

A new species of sponge inhabiting barnacle *Bryozobia* (Archaeobalanidae, Bryozobiinae) in the West Pacific

Meng-Chen Yu^{1,2}, Gregory A. Kolbasov³, Benny K.K. Chan^{1,2}

1 Biodiversity Research Center, Academia Sinica, Taipei 11529, Taiwan **2** Doctoral Degree Program in Marine Biotechnology, National Sun Yat-sen University and Academia Sinica, Kaohsiung 80424, Taiwan **3** White Sea Biological Station, Biological Faculty, Moscow State University, 119991, Moscow, Russia

Corresponding author: Benny K.K. Chan (chankk@gate.sinica.edu.tw)

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Abstract

This paper describes a new species, *Bryozobia rossi* **sp. n.**, collected by scuba diving in both Taiwan and Japan. *B. rossi* **sp. n.**, a member of the subfamily Bryozobiinae (Ross and Newman 1996), has atria and open end portals and a single irregular basal whorl of portals at the same level as basal hemiportals; this morphology varies from all previously described bryozobiines. According to our review of relevant literature, this is the first reported *Bryozobia* in the Pacific, and this study is the first to describe the morphology of oral cone, cirri, and penis for the genus *Bryozobia*.

Keywords

Sponge inhabiting barnacle, Archaeobalanidae, Bryozobiinae

Introduction

Barnacles of the subfamily Bryozobiinae are considered obligate symbionts of sponges attaching to various calcareous substrates, such as mollusk shells, bryozoans, corals. Morphologically, bryozobiines are unique in remaining attached to sponges substrates and possessing calcareous portals and atria (openings and tubular arched passages) in

their base and walls (Table 1 and Figure 1; Van Syoc and Newman 2010). The number of plates in the shell base, determined by either the partial or complete fusion of plate sutures in the shell base or the elimination of short carinolaterals² (CL²) that do not reach the base, varies from six to four. These barnacles can modify the external shell structure with atria and portals, thus creating additional chambers that allow the growth of encrusting or burrowing sponges (Gregg 1948; Pilsbry 1916; Ross and Newman 1996; Van Syoc and Newman 2010).

The subfamily Bryozobiinae and the type genus *Bryozobia* were first described by Ross and Newman (1996) using samples collected from Madagascar and Mauritius; they reported *Bryozobia* as an obligate symbiont of bryozoans. The unique characteristics of the subfamily Bryozobiinae are the unusual perforate calcareous tubes and passages (atria) in the shell wall and base (Table 1), in which the bryozoan tissue extends through the cavity. The genus *Bryozobia* is characterized by atria that open with portals arranged in two or three whorls resulting in a four-plated wall by eliminating CL² at the shell base. Subsequently, Van Syoc and Newman (2010) re-established the subfamily Bryozobiinae to include four additional genera, *Eoatria*, *Microporatria*, *Multatria*, and *Poratria*, which are obligated symbionts of sponges instead of bryozoans and additionally attach to various calcareous substrates including mollusks and corals. Van Syoc et al. (2015) revealed that bryozobiine species are commonly obligated on encrusting sponges.

Currently, Bryozobiinae consists of five genera and ten species. The shell structure of all species possesses calcareous tubular passages or atria of the base remaining attached to the substratum. The number of shell plates and their fusion/elimination at the base and the structure of atria and portals (Table 1, Figure 1) are diagnostic morphological characters of bryozobiines. Genus *Eoatria* possesses six interparietal hemiportals, six separate shell plates of similar length, and a nonperforate base. *Multatria* has six separate shell plates of similar length with a whorl of six interparietal basal portals between them and a perforate base. All six shell plates of *Poratria* are fused at the base, with a primary whorl of six interparietal portals and numerous basal portals and hemiportals, and a perforated base. *Microporatria* has CL² fused with the carina at the base of sutures below the portals; therefore, the shell has four plates in the base and a perforated base. Genus *Bryozobia* is characterized by smaller CL² eliminated with interparietal portal of the first elevated whorl; therefore, the shell has four plates in the base, and the portals form several whorls and remain attached to the basal atria through arched fillets (open portals). However, other bryozobiine portals dissociate from the basal atria during growth and elevation.

Only a single species *B. synaptos* (Ross and Newman 1996) from Madagascar and Mauritius was described for the genus *Bryozobia* (Ross and Newman 1996, Van Syoc et al. 2015). Recently, a few undetermined juveniles of *Bryozobia* sp. were found on a gastropod shell in Sri Lanka without description of opercula and a soft body (Van Syoc and Newman 2010). The soft tissue of *Bryozobia* was unknown as only available material was sub-fossil; therefore, the descriptions were incomplete.

In the present study, we collected several living bryozobiines from Green Island and Orchid Island (Taiwan) and Kochi (Japan) with only an irregular whorl of shell

Table 1. Glossary of nomenclature relevant to Bryozobinae. Modified from Van Syoc and Newman 2010.

Terms	Explanation	Types	Explanations
Atria	Arched chambers or passages of calcareous basis, radiating from center and opening to exterior with hemiportals and portals.	Atrial Footing	Footing area of basis
		Non-perforate Atria	Solid atria without pores
		Perforate Atria	Atria perforated with small pores
		Slit Atria	Atria perforated with elongated slits
Calcipeds	Calcareous projections of shell exterior of different shape.	Finger-like Parietal Calcipeds	Finger-shaped projections of parietal wall
		Finger-like Basal Calcipeds	Finger-shaped projections of basis
		Blade-like Parietal Calcipeds	Blade-shaped projections of parietal wall
		Blade-like Basal Calcipeds	Blade-shaped projections of basis
		Portal Fillets	Sliced passage opening
Portal	Openings on shell connected or not connected or not with atria, may be arranged in several whorls and elevated with growth of shell or not.	Interparietal (Sutural) Hemiportal	Non-encircled passage opening at basal part of wall plates suture
		Interparietal (Sutural) Portal	Encircled passage opening between wall plates at sutural area.
		Parietal Hemiportal	Non-encircled passage opening at base of parietes
		Parietal Portal	Encircled passage opening removed from base of parietes
		Open portals	Portals connected with basal atria via arched fillets
		Closed portals	Portals lost connection with basal atria
Footing	Massive processes of basis or basal part of parietes	Parietal Footing	Massive basal processes of parietes
		Atrial Footing	Massive processes of basis between atria

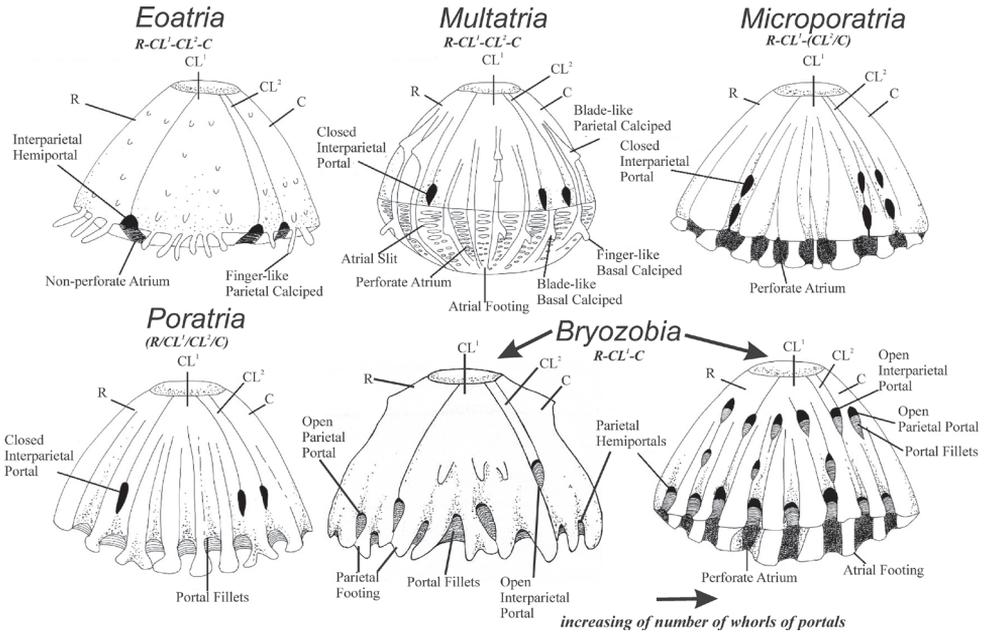


Figure 1. Diagrammatic representations of 5 genera of Bryozobiinae, with indication of plate formula for basal portion of shell in adults (see explanations in text). Modified from Van Syoc and Newman 2010.

portals and remained attached to the basal atria through arched fillets and smaller CL^2 eliminated by interparietal portal. These characters suggest that this is a new species of genus *Bryozobia* and the presence of soft bodies completes the description of this genus.

Material and methods

Bryozobiines were collected from thin encrusting sponges on rocks (*Agelas nakamura*i Hoshino 1985, *Theonella* aff. *conica* Kieschnick 1896, and *Theonella mirabilis* [de Laubenfels 1954]) in Taiwan (Green Island and Orchid Island) and Japan (Kochi) by scuba diving to a depth of 3–24 m (Figure 2). Barnacles were separated from the host sponges using forceps and 95% EtOH was injected into mantle cavity for better fixation of the soft tissue for molecular analysis, in prior to the whole specimen was immersed in Ethanol. Both the barnacle and sponges were subsequently preserved in 95% EtOH. Morphological characters of barnacle shell parts (basis, plates, scutum, and tergum) and somatic bodies (six pairs of cirri, the penis, and oral cone) were examined. The remnants of the sponge on the surface of shell, scutum, and tergum were removed using forceps and immersed in 2% bleach for about two hours to completely digest the organic tissue and rinsed subsequently in purified water for five times and air-dried. The shell, scutum, and tergum were observed under stereomicroscope Leica MZ 6 (Leica, Germany) and digital single-lens reflex cameras (Canon EOS 5D Mark

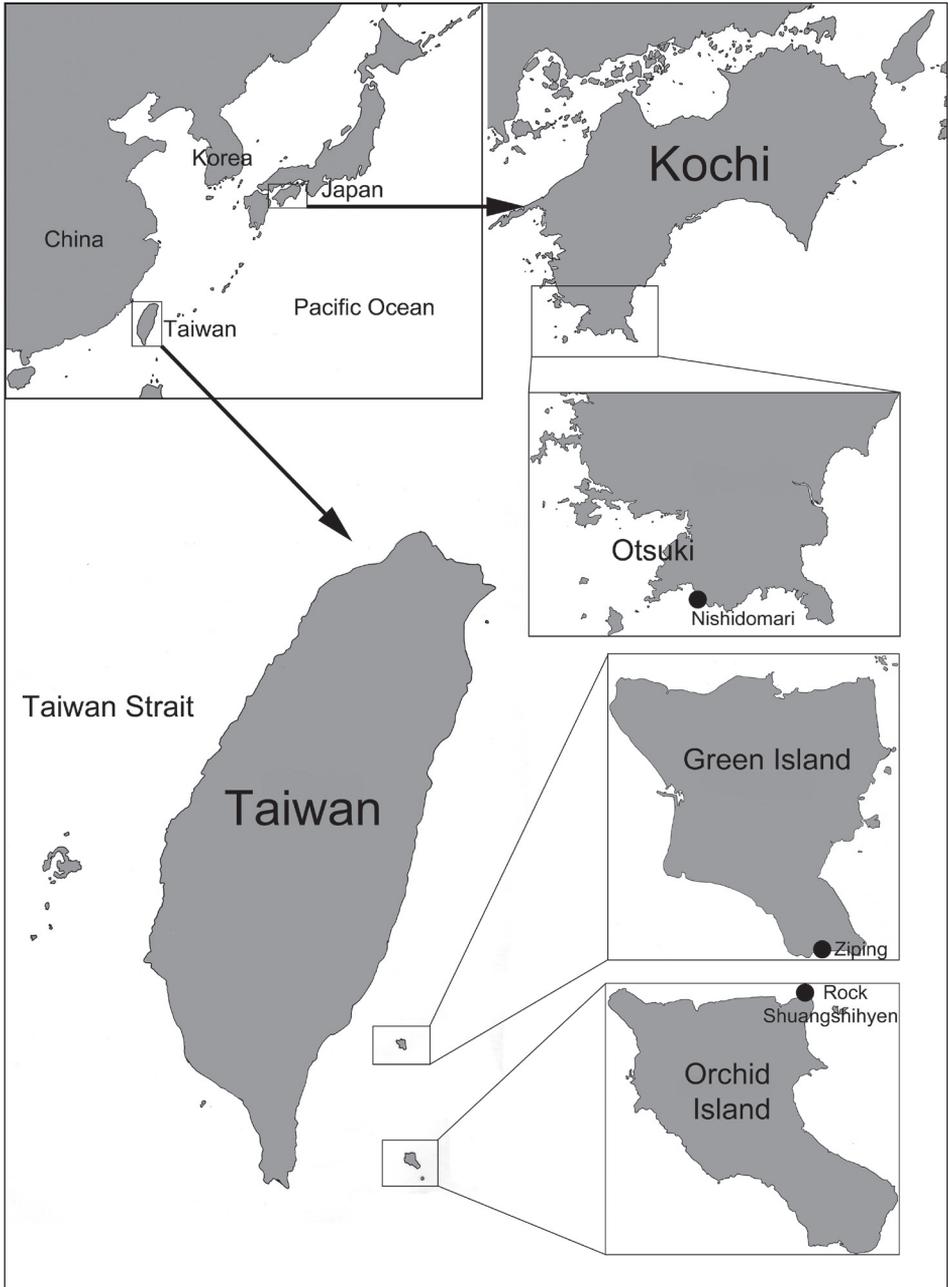


Figure 2. Collection sites of sponge-inhabiting bryozoibine barnacles in Taiwan and Japan.

III, Canon Camera Co. Ltd, Japan) installed with a 65 mm f/2.8 1–5× macro lens. Then shell, scutum and tergum were air-dried, gold-coated and observed under SEM, following methods in Chan et al. (2013).

All six pairs of cirri, penis, and oral cone were dissected from the somatic bodies, and the organic debris were removed using forceps and an ultrasonic cleaner (for 1–3 seconds) and examined through light microscopy (Zeiss Scope A1, Zeiss, Germany) using high-definition lenses (Zeiss Plan APO Chromat 40X/0.95) to clearly observe the setae types on the cirri and the mouthparts.

The glossary of nomenclature relevant to Bryozobiinae and setae morphology were described according to Van Syoc and Newman (2010) and Chan et al. (2008), respectively. The holotype and the paratypes were preserved at the Biodiversity Research Museum of Academia Sinica, Taipei, Taiwan (ASIZCR) and the Zoological Museum of Moscow State University (Mg) whereas the additional specimens were preserved at the barnacle collection of the Coastal Ecology Lab (CEL), Academia Sinica, Taiwan. The specimens of sponge were preserved at the National Penghu University of Science and Technology Porifera Collection (NPUST; POR).

Systematics

Suborder Balanomorpha Pilsbry, 1916

Superfamily Balanoidea Leach, 1817

Family Archaeobalanidae Newman & Ross, 1976

Subfamily Bryozobiinae Ross & Newman, 1996

Genus *Bryozobia* Ross & Newman, 1996

***Bryozobia rossi* Yu, Kolbasov & Chan, sp. n.**

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Figures 3–12

Type species. *Bryozobia synaptos* Ross & Newman, 1996

Materials examined. Holotype: Taiwan, Taitung, Green Island (Lyudao), Ziping, 22°37.99'N, 121°29.99'E, depth 24 m, November 15, 2011, coll. J.H.Y. Yu, ASIZCR-000338, on host sponge *Agelas nakamurai* (Hoshino, 1985), NPUST. POR.0357.

Paratypes: ASIZCR-000339, ASIZCR-000340 and Mg. 1222

Other materials. Taiwan, Taitung, Orchid Island (Lanyu Island), Rock Shuang-shihyen, 22°05.14'N, 121°34.10'E, depth 24 m, June 11, 2011, coll. J.H.Y. Yu, CEL-SOI33-1, on host sponge *Theonella* aff. *conica* (Kieschnick, 1896), NPUST.POR.0354.

Other materials: Japan, Nishidomari, Kochi, 32°46.48'N, 132°43.89'E, depth 5 m, July 22, 2011, coll. J.H.Y. Yu, CEL-SJP5-1, on host sponge *Theonella mirabilis* (de Laubenfels, 1954), NPUST.POR.0350.

Diagnosis. Shell with unfused sutures, external surface with a few calcipeds and indistinct longitudinal ribs, vestige of CL² with elevated interparietal portal on each side, an irregular whorl of open portals, and edges of parietal footings that may merge to completed portals. Calcareous base, base flat or saucer-shaped with numerous radial

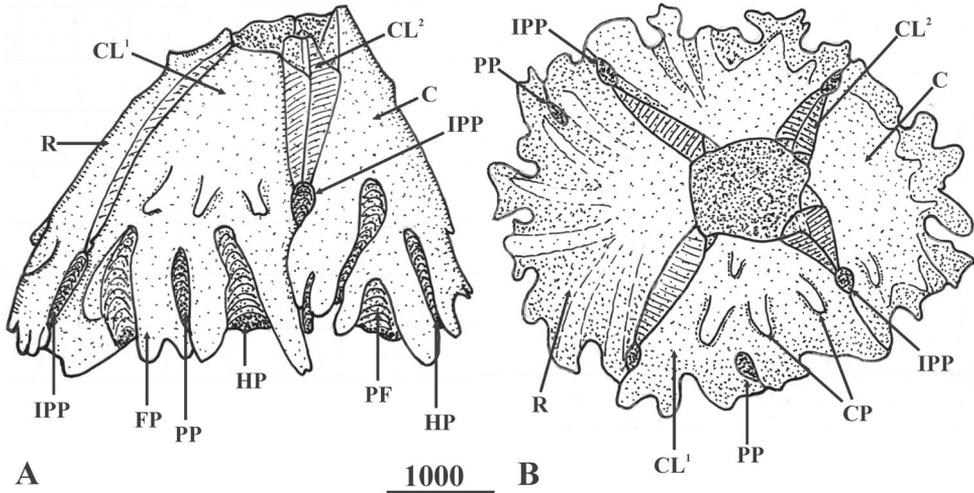


Figure 3. *Bryozobia rossi* sp. n., shell (opercular plates removed), general morphology. **A** general view, lateral side **B** top view. Abbreviations: C, carina; CL¹, carinolateral¹; CL², carinolateral²; CP, calcipeds; FP, parietal footing; HP, hemiportals; IPP, interparietal portal; PF, portal fillets; PP, parietal portal; R, rostrum. Scale bar in μm .

atria (app. 24) permeated by dense, irregularly shaped pores. Scutum with a prominent articular ridge, articular furrow low, concave pits of adductor and depressor muscles. Broad tergum with a beak-shaped apex, high and short articular ridge, and sloping spur.

Description. White shell, tinged pinkish toward apex, with a maximal height range of 3–3.7 mm, basal diameter range of 3.3–4.6 mm, orifice range of 1.0–1.3 mm, and six plates (R-CL¹-CL²-C) with unfused sutures, roughened and plicated exterior parietes with fine growth lines and few finger- and blade-like calcareous calcipeds on the surface (Figures 3, 4A–D, 5A–L, 6C, D, F, I–K, 7); smooth and digitate longitudinal ribs in the parietes base extending to the parietal footings that may merge and form completed portals (Figures 3, 4A–F, 6A, B, D, F, G, 7C–E); a whorl of rare interparietal and parietal portals in the shell base, two interparietal portals below rudimentary CL² slightly elevated; plates eliminated at half the total length of the shell (Figures 3, 4C, D, 5G–J, 6B, D, G, H, I, K, 7B, D, G, H). All portals were open and attached to the basal atria through arched sliced fillets (Figures 3, 4C, D, F, 6A, B, D, G, H, I, K, 7B). All plates, except CL², were wide and triangular, with irregular basal margins and internal longitudinal ribs rostrum being the biggest (Figures 3, 4A–D, 5A–L, 6A, I, K, 7A–E, G, H). The smallest CL² were irregularly rectangular two–three times shorter than other plates (Figures 3, 4C, D, 5G–J, 6I, J, K, 7A–E, G, H). Radii transparietal, summits slightly oblique, triangular, solid, horizontally striated (Figures 3, 4B–D, 5A–J, 7A, B). Alae developed in the summits almost horizontally. Sheath developed approximately one-fifth in the carina and one-third to one-half of the total height in other plates (Figures 5A–L, 7E–H). Calcareous base, flat or saucer-shaped with less than twenty atria, atria width approximately 0.1 mm, permeated by irregularly shaped small and dense pores were solid, radial, and indistinct

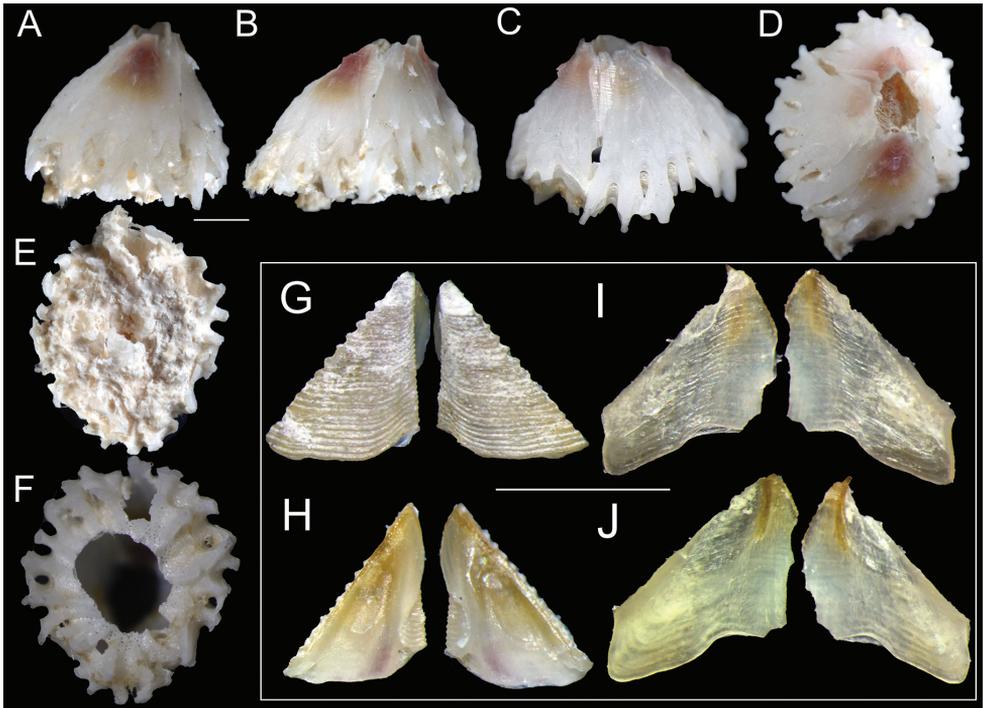


Figure 4. *Bryozobia rossi* sp. n. CEL-SJP5-1. Complete shell, scuta and terga. **A** rostral view **B** lateral view **C** carinal view **D** top view **E**, **F** basal view, sponge remnants and central part of basis removed in 'F' showing structure of basis **G** external view of scuta **H** internal view of scuta **I** external view of terga **J** internal view of terga. Scale bars: 1 mm.

calcipeds with separated atria, radiating from the center and extending out to basal margin and attached to the longitudinal ribs of parietes (Figures 4E, F, 5M, N, 6A, E, 7C, E).

Externally, scutum (Figure 4G, H) with horizontal growth ridges, without longitudinal striation; teeth present in the upper half of occludent margin; slightly bisinuous basal margin, strongly prominent articular ridge, approximately two-thirds the height of articular margin, articular furrow low, central adductor ridge, short, feeble, faint, and long depression for adductor muscle, and deep depressor and rostral muscles pits, lie directly at the basal margin. Tergum (Figure 4I, J) thin and semitransparent, nearly flat, with a beak-shaped apex; short and prominent articular ridge, broad articular furrow, without crests of depressor muscles; sloping spur not distinctly separated from the basiscutal angle of scutal margin, width approximately half of the basal margin, acute basiscutal angle; basal margin concave in the middle, wide and shallow spur furrow.

Labrum bilobed, separated by deep V-shaped notch (Figure 8A, B), with two or three small teeth on each side of the crest (Figure 8B).

Mandibular palp ovate with concave outer margin (Figure 8C, D), dense serrulate setae along the outer margin and tip (Figure 8E).

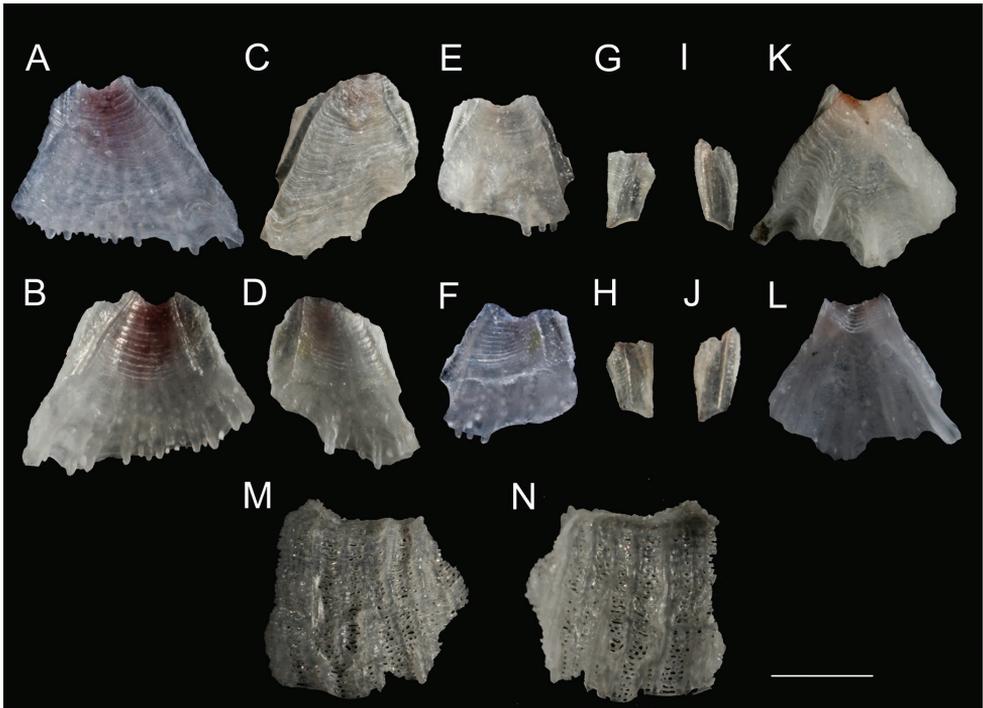


Figure 5. *Bryozobia rossi* sp. n. CEL-SOI33-1. Disassembled shell showing separated plates and part of basis after bleach treatment. **A, B** external and internal view of rostrum **C, E** external view of carinolaterals¹ **D, F** internal view of carinolaterals¹ **G, I** external view of carinolaterals² **H, J** internal view of carinolaterals² **K, L** external and internal view of carina **M, N** external and internal view of part of basis. Scale bar: 1 mm.

Mandible with five teeth (Figure 8F), second and third teeth bifid, upper margin bearing simple setae (Figure 8G) and the inferior angle ending in blunt angle with stout simple setae (Figure 8H).

Maxillule with a straight cutting edge and seven large cuspidate setae, and the upper and lower pairs largest (Figure 9A); upper margin with three pairs of simple setae and the lower margin with numerous simple setae (Figure 9B–D).

Maxilla bilobed, with a triangular distal portion with a truncated outer edge (Figure 9E), base without setae, outer edge of the distal lobe with simple setae (Figure 9F, H), the inner edges of lobes straight, and thick serrulate setae along the inner edges of lobes (Figure 9G, H).

Cirrus I with unequal rami, anterior ramus with eleven segments, twice as long as the posterior ramus (five segments; Figure 10A), a protopod without setae at the anterior margin, with a tuft of plumose setae at the posterior margin (Figure 10A, B), and both the rami with serrulate setae on the intermediate segments, and bidentate and serrulate setae on the distal ends of anterior and posterior rami, respectively (Figure 10C, D).

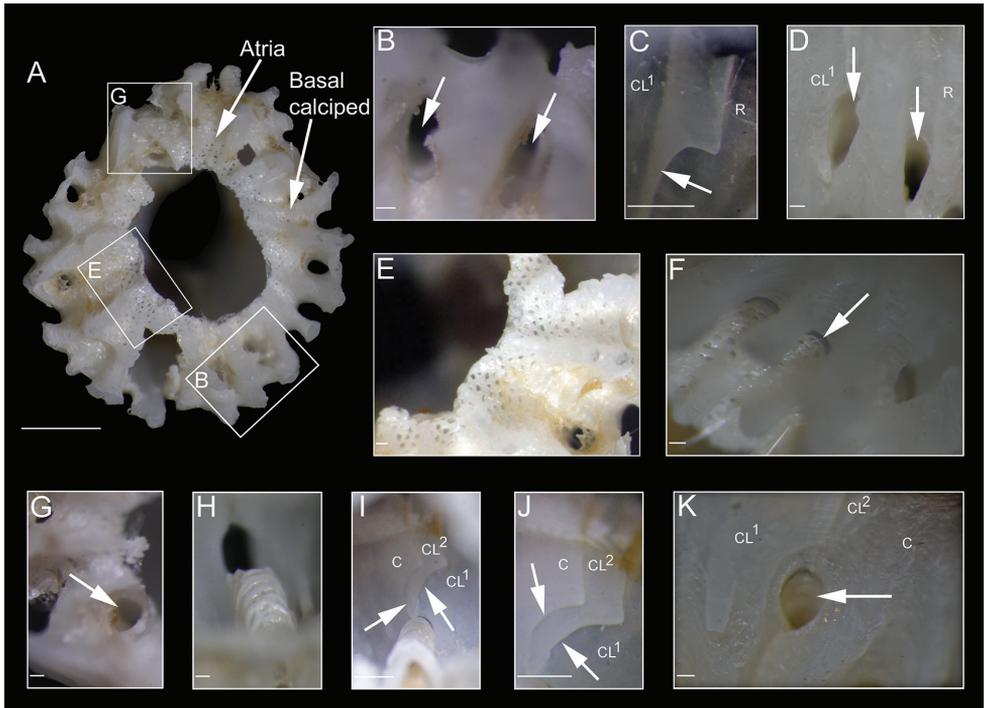


Figure 6. *Bryozobia rossi* sp. n. CEL-SJP5-1. **A** basal view of shell showing basis (central part destroyed) with atria and basal calcipeds **B** part of margin of basis with two atria and their portals (indicated by arrows) **C** suture (indicated by arrow) between CL¹ and R, interior view **D** exterior view of part of shell with interparietal and parietal portals (indicated by arrows) in basal parts of CL¹ and R **E** enlarged part of basis with porous atria **F** enlarged fillets of hemiportals (indicated by arrow) showing porous and sliced structure between basis and parietes, external view **G** basal view of interparietal portal opening **H** enlarged broken atrial fillet (tube) showing sliced structure (inner side of shell) **I** sutures between CL¹, CL² and C (indicated by arrows) and fillet of interparietal portal eliminated CL², interior view **J** enlarged sutures (indicated by arrows) between CL¹, CL² and C **K** exterior view of interparietal portal eliminates CL². Abbreviations: C, carina; CL¹, carinilateral¹; CL², carinilateral²; R, rostrum. Scales: 1 mm (**A**); 0.1 mm (**B–K**).

Cirrus II with unequal rami, posterior ramus (six segments) shorter than the anterior (eight segments; Figure 10E), a protopod with plumose setae at the anterior margin and a tuft of plumose setae at the posterior margin (Figure 10F), the intermediate segments of both the rami with serrulate setae, and the distal ends of both the rami with bidentate setae (Figure 10G, H).

Cirrus III with subequal rami, a ten-segmented posterior ramus, nine-segmented anterior ramus (Figure 11A), a protopod with serrulate setae at the anterior margin and plumose setae at the posterior margin, the intermediate segments of both the rami with serrulate setae, distal ends of both the rami with bidentate and serrulate setae (Figure 11A, B).

Cirrus IV with unequal rami, a twelve-segmented anterior ramus, a posterior ramus broken with eleven segments on its remaining part (Figure 11C), a protopod with

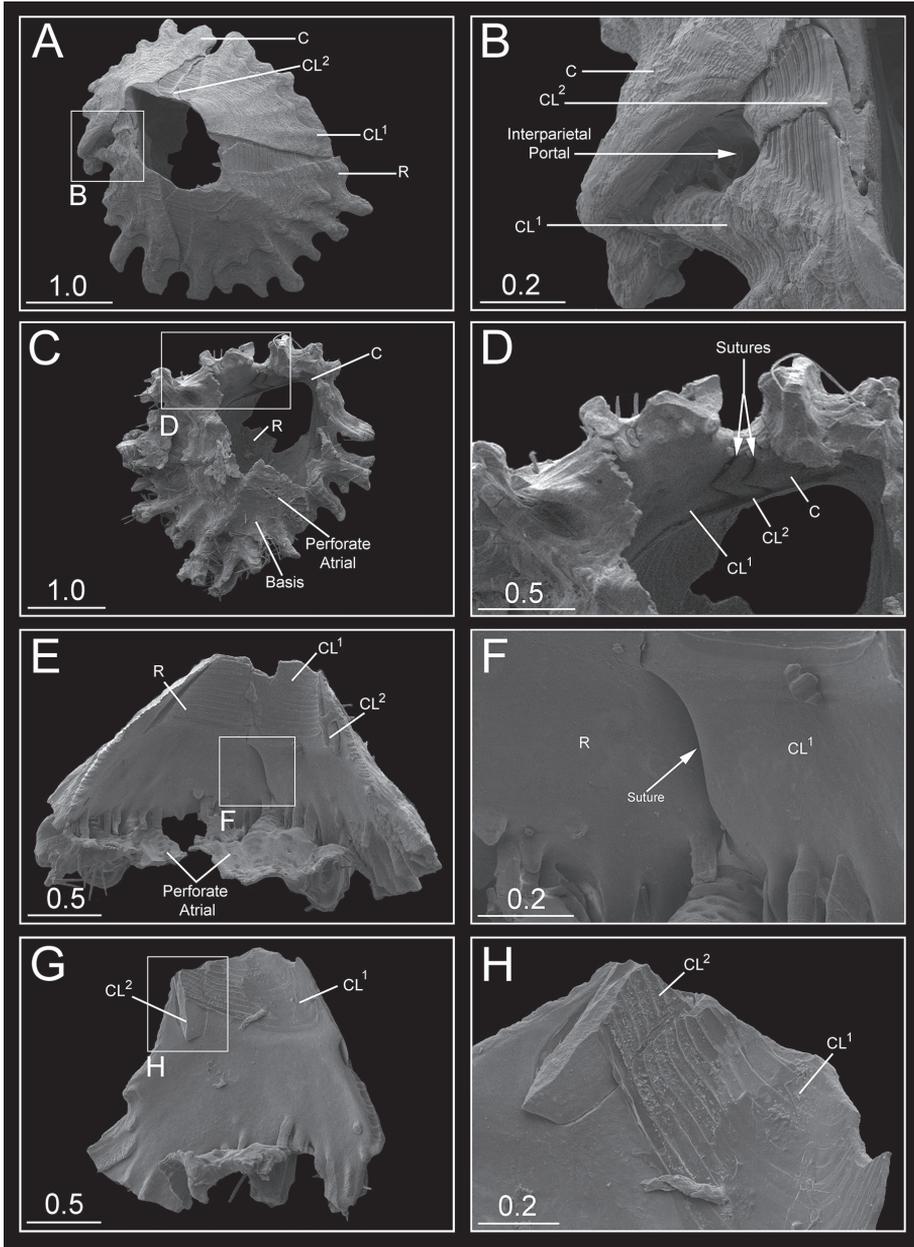


Figure 7. *Bryozobia rossi* sp. n. **A** ASIZCR-000338, Top view of shell showing unfused wall plates **B** ASIZCR-000338, enlarged external area of shell showing CL² eliminated by interparietal portal **C** ASIZCR-000339, basal view of shell with partially destroyed basis **D** ASIZCR-000339, internal view of wall plates showing unfused sutures between CL¹, CL² and C **E** ASIZCR-000340, internal view of wall plates with basal longitudinal ribs and basis fragment with perforated atria **F** ASIZCR-000340, enlarged part of inner wall surface with unfused suture between R and CL¹ **G** ASIZCR-000340, interior view of fragment of CL¹ and CL² **H** ASIZCR-000340, enlarged view of inner suture between CL¹ and CL². Abbreviations: C – carina, CL¹ – carinilateral¹, CL² – carinilateral², R – rostrum. Scale bars in mm.

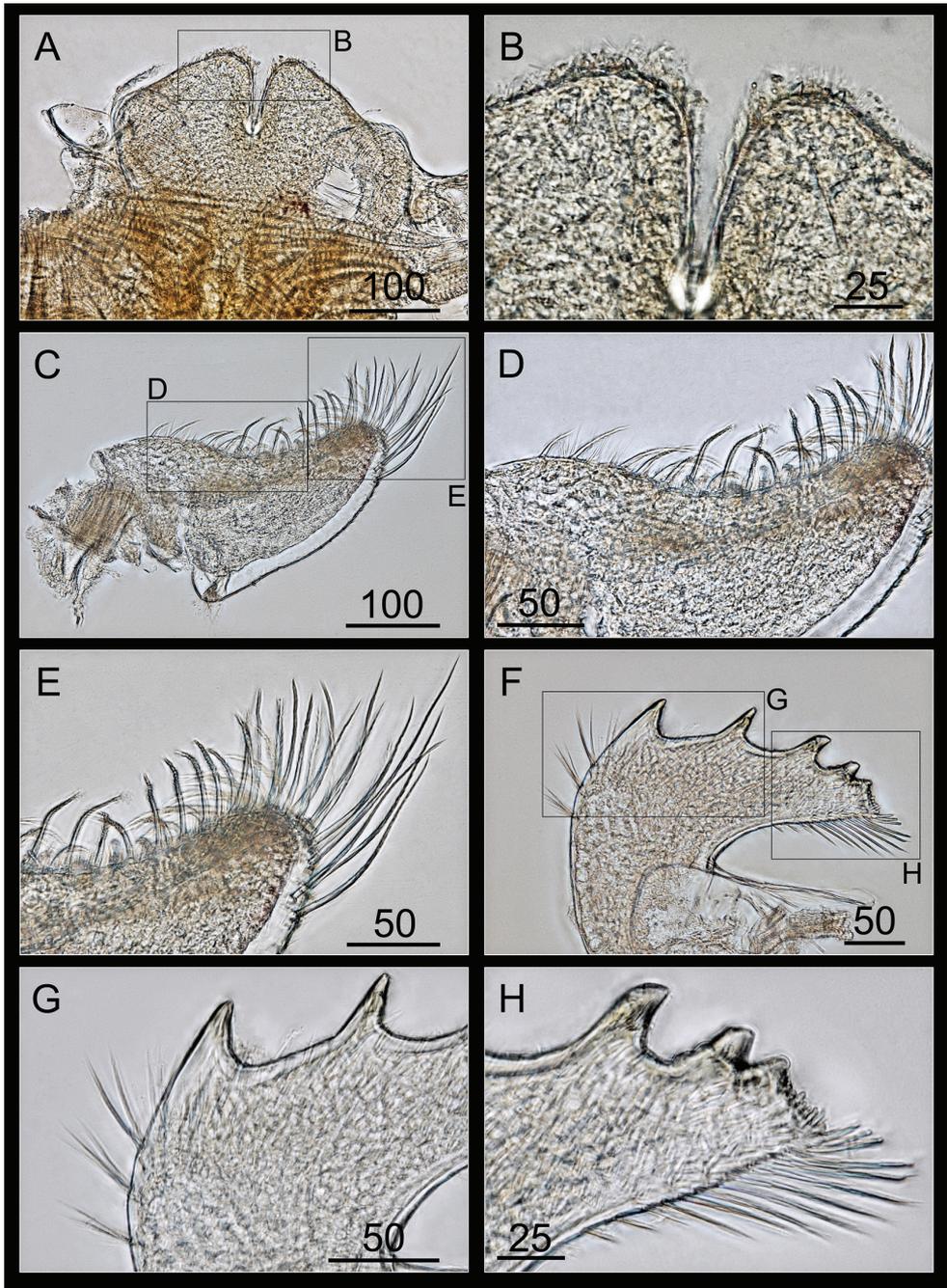


Figure 8. *Bryozobia rossi* sp. n. ASIZCR-000338. Labrum (**A**, **B**), mandibular palp (**C**–**E**) and Mandible (**F**–**G**). **A** labrum **B** teeth on crests **C** mandibular palp **D** outer margin **E** serrulate setae on distal part **F** mandible **G** upper part with bifid second teeth **H** inferior angle. Scale bars in μm .

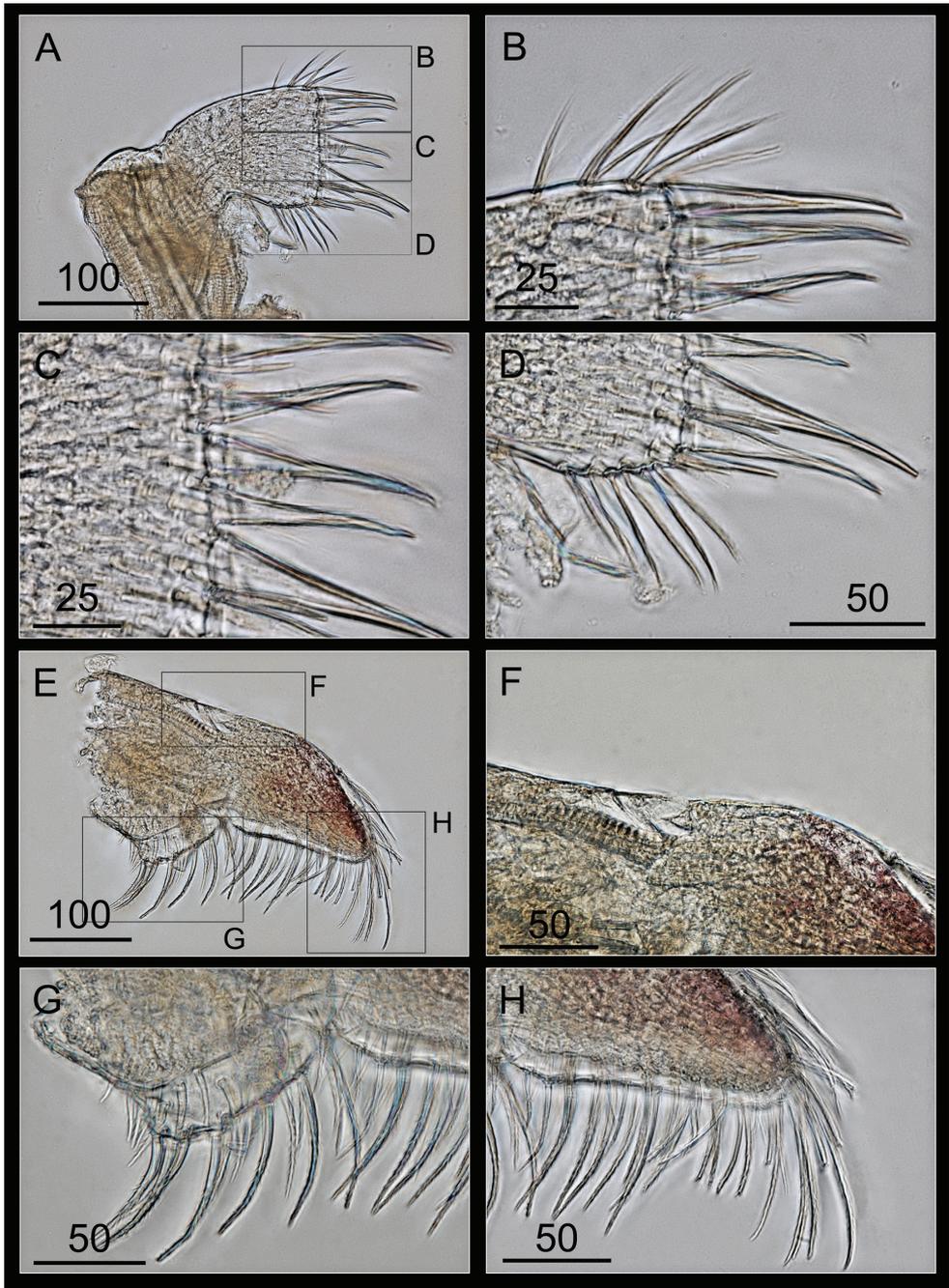


Figure 9. *Bryozobia rossi* sp. n. ASIZCR-000338. Maxillule (A–D) and maxilla (E–H). **A** maxillule **B** upper part of cutting edge **C** straight cutting edge **D** lower part of cutting edge **E** maxilla **F** outer edge of distal lobe **G** inner edge of distal lobe **H** terminal part of distal lobe. Scale bars in μm.

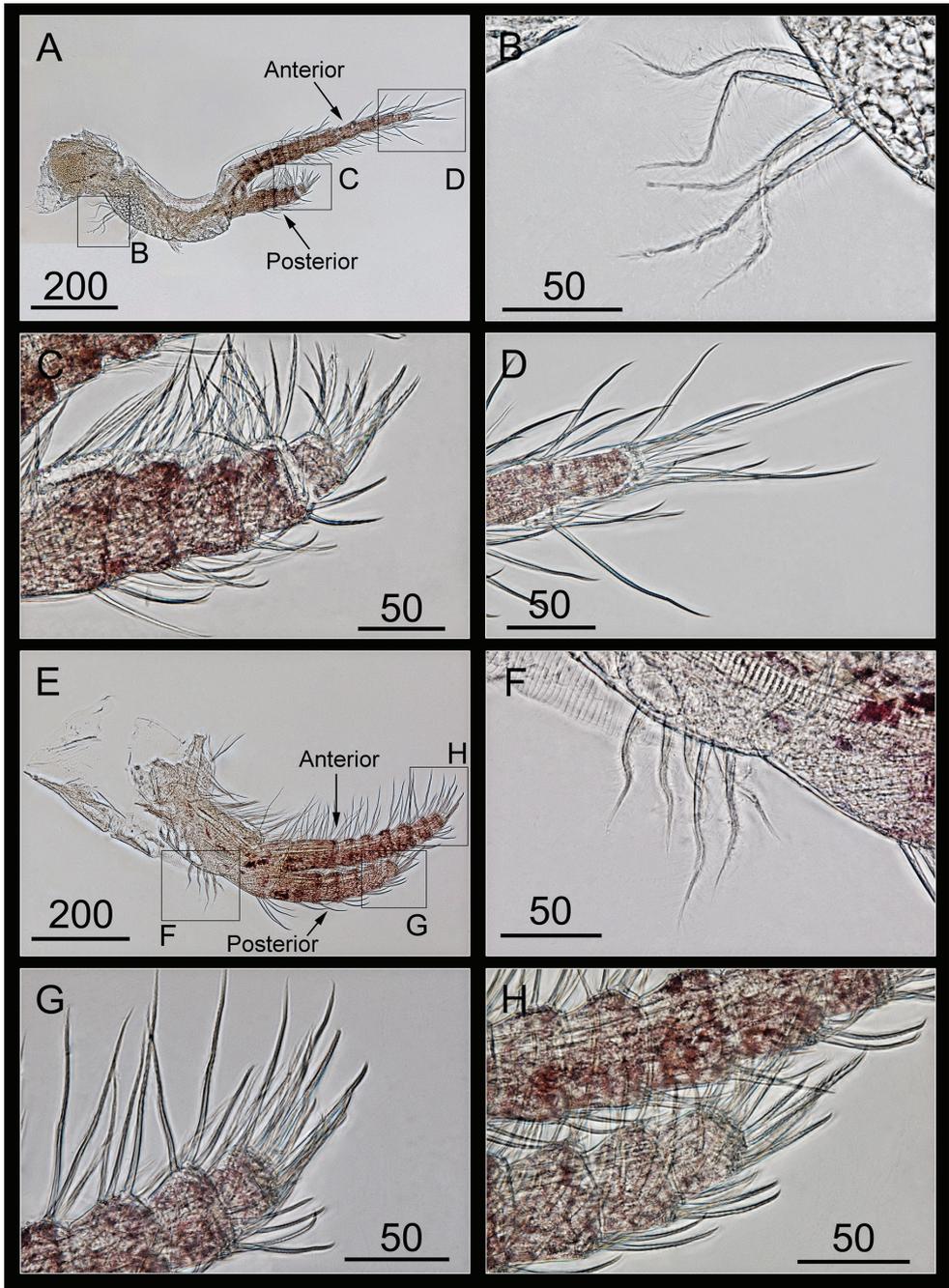


Figure 10. *Bryozobia rossi* sp. n. ASIZCR-000338. Cirri I (left, view from the posterior side) (A–D), II (left, view from the anterior side) (E–H). **A** cirrus I **B** tuft of setae on at base of protopod **C, D** distal segments of posterior and anterior rami **E** cirrus II **F** setae on posterior margin of protopod **G, H** distal segments of anterior and posterior rami. Scale bars in μm .

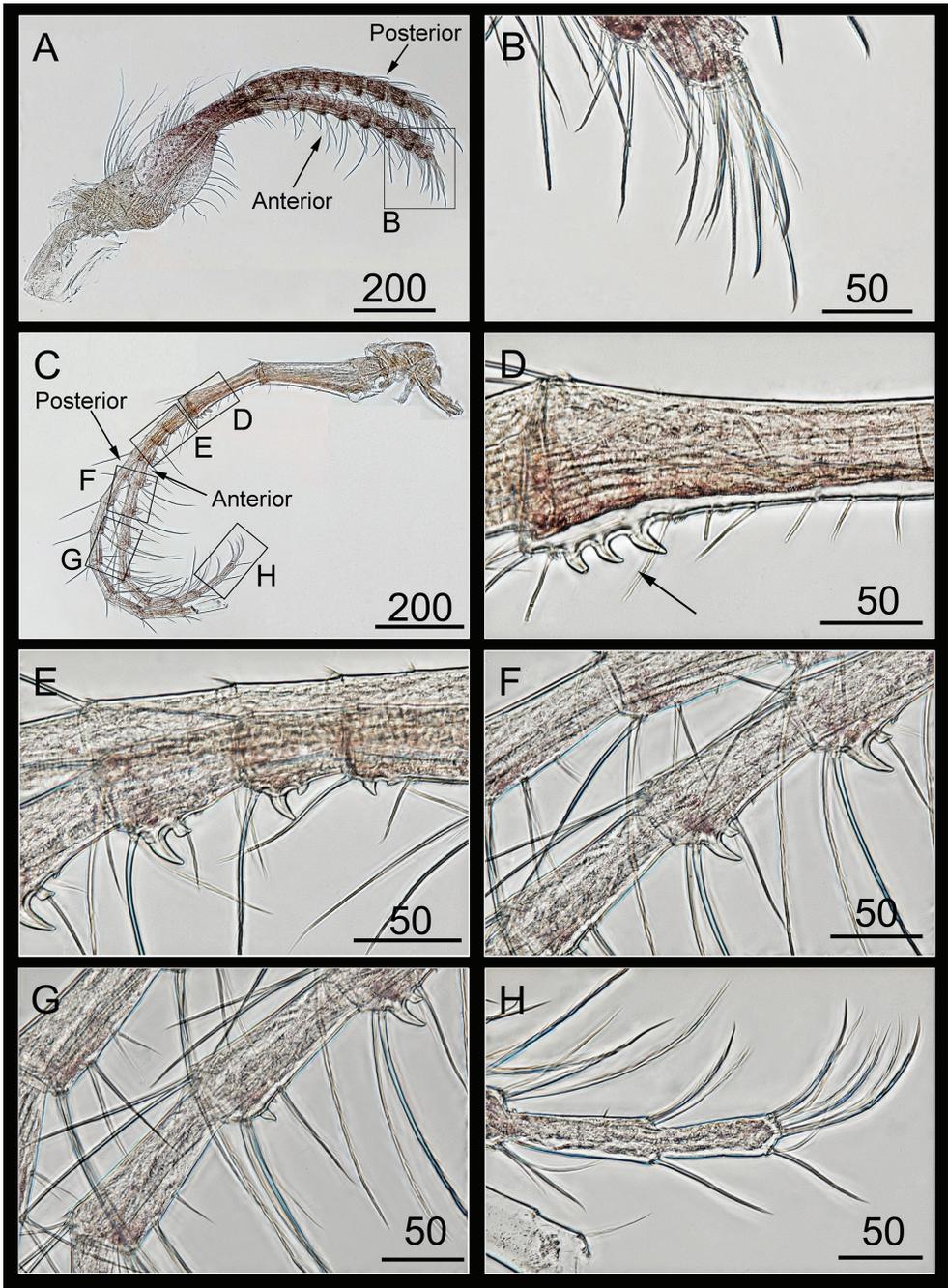


Figure 11. *Bryozobia rossi* sp. n. ASIZCR-000338. Cirri III (left, view from the posterior side) (**A**, **B**), IV (left, view from the anterior side) (**C**–**H**). **A** cirrus III **B** distal segment of anterior ramus **C** Cirrus IV **D** setae and denticles on basis **E**, **F** teeth on proximal segments of anterior and posterior rami **G** intermediate segments of anterior and posterior rami **H** distal segments of anterior ramus. Scale bars in μm .

short setae having three curved teeth on the anterior margin (Figure 11D), proximal segments of the anterior ramus with one or two curved teeth (Figure 11E, F), intermediate segments of the anterior ramus with two pairs of long and short serrulate setae, intermediate segments of the posterior ramus with three pairs of long, medium, and short serrulate setae (Figure 11F, G), and the last segment of the anterior ramus with serrulate setae (Figure 11H).

The cirri V and VI were similar in length, with the anterior rami of cirri V and VI both having twenty-one segments, and the posterior rami of cirri V and VI were both broken, with nine and fifteen segments on their remaining parts, respectively. A short and simple protopod was observed on the anterior margin and long serrulate setae on the posterior margin (Figure 12A, D), intermediate segments of both the rami with three pairs of long, medium, and short serrulate setae, and the last segments of both the rami with serrate setae (Figure 12B, E, C).

The penis was approximately the same length as the cirrus VI, finely annulated, gradually tapering at the tip (Figure 12G), with a vestigial basidorsal point (Figure 12H), and long scarce setae scattered along the penis (Figure 12G, I).

Etymology. We named the organisms after the famous cirripedologist late Prof. Arnold Ross (Scripps Institution of Oceanography, USA), who discovered the subfamily Bryozobiinae.

Remarks. All previously described specimens of *Bryozobia synaptos* from Madagascar and Mauritius and *Bryozobia* sp. from Sri Lanka possess several (two to three) more or less regular whorls of shell portals (Ross and Newman 1996, Van Syoc and Newman 2010). The interparietal portal below CL² belonging to the first elevated whorl eliminates this plate; therefore, the shell becomes four plated below this whorl. All studied specimens of *B. rossi* do not have the first elevated whorl of several portals; however, only a pair of interparietal portals below CL² eliminated these plates. *B. rossi* is characterized by a single irregular basal whorl of portals situated at the same level as the basal hemiportals and this differentiates the new species from the previously discovered forms of *Bryozobia*. Each whorl of shell portals is added ontogenetically and the sizes of studied specimens are similar to those studied from Indian Ocean, revealing that the new species has less number of whorls of portals compared with the previously described species. Although *B. rossi* has less number of portals and whorls of portals, it belongs to the genus *Bryozobia* because it has short, eliminated CL² and open portals remaining attached to with the basal atria through tubular fillets. Opercular plates of *B. rossi* were similar to those in *B. synaptos* (absent in the specimens of *Bryozobia* from Sri Lanka).

The previously described *Bryozobia* from Madagascar, the Mascarene Plateau and Sri Lanka states that the radii between the R-CL¹ are obsolete, whilst radii between R-CL¹ in *B. rossi* sp. n. in the present study is well developed. In addition, the original diagnosis of *Bryozobia* from Madagascar and the Mascarene Plateau did not include parietal calcipedia, in which this character is present in *B. rossi* sp. n. In the present study, we conclude it is premature to modify the diagnosis of *Bryozobia* due to whether

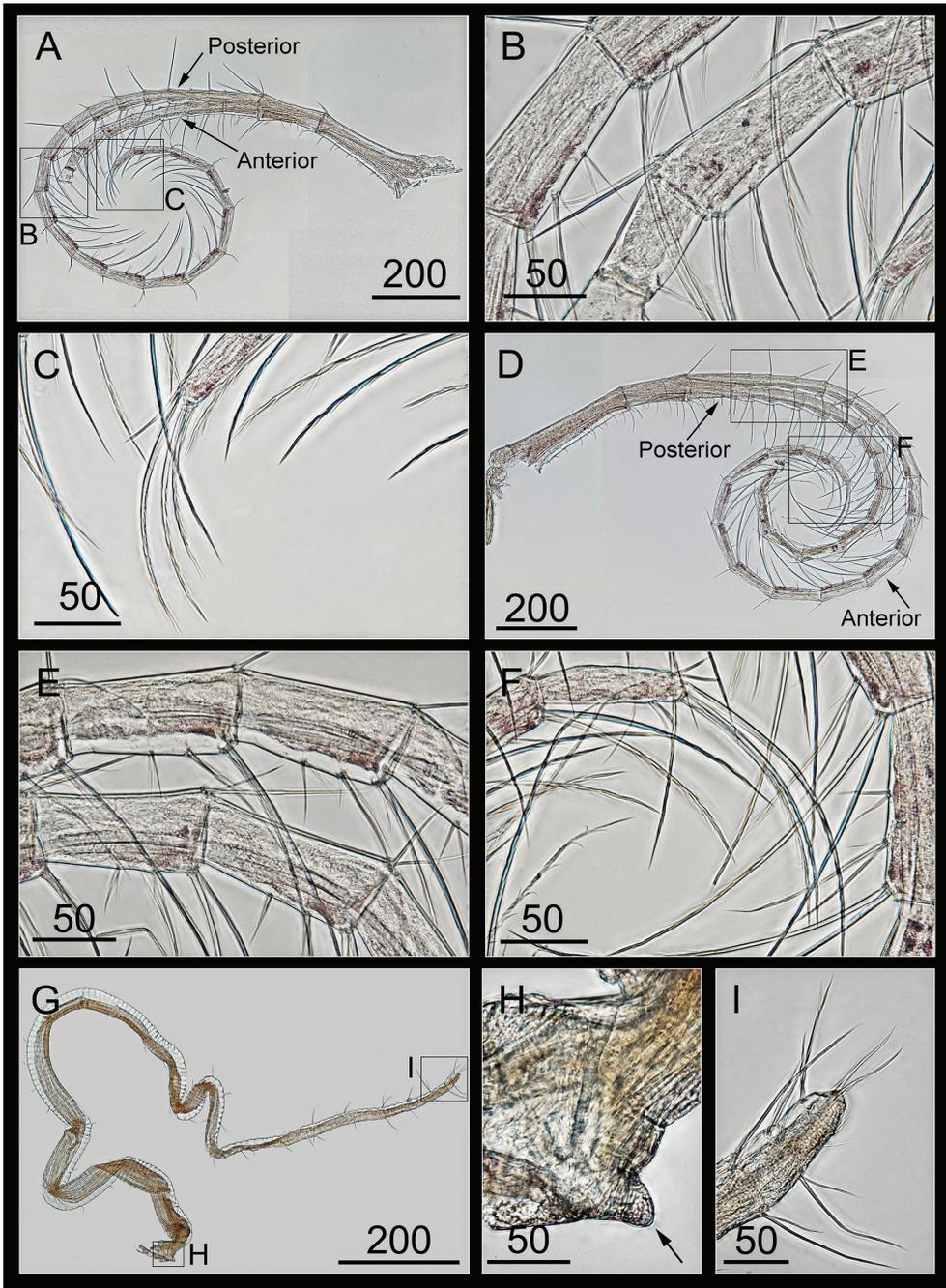


Figure 12. *Bryozobia rossi* sp. n. ASIZCR-000338. Cirri V (left, view from the anterior side) (A–C), VI (left, view from the posterior side) (D–F) and penis (G–I). A cirrus V B setae on intermediate segments of posterior and anterior rami C distal segment of posterior ramus D cirrus VI E setae on intermediate segments of posterior and anterior rami F distal segment of anterior ramus G penis H rudimentary basidorsal point I setae on tip. Scale bars in μm .

these discrepancies are ecotypic or specific differences is unknown. We propose to include *B. rossi* as *incertae sedis* in *Bryozobia*, deferring a decision as to whether or not it is a new genus in the Bryozobiinae when further molecular phylogenetic analysis is conducted in bryozobiine species.

The previously studied specimens of *Bryozobia* were represented by subfossil materials. The present description is the first for the morphology of the oral cone, cirri, and penis in this genus. Their morphology does not differ considerably from that in other bryozobiines, and cirrus IV with recurved teeth, characteristic of most of these barnacles. This is a first discovery of *Bryozobia* in Pacific; the previous ones were from the Indian Ocean.

Discussion

The morphological structures, such as atria, portals, pores of basis, calcipeds, and armament of cirri IV, were attached to the teratogenesis, and the adaptations of symbiosis to the sponge are the topics predominantly discussed in the bryozobiines (Van Syoc and Newman 2010). Other sponge-inhabiting barnacles of the subfamily Acastinae, living in massive sponges that completely surround them, develop a cup-shaped base and have a greater height/width ratio of the wall plates resulting from the increasing thickness of the sponge (Kolbasov 1993). However, the bryozobiines are closely associated with encrusting/burrowing sponges which spread across the substratum as a relatively thin cortex requiring adaptations differing from those in acastines (Van Syoc and Newman 2010). These barnacles, compared with acastines, retain various connections of the rather flat base with the substratum and have an approximately conical shell. Van Syoc and Newman (2010) reported correctly that the complex system of atria and hemiportals and the portals attached to them evolved as additional space for burrowing sponge host that may prevent barnacle overgrowth. Moreover, we propose that these structures may more appropriately fix the barnacle on the sponge substratum. Bryozobiines are attached to hard substrata (mollusk shell, coral etc.) through the small central portion of the base and its thin calcipeds between the atria. In addition, the burrowing sponge growing through the atria and its fillets sealing off at the portals and hemiportals may fix a barnacle in place within the sponge host. The genus *Eoatria* having only six unperforated atria ending with six basal hemiportals develops numerous basal calcipeds of parietes for more appropriately fixing on the substratum, whereas other bryozobiines that have a developed network of perforated atria, hemiportals, and portals possess either a few calcipeds or lack them. Evidently, portals originate from hemiportals when basal parietal footings are fused. Therefore, open portals of *Bryozobia* remaining attached to the basal atria through tubular fillets are rather plesiomorphic compared with the closed portals that dissociated from the base in *Multatria*, *Microporatria*, and *Poratria* genera. Further evolution within genus *Bryozobia* was expressed in the gradually increasing number of whorls of portals from an irregular whorl in *B. rossi* to two or three regular whorls in the *B. synaptos* and *Bryozobia* sp. from Sri Lanka.

The other plesiomorphic condition was the retained unfused six-plated shells observed in the *Multatria* and *Bryozobia* genera. However, *Bryozobia* having rudimentary CL² appears more advanced in this character compared with *Multatria*, which possesses six plates reaching the base. The genus *Poratria* with closed portals and all fused basal shell plates may be the most evolved Bryozobiinae.

We agree with suggestion of Van Syoc and Newman (2010) that the pores of the basal atria and those of the portals of Bryozobiinae and windows (fenestrae) in Acastinae (Kolbasov 1993) may facilitate chemical interactions with the sponge to prevent overgrowth. Some acastines (*Acasta spongites* (Poli, 1791)) possess distinct and numerous pores along the growth lines of the base not organized in the radial atria; however, it may have a similar function as the pores of the base in bryozobiines. In the coral associated barnacle *Pyrgoma kuri* (family Pyrgomatidae), the base have specialized perforated furrows which these structure is believed to allow chemical mediations between the coral host and barnacle through the perforations (Roos and Newman 2000). The recurved teeth on cirri IV developed in most of bryozobiines and several acastines clean the opercular aperture off the sponge overgrowth.

Only one species of Bryozobiinae was previously reported from the studied area, namely *Eoatria quinquevittatus* (Hoek 1913) from South West Japan (Van Syoc and Newman 2010). The *B. rossi* finding in tropical and subtropical Western Pacific spreads the distribution of the genus *Bryozobia* considerably. Thus, three bryozobiine genera, namely *Eoatria*, *Multatria*, and *Bryozobia* have an Indo–West Pacific distribution, whereas *Microporatria* and *Poratria* genera are yet restricted to the equatorial zone of Western Pacific.

Van Syoc et al. (2015) revealed that *Bryozobia* is obligate with the sponges *Clathria* in the family Microcionidae. In the present study, *Bryozobia* from Taiwan was collected from the encrusting sponges *Agelas* (family Agelasidae) and *Theonella* (family Theonellidae), thus providing additional records for the family of sponges inhabited by *Bryozobia* and bryozobiines as well.

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Review of the Southeast Asian millipede genus *Antheromorpha* Jeekel, 1968 (Diplopoda, Polydesmida, Paradoxosomatidae)

Natdanai Likhitrakarn¹, Sergei I. Golovatch², Somsak Panha³

1 Division of Plant Protection, Faculty of Agricultural Production, Maejo University, Chiang Mai 50290, Thailand **2** Institute for Problems of Ecology and Evolution, Russian Academy of Sciences, Leninsky pr. 33, Moscow 119071, Russia **3** Animal Systematics Research Unit, Department of Biology, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand

Corresponding authors: Somsak Panha (somsak.pan@chula.ac.th); Sergei I. Golovatch (sgolovatch@yandex.ru)

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Abstract

The genus *Antheromorpha* is redefined and shown to comprise 11 valid species: *A. miranda* (Pocock, 1895), *A. bistrriata* (Pocock, 1895), *A. comotti* (Pocock, 1895), *A. festiva* (Brölemann, 1896), *A. harpaga* (Attems, 1937), *A. mediovirgata* (Carl, 1941), *A. minlana* (Pocock, 1895), *A. pardalis* (Pocock, 1895), *A. paviei* (Brölemann, 1896), **comb. n.**, *A. rosea* Golovatch, 2013 and *A. uncinata* (Attems, 1931). Three new synonymies are proposed: *A. bivittata* (Pocock, 1895) and *A. melanopleuris* (Pocock, 1895) are synonymized under *A. miranda* (Pocock, 1895), and *A. orophila* (Carl, 1941) under *A. comotti* (Pocock, 1895). Detailed descriptions and illustrations of fresh material from Thailand and Malaysia are given, especially regarding colour patterns which appear to be crucial for accurate species identifications. Two *Antheromorpha* species proposed by Attems are redescribed, based on type material. The genus is rediagnosed and a key and a distribution map are also provided. At least in Thailand, adult *A. rosea* have been found to occur every year only for one or two weeks in September or October, disappearing thereafter.

Keywords

Review, Paradoxosomatidae, taxonomy, new synonymy, key, distribution, map

Introduction

The Southeast Asian millipede genus *Antheromorpha* Jeekel, 1968 is currently known to comprise 13 medium-sized to very large species showing moderately developed to very prominent paraterga and, above all, unlike the other, numerous genera of the basically Oriental tribe Orthomorphini Brölemann, 1916 to which it belongs, a very deeply bifid gonopod tip (Jeekel 1968, Golovatch 2013a). This genus is assumed to be particularly similar to the largely sympatric genus *Orthomorpha* Bollman, 1893, the species of which, like *Antheromorpha*, normally have large bodies and prominent paraterga, coupled with usually bright colour patterns. The main difference between these two genera lies in *Orthomorpha* spp. showing only a poorly differentiated gonopod tip, usually feebly bi- or trifold (Likhitrakarn et al. 2011). *Antheromorpha* species have hitherto been recorded in Myanmar (9), Thailand (2), China (1) and Vietnam (1).

Because of the remarkably bright colour patterns and large bodies, unidentified *Antheromorpha* species have repeatedly been reported throughout Thailand (<http://siamensis.org/webboard/topic/35582#comment-34142>; http://thailandwildlife.photoshelter.com/gallery-image/Other-Arthropods/G0000OdCpTbz8ENY/I0000PM-Jm_Wnsl8E; <http://www.projectnoah.org/spottings/10657453>; <https://www.flickr.com/photos/lennyworthington/sets/72157628909951579/>). Moreover, one of the species shows swarming behaviour (<http://www.manager.co.th/Local/ViewNews.aspx?NewsID=9490000084506>).

The only attempt at reviewing *Antheromorpha* and outlining its diagnosis (Jeekel 1980) considers the following species arranged in six species groups:

1. *A. bistriata* (Pocock, 1895), *A. bivittata* (Pocock, 1895), *A. festiva* (Brölemann, 1896), *A. mediovirgata* (Carl, 1941), *A. melanopleuris* (Pocock, 1895), *A. miranda* (Pocock, 1895).
2. *A. comotti* (Pocock, 1895), *A. orophila* (Carl, 1941).
3. *A. uncinata* (Attems, 1931).
4. *A. harpaga* (Attems, 1937).
5. *A. minlana* (Pocock, 1895).
6. *A. pardalis* (Pocock, 1895).

The only subsequent addition to the list seems to be *A. rosea* Golovatch, 2013, the first species of the genus to be reported from southern China, yet not placed into any of the species groups (Golovatch 2013a, 2013b).

The present paper provides an updated review of *Antheromorpha*, based on abundant new samples from Thailand and Malaysia. In addition, type material of two species of Attems (1931, 1937) has been revised and properly redescribed. As a result, the genus is rediagnosed and a key and a distribution map are also provided.

Material and methods

New material was taken throughout Thailand and from Malaysia between 2006 and 2015 by SP and members of the Animal Systematics Research Unit, Chulalongkorn University. Animals, both live and alcohol material, were photographed in the laboratory. Specimens were preserved in 75% ethanol and morphological investigations were carried out in the laboratory using an Olympus stereomicroscope. Scanning electron micrographs (SEM) of gonopods coated with gold were taken using a JEOL, JSM-5410 LV microscope, and the gonopods were returned to alcohol after examination. Digital images of the specimens were taken in the laboratory and assembled using the “Cell^D” automontage software of the Olympus Soft Imaging Solution GmbH package. In addition, line drawings of gonopods were prepared. Type material of two Attemsian species of *Antheromorpha* from Thailand and Vietnam, housed in the Naturhistorisches Museum Wien, Austria (NHMW), was photographed with Dino-Eye USB Camera AM423Z, the digital images assembled using the automontage software technique and the gonopod structure redrawn. Most of the new material is kept in the Museum of Zoology, Chulalongkorn University (CUMZ), Bangkok, Thailand, except for some duplicates donated to the collections of the Natural History Museum of Denmark, University of Copenhagen, Denmark (ZMUC), the Zoological Museum, State University of Moscow, Russia (ZMUM) and the NHMW, as indicated in the text.

Collecting sites were located by GPS using the WGS84 datum.

In the synonymy sections, D stands for the original description or subsequent descriptive notes or appearance in a key, R for subsequent record or records, whereas M for a mere mention.

Taxonomic part

Family Paradoxosomatidae Daday, 1889

Subfamily Paradoxosomatinae Daday, 1889

Tribe Orthomorphini Brölemann, 1916

Genus *Antheromorpha* Jeekel, 1968

Brachytropis Silvestri, 1896: 198 (D) (preoccupied).

Brachytropis – Attems 1937: 59 (D); Jeekel 1963: 269 (M); 1968: 57 (M).

Antheromorpha Jeekel, 1968: 57 (M).

Antheromorpha – Jeekel 1980: 71 (D); Hoffman 1980: 169 (M); Shelley et al. 2000: 84 (M); Nguyen and Sierwald 2013: 1233 (M); Golovatch 2013a: 24 (M).

Diagnosis. Body medium-sized to very large (ca 19–44.5 mm long, ca 2.3–6.1 mm wide), composed of 18 podous and one apodous ring, plus telson. Paraterga from

moderately to very strongly developed. Sterna without modifications. Sternal lobe or cone(s) between male coxae 4 present. Pleurosternal carinae usually well-developed. First pair of male legs without femoral adenostyles. Legs without particular modifications except for at least some ♂ legs bearing ventral brushes on tarsi, sometimes also on tibiae.

Gonopods long and rather slender; coxa slightly curved and long, with several setae distoventrally; prefemoral (= setose) part of telopodite short to very short, 1/3–1/4 as long as acropodite (= remaining part of telopodite); femorite slender to rather stout, straight to evidently curved, sometimes enlarged distally, with a strong distolateral sulcus (**s**) demarcating a “postfemoral” part; seminal groove running entirely mesally along femorite, the latter devoid of processes. Solenophore (**sph**) (= tibiotarsus) and solenomere relatively short to rather long; **sph** curved rather strongly caudad, consisting of a well-developed lamina medialis (**lm**) and a rather small lamina lateralis (**ll**); **lm** about halfway bearing a well-developed process **d**; **sph** usually bilobate to bifid, with a mesal process (**m**, or the end part of **lm**) and a ventral process (**v**, or the end part of **ll**), both supporting a long and flagelliform solenomere (**sl**).

Type species. *Orthomorpha miranda* Pocock, 1895, by direct substitution.

Other species included. *A. bivittata* (Pocock, 1895), *A. comotti* (Pocock, 1895), *A. festiva* (Brölemann, 1896), *A. harpaga* (Attems, 1937), *A. mediovirgata* (Carl, 1941), *A. minlana* (Pocock, 1895), *A. orophila* (Carl, 1941), *A. pardalis* (Pocock, 1895), *A. paviei* (Brölemann, 1896), comb. n., *A. rosea* Golovatch, 2013, *A. uncinata* (Attems, 1931).

Remarks. *Brachytropis* Silvestri, 1896, was originally established to distinguish several species of *Orthomorpha* Bollman, 1893 which occurred in Myanmar and Indochina (Jeekel 1963), with *Orthomorpha miranda* Pocock, 1895, as type species (Silvestri 1896). Because that name had been preoccupied by *Brachytropis* Fieber, 1858 (Hemiptera) (Jeekel 1963), Jeekel (1968) proposed a substitute name, *Antheromorpha*, with the same type species. In his later review of the genus, Jeekel (1980) provided its diagnosis, refined its scope, redescribed some of the constituent species and discussed their taxonomic statuses.

Antheromorpha miranda (Pocock, 1895)

Figs 1, 21

Orthomorpha miranda Pocock, 1895: 812 (D).

Orthomorpha miranda – Attems 1898: 327 (D); 1914: 192 (D); 1930: 132 (D); Weidner 1960: 85 (M); Jeekel 1965: 96 (M).

Orthomorpha (*Orthomorpha*) *miranda* – Attems 1936: 197 (D); 1937: 62 (D).

“*Orthomorpha*” *miranda* – Jeekel 1963: 269 (M).

Brachytropis miranda – Silvestri 1896: 198 (D).

Antheromorpha miranda – Jeekel 1968: 57 (M); 1980: 72 (D); Nguyen and Sierwald 2013: 1234 (M).

Orthomorpha bivittata Pocock, 1895: 814 (D), **syn. n.**

Orthomorpha bivittata – Attems 1898: 327 (D); 1914: 192 (D); 1930: 132 (D); Attems 1936: 204 (M); 1937: 93 (M).

“*Orthomorpha*” *bivittata* – Jeekel 1963: 269 (M).

Antheromorpha bivittata – Jeekel 1968: 57 (M); 1980: 81 (D); Nguyen and Sierwald 2013: 1234 (M).

Orthomorpha melanopleuris Pocock, 1895: 813 (D), **syn. n.**

Orthomorpha melanopleuris – Attems 1898: 337 (D); 1914: 192 (D); 1930: 132 (D); 1936: 205 (M); 1937: 94 (M); Weidener 1960: 85 (M); Jeekel 1965: 96 (M).

“*Orthomorpha*” *melanopleuris* Jeekel, 1963: 269 (M).

Antheromorpha melanopleuris – Jeekel 1968: 57 (M); 1980: 77 (D); Nguyen and Sierwald 2013: 1235 (M).

Remarks. This species was described from Yangon (Rangoon) (the type locality); Tharwaddy, Bago Division; Palon in Pegu (state/region); Thigian, upper Irrawaddy and Minhla, Myanmar (Pocock 1895). The quite large material, of which only the specimens coming from Rangoon should be considered as syntypes, because they were designated as *Types* by Pocock (1895) in the original description, is currently shared between the collections of the Natural History Museum in London, UK, the Museo Civico di Storia naturale in Genova, Italy (Jeekel 1980) and the Zoologisches Staat-institut und Zoologisches Museum in Hamburg, Germany (Weidner 1960). Jeekel (1980) provided a sufficiently detailed redescription of this species, based on 3 ♂ and 1 ♀ from Palon in Pegu, leg. L. Fea and 1 ♀ from Thigian, upper Irrawaddy, leg. L. Fea, mistakenly designating them as paralectotypes (= paratypes) pending the selection of a lectotype housed in the London Museum. For the time being the concept of *A. miranda* remains based on that actually non-type material, whereas the true type series from Rangoon must be revised to finally verify the species identity, as well as to reconfirm the two new synonymies.

In addition, according to H. Enghoff (in litt.), the ZMUC collection contains a sample (3 ♂, 2 ♀, one of the males mounted on an insect pin) labelled “*Orthomorpha Miranda* Poc. // Palon // Birma Fea”. There can be no doubt this material was once received from Pocock himself.

Based solely on Jeekel’s (1980) revision of the ♀ types of *A. bivittata* (Pocock, 1895), the ♀ lectotype and 1 ♀ paralectotype from Shenmaga, Myanmar (Pocock 1895) and of *A. melanopleuris* (Pocock, 1895), also the ♀ lectotype and 1 ♀ paralectotype from Teinzo on the Moolay River (Pocock 1895), as well as of the non-type ♂ from Minhla, Myanmar which Pocock (1895) provisionally identified as belonging to *A. miranda*, we venture to synonymize *A. bivittata* and *A. melanopleuris* with *A. miranda*, both **syn. n.** In this respect we follow Jeekel (1980) who also emphasized their close resemblance to one another as regards their colour patterns and somatic characters, even though *A. bivittata* and *A. melanopleuris* were both based on ♀ material alone.

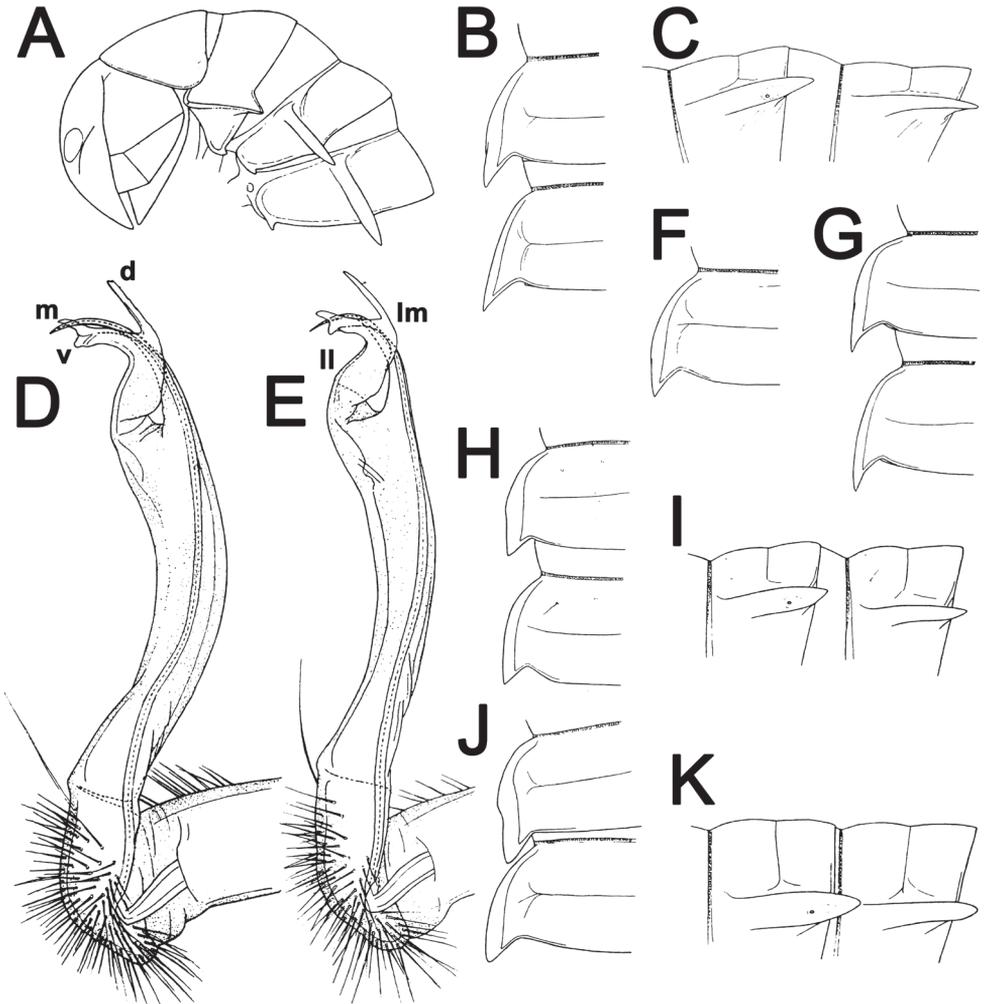


Figure 1. *Antheromorpha miranda* (Pocock, 1895), ♂ (**A–D**), ♀ (**F**) non-type material from Palon in Pegu, ♂ non-type material from Minhla (**E**, **G**), ♀ lectotype of *Orthomorpha bivittata* Pocock, 1895 (**H**, **I**), ♀ lectotype of *Orthomorpha melanopleuris* Pocock, 1895 (**J**, **K**). **A** anterior part of body, lateral view **B**, **C**, **G**, **H**, **I**, **J**, **K** segments 10 and 11, dorsal, lateral, dorsal, dorsal, lateral, dorsal and lateral views, respectively **D**, **E** right gonopod, mesal view **F** segment 10, dorsal view (after Jeekel 1980). No scale bar.

Antheromorpha bistriata (Pocock, 1895)

Figs 2A–C, 21

Orthomorpha bistriata Pocock, 1895: 814 (D).

Orthomorpha bistriata – Attems 1898: 327 (D); 1914: 237 (M); 1936: 204 (M); 1937: 93 (M); Jeekel 1965: 96 (M).

“*Orthomorpha*” *bistriata* – Jeekel 1963: 269 (M).

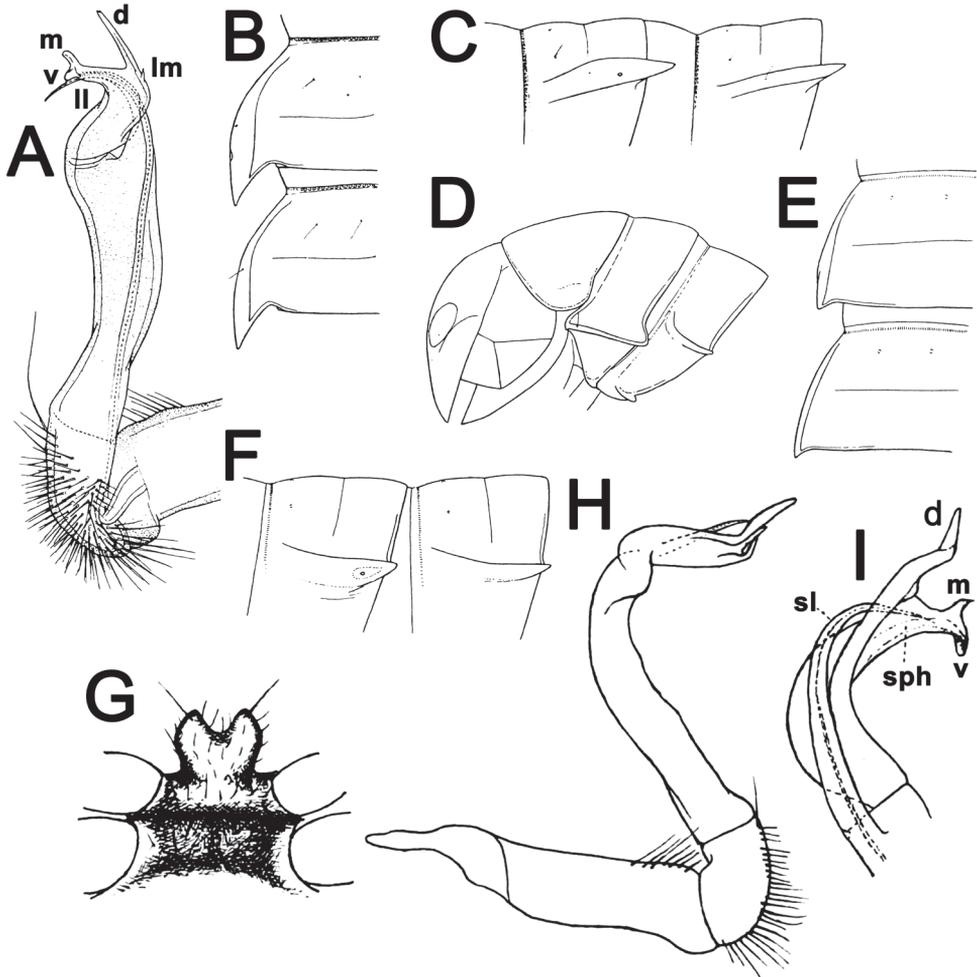


Figure 2. *Antheromorpha bistriata* (Pocock, 1895), ♂ holotype (**A–C**); *Antheromorpha comotti* (Pocock, 1895), ♀ holotype of *Orthomorpha comotti* Pocock, 1895 (**D–F**), ♂ holotype of *Orthomorpha (Orthomorpha) orophila* Carl, 1941 (**G–I**). **A, H, I** right gonopod, mesal, lateral and submesal views, respectively **B, C, E, F** segments 10 and 11, dorsal, lateral, dorsal and lateral views, respectively **D** anterior part of body, lateral view **G** sternal cones between coxae 4, subcaudal view view (after Carl 1941; Jeekel 1980). No scale bar.

Antheromorpha bistriata – Jeekel 1968: 57 (M).

Antheromorpha bistriata – Jeekel 1980: 79 (D); Nguyen and Sierwald 2013: 1234 (M).

Remark. This species was described from Bhamo, Myanmar (Pocock 1895), redescribed by Jeekel (1980) in due detail from the ♂ holotype which is deposited in the Genova Museum, Italy.

***Antheromorpha comotti* (Pocock, 1895)**

Figs 2D–I, 21

Orthomorpha comotti Pocock, 1895: 814 (D).*Orthomorpha Comotti* – Attems 1898: 327 (D); 1914: 192 (D).*Orthomorpha comotti* – Attems 1898: 338 (M); 1930: 132 (D); 1936: 204 (M); 1937: 93 (M).“*Orthomorpha*” *comotti* – Jeekel 1963: 269 (M).*Antheromorpha comotti* – Jeekel 1968: 57 (M); 1980: 83 (D); Nguyen and Sierwald 2013: 1234 (M).*Orthomorpha* (*Orthomorpha*) *orophila* Carl, 1941: 361 (D), **syn. n.**“*Orthomorpha*” *orophila* – Jeekel 1963: 269 (M).*Antheromorpha orophila* – Jeekel 1968: 57 (M); 1980: 85 (M); Nguyen and Sierwald 2013: 1235 (M).

Remarks. This species was described and still remains known only from Minhla, Myanmar (Pocock 1895), redescribed in due detail from the ♀ holotype (now in the Genova Museum, Italy) by Jeekel (1980). Jeekel found this species not only being very similar to *A. orophila* (Carl, 1941), which Carl (1941) had described from the northern Chin Hills, Myanmar, but he also suggested, albeit not formalized, their synonymy. Based on Jeekel’s (1980) redescription and opinion, we venture to formally synonymize *A. orophila* under *A. comotti*, syn. n. The syntypes (1 ♂, 1 ♀) of *A. orophila* are in the London Museum, UK (Carl 1941).

***Antheromorpha mediovirgata* (Carl, 1941)**

Figs 3A, B, 21

Orthomorpha (*Orthomorpha*) *mediovirgata* Carl, 1941: 364 (D).“*Orthomorpha*” *mediovirgata* – Jeekel 1963: 269 (M).*Antheromorpha mediovirgata* – Jeekel 1968: 57 (M); 1980: 85 (M); Nguyen and Sierwald 2013: 1235 (M).

Remark. This species was described and still remains known only from the northern Chin Hills, Myanmar (Carl 1941). The ♂ holotype of *A. mediovirgata* is in the London Museum, UK (Carl 1941).

***Antheromorpha minlana* (Pocock, 1895)**

Figs 3C, 21

Orthomorpha minlana Pocock, 1895: 816 (D).*Orthomorpha minlana* – Attems 1898: 327 (M); 1936: 197 (D); Weidner 1960: 85 (M).*Orthomorpha* (*Orthomorpha*) *minlana* – Attems 1936: 199 (M); 1937: 62 (D).

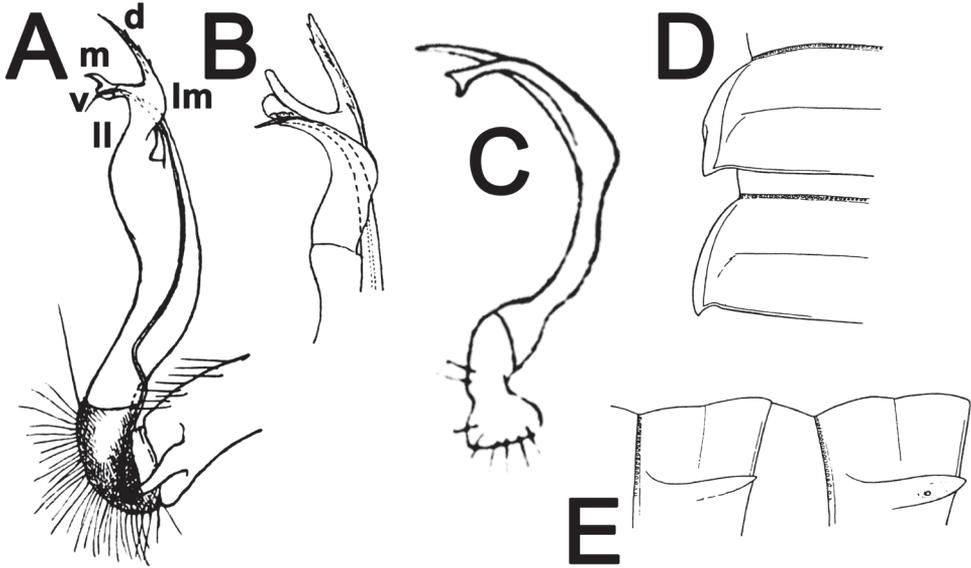


Figure 3. *Antheromorpha mediovirgata* (Carl, 1941), ♂ holotype (**A**, **B**); *Antheromorpha minlana* (Pocock, 1895), ♂ holotype (**C**); *Antheromorpha pardalis* (Pocock, 1895), ♀ holotype (**D**, **E**). **A**, **B** right gonopod, mesal and lateral views, respectively **C** left gonopod, mesal view **D**, **E** segments 10 and 11, dorsal and lateral views, respectively (after Pocock 1895; Carl 1941; Jeekel 1980). No scale bar.

“*Orthomorpha*” *minlana* – Jeekel 1963: 269 (M).

Orthomorpha miuhlana (sic!) – Attems 1914: 193 (D).

Antheromorpha minlana – Jeekel 1968: 57 (M); 1980: 85 (M); Nguyen and Sierwald 2013: 1235 (M).

Remark. This species was described and still remains known only from Minhla, Tharrawaddy District, Myanmar (Pocock 1895).

An indefinite number of ♂ and ♀ syntypes of *A. minlana* must be deposited in the London Museum, UK (Pocock 1895). According to H. Enghoff (in litt.), the ZMUC collection contains a sample (1 ♂, 1 ♀, both mounted on insect pins) labelled “*Orthomorpha minhlana* Poc. // ex typ. // Minhla // Birma fea”.

***Antheromorpha pardalis* (Pocock, 1895)**

Figs 3D, E, 21

Orthomorpha pardalis Pocock, 1895: 815 (D).

Orthomorpha pardalis – Attems 1898: 327 (D); 1914: 192 (D); 1930: 132 (D); 1936: 205 (M); 1937: 94 (M).

“*Orthomorpha*” *pardalis* – Jeekel 1963: 269 (M).

Antheromorpha pardalis – Jeekel 1968: 57 (M); Jeekel 1980: 82 (D); Nguyen and Sierwald 2013: 1235 (M).

Remarks. This species was described and still remains known only from a single ♀, the holotype which comes from Palon in Pegu, Myanmar (Pocock 1895) and is kept in the Genova Museum, Italy (Jeekel 1980). The species is similar to *A. miranda* (Pocock, 1895), but has a different colour pattern of the metaterga, the latter showing yellowish paramedian spots in front of the transverse sulcus (versus yellowish paramedian stripes), coupled with the sulcus starting with segment 2 (versus segment 5). Since the colour pattern is one of the most important taxonomic characters for species discrimination in the genus, *A. pardalis* for the time being is regarded as a separate species. However, only the discovery of topotypical ♂ specimens can provide decisive information concerning the identity of this species (Jeekel 1980).

***Antheromorpha paviei* (Brölemann, 1896), comb. n.**

Figs 4–6, 21

Orthomorpha Paviei Brölemann, 1896: 1 (D).

Orthomorpha Paviei – Brölemann 1904: 8 (D).

?*Prionopeltis Paviei* – Attems 1914: 204 (M).

Pratinus Paviei – Attems 1937: 122 (M).

Orthomorpha paviei – Jeekel 1963: 265 (M); 1964: 359 (M); 1968: 56 (M); Golovatch 1998: 42 (D); Enghoff et al. 2004: 34 (M); Enghoff 2005: 97 (M); Likhitrakarn et al. 2011: 52 (D); 2014: 2 (D, R).

Remarks. Redescribed based on new material from Khone Phapen Waterfall, Laos (Likhitrakarn et al. 2014), this species is distinguished by a more *Orthomorpha*-like colour pattern (only paraterga being contrasting light), yet, like a rather typical *Antheromorpha*, its solenophore tip is deeply split. It is the latter character that justifies the assignment of this species to *Antheromorpha*. The ♂ holotype of *A. paviei* is deposited in the Paris Museum, France (Brölemann 1896, 1904).

***Antheromorpha uncinata* (Attems, 1931)**

Figs 7–12, 21

Orthomorpha (*Orthomorpha*) *uncinata* Attems, 1931: 117 (D).

Orthomorpha uncinata – Attems 1930: 132 (D); 1936: 197 (D).

Orthomorpha (*Orthomorpha*) *uncinata* – Attems 1936: 199 (M); 1937: 62 (D); Weidner 1960: 86 (M).

“*Orthomorpha*” *uncinata* – Jeekel 1963: 269 (M).

Antheromorpha uncinata – Jeekel 1968: 57 (M); 1980: 85 (M); Enghoff 2005: 95 (R); Nguyen and Sierwald 2013: 1235 (M).

Lectotype ♂ of *Orthomorpha uncinata* (NHMW-3496), Thailand, Muok Lek, 01–02.1901, leg. H. Fruhstorfer.

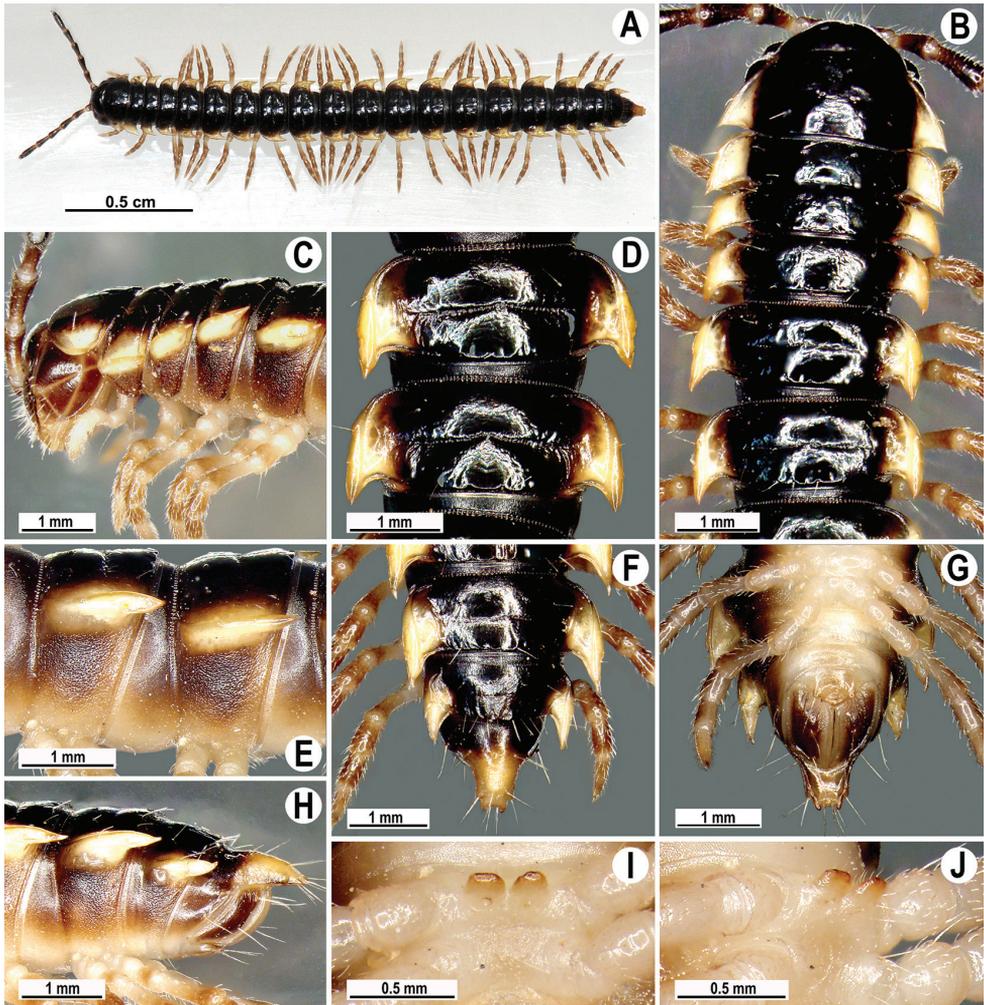


Figure 4. *Antheromorpha paviei* (Brölemann, 1896), ♂ from Laos. **A** habitus, live coloration **B, C** anterior part of body, dorsal and lateral views, respectively **D, E** segments 10 and 11, dorsal and lateral views, respectively **F–H** posterior part of body, dorsal, ventral and lateral views, respectively **I, J** sternal cones between coxae 4, subcaudal and sublateral views, respectively (After Likhitrakarn et al. 2014).

Paralectotype. 1 ♀ (NHMW-3496), same locality, together with lectotype.

Lectotype designation proposed herewith is necessary to ensure the species is based on a male.

Other material examined. 4 ♂, 9 ♀ (CUMZ), Thailand, Kanchanaburi Province, Sai Yok District, Sai Yoi Noi Waterfall, 14°14'14"N, 99°03'30"E, ca 150 m a.s.l., 08.05.2014, leg. P. Jirapatrasilp. 1 ♀ (CUMZ), same locality, 08.05.2010, leg. N. Likhitrakarn. 7 ♂, 4 ♀ (CUMZ), same District, Wat Tham Phromlok Khaoyai, 14°12'14"N, 99°07'57"E, ca 120 m a.s.l., 09.07.2009, leg. S. Panha, N. Likhitrakarn and C. Sutcharit. 1 ♀ (CUMZ), same locality, 29.10.2013, leg. R. Saokord. 3 ♀

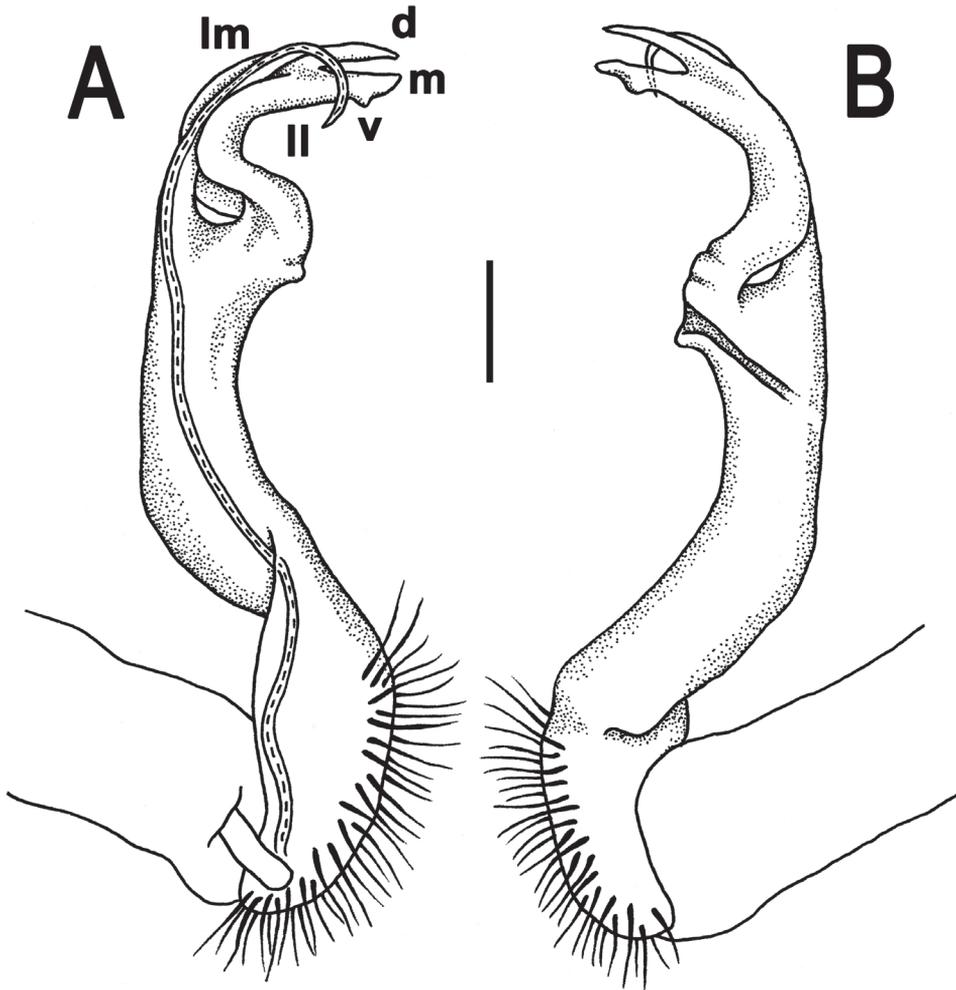


Figure 5. *Antheromorpha paviei* (Brölemann, 1896), ♂. **A, B** left gonopod, mesal and lateral views, respectively (After Likhitrakarn et al. 2014). Scale bar: 0.5 mm.

(CUMZ), same District, Chong Khao Khat, 14°22'23"N, 98°55'40"E, 414 m a.s.l., 29.08.2011, leg. S. Panha, N. Likhitrakarn and C. Sutcharit. 1 ♂, 2 ♀ (CUMZ), same District, near Cave Krasae, 14°09'12"N, 99°06'37"E, ca 75 m a.s.l., 10.12.2006, leg. S. Panha and C. Sutcharit. 2 ♂ (CUMZ), same Province, Si Sawat District, Arawan Waterfall, 14°22'31"N, 99°08'39"E, ca 90 m a.s.l., 13.05.2010, leg. S. Panha, N. Likhitrakarn and C. Sutcharit. 1 ♀ (CUMZ), same District, Chaloe M Rattanakosin National Park, Tham Lod Noi, 14°39'29"N, 99°18'19"E, ca 320 m a.s.l., 10.07.2006, leg. S. Panha and C. Sutcharit. 3 ♂ (CUMZ), same District, Srinakharin Dam, 14°24'09"N, 99°07'34"E, ca 220 m a.s.l., 13.05.2010, leg. S. Panha, N. Likhitrakarn and C. Sutcharit. 2 ♂, 2 ♀ (CUMZ), same Province, Nong Prue District, Wat Tham Phukung, 14°28'18"N, 99°06'34"E, ca 200 m a.s.l., 20.12.2013, leg. S. Panha, R.

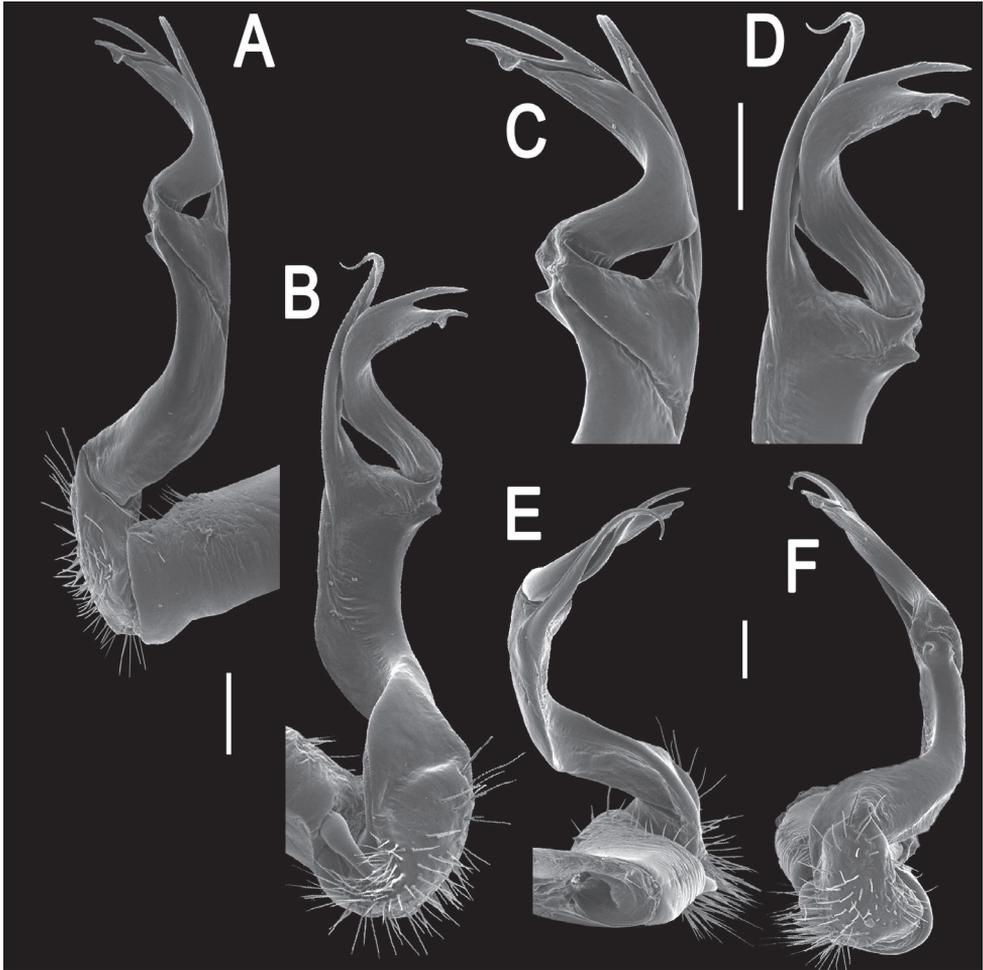


Figure 6. *Antheromorpha paviei* (Brölemann, 1896), ♂ from Laos, left gonopod. **A, B** lateral and mesal views, respectively **C, D** telopodite, lateral, mesal **E, F** distal part, subcaudal and suboral views, respectively (After Likhitrakarn et al. 2014). Scale bar: 0.2 mm.

Saokord and C. Sutcharit. 12 ♂, 5 ♀ (CUMZ), 2 ♂, 1 ♀ (ZMUM 03056), 2 ♂, 1 ♀ (ZMUC), 2 ♂, 1 ♀ (NHMW), Uthai Thani Province, Ban Rai District, Tham Prakaipheth, 15°12'17"N, 99°44'01"E, ca 90 m a.s.l., 08.07.2009, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 7 ♂, 10 ♀, 1 juv. (CUMZ), same District, Wat Tham Khao Wong, 15°01'59"N, 99°27'18"E, ca 110 m a.s.l., 08.07.2009, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 10 ♂, 5 ♀, 7 juv. (CUMZ), same District, Huaykhakhaeng Country Home Resort, 15°06'02"N, 99°35'42"E, ca 210 m a.s.l., 07.06.2008, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 1 ♀ (CUMZ), same locality, 27.10.2013, leg. S. Panha, R. Saokord and C. Sutcharit. 2 ♂, 2 ♀ (CUMZ), Sa Kaeo Province, Khlong Hat District, Tham Phet Phothong, 13°24'47"N, 102°19'32"E, ca 200 m a.s.l., 28.10.2010, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 1 ♂, 2 ♀ (CUMZ),

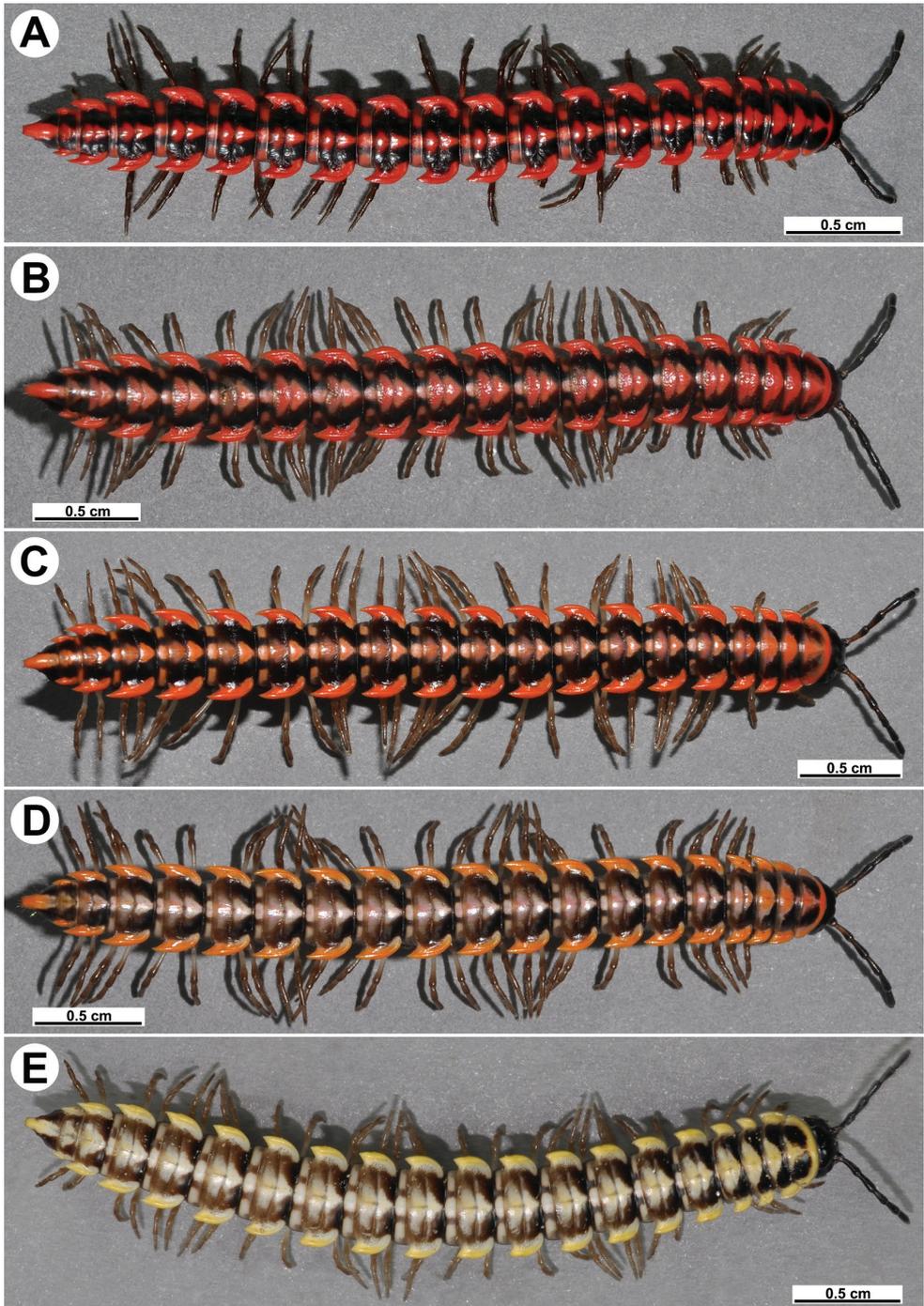


Figure 7. *Antheromorpha uncinata* (Attems, 1931), Habitus, live coloration (A–E) ♂ from Sakaerat Environmental Research Station Sakaerat Biosphere Reserves (A), ♂ from Tham Prakaipheth (B), ♂ from Srinakharin Dam (C, D), ♂ from Thap Sakae (E).

same locality, 22.05.2012, leg. R. Saokord. 1 ♂, 2 ♀ (CUMZ), same Province, Ta Phraya District, Amphoe Ta Phraya, 14°08'22"N, 102°40'11"E, ca 180 m a.s.l., 27.10.2010, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 1 ♂ (CUMZ), same Province, Wang Sombun District, Thamkhao Phrapphueng Thong, 13°26'55"N, 102°13'02"E, ca 180 m a.s.l., 22.05.2012, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 1 ♀ (CUMZ), Loei Province, Nong Hin District, Wat Tham Pho Thi Sat, 17°05'17"N, 101°46'51"E, 405 m a.s.l., 19.10.2007, leg. S. Panha and C. Sutcharit. 1 ♂ (CUMZ), same District, Wat Tham Dok Bua, 17°03'14"N, 101°44'39"E, ca 680 m a.s.l., 12.06.2013, leg. S. Panha and C. Sutcharit. 1 ♂ (CUMZ), same District, Hin Pha Ngam Park, 17°03'02"N, 101°44'37"E, ca 680 m a.s.l., 19.10.2007, leg. S. Panha and C. Sutcharit. 2 ♂ (CUMZ), Wang Saphung District, Wat Tham Wangsaphung, 17°19'38"N, 101°39'59"E, ca 275 m a.s.l., 18.10.2007, leg. S. Panha and C. Sutcharit. 1 ♂, 2 ♀ (CUMZ), Chiang Mai Province, Mae Rim District, near Mae Rim city, 18°54'23"N, 98°54'14.76"E, ca 340 m a.s.l., 17.09.2015, leg. N. Nantararat. 1 ♀ (CUMZ), Chiang Rai Province, Mueang Chiang Rai District, Pang Rimkorn, 19°50'51"N, 99°40'04"E, 485 m a.s.l., 10.07.2006, leg. S. Panha and C. Sutcharit. 2 ♂, 2 ♀, 1 juv. (CUMZ), Lopburi Province, Phatthana Nikhom District, Wat Dilang, 14°56'15"N, 100°53'46"E, ca 85 m a.s.l., 11.07.2008, leg. S. Panha and C. Sutcharit. 1 ♂, 1 ♀ (CUMZ), Phetchabun Province, Bueng Sam Phan District, Ban Phanom Phet, 15°46'56"N, 100°49'37"E, ca 100 m a.s.l., 10.04.2007, leg. S. Panha and C. Sutcharit. 5 juv. (CUMZ), same Province, Nam Nao District, Nam Nao National Park, 16°45'26"N, 101°33'41"E, ca 925 m a.s.l., 19.06.2014, leg. S. Noommeechai. 1 ♀ (CUMZ), Saraburi Province, Kaeng Khoi District, Siharatdechochai, 14°41'05"N, 101°03'17"E, ca 60 m a.s.l., 19.09.2009, leg. S. Panha and C. Sutcharit. 1 ♀ (CUMZ), Ratchaburi Province, Mueang Ratchaburi District, Wat Tham Khaobin, 13°35'35"N, 99°40'03"E, ca 50 m a.s.l., 30.10.2013, leg. S. Panha and C. Sutcharit. 1 ♀ (CUMZ), Sukhothai Province, Si Samrong District, Wat Tham Rakhang, 17°10'02"N, 99°33'29"E, ca 200 m a.s.l., 19.09.2009, leg. S. Panha and C. Sutcharit. 4 ♂, 1 ♀ (CUMZ), Nakhon Sawan Province, Mueang Nakhon Sawan District, Wat Mano, 15°48'41"N, 99°54'55"E, ca 90 m a.s.l., 29.05.2009, leg. S. Panha and C. Sutcharit. 1 ♂ (CUMZ), same Province, Takhli District, Wat Thampratun Temple, 15°14'07"N, 100°22'11"E, ca 30 m a.s.l., 27.10.2015, leg. N. Likhitrakarn and C. Sutcharit. 1 ♂, 1 ♀ (CUMZ), Nakhon Ratchasima Province, Wang Nam Khiao District, Sakaerat Environmental Research Station Sakaerat Biosphere Reserves, 14°30'42"N, 101°56'35"E, ca 340 m a.s.l., 24.04.2009, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 2 ♀, 2 juv. (CUMZ), same locality, 03.08.2013, leg. R. Saokord. 2 ♂, 2 ♀ (CUMZ), same Province, Pak Chong District, Khao Rup Chang, 14°31'33"N, 101°21'36"E, ca 415 m a.s.l., 24.04.2009, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 2 ♂, 3 ♀ (CUMZ), Prachuap Khiri Khan Province, Thap Sakae District, Thap Sakae, 11°33'57"N, 99°32'56"E, 85 m a.s.l., 31.08.2011, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 1 ♂, 1 ♀ (CUMZ), same Province, Bang Saphan District, Tham Khao Ma Rong, 11°12'20"N, 99°29'44"E, 7 m a.s.l., 12.10.2008, leg. S. Panha and C. Sutcharit. 3 ♀ (CUMZ), same locality, 22.05.2010, leg. N. Likhitrakarn, S.

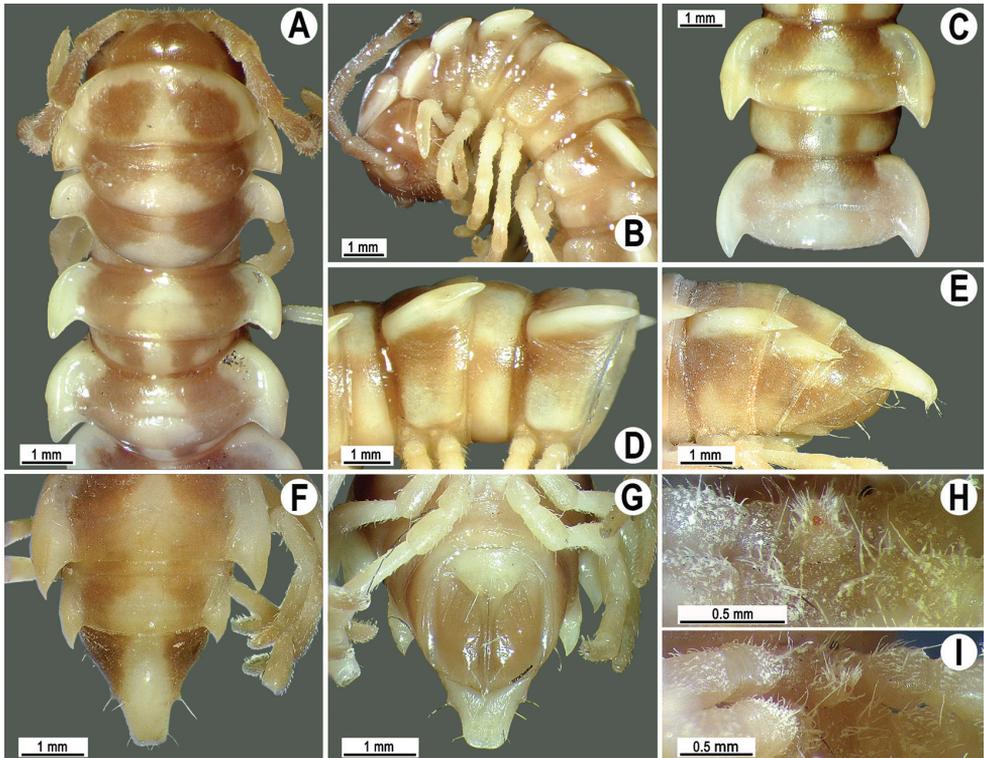


Figure 8. *Antheromorpha uncinata* (Attems, 1931), ♂ lectotype. **A, B** anterior part of body, dorsal and lateral views, respectively **C, D** segments 10 and 11, dorsal and lateral views, respectively **E–G** posterior part of body, lateral, dorsal and ventral views, respectively **H, I** sternal cones between coxae 4, subcaudal and sublateral views, respectively.

Panha and C. Sutcharit. 1 ♂ (CUMZ), same Province, Hua Hin District, Kaeng Krachan, 12°45'32"N, 99°32'59"E, ca 570 m a.s.l., 24.01.2012, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 1 ♂ (CUMZ), same Province, Kui Buri District, Ban Yang Chum, 12°05'33"N 99°42'59"E, ca 60 m a.s.l., 07.08.2014, leg. N. Likhitrakarn, S. Panha and C. Sutcharit. 1 ♂ (CUMZ), same Province, Kui Buri District, Kui Buri National Park, 12°03'05"N 99°37'24"E, 150 m a.s.l., 15.03.2010, leg. N. Likhitrakarn, S. Panha and C. Sutcharit.

Redescription. Length 30.0–42.5 (♂) or 34.0–44.5 mm (♀), width of midbody pro- and metazonae 2.6–4.0 and 2.9–4.4 mm (♂), 3.9–5.3 and 4.4–6.1 mm (♀), respectively.

Coloration of live animals red, orange to yellow (Fig. 7), with blackish to dark brown parallel bands on metaterga and prozonae; head and antennae blackish, legs dark to light brown (Fig. 7); coloration in alcohol, after a long term preservation, faded to pale yellowish (Figs 8, 9), the parallel bands faded to brownish to pale brown,

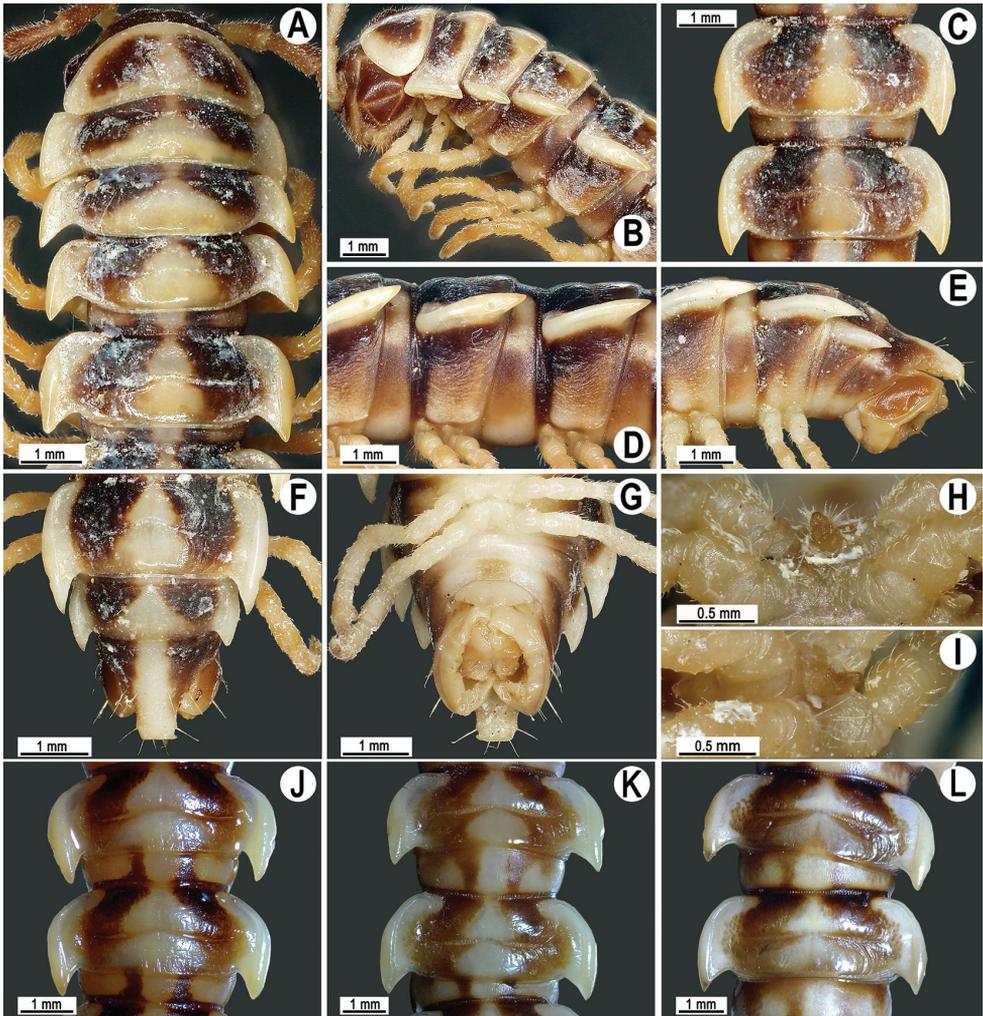


Figure 9. *Antheromorpha uncinata* (Attems, 1931), ♂ from Wat Tham Phromlok Khaoyai (**A–I**), ♂ from Tham Prakaipheth (**J**), ♂ from Tham Phet Phothong (**K**), male from Thap Sakae (**L**). **A, B** anterior part of body, dorsal and lateral views, respectively **C, D, J–L** segments 10 and 11, dorsal, lateral, dorsal, dorsal and dorsal views, respectively **E–G** posterior part of body, lateral, dorsal and ventral views, respectively **H, I** sternal cones between coxae 4, subcaudal and sublateral views, respectively.

head and antennae light brown to dark brown, legs and venter light yellowish to pale yellowish (Figs 8, 9).

Clypeolabral region densely, vertex sparsely setose; epicranial suture distinct. Antennae long (Figs 7, 8A, B, 9A), extending behind metaterga 3 when stretched dorsally (♂, ♀). In width, head < collum < segment 4 < 3 < 2 < 5–17 (♂) or head < collum < segment 2 < 4 < 3 < 5–17 (♀), gently and gradually tapering thereafter. Collum with three transverse rows of setae: 4+4 in anterior, 2+2 in intermediate and 3+3 in pos-

terior row; caudal corner of paraterga rounded, declined, not extending behind rear tergal margin (Figs 8A, 9A).

Tegument smooth and shining, prozonae finely shagreened, metaterga leathery and faintly rugulose, surface below paraterga finely microgranulate. Postcollum metaterga with two transverse rows of setae traceable at least as insertion points when setae broken off: 2+2 in anterior (pre-sulcus) and 3+3 in posterior (post-sulcus) row. Tergal setae long, strong, slender, about 1/3 of metatergal length. Axial line visible only on metaterga. Paraterga very strongly developed (Figs 8A–G, 9A–G, J–L), especially well so in ♂, mostly upturned, subhorizontal, all lying below dorsum, set at about upper 1/3 of midbody height, caudal corner narrowly rounded to pointed, increasingly strongly spiniform and produced behind rear tergal margin, best developed and slightly curved mesad on segments 15–19; in lateral view, paraterga modestly enlarged on pore-bearing segments, thinner on poreless ones. Calluses delimited only by a dorsal sulcus. Paraterga 2 broad, anterior edge angular, lateral edge with one larger and two smaller, but evident incisions in anterior 1/3; posterior edge well concave (Fig. 9A). Following paraterga with anterior edge broadly rounded, bordered and fused to callus, lateral edge without incisions, caudal corners extending behind tergal margin, posterior edge oblique to clearly concave, especially well so in segments 16–19 (Figs 8F, 9F). Ozopores evident, lateral, lying in an ovoid groove at about 1/3 of metatergite's length in front of caudal corner. Transverse sulcus usually distinct (Figs 8A, C, F, 9A, C, F, J–L), complete on metaterga 5–18, shallow, not reaching bases of paraterga, very faintly beaded at bottom, incomplete and nearly wanting on segments 4 and 19. Stricture between pro- and metazonae wide, rather deep, beaded at bottom down to base of paraterga (Figs 8A–F, 9A–D, J–L). Pleurosternal carinae complete crests with a sharp caudal tooth on segments 2–4, thereafter crests bulged anteriorly and with a small, sharp, caudal tooth on segments 5–9, a very small denticle on segments 10–15 (♂) (Figs 8B, D, E, 9B, D, E) or crests bulged anteriorly and with a small, sharp, caudal tooth on segments 5–10, thereafter a very small denticle on segments 11–14 (♀). Epiproct (Figs 8E–G, 9E–G) conical, flattened dorsoventrally, with two evident, caudoventrally curved, apical papillae; tip subtruncate; pre-apical papillae small, but visible, lying rather close to tip. Hypoproct roundly subtrapeziform to subtriangular, setiferous knobs at caudal edge evident and well-separated.

Sterna sparsely setose, without modifications; a large, central, setose cone between ♂ coxae 4 (Figs 8H, J, 9H, J). No conspicuous ridge in front of gonopod aperture. Legs moderately long and slender, midbody ones ca 1.2–1.4 (♂) or 0.8–0.9 (♀) times as long as body height, prefemora without modifications, ♂ tarsal brushes present until legs of segment 17.

Gonopods (Figs 10–12) with femorite about 3 times as long as prefemoral (= strongly setose) part. Femorite rather stout and long, strongly curved, postfemoral portion demarcated by an oblique lateral sulcus; tip of solenophore (**sph**) rather deeply bifid; process **d** slender, rounded to nearly pointed; process **m** rounded, longer than process **v**.

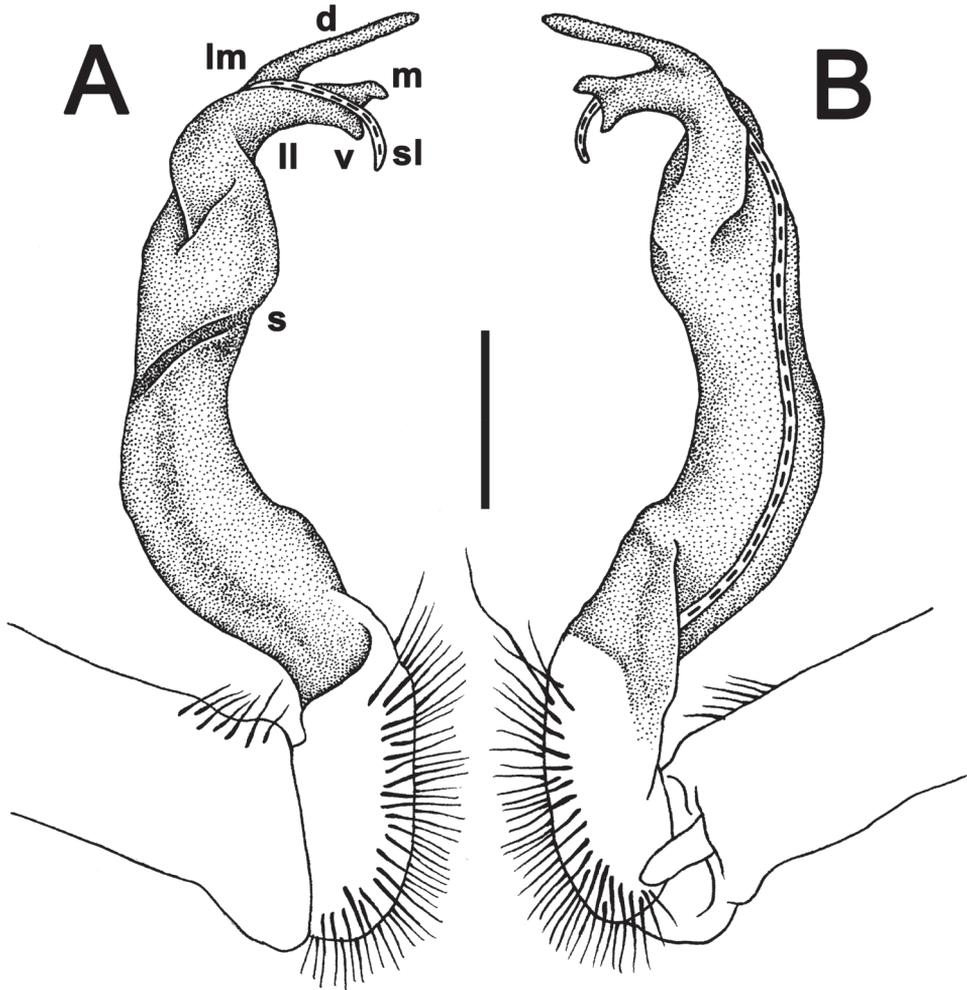


Figure 10. *Antheromorpha uncinata* (Attems, 1931), ♂ lectotype. **A, B** right gonopod, lateral and mesal views, respectively. Scale bar: 0.4 mm.

Remarks. This species was described from Muok Lek, Thailand (Attems 1931). Eng-hoff (2005), based on ZMUC material, added another four localities: Kamphaeng Phet Province; Sitang, Northeast Thailand; Phu Kradung; Phu Kugio, field on way to communist camp, Chayaphum Province. We revised Attems' type specimens, both in NHMW, and herewith designate a lectotype to ensure that the name-bearing specimen is a complete ♂. In most of their characters, the new samples are very similar to the type series except for body size and the shape of paraterga. In one and the same population, variation in the shape of paraterga is often observed, these ranging from more to less convex laterally and more or less strongly drawn caudad behind the rear tergal margin (Figs 8A, C, F, 9A,

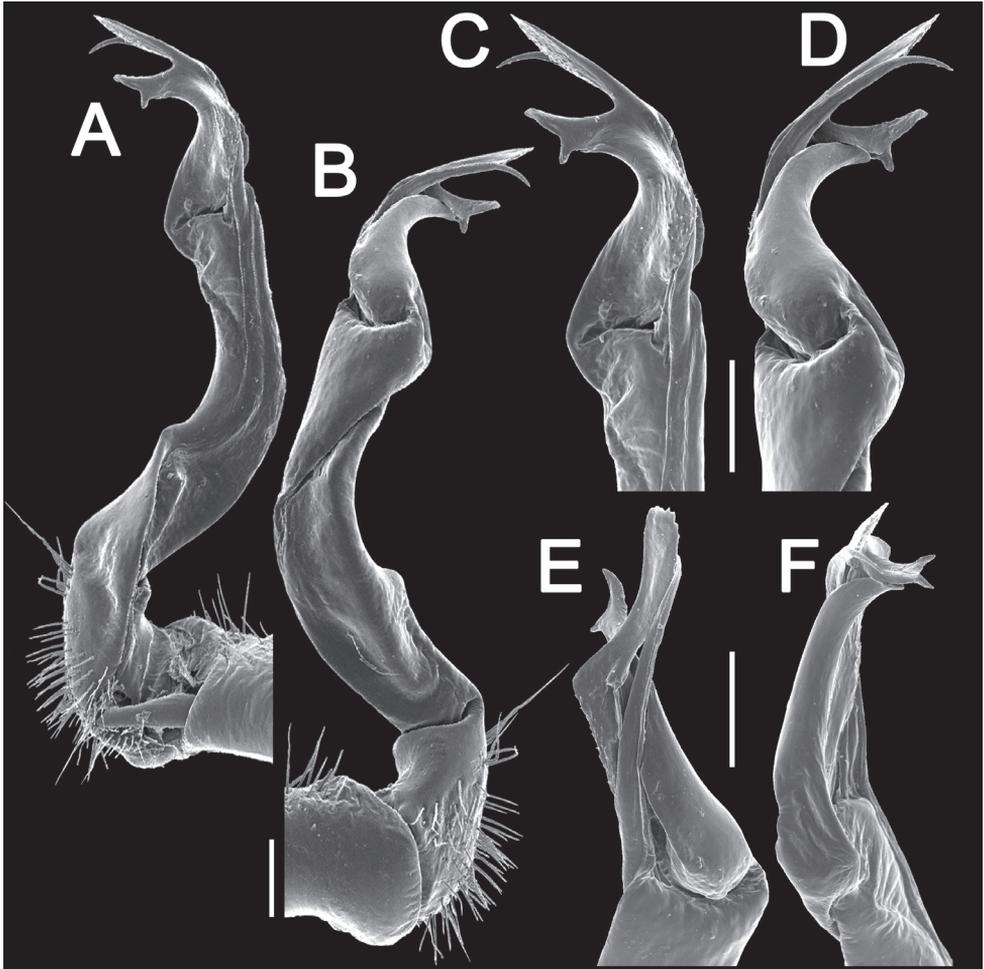


Figure 11. *Antheromorpha uncinata* (Attems, 1931), ♂ from Wat Tham Phromlok Khaoyai. **A, B** right gonopod, mesal and lateral views, respectively **C–F** distal part of right gonopod, mesal, lateral, subcaudal and suboral views, respectively. Scale bar: 0.2 mm.

C, F, J–L). In addition, colour variations can be seen, the body being mostly red (prevailing), orange or yellow, with all possible intergradations (Fig. 7). It is noteworthy that only adults show colour variations, whereas juveniles are colourless. At Pang Rimkorn, Chiang Rai Province, *A. uncinata* has been observed as showing swarming behaviour.

Antheromorpha rosea Golovatch, 2013

Figs 13–15, 21

Antheromorpha rosea Golovatch, 2013a: 23 (D).

Antheromorpha rosea – Golovatch 2013b: 308 (D); Nguyen and Sierwald 2013: 1235 (M).

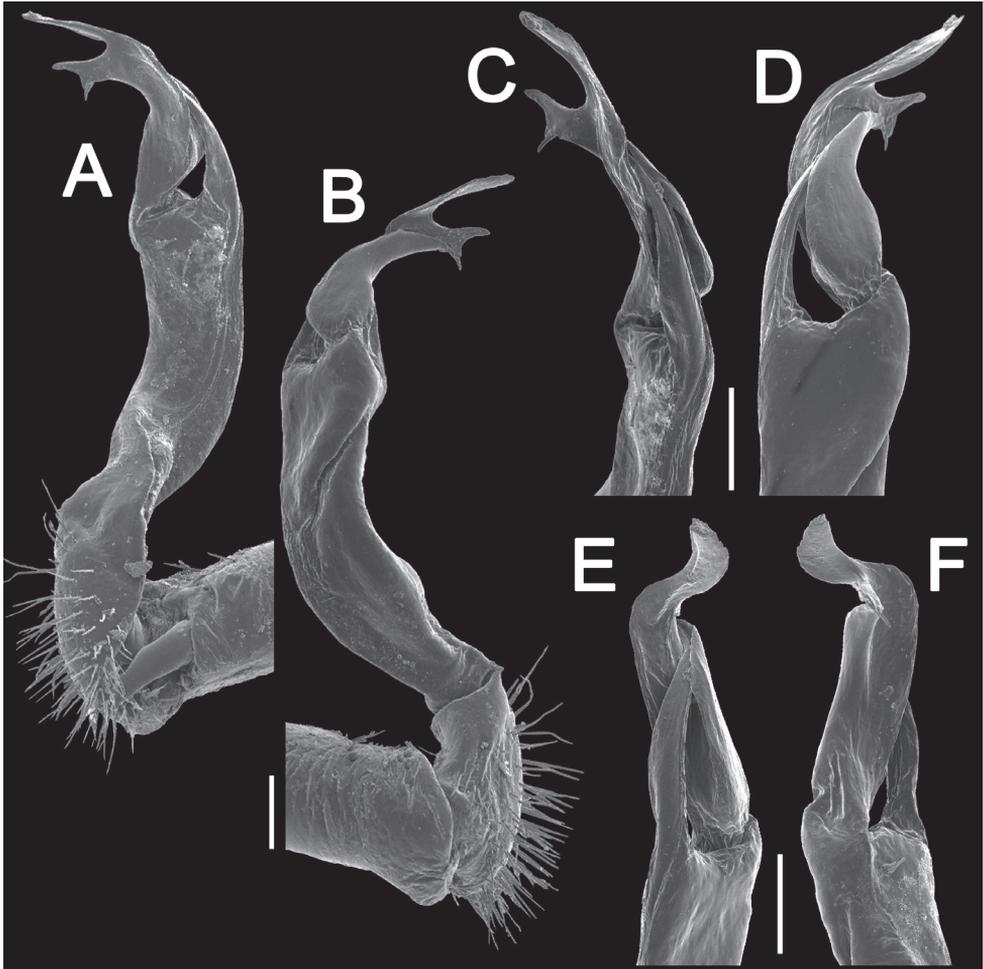


Figure 12. *Antheromorpha uncinata* (Attems, 1931), ♂ from Thap Sakae. **A, B** right gonopod, mesal and lateral views, respectively **C–F** distal part of right gonopod, submesal, sublateral, subcaudal and suboral views, respectively. Scale bar: 0.2 mm.

Material examined. 5 ♂, 9 ♀ (CUMZ), 1 ♂, 1 ♀ (ZMUM 03057), 1 ♂, 1 ♀ (ZMUC), 1 ♂, 1 ♀ (NHMW), Thailand, Chiang Mai Province, Mae Rim District, Queen Sirikit Botanic Garden, 18°53'47"N, 98°51'35"E, ca 640 m a.s.l., 25.09.2014, leg. N. Likhitrakarn. 2 ♂, 30 ♀ (CUMZ), same District, Pong Yang, Ban Muang Kham, 18°53'41"E, 98°49'31.59"E, ca 840 m a.s.l., 20.10.2014, leg. R. Saokord. 1 ♂ (CUMZ), same Province, Hang Dong District, Kaewtachang Waterfall, 18°48'15"E, 98°49'47"E, ca 590 m a.s.l., 24.10.2009, leg. N. Likhitrakarn. 1 ♂ (CUMZ), same Province, Chiang Dao District, Wat Tam Pha Plong, 19°24'13"E, 98°55'16"E, 470 m a.s.l., 28.09.2010, leg. N. Likhitrakarn. 1 ♂ (CUMZ), same Province, Mae Taeng District, Cave Buathong, 19° 4'31.06"N, 99° 5'9.45"E, ca 530 m a.s.l., 22.11.2012, leg. N. Likhitrakarn.

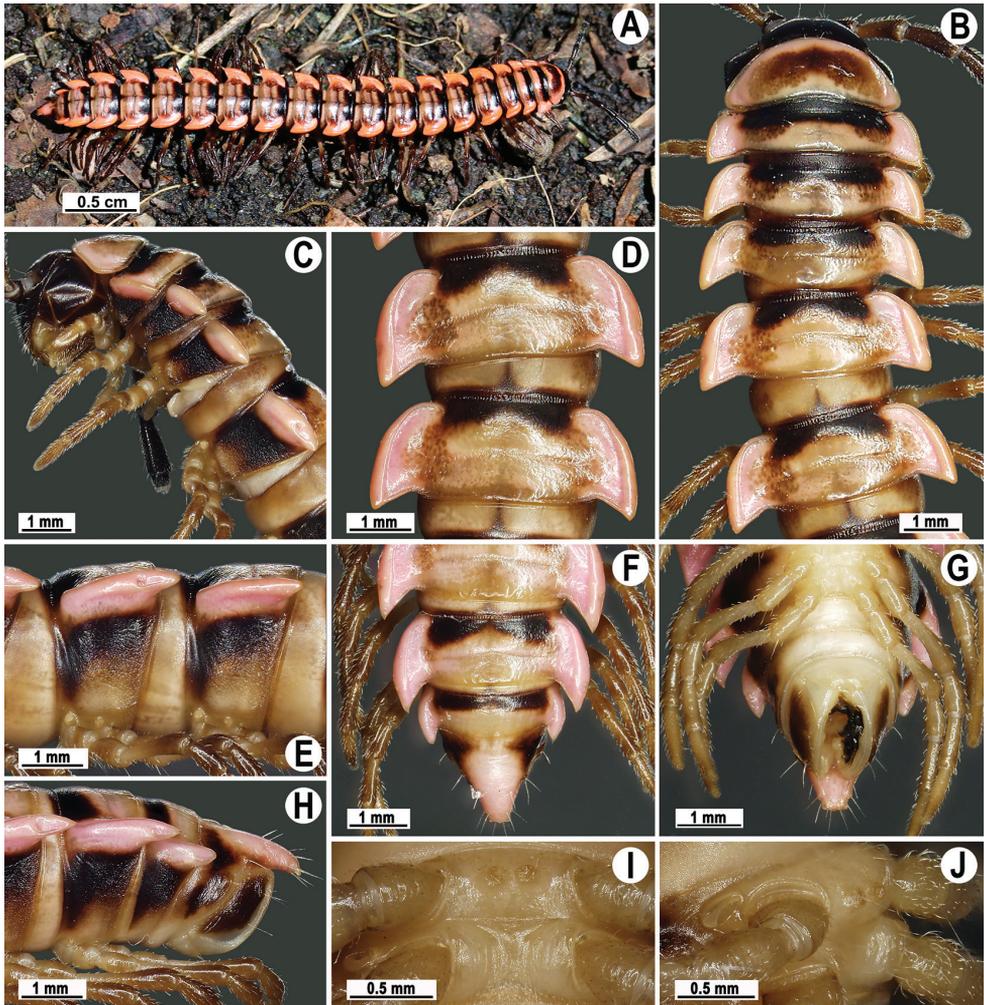


Figure 13. *Antheromorpha rosea* Golovatch, 2013, ♂ from Queen Sirikit Botanic Garden. **A** habitus, live coloration **B, C** anterior part of body, dorsal and lateral views, respectively **D, E** segments 10 and 11, dorsal and lateral views, respectively **F–H** posterior part of body, lateral, dorsal and ventral views, respectively **I, J** sternal cones between coxae 4, subcaudal and sublateral views, respectively.

Descriptive notes. Length 33.5–38.0 (♂) or 34.0–44.5 mm (♀), width of mid-body pro- and metazonae 2.6–3.5 and 4.4–5.0 mm (♂), 3.2–4.2 and 4.9–5.8 mm (♀), respectively.

Coloration of live animals pinkish (Fig. 13A), with an anterior black band on metaterga and collum; head and antennae blackish, legs dark to light brown; coloration in alcohol, after six months of preservation, faded to light pinkish to pale yellowish (Fig. 13B–H), with a dark brown to blackish brown band on anterior metaterga and collum; head and antennae blackish to light brown, legs light brown to pale yellowish.

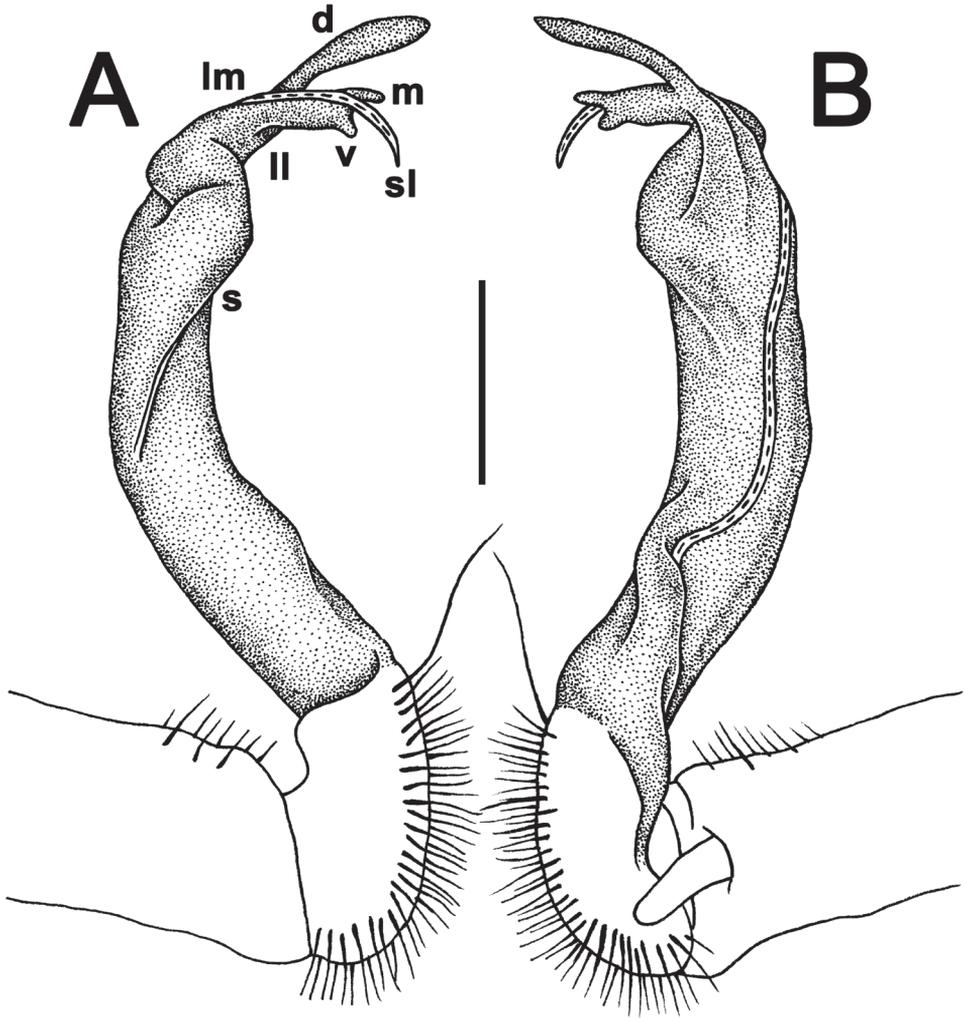


Figure 14. *Antheromorpha rosea* Golovatch, 2013, ♂ from Queen Sirikit Botanic Garden. **A, B** right gonopod, lateral and mesal views, respectively. Scale bar: 0.4 mm.

Antennae long (Fig. 13A, C), extending behind metaterga 3 when stretched dorsally (♂, ♀). In width, head < segment 3 = 4 < collum < segment 2 < 5–17 (♂, ♀), gently and gradually tapering thereafter (Fig. 13B). Paraterga very strongly developed (Fig. 13B–H), mostly slightly upturned, all lying below dorsum, set at about upper 1/3 of midbody height, caudal corner almost to fully pointed, increasingly acutangular, from narrowly rounded to nearly pointed, especially strongly so in segment 15, thereafter slightly curved mesad (Fig. 13B, D, F). Pleurosternal carinae complete crests with a sharp caudal tooth in segment 2, likewise a sharp caudal tooth in segments 3 and 4, a small, mostly sharp tooth until segment 16 (♂, ♀) (Fig. 13C, E). Sterna delicately

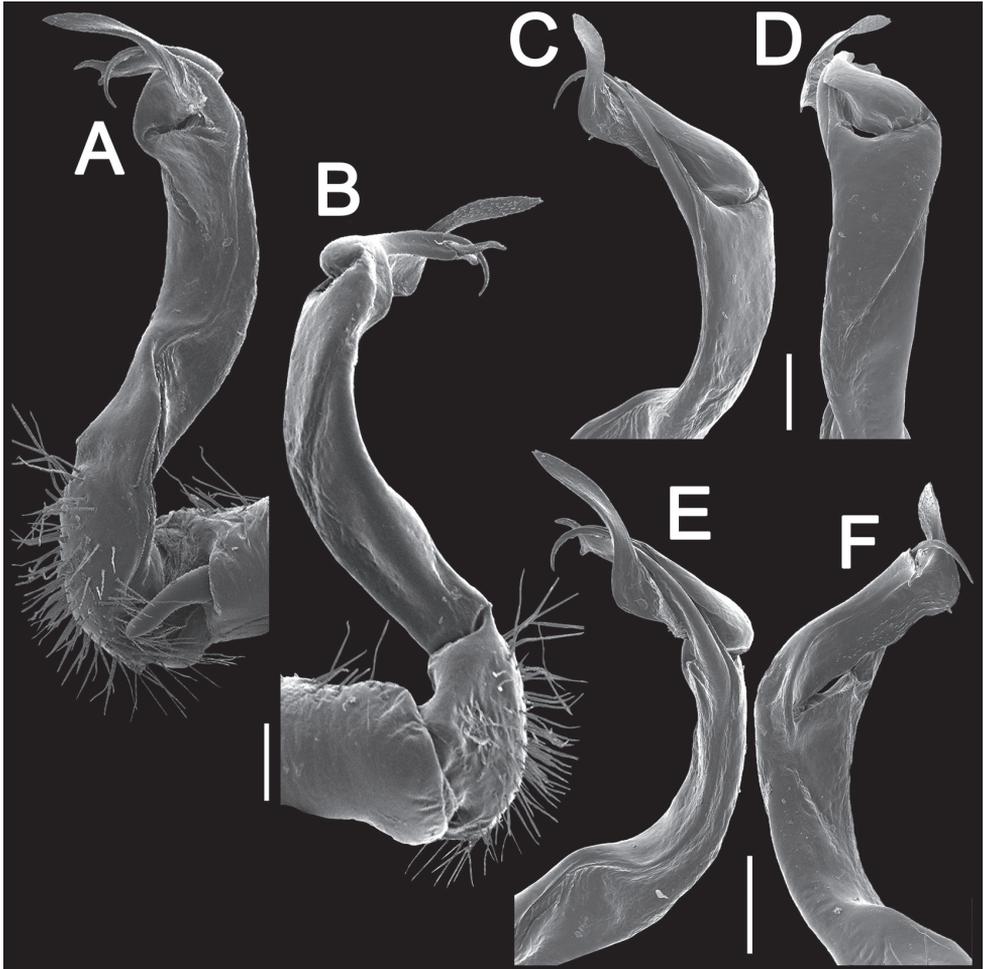


Figure 15. *Antheromorpha rosea* Golovatch, 2013, ♂ from Queen Sirikit Botanic Garden. **A, B** right gonopod, mesal and lateral views, respectively **C–F** distal part of right gonopod, subcaudal, suboral, submesal and sublateral views, respectively. Scale bar: 0.2 mm.

and sparsely setose, without modifications, but with a pair of small, rounded, fully separated cones between ♂ coxae 4 (Fig. 13I, J).

Remarks. The available descriptions (Golovatch 2013a, 2013b) of this species were sufficiently detailed to necessitate only a few notes on variation and some new illustrations (Figs 13–15) to show coloration, certain structural details and the gonopod conformation based on new material. This species was described from the ♂ holotype (kept in Senckenberg Museum Frankfurt, Germany) from Gaoligong Shan Moutains, south of Pianma, 25°58'N, 98°40'E, 1600–1700 m a.s.l., Yunnan Province, China (Golovatch 2013a), a little later reported (1 ♂, 1 ♀, deposited in the National Natural

History Museum, Sofia, Bulgaria) nearly from the same place (Golovatch 2013b). Even though both these Yunnan localities (Fig. 21) lie far away (ca 730 air-km) from the new Thai records, even despite minor variations, the species identity is beyond doubt.

At least in Thailand, adult *A. rosea* have been found to occur every year only for one or two weeks in September or October, disappearing thereafter.

***Antheromorpha festiva* (Brölemann, 1896)**

Figs 16–18, 21

Orthomorpha festiva Brölemann, 1896: 1 (D).

Orthomorpha festiva – Attems 1898: 339 (M); 1914: 194 (D); 1930: 131 (D); Brölemann 1904: 4 (D, R).

Orthomorpha (*Orthomorpha*) *festiva* – Attems 1936: 199 (M); 1937: 60 (D).

“*Orthomorpha*” *festiva* – Jeekel 1963: 269 (M).

Antheromorpha festiva – Jeekel 1968: 57 (M); 1980: 85 (M); Golovatch 1983: 181 (M); Enghoff et al. 2004: 37 (M); Enghoff 2005: 95 (R); Nguyen and Sierwald 2013: 1234 (R).

Material examined. 3 ♂ (CUMZ), Thailand, Nakhon Si Thammarat Province, Mueang Nakhon Si Thammarat District, Siamthani village, 8°27'53"N, 99°58'10"E, ca 5 m a.s.l., 11.01.2009, leg. N. Likhitrakarn. 1 ♂ (CUMZ), Surat Thani Province, Phanom District, Khao Sok Evergreen House Hotel, 8°54'38"N, 98°31'48"E, leg. C. Sutcharit. 1 ♂ (CUMZ), same Province, Kanchanadit District, Khao Phanom Wang, 9°05'33"N, 99°36'18"E, ca 40 m a.s.l., 15.01.2014, leg. R. Saokord. 12 ♂, 3 ♀ (CUMZ), Satun Province, Mueang Satun District, Wat Kao Noi, 6°45'11"N, 100°01'46"E, ca 40 m a.s.l., 16.01.2014, leg. C. Sutcharit. 7 ♂, 7 ♀ (CUMZ), 2 ♂, 2 ♀ (ZMUM Q3058), 2 ♂, 2 ♀ (ZMUC), 2 ♂, 2 ♀ (NHMW), same District, Wat Khao Nom Phothiyan, 8°57'22"N, 98°48'20"E, ca 55 m a.s.l., 16.01.2014, leg. R. Saokord and C. Sutcharit. 4 ♂ (CUMZ), Malaysia, Johor, Sungai Bekok, 2°07'11"N, 103°02'25"E, 35 m a.s.l., 21.05.2011, leg. R. Chanabun. 1 ♂ (CUMZ), Perak, Sungai Terong, 4°38'22"N, 100°42'50"E, 30 m a.s.l., 05.06.2014, leg. R. Saokord. 8 ♂, 10 ♀ (CUMZ), 1 ♂, 1 ♀ (ZMUC), 1 ♂, 1 ♀ (NHMW), same state, Kuala Kangsar, Kampung S. Ramasamy, 4°46'55"N, 101°07'14"E, ca 120 m a.s.l., 06.06.2014, leg. R. Saokord.

Redescription. Length 23.0–29.5 (♂) or 26.0–34.5 mm (♀), width of midbody pro- and metazonae 1.8–2.5 and 2.9–3.7 mm (♂), 2.7–3.1 and 3.6–4.4 mm (♀), respectively (vs length 28–30 mm, as given in the available descriptions (Brölemann 1896; Attems 1937).

Coloration of live animals dark red to red-brownish, with contrasting light red to pale pinkish paraterga and epiproct; a complete inverted V-shaped line on collum, a pair of parallel oblique bands on metazonae and a pair of parallel bands on prozonae

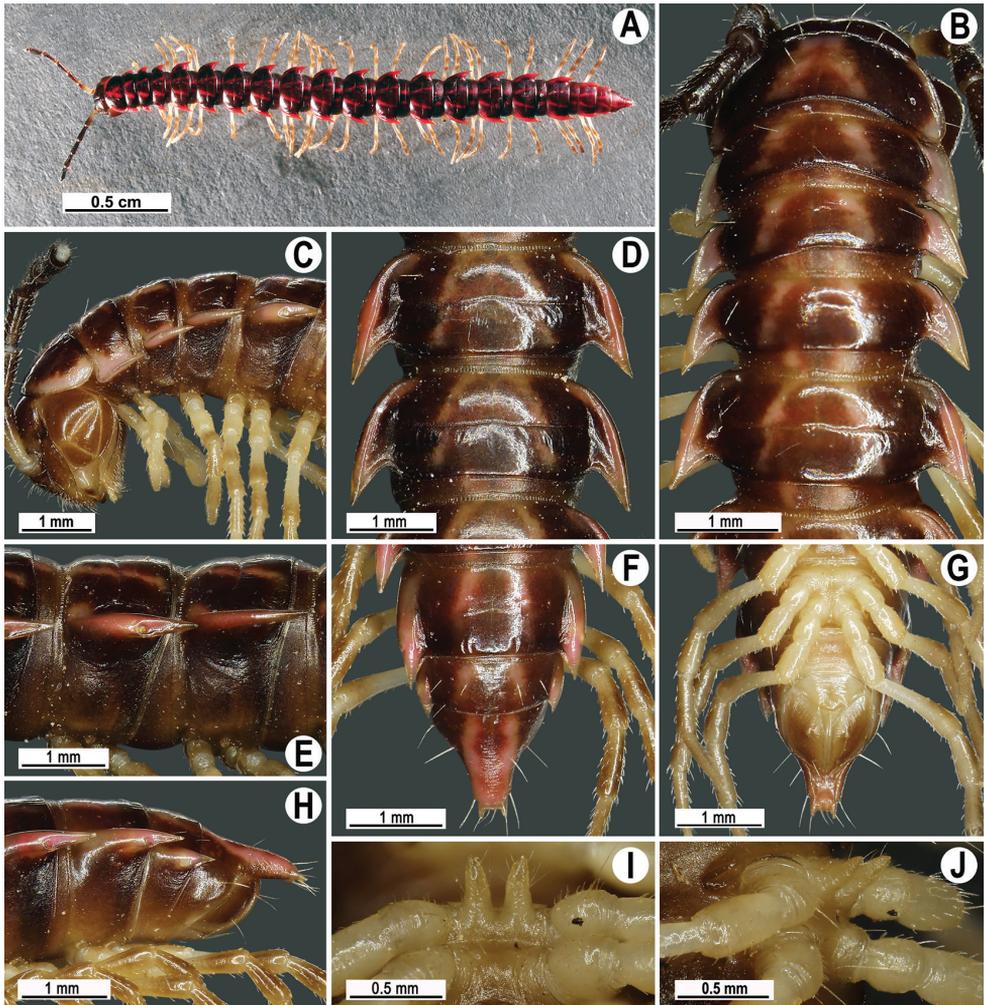


Figure 16. *Antheromorpha festiva* (Brölemann, 1896), ♂ from Sungai Bekok (A), ♂ from Kampung S. Ramasamy (B–J). A habitus, live coloration B, C anterior part of body, dorsal and lateral views, respectively D, E segments 10 and 11, dorsal and lateral views, respectively F–H posterior part of body, lateral, dorsal and ventral views, respectively I, J sternal cones between coxae 4, subcaudal and sublateral views, respectively.

of following segments; legs and venter brownish to pale brown; coloration of alcohol material after one year of preservation faded to castaneous or pale brown; paraterga, epiproct and parallel bands faded to pale pinkish or pale yellow, legs and venter paler brown to yellowish (Fig. 16B–J).

Clypeolabral region sparsely setose, epicranial suture distinct. Antennae short (Fig. 16A), reaching anterior edge of body segment 3 (♂) or 2 (♀) when stretched dorsally (antennomere 6 broadest). In width, head < collum < segment 2 < 3 < 4 < 5–16, gently

and gradually tapering thereafter. Collum with three transverse rows of setae: 3+3 in anterior, 1+1 in intermediate and 3+3 in posterior row, the latter mostly traceable as insertion points; caudal corner broadly rounded, slightly bordered and declined ventrally, not extending behind tergal margin (Fig. 16B, C).

Tegument smooth and shining, prozonae very finely shagreened, metazonae smooth and delicately rugulose; surface below paraterga finely microgranulate. Post-collum metaterga with two transverse rows of setae, these being always abraded and traceable as insertion points: 2+2 in anterior (pre-sulcus) row, 3+3 in posterior (post-sulcus) one. Tergal setae simple, slender, about 1/3 of metatergal length. Axial line visible both on pro- and metazonae, starting with collum. Paraterga very strongly developed (Fig. 16A–H), subhorizontal, all lying below dorsum, set at about upper 1/3 of midbody height, anterior edge of paraterga broadly rounded, bordered and fused to callus; lateral edge of paraterga 2 with three small incisions, but on following segments smooth with only insertion points of setae (at fore 1/4), mostly abraded; caudal corner almost completely to fully pointed, always extending behind rear tergal margin, bent posteriad on segments 17 and 18; posterior edge evidently concave (Fig. 16B, D, F). Calluses delimited by a sulcus both dorsally and ventrally. Ozopores evident, lateral, lying in an ovoid groove at about 1/2 of metatergite's length. Transverse sulcus usually distinct (Fig. 16B, D–F), complete on metaterga 5–17, incomplete on segments 4 and 18, narrow, wave-shaped, not reaching bases of paraterga, faintly beaded at bottom. Stricture between pro- and metazonae wide, deep, beaded at bottom down to base of paraterga (Fig. 16B–F). Pleurosternal carinae complete crests only on segments 2–4, each with an evident sharp denticle caudally on segments 5–8 (♂, ♀), thereafter increasingly reduced until segment 13 (♂) or 10 (♀). Epiproct (Fig. 16F–H) conical, flattened dorsoventrally, with two evident apical papillae, tip subtruncate; pre-apical papillae small, but visible. Hypoproct (Fig. 16G) roundly subtriangular, setiferous knobs at caudal edge well-separated.

Sterna sparsely setose, without modifications; a high paramedian pair of evident, high, nearly pointed, fully separated, setose cones between ♂ coxae 4 (Fig. 16I, J). Legs moderately long and slender, midbody ones ca 1.2–1.4 (♂) or ca 1.0–1.2 times (♀) as long as body height, prefemora without modifications, ♂ tarsal brushes present until segment 16.

Gonopods (Figs 17, 18) with femorite relatively short and rather stout, evidently curved and enlarged distad, postfemoral portion demarcated by an oblique lateral sulcus; tip of solenophore (**sph**) very deeply bifid, with a long, slender, nearly pointed process **d**; process **m** with an acute terminal lobule, longer than a small and terminally rounded process **v**.

Remarks. The new specimens fully agree with the most detailed and beautifully illustrated redescription of the species as given by Brölemann (1904), whereas the original description (Brölemann 1896) was indeed so concise and contained no type locality other than “Indo-Chine” that Attems (1937), obviously being unaware of Brölemann's 1904 paper, reiterated only the very short diagnosis of *Orthomorpha festiva*

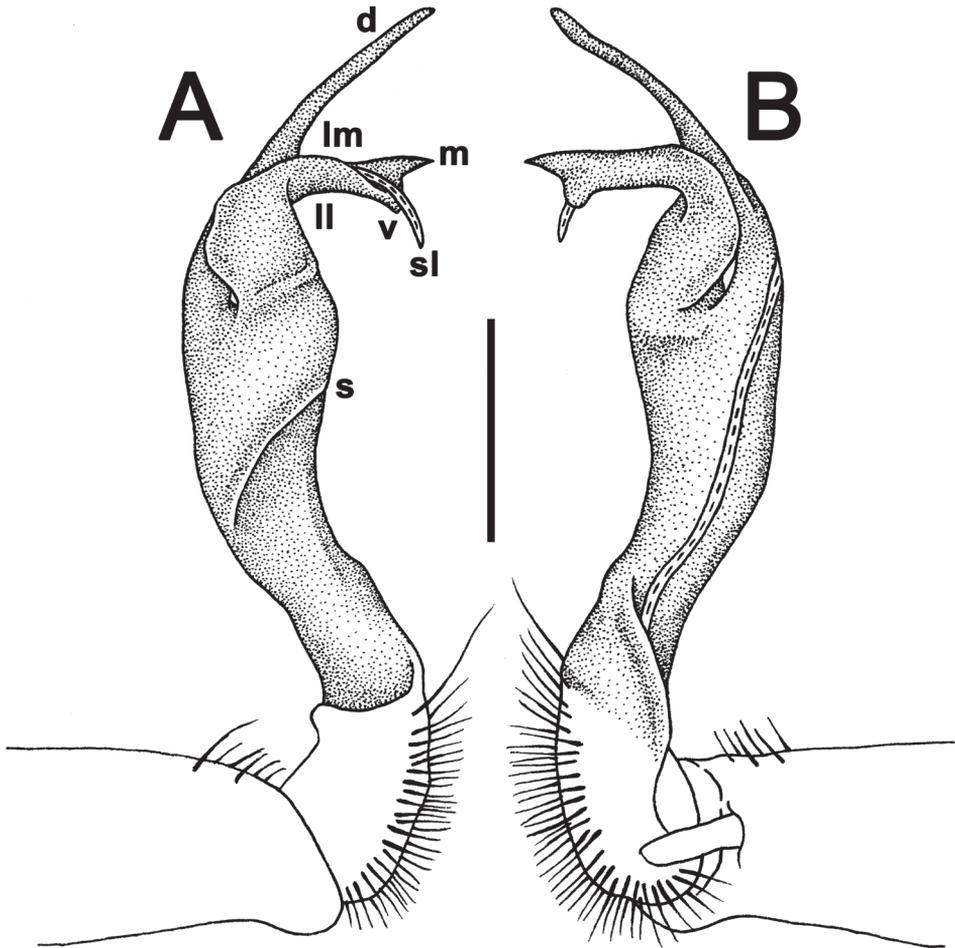


Figure 17. *Antheromorpha festiva* (Brölemann, 1896), ♂ from Kampung S. Ramasamy. **A, B** right gonopod, lateral and mesal views, respectively. Scale bar: 0.4 mm.

contained in Brölemann (1896). According to Brölemann (1904), however, this species (1 ♂ and 1 ♀ syntypes, now in the Paris Museum) actually derived from “Siam”. Enghoff et al. (2004), likewise unaware of Brölemann’s (1904) detailed redescription, erroneously listed *A. festiva* as coming from “southern Vietnam”, but very soon after that the mistake was corrected for “Siam” (Enghoff 2005).

The above samples thus derive from the first specified localities in Thailand. Moreover, *A. festiva* appears to be not only new to the fauna of Malaysia, but it also seems to be quite widespread across the southern half of Malay Peninsula both within lowland southern Thailand and Western Malaysia, being confined there to elevations not exceeding 60 m a.s.l. (Fig. 21).

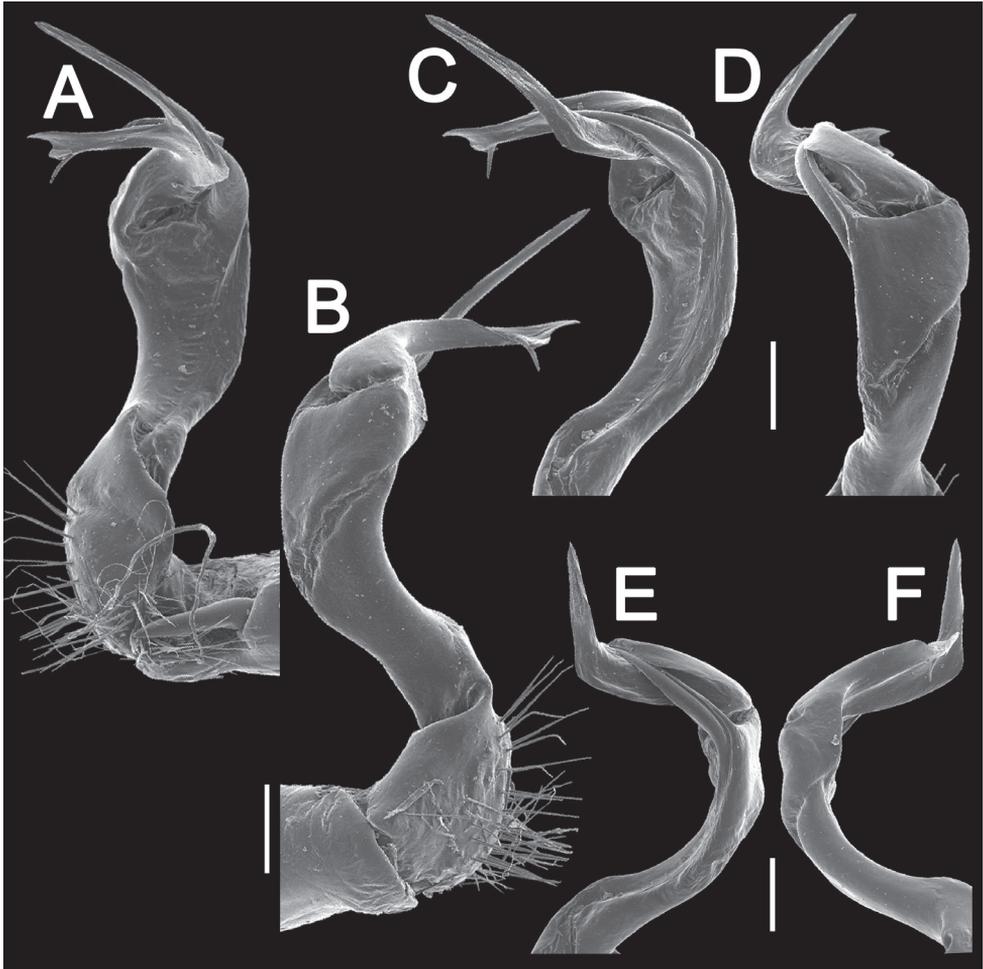


Figure 18. *Antheromorpha festiva* (Brölemann, 1896), ♂ from Kampung S. Ramasamy. **A, B** right gonopod, mesal and lateral views, respectively **C–F** distal part of right gonopod, submesal, sublateral, subcaudal and suboral views, respectively. Scale bar: 0.2 mm.

***Antheromorpha harpaga* (Attems, 1937)**

Figs 19–21

Orthomorpha harpaga Attems, 1937: 77 (D).

Orthomorpha harpaga – Attems 1938: 211 (D).

“*Orthomorpha*” *harpaga* – Jeekel 1963: 269 (M).

Antheromorpha harpaga – Jeekel 1968: 57 (M).

Antheromorpha harpaga – Jeekel 1980: 85 (M); Golovatch 1983: 181 (M); Enghoff et al. 2004: 37 (M); Nguyen and Sierwald 2013: 1234 (M).

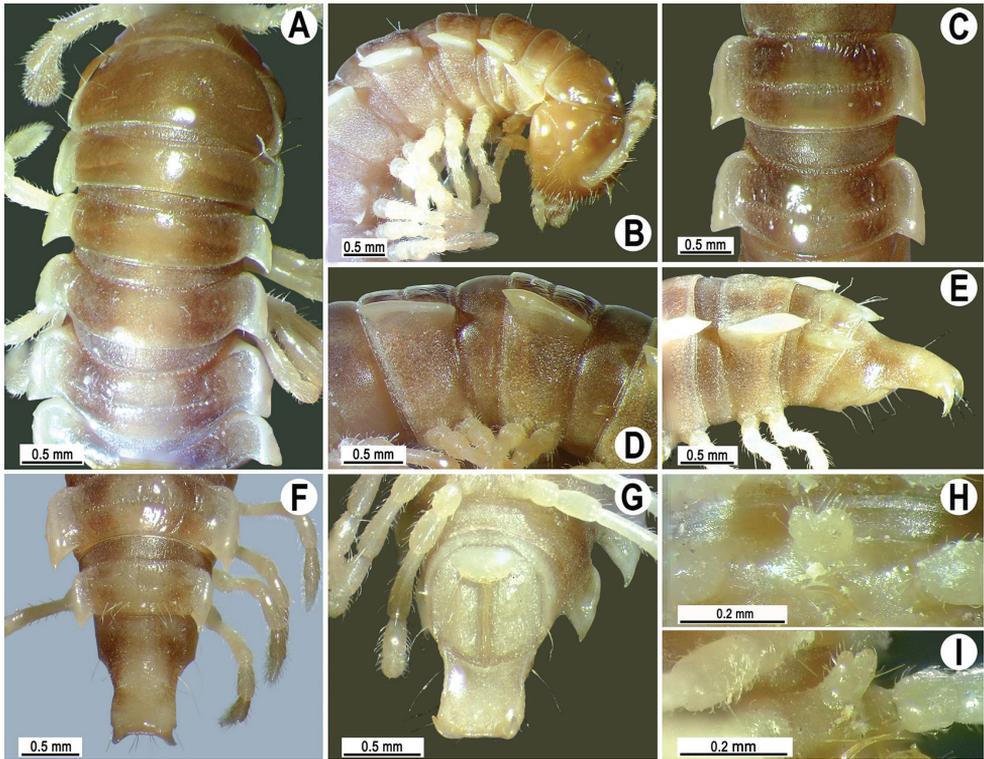


Figure 19. *Antheromorpha harpaga* (Attems, 1937), ♂ lectotype. **A, B** anterior part of body, dorsal and lateral views, respectively **C, D** segments 10 and 11, dorsal and lateral views, respectively **E–G** posterior part of body, lateral, dorsal and ventral views, respectively **H, I** sternal cones between coxae 4, subcaudal and sublateral views, respectively.

Lectotype ♂ of *Orthomorpha harpaga* (NHMW-3495), Vietnam, Khánh Hòa Province, 15 km southwest of Ngatrang, Souidau (= Cam Lam-Suoi Cat 1), 06.1933, leg. C. Dawydoff.

Paralectotype. 1 ♂ (NHMW-3495), same locality, together with lectotype.

The lectotype is designated here to ensure that the name-bearing specimen is a complete ♂.

Redescription. Length 19–21 mm (♂), width of midbody pro- and metazonae 1.8–1.9 and 2.3–2.6 mm, respectively (vs 1.8 and 2–2.5 mm in width of pro- and metazonae, respectively, as given in the available descriptions (Attems 1937, 1938)). Coloration in alcohol, after long-term preservation, uniformly brown with a pale yellowish median stripe (Fig. 19A–F), paraterga and epiproct pale whitish yellow or pale brown; antennae, legs and sterna whitish to pale brown.

Clypeolabral region sparsely setose, epicranial suture distinct. Antennae short (Fig. 19A), clavate (antennomere 6 broadest), reaching anterior edge of body segment 3 when stretched dorsally. In width, head < collum < segment 3 = 4 < segment 2 < 5–17,

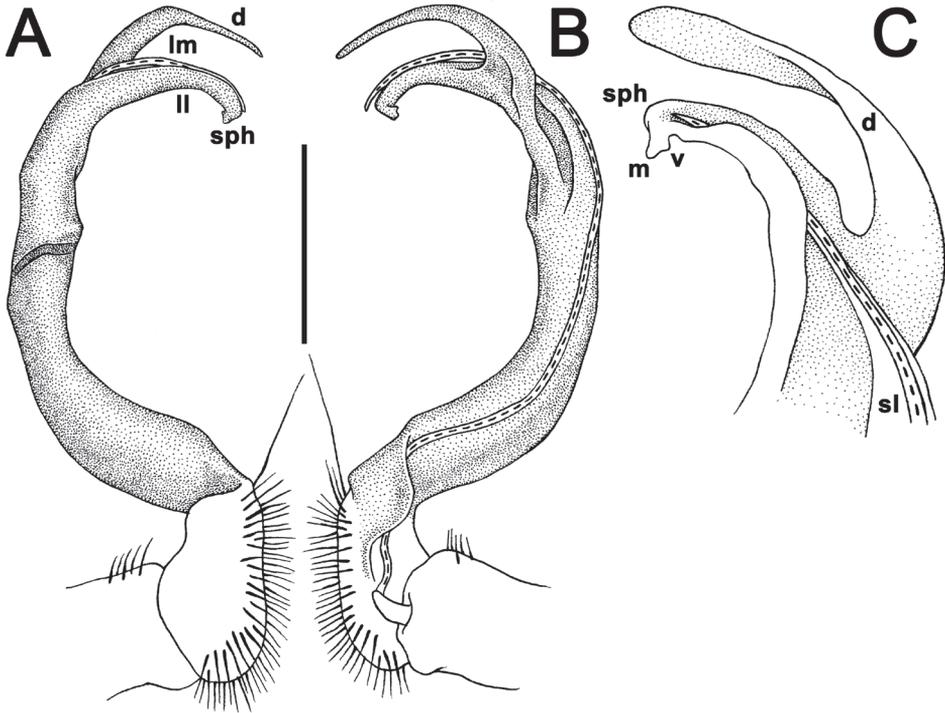


Figure 20. *Antheromorpha harpaga* (Attems, 1937), ♂ lectotype. **A, B** right gonopod, lateral and mesal views, respectively **C** left gonopod, lateral view. Scale bar: **A, B** 0.4 mm **C** drawn not to scale.

gently and gradually tapering thereafter. Collum with three transverse rows of setae: 4+4 in anterior, 3+3 in intermediate and 3+3 barely traceable insertion points in posterior row; caudal corner broadly rounded, slightly bordered and declined ventrally, not extending behind tergal margin (Fig. 19A, B).

Tegument smooth and finely shargreened, metaterga smooth and delicately rugulose; surface below paraterga finely microgranulate. Postcollum metaterga with two transverse rows of setae traceable at least as insertion points when setae broken off: 2+2 in anterior (pre-sulcus), 3+3 in posterior (post-sulcus) row. Tergal setae simple, slender, about 1/3 of metatergal length. Axial line barely visible, starting with collum. Paraterga very strongly developed (Fig. 19A–G), slightly upturned, all lying below dorsum, set at about upper 1/3 of midbody height, anterior edge of paraterga broadly rounded, bordered and fused to callus; lateral edge of paraterga 2 with three small incisions, with two small incisions in anterior half on poreless segments, with only one incision near front 1/3 on pore-bearing ones; caudal corner of paraterga narrowly rounded, increasingly well pointed on paraterga 16–19; paraterga bent posteriad, extending behind tergal margin; posterior edge oblique. Calluses delimited by a sulcus only dorsally. Ozopores evident, lateral, lying in an ovoid groove at about 1/4 of metaterga's length in front of caudal corner. Transverse sulcus usually distinct

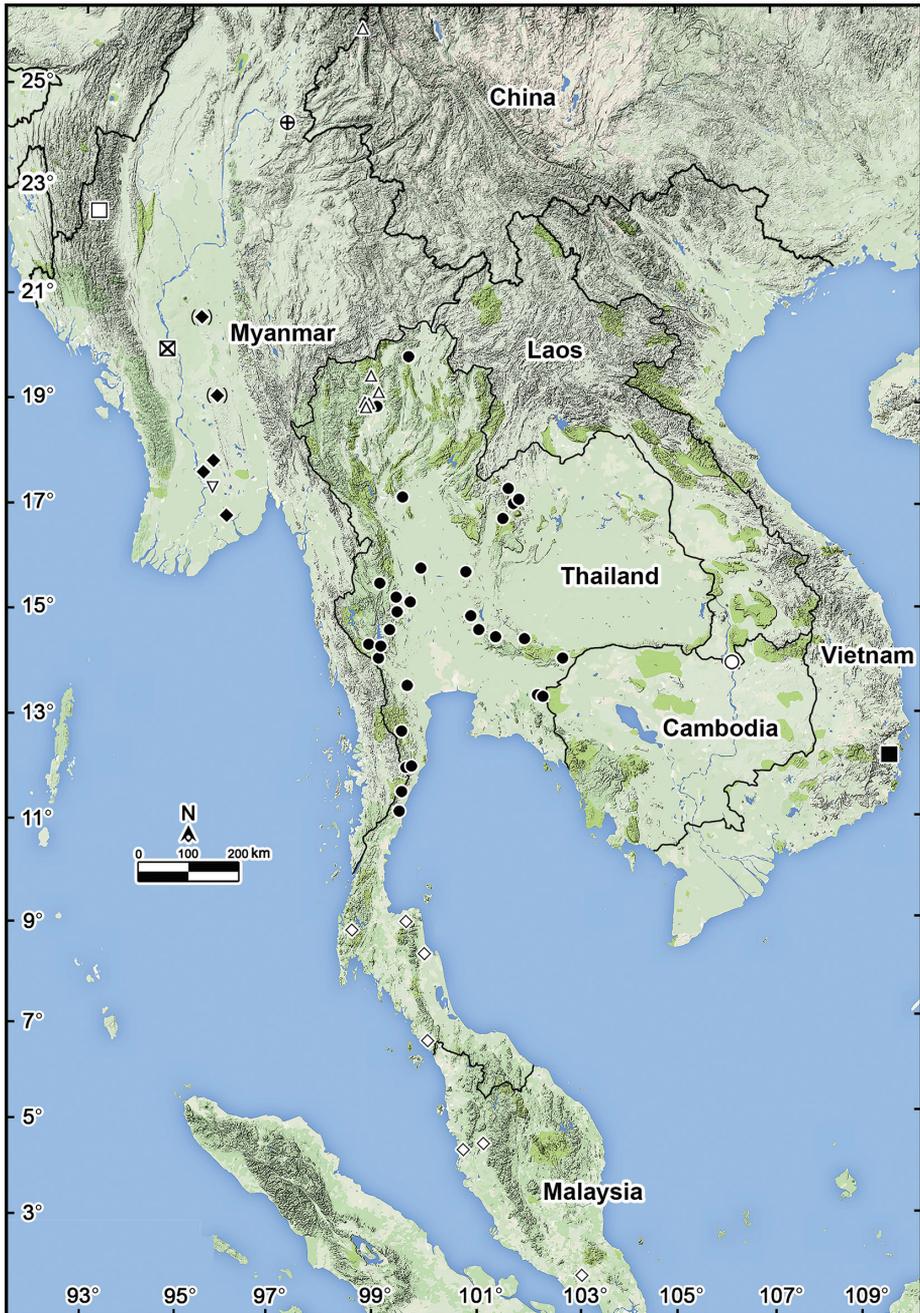


Figure 21. Distribution of *Antheromorpha* species (11 species). **Open triangle** *A. rosea* Golovatch, 2013 **Crossed circle** *A. bistrata* (Pocock, 1895) **Open square** *A. comotti* (Pocock, 1895) and *A. mediovirgata* (Carl, 1941) **Filled diamond** *A. miranda* (Pocock, 1895) **Crossed square** *A. comotti* (Pocock, 1895), *A. miranda* (Pocock, 1895) and *A. minlana* (Pocock, 1895) **Inverted open triangle** *A. pardalis* (Pocock, 1895) **Filled Circle** *A. uncinata* (Attems, 1931) **Open Circle** *A. paviei* (Brölemann, 1896) **Filled square** *A. harpaga* (Attems, 1937) **Open diamond** *A. festiva* (Brölemann, 1896).

(Fig. 19A, C, F), complete on metaterga 5–18, incomplete on segment 19, wide, line-shaped, reaching bases of paraterga, evidently ribbed at bottom. Stricture between pro- and metazonae wide, shallow, clearly ribbed at bottom down to base of paraterga (Fig. 19A–F). Pleurosternal carinae complete crests with a sharp caudal tooth on segments 2–4, bulged anteriorly and with a sharp caudal tooth on segments 5–7, thereafter only a small, sharp, caudal tooth on segments 8–11 (Fig. 19B, D, E). Epiproct (Fig. 19E–G) large, subrectangular, flattened dorsoventrally, with two apical papillae remarkably curved caudoventrally, claw-shaped; tip subtruncate; pre-apical papillae small, but visible, lying rather close to tip. Hypoproct semi-circular, setiferous knobs at caudal edge well-separated.

Sterna sparsely setose, without modifications; a high, subcordiform, sternal lobe between ♂ coxae 4 (Fig. 19H, I). Legs moderately long and slender, midbody ones ca 1.2–1.4 times as long as body height, prefemora without modifications, ♂ tarsal brushes present until legs of segment 18.

Gonopods (Fig. 20) long and slender. Prefemoral part about 3 times shorter than femorite (= strongly setose) part. Femorite slender, evidently curved, postfemoral part demarcated by an oblique lateral sulcus; tip of solenophore (**sph**) clearly deeply bifid, with a very long, slender, pointed process (**d**); processes **m** and **v** very small tubercles.

Remarks. This is the only species in this genus that has been reported from Vietnam (Attems 1937). It differs from congeners in the gonopod solenophore being deeply bifid and showing a long and slender process **d** and a bidentate tip (Fig. 20C).

Key to the known species of *Antheromorpha*, chiefly based on ♂.

- 1 Colour pattern of metaterga: yellowish paramedian spots in front of transverse sulcus, the latter visible starting with segment 2 *A. pardalis*
- Colour pattern of metaterga otherwise. Transverse sulcus present starting with segment 4 or 5 **2**
- 2 Colour pattern of metaterga: yellowish paramedian stripes **3**
- Colour pattern of metaterga otherwise **8**
- 3 Gonopod femorite relatively short (Figs 2A, 3A, 17, 18A, B) **4**
- Gonopod femorite longer (Figs 1D, E, 11A, B, 14, 15A, B, 20A, B) **6**
- 4 Metazonae ca 2.0 mm wide. Pleurosternal carinae poorly developed, in ♂ slightly projecting caudad behind rear tergal margin only until segment 5
..... *A. mediovirgata*
- Metazonae ≥ 2.9 mm wide. Pleurosternal carinae well-developed, in ♂ slightly projecting caudad behind rear tergal margin at least until segment 10 **5**
- 5 Sternal lamina between ♂ coxae 4 with a paramedian pair of evident, high, nearly pointed, fully separated, setose cones (Fig. 16I, J). Gonopod process **d** very long (Figs 17A, B, 18A, B). Southern Thailand and Western Malaysia (Fig. 21) *A. festiva*
- Sternal lamina between ♂ coxae 4 with only single small cone. Gonopod process **d** shorter (Fig. 2A). Northern Myanmar (Fig. 21) *A. bistriata*

- 6 Sternal lamina between ♂ coxae 4 a large, cordiform, ventrally evidently concave lobe (Fig. 2G). Gonopod solenophore longer and rather straight (Fig. 2H)..... ***A. comotti***
- Sternal lamina between ♂ coxae 4 a simple, rounded, conical knob. Gonopod solenophore evidently curved (Figs 1D, E, 3C).....7
- 7 Metazonae ca 2.6 mm (♂) or ca 3.0 mm wide (♀). Gonopod femorite rather straight, process **d** longer than solenophore (**sph**) (Fig. 3C).....***A. minlana***
- Metazonae 3.2–3.7 mm (♂) or 3.6–4.6 mm wide (♀). Gonopod femorite strongly curved caudad, process **d** shorter than solenophore (**sph**) (Fig. 1D, E) ***A. miranda***
- 8 Sternum between ♂ coxae 4 with a single lamina or cone (Figs 8H, I, 9H, I, 19H, I) **9**
- Sternum between ♂ coxae 4 with a pair of separated cones (Figs 4I, J, 13I, J) **10**
- 9 Colour pattern: a light axial stripe flanked on each side by a dark stripe on collum to epiproct (Figs 7, 8A, C, 9A, C, J–L). Epiproct simple, not especially large, with two small, but evident apical papillae (Figs 8E–G, 9E–G). Tip of gonopod split rather deeply, but process **d** shorter (Figs 10–12). Thailand (Fig. 21)..... ***A. uncinata***
- Colour pattern indistinct, with a pale yellowish median stripe against a uniformly brown background (Fig. 19A–F). Epiproct particularly large, with two apical papillae curved remarkably ventrad, claw-shaped (Fig. 19E–G). Tip of gonopod split deeper, process **d** very long (Fig. 20). Southern Vietnam (Fig. 21)..... ***A. harpaga***
- 10 Colour pattern: paraterga and epiproct contrasting dark yellow on a blackish body (Fig. 4A–H). Caudal corner of paraterga on anterior body part almost or fully pointed (Fig. 4A–H). ♂ tarsal brushes present until segment 8. Southern Laos (Fig. 21) ***A. paviei***
- Colour pattern: a dark band present only on posterior halves of proterga and posterior halves of metaterga (Fig. 13A–H). Caudal corner of paraterga on anterior body part narrowly rounded (Fig. 13A–H). ♂ tarsal brushes present until segment 17. Southern China and northern Thailand (Fig. 21)..... ***A. rosea***

Conclusions

As a result of our review, the genus *Antheromorpha* now comprises 11 species ranging from southern China, through Myanmar, Thailand, Laos and Vietnam, to Western Malaysia (Fig. 21). Allopatry seems to be prevailing if not complete. Even though Myanmar alone supports as many as six species of *Antheromorpha*, with *A. miranda*, *A. comotti* and *A. minlana* co-occurring at Minhla, *A. comotti* and *A. mediovirgata* in the Chin Hills and *A. miranda* and *A. pardalis* at Palon/Pegu, their strict sympatry remains questionable as the records from Myanmar are very old and thus somewhat uncertain.

The much better explored Thailand harbours three apparently strictly allopatric species. Even in Chiang Mai Province, where *A. uncinata* and *A. rosea* co-occur, allopatry looks complete, without any mixed populations observed.

The pair *A. uncinata* and *A. festiva* shows a remarkable geographical gap in southern Thailand, more specifically, in the northern half of the Malay Peninsula (Fig. 21). This gap strongly reminds of that observed between *Orthomorpha lauta* Golovatch, 1998 and *O. insularis* Pocock, 1895 (Likhitrakarn et al. 2011).

There can be no doubt that further collecting efforts, especially in still very poorly explored regions such as Laos, China, Malaysia and Vietnam, will reveal more *Antheromorpha* species, as well as further records of the known congeners. Cambodia remains an especially poorly prospected country in Indochina whence no *Antheromorpha* has been documented yet (Likhitrakarn et al. 2015).

Acknowledgements

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Two new species of the genus *Trouessartia* (Acari, Trouessartiidae) from laughingthrushes (Passeriformes, Leiothrichidae)

Ioana Cristina Constantinescu¹, Ioana Cobzaru²,
D. Khlur B. Mukhim³, Costică Adam¹

1 “Grigore Antipa” National Museum of Natural History, Sos. Kiseleff no.1, 011341 Bucharest, Romania
2 Ecology, Taxonomy and Nature Conservation Department, Institute of Biology, Romanian Academy, Splaiul Independenței no. 296, 060031 Bucharest, Romania **3** Zoology Department, Lady Keane College, 793001 Shillong, Meghalaya, India

Corresponding author: *Ioana Cristina Constantinescu* (cristinactinescu@yahoo.com)

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Abstract

Two new feather mite species of the genus *Trouessartia* Canestrini are described from laughingthrushes (Passeriformes: Leiothrichidae) captured in Meghalaya (India): *Trouessartia cyanouropterae* **sp. n.** from *Actinodura cyanouroptera* (Hodgson) and *Trouessartia alcippeae* **sp. n.** from *Alcippe nipalensis* (Hodgson). It is the first time when species of the genus *Trouessartia* are described from leiothrichids.

Keywords

Acari, Trouessartiidae, new species, systematics

Introduction

The feather mite genus *Trouessartia* Canestrini, 1899 comprises 110 species associated predominantly with birds from the order Passeriformes. A revision of this genus including 71 species was performed by Santana (1976); other species were described in

subsequent forty year by various authors (Mauri and De Alzuet 1968, Černý and Lukoschus 1975, Gaud 1977, Černý 1979, Mironov 1983, Gaud and Atyeo 1986, 1987, Mironov and Kopij 1996, 2000, Mironov and Galloway 2002, OConnor et al. 2005, Carleton and Proctor 2010, Constantinescu et al. 2013, Mironov and González-Acuña 2013, Hernandez 2014, Hernandez and Valim 2015). Santana (1976) estimated that species redescribed in his revision represent 10–15% of the real number of species. Hernandez and Valim (2015) suggested that this genus could possibly include over 500 species. Barreto et al. (2012) found 22 undetermined species of *Trouessartia* from Colombia, Silva et al. (2015) found 15 undetermined species of *Trouessartia* from Brazil and Atyeo (in McClure and Ratanaworabhan 1973) reported 162 undetermined species of the genus from Asia (unfortunately new species from this material have never been described).

In this paper two *Trouessartia* species are described from passerine birds of family Leiothrichidae, from the hosts *Actinodura cyanouroptera* (Hodgson) and *Alcippe nipalensis* (Hodgson). Atyeo (in McClure and Ratanaworabhan 1973) mentioned the existence of two new species of *Trouessartia* on these bird hosts, but as we noted above, that material remained undescribed. Thus, it is the first time when species of the genus *Trouessartia* are described from leiothrichid birds. Santana (1976) arranged some of species into five species groups, which were rather summarily defined. Gaud and Atyeo (1986, 1987) revised and gave expanded characteristics to the *appendiculata* and *minutipes* species groups; Mironov and Kopij (2000) revised *tenuipilata* species groups and established two more groups, *viduae* and *africana*. Both new species described herein cannot be referred to any of seven species groups that have been previously established in the genus *Trouessartia*, because of having a distinct combination of characters.

Materials and methods

The material used in the present paper was collected in Meghalaya (India) in February 2013. The birds were captured using mist-nets, identified, visually checked for the presence of mites and after collecting them were released back to the wild. Mite specimens were taken from birds manually with a needle and placed in vials with ethanol 96%. Later, in the laboratory, the mite specimens were cleared in lactic acid and mounted on microscope slides in Hoyer's medium. Drawings were made using an Olympus CX21 microscope, with a camera lucida drawing device. The bird specimens were identified according to Rasmussen and Anderton (2012) and Grimmett et al. (2011), and the taxonomy of the birds follows Clements et al. (2015). The setation of mite's body follows that of Griffiths et al. (1990) with modifications of Norton (1998) concerning coxal setae, while the setation of legs follows Gaud and Atyeo (1996). Descriptions of *Trouessartia* species are given according to the standards proposed for mites of the genus *Trouessartia* and related genera (Orwig 1968, Santana 1976), and the measuring techniques of particular structures used in the present paper were described by Mironov and González-Acuña (2013). We give the full set of measurements

for a holotype (male) and a range of measurements for corresponding paratypes. All measurements are in micrometres (μm). The holotypes and all paratypes of the new species are deposited in the Acarological Collection of the "Grigore Antipa" National Museum of Natural History, Bucharest, Romania.

Results

Family Trouessartiidae Gaud, 1957

Genus *Trouessartia* Canestrini, 1899

Trouessartia cyanouopterae Constantinescu, sp. n.

<http://zoobank.org/46E6D8B1-FBE0-4226-9632-0B0D829FCD84>

Figs 1–6

Type material. Male holotype (ANA623), 2 male (ANA624, ANA625) and 3 female (ANA626, ANA627, ANA628) paratypes 20.02.2013, from Blue-winged Minla *Actinodura cyanouoptera* (Hodgson) (Passeriformes, Leiothrichidae); **INDIA:** Meghalaya, Jaintia Hills, Khahnar village, (25°21'57.30"N, 92°36'51.72"E); 954 m; subtropical forest; collector D. Khlur B. Mukhim.

Description. MALE (Figs 1; 2; 3A–E; holotype, range for 2 paratypes in parentheses): Length of idiosoma from anterior end to bases of setae *h3* 344 (331–332), greatest width at level of humeral shields 164 (164–165). Length of hysterosoma from sejugal furrow to bases of setae *h3* 224 (208–216). Prodorsal shield length along midline 110 (90–95), greatest width in posterior part 122 (118–119), lateral margins not fused with scapular shields, with antero-lateral extensions produced laterally between bases of legs I, II, surface without ornamentation (Fig. 1). Internal scapular setae *si* filiform, 10 (11–12) long, separated by 50 (48–54); external scapular setae *se* situated on prodorsal shield, 96 (102–106) long, separated by 82 (80–84). Vertical setae *ve* represented only by alveoli. Humeral shield with setae *c2* filiform, 22 (21–22) long. Setae *c3* narrowly lanceolate with acute apex, 12 (13–14) long. Dorsal hysterosoma with prohysteronotal shield and lobar shield connected, delimited from each other by lateral incisions immediately posterior to setae *e2* and small desclerotized median area of rectangular form. Prohysteronotal shield length 142 (130–140), width at anterior margin 118 (104–114), lateral margins incised at level of trochanters III, bottom of these incisions with C-shaped dark sclerotisation, dorsal hysterosomal apertures (DHA) absent. Dorsal setae *d1*, *d2* present, minute. Length of lobar shield excluding lamellae 66 (60–70). Apical parts of opisthosomal lobes approximate, separated by narrow terminal cleft, length of this cleft from anterior end to apices of lamellae 30 (28–30), width in anterior part 8 (8–9). Lamellae ovate in general shape, their margins with 5–6 rounded denticles, length from bases of setae *h3* to lamellar apices 16 (15–16). Setae *h1* anterior to setae *h2*. Distance between dorsal setae: *c2-d2* 68 (52–66), *d2-e2* 83 (74–79), *e2-h2* 50 (50–51), *h2-h3* 16 (16–17), *h2-h2* 34 (32–36), *h3-h3* 28 (27–30), *d1-d2* 39

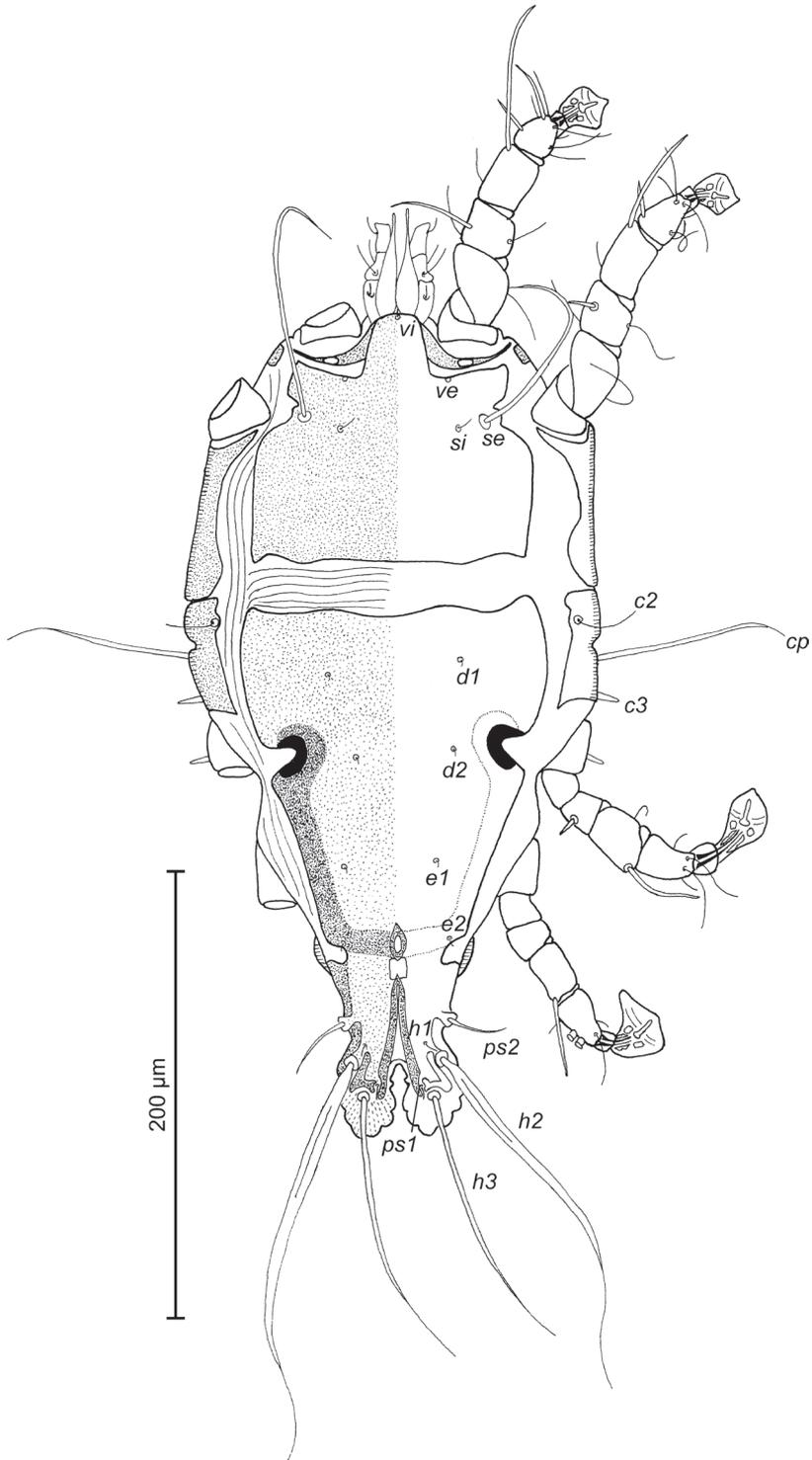


Figure 1. *Trouessartia cyanoupterae* sp. n., male holotype: dorsal view of idiosoma.

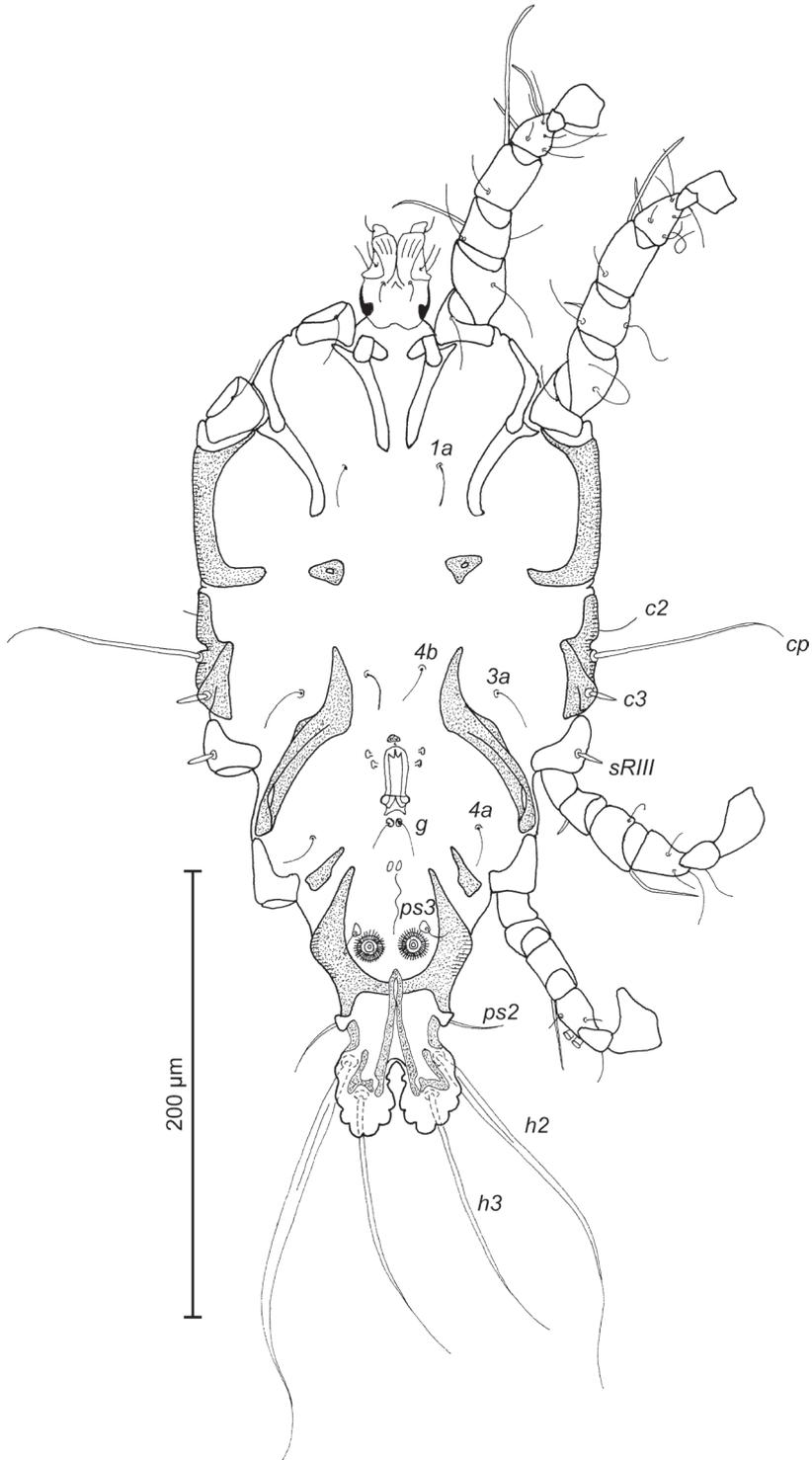


Figure 2. *Trouessartia cyanoupterae* sp. n., male holotype: ventral view of idiosoma.

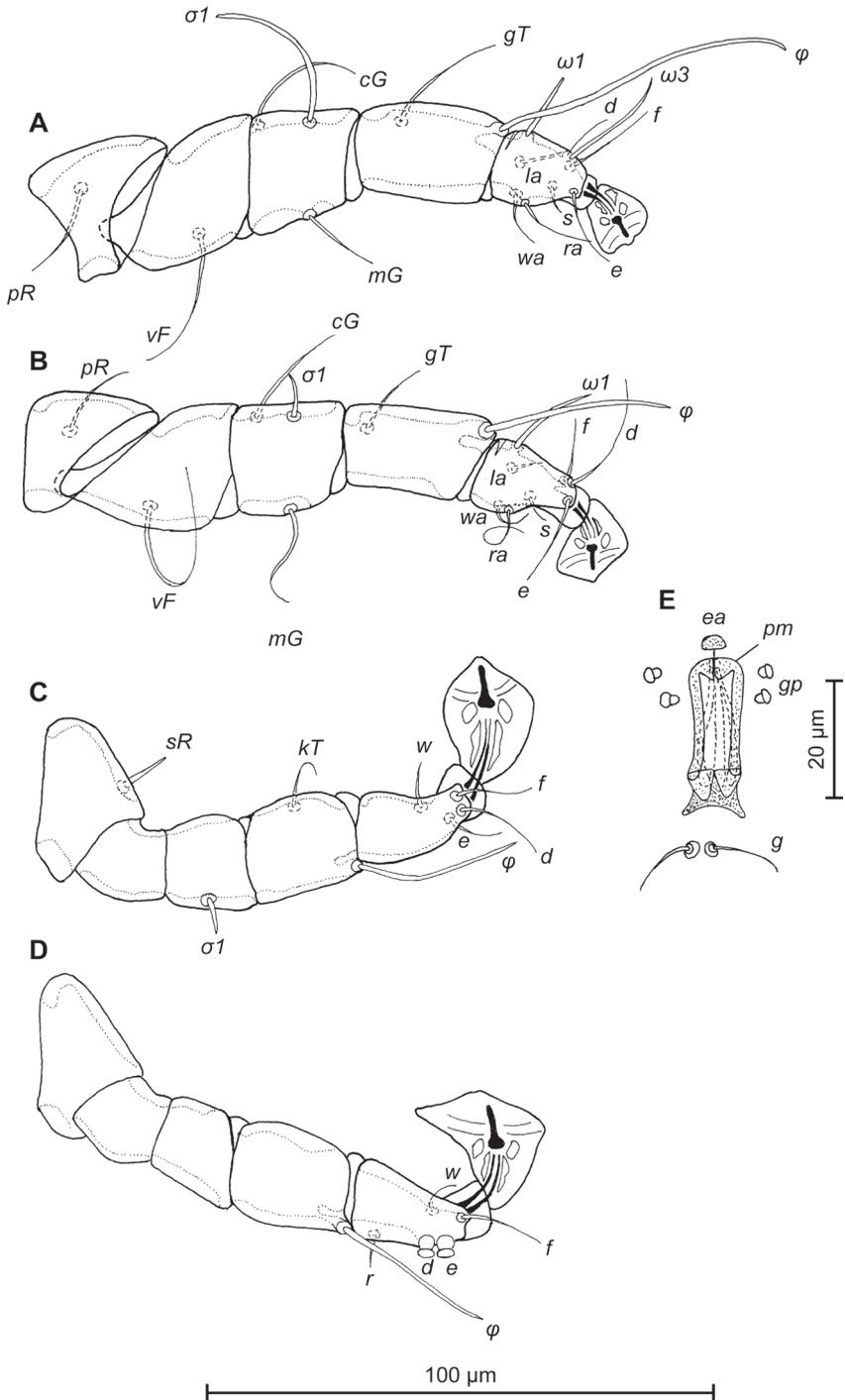


Figure 3. *Trouessartia cyanoupterae* sp. n., **A–D** details of male legs, dorsal view: **A** 9 leg **B** leg II **C** leg III **D** leg IV **E** ventral view of male genital apparatus; Abbreviations: ea–epiandrium; gp–genital papillae; pm–parameres.

(34–35), *e1-e2* 35 (31–34). Epimerites I free. Rudimentary sclerites rEpIIa present, roughly triangular. Genital apparatus situated between levels of trochanters III and IV, length 31 (28–29), greatest width 10 (9–10) (Fig. 2). Epiandrum present, small, setae *g* long and thin, almost touching at bases. Anterior genital papillae more distant from midline than posterior ones, postgenital plaque absent. Adanal apodemes heavily sclerotized, with narrow lateral membrane, without apophyses. Translobar apodeme present. Adanal shields small, triangular, bearing setae *ps3*. Anal suckers 11 (10–11) in diameter. Anterior ends of epimerites IV exceeding level of setae *4b*, epimerites IVa present, wide, anterior ends not reaching level of setae *4a*. Setae *4b* situated slightly anterior to level of setae *3a*, setae *g* and *4a* situated approximately at same transverse level. Distance between ventral setae: *4b-3a* 34 (33–34), *4b-g* 67 (62–64), *g-ps3* 46 (44–46), *ps3-h3* 72 (66–68). Setae *sR* of trochanters III short, narrowly lanceolate, with acute apex 10 (10–12) long. Tarsus IV 28 (24–25) long, modified setae *d* and *e* barrel-shaped, each with discoid cap, situated subapically (Fig. 3D). Legs IV with ambulacral disc extending to level of setae *h3*.

FEMALE (Figs 4; 5; 6A–E; range for 3 paratypes): Length of idiosoma from anterior end to apices of lamellar lobar processes 380–388, greatest width 170–176. Length of hysterosoma from sejugal furrow to apices of lamellar lobar processes 260–261. Prodorsal shield shaped as in male, 94–102 in length, 120–130 in width, surface without ornamentation. Setae *si* thin, filiform, 8–11 long, separated by 51–53, external scapular setae *se* situated on prodorsal shield, 104–108 long, separated by 70–86. Humeral shields with setae *c2* filiform, 22–23 long. Setae *c3* narrowly lanceolate, with acute apex, 10–12 in length. Hysteronotal shield length from anterior margin to bases of setae *h3* 228–232, width at anterior margin 112–116, lateral margins deeply incised at level of trochanters III, bottom of these incisions with C-shaped dark sclerotisation, DHA absent, posterior part with small ovate lacunae (Fig. 4). Dorsal setae *d1* present. Setae *h1* narrowly lanceolate with blunt apices, surrounded by triangular area of unsclerotized tegument, 8–10 long, situated antero-mesal to bases of setae *h2*, 17–22 from each lateral margin of hysteronotal shield. Setae *ps1* positioned dorsally on opisthosomal lobes, equidistant from outer and inner margins of lobe, closer to base of *h2* setae. Distance from bases of setae *h3* to membranous apices of lobes 24–26. Setae *f2* absent. Supranal concavity closed. Terminal cleft nearly parallel-sided, with tapering anterior end, length 71–74, width of cleft at level of setae *h3* 16–22. Interlobar membrane occupying anterior $\frac{1}{4}$ of terminal cleft, its anterior margin roughly rounded, lateral margins wavy; distance from its anterior margin to membranous lobar apices 54–58. External copulatory tube present, extremely short, 1–2 long, protruding from free margin of interlobar membrane. Spermatheca with primary spermaduct thickened in distal part, length of secondary spermaducts 25–30 (Fig. 6E). Distance between dorsal setae: *c2-d2* 59–71, *d2-e2* 80–94, *e2-h2* 42–46, *h2-h3* 38–42, *h2-h2* 56–60, *h3-h3* 36–42, *d1-d2* 30–41, *e1-e2* 40–42, *h1-h2* 14–16, *h1-h1* 29–34, *ps1-h3* 22–24. Epimerites I free. Epigynum 38–40 in length, 70–75 in width (Fig. 5). Epimerites IVa present, short. Setae *sR* of trochanters III narrowly lanceolate, with acute apex, 10–13 long. Legs IV with ambulacral disc extending to midlevel between setae *h2* and *h3*.

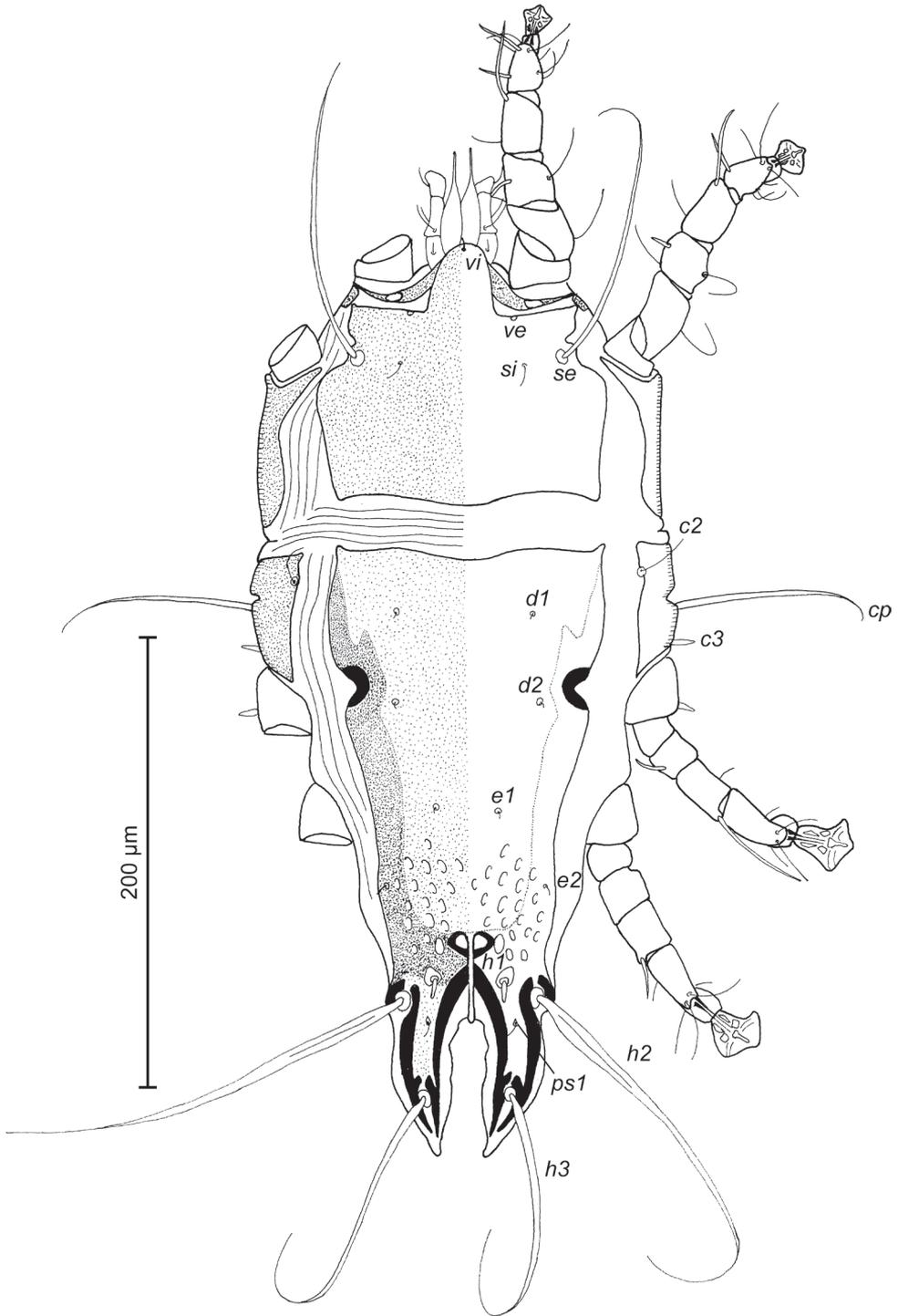


Figure 4. *Trouessartia cyanoupterae* sp. n., female paratype: dorsal view of idiosoma.

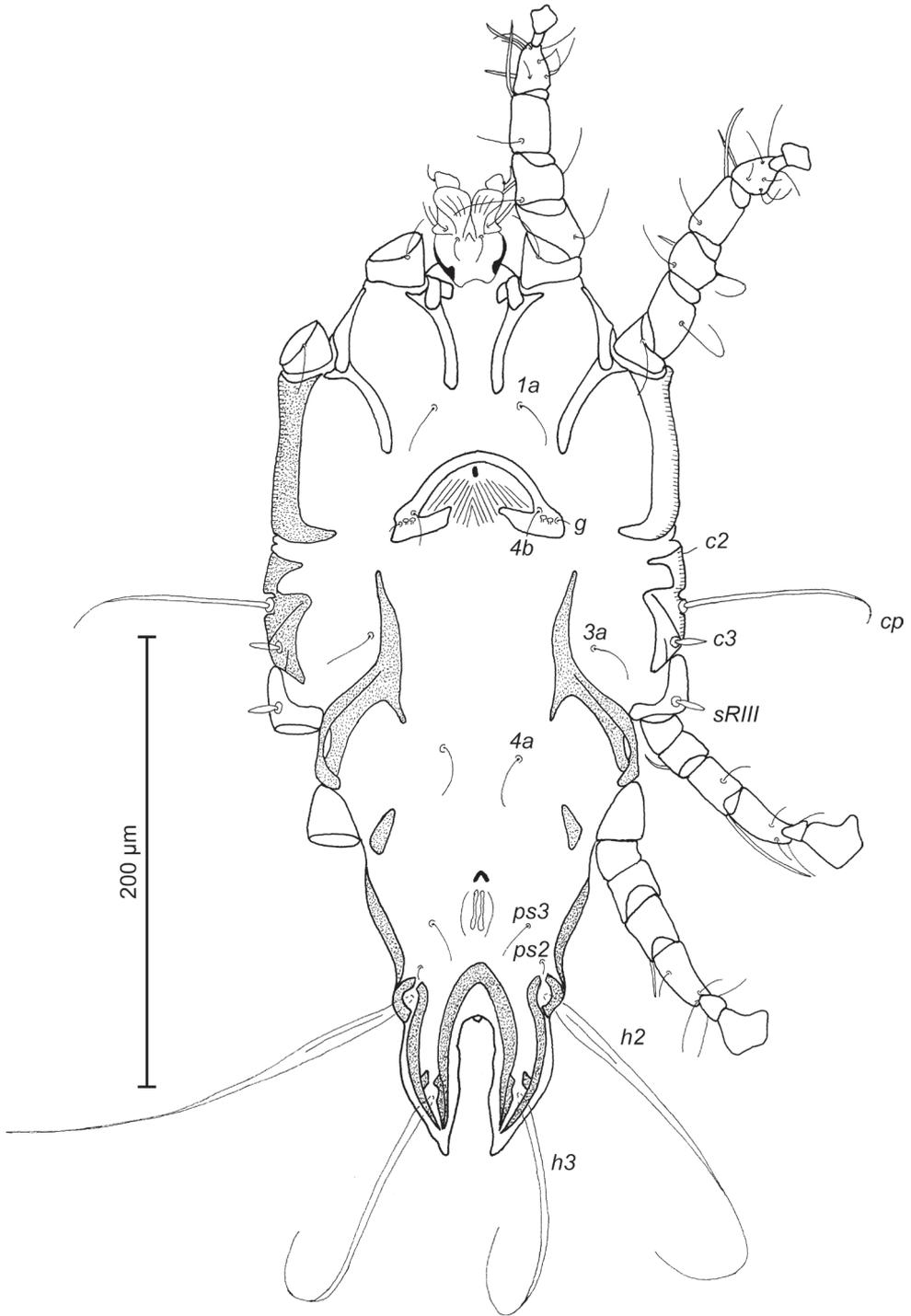


Figure 5. *Trouessartia cyanouropterae* sp. n., female paratype: ventral view of idiosoma.

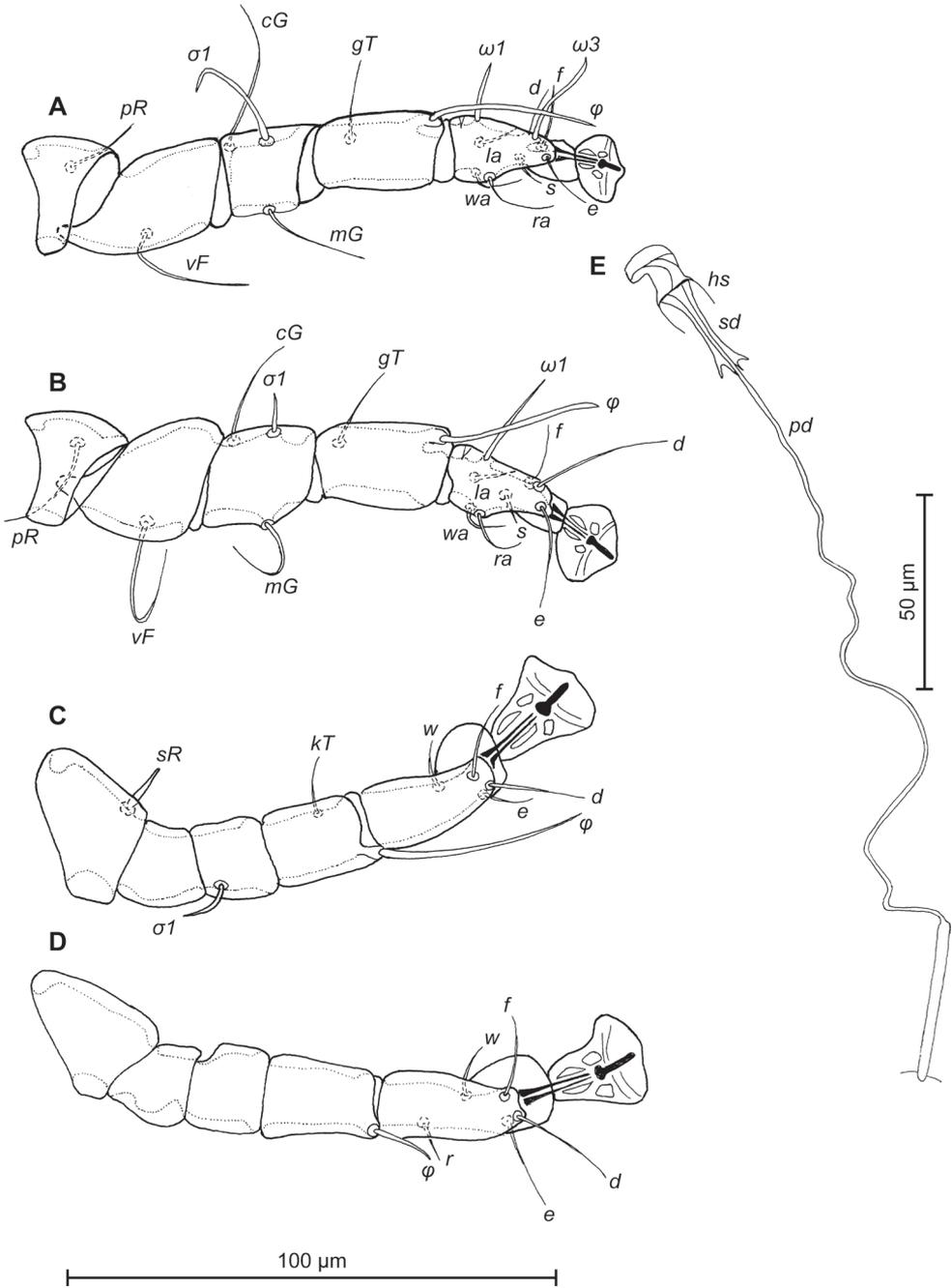


Figure 6. *Trouessartia cyanouropterae* sp. n., **A–D** details of female legs, dorsal view: **A** leg I **B** leg II **C** leg III **D** leg IV **E** spermatheca of female; Abbreviations: hs–head of spermatheca; pd–primary spermaduct; sd–secondary spermaduct.

Etymology. The name of the new species derives from the specific name of the type host and is a noun in the genitive case.

Remarks. The new species *Trouessartia cyanouropterae* Constantinescu, sp. n. is most similar to *T. creatophorae* Mironov & Kopij, 1996, described from *Creatophora cinerea* (Meuschen) (Passeriformes, Sturnidae) in South Africa, (Mironov and Kopij 1996), in having, in both sexes, a similar shape of the hysteronotal shields with lateral margins deeply incised at the level of trochanters III, DHA absent, setae *d1* present, setae *c3* and *sRIII* narrow lanceolate and, in females, an ornamentation of ovoid lacunae in posterior part of the hysteronotal shield. Both sexes of *T. cyanouropterae* differ from *T. creatophorae* by the following features: setae *si* and *c2* are filiform (*vs.* setae *si* are narrow lanceolate, *c2* are long, needle-like in *T. creatophorae*). In males of *Trouessartia cyanouropterae* the margins of lamellae have 5-6 denticles, the rudimentary sclerites rEpIIa are roughly triangular, setae *g* are almost touching at bases, the genital apparatus is situated between levels of trochanters III and IV, setae *e* of tarsus IV is with discoid cap. In males of *T. creatophorae* the margins of lamellae have 9 denticles, the rudimentary sclerites rEpIIa are ovoid, setae *g* are separated, the genital apparatus is situated at level of trochanters IV, and seta *e* of tarsus IV is without a discoid cap. In females of the new species, the external copulatory tube is very short (1–2), setae *h1* are narrowly lanceolate, setae *ps1* are located closer to the base of *h2* setae than to *h3*. Females of *T. creatophorae* have a long external copulatory tube (about 19 long), setae *h1* are filiform, setae *ps1* are located closer to the base of *h3* setae.

***Trouessartia alcippeae* Constantinescu, sp. n.**

<http://zoobank.org/A49FF0FD-0D3C-4D9B-B7F3-A840E472F45E>

Figs 7–12

Type material. Male holotype (ANA639), 2 male (ANA641, ANA642) and 2 female (ANA640, ANA643) paratypes 10.02.2013, from Nepal Fulvetta *Alcippe nipalensis* (Hodgson) (Passeriformes, Leiothrichidae); **INDIA:** Meghalaya, Jaintia Hills, Khahnar village, (25°21'57.30"N, 92°36'51.72"E); 954 m; subtropical forest; collector D. Khlur B. Mukhim.

Description. MALE (Figs 7; 8; 9A–E; holotype, range for 2 paratypes in parentheses): Length of idiosoma from anterior end to bases of setae *h3* 300 (304–324), greatest width at level of humeral shields 144 (152–154). Length of hysterosoma from sejugal furrow to bases of setae *h3* 200 (200–208). Prodorsal shield length along midline 94 (96–97), greatest width in posterior part 100 (108–110), lateral margins not fused with scapular shields, with antero-lateral extensions produced laterally between bases of legs I, II, surface without ornamentation (Fig. 7). Internal scapular setae *si* filiform, 7 (7–8) long, separated by 48 (50–52); external scapular setae *se* situated near lateral margins of prodorsal shield, 85 (94–106) long, separated by 72 (76–78). External vertical setae *ve* represented only by alveoli. Humeral shield with setae *c2* filiform, gradually tapering to apex 30 (30–40) long. Setae *c3* narrowly lanceolate, with acute

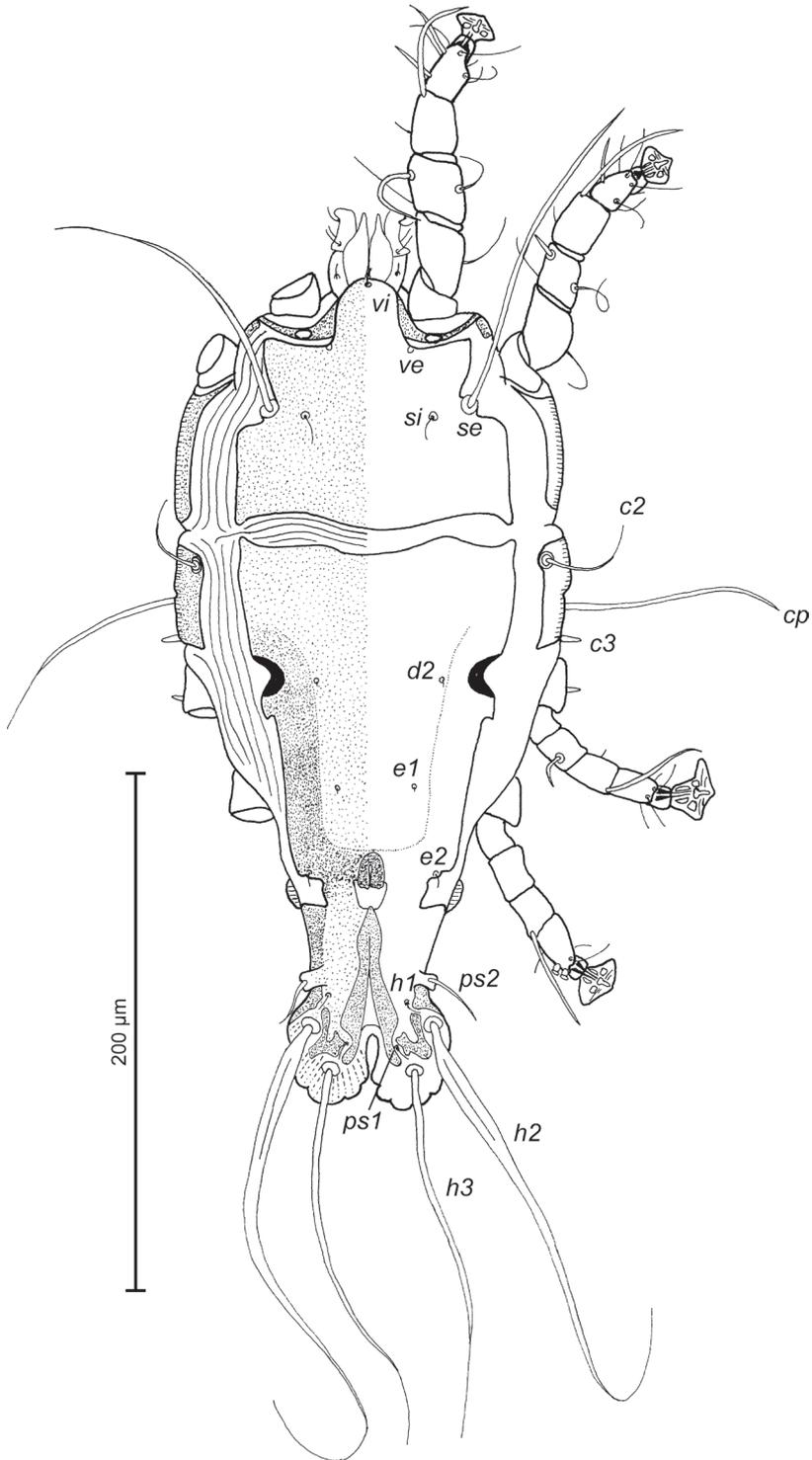


Figure 7. *Trouessartia alcippeae* sp. n., male holotype: dorsal view of idiosoma.

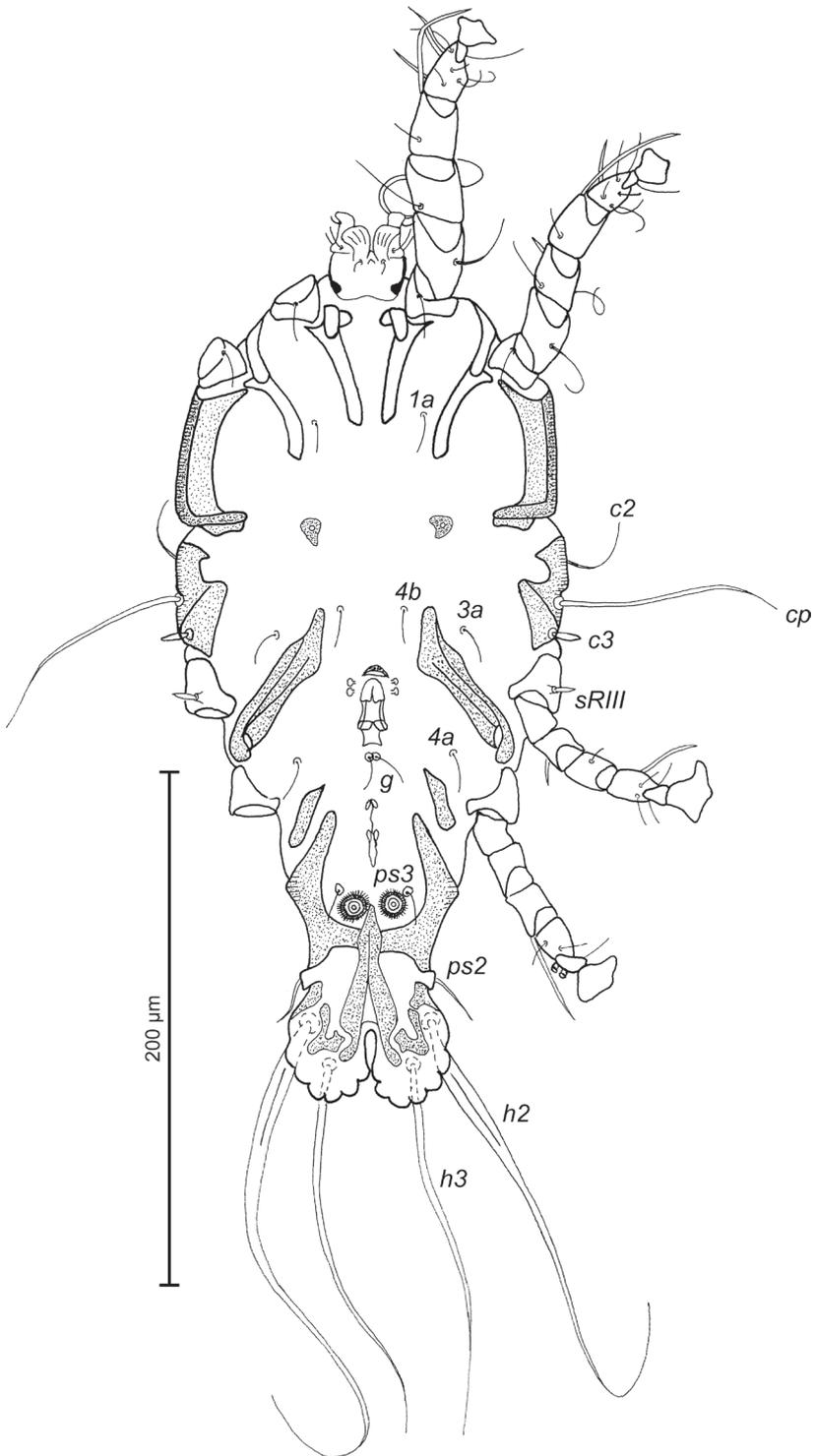


Figure 8. *Trouessartia alcippeae* sp. n., male holotype: ventral view of idiosoma.

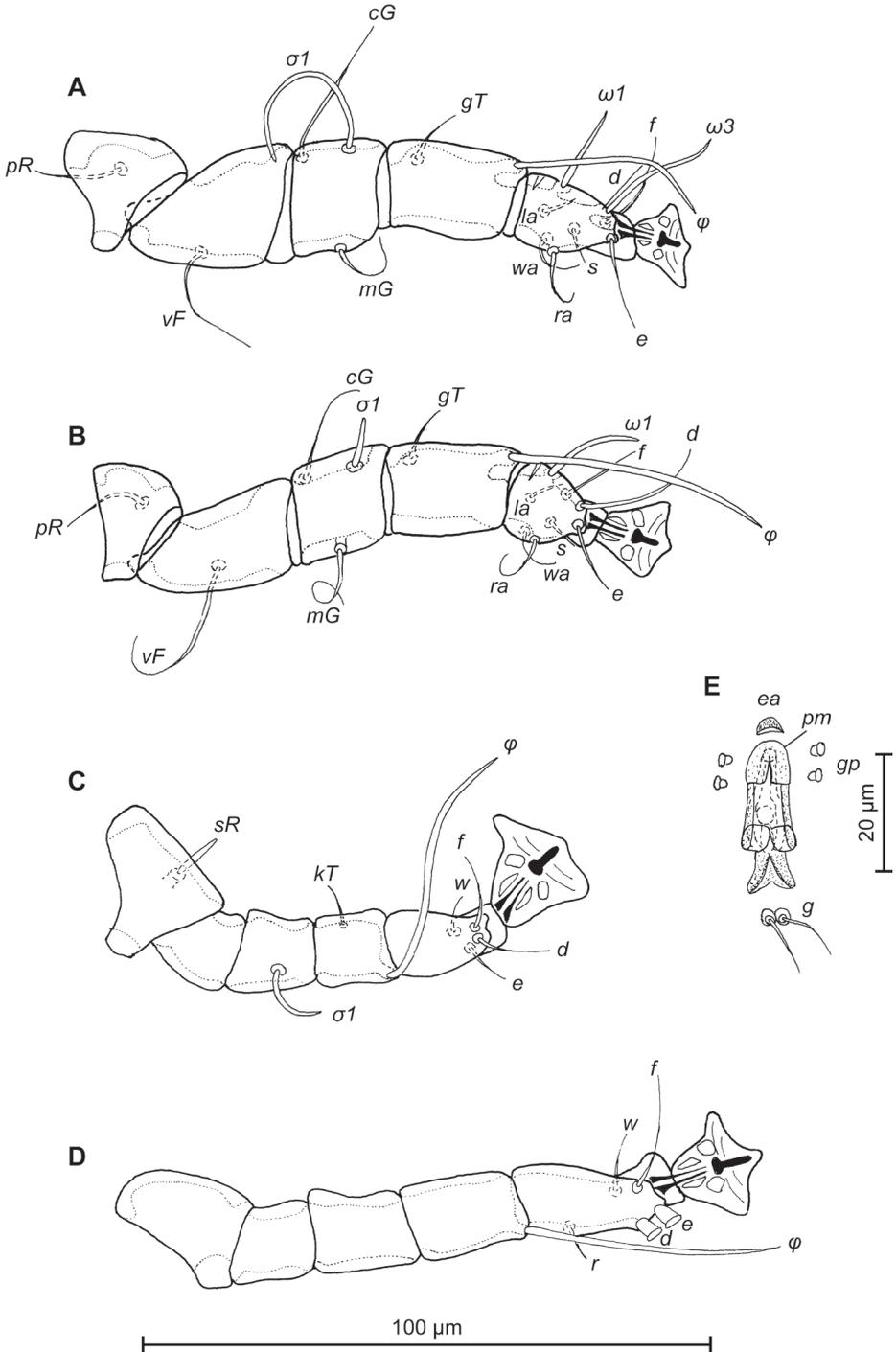


Figure 9. *Trouessartia alcippeae* sp. n., **A–D** details of male legs, dorsal view: **A** leg I **B** leg II **C** leg III **D** leg IV **E** ventral view of male genital apparatus; Abbreviations: ea–epiandrium; gp–genital papillae; pm–parameres.

apex, 11 (12–13) long. Dorsal hysterosoma with prohysteronotal and lobar shields connected, they delimited from each other by lateral incisions immediately posterior to setae *e2* and small unsclerotized medial area of trapezoidal form. Prohysteronotal shield length 128 (130–136), width at anterior margin 100 (96–108), lateral margins incised at level of trochanters III, dorsal hysterosomal apertures (DHA) absent. Dorsal setae *d1* absent, setae *d2* present, minute. Length of lobar shield excluding lamellae 56 (63–64). Apical parts of opisthosomal lobes approximate, separated by narrow terminal cleft, length of this cleft from anterior end to apices of lamellae 31 (29–30), width in anterior part 5 (5–7). Lamellae ovate in general shape, their margins with 4–7 rounded denticles, length from bases of setae *h3* to lamellar apices 16 (14–16). Setae *h1* anterior to setae *h2*. Distance between dorsal setae: *c2-d2* 62 (61–67), *d2-e2* 68 (74–76), *e2-h2* 50 (52–53), *h2-h3* 16 (16–17), *h2-h2* 38 (38–40), *h3-h3* 32 (31–32), *e1-e2* 32 (36–38). Epimerites I free. Rudimentary sclerites rEpIIa present, roughly triangular. Genital apparatus situated between levels of trochanters III and IV, length 30 (28–30), greatest width 9 (9–10) (Fig. 8). Epiandrum present, small, setae *g* long and thin, touching at bases, postgenital plaque absent. Anterior and posterior genital papillae at the same distance from midline. Adanal apodemes heavily sclerotized, with narrow lateral membrane, without apophyses. Translobar apodeme present. Adanal shields small, almost ovoid, bearing setae *ps3*. Anal suckers 10 (9–10) in diameter. Anterior ends of epimerites IV reaching level of setae *4b*, epimerites IVa present, wide, anterior ends not reaching level of setae *4a*. Setae *4b* situated slightly anterior to level of setae *3a*, setae *g* and *4a* situated approximately at same transverse level. Distance between ventral setae: *4b-3a* 27 (28–31), *4b-g* 56 (54–56), *g-ps3* 52 (52–54), *ps3-h3* 62 (62–64). Setae *sR* of trochanters III short, narrowly lanceolate, with acute apex, 13 (11–14) long. Tarsus IV 24 (24–26) long, modified setae *d* and *e* barrel-shaped, with discoid cap, situated subapically (Fig. 9D). Legs IV with ambulacral disc extending to level of setae *h2*.

FEMALE (Figs 10; 11; 12A–E; range for 2 paratypes): Length of idiosoma from anterior end to apices of lamellar lobar processes 376–377, greatest width 160–164. Length of hysterosoma from sejugal furrow to apices of lamellar lobar processes 252–260. Prodorsal shield shaped as in male, 102–106 in length, 112–118 in width, surface without ornamentation. Setae *si* thin, filiform, 10–11 long, separated by 55–57, external scapular setae *se* situated near lateral margins of prodorsal shield, 185–184 long, separated by 83–87. Humeral shields with setae *c2* filiform, gradually tapering to apex 39–44 long. Setae *c3* narrowly lanceolate, with acute apex, 12–14 in length. Hysteronotal shield length from anterior margin to bases of setae *h3* 226–232, width at anterior margin 108–112, lateral margins deeply incised at level of trochanters III, these incision with heavy C-shaped sclerotization, DHA absent, posterior part with small ovate lacunae (Fig. 10). Dorsal setae *d1* absent. Setae *h1* filiform, 5–6 long, situated antero-mesal to bases of setae *h2*, 17–18 from each lateral margin of hysteronotal shield. Setae *ps1* positioned dorsally on opisthosomal lobes, equidistant from outer and inner margins of lobe, closer to base of *h3* setae. Distance from bases of setae *h3* to membranous apices of lobes 26–32. Setae *f2* absent. Supranal concavity closed. Ter-

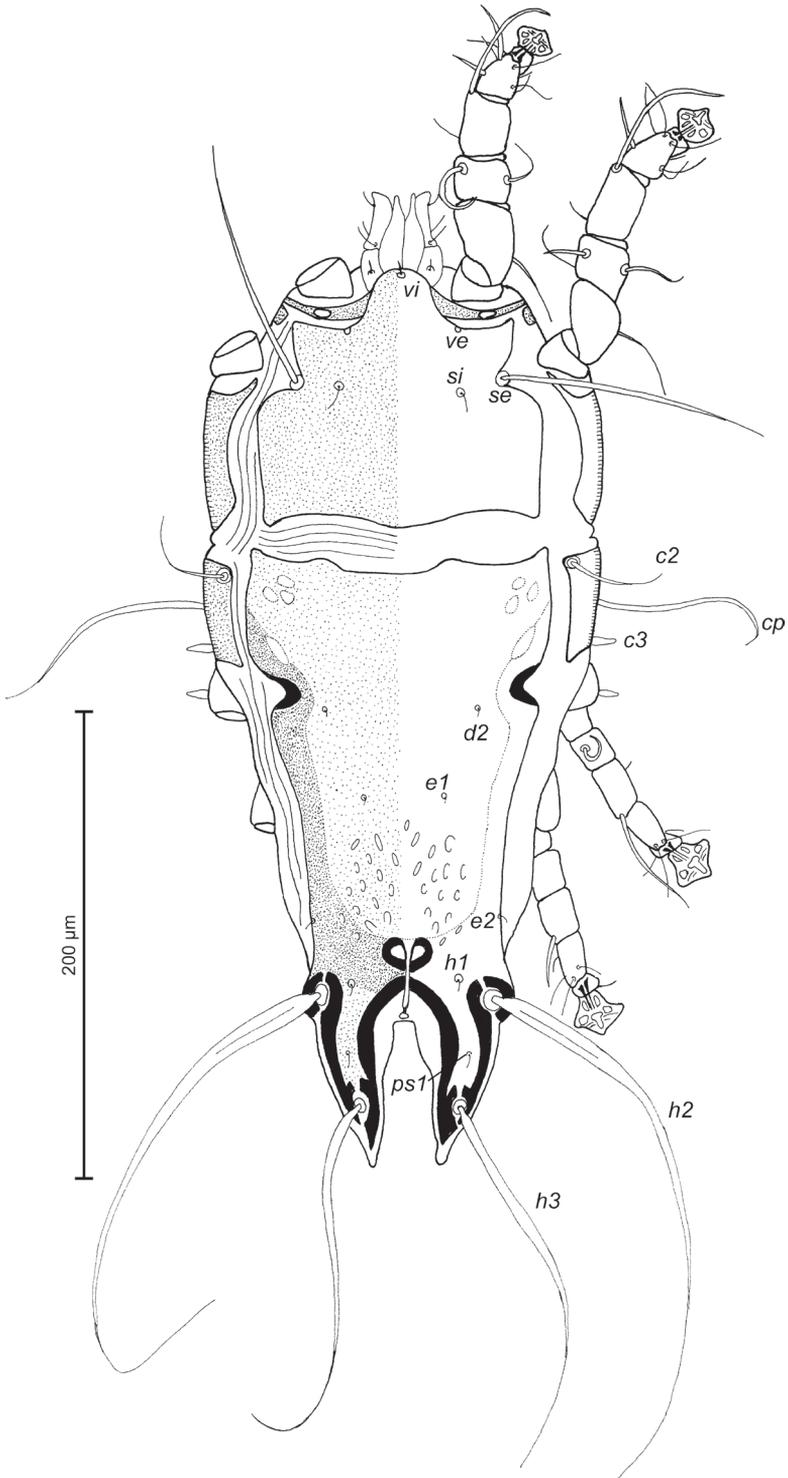


Figure 10. *Trouessartia alcippeae* sp. n., female paratype: dorsal view of idiosoma.

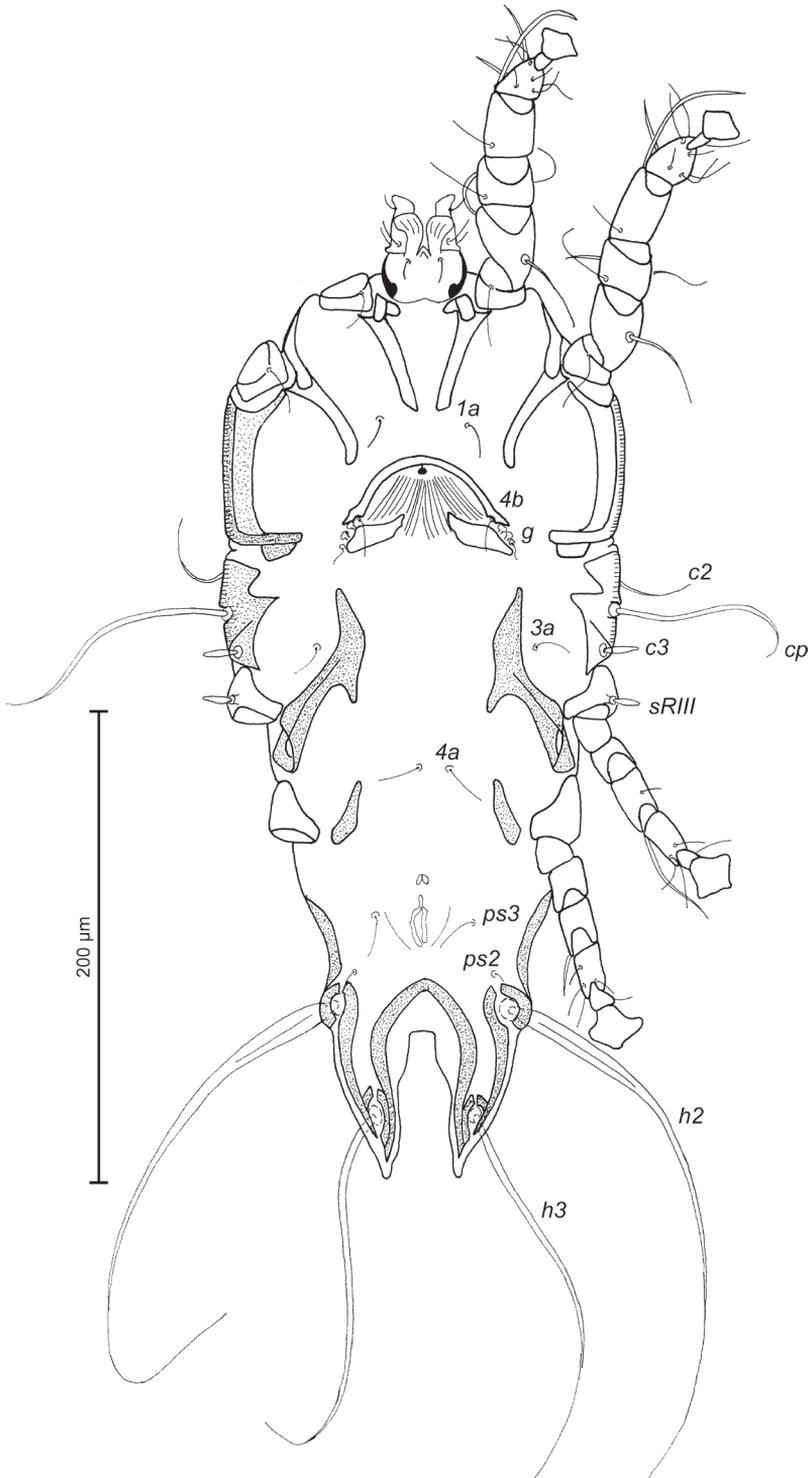


Figure 11. *Trouessartia alcippeae* sp. n., female paratype: ventral view of idiosoma.

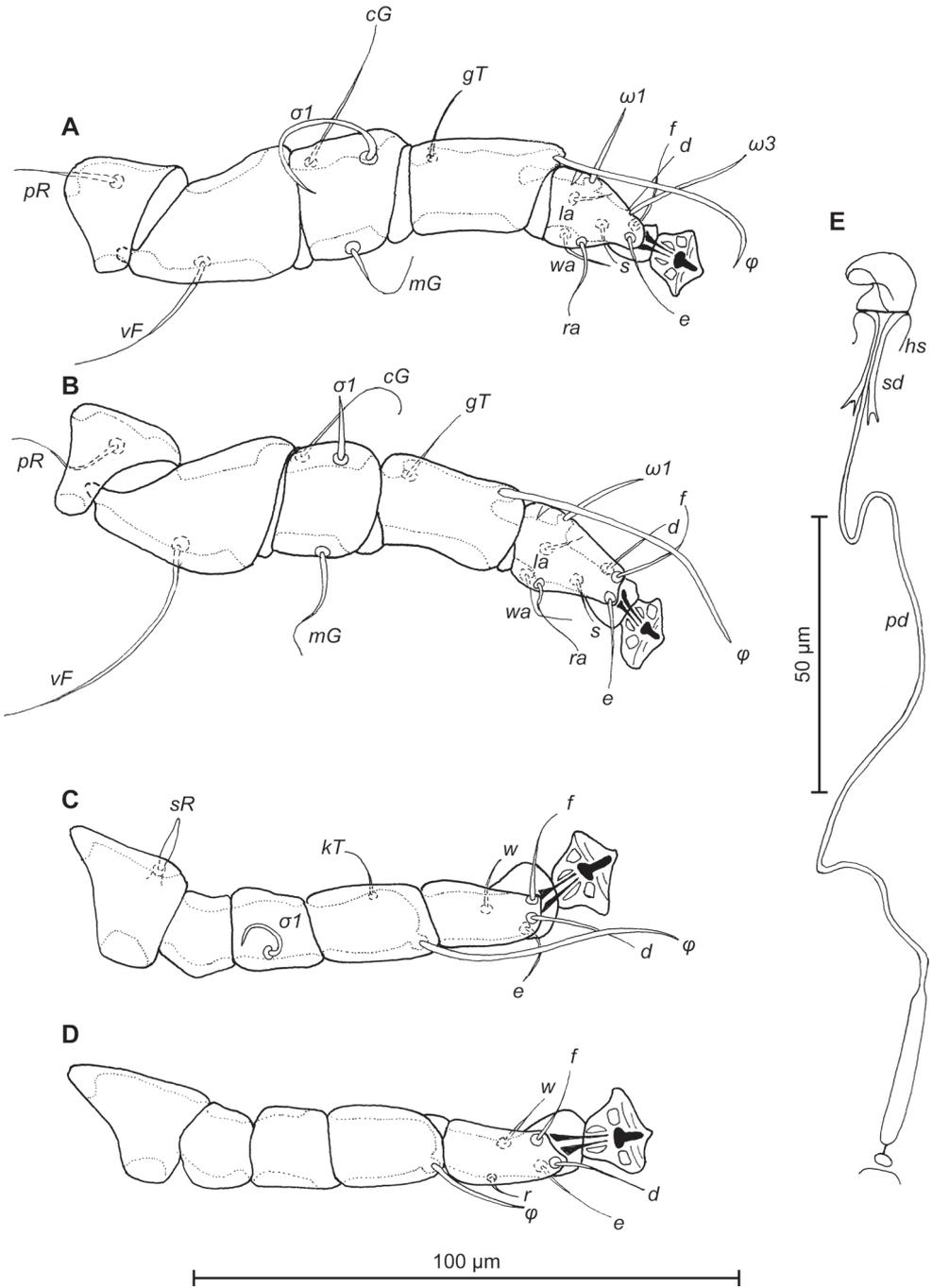


Figure 12. *Trouessartia alcippeae* sp. n., **A–D** details of female legs, dorsal view: **A** leg I **B** leg II **C** leg III **D** leg IV **E** spermatheca of female; Abbreviations: hs–head of spermatheca; pd–primary spermatheca; sd–secondary spermatheca.

minal cleft as an inverted U, length 78–86, width of cleft at level of setae *h3* 25–26. Interlobar membrane occupying anterior $\frac{1}{4}$ of terminal cleft, distance from free margin of membrane to membranous lobar apices 60–70. External copulatory tube absent, copulatory opening dorsally on interlobar membrane. Spermatheca with primary spermaduct thickened at base, length of secondary spermaducts 19–20 (Fig. 12E). Distance between dorsal setae: *c2-d2* 63–66, *d2-e2* 76–86, *e2-h2* 32–46, *h2-h3* 42–44, *h2-h2* 64–66, *h3-h3* 40–42, *e1-e2* 50–60, *h1-h2* 16–18, *h1-h1* 40–46, *ps1-h3* 22–26. Epimerites I free. Epigynum 39–40 in length, 72–76 in width (Fig. 11). Epimerites IVa present, short. Setae *sR* of trochanters III narrowly lanceolate, 11–12 long. Legs IV extending by ambulacral disc to midlevel between setae *h2* and *ps1*.

Etymology. The specific epithet derives from the generic name of the type host and is a noun in the genitive case.

Remarks. The new species, *Trouessartia alcippeae* Constantinescu, sp. n., is very similar in appearance to *Trouessartia cyanouropterae* described above in having, in both sexes, the dorsal shields similar in shape, the hysteronotal (prohysteronotal in males) shield with the lateral margins deeply incised at the level of trochanters III, DHA absent, and setae *c3* and *sRIII* narrow lanceolate. Males of the both species have a similar shape of epimerites (except epimerites IV), the lamellae ovate with rounded denticles, the setae *g* are close to each other, and the setae *d* and *e* are barrel-shaped, with a discoid cap, and situated apically. Females of the both species have a similar ornamentation of hysteronotal shield (ovoid lacunae), and the spermatheca is similar in shape. Both sexes of *T. alcippeae* differ from *T. cyanouropterae*, by the following characters: the setae *d1* are absent and setae *se* are situated on the lateral margins of prodorsal shield. In *T. cyanouropterae*, setae *d1* are present and setae *se* are situated on the prodorsal shield. Males of *T. alcippeae* have a small unsclerotized median area of trapezoidal form between the prohysteronotal shield and the lobar shield, epimerites IV are shorter and reach the level of setae *4b*, and the anterior and posterior genital papillae are at the same distance from midline. Males of *T. cyanouropterae* have a small rectangular unsclerotized area between the prohysteronotal shield and the lobar shield, epimerites IV are longer and exceeding the level of setae *4b*, and the anterior genital papillae are more distant from the midline than the posterior ones. Females of *T. alcippeae* have the setae *h1* filiform, the setae *ps1* are located closer to bases of setae *h3* and the external copulatory tube is absent. Females of *T. cyanouropterae* have the setae *h1* lanceolate, the setae *ps1* are located closer to the base of *h2* setae and the external copulatory tube is present.

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A new species of *Apolochus* (Crustacea, Amphipoda, Gammaridea, Amphilochidae) in Maryland coastal bays, USA with notes on its abundance and distribution

Andrés G. Morales-Núñez^{1,2}, Paulinus Chigbu^{1,2}

1 NSF – CREST Center for the Integrated Study of Coastal Ecosystem Processes and Dynamics in the Mid-Atlantic Region (CISCEP) **2** NOAA Living Marine Resources Cooperative Science Center (LMRCSC), Department of Natural Sciences, University of Maryland Eastern Shore, Princess Anne, MD 21853, USA

Corresponding author: Andrés G. Morales-Núñez (agmorales@umes.edu)

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Abstract

A new amphilochid amphipod, *Apolochus cresti* **sp. n.** is described from specimens collected in the shallow waters of Maryland coastal bays, Mid-Atlantic region, at depths from 1.7 to 2.1 m. The new species appears to be most closely related to the northeastern Atlantic species, *A. neapolitanus sensu* Krapp-Schickel, 1982. *Apolochus cresti* **sp. n.** can be distinguished from *A. neapolitanus* by a combination of characters, including the shape of the lateral cephalic lobe, shape of the mandible molar process, relative length of mandible palp article 3, the carpal lobe length of gnathopod 2, and the lack of sub-marginal spines on antero-lateral surface of gnathopod 2. Spearman's rank correlation analysis indicated a positive correlation between the abundance of *A. cresti* and the amount of macroalgae collected per station, bay, and month. Ovigerous females carrying eggs were present from March to May and in October, reaching their peak in May, although only ovigerous females carrying juveniles were found in May. Males were abundant in March and were collected also in May and October. A key for the separation of *Apolochus* species is presented.

Resumen

Una nueva especie de anfípodo, *Apolochus cresti* **sp. n.** es descrita con especímenes colectados en aguas someras de las bahías de Maryland, en la región del Atlántico medio a una profundidad entre 1.7 a 2.1 m. La nueva especie parece estar más cercanamente relacionada a la especie *A. neapolitanus sensu*

Krapp-Schickel, 1982 del Atlántico este. *Apolochus cresti* **sp. n.** puede ser distinguida de *A. neapolitanus* por una combinación de caracteres, incluyendo la forma del lóbulo lateral cefálico, la forma del proceso molar de la mandíbula, la longitud relativa proporción del artículo 3 del palpo mandibular, la longitud del lóbulo del carpo del gnatópodo 2, y la falta de espinas sub-marginales en la parte antero-lateral del gnatópodo 2. El análisis del coeficiente de correlación de Spearman indica una correlación positiva entre la abundancia de *A. cresti* y la cantidad de macro-algas colectadas por estación, y bahía, y mes. Hembras ovígeras cargando huevos fueron encontradas desde marzo a mayo y en octubre, alcanzando su pico en mayo; aunque solo hembras ovígeras cargando juveniles fueron encontradas en mayo. Machos fueron abundantes en marzo y fueron colectados también en mayo y octubre. Una clave para la separación de especies de *Apolochus* es presentada.

Keywords

Amphipoda, Amphilochidae, *Apolochus*, new species, Maryland coastal bays (MCBs), Mid-Atlantic Region

Palabras Claves

Anfípoda, Amphilochidae, *Apolochus*, nueva especie, bahías costeras de Maryland, región del Atlántico medio

Introduction

During a survey of benthic marine macro-invertebrates of the Maryland coastal bays (MCBs), hundreds of specimens of an undescribed species, belonging to the family Amphilochidae, with attributes of the genus *Apolochus* Hoover & Bousfield, 2001, were discovered among the amphipods collected. Amphilochids are very common in the marine benthic fauna, associated with macroalgae or as inquilines and commensals with sea fans, hydroids and other sessile marine invertebrates (Hoover and Bousfield 2001, Leite 2002, Azman 2009, Leite and Siqueira 2013). Members of this family are often overlooked because of their small size (McKinney 1978) and most of the specimens are extremely fragile and brittle (Azman 2009). In this study, a new species of *Apolochus* from MCBs is described and information on its abundance and distribution is provided. To date, the genus *Apolochus* contains eight species (WoRMS). Four species have been reported from the Atlantic Ocean: *Apolochus casahoya* (McKinney, 1978) and *Apolochus delacaya* (McKinney, 1978) from the Gulf of Mexico (McKinney 1978), Florida Keys (Barnard and Thomas 1983) and Venezuela (Martin et al. 2013); *Apolochus neapolitanus* (Della Valle, 1893) with a pantropical distribution from the Mediterranean (Della Valle 1893), Gulf of Mexico (McKinney 1978), Florida Keys (Thomas 1993), Venezuela (Martin et al. 2013) and Brazil (Wakabara and Serejo 1998); and *Apolochus pillaii* (Barnard & Thomas, 1983) from the Florida Keys (Barnard and Thomas 1983) and Gulf of Mexico (Paz-Ríos and Ardisson 2013). Four additional species have been reported from the eastern North Pacific: *Apolochus barnardi* Hoover & Bousfield, 2001 from central to southern California (Hoover and Bousfield 2001); *Apolochus litoralis* (Stout, 1912) from southern California, Oregon, Washington, British Columbia, and southern Alaska (Stout 1912, Hoover and Bousfield 2001); *Apolochus picadurus* (Barnard,

1962) from southern California (Barnard 1962); and *Apolochus staudei* Hoover & Bousfield, 2001 from British Columbia (Hoover and Bousfield 2001). Additionally, LeCroy (2002) reported the presence of an undescribed species of *Apolochus*, *Apolochus* sp. A., from the Gulf of Mexico and Florida Keys, a species probably misidentified in this region as *A. neapolitanus*. It is worthwhile to note that all illustrations indicating the presence of *A. neapolitanus* in different parts of the world show morphological differences, indicating that they are not the same species (LeCroy 2002). Unfortunately, the original description of *A. neapolitanus* is poor and incomplete (Della Valle 1883).

Materials and methods

The material examined was collected in the MCBs, mid-Atlantic region, on the east coast of the United States of America. The MCBs consist of five principal lagoons distributed in two areas. Assawoman and Isle of Wight Bays are located in the northern area of the MCBs; and Sinepuxent, Newport, and Chincoteague Bays are located in the southern area of the MCBs (Figure 1). These five bays are different with respect to depth, water flow, area, and level of anthropogenic impact. In general, the MCBs are shallow systems with an average depth of 1.2 m and are predominantly polyhaline, with salinities greater than 25 PSU. Additionally, the surface areas vary from 15.9 km² in Newport Bay to 189 km² in Chincoteague Bay (Chaillou et al. 1996; Wazniak et al. 2004).

Samples were taken at 13 stations (eight stations in the southern area and five in the northern area) (Fig. 1). Sampling was conducted monthly for nine months from March to December 2012, although due to inclement weather conditions, samples were not collected in September. Samples were collected using an epibenthic sled (area = 0.39 m²), with a 1 mm mesh size, to which was attached a flow meter Model 2030R (General Oceanics). Field sampling was completed in two days each month. At each station, two horizontal tows were conducted at an average speed of 2 knots for 5 min. In the field, the net was rinsed and all macroinvertebrates were passed through a 0.5 mm sieve. After sieving, all macroinvertebrates were fixed in 5% neutral buffered formalin. Additionally, the epifauna was separated from the macroalgae by shaking each macroalgal fragment in a bucket filled with seawater. The macroinvertebrates retained were passed through a 0.5 mm sieve and fixed in 5% neutral buffered formalin. All macroalgae collected with the sled were stored in plastic bags with seawater in a cooler. Subsequently, the wet weight of the macroalgae collected at each site was determined in the laboratory, and then the macroalgae and any remaining associated epifauna were preserved in 5% neutral buffered formalin. Finally, the macroalgae were washed over a sieve with a 0.3 mm mesh size. Each macroalgal fragment was then visually examined further to confirm that all epifaunal invertebrates were removed. All amphipods collected were counted, identified to the lowest practical taxonomic level and preserved in ethanol (70%). Thereafter, the macroalgae were identified to the lowest practical taxonomic level.

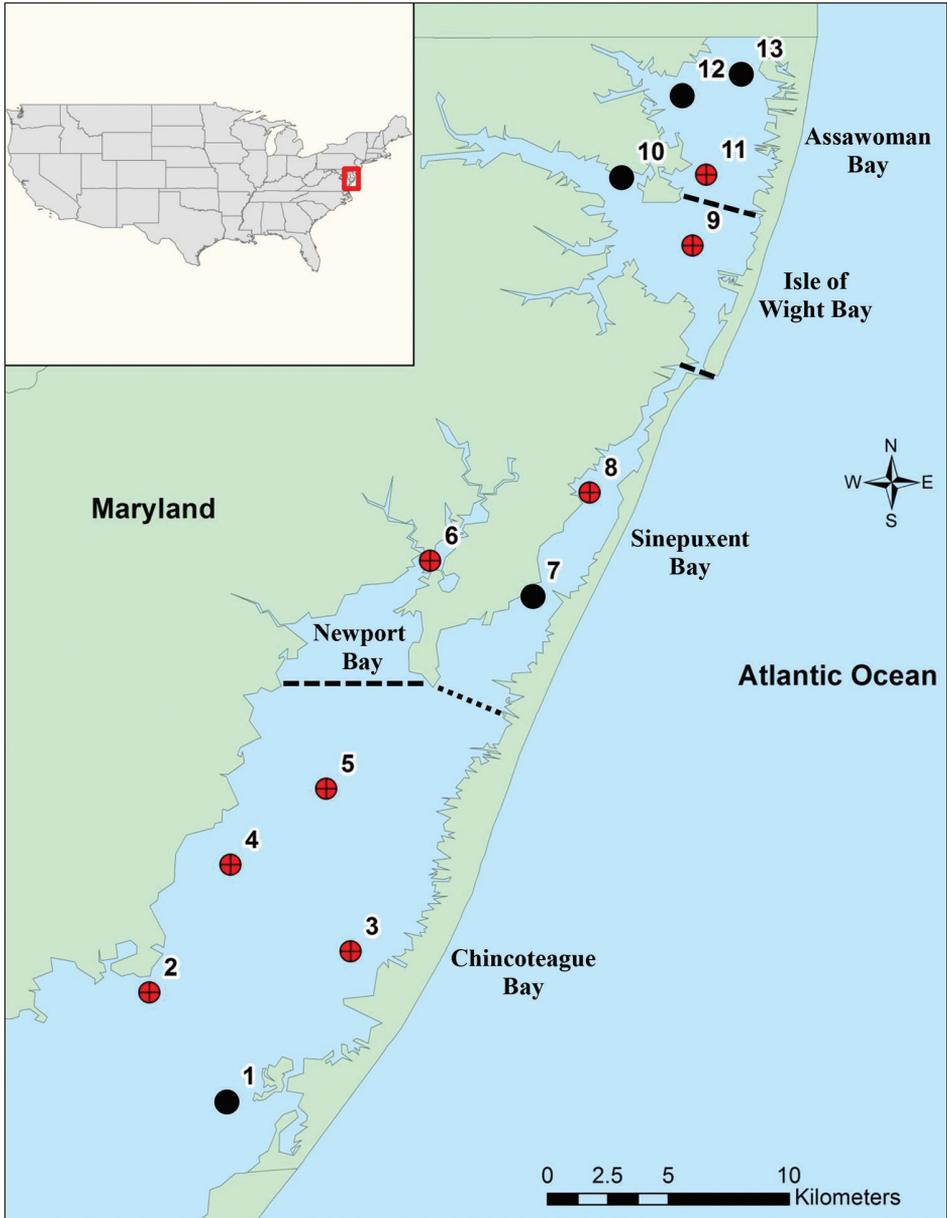


Figure 1. Map of Maryland Coastal Bays indicating the 13 stations sampled. Black circles indicate the five stations where *Apolochus cresti* sp. n., was found.

Water quality data were collected in situ using a YSI 6600 Multi-Parameter Water Quality Sonde and included water temperature, salinity, dissolved oxygen, and pH, which were all recorded at 0.3 m from the bottom (Tables 1–2). Additionally, water depth and clarity (i.e. Secchi disc transparency) were recorded at each station.

Table 1. Mean values of abiotic variables \pm SE per station from March to December 2012 in the Maryland Coastal Bays.

Stations	Temperature (°C)	Salinity (PSU)	Dissolved Oxygen (mg/L)	pH	Depth (m)	Secchi depth (m)
1	17.8 \pm 2.24	33.3 \pm 1.09	8.1 \pm 0.45	8.0 \pm 0.03	2.1 \pm 0.08	0.6 \pm 0.14
2	17.9 \pm 3.35	30.9 \pm 1.67	8.0 \pm 0.74	7.9 \pm 0.04	1.1 \pm 0.23	0.6 \pm 0.22
3	16.8 \pm 2.16	32.2 \pm 1.23	8.3 \pm 0.47	8.0 \pm 0.03	2.0 \pm 0.13	0.7 \pm 0.17
4	16.5 \pm 2.16	31.2 \pm 0.99	8.0 \pm 0.57	7.9 \pm 0.04	2.0 \pm 0.29	0.6 \pm 0.14
5	16.5 \pm 2.18	31.5 \pm 1.19	8.3 \pm 0.49	8.0 \pm 0.02	1.8 \pm 0.09	0.8 \pm 0.20
6	17.5 \pm 2.11	27.9 \pm 1.52	8.1 \pm 0.65	7.9 \pm 0.07	1.1 \pm 0.17	0.7 \pm 0.55
7	17.5 \pm 2.65	32.9 \pm 1.25	7.4 \pm 0.71	7.9 \pm 0.05	1.9 \pm 0.33	0.9 \pm 0.20
8	16.5 \pm 2.31	34.0 \pm 0.88	7.7 \pm 0.61	7.9 \pm 0.04	2.4 \pm 0.35	0.8 \pm 0.22
9	16.0 \pm 2.18	33.4 \pm 0.94	7.9 \pm 0.62	7.9 \pm 0.05	2.0 \pm 0.29	0.8 \pm 0.17
10	17.5 \pm 2.23	30.7 \pm 0.99	8.0 \pm 0.68	8.0 \pm 0.05	1.8 \pm 0.05	0.7 \pm 0.20
11	18.0 \pm 3.12	30.1 \pm 1.37	7.7 \pm 0.98	7.9 \pm 0.11	3.1 \pm 0.05	1.1 \pm 0.27
12	17.2 \pm 2.24	29.8 \pm 1.17	8.1 \pm 0.74	8.0 \pm 0.07	1.7 \pm 0.07	0.8 \pm 0.18
13	17.3 \pm 2.28	29.5 \pm 1.35	7.8 \pm 0.67	7.9 \pm 0.08	2.1 \pm 0.05	1.1 \pm 0.23

Table 2. Mean values of abiotic variables \pm SE per bay from March to December 2012 in the Maryland Coastal Bays.

Areas	Temperature (°C)	Salinity (PSU)	Dissolved Oxygen (mg/L)	pH	Depth (m)	Secchi depth (m)
Assawoman Bay	17.5 \pm 1.37	29.8 \pm 0.72	7.9 \pm 0.43	7.9 \pm 0.05	2.2 \pm 0.12	1.1 \pm 0.31
Isle of Wight Bay	16.7 \pm 1.52	32.1 \pm 0.74	7.9 \pm 0.44	7.9 \pm 0.04	1.9 \pm 0.14	0.9 \pm 0.30
Sinepuxent Bay	16.9 \pm 1.69	33.5 \pm 0.72	7.6 \pm 0.45	7.9 \pm 0.03	2.2 \pm 0.24	1.0 \pm 0.38
Newport Bay	17.5 \pm 2.11	27.9 \pm 1.52	8.1 \pm 0.65	7.9 \pm 0.07	1.1 \pm 0.17	0.7 \pm 0.55
Chincoteague Bay	17.0 \pm 1.00	31.9 \pm 0.53	8.1 \pm 0.23	8.0 \pm 0.07	1.8 \pm 0.10	0.8 \pm 0.19

The density of *Apolochus* sp. n. was estimated and expressed as number of individuals per m² (ind m⁻²), and the macroalgae biomass was expressed as gram wet weight per m² (g ww m⁻²). Spearman's rank correlations were calculated to determine whether the abundance and distribution of *Apolochus* sp. n. were related to the amount of macroalgae collected at the stations, bays, and within months during this study. Furthermore, Spearman's rank correlations were calculated per stations, bays, and months between biotic (i.e. abundance of amphipods and biomass of macroalgae) and abiotic variables such as water temperature, salinity, dissolved oxygen, pH, depth, and Secchi depth.

Specimens of *Apolochus* sp. n. were dissected under an Olympus ZS-16 stereomicroscope. Appendages were mounted on glass slides in glycerin and observed with an Olympus BX41 compound microscope, and drawings were made with a camera lucida. Illustrations were prepared with Adobe Illustrator and Photoshop CS6 Extended. The classification of crustacean spines and setae follows Watling (1989) and Zimmer et al. (2009).

Type material has been deposited in the National Museum of Natural History, Smithsonian Institution, Washington DC (USNM) and the Gulf Coast Research Laboratory (GCRL) Museum, Ocean Springs, Mississippi MS. All measurements are in millimeters (mm). Total body length (TL) was measured from the tip of the rostrum to the tip of the telson.

Systematics

Order Amphipoda Latreille, 1816

Suborder Gammaridea Latreille, 1802

Family Amphilochidae Boeck, 1871

Genus *Apolochus* Hoover & Bousfield, 2001

Type species. *Amphilochus neapolitanus* Della Valle, 1893

Generic diagnosis. See Hoover and Bousfield (2001).

Apolochus cresti sp. n.

<http://zoobank.org/56C24D6B-2E21-4711-928C-F63A291D0A33>

Figs 2–8; 9H, V, Z, B-1–C-1

Material examined. *Holotype*: ovigerous ♀ (USNM 1254651), 3.4 mm, station 10 (38°14.504'N; 75°09.306'W), Isle of Wight Bay, USA, 1.8 m, 17.5 °C, 30.7 PSU, 16 May 2012, coastal lagoon, coll. A.G. Morales-Núñez. *Paratypes*: 4 ♀♀ (USNM 1254652), 4 ♂♂ (USNM 1254653); 4 ♀♀ and 4 ♂♂ (GCRL 06537), same collection data as for holotype. Additional specimens from the type locality are in the collection of the authors.

Additional material. 587 specimens (558 undetermined, 11 non-ovigerous ♀♀, 1 ovigerous ♀, and 17 ♂♂), station 10 (38°14.504'N; 75°09.306'W), Isle of Wight Bay, 1.8 m, 17.5 °C, 30.7 PSU, 15 March 2012, coll. A.G. Morales-Núñez. – 327 specimens (313 undetermined and 14 ♂♂), station 12 (38°25.778'N; 75°05.956'W), Assawoman Bay, 1.7 m, 17.2 °C, 29.8 PSU, 15 March 2012, coll. A.G. Morales-Núñez. – 2 specimens (undetermined), station 1 (38°03.143'N; 75°16.114'W), Chincoteague Bay, 2.1 m, 17.8 °C, 33.3 PSU, 17 April 2012, coll. A.G. Morales-Núñez. – 1 specimen (ovigerous ♀), station 10 (38°14.504'N; 75°09.306'W), Isle of Wight Bay, 1.8 m, 17.5 °C, 30.7 PSU, 17 April 2012, coll. A.G. Morales-Núñez. – 15 specimens (6 undetermined and 9 ovigerous ♀♀), station 12 (38°25.778'N; 75°05.956'W), Assawoman Bay, 1.7 m, 17.2 °C, 29.8 PSU, 15 March 2012, coll. A.G. Morales-Núñez. – 8 specimens (2 undetermined, 1 non-ovigerous ♀, and 5 ovigerous ♀), station 13 (38°26.240'N; 75°04.651'W), Assawoman Bay, 2.1 m, 17.3 °C, 29.5 PSU, 17 April 2012, coll. A.G. Morales-Núñez. – 3 specimens (undetermined), station 7

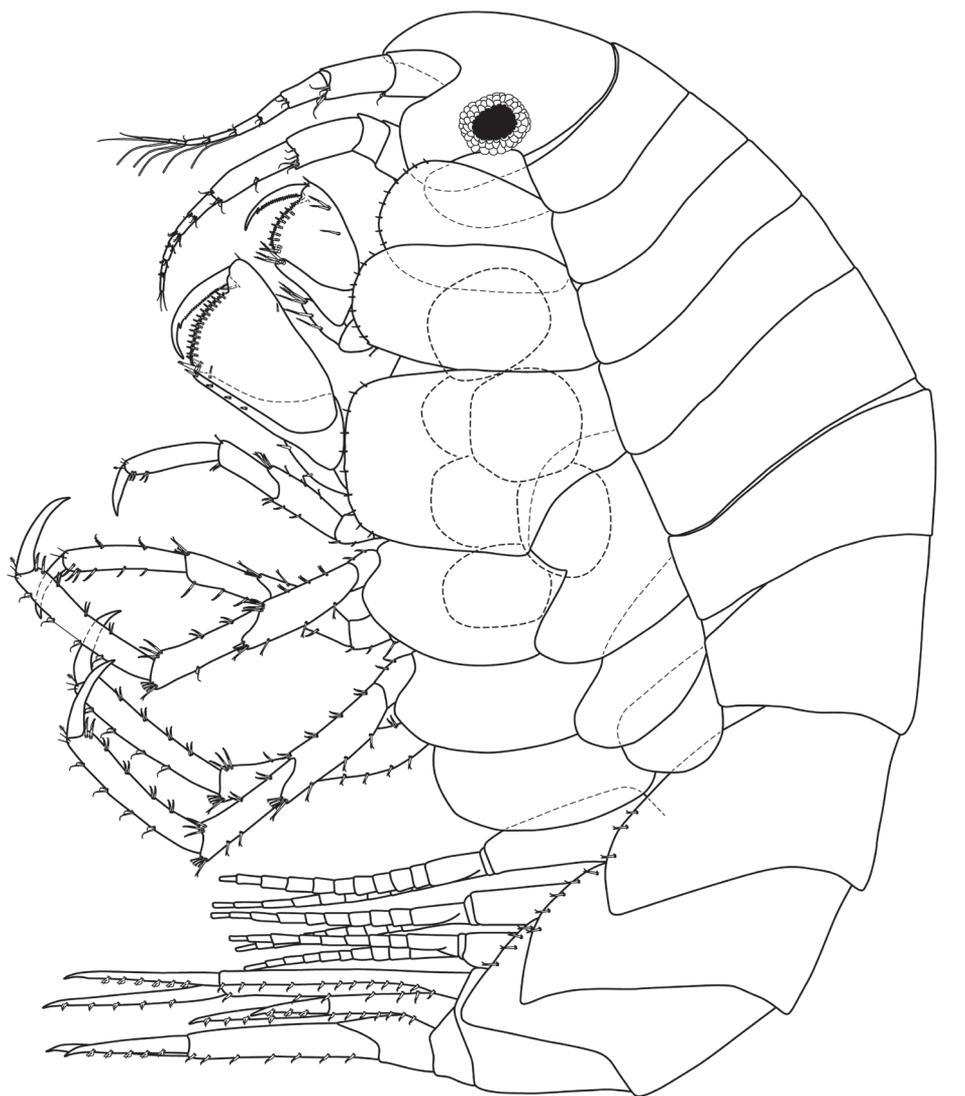


Figure 2. *Apolochus cresti* sp. n., Holotype female: lateral view. Scale bar: 1.0 mm.

(38°14.504'N; 75°09.306'W), Sinepuxent Bay, 1.9 m, 17.5 °C, 32.9 PSU, 21 May 2012, coll. A.G. Morales-Núñez. – 632 specimens (502 undetermined, 22 non-ovigerous ♀♀, 83 ovigerous ♀, and 25 ♂♂), station 10 (38°14.504'N; 75°09.306'W), Isle of Wight Bay, 1.8 m, 17.5 °C, 30.7 PSU, 21 May 2012, coll. A.G. Morales-Núñez. – 1 specimen (undetermined), station 12 (38°25.778'N; 75°05.956'W), Assawoman Bay, 1.7 m, 21 May 2012, coll. A.G. Morales-Núñez. – 552 specimens (517 undetermined, 28 ovigerous ♀, and 7 ♂♂), station 10 (38°14.504'N; 75°09.306'W), Isle of Wight Bay, 1.8 m, 17.5 °C, 30.7 PSU, 25 October 2012, coll. A.G. Morales-

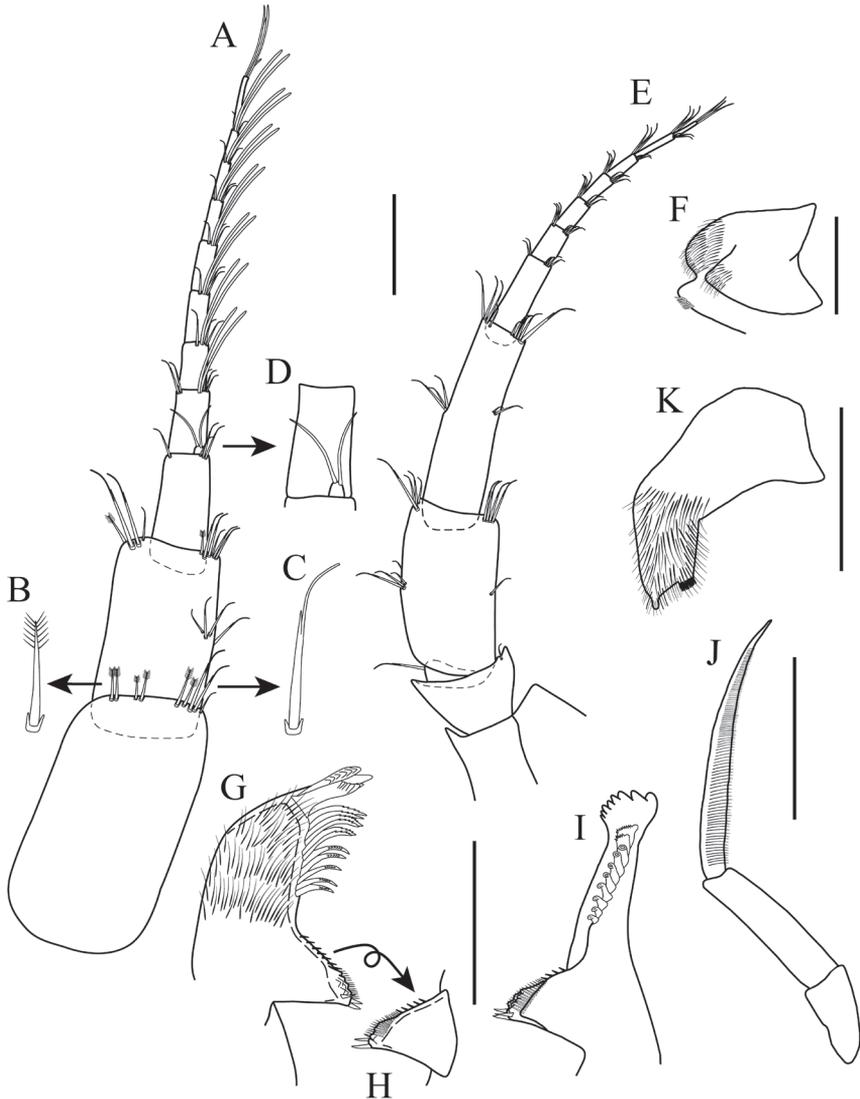


Figure 3. *Apolochus cresti* sp. n., Holotype female: **A** antenna 1, lateral view **B** enlargement of plumose seta **C** enlargement of cuspidate seta **D** enlargement of accessory flagellum **E** antenna 2, lateral view **F** upper lip **G** left mandible **H** opposite view of molar process of left mandible **I** right mandible **J** mandible palp **K** one side of lower lip. Scale bars: 0.1 mm (**A**, **E–J**).

Núñez. – 9 specimens (5 undetermined and 4 ovigerous ♀), station 13 (38°26.240'N; 75°04.651'W), Assawoman Bay, 2.1 m, 17.3 °C, 29.5 PSU, 25 October 2012, coll. A.G. Morales-Núñez.

Diagnosis. Female: *Antenna* 1 and 2 sub-equal in length; accessory flagellum uniaarticulate, small (hard to see without higher magnification). Mandibular molar with

row of spinules/setae running up the margin of the molar column, with three marginal spines on triturating surface. Mandible palp article 3 longer than two proximal articles. *Gnathopod 2* carpus with elongated lobe reaching along posterior margin of propodus to palmar angle; propodus without sub-marginal spines on antero-lateral surface.

Etymology. Named in honour of NSF – Centers of Research Excellence in Science and Technology (CREST), in recognition of its support to promote the development of new knowledge.

Type locality. Isle of Wight Bay (38°14.504'N; 75°09.306'W), Maryland Coastal Bays, United States of America.

Distribution. Maryland Coastal Bays, Mid-Atlantic region, USA, at depths ranging from 1.7 to 2.1 m.

Description. Oviparous female (eight eggs). *Body* (Fig. 2): Length 3.4 mm.

Head (Fig. 2): approximately 15% TL, slightly shorter than pereonites 1–3 combined; lateral cephalic lobe rounded; rostrum strong, downturned. Eyes circular with black center bordered by numerous opaque ommatidia.

Antenna 1 (Fig. 3A–D): sub-equal to antenna 2, slightly shorter than head and pereonites 1–3 combined, peduncle shorter than head. Peduncle article 1 length approximately 1.3 times as long as wide, with four plumose setae (Fig. 3B) on dorso-distal margin, with five (two plumose and three cuspidate (Fig. 3C) setae on ventro-distal margin. Peduncle article 2 length approximately 1.4 times as long as wide, with four (one plumose and three cuspidate) setae on dorso-distal margin; with a cluster of four cuspidate setae on mid-ventral margin, and six (one plumose and five cuspidate) setae disto-ventrally. Peduncle article 3 length approximately 2.2 times as long as wide, with cuspidate seta on dorso-distal margin; with three cuspidate setae on ventro-distal margin. Flagellum with 6 to 8 articles, longer than peduncle, ventro-distal margin of each article with 3 to 4 cuspidate setae, first seven articles bearing two aesthetascs, article 8 with four simple setae of varying lengths apically. Accessory flagellum uniaarticulate, small (difficult to see in low magnification), with two apical simple setae, length approximately $\frac{1}{8}$ that of peduncle article 3 (Fig. 3D).

Antenna 2 (Fig. 3E): sub-equal to antenna 1, peduncle slightly longer than head. Peduncle article 4 length approximately 1.7 times as long as wide, with two clusters (middle and distal) of cuspidate setae of varying lengths on dorsal and ventral margins. Peduncle article 5 length approximately 3.5 times as long as wide, with two clusters (middle and distal) of cuspidate setae of varying lengths on dorsal and ventral margins. Flagellum with seven articles, shorter than peduncle; first six articles with 2 to 5 cuspidate setae each, article 7 with three simple setae of sub-equal length apically.

Mouthparts: Upper lip (Fig. 3F): bilobed, densely pubescent apically.

Mandibles (Fig. 3G–J): molar broadly conical, with row of spinules/setae running up margin of molar column, with three marginal spines on triturating surface (Fig. 3G–I). Left mandible, densely setose, spine row with 11 to 13 accessory blades; blades increasing in width distally; *lacinia mobilis* with six teeth, incisor process dentate. Right mandible, densely setose, spine row with 10 accessory blades, incisor process dentate. *Palp*: with three articles; article 1 aetose, length less than half of article 2; article 2

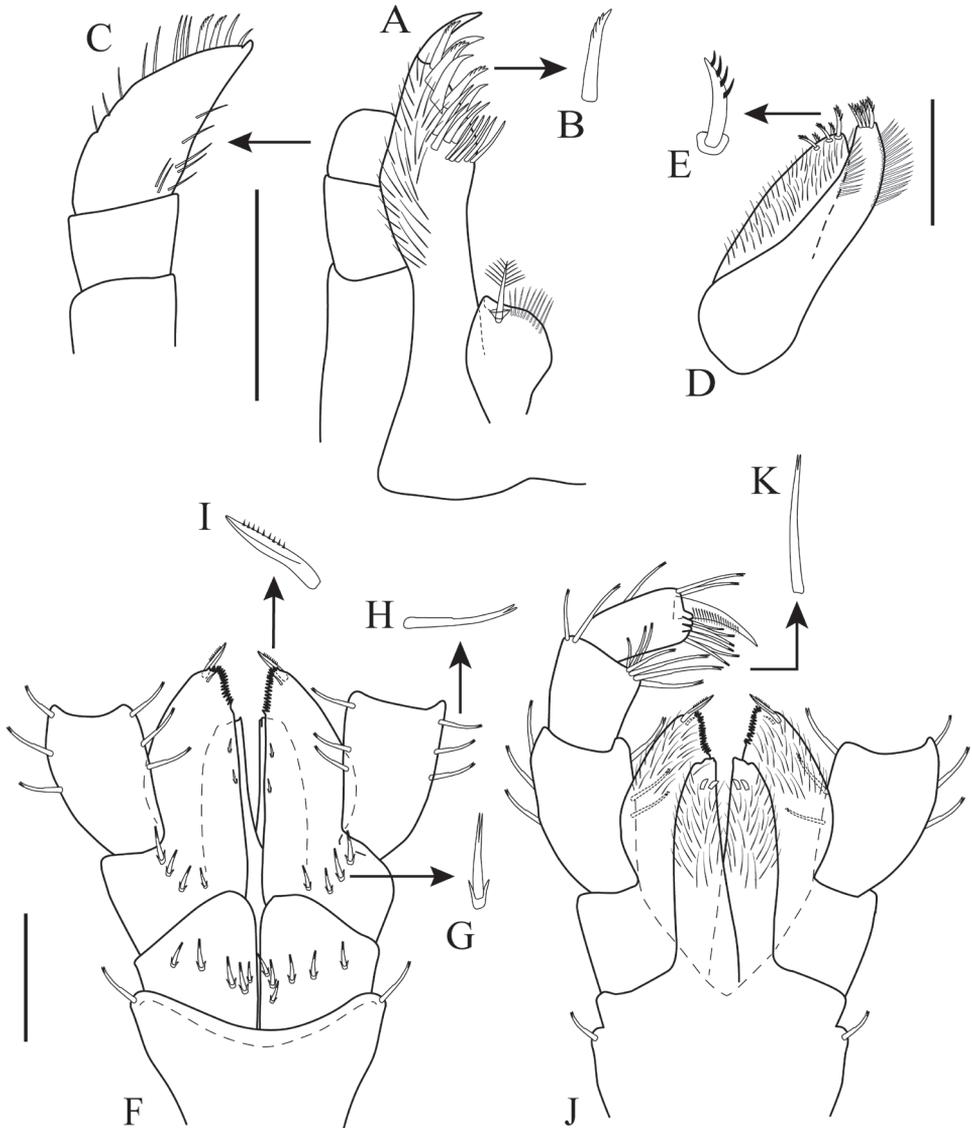


Figure 4. *Apolochus cresti* sp. n., Holotype female: **A** maxilla 1 **B** enlargement of serrate spine **C** maxilla 1 palp **D** maxilla 2 **E** enlargement of serrate spine **F** maxilliped, ventral view **G** enlargement of short bifurcate seta **H** enlargement of medium bifurcate seta **I** enlargement of well-developed serrate spine **J** maxilliped, dorsal view **K** enlargement of long bifurcate seta. Scale bars: 0.1 mm (**A**, **C–D**, **F**, **J**).

asetose, length more than twice of length of article 1; article 3 longest, lanceolate, twice length of article 2, with dense row of longitudinal fine comb setae on medial surface (Fig. 3J).

Lower lip (Fig. 3K): bilobed, outer lobe densely setose, with apical gap, distal inner margin with serrate lobe, outer margin with tubercle.

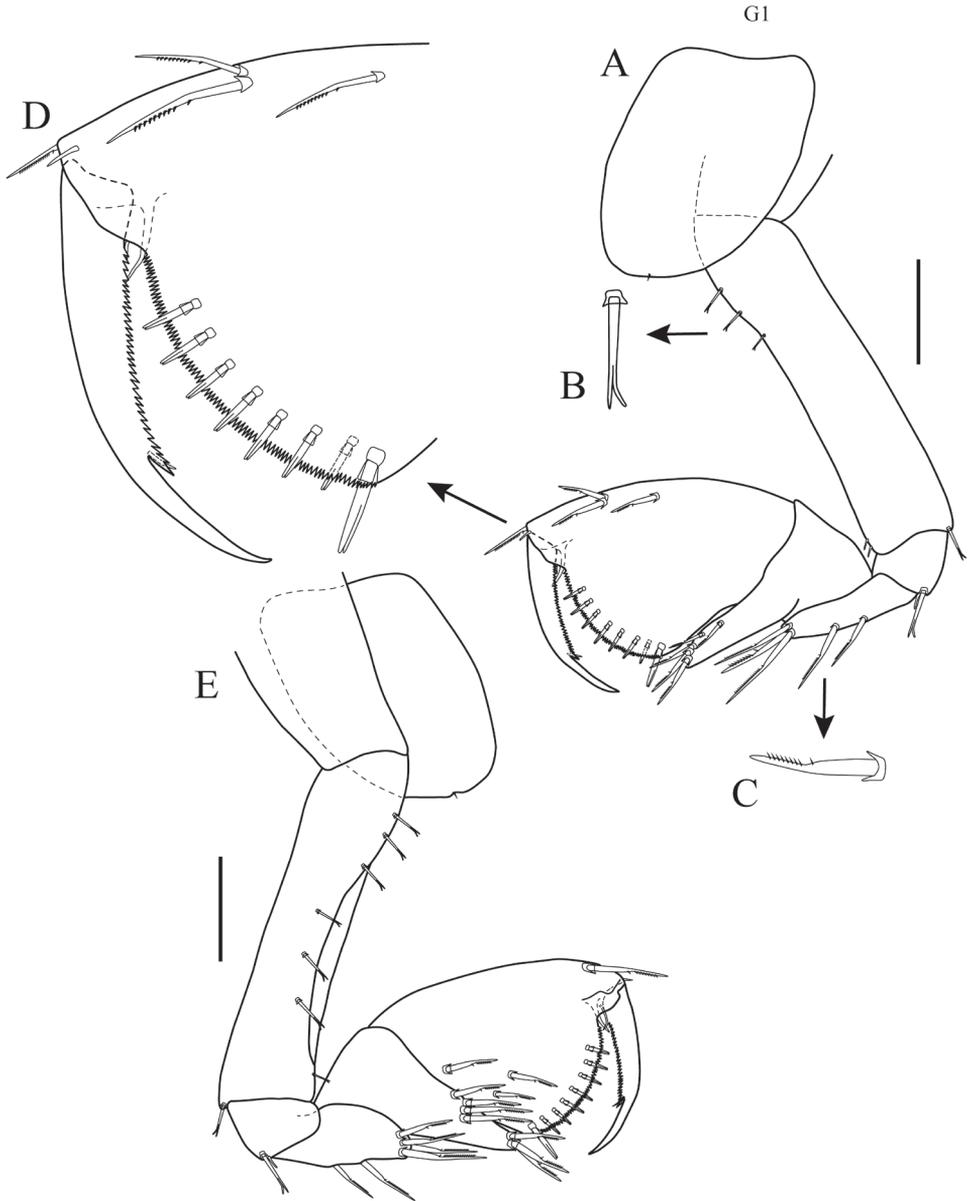


Figure 5. *Apolochus cresti* sp. n., Holotype female: **A** gnathopod 1, lateral view **B** enlargement of bifurcate seta **C** enlargement of serrate seta **D** enlargement of tip of propodus and dactylus of gnathopod 1 **E** gnathopod 1, medial view. Scale bar: 0.1 mm (**A**, **E**).

Maxilla 1 (Fig. 4A–C): inner plate rounded, with apical plumose seta and row of simple setae on distal margin (Fig. 4A); outer plate with oblique distal margin bearing eleven robust spines (eight simple and three serrate (Fig. 4B), with five long slender

setae on inner margin, outer margin densely setose (Fig. 4A). *Palp* (Fig. 4C): with two articles; article 1 asetose; article 2 length twice that of article 1, with two serrate (Fig. 4B) and two simple spines distally, mid-proximal inner margin and mid-distal outer margin with setae of different sizes.

Maxilla 2 (Fig. 4D–E): inner plate densely setose, with five serrate (Fig. 4E) terminal setae of varying length, outer margin with row of simple setae; outer plate longer than inner, with four serrate terminal setae, outer margin with row of simple setae.

Maxilliped (Fig. 4F–K): inner plate densely setose, with two sub-distal tooth-like modified setae (Fig. 4J); outer plate setose distally, with four short bifurcate (Fig. 4G) setae proximally, a serrate inner distal margin, two small marginal spines, one well-developed serrate spine (Fig. 4I) and a small seta terminally (Fig. 4F–J). *Palp* (Fig. 4J–K): with four articles; article 1 longest; inner and outer margin with two to three medium bifurcate setae (Fig. 4H); article 2, approximately two-thirds length of article 1, with seven bifurcate setae on inner distal margin, two bifurcate setae on outer distal margin; article 3 slightly longer than article 2, with six (three medium bifurcate setae and three long bifurcate (Fig. 4K)) setae on inner distal margin, with three denticles distally, with three (one central and two distal) bifurcate setae on outer margin; dactylus shorter than article 3, without unguis, lanceolate, with dense longitudinal row of fine comb setae.

Pereon (Fig. 2): approximately 42% TL, pereonites 1–7 deeper than wide; pereonite 7 longest and widest.

Gnathopod 1: Lateral view (Figs 3, 5A–D): subchelate; coxal plate short, sub-oval, partially hidden by coxa 2 (Fig. 3), with one marginal seta. Basis approximately 4.5 times as long as wide, anterior margin with three proximal bifurcate setae, two distal simple setae (Fig. 5B); postero-distal margin with one bifurcate seta. Ischium wider than long, with two setae of unequal length on postero-distal margin, longest seta bifurcate. Merus approximately 3.3 times as long as wide, posterior margin with two long serrate setae (Fig. 5C) centrally, three long serrate setae distally. Carpus with lobe reaching $\frac{2}{3}$ length of posterior margin of propodus, anterior margin of lobe with row of serrate setae. Propodus slightly expanding distally, palm convex, nearly transverse, serrate, lined with seven [6 to 9] slender bifurcate spines, corner defined by one stout bifurcate spine, anterior margin with three serrate setae, one near mid-margin and two sub-distal, with one serrate seta distally. Dactylus slightly more than $\frac{2}{3}$ length of propodus, slightly exceeding palmar angle, proximal $\frac{2}{3}$ of posterior margin serrate. *Medial view* (Fig. 5E): basis with seven bifurcate setae lining anterior and antero-medial margin. Propodus with three serrate setae on inner surface of palm. Dactylus with small seta inserted at distal end of posterior serrate margin.

Gnathopod 2: Lateral view (Figs 3, 6A–B): sub-chelate; coxal plate sub-rectangular, ventral margin convex, with short marginal setae. Basis approximately 4.8 times as long as wide, anterior margin with four short setae, two proximal, one central, and one distal; posterior margin lined with eleven small setae, one seta distally. Ischium wider than long, with one small seta on postero-distal margin. Merus approximately 4.7 times as long as wide, posterior margin with two setae, one central and one distal. Car-

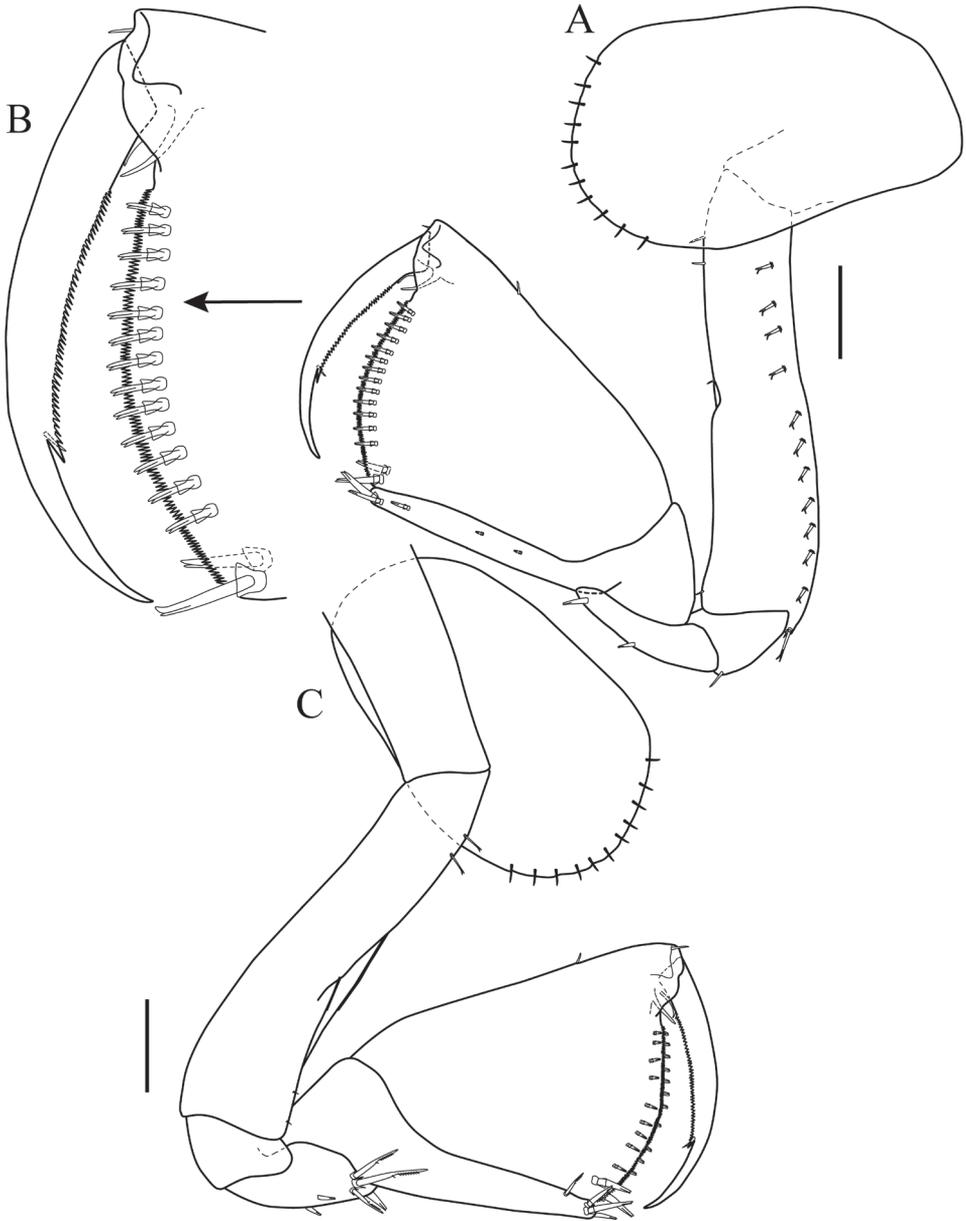


Figure 6. *Apolochus cresti* sp. n., Holotype female: **A** gnathopod 2, lateral view **B** enlargement of tip of propodus and dactylus of gnathopod 2 **C** gnathopod 2, medial view. Scale bars: 0.1 mm (**A, C**).

pus with elongated lobe reaching along posterior margin of propodus to palmar angle, lateral surface with two small spines and one seta, with two bifurcate setae distally. Propodus slightly expanding distally, palm convex, nearly transverse, serrate, lined with 13 [11 to 14] slender bifurcate spines, corner defined by two stout spines, anterior margin

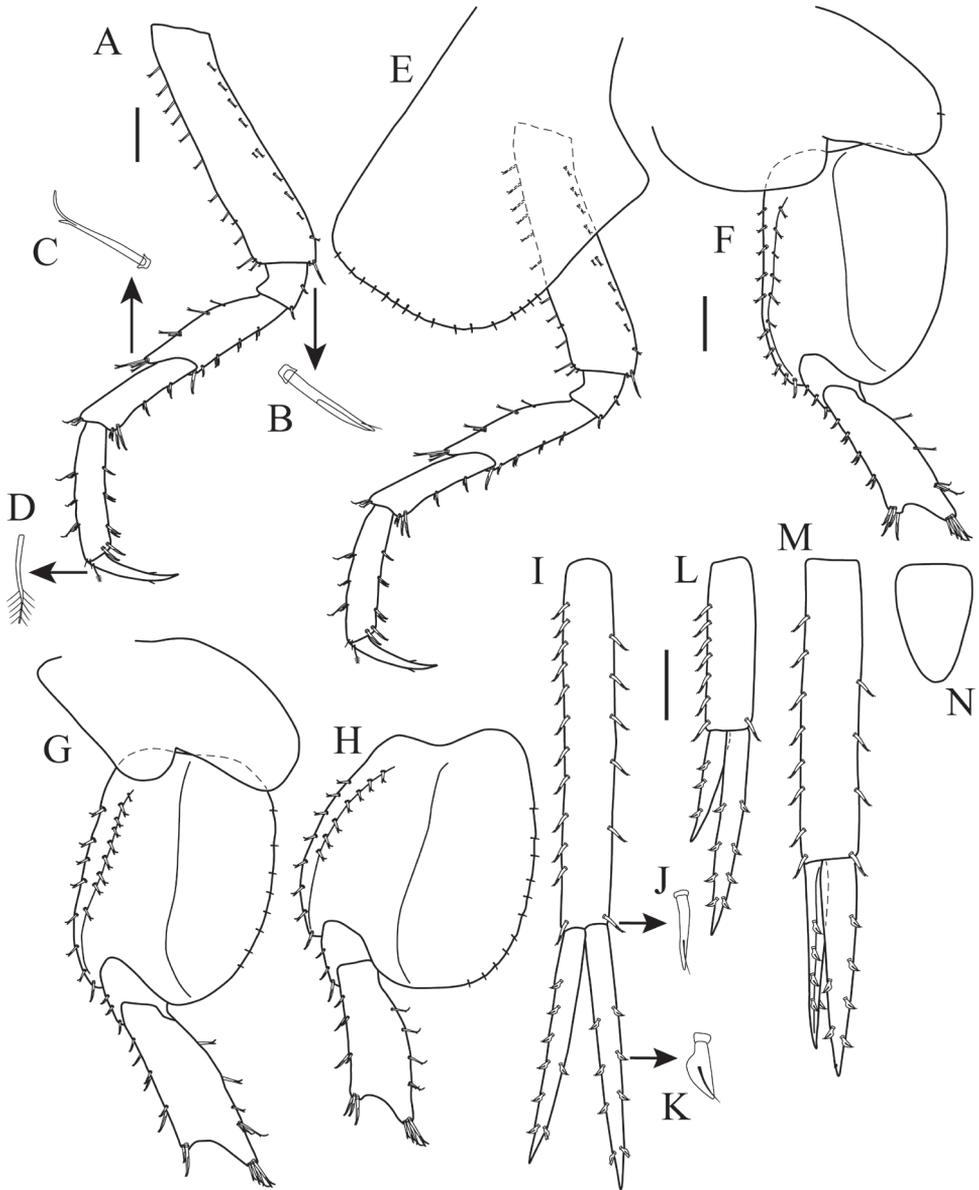


Figure 7. *Apolochus cresti* sp. n., Holotype female: **A** pereopod 3 **B** enlargement of cuspitate seta **C** enlargement of cuspitate seta **D** enlargement of plumose seta **E** pereopod 4 **F** pereopod 5 **G** pereopod 6 **H** pereopod 7 **I** uropod 1 **J** enlargement of cuspitate seta with accessory seta **K** enlargement of robust seta; **L** uropod 2 **M** uropod 3 **N** telson. Scale bars: 1.0 mm (**A**, **E-H**, **I**, **L-N**).

with small spine in distal $\frac{1}{3}$, without sub-marginal spines on antero-lateral surface. Dactylus slightly more than $\frac{2}{3}$ length of propodus, not quite reaching palmar angle, proximal $\frac{2}{3}$ of posterior margin serrate. *Medial view* (Fig. 6C): basis, anterior margin

with two spines sub-distally. Merus with three serrate setae on anterior distal margin. Dactylus with small seta inserted at distal end of posterior serrate margin.

Pereopod 3 (Figs 2, 7A–D): coxal plate sub-rectangular, longer than wide, ventral margin convex, with short marginal setae (Fig. 2). Basis approximately 4.5 times as long as wide, anterior margin lined with setae of varying lengths, anterodistal margin with four setae of unequal lengths; posterior margin lined with setae of varying lengths, postero-distal margin with one small seta and one cuspidate seta (Fig. 7B). Ischium sub-quadrate, posterior margin with two cuspidate setae, one central and one distal. Merus twice as long as wide, anterior margin with four setae, with three setae of unequal lengths distally; posterior margin with four clusters of two cuspidate setae and one longer cuspidate seta distally. Carpus approximately 3.7 times as long as wide, antero-distal margin with three cuspidate setae (Fig. 7C); posterior margin with two clusters of two cuspidate setae of varying lengths and four cuspidate setae distally. Propodus approximately 5.0 times as long as wide, anterior margin with three clusters of two setae and two simple setae distally; posterior margin with three clusters of two cuspidate setae and two cuspidate setae distally. Dactylus slightly more than 1/2 length of propodus, with plumose seta (Fig. 7D) on antero-proximal margin; with two small setae on each side distally.

Pereopod 4 (Figs 2, 7E): coxal plate larger than that of coxa 3, quadrate ventral margin straight, with short marginal setae, posterior margin excavate proximally; otherwise as pereopod 3.

Pereopod 5 (Figs 2, 7F): longer than pereopod 4, coxal plate wider than long, with rounded posterior lobe. Basis expanded, with two longitudinal ridges, anterior margin lined with setae, with cuspidate seta distally, anterior ridge lined with setae. Ischium wider than long, anterior margin lined with three cuspidate setae. Merus approximately 2.9 times as long as wide, posterior margin with two setae, cluster of three setae of unequal length, and four setae distally; anterior margin with one seta, three clusters of two cuspidate setae, with four cuspidate setae distally. Carpus approximately 4.0 times as long as wide, posterior margin with cluster of two setae, with five setae distally; anterior margin with two clusters of two cuspidate setae, with three cuspidate setae distally (Fig. 2). Propodus approximately about 6.2 times as long as wide, posterior margin with four clusters of two setae, with two simple setae distally; anterior margin with three clusters of two cuspidate setae, with two cuspidate setae distally (Fig. 2). Dactylus approximately half length of propodus (Fig. 2A).

Pereopod 6 (Figs 2, 7G): similar to pereopod 5 except coxal plate smaller than that of pereopod 5. Basis, merus, and propodus slightly longer and more setose.

Pereopod 7 (Figs 2, 7H): similar to pereopod 6 except coxal plate small and narrowly oval. Basis posterior lobe more expanded. Slightly longer and more setose than pereopod 6.

Pleon (Fig. 2): approximately 28% TL, pleonites 1–3 dorsally smooth; *Epimeron 1* (Fig. 2): ventral margin with three spines, postero-ventral corner of plate slightly produced. *Epimeron 2* (Fig. 2): ventral margin with five spines, postero-ventral corner of plate slightly produced. *Epimeron 3* (Fig. 2): ventral margin with four spines, postero-ventral corner of plate sub-quadrate. Pleopods 1–3 (Fig. 2): rami sub-equal in length.

Urosome (Fig. 2): approximately 15% TL, urosomites 1–3 dorsally smooth (Fig. 2); *Urosomite 1* longest (Fig. 2); *Urosomite 2* shortest (Fig. 2).

Uropod 1 (Figs 2, 7I–K): extending beyond peduncle of uropod 3; peduncle longer than rami, inner margin with six cuspidate setae with accessory seta (Fig. 7J), outer margin with 12 [10 to 12] setae cuspidate setae with accessory seta; inner ramus with four inner and four outer robust (Fig. 7K) marginal setae; outer ramus slightly shorter than inner ramus, with two inner and six [4 to 6] outer robust marginal setae; opposing margins of rami setulose (not shown).

Uropod 2 (Figs 2, 7L): peduncle shorter than peduncles of uropods 1 and 3, inner margin with one distal cuspidate seta with accessory seta, outer margin with seven to eight cuspidate setae with accessory seta; inner ramus with four to five inner and four outer robust marginal setae; outer ramus approximately $\frac{2}{3}$ as long as inner ramus, inner margin without setae, outer margin with two to three robust setae; opposing margins of rami setulose (not shown).

Uropod 3 (Figs 2, 7M): peduncle elongate, shorter than that of uropod 1, inner margin with four cuspidate setae with accessory seta, outer margin with eight cuspidate setae with accessory seta; inner ramus slightly longer than outer ramus, with four inner and two outer robust marginal setae; outer ramus with one inner and four outer robust marginal setae; opposing margins of rami setulose (not shown).

Telson (Fig. 7N): sub-triangular, longer than wide, apex rounded.

Adult male. *Body* (Fig. 8): Length 2.6 mm, smaller than female; similar to female except for eyes being larger and not completely rounded. Eyes may be darker than those of female (noticed in all males that were found in March 2012). Antenna 1–2 longer than those of female; antenna 1, aesthetascs of flagellum longer and more numerous than those of female.

Habitat. Marine epibenthic, in coastal shallow waters (≤ 2.1 m); *Apolochus cresti* sp. n. was associated with a mixture of macroalgae (e.g., *Agardhiella* sp., *Gracilaria* sp., *Ceramium* sp., and *Cladophora* sp.).

Remarks. Of the eight described species in the genus, *Apolochus cresti* sp. n. can be easily distinguished from *A. barnardi*, *A. casahoya*, the N-E Atlantic *A. neapolitanus* complex (Hoover and Bousfield 2001), *A. delacaya*, *A. picadurus*, and *A. pillai* by having the antenna 1 sub-equal to antenna 2 (antenna 1 is shorter than antenna 2 in the other species). However, *A. cresti*, *A. litoralis*, *A. neapolitanus* from the Mediterranean and *A. staudei* also have antenna 1 sub-equal to antenna 2. *Apolochus cresti* is distinct from *A. litoralis* by (1) the size of the carpal lobe of gnathopod 2 (elongated lobe reaching along posterior margin of propodus in *A. cresti* vs short lobe reaching halfway along posterior margin of propodus in *A. litoralis*), (2) mandible palp article 3 longer than articles 1–2 combined (shorter in *A. litoralis*), and (3) form of the telson (sub-triangular in *A. cresti* vs triangular in *A. litoralis*). The new species differs from *A. staudei* by (1) the size of the accessory flagellum (smaller in *A. cresti*), (2) size and shape of the molar process (bigger and not broadly triangular in *A. cresti*), (3) the number of accessory blades in the spine row of mandible (10–11 vs 15–17,

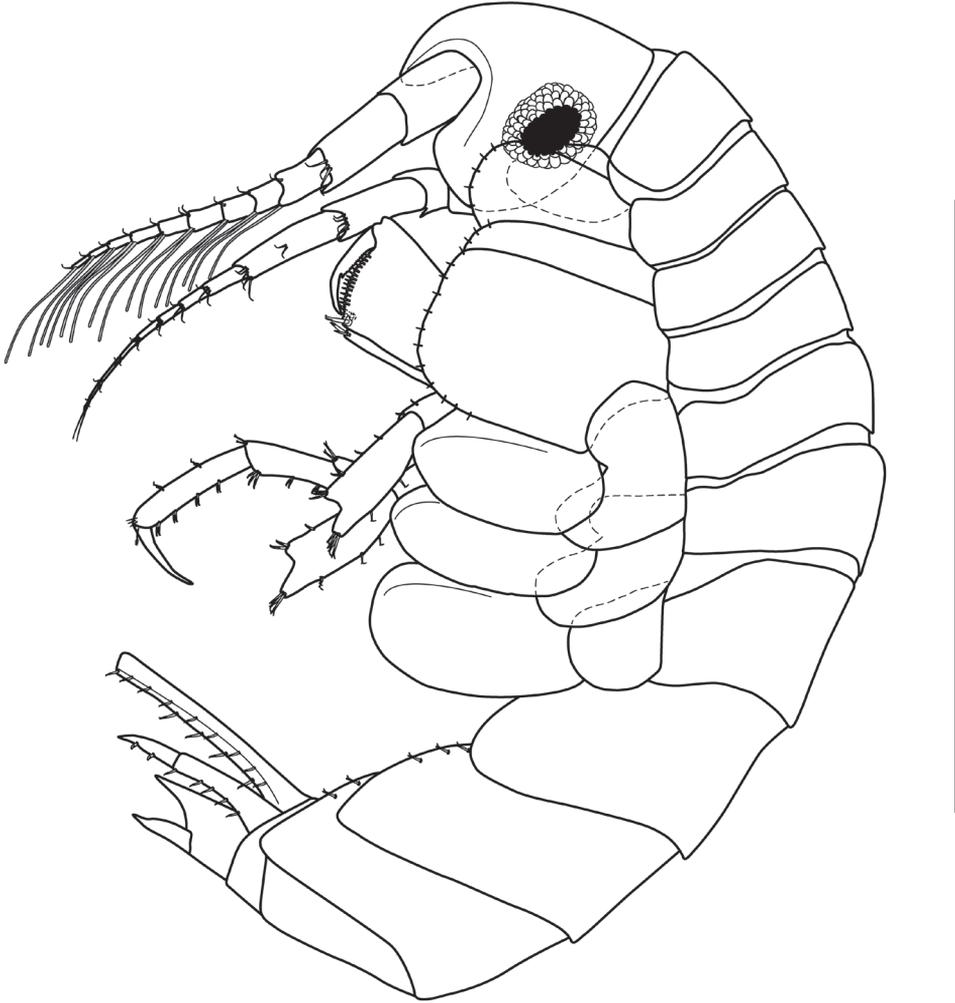


Figure 8. *Apolochus cresti* sp. n., Paratype male: lateral view. Scale bar: 1.0 mm.

respectively), and (4) the form of the telson (sub-triangular vs narrowly triangular, respectively).

Apolochus cresti appears to be most closely related to *A. neapolitanus* (Della Valle, 1893), as figured by Krapp-Schickel (1982) from the Mediterranean, but it can be distinguished by (1) shape of the lateral cephalic lobe (rounded vs truncated, respectively), (2) shape of the molar process (relative strong, with row of spinules/setae running up the margin of the molar column, with three marginal spines on triturating surface in *A. cresti* vs. rounded and rather feeble, lacking marginal setae on column and spines on triturating surface in *A. neapolitanus*), (3) proportion of mandible palp article 3 (longer than previous two articles combined in *A. cresti* vs. shorter than previous two

articles combined in *A. neapolitanus*), and (4) gnathopod 2, carpal lobe (just reaching corner of palm in *A. cresti* vs. slightly passing corner of palm in *A. neapolitanus*).

Apolochus cresti sp. n. is the fourth species of the genus to be described from the western Atlantic, after *A. casahoya* from Gulf of Mexico, *A. delacaya* from the Gulf of Mexico and Florida Keys, and *A. pillai* from the Florida Keys. *Apolochus cresti* differs from *A. casahoya* and *A. delacaya* by not having antero-lateral spines on the propodus of gnathopod 2 (*A. casahoya* has two spines and *A. delacaya* has four spines). Finally, it is distinct from *A. pillai* in having a long carpal lobe of gnathopod 2, reaching the corner of the palm on the propodus; the carpal lobe is short, not reaching the corner of the palm in latter species. *Apolochus cresti* also differs from *Apolochus* sp. A., which was reported from Florida waters (LeCroy 2002), by having a mandible molar process with a row of spinules/setae running up the margin of the molar column and three marginal spines on the triturating surface versus a mandible molar process with no setae on the margin of the column and a single large apical spine (triturating surface lacking).

The fact that illustrations of *A. neapolitanus* reported around the world are not similar, suggests that it is a complex of cryptic species, or that members of the species have been misidentified due to their small size, fragile body, and difficulty in accessing the mouth parts, which exhibit the most important characters used for taxonomic identification in this group. The following key may be used to further distinguish between the females of known *Apolochus* species.

Key to the currently recognized species of *Apolochus* (females)

- 1 Antenna 1 shorter than antenna 2 (Fig. 9A–D) **2**
- Antenna 1 sub-equal to antenna 2 (Fig. 9E–H) **6**
- 2 Accessory flagellum lacking (Fig. 9I) or minute (Fig. 9J–K); when it is present, shorter in length than the first article of flagellum (Fig. 9J–K) **3**
- Accessory flagellum sub-equal in length to the first article of flagellum (Fig. 9L) **5**
- 3 Accessory flagellum lacking (Fig. 9I) ***A. picadurus*** [southern California]
- Accessory flagellum minute, uniarticulate (Fig. 9J–K) **4**
- 4 Gnathopod 2, carpal lobe falling well short of palmar angle (Fig. 9M)
..... ***A. pillai*** [Florida Keys and Gulf of México]
- Gnathopod 2, carpal lobe nearly reaching palmar angle (Fig. 9N)
..... ***A. barnardi*** [central to southern California]
- 5 Gnathopod 2, propodus with 1-2 sub-marginal spines on anterolateral surface (Fig. 9O). Uropod 2, peduncle with 1 distal spine on inner margin; outer ramus, lateral margin with 2 stout spines larger than remaining spine (Fig. 9Q) ***A. casahoya*** [Gulf of Mexico, Florida Keys and Venezuela]
- Gnathopod 2, propodus with 4 sub-marginal spines on anterolateral surface (Fig. 9P). Uropod 2, peduncle without distal spine on inner margin; outer ra-

- mus, lateral margin without stout spines, all spines similar in size (Fig. 9R)..
 ***A. delacaya*** [Gulf of Mexico, Florida Keys and Venezuela]
- 6 Gnathopod 1, carpal lobe reaching halfway along posterior margin of propodus (Fig. 9S–T). Telson narrowly triangular (Fig. 9W–X) 7
- Gnathopod 1, carpal lobe reaching more than halfway along posterior margin of propodus (Fig. 9 U–V). Telson sub-triangular (Fig. 9Y–Z) **8**
- 7 Lateral cephalic lobe acute (Fig. 9E)
 ***A. stauderi*** [North Pacific region: British Columbia]
- Lateral cephalic lobe rounded (Fig. 9F).....
 ***A. litoralis*** [southern California to southern Alaska]
- 8 Lateral cephalic lobe truncated (Fig. 9G). Mandible molar process rounded, rather feeble, without row of spinules/setae running up the margin of the molar column, without marginal spines on triturating surface (Fig. 9A-1). Mandible palp article 3 sub-equal to articles 1–2 combined (Fig. 9A-1)
 ...***A. neapolitanus* (Della Valle) sensu Krapp-Schickel 1982** [Mediterranean]
- Lateral cephalic lobe rounded (Fig. 9H). Mandible molar process apex sub-cute, with row of spinules/setae running up the margin of the molar column, with three marginal spines on triturating surface (Fig. 9B-1–B-1’). Mandible palp article 3 longer than articles 1–2 combined (Fig. 9C-1)
 ***A. cresti* sp. n.** [Mid-Atlantic Region]

Ecological notes

A total of 2,105 individuals of *Apolochus cresti* were found in the MCBs. Specimens of *A. cresti* were only found in five of thirteen stations along the bays (Fig. 1). The highest mean abundance of *Apolochus cresti* (3.4 ± 2.0 ind m^{-2}) and mean values of macroalgae biomass (12.91 ± 8.33 g ww m^{-2}) were found at station 10 in Isle of Wight Bay, in the northern area (Fig. 9A–B, respectively). Spearman’s rank correlation analysis indicated positive correlation between the abundance of *A. cresti* and the amount of macroalgae collected per station ($r_s = 0.7$, $p < 0.001$), bay ($r_s = 0.8$, $p < 0.001$), and month ($r_s = 0.8$, $p < 0.001$) (Fig. 10A–C, respectively). Overall, *Apolochus cresti* was most abundant when a mixture of macroalgae (e.g., *Agardhiella* sp., *Gracilaria* sp., *Ceramium* sp., and *Cladophora* sp.) was observed in Isle of Wight and Assawoman Bays in the northern area of MCBs during March in this study. Furthermore, no significant correlations ($p > 0.05$) were observed between the abundance of *A. cresti* and abiotic variables measured in the bays (Tables 1–2).

The catch per effort of non-ovigerous females decreased from 11 (March) to 1 (April) before increasing to 22 (May). However, the relative abundance of non-ovigerous females in the population was similar (-3.5%) in April and May (Fig. 11). Ovigerous females carrying eggs were present from March (just one specimen) to May, and in October, reaching their peak in May (78). Conversely, the higher relative abundance

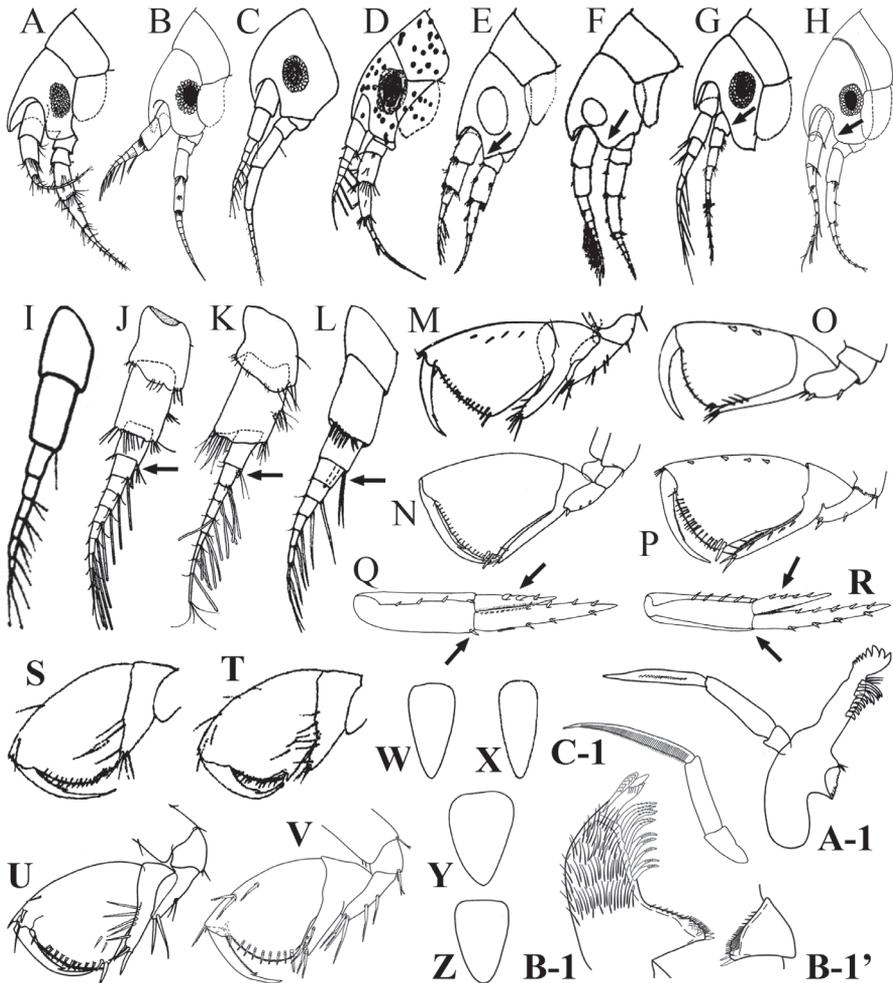


Figure 9. Female head and antennae: **A** *Apolochus barnardi* **B** *A. casahoya* **C** *A. picadurus* **D** *A. pillai* **E** *A. staudei* **F** *A. litoralis* **G** *A. neapolitanus* (sensu Krapp-Schickel, 1982) **H** *A. cresti* sp. n. Antenna 1 **I** *A. picadurus* **J** *A. pillai* **K** *A. barnardi* **L** *A. casahoya*. Gnathopod 2: **M** *A. pillai* **N** *A. barnardi* **O** *A. casahoya* **P** *A. delacaya*. Uropod 2: **Q** *A. casahoya* **R** *A. delacaya*. Gnathopod 1: **S** *A. staudei* **T** *A. litoralis* **U** *A. neapolitanus* (sensu Krapp-Schickel, 1982) **V** *A. cresti* sp. n. Telson: **W** *A. staudei* **X** *A. litoralis* **Y** *A. neapolitanus* (sensu Krapp-Schickel, 1982) **Z** *A. cresti* sp. n. Mandible: **A-1** *A. neapolitanus* (sensu Krapp-Schickel, 1982) **B-1** **B-1'** *A. cresti* sp. n. **C-1** *A. cresti* sp. n. [Figures modified from: **A**, **E**, **F**, **K**, **N**, **S**, **T**, **W**, and **X**, Hoover and Bousfield 2001; **B**, **L**, **O**–**R**, McKinney 1978; **C**, **I**, Barnard 1962; **D**, **J**, and **M**, Barnard and Thomas 1983; **G**, **U**, **Y**, and **A-1**, Krapp-Schickel 1982; **H**, **V**, **Z** and **B-1**–**C-1**, Morales-Núñez and Chigbu (this study)]. Not to scale.

of females carrying eggs was found in April (Fig. 11). Females carrying juveniles were only found in May (Fig. 11). Males were abundant in March and May, and were also collected in October (Fig. 11).

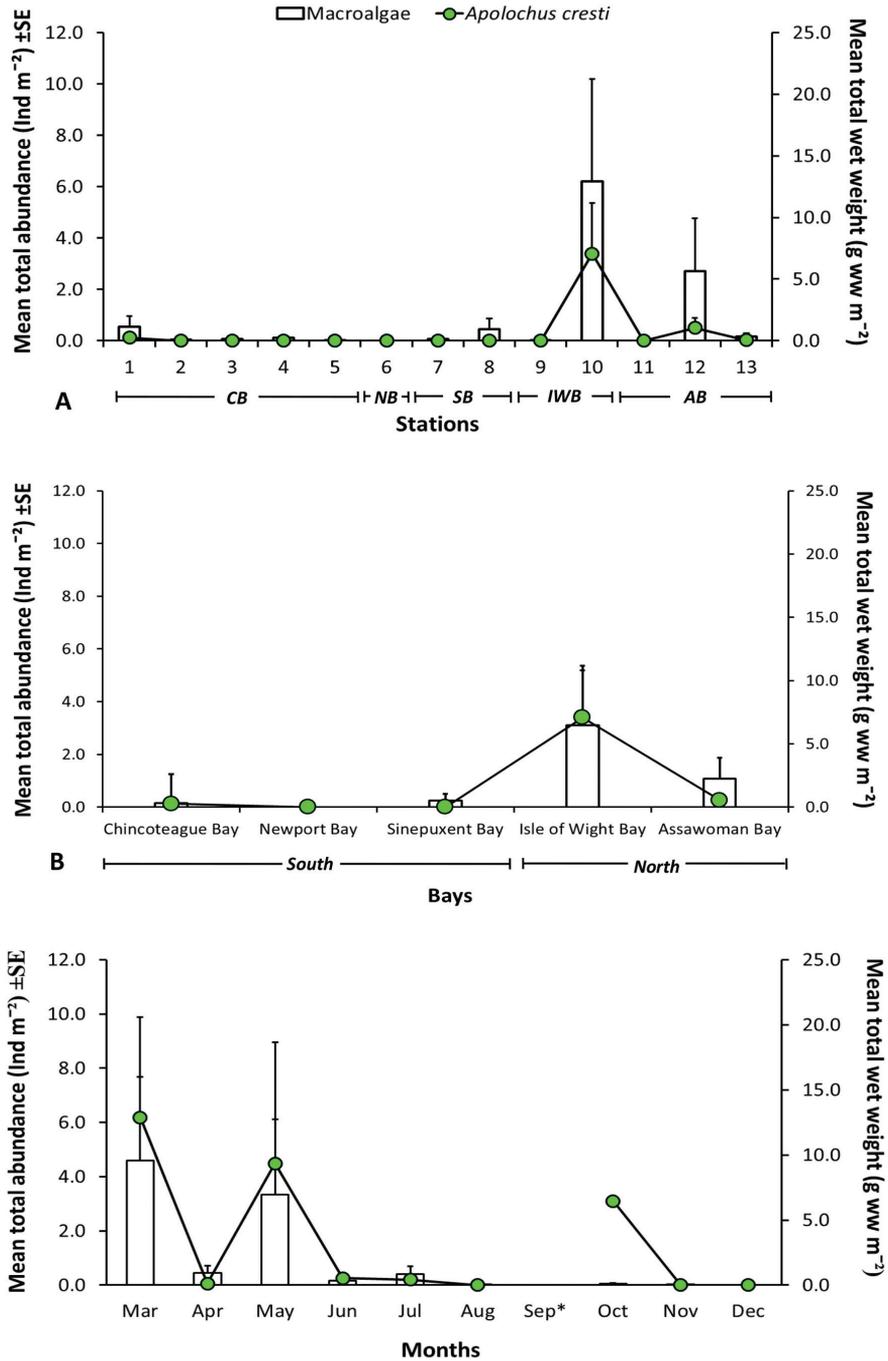


Figure 10. Mean total abundance ± SE of *Apolochus cresti* sp. n. and mean total wet weight of macroalgae ± SE found in Maryland Coastal Bays during this study: **A** stations **B** areas **C** months. **CB** = Chincoteague Bay; **NB** = Newport Bay; **SB** = Sinepuxent Bay; **IWB** = Isle of Wight Bay; and **AB** = Assawoman Bay. * Samples were not taken.

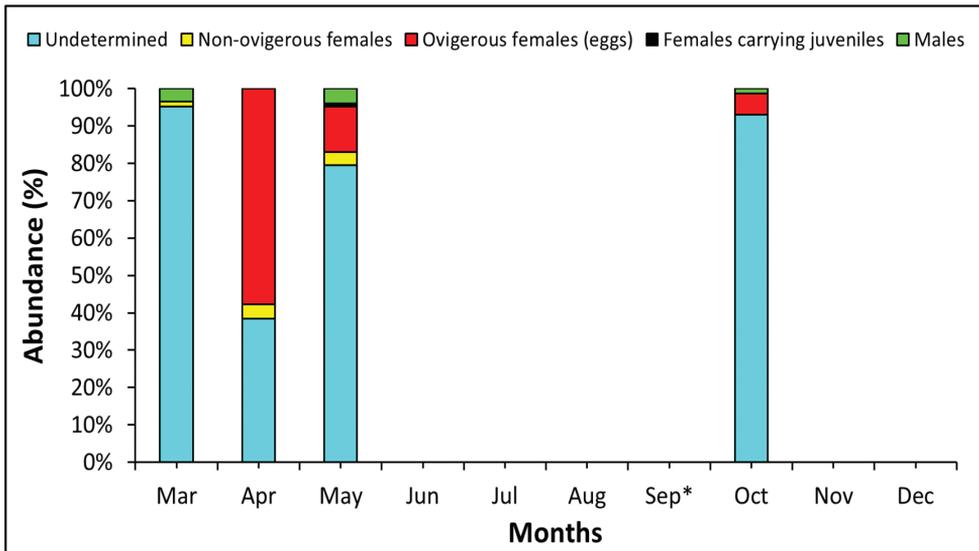


Figure 11. Percentage of undetermined, non-ovigerous females, ovigerous females and males of *Apolochus cresti* sp. n. found in Maryland Coastal Bays during this study. * Samples were not taken.

Acknowledgments

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***Culicoides hildebrandoi*, a new species of the reticulatus species group from the Brazilian Amazon Region (Diptera, Ceratopogonidae)**

Emanuelle de Sousa Farias¹, Antonio Marques Pereira Júnior^{2,3},
Maria Luiza Felipe-Bauer⁴, Felipe Arley Costa Pessoa¹,
Jansen Fernandes Medeiros³, Maria Clara Alves Santarém⁴

1 Laboratório de Ecologia de Doenças Transmissíveis da Amazônia (EDTA), Centro de Pesquisa Leônidas e Maria Deane, Fiocruz Amazônia, Rua Terezina, 476, Adrianópolis, CEP 69057-070, Manaus, Amazonas, Brazil **2** Fundação Universidade Federal de Rondônia, UNIR, Campus BR 364, Km 9.5, CEP 76801-059, Porto Velho, Rondônia, Brazil **3** Laboratório de Entomologia, Fundação Oswaldo Cruz/Rondônia, Rua da Beira, 7671, Lagoa, CEP 76812-245, Porto Velho, Rondônia, Brazil **4** Coleção de Ceratopogonidae, Laboratório de Diptera, Instituto Oswaldo Cruz-Fiocruz, Av. Brasil, 4365, 21040-900 Rio de Janeiro, RJ, Brazil

Corresponding author: Jansen Fernandes Medeiros (jmdeiro@gmail.com)

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Abstract

A new species of biting midge (Diptera: Ceratopogonidae), *Culicoides hildebrandoi* **sp. n.**, is described and illustrated based on female and male specimens from the states of Amazonas and Rondônia, Brazil. This new species belongs to the *reticulatus* species group and differs from the 24 other species of this group by the elongate slightly swollen 3rd palpal segment with scattered capitate sensilla but lacking a sensory pit.

Keywords

Amazonas, biting midges, Brazil, Rondônia

Introduction

The biting midges genus *Culicoides* Latreille (Diptera, Ceratopogonidae), presently includes 1355 extant worldwide species (Borkent 2015a), some of which can transmit pathogenic viruses and filarial nematodes to humans and other vertebrates. Due to their epidemiological importance, *Culicoides* are the best studied genus of Ceratopogonidae. Most species of *Culicoides* have wings with unique patterns of light and dark spots. Species with similar wing patterns have been included in subgenera or species groups with other similar morphological characters that are important for species identification (Felippe-Bauer 2003; Borkent 2015b).

The Neotropical *reticulatus* species group includes 24 species (Santarém et al. 2015). Santarém et al. (2014) redescribed *Culicoides reticulatus* Lutz and described seven new species, five of which were from three states in the Amazon Region of Brazil (Amazonas, Pará and Roraima). Santarém et al. (2014) noted an apparently undescribed, poorly mounted female from the state of Amazonas that they declined to describe. During our study of material from the state of Rondônia, we discovered an additional 12 female and four male specimens which we describe and illustrate herein.

Materials and methods

Specimens were collected with CDC light traps in the forest on Rancho Colorado farm, Porto Velho municipality, state of Rondônia, Brazil. The specimens were preserved in 70% ethanol and subsequently slide-mounted in phenol-balsam with the methods described by Wirth and Marston (1968). The female specimen from Balbina, Amazonas studied by Santarém et al. (2014) was also examined. Diagnostic features were microphotographed using a Digital System (SynopticsTM, Cambridge, UK) adapted to an optical microscope (Leica DMTM1000, Frankfurt, Germany). Images were taken with a digital camera (JVC 3CCDTM, Wayne, USA), and Auto Montage 4.0 used to obtain the final images.

Morphological terms are from the chapter on Ceratopogonidae by Borkent et al. (2009), in the recent the Manual of Central American Diptera. Terms of structures specific to *Culicoides* follow those described by Felippe-Bauer (2003). Measurements of spermathecae are in micrometers, whereas those of wings are in millimeters. Meristic information is presented as ranges of values, followed by mean and sample size. The holotype, allotype and some paratypes were deposited in the Ceratopogonidae Collection of Oswaldo Cruz Foundation (CCER), Rio de Janeiro, RJ, Brazil; other paratypes were deposited in the Laboratório de Ecologia de Doenças Transmissíveis da Amazônia, Leônidas and Maria Deane Institute (ILMD), Manaus, Amazonas, Brazil.

Results

Culicoides hildebrandoi sp. n.

<http://zoobank.org/78B8970A-218C-4CBC-8388-AA4B248A11A2>

Figs 1–3

Diagnosis. Female: only species of *Culicoides* in the Neotropical Region with the following combination of features: 2nd radial cell in dark spot, r_3 with four sparsely distributed pale spots, r-m crossvein pale; hind femur with subapical pale band; scutum with two anterior submedian clover-leaf shaped spots; third palpal segment elongate, slightly swollen, cylindrical, without a sensory pit but with capitate sensilla scattered on the surface cuticle. Male: only species in the Neotropical Region with the following combination of features: tergite 9 with a posteromedial notch, parameres with slightly sinuous stem, swollen on mid-portion and without a ventral lobe and the basal arch of aedeagus extending 2/3 of total length.

Description. Female. *Head* (Fig. 2d). Brown. Eyes bare, separated by distance equal to diameter of nearly one ommatidium (Fig. 2a). Antennal pedicel brown; flagellum pale brown, flagellomeres 1–8 pale on proximal ½; AR 0.90–1.00 (0.95, n = 8); sensilla coeloconica on flagellomeres 1, 6–8, two on 1, three on 6, three or four on 7 and four on 8. *Palpus* (Fig. 2b) brown; third segment elongate cylindrical, slightly swollen, without sensory pit, with sensilla scattered on surface; PR 3.30–3.90 (3.54, n = 12). Proboscis moderately long; P/H ratio 0.87–1.00 (0.95, n = 13); mandible (Fig. 2c) with 19–25 (22, n = 12) teeth.

Thorax (Fig. 2e). Dark brown, with prominent pattern of well-defined yellowish patches, humeral depression pale. Scutum with two anterior submedian clover-leaf shaped spots, two posterior submedian pale areas; lateral portion with anterior, posterior pale areas; prescutellar depressions pale; scutellum with yellowish lateral margins; postscutellum brown with pale median area. *Wing* (Fig. 1a) with contrasting pattern of pale and dark spots; distal ½ of 1st, all of 2nd radial cell in dark spot; pale spot over r-m extending from M_1 to just below radius; another pale spot from dorsal portion of radius to margin of costa; r_3 with four small separated pale spots: 1st rounded, between 2nd radial cell and M_1 ; 2nd extending posterior to 2nd radial cell, abutting wing margin; 3rd ovoid, in mid portion of cell, larger than 2nd spot; 4th distal pale spot close to 3rd spot, extending to wing margin; m_1 with two pale spots, 1st small, ovoid, beyond fork of M_1 and M_2 , 2nd larger than 1st, not close to wing margin; m_2 with four pale spots: 1st proximal to CuA, 2nd and 3rd between medial and mediocubital forks, 4th larger, not reaching wing margin; cua_1 with a rounded pale spot in middle of cell; anal cell with faint basal sinuous pale area and one distal pale spot near mediocubital fork that is nearly subdivided, abutting wing margin; wing base with faint pale spot on M ; apices of M_1 , M_2 and CuA_1 broadly pale; macrotrichia sparsely distributed on distal half of wing; wing length 1.10–1.30 (1.25, n = 13) mm, breadth 0.50–0.58 (0.56, n = 12) mm; CR 0.60–0.68 (0.65, n = 13). Halter stem pale, knob brown. *Legs* (Fig. 2g)

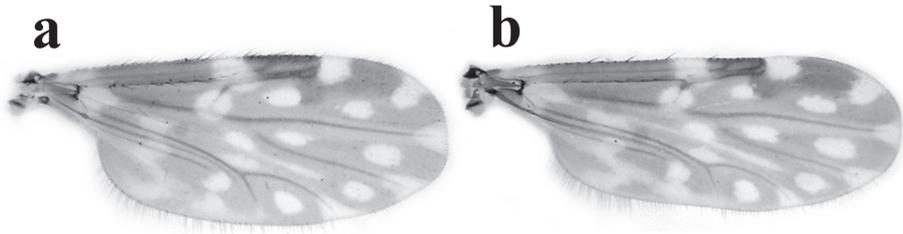


Figure 1. *Culicoides hildebrandoi* sp. n. Wing. **a** Female **b** Male.



Figure 2. a–g *Culicoides hildebrandoi*, female sp. n. **a** Eye separation, anterior view **b** Palpal segment 3 **c** Mandibular teeth **d** Head, anterior view **e** Thorax, dorsal view **f** Spermathecae **g** Legs (right to left) fore-, mid- and hind.

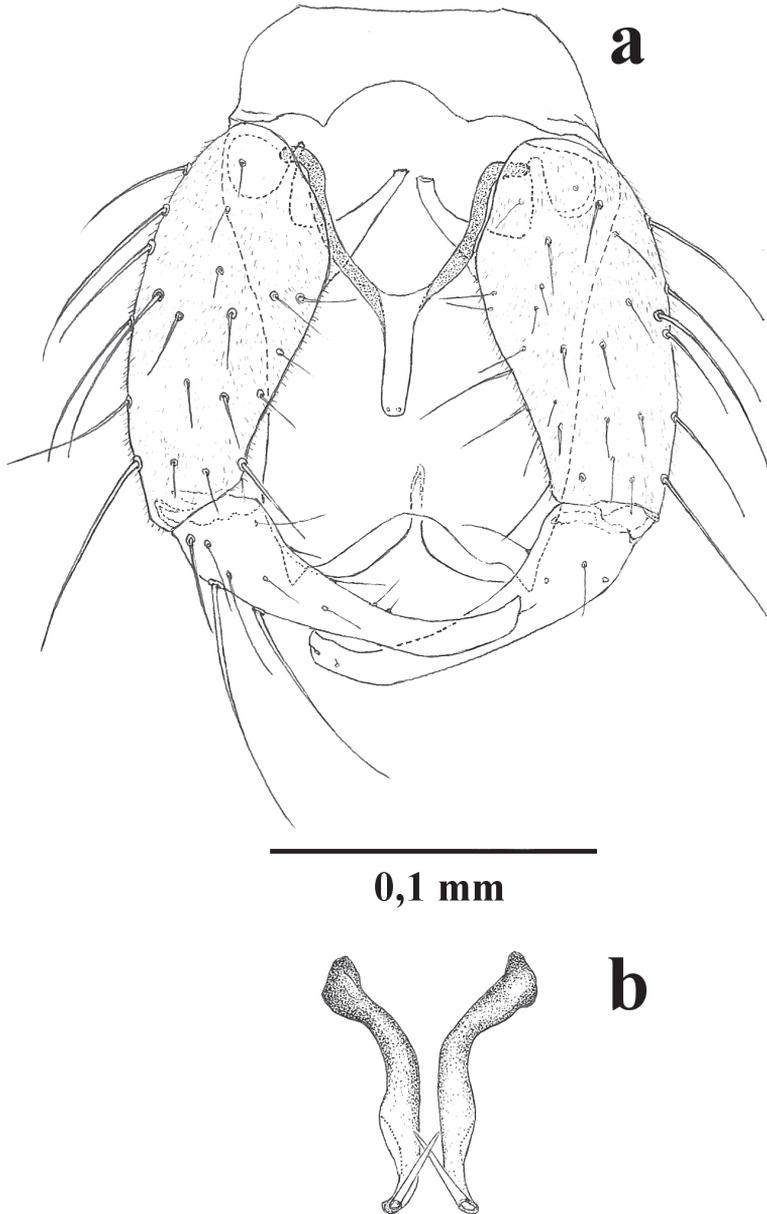


Figure 3. *Culicoides hildebrandoi*, male terminalia sp. n. **a** Terminalia and aedeagus (parameres removed), ventral view **b** Parameres, ventral view.

brown; femora with subapical, tibiae with subbasal pale bands; apex of hind tibia pale; hind tibial comb with four spines, that nearest spur longest.

Abdomen. Brown. Two subequal-size ovoid spermathecae (Fig. 2f), measuring $37.5\text{--}47.5 \times 32.5\text{--}35.0$ ($n = 2$) μm and $37.5\text{--}40.0 \times 30.0\text{--}32.5$ ($n = 2$) μm , slen-

der sclerotized necks with 7.5 μm ; third slender, elongate rudimentary spermatheca, length 27.5–30.0 ($n = 2$) μm .

Male. Similar to female with usual sexual differences. Sensilla coeloconica on flagellomeres 1, 6–10, one on 1, 6–8, two on 9, three on 10; AR 0.80–0.87 (0.85, $n = 4$). PR 1.6–2.0 (1.78, $n = 4$). Wing with pattern of pale spots as in Fig. 1b, wing length 0.95–1.08 (1.00, $n = 4$), breadth 0.35–0.40 (0.38, $n = 4$); CR 0.62–0.64 (0.63, $n = 4$). Terminalia (Fig. 3a): Tergite 9 long, tapered slightly at mid length, distal portion broader with short conical apicolateral processes, with distinct posteromedial notch; sternite 9 with rounded posteromedian excavation. Gonocoxite twice as long as broad, ventral, dorsal roots slender, elongated, sclerotized; gonostylus tapering distally, distal portion curved, apex broader with beak-like tip. Parameres (Fig. 3b) separate, each one with heavily sclerotized basal knob; stem long, curved near base, slightly sinuous, swollen on mid portion without ventral lobe; apical portion tapered, elongate, abruptly bent without lateral fringe of spicules. Aedeagus (Fig. 3a) Y-shaped; basal arms heavily sclerotized; basal arch triangular, extending 2/3 of total length; distal portion moderately slender, apex rounded.

Type material. Holotype female, labeled “Brazil, Rondônia, Porto Velho, Rancho Colorado Farm, 08°42'3.7"S; 63°59'3.8"W, 20.VIII.2014, CDC light trap, forest, Jansen F Medeiros col.” (CCER). Allotype male labeled as for female (CCER). Paratypes 12 females and three males: 11 females and three males same data as holotype (7 females, 2 males ILMD; 4 females, 1 male CCER); 1 female, Brazil, Amazonas, Balbina, 08.V.1985, CDC light trap, E. Castellón & S. Gomes col. (ILMD).

Distribution and bionomics. This is a forest species of the Amazon region of Brazil in the states of Amazonas and Rondônia.

Etymology. This species is named in memory of the late Dr. Luiz Hildebrando Pereira da Silva, a parasitologist who dedicated many years to studying Tropical Diseases such as Malaria and Chagas Disease. During his long career, Dr. Hildebrando was director of the Pasteur Institute, France. In Brazil he was a Medical School Professor at the University of São Paulo and Federal University of Rondônia. He also created the Institute for Research of Tropical Pathologies in Rondônia and was pivotal for the implementation of Oswaldo Cruz Foundation in Rondônia.

Taxonomic discussion

Culicoides hildebrandoi sp. n. is very similar to *C. reticulatus* and seven other closely related species described by Santarém et al. (2014) based on the number and distribution of pale spots on the wing and the clover-leaf pattern of yellowish patches on the anterio-submedian portion of the scutum. *Culicoides hildebrandoi* sp. n. can be distinguished from these eight congeners by its elongate, cylindrical third palpal segment with scattered capitate sensilla on its surface (third palpal segment is swollen and the capitate sensilla are in sensory pits in other species). Females of *C. hildebrandoi* sp. n. are larger than related species with a wing length of 1.10–1.30 mm (wing length < 1.0 mm in *C. amazonicus* Santarém, Felipe-Bauer & Trindade, *C. diplus* Santarém

& Felipe-Bauer, *C. profundus* Santarém, Felipe-Bauer & Trindade, *C. pseudoreticulatus* Santarém, Felipe-Bauer & Castellón and *C. rhombus* Santarém, Felipe-Bauer & Castellón), they have a more slender 3rd palpal segment, PR 3.3–3.9 (PR < 3.2 in the other species) and, a moderately long proboscis, P/H ratio 0.87–1.00 (P/H ratio ≥ 1.00 in *C. amazonicus*, *C. diplus*, *C. fluminensis* Santarém & Felipe-Bauer, *C. pseudoreticulatus*, *C. reticulatus* and *C. rhombus*).

This new species along with *C. amazonicus*, *C. irregularis* Santarém, Felipe-Bauer & Castellón, *C. profundus*, *C. pseudoreticulatus* and *C. rhombus* are associated with forested environments in the Brazilian Amazon Region, while the other three congeners are associated with mangrove swamps in the coastal regions of Colombia and Panama (*C. diplus*, Rio de Janeiro, Brazil (*C. fluminensis*), and Bahia and Pernambuco, Brazil (*C. reticulatus*).

With the description of *C. hildebrandoi* sp. n. here the “*reticulatus* species group” now has 25 species distributed throughout the Neotropics.

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A stunning new species of *Jamides* Hübner, 1819 (Lepidoptera, Lycaenidae), with notes on sympatric congeners from the Bismarck Archipelago, Papua New Guinea

Chris J. Müller¹

¹ *Honorary Associate, Australian Museum, 6 College Street, Sydney, NSW 2010* ² *Address for correspondence: PO Box 3228, Dural, NSW 2158*

Corresponding author: *Chris J. Müller* (chrismuller999@gmail.com)

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Abstract

Jamides vasilina sp. n., from montane West New Britain Province, Papua New Guinea, is described and illustrated. The new species is strongly divergent from other known *Jamides* Hübner, 1819 in possessing a high antenna-forewing length ratio, long androconia on the hindwing upperside and a strongly convex forewing inner margin in the male. It is compared by external structures, male genitalia and mtDNA sequence data to putative related species in the *cyta* group of *Jamides*. Notes on various *Jamides* taxa from the Bismarck Archipelago are also provided, with *J. pseudosias* (Rothschild, 1915) and *J. reverdini* (Fruhstorfer, 1915) recorded from New Britain for the first time.

Keywords

Taxonomy, Lepidoptera, Lycaenidae, Polyommatainae, new species, Bismarck Archipelago, androconia

Introduction

Jamides Hübner, 1819, butterflies, commonly known as Caeruleans, belong to the subfamily Polyommatainae. The genus is distributed throughout much of the Oriental, Australian and Pacific region tropics (Rawlins et al. 2014) and comprises approximately 60 described species, with a concentration in South East Asia and New Guinea. (Hirowatari 1992) recognised 57 species and additional species have been described by Tennent and Rawlins (2012), and Takanami (1994). From approximately west to east, Kunte et al. (2015), Corbet and Pendlebury (1993), Treadaway and Schröder (2012), Rawlins et al. (2014), Parsons (1998), Tennent (2002) and Tennent (2006) identified six species for India, 16 for the Malay Peninsula, 16 for the Philippines, 21 for Maluku, 15 for Papua New Guinea, eight for the Solomon Islands and nine for the remainder of the South West Pacific, respectively.

Hirowatari (1992) proposed two groups and eight subgroups for *Jamides*. He noted that, together with members of the genus *Nacaduba* Moore, 1881, there is exceptional diversity of the male genitalia valva and their morphology is useful in placing species and making phylogenetic inferences about the group.

The new species introduced herein is exceptionally distinct from all other *Jamides* species. A number of other phenotypically distinct butterflies have recently been recorded from West New Britain Province (Müller 2013, 2014; Müller and Wills 2013), the type locality of the new species.

Materials and methods

Examination of type and other relevant material was carried out in various institutions (as listed below). Adult specimens were photographed using a Nikon D300s Digital SLR Camera with a Nikon AF-S VR Micro-Nikkor 105mm f/2.8G IFED Macro lens and Nikon R1C1 Close-up Kit Flashes Speedlights. RAW images were edited using Adobe Photoshop CS6. Editing included alignment, auto contrasting and removal of background. A standardised procedure was followed with photography and image editing to ensure consistency of image output. Genitalia were extracted following maceration of abdomens in 10% KOH at room temperature for 36 hours. Genitalia were photographed in glycerol using the fore-mentioned camera body adapted to a Meiji Techno EMZ-5TR-P-FOI Trinocular Stereozoom Microscope, with OPTEK FL95E Fibreoptic Illuminator and twin arm optical fibre. Individual images were taken with the remote acquisition software DIYPhotoBits Camera Control 5.2. Sliced genitalia photographs were stacked and concatenated using the software Helicon Focus 6.0 and edited in Adobe Photoshop CS6. The plates were assembled in Adobe InDesign CS6 and the phylogeny tree in CorelDRAW X6. Genitalia were stored in small glycerol-filled vials pinned beneath the specimen.

Descriptions of external facies follow that of the numerical vein system of Corbet and Pendlebury (1993). Nomenclature of genitalic descriptions follows the same reference.

Tissue material (two legs) was collected from representatives of all of the eight *Jamides* subgroups of Hirowatari (1992), except that of the monotypic *celebica* Eliot, 1969 group, originally ascribed to *Epimastidia* Druce, 1891. Genomic DNA was extracted using the Qiagen DNEasy extraction kit, following the guided protocol by the manufacturer. Nucleotide sequence alignment was done by eye using Bioedit. For COI, a 654 bp fragment was amplified using Folmer et al. (1994) LCO (5'-GGTCAACAAATCAT-AAAGATATTGG-3') and HCO (5'-TAAACTTCAGGGTGACCAAAAAATCA-3').

Individual sequence properties were assessed using MEGA, version 4.1 (Tamura et al. 2006). Bayesian analyses of the dataset were carried out using MrBayes, version 3.0b4 (Ronquist and Huelsenbeck 2003). Three independent Bayesian runs at temperature settings in the range 0.2–0.4 were performed on the data using metropolis coupled Markov chain Monte Carlo simulations, from one to 5 million generations each, and tree sampling every 100 generations. Bayesian topology and branch posterior probabilities were computed by majority rule consensus after deleting the first 1000 000 generations (10 000 trees) as 'burn-in', after confirming that likelihood values had stabilized prior to the 100 000th generation.

Sequences were uploaded to GenBank (<http://www.ncbi.nlm.nih.gov/genbank/>) and are listed for each individual in the phylogenetic tree presented in Fig. 59. Additional sequences of *Jamides* taxa (also listed in the tree) were downloaded from Genbank and manually aligned with the dataset. Where possible, the species identity of the latter sequences was checked through the BOLD online database image gallery (<http://www.boldsystems.org/>).

Abbreviations

- AM** Australian Museum, Sydney, Australia.
CJMC Reference collection of Chris J. Müller, Sydney, Australia.
MNHU Museum für Naturkunde der Humboldt-Universität, Berlin, Germany.
NARI National Agricultural Research Institute, Boroko, Port Moresby, Papua New Guinea.
NHM Natural History Museum, London, England.
SMT Staatliches Museum für Tierkunde, Dresden, Germany.

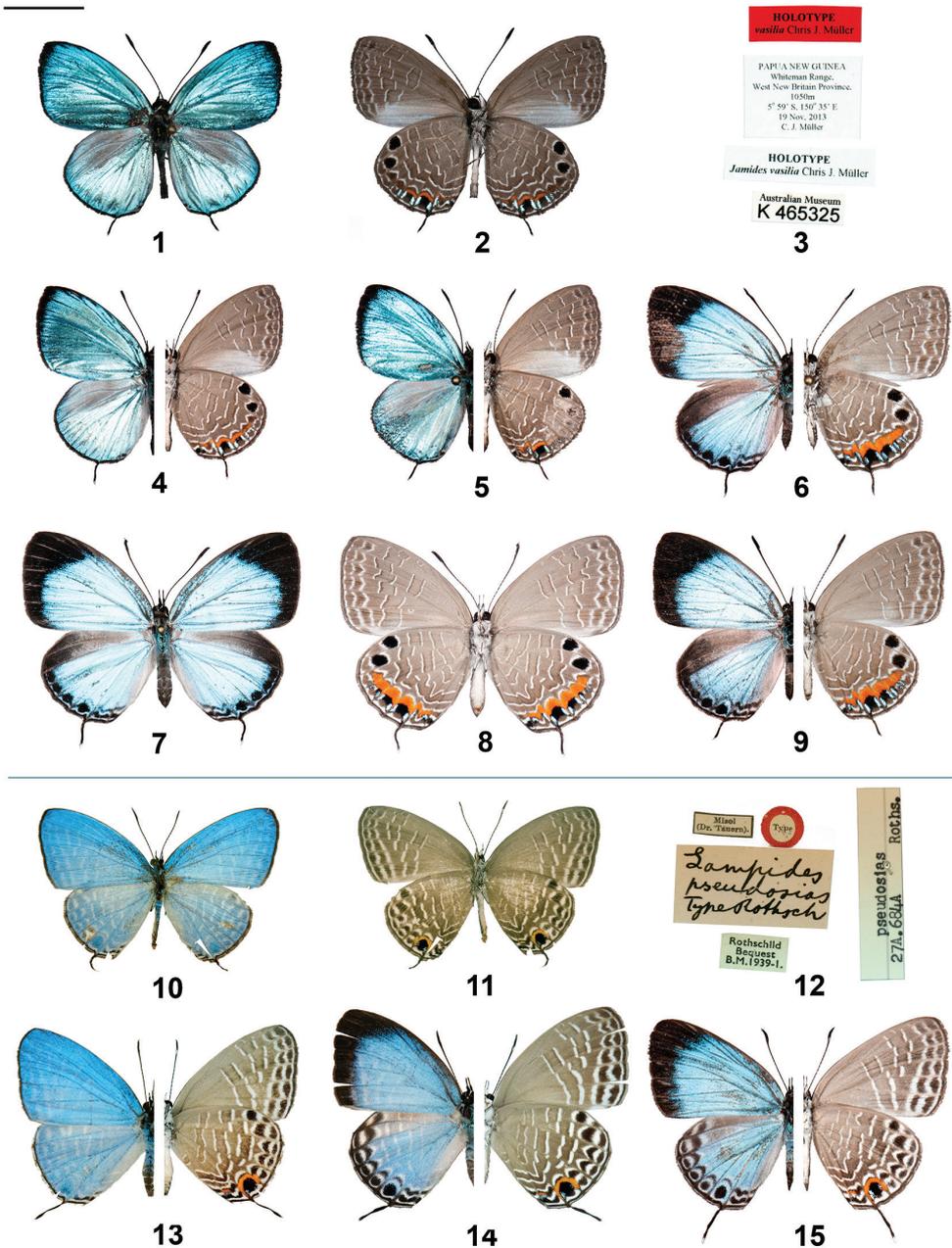
Taxonomy

Jamides vasilia Müller, sp. n.

<http://zoobank.org/2FF4EC45-5602-4583-BF61-424613106C50>

Figs 1–9, 46, 53

Type material. Holotype ♂ (Figs 1–3): Papua New Guinea, Whiteman Range, West New Britain Province, 1050m, 5°59'S, 150°35'E, 19 Nov, 2013, Chris J. Müller, geni-



Figures 1–15. *Jamides* adults (left side upperside and right side underside, where halved) and label data. **1** *Jamides vasilia* holotype ♂ upperside **2** *J. vasilia* holotype ♂ underside **3** *J. vasilia* holotype ♂ label data **4** *J. vasilia* paratype ♂ (halved) **5** *J. vasilia* paratype ♂ (halved) (note rubbed hindwing) **6** *J. vasilia* paratype ♀ (halved) (note rubbed forewing) **7** *J. vasilia* paratype ♀ upperside **8** *J. vasilia* paratype ♀ underside **9** *J. vasilia* paratype ♀ (halved) **10** *J. pseudosias* holotype ♂ upperside **11** *J. pseudosias* holotype ♂ underside **12** *J. pseudosias* holotype ♂ label data **13** *J. pseudosias* ♂ (halved) (New Ireland) **14** *J. pseudosias* ♀ (halved) (New Ireland) **15** *J. pseudosias* ♀ (halved) (New Britain). Scale bar = 10 mm.

talía dissected and held in vial pinned to specimen (AM), Registration: AM K.465325. Paratypes (3 ♂♂, 5 ♀♀): 1 ♂ labelled as holotype but dated 10 Nov, 2014 (NHM); 1 ♂ labelled as holotype but dated 26 Nov, 2014 (CJMC); 1 ♂ labelled as holotype but dated 22 Nov, 2014, Chris J. Müller (CJMC); 1 ♀ labelled as holotype but dated 10 Nov, 2014 (AM), Registration: AM K.465326.; 1 ♀ labelled as holotype but dated 13 Nov, 2014 (NHM); 1 ♀ labelled as holotype but dated 07 Dec, 2014 (CJMC); 1 ♀ labelled as holotype but dated 19 Apr, 2013 (CJMC); 1 ♀ labelled as holotype but dated 07 Nov, 2014 (NARI).

Diagnosis. Both sexes of *Jamides vasilía* are highly distinctive and cannot be confused with any other known species. The uppersides of both sexes are brighter and more reflective than those of other species in the genus, the ground colour of the male in particular rivalling *Morpho* butterflies in intensity and radiance. The male of *J. vasilía* is unusual from a structural perspective, having long antenna (versus forewing length) that extend well beyond the cell and reach the postmedian area. The antenna/forewing length ratio is ~ 0.6 , whereas in all other known *Jamides* species the antenna of the male is approximately half the length of the forewing. The shape of the male forewing is unique in that the tornus and inner margin are rounded, the latter being convex while in all other *Jamides* species the inner margin is straight. Also peculiar in the male is the large purple-brown patch occupying the costal one-third of the hindwing upperside. This patch is adorned with long androconial hairs (up to 5 mm in length). No other known *Jamides* bears such prominent structures. The male forewing upperside bears a thick terminal black border, tapering towards the tornus, not present in other species. On the underside, both sexes are easily recognised by the curved striae that are well displaced between veins on both wings and the two apical black spots on the hindwing are more rounded and pronounced than in other taxa. The area of orange bordered by metallic blue on the hindwing underside is extensive in both sexes, particularly the female, and extends from the inner margin all the way to space 5. The male forewing underside has the entire median area grey-white between the inner margin and vein 2.

The male genitalia of *J. vasilía* is unusual, bearing long teeth-like processes on the inner margin of the valva, with a spine-like process at the apex of the valva.

Description. ♂ Forewing length 15.8mm (Holotype), Antenna length 9.5mm (Holotype). Head grey; antenna long and extending well beyond end of cell, black ringed with white; thorax blue scaled on upperside, grey beneath; abdomen dark grey with blue scales near base on upperside; legs black with white between segments.

Forewing with tornus rounded (in congeners squared), and inner margin convex (in congeners straight).

Forewing upperside brilliant metallic sky blue, darkening slightly towards termen and apex, a prominent black termen border widening to ~ 1.5 mm at apex; cilia black. Forewing underside deep grey-brown; inner margin broadly pale grey-white (in spaces 1a and 1b), with some metallic sky blue scales along vein 1b; termen narrowly white; a narrow grey-brown subterminal band, narrowly edged with white that forms triangular marks on basal edge; a postmedian band of similar colour to ground colour, about 2mm wide, narrowly edged with curved white on outside margin and with

corresponding dark brown on inside margin, band is strongly displaced at veins by approximately 1mm, towards base in spaces 6 and 7 and incrementally towards base towards inner margin in spaces 2, 3 and 4; a median band at end of cell, approximately 1.5mm wide, curved and edged with white and dark brown as in postmedian band; cilia dark brown.

Hindwing rounded, with 2.5mm long, black tail at vein 2, tipped with white.

Hindwing upperside brilliant metallic sky blue, darkening slightly towards termen; a large purple-brown patch, clothed with long androconia along costa and in median area, occupying much of spaces 6 and 7 as well as part of cell and space 5; termen narrowly black; a series of diffuse black-dusted and indented subterminal spots, as well as two small black spots at tornus near intersection of vein 1b. Hindwing underside deep grey-brown; inner margin narrowly white, interspersed with black at vein ends; a large black apical spot (1.5mm diameter) in space 6 and another apical spot of similar colour and dimensions in space 7, both spots rimmed narrowly with white; two large subtornal black spots in spaces 2 (approx. 1mm across) and 3 (approx. 0.4mm across) and smaller, less regular black spots in spaces 1b and 4, each of these spots broadly edged along veins with metallic sky blue and basally with bright orange, and then fine white arcuate lines; an additional arcuate white subterminal line in space 5 linking the subapical and subtornal black spots; a postmedian band similar to that on the forewing underside, curved and strongly displaced at veins; a median band edged with white and dark brown at end of cell; a basal band approximately 1mm wide, edged narrowly with white, displaced at either side of cell; cilia dark brown.

♀: Forewing length 20.6mm, antenna length 10.8mm, antenna, thorax, abdomen and legs similar to male.

Forewing with inner margin straight.

Forewing upperside bright lustrous sky blue, darkening towards termen; apex of termen and apex broadly and sharply edged black (2.5mm and 8mm wide, respectively). Forewing underside similar to male, ground colour slightly paler and inner margin only narrowly white-grey and without blue scales, postmedian band extending to vein 1b, white edging to bands slightly wider and more diffuse.

Hindwing rounded, with black, white-tipped tail at vein 2 (approx. 4mm long).

Hindwing upperside bright lustrous sky blue, darkening towards termen; inner margin broadly black, basally transitional to brown, with narrow blue scaling along edge of space 6 and 7 adjacent to cell; a row of black subterminal spots (each averaging 0.6mm diameter) in spaces 2, 3, 4 and 5; two irregular black subtornal lines in spaces 1a and 1b, subparallel to termen; inner margin narrowly white. Hindwing underside similar to male, ground colour slightly paler, orange bordering subterminal spots wider and very extensive, reaching from the inner margin to space 5.

Male genitalia. Vinculum and tegumen ring broadly oval; sociuncus divergent; socii with lateral margin rounded, socii distinctly separated by straight, perpendicular sinus; saccus of even thickness, brachium widely bowed dorsally, yet sharply bent laterally, tapered dorsally; valva elaborate, hollowed, with serrated margin and teeth-like processes on inner margin, long narrow process stemming from near base of valva,

weakly clubbed with pointed ventral surface on club; phallus with prezonal section approximately one tenth the length of postzonal section, slender, with apical rounded pencil-like process.

Etymology. This enigmatic and exquisite new butterfly is named in honour of the author's wife, Vasilia (Vicki) Savvas (Muller). Vicki has always supported the author's obsession in butterfly research, despite the many sacrifices both on and off the field.

Distribution. New Britain Island, Papua New Guinea.

Ecology. Adults of *J. vasilia* inhabit moss forest and appear to have a more rapid, erratic flight than other members of the genus. Two females were initially observed flying around the base of a *Syzygium* R.Br. ex Gaertn. (Myrtaceae) sapling and resembled those of the lycaenid *Arhopala thamyras* (Linnaeus, 1758). The particular *Syzygium* plant had numerous, highly active, medium-sized brown ants present on the lichen-covered trunk but no early stages of *Jamides* could be located either on the foliage, trunk or in leaf litter surrounding the base of the plant. In the upper parts of the Whiteman Range (Figs 60, 61), *J. vasilia* flies with several other *Jamides* taxa, including *J. reverdini* (Fruhstorfer, 1915), *J. pseudosias* (Rothschild, 1915), *J. cyta* (Boisduval, 1832), *J. allectus* (Grose Smith, 1894), *J. soemias* Druce, 1891 and *J. amarauge* Druce, 1891. At lower elevations in the same mountain range, *J. celeno* (Cramer, 1775), *J. aetherialis* (Butler, 1884) and *J. nemophila* (Butler, 1876) are abundant.

Remarks. The phylogeny of *Jamides*, presented in Fig. 59, comprises representative species from each of Hirowatari's eight subgroups of *Jamides*, with the exception of the monotypic *J. celebica* (Eliot, 1969). In the Bayesian phylogeny, *J. vasilia* is recovered in a deeply diverged clade also comprising *J. cyta* and *J. nitens* Joicey & Talbot, 1916.

There is no significant variation in the type series of *J. vasilia*, with all specimens similar in size and shape. The male exhibits very slight variation in the width of the terminal black border.

The extent of distribution of *J. vasilia* on New Britain Island is not known. Based on the distribution of other endemic butterfly taxa on the island, it is unlikely to be restricted to the Whiteman Range, although no specimens have been observed during surveying, at a range of altitudes, of the Nakanai and Bainings Mountains, in central and east New Britain, respectively. *J. vasilia* appears to be a rare species.

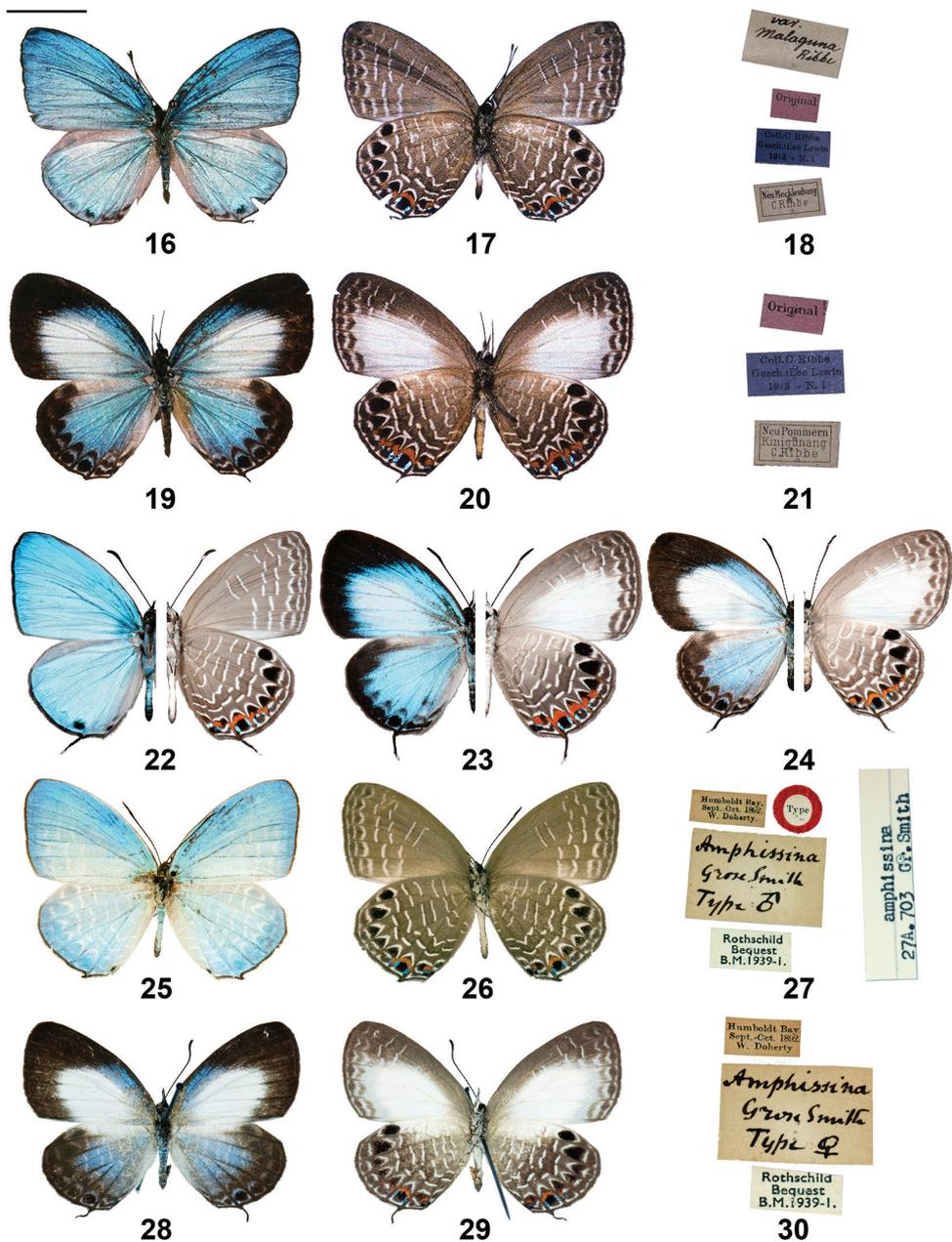
Notes on sympatric *Jamides* taxa in the Bismarck Archipelago

Jamides cyta (Boisduval, 1832)

Figs 16–30, 47, 48, 55

Catochrysops cyta: Boisduval (1832: 87); TL: New Ireland.

Remarks. The type (?types) of *Jamides cyta* (Boisduval, 1832) were taken in New Ireland, during the voyage of the *Astrolabe* through the Indo-Pacific during the period 1826–1829. The *Astrolabe*, captained by Dumont d'Urville, visited at least three coastal



Figures 16–30. *Jamides cyta* adults (left side upperside and right side underside, where halved) and label data. **16** *Lampides amphissina* var. *malaguna* lectotype ♂ upperside **17** As Fig. 16, underside **18** As Fig. 16, label data **19** *L. amph.* var. *malaguna* paralectotype ♀ upperside **20** As Fig. 19, underside **21** As Fig. 19, label data **22** *J. c. cyta* ♂ (halved) (New Britain) **23** *J. c. cyta* ♀ (halved) (New Britain) **24** *J. c. cyta* ♀ (halved) (New Ireland) **25** *J. c. amphissina* holotype ♂ upperside **26** *J. c. amphissina* holotype ♂ underside **27** *J. c. amphissina* holotype ♂ label data **28** *J. c. amphissina* allotype ♀ upperside **29** *J. c. amphissina* allotype ♀ underside **30** *J. c. amphissina* allotype ♀ label data. Scale bar = 10 mm.

sites in New Ireland; Port Praslin, Hèvre Cartret (Carteret Bay) and Likiliki in the Bay of Frondeurs (=Slinger's Bay) (Domeny de Rienzi 1838). Port Praslin and Carteret Bay are separated by about 15km on the western side of New Ireland near the southern tip, in the Cape Saint George Channel. The location of Slinger's Bay is given as "on the N. coast of New Ireland. Lon. 151. E. Lat. 3. S." by Worcester (1817). The type/s of *J. cyta* have not been located. However, the description by Boisduval is clear, as follows:

"Ailes d'un bleu-argenté luisant; les inférieures avec une petite queue; dessous des quatre avec plusieurs raies blanches interrompues; les inférieures ayant en outre une rangée marginale de taches noires, don't les trois voisines du bord abdominal marquées de fauve et de vert doré.

Il a le port et la taille d'Elpis, auquel il ressemble beaucoup.
Nouvelle-Irlande."

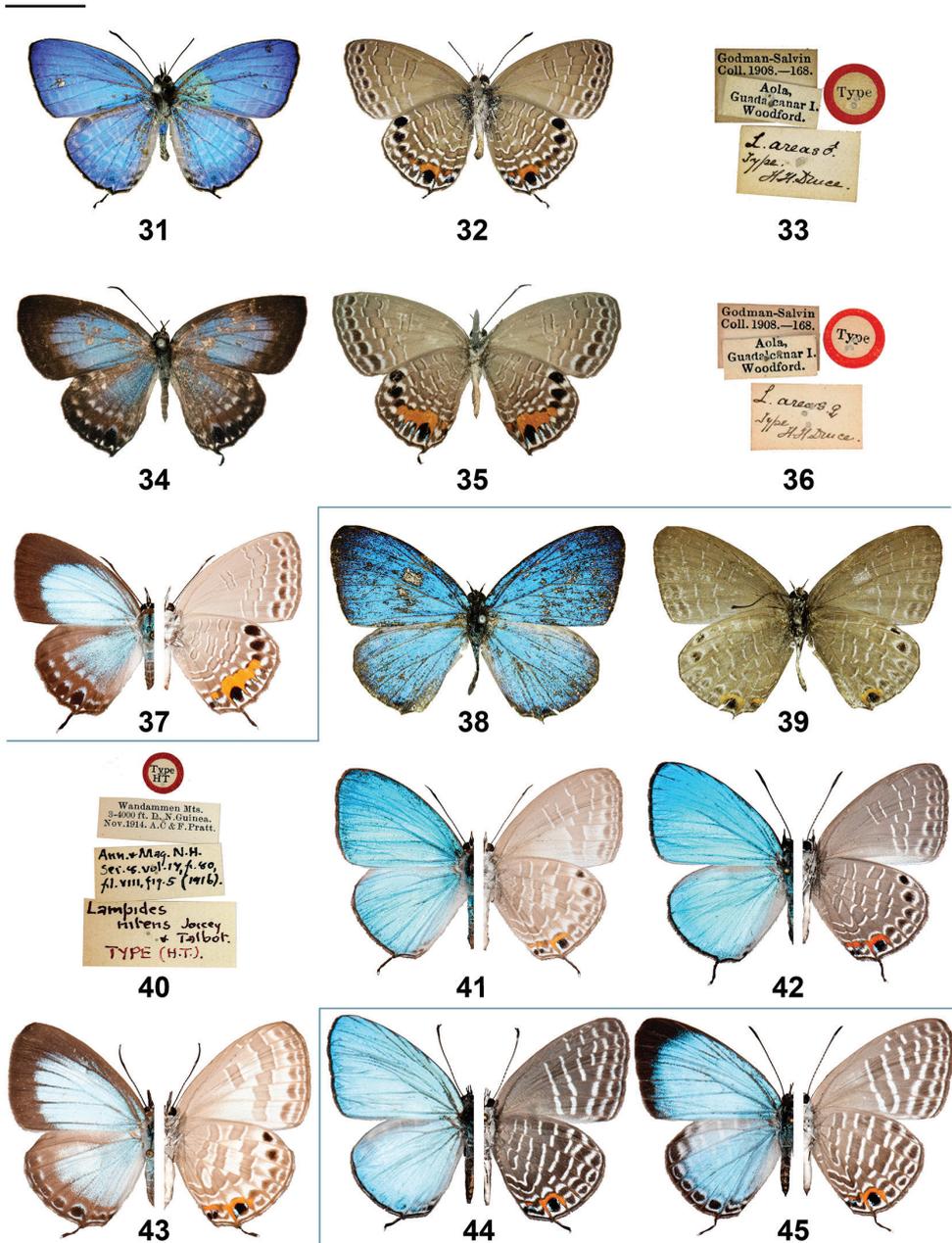
Translated, this states that the insect (presumably a male), has "Wings a shiny silvery blue; the hindwings with a small tail; underside of the four [wings] with several broken white stripes; the hindwings additionally having a marginal band of black spots, of which the three adjacent [closest] to the abdominal [inner] margin are marked with fawn and golden green. It has the appearance and size of Elpis [*Jamides elpis* (Godart, [1824])], which it closely resembles. New Ireland."

The description above is pertinent only to the male of *J. cyta*. The author has surveyed several sites throughout New Ireland, close to the localities visited by the *Astrolabe*, and found *J. cyta* to be particularly common at all of the lowland sites.

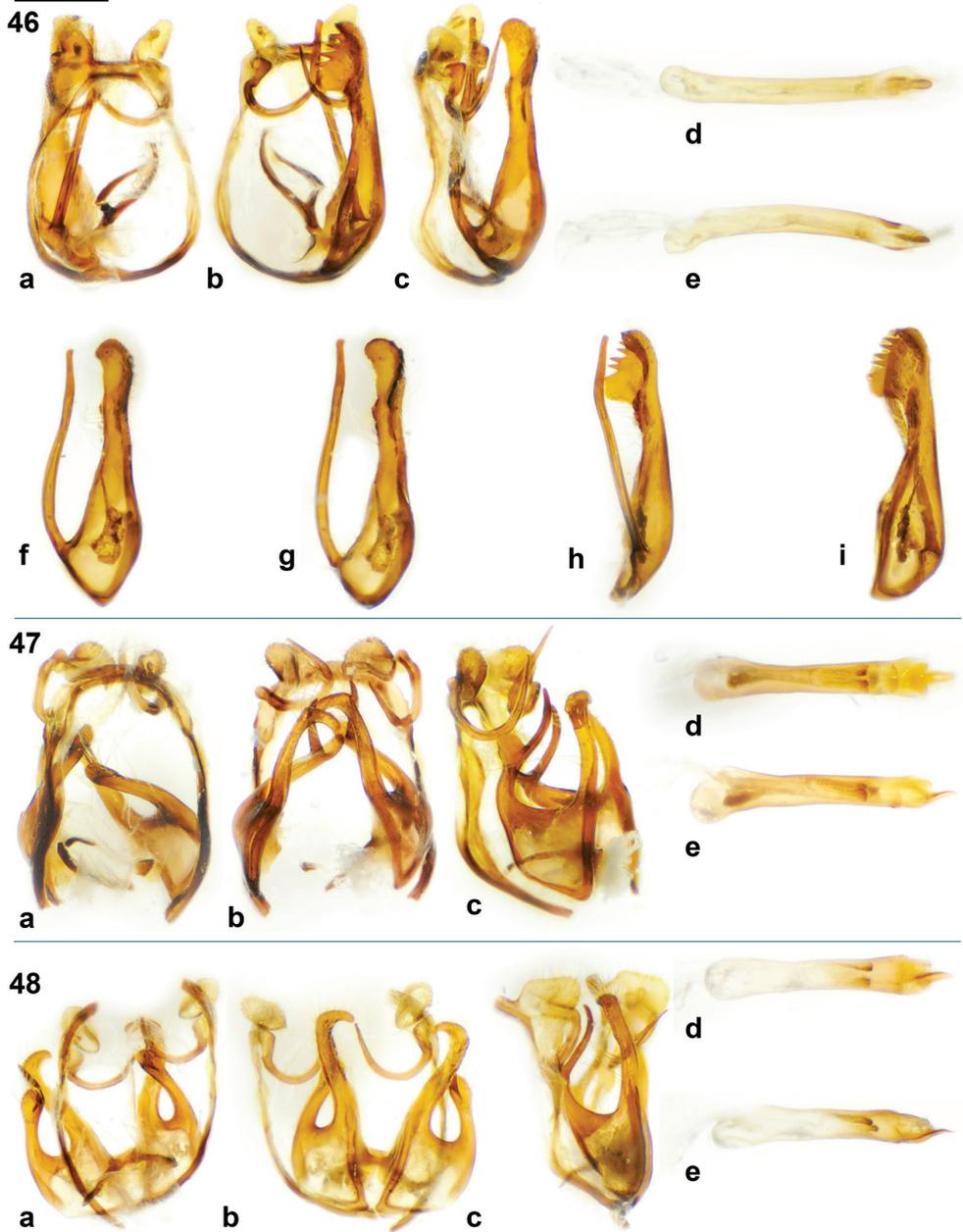
Toxopeus (1930), followed by Riley and Corbet (1938), recognised that *cyta* was the correct species name to be applied to the species known as *Catochrysope amphissa* (C. & R. Felder, 1860). Prior to that time, several subspecies of what are now known to represent *J. cyta* were described under *amphissa*, in particular several taxa from Maluku described by Fruhstorfer (1916). *J. cyta amphissa* is now known to be restricted to northern Maluku (Rawlins et al. 2014).

Ribbe (1899: 228) proposed the name *Lycaena amphissina* var. *malaguna* for specimens collected in New Britain, Duke of York Islands and New Ireland. This taxon was considered by D'Abbrera (1977: 355) to be a junior synonym of *Jamides cyta cyta* and Takanami (1989: 50) designated a male lectotype from New Ireland (Neu-Mecklenburg) and recorded three paralectotypes. Both the lectotype and a female paralectotype are here-in illustrated (Figs 16–21).

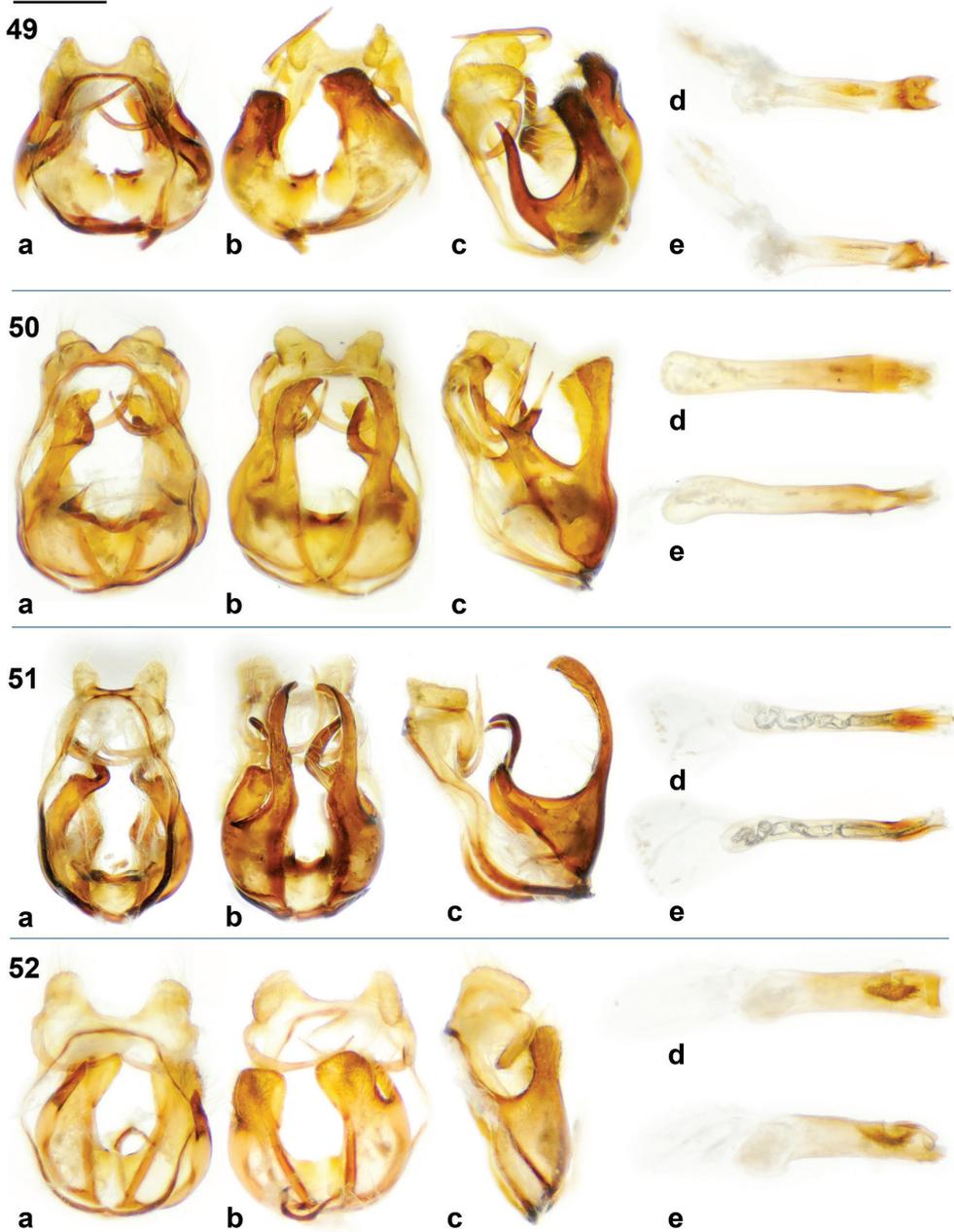
Nominate *cyta* from the Bismarck Archipelago is highly distinct from the New Guinea mainland subspecies *amphissina* Grose Smith, 1894 (not to be confused with *amphissa* from Maluku), in that the Bismarck specimens are larger and brighter, with much more pronounced orange on the hindwing underside. Bismarck *cyta* taxa may be further separated in that females from New Britain possess more extensive and brighter blue on the upperside than those from New Ireland and may warrant subspecific status. The types of *J. cyta amphissina* are illustrated in Figs 25–30 and both sexes of *J. cyta cyta* from the Bismarcks are also figured (Figs 22–24).



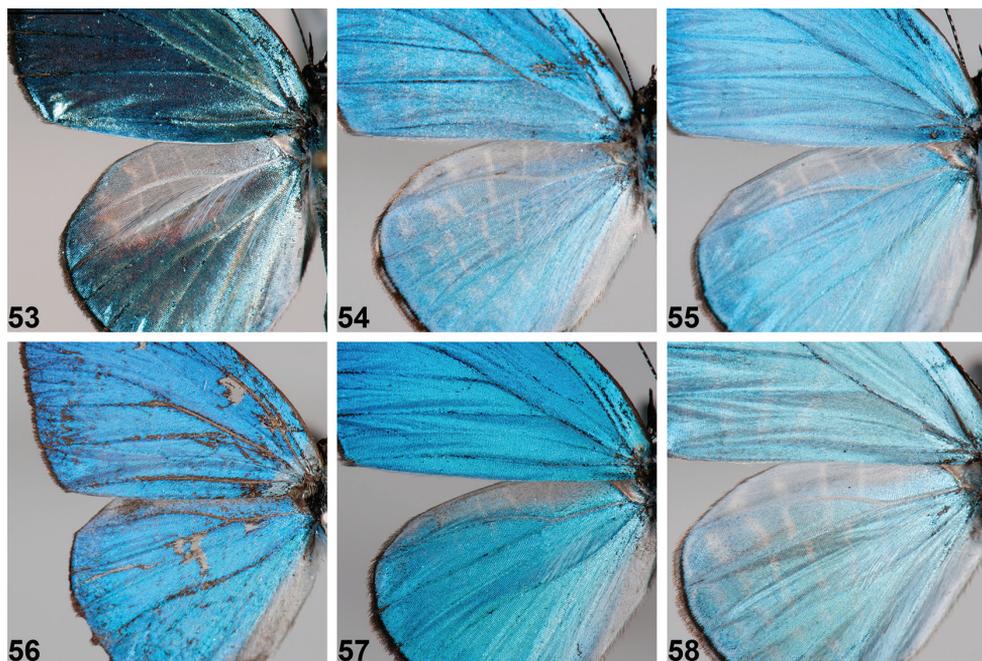
Figures 31–45. *Jamides* adults (left side upperside and right side underside, where halved) and label data. **31** *Jamides areas* holotype ♂ upperside **32** *J. areas* holotype ♂ underside **33** *J. areas* holotype ♂ label data **34** *J. areas* allotype ♀ upperside **35** *J. areas* allotype ♀ underside **36** *J. areas* allotype ♀ label data **37** *J. areas* ♀ (halved) (Guadalcanal) **38** *J. nitens* holotype ♂ upperside **39** *J. nitens* holotype ♂ underside **40** *J. nitens* holotype ♂ label data **41** *J. nitens* ♂ (halved) (Telefomin) **42** *J. nitens* ♂ (halved) (Mianmin Range) **43** *J. nitens* ♀ (halved) (Telefomin) **44** *J. reverdini* ♂ (halved) (New Britain) **45** *J. reverdini* ♂ (halved) (New Britain). Scale bar = 10 mm.



Figures 46–48. *Jamides* male genitalia. (a genitalia in dorsal view with aedeagus removed, b genitalia in ventral view with aedeagus removed, c genitalia in lateral view with aedeagus removed, d aedeagus in dorsal view, e aedeagus in lateral view, f valva in lateral external view, g valva in lateral interior view, h valva in dorsal view, i valva in ventral view. **46** *Jamides vasilia* holotype ♂ **47** *J. cyta cyta* (New Britain) **48** *J. cyta amphissina* (Sepik, mainland NG). Scale bar = approx. 1 mm.



Figures 49–52. *Jamides* male genitalia. **(a)** genitalia in dorsal view with aedeagus removed, **(b)** genitalia in ventral view with aedeagus removed, **(c)** genitalia in lateral view with aedeagus removed, **(d)** aedeagus in dorsal view, **(e)** aedeagus in lateral view. **49** *J. pseudosias* (Mianmin Range) **50** *J. areas* (New Georgia, Solomons) **51** *J. nitens* (Mianmin Range) **52** *J. reverdini* (New Britain). Scale bar = approx. 1 mm.



Figures 53–58. *Jamides* male hindwing apex, showing development (or absence) of androconia. **53** *Jamides vasilia* paratype ♂ **54** *J. pseudosias* (Mianmin Range) **55** *J. cyta cyta* (New Britain) **56** *J. areas* (New Georgia, Solomons) **57** *J. nitens* (Mianmin Range) **58** *J. reverdini* (New Britain). Scale bar = approx. 1 mm.

J. cyta is an easily recognised species, the male bearing a pale blue-white upperside and both sexes bear a row of triangular subterminal black spots on the hindwing underside. Note that the illustration of the male *J. 'cyta'* (as *Jamides 'cytus'*) in Parsons (1998) is in fact that of *J. pseudosias*.

***Jamides pseudosias* (Rothschild, 1915)**

Figs 10–15, 49, 54

Lampides pseudosias: Rothschild (1915: 138); TL: Misol [Misool].

Remarks. In the Bismarcks *J. pseudosias* was known only from one pair taken at an unspecified locality in New Ireland by A. F. Eichhorn in November 1923, which are held in the NHM (Figs 13, 14). A female taken at the type locality of *J. vasilia* is also figured (Fig 15), representing the first record from New Britain.

J. pseudosias is readily distinguished from its congeners by its long hindwing tail, which is at least 1.5 times that of related species in New Guinea and by the rich blue colour of the male upperside. The forewings of the male are narrower and the apex more rounded than in related species. The forewing underside median bar and postmedian

band are continuous across vein 3, though slightly oblique, giving the band a curved appearance. Note that Parsons (1998) illustrates a male of this species as that of *J. cyta* (as *J. 'cytus'*; see under *J. cyta* in this work).

***Jamides reverdini* (Fruhstorfer, 1915)**

Figs 44, 45, 52, 58

Lampides elpis reverdini: Fruhstorfer (1915: 143); TL: ST Holl. Zentral Neu Guinea, Kloofbivak [Papua, Indonesia].

Remarks. *Jamides reverdini* was previously known from the Bismarcks from just a single specimen from New Ireland, which Parsons (1998) considered to be possibly mislabelled. Additional material is here recorded from close to sea level near Poronbus in New Ireland and from both the Whiteman Range (approximately 1000m) and Bainings Mountains (2000m), in West and East New Britain Provinces, respectively. Therefore, the taxon has a notably extensive vertical range in the Bismarck Archipelago. In northern mainland New Guinea, for example in the Upper Sepik, *J. reverdini* is most commonly observed below 500m (pers. obs.)

This insect is unique in its comparatively large size, bright silvery blue upperside and boldly patterned underside. On the underside, the ground colour is a distinct deep grey and, like *J. pseudosias*, the forewing median bar and postmedian band are connected at vein 3. *J. reverdini* is easily separated from *J. pseudosias* by, among other fore-mentioned features, the shape of the subterminal band on the hindwing underside. In *J. reverdini*, this band constitutes a series of rectangular markings bordered heavily with white, whereas in *J. pseudosias* these markings are distinctly triangular.

Discussion

Jamides vasilia exhibits significant disparity from other members of *Jamides*. The male wing shape, with rounded tornus and convex inner margin, is unique, as is the black, tapering terminal border. On the forewing underside of the male the inner margin is broadly white-grey, relative to the remainder of the wing, a feature apparently unique in the genus. Also in the male, the hindwing upperside bears conspicuous androconia (Fig. 53), covering a purple-brown patch. Such prominent androconia are either absent or poorly developed in related species (Figs 54–58). The underside bands of both sexes are very curved and displaced at veins, unlike other *Jamides* taxa. *J. vasilia* is exceptionally bright, the male with the upperside luminescence possibly unmatched in Indo-Pacific Lycaenidae.

The male genitalia of *J. vasilia* (Fig. 46) are equally distinct and are unlike any of its congeners (Figs 47–52). The exaggerated teeth-like projections of the valva (Figs 46h, 46i) are unique. The dorsal projection of the valva is characteristic of the genus

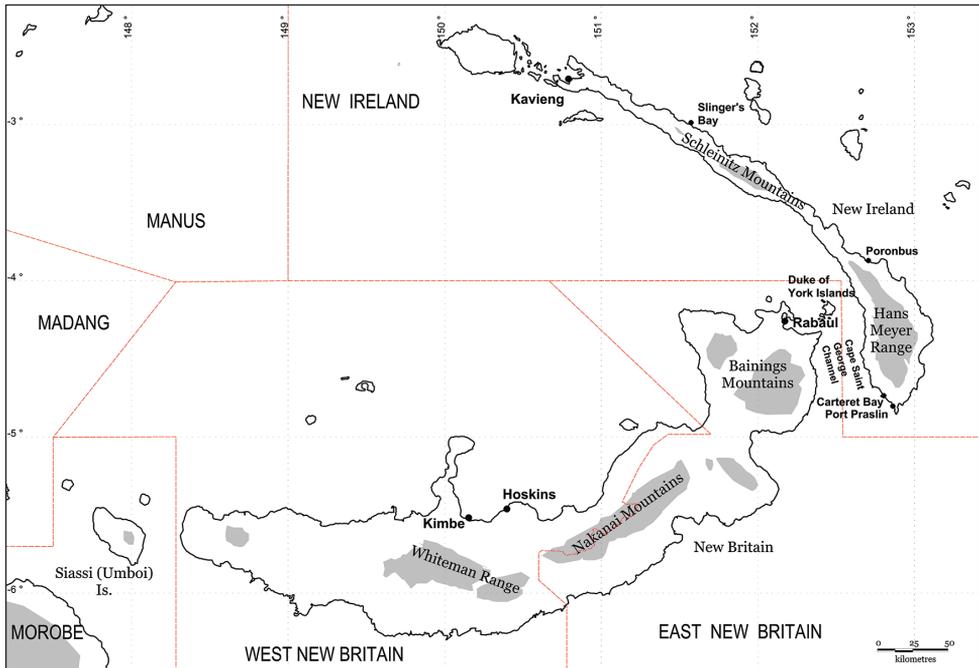


Figure 60. The Bismarck Archipelago, Papua New Guinea, showing all main islands (excluding the Admiralty Group), provinces (upper case), main centres and localities referred to in the text. Shading represents approximate expanse of land above 1000 m elevation.

Jamides and in Indo-Pacific Polyommatae appears to be shared only with the genus *Callictita* Bethune-Baker, 1908.

That *J. vasilia* was phylogenetically recovered, as a result of Bayesian Inference, within a clade of *Jamides* also comprising *J. cyta* and *J. nitens* is perhaps unexpected, considering that *J. vasilia* is phenotypically very different from either of these taxa. Indeed, there is significant genetic divergence (in COI barcode) between *J. vasilia* and *J. cyta* or *J. nitens*. However, a potential similarity between *J. vasilia* and *J. cyta* is that the latter has been recorded feeding on *Syzigium* in Australia (Braby 2000) and, based on adult female behaviour (see Remarks section), is possibly the food plant of *J. vasilia*. *J. nitens* (Figs 38–43) is one of the, otherwise, brightest *Jamides* taxa. Parsons (1998) noted that *J. nitens* exhibits a deeper blue than related species in Papua New Guinea. Although the male upperside rich sky blue appears to be constant in all specimens, both sexes exhibit some degree of variability of the amount of white suffusion bordering the striae on the underside (hence three males of *J. nitens* are figured, see Figs 38–42).

J. vasilia is a montane species, having been recorded from 850 to 1050m. An additional female was observed at 700m in the Whiteman Range. Of the related *Jamides* taxa, *J. nitens* is also a montane insect, Parsons (1998) recording it from 1200–1800m, although the author has recorded this species from the Mianmin Range from as low as 550m. *J. cyta* is typically a lowland species and is rarely recorded above about 500m,



Figure 61. The Whiteman Range, West New Britain; type locality of *Jamides vasilia*.

although it has been seen very occasionally up to 900m in the Whiteman Range (pers. obs.). Parsons (1998) records *J. cyta* from sea level to 700m. *J. reverdini* and *J. pseudosias* appear to be predominantly montane in New Britain, the former being seen by the author at over 2,000m in the Bainings Mts, East New Britain Province. However, in mainland New Guinea, both species tend to occur in the lowlands. In the Solomons, *J. areas* (Figs 31–37) is generally a lowland species and the species was found to be fairly common at Uepi Island, New Georgia Group, at sea level during 1986 (pers. obs.). It is unknown to what extent, if any, vertical elevation separation has played in the role of *Jamides* diversification in the New Guinea region.

Various phylogenetic analyses produced a range of trees for the *Jamides* dataset. Indeed, in several, including Neighbour-Joining, Maximum Likelihood and Maximum Parsimony, the resultant tree suggested that *J. vasilia* is sister to all assessed *Jamides* species groups and that it may represent a separate genus. Given the variable results from the different methods, COI alone is clearly not an adequate tool and additional sequencing of nuclear gene fragments would undoubtedly assist in better resolving the phylogenetic position of the new taxon.

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Taxonomic study of the genus *Meleonoma* Meyrick from Thailand (Lepidoptera, Gelechioidea)

Aihui Yin¹, Shuxia Wang¹

¹ College of Life Sciences, Nankai University, Tianjin 300071, China

Corresponding author: Shuxia Wang (cnmoths@163.com)

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Abstract

Five species of the genus *Meleonoma* Meyrick are reported from Thailand. *Meleonoma triangula* Wang, **sp. n.**, *M. dorsolobulata* Wang, **sp. n.**, *M. elongata* Wang, **sp. n.**, and *M. bilobata* Wang, **sp. n.** are described as new; *M. facialis* Li & Wang, 2002 is redescribed and recorded for the first time from Thailand.

Keywords

Lepidoptera, Oecophoridae, *Meleonoma*, new species, Thailand

Introduction

Meyrick (1914) established the genus *Meleonoma* in the family Oecophoridae, with *Cryptolechia stomota* Meyrick, 1910 as the type species. Gaede (1939) listed eleven *Meleonoma* species: three from Australia, two from India and two Sri Lanka, and one each from Madagascar, China, Sikkim and Borneo. Common (1996) synonymized *M. basanista* Meyrick, 1922 with *Oresitropha pentochra* (Lower, 1894), and placed *M. psammota* Meyrick, 1915 in the subfamily Oecophorinae; Edwards and Nielsen (1996) placed *M. capnodyta* (Meyrick, 1906), earlier transferred from *Borkhausenia*,

in the family Cosmopterigidae. Viette (1955) recognized one species from Madagascar. Clarke (1965) transferred *Pseudodoxia crocomitra* Meyrick, 1914 to *Meleonoma* and placed *Meleonoma* in the family Cosmopterigidae. Subsequently, Li and Wang (2002, 2004) described five species from China, and treated *Meleonoma* as a member of Cosmopterigidae. Lvovsky (2015) described five new *Meleonoma* species from Nepal and China; in the same paper, Lvovsky synonymized *Acryptolechia* that he established in 2010 in the family Cryptolechiidae with *Meleonoma*, and placed *Meleonoma* in the family Lypusidae. In a more recent study the Cryptolechiinae were recognized as a subfamily of the enlarged Depressariidae (Heikkilä et al. 2014), but *Meleonoma* was not included in that study.

The taxonomic positions and validity of *Acryptolechia* and *Meleonoma* needs to be further studied and confirmed since they have been reassigned so frequently. A combination of both molecular and morphological analyses is likely a method to resolve such a taxonomic problem, which is not the aim of the present study. We therefore treat *Meleonoma* as an unplaced genus in Gelechioidea. The present paper is to report the result of our recent study of the genus *Meleonoma* in Thailand, including descriptions of four new species.

Material and methods

The examined specimens were collected from Thailand in 1984, and were borrowed from the Natural History Museum of Denmark, where all types are deposited. Genitalia dissection and mounting methods follow the methods introduced by Li (2002). Photographs of adults were taken with a Leica M205A stereomicroscope plus Leica Application Suite 4.2 software, and illustrations of genitalia were prepared using a Leica DM750 microscope.

Taxonomy

Genus *Meleonoma* Meyrick, 1914

Meleonoma Meyrick, 1914: 255.

Type species. *Cryptolechia stomota* Meyrick, 1910, by original designation.

Diagnosis. The genus *Meleonoma* is characterized by the narrow lanceolate forewing with ground color pale yellow, yellow or pale ochreous yellow; by the male genitalia with spear-shaped or slender sticklike uncus, the absent, or membranous or weakly sclerotized circular gnathos, the varied shape of the sacculus, and the elongate or triangular saccus; by the female genitalia with entirely or partly sclerotized ductus bursae, and the signum often with spines, if present.

***Meleonoma triangula* Wang, sp. n.**

<http://zoobank.org/817C3454-64F0-459E-B972-0FF370C37CB5>

Figs 1, 6, 11

Type material. **Holotype**, ♂, **Thailand**: Nakhon Nayok Prov., Khao Yai Nat. Park, ca. 700 m, 29.ix.–6.x.1984, leg. Karsholt, Lomholdt & Nielsen, genitalia slide No. ZMUC-NK037. **Paratypes**: 1♀, 1♂, Loei Prov. Phu Luang Wildlife Sanctuary, ca. 700–900 m, 8–14.x.1984, leg. Karsholt, Lomholdt & Nielsen.

Diagnosis. This new species can be distinguished from its congeners by the distal half of the valva distinctly triangular and upturned, and the short sacculus wider than long in the male genitalia.

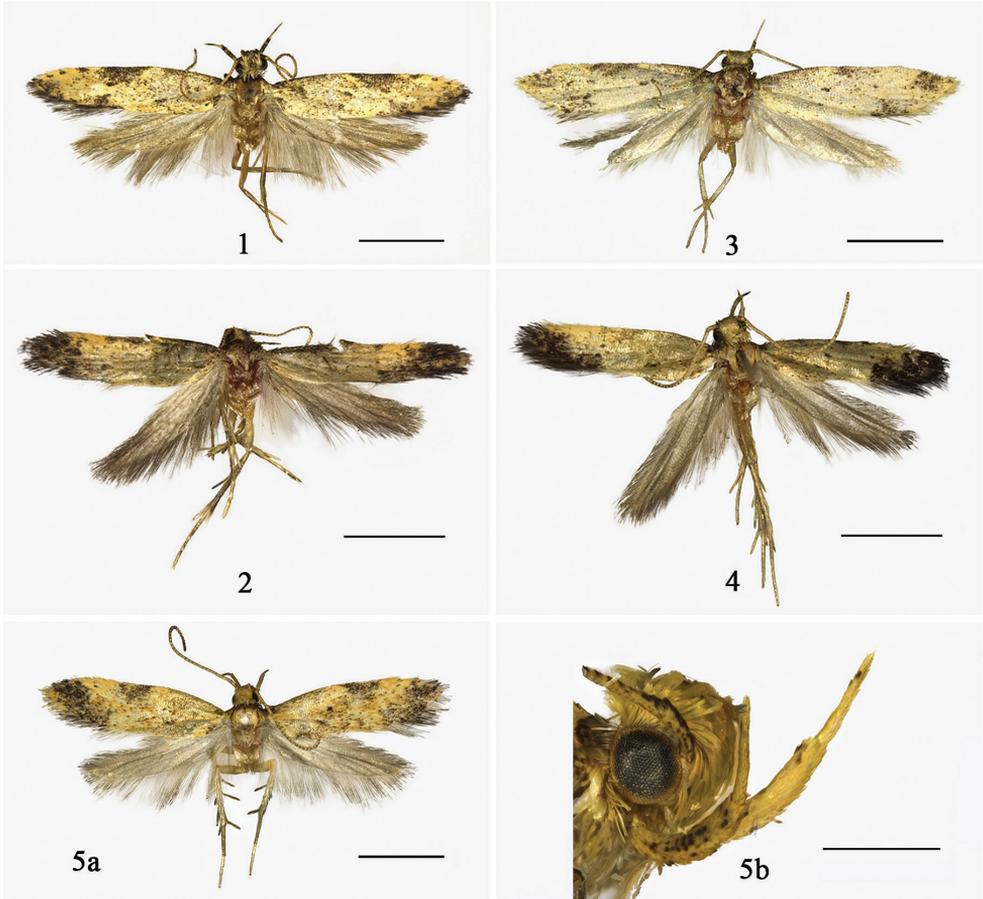
Description. Adult (Fig. 1): Wing expanse 10.0–12.0 mm. Head pale yellow, with scales copper brown tipped. Labial palpus pale yellow, covered with dense copper brown scales on entire second segment and on distal half of third segment. Antenna pale yellow, with dorsal surface brown on scape, ringed with pale brown on flagellum. Thorax yellowish brown; tegula greyish brown mottled yellow. Forewing yellow, with blackish brown scales throughout, concentrated along costal and ventral margins and at apex, forming blackish blotch or spots; costal margin with a large ill-defined inverted triangular blotch beyond middle, and with three small spots along distal 1/6; small black spot at base, middle and end of cell as well as at 2/3 of fold, respectively; cilia greyish brown. Hindwing and cilia pale grey. Legs brown on fore and mid tibiae and all tarsi except pale yellow at apex of each segment; hind leg brown on outer surface except pale yellow at apex.

Male genitalia (Fig. 6): Uncus twice as long as middle height of tegumen, slender, hooked distally. Gnathos weakly sclerotized. Valva narrow at base, gradually widened to approximately middle; distal half triangular, upturned, obviously narrowed to rounded apex; costa concave shallowly; ventral margin with a sclerotized narrow edge extending from near base to middle length, where it is produced to a small process exceeding ventral margin, with long dense setae on distal half; transtilla small, triangular, pointed distally. Sacculus subrectangular, length shorter than width, apically produced to a hairy papillary process. Saccus longer than uncus, narrowed slightly to apex. Juxta a thin band in semicircular shape. Aedeagus slightly longer than valva, blunt apically, with dense microspines on inner surface in distal third, with an irregular narrow plate before apex.

Female genitalia (Fig. 11): Papillae anales large and broad, setose. Posterior apophyses twice as long as anterior apophyses. Eighth tergite sclerotized posteriorly; eighth sternite with granules posteriorly; posterior margin concave at middle, forming two semioval plates with long setae. Ductus bursae weakly sclerotized entirely. Corpus bursae membranous, irregularly rounded.

Distribution. Thailand.

Etymology. The specific name is derived from the Latin adjective *triangulus* (triangular), referring to the shape of the distal half of the valva.



Figures 1–5. Adults of *Meleonoma* spp. **1** *M. triangula* sp. n., holotype, male **2** *M. dorsolobulata* sp. n., holotype, male **3** *M. elongata* sp. n., holotype, male **4** *M. bilobata* sp. n., holotype, male **5a** *M. facialis* Li & Wang, 2002, male **5b** Head of *M. facialis* Li & Wang, 2002. Scale bars: 2.0 mm (**1–5a**), 500 μ m (**5b**).

***Meleonoma dorsolobulata* Wang, sp. n.**

<http://zoobank.org/5C1EA723-9160-4734-97B6-5DED4190C4E9>

Figs 2, 7

Type material. Holotype: ♂, Thailand: Loei Province, Phu Luang Wildlife Sanctuary, 8–14.x.1984, ca. 700–800 m, leg. Karsholt, Lomholdt & Nielsen, genitalia slide No. ZMUC-NK047. Paratype: 1 ♂, same data as holotype.

Diagnosis. This new species can be separated easily from its congeners by the sacculus having a lobate process at base dorsally in the male genitalia.

Description. Adult (Fig. 2): Wing expanse 9.0–10.0 mm. Head yellow, tinged with greyish brown on vertex. Labial palpus yellow, with wide irregular brown rings at middle and at apex of second segment, as well as at 2/3 of third segment. Antenna yel-

low, dorsal surface black on scape, ringed with brown on flagellum. Thorax and tegula brown. Forewing yellow, with brown scales throughout, concentrated along costal 2/3, forming a narrow streak along basal 1/3, and forming a spot at middle; large blackish distal blotch from distal 1/5 of costal margin obliquely inward to end of fold; cell with small black spot at base and at middle, the former indistinct, with two black dots at end of cell, placed one above another, the lower one merged with large distal blotch, but distinct; cilia blackish brown. Hindwing and cilia grey. Legs whitish yellow; tibiae and tarsi greyish brown on outer surface, tibiae yellow at middle and at apex, tarsi yellow at apex of each segment.

Male genitalia (Fig. 7): Uncus nearly as long as saccus, basal half evenly wide, distal half gradually narrowed to blunt apex. Valva evenly wide from base to approximately 3/4, distal 1/4 slightly narrowed to rounded apex, upturned; costa concave medially; ventral margin straight basally, arched outward distally. Sacculus broad, subtriangular, apically produced to a hairy papillary process; large process arising from base of its dorsal margin, lobate, narrow basally, ovally inflated distally. Saccus triangular, wide at base, narrowed to apex. Juxta thin, broad V shaped. Aedeagus shorter than valva, with dense microspines on inner surface in distal 2/5, with a club-shaped process distally, approximately 1/3 length of aedeagus.

Female unknown.

Distribution. Thailand.

Etymology. The specific name, an adjective, is derived from the Latin *dorso-* (dorsal) and *lobulatus* (lobate), referring to the process at base of the dorsal margin of the sacculus.

***Meleonoma elongata* Wang, sp. n.**

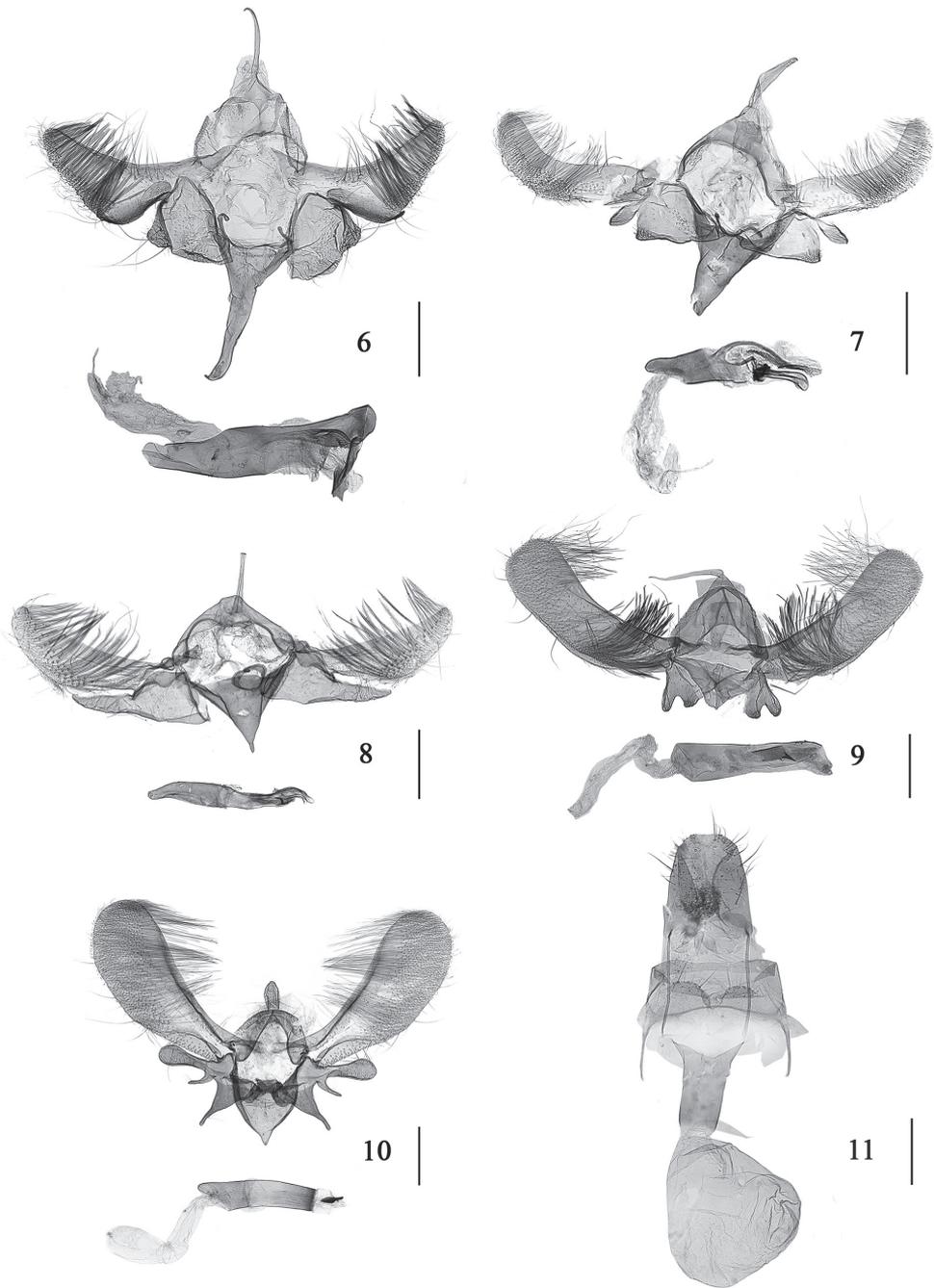
<http://zoobank.org/DB2F466F-73DE-4DE8-9E67-A26581717799>

Figs 3, 8

Type material. Holotype: ♂, Thailand: Chiang Mai Province, Doi Inthanon Nat. Park, Siriphum, 21–24.X.1984. ca. 1200–1300 m, leg. Karsholt, Lomholdt & Nielsen, genitalia slide No. ZMUC-NK053.

Diagnosis. This new species can be distinguished from its congeners in the male genitalia by having a narrowly elongate triangular sacculus and a broad saccus with an apical mastoid process.

Description. Adult (Fig. 3). Wing expanse 10.0 mm. Head pale yellow, tinged with brown. Labial palpus pale yellow, with brown scales at middle and at apex of second segment, as well as at 2/3 of third segment. Antenna with dorsal surface black on scape, ringed with brown on flagellum. Thorax and tegula greyish brown, tinged with yellow. Forewing yellow, with brown scales throughout, denser along costal margin, forming large diffused spot at base and at middle; apex blackish brown; cell with small black spot at middle and at end; fold with small black spot at middle; cilia whitish yellow, tinged with brown at tornus. Hindwing and cilia pale grey. Legs pale yellow, with brown scales.



Figures 6–11. Male genitalia of *Meleonoma* spp. **6** *M. triangula* sp. n., holotype, slide no. ZMUC-NK037 **7** *M. dorsolobulata* sp. n., holotype, slide no. ZMUC-NK047 **8** *M. elongata* sp. n., holotype, slide no. ZMUC-NK053 **9** *M. bilobata* sp. n., holotype, slide No. ZMUC-NK046 **10** *M. facialis* Li & Wang, 2002, slide no. ZMUC-NK054 **11** Female genitalia of *M. triangula* sp. n., paratype, slide no. ZMUC-NK038. Scale bar = 0.25 mm.

Male genitalia (Fig. 8). Uncus nearly as long as saccus, slightly wide at base, straight, stick-like. Valva somewhat knifelike in shape, widened medially, narrowed to base and apex; apex narrowly rounded, costa straight, ventral margin protruding outward medially. Sacculus less than half length of valva, elongate triangular; basal half broad, sclerotized dorsally and ventrally; distal half distinctly narrowed, apex narrowly rounded. Saccus broad, triangular, apically produced to a small process. Juxta a small ring. Aedeagus shorter than valva, slender, produced to a club-shaped process distally, with two slender, sclerotized, curved clubs distally.

Female unknown.

Distribution. Thailand.

Etymology. The specific name is derived from the Latin adjective *elongatus* (elongate), referring to the shape of the sacculus.

***Meleonoma bilobata* Wang, sp. n.**

<http://zoobank.org/849C7976-09F3-4C20-A3CA-4A25E632306C>

Figs 4, 9

Type material. Holotype: ♂, Thailand: Chiang Mai Province, 325 m, 15-30.x.1984, leg. Karsholt, Lomholdt & Nielsen, genitalia slide No. ZMUC-NK046.

Diagnosis. This new species can be distinguished from its congeners in the male genitalia by the sacculus being apically bilobed.

Description. Adult (Fig. 4). Wing expanse 9.0–10.0 mm. Head yellow. Labial palpus yellow. Antenna pale yellow, without distinct dark rings. Thorax and tegula yellow, tegula with brown scales at base. Forewing yellow, with brown and ochreous brown scales, with denser brown scales along costal margin, with denser pale ochreous brown scale along ventral margin; costal margin with a dark brown spot at base, with a dark brown diffusion beyond middle; large distal blotch black, from end of fold obliquely outward to apex; cell with small black spot at middle and at end of cell; fold with a small black dot at middle; cilia blackish brown. Hindwing and cilia grey. Legs whitish yellow; fore and mid legs with tibiae and tarsi blackish brown on outer surface, hind leg greyish brown; tarsi yellowish white at apex of each segment.

Male genitalia (Fig. 9). Uncus approximately twice as long as saccus, wide and triangular basally, gradually narrowed to pointed apex. Valva evenly wide except slightly narrowed at base, apex blunt; ventral margin with clustered long setae at 1/3. Sacculus wider than valva at base, shorter than saccus, apically concave at middle, forming two lobes: dorsal lobe longer, fingerlike, ventral lobe a rounded process. Saccus broad triangular, length same as height of tegumen. Aedeagus approximately 2/3 length of valva, strong and straight, with several tiny teeth along dorsal 1/6; cornutus a tiny spine, originating from a large sclerotized rectangular plate.

Female unknown.

Distribution. Thailand.

Etymology. The specific name is derived from the Latin adjective *bilobatus* (bilobate), referring to the apically bilobate sacculus.

***Meleonoma facialis* Li & Wang, 2002**

Figs 5, 10

Meleonoma facialis Li & Wang, 2002: 230.

Redescription. Adult (Fig. 5): Wing expanse 10.0–10.5 mm. Head pale yellow, with appressed scales. Labial palpus and antenna pale yellow, antenna ringed with pale brown on flagellum. Forewing yellow, with scattered black scales; black scales becoming denser at apex, forming irregular obscure blotch; costal margin with indistinct black spot at middle; small black dot set at middle of cell and at 2/3 of fold respectively; cilia same color as forewing. Hindwing and cilia greyish white. Legs yellowish white, fore and mid tibiae and tarsi brown on outer surface, with pale spots; mid tibia and tarsus tinged with brown scales.

Male genitalia (Fig.10): Uncus somewhat conic. Valva narrow at base, slightly widened distally, apex rounded; transtilla distally rounded. Sacculus rectangular basally, with three processes distally: dorsal process longest, somewhat elliptically dilated distally; median process small pine-like; ventral process subtriangular, wide at base, narrowed gradually to 2/3, distal 1/3 sharply narrowed, uniform, apex bluntly rounded. Saccus large, triangular, apex roundly pointed. Aedeagus shorter than valva, straight, with one short sclerotized cornutus.

Material examined. 1♂, Thailand: Loei province, Phu Luang Wildlife Sanctuary, 8–14.x.1984, leg. Karsholt, Lomholdt & Nielsen, genitalia slide No. ZMUC-NK054.

Distribution. Thailand, China (Jiangxi, Sichuan, Shaanxi, Yunnan).

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A remarkable new species of the genus *Teinotarsina* (Lepidoptera, Sesiidae) from Okinawa-jima, Japan

Sadahisa Yagi¹, Toshiya Hirowatari², Yutaka Arita³

1 Entomological Laboratory, Graduate School of Bioresource and Bioenvironmental Sciences, Kyushu University, Hakozaki 6-10-1, Fukuoka, 812-8581 Japan **2** Entomological laboratory, Faculty of Agriculture, Kyushu University, 6-10-1 Hakozaki, Fukuoka, 812-8581 Japan **3** Zoological laboratory, Faculty of Agriculture, Meiji University, Tempaku-ku, Nagoya, 468-8502 Japan

Corresponding author: Sadahisa Yagi (yagi.sadahisa@gmail.com)

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Abstract

A new species of long-legged clearwing moth *Teinotarsina aurantiaca* Yagi, Hirowatari & Arita, **sp. n.** is described from Okinawa-jima, the Ryukyus, Japan. The species is distinguishable at a glance from other related congeners by the remarkable orange scales ornamenting many parts of the body, such as antennae, palpi, legs, and wings. We hypothesize that the species acquired these differences as a result of convergence with toxic species (Batesian mimicry) or other mimics (Müllerian mimicry).

Keywords

Clearwing moth, mimicry, Sesiini, Taxonomy, Oriental region

Introduction

Clearwing moths, Sesiidae are diurnal and distributed all over the world. In recent years, many new species have been found in the eastern Palearctic, Oriental, Australian, Neotropical, and Ethiopian regions by attracting them with an artificial sex pheromone (Arita et al. 2009, Arita and Nasu 2011). In Japan, 44 species of Sesiidae have been recorded, and eight species are known from Okinawa-jima, the Ryukyus (Arita 2013). *Teinotarsina* Felder & Felder, 1874 is an Oriental tropical or subtropical genus,

that comprises 11 species (five species with long hind legs) (Pühringer and Kallies 2016, Eda et al. 2015). This genus is characterized by the shortly ciliate antenna (Arita and Gorbunov 2002) and the valva of male genitalia being strongly arched dorsally, with a distinct falcate apex and relatively sparse simple setae (Eda et al. 2015). However, the biology of this genus is little known and few specimens have been collected because its members are not attracted by the artificial sex pheromones used so far. In May 2015, one of us (Yagi) collected an unusual clearwing moth, of which it was immediately obvious that this was a species not known in Japan, or Okinawa-jima, the Ryukyus. Examination of morphological characters including male genitalia revealed that it is a new species of *Teinotarsina* and distinguishable at a glance from other congeners by the characteristic feature of the beautiful ornamentation with orange scales.

In this paper, we describe this new species and illustrate the genitalia, comparing them with those of related species. We also briefly discuss why this species might have acquired such unique characters from the view point of mimicry.

Material and methods

Only one specimen of the new species was collected on 30 May 2015 in Okinawa-jima, the Ryukyus, Japan (26°43'46"N; 128°11'52"E) (Figs 1, 2). The specimen (holotype) is preserved in the Entomological Laboratory at the Kyushu University, Fukuoka, Japan. For preparation of the genitalia, the abdomen was detached and boiled in 10% aqueous KOH. Illustrations of the genitalia were prepared by using a Leica S8 APO microscope.

Abbreviations

- ELKU** Entomological laboratory, Faculty of Agriculture, Kyushu University.
ETA External transparent area of forewing;
ATA Anterior transparent area of forewing;
PTA Posterior transparent area of forewing.

Taxonomy

Teinotarsina aurantiaca Yagi, Hirowatari & Arita, sp. n.

<http://zoobank.org/7532D2DB-E8B8-4961-BF9A-C317227932A0>

Figs 3–5

Type material. Holotype male (ELKU Type No.26), Hentona Kunigami-son, Kunigami-gun Okinawa Prefecture, Japan, 265 m, 30 May 2015, S. Yagi leg (ELKU).

Description. Male (Figs 2, 3). Alar expanse 29.0 mm; forewing 12.3 mm; body length 14.2 mm; antenna 8.5 mm.

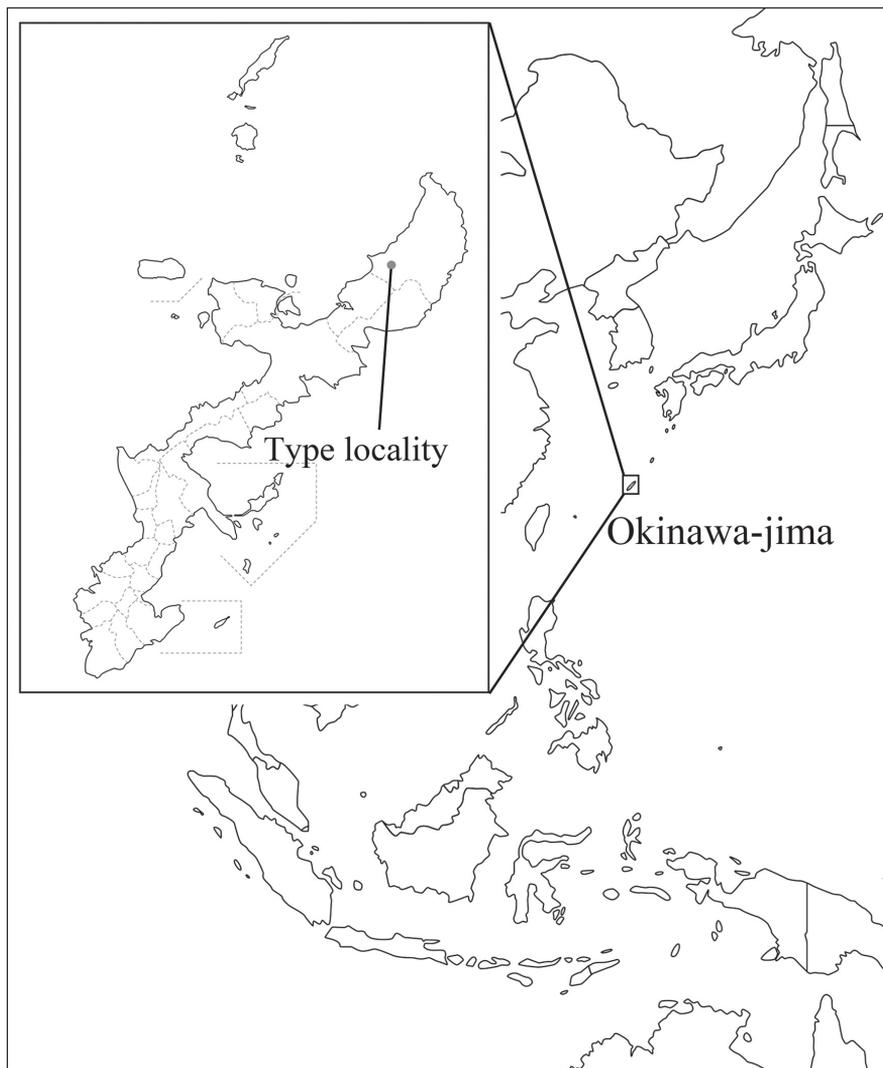


Figure 1. Map showing the type locality of *Teinotarsina aurantiaca* sp. n.

Head: frons black, with orange scales laterally; vertex black; pericephalic scales orange; collar with black hair-like scales, anteriorly with some orange hair-like scales; labial palps orange; scape orange; antenna dorsally covered with black scales in basal half, orange scales in apical half, ventrally naked, reddish brown, densely ciliate with yellow short sensory hairs; apical tuft yellow mixed with brown; proboscis yellowish orange.

Thorax: black; patagia black; tegula black, with orange scales anteriorly and long black hairs posteriorly; mesothorax black, with some orange scales laterally; metathorax black, with a tuft of orange hairs laterally.

Legs: fore coxa black with some orange scales basally; femur orange with black basally; fore tibia orange with black dorsally; fore tarsus yellowish orange; mid coxa,



Figure 2. Male holotype of *Teinotarsina aurantiaca* sp. n., lateral view, before mounting.

femur and tibia black with some orange scales distally; mid tarsus yellowish orange; hind coxa black with some orange scales distally; hind femur black; hind tibia in basal half with black fluffy hairs, in distal half basally black with dark violet-purple sheen, distally with black fluffy hairs and apical orange hairs; hind tarsus black in basal half, with yellowish orange hairs dorsally in distal half.

Abdomen: dorsally black with dark violet-purple sheen; tergite 5 with orange scales anteriorly, tergites 6-7 with narrow orange posterior margin; ventrally yellowish orange with dark violet-purple sheen. Sternite 3 with narrow orange anterior margin, sternite 4 with wide orange anterior margin, sternite 5 almost orange, sternites 6-7 orange with mixture of orange and black scales posteriorly; anal tuft short, orange mixed with black hair-like scales.

Forewing: basally transparent, other parts semitransparent with brownish sheen; costal and anal margins, CuA-stem black with dark violet-purple sheen, scattered with orange scales; discal spot yellow-orange; apical area narrow with yellowish orange scales; projections of dark brown scales from distal margin of forewing into cells of ETA; no projection into ATA and PTA; cilia dark brown with bronze sheen; dorsal margin mixed with black and orange scales.



Figure 3. *Teinotarsina aurantiaca* sp. n. (Holotype). Scale bar: 10 mm.

Hindwing: basally transparent, other parts semitransparent with brownish sheen; veins and outer margin dark brown with orange scales; discal spot undeveloped; apical area with orange scales; outer margin narrow, about two-three times as narrow as cilia; cilia dark brown.

Male genitalia (Fig. 5). Tegumen well separated from uncus; uncus with a tuft of long setae posterodorsally, posteroventrally with a brush of long setae on each side, apical process relatively long, sharply-pointed ventrally; gnathos undeveloped; valva trapezoid with apical half broad; setae of inner surface short, thick, not pointed in median ventral area, long in apical half of central area, thin in dorsal area; sacculus developed; saccus rounded anteriorly; vinculum with a pair of projections posteriorly; Phallus posterodorsally broad; vesica with many small spine-like cornuti; manica with many minute spinules.

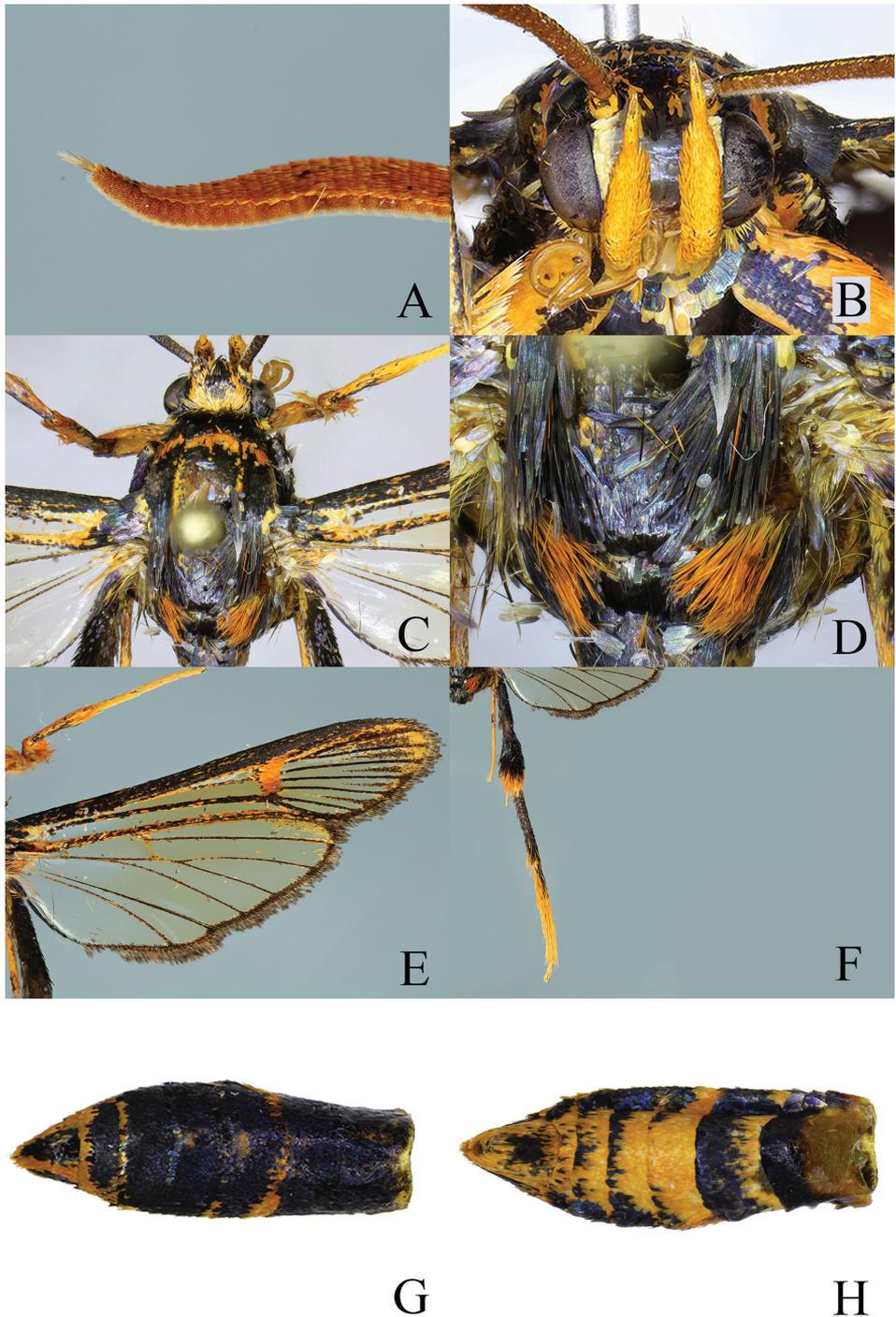


Figure 4. Body parts of *Teinotarsina aurantiaca* sp. n. (Holotype). **A** Apical part of antenna, lateral view **B** Head, frontal view **C** Thorax, dorsal view **D** Metathorax, dorsal view **E** Right wing **F** Hind leg, dorsal view **G** Abdomen, dorsal view **H** Ditto, ventral view.

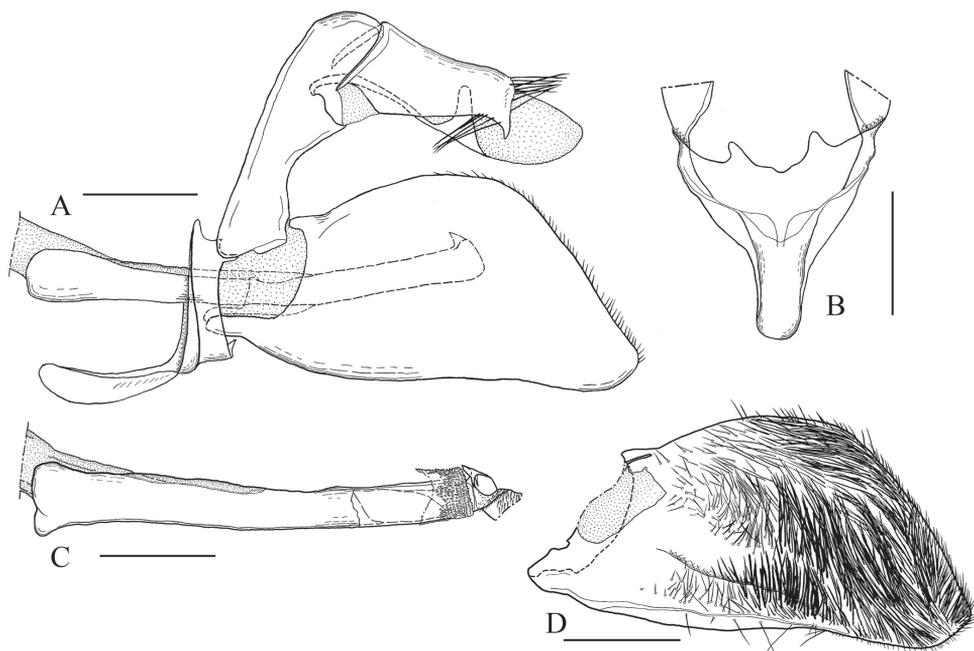


Figure 5. Male genitalia of *Teinotarsina aurantiaca* sp. n. (Holotype). **A** Whole genitalia, lateral view **B** Saccus and vinculum, ventral view **C** Phallus, lateral view **D** Valva, inner view. Scale bars: 0.5 mm.

Female. Unknown.

Etymology. The species name “*aurantiaca*” an adjective, the female form of Latin *aurantiacus* (= orange), refers to the orange body of the new species.

Biology. Unknown. The male holotype was collected on the roadside in a subtropical forest park “Shinrin Koen” (Fig. 6). In this habitat, *Castanopsis sieboldii* (Makino) Hatus. ex T.Yamaz. et Mashiba and *Pinus luchuensis* Mayr were dominant trees. The moth has been observed flying slowly at a height of approximately 0.7 m around 15:00.

Hostplant. Unknown.

Distribution. Okinawa-jima, Japan. Only known from the type locality.

Remarks. The new species can be separated from *T. longitarsa* Arita & Gorbunov, 2002, which occurs on Taiwan, by the orange coloration of the body, the relatively stout antennae with orange apical half (slender with a large white to pale yellow spot subapically in *T. longitarsa*), and the fore- and hindwings which are semi-transparent with a brownish sheen (transparent overall in *T. longitarsa*). The male genitalia of the new species are very similar to those of *T. longitarsa* but are distinguishable from the latter by the following characters: 1) the setae on the ventral part of the uncus are longer than those in *T. longitarsa*, 2) the apical process of the uncus is more sharply-pointed ventrally and relatively longer than that of *T. longitarsa*, 3) the apical half of the valva is slightly broader than that in *T. longitarsa*, 4) the anterior part of the aedeagus is broader than that of *T. longitarsa*.



Figure 6. Habitat of *Teinotarsina aurantiaca* sp. n.

Discussion

The family Sesiidae is generally considered to provide good examples of Batesian mimicry by mimicking hazardous insects such as bees and wasps (Duckworth and Eichlin 1974, Arita 2013)

The genus *Teinotarsina* often has antennae with a white spot subapically, as in *T. longitarsa* and *T. luteopoda* Kallies & Arita, 2004 and a blackish abdomen without a conspicuous stripe pattern. This suggests that Ichneumonidae (ichneumon wasps) might form a possible model for the genus *Teinotarsina*. However, in *Teinotarsina aurantiaca* sp. n., the coloration is distinctly different from the other species and this may indicate a different model species.

According to Terayama and Yamane (1999), in some wasp groups, the populations on Okinawa-jima are much darker (reddish or orange-tinged) in coloration than those on other islands of Nansei islands (chain of islands extending from southwestern Kyushu to Yonaguni-jima), to such a degree that they can be recognized as distinct subspecies. For instance, *Polistes rothneyi* Cameron, 1900 (Vespidae), which is generally maculated with bright yellow, is very dark on Okinawa-jima, so that most authors have mistaken it for the more melanistic *Polistes yakahamae* Radoszkowski, 1887. Many other hymenopterans, e.g. *Polistes japonicus* Saussure, 1858 and *Anterhynchium flavomarginatum* (Smith, 1852) (Eumenidae) show a comparable regional

convergence. This syndrome can be seen not only in Hymenoptera but occurs also in other orders such as in Diptera: Syrphidae (Terayama and Yamane 1999).

In addition, on Okinawa-jima, species of the the sesiid moth genus *Nokona* Matsumura, 1931, including *N. rubra* Arita & Toševski, 1992 and *N. nigra* Arita, Kimura & Owada, 2009 are darker than other *Nokona* species on the main islands of Japan. Moreover, *Pennisetia insulicola* Arita, 1992 from the middle of the Ryukyus, is separated from *P. fixseni* (Leech, 1889) that occurs in Honshu, Kyushu, and Tsushima. Given this general trend, it is possible that Müllerian mimicry (with Aculeata as model) as well as Batesian mimicry (e.g. between Sesiidae and Syrphidae) play a role in Sesiidae on this island. This unique variety is perhaps derived from geographic isolation, e.g. by the channel between the Central and Southern Ryukyu areas (Muraji et al. 2012). Many species of Sesiidae on Okinawa-jima are superficially distinctly different from those in other areas. *Teinotarsina aurantiaca* sp. n. is also very different from other related species.

As for the other morphological characters, the male genitalia resemble closely those of *Teinotarsina longitarsa* from Taiwan, to which *T. aurantiaca* is probably closely related. Further study is required to clarify the diversification of the genus *Teinotarsina*.

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A new large species of *Myloplus* (Characiformes, Serrasalminidae) from the Rio Madeira basin, Brazil

Marcelo C. Andrade^{1,2}, Michel Jégu³, Tommaso Giarrizzo^{1,2,4}

1 Universidade Federal do Pará, Cidade Universitária Prof. José Silveira Netto. Laboratório de Biologia Pesqueira e Manejo dos Recursos Aquáticos, Grupo de Ecologia Aquática. Avenida Perimetral, 2651, Terra Firme, 66077830. Belém, PA, Brazil **2** Programa de Pós-Graduação em Ecologia Aquática e Pesca. Universidade Federal do Pará, Instituto de Ciências Biológicas. Cidade Universitária Prof. José Silveira Netto. Avenida Augusto Corrêa, 1, Guamá, 66075110. Belém, PA, Brazil **3** Institut de Recherche pour le Développement, Biologie des Organismes et Ecosystèmes Aquatiques, UMR BOREA, Laboratoire d'Ichthyologie, Muséum national d'Histoire naturelle, MNHN, CP26, 43 rue Cuvier, 75231 Paris Cedex 05, France **4** Programa de Pós-Graduação em Biodiversidade e Conservação. Universidade Federal do Pará, Faculdade de Ciências Biológicas. Avenida Cel. José Porfírio, 2515, São Sebastião, 68372010. Altamira, PA, Brazil

Corresponding author: Marcelo C. Andrade (andrademarcosta@gmail.com)

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Abstract

Myloplus zorroi **sp. n.** is described from the Rio Madeira Basin in Amazonia. The new species had been treated as an undescribed *Tometes* species because of the absence of a marked abdominal keel and few small spines forming its prepelvic serrae, features commonly found in the species of the *Myleus* clade of the Serrasalminidae (species of genera *Myleus*, *Mylesinus*, *Ossubtus* and *Tometes*) and also in species of *Utiaritchthys*. *Myloplus zorroi* **sp. n.** shares the following characters with its congeners and *Utiaritchthys*: molariform teeth (versus incisiform teeth in *Myleus* clade members); a labial row of premaxillary teeth separated from lingual row by an internal gap (versus absence of internal gap between premaxillary teeth rows); and an ascending process of premaxilla wide from its base to the tip (versus ascending process tapering from its base to the tip). Like other *Myloplus* species, *M. zorroi* **sp. n.** differs from *Utiaritchthys* by having a deeper body, approximately 60% of standard length (versus usually less than 50% of standard length). Considering all the morphological evidence, including the presence of 13–19 low spines forming the prepelvic serrae in *M. zorroi* **sp. n.** versus more than 20 high spines forming a marked prepelvic keel in other species of *Myloplus*, the new species is here assigned to *Myloplus*. Comparisons of the new species with nominal species of *Myloplus*, representatives of the *Myleus* clade, and other related taxa are provided.

Keywords

Ostariophysi, *Myleus*, rapids, pacu, freshwater fish, taxonomy

Introduction

Myloplus Gill, 1896 comprises large Serrasalminae fishes that can reach up to 475 mm standard length (Jégu et al. 2003). The species of this genus, commonly known as ‘pacu’ in Brazil and ‘asitau’ or ‘kumaru’ in French Guiana, are of high commercial value, particularly in the Amazon (Jégu 2003, Meunier et al. 2004). They inhabit slow- or rapid-flowing rivers and have specialized dentition for crushing seeds (Goulding 1980, Ota et al. 2013). The Serrasalminae members are traditionally classified according to the morphology and arrangement of teeth (Ortí et al. 2008). Géry (1972) classified the species with premaxillary teeth weakly incisiform, two rows of teeth separated by an internal gap, premaxillary labial row forming a gentle arc, and symphyseal teeth always present in the subgenus *Myloplus* of the genus *Myleus* Müller & Troschel, 1844, and recognized three species: *Myleus (Myloplus) asterias* (Müller & Troschel, 1844), *Myleus (Myloplus) rubripinnis* (Müller & Troschel, 1844), and *Myleus (Myloplus) knerii* (Steindachner, 1881). However, Jégu and Santos (2002), in their revision of the taxonomic status of *Myleus (Myloplus) knerii*, distinguished this species from the former two species in having abutting premaxillary teeth rows versus premaxillary teeth rows separated by a gap. Later, Jégu et al. (2004) elevated *Myloplus* to the generic level and allocated to it the seed-eating *Myloplus asterias* and *Myloplus rubripinnis*, both of which, in addition to having two rows of premaxillary teeth that are set apart from each other, have molariform teeth, whereas the other species have incisiform teeth.

Three species are recognized within the genus *Myloplus* according to the morphological concept of Jégu et al. (2003, 2004): *M. asterias*, *M. rubripinnis*, and *Myloplus planquettei* Jégu, Keith & Le Bail, 2003; two additional *Myloplus* species are recognized according to the molecular phylogeny of Ortí et al. (2008): *Myloplus ternetzi* (Norman, 1929) and *Myloplus tiete* (Eigenmann & Norris, 1900). Despite being formally recognized as *Myleus*, six additional species are recognized as belonging to the genus *Myloplus* by most recent studies (e.g. Jégu and Ingenito 2007; Andrade et al. 2013; Ota et al. 2013) because they share the features considered diagnostic of the genus by Jégu et al. (2004): *Myloplus arnoldi* (Ahl, 1936), *Myloplus levis* (Eigenmann & McAtee, 1907), *Myloplus lobatus* (Valenciennes, 1850), *Myloplus rhomboidalis* (Cuvier, 1818), *Myloplus schomburgkii* (Jardine, 1841), and *Myloplus torquatus* (Kner, 1858).

From the material collected in the Rio Madeira Basin, Brazil, a previously undescribed species was identified by Camargo and Giarrizzo (2007) as a member of the genus *Tometes* Valenciennes, 1850, probably based on the very small prepelvic serrae of the specimens and because some of them have been collected in rapids, the preferred environment of *Tometes*. However, based on morphology, these specimens are assigned to *Myloplus* and described as a new species, thus bringing the total number of *Myloplus* species currently recognized to 12.

Methods

Counts and measurements were performed as described by Jégu et al. (2003). All measurements were calculated as proportions of the standard length (SL), and the subunits of the head are presented as proportions of the head length (HL). Measurements were taken with a digital caliper to the nearest 0.1 mm. The frequency of examined specimens with a particular count is provided within parentheses after the respective count, and the values for the holotype are indicated by an asterisk. Vertebrae and supraneural counts were made from radiographs of specimens MPEG 30663, INPA 48546 and ZUEC 10776. Additional description of dentition was performed from analysis of the dissected specimen ZUEC. The osteological terminology used is that proposed by Weitzman (1962). The total number of vertebrae includes those of the Weberian apparatus, counted as four elements, and the fused PU_1+U_1 counted as a single bone.

The institutional abbreviations follow Andrade et al. (2016) with addition of NMNH (National Museum of Natural History, Washington, DC), and NMW (Naturhistorisches Museum Wien, Vienna).

Taxonomy

Myloplus zorroi sp. n.

<http://zoobank.org/DE77D64E-F9F7-4361-9741-B1E69ECF570B>

Figures 1a, b; 2 and 4a, b, c; Table 1

Tometes sp.: Camargo and Giarrizzo 2007: 294 [Checklist of fish species of the Marmelos Conservation Area (BX044)].

Holotype. INPA 50880 (326.2 mm SL), Amazonas, Apuí, Corredeira dos Periquitos, Rio Aripuanã, 07°17'19.8"S, 60°38'10.0"W, 19 November 2014, Machado V. N. et al.

Paratypes. All from Brazil. INPA 50868 (3 specimens 183.8–339.5 mm SL), collected with holotype. MPEG 30680 (1 specimen 351.1 mm SL), Mato Grosso, Aripuanã, downstream of Salto de Dardanelos, Rio Aripuanã, 10°09'46.5"S, 59°26'54.9"W, 12 December 2014, V. Machado. MPEG 30663 (1 specimen 244.5 mm SL), INPA 48546 (1 specimen 249.9 mm SL), and ZUEC 10776, (1 specimen 246.5 mm SL), Brazil, Amazonas, Novo Aripuanã, Parque Nacional dos Campos Amazônicos, Rio Roosevelt, Madeira Basin, 8°11'51"S, 60°58'19.2"W, October 2003, M. Camargo-Zorro & T. Giarrizzo.

Diagnosis. *Myloplus zorroi* sp. n. can be distinguished from its congeners by the absence of abdominal keel and the prepelvic serrae formed by 13–19 low spines (Fig. 2), in contrast to a well-marked abdominal keel and prepelvic serrae of more than 20 high spines. The new species is distinguished from *M. asterias*, *M. levis*, and *M. torquatus* by the presences of fewer branched dorsal-fin rays (20–22 versus 23 or greater), and from *M. arnoldi*, *M. ternetzi*, and *M. torquatus* by having a greater number of branched anal-fin rays (32–34 versus 31 or fewer). *Myloplus zorroi* differs significantly from *M.*

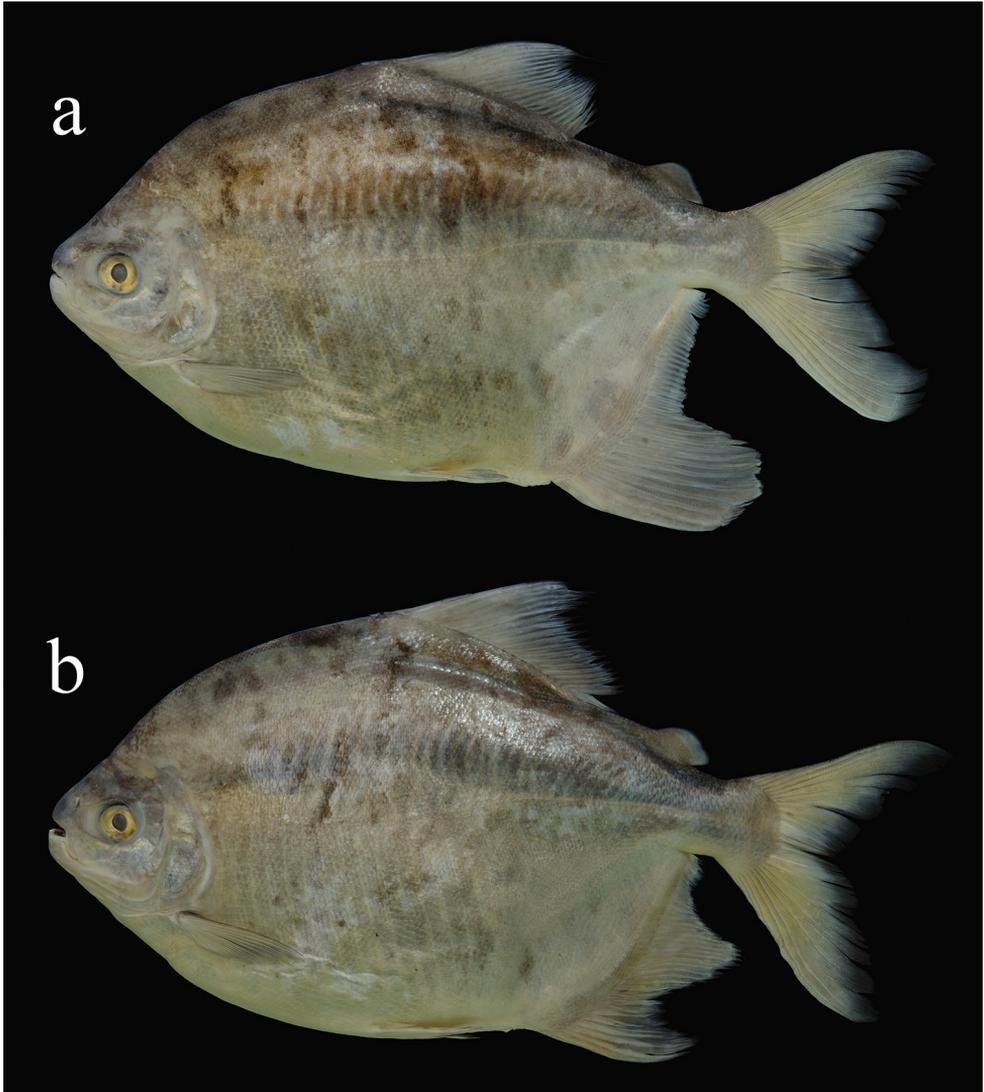


Figure 1. *Myloplus zorroi*, a new species from Rio Madeira Basin. **A** holotype, INPA 50880, female 326.2 mm SL **B** paratype, INPA 50868, male 339.5 mm SL. (Photographs by D. Bastos)

lobatus, *M. schomburgkii*, and *M. rhomboidalis* by having two rows of premaxillary teeth forming a slight arc (e.g., Fig. 3a) versus two rows of premaxillary teeth forming a shape that resembles the uppercase letter “A” (Fig. 3b). The shorter dorsal-fin base (27.6–30.1% of SL versus 31.8% of SL or higher), and the larger interdorsal distance (11.4–12.7% of SL versus 10.8% of SL or lower) are useful to distinguish *M. zorroi* from *M. asterias*, *M. levis*, *M. ternetzi*, and *M. torquatus*. Furthermore, the new species differs from *M. ternetzi* by the presence of a pair of symphyseal teeth versus their absence. The smaller vertical diameter of the eye (27.3–35.4% of HL versus 35.5% of

Table 1. Morphometric data of *Myloplus zorroi* (N = 8). Range values include the holotype. SD = standard deviation.

	Holotype	Range	Mean	SD
Standard length (mm)	326.2	183.8–351.1	282.9	*
		Percentages of standard length		
Body depth	59.3	59.1–62.5	60.4	1.3
Head length	24.3	21.8–24.6	23.4	0.9
Supraoccipital process	26.0	25.9–29.6	27.8	1.3
Predorsal length	53.7	51.9–55.8	54.1	1.3
Dorsal-fin base length	29.2	27.6–30.1	29.0	0.7
Interdorsal length	12.1	11.4–12.7	12.1	0.5
Adipose-fin base length	6.7	5.6–6.7	6.1	0.4
Caudal peduncle depth	10.8	10.1–11.1	10.6	0.3
Anal-fin base length	33.6	32.3–35.3	33.7	1.0
Preanal length	77.6	72.5–79.1	76.9	1.9
Prepelvic length	58.7	54.7–59.0	57.5	1.4
Prepectoral length	24.6	23.5–25.3	24.5	0.6
Anal-pelvic distance	21.5	21.2–24.0	22.6	1.0
Pelvic-pectoral distance	36.1	32.3–36.1	34.1	1.4
Width of peduncle	5.1	3.7–5.3	4.4	0.7
Pectoral-fin length	20.4	19.1–20.9	20.2	0.6
Pelvic-fin length	15.5	13.9–16.1	15.0	0.7
First anal-fin lobe length	30.7	24.0–32.4	29.4	3.5
Second anal-fin lobe length	*	13.9–18.2	15.4	2.4
Dorsal-fin length	27.9	25.2–31.1	28.2	1.6
Distance dorsal-fin origin to anal-fin origin	64.9	62.0–65.9	64.6	1.1
Distance dorsal-fin end to anal-fin origin	49.0	46.9–49.6	48.5	0.9
Distance dorsal-fin end to anal-fin end	26.0	24.1–26.7	25.3	0.8
		Percentages of head length		
Snout length	31.2	29.3–33.7	31.4	1.4
Interorbital width	53.8	49.2–56.5	53.0	2.7
Head width	66.8	64.9–71.1	68.4	2.3
Postorbital distance	34.2	32.8–36.6	34.0	1.2
Fourth infraorbital width	16.2	14.6–19.6	16.9	1.4
Eye vertical diameter	27.4	27.3–35.4	30.9	2.9
Mouth length	17.6	14.4–18.2	16.9	1.4
Third infraorbital width	11.8	11.8–14.1	12.9	0.8
Cheek gap width	9.9	9.2–12.6	11.1	1.1
Mouth width	36.1	31.7–38.5	35.9	2.0

HL or greater) separates *M. zorroi* from *M. arnoldi*, *M. asterias*, *M. levis*, *M. lobatus*, and *M. ternetzi*. *Myloplus zorroi* is additionally distinguished from *M. arnoldi* and *M. torquatus* by having a greater number of total vertebrae (40–41 versus 37 or less), by having anterior dorsal-fin rays lacking pigmentation (versus strongly dark pigmented



Figure 2. Prepelvic area of abdomen in ventral view of *Myloplus zorroi*. Paratype, MPEG 30663, male, 244.5 mm SL.

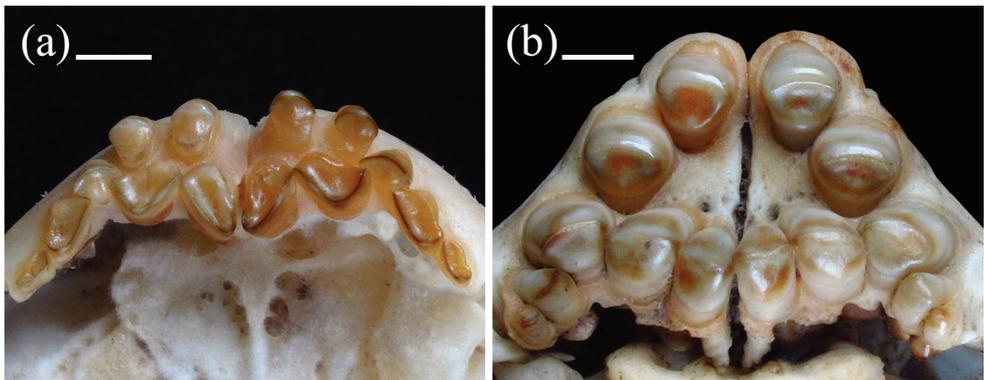


Figure 3. Ventral view of skeletonized premaxilla. **A** *Myloplus rubripinnis*, GEA 1301, 278 mm SL **B** *Myloplus rhomboidalis*, GEA 1500, 280 mm SL. Scale bars: 5 mm.

anterior dorsal-fin rays in *M. arnoldi*), and the presence of a diffuse dark band at caudal-fin distal border (versus the presence of a well-defined dark band in *M. arnoldi*). The elongated fontanel with similarly sized anterior and posterior portions (versus very short posterior fontanel and rounded anterior fontanel) further distinguishes *M. zorroi* from *M. asterias*.

Description. Morphometric data is presented in Table 1. Body laterally compressed, ovoid profile, greatest body depth at dorsal-fin origin (Fig. 1a, b). Dorsal profile of head distinctly convex from upper lip to vertical through anterior nares, nearly concave or gently straight from that point to distal margin of supraoccipital spine, and distinctly convex from that point to dorsal-fin origin. Dorsal-fin base slightly convex. Profile straight from dorsal-fin terminus to adipose-fin origin. Ventral profile of head slightly concave; ventral profile of body distinctly convex. Caudal peduncle relatively short, profile of lower caudal peduncle slightly concave. Anal-fin base distinctly convex at its basal third.

Snout gently rounded, mouth terminal, slightly oriented dorsally; jaws equal in size. Labial row of premaxillary teeth separated from lingual row by a gap; five teeth in labial row and two teeth in lingual row (Fig. 4a). Premaxillary and dentary teeth

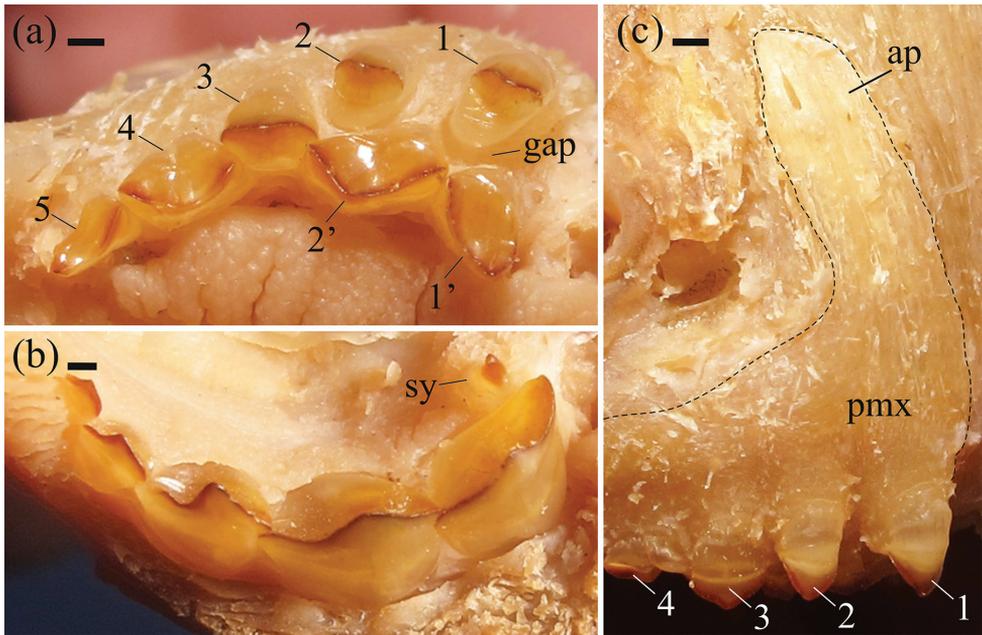


Figure 4. *Myloplus zorroi*, a new species from Rio Roosevelt, Madeira Basin. Paratype, ZUEC 10776, male, 246.5 mm SL. **A** Premaxilla in ventral view, molariform teeth, labial and lingual rows interspaced **B** Dentary view **C** Premaxilla in lateral view. 1–5: Labial row of premaxillary teeth; 1'–2': Lingual row of premaxillary teeth; gap: Gap between the labial and lingual rows of the premaxillary teeth; sy: Symphyseal tooth; pmx: Premaxilla; ap: Ascending process of the premaxilla. Dashed line: premaxilla contour. Scale bar: 1 mm.

molariform. Premaxillary teeth 1–3 of labial row with sharp edges, concave in lateral view, contralateral labial series separated by distinct gap, molariform teeth 1–2 with oval base, broad anteroposteriorly, molariform tooth 3 base rounded (Fig. 4a); 4 and 5 with elongate base anteroposteriorly, distinctly concave in lateral view, and cutting edge slightly curved internally. Premaxillary teeth 1'–2' of lingual row with base somewhat trapezoidal, with cutting edge curved, and concave labial face. Dentary with 5 (2) or 6* (6) teeth, first tricuspid, 2–5 bicuspid, anterior cusp largest. Symphyseal tooth posterior to main series present. Symphyseal teeth with blade-shaped anterior margin (Fig. 4b). Maxillary edentulous. First branchial arch with gill rakers elongated, stiff, and recurved. Epibranchial gill rakers 10 (1), 11 (1), or 13 (1). Ceratobranchial gill rakers 14 (1), 15 (1), or 18 (1); one gill raker at cartilage between ceratobranchial and epibranchial.

Scales cycloid, lateral line with 80 (1), 81 (3), 82 (2), or 83* (2) perforated imbricate scales from supracleithrum to hypural joint; total perforated scales 85 (1), 86 (2), 87 (1), 88* (2), or 89 (2). Scale rows between dorsal-fin origin and lateral line 39 (1), 40* (3), 41 (2), or 42 (2). Scale rows between lateral line and pelvic-fin insertion 36 (2), 38* (2), 39 (2), 40 (1), or 42 (1). Circumpeduncular scales 34 (1), 35* (3), or 36 (4). Prepelvic serrae with 13 (1), 17 (2), 18 (2), or 19* (3) very reduced spines (Fig.

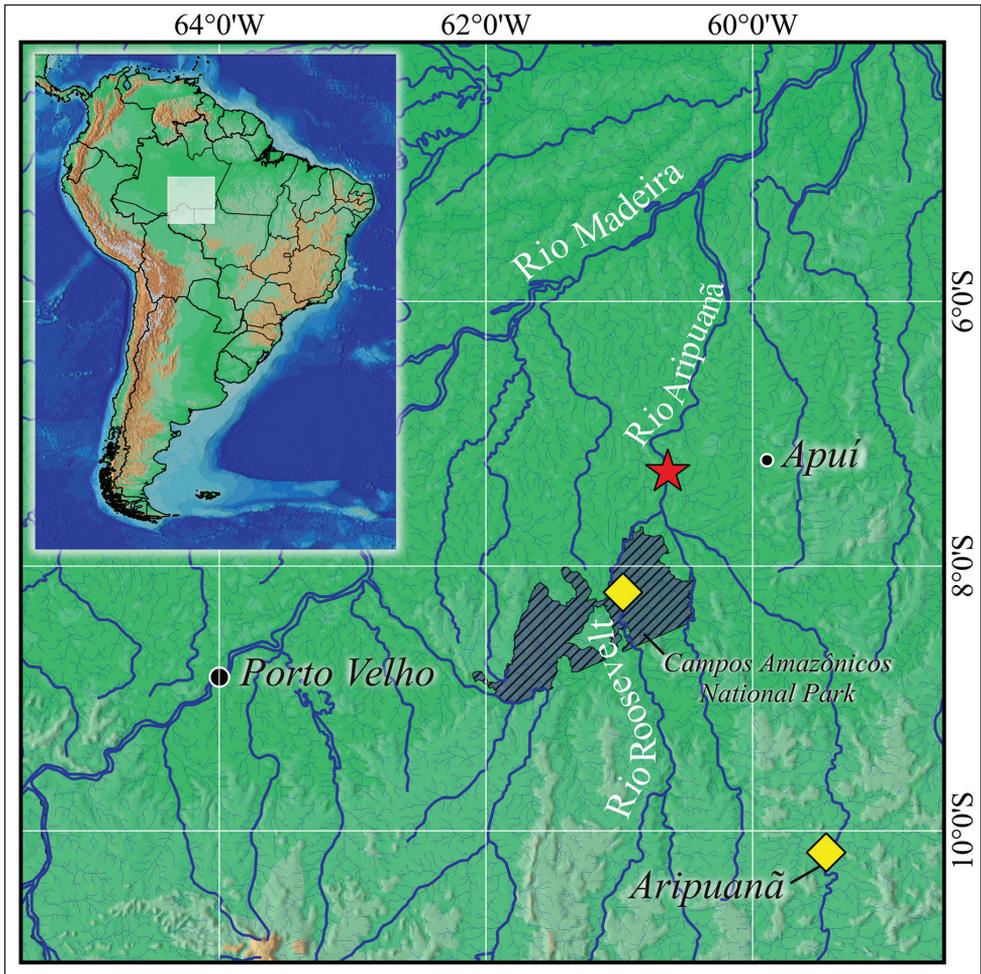


Figure 5. Collecting localities of *Myloplus zorro* in Rio Madeira Basin represented by the star and diamonds, (★) type locality.

2), 8 (2), 9* (4), or 10 (2) simple postpelvic spines, and 5 (1), 6* (6), or 7 (1) double postpelvic spines. Total spines 28 (1), 31 (2), 33 (1), 34* (3), or 35 (1).

Pectoral-fin rays i, 16 (2), i, 17 (5), or i, 18* (1). Pelvic-fin rays i, 7* (7), or i, 8 (1). Dorsal-fin origin at midbody preceded by strong forward-directed spine. Dorsal-fin rays ii* (4), or iii (4), and 20 (3), 21* (4), or 22 (1); anteriormost rays longest. Anal-fin rays iii (7), or iv* (1), and 32 (3), 33* (2), or 34 (3). Adipose fin with sub-rectangular distal margin. Caudal fin forked into lobes of similar size.

Total vertebrae 40 (1), or 41 (2). Predorsal vertebrae 10 (3). Postdorsal vertebrae 15 (2), or 16 (1). Vertebrae through last dorsal-fin pterygiophore and first anal-fin pterygiophore 2 (1), or 3 (2). Supraneurals 6 (3). Neurocranium in lateral view high, short, triangular, with concavity at epiphyseal bar level. Ascending process of premaxilla broader from its base to tip, with slightly rounded edge (Fig. 4c). Lateral process

of premaxilla after the last labial premaxillary tooth well developed, its length almost or more than three times the base length of the most posterior labial premaxillary tooth. Mesethmoid in dorsal view short, triangular, with broad base. Cranial fontanel elongated, with epiphyseal bar dividing anterior cranial fontanel and posterior cranial fontanel in equal parts. Dorsal process of supraoccipital spine very high.

Color in alcohol. Ground coloration silver brownish to yellowish silver, with pale hues. Darker coloration on humeral region. Overall pigmentation of head above eye somewhat darker than that of adjoining areas. Body more yellowish postero-ventrally on anal-fin region. Darker blotches, irregular in size and shape, scattered on the flanks (Fig. 1a, b) mainly in males. Dorsal, anal, and caudal fins somewhat yellowish, with distal margins darker, most conspicuous on the caudal fin. Pectoral and adipose fins overall hyaline. Pelvic fin hyaline with distal margin darker. Edge of teeth brownish (Fig. 4a–c).

Color in life. Based on photos of specimens collected by sport fishermen at Rio Aripuanã, *M. zorroi* sp. n., has ground coloration reddish silver, inconspicuous darker marks distributed on flanks, dorsum and head more darkened, and belly pale yellow. Dorsal, adipose, anal, and caudal fins yellowish brown.

Sexual dimorphism. The main secondary feature in mature males of *Myloplus zorroi* sp. n. is the additional anal-fin lobe centered on the 14th branched ray (Fig. 1b). Darker and irregularly shaped blotches are present over flanks at maturity (Fig. 1a, b). Filamentous extensions on dorsal fin and stiff hooks laterally curved on anal fin found in species of *Tometes*, *Myleus*, *Mylesinus*, and other *Myloplus* species were not present in three examined males of *Myloplus zorroi* sp. n.

Distribution. *Myloplus zorroi* is known from Aripuanã and Roosevelt rivers, two tributaries of the Rio Madeira basin (Fig. 5). The presence of the new species within a conservation unit was confirmed from the records for Rio Roosevelt in the area of the Campos Amazônicos National Park (formerly known as: Marmelos Conservation Area BX044), located on the boundaries of the Amazonas and Rondônia States, Brazil.

Habitat. The type locality of *Myloplus zorroi* is a moderately to rapidly flowing, clear-water river running over rocky and sandy bottoms (Fig. 6), with a depth ranging from approximately 2 m to at the most 8 m, and a mean width of 320 m. The river is surrounded by extensive riparian vegetation that is mainly composed of ombrophilous forest and is located at an elevation of approximately 78 m above sea level. Water flow in the main channel is significantly reduced during the dry season (June–September), with most of the inflow restricted to small channels with rapids and extensive spread of rock outcrops scattered along the course of the main river. The records of *Myloplus zorroi* in Rio Roosevelt were collected close to the vegetated edge, while the specimens collected in Rio Aripuanã were made around the rapids of Corredeira dos Periquitos and Salto de Dardanelos.

Etymology. The specific name ‘*zorroi*’ is dedicated to Mauricio Camargo-Zorro, a researcher at the Instituto Federal de Educação, Ciência e Tecnologia, in recognition of his invaluable contribution to the fish fauna inventory from the Marmelos Conservation Area. The name ‘*zorroi*’ also alludes to the Latin-American fictional character ‘Zorro’, which was the secret identity of Don Diego de la Vega, because the special features “masked” this fish as *Tometes*, concealing its true identity.



Figure 6. Corredeira dos Periquitos, Rio Aripuanã, type locality of *Myloplus zorroi*, Rio Madeira Basin, Brazil.

Discussion

Myloplus zorroi differs markedly from its congeners in having a rounded abdominal region that lacks a marked keel and has a low number of small spines forming the prepelvic serrae (Fig. 2). This configuration is common to species of *Utiaritchthys* and the *Myleus* clade *sensu* Ortí et al. (2008), the latter mainly including representatives of the genera *Myleus*, *Mylesinus* and *Tometes*. The low number of small prepelvic spines in the *Myleus* clade was considered a derived character state by Jégu (2004: 352, character 28). The reduction of prepelvic serrae in number and size in *Myloplus zorroi* is most likely an autapomorphic character state amidst *Myloplus* species, but a phylogenetic study is needed to better characterize prepelvic features and the relationships among the species sharing them.

Myloplus zorroi was incorrectly classified as an unknown species of the genus *Tometes* by Camargo and Giarrizzo (2007). A more detailed analysis of its dentition and osteological features suggests that it is better classified as a species of *Myloplus*. The most important characters placing the species in *Myloplus* and not in any genera of the *Myleus* clade are as follows: molariform teeth (versus incisiform teeth); rows of premaxillary teeth separated by a gap (versus rows abutting); and ascending process of the premaxilla broad from its base to the tip, with a rounded edge that is strongly attached to

the neurocranium (versus ascending process of the premaxilla narrowing from its base, with an acute edge that is weakly attached to the neurocranium). Goulding (1980) and Boujard et al. (1990) suggested that these features are possibly anatomical modifications allowing *Myloplus* specimens to crush seeds. In contrast, members of the *Myleus* clade with their incisiform teeth are specialized to cut leaves.

Several classifications of *Myloplus* have been proposed. Gill (1896) erected *Myloplus* for the South American representatives of *Myletes* Müller & Troschel, 1844 and placed the African species of *Myletes* Cuvier, 1818 in *Alestes* Müller & Troschel, 1844. Gill (1896) also proposed that *Myloplus* and *Myleus* Müller & Troschel, 1844 are subgenera of *Myleus*. Eigenmann (1915) resurrected *Myloplus*, distinguishing it from *Myleus* by features corresponding to sexual dimorphism. Gosline (1951) considered as irrelevant the characters proposed by Norman (1929) to differentiate *Myleus*, *Myloplus*, and also *Paramyloplus*, and he combined all of these genera in *Myleus*. Gosline (1951) also considered the species *Utiaritichthys sennaebregai* Miranda Ribeiro, 1937, which has reduced prepelvic serrae, as a possible species of *Myleus*. Gosline (1951) described 11 species within *Myleus*, many of which were synonymized later.

Géry (1972), following the classification of Gosline (1951), then proposed *Proso-myleus* Géry 1972 as a subgenus of *Myleus* and recognized four subgenera of *Myleus* based mainly on the arrangement and shape of the teeth: *Myloplus*, *Myleus*, *Paramyloplus*, and *Proso-myleus*. Based on molecular data, Ortí et al. (2008) indicated that *Myleus sensu* Géry (1972) forms a paraphyletic group and suggested that species of *Myleus* Müller & Troschel, 1844 are more closely related to *Mylesinus* and *Tometes* [the latter previously identified as 'N. gen. A' by Ortí et al. (1996)] than to species of *Myleus sensu* Géry (1972) and the subgenera *Myloplus* and *Proso-myleus*. However, a more comprehensive study involving anatomical and molecular analysis is required to further explain the relationships among these Serrasalminae genera.

Géry (1977), as well as Gosline (1951), proposed that *U. sennaebregai* should be treated as *Myleus sensu* Géry (1972) due to its reduced prepelvic serrae; however, until a study directed to solve this question is conducted, *Utiaritichthys* is considered distinct from *Myleus*. Jégu et al. (1992) redescribed the types of *U. sennaebregai* and showed that reports of the species made by several authors since Gosline (1951) were actually of species not belonging to *Utiaritichthys*. Additionally, Jégu et al. (1992) described *Utiaritichthys longidorsalis* Jégu, Morais & Santos, 1992 from the Rio Aripuanã, Madeira river basin. This species can be distinguished from its syntopic *M. zorroi* mainly by having an elongate body, body depth usually less than 50% of SL (versus deeper body, around 60% of SL in *M. zorroi*), 24–25 branched dorsal-fin rays (versus 20–22), and 26–30 spines forming the prepelvic serrae (versus 13–19). *Utiaritichthys sennaebregai* differs from *M. zorroi*, as well as *U. longidorsalis* by possessing a deeper body and by having 9–10 spines forming the prepelvic serrae (versus 13–19). Note that the counts of 9–13 prepelvic spines for *U. sennaebregai* observed by Gosline (1951), Géry (1979), and Pereira and Castro (2014) are actually from specimens of the newly described *Tometes acylorhynchus* Andrade, Jégu & Giarrizzo, 2016. In the morphological

phylogeny of Jégu (2004), the two species of *Utiaritchthys* form a polytomy with the *Myloplus* clade. Pending further study, *Utiaritchthys*, which shares most of the diagnostic features of *Myloplus* such as teeth morphology and arrangement of premaxillary teeth rows, remains a separate genus.

Comparative material

Myloplus arnoldi: IRSNB 21.253, 1 specimen, 147.7 mm SL, Rio Xingu, Cachoeira Von Martius, Mato Grosso, Brazil. MNHN 1998-1162, 2 specimens, 147.6–154.5 mm SL, Altamira market, Brazil. *Myloplus torquatus*: NMW 56449, 1 specimen, Paralectotype, 133 mm SL, Rio Branco, Marabitanos, Brazil. NMW 56450, Lectotype, 122 mm SL, Rio Branco, Brazil. *Myloplus ternetzi*: BMNH 1926.3.2.531-532, 2 specimens, Syntypes, 157.1–163.2 mm SL, Approuague River, Maparú Rapids, French Guiana. IEPA 3548, 5 specimens, 131.7–168.2 mm SL, Amapá, Brazil. IEPA 3560, 5 specimens, 98.4–117.5 mm SL, Flota do Amapá, Rio Araguari, Amapá, Brazil. IEPA 3586, 3 specimens, 18.1–29.9 mm SL, Oiapoque, Rio Anoitá, Amapá, Brazil. RMNH 26467, Holotype of *Myleus (Paramyloplus) ternetzi goslinei*, 178.3 mm SL; and RMNH 33828, 6 specimens, Paratypes of *Myleus (Paramyloplus) ternetzi goslinei*, 67.1–142.6 mm SL, Brokopondo, Suriname River, Suriname. *Myloplus lobatus*: BMNH 1849.11.8.32-33, 2 specimens, Syntypes, 143.6–152.6 mm SL; and BMNH 97.11.26.8, 1 specimen, 124.2 mm SL, Rio Capim, Pará, Brazil. GEA 1988, 1 specimen, 166.7 mm SL, Parque Nacional dos Campos Amazônicos, Rio Roosevelt, Madeira Basin, Brazil. MNHN 0000-5244, 1 specimen, 188.2 mm SL, Rio Amazonas, Brazil. *Myloplus rhomboidalis*: BMNH 1926.10.27.174-6, 3 specimens, 54.4–78.8 mm SL. Rio Amazonas, Monte Alegre, Brazil. GEA 1500, 1 dry skeleton, 280 mm SL, Altamira market, Xingu Basin, Brazil. GEA 1501, 1 specimen, 230.1 mm SL, Parque Nacional dos Campos Amazônicos, Rio Roosevelt, Madeira Basin, Brazil. IRSNB 20.221, 4 specimens, 66.9–95.6 mm SL, Camopi River, Polydor, French Guiana. IRSNB 20.222, 5 specimens, 68–87.9 mm SL, Oyapock River, French Guiana. MNHN 4423, 1 specimen, 150.1 mm SL, Rio Amazonas, Brazil. MNHN A-9739, 1 specimen, 128 mm SL, Essequibo River, Guyana. MNHN A-9862, 2 specimens, 138.5–140.2 mm SL, Maná River, French Guiana. *Myloplus schomburgkii*: GEA 1974, 1 dry skeleton, 135 mm SL, Rio Xingu, Brazil. GEA 1987, 1 specimen, 224 mm SL, Parque Nacional dos Campos Amazônicos, Rio Roosevelt, Madeira Basin, Brazil. *Myloplus asterias*: BMNH 1864.1.21.33, 1 specimen, 135.9 mm SL, Essequibo River, Guyana. BMNH 1900.4.2.5, 1 specimen, 237.1 mm SL, Pará State, Rio Acará, Brazil. BMNH 1971.5.10.63, 1 specimen, 182.5 mm SL; and BMNH 1971.5.10:61-62, 2 specimens, Paralectotypes, 115.3–122.8 mm SL, Essequibo River, Guyana. BMNH 1972.7.5:91-93, 3 specimens, 117.9–135.4 mm SL, Rupununi River, Wichabai, Guyana. BMNH 1982.9.24:105-107, 3 specimens, 135.5–177.1 mm SL; and BMNH 1982.9.24:83, 1 specimen, 148.6 mm SL, Xingu Basin, Brazil. GEA 1989, 1 specimen, 198.1 mm SL, Parque Nacional dos

Campos Amazônicos, Rio Roosevelt, Madeira Basin, Brazil. IEPA 2869, 1 specimen, 146.5 mm SL; and IEPA 2875, 1 specimen, 147.3 mm SL; and IEPA 2890, 1 specimen, 153.9 mm SL, Amapá, Brazil. MNHN 1998-0256, 4 specimens, 144.1–152.6 mm SL, Rio Amapari and Rio Araguari, Amapá, Brazil. *Myloplus planquettei*: IEPA 3544, 6 specimens, 136.4–167.5 mm SL; and IEPA 3545, 1 specimen, 108 mm SL, Rio Jari, Amapá, Brazil. MNHN 1997-0729, 1 specimen, Paratype, 66.7 mm SL, Maná River, Saut Valentin, French Guiana. MNHN 1997-0730, Holotype, 112.8 mm SL, Maroni River, Twenke, French Guiana. MNHN 2001-1224, 1 specimen, Paratype, 139.3 mm SL, Maná River, Kawatop, Litany, French Guiana. *Myloplus rubripinnis*: BMNH 1971.5.10.64, 1 specimen, Syntype, 76.5 mm SL, Essequibo River, Guyana. GEA 1301, 1 dry skeleton, 278 mm SL, Rio Bacajá, Brazil. IRSNB 19.298, 1 specimen, 43.9 mm SL, Distrikt Marowijne, Tapanahoni River, Paloemeu Vliegveld, Suriname. IRSNB 20.223, 3 specimens, 43.7–53.1 mm SL, Camopi River, Polydor, French Guiana. IRSNB 20.224, 2 specimens, 97.3–97.6 mm SL, Oyapock River downstream Crique Adjoumba, French Guiana. MNHN 2000-0148 (ex A-9870), 3 specimens, 176.6–224.4 mm SL, Cayenne, French Guiana. MNHN A-8632, 1 stuffed specimen, 248.3 mm SL, Cayenne, French Guiana. MNHN A-9870, 1 specimen, 285.4 mm SL, Cayenne, French Guiana. MNHN A-9895, 1 specimen, 237.2 mm SL, Colombia. RMNH 33703, 1 specimen, 177 mm SL; and RMNH 33704, 1 specimen, 183.9 mm SL, Mamadam, Surinam River, above Brokopondo, Surinam. ZMA 105-565, 2 specimens, 168.7–190.6 mm SL, Saramaca River Basin, Suriname. *Utiaritchthys longidorsalis*: INPA 3638, holotype, 198.4 mm SL, Mato Grosso, Aripuanã, Rio Aripuanã. *Utiaritchthys sennaebregai*: MZUSP 100015, 3 specimens, 28.4–72.0 mm SL, Mato Grosso, Rio Juruena downstream of bridge at BR-364. GEA 1994, 1 specimen, 245.0 mm SL, Mato Grosso, São Domingos, Rio Guaporé.

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