

Report on some monstrilloids (Crustacea: Copepoda) from Turkey with description of two new species

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Abstract: Monstrilloid copepods collected during zooplankton surveys carried out in Turkish coastal waters of the southern Black Sea were examined. A total of 3 species were found, of which two are undescribed, one of *Cymbasoma* Thompson, 1888 and one of *Monstrilopsis* Sars, 1921. The new species are described, illustrated and compared herein with their congeners. The new *Cymbasoma* belongs to a small group of species with the fifth leg exopodal lobe bearing two long outer setae and a minute inner seta; it can be distinguished by the shape of the genital somite and the asymmetry of the fifth leg endopodal lobes. The new *Monstrilopsis* is unique in having an unfused distal spine on the distal segment of the male antennule and paired processes at the base of the genital lappets. We also recorded the presumably widespread *Monstrilla grandis* Giesbrecht, 1893. The male specimen examined has some remarkable characters, particularly in the swimming legs 1-4, including a reduced, modified inner seta on the second segment of both first leg endopodal rami. Also, the inner seta of the first endopodal segment of legs 1-3 is absent and is present only on leg 4. Males of this species are less common than females; its intraspecific morphological variability compared with previous illustrated reports. The addition of the new species here described brings the number of nominal species of Monstrilloida in the Mediterranean-Black Sea region to 28.

Résumé : *Signalement de monstrilloïdes (Crustacea : Copepoda) de Turquie et description de deux nouvelles espèces.* Des copépodes monstrilloïdes récoltés lors des campagnes de zooplancton effectuées dans les eaux côtières turques du sud de la mer Noire ont été examinés. Un total de 3 espèces a été trouvé, dont deux non décrites, une du genre *Cymbasoma* Thompson, 1888 et une du genre *Monstrilopsis* Sars, 1921. Les nouvelles espèces sont décrites, illustrées et comparées avec leurs congénères. La nouvelle *Cymbasoma* appartient à un petit groupe d'espèces dont le lobe exopodal de la 5^{ème} patte porte deux longues soies externes et une soie interne ; il se distingue par la forme du somite génital et par l'asymétrie des lobes endopodaux de la 5^{ème} patte. Le nouveau *Monstrilopsis* est unique en ce qu'il présente une épine distale non fusionnée du segment distal de l'antennule mâle et des processus appariés à la base des phanères génitaux. Nous avons également vraisemblablement identifié *Monstrilla grandis* Giesbrecht, 1893. Le spécimen mâle examiné présente des caractères remarquables, en particulier sur les pattes natatoires 1-4, incluant des soies internes réduites et modifiées sur le second segment des rami endopodaux de la 1^{ère} patte. En outre, les soies internes du premier segment endopodal des pattes 1-3 sont absentes et présentes seulement sur la patte 4. Les mâles de cette espèce sont moins communs que les femelles, sa variabilité morphologique intraspécifique a été comparée aux précédents signalements illustrés. L'ajout de ces nouvelles espèces décrites ici porte à 28 le nombre d'espèces nominales de Monstrilloida dans la région Méditerranée-Mer Noire.

Keywords: Marine zooplankton • Taxonomy • Protelean copepods • Pelagic crustaceans

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Introduction

Monstrilloids are rare semi-parasitic copepods that are found as free-living adults in coastal plankton samples (Suárez-Morales, 2001b & 2011), they are protelean parasites, their juvenile stages infect benthic invertebrates including polychaetes and molluscs; adults are free-living, planktonic forms (Suárez-Morales et al., 2010). The order Monstrilloida is known to contain over 155 nominal species (Razouls, 1996; Suárez-Morales, 2011 & 2015; Suárez-Morales & Walter, 2017). Their taxonomy and diversity are still being explored in different regions of the world that have long remained unstudied for this group, including Australia (Suárez-Morales & McKinnon, 2014 & 2016), the Korean Sea (Chang, 2014; Lee & Chang 2016; Lee et al., 2016), and the Mediterranean (Suárez-Morales et al., 2017). According to Razouls (1996) and Suárez-Morales (2011), the monstrilloid fauna of the Mediterranean Sea-Black Sea region is among the best known, but most records are from the Mediterranean (Rose, 1933; Isaac, 1975; Suárez-Morales & Riccardi, 1997; Suárez-Morales, 1999, 2002 & 2011; Suárez-Morales et al., 2017), but the adjacent Black Sea remains practically unstudied. Kriczagin (1877) provided the first records of monstrilloids in the Black Sea, including *Monstrilla grandis* Giesbrecht, 1891 (as its synonym *M. intermedia*) (Isaac, 1975) and *M. pontica* Kriczagin, 1877, a species with an uncertain status, from the northeast sector. Later on, Dolgopolskaya (1948) recorded *M. grandis*, *M. helgolandica* Claus, 1863 and *Cymbasoma longispinosum* (Bourne, 1890) from Sevastopol bay, Ukraine and described *Monstrillopsis zernowi* Dolgopolskaya, 1948 based on male and female specimens from Karkinitzky Bay, Black Sea, Ukraine. The latter is probably a species of *Monstrilla*. Most of the zooplankton studies in the Black Sea have emphasized its northern region (Kovalev et al., 1999 & 2001) so the southern sector of the Black Sea has not been studied for these copepods except for the recent description of a new species of *Cymbasoma* (Üstün et al., 2014). In this contribution we present a taxonomic analysis of the monstrilloid copepods collected during plankton surveys carried out in the Sinop Peninsula, Turkey, in the southern Black Sea. The specimens obtained were taxonomically examined and illustrated; results are herein reported.

Materials and Methods

Zooplankton samples were obtained during a biological survey of the Turkish coasts in the southern Black Sea. Samples were obtained on 9 July 2015 and 6 June 2016 at two stations: sta. C, depth 9 m (35°02'36"E-42°03'40"N) and sta. B, depth 4 m (35°2'36"E-42°03'36"N) off Hamsilos Bay, Sinop, Turkey (Fig. 1). The zooplankton samples were collected vertically from the bottom to the surface using a standard plankton net (mesh size 112 µm, mouth diameter 50 cm). Samples were fixed and preserved in 4% buffered

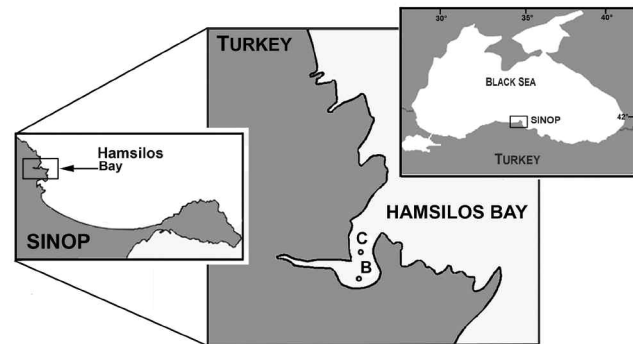


Figure 1. Location of zooplankton sampling stations at Hamsilos Bay, Sinop, northern Turkey, Black Sea where monstrilloid copepods were obtained.

formalin. Monstrilloids were sorted out from the original sample and processed for identification. These samples contained several monstrilloid copepods; they were sorted from the original sample under an Olympus SZX 16 stereomicroscope. The specimens were placed in glycerol and lightly stained with Methylene Blue for further taxonomical examination and dissection. Dissected appendages were mounted on slides using glycerol as mounting medium and sealed with acrylic nail varnish or with Entellan®. Drawings were prepared at 400-1000 X magnifications with the aid of a camera lucida mounted on an Olympus BX51 compound microscope with Nomarski DIC. The general morphologic nomenclature used followed Huys & Boxshall (1991) and Grygier & Ohtsuka (1995). The female antennular armature nomenclature is based on Grygier & Ohtsuka (1995) in which setae (Roman numerals) and spines (Arabic numerals) are clearly distinguished; Huys et al.'s (2007) nomenclature was followed for the armature of the terminal (fifth) segment of the male antennule. Total body lengths (mm) were measured from the anterior end of cephalothorax to the posterior end of the anal somite. The taxonomic analysis included semi-permanent mounting of whole specimens or dissected appendages in glycerine and sealed with acrylic nail varnish or with Entellan®. Drawings were prepared at 400-1000 X magnifications with the aid of a camera lucida. Specimens were deposited in the collection of Zooplankton held at El Colegio de la Frontera Sur (ECOSUR), in Chetumal, Mexico (ECO-CHZ).

Systematic account

Order MONSTRILLOIDA Sars, 1901

Family MONSTRILLIDAE Dana, 1849

Genus *Cymbasoma* Thompson, 1888

Cymbasoma turcorum sp. nov.

(Figs 2 & 3)

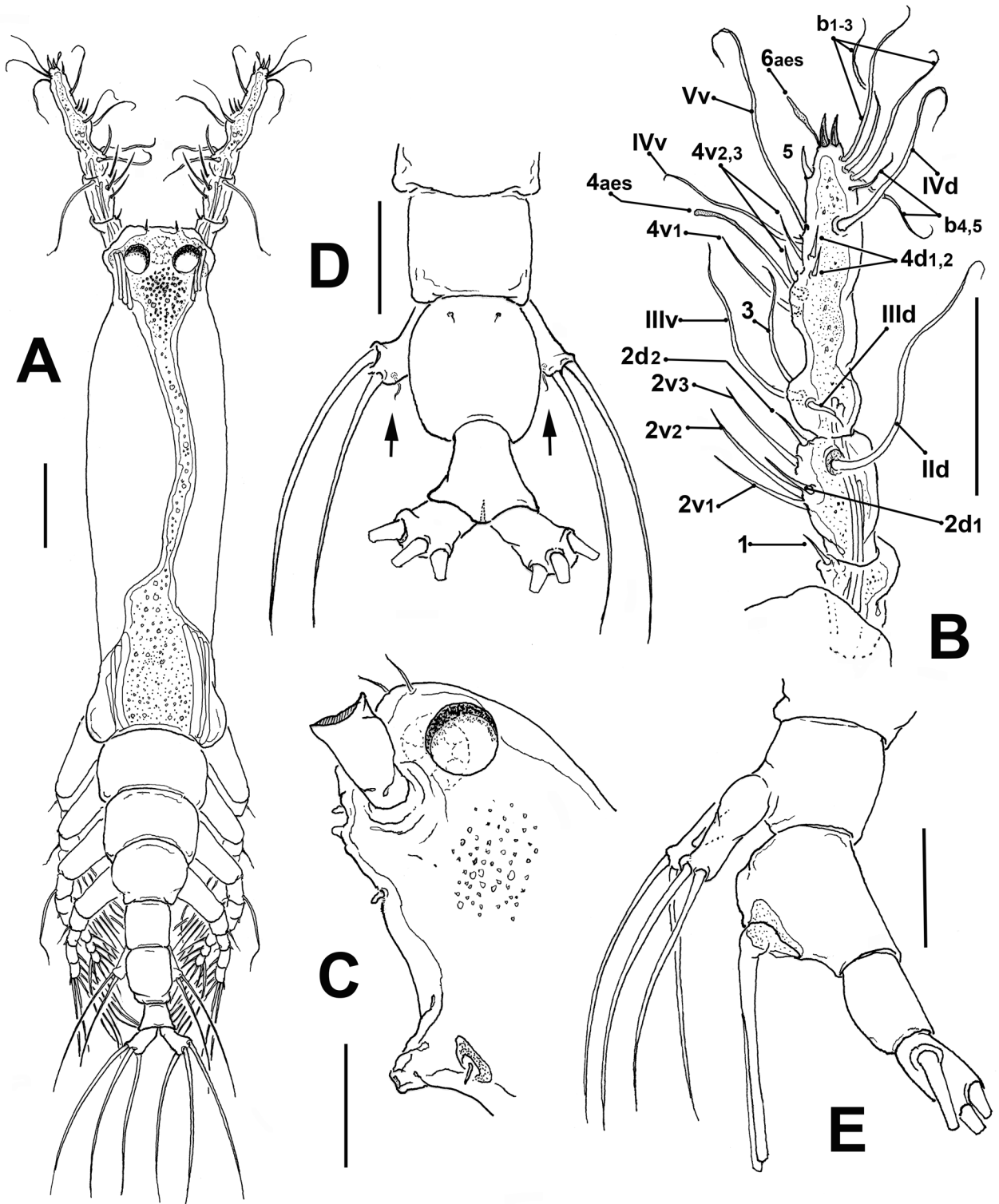


Figure 2. *Cymbasoma turcorum* sp. nov. Holotype adult female from Turkey. **A.** Habitus, ventral view. **B.** Right antennule, dorsal view. **C.** Cephalic region, lateral view. **D.** Urosome, dorsal view. **E.** Urosome and fifth legs, lateral view. Scale bars: A & B = 100 μ m, C-E = 50 μ m.

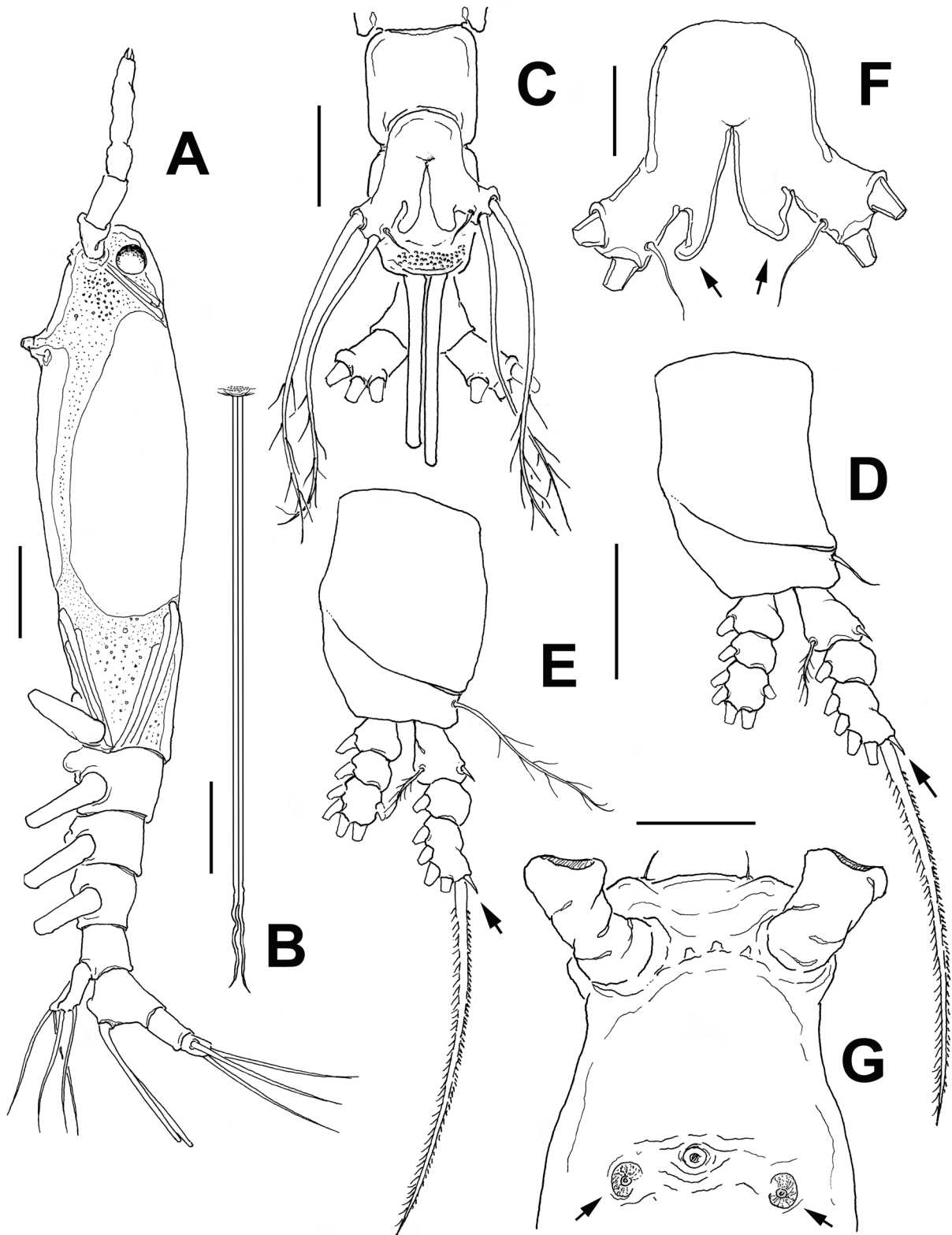


Figure 3. *Cymbasoma turcorum* sp. nov. Holotype adult female from Turkey. **A.** Habitus, lateral view. **B.** Ovigerous spines, ventral view. **C.** Urosome and fifth legs, ventral view. **D.** Second swimming leg. **E.** Third swimming leg. **F.** Fifth leg, ventral view showing asymmetrical endopodal lobes. **G.** Cephalic region, ventral view. Scale bars: A & B = 100 μ m, C-E & G = 50 μ m, F = 25 μ m.

Type material

Adult female holotype from Hamsilos Bay, Sinop, northern Turkey (35°02'36"E-42°03'36"N), Black Sea, specimen partially dissected. Selected appendages on slide mounted on glycerine, sealed with Entellan®. Date of collection: 6 June 2016 at station B. Plankton sample. Slide deposited in the collection of Zooplankton at El Colegio de la Frontera Sur (ECOSUR), in Chetumal, Mexico (ECO-CHZ-00000).

Description of adult female

Body moderately elongate, slender (Figs 2A & 3A); body length of holotype female 0.933 mm. Cephalothorax 0.56 mm long, representing 62.7% of total body length. Midventral oral papilla located at 26% of cephalothorax length. Pair of relatively large ocelli present, pigment cups well developed, separated medially by one eye diameter, strongly pigmented on anterior and medial margins; ventral cup and lateral cups equally sized (Figs 2A & 3A). Cephalic area with flat "forehead", adjacent dorsal surface smooth except for pair of sensilla (Fig. 2C); ventral surface of forehead with shallow transverse striations (Fig. 3G). Ventral cephalic cuticular ornamentation including: 1) row of three papilla-like processes on medial surface between antennule bases, 2) small, medial papilla-like process between antennule bases and oral papilla (Fig. 2C), 3) pair of flat, symmetrical spiral shaped processes in perioral area, with few shallow transverse adjacent striations (arrows in Fig. 2G).

Urosome measuring 14 µm, consisting of fifth pedigerous somite, genital double-somite and anal somite, together representing 11% of total body length. Relative lengths of urosomites (fifth pedigerous, genital-double, and free somites) as: 29.6: 37.6: 32.8 = 100, respectively. Fifth pedigerous somite subrectangular, outer margins straight (Fig. 2D), fifth legs inserted on distal 1/2 of somite. Genital double-somite with rounded, moderately expanded lateral margins, smooth dorsal and ventral surfaces (Fig. 2D & E), except for pair of medial sensilla on anterior dorsal surface. Anterior ventral half of genital double-somite moderately expanded; posterior half with insertion of ovigerous spines, ornamented with rugose field (Fig. 2C & E). Anal somite noticeably narrower than preceding somite, widest at distal margin, lateral margins smooth. Caudal ramus subrectangular, 1.4 times longer than wide, armed with three subequally long, sparsely setulated caudal setae. Ovigerous spines paired, relatively long, representing 70 % of total body length. Spines basally separated, slender, straight at their base and along shaft, without distal expansions (Fig. 3B).

Antennule length 0.214 µm, representing about 23% of total body length (excluding caudal rami) and 38% of cephalothorax length in the specimen examined; antennule 4-segmented, but lacking suture between segments 3 and 4

(Fig. 2B). Relative length of compound distal antennular segment: 58%. In terms of Grygier & Ohtsuka's (1995) nomenclature for female monstrilloid antennular armature, setae (Roman numerals) and spines (Arabic numerals), short, slender element 1 present on first segment; elements on second segment: 2d1-2, 2v1-3, and II; elements of 2v group remarkably long. Third segment with long, setiform element 3 as long as spiniform elements of the 2v group; setal elements IIIId and IIIv present, but IIIId reduced. Segment 4 bearing elements 4d1,2, 4v1-3, element 4v1 longest of 4v-d group. Aesthetasc 4aes present. Setae IVd, IVv, Vd, and Vv present. Element 5 spiniform, strong, not reaching distal margin of segment. Subterminal elements b1-5 present, unbranched; apical elements 61,2 and 6aes present (Fig. 2B).

Incorporated first pedigerous somite and succeeding three free pedigerous somites each bearing a pair of biramous legs. Pedigerous somites 2-4, together accounting for 21.7 % of total body length in dorsal view. Legs 1-4 slightly increasing in size posteriorly. Intercoxal sclerites of legs 1-4 subrectangular, widest at base, tapering distally. Bases of legs 1-4 articulating with large, rectangular coxa along oblique line; with outer basipodal seta; on leg 3, this seta about 4 times longer than in the other legs, biserially setulated from proximal 1/3 and slightly thicker than those on the other legs (Fig. 3E). Endopods and exopods of legs 1-4 triarticulated. Exopodal and endopodal setae all biserially plumose except spiniform outer seta on exopodal segments 1 and 3, and inner seta of first exopodal segment, these latter being short, slender, and sparsely setulated. Spine on distal exopodal segment of legs 2 and 3 short (arrows in Fig. 3E & D). Outermost apical exopodal setae of legs 1-4 with inner margin ornamented with short setules, outer margin spinulose.

Armature formula of legs 1-4:

	basis	endopod	exopod
leg 1	1-0	0-1;0-1;1,2,2	I-1;0-1;I,2,2
legs 2-4	1-0	0-1;0-1;1,2,2	I-1;0-1;I,1,2,2

Fifth legs medially conjoined, distinctly bilobate, inner (endopodal) lobes asymmetrical (arrowed in Fig. 3F): left inner lobe digitiform, unarmed, separated from fifth leg at inner medial margin of outer (exopodal) lobe, inner lobe reaching beyond midlength of outer lobe's inner margin. Right inner lobe with wider base and distal half, barely reaching middle margin of outer lobe. Outer (exopodal) lobe subrectangular, armed with two subequally long distal setae plus inconspicuous minute inner seta (Fig. 3C & F).

Male: unknown.

Type locality

Hamsilos Bay, Sinop, northern Turkey (35°02'36"E-42°03'36"N), Black Sea.

Etymology

The specific epithet makes reference to the country in which this species was found, Turkey. The name is proposed in genitive case with a neuter ending to match the genus.

Remarks

This female monstrilloid from Turkish waters was easily assigned to the genus *Cymbasoma* by its possession of three caudal setae and three urosomites (fifth pedigerous, genital-double, and anal somites) (Suárez-Morales, 2001a & 2011; Suárez-Morales & McKinnon, 2016). Most females of *Cymbasoma* have a fifth leg bearing an outer lobe armed with two or three setae and an inner lobe developed to different degrees. In most species the three exopodal setae are subequally long as in species of the *C. rigidum* group (Suárez-Morales, 2006; Suárez-Morales et al., 2017), or the innermost is relatively shorter, as in *C. striatus* Isaac, 1974 (as redescribed by Suárez-Morales, 1994, 1996, 1999 & 2000a), *C. guerrerense* Suárez-Morales, 2009 (Suárez-Morales & Morales-Ramírez, 2009), and *C. striifrons* Chang, 2012, among others. The specimen from Turkey is assignable to a small group of species with two long outer setae and a much reduced, inconspicuous inner seta on the exopodal (outer) lobe (i.e., as long as or shorter than the lobe width, probably unreported in some cases), a cephalothorax representing less than 60% of total body length, and ovigerous spines separated at base, thus excluding species of the *C. longispinosum* group (see Üstün et al., 2014). The species with such a reduced innermost exopodal seta include *C. thompsoni* (Giesbrecht, 1893), *C. nicolettae* Suárez-Morales, 2002, and *C. pseudobidentatum* Suárez-Morales, Goruppi, de Olazabal & Tirelli, 2017. We included in this comparison two Australian species with two setae on the fifth leg outer lobe: *C. lourdesae* Suárez-Morales & McKinnon, 2016, and *C. dakini* Suárez-Morales & McKinnon, 2016.

A fifth leg with a very weakly developed inner (endopodal) lobe, represented by a marginal expansion of the outer lobe or reaching less than halfway of inner margin of the outer lobe, is present in *C. thompsoni* (Giesbrecht, 1893; Sars, 1921) and *C. mediterraneum* Suárez-Morales, Goruppi, de Olazabal & Tirelli, 2017 emend. (see Grygier & Suárez-Morales, 2018). In Sars' (1921) illustrations of specimens from Norway the innermost seta is clearly shorter than in Giesbrecht's (1893) description from the Mediterranean and the shape of the genital double-somite is different; it is probable that the Norway specimens represent a different species. The new species can be distinguished from *C. thompsoni* by several characters: the ovigerous spines are about 35% of the total body length and reach slightly beyond the end of the caudal rami in *C. thompsoni* (Giesbrecht, 1893; Sars, 1921) and are

much longer in the new species (70% of total body length); in *C. thompsoni* the inner lobes are symmetrical, rounded and wide, thus differing from the asymmetrical pattern with one of the lobes being digitiform observed in the new species (see Fig. 3F). The new species can be distinguished from the Mediterranean *C. nicolettae* by the antennule length, it is about 50% of the cephalothorax length in this Mediterranean species vs. a noticeably longer antennule (84% of cephalothorax length) in the new species; also, the fifth leg endopodal lobes are symmetrical and distinctively mammiliform in *C. nicolettae* (Suárez-Morales, 2002, see fig. 8) vs. the unique, asymmetrical pattern of the inner lobes observed in *C. turcorum*. The anal somite is also noticeably shorter and wider in *C. nicolettae* (Suárez-Morales, 2002, see fig. 2) than it is in the new species (Fig. 2D). The recently described Mediterranean (Adriatic Sea) species *C. pseudobidentatum* has several affinities with the new species including the general body shape and proportions, a similar antennule segmentation and armature and shape of the genital double-somite (see Suárez-Morales et al., 2017, see fig. 4). These two species can be separated by several characters: 1) in the new species the antennular element 3 is setiform, flexible (Fig. 2B), whereas it is stout, spiniform in *C. pseudobidentatum*; also, elements $2v_{1-3}$ are relatively longer in the new species (Fig. 2B) than in *C. pseudobidentatum* (Suárez-Morales et al., 2017, see fig. 4c); 2) *C. pseudobidentatum* has a medial rounded protuberance between the antennule bases (Suárez-Morales et al., 2017, see fig. 4d) which is absent in the new species; 3) in *C. pseudobidentatum* the genital double-somite has a pair of distinctive posterodorsal processes (Suárez-Morales et al., 2017, see fig. 4e) that are lacking in the new species *C. turcorum* (Fig. 2D); 4) the fifth leg endopodal lobes are asymmetrical in the new species (Fig. 3B) whereas they are symmetrical, with a different shape and structure in *C. pseudobidentatum* (Suárez-Morales et al., 2017, see fig. 4h). The new species can be readily distinguished from the Australian congener *C. dakini* in the antennule segmentation; segments 3-4 are not fused in this species (Suárez-Morales & McKinnon, 2016, see fig. 6B); also, the cephalic ventral ornamentation is clearly different in both species, with a striated medial protuberance and corrugate preoral surface in the Australian species vs. an absent medial process and smooth preoral surface in *C. turcorum* (Figs 2C & 3G). In addition, the anal somite is clearly narrower and longer in the new species (Fig. 2D) than in *C. dakini* (Suárez-Morales & McKinnon, 2016, see fig. 8A) and the fifth legs lobes are asymmetrical in the new species and symmetrical in *C. dakini* (Suárez-Morales & McKinnon, 2016, see fig. 7E). The other Australian congener with two long setae on the fifth leg exopodal lobe is *C. lourdesae*; it has a remarkably globose genital double-somite with a truncate posterior margin (Suárez-Morales & McKinnon, 2016, see fig. 24 E & F) that

clearly diverge from the characters of the genital-double somite observed in the new species (see Fig. 2D & E). The unique combination of characters present in this specimen from Turkish waters of the Black Sea justifies the proposal of a new species of *Cymbasoma*.

Genus *Monstrillopsis* Sars, 1921
Monstrillopsis pontoeuxinensis sp.nov.
 (Figs 4 & 5)

Type material

Adult male holotype from Hamsilos Bay, Sinop, northern Turkey (35°02'36"E-42°03'36"N), Black Sea, specimen partially dissected. Selected appendages on slide mounted on glycerine, sealed with Entellan®. Date of collection: 6 June 2016 at station B. Plankton sample. Slides deposited in the collection of Zooplankton at El Colegio de la Frontera Sur (ECOSUR), in Chetumal, Mexico (ECO-CHZ-00000).

Description of adult male

Total body length excluding caudal rami: 561 µm. Cephalothorax 272 µm long, representing 48% of total body length (Fig. 4A-C). Midventral oral papilla well developed, located at 31% of cephalothorax length (Fig. 4B). Cephalic region not protuberant bilaterally in dorsal view, as wide as cephalothorax. Pair of dorsal ocelli present; pigment cups medium-sized. Ocelli close to each other medially, strongly pigmented on inner margin; ventral ocellus larger than diameter of lateral cups. No sensilla observed between antennular bases. Forehead area rounded, moderately produced, with notched anterior margin (Fig. 5A) and transverse striations (Fig. 5A). Other cuticular processes weak, represented by pair of preoral shallow nipple-like processes with adjacent faint striae on perioral area (Fig. 5A).

Urosome consisting of fifth pedigerous, genital somite (carrying genital complex), two free somites, and anal somite (Fig. 5C & D). Fifth pedigerous somite smooth, weakly produced ventrally, dorsal surface smooth. Genital somite slightly shorter than fifth pedigerous somite; genital complex of type II (Suárez-Morales & McKinnon, 2014), represented by short base bifurcating into pair of long, moderately divergent lappets with rounded end (Fig. 5D & G). In ventral view each lappet with pair of processes at common basal joint (arrowed in Fig. 5G). Incomplete intersegmental suture between second free (preanal) and anal somites (Fig. 5C), suture visible only on ventral and dorsal surfaces, lateral surface showing partial fusion. Anal somite about slightly longer than preanal somite. Caudal rami subrectangular, approximately 1.3 times as long as wide, longer than anal somite. As usual in genus, each

ramus armed with four subequally long caudal setae (Figs 4A, C & 5D).

Antennular length 340 µm including distal spiniform element (87 µm) on fifth segment. Antennules relatively long, representing 55% of total body length, and 1.2 times as long as cephalothorax; 5-segmented; segment 5 located distal to geniculation (Figs 4A-C & 5B). Element 1 on first segment slender, setiform, long, reaching halfway along second segment. Antennular elements 2_{V1-3}, 2_{d1-2}, and II_d present on second segment, with elements 2_{V1-3} being longest of 2_{v-d} group. Setal elements III_d, III_v, and 3 present on third segment; spiniform element 3 slender, long. Fourth segment with elements 4_{d1-2}, 4_{v1-3}, IV_d and IV_v; all elements on this group small, spiniform except 4_{v1} which is longest of group. As for Huys et al.'s (2007) setal nomenclature of the fifth segment, elements B-D and 1-6 present, unbranched, plus subapical 6 aes (Fig. 5B); element 2 spiniform, curved, clearly separated from segment.

Incorporated first pedigerous somite and succeeding three pedigerous somites each bearing well-developed biramous legs. Pedigerous somites 2-4, together accounting for 30% of total body length in dorsal view (Fig. 4A & B). Coxae of legs 1-4 unarmed, joined by intercoxal sclerites with varying size and shapes, larger, subrectangular in leg 1, subquadrate on leg 2, rhomboid on leg 3, small, oblong on leg 4 (Fig. 4D-G); all sclerites ornamented with spinules. Bases of legs 1-4 separated from coxae posteriorly by oblique articulation; with basipodal outer seta; on leg 3 (Fig. 5F), this seta about 7 times longer, sparsely setulated and slightly thicker than those on the other legs. Endopods and exopods of legs 1-4 triarticulated. Exopods of legs 1-4 slightly longer than endopods. Inner seta on first exopodal segment of legs 1-4 short, slender, sparsely setulated (arrowed in Fig. 5E & F). Outer spine on distal exopodal segment of legs 1-4 acute, about 0.3 times as long as segment. Also, outermost apical exopodal setae of legs 1-4 with outer margin smooth, inner margin sparsely setulose.

Armature formula of legs 1-4 as:

	basis	endopod	exopod
leg 1	1-0	0-1;0-1;1,2,2	I-1;0-1;I,2,2
legs 2-4	1-0	0-1;0-1;1,2,2	I-1;0-1;I,1,2,2

Female: unknown.

Type locality

Hamsilos Bay, Sinop, northern Turkey (35°02'36"E-42°03'36"N), Black Sea (Fig. 1).

Etymology

The species name is formed by the Antique Greek name of the Black Sea: Ponto Euxinus, a term that was Latinized in genitive case.

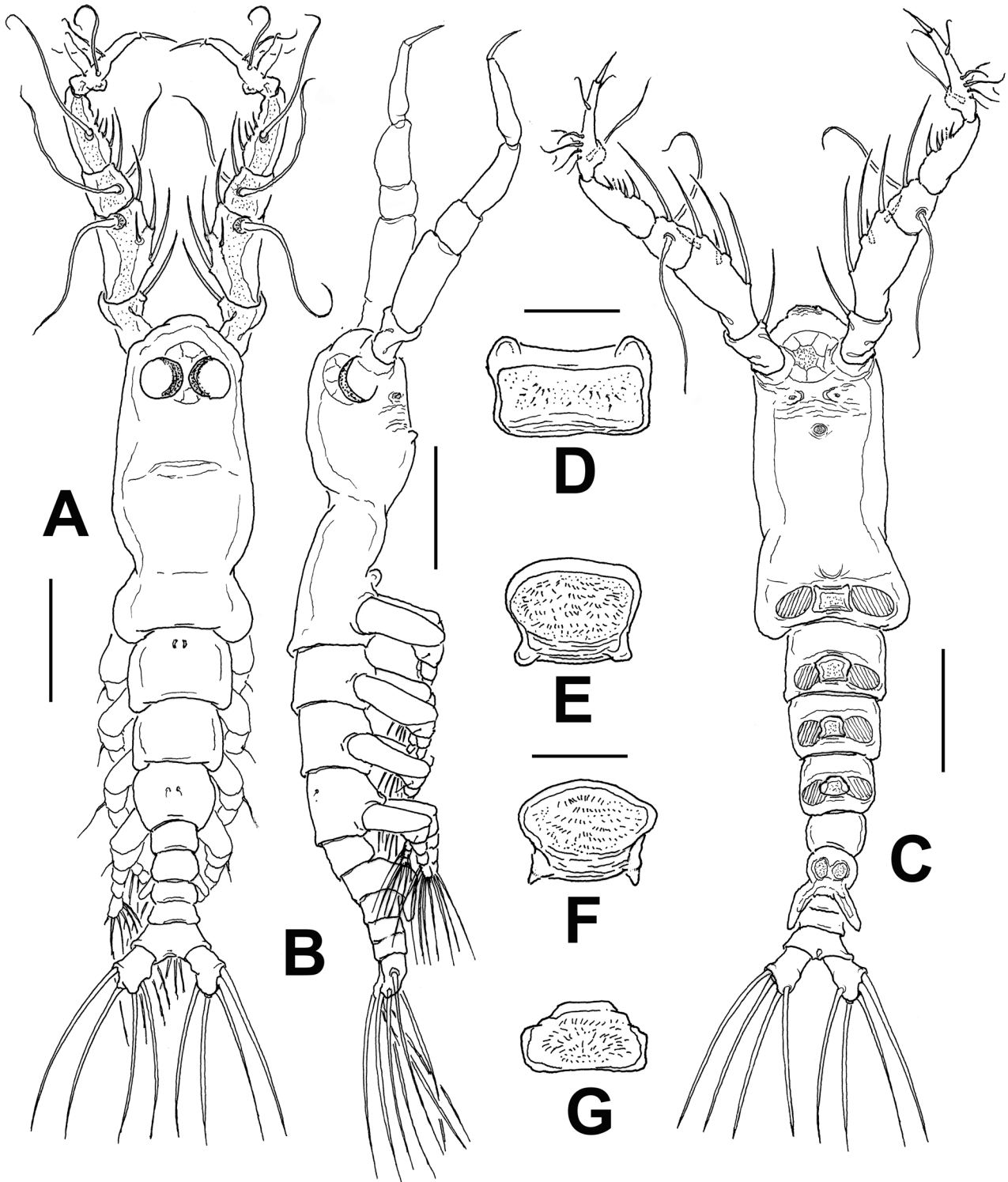


Figure 4. *Monstrillopsis pontoexinensis* sp. nov. Holotype adult male from Turkey. **A.** Habitus, dorsal view. **B.** Habitus, lateral view. **C.** Same, ventral view. **D-G.** Intercoxal sclerites of legs 1-4, anterior view. Scale bars: A-C = 100 μ m, D-G = 10 μ m.

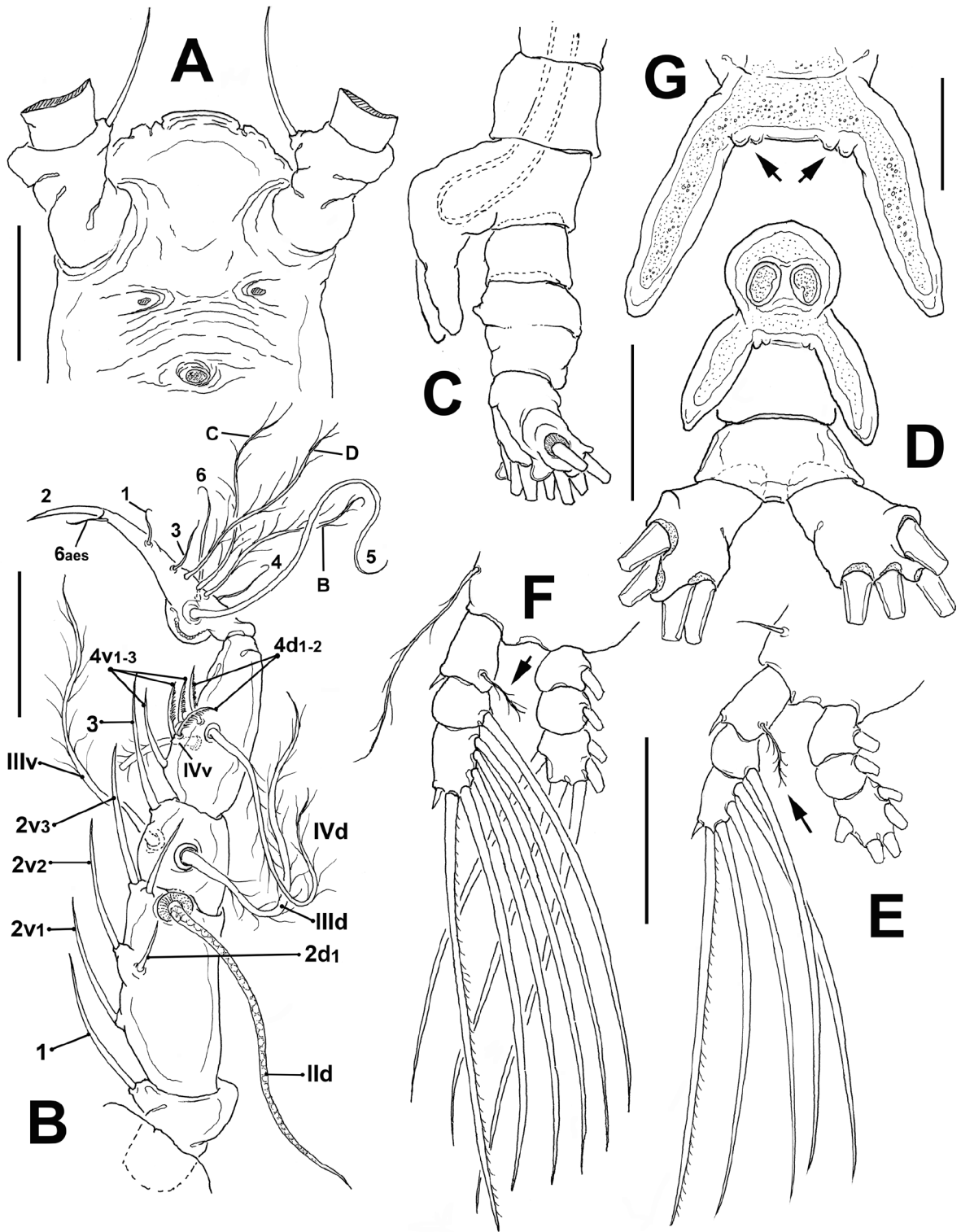


Figure 5. *Monstrillopsis pontoeuxinensis* sp. nov. Holotype adult male from Turkey. **A.** Cephalic region and first antennule segments, ventral view. **B.** Antennule showing armature elements. **C.** Urosome, lateral view showing genital complex. **D.** Urosome, ventral view showing genital lappets. **E.** Swimming leg 1. **F.** Swimming leg 3. **G.** Genital lappets showing paired basal protuberances (arrowed). Scale bars: A-F = 50 µm, G = 25 µm.

Remarks

This male specimen is easily assignable to the genus *Monstrillopsis* by its possession of a distinctively modified fifth antennular segment, with an inner rounded protuberance and an attenuated, sabre-like distal half (see Huys & Boxshall, 1991; Suárez-Morales et al., 2006). The position of the oral papilla far anteriorly on the cephalothorax, the strongly developed eyes, and the presence of four setal elements on the caudal rami are also regarded as diagnostic of this genus (Sars, 1921; Suárez-Morales et al., 2006).

The antennule of the new species shows the same general pattern of other male *Monstrillopsis*, with a proximal inner rounded expansion and an elongate, tapered distal end of the fifth antennular segment. It diverges from the male antennule of several congeners in the structure of the distal sabre-like process; in many species this apical process is fused with the fifth segment, like in *M. dubia* (T. Scott, 1904), *M. cahuitae* Suárez-Morales & Carrillo, 2013 (Suárez-Morales et al., 2013), *M. chilensis* Suárez-Morales, Bello-Smith & Palma, 2006, *M. boonwurrungorum* Suárez-Morales & McKinnon, 2014, *M. nanus* Suárez-Morales & McKinnon, 2014, and *M. hastata* Suárez-Morales & McKinnon, 2014. Conversely, in the new species the apical process is clearly separated from the fifth segment as a spiniform element (Fig. 5B), a condition shared by only a few congeners including *M. reticulata* (Davis, 1949), *M. sarsi* Isaac, 1974, *M. fosshageni* Suárez-Morales & Dias, 2001, *M. dubioides* Suárez-Morales, 2004 (Suárez-Morales & Ivanenko, 2004), *M. chathamensis* Suárez-Morales & Morales-Ramírez, 2009, and the recently described Korean species *M. coreensis* and *M. longilobata* (Lee et al., 2016). The Arctic species *M. bernardensis* (Willey, 1920), described as *Thaumaleus bernardensis*, is clearly a species of *Monstrillopsis* (Suárez-Morales & Walter, 2017; Delaforge et al., 2017) and shares this character with this group of congeners (Willey, 1920, see figs 68 & 70).

The structure of the genital complex provides additional elements to separate this group of species of *Monstrillopsis* with unfused distal process. A type II genital complex (see Suárez-Morales & McKinnon, 2014), with lappets separated at base is present in the new species and diverges from its congeners with a type I complex: *M. dubioides* (Sars, 1921, see pl. XIV, Suárez-Morales & Ivanenko, 2004), *M. reticulata* (Davis, 1949, see fig. 8), *M. fosshageni* (Suárez-Morales & Dias, 2001, see fig. 36, 37), and the intriguing *M. zernowi* (Dolgopolskaya, 1948, see fig. 3.8), which is probably not assignable to *Monstrillopsis*. The genital complex of *M. sarsi* (Isaac, 1974, see fig. 4D) and *M. longilobata* (Lee et al., 2016, see fig. 2B & C) have remarkably long, narrow lappets that diverge from those found in the new species. In *M. chathamensis* the distal process of the fifth antennular segment is clearly shorter

than in the new species (see Suárez-Morales & Morales-Ramírez, 2009, see fig. 4C) and the genital complex has a distinct arrangement, the lappets arise from a common short base, without separation at insertion points (Suárez-Morales & Morales-Ramírez, 2009, see fig. 4D). The lappets of the new species resemble those of *M. coreensis*, but the new species has a pair of small protuberances at the insertion of each genital lappet (Fig. 5G); this character is absent in *M. coreensis* (Lee et al., 2016, see fig. 5B). The fifth antennule segments of these two species have additional differences including a longer distal segment, shorter apical spine, and stronger inner proximal expansion in *M. marenigrensis* (Fig. 5B) than in *M. coreensis* (Lee et al., 2016, see fig. 5D). The new species can be distinguished from *M. bernardensis* by the inner process of the fifth antennular segment; it is absent in this species and well developed, strongly defined in the new species; also, in the Arctic species, the setal elements B-D are bifurcate (Willey, 1920, see fig. 70), whereas they are simple in the new species. The innermost caudal seta of *M. bernardensis* is distinctively shorter than the other three (Willey, 1920, see fig. 68), which is not the case of the new species *M. pontoeuxinensis*, with all four caudal setae subequally long (Fig. 4A & C). This is the first effective record of *Monstrillopsis* in the Black Sea. It is expected that new records will arise from further examination of zooplankton samples collected in the area.

The number of species of this genus is now 16 (Suárez-Morales et al., 2006, 2008 & 2013; Suárez-Morales & Morales-Ramírez, 2009; Suárez-Morales & McKinnon, 2014; Lee et al., 2016), most of them from male specimens. Females are known for only 8 species of *Monstrillopsis* (Delaforge et al., 2017).

The genus appears to distribute mainly in temperate and cold latitudes; of the 16 known nominal species, only four are known from tropical or subtropical latitudes (i.e., Costa Rica, Brazil, northern Australia) (Suárez-Morales & Morales-Ramírez, 2009; Suárez-Morales & McKinnon, 2014) and four (*M. bernardensis*, *M. ferrarii*, *M. igniterra*, *M. planifrons*) are known from polar regions (Delaforge et al., 2017).

Genus *Monstrilla* Dana, 1849
Monstrilla grandis Giesbrecht, 1891
(Figs 6 & 7)

Material examined

Adult male from Hamsilos Bay, Sinop, northern Turkey (35°02'36"E-42°03'40"N), Black Sea, collected 9 July 2015 at station C (Fig. 1).

Remarks

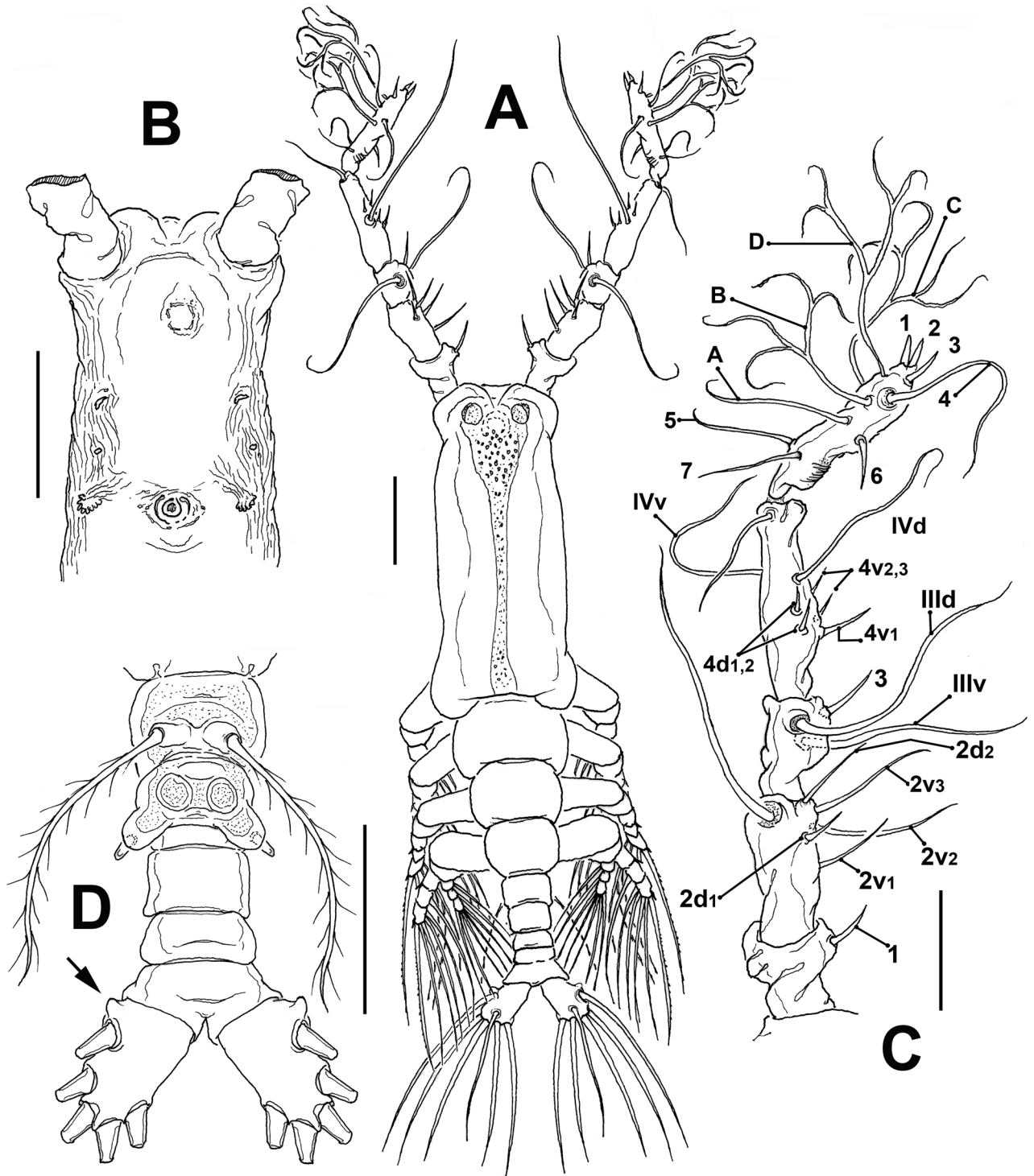


Figure 6. *Monstrilla grandis* Giesbrecht, 1891, adult male from Turkey. **A.** Habitus, dorsal view. **B.** Cephalic region showing cuticular ornamentation, ventral view. **C.** Antennule showing armature, dorsal view. **D.** Urosome with fifth legs and genital complex, ventral view. Scale bars: A, B & D = 100 μ m, C = 50 μ m.

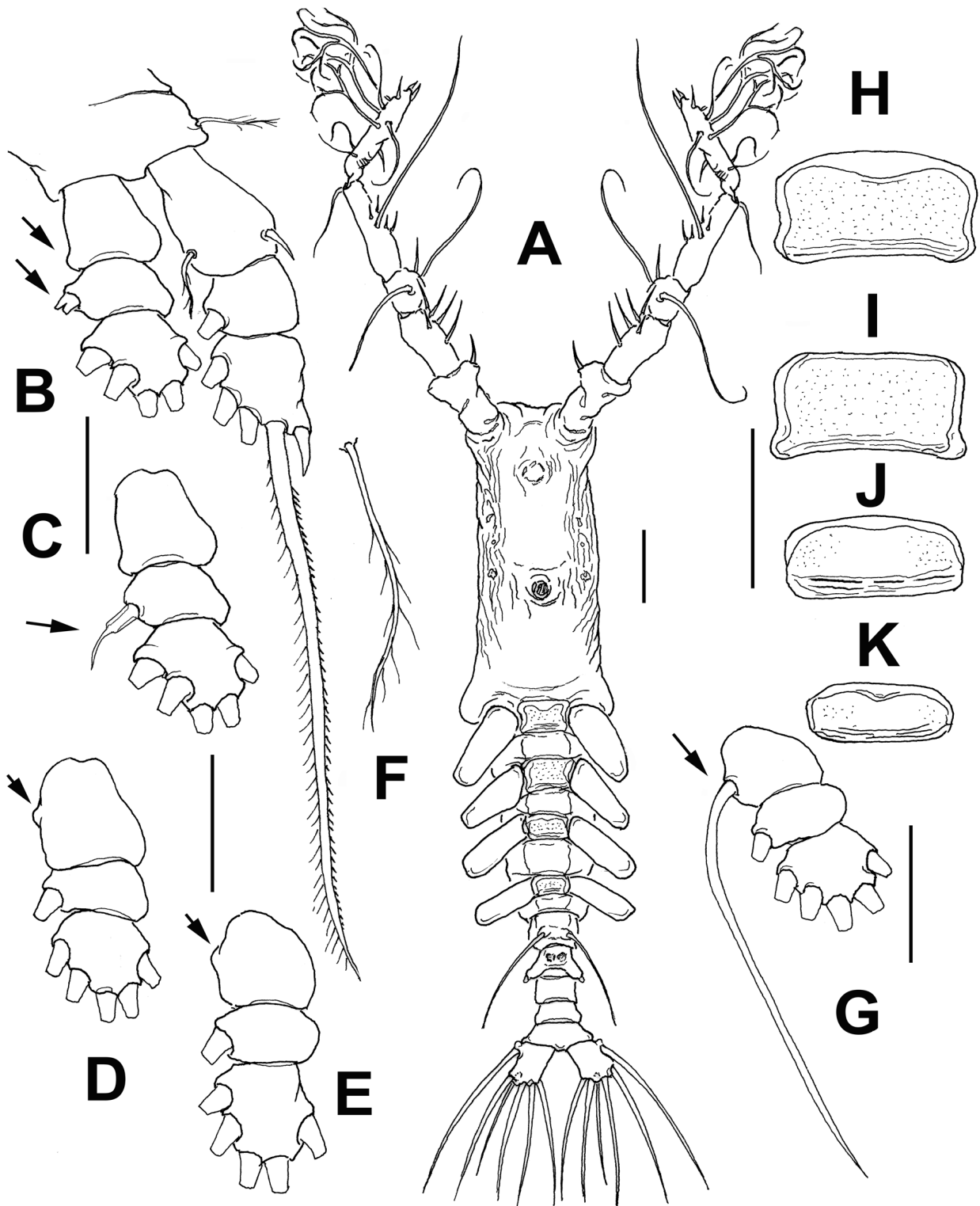


Figure 7. *Monstrilla grandis* Giesbrecht, 1891, adult male from Turkey. **A.** Habitus, ventral. **B.** Endopod of right swimming leg 1, ventral view showing modified inner seta on second segment (arrowed) and lack of seta on first segment (arrowed). **C.** Endopod of left swimming leg 1 showing modified seta on second segment. **D.** Swimming leg 2 showing lack of inner seta on inner margin of first segment (arrowed). **E.** Same, swimming leg 3. **F.** Basipodal seta of leg 3. **G.** Endopod of leg 4 showing presence of inner seta on first segment (arrowed). **H-K.** Intercoxal sclerites of legs 1-4, anterior view. Scale bars: A = 100 μ m, B-G = 25 μ m, H-K = 50 μ m.

The male specimen from Turkey was readily identified as *M. grandis* following the previous reports from the Black Sea-Mediterranean region by Dolgopolskaya (1948), Suárez-Morales et al. (2017), and Suárez-Morales (2000b) but also from other regions (i.e., Timm, 1893; Shen & Bai, 1956; Ramírez, 1971; Suárez-Morales et al., 2013). This presumably widespread species was originally described from the southwestern Atlantic at 49S, 65W by Giesbrecht (1891), but only a brief diagnosis was published at that time. The male was depicted from Mediterranean specimens by Giesbrecht (1893) and Suárez-Morales (2000b) provided an expanded description of males from Toulon Bay. The species has been recorded from a wide geographic range, including the North Sea (Timm, 1893), the Black Sea (Dolgopolskaya, 1948), the China Seas (Shen & Bai, 1956), the Caribbean area (Fish, 1962; Nutt & Yeaman, 1975), Argentine (Ramírez, 1971), the Mediterranean (Rose, 1933; Isaac, 1974 & 1975), Chile (Marín & Antezana, 1985), Costa Rica (Suárez-Morales et al., 2013), and Korea (Chang, 2014). The record by Ramírez (1971) off Argentina is the geographically closest to the type locality. Suárez-Morales et al. (2017) provided an updated analysis of the males of this species reported from different areas; we add our data from the southern Black Sea.

These characters include the relative length of the cephalothorax with respect to the total body length: the shortest cephalothorax (43% of body length) is known in the Costa Rica population (Suárez-Morales et al., 2013, see fig. 2B), the Turkish specimen has a longer cephalothorax (51.7%) (Figs 6A & 7A), comparable to populations from the northern Black Sea (48.7%), China (49%), and it is longer than the range (49.2-50.5%) reported in males from the Adriatic Sea (Suárez-Morales et al., 2017). In the Turkish specimens the antennule (measuring 0.59 mm) is clearly longer than in specimens known from Naples (48%), Argentine (55%), China (56%), and the northern Black Sea (57%); it is similar to the Costarrican (60%), northern Mediterranean (Toulon Bay) (61%), and within the range of males from the Adriatic (59-65%).

The position of the oral papilla along the cephalothorax has also some variation in the different reports: Mediterranean (Naples, Adriatic Sea, Toulon): 43-53%, Costa Rica (46%), China (49%); the specimen from the southern Black Sea (55%) has the oral papilla located most posteriorly than in any other population of male *M. grandis*. The relative lengths of the male fourth antennular segment is 26% in the Turkish specimen, resembling the value reported from Naples, Toulon and Costa Rica (26-27%), and it is longer than specimens from the northern Black Sea (20%), China and Argentina (23-24.4%), but shorter, outside the size range (28-32%) of specimens from the Adriatic Sea (Suárez-Morales et al., 2017).

The body size is also remarkably variable, less than 0.8 mm (Naples, Black Sea, Costa Rica) up to more than 1.5 mm (Naples, Barbados, Argentine, Brazil, Scotland) (see Scott,

1904; Dolgopolskaya, 1948; Fish, 1962; Ramírez, 1971; Suárez-Morales, 2000b; Razouls et al., 2005-2017). The body length of the male from Turkey is slightly over 900 μm . The cuticular ornamentation of the ventral surface of the male cephalothorax of different populations was compared by Delaforge et al. (2017). The pattern found in the Turkish specimens resemble that known from Toulon Bay (Suárez-Morales, 2000b) and the Adriatic Sea (Suárez-Morales et al., 2017), with three pairs of chitinous nipple-like processes and diverges from that observed in males from Costa Rica (Suárez-Morales et al., 2013, see fig. 2E) lacking such structures. In some of the Adriatic specimens these processes are arranged in a tighter pattern (Suárez-Morales et al., 2017, see fig. 11c) thus differing from our specimen in which these pairs are medially more separate (Fig. 6B), but still resemble another group of males from the Adriatic (Suárez-Morales et al., 2017, see fig. 11d). The specimens from Turkey also lack a group of rows of bud-like papillae surrounding the medial circular process (Fig. 6A); these structures are clearly present in the Costarrican males (Suárez-Morales et al., 2013, see fig. 2D & E) and have at least two different arrangements and numbers in males of the Adriatic (Suárez-Morales et al., 2017, see fig. 11b-d).

Ramírez (1971, see fig. 2) depicted a proximal rounded process on the outer margin of the caudal rami; this process is present in the Turkish male examined (arrowed in Fig. 6D) but has not been reported in other populations. Also, the Toulon males have an additional pair of protuberant processes on the inner margins of the caudal rami (Suárez-Morales, 2000b, see fig. 3G); these have not been reported in any other of the examined records, including the males from the Adriatic (Suárez-Morales et al., 2017) and Turkey.

Details of the male antennular armature (sensu Grygier & Ohtsuka, 1995) of our specimens (Fig. 6C) can be compared with illustrated records from Toulon (Suárez-Morales, 2000b), Costa Rica (Suárez-Morales et al., 2013), and the Adriatic (Suárez-Morales et al., 2017). In the first segment, element 1 has some variation even in individuals from the same population (Suárez-Morales et al., 2017); it can be as long as segment as in the Toulon and Adriatic specimens (Suárez-Morales, 2000b, see fig. 2E; Suárez-Morales et al., 2017, see fig. 10b) or about half its length as in the Costarrican (Suárez-Morales et al., 2013, see fig. 2C), the northern Black Sea (Dolgopolskaya, 1948, see fig. 1.3) and the Turkish (Fig. 6C) specimens. In all groups compared, elements $2v_{2,3}$ are the longest of setal group 2v-d. As observed in the Turkish specimen (Fig. 6C), element $4v_1$ is consistently the longest of the setal group 4v-d in the populations compared (Giesbrecht, 1893; Ramírez, 1971; Suárez-Morales, 2000b; Suárez-Morales et al., 2013 & 2017). Some males from the Adriatic show a modified (proximally expanded) caudal seta (Suárez-Morales et al., 2017); this character has not been recorded in any other population of *M. grandis*. In the Turkish specimen we observed interesting reductions on the setation of

legs 1-4: 1) the inner seta of leg 1 second endopodal segment is reduced, it is represented by a short, bifurcate stump-like element on the left ramus (arrowed in Fig. 7B) and a short seta with an attenuate, whip-like distal half on the right ramus (arrowed in Fig. 7C); 2) the inner seta on the first endopodal segment is absent in legs 1-3 (Fig. 7 B, D & E) and it is present in leg 4 (arrow in Fig. 7G). This reduction has not been reported in any other population of *M. grandis* and should be examined in additional specimens from the area. The size, shape, and ornamentation of the intercoxal sclerites has not been described except for the Costarrican specimen (Suárez-Morales et al. 2013, see fig. 3A & B) and they resemble those reported here, but are narrower and higher than those observed in the Turkish specimen (Fig. 7H-K).

Suárez-Morales et al. (2013) and Chang (2014) recognized that the apparently cosmopolitan distribution of this nominal species could be concealing a complex of cryptic species. Suárez-Morales et al. (2013 & 2017) discussed some differences in the males from various geographic areas but consistent morphological patterns have not been recognized. Chang (2014) correctly concluded that a complete redescription of the type specimens or topotypic specimens of both sexes should be performed in order to fully compare them with the European and Asian populations to clarify the taxonomic status of this species. Molecular studies should also be used to determine if there is in fact a divergence among these populations, but the wide geographic range from which it has been reported, including cold and fully tropical latitudes of different continents, certainly support the idea of a species group.

Discussion

The monstilloid fauna of the Mediterranean-Black Sea region is among the most diverse worldwide, up to 19 species have been recorded and the number has increased from recent additions by Üstün et al. (2014) and those in the present work. The current total of species in this region is 26, a number comparable with the diversity known from the Gulf of Mexico-Caribbean Sea and Australia (Suárez-Morales, 2011; Suárez-Morales & McKinnon, 2014 & 2016) but also in waters of the Iberian Peninsula (Suárez-Morales, 2015). In this study, we report the presence of one new *Cymbasoma*, a new species of *Monstrillopsis*, and the first observation of *Monstrilla grandis* for the southern sector of the Black Sea.

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