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## A revision of the bathyal and abyssal necrophage genus *Cyclocaris* Stebbing, 1888 (Crustacea: Amphipoda: Cyclocaridae) with the addition of two new species from the Atlantic Ocean

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### Abstract

Two new species of the deep-sea scavenging genus *Cyclocaris* (Crustacea: Amphipoda) are described from bathyal and abyssal depths in the North and tropical Atlantic Ocean, bringing the total number of species in the genus to four. An account of all four species is given and an updated key to the genus *Cyclocaris* is provided.

**Key words:** *Cyclocaris*, necrophage, Atlantic Ocean, bathyal, abyssal, new species, Amphipoda.

### Introduction

The use of baited traps in the deep sea has a long history. Traps were deployed from the *Hirondelle* in 1888 (Richard, 1934) and as early as 1892 amphipod specimens were recovered (Chevreux, 1903). Baited traps and cameras have been used in Institute of Oceanographic Sciences and National Oceanography Centre investigations for more than thirty years and have captured or pictured large numbers of amphipods (Thurston, 1979, 1990; Lampitt *et al.*, 1983; Horton, 2004, 2005; Diffenthal & Horton, 2007; Horton & Thurston, 2009, 2011; Horton *et al.*, 2013).

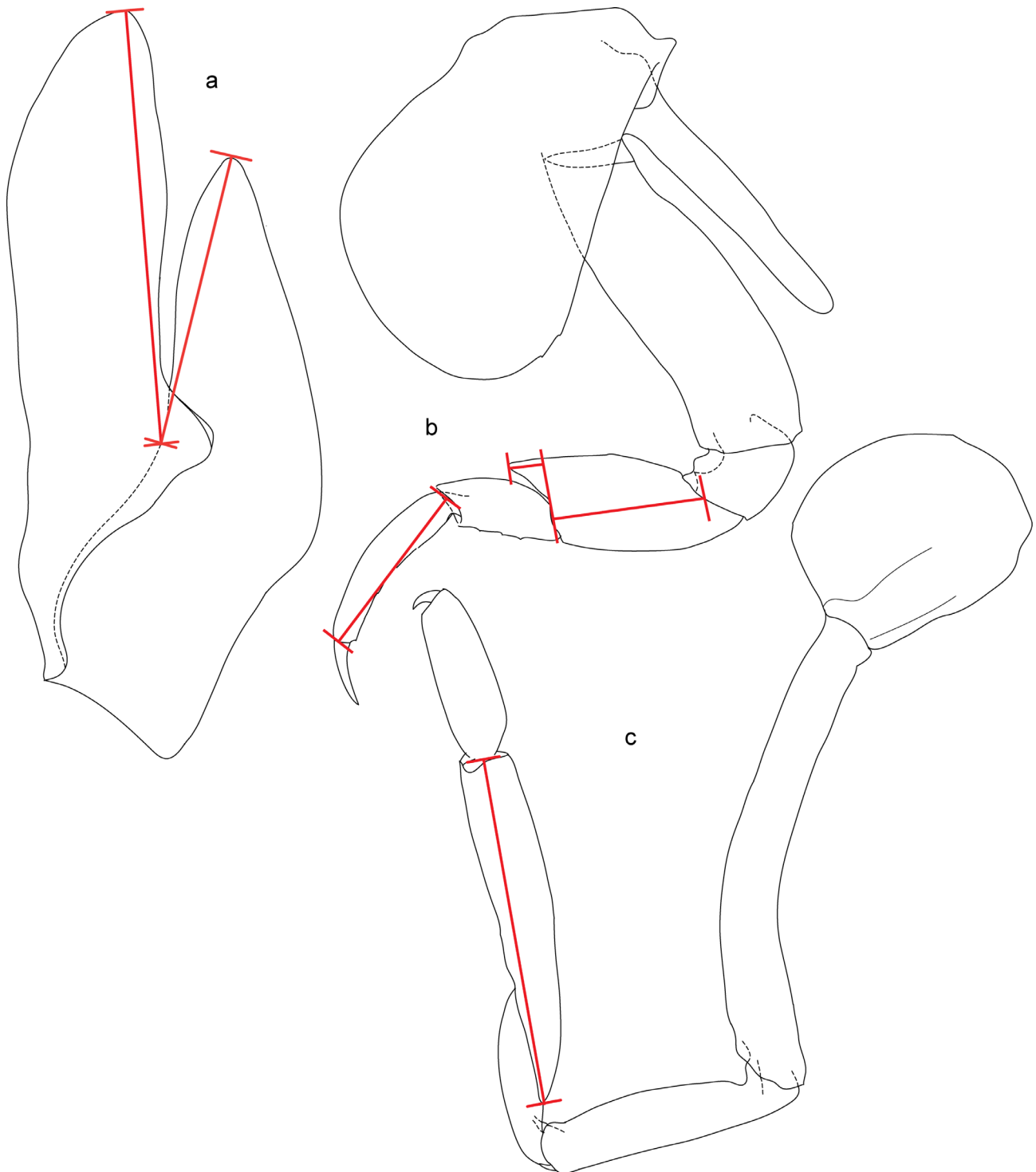
*Cyclocaris* Stebbing, 1888 is a small and distinctive genus, recently assigned to the family Cyclocaridae by Lowry & Stoddart (2011), and currently containing just two species: *C. tahitensis* Stebbing, 1888 from the South Pacific Ocean off Tahiti and *C. guilelmi* Chevreux, 1899 from the Norwegian Sea. Material trapped off the Cape Verde Islands (Atlantic) was reported by Chevreux (1903) as *C. tahitensis*, but this identity has been questioned (Barnard & Karaman, 1991; Lowry & Stoddart, 1994). Examination of extensive collections taken at various localities in the eastern North Atlantic Ocean and off Angola justify these doubts, and this new material comprises two new species described herein as *Cyclocaris lowryi* **sp. nov.** and *Cyclocaris franki* **sp. nov.**

### Methods

Specimens were collected within two metres of the sea floor using a variety of free-fall devices. Specimens were found in bait recovered from deployments of an experimental fish trap (TRAP B), a baited benthic camera system (BSNACK), in purpose-designed amphipod traps (AMPHITRAP, DEMAR (de-rated Mark & Recapture) VET (Vertical Eurythenes Trap)) and in simple auxiliary traps attached to benthic landers. In addition, specimens have been caught in various towed gears; benthic nets (BN 2.4, BN 1.5/5C, BN 1.5/3M), supra-benthic nets (SBN) attached to bottom nets, and single and multiple rectangular mid-water trawls (RMT 8, RMT 1+8M). Material was fixed in 4% formaldehyde and transferred to 80% Industrial Denatured Alcohol for sorting and storage.

Sorting, initial observation and dissection were undertaken using Wild M5 and Leica™ MZ 7.5 stereomicroscopes. Dissected parts were mounted in Polyvinyl-lactophenol stained with lignin pink. Illustrations were prepared using Wild M20 and Olympus™ BX51 compound microscopes. Illustrations of *Cyclocaris lowryi*

were hand-inked many years ago, prior to the advent of digital-inking technology; those of *Cyclocaris franki* were scanned and inked digitally using Adobe® Illustrator® and a WACOM™ digitiser tablet (Coleman, 2003). Type material of both new species has been deposited at the Natural History Museum, London (NHM). Additional material is held in the Discovery Collections, National Oceanography Centre, Southampton.



**FIGURE 1.** (a) Measurement of the lengths of inner and outer plates of maxilla 2 from the point of maximum curvature where the lateral margin of the inner plate overlies the base of the outer plate: (b) Lengths of individual articles of peraeopods measured from proximal to distal articular condyle: (c) Measurement of the total length of the carpus on gnathopods.

The lengths of inner and outer plates of maxilla 2 have been measured from the point of maximum curvature where the lateral margin of the inner plate overlies the base of the outer plate (Figure 1a). Descriptions of the new species rely in part on the relative lengths and proportions of gnathopods and pereopods. Lengths of individual articles measured along anterior or posterior margins are affected by the degree of flexure of the limb. As a consequence, lengths of appendage articles have been measured from proximal to distal articular condyle or their estimated positions (Figure 1b). Lengths measured in this way remain constant regardless of the degree of flexion of the appendage. The very oblique articulation between the merus and carpus of gnathopods 1 and 2 is not a simple bi-condylar articulation, and here the total length of the carpus has been used (Figure 1c).

Setal and mouthpart classifications follow Watling (1989) and Lowry & Stoddart (1992, 1993, 1995). The following abbreviations have been used: A, antenna; C, cephalon; E, epimeron; G, gnathopod; L, lower lip; Md, mandible; Mx, maxilla; Mxp, maxilliped; P, pereopod; T, telson; U, uropod; r, right; x, female holotype; y, male allotype.

## Systematics

### Superfamily Lysianassoidea Dana, 1849

#### Family Cyclocaridae Lowry & Stoddart, 2011

**Diagnostic description.** “*Head exposed or partially covered by pereonite 1*, slightly deeper than long, **with or without cheek notch**. *Antennae*, calceoli present or absent in male. *Antenna 2* peduncle article 3 without distal hook. *Epistome and upper lip* separate. *Epistome* with proximal portion not produced. *Mouthpart bundle* subquadrate. *Mandible* incisors well developed, asymmetrical, left straight, minutely serrate **or minutely and weakly scalloped**, right convex, smooth; left lacinia mobilis rod-like; accessory setal row with more than 5 robust setae, without distal setal tuft; molar a setose tongue; palp inserted distally. *Maxilla 1* inner plate with pappose setae along medial margin; outer plate with setal-teeth in 7/4 crown arrangement, setal teeth large, **slender**; palp large, with apical robust setae. *Maxilla 2* inner plate significantly shorter than outer plate, inner plate without oblique row of facial setae. *Maxilliped* outer plate present, medial setae small, blunt or bead-shaped, with apical slender setae; palp 4-articulate, article 4 well-developed.

*Gnathopod 1* simple; coxa vestigial; ischium long; carpus long; propodus small; dactyl slightly curved. *Gnathopod 2* coxa vestigial. *Pereopods* all simple; distal spurs absent. *Pereopod 4* coxa with posteroventral lobe weak. *Pereopod 5* coxa **posterior lobe deeper**.

*Uropod 3* biramous. *Telson* **long, deeply** cleft. (Modified after Lowry & Stoddart, 2011, modifications in bold text).

**Remarks.** Lowry & Stoddart (2011) erected the family Cyclocaridae in recognition of the distinctive characters of *Cyclocaris*. *C. lowryi* **sp. nov.** and *C. franki* **sp. nov.** resemble *C. tahitensis* and *C. guilelmi* but have characters of the head and incisor process that require emendation of the diagnostic description. Examination of material of *Cyclocaris guilelmi* at the Natural History Museum, London (including the type of *Cyclocaris faroensis* Norman, 1900) reveals that the habitus illustration of this species by Sars (1900) of subequal lobes of the pereopod 5 coxa, is erroneous. The diagnostic description has been emended accordingly.

#### Genus *Cyclocaris* Stebbing, 1888

*Cyclocaris* Stebbing, 1888: 664.—Stebbing, 1906:30.—Barnard, 1969: 338–339.—Barnard & Karaman, 1991: 479.—Lowry & Stoddart, 2011: 58–60.

**Type species.** *Cyclocaris tahitensis* Stebbing, 1888, original designation.

**Diagnosis.** As for the family. *Maxilla 1* palp apically strongly tridentate, each tooth crowned with a robust seta.

**Species composition.** *Cyclocaris tahitensis* Stebbing, 1888; *Cyclocaris guilelmi* Chevreux, 1899; *Cyclocaris lowryi* **sp. nov.**; *Cyclocaris franki* **sp. nov.**



**FIGURE 2.** a. *C. franki* sp. nov.: habitus; b. *C. franki* sp. nov.: ocular patches.

**Remarks.** The Cyclocaridae most closely resemble the Cebocaridae and can be distinguished by the head being only slightly deeper than long; the presence of eyes; the more strongly asymmetric incisors; the setose molar and the simple non-prehensile pereopods (Lowry & Stoddart, 2011). *C. guilelmi* is unusual in having eyes that cover most of the head and that are not destroyed by fixation and preservation. In the remaining three species eyes fade or disappear completely following preservation as was reported for *C. tahitensis* (Lowry & Stoddart, 2011). The two new species each possess four irregular and somewhat variable ocular patches; bright red in the case of *C. franki* **sp. nov.** (Figure 2). In common with some other lysianassoids, the bright red pigment found in the two new species is highly labile in alcohol (Thurston, 1974; Thurston & Bett, 1993).

Cyclocarids are necrophages to a greater or lesser extent; all species have been caught in baited traps. In common with otherwise unrelated necrophagous lysianassoids such as *Alicella*, *Eurythenes* and some members of the Uristidae, *Cyclocaris* species share a total loss of the triturating surface on the mandibular molar and a shortening of the inner plate of maxilla 2 (De Broyer & Thurston, 1987; Stoddart & Lowry, 2004; Lowry & Stoddart, 2011; unpublished observations). When fully gorged, the hugely extended sternites of the pereon make specimens of *Cyclocaris* very obvious in trap catches (Figure 3).

### ***Cyclocaris lowryi* sp. nov.**

(Figures 4–7)

*Cyclocaris* sp. ? nov. Thurston, 1990: 262–265 (ecology).

*Cyclocaris* **sp. nov.** Duffy, Horton & Thurston, 2012: 4865 (ecology)

**Type material.** Holotype: preparatory female, 17.1 mm, carcass and 6 slides; Sta. 12600#44, DEMAR, 9–10 October 1993 (bottom time 10 hours 45 minutes), 21° 05.2'N 31° 06.6'W, 4540 m, Cape Verde Abyssal Plain; NHMUK 2014. 437. Allotype: adult male, 12.6 mm; Sta. 12600#46, DEMAR, 10–11 October 1993 (bottom time 22 hrs 57 mins), 21° 01.2'N 31° 13.0'W, 4555 m, Cape Verde Abyssal Plain; NHMUK 2014. 438. Paratypes: Sta.12600#44, same data as holotype; 124 specimens, NHMUK 2014. 439–448. Sta. 12600#46, same data as allotype; 263 specimens, NHMUK 2014. 449–458.

**Additional material examined.** Specimens retained in the Discovery Collections, National Oceanography Centre, Southampton.

8524#1, BN 1.5/5C, 28 June 1974, 20° 45.5'N 22° 42.5'W–20° 46.6'N 22° 44.3'W, 4412 m, Cape Verde Abyssal Plain, 1 specimen.

9541#18, RMT 8, 18 April 1977, 20° 18.5'N 21° 41.2'W–20° 20.8'N 21° 53.0'W, 3970–4020 m (0–20 metres above bottom), Cape Verde Abyssal Plain, 1 specimen.

9541#19, RMT 8, 18 April 1977, 20° 19.7'N 21° 51.3'W–20° 18.4'N 21° 40.5'W, 3970–4040 m (0–20 mab), Cape Verde Abyssal Plain, 1 specimen.

9629#1, TRAP B, 27–28 October 1977 (bottom time 26 hrs 12 mins), 35° 47.4'N 13° 12.5'W, 4850 m, Horseshoe Abyssal Plain, 2 specimens.

52216#5, AMPHT, 23–25 June 1985 (bottom time 35 hrs 05 mins), 48° 50.02'N 16° 30.42'W, 4842 m, Porcupine Abyssal Plain, 2 specimens.

11261#56, RMT 8M/3, 4 July 1985, 31° 14.7'N 25° 14.6'W–31° 17.6'N 25° 18.3'W, 5415–5425 m (25–11 mab), Madeira Abyssal Plain, 1 specimen.

11261#64, RMT 1M/2, 6 July 1985, 31° 19.2'N 25° 21.4'W–31° 24.3'N 25° 21.3'W, 5385–5410 m (48–25 mab), Madeira Abyssal Plain, 1 specimen.

11262#17, BN1.5/3M SBN, 17 July 1985, 31° 13.3'N 25° 14.4'W–31° 11.5'N 25° 09.6'W, 5432 m, Madeira Abyssal Plain, 1 specimen.

11262#19, BN1.5/3M SBN, 18 July 1985, 31° 19.8'N 25° 29.0'W–31° 34.0'N 25° 26.9'W, 5432 m, Madeira Abyssal Plain, 5 specimens.

12174#20, BSNACK, 18–23 August 1990 (bottom time 111 hrs 34 mins), 31° 07.6'N 21° 10.0'W, 4941 m, Madeira Abyssal Plain, 9 specimens.

52701#35, DEMAR, 22–23 May 1991 (bottom time 20 hrs 21 mins), 48° 48.5'N 16° 23.6'W, 4843 m, Porcupine Abyssal Plain, 1 specimen.

12600#14, BSNACK, 1–7 October 1993 (bottom time 138 hrs 50 mins), 21° 01.1'N 31° 10.8'W, 4549 m, Cape

Verde Abyssal Plain, many specimens.

12600#41; BSNACK, 9–14 October 1993 (bottom time 130 hrs 4 mins), 21° 04.6'N 31° 11.6'W, 4615 m, Cape Verde Abyssal Plain, 19 specimens.

12600#60; DEMAR, 14–16 October 1993 (bottom time about 40 hours, soluble link parted prior to proposed release), 21° 05.1'N 31° 12.9'W, 4569 m, Cape Verde Abyssal Plain, many specimens.

13077#4, NIOZ LANDER, 14–18 March 1997 (bottom time 79 hrs 44 mins), 48° 55.82'N 16° 35.25'W, 4844 m, Porcupine Abyssal Plain, 2 specimens.

13077#35, NIOZ LANDER, 19–23 March 1997 (bottom time 82 hrs), 48° 58.10'N 16° 24.93'W, 4845 m, Porcupine Abyssal Plain, 2 specimens.

15734#1, DEMAR, 1–2 August 2005, (bottom time 21 hrs 28 mins), 39° 29.78'N 09° 57.89'W, 3600 m, Nazaré Canyon, 1 specimen.

15741#1, DEMAR, 4–5 August 2005 (bottom time 24 hrs 22 mins), 39° 34.95'N 10° 16.5'W, 4286 m, Nazaré Canyon, 25 specimens.

56839#1, VET, 4–5 May 2006 (bottom time 24 hrs 12 mins), 38° 06.57'N 09° 58.18'W, 4445 m, Setúbal Canyon, 1 female specimen.

56847#1, DEMAR, 7–8 May 2006 (bottom time 24 hrs 34 mins), 39° 35.50'N 10° 19.00'W, 4403 m, Nazaré Canyon, 3 specimens.

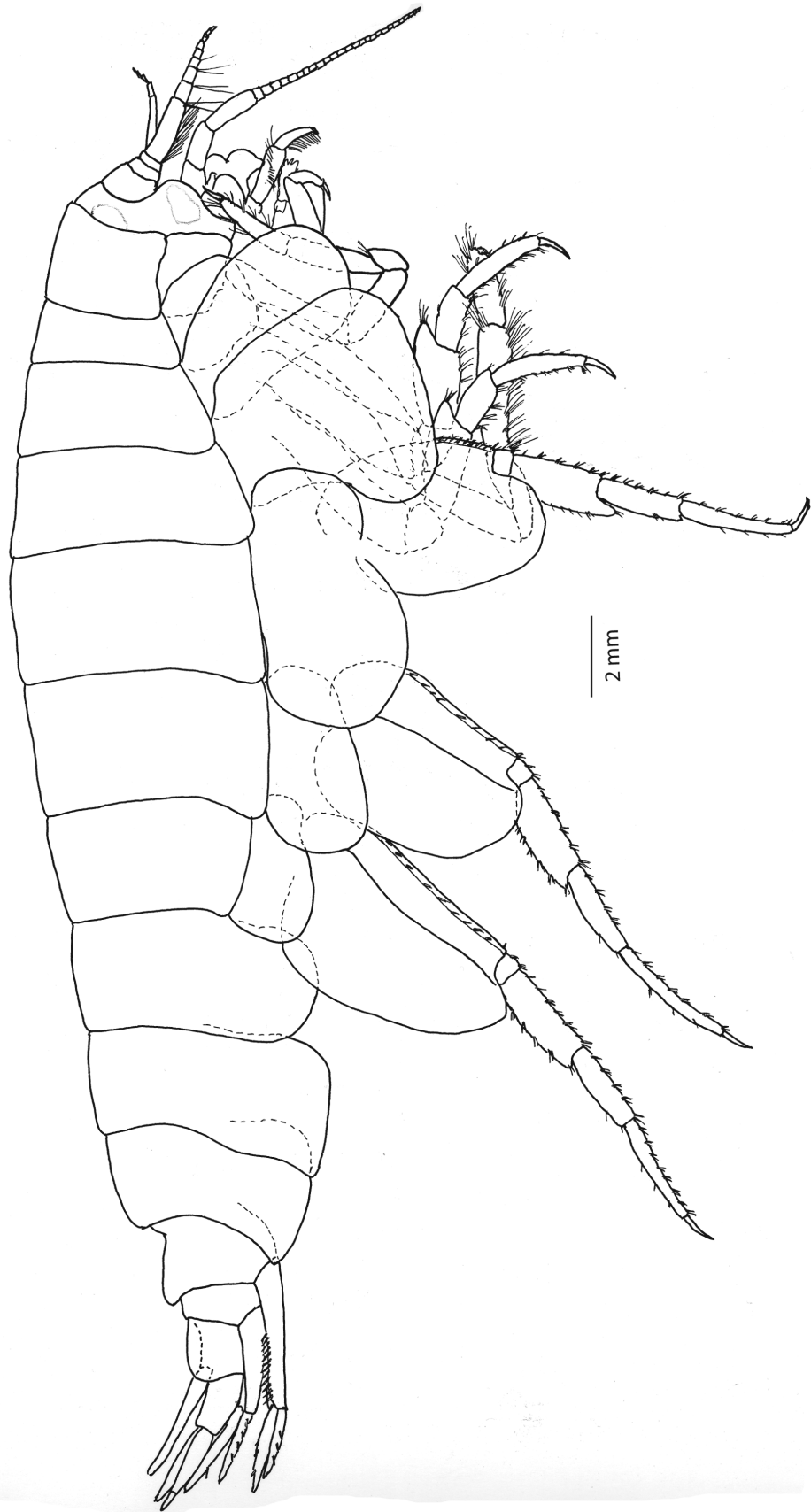
**Etymology.** This species is named for Jim Lowry in recognition of his huge contribution to our knowledge of amphipods in general and lysianassoids in particular.

**Description.** Holotype female, 17.1 mm. *Head:* exposed, deeper than long, rather short dorsally but telescoped into pereaeonite 1; lateral cephalic lobe moderate, rounded; rostrum very small. *Eyes:* four, pigmented, lacking ommatidea, pigment lost in alcohol; upper, small, sub-oval; lower, larger, sub-oval, in cephalic lobe. *Antenna 1:* short, 0.15 x body; peduncular article 1 short; peduncular article 2 short, 0.3 x article 1; peduncular article 3 short, 0.3 x article 1; primary flagellum 10-articulate; accessory flagellum long, 0.6 x primary flagellum, five-articulate, article 1 as long as articles 2–5 combined; callynophore strong two-field; calceoli absent. *Antenna 2:* short, 1.65 x antenna 1; peduncle with brush setae, not geniculate; peduncle article 1 not greatly enlarged; peduncle article 3 short, 0.4 x article 4; articles 4 and 5 not enlarged; flagellum well developed, 20-articulate.



**FIGURE 3.** *C. lowryi* sp. nov.: fully gorged specimen.





**FIGURE 4.** *C. lowryi* sp. nov.: holotype; adult female, 17.1 mm, habitus.

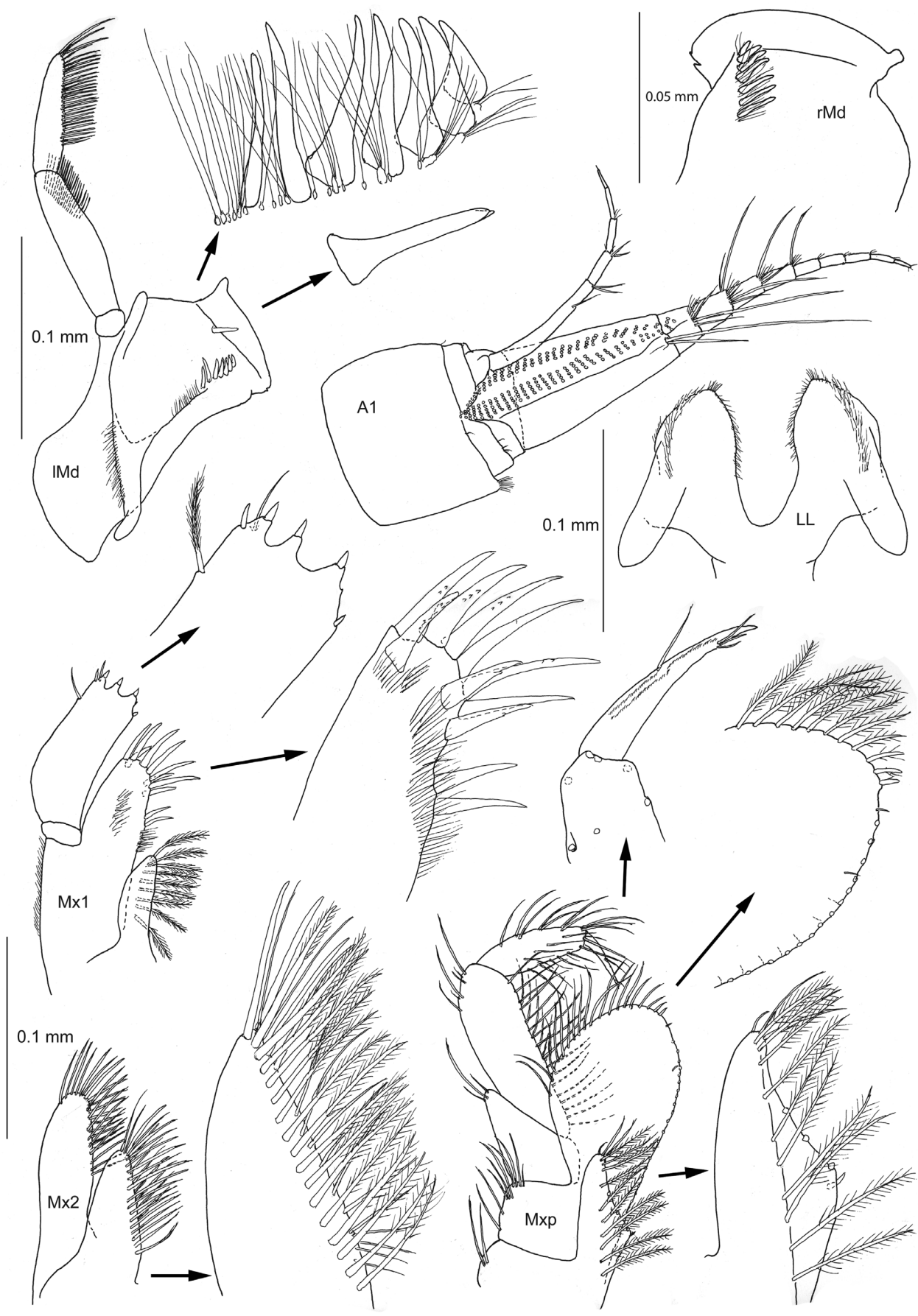
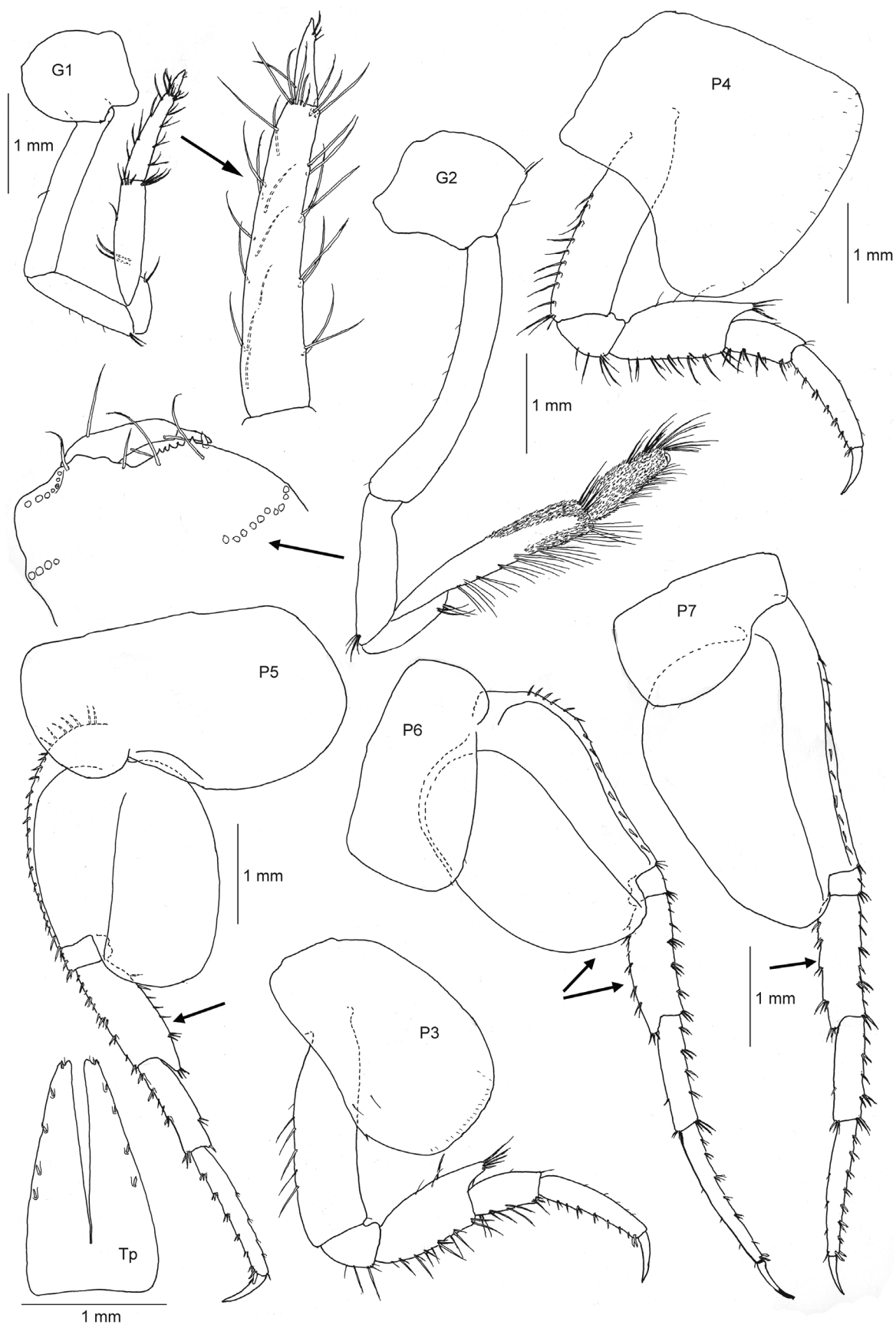
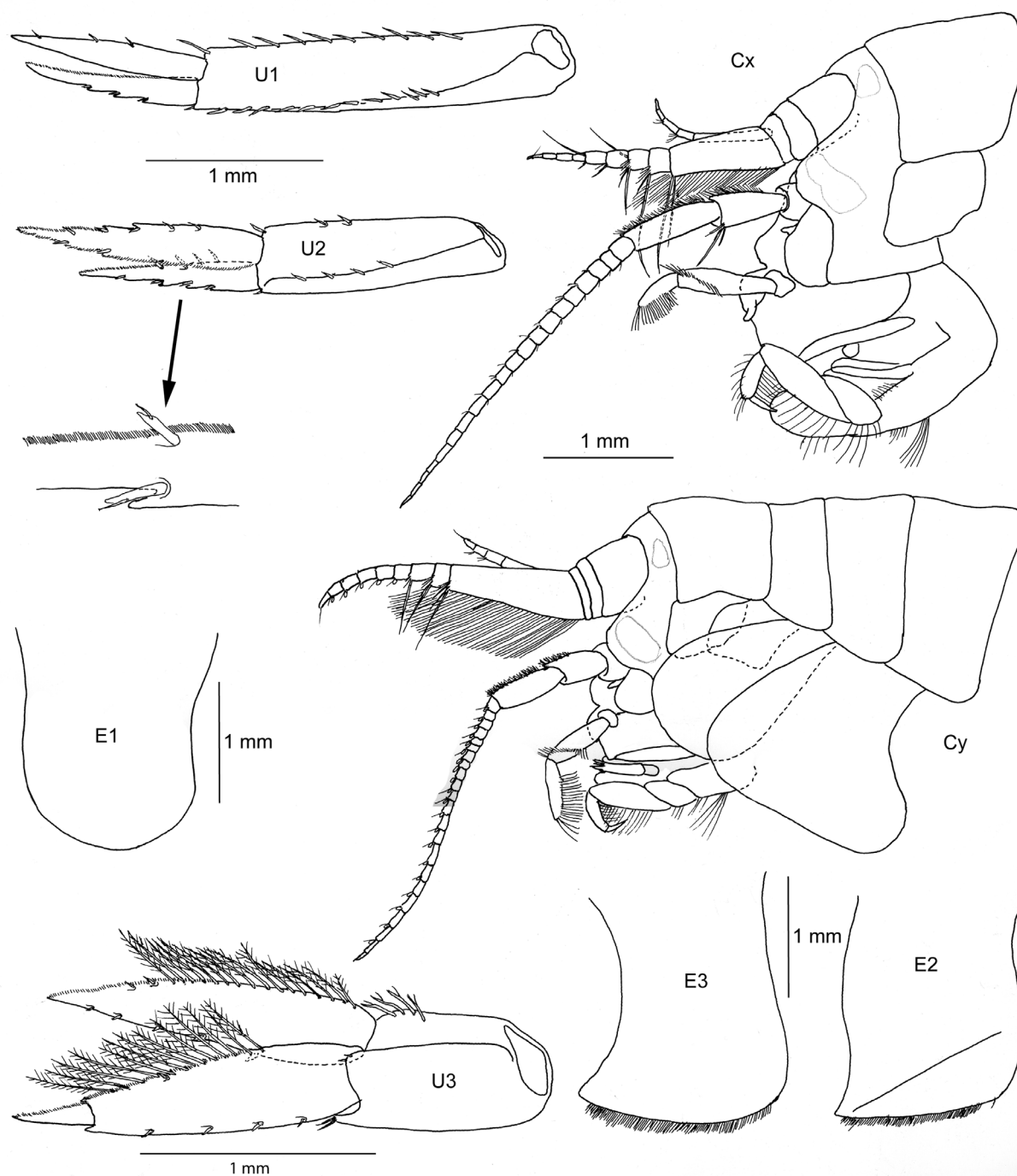


FIGURE 5. *C. lowryi* sp. nov.: holotype; adult female, 17.1 mm, mouthparts.





**FIGURE 6.** *C. lowryi* sp. nov.: holotype; adult female, 17.1 mm, gnathopods, pereopods and telson.



**FIGURE 7.** *C. lowryi* sp. nov.: holotype; adult female, 17.1 mm, head, epimera and uropods. Allotype; adult male, 12.6mm, head.

*Mouthpart bundle:* subquadrate. *Epistome and upper lip:* separate, rounded, weakly produced, epistome weakly dominant. *Mandible:* incisor smooth, weakly convex, with minute ventral hook; lacinia mobilis present on left mandible only, a slender peg minutely bifurcate distally; accessory setal rows with seven simple robust setae and many setules; molar a setose, proximally directed, non-triturating flap; palp attached distally; article 1 short, broader than long; article 2 slender, length 4.0 x breadth, with about 20 A2 setae on distal 0.4; article 3 slender, tapering, length 4.2 x breadth, with 25 D3 setae and three E3 setae. *Lower lip:* outer plates gaping, setose marginally, inner plates apparently absent (but see below), molar processes prominent, rounded distally. *Maxilla 1:* inner plate slender, with nine pappose setae along inner margin; outer plate with 11 setal-teeth in a 7/4 crown

arrangement, ST1–5 weakly one-, two- or three-cuspidate, ST 6–7 simple, ST7 displaced from ST6, STA–C obscurely cuspidate, STD simple; palp large, two-articulate, article 1 short, article 2 broadened with three short robust setae on tridentate apical margin, one flag seta, two subapical robust setae, and one pappose seta on dorsal margin. *Maxilla 2*: inner plate short, 0.67 x length of outer plate, tapering, with rows of marginal and submarginal pappose and simple setae; outer plate with marginal and apical stout and slender setae. *Maxilliped*: inner plate large, subtriangular, with three very small nodular spines on strongly oblique apical margin, oblique setal row strong, with ten pappose setae; outer plate large, subovate, with 19 pappose setae apically and laterally, no robust setae, and about 20 minute nodular setae on medial margin; palp large, four-articulate, article 2 slender, length 2.7 x breadth, article 3 long, slender, length 2.7 x width, dactyl well-developed, slender, with three short subterminal setae and two rows of minute denticles on the medial surface.

*Gnathopod 1*: simple; coxa vestigial, anterior margin straight, posterior margin convex; basis long, slender, length 5.8 x breadth, anterior margin straight, lacking setae, posterior margin straight, with one short seta; ischium long, length 3.7 x breadth; carpus very long, subquadrate, lacking posterior lobe, margins subparallel, length 4.1 x breadth, 1.3 x length of propodus; propodus long, subquadrate, length 4.8 x breadth, margins weakly convergent, anterior weakly convex, posterior weakly concave, palm absent; dactylus simple, length 0.29 x propodus, with subterminal setae. *Gnathopod 2*: subchelate; coxa vestigial, subrectangular; basis long, slender, curved, anterior margin convex, length 6.1 x breadth; ischium long, length 3.3 x breadth; carpus very long, length 5.7 x breadth, margins subparallel, posterior margin straight, 2.3 x length of propodus; propodus subovate, length 3.0 x breadth, setulose, palm slightly acute, weakly convex, serrate distally; dactylus inserted near middle of propodus distal margin, reaching corner of palm. *Peraeopod 3*: coxa large, weakly expanded, broadly rounded distally; basis straight, margins subparallel; merus narrowly produced anterodistally, extending 0.37 x length of carpus; dactyl slender, curved, 0.43 x length of propodus. *Peraeopod 4*: coxa as deep as wide, posteroventral lobe short, broadly rounded; distal articles as in peraeopod 3. *Peraeopods 5–7*: subequal in length. *Peraeopod 5*: coxa unequally bilobate, posterior lobe deeper, strongly produced posteriorly; basis expanded, subovate, posterior margin convex, posterodistal margin broadly rounded; merus slender, produced posterodistally, extending 0.23 x length of carpus, propodus slender, length 6.8 x breadth; dactylus slender, curved, 0.33 x length of propodus. *Peraeopod 6*: coxa bilobate, posterior lobe deeper, expanded posteriorly; basis expanded, posterior margin convex, posterodistal lobe broadly rounded; merus slender, posterior margin weakly convex, weakly produced. *Peraeopod 7*: coxa posterior lobate; basis expanded, tapering distally, posterior margin weakly convex, posterodistal lobe narrowly rounded; merus slender, weakly produced posterodistally. *Gills*: gnathopod 2 to peraeopod 7; peraeopod 7 gill large. *Oostegites*: gnathopod 2 to peraeopod 5.

*Pleonites 1 to 3*: not carinate. *Epimeron 1*: broadly rounded ventrally. *Epimeron 2*: subrectangular; anteroventral corner rounded, posteroventral corner with acute tooth, posterior margin sinuous, ventral margin setose. *Epimeron 3*: expanded distally; anteroventral corner rounded, posteroventral corner with subacute tooth, posterior margin concave, ventral margin setose. *Urosome*: urosomite 1 with low rounded boss; urosomite 2 nearly occluded dorsally; urosomite 3 produced posterolaterally, markedly concave dorsally, with strong dorsolateral flanges. *Uropod 1*: peduncle with 12 dorsolateral robust setae and nine dorsomedial robust setae; inner ramus 0.57 x length of peduncle, with three dorsomedial setae; outer ramus 0.90 x inner ramus, with three dorsolateral setae. *Uropod 2*: peduncle with four dorsolateral robust setae and two dorsomedial robust setae; inner ramus 1.1 x length of peduncle, with two lateral and five medial setae; outer ramus 0.72 x inner ramus, with four lateral and four medial setae. *Uropod 3*: peduncle short, with four dorsomedial setae; rami subequal, lanceolate, with plumose setae on medial margins; inner ramus 1.6 x peduncle, with five lateral and two medial robust setae; outer ramus 2-articulate, article 2 length 0.31 x article 1, article 1 with four lateral and one medial robust setae. *Telson*: long, lobes tapering, length 1.8 x breadth, cleft 81%; lobes with four dorsolateral robust setae, apices notched with one robust seta.

**Male.** Similar to female except for calceoli on both antennae and a longer callynophore.

**Remarks.** *C. lowryi* differs from *C. tahitensis* and *C. guilelmi* by the rounded triangular eyelobe. For characters separating *C. lowryi* from *C. franki*, see under the latter species.

The lower lip as figured here agrees closely with the illustration of Chevreux (1935) and appears to lack inner lobes. However, the lower lip of the holotype was damaged during dissection. An examination of other specimens shows that inner lobes are present but are very small; much smaller than those shown for *C. guilelmi* by Barnard (1959). They project dorsally, i.e. perpendicular to the outer lobes, and are fused with separated, rounded apices.

Most material has come from baited traps set at abyssal depths, but individuals occupy the benthopelagic zone (present material; Thurston, 1990).

**Distribution.** Atlantic Ocean, 8–49°N. Guiana, Cape Verde, Madeira, Horseshoe, Iberian and Porcupine Abyssal Plains, Portuguese canyons, 3600–5432 m, benthic and abyssopelagic (present material; Thurston, 1990).

***Cyclocaris franki* sp. nov.**

(Figures 8–11)

*Cyclocaris tahitensis* (not Stebbing, 1888).—Chevreux, 1903: 89–90.—Chevreux, 1935: 31, pl. 4, fig. 4.

*Cyclocaris* sp. Barnard & Karaman, 1991: 479. Lowry & Stoddart, 1994: 153.

**Type material.** Holotype: dissected female, 20.5 mm, carcass and seven slides; Sta. 56761#1, DEMAR, 30 October 2001 (bottom time 23 hours 15 minutes), 06° 18.68'S 10° 44.86'W, 2059 m, Angola Slope; NHMUK 2014. 459. Allotype: adult male, 15.5 mm, same data as holotype; NHMUK 2014. 460. Paratypes: 39 specimens, same data as holotype; NHMUK 2014. 461–470.

**Additional material examined.** Specimens retained in the Discovery Collections, National Oceanography Centre, Southampton.

7822#7, BN 2.4, 5 March 1972, 08° 59.1'N 20° 16.3'W–08° 59.9'N 20° 16.2'W, 1203 m, Sierra Leone Rise; 1 specimen.

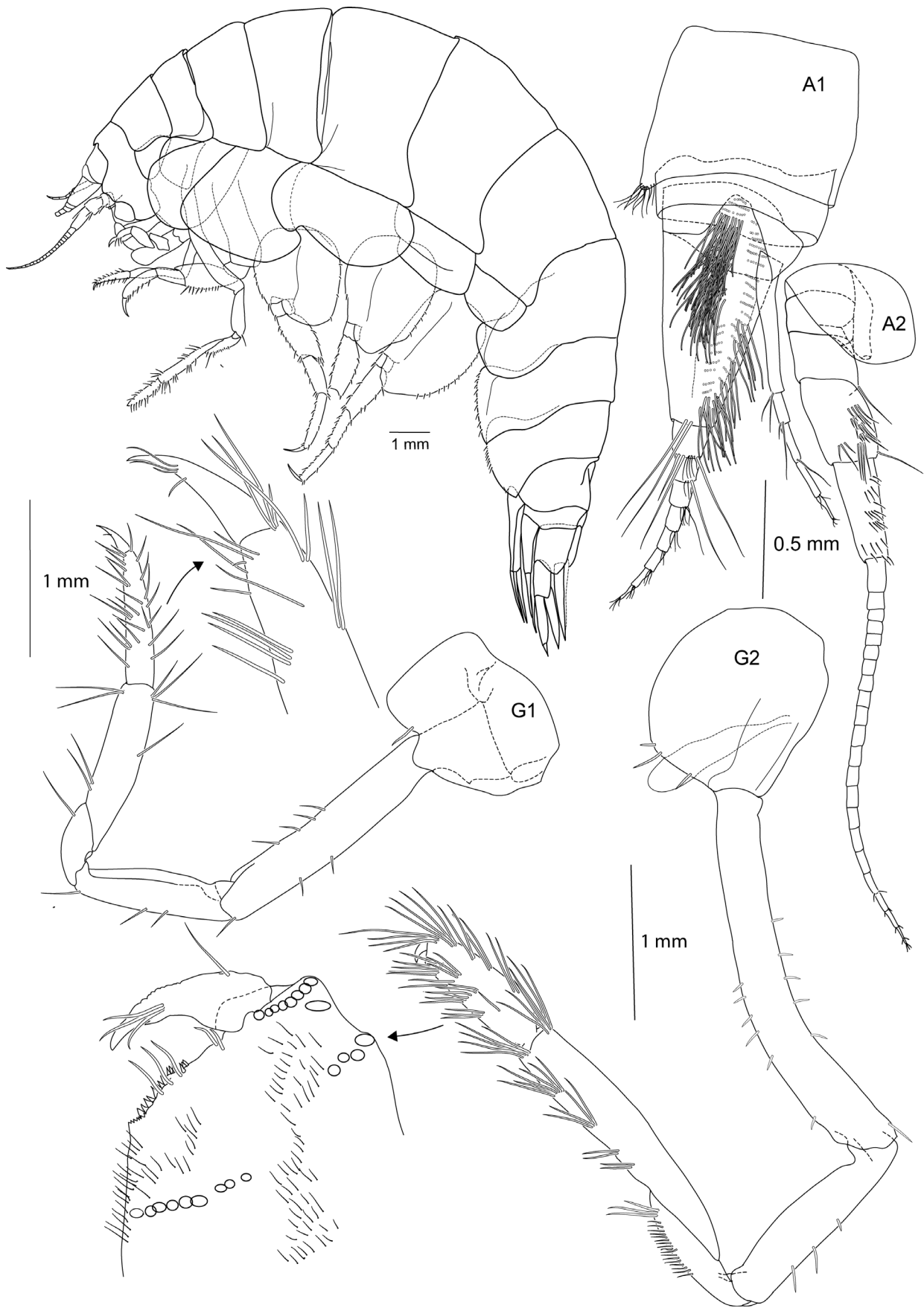
56770#1, DEMAR, 1 November, 2001 (bottom time 27 hours 47 minutes), 06° 12.88'S 10° 47.14'W, 1850 m, Angola Slope; 1 female specimen.

56734#1, DEMAR, 26 October 2001, (bottom time 22 hours 14 minutes), 06° 10.14'S 10° 46.62'W, 1859 m; 6 female specimens.

**Etymology.** The species is named in honour of the first author's son, Frank.

**Description.** Holotype female, 20.5 mm. *Head:* exposed, deeper than long, rather short dorsally but telescoped into peraeonite 1; lateral cephalic lobe moderate, subquadrate; rostrum small. *Eyes:* four, red pigmented, lacking ommatidea, pigment fades in alcohol; upper, undefined elongate shape spreading towards and covered by peraeonite 1; lower, larger, in cephalic lobe but partly covered by coxa 3. *Antenna 1:* short, 0.12 x body; peduncular article 1 short; peduncular article 2 short, 0.3 x article 1; peduncular article 3 short, 0.3 x article 1; primary flagellum nine-articulate; accessory flagellum long, 0.5 x primary flagellum, five-articulate, article 1 as long as articles 2–5 combined; calynophore strong two-field; calceoli absent. *Antenna 2:* short, 1.65 x antenna 1; peduncle without brush setae, not geniculate; peduncle article 1 not greatly enlarged; peduncle article 3 short, 0.5 x article 4; articles 4 and 5 not enlarged; flagellum well developed, 22-articulate.

*Mouthpart bundle:* subquadrate. *Epistome and upper lip:* separate, rounded, weakly produced, epistome dominant. *Mandible:* incisor smooth, weakly convex, with two small ventral 'teeth'; lacinia mobilis present on left mandible only, a slender peg without ornamentation; accessory setal rows with ten simple robust setae and many setules; molar a setose, proximally directed, non-triturating flap; palp attached distally; article 1 short, broader than long; article 2 slender, length 3.9 x breadth, with 14 A2 setae on distal 0.4; article 3 slender, tapering, length 4.1 x breadth, with 17 D3 setae and three E3 setae. *Lower lip:* outer plates gaping, setose marginally, inner lobes present, small, molar processes prominent, rounded distally. *Maxilla 1:* inner plate slender, with eight pappose setae along inner margin; outer plate with 11 setal-teeth in a 7/4 crown arrangement, ST1–6 weakly one-, two- or three-cuspidate, ST7 simple, ST7 displaced from ST6, STA–C one-cuspidate, STD, displaced from A–C, simple; palp large, two-articulate, article 1 short, article 2 broadened with three short robust setae on tridentate apical margin, one flag seta, three subapical robust setae, and one pappose seta on dorsal margin (not figured as damaged). *Maxilla 2:* inner plate short, 0.67 x length of outer plate, tapering, with rows of marginal and submarginal pappose and simple setae; outer plate with marginal and apical stout and slender setae. *Maxilliped:* inner plate large, subtriangular, with three very small nodular spines on strongly oblique apical margin, oblique setal row strong, with eight pappose setae; outer plate large, subovate, with 14 pappose setae and three robust setae apically and laterally, and about twenty minute nodular setae on medial margin; palp large, four-articulate, article 2 slender, length 2.4 x breadth, article 3 long, slender, length 3.1 x width, dactyl well-developed, slender, with three short subterminal setae.



**FIGURE 8.** *C. franki* sp. nov.: holotype; adult female, 20.5 mm, antennae and gnathopods. Paratype; adult female, 26.5 mm, habitus.

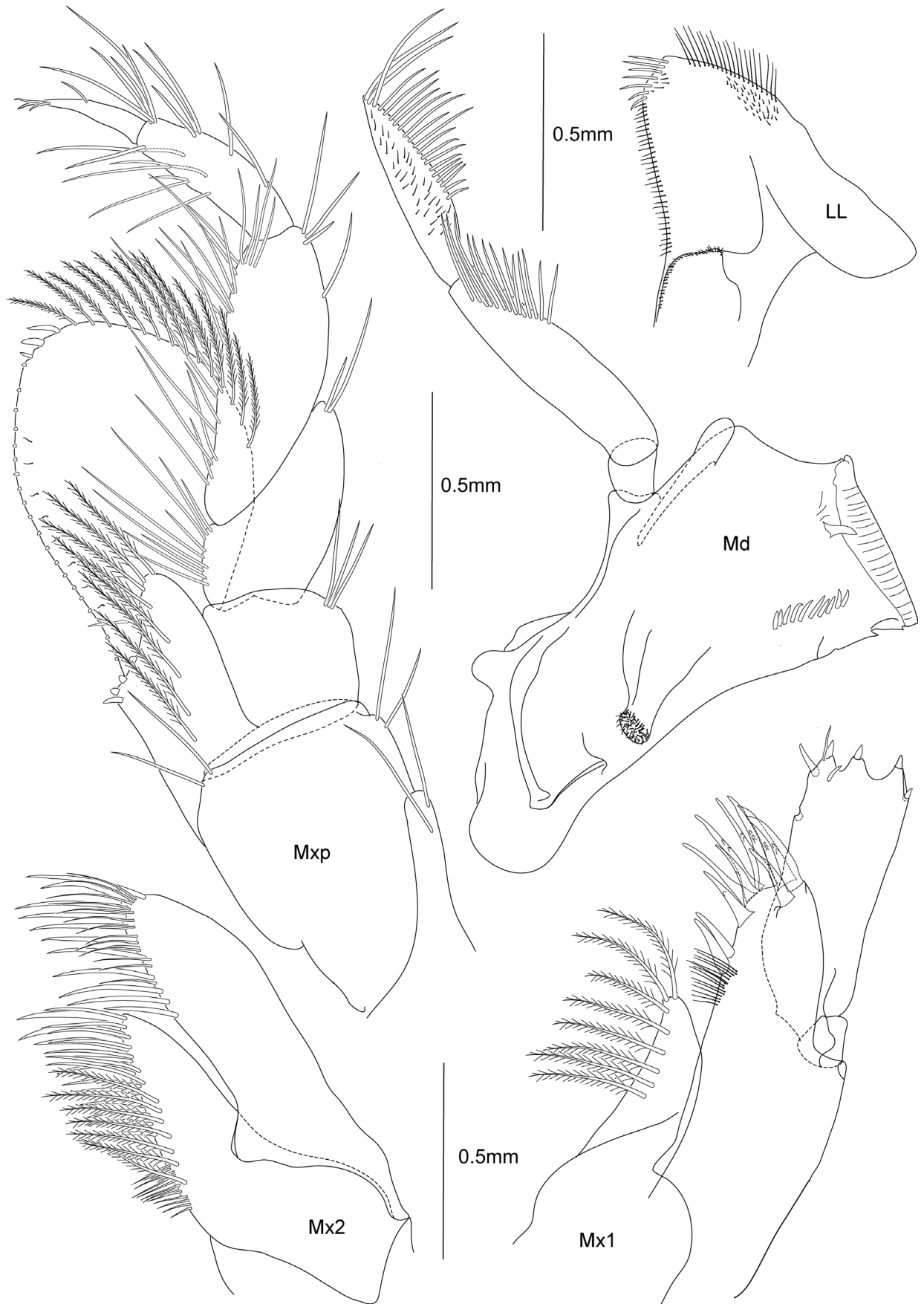
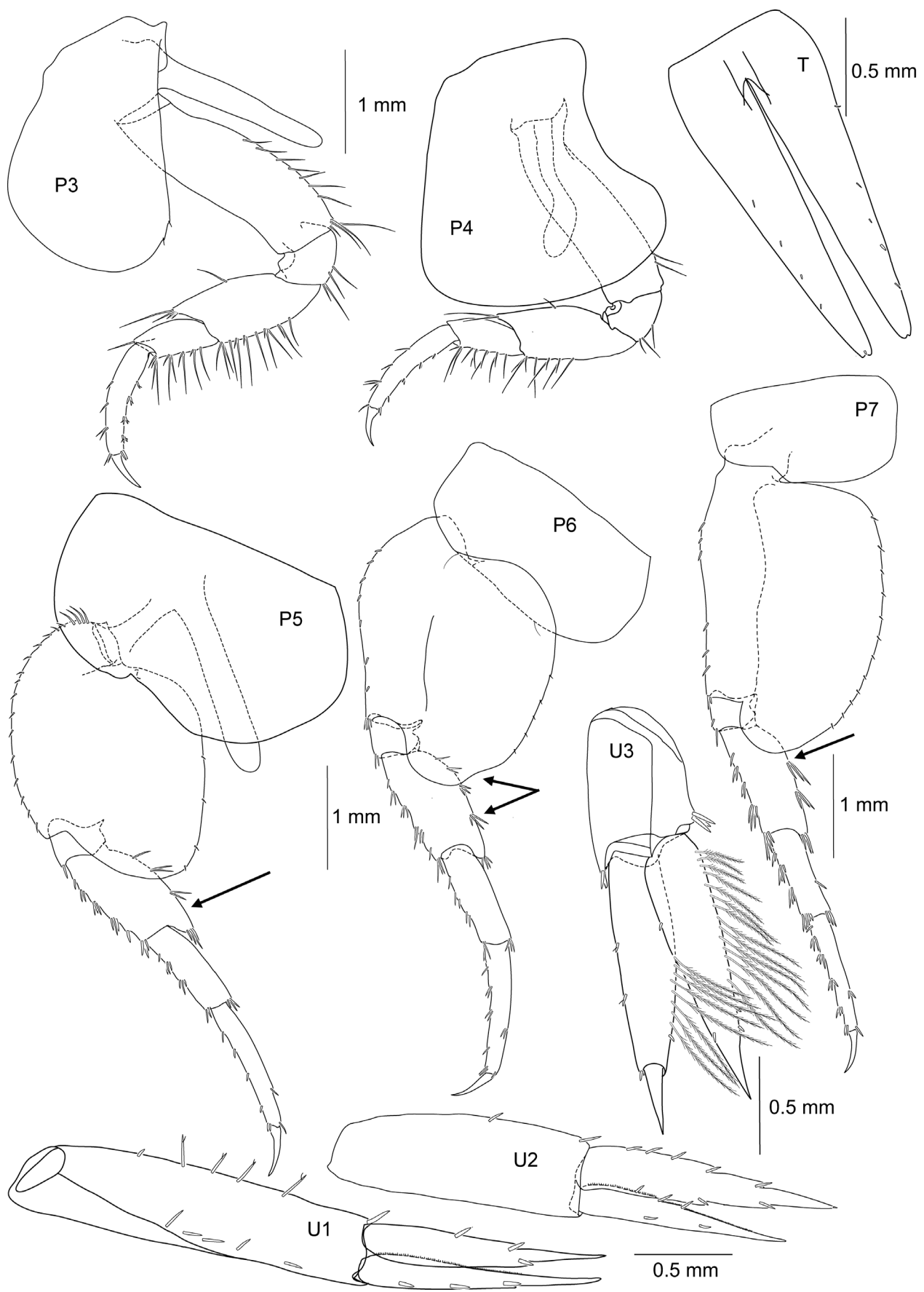
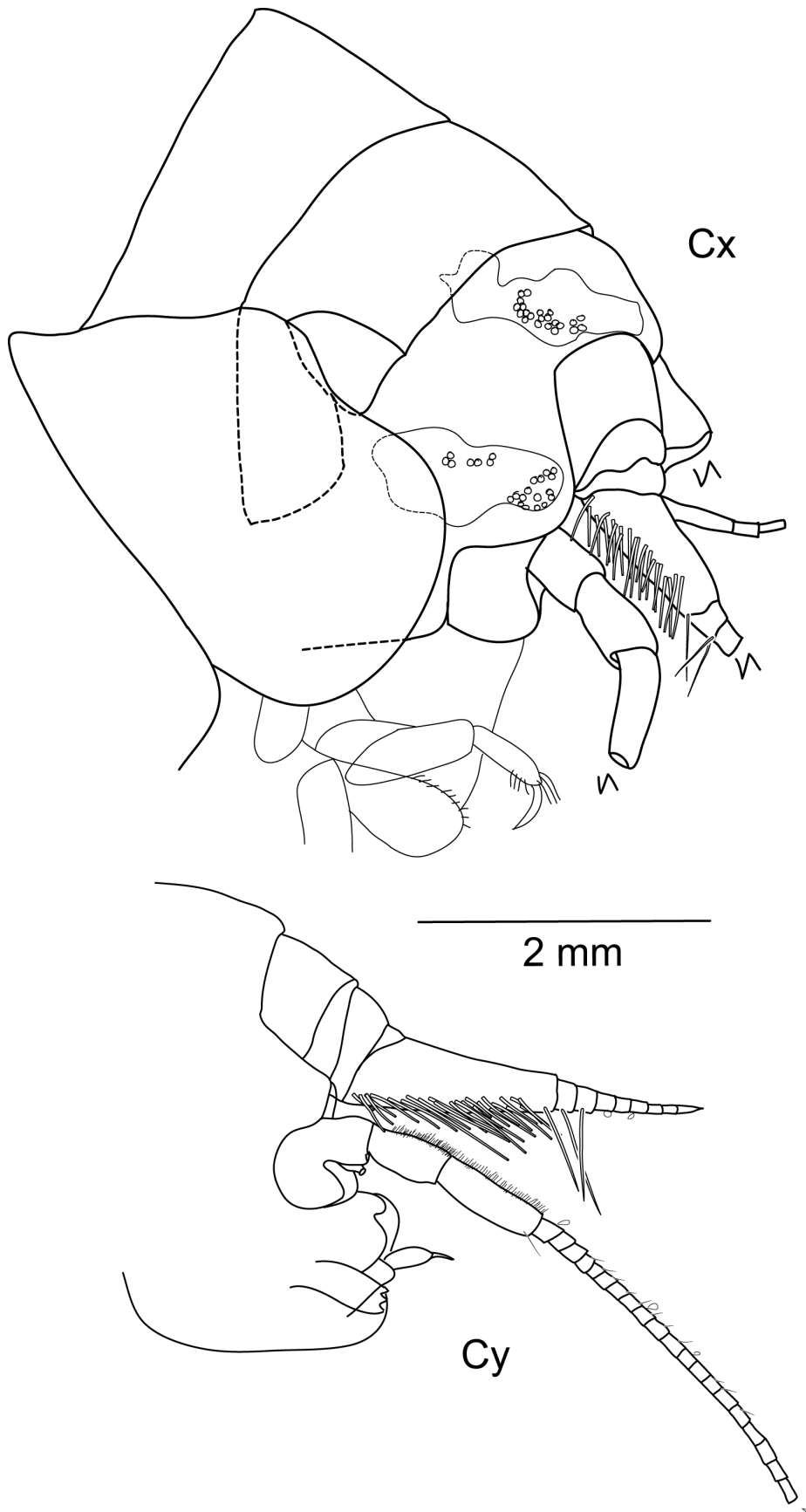


FIGURE 9. *C. franki* sp. nov.: holotype; adult female, 20.5 mm, mouthparts.





**FIGURE 10.** *C. franki* sp. nov.: holotype; adult female, 20.5 mm, peraeopods, uropods and telson.



**FIGURE 11.** *C. franki* sp. nov.: holotype; adult female, 20.5 mm, head. Allotype; adult male, 15.5 mm, head.

*Gnathopod 1*: simple; coxa vestigial, anterior margin straight, posterior margin convex; basis long, slender, length 5.5 x breadth, anterior margin straight, with four simple setae, posterior margin straight, with two simple setae; ischium long, length 3.4 x breadth; carpus very long, subquadrate, lacking posterior lobe, margins subparallel, length 4.2 x breadth, 1.3 x length of propodus; propodus long, subquadrate, length 4.9 x breadth, margins weakly convergent, anterior weakly convex, posterior weakly concave, palm absent; dactylus simple, length 0.34 x propodus, with subterminal setae. *Gnathopod 2*: subchelate; coxa vestigial, subrectangular; basis long, slender, curved, anterior margin convex, length 5.3 x breadth; ischium long, length 4.2 x breadth; carpus very long, length 5.6 x breadth, margins subparallel, posterior margin straight, 2.0 x length of propodus; propodus subovate, length 2.9 x breadth, setulose, palm acute, weakly convex, serrate distally; dactylus inserted near middle of propodus distal margin, reaching corner of palm. *Peraeopod 3*: coxa large, weakly expanded, broadly rounded distally; basis weakly sinuous, margins subparallel; merus narrowly produced anterodistally, extending 0.39 x length of carpus; dactyl slender, curved, 0.43 x length of propodus. *Peraeopod 4*: coxa as deep as wide, posteroventral lobe short, broadly rounded; distal articles as in peraeopod 3. *Peraeopods 5–7*: subequal in length. *Peraeopod 5*: coxa unequally bilobate, posterior lobe deeper, strongly produced posteriorly; basis expanded, subrectangular, posterior margin convex, posterodistal margin broadly rounded; merus produced posterodistally, extending 0.22 x length of carpus, propodus slender, length 6.4 x breadth; dactylus slender, curved, 0.38 x length of propodus. *Peraeopod 6*: coxa subrectangular, expanded posteriorly; basis expanded, posterior margin convex, distally bevelled, posterodistal lobe rounded; merus slender, posterior margin weakly convex, weakly produced. *Peraeopod 7*: coxa posterior lobate; basis expanded, tapering distally, posterior margin convex, posterodistal lobe narrowly rounded; merus slender, weakly produced posterodistally. *Gills*: gnathopod 2 to peraeopod 7; peraeopod 7 gill large. *Oostegites*: gnathopod 2 to peraeopod 5.

*Pleonites 1 to 3*: not carinate. *Epimeron 1*: broadly rounded ventrally. *Epimeron 2*: subrectangular; anteroventral corner rounded, posteroventral corner with acute tooth, posterior margin sinuous, ventral margin setose. *Epimeron 3*: expanded distally; anteroventral corner rounded, posteroventral corner with subacute tooth, posterior margin concave, ventral margin setose. *Urosome*: urosomite 1 lacking rounded boss; urosomite 2 occluded dorsally; urosomite 3 produced posterolaterally, markedly concave dorsally, with strong dorsolateral flanges. *Uropod 1*: peduncle with 5 dorsolateral robust setae and 5 dorsomedial robust setae; inner ramus 0.68 x length of peduncle, with 2 dorsomedial setae; outer ramus as long as inner ramus, with 3 dorsolateral setae. *Uropod 2*: peduncle with 1 dorsomedial robust seta; inner ramus as long as peduncle, with 2 lateral and 5 medial setae; outer ramus 0.83 x inner ramus, with 2 lateral and 3 medial setae. *Uropod 3*: peduncle short, with 3 dorsomedial setae; rami subequal, lanceolate, with plumose setae on medial margins; inner ramus 1.7 x peduncle, with 2 lateral and 2 medial robust setae; outer ramus 2-articulate, article 2 length 0.23 x article 1 with 2 lateral and 1 medial robust setae. *Telson*: long, lobes tapering, length 2.3 x breadth, cleft 85%; lobes with 4 dorsolateral robust setae, apices weakly notched, lacking robust setae.

**Male.** Similar to female except for calceoli on both antennae and a longer callynophore.

**Remarks.** This species is most closely related to *Cyclocaris lowryi*. It can be distinguished from that species by characters of pereopods 5–7. *C. franki* has the basis of peraeopod 5 produced posterodistally, the basis of peraeopod 6 emarginate posterodistally, and peraeopods 5–7 with broad meral articles (length/breadth ratios 1.6, 1.7 and 2.1 respectively). In contrast, *C. lowryi* has the basis of peraeopod 5 broadly rounded and produced distally, the basis of peraeopod 6 convex posterodistally, and peraeopods 5–7 with narrow meral articles (length/breadth ratios 2.2, 2.7 and 2.9 respectively). *C. franki* can be distinguished from *C. tahitensis* by the lack of eyelobes and the broadly rounded posterodistal lobe of coxa 4 of the latter.

*C. franki* differs from *C. guilelmi* in having subacute triangular eyelobes and four evanescent red-pigmented ocular patches in contrast to the broadly convex anteroventral head margin and permanent yellow-brown ocular pigment covering the whole head of the latter species.

The single specimen from Monaco Station 1206 close to the Cape Verde Islands, collected at a depth of 1477 m and recorded as *C. tahitensis* by Chevreux (1903, 1935) belongs to this species. Chevreux noted that the only differences he could find between the Tahiti specimen (*C. tahitensis*) and his specimen were that pereopods 5–7 were more spinose and the apices of the telson were a little different.

All known material of *C. franki* has been obtained from baited benthic traps.

**Distribution.** Atlantic Ocean. Angolan continental margin, 1850–2059 m; Sierra Leone Rise, 1203 m (present material); Cape Verde Islands, 1477 m (Chevreux, 1903, 1935).

### *Cyclocaris guilelmi* Chevreux, 1899

*Cyclocaris Guilelmi* Chevreux, 1899: 148–152, figs 1–5;—Sars, 1900: 20–25, pls 2–3;—Damas and Koefoed, 1907: p. 438;—Stephensen, 1917 (1913): 107–108;—Chevreux, 1935: 28–30, pl. 16, figs 3, 8, 24, 26.  
*Cyclocaris guilelmi* Stebbing, 1906: 31;—Brüggen, 1907: 215–216;—Stephensen, 1923: 52–54, chart 10;—Schellenberg, 1927: 664–665, fig. 59;—Stephensen, 1933: 8–9, map, fig. 3;—Stephensen, 1935: 43, figs 2–3;—Gurjanova, 1951: 181–182, fig. 53.—Barnard, 1958: 91.—Barnard, 1959: 116–117, figs 4–5.—Gurjanova, 1962: 87–88, fig. 18.—Barnard & Karaman, 1991: 479.—Bucklin *et al.*, 2010: 42, 46.  
*Cyclocaris faroensis* Norman, 1900: 197–198, pl. 6, figs 5–15.—Thurston & Allen, 1969: 358.

**Remarks.** This species differs from all others in the genus by the permanent yellow-brown ocular pigment covering the whole surface of the head. The absence of eyelobes separates it from *C. lowryi* and *C. franki*. The comparison is based on Barnard (1959), the best available account of the species.

*C. guilelmi* is a well known Arctic species. It occurs widely at mesopelagic and bathypelagic depths, mostly at 500–2000+m (Stephensen, 1923, Østvedt, 1955, Birstein & Vinogradov, 1958, 1970), but has been recorded in the epipelagic zone (Sars, 1900, Stephensen, 1933). The species is attracted to sediment traps in large numbers (Seiler & Brandt, 1997, Kraft *et al.* 2013) and has been taken occasionally in baited traps, both benthic, at 1095 m (Chevreux, 1899, 1935), and midwater, at 1800 m (Barnard, 1959). The species appears to breed throughout the year (Kraft *et al.* 2013).

**Distribution.** Disjunct: Arctic Ocean, north-west Pacific Ocean. Norwegian Sea, Greenland Sea, south to the Faroe-Shetland Channel (Norman, 1900, Stephensen, 1923, Østvedt, 1955, Seiler & Brandt, 1997, Vinogradov, 1997, Kraft *et al.* 2013); Baffin Bay (Stephensen, 1933, Buchanan & Sekerak, 1982); Arctic Ocean, Nansen, Amundsen, Makarov and Canadian Basins (Sars, 1900, Barnard, 1959, Kosobokova *et al.*, 2011); Pacific Ocean north of 39°N and west of 170°E (Birstein & Vinogradov, 1955, 1958, 1970).

### *Cyclocaris tahitensis* Stebbing, 1888

*Cyclocaris tahitensis* Stebbing, 1888: 664–668, pl. 8; 1906: 30, fig. 7.—Della Valle, 1893: 843, pl. 60, fig. 53.—J.L. Barnard 1958: 91.—Gurjanova, 1962: 85–86, 88, fig. 17.—Thurston & Allen, 1969: 358.—Wilson *et al.*, 1985: 1248, 1251.—Barnard & Karaman, 1991: 479.—Vinogradov & Vinogradov, 1991: 33.—Vinogradov, 1993: 43.—Lowry & Stoddart, 1994: 153.

**not** *Cyclocaris tahitensis*—Chevreux 1903: 89; 1935: 31, pl. 4, fig. 4 (= *Cyclocaris franki* sp. nov.).

**Material examined.** Holotype, ca. 17 mm, Challenger station 279, off Tahiti, collected in a plankton tow net, in a sounding of 768 m. The type material consists of 3 slides (Reg. No. NHMUK 1889.5.15.20). The slides are in poor condition but are recognisable as the specimen used for Stebbing's original illustrations.

**Remarks.** Material collected at the Îles Australes (south-west Pacific Ocean) shows the species to have a large, irregularly-shaped eye which fades with preservation (Lowry & Stoddart, 2011).

Vinogradov & Vinogradov (1991), Vinogradov (1993) and Lowry & Stoddart (1994) have shown that *C. tahitensis* is a widespread, abundant scavenger in the South Pacific Ocean. All material except the type specimen and the material reported by Vinogradov (1993) was collected in baited benthic traps.

**Distribution.** Pacific Ocean. Central North Pacific, Hamilton and Hess guyots, 1740–1790 m (Wilson *et al.*, 1985); south-west Pacific, Tahiti (depth unknown but less than 768 m), Îles Australes, 65–870 m, (Lowry & Stoddart, 1994); south-east Pacific, 24° 58'S 88° 24'W, 560 m (Vinogradov & Vinogradov, 1991), East Pacific vent region west of Sala y Gomez, 27° 00'S 111° 24'W, 2024–2038 m (Vinogradov, 1993).

### *Cyclocaris* sp.

*Cyclocaris* sp.—Shulenberg & Hessler, 1974: 185.—Shulenberg & Barnard, 1976: 257–258.—Hessler, Ingram & Smith, 1979: 703–714.—Ingram & Hessler, 1983: 690, 698.

**Remarks.** A single specimen showing “... numerous characteristics intermediate between the two known species of the genus ...” was recovered from a trap set at 5720 m at 28°N 155°W (Shulenberg & Barnard, 1976). A further

66 specimens were trapped in the same area centred around 30° N 158°W and 31°N 158°W at 5600–6000 m (Hessler *et al.*, 1979; Ingram & Hessler, 1983). No description has been given and the status of this material remains uncertain.

### Key to the species of *Cyclocaris*

1. Head without prominent eye lobe; single pair of eyes or eyes covering whole of head (may fade in alcohol).....2
- Head with distinct subtriangular eye lobe; two pairs of eyes present (may fade in alcohol) .....3
2. Eyes covering whole of head; Arctic Ocean, north-west Pacific Ocean, cold water species .....*Cyclocaris guilelmi*
- Large eye not covering whole of head; Pacific Ocean species. .... *Cyclocaris tahitensis*
3. Pereopods 5–7 merus expansion broad, (L/W ratios 1.6, 1.7, 2.2 for P5–7 respectively) (see Figure 10: P5–7); Pereopod 6 basis with bevel; basis broadly expanded, subquadrate (see Figure 10:P6)..... *Cyclocaris franki*
- Pereopods 5–7 merus expansion narrower, (L/W ratios 2.2, 2.8, 2.9 for P5–7) (see figure 6: P5–7); Pereopod 6 basis without bevel; basis expanded, oval (see Figure 6:P6) .....*Cyclocaris lowryi*

\*Arrows in Figure 6 and Figure 10 indicate key differences in Pereopods.

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