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A new species of *Eusirus* Krøyer, 1845 (Amphipoda, Amphilochidea, Eusiridae) from the seamount of the Caroline Plate, with redescription of *Meteusiroides keyensis* Pirlot, 1934

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Abstract

A new *Eusirus* Krøyer, 1845 species within the family Eusiridae Stebbing, 1888 is described based on specimens collected from seamounts of the Caroline Plate. *Eusirus carolinus* **sp. nov.** is characterized by having large, well-pigmented eyes, the distomiddorsal mediodorsal pointed process only present on pleonites 1 and 2, epimeral plate 3 with a smooth posterior margin, the elongated telson only cleft 20%, and the rami of uropod 3 being equal in length. A rare eusirid species, *Meteusiroides keyensis* Pirlot, 1934, is redescribed as providing the living coloration based on one female specimen. Sequences of two genes (16S rRNA and COI) were used to analyze their relationships with other species in the family Eusiridae and confirm the taxonomic placement. The result supports the monophyly of *Cleonardo* Stebbing, 1888; *Eusirus* and *Rhachotropis* S.I. Smith, 1883; and is consistent with morphological classification.

Key Words

Deep sea, Eusiridae, morphology, systematics, taxonomy, western Pacific

Introduction

Seamounts are isolated islands that can give rise to unique ecological communities (Richer de Forges et al. 2000; Hobbs et al. 2008). Hence, seamounts harbor vibrant biodiversity (Morato et al. 2010). However, despite wide recognition as important marine habitats, in both tropical and temperate oceans, seamounts remain one of the least explored and studied marine biomes on Earth (Clark et al. 2010; Yesson et al. 2011). The tropical Indo-West Pacific region, which is considered a global center of marine biodiversity, lacks significant research on seamounts (Clark et al. 2010). Most studies on Pacific seamount ecosystems and biodiversity have focused on the middle-eastern and eastern Pacific, as well as the southwestern Pacific (George 2013; Kitahashi et al. 2020).

As one of the largest orders of the Crustacea, Amphipoda encompasses over 10,000 reported species that inhabit all types of aquatic environments (cf. Barnard and Karaman 1991; Lowry and Myers 2017; Arfianti and Costello 2021; Horton et al. 2024). A few numbers of species have been described from seamounts (Bucklin et al. 1987; Lowry and Myers 2003; Kilgallen 2009; Lörz 2012; Hughes 2016; Wang et al. 2020; Espinosa-Leal et al. 2021; Lörz and Horton 2021; Frutos and Sorbe 2022). During the biodiversity of seamounts survey conducted by the Chinese research vessel KEXUE in the Caroline Plate, NW Pacific, between 2017 and 2019, three individuals belonging to the family Eusiridae Stebbing, 1888, were collected.

The status of the superfamily Eusiroidea Stebbing, 1888, is controversial (Verheye et al. 2016; d'Udekem d'Acoz and Verheye 2017; Myers and Lowry 2018).

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According to the current classification by Lowry and Myers (2017), the superfamily Eusiroidea contains four independent families, including Bateidae Stebbing, 1906; Eusiridae, Miramarassidae Lowry, 2006; and Thurstonellidae Lowry & Zeidler, 2008 (Horton et al. 2024). The family Eusiridae contains 13 valid genera with 125 species (Corbari et al. 2019; Ariyama and Kohtsuka 2022; Horton et al. 2024), which occur from intertidal to abyss (Bousfield and Hendrycks 1995; Lörz 2010). Among the collected individuals in the present study, two specimens were identified as a new species of the genus *Eusirus* Krøyer, 1845, which is described herein. We also highlight the morphological distinctions between the new species and other species within the genus. Additionally, one female specimen was identified as *Meteusiroides keyensis* Pirlot, 1934, which was first reported outside its type locality. The present study redescribed and illustrated *M. keyensis* and provided the living coloration of the species.

Material and methods

The examined material was collected by ROV FAXIAN during expeditions to seamounts on the Caroline Plate by the Institute of Oceanology, Chinese Academy of Sciences (IOCAS) during August 2017 and June 2019. The specimen is deposited in the Marine Biological Museum, Chinese Academy of Sciences, Qingdao, China. The individual was examined and dissected with a dissecting microscope (ZEISS Discovery V20). Line drawings were completed using the software Adobe Photoshop CS6 on a graphics tablet. The length measurement was made along the outline of the animal, beginning from the rostrum to the posterior margin of the telson.

DNA was obtained from their mitochondrial genome (unpublished works) by homologous alignment: 16S rRNA (16S, approximately 860 bp) and cytochrome oxidase I (COI, 1542 bp). 27 described and undescribed species within Eusiridae and two outgroup taxa of Liljeborgiidae Spence Bate, 1863 were encompassed in the phylogenetic analysis (Suppl. material 1).

The sequences obtained were aligned using MEGA 6 (Tamura et al. 2013) and concatenated using SequenceMatrix 1.8 (Vaidya et al. 2011), resulting in a combined sequence length of 995 bp. Phylogenetic trees were constructed by two methods: maximum likelihood (ML) and Bayesian inference (BI). The ML analyses were conducted online using W-IQ-TREE (http://iqtree.cibiv.univie.ac.at/) (Trifinopoulos et al. 2016), with clade support evaluated via 10,000 ML bootstrap replications. The optimal model of evolution for each dataset was determined using jModelTest 0.1.1 based on the Akaike information criterion (AIC) (Posada 2008). BI analyses were performed with MrBayes 3.2.7 (Huelsenbeck and Ronquist 2001), employing a Markov Chain Monte Carlo (MCMC) algorithm with two runs, each consisting of four chains, for 1,000,000 generations and sampling trees every 500 generations, totaling 2,000 sampled trees. The effective sample size (ESS) values for all sampling parameters were checked with Tracer v1.7 (Rambaut et al. 2018). The initial 500 trees were discarded as burn-in, and posterior probabilities (PP) were calculated from the remaining trees.

Multiple species delimitation methods were utilized to assess the hypothesis that the specimen is a distinct species. The COI data, comprising 58 homologous sequences, were subjected to Automated Barcode Gap Discovery (ABGD) analysis using a web-based interface (https://bioinfo.mnhn.fr/abi/public/abgd/abgdweb.html), as described by Puillandre et al. (2012). The analysis was conducted using the Kimura 2-parameter substitution model (TS/TV = 2.0), with a prior range for maximum intraspecific divergence set between 0.001 and 0.1, encompassing 10 recursive steps, and a relative gap width (X) of 1.0. Additionally, Bayesian implementation of the Poisson Tree Processes (bPTP) species delimitation model was employed as per Zhang et al. (2013), conducted on the web server of the Heidelberg Institute for Theoretical Studies, Germany (http://species.h-its.org/), using BI phylogenetic trees as the input data.

Systematic account

Order Amphipoda Latreille, 1816
Suborder Amphilochidea Boeck, 1871
Superfamily Eusiroidea Stebbing, 1888
Family Eusiridae Stebbing, 1888

Genus *Eusirus* Krøyer, 1845

Diagnosis. See Barnard and Karaman (1991).

Eusirus carolinus sp. nov.

https://zoobank.org/20295258-98BE-489C-9CBA-C5FF0E4F1960
Figs 1–5

Material examined. ***Holotype*:** Western Pacific • 1 brooding female (with 9 intra-marsupial individuals), 12.9 mm; seamount on Caroline Plate; 10°30'N, 140°9–10'E; depth 520–862 m; 26 Aug. 2017; MBM 286609.

***Paratype*:** Western Pacific • 1 male; 13 mm; seamount on Caroline Plate; 10°30'N, 140°9–10'E; depth 520–862 m; 26 Aug. 2017; MBM 286608.

Description. ***Body*.** Pleonites 1–3 carinate dorsally; pleonites 1 and 2 with acute distomiddorsal teeth; epimera 1 and 2 postero-distal corner subacute; epimeron 3 postero-distal corner rounded, without serration. ***Head*.** Lateral cephalic lobe with apically-oblique rostrum. Eyes large, reniform. Antenna 1 stout, with peduncular articles 1–3 in length ratio of 1: 0.95: 0.36; distal margin of peduncular article 1 with inner surface bearing two distal processes; article 2 distal margin produced as two triangular distal processes in outer and inner surfaces, respectively; primary flagellum 55-articulate; first article

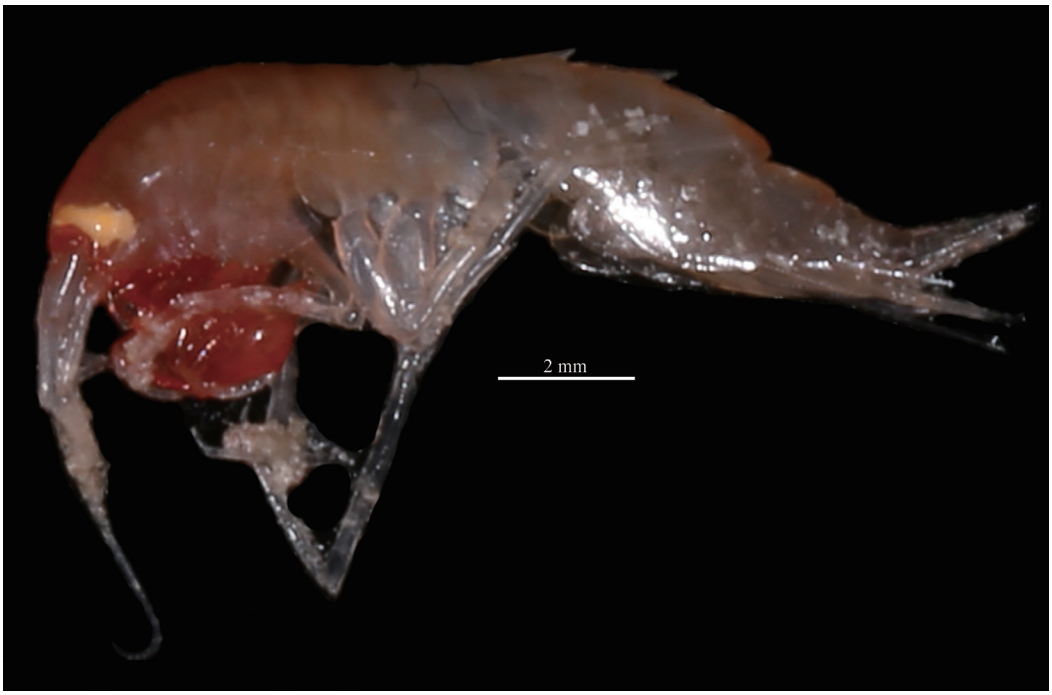

Figure 1. *Eusirus carolinus* sp. nov. female holotype (MBM 286609). Photographed immediately after collection by Jun-long Zhang.

nearly as long as the third peduncular article; accessory flagellum 1-articulate. Antenna 2 shorter than antenna 1, with peduncular article 4 subequal in length to article 5; flagellum distinctly longer than fifth peduncular article, 29-articulate.

***Mouthparts*.** Upper lip distally rounded, apex convex, and weakly produced, bearing fine submarginal setae. Right mandible with incisor bearing one blunt anterodistal tooth and not dentate lacinia mobilis; accessory setal row composed of 5 stout setae; molar triturative, columnar; palp 3-articulate, much longer than mandible body; article 1 shortest; article 2 slightly shorter than article 3, with row of long simple setae; article 3 with ventral margin heavily setose; and outer margin bearing one long (about 3/5 length of third palp article) simple seta. Left mandible, incisor with one blunt large anterodistal tooth, lacinia mobilis 8-dentate; accessory setal row composed of 6 setae; molar and palp similar to those of right mandible. Lower lip with weak inner lobe; outer lobe subovoid, rounded distally; both inner and outer lobes covered with marginal and submarginal setae. Maxilla 1 outer plate with 11 stout multicuspidate setae on apical margin; inner plate subovoid, apex bearing one seta; palp long far beyond outer lobe, 2-articulate; article 2 with about 15 setae along apex and mediodistal margin. Maxilla 2 with inner plate broader than outer plate, both with fine marginal setae. Maxilliped heavily setose, inner plate short, not reaching to distal margin of first palp article, distally armed with about 10 stout setae; outer plate extending to about 1/2 length of article 2 of palp, laterally armed with short robust setae and distally armed with long plumose setae; palp 4-articulate, slender, article 2 slightly longer and broader than article 3; dactylus shorter than article 3, claw-like, unguis very short, ventral margin bearing 5 long stout setae.

Coxal gills present on pereopods 2–7. Oostegites present on pereopods 2–5.

***Gnathopods and pereopods*.** Gnathopods similar in shape: gnathopod 1 subchelate, eusirid form; coxa 1 broadened distally, slightly expanded anteroventrally; basis steady in width, not distinctly broadened distally; anterior margin flat, bearing several setae; posterior margin with a group of setae distally; ischium short, with rounded lobe anterodistally; carpus lobe linguiform, narrow, covered with long setae anterior margin; outer face with acute pointed process distally and inner face rounded distally; propodus wider than long, subrectangular, shorter than carpus in length of anterior margin, with one group of defining setae; palm lined with numerous crooked setae submarginally; dactylus falcate, fitting palm. Gnathopod 2 similar to gnathopod 1, stout, eusirid form, coxa rectangular, ventral margin convex; basis slightly longer than that of gnathopod 1; ischium, merus, carpus propodus, and dactylus similar in appearance to gnathopod 1. Pereopod 3 slender, coxa rectangular; basis linear; anterior margin with simple setae; merus about twice as long as carpus, distinctly longer than propodus; propodus with posterior margin bearing several small stout setae; dactylus elongate, slightly curved; posterior margin dentate. Pereopod 4 broken, coxa subequal in length to coxa 3, posteriorly emarginated, postero-distal corner subacute, basis linear, anterior margin with simple setae. Pereopod 5 shorter than pereopods 6 and 7; coxa equilobate, both expanded posteroventrally; basis increasing in length from pereopods 5 to 7, with posteroventral lobe, posterior margins lateral border moderately expanded,

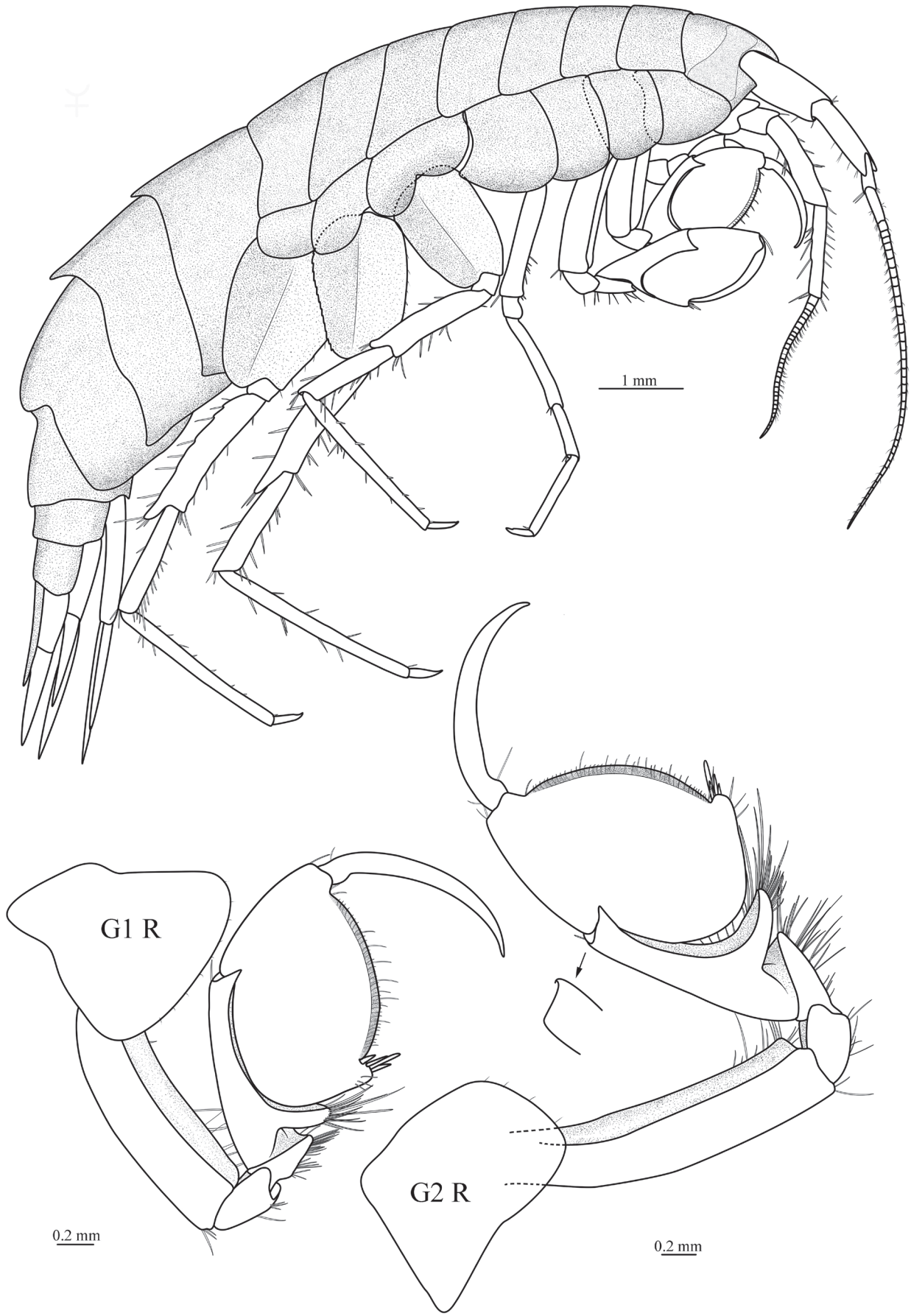

Figure 2. *Eusirus carolinus* sp. nov. female holotype (MBM 286609). **G1 R.** Right gnathopod 1; **G2 R.** Right gnathopod 2 (also showing the medial side of the distal margin of the carpus).

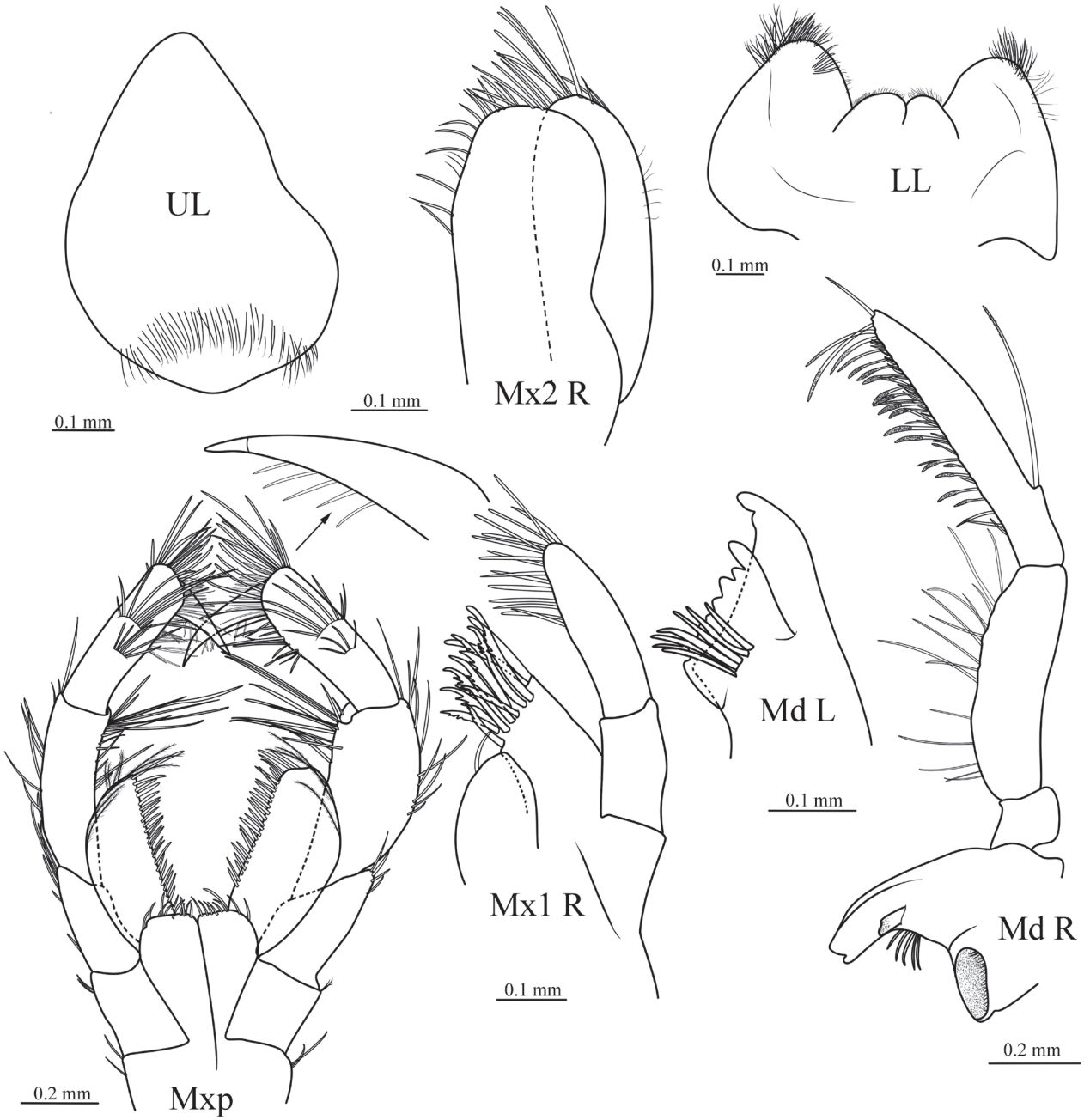

Figure 3. *Eusirus carolinus* sp. nov. female holotype (MBM 286609). **UL.** Upper lip; **LL**. Lower lip; **Md L.** Left mandible (not showing molar and palp); **Md R.** Right mandible; **Mx1 R.** Right maxilla 1; **Mx2 R.** Right maxilla 2; **Mxp.** Maxillipeds.

serrate, anterior margin with short robust setae; merus increasing in length from pereopods 5 to 7, posterodistally strongly produced, margins with stout setae; carpus subequal in length to merus, margins with stout setae; length ratios of merus to propodus 1: 0.77: 1.20; dactylus nearly straight, anterior margin with about distal 1/3 length dentate. Pereopods 6 and 7 subequal in length; coxa 6 bilobate; merus longer than that of pereopod 5; carpus distinct shorter than merus; propodus slender; margins with stout setae; length ratios of merus to propodus 1: 0.77: 1.31. Pereopod 7 with posterior margins of basis lateral border moderately expanded and distinctly concave, posterodistal corner subacute; length ratios of merus to propodus 1: 0.68: 1.25.

***Uropods and telson*.** Uropod 1 with peduncle subequal in length to outer ramus, bearing numerous short laterals and long medial robust setae dorsally, with one enlarged stout seta at mesiodistal corner; inner ramus 1.3 times as long as outer ramus, both rami bearing robust setae and lateral and medial margins. Uropod 2 with rami lanceolate; peduncle slightly shorter than outer ramus; lateral margin with two subdistal robust setae dorsally; medial margin with seven robust setae; inner ramus nearly twice as long as outer ramus; both rami with inner and medial margins bearing dense robust setae; outer ramus narrower than inner ramus. Uropod 3 shortest, rami lanceolate, subequal in length; peduncle 0.5 times as long as rami; lateral margin bearing one long distal robust sate

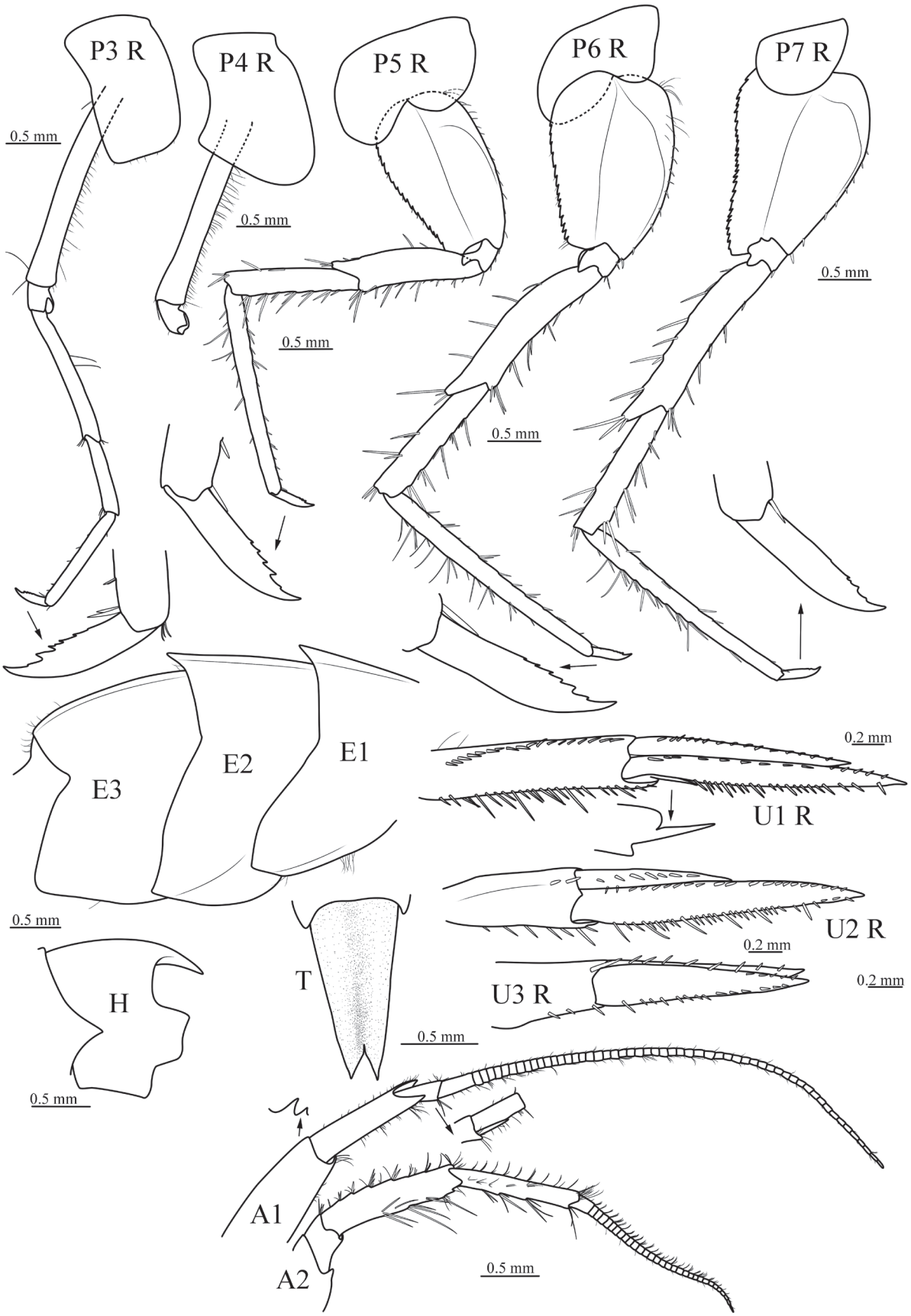

Figure 4. *Eusirus carolinus* sp. nov. female holotype (MBM 286609). **P3 R.** Right pereopod 3; **P4 R.** Right pereopod 4; **P5 R.** Right pereopod 5; **P6 R.** Right pereopod 6; **P7 R.** Right pereopod 7; **E1–3.** Epimeral plates 1–3; **U1 R.** Right uropod 1; **U2 R.** Right uropod 2; **U3 R.** Right uropod 3; **T.** Telson; **H.** Head; **A1.** Antenna 1 (also showing ventral side of distal margin of peduncular article 1 and accessory flagellum); **A2.** Antenna 2.

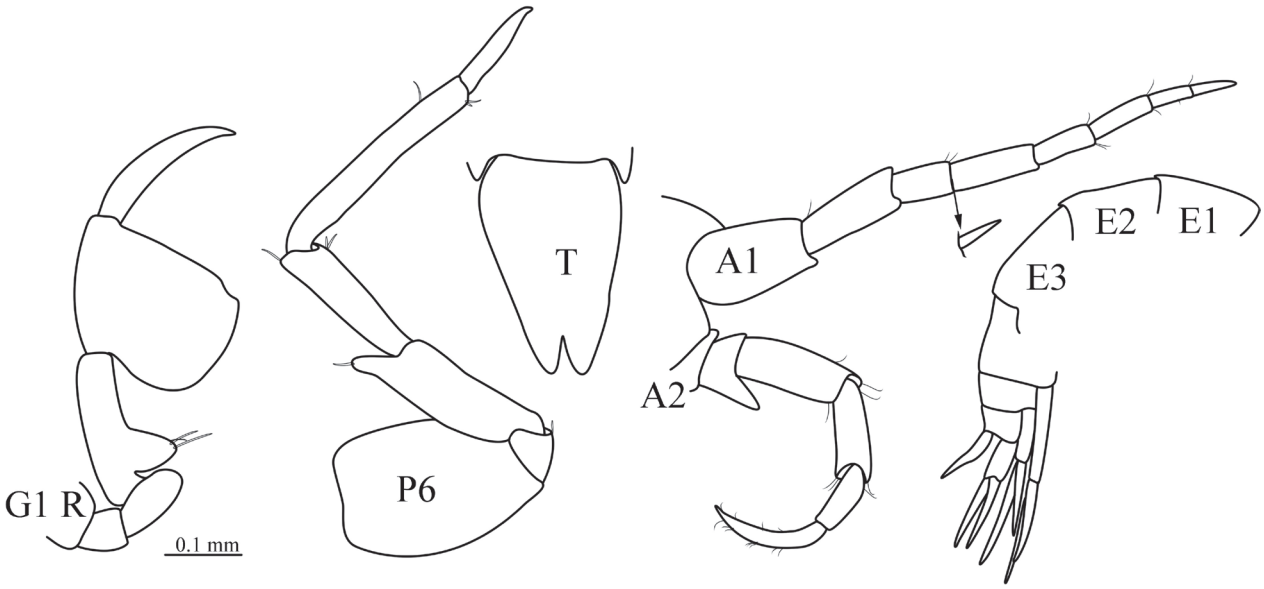

Figure 5. *Eusirus carolinus* sp. nov., one of the intra-marsupial individuals of female holotype (MBM 286609, 2.5 mm). **G1 R.** Right gnathopod 1; **P6 R.** Right pereopod 6; **T.** Telson; **A1.** Antenna 1 (showing accessory flagellum); **A2.** Antenna 2; **E1–3.** Dorsolateral parts of epimeral plates 1–3.

dorsally; medial margin bearing three small robust setae dorsally; both rami with lateral and medial margin setose dorsally. Telson long, slightly tapering distally, reaching about half of the length of uropod 3 rami, length about twice its breadth at base, cleft 15% of length.

Description of intra-marsupial individual. Based on one of the intra-marsupial individuals of the holotype. Rostrum present. Antenna 1 with peduncle articles less setose; primary flagellum only slightly longer than peduncle, 5-articulate; each article slightly longer than the third peduncular article, less setose; accessory flagellum 1-articulate. Antenna 2 much shorter than antenna 1, peduncle less setose; articulations of flagellum inconspicuous and less setose. Gnathopods 1–2 similar in shape and size, subchelate, eusirid form; carpus lobe linguiform broader than that of adult, only covered with several setae mediodistally; propodus similar in form to that of the adult, but without setae; anterior margin subequal in length to carpus; palm not bearing crooked setae submarginally; dactylus stout, slightly curved. Pereopods 3 and 4 subequal in length and similar in form, less setose; dactylus nearly straight, slightly shorter than propodus, with posterior margin not dentate. Pereopod 5 shorter than pereopods 6 and 7. Pereopod 6 basis with posterior margin smooth, not serrate, anterior margin without setae; merus with large posterodistal pointed process bearing one seta; length ratios of merus to propodus 1: 0.83: 1.33; dactylus elongate, about half length of propodus, nearly straight, anterior margin not dentate. Pleonites 1–3 not carinate; pleonites 1–2 with small acute mid-dorsal tooth. Uropods 1–3 similar to those of adults but without robust setae on peduncles and rami. Telson long, length 1.6 times its breadth at base, cleft 15% of length, narrower than that of adult, slightly tapering distally.

Coloration. Anterior part of body is red with yellow eyes; gnathopods 1–2 are deep red; and antennae 1–2 and posterior part of body are pale red.

Etymology. The new species is named after its type locality, the Caroline Plate.

Distribution. Presently known only from a seamount of the Caroline Plate at a depth of 520–862 meters.

Remarks. Table 1 shows the distribution, depth information, and important characters of *Eusirus* species. Nine species have been reported from the Pacific, including *Eusirus antarcticus* Thomson, 1880; *E. bathybius* Schellenberg, 1955; and *E. bulbodigitus* Jung, Kim, Soh & Yoon, 2016; *E. columbianus* Bousfield & Hendrycks, 1995; *E. cuspidatus* Krøyer, 1845; *E. fragilis* Birstein & M. Vinogradov, 1960; *E. hirayamai* Bousfield & Hendrycks, 1995; *E. liui* Wang, Sha & Ren, 2021; and *E. parvus* Pirlot, 1934. *Eusirus carolinus* sp. nov. can be distinguished from *E. bathybius*, *E. fragilis*, and *E. liui* by having large, well-pigmented eyes (Schellenberg 1955; Birstein and Vinogradov 1960; Wang et al. 2021). The new species differs from the remaining six Pacific *Eusirus* species by presenting the posterior margin of epimeron 3 as smooth, while epimeron 3 presents a serrate posterior margin in the mentioned six species (Krøyer 1845; Stebbing 1906; Pirlot 1934; Gurjanova 1951; Bousfield and Hendrycks 1995; Jung et al. 2016; Othaitz and Sorbe 2020). The body of *Eusirus carolinus* sp. nov. only has distomiddorsal teeth on pleonites 1–2, while the pereonite 7 of three species, *E. cuspidatus*, *E. hirayamai*, and *E. parvus*, also has a distomiddorsal tooth other than the teeth on pleonites 1–2 (Krøyer 1845; Pirlot 1934; Hirayama 1985). The new species also differs from *E. hirayamai* by the rami of uropod 3 subequal in length and from *E. parvus* by having a unilobed coxa 7 (Pirlot 1934; Hirayama 1985; Bousfield and Hendrycks 1995).

Table 1. Distribution, depth, and important characters of *Eusirus* species.

Species	Distribution	Important characters	Depth	References
E. abyssi	N Atlantic 60°37'N, 27°52'W	eyes absent, pereonite 7 unknown, pleonites 1–3 with distomiddorsal teeth, epimeron 3 unknown, coxa 7 unilobed, uropod 3 unknown, telson unknown.	1505 m	Stephensen 1944
E. antarcticus	S Pacific (New Zealand), S Indian Ocean, Antarctica	eyes present, pereonite 7 (with distomiddorsal tooth described by Stebbing (1906), while in the key of Andres et al. (2002) without that tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin serrate, coxa 7 unknown, uropod 3 unknown, telson cleft 40% of length.	0–1800 m	Stebbing 1906; Andres et al. 2002; Othaitz and Sorbe 2020
E. bathybius	NW Pacific, off Japan	eyes absent, pereonite 7 and pleonites unknown, epimeron 3 smooth, coxa 7 unilobed, uropod 3 with outer ramus shorter than inner one, telson only apex notched.	0–7900 m	Schellenberg 1955; Bousfield and Hendrycks 1995; Othaitz and Sorbe 2020
E. biscayensis	N Atlantic, Bay of Biscay, off Iceland	eyes present, pereonite 7 with distomiddorsal tooth, pleonites 1–3 with distomiddorsal teeth, epimeron 3 with posterolateral margin serrate, coxa 7 unilobed, uropod 3 with outer ramus slightly shorter than inner one, telson only apex notched.	358–4330 m	Bonnier 1896; Stebbing 1906
E. bonnieri	NE Atlantic Ocean	eyes absent, pereonite 7 with small distomiddorsal tooth, pleonites 1–3 with small distomiddorsal teeth, epimeron 3 serrate, coxa 7 unilobed, uropod 3 with outer ramus shorter than inner one, telson cleft 20% of length.	370–1099 m	Othaitz and Sorbe 2020
E. bouvieri	Southern Ocean	eyes present, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, Pleonite 3 with dorsal longitudinal carina, epimeron 3 serrate, coxa 7 and uropod 3 unknown, telson cleft less than 20% of length.	0–400 m	Chevreux 1911; Andres et al. 2002
E. bulbodigitus	NW Pacific, off Korea	eyes present, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, pleonite 3 without dorsal carina, epimeron 3 serrate, coxa 7 unilobed, uropod 3 with outer ramus slightly shorter than inner one, telson cleft less than 20% of length.	33 m	Jung et al. 2016
E. carolinus sp. nov.	Pacific	eyes present, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 smooth, coxa 7 unilobed, uropod 3 with rami subequal in length, telson cleft about 15% of length.	520–862 m	the present study
E. columbianus	NE Pacific, 52°–55°19'N, 128°30'–130°27'W	eyes present, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 serrate, coxa 7 bilobed, uropod 3 with outer ramus shorter than inner one, telson cleft about 30% of length.	12–150 m	Bousfield and Hendrycks 1995
E. crosnieri	Indian Ocean, NW Madagascar, 12°43'S, 48°15'E	eyes present but not pigmented, pereonite 7 with distomiddorsal tooth, pleonites 1–3 with distomiddorsal teeth, epimeron 3 serrate, coxa 7 unknown, uropod 3 with rami subequal in length, telson cleft about 30% of length.	245–255 m	Ledoyer 1982; Andres 1996; Othaitz and Sorbe 2020
E. cuspidatus	N Pacific; Arctic Basin	eyes present, pereonite 7 with distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin serrate, coxa 7 unilobed, uropod 3 with outer ramus shorter than inner one, and telson cleft 50% of length.	37–400 m	Krøyer 1845; Stebbing 1906; Gurjanova 1951; Bousfield and Hendrycks 1995; Jung et al. 2016; Othaitz and Sorbe 2020
*E. fragilis**	N Pacific	eyes absent, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 smooth, coxa 7 unilobed, uropod 3 unknown, and telson cleft less than 15% of length.	abyssal	Birstein and M. Vinogradov 1960; Bousfield and Hendrycks 1995
E. giganteus	Antarctica, 63°09'S, 59°10'W	eyes present, pereonite 7 with distomiddorsal tooth, pleonites 1–3 with distomiddorsal teeth, epimeron 3 serrate, coxa 7 unilobed, uropod 3 with outer ramus slightly shorter than inner one, telson cleft 18% of length.	221–690 m	Andres et al. 2002
E. hirayamai	NW Pacific, off Japan	eyes present, pereonite 7 with distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin fully serrate, coxa 7 unilobed, uropod 3 with rami subequal in length, telson cleft less than 30% of length.	<50 m	Hirayama 1985; Bousfield and Hendrycks 1995
E. holmii	Arctic Ocean, N Atlantic	eyes present, pereonite 7 with distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin fully serrate, coxa 7 unilobed, uropod 3 with rami subequal in length, telson cleft about 10% of length.	172–1900 m	Stebbing 1906; Stephensen 1912; 1944; Macnaughton et al. 2007
E. laevis	Antarctica	eyes present, pereonite 7 without distomiddorsal tooth, pleonites without distomiddorsal tooth, epimeron 3 smooth, coxa 7 unilobed, uropod 3 and telson unknown.	<48 m, epipelagic	Walker 1903; Andres et al. 2002
E. laticarpus	Antarctica	eyes present, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 only with 3 serrations at distomiddorsal corner, coxa 7 unilobed, uropod 3 with rami subequal in length, telson cleft 40% of length.	0–400 m	Chevreux 1906; Andres et al. 2002; Othaitz and Sorbe 2020
E. latirostris	Indian Ocean	eyes absent, pereonite 7 without distomiddorsal tooth, pleonite 3 with distomiddorsal tooth, epimeron 3 with posterior margin smooth, coxa 7, uropod 3 and telson unknown.	2500 m	Ledoyer 1982
E. leptocarpus	NE Atlantic	eyes present, pereonite 7 without distomiddorsal tooth, pleonites 1–3 with distomiddorsal teeth, epimeron 3 with posterior margin fully serrate, coxa 7 unilobed, uropod 3 with rami subequal in length, telson cleft about 20% of length.	346–1098 m	Krøyer 1845; G.O. Sars 1893; Stebbing 1906; Othaitz and Sorbe 2020

Species	Distribution	Important characters	Depth	References
E. liui	NW Pacific, Okinawa Trough, 27°32'N, 126°58'E	eyes absent, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin and posteroventral corner serrate, coxa 7 unilobed, uropod 3 with outer ramus slightly shorter than inner one, telson unknown.	1243 m	Wang et al. 2021
E. longipes	Arctic Ocean, NE Atlantic	eyes present, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin serrate, coxa 7 unilobed, uropod 3 with rami subequal in length, telson cleft about 20% of length.	6–1098 m	Krøyer 1845; Stebbing 1906; Lincoln 1979; Bousfield and Hendrycks 1995; Othaitz and Sorbe 2020
E. meteorae	NE Atlantic	eyes present, pereonite 7 with distomiddorsal tooth, pleonites 1–3 with distomiddorsal teeth, epimeron 3 with only distal part of posterior margin serrate, coxa 7 unilobed, uropod 3 with rami subequal in length, telson cleft about 30% of length.	50–150 m	Andres 1996
E. microps	Antarctica	eyes present, pereonite 7 with distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin fully serrate, coxa 7 and uropod 3 unknown, telson less than 30% of length.	epi- and mesopelagic	Walker 1906; Andres et al. 2002
E. minutus	Off Norway, off South Africa	eyes present, pereonite 7 with distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with lower 1/3 length of posterior margin serrate, coxa 7 unilobed, uropod 3 with outer ramus much shorter than inner one, telson cleft about 15% of length.	200 m, 752 m	Krøyer 1845; G.O. Sars 1893; Stebbing 1906
E. nevandis	Indian Ocean, off Kenya, 4°00'S, 41°27'E	eyes present, pereonite 7 with small distomiddorsal tooth, pleonites 1–2 with small distomiddorsal teeth, epimeron 3 with posterior margin smooth, coxa 7and uropod 3 unknown, telson less than 20% of length.	1510–2500 m	Barnard 1961; Ledoyer 1982
E. parvus	Western Pacific, Indonesia	eyes present, pereonite 7 with distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with half-length of posterior margin serrate, coxa 7 bilobed, uropod 3 and telson unknown.	315 m	Pirlot 1934; Jung et al. 2016
E. perdentatus	Antarctica	eyes present, pereonite 7 carinate, with large distomiddorsal tooth, pleonites 1–3 carinate, with large distomiddorsal teeth, epimeron 3 only posteroventral corner serrate, coxa 7 unilobed, uropod 3 with rami subequal in length, telson cleft less than 20% of length.	0–928 m	Emison 2000; Andres et al. 2002; Verheye and d'Udekem d'Acoz 2020
E. pontomedon	Antarctica	eyes present, pereonite 7 carinate, with large distomiddorsal tooth, pleonites 1–3 carinate, with large distomiddorsal teeth, epimeron 3 only posteroventral corner serrate, coxa 7 unilobed, uropod 3 with rami subequal in length, telson less than 20% of length.	107–668 m	Verheye and d'Udekem d'Acoz 2020
E. propeperdentatus	Antarctica, 61°30'S, 55°00'W	eyes present, pereonite 7 carinate, with large distomiddorsal tooth, pleonites 1–3 carinate, with large distomiddorsal teeth, pleonites, epimeron 3 smooth, only with small spines, coxa 7 unilobed, uropod 3 with outer ramus slightly longer than inner one, telson less than 20% of length.	epi-and mesopelagic	Andres 1979; Othaitz and Sorbe 2020
E. propinquus	N Atlantic	eyes present, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin serrate, coxa 7 unilobed, uropod 3 with rami subequal in length, telson cleft about 47% of length.	183–1141 m	Krøyer 1845; G.O. Sars 1893; Stebbing 1906; Othaitz and Sorbe 2020
E. tjalfiensis	Davis Strait, 70°41'N, 52°07'W	eyes present but not pigmented, pereonite 7 without distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin serrate, coxa 7 unilobed, uropod 3 with outer ramus much shorter than inner one, telson cleft less than 20% of length.	750–800 m	Stephensen 1912; 1944
E. tridentatus	Antarctica	eyes present but not pigmented, pereonite 7 with distomiddorsal tooth, pleonites 1–2 with distomiddorsal teeth, epimeron 3 with posterior margin smooth, distoventral margin lightly serrate, coxa 7, uropod 3 and telson unknown.	unknown	Bellan-Santini and Ledoyer 1974; Andres et al. 2002

*Translation of the original description: eyes absent; pereonites and pleonite 1 with weak longitudinal carina, pleonites 1 and 2 with small distomiddorsal teeth, pleonite 3 and segment 1 of without tooth, posteroventral angle of epimeron 1 produced into small acute tooth; head with anterolateral angle acute, rostrum extending 1/3 length of basal article of antenna 1, antennae 1 broken off at peduncular article 1; antenna 2 article 3 four times shorter than article 4 and three times shorter than article 5; upper lip rounded, mandible with stout cylindrical molar process, serrated incisor process, large lacinia mobilis and spine row, palp article 1 much longer than article 2, maxilla 1 inner lobe with 2 very short distal setae, outer lobe with 11 multi-cusped spine-teeth, palp thin, bearing row of fine setae on its end, palp article 1 two times shorter than article 2, maxilla 2 inner lobe rounded, as long as, but two times broader than outer lobe, both lobes equipped with setae distally; maxilliped similar with those of *E. bathybius*, but outer lobes slightly broader than inner lobes; coxa 1 strongly expanding distally, with rounded anterior margin; coxa 2 smaller than coxa 1; plate 4 small, with convex anterior and concave posterior margins; plates 5–7 oval, gnathopods 1 and 2 typical for *Eusirus*, gnathopod 1 significantly shorter than gnathopod 2, carpus with posterior margin bearing a tuft of setae on acute projection distally, propodus of gnathopods 1 and 2 similar in shape and size, width less than 1.5 times exceeding their length, Pereopods 3, 4, and 6 broken off; Pereopod 5 with basis slightly expanding distally; basis of pereopod 7 strongly expanding distally; width almost equal to the length, epimera 1 and 3 rounded, with smooth posterior margin, epimeron 2 with acute posteroventral angle, uropod 1 rami equal in length, uropod 2 exopod slightly shorter than endopod, uropod 3 broken off, telson triangular, width slightly less than length; distal end with an acute-angled notch. Remarks. The species described herein sharply differs from all other species of the genus by the smooth epimer III posterior margin and short triangular telson (Birstein and M. Vinogradov 1960, translated by Dr. Olga A. Golovan).

Genus *Meteusiroides* Pirlot, 1934

Diagnosis. See Pirlot (1934) and Barnard and Karaman (1991).

***Meteusiroides keyensis* Pirlot, 1934**

Figs 6–9

Meteusiroides keyensis Pirlot, 1934: 52–56, figs. 94–96.

Material examined. Western Pacific • 1 female (ovigerous), 12.2 mm; seamount on Caroline Plate; St. FX-Dive 218; 10°07'N, 140°14'E; depth 813–1242 m; 6 Jun. 2019; M6090; MBM 286612.

Description. ***Body*.** Smooth; epimera 1 and 2 with posteroventral angle produced into small acute tooth; epimeron 3 with posteroventral angle broadly rounded. ***Head*.** Rostrum longer than anterior cephalic lobe, extending to 1/4 length of peduncular article 1 of antenna 1; anterior cephalic lobe rounded; eyes large, reniform. Antenna 1 with peduncular article 1 subequal in length to article 2, ventral margin produced distally; article 2 narrower than article 1, outer margin convex distally; inner margin bilobate distally; article 3 shortest, shorter than 1/2 length of flagellar article 1; primary flagellum 82-articulate; accessory flagellum lacking. Antenna 2 much shorter than antenna 1, peduncular article 4 about twice as long as article 5; flagellum 61-articulate.

***Mouthparts*.** Upper lip margin smooth. Mandible with right incisor bearing 13 teeth, left incisor bearing 11 teeth; right lacinia mobilis with distal margin smooth, without tooth; left lacinia mobilis with 10 teeth; accessory setal row with 8 slender setae; molar strong, columnar; palp article 3 distinctly longer than article 2, with 7 apical long setae; inner margin with row of long simple setae. Lower lip with inner lobes distinctly smaller than outer lobes. Maxilla 1 inner plate subtriangular, with two long distal robust setae and one small setae; outer plate with 11 multicuspidated setae in two rows; palp 2-articulate, with 6 apical robust setae and a row of subapical slender long setae. Maxilla 2 with inner plate shorter and broader than outer plate, bearing about 16 fine simple marginal setae; outer plate bearing row of slender long apical setae. Maxilliped with inner plate subrectangular, short; outer plate bearing about 6 plumose setae on distal margin and more than 10 slender setae on inner margin; palp article 3 expanded distally, bearing a row of setae on distal and inner margins; dactylus very slender, as long as article 3.

Coxae 1–4 subrectangular, gradually increasing posteriorly; coxa 1 anteroventral corner subacute; coxa 4 excavate posteriorly. Coxae 5 and 6 bilobate, posterior lobe deeper and larger than anterior lobe. Coxa 7 smallest, rounded. Coxal gills present on pereopods 2–7.

***Gnathopods and pereopods*.** Gnathopods 1–2 similar in shape, but gnathopod 2 slightly longer. Gnathopod 1 basis with dense long simple setae on distal half of mesial surface; ischium posterior margin bearing group of setae distally; merus much shorter than carpus, posterior margin bearing groups of setae, distal margin with two acute mediodorsal pointed processes; carpus shorter than propodus, posterior margin bearing more than 10 groups of slender setae; propodus sub-ovate, propodus less than twice longer than wide, palmar margin obliquely convex, with a row of large

Figure 6. *Meteusiroides keyensis* Pirlot, 1934. Photographed immediately after collection by Shao-qing Wang.

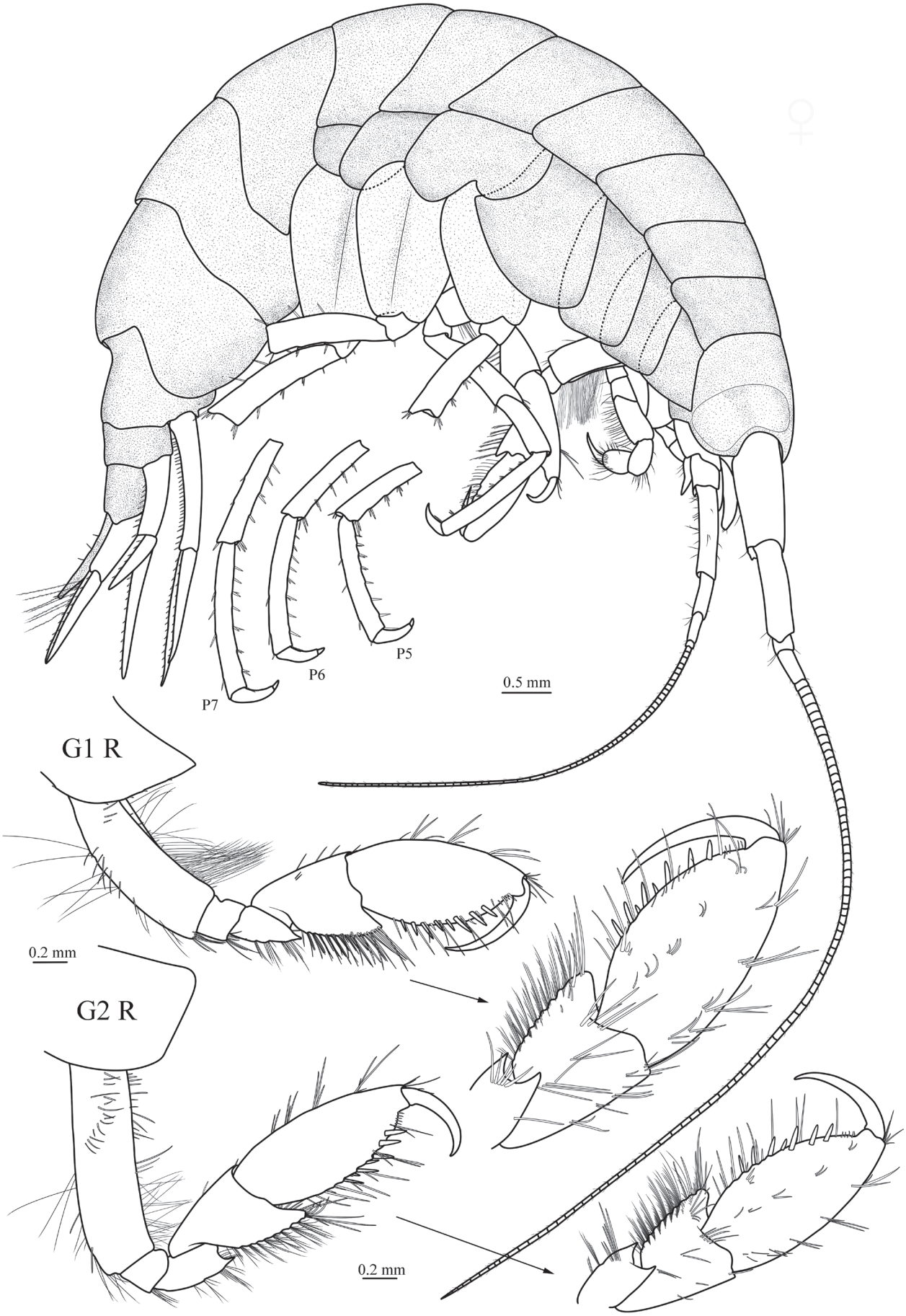

Figure 7. *Meteusiroides keyensis* Pirlot, 1934. **G1 R.** Right gnathopod 1; **G2 R.** Right gnathopod 2.

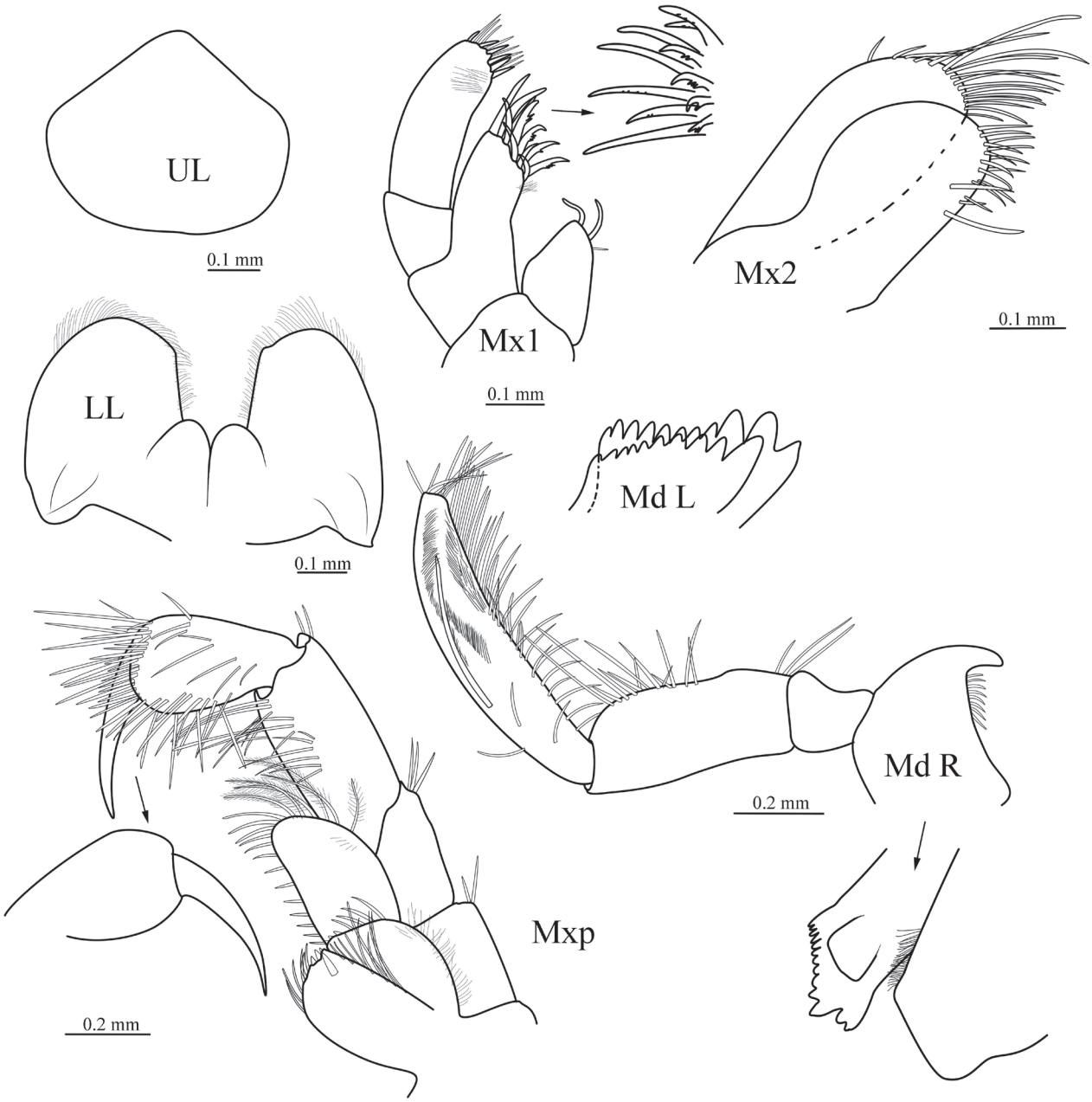

Figure 8. *Meteusiroides keyensis* Pirlot, 1934. **UL.** Upper lip; **LL.** Lower lip; **Md L.** Left mandible (not showing molar and palp); **Md R.** Right mandible; **Mx1.** Maxilla 1; **Mx2.** Maxilla 2; **Mxp.** Maxillipeds.

robust setae and slender setae, posterior margin with 6 groups of slender setae, surfaces with 6 clusters of setae; dactylus 3/5 the length of propodus, curved. Gnathopod 2 basis not bearing dense setae on mesial surface, but margins setose; ischium to carpus similar to gnathopod 1; propodus about twice longer than wide, similar in shape to gnathopod 1; dactylus 1/2 the length of propodus, curved. Pereopods 3 and 4 slender, basis linear, margins setose; merus longer than carpus but shorter than propodus, margins bearing short robust setae; dactylus slender. Pereopods 5–7 slightly increasing in length; basis expanded, narrowing distally; posterodistal lobes shallow; postero-ventral corner rounded; merus to propodus with margins setose; merus longer than carpus but shorter than propodus; dactylus slender.

***Uropods and telson*.** Uropod 1 with peduncle slightly longer than inner ramus, margins setose; rami lanceolate, lacking apical setae, margins setose; outer ramus shorter than inner one. Uropod 2 with peduncle shorter than outer ramus, margins setose, with ventromedial spur; rami lanceolate, lacking apical setae, margins setose; outer ramus much shorter than inner one. Uropod 3 with peduncle shorter than rami, outer margin lacking setae; rami subequal in length; both rami outer and inner margins setose; inner ramus with inner margin bearing long plumose setae. Telson linguiform; cleft about 70% of its length; posterior margin of each lobe concave; bearing three pairs

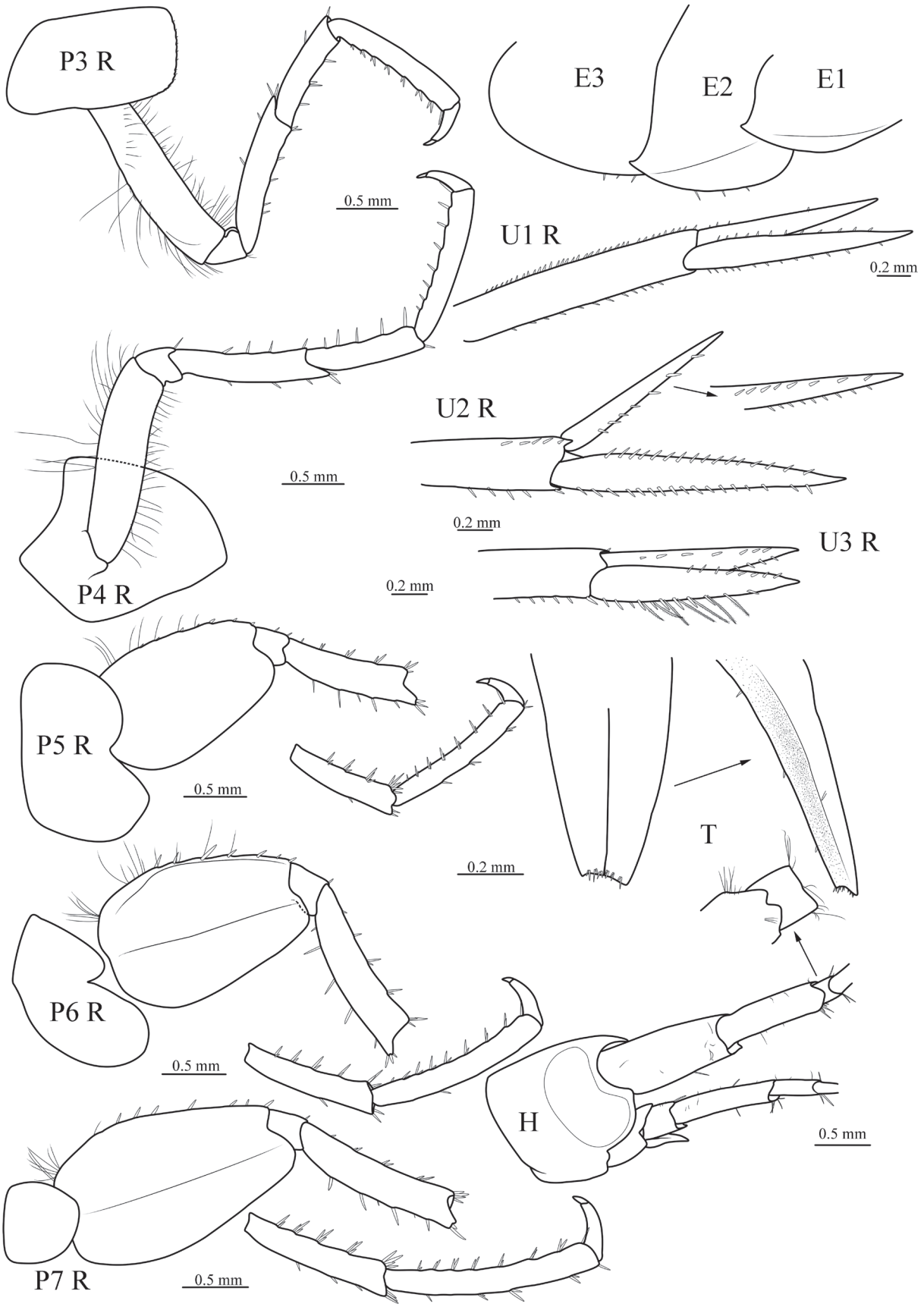

Figure 9. *Meteusiroides keyensis* Pirlot, 1934. **P3 R.** Right pereopod 3; **P4 R.** Right pereopod 4; **P5 R.** Right pereopod 5; **P6 R.** Right pereopod 6; **P7 R.** Right pereopod 7; **E1–3.** Epimeral plates 1–3; **U1 R.** Right uropod 1; **U2 R.** Right uropod 2; **U3 R.** Right uropod 3; **T.** Telson; **H.** Head, with antenna 1 and antenna 2.

of stout setae; keeled ventroproximally; margins bearing several stout setae on each side laterally.

Coloration. The body is transparent, pale red in color, with red gnathopods 1–2, and antennae 1–2, and deep red eyes.

Distribution. A seamount of the Caroline Plate at a depth of 813–1242 meters; Indonesia (5°48'S, 132°13'E) at a depth of 304 meters (Pirlot 1934; Barnard and Karaman 1991).

Remarks. *Meteusiroides keyensis* Pirlot, 1934, was originally described from Indonesia, with the description based on a female holotype found at a depth of 304 meters. The current ovigerous female specimen was collected from a depth of at least 813 meters, significantly deeper than the depth originally recorded. Morphologically, the present specimen only slightly differs from the original description of *M. keyensis* by the rami of Uropod 3 subequal in length, while the outer ramus is somewhat shorter than the inner ramus in the original illustration (Pirlot 1934, fig. 96). Nonetheless, the present specimen should be identified as *M. keyensis*.

Molecular data analysis

The phylogenetic trees produced by BI and ML analyses were congruent and generally well supported (Fig. 10).

The monophyly of the genera *Eusirus* and *Rhachotropis* S.I. Smith, 1883, was recovered in both ML and BI trees (BP = 54% and PP = 0.96). The genus *Meteusiroides* and *Dorotea* Corbari, Frutos & Sorbe, 2019 clustered together and were separated from *Cleonardo* Stebbing, 1888 (BP = 51% and PP = 0.87) The genus *Eusirus* was separated into two relatively moderately supported clades (BP = 50% and PP = 0.94). The new species, *E. carolinus* sp. nov., was separated from *E. hirayamai* with strong support (BP = 97% and PP = 0.83), with *E. pontomedon* Verheye & d'Udekem

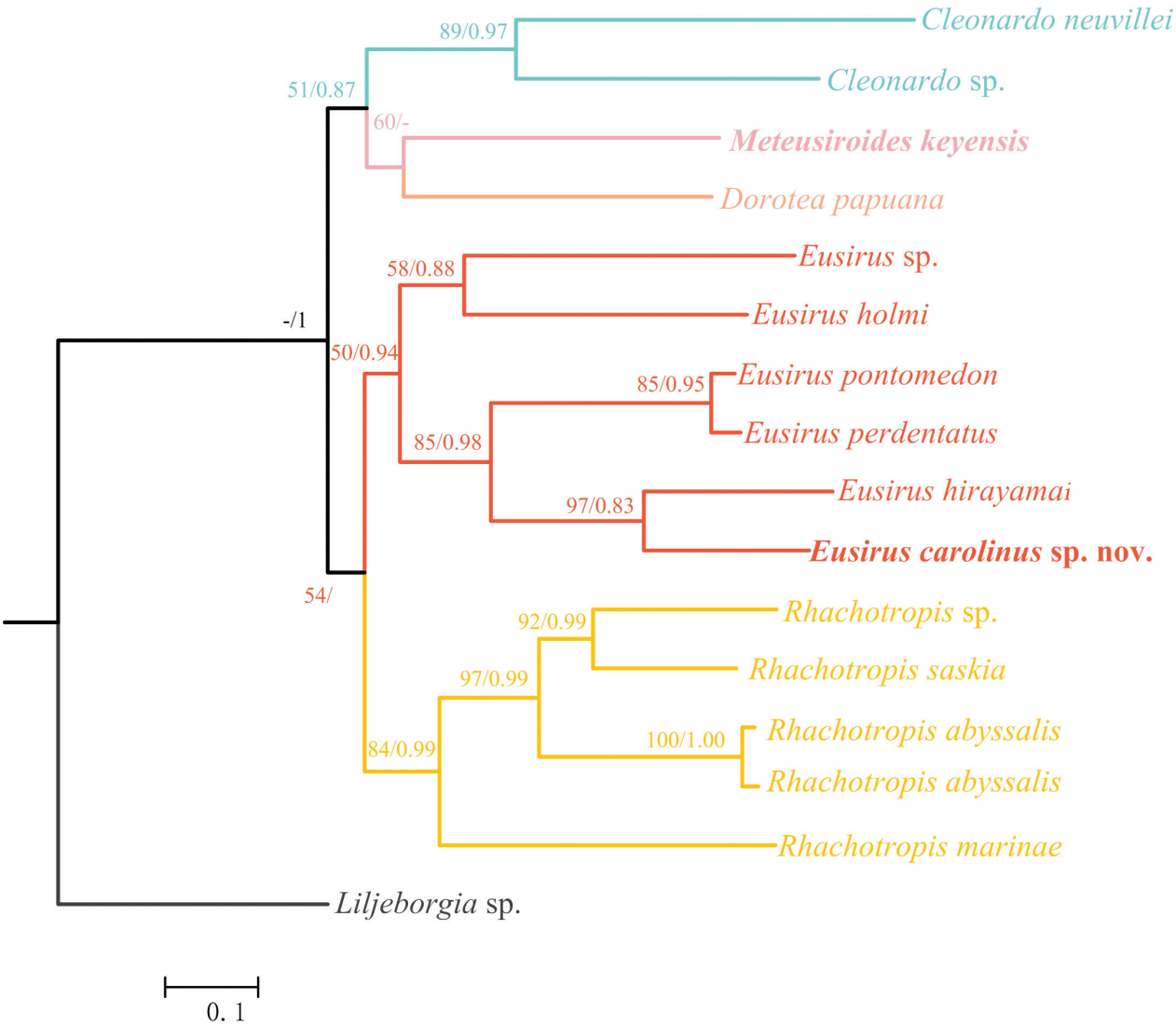

Figure 10. Maximum likelihood (ML) and Bayesian inference (BI) trees of Tropiometroidea using combined sequences of COI and 16S. The numbers at each node represent bootstrap values (BP) (left) and posterior probabilities (PP) (right). *Eusirus carolinus* sp. nov. is highlighted in bold.

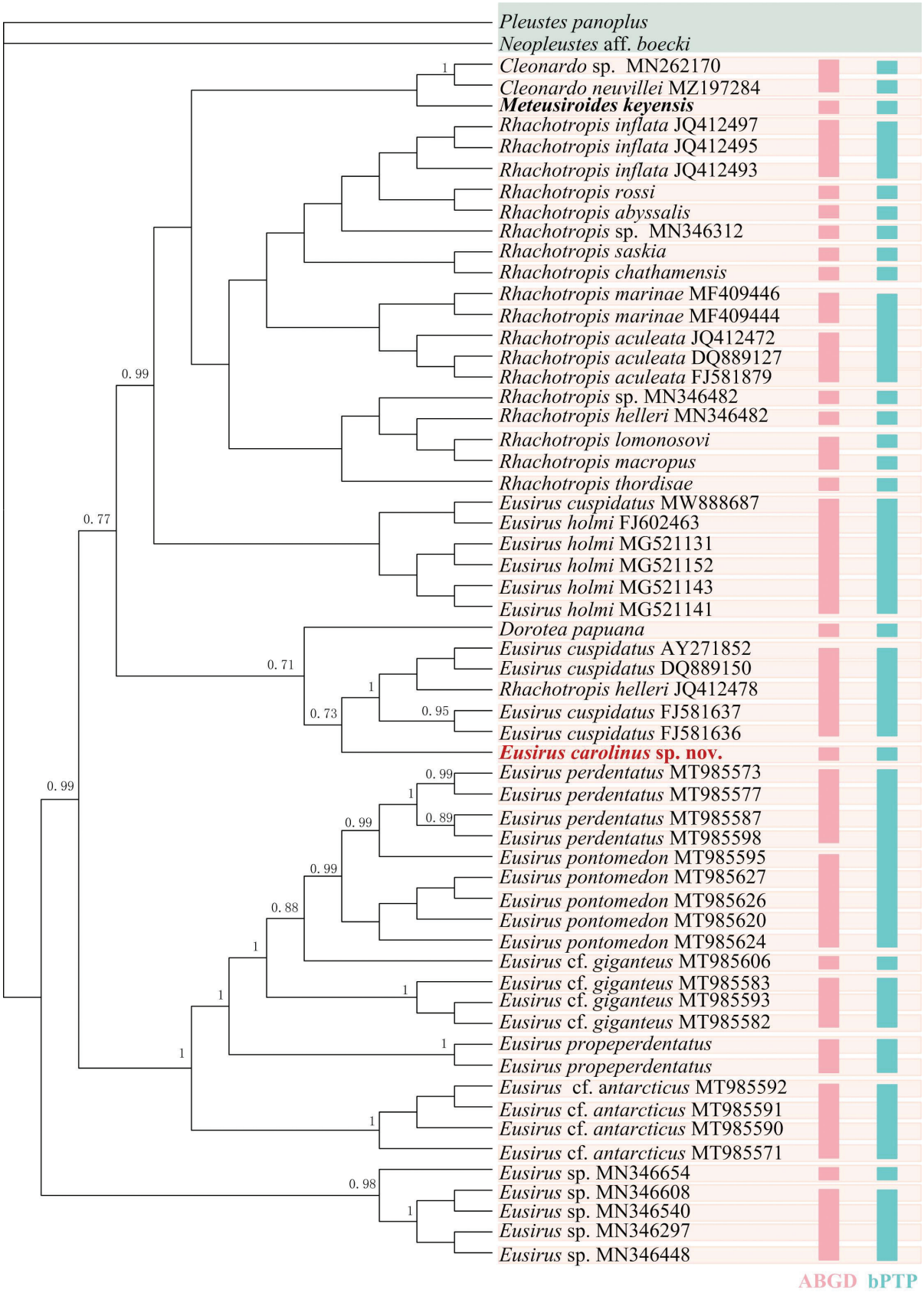

Figure 11. Bayesian Inference (BI) phylogenic tree based on COI showing the phylogenetic relationship between *Eusirus carolinus* sp. nov. and related eusirids, with bootstrap replications (BS) labeled (>50). Putative species identified by DNA-based species delimitation methods [Automated Barcode Gap Discovery (ABGD) and Bayesian implementation of the Poisson Tree Processes (bPTP)] applied to the COI tree/distance matrices are indicated by bars on the concatenated tree. Color codes indicate the support of each putative species.

d'Acoz, 2020, and *E. perdentatus* Chevreux, 1912, as sister groups (BP = 85% and PP = 0.98). The species delimitation based on both ABGD and bPTP methods has validated the new species (Fig. 11).

Discussion

Nine species of the genus, including the present new species and one mentioned by Pirlot (1934) as *Eusirus* sp., were documented in the Pacific (Jung et al. 2016; Wang et al. 2021). Among these, three species, *E. carolinus* sp. nov., *E. parvus*, and *Eusirus* sp., were found in the deep waters of the tropical western Pacific. *Eusirus bathybius* and *E. fragilis* were located at abyssal depths, while only *E. liui* inhabited vent fields. *Eusirus bulbodigitus* and *E. hirayamai* were reported from sublittoral depths. Furthermore, the depth range of *Meteusiroides keyensis* extended to at least 813 meters in the present study.

As one of the controversial families of Amphipoda (Verheye et al. 2016; d'Udekem d'Acoz and Verheye 2017; Myers and Lowry 2018), the higher classification of Eusiridae needed molecular and morphological investigations (Ariyama and Kohtsuka 2022). However, phylogenetic resolution falls outside the scope of this study.

The results of the present integrative taxonomic study reveal the validity of *Eusirus carolinus* sp. nov. Owing to the lack of molecular sequences, the phylogenetic relationships between this new species and the remaining *Eusirus* species are still unexplained. At the genus level, the analysis of molecular evidence is consistent with the morphological studies (Bousfield and Hendrycks 1995; Corbari et al. 2019), indicating a close relationship between *Eusirus* and *Rhachotropis*. Both of the above genera exhibit a strong eusirid form of gnathopods 1 and 2. Similarly, the other three genera, *Cleonardo*, *Dorotea*, and *Meteusiroides*, which have normal gnathopods 1 and 2, also cluster together in the current molecular study. However, a comprehensive understanding of the systematic relationships among genera within the Eusiridae calls for further taxonomic and molecular data sampling.

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Supplementary material 1

Additional data

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Data type: xlsx
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