

Two new Truncatelloidea species from Melissotrypa Cave in Greece (Caenogastropoda)

Andrzej Falniowski¹, Serban Sarbu²

1 Department of Malacology, Institute of Zoology, Jagiellonian University, Gronostajowa 9, 30-387 Cracow, Poland **2** Grupla de Explorari Subacvatice si Speologice, str Frumoasa 31-B, Bucuresti, Romania

Corresponding author: Andrzej Falniowski (andrzej.falniowski@uj.edu.pl)

Academic editor: M. Schilthuizen | Received 23 July 2015 | Accepted 24 September 2015 | Published 28 October 2015

<http://zoobank.org/B83EFD05-296C-4836-A49C-68B2D64C033A>

Citation: Falniowski A, Sarbu S (2015) Two new Truncatelloidea species from Melissotrypa Cave in Greece (Caenogastropoda). ZooKeys 530: 1–14. doi: 10.3897/zookeys.530.6137

Abstract

In the small lake located in the cave Melissotrypa in Thessalia, Greece, truncatelloidean gastropods representing two species were found, new to science. One of them, represented by two specimens only, has been described based on the shell characters only; with its cytochrome oxidase sequence it has been assigned to the genus *Iglica*, and to the family Moitessieriidae, *Iglica hellenica* **sp. n.** For the other species, represented by 30 collected specimens, the shell, protoconch, radula, head, penis and female reproductive organs have been described; all the morphological characters and cytochrome oxidase sequences have confirmed its assignment to the genus *Daphniola* (Hydrobiidae: Sadlerianinae), *Daphniola magdalenae* Falniowski, **sp. n.**

Keywords

Gastropoda, Hydrobiidae, Moitessieriidae, aquatic snails, morphology, cytochrome oxidase, taxonomy, troglobionts

Introduction

In June 2014, in Melissotrypa Cave in Greece (39°52'38"N and 22°02'58"E), several specimens of Truncatelloidea gastropods were collected. This was the third visit by the second author to this cave, but the snails were found for the first time.

The cave is located in Melissotrypa Kefalovriso Ellassona, north of Larissa, and is the largest known underground karstic form of karst system Kranias Ellassona, drilled

in marbles. The character of the cave is demonstrated by the remaining forms of dissolution and growth of the cave, the gypsum and detected hydrogen sulfide in the lakes of the cave. The cave covers an area 0.06 km² and has a total length of mapped passageways about 2103.6 m. The elevation in the region of the inlet orifice is 299 m while the interior reaches a depth up -47.3 m i.e. absolute altitude 251.7 m. The depth of the precipitous entry is 14.6 m (<http://7gym-laris.lar.sch.gr/perivalon/spilaia.htm>).

Many specimens of gastropods were concentrated in just one area in the sulfuric lake, close to the shore in a depth of approximately 10 cm. In the vicinity of the lake there are no terrestrial animals, although there are microbial biofilms and organic matter. The aquatic fauna is highly interesting: the most abundant form is an amphipod *Niphargus*, which swims upside down, seemingly an adaptation to such water chemistry. The snails do not live everywhere, but only in one place on a limestone wall, at 5–10 cm beneath the water surface. There were hundreds of individuals gathered in a compact group. Maybe there are more such groups, but the water is deep and one cannot reach the walls except by means of a small boat, the lake being very narrow. In this cave, there is also another lake, at several hundred meters away from the former, in which the water has no sulfur, and which is sometimes dry. No snails have been found in it.

Only two specimens with a turritiform shell were collected, and approximately 30 specimens with a valvatiform shell. The aim of the paper is to describe these two snails collected in Melissotrypa Cave.

Materials and methods

The snails were collected by hand and placed directly in 95% ethanol. The ethanol was changed twice, and the material stored at -20 °C.

The shells were photographed with a CANON EOS 50D digital camera, attached to a NIKON SMZ18 stereoscope microscope with dark field. They were dissected using a NIKON SMZ18 stereoscope microscope with a NIKON drawing apparatus, and a NIKON DS-5 digital camera. Radulae and protoconchs were examined using a JEOL JSM-5410 scanning electron microscope, applying the techniques described by Falniowski (1990).

DNA was extracted from foot tissue of two specimens. The tissue was hydrated in TE buffer (3 × 10 min); total genomic DNA was then extracted with the SHERLOCK extracting kit (A&A Biotechnology), and the final product was dissolved in 20 µl TE buffer. The PCR reaction was performed with the following primers: LCOI490 (5'-GGTCAACAAATCATAAAGATATTGG-3') (Folmer et al. 1994) and COR722b (5'-TAAACTTCAGGGTGACCAAAAAATYA-3') (Wilke and Davis 2000) for the cytochrome oxidase subunit I (COI) mitochondrial gene.

The PCR conditions were as follows: initial denaturation step of 4 min at 94 °C, followed by 35 cycles of 1 min at 94 °C, 1 min at 55 °C 2 min at 72 °C, and a final extension of 4 min at 72 °C. The total volume of each PCR reaction mixture was

50 µl. To check the quality of the PCR products 10 µl of the PCR product was run on 1% agarose gel. The PCR products were purified using Clean-Up columns (A&A Biotechnology) and were then amplified in both directions using BigDye Terminator v3.1 (Applied Biosystems), following the manufacturer's protocol and with the primers described above. The sequencing reaction products were purified using ExTerminator Columns (A&A Biotechnology); DNA sequences then underwent electrophoresis on an ABI Prism sequencer.

The COI sequences were aligned by eye using BioEdit 5.0.0 (Hall 1999). The saturation test of Xia et al. (2003) was performed using DAMBE (Xia 2013). Sequences obtained from the snails from Melissotrypa Cave in the present work were used in a phylogenetic analysis with other sequences obtained from GenBank (Table 1). A maximum likelihood (ML) approach was conducted in RAxML v8.0.24 (Stamatakis 2014). One thousand searches were initiated with starting trees obtained through randomized stepwise addition maximum parsimony method. The tree with the highest likelihood score was considered as the best representation of the phylogeny. Bootstrap support was calculated with 1000 replicates and summarized onto the best ML tree. RAxML analyses were performed using free computational resource CIPRES Science Gateway (Miller et al. 2010). Genetic *p*-distances between the species of *Daphniola* were calculated using MEGA6 (Tamura et al. 2013), with standard errors estimated by 1,000 bootstrap replications with pairwise deletion of missing data. The maximum composite likelihood distance and Tajima relative rate tests of local clock-like behavior (Tajima 1993) were performed using MEGA6.

Systematic part

Family Moitesseriidae Bourguignat, 1863

Genus *Iglica* Wagner, 1927

Iglica hellenica sp. n.

<http://zoobank.org/44EEDD4D-448D-4ABB-9128-E6AFC35F5B51>

Holotype. Ethanol-fixed specimen, Melissotrypa Cave, Thessalia, Greece, 39°52'38"N, 22°02'58"E, sulphidic lake, near the shore, June 2014, S. Sarbu coll., ZMUJ-M.2107.

Paratype. One specimen destroyed for DNA extraction details as for holotype.

Diagnosis. Shell relatively big, turritiform, readily distinguished from geographically close and related species *I. sidariensis*, *I. maasseni*, *I. wolfscheri* and *I. alpheus* by its larger size and more convex whorls *Iglica hellenica* is readily distinguished from the geographically closest species *Paladilhiopsis thessalica* by its larger size and narrow aperture.

Description. Shell (Fig. 1) up to 4.04 mm tall, 5.5 whorls, spire height 281% width of shell. Holotype measurements: shell height 4.04 mm, spire height 1.85 mm, body whorl breadth 1.44 mm, aperture height 1.22 mm, aperture breadth 1.05 mm, whorls number 5½. Teleoconch whorls highly convex, evenly rounded. Aperture nar-

Table 1. Taxa used for phylogenetic analyses, with their GenBank Accession Numbers and references.

Species	COI GB#	References
<i>Adrioinzulana conovula</i> (Frauenfeld, 1863)	AF367628	Wilke et al. (2001)
<i>Agrafia wiktoria</i> Szarowska & Falniowski, 2011	JF906762	Szarowska and Falniowski (2011)
<i>Alzoniella finalina</i> Giusti & Bodon, 1984	AF367650	Wilke et al. (2001)
<i>Anagastina zetavalis</i> (Radoman, 1973)	EF070616	Szarowska (2006)
<i>Avenionia brevis</i> (Draparnaud, 1805)	AF367638	Wilke et al. (2001)
<i>Belgrandiella kusceri</i> (Wagner, 1914)	KT218520	Falniowski and Beran (2015)
<i>Bithynia tentaculata</i> (Linnaeus, 1758)	AF367643	Wilke et al. (2001)
<i>Boleana umbilicata</i> (Kuščer, 1932)	KT218521	Falniowski and Beran (2015)
<i>Bythinella austriaca</i> (Frauenfeld, 1857)	FJ545132	Falniowski et al. (2009)
<i>Bythiospeum</i> sp.	AF367634	Wilke et al. (2001)
<i>Bythiospeum acutum</i> (Geyer, 1904)	HM107120	unpublished, from GenBank
<i>Bythiospeum francomontanum</i> Bernasconi, 19730	HM107131	unpublished, from GenBank
<i>Bythiospeum hungaricum</i> (Soós, 1927)	KP296923	unpublished, from GenBank
<i>Bythiospeum husmanni</i> (C.R. Boettger, 1963)	HM107134	unpublished, from GenBank
<i>Bythiospeum pellucidum</i> (v. Wiedersheim, 1973)	HM107124	unpublished, from GenBank
<i>Bythiospeum suevicum</i> (Geyer, 1905)	HM107118	unpublished, from GenBank
<i>Dalmatinella fluviatilis</i> Radoman, 1973	KC344541	Falniowski and Szarowska (2013)
<i>Daphniola exigua</i> (A. Schmidt, 1856)	EU047767	Falniowski et al. (2007)
<i>Daphniola hadei</i> (Gittenberger, 1982)	JF916477	Falniowski and Szarowska (2011a)
<i>Daphniola graeca</i> Radoman, 1973	EF070618	Szarowska (2006)
<i>Daphniola louisii</i> Falniowski & Szarowska, 2000	EU047769	Falniowski et al. (2007)
<i>Daphniola</i> sp.	KM887915	Szarowska et al. (2014)
<i>Daphniola magdalenae</i> sp. n.	KT825578-80	present study
<i>Dianella thiesseana</i> (Kobelt, 1878)	AY676127	Szarowska et al. (2005)
<i>Fissuria boui</i> Boeters, 1981	AF367654	Wilke et al. (2001)
<i>Gnaecoarganiella parnassiana</i> Falniowski & Szarowska, 2011	JN202348	Falniowski and Szarowska (2011b)
<i>Graziana alpestris</i> (Frauenfeld, 1863)	AF367641	Wilke et al. (2001)
<i>Grossuana codreanui</i> (Grossu, 1946)	EF061919	Szarowska et al. (2007)
<i>Hauffenia tellinii</i> (Pollonera, 1898)	AF367640	Wilke et al. (2001)
<i>Heleobia dalmatica</i> (Radoman, 1974)	AF367631	Wilke et al. (2001)
<i>Horatia klecakiana</i> Bourguignat, 1887	KJ159128	Szarowska and Falniowski (2014)
<i>Hydrobia acuta</i> (Draparnaud, 1805)	AF278808	Wilke and Davis (2000)
<i>Iglica hellenica</i> sp. n.	KT825581	present study
<i>Islamia piristoma</i> Bodon et Cianfanelli, 2001	AF367639	Wilke et al. (2001)
<i>Lithoglyphus naticoides</i> (C. Pfeiffer, 1828)	AF367642	Wilke et al. (2001)
<i>Marstoniopsis insubrica</i> (Küster, 1853)	AY027813	Falniowski and Wilke (2001)
<i>Moitessieria cf. puteana</i> (Coutagne, 1883)	AF367635	Wilke et al. (2001)
<i>Montenegrospeum bogici</i> (Pešić & Glöer, 2012)	KM875510	Falniowski et al. (2014)
<i>Pseudamnicola lucensis</i> (Issel, 1866)	AF367651	Wilke et al. (2001)
<i>Pyrgula annulata</i> (Linnaeus, 1767)	AY341258	Szarowska et al. (2005)
<i>Radomaniola callosa</i> (Paulucci, 1881)	AF367649	Wilke et al. (2001)
<i>Rissoa labiosa</i> (Montagu, 1803)	AY676128	Szarowska et al. (2005)
<i>Sadleriana fluminensis</i> (Küster, 1853)	AY273996	Wilke et al. (2001)
<i>Tanousia zrmanjae</i> (Brusina, 1866)	Xx	Beran et al. (2015)
<i>Trichonia kephalovrissonia</i> Radoman, 1973	EF070619	Szarowska (2006)
<i>Ventrosia ventrosa</i> (Montagu, 1803)	AF118335	Wilke and Davis (2000)



Figure 1. Shells of *Iglica hellenica* sp. n.: **A** holotype **B** sequenced specimen. Scale bar 1 mm.

row, ovate, weakly angled adapically, separated from body whorl by a broad groove. Parietal lip complete, adnate, no umbilicus. Outer lip simple, orthocone. Shell glossy with no sculpture, periostracum yellowish. Soft parts pinkish, with no pigment. External morphology and anatomy unknown.

Etymology. The specific epithet (*hellenica*) is a Greek adjective meaning Greek.

Distribution and habitat. Known from two specimens from the type locality only.

Family Hydrobiidae Troschel, 1857**Subfamily Sadlerianinae Radoman, 1973****Genus *Daphniola* Radoman, 1973*****Daphniola magdalенаe* Falniowski, sp. n.**

<http://zoobank.org/AF91ADE8-10B4-4737-8022-7EFDDC316EAD>

Types. Ethanol-fixed specimens, Melissotrypa Cave, Thessalia, Greece, 39°52'38"N, 22°02'58"E, sulphidic lake, near the shore, June 2014, S. Sarbu coll., holotype: ZMUJ-M.2109; 20 paratypes: ZMUJ-M.2110–ZMUJ-M.2130.

Diagnosis. Shell relatively big, valvatiform-trochiform; soft parts with no pigment, no eyes, penis with long and slender filament and big outgrowth on the left side. Readily distinguished from geographically and closely related *D. exigua* (= *D. graeca*) by its bigger size (2.5 vs. 1.5 mm), reddish operculum, broader base and longer and thinner filament of the penis. Differentiated from *D. louisi* (from Kessariani at Athens) by its larger size, higher spire, longer and thinner filament and more prominent outgrowth on the left side of the penis. Differs from *D. hadei* (from Gythion at Peloponnese) by its double size, higher spire and much more prominent outgrowth on the left side of the penis.

Description. Shell (Fig. 2A–D) valvatiform-trochiform, up to 2.68 mm tall, having 3.5–3.75 whorls, spire height 16% height of shell, and 13–16% width of shell. Teleoconch whorls moderately convex, evenly rounded, growing rapidly in diameter. Aperture circular, parietal lip complete, umbilicus very broad, outer lip simple, ortho-cline. Teleoconch with delicate growth lines, periostracum pinkish. Shell parameters for a series of paratypes are given in Table 2. On the surface there are numerous pellets of sediment, most probably of sulfuric bacteria.

Inner and outer sides of operculum smooth. Operculum pink (Fig. 2A–D). Protoconch of 1.25–1.40 whorls growing slowly (Fig. 3), with a net-like pattern of dense depressions, their shape irregular (Fig. 4), covering all the protoconch and initial part of the teleoconch.

Radula (Figs 5–7): taenioglossate, typically hydrobiid; the cusps on the central, lateral and inner marginal teeth prominent, long and sharp; the central tooth trapezoid (Figs 5–6), with one pair of big basal cusps arising from the tooth face (Fig. 5) and numerous long cusps along the cutting edge, the basal tongue broadly V-shaped and about equal in length to the lateral margins, lateral cusps five–six. Lateral teeth (Figs 6–7) having four cusps on inner, and five cusps on outer side, central cusp broad and blunt. Inner marginal tooth (Fig. 7) with 35–36 cusps, outer marginal teeth (Figs 6–7) with 21–23 cusps.

Animal brownish, with no pigment, and no eyes (Fig. 8). Penis (Figs 9–11) having broad base bent U-shaped in natural position (Fig. 8), long and narrow filament and prominent outgrowth on its left edge. Female reproductive organs (Fig. 12) with big bursa copulatrix with long duct and two small receptacula seminis.

Etymology. Named in memory of Dr Magdalena Szarowska, a malacologist, wife and best friend of the first author.

Distribution and habitat. Known from the type locality only.

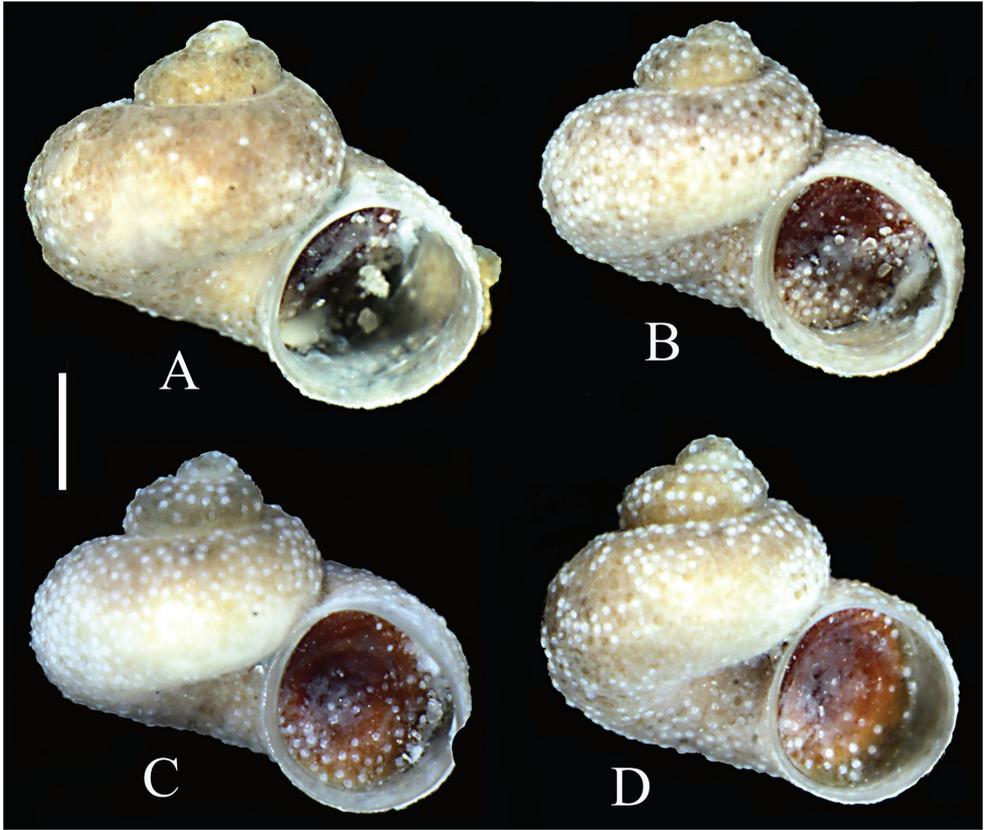


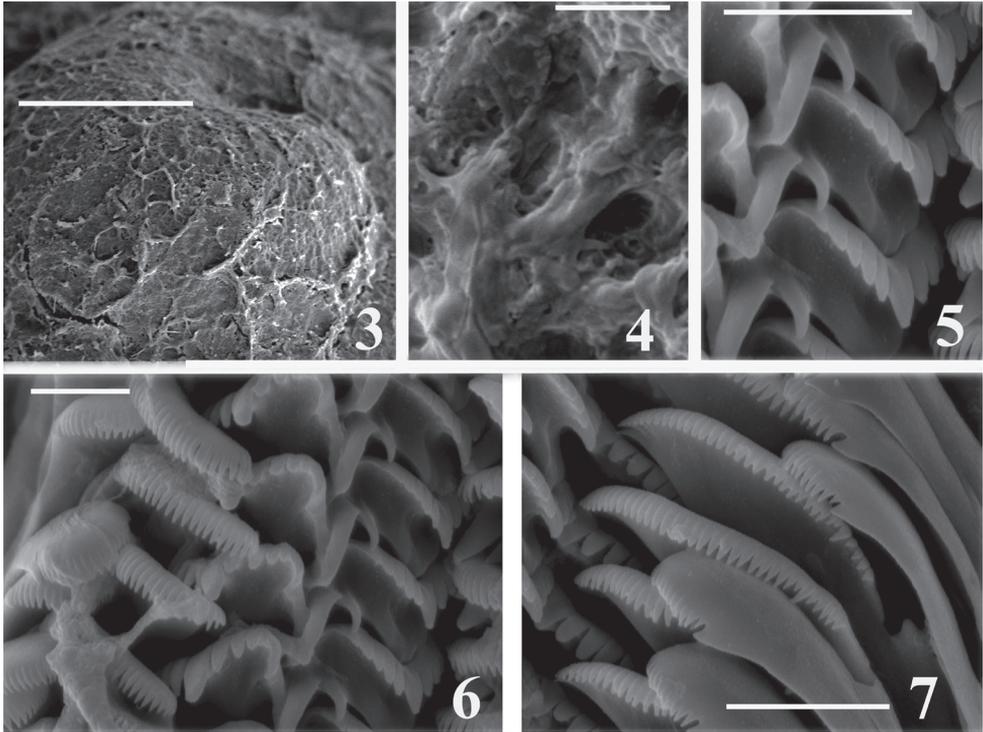
Figure 2. Shells of *Daphniola magdalena* sp. n: **A** holotype **B–D** paratypes. Scale bar: 0.5 mm

Table 2. Shell measurements of *Daphniola magdalena*, n = 10.

shell height	shell height (mm)	spire height (mm)	body whorl width (mm)	aperture height (mm)	aperture width (mm)	whorl number
holotype	2.51	0.38	1.99	1.37	1.34	3.5
mean	2.335	0.363	1.895	1.346	1.280	3.70
sd	0.1788	0.0503	0.1506	0.0797	0.0643	0.1083
minimum	2.16	0.28	1.76	1.20	1.19	3.50
maximum	2.68	0.43	2.21	1.44	1.39	3.75

Molecular relationships of the new taxa

The saturation test of Xia et al. (2003) revealed a significant degree of saturation in the third position of the sequences. In rissoids, COI approaches saturation with approximately 18.6% or 120 nucleotide differences (Davis et al. 1998), which seems to happen after approximately 10 million years. However, to avoid a substantial loss of information in the case of closely related species, this position was not excluded from

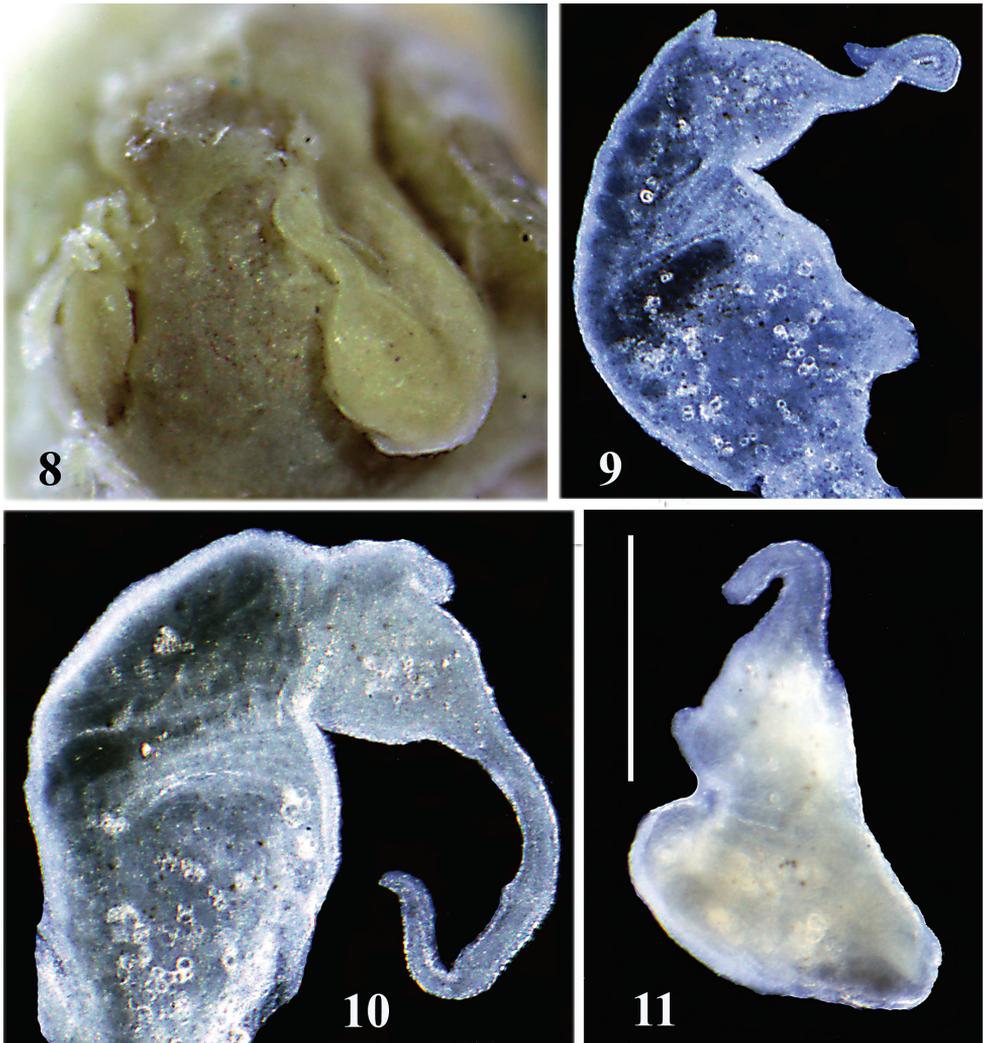


Figures 3–7. Protoconch and radula of *Daphniola magdalenae*: **3–4** protoconch **5–7** radula **5** central teeth **6** central, lateral and marginal teeth **7** marginal teeth. Scale bar: 100 µm (**3**); 3 µm (**4, 5**); 4 µm (**6, 7**).

the dataset and it was used for the analysis. The maximum likelihood tree (Fig. 13) was characterized by low bootstrap values at deep nodes, which is typical of cytochrome oxidase-based phylogenies, but clearly showed that *Daphniola magdalenae* sp. n. belonged to the genus *Daphniola* (bootstrap value 63%), although it was clearly a distinct species. Its closest relatives were *Daphniola* sp. from Khios and Rhodes islands, and *D. exigua*/*D. graeca* from Tembi valley (bootstrap support 79%). The bootstrap support of the clade of *Daphniola*, *Trichonia* Radoman, 1973, and *Grossuana* Radoman, 1973 was 89%. The p-distance between *Daphniola magdalenae* sp. n. and *D. exigua* was $p = 0.1325$. The relative rates test for all the *Daphniola* species confirmed the ultrametricity of the data. The tree also confirmed close relationships of *Iglica hellenica* sp. n. with “*Bythiospeum*” *hungaricum* (bootstrap value/support 64%), and that both *Iglica hellenica* and “*Bythiospeum*” *hungaricum* do not belong to the genus *Bythiospeum* Bourguignat, 1882.

Discussion

With one (since the other had to be destroyed for DNA extraction) available specimen of *Iglica hellenica* sp. n. it has not been possible to study its soft parts. However, nearly all the representatives of *Bythiospeum*, *Paladilhiopsis*, *Iglica*, etc. are known as empty



Figures 8–11. Head and penes of *Daphniola magdalenae*: **8** head with penis, **9–11** penes. Scale bar: 250 μ m.

shells only. The distinction between these genera remains unclear. The molecular tree, as well as the phylogeny presented by Wilke et al. (2013), does not confirm even the close relationships between *Bythiospeum*, *Iglica hellenica* sp. n., and *Moitessieria*. It also does not confirm that “*Bythiospeum*” *hungaricum* belongs to the genus *Bythiospeum*, but confirms its close relationships with *Iglica hellenica*. From Greece there are four known species of *Iglica*: *I. sidarensis* Schütt, 1980 from Corfu, *I. maasseni* Schütt, 1980 from Rhodes, and two species from the Peloponnese: *I. wolfischeri* A. & P. Reischutz, 2004 and *I. alpheus* A. & P. Reischutz, 2004. With the exception of *I. alpheus*, the shells of all are similar to the one of *I. hellenica*, but much smaller with shell heights of 1.5–2.3 mm, compared with 4.04 mm in *I. hellenica*. The representatives of another cave-inhabiting genus *Paladilhiopsis* Pavlovic, 1913 should also be considered. From Greece there are three species in this genus: *P. blanci* (Westerlund, 1886) from the is-

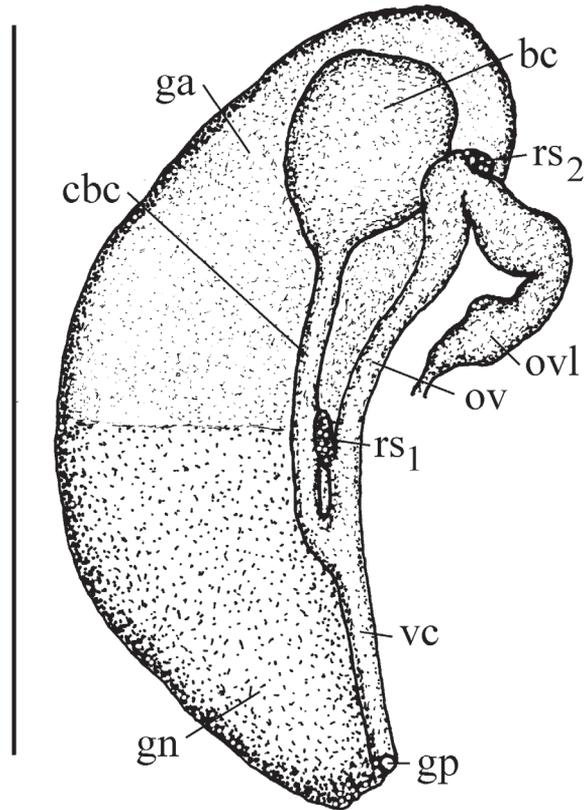


Figure 12. Renal and pallial section of female reproductive organs of *Daphniola magdalenae* (bc – bursa copulatrix, cbc – duct of bursa copulatrix, ga – albuminoid gland, gn – nidamental gland, gp – gonoporus, ov – oviduct, ovl – loop of (renal) oviduct, rs₁, rs₂ – receptacula seminis, nomenclature after Radoman (1973, 1983), vc – ventral canal). Scale bar 1 mm.

lands Cephalonia and Lefkada, *P. janinensis* Schütt, 1962 from the springs at the shore of Pamvotis Lake (now the springs are completely dry), and *P. thessalica* Schütt, 1970, from Pyrgetos at Tembi Valley. This locality is only 46 km away from Melissotrypa Cave. However, the shell but especially the aperture of *I. hellenica* is typical of *Iglica*, not of *Paladilhiopsis* (e. g. Schütt 1980). Moreover, the 18S sequence of *I. hellenica* (unpublished data) was very different from the one of *Paladilhiopsis carpatica* Soós, 1940 from Vadu Crisul Cave in Romania (Szarowska 2006). Thus the assignment of *I. hellenica* to the genus *Iglica* remains justified based on the available data.

The shells of *Daphniola exigua* are highly variable (Falniowski et al. 2007), including the similar shells of *D. magdalenae* sp. n., but are much smaller (maximum 1.58 mm *vs.* 2.68 in *D. magdalenae*). The shells of the other species of *Daphniola* have lower spires, and are also maximum 1.5 mm tall (Falniowski et al. 2007, Falniowski and Szarowska 2011a). The penis of *Daphniola magdalenae* sp. n. differs in its long and narrow, sharply pointed filament of the penes from those of *D. exigua* and *D. graeca* (Radoman 1983, Szarowska 2006), and *D. louisii* (Falniowski & Szarowska, 2000). A similar filament,



Figure 13. Maximum likelihood tree computed for cytochrome oxidase I sequences, bootstrap supports given if > 50%.

but less prominent outgrowth on the left side of the penis is characteristic of *D. hadei* (Falniowski and Szarowska 2011a). The female reproductive organs of *D. magdalenae* are characteristic of *Daphniola* (Radoman 1973, 1983, Szarowska 2006). Some differences in size proportions of the receptacula and bursa could be observed between the species, but the variability is high; even the genera of the Hydrobiidae with two receptacula could not always be recognized with this character (Falniowski et al. 2012). *Daphniola exigua* inhabits two springs in Tembi Valley, approximately 50 km from Melissotripa cave, but in the molecular tree it is not the sister species of *D. magdalenae* sp. n.. The genetic distance between *D. magdalenae* and *D. exigua* is $p = 0.1325$. Based on mtCOI clock calibrations of 1.83% per million years for European Hydrobiidae (Wilke 2003) and 1.62% per million years for *Pyrgulopsis* (Hershler and Liu 2008), the estimated divergence times of the two species ranged from 7.24 to 8.20 mya, thus the very beginning of the Messinian or even upper Tortonian in the Miocene.

The molecular tree confirms relationships of both new species *Iglica hellenica* and *Daphniola magdalenae*. As it is based on one short fragment of mitochondrial DNA, it presents the phylogeny of this fragment, certainly not of the species/genera (e.g., Avise 2000), and its deep nodes are not supported. Thus the tree cannot be interpreted as phylogeny of the Truncatelloidea. However, it seems sufficient to detect the closest relatives of the new species described in this paper.

Acknowledgements

The study was supported by a grant from the National Science Centre (2012/05/B/NZ8/00407).

References

- Avise JC (2000) Phylogeography. The history and formation of species. Harvard University Press, Cambridge, MA and London, 447 pp.
- Beran L, Hofman S, Falniowski A (2015) *Tanousia zrmanjiae* (Brusina, 1866) (Caenogastropoda: Hydrobiidae): a living fossil. *Folia Malacologica* 23(3): 11–15.
- Davis GM, Wilke T, Spolsky C, Qiu C-P, Qiu D-C, Xia M-Y, Zhang Y, Rosenberg G (1998) Cytochrome oxidase I-based phylogenetic relationships among the Pomatiopsidae, Hydrobiidae, Rissoidae and Truncatellidae (Gastropoda: Caenogastropoda: Rissoacea). *Malacologia* 40: 251–266.
- Falniowski A (1990) Anatomical characters and SEM structure of radula and shell in the species-level taxonomy of freshwater prosobranchs (Mollusca: Gastropoda: Prosobranchia): a comparative usefulness study. *Folia Malacologica* 4: 53–142.
- Falniowski A, Beran L (2015) *Belgrandiella* A.J. Wagner, 1928 (Caenogastropoda: Truncatelloidea: Hydrobiidae): how many endemics? *Folia Malacologica* 23.
- Falniowski A, Pešić V, Glöer P (2014) *Montenegrospeum* Pešić et Glöer, 2013: a representative of Moitessieriidae? *Folia Malacologica* 22: 263–268.

- Falniowski A, Szarowska M (2000) A new species of *Daphniola* Radoman, 1973 (Gastropoda: Hydrobiidae) from Greece. *Folia Malacologica* 8: 181–188. doi: 10.12657/folmal.008.013
- Falniowski A, Szarowska M (2011a) Genus *Daphniola* Radoman, 1973 (Caenogastropoda: Hydrobiidae) in the Peloponnese, Greece. *Folia Malacologica* 19: 131–137. doi: 10.2478/v10125-011-0020-9
- Falniowski A, Szarowska M (2011b) A new genus and new species of valvatiform hydrobiid (Rissooidea; Caenogastropoda) from Greece. *Molluscan Research* 31(3): 189–199.
- Falniowski A, Szarowska M (2013) Phylogenetic relationships of *Dalmatinella fluviatilis* Radoman, 1973 (Caenogastropoda: Rissooidea). *Folia Malacologica* 21: 1–7. doi: 10.12657/folmal.021.001
- Falniowski A, Szarowska M, Glöer P, Pešić V (2012) Molecules *vs.* morphology in the taxonomy of the *Radomaniola/Grossuana* group of Balkan Rissooidea (Mollusca: Caenogastropoda). *Journal of Conchology* 41: 19–36.
- Falniowski A, Szarowska M, Grzmil P (2007) *Daphniola* Radoman, 1973 (Gastropoda: Hydrobiidae): shell biometry, mtDNA, and the Pliocene flooding. *Journal of Natural History* 41: 2301–2311. doi: 10.1080/00222930701630733
- Falniowski A, Szarowska M, Sirbu I (2009) *Bythinella* Moquin-Tandon, 1856 (Gastropoda: Rissooidea: Bythinellidae) in Romania: species richness in a glacial refugium. *Journal of Natural History* 43: 2955–2973. doi: 10.1080/00222930903359636
- Falniowski A, Wilke T (2001) The genus *Marstoniopsis* (Gastropoda: Rissooidea): intra- and intergeneric phylogenetic relationships. *Journal of Molluscan Studies* 67: 483–488. doi: 10.1093/mollus/67.4.483
- Folmer O, Black M, Hoeh W, Lutz RA, Vrijenhoek RC (1994) DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology* 3: 294–299.
- Hall TA (1999) BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucleic Acids Symposium Series* 41: 95–98.
- Hershler R, Liu H-P (2008) Ancient vicariance and recent dispersal of springsnails (Hydrobiidae: *Pyrgulopsis*) in the Death Valley system, California-Nevada. *The Geological Society of America Special Paper* 439: 91–101. doi: 10.1130/2008.2439(04)
- Miller MA, Pfeiffer W, Schwartz T (2010) Creating the CIPRES Science Gateway for inference of large phylogenetic trees. *Proceedings of the Gateway Computing Environments Workshop (GCE)*, 14 Nov., New Orleans, LA, 1–8. doi: 10.1109/gce.2010.5676129
- Radoman P (1973) New classification of fresh and brackish water Prosobranchia from the Balkans and Asia Minor. *Posebna Izdanja, Prirodnjacki Musej u Beogradu* 32: 1–30.
- Radoman P (1983) Hydrobioidea a superfamily of Prosobranchia (Gastropoda). I. Systematics. *Monographs Serbian Academy of Sciences and Arts, DXLVII, Department Sciences* 57: 1–256.
- Reischütz A, Reischütz PL (2004) Hellenikā pantoia, 8: Olympische Idylle - Neue Hydrobiiden (Gastropoda: Prosobranchia: Hydrobiidae) und einige andere seltene Arten aus dem Genist des Alfios bei Olimbia (Ilia, Peloponnes, Griechenland). *Nachrichtenblatt der Ersten Vorarlberger Malakologischen Gesellschaft* 12: 3–4.
- Schütt H (1980) Zur Kenntnis griechischer Hydrobiiden. *Archiv für Molluskenkunde* 110: 115–149.
- Stamatakis A (2014) RAxML Version 8: A tool for Phylogenetic Analysis and Post-Analysis of Large Phylogenies. *Bioinformatics* 30: 1312–1313. doi: 10.1093/bioinformatics/btu033

- Szarowska M (2006) Molecular phylogeny, systematics and morphological character evolution in the Balkan Risssooidea (Caenogastropoda). *Folia Malacologica* 14: 99–168. doi: 10.12657/folmal.014.014
- Szarowska M, Falniowski A (2011) An unusual, flagellum-bearing hydrobiid snail (Gastropoda: Risssooidea: Hydrobiidae) from Greece, with descriptions of a new genus and a new species. *Journal of Natural History* 45: 2231–2246. doi: 10.1080/00222933.2011.591067
- Szarowska M, Falniowski A (2014) *Horatia* Bourguignat, 1887: is this genus really phylogenetically very close to *Radomaniola* Szarowska, 2006 (Caenogastropoda: Truncatelloidea)? *Folia Malacologica* 22: 31–39. doi: 10.12657/folmal.022.003
- Szarowska M, Falniowski A, Riedel F, Wilke T (2005) Phylogenetic relationships of the subfamily Pyrgulinae (Gastropoda: Caenogastropoda: Hydrobiidae) with emphasis on the genus *Dianella* Gude, 1913. *Zootaxa* 891: 1–32.
- Szarowska M, Grzmil P, Falniowski A, Sirbu I (2007) *Grossuana codreanui* (Grossu, 1946) and the phylogenetic relationships of the East Balkan genus *Grossuana* (Radoman, 1973) (Gastropoda: Risssooidea). *Hydrobiologia* 579: 379–391. doi: 10.1007/s10750-006-0530-4
- Szarowska M, Hofman S, Osikowski A, Falniowski A (2014) *Daphniola* Radoman, 1973 (Caenogastropoda: Truncatelloidea) at east Aegean islands. *Folia Malacologica* 22: 11–20. doi: 10.12657/folmal.022.021
- Tajima F (1993) Simple methods for testing the molecular evolutionary clock hypothesis. *Genetics* 135: 599–607.
- Tamura K, Stecher G, Peterson D, Filipski A, Kumar S (2013) MEGA6: molecular evolutionary genetics analysis version 6.0. *Molecular Biology and Evolution* 30: 2725–2729. doi: 10.1093/molbev/mst197
- Wilke T (2003) *Salenthydrobia* gen. nov. (Risssooidea: Hydrobiidae): a potential relict of the Messinian Salinity Crisis. *Zoological Journal of the Linnean Society*, 137: 319–336. doi: 10.1046/j.1096-3642.2003.00049.x
- Wilke T, Davis GM (2000) Intraspecific mitochondrial sequence diversity in *Hydrobia ulvae* and *Hydrobia ventrosa* (Hydrobiidae: Risssoacea: Gastropoda): Do their different life histories affect biogeographic patterns and gene flow? *Biological Journal of the Linnean Society* 70: 89–105. doi: 10.1111/j.1095-8312.2000.tb00202.x
- Wilke T, Davis GM, Falniowski A, Giusti F, Bodon M, Szarowska M (2001) Molecular systematics of Hydrobiidae (Gastropoda: Risssooidea): testing monophyly and phylogenetic relationships. *Proceedings of the Academy of Natural Sciences of Philadelphia* 151: 1–21. doi: 10.1635/0097-3157(2001)151[0001:MSOHMG]2.0.CO;2
- Wilke T, Haase M, Hershler R, Liu HP, Misof B, Ponder W (2013) Pushing short DNA fragments to the limit: Phylogenetic relationships of ‘hydrobioid’ gastropods (Caenogastropoda: Risssooidea). *Molecular Phylogenetics and Evolution* 66: 715–736. doi: 10.1016/j.ympev.2012.10.025
- Xia X (2013) DAMBE: A comprehensive software package for data analysis in molecular biology and evolution. *Molecular Biology and Evolution* 30: 1720–1728. doi: 10.1093/molbev/mst064
- Xia X, Xie Z, Salemi M, Chen L, Wang Y (2003) An index of substitution saturation and its application. *Molecular Phylogenetics and Evolution* 26: 1–7. doi: 10.1016/S1055-7903(02)00326-3

A new species of *Jesogammarus* from the Iki Island, Japan (Crustacea, Amphipoda, Anisogammaridae)

Ko Tomikawa¹

¹ Department of Science Education, Graduate School of Education, Hiroshima University, Higashi-Hiroshima 739-8524, Japan

Corresponding author: Ko Tomikawa (tomikawa@hiroshima-u.ac.jp)

Academic editor: O. Coleman | Received 27 May 2015 | Accepted 21 August 2015 | Published 28 October 2015

<http://zoobank.org/DC6C1B50-B660-461F-BF0E-4A101C1CD551>

Citation: Tomikawa K (2015) A new species of *Jesogammarus* from the Iki Island, Japan (Crustacea, Amphipoda, Anisogammaridae). ZooKeys 530: 15–36. doi: 10.3897/zookeys.530.6063

Abstract

A new species of anisogammarid amphipod, *Jesogammarus* (*Jesogammarus*) *ikiensis* sp. n., is described from freshwaters in the Iki Island, Nagasaki Prefecture, Japan, based on results of morphological and molecular analyses. The new species is distinguished from all members of the genus by the combination of small number of setae on dorsal margins of pleonites 1–3, short and small number of setae on posterior margins of peduncular articles of antennae, mandibular article 1 without setae, well developed posterior lobes of accessory lobes of coxal gills on gnathopod 2 and pereopods 3–5, and pectinate setae on palmar margin of female gnathopod 2. A key to all the species of *Jesogammarus* is provided.

Keywords

Jesogammarus, Anisogammaridae, Amphipoda, Iki Island, Japan, new species, taxonomy

Introduction

The amphipod genus *Jesogammarus* Bousfield, 1979 has been recorded from fresh and brackish waters of the Japanese archipelago, the Korea peninsula, and the Chinese continent (Bousfield 1979; Morino 1984, 1985, 1986, 1993; Lee and Seo 1990, 1992;

Tomikawa and Morino 2003; Tomikawa et al. 2003, Hou and Li 2004, 2005). To date, 17 species in two subgenera, *Jesogammarus* Bousfield, 1979 and *Annanogammarus* Bousfield, 1979, have been recognized.

In 2010, Mr. Y. Tohyama of Hiroshima University provided a few specimens of freshwater amphipod collected from the Iki Island, Nagasaki Prefecture, Japan. They proved to belong to a previously unknown species of *Jesogammarus*. The Iki Island is located between Kyushu and the Tsushima Island, and 14 km from east to west and 17 km from north to south (Fig. 1). During field surveys of freshwater amphipods in the Iki Island, made in 2010–2015, a significant number of specimens of this species have been accumulated. Close examination of the external morphology and molecular analyses based on mitochondrial DNA sequences revealed that the Iki species is distinct from its congeners, and it is described as a new species.

Materials and methods

Samples

Specimens of *Jesogammarus ikiensis* sp. n. were collected from four localities in Iki Island, Nagasaki Prefecture, Japan (Fig. 1) by scooping with a fine-mesh hand-net, and preserved in 99% ethanol at the sites. For comparison, DNA sequences data were obtained for specimens of all the Japanese species of *Jesogammarus*, *J. (A.) annandalei* (Tattersall, 1922), *J. (A.) fluvialis* Morino, 1985, *J. (J.) fujinoi* Tomikawa & Morino, 2003, *J. (J.) hinumensis* Morino, 1993, *J. (J.) hokurikuensis* Morino, 1985, *J. (J.) jesoensis* (Schellenberg, 1937), *J. (J.) mikadoi* Tomikawa, Morino & Mawatari, 2003, *J. (A.) naritai* Morino, 1985, *J. (J.) paucisetulosus* Morino, 1984, *J. (J.) shonaiensis* Tomikawa & Morino, 2003, *J. (J.) spinopalpus* Morino, 1985, and *J. (A.) suwaensis* Morino, 1986. Details of these specimens are shown in Table 1. No sequence data are available for *J. (A.) debilis* Hou & Li, 2005, *J. (J.) fontanus* Hou & Li, 2004, *J. (J.) hebeiensis* Hou & Li, 2004, *J. (J.) ilhoii* Lee & Seo, 1990, or *J. (A.) koreaensis* Lee & Seo, 1992.

Morphological observation

All appendages of the examined specimens of *Jesogammarus ikiensis* sp. n. were dissected in 99% ethanol and mounted in gum-chloral medium on glass slides under a stereomicroscope (Olympus SZX7). Specimens were examined using a light microscope (Nikon Eclipse Ni) and illustrated with the aid of a camera lucida. The body length from the tip of the rostrum to the base of the telson was measured along the dorsal curvature to the nearest 0.1 mm. The nomenclature of the setal patterns on the mandibular palp follows Stock (1974). The specimens are deposited in the Tsukuba Collection Center of the National Museum of Nature and Science, Tokyo (NSMT).

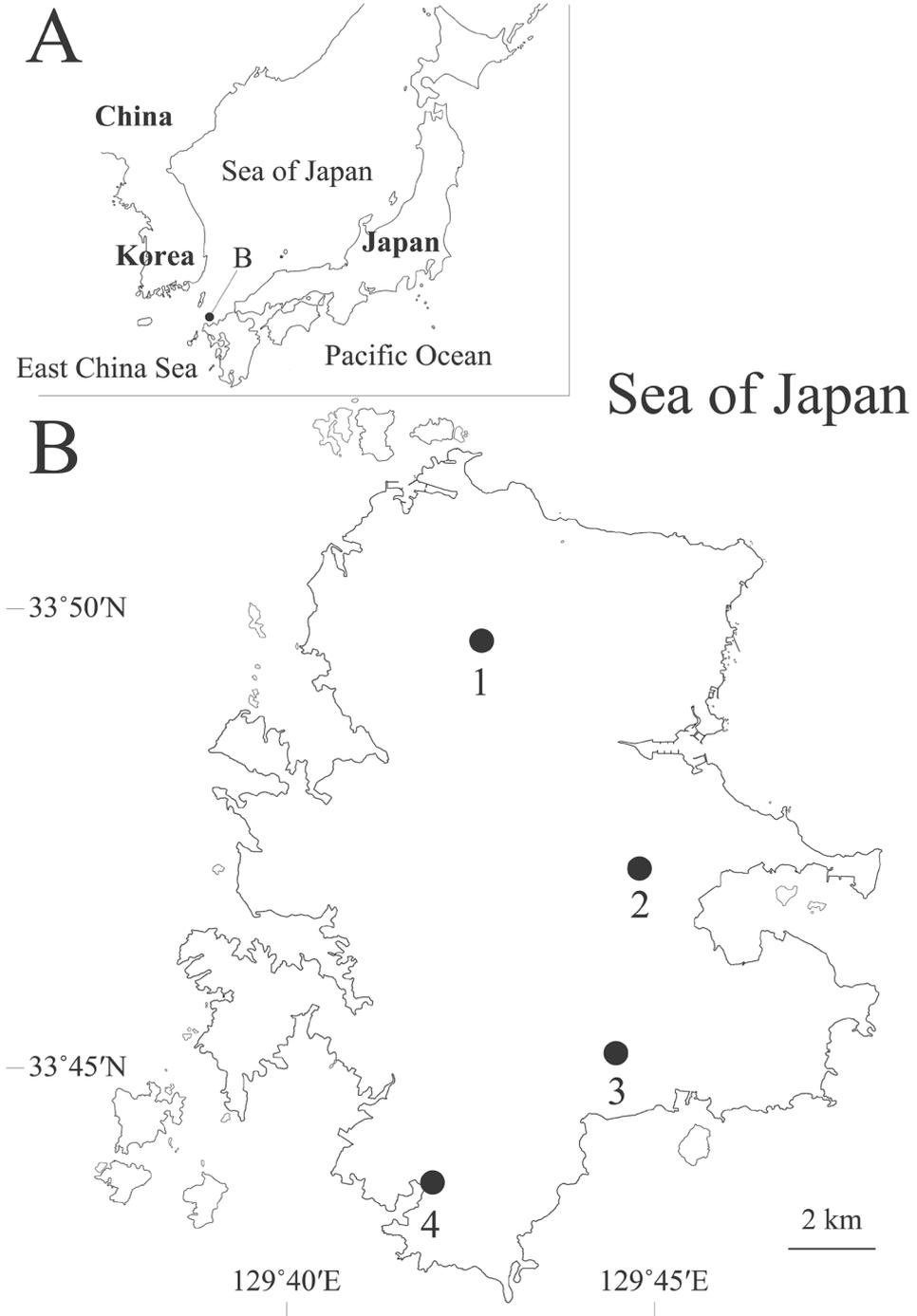


Figure 1. Sampling localities for *Jesogammarus (Jesogammarus) ikiensis* sp. n. **A** Map of Japan and adjacent area showing Iki Island, Nagasaki Prefecture, Japan **B** the collecting localities of Iki Island: 1, Katsumoto; 2, Ashibe; 3, Ishida; 4, Gonoura.

Table 1. Species, sampling localities, and numbers of specimens used for molecular phylogenetic study.

Species	Voucher	Locality	DDBJ Acc. No.		Reference
			COI	16S	
<i>Eogammarus kygi</i>	G1	Naibetsu River, Eniwa, Hokkaido, Japan	LC052229	LC052250	this study
<i>Eogammarus possjeticus</i>	G3	Akkeshi, Hokkaido, Japan	LC052230	LC052251	this study
<i>Jesogammarus annandalei</i>	G1162	Lake Biwa, Shiga Prefecture, Japan	LC052231	LC052252	this study
<i>Jesogammarus fluviialis</i>	G83	Samegai, Shiga Prefecture, Japan	LC052232	LC052253	this study
<i>Jesogammarus fujinoi</i>	G17	Gobanmiki, Yamagata, Yamagata Prefecture, Japan	LC052233	LC052254	this study
<i>Jesogammarus hinumensis</i>	G52	Lake Hinuma, Ibaraki Prefecture, Japan	LC052234	LC052255	this study
<i>Jesogammarus hokurikuensis</i>	G383	Takinami, Fukui, Fukui Prefecture, Japan	LC052235	LC052256	this study
<i>Jesogammarus jesoensis</i>	G164	Sapporo, Hokkaido, Japan	LC052236	LC052257	this study
<i>Jesogammarus mikadoi</i>	G13	Rokugo, Akita Prefecture, Japan	LC052237	LC052258	this study
<i>Jesogammarus naritai</i>	G1167	Lake Biwa, Shiga Prefecture, Japan	LC052238	LC052259	this study
<i>Jesogammarus paucistulosus</i>	G1037	Mito, Ibaraki Prefecture, Japan	LC052239	LC052260	this study
<i>Jesogammarus shonaiensis</i>	G192	Sakata, Yamagata Prefecture, Japan	LC052240	LC052261	this study
<i>Jesogammarus ikiensis</i> sp. n.	G515	Katsumoto, Iki, Nagasaki Prefecture, Japan	LC052241	LC052262	this study
<i>Jesogammarus ikiensis</i> sp. n.	G665	Ishida, Iki, Nagasaki Prefecture, Japan	LC052242	LC052263	this study
<i>Jesogammarus ikiensis</i> sp. n.	G695	Ishida, Iki, Nagasaki Prefecture, Japan	LC052243	LC052264	this study
<i>Jesogammarus ikiensis</i> sp. n.	G885	Ishida, Iki, Nagasaki Prefecture, Japan	LC052244	LC052265	this study
<i>Jesogammarus ikiensis</i> sp. n.	G886	Ishida, Iki, Nagasaki Prefecture, Japan	LC052245	LC052266	this study
<i>Jesogammarus spinopalpus</i>	G32	Onjuku, Chiba Prefecture, Japan	LC052246	LC052267	this study
<i>Jesogammarus suwaensis</i>	G88	Lake Suwa, Nagano Prefecture, Japan	LC052247	LC052268	this study
<i>Jesogammarus suwaensis</i>	G89	Lake Suwa, Nagano Prefecture, Japan	LC052248	LC052269	this study
<i>Spasskogammarus spasskii</i>	G35	Akkeshi, Hokkaido, Japan	LC052249	LC052270	this study

DNA extraction, PCR amplification, and DNA sequencing

Total genomic DNA was extracted from pereopod musculature of each sequenced amphipod (Table 1), by means of the DNeasy blood and tissue kit (Qiagen, Hilden, Germany); the final volume of the DNA solution following extraction was 200 µl. Part of the mitochondrial cytochrome *c* oxidase subunit I (COI) and 16S ribosomal RNA (rRNA) genes were amplified by polymerase chain reaction (PCR) using the following primer pair: Am-COI-H [CG(AG)GC(CGT)TA(CT)TT(CT)AC(CT)TC(ATC)GC(AC)ACTAT] and Am-COI-T [CGTCG(AGT)GG(CT)AT(ACG)CC(ACGT)

CT(AGT)A(AG)(ATC)CCTA] (Tomikawa et al. 2007); 16STf [GGTAA(T)A(CT)C(T)TA(G)ACC(T)GTGCTAAG] (Macdonald et al. 2005) and 16Sbr [CCGGTTT-GAACTCAGATCATGT] (Palumbi et al. 1991). PCR reactions containing 0.5 μ l template solution, 2 mM MgCl₂, 2.5 mM dNTP, 10 pmol of each primer, and 5U/ μ l Taq polymerase (TaKaRa Ex Taq®) in 1X buffer provided by the manufacturer were performed in 10- μ l volumes in an PC-320 thermal cycler (ASTEC). Amplification conditions were as follows: an initial denaturation for 7 min at 94 °C; 35 cycles of denaturation for 45 s at 94 °C, annealing for 1 min at 42–50 °C depending on samples, and extension for 1 min at 72 °C; and final extension for 7 min at 72 °C. Amplification products were purified by the silica method (Boom et al. 1990). All sequencing reactions were performed according to the manufacturer's instructions using the BigDye Terminator v3.1 Cycle Sequencing Reaction Kit (Applied Biosystems, Foster City, CA). Cycle sequencing conditions were 25 cycles of 10 s at 96 °C, 5 s at 50 °C, and 4 min at 60 °C. Sequencing reaction products were purified by ethanol precipitation. Labeled fragments were analyzed using an ABI 3130x Genetic Analyzer (Applied Biosystem). Sequences were obtained from both strands of the gene segments for verification using the same primers. The nucleotide sequences have been submitted to the DNA Databank of Japan (DDBJ) nucleotide-sequence database (linked to the EMBL and GenBank databases) (Table 1).

Molecular phylogenetic analyses

The nucleotide sequences were aligned using the multiple alignment algorithm in Clustal W (Thompson et al. 1994) with default setting (i.e., gap opening penalty = 15, gap extension penalty = 6.66, transition weight = 0.5). Phylogenetic relationships were reconstructed by the Neighbor-Joining method (NJ; Saitou and Nei 1987), the equally weighted maximum parsimony method (MP), and the maximum likelihood method (ML) with MEGA6 software (Tamura et al. 2013). There was no indel in COI sequences of the ingroup taxa. On the other hand, eight indels were found in 16S sequences of the ingroup taxa, which were treated as missing data in all analyses. In the NJ analysis, the Kimura 2-parameter (K2P) model (Kimura 1980) of nucleotide substitution was used to estimate genetic distances. In the MP analysis, a tree was obtained using the Close-Neighbor-Interchange algorithm, in which the initial trees were obtained with the random addition of sequences (10 replicates). The ML analysis used the T92 + G + I model for COI and HKY + G for 16S and COI + 16S; this was selected as the best-fit model using the Bayesian information criterion (BIC) in MEGA6. To estimate statistical support for branching patterns, 1,000 bootstrap replications each (Felsenstein 1985) were performed for the NJ, MP, and ML analyses. As outgroup taxa, three anisogammarid species, *Eogammarus kygi* (Derzhavin, 1923), *E. possjeticus* (Tzvetkova, 1967), and *Spasskogammarus spasskii* (Bulycheva, 1952), were used (Table 1).

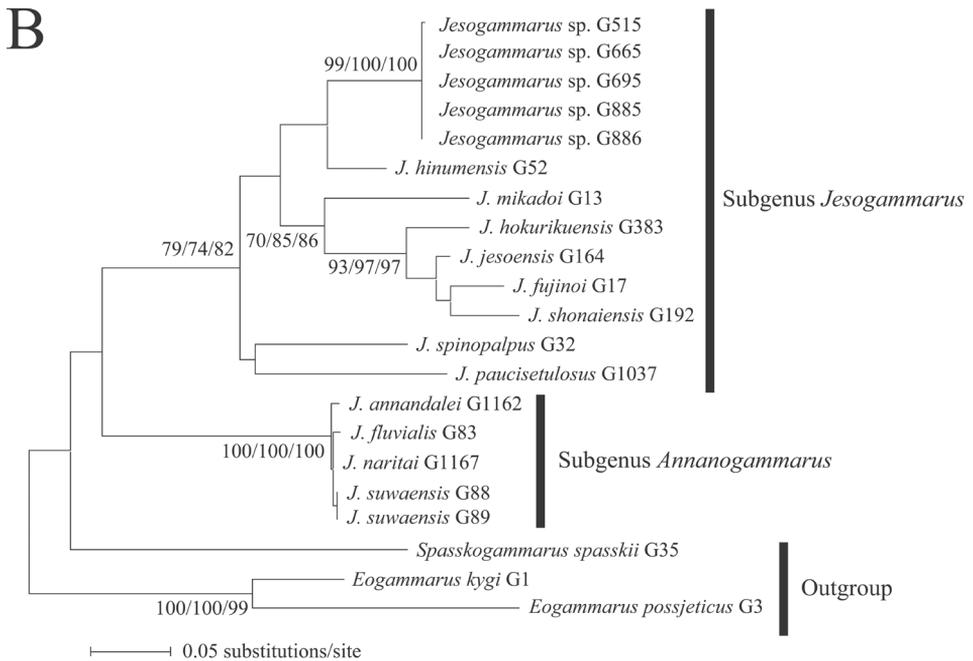
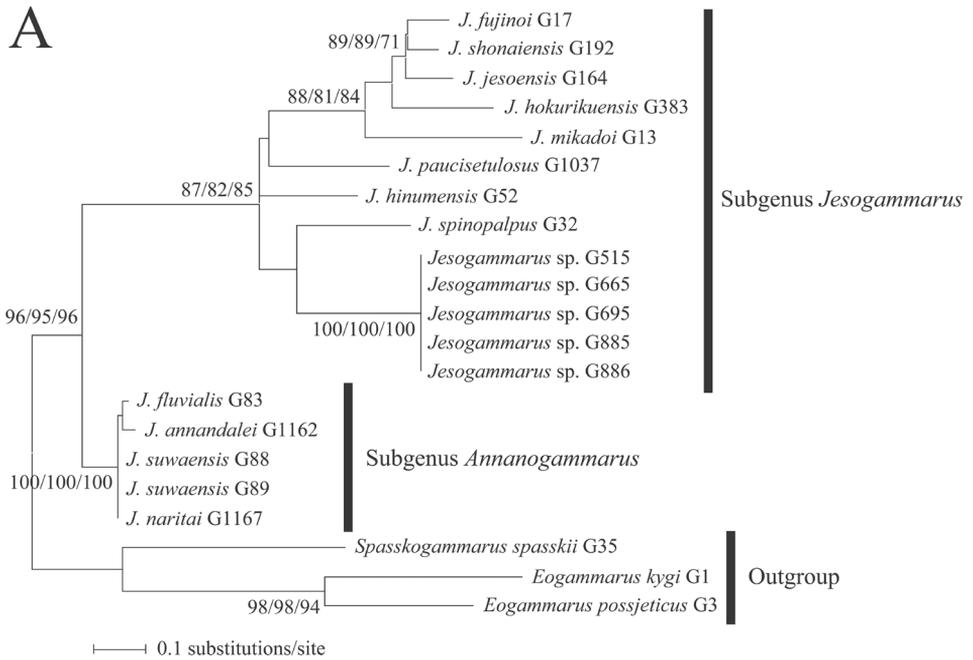


Figure 2. A maximum-likelihood tree from a 333 bp sequence of COI gene **B** maximum-likelihood tree from a 416 bp sequence of 16S rRNA gene. Numbers near the branches are ML/NJ/MP bootstrap values. Bootstraps are shown when $\geq 70\%$. Vouchers are shown after species names as in Table 1.

Remarks

Monophyly of the subgenera *Jesogammarus* and *Annanogammarus* were supported in COI, 16S, and COI + 16S trees (Figs 2, 3). *Jesogammarus ikiensis* sp. n. from Iki Island was included in the clade of the subgenus *Jesogammarus*. However, phylogenetic position of *J. ikiensis* was not clearly resolved in the phylogenetic trees based on the COI and 16S rRNA genes due to low bootstrap values. *Jesogammarus ikiensis* differs from the all Japanese congeners by large genetic distances (18.6–25.8% for COI and 12.7–18.7% for 16S) (Table 2), which were larger than intraspecific distances among many species of *Jesogammarus*. In addition, *J. ikiensis* was morphologically distinguished from its congeners. Thus, it can be concluded that *J. ikiensis* from Iki Island as a distinct new species and is described below.

Systematics

Jesogammarus (Jesogammarus) ikiensis sp. n.

<http://zoobank.org/75FDE441-CD57-41C4-B154-1E3D29ECAC3E>

New Japanese name: Iki-yokoebi

Figures 3–9

Material examined. Holotype: NSMT-Cr 24107, male (13.1 mm, 8 slides), river at Ishida (33°45'1.7"N, 129°44'33.7"E), Iki, Nagasaki Prefecture, Japan, collected by K. Tomikawa and S. Tashiro on 9 March 2012. Paratypes: NSMT-Cr 24108, ovigerous female (10.4 mm, 6 slides), NSMT-Cr 24109, 1 male and 1 ovigerous female in ethanol vial, data same as for holotype; NSMT-Cr 24110, 2 males and 2 ovigerous females in ethanol vial, river at Ishida (33°45'1.7"N, 129°44'33.7"E), Iki, Nagasaki Prefecture, Japan, collected by K. Tomikawa and S. Tashiro on 2 April 2015; NSMT-Cr 24111, male (12.0 mm, 6 slides), NSMT-Cr 24112, ovigerous female (9.4 mm, 5 slides), river at Katsumoto (33°49'30.1"N, 129°42'51.5"E), Iki, Nagasaki Prefecture, Japan, collected by K. Tomikawa and S. Tashiro on 8 March 2012; NSMT-Cr 24113, male (11.9 mm, 5 slides), NSMT-Cr 24114, ovigerous female (10.0 mm, 5 slides), river at Ashibe (33°47'3.1"N, 129°45'3.8"E), Iki, Nagasaki Prefecture, Japan, collected by K. Tomikawa and S. Tashiro on 9 March 2012; NSMT-Cr 24115, male (9.2 mm, 5 slides), NSMT-Cr 24116, female with offsprings (7.4 mm, 5 slides), irrigation ditch at Gonoura (33°43'26"N, 129°41'52"E), Iki, Nagasaki Prefecture, Japan, collected by K. Tomikawa and S. Tashiro on 9 March 2012.

Description of male (holotype, NSMT-Cr 24107). Head (Fig. 4) with short rostrum; ventral margin of lateral cephalic lobe weakly concave; antennal sinus rounded; eyes reniform, major axis 0.4 × height of head. Dorsal surfaces of pereonites smooth (Fig. 4). Dorsal margins of pleonites 1–3 (Fig. 9C–E) with three, two, and two setae, respectively. Posterior margin of epimeral plate 1 rounded with seta, anteroventral cor-

Table 2. Uncorrected pairwise differences (%: p-distance) of partial COI (upper right) and 16S rRNA (lower left) gene sequences between species.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1: <i>Eogammarus kygi</i> (N = 1)		19.5	24.3	23.7	30.6	27.3	27.0	27.9	30.0	24.3	28.5	29.1	29.4	27.6	24.3	25.2
2: <i>Eogammarus posseticus</i> (N = 1)	16.3		24.9	24.0	27.0	27.0	26.4	25.5	27.6	23.7	28.5	27.6	28.5	28.2	23.4	24.3
3: <i>Jesogammarus annandalei</i> (N = 1)	20.8	22.3		3.0	24.0	20.7	23.1	22.5	25.8	3.3	20.7	24.3	21.6	20.7	3.0–3.3	22.5
4: <i>Jesogammarus fluviatilis</i> (N = 1)	20.4	22.0	2.0		24.0	19.5	22.5	21.9	25.2	2.1	20.7	22.8	21.6	20.4	1.8–2.1	22.8
5: <i>Jesogammarus fujinoi</i> (N = 1)	25.1	24.0	20.6	20.7		19.8	15.3	10.5	18.9	22.5	20.4	9.3	24.6	21.3	22.8–23.1	27.9
6: <i>Jesogammarus hinumensis</i> (N = 1)	22.3	23.9	18.0	17.6	15.1		20.7	17.7	21.9	19.5	18.6	18.6	19.5	18.6	19.2–19.5	25.8
7: <i>Jesogammarus bokurikuensis</i> (N = 1)	24.3	24.3	20.3	20.2	11.2	15.6		17.1	21.3	22.5	19.5	12.6	23.7	19.8	22.2–22.5	26.1
8: <i>Jesogammarus jesoensis</i> (N = 1)	24.2	23.8	20.2	20.0	6.9	13.6	10.8		18.6	21.6	20.1	10.5	25.8	21.0	21.0–21.3	28.2
9: <i>Jesogammarus mikadai</i> (N = 1)	25.1	24.7	21.0	20.7	15.4	16.4	15.6	14.3		24.0	20.4	18.9	25.8	21.6	23.7–24.0	28.5
10: <i>Jesogammarus naritai</i> (N = 1)	20.8	21.6	1.9	1.2	19.8	17.5	19.9	19.6	20.0		20.1	22.2	20.7	20.1	0.3–0.6	23.4
11: <i>Jesogammarus paucisetulosus</i> (N = 1)	24.2	25.2	18.7	18.8	16.3	15.6	16.3	16.4	18.7	18.3		19.8	21.0	21.0	20.1–20.7	25.2
12: <i>Jesogammarus shonaiensis</i> (N = 1)	25.5	25.1	21.9	21.4	7.3	15.5	10.3	7.3	15.1	20.8	17.4		22.8	20.4	21.9–22.2	27.9
13: <i>Jesogammarus ikenis</i> sp. n. (N = 5)	23.4–23.5	24.0–24.2	18.2–18.3	18.3–18.4	18.0–18.2	12.7–12.8	17.8–17.9	18.2–18.3	18.6–18.7	17.6–17.8	16.8–17.0	17.4		18.6	20.4–20.7	26.1
14: <i>Jesogammarus spinopalpus</i> (N = 1)	23.0	24.6	17.0	17.0	17.1	15.9	16.6	16.7	16.8	16.6	16.4	17.1	14.8–15.0		19.5–19.8	24.6
15: <i>Jesogammarus sutuensis</i> (N = 2)	20.8–21.0	21.6–21.8	1.9–2.0	1.2–1.3	20.0–20.2	17.5–17.6	20.0–20.2	19.5–19.6	20.0–20.2	0.3–0.4	18.3–18.4	20.8–21.0	17.6–17.9	16.4–16.6		22.8–23.1
16: <i>Spasogammarus spasskiti</i> (N = 1)	22.2	22.8	20.6	20.8	22.7	22.0	22.2	22.3	23.0	20.8	21.1	22.4	21.5–21.6	21.0	20.6–20.7	

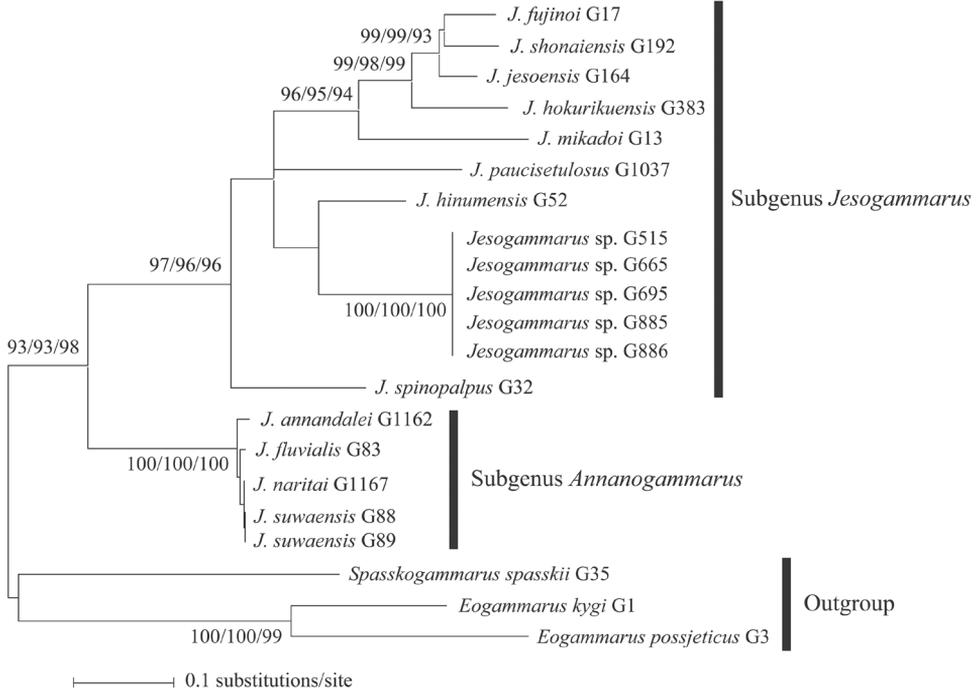


Figure 3. Maximum-likelihood tree from a 749 bp sequence of COI + 16S rRNA genes. Numbers near the branches are ML/NJ/MP bootstrap values. Bootstraps are shown when $\geq 70\%$. Vouchers are shown after species names as in Table 1.

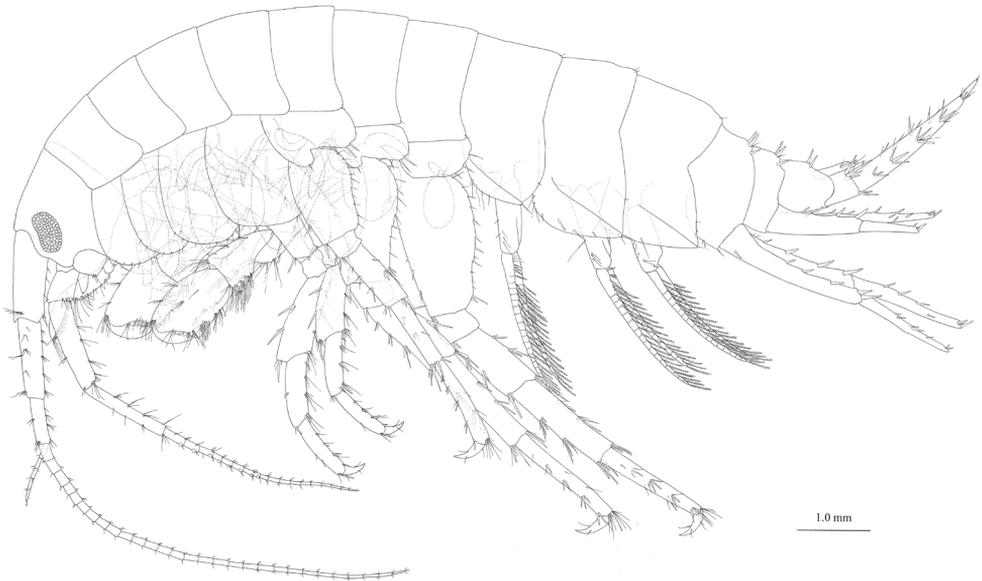


Figure 4. *Jesogammarus (Jesogammarus) ikiensis* sp. n., holotype, male, 13.1 mm, NSMT-Cr 24107, Ishida, Iki, Nagasaki Prefecture, Japan. *Habitus*, lateral view.

ner with many setae (Fig. 9I); posterior margin of plate 2 with one seta, posteroventral corner quadrate, anteroventral corner with three setae, ventral submargin with four robust setae (Fig. 9J); posterior margin of plate 3 with two setae, posteroventral corner quadrate, anteroventral to ventral margin with six setae (Fig. 9K). Urosomites 1–3 (Fig. 9F–H) with seven, four, and two robust setae associated with slender setae.

Antenna 1 (Fig. 5A): length $0.7 \times$ body length; peduncular articles 1–3 in length ratio of $1.0 : 0.9 : 0.5$; posterodistal corner of peduncular article 1 with one robust seta, posterior margin of peduncular article 2 with one cluster and three pairs of setae, posterior margin of peduncular article 3 with one cluster and one pair of setae; accessory flagellum seven-articulate; primary flagellum 29-articulate, each article with one aesthetasc.

Antenna 2 (Fig. 5B): length $0.7 \times$ antenna 1; posterior margin of peduncular article 4 with three clusters of setae, posterior margin of peduncular article 5 with three clusters of setae and one single seta; flagellum 18-articulate, calceoli present (Fig. 5C).

Mouthparts. Upper lip (= labrum) (Fig. 5D) with rounded distal margin, bearing fine setae. Lower lip (= labium) (Fig. 5E) with broad outer lobes, inner lobes indistinct. Mandibles (Fig. 5F–H) with left and right incisors six- and four-dentate, respectively, left lacinia mobilis five-dentate, right one bifid, bearing many teeth; molar process tritritative, with plumose seta; accessory setal rows of left and right mandibles each with seven blade-like setae; left palp three-articulate with length ratio of $1.0 : 3.8 : 3.8$, palp article 1 bare, article 2 with 28 setae, article 3 with two clusters and one pair of A-setae, one pair of B-setae, and many C-, D-, and E-setae, article 3 of right palp with three clusters of A-seta and one B-seta. Maxilla 1 (Fig. 5I) with inner and outer plates and palp; medial margin and apical submargin of inner plate with 31 plumose setae; outer plate subrectangular, with 11 serrate teeth apically (Fig. 5J); right palp two-articulate, much longer than outer plate, article 1 lacking marginal setae, article 2 with seven robust and six slender setae on its apical margin, outer margin with three setae, left palp lacking setae on outer margin of article 2. Maxilla 2 (Fig. 5K) with oblique inner row of 23 plumose setae on inner plate; outer plate slightly longer than inner plate. Maxilliped (Fig. 6A) with inner and outer plates and palp; inner plate (Fig. 6C) with six robust setae along apical and inner margins; outer plate (Fig. 6B) with plumose setae on apical margin and robust setae on inner margin; palp four-articulate, article 2 with inner marginal and submarginal rows of setae, article 3 with facial setae, article 4 slightly curved inward, with slender nail.

Gnathopod 1 (= pereopod 1) (Fig. 6D): coxa (= article 1) with six setae on ventral margin; anterior and posterior margins of basis (= article 2) with long setae; carpus (= article 5) length $1.4 \times$ width, anterior margin with seta; propodus (= article 6) length $1.2 \times$ length of carpus and $1.3 \times$ width of propodus, anterior margin with one pair and two clusters of setae, palmar margin (Fig. 6E) oblique, weakly convex, with 16 peg-spines (= robust setae); dactylus (= article 7) (Fig. 6E) as long as palmar margin, with posterior accessory blade longer than nail, blade basally elevated.

Gnathopod 2 (= pereopod 2) (Fig. 6F): coxa with seven marginal and one submarginal setae on ventral part, posteroproximal part with two setae; anterior and posterior

margins of basis with long setae; carpus length $1.7 \times$ width, anterior margin with cluster of setae and single seta; propodus almost as long as carpus and $1.5 \times$ width of propodus, anterior margin with two clusters of setae, palmar margin (Fig. 6G) oblique, weakly convex, with 12 peg-spines (= robust setae) and one serrate seta; dactylus (Fig. 6G) as long as palmar margin, with posterior accessory blade longer than nail.

Pereopod 3 (Fig. 7A, B): coxa with seven marginal setae on ventral part, posterior-proximal part with two setae; anterior and posterior margins of basis with long setae, antero-distal corner of basis with robust seta.

Pereopod 4 (Fig. 7C, D): coxa expanded with posterior concavity, bearing one seta on anterodistal corner and five setae on posterodistal margin; anterior and posterior margins of basis with long setae, anterodistal corner with robust seta.

Pereopod 5 (Fig. 7F, G): coxa bilobed, anterior lobe with apical seta, ventral margin of posterior lobe with three setae; posterior margin of basis weakly expanded, with ten setae; anterior and posterior margins of merus to propodus with robust and slender setae.

Pereopod 6 (Fig. 8A, B): coxa bilobed, anterior lobe with apical seta and antero-proximal setae, ventral margin of posterior lobe with three setae; posterior margin of basis weakly expanded, with 18 setae; anterior and posterior margins of merus to propodus with robust and slender setae.

Pereopod 7 (Fig. 7D, E): ventral margin of coxa weakly concave, bearing slender setae on anterior part and three setae on posteroventral part; posterior margin of basis weakly expanded, with 20 setae; anterior and posterior margins of merus to propodus with robust and slender setae.

Coxal gills on gnathopod 2 and pereopods 3–5 (Figs 6H, 7A, C, E) with two accessory lobes, gills on pereopods 6 and 7 (Fig. 8C, F) each with one accessory lobe.

Pleopods 1–3 (Fig. 8G) each with paired retinacula (Fig. 8H) on inner margin of peduncle, and bifid plumose setae (= clothes-pin setae) (Fig. 8I) on inner basal margin of inner ramus.

Uropods. Uropod 1 (Fig. 8J): peduncle with robust seta on basofacial part, inner and outer margins each with three robust setae, inner proximal part with three short setae; inner ramus length $0.8 \times$ peduncle, inner margin with three robust setae and outer margin with robust seta and minute seta; outer ramus length $0.9 \times$ inner ramus, inner and outer margins each with two and three robust setae. Uropod 2 (Fig. 8K): peduncle with three robust setae on inner and outer margins, respectively; inner ramus length $0.9 \times$ peduncle, its inner and outer margins with two robust setae, respectively; outer ramus length $0.8 \times$ inner ramus, its outer margin with robust seta. Uropod 3 (Fig. 9A): peduncle length $0.3 \times$ outer ramus; inner ramus length $0.25 \times$ outer ramus (both proximal and terminal articles), with two robust setae on inner margin; outer ramus two-articulate, inner margin of proximal article with five plumose setae, and several robust setae and simple setae, outer margin with robust setae and simple setae, terminal article length $0.2 \times$ proximal article, with short setae apically.

Telson (Fig. 9B) length $1.1 \times$ width, cleft for 59% of length in V-shape; each lobe with one lateral and one apical robust seta.

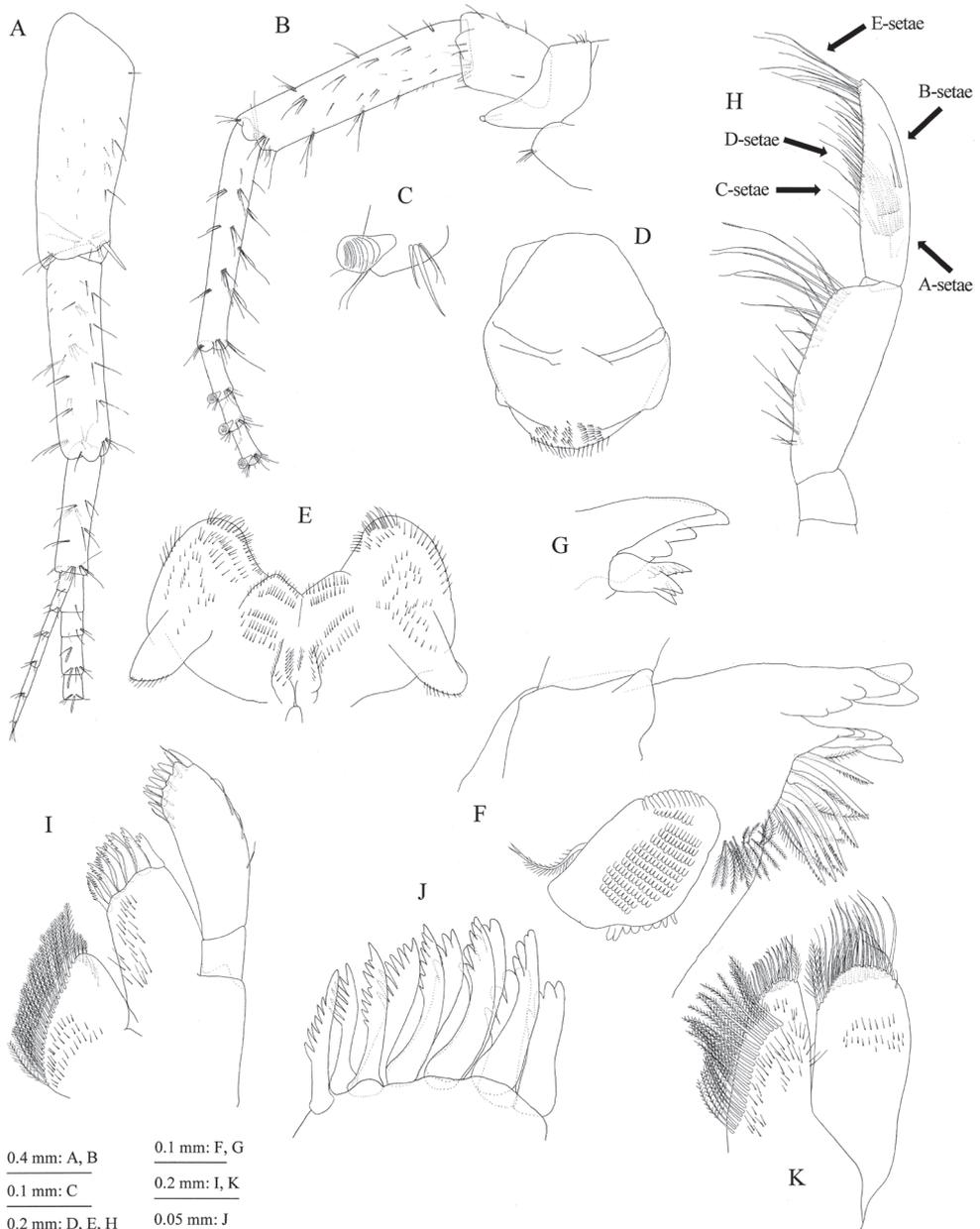


Figure 5. *Jesogammarus (Jesogammarus) ikiensis* sp. n., holotype, male, 13.1 mm, NSMT-Cr 24107, Ishida, Iki, Nagasaki Prefecture, Japan. **A** peduncular articles 1–3, accessory flagellum, and flagellar articles 1–4 of antenna 1, medial view (postero-marginal setae on peduncular articles 2 and 3 indicated by arrowheads) **B** peduncular articles 1–5 and flagellar articles 1–3 of antenna 2, medial view (postero-marginal setae on peduncular articles 4 and 5 indicated by arrowheads) **C** calceolus of antenna 2, medial view **D** upper lip, anterior view **E** lower lip, ventral view **F** left mandible except palp, medial view **G** incisor and lacinia mobilis of right mandible, lateral view **H** palp of right mandible, medial view **I** maxilla 1, dorsal view **J** outer plate of maxilla 1, dorsal view **K** Maxilla 2, dorsal view.

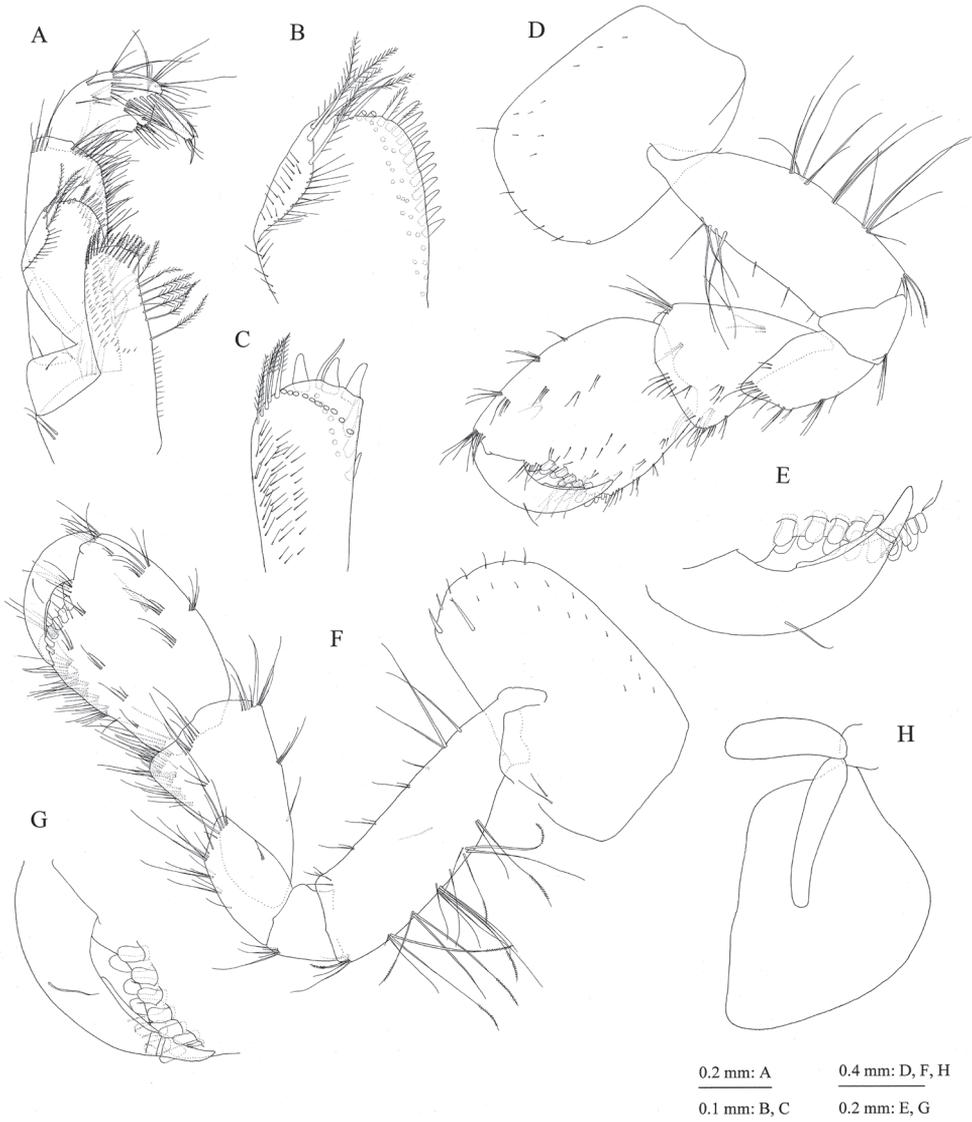


Figure 6. *Jesogammarus (Jesogammarus) ikiensis* sp. n., holotype, male, 13.1 mm, NSMT-Cr 24107, Ishida, Iki, Nagasaki Prefecture, Japan. **A** maxilliped, dorsal view **B** outer plate of maxilliped, dorsal view **C** inner plate of maxilliped, dorsal view **D** gnathopod 1, medial view **E** palmar margin of propodus and dactylus of gnathopod 1, medial view **F** gnathopod 2, medial view **G** palmar margin of propodus and dactylus of gnathopod 2, medial view **H** coxal gill of gnathopod 2, medial view.

Description of ovigerous female (paratype, NSMT-Cr 24108). Antenna 1 (Fig. 9L): length $0.7 \times$ body length; peduncular articles 1–3 in length ratio of 1.0 : 0.8 : 0.5; accessory flagellum seven-articulate; primary flagellum 36-articulate.

Antenna 2 (Fig. 9M): length $0.5 \times$ antenna 1; flagellum 12-articulate, calceoli absent.

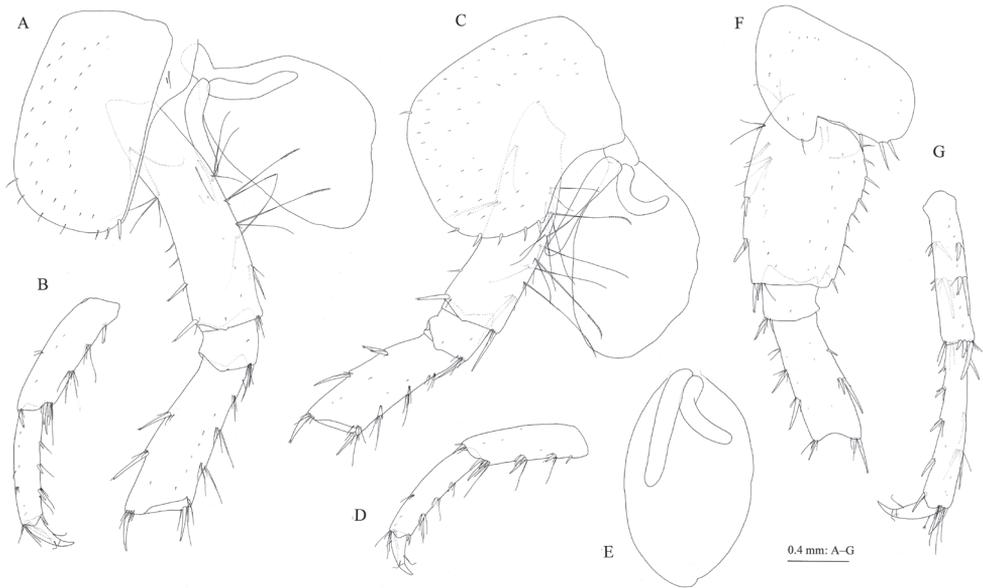


Figure 7. *Jesogammarus (Jesogammarus) ikiensis* sp. n., holotype, male, 13.1 mm, NSMT-Cr 24107, Ishida, Iki, Nagasaki Prefecture, Japan. **A** coxa–merus and coxal gill of pereopod 3, lateral view **B** carpus–dactylus of pereopod 3, lateral view **C** coxa–merus and coxal gill of pereopod 4, lateral view **D** carpus–dactylus of pereopod 4, lateral view **E** coxal gill of pereopod 5, lateral view **F** coxa–merus of pereopod 5, lateral view **G** carpus–dactylus of pereopod 5, lateral view.

Gnathopod 1 (Fig. 10A): carpus length $1.7 \times$ width, with cluster of setae and single seta on anterior margin; propodus almost as long as carpus and $1.5 \times$ width of propodus, bearing two clusters and one pair of setae on anterior margin; palmar margin (Fig. 10B) with seven robust setae and two pectinate setae.

Gnathopod 2 (Fig. 10C): carpus length $2.2 \times$ width, with one cluster, one pair, and one single seta on anterior margin; propodus length 0.9 and $2.0 \times$ carpus and width of propodus, respectively, bearing one cluster and one pair of setae on anterior margin; palmar margin (Fig. 10D) with two robust and 10 pectinate setae.

Posterior margin of bases of pereopods 5–7 more expanded than in male (Fig. 10F–H).

Brood plates (= oostegites) (Fig. 10E): broad, with numerous marginal setae.

Uropod 3 (Fig. 10I): peduncle length $0.3 \times$ outer ramus; inner ramus length $0.3 \times$ outer ramus (both proximal and terminal articles), with robust seta on inner margin; inner margin of proximal article of outer ramus with plumose seta, terminal article length $0.2 \times$ proximal article.

Egg number: 175.

Variations. The number of setae and/or setal bundles on posterior margin of peduncular articles of antennae is variable: antenna 1, two or three on article 1, three or four on article 2, one or two on article 3; antenna 2, two to four on article 4, three to

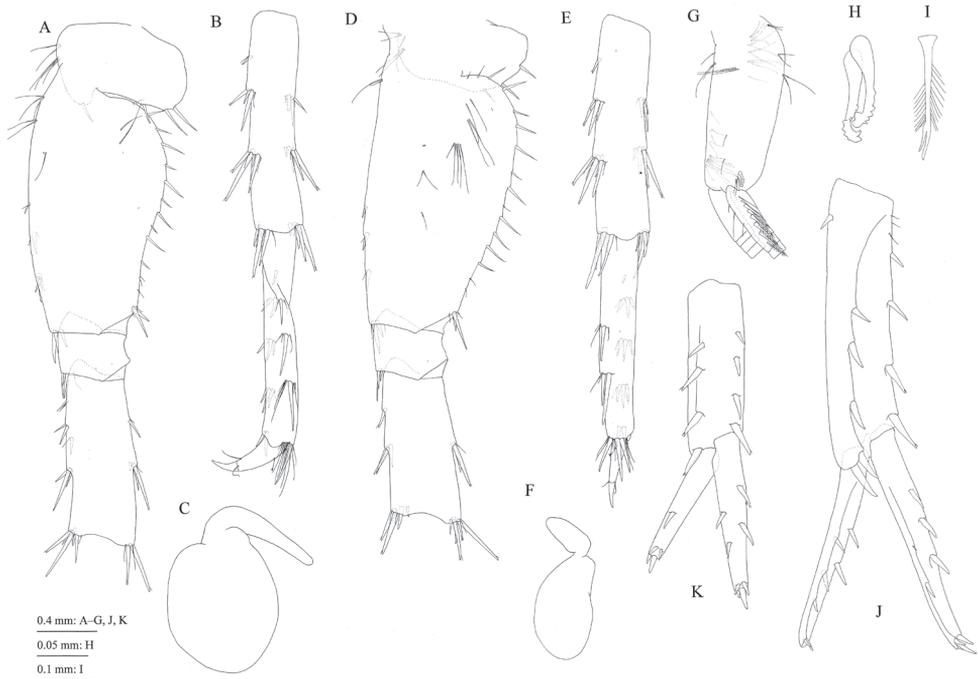


Figure 8. *Jesogammarus (Jesogammarus) ikiensis* sp. n., holotype, male, 13.1 mm, NSMT-Cr 24107, Ishida, Iki, Nagasaki Prefecture, Japan. **A** coxa–merus of pereopod 6, lateral view **B** carpus–dactylus of pereopod 6, lateral view **C** coxal gill of pereopod 6, lateral view **D** coxa–merus of pereopod 6, lateral view **E** carpus–dactylus of pereopod 6, lateral view **F** coxal gill of pereopod 7, lateral view **G** pleopod 1, medial view, distal parts of rami omitted **H** retinacula on peduncle of pleopod 1, medial view **I** bifid plumose seta (clothes-pin seta) on inner basal margin of inner ramus of pleopod 1, medial view **J** uropod 1, dorsal view **K** uropod 2, dorsal view.

five on article 5. Most specimens have a pair of setae on dorsal margins of pleonites 1–3 but several specimens have three setae. The length ratio of inner ramus of uropod 3 to outer ramus ranged from 0.2 to 0.3 in both sexes. The number of plumose setae on inner margin of outer ramus of uropod 3 varied from two to eight in males and one to three in females. Oviparous females have 58 to 175 eggs.

Remarks. *Jesogammarus ikiensis* sp. n. is assigned to the subgenus *Jesogammarus* in having well developed posterior accessory lobe of coxal gills on gnathopod 2 and pereopods 3–5, and pectinate setae on palmar margin of female gnathopod 2. The new species is distinguished from *J. fontanus* Hou & Li, 2004, *J. hebeiensis* Hou & Li, 2004, *J. hinumensis* Morino, 1993, and *J. spinopalpus* Morino, 1985 by absence (*vs.* presence) of setae on article 1 of mandibular palp. *Jesogammarus ikiensis* is distinguished from *J. mikadoi* Tomikawa, Morino & Mawatari, 2003 by absence (*vs.* presence) of setae on dorsal margin of pereonites 5–7 and two or three (*vs.* more than seven) setae on dorsal margins of pleonites 1–3. *Jesogammarus ikiensis* is distinguished from *J. paucisetulosus* Morino, 1984 by medium eye, major axis of eyes 0.4 × height of

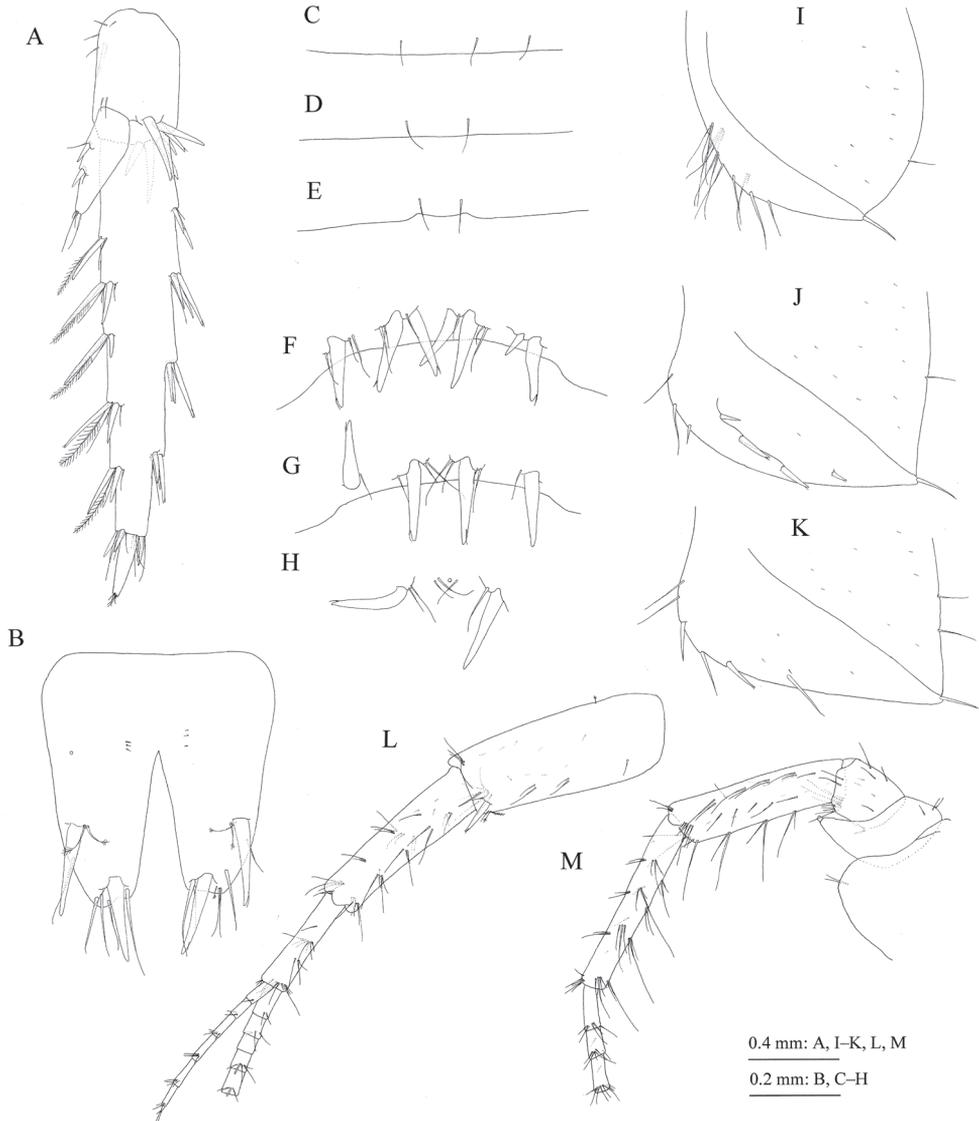


Figure 9. *Jesogammarus (Jesogammarus) ikiensis* sp. n., Ishida, Iki, Nagasaki Prefecture, Japan. Holotype, male, 13.1 mm, NSMT-Cr 24107 (A–K) and paratype, female, 10.4 mm, NSMT-Cr 24108 (L and M). **A** uropod 3, dorsal view **B** telson, dorsal view **C–E** pleonites 1–3, respectively, dorsal views **F–H** urosomites 1–3, respectively, dorsal views **I–K** epimeral plates 1–3, respectively, lateral views **L** peduncular articles 1–3, accessory flagellum, and flagellar articles 1–5 of antenna 1, medial view **M** peduncular articles 1–5 and flagellar articles 1–3 of antenna 2, medial view.

head (*vs.* small, less than 0.3), posterodistal corner of peduncular article 1 of antenna 1 with a robust (*vs.* slender) seta, posterior margin of peduncular article 2 of antenna 1 with three or four (*vs.* more than five) setae and/or setal bundles, and posterior-marginal setae on peduncular article 4 of antenna 2 shorter (*vs.* longer) than width of

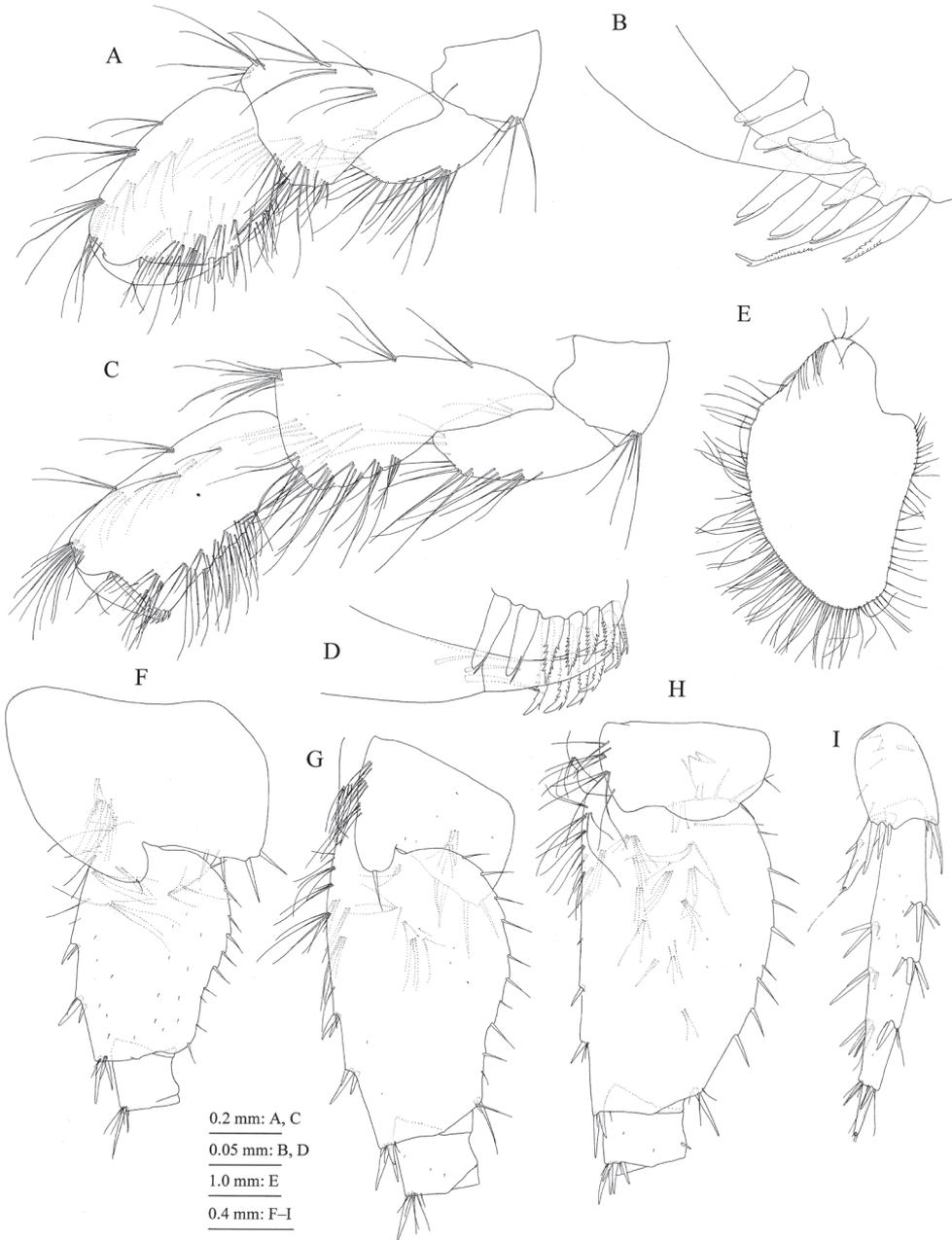


Figure 10. *Jesogammarus (Jesogammarus) ikiensis* sp. n., paratype, female, 10.4 mm, NSMT-Cr 24108, Ishida, Iki, Nagasaki Prefecture, Japan. **A** ischium–dactylus of gnathopod 1, lateral view **B** posterodistal part of palmar margin of propodus and part of dactylus of gnathopod 1, medial view **C** ischium–dactylus of gnathopod 2, lateral view **D** posterodistal part of palmar margin of propodus and part of dactylus of gnathopod 2, medial view **E** brood plate of gnathopod 2, lateral view **F** coxa–ischium of pereopod 5, lateral view **G** coxa–ischium of pereopod 6, lateral view **H** coxa–ischium of pereopod 7, lateral view **I** uropod 3, ventral view.

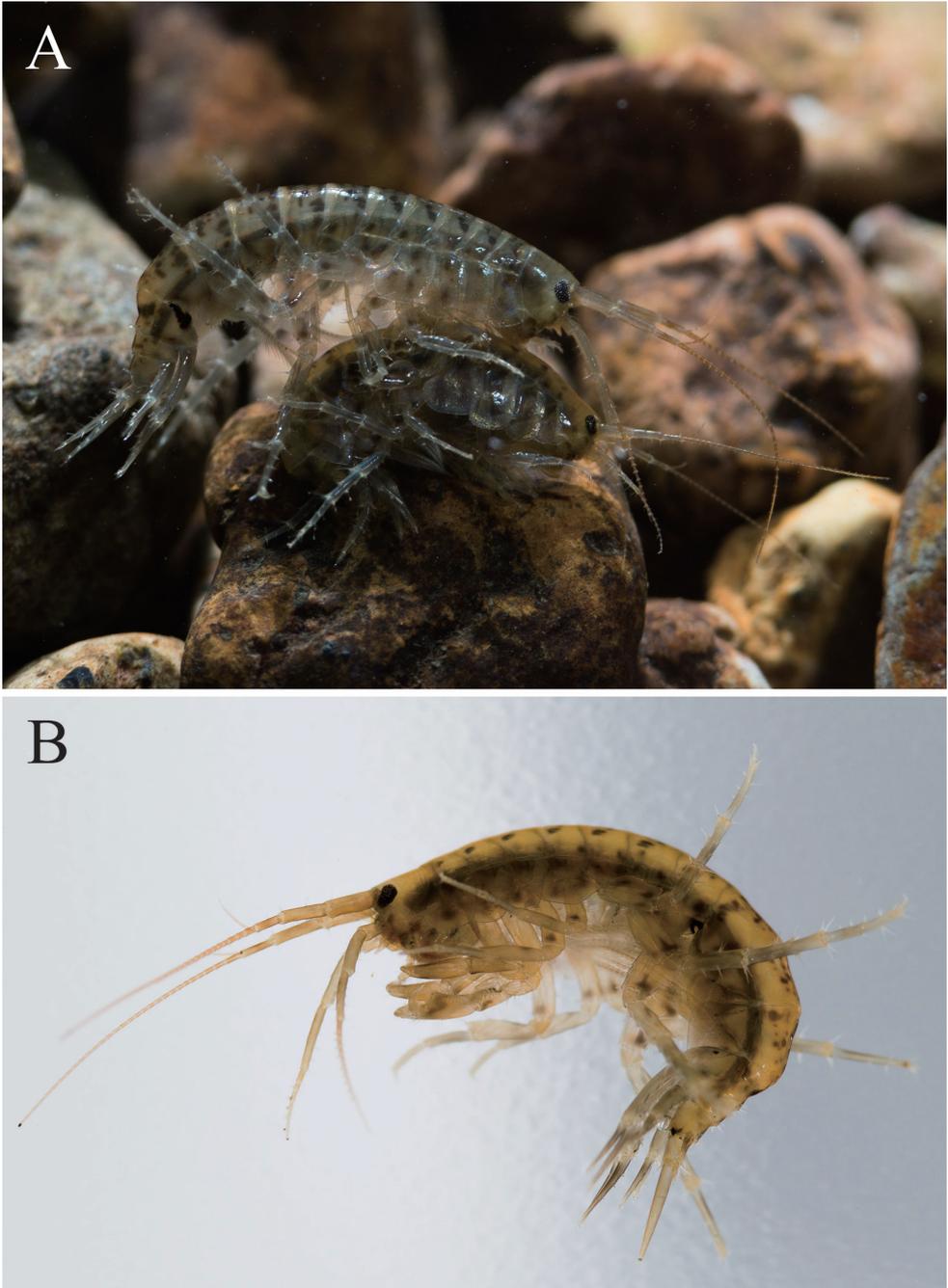


Figure 11. *Jesogammarus (Jesogammarus) ikiensis* sp. n., not preserved. **A** preopercula pair (male: upper, female: lower) **B** male, approx. 13 mm. Photographed by Ryu Uchiyama.

article 4 in male;. *Jesogammarus ikiensis* differs from the *J. jesoensis* complex including *J. fujinoi* Tomikawa & Morino, 2003, *J. hokurikuensis* Morino, 1985, *J. jesoensis* (Schellenberg, 1937), *J. shonaiensis* Tomikawa & Morino, 2003, by two or three (*vs.* more than seven) setae on dorsal margins of pleonites 1–3 and three or four (*vs.* two) setae and/or setal bundles on posterior margin of peduncular article 2 of antenna 1. *Jesogammarus ikiensis* differs from *J. ilhoii* Lee & Seo, 1992 by absence (*vs.* presence) of pectinate setae on palmar margin of propodus of male gnathopod 2 and two or three (*vs.* more than ten) setae on dorsal margins of pleonites 1–3.

Etymology. The specific name is from the Latinized Japanese *ikiensis* (of Iki), referring to the type locality of the new species.

Distribution. Known only from Iki Island.

Habitat. River and irrigation ditch.

Key to species of *Jesogammarus*

Since species of the *J. jesoensis* complex including *J. fujinoi*, *J. hokurikuensis*, *J. jesoensis*, *J. shonaiensis* are difficult to distinguish from each other due to high variability of morphological characters (Kusano and Ito 2003, Tomikawa unpublished data), only the *J. jesoensis* complex is included in the key. In addition, *J. naritai* Morino, 1985 is not morphologically distinguishable from *J. suwaensis* Morino, 1986 (Tomikawa et al. 2007), and the latter is treated as the same as the former in the key.

- 1 Accessory lobes of coxal gills on gnathopod 2 and pereopods 3–5 well developed, both anterior and posterior lobes subequal in length or posterior lobe longer than anterior one; palmar margin of propodus of female gnathopod 2 with pectinate setae..... **2** (subgenus *Jesogammarus*)
- Accessory lobes of coxal gills on gnathopod 2 and pereopods 3–5 weakly developed, anterior and posterior lobes unequal in length, often posterior lobe rudimentary; palmar margin of propodus of female gnathopod 2 without pectinate setae..... **10** (subgenus *Annanogammarus*)
- 2 Article 1 of mandibular palp with setae..... **3**
- Article 1 of mandibular palp without setae..... **6**
- 3 Dorsal margin of pleonites 1–3 each with 1–2 setae; eye large; article 1 of mandibular palp with 1 robust seta; female pereopods densely setose.....
..... ***J. (J.) hinumensis* Morino, 1993**
- Dorsal margin of pleonites 1–3 each with more than 4 setae; eye small to medium; article 1 of mandibular palp with 2 or 3 robust setae; female pereopods not densely setose **4**
- 4 Peduncular article 1 of antenna 1 with robust seta on posterodistal corner....
..... ***J. (J.) spinopalpus* Morino, 1985**
- Peduncular article 1 of antenna 1 with slender seta on posterodistal corner... **5**

- 5 Inner ramus of uropod 3 length $1/4 \times$ outer ramus; inner margin of outer ramus of uropod 3 with 4–6 plumose setae.....***J. (J.) fontanus* Hou & Li, 2004**
- Inner ramus of uropod 3 length $1/3 \times$ outer ramus; inner margin of outer ramus of uropod 3 with about 10 plumose setae.....***J. (J.) hebeiensis* Hou & Li, 2004**
- 6 Dorsal margin of pereonites 1–3 each with 2 long setae.....***J. (J.) mikadoi* Tomikawa et al., 2003**
- Dorsal margin of pereonites 1–3 without setae7
- 7 Posterior margin of peduncular article 2 of antenna 1 with fewer than five setae and/or setal bundles; posteromarginal setae on peduncular article 4 of antenna 2 shorter than width of article 4 in male; posterodistal corner of peduncular article 2 of antenna 1 with robust seta (occasionally lacking).....**8**
- Posterior margin of peduncular article 2 of antenna 1 with more than 5 setae and/or setal bundles; posteromarginal setae on peduncular article 4 of antenna 2 longer than width of article 4 in both sexes; posterodistal corner of peduncular article 2 of antenna 1 without robust seta.....***J. (J.) paucisetulosus* Morino, 1984**
- 8 Dorsal margins of pleonites 1–3 each with 2 or 3 setae; posterior margin of peduncular article 2 of antenna 1 with 3 or 4 setae and/or setal bundles***J. (J.) ikiensis* sp. n.**
- Dorsal margins of pleonites 1–3 each with more than 7 setae; posterior margin of peduncular article 2 of antenna 1 with 2 setae and/or setal bundles ..9
- 9 Palmar margin of propodus of male gnathopod 2 without pectinate setae.....***J. (J.) jesoensis* complex**
- Palmar margin of propodus of male gnathopod 2 with pectinate setae.....***J. (J.) ilhoii* Lee & Seo, 1992**
- 10 Dorsal margin of pleonite 3 with robust setae; posterior margin of peduncular article 4 and 5 with more than 5 long-setal bundles***J. (A.) naritai* Morino, 1985**
- Dorsal margin of pleonite 3 without robust setae; posterior margin of peduncular article 4 and 5 with less than 3 short-setal bundles**11**
- 11 Posterodistal corner of bases of pereopods 5–7 with long setae***J. (A.) annandalei* (Tattersal, 1922)**
- Posterodistal corner of bases of pereopods 5–7 without short setae**12**
- 12 Dorsal margins of pleonites 1–3 each with 2–4 setae***J. (A.) fluvialis* Morino, 1985**
- Dorsal margins of pleonites 1–3 each with more than 10 setae**13**
- 13 Posterodistal corner of peduncular article 1 of antenna 1 with robust seta; palmar margin of propodus of female gnathopod 2 with simple setae only ...***J. (A.) koreanus* Lee & Seo, 1990**
- Posterodistal corner of peduncular article 1 of antenna 1 without robust seta; palmar margin of propodus of female gnathopod 2 with weakly pectinate setae.....***J. (A.) debilis* Hou & Li, 2005**

Acknowledgements

I thank Mr. Y Tohyama (Hiroshima University) for providing specimens and Ms. S. Tashiro (Hiroshima University) for assistance in collection. Thanks are also due to Ryu Uchiyama (nature photographer) for providing photographs of live specimens. I am grateful Dr. Cene Fišer (University of Ljubljana) and two anonymous reviewers for their critical reading of and valuable comments on this manuscript. This work was partly supported by grants from the Japan Society for the Promotion of Sciences (JSPS: 25242015 and 25840140).

References

- Boom R, Sol CJA, Salimans MMM, Jansen CL, Wertheim-van Dillen PME, van der Noordaa J (1990) Rapid and simple method for purification of nucleic acids. *Journal of Clinical Microbiology* 28: 495–503.
- Bousfield EL (1979) The amphipod superfamily Gammaroidea in the northeastern Pacific region: Systematics and distributional ecology. *Bulletin of Biological Society of Washington* 3: 297–357.
- Felsenstein J (1985) Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39: 783–791. doi: 10.2307/2408678
- Hou Z, Li S (2004) Two new freshwater species of the genus *Jesogammarus* (Crustacea: Amphipoda: Anisogammaridae) from China. *Raffles Bulletin of Zoology* 52: 455–466.
- Hou Z, Li S (2005) Amphipod crustaceans (Gammaroidea) from Beijing, P. R. China. *Journal of Natural History* 39: 3255–3274. doi: 10.1080/00222930500289590
- Kimura M (1980) A simple method for estimating evolutionary rates of base substitutions through comparative studies of nucleotide sequences. *Journal of Molecular Evolution* 16: 111–120.
- Kusano H, Ito T (2003) Distribution of freshwater amphipods in Eniwa City, Hokkaido, northern Japan. *Biology of Inland Waters* 18: 7–14. [In Japanese with English abstract]
- Lee KS, Seo IS (1990) One new species of freshwater *Jesogammarus* (Crustacea, Amphipoda, Anisogammaridae) from South Korea. *Korean Journal of Systematic Zoology* 6: 251–260.
- Lee KS, Seo IS (1992) One new species of freshwater *Jesogammarus* (Crustacea, Amphipoda, Anisogammaridae) from South Korea. *Korean Journal of Systematic Zoology* 35: 344–349.
- Macdonald KS, Yampolsky L, Duffy JE (2005) Molecular and morphological evolution of the amphipod radiation of Lake Baikal. *Molecular Phylogenetics and Evolution* 35: 323–343. doi: 10.1016/j.ympev.2005.01.013
- Morino H (1984) On a new freshwater species of Anisogammaridae (Gammaroidea: Amphipoda) from central Japan. *Publications of the Itako Hydrobiological Station* 1: 17–23.
- Morino H (1985) Revisional studies on *Jesogammarus*–*Annanogammarus* group (Amphipoda: Gammaroidea) with descriptions of four new species from Japan. *Publications of the Itako Hydrobiological Station* 2: 9–55.
- Morino H (1986) A new species of the subgenus *Annanogammarus* (Amphipoda: Anisogammaridae) from Lake Suwa, Japan. *Publications of the Itako Hydrobiological Station* 3: 1–11.

- Morino H (1993) A new species of the genus *Jesogammarus* (Amphipoda: Anisogammaridae) from brackish waters of Japan. Publications of the Itako Hydrobiological Station 6: 9–16.
- Palumbi SR, Martin A, Romano S, McMillan WV, Stice L, Grabowski G (1991) The Simple Fool's Guide to PCR. version 2.0. University of Hawaii, 94 pp.
- Saitou N, Nei M (1987) The neighbor-joining method: a new method for reconstructing phylogenetic trees. *Molecular Biology and Evolution* 4: 406–425.
- Stock JH (1974) The systematics of certain Ponto-Caspian Gammaridae (Crustacea, Amphipoda). *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 70: 75–95.
- Tamura K, Stecher G, Peterson D, Filipowski A, Kumar S (2013) MEGA6: molecular evolution genetics analysis version 6.0. *Molecular Biology and Evolution* 30: 2725–2729. doi: 10.1093/molbev/mst197
- Thompson JD, Higgins DG, Gibson TJ (1994) CLUSTAL W: Improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. *Nucleic Acids Research* 22: 4673–4680. doi: 10.1093/nar/22.22.4673
- Tomikawa K, Kobayashi N, Morino H, Hou Z, Mawatari SF (2007) Phylogenetic relationships within the genus *Jesogammarus* (Crustacea, Amphipoda, Anisogammaridae) deduced from mitochondrial COI and 12S sequences. *Zoological Science* 24: 173–180. doi: 10.2108/zsj.24.173
- Tomikawa K, Morino H (2003) Two new freshwater species of the genus *Jesogammarus* (Crustacea: Amphipoda: Anisogammaridae) from northern Japan. *Zoological Science* 20: 229–241. doi: 10.2108/zsj.20.229
- Tomikawa K, Morino H, Mawatari SF (2003) A new freshwater species of the genus *Jesogammarus* (Crustacea: Amphipoda: Anisogammaridae) from northern Japan. *Zoological Science* 20: 925–933. doi: 10.2108/zsj.20.925

Review of New Caledonian species of *Oxyethira* Eaton, with description of 17 new species, and new records for *Hydroptila* Dalman and *Hellyethira* Neboiss (Trichoptera, Hydroptilidae)

Alice Wells¹, Kjell Arne Johanson²

1 Australian Biological Resources Study, PO Box 787, Canberra, ACT 2601 Australia **2** Zoology Department, Swedish Museum of Natural History, Box 50007, SE-104 05 Stockholm, Sweden

Corresponding author: Alice Wells (alice.wells@environment.gov.au)

Academic editor: R. Holzenthal | Received 13 May 2015 | Accepted 7 September 2015 | Published 28 October 2015

<http://zoobank.org/6B52F314-01BE-48EE-9C40-0A467D24040E>

Citation: Wells A, Johanson KA (2015) Review of New Caledonian species of *Oxyethira* Eaton, with description of 17 new species, and new records for *Hydroptila* Dalman and *Hellyethira* Neboiss (Trichoptera, Hydroptilidae). ZooKeys 530: 37–90. doi: 10.3897/zookeys.530.6047

Abstract

New Caledonian representation of the cosmopolitan genus *Oxyethira* Eaton is reviewed, with the description of new species bringing to 26 the total for the genus on the island. The species are referred to three subgenera: *Trichoglene* Neboiss (11 species), *Pacificotrichia* Kelley (13 species) and *Dampfitrichia* Ulmer (one species) and one species is unplaced to subgenus. A key is provided to *Oxyethira* species of New Caledonia. In addition, new records are given for two otherwise Australian species, *Hydroptila losida* Mosely and *Hellyethira malleoforma* Wells. Points marked on a series of small maps of New Caledonia indicate the site or sites at which the species were collected. This final paper in a series of generic revisions brings the hydroptilid fauna of the island of New Caledonia to 60 species, distributed in six genera.

Keywords

Spicipalpia, Hydroptilidae, New Caledonia, endemic, key, new species

Table of contents

Introduction.....	3
Methods.....	4
Systematics.....	5
<i>Oxyethira</i> Eaton.....	5
Subgenus <i>Trichoglène</i> Neboiss.....	5
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>spinifera</i> sp. n.	6
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>tiwaka</i> sp. n.....	8
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>perignonica</i> sp. n.....	9
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>abbreviata</i> sp. n.	10
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>incurvata</i> sp. n.....	11
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>caledoniensis</i> Kelley.....	13
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>arok</i> Oláh & Johanson	15
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>amieu</i> sp. n.....	16
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>houailou</i> sp. n.....	16
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>insularis</i> Kelley.....	18
<i>Oxyethira</i> (<i>Trichoglène</i>) <i>parinsularis</i> sp. n.	19
Subgenus <i>Pacificotrichia</i> Kelley, 1989	20
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>oropedion</i> Kelley.....	20
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>quadrata</i> sp. n.	24
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>dorsennus</i> Kelley.....	25
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>indorsennus</i> Kelley.....	25
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>rougensis</i> sp. n.....	27
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>mouirange</i> sp. n.	29
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>ouenghi</i> sp. n.	29
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>enigmatica</i> sp. n.....	30
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>melasma</i> Kelley.....	32
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>nehoue</i> sp. n.	33
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>scutica</i> Kelley.....	34
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>spicula</i> sp. n.....	36
<i>Oxyethira</i> (<i>Pacificotrichia</i>) <i>digitata</i> sp. n.	37
Subgenus <i>Dampftrichia</i> Ulmer	37
<i>Oxyethira</i> (<i>Dampftrichia</i>) <i>incana</i> Ulmer.....	39
<i>Oxyethira</i> species unplaced to subgenus.....	40
<i>Oxyethira</i> <i>macropennis</i> sp. n.....	40
New records of other genera.....	46
<i>Hydroptila losida</i> Mosely.....	46
<i>Helyethira malleoforma</i> Wells	49
Key to males of New Caledonian species of <i>Oxyethira</i>	50
Acknowledgements.....	53
References	53

Introduction

The cosmopolitan genus *Oxyethira* Eaton exhibits a diverse array of male genital structures and arrangements. The species show some variability in female terminalia, but exhibit extreme conservatism in larval and case morphology. Representatives of the genus found in New Caledonia appear to be no exception. This is apparent upon consideration of the variability among 26 species recorded here, and the similarity of the considerable number of unassociated final instar larvae collected at many sites by Mary (2002) in her survey of macroinvertebrates of the island's streams.

This final paper in a series of genus-level reviews (Wells and Johanson 2012, 2014; Wells, Johanson and Mary-Sasal 2013) brings to 60 species, in six genera, the presently known hydroptilid fauna of New Caledonia, only surpassed by Ecnomidae in number of species found on the island (Espeland and Johanson 2010). The study is based for the greater part on collections of Hydroptilidae made by members of the Swedish Museum of Natural History and deals primarily with the genus *Oxyethira*. It also presents new records for the previously reported (Wells 1995) sole New Caledonian representatives of two other hydroptilid genera, *Hydroptila losida* Mosely, 1953 and *Hellyethira malleoforma* Wells, 1979, both common in eastern Australia.

Oxyethira is well represented in New Caledonia, at genus level only surpassed in known species diversity among the island Trichoptera by the helicopsychid genus *Helicopsyche* (Johanson 1999; Johanson and Mary 2000), with 30 described species, and the ecnomid genus *Agmina* (Espeland & Johanson, 2010), with 28 described and nearly 50 undescribed species. Seven New Caledonian *Oxyethira* species were described by Kelley (1989), based on a collection in the B.P. Bishop Museum, Honolulu. He assigned the species to two subgenera: subgenus *Trichoglene* Neboiss (*O. caledoniensis* Kelley and *O. insularis* Kelley); and a new subgenus, *Pacificotrichia* Kelley (*O. oropedion* Kelley, *O. dorsennus* Kelley, *O. indorsennus* Kelley, *O. melasma* Kelley, and *O. scutica* Kelley), all assigned to the "oropedion group". Oláh and Johanson (2010a) described three additional New Caledonia species: *O. tompa*, which they referred to subgenus *Pacificotrichia*; and two species, *O. arok* and *O. derek*, which they assigned to subgenus *Trichoglene*. One representative of a third subgenus, *Dampftrichia* Ulmer, the widespread SE Asian-Australasian species *Oxyethira* (*Dampftrichia*) *incana* (Ulmer) described from Java, is recorded from New Caledonia for the first time.

Most of the 17 species newly described here from New Caledonian can be referred to the above three subgenera with a degree of confidence. One species, however, cannot be placed at present: *O. macropennis* sp. n. shares the diagnostic features of *Oxyethira* as defined by Kelley (1984) and is left unplaced.

Among females in the samples at least two general morphological forms can be recognised in abdominal terminalia: a short oviscapt of the form illustrated by Kelley (1989: figs 55, 56) for the Vanuatuan *O. efatensis* Kelley; and a slender, elongate oviscapt such as he illustrated for *O. oropedion* (Figs 50, 51) and *O. scutica* (Figs 52, 53),

sometimes with a small, rounded black area ventrally on abdominal segment X as in *O. oropedion*. The distinctive female of *O. incana* is readily recognised by the quadrate black patch ventrally on segment X. Some of the other females were associated with males tentatively, but we are not sufficiently confident of their identity to include them here.

Apparent distributions of species are difficult to interpret (see Figs 86–113). Almost all collections were made during November to mid January, normally the warmer season of the year. At least over that period, some species appear to be very localised, others widespread and still others disjunct in distribution, being taken from far northern and far southern localities. Further studies are needed at other times of year to determine whether these data reflect reality, seasonality, or some aspect of behaviour, such that collecting methods missed particular species.

Methods

Most of the material this study is based upon was collected in light traps and Malaise traps situated near or across running water. Specimens were prepared for study as Canada balsam slide mounts following maceration in KOH and clearing in clove oil. Male genitalia are illustrated in line drawings, traced from draft figures using Adobe Illustrator CS5, for species for which suitable slides are available.

An identification key and descriptions of New Caledonian *Oxyethira* species are provided, as well as brief diagnoses of previously described *Oxyethira* species and new illustrations of their male genitalia, drawn from types and/or newly collected non-type specimens. Species descriptions are based on male genital features, although identification of homologies among these is often difficult, especially for some of the more aberrant species. Usually diagnostic features are indicated on figures. Terms applied to genital structures follow the recommendations of Oláh and Johanson (2010b) and itemised by Wells and Johanson (2014: 3) when reviewing New Caledonian species of the genus *Acritoptila*.

Development of a useful key for easy identification of species was difficult as observation of most readily diagnostic features requires preparation of slide mounts of specimens and examination under a compound microscope.

Collection sites for species were plotted on a series of maps (Figs 86–113). Specimens in this study are deposited in the following repositories:

- MNHP** Muséum National d'Histoire Naturelle, Paris, France
- NHRS** Swedish Museum of Natural History, Stockholm, Sweden
- ANIC** Australian National Insect Collection, CSIRO, Canberra, Australia
- BPBM** Bishop Museum, Hawaii, USA

Systematics

Oxyethira Eaton

Subgenus *Trichoglene* Neboiss

The chief diagnostic characteristics that Kelley (1989) notes for subgenus *Trichoglene* are: in males, “a complete non-excised [abdominal] segment VIII”, identified as plesiomorphic, and “aedeagus with recurved sub-distal spinous process and subgenital processes widely separated and partly fused with each pleuron of segment IX”, features identified as apomorphic. Additional features are included in Kelley’s description of the subgenus, including a titillator on the “aedeagus” [= phallic apparatus]. The subgenital processes in most members of this subgenus are in the form of a pair of well-separated rods, spines or strap-like structures, connected basally with the gonopods (= inferior appendages of Kelley) and a pair of digitiform membranous lobes, each bearing an apical seta.

In discussions of subgenus *Trichoglene* (Kelley 1984, 1989), some confusion is evident in understanding of the type species of *Trichoglene*. Neboiss (1977) established the genus *Trichoglene* for *Trichoglene columba* Neboiss, described from Tasmania. This species was recognised by Wells (1981) as a species of *Oxyethira*. Upon designation of *Trichoglene* as a subgenus of *Oxyethira*, Kelley (1984) incorrectly gave the New Zealand *Oxyethira albiceps* (McLachlan, 1862) (= *Hydroptila albiceps* McLachlan, 1862) as the type. He repeated and compounded the error (Kelley 1989) by stating that “the type species of *Trichoglene* was incorrectly identified as *Oxyethira columba* (Neboiss) in Kelley (1984) [which it is not]... [i]t should be *O. albiceps* (MacLachlan)”. Perhaps he meant to imply that *Hydroptila albiceps* and *Trichoglene columba* (= *Oxyethira columba*) are synonyms, but they are distinct. *Trichoglene columba* Neboiss is the type species of the subgenus. Subgenus *Trichoglene* is Australasian in distribution, occurring in Australia, including Tasmania and Norfolk Island, and in New Zealand, as well as New Caledonia. Among New Caledonian species, Kelley assigned *O. caledoniensis* and *O. insularis* to subgenus *Trichoglene*; and eight species are newly described here.

Three species groups are recognised among these New Caledonian members of subgenus *Trichoglene*. A set of species, the *spinifera*-group, with abdominal segment IX subquadrate comprises *O. spinifera* sp. n., *O. tiwaka* sp. n., *O. perignonica* sp. n., and *O. abbreviata* sp. n. A second set, the *caledoniensis*-group, with venter of abdominal segment IX in ventral view produced anteriorly, proximally either rounded or tapered and somewhat triangular, includes *O. caledoniensis* Kelley, *O. incurvata* sp. n., *O. arok* Oláh & Johanson, *O. amieu* sp. n., and *O. houailou* sp. n. The distinctions between these two groups of species, however, are not clear cut. The venter of *O. caledoniensis* Kelley is only slightly produced anteriorly. A third group, the *insularis*-group, characterised by the prominently Y-shaped gonopods has only two members: *O. insularis* sp. n. and *O. parinsularis* sp. n.

***Oxyethira (Trichoglene) spinifera* sp. n.**

<http://zoobank.org/EC7AC788-3322-4798-88A2-1F1C876C5FF1>

Figs 1–3, 86

Diagnosis. Males closely resemble those of *O. (T.) tiwaka* sp. n. and *O. (T.) perignonica* sp. n. in having abdominal segment IX subquadrate in ventral view, with the apico-ventral margin truncate but both those species have recognisable gonopods, albeit strongly reduced, whereas as in *O. (T.) arok*, *O. (T.) amieu* and *O. (T.) spinifera* gonopods are so severely reduced that no gonopods can be identified. The rods of ventral processes of *O. (T.) spinifera* are slender and spiny, rather sharper than in *O. (T.) tiwaka* sp. n. but in both species the rods are almost parallel whereas in *O. (T.) perignonica* sp. n. they are sharply pointed and convergent.

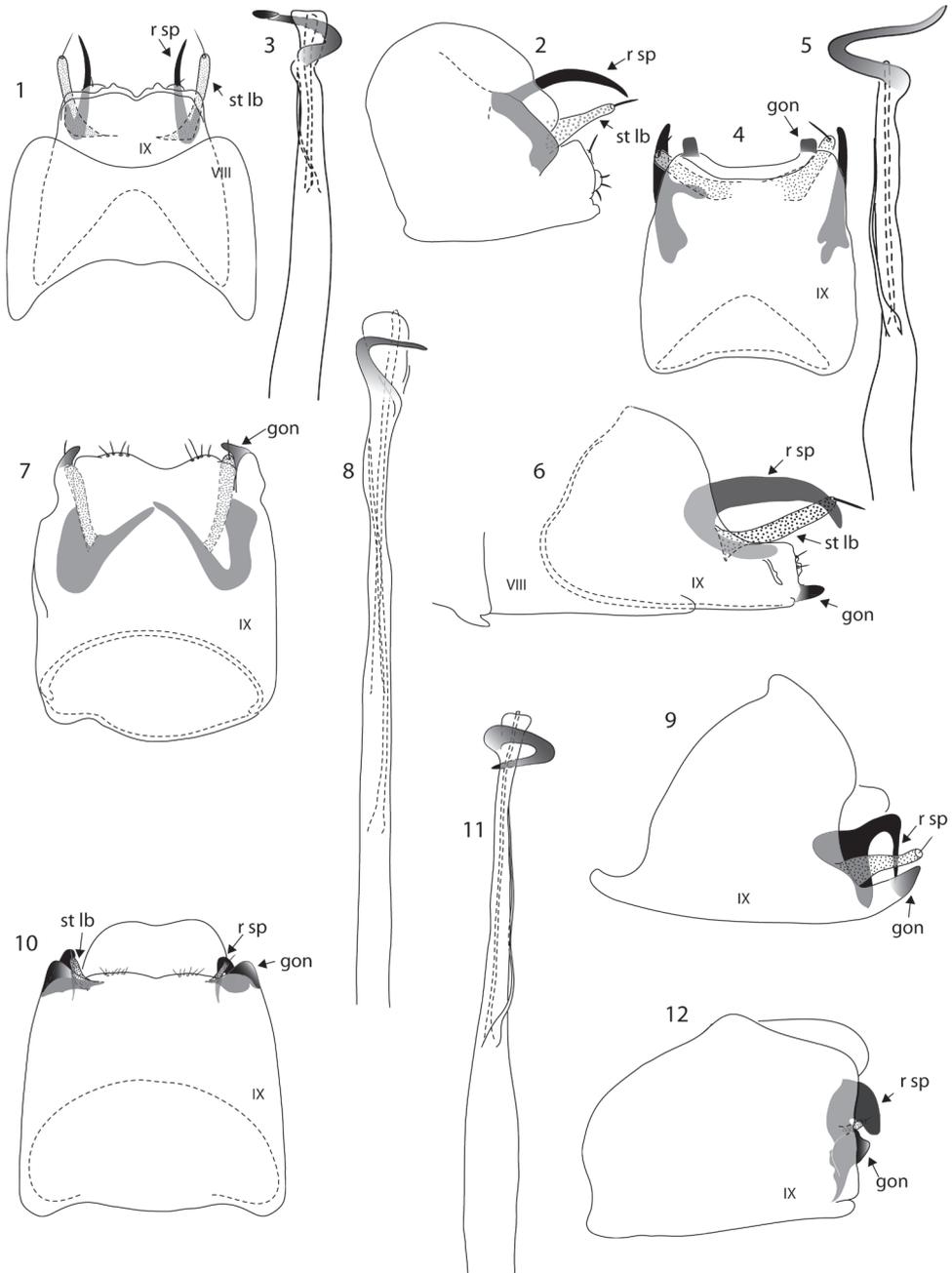
Description. Male antennae with 23–25 flagellomeres, flagellomeres rectangular in profile, without *sensilla placodea*, terminal 3 flagellomeres pale, rest dark; anterior wing length 1.3–1.5 mm (n=8); tibial spurs 0,3,4. Female antennae with 18 flagellomeres, flagellomeres all dark; anterior wing length 1.3–1.6 mm (n=4); tibial spurs 0,3,4. Abdominal sternite VII with sharp median spur.

Male, genitalia (Figs 1–3). Abdominal segment VIII in ventral view: width exceeds length; margins concave proximally and distally. Abdominal sternite IX: truncate distally. Gonopods reduced, not recognisable on apical margin. Rods of subgenital processes widely separated, parallel, in form of sharp spines. Phallic apparatus elongate, with slender titillator, and subapical narrow sinuous spine.

Material examined. Holotype. Male (on slide), New Caledonia, small fall ~10 km SW Houailou on Houailou-Bourail road, 26.xii.1998, leg. A. Wells (MNHP).

Paratypes. 2 males (on slides), small stream ~15 km SW Houailou on Houailou-Bourail road, 26.xii.1998, leg. A. Wells (ANIC); 1 male (on slide), stream, ~20 km SW Thio on Boulouparis-Thio road, 28.xii.1998, leg. A. Wells (NHRS); 1 male, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, 2.0 km E Pic Mourange, 22°12.356'S, 166°40.798'E, 220 m, 7–16.xi.2003, Malaise trap, loc#014, leg. K.A. Johanson (NHRS); 15 males, Province Sud, W slope Mt Ningua, Kwé Néco, Stream, at Camp Jacob, 3.7 km WNW summit of Mt Ningua, on Boulouparis-Thio Road, about 50 m upstream road, 21°43.613'S, 166°06.567'E, 150 m, 29.xi–12.xii.2003, Malaise trap, loc#054, leg. K.A. Johanson (NHRS); 24 males, 13 females (3 on slides), Province Nord, Wemwâdiu stream, 850 m E summit Kögi Mtn, 5 m upstream road, about 200 m S Tiwaka River, 20°49.020'S, 165°14.165'E, 24 m, 6–27.xii.2003, Malaise trap, loc#067, leg. K.A. Johanson (NHRS).

Additional material. 12 males, 6 females, Province Sud, Sarraméa, 2907 m, stony forest stream, loc 13, 21°37.097'S 165°49.351'E, Malaise trap, 18–21.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS); 1 male, 1 female, Province Sud, Sarraméa, 220 m, forest stream, loc 10, 21°37.883'S 165°51.958'E, Malaise trap, 18–21.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS); 5 males, 4 females, Province Sud, Monts des Koghis, ca 300 m S Koghi Restaurant, 22.18288°S, 166.50167°E,



Figures 1–12. *Oxyethira* species male genitalia. **1–3** *O. spinifera* sp. n., ventral and lateral views, and phallic apparatus **4–6** *O. tiwaka* sp. n., ventral view, phallic apparatus and lateral view **7–9** *O. perignonica* sp. n., ventral view, phallic apparatus and lateral view **10–12** *O. abbreviata* sp. n., ventral view, phallic apparatus and lateral view. Abbreviations: gon = gonopod; r sp = rod of subgenital process; st lb = setose lobe of subgenital process; VIII, IX = abdominal segments VIII and IX.

417 m, 2–16.xi.2003, Malaise trap, loc#004, leg. K.A. Johanson (NHRS); 18 males, 10 females, Province Sud, Monts des Koghis, ca 800 m S Koghi Restaurant, 22.18311°S, 166.50564°E, 460 m, 10–26.xi.2003, Malaise trap, loc#019, leg. K.A. Johanson (NHRS); males, females, Province Sud, W slope Mt Ningua, Kwé Néco Stream, 3.9 km W summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°44.359'S, 166°06.009'E, 117 m, 20.xi–12.xii.2003, Malaise trap, loc#035, leg. K.A. Johanson (NHRS).

Etymology. Name *spinifera* is descriptive of the sharp spines of the subgenital processes.

Remarks. This species appears to be quite widespread from the far south towards the north of the island (Fig. 86).

***Oxyethira (Trichoglene) tiwaka* sp. n.**

<http://zoobank.org/B1B6D5FA-BB85-4891-BE05-7B8F0C950129>

Figs 4–6, 75, 87

Diagnosis. Readily recognised by the short, blunt, darkly sclerotised peg-like gonopods but in other respects showing very close resemblance to *O. (T.) spinifera* which has gonopods reduced so severely that they can be recognised as only small convexities on the apico-ventral margin of segment IX. Also similar to *O. (T.) perignonica* sp. n. in having abdominal segment IX subquadrate, but that species has the gonopods situated laterally, and curved mesally, and the subgenital processes in the form of convergent, rather than parallel, spines.

Description. Male antennae with 18–19 flagellomeres, flagellomeres all dark, without *sensilla placodea*, each flagellomere about as long as wide; anterior wing length 1.4–1.7 mm (n=8); tibial spurs 0,3,4; abdominal sternite VII with small sharp median spur.

Male, genitalia (Figs 4–6). Abdominal segment IX quadrate in ventral view, slightly concave apico-ventrally, dorsally with proximal margin excised, V-shaped. Gonopods in form of two widely spaced, blunt black pegs. Setose lobes of ventral process angled laterally, ventral processes elongate, widely separated, tapered to narrowly rounded apices. Phallic apparatus elongate, with slender titillator and apically narrow, sinuous spine.

Material examined. Holotype. Male, (on slide), New Caledonia, Province Nord, Bouérabate Stream, S Mont Ninndo, along road Barabache–Boulagoma, 20°17.409'S, 164°11.242'E, 60 m, 19.xii.2003–7.i.2004, Malaise trap, loc#089, leg. K.A. Johanson (MNHP).

Paratypes. 1 male (on slide), data as for holotype, (NHRS); 1 male, Province Sud., Rivière Bleue, 282 m, stony river, loc 4, 22°05.705'S, 166°38.225'E, Malaise trap, 13–16.xi.2001, leg. K.A. Johanson, T. Pape, B. Viklund (NHRS); 18 males, 11 females (3 on slides), Province Sud, Col d'Amieu, fauna reserve, 415 m, small forest stream, loc 25, 21°33.830'S, 165°45.584'E, Malaise trap, 30.xi–5.xii.2001, leg. K.A.

Johanson, T. Pape, B. Viklund (NHRS); 1 male, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, Rivière des Pirogues, 22°11.225'S, 166°43.338'E, 100 m, 7.xi.2003, light trap, loc#016, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Mt Dzumac, source stream of Ouinne River, downstream crosspoint to mountain track, 22°01.997'S, 166°28.486'E, 795 m, over about 30 m waterfall, 18.xi–4.xii.2003, Malaise trap, loc#031, leg. K.A. Johanson (NHRS); 2 male, 4 females, Province Sud, W slope Mt Ningua, Kwé Néco Stream, at Camp Jacob, 3.9 km W summit of Mt Ningua, on Boulouparis—Thio Road, about 50 m upstream road, 21°44.083'S, 166°06.298'E, 117 m, 29.xi.2003–12.xii.2003, Malaise trap, loc#053, leg. K.A. Johanson (NHRS); 10 males, Province Sud, W slope Mt Ningua, Kwé Néco, Stream, at Camp Jacob, 3.7 km WNW summit of Mt Ningua, on Boulouparis—Thio Road, about 50 m upstream road, 21°43.613'S, 166°06.567'E, 150 m, 29.xi–12.xii.2003, Malaise trap, loc#054, leg. K.A. Johanson (NHRS); 1 male (on slide), Province Nord, Wemwâdiu stream, 850 m E summit Kōgi Mtn, 5 m upstream road, about 200 m S Tiwaka River, 20°49.020'S, 165°14.165'E, 24 m, 6–27.xii.2003, Malaise trap, loc#067, leg. K.A. Johanson (NHRS); 1 male (no genitalia) labelled “sp. D”, Province Sud, Co Rigule Stream, 2.1 km N bridge over Baie de Yaté, 4.3 km S Wé Ngéré, 22°08.147'S, 166°56.072'E, 14 m, 18.i.2004, light trap, loc#122, leg. K.A. Johanson (NHRS).

Etymology. Named for the river beside which one of the specimens was collected.

Remarks. *Oxyethira tiwaka* was collected quite commonly in the southern region, but at only two disjunct localities in the north (Fig. 87). A photograph of the type locality with the trap is rendered in Fig. 75.

***Oxyethira (Trichoglene) perignonica* sp. n.**

<http://zoobank.org/7DC78980-D10D-49A9-92AF-E60A7CC8CF7C>

Figs 7–9, 76, 88

Diagnosis. Male is distinguished from *O. incurvata* sp. n. which also has the gonopods situated laterally and mesally directed although in *O. perignonica* they are more spur-like, and the rods of the ventral processes are sharply pointed and convergent.

Description. Male antennae with 17–18 flagellomeres, flagellomeres without *sensilla placodea*, each flagellomere about 1.5 X longer than wide; anterior wing length 1.4–1.7 mm (n=2); tibial spurs 0,2,4; abdominal sternite VII without median spur.

Male, genitalia (Figs 7–9). Abdominal segment IX in ventral view subquadrate, distally truncate with a small tuft of short setae each side of midline. Gonopods in ventral view forming a short, stout, mesally directed spur at each apico-lateral angle; setose lobes and rods of subgenital processes widely separated at bases, rods obliquely arranged, apically convergent; in lateral view, rods sharply down-turned. Phallic apparatus elongate, almost length of segments VII–IX, with a fine titillator and, subapically, a slender spine which in some specimens lies parallel to the length of the phallic apparatus, in others is twisted about it orthogonally.

Material examined. Holotype. Male (on slide), New Caledonia, Province Sud, stream draining to Marais de la Rivière Blanche, 5 km SW Pont Pérignon, 22°09.513'S, 166°39.942'E, 180 m, 6–16.xi.2003, Malaise trap, loc#011, leg. K.A. Johanson (MNHP).

Paratypes. 2 males (1 on slide), Province Sud, W part of Plaine des lacs, 150 m downstream bridge at La Capture, 22°15.967'S, 166°49.493'E, 261 m, 04–22.xi.2003, Malaise trap, loc#007, leg. K.A. Johanson (NHRS); 1 male, Province Sud, stream draining to Marais de la Rivière Blanche, 1.35 km S Pont Pérignon, 22°08.496'S, 166°42.152'E, 180 m, 6–16.xi.2003, Malaise trap, loc#009, leg. K.A. Johanson (NHRS); 2 males, Province Sud, stream draining to Marais de la Rivière Blanche, 2.25 km SW Pont Pérignon, 22.14158°S, 166.67993°E, 157 m, 6–16.xi.2003, Malaise trap, loc#010, leg. K.A. Johanson (NHRS); 2 males (one headless), same data as for holotype, (NHRS); 1 male (on slide), Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, 1.5 km E Pic Mouirange, 22°12.545'S, 166°40.246'E, 143 m, 9.xi.2003, light trap, loc#018, leg. K.A. Johanson (NHRS).

Etymology. Named for the bridge on the river near where the holotype was collected.

Remarks. Taken only at several sites in the south of the island (Fig. 88), this species appears to have a highly localised distribution. A photograph of the type locality with the trap is rendered in Fig. 76.

***Oxyethira (Trichoglene) abbreviata* sp. n.**

<http://zoobank.org/83DD6477-6E0C-40ED-8397-12FA3A34508A>

Figs 10–12, 77, 89

Diagnosis. Most closely similar to *O. perignonica* and *O. tiwaka*, all 3 having males with abdominal segment IX quadrate in ventral view. But *O. abbreviata* sp. n. is distinguished by having the ventral processes distally rounded and with a short sharp spine angled proximally compared with elongate convergent spines of *O. perignonica*, and elongate parallel spines of *O. tiwaka*.

Description. Male antennae with 18–19 flagellomeres, flagellomeres rectangular in profile, *sensilla placodea* absent; anterior wing length 1.4–1.7 mm (n=4); tibial spurs 0,3,4; abdominal sternite VII with small sharp medial spine on distal margin.

Male, genitalia (Figs 10–12). Abdominal segment IX tubular, subquadrate in ventral view, distal margin truncate. Gonopods short, conical, widely separated, ventral processes also very short, rounded distally, in ventral view sharply pointed proximally, no setose lobes apparent. Phallic apparatus elongate, exceeding 3 abdominal segments in length, narrow; slender titillator present and subapically a tightly curved spine.

Material examined. Holotype. Male (on slide), New Caledonia, Province Sud, Monts des Koghis, ca 800 m S Koghi Restaurant, 22.1844°S, 166.50315°E, 400 m, 11–26.xi.2003, Malaise trap, loc. 23, leg. K.A. Johanson (MNHP).

Paratypes. 2 males, Province Nord, Mt Aoupinié, 354 m, stream, loc. 17, light trap, 24.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS); 1 male, Prov-

ince Sud, Col d'Amieu, 323 m, small stony river, loc. 24, 21°34.844'S, 165°49.677'E, Malaise trap, 30.xi–5.xii.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS); 1 male, Province Sud, Mt Dzumac, source stream of Ouinne River, at crosspoint to mountain track, 22°02.218'S, 166°28.566'E, 797 m, 18.xi.2003, light trap, loc#032, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Platou de Dogny, source of Dogny River, about 900 m SE summit of Platou de Dogny, 21.61917°S, 165.88072°E, 919 m, 25.xi–16.xii.2003, Malaise trap, loc#046, leg. K.A. Johanson (NHRS).

Etymology. *abbreviata*, named for the very abbreviated male genital structures.

Remarks. This species was collected from several quite central sites (Fig. 89) from small rocky streams. A photograph of the type locality with the trap is rendered in Fig. 77.

***Oxyethira (Trichoglene) incurvata* sp. n.**

<http://zoobank.org/B6FE045D-C60B-4DCD-AD73-6DDB8921C6D3>

Figs 13–15, 78, 90

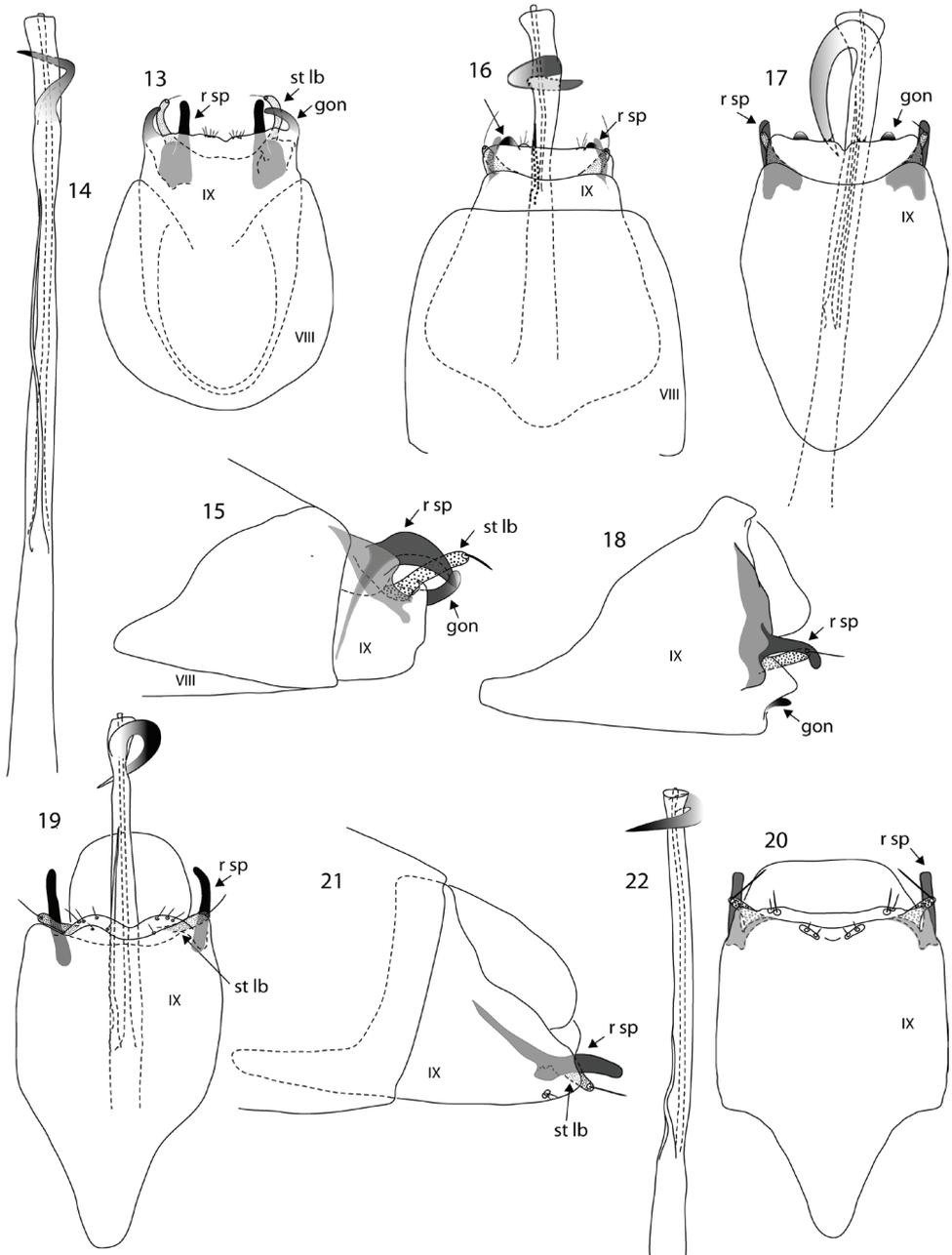
Diagnosis. Males resemble superficially those of *O. perignonica* both having mesally directed, laterally situated gonopods, but in ventral view these are more slender than those of *O. perignonica* and the rods of the subgenital processes are aligned in parallel with the distal margins of sternite IX in contrast to *O. perignonica* in which they form sharp spines angled obliquely.

Description. Male antennae with 20–25 flagellomeres, flagellomeres with few *sensilla placodea*, each rectangular in profile and 1.5–2× longer than wide; anterior wing length 1.2–1.5 mm (n=8); tibial spurs 0,3,4; abdominal sternite VII without median spur.

Male, genitalia (Figs 13–15). Abdominal segments VIII and IX rounded proximally. Abdominal sternite IX truncate distally, small areas of short setae apically each side of midline. Gonopods forming two strongly in-curved sclerotised processes at apico-lateral angles, setose lobes and sclerotised rods of subgenital processes widely separated, rods tapered to narrowly rounded apices. Phallic apparatus elongate, a slender sinuous spine subapically.

Material examined. Holotype. Male, New Caledonia, Province Nord, Mt Panié, 20.57306°S, 164.77139°E, 902 m, 9.xii.2003, Malaise trap, loc#075, leg. K.A. Johanson (MNHP).

Paratypes. 4 males (2 on slides), Province Sud., Rivière Bleue, 282 m, stony river, loc 4, 22°05.705'S, 166°38.225'E, Malaise trap, 13–16.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS); 5 males, Province Sud, stream draining to Marais de la Rivière Blanche, 1.35 km S Pont Pérignon, 22°08.496'S, 166°42.152'E, 180 m, 6–16.xi.2003, Malaise trap, loc#009, leg. K.A. Johanson (NHRS); 5 males, Province Sud, side stream to Rivière Blanche, 10.75 km SW Pont Pérignon, 22°10.073'S, 166°39.903'E, 180 m, 6–16.xi.2003, Malaise trap, loc#012, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E, 810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson (NHRS); 3 males (1 on slide), Province



Figures 13–22. *Oxyethira* species male genitalia. **13–15** *O. incurvata* sp. n., ventral view, phallic apparatus and lateral view. **16–18** *O. caledoniensis* Kelley: **16** ventral view of holotype specimen drawn from holotype **17, 18** ventral and lateral views of variant form **19–22** *O. arok* Oláh & Johanson: **19** ventral view drawn from paratype specimen **20–22** ventral and lateral views and phallic apparatus of variant form. Abbreviations: gon = gonopod; r sp = rod of subgenital process; st lb = setose lobe of subgenital process; VIII, IX = abdominal segments VIII and IX.

Sud, Mt Dzumac, source stream of Ouinne River, downstream crosspoint to mountain track, 22°01.997'S, 166°28.486'E, 795 m, over about 30 m waterfall, 18.xi–4.xii.2003, Malaise trap, loc#031, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.439'S, 166°28.646'E, 805 m, 18.xi–4.xii.2003, Malaise trap, loc#029, leg. K.A. Johanson (NHRS).

Etymology. The name *incurvata* is descriptive of the orientation of the gonopods.

Remarks. From the collecting records the distribution of this species appears to be highly disjunct (Fig. 90), with records from the northern and southern extremes of the island. A photograph of the type locality with the trap is rendered in Fig. 78.

Oxyethira (Trichoglène) caledoniensis Kelley

Figs 16–18, 75, 91

Oxyethira caledoniensis Kelley, 1989: 196, figs 33, 42, 56.

Revised diagnosis. A typical member of subgenus *Trichoglène*, with males superficially difficult to distinguish from other closely similar species such as *O. abbreviata*, *O. arok* and *O. spinifera*. Neither *O. arok* nor *O. spinifera* sp. n. has recognisable gonopods whereas both *O. caledoniensis* and *O. abbreviata* sp. n. have widely separated, shallowly dome-shaped gonopods; *O. abbreviata* sp. n. has very short, sharply pointed subgenital processes that are directed anteriorly and abdominal segment IX quadrate in ventral view, compared with the rod-shaped dorsal processes of *O. caledoniensis* and sub-triangular to shield-shaped abdominal segment IX.

Antennae: male with 19–24 flagellomeres, all dark; flagellomeres rectangular in profile, without *sensilla placodea*; female with 15 flagellomeres. Anterior wing length: male 1.4–1.9 mm (n=12); female 1.4–1.7 mm (n= 8). Tibial spurs 0,3,4. Abdominal segment VII with mid-ventral sharp spine.

Material examined. Holotype. Male, New Caledonia, Plum, (BPBM). **Other material.** 1 male, province Sud, Ouenghi River, Boulouparis, 19.xii.1983, AW (ANIC); 4 males, Province Sud., Rivière Bleue, 282 m, stony river, loc 4, 22°05.705'S, 166°38.225'E, Malaise trap, 13–16.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS); 4 males (on slides), Province Sud, stream draining to Marais de la Rivière Blanche, 1.35 km S Pont Pérignon, 22°08.496'S, 166°42.152'E, 180 m, 6–16.xi.2003, Malaise trap, loc#009, leg. K.A. Johanson (NHRS); 2 males, Province Sud, stream draining to Marais de la Rivière Blanche, 2.25 km SW Pont Pérignon, 22.14158°S, 166.67993°E, 157 m, 6–16.xi.2003, Malaise trap, loc#010, leg. K.A. Johanson (NHRS); 3 males (on slides), females, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.439'S, 166°28.646'E, 805 m, 18.xi–4.xii.2003, Malaise trap, loc#029, leg. K.A. Johanson (NHRS); 9 males, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E,

810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson (NHRS); 9 males, 8 females, Province Sud, Mt Dzumac, source stream of Ouinne River, downstream crosspoint to mountain track, 22°01.997'S, 166°28.486'E, 795 m, over about 30 m waterfall, 18.xi–4.xii.2003, Malaise trap, loc#031, leg. K.A. Johanson (NHRS); 2 males, Province Sud, W slope Mt Ningua, Kwé Néco Stream, 3.9 km W summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°44.359'S, 166°06.009'E, 117 m, 20.xi–12.xii.2003, Malaise trap, loc#035 leg. K.A. Johanson (MNHN); 1 male, Province Sud, on road between Noumea and Yaté, 1.0 km NW Pont des Japonais, 22°11.427'S, 166°42.868'E, 113 m, 22.xi–4.xii.2003, Malaise trap, loc#039, leg. K.A. Johanson (NHRS); 10 males (5 on slides), Province Sud, W slope Mt Ningua, Kwé Néco, Stream, at Camp Jacob, 3.7 km WNW summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°43.613'S, 166°06.567'E, 150 m, 29.xi–12.xii.2003, Malaise trap, loc#054, leg. K.A. Johanson (NHRS, ANIC); 59 males, 15 females, Province Nord, Mt Panié, stream at camp, 20.58167°S, 164.76472°E, 1311 m, 9.xii.2003, Malaise trap, loc#073, leg. K.A. Johanson (NHRS); 1 male, Province Nord, Mt Panié, stream at camp, 20.58139°S, 164.76444°E, 1310 m, 9.xii.2003–2.i.2004, Malaise trap, loc#074, leg. K.A. Johanson (NHRS); 23 males, 3 females, Province Nord, Mt Panié, 20.57306°S, 164.77139°E, 902 m, 9.xii.2003, Malaise trap, loc#075, leg. K.A. Johanson (NHRS); 3 males, Province Nord, stream in Creek de Bambou, 5 m N road RT7 Ouégoa–Koumac, 20°27.863'S, 164°19.784'E, 58 m, 19.xii.2003, Malaise trap, loc#087, leg. K.A. Johanson (NHRS); 4 males (2 on slides), Province Nord, Bouérabate Stream, S Mont Ninndo, along road Barabache–Boulagoma, 20°17.409'S, 164°11.242'E, 60 m, 19.xii.2003–7.i.2004, Malaise trap, loc#089, leg. K.A. Johanson (NHRS); 5 males, Province Nord, Forêt Plate, Ouendé River, at 2.5 km WNW summit of Katépouenda, 23.3 km E Pouembout, 21°07.490'S, 165°06.723'E, 470 m, 8–15.i.2004, Malaise trap, loc#112, leg. K.A. Johanson (NHRS).

Remarks. Delineation of this species among the large collection before us proved difficult, with only a very few specimens conforming closely to the holotype. In describing the species, Kelley (1989) had access to only a single specimen, re-examination of which shows it to be as illustrated in Kelley's fig. 56 (redrawn here from the type in Fig. 14), except that the subgenital processes are gently curved mesally, not slightly sinuous as figured by Kelley. A considerable number of specimens have been examined that agree in general features, but have abdominal segment IX either shorter but much the same shape as in the holotype male, or more elongate and rounded anteriorly; in some the spine on the phallic apparatus is longer and more strongly recurved and arising closer to the apex than in the type. This latter form is illustrated in Fig. 17 and was initially thought to be a separate species. However, following examination of further material of forms intermediate between *O. caledoniensis* sensu Kelley and this particular form, it is included tentatively as a variant form of *O. caledoniensis* together with all newly available specimens with the apico-ventral margin of abdominal segment IX truncate, sometimes with some slight marginal sclerotisation, the gonopods reduced to short domes, and abdominal segment IX sub-triangular to conical. Future studies may show reveal that these represent more than one species. *Oxyethira caledoniensis* is recorded from sites

along the length of the island, but most commonly in the far south (Fig. 91). A photograph of one of the northern collecting sites is shown in Fig. 75, the type locality of *O. tiwaka* and *O. ouenghi*, and shared with a number of other *Oxyethira* species.

***Oxyethira* (*Trichoglène*) *arok* Oláh & Johanson**

Figs 19–22, 92

Oxyethira arok Oláh & Johanson, 2010a: 91, figs 42–44.

Revised diagnosis. In general appearance of male genitalia *O. arok* is closest to *O. caledoniensis* but appears to have gonopods reduced completely, which feature it shares with *O. amieu* sp. n. and *O. spinifera*; however, *O. arok* has abdominal segment IX almost parallel-sided in distal half, rather than tapered as in *O. amieu* sp. n., and *O. spinifera* has the rods of subgenital processes tapered to acute apices compared with the blunt apices of *O. arok*.

Antennae: male with 20–21 flagellomeres; flagellomeres quadrate to slightly rectangular in profile; female with 17 flagellomeres, terminal 2 pale, rest dark. Anterior wing length: male 1.2–1.8 mm (n=10); female 1.4–1.6 mm (n=10). Tibial spurs 0,3,4. Abdominal sternite VII with small median spur offset from distal margin. Female with length of abdominal segment IX almost twice width, distal margin, with a sclerotised margin, mesally produced distally. Segment X stouter at base than apex, gradually tapered distally, truncate apically.

Material examined. Paratype. 1 male, New Caledonia, Province Sud, Monts Kwa Ne Mwa, on road between Nouméa and Yaté, 2.0 km E Pic Mouirange, 22°12.356'S, 166°40.798'E, 220 m, 16–30.xi.2003, Malaise trap, loc#014, leg. K.A. Johanson.

Other material. 5 males, Province Nord, Mt Aoupinié, 354 m, stream, loc 17, light trap, 24.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS); 2 males, Province Sud, Monts des Koghis, ca 300 m S Koghi Restaurant, 22.18288°S, 166.50167°E, 417 m, 2–16.xi.2003, Malaise trap, loc#004, leg. K.A. Johanson (NHRS); 11 males, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, Rivière des Pirogues, 22°11.225'S, 166°43.338'E, 100 m, 7.xi.2003, light trap, loc#016, leg. K.A. Johanson (NHRS); numerous males (5 on slides), females (5 on slides), Province Sud, Monts Kwa Ne Mwa, on road between Nouméa and Yaté, 2.0 km E Pic Mouirange, 22°12.356'S, 166°40.798'E, 220 m, 7–16.xi.2003, Malaise trap, loc#014, leg. K.A. Johanson (NHRS); 2 males, Province Nord, Aoupinié Mtn, Réserve spéciale de faune de l'Aoupinié, spring to side stream to Öropömwati river, 21°09.032'S, 165°19.179'E, 441 m, 6–27.xii.2003, Malaise trap, loc#065, leg. K.A. Johanson (NHRS).

Remarks. Specimens here identified as *O. arok* show some variability in proportions of abdominal segment IX and in male genital structures as apparent in Figures 17–19, but for the present these differences are considered insignificant.

Oxyethira arok has been collected from disjunct localities in the far south and central part of the island (Fig. 92).

***Oxyethira (Trichoglene) amieu* sp. n.**

<http://zoobank.org/B4BFF0C3-89A6-4825-A833-EFDFB92E5BD8>

Figs 23, 24, 93

Diagnosis. Males are similar to *O. arok* and *O. houailou* sp. n. in the shape of abdominal segment IX, which in ventral view is strongly tapered and more or less triangular proximally, but both *O. amieu* sp. n. and *O. houailou* sp. n. also taper distally, while *O. arok* is more or less parallel-sided in distal half; in *O. amieu* sp. n. and *O. arok* gonopods are so reduced they cannot be identified clearly whereas in ventral view they are subquadrate in *O. houailou* sp. n.

Description. Male antennae with 22 flagellomeres; flagellomeres rectangular in profile, without *sensilla placodea*; anterior wing length 1.4 mm (n=1); tibial spurs 0,3,4; abdominal sternite VII with a short slender apico-mesal spur.

Male, genitalia (Figs 23, 24). Abdominal segment IX in ventral view subtriangular in proximal half, with proximal margin broadly rounded, distally tapered to about half maximum width; in lateral view triangular; gonopods reduced completely, subgenital processes rod-like, tapered distally, setal lobes almost at right angles to length of body; phallic apparatus with slender titillator and narrow, elongate subapical spine.

Material examined. Holotype. Male, New Caledonia, Chute, ~15 km N Col d'Amieu on La Foa–Canala Rd, xii.1998, A. Wells, (MNHP).

Etymology. Named for the Col d'Amieu.

Remarks. Known only from the type locality, a waterfall towards the top of the massif (Fig. 93).

***Oxyethira (Trichoglene) houailou* sp. n.**

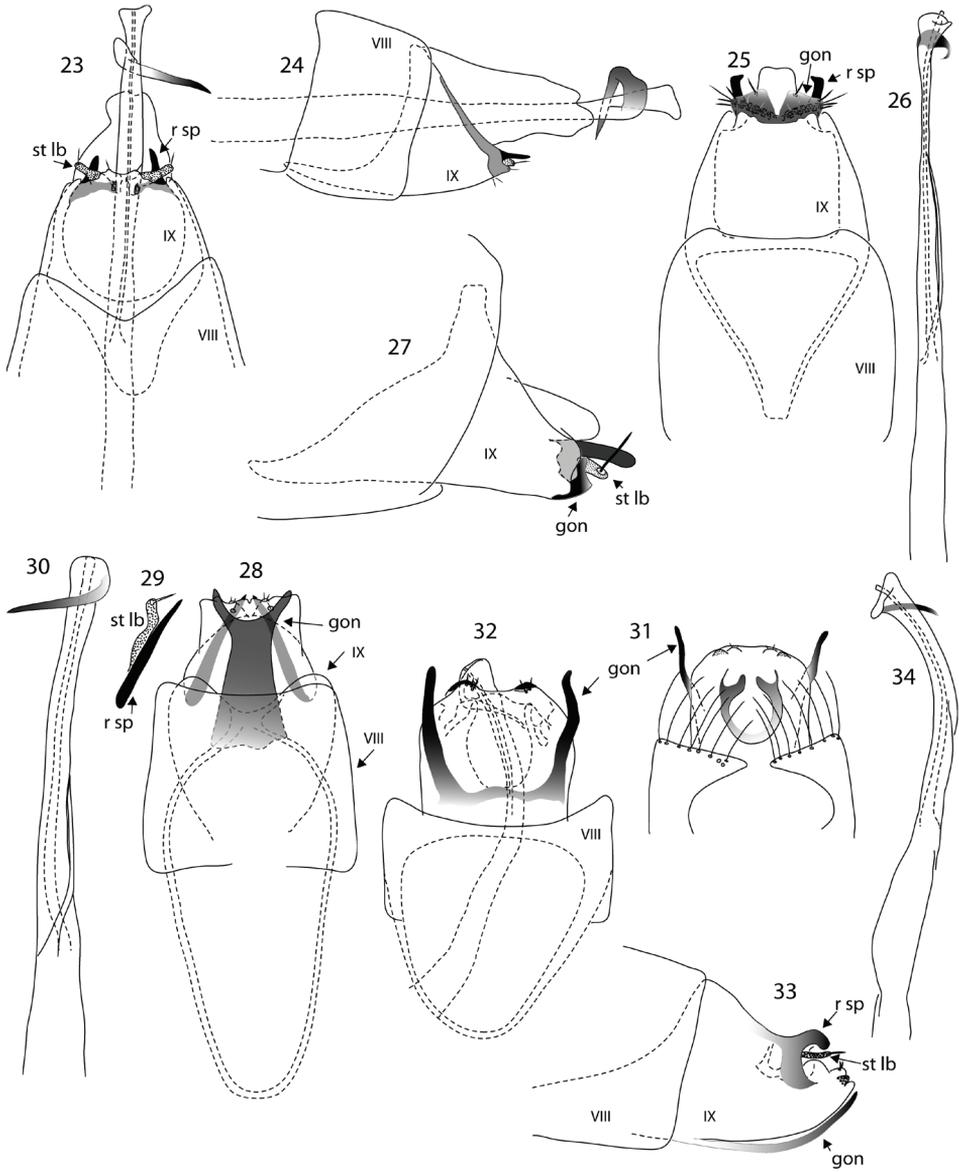
<http://zoobank.org/5EDFA209-521B-4CE3-83FA-7C99B781B4C7>

Figs 25–27, 94

Diagnosis. Males of *O. houailou* sp. n. resemble those of *O. amieu* and *O. arok*, but are distinguished by having gonopods quadrate in ventral view and separated by mid-ventral V-shaped excision, by having mesally directed apices on ventral processes, and spine on the phallic apparatus subapical and short compared with longer spines of the other two species

Description. Male antennae with 21–27 flagellomeres; flagellomeres subquadrate in profile, without *sensilla placodea*, but with dense *sensilla auricillica*; anterior wing length, male 1.4–1.9 mm (n=10); tibial spurs 0,3,4; abdominal sternite VII with a short sharp mesal spur.

Male, genitalia (Figs 25–27). Abdominal segment IX in ventral view subtriangular in proximal half, with proximal margin truncate to broadly rounded, distally tapered to about half maximum width at distal margin; in lateral view triangular. Subgenital processes in form of stout sclerotised rods, their apices blunt, and short setose lobes, in ventral view almost at right angles to length of body. Phallic apparatus elongate,



Figures 23–34. *Oxyethira* species male genitalia. **23, 24** *O. amieu* sp. n., ventral and lateral views **25–27** *O. houailu* sp. n., ventral view, phallic apparatus and lateral view **28–30** *O. insularis* Kelley, ventral view, spine and setose lobe of left subgenital process and phallic apparatus **31–34** *O. parinsularis* sp. n., dorsal, ventral and lateral views and phallic apparatus. Abbreviations: gon = gonopod; r sp = rod of subgenital process; st lb = setose lobe of subgenital process; VIII, IX = abdominal segments VIII and IX.

slender, with fine titillator, and subapically a short curved spine. Abdominal tergite X only slightly longer than rods of ventral processes, membranous.

Female unknown.

Material examined. Holotype. Male (on slide), New Caledonia, Province Nord, small fall ~10 km SW Houailou, on Bourail road, 16.xii.1998, A. Wells (MNHP).

Paratypes. New Caledonia: 1 male (on slide), data as for holotype, (ANIC); 1 male, Province Sud, Col d'Amieu, 323 m, small stony river, loc 24, 21°34.844'S, 165°49.677'E, Malaise trap, 30.xi–5.xii.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS); 6 males, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, Rivière des Pirogues, 22°11.225'S, 166°43.338'E, 100 m, 7.xi.2003, light trap, loc#016, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.439'S, 166°28.646'E, 805 m, 18.xi–4.xii.2003, Malaise trap, loc#029, leg. K.A. Johanson (NHRS); 2 males, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E, 810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Platou de Dogny, source of Dogny River, about 1.2km SE summit of Platou, about 200 m from waterfall, 21.62067°S, 165.88290°E, 915 m, 25.xi–16.xii.2003, Malaise trap, loc#048, leg. K.A. Johanson (NHRS); 1 male (on slide), Province Nord, Wé Caot Stream, draining NNE side of Mt Panié, 0.9 km NW Cascade de Tao, 20°33.311'S, 164°48.064'E, 18.xii.2003, light trap, loc#084, leg. K.A. Johanson (NHRS).

Etymology. Named for the settlement of Houailou, near the type locality.

Remarks. This species was collected from widespread localities along the length of the island (Fig. 94).

Oxyethira (Trichoglène) insularis Kelley

Figs 28–30, 95

Oxyethira insularis Kelley, 1989: 196, figs 34, 43, 57.

Revised diagnosis. This species shares with *O. parinsularis* sp. n. the feature of gonopods, in ventral view, in the form of a prominent, sclerotised, Y-shaped structure, arising at around the distal third of abdominal segment IX, but differs from *O. parinsularis* sp. n. by having the fused basal section over 2× length of the divergent distal arms, not forming a shallow sclerotised band, and the bifid distal arms about 1/3 length of basal stem, not greatly exceeding length of base as in *O. parinsularis* sp. n.

Male antennae with 18 flagellomeres; flagellomeres rectangular in profile, without *sensilla placodea*, with abundant *sensilla auricillica*. Anterior wing length 1.5–1.8 mm (n=3). Tibial spurs 0,3,4. Venter of abdominal sternite VII with median spine.

Material examined. Holotype. Male, New Caledonia, mountain stream up Boulari River, (BPBM). **Other material.** 2 males (1 on slide), Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E, 810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson (NHRS); 1 male, Prov-

ince Sud, on road between Noumea and Yaté, 1.0 km NW Pont des Japonais, 22°11.427'S, 166°42.868'E, 113 m, 22.xi–4.xii.2003, Malaise trap, loc#039, leg. K.A. Johanson.

Remarks. Among the extensive collection of New Caledonian *Oxyethira* at hand, only three specimens of this species were identified, all from the south of the island (Fig. 95). Other specimens from one of the sites at which they were taken are distinct and are referred to *O. parinsularis* sp. n.

***Oxyethira (Trichoglène) parinsularis* sp. n.**

<http://zoobank.org/FCEEFD2A-73D2-4DC0-BADF-FA58E6EA630B>

Figs 31–34, 79, 96

Diagnosis. Males are distinguished from those of the closely similar *O. insularis* by the shape of gonopods which have longer, more elongate and slender divergent arms and very short, fused basal portion.

Description. Male antennae with 18–19 flagellomeres, flagellomeres rectangular in profile, without *sensilla placodea*, with numerous *sensilla auricillica*; anterior wing length 1.5–1.8 mm (n=7); tibial spurs 0,3,4; abdominal sternite VII with median spine.

Male, genitalia (Figs 31–34). Abdominal segment IX rounded proximally, in ventral view apically almost truncate but shallowly excavated medially, in dorsal view deeply and roundly excavated, with a pair of short, curved sclerotised processes mesally, interpreted as homologues of ventral processes, with associated short setose lobes; gonopods forked, forming a pair of widely divergent slender, curved spines, basally fused in a narrow band; phallic apparatus with a strongly recurved narrow spine apically; titillator present.

Material examined. Holotype. Male (on slide), New Caledonia, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E, 810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson, (MNHP).

Paratypes. 12 males (2 on slides), data as for holotype, (NHRS); 8 males, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.439'S, 166°28.646'E, 805 m, 18.xi–4.xii.2003, Malaise trap, loc#029, leg. K.A. Johanson (NHRS); 1 male, New Caledonia, Province Sud, Plateau de Dogny, source of Dogny River, about 1.4 km SE summit of Plateau, about 20 m upstream waterfall, 21.62054°S, 165.88503°E, 912 m, 25.xi–16.xii.2003, Malaise trap, loc#049, leg. K.A. Johanson, leg. K.A. Johanson (NRMS); 1 male (on slide), Province Sud, W slope Mt Ningua, Kwé Néco, Stream, at Camp Jacob, 3.7 km WNW summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°43.613'S, 166°06.567'E, 150 m, 29.xi–12.xii.2003, Malaise trap, loc#054, leg. K.A. Johanson (ANIC).

Remarks. The close similarity between this species and *O. insularis* is worrying, especially since both were taken at one site, yet the differences are clear and consistent. The species was taken only in the southern province (Fig. 96). A photograph of the type locality with the trap is rendered in Fig. 79.

Subgenus *Pacificotrichia* Kelley, 1989

Subgenus *Pacificotrichia*, based on the type species, *Oxyethira oropedion* Kelley, was diagnosed by Kelley (1989) by the following features of males: "... shallowly excised venter VIII ..., the deeply excised dorsum VIII ..., fused R4 and R5 forewing veins, configuration of the subgenital processes [these are fused], and reduction or loss of the pre-apical spur on the meso-tibia". Kelley commented on the similarity between the genitalia of males of this subgenus and those of the *minima* group in subgenus *Dampftrichia*, but noted that in *Pacificotrichia* the subgenital processes are "distally fused ... do not bear distal setae ... and retain the bilobed process". The structure formed by the fused subgenital processes is generally characteristic for species, forming, in ventral view, what appears to be a plate ventral to the phallic apparatus. In common with *minima* group species in *Dampftrichia*, most species in the *Pacificotrichia* group have a slender mid-ventral apodeme usually almost as long as the venter of abdominal segment IX, and unlike members of subgenus *Trichoglène*, lack a titillator on the phallic apparatus.

Seven species were referred by Kelley (1989) to subgenus *Pacificotrichia*, among which five were referred to an *oropedion* group and two to an *efatensis* group; the latter group was recorded only from Fiji and Vanuatu (one species each). However he did not define the two groups, and retention of these groups seems unnecessary.

The following New Caledonian species are referred to this subgenus: *O. oropedion* (including *O. derek* Oláh & Johanson (syn. n.)); *O. quadrata* sp. n.; *O. dorsennus* Kelley; *O. rougensis* sp. n.; *O. indorsennus* Kelley (including *O. tompa* Oláh & Johanson (syn. n.)); *O. melasma* Kelley; *O. nehoue* sp. n.; *O. ouenghi* sp. n.; *O. mouirange* sp. n.; *O. enigmatica* sp. n.; *O. scutica* Kelley, *O. spicula* sp. n. and *O. digitata* sp. n.

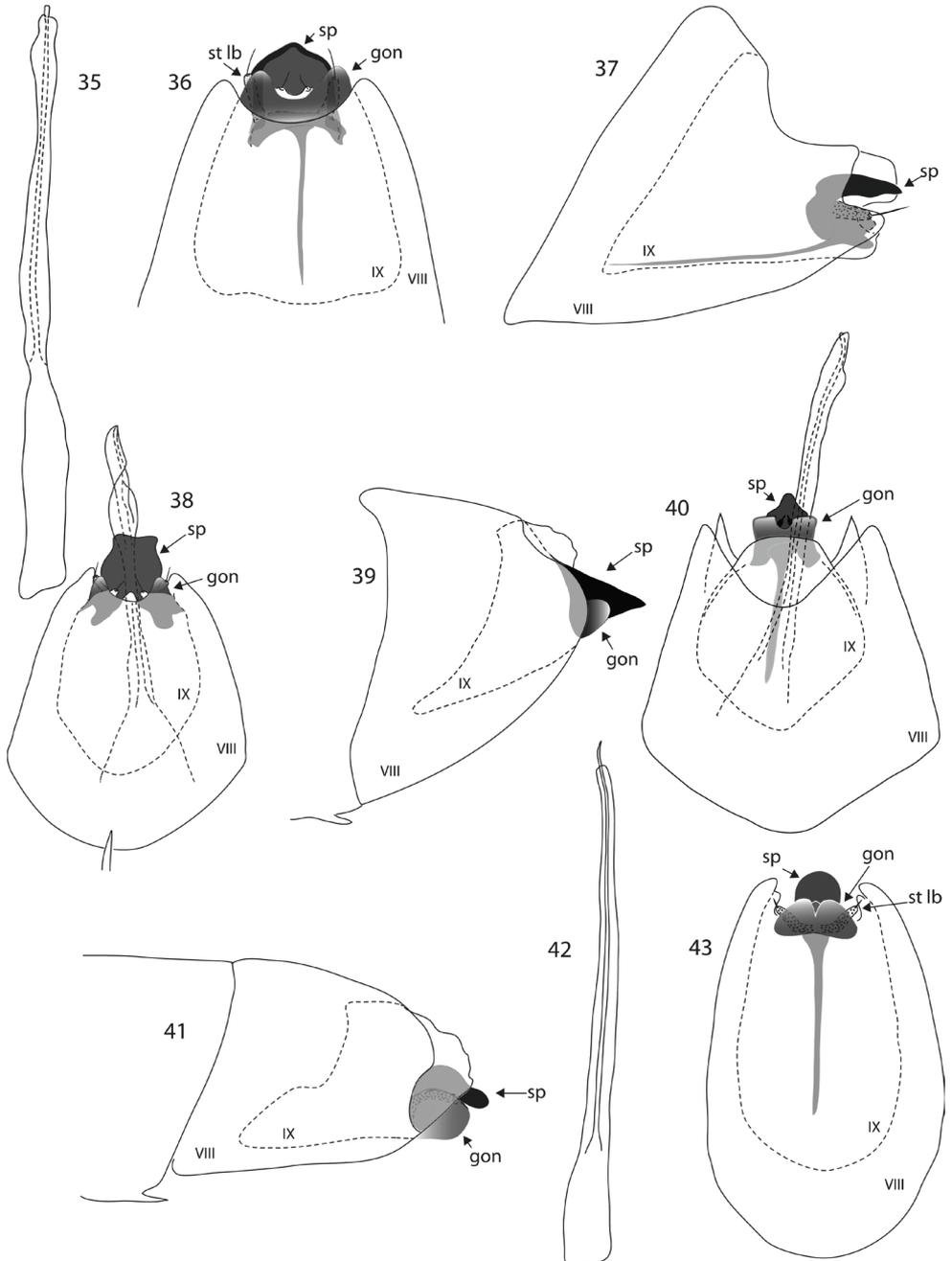
Oxyethira (*Pacificotrichia*) *oropedion* Kelley

Figs 35–37, 78, 79, 97

Oxyethira oropedion Kelley, 1989: 198, figs 38, 46, 50, 51, 60.

Oxyethira derek Oláh & Johanson, 2010a: 95, figs 49–51. **syn. n.**

Revised diagnosis. Males are readily recognised by the short, setose mid-apicoventral lobes situated between the gonopods [present in the holotype, although not illustrated clearly by Kelley (1989: fig. 60)]. In other respects they resemble *O. quadrata* sp. n., *O. indorsennus*, and *O. rougensis* sp. n. but differ in ventral view from *O. quadrata* sp. n. in the apically subtriangular to rounded shape of the subgenital process, rather than quadrate, and the simple, straight phallic apparatus lacking distal flanges; from *O. indorsennus* in the wider separation of the gonopods; and from *O. rougensis* sp. n. by the broad, shallow excision of abdominal segment VIII, rather than deep almost V-shaped excision. The female is distinctive in having abdominal segments IX and X slender with



Figures 35–43. *Oxyethira* species male genitalia. **35–37** *O. oropedion* Kelley, phallic apparatus, ventral and lateral views **38** *O. quadrata* sp. n. ventral view **39, 40** *O. dorsennus* Kelley, lateral and ventral views **41–43** *O. indorsennus* Kelley, lateral view, phallic apparatus and ventral view. Abbreviations: gon = gonopod; sp = subgenital process; st lb = setose lobe of subgenital process; VIII, IX = abdominal segments VIII and IX.

a small jet black spot ventrally on abdominal segment X (Kelley 1989: figs 50, 51 unlike the female of *O. incana* Ulmer which has the entire ventral surface of abdominal segment X very darkly sclerotised).

Antennae: male 22–23 flagellomeres, banded with terminal 3 flagellomeres pale, then 5 dark, 1 light, 2 dark 4 light, then dark to base, flagellomeres bearing *sensilla placodea*; female antennae with 19 flagellomeres, with terminal 3 flagellomeres pale, 5 dark, 5 light, then dark to base. Wing length male 1.6–1.9 mm; female 1.4–1.9 mm. Tibial spurs 0,3,4. Abdominal sternite VII with median spur on distal margin.

Material examined. Holotype. Male, New Caledonia, Plateau de Dogny, (BPBM). **Other material.** 1 males (on slide), Province Sud, NW of Farino on Moin-dou road, ~10 km, ford at confluence, 20.xii.1998, A. Wells (ANIC); 1 male (on slide) small fall ~20 km SW Houailou, on Houailou–Bourail road, 26.xii.1998, AW (ANIC); 1 male (on slide), chute ~15km N Col d'Amieu on La Foa–Canala Rd], 27.XII. 1998 AW (ANIC); 1 male (on slide), La Foa, 27.xii.1998, A Wells, (ANIC); 1 male (on slide), stream ~15 km SW Thio on Boulouparis–Thio road, 28.xii.1998, AW (ANIC); 4 males, Province Sud., Rivière Bleue, 282 m, stony river, loc 4, 22°05.705'S, 166°38.225'E, Malaise trap, 13–16.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); 3 males, 7 females, Province Sud, Sarraméa, 220 m, forest stream, loc 10, 21°37.883'S 165°51.958'E, Malaise trap, 18–21.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS); 6 males, 26 females, Province Sud, Sarraméa, 2907 m, stony forest stream, loc 13, 21°37.097'S 165°49.351'E, Malaise trap, 18–21.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); numerous males, females, Province Nord, Amoa River, 23 m, loc 20, 12 km W Poindimié, 22°58.092'S, 165°11.804'E, light trap, 26.xi.2001, Leg. K.A. Johanson, T. Pape & B. Viklund leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); 4 males, 7 females, Province Sud, Col d'Amieu, 323 m, small stony river, loc 24, 21°34.844'S, 165°49.677'E, Malaise trap, 30.xi–5.xii.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); 27 males, Province Sud, stream draining to Marais de la Rivière Blanche, 5.0 km SW Pont Pérignon, 22°09.513'S, 166°39.942'E, 180 m, 6–16.xi.2003, Malaise trap, loc#011, leg. K.A. Johanson (NHRS); 2 males, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, Rivière des Pirogues, 22°11.225'S, 166°43.338'E, 100 m, 7.xi.2003, light trap, loc#016, leg. K.A. Johanson (NHRS); 3 males, 2 females, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.439'S, 166°28.646'E, 805 m, 18.xi–4.xii.2003, Malaise trap, loc#029, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E, 810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.439'S, 166°28.646'E, 805 m, 18.xi–4.xii.2003, Malaise trap, loc#029, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Tamo River, 700m S road RT1 between Noumea and La Foa, 22°04.518'S, 166°16.592'E, 19.xi.2003, light trap, loc#033, leg. K.A. Johanson (NHRS); 3 males, 4 females, Province Sud, Hwa Haca Mtn, Hwa Motu River, at Pont Wamuttu, 1.0 km E Nassirah,

about 200 m upstream bridge, 21°48.094'S, 166°04.298'E, 137 m, 20.xi–12.xii.2003, Malaise trap, loc#034, leg. K.A. Johanson (NHRS); numerous males, Province Sud, W slope Mt Ningua, Kwé Néco Stream, 3.9 km W summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°44.359'S, 166°06.009'E, 117 m, 20.xi–12.xii.2003, Malaise trap, loc#035, leg. K.A. Johanson (NHRS); 2 male, 3 females, Province Sud, on road between Noumea and Yaté, 1.0 km NW Pont des Japonais, 22°11.427'S, 166°42.868'E, 113 m, 22.xi–4.xii.2003, Malaise trap, loc#039, leg. K.A. Johanson (NHRS); numerous males (1 on slide), females 1 on slide), Province Sud, Platou de Dogny, source of Dogny River, about 1.2 km SE summit of Platou, about 200 m from waterfall, 21.62067°S, 165.88290°E, 915 m, 25.xi–16.xii.2003, Malaise trap, loc#048, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, W slope Mt Ningua, Kwé Néco Stream, at Camp Jacob, 3.9 km W summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°44.083'S, 166°06.298'E, 117 m, 29.xi.2003–12.xii.2003, Malaise trap, loc#053, leg. K.A. Johanson (NHRS); 17 males Province Sud, W slope Mt Ningua, Kwé Néco, Stream, at Camp Jacob, 3.7 km WNW summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°43.613'S, 166°06.567'E, 150 m, 29.xi–12.xii.2003, Malaise trap, loc#054, leg. K.A. Johanson (NHRS); 7 males, Province Sud, stream draining to Rivière des Pirogues, 850 m E summit of Mont Imbaah, 5.5 km E Lucky Creek in Plum, 22°16.837'S, 166°42.195'E, 31 m, 01.xii.2003, light trap, loc#060, leg. K.A. Johanson (NHRS); males, 2 females, Province Nord, Aoupinié Mtn, Réserve spéciale de faune de l'Aoupinié, spring to side stream to Öropömwati river, 21°09.032'S, 165°19.179'E, 441 m, 6–27.xii.2003, Malaise trap, loc#065, leg. K.A. Johanson (NHRS); 3 males, Province Nord, small stream crossing road RPN3 between Touho and Poindimié, about 200 m S Tiwaka River, 20°49.105'S, 165°15.182'E, 30 m, 6–27.xii.2003, Malaise trap, loc#066, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Wemwâdiu stream, 850 m E summit Kögi Mtn, 5 m upstream road, about 200 m S Tiwaka River, 20°49.020'S, 165°14.165'E, 24 m, 6–27.xii.2003, Malaise trap, loc#067, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, 50 m upstream bridge on Hienghène–Tnèdo road, 3.9 km S summit of Mt Tnèdo, 2.2 km E Tnèdo, 20°43.085'S, 164°49.928'E, 29 m, 7.xii.2003, light trap, loc#071, leg. K.A. Johanson (NHRS); 2 males, 3 females, Province Nord, 1 m upstream road, below waterfall on Hienghène–Tnèdo road, 2.2 km SSW summit of Mt Unpac, 4.9 km ESE Tnèdo, 20.73879°S, 164.85508°E, 7.xii.2003, light trap, loc#072, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Bouébate Stream, S Mont Ninndo, along road Barabache–Boulagoma, 20°17.409'S, 164°11.242'E, 60 m, 19.xii.2003–7.i.2004, Malaise trap, loc#089, leg. K.A. Johanson (NHRS); numerous males (4 on slides), females, Province Nord, Rivière Néhoué, camp Aménage de Néhoué, 20°25.037'S, 164° 13.222'E, 12 m, 19.xii.2003, light trap, loc#090, leg. K.A. Johanson (NHRS); numerous males (1 on slide), females, Province Nord, Ponandou Tiôgé River at Kögi, 3.9 km SSW Touho, 20°49.043'S, 165°13.551'E, 25 m, 26.xii.2003, light trap, loc#100, leg. K.A. Johanson (NHRS, ANIC); 5 males, 3 females, Province Nord, Plaine des Gaïacs, Rivière Rouge, 14.2 km

NW summit of Mt Rouge, 50 m upstream road RT1 Noumea–Koné, 21°31.573'S, 164°46.690'E, 23 m, 2.i.2004, light trap, loc#104, leg. K.A. Johanson (NHRS); 3 males, Province Sud, Fö Néchédeva stream, 2 m upstream bridge on La Foa–Koindé road, 21°38.812'S, 165°56.076'E, 124 m, 4.i.2004, light trap, loc#106, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Sarraméa, Xwê Wya River, 21°38.318'S, 165°51.582'E, 127 m, 17–18.i.2004, light trap, loc#121, leg. K.A. Johanson (NHRS); 4 males Province Sud, stream crossing way to sanatorium 2.3 km E St Laurent, ca. 150 m upstream bridge, 22°04.484'S, 166°19.910'E, loc 027, Malaise trap, 17–19.x.2006, leg. K.A. Johanson M Espeland, (NHRS).

Remarks. *Oxyethira oropedion* is one of the more commonly collected New Caledonian *Oxyethira* species, occurring throughout the island (Fig. 97); several of the collecting sites are shown in photographs of type localities of other species (Figs 75, 76, 79, 81). Kelley's (1989) illustration of the ventral view of the male exaggerates the separation of the lobes of the gonopods, which was undoubtedly what led Oláh and Johanson (2010a: fig. 50) to interpret the closer position seen in the single specimen on which they based *O. derek* as indicative of a separate morphospecies. Examination of the type of *O. oropedion* shows that it shares the features of *O. derek* and thus we suppress *O. derek* in synonymy.

***Oxyethira (Pacifcotrichia) quadrata* sp. n.**

<http://zoobank.org/C107DB43-8193-4F74-8635-D96FDB94AFE5>

Figs 38, 98

Diagnosis. This species is distinguished in the male from the similar species *O. oropedion* by the broadly truncate subgenital process rather than triangular to rounded, flanges on the phallic apparatus; and by the significantly longer antennae of 32 flagellomeres compared to 22–24 flagellomeres.

Description. Male antennae with 32 flagellomeres, flagellomeres rectangular in profile, without *sensilla placodea*; anterior wing length 1.8 mm (n=1); tibial spurs 0,3,4; posterior spurs on hind leg longer than anterior spurs; abdominal sternite VII with sharp spur sub-apico-medially.

Male, genitalia (Fig. 38). Abdominal segment VIII rounded proximally, tapered slightly to distal margin, a pair of small setose lobes mesally at base of gonopods, gonopods in form of short discrete conical lobes, setose lobes of ventral processes short, subgenital process a subquadrate plate. Phallic apparatus distally with a lateral flange, but no free spine or titillator present.

Material examined. Holotype. Male (on slide), New Caledonia, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E, 810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson (MNHP).

Etymology. The name *quadrata* is descriptive of the shape of the subgenital processes.

Remarks. Only one specimen of this species was identified, from the far south of the island (Fig. 98). Were it not for the exceedingly long antennae, we would probably

have referred it to *O. oropedion*, broadening the concept of *O. oropedion*. A photograph of the type locality with the trap is rendered in Fig. 79.

***Oxyethira (Pacifcotrichia) dorsennus* Kelley**

Figs 39, 40, 80, 99

Oxyethira dorsennus Kelley, 1989: 199, figs 35, 44, 58.

Revised diagnosis. Males are distinguished from the closely similar *O. indorsennus* by having spur formula 0,2,4, apical margins of gonopods truncate and subgenital process triangular rather than rounded as in *O. indorsennus*. These features also distinguish *O. dorsennus* from *O. oropedion*, which has apically well-separated gonopods with a pair of small setose lobes midventrally. Kelley (1989) distinguished *O. dorsennus* from *O. indorsennus* on the basis of spur count and the shape of dorsum [abdominal segment] VIII; this latter feature, however, appears to be less reliable than the shape of genital structures.

Male, antennae with 24 flagellomeres, flagellomeres rectangular in profile, without *sensilla placodea*. Anterior wing length, 1.5–2.1 mm (n=2). Tibial spurs 0,2,4. Abdominal sternite VII with short strong spur medially, offset from distal margin.

Material examined. Holotype. Male, New Caledonia, mountain stream up Boulari River, (BPBM). **Other material.** 1 male (on slide), Province Sud, Couvelée River at Haute Couvelée, 2.8 km SV summit of Mt Piditéré, 3.5 km NNE Dumbéa, 22°07.405'S, 166°28.023'E, 27 m, 28.xi.2003, light trap, loc#052, leg. K.A. Johanson (NHRS); 1 male (on slide), Province Sud, Xwé Pemöu Stream, 300 m N bridge over Dathio River at Atè, 6.2 km WNW Thio, 21.58835°S, 166.15117°E, 13 m, 29.xi.2003, light trap, loc#056, leg. K.A. Johanson (NHRS); 1 male, Province Sud, lower part Rivière des Pirogues, 800 m WNW summit of Mont Imbaah, 4.7 km E Lucky Creek in Plum, 22°18.559'S 166°41.227'E, 1.3 m, 1.xii.2003, light trap, loc#059, leg. K.A. Johanson (NHRS).

Remarks. Only three further specimens of this species have been identified, all from the south of the island (Fig. 99). They conform in detail with the type. A photograph of the type locality with the trap is rendered in Fig. 80.

***Oxyethira (Pacifcotrichia) indorsennus* Kelley**

Figs 41–43, 100

Oxyethira indorsennus Kelley, 1989: 199, fig. 36.

Oxyethira tompa Oláh & Johanson, 2010a: 98, figs 56–58. **Syn. n.**

Revised diagnosis. In ventral view males of *O. indorsennus* are distinguished from those of similar species, such as *O. dorsennus*, *O. oropedion* and *O. quadrata* by the

rounded apical margins of the gonopods and apically rounded subgenital process, which contrast with the truncate apical margins of gonopods and triangular subgenital process of *O. dorsennus*; the absence of a pair of small median setose lobes between gonopods and clearly rounded subgenital process distinguish them from *O. oropedion*; and closely abutting gonopods, rather than widely separated, and rounded subgenital process rather than quadrate separates *O. indorsennus* from *O. quadrata*.

Male, antennae with 23–24 flagellomeres, flagellomeres rectangular in profile, without *sensilla placodea*. Anterior wing length, 1.3–2.1 mm (n=10). Tibial spurs 0,3,4. Abdominal sternite VII with sharp median spine, offset from distal margin.

Material examined. *Oxyethira indorsennus* Kelley, **Holotype**, male, New Caledonia, mountain stream up Boulari River, (BPBM).

Other material. 1 Male, Province Sud., Rivière Bleue, 282 m, stony river, loc 4, 22°05.705'S, 166°38.225'E, Malaise trap, 13–16.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); 1 male (on slide), 6 females (1 on slide), Province Sud, stony stream draining Lac Yaté, 200 m, loc 5, 22°08.795'S, 166°42.313'E, Malaise trap 13–16.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); 11 males, 5 females, Province Nord, Mt Acupinié, fauna reserve, 482 m, stream, loc 19, 2109.369'S, 16519.209'E, Malaise trap, 24–28.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); 10 males, 12 females, Province Sud, stream draining to Marais de la Rivière Blanche, 1.35 km S Pont Pérignon, 22°08.496'S, 166°42.152'E, 180 m, 6–16.xi.2003, Malaise trap, loc#009, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, stream draining to Marais de la Rivière Blanche, 2.25 km SW Pont Pérignon, 22.14158°S, 166.67993 °E, 157 m, 6–16.xi.2003, Malaise trap, loc#010, leg. K.A. Johanson (NHRS); 14 males, Province Sud, side stream to Rivière Blanche, 10.75 km SW Pont Pérignon, 22°10.073'S, 166°39.903'E, 180 m, 6–16.xi.2003, Malaise trap, loc#012, leg. K.A. Johanson (NHRS); 2 males, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, 2.0 km E Pic Mouirange, 22°12.356'S, 166°40.798'E, 220 m, 7–16.xi.2003, Malaise trap, loc#014, leg. K.A. Johanson (NHRS); numerous males, Province Sud, W slope Mt Ningua, Kwé Néco Stream, 3.9 km W summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°44.359'S, 166°06.009'E, 117 m, 20.xi–12.xii.2003, Malaise trap, loc#035, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Platou de Dogny, source of Dogny River, about 900 m SE summit of Platou de Dogny, 21.61917°S, 165.88072°E, 919 m, 25.xi–16.xii.2003, Malaise trap, loc#046, leg. K.A. Johanson (NHRS); 1 male, Province Sud, W slope Mt Ningua, Kwé Néco Stream, at Camp Jacob, 3.9 km W summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°44.083'S, 166°06.298'E, 117 m, 29.xi.2003–12.xii.2003, Malaise trap, loc#053, leg. K.A. Johanson (NHRS); 8 males (2 on slides), Province Sud, W slope Mt Ningua, Kwé Néco Stream, at Camp Jacob, 3.7 km WNW summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°43.613'S, 166°06.567'E, 150 m, 12.xii.2003–05.i.2004, Malaise trap, loc#054, leg. K.A. Johanson (NHRS); 54 males, 18 females, Province Nord, Mt Panié, stream at camp, 20.58167°S, 164.76472°E, 1311 m, 9.xii.2003, Malaise trap, loc#073, leg. K.A. Jo-

hanson (NHRS); numerous males, females, Province Nord, Mt Panié, stream at camp, 20. 58139°S, 164.76444°E, 1310 m, 9.xii.2003–2.i.2004, Malaise trap, loc#074, leg. K.A. Johanson (NHRS); 4 males, Province Nord, stream in Creek de Bambou, 5 m N road RT7 Ouégoa–Koumac, 20°27.863'S, 164°19.784'E, 58 m, 19.xii.2003, Malaise trap, loc#087, leg. K.A. Johanson (NHRS); 36, 15 females, Province Nord, Bouérabate Stream, S Mont Ninndo, along road Barabache–Boulagoma, 20°17.409'S, 164°11.242'E, 60 m, 19.xii.2003–7.i.2004, Malaise trap, loc#089, leg. K.A. Johanson (NHRS); 2 males, Province Sud, Co Rigule Stream, 2.1 km N bridge over Baie de Yaté, 4.3 km S Wé Ngéré, 22°08.147'S, 166° 56.072'E, 14 m, 18.i.2004, light trap, loc#122, leg. K.A. Johanson (NHRS).

Remarks. Kelley (1989: 199, fig. 36) distinguished *O. indorsennus* from *O. dorsennus* on the basis of difference in spur formula (0,3,4 cf. 0,2,4) and "... shape of dorsum VIII". However, examination of the types shows *O. indorsennus* to differ also in shape of the apical margins of gonopods and subgenital process, these being rounded as illustrated for *O. tompa* which also shares features such as spur formula and number of antennal flagellomeres (=24). Thus we are synonymising *O. tompa* with *O. indorsennus*. The species was collected widely throughout the island (Fig. 100).

This species shows a general resemblance to *O. smolpela* Wells, from New Guinea, but that species has a distinctive titillator on the phallic apparatus which is lacking in *O. indorsennus*.

***Oxyethira (Pacifcotrichia) rougensis* sp. n.**

<http://zoobank.org/9B1D6AF1-0FEC-41A1-8DD1-E5F4A3591C32>

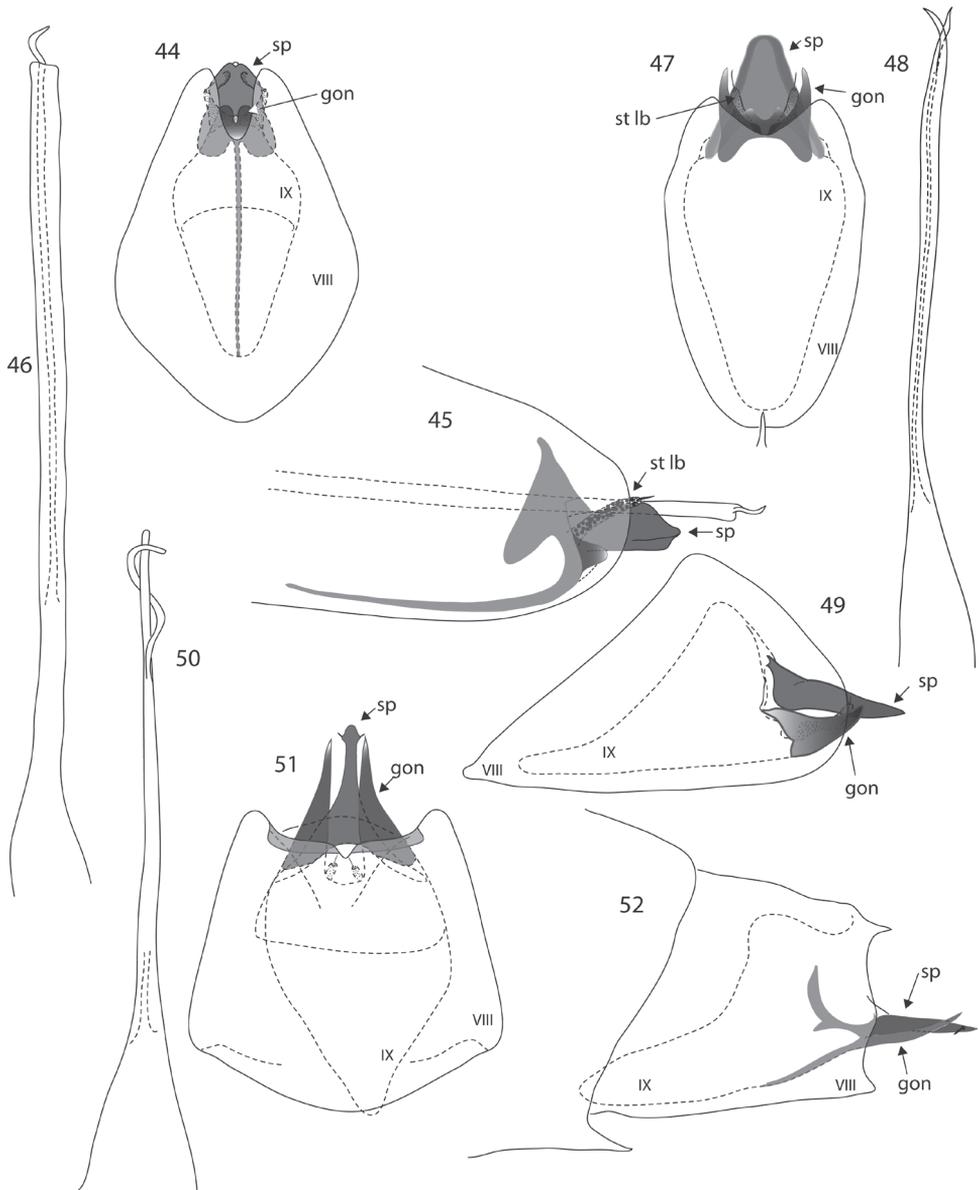
Figs 44–46, 81, 101

Diagnosis. *Oxyethira rougensis* sp. n. groups with *O. oropedion*, *O. quadrata*, *O. dorsennus*, and *O. indorsennus*, but unlike any of those species, males have venter of abdominal segment VIII deeply and narrowly excised apico-medially and subgenital process sculptured latero-distally.

Description. Male antennae: with 23–24 flagellomeres, flagellomeres rectangular in profile; anterior wing length 1.1–1.8 mm (n=3); tibial spurs 0,3,4; abdominal sternite VII with short sharp median spine on distal margin.

Male, genitalia. Abdominal segment VIII conical, distally about half width of proximal quarter. Segment IX in ventral view almond shaped, in lateral view triangular proximally, mid-dorsally less than half length of venter. Gonopods fused basally, discrete and rounded distally, with slender mid-ventral apodeme reaching to proximal margin of segment IX; subgenital processes fused, forming a stout plate, rounded distally in ventral view, angular in lateral view, with subapical sculpturing towards apex on each side, and small notch mid apically; setose lobes about 2/3 length of plate. Phallic apparatus slender, straight, with short apical spine.

Material examined. Holotype. Male (on slide), New Caledonia, Province Nord, Plaine des Gaïacs, Rivière Rouge, 14.2 km NW summit of Mt Rouge, 50 m upstream



Figures 44–52. *Oxyethira* species male genitalia. **44–46** *O. rougensis* sp. n., ventral and lateral views and phallic apparatus **47–49** *O. mourange* sp. n., ventral view, phallic apparatus and lateral view **50–52** *O. ouenghica* sp. n., phallic apparatus, ventral and lateral views. Abbreviations: gon = gonopod; sp = subgenital process; st lb = setose lobe of subgenital process; VIII, IX = abdominal segments VIII and IX.

road RT1 Noumea–Koné, 21°31.573'S, 164°46.690'E, 23 m, 2.i.2004, light trap, loc#104, leg. K.A. Johanson (NHRS).

Paratypes. 2 males (on slides), collection data as for holotype.

Remarks. *Oxyethira rougensis* was taken only at the type locality, in the north-west of the island (Fig. 101). A photograph of the type locality with the trap immediately below the small waterfall is rendered in Fig. 81.

***Oxyethira (Pacifcotrichia) mouirange* sp. n.**

<http://zoobank.org/323D9AB1-425C-4A4D-9B82-3DAD6EF9CBE0>

Figs 47–49, 102

Diagnosis. A member of *Pacifcotrichia* subgenus, but distinguished from other species by males with discrete, elongate, sub-triangular gonopods.

Description, male. Antennae with 24–25 flagellomeres; flagellomeres without *sensilla placodea*, rectangular in profile; anterior wing length 1.6–1.7 mm (n=2); tibial spurs 0,3,4; abdominal sternite VII with small sharp median spur.

Male, genitalia. In ventral view with abdominal segment VIII ovoid, apical margin with wide V-shaped excavation medially; without midventral apodeme; in lateral view, with apical margins broadly rounded; abdominal segment IX almond shaped. Gonopods sharply triangular; subgenital processes fused, forming subtriangular plate that is sharply triangular in lateral view; setose lobes less than half length of plate. Phallic apparatus extremely long, apically bifid, split into two equal-length sections.

Material examined. Holotype. Male (on slide), New Caledonia, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, 2.0 km E Pic Mouirange, 22°12.356'S, 166°40.798'E, 220 m, 7–16.xi.2003, Malaise trap, loc#014, leg. K.A. Johanson (MNHP).

Paratypes. 2 males (on slides, one headless), collection data as for holotype (NHRS); 1 male, Province Sud, Sarraméa, Xwé Wya River, 21°38.318'S, 165°51.582'E, 127 m, 17–18.i.2004, light trap, loc#121, leg. K.A. Johanson (NHRS).

Etymology. Named for Mt Mouirange near which the type was collected.

Remarks. Taken only at two well-separated sites in the south of the island (Fig. 102).

***Oxyethira (Pacifcotrichia) ouenghi* sp. n.**

<http://zoobank.org/79A15B02-C3D1-4175-A9A4-539A06DE8894>

Figs 50–52, 75, 103

Diagnosis. Males resemble *O. nehoue* sp. n., *O. melasma*, and *O. spicula* sp. n. in having more or less triangular median ventral processes in the male genitalia. However, males of *O. ouenghi* differ from other New Caledonian species, having gonopods in form of slender curved spines adjacent to the narrow midventral process.

Description, male. Antennae with 23–25 flagellomeres, each flagellomere length greater than width, without *sensilla placodea*; Anterior wing length 1.7–1.8 mm (n=2); tibial spurs 0,3,4; abdominal sternite VII with mid apical spine.

Male, genitalia (Figs 50–52). Abdominal segment VIII tapered slightly towards apex, only slightly longer than wide, with small cleft apico-ventrally and short apico-lateral lobes; in ventral view abdominal segment IX broadest mid length, tapered sharply proximally and distally, with gonopods forming a pair of narrow curved spines closely adpressed to an elongate triangular ventral process that terminates with a pair of tiny setae; phallic apparatus elongate, slender, with a long fine sinuous subapical process.

Material examined. Holotype. Male (on slide), New Caledonia, Province Nord, Bouérabate Stream, S Mont Ninndo, along road Barabache–Boulagoma, 20°17.409'S, 164°11.242'E, 60 m, 19.xii.2003–7.i.2004, Malaise trap, loc#089, leg. K.A. Johanson (MNHP).

Paratypes. 8 males, same data as for holotype; 1 male (on slide), Ouenghi River, nr Boulouparis, 14.xii.1983, A Wells (ANIC); 1 male, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, 2.0 km E Pic Mouirange, 22°12.356'S, 166°40.798'E, 220 m, 7–16.xi.2003, Malaise trap, loc#014, leg. K.A. Johanson (NHRS); 1 male (on slide), Province Sud, Monts des Koghis, ca 800 m S Koghi Restaurant, 22.18311°S, 166.50564°E, 460 m, 10–26.xi.2003, Malaise trap, loc#019, leg. K.A. Johanson (NHRS); 3 males, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E, 810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson (NHRS).

Etymology. Named for the Ouenghi River beside which the first specimen was collected.

Remarks. The apparent distribution of this very distinctive species is very odd, with one sample being taken in the extreme north of the island, the rest at sites in the south-west (Fig. 103). A photograph of the type locality with the trap is rendered in Fig. 75.

***Oxyethira (Pacifcotrichia) enigmatica* sp. n.**

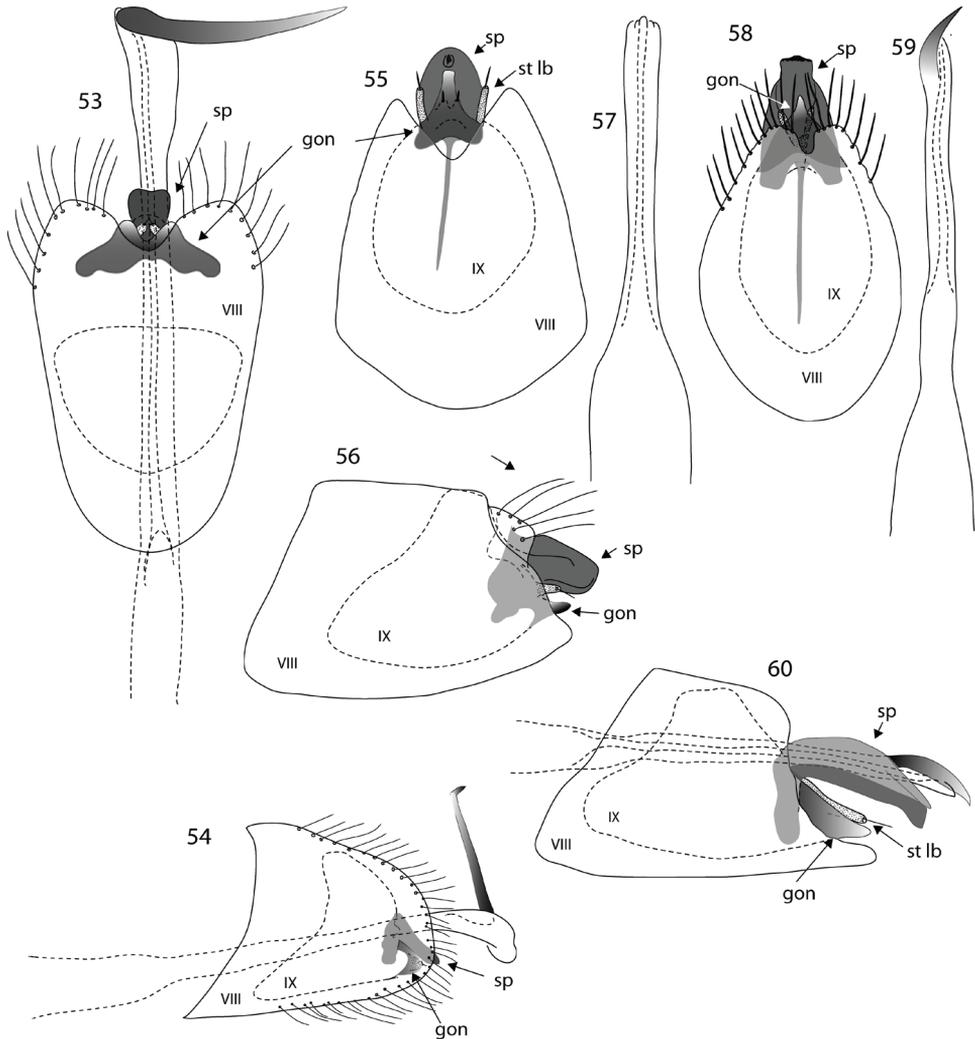
<http://zoobank.org/BFA21817-6E77-4056-BD89-45C2483C51F3>

Figs 53–54, 82, 104

Diagnosis. In having an elongate apical spine on the phallic apparatus, males of this species resemble those of *O. scutica*, but in *O. enigmatica* sp. n. the spine is shorter and strap-like, not thread-like as in *O. scutica*; abdominal segment VIII tapers and gradually increases in width distally, and distal margin of venter is more widely and shallowly excavated than in *O. scutica* in which it is deeply and narrowly excised.

Description. Male antennae with 23–24 flagellomeres, flagellomeres without *sensilla placodea*, in profile almost subquadrate, but wider apically than proximally; anterior wing length, 1.5–1.6 mm (n=10); tibial spurs 0,2,4; abdominal segment VII with a sharp spur medially on distal margin.

Male, genitalia (Figs 53–54). Abdominal segment IX in ventral view wider distally than proximally, with distal margin shallowly excavated, proximal margin rounded, midventral apodeme present; in lateral view dorsal margin about half depth of ventral



Figures 53–60. *Oxyethira* species male genitalia. **53, 54** *O. enigmatica* sp. n., ventral and lateral views **55–57** *O. melasma* Kelley, ventral and lateral views, and phallic apparatus, drawn from holotype **58–60** *O. nehoue* sp. n., ventral view, phallic apparatus and lateral view. Abbreviations: gon = gonopod; sp = subgenital process; st lb = setose lobe of subgenital process; VIII, IX = abdominal segments VIII and IX.

margin. Gonopods fused basally, distally discrete, conical; subgenital processes forming short, subquadrate plate. Phallic apparatus straight, with long sharply twisted apical spine, at right angle to and almost one third length of phallus; without titillator.

Material examined. Holotype. Male (on slide), Province Sud, W part of Plaine des lacs, 150 m downstream bridge at La Capture, 22°15.967'S, 166°49.493'E, 261 m, 4–22.xi.2003, Malaise trap, loc#007, leg. K.A. Johanson (MNHP).

Paratypes. 54 males (9 on slides), data as for holotype.

Etymology. *Enigmatica*: enigmatic in presenting a puzzle, being so similar to *O. (P) scutica* in some respects, yet distinctive.

Remarks. This species is known only from the large sample taken at the type locality in the extreme south of the island (Fig. 104). A photograph of the type locality with the trap is rendered in Fig. 82.

***Oxyethira (Pacifictrichia) melasma* Kelley**

Figs 55–57, 105

Oxyethira melasma Kelley, 1989: 200, figs 37, 45, 59.

Note. A mismatch between the published description and Kelley's (1989) figures and the holotype specimen in the BPBM labelled "*Oxyethira melasma*" is a puzzle. The genital features of the holotype (examined by AW) are as in Fig. 56, and disagree with Kelley's text description and illustrations (his figs 37, 45, 59) of "*Oxyethira melasma*". However, the tibial spur count of the holotype is 0,2,4, as given by Kelley, and as in the type species. Kelley's three figures of genital structures agree with the features of a series of specimens, described here as *Oxyethira nehoue* and illustrated in Figs 58–60; in contrast to Kelley's "holotype", these specimens all have a tibial spur count of 0,3,4.

Oxyethira melasma Kelley is here redescribed and figured from the holotype specimen. We can only suggest that Kelley had several specimens at hand, macerated one and labelled it "holotype", but described and illustrated a specimen other than that labelled "Type". The type has to be the name-bearing specimen and is redescribed here.

Revised diagnosis. Males resemble *O. nehoue* sp. n., *O. spicula* sp. n., and *O. ouenghi* in having have a more or less triangular median ventral processes in the male genitalia. However, they most closely resemble *O. nehoue* sp. n. from which they are distinguished by spur count 0,2,4, gonopods fused, in ventral view sharply tapered proximally, narrowly parallel-sided distally, rounded apically, apex of phallic apparatus rounded without apical spine, in contrast to *O. nehoue* sp. n. in which the fused gonopods appear triangular in ventral view, and acuminate apically, and ventral process in lateral view sclerotised and arched ventrally.

Revised description, male. Antennae with 19–26 flagellomeres, apical 3 flagellomeres pale, next 5 dark, then 13 pale and basal flagellomeres dark; anterior wing length 1.4–1.9 mm (n=10); tibial spurs 0,2,4; abdominal sternite VII with small sharp median spine, offset from margin.

Male, genitalia (Figs 55–57). Abdominal segment VIII more or less conical, a deep broadly V-shaped excision apico-ventrally. Abdominal segment IX in lateral view broadly bell-shaped; in ventral view rounded proximally, tapered distally, a pair of small short processes apically, each bearing a single seta. Gonopods sclerotised, fused, tapered to narrowly truncate apex, basal setose processes widely separated, slender, elongate, but shorter than fused gonopods, a slender basal apodeme midventrally; subgenital plate broad based, tapered to rounded apex, mostly membranous, but with a

small ventrally curved prominence subapically. Phallic apparatus swollen in basal third, narrow in distal 2/3, without apical spine, ejaculatory tube medial.

Material examined. Holotype. Male, Mountain stream up Boulari River (BPBM).

Other material. 18 males, Province Sud, W part of Plaine des lacs, 150 m downstream bridge at La Capture, 22°15.967'S, 166°49.493'E, 261 m, 04–22.xi.2003, Malaise trap, loc#007, leg. K.A. Johanson (NHRS); 31 males, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E, 810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Mt Dzumac, source stream of Ouinne River, downstream crosspoint to mountain track, 22°01.997'S, 166°28.486'E, 795 m, over about 30 m waterfall, 18.xi–4.xii.2003, Malaise trap, loc#031, leg. K.A. Johanson (NHRS); 1 male (on slide), Province Sud, W slope Mt Ningua, Kwé Néco, Stream, at Camp Jacob, 3.7 km WNW summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°43.613'S, 166°06.567'E, 150 m, 29.xi–12.xii.2003, Malaise trap, loc#054, leg. K.A. Johanson (NHRS); 4 males, Province Sud, Co Rigule Stream, 2.1 km N bridge over Baie de Yaté, 4.3 km S Wé Ngéré, 22°08.147'S, 166° 56.072'E, 14 m, 18.i.2004, light trap, loc#122, leg. K.A. Johanson (NHRS).

Remarks. The species was taken at a number of sites in the southern province of the island (Fig. 105).

***Oxyethira (Pacifictrichia) nehoue* sp. n.**

<http://zoobank.org/EE2F9749-F988-4653-9556-D40FFD285635>

Figs 58–60, 83, 106

Diagnosis. This species resembles *O. melasma* and was illustrated and described as that species by Kelley (1989); however the holotype is as in Figs 55–57, see discussion above. The two species are distinguished by male genital features: *O. nehoue* sp. n. has abdominal segment VIII in ventral view shallowly and narrowly excavated mid apically, not widely and deeply; fused gonopods tapered to an acute apex, not truncate; subgenital process elongate rectangular, truncate apically, not rounded, in lateral view sclerotised and arched ventrally; and phallic apparatus with a broad spine arising sub apically.

Description. Male antennae with 25–27 flagellomeres; anterior wing length 1.3–1.7 mm (n=7); tibial spurs 0,3,4; abdominal sternite VII with sharp apical spine.

Genitalia (Figs 58–60). Abdominal segment VIII in ventral view rounded proximally, gradually tapered towards apex, with a shallow, narrow excavation mid apically. Abdominal segment IX similar in shape to VIII. Gonopods fused, triangular in ventral view, dorsal setose lobes slightly shorter than gonopods conjoined at base, subgenital process elongate, forming narrowly rectangular plate, apically truncate, but with slight bulge mid-apically. Phallic apparatus with a broad spine arising subapically, extending beyond apex.

Female unknown.

Material examined. Holotype. Male (on slide), Province Nord, Rivière Néhoué, camp Aménage de Néhoué, 20°25.037'S, 164°13.222'E, 12 m, 19.xii.2003, light trap, loc#090, leg. K.A. Johanson (MNHP).

Paratypes. 5 males (on slides), data as for holotype (NHRS); 1 male, Province Sud, creek on road between Sarraméa & La Foa, 15.xii.1983, A. Wells (ANIC); 1 male (on slide), Province Sud, stream NE turnoff to Tribu Kouraga on Boulouparis-Thio road, 19.xii.1983, AW (ANIC); 1 male, Ouenghi River, nr Boulouparis, 20.xii.1983, A. Wells (ANIC); 1 male (on slide), Province Sud, NW Farino on Moindou road, 20.vii.1998, AW (ANIC); 20 males, Province Sud, Tamoia River, 700m S road RT1 between Noumea and La Foa, 22°04.518'S, 166°16.592'E, 19.xi.2003, light trap, loc#033, leg. K.A. Johanson (NHRS).

Etymology. Named for the Rivière Néhoué where it was collected.

Remarks. The distribution of this species is similar to that of *O. ouenghi*, mainly collected from a cluster of southern sites, but with one site in the far north (Fig. 106). A photograph of the type locality with the trap is rendered in Fig. 83.

Oxyethira (Pacifcotrichia) scutica Kelley

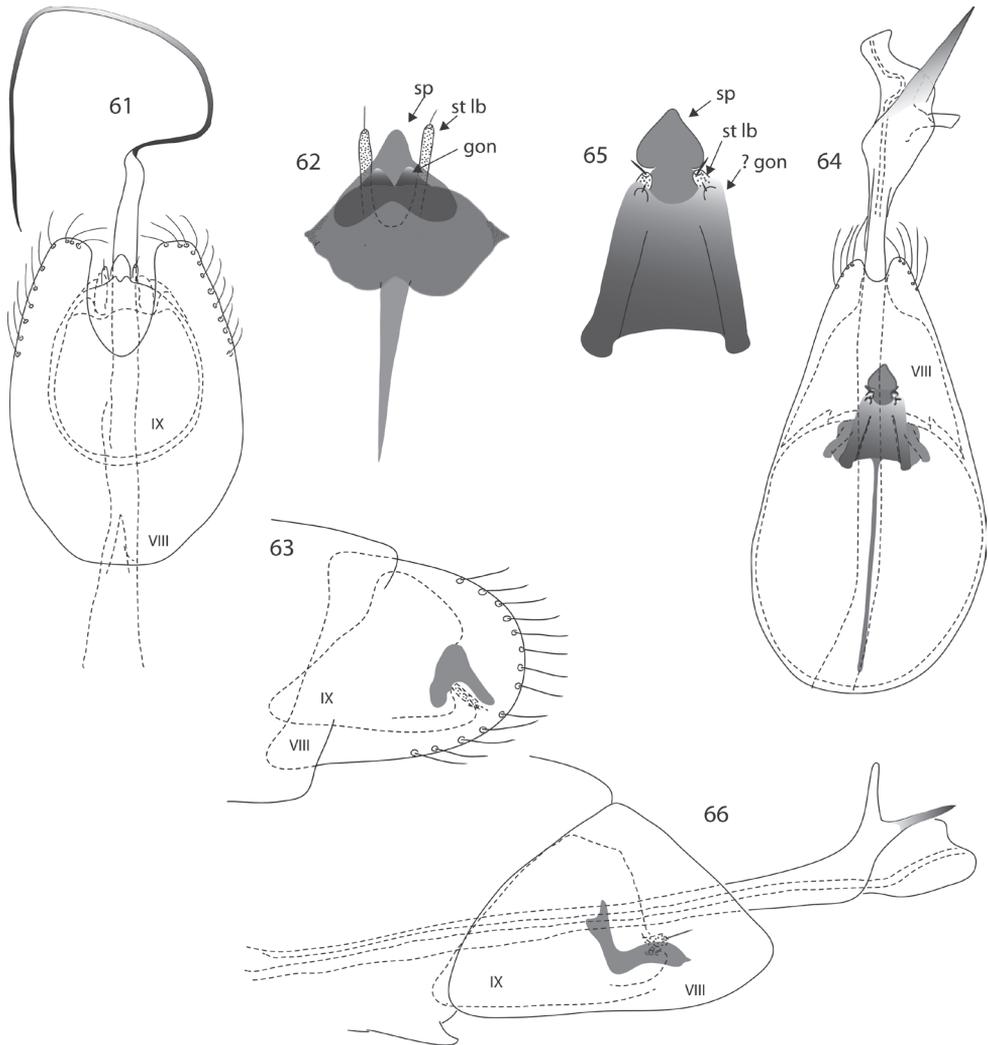
Figs 61–63, 107

Oxyethira scutica Kelley, 1989: 200, figs 39, 47, 52, 53, 61.

Diagnosis. Males superficially resemble those of *O. enigmatica*, having a long apical process on the phallic apparatus, antennae with 23–25 flagellomeres, and spur formula of 0,2,4, but are distinguished by apical process on phallic apparatus longer and thread- or whip-like in appearance, rather than strap-like as in *O. enigmatica*, and abdominal segment VIII with distal margin of venter of deeply and narrowly excised, compared with shallowly excavated margin of *O. enigmatica*. Females resemble those of *O. oropedion* (Kelley 1989: figs 50, 51, both having abdominal terminalia in form of a slender oviscapt and cerci slender, elongate, about length of segment X, but females of *O. scutica* lack the darkly sclerotised area on the venter of segment IX (Kelley 1989: figs 52, 53).

Antennae: male with 21–24 flagellomeres, flagellomeres subquadrate in profile, without sensilla placodea; female with 18 flagellomeres. Fore wing length: male 1.1–1.5 mm (n=8), female 1.4 mm (n=2). Spurs 0,2,4. Abdominal sternite VII with sharp median spur.

Material examined. Holotype. Male, New Caledonia, mountain stream up Boulari River, (BPBM). **Other material.** 1 male (on slide), Province Sud, Ouenghi River, Boulouparis, 19.xii.1983, A Wells, (ANIC); 1 male (on slide), Province Sud, side stream to Rivière Blanche, 10.75 km SW Pont Pérignon, 22°10.073'S, 166°39.903'E, 180 m, 6–16.xi.2003, Malaise trap, loc#012, leg. K.A. Johanson (NHRS); 7 males, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, 1.5 km E



Figures 61–66. *Oxyethira* species male genitalia. **61–63** *O. scutica* Kelley, ventral view and enlarged gonopods and subgenital process, and lateral view **64–66** *O. spicula* sp. n., ventral view and enlarged gonopods and subgenital process, and lateral view. Abbreviations: gon = gonopod; sp = subgenital process; st lb = setose lobe of subgenital process; VIII, IX = abdominal segments VIII and IX.

Pic Mouirange, 22°12.545'S, 166°40.246'E, 143 m, 9.xi.2003, light trap, loc#018, leg. K.A. Johanson (NHRS); 2 males, Province Sud, Mt Dzumac, source stream of Quinne River, at crosspoint to mountain track, 22°02.218'S, 166°28.566'E, 797 m, 18.xi.2003, light trap, loc#032, leg. K.A. Johanson (NHRS); 1 male, 1 female, Province Sud, on road between Noumea and Yaté, 1.0 km NW Pont des Japonais, 22°11.427'S, 166°42.868'E, 113 m, 22.xi–4.xii.2003, Malaise trap, loc#039, leg. K.A.

Johanson (NHRS); 2 male, 1 female, Province Sud, lower part Rivière des Pirogues, 800 m WNW summit of Mont Imbaah, 4.7 km E Lucky Creek in Plum, 22°18.559'S, 166°41.227'E, 1.3 m, 01.xii.2003, light trap, loc#059, leg. K.A. Johanson (NHRS); 10 males, Province Sud, stream draining to Rivière des Pirogues, 850 m E summit of Mont Imbaah, 5.5 km E Lucky Creek in Plum, 22°16.837'S, 166°42.195'E, 31 m, 01.xii.2003, light trap, loc#060, leg. K.A. Johanson (NHRS).

Remarks. This appears to be another southern species (Fig. 107).

***Oxyethira (Pacifcotrichia) spicula* sp. n.**

<http://zoobank.org/D92127AE-797C-47BD-BDF8-28B57C2D09A7>

Figs 64–66, 108

Diagnosis. Males are most similar to *O. melasma*, *O. nehoue* and *O. ouenghi* all of which have more or less triangular median ventral processes in the male genitalia, but can be recognised by the expanded apex of the phallic apparatus with a prominent acute spine, the very long, proximally rounded, abdominal segment VIII that tapers distally and completely obscures segment IX, and the shape of the plate formed from fused gonopods and subgenital processes.

Description. Male antennae damaged, at least with 19 flagellomeres, flagellomeres rectangular in profile, without *sensilla placodea*; anterior wing length 1.9 mm (n=1); tibial spurs 0,3,4; abdominal sternite VII with a coarse spur medially.

Male, genitalia (Figs 64–66). Abdominal segment VIII pear-shaped, ventrally with narrow distal margin excavated apically; abdominal segment IX obscured by VIII; gonopods fused forming a triangular plate ventrally with subgenital process a short knob-shaped lobe apically and a deep mid ventral apodeme reaching almost full length of segment; phallic apparatus elongate and slender in proximal 3/4, irregularly dilated distally, with sharp apical spine and short lateral process.

Female unknown, although a single unknown female of an *Oxyethira* species was collected with the holotype and could be of this species. The terminalia of this female are slender and elongate, of the form seen in *O. oropedion* and *O. scutica*, with a V-shaped marking ventrally on abdominal segment VIII.

Material examined. Holotype. Male (slide), New Caledonia, Province Sud, Rivière des Lacs, 1.1 km NW Lac en Huit, 4.9 km NW summit of Pic du Grand Kao-ri, 22°15.195'S, 166°52.178'E, 10.xii.2003, light trap, loc#078, leg. K.A. Johanson (MNHP).

Etymology. Name being descriptive of the spicule-like spine on the phallic apparatus.

Remarks. This species is known only from the type specimen, collected in the far south (Fig. 108) and now on a prepared slide. It is impossible to know if the state of abdominal segment IX of the type is the usual situation, or simply unusual that segment has retracted in this particular specimen. Regardless, the form of the phallic apparatus is highly distinctive.

***Oxyethira (Pacifcotrichia) digitata* sp. n.**

<http://zoobank.org/7FE76CC0-F62E-471F-B616-2B9BC4724A78>

Figs 67–69, 84, 109

Diagnosis. One of the New Caledonian species of *Oxyethira* with genitalia retracted within the very rounded abdominal segment VIII but differs from other species with this feature such as *O. incana* and *O. spicula* by well-defined clearly branched gonopods and the phallic apparatus a simple rod, sharply bifid apically.

Description. Male antennae with 25–29 flagellomeres; flagellomeres slender rectangular in profile, without *sensilla placodea*, terminal 5 flagellomeres pale, followed by 3 dark, 10 pale, rest dark; anterior wing. Length 3.0–3.7 mm (n=4); tibial spurs 0,3,4; abdominal segment VII short, sharp mid ventral spur.

Male, genitalia (Figs 67–69). Abdominal segment VIII broadly rounded, ventrally and dorsally concave apically; abdominal segment IX in ventral view rounded, sharply triangular in lateral view, retracted within VIII; gonopods fused basally, distally stoutly bilobed, subgenital process V-shaped, fused ventrally with gonopods; phallic apparatus a simple elongate rod, distally forming sharply bifid apex.

Material examined. Holotype. Male (on slide), Province Sud, side stream to Rivière Blanche, 10.75 km SW Pont Pérignon, 22°10.073'S, 166°39.903'E, 180 m, 6–16.xi.2003, Malaise trap, loc#012, leg. K.A. Johanson (MNHP).

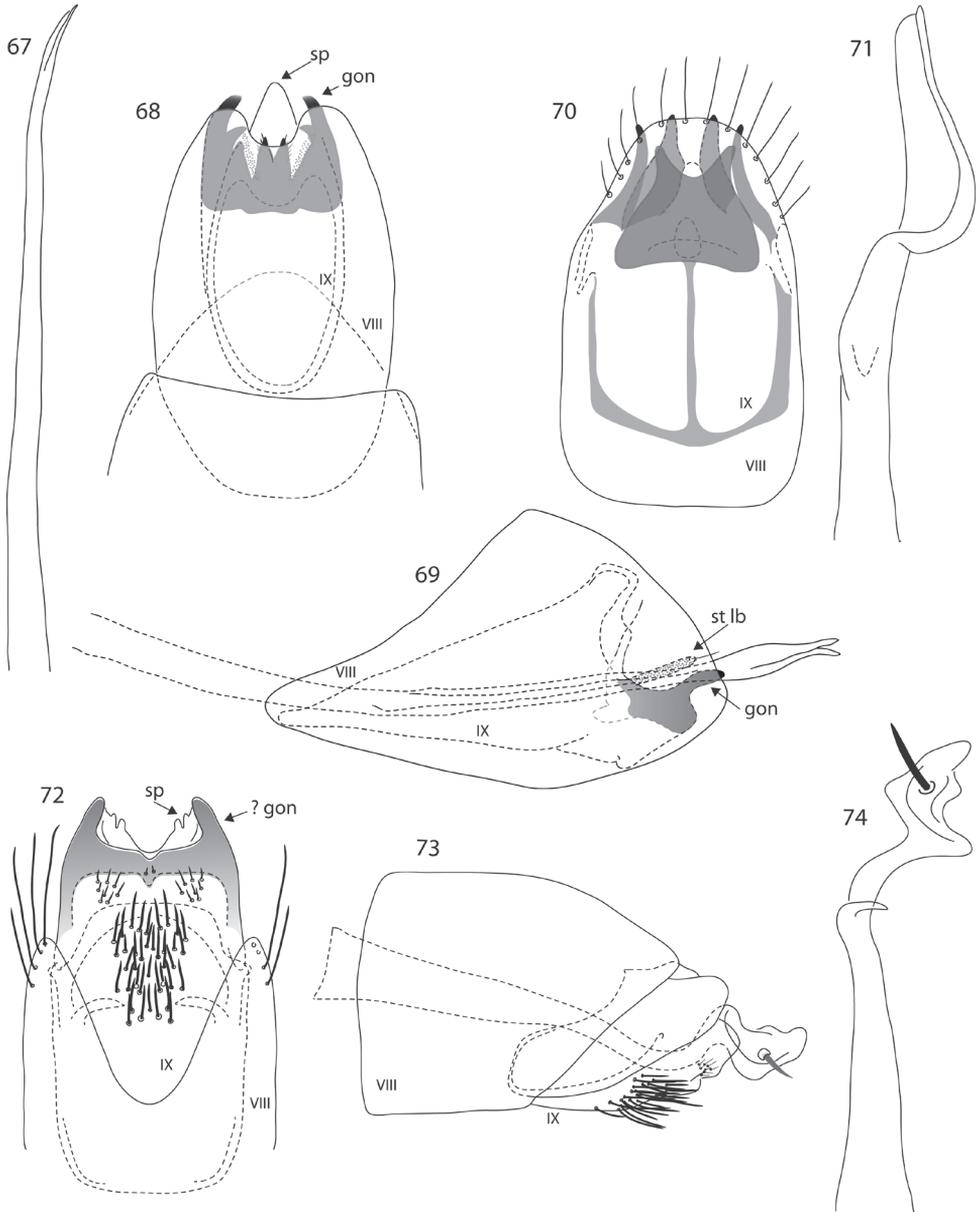
Paratypes. 6 males (on slides), same data as holotype (NHRS); 1 male Province Sud, stream draining to Marais de la Rivière Blanche, 1.35 km S Pont Pérignon, 22°08.496'S, 166°42.152'E, 180 m, 6–16.xi.2003, Malaise trap, loc#009, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, Rivière des Pirogues, 22°11.225'S, 166°43.338'E, 100 m, 7.xi.2003, light trap, loc#016, leg. K.A. Johanson (NHRS); 1 male (on slide), Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.073'S, 166°28.460'E, 810 m, 18.xi–4.xii.2003, Malaise trap, loc#030, leg. K.A. Johanson (NHRS); 1 male (on slide), Province Sud, W slope Mt Ningua, Kwé Néco, Stream, at Camp Jacob, 3.7 km WNW summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°43.613'S, 166°06.567'E, 150 m, 29.xi–12.xii.2003, Malaise trap, loc#054, leg. K.A. Johanson (NHRS).

Etymology. Named for the finger-like lobes of the gonopods in male.

Remarks. *Oxyethira digitata* shares a southern distribution (Fig. 109) with *O. melasma* and *O. scutica*. A photograph of the type locality with the trap is rendered in Fig. 84.

Subgenus *Dampfitrichia* Ulmer

Erected at genus level by Mosely (1937: p.169), and synonymised with *Oxyethira* by Ross (1944), *Dampfitrichia* was accorded subgenus status by Kelley (1984) in *Oxyethira*



Figures 67–74. *Oxyethira* species male genitalia. **67–69** *O. digitata* sp. n., phallic apparatus, ventral and lateral views **70, 71** *O. incana* (Ulmer), ventral view and phallic apparatus **72–74** *O. macropennis* sp. n., ventral and lateral views and phallic apparatus. Abbreviations: gon = gonopod; sp = subgenital process; st lb = setose lobe of subgenital process; VIII, IX = abdominal segments VIII and IX.

and diagnosed as "... characterised by a fusion of veins R4 and R5 in the forewing and the subdistal sclerotised bridge between the subgenital processes"; Kelley noted that the phallic apparatus usually lacks a titillator.

***Oxyethira (Dampftrichia) incana* Ulmer**

Figs 70, 71, 110

Oxyethira incana Ulmer, 1906: 102 (see Morse 2015 for full synonymy)

Diagnosis. Males of this species are distinguished from others in the New Caledonian fauna by abdominal segment VIII with disto-lateral angles spiny, and venter produced and rounded distally not excised apico-ventrally, forming a shield over other genital structures which are strongly fused; and by phallic apparatus curiously stout and medially curved, lacking a titillator. Female terminalia longer and terminally more slender than those of *caledoniensis* group species, but not as slender as in members of subgenus *Pacificotrichia*, with sternite X bearing a jet black quadrate plate.

Antennae: males 25–28 flagellomeres, flagellomeres about twice as long as wide; female 20–21 flagellomeres, flagellomeres subquadrate in profile. Anterior wing length: males 1.8–2.2 mm (n=10); females 1.8–2.4 mm (n=10). Spurs 0,3,4. Abdominal sternite VII without median spine.

Material examined. Numerous males, females, Province Nord, Amoa River, 23 m, loc 20, 12 km W Poindimié, 22°58.092'S, 165°11.804'E, light trap, 26.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS, ANIC); 2 males, 2 females, Province Nord, 50 m upstream bridge on Hienghène–Tnèdo road, 3.9 km S summit of Mt Tnèda, 2.2 km E Tnèdo, 20°43.085'S, 164°49.928'E, 29 m, 7.xii.2003, light trap, loc#071, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, 1 m upstream road, below waterfall on Hienghène–Tnèdo road, 2.2 km SSW summit of Mt Unpac, 4.9 km ESE Tnèdo, 20.73879°S, 164.85508°E, 7.xii.2003, light trap, loc#072, leg. K.A. Johanson (NHRM); 3 males, 6 females, Province Nord, stream in Creek de Bambou, 5 m N road RT7 Ouégoa–Koumac, 20°27.863'S, 164°19.784'E, 58 m, 19.xii.2003, Malaise trap, loc#087, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Bouérabate Stream, S Mont Ninndo, along road Barabache–Boulagoma, 20°17.409'S, 164°11.242'E, 60 m, 19.xii.2003–7.i.2004, Malaise trap, loc#089, leg. K.A. Johanson; 2 males, 4 females, Province Nord, Rivière Néhoué, camp Aménage de Néhoué, 20°25.037'S, 164°13.222'E, 12 m, 19.xii.2003, light trap, loc#090, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Héémwâ Pwei River, 50 m upstream bridge on Touho–Hienghene road, 1.0 km N Paola, 20.76512°S, 165.10979°E, 22.xii.2003, light trap, loc#095, leg. K.A. Johanson (NHRM); 3 male, 6 females, Province Nord, Ponandou Tiôgé River at Kögi, 3.9 km SSW Touho, 20°49.043'S, 165°13.551'E, 25 m, 26.xii.2003, light trap, loc#100, leg. K.A. Johanson (NHRS).

Remarks. In New Caledonia this species was taken only in the northern province (Fig. 110); elsewhere it is widespread from Java, through South-East Asia to New Guinea and northern Australia.

***Oxyethira* species unplaced to subgenus.**

One highly aberrant species, *O. macropennis* sp. n., is here unplaced to subgenus. Males share the diagnostic features of species of *Oxyethira*, including wing shape and venation, but have unusual male genital features, possibly aligning the species more with species of *Paroxyethira*. For the present we assign it to *Oxyethira*, albeit tentatively.

***Oxyethira macropennis* sp. n.**

<http://zoobank.org/3FA585C6-F464-4B22-B39E-C3B1172F5A0C>

Figs 72–74, 85, 111

Diagnosis. Immediately recognised by the remarkable form of the phallic apparatus, which has a contorted twist towards the stout seta-bearing apex, and the brush of shorter stout setae medially on abdominal sternite IX. By these features it is distinguished clearly from all other New Caledonian species.

Description. Male antennae with 22–24 flagellomeres; flagellomeres urn-shaped, few *sensilla placodea* subapically, dense *sensilla auricillica*; anterior wing length 1.7–2.1 mm (n=5); tibial spurs 0,3,4; abdominal sternite VII without medial spur.

Male, genitalia (Figs 72–74). Abdominal segment VIII quadrate in profile; abdominal segment IX subrectangular, ventrally bearing a brush of stout setae medially, and on each side a cluster of shorter setae subapically, mid dorsally short, apical margin shallowly excavated; gonopods may be represented by the sclerotised apico-lateral lobes on abdominal segment IX; phallic apparatus strongly twisted in distal half, beyond a short lateral process that may represent titillator, subapically irregular in shape, bearing a stout seta.

Remarks. *Oxyethira macropennis* is quite unlike all other New Caledonian species, however it conforms with the diagnostic features of members of the *Oxyethira* and thus is assigned to this genus, albeit somewhat tentatively.

Material examined. Holotype. Male (on slide), New Caledonia, Province Sud, south of Plaine des Lacs, 4.0 km N Prony, 22°16.906'S, 166°49.402'E, 9–22.xi.2003, Malaise trap, loc#017, leg. K.A. Johanson (MNHP).

Paratypes. 6 males (2 on slides), data as for holotype (NMHR); 1 male, Province Sud, Sarraméa, 220 m, forest stream, loc 10, 21°37.883'S 165°51.958'E, Malaise trap, 18–21.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund (NHRS).

Etymology. Name descriptive of the relatively large phallic apparatus.

Remarks. *Oxyethira macropennis* was taken only at two well-separated sites in the south of the island. A photograph of the type locality with the trap is rendered in Fig. 85.



75



76



77



78



79



80

Figures 75–80. Type localities of *Oxyethira* species. **75** *O. tiwaka* sp. n. and *O. ouenghi* sp. n. (collected together with the hydroptilid species *Oxyethira caledonensis*, *O. oropedion*, *O. indorsennus*, *O. incana*, *Hydroptila losida*, *Helyethira malleoforma*, *Acritoptila disjuncta* Kelley, 1989, *A. crinita* Kelley, 1989, *A. glossocercus* Kelley, 1989 and *A. amphapsis* Kelley, 1989) **76** *O. perignonica* sp. n. (collected together with the hydroptilid species *Oxyethira oropedion*) **77** *O. abbreviata* sp. n. (no other Hydroptilidae species collected at this site) **78** *O. incurvata* (collected together with the hydroptilid species *Oxyethira caledonensis*) **79** *O. parinsularis* sp. n. and *O. quadrata* sp. n. (collected together with the hydroptilid species *Oxyethira incurvata* sp. n., *O. caledonensis*, *O. houailou* sp. n., *O. insularis*, *O. oropedion*, *O. melasma*, *O. digitata* sp. n., *Acritoptila disjuncta*, *A. crinita*, *A. ouenghica* Wells, 1995, *Caledonotrichia illiesi* Sykora, 1967, *C. minuta* Wells, Johanson & Mary-Sasal, 2013, *C. ouinnica* Wells, Johanson & Mary-Sasal, 2013, *C. nyurga* Oláh & Johanson, 2010, *Paroxyethira atypica* Wells & Johanson, 2012 and *P. dzumac* Wells & Johanson, 2012) **80** *O. dorsennus* sp. n. (collected together with the hydroptilid species *Hydroptila losida* and *Paroxyethira dumagnes* Kelley, 1984).



81



82



83

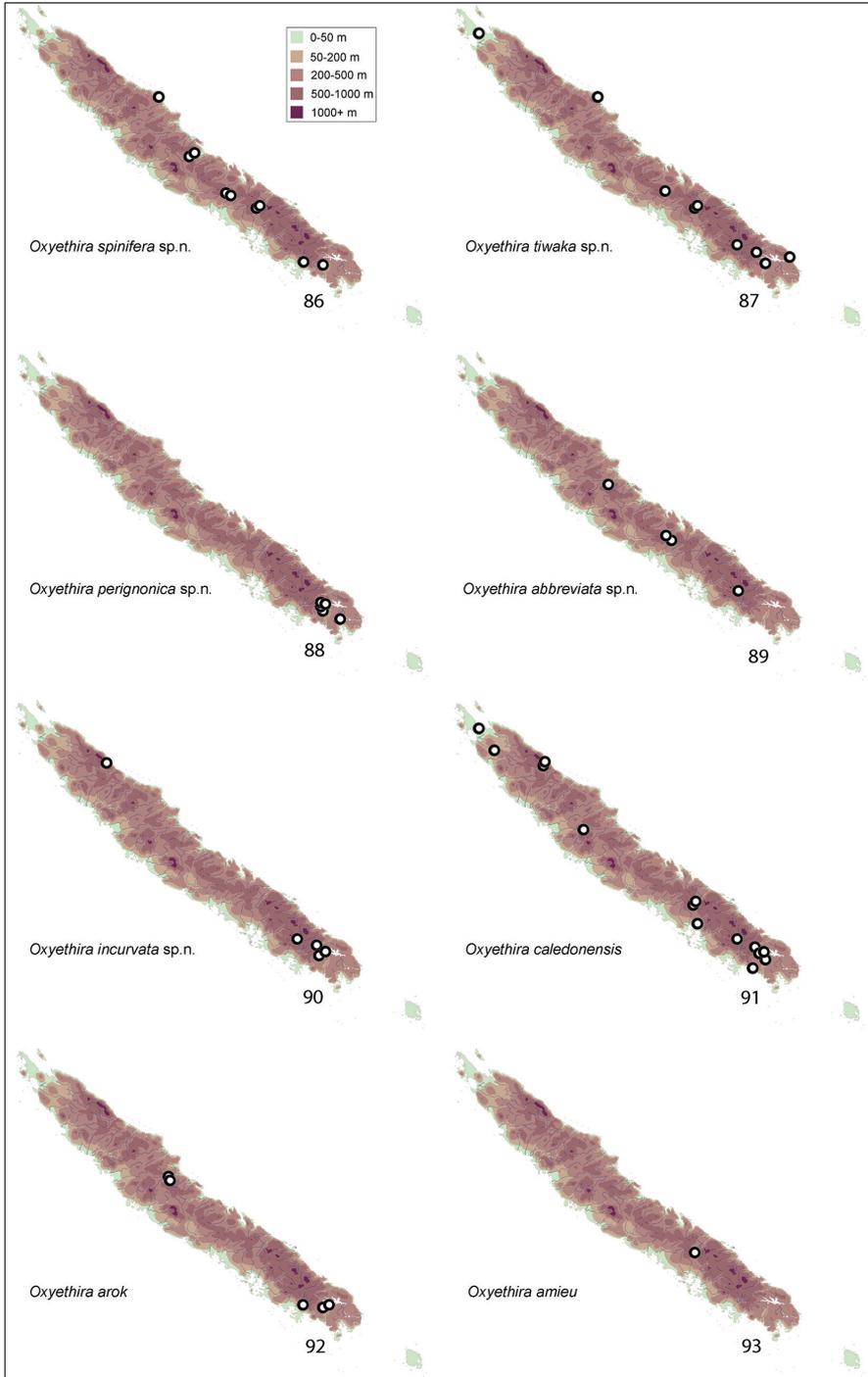


84

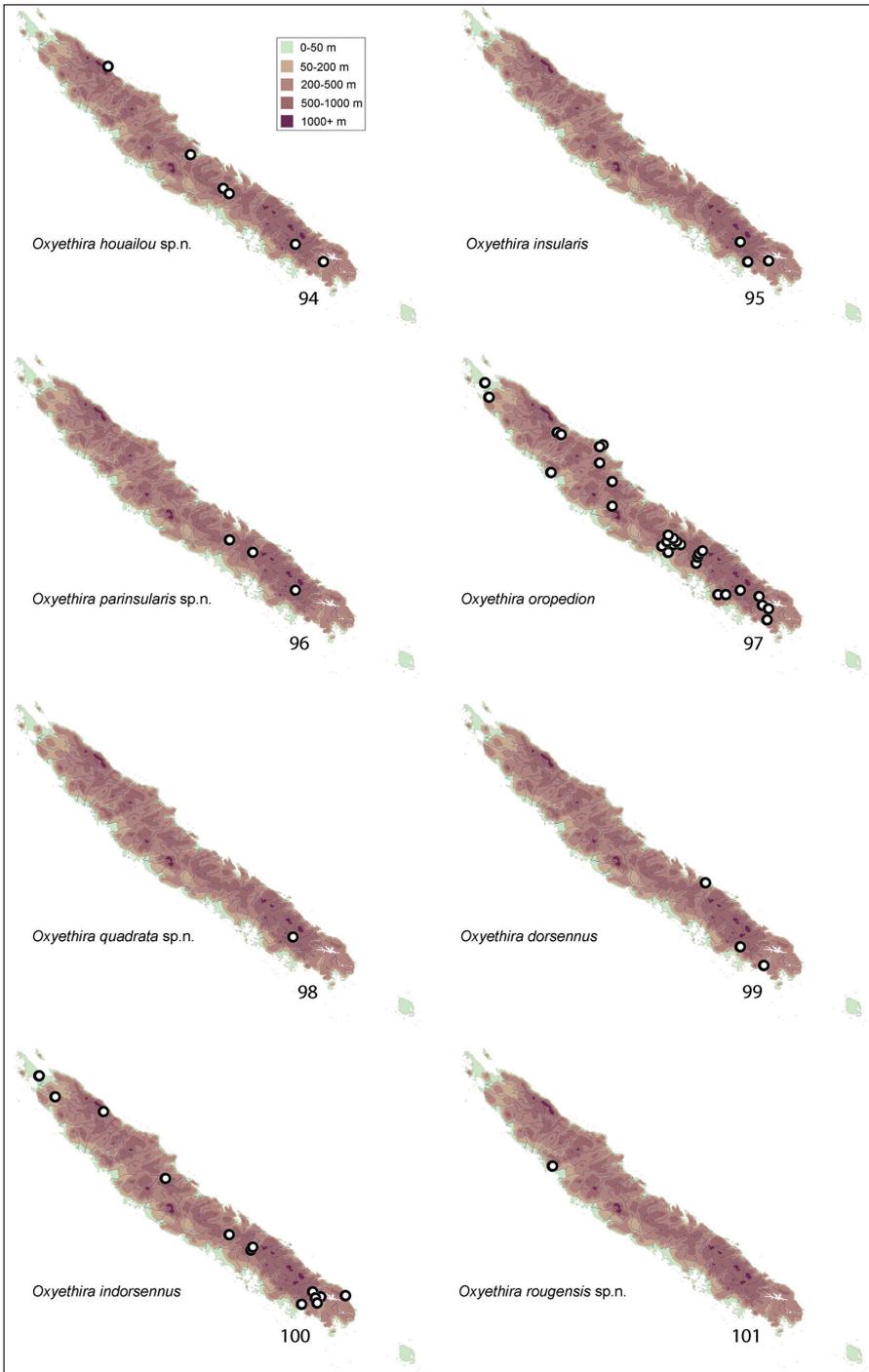


85

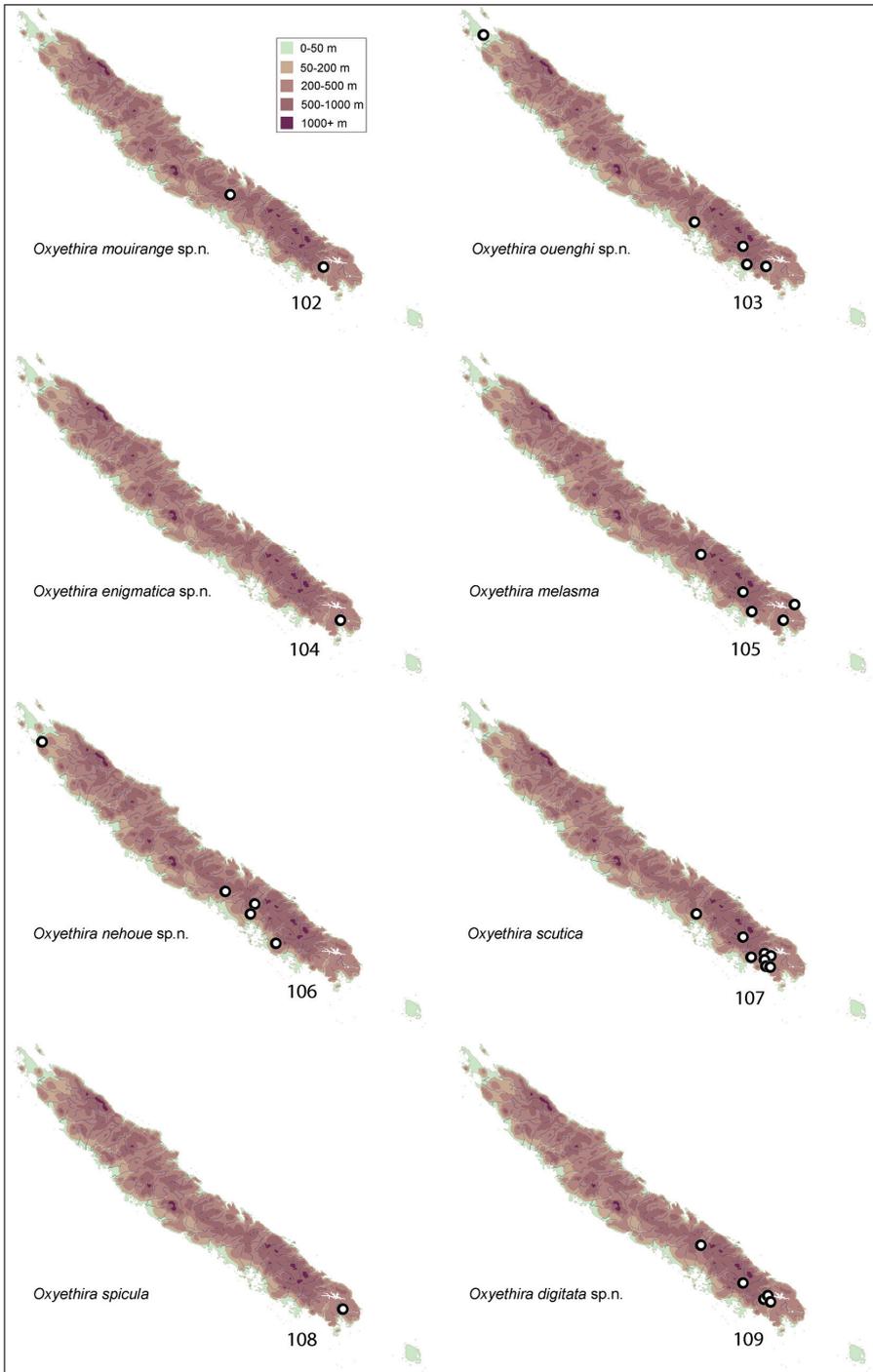
Figures 81–85. Type localities of *Oxyethira* species. **81** *O. rougensis* sp. n. (collected together with the hydroptilid species *Oxyethira oropedion*, *Hydroptila losida*, *Hellyethira malleoforma*, *Acritoptila crinita*, *A. macrospina* Wells & Johanson, 2014 and *Paroxyethira opposita* Wells & Johanson, 2012) **82** *O. enigmatica* sp. n. (collected together with the hydroptilid species *O. perignonica* sp. n., *O. melasma* and *Acritoptila disjuncta*) **83** *O. nehoue* sp. n. (collected together with the hydroptilid species *Oxyethira oropedion*, *O. incana*, *Hydroptila losida*, *Hellyethira malleoforma* and *Acritoptila disjuncta*) **84** *O. digitata* sp. n. (collected together with the hydroptilid species *Oxyethira incurvata* sp. n., *O. indorsennus*, *O. scutica*, *Hydroptila losida*, *Caledonotrichia illiesi* and *C. minuta*) **85** *O. macropennis* sp. n. (no other Hydroptilidae species collected at this site).



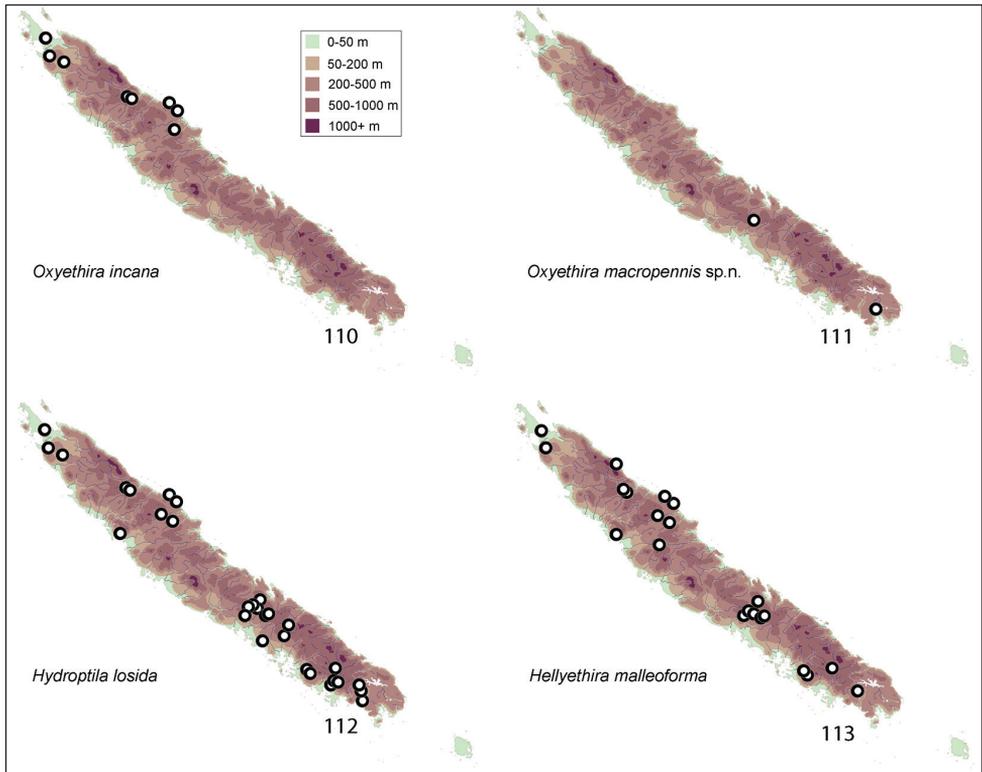
Figures 86–93. Maps of New Caledonia, with collecting sites plotted for Hydroptilidae species. **86** *Oxyethira spinifera* sp. n. **87** *O. tiwaka* sp. n. **88** *O. perignonica* sp. n. **89** *O. abbreviata* sp. n. **90** *O. incurvata* sp. n. **91** *O. caledonensis* **92** *O. arok* **93** *O. amieu* sp. n.



Figures 94–101. Maps of New Caledonia, with collecting sites plotted for Hydroptilidae species. **94** *Oxyethira houailou* sp. n. **95** *O. insularis* **96** *O. parinsularis* sp. n. **97** *O. oropedion* **98** *O. quadrata* sp. n. **99** *O. dorsennus* **100** *O. indorsennus* **101** *O. rougensis* sp. n.



Figures 102–109. Maps of New Caledonia, with collecting sites plotted for Hydroptilidae species. **102** *Oxyethira mouirange* sp. n. **103** *O. ouenghi* sp. n. **104** *O. enigmatica* sp. n. **105** *O. melasma* **106** *O. nehoue* sp. n. **107** *O. scutica* **108** *O. spicula* sp. n. **109** *O. digitata* sp. n.



Figures 110–113. Maps of New Caledonia, with collecting sites plotted for Hydroptilidae species. **110** *Oxyethira incana* **111** *O. macropennis* sp. n. **112** *Hydroptila losida* sp. n. **113** *Hellyethira malleoforma*.

New records of other genera

Hydroptila losida Mosely

Fig. 112

Hydroptila losida Mosely, 1953: 505; Wells 1978 [1979]: 757, figs 35–38; Wells 1995: 231.

Diagnosis. The only *Hydroptila* species among New Caledonian micro-caddisflies, *H. losida* is recognised by the absence of ocelli on the dorsal head, and tibial spur count of 0,2,4; and in the male by gonopods well developed, in ventral view elongate divergent rods, each with a pair of dark spurs distally, in lateral view, club-shaped; and phallic apparatus slender, distally comprising a slender, tapered spine adpressed to the section containing the ejaculatory duct, or in some specimens these two parts are separated and divergent; and in the female by the triangular shape of sternite VIII with the two small triangular sclerotised areas laterally at about half length of the sternite.

Material examined. Numerous males, females, Province Nord, Amoa River, 23 m, loc 20, 12 km W Poindimié, 22°58.092'S, 165°11.804'E, light trap, 26.xi.2001,

leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); 6 females, Province Sud, Col d'Amieu, 323 m, small stony river, loc 24, 21°34.844'S, 165°49.677'E, Malaise trap, 30.xi–5.xii.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); numerous males, females, Province Nord, 2.8 km ENE Bopope, Rivière Oua Mendiou, 100 m S RPN2 Koné–Poindimié, 20°54.455'S, 165°06.300'E, 78 m, 14.i.2003, light trap, loc#119, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Dumbea river, Branche sud, 22°08.344'S, 166°30.147'E, 42 m, 03.xi.2003, light trap, loc#006, leg. K.A. Johanson (NHRS); 3 males, Province Sud, side stream to Rivière Blanche, 10.75 km SW Pont Pérignon, 22°10.073'S, 166°39.903'E, 180 m, 6–16.xi.2003, Malaise trap, loc#012, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, 2.0 km E Pic Mouirange, 22°12.356'S, 166°40.798'E, 220 m, 7–16.xi.2003, Malaise trap, loc#014, leg. K.A. Johanson (NHRS); 4 males, 12 females, Province Sud, Sarraméa, 220 m, forest stream, loc 10, 21°37.883'S 165°51.958'E, Malaise trap, 18–21.xi.2001, Leg. K.A. Johanson, T. Pape & B. Viklund; 1 male, 6 females, Province Sud, Sarraméa, 2907 m, stony forest stream, loc 13 21°37.097'S 165°49.351'E, Malaise trap, 18–21.xi.2001, Leg. K.A. Johanson, T. Pape & B. Viklund (RHNS); 1 male, 2 females, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.439'S, 166°28.646'E, 805 m, 18.xi–4.xii.2003, Malaise trap, loc#029, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Tamoia River, 700m S road RT1 between Noumea and La Foa, 22°04.518'S, 166°16.592'E, 19.xi.2003, light trap, loc#033, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Hwa Hace Mtn, Hwa Motu River, at Pont Wamutu, 1.0 km E Nassirah, about 200 m upstream bridge, 21°48.094'S, 166°04.298'E, 137 m, 20.xi–12.xii.2003, Malaise trap, loc#034, leg. K.A. Johanson (NHRS); 2 males, 8 females, New Caledonia, Province Sud, stream at Refuge de Farino, 4.0 km W Grand Couli village, 21°38.934'S, 165°46.845'E, 260 m, 25.xi.2003, light trap, loc#044, leg. K.A. Johanson (NHRS); 30 males, Province Sud, St. Vincent, Bongou Stream, at bridge on road to Tribu de Bangou, 700 m N RT1 Noumea–Tontoutou road, 22°03.477'S, 166°15.718'E, 26.xi.2003, light trap, loc#050, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Couvelée River at Haute Couvelée, 2.8 km SV summit of Mt Piditéré, 3.5 km NNE Dumbéa, 22°07.405'S, 166°28.023'E, 27 m, 28.xi.2003, light trap, loc#052, leg. K.A. Johanson (NHRS); 3 females, Province Sud, W slope Mt Ningua, Kwé Néco, Stream, at Camp Jacob, 3.7 km WNW summit of Mt Ningua, on Boulouparis–Thio Road, about 50 m upstream road, 21°43.613'S, 166°06.567'E, 150 m, 29.xi–12.xii.2003, Malaise trap, loc#054, leg. K.A. Johanson (NHRS); 4 males, 12 females, Province Sud, lower part of Dumbea River, 1.0 km SSW bridge over Dumbea River at Dumbea, 22°09.750'S, 166°26.700'E, 0.5 m, 30.xi.2003, light trap, loc#058, leg. K.A. Johanson (NHRS); 1 male, 6 female, Province Sud, lower part Rivière des Pirogues, 800 m WNW summit of Mont Imbaah, 4.7 km E Lucky Creek in Plum, 22°18.559'S, 166°41.227'E, 1.3 m, 01.xii.2003, light trap, loc#059, leg. K.A. Johanson (NHRS); 6 males, 4 females, Province Nord, 50 m upstream bridge on Hienghène–Tnèdo road, 3.9 km S summit

of Mt Tnèda, 2.2 km E Tnèdo, 20°43.085'S, 164°49.928'E, 29 m, 7.xii.2003, light trap, loc#071, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, 1 m upstream road, below waterfall on Hienghène–Tnèdo road, 2.2 km SSW summit of Mt Unpac, 4.9 km ESE Tnèdo, 0.73879°S, 164.85508°E, 7.xii.2003, light trap, loc#072, leg. K.A. Johanson (NHRS); 1 male, 3 females, Province Nord, stream in Creek de Bambou, 5 m N road RT7 Ouégoa–Koumac, 20°27.863'S, 164°19.784'E, 58 m, 19.xii.2003, Malaise trap, loc#087, leg. K.A. Johanson (NHRS); 3 males, Province Nord, Bouérabate Stream, S Mont Ninndo, along road Barabache–Boulagoma, 20°17.409'S, 164°11.242'E, 60 m, 19.xii.2003–7.i.2004, Malaise trap, loc#089, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Rivière Néhoué, camp Aménage de Néhoué, 20°25.037'S, 164° 13.222'E, 12 m, 19.xii.2003, light trap, loc#090, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Rivière Néhoué, camp Aménage de Néhoué, 20°25.015'S, 164°13.245'E, 12 m, 19.xii.2003, light trap, loc#091, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Héémwâ Pwei River, 50 m upstream bridge on Touho–Hienghène road, 1.0 km N Paola, 20.76512°S, 165.10979°E, 22.xii.2003, light trap, loc#095, leg. K.A. Johanson (NHRS); numerous males, females Province Nord, Ponandou Tiôgé River at Kôgi, 3.9 km SSW Touho, 20°49.043'S, 165°13.551'E, 25 m, 26.xii.2003, light trap, loc#100, leg. K.A. Johanson (NHRS); males, females, Province Nord, Plaine des Gaïacs, Rivière Rouge, 14.2 km NW summit of Mt Rouge, 50 m upstream road RT1 Noumea–Koné, 21°31.573'S, 164°46.690'E, 23 m, 2.i.2004, light trap, loc#104, leg. K.A. Johanson (NHRS); 1 male, Province Sud, Creek Froid, 10 m upstream bridge on La Foa–Koindé road, 200 m W crossroad to Ouipouin, 21°38.581'S, 165°56.672'E, 180 m, 4.i.2004, light trap, loc#105, leg. K.A. Johanson (NHRS); 3 males, Province Sud, Fö Néchédeva stream, 2 m upstream bridge on La Foa–Koindé road, 21°38.812'S, 165°56.076'E, 124 m, 4.i.2004, light trap, loc#106, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Etnbl. thermal de la Crouen, along Riv. la Crouen, 30 m upstream road RM3, 21°32.105'S, 165°53.319'E, 15 m, 5.i.2004, Malaise trap, loc#110, leg. K.A. Johanson (NHRS); 1 male, 5 females, Province Sud, Xwé Dachava Stream, Rembai Mtn, 21°34.854'S, 165°49.478'E, 317 m, 5–12.i.2004, Malaise trap, loc#108, leg. K.A. Johanson (NHRS); 11 males, Province Sud, Col d'Amieu, Xwé Ko River, on road to St. Forestière, 21°35.612'S, 165° 48.241'E, 368 m, 8.i.2004, light trap, loc#114, leg. K.A. Johanson (NHRS); numerous males, females, Province Sud, Sarraméa, Xwé Wya River, 21°38.318'S, 165°51.582'E, 127 m, 17–18.i.2004, light trap, loc#121, leg. K.A. Johanson (NHRS); 2 males, numerous females, Province Sud, artificial lake 2.6 km S summit of Mt Mè Tu Novia, about 400 m N Pocquereux River, 7.4 km E La Foa, 21°43.859'S, 165°54.034'E, 28 m, 19.i.2004, light trap, loc#123, leg. K.A. Johanson (NHRS).

Remarks. In New Caledonia *H. losida* is abundant and widespread across the island (Fig. 112). A similar wide distribution is true of this species in eastern Australia where it is common throughout the wetter coastal regions, including the south-west and Tasmania, but not the far north of the continent.

***Hellyethira malleoforma* Wells**

Fig. 113

Hellyethira malleoforma Wells, 1979: figs 41–45; Wells 1995: 232.

Diagnosis. Males of this species are distinguished by their complex asymmetrical genital structures, including multilobed gonopods, and females by the sclerotised annulus formed by abdominal segment VIII (see Wells 1979).

Material examined. 2 males, females, Province Sud, Sarraméa, 220 m, forest stream, loc 10, 21°37.883'S 165°51.958'E, Malaise trap, 18–21.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); 1 male, 4 females, Province Sud, Sarraméa, 2907 m, stony forest stream, loc 13, 21°37.097'S 165°49.351'E, Malaise trap, 18–21.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); numerous males, females, Province Nord, Amoa River, 23 m, loc 20, 12 km W Poindimié, 22°58.092'S, 165°11.804'E, light trap, 26.xi.2001, leg. K.A. Johanson, T. Pape & B. Viklund(NHRS); 1 male, 4 females, Province Sud, Monts Kwa Ne Mwa, on road between Noumea and Yaté, 2.0 km E Pic Mouirange, 22°12.356'S, 166°40.798'E, 220 m, 7–16.xi.2003, Malaise trap, loc#014, leg. K.A. Johanson (NHRS); 2 males, 17 females, Province Sud, Mt Dzumac, source stream of Ouinne River, near crosspoint to mountain track, 22°02.439'S, 166°28.646'E, 805 m, 18.xi–4.xii.2003, Malaise trap, loc#029, leg. K.A. Johanson (NHRS); males, females, Province Sud, Tamoa River, 700m S road RT1 between Noumea and La Foa, 22°04.518'S, 166°16.592'E, 19.xi.2003, light trap, loc#033, leg. K.A. Johanson (NHRS); males, females, Province Sud, stream at Refuge de Farino, 4.0 km W Grand Couli village, 21°38.934'S, 165°46.845'E, 260 m, 25.xi.2003, light trap, loc#044, leg. K.A. Johanson (NHRS); 4 males, 2 females, St. Vincent, Bongou Stream, at bridge on road to Tribu de Bangou, 700 m N RT1 Noumea–Tontoutu road, 22°03.477'S, 166°15.718'E, 26.xi.2003, light trap, loc#050, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, 50 m upstream bridge on Hienghène–Tnèdo road, 3.9 km S summit of Mt Tnèda, 2.2 km E Tnèdo, 20°43.085'S, 164°49.928'E, 29 m, 7.xii.2003, light trap, loc#071, leg. K.A. Johanson (NHRS); males, females, Province Nord, 1 m upstream road, below waterfall on Hienghène–Tnèdo road, 2.2 km SSW summit of Mt Unpac, 4.9 km ESE Tnèdo, 20.73879°S, 164.85508°E, 7.xii.2003, light trap, loc#072, leg. K.A. Johanson (NHRS); males, females, Province Nord, Wan Pwé on stream, draining NNE side of Mt Panié, 3.9 km NW Cascade de Tao, 20°31.820'S, 164°47.016'E, 18.xii.2003, light trap, loc#085, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Bouérabate Stream, S Mont Ninndo, along road Barabache–Boulagoma, 20°17.409'S, 164°11.242'E, 60 m, 19.xii.2003–7.i.2004, Malaise trap, loc#089, leg. K.A. Johanson (RHNS); males, females, Province Nord, Rivière Néhoué, camp Amenage de Néhoué, 20°25.037'S, 164°13.222'E, 12 m, 19.xii.2003, light trap, loc#090, leg. K.A. Johanson (NHRS); males, females, Province Nord, Rivière Néhoué, camp Amenage de Néhoué, 20°25.015'S, 164°13.245'E, 12 m, 19.xii.2003, light trap, loc#091, leg. K.A. Johanson (NHRS); male, females, Province Nord, Héémwâ Pwei River, 50 m upstream bridge on Touho–

Hienghene road, 1.0 km N Paola, 20.76512°S, 165.10979°E, 22.xii.2003, light trap, loc#095, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Ponandou Tiôgé River at Kögi, 3.9 km SSW Touho, 20°49.043'S, 165°13.551'E, 25 m, 26.xii.2003, light trap, loc#100, leg. K.A. Johanson (NHRS); males, females, Province Nord, Plaine des Gaïacs, Rivière Rouge, 14.2 km NW summit of Mt Rouge, 50 m upstream road RT1 Noumea–Koné, 21°31.573'S, 164°46.690'E, 23 m, 2.i.2004, light trap, loc#104, leg. K.A. Johanson (NHRS); 1 male, KAJ sp. F, Province Sud, Creek Froid, 10 m upstream bridge on La Foa–Koindé road, 200 m W crossroad to Oupouin, 21°38.581'S, 165°56.672'E, 180 m, 4.i.2004, light trap, loc#105, leg. K.A. Johanson (NHRS); 1 male KAJ sp. F, Province Sud, Fö Néchédeva stream, 2 m upstream bridge on La Foa–Koindé road, 21°38.812'S, 165°56.076'E, 124 m, 4.i.2004, light trap, loc#106, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, Etnbl. thermal de la Crouen, along Riv. la Crouen, 30 m upstream road RM3, 21°32.105'S, 165°53.319'E, 15 m, 5.i.2004, Malaise trap, loc#110, leg. K.A. Johanson 1 male KAJ “F”, Province Nord, Forêt Plate, Ouendé River, at 2.5 km WNW summit of Katépouenda, 23.3 km E Pouembout, 21°07.474'S, 165°06.781'E, 470 m, 8–15.i.2004, Malaise trap, loc#113, leg. K.A. Johanson (NHRS); numerous males, females, Province Nord, 2.8 km ENE Bopope, Rivière Oua Mendiou, 100 m S RPN2 Koné–Poindimié, 20°54.455'S, 165°06.300'E, 78 m, 14.i.2003, light trap, loc#119, leg. K.A. Johanson (NHRS).

Remarks. *Hellyethira malleoforma* is the only representative in New Caledonia of this diverse Australian genus that also occurs more broadly but less commonly in SE Asia and New Guinea. This species is widespread and often abundant in New Caledonia (Fig. 113). It was described from south-eastern Australia where it is one of the most common species in lower altitude streams.

Key to males of New Caledonian species of *Oxyethira*

- 1 Tibial spur formula 0,2,4 2
- Tibial spur formula 0,3,4 6
- 2(1) Phallic apparatus tipped by fine whip-like flagellum (Fig. 61) *O. scutica*
- Phallic apparatus with strap-like distal process (Figs 7, 53), or without process (Figs 40, 57) 3
- 3(2) Phallic apparatus with strap-like apical or subapical process (Figs 8, 53) 4
- Phallic apparatus without apical process (Figs 40, 57) 5
- 4(3) Phallic apparatus with elongate strap-like apical process (Fig. 53); abdominal segment IX in ventral view distally bilobed (Fig. 53) *O. enigmatica*
- Phallic apparatus with short strap-like subapical process (Fig. 8); abdominal segment IX in ventral view subquadrate (Fig. 7) *O. perignonica*
- 5(3) Gonopods fused at base, separate distally, apices truncate in ventral view (Fig. 40); ventral process sharply triangular in lateral view (Fig. 39) *O. dorsennus*

- Gonopods fused throughout, narrowly truncate apically, a pair of small setose lobes at mid length (Fig. 55); ventral process broadly rounded to truncate in lateral view (Fig. 56) ***O. melasma***
- 6(1) Phallic apparatus twisted and irregular in shape distally, bearing a single stout seta (Fig. 74) ***O. macropennis***
- Phallic apparatus without seta, with strap-like flange or process (e.g. Figs 11, 30), or simple without apical or subapical processes (e.g. Figs 57, 71) 7
- 7(6) Gonopods inserted midway or proximally on venter of abdominal segment IX, in ventral view in form of Y-shaped structure or pair of widely separated ‘horns’ (Figs 28, 32), in lateral view in form of curved spines (Fig. 33) **8**
- Gonopods situated distally on venter of abdominal segment IX (e.g. Figs 10, 25, 70) or completely reduced (e.g. Figs 1, 64) **9**
- 8(7) Gonopods in ventral view distinctly Y-shaped (Fig. 28) ***O. insularis***
- Gonopods in ventral view in form of pair of widely separated spines joined basally by short sclerotised strip (Fig. 32) ***O. parinsularis***
- 9(7) Abdominal segment VIII extended disto-laterally as pair of sclerotised spines (Fig. 70) ***O. incana***
- Abdominal segment VIII without apico-lateral sclerotised spines (Figs 1, 4, 10) **10**
- 10(9) Ventral processes in form of pair of laterally situated rods or spines (Figs 1, 4, 10) **11**
- Ventral processes fused, in ventral view forming median plate (Figs 36, 38, 40, 44) **18**
- 11(10) Abdominal segment IX in ventral view subquadrate (Figs 2, 4, 10) **12**
- Abdominal segment IX in ventral view rounded, conical or triangular proximally (Figs 13, 19, 23) **14**
- 12(11) Gonopods forming sclerotised cones at apico-lateral angles of abdominal segment IX (Fig. 10) ***O. abbreviata***
- Gonopods reduced completely or in form of short blunt tabs, widely separated on apical margin of abdominal segment IX (Figs 1, 4) **13**
- 13(12) Gonopods reduced completely (Fig. 1); ventral processes acute apically (Figs 1, 2) ***O. spinifera***
- Gonopods in ventral view in form of blunt sclerotised tabs scarcely longer than wide, well separated on apical margin of abdominal segment IX (Fig. 4); ventral processes not as sharp as in *O. spinifera* (Figs 4, 6) ***O. tiwaka***
- 14(10) Gonopods apparently reduced completely or possibly present as marginal sclerotisations on distal margin of abdominal segment IX (Figs 19, 20, 23) **15**
- Gonopods recognisable as sclerotised prominences or processes on distal margin of abdominal segment IX (Figs 13, 16, 17, 25) **16**
- 15(14) Abdominal segment IX in ventral view tapered distally (Fig. 23); ventral processes sharply pointed in lateral view (Fig. 24); strap-like process subapical on phallic apparatus (Fig. 23) ***O. amieu***

- Abdominal segment IX in ventral view parallel-sided in distal half (Figs 19, 20); ventral processes bluntly rounded apically in lateral view (Fig. 21); strap-like process subapical on phallic apparatus (Figs 19, 22) ***O. aroka***
- 16.(14) Gonopods in form of short domes situated slightly laterally on distal margin of abdominal segment IX (Figs 16, 17) ***O. caledoniensis***
- Gonopods in ventral view broad, stoutly quadrate and separated by narrow v-shaped cleft (Fig. 25) or slender, laterally situated and curving mesially (Fig. 13) **17**
- 17(16) Gonopods in ventral view stoutly quadrate (Fig. 25)..... ***O. bouailu***
- Gonopods in ventral view in form of laterally situated finger-like mesally curved processes (Fig. 13) ***O. incurvata***
- 18(10) Phallic apparatus dilated distally, with a sharp, sclerotised straight apical spine (Fig. 64); abdominal segment VIII completely obscuring gonopods and other genital processes (Fig. 64) ***O. spicula***
- Phallic apparatus not as above; abdominal segment VIII not completely obscuring gonopods and other genital processes (e.g. Figs 38, 44, 68) **19**
- 19(18) Gonopods completely fused, in ventral view in form of triangular plate; ventral process in lateral view a stoutly sclerotised arch (Fig. 58) ***O. nehoue***
- Gonopods either not fused or only fused basally (e.g. Figs 36, 38, 44, 51)... **20**
- 20(19) Gonopods in ventral view branched, digitiform (Fig. 68)..... ***O. digitata***
- Gonopods unbranched (e.g. Figs 36, 43) **21**
- 21(20) Gonopods elongate triangular, acute apically (Figs 44, 47)..... **22**
- Gonopods in ventral view rounded apically (Figs 36, 38, 43, 44)..... **23**
- 22(21) Plate formed by fusion of subgenital processes subtriangular, slender in distal half, with paired short setae subapically (Fig. 44) ***O. ouenghica***
- Plate formed by fusion of subgenital processes broadly triangular, rounded apically and without setae (Fig. 47)..... ***O. mourange***
- 23(22) Abdominal segment VIII, in ventral view, with medial cleft on distal margin narrow, deeper than wide (Fig. 44)..... ***O. rougensis***
- Abdominal segment VIII, in ventral view, with wide U- or V-shaped excavation on distal margin, width greatly exceeding depth (Figs 36, 38, 43)..... **24**
- 24(23) Fused subgenital processes in ventral view in form of subquadrate plate (Fig. 38)..... ***O. quadrata***
- Fused subgenital processes in ventral view tapered or rounded distally (Figs 36, 43)..... **25**
- 25(24) Gonopods in ventral view fused basally, widely separated distally pair of small membranous lobes in mid ventral position, each bearing a pale stout seta (Fig. 36) ***O. oropedion***
- Gonopods in ventral view fused basally, free but closely abutting, with only sharp median cleft separation; without pair of median setal lobes (Fig. 43) ...
..... ***O. indorsennus***

Acknowledgements

As part of the broader study on the Trichoptera of New Caledonia by researchers from the Swedish Museum of Natural History, this work was supported by the Swedish Research Council (grant #2005-4834) and National Geographic Committee for Research and Exploration (grant #7546-03). Advice on localities and help with field work were contributed by Dr. Christina Pöllabauer (Etudes et Recherches Biologiques, New Caledonia), and Dr. Nathalie Mary-Sasal (at the time in New Caledonia). We are grateful to the authorities at Direction des Ressources Naturelles (Nouméa, New Caledonia) and the authorities at the Environment Division, Department of Economic Development and Environment, Province Nord (Koné, New Caledonia) for supporting the project with collecting and export permits. Dr. Christian Mille (Institut Agronomique néo-Calédonien, Station de Recherches Fruitières de Pocquereux, Laboratoire d'entomologie, La Foa, New Caledonia) was always enthusiastically helpful during the collecting on New Caledonia. Access for A. Wells to laboratory facilities at the Australian National Insect Collection, Canberra, is gratefully acknowledged, and for computer facilities AW thanks Australian Biological Resources Studies. The Bishop Museum, Honolulu, and particularly Shepherd Meyers, kindly hosted A. Wells' visit in 2013 and facilitated access to the Kelley types. Two anonymous referees are thanked for their very constructive comments on the manuscript.

References

- Espeland M, Johanson KA (2010) The diversity and radiation of the largest monophyletic animal group on New Caledonia (Trichoptera: Ecnomidae: *Agmina*). *Journal of Evolutionary Biology* 23: 2112–2122. doi: 10.1111/j.1420-9101.2010.02072.x
- Johanson KA (1999) Seventeen new species of *Helicopsyche* from New Caledonia (Trichoptera: Helicopsychidae). *Tijdschrift voor Entomologie* 142: 37–64. doi: 10.1163/22119434-99900018
- Johanson KA, Mary N (2000) *Helicopsyche trispina* sp. n. (Trichoptera, Helicopsychidae) from New Caledonia. *Aquatic Insects* 23: 315–322. doi: 10.1076/aqin.23.4.315.4882
- Kelley RW (1984) Phylogeny, morphology, and classification of the micro-caddisfly genus *Oxyethira* (Trichoptera: Hydroptilidae). *Transactions of the American Entomological Society* 110: 435–463.
- Kelley RW (1989) New species of micro-caddisflies (Trichoptera: Hydroptilidae) from New Caledonia, Vanuatu and Fiji. *Proceedings of the Entomological Society of Washington* 91(2): 190–202.
- McLachlan R (1862) Characters of new species of exotic Trichoptera. *Transactions of the Entomological Society of London* (3) 1: 301–311.
- Mary NJ (2002) Spatio-temporal variations in macroinvertebrate assemblages of New Caledonian streams. *Bulletin Française de Piscologie* 364: 197–215. doi: 10.1051/kmae:2002011

- Morse J (2015) Trichoptera World Checklist. <http://entweb.clemson.edu/database/trichopt/index.htm> [accessed 10 July 2015]
- Mosely ME (1937) Mexican Hydroptilidae (Trichoptera). Transactions of the Royal Entomological Society of London 86: 151–189. doi: 10.1111/j.1365-2311.1937.tb00242.x
- Mosely ME (1953) In: Mosely ME, Kimmins DE. The Trichoptera of Australia and New Zealand. British Museum (Natural History), London.
- Neboiss A (1977) A taxonomic and zoogeographic study of Tasmanian caddis-flies (Insecta: Trichoptera). Memoirs of the National Museum of Victoria 38: 1–208.
- Oláh J, Johanson KA (2010a) Description of 46 new Old World Hydroptilidae (Trichoptera). Folia Entomologica Hungarica 71: 65–155.
- Oláh J, Johanson KA (2010b) Reasoning and appendicular and functional caddisfly genital terminology. Braueria 35: 29–40.
- Ross HH (1944) The Caddisflies or Trichoptera of Illinois. Bulletin of the Illinois Natural History Survey 23: 1–326.
- Ulmer G (1906) Neuer beitrag zur kenntnis aussereuropäischer Trichopteren. Notes from the Leyden Museum 28: 1–116.
- Wells A (1978)[1979] A review of the Australian species of *Hydroptila* Dalman (Trichoptera: Hydroptilidae) with descriptions of new species. Australian Journal of Zoology 26: 745–762. doi: 10.1071/ZO9780745
- Wells A (1979) A review of the Australian genera *Xuthotrichia* Mosely and *Hellyethira* Neboiss (Trichoptera: Hydroptilidae), with descriptions of new species. Australian Journal of Zoology 27: 311–329. doi: 10.1071/ZO9790311
- Wells A (1981) The genera *Oxyethira* Eaton, *Gnathotrichia* Ulmer and *Stenoxyethira* Kimmins (Trichoptera: Hydroptilidae) in Australia. Australian Journal of Zoology 29: 103–118. doi: 10.1071/ZO9810103
- Wells A (1995) New Caledonian Hydroptilidae (Trichoptera) with new records, descriptions of larvae and a new species. Aquatic Insects 17: 223–239. doi: 10.1080/01650429509361591
- Wells A, Johanson KA (2012) Review of the New Caledonian *Paroxyethira* Mosely, 1924 (Trichoptera: Hydroptilidae). Zootaxa 3478: 330–344.
- Wells A, Johanson KA (2014) Review of the New Caledonian species of *Acritoptila* Wells, 1982 (Trichoptera: Insecta), with descriptions of 3 new species. ZooKeys 397: 1–23. doi: 10.3897/zookeys.397.7059
- Wells A, Johanson KA, Mary-Sasal N (2013) The New Caledonian genus *Caledonotrichia* Sykora (Trichoptera, Insecta) reviewed, with descriptions of 6 new species. ZooKeys 287: 59–89. doi: 10.3897/zookeys.287.4615

Ashea megacephala Kim & Ahn (Coleoptera, Staphylinidae, Aleocharinae), a new gyrophaenine genus and species from Peru

Yoon-Ho Kim¹, Kee-Jeong Ahn²

¹ Scientific Collection & Conservation Team, National Science Museum, Daejeon 34143, Republic of Korea

² Department of Biology, Chungnam National University, Daejeon 34134, Republic of Korea

Corresponding author: Kee-Jeong Ahn (kjahn@cnu.ac.kr)

Academic editor: V. Assing | Received 9 July 2015 | Accepted 5 October 2015 | Published 28 October 2015

<http://zoobank.org/52EEB2FF-F8BC-4C83-984B-A3DC8C8D486E>

Citation: Kim Y-H, Ahn K-J (2015) *Ashea megacephala* Kim & Ahn (Coleoptera, Staphylinidae, Aleocharinae), a new gyrophaenine genus and species from Peru. ZooKeys 530: 91–99. doi: 10.3897/zookeys.530.6110

Abstract

Ashea megacephala, a new Peruvian genus and species is described. The specimens were collected on mushrooms and mushroom-associated trees. This genus can be readily distinguished from the other genera of the subtribe Gyrophaenina by the large head and the three indistinctly articulated labial palpomeres. A key to the known genera of Gyrophaenina is provided. A habitus photograph and illustrations of diagnostic characters are also presented.

Keywords

Gyrophaenina, key, new genus, new species, Peru, Staphylinidae

Introduction

The subtribe Gyrophaenina Kraatz contains 833 species in 21 genera worldwide (Newton and Thayer 2005, Ashe 2007) and most are obligate inhabitants of fresh mushrooms in the larval and adult stages (Ashe 1984). Members of Gyrophaenina are characterized by the following characters: lacinia truncate at apex with well-developed spinose area, spines and setae reduced on inner margin of lacinia; labial palpus with

two palpomeres, non-styliform, one medial seta on prementum; mesocoxal cavities broadly separated, broad meso- and metaventral processes not joined by isthmus but meeting along broad suture (Ashe 2001).

During an ongoing worldwide revisionary study of the Homalotini, a series of small specimens were found in the Snow Entomological Museum Collection, Lawrence, USA, each with very large head. After detailed study of the specimens, we conclude that this is a new genus and species belonging to Gyrophaenina.

In this paper, *Ashea megacephala* gen. n. and sp. n. is described and a key to the known genera of Gyrophaenina is provided, as well as a habitus photograph with illustrations of diagnostic characters.

Methods

Specimens were dissected in water and mounted on sticky carbon tape. They were dried at 60 °C on a slide warmer for 24 h, sputter-coated with Pt/Pd nanoparticles using a sputter coater (208 HR, Cressington Scientific Instruments, Watford, Hertfordshire, UK), and examined with SEM (S-4800, Hitachi High-Technologies, Tokyo, Japan). Descriptive terms used here follow Ashe (1984). Holotype and six paratypes are deposited in Snow Entomological Museum Collection (SEMC), University of Kansas, Lawrence, USA. Six paratypes are deposited in the Chungnam National University Insect Collection (CNUIC), Daejeon, Korea.

Results

Ashea gen. n.

<http://zoobank.org/69A1EB75-782C-4E89-BEA6-CABBE067AF8F>

Type species. *Ashea megacephala* sp. n.

Diagnosis. Head (Fig. 2) very large, as wide as and distinctly longer than pronotum; eye large, longer than temple; labrum (Fig. 4) markedly transverse, seven pairs of macrosetae present; right mandible (Fig. 5) with very large median tooth; ligula (Fig. 14) short, entire apically, labial palpus with three indistinct palpomeres; pronotum (Fig. 8) markedly transverse, more than 2.0 times as wide as long; hypomeron not visible in lateral aspect; mesoventrite (Fig. 15) without medial longitudinal carina; tergite X (Fig. 9) with medial setose area arranged in distinct V-shape, composed of two indistinct rows of setae, setae subspatulate; median lobe (Fig. 10) bulbous at base, apical process long and slender.

Description. Body (Fig. 1) very small, length 1.0–1.4 mm. Body slightly flattened dorso-ventrally, parallel-sided; surface sculpture reticulate throughout, slightly glossy and pubescent; light brown to brown but head, elytra, posterior half of abdominal tergite V and tergites VI–VII dark brown. *Head.* (Figs 1–2) Very large, slightly trans-



Figures 1. *Ashea megacephala*, habitus, 1.3 mm.

verse and flattened, as wide as and distinctly longer than pronotum; eye large, longer than temple; infraorbital carina well developed, complete; gular suture moderately separated, subparallel-sided; antenna (Fig. 3) moderate in size, with eleven antennomeres, antennomere 4 transverse, 5–7 slightly transverse, 8–10 transverse, 5–10 slightly increase in relative width from base to apex. *Mouthparts.* Labrum (Fig. 4) markedly transverse, seven pairs of macrosetae present, sensilla of antero-medial sensory area distinct, α -sensillum with short setose process, β and γ minute and conical, ϵ with short setose process, almost as long as α , two lateral sensilla present on lateral

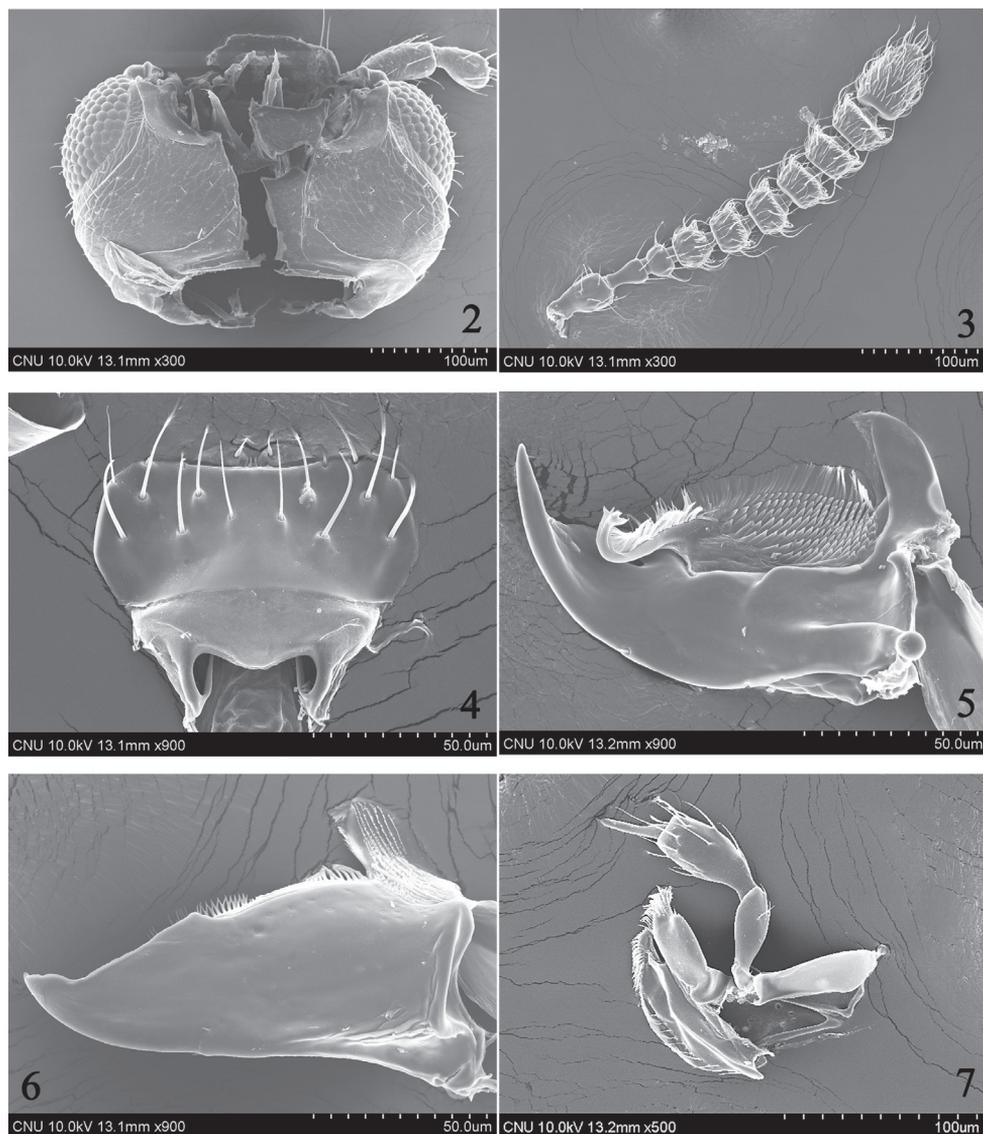
margin of epipharynx, without transverse row of sensory pores on basal region of epipharynx; mandible (Figs 5–6) asymmetrical, decurved and pointed apically, ventral condylar molar patch moderate in size with densely arranged denticles, prosthema well developed, right mandible with very large median tooth; maxilla (Fig. 7) with four palpomeres, palpomeres 2–3 slightly dilated distally, 3 longer than 2, 4 elongate with a small spine at apex, filamentous sensilla reaching to basal third, lacinia with apex obliquely truncate with well developed “spore brush”, teeth of spore brush small and densely arranged, inner margin without spines, with a longitudinal row of setae; labium (Fig. 14) with ligula short, entire apically, labial palpus indistinctly composed of three palpomeres, palpomere 1 almost as long as 3, distinctly longer than 2, one medial seta present on prementum, medial pseudopore field of prementum narrow and without pseudopores, lateral pseudopore field with one setose pore, one real pore and three pseudopores, mentum moderately emarginate in anterior margin. *Thorax*. Pronotum (Fig. 8) markedly transverse, more than 2.0 times as wide as long, widest in middle, surface slightly pubescent, several macrosetae present; hypomeron not visible in lateral aspect; prosternum transverse, without distinct median knob; elytra (Fig. 12) slightly wider and distinctly longer than pronotum, postero-lateral margin moderately sinuate; hind wing without setose lobe on flabellum; mesoventrite (Fig. 15) without medial longitudinal carina, mesoventral process broad and not fused to metaventral process, apex truncate; apex of metaventral process indistinguishable; isthmus absent; mesocoxal cavities widely separated; metepisternum with single row of setae; tarsal formula 4-4-5, tarsomere 1 of pro- and mesolegs as long as 2, 1 of metaleg slightly longer than 2, with one empodial seta between tarsal claws, shorter than claw. *Abdomen*. Tergites III–VI transversely impressed; tergite X (Fig. 9) with medial setose area arranged in distinct V-shape, composed of two indistinct rows of setae, setae subspatulate, with six to nine macrosetae on each side of midline. *Genitalia*. Spermatheca (Fig. 16) simple and round; median lobe (Fig. 10) bulbous at base, apical process long and slender, flagellum long, slender and more or less whip-like; paramere (Fig. 11) with apical lobe of paramerite short and subcylindrical with four setae, paramerite enlarged, slightly longer than apex of condylite. *Secondary sexual characteristics*. Male: elytron (Fig. 12) with tubercle near suture about 0.2 length of elytron from posterior margin; subapical margin of tergite VII (Fig. 13) with two tooth-like tubercles; posterior-median margin of tergite VIII (Fig. 17) with triangular projection.

Etymology. Named after the late James S. Ashe in honor of his research on the subtribe Gyrophaenina. He was the first collector of these beetles.

Distribution. Peru.

Remarks. *Ashea* gen. n. can be distinguished from other gyrophaenine genera by the diagnostic characters presented above. Especially, the combination of the large head and indistinctly articulated three labial palpomeres clearly makes this new genus unique among all other Gyrophaenina.

Ashea gen. n. belongs to the “*Gyrophaena*” lineage (*sensu* Ashe 1984) based on the following characters: body slightly pubescent; ligula entire apically, prementum with a single medial seta. Among the lineage, this genus is probably the most closely related



Figures 2–7. *Ashea megacephala*, SEM photographs: **2** head, ventral aspect **3** antenna (antennomeres 2–11) **4** labrum, ventral aspect **5** right mandible, ventral aspect **6** left mandible, dorsal aspect **7** maxilla, ventral aspect.

to *Eumicrota* Casey. These two genera share a small body size, entire and protruded ligula, markedly transverse pronotum, mesoventrite without medial longitudinal carina, tergite X with medial setose area arranged in distinct V-shape, and median lobe with apical process slender and elongate.

Tergite X provides useful characters in the study of the subtribe Gyrophaenina classification (Ashe 1984). Loss of setae antero-medially and postero-laterally results in

one or a few rows of setae arranged in a distinct “V” shape. This distribution of microsetae is found only in *Eumicrota* and *Ashea* gen. n.

On the other hand, the genus *Ashea* gen. n. differs from *Eumicrota* by the following diagnostic characters: head very large, as wide as and distinctly longer than pronotum; right mandible with very large median tooth; labial palpus with three indistinctly separated palpomeres.

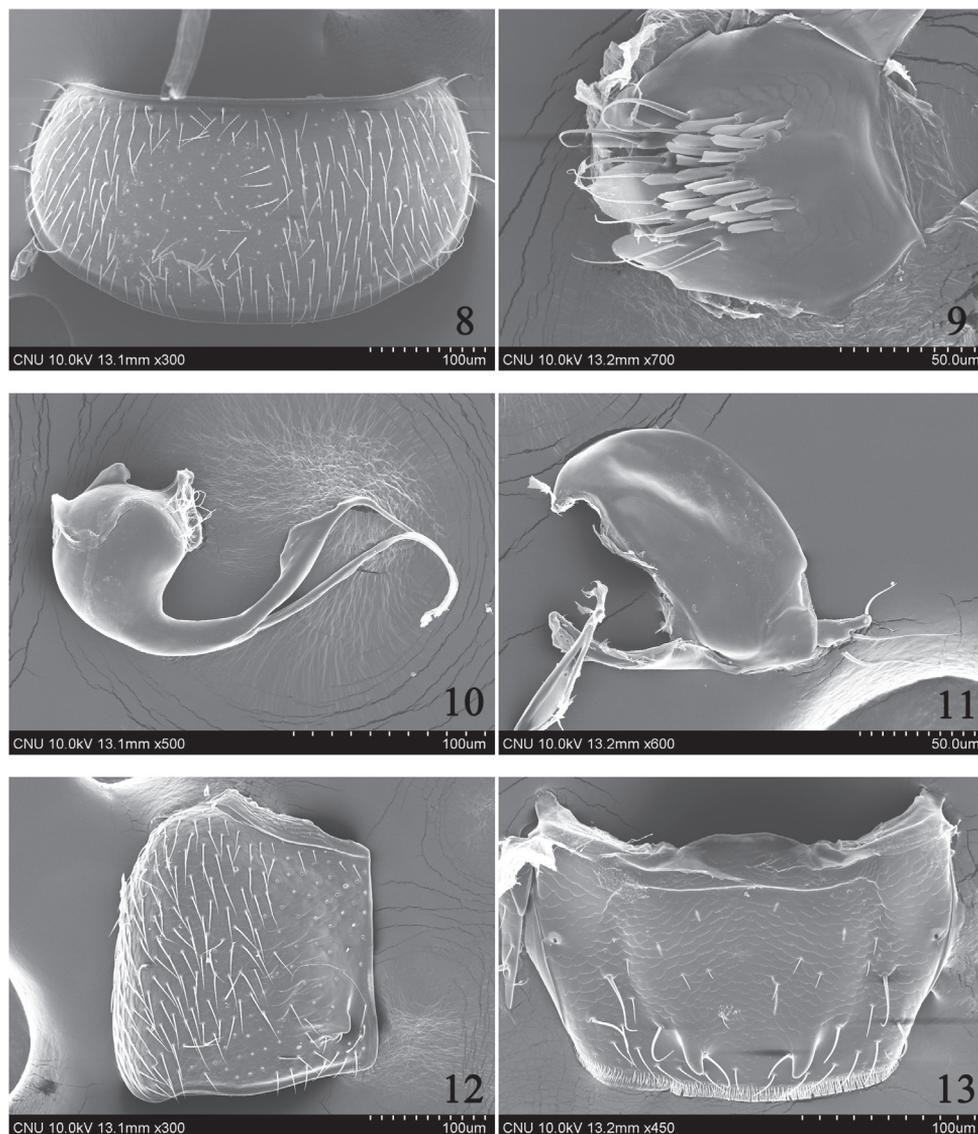
We have not had the opportunity to study any specimens of the following three gyrophaenine genera (*Brachycantharus* Bierig, *Microbrachida* Bierig, *Neobrachychara* Bierig) described from Central America by Bierig (1939). Original descriptions of these genera did not include sufficient diagnostic characters and they have not been re-described since their original description. However, Bierig (1939) provided very clear scientific habitus illustrations and they can be easily distinguished from *Ashea* gen. n. by the following diagnostic characters: body subparallel-sided in *Ashea* (body elongated-oval, sides of abdomen convergent to apex in *Microbrachida*); pronotum strongly transverse in *Ashea* (pronotum moderately transverse in *Brachycantharus*); tergite X with medial setose area arranged in distinct V-shape in *Ashea* (tergite X with medial setose area arranged in chevron-shape in *Neobrachychara*).

***Ashea megacephala* Kim & Ahn, sp. n.**

<http://zoobank.org/BC7C5FB9-EF97-45F7-9571-DA6856CEC74A>

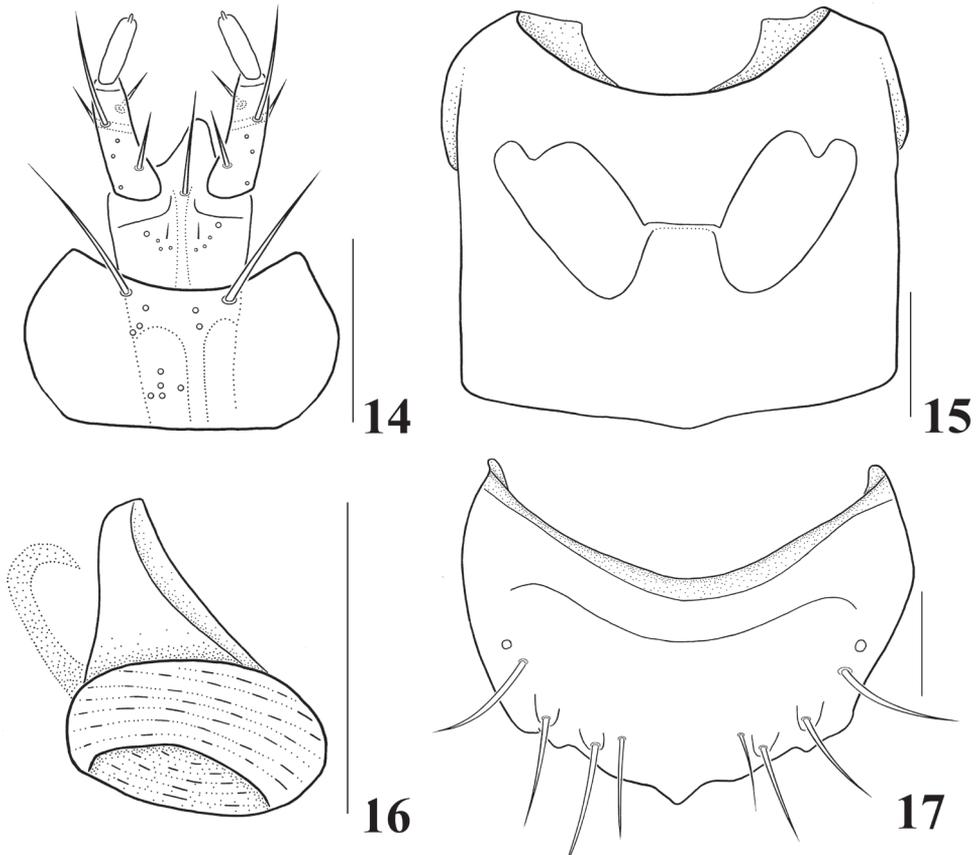
Type material. Holotype, male, labeled as follows: Peru: Tambopata Prov., 15 km NE Pto. Maldonado, 6 July 1989, 200 m, J. Ashe, R. Leschen, #427, *ex: Daedaleopsis*; Holotype, *Ashea megacephala* Kim and Ahn, Desig. Y.-H. Kim and K.-J. Ahn 2015. **Paratypes**, 5♂♂4♀♀ (2♂♂1♀ on slides), same data as holotype; 1♀, Tambopata Prov., 15 km NE Pto. Maldonado, 13 July 1989, 200 m, J. Ashe, R. Leschen, #507, *ex: rotten tree*; 1♀, Tambopata Prov., 15 km NE Pto. Maldonado, 13 July 1989, 200 m, J. Ashe, R. Leschen, #508, *ex: polypore*; 1♀, Tambopata Prov., 15 km NE Pto. Maldonado, 13 July 1989, 200 m, J. Ashe, R. Leschen, #515, *ex: Irpex-like*; 1♀, Tambopata Prov., 15 km NE Pto. Maldonado, 9 July 1989, 200 m, J. Ashe, R. Leschen, #454, *ex: Schizopora*; 2♀♀, Tambopata Prov., 15 km NE Pto. Maldonado, 17 July 1989, 200 m, J. Ashe, R. Leschen, #537, *ex: Thelephoraceae*; 1♀, Tambopata Prov., 15 km NE Pto. Maldonado, 16 July 1989, 200 m, J. Ashe, R. Leschen, #86, *ex: Auricularia auricula*.

Description. Body length 1.0–1.4 mm. *Head.* Very large, slightly transverse and flattened, as wide as and distinctly longer than pronotum; eye large, longer than temple, length ratio of eye to temple 1.56; antennomere 1 longest, about 2.8 times as long as wide, 2 about 1.5 times as long as wide and 1.5 times as long as 3, 3 about 1.4 times as long as wide, 4 about 1.4 times as wide as long, 5 about 1.1 times as wide as long, 6–7 about 1.2 times as wide as long, 8–9 about 1.3 times as wide as long, 10 about 1.36 times as wide as long, 11 about 1.4 times as long as wide (Fig. 3). *Mouthparts.* Labrum (Fig. 4) markedly transverse, about 2.3 times as wide as



Figures 8–13. *Ashea megacephala*, SEM photographs: **8** pronotum, dorsal aspect **9** tergite X, dorsal aspect **10** median lobe, lateral aspect **11** paramere, lateral aspect **12** male elytron, dorsal aspect **13** male tergite VII, dorsal aspect.

long; mandible (Figs 5–6) about 1.5 times as long as basal width, ventral condylar molar patch moderate in size, about 0.3 times of basal width; maxillary palpomere 2 (Fig. 7) about 2.3 times as long as wide, 3 about 2.25 times as long as wide and about 1.4 times as long as 2; prementum (Fig. 14) with medial seta distinctly longer than ligula. *Thorax*. Pronotum (Fig. 8) markedly transverse, more than 2.0 times as wide as long, widest at middle; mesoventral process (Fig. 15) extended to about half



Figures 14–17. *Ashea megacephala*: **14** labium, ventral aspect **15** meso- and metaventrites, ventral aspect **16** spermatheca, **17** male tergite VIII, dorsal aspect. Scale bars 0.1 mm.

of mesocoxal cavities. **Genitalia.** Spermatheca (Fig. 16) simple and round at base; median lobe (Fig. 10) bulbous at base, apical process long, slender and recurved subapically, flagellum long, slender and more or less whip-like; paramere (Fig. 11) with apical lobe of paramerite short and subcylindrical with four setae, basal two distinctly longer than others, paramerite enlarged, slightly longer than apex of condylite. **Secondary sexual characteristics.** Male: elytron (Fig. 12) with tubercle at near suture about 0.2 length of elytron from posterior margin; subapical margin of tergite VII (Fig. 13) with two tooth-like tubercles; posterior-medial margin of tergite VIII (Fig. 17) with triangular projection.

Distribution. Tambopata, Peru.

Etymology. Named from the Greek *mega* meaning “large” and *cephalus* meaning “head”, which refers to large head.

Remarks. Specimens were collected on mushrooms and/or mushroom associated trees in Peru.

Key to the genera of the “*Gyrophaena*” lineage of subtribe Gyrophaenina Kraatz (modified from Ashe 1984)

- 1 Pronotum (Fig. 8) markedly transverse, about 2.0 times as wide as long; tergite X (Fig. 9) with medial setose area in distinct V-shaped row..... **2**
- Pronotum (Kim and Ahn 2014: Fig. 7H) of most specimens 1.2 to 1.7 times as wide as long; tergite X with medial setose area more or less subquadrate.... **3**
- 2 Head (Fig. 1) large, distinctly longer than pronotum; right mandible with large median tooth; labial palpus with three indistinct palpomeres.....
..... ***Ashea* gen. n.**
- Head moderate in size, shorter than or as long as pronotum; right mandible with small median tooth; labial palpus with two palpomeres ***Eumicrota* Casey**
- 3 Eyes extremely large (Kim and Ahn 2014: Fig. 8A), occupying most of lateral margins of head ***Phanerota* Casey**
- Eyes moderate in size (Kim and Ahn 2014: Fig. 8B).....
..... ***Gyrophaena* Mannerheim**

Acknowledgments

We thank Z. Falin (SEMC) for arranging the loan of valuable specimens. Comments by J. H. Frank (University of Florida) improved the manuscript.

References

- Ashe JS (1984) Generic revision of the subtribe Gyrophaenina (Coleoptera: Staphylinidae: Aleocharinae) with a review of the described subgenera and major features of evolution. *Quaestiones Entomologicae* 20: 129–349.
- Ashe JS (2001) Aleocharinae, Staphylinidae Latreille, 1802. In: Newton AF, Thayer MK, Ashe JS, Chandler DS. Staphylinidae. In: American beetles, Vol. 1. Archostemata, Myxophaga, Adephaga, Polyphaga: Staphyliniformia. CRC Press, Boca Raton, FL, 295–324, 358–375, 397–418.
- Ashe (1947–2005) JS (2007) Aleocharinae. Version 25 April 2007. <http://tolweb.org/Gyrophaenina/64820/2007.04.25> in the Tree of Life Web Project, <http://tolweb.org/>
- Bierig A (1939) Neue neotropische Staphylinidae der Subfamilie Aleocharinae (Coleoptera) (25. Beitrag zur Kenntnis der Staphylinidae). *Arbeiten über Morphologische und Taxonomische Entomologie aus Berlin-Dahlem* 6: 16–31, pls 2–3.
- Kim YH, Ahn KJ (2014) Insect fauna of Korea, Homalotini (Arthropoda: Insecta: Coleoptera: Staphylinidae: Aleocharinae: Homalotini). National Institute of Biological Resources, 113 pp.
- Newton AF, Thayer MK (2005) Catalog of higher taxa, genera, and subgenera of Staphyliniformia [online]. Field Museum of Natural History, Chicago. http://www.fieldmuseum.org/peet_staph/db_1d.html [last updated November 3, 2005; accessed/downloaded May 29, 2012]

New species of Cerambycidae (Coleoptera) from South and Central America

Maria Helena M. Galileo¹, Antonio Santos-Silva², Stéphane Le Tirant³

1 PPG Biologia Animal, Departamento de Zoologia, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Brazil (Fellow of the Conselho Nacional de Desenvolvimento Científico e Tecnológico) **2** Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil **3** Insectarium de Montréal, 4581 rue Sherbrooke est Montréal, Québec, Canada

Corresponding author: Maria Helena M. Galileo (galileomh@yahoo.br)

Academic editor: S. Lingafelter | Received 2 August 2015 | Accepted 3 October 2015 | Published 28 October 2015

<http://zoobank.org/E01537AF-A86A-4794-8E66-ECC4BD803FB4>

Citation: Galileo MHM, Santos-Silva A, Le Tirant S (2015) New species of Cerambycidae (Coleoptera) from South and Central America. ZooKeys 530: 101–111. doi: 10.3897/zookeys.530.6155

Abstract

Three new species are described: *Tropidion birai* (Cerambycinae, Neoibidionini) from Bolivia; *Chrysoprasia birai* (Cerambycinae, Heteropsini) from Panama; and *Recchia nearnsi* (Lamiinae, Aerenicini) from Bolivia. The new species are included in amended versions of previously published keys to species of each genus.

Keywords

Longhorned beetle, Tropidina, taxonomy

Introduction

Currently *Tropidion* Thomson, 1867 encompasses 75 species, distributed mainly in South America, with only four species occurring in Central America (Monné 2015a). Martins and Galileo (2007) revised the South American species of *Tropidion* and provided a key to the species of that region. Accordingly, Neoibidionini is divided in three subtribes: Ibidionina Thomson, 1860 (currently, Neoibidionina Monné, 2012), Compsina Martins & Galileo, 2007 and Tropidina Martins & Galileo, 2007. Compsina has the procoxal cavities closed behind, while in Tropidina and Neoibidionina they are open behind. *Tropidion* is the type genus of Tropidina, a subtribe that differs from Neoibidionina by the scape piriform, usually with basal sulcus, and by the antennomeres III–V

with subequal length. In Neoibidionina the scape is cylindrical, slightly and gradually thickened toward apex, and antennomere IV is shorter than III and V.

Chrysoprasis Audinet-Serville, 1834 includes 70 species from North (Mexico) to South America (Monné 2015a). Napp and Martins (1995, 1997, 1998, 1999) divided the genus in four groups of species: Group *basalis*, characterized by the elytra bicolorous or, when with a single color, the prothorax with integument bicolorous or totally orangish; Group *chalybea*, with elytra and/or prothorax with single metallic color, and the ventrites are black or have metallic color; Group *hypocrita*, with the ventrites reddish and pronotal and elytral integument with single metallic color; and Group *aurigena*, with the elytra with bands or maculae of metallic color cupreous, golden, blue or violaceous. The new species herein described belongs to the latter group.

The genus *Recchia* was described by Lane (1966) with a single species, *R. ludibriosa* Lane, 1966, from São Paulo (Brazil). Martins and Galileo (1985) revised *Recchia*, described eight new species, and transferred an additional eight species to the genus. Martins and Galileo (1998) revised Aerenicini, described three more new species in *Recchia*, and provided a key to the species of the genus. Monné (2015b) listed 22 species in *Recchia*, distributed most in South America (only *Recchia hirsuta* (Bates, 1881) occurring in Central America). Recently, Mehl et al. (2015) described a new species from Paraguay. Thus, with the new species herein described, currently *Recchia* has 24 species.

Material and methods

Photographs were taken with a Canon EOS Rebel T3i DSLR camera, Canon MP-E 65mm f/2.8 1–5X macro lens, controlled by Zerene Stacker AutoMontage software. Measurements were taken in “mm” using a micrometer ocular Hensoldt/Wetzlar - Mess 10 in the Leica MZ6 stereomicroscope, also used in the study of the specimen.

The collection acronyms used in this study are as follows:

- MNKM** Museo de Historia Natural Noel Kempff Mercado, Santa Cruz, Bolivia;
MZSP Museum of Zoology of the University of São Paulo, São Paulo, Brazil;
USNM National Museum of Natural History, Washington, DC, USA.

Systematics

Neoibidionini Monné, 2012

Tropidion birai sp. n.

<http://zoobank.org/816A1A7B-73E1-45C6-8D54-CC8DCA9AC3EB>

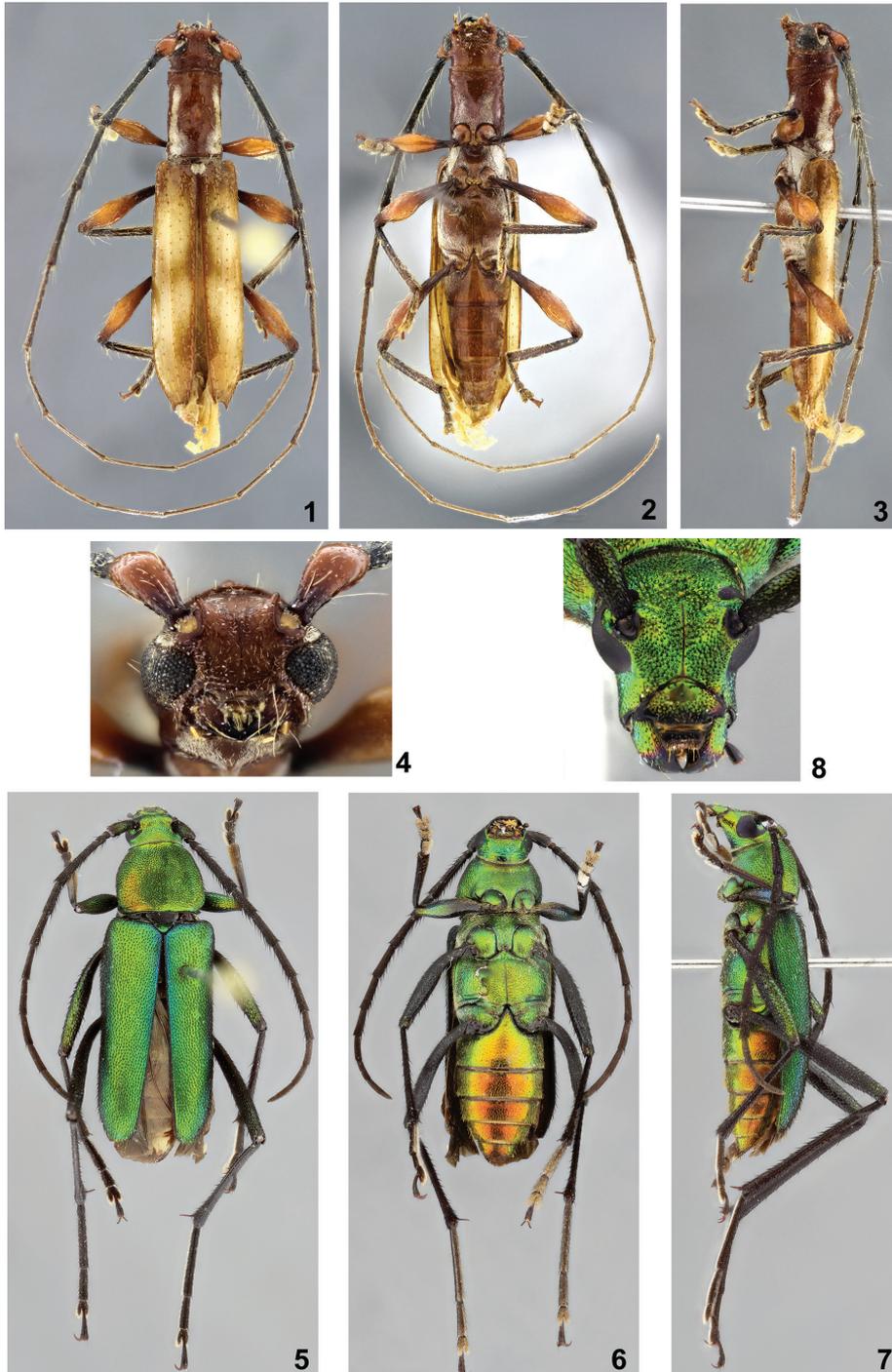
Figs 1, 2, 3, 4

Description. Male. Integument brown, except for apex of mandibles black; parts of head reddish-brown; base of scape dark-brown, remaining surface orangish-brown;

pedicel and antennomeres dark-brown, gradually lighter toward distal antennomeres (but with apex of antennomeres blackish); two large, yellowish maculae on each elytron; most of peduncle of femora dark-brown; most femoral club orangish-brown; apex of femoral club brownish; tibiae dark-brown, except for reddish area inside of longitudinal sulcus; ventrites orangish-brown.

Head. Frons punctate-rugose; with short, moderately abundant setae, not obliterating integument. Area between antennal tubercles and eyes microsculptured, interspersed with coarse, sparse punctures. Area between posterior ocular edge and prothorax moderately coarsely, abundantly punctate (punctures denser near prothorax). Area behind lower eye lobes with punctures slightly distinct; with long, sparse setae close to eye; area under lower eye lobes with short, moderately abundant, yellowish-white setae. Area between anterior emargination of eyes and antennal fovea with short, dense yellowish-white pubescence. Genae moderately coarsely, abundantly punctate; with short setae interspersed with moderately long, sparse setae. Coronal suture distinct from clypeus to level of posterior ocular edge. Antennal tubercles notably projected upward, in frontal view, horn-like. Distance between upper eye lobes 0.55 times length of scape; distance between lower eye lobes 1.2 times length of scape in ventral view, 0.8 times length of scape in frontal view. Submentum not well-delimited, transversely striate, moderately coarsely, abundantly punctate; with short, moderately abundantly setae (not obliterating integument), interspersed with long, sparse setae. Antennae as long as 3.0 times elytral length; reaching elytral apex at basal quarter of antennomere VII; scape dorsally with distinct sulcus from base to about middle, with short, sparse setae, interspersed with very long setae; antennomere III dorsally longitudinally sulcate, pubescent, with fringe of long setae on inner lateral side; remaining antennomeres pubescent, with fringe of setae on inner lateral side gradually sparser; antennal formula (ratio) based on antennomere III: scape = 0.52; pedicel = 0.18; IV = 0.94; V = 1.11; VI = 1.15; VII = 1.02; VIII = 1.02; IX = 1.02; X = 0.82; XI = 1.39.

Thorax. Prothorax cylindrical, 1.7 times as long as wide; basal and distal sixth somewhat enlarged. Pronotum finely, sparsely punctate, except for basal sixth, where punctures are slightly coarser, distinctly denser; with five tubercles: one, subrounded, on each side of basal third; one, subrounded, on each side just after middle; one, subconical, on center; one each side, with wide band with yellowish-white pubescence, wider at base, that does not reach anterior margin; remaining surface with short, very sparse setae, interspersed on distal half by long setae. Prothorax laterally glabrous, finely, sparsely punctate, except for anterior sixth with transverse, fine striae. Prosteronum finely, transversely striate on anterior half; each side of basal half with band with yellowish-white pubescence, divergent, narrowed from procoxal cavity to just after middle. Prosternal process longitudinally sulcate (mainly on distal half), pubescent; distal portion subcordiform. Mesosternum without tubercle, almost glabrous centrally, pubescent laterally (pubescence not obliterating integument). Mesepisterna and mesepimera densely pubescent (obliterating integument). Metasternum laterally and posteriorly pubescent (not obliterating integument); remaining surface with moderately sparse pubescence, except for glabrous central area near mesocoxal cavities. Me-



Figures 1–8. 1–4 *Tropidion birai* sp. n., holotype male: 1 Dorsal habitus 2 Ventral habitus 3 Lateral habitus 4 Head, frontal view 5–8 *Chrysoprasis birai* sp. n., holotype female: 5 Dorsal habitus 6 Ventral habitus 7 Lateral habitus 8 Head, frontal view.

tepiſterna densely pubescent (partially obliterating integument). Scutellum densely pubescent. Elytra sparsely punctate, nearly all with a moderately long, yellowish setae (on circum-scutellar region punctures are blackish, part of them asperate-like); apical margin concave, with long spine at outer angle and projected at sutural angle. Legs. Femora clavate, very finely pubescent, with long, sparse setae; apex rounded on both sides. Tibiae longitudinally sulcate on both sides. Metatarsomere I as long as II–III together.

Abdomen. Ventrites I–IV pubescent laterally, centrally with short, sparse setae, interspersed with some long setae. Ventrite V with short, very sparse setae on basal third; distal two-thirds pubescent, interspersed with long setae; apex truncate, slightly emarginate.

Dimensions in mm (holotype male). Total length (from mandibular apex to abdominal apex), 11.80; prothorax: length, 2.70; anterior width, 1.65; posterior width, 1.70; humeral width, 2.30; elytral length, 7.70.

Type material. Holotype male from BOLIVIA, Yungas, 1-28.VI.2005, Y. Callegari col. (MZSP).

Etymology. The new species is named after the late Ubirajara Ribeiro Martins de Souza (Bira).

Remarks. *Tropidion birai* sp. n. is similar to *Tropidion centrale* (Bates, 1872), a species very variable in color, but differs mainly by the pronotum with longitudinal bands of pubescence and with distinct tubercles. *Tropidion centrale* has pubescence on pronotum only on narrow transverse basal band, and does not have distinct tubercles on pronotum. From *T. abditum* Martins, 1968 by the pronotum with bands of pubescence (not pubescent in *T. abditum*), and by the apex of elytra with distinct spine at outer angle (unarmed in *T. abditum*). It differs from *T. bituberculatum* (Audinet-Serville, 1834) by the antennal tubercles acute at apex (not so in *T. bituberculatum*), by the inner side of antennomere III with abundant and long setae (short and sparse in *T. bituberculatum*), and by the central tubercle of pronotum very distinct (slightly distinct in *T. bituberculatum*). It can be separated from *T. buriti* Martins & Galileo, 2012 by the pronotum with distinct tubercles (slightly conspicuous in *T. buriti*) and with bands of pubescence (without bands of pubescence in *T. buriti*), and by the apex of elytra with distinct spine at outer angle (unarmed in *T. buriti*). From *T. carinicolle* (Bates, 1872), *T. intermedium* (Martins, 1962), and *T. flavum* (Martins, 1962) it differs mainly by the presence of yellowish maculae on elytra (absent in those species). *Tropidion birai* differs from *T. festivum* (Martins, 1962) and *T. validum* (Martins, 1962), by the basal antennomeres distinctly dark (uniformly reddish in those species), by the elytral maculae distinctly large, mainly the posterior. It differs from *T. jolyi* Martins & Galileo, 2012 by the antennomere III distinctly carinate in male (not so in *T. jolyi*), and by the presence of bands of pubescence on pronotum (absent in *T. jolyi*). It differs from *T. hermione* (Thomson, 1867) mainly by the pronotum with bands of pubescence (absent in *T. hermione*). From *T. mirabile* Martins, 1971 and *T. praecipuum* Martins, 1971 it differs by the posterior yellowish band of elytra oblique to the suture (transverse in those species).

Tropidion birai can be included in the alternative of couplet “70”, from Martins and Galileo (2007) (translated):

- 70(66) Basal antennomeres dark-brown; posterior yellowish macula of the elytra wide. Bolivia..... *T. birai* sp. n.
 – Antennomeres reddish; posterior yellowish macula of the elytra narrow...70'
 70'(70) Prothorax narrower at level of posterior third; pronotum shiny, with central tubercle longitudinal and well-marked; punctures near scutellum asperous. Bolivia *T. festivum* (Martins, 1962)
 – Prothorax with basal constriction slightly notable; pronotum opaque, microsculptured (32 ×), and central tubercle less distinct; punctures near scutellum not asperous. Bolivia, Paraguay..... *T. validum* (Martins, 1962)

***Chrysoprasis birai* sp. n.**

<http://zoobank.org/AC84D640-87A6-46AB-A42A-E3C720E92910>

Figs 5, 6, 7, 8

Description. Female. Integument metallic green with golden reflex; elytra darker, without golden reflex, with narrow violaceous band on base and along suture (slightly wider on basal two-thirds of suture), and wide violaceous band laterally (less conspicuous depending on angle of incidence of light; anteclypeus most reddish; apex of labrum reddish; ventrites cupreous, with violaceous and green reflexes, more distinctly violaceous on ventrite V; scape with distinct violaceous reflexes, more distinct depending on angle of incidence of light; antennomeres dark violaceous with some green reflexes (distal antennomeres more opaque); legs violaceous with green reflexes.

Head. Frons moderately finely, abundantly, confluent punctate, with short, decumbent, abundant setae (very slightly conspicuous). Coronal suture well-marked from clypeus to anterior level of eyes. Postclypeus with microsculptured, subtriangular area at base (interspersed with some coarse punctures); remaining surface moderately finely, abundantly punctate; punctate area with very short, slightly conspicuous setae, and one long seta on each side. Anteclypeus narrow. Labrum smooth at base, moderately finely, abundantly punctate on remaining surface; on punctate area with short, moderately abundant setae (mainly at distal third), interspersed with long setae. Antennal tubercles with sculpture as on frons. Area between antennal tubercles and upper eye lobes transversely sulcate. Vertex with sculpture as on frons. Area behind upper eye lobes with sculpture as on frons, gradually slightly sparser towards behind lower eye lobes (somewhat striate close to prothoracic margin). Genae moderately finely, abundantly punctate, punctures finer toward apex. Gula transversely striate on narrow area closer to thorax (centrally smooth), coarsely vermiculate-punctate on large area closer to maxilla; this latter with short, moderately abundant setae, interspersed with long setae. Distance between upper eye lobes 0.85 times length of scape; distance between lower eye lobes, in frontal view, 1.05 length of scape. Antennae as long as 1.5

times elytral length; reaching elytral apex at middle of antennomere XI; scape coarsely, densely punctate, with long, thick, sparse, dark setae; antennomeres III–VI with short, but distinct spine at inner apex; antennomeres VI–X with distal outer distal angle projected; antennomere XI somewhat divided at distal third, almost forming twelfth segment; antennal formula (ratio) based on antennomere III: scape = 1.84; pedicel = 0.15; IV = 0.56; V = 0.64; VI = 0.66; VII = 0.66; VIII = 0.58; IX = 0.50; X = 0.43; XI = 0.61.

Thorax. Prothorax wider than long; lateral sides divergent from anterior margin to about apex of anterior third, subparallel toward posterior margin; anterior margin notably narrower than basal margin. Pronotum moderately coarsely, densely punctate, except for narrow, transverse, smooth band close to basal margin; with short, abundant, but slightly conspicuous setae, interspersed with some long setae laterally. Lateral sides of prothorax moderately coarsely, densely punctate (punctures slightly larger and shallower than on pronotum); setae as on pronotum. Prosternum finely, densely punctate throughout, with short, abundant setae. Prosternal process longitudinally sulcate, centrally narrowed; with sculpture and setae as on prosternum. Mesosternum and mesosternal process with sculpture and setae as on prosternum. Apex of mesosternal process strongly emarginate. Mesepisterna moderately finely, densely punctate. Mese-pimera finely, abundantly punctate. Metepisterna moderately finely, densely punctate; with short, decumbent, abundant setae. Metasternum moderately finely, abundantly punctate throughout (punctures slightly finer toward center); with short, abundant, decumbent setae. Scutellum finely punctate laterally, longitudinally sulcate, smooth at center. Elytra. Surface microsculptured; moderately coarsely, densely punctate; with short, abundant, decumbent setae, interspersed with thick, dark setae, mainly at base and distal third; apex truncate, with outer angle projected and sutural angle rounded. Legs. Femora moderately finely densely punctate on peduncle, coarsely, densely punctate on club. Metatarsi slightly shorter than metatibiae; metatarsomeres I and II cylindrical; metatarsomere I notably elongate, 2.1 times longer than II.

Abdomen. Ventriles finely, abundantly punctate; with short, moderately abundant setae interspersed with long setae; apex of ventrite V rounded.

Type material. Holotype female from PANAMA, *Panama*: Barro Colorado Island, 13–20.V.1998, Don Windsor col. (USNM).

Dimensions in mm (female). Total length, 12.3; length of prothorax at center, 2.5; anterior width of prothorax, 1.9; posterior width of prothorax, 2.9; largest width of prothorax, 3.1; humeral width, 3.6; elytral length, 7.7.

Etymology. The new species is named after the late Ubirajara Ribeiro Martins de Souza (Bira).

Remarks. *Chrysoprasis birai* sp. n. differs from *C. quadrimaculata* Gounelle, 1913, and *C. suturalis* Lameere, 1884, mainly by the prothorax wider than long (about as long as wide in those species), and by the spine of the antennomeres III–VI distinctly short (very distinct in both species). It differs from *C. viridis* Fisher, 1944 mainly by the sides of prothorax not uniformly rounded from anterior to basal margin (rounded in *C. viridis*), and by the metasternum finely punctate (“coarsely foveolate-punctate” in *C. viridis*, according to Fisher 1944). It can be separated from *C. aurata* Aurivillius,

1910 by the sides of the prothorax not uniformly rounded (rounded in *C. aurata*), by the punctures on pronotum and metasternum finer (coarse in *C. aurata*).

All other species of *Chrysoprasis* occurring in Panama belong to the Group *hypocrita*: *C. festiva* Audinet-Serville, 1834; *C. hirtula* White, 1853; *C. hypocrita* Erichson, 1847; *C. rotundicollis* Bates, 1870; and *C. seticornis* Bates, 1880.

As the limits between the Groups *chalybea* and *aurigena* are narrow, and some species can be included in both, we are including *C. birai* in the key for both groups.

In the key to species of the Group *aurigena* the new species can be included in the alternative of couplet “3”, from Napp and Martins (1999) (translated):

- 3'(2) Sides of prothorax not uniformly rounded..... ***C. birai* sp. n.**
 – Sides of prothorax uniformly rounded and/or longer than wide.....**3**

In the key to species of the Group *chalybea* the new species can be included in the alternative of couplet “21”, from Napp and Martins (1997) (translated):

- 21'(20) Sides of prothorax not uniformly rounded from anterior to basal margin; lateral sides of metasternum finely punctate..... ***C. birai* sp. n.**
 – Sides of prothorax uniformly rounded from anterior to basal margin; lateral sides of metasternum coarsely punctate.....**21**

***Recchia nearnsi* sp. n.**

<http://zoobank.org/D7C523C4-AD13-4829-AC9D-8DDCF9E20957>

Figs 9, 10, 11, 12

Description. Female. Integument most orange-brown, with dense, brownish-yellow pubescence.

Head. Frons trapezoidal, abundantly, moderately coarsely punctate; with dense pubescence interspersed with long setae, sparser near clypeus. Clypeus smooth centrally, coarsely punctate laterally. Labrum coarsely punctate. Antennal tubercles finely punctate, with yellowish-orange pubescence. Dorsal surface between antennal tubercles and before upper eye lobes sparsely punctate. Area between middle of upper eye lobes and prothorax, and behind upper eye lobes to about middle of lower eye lobes with dense, yellowish-white pubescence; around margins of eyes with narrow band with yellowish-white pubescence, except for area close to gena. Genae short, sparsely pubescent. Gula glabrous, shiny, coarsely punctate laterally. Coronal suture distinct from clypeus to anterior edge of prothorax. Upper eye lobes with nine rows of ommatidia; distance between upper eye lobes 0.3 times length of scape; distance between lower eye lobes, in frontal view, 0.6 times length of scape. Antennae as long as 1.4 times elytral length, reaching elytral apex at apical end of antennomere IX; orange-brown, with yellowish-orange pubescence; scape densely punctate; antennomeres IV–XI brown on distal portion (this area darker, longer toward distal antennomeres, covering from apical half to apical three-fourths of segment); antennomeres with moderately abundant, short setae on ventral side, interspersed with black,



Figures 9–12. *Recchia nearnsi* sp. n., holotype female: **9** Dorsal habitus **10** Ventral habitus **11** Lateral habitus **12** Head, frontal view.

coarse setae (mainly on dark area), denser on antennomeres X and XI; antennal formula (ratio) based on antennomere III: scape = 1.09; pedicel = 0.13; IV = 1.0; V = 0.93; VI = 0.86; VII = 0.81; VIII = 0.74; IX = 0.69; X = 0.58; XI = 0.55.

Thorax. Prothorax quadrangular; sparsely, coarsely punctate. Pronotum with pubescence concealing integument; with two narrow, longitudinal, dense, bands with yellowish-white pubescence laterally; with narrow, longitudinal, smooth, shiny area centrally; with band with yellowish-white pubescence centrally, from base to apex, involving smooth area. Prosternum, center of mesosternum, with dense, yellowish pubescence; sides of mesosternum, inner half of metepisterna, center of metasternum with yellowish-brown pubescence (less conspicuous depending on angle of incidence of light). Lateral sides of prosternum, mesosternum and metasternum moderately coarse, sparsely punctate (punctures partially obliterated by pubescence). Elytra elongate, 5.2 times prothorax length, 3.2 times humeral width; integument concealed under pubescence; apical third with three longitudinal bands with dense, yellowish-white pubescence, close each other, together forming a semicircle: innermost short, narrow; central one wider, slightly longer than innermost, with irregular lateral edges; outer-

most slightly curved, elongate, 1.8 times length of central band, starting near apex of latter, almost reaching elytral apex; elytral apex narrowed, without apical spine. Legs. Segments pubescent, with long, abundant setae, denser, longer on tibiae. Meso- and metafemora more brownish toward apex; metatarsomere I as long as II–III together.

Abdomen. Ventrites I–IV with brownish pubescence, except for wide, yellowish-white band laterally and two narrow, yellowish-white pubescent bands on each side of center (not distinct depending on angle of incidence of light).

Dimensions in mm (holotype female). Total length, 15.8; length of prothorax at center, 2.3; widest width of prothorax, 2.3; anterior width of prothorax, 2.1–2.2; posterior width of prothorax, 2.2–2.3; humeral width, 3.8; elytral length, 12.3.

Type material. Holotype female, BOLIVIA, *Santa Cruz*: 4 km N Bermejo (Refugio Los Volcanes, 18°06'S / 63°36'W; 1045–1350 m), 11–17.XII.2012, Wappes & Skillman col. (MNKN).

Etymology. The species is named after Eugenio H. Nearn (Purdue Entomological Research Collection, Purdue University, USA) for his friendship and contributions towards knowledge of Cerambycidae.

Remarks. *Recchia nearnsi* sp. n. is similar to *R. ludibriosa* Lane, 1966 but differs as follows: antennae most orange-brown, with short, sparse pubescence; antennomeres IV–XI darker on apical region (more distinct after VII); pronotum with longitudinal, yellowish-white pubescent band; sides of mesosternum, and inner half of metepisterna with yellowish-brown pubescence; elytral length 5.2 times pronotal length; elytra with longitudinal bands with yellowish-white pubescence only at apical third. In *R. ludibriosa* the antennae are reddish-brown, with antennomere XI black, and the antennomeres have dense, elongate pubescence, the pronotum is uniformly pubescent, without yellowish-white pubescent bands, the sides of mesosternum and inner half of mesepisterna have dense, long, dark-brown pubescence, the elytral length is 4.0 times the pronotal length, and the apical two-thirds of elytra have oblique whitish bands. It differs from *R. ravida* Martins & Galileo, 1985 by elytra with dense yellowish-brown pubescence, obliterating integument, and tree longitudinal yellowish-white pubescent bands at apical third of elytra. In *R. ravida* the elytral pubescence is slightly sparser, not obliterating the integument, and has grayish-white pubescent bands on circum-scutellar region and oblique bands on distal two-thirds. *Recchia nearnsi* differs from *R. fallaciosa* Lane, 1966 and *R. veruta* Lane, 1966 mainly by the elytral apex not spiny (distinctly spiny in both species), and by the basal half of the elytra without bands of pubescence (present in both species).

Recchia nearnsi sp. n. can be included in the alternative of couplet “14”, from Martins and Galileo (1985) (translated; alternative couplet “13” modified):

- 13(12) Upper eye lobes with nine rows of ommatidia; total length 12–16 mm ... 14'
 – Upper eye lobes with five or six rows of ommatidia; total length 7.4–11.3 mm.....*R. abauna* Martins & Galileo, 1998
 14'(13) Elytra without longitudinal bands of pubescence on basal half..... *R. nearnsi* sp. n.
 – Elytra with longitudinal bands of pubescence on basal half..... 14

Acknowledgments

We express our sincere thanks to James E. Wappes (ACMT) for the loan of part of the specimens used in this work.

References

- Fisher WS (1944) *Cerambycidae* (Coleoptera) of Caripito, Venezuela. *Zoologica* 29(1): 3–12.
- Lane F (1966) Novos gêneros e espécies de Aerenicini (Coleoptera, Lamiidae). *Papéis Avulsos do Departamento de Zoologia* 18(19): 231–235.
- Martins UR, Galileo MHM (1985) Contribuição ao estudo da tribo Aerenicini (Coleoptera, Cerambycidae, Lamiinae). VI. Revisão do gênero *Recchia* Lane, 1966, adenda, correções e elenco da tribo. *Revista Brasileira de Entomologia* 29(3-4): 481–496.
- Martins UR, Galileo MHM (1998) Revisão da tribo Aerenicini Lacordaire, 1872 (Coleoptera, Cerambycidae, Lamiinae). *Arquivos de Zoologia* 35(1): 1–133. doi: 10.11606/issn.2176-7793.v35i1p1-133
- Martins UR, Galileo MHM (2007) Tribo Ibidionini, Subtribo Tropidina. In: Martins UR (Org.) *Cerambycidae Sul-Americanos* (Coleoptera). *Taxonomia*. Sociedade Brasileira de Entomologia, Curitiba, v. 9, 1–176.
- Mehl O, Martins UR, Galileo MHM, Santos-Silva A (2015) Four new species of Cerambycidae (Coleoptera) from Paraguay. *ZooKeys* 507: 31–40. doi: 10.3897/zookeys.507.9277
- Monné MA (2015a) Catalogue of the Cerambycidae (Coleoptera) of the Neotropical Region. Part I. Subfamily Cerambycinae. http://www.cerambyxcat.com/Part1_Cerambycinae.pdf [accessed 11 July 2015]
- Monné MA (2015b) Catalogue of the Cerambycidae (Coleoptera) of the Neotropical Region. Part II. Subfamily Lamiinae. http://www.cerambyxcat.com/Part2_Lamiinae.pdf [accessed 11 July 2015]
- Napp DS, Martins UR (1995) Revisão do gênero *Chrysoprasis* A.-Serville, 1834 (Coleoptera, Cerambycidae, Cerambycinae, Heteropsini). I. Grupo *basalis*. *Revista Brasileira de Entomologia* 39(4): 901–910.
- Napp DS, Martins UR (1997) Revisão do gênero *Chrysoprasis* A.-Serville, 1834 (Coleoptera, Cerambycidae, Cerambycinae, Heteropsini). III. grupo *chalybea*. *Revista Brasileira de Entomologia* 41(1): 17–41.
- Napp DS, Martins UR (1998) Revisão do gênero *Chrysoprasis* A.-Serville, 1834 (Coleoptera, Cerambycidae). IV. Grupo hypocrita. *Revista Brasileira de Entomologia* 41(2-4): 465–499.
- Napp DS, Martins UR (1999) Revisão do gênero *Chrysoprasis* A.-Serville, 1834 (Coleoptera, Cerambycidae). V. Grupo *aurigena*. *Revista Brasileira de Entomologia* 43(3/4): 147–161.

Biometry and phenology of two sibling *Phylloscopus* warblers on their circum-Mediterranean migrations

Piotr Zduniak¹, Reuven Yosef², Keith J. Bensusan³,
Charles E. Perez⁴, Piotr Tryjanowski⁵

1 Department of Avian Biology and Ecology, Faculty of Biology, Adam Mickiewicz University, Umultowska 89, 61-614 Poznań, Poland **2** Ben Gurion University – Eilat Campus, P. O. Box 272, Eilat 88000, Israel **3** University of Gibraltar, Gibraltar Botanic Gardens Campus, P.O. Box 843, Gibraltar **4** Gibraltar Ornithological and Natural History Society (GONHS), Jew's Gate, Upper Rock Nature Reserve, P.O. 843, Gibraltar **5** Institute of Zoology, Poznań University of Life Sciences, Wojska Polskiego 71 C, 60-625 Poznań, Poland

Corresponding author: Piotr Zduniak (kudlaty@amu.edu.pl)

Academic editor: G. Sangster | Received 2 December 2014 | Accepted 29 September 2015 | Published 28 October 2015

<http://zoobank.org/23D281A5-34B3-4D4C-BBE7-5E9EC5A53F76>

Citation: Zduniak P, Yosef R, Bensusan KJ, Perez CE, Tryjanowski P (2015) Biometry and phenology of two sibling *Phylloscopus* warblers on their circum-Mediterranean migrations. ZooKeys 530: 113–127. doi: 10.3897/zookeys.530.5955

Abstract

The Mediterranean Sea is known as an ecological barrier for numerous migratory birds flying from European breeding grounds to African wintering sites. Birds generally avoid migration over open sea and fly over land. In the Mediterranean Basin, few land bridges or bottlenecks for migratory birds exist. The narrowest are at the western and eastern extremes: the Strait of Gibraltar and Israel. Comparative studies between these locations are extremely rare to date. Therefore, in order to elucidate the differences between the two flyways, we compared data collected simultaneously for two sister leaf warbler species, the Bonelli's Warbler complex, *Phylloscopus bonelli* and *Ph. orientalis*, at ringing stations in the western Mediterranean Basin Gibraltar, and the eastern Eilat, Israel. Data on biometrics and passage dates of individuals trapped at Gibraltar and Eilat were used, and it was found that mean arrival date of Western Bonelli's Warblers at Gibraltar was 15 days later than Eastern Bonelli's Warblers at Eilat. Furthermore, Western Bonelli's Warblers had shorter wings than Eastern Bonelli's Warblers. On the other hand, birds in Eilat were in poorer body condition than individuals in Gibraltar. The comparison between geographically distant stop-over sites contributes to furthering our understanding of the development of migration strategies across ecological barriers in sibling species. Our study showed that populations that breed in southwestern Europe migrate through Gibraltar and winter in West Africa are able to accomplish migration in comparatively good body condition. This is in contrast to those that winter in East Africa, migrate through Israel and have to endure the combined challenge of crossing the Sahel, Sahara and Sinai deserts before reaching

their breeding grounds across southeast Europe and southwest Asia. Hence, the discrepancies described between the western and the eastern flyway suggest that individuals in the west, in general, migrate shorter distances, have a physiologically less demanding crossing of the North African deserts and appear to stage before their crossing the Strait of Gibraltar, a privilege unavailable to the migrants of the eastern flyway.

Keywords

Geographical barrier, Mediterranean, migration, *Phylloscopus bonelli*, *Phylloscopus orientalis*

Introduction

Bird populations migrate annually from breeding sites to wintering localities and back. This phenomenon influences not only their proximate behavior and ecology, but also their ultimate evolutionary processes (Newton 2008, Pulido and Berthold 2010). Evolution, leading to speciation, may be especially strong if bird populations are divided into different migratory patches, wherein different breeding populations use varied patches to avoid ecological barriers during migration (Newton 2008, Chernetsov 2012). In the European avian migratory system, the Mediterranean Sea is a well known ecological barrier for numerous migratory birds that fly from their European breeding grounds to African wintering sites after the breeding season and return in the spring (e.g., Rubolini et al. 2002). Most birds try to avoid migration over large expanses of water if possible and many choose to fly over land even if this results in an extended migration (e.g., Newton 2008, Chernetsov 2012, Zduniak and Yosef 2012). Alerstam (2001) evaluated a number of observed and potential detours in relation to the general predictions of maximum detours and found that reduction of fuel transport costs may well be a factor of widespread importance at wide ecological barriers (seas, deserts, etc). However, to date this hypothesis has not been tested using a study system of sister species migrating through different, geographically distant stop-over sites. Hence, we undertook a study at two extreme points of circumnavigation around the Mediterranean Basin, where birds migrate past Gibraltar in the west and through Israel in the east. Both are well-known bottlenecks for migratory bird populations that breed in Eurasia and winter in Africa (Finlayson 1992, Yosef and Tryjanowski 2002, Partida 2006, Bensusan et al. 2007, Newton 2008, Zduniak and Yosef 2012).

Intra- and interspecific comparisons of the two bottlenecks are of interest because they are located at extreme ends of the Mediterranean Basin and birds use them to avoid long sea crossings. However, the two sites are ecologically distinct: Gibraltar is located on a mountain range with well-developed vegetation and has a hinterland with typically Mediterranean vegetation whilst Eilat is situated in the midst of a complex of deserts (Sahara to the south, Arabian to the east, Sinai to the west, Negev to the north). Differences in habitat around stop-over sites may favor different migratory strategies, especially phenology and time of stop-over use (Jakubas and Wojczulanis-Jakubas 2010, Kovács et al. 2011).

Leaf warblers (*Phylloscopus* spp.) are considered model species in bird migration studies because of their wide spectrum of ecological and migratory traits. Nevertheless

European studies are mostly limited to Willow Warbler (*Phylloscopus trochilus* Linnaeus, 1758) and Chiffchaff (*Phylloscopus collybita* Vieillot, 1817) (e.g., Norman 1983, Green 1988, Catry 2005, Barriocanal and Robson 2007) and present knowledge of leaf warbler migration is incomplete (Ciach 2009).

In this paper, we analyzed two sibling leaf warbler species: the Western and Eastern Bonelli's Warbler (*Phylloscopus bonelli* Vieillot, 1819 and *Ph. orientalis* Brehm, 1855). These species are biogeographically and ecologically separated and were recently split as full species, having previously been classified as subspecies of *Phylloscopus bonelli* (Helbig et al. 1995, Baker 1997, Sangster et al. 2002). The Western Bonelli's Warbler breeds in southwest Europe and North Africa and the Eastern Bonelli's Warbler in southeast Europe and Asia Minor (see Marchetti et al. 1995, Katti and Price 2003). The species also have separate wintering ranges. The Western Bonelli's Warbler winters in a narrow belt along the southern edge of the Sahara, mostly 10–17°N, from Senegal and southern Mauritania east to the Lake Chad basin. The winter quarters of the Eastern Bonelli's Warbler are in northeast Africa (Sudan and Ethiopia), with some perhaps further west (Cramp 1998).

In order to avoid migration over large expanses of desert and then water, both species have to migrate over the Sahara and then circumnavigate the Mediterranean basin, crossing at Gibraltar in the west and Israel in the east. Because information in many handbooks and ringers manuals is, to date, strongly limited for both species and not provided to the species level (given as races/subspecies), basic morphometric and phenology studies are considered to be of importance (*cf.* Moore and Kerlinger 1987). Moreover, information regarding the migration of these sibling species at such migratory hotspots is scarce. Hence, the aim of the study is to describe differences in phenology at two stopover sites located on the threshold of the ecological barrier that stretches across the breadth of North Africa and to check for biometric differences between two sibling species of leaf warblers. We also hoped to further our understanding of the (dis-)similarities in the migration strategies of two sibling species with different wintering grounds, migratory routes with different geophysical barriers, and breeding areas. The two stopover sites are characterized by different habitat types and positions relative to the extensive desert barriers: Gibraltar is separated from desert habitats by hundreds of kilometres whilst Eilat is surrounded by it on all sides. This probably reflects their quality and importance for migrants.

Methods

Study areas

Owing to the fact that bird migration in the Mediterranean Basin is North-South-North, we collated data simultaneously at the two outermost sites (east and west), located ca. 3820 km from each other.

The Rock of Gibraltar is located at the eastern end of the Strait of Gibraltar (36°07'N; 5°21'W), where the Mediterranean meets the Atlantic. It lies ca. 21 km

north of North Africa. Habitat in Gibraltar is typically Mediterranean and the vegetation around the ringing station at Jews' Gate consists of dense maquis that is dominated by fruit-bearing shrubs (Perez and Bensusan 2005). Gibraltar is separated from Morocco's arid, desert type ecosystems by ca. 400 km.

Eilat (29°33'N; 34°57'E) is located at the southernmost end of Israel and at the northern tip of the Gulf of Aqaba. Eilat provides a land bridge between three continents, Africa, Asia and Europe, and is located along a set of flyways used by birds wintering in sub-Saharan Africa and breeding in Eurasia. For migratory birds, Eilat is located before (late summer and autumn, or post-nuptial migration) or after (spring, or pre-nuptial migration) the Sahel, Sahara and Sinai Desert crossings, at the edge of almost 2000 km of continuous desert. To the northeast lies the Syrian Desert and to the east the Arabian Desert (Yosef 1997). Directly to the north is the Negev Desert (Izhaki and Maitav 1998).

Field methods

Data analyzed were collected during the same period of 19 years, from 1992 to 2010. All trapping at Gibraltar was undertaken with mist-nets which were operated for ca. 6 hrs daily during the spring (March-May) and autumn (September-November) migration seasons. At Eilat, birds were trapped with mist nets for ca. 6 hr/d in the years 1992–1999. After 2000, birds were trapped using eight Helgoland/Rybachy traps, located along the trapping lanes of the mist-nets in the boundaries of the Eilat Bird Sanctuary and operated for ca. 6 hrs daily during the migration seasons. At both ringing stations, the trapping effort did not differ between spring and autumn in individual years and did not change throughout each season.

All trapped birds were ringed with the standard aluminum rings and biometrics were recorded. Flattened maximum wing chord was measured to the nearest millimeter and body mass determined using Pesola and/or digital scales to the nearest 0.1 g. Although adult *Phylloscopus* warblers have slightly longer wings than juveniles, as is the case in most passerines, we did not attempt to include age of birds in the analyses because leaf warblers are notoriously difficult to age during the pre-nuptial migration, following a complete molt in the wintering areas (Svensson 2006).

Data processing and analysis

During the 19 years of study, 1101 Western Bonelli's Warblers and 1706 Eastern Bonelli's Warblers were ringed. Both species were recorded mainly during the pre-nuptial passage (98.1% and 99.2% of all ringed individuals of Western and Eastern Bonelli's Warblers, respectively). Hence, owing to the sparse post-nuptial migration data we analyzed only data collected during the pre-nuptial migration. Furthermore, for the pre-nuptial period we chose to include in the analyses only those seasons for

which at least ten individuals were recorded (18 springs in Gibraltar with insufficient data for 1999 and 16 springs in Eilat with insufficient data for 1994, 1997 and 2004). The average sample size per season was 59.6 birds (95% CL: 38.5–80.7, $N = 18$) for Gibraltar and 104.6 birds (95% CL: 58.0–151.3, $N = 16$) for Eilat. The total number of birds included in the in-depth analysis was 1073 for Gibraltar and 1674 for Eilat.

We checked for possible differences between species in migration phenology according to Julian days and the biometric parameters wing chord length and body mass. In these analyses only data from the first captures were used. Moreover, to examine possible differences between stopover sites, which have habitat types that probably differ in quality and importance for migrants, we also calculated and compared body condition index (body mass divided by wing length; e.g., Markovets et al. 2008, Zduniak and Yosef 2011, Zduniak and Yosef 2012) as well as the seasonal probability of recapture of ringed birds during each passage season. We considered recapture as that of individuals recorded subsequent to the day after first ringing, or later in the same migration season.

Because timing of migration and biometric parameters (wing chord length, body mass and body condition index) compared between species at the two study sites could be influenced by year, we controlled for year as a factor in the analyses. Comparisons between species were performed using Main Effects ANOVA with species and year as factors. Furthermore, we checked for patterns in changes of biometrics during spring migration. In the analyses we used a standardized time of migration for each study site calculated by subtracting the median Julian date of catching time for each spring season from each catching date in that season. Full biometric data were not always available for all individuals ringed and this has resulted in different sample sizes between individual analyses.

Standard statistical methods were used to describe and analyze the data (Zar 1999). All statistical tests were two-tailed. Calculations were performed using STATISTICA for Windows (StatSoft Inc. 2011). Throughout the text, mean values are presented with 95% confidence limits (CL).

Results

Phenology of migration

In general, migration period and duration of spring passage were similar for both species. Both in Gibraltar and Eilat the passage began in early March and lasted to mid May. However, the main passage period of Western Bonelli's Warbler occurred from the third decade of March till the second decade of May with the peak at the second decade of April (Fig. 1a). The majority of Eastern Bonelli's Warblers migrated between the second decade of March till the third decade of April and the peak of passage was at the third decade of March (Fig. 1b). Mean arrival date of Western Bonelli's Warbler at Gibraltar was 15 days later than Eastern Bonelli's Warbler at Eilat (two-way ANOVA, $F_{1,2727} = 855.44$, $P < 0.001$, $\bar{x} = 105.5$ day, CL: 104.7–106.2, range: 66–136 *vs.* $\bar{x} = 90.3$ day, CL: 89.6–91.1, range: 61–139, respectively).

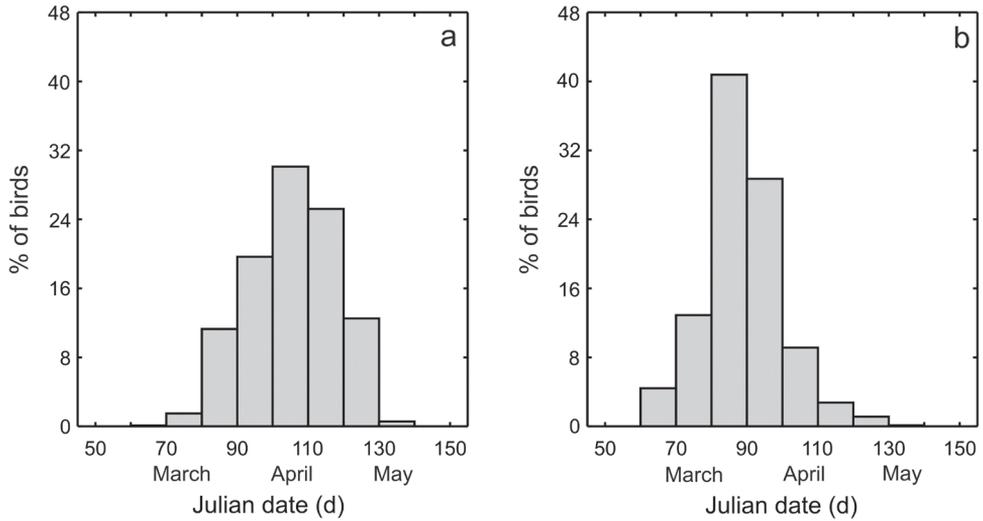


Figure 1. Migration phenology of Western Bonelli's Warbler in Gibraltar (N = 1073; **a**) and Eastern Bonelli's Warbler in Eilat, Israel (N = 1674; **b**).

Table 1. Mean values with 95% confidence of limits in parentheses, ranges and sample size for wing chord length, body mass and body condition index of Western and Eastern Bonelli's Warbler recorded in Gibraltar and Eilat, Israel, respectively.

Variable	Western Bonelli's Warbler	Eastern Bonelli's Warbler
wing chord length (mm)	63.6 (63.4–63.8) range: 56–73, N = 1072	66.0 (65.9–66.2) range: 49–77, N = 1666
body mass (g)	7.2 (7.2–7.3) range: 4.8–10.5, N = 1025	7.0 (6.9–7.0) range: 4.6–11.0, N = 1646
body condition index	0.114 (0.113–0.115) range: 0.075–0.161, N = 1025	0.106 (0.105–0.106) range: 0.073–0.167, N = 1644

Wing chord length, body mass and body condition index

Western Bonelli's Warblers trapped in Gibraltar had shorter wings (two-way ANOVA, $F_{1,2718} = 352.73$, $P < 0.001$; Table 1) and were slightly heavier ($F_{1,2651} = 58.18$, $P < 0.001$; Table 1) than Eastern Bonelli's Warblers at Eilat. Furthermore, Western Bonelli's Warblers were in significantly better condition than individuals recorded in Eilat (two-way ANOVA, $F_{1,2649} = 289.75$, $P < 0.001$; Table 1). The difference in body mass between individuals that had the same wing length was on average 0.5 g between sites. Taking into account the similar average body mass of populations of both species analyzed (Table 1), the difference averages to about 7% of body mass. Minimal and maximal values obtained for body mass and body condition index for both analyzed species were similar (Table 1). The exception was wing chord length, for which the range was greater for Eastern than for Western Bonelli's Warbler (Table 1).

A significant decrease of the wing length during the spring passage was recorded both in the case of the Western as well as the Eastern Bonelli's Warbler (Pearson correlation, $r = -0.28$, $N = 1072$, $P < 0.001$; $r = -0.29$, $N = 1666$, $P < 0.001$, respectively). However the body condition of migrants decreased over the passage only in the case of Eastern Bonelli's Warbler ($r = -0.15$, $N = 1644$, $P < 0.001$) and no such pattern was observed in the case of Western Bonelli's Warbler ($r = -0.03$, $N = 1025$, $P = 0.323$).

Retraps

Throughout the study period we retrapped 17 (1.6%) Western and 339 (20.2%) Eastern Bonelli's Warblers. The probability of Western and Eastern Bonelli's Warblers recapture during the pre-nuptial period differed significantly between sites (Mann-Whitney U test, $Z = 3.37$, $P < 0.001$). The mean probability of recapture was 0.009 (CL: 0.020–0.017, $N = 18$) at Gibraltar and 0.159 (CL: 0.090–0.228, $N = 16$) at Eilat.

Discussion

This study documents differences in migration phenology and energetic requirements between the Western and the Eastern Bonelli's Warblers at the two extremes of the Mediterranean Sea: Gibraltar in the west and Eilat, Israel, in the east. The Eastern Bonelli's Warbler peaked in the third decade of March, whereas the Western Bonelli's Warbler peaked in the second decade of April; the mean arrival date of Western Bonelli's Warbler at Gibraltar was 15 days later than that of Eastern Bonelli's Warbler at Eilat. Western Bonelli's Warblers trapped in Gibraltar had shorter wings and were in significantly better condition than Eastern Bonelli's Warblers at Eilat, but the body condition of migrants only decreased over the passage period in Eastern Bonelli's Warbler. Furthermore, a decrease of wing length was found during the spring passage in both species. Also, the mean probability of recapture was greater at Eilat.

Gibraltar and Israel (especially Eilat in the south) are located along very important flyways for birds migrating between Eurasia and Africa. Comparisons of data collected at such ringing stations can shed new light on bird migration strategies after having crossed the Sahara Desert and around the Mediterranean Sea. However, although ringing operations have been conducted at these two migratory hotspots simultaneously since 1992, a study comparing their respective data has never been undertaken. To our knowledge and in spite of numerous advances in migration research over the past decades (Newton 2008), the results presented here are the first encompassing the circum-Mediterranean avian migration system. It provides additional data regarding the phenomenon and highlights the importance of such comparisons.

A large disparity in numbers was recorded between the spring and autumn migration seasons at both sites. Almost all migrants from both species were recorded during

the pre-nuptial passage (98.1% and 99.2% of all ringed individuals of Western Bonelli's Warbler at Gibraltar and Eastern Bonelli's Warbler at Eilat, respectively). A similar disparity has also been observed in some other species of long distance migrant passerines studied at Eilat (e.g., Yosef and Tryjanowski 2002, Yosef and Chernetsov 2004, 2005, Zduniak and Yosef 2012).

In the case of both ringing sites, the very low number of birds recorded during the post-nuptial migration could be the result of the majority of Western and Eastern Bonelli's Warbler populations having their stopovers further to the north, allowing them to overfly Gibraltar and Eilat on their way south (e.g., Markovets et al. 2008, Zduniak and Yosef 2012). Certainly in the case of Gibraltar, important breeding grounds lie within close proximity and birds breeding in southern Iberia at least may not need to stop at Gibraltar so soon after commencing their migration. Such a strategy would also avoid potentially strong competition for food during a period in which, around the Strait of Gibraltar at least, availability of invertebrates is low (Bensusan 2007). However, one must also take into account that the Moroccan side of the Strait of Gibraltar has not been studied and it is not well understood whether some of the migrant populations stop over prior to initiating the desert crossing. Also, Western Bonelli's Warblers breed in North Africa. This suggests that some of the European migrants may only have to cross the Strait of Gibraltar to find safe stopover sites, resulting in a short migratory hop.

It is also possible that both sibling-species engage in loop migration, wherein the majority of the population flies to the wintering grounds along a different flyway, or that both species migrate on a broad front on their way to Africa by flying straight across the Mediterranean Sea (Moreau 1961). However, upon their return journey both species have to cross the cumulative distance of about 2000 km of desert, which could shape the migration pattern further north. Many Western Bonelli's Warblers are probably avoiding a long sea crossing by choosing the shortest route over the Mediterranean Sea - the Strait of Gibraltar - and are therefore recorded frequently at Gibraltar during spring. This is corroborated by Pilastro et al. (1998), who demonstrated the importance of the Strait of Gibraltar during the northward migration in their study of the migratory routes of eight trans-Saharan passerines through the central and western Mediterranean. From the 21 ringing points included in their study, Western Bonelli's Warblers were most frequent at Gibraltar. In the case of Eastern Bonelli's Warbler, the large number of migrants recorded in spring compared to the post-nuptial passage is most probably the result of the fact that the Eilat region is the first suitable staging area encountered after crossing an extensive desert. Therefore birds are forced to stop and refuel before continuing their northward migrations (*cf.* Tracy et al. 2005, Wojciechowski et al. 2005). This assumption is supported by the fact that within the same pre-nuptial migration seasons, mean probability of recapture of ringed individuals was 0.159 in Eilat and only 0.009 in Gibraltar. This indicates that Eilat is an important stopover site where Eastern Bonelli's Warbler replenish their reserves just after the desert crossing and before they are able to continue to migrate north to their breeding grounds, whereas Gibraltar is located along the important northern flyway for Western Bonelli's Warblers but is not so important for refueling. This is further confirmed by

the difference in body condition index: Western Bonelli's Warblers in Gibraltar were in better condition than Eastern Bonelli's Warblers reaching Eilat. Once again, we raise the point of the need for future studies on the Moroccan side of the Mediterranean to understand the discrepancy. Furthermore, the data suggest that Eilat is used as a refuelling site by Eastern Bonelli's Warblers because of their strenuous flight across the desert and the need to recoup physiologically (*cf.* Wojciechowski et al. 2014). This is strengthened by the fact that Chernetsov et al. (2007) found that Red-breasted Flycatcher (*Ficedula parva* Bechstein, 1794) caught in mist nets were significantly lighter in body mass than over-flying individuals that were shot, suggesting that weaker birds must stop to refuel while the healthier individuals overfly the site.

The morphometric data for the two taxa offered in the published literature are similar to this study. The mean wing length and body mass of Eastern Bonelli's Warbler on a Greek island was 67.1 mm and 6.9 g, respectively (Barboutsis et al. 2013). Similarly, the mean wing length and body mass recorded for Western Bonelli's Warblers in north Morocco, Catalonia, the Balearics and the Columbretes were 60.8 mm–63.3 mm and 6.6 g–7.5 g, respectively (Gargallo et al. 2011). Mean wing length of Western Bonelli's Warblers trapped in Gibraltar was shorter than that of Eastern Bonelli's Warbler in Eilat (Table 1). Furthermore, the range of wing length was much wider for Eastern Bonelli's Warbler than for Western Bonelli's Warbler. The differences in wing length suggest that the geographic distance covered from the breeding to wintering grounds are not as large for the Western Bonelli's Warbler as that of their Eastern sibling species, whose breeding distribution spreads from central Europe to central Asia. Another possible explanation is that a greater proportion of the birds caught at Gibraltar are juveniles (*cf.* Jenni and Winkler 1994). This could be particularly true if Gibraltar is not an important refueling site and landfall is incidental and more likely in less experienced birds. However, although the data remain speculative because of the unreliability of ageing both species, such a difference between sites seems unlikely, because a similar pattern between wing length and migratory period is observed at both sites.

Gwinner (1996) and Berthold (2001) thought that the beginning of the spring migration was controlled by the photoperiod or by endogenous programs initiated in the breeding grounds and winter in the sub-Saharan region. This appears to be true for both our study sibling-species, for which the migration period and duration of passage were similar when compared at the extreme points of the Mediterranean basin. Passage began in early March and lasted until mid May at both Gibraltar and Eilat. However, annual variations of spring migration phenology suggest that the initiation of the migration could also be connected to extrinsic factors (e.g., weather) in sub-Saharan Africa.

At Eilat, Eastern Bonelli's Warblers peaked in the third decade of March. In contrast, for Eastern Bonelli's Warblers on Antikythira, Greece, the median date of spring passage was 4 April (1st, 3rd quartiles: 2 April, 14 April), with the earliest bird trapped on 21 March 2008 and the latest on 8 May 2010 (Barboutsis et al. 2013). This indicates that Eastern Bonelli's Warblers from the western extremes of its breeding distribution may be making a cross-Mediterranean flight later in the spring and that the popula-

tions migrating through Eilat are more Asiatic oriented. This was shown for migratory Chiffchaff at Eilat, where the species showed a strong directionality to the east with a very small proportion of only 13% towards the northwest (Ożarowska et al. 2004), even though all of the recoveries/controls from Chiffchaffs ringed at Eilat are from western and central Europe (Yosef 1997). A similar phenomenon might be occurring with the Eastern Bonelli's Warblers, which could be spreading out like a fan after the desert crossing, towards their breeding grounds. This idea is further enhanced by the fact that Eastern Bonelli's Warblers have been reported as common throughout Egypt between mid March and mid May (Goodman and Meininger 1989), unlike at Eilat. However, Horner (1977) found Eastern Bonelli's Warblers mainly between 16 March and 12 April at Bahig on the northern coast, and the timing of migration in Egypt is in accordance with our results and substantiates the idea that the more western populations may undertake a sea crossing after the deserts.

Western Bonelli's Warbler migration peaked in the second decade of April at Gibraltar. This is similar to Gargallo et al. (2011), who undertook a 16-year ringing project on western Mediterranean islands. They found that apart from the arrival of some very early individuals in mid-March, the main passage period occurred from late March onwards, with a peak at the end of April and a steep decrease thereafter, during May. This pattern was similar in all three study areas (N Morocco, Catalonia, Balearics, Columbretes). They contended that the overall, passage resembled the pattern described for birds on spring migration in the Gibraltar area (Finlayson 1992) and La Camargue (S France) (Blondel and Isenmann 1981). Along the Atlantic coast of Morocco, passage was somewhat earlier and was occasionally observed in late February in the south (Thévenot et al. 2003), although usually not until mid-March onwards in the SE (Gargallo et al. 2011).

It is of further interest that within the above mentioned similarity in migration period, the mean arrival date of Western Bonelli's Warblers at Gibraltar was on average 15 days later than that of Eastern Bonelli's Warblers at Eilat. One might argue that the position of Eilat at ca. 730 km further south than Gibraltar might play a part in this, although the discrepancy in the number of days is too great for the small difference in distance involved between the two sites. Differences may also be related to conditions in African wintering grounds, which can influence migratory patterns and phenology in particular, in a similar way to weather at stopover and breeding grounds (Gordo and Sanz 2006, Gordo 2007). However, a more plausible idea might be that inferred by combining the differences in wing chord length with phenology and inferring that the longer-winged Eastern Bonelli's Warblers have a greater distance to cover to their breeding grounds, and hence arrive at Eilat *ca.* 15 days earlier than the Western Bonelli's Warblers, which have to fly a comparatively shorter distance.

We recommend future studies of similar focus to expand the scope by evaluating stop over sites on the Mediterranean coastline prior to their crossing the sea to Europe. This could explain why Isenmann (1989) recorded Western Bonelli's Warblers migrating across France between the 11th of April and the 20th of May, later than at Gibraltar. Also, an effort must now be made by ringers to establish a method wherein monotypic species can be aged and sexed, either in the hand or by DNA-analyses. It is

also of great interest to verify whether the migration routes assumed by researchers are indeed true in the field for the species. Orientation studies might show the azimuth of migration from North Africa and result in a fanning out of the Western Bonelli's Warblers such that the westernmost populations of the species concentrate at Gibraltar, but those of the eastern extremities of their range are island-hopping across the western Mediterranean, as evidenced in the study of Gargallo et al. (2011).

Another point of interest in our data that relates to the idea forwarded that the two species may be fanning out of Africa to their breeding grounds in Europe, while the more easterly choose to stop over at Eilat, is the fact that we found a significant decrease in wing length during the spring passage in both study species. It has been established that longer distance migrants have relatively longer wings than conspecifics with shorter wings that migrate correspondingly shorter distances (for Eilat *cf.* Yosef and Meissner 2006, Yosef and Wineman 2010). It should be of interest to conduct an orientation, isotope analysis experiment to check if the shorter winged birds that arrive later in the season are also short distance migrants.

It is of interest that body condition of migrants only decreased over the passage period in the case of Eastern Bonelli's Warbler and not that such pattern was evident in Western Bonelli's Warbler. There may be several reasons for this loss of body mass. Older, more experienced birds are known to migrate more efficiently than inexperienced juveniles (*cf.* Yosef et al. 2006). However, our inability to age and sex the species prevents us from carrying out further analyses to understand if our assumption is correct. Another possibility is that conditions in sub-Saharan Africa do not allow the birds to better prepare for the crossing later in the spring. This could be further confounded by the inclement weather conditions that occur in the deserts in the late spring. This can only be verified by ringing birds in sub-Saharan Africa in the spring in a future study.

In conclusion, our results not only expand existing knowledge of leaf warbler *Phylloscopus* migration patterns (e.g., Ciach 2009), but also the observed similarities and differences in biometrics, migration phenology and ecology, which also validate further the recent taxonomic changes for these two *Phylloscopus* warblers. We were unable to corroborate Alerstam (2001), who considered energetic requirements and resulting stop-over sites to dictate migratory routes and strategies, owing to a lack of data of what is happening in Africa. Yet our study allows us to understand the relative importance of stop-over sites to migratory populations and the need for their continued conservation.

Acknowledgments

We dedicate this study to all of those who have devoted their time and effort in ringing at both locations over the past decades. Furthermore, we thank Ian Henshaw and two anonymous referees for constructive comments on the manuscript. The data analyses were financially supported by the Polish Ministry of Science and Higher Education (grant to P.Z. No. IP2011063771).

References

- Alerstam A (2001) Detours in bird migration. *Journal of Theoretical Biology* 209: 319–331. doi: 10.1006/jtbi.2001.2266
- Barboutis Ch, Evangelidis A, Akriotis T, Fransson T (2013) Spring migration phenology and arrival conditions of the Eastern Bonelli's Warbler and the Semi-collared Flycatcher at a small Greek island. *Ringling & Migration* 28: 39–42. doi: 10.1080/03078698.2013.811118
- Baker K (1997) Warblers of Europe, Asia and North Africa. Princeton Univ. Press, Princeton, New Jersey, 400 pp.
- Barriocanal C, Robson D (2007) Spring passage of Willow Warbler *Phylloscopus trochilus* across the western Mediterranean: comparing islands with the mainland. *Ardea* 95: 91–96. doi: 10.5253/078.095.0110
- Bensusan KJ (2007) The ecology of migrant and resident passerines around the Strait of Gibraltar, PhD thesis, University of Leeds, Leeds, UK, 165 pp.
- Bensusan KJ, Garcia EFJ, Cortes JE (2007) Trends in abundance of migrating raptors at Gibraltar in spring. *Ardea* 95: 83–90. doi: 10.5253/078.095.0109
- Berthold P (2001) Bird migration: a general survey. 2nd ed. Oxford University Press.
- Blondel J, Isenmann P (1981) Guide des Oiseaux de Camargue. Delachaux et Niestlé, Neuchâtel, 334 pp.
- Catry P, Lecoq M, Araújo A, Conway G, Felgueiras M, King JMB, Rumsey S, Salima H, Tenreiro P (2005) Differential migration of chiffchaffs *Phylloscopus collybita* and *P. ibericus* in Europe and Africa. *Journal of Avian Biology* 36: 184–190. doi: 10.1111/j.0908-8857.2005.03445.x
- Chernetsov N (2012) Passerine migration: stopovers and flight. Springer Berlin Heidelberg. doi: 10.1007/978-3-642-29020-6
- Chernetsov N, Bulyuk VN, Ktitorov P (2007) Migratory stopovers of passerines in an oasis at the crossroads of the African and Indian flyways. *Ringling & Migration* 23: 243–251. doi: 10.1080/03078698.2007.9674372
- Ciach M (2009) Leaf warblers *Phylloscopus* as a model group in migration ecology studies. *Ring* 31: 3–13. doi: 10.2478/v10050-008-0050-x
- Cramp S (1998) The complete birds of the Western Palearctic on CDROM, Oxford University Press, Oxford. Digital handbook.
- Finlayson JC (1992) Birds of the Strait of Gibraltar. T. & A.D. Poyser, London.
- Gargallo G, Barriocanal C, Castany J, Clarabuch O, Escandell R, López-Iborra G, Rguibi-Idrissi H, Robson D, Suárez M (2011) Spring migration in the western Mediterranean and NW Africa: the results of 16 years of the Piccole Isole project. *Monografies del Museu de Ciències Naturals* 6. Barcelona, Spain.
- Goodman SM, Meininger PL (1989) The Birds of Egypt. Oxford University Press, Oxford.
- Gordo O (2007) Why are bird migration dates shifting? A review of weather and climate effects on avian migratory phenology. *Climate Research* 35: 37–58. doi: 10.3354/cr00713
- Gordo O, Sanz JJ (2006) Climate change and bird phenology: a long-term study in the Iberian Peninsula. *Global Change Biology* 12: 1993–2004. doi: 10.1111/j.1365-2486.2006.01178.x

- Green GR (1988) The autumn migration of chiffchaffs at an inland site in south-east England. *Ringling & Migration* 9: 65–67. doi: 10.1080/03078698.1988.9673926
- Gwinner E (1996) Circadian and circannual programmes in avian migration. *Journal of Experimental Biology* 199: 39–48.
- Helbig AJ, Seibold I, Martens J, Wink M (1995) Genetic differentiation and phylogenetic relationships of Bonelli's Warbler *Phylloscopus bonelli* and Green Warbler *P. nitidus*. *Journal of Avian Biology* 26: 139–153. doi: 10.2307/3677063
- Horner KO (1977) A statistical analysis of spring bird migration at Bahij, Arab Republic of Egypt. Unpublished PhD thesis. Virginia Polytechnic Institute and State University.
- Isenmann P (1989) Bonelli's warbler *Phylloscopus bonelli*, movements across Mediterranean France. *Alauda* 57: 184–188.
- Izhaki I, Maitav A (1998) Blackcaps *Sylvia atricapilla* stopping over at the desert edge; physiological state and flight-range estimates. *Ibis* 140: 223–233. doi: 10.1111/j.1474-919X.1998.tb04383.x
- Jakubas D, Wojczulanis-Jakubas K (2010) Sex- and age-related differences in the timing and body condition of migrating Reed Warblers *Acrocephalus scirpaceus* and Sedge Warblers *Acrocephalus schoenobaenus*. *Naturwissenschaften* 97: 505–511. doi: 10.1007/s00114-010-0666-y
- Jenni L, Winkler R (1994) Moulting and ageing of European passerines. Academic, London.
- Katti M, Price TD (2003) Latitudinal trends in body size among overwintering leaf warblers (genus *Phylloscopus*). *Ecography* 26: 69–79. doi: 10.1034/j.1600-0587.2003.03264.x
- Kovács S, Csörgő T, Harnos A, Fehérvári P, Nagy K (2011) Change in migration phenology and biometrics of two conspecific *Sylvia* species in Hungary. *Journal of Ornithology* 152: 365–373. doi: 10.1007/s10336-010-0596-7
- Marchetti K, Price T, Richman A (1995) Correlates of wing morphology with foraging behaviour and migration distance in the genus *Phylloscopus*. *Journal of Avian Biology* 26: 177–181. doi: 10.2307/3677316
- Markovets M, Zduniak P, Yosef R (2008) Differential sex- and age-related migration of Blue-throats *Luscinia svecica* at Eilat, Israel. *Naturwissenschaften* 95: 655–661. doi: 10.1007/s00114-008-0371-2
- Moreau RE (1961) Problems of Mediterranean-Sahara migration. *Ibis* 103: 373–427. doi: 10.1111/j.1474-919X.1961.tb02454.x
- Moore F, Kerlinger P (1987) Stopover and fat deposition by North American wood-warblers (Parulinae) following spring migration over the Gulf of Mexico. *Oecologia* 74: 47–54. doi: 10.1007/BF00377344
- Newton I (2008) The migration ecology of birds. Academic Press, London.
- Norman SC (1983) Variations in wing-lengths of willow warblers in relation to age, sex and season. *Ringling & Migration* 4: 269–274. doi: 10.1080/03078698.1983.9673819
- Ożarowska A, Yosef R, Busse P (2004) Orientation of Chiffchaff (*Phylloscopus collybita*), Blackcap (*Sylvia atricapilla*) and Lesser White-throat (*S. curruca*) on spring migration at Eilat, Israel. *Avian Ecology and Behavior* 12: 1–10.
- Partida FB (2006) Nomads of the Strait of Gibraltar, Graftsur, Spain.

- Perez CE, Bensusan KJ (2005) Upper Rock Nature Reserve. A management and action plan, Gibraltar. Gibraltar Ornithological & Natural History Society (GONHS).
- Pilastro A, Macchio S, Massi A, Montemaggiore A, Spina F (1998) Spring migratory routes of eight trans-Saharan passerines through the central and western Mediterranean; results from a network of insular and coastal ringing sites. *Ibis* 140: 591–598. doi: 10.1111/j.1474-919X.1998.tb04704.x
- Pulido F, Berthold P (2010) Current selection for lower migratory activity will drive the evolution of residency in a migratory bird population. *Proceedings of the National Academy of Sciences* 107: 7341–7346. doi: 10.1073/pnas.0910361107
- Rubolini D, Pastor AG, Pilastro A, Spina F (2002) Ecological barriers shaping fuel stores in Barn Swallows *Hirundo rustica* following the central and western Mediterranean flyways. *Journal of Avian Biology* 33:15–22. doi: 10.1034/j.1600-048X.2002.330104.x
- Sangster G, Knox AG, Helbig AJ, Parkin DT (2002) Taxonomic recommendations for European birds. *Ibis* 144: 153–159. doi: 10.1046/j.0019-1019.2001.00026.x
- Statsoft Inc. (2012) STATISTICA (data analysis software system), version 10, www.statsoft.com
- Svensson L (2006) Identification guide to European Passerines, 4th ed., British Trust for Ornithology.
- Thévenot M, Vernon R, Bergier P (2003) The Birds of Morocco. BOU Checklist, no. 20. British Ornithologists' Union and British Ornithologists' Club, The Natural History Museum, Tring.
- Tracy CR, Wojciechowski M, McWhorter TJ, Yosef R, Karasov WH, Pinshow B (2005) Carbohydrate absorption in migrating blackcaps, upon arrival and after refeeding, at a stopover in southern Israel. *Integrative and Comparative Biology* 45: 1085. doi: 10.1242/jeb.040071
- Wojciechowski M, Yosef R, Pinshow B (2005) Body composition of small migrating birds at a stopover site in southern Israel. *Integrative and Comparative Biology* 44: 666.
- Wojciechowski M, Yosef R, Pinshow B (2014) Body composition of north and southbound migratory blackcaps is influenced by the lay-of-the-land-ahead. *Journal of Avian Biology* 45: 264–272. doi: 10.1111/j.1600-048X.2013.00345.x
- Yosef R (1997) Clues to the migratory routes of the eastern flyway of the western Palearctics – ringing recoveries at Eilat, Israel. ([I–Ciconiiformes, Charadriiformes, Coraciiformes and Passeriformes.]). *Die Vogelwarte* 39: 131–140.
- Yosef R, Chernetsov N (2004) Stopover ecology of migratory Sedge warblers (*Acrocephalus schoenobaenus*) at Eilat, Israel. *Ostrich* 75: 52–56. doi: 10.2989/00306520409485412
- Yosef R, Chernetsov N (2005) Longer is fatter, body mass changes of migrant Reed Warblers (*Acrocephalus scirpaceus*) staging at Eilat, Israel. *Ostrich* 76: 142–147. doi: 10.2989/00306520509485486
- Yosef R, Meissner W (2006) Seasonal age and sex differences in weight and biometrics of migratory Dunlins (*Calidris alpina*) at Eilat, Israel. *Ostrich* 77: 67–72. doi: 10.2989/00306520609485510
- Yosef R, Tryjanowski P (2002) Avian species saturation at a long-term ringing station – a never-ending story? *Journal of Yamashina Institute of Ornithology* 34: 89–95. doi: 10.3312/jyio1952.34.89

- Yosef R, Wineman A (2010) Differential stopover ecology of Blackcaps (*Sylvia atricapilla*) by sex and age at Eilat, Israel. *Journal of Arid Environments* 74: 360–367. doi: 10.1016/j.jaridenv.2009.09.004
- Yosef R, Markovets M, Mitchell L, Tryjanowski P (2006) Body condition as a determinant for stopover in Bee-eaters on spring migration in the Arava Valley, southern Israel. *Journal of Arid Environments* 62: 401–411. doi: 10.1016/j.jaridenv.2005.06.012
- Zar JH (1999) *Biostatistical analysis*, 4th ed., Prentice Hall, New Jersey.
- Zduniak P, Yosef R (2011) Migration and staging patterns of the Red-throated (*Anthus cervinus*) and Tree Pipits (*Anthus trivialis*) at the migratory bottleneck of Eilat, Israel. *Ornis Fennica* 88: 129–137.
- Zduniak P, Yosef R (2012) Crossing the desert barrier: Migration ecology of the Lesser White-throat (*Sylvia curruca*) at Eilat, Israel. *Journal of Arid Environments* 77: 32–38. doi: 10.1016/j.jaridenv.2011.09.002

Pycnogonids associated with the giant lion's-paw scallop *Nodipecten subnodosus* (Sowerby) in Ojo de Liebre Bay, Guerrero Negro, Baja California Sur, Mexico

Angel de León-Espinosa¹, Jesus A. de León-González¹

¹ Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Laboratorio de Biosistemática, Ap. Postal 5 "F", San Nicolás de los Garza, Nuevo León. 66451 México

Corresponding author: Jesus A. de León-González (jesus.deleongn@uanl.edu.mx)

Academic editor: Bonnie Bain | Received 28 May 2015 | Accepted 12 October 2015 | Published 29 October 2015

<http://zoobank.org/0DC7680D-0A89-42CA-9083-5CD981A2A072>

Citation: de León-Espinosa A, de León-González JA (2015) Pycnogonids associated with the giant lion's-paw scallop *Nodipecten subnodosus* (Sowerby) in Ojo de Liebre Bay, Guerrero Negro, Baja California Sur, Mexico. ZooKeys 530: 129–149. doi: 10.3897/zookeys.530.6064

Abstract

Five species of epibenthic pycnogonids collected on the giant lion's-paw scallop *Nodipecten subnodosus* are recorded. A new species of *Eurycyde*, *E. bamberi*, is described. Of the 19 species known in this genus; the new species is closest to *E. hispida* Kroyer, 1844 but differs from it in the absence of plumose spines and the shapes of the lateral process, first coxa, and ocular tubercle. The new species represents the third member of *Eurycyde* from the eastern Pacific in addition to *E. spinosa* Hilton, 1916 and *E. clitellaria* Stock, 1955. Besides *E. bamberi*, the following species were collected: *Nymphopsis duodorsospinosa* Hilton, 1942c; *Callipallene californiensis* (Hall, 1913); *Nymphon lituus* Child, 1979; and *Pycnogonum rickettsi* Schmitt, 1934. *Pycnogonum rickettsi* is recorded for first time from Mexican waters, as is *Nymphon lituus* from the western coast of Baja California Peninsula. Each of these four species are re-described and re-illustrated in order to fill in existing gaps in the literature of the region.

Keywords

Pycnogonida, new species, new records, Mexico, epifauna, *Nodipecten subnodosus*

Introduction

Pycnogonids are arthropods known as “sea spiders,” comprising a relatively small group of invertebrates that are distributed in all marine habitats from the intertidal zone to abyssal depths (Hedgpeth 1947, Arnaud and Bamber 1988, Genzano 2002, Cano-Sánchez and López-González 2007).

Pycnogonid studies in Mexico have been discontinuous and sporadic: Hilton (1942a) cited the first species from Mexico (*Nymphon pixellae* Scott, 1912), and later authors such as Hedgpeth (1948), Stock (1955), and Arnaud (1978) mentioned some pycnogonids from Mexican coasts. The most influential research for Mexico has been that of Child (1979), who reported 21 species from the Mexican Pacific. Munilla (2002) synthesized the information for Mexican littoral records, and found that 42 species were included in 17 genera and 6 families. In the present paper, we report the epibenthic pycnogonid specimens collected from the giant lion’s-paw scallop *Nodipecten subnodosus* (Sowerby).

Methods

During a series of samplings made between 2012 and 2013 in Ojo de Liebre bay, Guerrero Negro, Baja California Sur, giant lion’s paw scallops were captured by scuba diving at depths not exceeding 10 meters in four fishing areas: El Datil (AD), El Chocolatero (AH), La Concha (AC) and El Zacatoso (AZ). Each scallop was collected individually in zip-lock bags to prevent loss of specimens associated with this clam. The biological material was transported in plastic containers to the station of the Centro de Investigaciones Biológicas del Noroeste in Guerrero Negro, the associated fauna were separated under a stereomicroscope, and placed in vials with 70% ethanol for later identification. Five pycnogonid species were found, and they were deposited in the Collection Carcinológica de la Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León. For each species the material examined section is listed as follows: fishing area name, coordinates, catalog number (UANL-FCB-PYCNO), number of scallop, the number of specimens (in parentheses), and date.

Systematic account

Class Pycnogonida Latreille, 1810

Order Pantopoda Gerstäcker, 1863

Family Ammotheidae Dohrn, 1881

Genus *Eurycyde* Schiödte, 1857

***Eurycyde bamberi* sp. n.**

<http://zoobank.org/00096DAA-9488-42A6-8EE6-3BFC80552F22>

Fig. 1

Material examined. Holotype (1 male), Ojo de Liebre bay, Guerrero Negro, Baja California Sur, scallop fishing area: El Datil, 27°48'43"N, 114°15'06"W, (UANL-FCB-PYCNO-0031), AD-1, (1), 01/12/2012.

Description. Proboscis articulated, proximal portion a cylindrical tube approximately one quarter of the total size, distal part pyriform, 3 smooth lips (Fig. 1A–B).

Chelifores with three segments, first scape segment slightly longer than second, with a long spine at the distal part directed forward, second scape segment with five ventrolateral spines and a smaller dorsal spine. Third segment approximately 1/3 the size of the second one, spineless, widening towards the distal part, ending in a smooth chela without auxiliary teeth (Fig. 1C).

Palp consists of ten segments, first one short, 0.05 mm long, second segment shorter than first one (1/3 its length), third segment approximately 0.55 mm long with two dorsal spines between the second and final third of the segment; the fourth segment smaller, 1/3 of the third one, with a spine on the distal end; fifth segment as long as the third one, with a line of lateral spines aligned forward starting in the second third of the segment and ending at the distal end; sixth segment small, half the size of the fourth, with three spines on the ventrodiscal end, two on the ventral side and one at the dorsodiscal end; seventh to ninth segments similar in both size and shape, with two rows of spines running along the entire ventral surface; tenth segment smaller than previous ones, with a row of spines on the ventral surface (Fig. 1D).

Small ocular tubercle, inserted at edge of cephalic segment, without lateral spines, twice as tall as its diameter capped with an inverted cone, with four pronounced eyes (Fig. 1B).

Trunk compact, spineless, suture lines slightly marked (Fig. 1A–B).

Lateral processes smooth, well-developed, longer than the width of the body and without spines or tubercles, separated by less than half of their own diameter.

With four long, slender walking leg pairs. Coxa I very short (0.1mm) with two thick dorsolateral tubercles, coxa II longer (0.17mm) with two short spines, one median dorsal and one ventrodiscal, coxa III (0.14mm) slightly shorter than coxa II, with two short ventral spines, one median and one at the dorsodiscal end. Femur smooth, armed with three long distal spines, one dorsal and two lateral. Tibiae I and II long,

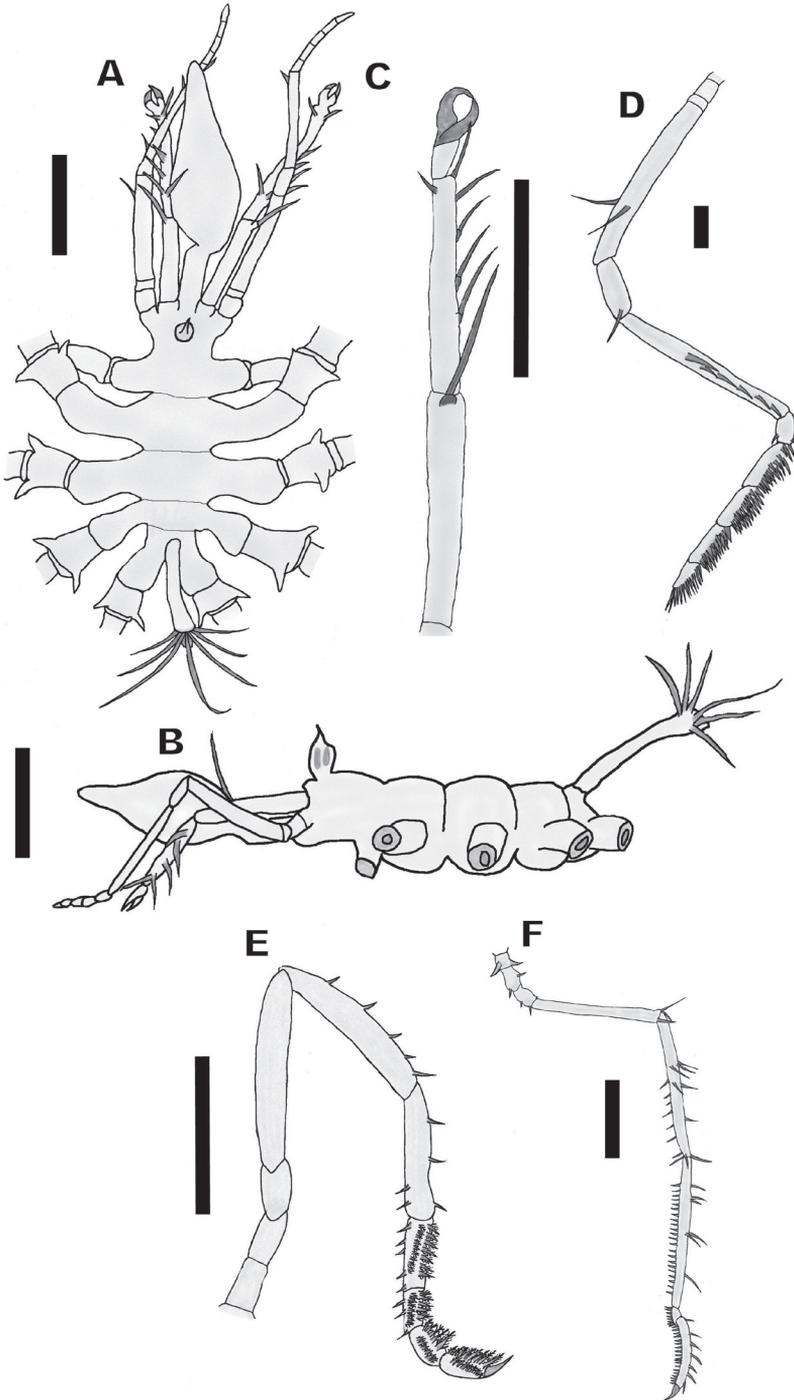


Figure 1. *Eurycyde bamberi* sp. n. Holotype, male (UANL-FCB-C-P000). **A** Trunk, dorsal view **B** Trunk, lateral view **C** Chelifore, lateral view **D** Palp, lateral view **E** Oviger, lateral view **F** Third leg, lateral view. Scale bars: 0.5 mm (**A–C, E–F**); 0.1 mm (**D**).

nearly subequal. Tibia I, armed with three dorsal and two mid-lateral spines, a long dorsodistal spine, seven ventral spines, smaller, in a row and two longer distal spines. Tibia II, with six long dorsal spines and a ventral row with 22 smaller setae. Tarsus, with a ventral row formed by eight setae. Propodus slightly curved, armed with seven dorsal spines and a ventral row of 19 sole spines. Thick claw, without auxiliary claws (Fig. 1F).

Oviger composed of 10 segments, first three short, segments 1 and 3 subequal, segment 2 slightly longer, fourth and fifth segments long and subequal, first to fourth segments without spines or setae, fifth segment with a ventral row of five moderately sized setae, sixth segment 2/3 the length of segment 5, with three ventral and two apical setae located dorsally, seventh to tenth segments smaller, with two rows of spines, the first row with the formula 7: 5: 5: 8, and the second row of spines similar in shape, but smaller than the first ones with the formula 9: 7: 6: 8. Last segment ends in a thick terminal claw (Fig. 1E). Eggs not observed.

Long cylindrical abdomen, extended at an angle of 45°, exceeding the length of the lateral processes and first coxae combined, of the fourth pair of legs; distal end of abdomen with 7 long thin spines, the rest smooth (Fig. 1B).

Standard measurements. Proboscis 1.3 mm long, divided in two segments, proximal one of 0.35 mm long, distal segment 0.95 mm long, 0.35 mm wide.

Body 1.5 mm long from anterior end of cephalic segment to end of fourth lateral processes, 1 mm wide between second pair of lateral processes.

Leg 1 3.72 mm long from coxa I to the tip of main claw. Coxa I, 0.1 mm, coxa II, 0.17 mm, coxa III, 0.14 mm, femur 0.81 mm, tibia I, 0.89 mm, tibia II, 0.97 mm, tarsus, 0.08 mm, propodus 0.44 mm, claw 0.12 mm.

Oviger 2.45 mm long, first segment 0.09 mm, second 0.11 mm, third 0.09 mm, fourth 0.62 mm, fifth 0.56 mm, sixth 0.40 mm, seventh 0.2 mm, eighth 0.13 mm, ninth 0.12 mm, tenth 0.13 mm.

Distribution. This species is known only from Ojo de Liebre bay, Guerrero Negro, Baja California Sur, Mexico.

Etymology. Specific name is in honor of Roger Bamber for his great work on the knowledge of pycnogonids, who died recently on February 16, 2015.

Remarks. *Eurycyde* is a relatively small genus. Until the present report, it was represented by 19 species and of these, only *E. spinosa* Hilton, 1916 and *E. clitellaria* Stock, 1955 have been previously recorded for the eastern Pacific. The first one was described from Laguna Beach, California, the second described from the Virgin Islands in the Caribbean Sea and later reported from Tenacatita Bay, Jalisco by Child (1979). This report is the third finding of a species of *Eurycyde* in the eastern Pacific. Table 1 shows important characteristic features of these *Eurycyde* species.

Based on the key proposed by Nakamura and Chullasorn (2000), this species is very close to *E. hispida* Kroyer, 1844, described from Greenland and whose type material has been lost; *E. hispida* has also occasionally been reported from the coasts of the north Atlantic. *Eurycyde hispida* has plumose spines on its legs and abdomen, lateral process with setae laterally, coxa I without a lateral tubercle, and a tall thin ocular tubercle. In

Table 1. Morphological characteristics of known *Eurycyde* species.

Species	Plumose spines	Lateral processes	Coxa I	Ocular tubercle shape	Type locality	Reference
<i>E. acanthopus</i> Stock, 1979	Present on 1 st and 2 nd tibia	With a dorsal spine	With two tall dorsal pointed spines	Tall and slender, without distal spines	Caracas, Venezuela	Stock (1979)
<i>E. antarctica</i> Child, 1987	Present on 1 st tibia	With a short dorsal tubercle inserted distally	Without associated structures	With broad base tapering to slender anterior tip, with four tiny slender tubercles	Adare Peninsula, Ross Sea	Child (1987)
<i>E. arctica</i> Child, 1995	Absent	With a short dorsal tubercle inserted distally	With two short latero-dorsal spines	Short, twice taller than its diameter	Amchitka Island, Aleutians	Child (1995)
<i>E. bambergi</i> sp.n.	Absent	Without associated structures	With two thick dorsolateral spines	Short, globose, distally pointed, twice taller than its diameter	Ojo de Liebre Bay, Baja California Sur, México	This work
<i>E. chitellaria</i> Stock, 1955	Present on 1 st and 2 nd tibia	With a dorsal spine	With two tall dorsal pointed spines	Tall and slender, with subdistal spines	Virgin Islands, Caribbean Sea	Muller and Krapp (2009)
<i>E. curvata</i> Child, 1979	Present on 1 st and 2 nd tibia	With a distal and lateral tubercles	With five tubercles inserted distally	Thin and tall, without distal spines	Cabo de la Vela, Colombia, Caribbean	Child (1979)
<i>E. depressa</i> Child, 1995	Absent	With two short latero-dorsal spines	With 3-4 short spines	Very low, as wide as tall	Semisopochnoi Island, Aleutians	Child (1995)
<i>E. diacantha</i> Stock, 1990	Present on distal end of femur, 1 st and 2 nd tibia	Without associated structures	With two heavy, almost triangular, pointed tubercles	Short, 2.5 times longer than its diameter	Cape Verde Islands	Stock (1990)
<i>E. flagella</i> Nakamura & Chullasorn, 2000	Present on chelifore, coxae I and II, and on ocular tubercle	First to third pairs of lateral processes with tall tubercles, fourth pair with low tubercles	With two long feathered spines on first two coxae	Tall, slender, four times longer than its diameter, with three feathered spines at tip	Puket Island, Thailand	Nakamura and Chullasorn (2000)
<i>E. gondia</i> Child, 1979	Present on coxa II, distal end of femur, 1 st and 2 nd tibia	Without associated structures	Without associated structures	Short, thick, with a distal circle of pointed spines	Galeta Island, Panamá, Caribbean	Child (1979)
<i>E. hispidula</i> (Krøyer, 1844)	Present on legs and abdomen	With a setae inserted laterally	Without associated structures	Tall and thin	Greenland	Nakamura and Chullasorn (2000)

Species	Plumose spines	Lateral processes	Coxa I	Ocular tubercle shape	Type locality	Reference
<i>E. longioculata</i> Muller, 1990	Absent	Without associated structures	With two thick dorsolateral spines, anterior one smaller than posterior one on first three pairs of coxae, last pair with equal size protuberances	Tall and thin, with more than five distal spines	Bora Bora, Society Islands, South Pacific	Müller (1990)
<i>E. longisetosa</i> Hilton, 1942	Present on distal end of femur, 1 st and 2 nd tibia	Without associated structures	With two latero-dorsal tubercles inserted distally	Short and slender, with two long and thin distal spines	Utria Harbor, Pacific of Colombia	Hilton (1942c)
<i>E. muricata</i> Child, 1995	Present along body	Present with 3-5 short spines	With two long lateral and one dorsal spines	Tall and slender, globose distally	Rat Islands Group, Aleutians	Child (1995)
<i>E. platyspina</i> Stock, 1992	Present on coxa II and III, distal end of femur, 1 st and 2 nd tibia	Present, a short dorsal tubercle inserted distally and some scattered spines	With two latero-dorsal tubercles inserted distally and two proximal spines	Short, three times taller than its diameter	North to Rio de Janeiro, Brasil	Stock (1992)
<i>E. raphiaster</i> Loman, 1912	Absent	With a dorsal tiny spine	With two protuberances, anterior one smaller than posterior one on first three pairs of coxae, last pair with equal size protuberances	With six long apical spines	Originally described from Monaco; type locality not specified, other records are from Caribbean Sea and Cape Verde Islands	Loman (1912); Hedgpeth (1948)
<i>E. sertula</i> Child, 1991	Present along body	First to third pairs of lateral processes with conical tubercles, fourth pair with smaller tubercles	First to third pairs of coxae with a small conical antero-distal tubercle, and a larger postero-distal tubercle armed with two long plumose spines	Short, 2.5 times longer than its diameter, with five long apical spines	Guam island, Philippine Sea	Child (1991)
<i>E. setosa</i> Child, 1988	Present along legs from coxae to tibia II	With a short rounded distal tubercle that decrease in size from anterior to posterior lateral processes	With two heavy, almost triangular, pointed tubercles, anterior one shorter than posterior one, both covered by tiny spines	Three times as long as maximum diameter, with seven spines inserted distally	Batan Island, Philippines	Child (1988)
<i>E. spinosa</i> Hilton, 1916	Absent	Without associated structures	With two thick dorsolateral spines and a single large spine	Short, conical	Laguna Beach, California	Hilton (1916)
<i>E. unispina</i> Stock, 1986	Present on 1 st and 2 nd tibia	Without associated structures	With a tall dorsal spur	Strongly pointed, with a distal spine	Straits of Florida	Stock (1986)

contrast, the new species has simple spines on the abdomen and legs, lateral processes without tubercles or spines, coxa I with two dorsolateral spines, and the ocular tubercle short, narrowing towards the tip. Another closely related species is *E. spinosa* Hilton, 1916. These two species can be separated by the presence of a large posterior spine on each coxa I, and the ocular tubercle is conical with one large spine and several smaller spines in *E. spinosa*, while *E. bamberi* sp. n. does not have posterior spines on the first coxa, and the ocular tubercle is globose, distally pointed, without spines.

The following species are illustrated and described in full since their previous descriptions are quite outdated and in some cases, like *Nymphopsis duodorsospinosa*, very incomplete. This will help facilitate future identification of eastern Pacific pycnogonids as well as help to differentiate new species as they are collected and described from this region.

Genus *Nymphopsis* Haswell, 1885

Nymphopsis duodorsospinosa Hilton, 1942c

Fig. 2

Nymphopsis duodorsospinosa Hilton 1942c: 303, pl. 45; Hilton 1943a: 98; Hedgpeth 1948: 250–252, fig. 40; Child and Hedgpeth 1971: 609; Kraeuter 1973: 496; Stock 1975: 978; Child 1979: 21.

Material examined. Ojo de Liebre Bay, Guerrero Negro, Baja California Sur, scallop fishing area: La Concha, 27°50'35"N, 114°16'22"W, (UANL-FCB-PYCNO-0032), AC-3 (6♀, 1♂); (UANL-FCB-PYCNO-0033), AC-5 (1♀, 2♂); (UANL-FCB-PYCNO-0034), AC-6 (3♀, 1♂); (UANL-FCB-PYCNO-0035), AC-10 (9♂); (UANL-FCB-PYCNO-0036), AC-16(3♀, 2♂); (UANL-FCB-PYCNO-0037), AC-21 (1♀, 2♂); (UANL-FCB-PYCNO-0038), AC-22 (1♀, 4♂); (UANL-FCB-PYCNO-0039), AC-28 (1♂); (UANL-FCB-PYCNO-0040), AC-30 (2♀, 1♂); (UANL-FCB-PYCNO-0041), AC-31 (1♀), 01/10/2013; El Datil, 27°48'43"N, 114°15'06"W, (UANL-FCB-PYCNO-0042), AD-17 (1♀, 2♂), 01/12/2012; (UANL-FCB-PYCNO-0043), AD-(20) (2), 21/11/2013; El Zacatoso, 27°51'45"N, 114°12'19"W, (UANL-FCB-PYCNO-0044), AZ-2 (2♂); (UANL-FCB-PYCNO-0045), AZ-7 (1♀, 1♂); (UANL-FCB-PYCNO-0046), AZ-28 (1♀, 1♂) 01/09/2013.

Description. Proboscis cylindrical, vertical to body, with three smooth lips, narrow at the proximal portion, thicker toward the distal part, three times longer than wide (Fig. 2B).

Chelifore scape two-segmented, first one short, with two small setae on distal end, second one three times as long as 1st segment, narrow for most of its length and widening at its distal end, with a long dorsal spine and two smaller distal setae located directly in front of the long spine. The widened distal end is encircled by a fringe of long setae. Chela small, retractable inside the wide end of the second scape segment (Fig. 2B).

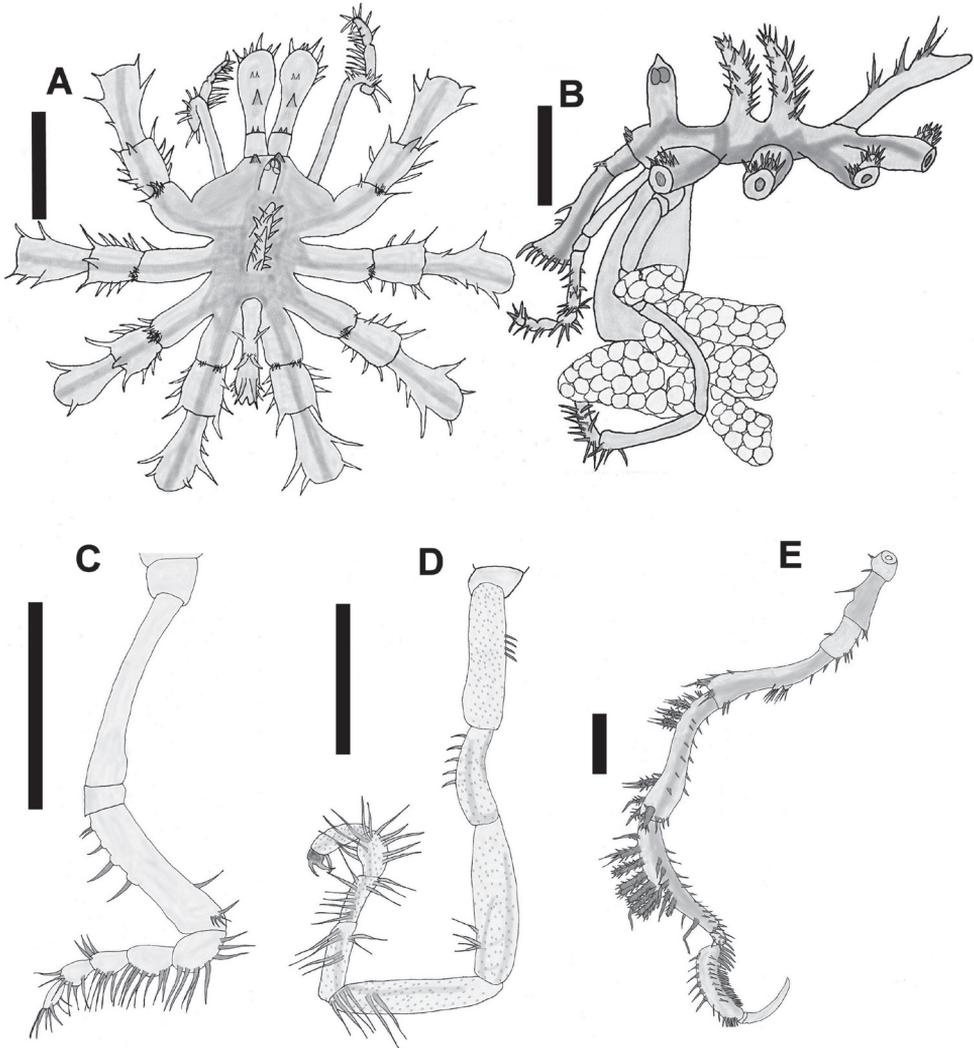


Figure 2. *Nymphopsis duodorsospinosa* Hilton, 1942. **A** Trunk, dorsal view **B** Trunk, lateral view **C** Palp, lateral view **D** Oviger, lateral view **E** Third leg, lateral view. Scale bars: 1 mm (**A–B, E**), 0.5 mm (**C–D**).

Palp with nine segments, first and third short, second one longest, all these without setae. Segment four $\frac{2}{3}$ length of segment 2, with a series of five dorsal setae, two isolated ventral setae, and a group of smaller basal setae; segments 5–9 with a row of long ventral setae; segments 7–8 each with a cluster of anterior distal setae (Fig. 2C).

A well-developed ocular tubercle inserted a little behind the anterior margin of the body, tall, cylindrical, ending in a conical apex, with four black eyes near the top (Fig. 2B).

Trunk slightly longer than wide, 3.1 mm long from anterior end of chelifore to distal end of abdomen, 2.1 mm wide between second pair of lateral processes, with spines on the dorsodistal end of the lateral processes. With two notable dorsal trunk

tubercles covered with spines. No segmentation lines between body segments (Fig. 2A). Located just posterior to the insertion of the scape of the chelifore are two short dorsal tubercles surrounded by small spines (Fig. 2B).

Lateral processes well developed, longer than the width of the body, separated by a space equal to their own diameter, with one or two tufts of small setae on the dorso-distal end of each process. Lateral processes on legs 1–3 each have one or two additional longer spines at the dorso-distal end.

Legs adorned with numerous spines. Coxa I and III together, as long as coxa II, coxa I (0.3 mm) with a median dorsal spine (legs 1–3) and a row of lateral spines on each side, coxa II (0.67 mm) with a long dorsal spine inserted medially, and two ventrodistal spines on legs 1 and 2 (Fig. 2E); on legs 3 and 4, instead of those spines, there appears a ventrodistal tubercle adorned with seven pairs of lateral spines, present only in male specimens. The male gonopore is located on this tubercle, coxa III (0.48 mm) with a series of ventral setae and one longer dorsal seta. Femur and tibia I subequal, tibia II is slightly shorter. Femur with widely spaced setae on ventral side and distal end, tibia I with two rows of small setae on ventral side, and two dorsal groups of large complex spines, one group proximal and the other distal. Tibia II with one median dorsal row of large complex spines and one additional row of smaller complex spines off to one side. Tarsus small, curved, ventral surface with 5–6 spines. Propodus curved, five times longer than tarsus, with one median dorsal spine row and two lateral spine rows. At the dorsodistal end, there is a cluster of smaller spines. The ventral surface of the propodus has four large thick heel spines and a row of smaller sole spines. Long curved terminal claw, 85% the length of the propodus, auxiliary claws absent. (Fig. 2E).

Oviger formed by ten segments, first one very short, second, fourth, and fifth longest, nearly subequal, third segment is $2/3$ the length of segment 2 and curved, armed with a dorsal row of setae, fourth with a small cluster of dorsodistal setae, fifth with two long lateral spines and a ventral cluster of long spines at the distal end. Segment six with two lateral groups of two spines each, and a dorso-distal group of two smaller spines. Segment seven with a lateral row of seven long spines, and a dorso-distal row of three spines; segment eight with a row of five dorsal spines, a row of four lateral spines and two ventral spines; segment nine longer than seven, with a dorso-ventral hook-like spine. Segment ten very small, with two hook-like terminal spines (Fig. 2D).

Long slightly curved abdomen, directed posteriorly at an angle less than 45° , with three pairs of dorsal spines, each one with small setae at the base (Fig. 2B).

Standard measurements. Proboscis 1.5 mm long, 0.76 mm wide.

Body 1.45 mm long from anterior end of cephalic segment to end of 4th lateral processes, 2.57 mm wide between second pair of lateral processes.

Leg 1 7.98 mm long from coxa I to the tip of main claw. Coxa I, 0.3 mm, coxa II, 0.67 mm, coxa III, 0.48 mm, femur 1.58 mm, tibia I, 1.58 mm, tibia II, 1.5 mm, tarsus, 0.3 mm, propodus 0.8 mm, claw 0.68 mm.

Oviger 2.71 mm long, first segment 0.06 mm, second 0.49 mm, third 0.32 mm, fourth 0.53 mm, fifth 0.56 mm, sixth 0.24 mm, seventh 0.19 mm, eighth 0.14 mm, ninth 0.18 mm, and tenth 0.04 mm.

Distribution. The type locality of *Nymphopsis duodorsospinosa* is San Francisco Bay, Gulf of California (Hilton 1942c); Hilton (1943a) recorded this species from San Francisco Bay to Lower California, including several localities in the Gulf of California and also from the Galapagos. Hedgpeth (1948) cited this species from South Carolina and Florida, Child and Hedgpeth (1971) listed this species from the Galapagos. Child (1979) recorded this species from western Mexico and both coasts of Panama.

Remarks. Hilton (1942c) noted that *N. duodorsospinosa* is close to *N. spinosissima* (Hall, 1912); however, these can be differentiated by the number of dorsal tubercles (two and three respectively), differences in the chelifore and chelifore scape, spination on the abdomen, lateral processes, and legs, propodal heel and sole spines, and size and shape of the eye tubercle. According to Hedgpeth (1948), the oviger of *N. duodorsospinosa* is formed by ten segments, not nine as described by Hilton (1942c). Furthermore, the fifth segment in *N. duodorsospinosa* is larger with a basal group of spines, not short and covered on all sides with small "hairs" as in *N. spinosissima*.

Family Callipallenidae Flynn, 1929

Genus *Callipallene* Flynn, 1929

Callipallene californiensis (Hall, 1913)

Fig. 3

Pallene californiensis Hall 1913: 133, Pl. 4, figs 9–13; Hilton 1915a: 67; 1915b: 204; 1916: 465, fig. 6; 1920: 93.

Callipallene californiensis: Hilton 1942b: 281, pl. 36; 1942c: 38.

Callipallene sollicitatus Child 1979: 44–46, fig. 15.

Material examined. Ojo de Liebre Bay, Guerrero Negro, Baja California Sur, scallop fishing area: La Concha, 27°50'35"N, 114°16'22"W, (UANL-FCB-PYCNO-0047), AC-2, (1♂), 01/12/2012.

Description. Proboscis short and rounded distally (Fig. 3A), with three smooth lips.

Chelifores with two segments: scape one-segmented, short, with a distal row of short spines. Chela large, chelate, with two dorsal and lateral rows of three spines each. The inferior chela finger is thin, articulated, with eleven teeth, extending beyond the distal portion of the upper finger, armed with nine teeth (Fig. 3C).

Palps absent. Ocular tubercle conical and apparently eyeless, located on cephalic segment just forward of the first pair of lateral processes (Fig. 3B).

Trunk short, robust, anterior corners of the first body segment rounded. Slender neck basally, almost as thick as its length in the distal part (Fig. 3A). Distinct segmentation lines between body segments.

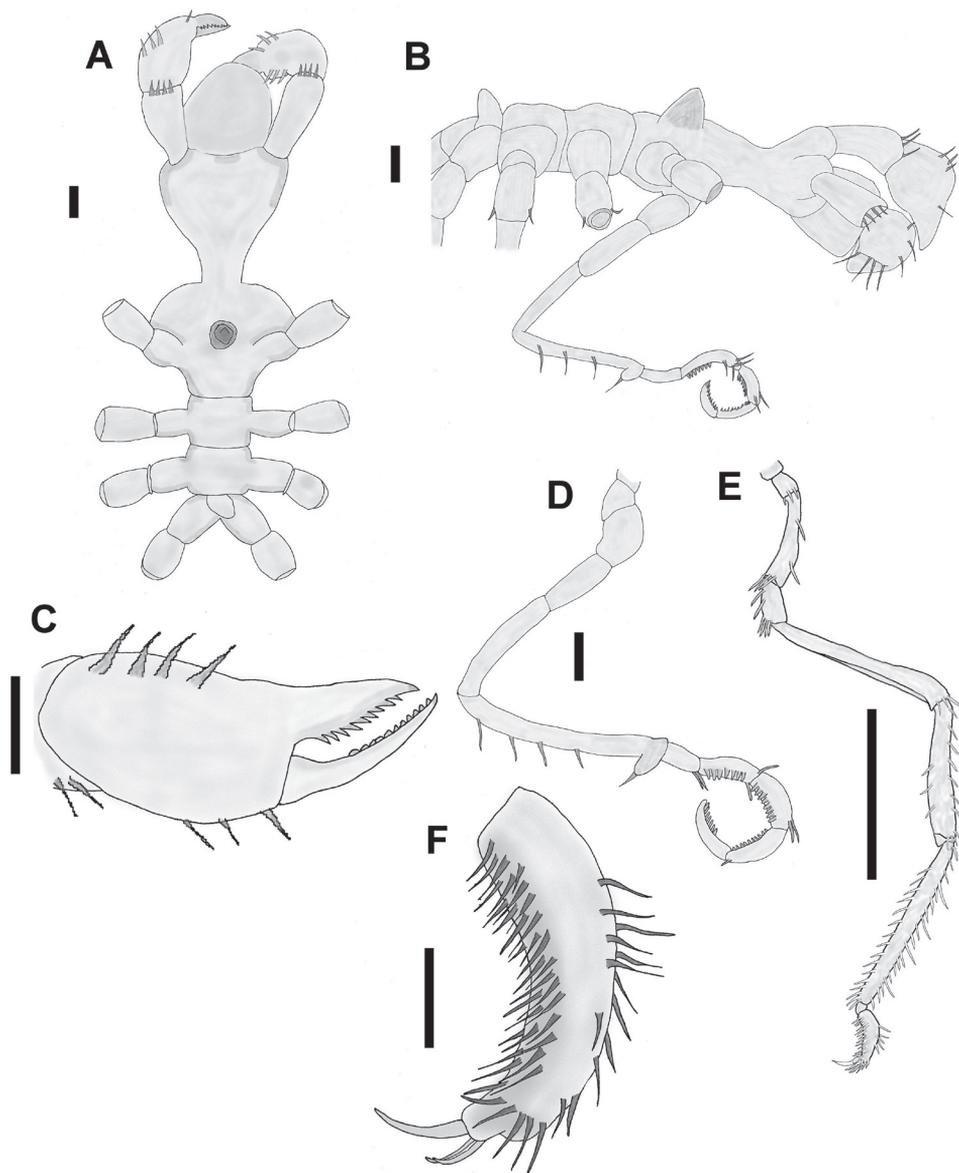


Figure 3. *Callipallene californiensis* (Hall, 1913). **A** Trunk, dorsal view **B** Trunk, lateral view **C** Chela, lateral view **D** Oviger, lateral view **E** Third leg, lateral view **F** Propodus, lateral view. Scale bars: 0.1 mm (**A–D, F**), 1 mm (**E**).

Lateral processes without accessory structures, first and second pairs separated approximately by twice their diameters, second to fourth pairs separated approximately by their own diameter (Fig. 3A, B).

Oviger consists of ten segments, first three short, fourth segment as long as the second and third ones together. Fifth segment longest, with an apophysis at the distal

end and a row of four long spines on the ventral surface. Apophysis has several long ventral setae. Sixth segment short, with a cluster of long setae at the ventrodistal end. Segments seven to ten (strigilis) each have a single ventral row of denticulate oviger spines with the formula 7: 8: 10: 7, and long setae are present on the dorsodistal end of segments seven, eight, and nine (Fig. 3D). Terminal oviger claw absent.

Legs consisting of eight segments (Fig. 3E). Coxa I very short, with a row of setae along the distalmost edge of the segment. Coxa II, longest of the three coxae, with two spines on the dorsal side and a cluster of long spines at the distalmost ventral edge of the segment. Coxa III, slightly longer than coxa I, with two spines on the ventral surface and a cluster of long spines at the distalmost ventral edge of the segment. Femur narrow in its proximal part, broadening at the distal end, with a row of long spines at the dorsodistal end. Tibia I with a row of long spines covering the entire dorsal surface and a short row of spines covering the second half of the ventral surface. Tibia II with a row of long spines running nearly the entire length of the ventral surface and a row of spines running the entire length of the dorsal surface, in the following pattern: 2–4 short spines then a long spine (twice as long as the short spines), repeated several times. Tarsus short, curved, about half the length of coxa I, without spines. Propodus with a scattered row of long spines on the dorsal surface and a row of long spines at the distalmost end. There are several rows of long heel and sole spines on the ventral surface, a thick terminal claw less than $\frac{1}{2}$ (0.41) the length of the propodus, and two thin auxiliary claws, $\frac{1}{2}$ the length of the terminal claw (Fig. 3F).

Abdomen short, conical, as long as its diameter, located above the fourth segment of the body, its front end marking the separation between the third and fourth segments (Fig. 3A–B).

Standard measurements. Proboscis 0.3 mm long, 0.29 mm wide.

Body 0.7 mm long from anterior end of cephalic segment to end of fourth lateral processes, 0.43 mm wide between second pair of lateral processes.

Leg 1 4.39 mm long from coxa I to the tip of main claw. Coxa I, 0.15 mm, coxa II, 0.54 mm, coxa III, 0.23 mm, femur 1.08 mm, tibia I, 0.78 mm, tibia II, 1.08 mm, tarsus, 0.05 mm, propodus 0.34 mm, claw 0.14 mm.

Oviger 1.5 mm long, first segment 0.05 mm, second 0.1 mm, third 0.14 mm, fourth 0.25 mm, fifth 0.37 mm, sixth 0.11 mm, seventh 0.12 mm, eighth 0.11 mm, ninth 0.13 mm, tenth 0.12 mm.

Distribution. Laguna Beach, California, La Paz Bay, Gulf of California, and Pacific coast of Panama.

Remarks. *Callipallene californiensis* (Hall, 1913) had been reported rarely and appeared to be restricted to California. Hilton (1942c) re-described the species and provided an illustration of a complete specimen. Later, Child (1979) described *C. sollicitatus* from La Paz Bay, Gulf of California and the Pacific coast of Panama, providing a complete description and illustrations. Child (1987) reviewed the types of Hall and commented upon previous reports of this species, as well as designating *C. sollicitatus* a junior synonym of *C. californiensis*. Our specimen agrees with the original description of *C. californiensis*, and is located within its range of distribution (California to

Panama). However, one character varies significantly, the proportion of the main claw is 75% the length of the propodus in *C. californiensis*, whereas in our specimen it is 41%; otherwise, all other characters are similar.

Family Nymphonidae Wilson, 1878

Genus *Nymphon* Fabricius, 1794

Nymphon lituus Child, 1979

Fig. 4

Nymphon lituus Child 1979: 38–40, fig. 13.

Material examined. Ojo de Liebre Bay, Guerrero Negro, Baja California Sur, scallop fishing areas: Chocolatero, 27°53'04"N, 114°15'06"W, (UANL-FCB-PYCNO-0048), AH-28, (1♂), 01/10/2012; El Datil, 27°48'43"N, 114°15'06"W, (UANL-FCB-PYCNO-0049), AD-8, (1♂, 1♀), 01/12/2012; La Concha, 27°50'35"N, 114°16'22"W, (UANL-FCB-PYCNO-0050), AC-11, (1♂), 01/12/2012; (UANL-FCB-PYCNO-0051), AC-14, (1♂); (UANL-FCB-PYCNO-0052), AC-15, (1♀), 01/10/2013; (UANL-FCB-PYCNO-0053), AC-10, (1♂), 22/11/2013.

Description. Proboscis cylindrical, longer than wide, horizontal to body (Fig. 4A), with three smooth lips.

Chelifore with two segments, the scape cylindrical. Fingers of the chela slender, longer than the basal part, which is inflated and rectangular, with a single median dorsal spine and 3 large dorsal setae in a row at the distal end, next to the articulation with the movable finger; and 2 long and 3 shorter setae on the ventral surface. The fixed finger has 29–30 slender chela teeth. Upper movable finger without setae, armed with 25 small teeth. The tips of the fingers slightly curved, overlapping distally (Fig. 4B).

Palps of five segments. First segment, very short. Second segment longest, with one large dorsodistal seta. Third segment is 2/3 the length of segment two with three ventral isolated setae. Fourth segment twice as long as segment one, with a ventral row of eight setae. Fifth segment 1.5 times as long as fourth segment, with two parallel rows of nine and seven long ventral setae, terminal end with a cluster of four setae (Fig. 4C).

Ocular tubercle inserted between the first pair of lateral processes, cone-shaped, with two small projections in the form of papillae, with two pairs of eyes (Fig. 4A).

Trunk slender, segmented. Neck 4.5 times longer than its width, smaller, cylindrical, widening in the form of a calyx, with a pair of conical, short anterior projections (Fig. 4A).

Lateral processes between first and second pairs separated slightly by their own diameters, second and third pairs separated by 1.5 times their diameters, and third and fourth pairs separated by less than their own diameters (Fig. 4A).

Legs long and slender (Fig. 4F, G). Coxa I short, without setae. Coxa II two times longer than coxa I, with two ventral anterior setae. Coxa III slightly longer than coxa I,

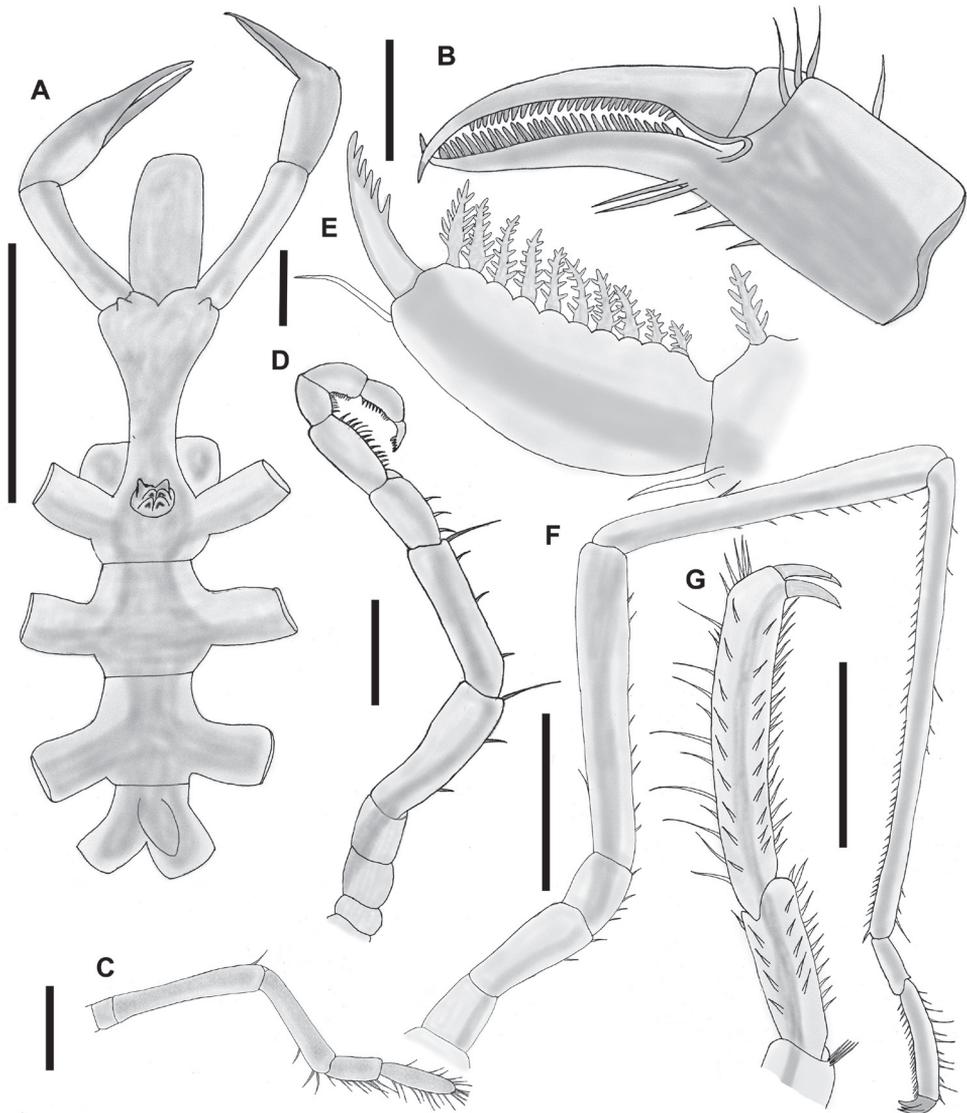


Figure 4. *Nymphon lituus* Child, 1979. **A** Trunk, dorsal view **B** Chela, lateral view **C** Palp, lateral view **D** Ovipositor, lateral view **E** Ovipositor, terminal end, lateral view **F** Third leg, lateral view **G** Propodus, lateral view. Scale bars: 1 mm (**A**, **F**), 100 μ m (**B**), 0.5 mm (**C-D**, **G**), 50 μ m (**E**).

with a row of four small ventral setae. Femur long, with one dorsal seta and scattered ventral setae. Tibia I with a single long median dorsal seta, and a ventral row of 9 smaller setae. Tibia II with a row of 45–50 small ventral setae, and 8–9 dorsal setae. Tarsus half as long as propodus with 10–11 ventral setae, a lateral row of six setae and a dorsal row of four setae. Propodus two times longer than tarsus, slightly curved, with a row of 19–20 sole spines, a median lateral row of ten spines, and two dorsal rows of 18–20 spines each,

one row composed of short and the other of long spines. Main claw short, less than $\frac{1}{4}$ the length of the propodus, auxiliary claws nearly as long as main claw (Fig. 4G).

Oviger (Fig. 4D, E) inserted in the distal half of the first lateral process. First three segments short, first segment is half the size of the second one, second and third segments are subequal. Fourth and fifth segments longest, subequal. Fourth segment with two short ventral setae, and one long ventrodiscal spine, fifth segment with a ventral row of three setae and one long ventrodiscal spine. Sixth segment as long as the first and second together, with a ventral row of three setae. Last four segments armed with compound ovigerous leg spines, each with the following formula: 13: 9: 8: 10. Compound spines with 3–6 pairs of lateral teeth depending upon the size of the spine. Terminal claw long, curved, with six teeth (Fig. 4E).

Female gonopores oval in shape, present on ventrodiscal end of coxa II of all leg pairs. These were observed on only two specimens (AD-8 and AC-15). All other specimens (males) without readily visible gonopores.

Abdomen as long as lateral processes of 4th pair of legs, elevated from the body at an angle of about 30° (Fig. 4A).

Standard measurements. Proboscis 0.57 mm long, 0.28 mm wide.

Body 1.43 mm long from anterior end of cephalic segment to end of 4th lateral processes, 1.0 mm wide between second pair of lateral processes.

Leg 1 9.35 mm long from coxa I to the tip of main claw. Coxa I, 0.37 mm, coxa II, 0.71 mm, coxa III, 0.41 mm, femur 1.84 mm, tibia I, 2.02 mm, tibia II, 2.78 mm, tarsus, 0.35 mm, propodus 0.71 mm, claw 0.16 mm.

Oviger 3.19 mm long, first segment 0.78 mm, second 0.81 mm, third 0.38 mm, fourth 0.44 mm, fifth 0.19 mm, sixth 0.22 mm, seventh 0.38 mm, eighth 0.24 mm, ninth 0.24 mm, tenth 0.21 mm.

Distribution. This species is known from Gulf of California and Panama: specimens from Gulf of California were taken on floating *Sargassum* around Puerto Peñasco, Sonora, and in Panama City, among hydroids and bryozoans (Child 1979, p. 40). With this record, the distribution of *N. lituus* is extended to the western coast of Baja California Peninsula.

Remarks. The genus *Nymphon* includes 277 valid species (Bamber et al. 2015). Despite the great diversity of the genus, only ten species are known from the eastern Pacific: *Nymphon aculeatum* Child, 1994 from San Clemente Basin, California; *N. apheles* Child, 1979 from Panama; *N. duospinum* (Hilton, 1942) from Alaska; *N. heterodenticulatum* Hedgpeth, 1941 from Santa Catalina Island, southern California; *N. hirsutum* Child, 1995 from the Bering Sea; *N. lituus* Child, 1979 from the Gulf of California and Panama; *N. longicollum* Hoek, 1881 from Chile (also from New Zealand and Auckland Islands); *N. pixellae* Scott, 1912 from Vancouver, Canada (also from California and Japan); *N. similis* Child, 1992 from Ecuador; and *N. stipulum* Child, 1990 from southern California. *Nymphon lituus* is a species known only from its original description; the specimens found in this study vary slightly in the number of compound ovigerous leg spines, with the formula 13: 9: 8: 10, in contrast to the original description of *N. lituus* with the formula 15: 10: 10: 11. The other features do not present major variations.

Family Pycnogonidae Wilson, 1878

Genus *Pycnogonum* Brünnich, 1764

***Pycnogonum rickettsi* Schmitt, 1934**

Fig. 5

Pycnogonum rickettsi Schmitt 1934: 62, Fig. 1 A-D.

Pycnogonum rickettsi. Child and Hedgpeth 2007: 665; Hilton 1943b: 19; Hedgpeth 1975: 41a7, 424; pl. 99, fig. 3; Hedgpeth and Haderlie 1980:638, fig. 27.2.

Material examined. Ojo de Liebre Bay, Guerrero Negro, Baja California Sur, scallop fishing area: La Concha, 27°50'35"N, 114°16'22"W, (UANL-FCB-PYCNO-0054), AC-3 (1♀), 01/12/2012.

Description. Proboscis robust, longer than wide, slightly down-curved, articular membrane at base of proboscis narrow (Fig. 5A–C).

Ocular tubercle high, bell-shaped, with two pairs of large strongly pigmented eyes (Fig. 5C).

Trunk robust, segmented, integument granular (Fig. 5A, C), with reticulations evident on dorsal and ventral surfaces. Fully segmented, first three trunk segments armed with a high dorsal ridge at posterior end of each body segment.

Lateral processes separated by approximately one third of their width, all as long as wide, those of the first segment are directed forward, the second and third lateral processes are directed straight out and the fourth ones point backwards (Fig. 5A).

Legs: Coxae I and II subequal, coxa III shortest, articular membrane between segments wide. Femur is the longest segment, with two conical projections on dorsodistal end and a group of isolated setae on ventral surface. Tibia I is slightly shorter than femur and is nearly twice the length of tibia II, with two dorsodorsal conical projections, similar to those found on the femur, with a strong recurved spine between the conical projections, and isolated setae on the ventral surface; tibia II short, with a slight dorsal depression mid-segment, a strong distal recurved spine, and a small group of ventral setae placed in 3–4 regular rows. Tarsus short, with 6–7 rows of setae that almost completely cover the ventral surface. Propodus nearly as long as femur, with four rows of sole spines. Claw approximately 50% of propodus length, auxiliary claws absent (Fig. 5E).

Chelifores: absent

Palps: absent

Oviger: absent.

Female gonopore evident, oval, well-defined, situated on dorso-lateral surface of coxa II of fourth pair of legs (Fig. 5D).

Abdomen 0.8 mm long, smooth, cylindrical, reaching distal margin of coxa I on fourth pair of legs, with four small spines on middle dorsal area (Fig. 5C), posterior end truncate (Fig. 5A, D), and anus terminal.

Standard measurements. Proboscis 2.2 mm long, 0.9 mm wide.

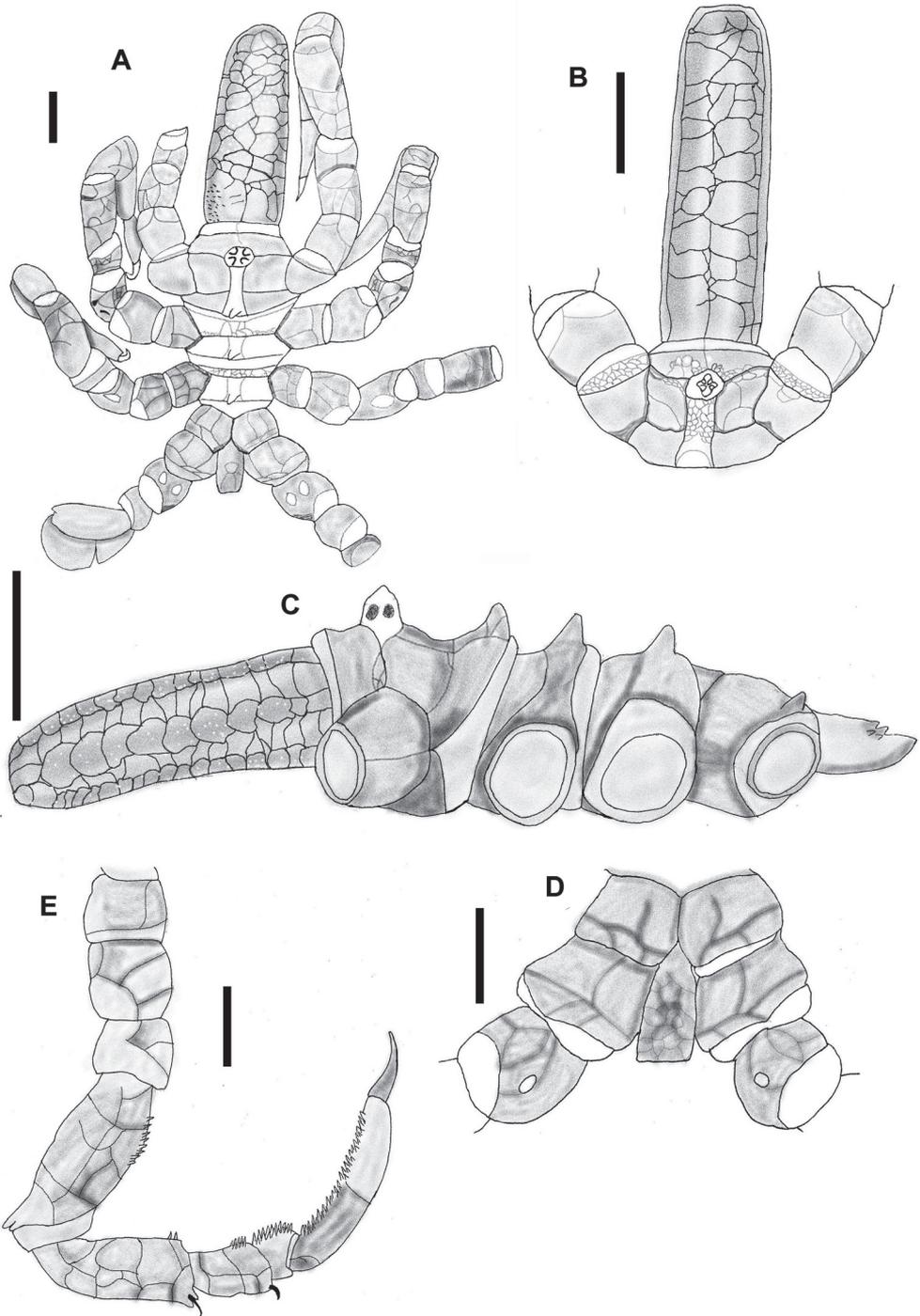


Figure 5. *Pycnogonum rickettsi* Schmitt, 1934. **A** Trunk, dorsal view **B** Trunk, dorsal view detail anterior end **C** Trunk, lateral view **D** Trunk, dorsal view, detail posterior end **E** Third leg, lateral view. Scale bars 1 mm (**A–C**), 0.5 mm (**D–E**).

Body 2.08 mm long from anterior end of cephalic segment to end of fourth lateral processes, 1.91 mm wide between second pair of lateral processes.

Leg 1 6.0 mm long from coxa I to the tip of main claw. Coxa I, 0.5 mm, coxa II, 0.6 mm, coxa III, 0.3 mm, femur 1.2 mm, tibia I, 1.1 mm, tibia II, 0.6 mm, tarsus, 0.2 mm, propodus 1.0 mm, claw 0.5 mm.

Distribution. Puget Sound to the southern California Bight; this is the first record from western Mexico.

Remarks. Only a single female specimen was collected in this study. The specimen reported in this paper differs in some characteristics from the holotype of *Pycnogonum rickettsi*. However, we think it may be premature to describe this specimen as a new species because our specimen is a female and that described by Schmitt (1934) is a male.

Acknowledgments

This work was financially supported by the Universidad Autónoma de Nuevo León (Grant number PAICYT CN937). We are extremely grateful to Katsumi Miyazaki, Anna Soler and Bonnie Bain reviewers and editor respectively whose comments and suggestions were much appreciated and very helpful in improving the manuscript. Many thanks to Jesús Flores and Jesús Mendieta for their help with the collections and sorting of samples. We are grateful to David Lazcano for providing valuable comments on an earlier manuscript.

References

- Arnaud F (1978) A new species of *Ascorhynchus* (Pycnogonida) found parasitic on an opisthobranchiate mollusc. In: Sea Spiders (Pycnogonida). Zoological Journal of the Linnean Society of London 63(1+2): 99–104. doi: 10.1111/j.1096-3642.1978.tb02092.x
- Arnaud F, Bamber RN (1988) The Biology of Pycnogonida. *Advances in Marine Biology* 24: 1–96. doi: 10.1016/S0065-2881(08)60073-5
- Bamber RN, El Nagar A, Staples D (2015) Pycnobase: World Pycnogonida Database. <http://www.marinespecies.org/aphia.php?p=taxdetails&id=1302> [accessed on 26 May 2015]
- Cano-Sánchez E, López-González PJ (2007) Pycnogonids and the possible effect of the climatic change in the Andalusian fauna. *El cambio climático en Andalucía: evolución y consecuencias medioambientales*. Consejería de Medio Ambiente (Junta de Andalucía) 9: 169–178.
- Child CA (1979) Shallow-water Pycnogonida of the Isthmus of Panama and the Coasts of Middle America. *Smithsonian Contributions to Zoology* 293: 1–86. doi: 10.5479/si.00810282.293
- Child CA (1987) The Pycnogonida Types of H.V.M. Hall. *Proceedings of the Biological Society of Washington* 100(3): 552–558.
- Child CA (1988) Pycnogonida of the Western Pacific Islands, III: Recent Smithsonian-Philippine Expeditions. *Smithsonian Contributions to Zoology* 468: 1–32. doi: 10.5479/si.00810282.468

- Child CA (1991) Pycnogonida of the Western Pacific Islands, IX. A shallow-water Guam survey, 1984. *Proceedings of the Biological Society of Washington* 104(1): 138–146.
- Child CA (1995) Pycnogonida of the Western Pacific Islands, XI: Collections from the Aleutians and other Bering Sea Islands, Alaska. *Smithsonian Contributions to Zoology* 569: 1–30. doi: 10.5479/si.00810282.569
- Child CA, Hedgpeth JW (1971) Pycnogonida of the Galapagos Islands. *Journal of Natural History* 5: 609–634. doi: 10.1080/00222937100770461
- Child CA, Hedgpeth JW (2007) Pycnogonida. In: Carlton J (Ed.) *The Light and Smith Manual: Intertidal Invertebrates from Central California to Oregon* (4th edition). University of California Press, Berkeley, 656–665.
- Genzano GN (2002) Associations between pycnogonids and hydroids from the Buenos Aires littoral zone, with observations on the semi-parasitic life cycle of *Tanystylum orbiculare* (Ammonotheidae). *Scientia Marina* 66(1): 83–92.
- Hall HVM (1913) Pycnogonida from the coast of California, with descriptions of two new species, *University of California Publications in Zoology* 11: 127–42.
- Hedgpeth JW (1947) On the evolutionary significance of the Pycnogonida. *Smithsonian Miscellaneous Collections* 106: 1–54.
- Hedgpeth JW (1948) The Pycnogonida of the western North Atlantic and the Caribbean. *Proceedings of the United States National Museum* 97(3216): 157–342.
- Hedgpeth JW (1975) Pycnogonida. In: Smith RI, Carlton JT (Eds) *Light's Manual: Intertidal Invertebrates of the Central California Coast* (3rd edition). University of California Press, 413–424.
- Hedgpeth JW, Haderlie EC (1980) Chapter 27 – Pycnogonida: The Sea Spiders. In: Morris RH, Abbott DP, Haderlie EC (Eds) *Intertidal Invertebrates of California*. Stanford University Press, 636–640.
- Hilton WA (1915a) Pycnogonids collected during the summer of 1914 at Laguna Beach. *Journal of Entomology and Zoology of Pomona College* 7(1): 67–70.
- Hilton WA (1915b) Pycnogonids collected during the summer of 1915 at Laguna Beach. *Journal of Entomology and Zoology of Pomona College* 7(3): 201–206.
- Hilton WA (1916) The nervous system of Pycnogonids. *Journal of Comparative Neurology* 26(5): 463–472. doi: 10.1002/cne.900260502
- Hilton WA (1920) Notes on Pacific Coast Pycnogonids. *Journal of Entomology and Zoology of Pomona College* 12(4): 93.
- Hilton WA (1942a) Pantopoda chiefly from the Pacific, 1-Nymphonidae. *Pomona Journal of Entomology and Zoology* 34(1): 3–7.
- Hilton WA (1942b) Pantopoda (Continued). II; Family Callipallenidae. *Pomona Journal of Entomology and Zoology* 34(2): 38–41.
- Hilton WA (1942c) Pycnogonids from the Allan Hancock Expeditions. *Allan Hancock Pacific Expeditions (University of Southern California)* 5(9): 277–339.
- Hilton WA (1943a) Pycnogonids from the Pacific. Family Ammonotheidae, *Journal of Entomology and Zoology Pomona College* 34(4): 93–99.
- Hilton WA (1943b) Pycnogonids of the Pacific. Family Pycnogonidae, Family Endeidae. *Journal of Entomology and Zoology, Pomona College* 35(2): 19.

- Kraeuter JN (1973) Pycnogonida from Georgia, U.S.A. *Journal of Natural History* 7(5): 493–498. doi: 10.1080/00222937300770381
- Loman JCC (1912) Note préliminaire sur les “Podosomata” Pycnogonides du Musée Océanographique de Monaco. *Bulletin l’Institut Océanographique, Monaco* 238: 1–14.
- Müller HG (1990) Flachwasser-Pantopoden von Bora Bora, Gesellschaftsinseln, S-Pazifik, mit zwei Neubeschreibungen (Pantopoda). *Senckenbergiana biológica* 70 (1989) (1/3): 185–201.
- Muller HG, Krapp F (2009) The pycnogonid fauna (Pycnogonida, Arthropoda) of the Tayrona national park and adjoining areas on the Caribbean coast of Colombia. *Zootaxa* 2319: 1–138.
- Munilla-León T (2002) Pycnogonida. In: Llorente-Bousquets J, Morrone JJ (Eds) *Biodiversidad, taxonomía y biogeografía de artrópodos de México: Hacia una síntesis de su conocimiento*. Vol. III, Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México, 215–222.
- Nakamura K, Chullasorn S (2000) *Eurycyde flagella*, a new pycnogonid species from Phuket Island, Thailand. *Publications Seto Marine Biological Laboratory* 39(1): 1–7. <http://hdl.handle.net/2433/176295>
- Schmitt WL (1934) Notes on certain pycnogonids including descriptions of two new species of *Pycnogonum*. *Journal of Washington Academy of Sciences* 24(1): 61–70.
- Stock JH (1955) Pycnogonida from the West Indies, Central America and the Pacific Coast of North America. *Papers from Dr Th. Mortensen's Pacific Expedition 1914–1916. Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening I Kjobenhavn* 117: 209–266.
- Stock JH (1975) Pycnogonida from the Continental Shelf, Slope, and Deep Sea of the Tropical Atlantic and East Pacific. In *Biological Results of the University of Miami Deep-Sea Expeditions*, 108. *Bulletin of Marine Science* 24(4): 957–1092.
- Stock JH (1979) Pycnogonida from the mediolittoral and infralittoral zones in the tropical Western Atlantic. *Studies on the Fauna of Curaçao and other Caribbean Islands* 59(184): 1–32.
- Stock JH (1986) Pycnogonida from the Caribbean and the Straits of Florida. *Bulletin of Marine Science* 38(3): 399–441.
- Stock JH (1990) Macaronesian Pycnogonida. CANCAP-project. Contribution no.78. *Zoologische Mededelingen* 63(16): 205–233.
- Stock JH (1992) Pycnogonida from Southern Brazil. *Tijdschrift voor Entomologie* 135: 113–139.

