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Two new species of *Elaphoidella* (Copepoda, Harpacticoida) from caves in southern Thailand and a key to the species of Southeast Asia

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Abstract

Elaphoidella paraaffinis **sp. nov.** and *E. ligorae* **sp. nov.** are described from Phra Kayang and Khao Plu caves respectively in southern Thailand. They both belong to Group I *sensu* Lang (1948). *Elaphoidella paraaffinis* and *E. ligorae* are similar to *E. affinis* Chappuis, 1933 and *E. cabezasi* Petkovski, 1982 respectively. *Elaphoidella paraaffinis* differs from *E. affinis* by (1) its larger sized setae on Exp P5, (2) the absence of an inner seta on Endp P1–P4, (3) fewer setae on P3 Endp-2, and (4) a larger number of ventral spinules on its anal segment. *Elaphoidella ligorae* differs from *E. cabezasi* by (1) its serrated posterior margins of urosomites, (2) the presence of strong inner spinules on its caudal ramus, (3) larger sized and a lower number of ventral spinules on its anal segment in male and female respectively, (4) larger sized setae on P5 in female, (5) the presence of an inner seta on Endp-1 P2, and (6) a larger number of setae on Endp-2 P2 in male. An identification key to the Southeast Asian species of the genus *Elaphoidella* Chappuis, 1929 is provided.

Key words: Canthocamptidae, epikarst, karstic caves, stygobites, taxonomy

Introduction

Twenty-six species and subspecies of *Elaphoidella* have been reported thus far from Southeast Asia (SEA), excluding the two new species described herein. They are found in Indonesia (15 taxa), Thailand (9 taxa), Vietnam (6 taxa), Malaysia (5 taxa), and the Phillipines (3 taxa), as shown in Table 1 and Fig. 1 (Chappuis 1928, 1931, 1933, 1941; Borutzky 1967; Dussart & Defaye 1990; Mamaril 2001; Apostolov 2007; Watiroyram *et al.* 2015a; Alekseev *et al*. 2016; Watiroyram & Brancelj 2016). Two cosmopolitan species have been reported so far from SEA: *E. bidens* (Schmeil, 1894) s. l. and *E. grandidieri* (Guerne & Richard, 1893), while two species, *E. cuspidata* Chappuis, 1941 and *E. superpedalis* Shen & Tai, 1964, have shown a wider range of distribution in the region (Chang 2010; Alekseev *et al*. 2016).

Of the 26 known species and subspecies 13 were described by Chappuis (1928, 1931, 1933, 1941), who sampled epigean species in several water bodies in the area, with special focus on small habitats associated with terrestrial plants (i.e. phytotelmata) (Greeney 2001).

After 1967, some hypogean habitats in SEA (and especially in Thailand) were surveyed by Borutzky (1967) (caves), later by Pesce & Apostolov (1985), and Bruno & Cottarelli (2015) (interstitial hyporheic), and most recently by Brancelj *et al.* (2010), Watiroyram *et al*. (2012, 2015a, 2015b), Boonyanusith *et al*. (2013), Watiroyram & Brancelj (2016) (caves, with special focus on the epikarst).

During previous studies of freshwater copepods in Thailand, nine species of *Elaphoidella* belonging to five groups (*sensu* Lang 1948) were recorded: a) Group I (*E. margaritae* Pesce & Apostolov, 1985), b) Group II (*E. bidens decorata* (Daday, 1901); *E. grandidieri*; *E. intermedia* Chappuis, 1931), c) Group IV (*E. jaesornensis* Watiroyram, Brancelj & Sanoamuang, 2015; *E. namnaoensis* Brancelj, Watiroyram & Sanoamuang, 2010), d) Group VII (*E. bromeliaecola* (Chappuis, 1928); *E. sanoamuangae* Watiroyram & Brancelj, 2016), and e) Group

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VIII (*E. thailandensis* Watiroyram, Brancelj & Sanoamuang, 2015) (Brancelj *et al*. 2010; Watiroyram *et al*. 2015a; Watiroyram & Brancelj 2016).

The first author collected samples from epikarstic drips during 2014 and 2015 in 93 caves in the Phuket and Nakhon Si Thammarat mountain ranges (southern Thailand). Two additional new cave-dwelling species were discovered and are described herein. Additionally, all relevant documents reporting species of the genus *Elaphoidella* from the SEA countries were reviewed to present current knowledge of the genus distribution and to provide an identification key to species in the region.

Material and methods

Elaphoidella paraaffinis **sp. nov.** was collected in Phra Kayang Cave, Lum Liang Subdistrict, Kraburi District, Ranong Province, southern Thailand. The coordinates of the entrance are 10 19′ 34.03″ N and 98 45′ 55.70″ E, altitude: 20 m a.s.l. The cave consists of a horizontal gallery about 300 m long. A 45 m high helix ladder is attached to the cave's wall in the innermost part of the cave. Samples were collected from several small pools on stalagmites close to the ladder, about 10 m above the floor. Pools with a volume of 0.5–1 litre are filled exclusively by dripping water, originating from the cave ceiling, which is 5–10 m in thickness.

Elaphoidella ligorae **sp. nov.** was collected in Khao Plu Cave, Khao Ro Subdistrict, Thung Song District, Nakhon Si Thammarat Province, southern Thailand. The coordinates of the entrance are 08° 01′ 22.50″ N and 99° 34′ 36.09″ E, altitude 45 m a.s.l. The cave consists of a horizontal gallery about 10 m long. There is a small concrete pool in the dark zone, about 8 m from the entrance, with a volume of about 1 litre and filled exclusively by dripping water originating from the cave ceiling, which is 2–8 m in thickness. There was no phreatic water inside or surface water running into the cave.

Samples from each location were filtered using a filtering bottle with a 60 µm mesh size (Brancelj 2004), transferred into 120 ml plastic bottles and preserved in 70% ethanol. Samples were examined in the laboratory under a stereomicroscope at 40x magnification. Before dissection, specimens were placed in a mixture of glycerol and 70% ethanol (ratio ~ 1:10 v/v), which was replaced within one hour with pure glycerol. Specimens were dissected at 40–100x magnification under an Olympus SZ51 stereomicroscope.

All appendages and body ornamentation were examined at 1000x magnification. All the drawings were made at this magnification, using a drawing tube mounted on an Olympus compound microscope (CX31). The final versions of the drawings were made using the CorelDraw® 12.0 graphics program. For permanent slides, all body parts were put in a drop of glycerol on a microscope slide, under a cover glass, and sealed with nail polish.

The following abbreviations are used throughout the text and figures: Endp, endopod; Exp, exopod; Exp/Endp-1, proximal segment; Exp/Endp-2, middle segment; Exp-3, distal segment; P1–P6, swimming legs 1–6. The nomenclature and descriptive terminology follows Huys & Boxshall (1991), including analysis of caudal setae (I–VII). Specimens were deposited at the Natural History Museum, London, United Kingdom (NHMUK) and at the Nakhon Phanom University, Faculty of Science, Thailand (NPU).

Taxonomy

Order HARPACTICOIDA Sars, 1903

Family CANTHOCAMPTIDAE Brady, 1880

Genus *Elaphoidella* Chappuis, 1929

Elaphoidella paraaffinis sp. nov.

(Figs. 2–6)

Type locality. Phra Kayang Cave, Lum Liang Subdistrict, Kraburi District, Ranong Province, southern Thailand (Fig. 1).

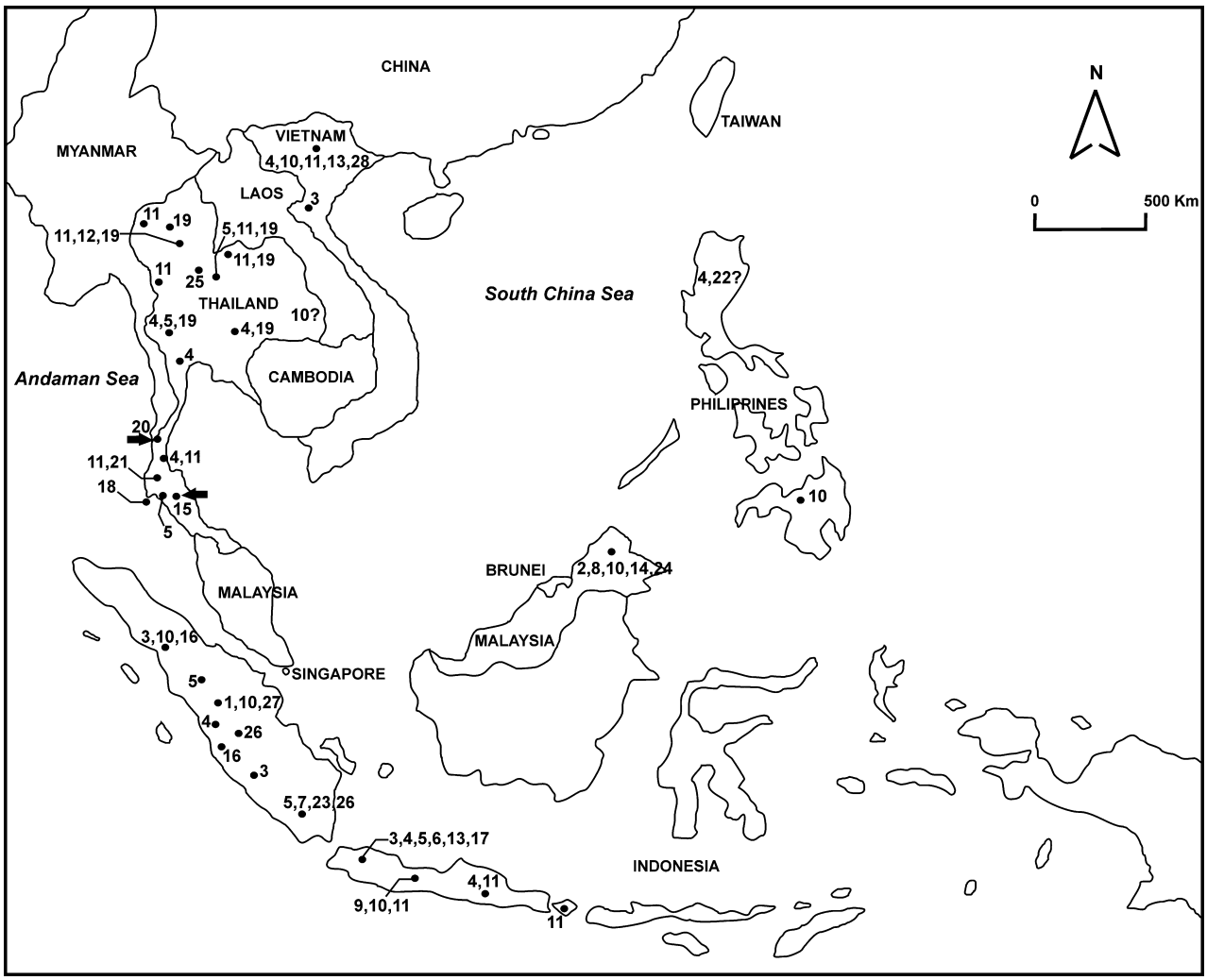

FIGURE 1. The geographical distribution of the genus *Elaphoidella* Chappuis, 1929 in Southeast Asia. Black dots indicate approximate locations of *Elaphoidella* sampling sites; arrows indicate locations of two new species. Numbers are the same as in Table 1.

Material examined. Holotype: adult female, length 520 µm (access No.: NHMUK 2016.642), completely dissected and mounted on one slide. Allotype: adult male, length 480 µm (access No.: NHMUK 2016.643), completely dissected and mounted on one slide. Paratypes: three females with egg sacs and three males, stored in 70% ethanol (access No.: NHMUK 2016.644–649); four females with egg sacs and four males, stored in 70% ethanol (access No.: NPU 2016-001). All material was collected from Phra Kayang Cave (loc. typ.) by S. Watiroyram on 15 August 2015.

Etymology. The specific name *paraaffinis,* formed with the Greek prefix *para* (= near, beside), refers to the similarity of the new species with *E. affinis*. The species epitheton is a feminine singular adjective.

Description of female. Body length, measured from anterior margin of rostrum to posterior margin of caudal rami, 500–550 µm (mean = 530 µm, n = 5). Habitus elongated, subcylindrical, width evenly decreased from cephalothorax to last urosomite; preserved specimens colourless (Fig. 2A). Naupliar eye not discernible. Cephalothorax with several pairs of sensilla, integumental window saddle-shaped, well discernible. Posterior margins of prosomites 1 to 3 and urosomite 1 serrated laterally; genital double-somite and urosomites 3 and 4 serrated along entire free margins. Somite of the genital double-somite completely fused (Figs. 2B–D), about 0.8 times as long as wide, with row of strong spinules on distal dorso-lateral margin. Genital complex (Fig. 2C) with a large, bell-shaped median copulatory pore; seminal receptacles symmetrical, well developed. Urosomites 3 and 4 with row of robust spinules distally along dorsoventral margin. Anal somite (Figs. 2B–D) with one pair of sensilla dorsally at base of anal operculum; transversal row of small spinules laterally; five strong spinules ventrally on posterior margin, near inner corner of base of each caudal ramus.

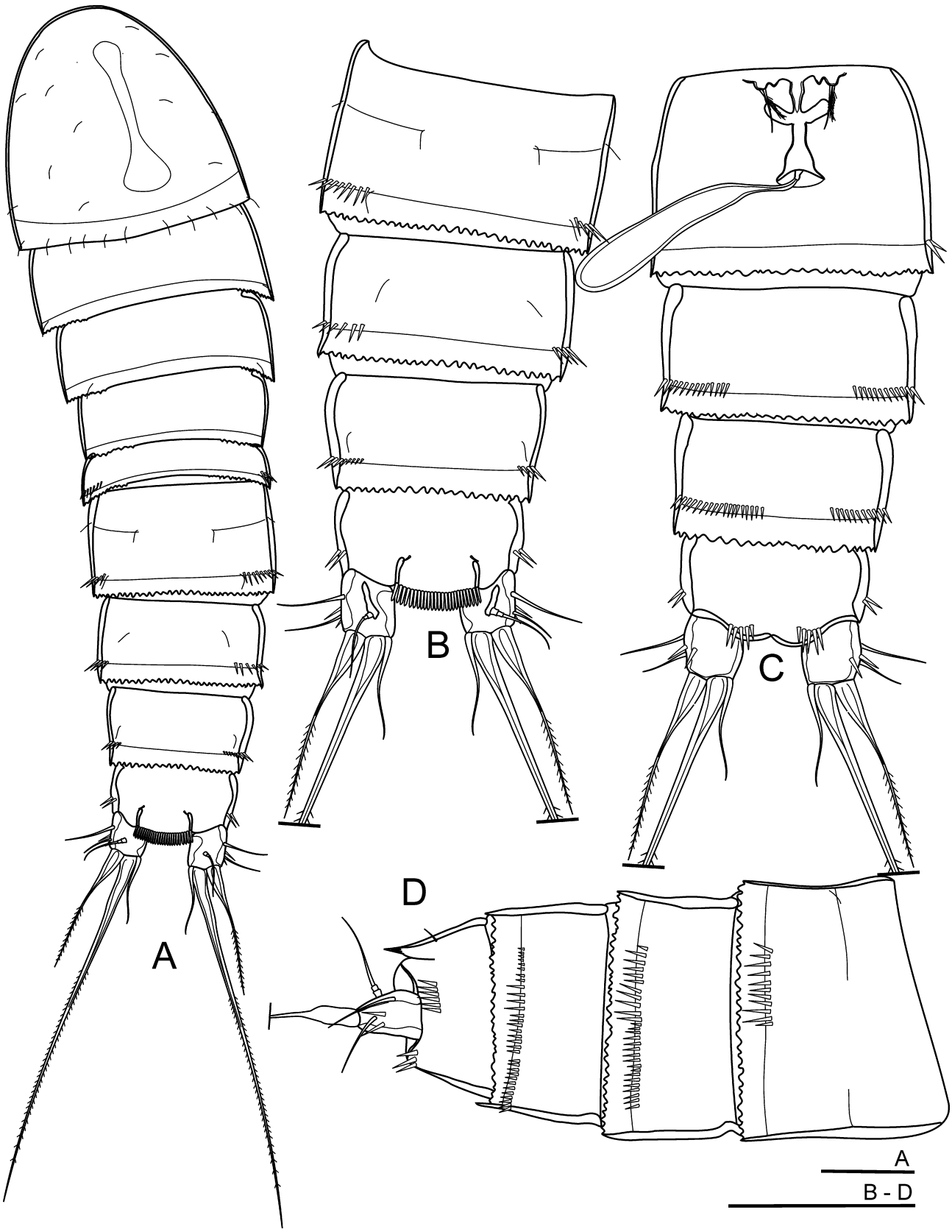

FIGURE 2. *Elaphoidella paraaffinis* **sp. nov.** Female: A, habitus, dorsal view; B, urosome (without urosomite 1), dorsal view; C, urosome (without urosomite 1), ventral view; D, urosome (without urosomite 1), lateral view. Scale bar: 50 µm.

FIGURE 3. *Elaphoidella paraaffinis* **sp. nov.** Female: A, antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; F, maxilliped. Male: G, antennule. Scale bar: 50 µm.

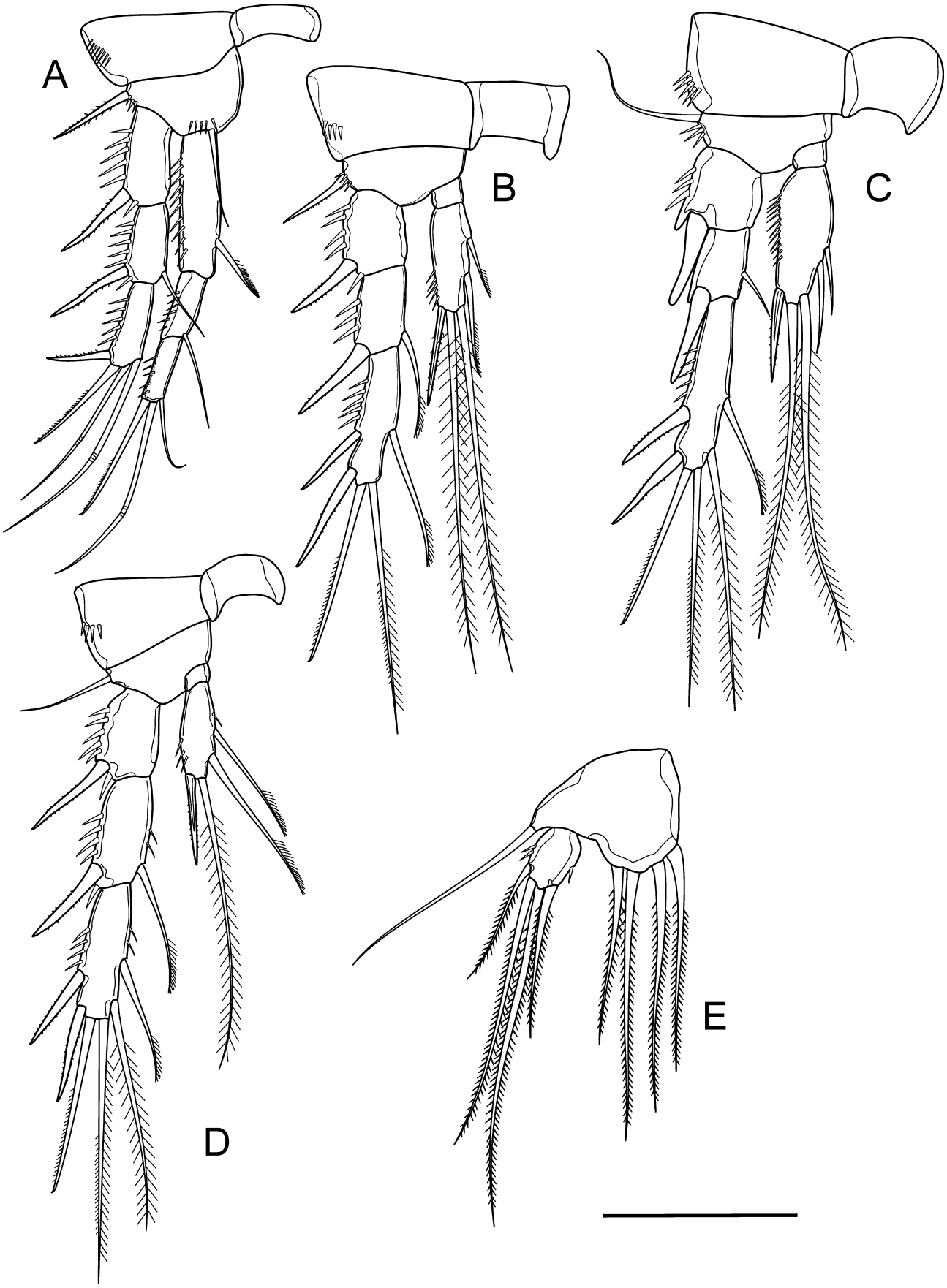

FIGURE 4. *Elaphoidella paraaffinis* **sp. nov.** Female: A, P1; B, P2; C, P3; D, P4; E, P5. Scale bar, 50 μm.

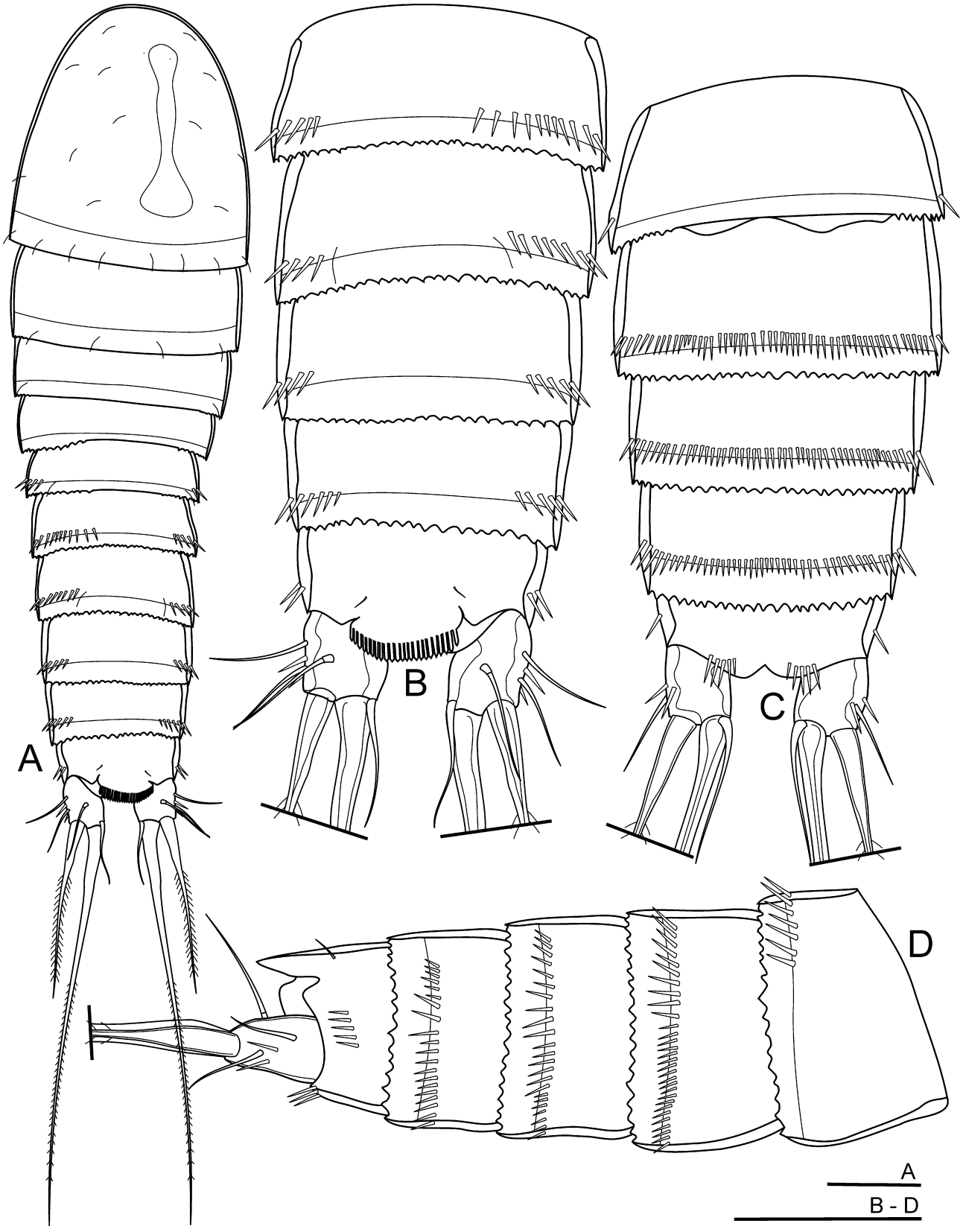

FIGURE 5. *Elaphoidella paraaffinis* **sp. nov.** Male: A, habitus, dorsal view; B, urosome (without urosomite 1), dorsal view; C, urosome (without urosomite 1), ventral view; D, urosome (without urosomite 1), lateral view. Scale bar: 50 µm.

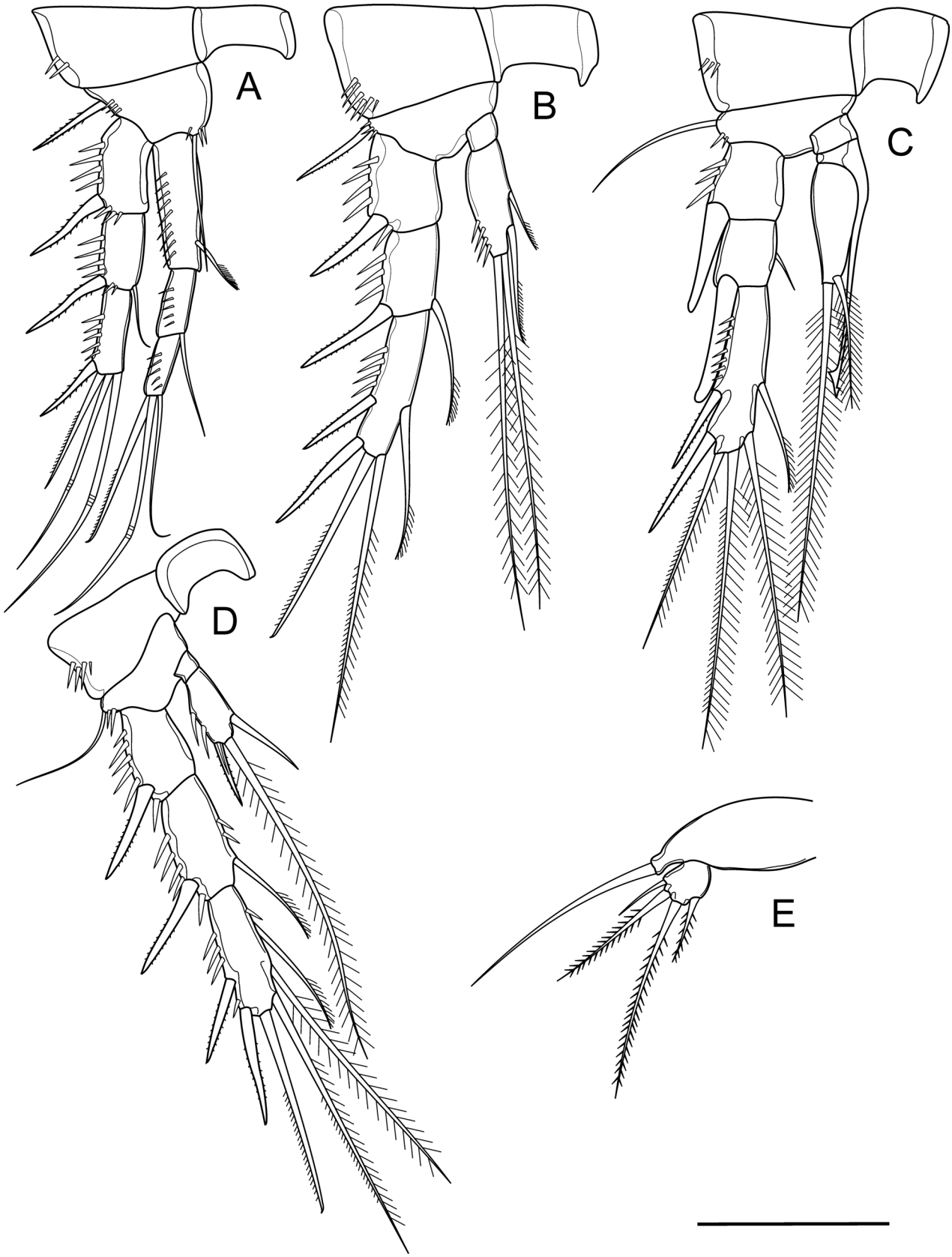

FIGURE 6. *Elaphoidella paraaffinis* **sp. nov.** Male: A, P1; B, P2; C, P3; D, P4; E, P5. Scale bar, 50 µm.

Anal operculum (Figs. 2B, D) large, with about 25 (range: 24–27) strong spinules along free margin; with an operculum margin reaching distal end of anal somite and spinules extending half of caudal ramus length.

Caudal rami parallel (Figs. 2B, C). Caudal ramus rectangular, as long as wide, with a small dorsal keel. Anterolateral accessory seta (I) absent. Setae II, III, VI, VII bare and thin. Anterolateral seta (II) inserted at about 1/3 of caudal ramus length. Posterolateral seta (III) inserted at 2/3 of caudal ramus length, slightly shorter than seta II, with two strong spinules near its base, inserted on ventral surface of caudal rami. Outer apical seta (IV) about four times as long as caudal ramus, spiniform, without a breaking plane. Inner apical seta (V) longest, swollen at its base, without a breaking plane. Inner accessory seta (VI) about 0.5 times as long as seta IV. Dorsal seta (VII) as long as seta II, inserted at half of caudal ramus length.

Antennule (Fig. 3A) eight-segmented, not reaching posterior margin of cephalothorax. Aesthetasc on segment 4 reached middle of distal segment. Aesthetasc on segment 8 long and slim. Both aesthetascs fused with seta at its base (= acrotheck). Setal formula: 1, 9, 5, 2+aesthetasc, 1, 3, 2, 7+aesthetasc.

Antenna (Fig. 3B) composed of coxa, allobasis, one-segmented Exp and Endp. Coxa slightly shorter than wide and unornamented. Allobasis about three times as long as wide, with five spinules along its outer margin. Exp with two apical and two subapical unipinnatae setae. Endp as long as allobasis, with two strong spines along outer margin at distal part; several strong spinules at proximal part of segment, and one strong spinule on each side of insertion of a distal lateral spine. Apically five elements: three geniculate setae, one normal smooth seta, one strong spine. External surface of Endp with thin seta inserted subapically.

Mandible (Fig. 3C) robust, with five strongly chitinized teeth and one smooth seta on the dorsal side of gnathobase. Mandibular palp two-segmented; with seta on proximal segment and five setae on distal segment: four apically, and one laterally. All setae thin and smooth.

Maxillule (Fig. 3D) composed of robust praecoxa, coxa, and basis. Praecoxal arthrite with three strong spines and two short spiniform setae on arthrite base. Coxa with two smooth setae on cylindrical endite. Basis with one unipinnate and one smooth seta apically; Exp and Endp reduced to two smooth setae along inner margin of basis.

Maxilla (Fig. 3E) two-segmented; syncoxa with two endites, each with two setae. Basis drawn out into strong, beak-like apophysis, with few spinules distally; Exp and Endp reduced to two smooth setae.

Maxilliped (Fig. 3F) prehensile; comprising syncoxa, basis, and one-segmented Endp. Syncoxa unornamented. Basis about two times as long as wide, with a row of 12 spinules along its inner margin. Endp drown out into an unipinnate claw, as long as basis; with a small seta at its base.

P1 with three-segmented Exp and Endp; P2–P4 with three-segmented Exp and two-segmented Endp. An armature formula of P1–P4 is as follows (legend: inner-outer seta/spine; inner-apical-outer; Arabic numerals represent setae, Roman numerals represent spines):

Leg	Coxa	Basis	Exopod			Endopod		
			1	2	3	1	2	3
1	0-0	1-I	0-I	1-I	0-2+I-I	1-0	1-0	0-3-0
2	0-0	0-I	0-I	1-I	1-2-II	0-0	2-2+I-0	----
3	0-0	0-1	0-I	1-I	2-2-II	0-0	3-1-I	----
4	0-0	0-1	0-I	1-I	2-2-II	0-0	2-1+I-0	----

P1 Endp slightly longer than Exp (Fig. 4A). Coxa with rows of small spinules on its outer margin. Basis with thin inner seta and a slim outer spine; with spinules at base of both elements. Exp-1–3 similar in length, each with a strong outer spine. Exp-3 with a strong unipinnate spine and two long geniculate setae apically. Endp-1 long, slightly shorter than Exp-1 and Exp-2 combined, with unipinnate spiniform seta on inner margin. Endp-2 with thin and smooth seta on inner distal corner. Endp-3 with three setae apically: innermost seta thin, shortest; middle one geniculated, longest; outermost seta spiniform.

P2 (Fig. 4B) coxa ornamented as in P1. Basis with a spine and few spinules at its base. Exp-1 and Exp-2 with a strong spine on each of its outer margins. Exp-1 as long as Exp-2. Exp-2 with a long unipinnate seta on inner distal corner of this segment. Exp-3 2.5 times as long as wide; with two spines on its outer margin, two apical setae (outer seta unipinnate, inner one pinnate), and a long unipinnate seta on its inner margin. Endp-1 small, shorter than wide, without seta on its inner margin. Endp-2 2.5 times as long as wide, with a spine on its outer margin, two long pinnate setae apically and two short unipinnate setae on its inner margin.

P3 (Fig. 4C) coxa ornamented as P2; basis with thin and smooth seta on its outer margin. Exp-1 as long as wide; with a strong spine having a rounded tip on its outer margin. Exp-2 with a short smooth seta on inner margin and a strong spine with a rounded tip on outer margin. Exp-3 similar to P2 Exp-3, but with additional pinnate seta subapically on inner margin. Endp two-segmented, as long as Exp-1 and Exp-2 combined. Endp-1 small, shorter than wide, without seta on inner margin. Endp-2 about two times as long as wide, with a spine on outer margin, one long pinnate seta-apically, one long pinnate seta and two short smooth setae on inner margin.

P4 (Fig. 4D) coxa with few spinules on outer margin. Basis with thin smooth seta on outer margin. Exp three-segmented, with one strong spine on outer margin of Exp-1 and Exp-2 and two strong spines on outer margin of Exp-3. Exp-1 about 1.3 times as long wide. Exp-2 as long as Exp-3, about 2.5 times as long as wide, with unipinnate seta on inner margin. Exp-3 with two unequal setae apically (inner pinnate, outer unipinnate), with one pinnate and one unipinnate seta on inner margin. Endp as long as Exp-1. Endp-1 small, shorter than wide, without seta on inner margin. Endp-2 two times as long as wide, with a spine and long pinnate seta apically and two unipinnate setae on inner margin.

P5 (Fig. 4E) Exp and baseoendopod well separated. Baseoendopod about as long as Exp, with four long, strong spiniform setae; second outer one (III) longest, followed by second inner one (II), innermost seta (I) and outermost seta (IV). Outer lateral seta on baseoendopod long and smooth. Exp small, sub-oval; with four strong spiniform setae; second inner seta (II) longest followed by second outer seta (III), innermost seta (I) and outermost seta (IV).

P6 (Fig. 2C) fused, small, forming a simple plate, with two subequal setae on each side of copulatory pore; inner one bare, and outer one pinnate.

Egg sac: holotype with 15 eggs; other females with 13–16 eggs (n = 5).

Description of male. Slightly smaller than female (Fig. 5A); body length, measured from anterior margin of rostrum to posterior margin of caudal rami, 460–500 μm (mean = 480 μm, n = 5); preserved specimens colourless; naupliar eye not discernible. Cephalothorax with a well discernible integumental window. Habitus similar to female; posterior margins of prosomites and urosomite 1 serrated laterally; urosomites 2–5 serrated along entire free margins. Urosomites 3–5 ventrally with a continuous row of unequal spinules along free margin (Fig. 5C). Anal somite, caudal rami, antenna, mouthparts and P1 similar to those of female (Figs. 3B–F, 5A–D, 6A). Anal operculum well developed, with about 23 (range 22–24) strong spinules on free margin, reaching middle of caudal rami (Figs. 5B, D).

Antennule (Fig. 3G) seven-segmented, with three strong spinules on first segment. Setal formula: 1, 8, 7+aesthetasc, 4, 0, 0, 7+aesthetasc. First aesthetasc cylindrical, slightly curved, with a rounded tip, reaching distal end of antennule. Distal aesthetasc shorter than proximal one, about 1.2 times as long as terminal segment. Both aesthetascs combined with a seta as an acrotheck.

P2 (Fig. 6B) coxa, basis and Exp as in female. Endp two-segmented, Endp reaching middle of Exp-2. Endp-1 small, shorter than wide, with no seta on inner margin. Endp-2 about 2.5 times as long as wide, with two long setae apically, reaching well above Exp-3; with two pinnate setae on inner margin: distal one as long as segment bearing it, longer than proximal seta.

P3 (Fig. 6C) coxa, basis and exopodite as in female. Endp three-segmented, as long as Exp-1 and Exp-2 combined. Endp-1 shorter than wide, with no seta on inner margin. Endp-2 with a short apophysis shaped in a harpoon-like tip, reaching middle of Exp-3. Endp-3 about two times longer than wide, with two pinnate setae apically (inner one as long as segment bearing it; outer one about three times as long as inner one).

P4 (Fig. 6D) coxa, basis and exopodite as in female. Endp two-segmented, short, as long as Exp-1. Endp-1 shorter than wide, with no seta on inner margin. Endp-2 about two times as long as wide; with a spine and pinnate seta apically, smooth spiniform seta on inner margin, and two strong spinules on outer margin.

Detailed ornamentation of P1–P4 as in Figs. 6A–D.

P5 (Fig. 6E) with a distinctly separated Exp and baseoendopod. Baseoendopodal lobe small, with smooth seta on outer margin. Exp small, as long as wide, with three spiniform and one smooth seta. Innermost (I) and outermost (IV) seta shortest, slightly longer than segment. Second inner (II) seta longer than second outer (III) seta, about four times as long as segment bearing it. Baseoendopod with no elements.

P6 (Fig. 5C) represented by a simple bilobate plate, with a smooth free margin.

Variability. Not found, except for anal operculum with 22–24 strong spinules along free margin in males and 24–27 in females.

***Elaphoidella ligorae* sp. nov.**
(Figs. 7–11)

Type locality. Khao Plu Cave, Khao Ro Subdistrict, Thung Song District, Nakhon Si Thammarat Province, southern Thailand (Fig. 1).

Material examined. Holotype: adult female, length 460 µm (access No.: NHMUK 2016.650), completely dissected and mounted on one slide. Allotype: adult male, length 440 µm (access No.: NHMUK 2016.651), completely dissected and mounted on one slide. Paratypes: three females with egg sacs and three males, stored in 70% ethanol (access No.: NHMUK 2016.652–657); three females with egg sacs and three males, stored in 70% ethanol (access No.: NPU 2016–002). The material was collected from Khao Plu Cave (loc. typ.) by S. Watiroyram on 29 October 2015.

Etymology. The specific name *ligorae*, refers to the settlement name of Ligor from the 16th century, which today is known as Nakhon Si Thammarat, the locality where the new species was collected. The species epitheton is the feminine singular genitive.

Description of female. Body length, measured from anterior margin of rostrum to posterior margin of caudal rami, 430–490 µm (mean = 450 µm, n = 5). Habitus (Fig. 7A) elongated, subcylindrical; maximal width at posterior margin of cephalothorax; preserved specimens colourless; naupliar eye not discernible. Cephalothorax with several pairs of sensilla, integumental window well discernible, and expanded anteriorly. Posterior margins of prosomites and urosomite 1 smooth, with several pairs of sensilla on each somite. Genital double-somite (Figs. 7A–D) about 0.8 times as long as wide, completely fused; with a row of strong spinules dorsally, ventrally and laterally; with distinct gap on dorsal and ventral rows. Genital complex (Fig. 7C) with a large bell-shaped copulatory pore; seminal receptacles symmetrical and well developed. Urosomites 2–4 serrated along entire free margins. Urosomite 3 with a row of strong spinules dorsally, laterally and ventrally, and a row of dorsal spinules with a gap in middle. Urosomite 4 with two strong spinules laterally and a group of small spinules vertically along distal margin. Anal somite (Figs. 7B–D) with one pair of thin sensilla dorsally, at base of anal operculum; no spinules ventrally at base of caudal ramus.

Anal operculum (Figs. 7B, D) large, with a row of numerous fine spinules along free margin; not reaching distal end of anal somite.

Caudal rami parallel (Figs. 7B, C). Caudal ramus asymmetrically conical, about 1.5 times as long as wide, with a well developed dorsal keel. Inner margin with several strong spinules at distal half of caudal ramus. Anterolateral accessory seta (I) reduced, and inserted close to seta II. Setae II, III, VI, VII bare and thin. Anterolateral seta (II) inserted at about 1/3 of caudal ramus length, as long as caudal ramus. Posterolateral seta (III) at 2/3 of caudal ramus length, slightly shorter than anterolateral seta (II). Outer terminal seta (IV) about two times as long as caudal ramus, spiniform, without a breaking plane. Inner terminal seta (V) longest, pinnate, without a breaking plane. Inner accessory seta (VI) slightly shorter than seta III. Dorsal seta (VII) slightly longer than seta II, inserted on the end of dorsal keel.

Antennule (Fig. 8A) relatively short, eight-segmented, not reaching posterior margin of cephalothorax. Aesthetasc on segment 4 reached well beyond distal segment. Second aesthetasc on last segment long and slim. Both aesthetascs combined with seta as an acrotheck. Setal formula: 1, 8, 5, 3+aesthetasc, 2, 2, 2, 7+aesthetasc.

Antenna (Fig. 8B) composed of coxa, allobasis, one-segmented Exp and Endp. Coxa as long as wide, unornamented. Allobasis with two short spinules at half the length of inner margin. Exp with four unipinnate setae, unequal in length (laterally two thin setae; apically one stout and one thin seta). Endp laterally with two strong spines at distal half of segment and two rows of strong spinules along inner margin, proximal row with five spinules, and distal row with two spinules. Apically five elements; three geniculate, one thin and one spine-like seta; outer surface of Endp with thin seta inserted subapically.

Mandible (Fig. 8C) robust, with eight strongly chitinized teeth and one unipinnate seta on dorsal side of gnathobase. Mandibular palp two-segmented; proximal segment with smooth seta; distal segment with smooth seta at half the length of margin and four unequal setae apically.

Maxillule (Fig. 8D) composed of robust praecoxa, coxa, and basis. Praecoxal arthrite with four strong spines on arthrite base, unequal in length. Coxa with a cylindrical endite bearing two pinnatae setae. Basis with a smooth seta and pinnate seta apically; three smooth setae along inner margin representing reduced Exp and Endp.

Maxilla (Fig. 8E) two-segmented; syncoxa with two endites, each with two setae. Basis drawn out into strong, beak-like spine with few distal spinules; Exp and Endp reduced to two smooth setae.

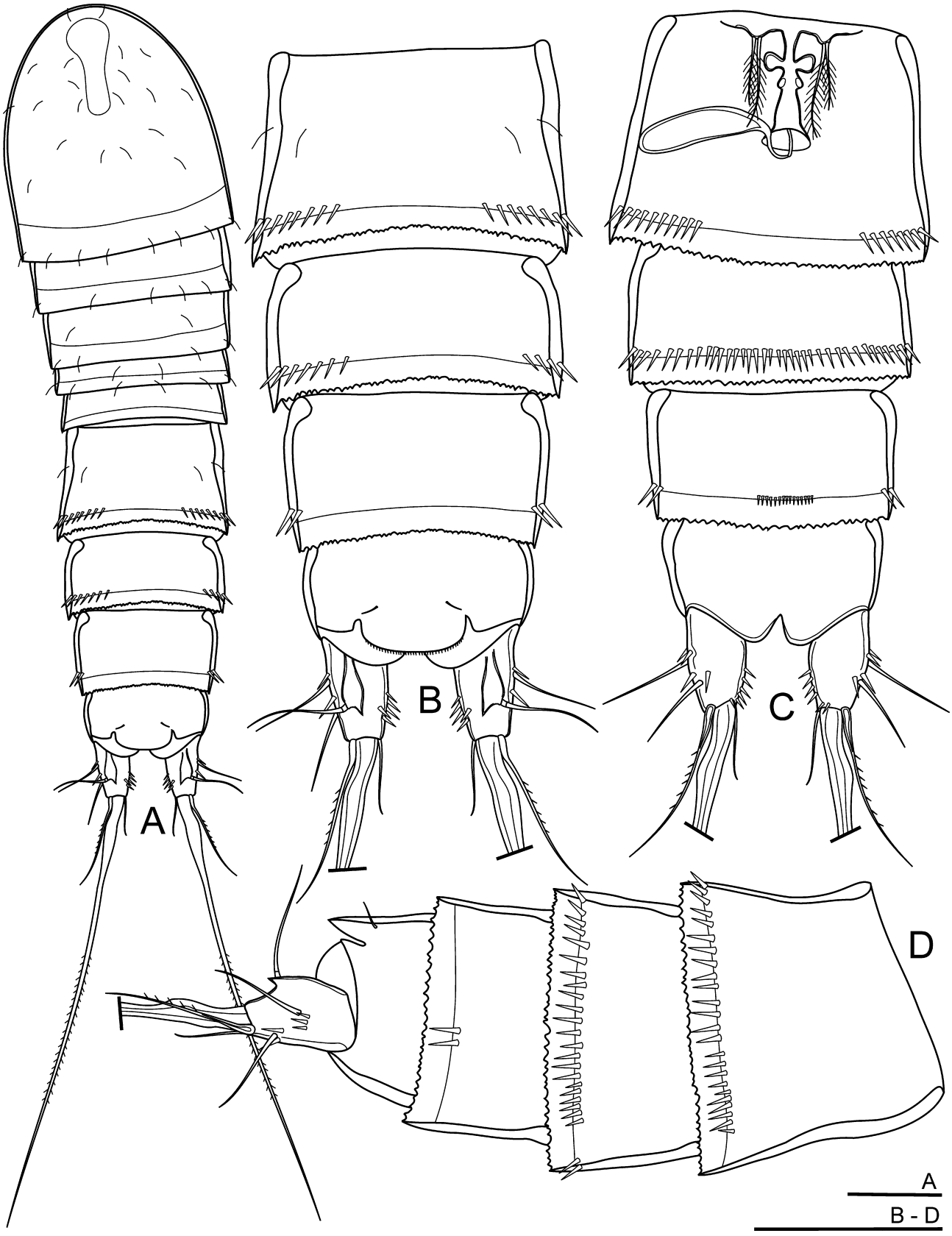

FIGURE 7. *Elaphoidella ligorae* **sp. nov.** Female: A, habitus, dorsal view; B, urosome (without urosomite 1), dorsal view; C, urosome (without urosomite 1), ventral view; D, urosome (without urosomite 1), lateral view. Scale bar: 50 µm.

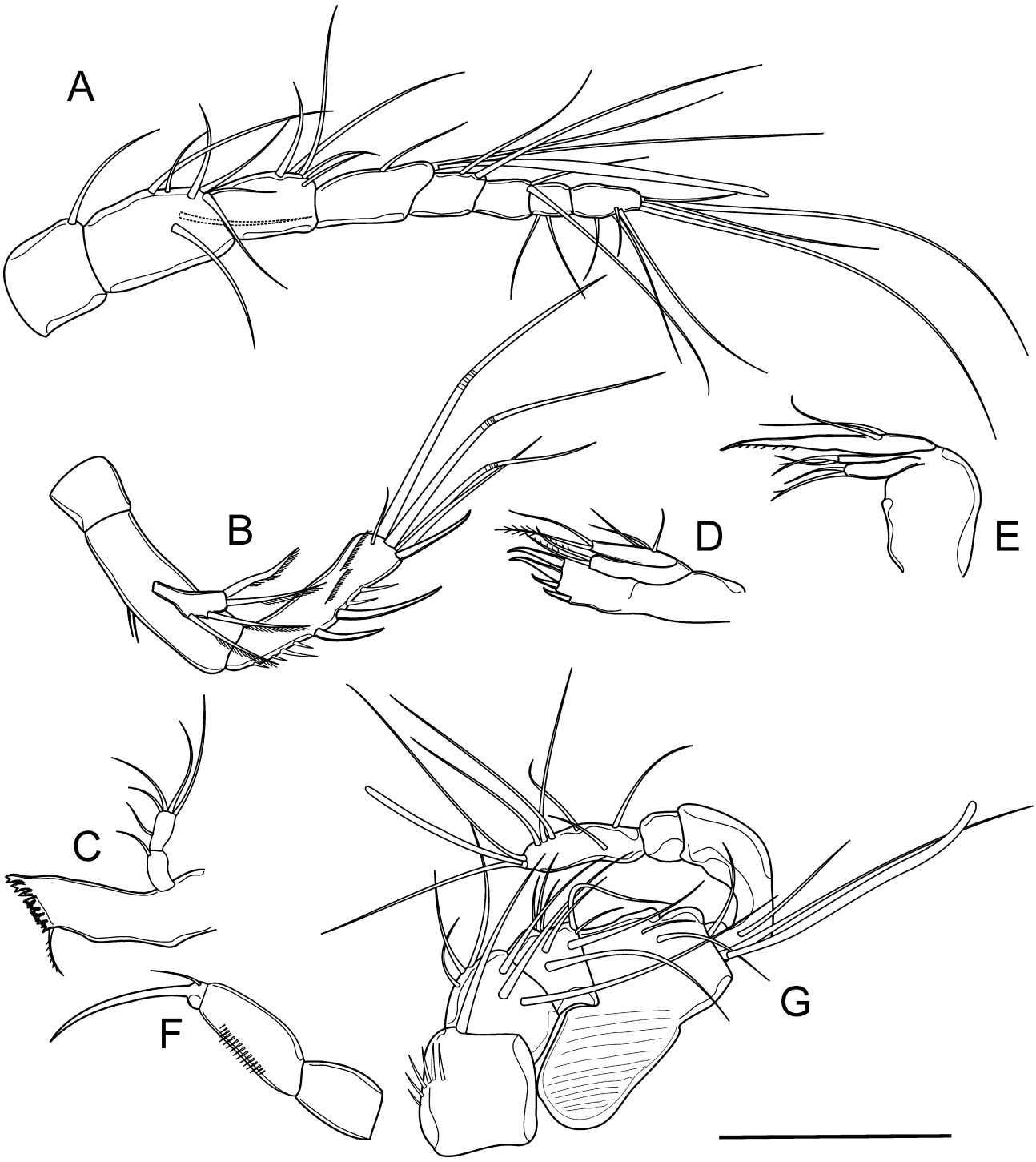

FIGURE 8. *Elaphoidella ligorae* **sp. nov.** Female: A, antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; F, maxilliped. Male: G, antennule. Scale bar: 50 µm.

Maxilliped (Fig. 8F) prehensile; comprising syncoxa, basis, and one-segmented Endp. Syncoxa unornamented. Basis more than two times as long as wide, with about 15 spinules along inner margin. Endp drawn out into a smooth, curved claw, as long as basis; with a small seta at its base.

P1 with three-segmented Exp and Endp; P2–P4 with three-segmented Exp and two-segmented Endp. The armature formula of P1–P4 is as follows (legend: inner-outer seta/spine; inner-apical-outer; Arabic numerals represent setae, Roman numerals represent spines):

Leg	Coxa	Basis	Exopod			Endopod		
			1	2	3	1	2	3
1	0-0	1-I	0-I	1-I	0-2+I-I	1-0	1-0	0-2+I-0
2	0-0	0-I	0-I	1-I	1-2+I-I	1-0	2-2-I	----
3	0-0	0-1	0-I	1-I	2-2-II	0-0	2-2-I	----
4	0-0	0-1	0-I	1-I	2-2-II	0-0	2-1+I-0	----

P1 Exp as long as Endp-1 and Endp-2 combined; Exp and Endp with strong spinules along outer margins (Fig. 9A). Coxa with rows of small spinules on outer margin. Basis with thin inner and stout outer seta, and spinules at base of both elements; an additional row of spinules at insertion of Endp-1. Exp-1–3 similar in length, each with a strong spine on outer margin. Exp-2 with thin and bare seta on inner margin. Exp-3 with three elements apically; a strong unipinnate spine and two long geniculate setae. Endp-1 longer than Exp-1 and Exp-2 combined, with unipinnate spiniform seta on inner margin. Endp-2 with smooth seta on inner margin. Endp-3 two times as long as wide, with three setae apically; innermost seta thin, middle one geniculated and longest, outermost spiniform, as along as innermost one.

P2 (Fig. 9B) coxa with a short row of spinules on outer margin. Basis with stout seta on outer margin and few strong spinules at its base. Exp-1–3 with strong spinules on outer margin. Exp-1 as long as Exp-2. Exp-1 and Exp-2 each with a strong spine on outer margin. Exp-2 with long unipinnate seta on inner margin. Exp-3 3.5 times as long as wide, with a spine and two pinnate setae apically; an unipinnate seta on inner margin. Endp-1 small, shorter than wide, with smooth seta on its inner margin. Endp-2 about 3 times as long as wide, with a spiniform spine on outer margin, two long pinnate setae apically, and two short and smooth setae on inner margin.

P3 (Fig. 9C) coxa ornamented as P2; basis with thin seta on outer margin, with few spinules at its base. Exp-1 slightly longer than wide; with a strong spine having a rounded tip on outer margin. Exp-2 with short unipinnate seta on inner margin and a strong spine with a rounded tip on outer margin. Exp-3 with two setae on its inner margin, proximal seta unipinnate, and distal one pinnate; apical margin with two pinnate setae; outer margin with two strong spines. Endp-1 small, shorter than wide, without seta on inner margin. Endp-2 about four times as long as wide, with a spine on outer margin subapically, two long pinnate setae apically and two smooth setae on inner margin.

P4 (Fig. 9D) coxa with few spinules on outer margin. Basis with thin smooth seta on outer margin. Exp-1–2 similar in length, about 1.3 times as long wide. Exp-2 with unipinnate spiniform seta on inner margin. Exp-3 about 3.5 times as long as wide, with two spines on outer margin, two pinnate seta apically and two setae on inner margin (proximal one unipinnate, spiniform; distal seta long, pinnate). Endp two-segmented, as long as Exp-1. Endp-1 shorter than wide, without seta on inner margin. Endp-2 about four times as long as wide, with a spine and long pinnate seta apically; two smooth setae on inner margin.

P5 (Fig. 9E) Exp and baseoendopod well separated. Baseoendopod shorter than half of Exp; with four strong spiniform setae; second inner one (II) longest followed by innermost seta (I), second outer one (III), and outermost seta (IV). Outer lateral seta on baseoendopod long and bare. Exp subrectangular, with four strong spiniform setae: second inner seta (II) longest followed by second outer seta (III) and outermost (IV); innermost seta (I) shortest.

Additional ornamentation of P1–P5 as in Figs. 9A–E.

P6 (Fig. 7C) fused, small, forming a simple plate, with two pinnate setae on each side of copulatory pore; inner one longer than outer one.

Egg sac: holotype with 10 eggs; other females with 6–12 eggs (n = 5).

Description of male. Slightly smaller than female; body length, measured from the anterior margin of rostrum to posterior margin of caudal rami, 420–460 μm (mean = 450 μm, n = 5); preserved specimens colourless; naupliar eye not discernible. Cephalothorax with a well discernible integumental window having anterior and posterior sections expanded. Habitus similar to female but tapering posteriorly. Urosomites serrated along entire free margins, urosomite 1 without spinulation. Urosomite 2 dorsally and laterally with a row of spinules and two groups of spinules ventrally on posterior margins. Urosomites 3 and 4 dorsally, laterally and ventrally with a row of spinules on posterior margins, dorsal rows with gap in middle. Urosomite 5 with a row of spinules laterally. Anal

somite with three small ventral spinules near insertion of caudal rami. Caudal rami, antenna, mouthparts, P1 and P2 similar to those of female (Figs.10A–D, 11A–B).

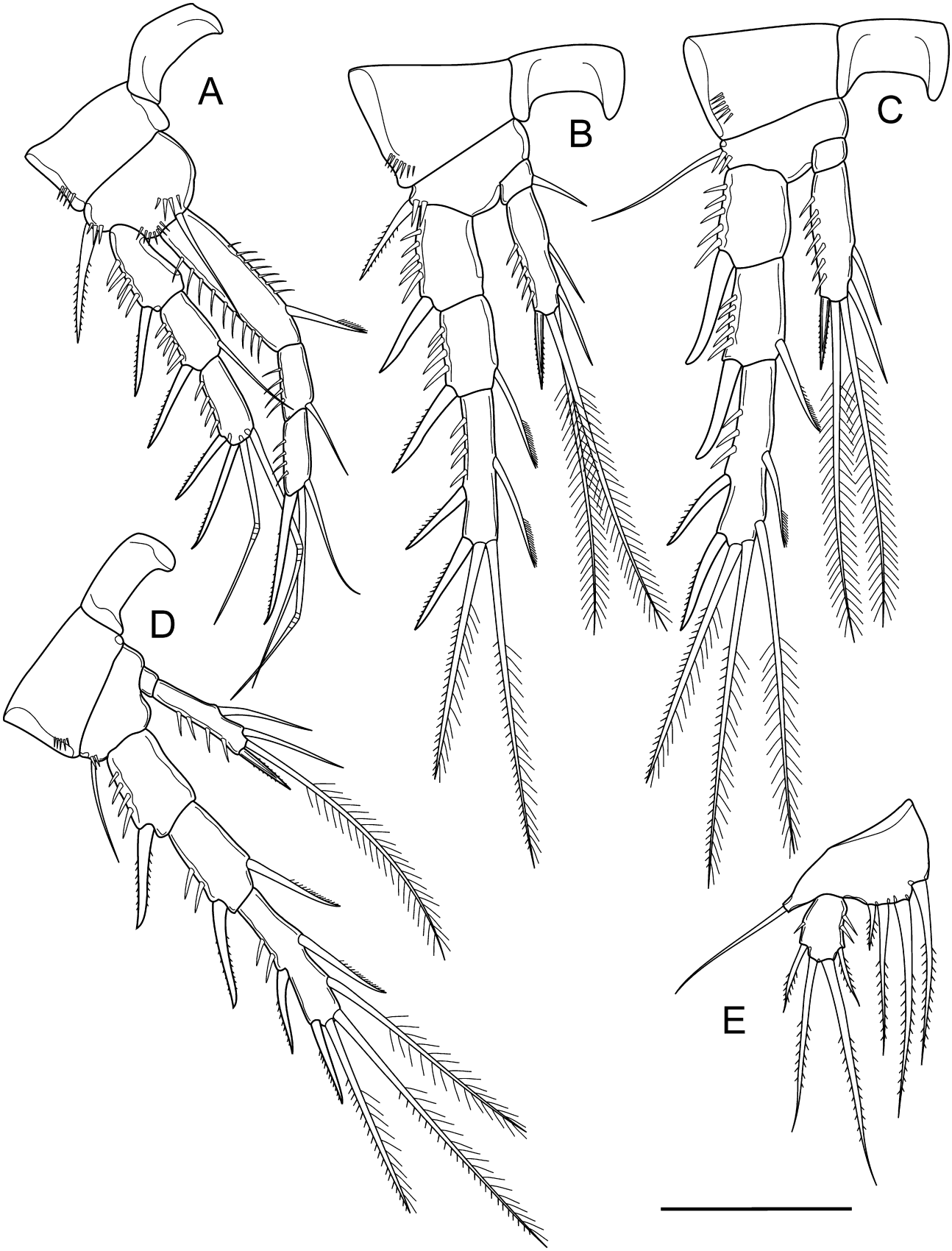

FIGURE 9. *Elaphoidella ligorae* **sp. nov.** Female: A, P1; B, P2; C, P3; D, P4; E, P5. Scale bar: 50 µm.

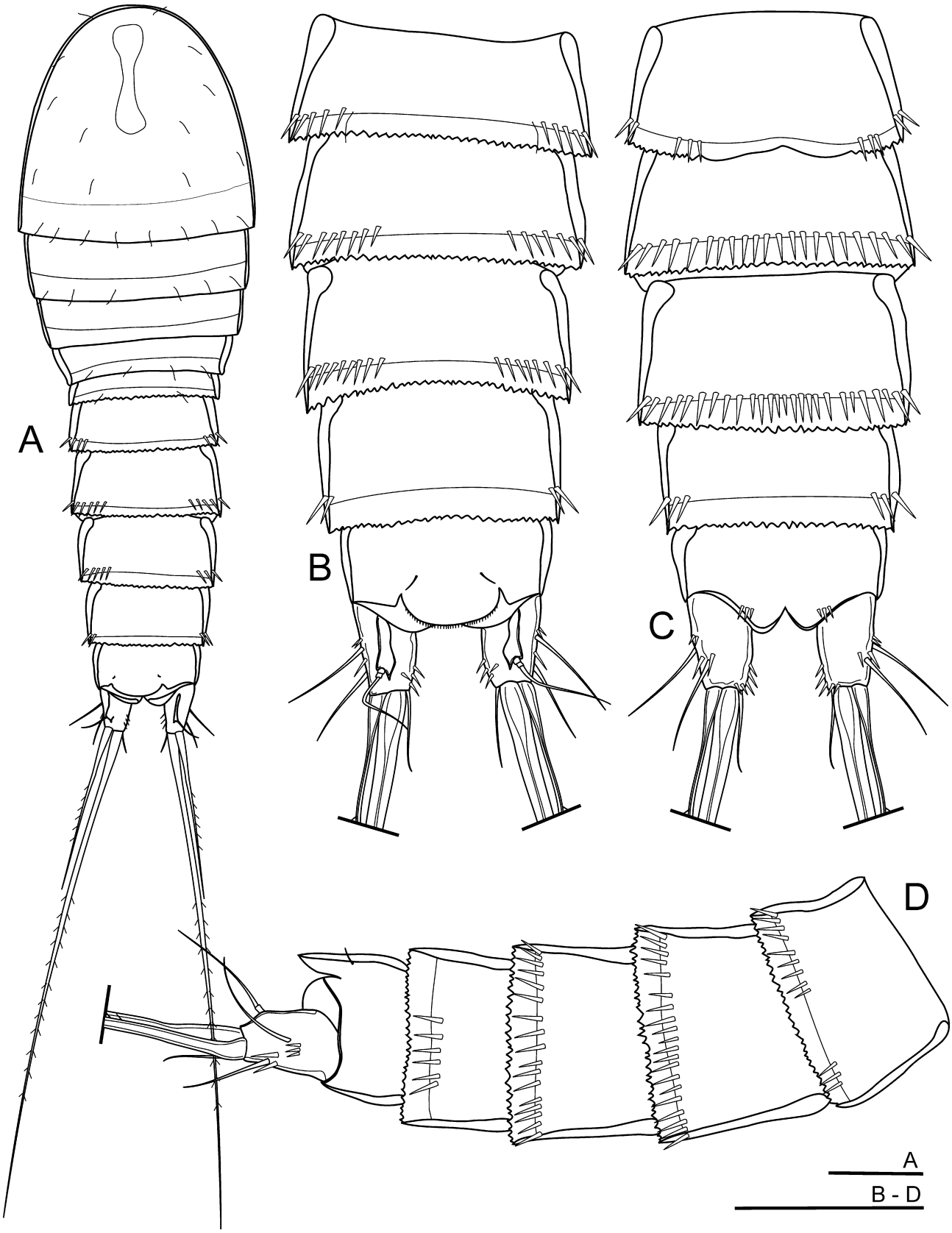

FIGURE 10. *Elaphoidella ligorae* **sp. nov.** Male: A, habitus, dorsal view; B, urosome (without urosomite 1), dorsal view; C, urosome (without urosomite 1), ventral view; D, urosome (without urosomite 1), lateral view. Scale bar: 50 µm.

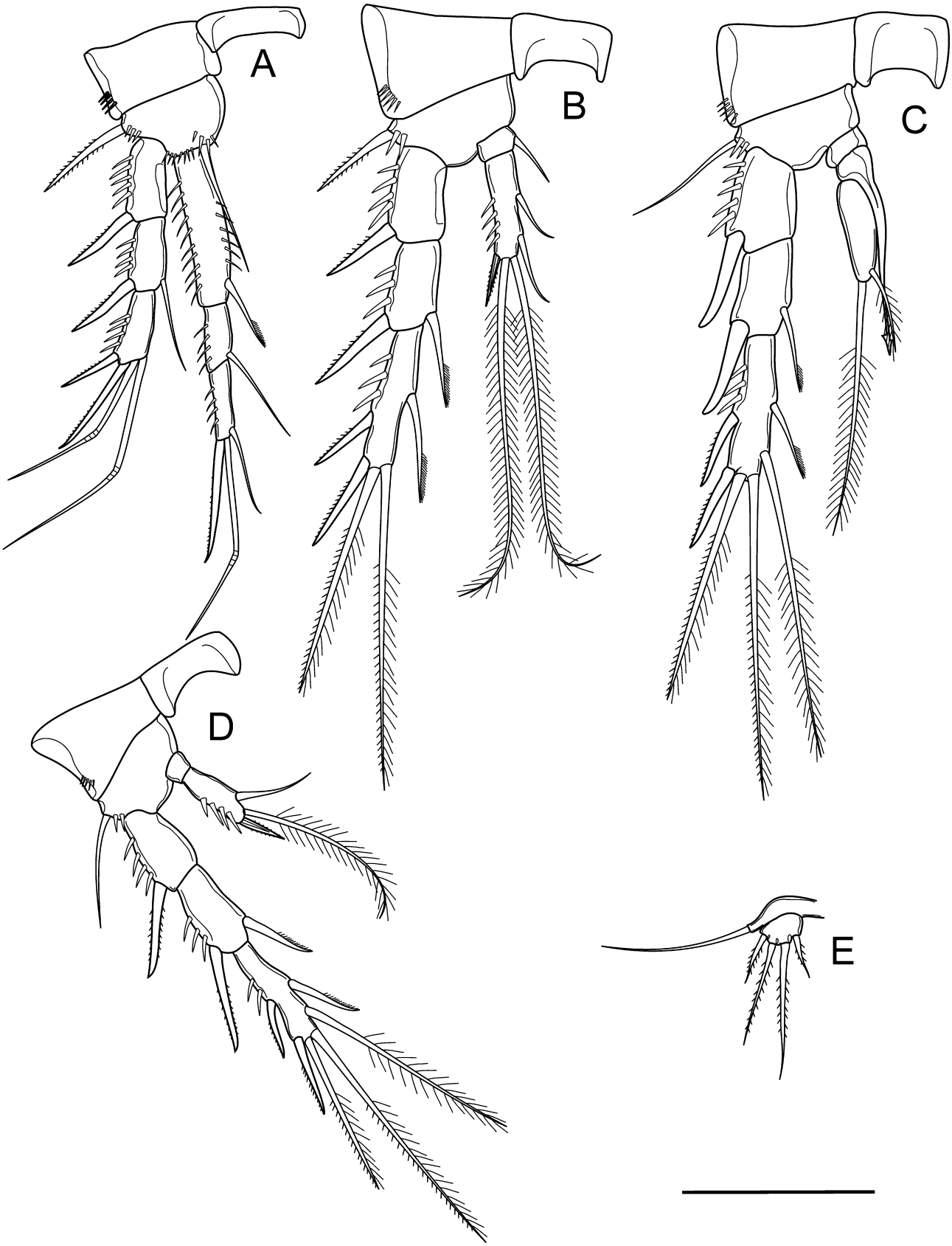

FIGURE 11. *Elaphoidella ligorae* **sp. nov.** Male: A, P1; B, P2; C, P3; D, P4; E, P5. Scale bar: 50 µm.

Antennule (Fig. 8G) seven-segmented. First aesthetasc cylindrical, not reaching distal end of antennule. Second aesthetasc shorter than first one, about 1.2 times as long as terminal segment. Both aesthetascs combined with adjacent setae as an acrotheck. Setal formula: 1, 6, 8, 5+aesthetasc, 0, 0, 8+aesthetasc.

P3 (Fig. 11C) coxa, basis and Exp as in female. Endp three-segmented, slightly longer than Exp-1. Endp-1 shorter than wide, without seta on inner margin. Endp-2 with a short apophysis shaped in a harpoon-like tip, reaching the end of Exp-2. Endp-3 about two times as long as wide, with two pinnate setae apically; inner one small, shorter than segment bearing it; outer one long, about two times as long as segment.

P4 (Fig. 11D) coxa, basis and exopodite as in female. Endp two-segmented, as long as Exp-1. Endp-1 shorter than wide, without seta on inner margin. Endp-2 about two times as long as wide, with a spine and pinnate seta apically; smooth seta on inner margin.

Additional ornamentation of P1–P4 as in Figs. 11A–D.

P5 (Fig. 11E) Exp and baseoendopod distinctly separated. Outer lateral seta on baseoendopod long and smooth. Exp small, oval, with four spiniform setae: second inner seta (II) longest followed by second outer seta (III) and innermost (I); outermost seta (IV) shortest. Baseoendopod with no elements.

P6 (Fig. 10C) represented by a simple bilobate plate, with a smooth free margin.

Variability. Not found.

Differential diagnosis

Elaphoidella paraaffinis **sp. nov.** and *E. ligorae* **sp. nov.** have the diagnostic features of the genus *Elaphoidella* Chappuis, 1929 based on the armature of P5 in both sexes (Figs. 4E, 6E for *E. paraaffinis*; Figs. 9E, 11E for *E. ligorae*). Examination of the female armature of P5 and male armature of P4 Exp-3 (Figs. 6D, 11D), shows that the two new species fit well into the *Elaphoidella* species "Group I" (i.e., *similis* group *sensu* Lang (1948)). The group is characterised by the absence of a transformed spine on P4 Exp-3 in the male; P5 baseoendopod and Exp with four setae in the female. The two new species share some characteristics: (1) urosomites serrated along the entire free margin in both sexes, (2) P3–P4 Endp-1 of both sexes have no inner seta, (3) P3–P4 Endp-2 of the female have five and four setae, respectively, and (5) P5 Exp of the male has four (spiniform) setae.

Elaphoidella paraaffinis differs from *E. ligorae* in several characters: (1) the anal operculum has strong spinules on the free margin in both sexes, while *E. ligorae* has fine spinules, (2) the ventral side of the anal somite, near the base of the caudal rami has five spinules in both sexes, while *E. ligorae* has three spinules in the male but they are absent in the female, (3) P5 baseoendopod is almost the same length as the Exp in the female, while the basoendopod is much smaller than the Exp in *E. ligorae*, (4) P2 Endp-1 has no inner seta in either of the sexes, while both sexes of *Elaphoidella ligorae* have this seta on P2 Endp-1, and (5) Endp-2 P2 in the male has four setae, while *Elaphoidella ligorae* has a spine and four setae.

Elaphoidella paraaffinis is most similar to *E. affinis* from Indonesia (Sumatra Island). However, the new species can be distinguished by examining the female of *E. affinis*: (1) *E. paraaffinis* has four longer setae on Exp P5 compared to those of *E. affinis*, especially the outermost (IV) seta (in *E. affinis* seta IV is almost spiniform), (2) *E. paraaffinis* has no seta on the inner margin of Endp-1 P1–4, but present in *E. affinis*, (3) P3 Endp-2 has five elements in the new species, but has six elements in *E. affinis*, (4) the anal segment is ventrally ornamented with five spinules near the base of caudal rami in *E. paraafinis* but has only one spinule in *E. affinis*. The male of *E. affinis* is unknown.

Elaphoidella ligorae resembles *E. cabezasi* from Cuba in that: (1) the anal operculum has fine spinules in both sexes, (2) P1 Exp and Endp in both sexes has three segments, (3) P3 and P4 Endp-1 has no inner seta in either of the sexes, (4) the distal segment of P3 has five elements in the female and two setae in the male, and (5) P4 Endp-2 has four elements in the female and three elements in the male. However, the new species differs from *E. cabezasi* in several morphological characters: (1) the posterior margins of urosomites are serrated in the male and female of the new species, but are smooth in *E. cabezasi*, (2) the inner margin of caudal ramus has strong spinules in the distal half of *E. ligorae* in both sexes but is absent in *E. cabezasi*, (3) the anal somite of *E. ligorae* has no ventral spinules near the base of caudal ramus in the female and has three spinules in the male, while *E. cabezasi* has two spinules in both sexes, (4) the outermost spiniform seta (IV) of Exp and baseoendopod of the P5 of the female in *E. ligorae* are longer than those in *E. cabezasi*, (5) in the female of the new species, the innermost baseoendopodal seta of P5 (II) is the longest, while the outermost seta (IV) is the longest in *E. cabezasi*, (6) P2 Endp-1 in both sexes has a seta on its inner margin in the new species, but this is absent in *E. cabezasi*, and (7) P2 Endp-2 of male with has five elements (one spine and four setae) in the new species, but only four elements (one spine and three setae) in *E. cabezasi*.

Currently, the *Elaphoidella* Group I in SEA was comprised of six species; *E. affinis, E. similis* (endemic to Indonesia, Sumatra Island)*, E. margaritae* (endemic to Phuket, Thailand) and *E. trisaetosa* Chappuis, 1933 (distributed in India and in Indonesia, Sumatra Island), *E. paraaffinis* (endemic of Ranong, Thailand), and *E. ligorae* (endemic of Nakhon Si Thammarat, Thailand). There are also clear differences among members of Group I in following characters: (1) the anal operculum of *E. ligorae* has fine spinules on its free margin while the other five species have strong spinules; (2) the number of spinules on the ventral side of the anal somite, near the base of the caudal rami is 0:3, 5:3, 1:?, 5:5, 2:?, 0:0, respectively for *E. ligorae, E. margaritae*, *E. affinis*, *E. paraaffinis*, *E. trisaetosa*, and *E. similis* (female: male). In relation to the number of setae on P5 in female, the females of the new species have four setae on baseoendopod : exopod while in *E. margaritae*, *E. affinis, E. trisaetosa,* and *E. similis* the numbers of setae are 4:2, 4:3, 3:5, and 4:5, respectively. Although the number of setae in *E. paraaffinis* and *E. ligorae* are identical, P5 basoendopod is much smaller than Exp in *E. ligorae* (but almost of the same length in *E. paraaffinis*). Additionally, P5 Exp of the male in *E. similis, E. ligorae* and *E. paraaffinis* has four (spiniform) setae, while *E. margaritae* has two setae. The number of setae of *E. ligorae* is identical to *E. paraaffinis,* but basoendopod is much smaller than in the latter species (in the other two species, the number of setae is unknown as males were not described). Another character that differentiates males and females of different species is related to the setation of P2 Endp. In *E. ligorae*, both sexes have an inner seta on P2 Endp-1 but the seta is absent in *E. margaritae* and *E. paraaffinis*. *Elaphoidella ligorae* has a spine and four setae on P2 Endp-2 in the male while *E. margaritae* has three setae, and *E. paraaffinis* has only four setae. In both sexes, P3–P4 Endp-1 of the two new species have no inner seta, while one seta is present in the females of *E. affinis, E. similis*, and *E. trisaetosa*. The combination of the number of setae on P3–P4 Endp differs too: P3–P4 Endp-2 in the females of both new species have five and four setae, respectively, while *E. margaritae* has five and three setae, and *E. affinis, E. similis* and *E. trisaetosa* have six and four setae each.

Discussion

A total of 11 *Elaphoidella* species are presently known from inland freshwater habitats in Thailand. Most species are reported from groundwater, and two of them were later found in the epigean habitats in the northeast part of the country: 1) *E. namnaoensis* was found in a pond in Loei Province and in a stream in Nakhon Ratchasima Province; 2) *E. bidens decorata* was found in a reservoir in Nakhon Ratchasima Province. Another epigean species, *E. grandidieri*, was reported from Thailand, but its exact locality is unknown (Dussart & Defaye 1990; Chang 2010). Five species (*E. thailandensis*, *E. jaesornensis*, *E. sanoamuangae*, *E. paraaffinis* **sp. nov.** and *E. ligorae* **sp. nov.**) are restricted to the epikarst and they are so far known only from Thailand, where epikarstic habitats have been intensively studied over the last five years. *Elaphoidella sanoamuangae* was only once collected from water containers filled exclusively by trickling water from the ceiling, whereas other species were sampled from natural pools filled by dripping water on different types of cave floors. There is no doubt that the origin of the species is the epikarst, as all sampled caves have no connection to groundwater and/or surface water. From the very early studies of the epikarstic copepods in Thailand, it appeared that the most dripping water streams are populated with endemic stygobiotic species with rather limited distribution (Brancelj *et al*. 2013). However, some stygophilic species also occur in the epikarst, such as *E. bidens, E. intermedia, E. namnaoensis,* along with some other ubiquitous harpacticoids, e.g., *Epactophanes richardi* Mrázek, 1893 and *Phyllognathopus viguieri* (Maupas, 1892) (Watiroyram 2012; Boonyanusith 2013; Watiroyram *et al*. 2015a; Watiroyram, unpublished data). From this point of view, the epikarst is a very important shallow subterranean habitat for stygobionts, especially for copepods (Culver *et al*. 2012).

During our five year study of the copepods in caves from different parts of Thailand, 628 samples from 169 caves were analysed: 154 samples from 29 caves in six provinces in the northern region of Thailand, 94 samples from 15 caves in two provinces in the western region of the country, 42 samples from 32 caves in one province in the northeastern region of the country, and 338 samples from 93 caves in 10 provinces in the southern region of the country (Watiroyram 2012, unpublished data; Boonyanusith 2013). Six species, out of 11 recorded from Thailand, are so far known only from the cave where the species was initially collected (in the north: *E. jaesornensis* and *E. thailandensis*; in the south: *E. margaritae*, *E. sanoamuangae, E. paraaffinis,* and *E. ligorae*) while the other species, except *E. namnaoensis,* are distributed across the whole country (Fig. 1). The spatial distribution and ecology of *Elaphoidella* species in Thailand has already been discussed (see Watiroyram 2012; Boonyanusith

2013; Boonyanusith & Athibai 2014; Watiroyram *et al*. 2015a; Watiroyram & Brancelj 2016). The species richness is beyond any doubt underestimated as most of the areas have been so far very poorly investigated, particularly those in the central, eastern and northeastern regions of Thailand. The occurrence of the genus in Thailand is predominantly in groundwater, but most of previous studies neglected these habitats. In the future, sampling of these habitats is expected to gain more knowledge on regional diversity, not only of the genus *Elaphoidella,* but also other genera.

The paucity of the knowledge of the actual distribution pattern of *Elaphoidella* species across SEA is supported by the fact that the majority of the species (22 out of 28) are known to be found in only one country (Table 1). *Elaphoidella grandidieri* is the only species distributed over the whole of SEA, followed by *E. bidens decorata* recorded in four countries, *E. intermedia* in three countries, while *E. bidens coronata*, *E. bromeliaecola,* and *E. javaensis* are found in only two countries.

During the late Pleistocene, the SEA islands (Sumatra, Java, Borneo, except Philippines) were connected to Indochina (Singapore, Malay Peninsula, Thailand, Myanmar, Laos, Cambodia, Vietnam) by a land mass at 120 m above sea level (Voris 2000). As a result, many epigean species (*E. bidens*, *E. grandidieri*, *E. intermedia*, *E.javaensis*, and *E. bromeliaecola*) were easily dispersed across SEA by water systems, wind and anthropic activities. The number of SEA stygobionts (27% of the total *Elaphoidella* species) so far tend to be fewer than in Europe or the Holoractic countries, at least lower than Slovenia (33%) (Mori & Brancelj 2008). According to Galassi *et al*. (2009), this difference may have been a legacy of Pleistocene glaciation, which led to the extinction and speciation of stygobionts along latitudinal gradients. The stygobization process in SEA may have occurred after ancestral surface species had penetrated into groundwater before or after the Quaternary glaciation (Lewis 1986), but probably not later than the Jurassic period when the Gondwana supercontinent broke up and the last fragments (South West Borneo and/or East Java-West Sulawesi) were accreted to SE Sundaland in the Cretaceous period (Metcalfe 2011). This separation may explain why the genus occurred in low numbers in Australia (only *E. bidens*, *E. grandidieri*, and *E. humphreysi* Karanovic, 2006), probably due to its recent arrival to Australia (Hammond 1987; Karanovic 2006). The geography of SEA after glaciation was responsible for new genetic barriers, which increased stygobiotic richness. The islands and ancestral populations were separated from each other by the rising sea, and probably increased the opportunities of vicariant events. Finding these new species is an example of "spot distribution" as well as previous stygobionts (Galassi 2001). Migration was less important or weak dispersal within groundwaters led to confinement in a single locality, such as with the 150 km separation of *E. sanoamuangae* and *E. ligorae,* which were closely distributed compared to other SEA stygobionts. Additionally, the most known stygobionts in the region were found on peninsulas and islands near marine margins and probably this is the most significant reason for vicariance (Culver *et al*. 2009).

In Thailand, the males of two species, *E. jaesornensis* and *E. namnoaensis,* are still unknown. Specimens of *E. jaesornensis* are to date known only from the type locality and in low numbers. The presence of males rather than absence could be expected. A different situation pertains to *E. namnoaensis*, where females were collected in many locations across the country. In 75 % of the sampled sites (Fig. 1), sometimes up to 200 females were collected per site (Watiroyram *et al*. 2015a). Thus, the absence of males suggests parthenogenesis or at least a potential parthenogenetic mode of reproduction, where males are present in low numbers and the majority of reproduction within populations is actually done in a parthenogenetic mode. Parthenogenesis gives some species an advantage in colonizing and/or surviving in environments with low energy input or confined mobility (Moore *et al*. 2005), such as caves and especially in the epikarst, where most of the *Elaphoidella* from Thailand were found.

Parthenogenetic reproduction produces more offspring in a shorter time compared to sexual reproduction, as is already known from epigean Rotifera (Nogrady 1993) and Cladocera (Dumont & Negrea 2002). Reproduction of cave-dwelling copepods is rather slow, both in terms of time and number of offspring (Rouch 1968), thus parthenogenesis in the subterranean environment can also be advantageous in comparison to sexual reproduction. This could explain the relatively wide distribution of *E. namnaoensis,* although the number of eggs per egg sac (8–13) is comparable to other species found in Thailand (*E. jasornensis*: 10–13; *E. ligorae*: 6–12; *E. paraaffinis*: 13–16; *E. thailandensis*: 9–11), with the exception of *E. sanoamuangae* (6–8). Chang (2010) postulated that the parthenogenetic behavior of *E. grandidieri* was a common phenomenon in *Elaphoidella,* and this reproductive mode supported their worldwide distribution. Other parthenogenetic and cosmopolitan species have been reported in canthocamptids and parastenocaridids, such as *Canthocamptus staphylinus* (Jurine), *E. bidens*, and *Epactophanes richardi* (see Morales 2015; Pesce 2016).

TABLE 1. List of *Elaphoidella* species in Southeast Asia; X = present.

Species / subspecies		Group (*sensu* Lang, 1948)	Indonesia	Thailand	Vietnam	Malaysia	Philippines
1	*E. affinis* Chappuis, 1933	I	X				
2	*E. bidens bidens* (Schmeil, 1894)	II				X	
3	*E. bidens coronata* (Sars G.O., 1904)	II	X		X		
4	*E. bidens decorata* (Daday, 1901)	II	X	X	X		X
5	*E. bromeliaecola* (Chappuis, 1928)	VII	X	X			
6	*E. bryophila* (Chappuis, 1928)	II	X				
7	*E. cornuta* Chappuis, 1931	X	X				
8	*E. cuspidata* Chappuis, 1941	II				X	
9	*E. elegans* Chappuis, 1931	X	X				
10	*E. grandidieri* (Guerne & Richard, 1893)	II	X	X	X	X	X
11	*E. intermedia* Chappuis, 1931	II	X	X	X		
12	*E. jaesornensis* Watiroyram, Brancelj & Sanoamuang, 2015	IV		X			
13	*E. javaensis* (Chappuis, 1928)	X	X		X		
14	*E. labani* Loffler, 1973	VII				X	
15	*E. ligorae* **sp. nov.**	I		X			
16	*E. longipedis* Chappuis, 1931	II	X				
17	*E. malayica* (Chappuis, 1928)	VIII	X				
18	*E. margaritae* Pesce & Apostolov, 1985	I		X			
19	*E. namnaoensis* Brancelj, Watiroyram & Sanoamuang, 2010	IV		X			
20	*E. paraaffinis* **sp. nov.**	I		X			
21	*E. sanoamuangae* Watiroyram & Brancelj (2016)	VII		X			
22	*E. sewelli* (Chappuis, 1928)	VIII					X
23	*E. similis* Chappuis, 1931	I	X				
24	*E. superpedalis* Shen & Tai, 1964	II				X	
25	*E. thailandensis* Watiroyram, Brancelj & Sanoamuang, 2015	VIII		X			
26	*E. thienemanni* Chappuis, 1931	VII	X				
27	*E. trisaetosa* Chappuis, 1933	I	X				
28	*E. vietnamica* Borutzky, 1967	VIII			X		
Total			15	11	6	5	3

Within the genus *Elaphoidella,* there are at least four more species with wider distributions in which males are unknown or their records are very rare: *E. grandidieri*, *E. elaphoides* (Chappuis)*, E. superpedalis*, and *E. leruthi* Chappuis (Sarvala 1979; Janetzky *et al*. 1996; Alekseev *et al*. 2016). Hence, the presence of parthenogenesis (or at least a potentially parthenogenetic mode) is not exceptional in the genus. For *E. grandidieri*, it has also been observed in cultures that males are scarce (Gutiérrez-Aguirre *et al*. 2011). For that reason, experiments in culturing selected *Elaphoidella* species in their natural conditions are required for subsequent authors interested in their biology to determine their actual population / sexual structure.

Key to species of *Elaphoidella* Chappuis, 1929 from SEA based on females

1	P5 baseoendopod with 3 setae	*E. trisaetosa*
-	P5 baseoendopod with 4 setae	2
2	P5 Exp with 2–3 setae	3
-	P5 Exp with 4–6 setae	6
3	P5 Exp with 2 setae	*E. margaritae*
-	P5 Exp with 3 setae	4
4	P5 with less developed beseoendopod; shorter than half of Exp length	*E. superpedalis*
-	P5 with well developed beseoendopod; longer than half of Exp length	5
5	Inner margin of caudal ramus with thorn-like seta	*E. cornuta*
-	Inner margin of caudal ramus with normal seta	*E. javaensis*
6	P1 Endp 2-segmented	7
-	P1 Endp 3-segmented	10
7	P5 Exp with 5 setae	*E. bidens bidens*
-	P5 Exp with 4 setae	8
8	Posterior margin of urosomites smooth.	*E. sanoamuangae*
-	Posterior margin of urosomites serrate	9
9	P4 Endp absent	*E. thailandensis*
-	P4 Endp present.	*E. elegans*
10	Inner seta on P4 Endp-1 absent	11
-	Inner seta on P4 Endp-1 present	21
11	P5 Exp with 5 setae	12
-	P5 Exp with 4 setae	13
12	Posterior margin of urosomites smooth.	*E. jaesornensis*
-	Posterior margin of urosomites serrate	*E. bidens coronata*
13	Endopod-2 of P4 with 2–3 setae and spines	14
-	Endopod-2 of P4 with 4 setae and/or spines	17
14	Inner seta on P2 Endp-1 present	*E. labani*
-	Inner seta on P2 Endp-1 absent	15
15	P3 Endp-2 with 4 setae	*E. vietnamica*
-	P3 Endp-2 with 5 setae	16
16	Posterior margin of urosomites smooth.	*E. malayica*
-	Posterior margin of urosomites serrate	*E. sewelli* s. str.
17	Posterior margin of urosomites smooth.	*E. namnaoensis*
-	Posterior margin of urosomites serrate	18
18	Inner seta on P2 Endp-1 absent	*E. paraaffinis* **sp. nov.**
-	Inner seta on P2 Endp-1 present	19
19	Inner seta on P3 Endp-1 absent	*E. ligorae* **sp. nov.**
-	Inner seta on P3 Endp-1 present	20
20	P3 Endp-2 with 3 setae	*E. bromeliaecola*
-	P3 Endp-2 with 5 setae	*E. thienemanni*
21	Posterior margin of urosomites smooth.	22
-	Posterior margin of urosomites serrate	25
22	P5 with well developed beseoendopod; about a half of Exp length	*E. cuspidata*
-	P5 with less developed beseoendopod; shorter than half of Exp length	23
23	P5 Exp as long as wide	*E. bryophila*
-	P5 Exp more than 1.5 times as long as wide	24
24	P5 Exp about 2.0 times as long as wide	*E. grandidieri*
-	P5 Exp more than 2.5 times as long as wide	*E. longipedis*
25	P5 Exp with 4 setae	*E. affinis*
-	P5 Exp with 5 setae	26
26	Anal operculum with 10–14 spinules	*E. bidens decorata*
-	Anal operculum with more than 18 spinules.	27
27	Caudal ramus about 2.0 times as long as wide	*E. intermedia*
-	Caudal ramus less than 1.5 times as long as wide.	*E. similis*

Key to species of *Elaphoidella* Chappuis, 1929 from SEA based on males

Note: males of *E. affinis, E. bidens, E. cornuta, E. elegans, E. jaesornensis, E. longipedis, E. namnoaensis, E. superpedalis*?*, E. trisaetosa* are so far unknown)

1	P5 Exp with less than 4 setae	2
-	P5 Exp with 4 setae	11
2	P5 Exp with 2 setae	3
-	P5 Exp with 3 setae	4
3	P4 Endp-2 with 2 elements	*E. javaensis*
-	P4 Endp-2 with 3 elements	*E. margaritae*
4	P1 Endp 2-segmented	5
-	P1 Endp 3-segmented	6
5	P4 Endp absent	*E. thailandensis*
-	P4 Endp present	*E. sanoamuangae*
6	P2 Endp-1 with inner seta	7
-	P2 Endp-1 without inner seta	9
7	P2 Endp-2 with 4 elements	*E. grandidieri*
-	P2 Endp-2 with 3 elements	8
8	Posterior margin of urosomites weakly serrate	*E. bromeliaecola*
-	Posterior margin of urosomites strongly serrate	*E. thienemanni*
9	P4 Endp-2 with 2 elements	*E. labani*
-	P4 Endp-2 with 3 elements	10
10	P2 Endp-2 with 3 elements	*E. malayica*
-	P2 Endp-2 with 4 elements	*E. vietnamica*
11	P4 Exp-3 without transformed spine	12
-	P4 Exp-3 with transformed spine	15
12	P4 Endp-2 with 2 elements	*E. similis*
-	P4 Endp-2 with 3 elements	13
13	P2 Endp-2 with 5 elements	*E. ligorae* **sp. nov.**
-	P2 Endp-2 with 4 elements	14
14	P2 Endp-1 with inner seta	*E. cuspidata*
-	P2 Endp-1 without inner seta	*E. paraaffinis* **sp. nov.**
15	P2 Endp-2 with 3 elements	*E. sewelli* s. str.
-	P2 Endp-2 with 4 elements	16
16	Caudal ramus with dorsal keel	*E. intermedia*
-	Caudal ramus without dorsal keel	*E. bryophila*

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