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A new species of *Cardiodectes* Wilson C.B., 1917 (Copepoda: Siphonostomatoida: Pennellidae) from Spinyjaw greeneye, *Chlorophthalmus corniger* Alcock, 1894 off the Indian Ocean

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Abstract

A new species of flesh penetrating parasitic copepod of the genus *Cardiodectes* Wilson C.B., 1917 (Siphonostomatoida: Pennellidae) parasitizing the fish Spinyjaw greeneye, *Chlorophthalmus corniger* Alcock, 1894 (Chlorophthalmidae), inhabiting at depths of 265 to 458 meters from the south-west coast of India is described and illustrated. The new species, *Cardiodectes vampire* **sp. nov.**, can be distinguished from its other 16 congeners by the following features: (i) trunk 3.15 times as long as wide; (ii) extremely long (3.5 times as long as total body length) and uncoiled egg sacs; (iii) difference in the armature of legs 1–3; (iv) comparatively longer trunk (0.7 times as long as total body length). A checklist of valid global species of *Cardiodectes* with its host and distribution is also provided.

Key words: Fish parasite, copepod, *Cardiodectes vampire* **sp. nov.**, Pennellidae, deep-sea, India

Introduction

The highly transformed fish parasitic copepod of the family Pennellidae Burmeister, 1835 currently includes 142 species included in 24 valid genera (Walter and Boxshall 2023). Among them *Lernaeenicus* Lesueur, 1824 is the most speciose genus (32 species) followed by *Cardiodectes* Wilson C.B., 1917 (16 species), and six genera are monotypic (Walter and Boxshall 2023).

Currently, *Cardiodectes* comprises 16 species, which are separated into two morphological groups, '*medusaeus*' and '*rubosus*' (Izawa, 1970; Bellwood, 1981). The former contains the following 5 species, *Cardiodectes anchorellae* Brian and Gray, 1928, *C. bellottii* (Richiardi, 1882), *C. cristatus* Shiino, 1958, *C. frondosus* Schuurmans-Stekhoven, 1937, *C. longicervicus* Shiino, 1958, and the group is recognized by possessing a urosome. The second group comprises the remaining 11 species; *C. asper* Uyeno and Nagasawa, 2010, *C. bertrandi* Uyeno and Nagasawa, 2010, *C. bellwoodi* Uyeno, 2013, *C. boxshalli* Bellwood, 1981, *C. hardenbergi* Markevich, 1936, *C. krishnai* Sebastian, 1968, *C. rotundicaudatus* Izawa, 1970, *C. rubosus* Leigh-Sharpe, 1934, *C. shini* Uyeno, 2013, *C. spiralis* Bellwood, 1981, and *C. roatanenis* Suárez-Morales, Vásquez-Yeomans and Vidotto, 2022 (Izawa, 1970; Bellwood, 1981; Uyeno, 2013; Sua´rez-Morales *et al.* 2022).

From the Indian Exclusive Economic Zone (EEZ), only two species of *Cardiodectes* are previously known, *C. anchorellae* Brian and Gray, 1928 and *C. krishnai* Sebastian, 1968 (Sebastian, 1968; Pillai 1985). In the present study, we describe a new species, *Cardiodectes vampire* sp. nov., from the Spinyjaw greeneye, *Chlorophthalmus*

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corniger Alcock, 1894 (Aulopiformes: Chlorophthalmidae), inhabiting depths from 265 to 458 m off the south-west coast of India. In addition, we provide comments on its ecology and a checklist of species of *Cardiodectes* with its host and distribution.

Materials and Methods

Flesh penetrating parasitic copepods were recovered from the external body surface of the Spinyjaw greeneye, *Chlorophthalmus corniger*, collected from trawlers operating at depths of 265 to 458 metres off Neendakara ($08^0$30.0'N $76^0$53.30'E), Kollam district, Kerala state, southwest coast of India in 2018. The copepods were removed from the host and preserved in 75% ethanol (Aneesh *et al.* 2018, 2021a). Methods for collection, preservation, dissection, mounting, drawings of appendages, and digital inking were made according to the techniques described by Aneesh *et al.* (2020, 2021b, 2023). The specimens were microphotographed using a multi-focusing dissection microscope Leica-M205A and image-capturing software (Leica Application Suit). Morphological details of the species were also examined using a scanning electron microscope (JEOL SEM, JSM-6510LV). Morphological terminology follows Huys and Boxshall (1991), and the host nomenclature was based on Fish Base (Froese and Pauly 2023) and Catalogue of Fishes (Fricke *et al.* 2023). The type specimens are deposited in the Western Ghat Field Research Centre of the Zoological Survey of India (ZSI/WGRC), Kozhikode and the remaining few non-types were in PTA's & AKH's personal collection, (CAH).

Results

Order Siphonostomatoida Burmeister, 1835

Family Pennellidae Burmeister, 1835

Genus: *Cardiodectes* Wilson C.B., 1917

Cardiodectes Wilson, 1917, p. 50; Yamaguti, 1963, p. 188; Pillai, 1985, p727.

Type species: Cardiodectes medusaeus (Wilson, 1908) accepted as *Cardiodectes bellottii* (Richiardi, 1882) (type by original designation). Wilson (1908) described *Lernaeenicus medusaeus* Wilson, 1908, and transferred *Peroderma bellotti* Richiardi, 1882 into the genus *Lernaeenicus* Lesueur, 1824. Later on, Wilson (1917) established the genus *Cardiodectes* Wilson, 1917 to transfer both *Lernaeenicus medusaeus* Wilson, 1908 and *Lernaeenicus bellotti* (Richiardi, 1882) and designated the former [=*Cardiodectes medusaeus* (Wilson, 1908)] as the type species. *Cardiodectes medusaeus* (Wilson, 1908) was later synonymized with *Cardiodectes bellottii* (Richiardi, 1882).

Cardiodectes vampire sp. nov.

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(Figures 1–9)

Materials examined. 28 ♀♀

Holotype.1♀ (12 mm, excluding egg strings), from *Chlorophthalmus corniger* Alcock, 1894 (TL 37 cm) from the Arabian Sea, off Neendakara, Kollam district, Kerala, India (Reg. No. ZSI/WGRC/IR/ INV/ 25193) coll. PT Aneesh, 13th November 2018.

***Paratypes*.** Same information as the holotype with the following measurements and registration details: 1♀ (11.5 mm, excluding egg strings), (Reg. No. ZSI/WGRC/I.R./INV/25194) coll. PT Aneesh, 22nd November 2018; 1♀ (11 mm, excluding egg strings), (Reg. No. ZSI/WGRC/IR/INV/25195) coll. PT Aneesh, 24th November 2018; 1♀ (11 mm, excluding egg strings), (Reg. No. ZSI/WGRC/IR/INV/25196); 1♀ (12 mm, excluding egg strings), (Reg. No. ZSI/WGRC/IR/INV/25197); 1♀ (11.5 mm, excluding egg strings), (Reg. No. ZSI/WGRC/IR/INV/25198); 1♀ (11 mm, excluding egg strings), (Reg. No. CAH/INV/COP 0217), 1♀ (10.8 mm, excluding egg strings), (Reg. No. CAH/INV/COP 0218); 1♀ (11.7 mm, excluding egg strings), (Reg. No. CAH/INV/COP 0219) coll. PT Aneesh, 26th November 2018.

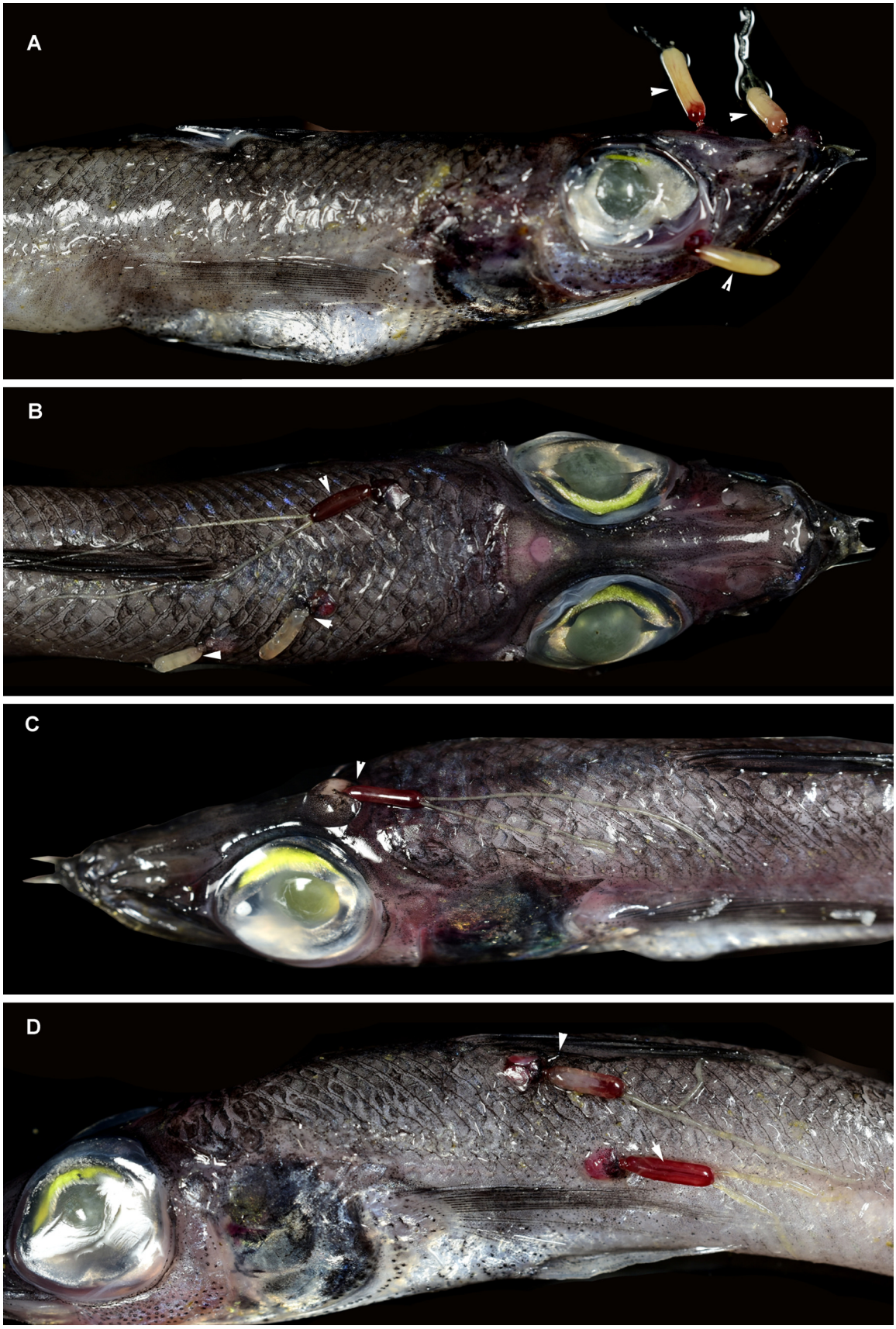

FIGURE 1. Attachment sites of mature post-metamorphic adult females of *Cardiodectes vampire* **sp. nov.**, on Spinyjaw greeneye, *Chlorophthalmus corniger* Alcock, 1894. **A**, on the upper and lower jaws (arrows); **B**, on the dorsal and dorso-lateral body surface between eyes and dorsal fin (arrows); **C**, dorsal surface of the host's head, carrying the parasite which induced a swelling on the head (arrow); **D**, lateral body surface (arrows).

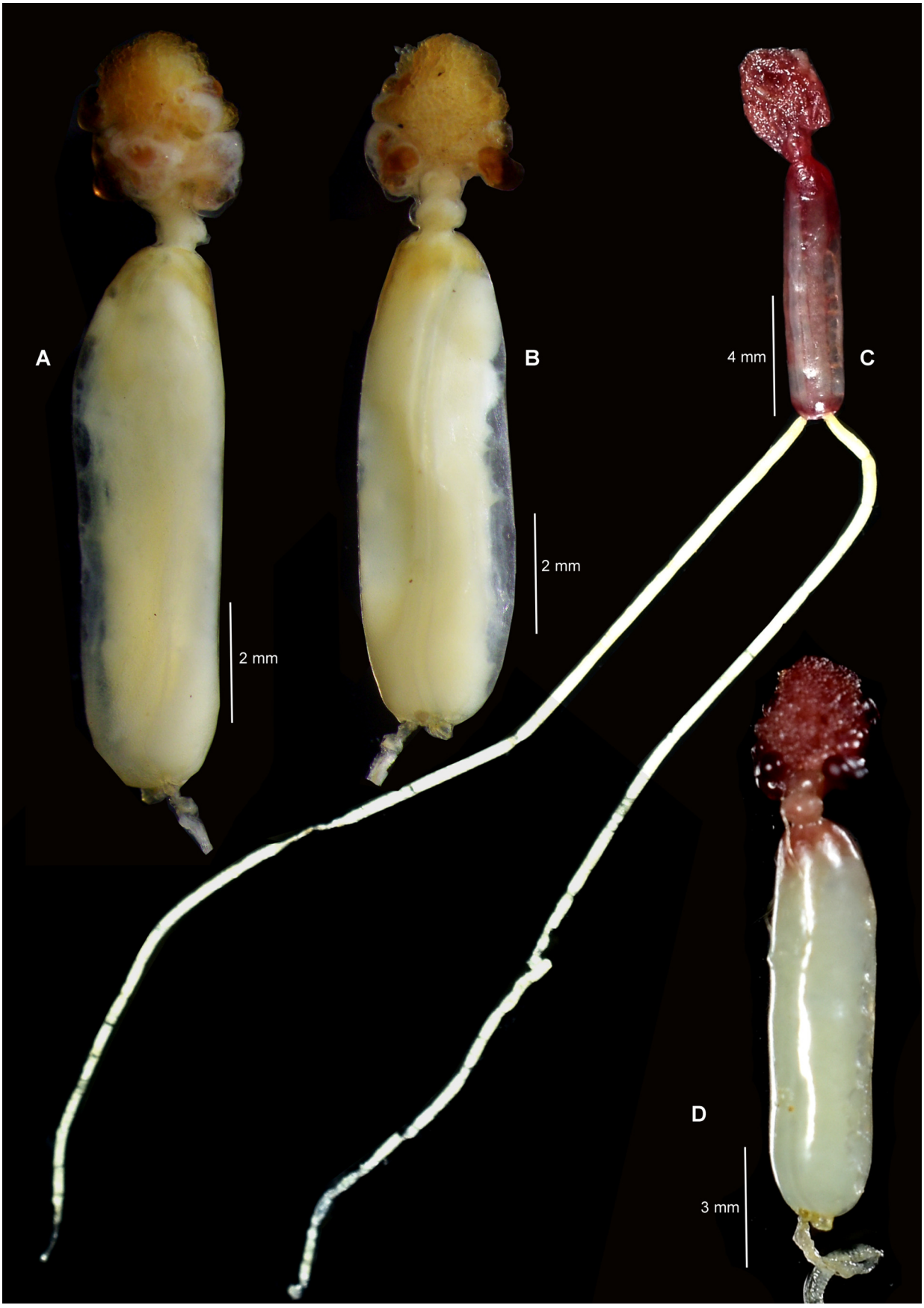

FIGURE 2. *Cardiodectes vampire* **sp. nov.**, mature post-metamorphic adult females. **A–B**, paratype (preserved)(Reg. No. ZSI/WGRC/IR/ INV/ 25194) dorso-lateral and ventral views; **C**, holotype (fresh)(Reg. No. ZSI/WGRC/IR/ INV/ 25193); **D**, paratype (fresh)(Reg. No. ZSI/WGRC/IR/ INV/ 25196).

FIGURE 3. *Cardiodectes vampire* **sp. nov.**, **A**, dorsal view of ovigerous female paratype (preserved) (Reg. No. ZSI/WGRC/IR/ INV/ 25195); **B–D**, dorsal, ventral and lateral views of ovigerous female paratype (preserved) (Reg no. Reg. No. ZSI/WGRC/ IR/ INV/ 25198).

Non-types: 17 ♀♀ (size range 10.8–12 mm excluding egg strings) (Reg. No. CAH/INV/COP 0200–216) coll. PT Aneesh, 26th November 2018.

Description

Post-metamorphic adult ovigerous female: Body (Figs 1–4) slender, 11–12 mm (excluding egg strings) long, consisting of cephalothorax, short neck and long trunk. *Cephalothorax* (Figs. 2–4, 5A–D), 1.2 times wider than long, bearing two pairs of lateral lobes, one large median lobe posteriorly and pair of ventral lobes; posterior lateral lobes larger with irregular ridges, extended ventrolaterally between first neck lobe. Cephalothorax anteriorly bearing small nodular, tightly packed and branching processes; anterior processes extended between anterior half of cephalothorax dorsally and posterior lobes ventrally (Figs. 2–4, 5A–D). Neck region (Figs. 2–4, 5A, D–F) narrow, about 0.1 time as total body length, bearing pair of lobes. Trunk (Figs. 2–4, 9) 3.15 times as long as wide (8.5 mm L; 2.7 mm W), 70% as TL, oval with greatest width at posterior, posterior margin convex. Paired gonopores located sub-terminally.

Egg strings long (maximum 41 mm), uncoiled (Figs 1, 2C); eggs uniseriate (Figs 1, 2C, 9D). Number of eggs per string ranged from 550 to 620, depending on string length. *Caudal rami* absent.

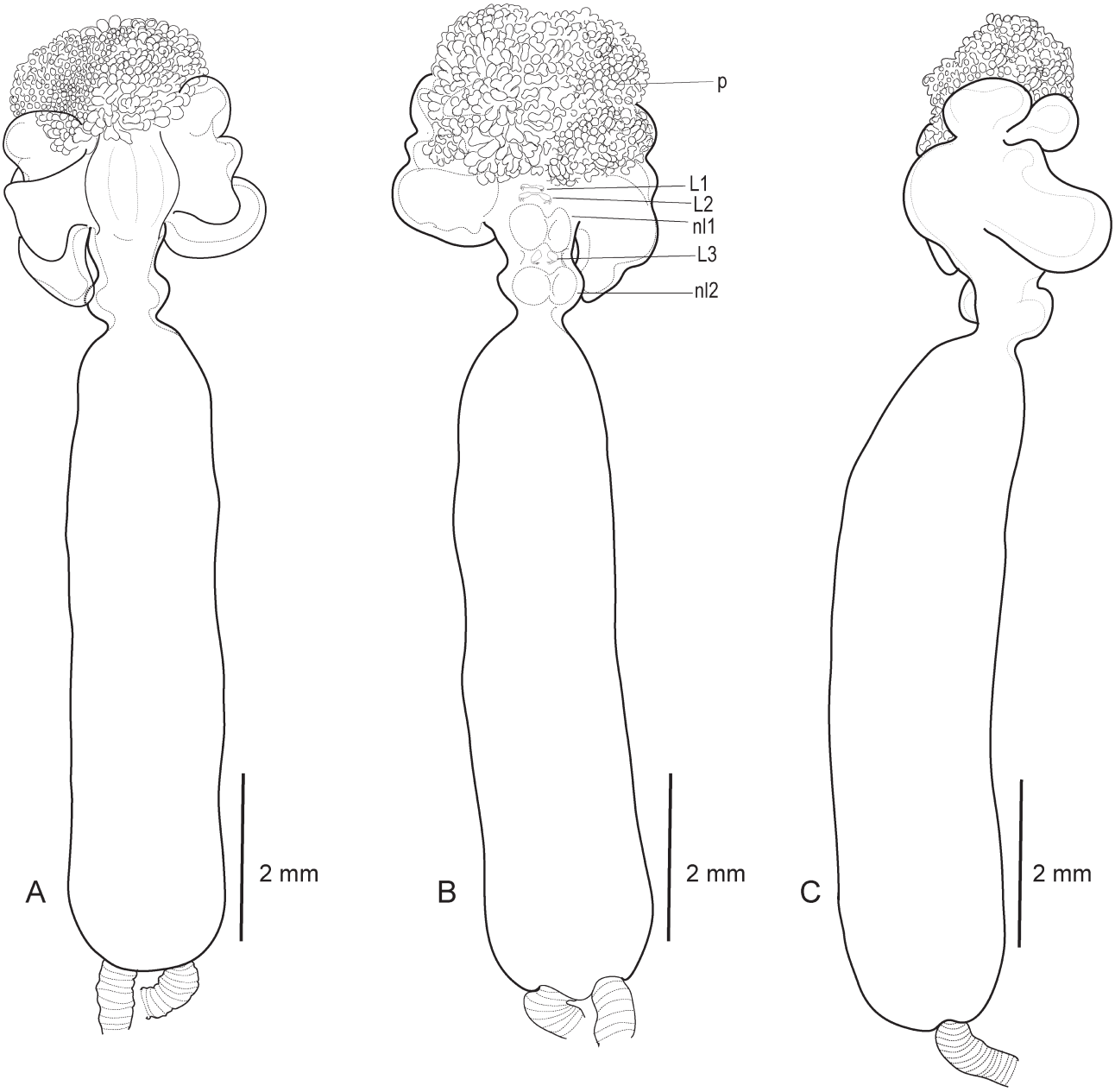

FIGURE 4. *Cardiodectes vampire* **sp. nov.**, **A–C**, dorsal, ventral and lateral views of ovigerous female paratype (Reg. No. ZSI/WGRC/IR/ INV/ 25194).

Rostrum, antennules, and antennae situated closely on anterodorsal surface of cephalothorax (Fig. 6). Antennule (Fig. 6A, 7A–C) unsegmented, bearing around 35 setae mainly on anterior terminal part and lateral margins; distal tip with 1 long aesthetasc. Antenna (Fig. 6B, 7D–F) 3-segmented, chelate, typical pennellid form; proximal segment with highly sclerotized ridge on inner surface; segment 2 with inner medial pointed projection. Mouth tube, maxillule, and maxilla located on anterior part of ventral surface of cephalothorax (Fig. 4B). Maxillule (Fig. 6C) knoblike, bilobate; lobe 1 having 2 simple processes and lobe 2 with 1 process. Maxilla (Fig. 6D) 2-segmented; proximal segment with pointed anteromedial process; terminal segment indistinctly 2-segmented, with fine terminal spinules. Maxilliped absent.

Legs, 3 pairs, legs 1 and 2 (Figs. 6E,F,8) biramous, present centrally on cephalothorax (Fig. 5E, H). Leg 3 (Figs. 5G, 6G) uniramous, situated behind lobe on neck (Figs. 5D–G). Rami of all legs 2-segmented. Leg 3 bearing protopod separated from intercoxal sclerite. Armature formula as follow (Roman numerals indicate spines and Arabic numerals indicate plumose setae).

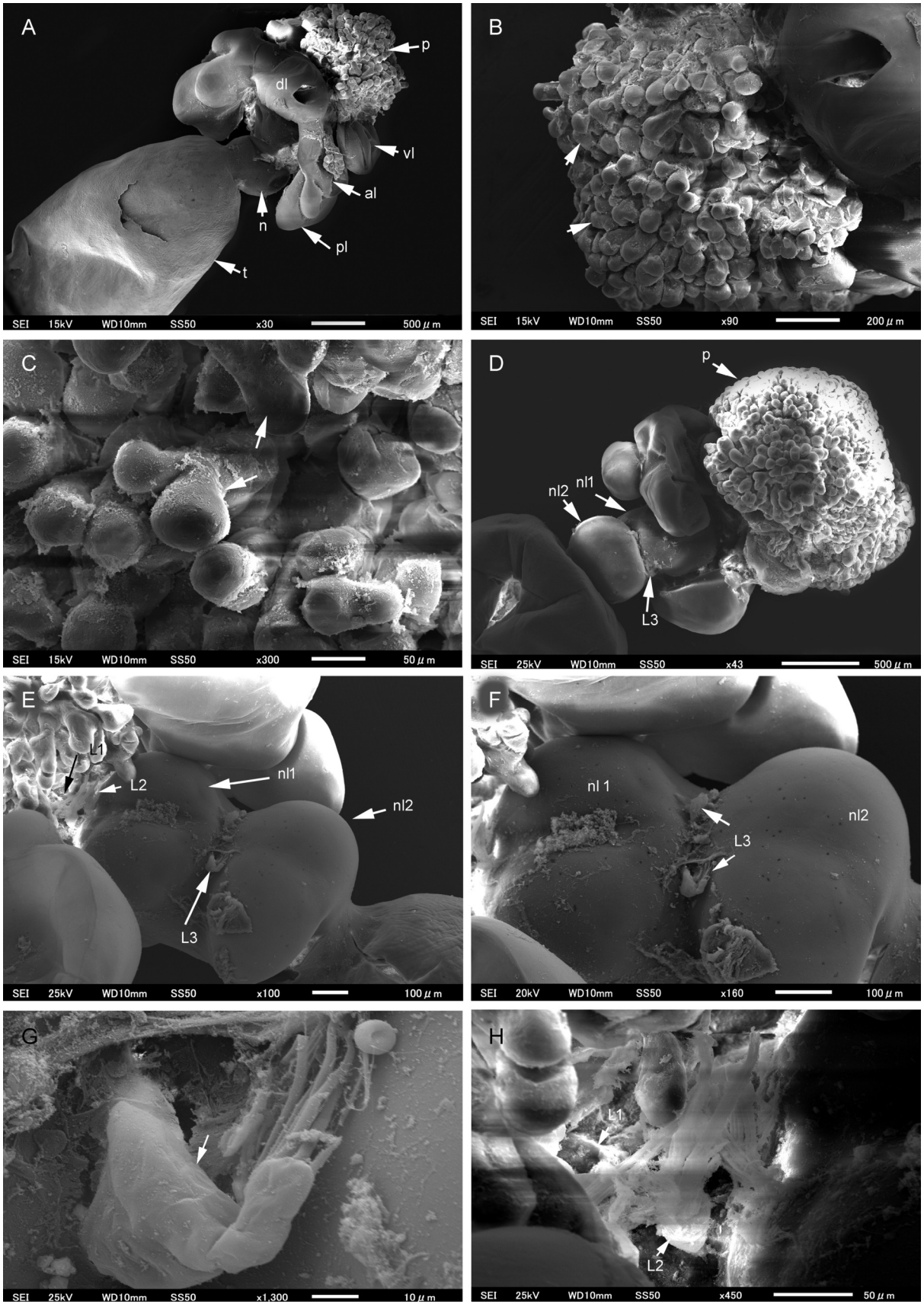

FIGURE 5. Scanning electron micrographs of *Cardiodectes vampire* **sp. nov.**, ovigerous female, **A**, dorsal view of body anterior showing cephalic lobes, neck lobes and cephalic processes; **B–C**, cephalic processes (arrows); **D**, ventral view of body anterior; **E–F**, neck; **G**, Leg 3; **H**, legs 1 and 2. p—cephalic processes; dl—dorsal lobe; vl—ventral lobe; al—anterior lobe; pl—posterior lobe; n—neck; nl1—first neck lobe; nl2—second neck lobe; t—trunk; L1—leg 1; L2—leg 2; L3—leg 3.

TABLE.

	Protopod	Exopod	Endopod
Leg 1	0-0	I; II, 5	0; 7
Leg 2	0-0	0;7	0; I, 6
Leg 2	0-0	0; I, 7	Absent

Size. Matured post-metamorphic adult female: 11–12 mm (total length excluding egg strings).

Intra-specific variation. No significant intra-specific variation was observed other than the length.

Colour. Fresh specimens are translucent dark red colour.

Host. *Chlorophthalmus corniger* Alcock, 1894 (Chlorophthalmidae).

Attachment site. The cephalothorax and neck region of *Cardiodectes vampire* **sp. nov.** were embedded in the host's body musculature, while its trunk and egg sacs were freely hanged (see Fig. 1).

Ecological remarks. In this study, out of 45 host fish (*C. corniger*; TL 11–14 cm) examined, 26 were found to be infested with *Cardiodectes vampire* **sp. nov.** with a prevalence of 57.7%. A total of 78 pennellids were recovered from these 26 host fish, with intensity ranging from 2 to 6 (mean intensity = 3). All recovered females were post-metamorphic adults as evident from the presence of fully filled/filling/empty egg sacs. Mature post-metamorphic adult females of *C. vampire* **sp. nov.** recovered from the external body surface of the host fish *C. corniger.* In the body surface, it is found penetrating on the upper and lower jaws (Fig. 1A), on the dorsal and dorsolateral body surface between eyes and dorsal fin (Fig. 1B), in the dorsal surface of the host's head, which induced a swelling on the head (Fig. 1C) and lateral body surface (Fig. 1D). The cephalothorax and neck region of the parasites embedded in the host's body musculature and the trunk and egg sacs are freely hanged. Further, the cephalothorax of live/fresh parasites was dark reddish due to host blood feeding (see fig. 2).

Distribution. Known only from the type locality, Neendakara, Kerala coast of the Arabian Sea, India.

Etymology. The specific name is derived from the word 'vampire' means a mythical creature that subsists by feeding on the blood of the living; noun apposition.

Diagnosis: The diagnostic features of *Cardiodectes vampire* **sp. nov.,** include: trunk 3.15 times as long as wide; extremely long (3.5 times as long as total body length) and uncoiled egg sacs; difference in the armature of legs 1–3; comparatively longer trunk (0.7 times as long as total body length).

Remarks

The new species, *Cardiodectes vampire,* clearly belongs to the ''*rubosus*'' species group as it lacks an abdomen and can be distinguished from other members of the genus by the combination of the following characteristic features: trunk 3.15 times as long as wide; extremely long and uncoiled eggsacs; the difference in the armature of legs 1–3; comparatively long trunk (0.7 times as long as total body length).

Species of *Cardiodectes* are known from, North Pacific Ocean, Japan (Shiino 1958; Uyeno and Nagasawa 2010), off Kadone in Sagami Bay (Izawa 1970), Indo-Pacific (Gnanamuthu 1951; Sebastian 1968; Pillai 1985), Salmon Island, Graham Land (Leigh-Sharpe 1934), New Guinea (Bellwood 1981), North Atlantic Ocean and Mediterranean Sea (Jungersen 1911; Wilson 1917; Capart 1953; Hogans 2017), Great Barrier Reef, Australia (Uyeno 2013), South Pacific Ocean, New Caledonia (Uyeno and Nagasawa 2010), Java Sea (Markevich 1936), off Jamaica, the Carribean part of Central America (Bellwood 1981; Suárez-Morales *et al.* 2022) (see Table 1).

In relation to host, the family Gobiidae is parasitized with 5 species of *Cardiodectes*, followed by Myctophidae (4 species), Engraulidae (2 species) and Scaridae (2 species), other families such as Apogonidae, Chlorophthalmidae, Phosichthyidae and Serranidae were found with 1 species (see Table 1).

Species of *Cardiodectes*, shows different levels of host specificity. Out of five species of *Cardiodectes* known from Gobiid fishes, four species are recorded only from the type host: *C. asper* from *Trimma grammistes; C. bellwoodi* from *Istigobius nigroocellatus; C. bertrandi* from *Eviota* sp.*; C. rotundicaudatus* from *Suruga fundicola* and on the other hand *C. shini* is recorded from following four species of host fishes *Pleurosicya micheli*, *Eviota sebreei, Eviota* sp., and *Priolepis* sp. Similarly, two *Cardiodectes* species are known from engraulid fishes; *C. anchorellae* recorded from following three fishes, *Stolephorus tri*, *Stolephorus indicus* and *Thryssa hamiltonii*; and *C. hardenbergi* known only from the type host *Encrasicholina heteroloba* (Izawa, 1970; Bellwood, 1981; Uyeno, 2013).

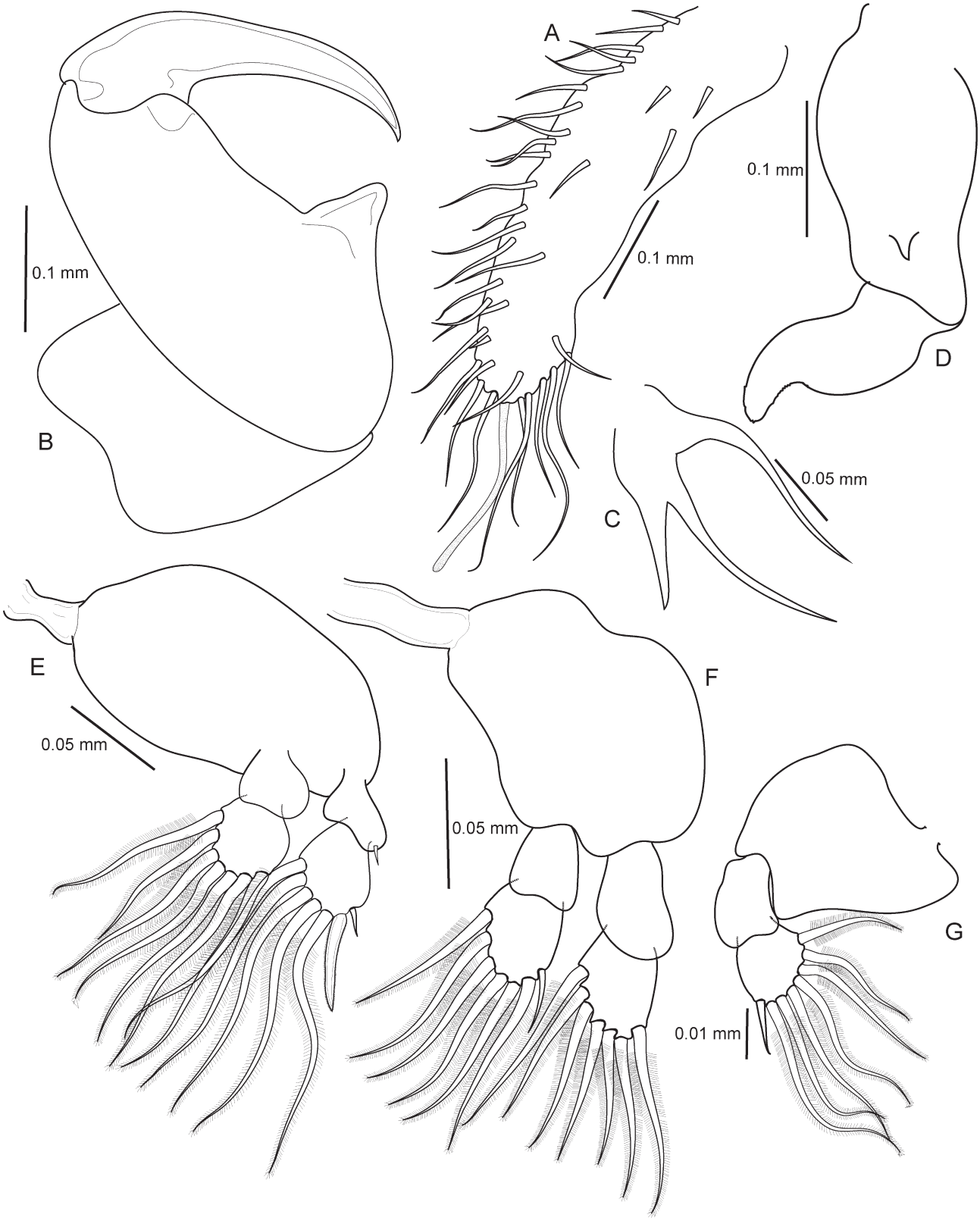

FIGURE 6. *Cardiodectes vampire* **sp. nov.**, matured post-metamorphic adult female, **A**, antennule; **B**, antenna; **C**, maxillule; **D**, maxilla; **E**, leg 1 with inter-coxal sclerite; **F**, leg 2 with inter-coxal sclerite; **G**, legs 3.

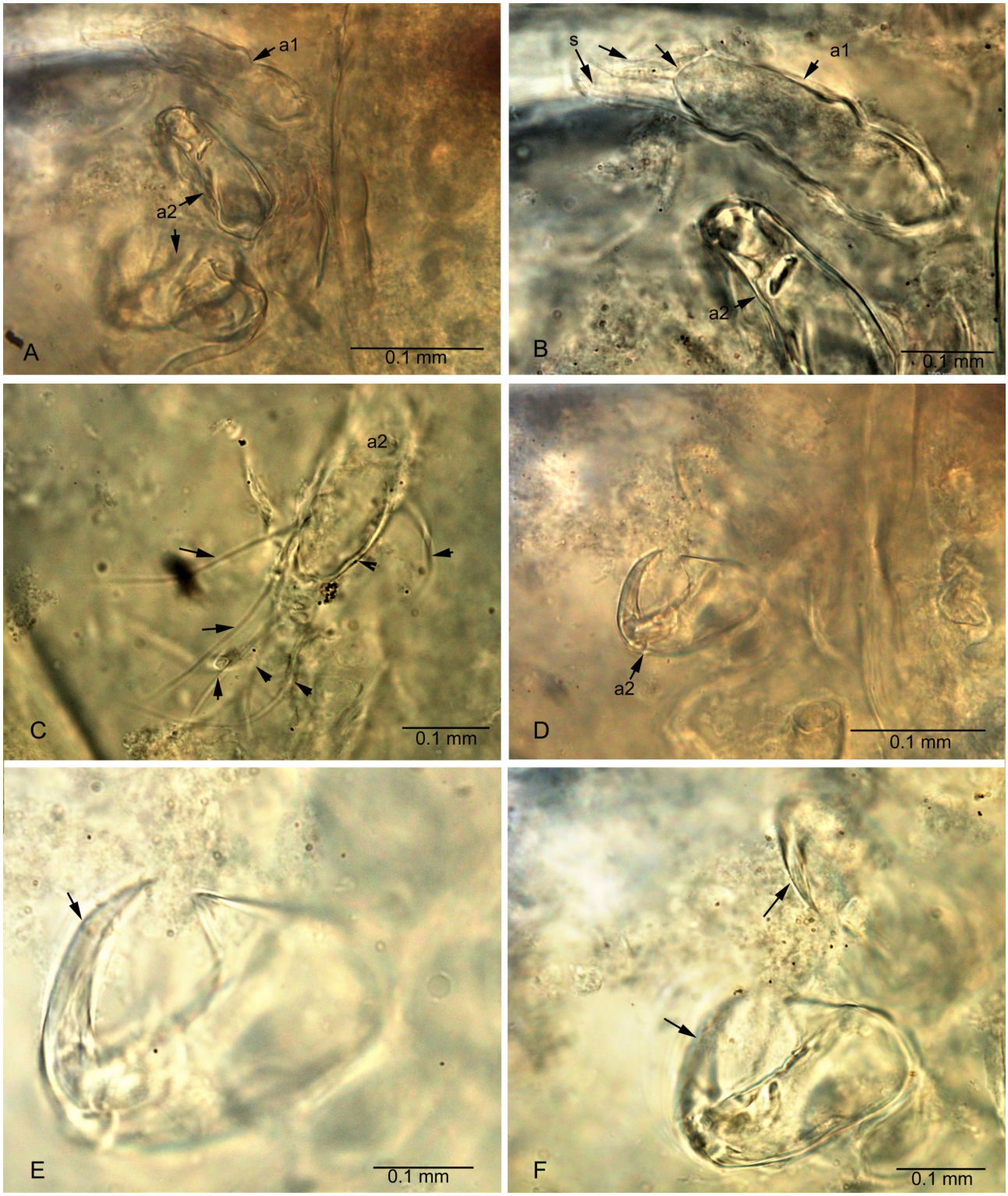

FIGURE 7. *Cardiodectes vampire* **sp. nov.**, matured post-metamorphic adult female, **A–B**, antennule and antenna; **C**, antennule showing setae (arrows); **D–F**, antenna (arrow). a1—antennule; a2—antenna; s—seta.

Another four species are recorded from the fishes of the family Myctophidae. Among them *C. bellottii* is recovered from following five hosts; *Hygophum benoiti*, *Notoscopelus caudispinosus*, *Benthosema glaciale*, *Diaphus rafinesquii*, *Myctophum* sp. and remaining three *Cardiodectes* species known only from its type host; *C. cristatus* from *Diaphus suborbitalis*; *C. frondosus* from *Dasyscopelus spinosus*; and *C. longicervicus* from *Dasyscopelus asper* (Izawa, 1970; Bellwood, 1981; Uyeno, 2013).

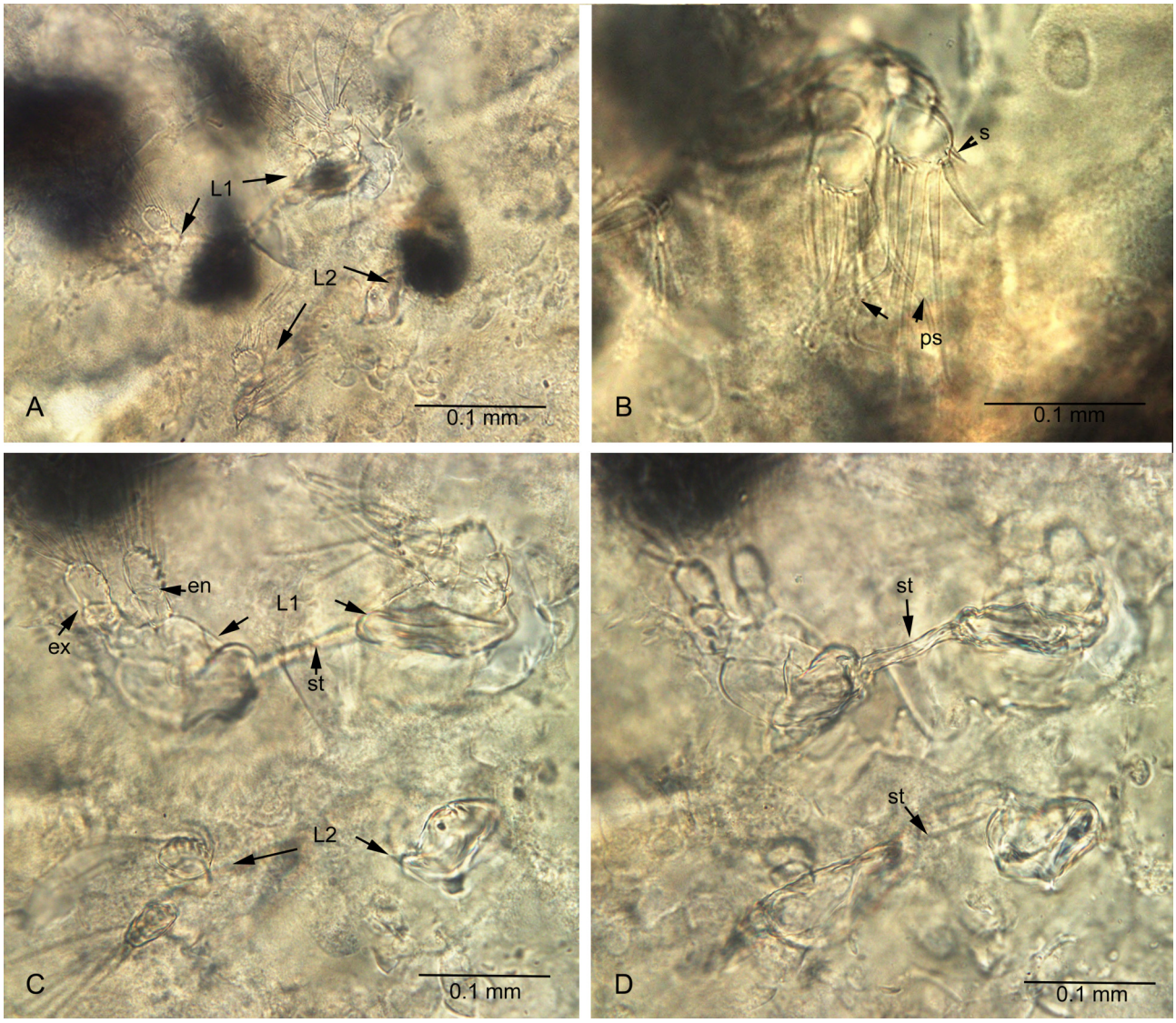

FIGURE 8. *Cardiodectes vampire* **sp. nov.**, matured post-metamorphic adult female, **A**, legs 1 and 2; **B**, leg 1 with plumose setae and spine; **C–D**, legs 1 and 2 with inter-coxal sclerite. ps—plumose setae; s—seta; ex—exopod; en—endopod; st—coxal sclerite.

Cardiodectes boxshalli and the recently described *C. roatanensis* are known only from their type host such as *Nicholsina usta* and *N. ustis*, respectively both are from the family Scaridae (Uyeno, 2013; Sua´rez-Morales *et al.* 2022). Similar to that the remaining four species of *Cardiodectes*, including the new species described here are recorded only from its type host; *C. rubosus* from *Apogen* sp. (Apogonidae), *C. vampire* **sp. nov.** from *C. corniger* (Chlorophthalmidae), *C. krishnai* from *Vinciguerria lucetia* (Phosichthyidae) and *C. spiralis* from *Pseudanthias tuka* (Serranidae) (Sebastian, 1968; Pillai, 1985; Uyeno, 2013)**.**

With the description of *Cardiodectes vampire* **sp. nov**., the total number of species under the genus are currently seventeen. By the absence of an abdomen, the new species can be well separated from '*medusaeus*' group. *Cardiodectes vampire* **sp. nov.** differs from *C. asper, C. bellwoodi, C. bertrandi, C. boxshalli, C. roatanensis*, *C. spiralis,* and *C. shini* by having a trunk 3.15 times as long as wide (vs. twice or less than twice as long as wide) (Leigh-Sharpe 1934; Markevich 1936; Sebastian 1968; Izawa 1970; Bellwood 1981; Uyeno and Nagasawa 2010; Uyeno 2013; Suárez-Morales *et al.* 2022).

TABLE 1. List of valid species of *Cardiodectes* Wilson C.B., 1917, including their known geographic distribution and fish hosts.

	Species of *Cardiodectes*	Host		Distribution	References
		Name	Family		
1.	*C. anchorellae* Brian and Gray, 1928	1. *Stolephorus tri* (Bleeker, 1852) 2. *Stolephorus indicus* (van Hasselt, 1823) 3. *Thryssa hamiltonii* Gray, 1835	Engraulidae	India (Madras, Kerala), Sri Lanka	Brian and Gray 1928 Gnanamuthu 1951 Pillai 1985
2.	*C. asper* Uyeno and Nagasawa, 2010	*Trimma grammistes (Tomiyama, 1936)*	Gobiidae	Izu-Oshima Island, Tokyo, North Pacific Ocean, Japan	Uyeno and Nagasawa 2010
3.	*C. bellottii* (Richiardi, 1882)	1. *Hygophum benoiti* (Cocco, 1838) 2. *Notoscopelus caudispinosus* (Johnson, 1863) 3. *Benthosema glaciale* (Reinhardt, 1837) 4. *Diaphus rafinesquii* (Cocco, 1838) 5. *Myctophum* sp.	Myctophidae	North Atlantic Ocean and Mediterranean Sea	Jungersen 1911 Wilson 1917 Capart 1953 Hogans 2017
4.	*C. bellwoodi* Uyeno, 2013	*Istigobius nigroocellatus* (Günther, 1873)	Gobiidae	Pioneer Bay, Orpheus Island, Great Barrier Reef, Australia	Uyeno 2013
5.	*C. bertrandi* Uyeno and Nagasawa, 2010	*Eviota sp.*	*Gobiidae*	Loyalty Islands, South Pacific Ocean, New Caledonia	Uyeno and Nagasawa 2010
6.	*C. boxshalli* Bellwood, 1981	*Nicholsina usta* (Valenciennes, 1840)	Scaridae	off Jamaica	Bellwood 1981
7.	*C. cristatus* Shiino, 1958	1. *Diaphus suborbitalis* Weber, 1913	Myctophidae	Japan	Shiino 1958
8.	*C. frondosus* Schuurmans Stekhoven J.H. Jr, 1937	*Dasyscopelus spinosus* (Steindachner, 1867)	Myctophidae	-	Stekhoven 1937
9.	*C. hardenbergi* Markevich, 1936	*Encrasicholina heteroloba* (Rüppell, 1837)	Engraulidae	Java See	Markevich 1936
10.	*C. krishnai* Sebastian, 1968	*Vinciguerria lucetia* (Garman, 1899)	Phosichthyidae	Arabian Sea	Sebastian 1968; Pillai 1985
11.	*C. longicervicus* Shiino, 1958	*Dasyscopelus asper* (Richardson, 1845)	Myctophidae	Japan	Shiino 1958
12.	*C. roatanensis* Suárez-Morales, Vásquez-Yeomans and Vidotto, 2022	*Nicholsina ustis* (Valenciennes, 1839)	Scaridae	Roatan Island, Honduras, Central America	Suárez-Morales *et al.* 2022
13.	*C. rotundicaudatus* Izawa, 1970	*Suruga fundicola* Jordan and Snyder, 1901	Gobiidae	off Kadone in Sagami Bay	Izawa 1970
14.	*C. rubosus* Leigh-Sharpe, 1934	*Apogon* sp.	Apogonidae	Salmon Island, Graham Land	Leigh-Sharpe 1934
15.	*C. shini* Uyeno, 2013	*Pleurosicya micheli* Fourmanoir, 1971 *Eviota* sp. *Eviota sebreei* Jordan and Seale, 1906 *Priolepis* sp.	Gobiidae	Okinawa-jima Island, Ryukyu Islands, North Pacific Ocean, Japan	Uyeno 2013
16.	*C. spiralis* Bellwood, 1981	1. *Pseudanthias tuka* (Herre and Montalban, 1927)	Serranidae	off the Massas Islands, New Guinea	Bellwood 1981
17.	*C. vampire* **sp. nov.**	*Chlorophthalmus corniger* Alcock, 1894	Chlorophthalmidae	south-west coast of India	Present study

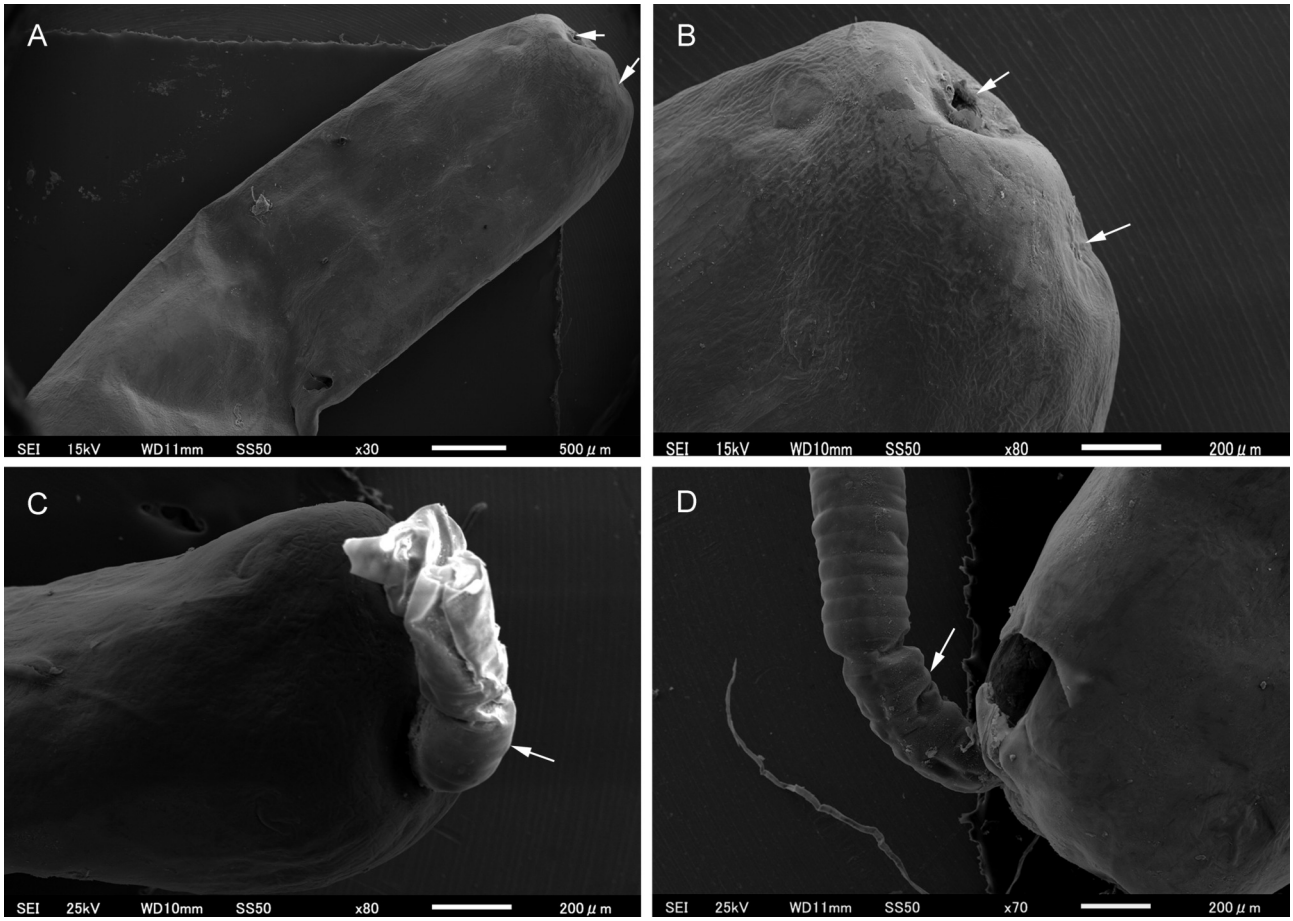

FIGURE 9. Scanning electron micrographs of *Cardiodectes vampire* **sp. nov.**, ovigerous female, **A–B**, trunk posterior showing genital orifice (arrow); **C–D**, trunk posterior showing egg sac (arrow).

Remaining four species, *C. hardenbergi, C. krishnai, C. rotundicaudatus,* and *C. rubosus* having a trunk greater than twice as long as wide. *Cardiodectes krishnai* can be well distinguished from *C. vampire* **sp. nov.** by having a trunk about 5 times as long as wide (vs. trunk 3.15 times as long as wide) (Sebastian 1968; Bellwood 1981). The following three species *C. hardenbergi, C. rotundicaudatus,* and *C. rubosus* can be separated from the new species *C. vampire* by having the body 1.7 times longer than cephalothorax and neck combined (vs. 2.4 times longer than cephalothorax and neck combined). Furthermore, in *C. rubosus* four pairs of legs are present (vs. three pairs in *C. vampire*). Both *C. hardenbergi* and *C. vampire* **sp. nov.** possessing the uncoiled eggsacs, however in *C. vampire* **sp. nov.** it is extremely long (3.5 times longer than total body length).

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Declarations

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval The specimen is not under the listed category of experimental animal which needs ethics approval.

Sampling and field studies All necessary permits for sampling and observational field studies have been obtained by the authors from the competent authorities.

Data availability All data generated or analyzed during this study are included in this published article.

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