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First record and a new taxon of *Stammericaris* Jakobi, 1972 (Copepoda, Harpacticoida) from the Philippines; with an amendment to the generic diagnosis and reassignment of three Palearctic species

VEZIO COTTARELLI[1] & MARIA CRISTINA BRUNO[2,3*]
[1]*Department for Innovation in Biological, Agro-food and Forest systems, Tuscia University. Largo dell'Università snc, 01100 Viterbo, Italy.*
cottarel@unitus.it; https://orcid.org/0000-0001-9925-0250
[2]*Research and Innovation Centre, Fondazione Edmund Mach, Via E. Mach 1, 38098 S. Michele all'Adige (TN), Italy.*
cristina.bruno@fmach.it; https://orcid.org/0000-0001-7860-841X
[3]*NBFC, National Biodiversity Future Center, Palermo 90133, Italy.*
** Corresponding author.*

Abstract

We report on the finding of *Stammericaris galichai* **sp. nov.** in the hyporheic habitat of Cantingas River, Sibuyan Island, the Philippines. The new species is attributed to the genus based on the morphology of the male antennule (of the "pocket-knife" type); the presence of a hook on the inner margin of the basis of the male first pereopod; the male third pereopod with a long apophysis and two groups of outer spinules on the first exopodal segment; the endopodite of the male forth pereopod reduced, but corresponding to the basic morphology of the genus, and the basis ornamented with two spinules on inner margin, one of which long and inwardly-curved, one small and with apex consisting of three small lobes. *Stammericaris galichai* **sp. nov.** does not have one taxonomically and morphologically closest species within the genus, possibly due to its geographical isolation. Based on some aspects of the morphology of *Stammericaris galichai* **sp. nov.** (namely, the shape of the fifth pereopod) and other species of *Stammericaris*, the description of the genus is slightly amended, and the Palearctic taxa *Parastenocaris balcanica* Petkovski, 1959, *P. nertensis* Rouch, 1990, *P. triphyda* Cottarelli & Bruno, 1993 are transferred to the genus *Stammericaris*. *Stammericaris galichai* **sp. nov.** is the first representative of the genus for the Philippines, and for the entire Oriental Region. The faunistic and biogeographical relevance of the new species is discussed with particular focus on the discovery of this freshwater stygobitic species in a volcanic island which has never been in contact with other landmasses. A map of the distribution of Parastenocarididae hitherto known for the Philippines, including a new station in Mindoro for the endemic *Parastenocaris distincta* Cottarelli, Bruno & Berera, 2006, is also provided.

Key words: Philippino dwelling fauna, hyporheos, Parastenocaridinae

Introduction

The Philipppines represent a biodiversity hotspot (Myers *et al.* 2000; Ong *et al.* 2002) due to their geographic position and geological history; freshwater habitats cover at least 2,000 km^2 of the total 300,000 km^2 land area (Lopez *et al.* 2017) of the Philippines but are still poorly investigated. This is particulatly true for microcrustaceans: if planktonic groups have been recently and comprehensively listed by Lopez *et al.* (2017), the groundwater crustacean fauna of the Philippines remains scarcely known, and Brancelj *et al.* (2013) cite only six known groudwater copepod species. Among this faunistic group, members of the family Parastenocarididae Chappuis, 1940 are becoming an essential representative of the Philippino groundwater biodiversity, by being a very specialized family, exclusively dwelling in groundwaters. *Parastenocaris mangyans* Bruno & Cottarelli, 1999, now accepted as *Horstkurtcaris mangyans* (Bruno & Cottarelli, 1999) is the first representative of this family for the Philippines and was collected from hyporheic and phreatic (i.e., from one well) waters in the Oriental Mindoro Province (Bruno & Cottarelli 1999). Corgosinho *et al.* (2017a) rejected the attribution of *P. mangyans* to the genus *Horstkurtcaris*, stating that "the use

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of the generic name *Horstkurtcaris* should be restricted to *H. nolli* (Kiefer, 1930) and *H. nolli alpina* (Kiefer, 1960) only". We agree with Corgosinho *et al.* (2017a), and we hope that future work will clarify this issue.

Parastenocaris distincta Cottarelli, Bruno & Berera, 2006 is the second Philippino taxon, collected in the freshwater interstitial habitat near the mouth of a river in Western Mindoro Province. Two more species were reported but not described: one (all specimens in the copepodid stage) from the Mountain Province of Luzon Island near Bontoc Town (Bruno & Cottarelli 1999), and one from Sibuyan Island, Romblon Province (Cottarelli *et al.* 2006). The specimens from Sibuyan are here attributed to the genus *Stammericaris* Jakobi, 1972, thus representing the first record of this genus not only for the Philippines, but also for the whole Oriental Region. The new species, *Stammericaris galichai* sp. nov., was collected from the interstitial hyporheic habitat of the lower course of the Cantingas River, in the south-eastern region of Sibuyan, an area known to host a high biodiversity. The new species is interesting in several respects, which will be discussed, but it must be remarked the exceptionality of the collection of a taxon exclusive to groundwater in a volcanic island that, since its origin, has never been in contact with other landmasses (see below).

The genus *Stammericaris* (Parastenocaridinae Chappuis, 1940) was instituted by Jakobi (1972) and later revised and redefined by Schminke (2013) who included the genus *Phreaticaris* Jakobi, 1972 in *Stammericaris*; later, Bruno *et al.* (2017) slightly modified Schminke's diagnosis based on taxonomic and molecular studies of some species of *Stammericaris.* The genus currently includes the following fourteen known species: the type-species *S. stammeri stammeri* (Chappuis, 1937), *S. acherusia* (Noodt, 1954), *S. amyclaea* (Cottarelli, 1969), *S. destillans* Bruno & Cottarelli, 2017 (in Bruno *et al.* 2017), *S. diversitatis* (Cottarelli & Bruno, 2012) (in Cottarelli *et al.* 2012), *S. lorenzae* (Pesce, Galassi & Cottarelli, 1995), *S. orcina* (Chappuis, 1938), *S. palmerae* (Reid, 1992), *S. pasquinii* (Cottarelli, 1972), *S. phreatica* (Chappuis, 1936), *S. remotaepatriae* Cottarelli & Bruno 2021, *S. similior* Bruno & Cottarelli, 2023 (in Bruno *et al.* 2023), *S. trinacriae* (Pesce, Galassi & Cottarelli, 1988), *S. vincentimariae* Bruno & Cottarelli, 2020 (in Bruno *et al.* 2020). One species from Northern Italy and one from Anatolic Turkey are still undescribed and presently under study (Cottarelli & Bruno, unpublished). Most of the species are endemic for Italy: *S. destillans*, *S. diversitatis* and *S. similior* were collected each one in a different cave in Sicily, *S. trinacriae* in a cave and two phreatic systems in Sicily, *S. vincentimariae* in a Calabrian cave; most of the remaining species (i.e., *S .pasquinii*, *S. lorenzae*, *S. acherusia*, *S. amyclaea*, *S. orcina*) are known only for Italy but with a wider distribution (Chappuis 1938; Cottarelli & Drigo 1972; Bruno *et al.* 2017). *Stammericaris stammeri stammeri* and *S. phreatica* are endemic to Spain/France and Romania/Czech Republic, respectively (Chappuis 1936, 1937; Rouch 1986); *S. remotepatriae* and *S. palmerae* are the only species known from the Nearctic region, having been collected in Virginia and Massachussets, USA (Reid 1992; Cottarelli & Bruno 2021).

With the present research, we therefore aimed to: i) fully describe, discuss, and identify the distinguishing characters and affinities of *Stammericaris galichai* sp. nov., the first species of the genus for the Oriental Region, and to justify the attribution of the new species to the subfamily Parastenocaridinae and to the genus *Stammericaris*; ii) slightly amend the diagnosis of *Stammericaris* as a consequence of the finding of the new species and of the critical reassessment of other known species; iii) contribute, albeit slightly, to the rearrangement of the genus *Parastenocaris* that is still, partly, a repository of phylogenetically unrelated taxa, by attributing three species of *Parastenocaris* to *Stammericaris*, as new combinations: *P. balcanica* Petkovski, 1959 discovered in a cave in former Yugoslavia, *P. nertensis* Rouch, 1990 from the French Pyrenees, and *P. triphyda* Cottarelli & Bruno, 1993 from the Bue Marino cave in Sardinia (Italy); iv) propose an up-to-date taxonomic key for the identification of the known species of *Stammericaris;* v) briefly discuss a new record of *Parastenocaris distincta*; v) highlight the biogeographic and faunal value of the new record, the colonization patterns of Sibuyan parastenocaridids, and the need for the protection and conservation of Sibuyan biodiversity.

Materials and methods

Specimens were collected using the Karaman-Chappuis method (Delamare-Deboutteville 1960), by filtering the water from holes dug in the sandy soil along the river banks. Samples were fixed in 5% buffered formaldehyde solution, sorted in the laboratory and mounted in Faure's medium under a stereoscope. Illustrations were drawn at different magnifications up to a maximum of 1250 x, using drawing tubes mounted on a Zeiss Axioskop® phase-contrast microscope and a Polyvar Reichert-Jung® interferential-contrast microscope. Specimens of the type series are deposited at La Specola Museum of Natural History, Zoology Section Florence, Italy (MZUF).

The following abbreviations are used throughout the text and figures: A1: antennule; A2: antenna; ae = aesthetasc; mdb = mandible; mx1 = maxillule; mx2 = maxilla; mxp = maxilliped; P1–P5 = first to fifth pereiopod; P6 = rudimentary sixth pereiopod; enp = endopod; exp = exopod; enp1–3 = endopodal segments 1–3, exp1–3 = exopodal segments 1–3. The nomenclature and descriptive terminology follow Huys & Boxshall (1991); terminology and homologisation of maxillary and maxillipedal structures follow Ferrari & Ivanenko (2008).

Taxonomic results

Subclass Copepoda

Order Harpacticoida

Family Parastenocarididae Chappuis, 1940

Subfamily Parastenocaridinae Chappuis, 1940

Genus *Stammericaris* Jakobi, 1972

Type species. *Stammericaris stammeri stammeri* (Chappuis, 1937).

Other species. *Stammericaris acherusia* (Noodt, 1954); *Stammericaris amyclaea* (Cottarelli, 1969); *Stammericaris destillans* Bruno & Cottarelli, 2017; *Stammericaris diversitatis* (Cottarelli & Bruno, 2021); *Stammericaris lorenzae* (Pesce, Galassi & Cottarelli, 1995); *Stammericaris orcina* (Chappuis, 1938); *Stammericaris palmerae* (Reid, 1992); *Stammericaris pasquinii* (Cottarelli, 1972); *Stammericaris phreatica* (Chappuis, 1936); *Stammericaris remotaepatriae* Cottarelli & Bruno, 2021; *Stammericaris similior* Bruno & Cottarelli, 2023; *Stammericaris trinacriae* (Pesce, Galassi & Cottarelli, 1988); *Stammericaris vincentimariae* Bruno & Cottarelli, 2020.

Stammericaris galichai sp. nov.

(Figures 1–4)

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Type locality. Sibuyan Island, Romblon Province, Cantingas River, hyporheic habitat on the right bank; approximate coordinates 12°19'33.80" N, 122°34' 38.50" E, 26 m a.s.l.

Type material. Holotype : dissected male mounted on two slides labelled: "*Stammericaris galichai* holotype: male, Sibuyan, Philippines, 28/VIII/1998 slide 1" (MZUF 705) and "*Stammericaris galichai* holotype: male, Sibuyan, Philippines, 28/VIII/1998 slide 2" (MZUF 706). Paratypes: 1 male, dissected and mounted on one slide labelled: "*Stammericaris galichai* paratype: male, Sibuyan, Philippines, 28/VIII/1998" (MZUF 707); 4 males, undissected and mounted each on one slide labelled: "*Stammericaris galichai* paratype: male, Sibuyan, Philippines, 28/VIII/1998" (MZUF 708, 709, 710, 711); 4 females; undissected and mounted each on one slide labelled: "*Stammericaris galichai* paratype: female, Sibuyan, Philippines, 28/VIII/1998" (MZUF 712, 713, 714, 715); 2 females, dissected and mounted each on one slide labelled: "*Stammericaris galichai* paratype: female, Sibuyan, Philippines, 28/VIII/1998" (MZUF 716, 717). All material collected by Vezio Cottarelli.

Diagnosis. Male: antennule eight-segmented, of the "pocket-knife" type *sensu* Schminke (2010), seventh segment with tapering apical tip; cephalothorax with elliptical dorsal integumental window. Urosomites 2–5 each with dorsal elliptical integumental window; anal operculum well-developed, with rounded distal free margin reaching distal margin of anal somite, with transversal row of spinules ventrally; caudal rami shorter than anal somite; inner margin of P1 basis with hook; P2 enp as long as 3/4 of the corresponding exp-1, with few apical spinules and distal seta; P3 robust and slightly curved, with two groups of spinules on distal half of outer margin of exp-1; apophysis (i.e., ancestral distal segment) with constriction at midlength and distal half with membranous edge; thumb shorter than apophysis and characteristically curved. P4 endopod small and of peculiar shape, with small, triangular inner

tip and single distal pinnate outgrowth; P4 basis ornamented with two spinules of different lengths, the one closer to the enp shortest, with a trilobed apex. P5 a trapezoidal plate with four distal setae. Female: cephalothorax with elliptical integumental window dorsally, urosomites 2–4 each with elliptical integumental window dorsally, anal operculum and caudal rami as in male, inner margin of P1 basis with long thin seta; P2 endopod with spinules apically and seta as in male; P3 endopod a pointed segment about 1/2 the length of the corresponding exp-1; P4 endopod about 2/3 the length of the corresponding exp-1, ending in spiniform seta with spinules around insertion. P5 quadrangular, narrower and more elongated than in male, armature as in male but setae lengths differ.

Etymology. The new species is dedicated to Rodne Rodiño Galicha, Filipino environmentalist and human rights activist, born in Sibuyan Island, in recognition of its involvement in biodiversity conservation and natural resources conservation. The specific epithet is a singular masculine noun in the genitive case.

Description. Adult male. Body unpigmented, nauplius eye absent. Total body length, measured from tip of rostrum to posterior margin of caudal rami (excluding caudal setae) from 344 to 580 μm, mean 483 μm (n = 6). Habitus (Figure 1A) cylindrical and slender, without any demarcation between prosome and urosome; prosome/urosome length ratio= 0.9. Free pedigerous somites without lateral or dorsal expansions, all connected by well-developed arthrodial membranes. Integument weakly sclerotized, without cuticular pits, ornamented with sensilla on all somites but preanal one. Sensillar pattern as in Figure 1A. Cephalothorax with rounded dorsal integumental window (Figure 1A), urosomites 2–5 with dorsal elliptical integumental window (Figure 1A). Anal somite (Figures 1A, 2A) with pair of large dorsal sensilla at base of anal operculum, anal sinus wide open, with two diagonal rows of small proctodeal spines. Anal operculum (Figure 2A) well-developed, with convex distal margin, transverse row of ventral spinules discernible through transparent operculum.

Caudal rami (Figures 1A, 2A). Diverging, approximately cylindrical, tapering distally, shorter than anal somite, anal somite/caudal ramus length ratio = 1.5; caudal ramus length/ width ratio = 2.18. Anterolateral accessory seta (I) shorter than anterolateral seta (II), posterolateral seta (III) short, all setae inserted together distally at 3/4 the length of caudal ramus; outer terminal seta (IV) long and pinnate (seta/caudal rami length ratio= 1.4), inserted subapically; inner terminal seta (V) without fracture plane; terminal accessory seta (VI) short (seta/caudal ramus length ratio= 0.9) and bare; dorsal seta (VII) bare, articulated, inserted distally at 3/4 length of the caudal ramus.

Rostrum (arrowed in figure 2B). Small, not demarcated at base, almost reaching distal margin of first antennulary segment, ornamented with two dorsal sensilla.

A1 (Figure 2B). Prehensile, eight-segmented; seventh segment sickle-shaped, folded back onto the fifth segment, with eighth segment pointing medially, i.e., pocket-knife type *sensu* Schminke (2010). First segment short and bare; second segment longest, with five setae, one of which unipinnate; third segment with four distal bare setae of similar lengths; fourth segment reduced to small bare sclerite (indicated with an asterisk in figure 2B); fifth segment enlarged with inner triangular pointed expansion, distal tubercle with one basal short seta, two long subequal distal setae and large apical aesthetasc reaching past the distal margin of eighth segment; sixth segment bare, small and cylindrical, partially fused to previous one; seventh segment bare, sickle-shaped, with distal anterior corner protruding as curved apophysis ending in tip; eighth segment with seven setae and apical acrothek represented by one seta and slender long aesthetasc basally fused. Armature formula: 1-[0], 2-[1 uniplumose + 4 bare], 3-[4 bare], 4-[1 bare], 5-[2 bare +(1+ ae)], 6-[0], 7-[0], 8-[7 bare + (1 bare + ae)].

A2 (Figure 2C). Coxa unarmed; allobasis with one abexopodal transverse row of spinules. Exp represented by small segment partially merged with allobasis, with bipinnate apical seta. Enp bearing along inner margin from proximal to distal: seven spinules of different lengths (four short, three long), two unipinnate spines of subequal lengths inserted at about 2/3 of margin; apically: two geniculate, two spiniform, and one transformed setae of different lengths, the transformed seta proximally smooth, medially serrate, and distally smooth. Two long and thin spinules along the outer margin, near the insertions of apical transformed seta.

Mandible (Figure 2D). Coxal gnathobase with lateral pinnate short seta, cutting edge with two large and three small apical teeth. Palp one-segmented, with two distal setae of subequal lengths.

Maxillule (Figure 2E). Praecoxal arthrite with three apical curved robust spines apically denticled, one lateral curved seta. Coxal endite long, with apical pinnate seta. Basis cylindrical, with two distal bipinnate setae of subequal lengths. Endopod and exopod absent (fused to basis without trace).

Maxilla (Figure 2F). Syncoxa with two endites, proximal endite short, with one seta; distal endite cylindrical, armed apically with two subequal thin bare setae and one transformed, leaf-like pinnate seta; proximal endopodal segment drawn into apical unipinnate claw; vestige of distal endopod represented by two long setae of different lengths.

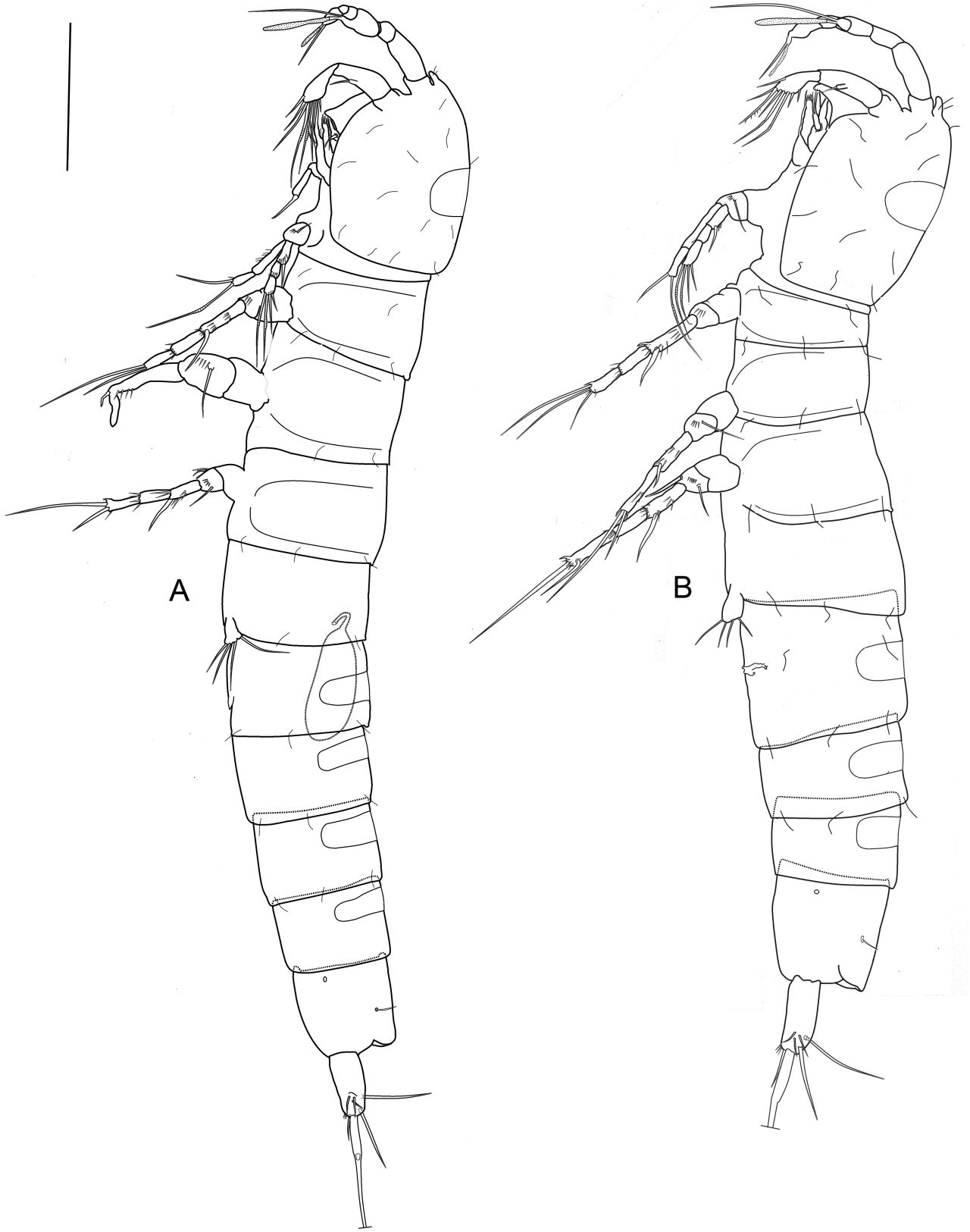

FIGURE 1. *Stammericaris galichai* sp. nov. Habitus, lateral view. A) male; B) female. Scale bar: 50 micrometers.

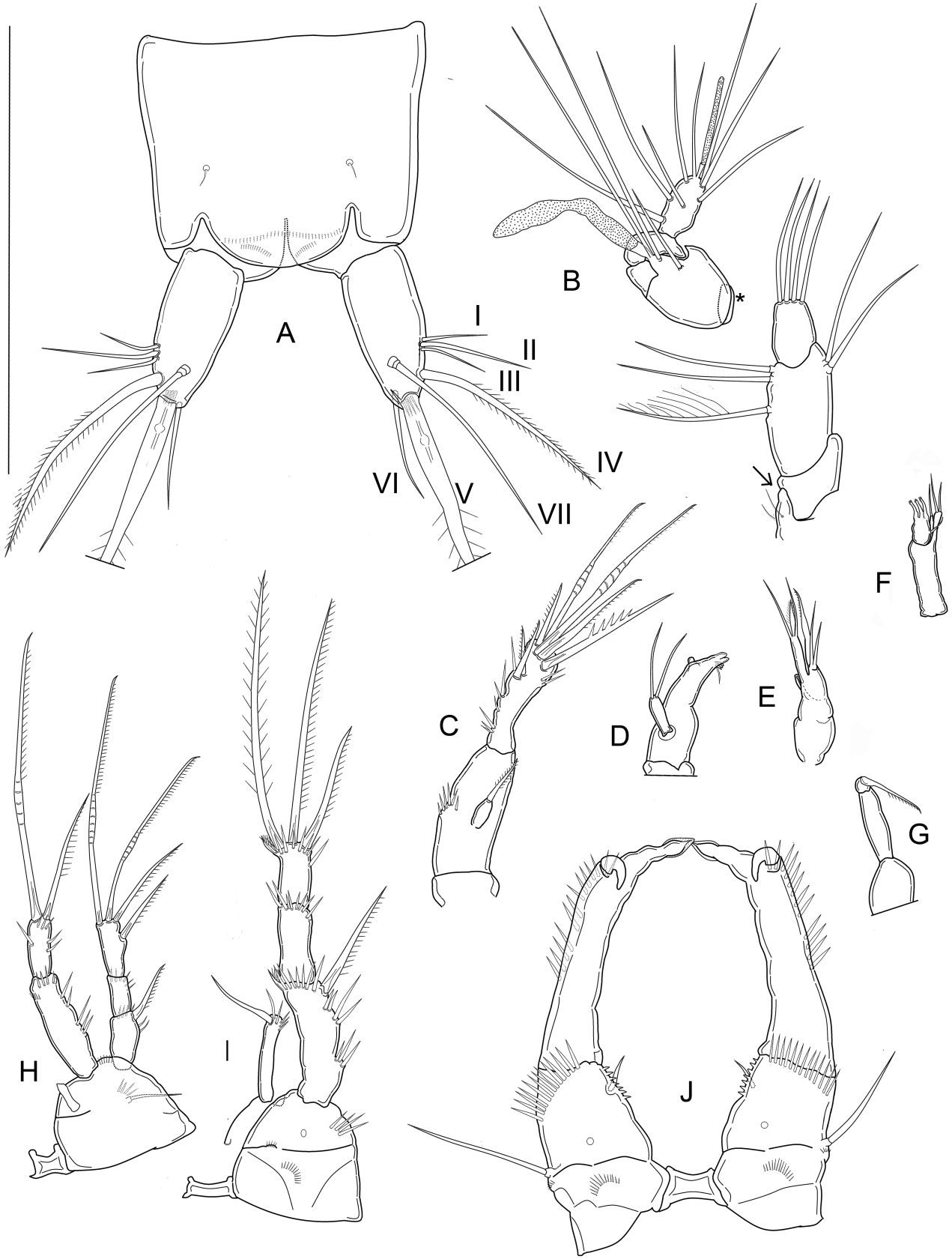

FIGURE 2. *Stammericaris galichai* sp. nov., male. A) anal somite, anal operculum and caudal rami, dorsal view, setae identified by Roman numbers; B) rostrum (arrowed) and antennule (split into two parts: segments I–III, and IV–VIII. Segment IV marked with asterisk), dorsal view; C) antenna; D) mandible; E) maxillule; F) maxilla; G) maxilliped; H) P1; I) P2; J) P3 (variability). Scale bar: 50 micrometers.

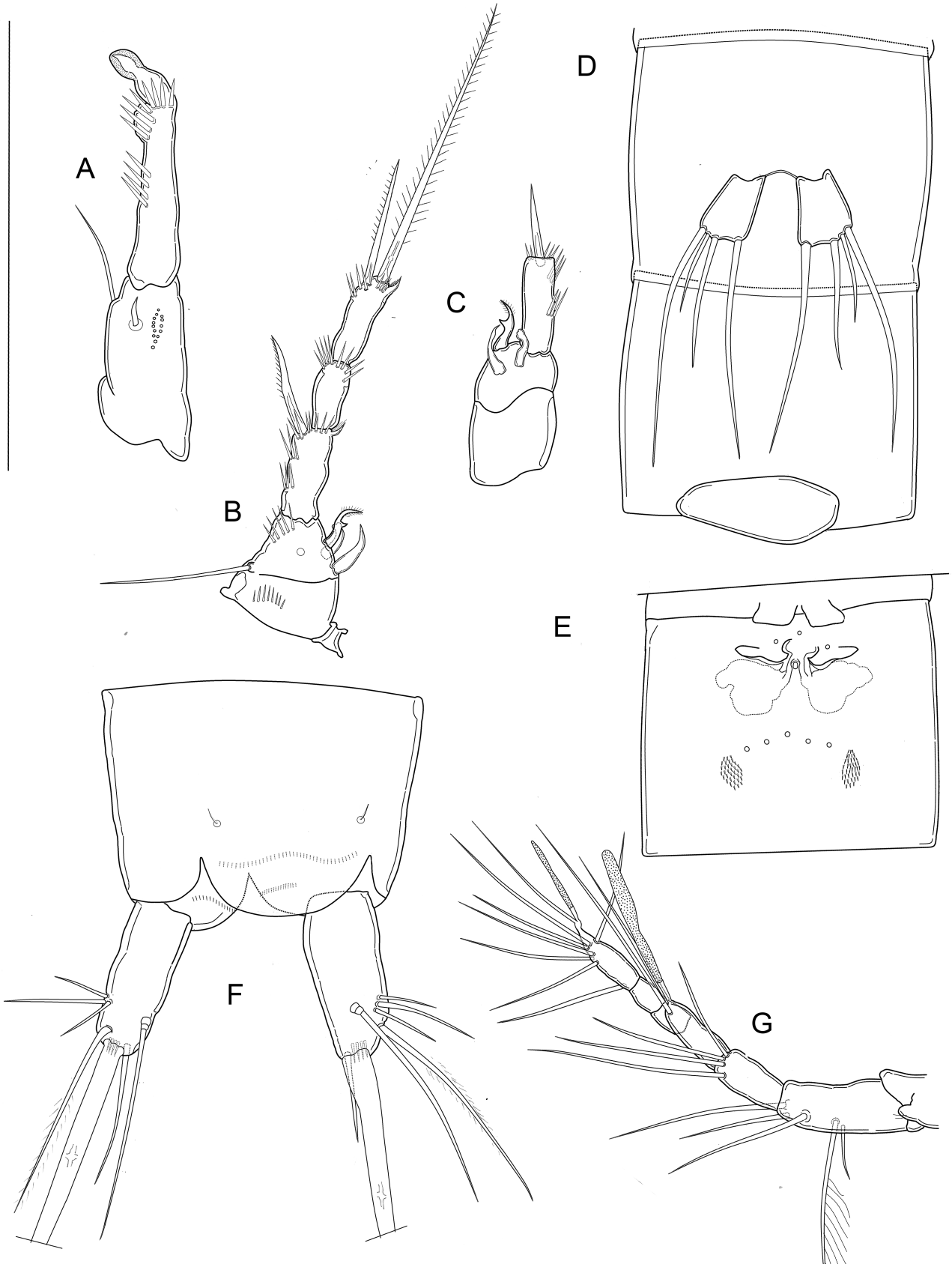

FIGURE 3. *Stammericaris galichai* sp. nov., A–D: male; E–G: female. A) P3, inner (medial) view; B) P4; C) P4 basis, endopod, exp-1, inner (medial) view; D) P5, P6, first and second urosomites, ventral view; E) genital double somite, genital field, P6, ventral view; F) anal somite, anal operculum and caudal rami, dorsal view; G) antennule. Scale bar: 50 micrometers.

Maxilliped (Figure 2G). Prehensile; syncoxa small and unarmed; basis slim and elongate, unarmed; endopod represented by distally unipinnate claw.

P1 (Figures 2H). Intercoxal sclerite smooth and small; coxa bare. Basis large, armed with single slender seta and row of four spinules on outer margin, and lamellar, long inner hook with rounded tip near enp insertion. Exp three-segmented, slightly shorter than enp; exp-1 with unipinnate spine on outer distal corner; exp-2 shortest and unarmed; exp-3 with two apical geniculate setae, bipinnate in the distal half, and one unipinnate apical and one unipinnate subapical spines. Enp two-segmented; enp-1 as long as first two segments of corresponding exp combined, with spinules along outer margin; enp-2 shorter and thinner than enp-1, with one spinule at 2/3 of inner margin and two spinules along outer margin; apical margin with long geniculate unipinnate seta and shorter unipinnate spiniform seta.

P2 (Figure 2I). Intercoxal sclerite quadrangular and smooth, with concave distal margin. Coxa with spinular row. Basis unarmed, with row of four spinules and small pore on outer margin. Exp robust, three-segmented, exp-1 longest, slightly curved inwards, with transversal rows of spinules at 1/3 and 2/3 of outer margin, and two short longitudinal spinules proximal to strong distolateral unipinnate spine. Exp-2 unarmed, with distal row of spinules; exp-3 short, with inner hyaline frill and distal row of spinules, armed with subapical outer unipinnate spiniform seta, one apical seta and one apical spine, both unipinnate. Enp one-segmented, slightly shorter than corresponding exp-1, cylindrical, with bare subapical seta about as long as segment, and five apical spinules.

P3 (Figures 2J, 3A). Intercoxal sclerite narrow and long, trapezoidal, unornamented, with concave distal margin. Coxa with spinular row. Basis robust, with basal pore on the dorsal surface, and long, slender, smooth outer seta and row of long spinules obliquely inserted along outer distal margin; row of small chitinous denticles along inner margin; enp reduced to short and thin seta. Exp-1 slender distally, two rows of four and eight spinules of similar length along outer margin in the second 1/2 of segment; exp-2 fused with exp-1, without ornamentation, prolonged into long finger-like apophysis, slightly bent inwards, with constriction at midlength, and distal half with membranous edges, ending with rounded tip. Distal thumb short, inwardly bent, long, approximately half as long as apophysis.

P4 (Figures 3B, C). Intercoxal sclerite smaller than in P1-P3, with concave, smooth distal margin. Coxa with spinular row. Basis with anterior pore, armed with slender seta on outer margin; ornamented with row of spinules on distal outer margin and two spinules on inner margin, one of which long and inwardly-curved, one small and with apex consisting of three small lobes. Exp three-segmented, first segment strongest, second shortest; exp-1 armed with outer distal unipinnate spine and inner hyaline frill; with transversal rows of three spinules at 1/3 and 2/3 of outer margin and two spinules below insertion of spiniform seta, and spinular row along distal margin. Exp-2 unarmed, with row of spinules along outer distal margin extending to the inner distal corner; exp-3 armed with outer unipinnate spine and long apical bipinnate seta, spine about 1/3 the length of seta; ornamentation represented by row of apical spinules, row of spinules along distal outer corner, and inner hyaline frill. Enp one-segmented, slightly longer than 1/2 the length of the corresponding exp-1, represented by a plate curved inwards with pinnate tip and with one small, pointed outgrowth.

P5 (Figure 3D). Pair of P5 not fused to intercoxal sclerite; represented by two trapezoidal cuticular plates with long basipodal seta. Armature on free distal margin, from inner to outer: three bare setae of which outermost short, innermost very long, middle one shortest.

P6 (Figure 3D). Vestigial, fused into simple cuticular asymmetrical oval plate, unornamented and unarmed.

Adult female. Habitus (Figure 1B) cylindrical and slender, without any demarcation between prosome and urosome. Body length, excluding caudal setae, from 300 to 542 μm, mean 468 μm (n = 6). Free pedigerous somites without any lateral or dorsal expansions, all connected by well-developed arthrodial membranes. Cephalothorax and urosomites 2–4 with dorsal elliptical integumental window of different sizes, largest one on genital double somite. Ornamentation of cephalothorax, somites, pigmentation, and lack of nauplius eye as in male, except genital and first urosomites fused into genital double-somite. Prosome/urosome length ratio= 1.0. Genital double-somite (Figure 3E) without any trace of subdivision, with three ventral pores proximal and two ventral pores distal to genital field, and, two spinular rows distal from the two pores. Genital field (Figure 3E) occupying anterior ventral third of genital double-somite; copulatory pore located medially at proximal third of genital double-somite, not covered by fused vestigial P6.

Anal operculum and anal sinus (Figure 3F) as in male.

Caudal rami (Figures 1B, 3F). Shape, ornamentation and armature similar to those of male but rami proportionally longer, length/width ratio= 2.27.

Mouthparts, rostrum, A2 as in male.

A1 (Figure 3G). Seven-segmented, aesthetasc on fourth segment as long as in male but proportionally thinner, reaching beyond seventh segment. First segment bare, second segment longest. Apical acrothek represented by one seta and slender aesthetasc basally fused. Armature formula: 1-[0], 2-[1 pinnate + 4 bare], 3-[4 bare], 4-[2 bare + ae], 5-[0], 6-[0], 7-[7 bare + (1 bare + ae)].

P1 (Figure 4A). Intercoxal sclerite and coxa as in male. Basis as in male, but with thin and long inner seta instead than lamellar hook and pore; exp and enp similar to those of male.

P2 (Figure 4B). Intercoxal sclerite, coxa, basis and exp as in male. Enp similar in shape to that of male, but apical seta smaller and thinner.

P3 (Figure 4C). Intercoxal sclerite small, trapezoidal, with concave margin, bare. Coxa with spinular row. Basis armed with single seta, with pore and outer spinular row; exp two-segmented: exp-1 slightly longer and larger than exp-2, with distal curved unipinnate spine and two subdistal spinules, transversal spinular row at 1/3 of outer margin, hyaline frill on inner distal corner. Exp-2 with subapical outer unipinnate spine and longer apical bipinnate seta, subdistal outer spinule, apical spinular row and hyaline frill on inner distal corner. Enp represented by pointed and apically bipinnate segment, about 1/2 the length of the corresponding exp-1.

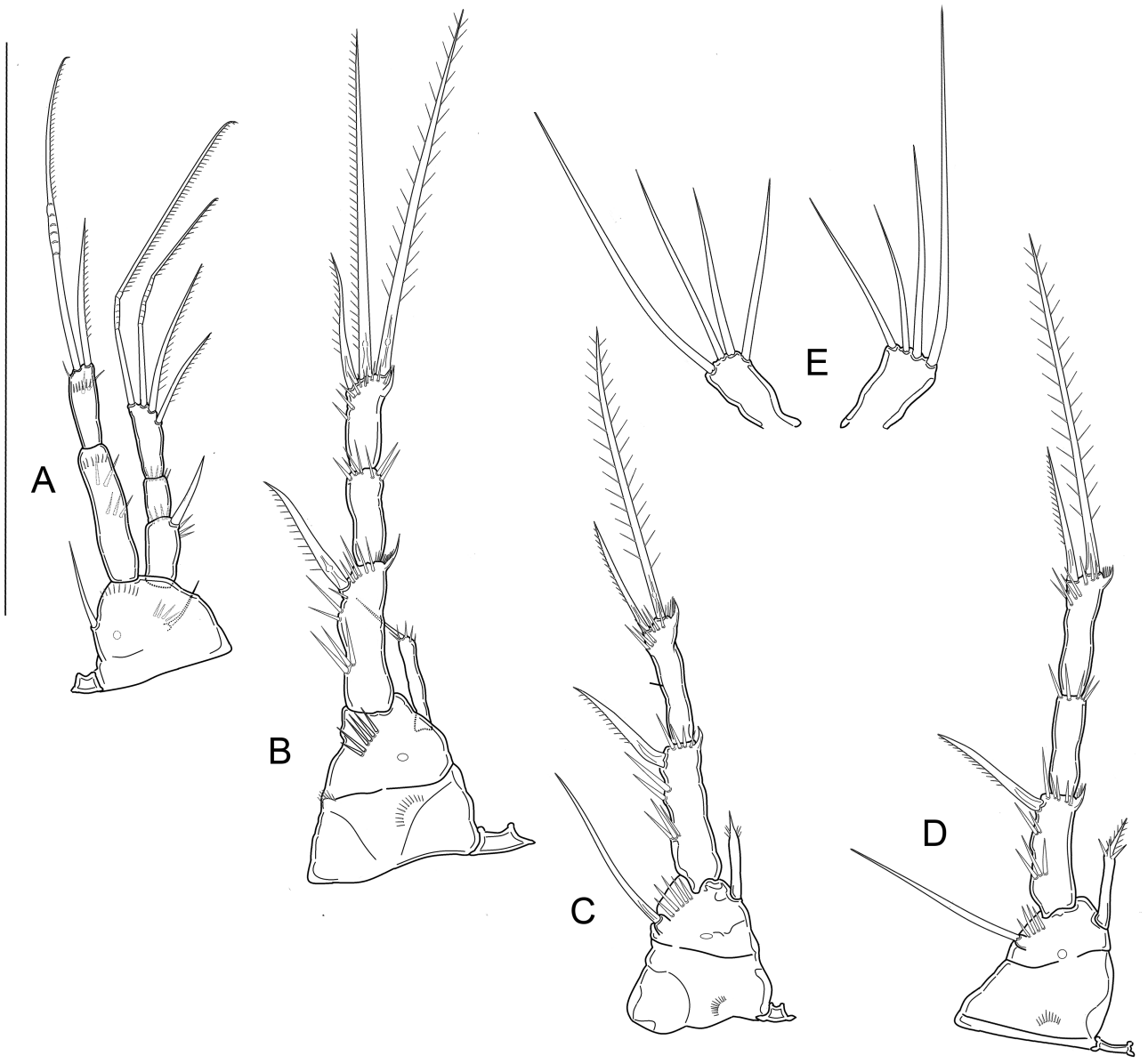

FIGURE 4. *Stammericaris galichai* sp. nov., female. A) P1; B) P2; C) P3; D) P4; E) P5. Scale bar: 50 micrometers.

P4 (Figure 4D). Intercoxal sclerite much narrower than in male, coxa as in male, basis as in male but without strong spinules on inner margin. Exp-1 as long as exp-3, exp-2 shortest; exp-1 with distolateral curved unipinnate spine and two transversal rows of spinules at 1/3 and 2/3 of outer margin, with distal spinular row and inner hyaline frill on distal corner. Exp-2 with distal spinular row; exp-3 with apical outer unipinnate spine and longer apical bipinnate seta, with distal spinule on outer margin, with apical spinular row, and inner hyaline frill on distal corner. Enp represented by thin claviform segment about 2/3 the length of the corresponding exp-1, ending in spiniform seta with spinules around insertion.

P5 (Figure 4E). Pair of P5 not fused to intercoxal sclerite, represented by rectangular plates; narrower and more elongated than in male, armature as in male but the three innermost setae are of subequal lengths (i.e., two are longer and one is shorter than in male).

P6 (Figure 3E). Two vestigial rectangular cuticular plates, not covering gonopore, unornamented and unarmed.

Variability. The exp-1 of the left P3 in the male holotype has a distal row of eight spinules along the outer margin, and a row of nine spinules on the right P3 (Figure 2J), in all the paratypes, the row consists of eight spinules on both pereiopods.

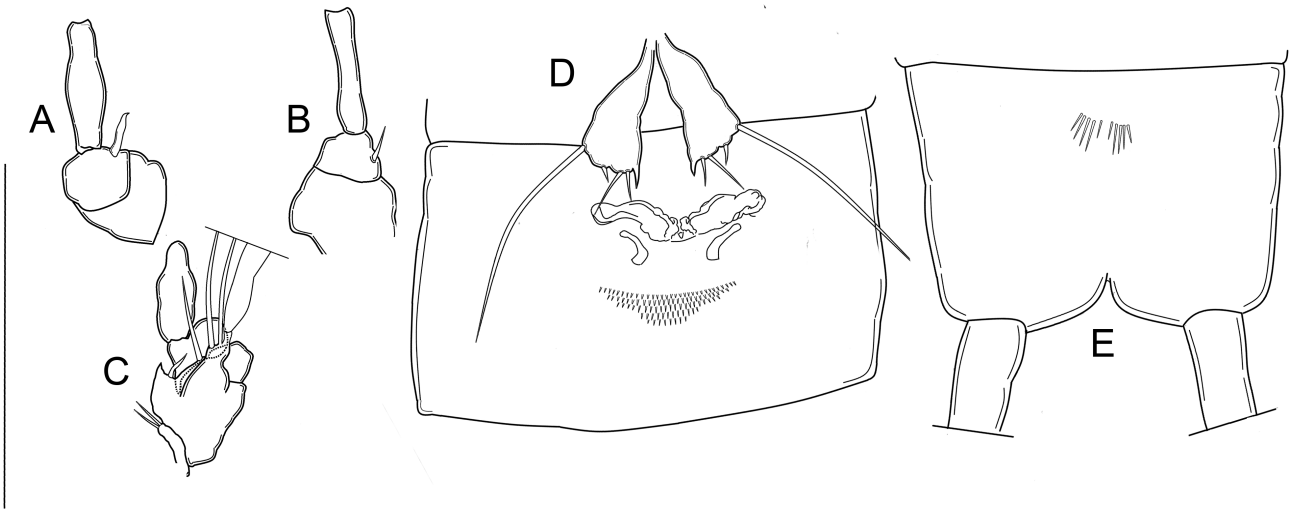

FIGURE 5. *Stammericaris triphyda* comb. nov., A, C: male; B, D, E: female. A) P1 basis, inner view; B) P1 basis, inner view; C) A1, segments 4–8 (schematic, armature omitted); D) P5, genital double somite, genital field; E) anal somite, ventral view. Scale bar: 50 micrometers.

Discussion

Attribution of the new species to the subfamily Parastenocaridinae Chappuis 1940 and to the genus *Stammericaris* Jakobi, 1972. Schminke (2010) divided the family Parastenocarididae into two subfamilies: Parastenocaridinae Chappuis, 1940 and Fontinalicaridinae Schminke, 2010, listing the following set of morphological characters needed to identify the subfamily Parastenocaridinae: i) male antennule of the "pocket-knife" type; ii) endopod of female P3 with a stout terminal seta, both together being relatively long; iii) spinules on the basis of the male P4 inserted medially of (i.e., internally from) the endopod or at its base; iv) female genital field rectangular, band-like; v) one inner seta on the basis of female P1; vi) one inner hook or ridge on the basis of the male P1. In the same work Schminke (2010) also indicated the following "accessory" characters: i) fusion of terminal seta and apophysis of the male P3 exopod; ii) small P5; iii) the dorsal seta and the three lateral setae of the caudal rami having the same position more or less opposite to each other. The morphological analysis of the species collected in Sibuyan shows that the specimens of both sexes possess all the diagnostic characters indicated above, and thus can easily be assigned to the subfamily Parastenocaridinae.

The following discussion on the taxonomy and affinities of the new species of *Stammericaris* is based on the available descriptions, illustrations, scanning microscopy images, and the re-examinations of specimens in our collections, of the following 13 taxa*: S. amyclaea*, *S. destillans*, *S. diversitatis*, *S. lorenzae*, *S. orcina*, *S. palmerae*,

S. pasquinii, *S. remotaepatriae*, *S. trinacriae*, *S. vincentimariae*, *S. similior*, *Stammericaris* sp. 1 (Trento, Northern Italy, unpublished), *Stammericaris* sp. 2 (Eðirdir Lake, Turkey, unpublished).

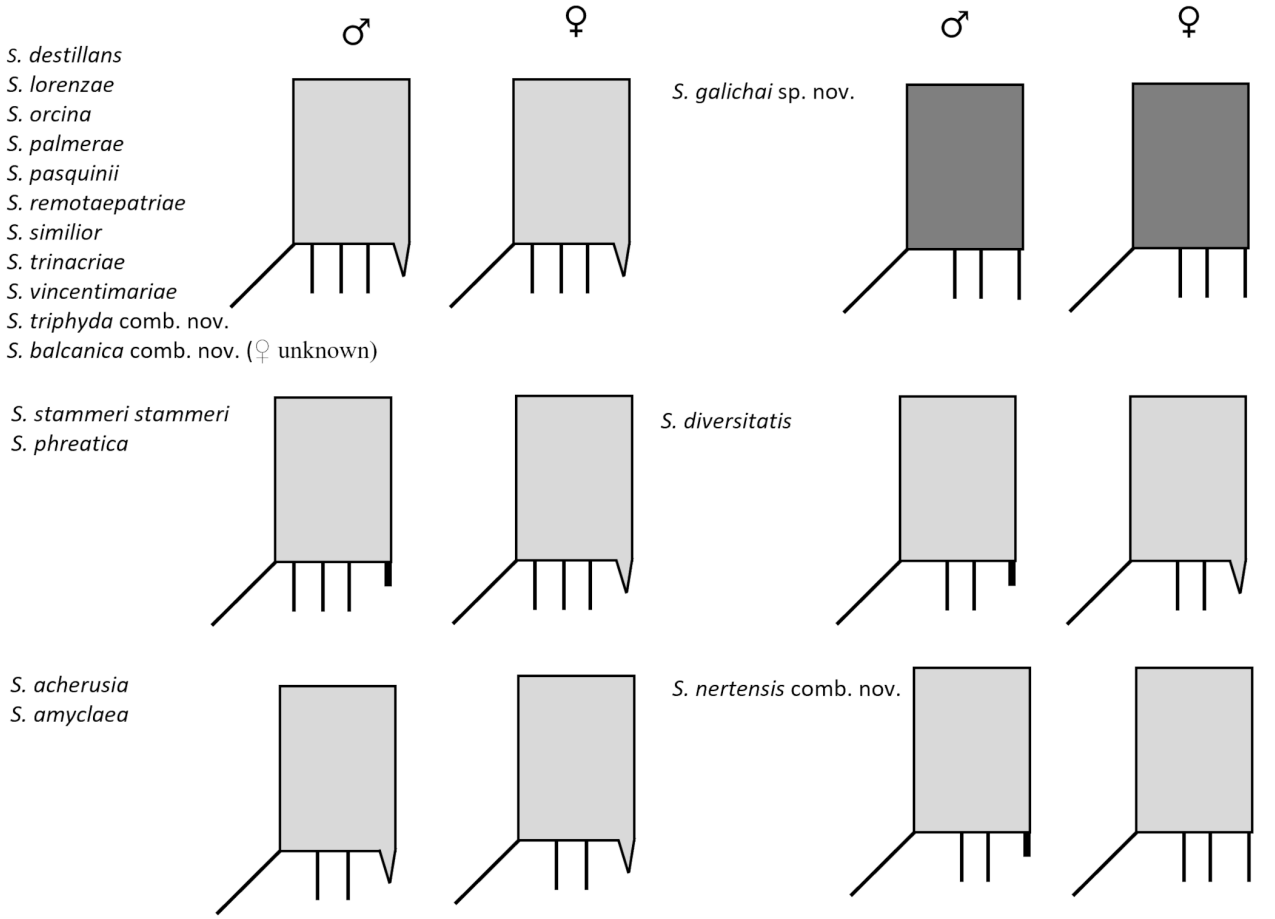

FIGURE 6. Schematic representation of the right P5 armature of all known *Stammericaris* species (as described and/or illustrated in: Chappuis 1936, 1937; Noodt 1954; Petkovski 1959; Cottarelli 1969; Cottarelli & Drigo 1972; Pesce *et al.* 1995; Rouch 1990; Reid 1992; Cottarelli and Bruno 1993, 2021; Bruno and Cottarelli 1998; Cottarelli *et al*. 2012; Bruno *et al.* 2017, 2020, 2023). Drawings orientation: right side= inner (medial) margin, left side: outer margin. Long, black lines: basipodal seta (bottom-left corner) and 2–3distal setae; short thick line on bottom-right corner: inner spine; triangle on bottom-right corner: inner tip.

We initially followed the diagnosis by Schminke (2010) as amended in Bruno *et al.* (2017), to attribute the new species to the genus *Stammericaris*, since *S. galichai* sp. nov. shows all the following diagnostic features: 1) male: i) antennule of the pocket-knife type; ii) basis of P1 with hook. It should be recalled that the male's pocket-knife A1 and the hook on the P1 basis are not exclusive characters of *Stammericaris*; they are also present in some other genera, e.g., *Cottarellicaris* Schminke, 2013, a genus morphologically and phylogenetically (Bruno *et al.* 2023) close to the former, and also in other phylogenetically unrelated taxa, and are probably due to convergent evolution. In fact, as regards the inner armature on the basis of P1 of males, the two other known species from the Philippines (i.e., *Horstkurtiscaris mangyans* and *Parastenocaris distincta*) albeit not being phylogenetically related to the one discussed here, carry, respectively, a "thin seta" and an "enlarged, chitinous protrusion, with rounded bifid tip"; in the three known species of the genus *Indocaris* Ranga Reddy, Totakura & Shaik, 2016, collected in peninsular India (Ranga Reddy 2011; Ranga Reddy *et al.* 2016), the inner armature element is represented by "one strong, small, hook-like spine" in *I. imbricata* Ranga Reddy, Totakura & Shaik, 2016, or "one small outcurved, blunt, knob-like, small spine" in *I. inopinata* Ranga Reddy, Totakura & Shaik, 2016, or "a digitiform chitinous structure" in *I. tirupatiensis* (Ranga Reddy, 2011). In contrast to males, a hook or a hook and seta are never present on the P1 basis in females of any parastenocaridid: armature may be lacking altogether as in *H. mangyans*, it can be a short seta as in *P. distincta* and in several species of *Cottarellicaris* or, finally, it can be a true long seta in the species described here; a seta of similar size has been reported for *Eirinicaris antonioi* Corgosinho, Schizas, Previattelli, Rocha

& Santos-Silva, 2017a, a Brazilian monospecific genus of Parastenocaridinae. In agreement with Corghoshino *et al.* (2008), an inner seta on the basis of P1 probably appeared independently in different phyletic lineages of Parastenocarididae, thus representing a synapomorphy for the two sister genera *Cottarellicaris* and *Stammericaris*, and a distinct apomorphy for the other genera. Unfortunately, the armature of the P1 basis was not reported in the older descriptions because, at that time, it was not observed or not considered useful, but which might be present, as it occurred, for instance, in *S. amyclaea*, *S. pasquinii* and *S. trinacriae* (as reviewed in Bruno *et al.* 2017); iii) P3: outer margin of exp-1 proximally and distally with group of several spinules; apophysis long with a rounded tip and slightly curved inwards, being twice as long as the thumb or even longer. The P3 exp-1 of males of *Stammericaris galichai* sp. nov. has two spinular rows on the outer margin, and the length of the apophysis is about twice that of the thumb, and therefore coincides with the generic diagnosis, however, the two spinular rows are usually located proximally and distally, while in *Stammericaris galichai* sp. nov. one row originates at about half the length of the segment, and the other is disto-apical; iv) P4: basis with an inner row of 1–4 curved spinules decreasing in size laterally; v) P4 endopod a curved plate with a pointed inner tip carrying at its outer border two outgrowths, in most cases the distal one is a feathered or plain seta. The basis of the male P4 is ornamented with an inner row of two spinules of decreasing length, thus in line with the generic diagnosis, but the apex of the smaller spine consists of three small lobes instead of being sharp-pointed. The endopodite, on the other hand, is smaller than the one of most congeners and "simplified" because it lacks the proximal outgrowth on its outer margin, while it bears the distal elongated and feathered outgrowth, characteristic of the genus. In this regard, *Stammericaris* with reduced P4 enp have been described (specifically, *S. destillans* and *S. similior*), and as for the disappearance of the proximal outgrowth, this has already been reported for the Palearctic *S. orcina*, *S. balcanica*, *S. nertensis*, and the Nearctic *S. remotaepatriae*. Endopods with a similar morphology, even if reduced as in the new species, have so far been recorded only in two genera of Parastenocarididae, viz. *Cottarellicaris* and *Stammericaris*, but the latter is the only genus to which *S. galichai* sp. nov. can be attributed. 2) female: i) basis P1 with small seta or without armature; ii) endopod P3 half as long as or shorter than first segment of corresponding exopod. 3) both sexes: i) caudal rami cylindrical, almost as long as anal somite, group of lateral setae located at end of rami. The morphology and size of the P3 endopod of the female of *Stammericaris galichai* sp. nov. falls within the diagnosis of the genus; this is also true for the ornamentation of the caudal rami of both sexes, which, however, are shorter than the anal somite while, according to the generic diagnosis (as amended in Bruno *et al*. (2017)), they should be at least as long as the anal somite. In this regard, we recall that there are four other species of *Stammericaris* (viz., *S. destillans*, *S. vincentimariae*, *S. remotaepatriae* and *S. similor*) with short caudal rami and yet they are true *Stammericaris* as also shown by recent molecular analyses (Bruno *et al.*, 2017, 2020, 2023).

Based on the characters discussed above, *Stammericaris galichai* sp. nov. can be attributed to *Stammericaris* since we have demonstrated the presence of most of the generic characters. We must, however, also note that the shape and armature of the P5 of both sexes of *Stammericaris galichai* sp. nov. differs from those of most of the other known speciers of *Stammericaris*, where the P5 is represented by a quadrangular/trapezoidal lamina with the distal margin longer than the basal one, most frequently provided with a spiniform tip, rarely a true spine or a seta, on the inner distal (median) corner. The remaining armature of the P5 is represented by a long basal seta followed very often by a short spine and one or two setae of different lengths but always longer than the spine (Figure 6); the P5 is usually sexually dimorphic because in the female it is either larger or narrower and more elongated with a more developed distal tip than in the male. In contrast, in *Stammericaris galichai* sp. nov., these appendages are very similar in the two sexes: they are quadrangular, lacking the tip on the inner distal corner which, instead, carries a long seta, followed by three other setae; the sexual dimorphism is reduced to the size, i.e., the P5 is slightly smaller in the male, and to the greater length of the setae in the female. A different condition is present in *Parastenocaris nertensis* (see below for the taxonomic status of this species, and Figure 6), where the P5 of both sexes is trapezoidal in shape, with the inner distal corner carrying a spine in the male and a seta in the female and thus lacking the tip. The condition already observed by Cottarelli & Bruno (2012) in *Stammericaris diversitatis* but also present in S. *phreatica* and *S. stammeri*, is an “intermediate” condition (Figure 6), with the male P5 being a quadrangular plate with a spine on the distal inner corner, and the female P5 with the "normal" morphology and armature discussed above.

Diagnostic characters of *Stammericaris galichai* sp. nov. Several features distinguish *Stammericaris galichai* sp. nov. from its congeners; we mention some of them again: the males are recognizable by: 1) the unique P4 enp, very small and with only one outgrowth; ii) the median basipodal spinule of P4 with apically trilobed apex, which so

far is autapomorphic for this species; iii) the insertion of the spinules on the outer margin of the exp-1 of the P3 and the "sickle-shaped" appearance of its thumb, which are characteristically unique. In addition, the P5 of both sexes has no match in the known congeners by carrying a long seta on the inner distal corner instead than a tip or a spine (Figure 6). The females can be easily distinguished by the size of the median basipodal seta of the P1 which is likely an apomorphic character: we do not know of any other *Stammericaris* with a similar armature, but a seta of similar length and size has been illustrated and described for *Parastenocaris sontraensis* Tran, 2021 from Vietnam and could be due to homoplasy. The morphological affinities of the new species with its congeners have been described above, but the definition of the phylogenetic affinites will be possible when molecular data (unluckily, the preservation of the material in formaldehyde did not allowed us to carry out molecular analyses), and new microcharacters will be available, and when the discovery of new species and/or new records of known species from the Palearctic-Asian and Eastern Regions reduces the current large knowledge gap.

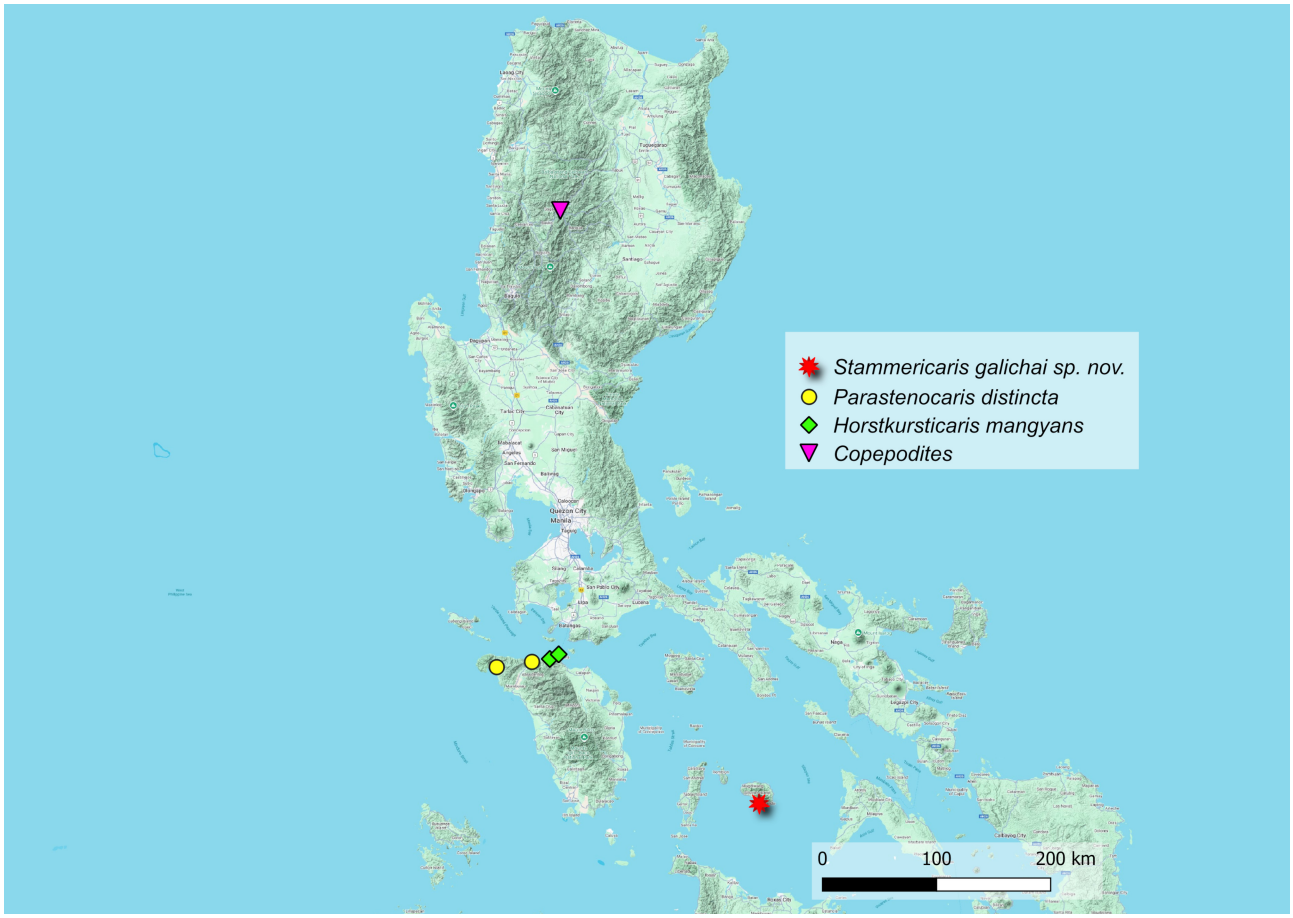

FIGURE 7. Distribution map of Parastenocarididae in the Philippines (data from: Bruno & Cottarelli, 1999; Cottarelli *et al.*, 2006)

Taxonomic status of *Parastenocaris balcanica* Petkovski, 1959, *P. nertensis* Rouch, 1990, *P. triphyda* Cottarelli & Bruno, 1993

Parastenocaris balcanica was collected in the "Donja Duka", a karstic cave located 18 km west from Skopje, Macedonia, which hosts a rich copepod fauna (Petkovski 1959); only the male of this species is known. Petkovski (1959) correctly assigned *P. balcanica* to Lang's (1948) *minuta* species-group; interestingly, Petkovski (1959) listed *P. phreatica* Chappuis 1936, which is a true *Stammericaris*, among the taxa related to *P. balcanica*. The careful examination of the original iconography of the species supports a reasonably confident attribution of *P. balcanica* to *Stammericaris*: the male A1 (see Petkovski (1959, figures 20, 22)) was depicted in a very simplified manner, but nonetheless it is evident that it is of the pocket-knife type, with the penultimate segment folded over the fifth,

and with the terminal segment being characteristically folded upward; the apophysis on the male P3 (see Petkovski (1959, figures 20, 23)) is much longer than the thumb, as characteristic for *Stammericaris*, but it lacks the spinular rows on the outer margin of exp-1: this is a rare condition for the genus, so far observed only in *S. trinacriae* (Bruno *et al.* 2017), but it does not prevent the attribution to the genus. The P5 (see Petkovski (1959, figures 20, 24)) has the typical morphology and armature, with the inner distal corner prolonged into a tip and a short spiniform seta inner to the long, basipodal one; the insertion of setae I–III and VII of the caudal rami (see Petkovski (1959, figures 20, 21)) is typical for the genus; the caudal rami are a little shorter than the anal somite but this condition has been found in six other congeners: *S. destillans*, *S. lorenzae*, *S. phreatica*, *S. vincentimariae*, *S. remotaepatriae*, *S. similior* (Bruno *et al.* 2023). The P4 endopod (see Petkovski (1959, figure 25)) is very similar to that of four other species in the genus (i.e., *S. remotepatriae*, *S. diversitatis*, *S. vincentimariae*, *S. orcina*). Based on this set of characters, *P. balcanica* is here formally transferred to the genus *Stammericaris* as *Stammericaris balcanica* (Petkovski, 1959) comb. nov.

Parastenocaris nertensis Rouch, 1990 was collected from the hyporheic habitat of a stream in the Pyrenées, in France (Rouch 1990). In his description, Rouch (1990) included the species in the *minuta* species-group, remarking that due to the "simplified "structure of the male P4 enp (i.e., lacking the proximal outgrowth on the distal margin), the species was close to *S. orcina*, *S. balcanica* comb. nov., and *S. trinacriae*. As regards the similarities with the latter species, Rouch (1990) referred to the original description of *S. trinacriae* by Pesce *et al.* (1988) where the P4 enp was described and illustrated with only one outgrowth; subsequent research (Bruno *et al.* 2017) showed that, indeed, the P4 enp of *S. trinacriae* has two outgrowths (see Bruno *et al.* (2017), figure 9F). The proximal outgrowth of the P4 enp is absent also in *S. triphyda* and *S. remotaepatriae*, leaving no doubt that in this respect, *P. nertensis* can be included within *Stammericaris*. In addition to the structure of the P4 enp, certainly an important diagnostic character, the Pyrenèean species shares all the other diagnostic characters already listed for the males of *S. galichai* sp. nov. with only two exceptions: the basis of P1 enp lacks armature in the original drawings and description, but as already noted, the presence or absence of this feature was often overlooked; furthermore, as already discussed, the morphology of P5 does not completely satisfy the characters of *Stammericaris* in that, in *P. nertensis*, it is an almost rectangular plate similar in both sexes, while in other species of *Stammericaris*, the female P5 is, in most cases, larger, or longer, or with a more elongated/stronger inner corner than in males. The armature of the male P5 of *P. nertensis*, on the other hand, may be acceptable as typical of *Stammericaris* (Figure 6): the inner distal corner carries a short spine followed by a seta, another short spine, and finally by the basipodal seta; the same condition occurs, e.g., in *S. diversitatis.* In the females of *P. nertensis*, the “spine” of the inner distal angle is replaced by a true seta (although Rouch (1990) described the P5 of both sexes as armed “with spines”, see also Figures 2f and 2g in Rouch (1990)) while the remaining armature elements are represented, in our opinion, by two spines and the basipodal seta. We emphasize that not only the remaining diagnostic characters of the male, e.g., the A1 clearly of the pocket-knife type, but also other charatcters of the female, such as the P3 and P4 endopods, and the morphology and armature of the caudal rami in both sexes, are consistent with the morphology typical for the genus, and although references and illustrations of the female genital field are lacking, it seems to us that the elements discussed earlier are well sufficient to henceforth assign *P. nertensis* to *Stammericaris* as *Stammericaris nertensis* (Rouch 1990) comb. nov.

Parastenocaris triphyda Cottarelli & Bruno, 1993 was collected in the Bue Marino Cave (Sardinia, Italy), a remarkable biodiversity hotspot that is part of a massive karst complex about 70 km long, opening in a sea grotto. Like the previous one, also this species was attributed to the *minuta* species-group when first studied, and Cottarelli & Bruno (1993) emphasized its affinities with *P. trianacriae* and, especially, with *P. nertensis*, both species being now attributed to *Stammericaris*. Luckily, the slides of the specimens of the type series in our collection are still in good conditions and allowed us to check the diagnostic characters discussed above; hence, the following discussion refers to the re-examination of the type specimens, the published description and illustrations in Cottarelli & Bruno (1994), and our original drawings. Careful inspection of the type series of *P. triphyda* revealed that the structure of the male P4 enp is the one already seen for the species discussed above, which is "simplified" but still typical of the genus; the exp-1 of the male P3 has two groups of spinules along the outer margin, and the apophysis is much longer than the thumb; the P5 and caudal rami of both sexes also correspond to the amended generic diagnosis. The divergences concern the apparent absence of armature on the inner margin of the P1 basis in both sexes, the morphology of the male A1, the shape of the male P3 apophysis, the length of the female P3 enp, and morphology of the genital field of the female. The armature on the inner margin of the P1 of both sexes was not usually checked nor described in the descriptions of Parastenocarididae predating Galassi & De Laurentiis (2004), who discussed in

detail the phylogenetic value of this character. We can therefore confirm that this armature is indeed present in *P. tryphida* and is represented by a distally pointed hook in the male P1 (Figure 5A), and a slightly curved seta in the female P1 (Figure 5B). The male A1 was originally described as seven-segmented because the small fourth article was overlooked (see Cottarelli & Bruno (1993), figure 68); the fourth (actually the fifth) segment was described as "not very enlarged" because it was drawn in lateral view. We verified that the A1 is indeed of the pocket-knife type, the sixth (actually seventh) segment was originally illustrated and described as "prolonged distally", but the ventral view of the fifth segment shows the typical triangular pointed expansion (Figure 5C) and the sharpened aphophysis on the seventh segment, a morphological modification which always co-occurs with the modified fifth segment to form the "pocket-knife" part of the antennule (Figure 5C). The male P3 apophysis was re-examined, and it was confirmed that it corresponds to the original description, i.e., "a long spoon-like and very sharpened aphophysis" and therefore the length is compatible with a *Stammericaris*, but not the morphology of the distal part (i.e., "very sharpened") which in *Stammericaris* is a "long, rounded tip". However, a pointed distal part of the apophysis is present in other species as discussed above, making the male P3 compatible with the diagnostic one of *Stammericaris*. The female P3 enp slightly exceeds 1/2 the length of the corresponding P3 exp-1. The genital field, not originally illustrated nor described, is narrow and rectangular (Figure 5D), therefore compatible with those of Parastenocaridinae. The re-examination of the material also allowed us to correct some inaccuracies and omissions of the original work, namely: i) male A1: as mentioned above, the small fourth segment was overlooked; this segment is indeed present and ornamented with two setae (Figure 5C); the armature of the second, fifth and eighth segments was incomplete, the correct armature formula is the following: 1-[0], 2-[1 uniplumose + 5 bare], 3-[4 bare], 4-[2 bare], 5-[3 bare +(1+ ae)], 6-[0], 7-[0], 8-[7 bare + (1 bare + ae)]; ii) female P5: it was described with one less seta than in the male on the distal margin (Bruno & Cottarelli (1993, figure 65)) while the armature is the same for both sexes (Figure 5D); iii) genital double-somite (Figure 5D) without any trace of subdivision, with one ventral spinular row below the genital field; iv) genital field (Figure 5D) occupying anterior ventral 1/3 of genital double-somite, copulatory pore located medially at proximal third of double-somite, not covered by fused vestigial sixth legs; v) last abdominal somite in the female with two ventral groups of characteristic spinules (Figure 5E). In conclusion, in our opinion these are numerous and valid reasons to assign this species to *Stammericaris* as *Stammericaris triphyda* (Cottarelli and Bruno, 1993) comb. nov., representing the first species of this genus recorded from Sardinia, an island rich in endemic parastenocaridids.

To further support our decisions to reassign these species to the genus *Stammericaris*, we have already reported that Schminke (2013) mentioned these same three species, stating that "it could also be that *P. balcanica*, *P. nertensis*, and *P. triphyda* belong to the group of species dealt with here" but refused to consider as part of *Stammericaris* due to the structure of male P4 enp with only two outgrowths; subsequently, Schminke (2013) claimed that "also other characters do not fit, in particular, the male P3 in all three species and the P5 in the case of *P. nertensis*". At the time of Schminke's (2013) publication, his observations were certainly valid, but now it has been seen that the male P4 enp with two outgrowths is widespread in *Stammericaris* (see also Bruno *et al.* (2023)) and as for P3 and P5, we refer to the discussion presented above.

One remark related to all Parastenocarididae discussed here concerns the fact that, at present, it is useful and "economical" to try to prevent the genus *Parastenocaris* from continuing to be a repository of unrelated taxa; it therefore seems justified to allocate to more coherent genera any taxon that may be removed from *Parastenocaris*, sometimes even if with some uncertainty, as it is the case for *S. galichai* sp. nov. In this respect, a recent paper by Tran. *et al.* (2021) with the description of two new species of *Parastenocaris* from Vietnam is interesting from the faunistic and biogeographic point of view because it reports the occurrence of Parastenocarididae in that country for the first time. Although discussing it is beyond the scope of this paper, we must nevertheless anticipate here that in our opinion the paper by Tran. *et al.* (2021) raises some taxonomic and systematic doubts, because of several imprecisions and errors so that the inclusion of the two species described therein in *Parastenocaris* appears very questionable, as we will discuss in depth in a forthcoming paper on the Parastenocarididae of Thailand.

Amendement of the diagnosis of the genus *Stammericaris* Jakobi, 1972. Based on the recorded variability within the genus, it seems appropriate to integrate the variation of the P5 and morphology of the caudal rami in the diagnosis of *Stammericaris* presented in Bruno *et al.* (2017) as follows:

Amended diagnosis. Male antennule 8-segmented and of the pocket-knife type. Male P1 basis with hook or with hook and seta, without armature near endopod insertion. Female P1 basis with seta or without armature. Female P3 enp half as long as or shorter than the first segment of corresponding exopod. Outer margin of male P3

exp-1 proximally and distally with group of several spinules, or spinules only proximally (at the present state of knowledge in one species, *Stammericaris destillans*) or without spinules (at the present state of knowledge in two species, *Stammericaris balcanica* comb. nov. and *S. trinacriae*); apophysis long with a rounded or, at the present state of knowledge in some species (i.e., *S. destillans*, *S. similior*, *S. tryphida* comb. nov.), with pointed tip and slightly curved inward, being twice as long as the thumb or even longer. Male P4 basis with an inner row of 1–4 curved spinules decreasing in size laterally; male P4 enp a curved plate with a pointed inner tip carrying at its outer border one or two outgrowths, in most cases the distal one is a feathered or plain seta. P5 a quadrangular/trapezoidal lamina with distal margin wider than the basal one, with basipodal long seta; males with one tip on the inner distal corner and two-three distal setae, or one spine on the inner distal corner and two–three distal setae, or three distal setae; females with one tip on the inner distal corner and two–three distal setae, or three distal setae. Caudal rami cylindrical, as long as, or slightly shorter than anal somite in most species (slightly longer in *S. trinacriae*, *S. triphyda*, *S. orcina*); group of lateral setae located distally.

Accompanying fauna. Two copepodites of *Phyllognathopus* sp. and two adult males of *Bryocyclops* sp. were collected together with the type specimens of *S. galichai* sp. nov.. The genus *Bryocyclops* includes several stygobitic species and is present in the Oriental Region (Watiroyram *et al*. 2015; Watiroyram 2021) but it had never been found in the Philippines.

Biogeography

Until recently, the presence of *Stammericaris* was limited to the Palearctic region with a typical peri-Mediterranean distribution (Bruno *et al.* 2017); subsequently, it was discovered that the genus was also present in the Nearctic region with two North American species (Cottarelli & Bruno 2021). The current discovery of the new Philippine species significantly extends the genus' biogeography to the Oriental Region. If we consider the large gap in distribution between *S. galichai* sp. nov. and the other known species, which are peri-Mediterranean and Nearctic (see Cottarelli & Bruno (2021) for a distribution map), we could hypothesize a "European researcher effect" consisting of the mistaken attempt to define as “Paleartic” some biogeographically-distant taxa, that appear similar to the real Palearctic ones, perhaps due to convergence phenomena. In contrast to this, the significant distance between the new Philippine *Stammericaris* and its congeners could be greatly reduced with the likely discovery of new species in other biogeographic regions. In any case, the range distribution of other genera of Parastenocarididae are, at least, as extensive as the one reported here, such as *Parastenocaris*, *Proserpinicaris*, and *Kinnecaris*. In any case, the Philippine parastenocaridid fauna might be richer than presently known; in a research campaign held in 2005 in the hyporheic habitat of the Calawagan River in the territory of Paluan Town, Western Mindoro, we collected specimens of *P. distincta*, another parastenicarid with remarkable morphological and ecological characteristics, that appears, for now, to be endemic to Western Mindoro (Brancelj *et al*. 2013). Finally, some copepodids of an unidetifiable, possibly new Parastenocarididae, were collected in Luzon Island near Bontoc Town (Bruno and Cottarelli 1999). The updated distribution of the known Parastenicarididae in the Philippines is shown in Figure 7.

The geological evidence indicates that Sibuyan, being a volcanic island, has never been connected to any other landmass, and it remained isolated even through the Pleistocenic climatic oscillations that resulted in the formation of enlarged aggregate island complexes in other parts of the Romblon archipelago (Brown *et al.* 2011, and references therein). Hołyńska and Sługocki (2023) analyzed the insular diversity in Cyclopidae, and recorded an unexpected low relationship between the Philippine and the Sri Lankan and Greater Sundan fauna, despite their relative geographical proximity. This was due to the isolation of the Philippines from the Asian shelf, which excluded them from the wide dispersal corridor, extending from the Russian Far East to Vietnam, for both temperate-Palearctic and tropical-Oriental organisms during Late Neogene and Quaternary climatic oscillations (Hołyńska and Sługocki 2023, and references therein). How copepods in general, and parastenocaridids in particular, given their stygobiotic characteristics, managed to colonize the groundwater system of the Philippine islands remains unknown. Passive colonization could be a likely explanation, although the relative importance of the different vectors such as wind, rain, animals, and humans for long-distance dispersal of freshwater invertebrates is still poorly understood. Schabetsberger *et al.* (2009) examined the species richness in isolated freshwater ecosystems of Oceania, recording a high proportion of small, cosmopolitan invertebrate taxa, which was intepreted as the indication of arrival by wind and rain, but also remarked the importance of migrating birds as vectors and, especially of human-mediated long-

distance dispersal of zooplanktonic species and subsequent establishment of populations. Human colonization waves in the Pacific Islands started from East Asia 3,000–4,000 yr ago, and humans imported tools, crops, and animals that could have been contaminated with diapausing stages of freshwater invertebrates (Schabetsberger *et al.* 2009). The same could have occurred in Sibuyan Island. Schabetsberger *et al.* (2009) reported on the collection of three species of Parastenocarididae in Fiji; remarkably, in the same volcanic archipelago, we collected one undescribed hyporheic species of *Proserpinicaris* and a second hyporheic species of Parastenocarididae (Cottarelli, pers. com.). This record confirms the presence of continental groundwater taxa in oceanic islands, thus apparently not capable to cross large oceanic expanses. In this regard, it is useful to mention here that laboratory rearing experiments of two Italian species of Parastenocarididae, namely *Proserpinicaris amalasuntae* (Bruno & Cottarelli, 1998) and *Stammericaris pasquinii* (Cottarelli, pers. com.), showed how these extremely fragile harpacticoids, apparently adapted to a very restricted range of environmental conditions, were able to survive for a long period of time (more than three months) with limited trophic resources and with abrupt and strong changes in temperature and oxygen concentration, thus showing the resilience of these taxa, that could therefore be able to withstand even the "difficult" conditions typical of passive transport. The ability of Parastencarididae to colonize new habitats should also not be underestimated: it is true that these harpactioids frequently inhabit all kinds of groundwater, but they are also found in environments as diverse as phytotelmata, moist, soil, leaf litter, the littoral zone of the local "aguadas," and temporal wetlands (Corgoshino *et al*. 2017b; Mercado-Salas *et al*. 2021). To conclude, in our opinion, the first batch of *Stammericaris* was likely introduced on Sibuyan from some continental location, but the validation of this hypothesis will only be possible when specimens of this genus (or a very similar one) will be found elsewhere. Also, we have thoroughly explored not only Sibuyan, but also the other major islands of Romblon Province, namely Tablas and Romblon, but we did not find any other parastenocaridids, which might confirm the accidental arrival from distant locations.

Conservation

According to the Fauna & Flora International and the Foundation for the Philippine Environment (2013), the island of Sibuyan hosts, among many species of flora and fauna, 700 vascular plant species, 54 of which are endemic to the island, and 144 species of trees, 33 of which are endemic to the Philippines and 2 to Sibuyan; the animal endemisms are numerous as well, with 83 species of fauna endemic to the Philippines and 4 to Sibuyan, 18 of which are included in the International Union for Conservation of Nature's Red List. The island hosts 130 species of birds, 9 terrestrial mammals, 4 species of bats, and 16 species of reptiles. The island is a biodiversity hotspot: for example, in 2021, researchers from the University of the Philippines discovered 14 new species of amphibians and reptiles and claim that there is still much to discover. This assertion is even more valid for those components of a "hidden" and unremarkable, yet equally important, fauna, such as the interstitial fauna. This is particularly relevant when considering the "Racovitzan impediment" (Ficetola *et al.* 2019), and that “below the surface, where there are areas of our planet less explored than the surface of the moon, and these areas harbor a neglected biodiversity. Recognizing the Racovitzan impediment is essential to fill the (huge) knowledge gaps and to improve the way we exploit and manage ecosystems that are out of our sight but must remain in our minds” (Ficetola *et al.* 2019: 216).

Taxonomic key for the identification of males of the know species of *Stammericaris*

* species description and illustrations not consistent with the current morphological details requirements. Modified from Bruno *et al*. (2023)

1. P4 endopod a curved plate with a pointed inner tip carrying at its outer border 1 or 2 outgrowths, the distal one being a feathered or plain seta; caudal rami sub-cylindrical, usually longer than last abdominal somite 2
- P4 endopod approximately cylindrical, distally enlarged in two/ three protrusions; caudal rami sub-cylindrical, slightly shorter than last abdominal somite 3
2. P3 exp-1 with longitudinal rows of spinules on outer margin 5
- P3 exp-1 without longitudinal rows of spinules on outer margin 17
3. P4 endopod approximately cylindrical, distally enlarged in two protrusions . . . . . .*S. galichiai* sp. nov.
- P4 endopod approximately cylindrical, distally enlarged in three protrusions 4
4 P1 basis with hook on inner margin; P3 exp-1 with longitudinal row of two spinules proximally on outer margin; P4 basis with two spiniform processes of different size on inner margin, the one closest to the endopod is the largest; P4 endopod represented by a small cylindrical segment, as long as ½ of the corresponding exp-1, with three small apical protrusions . . . . *S. destillans*

- P1 basis with hook and spinule on inner margin; P3 exp-1 with longitudinal row of three spinules proximally on outer margin; P4 basis with two spiniform processes of different size on inner margin, the one closest to the endopod is the smallest; P4 endopod represented by a small cylindrical segment, apically bent at 90°, slightly longer than ½ of the corresponding exp-1, with three small apical protrusions . . . . . *S. similior*

5 Caudal rami with pointed dorsal distal apophysis 6

- Caudal rami without pointed dorsal distal apophysis 9

6 Caudal rami sub-cylindrical, shorter than last abdominal somite. P1 basis with one spinule on inner margin . . . . . *S. lorenzae*

- Caudal rami sub-cylindrical, shorter than last abdominal somite. P1 basis with one spinule and one hook on inner margin . . 7

7 P3 exp-1 with proximal row of two stronger, and distal row of five thinner, longitudinal spinules on outer margin; enp P4 slightly shorter than the first two segments of the corresponding exp, the inwardly curved inner tip with lateral pinnate expansion . . . . . *S. pasquinii*

- P3 exp-1 with proximal row of two and distal row of four longitudinal spinules on outer margin; enp P4 as long as or slightly longer than the corresponding exp-1, the inwardly-curved inner tip apically bilobate 8

8 P1 basis with spinule and longer hook on inner margin; P3 exp-1 with proximal row of two spinules, distal row of four longitudinal spinules, all of them of similar size, on outer margin; P4 basis with three processes with blunt tip on inner margin, the medial-most much larger than the other ones . . . . . *S. diversitatis*

- P1 basis with spinule and hook of similar length on inner margin; P3 exp-1 with proximal row of two spinules, and distal row of two larger and two smaller spinules (almost divided in two groups), on outer margin; P4 basis with four spinules on inner margin, the distalmost from the endopod is transversally inserted, the remaining ones decrease in size from inner to outer . . . . . *S. vincentimariae*

9 Caudal rami cylindrical and narrow, not tapering, longer than the last abdominal somite; enp P4 slightly longer than the corresponding exp-1, with only inner tip and apical pinnate outgrowth (proximal spiniform outgrowth missing) 10

- Caudal rami sub-cylindrical and narrow, tapering distally, shorter than the last abdominal somite; enp P4 of different shape 11

10 P5 with spine on inner corner . . . . . *S. nertensis*

- P5 with tip on inner corner 16

11 P4 basis, inner margin with three spinules increasing in length from outer to inner one. 12

- P4 basis with only one spinule on the inner margin 14

12 Exp-2 apophysis much longer than thumb . . . . . **S. phreatica*

- Exp-2 apophysis slightly longer than thumb 13

13 P3 exp-1, outer margin with proximal longitudinal row of two spinules and distal longitudinal row of six spinules, all of same length; enp P4 longer than the corresponding exp- . . . . . **S. stammeri stammeri*

- P3 exp-1, outer margin with proximal and distal longitudinal row of two spinules all of same length; enp P4 as long as the corresponding exp-1 . . . . . *S. amyclaea*

14 P3 exp-1, outer margin with proximal row of three spinules and distal row of four spinules; P4 basis with one thin and straight spinule on the inner margin . . . . . **S. acherusia*

- P3 exp-1, outer margin with two longitudinal rows of spinules, both inserted in the proximal half of the outer margin; P4 basis with one large, inwardly-curved spinule on the inner margin 15

15 Urosomites not pitted. P3 exp-1, outer margin with proximal and distal longitudinal row of two spinules; enp P4 represented by plate curved inwards in an almost L-shape, with strongly bifid tip; P4 exp-1 characteristically enlarged and strongly bent inwards . . . . . *S. remotaepatriae*

- Urosomites pitted (character present only in this species); P3 exp-1, outer margin with proximal row of three or four spinules and distal row of four spinules; P4 endopod of different shape; P4 slightly enlarged at base and straight . . . . . *S. palmerae*

16. Caudal rami much longer than anal somite; thumb on P3 narrow and sinuous, ending in three tips . . . . . *S. triphyda*

-. Caudal rami much longer than anal somite; thumb on P3 short and straight, ending in one tip . . . . . *S. orcina*

17. P4 basis ornamented with one short seta and two spinules of same length and slightly curved outwards aligned along inner margin. . . . . *S. trinacriae*

- P4 basis ornamented with two spinules of different length and slightly curved outwards aligned along inner margin . . . . . *S. balcanica*

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