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Historical record and supplementary description of *Cymbasoma bullatum* (A. Scott) (Copepoda: Monstrilloida) from the "Albatross" cruise in the Philippines

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Abstract

A male monstrilloid copepod of the genus *Cymbasoma* Thompson, 1888, collected in 1908 by the U.S. Fisheries Steamer "Albatross" off Mindanao, Philippines, and deposited in the U.S. National Museum of Natural History, was originally identified and labeled as *Monstrilla leucopsis* (*sic*) Sars, 1921 by C. B. Wilson. Reexamination of this historical sample revealed that the specimen is in fact assignable to *Cymbasoma bullatum* (A. Scott, 1909), described from specimens collected in 1899 in the Moluccan Sea during the Dutch "Siboga" Expedition. My earlier redescription of this species, based on the incomplete, damaged specimens of the type lot, lacked taxonomically relevant details and is supplemented herein. This species can be distinguished from its congeners by a combination of characters including the body proportions, armature of the antennules, presence of an anterior rostral protuberance, and structure of the genital lappets. New characters for distinguishing males of *Cymbasoma* species are evaluated. A relatively recent (1981) record of *C. bullatum* in Japan was evaluated in the light of these new data. Several differences in, e.g., antennulary armature, proportions of fifth pedigerous and anal somites, and morphology of the genital lappets, suggest that the Japanese specimens represent an undescribed taxon.

Key words: invertebrate taxonomy, marine zooplankton, crustaceans, copepods, protelean parasites

Introduction

The planktonic copepods collected in Far-Eastern seas during the expeditions of the United States Fisheries Steamer "Albatross" (1887–1909) were studied by C.B. Wilson (1950). Part of this material is currently deposited in the National Museum of Natural History, Washington, D.C. There is a record of a single female of *Monstrilla leucopsis* (*sic*) Sars, 1921 from the Philippines (C. B. Wilson 1950). According to C. B. Wilson's (1950) data, the specimen was collected in February 1908, at the Caldera Bay anchorage, Sulu Sea, Philippines, during a cruise of the "Albatross" in the region. The specimen is deposited in a single vial under number USNM 74006. A recent inspection of this specimen resulted in the realization that this specimen is a male and that it is not assignable to this species nor even to the genus *Monstrilla* Dana, 1849. Species of *Cymbasoma* recorded by C.B. Wilson (1950) from Caldera Bay Anchorage are *C. longispinosum* (Bourne, 1890) and *C. rigidum* Thompson, 1888, both from female specimens.

A detailed examination of this male showed that it is conspecific with *C. bullatum* (A. Scott, 1909). This latter species is known from the lectotype and several damaged paralectotypes collected off Laiwui, in the Moluccas Sea, during the "Siboga" Expedition in 1899, and described then as a new species (see A. Scott 1909). Suárez-Morales (2001) redescribed this species based on the type lot; he recognized that many structures were damaged and the setation patterns of some appendages, particularly the antennules, were largely incomplete and thus remained undescribed. Based on both the recently discovered "Albatross" specimen and

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the "Siboga" lectotype, the description of the species is supplemented here, mainly with respect to the armature of the legs and the antennules, following the current descriptive standards for monstrilloid copepods (Grygier & Ohtsuka 1995). With these new data, the characters defining this species are revised and compared with those of its closest congeners. Based on this information, a relatively recent record of *C. bullatum* from Japanese waters (Sekiguchi 1981) is analyzed and discussed.

Taxonomy

Order Monstrilloida Sars, 1901

Genus *Cymbasoma* Thompson, 1888

Cymbasoma bullatum (A. Scott, 1909)

(Figs 1–3)

Material examined. Adult male lectotype, ethanol-preserved, undissected. Plankton collection, Siboga Expedition, Station 142, off Laiwui, Paternoster Islands, Moluccan Sea (approx. 0°24'37"S; 127°36'32"E). Twenty-one adult male paralectotypes, all broken and damaged to different degrees, ethanol-preserved, undissected. Plankton collection, Siboga Expedition, same locality, vial deposited in the Zoological Museum of the University of Amsterdam, The Netherlands, under catalogue number ZMA 201476. One adult male, vial deposited in the National Museum of Natural History, Smithsonian Institution (USNM 74006), Washington, D.C., USA. Caldera Bay, Sulu Sea, Philippines, plankton trawl, surface waters, collected 6 February, 1908. The label in the vial reads "*Monstrilla leucopsis* Sars" (*sic*). Although C. B. Wilson (1950) stated Caldera Bay to be the sampled locality, the label indicates "Albatross" cruise sta. 5133. Station 5133 is located off Panabutan Pt., Mindanao (approx. 07°35'16"N; 122°08'08"E). For a discussion of this discrepancy, see below.

Diagnosis. Cephalothorax long, cylindrical. Antero-ventral surface with protuberant preoral cone and pair of well-developed, nipple-like cuticular processes. Antennules with 5 free segments; geniculation between segments 4 and 5. Setal element on first segment extremely long, setulate. Fifth legs absent. Genital complex formed by pair of widely divergent, mamilliform genital lappets, with rounded process at insertion of lappets. Anal somite relatively large, with ventrally protruding anterior half. Caudal rami short, each ramus bearing 4 setae with expanded bases.

Description of adult male. Total body length (measured in dorsal view from anterior end of cephalothorax to posterior margin of anal somite): 1.62–1.74 mm, mean: 1.65 mm, N = 5. Cephalothorax 0.83–0.86 mm long, representing between 47% and 49% of total body length (Figs 1A–C). Oral papilla moderately prominent, between 17% and 23% of way back along ventral surface of cephalothorax (Figs 1A, C). Cephalic region slightly protuberant bilaterally in dorsal view. Pair of dorsal ocelli present, weakly developed; pigment cups relatively small in Mindanao specimen, larger in type material from Laiwui. These ocelli separated by the length of two (Mindanao) or less than one (Laiwui) eye diameters; lightly pigmented in both cases. Ventral ocellus relatively small, not easily distinguishable. No sensillae observed on anterior part of cephalic region. Antero-ventral surface of head between antennulary bases and oral papilla bearing pair of horn-like cuticular processes and large, ventral conical process between them (Figs 2C–D). Pair of usual nipple-like cuticular processes with convergent striae set to either side of oral papilla.

Antennulary length 0.42 mm in type specimens from Laiwui, 0.53 mm in Mindanao specimen. Antennules representing between 27% and 31% of total body length, and 66–68% of cephalothorax length. As usual in male monstrilloids, antennule 5-segmented, all segments separated, with segment 5 distal to geniculation (Figs 2A–B). Length ratio of antennulary segments, from first to fifth: 15.6: 23.1: 13.7: 26.8: 20.8 (= 100). In lectotypic material many setae and spines missing or broken off, mainly those on distal segment. In Mindanao

specimen, armature almost complete, summarized as follows: segments 1–5 armed with 1-0; 1-V; 2-I; 3-III; 6-II setae (in Arabic numbers) and spines (in Roman numbers), respectively. In terms of basic setal nomenclature of Grygier and Ohtsuka (1995) for female monstrilloid copepod antennules, most setal elements were identified. For setal elements on the fifth segment the nomenclature proposed by Huys et al. (2007) was also compared (Figs 2A–B). Setal element 1 on first segment noticeably long, biserially setulate, relatively longer in type specimens, reaching proximal 1/3 of fourth segment, but in Mindanao specimen only reaching distal margin of third segment. Antennulary elements $2v_{1-3}$, $2d_{1,2}$, and IId present on second segment, with element $2d_2$ particularly long in both Laiwui and Mindanao specimens and strongly developed, bearing transverse ornamentations along shaft (Fig. 2A; Suárez-Morales 2001: fig. 26). Elements IIId, IIIv, and 3 present on third segment (only element 3 present in lectotype). Fourth segment with elements $4d_{1,2}$, $4v_{1-3}$, IVd, and IVv; IVd present in lectotype only. Fifth segment with 5 "b"-group setae, elements b_1-b_3 dichotomously branched distally; element 6_1 present in distal position. As for Huys et al. (2007) setal nomenclature of the distal segment, elements A–E and 1–4 present from integrated armature of both antennules.

First pedigerous thoracic somite incorporated into cephalothorax. This tagma and succeeding 3 pedigers each bearing well-developed swimming legs. Coxa of each pair unarmed, joined by intercoxal sclerite slightly longer than wide. Basis separated from coxa posteriorly by diagonal articulation. Exopods of legs 1–4 longer than endopods. Usual seta on outer margin of basis of swimming legs 1–4 not observed, possibly broken off in all specimens examined. All swimming legs with 3-segmented rami and same armament pattern, except for leg 1 exopod with its usual reduced pattern of 5 rather than 6 elements total on third segment (Fig. 3A). Outer distal corner of first and third exopodal segments of legs 1–4 each with short, spinelike seta, about 1/3 as long as bearing segment. All natatory setae biserially setulate, except for stout distal seta on third exopodal segments of legs 1–4. Outer distal spiniform seta on leg 1 naked along outer margin, inner margin armed with short setules (Fig. 3A); corresponding seta on legs 2–4 with row of small denticles along outer margin, inner margin setulate (Figs 3B–D). Inner seta on first exopodal segment of leg 1 relatively longer than that on any other of the swimming legs (Fig. 3A).

Armature formula of legs as follows:

	coxa	basis	exopod	endopod
Leg 1	0-0	0-0?	I-1; 0-1; I,2,2	0-1; 0-1; 1,2,2
Legs 2–4	0-0	0-0?	I-1; 0-1; I,2,3	0-1; 0-1; 1,2,2

Urosome consisting of 4 somites: fifth pedigerous somite (fifth legs absent, as usual in males of *Cymbasoma*), genital somite (containing genital complex), single preanal somite, and anal somite. Genital complex represented by pair of strongly divergent, cylindrical, and distally mammilliform genital lappets (Fig. 2E), these being moderately elongated and dorsally directed in lateral view (Fig. 2F), reaching to midlength of long preanal somite. Rounded process present at common basal joint of lappets (Fig. 2E). Anal somite about twice as long as genital somite, comprising 34-37% of urosome length, ventrally protuberant in anterior half; faint suture visible on ventral surface only (Figs 1C, 2F).

Caudal rami subquadrate, approximately as long as wide (Fig. 3E). Each ramus with 4 basally expanded setae (3 terminal and 1 subterminal); some setae broken in Mindanao specimen; only 3 broken setae present in lectotype, outermost one absent on both rami (Suárez-Morales, 2001: fig. 23).

Adult female. Unknown.

Remarks. In his report on the copepods collected during the "Siboga" expedition, A. Scott (1909) included several records of species of Monstrilloida that were collected from the Paternoster Islands; this is a colonial-period name that is not used anymore. However, as discussed by Suárez-Morales (2000b), some known localities of the Moluccas Sea retained their indigenous toponyms, such as Obi Major and Laiwui, and these are mentioned as part of the Paternoster Islands. Hence, the type-locality of *C. bullatum* was determined

by Suárez-Morales (2000b) as being off Laiwui, southwestern coast of Mindanao, in the Moluccas archipelago (see geographic coordinates in Material examined).

Determining the geographic location of the "Albatross" record along the coast of Mindanao also represented a problem because of the discrepancy between the station number and the site name inscribed on the label. The sampling site indicated is Caldera Bay Anchorage, but the actual location of the station number on the label (sta. 5133 of the "Albatross" series) is in Panabutan Bay. Caldera Bay is currently known as Recodo Bay (06°57'03"N; 121°58'09"E), which is located on the southwest coast of Mindanao. According to C. B. Wilson's (1950) data, Caldera (Recodo) Bay, the Butaritari Lagoon, Makin Island, and the Taiwan Strait were the only sites where monstrilloid copepods were collected. No monstrilloid was reported from station 5133 (C. B. Wilson 1950). The fact that this male was labeled as *M. leucopsis* (*sic*) by C.B. Wilson, a species recorded in Caldera Bay, suggests that the station number was mistakenly inscribed and the actual locality for *C. bullatum* in the Philippines is Recodo Bay and not Panabutan.

The Mindanao specimen is in exceptionally good condition considering the long time elapsed (almost one century) since it was originally collected. The same is true for other copepods collected in this campaign (Suárez-Morales 1996). However, the appendages are stiff and fragile, and dissection was not attempted, even after glycerin treatment. Some structures (setae and aesthetascs) are missing or broken off, as described. Despite this, it was possible to complete the description of the species.

The male specimen studied here can be included in the genus *Cymbasoma* based on the presence of two free postgenital somites and the unmodified structure of the geniculate antennule (Isaac 1975). The presence, as observed herein, of four caudal setae is among the main characters defining the genus *Monstrillopsis* Sars, 1921 (Suárez-Morales *et al*. 2006), but there are other males of *Cymbasoma* bearing four caudal setae: *C. bali* Desai & Krishnaswamy, 1962, *C. chelemense* Suárez-Morales & Escamilla, 1997, *C. tumorifrons* (Isaac, 1975) (see Suárez-Morales 1999), *C. rochai* Suárez-Morales & Dias, 2001, *C. rigidum* (Thompson, 1888), and *C. quintanarooense* (Suárez-Morales, 1994) (see Suárez-Morales 2000a, 2003). Based on the reduced urosomal segmentation and the absence of other diagnostic characters of *Monstrillopsis*, they are all assignable to *Cymbasoma*, a taxon in which the number of furcal setae is related to sexual dimorphism.

The male specimen from Mindanao was identified as *C. bullatum* mainly by the combined presence of: 1) a distinctly long and strongly developed setal element 1 on the first antennulary segment; 2) two horn-like processes and a strong medial process on the antero-ventral surface of the cephalic area; 3) the structure of the genital lappets; 4) the relatively large anal somite; and 5) the expanded bases of caudal seta. In addition, the proportions of the urosomites match, this being a character used by A. Scott (1909) to define the species.

The structure of the genital lappets is one of the main characters to distinguish species of male monstrilloids (Isaac 1975; McAlice 1985; Suárez-Morales 2000a). Particularly in *Cymbasoma*, the genital lappets have a narrow range of variation. Being widely divergent and with a mammiliform or acute shape on the distal end, the male genital lappets of *C. bullatum* are similar to those of *C. longispinosum* (see Sars 1921), *C. thompsoni* (Giesbrecht, 1893), *C. tenue* (Isaac, 1975) (see Suárez-Morales & Riccardi 1997), *C. rigidum* (see Sars 1921), *C. bali*, *C. chelemense*, *C. quintanarooense* (see Suárez-Morales 2000a, 2003), *C. mcalicei* Suárez-Morales, 1996, *C. tumorifrons* (see Suárez-Morales 1999 and Suárez-Morales & Alvarez-Silva 2001), and *C. rochai*. In contrast, other known males of this genus have lappets that are distally rounded or blunt and not divergent. *Cymbasoma bullatum* is unique in having a strong, medial, rounded protuberance at the insertion of the lappets. Other species have a straight margin or a weak protuberance (i.e., *C. longispinosum*, *C. rigidum*, *C. quintanarooense*, and *C. tumorifrons*), a spiniform process (*C. tenuis* (Isaac, 1974) and *C. rochai*), or a corrugated margin (*C. chelemense* and *C. mcalicei*). Because of the general morphological similitude and degree of variation of the genital lappets within this group, this character remains relevant, but not definitive, for species identification. However, some species have peculiar characters, such as associated processes or a distinctive shape, which might lead to a reliable identification (see McAlice 1985; Suárez-Morales 1996, 2001).

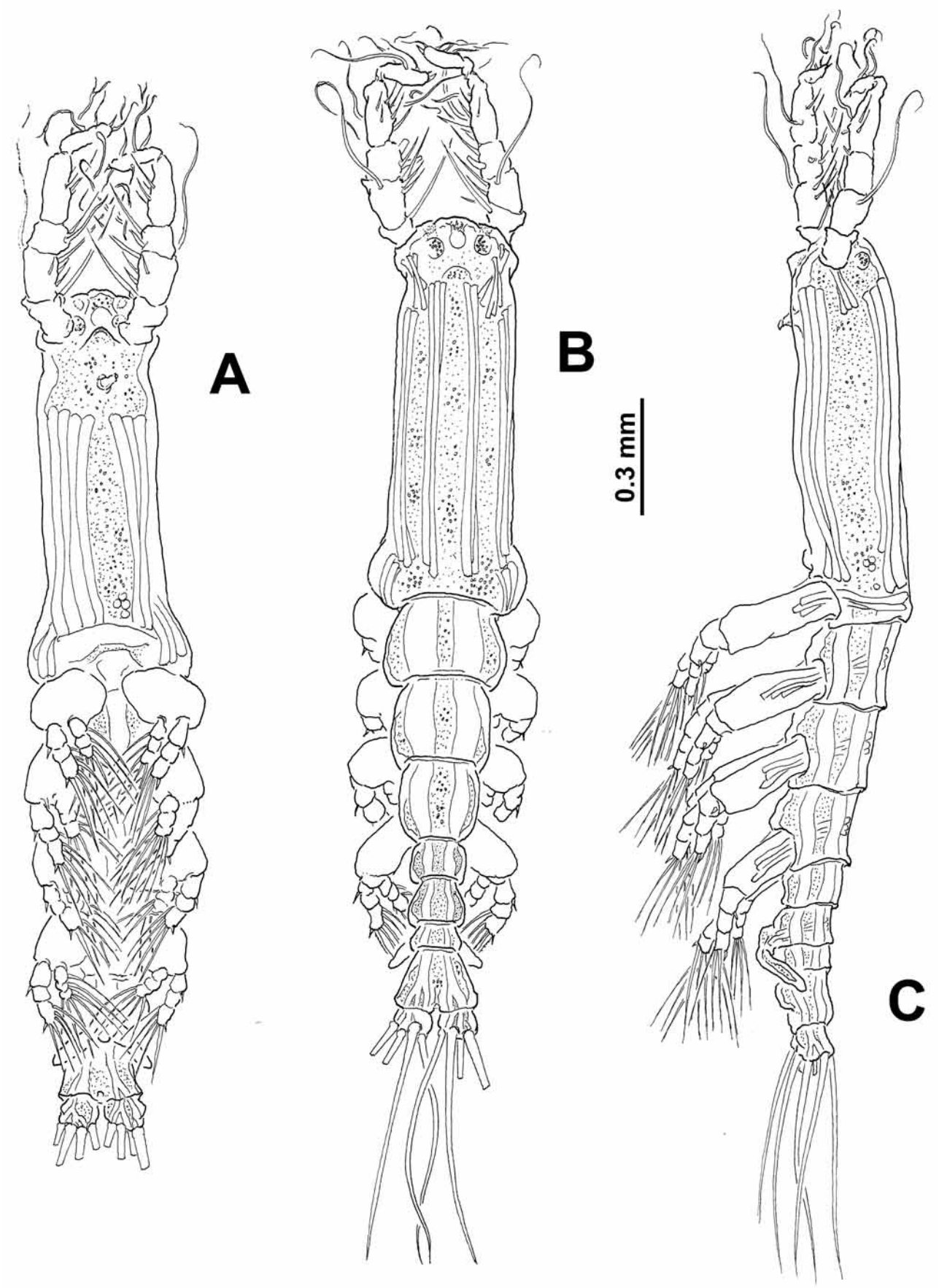

FIGURE 1. *Cymbasoma bullatum* (A. Scott, 1909), adult male from Recodo Bay, Mindanao. A) habitus, ventral view; B) habitus, dorsal view; C) habitus, lateral view.

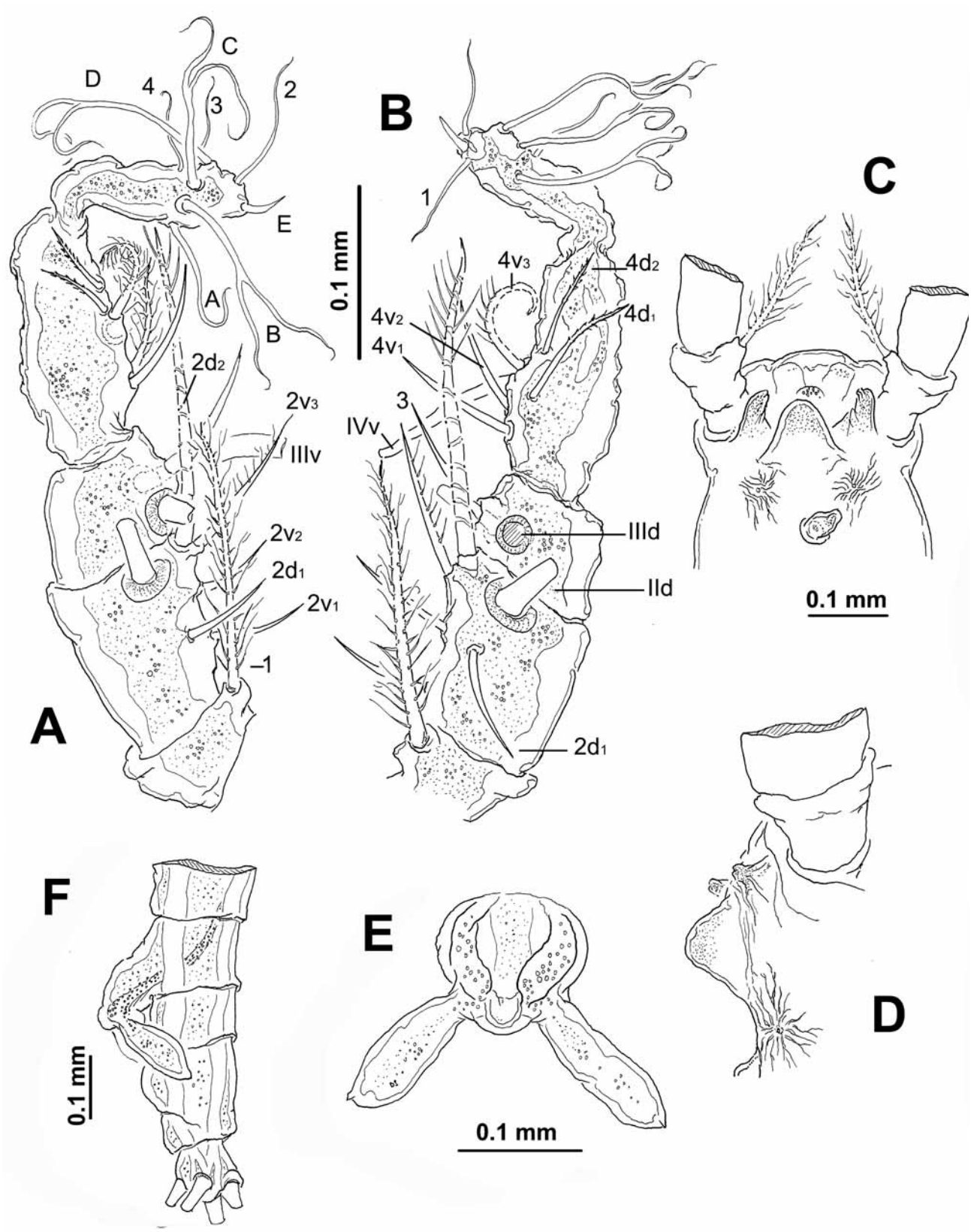

FIGURE 2. *Cymbasoma bullatum* (A. Scott, 1909), adult male from Recodo Bay, Mindanao. A) left antennule, dorsal, showing setal nomenclature of Grygier and Ohtsuka (1995) for segments 1 to 4 and Huys et al. (2007) for the distal segment; B) right antennule, dorsal, labeled as in (A); C) cephalic region, ventral, showing protuberance and adjacent cuticular processes; D) cephalic processes, lateral view; E) genital lappets, ventral view; F) urosome and caudal rami (caudal setae cut short), lateral view.

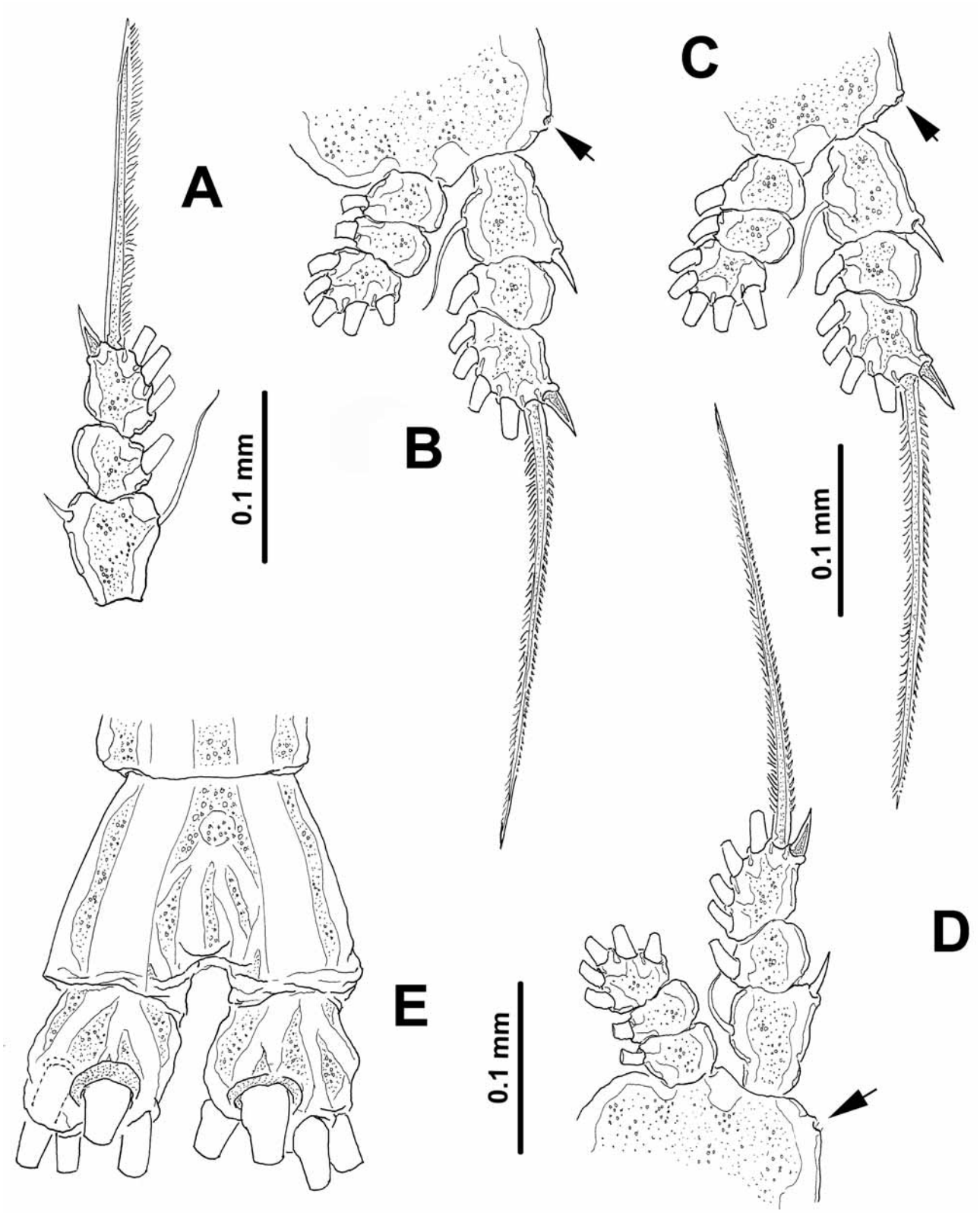

FIGURE 3. *Cymbasoma bullatum* (A. Scott, 1909), adult male from Recodo Bay, Mindanao. A) exopod of first swimming leg; B) second swimming leg; C) third swimming leg; D) fourth swimming leg; E) caudal rami, ventral view. Natatory setae of legs are cut short for illustration purposes. Sockets of outer basipodal setae arrowed.

The results of the present analysis suggest that other structures can be used to differentiate males of *Cymbasoma*. One of these characters is the length of the seta on the first antennulary segment; it is very long in *C.*

bullatum (see Figs 2A–B), surpassing the distal margin of the third antennulary segment. The males of certain other species also have a well-developed seta on the first segment, in which it reaches to midlength of the fourth antennulary segment as in *C. mcalicei*, or reaching the third segment in *C. longispinosum* (see Giesbrecht 1893) and *C. chelemense*. This seta is short in *C. tumorifrons* (see Suárez-Morales & Alvarez-Silva 2001), *C. thompsoni*, *C. quintanarooense* (see Suárez-Morales 2003), and *C. tenue* (see Suárez-Morales & Riccardi 1997), among others.

The length of the antennulary setal element $2d_2$, reaching to between midlength and the distal margin of the fourth antennulary segment in *C. bullatum* (Figs 2A–B; Suárez-Morales 2001: fig. 25), is yet another character separating this species from most of its known congeners, in which this element is clearly shorter. Other species with relatively long seta $2d_2$ are *C. longispinosum* (Giesbrecht 1893: fig. 23), *C. bali* (Desai & Krishnaswamy 1962: fig. 7), and *C. chelemense* (Suárez-Morales & Escamilla 1997: fig. 2C).

The presence of a medio-ventral protuberance on the cephalic region together with two adjacent horn-like processes seems to be a strong character to distinguish *C. bullatum* from most other known species of the genus. A similar protuberance, but without the adjacent horn-like processes, has been depicted for *C. tenue* (see Suárez-Morales & Riccardi 1997), while a much lower process is present in *C. rochai* from Brazil (Suárez-Morales & Dias 2001).

No information concerning the structure or armature of the swimming legs was provided in A. Scott's (1909) original description of *C. bullatum*; because of the poor condition of the type specimens, Suárez-Morales (2001) could not add much in this aspect, but examination of both the type and the Mindanao specimens reveals a normal setation pattern. The absence of the usual basipodal setae on legs 1–4 in the studied material is most likely related to the long period of preservation and the consequent deterioration of the specimens.

The present record confirms a modest extension of the known geographical range of *C. bullatum* from the Moluccan Sea to Mindanao. There is one other relatively recent record of *C. bullatum* (as *C. bullatus*) from Japanese waters (Sekiguchi 1981), based on 52 male specimens collected in Ago Bay, central coast of Japan. Sekiguchi provided a brief description of these specimens and some illustrations. His decision to allocate these males to *C. bullatum* was evidently based on general body similarity and the presence of four caudal setae with expanded bases. Several differences are apparent, though, between the Japanese specimens and *C. bullatum*. The seta on the first antennulary segment is much shorter than in *C. bullatum*, reaching only to the distal margin of the second antennulary segment. Element $2d_2$ is also shorter, reaching only to midlength of the fourth segment (Sekiguchi 1981: fig. 1E), whereas in *C. bullatum* it surpasses the distal margin of the same segment in both Mindanao and Moluccas specimens. Apparently these specimens lack a ventral protuberance and other processes on the cephalic region (cf. Sekiguchi 1981: fig. 1B). The fifth pedigerous somite is as long as the fourth pedigerous somite and almost twice as long as the genital somite (Sekiguchi 1981: figs. 1A–B), whereas this somite is shorter than the fourth pedigerous somite and as long as the genital somite in *C. bullatum* (Figs 1B–C; Suárez-Morales, 2001: fig. 20). The anal somite is relatively shorter in the Japanese specimens, representing 23% of the urosome length, versus 30–33% in *C. bullatum*; also, the lateral margins of the anal somite are weakly divergent and almost straight, whereas this somite is clearly expanded in *C. bullatum*. The genital lappets are clearly shorter in the Japanese specimens, barely reaching the distal margin of the first postgenital somite, whereas in *C. bullatum* they reach to midlength of the anal somite. Sekiguchi´s (1981) drawings show the lappets as proximally robust, whereas they are noticeably elongate and slender in *C. bullatum*. All these differences indicate that the specimens analyzed by Sekiguchi (1981) belong to a different, probably undescribed species of *Cymbasoma*. These specimens were not available for direct examination (S. Ohtsuka, pers. comm.), and nothing more can be said about them at present.

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