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Tetraclita ehsani sp. n. (Cirripedia, Tetraclitidae), a common intertidal barnacle from the Gulf of Oman, Iran

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Abstract

A new species of intertidal acorn barnacle *Tetraclita ehsani* **sp. n.** was identified from the Iranian coast in the Gulf of Oman. *T. ehsani* **sp. n.** inhabits low exposed rocky shores and also attaches to shells of molluscs and the barnacle *Megabalanus* species. Parietes of *T. ehsani* ranged from white to pink which is different from *T. serrata* (in South African waters), which has green parietes. Morphology of the tergum and cirrus III of *T. ehsani* **sp. n.** is distinctive from other described West Indian Ocean species which have pink or white parietes (*T. rufotincta*, *T. achituvi* and *T. reni*). The tergum of *T. ehsani* is very narrow and the basal margin is slightly concave or straight, in contrast to *T. rufotincta* and *T. reni*, in which the tergum are board and with a very concave basal margin. Cirrus I anterior ramus of both *T. ehsani* and *T. reni* is antenniform and thus differing from the cirrus I of *T. rufotincta* (see Chan et al. 2009). Cirrus III of *T. ehsani* **sp. n.** is non-antenniform and lacks multicuspidate type setae, which is different from *T. reni* by having an antenniform cirrus III and with multicuspidate setae.

Keywords

Crustacea, Cirripedia, Tetraclitidae, barnacles, Indian Ocean, Gulf of Oman, Iran

Introduction

Tetraclita species are common rocky intertidal acorn barnacles in the tropical and subtropical waters of the world (Newman and Ross 1976). *Tetraclita squamosa* Bruguière, 1789 had been recorded worldwide and was considered to be composed of nine sub-species due to high degree of morphological variations (Newman and Ross 1976). *Tetraclita squamosa* has since been split into 23 species using morphological and molecular approaches (Chan et al. 2007a, b, c), but the taxonomy of the species in the West Indian Ocean has still received scant attention (Chan et al. 2009). Pilsbry (1916) described *Tetraclita rufotincta* (= *Tetraclita squamosa rufotincta* Pilsbry, 1916) from Yemen and Zanzibar, and designated Yemen as the type locality. *T. rufotincta* was subsequently recorded in the northwest coast of India (Wagh 1971, 1972), the Red Sea (Achituv and Barnes 1978) and the Persian Gulf (Utinomi 1969). Ross (1999) additionally described *T. achituvi* Ross, 1999 and *T. barnesorum* Ross, 1999 from *T. rufotincta* in the Red Sea but subsequent molecular studies (Appelbaum et al. 2002) revealed *T. barnesorum* was a synonym to *T. rufotincta*. Ren (1989) described *T. africana* from Madagascar, but as this name was preoccupied and it was renamed *T. reni* Chan, Hsu & Tsai, 2009 by Chan et al. (2009). In the West Indian Ocean, *T. reni* is distributed in southern Madagascar and adjacent waters (Chan et al. 2009).

Taxonomic studies of Iranian barnacles after Utinomi (1969) are scant (Jones 1968; Southward and Newman 2003). Recently, extensive barnacle collections was carried out by Shahdadi (2007), Shahdadi and Sari (2011) on intertidal barnacles of the Persian Gulf and Gulf of Oman. *Tetraclita rufotincta* is common in the intertidal of the Persian Gulf (Shahdadi 2007). However, *Tetraclita* specimens collected from exposed rocky shores at the Gulf of Oman, Iran were morphologically different from other known *Tetraclita* species of the West Indian Ocean, suggesting that this is a new species. The *Tetraclita* specimens from the Gulf of Oman were examined by one of us (BKK Chan) using COI molecular markers, which showed a large genetic divergence from all known species in the West Indian Ocean (sequence of *Tetraclita* specimen from Gulf of Oman submitted to GenBank, unpublished data for phylogenetic comparisons). This further confirms the *Tetraclita* collected from the Gulf of Oman is a new species and described herein.

Materials and methods

Tetraclita specimens were collected from the low intertidal shores at Ramin, Chabahar (25° 16’ N, 60° 44’ E) and Tis, Chabahar Bay (25° 16’ N, 60° 40’ E), Gulf of Oman, Iran. Barnacles were preserved in 95% Ethanol upon collection. The opercular plates, cirri and mouth parts were dissected and observed under compound light microscopes. The first three pairs of cirri and mouth parts were further investigated using a FEI Quanta 200 Scanning Electron Microscope (SEM) following Chan et

al. (2007a, c, 2009). Terminology in describing the setae follows Chan et al. (2008). The COI barcode region was sequenced from the somatic body of the *Tetraclita* (paratype, ASIZCR 000231) collected from Chabahar, Gulf of Oman. DNA extraction and PCR protocol followed Chan et al. (2007a, c) and sequence was deposited in the GenBank.

The holotype and two paratypes are deposited in the Zoological Museum, University of Tehran (ZUTC) and one of the paratype was deposited in the Biodiversity Museum, Academia Sinica, Taiwan (ASIZCR).

Systematics

Superfamily Tetraclitoidea Gruvel, 1903
Family Tetraclitidae Gruvel, 1903
Tetraclitinae Gruvel, 1903
***Tetraclita* Schumacher, 1817**

***Tetraclita ehsani* sp. n.**
urn:lsid:zoobank.org:act:9829EE59-762C-4557-81AE-CB51DA038234
http://species-id.net/wiki/Tetraclita_ehsani
Figures 1–5

Material examined. HOLOTYPE. ZUTC-Cirri 1275, 1 specimen, Ramin, Chabahar, Gulf of Oman, Iran (25°16'N, 60°44'E), basal carino-rostro diameter 19.64 mm, height 13.74mm, orifice diameter 5.24mm. PARATYPE. ASIZCR 000231, 1 specimen, locality same as holotype, basal carino-rostro diameter 18.16 mm, height 11.91 mm, orifice 5.78 mm. PARATYPE. ZUTC-Cirri. 1276, 1 specimens, locality same as holotype. from Ramin (type locality). PARATYPE. ZUTC-Cirri. 1277, 1 specimen, Tis (Portuguese Castle), Chabahar Bay, Gulf of Oman, Iran (25°16'N, 60°40'E). GenBank accession number of paratype ASIZCR 000231: JN603678.

Diagnosis. Parietes white or pink, tergum very narrow, basal margin slightly concave or almost straight, tergal spur long and narrow. Mandible with five teeth, labrum with 4 large sharp teeth on each side of the cutting edge. Anterior ramus of cirrus I antenniform.

Description. *Parietes* conical, white to pink or white with pink ribs (Fig. 1A), radii and alae narrow, sheath striate, parallel to base and about ½ height of wall, sheath white to dirty white, or pink. Parietes composed of 3-4 rows of honey comb parietal tubes (Fig. 1B). *Scutum* and *tergum* white (Fig. 1B, C, D). *Scutum* narrow, 1.5 times higher than wide, lower half of occludent margin with >10 oblique teeth, articular ridge sinuous, adductor ridge extremely developed, angular and extending to basal margin, adductor muscle pit shallow, seven distinct rostral and four to six lateral depressor crests (Fig. 1B, C, D), external surface smooth with faint horizon-

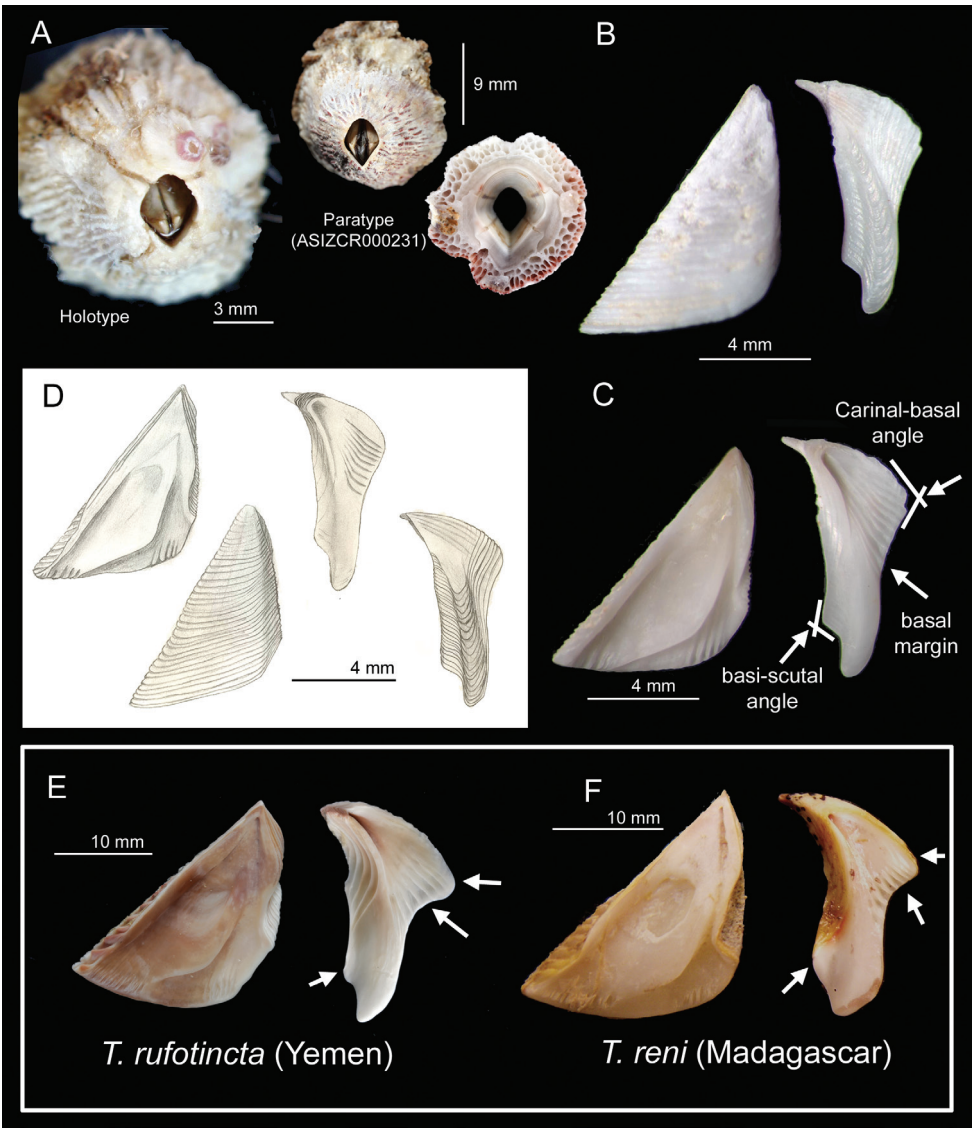

Figure 1. *Tetraclita ehsani* sp. n. **A** external parietes of the holotype and the top and basal view of the parietes of a paratype (ASIZCR 000231); note the basal view showing the parietal tubes **B** external view of scutum and tergum of the paratype (ASIZCR 000231) **C** internal view of scutum and tergum, (ASIZCR 000231); arrows indicate the diagnostic features of tergum from other Western Indian Ocean species (see table 1) **D** drawing of the holotype of the scutum and tergum **E** Scutum and tergum of *Tetraclita rufotincta* collected from Yemen (type locality) (after Chan et al. 2009) **F** scutum and tergum of *Tetraclita reni* collected from Madagascar (type locality) (after Chan et al. 2009).

tal striations (Fig. 1). *Tergum* long and narrow (length more than twice as width) with ten definite depressor crests, scutal margin slightly concave, spur long and narrow, external spur surface with a medial furrow, basi-scutal angle sharp and about

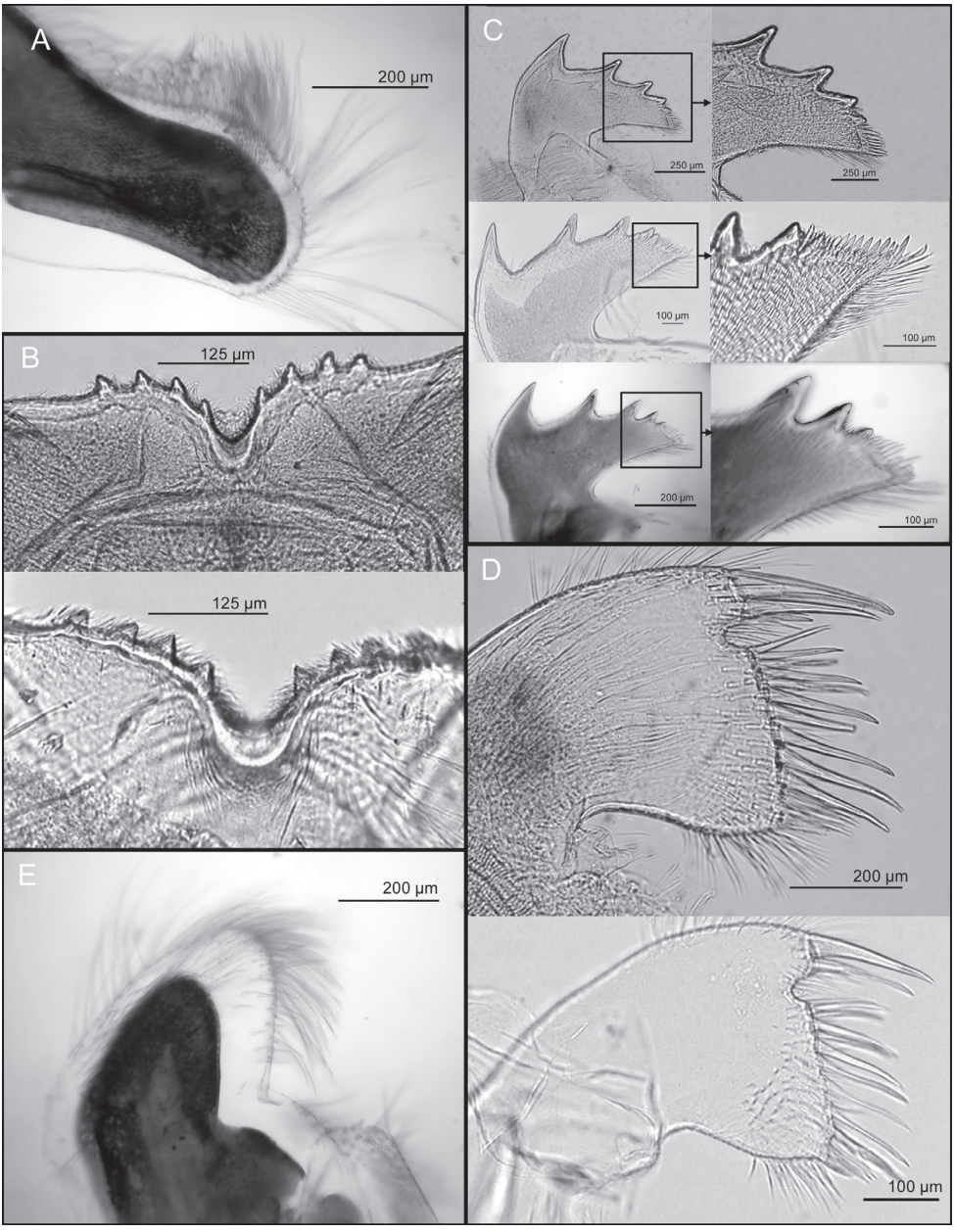

Figure 2. *Tetraclita ehsani* sp. n. Light microscopy showing: **A** mandibular palp **B** labrum (two individuals) **C** mandibles (3 individuals) and with enlarged views of lower margin and inferior angle **D** maxillule (2 individuals) and **E** maxilla.

117.8°, upper carinal margin convex and basal margin slightly concave or straight (Fig. 1B, C, D). Carinal-basal angle (angle between the carinal and basal margin) is ~103° (Fig. 1C).

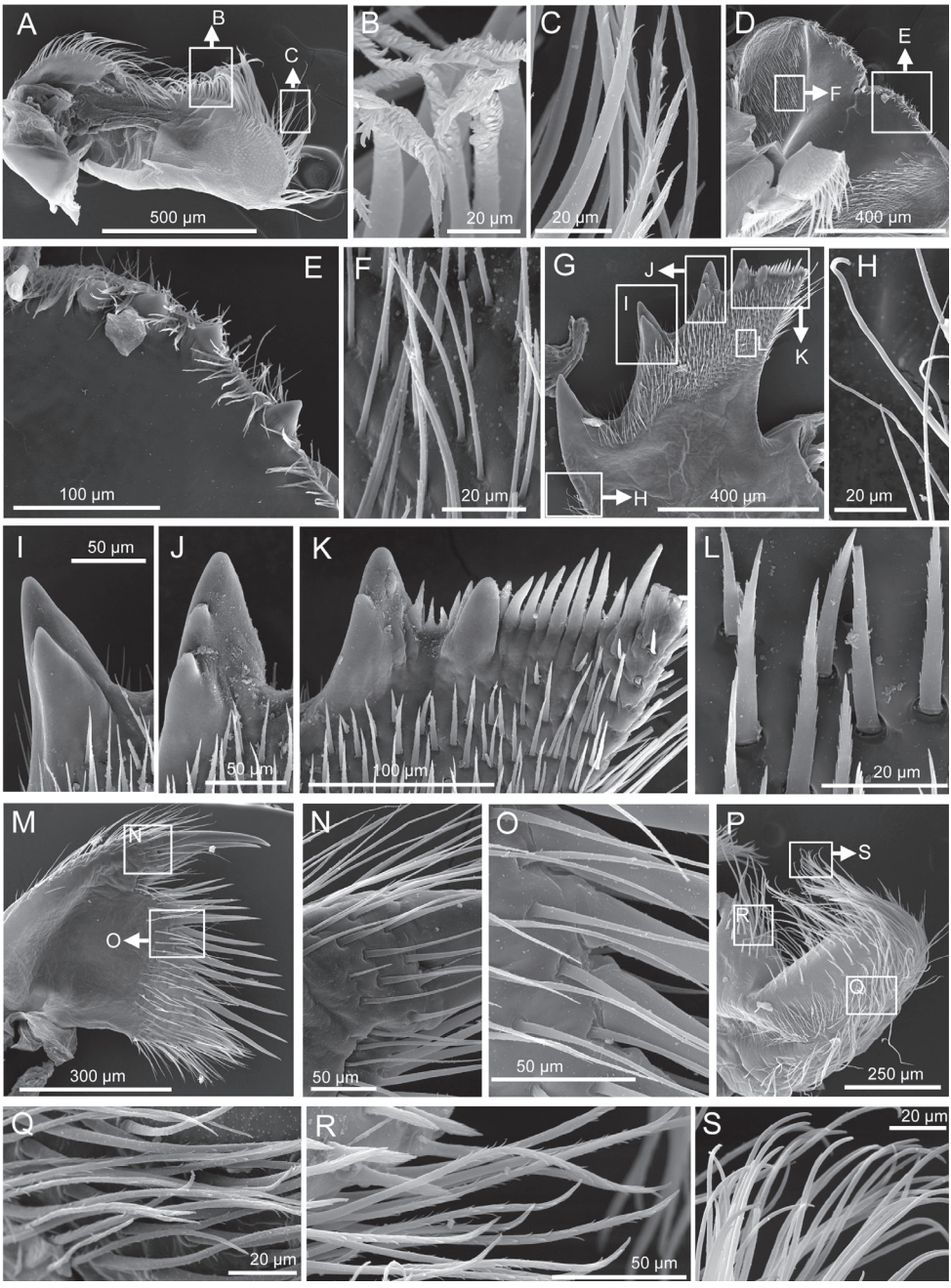

Figure 3. *Tetraclita ehsani* sp. n. SEM showing: **A** mandibular palp **B, C** serrulate type setae on mandibular palp **D** labrum **E** cutting edge of labrum showing the 4 large sharp teeth **F** simple type setae on inner side of labrum **G** mandible **H** simple setae on the lateral side of the mandible **I** second bi-dentated tooth of the mandible **J** third tri-dentated tooth of the mandible **K**, fourth and fifth tooth of the mandible **L**, serrulate blade shaped setae on mandible **M** Maxillule **N, O** serrulate setae on maxillule surface **P** maxilla **Q, R**, serrulate setae on maxilla **S** simple setae on tip of maxilla.

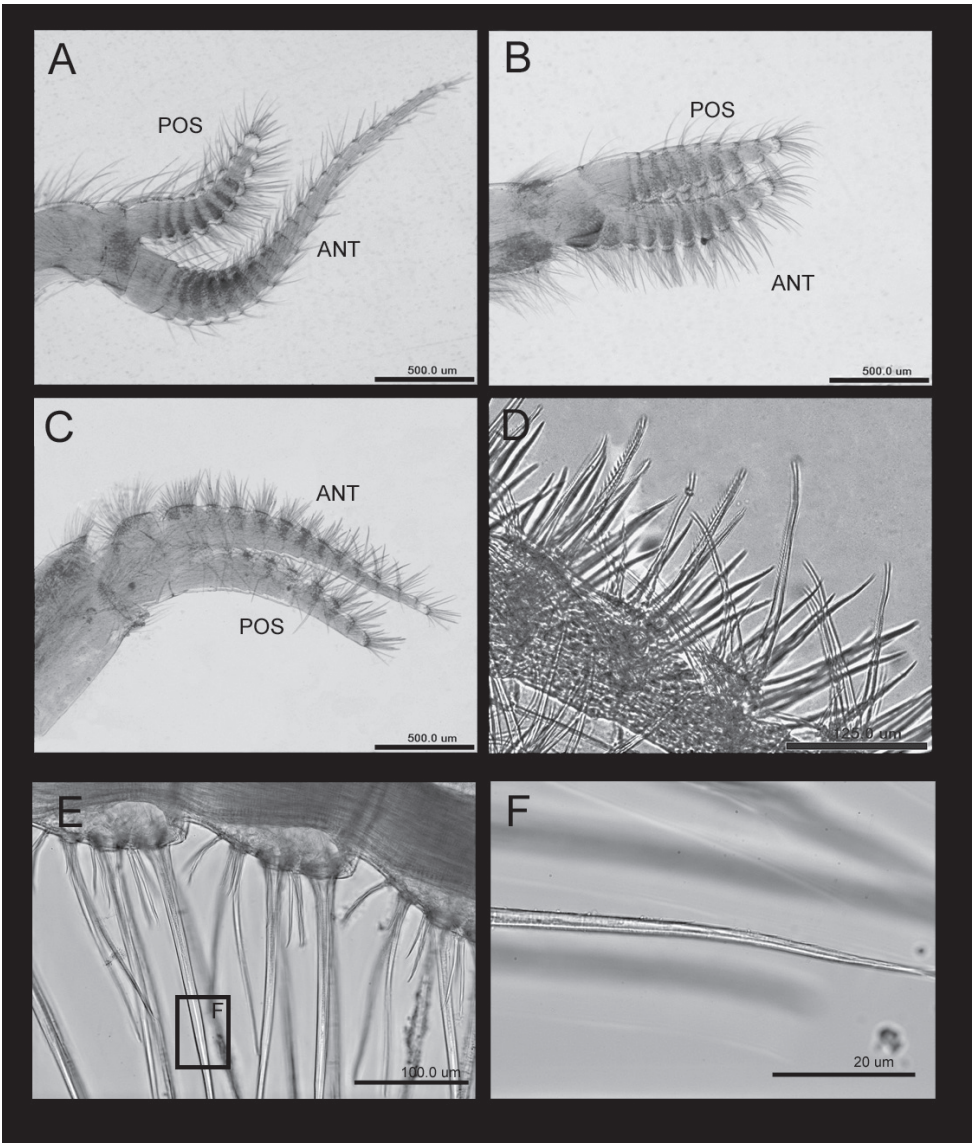

Figure 4. *Tetraclita ehsani* sp. n. Light microscopy showing: **A** cirrus I **B** cirrus II **C** cirrus III **D** bidentate serrulate type setae on rami of cirrus III **E** intermediate segment of anterior ramus of cirrus VI **F** Long serrulate setae at cirrus VI. ANT – Anterior ramus, POS – Posterior ramus.

Mandibular palps elongate, setae on superior margin only, simple type setae at tip and serrulate setae at the middle region of the superior margin (Figs 2A, 3A, B, C). *Labrum* notched, notch shallow, four erect large teeth on each side of the cutting edge (Figs 2B, 3E–H). *Mandible* with five teeth excluding the inferior angle, first tooth separated from the remaining teeth, second and fourth teeth bidentate, third teeth tridentated fifth tooth small and located close to the fourth tooth, lower margin with

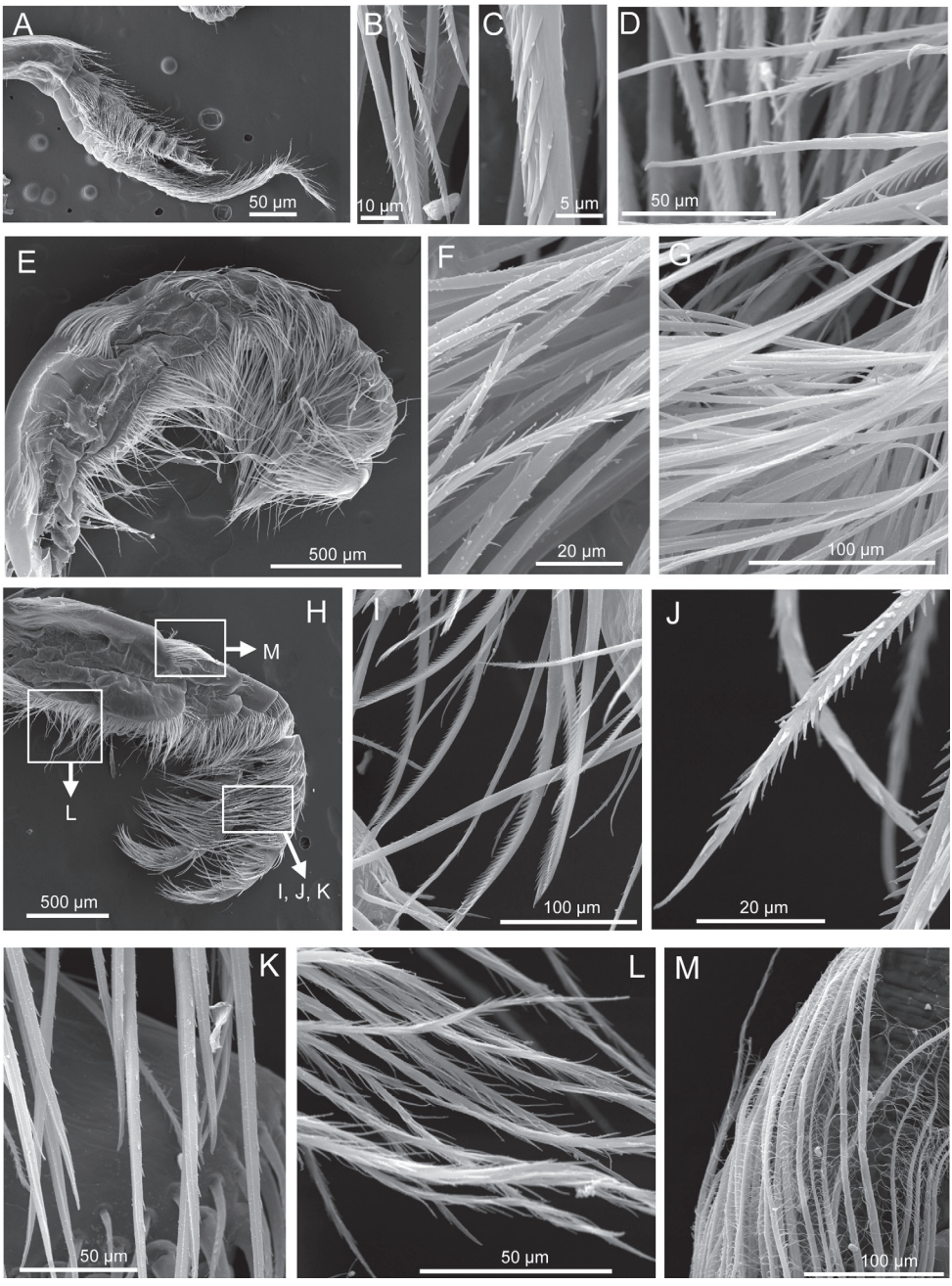

Figure 5. *Tetraclita ehsani* sp. n. SEM showing: **A** cirrus I **B, C, D**, serrulate type setae on rami of cirrus I **E** cirrus II **F, G** serrulate type setae on rami of cirrus II **H** cirrus III **I, J, K**, serrulate type setae on rami of cirrus III **L** serrulate type setae on protopod of cirrus III **M** pappose setae on protopod of cirrus III.

>10 setae, height of setae similar to height of the fifth tooth, inferior angle sharp, with two large setae on tip, mandible surface with blade shaped serrulate type setae (Figs 2C, 3G–L). *Maxillule* notched, with two large and four small simple setae above notch, 11 setae in median cluster and 10 small and slender simple setae on the cutting margin below notch (Figs 2D, 3M–O). *Maxilla* bi-lobed, serrulate type setae at both lobes (Figs 2E, 3P–S).

Cirrus I anterior ramus antenniform, twice as long (27 segments) as posterior ramus (10 segments) (Figs 4, 5A), both rami with a feathery serrulate type setae (3–4 rows dense setules in each seta) and a serrulate type setae (very sparse setule along the seta) (Fig. 5B–D). *Cirrus II* with shorter rami, anterior and posterior ramus similar in length (each with 10 segments), with serrate and simple setae (Fig. 5E–G). *Cirrus III* with longer anterior ramus (anterior and posterior ramus 13 and nine segments respectively; Fig. 4). Both rami bear bidentate serrate setae, feathery serrulate setae and blade shaped serrulate setae, protopod bears pappose setae with long feather seta (Fig. 5H–M). *Cirrus IV–VI* ctenopods, cirrus IV with 17 segments for both anterior and posterior rami, cirrus V, anterior ramus 21 segments, posterior ramus 19 segments, cirrus VI, anterior ramus 18 segments, posterior ramus 22 segments. Intermediate segment of anterior ramus of cirrus VI bears 3 pairs of long serrulate setae and 3 pairs of short setae (Fig. 4E, F).

Etymology. This species is named in honour of Ehsan Entezari-Zarch, B.Sc. student in Animal Biology at the University of Tehran, who unfortunately passed away during a field collection in October 2009.

Habitat. This species was present at the exposed low shores at intertidal zone, attaching on rocks but sometimes were observed on mollusk shells and on the shell surface of the barnacle *Megabalanus* species at the Gulf of Oman.

Distribution. At present, only known from the Iranian coast in the Gulf of Oman and absent from the Persian Gulf (see Shahdadi 2007).

Discussion

Tetraclita ehsani sp. n., from Iranian waters, shows diagnostic morphological characters that distinguish it from other known species in the Western Indian Ocean (*T. rufotincta*, *T. reni*, *T. achituvi* and *T. serrata*). All the *Tetraclita* in the West Indian Ocean have white to pink parietes except *T. serrata* Darwin, 1854 which has green parietes. In addition to the colour of the parietes, *T. serrata* has serrated lines on parietes surface and with a broader spur in tergum, when compared to *Tetraclita ehsani*. It is difficult to distinguish *T. ehsani* from *T. reni*, *T. achituvi* and *T. rufotincta* using the external shell morphology. *T. ehsani* can be, however, distinguished from the other species by the tergum morphology and arthropodal characters. The ter-

Table 1. Morphological comparison of *Tetraclita ehsani* sp. n. with other *Tetraclita* from the west Indian Ocean. *T. serrata* was not included into comparison as the shell colour of *T. serrata* is green, which is obviously different from other West Indian Ocean species. For morphology features of *T. rufotincta*, *T. reni* and *T. achituvi*, see Pilsbry (1916), Chan et al. (2009) and Ross (1999).

Characters	***Tetraclita ehsani* sp. n.**	***T. rufotincta* Pilsbry, 1916**	***T. reni* Chan et al., 2009**	***T. achituvi* Ross, 1999**
Shell colour	White to pink	Pink to grey	White to pink	Pink to white
Tergum colour and length	White, twice longer than wide	Yellow to pink, longer than wide (less than twice)	Yellow to pink, longer than wide (less than twice)	White, longer than wide (about twice)
Tergum Spur	Longer than wide (~1.2 times)	Wider than long (~1.2 times)	Wider than long (about twice)	Wider than long (1.5 times)
Basal margin of tergum	Slightly concave with no clear angle	Strongly concave, forming almost right angle	Strongly concave, forming almost right angle	Slightly concave
Adductor muscle pit in scutum	shallow	deep	shallow	deep
Adductor ridge in scutum	Extremely developed, angular and extending to basal margin	Developed but not extending to basal margin	Developed but not extending to basal margin	Extremely developed
Labrum teeth	Four, large, sharp and erect on each side of notch	Absent or four small blunt on cutting margin	Four small blunt teeth at each side of the cutting margin	Six small teeth in notch
Cirrus III	Non-antenniform, without multicuspidate setae	Non-antenniform, without multicuspidate setae	Antenniform, with multicuspidate setae	Antenniform, without multicuspidate setae

gum of *T. ehsani* is very narrow and the basal region is slightly concave or almost straight, contrasting to the tergum of *T. rufotincta* and *T. reni*, which are board and with a strongly concave basal margin (Fig. 1E, F). The basi-carinal angle of *T. ehsani* sp. n. is ~100°, which is larger than that in *T. reni* (80°) and *T. rufotincta* (73°; Fig. 1C, D, E). The basi-scutal angle of the tergum of *T. ehsani* is ~120°, more angular than that of *T. reni* (150 °) (Fig. 1C, D, E; see Chan et al. 2009). Anterior ramus of the cirrus I of both *T. ehsani* and *T. reni* is antenniform, thus differing from *T. rufotincta* (see Chan et al. 2009). Cirrus III *T. ehsani* sp. n. is non-antenniform and lacks multicuspidate setae, which is different from *T. reni*, in which the both anterior and posterior rami are antenniform and possess multicuspidate setae (see Chan et al. 2008) (Table 1).

The biogeography of *Tetraclita* species in the West Indian Ocean appears to be distinctive between different oceanographic systems. *T. rufotincta* has the widest distribution, covering the Persian Gulf, the Red Sea and the East African coast and absent from South Africa and southern Madagascar. *T. reni* is confined to southern Madagascar and adjacent waters and *T. achituvi* has been reported only from the Red Sea. *T.*

ehsani has not been recorded in other parts of the Western Indian Ocean, except from the Iranian coast in the Gulf of Oman and it is absent from the Persian Gulf. It may be possible that *T. ehsani* is common in the Arabian Sea. It is essential to conduct further biodiversity surveys in the Arabian Sea region, including the west coast of India (see Wagh 1972) to ascertain the geographic distribution of *T. ehsani*.

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RESEARCH ARTICLE

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A new genus and species of deep-sea glass sponge (Porifera, Hexactinellida, Aulocalycidae) from the Indian Ocean

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Abstract

New hexactinellid sponges were collected from 2589 m depth on the Carlsberg Ridge in the Indian Ocean during deep-sea dredging. All fragments belong to a new genus and species, *Indiella* **gen. n.** *ridgenensis* **sp. n.**, a representative of the family Aulocalycidae described here. The peculiar features of this sponge, not described earlier for other Aulocalycidae, are: longitudinal strands present in several layers and epirhyses channelization.

Keywords

Porifera, Hexactinellida, Aulocalycidae, glass sponge, new genus, new species, Carlsberg Ridge, Indian Ocean

Introduction

The family Aulocalycidae was established by Ijima (1927) for 5 genera (Fig. 1): *Aulocalyx* Schulze, 1886, *Rhabdodicyum* Schmidt, 1880, *Tretopleura* Ijima, 1927, *Euryplegma* Schulze, 1886 and *Fieldingia* Kent, 1870. One genus *Ijimadyctyum* Mehl, 1992 was

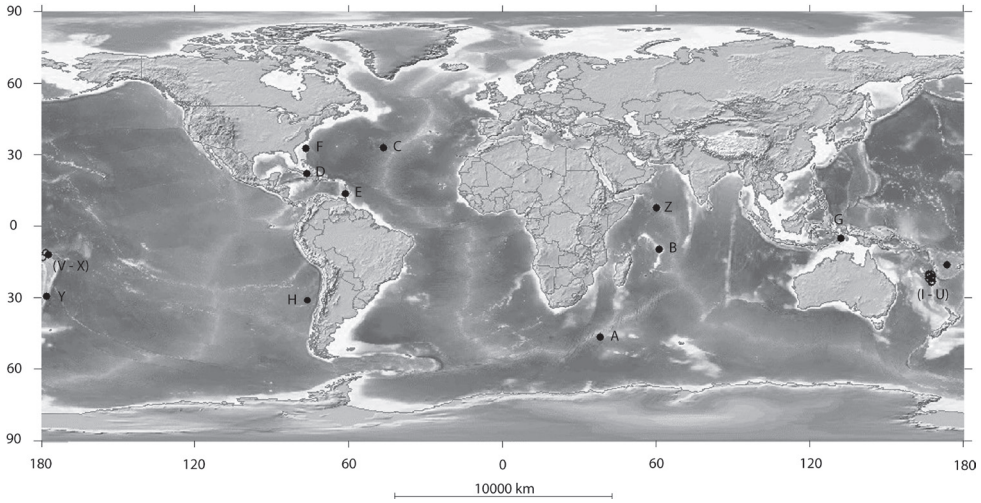

Figure 1. Global distribution of Aulocalycidae including the present study **A** *Aulocalyx irregularis* **B** *Aulocalyx serialis* **C–F** *Rhabdodictyon delicatum* **G** *Ijimadyctyum kurense* **H** *Leioplegma polyphyllon* **I–Y** *Euriplegma auriculare* **Z** *Indiella* gen.n. *ridgenensis* sp.n.

raised from a previously known second species, *Rhabdodicyum kurense* Ijima, 1927. One genus was added later *Leioplegma* Reiswig & Tsurumi, 1996. Tabachnick and Reiswig (2000) ejected two genera: *Tretopleura* and *Fieldingia* form the family and a suggested a new order Aulocalycoida with a single reorganized family. A new subfamily Uncinateriinae with two genera: *Uncinatera*, Topsent, and *Tretopleura* were suggested by Reiswig (2002) as a subdivision of Aulocalycidae together with Aulocalycinae (with the scope and definition of former Aulocalycidae of Tabachnick and Reiswig (2000)). A new subfamily Cyathellinae of the family Aulocalycidae with the only genus *Cyathella* Schmidt, 1870 was suggested by Janussen and Reiswig (2003). The new genus, describing in this paper is a unquestionable representative of the family Aulocalycidae sensu Tabachnick and Reiswig (2000) and subfamily Aulocalycinae *sensu* Reiswig (2002).

Taxonomy

Family Aulocalycidae Ijima, 1927

Indiella gen. n.

urn:lsid:zoobank.org:act:DDD70A14-F35A-4F19-99A1-B58720834CF5
http://species-id.net/wiki/Indiella

Diagnosis. Fan (or funnel)-like basiphytous sponge with thin walls and numerous epirhyses. Framework contains several layers of regular dictyonal strands (mainly from the atrial side) and irregular fused hexactinic spicules (which form a typical aulocaly-

coid skeleton) located among them and from the dermal side. Dermalia and atrialia are pentactins. Microscleres are discohexasters.

Etymology. The name of the genus is derived from its place of collection and refers to the Indian Ocean.

Definition. Aulocalycidae with fan (or funnel)-like body, epirhyses, and several regular layers of dictyonal strands located mainly on the atrial side.

Remarks. It is likely that the body is rather fan-like than cup or funnel-like since the fragments are flat, thus the funnel-like body shape should be of a very large diameter. The original shape of the body is already known in Aulocalycoidae: *Leioplegma* Reiswig &Tsurumi, 1996, while wide funnels are unknown. Basiphytous type of fixation to likely hard substratum is suspected since all other representatives of the family have it. The taxonomic affiliation of genus *Cyathella* (its attribution to the Aulocalycoida, Aulocalycidae with definition of a new subfamily Cyathellinae was made by Janussen and Reiswig 2003), possessing a rhizophytous type of fixation is unique for recent hexactinellids with rigid skeleton.

The walls in the new genus are relatively thick (in comparison with other representatives of the family). Usually the aulocalycoid skeleton is composed of large hexactins located approximately in a single layer, their rays are distributed in a single plane (the distal one and proximal are bent), fusion takes place at points of mutual contact, so the wall thickness includes an only dictyonal layer. The regular dictional strands are observed in *Leioplegma* only, they are present as a single layer of parallel units longitudinally distributed, and irregular aulocalycoid skeleton is situated among them (Reiswig and Tsurumi 1996). The walls in *Euryplegma* appear to be very complicated and their construction has no equivalent interpretation (Tabachnick and Reiswig 2000). *Cyathella* has similar framework construction with several layers of dictyonal strands, but it has no channels and likely no loose spicules.

The presence of epirhyses type of channelization is unique for the family. It is known in Euretidae (Hexactinosida), for instance, in *Chonelasma* (Reiswig & Wheeler, 2002). Among the other types of channelization in Aulocalycoidae, only schizorhyses-like ones are known in *Euryplegma*, meantime as in the case with complicated wall construction, they may be intercavaedia-like constructions between the atrial cavity and numerous small lateral oscula (Tabachnick and Reiswig 2000).

The loose spicules are typical for the family where few species possess scepters and uncinates. A more simplified spicule set is observed in *Heterochone* (Hexactinosida: Euretidae), which has no loose spicules other then discohexasters (Reiswig and Wheeler 2002).

The situation with aulocalycoid, paraulocalycoid and skeleton of *Cyathella*-like construction (Reiswig 2002 b; Janussen and Reiswig 2003) is becoming more complicated after finding in the dictional strands of *Farrea* numerous axial canals (Reiswig 2004), thus the definition of Aulocalycidae into subfamilies seems to be poorly established and the new genus is regarded as a representative of Aulocalycidae.

Type species. *Indiella ridgenensis* sp.n.

***Indiella ridgenensis* sp.n.**
urn:lsid:zoobank.org:act:185CC226-9FF5-42C9-8EA1-999CB8EF1146
http://species-id.net/wiki/Indiella_ridgenensis
Figs 2–4

Etymology. The species name is derived from its type locality, the ridge (Carlsberg Ridge) habitat.

Material examined. Carlsberg Ridge, Indian Ocean: 'Akademic Bois Petrov' station. DR-13, 07°00.466'N, 59°56.295'E, 2589 m, November 2009.

Holotype. NIO/BOD/5-H/2011, stored in ethanol. NIO/SPONGE/DR-13/H, slide, stored in ethanol. IORAS (Institute of Oceanology of Russian Academy of Sciences) 5/2/ NIO/BOD/5-H/2011 (slides).

Paratypes: NIO/BOD/5-P1, NIO/BOD/5-P2, NIO/BOD/5-P3, stored in ethanol. NIO/SPONGE/DR-13/Pi, NIO/SPONGE/DR-13/Pii, NIO/SPONGE/DR-13/Piii, slides. IORAS NIO/BOD/5-P1, NIO/BOD/5-P2, NIO/BOD/5-P3, slides.

Description. Body: The sponge consists of small, lamellate, thin fragments. The holotype is a flat fragment approximately 40×17 mm about 1 mm in thickness (Fig. 2i). Paratypes are similar: Pi is a lamellum 20×25 mm (Fig. 2ii); Pii is 30×20 mm (Fig. 2iii); Piii is 50×45 mm (Fig. 2iv). From the dermal side numerous epirhyses are observed, they are 1.3–1.5 mm (Fig. 4C) in diameter and penetrate about a half of the wall thickness.

Spicules framework is seems to be constructed of different elements: regular, longitudinally directed dictyonal strands, located mostly in the vicinity of the atrial surface (approximately 4 layers) and irregular hexactins fused to each other and to the regular elements at points of mutual contacts, at all levels of the wall thickness. All framework surfaces are covered by very small spines, the free outer ray ends are conically pointed. The dictyonal strands are easily observed, they have diameter 0.09–0.12 mm, beams between the strands are 0.03–0.07 mm in diameter. Free rays of the dictyonal strands are protruded atrially. The meshes between the dictyonal strands and their connecting beams are rather regular, usually rectangular, 0.3–0.5×0.5–0.8 mm. Adjacent hexactinic spicules located among the dictyonal strands are irregularly and sparsely distributed among their meshes, they are connected to the framework by a single ray (small hexactins with rays 0.07–0.12/0.003–0.006 mm) and often at points of mutual contact (large hexactins with rays about 0.5/0.012–0.018 mm). The meshes there are very irregular and of different sizes. The dictyonal strands may be also observed in the vicinity of dermal surface but due to numerous epirhyzes, they are not straight as those from the atrial surface.

Loose spicules: dermal and atrial pentactins are similar to each other, they always have a rudiment about 0.02 mm long instead of the ray directed outside the body, rough surface, their outer ends are clavate, rounded, lanceolate or sometimes conically pointed. Tangential rays of dermal pentactins are 0.102–0.432 mm long (Table 1), the ray directed inside the body is 0.048–0.258 mm long (Table 1), the diameter of these

Figure 2. *Indiella* gen.n. *ridgenensis* sp.n. **A** view from the dermal side **B** view from the atrial side; (i) holotype, (ii) to (iv) paratypes

rays is 0.002–0.009 mm. Tangential rays of atrial pentactins are 0.078–0.372 mm long, ray directed inside the body is 0.036–0.342 mm long (Table 1), the diameter of these rays is 0.004–0.009 mm.

Microscleres are stellate discohexasters only, with 8–14 secondary rays. The diameter of the discohexaster is 0.025–0.046 mm, their primary rosette is 0.006–0.018 mm in diameter (Table 1).

Remarks. Since all these fragments of the holotype and of paratypes were collected from the same station, there is a great probability that they belong to a single specimen.

Table 1. Spicule dimensions of *Indiella* gen. n. *ridgenensis* sp.n. (in mm). L - length, D - diameter, d - diameter of a primary rosette (N = number of observations; Min = minimum; Max = maximum; Avg = average; SD = standard diviations). Bold measurements are used in the text sections.

Type		L Dermal pentactin		L Atrial pentactin		Discohexaster	
		Tangential ray	Ray directed inside body	Tangential ray	Ray directed inside body	D discohexaster	d discohexaster
Holotype	N	25.000	25.000	25.000	25.000	28.000	28.000
	Min	**0.102**	0.060	**0.078**	0.042	**0.025**	**0.006**
	Max	**0.432**	**0.258**	0.360	**0.342**	**0.046**	**0.018**
	Avg	0.280	0.103	0.228	0.100	0.039	0.012
	SD	0.099	0.048	0.081	0.067	0.005	0.003
Paratype-1	N	16.000	16.000	12.000	12.000	14.000	14.000
	Min	0.168	**0.048**	0.108	0.060	0.032	0.009
	Max	0.408	0.180	0.360	0.156	0.042	0.018
	Avg	0.256	0.113	0.264	0.115	0.037	0.012
	SD	0.070	0.049	0.076	0.032	0.003	0.002
Paratype-2	N	7.000	7.000	6.000	6.000	3.000	3.000
	Min	0.240	0.078	0.132	0.048	0.039	0.012
	Max	0.414	0.192	**0.372**	0.114	0.041	0.014
	Avg	0.348	0.127	0.241	0.075	0.040	0.013
	SD	0.060	0.039	0.095	0.023	0.001	0.001
Paratype-3	N	5.000	5.000	4.000	4.000	1.000	1.000
	Min	0.168	0.072	0.150	**0.036**	0.032	0.008
	Max	0.312	0.168	0.240	0.084	0.032	0.008
	Avg	0.252	0.110	0.197	0.066	0.032	0.008
	SD	0.067	0.037	0.038	0.021	-	-

Key to the Genera of Aulocalycidae

1 Dictyonal strands not obvious, likely entirely absent (if present they are distributed chaotically), choanosomal hexactins fuse at points of mutual contacts, their distal and proximal rays are bent in the tangential plane (aulocalycoid skeleton) **2**

– Dictyonal strands present in addition to aulocalycoid skeleton, dictyonal strands are distributed in common, longitudinal direction **5**

2 Body of branching tubes or cup with short lateral tubes..... **3**

– Body fan- or tongue-shape without tubular elements..... ***Euryplegma***

3 With rhopalasters as distinctive microscleres ..... ***Aulocalyx***

– Without rhopalasters **4**

4 Parietal gaps large and closely spaced; wall lace-like..... ***Rhabdodictyum***

– Parietal gaps small, sparse; wall thin and mostly imperforate... ***Ijimadictyum***

5 Walls unchannelized ..... ***Leioplegma***

– Walls channelized by epirhyses..... ***Indiella* gen. n.**

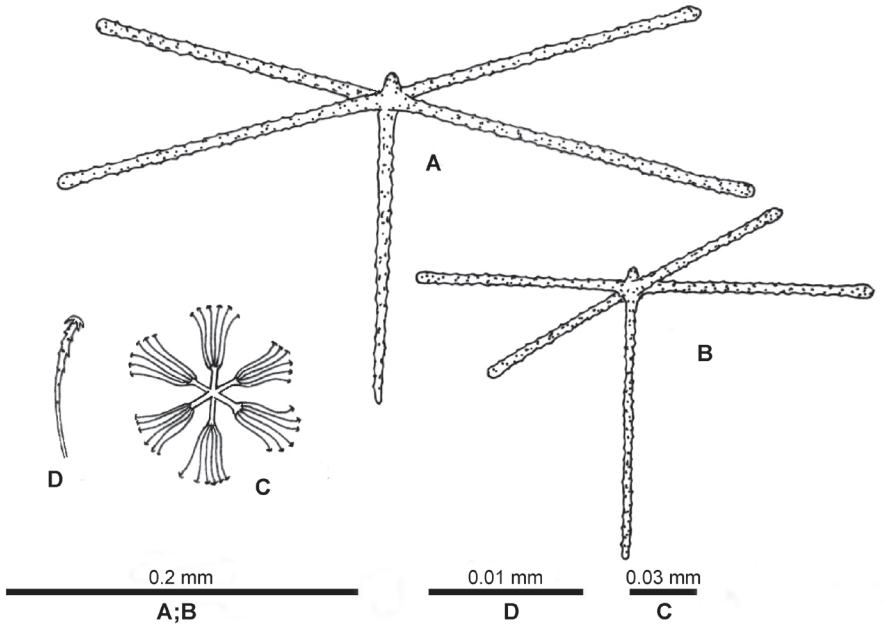

Figure 3. *Indeilla* gen n. *ridgenensis* sp.n. drawings of spicules of the holotypes **A** dermal pentactin **B** atrial pentactin, **C** discohexaster **D** secondary ray of discohexaster

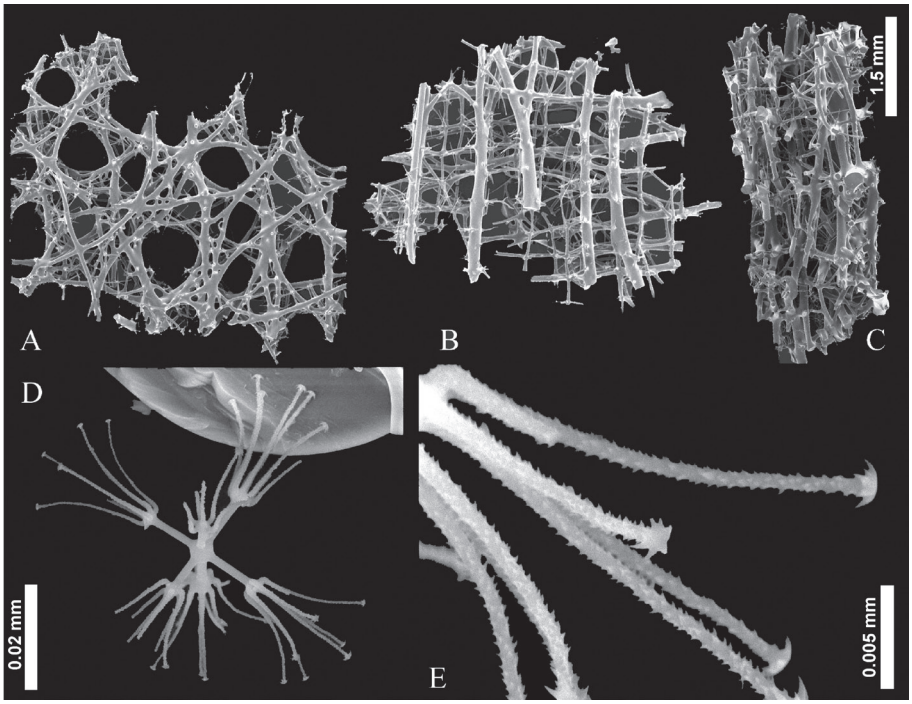

Figure 4. Scaning Electron Microscopy of *Indeilla* gen. n. *ridgenensis* sp. n. Frameowrk and spicules of the holotypes **A** dermal layer **B** atrial layer **C** lateral view **D** discohexaster **E** secondary ray tuft of discohexaster

Remarks. It is not obvious that the genus *Euryplegma* has schizorhyses, as postulated in the key of genera by Reiswig (2002); a possibility of lateral oscula and cavaedia (Tabachnick and Reiswig 2000) cannot be rejected. This newly suggested version of the key to genera of Aulocalycoidae family avoids this problem.

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RESEARCH ARTICLE

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First record of the littoral family Isotogastruridae (Collembola) in Asia

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Abstract

The new species *Isotogastrura trichaetosa* **sp. n.** is described from a sand beach of Hainan, South China. It differs from all its congeners by 3+3 axial setae on Abd. IV (vs. 2+2) and by the presence of a pair of tubercles on Abd.VI. The geography of this strictly littoral genus is discussed.

Keywords

Collembola, Taxonomy, Hainan, China, Tropical area

Introduction

Isotogastruridae Thibaud and Najt 1992 is a small family with well developed prothoracic tergit but without seta, together with many special characters shared with families Isotomidae and Hypogastruridae, and thus have an intermediate position between the orders Poduromorpha and Entomobryomorpha (Thibaud and Najt 1992). It is

generally accepted that Isotogastruridae rather belongs to Poduromorpha although its phylogenetic position is still not fully understood (Fjellberg 1995).

The single genus *Isotogastrura* of this family includes seven species recorded in the Caribbean Islands (*I. arenicola* Thibaud & Najt, 1992), the Canary Islands and Mediterranean (*I. coronata* Fjellberg, 1995; Thibaud and Peja 1996), New Caledonia (*I. litoralis* Thibaud & Weiner, 1997), Mexico (*I. ahuizotli* Palacios-Vargas & Thibaud, 1998, *I. veracruzana* Palacios-Vargas & Thibaud, 1998, *I. atuberculata* Palacios-Vargas & Thibaud, 2001), and Madagascar (*I. madagascariensis* Thibaud, 2008). *I. coronata* was also found in Morocco later (Thibaud and Boumezzough 2006). So far all species have been described from littoral sands of tropical areas (Fig. 10).

In the present paper we describe a new species of Isotogasturidae which was found in sands of Hainan Island (South China) during a joint project between China and Russia investigating the littoral Collembola of the Pacific coast of Asia. So far it is the first record of the family in Asia.

All specimens were mounted on the slide using Hoyer's solution and dried up for three days in an oven at 60°C.

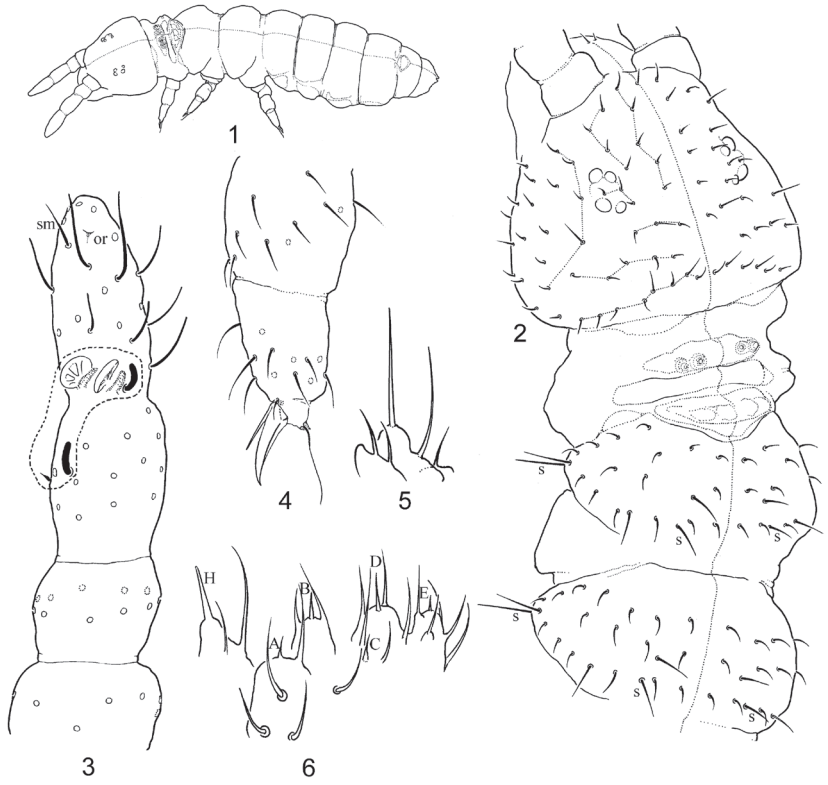
Abbreviations used in the descriptions are: **Th.** thoracic segment; **Abd.** abdominal segment; **Ant.** antennal segment; **Man.** Manubrium; **s** sensillum/a.

Taxonomy

***Isotogastrura trichaetosa* sp. n.**
urn:lsid:zoobank.org:act:A1E1B55F-FA71-4E44-8333-8B94C638A61
http://species-id.net/wiki/Isotogastrura_trichaetosa

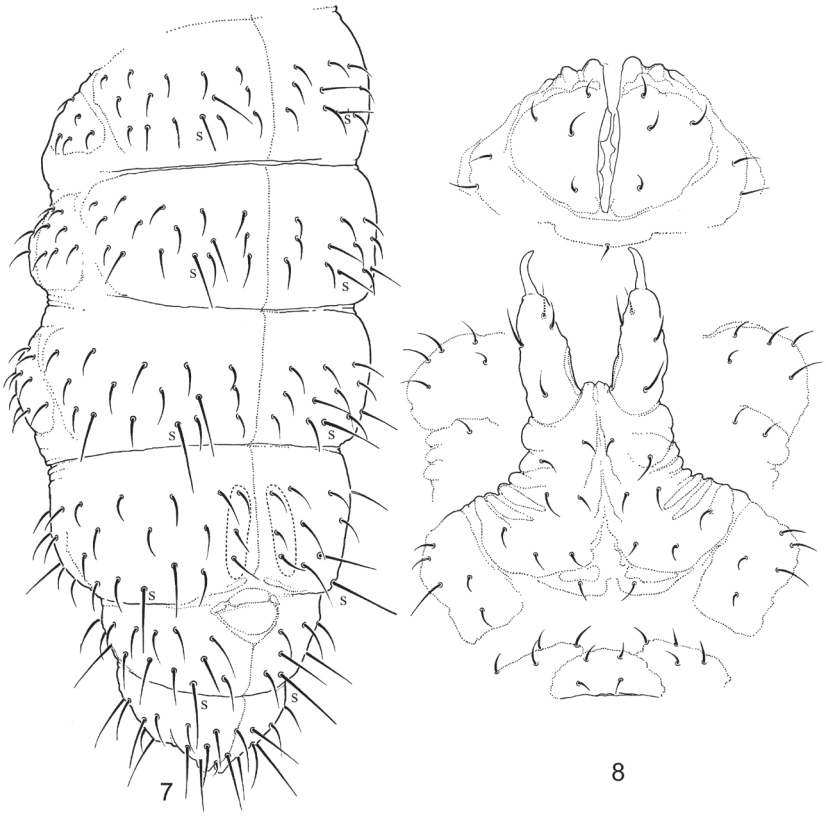
Material. Holotype: Female, South China, Hainan Province (western coast), Changjiang County, vicinity of Changhua town, Qizi Bay, 19°21'12"N, 108°40'25"E, beach, flotation of sand samples (No. 34, 35 and 38). 7. IV. 2011, Y. Bu, C.W. Huang, M.B. Potapov and N. A. Kuznetsova leg. Paratype: Three females, same as holotype. Holotype and two paratypes are deposited in Shanghai Institute of Plant Physiology and Ecology, Shanghai Institutes for Biological Sciences, CAS (China); one paratype is deposited at Moscow State Pedagogical University (Russia).

Description. Body length under slide (n=4): 0.42 mm (range 0.4-0.5 mm), holotype length 0.4 mm. Pale in alcohol, with grey pigmentation uniformly distributed over dorsal areas except for the darker eye patches. Body shape typical of genus, not slender (Fig. 1), without secondary granulation, primary granulation well visible. Head large, with exserted mouth parts as common for the genus (Fig. 2). Ventral side of abdomen wrinkled, especially on manubrium (Fig. 8), which may less visible if the animals are more swollen. Th. I with four dorsal tubercles (Fig. 2). Anterior edge of Abd. V with dorsal glandular opening partly covered by cuticular fold (Fig. 7). One pair of tubercles present at posterior edge of Abd. VI (Fig. 7).



Figures 1–6. *Isotogastrura trichaetosa* sp. n. **1** habitus, **2** head and thorax, **3** antenna (with antennal organ marked), **4** apical part of Leg 2, **5** maxillary outer lobe (apical palp, sublobal hairs and basal seta shown), **6** labial palp. s - sensillum, or - organite, sm - subapical microsensillum.

Ant. I and II with 7 (rarely 6) and 11 (rarely 12) setae, respectively. Antennal organ of Ant. III with two granulated cuticular papillae, two blade-like inner sensilla, and two outer tubular simple sensilla, one of which is grouped together with inner ones, the other one positioned more proximally and associated with lateral sensillum, which is small and pointed (Fig. 3). Ant. IV with several thin sensilla, two of which are longer. Subapical organite small and strongly depressed. Subapical microsensillum absent or, less probably, shaped as other setae of the segment (Fig. 3). Labrum with 10 setae grouped together at distal edge as in other species of the genus. Two prelabral minute setae (Fig. 2). Maxillary outer lobe with bifurcate (simple in one individual) apical palp and two sublobal hairs. Branch of apical palp well detached from the main part (Fig. 5). Labium with 5 basolateral and 4 basomedian setae. 3(2)+3(2) postlabial setae, posterior pair of setae absent or positioned more laterally. Hypostomal lobe of labial palp well developed, with strong and thick seta H (Fig. 6). Some elements of labial palp difficult to interpret: apical palps of all papillae (A, B, C, D, E) present but reduced and never beyond (normally shorter) associated guards, papilla E smallest. At



Figures 7-8. *Isotogastrura trichaetosa* sp. n. **8** dorsal chaetotaxy of abdomen, **9** ventral tube and furcal area (retinaculum not shown).

least 4 proximal setae and 13 guards (possible variation was not studied because limited number of specimens) (Fig. 6). Mandibles slender as typical for the genus. Maxillary head with most lamellae strong and serrated. Head with 4+4 ocelli, two inner smaller. Postantennal organ absent.

Dorsal chaetotaxy shown is in Figs. 2, 7, 8. Th. II-Abd. IV with 3+3 axial setae each. Number of sensilla 2, 2/1,1,1,1,1, microsensilla absent. Sensilla long, with blunt tips, which distinguished from macrosetae. The leg chaetotaxy of subcoxa 1, subcoxa 2, coxa, trochanter, femur, and tibiotarsus is 1,1,4, 6,11,12; 1,3,7, 6,11,12 and 2,3,8-9, 5,10,11 from I to III. Claw and empodium as in Fig. 4, empodium filiform, longer than claw. Thorax without ventral setae. Ventral tube with 6+6 lateral paired setae (4+4 in distal and 2+2 in basal position) and one unpaired posterior seta (Fig. 8). Retinaculum with 3+3 teeth, seta absent. Dens with 1 anterio-median and 3 posterior setae. Manubrium without anterior setae. Posterior side of manubrium with 8+8 setae; subcoxae furcalis with 5+5 setae, (Anterior furcal subcoxa with 5(6), posterior one with 2(1) setae) (Fig. 8). Only females known from the material studied.

Remarks. The new species differs from all congeners by 3+3 axial setae on Abd. IV (vs. 2+2) and by presence of a pair of tubercles on Abd.VI (absent in other species.). *Isotogastrura trichaetosa* sp.n. is the most primitive species of the genus which having more homonomic axial chaetotaxy of abdomen (3,3,3,3) than as common in the genus (3,3,3,2), normal shape of body, and thin sensilla on Ant. IV. Other primitive character, simple (vs. bifurcate) tubular outer sensilla of antennal organ, is shared with *I. coronata* Fjellberg, 1995 (Canary Islands) and *I. madagascariensis* Thibaud, 2008 (Madagascar).

Name derivation. The new species has 3+3 axial setae on Abd. IV (three setae/chaetae).

Distribution and ecology. The species is known only from the type locality. Small body size of *I. trichaetosa* indicates inhabiting narrow passages among the grains of sand. The habitat of other congeners is a fine sand of the upper-littoral zone and thus the genus is ecologically psammobiotic (Thibaud 2007). After the literature data, only *I. coronata* penetrates to higher area of littoral, in coastal sand of dunes with roots of halophytes. The type locality of *I. trichaetosa* sp. n. is an open coastal beach with very fine sand and some small pebbles (the species was only found in pure sand) and was not recorded by us in the zone of halophytes. Sampling site is shown in Fig. 9.

The geography of the genus. The most species of the genus occur between the Tropic of Capricorn and the Tropic of Cancer, except *I. coronata* penetrating to Mediterranean (Fig.10). Our record indicates that *Isotogastrura* is also distributed in the tropical Asia and thus make the genus completely pantropical. Usually, littoral species are distributed widely along the coasts due to transport possibilities by water and similar conditions of the habitat. In Collembola, Thibaud (2007) remarked many species from interstitial littoral sands having all a trans-oceanic distribution. High ability of water dispersal was not experimentally confirmed for these species but so was done by Coulson et al. (2002) in five species of Collembola distributed in Arctic. In other groups, littoral species distributed widely along the sea coast are also well known (Chernov 1997), for instance seaweed and beach flies *Coelopa frigida* (Fabricius, 1805) and *Fucellia maritima* (Haliday, 1838). Contrary to this trend the genus *Isotogastrura* so far shows the considerable geographical segregation of locally distributed species.

Acknowledgements

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Figure 9. Type locality in Qizi Bay (Southeast China), ★ indicates the sample site.

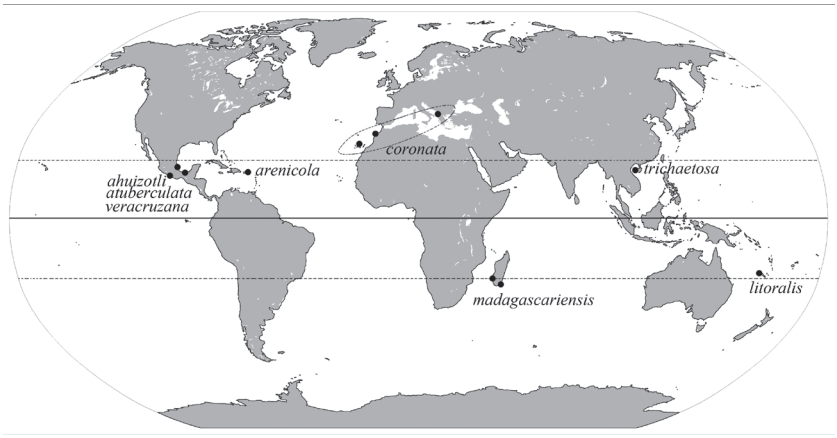

Figure 10. The records of the species of genus *Isotogastrura*

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RESEARCH ARTICLE

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The genus *Ectonura* Cassagnau, 1980 in South Africa (Collembola, Neanuridae, Neanurinae), with a key to South African Neanurinae

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Abstract

Two new species of Neanurinae (Collembola) are described from the Western Cape, South Africa: *Ectonura monochaeta* **sp. n.** and *Ectonura barrai* **sp. n.** *E. monochaeta* **sp. n.** differs from other species in the genus by its strongly reduced chaetotaxy, and the lateral shift of dorso-internal chaetae on Abd. V and their integration in the tubercles (De+DL). *E. barrai* **sp. n.** is similar to *E. natalensis* (Womersley, 1934), but differs in chaetotaxic details and chaetal group arrangement. A key to the seven species of Neanurinae recorded from South Africa is given.

Keywords

Taxonomy, new species, Western Cape, Fynbos

Introduction

Neanurinae Collembola are represented in tropical Africa by a large number of species in the tribe Paleonurini, and a single representative of the tribe Neanurini, the parthenogenetic species *Neanura muscorum* (Templeton, 1835). However, only a few areas have been sampled outside the mountain ranges of Eastern Africa (Cassagnau 1991, 1996, 2000; Weiner and Najt 1998). In South Africa, only three genera and five species of Neanurinae have been recorded so far (Fig. 1): *Neanura* MacGillivray, 1893 with *N. muscorum*; *Vitronura* Yosii, 1969 with *V. joanna* (Coates, 1968), and *Ectonura* Cassagnau, 1980 with *E. natalensis* (Womersley, 1934), *E. oribiensis* (Coates, 1968) and *E. coatesi* Barra, 1994. *N. muscorum* has been probably introduced from Europe, where all other species of the genus *Neanura* occur. The genus *Vitronura*, diversified in China, Sunda and western Pacific islands, has a single widespread species, *V. giselae* (Gisin, 1950), that occurs both in the tropics and in gardens in Europe. Therefore, the presence of another distinct species isolated in South Africa requires confirmation, as *V. joanna* is morphologically very close to *V. giselae*. The genus *Ectonura*, limited to South Africa in the African continent, includes the only Neanurinae unambiguously native of South Africa; the genus is otherwise present in New Caledonia with 11 species (Deharveng and Bedos 2002), and an undescribed species is recorded from South Australia by Greenslade and Deharveng (1991).

Among the large amount of samples recently collected in the Western Cape Province in the frame of the Franco-South African PROTEA project "Uncovering Springtail Diversity in the South African Cape Floristic Region: a combined taxonomic and barcoding approach", we retrieved representatives of the three cited genera, including new *Ectonura* species, as well as a single species of a fourth genus, *Paleonura* Cassagnau, 1982. This confirms that South Africa fauna of Neanurinae is particularly poor, com-

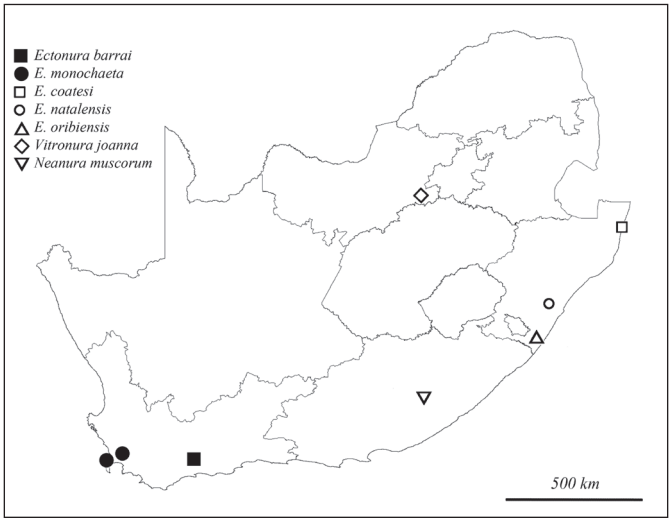

Figure 1. Distribution of Neanurinae recorded from South Africa.

pared to that of East African mountains or Madagascar (Cassagnau 1996, 2000), or other gondwanian territories such as Australia (Greenslade and Deharveng 1991). Its richness in Neanurinae is actually similar to that of southern America subtemperate areas, where *N. muscorum* also occurs, together with a few endemic *Paleonura* (Cassagnau and Oliveira 1990).

Ectonura is therefore the most diversified genus of Neanurinae in southern Africa. Several undescribed species were present in our samples, mostly as isolated specimens. Two of them were collected in sufficient number and are described in this paper: *Ectonura monochaeta* sp. n. from Table Mountain and *Ectonura barrai* sp. n. from Grootvadersbosch, both located in the Western Cape Province.

Abbreviations used

Type deposit – **IM**, Iziko Museum (Cape Town, South Africa); **MNHN**, Museum National d'Histoire Naturelle (Paris, France).

Chaetal arrangement and notation follow Deharveng (1983) and Smolis (2008). Abbreviations used in species descriptions and tables:

Tubercles and chaetal groups – **Af**, antenno-frontal; **CL**, clypeal; **De**, dorso-external; **Di**, dorso-internal; **DL**, dorso-lateral; **L**, lateral; **Oc**, ocular; **So**, subocular; **VL**, ventro-lateral; **Ve**, ventro-external; **Vi**, ventro-internal; **Ag**, antegenital; **An**, anal.

Appendages – **Cx**, coxa; **Fe**, femur; **Fu**, furcal rest; **Scx2**, subcoxa 2; **Tita**, tibiotarsus; **Tr**, trochanter; **VT**, ventral tube.

Types of chaetae – **M**, macrochaeta; **me**, mesochaeta; **mi**, microchaeta; **S**, S-chaeta ("sensillum" *auct.*) ; **ms**, s-microchaeta.

Others – **omma**, ommatidia; **Abd.**, abdominal segment; **Ant.**, antennal segment; **Th.**, thoracic segment.

Key to South African species of Neanurinae

1 Three eyes on each side of the head, body bluish in colour ..... ***Neanura muscorum* (Templeton, 1835)** (temperate cosmopolite)

– Two eyes on each side of the head, body not blue **2**

2 Central area of head with 3 tubercles ..... ***Vitronura joanna* (Coates, 1968)** (uncertain status)

– Central area of head with 2 tubercles ..... ***Ectonura* 3**

3 Dorso-internal tubercle of tergites from Th. II to Abd. IV with at least two chaetae **4**

– Dorso-internal tubercle of tergites with one chaeta from Th. II to Abd. IV ... . ***E. monochaeta* sp. n.**

4 Chaeta A absent on head **5**

– Chaeta A present on head **6**

5* Modified chaetae Ag on Abd. V of the male much shorter than lateral Ag, very thick, truncated, apically ciliated..... ***E. oribiensis*** **(Coates, 1968)** (endemic)

– Modified chaetae Ag on Abd. V of the male as long as lateral Ag, thin, pointed, with several unequal distal cilia .....***E. coatesi*** **Barra, 1994** (endemic)

6 Five chaetae on each central group of chaetae on head (1/2Af+Oc), chaeta D absent; one chaeta Di on Abd. V (Di2 absent); tubercles Di of Abd. V fused on axis .....***E. natalensis*** **(Womersley, 1934)** (endemic)

– Six chaetae on each central group of chaetae on head (1/2Af+Oc), chaeta D present; two chaetae Di on Abd. V (Di2 present); tubercles Di of Abd. V separate..... ***E. barrai*** **sp. n.**

* The only differential character separating unambiguously *E. coatesi* from *E. oribiensis* is the morphology of modified chaetae Ag in the male.

Taxonomy

Ectonura **Cassagnau, 1980**
Type species: *Achorutes natalensis* Womersley, 1934 (Natal, South Africa)

Ectonura monochaeta **sp. n.**
urn:lsid:zoobank.org:act:FBCFC562-E830-4085-B711-3BCF1F4758DD
http://species-id.net/wiki/Ectonura_monochaeta
Figs 2–3, Table 1

Type material. Holotype female on slide. South Africa: Western Cape, Cape Town, Table Mountain National Park, 10/03/2009, native broadleaved forest, sieving of litter and extraction on Berlese funnel, Louis Deharveng and Anne Bedos leg (SAF-141).

8 paratypes on slides (3 males, 4 females, 1 juvenile) and more than 50 in alcohol, same data as holotype — 1 male on slide, ibid, Table Mountain, collapse of New Year cave system, 07/03/2009, native forest, litter, Berlese extraction, Louis Deharveng and Anne Bedos leg (SAF-129) — 1 male and 1 female on slides, ibid, Table Mountain, in a collapse, 10/03/2009, native forest, soil, Berlese extraction, Louis Deharveng and Anne Bedos leg (SAF-139) — 1 male and 1 female on slides, 5 specimens in alcohol, ibid, Table Mountain, Inchuk cave entrance, 10/03/2009, native forest, litter, Berlese extraction, Louis Deharveng and Anne Bedos leg (SAF-144).

Type deposition. Holotype, 6 paratypes on slides (3 males, 3 females) and 25 paratypes in alcohol in IM; 7 paratypes on slides (3 males, 3 females, 1 juv.) and 25 paratypes in alcohol in MNHN.

Non-type material. 1 male on slide, 7 specimens in alcohol. South Africa: Western Cape, Stellenbosch, Jonkershoek Nature Reserve, Sosys trail, 12/03/2008, forest litter, Berlese extraction, Louis Deharveng and Anne Bedos leg (SAF-071) — 1 juvenile and 2 females on slides, ibid, Jonkershoek Nature Reserve, Sosys trail, 12/08/2010, litter, Charlene Janion leg (RSA10_JNK026 and RSA10_JNK032, 33°59.758'S,

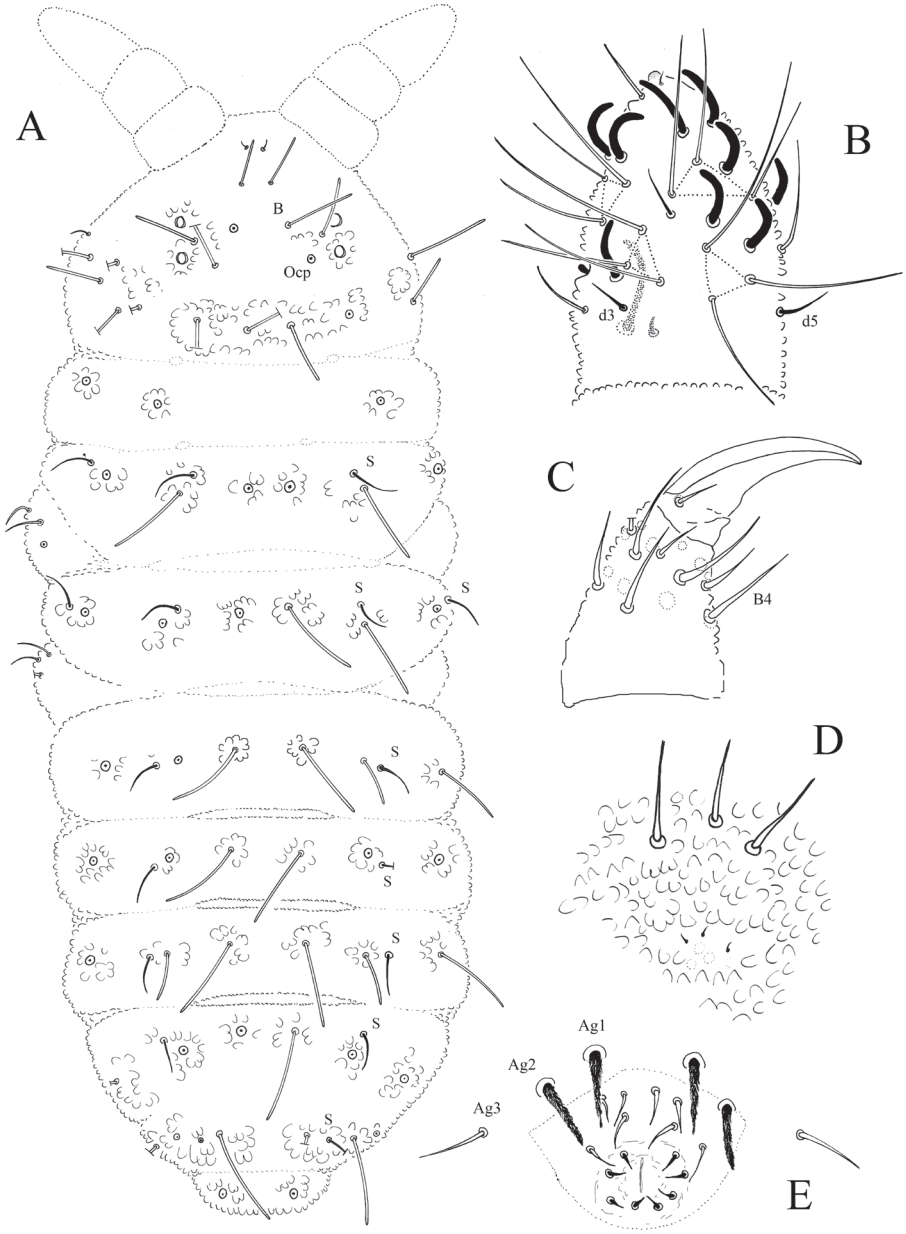

Figure 2. *Ectonura monochaeta* sp. n.; **A** dorsal chaetotaxy **B** Ant. III-IV dorsal side **C** tibiotarsus and praetarsus of leg I **D** furcal rest **E** male genital area.

18°57.156'E) — 1 male, 1 female and 1 juvenile on slides, about 130 in alcohol, ibid, Fish Hoek, Kalk Bay, Echo Valley forest, 05/11/2010, decaying wood of yellowwood, Berlese extraction, Louis Deharveng and Anne Bedos leg (SAF-196).

Table 1. Chaetotaxy of *Ectonura monochaeta* sp. n.

A-Cephalic chaetotaxy				
Group of chaetae	**Tubercle**	**Number of chaetae**	**Type of chaetae**	**Chaetae**
CL	(-)	2	M	F
		2	me	G
1/2Af+Oc	(+)	3	M	B, Ocm, Ocp
2Di, 2De	(+)	2+2	M	Di1, De1
DL, L, So	(-)	5	M	DL1, DL5, L1, L4, So1
		4	me	So3 to 6

B-Tergite chaetotaxy				
	Di	**De**	**DL**	**L**
Th. I	-	1	1	-
Th. II	1	1+S	1+S+ms	3
Th. III	1	1+S	1+S	3
Abd. I	1	1+S	1	2
Abd. II	1	1+S	1	2
Abd. III	1	1+S	1	2
Abd. IV	1	1+S	1	5
Abd. V	3+S			2
Abd. VI	6*			

C-Leg chaetotaxy					
	Scx2	**Cx**	**Tr**	**Fe**	**Tita**
Leg I	0	3	6	13	18
Leg II	2	7	6	12	18
Leg III	2	8	6	11	17

D-Sternite chaetotaxy		
Abd. I	VT: 4	
Abd. II	Ve: 4	(Ve1 present)
Abd. III	Ve: 3	Fu: 3-5me+3mi
Abd. IV	Ve: 7	VL: 4
Abd. V	Ag: 3	VL: 1, with L
Abd. VI	Ve: 12-13	An: 2 mi

*the ventralmost pair of chaetae is replaced by a unique uneven chaeta in some specimens

Description. Length 0.82 – 1.1 mm (males) and 0.75 – 0.85 mm (females). Colour white in alcohol, yellow alive (SAF-196 sample). Eyes 2+2, unpigmented, small (diameter about 1.5–1.8 times that of Ocm socket, Fig. 3A). Habitus similar to *Paleonura* (Fig. 2A). No cryptopygy. Secondary granules rather large (the size of a mesochaeta socket). Dorsal tubercles visible but poorly delimited except on Abd. V-VI, indicated by secondary granules enlarged and irregularly arranged, without clearly developed tertiary granules. No reticulations. No plurichaetosis. Most ordinary dorsal chaetae are macrochaetae of similar length and morphol-

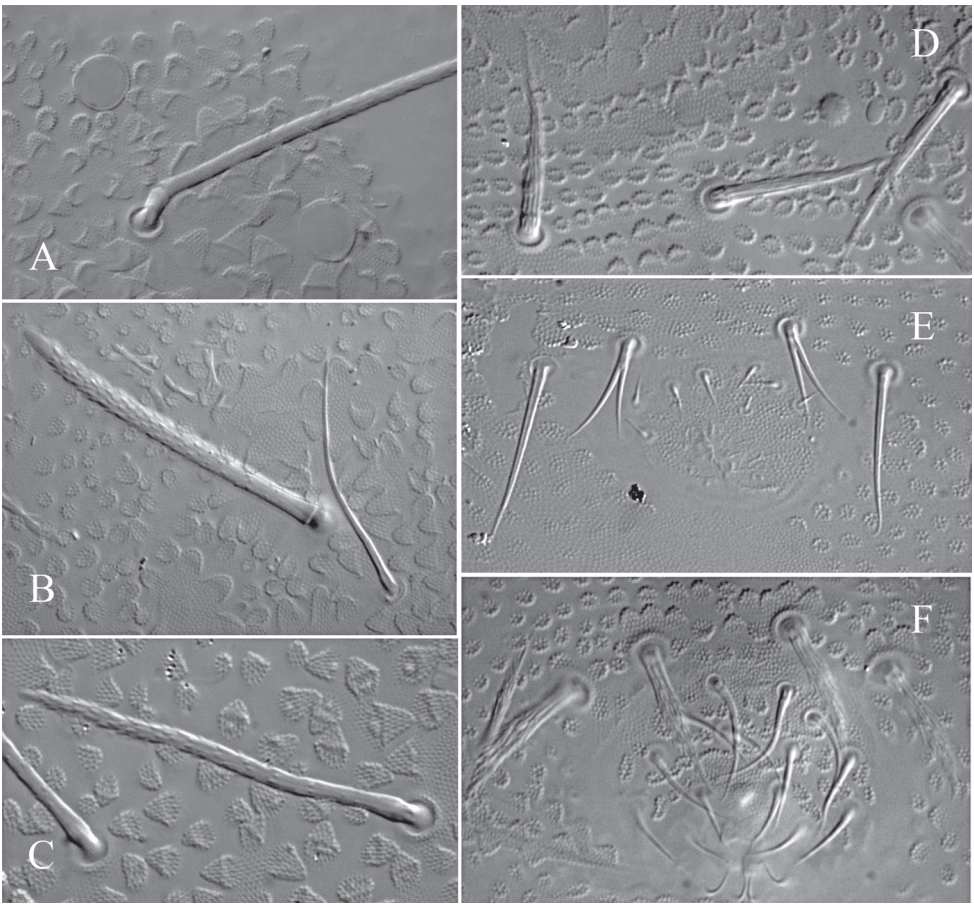

Figure 3. *Ectonura monochaeta* sp. n.; **A** Ocular plate with macrochaeta Ocm **B** macrochaeta De1 on Th. II **C** chaeta B on head **D** chaetae Ve posterior of Abd. IV in a paratype male adult **E** genital plate of a male juvenile from Jonkershoek **F** genital plate of a male adult.

ogy, basally swollen, straight, cylindrical, long, thick, covered in their 2/3 distal of numerous minute scales, distally sheathed, rounded apically (Figs 2A, 3A, B, C). Some dorsal mesochaetae shorter, bent, acuminate, smooth or weakly rugose on the lateral area of head, on tubercles L of tergites and on Abd. VI. No dorsal microchaetae. S-chaetae thin, 2/3 as long as or slightly shorter than closest macrochaeta (Figs 2A, 3B).

Ant. I with 7 chaetae, Ant. II with 11 chaetae, Ant. III with 16 or 17 chaetae (chaetae d4 and d5 or only d4 absent). Ant. IV organite as a short thick rod; apical bulb simple, low and fused to Ant. IV tip (Fig. 2B). Buccal cone moderately elongated. Maxilla styliform, mandible thin and bidentate with distal tooth subdivided in 2 or 3 minute cilia. Labrum elongate, rounded apically, with ventral sclerifications arc-like. Labral formula 0/2,4. Labium with 4 basal, 3 distal and 3 lateral chaetae, and 2 minute sphaerical x papillae (as in *E. barrai* sp. n., Fig. 5B).

Head chaetotaxy as in Table 1A and Fig. 2A. Head with 6 chaetal groups: CL, 2 (½ Af + Oc), (2 Di, 2 De), 2 (DL, L, So). Central area with B, F, G, Ocm and Ocp. Macrochaeta Ocm internal to ocular line, equally distant to omma or slightly closer to anterior omma; Ocp macrochaeta internal to and at level of posterior omma; Oca absent (Fig. 3A). Posterior area with a very faint tubercle and only 2+2 macrochaetae (Di1 and De1). Five chaetae Vi ventrally on head (Vi5 absent).

Tergite chaetotaxy as in Table 1B and Fig. 2A. Chaeta Di absent on Th. I. Tubercles De and DL separate on Abd. IV. Tubercle L of Abd. IV shift ahead the tubercle line Di-De-DL. Tubercles Di, De and DL fused on Abd. V on each side of axis. Tubercle Di of Abd. V with Di1 macrochaeta, Di2 and Di3 absent. Abd. VI not or hardly bilobed, with strong secondary granules, present even on the axis. S-chaetotaxic formula: 2+ms, 2/11111. Ventral chaetotaxy similar to that of *E. barrai* sp. n., except the furcal rest in some specimens (Fig. 4C). Secondary sexual characters well developed in the adult male consists of chaetae Ag1 and Ag2 of Abd. V strongly thickened and serrated (Figs 2E, 3F), and chaetae of furcal rest, some Ve of Abd. IV (Fig. 3D), sometimes Ag3 of Abd. V (Fig. 3F), and 3+3 Ve of Abd. VI serrated but less strongly. In a male juvenile from Jonkershoek, chaetae Ag1 were bifid (Fig. 3E).

Microchaetae of furcal rest smaller than secondary granules, often unconspicuous (Fig. 2D). Leg chaetotaxy given in Table 1C. Tita without chaeta M and with chaetae B4-B5 short, not longer than other long chaetae of Tita (Fig. 2C). Claw untoothed, not striated in its basal part, and devoid of secondary granulation.

Derivatio nominis. The species name refers to its reduced chaetotaxy of dorso-internal tubercles of tergites, which bear only one chaeta from Th. II to Abd. IV (2 or 3 in other species of the genus).

Ecology. All known localities of *Ectonura monochaeta* sp. n. belong to the Southern Afrotemperate Forest vegetation type. The species is common in this habitat, typically found in the Western Cape, but absent in shrub formations of the fynbos. The distribution ranges from Table Mountain National Park to Jonkershoek Nature Reserve, Stellenbosch. The species is mixed in Stellenbosch with another undescribed species of *Ectonura*.

Discussion. The new species *Ectonura monochaeta* is unique in the genus by the lateral shift of dorso-internal chaetae on Abd. V and their integration in the tubercles (De+DL). Such a lateral shift is only know in *Ectonura paralata* Deharveng, Weiner & Najt, 1997 from New Caledonia, but less marked and without integration of Di chaetae in (De+DL). By other chaetotaxic characters (Di2 and De2 present on head and on tergites of Th. II-Abd. IV; D, E, OcA present on head) and tubercle arrangement (tubercle Di not developed, others as large flat plates), *E. paralata* is however only remotely related to our species. *E. monochaeta* is also distinct from other species of the genus *Ectonura* by the strong reduction of its chaetotaxy: absence of several chaetae on head (A, O, C, D, E, Oca), absence of Di2, De2 and DL2 on tergites, only 2+2 dorsal chaetae on Th. I, and only 6+6 chaetae on Abd. VI.

The lateral shift of Di on Abd. V is one of the characteristic feature of two genera, the monotypic genus *Zelandanura* Deharveng & Wise, 1991 from Campbell Island

and *Pronura* Delamare Debouteville, 1953 which is highly diversified in Africa and in Asia. *Zelandanura* differs from *Ectonura* by the fusion in one plate of all tubercles of the central area of head, and by the fusion of Di tubercles on the axis on Abd. IV. Contrary to *Ectonura*, chaetae of the central area of head are not separated in two groups on both side of the axis in *Pronura*.

***Ectonura barrai* sp. n.**
urn:lsid:zoobank.org:act:E0C421EE-4014-41F9-9A71-F23C8A7A6AEB
http://species-id.net/wiki/Ectonura_barrai
Figs 4–6, Table 2

Type material. Holotype male on slide. South Africa: Western Cape, Grootvadersbosch Nature Reserve, Heidelberg, 24/08/2010, Southern Afrotemperate Forest vegetation, in litter, extraction on Berlese funnel, Charlene Janion leg (RSA10_GVB009, 33°59.167'S, 20°48.639'E).

1 male paratype on slide, same data as holotype — 2 paratypes on slides (1 male, 2 juveniles) and 5 paratypes in alcohol, ibid, Grootvadersbosch Nature Reserve, Heidelberg, 24/08/2010, same habitat, extraction on Berlese funnel, Charlene Janion leg (RSA10_GVB008, 33°58.964'S, 20°48.524'E)

Type deposition. Holotype and 4 paratypes (1 male and 1 juvenile on slides, 2 in alcohol) in IM; 5 paratypes (1 male and 1 juvenile on slides, 3 in alcohol) in MNHN.

Description. Length 1.1–1.3 mm (males). Colour white in alcohol. Eyes 2+2, unpigmented, rather large (diameter about 3 times that of Ocm socket, Fig. 5A). Habitus similar to *Paleonura* (Fig. 4A). No cryptopygy. Secondary granules rather large (the size of a mesochaeta socket). Dorsal tubercles not clearly delimited, only indicated by secondary granules irregularly arranged, without tertiary granules. No reticulations. No plurichaetosis. Ordinary dorsal chaetae differentiated in macrochaetae, mesochaetae and microchaetae (Figs 4A, 6). Dorsal macrochaetae basally swollen, straight or slightly bent, subcylindrical, long, moderately thick, with minute scales sparsed apparently unilaterally, in their distal half, distally sheathed, rounded apically (Figs 5C, D, 6). Dorsal mesochaetae shorter, acuminate to blunt, smooth or weakly rugose. Dorsal microchaetae thin, smooth, less than 1/5 of macrochaetae, present on all tergites (Di2 from Th. II to Abd. V, De3 on Th. II-III, and De2 on Abd. I-V). S-chaetae thin, smooth, acuminate, 2/3 as long as or slightly shorter than closest macrochaeta (Figs 5C, 6).

Ant. I with 7 chaetae, Ant. II with 11 chaetae, Ant. III with 18 chaetae (chaetae d4 and d5 present). Ant. IV organite as a very short thick rod; apical bulb feebly trilobed, fused to Ant. IV tip (Fig. 4B). Buccal cone moderately elongated. Maxilla styliform, mandible thin and bidentate with distal tooth subdivided in 2 or 3 minute cilia. Labrum elongate, rounded and finely denticulated apically, with ventral sclerifications arc-like distally. Labral formula 0/2,4. Labium with 4 basal, 3 distal and 3 lateral chaetae, and 2 minute sphaerical x papillae (Fig. 5B).

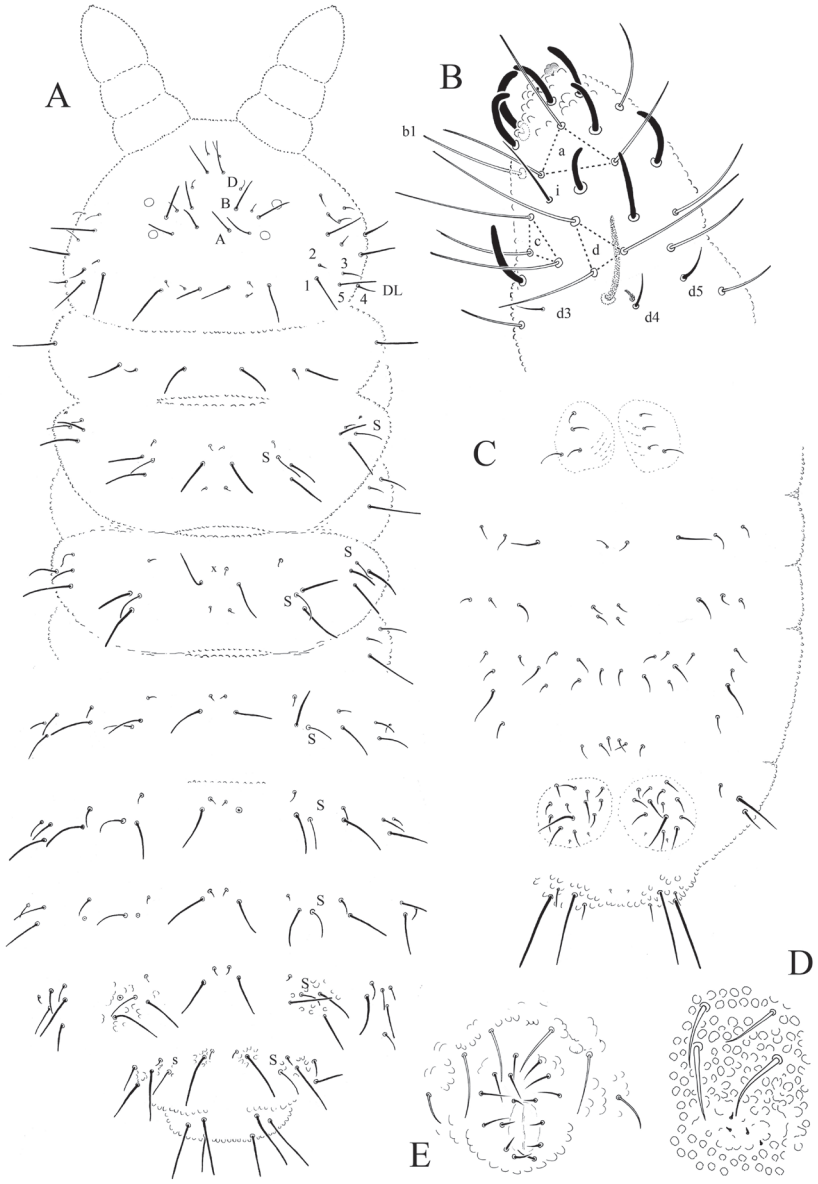

Figure 4. *Ectonura barrai* sp. n.; **A** dorsal chaetotaxy (tubercles not represented except on Abd. IV-V; x, chaeta Di2 absent unilaterally on Th. III) **B** Ant. III-IV dorsal side **C** ventral chaetotaxy of abdomen **D** Furcal rest **E** male genital plate.

Head chaetotaxy as in Table 2A and Fig. 4A. Head with 9 chaetal groups: CL, 2 (½ Af + Oc), 2 DL, 2 (L, So), 2 (Di, De) on very faint tubercles hardly separated on axis. Central area with A, B, D, F, G, Oca, Ocm and Ocp (alternatively, Oca might be homologous of chaeta E). Macrochaeta Ocm internal to ocular line, equally distant

Table 2. Chaetotaxy of *Ectonura barrai* sp. n.

A-Cephalic chaetotaxy				
Group of chaetae	**Tubercle**	**Number of chaetae**	**Type of chaetae**	**Chaetae**
CL	(-)	2	M	F
		2	me	G
1/2Af+Oc	(+)	4	M	A, B, Ocm, Ocp
		2	me	D, Oca
Di, De	(+)	2	M	Di1, De1
		2	mi	Di2, De2
DL	(+)	2	M	DL1, DL5
		2	me	DL3, DL4
		1	mi	DL2
L, So	(-)	3	M	L1, L4, So1
		5	me	L2, So3 to 6

B-Tergite chaetotaxy				
	Di	**De**	**DL**	**L**
Th. I	1	2	1	-
Th. II	2-3	3+S	3+S+ms	3
Th. III	2-3	3+S	3+S	3
Abd. I	2	2+S	2	3
Abd. II	2	2+S	2	3
Abd. III	2	2+S	2	3-4
Abd. IV	2	4+S		6
Abd. V	2	4+S		3
Abd. VI	7			

C-Leg chaetotaxy					
	Scx2	**Cx**	**Tr**	**Fe**	**Tita**
Leg I	0	3	6	13	18
Leg II	2	7	6	12	18
Leg III	2	8	6	11	17

D-Sternite chaetotaxy		
Abd. I	VT: 4	
Abd. II	Ve: 4	(Ve1 present)
Abd. III	Ve: 3	Fu: 4me+4mi
Abd. IV	Ve: 7	VL: 4
Abd. V	Ag: 3	VL: 1, with L
Abd. VI	Ve: 12-13	An: 2 mi*

* those of upper valve shift close to the chaetae of Abd. VI

from omma; Ocp macrochaeta internal to and at level of posterior omma; Oca antero-internal to Ocm (Fig. 5A). Five chaetae Vi ventrally on head (Vi5 absent).

Tergite chaetotaxy as in Table 2B and Figs 4A and 6. Chaeta Di present on Th. I. Tubercles De and DL fused on Abd. IV. Tubercle L of Abd. IV slightly shift ahead the

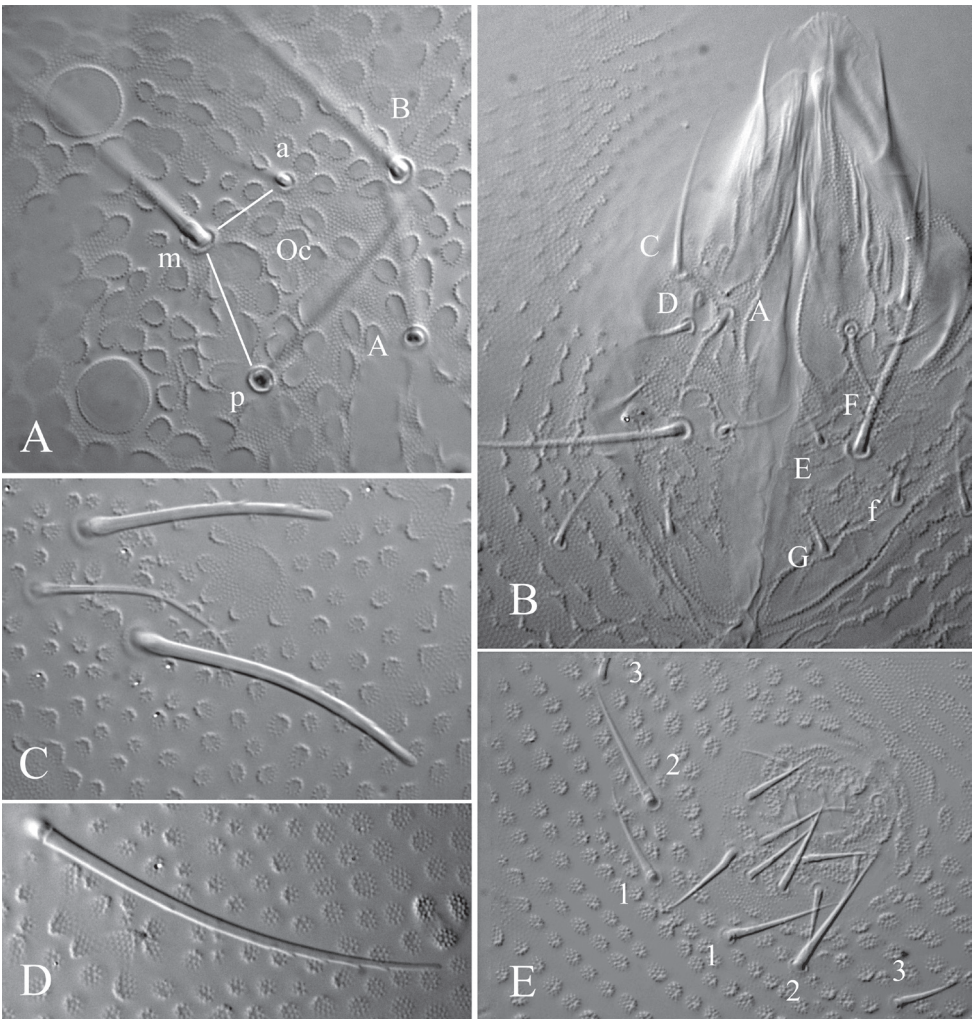

Figure 5. *Ectonura barrai* sp. n.; **A** ocular plate **B** Labium **C** chaetal group De on Th. III (without the De3 microchaeta) **D** macrochaeta DL on Abd. I **E** male genital plate.

tubercle line Di-De-DL. Tubercles De and DL fused on Abd. V, separated from Di. Tubercle Di of Abd. V with Di1 macrochaeta, Di2 microchaeta and Di3 absent. Abd. VI not or hardly bilobed, with 1+1 areas of slightly enlarged and irregularly arranged secondary granules. S-chaetotaxic formula: 2+ms, 2/11111. No modified chaetae in male (Figs 4E, 5E).

Microchaetae of furcal rest minute and thick, smaller than secondary granules (Fig. 4D). Leg chaetotaxy given in Table 2C, similar to that of *E. monochaeta* sp. n. (Fig. 2C). Tita without chaeta M and with chaetae B4-B5 short, not longer than other long chaetae of Tita. Claw untoothed, not striated in its basal part, and devoid of secondary granulation.

Derivatio nominis. This species is named in honour of Jean-Auguste Barra, for his important contribution to the knowledge of South African Collembola.

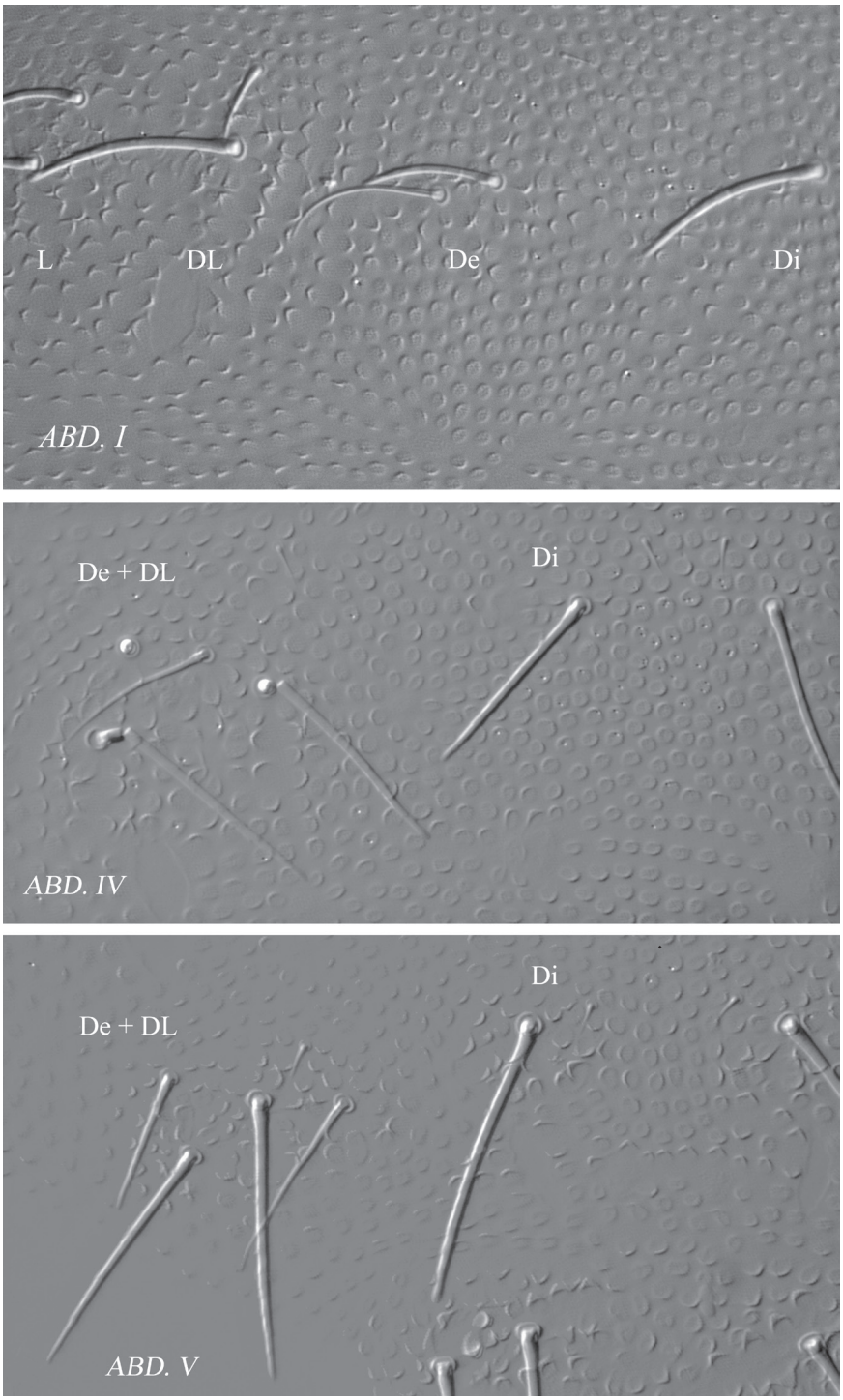

Figure 6. *Ectonura barrai* sp. n.; chaetal groups and faint tubercles Di, De and DL on Abd I, Abd. IV and Abd. V.

Ecology. This species was collected in the yellowwood forest leaf litter of Grootvadersbosch Nature Reserve. This is a remnant forest of the larger Tsitsikamma Forest Reserve situated 300 km to the south. The forest consists of indigenous trees such as yellowwood, ironwood and stinkwood.

Discussion. *Ectonura barrai* sp. n. is similar to *E. natalensis* in its relatively complete chaetotaxy, but different in several details of chaetal arrangement. Based on the redescription of Coates (1968), *E. natalensis* has a more reduced chaetotaxy than *E. barrai* sp. n.: absence of meso/microchaetae D, Di2 and De2 on head, absence of De2 on Th. I, absence of De3 and DL3 on Th. II-III, absence of Di2 on Abd IV-V. Conversely, chaetae Di2, De2 and DL2 on Abd. I-III of *E. natalensis* are much larger than homologous chaetae of *E. barrai* sp. n. (macrochaetae or large mesochaetae versus short mesochaetae). Chaetal groups De and DL of Abd. IV are separate in *E. natalensis* versus fused in *E. barrai* sp. n., and chaetal groups Di of Abd. V are fused on axis in *E. natalensis* versus separate in *E. barrai* sp. n. The unusual arrangement of S-chaetae on Ant. IV figured by Coates (1968) is probably an erroneous interpretation, and not considered here as a valid differential character.

Acknowledgements

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RESEARCH ARTICLE

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Larvae and a new species of *Ancyronyx* Erichson, 1847 (Insecta, Coleoptera, Elmidae) from Palawan, Philippines, using DNA sequences for the assignment of the developmental stages

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Abstract

Ancyronyx montanus **sp. n.** is described based on adults and larvae, matched using their *cox1* DNA sequence data. Larvae of six additional species of *Ancyronyx* Erichson, 1847 were also described here for the first time, aided by *cox1* or *cob* data: *A. helgeschneideri* Freitag & Jäch, 2007, *A. minerva* Freitag & Jäch, 2007, *A. patrolus* Freitag & Jäch, 2007, *A. procerus* Jäch, 1994, *A. punkti* Freitag & Jäch, 2007, *A. pseudopatrolus* Freitag & Jäch, 2007. *Ancyronyx procerus* is newly recorded from the Philippines by a larval specimen from Busuanga island. The new species and larval stages are described in detail and illustrated by digital and SEM images. A key to the *Ancyronyx* larvae of Palawan and an updated checklist of Philippine *Ancyronyx* is provided.

Keywords

Ancyronyx, larva, *cox1*, DNA barcoding, new species, taxonomy, AQUA Palawana, Spider Water Beetle, Elmidae

Introduction

The genus *Ancyronyx,* usually referred to as spider water beetle, belongs to the predominantly aquatic riffle beetle family Elmidae Curtis, 1830 (Coleoptera), subfamily Elminae Curtis, 1830. Ancyronychini Ganglbauer, 1904 has been erected exclusively for this genus which is known from North America and Southeast Asia. The adults have extremely long legs and strong claws as an adaptation to their riverine habitats. Elmidae are often highly sensitive to water pollution and are therefore of great value as bioindicators (e.g. Moog & Jäch 2003; Hilsenhoff 1982). This requires, however, taxonomic knowledge and appropriate identification tools. *Ancyronyx* larvae were unknown until Brown (1972) illustrated those of the North-American species *A. variegatus* (Germar, 1824). Philippis (1997) published the first data on the life cycle and growth of this species. He successfully used head capsule width to assign the respective instar stage to the larvae.

Publications dealing with molecular data of Elmidae are very rare and DNA data are only available for one *Ancyronyx* species, *A. procerus* Jäch, 1994 (Čiampor & Ribera 2006).

The first *Ancyronyx* species from the Philippines was recorded and described by Jäch (1994). Subsequently, seven new species were added (Jäch 2004, Freitag & Jäch 2007) and more new species await description. Currently, the Philippine province of Palawan is very well sampled with regard to Elmidae due to the AQUA Palawana Program (http://aquapalawana.nhm-wien.ac.at) conducted by the first author for more than 10 years. The copious collection of *Ancyronyx* specimens, both adult and larvae, retrieved by this taxonomic research initiative gave us the opportunity to study the larvae of this genus taxonomically for the first time.

Material and methods

Taxon sampling

The larvae examined were partly collected by standardized methods for ecological studies such as colonization and drift sampling during a survey in 2000 / 2001 (Freitag 2005). Such samples are referred to by the letters “C” (colonization sample) or “D” (drift sample), while manual samples are indicated by “M” at the end of a collection label. This variety of methods appeared to be more successful to retrieve rare species (Freitag, 2008). Most larval material of *Ancyronyx helgeschneideri* was obtained this way. However, the collected samples were preserved in formalin, thus the materials are consequently not suitable for molecular-genetic analysis.

All materials from more recent surveys have been retrieved by means of manual collection from submerged wood debris or through the use of a fine-meshed hand net. This material was preserved in absolute ethyl alcohol and thus, it was suitable for genetic sequencing. The best manual sampling was possible in permanent small to medium sized rivers in forested area (Fig. 1).

Figure 1. Small to medium sized, permanent forest streams with heterogeneous morphology and rich in submerged woods and root packs are usually inhabited by the highest numbers of *Ancyronyx* species. This picture shows the type locality of *Ancyronyx montanus* where also *A. minerva*, *A. patrolus*, *A. pseudopatrolus* and *A. punkti* occurred sympatrically.

The label codes for the sampling sites of the first author are arbitrary. They do not follow any temporal or spatial pattern, except for the fact, that eventually varying small letters following a common code number refer to different sections of the same water system.

DNA extraction and sequencing

DNA was extracted from 15 whole specimens (Fig. 2) using Qiagen DNeasy kit (Qiagen, Hilden, Germany) and a single elution following the protocol for animal tissues (Qiagen 2002). The 3' end of the cytochrome *c* oxidase subunit I (*cox1*) gene was amplified using polymerase chain reaction (PCR) following standard protocols (e.g. Caterino et al. 2005) and using primer pairs C1-J-2183 (5'-caa cat tta ttt tga ttt ttt gg-3'; *Jerry*) and TL2-N-3014 (5'-tcc aat gcs cts atc tgc cat aat a-3'; *Pat*) (Simon et al. 1994) and *Mango Taq* DNA polymerase (Bioline, Luckenwalde, Germany). The PCR temperature progression was: 30 s at 94 °C, 30 s at 47 °C, 60 s at 72 °C (× 35 cycles), 600 s at 72 °C. Amplification products were purified with Qiagen Qiaquick

Table 1. Genbank accession numbers of DNA sequences, geographical origins, collectors, collection sites and organismic sample references of specimens used for molecular-genetic analyses.

Species	Stage	Locality	Site	Collector	Voucher	*cox1*	*cob*
Ancyronyx montanus Freitag & Balke, sp. n.	adult	Palawan	16h	Freitag	NMW FR 037	HE588174	-
Ancyronyx montanus Freitag & Balke, sp. n.	larva	Palawan	16h	Freitag	ZSM FR 038	HE588175	-
Ancyronyx minerva Freitag & Jäch, 2007	adult	Palawan	154	Freitag	ZSM FR 001	HE588179	-
Ancyronyx minerva Freitag & Jäch, 2007	larva	Palawan	159	Freitag	ZSM FR 025	HE588180	-
Ancyronyx punkti Freitag & Jäch, 2007	adult	Palawan	154	Freitag	ZSM FR 008	HE588169	-
Ancyronyx punkti Freitag & Jäch, 2007	larva	Palawan	154	Freitag	ZSM FR 002	HE588170	-
Ancyronyx pseudopatrolus Freitag & Jäch, 2007	adult	Palawan	16f	Freitag	ZSM FR 003	HE588172	-
Ancyronyx pseudopatrolus Freitag & Jäch, 2007	larva	Palawan	16b	Freitag	ZSM FR 040	HE588173	-
Ancyronyx patrolus Freitag & Jäch, 2007	adult	Busuanga	165	Freitag	ZSM FR 032	HE588178	-
Ancyronyx patrolus Freitag & Jäch, 2007	adult	Palawan	20	Freitag	ZSM FR 005	HE588176	-
Ancyronyx patrolus Freitag & Jäch, 2007	larva	Palawan	20	Freitag	ZSM FR 006	HE588177	-
Ancyronyx helgeschneideri Freitag & Jäch, 2007	adult	Busuanga	169	Freitag	ZSM FR 013	HE588168	-
Ancyronyx helgeschneideri Freitag & Jäch, 2007	adult	Palawan	CR4	Freitag	ZSM FR 007	HE588167	HE588183
Ancyronyx helgeschneideri Freitag & Jäch, 2007	larva	Palawan	CR4	Freitag	ZSM FR 061	-	HE588184
Ancyronyx procerus Jäch, 1994	adult	Borneo		Čiampor	MNCN FC-B05	DQ266500	DQ266511
Ancyronyx procerus Jäch, 1994	larva	Busuanga	169	Freitag	ZSM FR 014	HE588171	HE588182
Podelmis viridiaenea Jäch, 1982	adult	Sri Lanka	1	Freitag	ZSM FR 035	HE588181	-

PCR purification columns (Qiagen, Hilden, Germany). Cycle sequencing was performed as follows: 15 s at 96 °C, 15 s at 50 °C, and 240 s at 60 °C (× 35 cycles) using PCR primers with BigDye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems, Foster City, California, USA). The sequencing products were purified by ethanol precipitation (25 µl of cold (-20°C) 99% ethanol, 2.5 µl of 3M sodium acetate added to product; centrifuged; washed with 25 µl of 70% ethanol), and additionally with Agencourt CleanSEQ (Agencourt Bioscience, Beverly, Massachusetts, USA) following protocol 000600v32 (Agencourt Bioscience 2006) before electrophoresis.

Additionally, a central part of the cytochrome b apoenzyme (*cob*) gene of four specimens was amplified as described above by using the primer pair 5'-gag gag caa ctg taa tta cta a-3' (CB3) and 5'-aaa aga aa(ag) tat cat tca ggt tga at-3' (CB4) (Baraclough et al., 1999). This was done to support the matching of a larva for which *cox1* data were not available.

Phylogenetic analysis

Podelmis viridiaenea Jäch, 1982 (Elmidae: Elminae: Elmini) from Sri Lanka was used as an outgroup. Two additional sequences of *Ancyronyx procerus* were retrieved from GenBank: DQ266500.1, DQ266511.1 (Čiampor and Ribera 2006). Sequences were edited and aligned in CLUSTALW (Thompson et al. 1994) using BIOEDIT version 7.0.5.2. (Hall 1999) and default parameters. Phylogenetic analyses were conducted with MRBAYES vers. 3.1.2 (Ronquist and Huelsenbeck 2003) using the GTR (General Time Reversible) model (Tavaré 1986) with default priors starting with random trees with three heated and one cold Markov chains. The analysis was run by 1,000,000 generations, 7,501 trees were sampled after the first 25% of samples from the cold chain have been discarded as burnin. Branch support for the Bayesian trees was assessed with posterior probabilities determined via the 50% majority rule consensus. This "quick" analysis was sufficient for the task of detecting which larva might be associated with which adult.

Morphological analysis

Scanning electron microscope (SEM) images were obtained using a ZEISS EVO 50 XVP at SMTD. The specimens were coated with gold using two samples each if enough material was available. Those taxa of which only a single or few specimens have been available were only vacuum dried, but not gold-coated prior to scanning. This resulted in lower quality of the micrographs, but has kept the specimen´s surface natural.

Digital habitus photographs were taken with a NIKON SMZ800 stereo microscope with digital photo adapter NIKON DS-Fi1 (unit in DLSU). These photographs were taken at various focus layers and were subsequently combined using COMBINEZM software (Hadley 2008) to retrieve images with sufficient depth of focus. The same system was used for the dissection of adult specimens and the detailed material examination.

Examination, biometric measuring and imaging of dissected parts were conducted using a NIKON Eclipse 600 microscope with a ZEISS AxioCam MRc5 digital camera (unit in SMTD). The morphological details of larvae are described from external view as they are usually visible without dissection, if not stated opposite. The listing of examined material includes the head width (in mm) of all measured larvae.

Morphological terminology used herein mainly follows the Elmidae chapter of the recently published Handbook of Zoology / Coleoptera (Kodada and Jäch 2005).

Abbreviations

asl	above sea level (altitude)
C	colonization sample
CL	calculated length (PL + EL)
CPOM	Coarse Particulate Organic Matter
D	drift sample
EL	elytral length
EW	elytral width
ex. / exs.	exemplar / exemplars of adult specimen
FPOM	Fine Particulate Organic Matter
HW	head width
ID	interocular distance
L	larva / larvae
M	manual collection
MW	maximum pronotal width
PL	pronotal length
CFP	H. Freitag private collection, Dresden, Germany
IMRL	Phyllodrom, Institut und Museum für Regenwaldökologie Leipzig, Germany
NMW	Natural History Museum Vienna, Austria
MNCN	Museo Nacional de Ciencias Naturales Madrid, Spain
PCSD	Palawan Council for Sustainable Development, Philippines
SMTD	Senckenberg Museum für Tierkunde Dresden, Germany
UPLB	University of the Philippines Los Baños, Museum of Natural History, Entomological Collection, Philippines
ZMUC	Zoological Museum of the University Copenhagen, Denmark
ZSM	Zoological State Collections Munich, Germany

Results

DNA sequence analysis

Alignment of the *cox1* data and trimming ambiguous bases at the 3' and 5' ends yielded a matrix of 770 bp. None of the sequences contained indels. The sequence of the larvae of *A. pseudopatrolus* had ambiguous six positions in-between, that were coded as 'N's.

The sequence divergence between *Ancyronyx* species was between 3.3.% (25 positions different: *A. patrolus* / *A. montanus*) and 18% (139 positions different: *A. helgeschneideri* / *A. montanus*). The highest divergence with another taxon (17%–20%) was with the outgroup species in all cases.

All adults and larvae could be matched unambiguously. Sequences of adult and larva of the same species from the same locality or island showed low difference of positions in most species (2–3 positions different, 0.2–0.4% divergence). *Ancyronyx pseudopatrolus* would be within this range when assumed that all unidentified positions are not varying between adult and larva, which is likely as these positions appear to be conserved sites in *Ancyronyx*. Sequence samples of the same species, but from different islands showed slightly higher divergence of 0.6%–2.1% (5–16 positions). A 50% majority rule consensus trees based on *cox1* data is illustrated in Fig. 2.

The sequencing of *cox1* of the one and only available alcohol-preserved larva of *Ancyronyx helgeschneideri* failed and is consequently not included in the phylogenetic analyses. However, we were able to amplify the *cob* sequence of that larval specimen and match it with its adult stage. Their aligned *cob* sequences of 378 bp were identical except for two positions of synonymous exchange of a base (0.5% divergence). In *Ancyronyx procerus* six positions of the *cob* sequences varied between adult and larval specimens by synonymous changes (1.6% divergence). Both species varied in 61 positions of their *cob* sequence (16% divergence).

All sequences were submitted to GENBANK. Accession numbers and curatory information are listed in Table 1.

Taxonomy

***Ancyronyx minerva* Freitag & Jäch, 2007**
http://species-id.net/wiki/Ancyronyx_minerva
Figs 3, 11A–L

Ancyronyx minerva Freitag & Jäch, 2007: 50–53 (adult description); Freitag & Pangantihon, 2010: 133 (first record Mindoro).

Material examined. 2L (0.21, 0.24) (PCSD) “PHIL.: Palawan, P. Princesa Panaguman R., Marufinas 10°15'09"N, 118°58'03"E 15.6.2001, leg. Freitag (PR1) C-R".1♀ (CFP) “PHIL.: Palawan, P.Princesa; Concepcion, Tagpaya, Camp Aga, Taranaban R. trib.; mount.creek c.8km upstr. Highw., dist. prim. forest; riffle; rocks, boulders, roots; c.450m asl 10°05'N, 119°01'E, 26.4.1995 leg. Pangantihon (16f)M“; 2L (0.28, 0.29) (CFP) “PHIL.:Palawan, P.Princesa, Sta. Cruz, Calatobong Riv., Nat.Highw. km29; rocks CPOM, riffe & side pools; heavy metal soil,sec. veget.,25m asl, 9°56'41"N, 118°44'56"E 14.11.1995, leg.Freitag (124)"; 42 exs, 3L (0.27, 0.28, 0.30) (PCSD, NMW) “PHIL.: Palawan, P. Princesa, Iwahig, Balsahan Riv., upstr.dam; riffle, boulders, gravel, wood, moss; 9°46'36"N, 118°39'55"E 24.1.1995, leg. Freitag (20)M"; 2L (2 × 0.27) (CFP) “PHIL.: Palawan, P. Princesa, Irawan River, 6km NW of PPC, 2km upstream of water plant 9°49'N, 118°39'E 06.4.1994, leg. Freitag (60)M"; 1L (0.27) (ZSM [FR025]) “PHIL.: Palawan, P. Princesa, Iwahig, Salomon Riv.; rural near sec. forest, riffle, boulders, gravel, wood;

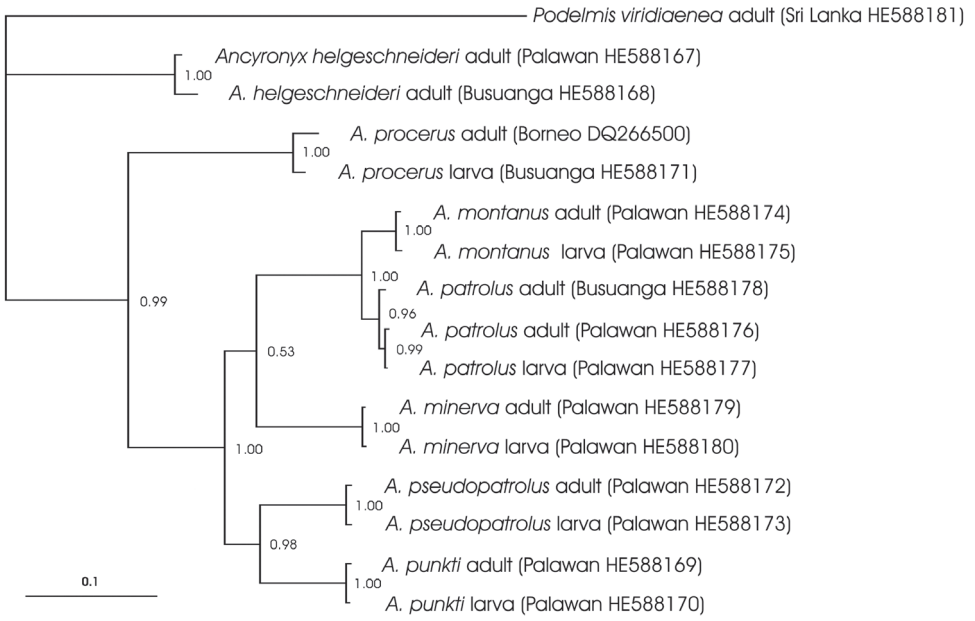

Figure 2. Phylogram of the consensus tree of the Bayesian analysis with branch lengths measured in expected substitutions per site. Posterior probability values (printed when > 0.5) at respective branches. Sample labels with island of origin and code of the collection site or genbank code.

9°46'59"N, 118°40'53"E 24.1.1994, leg. Freitag (159)M"; 2♂♂, 1♀, 4exs., 1 L (0.26) (CFP) "PHIL: Palawan, P.Princesa, Bgy. Montible, rd. km 29, Iwahig River, big mount. river, boulders, CPOM; 9°41'20"N, 118°37'29"E 24.11.2007, leg. Freitag (130)M"; 1♀, 4 exs., 1 L (0.24) (ZSM [FR001], ZMUC) "PHIL.: Palawan, Aborlan; Cabigaan, Talakaigan R.; mount.Riv. upst.dam, riffle, rocks, boulders, CPOM, forest, c.50m asl, 9°26'50"N, 118°26'49"E 25.2.1995, leg. Freitag (154) M"; 2♂♂, 1♀, 11 L (2 × 0.22, 2 × 0.25, 2 × 0.26, 3 × 0.27, 2 × 0.28) (SMTD) "PHIL.: Palawan, Narra, 7 km N town centre, downstr. Estrella Falls, mountain riv.; sec. forest; gravel, boulders, submerged wood, riffle; c. 50m asl., c. 9°20'N 118°23'E 16.4.2010, leg. Freitag & Pangantihon (180a)"; 12 exs. (CFP) "PHIL.: Palawan, Narra, 5 km W town proper, Taritien River, riffle, boulders, leaf litter; c. 100m asl. 9°19'11"N, 118°22'35"E 17.4.2010, leg. Freitag et al. (182a)"; 1♂ (CFP) "PHIL.: Palawan, Rizal, Campung-ulay, Kalitawan Riv.; HW km 212.2, sec. veget/forest; slightly polluted, submerged wood in run, c. 30m asl. 9°19'11"N, 118°22'35"E 02.7.2010, leg. Freitag (186)"; 7 exs. (ZSM) "PHIL.: Palawan, Rizal, Ransang, Ransang Riv., E of HW km 223; sec. veget. Caingin; submerged wood, c. 50m asl. 9°19'11"N, 118°22'35"E 02.7.2010, leg. Freitag (184b)"; 1♀ (CFP) "PHIL.: Palawan, Rizal, Punta Baja, Malambunga Riv.; HW km 202.1, farmland; submerged wood in run, c. 10m asl. 9°19'11"N, 118°22'35"E 02.7.2010, leg. Freitag (187a)";

Figure 3–10. Habitus of **3** *Ancyronyx minerva* Freitag & Jäch, 2007, larva, **4** *A. punkti* Freitag & Jäch, 2007, larva, **5** *A. pseudopatrolus* Freitag & Jäch, 2007, larva, **6** *A. patrolus* Freitag & Jäch, 2007, larva, **7** *A. montanus* Freitag & Balke, sp. n., adult, **8** *A. montanus* Freitag & Balke, sp. n., larva, **9** *A. procerus* Jäch, 1994, larva, **10** *A. helgeschneideri* Freitag & Jäch, 2007, larva.

Larval description (based on 6th instar). Colour as in Fig. 3, predominantly dark-brown; legs, antennae, posterior and lateral head portions yellowish. Most anterior portion of pronotum with yellowish band reaching up to the lateral margins, this pale band slightly extended posteriad along the midline. Meso- and metanotum and abdominal segments at medioposterior margin with broadly subtriangular yellow pat-

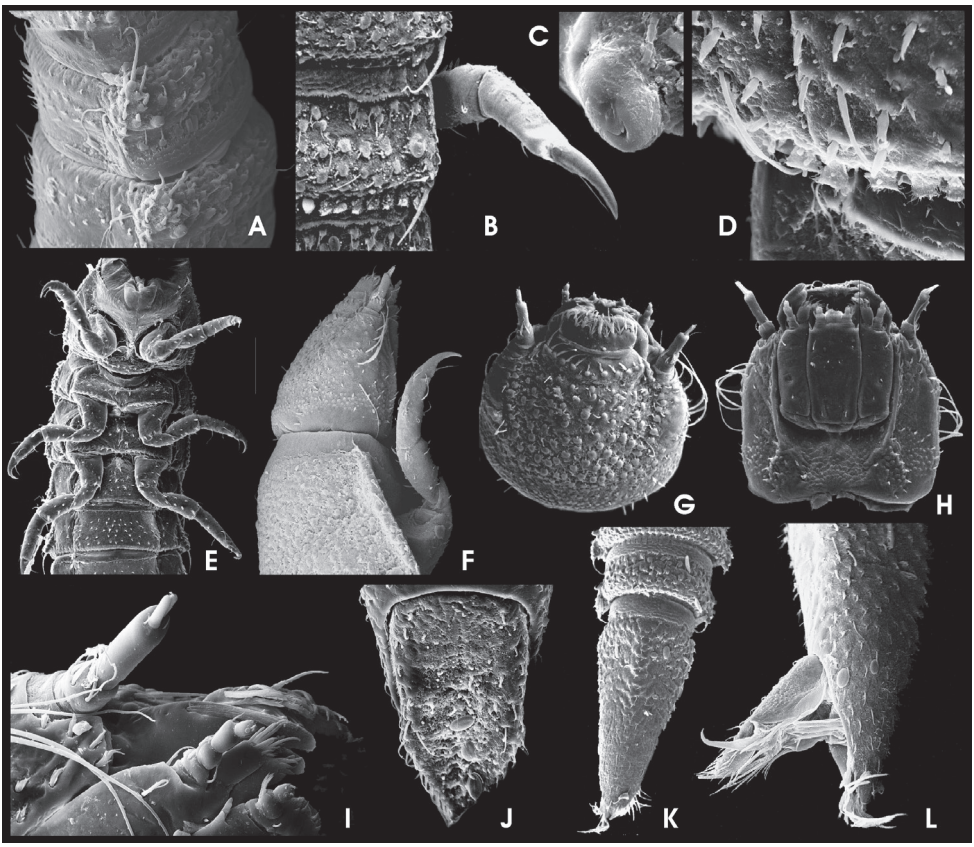

Figure 11. *Ancyronyx minerva* Freitag & Jäch, 2007, larva (SEM photographs), **A** abdominal segments, lateral, with posterolateral projections and spiracles, **B** posterior portion of metanotum and first abdominal segment, dorsal, with different setae, posterolateral trichoid tooth and spiracle, **C** abdominal spiracle, **D** posterolateral detail of abdominal segment V, dorsal, with different types of setae, **E** thoracic and first abdominal segments, ventra, **F** head and pronotum, lateral, **G** head, dorsal, **H** head, ventral, **I** antenna and distal parts of maxilla, labium and mandible, ventral, **J** operculum, ventral, **K** abdominal segments VIII and IX, dorsal, **L** distal portion of abdominal segment IX, lateral, with opened operculum, abdominal gill chamber and terminal hooks.

tern. A light colour pattern might by present or lacking at the apex of abdominal segment IX, but never extends anteriad up to more than 0.2 posterior .

HW c. 0.27 mm; entire larva about 3.0 mm long. Body torpedo-like elongate, subsemicircular in cross section, dorsally vaulted, ventrally almost flat. Posterolateral margins of abdominal segments I–VIII moderately produced (Fig. 11A). These projections either not, or only slightly overreaching posterior segment margins. Posterolateral edge of these projections with long posteriad-directed trichoid tooth, overreaching middle of subsequent abdominal segment when that retracted (11B). Spiracles (Figs 11A–C) present laterally on mesothorax and abdominal segments I–VIII, surrounded by glabrous areas. Dorsal side densely covered with setiferous tubercles (Fig.11B). Ven-

tral side smoother, with scattered setae (Fig. 11D). Retractable portions of body segments without setae and tubercles (Figs 11A, E).

Head (Figs 3; 11F–I) exposed, distinctly prognathous, sides subparallel in posterior half, with lateral clumped, not exposed stemmata in a glabrous area, lined by a irregular row of six long acuminate setae on each side (Fig. 11F). Frontal suture U-shaped, rather inconspicuous; frontoclypeal suture arcuate (Fig. 11G). Clypeus distally glabrous, with subbasal fringe of fasciculate setae originated from tubercles (Fig. 11G). Ventral side (Fig. 11H) with almost glabrous median portion, lateroposteriorly with tubercles. Gula with concentrically arranged asperities. Antenna (Fig. 11I) three-segmented, c. 1/3 as long as head, basally connected to a segment-like membranous peduncle. Peduncle stout, bald, partly retracted into head capsule; scape slightly longer than peduncle about as long as broad, with dorsolateral fringe of branched trichoid setae; pedicel cylindrical, more than two times as long as scape and c. three times as long as broad, with few apical trichoid setae; flagellum and sensorium cylindrically elongate, subequal in length; apex of flagellum with cylindrically elongate sensillum. Labrum (Fig. 11G) subrectangular, c. 2.5 times as wide as long, with a subapical fringe of ramose setae and scattered trichoid and truncate (sensory) setae, proximal portion glabrous. Mandibles with distal portion subfalcate; apex tridentate; incisory margin densely setose; outer margin glabrous, with one elongate, ramose squamose seta (Fig. 11I). Maxilla (Figs 11H, I) moderately broad; cardo stout, divided, lateral portion with one median lanceolate seta; stipes subtrapezoidal, glabrous, with few lanceolate and one latero-subapical trichoid seta; maxillary palpus four-segmented, approx. as long as stipes broad, distal segment subglobular with several apical sensilla of various shape; predistal segment with lateroapical trichoid seta; galea and lacinia subequal in length and shape, shorter than palpus, apically with acuminate setae. Labium as in Figs 11H, I; mentum (postmentum) broad (about 1.5 times of stipes), with median groove most depressed posteriorly, with one pair of moderately long trichoid setae sublaterally at anterior 0.25, one pair of subbasal spinose setae and one pair of short subapical lateral spines; submentum (prementum) short, subrectangular, with one laterobasal pair of setae; ligula inconspicuous with various setae and pegs; labial palpi short, with short and stout palpifer; apical segment similar to that of maxillary palpi, preapical segment with lateral tuft.

Pro-, meso- and metathorax (Figs 3; 11E, F) subtrapezoidal, slightly narrower anteriorly, broader than long; with lateral rim distinctly produced laterad. Pronotum longest, with rather inconspicuous round signa (glabrous areas) in posterior half. Meso- and metathorax distinctly shorter than prothorax. Venter of prothorax (Fig. 11E) with five sclerites: two oblique anterior (fused episternum and basisternum), two lateral (pleuron), and one posteromedial sclerite (sternellum), posterior portions of lateral sclerites strongly extended mesad, meeting posteromedial sclerite; posteromedial sclerite with posterior fringe of short setae; procoxal cavity closed posteriorly; anterior and lateral portions glabrous, few setiferous tubercles in posterior portions. Venter of meso- and metathorax (Fig. 11E) with six sclerites: two large anterior (divided basisternum), two subcircular sclerites anterolateral (divided pleuron), two meso-posterolateral sclerites

(divided pleuron); coxal cavities open posteriad; setiferous tubercles sparse on median portion; lateral portions almost glabrous. Posterior margin of anterior sclerites with fringe of setiferous tubercles.

Legs (Figs 11E, F) moderately long (compared to larvae of other genera), but much shorter than in adults, similar in shape and length, with scattered ramose squamose sensilla and additional trichoid sensilla at femora and tibiae. Coxae large, subtrapezoidal; trochanter shorter, subtriangular; femora subconical, broadest distal; tibiae subcylindrical, longest segment, narrower than femur, broadest basally. Claws elongate, strongly bent (basal to distal part in rectangular angle) with one subbasal trichoid tooth.

Abdomen (Figs 3; 11A–D, J–L). Segment IX with large, ventral, subtrapezoidal operculum (Fig. 11J). Segments I–VIII similar in shape, subrectangular in dorsal view. Retractable anterior portion with squamose asperities (Fig. 11A); posterior margin dorsally and ventrally with a rim of squamose setae (Fig. 11D). Remaining median portions of terga covered with setiferous tubercles, most densely at the sagittal area, forming slightly elevated dorsosagittal carinae at the posterior portions of segments I–VIII and the subanterior portion of segment IX (Fig. 11K). Ventral sclerites of segments I–VIII subrectangular, increasingly fused with pleural sclerites from 1st to 8th segment (pleural sclerites not distinguishable in segments VII and VIII); ventral sclerite of segment I with sagittal ridge in anterior third (Fig. 11E). Segment IX (Figs 11J–L) elongate, conical, apex not emarginate. Operculum (Fig. 11J) c. double as long as broad, medially depressed, rugose, laterally with rim of trichoid setae, with a pair of hooks inserted at median dorsal (inner) side (Fig. 11L). Gill chamber with long, ramose gill tufts overreaching the opercular margin (Fig. 11L).

Variation between larval instars. Almost the entire material studied belongs to the final instar stage. The two presumably prefinal instar specimens do not vary conspicuously from the description above. The legs appear slightly broader and shorter in relation to the body and their setae patterns are slightly different.

Distribution. Only known from Palawan and Mindoro (Freitag & Pangantihon, 2010).

Ancyronyx punkti Freitag & Jäch, 2007

http://species-id.net/wiki/Ancyronyx_punkti
Figs 4, 12A–K

Ancyronyx punkti Freitag & Jäch, 2007: 47–50 (adult description).

Material examined. 1♀ (ZMUC) "PHIL.: Palawan, P.Princesa; Bgy. Binduyan, Olanguan Falls/Brdg., Nat. Highway km 29; 2.5 km upstr.,rocks, gravel boulder, CPOM; degr. prim. veget.,10°02'11"N, 119°03'01"E 28.08.2010, leg. Freitag (126a) M"; 3 exs. (CFP) PHIL.: Palawan, P.Princesa; 2km SE Laptay/Napsan, Bubugtungan mountain stream, semi-prim.forest, 9°41'14"N, 118°27'17"E 07.9.2008, leg.

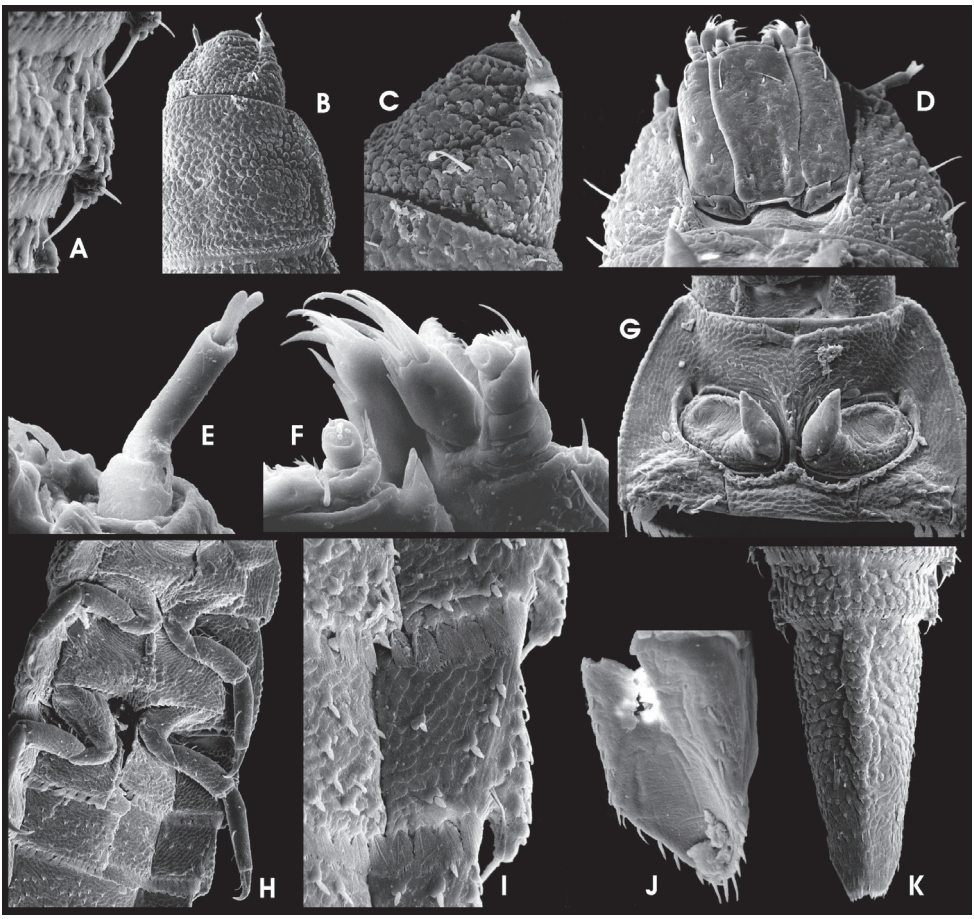

Figure 12. *Ancyronyx punkti* Freitag & Jäch, 2007, (SEM photographs) larva: **A** Posterolateral detail of abdominal segment VI, dorsal, with with posterolateral projections and spiracles, **B** pronotum and head, dorsal, **C** head, dorsolateral, **D** head, ventral, **E** antenna, ventral, **F** apical portions of labium and maxilla, ventral, **G** prothorax, ventral, **H** thoracic and first abdominal segments, ventral, **I** lateral and parts of median sclerites of abdominal venter, with asperities, setiferous tubercles and lateral projections, **J** operculum, lateroventral, **K** abdominal segments VIII and IX, dorsal.

Freitag (23a)M; 2 exs., 1L (0.27) (CFP) "PHIL.: Palawan, P.Princesa; Concepcion, Taranaban R.; c.6km upstr. Highw., mount.riv., riffle; boulders, woodlitter; c.150m asl 10°02'30"N, 119°00'45"E, 20.1.1995 leg. Freitag (16b)M"; 5♂♂, 6♀♀, 2 L (0.28, 0.31) (ZSM [FR002, FR008], CFP) "PHIL.: Palawan, Aborlan; Cabigaan, Talakaigan R.; mount.Riv. upst.dam, riffle, rocks, boulders,CPOM,forest, c.50m asl, 9°26'50"N, 118°26'49"E 25.2.1995, leg. Freitag (154)M"; 34 exs., 3L (0.29, 0.30, 0.31) (NMW, SMTD) "PHIL.: Palawan, Narra, 7 km N town centre, downstr. Estrella Falls, mountain riv.; sec. forest, gravel, boulders, submerged wood, riffle; c. 50m asl., c. 9°20'N 118°23'E 16.4.2010, leg. Freitag & Pangantihon (180a)"; 1♂, 2L (0.20, 0.28) (CFP) "PHIL.: Palawan, Narra, 5 km W town proper, Taritien River near DENR Station;

riffle, boulders, gravel, wood litter 9°18'55"N, 118°22'56"E 17.4.2010, leg. Freitag et al. (182b)M"; 37exs., 13L (0.24, 0.25, 0.26, 2 × 0.28, 4 × 0.30, 2 × 0.31, 2 × 0.32) (NMW, ZMUC, IMRL) "PHIL.: Palawan, Narra, 5 km W town proper, Taritien River, riffle, boulders, gravel, wood litter/leaf litter c. 100m asl. 9°19'11"N, 118°22'35"E 17.4.2010, leg. Freitag et al. (182a)"; 3 exs. (CFP) "PHIL.: Palawan, Rizal, Campungulay, Kalitawan Riv.; HW km 212.2, sec. veget/forest; slightly polluted, submerged wood in run, c. 30m asl. 9°19'11"N, 118°22'35"E 02.7.2010, leg. Freitag (186)"; 2L (0.29, 0.32) (CFP) "PHIL.: Palawan, Brookes P., Salogon, Manguguran Riv./Sitio, mount. riv.; rocks, CPOM, sand; riffle sec. veget., 70m asl., 8°44'07"N, 117°42'15"E 01.9.1994, leg. Freitag (148)M"; 1 L (0.31) (PCSD) "PHIL.: Palawan, Brookes P., Sabsaban River, c.10km NW of town proper, downstr. falls, grassbank rills, 8°49'N 117°48'E 20.5.1994, leg. Freitag (79c)M".

Larval diagnosis (based on 6th instar). Colour (Fig. 4) very similar to that of *A. minerva,* but most distinctly different by ventral head portions pale; anterior yellow pronotal band not extended posteriad along the midline; meso-, metanotum and abdominal segments with rather inconspicuous or without yellow pattern at medioposterior margin and apex of abdominal segment IX with conspicuous yellow pattern extending anteriad up to c. posterior 0.3.

HW 0.32 mm; entire larva about 3.0 mm long. Body elongate, broader than that of *A. minerva,* but very similar in the external characters, except for the following:

Posterolateral projections (Fig. 12A) of abdominal segments IV–VIII distinctly overreaching posterior segment margins (approximately as long as the squamose setae at posterior segment margins).

Head (Figs 4; 12B–F) broadest posterior 0.4, not subparallel in posterior half; lateral setae moderately long; dorsolaterally with a pair of rather long double setae (Fig. 12C). Frontal suture V-shaped, rather inconspicuous (Fig. 4). Subbasal fringe of clypeus with rather short fasciculate setae. Ventral side (Fig. 12D) dominantly rugulose, without glabrous areas. Antennae as in Fig. 12E, fringe of scapus setae fasciculate with one long trichoid medial extension each, pedicel longer than in *A. minerva* (c. four times as long as broad); apex of flagellum with cylindrically elongate sensillum (broken off in figured specimen). Maxilla (Figs 12D, F) with stipes slightly tapering towards apex; maxillary palpus (Fig. 12F) slightly broader and stouter than in *A. minerva*. Labial mentum (Figs 12D, F) distinctly concave in posterior half, narrowest at basal 0.25, pair of trichoid setae long (reaching anterior margin) inserted sublaterally at anterior 0.2; lateroapical pair of spines broad, subtriangular, positioned at distal edge, not subapical. Submentum (prementum), ligula and labial palpi as in *A. minerva*.

Pro-, meso- and metathorax (Figs 4; 12G, H) distinctly narrower anteriorly. Pronotum with several rather inconspicuous small round signa (glabrous areas) in posterior half (Fig. 12B). Sclerites of venter of prothorax (Fig. 12G) with concentrically arranged asperities and therefore rugulose, not glabrous. Venter of meso- and metathorax (Fig. 12H) rugulose due to dense cover with asperities.

Legs (Fig. 12H) slightly slenderer than those of *A. minerva* and with asperities at coxae, trochanter and femora.

Abdomen (Figs 4; 12A, H– K) without noticeable dorsosagittal carinae except for subanterior portion of segment IX (Fig. 12J); squamose setae at posterior rim of segments I–VIII large and overlapping (Fig. 12I). Ventral sclerites of segment I with sagittal ridge almost reaching up to posterior margin, distinctly longer than 1/3 of segment length (Fig. 12H)

Operculum (Fig. 12J) with deep median depression. Apex of segment IX (Fig. 12K) truncate to very slightly emarginate.

Variation between larval instars. The few available prefinal instar specimens vary from the description above by relatively slenderer thoracic and abdominal segments, the relatively longer posterolateral projections, the distinctly shorter and broader legs and fewer setae on tibiae and femora.

Larval differential diagnosis. The species can most easily be distinguished from *A. minerva* which looks superficially most similar by the colour pattern of ventral head, pronotum and last abdominal segment and the longer median crest of the first abdominal segment venter.

Distribution. Known from Palawan island.

Ancyronyx pseudopatrolus Freitag & Jäch, 2007

http://species-id.net/wiki/Ancyronyx_pseudopatrolus
Figs 5, 13A–E, 14A–I

Ancyronyx pseudopatrolus Freitag & Jäch, 2007: 46–47 (adult description).

Material examined. 11L (2 × 0.17, 2 × 0.22, 0.23, 0.24, 3 × 0.27, 0.28, 2 × 0.29) (NMW, ZMUC, CFP) "PHIL.: Palawan, P. Princesa Panaguman R. 10°15'09"N, 118°58'03"E 17.5.2001, leg. Freitag (PR1)D"; 2L (0.23, 0.27) (PCSD) "PHIL.: Palawan, P. Princesa Panaguman R., Marofinas 10°15'09"N, 118°58'03"E 01.8.2001,leg. Freitag(PR1)C-R"; 2L (0.24, 0.28) (SMTD) "PHIL.: Palawan, P. Princesa Panaguman R., Marofinas 10°15'09"N, 118°58'03"E 15.6.2001, leg.Freitag(PR1)C-R"; 3♂♂, 1♀ (UPLB, ZSM [FR003], PCSD, IMRL) "PHIL.: Palawan, P.Princesa; Concepcion, Taranaban R. trib.; mount.creek c.8km upstr.; dist. prim. forest; riffle;rocks, boulders,roots; c.450m asl 10°05'N 119°01'E, 28.1.1995 leg. Freitag (16f)M"; 3♂♂, 2♀♀ 1L (0.29) (SMTD, ZSM [FR040], NMW, ZMUC, CFP) "PHIL.: Palawan, P.Princesa; Concepcion, Taranaban R.; c.6km upstr. Highw., mount.riv., riffle; boulders, woodlitter; c.150m asl 10°02'30"N, 119°00'45"E, 20.1.1995 leg. Freitag (16b)M".

Remarks. This species was originally described based on a single male exemplar. As additional material including females have been collected since then we will provide a short diagnosis of the female characters and sexual dimorphisms. Furthermore, the aedeagus (Fig. 13A) is figured in here as SEM micrograph, for the detailed diagnosis see Freitag & Jäch (2007), pp. 41 & 46; Figs 12a, b.

Adult female diagnosis. Ovipositor as in Fig. 13B. Total length c. 500 µm. Stylus comparably stout as in *A. punkti* (see Freitag & Jäch, 2007, Fig. 13d), slightly conical

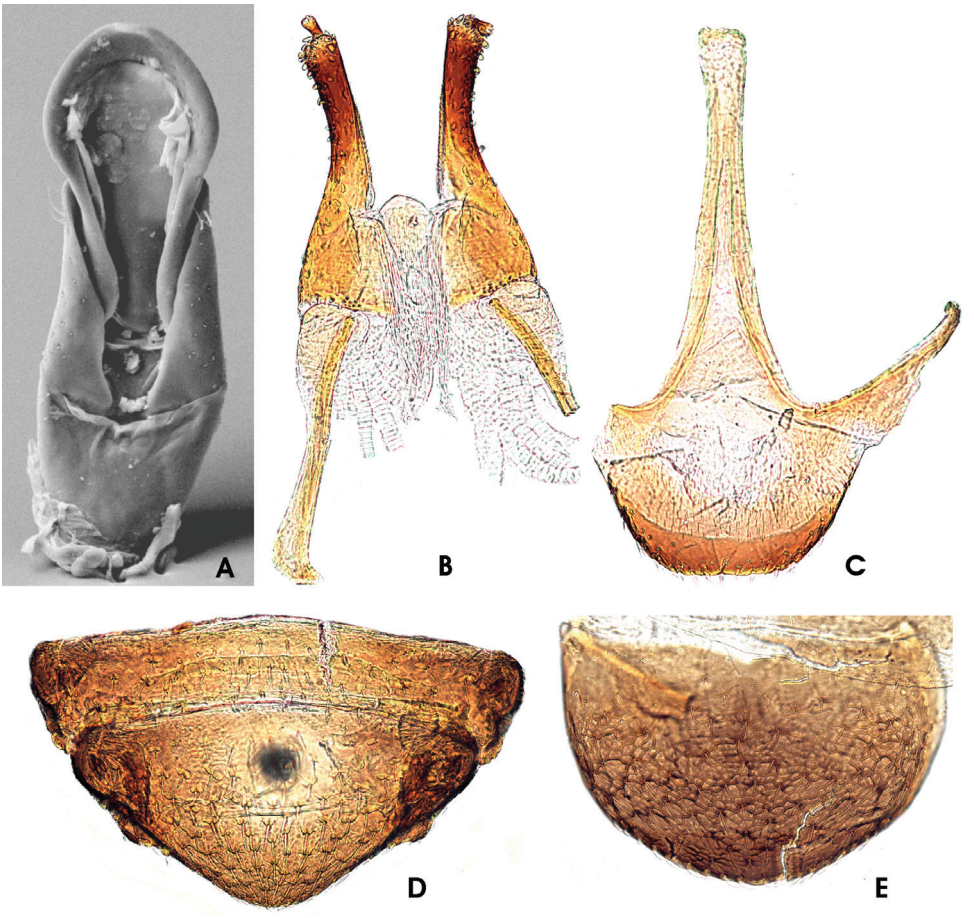

Figure 13. *Ancyronyx pseudopatrolus* Freitag & Jäch, 2007, adult male: **A** aedeagus in ventral few (SEM photograph); adult female: **B** ovipositor in ventral view; **C** sternite VIII in ventral view; **D** ventrite 4 & 5 in ventral view; **E** tergite VIII in dorsal view.

towards base (broader apically), slightly outwards directed. Coxite long and slender as in *A. patrolus* (comp. Freitag & Jäch, 2007, Fig. 11d); setae rather short, peg-like, apically rounded, not acute, most densely dispersed at coxite apex; mesal coxite margin moderately pubescent; basal portion c. half as long as distal portion, with slightly more acute and pointed setae than those at distal portion, most densely set at proximal and lateral margins. Valvifer about as long as coxite; fibula enlarged and curved inwards at proximal end.

Secondary sexual characters. Sternite VIII in female (Fig. 13C) overall very similar to that of *A. punkti*, with median strut apically widened and truncate; posterior portion with disc densely covered with small, inconspicuous setae; posterior margin with moderately long trichoid setae. Sternite VIII in male weakly sclerotized, median strut distinctly shorter than in female. Ventrite 5 in female (Fig. 13D) overall very similar to that of *A. punkti*, subtriangular, with small and only slightly elevated lateral projec-

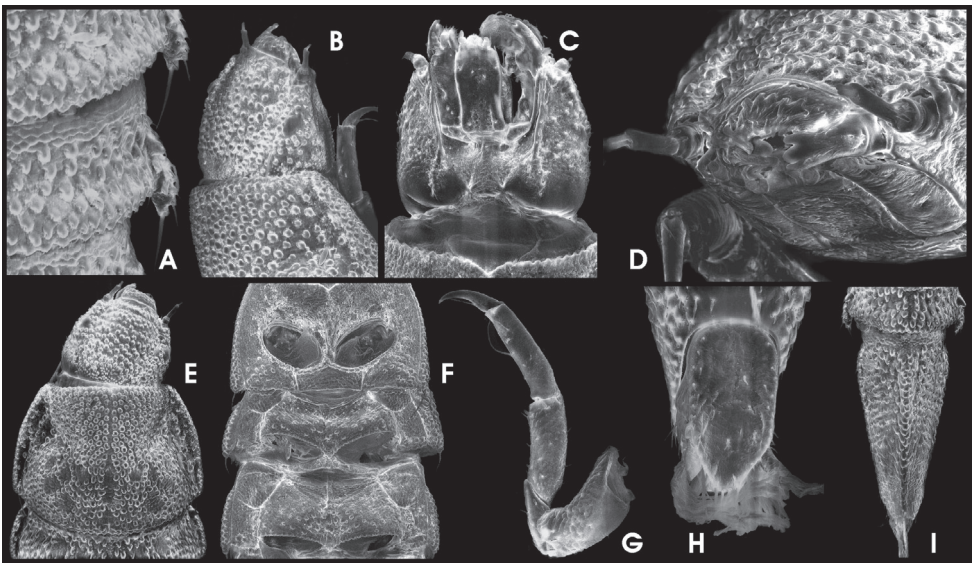

Figure 14. *Ancyronyx pseudopatrolus* Freitag & Jäch, 2007, larva (SEM photographs): **A** lateral detail of abdomen, dorsal, with posterolateral projections and spiracles; **B** anterior portion of pronotum and head, lateral; **C** head, ventral; **D** head, frontal; **E** pronotum and head, dorsal; **F** thoracic segments, ventral; **G** foreleg, ventral; **H** distal portion of abdominal segment IX with operculum, ventral; **I** abdominal segment IX, dorsal.

tions. Ventrite 5 in male (see Freitag & Jäch, 2007, Fig. 12d) suboval, stouter and with large and distinctly elevated lateral projections. Tergite VIII in female (Fig. 13E) longer than broad; condyles more or less straight; asperities only conspicuous laterally.

Larval diagnosis (based on 6th instar). Colour (Fig. 5) somewhat similar to that of *A. minerva* and *A. punkti*, but differs slightly in the dorsal and leg colour patterns. Anterior yellow pronotal band very broad, reaching up to anterior 0.4, sublaterally extended posteriad (area of explanate lateral pronotal gutter). Meso- and metanotum and abdominal segments with paler entire posterior margin or entirely dark brown (except for paler posterolateral projections). Colour patterns of head and abdominal segment IX as in *A. punkti*. Legs yellowish pale except for dark distal tibia area around claw insertion.

HW c. 0.29 mm; entire larva about 3.0 mm long. Body shape as in *A. punkti*, except for the following characters:

All abdominal posterolateral projections (Fig. 14A) very prominent, distinctly overreaching posterior segment margins. Setiferous tubercles at dorsal site very prominent and protruding (Figs 14A, B). Ventral side densely covered with asperities and scattered setiferous tubercles (Fig. 14E).

Head (Figs 5; 14B–D) broadest at c. posterior 0.3, margins not subparallel. Lateral head with clumped stemmata arranged in well defined round, protruding glabrous area (Fig. 14B); lateral setae short and rather inconspicuous; dorsolateral pair of double setae present and long (Fig. 14B); frontal suture V-shaped (Fig. 5). Labium (Fig. 14C)

as in *A. punkti*, except for setae and spines of the mentum: sublateral trichoid setae moderately long; lateroapical pair of spines slender, inserted subapically. Antennae, labrum (both Fig. 14D), maxillae and gula (both Fig. 14C) as in *A. punkti*.

Pro-, meso- and metathorax (Figs 5; 14E, F) distinctly narrower anteriorly. Pronotum with conspicuous small signa in posterior half arranged as in Fig. 14E.

Sublateroposterior portions and anteriomedian sclerites of thoracic venters with setiferous tubercles (Fig. 14F); remaining ventral areas densely covered with asperities.

Legs (Fig. 14G) as those of *A. punkti*.

Abdomen (Figs 5; 14A, H– I) with dorsosagittal carinae at the posterior portions of segments I–VIII and most distinct at the almost entire segment IX (Fig. 14I). Squamose setae at posterior rim of segments I–VIII broken off in specimen figured under SEM, but generally developed (Fig. 5). Sagittal ridge of ventral sclerite of segment I longer than 1/2 of segment length. Apex of segment IX slightly emarginate. Operculum (Fig. 14H) medially deeply impressed, rugulose, with few setae at disk.

Variation between larval instars. For this species, quite a number of prefinal instar specimens is available. They vary from the final instar description by the overall paler colour, relatively longer posterolateral projections, relatively shorter and broader legs and fewer setae on tibiae and femora.

Larval differential diagnosis. The species can most easily be distinguished from its congeners *A. minerva* and *A. punkti* by the colour pattern of the anterior pronotum and the dorsal posterior margins of thoracic and abdominal segments and the more distinctly developed, protruding tubercles and of the dorsal crest of the abdominal segment IX.

Distribution. Only known from few rivers in central Palawan.

Ancyronyx patrolus Freitag & Jäch, 2007

http://species-id.net/wiki/Ancyronyx_patrolus
Figs 6, 15A–K

Ancyronyx patrolus Freitag & Jäch, 2007: 41, 44–46 (adult description).

Material examined. 1♂ (ZSM [FR032]) PHIL.: Busuanga, Coron, San Nicolas/Borac, “7Falls" mount. creek; riffle & pool; gravel, boulders, CPOM, sec. forest/rural; c.50m asl, 12°03'11"N, 120°15'28"E 02.2.1995, leg. Freitag (165)M; 4L (0.23, 0.31, 2 × 0.32) (CFP) “PHIL.:Palawan, El Nido, Bgy.Pasadeña Nagkalit-Kalit Falls, small mountain river, degr. prim. forest, rocks, gravel, wood litter, c. 11°15'N 119°26'E 14.10.1994, leg. Freitag (112)M"; 1L (0.19) (CFP) “PHIL.: Palawan, P. Princesa Panaguman R. 10°15'09"N, 118°58'03"E 17.5.2001, leg. Freitag (PR1)D“; 21 exs.; 1L (0.30) (NMW) “PHIL.: Palawan, P.Princesa; Concepcion, Taranaban R.; c.6km upstr. Highw., mount.riv., riffle; boulders, woodlitter; c.150m asl 10°02'30"N, 119°00'45"E, 20.1.1995 leg. Freitag (16b)M“; 2L (0.30, 0.32) (CFP) “PHIL.: Palawan, P.Princesa; Concepcion, Taranaban R. trib.;mount.creek c.8km upstr.; dist.

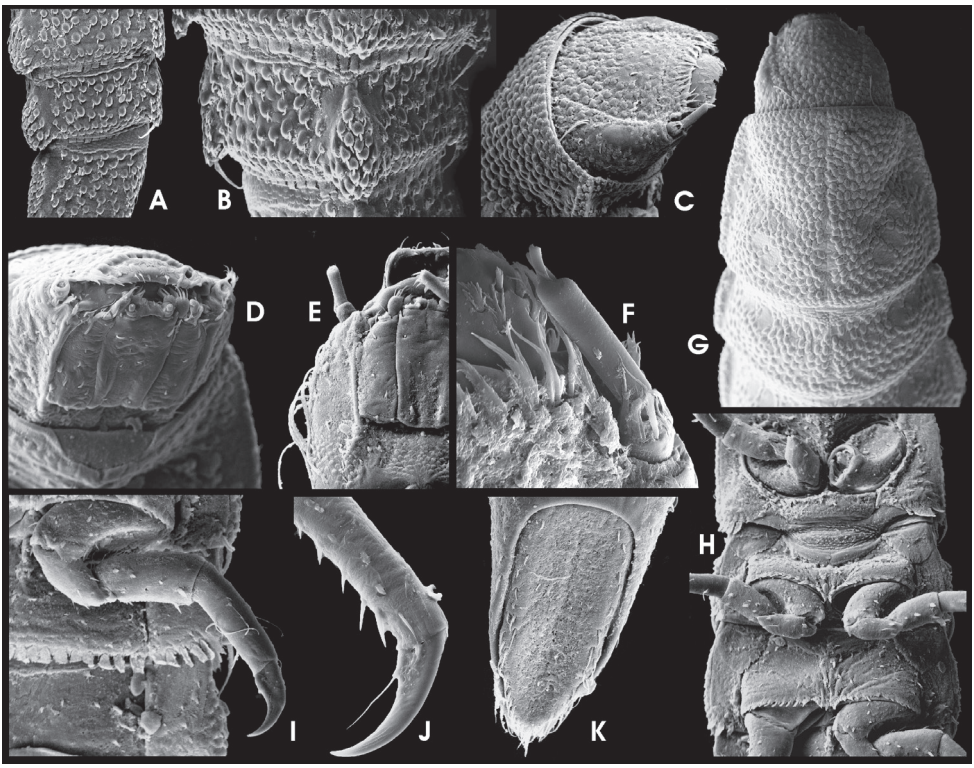

Figure 15. *Ancyronyx patrolus* Freitag & Jäch, 2007, larva (SEM photographs): **A** abdominal segments VII–IX, lateral, with dorsosagittal carinae (left), **B** abdominal segment VIII, dorsal, with drop-shaped protuberance of dorsosagittal carina, posterolateral trichoid tooth and spiracle, **C** head, dorsolateral, **D** head, frontoventral, **E** head, ventral, **F** antenna and lateral portions of clypeus with subbasal fringe of fasciculate setae, dorsal, **G** head, pronotum and mesonotum with signa, dorsal, **H** thoracic segments, ventral, **I** hindleg and first abdominal segments, ventral, **J** tibia and claw of last instar foreleg, lateral, **K** operculum, ventral.

prim. forest; riffle;rocks, boulders,roots; c.450m asl 10°05'N 119°01'E, 28.1.1995 leg. Freitag (16f)M"; 2♀♀, 1L (0.26) (CFP, SMTD) "PHIL.: Palawan, P.Princesa; Concepcion, Tagpaya, Camp Aga, Taranaban R. trib.; mount.creek c.8km upstr. Highw., dist. prim. forest; riffle;rocks, boulders, roots; c.450m asl 10°05'N 119°01'E, 26.4.1995 leg. Pangantihon (16f)M"; 1L (0.30) (CFP) "PHIL.: Palawan, P. Princesa, Bacungan, Bisor Riv.,6km NW Highw. km23, mount. riv., sec. forest; riffle, boulders, gravel, wood, mos; algae, c.9°57'42"N, 118°41'47"E 22.1.1995, leg. Freitag (140b)M";15L (0.26, 0.27, 2 × 0.30, 5 × 0.31, 0.32, 5 × 0.33) (NMW) "PHIL.: Palawan, P. Princesa, Irawan River, 6km NW of PPC, 2km upstream of water plant 9°49'N 118°39'E 06.4.1994, leg. Freitag (60)M"; 1L (0.25) (CFP) "PHIL.: Palawan, P. Princesa, Iwahig, Salomon Riv.; rural near sec. forest, riffle, boulders, gravel, wood; 9°46'59"N, 118°40'53"E 24.1.1994, leg. Freitag (159)M"; 1♂, 4♀♀, 18L (0.20, 0.29, 0.21, 0.30, 6 × 0.32, 6 × 0.31, 2 × 0.33) (NMW, ZSM [FR005, FR006])

"PHIL.: Palawan, P. Princesa, Iwahig, Balsahan Riv., upstr.dam; riffle, boulders, gravel, wood, moss; 9°46'36"N, 118°39'55"E 24.1.1995, leg. Freitag (20)M"; 5L (0.25, 0.28, 2 × 0.30, 0.31) (PCSD) "PHIL.: Palawan, P.Princesa; Junction to Napsan, 8km SW PPC; 20m S Binuan Bridge,gravel, root packs, riffle, sec.veget. c.20m asl 9°43'N 118°40'E, 08.2008 leg. Freitag (22b)M"; 3L (0.26, 0.30, 0.32) (SMTD, ZSM) "PHIL.: Palawan, Aborlan; Cabigaan, Talakaigan R.; mount.Riv. upst.dam, riffle, rocks, boulders,CPOM,forest, c.50m asl, 9°26'50"N, 118°26'49"E 25.2.1995, leg. Freitag (154)M"; 1♀, 4L (0.28, 2 × 0.31, 0.32) (SMTD) "PHIL.: Palawan, Narra, 7 km N town centre, downstr. Estrella Falls, mountain riv.; sec. forest, gravel, boulders, submerged wood, riffle; c. 50m asl., c. 9°20'N 118°23'E 16.4.2010, leg. Freitag & Pangantihon (180a)"; 1L (0.30) (CFP) "PHIL.: Palawan, Narra, 5 km W town proper, Taritien River, riffle, boulders, gravel, leaf litter c. 100m asl. 9°19'11"N, 118°22'35"E 17.4.2010, leg. Freitag et al. (182a)".

Larval diagnosis (based on 6th instar). Colour as in Fig. 6: almost entirely dark-brown; antennae, area of explanate lateral thoracic and abdominal gutter, lateral head portions and legs (except for darkened area around claw insertation) pale brown or yellowish. Mouthparts and surrounding portions of head capsule almost black. Without pale pattern at dorsal thoracic and abdominal segments; only apex of abdominal segment sightly paler. Ventral side pale brown.

HW 0.32 mm; entire larva up to 3.5 mm long. Body shape as in *A. minerva,* except for the following: dorsosagittal carinae at the posterior portions of abdominal segments IV–VIII and the entire length of segment IX very distinct (Figs 15A, B). Setiferous tubercles at dorsal side very prominent and protruding (Figs 15A, B) as in *A. pseudopatrolus*. Ventral side smoother, with scattered setae (Fig. 15I).

Head as in Fig. 6 and Figs 15C–F, similar to that of *A. pseudopatrolus*. Glabrous area with stemmata slightly exposed. With few short, acuminate setae on each side and a dorsolateral pair of long double setae (Fig. 15C). Frontal suture U-shaped (Fig. 6). Fasciculate setae at subbasal fringe of clypeus very long (Figs 15C, F). Gula (Fig. 15D), labium (Figs 15D, E), maxillae (Figs 15D, E) and labrum (Figs 15D, F) as in *A. minerva*. Antennae (Fig. 15F) as in *A. punkti*.

Pro-, meso- and metathorax as in Figs 6, 15G and Fig. 15H. Dorsal thoracic segments with conspicuous small round signa (arranged as in Fig. 15G) and a distinct sagittal line (sagittal line partly fused with signa). Thoracic venters (Fig. 15H) rather smooth as in *A. minerva*. Legs (Figs 15H–J) similar to those of *A. minerva*; inner side of tibiae and femora with longitudinal rim of spinous setae (Fig. 15J); all other parts with scattered squamose setae.

Abdomen (Figs 6; 15A, B, I, K) with distinct dorsal sagittal line and slightly elevated surrounding portions in segments I–IV. Dorsosagittal carinae at the posterior portions of abdominal segments IV–VIII distinctly elevated, somewhat drop-shaped and densely covered with setiferous tubercles (Fig. 15B). Sagittal ridge of ventral sclerite of first segment distinctly shorter than 1/2 of segment length (Fig. 15I). Apex of segment IX emarginate. Operculum (Fig. 15K) elongately subtrapezoidal, medially moderately impressed, rugulose.

Variation between larval instars. Specimens of 4th and 5th instar vary only little from the final larval instar. The species typical dorsosagittal carinae of the posterior abdominal segments are very distinct. However, the emargination of the abdominal segment IX` apex is not conspicuous, the overall colour is paler, the thoracic and abdominal segments are relatively narrower, the legs are slightly shorter and broader and the setae on tibiae and femora are fewer and not well arranged in rims.

Larval differential diagnosis. The species can clearly be distinguished from other Palawan species by the lack of pale dorsal colour patches and its highly elevated dorsosagittal carinae which is most conspicuous at the posterior portion of abdominal segment VIII where it appears as a drop-shaped protuberance.

Distribution. Only known from Palawan and Busuanga.

***Ancyronyx montanus* Freitag, sp. n.**
urn:lsid:zoobank.org:act:A0935C7F-E1D7-4211-8B4F-CDE0A020869A
http://species-id.net/wiki/Ancyronyx_montanus
Figs 7, 8, 16A–P, 17A–K

Type material. Holotype ♂ (NMW [FR012]) "PHIL.: Palawan, P.Princesa; Concepcion, Taranaban R. trib.;mount.creek c.8km upstr.; dist. prim. forest; riffle;rocks, boulders,roots; c.450m asl 10°05'N 119°01'E, 28.1.1995 leg. Freitag (16f)M", terminal parts of abdomen incl. aedeagus glued separately, two tarsi lacking. **Paratypes:** 1♀ (NMW), 1L (0.37) (ZSM [FR038]): same data as holotype; 2♂, 4L (0.30, 0.31, 0.36, 0.37) (SMTD, UPLB, NMW, CFP) "PHIL.: Palawan, Roxas, Bgy.Dumarao downstr. New Rizal Falls, sec. forest, c. 120m asl; boulders, sand, CPOM; 10°28'10"N, 119°19'52"E 05.12.1994, leg. Freitag (135)M".

Adult description. Body 1.82–1.88 mm long (CL), 0.79–0.83 mm broad (EW), 2.2–2.4 times as broad as wide (CL/EW). Body form elongate, moderately convex dorsally.

Colouration (Fig. 7) predominantly dark brown to black; legs pale brown to dark brown, (articulations slightly darker); claws and antennae pale brown (distal antennal segment darker); elytra without pale patches; ventral side slightly paler than dorsal, but still dark brown.

Head (Figs 7; 16A, B) 0.41–0.45 mm broad (HW); ID 0.28–0.26 mm; labrum (Fig. 16A) micropunctate, moderately densely covered with long and trichoid setae; frons (Fig. 16A) punctate; clypeus (Fig. 16A) reticulate, moderately densely pubescent; frontoclypeal suture almost straight, slightly impressed. Eyes protruding (Figs 16A, B). Antennae (Fig. 16A) 11–segmented, slender, very slightly longer than head broad. Gula (Fig. 16B) microreticulate, moderately pubescent; gular sutures inconspicuous.

Pronotum (Figs 7; 16C) 0.54–0.65 mm long (PL), 0.52–0.57 mm broad (MW), slightly longer than wide (PL/MW), widest at about posterior 0.2, distinctly narrower than elytra, anteriorly attenuate; anterior margin slightly acuate; margin between pronotum and hypomeron inconspicuous; anterior transverse groove distinct and mod-

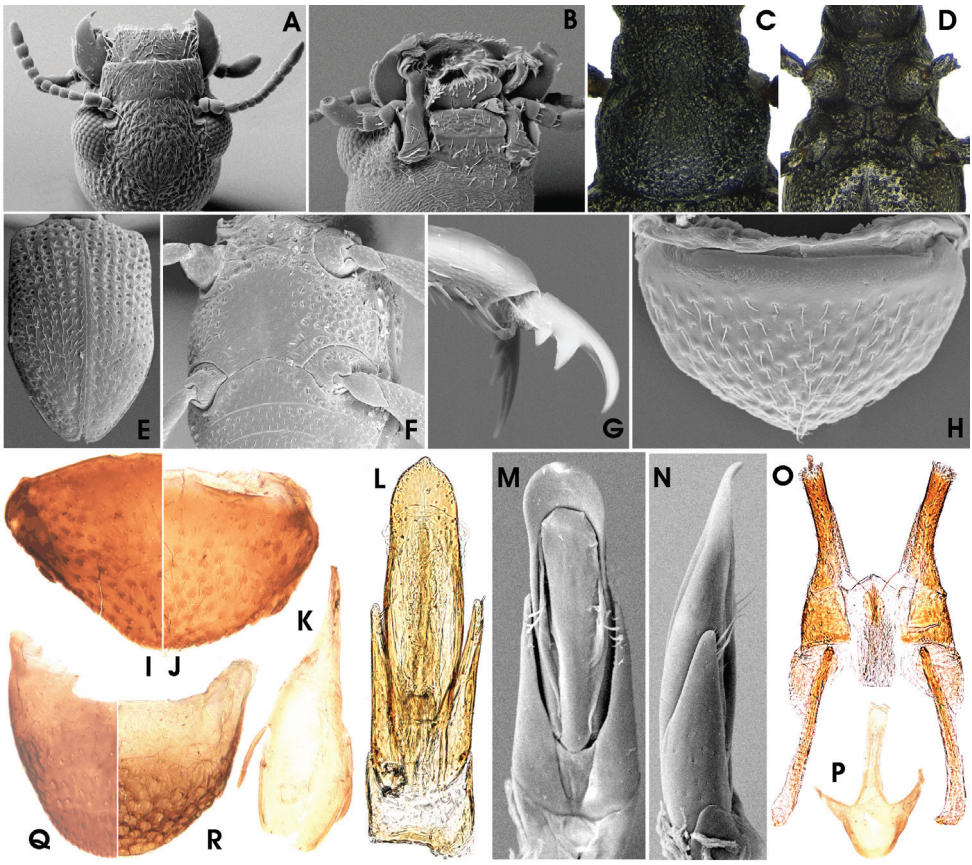

Figure 16. *Ancyronyx montanus* Freitag & Balke, sp. n., (SEM photographs with grey background, stereo microscope photographs with white background) adult male: **A** head, dorsal, **B** head, ventral, **C** pronotum, dorsal, **D** pro-, meso-, and metaventrite, ventral, **E** elytra, dorsal, **F** meso- and metacoxae, metaventrite, ventrites 1–2, ventral, **G** hind claw, **H** ventrite 5, ventral; adult female: **I** ventrite 5, ventral; adult male: **J** ventrite 5, ventral, **K** sternite IX, **L** & **M** aedeagus, ventral, **N** aedeagus, lateral; adult female: **O** ovipositor, ventral, **P** sternite VIII, ventral, **Q** tergite VIII, dorsal; adult male: **R** tergite VIII, dorsal.

erately deeply impressed, medially shallower; anteriorly and posteriorly of transverse groove gently vaulted; posterolateral oblique grooves shallow, inconspicuous; pronotal surface entirely distinctly reticulate; hypomeron reticulate. Prosternum (Fig. 16D) reticulate; prosternal process distinctly narrower medially, medially impressed, posterior margin obtuse.

Scutellum subpentagonal, anteriorly slightly impressed, glabrous. Elytra (Figs 7; 16E) elongate, 1.16–1.35 mm long (EL), c. 1.6–1.8 times as long as wide (EL/EW), almost parallel-sided in anterior 0.1–0.7, posteriorly roundly convergent to apices; elytral apices separately rounded; with c. 10 longitudinal, quite regular, deeply impressed rows of punctures (five strial rows between suture and shoulder); punctures large and deeply impressed; interstices and intervals convex, granulous; lateral elytral gutter moderately broad; humeri prominent. Mesoventrite (Fig. 16D) very short, with

longitudinal impression, with few deep punctures. Metaventrite (Fig. 16F) prominent, with distinct discrimen, subanteriorly and medially impressed along the groove, lateral parts punctate to reticulate; anepisternum 3 prominent, with two irregular rows of punctures. Hind wings present; venation not examined.

Legs slightly longer than body; pro- and mesocoxae large, globular; metacoxae only slightly protruding laterally; femora, tibiae, and tarsi (except distal tarsal segment) covered with elongate setiferous tubercles; tibiae distally with a distinct rim of setae; claws (Fig. 16G) well developed, rather gently curved; base of each claw with three teeth, distal one largest, basal one shortest.

Ventrites 1–4 almost glabrous, posteromedially punctate, reticulate anteriorly and laterally; ventrite 5 (Figs 16H–J), moderately densely covered with short adpressed setae emerging from flat tubercles; lateral projection small and inconspicuous.

Sternite IX (spiculum gastrale) as in Fig. 16K; apical margin almost straight, only very slightly emarginate; paraprocts short, not reaching apical margin.

Aedeagus (Figs 16L–N) very similar to that of *A. punkti* (see Freitag & Jäch, 2007: Figs 13a, b), but distinctly larger, 440–490 µm long. Median lobe moderately long and slender, distinctly widened subapically (c. 80 µm broad), slightly curved ventrad, with numerous distinct microtube-like structures ending sublateroapically; ventral sac weekly sclerotized; fibula well sclerotized, conspicuous in transillumination (Fig. 16L); corona well developed. Phallobase asymmetrical, slightly widened ventrally, with conspicuous, strongly sclerotized margin; basolateral (penile) apophyses rather short. Parameres elongately subtriangular with basal margin strongly emarginate (lateral view, Fig. 16N), reaching about basal 0.63 of aedeagus, not contiguous ventrally.

Ovipositor (Fig. 16O). Total length c. 620 µm. Stylus slender, slightly bent outwards (partly broken off in specimen examined). Coxite long and slender, distal portion distinctly elongate, with several comparably long, lanceolate setae, most densely set at apex; mesal margin densely pubescent; basal portion c. half as long as distal portion, with same type of setae in distinct patterns as in Fig. 16O. Valvifer about as long as coxite; fibula (mesal, longitudinal sclerotisation) genus typical as in Fig. 16O.

Secondary sexual characters. Sternite VIII in female (Fig. 16P) with median strut apically widened, almost truncate, posterior portion slightly pubescent; sternite VIII in male weakly sclerotized, median strut distinctly shorter than in female. Ventrite 5 in female subtriangular (Fig. 16I), in male (Fig. 16J) shorter and suboval. Tergite VIII in female (Fig. 16Q) longer than broad; condyles more or less straight and prominent; reticulations only conspicuous laterally. Tergite VIII in male (Fig. 16R) broader than long, reticulation more developed than in female covering apical half; basal half patterned with lines of asperities; condyles not distinctly curved, overreaching anterior margin.

Adult differential diagnosis. *A. montanus* superficially resembles dark specimens of *A. patrolus* (Freitag & Jäch 2004: Fig. 4), from which it can be easily distinguished by the larger size, slenderer body (EL/EW), the entirely reticulate pronotal surface that lacks any glabrous areas, the medially narrowed prosternal process and its genital characters.

Larval description (based on 6th instar). Colour as in Fig. 8: very similar to that of *A. patrolus*, but overall darker and somewhat shiny; legs entirely pale brown to yellowish. Mouthparts and surrounding portions not distinctly darker than dorsal and ventral head portions. Without pale pattern at dorsal thoracic and abdominal segments; only apex of abdominal segment slightly paler. Ventral side pale brown.

HW 0.37–0.41 mm; entire larva up to 3.3 mm long. Body shape as in *A. patrolus*, except for the following: entire body more vaulted in cross section; dorsal sagittal area flat, with rather indistinct sagittal line, without carina at all thoracic and abdominal segments. Setiferous tubercles at dorsal side rather flat, not as elevated as in the other species (Fig. 17A), those of ventral side very flat and inconspicous (Fig. 17B). Setae originated from tubercles (Figs 17A–C) lanceolate to trichoid and distinctly longer than in the previous species. Posterolateral abdominal projections comparably small, attenuate, distinctly larger at anterior abdominal segments (Figs 8, 17C). Trichoid teeth not reaching middle of subsequent abdominal segment when that retracted.

Head (Figs 8, 17D-F) basically as in the previous species, but with the following varying characters: broadest posterior 0.25, laterally slightly convex. Glabrous area with stemmata not exposed. With few long, trichoid setae on lateral sides and one dorsolateral pair of long double setae (Figs 17D–F). Entire head more or less densely covered with squamose to fascicular setae originated from slightly elevated tubercles and additionally with several moderately long trichoid setae (Figs 17E–F). Frontal suture V-shaped. Fasciculate setae at subbasal fringe of clypeus very long, overreaching labrum (Fig. 17E); labrum with large fasciculate setae (Fig. 17E). Gula, maxillae and labium (Fig. 17F) almost as in *A. minerva,* but with few squamose setae and shorter maxillary and labial palpi. Mandibles as in Fig. 17E. Antennae (Fig. 17E) almost as in *A. patrolus*, scapus with large plumose setae.

Pro-, meso- and metathorax as in Figs 8 and 17G, H. Thoracic terga with small round signa in sublateral portions; sagittal line rather inconspicuous. Thoracic venters (Figs 17G, H) with asperities and irregularly distributed setiferous tubercles; anterior sclerites and posterior portion of lateral sclerites of prothorax (Fig. 17G) densely covered with tubercles. Posteromedial sclerite bald and rugulose. Meso- and metathorax with scattered setiferous tubercles at distal portions of all sclerites, lateral sclerite portions densely covered with asperities (Fig. 17H). Legs (Fig. 17I) similar to those of *A. patrolus,* but with comparably long and slender femora (c. as long as tibiae); coxae with distinct asperities; other surfaces rather glabrous. Claws slender and long, moderately bent (Fig. 17I).

Abdomen (Figs 8; 17A–C, J–K) without any elevations or carinae at dorsal sagittal area; segments I–VI with a pair submedian trichoid setae, that are distinctly longer than surrounding lanceolate to trichoid setae (Fig. 17A). Ventral sclerite of first segment without sagittal ridge (Fig. 17H). Apex of segment IX distinctly emarginate (Fig. 17K). Operculum (Fig. 17J) subovate, medially slightly impressed, with scattered lanceolate setae in apical and lateral portions.

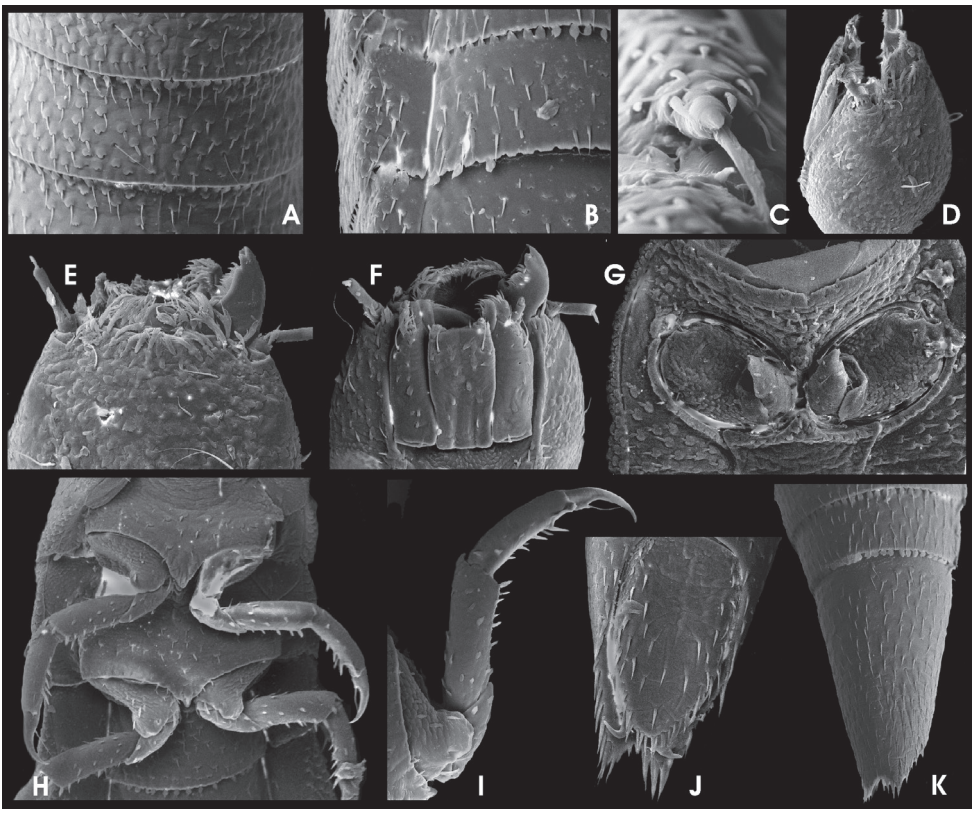

Figure 17. *Ancyronyx montanus* Freitag & Balke, **sp. n.**, larva (SEM photographs), **A** abdominal segments VI–VIII, dorsal, **B** lateral and parts of median sclerites of abdominal venter, with different types of setae and lateral projections, **C** posterolateral abdominal projection with trichoid tooth, **D** head, dorsolateral, **E** head, dorsal, **F** head, ventral, **G** prothorax, ventral, **H** thoracic and first abdominal segments, ventral, **I** hindleg, lateral, **J** operculum, ventral, **K** abdominal segments VIII and IX, dorsal.

Variation between larval instars. The two specimens of prefinal instar stage vary most conspicuously from the above description by the overall paler brown colour, the more conspicuous dorsal setiferous tubercles that let the pronotal signa appear clearly as well as the slightly crested (in cross-section subtriangular) abdominal segment IX.

Larval differential diagnosis. The species is easily distinguishable from other Palawan species by the lack of any dorsosagittal carinae or elevations, the dark, shiny dorsal colour, its rather large size and the rather shallow dorsal tubercles bearing comparably long, lanceolate to trichoid setae.

Distribution. Only known from the type locality in central Palawan and one site in northern Palawan (Fig. 20).

Etymology. The species is named in reference to the remote mountainous river habitats where it was exclusively recorded from.

***Ancyronyx procerus* Jäch, 1994**
http://species-id.net/wiki/Ancyronyx_procerus
Figs 9, 18A–J

Ancyronyx procerus Jäch, 1994: 611–613 (adult description); Jäch, 2003: 259 (new records).

Material examined. 1 L (0.61) (ZSM [FR014]) "PHIL.: Busuanga, Coron; Guadelupe, Balolo R./Brdg. Nat.Rd. km 14; lowld. creek; sec.veget.; run, gravel, CPOM, c.10m asl, 12°01'43"N, 120°06'48"E 03.2.1995, leg. Freitag (169)M"; 1L (0.63) (NMW) "MALAYSIA, Sarawak, Mulu NP, Long Iman 4.3.1993 leg. M. Jäch (20)".

Larval description (based on 6th instar). Colour (Fig. 9) predominantly brown; head distinctly darker to almost black dorsally; lateral head, antennal scape, anterior pronotal collar and legs whitish or yellowish pale. Entire ventral side (except for parts of genae), antennal pedicel, anterior margin of pronotum, claws, lateral abdominal projections, small medioposterior areas or entire posterior margin of thoracic and abdominal segments and a median middle portion of abdominal segment IX pale brown to yellowish.

HW c. 0.62 mm, entirely c. 3.7 mm long. Body flattened dorsoventrally, moderately vaulted dorsally, almost flat ventrally, with sagittal line (longitudinal groove from prothorax at least up to 5th abdominal segment). Dorsal side moderately densely covered with setiferous tubercles (Fig. 18A). Ventral side smoother, with scattered setae and few setiferous tubercles (Fig. 18B). Retractable portions of body segments and pronotal collar without setae and tubercles (Fig. 18A). Lateral margins of abdominal segments I–VIII produced laterad forming posterolateral-directed conical projections (Fig. 18C). Projections increasing in size caudad, those of segment VIII c. 3.5 times as long as such on segment I. Rather inconspicuous spiracles present laterally on mesothorax and abdominal segments I–VIII.

Head (Figs 18A, D–F) subquadrate, partly retractable, distinctly prognathous, with three anterior-dorsad directed, pointed projections, one each side between antenna and clypeus and one at median frons (Fig. 18A). Frons rather glabrous, only with small and scattered setiferous tubercles. Stemmata arranged as single lateral spot in a glabrous area, slightly exposed. One irregular rim of moderately long setae at ventrolateral head margin (not visible in dorsal view). Frontal suture broadly V-shaped. Frontoclypeal suture uneven, but somewhat straight. Clypeus distally microreticulate, with protuberant anterior seam; without subbasal fringe of setae or tubercles. Ventral side (Fig. 18D) with few scattered setae and an obvious longitudinal crest each side lateral of gula and maxillae. Genae rugose, with asperities and scattered tubercles. Gula with rather inconspicuous asperities. Maxilla (Figs 18D, E) moderately broad; cardo stout, undivided; lateral portion with one median acuminate seta; stipes subrectangular, glabrous, with few short and one long latero-subapical trichoid setae; maxillary palpus (Fig. 18E) four-segmented, approx. as long as stipes broad, distal segment smallest, cylindrical with several apical sensilla of various

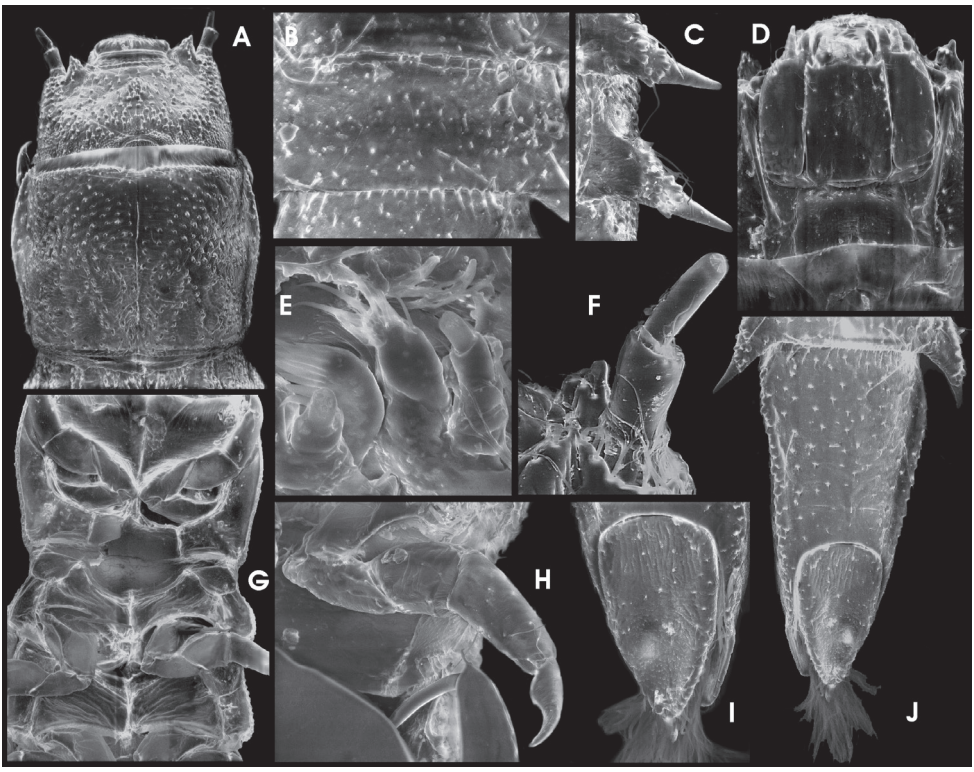

Figure 18. *Ancyronyx procerus* Jäch, 1994, larva (SEM photographs): **A** pronotum and head, dorsal, **B** detail of abdominal segment III, ventral, **C** abdominal posterolateral projections, ventral, **D** head, ventral, **E** apical portions of labium and maxilla, ventral, **F** antenna, ventral, **G** thoracic segments, ventral, **H** hindleg, ventral, **I** operculum, ventral, **J** abdominal segment IX, ventral.

shape; predistal segment with lateroapical trichoid seta; galea and lacinia subequal in length and shape, approx. as long as palpus, apically with sensilla. Labium (Figs 18D, E) with broad (about 1.7 times of stipes) mentum (postmentum), broadest at basal half, with median groove most depressed posteriorly, with one pair of moderately long trichoid setae sublaterally at anterior 0.25, one subbasal pair each of spinose and trichoid setae and one pair of short apical lateral teeth. Submentum (prementum) short, transverse, apically convex, with sagittal ridge and one laterobasal pair of setae; ligula inconspicuous with various setae and pegs; labial palpi short, with short and stout palpifer; apical segment similar to that of maxillary palpi, preapical segment with lateral tuft (Fig. 18E). Mandibles not examined. Labrum c. 3 times as wide as long, anterior margin distinctly convex, with a subapical fringe of ramose setae and scattered trichoid and truncate (sensory) setae, proximal portion glabrous. Antenna (Fig. 18F) three-segmented, c. 1/2 as long as head. Peduncle short, about as long as broad, without (visible) dorsolateral fringe of branched trichoid setae; scape cylindrical, longer than pedicel and c. twice as long as broad, with few apical trichoid setae; pedicel cylindrically elongate, comparably short, only slightly longer

than scape; flagellum and sensorium (broken off in figured specimen) subequal in length, slender, cylindrically elongate, c. five times as long as broad; apex of flagellum with inconspicuous elongate sensillum.

Prothorax subquadrate, almost as long as broad, with round signa (glabrous areas) in posterior half and near depressed sagittal line. Meso- and metathorax subtrapezoidal, distinctly broader than long, distinctly shorter than prothorax (Fig. 9); medial longitudinal groove and lateral rims distinctly produced posterolaterad. Venter of prothorax (Fig. 18G) with five sclerites: two oblique anterior, two lateral, and one posteromedial sclerite. Anterior sclerites subtriangular; procoxal cavity closed posteriorly; lateral sclerites posteriorly extend mesad, anteriorly appearing divided by an oblique incomplete suture. Entire anterior and lateral prothoracic venter glabrous, few setiferous tubercles in posterior portions. Venter of meso- and metathorax (Fig. 18G) with six sclerites: two oblique anterior, two subquadrate sclerites anterolateral, two elongate meso-posterolateral sclerites; coxal cavities open posteriad; setiferous tubercles sparse on lateral portion; medial portions almost glabrous. Membrane connecting pro- and mesothoracic venter largely extended medially, appearing almost as a separate sclerite (like a prosternal process in adults). Posterior margin of anterior sclerites with fringe of setiferous tubercles.

Legs (Figs 18G, H) stout (compared to larvae of the previous species and adults), similar in shape and length, with scattered trichoid sensilla mainly at femora and tibiae. Coxae large, subtrapezoidal; trochanter shorter, elongately subtrapezoidal, rather slender; femora subtrapezoidal, short; tibiae subcylindrical, broadest basal, distinctly narrower than femur, longer than other segments. Claws elongate, moderately bent, with one subbasal presumably trichoid tooth (broken or invisible in specimen examined).

Abdomen (Figs 9; 18B, I, J). Segments I–VIII similar in shape, broadly subrectangular in dorsal view; terga with depressed sagittal line at least from 1st up to 5th segment. Retractable anterior portion with squamose asperities; posterior terga margins with a rim of squamose setae. Remaining median portions of terga more or less equally covered with setiferous tubercles. Ventral sclerites of segments I–VIII subrectangular, extendingly fused with pleural sclerites from 1st to 8th segment; posterior venter margins with a rim of squamous setae. Segment IX (Figs 18I, J) elongate, subconical (broadest subbasally), subtriangular in cross-section; apex broadly rounded, not emarginate; dorsal and lateral portions densely covered with setiferous tubercles; ventral side with scattered short trichoid setae and some long filiform setae sublaterally (most broken off in specimen figured in Fig. 18J). Operculum (Fig. 18I) subtrapezoidal to subtriangular, less than double as long as broad, medially depressed, rugose. Basal half with small longitudinal ridges and scattered sensilla; apical half with squamose asperities and a lateral rim of trichoid setae; the internally inserted pair of hooks rather small. Gill chamber with long, ramose gill tufts overreaching the opercular margin.

Variation between larval instars. The two final instar specimens available do not allow to draw conclusions about variations between the instars.

Larval differential diagnosis. The species resembles the previous ones only in very general characters, such as the presence of posterolateral appendages and the distribu-

tion of spiracles. This larva is, however, not torpedo-like elongate and subsemicircular in cross section, but dorsoventrally somewhat depressed, only slightly vaulted dorsally. By this it rather resembles the species *A. variegatus* from North-America than those of the *A. patrolus* group (Freitag & Jäch, 2007, p. 58).

Distribution. Known from Busuanga, Philippines (recent study; Fig. 20), Malaysia, Brunei and Vietnam (Jäch 1994)

Ancyronyx helgeschneideri Freitag & Jäch, 2007

http://species-id.net/wiki/Ancyronyx_helgeschneideri
Figs 10, 19A–L

Ancyronyx helgeschneideri Freitag & Jäch, 2007: 55–58 (adult description).

Material examined. 21 exs., 1L (0.45) (PCSD, SMTD, ZMUC, IMRL, CFP, NMW, ZSM [FR007, FR061]) "PHIL.: Palawan, P. Princesa S Manturon, Cabayugan R. 10°09'28"N, 118°53'26"E 05.3.2001, leg. Freitag (CR4)M"; 5L (0.39, 0.45, 0.48, 0.49, 0.50) (NMW) "PHIL.: Palawan, P. Princesa S Manturon, Cabayugan R. 10°09'16"N, 118°52'30"E 21.4.2001, leg. Freitag (CR3)C"; 4L (0.32, 0.37, 0.40, 0.43) (CFP) "PHIL.: Palawan, P. Princesa S Manturon, Cabayugan R. 10°09'16"N, 118°52'30"E 18.10.2000, leg. Freitag (CR3)M"; 2L (0.25, 0.48) (CFP) "PHIL.: Palawan, P. Princesa S Manturon, Cabayugan R. 10°09'16"N, 118°52'30"E 13.2.2001, leg. Freitag (CR3)C"; 1L (0.42) (IMRL) "PHIL.: Palawan, P. Princesa S Manturon, Cabayugan R. 10°09'16"N, 118°52'30"E 04.9.2000, leg. Freitag (CR3)C-P"; 3L (0.41, 0.46, 0.48) (ZSM) "PHIL.: Palawan, P. Princesa S Manturon, Cabayugan R. 10°09'16"N, 118°52'30"E 31.7.2001, leg. Freitag (CR3)C"; 2L (2 × 0.47) (PCSD) "PHIL.: Palawan, P. Princesa S Manturon, Cabayugan R. 10°09'28"N, 118°53'26"E 04.9.2000, leg. Freitag (CR4)C-R"; 5L (SMTD) "PHIL.: Palawan, P. Princesa S Manturon, Cabayugan R. 10°09'28"N, 118°53'26"E 16.10.2000, leg. Freitag (CR4) C";1L (0.46) (ZMUC) "PHIL.: Palawan, P. Princesa S Manturon, Cabayugan R. 10°09'28"N, 118°53'26"E 25.5.2001, leg. Freitag (CR4)D"; 1L (0.32) (NMW) "PHIL.: Palawan, P. Princesa SE Manturon, Karst spring 10°09'29"N, 118°53'30"E 18.10.2001, leg.Freitag (LS4)C"; 1L (0.45) (ZMUC) "PHIL.: Palawan, P. Princesa SE Manturon, Karst spring 10°09'29"N, 118°53'30"E 09.12.2001, leg.Freitag (LS4) C"; 2♂♂, 1♀ (SMTD, CFP) "PHIL.: Palawan, Rizal, Campung-ulay, Kalitawan Riv.; HW km 212.2, sec. veget/forest; slightly polluted, submerged wood in run, c. 30m asl. 9°19'11"N, 118°22'35"E 02.7.2010, leg. Freitag (186)"; 1♂, 2♀♀ (NMW, ZSM: [FR013])"PHIL.: Busuanga, Coron; Guadelupe, Balolo R./Brdg. Nat.Rd. km 14; lowld. creek; sec.veget.; run, gravel, CPOM, c.10m asl, 12°01'43"N, 120°06'48"E 03.2.1995, leg. Freitag (169)M".

Larval diagnosis (based on 6th instar). Colour as in Fig. 10; dorsal head, pronotal disc and abdominal segment IX from apical 0.1 to apical 0.4 dark brown; lateral head, antennae, anterior and lateral pronotal margins, legs (except for tip of claw), lateral

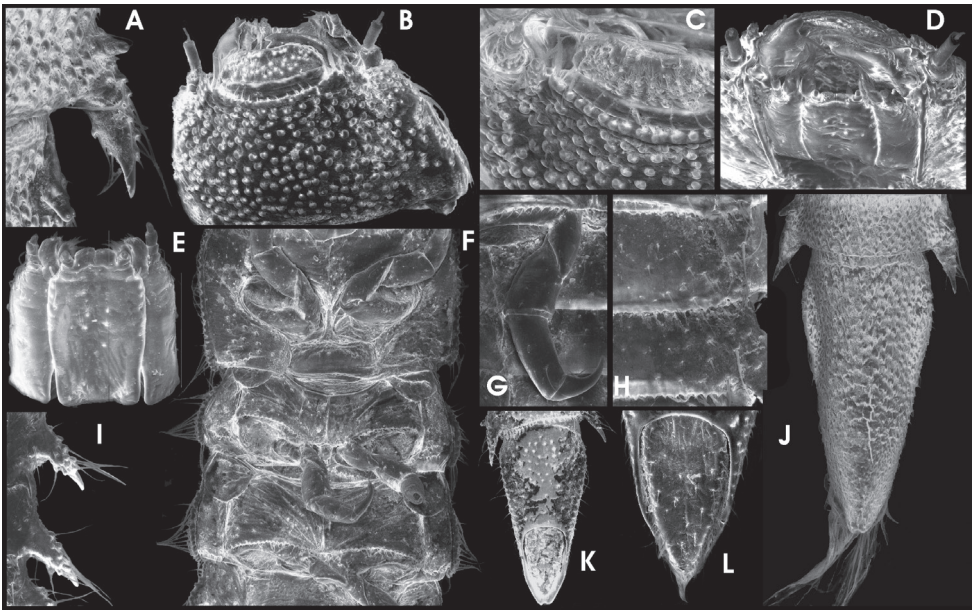

Figure 19. *Ancyronyx helgeschneideri* Freitag & Jäch, 2007, larva (SEM photographs): **A** lateral portion of abdominal segment VI with posterolateral trichoid tooth and spiracle, dorsal, **B** head, dorsal, **C** head portion with labrum, frontodorsal, **D** head, frontoventral, **E** maxillae & labium, ventral, **F** thoracic segments, ventral, **G** hindleg, ventral, **H** portion of abdominal segments, ventral, **I** abdominal posterolateral projections, ventral, **J** abdominal segment VIII & IX, dorsal, **K** abdominal segment IX, ventral, **L** operculum, ventral.

abdominal, meso- and metathoracic margins including projections as well as median portion of segment IX pale yellowish; anterior pronotal edges with conspicuous pale pattern that is extending mediad to disc; remaining parts of dorsal thorax and abdomen brown with indistinct pale patterns; the latter most conspicuous as yellowish spot at posterosagittal margin of all segments. Ventral side entirely pale, except for pale brown gula, maxillae, labium and ventral parts of genae.

HW c. 0.50 mm, entire larve up to 4.5 mm long. Body shape somewhat similar to that of *A. procerus* in the external characters, except for the following characters: spiracles distinctly larger, very prominent (Figs 10, 19A); entire lateral margin with distinct long, trichoid setae (Figs 10, 19F); tubercles at dorsal side more prominent (Figs 19A, B), but dorsal setae very short.

Head (Figs 19B–E) broadest subbasally, slightly conical anteriad, without median pointed projection at frons; pair of sublateral anterior projections between antenna and clypeus rather shallow and inconspicuous (Fig. 19B). Frons moderately densely covered with moderately large and equally dispersed setiferous tubercles; genae rugose, with scattered tubercles; lateral glabrous area with stemmata irregularly shaped. Antenna (Figs 19B–D) short, c. 1/3 as long as head. Scape short, as long as broad, with subapical fringe of stout sensilla; pedicel cylindrical, less than two times as long as scape and c. three times as long as broad, with few inconspicuous apical sensilla;

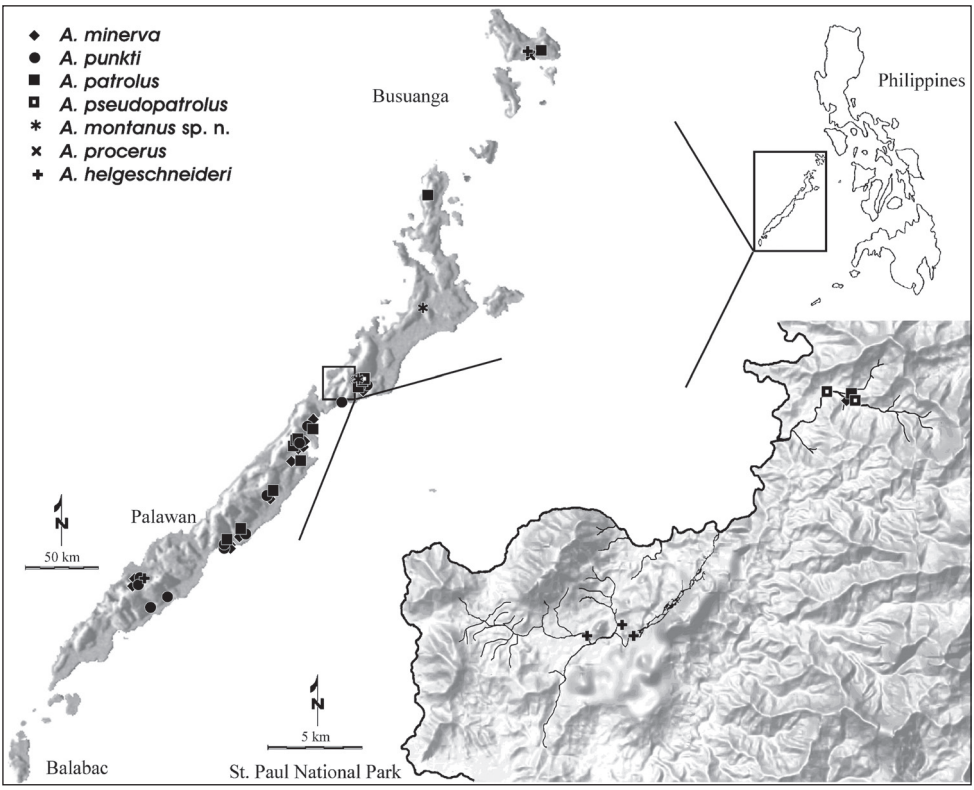

Figure 20. Collecting sites of the *Ancyronyx* species treated herein in Palawan and Busuanga, including enlarged map of St. Paul National Park. See Freitag & Jäch, 2007, Fig. 17 for previous records.

flagellum and sensorium as in *A. procerus*. Labrum (Fig. 19C) c. 2.5 times as wide as long; lateroapical edges rounded; dorsal surface with tubercles, ramose setae and short trichoid setae. Ventral head (Figs 19D, E) with well-developed longitudinal crests. Maxilla (Figs 19D, E) almost as in *A. procerus.* Labium (Figs 19D, E) with mentum (postmentum) broadest in apical half, one pair of moderately long trichoid setae inserted sublaterally at anterior 0.25; some additional inconspicuous setae present at lateral margin in apical half; pair of apicolateral teeth slender, inserted at a distinct subapical crenation; submentum (prementum) divided.

Prothorax slightly broader than long; tergum with irregularly shaped signa in posterior half. Venter of pro-, meso and metathorax (Fig. 19F) similar to that in *A. procerus*, but anterior sclerites more oblique.

Legs as in Figs 19F, G and very similar to those in *A. procerus*.

Abdomen (Figs 10; 19A, G–L) with terga slightly depressed groove along sagittal line at least from 1st up to 4th segment; venter almost glabrous, with scattered trichoid setae of different length; segment IX as in Figs 19J–L with emarginate apex; operculum (Fig. L) glabrous, with rather inconspicuous basal ridges; disc without conspicuous asperities, covered with few scattered setae.

Variation between larval instars. Specimens of the 3rd to the 6th (final) instar stage are available for study. Within this range it is obvious that the younger the specimens the paler they are, the longer are all kinds of setae (in relation to the body) and the fewer setiferous asperities are present. Additionally, the limb setae are varyingly arranged and the terminal abdominal segment is relatively shorter and broader as well as the legs. The latter is most obvious between the final and prefinal instar stages.

Larval differential diagnosis. The larvae of *A. helgeschneideri* resemble those of *A. procerus* but can be clearly distinguished by absence of the pointed projections at median frons, the more shallow projections between the antenna and clypeus, the larger and more protruding spiracles, the more convex head shape, the varying labrum and antennae and the dorsal surfaces of head, thorax and abdomen that are densely covered with larger tubercles as well as the entire lateral body margin bearing long, conspicuous setae.

Distribution. Only known from Palawan and Busuanga.

Key to the larvae of *Ancyronyx* species of Palawan and Busuanga (without *A. minutulus*)

Ancyronyx larvae can be distinguished from other Elmid larvae by the unique combination of the following characters:

Body form subsemicircular in cross-section or dorsoventrally flattened (depressed), with posterolateral projections or processes on abdominal segments I–VIII and lateral spiracles on mesothorax and abdominal segments I–VIII. Ventral prothorax with five sclerites (including one posteromedial sternellum), meso- and metathorax with six sclerites. Abdomen with pleura on segments I–VIII.

1 Body torpedo-like elongate, subsemicircular in cross section. Posterolateral abdominal projections small, lobate with tip posteriad directed (Figs 3–6, 8) **2**

– Body flattened dorsoventrally (depressed), only slightly vaulted. Posterolateral abdominal projections large, conical with tip posterolaterad directed (Figs 9–10).....**6**

2 At least terminal segment, but usually several posterior abdominal segments with dorsosagittal carina or elevation (Figs 11K, 12K, 14I). Terminal abdominal segment subtriangular in cross section. Dorsal surface appearing granulate by distinct tubercles (Figs 3–6).....**3**

– All abdominal segments without dorsosagittal carinae or elevations (Fig. 17K). Terminal abdominal segment subsemicircular in cross section. Dorsal surface shiny (Fig. 8), tubercles indistinct (Palawan, rare) ..... ***A. montanus***

3 Some peripheral areas of dorsal pronotum with obvious pale colour patches (Figs 3–5). Dorsosagittal carinae low, not extended into a drop-shaped protuberance on abdominal segment VIII **4**

– Entire dorsal surface colour without obvious pale patches (Fig. 6). Dorsosagittal carinae high, extended into a drop-shaped protuberance at the posterior

portion of abdominal segment VIII (Fig. 15B).(Palawan and Busuanga; common).....***A. patrolus***

4 Pronotum anteriorly with small transverse yellow band (less broad than 1/4 of pronotum, Figs 3–4). Posterior third of abdominal segment IX without distinct dorsosagittal carina (Figs 11K, 12K).....**5**

– Pronotum anteriorly with broad transverse, rather pale band (extended over c. 1/3 of pronotum, Fig. 5). Entire abdominal segment IX with distinct dorsosagittal carina (Fig. 14K). (Palawan; rare).....***A. pseudopatrolus***

5 Anterior yellowish band of pronotum slightly extended posteriad along the midline (Fig. 3). Abdominal apex rounded (Fig. 11K), pale dorsal colour pattern lacking or limited to tip (Fig. 3). (Palawan, Busuanga, Mindoro; common).....***A. minerva***

– Anterior yellowish pronotal band not extended posteriad along the midline (Fig. 4). Abdominal apex truncate or slightly emarginate (Fig. 12K), apical pale dorsal colour pattern conspicuous and extending about one third of terminal segment (Fig. 4). (Palawan, Busuanga, Mindoro; common) ....***A. punkti***

6 Frons with one median pointed projection ("horn") (Fig. 18A). (Busuanga and presumably other Philippine islands; presumably rare) .....***A. procerus***

– Frons without median pointed projection (Fig. 19B). (Palawan, Busuanga; locally abundant) .....***A. helgeschneideri***

Updated check list of the Philippine species of *Ancyronyx*

1. *Ancyronyx helgeschneideri* Freitag & Jäch, 2007 (Palawan, Busunga)
2. *Ancyronyx minerva* Freitag & Jäch, 2007 (Palawan, Mindoro)
3. *Ancyronyx minutulus* Freitag & Jäch, 2007 (Palawan)
4. *Ancyronyx montanus* Freitag & Balke, new species (Palawan)
5. *Ancyronyx patrolus* Freitag & Jäch, 2007 (Palawan, Busuanga)
6. *Ancyronyx procerus* Jäch, 1994 (Busuanga, Borneo, Vietnam)
7. *Ancyronyx pseudopatrolus* Freitag & Jäch, 2007 (Palawan)
8. *Ancyronyx punkti* Freitag & Jäch, 2007 (Palawan)
9. *Ancyronyx schillhammeri* Jäch, 1994 (Mindoro)
10. *Ancyronyx sophiemarie* Jäch, 2004 (Sibuyan)

Discussion

We successfully used mitochondrial DNA sequencing to associate different life stages of beetles with each other, substantiated by morphological description of larvae. Use of DNA sequences has helped to avoid potential pitfalls, as for *A. procerus* samples where an unknown larva of a species, which was formerly not recorded in the area, occurred

syntopically on the very same piece of wood debris with adults only of another species. This could have led to a misinterpretation as to which larva belongs to which adult.

The morphological species groups suggested by Freitag & Jäch (2007) were supported here by morphological characters of the larvae. Two main types are recognized. The *Ancyronyx patrolus* species group is characterized by smaller size, more vaulted larval body shape (in cross section) and rather small, caudal-directed posterolateral abdominal projections. The larvae of the *A. variegatus* species group are larger, depressed (in cross section), and display large, lateral-directed posterolateral projections.

The female and the larva of *Ancyronyx minutulus* Freitag & Jäch, 2007 still remain unknown to science. No additional material has been collected since the single holotype male was described despite intense sampling on Palawan Island including its type locality.

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RESEARCH ARTICLE

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A new species of *Cisaris* (Hymenoptera, Ichneumonidae, Cryptinae) with a key to the world species

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Abstract

A new species, *Cisaris canaliculatus* Sun & Sheng, **sp. n.**, belonging to the tribe Phygadeuontini of the subfamily Cryptinae (Hymenoptera: Ichneumonidae), collected from Jiangxi Province, China, is reported. A key to the species of the genus *Cisaris* Townes, 1970, is provided.

Keywords

Phygadeuontini, *Cisaris*, new species, key, taxonomy, China

Introduction

Cisaris Townes, 1970, belonging to the tribe Phygadeuontini of the subfamily Cryptinae (Hymenoptera, Ichneumonidae), comprises four described species (Yu et al. 2005), of which two are from the Oriental part of China (Kusigemati 1985, Pei and Sheng 2000, Sheng and Sun 2009), one from Japan (Kusigemati 1985), belonging to the Eastern Palaearctic Region, and one from the Philippines (Townes 1970). The status of the genus was defined by Townes (1970). There in an unknown number of undescribed species present in collection from the Oriental Region but few species occur in China or neighbouring countries.

In the last four years the authors have been exploring Jiangxi Province, situated in the northern border of the Oriental part of China. New discoveries have been reported (Sheng et al. 2009, 2010, 2011), and will be reported successively. In this article, one new species of *Cisaris* is reported.

Materials and methods

Specimens were collected using entomological nets in the forests of Quannan, Yifeng and Zixi Counties, Jiangxi Province (CHINA). Images of whole bodies were taken using a CANON Power Shot A650 IS. Other images were taken using a Cool SNAP 3CCD attached to a Zeiss Discovery V8 Stereomicroscope and captured with QCapture Pro version 5.1.

The morphological terminology is mostly that of Gauld (1991). Wing vein nomenclature is based on Ross (1936) and the terminology on Mason (1986, 1990).

Type specimens are deposited in the Insect Museum, General Station of Forest Pest Management, State Forestry Administration, People's Republic of China.

Taxonomy

***Cisaris* Townes, 1970**
http://species-id.net/wiki/Cisaris

Cisaris Townes, 1970. Memoirs of the American Entomological Institute, 12(1969):82.
Type-species: *Cisaris tenuipe* Townes.

Diagnosis. Head and mesosoma heavily punctate. Head comparatively large. Eye with sparse hairs. Margin of clypeus reflexed, median section often slightly produced. Mandible with upper tooth much longer than lower tooth. Notaulus not reaching to center of mesoscutum. Posterior edge of mesoscutum without transverse groove. Scutoscutellar groove without median longitudinal carina. Fore wing without areolet. Fore wing vein 2m-cu subvertical, with one bulla. Area superomedia hexagonal or trapezoidal. Hind tibia with dense inner, apical fringe of setae and with polished groove between setal fringe and tarsal insertion. First to third terga polished. First tergum slender, spiracle far behind middle. First sternite slightly basal of spiracle. Ovipositor compressed, its tip very long and gradually tapered. Dorsal valve with a weak nodus. Ventral valve without ridges.

Key to the species of *Cisaris*

1 Female **2**
– Male **6**
2 Antenna without white ring. Fore wing with vein 1cu-a distad of 1/M. Area superomedia longer than wide, with costula near its middle. (Male unknown) ..... ***C. tenuipes* Townes**
– Antenna witht white ring. Fore wing with vein 1cu-a opposite 1/M. Area superomedia wider than long, or approximately as long as wide, with costula behind its middle or near its posterior corner **3**
3 Terga red or reddish brown. Area superomedia and area petiolaris separated by a strong carina **4**
– Terga black. If black with apical terga blackish brown (Fig. 1), area superomedia and area petiolaris combined (Fig. 5) **5**
4 Face 1.8 to 1.9 times as wide as long at level of upper margin. Malar space approximately 0.6 times as long as basal width of mandible. Costula originating from anterior corner of area petiolaris ..... ***C. takagii* Kusigemati**
– Face 2.2 times as wide as long at level of upper margin. Malar space approximately 0.92 times as long as basal width of mandible. Area superomedia with costula slightly behind its middle ..... ***C. mitis* Pei & Sheng**
5 Area superomedia trapezoidal, anterior and posterior sides (carinae) very weak or almost absent, with costula at its posterior corner, transverse (Fig. 5). Ocular-ocellar line at least 2.0 times as long as largest diameter of ocellus (Fig. 3) ..... ***C. canaliculatus* Sun & Sheng, sp. n.**
– Area superomedia hexagonal, with complete and strong carinae, costula originating from its posterior corner, leaning slightly forward laterally. Ocular-ocellar line 1.6 times as long as largest diameter of ocellus. (Male unknown) ..... ***C. niger* Kusigemati**
6 Terga and hind leg entirely black (Fig. 2). Malar space 0.42 to 0.47 times as long as basal width of mandible. Area superomedia and area petiolaris completely combined ..... ***C. canaliculatus* Sun & Sheng, sp. n.**
– Terga brown or darkish brown. Hind leg reddish brown or darkish brown. Malar space at most 0.3 times as long as basal width of mandible. Area superomedia separated from area petiolaris by strong carina **7**
7 Area superomedia approximately 1.5 times as wide as long, costula originating from its middle ..... ***C. mitis* Pei & Sheng**
– Area superomedia approximately 2.7 times as wide as long. Costula originating from anterior corner of area petiolaris ..... ***C. takagii* Kusigemati**

***Cisaris canaliculatus* Sun & Sheng sp. n.**
urn:lsid:zoobank.org:act:0836E352-AA13-4BC0-8509-7317277E2D0D
http://species-id.net/wiki/Cisaris_canaliculatus
Figures 1–6

Etymology. The specific name is derived from the median trough of the propodeum.

Material examined. *Holotype*: female. CHINA: Matoushan, 400m, Zixi County, Jiangxi Province, 8 May 2009, leg. Mei-Juan Lou. *Paratypes*: 1 female, CHINA: Quannan County, Jiangxi Province, 29 April 2008, leg. Shi-Chang Li; 15 males, same data as holotype except 10 to 17 April 2009; 1 male, CHINA: Guanshan Natural Reserve, Yifeng County, Jiangxi Province, 20 April 2009, leg. Mao-Ling Sheng; 2 males, CHINA: Guanshan Natural Reserve, Yifeng County, Jiangxi Province, 24 April 2011, leg. Shu-Ping Sun and Mao-Ling Sheng.

Diagnosis. Head, mesosoma, coxae and terga black, except apical portion of female more or less blackish brown. Flagellum with white ring. Tegula brownish black. Area superomedia trapezoid, anterior and posterior sides of area superomedia very weak or almost absent (Fig. 5). Apical-median portion from area superomedia to apex of area petiolaris strongly concave longitudinally. Costula present at posterior corner of area superomedia. Propodeal apophysis very strong and compressed.

Description. Female. Body length 7.5 to 8.0 mm. Fore wing length 6.5 to 7.0 mm. Ovipositor sheath length 2.0 to 2.5 mm.

Head. With dense brown hairs. Face very wide, 2.4 to 2.5 times as wide as long at level of upper margin, distinctly convex centrally, with dense and uneven punctures, near upper margin, beneath antennal socket, with shallow transverse groove. Lateral portion of clypeal suture deep, median portion weak. Clypeus evenly convex, 2.5 to 2.6 times as wide as long; with punctures as that of face; subapical margin distinctly raised, slightly concave centrally; apical margin weakly cambered forward. Mandible strong, upper and lower margins almost parallel, basal portion with dense punctures and brown hairs, apical portion smooth. Upper tooth of mandible sharp, 1.7 to 1.8 times as long as lower tooth. Cheek with coarse punctures. Malar space approximately 0.8 times as long as basal width of mandible. Subocular sulcus vestigial. Gena wide, slightly convergent backwardly, in dorsal view 1.0 to 1.1 times as long as width of eye, with dense punctures, distance between punctures 0.2 to 1.5 times diameter of puncture. Vertex (Fig. 3) not convex, between eye and lateral ocellus with correspondingly sparse and irregular punctures, distance between punctures 0.5 to 2.5 times diameter of puncture; on the portion between lateral ocelli and occipital carina with punctures as that of gena. Postocellar line about 0.6 times as long as ocular-ocellar line. Ocular-ocellar line 1.9 to 2.0 times as long as largest diameter of ocellus, 2.2 to 2.3 times as long as shortest diameter of ocellus. Frons approximately flat, with dense and irregular punctures, distance between punctures 0.2 to 0.5 times diameter of puncture. From fifth flagellomere to apex of antenna correspondingly thicker than basal four flagellomeres, scape almost cylindric, apical truncation weakly oblique, approximately 15 to 16 degrees from transverse; with 17 flagellomeres, slightly thickened beyond middle.

Figure 1. *Cisaris canaliculatus* Sun & Sheng, sp. n. Female (Holotype). Body, lateral view.

Figure 2. *Cisaris canaliculatus* Sun & Sheng, sp. n. Male. Body, lateral view

Ratio of length from first to fifth flagellomeres: 2.6:2.5:2.0:1.4:1.2. Occipital carina complete and strong.

Mesosoma. With dense brown hairs. Pronotum with dense and irregular punctures, anterior portion rough, with indistinct longitudinal wrinkles, dorsal-anterior portion with distinct short longitudinal wrinkles, dorsal-porsterior smooth and shining. Epomia strong. Mesoscutum with dense punctures, distance between punctures on anterior and lateral portion 0.2 to 0.5 times diameter of puncture; posterior-median portion slightly rough, punctures elongate. Notauli present, anterior 0.3 sharp. Posterior edge of mesoscutum distinct, without transverse groove. Scutoscutellar groove deep, almost "U-shaped", with dense longitudinal wrinkles. Scutellum almost flat, with dense and irregular punctures. Postscutellum rough, small, rectangular, anterior-lateral portion deeply concave. Mesopleuron (Fig. 4) extremely rough, with dense and

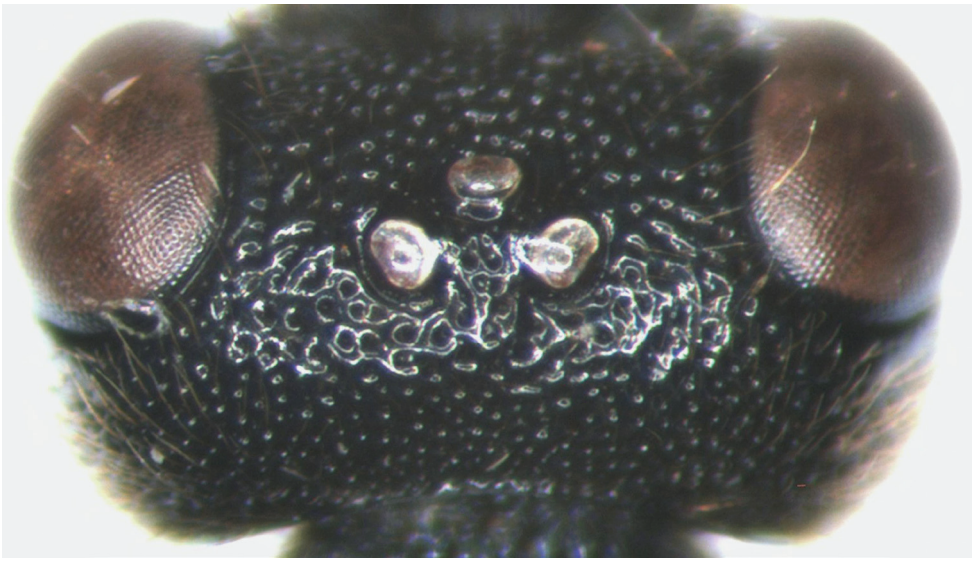

Figure 3. *Cisaris canaliculatus* Sun & Sheng, sp. n. Female (Holotype). Vertex.

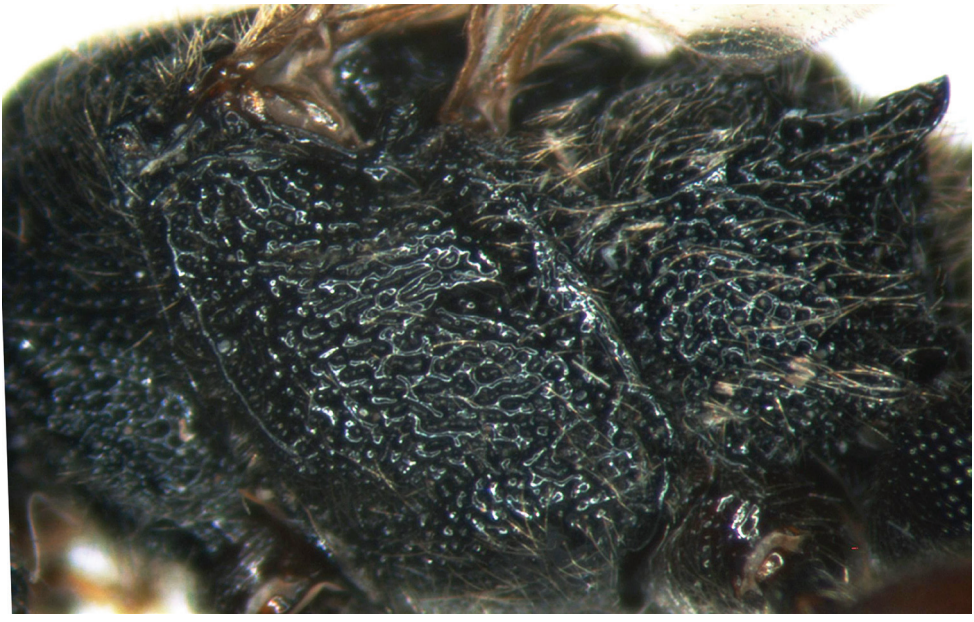

Figure 4. *Cisaris canaliculatus* Sun & Sheng, sp. n. Female (Holotype). Mesopleuron.

irregular wrinkles and indistinct punctures, median portion with indistinct transverse wrinkles. Subalar prominence convex, as a thin lobe. Epicnemium with short transverse carina opposite lower corner of pronotum. Epicnemial carina strong, upper end reaching to subalar prominence. Speculum small and smooth, or with punctures. Mesopleural fovea consisting of a deep horizontal groove that connecting with mesopleural

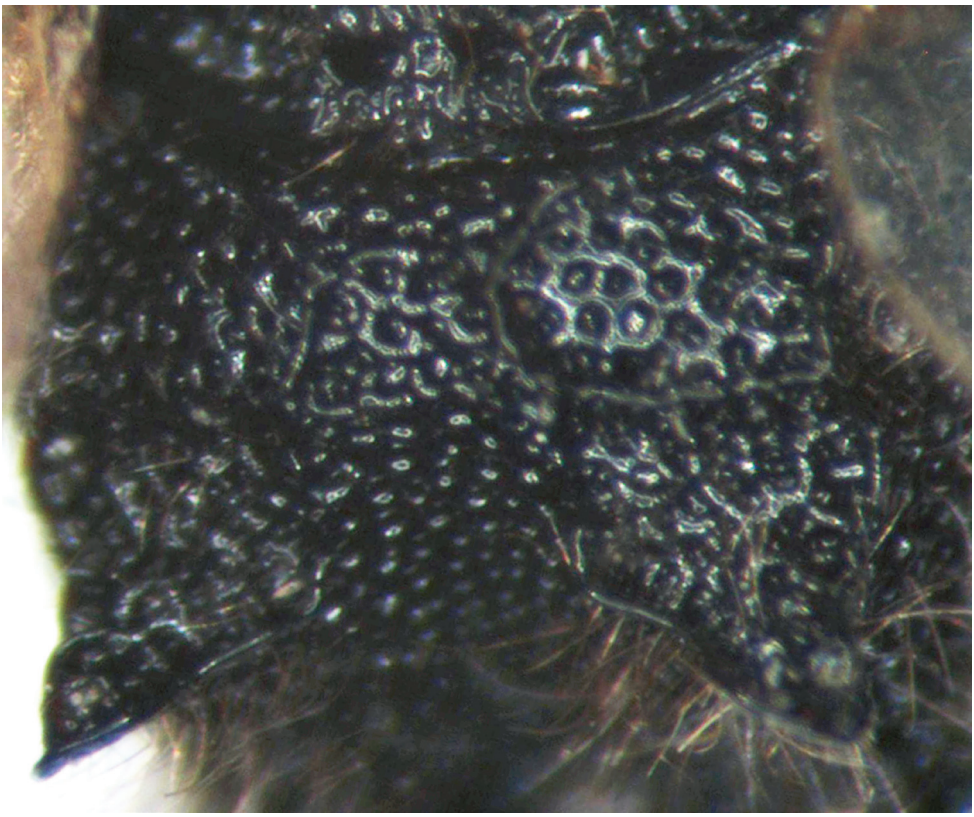

Figure 5. *Cisaris canaliculatus* Sun & Sheng, sp. n. Female (Holotype). Propodeum.

suture. Anterior half of sternaulus deep, posterior half weak, reaching to posterior margin of mesopleuron above its lower posterior corner. Metapleuron coarse, with reticulate wrinkles. Juxtacoxal carina complete. Submetapleural carina strongly lobed. Legs with dense brown hairs. Hind coxa and outer profile of hind femur with dense punctures. Hind tibia coarsely sculptured. Ratio of length of hind tarsomeres 1:2:3:4:5 is 5.2:2.0:1.6:1.0:1.6. Wings slightly brownish, hyaline. Fore wing with vein 1cu-a opposite 1/M. Vein 2rs-m approximately as long as distance between it and 2m-cu. Vein 2-Cu approximately 2.0 times as long as 2cu-a. Hind wing M+Cu slightly arched. Vein 1-cu distinctly inclivous, about 2.0 times as long as cu-a. Propodeum (Fig. 5) with strong carinae, punctures large and dense, lateral and apical portion with reticulate texture. Area basalis short and wide. Area superomedia trapezoid, slightly wider than long. Median sections of anterior and posterior transverse carinae, anterior and posterior sides of area superomedia, very weak or almost absent. Apical-median portion from area superomedia to apex of area petiolaris strongly concave longitudinally. Costula present at posterior corner of area superomedia. Propodeal apophysis very strong and compressed. Propodeal spiracle almost round.

Metasoma. Terga smooth and shining, apical portion compressed. First and second terga without punctures. First tergum slender, 2.4 to 2.5 times as long as apical

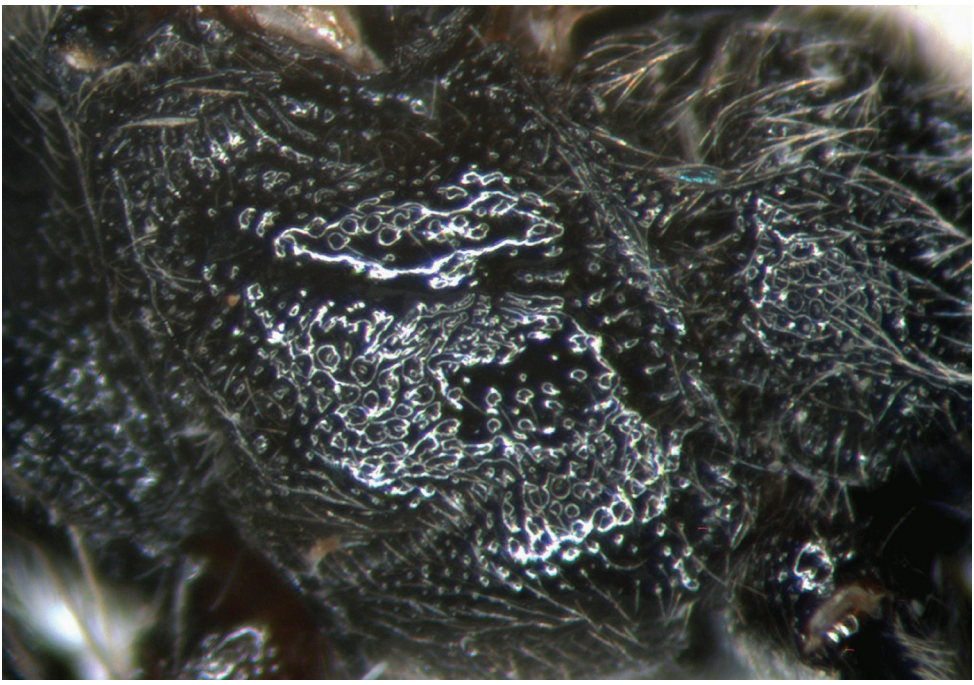

Figure 6. *Cisaris canaliculatus* Sun & Sheng, sp. n. Male. Mesopleuron.

width. Median dorsal carina weak, reaching to spiracle. Dorsolateral carina weak but complete. Spiracle small, round, beneath dorsolateral carina, slightly convex, located approximately at apical 0.3 of first tergum. Second tergum about 0.7 to 0.8 times as long as apical width. Third tergum about 0.7 times as long as basal width, lateral portion and posterior margin with sparse and fine punctures and weak brown hairs. Posterior portions of remaining terga with distinct and fine punctures and brown hairs. Ovipositor sheath about 0.95 to 1.0 times as long as hind tibia. Nodus of dorsal valve indistinct.

Color (Fig. 1). Black, except the following. Flagellomeres 5 to 7 (8) white, ventral profile of apical flagellum taupe. Apical portion of mandible except black teeth reddish brown. Front and mid coxae, trochanters and basal portions (without dividing line and gradually changed to apical portion) of femora brownish black; apical portions of femora, tibiae and tarsi reddish to darkish brown. Apical portion of metasoma obscurely blackish brown. Maxillary and labial palpi yellowish brown, tegula brownish black. Fore wing veins and stigma brownish black. Hind wing veins brownish yellow.

Male (Figs. 2, 6). Body length 6.5 to 8.0 mm. Fore wing length 6.0 to 7.0 mm. Head correspondingly large. Malar space approximately 0.42 to 0.47 times as long as basal width of mandible. Antenna slightly shorter than body, with 22 flagellomeres, without white ring. Lateral-median portion of pronotum, beneath epomia, glazed and shining. Median portion of mesopleuron (Fig. 6) coarse and with distinct oblique transverse wrinkles, subupper portion transversely smooth. Area basalis very short and

wide. Area superomedia and area petiolaris completely combined, straight slanted from anterior transverse carina to apex of propodeum. Front and middle coxae, trochanters, hind legs, tegula and all terga black. Other characters as in female.

Variation. The sculpture of the male mesopleuron varies from distinct oblique transverse wrinkles or almost without wrinkles and with distinct punctures.

Remarks. Similar to *C. niger* Kusigemati 1985, but can be easily distinguished from the latter in having the pronotum with a smooth, shining and impunctate area on the subdorsal portion; the propodeal apophysis (Figs 1, 5) is very strong and compressed; the area superomedia and area petiolaris are combined. In *C. niger* the pronotum lacks an impunctate area on the subdorsal portion; the propodeal apophysis is indistinct; the area superomedia and area petiolaris are separated by a strong carina. It can be separated from all other known species by the key.

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The authors are deeply grateful to Dr. Gavin Broad and an anonymous referee for reviewing this manuscript, and also thank Prof. Dong-Sun Ding, Jun-Gen Luo and Shi-Chang Li for their help in the course of exploration in Jiangxi Province. Dr. D. R. Kasparyan (Zoological Institute, Russian Academy of Sciences, Russia) is appreciated for presenting valuable materials. This research was supported by the National Natural Science Foundation of China (NSFC, No.30872035, No.31010103057).

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RESEARCH ARTICLE

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Redescription and revision of the Neotropical genus *Pseudoheptascelio* Szabó (Hymenoptera, Platygastridae, Scelioninae), parasitoids of eggs of short-horned grasshoppers (Orthoptera, Acrididae)

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Abstract

The genus *Pseudoheptascelio* Szabó is redescribed and its species revised. We recognize four species: *P. muesebecki* Szabó, *P. cornopis* Masner, *P. tico* **sp. n.** and *P. rex* **sp. n.** The genus is found from Guatemala south to the Brazilian state of Rio Grande do Sul. The species *P. cornopis* is recorded as a parasitoid of the eggs of *Cornops aquaticum* (Bruner) on water hyacinth, *Eichhornia crassipes* (Mart.) Solms.

Keywords

Platygastridae, Platygastroidea, Scelioninae, egg-parasitoid, *Cornops*, key, biological control, water hyacinth, *Eichhornia*

Introduction

The genus *Pseudoheptascelio* was described by Szabó (1966) from a single female collected in the state of Pará in northern Brazil. Masner (1972) subsequently erected *Tanaoscelio* for a single species collected in Trinidad and recorded as attacking the eggs of *Cornops longicorne* (Bruner) (Orthoptera: Acrididae, Leptysminae), a grasshopper that was being studied as a potential biological control agent for water hyacinth, *Eichhornia crassipes* (Mart.) Solms (Commelinales: Pontederiaceae). Masner (1976) later discovered an error in Szabó's original description concerning the presence of a complete radial vein in the hind wing. In fact, the tubular portion of the vein is abbreviated and does not reach the costal margin of the wing. Therefore, Masner concluded that these two taxonomic concepts were equivalent.

Pseudoheptascelio is found only in the New World tropics, from Belize and Guatemala south to southeastern Brazil. The distribution of the only known host, *Cornops*, is very similar, although its range extends north along the coasts of Mexico (Adis et al. 2007). Developments in our understanding of this group of grasshoppers subsequent to the original description of *Tanaoscelio* (Roberts & Carbonell, 1979) suggest that the species identification of the host should be updated. *Cornops longicorne* is now considered to be a junior synonym of *C. frenatum (*Marschall). This latter species, however, is terrestrial and its host plants are unknown (Roberts and Carbonell 1979). The only semi-aquatic species attacking *Eichhornia* in Trinidad appears to be *C. aquaticum* (Bruner) (Roberts and Carbonell 1979, Adis et al. 2007).

Materials and methods

This work is based upon specimens in the following collections, with abbreviations used in the text: AEIC, American Entomological Institute, Gainesville, FL[1]; BMNH, The Natural History Museum, London, UK[2]; BPBM, Bernice P. Bishop Museum, Honolulu, HI[3]; CNCI, Canadian National Collection of Insects, Ottawa, Canada[4]; HNHM, Hungarian Natural History Museum, Budapest, Hungary[5]; MIZA, Museo del Instituto de Zoología Agrícola, Maracay, Venezuela[6]; OSUC, C.A. Triplehorn Insect Collection, Ohio State University, Columbus, OH[7]; TAMU, Texas A&M University Insect Collection, College Station, TX[8]; USNM, National Museum of Natural History, Washington, DC[9].

Abbreviations and morphological terms used in text: A1, A2, ... A12: antennomere 1, 2, … 12; claval formula: distribution of the large, multiporous basiconic sensilla on the underside of apical antennomeres of the female, with the segment interval specified followed by the number of sensilla per segment (Bin, 1981); EH: eye height, length of compound eye measured parallel to dorsoventral midline of head; IOS: interocular space, minimal distance on frons between compound eyes; OD: ocellar diameter, greatest width of ocellus; OOL: ocular ocellar line, the shortest distance from inner orbit and outer margin of lateral ocellus (Masner 1980); T1, T2, ... T7: metasomal ter-

gite 1, 2, ... 7; S1, S2, … S7: metasomal sternite 1, 2, … 7. Morphological terminology otherwise follows Masner (1980) and Mikó *et al.* (2007).

Appendix 1 lists terms associated with identifiers in the Hymenoptera Anatomy Ontology (Yoder et al. 2010). Identifiers in the format HAO_XXXXXXX represent concepts in the HAO version 2011-07-14 and are provided to enable readers to confirm their understanding of the concepts being referenced. To find out more about a given concept use the identifier as a search term at http://glossary.hymao.org. The identifier can also be used as a URI (universal resource identifier) by appending the identifier to 'http://purl.obolibrary.org/obo/' (e.g. http://purl.obolibrary.org/obo/HAO_0000124). URLs in the format http://purl.org/net/hao/HAO_0123456 resolve to the HAO's community-based resource that includes additional images, notes, and other metadata.

In the Material Examined section the numbers prefixed with "OSUC" are unique identifiers for the individual specimens. The label data for all specimens have been georeferenced and recorded in the Hymenoptera On-Line database, and details on the data associated with these specimens can be accessed at the following link, hol.osu.edu, and entering the identifier in the form. Note the space between the acronym and the number.

Data associated with the genus *Pseudoheptascelio* can be accessed at http://hol.osu.edu/index.html?id=548. The generic and species descriptions were generated using a database application, vSysLab, designed to facilitate the production of a taxon by character data matrix, and to integrate those data with the existing taxonomic and specimen-level database. Data may be exported in both text format and as input files for other applications. The text output for descriptions is in the format of "Character: Character state (s)". Images and measurements were made using AutoMontage and Cartograph extended-focus software, using JVC KY-F75U digital camera, Leica Z16 APOA microscope, and 1X objectve lens. A standard set of images is provided for each species: dorsal habitus, lateral habitus, dorsal and lateral views of the head and mesosoma, and anterior view of head. Images are archived at Morphbank (www.morphbank.net) and in Specimage (specimage.osu.edu), the image database at The Ohio State University.

The electronic version of the paper contains hyperlinks to external resources. Insofar as possible, the external information conforms to standards developed and maintained through the organization Biodiversity Information Standards (Taxonomic Database Working Group). All new species have been prospectively registered with Zoobank (Polaszek et al. 2005, www.zoobank.org), and other taxonomic names, where appropriate, have been retrospectively registered. The external hyperlinks are explicitly cited in the endnotes so that users of the printed version of this article have access to the same resources. Life sciences identifiers, LSIDs, may be resolved at the specified URLs or at lsid.tdwg.org.

This work is conducted as part of the Platygastroidea Planetary Biodiversity Inventory. The authors made equal contributions.

Taxonomy

***Pseudoheptascelio* Szabó**
urn:lsid:zoobank.org:act:50643EC2-1EF4-496D-937B-8FBFDC9F9B8E
urn:lsid:biosci.ohio-state.edu:osuc_concepts:548
http://species-id.net/wiki/Pseudoheptascelio

Pseudoheptascelio Szabó, 1966: 166 (original description. Type: *Pseudoheptascelio muesebecki* Szabó, by monotypy and original designation); Masner, 1976: 18 (description, key to species); De Santis, 1980: 315 (catalog of species of Brazil); Johnson, 1992: 467 (catalog of world species); Loiácono & Margaría, 2002: 558 (catalog of Brazilian species).
urn:lsid:zoobank.org:act:EF9EA824-0219-42C1-A057-055D8E11FE8
urn:lsid:biosci.ohio-state.edu:osuc_concepts:9625

Tanaoscelio Masner, 1972: 1213 (original description. Type: *Tanaoscelio cornopis* Masner, by monotypy and original designation); Masner, 1976: 18 (junior synonym of *Pseudoheptascelio* Szabó).

Description. Body length: 4.09–5.45 mm (n=81).

Head. Head shape in dorsal view: weakly transverse, width approximately 1.5× greatest length. Hyperoccipital carina: absent. Occipital carina: present laterally, broadly interrupted medially. Occipital carina sculpture: crenulate. OOL: lateral ocellus nearly contiguous with inner orbits, OOL < 0.5 OD. Upper portion of frons: convex, without frontal shelf. Scrobe shape: frons with shallow unmargined depression above toruli. Frons sculpture: areolate rugose, transversely striate within scrobe. Submedian carina: absent. Orbital carina: absent. Inner orbits: diverging ventrally. IOS/EH: IOS slightly less than EH. Interantennal process: rounded, strongly developed. Central keel: absent. Torulus opening: laterally on interantennal process. Lower frons striae: absent. Malar sulcus: present. Compound eye size: of normal proportions, not significantly reduced. Compound eye setation: sparsely setose. Gena: broad, convex, distinctly produced behind eye. Clypeus shape: transversely rectangular. Apical margin of clypeus: straight. Anteclypeus: present, delimited dorsally by raised carina. Postclypeus: present, strongly transverse. Labrum: not visible, hidden behind clypeus. Mandible shape: short, inconspicuous. Mandibular teeth: apex with 2, acute, subequal teeth. Arrangement of mandibular teeth: transverse. Number of maxillary palpomeres: 4. Shape of maxillary palpomeres: cylindrical. Number of labial palpomeres: 2.

Antenna. Number of antennomeres in female: 12. Number of antennomeres in male: 10. Insertion of radicle into A1: parallel to longitudinal axis of A1. Shape of A1: more or less cylindrical, not flattened. Length of A3 of female: distinctly longer than A2. Number of clavomeres in female antenna: 7. Claval formula of female antenna: A12–A7/1-2-2-2-2-2. Arrangement of doubled multiporous plate sensilla on female clava: in longitudinal pairs. Tyloid distribution on male antenna: A5 only. Shape of male flagellum: subclavate.

Mesosoma. Mesosoma shape in dorsal view: longer than wide. Mesosoma shape in lateral view: longer than high. Medial portion of transverse pronotal carina: weakly indicated laterally. Posterior apex of pronotum in dorsal view: straight, bifid apically to articulate with tegula. Vertical epomial carina: present. Dorsal epomial carina (corresponding to lateral portion of transverse pronotal carina of Vilhelmsen et al. 2010): present. Anterior face of pronotum: oblique, visible dorsally, short. Lateral face of pronotum: weakly concave below dorsal epomial carina. Netrion: present. Netrion shape: moderately wide, closed ventrally. Anterior portion of mesoscutum: vertical, flexed ventrally to meet pronotum. Mesoscutum shape: semielliptical, excavate at base of wings. Skaphion: absent. Notauli: present, percurrent. Parapsidal lines: absent. Admedial lines: absent. Transscutal articulation: well-developed, wide, bridged by 6–10 trabecula. Shape of mesoscutellum: quadrate to trapezoidal. Armature of mesoscutellum: axillula produced posteriorly into short, broad spines. Surface of mesoscutellum: convex anteriorly, depressed posteriorly. Median longitudinal furrow on mesoscutellum: absent. Shape of axillula: large, triangular, extending length of mesoscutellum. Metascutellum: clearly differentiated. Metascutellar armature: produced medially into short, shallowly bidentate process. Metapostnotum: not delimited externally. Extent of metasomal depression of propodeum: percurrent, extending anteriorly to anterior margin of propodeum. Lateral propodeal projection: well-developed, extending clearly beyond anterior margin of T1. Mesopleural carina: absent or strongly abbreviated, present only near mid coxa. Mesal portion of acetabular carina: projecting anteriorly, not separating fore coxae. Mesopleural pit: present. Sternaulus: absent. Posterodorsal corner of mesopleuron: rounded anteriorly.

Legs. Number of mid tibial spurs: 1. Number of hind tibial spurs: 1. Dorsal surface of hind coxa: smooth. Hind tibia shape: cylindrical, ecarinate. Trochantellus: indicated only as basal swelling of femur.

Wings. Wing development of female: macropterous. Wing development of male: macropterous. Tubular veins in fore wing: present. Bulla of fore wing R: absent. Extent of marginal venation of fore wing: R1 reaching and ending at costal margin. Origin of r-rs in fore wing: arising before (basad of) R/R1 attains costal margin. Development of basal vein (Rs+M) in fore wing: spectral. Development of R in hind wing: abbreviated, not attaining costal margin.

Metasoma. Number of externally visible terga in female: 6. Number of externally visible sterna in female: 6. Number of externally visible terga in male: 7. Number of externally visible sterna in male: 7. Shape of metasoma: lanceolate. Laterotergites: present, narrow. Laterosternites: present. T1 of female: raised medially into low, rectangular platform, laterally depressed. Relative size of metasomal tergites: T2–T4 largest, subequal in size. Terga with basal crenulae: T1–T3. Sublateral carinae on tergites: present on T1–T4. Median longitudinal carina on metasomal tergites: present T2–T3, variably extending beyond. Anterior margin of S1: protruding anteriorly as short sharp extension of median longitudinal carina of S1. Distribution of felt fields: present on S2, S3. Ovipositor type: Scelio-type (Austin and Field 1997).

Diagnosis. Within the tribe Scelionini *s. str.* the genera *Pseudoheptascelio, Scelio, Sceliocerdo,* and *Synoditella* have 10-segmented antennae in the male. *Pseudoheptascelio*

may be separated from the vast majority of these species by the presence of short, hook-like axillular projections on the mesoscutellum, the medially produced metascutellum, the densely setose anterior margins of both the mesopleuron and metapleuron (Figs 2, 12, 18, 24), the rigid unflexed metasoma (Figs 1, 11, 17, 23), well-developed notauli (Figs 4, 14, 20, 26), the absence of fanlike striae arising from the base of the mandible (Figs 6, 15, 21, 27), and the broadly interrupted occipital carina (Figs 4, 14, 20, 26). At least one Neotropical species of *Scelio* has axillular points and a projecting metascutellum. *Pseudoheptascelio* may be distinguished from this by the posteriorly declivous mesoscutellum, distinct notauli, the presence of dense pilosity on the anterior margins of the meso- and metapleuron, the subclavate male antenna (Fig. 9), the elongate T2–T6 (clearly longer than wide), and the smooth transition of the lateral margins of T5–T7 and subclavate antenna in the male (Fig. 8).

Key to species

1 T2–T3 reticulate (Figs 5, 13, 19), without distinct longitudinal rugulae; mesosoma black; T6 longer than wide basally **2**

– T2–T3 with distinct longitudinal rugulae (Fig. 25); mesosoma often with reddish portions (Figs 23–26); basal width of T6 greater than its length **3**

2 Occiput without microsculpture within foveolae, appearing shining; length of T5 1.3–1.8 × its maximum width (Fig. 16)..... ***P. muesebecki***

– Occiput with dense fine microsculpture within foveolae, appearing matte (Fig. 10); length of T5 1.6–2.2 × its maximum width (Fig. 7) ..... ***P. cornopis***

3 Head and mesosoma without coriaceous microsculpture, appearing shining; metascutellum short, subquadrate (Fig. 20) ..... ***P. rex***

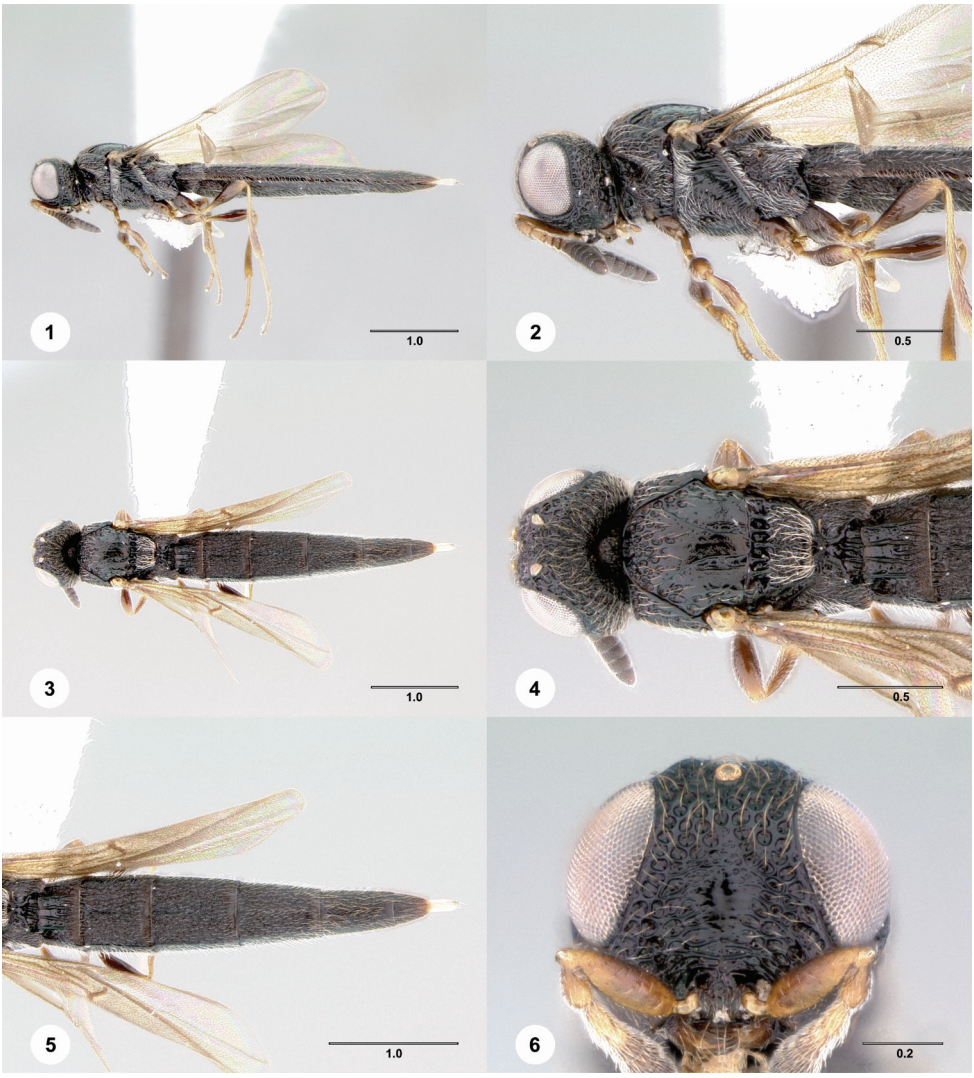
– Head and mesosoma with distinct superimposed coriaceous microsculpture, giving body overall matte appearance; metascutellum distinctly longer than wide (Fig. 26) ..... ***P. tico***

***Pseudoheptascelio cornopis* (Masner)**
urn:lsid:zoobank.org:act:270062C9-88EC-4138-8ADF-284DF6B24F93
urn:lsid:biosci.ohio-state.edu:osuc_concepts:5132
http://species-id.net/wiki/Pseudoheptascelio_cornopis
Figures 1–10; Morphbank[10]

Tanaoscelio cornopis Masner, 1972: 1214 (original description).
Pseudoheptascelio cornopis (Masner): Masner, 1976: 18 (generic transfer).

Description. Body length of female: 4.37–5.45 mm (n=11). Body length of male: 4.58–5.22 mm (n=4). Mesosoma color: black. Body microsculpture pattern: smooth.

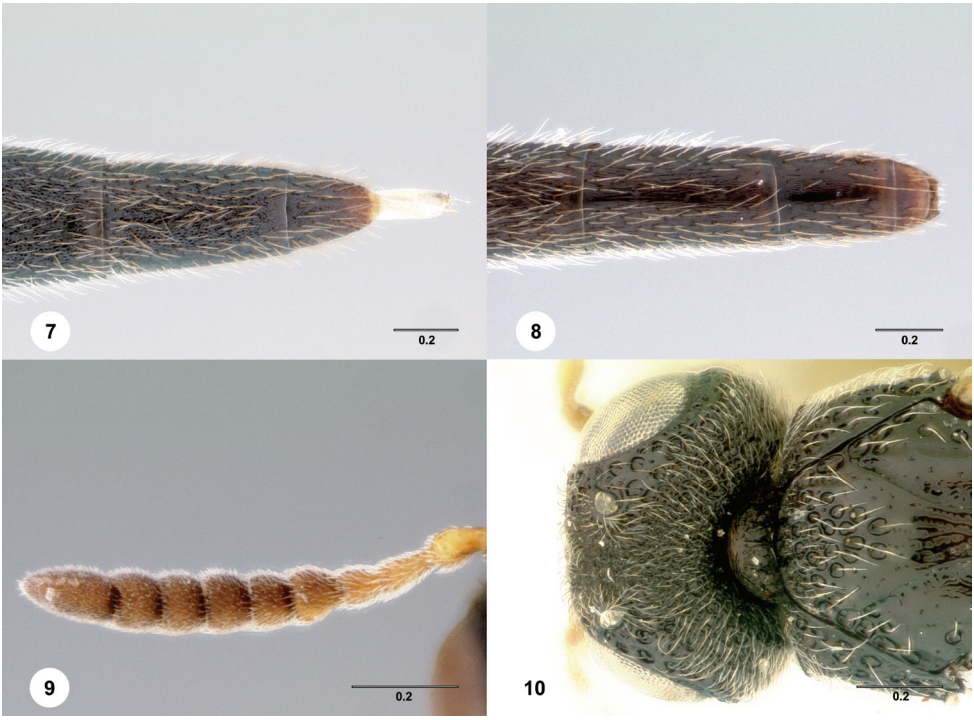
Rugae on occiput: reticulate. Microsculpture between occipital rugae: foveolate (Fig. 10). Setae on crests of occipital rugae: absent. Shape of female A4: length



Figures 1–6.[30] *Pseudoheptascelio cornopis* (Masner), female (OSUC 186250) **1** Lateral habitus **2** Head and mesosoma, lateral view **3** Dorsal habitus **4** Head and mesosoma, dorsal view **5** Metasoma, dorsal view **6** Head, anterior view. Scale bars in millimeters.

subequal to width. Shape of female A5: transverse. Shape of female A6: distinctly transverse.

Setation of pronotal depression: moderately to densely setose. Setation of netrion: moderately to densely setose (Fig. 2). Sculpture of midlobe of mesoscutum: foveate to areolate anteriorly, sculpture effaced, sparser posteriorly (Figs 4, 10). Number of trabecula across transscutal articulation: 7–8, widely spaced. Shape of metascutellum: short, shallowly cleft medially (Fig. 4). Sculpture of mesopleural depression: almost entirely sculptured, with transverse rugulae and interspersed irregular fovea.



Figures 7–10.[31] *Pseudoheptascelio cornopis* (Masner) **1** Apex of metasoma, female, dorsal view (OSUC 186250) **2** Apex of metasoma, male (OSUC 248318) **3** Antenna, segments 2–10, male (OSUC 248318) **4**, Head, dorsal view, holotype female (B.M. TYPE HYM. 9.772). Scale bars in millimeters.

Sculpture of T2–T3: irregularly reticulate, without longitudinal orientation. Length/width of female T5: 1.61–2.22 mm (n=12). Length/width of female T6: 1.10–1.50 mm (n=11). Sculpture of T6: with reticulate microsculpture only. Apex of male T7: pointed laterally, shallowly excavate or straight medially (Fig. 8).

Diagnosis. *Pseudoheptascelio cornopis* is distinguished from *P. muesebecki* by the densely and finely sculptured vertex and the more elongate T5 (length/width 1.6–2.2).

Link to Distribution Map.[11] [http://hol.osu.edu/map-full.html?id=5132]

Associations. Data from specimen labels: emerged from egg of *Cornops* Scudder: [Orthoptera: Acrididae]; solitary egg parasitoid of *Cornops* Scudder: [Orthoptera: Acrididae]; unspecified association *Cornops frenatum* (Marschall): [Orthoptera: Acrididae]; emerged from egg of *Cornops longicorne* (Brunner): [Orthoptera: Acrididae]; solitary egg parasitoid of *Cornops longicorne* (Brunner): [Orthoptera: Acrididae]; emerged from egg on *Eichhornia crassipes* (Mart.): [Liliales: Pontederiaceae]; solitary egg parasitoid ex *Eichhornia crassipes* (Mart.): [Liliales: Pontederiaceae]; unspecified association *Eichhornia crassipes* (Mart.): [Liliales: Pontederiaceae]

Material Examined. *Holotype*, female, *T. cornopis*: **TRINIDAD AND TOBAGO**: Trinidad Isl., Débé, V-1970, B.M. TYPE HYM. 9.772 (deposited in BMNH). *Paratypes*: **TRINIDAD AND TOBAGO:** 3 females, 1 male, 2 unknowns,

BMNH(E)#790244–790245 (BMNH); OSUC 186160–186162 (CNCI); OSUC 248318 (USNM). *Other material*: (9 females, 2 males) **BOLIVIA:** 7 females, 1 male, OSUC 186242, 186245–186250, 186253 (CNCI). **BRAZIL:** 1 female, 1 male, OSUC 186241 (CNCI); OSUC 131887 (OSUC). **GUYANA:** 1 female, OSUC 215796 (BPBM). Allotype: **TRINIDAD AND TOBAGO:** 1 male, BMNH(E)#790243 (BMNH). **VENEZUELA:** 1 female, OSUC 221615 (MIZA).

Comments. In the brief key to species Masner (1976) stated that the stigmal vein (r-rs) is embedded in a milky spot, forming a pseudostigma. The species *P. muesebecki*, in contrast, was characterized as having the area around the stigmal vein transparent. We find that there is considerable variability in the development of the pseudostigma and that it is present in all specimens of *Pseudoheptascelio*.

***Pseudoheptascelio muesebecki* Szabó**
urn:lsid:zoobank.org:act:E3EF612E-195C-45DD-86BA-14EB72125754
urn:lsid:biosci.ohio-state.edu:osuc_concepts:5133
http://species-id.net/wiki/Pseudoheptascelio_muesebecki
Figures 11–16; Morphbank[12]

Pseudoheptascelio muesebecki Szabó, 1966: 167 (original description); Masner, 1976: 18 (type information).

Description. Body length of female: 4.09–5.42 mm (n=15). Mesosoma color: black. Body microsculpture pattern: smooth.

Rugae on occiput: reticulate. Microsculpture between occipital rugae: absent. Setae on crests of occipital rugae: absent. Shape of female A4: length subequal to width. Shape of female A5: transverse. Shape of female A6: distinctly transverse.

Setation of pronotal depression: moderately to densely setose (Fig. 12). Setation of netrion: moderately to densely setose. Sculpture of midlobe of mesoscutum: foveate to areolate throughout; foveate to areolate anteriorly, or sculpture effaced, sparser posteriorly (Fig. 14). Number of trabecula across transscutal articulation: 7–8, widely spaced. Shape of metascutellum: short, shallowly cleft medially (Fig. 14). Sculpture of mesopleural depression: almost entirely sculptured, with transverse rugulae and interspersed irregular fovea.

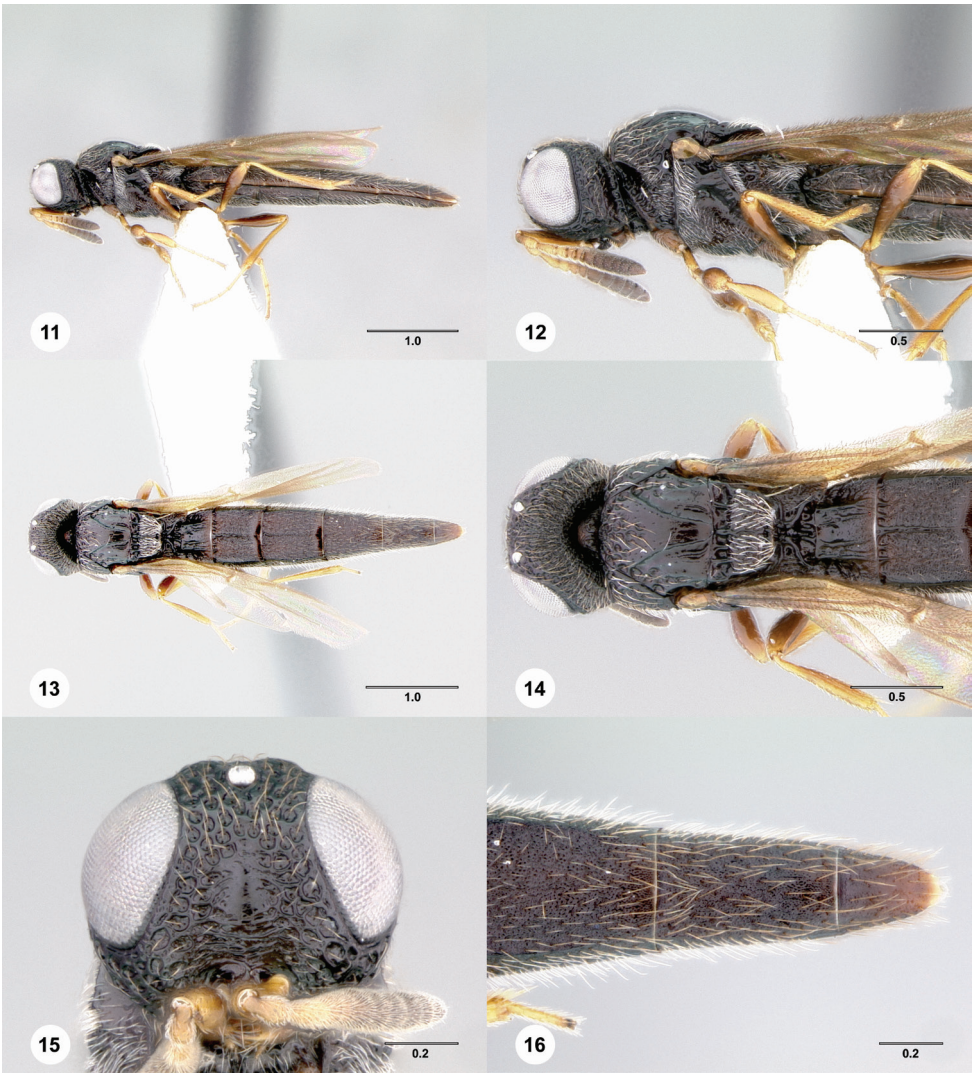
Sculpture of T2–T3: irregularly reticulate, without longitudinal orientation. Length/width of female T5: 1.26–1.80 mm (n=15). Length/width of female T6: 1.05–1.53 mm (n=15). Sculpture of T6: with reticulate microsculpture only.

Diagnosis. This species is very similar to *P. cornopis*, and it may be distinguished by the less elongate T5 and the coarse areolate sculpture on the vertex.

Link to Distribution Map.[13] [http://hol.osu.edu/map-full.html?id=5133]

Assocations. No data available.

Material Examined. *Holotype*, female: **BRAZIL**: PA, Belém, no date, E. Horváth, HNHM 0015 (deposited in HNHM). *Other material*: (14 females) **BOLIVIA**: 1 fe-



Figures 11–16.[32] *Pseudoheptascelio muesebecki* Szabó, female (OSUC 186208) **11** Lateral habitus **12** Head and mesosoma, lateral view **13** Dorsal habitus **14** Head and mesosoma, dorsal view **15** Head, anterior view **16** Apex of metasoma, dorsal view. Scale bars in millimeters.

male, OSUC 186244 (CNCI). **BRAZIL**: 9 females, OSUC 186233–186240 (CNCI); OSUC 58878 (OSUC). **ECUADOR**: 1 female, OSUC 186208 (CNCI). **PARAGUAY**: 2 females, OSUC 176024, 176033 (OSUC). **TRINIDAD AND TOBAGO**: 1 female, OSUC 186163 (CNCI).

***Pseudoheptascelio rex* Johnson & Musetti, sp. n.**
urn:lsid:zoobank.org:act:32540FD3-5763-4536-BD1A-A50849D8A6D6
urn:lsid:biosci.ohio-state.edu:osuc_concepts:242983
http://species-id.net/wiki/Pseudoheptascelio_rex
Figures 17–22; Morphbank[14]

Description. Body length of female: 4.13–5.26 mm (n=20). Body length of male: 4.50–5.16 mm (n=13). Mesosoma color: black; red brown at least dorsally, otherwise dark to brown black. Body microsculpture pattern: smooth.

Rugae on occiput: longitudinal. Microsculpture between occipital rugae: absent. Setae on crests of occipital rugae: present. Shape of female A4: length subequal to width; length distinctly greater than width. Shape of female A5: transverse; subquadrate. Shape of female A6: distinctly transverse; weakly transverse.

Setation of pronotal depression: glabrous or sparsely setose. Setation of netrion: moderately to densely setose. Sculpture of midlobe of mesoscutum: foveate to areolate throughout (Fig. 20). Number of trabecula across transscutal articulation: 7–8, widely spaced. Shape of metascutellum: short, shallowly cleft medially (Fig. 20). Sculpture of mesopleural depression: foveolate anteriorly, transversely rugulose ventrally, with large smooth area dorsally surrounding mesopleural pit.

Sculpture of T2–T3: reticulate, with distinct longitudinal orientation. Length/width of female T5: 0.89–1.72 mm (n=20). Length/width of female T6: 0.81–1.26 mm (n=20). Sculpture of T6: with shallow foveolae impressed on reticulate background microsculpture. Apex of male T7: pointed laterally, shallowly excavate or straight medially.

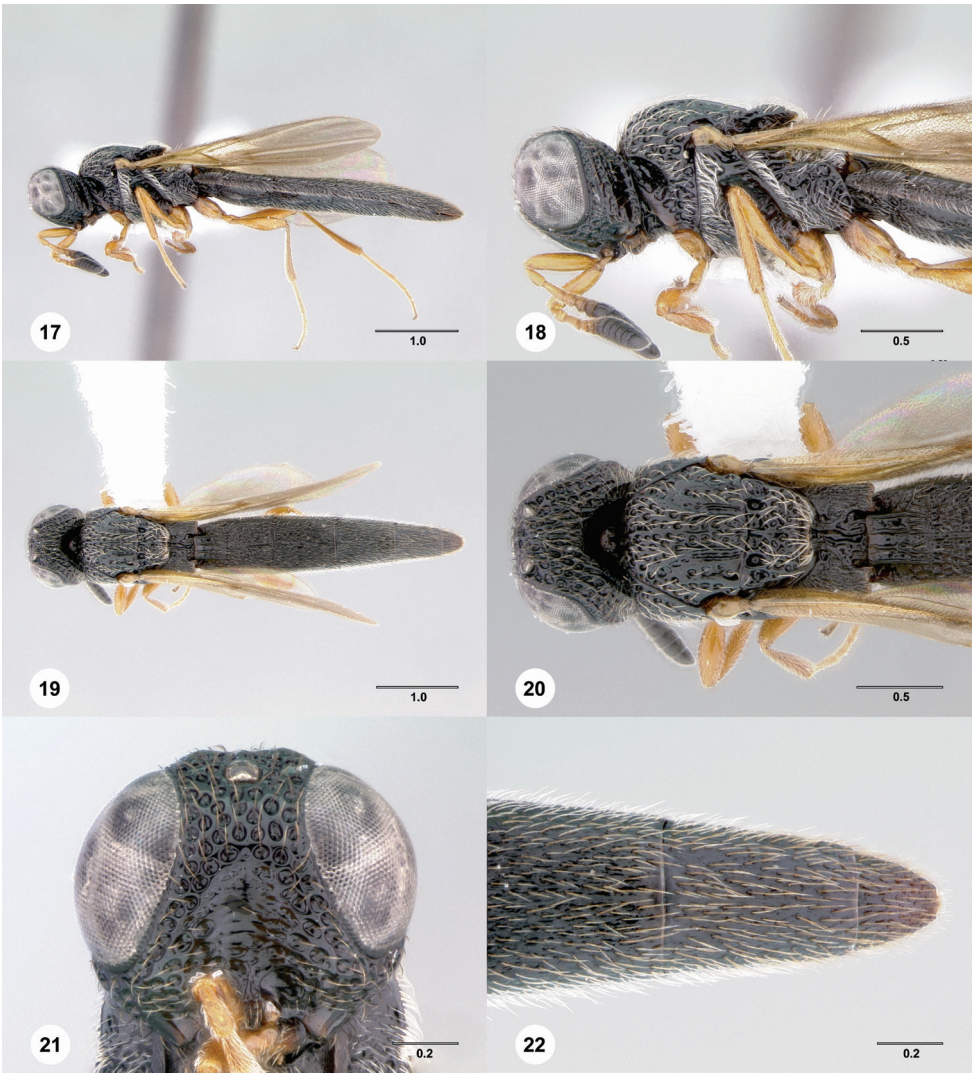
Diagnosis. This species shares the short female T6 (Fig. 22) and, in many specimens, the red mesosoma with *P. tico*. It may be distinguished by the short metascutellum (Fig. 20) and the absence of coriaceous microsculpture on the head and mesosoma.

Etymology. The specific epithet is Latin for king and should be treated as a noun in apposition.

Link to Distribution Map.[15] [http://hol.osu.edu/map-full.html?id=242983]

Associations. Data from specimen labels: collected on *Trichocentrum panamensis* Rolfe: [Orchidales: Orchidaceae]

Material Examined. *Holotype*, female: **ECUADOR:** Sucumbíos Prov., Sacha Lodge, 00°30'S 76°30'W, 270m, 27.VIII–10.IX.1995, malaise trap, P. Hibbs, OSUC 186230 (deposited in CNCI). *Paratypes*: (49 females, 14 males) **BOLIVIA:** 6 females, 1 male, OSUC 186251–186252, 186254–186258 (CNCI). **COLOMBIA:** 10 females, 2 males, OSUC 287928 (CNCI); OSUC 210338–210341 (FSCA); OSUC 144252–144253, 189092, 191363, 193964, 210336, 224326 (OSUC). **COSTA RICA:** 2 females, OSUC 186186, 186194 (CNCI). **ECUADOR:** 19 females, 9 males,



Figures 17–22.[33] *Pseudoheptascelio rex*, sp. n., holotype female (OSUC 186230) **17** Lateral habitus **18** Head and mesosoma, lateral view **19** Dorsal habitus **20** Head and mesosoma, dorsal view **21** Head, anterior view **22** Apex of metasoma, dorsal view. Scale bars in millimeters.

OSUC 186203–186207, 186209–186229, 186231 (CNCI); OSUC 58879 (OSUC). **FRENCH GUIANA:** 2 females, OSUC 186202, 287926 (CNCI). **GUYANA:** 1 male, OSUC 215795 (BPBM). **NICARAGUA:** 1 male, OSUC 320737 (TAMU). **PANAMA:** 9 females, OSUC 186199–186200 (CNCI); OSUC 248311–248317 (USNM). **PERU:** 1 female, OSUC 186232 (CNCI).

***Pseudoheptascelio tico* Johnson & Musetti, sp. n.**
urn:lsid:zoobank.org:act:23DBB9A2-4F23-4F7E-AFC8-38A2906EE95E
urn:lsid:biosci.ohio-state.edu:osuc_concepts:242982
http://species-id.net/wiki/Pseudoheptascelio_tico
Figures 23–28; Morphbank[16]

Description. Body length of female: 4.44–5.14 mm (n=12). Body length of male: 4.42–4.85 mm (n=5). Mesosoma color: red brown at least dorsally, otherwise dark to brown black. Body microsculpture pattern: with widespread superimposed coriaceous microsculpture.

Rugae on occiput: reticulate. Microsculpture between occipital rugae: absent. Setae on crests of occipital rugae: absent. Shape of female A4: length distinctly greater than width. Shape of female A5: subquadrate. Shape of female A6: weakly transverse.

Setation of pronotal depression: glabrous or sparsely setose (Fig. 24). Setation of netrion: glabrous or sparsely setose. Sculpture of midlobe of mesoscutum: foveate to areolate throughout (Fig. 26). Number of trabecula across transscutal articulation: 9–11, closely spaced. Shape of metascutellum: distinctly elongate, deeply cleft medially. Sculpture of mesopleural depression: irregularly foveolate, transverse rugulae very weakly indicated.

Sculpture of T2–T3: reticulate, with distinct longitudinal orientation. Length/width of female T5: 0.97–1.16 mm (n=13). Length/width of female T6: 0.93–1.13 mm (n=13). Sculpture of T6: with shallow foveolae impressed on reticulate background microsculpture. Apex of male T7: weakly pointed laterally, distinctly sinuous medially.

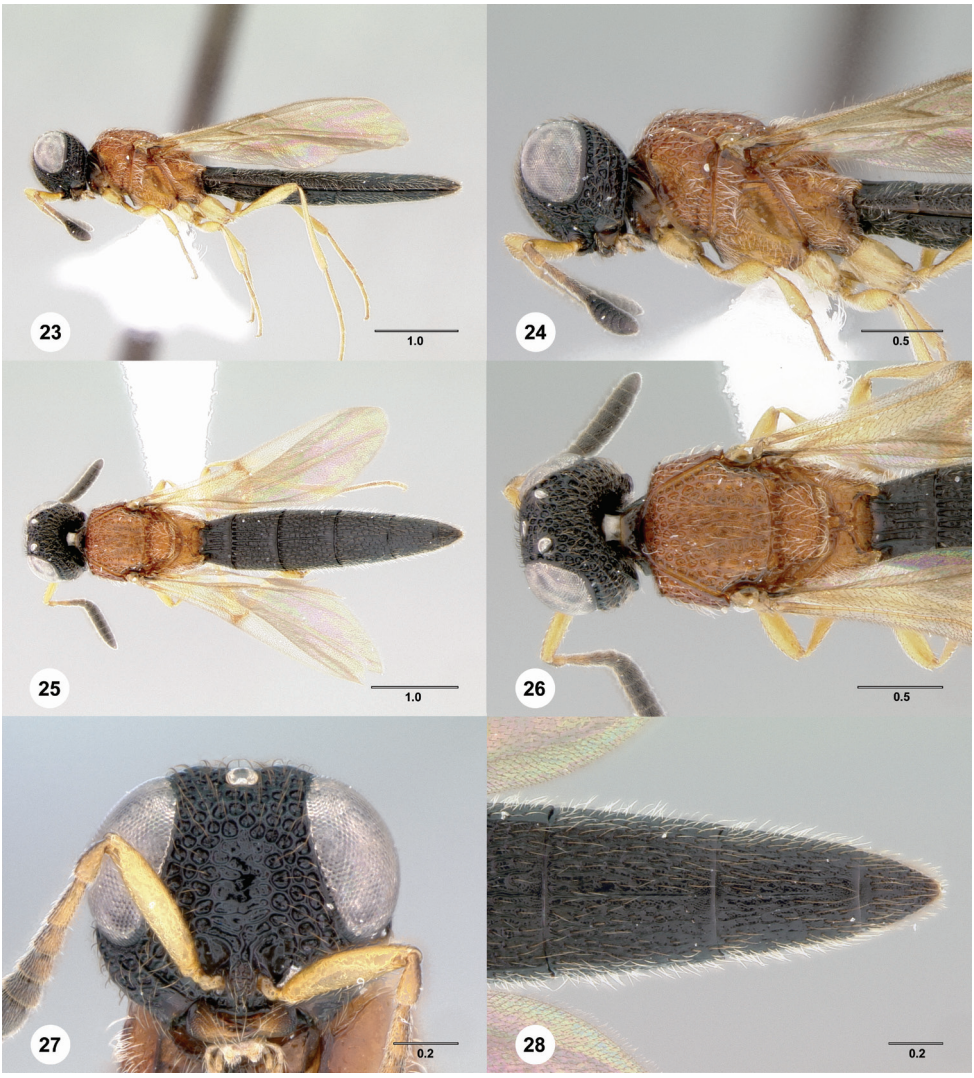
Diagnosis. This species should only be confused with red specimens of *P. rex*. It may be distinguished by the well-developed coriaceous microsculpture on the head and mesosoma, and the elongate, deeply cleft metascutellum (Fig. 26).

Etymology. The specific epithet is a colloquial term for a Costa Rican, reflecting the origin of most of the specimens we have seen. It should be treated as a noun in apposition.

Link to Distribution Map.[17] [http://hol.osu.edu/map-full.html?id=242982]

Assocations. No data available.

Material Examined. *Holotype*, female: **COSTA RICA:** Alajuela Prov., creekbed, San Ramón Biological Station, 700m, 24.III–26.III.1996, yellow pan trap, L. Masner, OSUC 186191 (deposited in CNCI). *Paratypes*: (12 females, 5 males) **BELIZE:** 1 female, OSUC 287927 (USNM). **COSTA RICA:** 9 females, 5 males, OSUC 186181–186185, 186187–186190, 186192, 186195–186198 (CNCI). **GUATEMALA:** 1 female, OSUC 186268 (AEIC). PANAMA: 1 female, OSUC 186201 (CNCI).



Figures 23–28.[34] *Pseudoheptascelio tico*, n.sp., holotype female (OSUC 186191) **23** Lateral habitus **24** Head and mesosoma, lateral view **25** Dorsal habitus **26** Head and mesosoma, dorsal view **27** Head, anterior view **28** Apex of metasoma, dorsal view. Scale bars in millimeters.

Acknowledgments

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Endnotes

1 http://biocol.org/urn:lsid:biocol.org:col:1008
2 http://biocol.org/urn:lsid:biocol.org:col:1009
3 http://biocol.org/urn:lsid:biocol.org:col:1010
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10 http://www.morphbank.net/?id=644094
11 http://hol.osu.edu/map-full.html?id=5132
12 http://www.morphbank.net/?id=644091
13 http://hol.osu.edu/map-full.html?id=5133
14 http://www.morphbank.net/?id=644092
15 http://hol.osu.edu/map-full.html?id=242983
16 http://www.morphbank.net/?id=644093
17 http://hol.osu.edu/map-full.html?id=242982
18 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:20940
19 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:131
20 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:235
21 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:229
22 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:21243
23 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:998
24 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:311
25 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:474
26 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:21300
27 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:23221
28 http://lsid.tdwg.org/urn:lsid:biosci.ohio-state.edu:osuc_pubs:452
29 doi:10.1371/journal.pone.0015991
30 http://www.morphbank.net/?id=644067
31 http://www.morphbank.net/?id=644072
32 http://www.morphbank.net/?id=644091
33 http://www.morphbank.net/?id=644092
34 http://www.morphbank.net/?id=644093

Appendix 1

Correspondence between anatomical terms used and the Hymenoptera Anatomy Ontology. Identifiers may be resolved by appending them to the following URL: http://purl.obolibrary.org/obo/

A1	HAO_0000908
A2	HAO_0000706
A3	HAO_0001148
A7	HAO_0001885
A12	HAO_0001884
acetabular carina	HAO_0000292
admedian line	HAO_0000128
anteclypeus	HAO_0000209
antenna	HAO_0000101
antennomere	HAO_0000107
anterior margin of clypeus	HAO_0001767
area	HAO_0000146
articulation	HAO_0001485
axillula	HAO_0000160
basal vein	HAO_0000170
body	HAO_0000182
bulla	HAO_0000184
carina	HAO_0000188
central keel	HAO_0000109
clava	HAO_0001185
clavomere	HAO_0001186
clypeus	HAO_0000212
compound eye	HAO_0000217
corner	HAO_0000223
coxa	HAO_0000228
depression	HAO_0000241
egg	HAO_0000286
epomial carina	HAO_0000307
eye	HAO_0000217
felt field	HAO_0000322

femur	HAO_0000327
flagellum	HAO_0000343
fore wing	HAO_0000351
fovea	HAO_0000241
frons	HAO_0001523
frontal shelf	HAO_0001886
gena	HAO_0000371
head	HAO_0000397
hind coxa	HAO_0000587
hind tibia	HAO_0000631
hind tibial spur	HAO_0001121
hind wing	HAO_0000400
hyperoccipital carina	HAO_0000406
inner orbit	HAO_0000419
interantennal process	HAO_0000422
labrum	HAO_0000456
lateral face of pronotum	HAO_0000483
lateral ocellus	HAO_0000481
laterotergite	HAO_0000493
laterosternite	HAO_0001838
line	HAO_0001586
lower frons striae	HAO_0001770
malar sulcus	HAO_0000504
mandible	HAO_0000506
mandibular tooth	HAO_0001019
margin	HAO_0000510
median longitudinal carina of S1	HAO_0001878
median longitudinal carina on metasomal tergite	HAO_0001878
median longitudinal carina of mesoscutellum	HAO_0001878
mesopleural carina	HAO_0000559
mesopleural pit	HAO_00001358
mesopleuron	HAO_0000566
mesoscutellum	HAO_0000574

mesoscutum	HAO_0001490
mesosoma	HAO_0000576
metapleuron	HAO_0000621
metapostnotum	HAO_0000622
metascutellum	HAO_0000625
metasoma	HAO_0000626
metasomal depression of propodeum	HAO_0000627
mid coxa	HAO_0000635
mid tibial spur	HAO_0001120
midlobe of mesoscutum	HAO_0000520
multiporous plate sensillum	HAO_0000640
netrion	HAO_0000644
notauli (notaulus)	HAO_0000647
occipital carina	HAO_0000653
occiput	HAO_0000658
ocellus	HAO_0000661
ocular ocellar line	HAO_0000662
orbit	HAO_0000672
orbital carina	HAO_0000810
ovipositor	HAO_0000679
palpomere	HAO_0001866
pit	HAO_0000718
parapsidal line	HAO_0000694
postclypeus	HAO_0000743
propodeal lateral projection	HAO_0000763
process	HAO_0000822
projection	HAO_0000829
pronotum	HAO_0000853
propodeum	HAO_0001248
radial vein	HAO_0000888
radicle	HAO_0000889
scrobe	HAO_0000911
sculpture	HAO_0000913
segment	HAO_0000929
skaphion	HAO_0000940

sternaulus	HAO_0001205
sternite	HAO_0001654
submedian carina	HAO_0000973
sulcus	HAO_0000978
tegula	HAO_0000993
tergite	HAO_0001783
tibia	HAO_0001017
torulus	HAO_0001022
transscutal articulation	HAO_0001623
transverse pronotal carina	HAO_0001031
trochantellus	HAO_0001033
tyloid	HAO_0001199
vein	HAO_0001095
venation	HAO_0001096
vertex	HAO_0001077
vertical epomial carina	HAO_0000307
wing	HAO_0001089