply pointed, finely serrated on $1/3$ of inner margin and with 4 acuminate setae in middle. Exopod shorter than endopod, with 2 distal acuminate seta and 3 setae on inner margin.

Adult male 4.75 mm total length. Carapace $1/3$ of total length, without ridges or carinae but with a small protuberance on each side. Pleonites without carinae. Uropod peduncle longer than pleonite 6, with about 20 long plumose or microsetulate setae; endopod shorter than peduncle with 11 microsetulate setae on inner margin; Exopod 2-segmented, shorter than endopod with 6 acuminate setae on inner margin and 2 setae distally.

Etymology. Greek word meaning not separated, confused, referring its great resemblance with *C. cingulata*, which we were firstly confused with.

Remarks. Although the great resemblance of *C. adiaستolos* sp. nov with *C. cingulata* Calman, 1907, the study of the type material of the latter (ZMK CRU-6038, CR-9163, CRU-9164) clarified their differences. In *C. cingulata* the transversal ridge encircle entirely the carapace

and clearly separates it in two parts, even on the middorsal line. Near the lower margin, this ridge curves forward reaching the margin, as well as in specimen figured by Calman (1907: pl. 4, figs. 1, 2). In *C. adiaستolos* the transversal ridge is interrupted on the middorsal line and does not reach the lower margin of the carapace. Moreover, *C. cingulata* has two dorsal parallel carinae on the posterior third of carapace, which are reduced to a two semicircular tubercles in *C. adiaستolos*.

Genus *Eocuma* Marcusen, 1894

***Eocuma carinocurvum* sp. nov. (Fig. 4, 5)**

Type material. *Holotype*: ov. female, partially dissected in two slides, Assaluyeh, North Nay Band Bay, Persian Gulf, stn 20, 52°33.763'N 27°20.193'E, 27 m, November 2002 (ICM CUM-0046).

Diagnosis. Carapace strongly flattened, with a sharp marginal carina bearing a pair of blunt horns not forward curved, with a pair of dorsal carinae on the posterior half of carapace, running more or less parallel to the middorsal line in its anterior half, but curved to the lateral margin before reaching hinder edge of carapace. Eyelobe rounded, with three lenses. Uropod peduncle shorter than half length of rami, with 5 plumose setae on inner margin; endopod subequal to exopod,

Description. Ovigerous female, 9.0 mm total length. Carapace as long as 1/3 total length, strongly flattened, with a sharp marginal carina bearing a pair of blunt horns not forward curved; dorsal median carina runs from behind of eyelobe to hinder margin; a pair of dorsal carinae on the posterior half of carapace, running more or less parallel to the middorsal line in its anterior half, but curved to the lateral margin before reaching hinder edge of carapace. Eyelobe rounded, with three lenses; pseudorostral lobes short and wide, meeting in front the eyelobe.

Antennula peduncle 3-articulate; article 1 flattened, broader at base; article 2 and 3 cylindrical; main flagellum 2-articulate and with 2 aesthetascs, accessory flagellum rudimentary. Mouth appendages do not dissected in order to preserve de holotype. Maxilliped 3 opercular, basis flattened and strongly produced distally; ischium longer than merus with 7

plumose setae on inner margin; merus produced distally; carpus with distal inner corner acutely produced; dactylus slender and longer than propodus. Pereopod 1 basis flattened and expanded centrally, slightly longer than following three segments combined length, with an acute process distally; merus half length of carpus; propodus shorter than merus and as long as dactylus. Pereopod 2 very small, basis shorter than the rest of appendage, with 4 long plumose setae; ischium absent; merus, carpus and propodus similar in length; dactylus twice as long as propodus. Pereopod 3 basis shorter than the rest of appendage, with 4 long plumose setae; merus longer than carpus; carpus with 4 long simple setae, 2 of them distally; propodus with 1 long simple seta distally. Pereopods 4 and 5 similar, basis shorter than the rest of appendage, with long plumose setae; merus longer than carpus; carpus with 2 simple seta on the margin and 2 long simple setae distally.

Uropod peduncle shorter than half length of rami, with 5 plumose setae on inner margin; endopod subequal to exopod, with 19 long plumose and 3 acuminate setae on inner margin and one spiniform terminal seta; exopod 2-articulate, proximal article half length of distal one, which has simple setae on inner margin and one acuminate microsetulate seta distally.

Etymology. Referring to the shape of the pair of dorsal carinae of the carapace.

Remarks. *Eocuma carinocurvum* sp. nov. resembles *E. hilgendorfi* Marcusen, 1894 by: carapace dorsoventrally flattened, the entire border carinae, the paired dorsal ridges and the eyelobe with three lenses. Both species may be distinguished by the shape of dorsal carinae, which are more or less parallel and reaching the hinder margin of the carapace in *E. hilgendorfi* while they are curved to the lateral margin in *E. carinocurvum*, and the shape of the lateral horns that are acute and forward directed in *E. hilgendorfi*. Kurian and Radhadevi (1983) described *E. striata* only by comparison with *E. sanguinea* without illustrations. Although *E. striata* has a pair of dorsal carina, it lacks lenses on the eyelobe and the width of the posterior margin of carapace is a third of those measured across the horns.

***Eocuma longicorne* Calman, 1907**

Eocuma longicornis Calman, 1907: 20-21, pl. 6, figs. 1-6.

Eocuma producta Calman, 1907: 24-25, pl. 6, figs. 18-20.

Eocuma longicorne Stebbing, 1913: 21. Kurian, 1951: 95-96.

Material examined. Assaluyeh, north Nay Band Bay, Persian Gulf: 2 pread. females, 1 pread. male, 1 ov. female, stn 10, 52°33.069'N 27°29.796'E, August 1998, 30 m; stn 15, 52°33.344'N 27°29.421'E, 27 m, August 1998; 1 ov. female, stn 20, 52°33.763'N 27°20.193'E, 27 m, August 1998; 1 ov. female, stn 10, 52°33.069'N 27°29.796'E, 30 m, November 2002.

Distribution. Red Sea, Malaysia (Calman 1907), coast of India (Kurian 1951) and Persian Gulf in shallow waters (<30 m depth).

***Eocuma travancoricum* Kurian, 1951 (Figs. 6-8)**

Eocuma travancoricum Kurian, 1951: 97-99, pl. 2, fig. 21-28.

Material examined. Assaluyeh, north Nay Band Bay, Persian Gulf. Campaign 1998: 1 ov. female, 1 pread. male, stn 3, 52°33.464'N 27°30.828'E, 19 m depth; 1 pread. female, stn 4, 52°33.207'N 27°30.560'E, 21 m depth; 1 pread. female, 1 pread. male, stn 8, 52°33.574'N 27°30.229'E, 19 m depth; 1 pread. female, 2 ov. females, 1 pread. male, stn 9, 52°33.323'N 27°30.064'E, 21 m depth; 1 ov. female, stn 13, 52°33.831'N 27°29.948'E, 15 m depth; 3 pread. females, 5 ov. females, 2 pread. males, 2 juv., stn 14, 52°33.591'N 27°29.677'E, 19 m depth; 1 pread. female, 5 ov. females, 1 manca, stn 18, 52°33.244'N 27°29.406'E, 16 m depth; 2 pread. females, 7 ov. females, 1 ad. male, 1 juv., stn 19, 52°34.003'N 27°29.156'E, depth 19 m, 1 ov. female, stn 20, 52°33.763'N 27°20.193'E, 27 m depth; 6 ov. females, 2 pread. males, stn 23, 52°34.429'N 27°29.065'E, 14 m depth; 4 pread. females, 3 ov. females stn 24, 52°34.168'N 27°28.797'E, 18 m depth.

Campaign 2002: 2 ov. females, 2 pread. females, 1 pread. males, 1 juv., stn 3, 52°33.464'N 27°30.828'E, 19 m depth; 2 ov. females, 1 ad. male, stn 4, 52°33.207'N 27°30.560'E, 21 m depth; 2 ovi. females, 1 ad. male, stn 9, 52°33.323'N 27°30.064'E, 21 m depth; 6 ovi. females, 3 pread. females, 1 ad. male, 1 juv., stn 13, 52°33.831'N 27°29.948'E, 15 m depth; 3 ovi. females, 1 pread. female, 1 ad. male, stn 14, 52°33.591'N 27°29.677'E, 19 m depth; 10 ov. females, 2 pread. f, 1 pread. males, 3 juv stn 24, 52°34.168'N 27°28.797'E, 18 m depth.

Diagnosis. Carapace less than 1/3 of total length, integument calcified, covered by small denticles. Lateral horns behind the level of the eyelobe, large and forward directed. Uropod peduncle shorter than half length of the endopod, with some simple and plumose setae on inner face. Endopod 1-articulate, as long as exopod.

Description. Ovigerous female, 4.95 mm total length. Carapace less than 1/3 of total length, integument calcified, covered by small denticles. Eyelobe rounded, pseudorostral lobes meeting in front of the eyelobe for an equal length of the eyelobe. Lateral horns behind the level of the eyelobe, large and forward directed.

Antennula peduncle 3-articulate, article 1 as long as article 3 and slightly longer than article 2; main flagellum 2-articulate, very short, with 1 aesthetascs distally. Mandible with 13 setae between pars incisiva and pars molaris. Maxillula inner endite with 4 acuminate and 1 serrate setae. Maxilla endites exceeding the protopod, with simple and serrated setae. Maxilliped 1 basis produced distally and with 7 plumose setae on inner margin; carpus with seven flattened setae on inner margin. Maxilliped 2 basis longer than the rest of appendage with 2 long plumose setae distally; carpus longer than merus, with plumose setae on inner margin. Maxilliped 3 basis short, as long as the following three segments combined length, distal part produced into a long, narrow, curved process reaching beyond the mero-carpal articulation, with a row of setae on inner margin; ischium shorter than merus, with four plumose setae on inner margin; merus produced distally; carpus longer than propodus; propodus and carpus slender. Pereopod 1 basis slightly longer than the three following segments combined length, produced distally beyond the end of ischium into a pointed process; carpus slightly longer than propodus and more than twice as long as dactylus. Pereopod 2 small, basis shorter than the remaining segments, ischium fused, with the basis. Pereopod 3 and 4 similar, basis longer than rest of appendage with plumose setae on margins and 1 simple seta on distal corner; merus as long as carpus; carpus and propodus with 1 long simple seta on distal corner; dactylus shorter than its distal seta. Pereopod 5 basis shorter than rest of appendage merus as long as carpus; carpus and propodus with 1 long simple seta on distal corner; dactylus shorter than its distal seta.

Uropod peduncle with 4 plumose setae on inner margin, shorter than half length of rami. Both rami of the same length; endopod with 8 plumose and 3 acuminate setae on inner margin, its tip with a setulated seta; exopod 2-articulate with 2 plumose setae on inner margin of the article 2, its tip with 2 curved setulated setae.

Adult male 5.2 mm total length. Carapace very different than in female, with a lot of small circular depressions, a 1/3 of total length and twice as long as deep, with two lateral horns behind the level of the eyelobe; eyelobe better developed than in female, with several lenses. Antenna 1 peduncle 3-articulate; article 1 longer than article 3 and about twice long as article 2; main flagellum 2-articulate, very short, with 1 aesthetascs on article 1 and a longer one on article 2. Antenna 2 peduncle articles 4 and 5 with rows of sensorial setae on its ventral face. Pereopod 2 ischium fused with the basis, basis as long as the following three articles combined lengths; merus carpus and propodus of similar length; dactylus longer than propodus with 4 setae terminally and 2 setae on the margins.

Uropod peduncle shorter than half length of the endopod, with some simple and plumose setae on inner face. Endopod 1-articulate, with several plumose and microsetulated setae on inner margin. Exopod 2-articulate, as long as the endopod, with plumose setae on dorsal and ventral margins and a pair of curved setulated setae on the tip.

Remarks. Specimens from the Persian Gulf agree with the description of Kurian (1951). Only small differences were observed in the orientation of the lateral horns that could be due to the relative position of the carapace.

Distribution. South coast of India (Kurian 1951) and Persian Gulf, between 23 and 28 m depth.

Genus *Iphinoe* Bate, 1856

***Iphinoe calmani* Fage, 1945**

? *Iphinoe* sp. Calman, 1907: 28.

Iphinoe calmani Fage, 1945: 189-193, figs. 15-19; Kurian 1954: 276-278, fig. 1a-b; Radhadevi & Kurian, 1982: 136-137; 1989: 21; 1990: 29.

Material examined. Assaluyeh, north Nay Band Bay, Persian Gulf: 1 juvenile, stn 10, 52°33.069'N 27°29.796'E, 30 m, August 1998; 1 pread. female, stn 25, 52°33.921'N 27°28.547'E, 27 m, August 1998.

Remarks. Females and juveniles of this species can be identified by a gap in the dorsal serration of the carapace after the first (or the second in adult females) tooth. The length of the carapace is slightly more than twice its depth.

Distribution. Viet Nam (Fage, 1945), Thailand (Calman 1907), Andaman Islands (Kurian 1954), East and West coast of India (Radhadevi & Kurian 1989, 1990) and Persian Gulf. Between 4 and 27 m depth.

Subfamily Vaunthompsoniinae Sars, 1878

Genus *Heterocuma* Miers, 1879

***Heterocuma inerme* sp. nov. (Figs. 9-11)**

Type material. Assaluyeh, north Nay Band Bay, Persian Gulf. *Holotype*: 1 ov. female, stn 20, 52°33.763'N 27°20.193'E, 27 m depth, November 2002, (ICM CUM-0052). *Allotype*: 1 ad. male partially dissected in one slide, stn 25, 52°33.921'N 27°28.547'E, 27 m depth, November 2002, (ICM CUM-0053). *Paratypes*: 2 juveniles, 3 pread. females, 3 ov. females, 6 pread. males, 1 adult male, same station of holotype, (ICM CUM-0054); 2 pread. females, 5 ov. females, one of them dissected in one slide, 1 adult male, stn 4, 52°33.207'N 27°30.560'E, 21 m depth, November 2002, (ICM CUM-0055).

Other material. Assaluyeh, north Nay Band Bay, Persian Gulf, campaign 1998: 1 pread. female, 1 ov. female, 1 ad. male, stn 4, 52°33.207'N 27°30.560'E, 21 m depth; 1 ovi. female, stn 5, 52°32.959'N 27°30.292'E, 26 m depth; 1 ov. female, 1 ad. male, stn 14, 52°33.591'N 27°29.677'E, 19 m depth; 1 pread. female, stn 18, 52°33.244'N 27°29.406'E, 16 m depth; 1 pread. female, 1 ad. male, stn 19, 52°34.003'N 27°29.156'E, 19 m depth; 1 pread. female, 1 ov. female, 1 pread. male, stn 20, 52°33.763'N 27°20.193'E, 27 m depth.

Campaign 2002: 1 pread. females, 1 juvenile, stn 3, 52°33.464'N 27°30.828'E, 19 m depth; 1 pread. female, stn 10, 52°33.069'N 27°29.796'E, 30 m depth; 1 juvenile, 1 pread. female, 2 ov. females, stn 13, 52°33.831'N 27°29.948'E, 15 m depth; 4 ov. females, stn 14, 52°33.591'N 27°29.677'E, 19 m depth; 5 juveniles, 5 preadult females, 1 ov. female, 1 pread. male, 1 ad. male, stn 15, 52°33.344'N 27°29.421'E, 27 m depth; 1 ov. female, stn 19, 52°34.003'N 27°29.156'E, 19 m depth; 1 juvenile, 3 pread. females, 3 ov. females, stn 24,

52°34.168'N 27°28.797'E, 18 m depth; 1 ad. male without abdomen stn 25, 52°33.921'N 27°28.547'E, 27 m depth.

Diagnosis. Carapace with a dorsal median carina prominent in the anterior half that becomes paired in the hinder half. Anterolateral angle acute and the lower margin smooth. Free thoracic somites with a paired dorsal carina, pereonites fourth and fifth with a faint additional dorsolateral pair. Female antenna proximal article with 4 plumose setae. Uropod endopod article 1 shorter than article 2.

Description. Ovigerous female, 6.32 mm total length. Carapace near 1/4 of total length; dorsal median carina prominent in the anterior half becomes paired in the hinder half. Eyelobe rounded with a pigmented eye; pseudorostral lobes short not meeting in front the eyelobe. Antennal notch deep, anterolateral angle acute and the lower margin smooth. Free thoracic somites with a paired dorsal carina, pereonites fourth and fifth with a faint additional dorsolateral pair.

Antennula peduncle 3-articulate, article 1 shorter than the following two combined length; article 2 and 3 equal length; accessory flagellum 1-articulate, main flagellum 2-articulate with two aesthetascs and a long simple seta distally. Antenna proximal article with 4 plumose setae. Mandible with 14 setae between pars incisiva and truncated pars molaris. Maxilla palp long, with two unequal filaments. Maxilla endites exceeding the protopod, with simple and serrated setae. Maxilliped 1 basis with 8 plumose setae on inner margin; carpus with 8 acuminate setae on inner margin, some simple setae on ventral face and 1 plumose setae on distal outer corner. Maxilliped 2 basis longer than rest of appendage with 2 long plumose setae distally; carpus longer than propodus and dactylus combined length, with simple and plumose setae on inner margin; propodus broader distally; dactylus shorter than propodus with a long acuminate seta terminally. Maxilliped 3 basis produced distally, reaching beyond mero-carpal articulation, inner margin of the projection with long plumose setae; ischium short with four plumose setae on inner margin; merus produced distally with a long plumose seta on the tip of the projection; carpus with the inner margin convex; propodus slightly longer than dactylus. Pereopod 1 basis shorter than the rest of appendage, with some setae on the distal half of both margins; ischium shorter than merus; carpus near twice as long as merus and longer than propodus; propodus with a group of long setae on its distal end; dactylus shorter than propodus with two long setae. Pereopod 2 basis shorter than rest of

appendage, with a rudimentary 1-articulate exopod; ischium very short; merus with a outstanding acuminate seta distally; dactylus longer than merus and carpus, with some rows of acuminate setae, distal seta the longest. Pereopod 3 basis longer than the remaining segments together, with a 1-articulate exopod; carpus slightly shorter than merus, with 2 simple setae on margin and 3 long simple setae on distal corner; propodus half length of carpus, with 1 long simple seta on distal corner. Prereopods 4 and 5 similar, basis shorter than rest of appendage, with some simple setae; ischium less than half merus length; carpus slightly shorter than merus, with 3 simple setae on margin and 3 long simple setae on distal corner.

Last pleonite not produced between the uropod peduncles, laterally emarginated. Uropod peduncle shorter than rami, with 15 acuminate setae on inner margin; endopod 2-articulate, slightly shorter than exopod; article 1 shorter than 2, with 10 acuminate setae on inner margin, most distal seta the longest; some plumose setae on outer margin; second segment with 8 microsetulate setae on inner margin and 3 longer on the tip, outer margin with 7 plumose setae.

Male 5.75 mm total length. Carapace about 1/4 of body length, nearly twice as long as deep, with a dorsal median carina that becomes paired on the hinder half; eyelobe rounded and well pigmented, reaching the tip of pseudorostral lobes; antennal notch shallow, anterolateral angle rounded and smooth.

Antennula peduncle 3-articulate, article 1 nearly as long as the remaining two, articles 2 and 3 equal in length; accessory flagellum rudimentary, with 3 setae; main flagellum 2-articulate, article 1 twice long as article 2, with some aesthetascs on the proximal half; article 2 with 2 aesthetascs and 2 long simple setae. Pereopod 1 basis shorter than the rest of appendage with 6 plumose setae on ventral margin; carpus near twice as long as merus and longer than propodus; propodus longer than dactylus and its terminal setae combined length, with a group of long setae distally. Pereopod 2 with a 1-articulate exopod.

Uropod peduncle nearly as long as the rami; peduncle inner margin with several unequal setae that are more numerous and arranged in different rows in the middle; endopod 2-articulate, article 1 as long as article 2, with 12 acuminate setae on inner margin and 8 plumose setae on outer margin; article 2 with 8 setulated setae on inner margin, 7 plumose setae on outer margin and a long microsetulated seta terminally; exopod article 1 shorter than article 2; article 2 with 9 long plumose setae on inner margin and 4 microsetulated setae terminally.

Etymology. From the Latin *inermis*, meaning unarmed, referring the smooth lower margin of anterolateral angle.

Remarks. *Heterocuma inerme* sp. nov. resembles very much *H. andamani* Kurian, 1954 but it differs by the smooth anterolateral margin of carapace, the carpus of first pereopod that is longer than propodus, the number of plumose setae on the second antenna of female, and the lower number of setae on the endopod of uropod. Moreover, the second and third pereonites have only a paired dorsal carina and lack the prominent dorsolateral and lateral carinae that are characteristic for *E. andamani*. Both species have the article 1 of endopod shorter than article 2, which differentiate them from *H. sarsi* Miers, 1879. This character was misunderstood by Day (1978) in her key of the genus *Heterocuma*, who mentioned *H. sarsi* as having uropod endopod article 1 shorter than article 2.

Key to the species of *Heterocuma*

- 1. Endopod of uropod distinctly shorter than peduncle 2
- Endopod of uropod at least as long as peduncle 3
- 2. Pereopod 2 and 3 with 2-articulate exopods
 *H. africanum intermedium* (Fage, 1924)
- Pereopod 2 and 3 with 1-articulate exopods
 *H. africanum africanum* Zimmer, 1921
- 3. Uropod endopod article 1 shorter than article 2 4
- Uropod endopod article 1 longer than article 2 *H. sarsi* Miers, 1879
- 4. Pleonites without carinae *H. armatum* Kurian 1954
- Pleonites with carinae 5
- 5. Pereonites 2 and 3 with a paired dorsal carina, anterolateral margin of carapace smooth.....
 *H. inerme* sp. nov.
- Pereonites 2 and 3 with a median dorsal carina and prominent dorsolateral and lateral
 carinae, anterolateral margin of carapace serrated *H. andamani* Kurian, 1954

Genus *Pseudosympodomma* Kurian, 1954

***Pseudosympodomma persicum* sp. nov. (Figs. 12-14)**

Type material. *Holotype*, ov. female, Assaluyeh, north Nay Band Bay, Persian Gulf, stn 14, 52°33.591'N 27°29.677'E, 19 m depth, August 1998 (ICM CUM-0047). *Allotype*: 1 ad. male, stn 18, 52°33.244'N 27°29.406'E, 16 m, November 2002 (ICM CUM-0048). *Paratypes*: 2 pread. females, 1 pread. male, same station of holotype (ICM CUM-0049); 1 ov. female partially dissected in two slides, stn 19, 52°34.003'N 27°29.156'E, August 1998, 19 m depth, (ICM CUM-0050); 1 ov. female, stn 24, 52°34.168'N 27°28.797'E, 18 m, August 1998, (ICM CUM-0051).

Other material examined. Campaign 1998: 1 pread. female, stn 9, 52°33.323'N 27°30.064'E, 21 m depth; 1 pread. female, 1 juvenile, stn 18, 52°33.244'N 27°29.406'E, 16 m depth; 1 pread. female, 1 imm. male, stn 23, 52°34.429'N 27°29.065'E, 14 m depth.

Campaign 2002: 1 ad. male (without abdomen), stn 4, 52°33.207'N 27°30.560'E, 21 m depth; 1 ad. male, stn 9, 52°33.323'N 27°30.064'E, 21 m depth; 1 pread. male, 2 juveniles, stn 13, 52°33.831'N 27°29.948'E, 15 m depth; 1 pread. female, stn 14, 52°33.591'N 27°29.677'E, 19 m depth; 1 ov. female, 1 pread. female, stn 18, 52°33.244'N 27°29.406'E, 16 m depth; 2 ov. females, 1 pread. female, 1 pread. male, 2 juveniles, stn 24, 52°34.168'N 27°28.797'E, 18 m depth.

Diagnosis. Dorsal median carina of the carapace with three teeth directed forwards occupying more than half of dorsal margin in females; dorsal median carina paired on the hinder third of the carapace and on pereonites 2-5. Antero-lateral angle rounded and lower margin smooth

Description. Ovigerous female, 9.25 mm total length. Carapace slightly more than a 1/5 of total length; dorsal median carina with three teeth directed forwards occupying more than half of dorsal margin, the most anterior teeth the smallest, with a rounded tip in the holotype (this teeth is more acute in preadult females); dorsal median carina paired on the hinder third of the carapace. Eyelobe narrow and linguiform reaching beyond the pseudorostral lobes; antennal notch shallow, anterolateral angle rounded and lower margin smooth. Pereon as long as the carapace, all pereonites visible laterally and dorsally; pereonite 1 the shortest, pereonites 2-5 with a paired dorsal median carina.

Antennula peduncle 3-articulate, article 1 as long as the other two combined length, article 2 and 3 of the same length; accessory flagellum 2-articulate, main flagellum 2-articulate with 2 aesthetascs and a long simple seta distally. Mandible with 17 setae between pars incisiva and truncated pars molaris. Maxillula palp with two unequal filaments, inner endite with five setae, 1 trifold, 1 microsetulated and 3 acuminate; outer endite with serrated and setulated setae. Maxilla endites exceeding the protopod, with simple and serrated setae. Maxilliped 1 basis with 8 plumose setae on inner margin, its endite with 2 retinacula, 2 broad multicuspidated, 2 plumose and some simple setae; carpus with 8 flattened hand-like seta on inner margin. Maxilliped 2 basis longer than rest of appendage, with 4 plumose setae on distal inner corner; carpus as long as ischium and merus combined length, with 9 setae on inner margin and one long plumose seta on the distal outer corner. Maxilliped 3 and pereopods 1 and 2 with well developed exopods. Maxilliped 3 basis 1.5 times as long as the rest of appendage, distally produced reaching the end of merus, with a row of plumose setae on the inner margin and 2 long plumose setae at the tip of projection; ischium shorter than merus, with 4 plumose setae on inner margin; merus slightly produced distally. Pereopod 1 basis shorter than rest of appendage, with 3 small acuminate setae on the inner margin; ischium half length of merus; propodus as long as merus and carpus combined length; dactylus slightly longer than merus. Pereopod 2 basis shorter than the rest of appendage; ischium very short with 1 long plumose seta; merus near as long as the carpus, both with acuminate setae on distal margin; dactylus longer than two preceding articles, with 3 small acuminate setae proximally and 4 setae terminally, being the longest half length of dactylus. Pereopod 3 basis longer than rest of appendage with some plumose setae on the margin and 1 on the distal corner; merus shorter than carpus, with 1 simple seta on distal corner; carpus with 3 long simple setae on distal corner; propodus half length of carpus, with 1 long simple seta distally. Pereopod 4 and 5 similar, basis shorter than following 3 articles combined length, with plumose and simple setae; merus shorter than carpus; carpus with 3 long simple setae on distal corner; propodus less than 1/3 of carpus.

Uropod peduncle 1.3 as long as endopod, with 29 acuminate setae on the inner margin. Endopod 2-articulate, longer than exopod; article 1 longer than article 2, with 10 acuminate setae on inner margin and 8 setae on the outer margin; article 2 with 10 acuminate setae on the inner margin, 7 on the outer margin and 1 distally. Exopod article 2 with 12 acuminate setae on the outer margin, a row of plumose setae on inner margin and 3 long acuminate setae distally.

Adult male, 9.3 mm total length. Carapace 1.75 as long as high, with paired middorsal carina running from behind frontal lobe to posterior margin of carapace. Antero-lateral angle rounded and lower margin smooth. Pereonites 2-5 with paired middorsal carina.

Uropod peduncle longer than rami with more than 40 acuminate and microsetulate setae. Endopod 2-articulate, slightly longer than exopod; article 1 longer than article 2, with 18 acuminate and 10 microsetulate setae on inner margin and 11 simple setae on outer margin; article 2 with 16 acuminate setae on inner margin, 7 simple setae on outer margin and 2 long acuminate setae terminally. Exopod 2-articulate, article 2 with 11 long plumose setae on inner margin, 14 simple setae on outer margin and 4 microsetulate setae terminally.

Etymology. Referring the type locality.

Remarks. *Pseudosympodomma persicum* sp. nov. is related with *P. africanum* (Stebbing, 1912) and *P. hoinicae* Petrescu, 1998 in having the first segment of the uropod endopod longer than second, but differs from the *P. africanum* in smooth lower margin of the carapace and from *P. hoinicae* by a greater number of setae on the uropods. Moreover, *P. persicum* has the dorsal median carina of the female paired on the hinder third of the carapace while it is single in the other two species. This last feature is of high relevance in the differentiation of species of this genus (Corbera & Martin 2002).

Key to the species of *Pseudosympodomma* Kurian, 1954

- 1. Uropod endopod article 1 longer than article 2 2
- Uropod endopod article 2 longer than article 1 4

- 2. Lower margin of the carapace serrated, with a single dorsal median carina on the hinder half of the carapace *P. africanum* (Stebbing, 1912)
- Lower margin of the carapace smooth 3

- 3. Carapace with a single middorsal carina on its hinder 1/3
 *P. hoinicae* Petrescu, 1998

– Carapace with a paired middorsal carina on its hinder 1/3 in female or behind the eyelobe in male *P. persicum* sp. nov.

4. With a paired dorsal median carina on the hinder half of the carapace. Lower margin of the carapace serrated *P. indicum* Kurian, 1954

– Hinder 1/3 of the carapace with a single dorsal median carina. Pereonites 2 to 4 with a developed median carina acute in front *P. carinatum* Corbera and Martin, 2002

In addition, Mühlenhardt-Siegel (1996) described a broken specimen (without pleon), *Pseudosympodomma* sp., collected in the Red Sea. It had the carapace with a paired dorsal median carina on the hinder half and the lower margin of its carapace was slightly serrated.

Family Nannastacidae Bate, 1866

Genus *Cumella* Sars, 1865

***Cumella* cf. *schieckei* Bacescu and Muradian, 1975 (Fig. 15)**

Cumella schieckei Bacescu and Muradian, 1975: 61-63, fig. 15.

Material examined. Assaluyeh, north Nay Band Bay, Persian Gulf. Campaign 1998: 1 ov. female, stn 3, 52°33.464'N 27°30.828'E, 19 m depth; 1 adult male, stn 5, 52°32.959'N 27°30.292'E, 26 m depth; stn 8, 1 preadult male 52°33.574'N 27°30.229'E, 19 m depth; 4 ovigerous females, stn 13, 52°33.831'N 27°29.948'E, 15 m depth; 1 adult male damaged, stn 18, 52°33.244'N 27°29.406'E, 16 m depth; 1 adult male, 1 ovigerous female, stn 19, 52°34.003'N 27°29.156'E, 19 m depth; 1 ovigerous female, stn 23, 52°34.429'N 27°29.065'E, 14 m depth. Campaign 2002: 1 prep. male, stn 24, 52°34.168'N 27°28.797'E, 18 m depth.

Description. Ovigerous female 1.82 mm total length. Carapace less than 1/3 of total length, with a small posterior gibbosity; eyelobe rounded; anterolateral angle without ornamentation; in two specimens there is a tooth in the centre of the middorsal line while in the rest, the carapace is smooth.

The three articles of antennula of decreasing length from the basal to the distal; main flagellum 2-articulate with 2 distal aesthetascs; accessory flagellum rudimentary. Maxilliped 3 basis shorter than rest of appendage, distal outer corner produced slightly and with 2 long plumose setae; merus also produced distally and with 1 long plumose seta; carpus shorter than propodus. Pereopod 1 basis slightly longer than the 3 following articles combined; carpus 1.5 as long as propodus. Pereopod 2 basis shorter than the rest of appendage, with a simple seta distally; ischium short; merus slightly shorter than carpus; dactylus twice length of propodus and armed with several acuminate setae, being the longest longer than the article. Pereopod 5 carpus shorter than basis and 1.5 as long as propodus.

Uropod peduncle slightly shorter than telsonic somite, with 2 small acuminate setae on inner margin. Endopod longer than exopod, having 2 acuminate setae on inner margin and a long seta distally. Exopod 2-articulate, article 2 with a distal seta longer than the segment.

Remarks. The specimens collected in the Persian Gulf agree with the description of *Cumella schieckei* in the proportions of uropod that has the peduncle slightly shorter than the last pleonite, the anterolateral angle smooth and the lack of ornamentation on the dorsal line of the carapace. However, two adult females, collected in 1998 at the station 13, have a dorsal tooth on the center of carapace. The possibility that carapace ornamentations could present intraspecific variations, as observed in *C. limicola* Sars, 1879 (unpubl. data), suggest assigning provisionally the material of the Gulf to *C. schieckei*.

Distribution. *Cumella schieckei* is only previously known from the Red Sea between 2 and 3 m depth (Bacescu and Muradian 1975).

Ecological remarks

The environmental conditions of the studied area were very similar during August 1998 and November 2002 (Table 1). The only differences occurred for the organic matter (lower in 1998 than in 2002) and the organic carbon (higher in 1998 than in 2002) contents. Thus, the cumacean assemblages were also very similar (Table 1). Environmental (mainly linked to sediment) characteristics, however, seems to have a relevant influence on the cumacean assemblages, as their density and diversity tended to be higher when the gravel content increased and tended to decrease when both the organic matter content and depth decreased.

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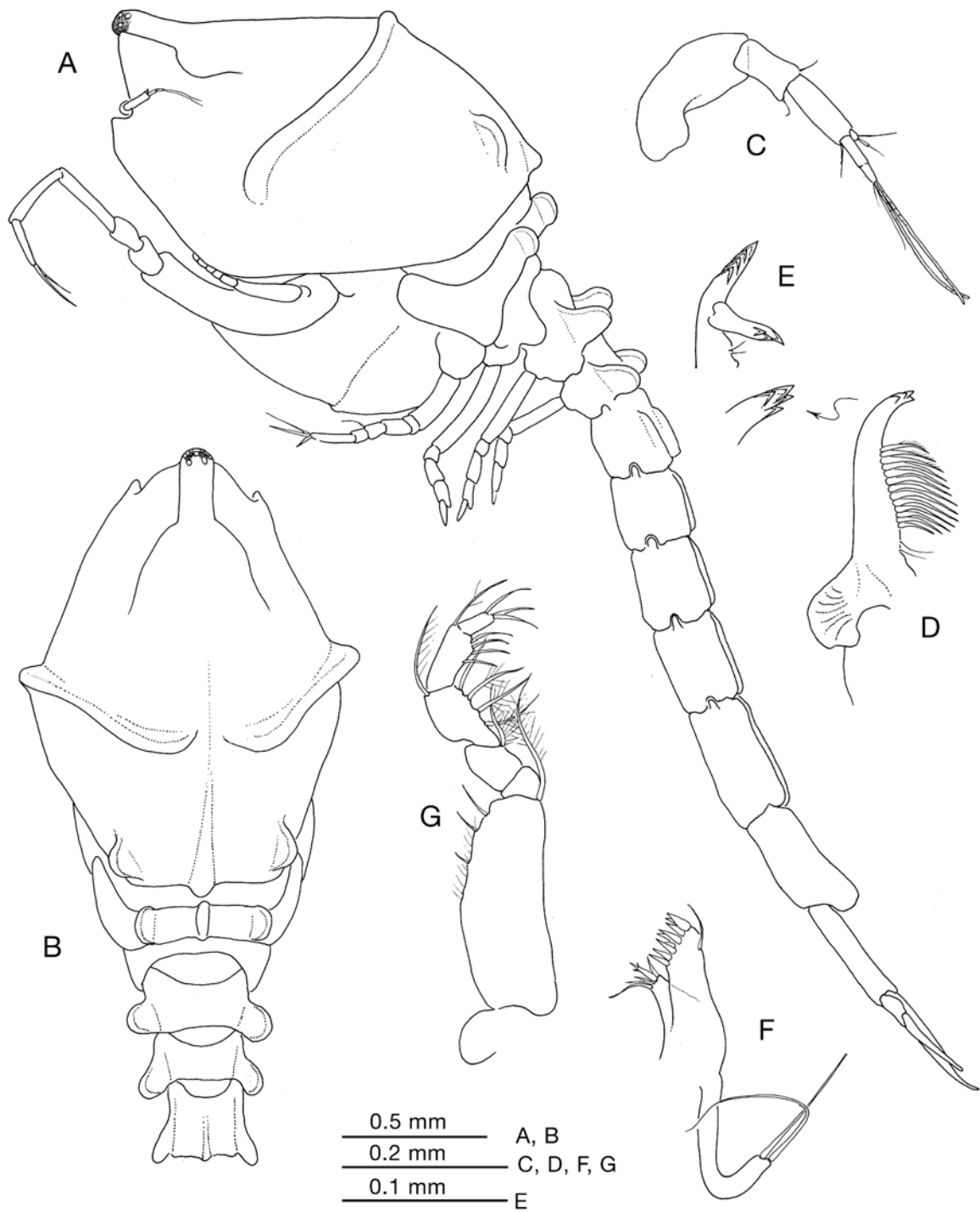


FIGURE 1. *Cyclaspis adiaستolos* adult female. A, whole animal in lateral view; B, carapace and pedigerous somites in dorsal view; C, antenna 1; D, right mandible; E, tip of the left mandible showing the lacinia mobilis; F, maxilla 1; G, maxilliped 2.

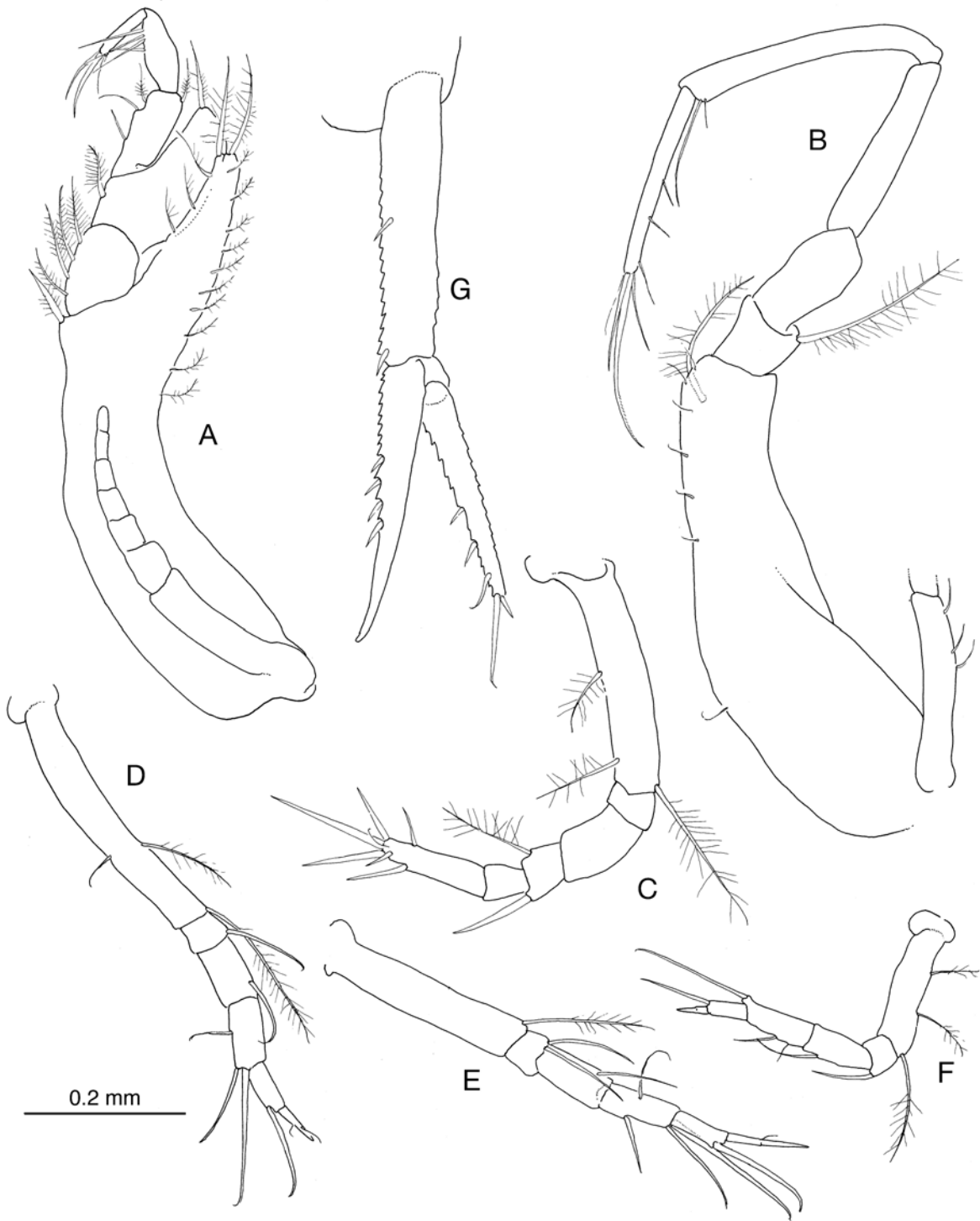


FIGURE 2. *Cyclops adiaastolos* adult female. A, maxilliped 3; B, pereopod 1; C, pereopod 2; D, pereopod 3; E, pereopod 4; F, pereopod 5; G, uropod.

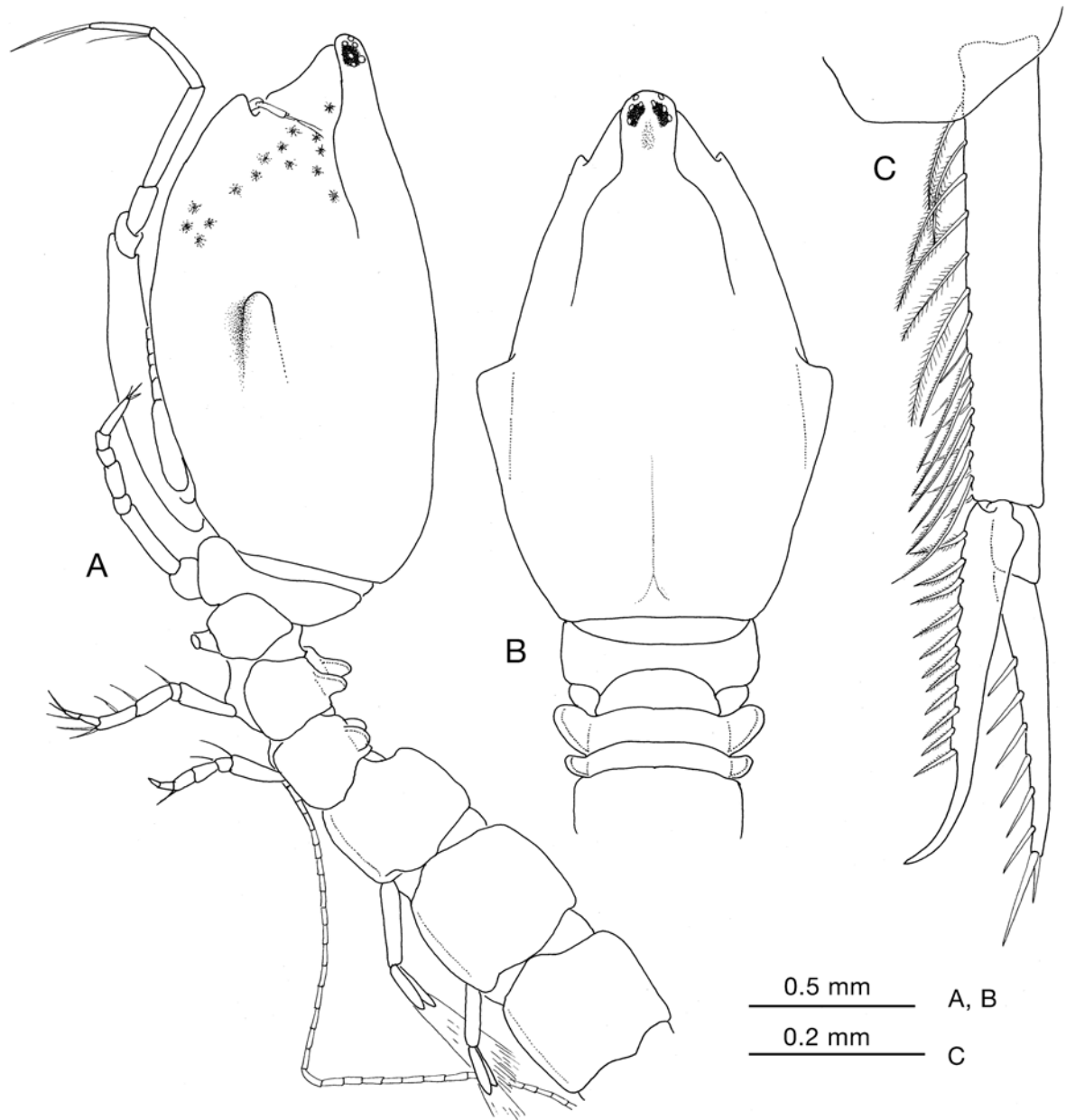


FIGURE 3. *Cyclops diastolos* adult male. A, carapace, pedigerous somites and three abdominal somites in lateral view; B, carapace and pedigerous somites in dorsal view; C, uropod.

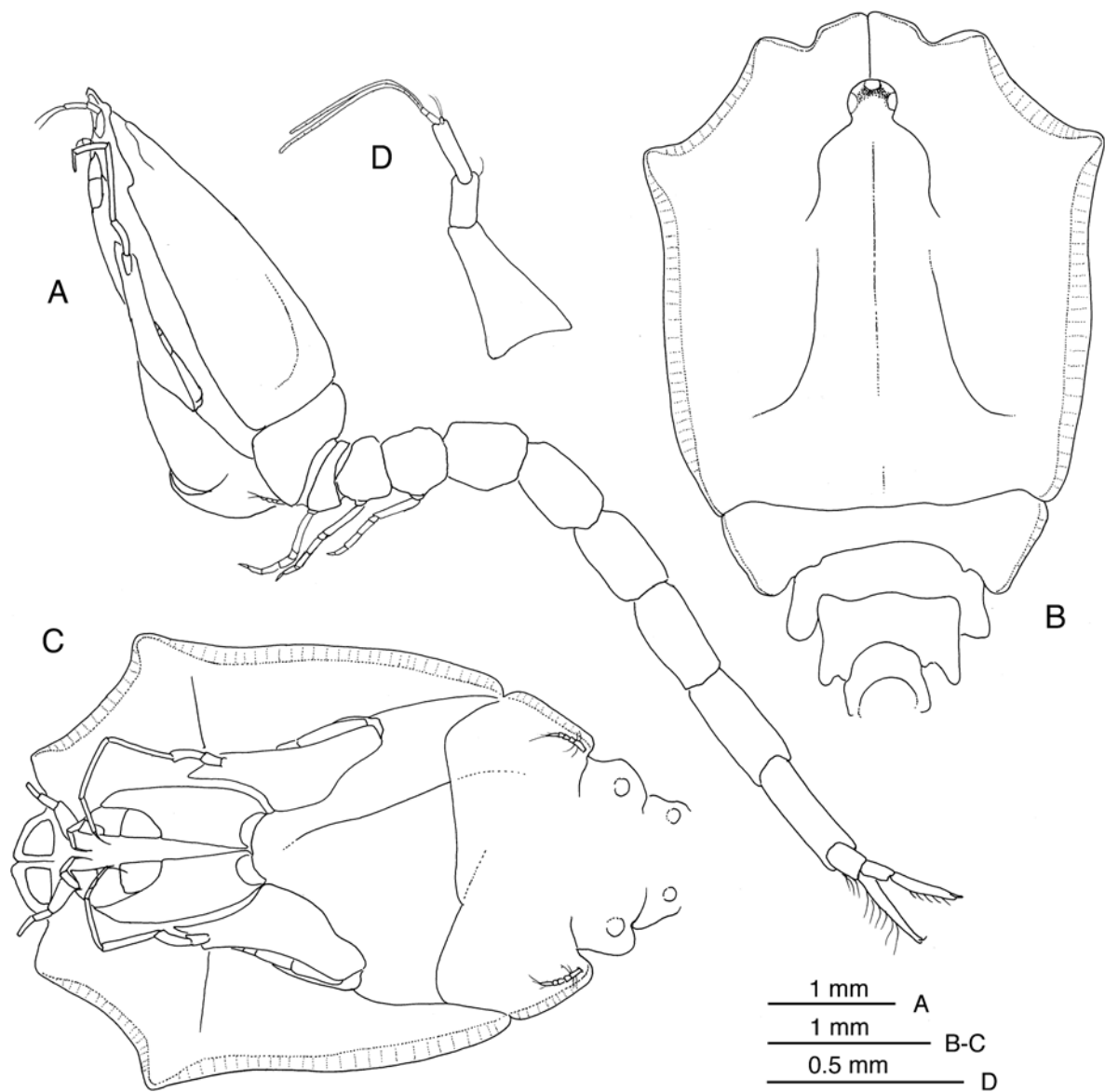


FIGURE 4. *Eocuma carinocurvum* sp. nov., adult female, holotype. A, whole animal in lateral view; B, dorsal view of the carapace; C, ventral view of the carapace; D, antennula.

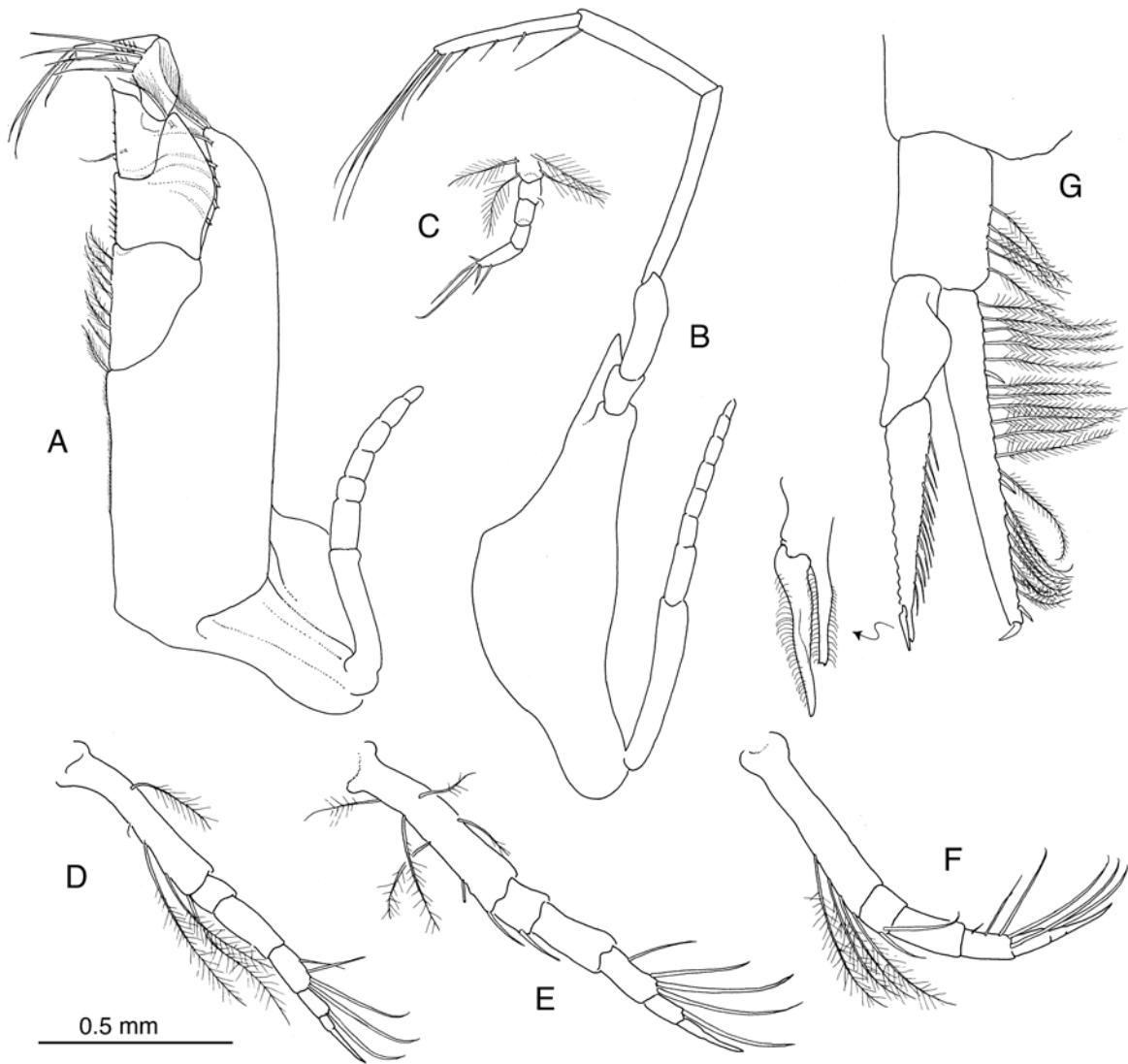


FIGURE 5. *Eocuma carinocurvum* sp. nov., adult female, holotype. A, maxilliped 3; B, pereopod 1; C, pereopod 2; D, pereopod 3; E, pereopod 4; F, pereopod 5; G, uropod.

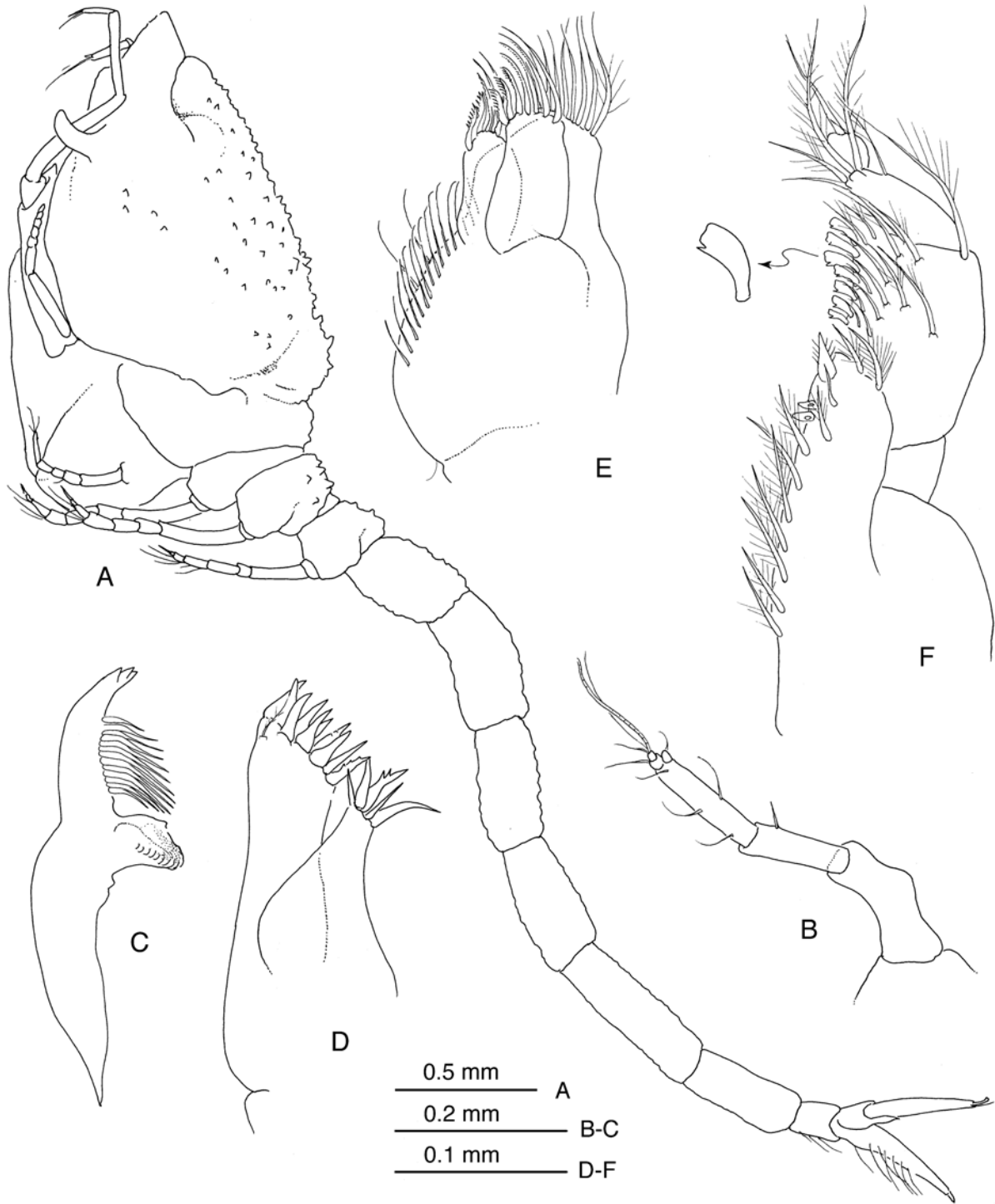


FIGURE 6. *Eocuma travancoricum* Kurian 1951, adult female. A, whole animal in lateral view; B, antennula; C, mandible; D, maxillula; E, maxilla; F, maxilliped 1.

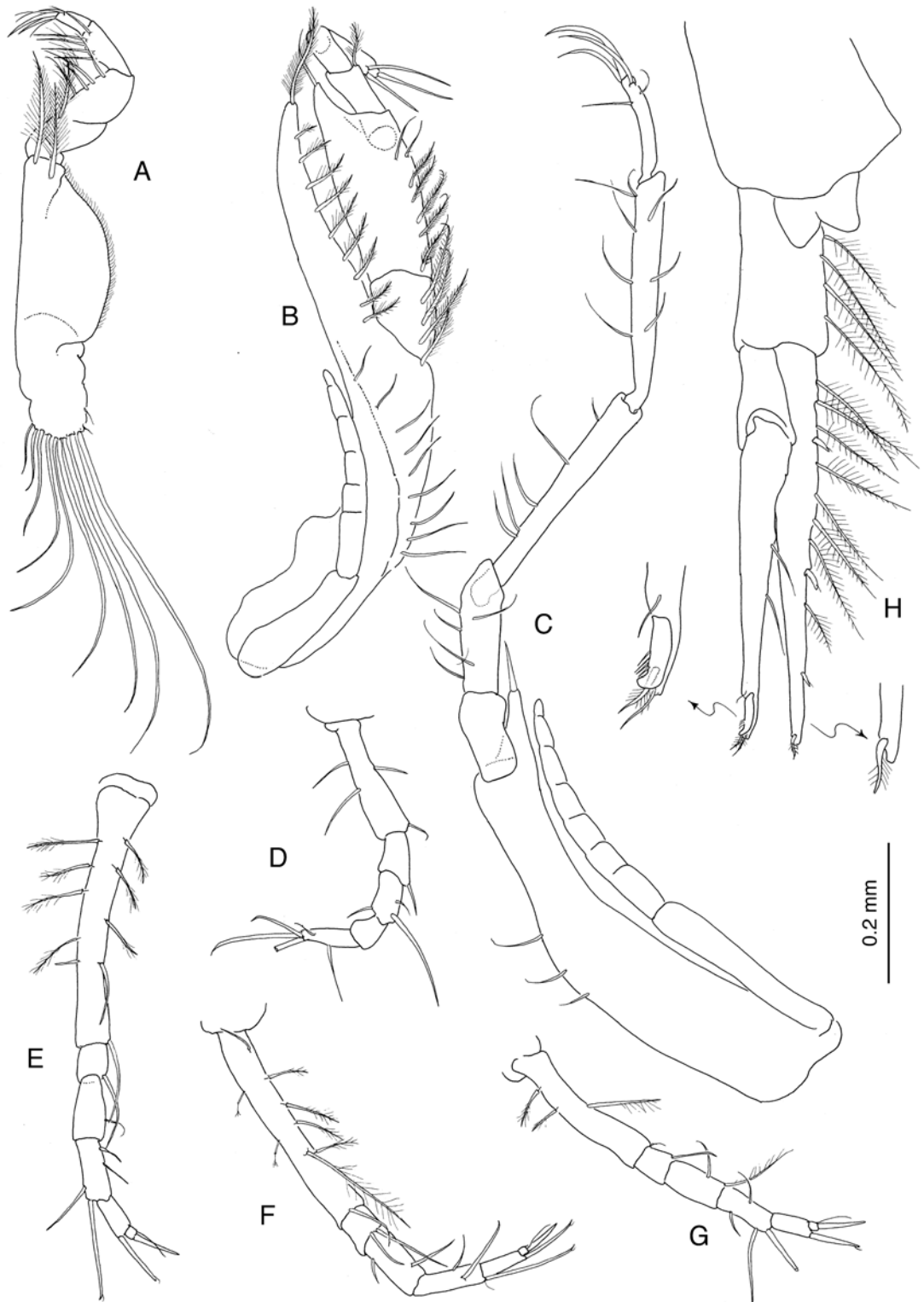


FIGURE 7. *Eocuma travancoricum* Kurian 1951, adult female. A, maxilliped 2; B, maxilliped 3; C, pereopod 1; D, pereopod 2; E, pereopod 3; F, pereopod 4; G, pereopod 5; H, uropod.

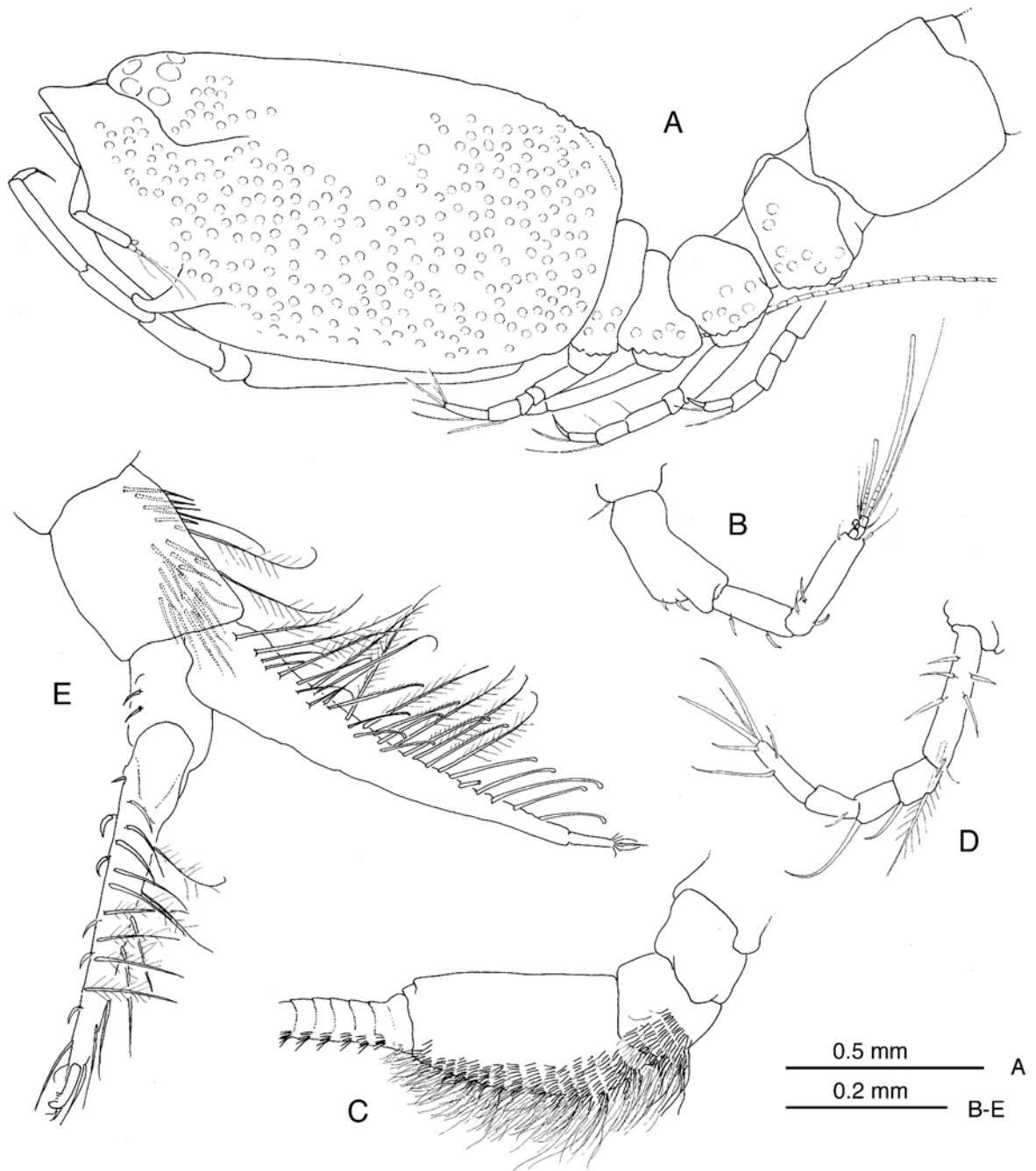


FIGURE 8. *Eocuma travancoricum* Kurian 1951, adult male. A, carapace in lateral view; B, antennula; C, peduncle of antenna (first segment lost during dissection); D, pereopod 2; E, uropod.

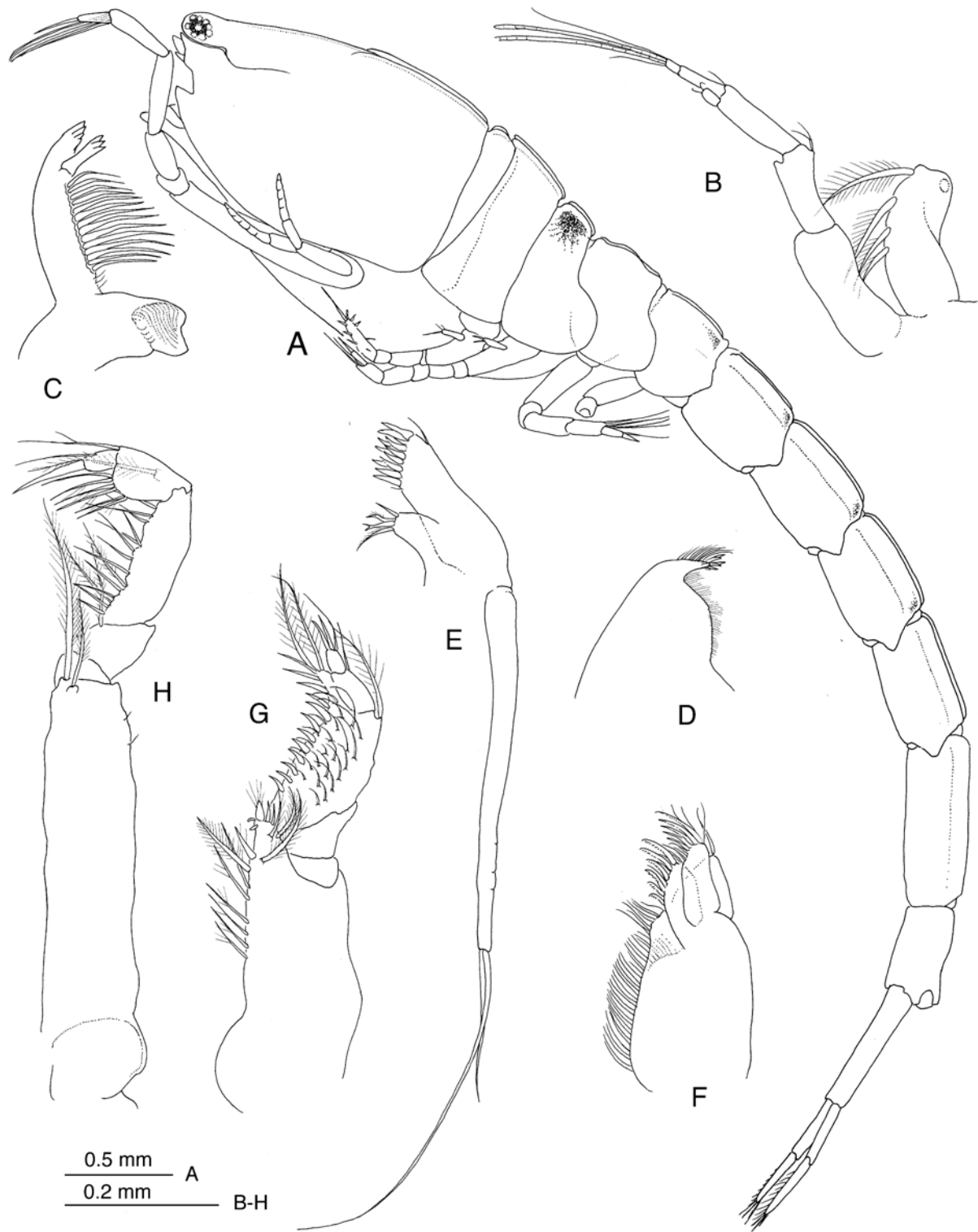


FIGURE 9. *Heterocuma inerme* sp. nov., adult female. A, whole animal in lateral view; B, antennula and antenna; C, left mandible; D, labium; E, maxillula; F, maxilla; G, maxilliped 1.

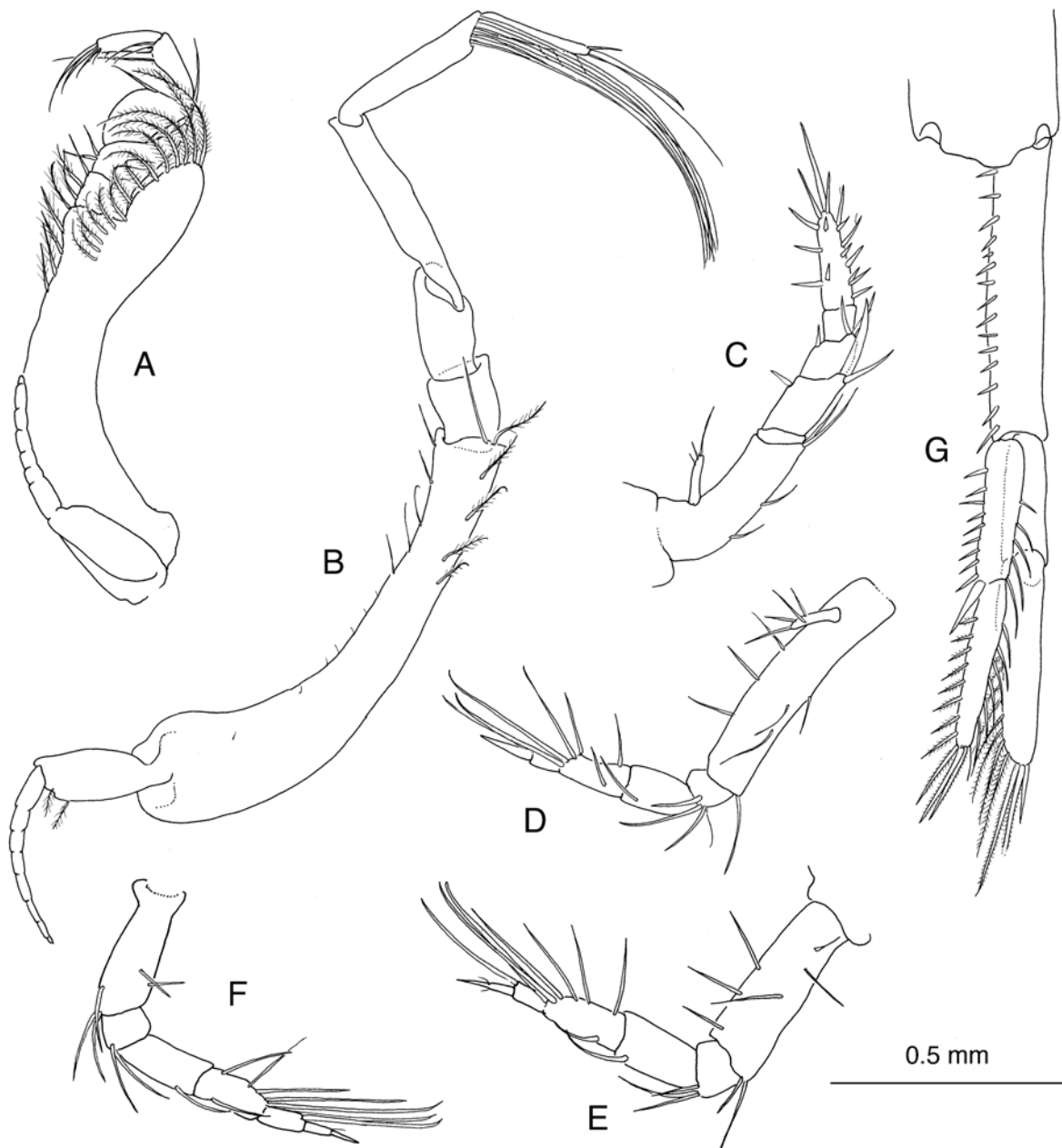


FIGURE 10. *Heterocuma inerme* sp. nov., adult female. A, maxilliped 3; B, pereopod 1; C, pereopod 2; D, pereopod 3; E, pereopod 4; F, pereopod 5; G, uropod.

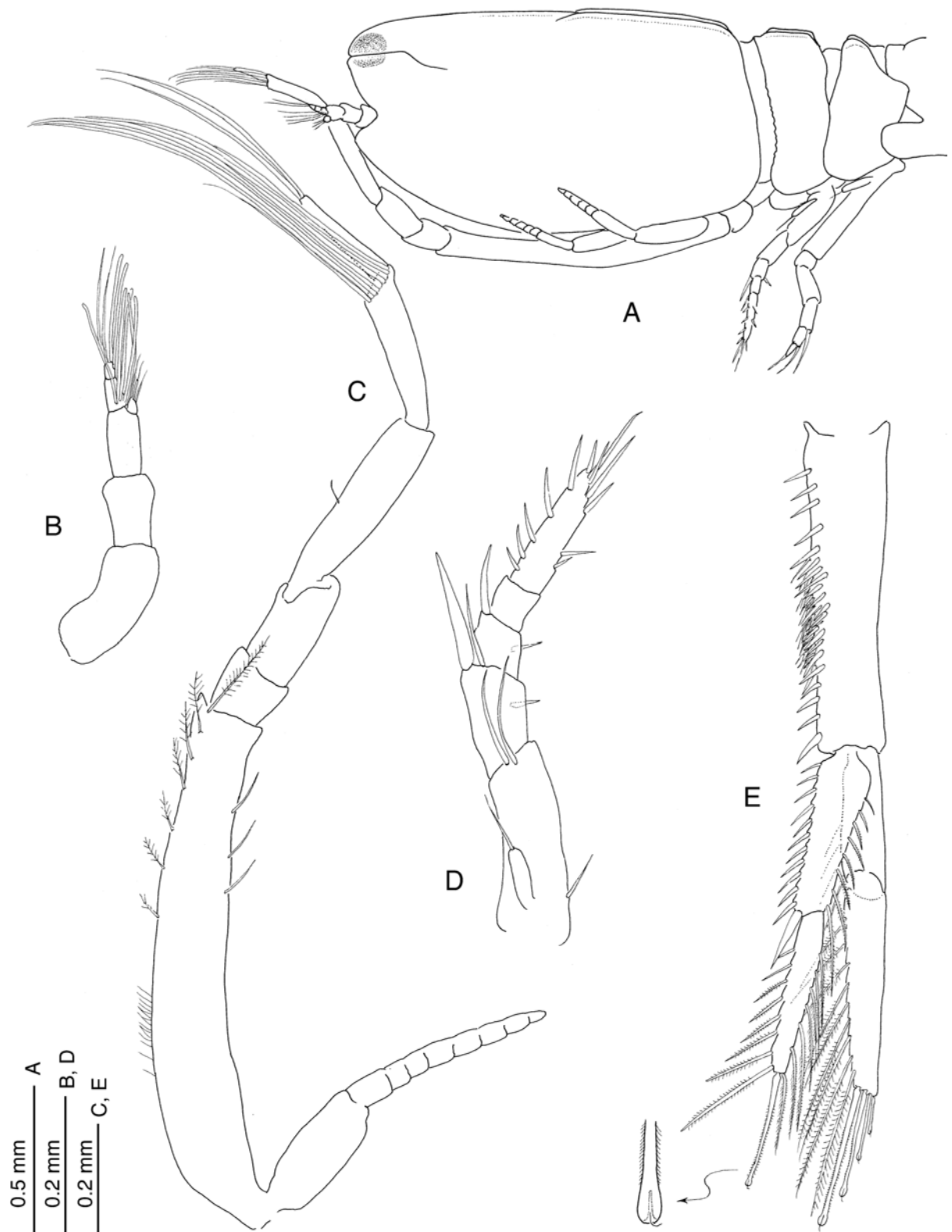


FIGURE 11. *Heterocuma inerme* sp. nov., adult male. A, carapace and pedigerous somites in lateral view; B, antennula; C, pereopod 1; D, pereopod 2; E, uropod.

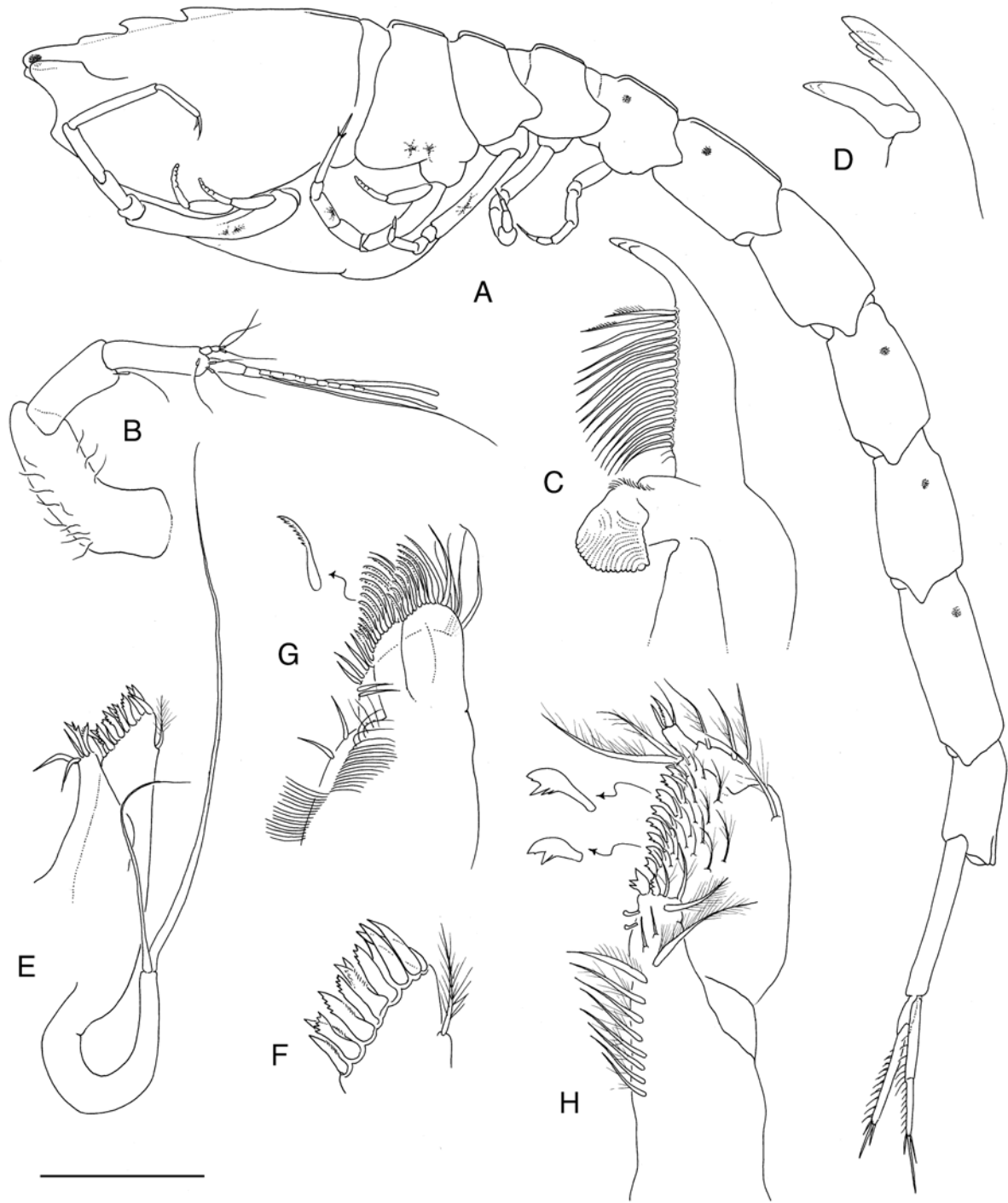


FIGURE 12. *Pseudosymphodomma persicum* sp. nov., adult female. A, whole animal in lateral view; B, antennula; C, right mandible; D, tip of the left mandible; E, maxillula; F, enlarged tip of maxillula; G, maxilla; H, maxilliped 1.

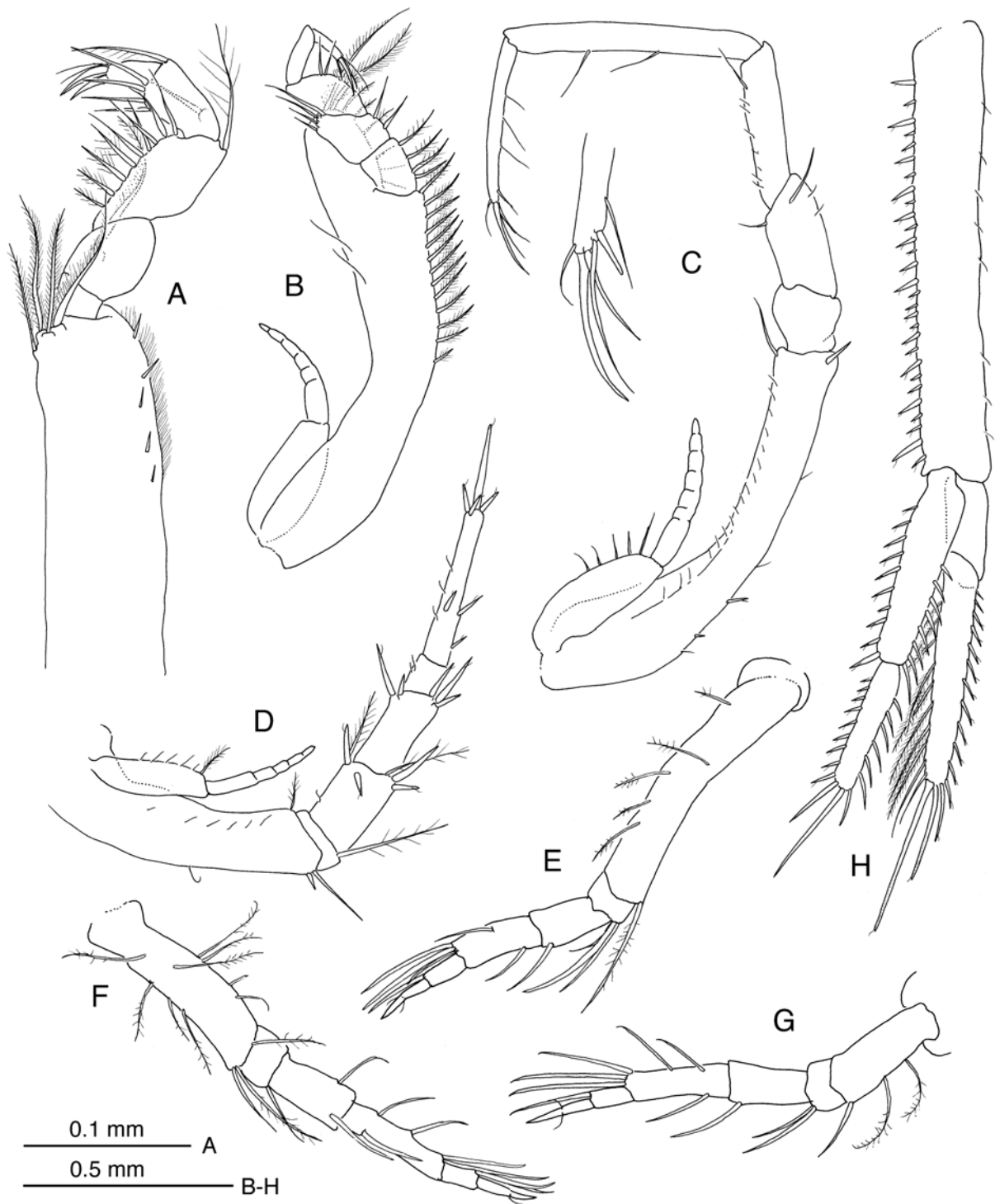


FIGURE 13. *Pseudosympodomma persicum* sp. nov., adult female. A, maxilliped 2; B maxilliped 3; C, pereopod 1; D, pereopod 2; E, pereopod 3; F, pereopod 4; G, pereopod 5; H, uropod.

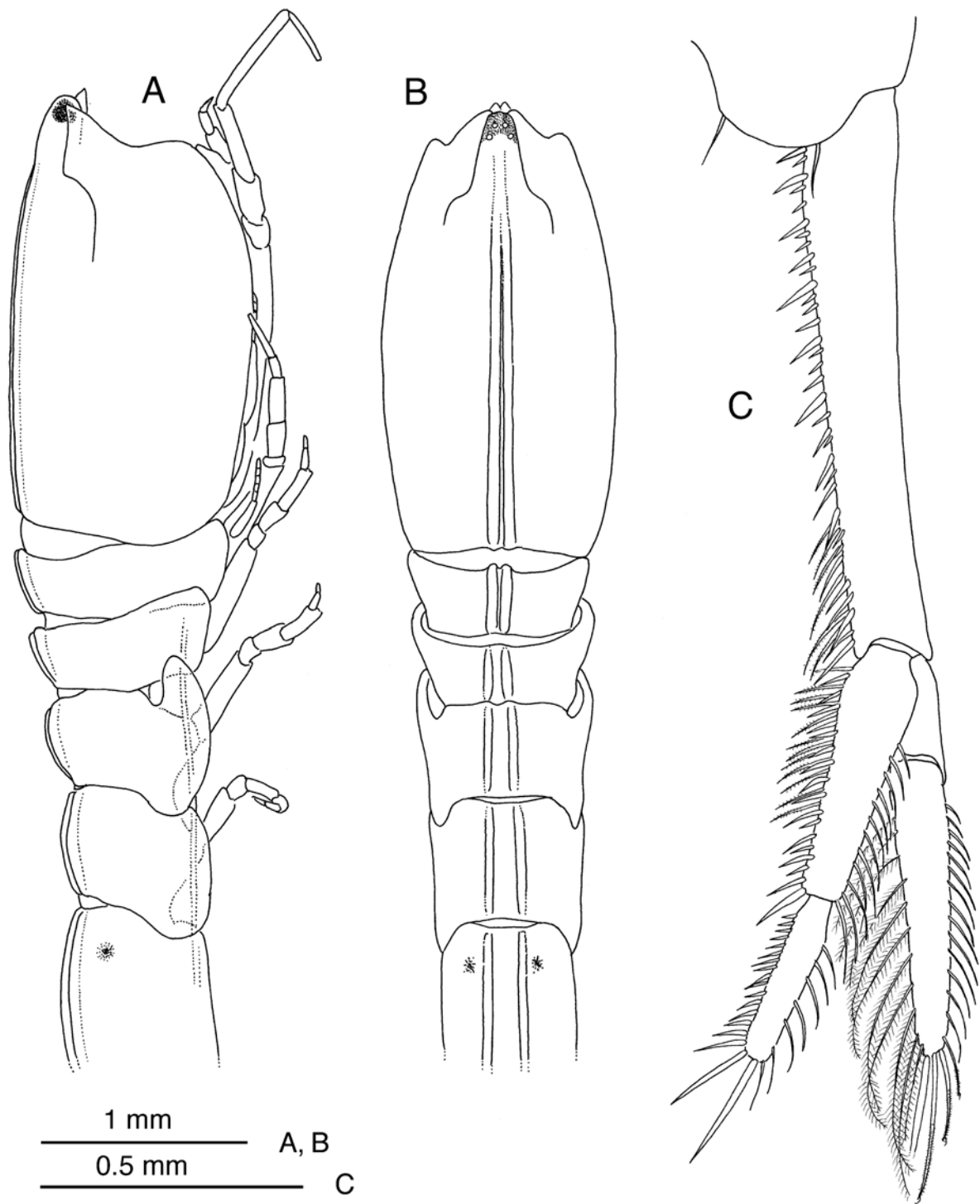


FIGURE 14. *Pseudosymphodomma persicum* sp. nov., adult male. A, carapace and pedigerous somites in lateral view; B, carapace and pedigerous somites in dorsal view; C, uropod.

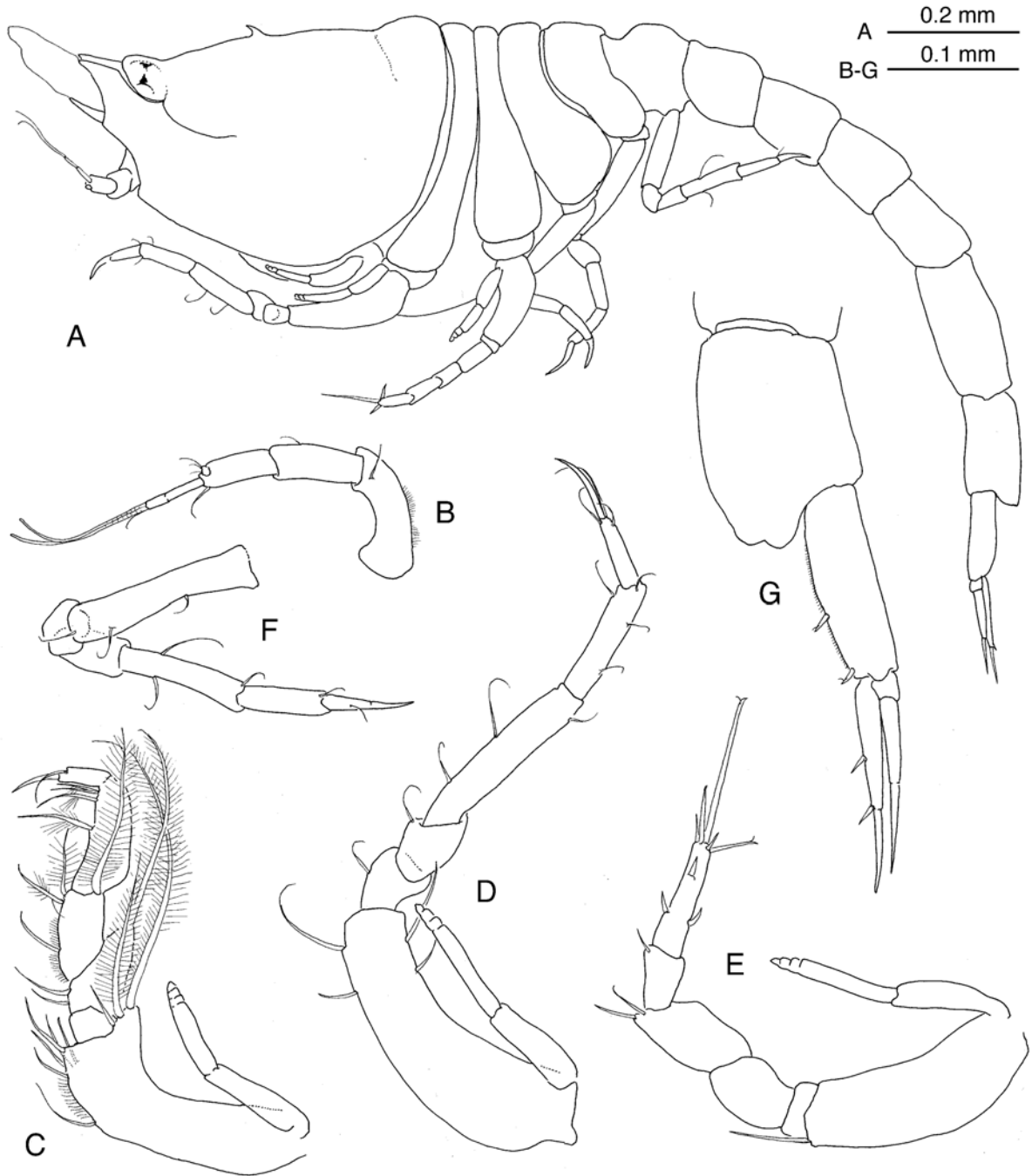


FIGURE 15. *Cumella* cf. *scheckei* Bacescu and Muradian, 1975, adult female. A, whole animal in lateral view; B, antennula; C, maxilliped 3; D, pereopod 1; E, pereopod 2; F, pereopod 5; G, uropod and last pleonite.

TABLE 1. Averages and range of variability of the environmental variables and biological descriptors of the cumacean assemblages collected in August 1998 and November 2002.

Environmental variables	1998			2002		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Depth (m)	14	30	21	14	30	21
Silt and clay (%)	3.75	44	14.2	1.96	24.4	9.3
Gravels (%)	45.6	95.2	80.4	50.7	96.77	84
Median grain size (μm)	164.6	411.5	289.9	141.5	377.6	249.4
Pore water (%)	19.7	39.3	27.9	19.5	37.7	27.8
Organic matter (%)	2.5	5.2	3.6	2.4	8.8	5.2
Organic carbon (%)	0.37	3.4	0.82	0.25	0.68	0.4
Assemblage descriptors						
Number of species per sample	1	4	2.6	1	4	2.3
Density (Ind. m^{-2})	3	69	15	1	26	6.7
Evenness	0	0.922	0.738	0	1	0.632
Diversity	0	1.045	0.699	0	1.242	0.558