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## REDESCRIPTION OF TWO SPECIES OF *CYMBASOMA* FROM SOUTHWEST BRITAIN AND FROM INDONESIA (COPEPODA: MONSTRILLOIDA), WITH NOTES ON TAXONOMY

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### ABSTRACT

One of the main current problems in the taxonomy of the monstrolloid copepods is the lack of detailed descriptions. Most of these descriptions are poorly illustrated making the recognition of species even more difficult. Reexamination of specimens deposited in different museums of the world has yielded new taxa but also the opportunity of redescribing these species according to upgraded standards. Two species of *Cymbasoma*, one from southwest England and the other from the Java Sea are redescribed from the holotype specimens following upgraded standards. Both species are compared with related forms for the first time. The former species (*C. striatus*) has several interesting characters of which the most important is a fringe of striations covering about half its cephalothorax. The other one (*C. javensis*) is herein transferred to the genus *Cymbasoma* by having a urosome with two free somites posterior to the genital complex. It shows previously unreported and unique characters such as the basal ornamentation of two antennular setae, and most importantly, a set of four paired postantennular structures which may represent remains of oral appendages which were supposed to be lost in the entire group.

### INTRODUCTION

Monstrolloid copepods are in urgent need of revision (Huys & Boxshall, 1991). However, the group has nomenclatorial problems associated to poorly defined taxa and to superficial descriptions (Grygier, 1994). About half of the ca. 95 species currently known were described during the last decades of the 19th century and the two first decades of the 20th century. Some of them are in

fact good descriptions, well illustrated, i.e., Sars (1921), Giesbrecht (1892). Other works of this period and most of the following decades offer inadequate, incomplete descriptions, and draft illustrations with a questionable taxonomic value. Hence, upgraded morphological descriptions are needed to conduct any attempt of revision of these copepods.

In the mid 1970's, the British copepodologist Michael J. Isaac described several new species of

Monstrilloida from different parts of the world. Most of these new taxa were described or depicted in Isaac (1974a, b, c, 1975). Despite the fact that probably all Isaac's new species are valid, several of his species have been or are currently being redescribed (Suárez-Morales & Riccardi, 1997; Suárez-Morales, 1999). Some of his species cannot be adequately compared with related forms. One of these species is *Cymbasoma striatus* (Isaac, 1974c), a species known only from the holotype specimen (Land's End, southwest England) and from two females from different areas (English Channel, Irish Sea). Another species is *M. javensis* (Isaac, 1974a) from the Java Sea, perhaps Isaac's most poorly described species. It was described after examination of specimens deposited in the Zoological Museum of Berlin (Isaac, 1974a). Both species are fully redescribed herein based on the reexamination of the holotype specimens and following the upgraded standards for monstrilloid copepods descriptions set by Grygier & Ohtsuka (1995). Taxonomical comments and comparisons are made for both species.

## SYSTEMATIC DESCRIPTIONS

### ***Cymbasoma striatus*** (Isaac, 1974c)

Figs. 1-10

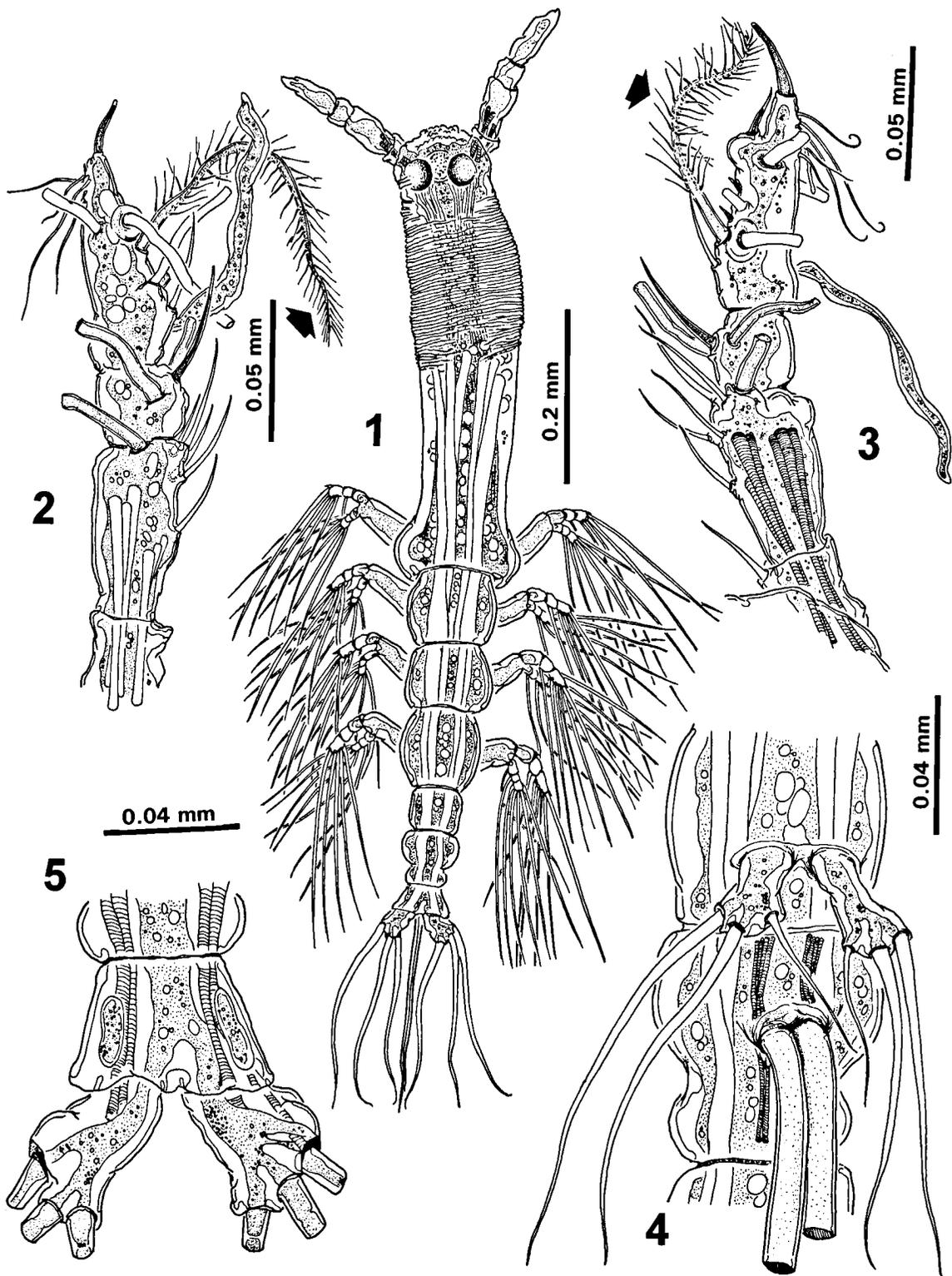
**MATERIAL.** - Adult female, holotype, ethanol preserved, undissected. Plankton collection RV 'Ocean Crest', 50m (50°11N 5°45'W), north of Land's End, Cornwall, Southeastern Britain. Collected July 9, 1971. Ethanol-preserved, vial deposited at the Natural History Museum, London, U.K. (1972.11.1.6).

**DESCRIPTION.** - Female: total body length of holotype 0.95 mm measured from anterior end of cephalic somite to posterior margin of anal somite. Cephalothorax (incorporating first pedigerous somite) slightly curved, probably a result of fixation, accounting for 55% of total body length (Figs. 1, 6). Forehead with medial protuberance formed by several bumps with irregular arrangement. Pair of short, slender sensilla inserted widely apart from each other (Fig. 8).

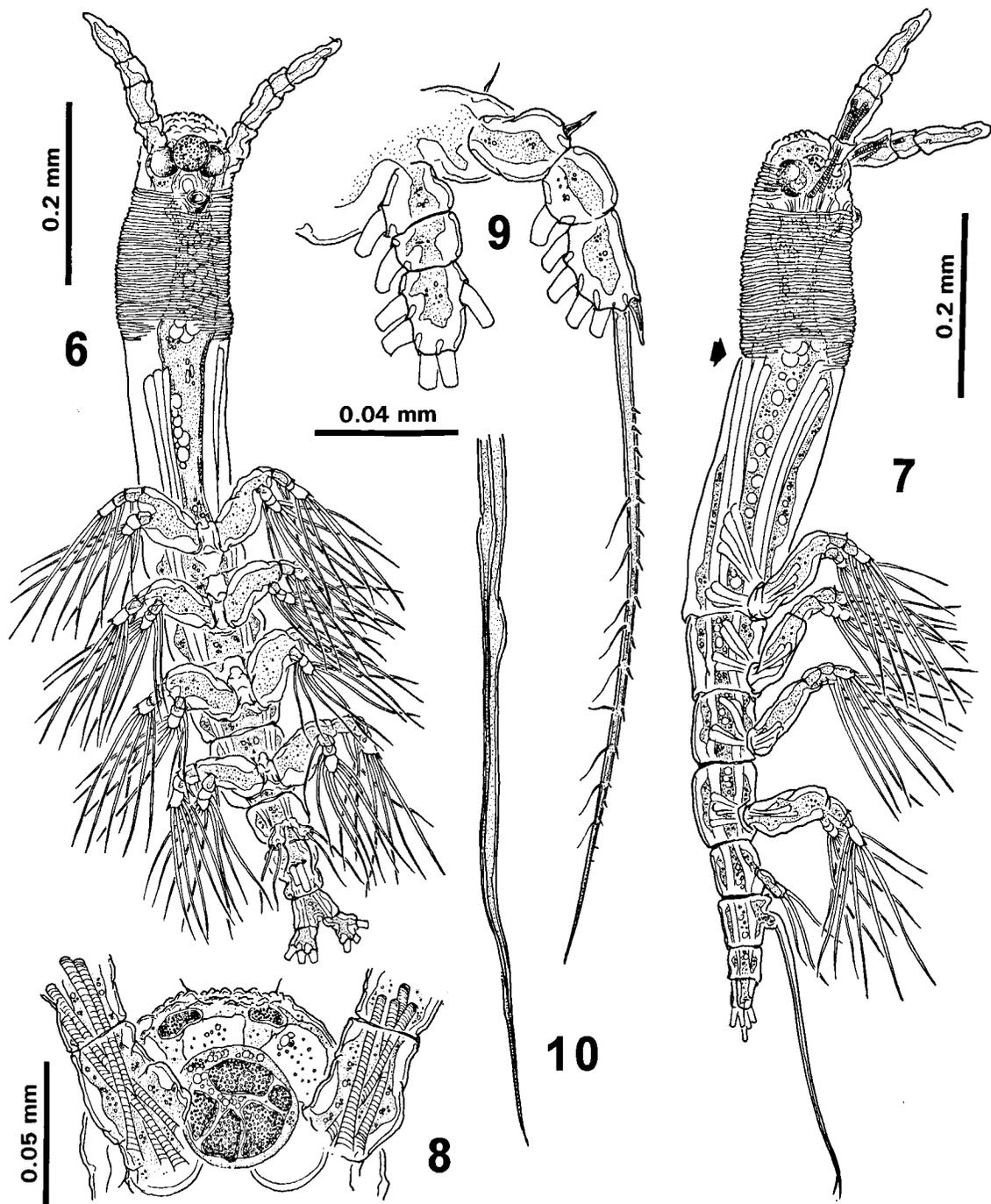
Anterior part of cephalothorax with a wide fringe of fine cuticular striations running around the body, and covering almost half the length of cephalothorax. Secondary striations on lateral margin of the head part, near the eyes. Posterior end of striation fringe incomplete, covering the lateral margins only, not meeting on ventral or dorsal surfaces (Figs. 1, 6, 7). Oral papilla lying midventrally 0.18 of way back along cephalothorax (Fig. 7). Nauplius eye present, well developed, ocelli large, slightly pigmented on inner half, rounded, separate to each other by a distance equal to 80% of an eye diameter.

Antennule four-segmented. Ratio of length of antennule segments, from proximal to distal: 9.5:33.4:16.5:40.6 (= 100). Antennules relatively short, slightly longer than 21% of total body length, armed with 0, I; 1, V; 2, I; 12, IV setae (Arabic numerals) and spines (Roman numerals), plus one large aesthetasc (Figs. 2, 3). In terms of pattern described by Grygier & Ohtsuka (1995) for monstrilloid antennular armature, setae and spines on first (1), second (2d<sub>1-3</sub>, 2v<sub>1</sub>, 2v<sub>2</sub>, II<sub>d</sub>), third (3, III<sub>v</sub>, d), and most on fourth (4aes, 4v<sub>1</sub>, 3, 4d<sub>1</sub>, 2, IV<sub>d</sub>, v, V<sub>v</sub>, V<sub>d</sub>, 6<sub>2</sub>, 6<sub>1</sub>, b<sub>1-6</sub>) segments, complete. Element 4v<sub>2</sub> missing on last segment of right and left antennules; setae b<sub>1-3</sub> unbranched. Spines 1, 4v<sub>1-3</sub>, and 4d<sub>1</sub>, 2 long and slender, setiform. Both setae IV<sub>v</sub> (arrowed in Fig. 3) and V<sub>v</sub> (arrowed in Fig. 2) very well developed, long, setulated, the former present on right antennule only, the latter on the left one only.

Incorporated first pedigerous somite and three free succeeding pedigerous somites each bearing a pair of biramous swimming legs. Basis with diagonal division articulating it with large, rectangular coxa. Basis with lateral hair-like seta on legs 1-4; on leg 3 seta at least 2 times longer and noticeably thicker than in the others. Endopodites and exopodites of legs 1-4, triarticulated. Legs 1-4 slightly decreasing in size posteriorly. Outer distal corner of first and third exopodal segments of legs 1-4 each with short, spinelike seta, about one-fourth as long as bearing segment. All natatory setae biserially plumose except for seta on outer distal corner of third exopodal segments of legs 1-4, this having a few small setules along inner side and a row of sparsely distributed denticles along outer margin (Fig. 9).



Figs. 1-5. *Cymbasoma striatus* (Isaac). Female holotype. 1, habitus, dorsal view. 2, left antennule, dorsal view. 3, right antennule, dorsal view. 4, fifth leg and genital area, ventral view. 5, anal somite and caudal rami, dorsal view.



Figs. 6-10. *Cymbasoma striatus* (Isaac). Female holotype. 6, habitus, ventral view. 7, habitus, lateral view. 8, cephalic area, ventral view. 9, third swimming leg. 10, distal part of ovigerous spines.

Armature of swimming legs as:

	basis	endopodite	exopodite
leg 1	1-0	0-1; 0-1; 1, 2, 2	I-0; 0-1; I, 1, 3
legs 2-4	1-0	0-1; 0-1; 1, 2, 2	I-0; 0-1; I, 1, 2, 2

Fifth legs represented by single lobe, elongated, separated at base. Basal portion inserted on posterior one-third of fifth pedigerous somite, about 1.6 times wider at distal end. Lobe about 1.6 times longer than wide at its distal end, armed with three long, lightly plumose seta, two outer subequal in length and breadth, innermost much shorter (Fig. 4). Outer setae about 3 times as long as lobe, setae reach about halfway of anal somite.

Urosome consisting of fifth pedigerous somite, genital double somite, and one free abdominal somite. Pedigerous somites 2-4 accounting for 28% of total length. Urosome, excluding furcal rami, accounting for 16.2% of total body length. Genital double somite globose, widest at proximal half, and tapering abruptly to a rounded margin. Double somite representing slightly more than 1/3 of length of urosome. Ratio of length of fifth pedigerous somite, genital double somite and free abdominal somite being: 38.5:34.6:26.9 (= 100). Medial portion of genital double somite moderately swollen on ventral anterior margin, bearing pair of long ovigerous spines which are basally separated, mostly slender but with subterminal rounded swellings distally (Fig. 10). Ovigerous spines inserted on middle of ventral surface of genital double-somite, representing about 34% of total body length, stretching posteriorly at about the same length of setae of caudal rami (Fig. 1). Caudal rami subquadrate, 1.2 times longer than wide, moderately divergent, bearing three terminal setae subequal in length and breadth (Fig. 5).

Male: unknown.

REMARKS. - This species was described by Isaac (1974b, c) noticing the characteristic striations on the anterior half of the cephalothorax. According to Grygier (1995), the mention of this unique feature was enough to make the name available, although all the new species described in Isaac (1974b, c) were diagnosed very poorly. Isaac's drawings do not show several additional struc-

tures relevant for the species recognition. Mainly, they do not show the striations on the cephalothorax, which is the main distinguishing character of *C. striatus*. He stressed the depression on the dorsal surface of the cephalothorax in lateral view (arrowed in Fig. 7). This feature marks, in fact, the connection between the striated and the non-striated sections of the cephalothorax. Furthermore, the depression, and probably also the slight curvature of the cephalothorax could be a result of differential contraction of both the striated and the non-striated areas during fixation. Hence, this character, used in Isaac's (1975) key, seems to be unreliable.

Isaac's antennule sketch of this species shows some setae, but no segmentation is shown, as if all the antennular segments were fused, which in fact occurs in other species. The antennules show some unusual characters such as the length and setiform aspect of elements 1, 4v<sub>1-3</sub>, and 4d<sub>1, 2</sub> of the Grygier & Ohtsuka (1995) pattern. These are commonly spiniform elements. Particularly, spine 1 is short and clearly spiniform in most species of *Cymbasoma*. A similar tendency, with long, setiform condition of spiniform antennular elements has been observed in the male of *C. tumorifrons* (Isaac, 1975), as redescribed by Suárez-Morales (1999), and of *C. mcalicei* Suárez-Morales, 1996. The large ventral asthetasc (4aes) on the fourth segment was not previously mentioned or depicted. Probably, the second most distinguishing character on the cephalothorax is the dorsal hump, a character not previously described in any other monstrilloid copepod.

Females of several other *Cymbasoma* species show the same single lobe with three terminal-subterminal setae pattern on the fifth legs. This group includes *C. reticulatus* Giesbrecht, 1892, *C. tumorifrons* (Isaac, 1975), *C. quintanarooense* (Suárez-Morales, 1994), and *C. bowmani* Suárez-Morales 1998. *Cymbasoma striatus* can be easily distinguished from *C. reticulatus* and *C. bowmani* by the body shape and proportions, these two have a

Table 1. Comparison of main taxonomic features in species of *Cymbasoma* with a cephalothorax relative length equal or over 60%, females only. Key to species: A: *C. boxshalli* (Suárez-Morales, 1993). B: *C. bowmani* Suárez-Morales & Gasca, 1998. C: *C. californiense* Suárez-Morales & Palomares, 1999. D: *C. longispinosum* Bourne, 1890. E: *C. morii* Sekiguchi, 1892. F: *C. nicolettae* Suárez-Morales, 2000. G: *C. quintanarooense* (Suárez-Morales, 1994). H, *C. striatus* (Isaac, 1975). I: *C. thompsoni* Giesbrecht, 1892. J: *C. tumorifrons* (Isaac, 1975). K: *Cymbasoma* sp. (from Brazil). L: *C. chelemense* Suárez-Morales & Palomares, 1997.

	A	B	C	D	E	F	G	H	I	J	K	L
Genital double somite clearly globose	yes	yes	no	no	no	no	yes	yes	yes	yes	yes	no
Anal somite with marginal notch	no	no	no	no	no	no	yes	no	no	no	no	no
Fifth leg with 1 lobe	yes	yes	no	no	no	no	yes	yes	no	yes	no	no
Inner seta of fifth leg smaller than others	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	no	yes
Inner seta less than 50% of the others (P5)	yes	no	yes	no	yes	yes	no	no	yes	yes	no	no
Mouth position along cephalothorax	20-24	21.7	21	15	18-22	30	28	16	22	12	11.7	19
Relative length of AI considering total length	14-17	22.8	17.5	27.7	16.3	28	37	18.6	15.1	22.2	25.4	14.5
Genital somite with ventral anterior protuberance	yes	yes	no	yes	no	no	yes	no	no	no	yes	yes
Ovigerous spines length considering total length	44-55	42	143	142.6	204.5	37	50	45.4	40.4	60	12.4	138

very long cephalothorax (see Suárez-Morales & Gasca, 1998). Furthermore, setae on the fifth leg are of equal or subequal length in *C. reticulatus*, *C. quintanarooense*, and in *C. bowmani*. This diverges from the *C. striatus* pattern with the inner seta much smaller than the two outer ones. Isaac (1974b, c) illustrated the fifth leg of *C. striatus* as being almost five times as long as lobe. The proportion of 3-3.5 times measured from the same holotype specimen is more accurate. However, the proportion of the length of the small inner seta (about 40% smaller) with respect to the outer ones is correct as depicted by Isaac.

*Cymbasoma tumorifrons* is clearly the most similar species to *C. striatus*, both have the same body proportions and size (between 0.76-1.0 mm), a fifth leg with three setae, the inner one being shorter than the others, a four segmented antennule, a globose double genital somite, and an oral papilla located at about the same position as in *C. striatus*. Besides the distinguishing striation pattern and the dorsal hump shown by *C. striatus*, both species have other differences. The genital double somite of *C. tumorifrons* shows a clear partial intersegmental division on the dorsal surface (Isaac, 1974b); this suture is absent in *C. striatus*. Another

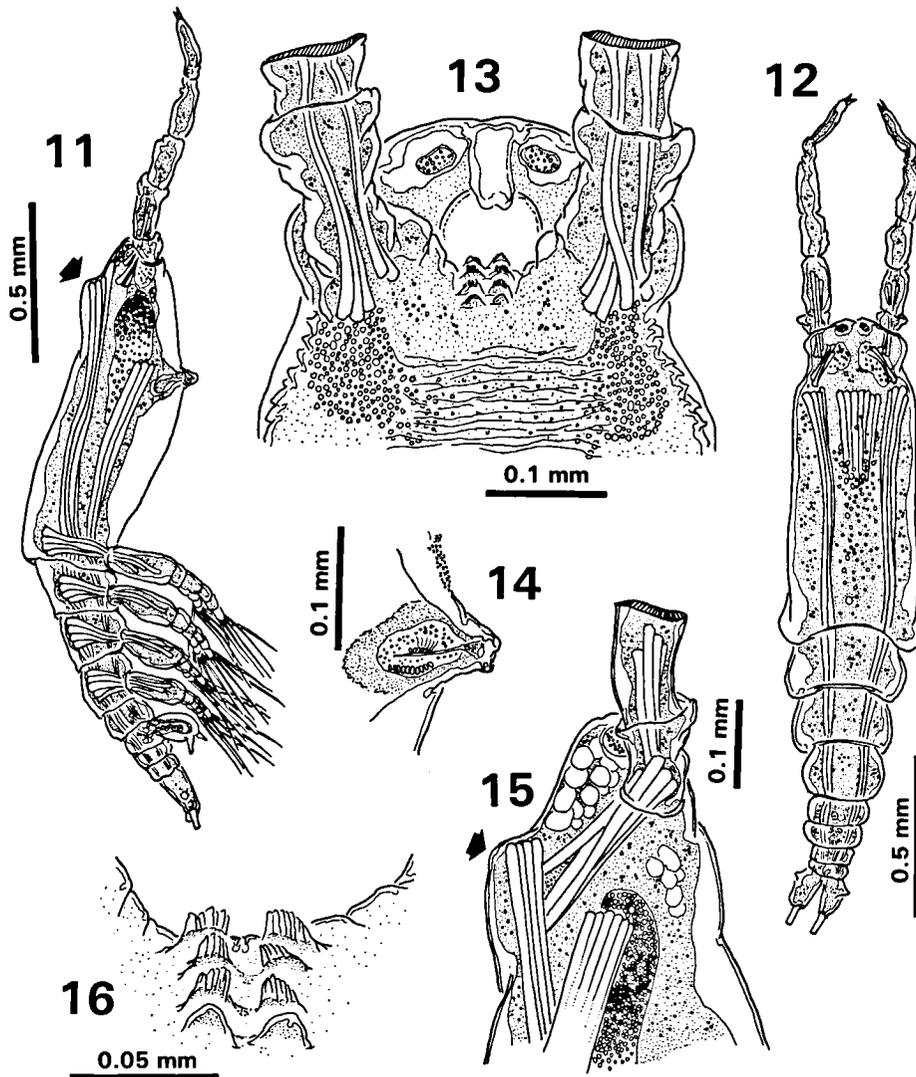
difference is the length of the ovigerous spine, it reaches the distal part of the caudal setae in *C. striatus* whereas it is much longer in *C. tumorifrons*, reaching well beyond the distal end of the caudal setae. The antennular armature shows also a different arrangement in both species, but the main distinguishing character in this appendage is the position of spines 6<sub>1</sub> and 6<sub>2</sub>, they are both terminal in *C. tumorifrons* whereas spine 6<sub>1</sub> is terminal and 6<sub>2</sub> is subterminal, inserted on a protuberance in *C. striatus* (see Fig. 3). *Cymbasoma striatus* belongs to a group of species of *Cymbasoma* with a cephalothorax representing 60% or more of the total body length. In Table 1 a comparative set of characters is presented to help in the identification of these species.

### ***Cymbasoma javensis* (Isaac, 1974a)**

Figs. 11-26

*Monstrilla javensis* Isaac, 1974a: 132, figs. 2A-D.

MATERIAL. - Adult male, holotype, ethanol-preserved, undissected. Bangka Strait, western Java Sea, Indonesia (aprox. 02°21'S 105°45'E). Labeled as: Leg Prinz Adalbert, Dr. Sanders. Det. M.J. Isaac, 1973. The date of collection is absent from label. Vial deposited at the Museum für

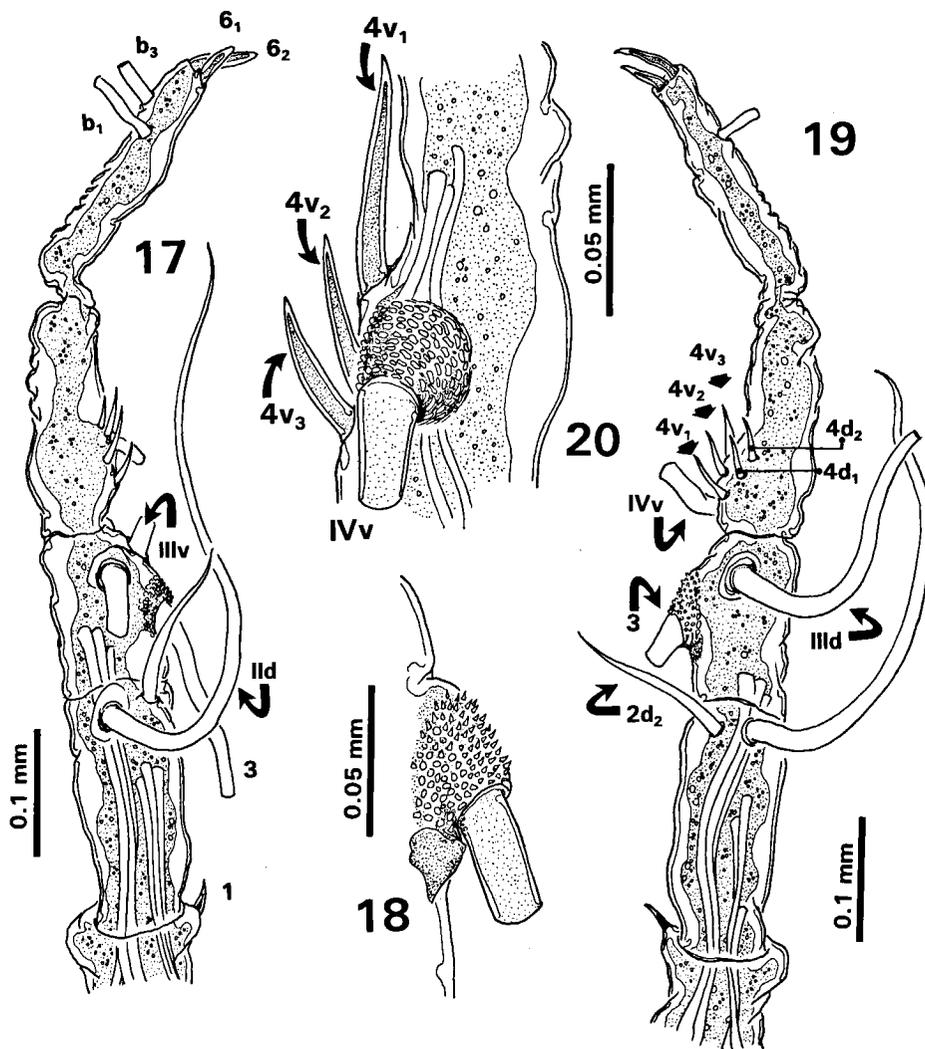


Figs. 11-16. *Cymbasoma javensis* (Isaac). Male holotype. 11, habitus, lateral view. 12, habitus, dorsal view. 13, head, ventral view. 14, oral papilla, lateral view. 15, anterior part of cephalothorax, lateral view. 16, four paired structures on ventral surface between antennule bases.

Naturkunde, Berlin, Germany (sample no. 26279).

**DESCRIPTION.** - Male: mean body length of holotype specimen 1.18 mm, measured in dorsal view from anterior end of cephalothorax to posterior edge of anal somite. Cephalothorax 0.93 mm long, representing 55% of total body length (Fig. 12). Oral papilla protruding from ventral surface (Fig. 14), located at almost 40% of way back along ventral surface of cephalothorax (Fig. 11). Cephalic region with constriction on anterior

part, cephalothorax gradually broadening to about same width. Forehead with central depression. Dorsal hump present on anterior 1/3 of cephalothorax, visible in lateral view (arrowed in Figs. 15, 11). Dorsal ocelli present, close to anterior edge of head, pigment cups small and widely separated by a distance equal to 1.5 times an eye diameter; poorly developed, almost unpigmented, ovoid in dorsal view. No sensilla observed on anterior part of cephalic region. Frontal region between antennular bases with

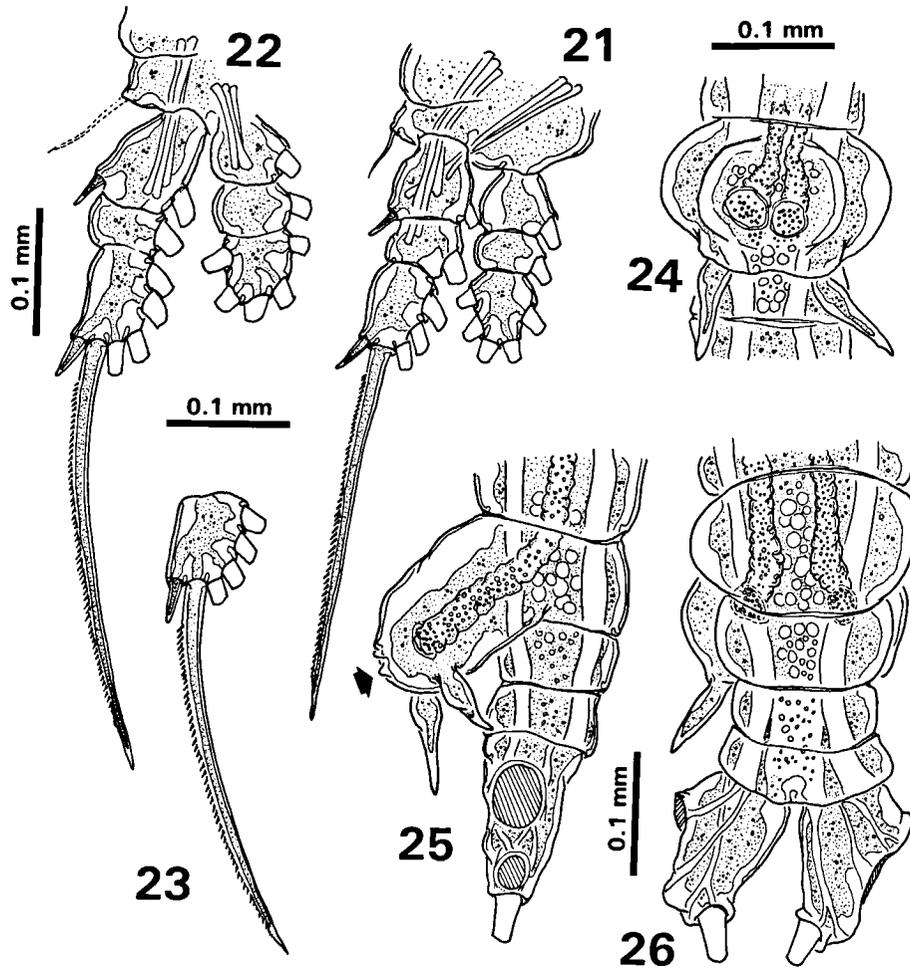


Figs. 17-20. *Cymbasoma javensis* (Isaac). Male holotype. 17, right antennule, dorsal view. 18, detail of seta 3 showing ornamented base area. 19, left antennule, dorsal view. 20, detail of seta IVv area showing ornamentation of basal area.

four pairs of rounded processes, the posterior-most naked, the other three tipped with row of subrectangular scale-like processes (Figs. 13, 16). Fringe of transverse cuticular striations on ventral surface between paired processes and oral papilla (Fig. 13).

Antennular length of holotype specimen 0.48 mm, close to 40% of total body length, and ca. 73% as long as cephalothorax. Five-segmented, length ratio of antennular segments, from first to fifth: 10:25.6:16.4:23.6:24.4 (= 100) (Figs. 17, 19). Several setae and spines broken, mainly those of

distal segment. Segments armed with 0-I; 2-0; 2-I; 1-IV; 0-2 setae (in Arabic numbers), spines (in Roman numbers), and aesthetascs (aes), respectively. In terms of basic setal nomenclature of Grygier & Ohtsuka (1995) for female monstrilloid copepod antennules, two aesthetascs (4aes, 6aes) and most setae and spines of segments 2 and 5 are absent in the studied specimen. The most complete setal groups identified in this specimen are on segments 3 and 4. In the former, setae IIIv and IIIId clearly present; between them arises Grygier & Ohtsuka's (1995) spine 3. This spine



Figs. 21-26. *Cymbasoma javensis* (Isaac). Male holotype. 21, first swimming leg. 22, third swimming leg showing expected position and length of basipodal outer seta (broken line). 23, terminal exopodal segment of fourth swimming leg. 24, genital complex, ventral view. 25, distal urosomites and genital complex, lateral view. 26, same, dorsal view.

setiform, long (Figs. 17, 19), with a peculiar base, covered with anterior patch of wide-based spines (Fig. 18). Antennular segment four with most "4-IV" elements of Grygier & Ohtsuka (1995) (4v<sub>1-3</sub>; 4d<sub>1, 2</sub>; IVv). Seta IVv present on both antennules. In ventral view its base is a wide-based conical structure ornamented with patch of low-profile scales of ovoid shape (Fig. 20).

First pedigerous thoracic somite incorporated into cephalothorax. This and succeeding three pedigers each bearing well developed swimming legs. Coxae of each pair unarmed, joined by intercoxal sclerite slightly longer than wide. Basis

separated from coxa posteriorly by diagonal articulation. Legs 1 and 2 slightly larger than 3 and 4; exopods longer than endopods in all cases. Outer margin of basis of swimming legs 1, 2, and 4 with a small, thin seta (Fig. 21); basipodal seta on leg 3 not observed, but commonly larger and thicker than in the other legs, frequently setulated (expected position and length in Fig. 22). All swimming legs with 3-segmented rami and with same armament pattern, except for leg 1 exopod (see Figs. 21, 22). Outer distal corner of first and third exopodal segments of legs 1-4 each with short, spinelike seta, about one-fourth as long as

bearing segment. All natatory setae naked except for seta on outer distal corner of third exopodal segments of legs 1-4, this being naked along inner side, but bearing row of small denticles along outer margin (Figs. 21-23).

Armature of swimming legs as:

	basis	endopodite	exopodite
leg 1	0-1	0-1; 0-1; 1, 2, 2	I-1; 0-1; I, 2, 2
legs 2-4	0-1	0-1; 0-1; 1, 2, 2	I-1; 0-1; I, 2, 3

As usual in monstrilloid males, fifth leg absent. Genital complex on succeeding somite, represented by massive basal structure, rounded in dorsal and ventral views (Figs. 24, 26), cylindrical in lateral view (Fig. 25). Pair of subterminal digitiform genital lappets present on distal 1/3 of genital structure, both appearing elongated, strongly divergent, distally slender. Digitiform processes reaching half-way down of caudal rami (Fig. 15). Two subtriangular processes present on tip of genital structure (arrowed in Fig. 25).

Urosome consisting of four somites: fifth pedigerous (with no appendages), genital somite (with genital complex) and two free somites, the last of which is the anal somite. From dorsal view, genital somite slightly longer than anal and preanal urosomites, somite expanded laterally. Anal somite being the shortest of the urosome.

Caudal rami subtriangular, with terminal margin 25% narrower than proximal. Approximately twice as long as wide. Specimen with terminal seta only; sockets of two additional setae were observed.

Female: unknown.

REMARKS. - The specimen studied is relocated in the genus *Cymbasoma* mainly by having only two free somites after the genital complex, and secondarily by showing probably only three caudal setae. In the original description Isaac (1974a) depicted three somites after the genital complex, but this probably resulted from misinterpretation of the urosomite segmentation. Furthermore, it is common that males of *Monstrilla* show a reduced fifth leg inserted ventrally on the fifth pedigerous somite (see Sars, 1921; Isaac, 1975; Huys & Boxshall, 1991). This structure is absent in all males of *Cymbasoma* (Suárez-Morales, 2000) as it is absent in *Monstrillopsis* and in several *Monstrilla*

(Huys & Boxshall, 1991). However, its absence in *C. javensis* is yet another secondary character supporting its inclusion within *Cymbasoma*.

Isaac (1974a) indicated that "...the specimen is in rather poor condition, being dirty, with many

setae missing." In fact, re-examination showed this, but in order to make this redescription, the specimen was cleaned from detritus without damaging it using the techniques described by Huys & Boxshall (1991). It was then treated with alcohol-glycerine and glycerine for several days to improve the tissues elasticity and clarity. Only after this process was over, most of the structures with taxonomical value could be observed in the microscope.

The first thing calling the attention in the holotype specimen is the dorsal hump of the cephalothorax which is only outlined in Isaac's description. This is a unique character among the *Monstrilloida*. The cephalothorax details, including the cuticular processes and the central depression on the forehead were not mentioned by Isaac. The most relevant character on the cephalothorax is probably the four paired structures located between the antennular bases (Figs. 13, 16). These structures and their arrangement have not been described previously in the *Monstrilloida* and so far, they are exclusive of this species. Their paired arrangement and location suggest that they might represent reduced post-antennular appendages. This could then modify the general idea that oral appendages are completely lost in this group. There is a similar set of structures present in *M. inserta* A. Scott, 1909 and in a new Brazilian species (Suárez-Morales, pers. obs.). However, these structures, although on about the same position, are sensilla-like and only one pair is present.

Other relevant characters of *C. javensis* are the peculiar, ornamented bases of antennular elements 3 and IVv (Figs. 18, 20). These are features not described before in monstrilloid copepods and is, definitely, another specific distinctive character.

No previous data on the structure or armature of the swimming legs was provided by Isaac's (1974a) work; he mentioned that "...four pairs of swimming legs appear to be struck together, and there is some detritus etc. caught up in them..", explaining in this way the gap in the description. Examination of the swimming leg structure showed some relevant details. One is the complete absence of setules on all the swimming setae of legs 1-4. These setae are commonly biserially plumose. Another relevant character is the absence of setules on the inner margin of the terminal spiniform seta of the third exopodal segments of legs 1-4. The inner margin is commonly ornamented with setules.

The genital complex, as stated by Isaac (1974a), indeed reminds the structure shown by *Monstrilla wandelli* Stephensen, 1913 (see Park, 1967), but differs in having the lappets with a simple distal end whereas it is bifid in *M. wandelli*. Besides the generic differences, these two species cannot be confused due to the fact that the male of *M. wandelli* has fifth legs (see Park, 1967), which are absent in *C. javensis*.

Due to the poor and superficial original description of this species, it was considered undiagnosed and the name a nomen nudum (Grygier, 1995). This redescription will allow this name to become available.

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The valuable help of Ann Whittall, The Natural History Museum, London, United Kingdom is very much appreciated for making available to me the holotype specimen of *C. striatus* (as *Thaumaleus striatus*) through loan CR99/84T. C. Oliver Coleman, curator of the Crustacea Collection of the Museum Für Naturkunde, Berlin, kindly granted the loan of the holotype of *C. javensis* (as *Monstrilla javensis*).

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