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A new species of *Brianola* Monard, 1926 (Copepoda: Harpacticoida: Canuellidae) from Rawai Beach, Phuket Island, Thailand

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A new species of the canuellid genus *Brianola* Monard, 1926 (Copepoda: Harpacticoida) was collected during a meiofauna survey in July 2021 at the intertidal muddy sand of Phuket Island, Thailand. Currently, there are only eight known species of *Brianola*: *B. stebleri*, *B. exigua*, *B. curvirostris*, *B. elegans*, *B. sydneyensis*, *B. vangoethemi*, *B. hamondi*, and *B. haliensis*. Thus, the *Brianola rawaiensis* **sp. nov.** from Thailand is the ninth species of the genus. The new species, ***Brianola rawaiensis*** is most closely related to *B. haliensis* by sharing a four-segmented antennule in females and five-segmented antennule in males, eight-segmented antennary exopod and three-segmented antennary endopod, and P1 exp-3 with 5 spines/setae. However, *B. rawaiensis* **sp. nov.** is different from *B. haliensis* by having: 1) P1 exp-1 with 1 outer pinnate spine, 2) P1 exp-2 with inner plumose seta, 3) P2 exp-3 with 3 setae/spines, 4) P2 enp-1 with one inner plumose seta, 5) P4 enp-1 with inner seta. Sexual dimorphism is expressed in the antennule and segmentation of the urosome. Ovigerous female bearing one egg sac with 20 eggs.

Keywords: *Brianola*, Harpacticoida, Phuket Island, Rawai Beach, Thailand

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Introduction

Members of the harpacticoid copepod genus *Brianola* Monard, 1926 (family Canuellidae) are placed in the order Harpacticoida because Khodami *et al*. (2020) retracted subsequently from the order Canuelloida. These species were found in the intertidal zones and are assumed to have a worldwide distribution. Among the 18 genera of Canuellidae, the genus *Brianola* has the key characters of swimming legs as follows: (1) P1 exopod three-segmented, (2) P2 exp-3 with four setae and spines, (3) P3 exp-3 with four setae and spines, and (4) P4 enp-3 with four setae and spines (Huys *et al*., 1996; Huys, 2016). Iwasaki (1993) found *Brianola* encompassed 71.0–90.2% of the copepod fauna on the creek banks of the Pauatahanui Inlet in New Zealand. Wells (2007) wrote that the descriptions of the species of *Brianola* are poor quality, for example, Wells and Rao (1987) stated that the setation of P1 exp-3 of *B. hamondi* is identical with that of *B. sydneyensis* but the illustration of the former shows only four setae and spines instead of five (Hamond, 1973, Fig. 29). Currently, the genus *Brianola* accommodates eight valid species: *B. stebleri* (Monard, 1926) from France; *B. exigua* Por, 1967 from the Gulf of Eilat (Red Sea) in Israel; *B. curvirostris* Bozic, 1968 from the Mediterranean Sea; *B. elegans* Hamond, 1973 from the coastal suburbs of metropolitan Sydney; *B. sydneyensis* Hamond, 1973 from the coastal suburbs of metropolitan Sydney; *B. vangoethemi* Fiers, 1982 from the coastal waters of Papua New Guinea; *B. hamondi* Wells & Rao, 1987 from Andaman and Nicobar Islands; and *B. haliensis* Nazari, Mirshamsi, Sari, Aliabadian & Martinez Arbizu, 2018 from the intertidal zone of Northern Haleh, Nayband, Iran. Hence, the present ***B. rawaiensis*** **sp. nov.** from Rawai Beach of Phuket Island, Thailand, is the ninth species of the genus.

In July 2021, a new species, *B. rawaiensis* was found during low tide in the Rawai muddy sand Beach of Phuket Island during a survey funded by the National Research Council of Thailand (NRCT) titled "Survey of meiofauna distribution and diversity focusing on Harpacticoid copepods at various habitats in Phuket Province, Thailand", The present paper aims to describe the morphological characteristics of the new species from Thai waters.

Materials and Methods

Adults of both genders of *B. rawaiensis* **sp. nov.** were collected during low tide at Rawai Beach in Phuket Province, Thailand. Specimens were fixed in 6% buffered formalin, subsequently preserved in 70% ethanol, and cleared in lactic acid. All measurements and dissections were made using a Leica MZ8 stereomicroscope. Drawings were made with the aid of a camera lucida mounted on a Nikon BH-2, HFX-DX compound microscope. Dissected specimens were mounted on slides in glycerol and sealed with transparent nail varnish.

The body and appendage morphology terminology follows Huys and Boxshall (1991) and Huys *et al*. (1996). Abbreviations used in the text are *ae*, aesthetasc; *exp*, exopod; *enp*, endopod; *exp* (*enp*)-*1*(*2*,*3*), proximal (middle, distal) segment of exopod (endopod); *P1–P4*, first to fourth swimming legs; and *P5–P6*, fifth to sixth leg. Body length was measured from the anterior tip of the rostrum to the posterior margin of the caudal rami. Measurements were made with an ocular and slide micrometer. The type of material of *Brianola rawaiensis* **sp. nov.** was deposited in the collections of the National Institute of Biological Resources (NIBR), Korea.

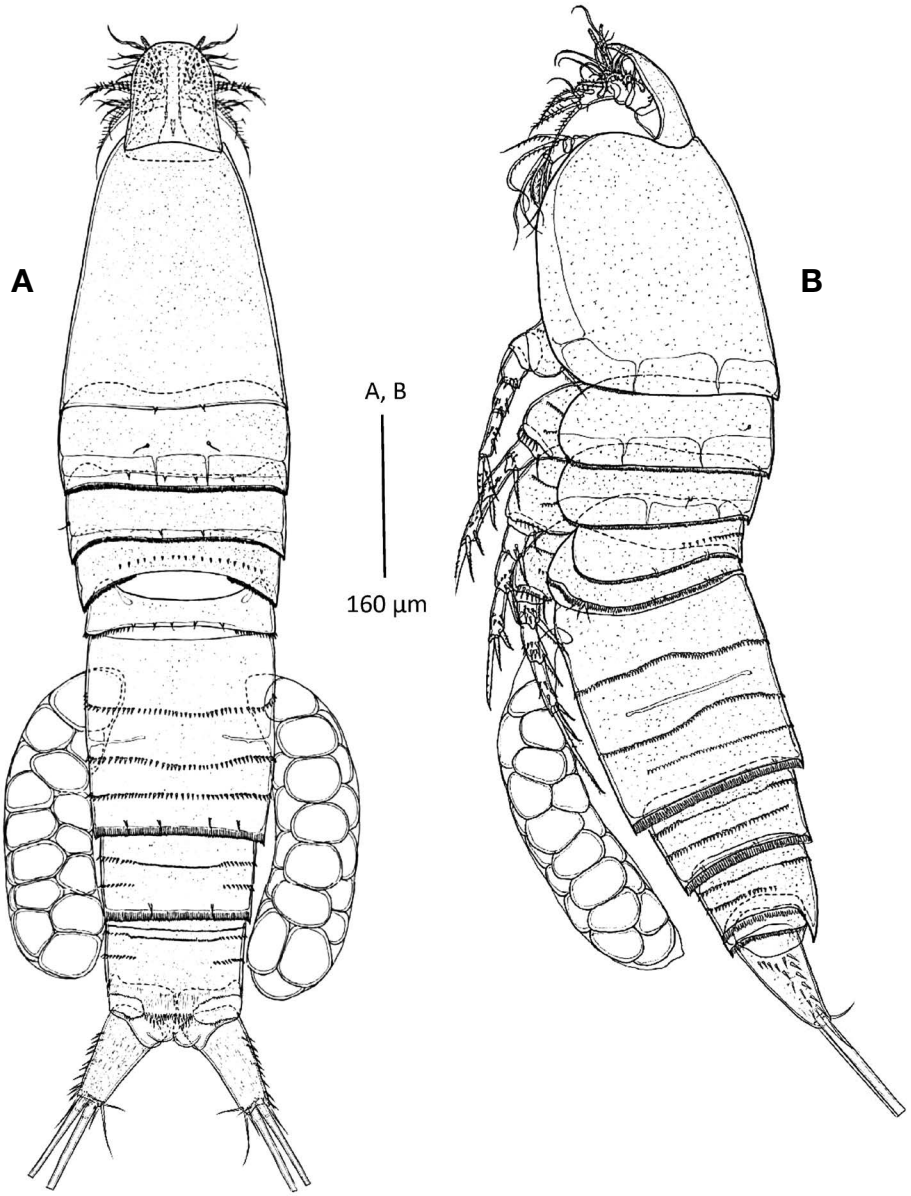

Fig. 1. *Brianola rawaiensis* **sp. nov.**, female: (A) habitus, dorsal; (B) habitus, lateral.

SYSTEMATICS

Order Harpacticoida Sars, 1903
Family Canuellidae Lang, 1944
Genus *Brianola* Monard, 1926

Brianola rawaiensis sp. nov. (Figs. 1–9)

Type locality. Intertidal zone at Rawai Beach of Phuket Island, Thailand, 7°46′17″N 98°19′15.7″E.
Material examined. Holotype: ovigerous female (NIBR IV0000910337) dissected on 8 slides; adult male allotype (NIBRIV0000910338) dissected on 7 slides, 3 females and 3 paratype males (NIBRIV0000910339) preserved in 70% ethanol.

Etymology. The species name refers to the type locality at Rawai muddy sand Beach of Phuket Island.
Description. Female. Habitus (Fig. 1A, B). Body length 992 μm. Body length of paratypes 821–1,026 μm ($n = 6$, mean = 919 μm). Body fusiform, the entire body surface ornamented with minutely punctate on the cephalothorax and thoracic segments, otherwise unornamented and with an entire hyaline frill; prosome gradually tapering anteriorly, few sensilla on the body surface. Nauplius eye not visible. Prosome four-segmented, comprising cephalosome fused to first pedigerous somite, and three free pedigerous somites.

Cephalothorax longer than three prosomites combined, posterior margin of second to fourth prosomites ornamented with rows of hyaline frills. Posterior margin of uroso-

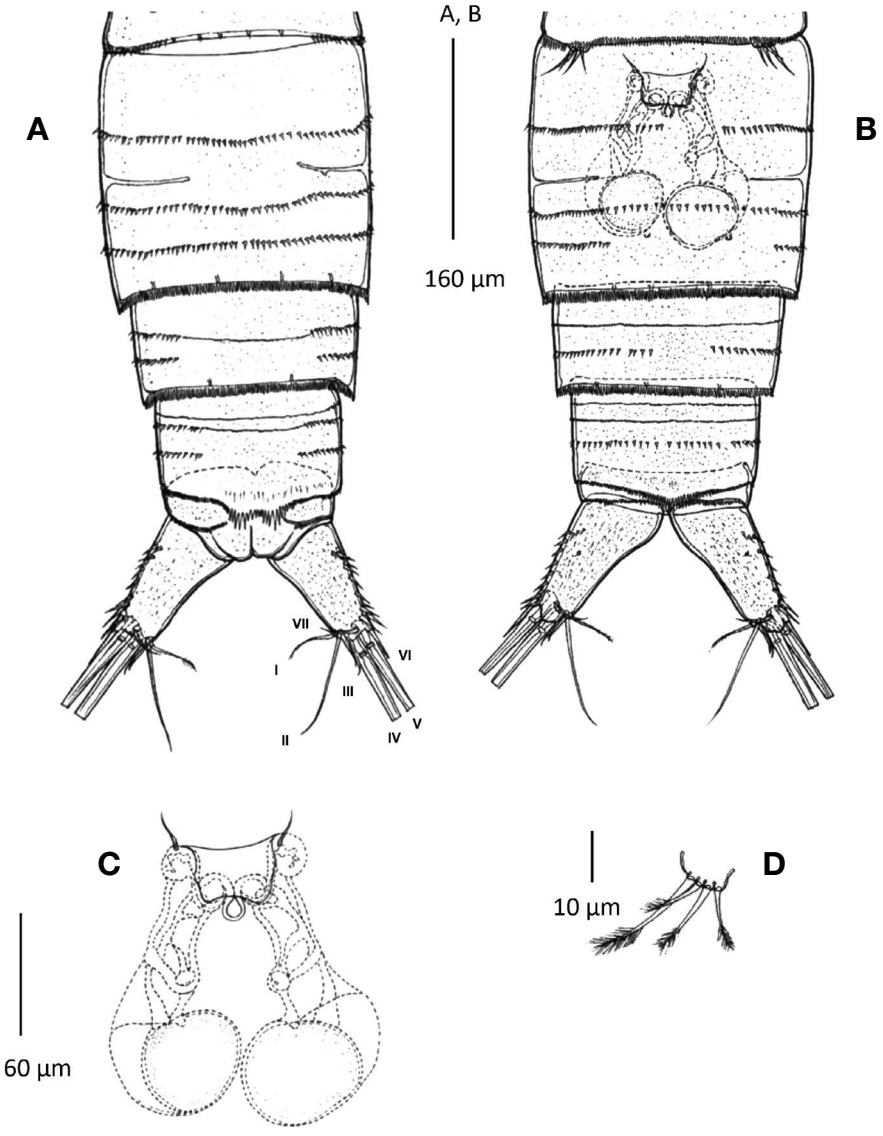

Fig. 2. *Brianola rawaiensis* **sp. nov.**, female: (A) urosome dorsal; (B); urosome ventral; (C) genital area; (D) P5.

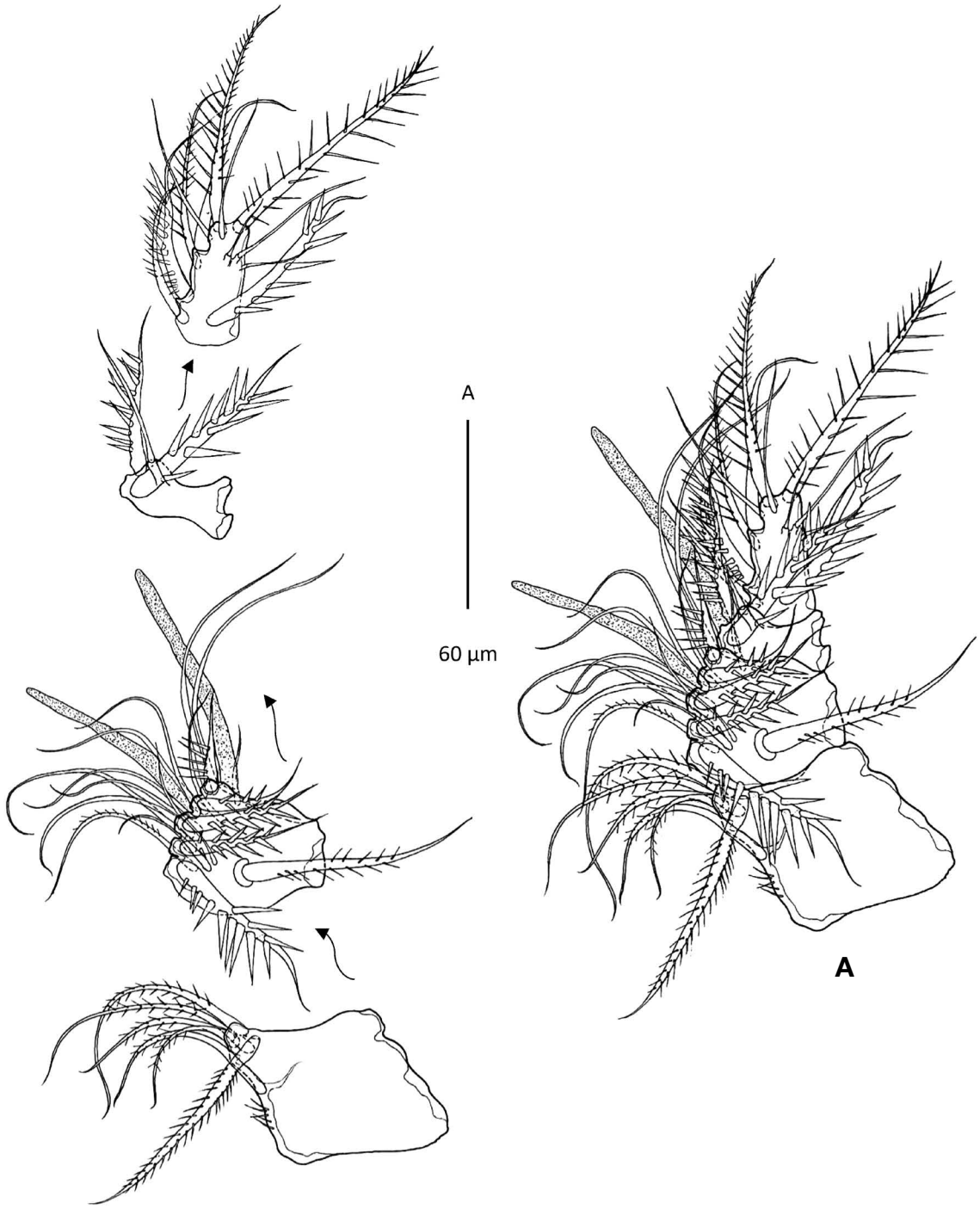

Fig. 3. *Brianola rawaiensis* **sp. nov.**, female: (A) antennule (disarticulated).

mites ornamented with fine spinules and hyaline frills. Rostrum very large, bell-shaped, slightly exceeding the length of antennules, with two sensilla (but could not see).

Urosome (Fig. 2A, B) five-segmented, consisting of rectangular somites, ornamented with rows of fine spinules and hyaline frills dorsally and ventrally, genital double-somite fused, two abdominal somites, and anal somite. Genital area indistinct, ventrally with one copulatory pore, and two genital apertures (Fig. 2C). Third and fourth urosomites with rows of spinules on the surface and are ornamented with hyaline frills along the outer margin dorsally and ventrally. Anal operculum semicircular and smooth.

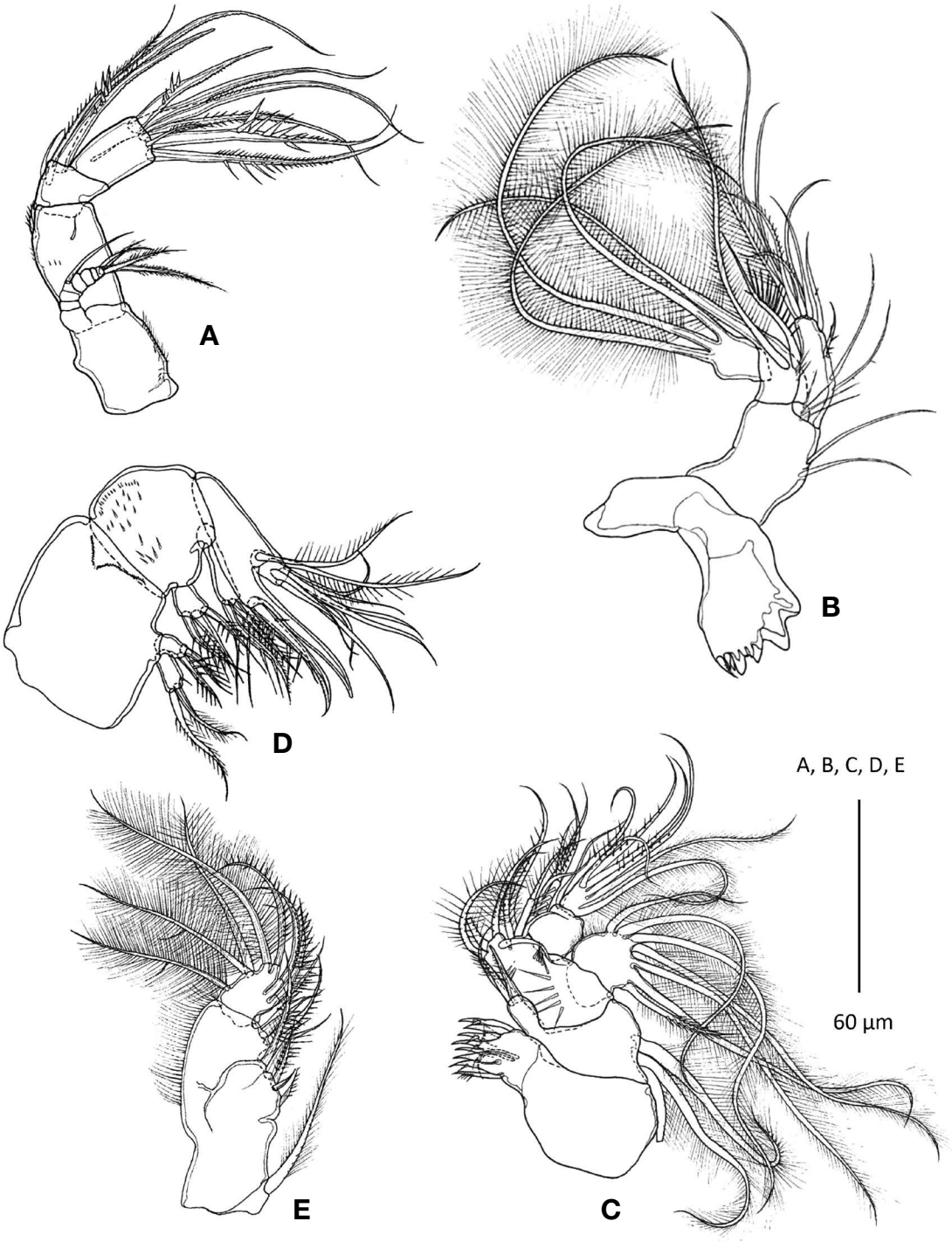

Fig. 4. *Brianola rawaiensis* **sp. nov.**, female: (A) antenna; (B) mandible; (C) maxillule; (D) maxilla; (E) maxilliped.

Caudal rami unsegmented, twice as long as wide, ornamented with spinules on the outer margin. Each ramus (Figs. 1A; 2A, B) armed with seven setae: seta I short and located at the outer margin close to seta IV; seta II longer than seta I and III; seta IV shorter than seta V; seta V longest; seta VI short close to seta V; seta VII shortest located close to the insertion point of seta V.

Antennule (Fig. 3A) four-segmented indistinctly, without spinules on the dorsal surface. First segment with five spinules at the inner margin and six pinnate setae at the

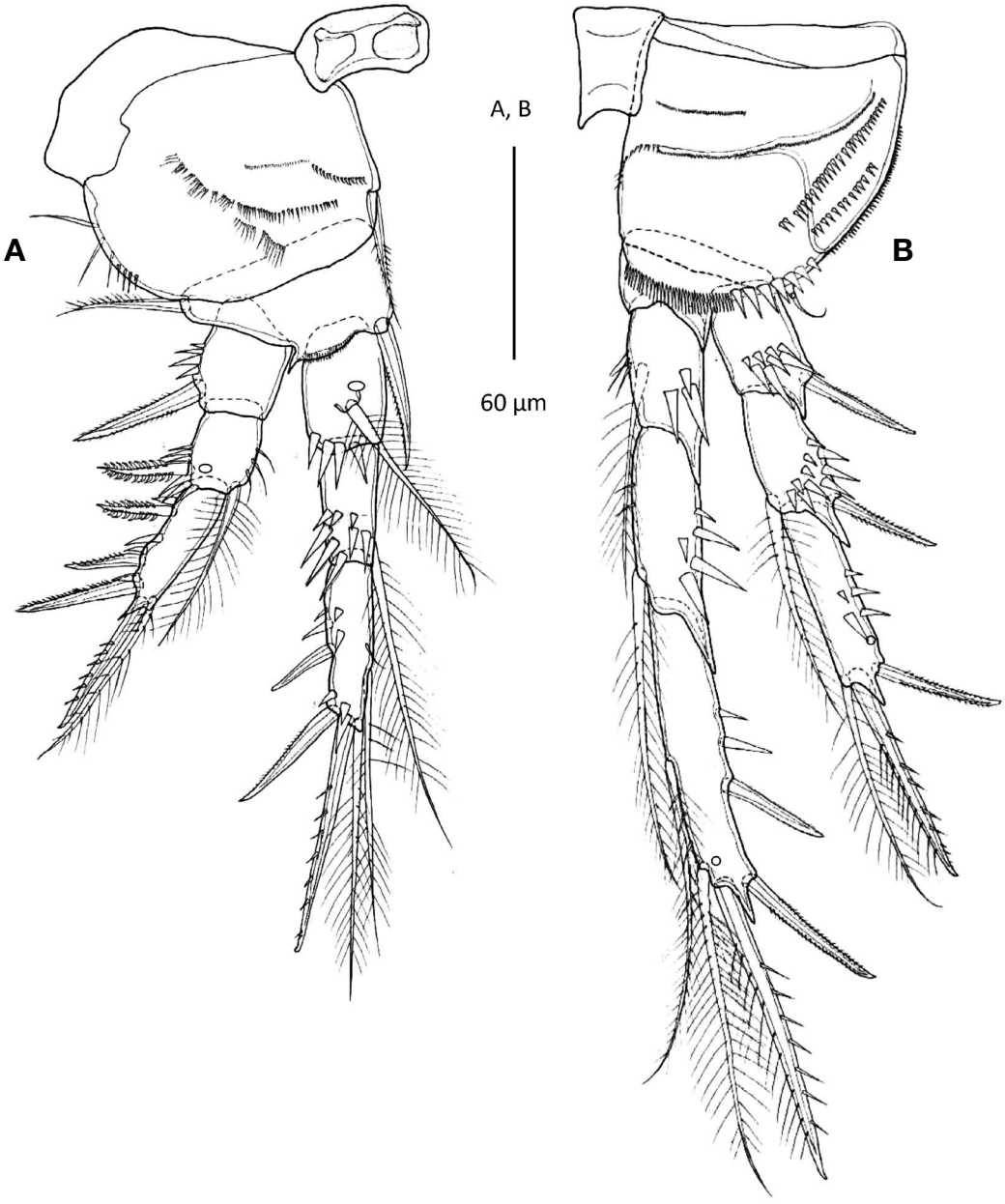

Fig. 5. *Brianola rawaiensis* **sp. nov.**, female: (A) P1, anterior; (B) P2, posterior.

inner corner. Second segment with seven spinulose and twelve smooth setae plus two aesthetascs. Third segment bearing two spinulate setae and one smooth seta. Distal segment with seven spinulate and six smooth setae. Armature formula: 1-(6), 2-(19 + 2 ae), 3-(3), 4-(13).

Antenna (Fig. 4A). Basis with small spinules on middle and outer margin. Exopod consist of eight segments; fourth segment with one long naked seta; ultimate segment with four pinnate setae. Endopod three-segmented; enp-1 with one long setule and spinular row along outer margin and anterior surface, enp-2 with one naked seta and three spinulose setae, enp-3 with six spinulose setae, one pinnate seta and one naked short seta.

Mandible (Fig. 4B) with large and elongated coxa, without surface ornamentation. Gnathobase well-developed, cutting edge with two rows of strong teeth in different sizes. Basis bearing two naked setae. Endopod two-segmented, enp-1 with two pinnate and one spinulose setae; enp-2 with three plumose setae fused with segment. Exopod one-segmented, with seven naked and three plumose setae.

Maxillule (Fig. 4C). Praecoxa arthrite with two juxtaposed slender setae on anterior surface and with eight dis-

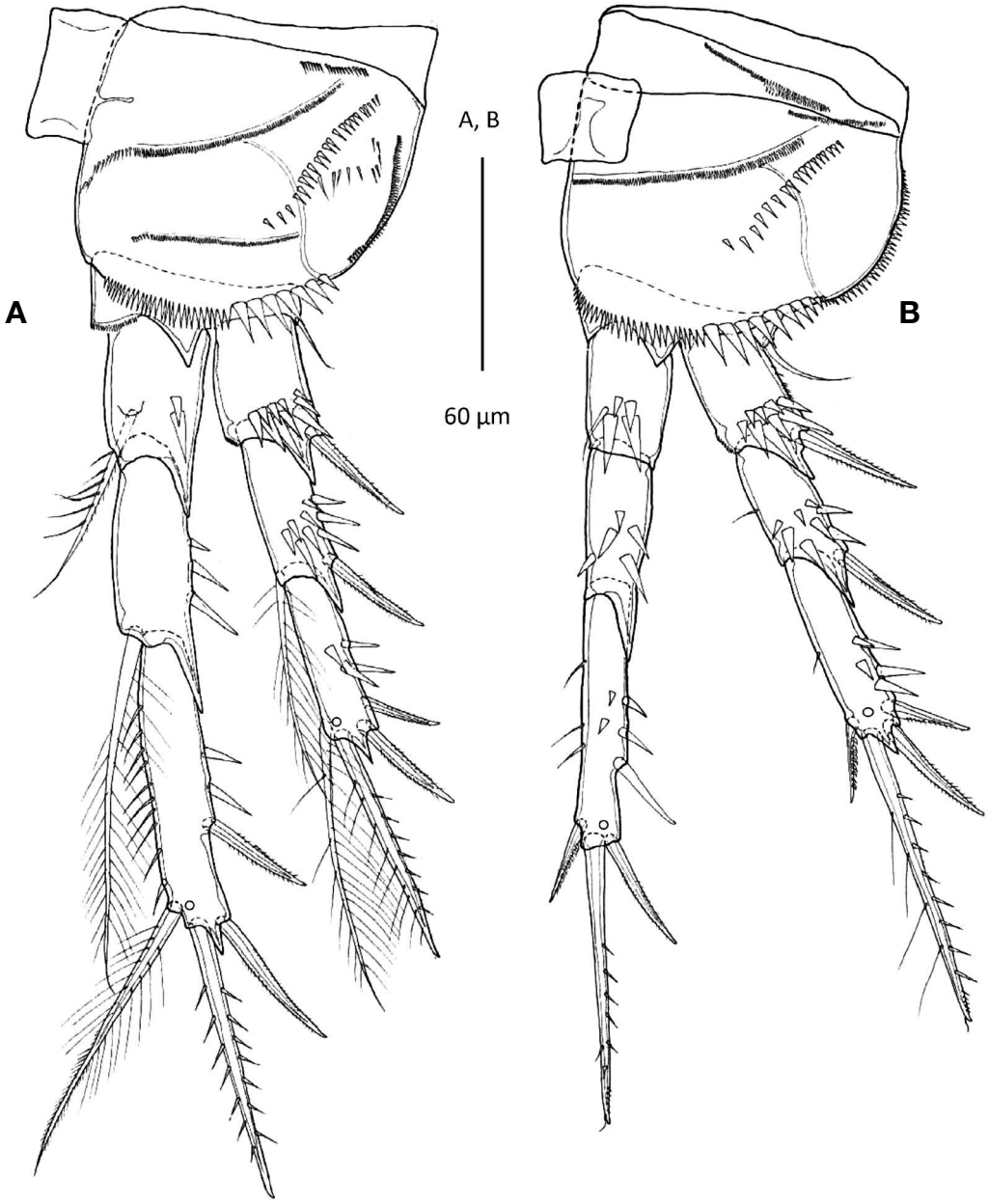

Fig. 6. *Brianola rawaiensis* **sp. nov.**, female: (A) P3, posterior; (B) P4, posterior.

tal spines. Coxal endite cylindrical, bearing three spinulose setae; epipodite represented by three plumose setae. Basis ornamented with rows of spinules on surface, basal endite bearing six spinulose and two smooth setae. Endopod two-segmented, end-1 bearing three spinulose and two smooth setae; enp-2 bearing four spinulose and two plumose setae. Exopod one-segmented, with six plumose setae fused with segment and one pectinate seta.

Maxilla (Fig. 4D) comprising praecoxa, coxa, allobasis, and one-segmented endopod. Praecoxa bearing one row of spinules, two praecoxal endites with two pinnate setae and two spinulose setae; coxa ornamented with different sizes of spinules on surface, bearing two coxal endites with three spinulose setae each; basis extended into a strong claw and one spinulose spine, basal endite with two plumose setae. Endopod one-segmented, with seven smooth setae.

Maxilliped (Fig. 4E) phyllopodial, comprising syncoxa (praecox and coxa fused); basis, and one-segmented endopod. Syncoxa bearing one long plumose seta at base and five spinulose and one naked seta. Basis bearing four spinulose setae, and one row of long setules along outer margin. Endopod with three spinulose and four plumose setae.

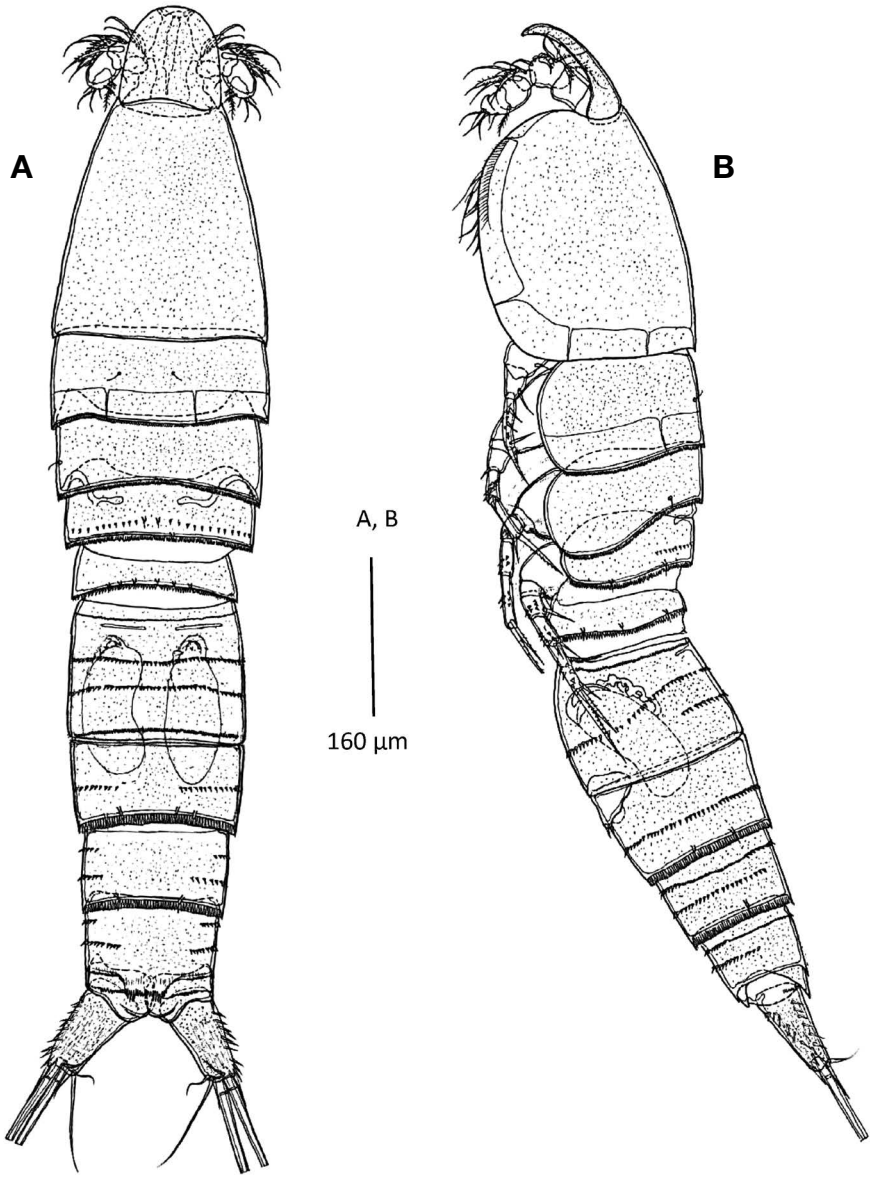

Fig. 7. *Brianola rawaiensis* **sp. nov.**, male: (A) habitus, dorsal; (B) habitus, lateral.

All swimming legs (Figs. 5A, B; 6A, B) biramous; P1–P4 with three-segmented exopods and endopods. Members of each leg pair are connected by simple intercoxal sclerite.

P1 (Fig. 5A). Coxa with one inner pinnate spine, ornamented with rows of spinules on the surface, outer margin with two setules and five spinules. Basis ornamented with setules distally, with one inner pinnate spine and one outer spinulose seta. Exopod shorter than endopod. Exp-1 with one outer pinnate spine; exp-2 with one outer pectinate spine and one inner plumose seta; exp-3 with one outer pectinate and one outer pinnate spine, one distal pinnate spine and one distal spinulose spine, and one inner plumose seta. Enp-1 and enp-2 with plumose inner seta each; enp-3 with one naked and one pinnate outer spine, one spinulose spine and one plumose seta distally, and one short bare seta and one plumose seta on inner margin.

P2 (Fig. 5B). Coxa ornamented with several spinular rows of unequal length on the anterior surface, and a row of spinules along the outer margin. Basis ornamented with small and large spinules along the outer margin and one outer small seta. Exopod shorter than endopod. Exp-1 with one outer pinnate spine; exp-2 with one outer pinnate spine and one inner plumose seta; exp-3 with one outer pinnate spine, one distal spinulose spine, and one inner plumose seta. Enp-1 and enp-2 with one inner plumose

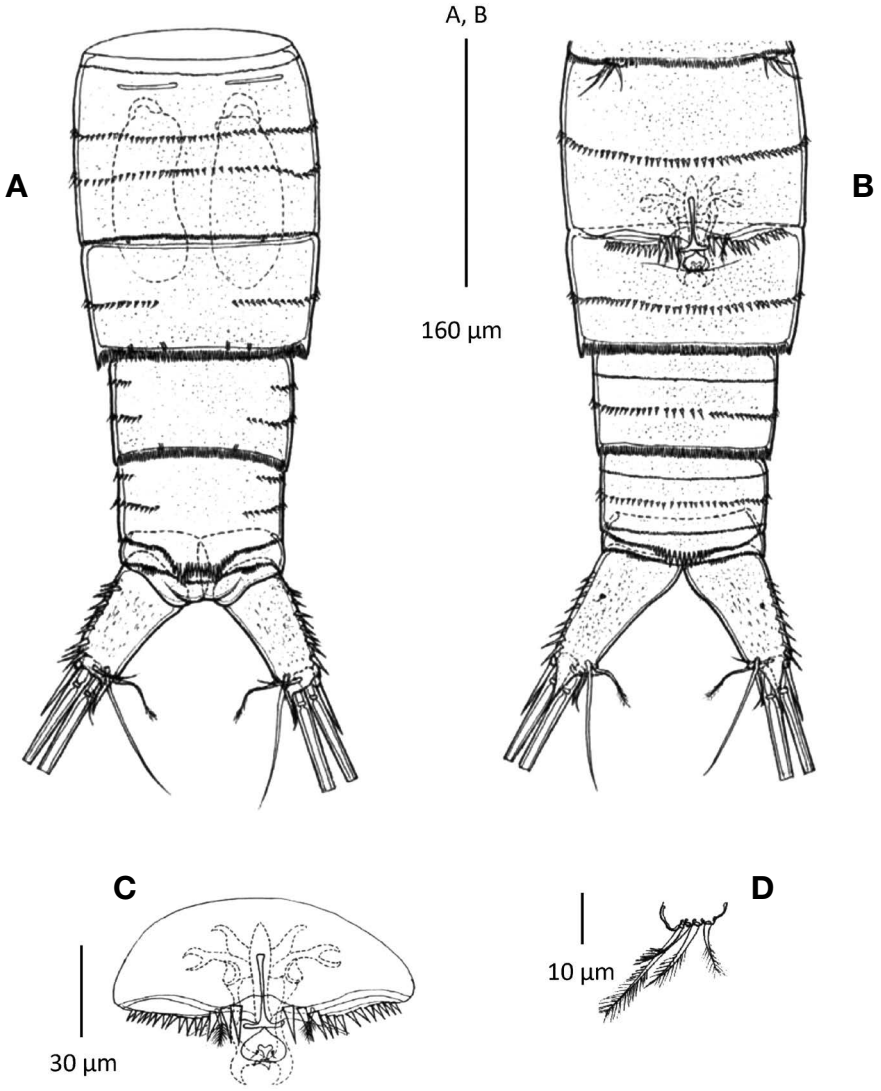

Fig. 8. *Brianola rawaiensis* **sp. nov.**, male: (A) urosome, dorsal; (B) urosome, ventral; (C) genital area; (D) P5.

seta each; enp-3 with one outer pinnate spine, one distal pinnate spine and one distal spinulose spine, and two inner plumose setae.

P3 (Fig. 6A) rather like P2 except for setal formulae. Exp-3 and enp-3 with one outer pinnate spine, one distal pinnate spine and one distal spinulose spine, and one inner plumose seta, respectively.

P4 (Fig. 6B). Coxa and basis ornamentation are almost the same as P2 and P3. Exp-1 and exp-2 with outer pinnate spine each; exp-3 with one outer pinnate spine, one distal pinnate spine and one distal spinulose spine, and one inner pectinate spine. Enp-1with very short smooth inner seta; enp-2 bare; enp-3 with outer bare spine, one distal pinnate spine and one distal spinulose spine, and one inner pectinate spine.

The spine and setal formula of the swimming legs of *Brianoloa rawaiensis* **sp. nov.** are as follows:

	Exopod	Endopod
P1	0.1.122	1.1.222
P2	0.1.111	1.1.221
P3	0.1.121	1.1.121
P4	0.0.121	1.0.121

P5 (Fig. 2D) reduced, incorporated into somite; connected by deeply incised hyaline frills; with four pinnate setae: outer seta longest, two inner setae equal in length.

Description of allotype male. Habitus is almost as in female (Fig. 7A, B). The body length of the allotype 902 μm. Body length of paratypes males 796–929 μm ($n = 12$, mean = 874 μm). Antennae, mouthparts, swimming legs, and caudal rami as in female. Sexual dimorphisms are expressed in antennules and abdominal somites.

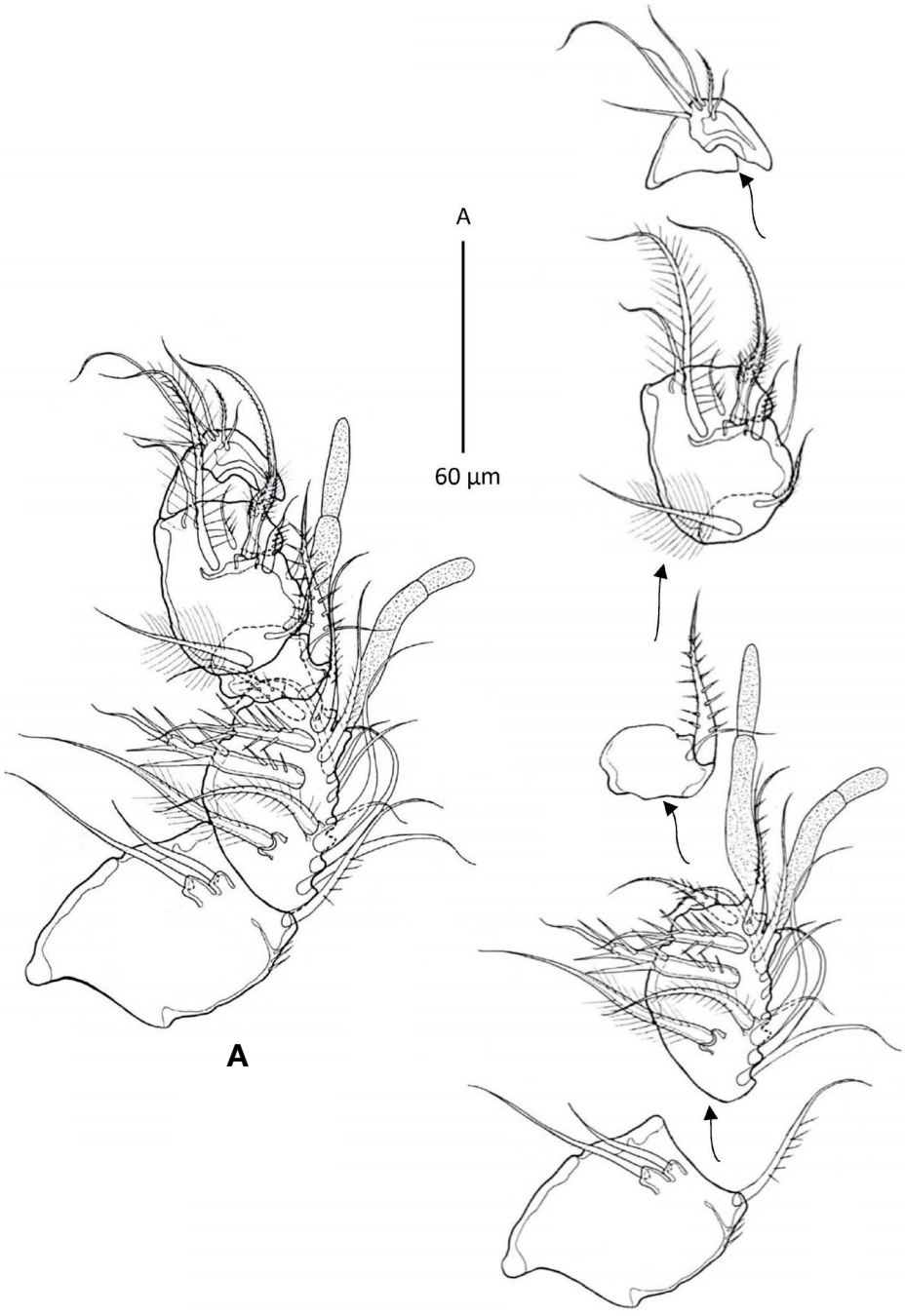

Fig. 9. *Brianola rawaiensis* **sp. nov.**, male: (A) antennule (disarticulated).

Table 1. Character difference between *Brianola rawaiensis* **sp. nov.** and *B. haliensis*.

	B. rawaiensis **sp. nov.**	*B. haliensis*
P1 exp-1	One outer pinnate spine	One outer pectinate spine
P1 exp-2	One plumose inner seta	Without inner seta
P2 exp-3	2 spines and 1 seta	3 spines and 1 seta
P4 enp-1	Without inner seta/spine	One short stout inner spine

Table 2. Occurrence information about species belonging to *Brianola* Monard, 1926.

	Species	Locality	Source
1.	*B. stebleri* Monard, 1926	France	Monard (1926)
2.	*B. exigua* Por, 1967	Gulf of Eilat in Israel	Por (1967)
3.	*B. curvirostris* Bozic, 1968	Mediterranean Sea	Bozic (1968)
4.	*B. elegans* Hamond, 1973	Metropolitan Sydney	Hamond (1973)
5.	*B. sydneyensis* Hamond, 1973	Metropolitan Sydney	Hamond (1973)
6.	*B. vangoethemi* Fiers, 1982	Papua New Guinea	Fiers (1982)
7.	*B. hamondi* Wells & Rao, 1987	Andaman & Nicobar Islands	Wells and Rao (1987)
8.	*B. haliensis* Nazari *et al*., 2018	Nayband, Iran	Nazari *et al*. (2018)
9	*B. rawaiensis* **sp. nov.**	Phuket, Thailand	Present study

Antennule (Fig. 9A) five-segmented. First segment largest, with two smooth and one unipinnate seta, and three small spinules close to the base of the unipinnate seta. Second segment large, with three pinnate, four spinulose, and seven smooth setae/spines and two aesthetascs. Third segment small, with one spinulose and one small smooth seta. Fourth segment large, with two plumose, one spinulose, three pinnate, and one smooth seta and one modified element. Distal segment small, with one pinnate and five smooth setae. Armature formula: 1-(6), 2-(14 + 2 ae), 3-(2), 4-(7), 5-(6).

Urosome (Fig. 8A, B) five-segmented and consisting of P5-bearing somite, genital somite, two urosomites, and anal somite. Genital area and P6 oval-shaped ornamented with spinules as Fig. 8C. Spermatophores paired. P5 with four bipinnate setae (Fig. 8D).

Discussion

With the discovery of *Brianola rawaiensis* **sp. nov.** establishing the nine species of the genus *Brianola*, the family Canuellidae shows the diagnostic characters of the genus as follows: first pedigerous somite fused to the cephalosome; P1−P4 exp-3 with 5, 3, 4, 4 setae/spines respectively; P1−P4 enp-3 with 6, 5, 4, 4 setae/spines respectively; P1 exp-2 with an inner seta except for *B. exigua* and *B. haliensis*; swimming legs without sexual dimorphism.

In Table 3, it is shown that *Brianola rawaiensis* **sp. nov.** is most similar to *B. haliensis* by sharing a four-segmented antennule in female and five-segmented antennule in male, three-segmented antennary endopod, and eight-segmented antennary exopod, P1 exp-3 with 5 spines/setae, two-segmented mandibular endopod, and one-segmented mandibular exopod. P1 exp-3 has five spines/setae and P1 enp-3 with one very short inner seta.

In contrast to the *B. haliensis* from Nayband, Iran, *Brianola rawaiensis* **sp. nov.** has the following differences: 1) the body length of both females and males of *B. rawaiensis* is shorter than that of *B. haliensis*, 2) the last urosomite of female *B. rawaiensis* is ornamented with small spinules, whereas *B. haliensis* is ornamented with hyaline frills instead, 3) the shape and structure of male antennule, 4) P1 exp-1 with a pinnate spine (vs. pectinate spine in *B. haliensis*), P1 exp-2 with a plumose inner seta (vs. without inner seta in *B. haliensis*), 5) P2 exp-3 with 3 spines/setae spines (vs. 4 spines/setae in *B. haliensis*), 6) P4 enp-1 without inner spine (vs. with inner spine in *B. haliensis*). The differences in characteristics of the *Brianola* species are summarized in Table 3.

As shown in the Table 2, the species within the genus *Brianola* have an even worldwide distribution except for the polar regions, Arctic and Southern Ocean so far: Atlantic Ocean (*B. stebleri*, *B. exigua*, and *B. curvirostris*); Pacific Ocean (*B. elegans*, *B. sydneyensis*, and *B. vangoethemi*); and Indian Ocean (*B. hamondi*, *B. haliensis*, *B. sydneyensis*, and *B. rawaiensis* **sp. nov.**). Interestingly, only *B. sydneyensis* has been reported from two regions, Sydney, Australia and Andaman Islands (middle and south, Wells and Rao, 1987). The present representative provides the fourth record from the Indian Ocean.

Conflicts of Interest

The author of this paper has no affiliation with any interests and is solely responsible for the paper.

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Table 3. Some important morphological characteristics of *Brianola* species (from Nazari *et al*. 2018).

		curvirostris	*elegans*	*exigua*	*hamondi*	*stebleri*	*sydneyensis*	*vangoethemi*	*haliensis*	*rawaiensis*
size (µm)	female (*f*)	700	970	810	942	950	1,430	1,140	1,100–1,250	992
	male (*m*)	700	800	810	637	750	1,380	780	1,000	902
Antennule segmentation	female (*f*)	5	5	5	4–5	5	4–5	4–5	4	4
	male (*m*)	–	–	6–7	–	5	–	3	5	5
A2 endopod: segmentation		–	2	3	3	–	3	3	3	3
A2 exopod segmentation		7	6	6	6	6	6	7	8	8
Mandibular endopod: seg.		2	2	1	1	–	1	2	2	2
Mandibular exopod: seg.		1	1	2	2	–	2	2	1	1
P1 exp 1–3 outer spines		Finely pinnate	Finely pinnate	Finely pinnate	Heavily pectinate	–	Finely pinnate	Heavily pectinate	Heavily pectinate	Pinnate & pectinate
P1 enp-3 inner seta		Very long	Very long	Long	Short	–	Long	Very short	Very short	Very short
P1 exp-2 inner seta		1	1	0	1	1	1	1	0	1
P1 exp-3 number of seta/spine		6	6	4	4	5	5	5	5	5
P1 enp-3 number of seta/spine		6	6	6	6	4	6	5	6	6
P2 enp-1 inner seta		–	Serrate	Spinulate	Serrate	–	Serrate	Serrate	Spinulate	Plumose
P4 enp-1 inner spine/seta		Long pinnate spine	Long smooth spine	Long curved pinnate spine	Very short stout spine	Very short stout spine	Slender spine	0	Very short stout spine	Very short smooth seta

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