

Eight new species of the spider genera *Raveniola* and *Sinopesa* from China and Vietnam (Araneae, Nemesiidae)

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Abstract

Eight new species, seven *Raveniola* Zonstein, 1987 and one *Sinopesa* Raven & Schwendinger, 1995 from China and Vietnam are described: *Raveniola alpina* sp. n., *R. bellula* sp. n., *R. chayi* sp. n., *R. gracilis* sp. n., *R. rugosa* sp. n., *R. spirula* sp. n. and *R. yajiangensis* sp. n. and *Sinopesa ninhbinhensis* sp. n. Keys to all East-Asian congeners, diagnoses of the new species, and new distribution data of *R. montana* Zonstein & Marusik, 2012, with a first record for Sichuan, China, are provided.

Keywords

Taxonomy, mygalomorph spiders, new records, South-East Asia

Introduction

The Nemesiidae are known to include 45 genera and 382 species (World Spider Catalog 2015). The members of five nemesiid genera are distributed within Eastern and South-Eastern Asia: *Atmetochilus* Simon, 1887, *Damarchilus* Silival, Molur & Raven, 2015, *Damarchus* Thorell, 1891, *Raveniola* Zonstein, 1987 and *Sinopesa* Raven &

Schwendinger, 1995. Before our study, eleven species in three genera were known from China (Li and Wang 2014; Zonstein and Marusik 2012) and none from Vietnam.

While sorting and identifying nemesiid material in the Institute of Zoology, Chinese Academy of Sciences, eight new species belonging to *Raveniola* and *Sinopesa* were found; they are described here. The systematic position of both genera was recently considered by Zonstein and Marusik (2012). The latter genus was shown to be more closely related to the former rather than to the African *Entypesa* Simon, 1902 as suggested by Raven and Schwendinger (1995).

To permit reliable identification and stimulate further studies in this area, all new descriptions are illustrated and keys to the studied genera and species are added.

Material and methods

Specimens were examined and measured with a LEICA M205 C stereomicroscope and details were studied with an Olympus BX51 compound microscope. Illustrations were made using a camera lucida attached to the Olympus BX51 microscope and inked with an ink jet plotter. Male palps and female genitalia were examined and illustrated after they were dissected from the spiders. Vulvae were treated in a warm solution of 10% potassium hydroxide (KOH). The left palp and left legs I and II of male spiders were illustrated, unless otherwise indicated. Specimens were preserved in a 75% ethanol solution. Photos were taken with an Olympus C7070 wide zoom digital camera (7.1 megapixels) mounted on an Olympus SZX12 stereomicroscope. The images were assembled using Helicon image stacking software. All measurements are given in millimetres unless otherwise noted. Leg measurements are given as: total length (femur + patella + tibia + metatarsus + tarsus). Leg segments were measured on the dorsal side.

The following abbreviations are used: AL – abdomen length; ALE – anterior lateral eye(s); AME – anterior median eye(s); AW – abdomen width; CL – carapace length; CW – carapace width; PLE – posterior lateral eye(s); PLS – posterior lateral spinneret(s); PME – posterior median eye(s); PMS – posterior median spinneret(s); TL – total length (including chelicerae, but not spinnerets).

All specimens used in this study are deposited in the Institute of Zoology, Chinese Academy of Sciences (IZCAS) in Beijing, China. The only exception is the female paratype of *R. chayi* sp. n., kept at the Senckenberg Museum, Frankfurt am Main, Germany (SMF).

Taxonomy

Family Nemesiidae Simon, 1889

Notes. Only two genera of the family occur with some degree of certainty in eastern Asia. Judging from the original description, *Nemesia sinensis* Pocock, 1901 probably belongs to the Cyrtauchenidae (see Zonstein and Marusik 2012).

Key to the East and South-East Asian genera of Nemesiidae:

The distribution of *Atmetochilus* is given considering data provided by Schwendinger (1996) and Zonstein and Marusik (in press).

- 1 Thoracic fovea short, U-shaped; posterior sternal sigilla distinctly larger and farther from sternal margin than other sigilla, in many cases subcentral or confluent; paired tarsal claws either with two more or less distinctly juxtaposed teeth rows (females) or with one S-shaped row (males); PMS well developed; male tibia I with coupling spur and megaspines located proventrally **2**
- Thoracic fovea short, straight or pit-like; posterior sternal sigilla submarginal; paired tarsal claws with two similar teeth rows on promargin and retromargin in males and females; PMS small to absent; male tibia I with two enlarged retroventral distal spines and without coupling spur **4**
- 2 Posterior sternal sigilla submarginal to subcentral but not confluent (Raven 1985: fig. 53; Siliwal et al. 2015: figs 1D, 2D)..... **3**
- Posterior sternal sigilla confluent; (Raven 1985: fig. 59)
..... *Atmetochilus* (India, Indonesia, Myanmar and Thailand)
- 3 Metatarsal preening combs absent on legs III and IV; female tarsus IV with scopula..... *Damarchilus* (Eastern India)
- Metatarsal preening combs present on legs III and IV; female tarsus IV without scopula *Damarchus* (Eastern India, Indonesia, Malaysia, Myanmar, Singapore and Thailand)
- 3 Carapace hirsute and with finely granular texture; hairs on legs I–IV long and non-uniform; tarsal scopula more or less dense and long; male intercheliceral tumescence reduced if present.....
..... *Raveniola* (south Palearctic, from Turkey to China)
- Carapace with only a few bristles; hairs on legs I–IV more or less uniformly short; tarsal scopula thin and short; male intercheliceral tumescence well developed.....
..... *Sinopesa* (South-eastern China, Ryukyu Isles, Thailand and Vietnam)

Genus *Raveniola* Zonstein, 1987

Type species. *Brachythele virgata* Simon, 1891, from Central Asia, by the original designation.

Diagnosis. *Raveniola*, similar to *Sinopesa* Raven & Schwendinger, 1995, has two enlarged retroventral distal spines on tibia I in males and divided receptacles in females, as well as the absence of a serrula and metatarsal preening combs. The leg scopula in *Raveniola* is more developed than it is in *Sinopesa*. By contrast, the male intercheliceral tumescence in *Raveniola* is lost or vestigial, whereas in *Sinopesa*, it is well-developed. Like *Sinopesa*, members of *Raveniola* have more or less reduced PMS, which are completely lost in some species. The apical segment of the PLS in *Raveniola* is usually shorter than that in *Sinopesa*.

Composition. *Raveniola* currently comprises 29 species, including the new species described here; 14 of them occur in China: *R. alpina* sp. n., *R. bellula* sp. n., *R. chayi* sp. n., *R. gracilis* sp. n., *R. guangxi* (Raven & Schwendinger, 1995), *R. hebeinica* Zhu, Zhang & Zhang, 1999, *R. montana* Zonstein & Marusik, 2012, *R. rugosa* sp. n., *R. shangrila* Zonstein & Marusik, 2012, *R. songi* Zonstein & Marusik, 2012, *R. spirula* sp. n., *R. xizangensis* (Hu & Li, 1987), *R. yajiangensis* sp. n. and *R. yunnanensis* Zonstein & Marusik, 2012.

Key to East Asian *Raveniola* species

Females of *R. alpina* sp. n., *R. gracilis* sp. n., *R. guangxi*, *R. rugosa* sp. n., *R. shangrila*, *R. songi*, *R. spirula* sp. n. and *R. yunnanensis* are unknown.

1	Males.....	2
–	Females.....	15
2	PMS present.....	3
–	PMS absent.....	9
3	Carapace length > 10 mm. Embolus with distinct subapical keel... <i>xizangensis</i>	
–	Carapace length 3.0–7.3 mm. Embolic keel absent or vestigial.....	4
4	Palpal tibia relatively short, with a length/width ratio of 3.0–3.2 (Fig. 11A–C). Embolus short and with deep subbasal ridges (Fig. 12A–C).....	<i>montana</i>
–	Palpal tibia and embolus relatively long, with a length/width ratio of 3.6–4.5 (Figs 1A–C, 2A–C, 3A–C, 5A–C, 6A–C, 7A–C, 9A–C, 10A–C, 13A–C, 14A–C, 15A–C, 16A–C, 17A–C, 19A–C).....	5
5	Embolus with distally hooked tip (Figs 9A–C, 10A–C).....	<i>gracilis</i> sp. n.
–	Embolus tip not hooked.....	6
6	Embolus more or less twisted.....	7
–	Distal part of embolus curved gradually (Zonstein and Marusik 2012: fig. 39).....	<i>hebeinica</i>
7	Tibia I equal in length to or shorter than metatarsus (as in Fig. 17E). Few spines on cymbium (as in Fig. 19A–C).....	8
–	Tibia I considerably longer than metatarsus (see Zonstein and Marusik 2012: fig. 29). Cymbium with numerous dorsal spines (Op. cit.: fig. 35).....	<i>yunnanensis</i>
8	Embolus only slightly twisted (Op. cit.: fig. 42).....	<i>songi</i>
–	Embolus distinctly twisted (Figs 19A–C).....	<i>yajiangensis</i> sp. n.
9	Embolus with hooked tip (see Zonstein and Marusik 2012: figs 37, 38).....	<i>guangxi</i>
–	Embolus tip not hooked.....	10
10	Embolus strongly spiralled as in Figs 15A–C, 16A–C.....	<i>spirula</i> sp. n.
–	Embolus more or less curved, slightly spiralled or bent as in Figs 1A–C, 2A–C, 3A–C, 5A–C, 6A–C, 7A–C, 13A–C, 14A–C.....	11
11	Embolus slightly spiralled as in Figs 1A–C, 2A–C.....	<i>alpina</i> sp. n.

- Embolus curved or gradually twisted 12
- 12 Entire embolus arched as in Figs 13A–C, 14A–C *rugosa* sp. n.
- Embolus more or less distinctly twisted as in Figs 3A–C, 5A–C, 6A–C, 7A–C 13
- 13 Abdomen with dorsal and ventral spotted pattern (Figs 3D, G, 6D, G). Embolus only slightly twisted (Figs 3A–C, 5A–C, 6A–C, 7A–C)..... 14
- Abdomen uniformly dark brown. Embolus noticeably twisted (see Zonstein and Marusik 2012: fig. 41) *shangrila*
- 14 Dorsal abdominal pattern consists of numerous darker spots on a lighter background (Fig. 3D). Metatarsus I very gently curved (Fig. 3E). Embolus moderately long without ridges (Figs 3A–C, 5A–C) *bellula* sp. n.
- Dorsal abdominal pattern consists of numerous lighter spots on a darker background (Fig. 6D). Metatarsus I noticeably curved (Fig. 6E). Embolus long and tapering with ridges (Figs 6A–C, 7A–C) *chayi* sp. n.
- 15 PMS present 16
- PMS absent 19
- 16 Carapace length > 10 mm. Median (ental) branch of receptacle bifurcate (Op. cit., fig. 50)..... *xizangensis*
- Carapace length < 8 mm. Median (ental) branch of receptacle entire..... 17
- 17 Median (ental) branch of receptacle curved inward as shown in Figs 18, 19D *yajiangensis* sp. n.
- Shape of receptacles different 18
- 18 PLS: apical segment triangular. Receptacular bases narrow (Zonstein and Marusik 2012, fig. 47) *hebeinica*
- PLS: apical segment digitiform. Receptacular bases widened (Op. cit., fig. 48) *montana*
- 19 Receptacles as shown in Figs 4A, 5D *bellula* sp. n.
- Receptacles as shown in Figs 8B–C *chayi* sp. n.

***Raveniola alpina* sp. n.**

<http://zoobank.org/E841EDAB-BDA2-49FC-B8B8-9C435C8303B3>

Figs 1–2

Type material. Holotype ♂ – CHINA, Yunnan Province, Zhongdian County, northern Zhongdian [27°50.119'N, 99°42.426'E, elevation 3285 m], July 23–30, 2000, X. Yu & H. Zhou (IZCAS). Paratypes: same data but Xiaoxueshanyakou [27°49.119'N, 99°41.426'E, elevation 3265 m] – 1♂ (IZCAS); same data but Bitahaixi [27°48.105'N, 99°40.429'E, elevation 3285 m] – 2♂ (IZCAS).

Etymology. The specific name is taken from the Latin adjective “*alpinus*”, which means “alpine” and refers to the high altitude of the type locality.

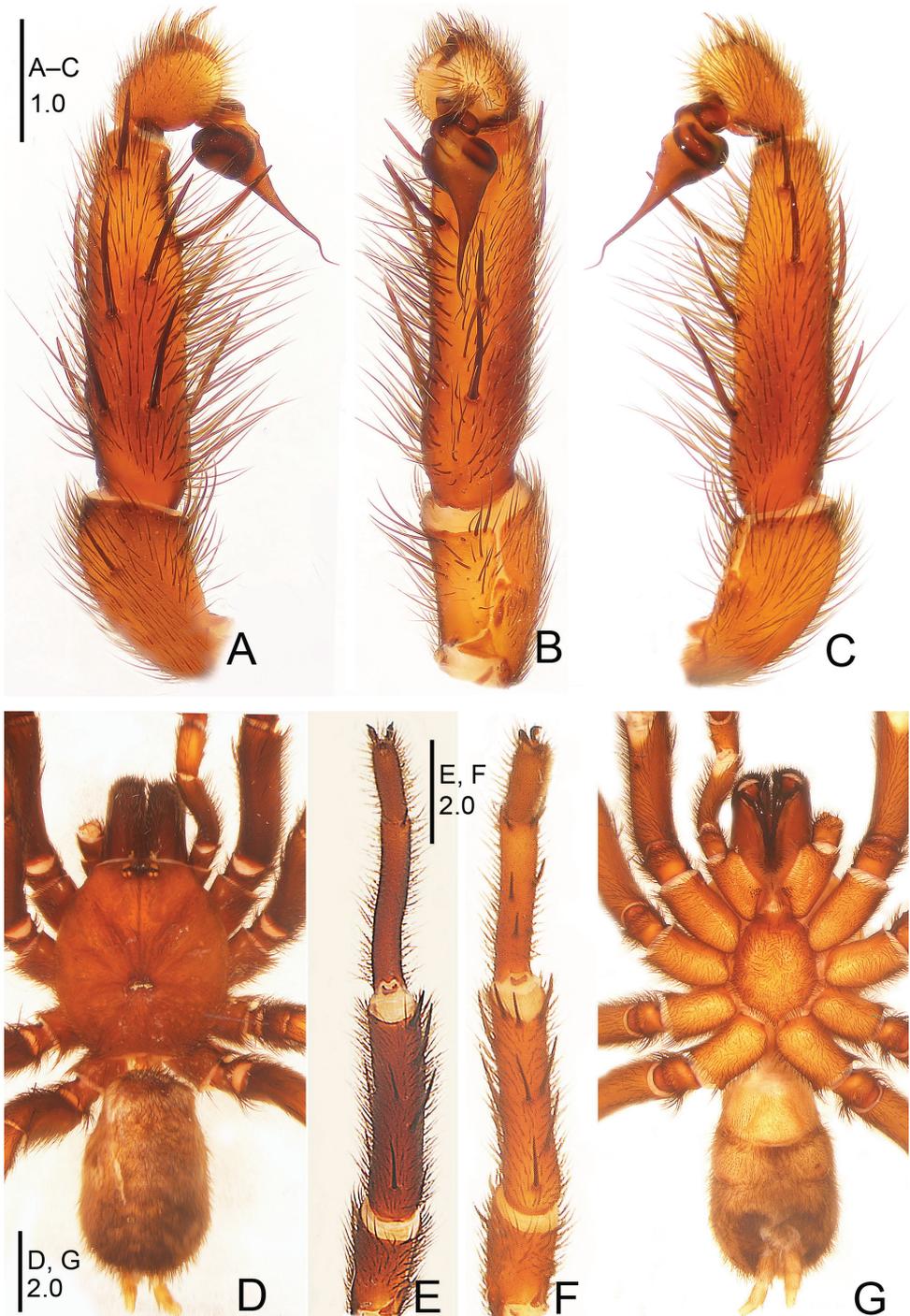


Figure 1. *Raveniola alpina* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** habitus, dorsal view **E** leg I, ventral view **F** leg II, ventral view **G** habitus, ventral view. Scale bars: 1.0 mm (**A-C**); 2.0 mm (**D-G**).

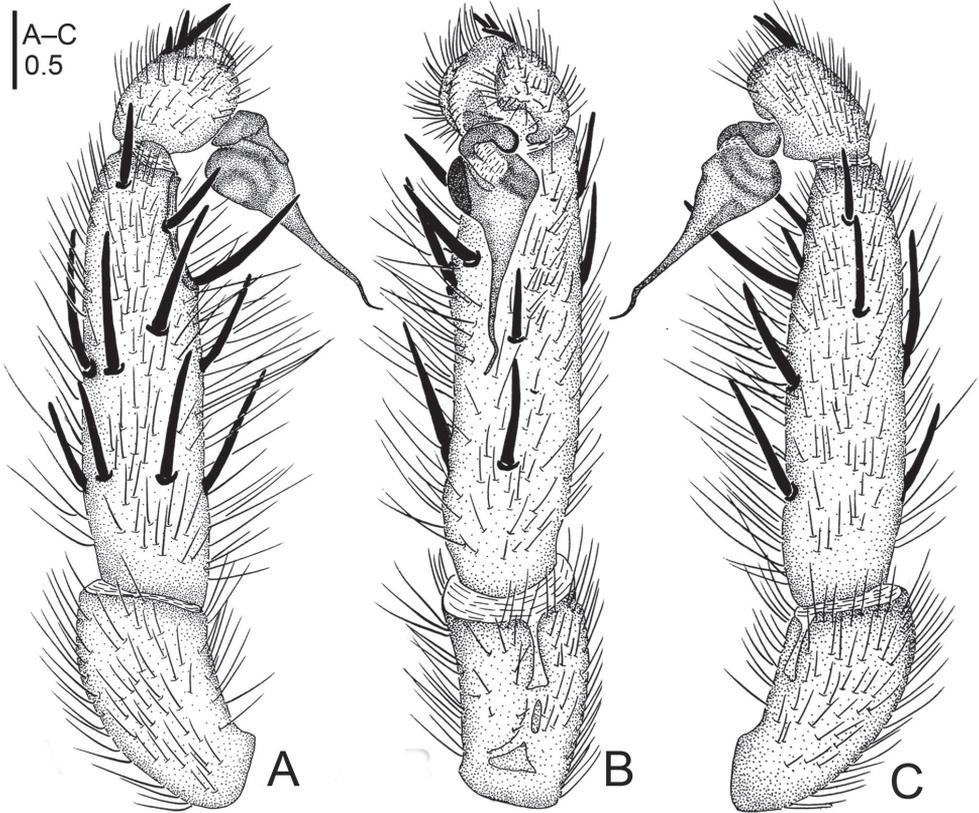


Figure 2. *Raveniola alpina* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view. Scale bar: 0.5 mm.

Diagnosis. The new species is similar to *R. chayi* sp. n., *R. shangrila* and *R. songi*, all also occurring in Yunnan, but differs by the slightly twisted and bent distal portion of the embolus (Figs 1A–C, 2A–C, cf. Figs 6A–C, 7A–C). *R. alpina* sp. n. can be distinguished from the latter species also by the absence of PMS (present in *R. songi*).

Description. Male (holotype): TL 14.50, CL 5.75, CW 5.25, AL 6.55, AW 4.00. Eye diameters and interdistances: AME 0.17, ALE 0.31, PME 0.13, PLE 0.15, AME–AME 0.19, AME–ALE 0.10, PME–PME 0.55, PME–PLE 0.08. Leg lengths: I: 17.05 (4.90+2.10+4.40+3.50+2.15), II: 16.15 (4.85+1.50+4.30+3.40+2.10), III: 14.50 (4.25+1.70+3.10+3.25+2.20), IV: 18.45 (5.10+2.15+4.55+4.10+2.55). Labium, sternum and maxillae as shown in Fig. 1G. Maxillae with 15–20 cuspules. Prosoma, palps and legs brown. Spinnerets deep grey (Fig. 1D, G). Metatarsus I noticeably curved (Fig. 1E). PMS entirely reduced, apical segment of PLS digitiform (Fig. 1D, G). Palpal tibia long, cylindrical; bulb long, pyriform; embolus gradually tapering to a slender bent point; distal cymbium with three short, stout spines (Figs 1A–C, 2A–C).

Female. Unknown.

Distribution. China: northern Yunnan.

***Raveniola bellula* sp. n.**

<http://zoobank.org/CAB030BD-41D7-43E9-978F-0C0FE340CE19>

Figs 3–5

Type material. Holotype ♂ – CHINA, Yunnan Province, Mengla County, Xishuangbanna, Menglun Town, primary tropical seasonal rainforest in Menglun Nature Reserve [21°57.445'N, 101°12.997'E, 744 m], January 16–31, 2007, G. Zheng (IZ-CAS). Paratypes: 26♂, 2♀ (IZCAS), same data as holotype.

Etymology. The specific name is taken from the Latin adjective “bellulus” (the diminutive form of “bellus”), which means “beautiful” and refers to the perfect shape of the palpal bulb.

Diagnosis. This new species is similar to *R. chayi* sp. n. and *R. yunnanensis* but can be distinguished by having a considerably shorter embolus than that in *R. chayi* sp. n. (Figs 3A–C, 5A–C; cf. Figs 6A–C, 7A–C), by possessing a longer cymbium and a less twisted embolus than *R. yunnanensis*, as well as by having a ventral abdominal pattern and completely reduced PLS (Fig. 3A–C; cf. Zonstein and Marusik 2012: figs 35, 43). Females are characterised by the unique shape of the receptacles, divided into a long, digitiform inner branch and a short, knob-shaped outer branch (Figs 4A, 5D). The habitus and the abdominal pattern of *R. bellula* sp. n. resemble that of *Sinopesa maculata*, but it is distinguished by generic characters, such as well-developed body and leg setation and by much longer and denser tarsal scopula.

Description. Male (holotype): TL 7.90, CL 3.50, CW 2.55, AL 3.60, AW 2.25. Eye diameters and interdistances: AME 0.20, ALE 0.24, PLE 0.16, PME 0.12, AME–AME 0.09, AME–ALE 0.04, PME–PME 0.35, PME–PLE 0.03. Leg lengths: I: 10.04 (2.75+1.65+2.65+1.80+1.55), II: 9.70 (2.75+1.30+2.30+1.85+1.50), III: 9.05 (2.50+1.15+1.65+2.25+1.50), IV: 12.40 (3.25+1.25+3.10+3.15+1.65). Labium, sternum and maxillae as shown in Fig. 3G. Maxillae with ca. 20 cuspules. Prosoma, palps and legs light brown. Spinnerets light grey. Light yellowish grey abdomen with darker (brown) dorsal and ventral pattern (Fig. 3D, G). Metatarsus I very slightly curved (Fig. 3E). PMS absent; apical segment of PLS digitiform (Fig. 3D, G). Palpal tibia moderately long, subcylindrical; bulb long, oval; embolus gradually tapering to a slender point; cymbium with four short, stout spines (Figs 3A–C, 5A–C).

Female. TL 6.75, CL 3.25, CW 2.50, AL 2.75, AW 2.40; body and legs colouration as in male. Eye diameters and interdistances: AME 0.22, ALE 0.24, PME 0.10, PLE 0.15, AME–AME 0.08, AME–ALE 0.05, PME–PME 0.36, PME–PLE 0.04, Leg lengths: I: 10.15 (2.65+1.60+2.55+1.90+1.45), II: 9.55 (2.65+1.45+2.25+1.75+1.45), III: 8.75 (2.45+1.10+1.50+2.25+1.45), IV: 12.00 (3.20+1.15+3.00+3.10+1.55). Genital area as in Fig. 4B. Receptacles divided into a long, digitiform inner branch and a short, knob-shaped outer branch that is bent forward (Figs 4A, 5D).

Variation. Total length of males and females: 6.75–7.93 (n=8).

Distribution. The species is known only from the type locality.

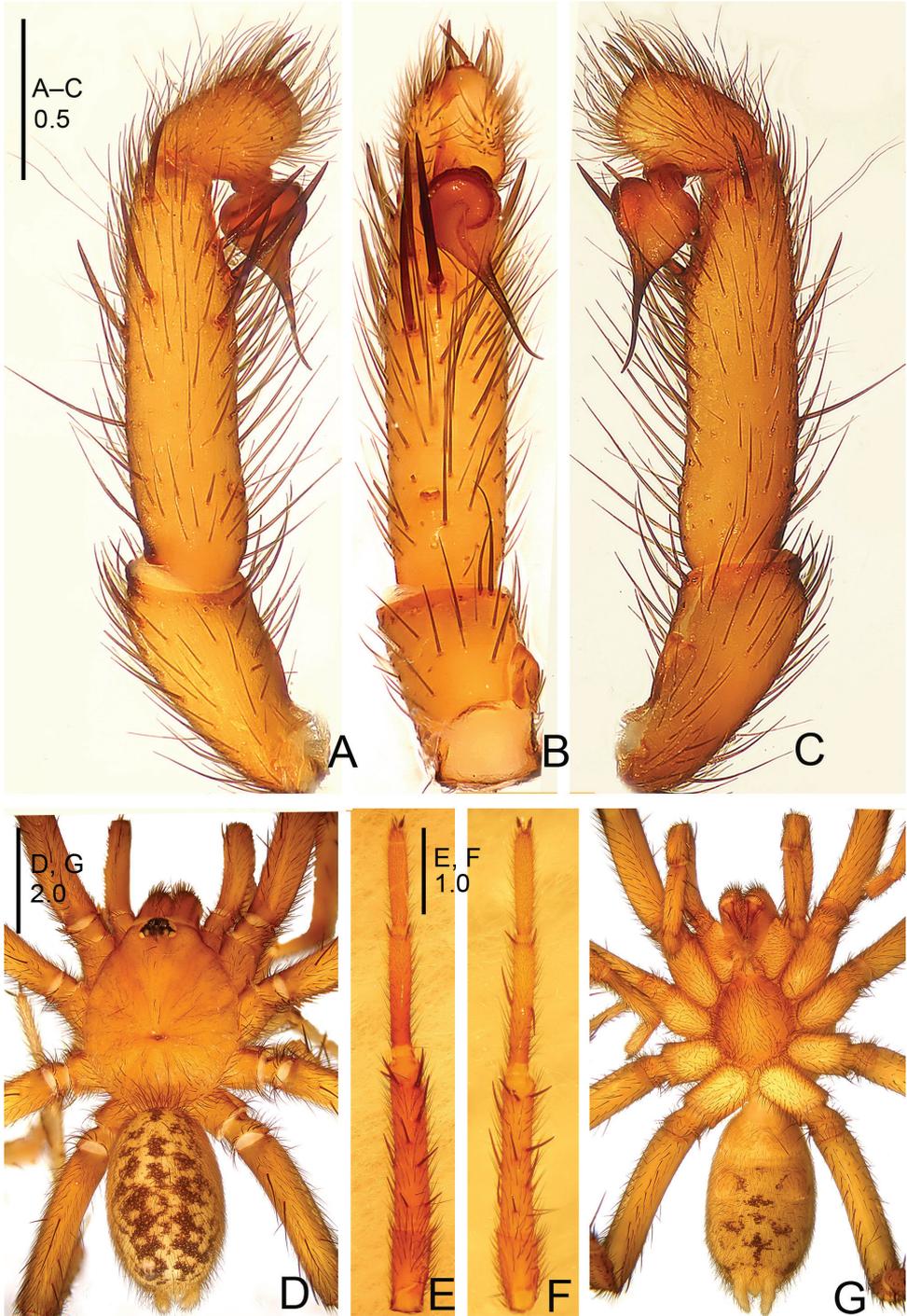


Figure 3. *Raveniola bellula* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** habitus, dorsal view **E** leg I, ventral view **F** leg II, ventral view **G** habitus, ventral view. Scale bars: 0.5 mm (**A-C**); 2.0 mm (**D, G**); 1.0 mm (**E, F**).

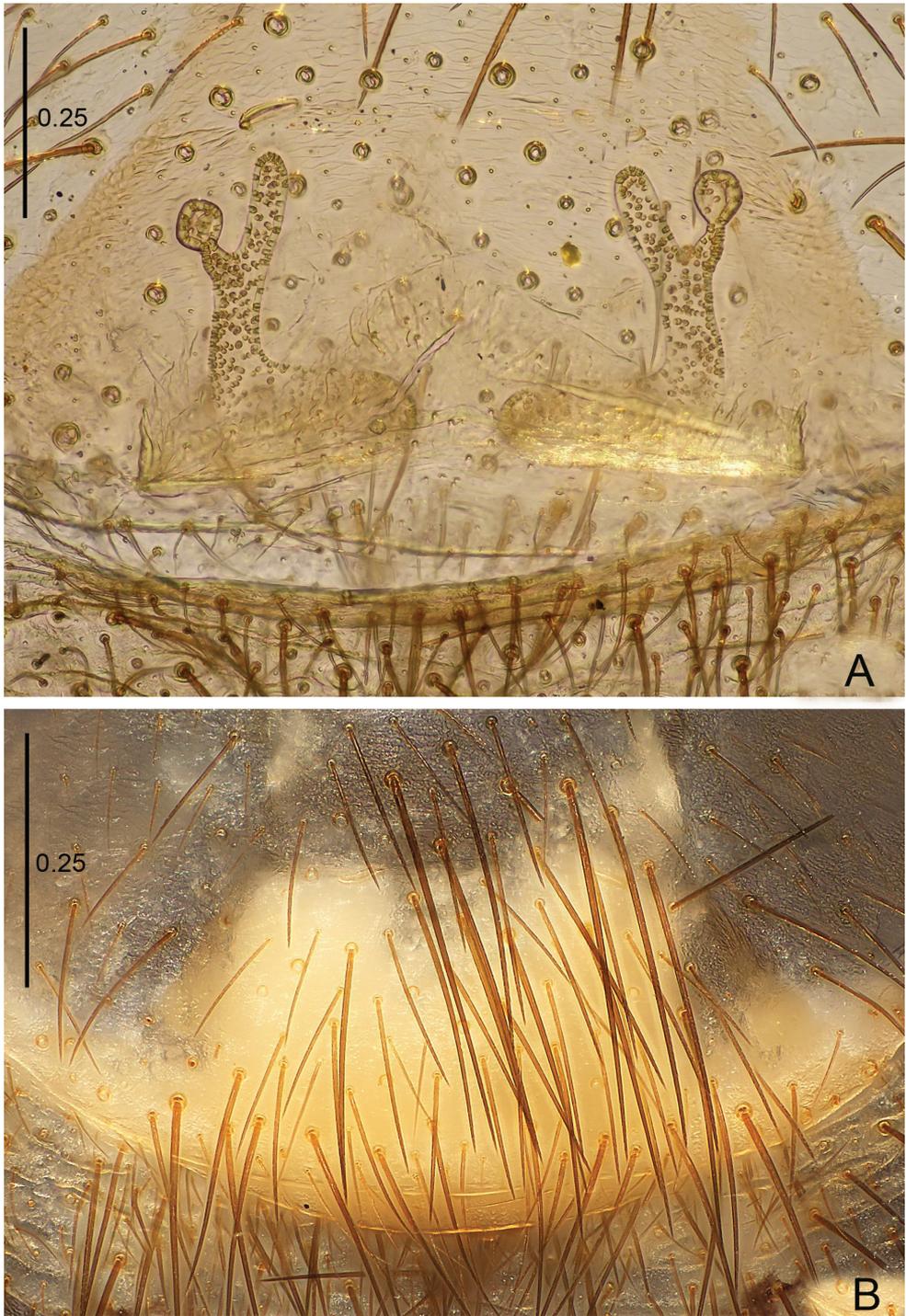


Figure 4. *Raveniola bellula* sp. n., female paratype. **A** vulva, dorsal view **B** genital area, ventral view. Scale bars: 0.25 mm.

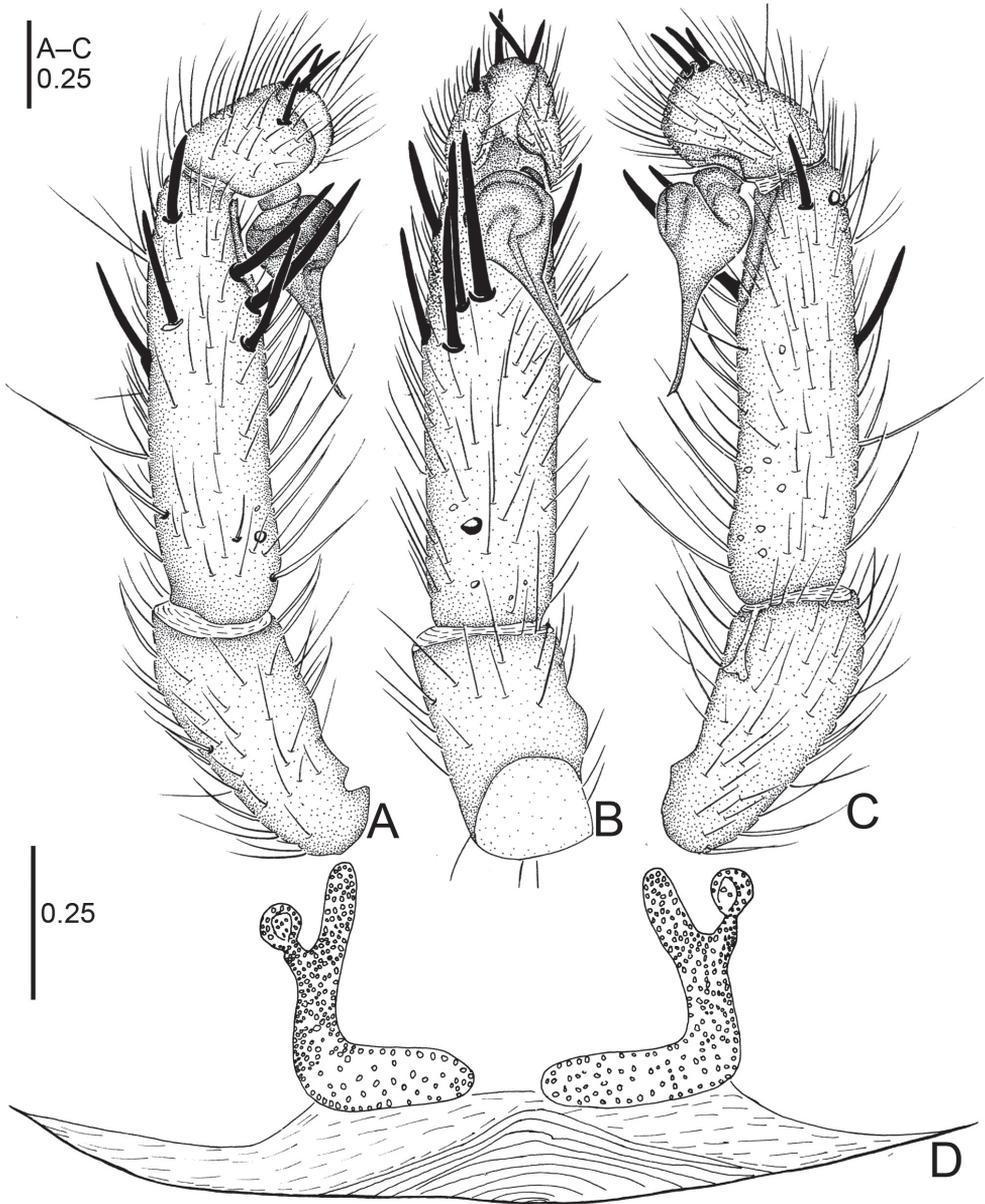


Figure 5. *Raveniola bellula* sp. n., male holotype (A–C) and female paratype (D). **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** vulva, dorsal view. Scale bars: 0.25 mm.

***Raveniola chayi* sp. n.**

<http://zoobank.org/DE55EA80-52FE-464E-B37E-4D25F7C38DA9>

Figs 6–8

Type material. Holotype ♂ – CHINA: Yunnan Province, Lijiang County, Mt. Yulongxueshan, Maoniuping [27°05.503'N, 100°15.403'E, elevation 3061 m], Au-

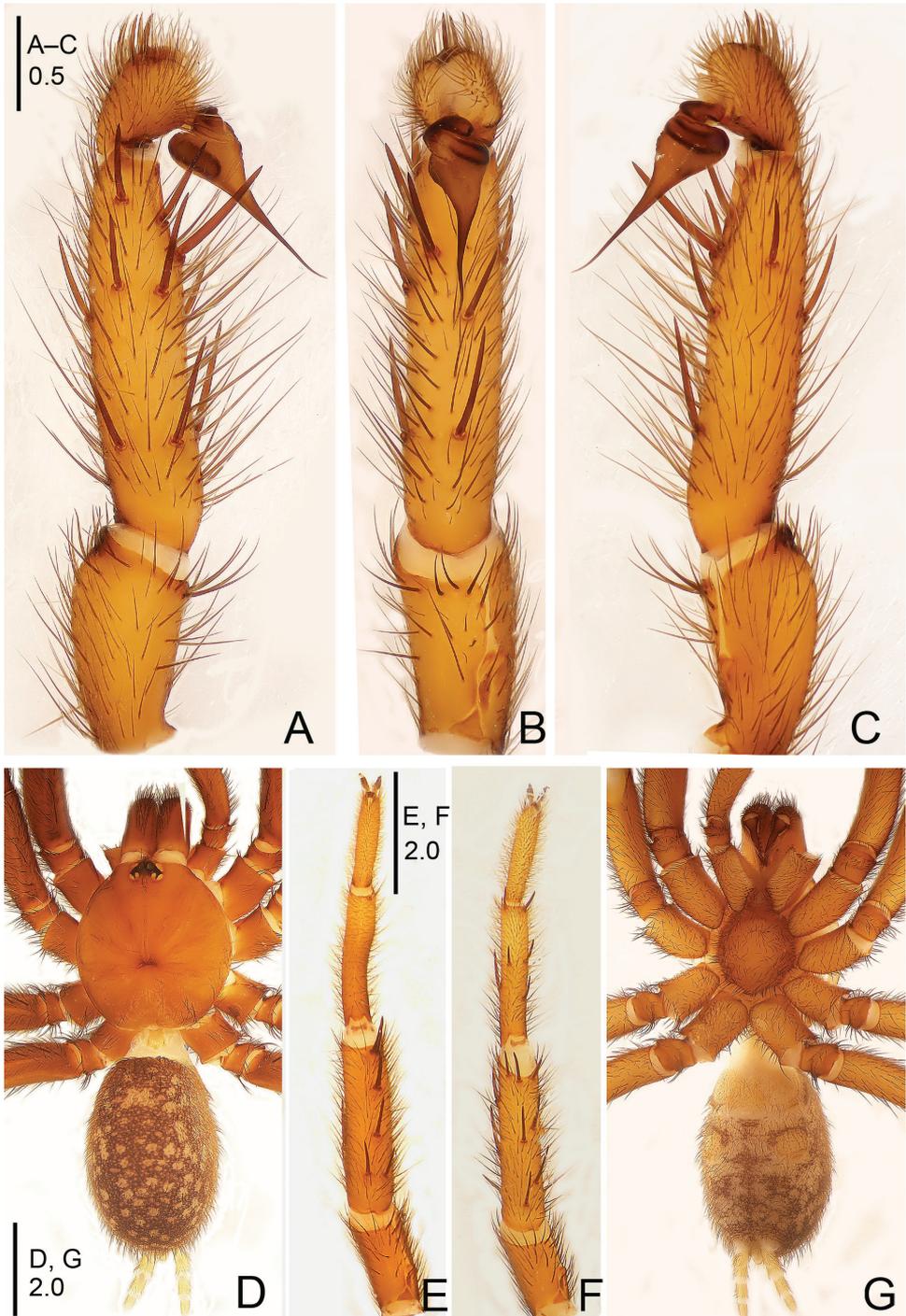


Figure 6. *Raveniola chayi* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** habitus, dorsal view **E** leg I, ventral view **F** leg II, ventral view **G** habitus, ventral view. Scale bars: 0.5 mm (**A–C**); 2.0 mm (**D–G**).

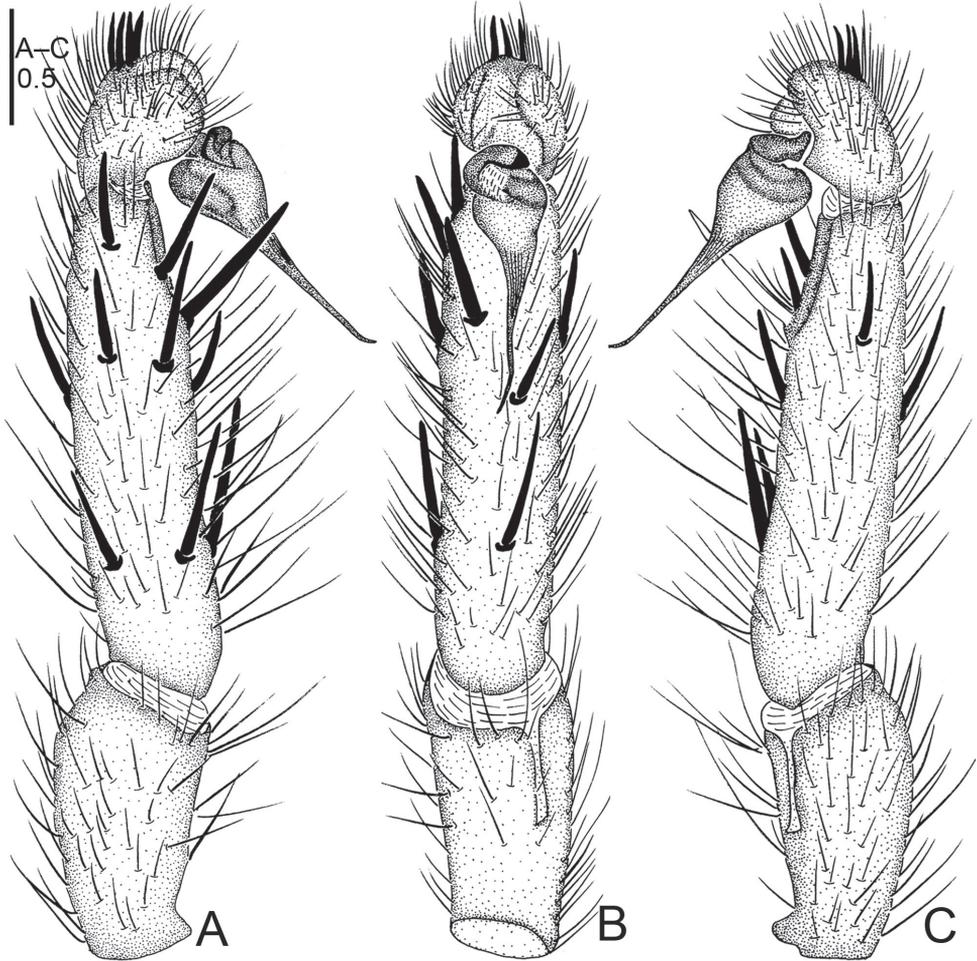


Figure 7. *Raveniola chayi* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view. Scale bar: 0.5 mm.

gust 1–3, 2000, X. Yu (IZCAS). Paratypes: 16♂ (IZCAS), same data as holotype; 1♀ – Sichuan Province, Yanyuan County, around Lugu Lake [27°48'N, 100°49'E, elevation 3300 m], May 28, 2011, J. Martens (SMF).

Etymology. The specific name is from the Chinese word for difference (*chā yì*), in reference to the difference between the new species with *R. songi* and *R. yunnanensis*; noun.

Diagnosis. The new species is similar to *R. alpina* sp. n., *R. songi* and *R. yunnanensis* but can be distinguished by the smooth distal portion of the embolus (Figs 6A–C, 7A–C), the presence of 4 spines on the cymbium (Figs 6A–C, 7A–C) and the presence of ridges on the proximal portion of the embolus (Figs 6A–C, 7A–C); it can be distinguished from latter two congeners by lacking the PMS (present in those species).

Description. Male (holotype): TL 10.30, CL 4.30, CW 3.65, AL 4.90, AW 3.10. Eye diameters and interdistances: AME 0.17, ALE 0.23, PME 0.13, PLE 0.21;

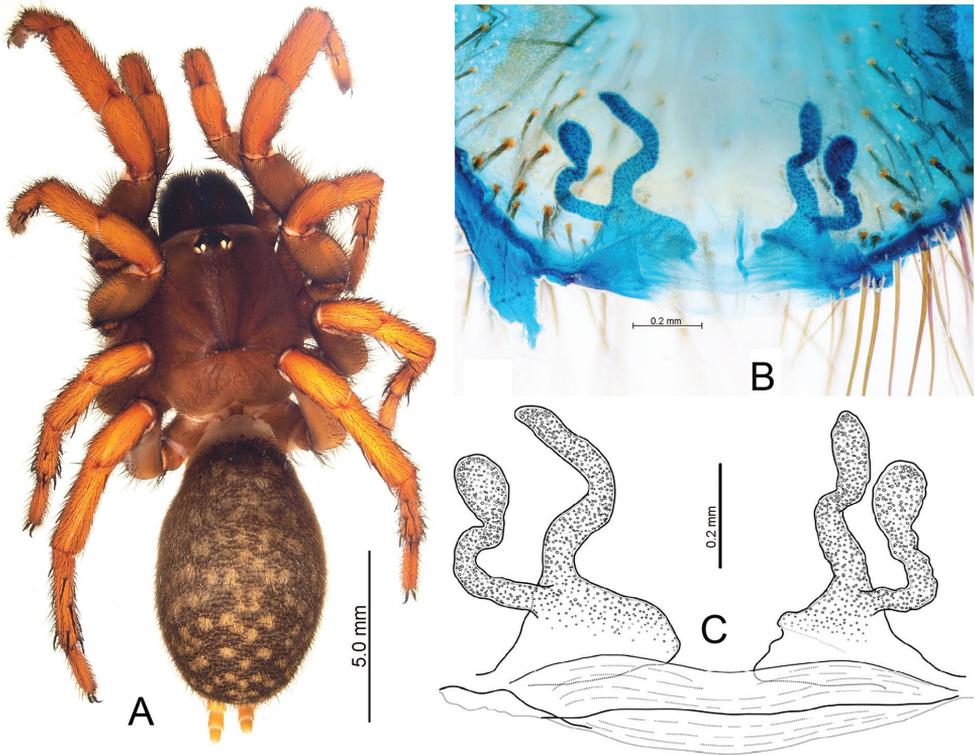


Figure 8. *Raveniola chayi* sp. n., female paratype. **A** habitus, dorsal view **B, C** vulva, dorsal view. Scale bars: 5.0 mm (**A**); 0.2 mm (**B–C**).

AME–AME 0.11, AME–ALE 0.06, PME–PME 0.31, PME–PLE 0.05. Leg lengths: I: 12.50 (3.60+1.25+2.95+2.45+2.25), II: 11.65 (3.55+1.25+2.85+2.50+1.50), III: 10.55 (2.55+1.10+2.50+2.65+1.75), IV: 14.40 (4.00+1.30+3.10+4.05+1.95). Maxillae, labium and sternum as shown in Fig. 6G. Maxillae with 12–15 cuspules. Prosoma, palps and legs light brown. Spinnerets light grey, abdomen brown with light dorsal and ventral spots (Fig. 6D, G). Metatarsus I noticeably curved (Fig. 6E). PMS absent; apical segment of PLS digitiform (Fig. 6D, G). Palpal tibia long, subcylindrical; cymbium with four short, stout spines; bulb long, pyriform; embolus gradually tapering to a slender point (Figs 6A–C, 7A–C).

Female (paratype): TL 14.75, CL 5.75, CW 4.90, AL 9.00, AW 5.25. Eye diameters and interdistances: AME 0.17, ALE 0.30, PME 0.17, PLE 0.23, AME–AME 0.21, AME–ALE 0.12, PME–PME 0.47, PME–PLE 0.04. Leg lengths: I: 13.15 (4.20+2.25+3.00+2.30+1.40), II: 11.95 (3.70+2.20+2.35+2.30+1.40), III: 11.90 (3.15+2.00+2.05+3.05+1.65), IV: 15.90 (4.25+2.30+3.10+4.30+1.95). Most characters, including the colouration peculiarities (Fig. 8A) and the absence of PMS, are as in the male. Receptacles divided into a stocking-shaped inner branch and a clubbed outer branch; both branches long and crimped (Fig. 8B–C).

Variation. Total length of males: 9.49–11.10 (n=8).

Distribution. China: north-western Yunnan, south-western Sichuan.

***Raveniola gracilis* sp. n.**

<http://zoobank.org/1CC980B2-6464-44C3-9225-F5AD0BBE168C>

Figs 9–10

Type material. Holotype ♂ – CHINA: Zhejiang Province, Hangzhou County, Hangzhou [30°16.276'N, 120°09.178'E, 260 m], July 1980, Z. Chen (IZCAS).

Etymology. The specific name is taken from the Latin adjective “*gracilis*”, which means “slender” and refers to the shape of embolus.

Diagnosis. This new species can be easily distinguished from all known congeners by its slender and subapically curved embolus (Figs 9A–C, 10A–C).

Description. Male (holotype): TL 8.30, CL 4.05, CW 3.25, AL 3.90, AW 2.40. Eye sizes and interdistances: AME 0.15, ALE 0.22, PME 0.11, PLE 0.15, AME–AME 0.11, AME–ALE 0.07, PME–PME 0.34, PME–PLE 0.04. Leg lengths: I: 11.90 (3.50+1.55+2.95+2.15+1.75), II: 11.00 (3.05+1.60+2.70+1.80+1.85), III: 10.75 (2.75+1.60+2.25+2.25+1.60), IV: 12.85 (3.25+1.60+3.15+3.10+1.75). Carapace yellowish brown dorsally, with a few brownish setae. Eye tubercle blackish brown. Chelicerae reddish dark brown. Sternum, labium, maxillae and legs light brown ventrally. Abdomen dorsally light brown, with blackish cloudy maculae and brownish setae. Ventral surface of abdomen and spinnerets yellowish brown, with dense brownish setae (Fig. 9D, G). Fovea broad, slightly recurved (Fig. 9D). Chelicerae without rastellum but with strong setae (Fig. 9D, G). Maxillae with 7–9 cuspules. Three pairs of cloudy sternal sigilla (Fig. 9G). Leg tarsi without spines. Tarsal claws with two rows of uniform teeth. Metatarsus I curved and bent (Fig. 9E). Two pairs of spinnerets, apical segment of PLS digitiform. Tip of cymbium with 5 strong spines. Bulb smooth, pyriform, with long, slender embolus (Figs 9A–C, 10A–C).

Female. Unknown.

Distribution. The species is known only from the type locality.

***Raveniola montana* Zonstein & Marusik, 2012**

Figs 11–12

Material. CHINA: Sichuan Province, Baoxing County, Baoxing [30°22.052'N, 102°48.534'E, elevation 1115 m], June 2001, X. Yu & H. Zhou – 3♂ (IZCAS); same county, Qiaoqi Town [30°41.129'N, 102°42.370'E, 2447 m], June 6–7, 1997, leg. Z. Zhang.

Diagnosis. This species can be easily distinguished from all known East Asian congeners by its short and stout palpal tibia and by a short and flattened embolus (Fig. 11A–C), combined with the presence of ridges on the wide proximal portion of the embolus (Fig. 12A–C) and the unique shape of the receptacles in females (Zonstein and Marusik 2012: fig. 48).

Description. See Zonstein and Marusik (2012): 77, figs 5, 9, 10, 17, 18, 26, 32, 40, 48.

Variation. Total length: 10.46–11.56 in males from Sichuan (n=8) *vs.* 15.50 in the male holotype from Yunnan.

Distribution. China: northern Yunnan and southern Sichuan.

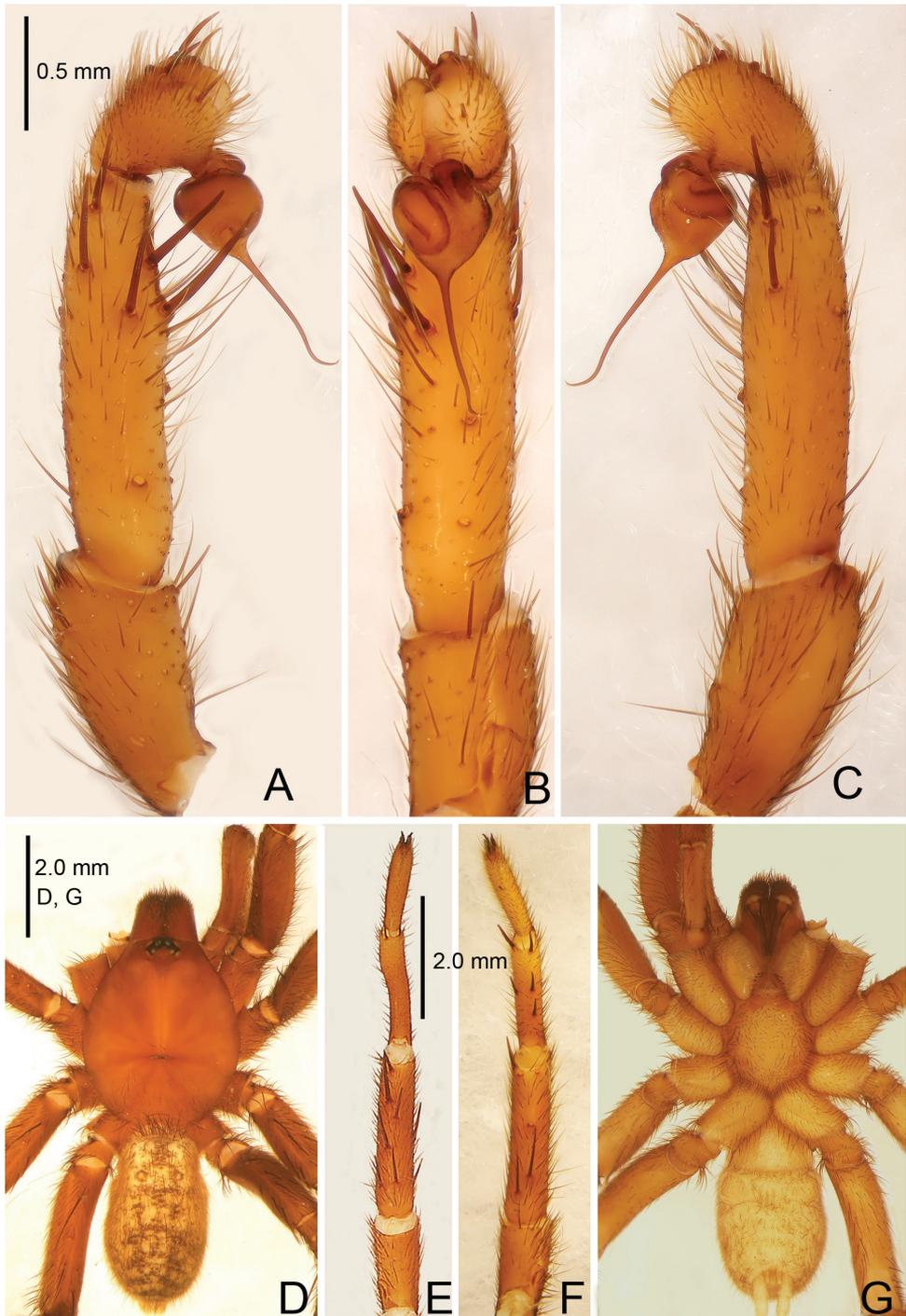


Figure 9. *Raveniola gracilis* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** habitus, dorsal view **E** leg I (right side), ventral view **F** leg II, ventral view **G** habitus, ventral view. Scale bars: 0.5 mm (**A–C**); 2.0 mm (**D–G**).

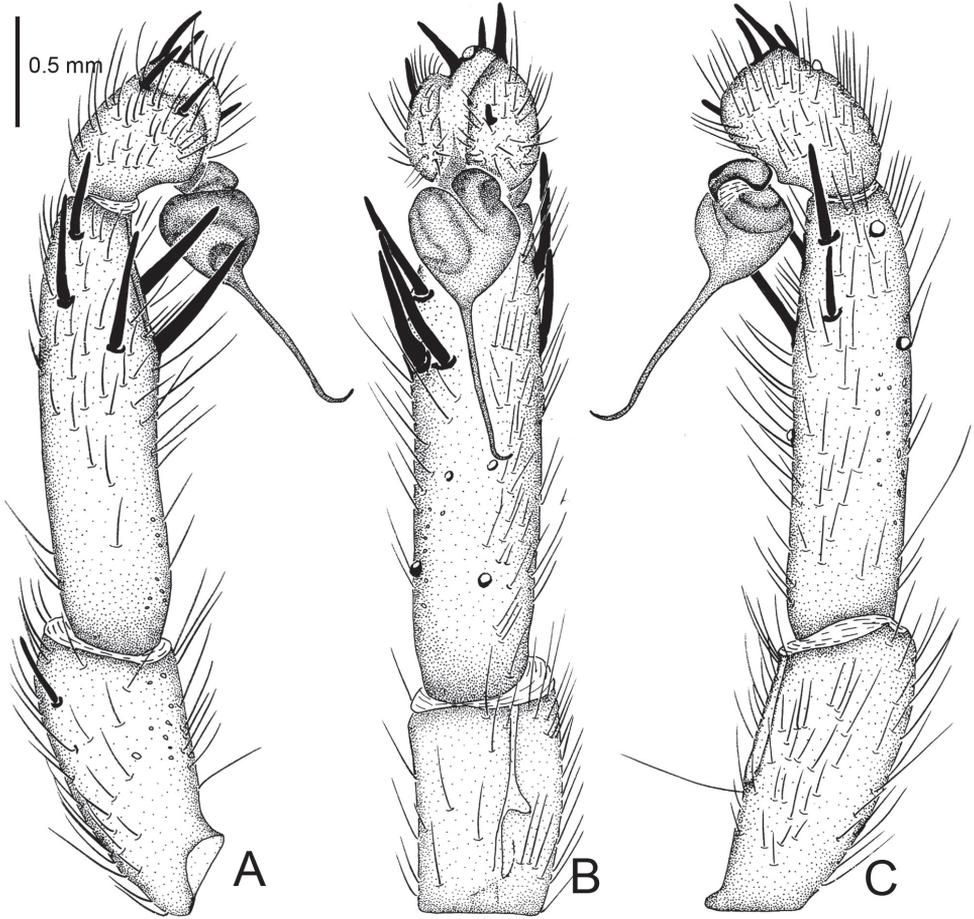


Figure 10. *Raveniola gracilis* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view. Scale bar: 0.5 mm.

***Raveniola rugosa* sp. n.**

<http://zoobank.org/307964FF-DEC2-410A-9CDF-8CA41D5D924E>

Figs 13–14

Type material. Holotype ♂ – CHINA: Yunnan Province, Lijiang County, Shigu Town, Shigu east [26°52.014'N, 100°13.588'E, elevation 2393 m], July 31 to August 4, 2007, X. Yu (IZCAS).

Etymology. The specific name is taken from the Latin adjective “*rugosus*”, meaning “wrinkled” and refers to the wrinkled transition between embolus and bulb.

Diagnosis. The new species is similar to *R. chayi* sp. n. but can be distinguished by its embolus gradually curved to the tip (twisted in the latter species) and by the considerably better developed embolic ridges (Figs 7A–C; cf. 14A–C). It can be distinguished

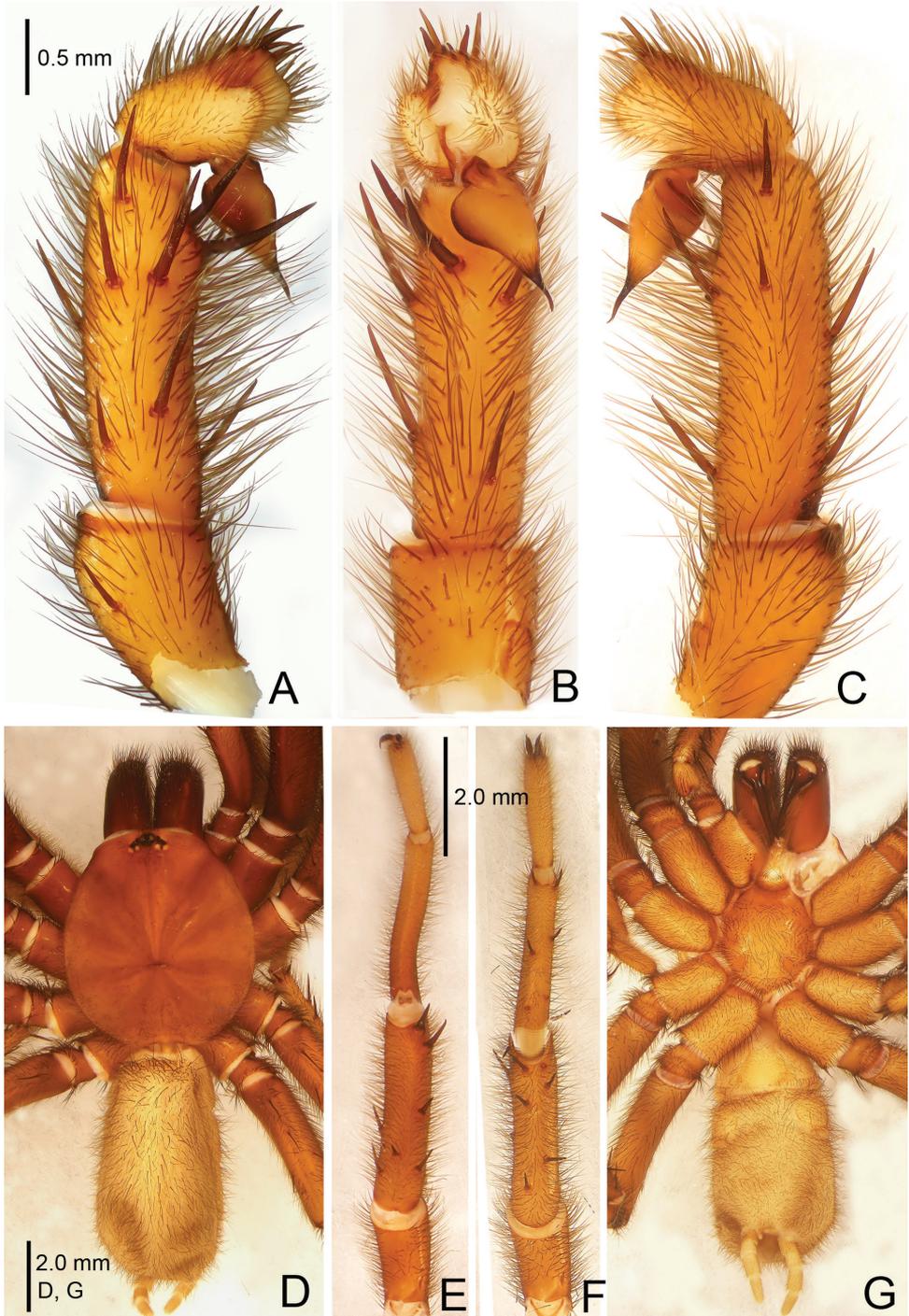


Figure 11. *Raveniola montana* Zonstein & Marusik, 2012, male (Sichuan Prov.). **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** habitus, dorsal view **E** leg I, ventral view **F** leg II, ventral view **G** habitus, ventral view. Scale bars: 0.5 mm (**A–C**); 2.0 mm (**D–G**).

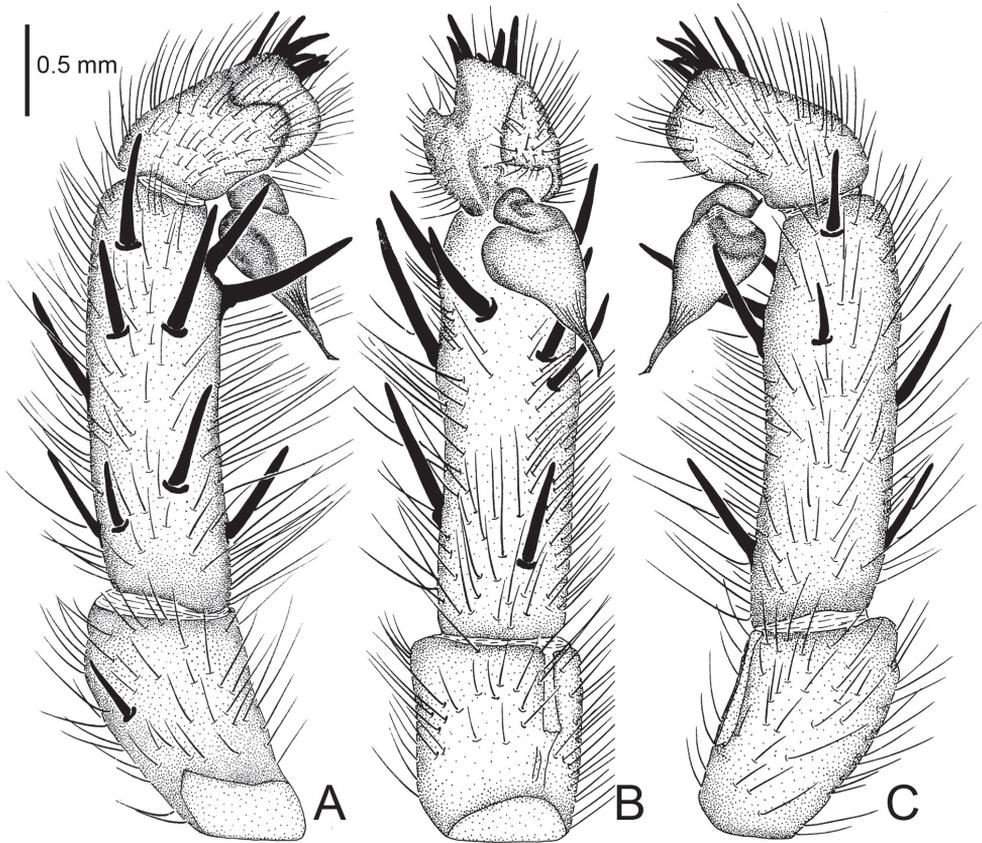


Figure 12. *Raveniola montana* Zonstein & Marusik, 2012, male (Sichuan Prov.). **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view. Scale bar: 0.5 mm.

from *R. montana*, which also possesses embolic ridges on the bulb, by a much longer palpal tibia and a longer embolus (Figs 12A–C; cf. 14A–C).

Description. Male (holotype): TL 14.50, CL 6.15, CW 4.65, AL 6.25, AW 4.00. Eye diameters and interdistances: AME 0.20, ALE 0.24, PME 0.17, PLE 0.19, AME–AME 0.09, AME–ALE 0.04, PME–PME 0.36, PME–PLE 0.06. Leg lengths: I: 16.50 (4.60+2.25+4.25+3.10+2.30), II: 13.95 (4.10+1.60+3.55+2.55+2.15), III: 12.70 (3.75+1.25+2.75+2.70+2.25), IV: 16.95 (4.55+1.60+4.25+4.05+2.50). Venter as shown in Fig. 13G. Maxillae with numerous (*ca.* 35–40) cuspules. Prosoma, palps and legs reddish brown. Abdomen, including spinnerets, light brownish grey (Figs 13D, G). Metatarsus I very gently curved (nearly straight) as in Fig. 13E. PMS absent, apical segment of PLS digitiform (Fig. 13D, G). Palpal tibia slightly swollen at base and slightly arcuate; cymbium with six short, stout spines; bulb long, pyriform; embolus slightly and evenly bent, gradually tapering to a slender point (Figs 13A–C, 14A–C).

Female. Unknown.

Distribution. The species is known only from the type locality.

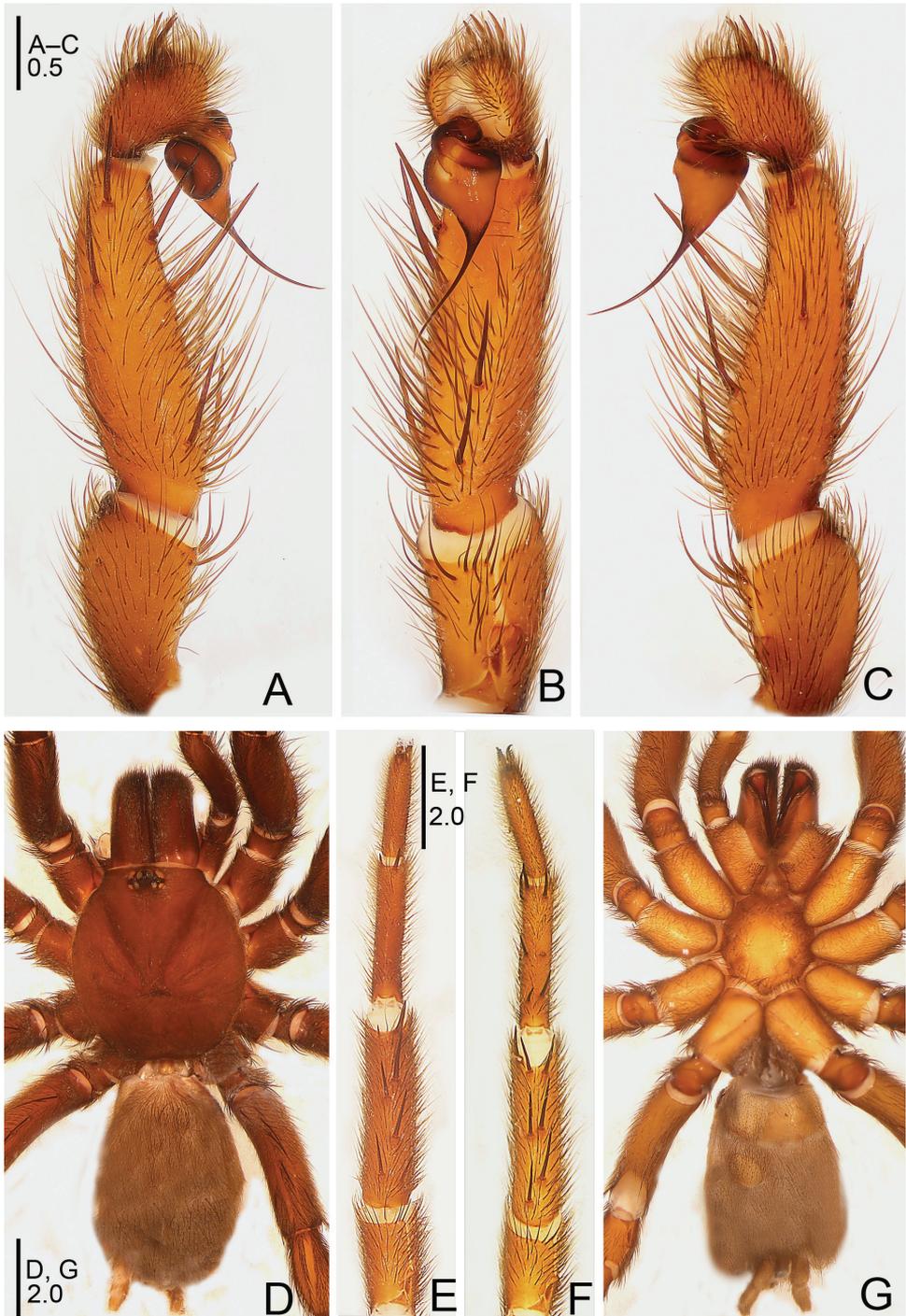


Figure 13. *Raveniola rugosa* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** habitus, dorsal view **E** leg I, ventral view **F** leg II, ventral view **G** habitus, ventral view. Scale bars: 0.5 mm (**A–C**); 2.0 mm (**D–G**).

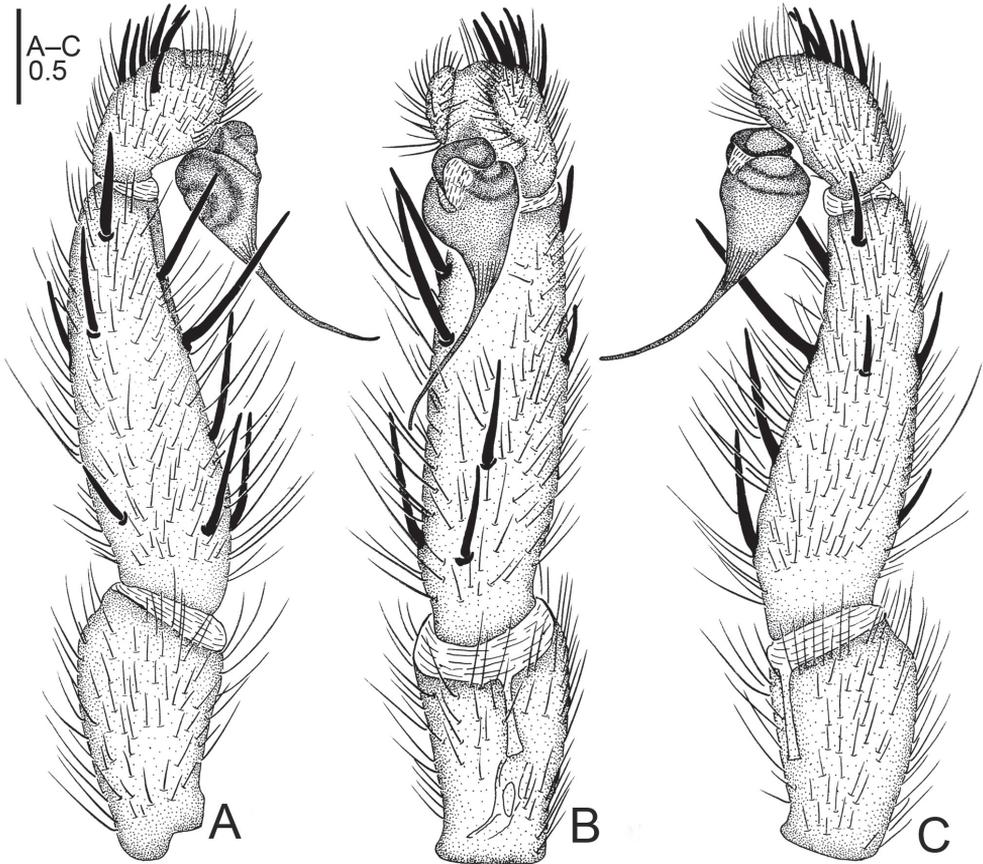


Figure 14. *Raveniola rugosa* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view. Scale bar: 0.5 mm.

***Raveniola spirula* sp. n.**

<http://zoobank.org/C2F3F8EF-C26B-4677-8681-CBB7739959D3>

Figs 15–16

Type material. Holotype ♂ – CHINA: Hubei Province, Shennongjia Forest Region, Mt. Guanmenshan [31°25.483'N, 110°21.565'E, elevation 1601 m], July 23–30, 1998, H. Zhou (IZCAS). Paratypes: 22♂ (IZCAS), same data as holotype.

Etymology. The specific name is taken from the Latin noun “*spirula*” (the diminutive form of “*spira* = spiral”), which means “small spiral” and refers to the spiral embolus.

Diagnosis. The new species is similar to *R. yunnanensis* but can be distinguished by a noticeably longer and less spinose cymbium, by its more twisted, corkscrew-shaped distal portion of the embolus (see Fig. 16A–C and Zonstein and Marusik 2012: figs 35, 43) and by the absence of PMS (present in the latter species).

Description. Male (holotype): TL 11.25, CL 3.95, CW 3.50, AL 5.65, AW 2.25. Eye diameters and interdistances: AME 0.11, ALE 0.26, PME 0.09, PLE 0.10,

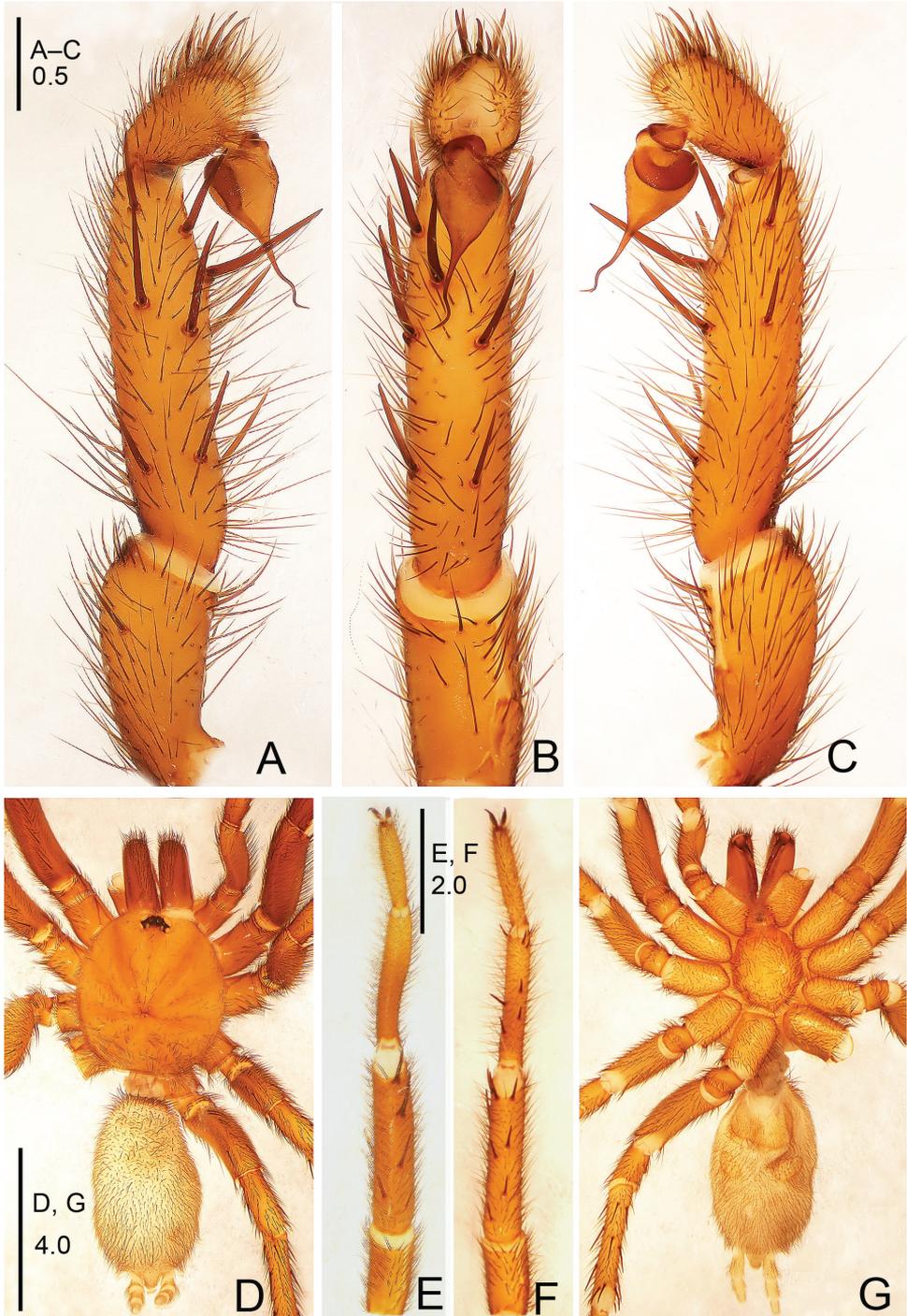


Figure 15. *Raveniola spirula* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** habitus, dorsal view **E** leg I, ventral view **F** leg II, ventral view **G** habitus, ventral view. Scale bars: 0.5 mm (**A–C**); 4.0 mm (**D, G**); 2.0 mm (**E, F**).

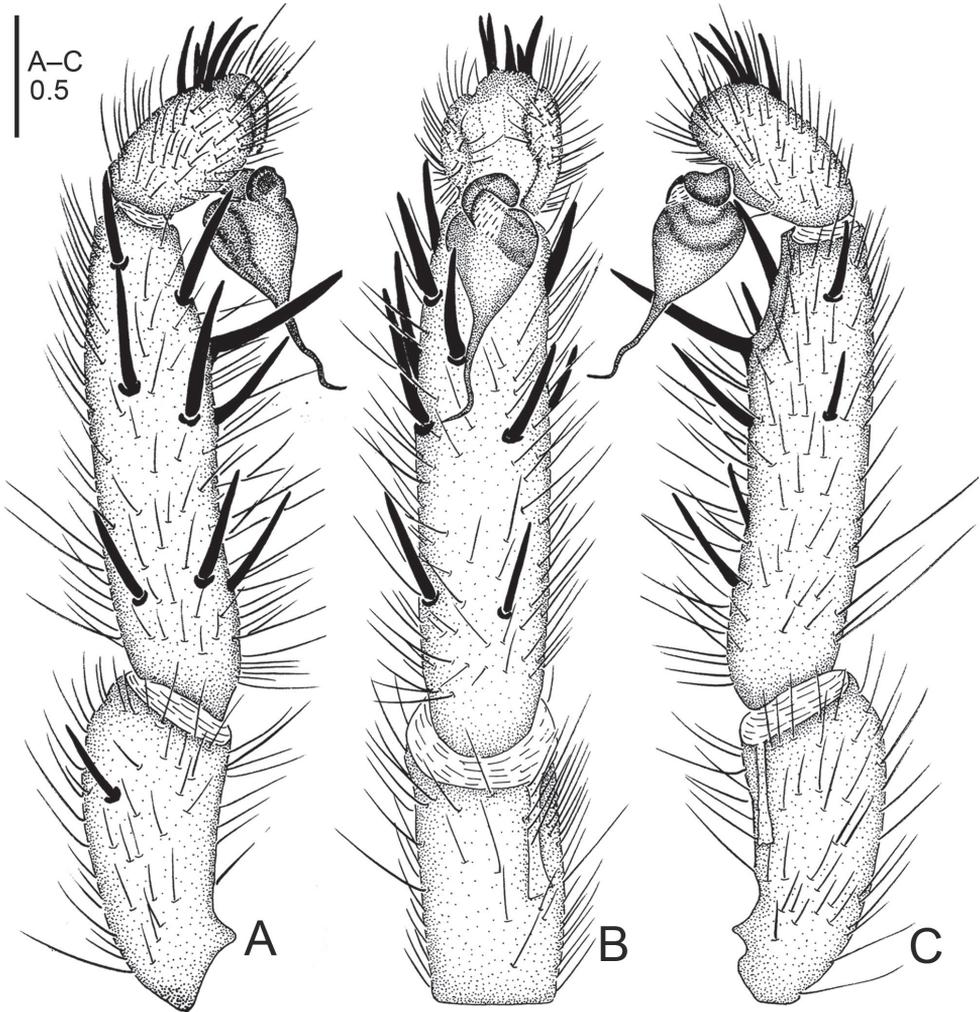


Figure 16. *Raveniola spirula* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view. Scale bar: 0.5 mm.

AME–AME 0.08, AME–ALE 0.05, PME–PME 0.28, PME–PLE 0.04. Leg lengths: I: 11.65 (3.25+1.45+3.10+2.30+1.55), II: 10.55 (3.10+1.25+2.55+2.15+1.50), III: 9.65 (2.55+1.05+2.05+2.55+1.75), IV: 13.55 (3.35+1.30+2.75+4.10+2.05). Venter as shown in Fig. 15G. Maxillae with 5 cuspules. Prosoma, palps and legs light brown. Abdomen including spinnerets light grey. Metatarsus I curved outwards (retrolaterally) as in Fig. 15E. PMS absent, apical segment of PLS digitiform (Fig. 15D, G). Palpal tibia long, subcylindrical; cymbium with five short, stout spines; bulb pyriform; embolus strongly twisted, corkscrew-shaped. (Figs 15A–C, 16A–C).

Female. Unknown.

Variation. Total length: 10.46–11.56 (n=8).

Distribution. Known only from the type locality.

***Raveniola yajiangensis* sp. n.**

<http://zoobank.org/67450C7D-41B8-438E-BD34-E7FAE4FCBDB4>

Figs 17–19

Type material. Holotype ♂ – CHINA: Sichuan Province, Yajiang County, Yajiang [27°50.119'N, 99°42.426'E, elevation 3285 m], 7 June 2001, X. Yu & H. Zhang (IZ-CAS). Paratypes: same area but Longjiangbian [27°49.119'N, 99°41.426'E, elevation 3265 m], 27 May 2009, X. Yu & H. Zhang – 1 ♀ (IZCAS).

Etymology. The specific epithet, a Latinised adjective, refers to the type locality.

Diagnosis. Judging from the shape of the bulb and the distal portion of the embolus, this new species is similar to *R. shangrila* (Zonstein and Marusik 2012, figs 33, 41) but can be distinguished by the slightly curved distal portion of the embolus (Figs 17A–C, 19A–C); conspecific females possess uniquely shaped receptacles, with the inner branches curved inward (Figs 18, 19D).

Description. Male (holotype): TL 14.10, CL 5.60, CW 5.45, AL 6.20, AW 3.55. Eye diameters and interdistances: AME 0.19, ALE 0.25, PME 0.16, PLE 0.14, AME–AME 0.15, AME–ALE 0.07, PME–PME 0.45, PME–PLE 0.07. Leg lengths: I: 20.96 (6.09+2.24+5.45+4.49+2.69), II: 24.23 (6.47+3.27+5.83+5.45+3.21), III: 17.76 (4.49+2.18+4.10+4.55+2.44), IV: 22.56 (5.83+2.56+4.81+6.67+2.69). Venter as shown in Fig. 17G. Prosoma, palps and legs brown. Abdomen, including spinnerets, deep grey (Fig. 17D, G). Palpal tibia long, subcylindrical; cymbium apically with five short, stout spines; bulb long and pyriform; embolus gradually tapering to a slender bent tip (Figs 17A–C, 19A–C). Small PMS present, apical segment of PLS digitiform (Fig. 17D, G).

Female (paratype): TL 16.50, CL 6.75, CW 5.80, AL 7.25, AW 5.90. Colouration and most somatic characters as in the male. Eye diameters and interdistances: AME 0.21, ALE 0.35, PME 0.17, PLE 0.23, AME–AME 0.18, AME–ALE 0.12, PME–PME 0.53, PME–PLE 0.07. Leg lengths: I: 16.05 (5.05+2.30+3.90+3.05+1.75), II: 15.15 (4.25+2.75+3.30+2.80+2.05), III: 14.45 (4.30+1.95+2.85+3.25+2.10), IV: 19.90 (5.25+2.25+4.40+5.25+2.75). Receptacles divided into a long digitiform inner branch that is bent inward and a short club-shaped outer lobe that is bent anteriorly (Figs 18, 19D).

Distribution. China: southern Sichuan.

Genus *Sinopesa* Raven & Schwendinger, 1995

Type species. *Sinopesa maculata* Raven & Schwendinger, 1995, by the original designation.

Diagnosis. *Sinopesa*, like *Raveniola*, differs from *Hermacha* and *Entypesa* by lacking serrula and metatarsal preening combs and by possessing two enlarged retroventral spines in males and divided receptacles in females. As in members of *Raveniola*, the PMS in *Sinopesa* are reduced in size and even lost in some species – a condition which has never been observed in *Hermacha* and *Entypesa*. *Sinopesa* differs from its close

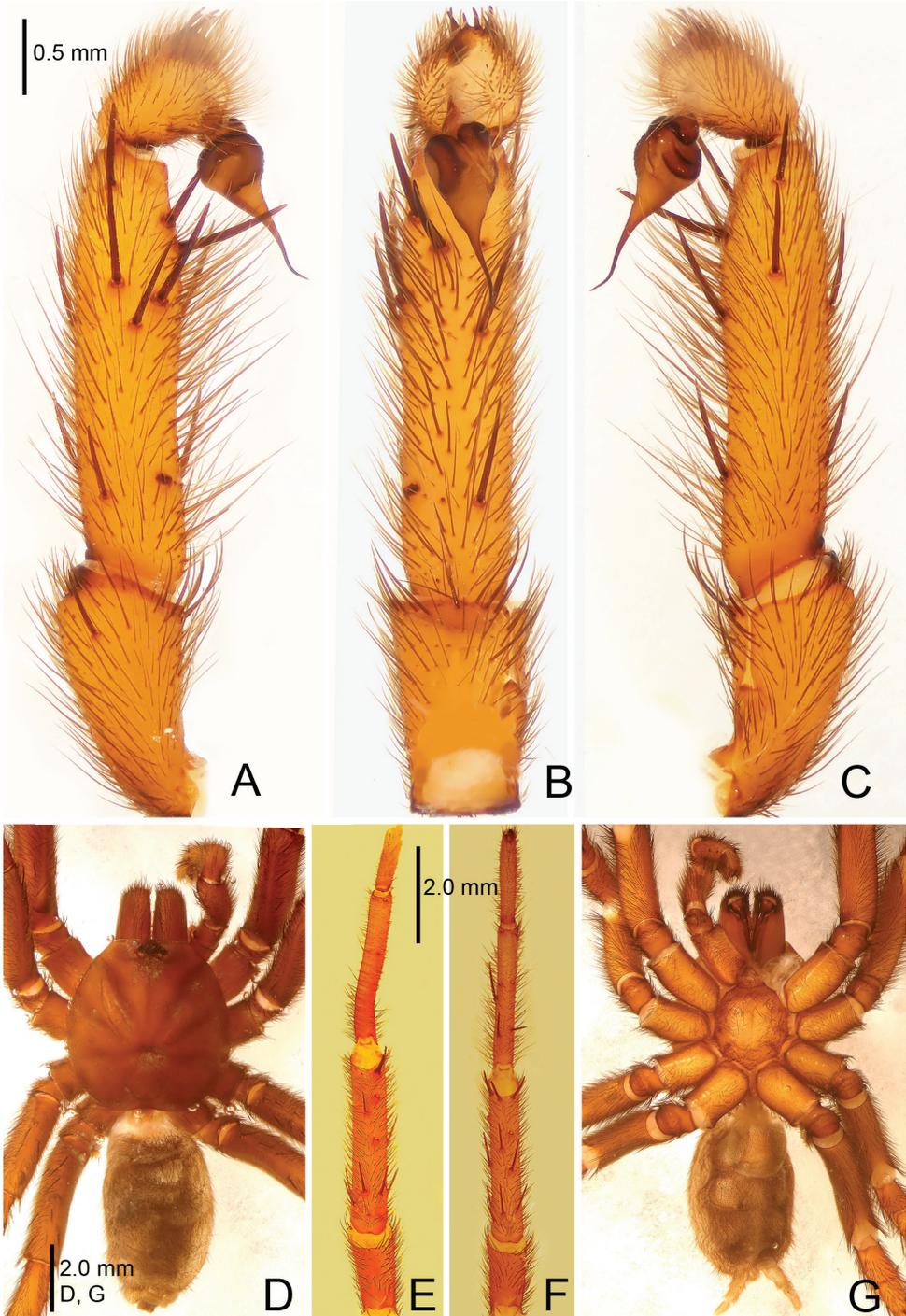


Figure 17. *Raveniola yajiangensis* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** habitus, dorsal view **E** leg I, ventral view **F** leg II, ventral view **G** habitus, ventral view. Scale bars: 0.5 mm (**A-C**); 2.0 mm (**D-G**).

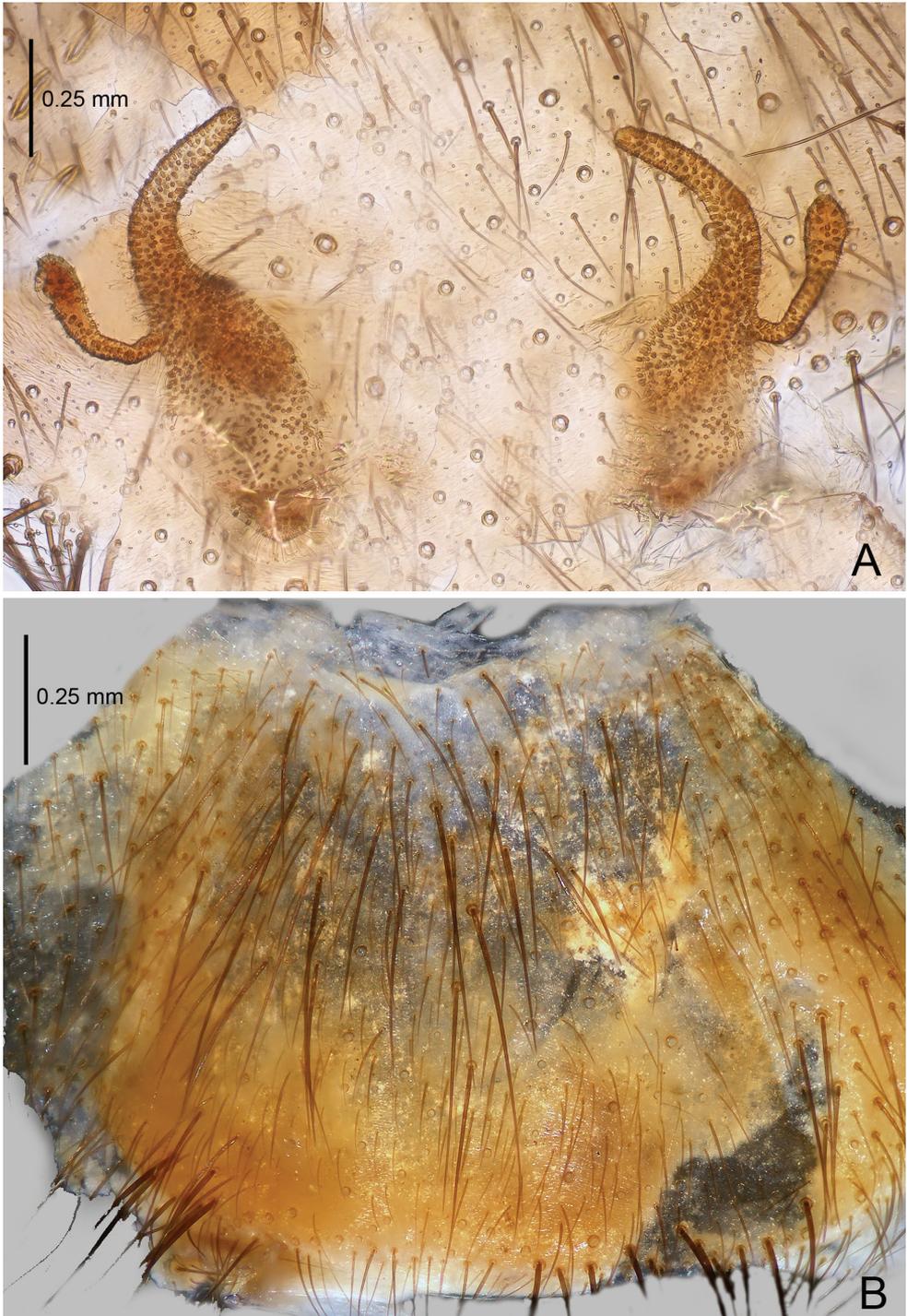


Figure 18. *Raveniola yajiangensis* sp. n., female paratype. **A** vulva, dorsal view **B** genital area, ventral view. Scale bars: 0.25 mm.

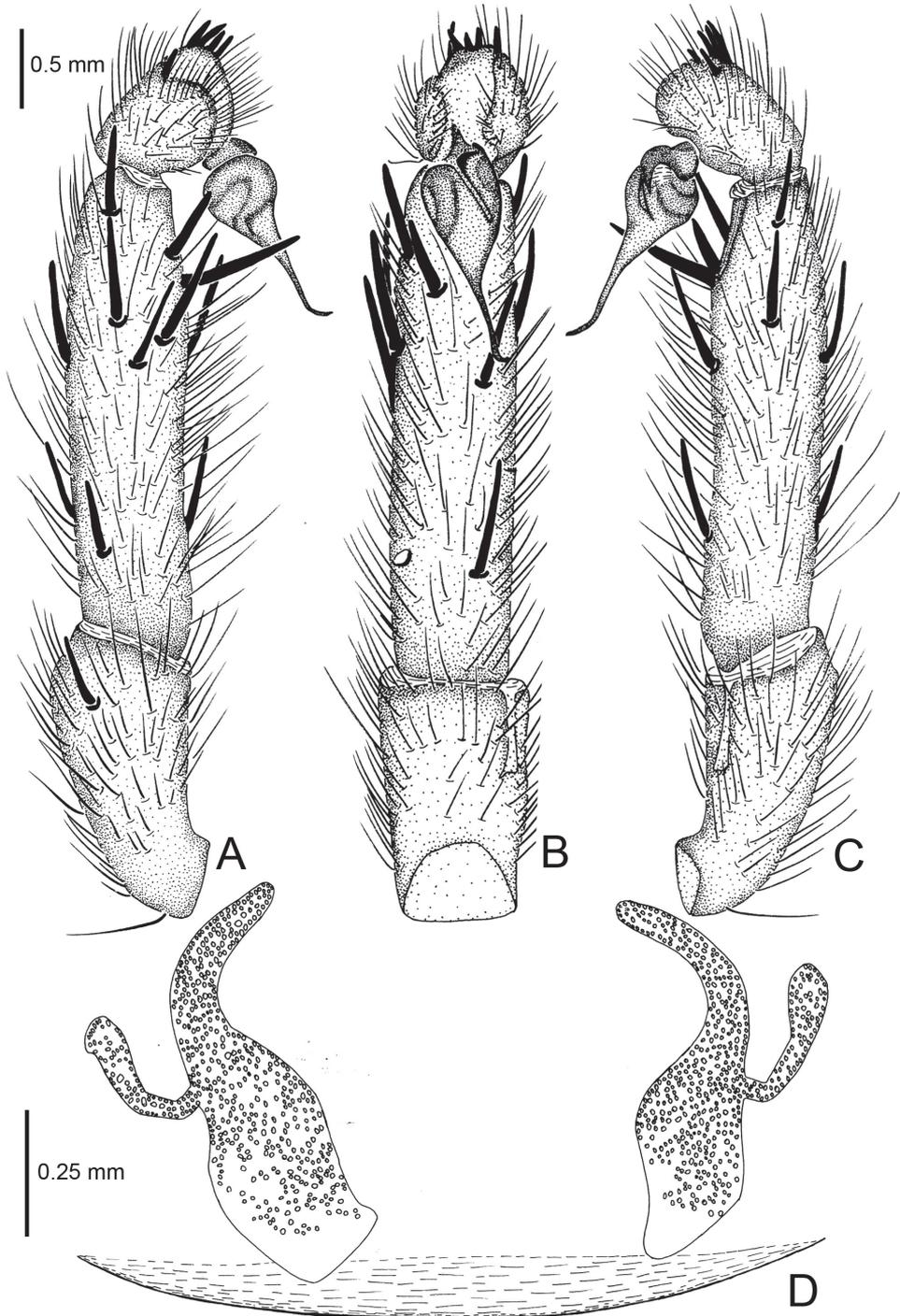


Figure 19. *Raveniola yajiangensis* sp. n., male holotype (**A–C**) and female paratype (**D**). **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** vulva, dorsal view. Scale bars: 0.5 mm (**A–C**); 0.25mm (**D**).

relative *Raveniola* by a thin and less developed scopula and by the presence of a well-developed male interchelicerum tumescence (which is less developed in *Raveniola* and completely lost in all Chinese members of this genus).

Composition. Six species – *S. chengbuensis* (Xu & Yin, 2002) (China), *S. chinensis* (Kulczyński, 1901) (China), *S. ninhbinhensis* sp. n. (Vietnam), *S. kumensis* Shimojana & Haupt, 2000 (Ryukyu Isles), *S. maculata* Raven & Schwendinger, 1995 (Thailand) and *S. sinensis* (Xu & Yin, 2002) (China). The new species is described below.

Key to species of *Sinopesa*

Males of *S. chengbuensis* and females of *S. ninhbinhensis* sp. n. are unknown

1	Males.....	2
–	Females.....	6
2	PMS present.....	3
–	PMS absent.....	5
3	Dorsal abdominal pattern present. Palpal tibia cylindrical, embolus hooked ...	4
–	Abdomen uniformly coloured. Palpal tibia arched, embolus corkscrew-shaped (see Shimojana and Haupt 2000: fig. 3A–B).....	<i>kumensis</i>
4	Large species: TL 17 mm. Embolus long: approximately half as long as palpal tibia (see Song et al. 2001: fig. 17H).....	<i>sinensis</i>
–	Small species: TL 10–12 mm. Embolus short: approximately 0.3 times as long as palpal tibia (see Zonstein and Marusik 2012: fig. 46).....	<i>chinensis</i>
5	Abdomen spotted; embolus corkscrew-shaped (Zonstein and Marusik 2012: figs 2 and 36).....	<i>maculata</i>
–	Abdomen uniformly pale; embolus with hooked tip (Figs 20A–C, D, G, 21A–C).....	<i>ninhbinhensis</i> sp. n.
6	PMS present; abdomen uniformly coloured; receptacles U- or Y-shaped	7
–	PMS absent; abdomen spotted; receptacles Y-shaped, with short inner and longer outer branch (Raven and Schwendinger 1995: fig. 7G).....	<i>maculata</i>
7	Receptacles U-shaped, with inner and outer branches equal in length (Xu and Yun 2002: fig. 7).....	<i>chengbuensis</i>
–	Receptacles Y-shaped, with outer branch twisted and much longer than the very short inner branch (Shimojana and Haupt 2000: fig. 3F).....	<i>kumensis</i>

Sinopesa ninhbinhensis sp. n.

<http://zoobank.org/7D0D0ADA-6B9A-4BC4-8379-6AA61F590E4F>

Figs 20–21

Type material. Holotype ♂ – VIETNAM: Ninh Binh Province, disturbed forest of Cuc Phuong National Park [20°17.066'N, 105°40.253'E, elevation 273 m], pitfall traps, March 1–30, 2008. Paratypes: 26♂ (IZCAS), same data as holotype.

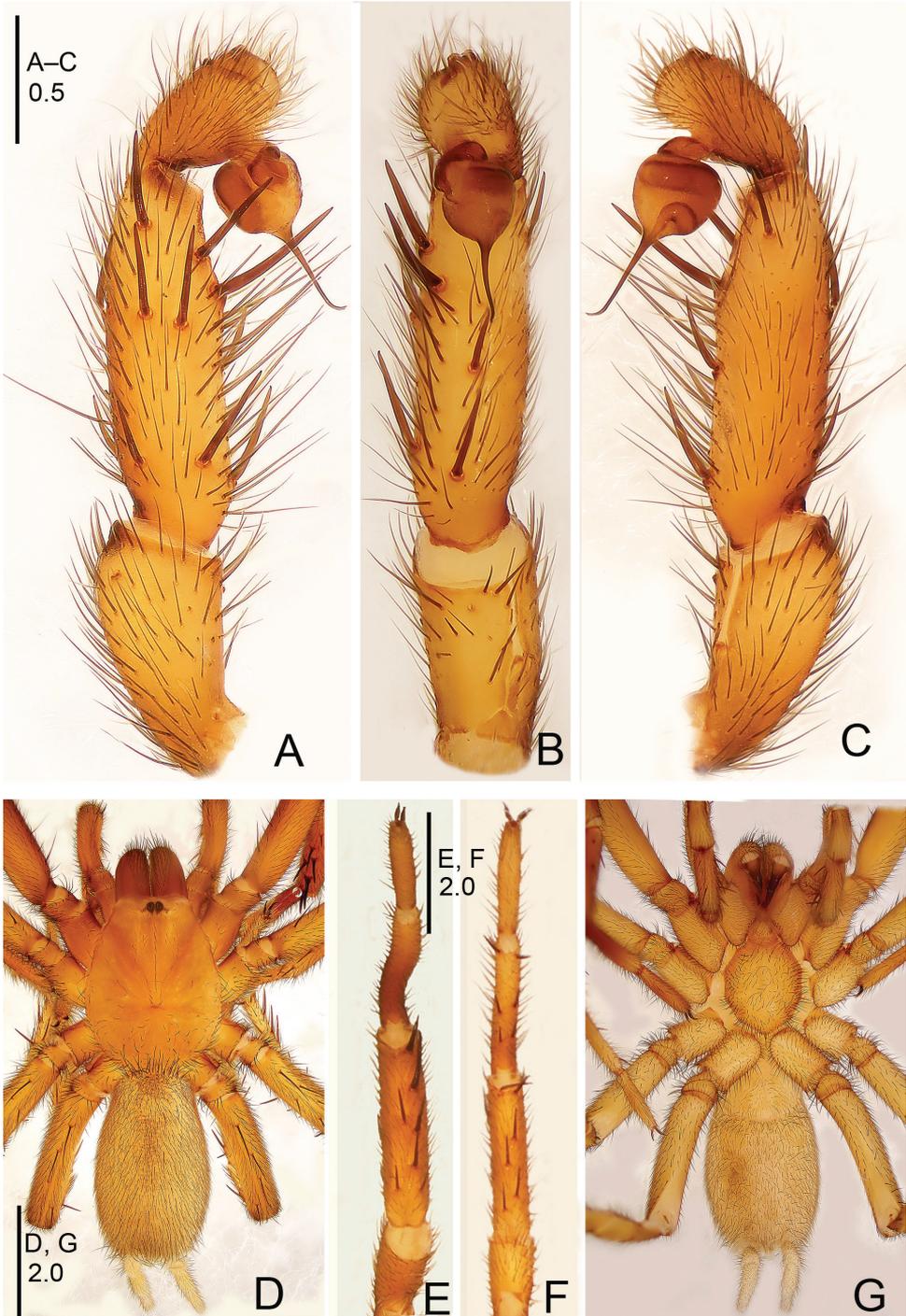


Figure 20. *Sinopesa ninbbinhensis* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view **D** habitus, dorsal view **E** leg I, ventral view **F** leg II, ventral view **G** habitus, ventral view. Scale bars: 0.5 mm (**A-C**); 2.0 mm (**D-G**).

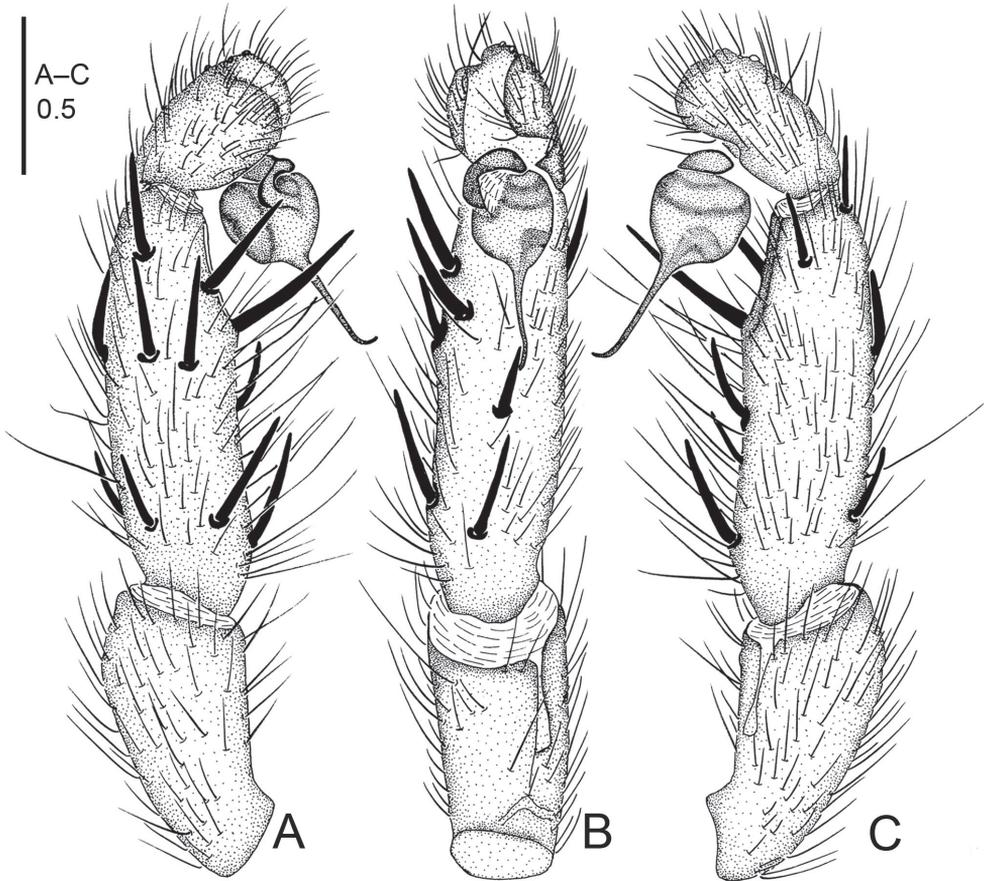


Figure 21. *Sinopsea ninbbinhensis* sp. n., male holotype. **A** palp, prolateral view **B** palp, ventral view **C** palp, retrolateral view. Scale bar: 0.5 mm.

Etymology. The specific epithet, a Latinised adjective, refers to the type locality.

Diagnosis. The new species shares with *S. kumensis* the complete absence of an abdominal pattern and the presence of a short male palpal tibia, but it can be distinguished from the latter species by the complete absence of PMS and by the presence of a globular bulb and of a gradually tapering and apically hooked embolus (oval and corkscrew-shaped, respectively) in *S. kumensis* (see Figs 20A–C, 21A–C, and Shimojana and Haupt 2000: figs. 3A–B).

Description. Male (holotype): TL 7.55, CL 2.95, CW 2.45, AL 3.20, AW 1.85. Eye diameters and interdistances: AME 0.11, ALE 0.14, PME 0.12, PLE 0.10, AME–AME 0.07, AME–ALE 0.04, PME–PME 0.26, PME–PLE 0.03. Leg lengths: I: 9.90 (2.75+1.50+2.55+2.15+1.25), II: 8.10 (2.25+1.15+2.10+1.50+1.10), III: 8.15 (1.75+0.95+2.00+2.15+1.30), IV: 10.60 (2.80+1.15+2.40+2.80+1.45). Venter as shown in Fig. 20G. Maxillae with a few (*ca.* 10) cuspules. Prosoma, palps and

legs light brown. Abdomen, including spinnerets, light grey (Fig. 20D, G). Metatarsus I considerably curved and bent (Fig. 20E). PMS absent, apical segment of PLS digitiform (Fig. 20D, G). Palpal tibia moderately short and slightly swollen; bulb globular, thin and narrow-based embolus hooked distally (Figs 20A–C, 21A–C).

Female. Unknown.

Variation. Total length: 6.95–7.70 (n=10).

Distribution. Vietnam: Ninh Binh Province.

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Additions to the checklist of Scoliidae, Sphecidae, Pompilidae and Vespidae of Peru, with notes on the endemic status of some species (Hymenoptera, Aculeata)

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Abstract

The first checklist of the Peruvian Hymenoptera listed 1169 species and subspecies of aculeate wasps, including 173 species of Pompilidae, seven of Scoliidae, 39 of Sphecidae and 403 of Vespidae. Herein are reported 32 species as new for Peru based mainly on the collection of the Natural History Museum, London. The loss of the endemic status of two species is also reported: *Entypus peruvianus* (Rohwer) (Pompilidae: Pepsinae) and *Omicron ruficolle schunkei* Giordani Soika (Vespidae: Eumeninae).

Keywords

Apoidea, Vespoidea, endemic species, social wasps, potter wasps, spider wasps, digger wasps

Introduction

Pompilidae, Scoliidae and Vespidae together with other seven families have been included in Vespoidea, while Sphecidae has been positioned in Apoidea, both included in Hymenoptera Aculeata (Brothers and Finnamore 1993, Hanson and Gauld 2006). Rasmussen and Asenjo (2009) compiled the first checklist of Hymenoptera Aculeata for Peru, including 1158 species and subspecies, with the majority (52%) of them belonging to Pompilidae, Scoliidae, Sphecidae and Vespidae. In addition, it included 226 endemic species for Peru, with 50 Pompilidae, one Scoliidae, two Sphecidae and 67 Vespidae.

Pompilidae includes approximately 5,000 species worldwide, with 850 neotropical species among 56 genera (Fernández 2000), of which 159 species in 33 genera are recorded for Peru (Rasmussen and Asenjo 2009). Scoliidae is a small component of the aculeate hymenopteran fauna, with nearly 300 species in the world, 47 of which are found in the New World (Hanson 2006). For Peru, Rasmussen and Asenjo (2009) listed eight species in three subgenera of *Campsomeris* Guerin. The biology of Scoliidae is poorly known, and the existing studies indicate that species are idiobiont ectoparasitoids of coleopteran larvae (Brothers and Finnamore 1993, Hanson 2006, Fernández 2006).

Sphecidae and Vespidae comprise, respectively, more than 660 and 5,000 described species of predatory wasps throughout the world (Goulet and Huber 1993, Pickett and Carpenter 2010). Rasmussen and Asenjo (2009) listed 39 species of 12 genera of Sphecidae classified in four subfamilies: Ammophilinae, Chloriontinae, Sceliphrinae and Sphecinae, all of them with neotropical representatives (Goulet and Huber 1993, Hanson and Menke 2006). Species of Ammophilinae are predators of Lepidoptera or Symphyta (Hymenoptera) larvae, while species of Chloriontinae have been recorded as predators of Gryllidae (Orthoptera) and Blattaria, Sceliphrinae as predator of Araneae and Blattaria, and Sphecinae as predators of Orthoptera (Goulet and Huber 1993, Hanson and Menke 2006). Vespidae, in turn, are classified in six subfamilies (Carpenter 1982, Pickett and Carpenter 2010), three of them, Eumeninae, Masarinae and Polistinae, known from the neotropical region (Carpenter 1993, Carpenter et al. 2006, Hermes et al. 2013). Rasmussen and Asenjo (2009) recorded 403 species and subspecies of 52 genera of Vespidae for Peru. Masarinae are solitary wasps and commonly known as “pollen wasps”, since their larvae are fed with pollen and nectar (Gess 1996) while Eumeninae and Polistinae, respectively, are solitary or social wasps preying on lepidopteran larvae as food for their larvae (Bohart and Stange 1965, West-Eberhard et al 2006).

Contributing to knowledge of the neotropical hymenopteran fauna, herein are presented new species records of Pompilidae, Scoliidae, Sphecidae and Vespidae from Peru.

Material and methods

The checklist of Rasmussen and Asenjo (2009) is updated, including new species records from Peru based on specimens deposited mainly in the Natural History Museum,

London (NHM, Dr. David Norton (curator of the Apoidea collection) and Dr. Gavin Broad (curator of the Vespoidea collection)), with some sporadic records from other institutions, as follows: American Museum of Natural History (AMNH, Dr. James M. Carpenter), Instituto de Biociências, Letras e Ciências Exatas da Universidade Estadual de São Paulo (IBILCE-UNESP, Dr. Fernando Barbosa Noll), Instituto Fundación Miguel Lillo (IFML, Emilia Constanza Pérez), Museu Paraense Emílio Goeldi (MPEG, Dr. Orlando Tobias Silveira), Museo di Storia Naturale di Venezia (MSNVE, Dr. Marco Uliana) and Museu de Zoologia da Universidade de São Paulo (MZUSP, Dr. Carlos Roberto Ferreira Brandão), Smithsonian Institution National Museum of Natural History (USMN, Dr. Sean Brady). Species identification of Pompilidae and Sphecidae deposited in the NHM and included herein were confirmed. Dubious identification were not included in the present list. For Scoliidae and Vespidae, only specimens labeled with specialist's identification were included. In this way, only species of Scoliidae determined by the Dr. James Chester Bradley (1884–1975) or Dr. Johan George Betrem (1899–1980) were considered. These two entomologists were the two main specialists in Scoliidae. All identification deposited in AMNH, IBILCE-UNESP, IFML, MPEG, MSNVE, MZUSP and USMN was confirmed. In addition,

The present checklist is organized alphabetically, following Rasmussen and Asenjo (2009) and adopting the most traditional family classification, in that Pompilidae, Scoliidae and Vespidae are placed in Vespoidea and Sphecidae in Apoidea with three subfamilies, differing from Rasmussen and Asenjo (2009) who adopted four subfamilies for Sphecidae. For Pompilidae, Rasmussen and Ansejo (2009) used the Pitts et al.' (2008) proposal, however, they adopted a hypothesis among 720 other equally parsimonious ones. Then, we decided to use the classification proposed by Shimizu (1994), which positioned *Epipompilus* in Epipompilinae and *Notocyphus* in Notocyphinae. The Vespidae tribe classification was based on Hermes et al. (2014).

All new records are assigned a cross (†). Abbreviations for the departments of Peru used in the present checklist are the same as in Rasmussen and Asenjo (2009), as follows: AM, Amazonas; AN, Ancash; AP, Apurímac; AR, Arequipa; CA, Cajamarca; CL, Callao; CU, Cusco; HU, Huánuco; HV, Huancavelica; JU, Junín; LA, Lambayeque; LI, Lima; LL, La Libertad; LO, Loreto; MD, Madre de Dios; PA, Pasco; PI, Piura; SM, San Martín; UC, Ucayali.

Results and discussion

In total, 32 species are recorded for the first time from Peru, 20 species of Pompilidae, three of Scoliidae, five of Sphecidae and four of Vespidae, and more than 250 records are new for Peruvian departments or localities. Moreover, seven species of Vespidae have been described by Cooper (2010, 2013a, 2013b, 2014), Silveira (2013) and Santos et al. (2015) for Peru, after the publication of Rasmussen and Asenjo's (2009) checklist. Santos et al. (2015) also resurrected *P. diligens* (Smith). Based on the taxonomic update and the present compilation, 1196 species of Hymenoptera Aculeata are now known

for Peru (see Suppl. material 2: Updated checklist). Pompilidae is currently represented by 173 species belonging to 33 genera, Scoliidae by eleven species in two genera, Sphecidae by 44 species of 12 genera and Vespidae by 405 species and sub-species of 53 genera. In the case of Scoliidae, a species of Scoliinae, *Scolia (Hesperoscolia) rufiventris* (Fabricius), is recorded for the first time for Peru.

In addition, the NHM's collection includes specimens of *Entypus peruvianus* (Rohwer) from Argentina and Bolivia, indicating that it is not a Peruvian endemic species. Another taxon that has lost its endemic status is *Omicron ruficolle schunkei* Giordani Soika, which has been recorded in Brazil in this work.

***Entypus peruvianus* (Rohwer, 1913)**

Specimen data. ARGENTINA: 1♀, S. de Estero, 37–47k. S.e. Anatumya, 20.xi.1979, C. & M. Vardy [NHM]. 1♀ and 1♂, Salta, Orán, Abra Grande, x.18–25 1968, C. Porter [NHM]. 1♀ and 1♂, Salta, Orán, Abra Grande, x.18–25 1968, C. Porter [NHM]. BOLIVIA: 1♀, La Paz, Zongo Valley, Cahua, 1400m, 22–23.vi.1979, M. Cooper, B.M. 1979-397 [NHM]. 3♀♀, La Paz, Coroico, 20.v.1989, 1200m, M. Cooper, 1979-216 [NHM]. 1♀, La Paz, Chulumani, 1700m, 25.iii.1979, M. Cooper, B.M. 1979-216 [NHM].

***Omicron ruficolle schunkei* Giordani Soika, 1978**

Specimen data. BRAZIL: 5♀♀, SP, Pindorama, 21°13'27"S 48°55'35"W, 08/viii/2014, Soleman, R.A. col. [IBILCE-UNESP]

Futhermore, Castro-Huertas et al. (2014) recorded other three species of Pompilidae from Colombia (Pepsinae: *Ageniella pretiosa* Banks and *Mystacagenia bellula* Evans; Pompilinae: *Aporus (Aporus) cuzco* Evans), and Santos et al. (2015) another one of Polistinae (Vespidae) from Brazil (*Protopolybia chanchamayensis* Bequaert) that were regarded as endemic by Rasmussen and Asenjo (2009). On the other hand, Silveira (2013) and Santos et al. (2015) described new species of Polistinae (*Mischocyttarus tayacaja* Silveira; *Protopolybia similis* Santos, Silveira & Carpenter), and Cooper (2013a) described one of Eumeninae (*Pararhaphidoglossa carpenteri* Cooper) that are known only from Peru. These aspects indicate the hymenopteran fauna of several South American regions are still poorly sampled, and new collecting efforts and identification efforts of already collected material should increase the number of species recorded for Peru.

SPHECIDAE**Chloriontinae*****Chlorion* Latreille, 1802***viridicoeruleum* Lepeletier & Seville, 1828†: UC (Pucallpa)**Sceliphrinae*****Penepodium* Menke in Bohart & Menke, 1976***gorianum* (Lepeletier, 1845): UC (Pucallpa)*romandinum* (de Saussure, 1867): UC (Pucallpa)***Podium* Fabricius, 1804 [Kohl 1902]***agile* Kohl, 1902†: UC (Pucallpa)*denticulatum* Smith, 1856: UC (Pucallpa)*kohlii* Zavattari, 1908: UC (Pucallpa)*rufipes* Fabricius, 1804†: UC (Pucallpa)**Sphecinae*****Sphex* Linnaeus, 1758**Subgenus: *Sphex* Linnaeus, 1758*nitidiventris* Spinola, 1853†: UC (Pucallpa)*tinctipennis* Cameron, 1888†: CU (Atalaya), HU (Previsto), UC (B. Abad)**POMPILIDAE****Ceropalinae*****Ceropales* Latreille, 1796**Subgenus: *Bifidoceropales* Priesner, 1969*isolde* subsp. *isolde* (Banks, 1945)†: LL (Trujillo)***Irenangelus* Schulz, 1906***reversus* (Smith, 1873): UC (B. Abad)**Epipompilinae*****Epipompilus* Kohl, 1884***williamsi* (Banks, 1947)†: PA (Oxapampa)**Pepsinae****Ageniellini*****Ageniella* Banks, 1912**Subgenus: *Alasagenia* Banks, 1944*fortipes* (Smith, 1873) †: UC (Pucallpa)

pilifrons (Cameron, 1912) †: HU (Monzón-Rondos River), JU (Chanchamayo),
UC (B. Abad, Pucallpa)

Subgenus: *Ageniella* Banks, 1912

ruficeps (Smith, 1864) †: UC (Pucallpa)

***Auplopus* Spinola, 1841**

deceptor (Smith, 1873) †: HU (Cord. Azul)

***Priocnemella* Banks, 1925**

hexagona subsp. *omissa* Banks, 1946: HU (Tingo María), JU (Chanchamayo), UC
(Atalaya, Pucallpa)

Pepsini

***Caliadurgus* Pate, 1946**

pretiosus (Fox, 1897) †: PA (Oxapampa)

***Entypus* Dahlbom, 1843**

decoloratus (Lepeletier, 1845) †: HU (Monzón)

dumosus (Spinola, 1851) †: LA (Jayanca), LI (Matucana), LL (Simbal)

gigas (Fabricius, 1804) †: UC (Pucallpa)

molestus (Banks, 1946): Endemic, LA (Lambayeque), LI (Matucana), LL (Simbal)

nitidus (Banks, 1946): HU (Cayumba)

peruvianus (Rohwer, 1913): CU (Apurimac River, Machu Picchu, Urubamba River)

Pompilinae

Aporini

***Aporus* Spinola, 1808**

Subgenus: *Aporus* Spinola, 1808

cuzco Evans, 1973: CU (Urubamba River)

Subgenus: *Neoplaniceps* Bradley, 1944

umbratilis Evans, 1966: CU (Urubamba), HU (Tingo María)

Subgenus: *Notoplaniceps* Bradley, 1944

canescens Smith, 1873: MD (Pantiacolla)

***Euplaniceps* Haupt, 1930**

varia Bradley, 1944: CU (Atalaya), UC (B. Abad)

Pompilini

***Anoplius* Dufour, 1834**

Subgenus: *Anopliodes* Banks, 1939

varius (Fabricius, 1804): HU (Cord. Azul, Tingo María), UC (B. Abad)

Subgenus: *Anoplius* Dufour, 1834

ambatoensis (Cameron, 1903)†: CU (Urubamba), LI (Chosica)

Subgenus: *Arachnoproctonus* Howard, 1901

inculcatrix (Cameron, 1912): JU (Chanchamayo), LO (Est. Jenaro Herrera)

***Austrochares* Banks, 1947**

elsinore Banks, 1947: Endemic, CL (Ventanilla), LA (Chiclayo, Jayanca, Lambayeque, Olmos), LL (Simbal, Trujillo)

***Balboana* Banks, 1944**

auripennis (Fabricius, 1804): CU (Quincemil), HU (Tingo María), UC (Atalaya, Pucallpa)

manifestata (Smith, 1864) †: LO (Est. Jenaro Herrera)

***Evagetes* Lepeletier, 1845**

copiosus Banks, 1947†: CU (Cusco)

***Paracyphononyx* Gribodo, 1884**

unicolor (Smith, 1879) †: CU (Apurimac River, Machu Picchu, Urubamba River), HU (Tingo María), JU (Chanchamayo)

***Poecilopompilus* Howard, 1901**

rubricatus (Smith, 1879): LA (Chiclayo, Jayanca, Lambayeque), LI (Cieneguilla, Lima), LL (Trujillo, Jequetepeque River)

***Priochilus* Banks, 1944**

captivum (Fabricius, 1804)†: LO (Contamana, Iquitos), PA (Pichis), UC (Pucallpa)

formosus Banks, 1944: CU (Quincemil), JU (Chanchamayo), SM (Nuevo Progreso)

gloriosum subsp. *gloriosum* (Cresson, 1869)†: JU (Chanchamayo), UC (B. Abad, Pucallpa)

gracillimus (Smith, 1855) (= *scrupulum* (Fox, 1897)): HU (Tingo María), UC (Pucallpa)

pectoralis (Smith, 1855) (= *imperius* Banks, 1944): CA (Jaén), LO (Est. Jenaro Herrera), MD (Atalaya), UC (Pucallpa).

regius subsp. *regius* (Fabricius, 1804): HU (Cayumba, Tingo María, Yanayacu), JU (Chanchamayo), UC (Atalaya, B. Abad, Pucallpa)

ruficoxalis (Fox, 1897)†: UC (Pucallpa)

sericeifrons (Fox, 1897): CU (Quincemil), HU (Monzón- Rondos River, Tingo María), UC (B. Abad, Pucallpa).

splendidulum subsp. *splendidulum* (Fabricius, 1804): HU (Cord. Azul, Tingo María), LO (Est. Jenaro Herrera), UC (B. Abad, Pucallpa).

veraepascis (Cameron, 1893): LO (Est. Jenaro Herrera).

***Tachypompilus* Ashmead, 1902**

pallidus Banks, 1947: Endemic, LI (Chosica), LL (Simbal)

Notocyphinae***Notocyphus* Smith, 1855**

crassicornis Smith, 1864†: JU (Chanchamayo), LO (Est. Jenaro Herrera), UC (Pucallpa).

laetabilis (Smith, 1873)†: UC (Pucallpa).

multipicta Smith, 1873†: LO (Est. Jenaro Herrera), UC (B. Abad, Pucallpa)

saevissimus Smith, 1855†: UC (Pucallpa)

thetis Banks, 1945†: CU (Atalaya), UC (Pucallpa)

SCOLIIDAE**Campsomerinae*****Campsomeris* Guérin-Méneville, 1839**

Subgenus: *Aelocampsomeris* Bradley, 1957

variegata Fabricius, 1793: JU (Chanchamayo)

Subgenus: *Lissocampsomeris* Bradley, 1957

arneohirta (Fox, 1896)†: JU (Chanchamayo), UC (B. Abad)

wesmaeli (Lepeletier, 1845)†: CU (Atalaya), HU (Monzón – Rondos River), JU (Chanchamayo), UC (B. Abad, Pucallpa)

Scoliinae***Scolia* Fabricius, 1775**

Subgenus: *Hesperoscolia* Bradley, 1974

rufiventris (Fabricius, 1804)†: JU (Chanchamayo), UC (B. Abad, Pucallpa).

VESPIDAE**Eumeninae****Eumenini*****Brachymenes* Giordani Soika, 1961**

wagnerianus (de Saussure, 1875): UC (Cord. Azul).

***Eumenes* Latreille, 1802**

Subgenus: *Zeteumenoides* Giordani Soika, 1972

filiformis (de Saussure, 1855): MD

Omicron de Saussure, 1855

paranymphum (Zavattari, 1912): UC (Previsto)

Pachymenes de Saussure, 1852

consuetus Giordani Soika, 1990: MD, JU (Chanchamayo) (= *obscurus* subsp.

consuetus Giordani Soika, 1990 – Grandinete et al. 2014)

ghilianii Spinola, 1851: MD (= *ghilianii* subsp. *olivaceus* (de Saussure, 1875);

= *peruanus* Schrottky, 1911 – see Grandinete et al. 2014)

orellanae (Schulz, 1905): HU (Tingo María), LO (Iquitos), MD (Res. Nac.

Tambopata), UC (B. Abad) (= *orellanae* subsp. *orellanae* (Schulz, 1905), =

orellanae subsp. *vardyi* Giordani Soika, 1990 – see Grandinete et al. 2014)

Pararhaphidoglossa von Schulthess, 1910

carpenteri Cooper, 2013: Endemic, LO (Iquitos) [Cooper 2013a]

gribodoi (Zavattari, 1912): JU (Pan de Azucar) [Cooper 2013b]

mestiza Giordani Soika, 1978: HU (Yanayacu) [Cooper 2012]

schunkei Cooper, 2014: UC (B. Abad) [Cooper 2014]

sulcata Cooper, 2013: LO (Iquitos) [Cooper 2013b]

Pirhosigma Giordani Soika, 1978

nearimense subsp. *nearimense* (Zavattati, 1912)†: UC (Pucallpa)

Sphaeromenes Giordani Soika, 1978

discrepatus Giordani Soika, 1978: LI (Santa Rosa de Quives), LL (Trujillo)

Odynerini**Hypalastoroides de Saussure, 1852**

Subgenus: *Hypalastoroides* de Saussure, 1852

brasiliensis (de Saussure, 1856): LO (Iquitos)

Hypodynerus de Saussure, 1855

arequipensis (du Buysson, 1913): JU (Yanamaria)

obscuripennis (Spinola, 1851): AR (Arequipa)

Pseudodynerus de Saussure, 1855

subapicalis (Fox, 1902): HU (Huánuco)

Zethini**Zethus Fabricius, 1804**

Subgenus: *Zethus* Fabricius, 1804

cataractae Cooper, 2010: JU (Quebrada Mala Noche) [Cooper 2010]

Polistinae**Epiponini*****Agelais* Lepeletier de Saint Fargeau, 1836**

myrmecophila (Ducke, 1905): HU (Llullapichis), LO

***Brachygastra* Perty, 1833**

albula Richards, 1978†: CU (Cadena, Cusco). [Andena and Carpenter 2012]

augusti (de Saussure, 1854): CU (Cadena), MD (Res. Nac. Tambopata), LO (Estiron), UC (Cord. Azul, Pucallpa)

baccalaurea (R. von Ihering, 1903): CU (Machu Picchu), PI (Huacabamba)

bilineolata Spinola, 1841: CU (Cadena), LO (Dos de Mayo, Iquitos), PA (Cerro de Pasco)

lecheguana (Latreille, 1824): CA (Quebrada Nancho), LA (Jequetepeque), LL (Pascamayo), UC (Yarinacocha)

propodealis Bequaert, 1943: CU (Cadena), MD (Puerto Maldonado)

scutellaris (Fabricius, 1804): HU (Llullapichis River)

smithii (de Saussure, 1854): LA (Jequetepeque), LL (Pascamayo), LO (Galicia)

***Chartergellus* Bequaert, 1938**

fulvus Fox, 1898: HU (Tingo María), LO (Mishuyacu)

***Polybia* Lepeletier, 1836**

Subgenus: *Alpha* de Saussure, 1854

bifasciata de Saussure, 1854: JU (Chanchamayo), UC (B. Abad)

quadricincta de Saussure, 1854: UC (Pucallpa)

Subgenus: *Apopolybia* Richards, 1978

jurinei de Saussure, 1854: LO (Iquitos), UC (Previsto, Pucallpa)

Subgenus: *Cylindroeca* Richards, 1978

dimidiata (Olivier, 1791): JU (Chanchamayo), UC (Previsto, Pucallpa)

Subgenus: *Formicicola* Richards, 1978

rejecta (Fabricius, 1798): HU (Yanayacu), UC (Previsto, Pucallpa)

Subgenus: *Myrapetra* White, 1841

bistriata (Fabricius, 1804): UC (Pucallpa)

catillifex Möbius, 1856: UC (Atalaya, B. Abad, Previsto)

diguetana du Buysson, 1905: PA (Oxapampa), UC (Pucallpa)

fastidiosuscula de Saussure, 1854: JU (Chanchamayo), LA (Chiclayo)

parvulina Richards, 1970†: JU (Chanchamayo), UC (Previsto)

Subgenus: *Platypolybia* Richards, 1978

incerta Ducke, 1907: HU (Tingo María), JU (Chanchamayo), UC (San Alejandro)

procellosa subsp. *dubitata* Ducke, 1910: UC (B. Abad, Previsto)

Subgenus: *Polybia* Lepeletier de Saint Fargeau, 1836

striata (Fabricius, 1787): HU (Tingo María), UC (Pucallpa)

Subgenus: *Trichinothorax* Carpenter & Day, 1988

micans Ducke, 1904: PA (Puerto Bermúdez)

rufitarsis subsp. *peruviana* Bequaert, 1943: LO (Iquitos), UC (B. Abad)

sericea (Olivier, 1791): CA (Jaén)

tinctipennis subsp. *tinctipennis* Fox, 1898: UC (Pucallpa)

velutina Ducke, 1905: UC (Atalaya, Boq. Abad, Previsto), HU (Tingo María)

***Protopolybia* Ducke, 1905**

acutiscutis (Cameron, 1907): LO (Nanay River)

bella (R. von Ihering, 1903): CU (Paucartambo), HU (Tingo María)

chartergoides subsp. *chartergoides* (Gribodo, 1891): UC (Pucallpa)

clypeata Santos, Silveira & Carpenter (2015): LO (Galicia, San Pedro, Yarin) [Santos et al. 2015]

diligens (Smith, 1857): LO (Napo) [Santos et al. 2015]

sedula (de Saussure, 1854): UC (Pucallpa)

similis Santos, Silveira & Carpenter, 2015: JU (San Ramón) [Santos et al. 2015]

Mischocyttarini

***Mischocyttarus* de Saussure, 1853**

Subgenus: *Phi* de Saussure, 1854

alfkenii Ducke, 1904: LO [Silveira, 2013]

flavicornis Zikán, 1949 (= *flavicornis* subsp. *nigricornis* Zikán, 1949 – see Silveira 2013): CU (Cusco, Urubamba), JU (Satipo) [Silveira 2013]

flavoniger Zikán, 1949: JU (Chanchamayo) [Silveira 2013]

tayacaja Silveira, 2013: HV (Campo Armiño) [Silveira 2013]

Polistini

***Polistes* Latreille, 1802**

Subgenus: *Aphanilopterus* Meunier, 1888

claripennis Ducke, 1904: UC (Pucallpa)

deceptor Schulz, 1905: JU (Chanchamayo), SM (Rioja), UC (Pucallpa)

maranonensis Willink, 1964: AM (Utcubamba)

pacificus subsp. *modestus* Smith, 1868†: HU (Tingo María)

testaceicolor Bequaert, 1937: UC (Previsto, Pucallpa)

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Appendix I

Localities reported in the checklist including coordinates and altitude range (m a.s.l.).

Department	Locality	Longitude	Latitude	Altitude
AMAZONAS	Utcubamba, Valley	-78.55250	-5.53500	1700
AREQUIPA	Arequipa	-71.51667	-16.38333	2300
CAJAMARCA	Quebrada Nancho	-79.25000	-6.96667	400
	Jaén	-78.81667	-5.70000	750
CALLAO	Ventanilla	-77.07361	-11.85556	97
CUSCO	Apurimac River (68 km west Cusco)	-72.11667	-13.64667	2400
	Atalaya	-71.35000	-12.90000	600
	Cadena	-70.717	-13.4000	1600
	Cusco	-71.98333	-13.51667	3400–4200
	Machu Picchu	-72.54579	-13.16319	2385–2700
	Paucartambo	-71.60000	-13.31667	2900
	Quincemil	-70.76667	-13.23333	630–650
	Urubamba	-72.28530	-13.23250	3500
HUANUCO	Urubamba River	-72.11667	-13.30417	2900
	Cayumba	-75.95000	-9.50000	2000
	Cord. Azul (= Cordillera Azul)	-75.93333	-9.15000	1600
	Llullapichis	-74.93333	-9.61667	260
	Monzón, Valley	-76.40000	-9.28333	950
	Monzón, Valley – Rondos River	-76.08333	-9.25000	950
HUANCAVELICA	Tingo María	-76.00000	-9.30000	670
	Yanayacu	-74.97611	-9.55722	200
JUNÍN	Campo Armiño	-74.65000	-12.35000	1600–1880
	Chanchamayo, Valley of	-75.31667	-11.05000	700–1300
	Pan de Azucar (Km 83 Tarma to San Ramon)	-75.45250	-11.17830	1400
	Quebrada Mala Noche	-75.41110	-11.12690	1300–1500
JUNÍN	San Ramón	-75.35000	-11.13333	900
	Satipo	-74.63674	-11.25423	631
LAMBAYEQUE	Yanamaria [Ana Maria?], near Jauja	-75.66410	-11.79200	3470
	Chiclayo	-79.85000	-6.76667	21
	Jayanca	-79.82194	-6.39083	61
	Lambayeque	-79.90000	-6.70000	20
LIMA	Olmos	-79.75000	-5.98333	150
	Chosica	-76.70000	-11.93333	850
	Cieneguilla	-76.81160	-12.11730	550
	Lima	-77.03333	-12.05000	50
	Matucana	-76.38550	-11.84576	2400
LA LIBERTAD	Santa Rosa de Quives	-76.78877	-11.66904	1100–1550
	Jequetepeque River	-78.87861	-7.50496	818
	Pascamayo	-79.56667	-7.41667	20
	Simbal	-78.81667	-7.96667	576
	Trujillo	-79.03333	-8.11667	20

Department	Locality	Longitude	Latitude	Altitude
LORETO	Contamana	-75.00000	-7.35000	150
	Dos de Mayo	-75.11700	-6.40000	100–124
	Estación Jenaro Herrera	-73.65011	-4.89861	121
	Estirón, Ampiyacu River	-72.00800	-3.36800	93
	Galicia	-73.80000	-5.28333	700
	Iquitos	-73.25000	-3.75000	100
	Mishuyacu, River	-73.30000	-3.78333	120
	Nanay River	-73.38889	-3.81806	97
	Napo – Sucusari River	-72.91850	-3.26650	84
	San Pedro	-74.25000	-4.45000	75–170
	Yarin, Quebrada	-74.03333	-3.90000	127
MADRE DE DIOS	Avispas	-70.35000	-12.98333	350–400
	Atalaya, Manu Nat. Park	-71.72139	-11.85639	305–1000
	Puerto Maldonado	-69.18333	-12.60000	200
	Reserva Nacional de Tambopata	-69.28300	-12.85000	236
	Pantiacolla - Upper Madre de Dios River	-71.23180	-12.65570	404
PASCO	Cerro de Pasco	-76.26200	-10.68600	4310
	Oxapampa	-75.40000	-10.58333	1800
PASCO	Pichis, River	-74.93333	-9.90000	300
	Puerto Bermúdez	-74.93333	-10.30000	3–700
PIURA	Huancabamba	-79.44300	-5.25700	2713
SAN MARTIN	Nuevo Progreso	-76.32465	-8.448889	511
	Rioja	-77.16667	-6.6667	900
UCAYALI	Atalaya	-73.76667	-10.73333	250
	B. Abad (= Boquerón del Padre Abad)	-75.68061	-9.07082	500
	Previsto - Cord. Azul (= Cordillera Azul)	-75.83200	-9.07500	700–2000
	Previsto	-75.63333	-9.05000	420–500
	Pucallpa	-74.53055	-8.37971	180–500
	San Alejandro	-75.76667	-9.08333	1300–1600
	Yarinacohca	-74.60000	-8.35000	150–300

Supplementary material 1

Full Checklist of the Peruvian Scoliidae, Sphecidae, Pompilidae and Vespidae

Authors: Eduardo Fernando dos Santos, Yuri Campanholo Grandinete, Fernando Barbosa Noll

Data type: occurrence

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Supplementary material 2

Table S1

Authors: Eduardo Fernando dos Santos, Yuri Campanholo Grandinete, Fernando Barbosa Noll

Data type: Checklist

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Richness, systematics, and distribution of molluscs associated with the macroalga *Gigartina skottsbergii* in the Strait of Magellan, Chile: A biogeographic affinity study

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Abstract

Knowledge about the marine malacofauna in the Magellan Region has been gained from many scientific expeditions that were carried out during the 19th century. However, despite the information that exists about molluscs in the Magellan Region, there is a lack of studies about assemblages of molluscs co-occurring with macroalgae, especially commercially exploitable algae such as *Gigartina skottsbergii*, a species that currently represents the largest portion of carrageenans within the Chilean industry. The objective of this study is to inform about the richness, systematics, and distribution of the species of molluscs associated with natural beds in the Strait of Magellan. A total of 120 samples from quadrates of 0.25 m² were obtained by SCUBA diving at two sites within the Strait of Magellan. Sampling occurred seasonally between autumn 2010 and summer 2011: 15 quadrates were collected at each site and season. A total of 852 individuals, corresponding to 42 species of molluscs belonging to Polyplacophora (9 species), Gastropoda (24), and Bivalvia (9), were identified. The species richness recorded represents a value above the average richness of those reported in studies carried out in the last 40 years in sublittoral bottoms of the Strait of Magellan. The biogeographic affinity indicates that the majority of those species (38%) present an endemic Magellanic distribution, while the rest have a wide distribution in the Magellanic-Pacific,

Magellanic-Atlantic, and Magellanic-Southern Ocean. The molluscs from the Magellan Region serve as study models for biogeographic relationships that can explain long-reaching patterns and are meaningful in evaluating possible ecosystemic changes generated by natural causes or related to human activities.

Keywords

Mollusca, biodiversity, biogeography, algae beds, Magellan Region

Introduction

In the South-eastern Pacific Ocean, the Magellanic biogeographic province (43°S to 56°S) is constituted by a large extension of channels and fjords with diverse coastal environments from glacial influence to direct exposure by the Pacific Ocean (Camus 2001, Spalding et al. 2007). Two biogeographic districts have been categorised for this biogeographic province: the Austral and the Subantarctic. The latter extends from about 52°–53°S to 56°S (Camus 2001); in other words, from the Strait of Magellan to Cape Horn. This territory is characterised by different environmental conditions that determine sub-areas of physiogeology and orography, geology, soils, and differentiated climates (Pisano 1977). Within the Subantarctic biogeographic region, the Strait of Magellan connects the Pacific and Atlantic oceans. For this reason, the Strait of Magellan offers unique characteristics for studying biodiversity and, specifically, aspects related to biogeography (Ríos et al. 2003).

Knowledge about a large part of the marine fauna in the Magellan Region was first attained from scientific expeditions carried out during the 19th century. The historical contributions to the knowledge of molluscs from the Magellanic biogeographic province have been detailed by Reid and Osorio (2000), Cárdenas et al. (2008), and Aldea and Rosenfeld (2011). Currently, many researchers have contributed to the knowledge about these molluscs, principally in descriptive taxonomy and ecology in the Magellan Region (e.g. Linse 2002, Ríos et al. 2003, Zelaya and Ituarte 2003, 2004, Pastorino 2005a, 2005b, Linse et al. 2006, Schwabe et al. 2006, Sirenko 2006, Zelaya and Geiger 2007, Ojeda et al. 2010, Aldea and Rosenfeld 2011, Rosenfeld and Aldea 2011, Rosenfeld et al. 2011, Signorelli and Pastorino 2011). Recently, new contributions have been made using molecular tools in order to study specific groups of molluscs (e.g. Espoz et al. 2004, Aranzamendi et al. 2009, Gonzalez-Wevar et al. 2010, 2011). One crucial aspect of molluscs from these latitudes is their biogeographic relationship that can explain “long reaching patterns” (e.g. Linse et al. 2006, Clarke et al. 2007, Fortes and Absalao 2011). Therefore, molluscs are interesting as a study group to evaluate possible ecosystemic changes generated by natural or human causes.

Although much knowledge exists about molluscs from the Magellan Region, the majority of this knowledge has been centred only on the characterisation of the taxon and not on the search for assemblages and biogeographic patterns. Some contributions to this interaction have come from studies on invertebrates associated with giant kelp, *Macrocystis pyrifera* (Ojeda and Santelices 1984, Adami and Gordillo 1999, Ríos et al. 2007). Currently, the only macroalgae in the Magellan Region with massive commer-

cial exploitation corresponds to the carreeganofite *Gigartina skottsbergii*. This species is distributed from 39°52'S (Romo et al. 2001) toward the Antarctic Peninsula (Wiencke and Clayton 2002). *G. skottsbergii* is characterised as forming a dense sublittoral bed, reaching a biomass density of around 1773 g/m² and densities of 15 individuals/m² (Ávila et al. 2004). The extraction of this species has the objective of providing the principal raw material for the production of carrageenan hydrocolloid (carrageenan), a gel with multiple applications in the food and cosmetics industries (Romo et al. 2001; Pujol et al. 2006; Barahona et al. 2012). Due to the growing national and international demand for this raw material, algae beds have suffered significant losses and their restoration has been quite slow, showing largely damaged communities in beds of Puerto Montt (-41°S; Romo et al. 2001). For this reason, a good share of the extractive pressure has moved toward the south, especially in the area of the Gulf of Penas (-47°S) as well as the Magellan Region (-53°S; Romo et al. 2001, Mansilla et al. 2008).

Differing from other distribution sites of *G. skottsbergii*, the Strait of Magellan still has a natural bed of *G. skottsbergii* (Ávila et al. 2004), and it is important for analysis for two reasons: i) describing the current situation of the fauna present in natural beds and ii) because analysis of the systematics and distribution of molluscs throughout the Strait of Magellan is a good model to characterise possible faunistic connections between different environments (e.g. Atlantic-Pacific). Thus, populations of *G. skottsbergii* in the Magellan Region constitute an excellent alternative to study the benthic biodiversity. Here it is possible to study molluscs that are associated with algae and form beds that provide a shelter for associated species (Mansilla 2013), potentially contribute to conservation (Gray 1997, Fernández et al. 2000, Lancellotti and Vásquez 2000) or allow to determine an eventual loss of diversity for the function of the ecosystem (Purvis and Hector 2000). In this sense, the objective of this study is to describe the species richness and distribution of the mollusc species associated with the natural bed of *G. skottsbergii* in the Strait of Magellan, and to evaluate the biogeographic affinities of all the species.

Material and methods

The study area was localised in two sampling sites with the presence of a bed of *G. skottsbergii* in the Strait of Magellan: i) Punta Santa Maria, located in Tierra del Fuego (53°21'S – 70°27'W), and ii) Punta Santa Ana, located 60 km to the south of Punta Arenas (53°37'S – 70°52'W) (Fig. 1). The samples were obtained by SCUBA diving at ~10 m depth in quadrates of 0.25m², which were selected randomly within the bed. In each quadrate, all molluscs were collected, and also the substrate, where *G. skottsbergii* settled, was investigated. Subsequently, the rocks were scraped to ensure that all the species and specimens were collected. Fifteen quadrates were sampled during one dive in each site and season, resulting in 60 quadrates per site (2 sites × 4 seasons × 15 quadrates). Sampling was carried out in autumn, winter, and spring of 2010, and in summer of 2011. The samples obtained were deposited in plastic bags, tagged and preserved in Formalin, diluted to 4–5% in seawater, and buffered with sodium borate.

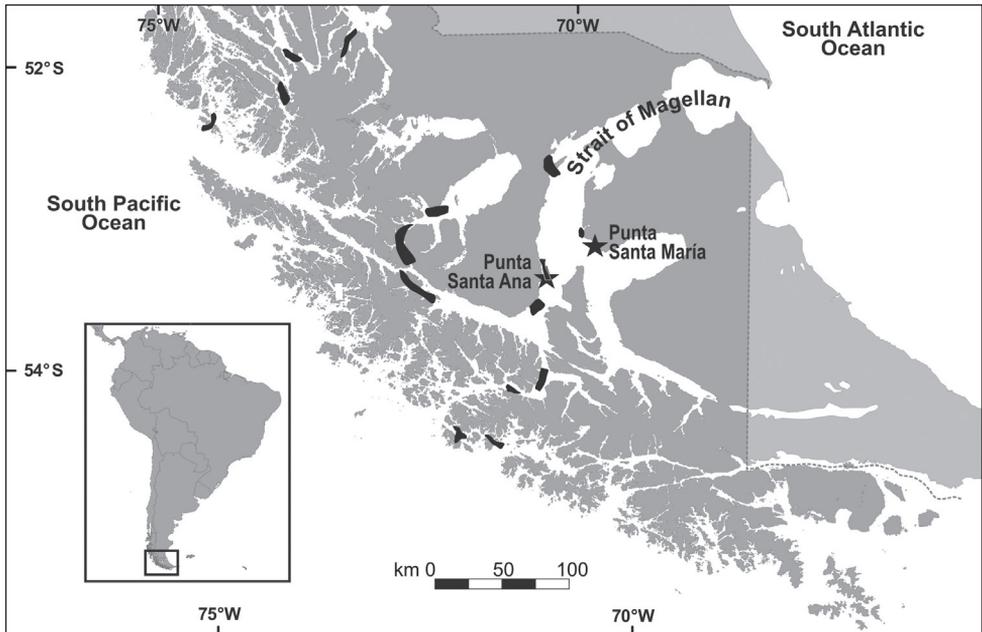


Figure 1. Study area. Location of sampling sites: Punta Santa Ana and Punta Santa María (stars) and natural beds of *Gigartina skottsbergii* (shading areas, extrated from Ávila et al. 2004).

Systematics analysis

Taxonomic identification of the molluscs and the registry of the geographic distribution of each species was based on a complete study of the current literature (e.g. Reid and Osorio 2000, Linse 2002), as well as on classic works (e.g. Smith 1881, Rochebrune and Mabilie 1889, Strebel 1905a, 1905b), systematics studies about specific taxa (e.g. Villaroel and Stuardo 1998, Pastorino and Harasewych 2000, Zelaya 2004), and academic databases available on the internet (Morris and Rosenberg 2005, USNM 2010).

All of the morphotypes that were identified at species level are included in this report, with the following information presented for each one: a) material examined, b) synonymy, c) remarks, and d) distribution. The material examined is detailed for each bed, showing the number of live specimens collected (spm.) and including the dimensions of the largest and smallest specimens. The synonymy is derived from the last taxonomic study. In the remarks, taxonomic, morphological, and/or ecological aspects are discussed. The distribution shows all previous records of the species, arranged from north to south in both oceans (Pacific and Atlantic). These records were matched into the following marine biogeographic regions (Spalding et al. 2007): Warm Temperate South-eastern Pacific (WTSP), Magellanic, Warm Temperate South-western Atlantic (WTSA) and Southern Ocean (SO). Dimensions of the polyplacophorans refer to their maximum longitude and maximum width. For gastropods, the maximum height is from the ventral umbo of the shell, and the maximum width is perpendicular to the

height. Finally, for bivalves, the maximum height is from the umbo on the ventral margin, and the width is between the upper and lower margins.

In addition, larval development was investigated in order to evaluate reproductive strategy related to the dispersion mode of each species. The source of this information was: McLean (1984), Hain and Arnaud (1992), Ponder and Worsfold (1994), Osorio (2002), Pastorino (2002), Pastorino and Penchaszadeh (2002), Linse and Page (2003), Zelaya (2004), Schwabe (2009), Zelaya (2009a, 2009b), González-Wevar et al. (2011), Torroglosa and Gimenez (2012), and Liuzzi and Zelaya (2013).

Statistical analysis

In order to detect whether our sampling effort was able to estimate the total species of molluscs, the linear dependence model was used. This was designed to estimate species richness, depending on the number of samples (Soberon and Llorente 1993). All samples were randomised so as not to affect the shape of the curve (Colwell and Coddington 1994, Moreno and Halffter 2000). The estimation method Simplex and Quasi-Newton of the statistical package STATISTICA 7 was used to estimate the coefficients of the nonlinear regression model.

Possible changes in the assemblage of molluscs throughout the year were determined using a nested design that considered each sampling site and season as sources of variation. For this, a PERMANOVA analysis was performed using species richness (Anderson 2005). Previously, the distance from Bray-Curtis similarity between pairs of observations was calculated, and 9999 permutations were used without data constraints (Anderson 2001). This analysis was developed in the FORTRAN package (Anderson 2005).

Furthermore, we defined species represented by a single individual as “singletons” and species represented by only two individuals as “doubletons” (Colwell and Coddington 1994) as a measure of species rarity.

Analysis of biogeographic aspects

Biogeographic distribution was delimited for the species as “Widespread”, “Magellanic-Pacific southeast temperate”, “Magellanic”, “Magellanic-Atlantic southwest temperate”, and “Magellanic-Southern Ocean”, following the classification of provinces and biogeographic ecoregions proposed by Spalding et al. (2007) and taking into account previous research (Stuardo 1964, Brattström and Johanssen 1983, Lancelotti and Vásquez 2000, Camus 2001) of the Chilean Coast. In order to estimate the biogeographic affinities of the molluscs recorded in this study, a literature revision was carried out from the different provinces and regions of the South American and Antarctic coasts. A comprehensive review of the bathymetry of each species was performed. All species inhabiting depths less than 30 m were included and considered as “shallow-

water species”. For the different provinces or regions of the Pacific Coast, the number of species was obtained from the revisions of Valdovinos (1999) and Ramirez et al. (2003). For the Atlantic Coast, the checklists of Scarabino (2003a, 2003b, 2004) and Carcelles (1950) were used. For the province of the Scotia Sea and continental Antarctic, the work of Griffiths et al. (2003) and a personal data compilation were used. Degrees of faunistic affinity between the studied areas were evaluated using the Simpson similarity coefficient (Cheetham and Hazel 1969), and similarities were calculated as quotient between shared species and local richness (SL; see Zelaya 2005).

Results

From a total of 852 mollusc specimens sampled, 42 species were identified, corresponding to 9 orders, 23 families, and 31 genera. Three identities (morphotypes) were identified only at a genus level (Table 1). In terms of richness by class, Gastropoda was represented by 24 species, and Polyplacophora and Bivalvia were each represented by 9 species (Table 1). Of the total species, 38.1% were rare, with 28.6% singletons and 9.5% doubletons (Table 1). Comparing the three classes, Gastropoda had most of the rare species at 45.8% (singletons plus doubletons).

PERMANOVA analysis showed no significant differences ($F = 0.9084$; $p = 0.6835$) in the seasonal species composition of the two sites (Table 2). However, it showed significant differences ($F = 171.972$; $p = 0.0001$) in species composition between the two study sites.

The species richness associated with sampling effort was determined by the linear dependence model. For Punta Santa Maria, prediction constants were $a = 0.126$ and $b = 4.179$; therefore, the expected maximum richness (a / b) was 33 species with an $R^2 = 0.96$ and slope = 0.002. This value is lower than that observed in the field ($S = 36$) (Fig. 2A). Finally, for Punta Santa Ana, prediction constants were $a = 1.522$ and $b = 0.093$; therefore, the expected maximum richness (a / b) was 16 species with an $R^2 = 0.93$ and slope = 0.005. This value is lower than that observed in the field ($S = 18$) (Fig. 2B). Therefore, in this study, the richness obtained from the model of linear dependence for both sites was lower than that observed in the field.

Systematics and distribution

Ischnochiton stramineus (Sowerby I, 1832)

Fig. 3A

Material examined. 41 spm ($5 \times 2 - 10 \times 5$ mm).

Synonymy. See Kaas and Van Belle (1990).

Remarks. This species is capable of incubating its eggs in the pallial cavity until they are metamorphosed juveniles (Schwabe 2009). In the Strait of Magellan, Sirenko (2006) observed that the incubation period is during the month of May.

Table 1. Systematics list of all species of molluscs collected in quadrats and outside of them, indicating the presence (+) in the beds of Punta Santa Ana (SA) and Punta Santa and María (SM), their development mode, and rarity.

Taxon	Species	SA	SM	Development	Rarity
POLYPLACOPHORA					
Order Chitonida					
Ischnochitonidae	<i>Ischnochiton stramineus</i>	+	+	Direct	
	<i>Ischnochiton pusio</i>		+	Unknown	
Callochitonidae	<i>Callochiton puniceus</i>		+	Unknown	
Chitonidae	<i>Tonicia lebruni</i>	+	+	Direct	
	<i>Tonicia chilensis</i>		+	Unknown	
	<i>Tonicia atrata</i>		+	Unknown	
	<i>Chiton bowenii</i>	+	+	Unknown	
Mopaliidae	<i>Plaxiphora aurata</i>		+	Unknown	Singleton
	<i>Nuttallochiton martiali</i>	+		Unknown	Singleton
GASTROPODA					
Order Patellogastropoda					
Nacellidae	<i>Nacella deaurata</i>		+	Indirect	
	<i>Nacella flammea</i>	+	+	Indirect	
	<i>Nacella mytilina</i>		+	Indirect	Singleton
	<i>Nacella</i> sp		+	Indirect	
Lepetidae	<i>Iothia emarginuloides</i>		+	Unknown	
Order Vetigastropoda					
Fissurellidae	<i>Fissurella picta</i>		+	Indirect	
	<i>Fissurella oriens</i>	+	+	Indirect	
Trochidae	<i>Margarella violacea</i>	+	+	Direct	
	<i>Margarella expansa</i>	+		Direct	Singleton
Calliostomatidae	<i>Calliostoma nudum</i>		+	Unknown	Singleton
	<i>Calliostoma modestulum</i>	+		Unknown	Doubleton
	<i>Photinastoma taeniatum</i>		+	Unknown	Singleton
Order Littorinimorpha					
Calyptraeidae	<i>Trochita pileus</i>		+	Mixed	
Ranellidae	<i>Fusitriton magellanicus</i>	+		Mixed	
Eatoniellidae	<i>Eatoniella nigra</i>		+	Indirect	Singleton
Order Ptenoglosa					
Newtoniellidae	<i>Eumetula pulla</i>	+	+	Unknown	Doubleton
Order Neogastropoda					
Buccinidae	<i>Savatieria meridionale</i>		+	Unknown	Singleton
	<i>Pareuthria cerealis</i>		+	Unknown	
	<i>Pareuthria plumbea</i>	+		Direct	
	<i>Pareuthria paessleri</i>		+	Unknown	Singleton
	<i>Pareuthria janseni</i>	+		Unknown	Singleton
Muricidae	<i>Trophon geversianus</i>		+	Direct	
	<i>Fuegotrophon pallidus</i>	+	+	Direct	
	<i>Xymenopsis muriciformis</i>	+	+	Direct	

Taxon	Species	SA	SM	Development	Rarity
Order Heterobranchia					
Acteonidae	<i>Acteon biplicatus</i>		+	Unknown	Doubleton
BIVALVIA					
Order Pteriomorpha					
Mytilidae	<i>Aulacomya atra</i>	+	+	Indirect	
	<i>Mytilus edulis platensis</i>		+	Indirect	Singleton
Astartidae	<i>Astarte longirostris</i>		+	Indirect	
Limidae	<i>Limea pygmaea</i>		+	Direct	
Pectinidae	<i>Zygochlamys patagonica</i>		+	Indirect	Doubleton
	<i>Austrochlamys natans</i>	+		Indirect	Singleton
Philobryidae	<i>Philobrya</i> sp		+	Direct	Doubleton
Order Heterodonta					
Hiatellidae	<i>Hiatella</i> sp	+	+	Indirect	Singleton
Carditidae	<i>Carditella naviformis</i>		+	Unknown	
Veneridae	<i>Tawera elliptica</i>		+	Indirect	
Gaimardiidae	<i>Gaimardia trapesina</i>		+	Direct	

Table 2. Analysis of permutations (PERMANOVA) of mollusc assemblages inhabiting beds of *G. skottsbergii*. The sampling design was nested, considering season and sites. Data were transformed to presence/absence without permutation restrictions, based in Bray–Curtis dissimilarity analysis. The number of permutations was 9999.

Source	Df	Richness		
		Ms	F	p
Site	1	62049.77	171.972	0.0001
Site (season)	6	3277.73	0.9084	0.6835
Residual	112	3608.12		
Total	119			

Distribution. WTSP: Perú (Kaas and Van Belle 1990), Juan Fernández Islands (Plate 1899), Antofagasta (Plate 1899), Coliumo Bay and Mocha Island (Aldea and Valdovinos 2005). Magellanic: Chiloé Archipelago (Broderip and Sowerby 1832, Tryon and Pilsbry 1892), Gulf of Ancud (Leloup 1956), Punta Gaviota (Dell 1971), Estero Elefantes (Reid and Osorio 2000), and Puerto Edén (Dell 1971); Strait of Magellan (Plate 1899, Dell 1964, Sirenko 2006): Punta Santa María (Leloup 1956; this record) and Carlos III Island (Aldea et al. 2011a); Cockburn Channel (Plate 1899), London Island (Pelseneer 1903), Beagle Channel (Plate 1899), Hermite Islands (Dell 1971), Seno Grandi (Dell 1971), Malvinas/Falkland Islands (Kass and Van Belle 1990, Sirenko 2006), Tierra del Fuego (Sirenko 2006), and Staten Island (Sirenko 2006). SO: South Georgia Island (Kass and Van Belle 1990).

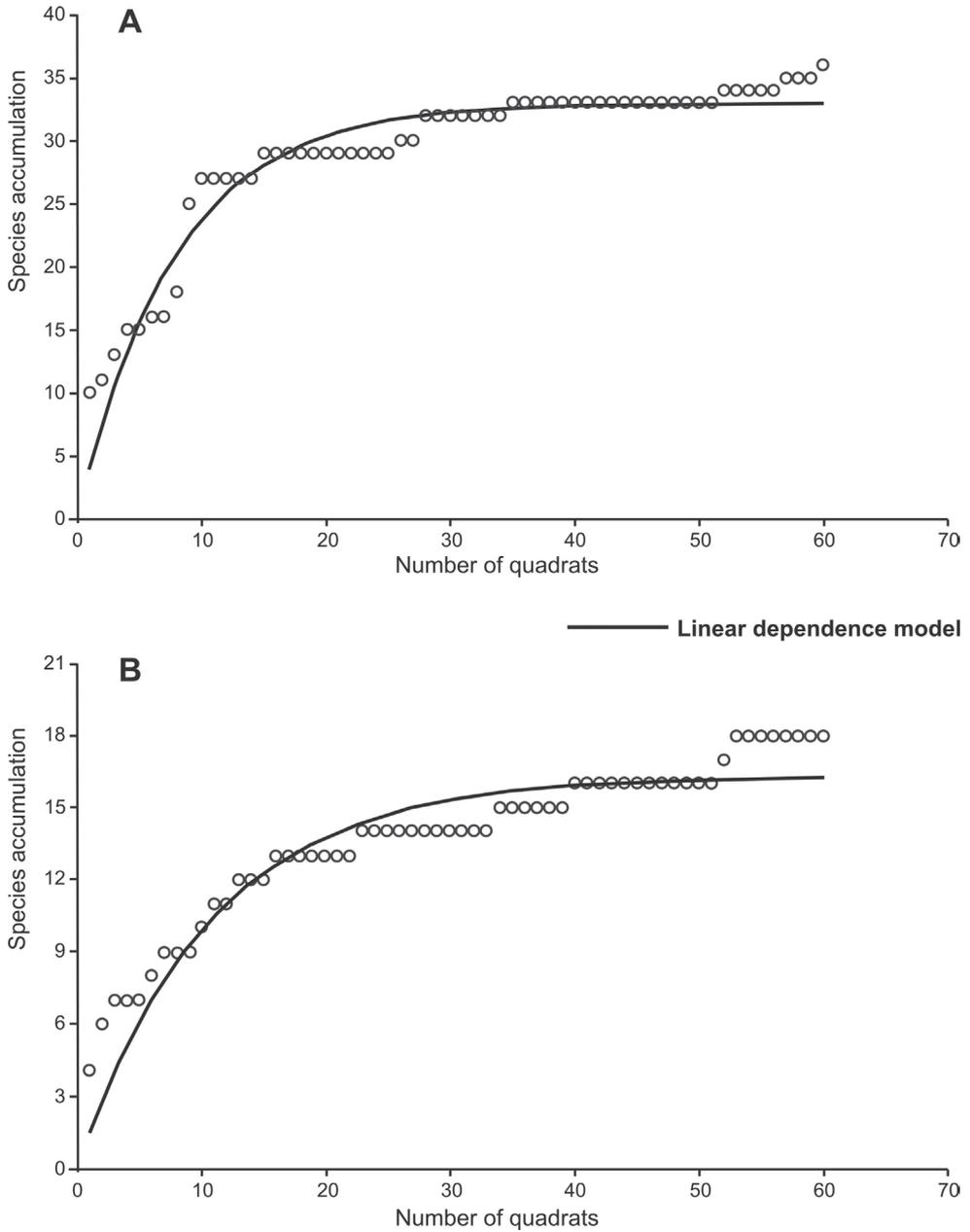


Figure 2. Linear dependence model to estimate the species richness associated with sampling effort in sampling sites. **A** Punta Santa Maria and **B** Punta Santa Ana.

***Ischnochiton pusio* (Sowerby I, 1832)**

Fig. 3B

Material examined. 3 spm (11 × 6 – 16 × 9 mm).**Synonymy.** See Kaas and Van Belle (1994).**Remarks.** Regarding its habits, Reid and Osorio (2000) commented that *I. pusio* inhabits the lower part of the rocks and other hard substrates in the intertidal zone up to 90 m, with a depth preference between 5 and 30 m in the fjord zones. Consequently, Schwabe et al. (2006) mentioned that this species is less tolerant of the fluctuations in salinity, and for that reason, inhabits below the halocline.**Distribution.** WTSP: Perú (Kass and Van Belle 1994), Juan Fernández Islands (Kass and Van Belle 1994), Antofagasta (Plate 1899), Valparaíso (Broderip and Sowerby 1832) and Talcahuano (Plate 1899). Magellanic: Puerto Montt (Plate 1899), Gulf of Ancud (Leloup 1956), Reloncaví Sound (Leloup 1956), Comau Fjord (Schwabe et al. 2006), Estero Elefantes (Reid and Osorio 2000), Puerto Edén (Dell 1971), and Smyth Channel (Castellanos 1956); Strait of Magellan (Castellanos 1956): Punta Santa María (this record) and Carlos III Island (Aldea et al. 2011a).***Callochiton puniceus* (Gould, 1846)**

Fig. 3C

Material examined. 76 spm (2 × 2.5 – 11 × 6 mm).**Synonymy.** See Kaas and Van Belle (1985).**Remarks.** Morphologically, this species is similar to *Stenosemus exaratus* (G.O. Sars, 1878) but differs by presenting a wider perinotum, black pigmented aesthetes, and different elements of the dorsal perinotum (Schwabe 2009). In relation to its colour, Sirenko (2006) mentioned that it can vary from white to red.**Distribution.** Magellanic: Puerto Montt (Dell 1971), Gulf of Corcovado (Cárdenas et al. 2008), and Puerto Edén (Dell 1971); Strait of Magellan (Dell 1964, Sirenko 2006): eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Punta Santa María (this record), Inútil Bay (USNM 2010), Cape Froward (USNM 2010), and Carlos III Island (Aldea et al. 2011a); Puerto Williams (Dell 1971), Róbalo Bay (Dell 1971), Orange Bay (Rochebrune and Mabile 1889), Hermite Islands (Dell 1971), Seno Grandi (Dell 1971), and Cape Horn (Kaas and Van Belle 1985, USNM 2010); Chubut (Bigatti 2010), Malvinas/Falkland Islands (Dell 1964, Sirenko 2006), and Staten Island (Sirenko 2006). SO: Queen Maud Land (Smirnov et al. 2000), Enderby Land (Smirnov et al. 2000), and Amery Ice-Shelf (Constable et al. 2007).***Tonicia lebruni* (Rochebrune, 1884)**

Fig. 3D

Material examined. 117 spm (12 × 6 – 32 × 16 mm).

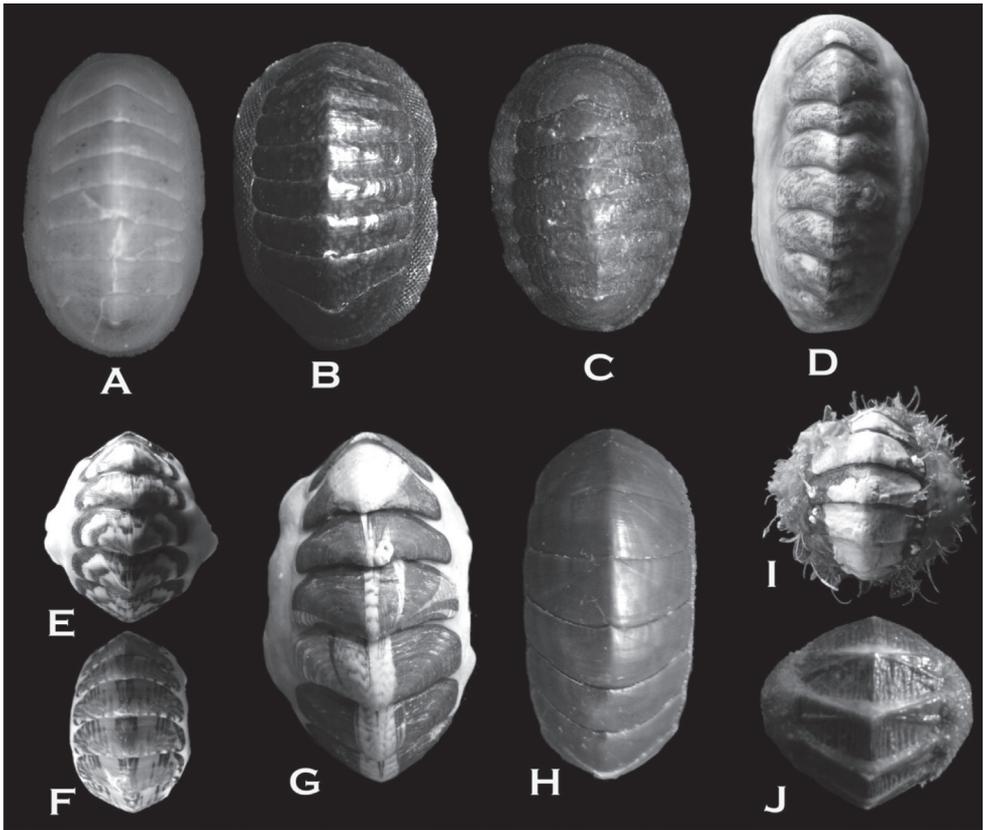


Figure 3. **A** *Ischnochiton stramineus* (10 × 5 mm) **B** *Ischnochiton pusio* (11 × 6 mm) **C** *Callochiton puniceus* (11 × 6 mm) **D** *Tonicia lebruni* (25 × 13 mm) **E-F** *Tonicia chilensis* (20 × 10 mm and 22 × 11 mm) **G** *Tonicia atrata* (50 × 26 mm) **H** *Chiton bowenii* (26 × 13 mm) **I** *Plaxiphora aurata* (30 × 20 mm) **J** *Nuttallochiton martiali* (20 × 10 mm).

Synonymy. See Kaas et al. (2006).

Remarks. Frequently, it was considered a synonym for the species *T. calbuensis* Plate, 1898, until *T. calbuensis* was re-established as a valid species, based on six different characteristics between both species (Schwabe et al. 2006, p. 15). Sirenko (2006) stated that this species incubates its eggs in the pallial cavity until juvenile, and consequently in this study, a sample from the winter season was found with juveniles in the pallial cavity.

Distribution. Magellanic: Gulf of Ancud (Leloup 1956) and Puerto Edén (Dell 1971); Strait of Magellan (Rochebrune and Mabille 1889, Tryon and Pilsbry 1892, Sirenko 2006): eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Punta Arenas (Rochebrune and Mabille 1889, Tryon and Pilsbry 1892), Río de los Ciervos (Leloup 1956), Punta Santa Ana (this record), Punta Santa María (Leloup 1956; this record), Inútil Bay (Thiele 1908), and Carlos III Island (Aldea et al. 2011a); Beagle Channel (Thiele 1908), Ushuaia (Thiele 1908), Puerto Williams, Róbalo Bay, Hermite Islands, Bertrand Island and Seno Grandi (Dell 1971), Basket Island (Thiele 1908),

Orange Bay (Rochebrune and Mabilie 1889, Tryon and Pilsbry 1892), and Puerto Toro (Thiele 1908); from the Chubut Province southward (Sirenko 2006), Malvinas/Falkland Islands (Sirenko 2006), Tierra del Fuego (Sirenko 2006), and Staten Island (USNM 2010).

***Tonicia chilensis* (Frembly, 1827)**

Fig. 3E–F

Material examined. 40 spm (9 × 5 – 26 × 13 mm).

Synonymy. See Kaas et al. (2006).

Remarks. Sirenko (2006) did not include this species within the list of Magellanic Polyplacophora. However, Schwabe et al. (2006) named it as *T. chilensis* for all individuals that presented the following characteristics: well-marked micro-granulations in all of the valves, granules that are marked towards the margins of the valves, characteristics that other species of the genus did not present, except *T. lebruni*. Our specimens did present granules but disposed in an irregular form, and *T. calbuencis* sometimes can present granules along the entirety of the margins (Schwabe et al. 2006).

Distribution. WTSP: Perú (Leloup 1956), Valparaíso (Leloup 1956), Montemar (Leloup 1956), Punta Pingüeral and Cape Tirúa (Aldea and Valdovinos 2005), Gulf of Arauco (Leloup 1956) and Valdivia (Zagal and Hermosilla 2001). Magellanic: Comau Fjord (Schwabe et al. 2006), Punta Pulga (Dell 1971), Gulf of Ancud (Leloup 1956), and Estero Elefantes (Reid and Osorio 2000); Strait of Magellan: eastern micro-basin of the Strait of Magellan (Ríos et al. 2003) and Punta Santa María (this record); Róbaló Bay (Ojeda et al. 2010).

***Tonicia atrata* (Sowerby II, 1840)**

Fig. 3G

Material examined. 7 spm (17 × 8 – 50 × 26 mm).

Synonymy. See Kaas et al. (2006).

Remarks. Sirenko (2006) mentioned that the coloring of the valves of this species is variable. It is known that this species houses the protozoa parasite *Chitonicum simplex* Plate 1898 (Schwabe et al. 2006).

Distribution. WTSP: between Punta Pingüeral and Cape Tirúa (Aldea and Valdovinos 2005) and Valdivia (Zagal and Hermosilla 2001). Magellanic: Comau Fjord (Schwabe et al. 2006), Punta Pulga (Dell 1971), Gulf of Ancud (Leloup 1956), Chonos Archipelago (Leloup 1956), Estero Elefantes (Reid and Osorio 2000), and Puerto Edén (Dell 1971); Strait of Magellan (Sirenko 2006): eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Laredo Bay (Mutschke et al. 1998), Punta Arenas (Thiele 1908), Río de los Ciervos (Leloup 1956), Porvenir (Thiele 1908), Punta Santa María (this study), Punta Santa Ana (Ríos et al. 2007), and Carlos III

Island (Aldea et al. 2011a); Smyth Channel (Thiele 1908), London Island (Pelseneer 1903), Beagle Channel (Pelseneer 1903), Ushuaia (Thiele 1908), Puerto Williams (Dell 1971), Róbaló Bay (Dell 1971, Ojeda et al. 2010), Bertrand Island (Dell 1971), and Seno Grandi (Dell 1971); Malvinas/Falkland Islands (Sowerby 1840, Tryon and Pilsbry 1892, Melvill and Standen 1914, Sirenko 2006).

***Chiton bowenii* (King & Broderip, 1831)**

Fig. 3H

Material examined. 15 spm (13 × 7 – 29 × 15 mm).

Synonymy. See Kaas et al. (2006).

Remarks. Sirenko (2006) commented that *C. bowenii* is a rare species. However, in this study, it was present in two sampling sites.

Distribution. Magellanic: Strait of Magellan (King and Broderip 1832, Sirenko 2006): Laredo Bay (Sirenko 2006), Punta Santa Ana (Sirenko 2006; this record), Punta Santa María (this record), and Carlos III Island (Aldea et al. 2011a); Orange Bay (Rochebrune and Mabilie 1889).

***Plaxiphora aurata* (Spalowsky, 1795)**

Fig. 3I

Material examined. 1 spm (30 × 20 mm).

Synonymy. See Kaas and Van Belle (1994).

Remarks. Reid and Osorio (2000) mentioned that this species together with the tiny species *Leptochiton medinae* (Plate, 1899) are the only chitons capable of inhabiting environments with low salinity. Morphologically, this species is distinguished by presenting variable coloring in the valves and in the tegument sculpture (Sirenko 2006).

Distribution. WTSP: Valparaíso (King and Broderip 1832), between Punta Pingüeral and Cape Tirúa (Aldea and Valdovinos 2005). Magellanic: Gulf of Ancud (Leloup 1956), Estero Elefantes (Reid and Osorio 2000), Puerto Edén (Dell 1971), Paso de Indio (Dell 1971), and Piazzi Island (Dell 1971); Strait of Magellan (Dell 1964): Buque Quemado (Aldea and Rosenfeld 2011), eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Laredo Bay (Mutschke et al. 1998), Punta Arenas (Rochebrune and Mabilie 1889), Río de los Ciervos (Leloup 1956), Punta Santa Ana (Ríos et al. 2007), Punta Santa María (Leloup 1956; this record), and Carlos III Island (Aldea et al. 2011a); Cockburn Channel (Dell 1964), Puerto Williams (Dell 1971), Róbaló Bay (Dell 1971, Ojeda et al. 2010), Hermite Islands (Dell 1971), Bertrand Island (Dell 1971), and Orange Bay (Rochebrune and Mabilie 1889); Malvinas/Falkland Islands (Dell 1964, Sirenko 2006), San Sebastián Bay (USNM 2010), and Staten Island (Sirenko 2006, USNM 2010). SO: Also reported for Antarctica (Götting 1989).

***Nuttallochiton martiali* (Rochebrune in Rochebrune & Mabille, 1889)**

Fig. 3J

Material examined. 1 spm (20 × 10 mm).**Synonymy.** See Kaas and Van Belle (1987).**Remarks.** This species presents a morphological similarity to *P. aurata* but presents longitudinal elevations in the pleural areas, while *P. aurata* does not possess this sculpture (Schwabe 2009). According to Sirenko (2006), it is a rare species.**Distribution.** Magellanic: Gulf of Corcovado (Cárdenas et al. 2008) and Comau Fjord (Schwabe et al. 2006); Strait of Magellan (Leloup 1956): Punta Santa Ana (this record) and Carlos III Island (Aldea et al. 2011a); Róbaló Bay (Dell 1971); Malvinas/Falkland Islands (Dell 1964, Sirenko 2006) and Staten Island (Sirenko 2006).***Nacella deaurata* (Gmelin, 1791)**

Fig. 4A–B

Material examined. 66 spm (17 × 12 × 8 – 21 × 17 × 11 mm).**Synonymy.** See Valdovinos and Rütth (2005).**Remarks.** According to the classification done by Valdovinos and Rütth (2005), the shell morphology of *Nacella deaurata* is similar to the species *Nacella delicatissima*. Later, Arazamendi et al. (2009), based on molecular techniques, concluded that the specimens of *N. delicatissima* are combined with the specimens of *N. magellanica* and *N. deaurata*, suggesting that *N. delicatissima* is a morphotype of both species.**Distribution.** Magellanic: Apiao Archipelago (Valdovinos and Rütth 2005), Estero Elefantes (Reid and Osorio 2000), and Summer Island (Valdovinos and Rütth 2005); Strait of Magellan (Tryon and Pilsbry 1891, Powell 1951): Buque Quemado (Aldea and Rosenfeld 2011), eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Laredo Bay (Mutschke et al. 1998, Valdovinos and Rütth 2005, González-Wevar et al. 2010), Punta Santa María (Valdovinos and Rütth 2005; this record), Punta Santa Ana (Valdovinos and Rütth 2005), Águila Bay (González-Wevar et al. 2010), Caleta Carden, Leñadura Beach, Punta Arenas and Punta Chilota (Valdovinos and Rütth 2005), Dawson Island (Ramírez 1996, USNM 2010), and Carlos III Island (Aldea et al. 2011a); Beagle Channel and Ushuaia (Arazamendi et al. 2009), Puerto Williams (Valdovinos and Rütth 2005), Róbaló Bay (Ojeda et al. 2010), Orange Bay and Hoste Island (Valdovinos and Rütth 2005), Cape Horn (Rochebrune and Mabille 1889), Diego Ramírez Islands (Valdovinos and Rütth 2005) and Malvinas/Falkland Islands (González-Wevar et al. 2011). WTSA: from 38°S toward south (Morris and Rosenberg 2005). SO: Kerguelen Islands (Lamy 1905, Carcelles 1950).

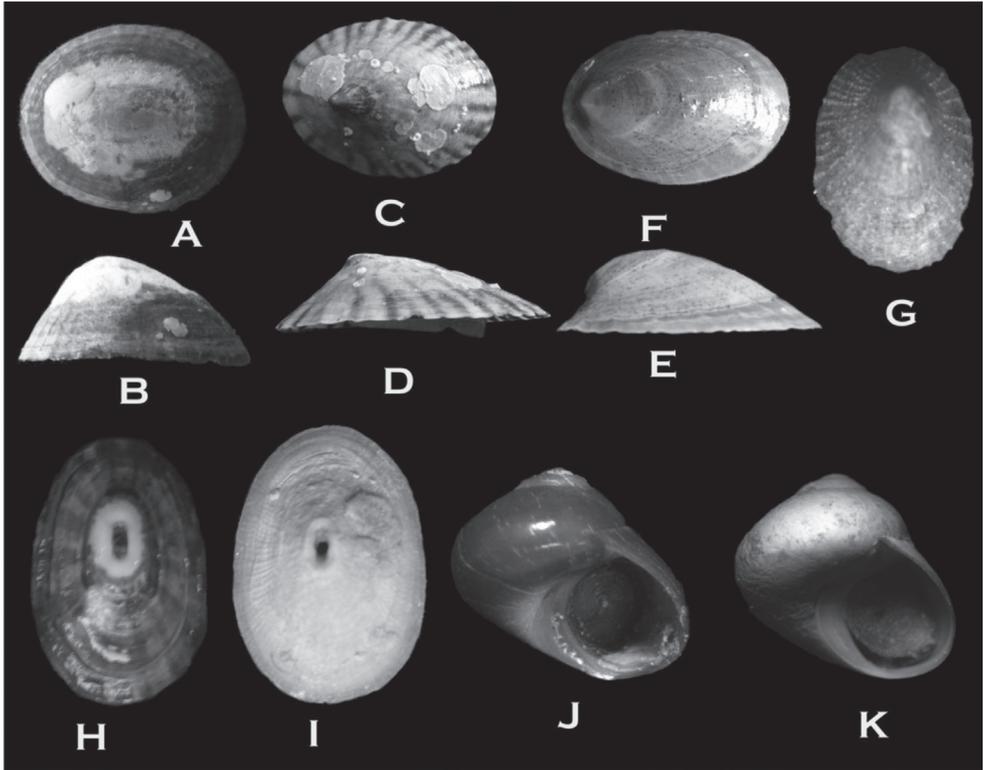


Figure 4. **A–B** *Nacella deaurata* (17 × 12 × 8 mm) **C–D** *Nacella flammea* (45 × 33 × 10 mm) **E–F** *Nacella mytilina* (26 × 18 × 10 mm) **G** *Iothia emarginuloides* (4 × 2.3 × 1.5 mm) **H** *Fissurella picta picta* (19 × 16 × 10) **I** *Fissurella oriens* (43 × 32 × 16 mm) **J** *Margarella violacea* (9 × 9 mm) **K** *Margarella expansa* (7.5 × 8 mm).

Nacella flammea (Gmelin, 1791)

Fig. 4C–D

Material examined. 19 spm (9 × 7 × 3 – 45 × 33 × 10 mm).

Synonymy. See Valdovinos and R uth (2005).

Remarks. *Nacella flammea* and *N. mytilina* inhabit subtidal environments. *Nacella flammea* presents a shell morphology different from the rest of the species of the genus (Valdovinos and R uth 2005). This species mainly inhabits rocky bottoms, feeding on benthic microalgae (Gonzalez-Wevar et al. 2011).

Distribution. Magellanic: Ays n (Valdovinos and R uth 2005) and Guarello Island (Valdovinos and R uth 2005); Strait of Magellan: Laredo Bay (Mutschke et al. 1998), Punta Santa Ana (G onzalez-Wevar et al. 2010), Punta Santa Mar a (this record), Carlos III Island (Aldea et al. 2011a), and Almirantazgo Sound (Valdovinos and R uth 2005); R obalo Bay (Ojeda et al. 2010).

***Nacella mytilina* (Helbling, 1779)**

Fig. 4E–F

Material examined. 1 spm (26 × 18 × 10 mm).**Synonymy.** See Valdovinos and Rütth (2005).**Remarks.** This species was recorded as a junior synonym of *Nacella kerguelensis* by Cantera and Arnaud (1985). Nevertheless, Valdovinos and Rütth (2005) commented that morphologically *Nacella mytilina* is clearly different from the rest of the species. The molecular study carried out by Gonzalez-Wevar et al. (2010) backed the establishment of *N. mytilina* and *N. kerguelensis* as different species. *N. mytilina* is a common component of the epibiontic community associated with *Macrocystis pyrifera* kelp forests of the Magellan Region (Reid and Osorio 2000). In this study, it was found inhabiting the fronds of *G. skottsbergii*.**Distribution.** Magellanic: Estero Elefantes (Reid and Osorio 2000), Carlos Island in Puerto Edén (Dell 1971), and Guarello Island (Valdovinos and Rütth 2005); Strait of Magellan (Tryon and Pilsbry 1891): Punta Arenas (Valdovinos and Rütth 2005), Punta Chilota (Valdovinos and Rütth 2005), Punta Santa Ana (Gonzalez-Wevar et al. 2010), Punta Santa María (this record), Dawson Island (Valdovinos and Rütth 2005, USNM 2010), Magdalena Island (Pelseneer 1903), Carlos III Island (Gonzalez-Wevar et al. 2010, Aldea et al. 2011a), Puerto Hope (Pelseneer 1903), and McClelland River in Tierra del Fuego (Smith 1905); London Island (Pelseneer 1903), Beagle Channel (Pelseneer 1903), Puerto Williams (Dell 1971), Puerto Róbaló (Dell 1971), Puerto Harberton, Bertrand Island (Dell 1971), Puerto Deseado (Aranzamendi et al. 2009), and Staten Island (Pelseneer 1903, USNM 2010). WTSA: from 39°S toward south (Carcelles 1950). SO: Kerguelen Islands (Smith 1879, Tryon and Pilsbry 1891, Thiele 1912, Troncoso et al. 2001).***Iothia emarginuloides* (Philippi, 1868)**

Fig. 4G

Material examined. 13 spm (3 × 2 × 1 – 4 × 2.3 × 1.5 mm).**Synonymy.** See Waren et al. (2011).**Remarks.** Waren et al. (2011) studied the species of Lepetidae and concluded that specimens of *I. coppingeri* and *I. emarginuloides* are similar. This is concurrent with Strebel (1907) that these species are synonyms, establishing *I. coppingeri* as a junior synonym of this species.**Distribution.** WTSP: Valdivia (Dell 1990). Magellanic: Gulf of Ancud (Waren et al. 2011), Chiloé Archipelago (Cárdenas et al. 2008), and Estero Elefantes (Reid and Osorio 2000); Strait of Magellan (Smith 1881, Dell 1990): Punta Arenas (Thiele 1912, Waren et al. 2011), eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Punta Santa María (this record), and Carlos III Island (Aldea et al. 2011a); Beagle Channel (Linse 1997) and Cape Horn (Rochebrune and Mabilie 1889); Malvinas/Falkland Islands (Strebel 1908, Powell 1951) and Staten Island (Dell 1990). SO:

South Georgia Island (Zelaya 2005), South Orkney Islands (Dell 1990), Weddell Sea (Dell 1990, Hain 1990, Gutt et al. 2003), Ross Sea (USNM 2010, OBIS 2014), South Shetland Islands (Dell 1990, Aldea and Troncoso 2008), Kerguelen Islands (Powell 1957, Cantera and Arnaud 1985), Macquaire Island (USNM 2010), Wilkes Land (USNM 2010), and Enderby Land (Powell 1958).

***Fissurella picta picta* (Gmelin, 1791)**

Fig. 4H

Material examined. 3 spm (19 × 16 × 10 – 38 × 25 × 14 mm).

Synonymy. See McLean (1984).

Remarks. Aldea and Rosenfeld (2011) commented that it is generally similar to *Fissurella radiosa radiosa* Lesson, 1831, sharing geographic distribution points. McLean (1984) mentioned the characteristics that differentiate them: *F. picta* presents more wide shell margins in all of its development stages and the foramen is more centralized and presents black rays that do not occur on *F. radiosa*.

Distribution. WTSP: Valparaíso (Hupé 1854, Tryon and Pilsbry 1890, McLean 1984), Papudo (Ramírez 1996), Punta Pingueral and Cape Tirúa (Aldea and Valdovinos 2005), and Valdivia (Zagal and Hermosilla 2001). Magellanic: Chiloé Archipelago (McLean 1984), Estero Elefantes (Reid and Osorio 2000), and Puerto Edén (Dell 1971); Strait of Magellan (Rochebrune and Mabilie 1889): Buque Quemado (Aldea and Rosenfeld 2011), Laredo Bay (Mutschke et al. 1998), Punta Arenas (Rochebrune and Mabilie 1889), Punta Santa Ana (Ríos et al. 2007), Punta Santa María (this record), Inútil Bay (Ramírez 1996), and Carlos III Island (Aldea et al. 2011a); Ushuaia (Strebel 1908), Puerto Williams (Dell 1971), Róbalo Bay (Dell 1971, Ojeda et al. 2010), Orange Bay (Rochebrune and Mabilie 1889), and Navidad Bay (Ramírez 1996); Malvinas/Falkand Islands (Rochebrune and Mabilie 1889, Melvill and Standen 1914) in Port Stanley (Watson 1886, Powell 1951).

***Fissurella oriens* Sowerby I, 1834**

Fig. 4I

Material examined. 62 spm (12 × 8 × 4 – 43 × 32 × 16 mm).

Synonymy. See McLean (1984).

Remarks. According to McLean (1984), the most similar species is *F. radiosa*, which is similar in size and presents similar colors and variations. The same author comments that the only distinguishing characteristic between the shells is the presence of primary ribs that are longer than the adjacent ribs present in *F. radiosa*. These primary ribs are absent in the species *F. oriens*.

Distribution. WTSP: Mehuín (McLean 1984). Magellanic: Chiloé Archipelago (Dall 1909), Calbuco (Ramírez 1996), Queullín Island (Ramírez 1996), Punta Chulao

(Ramírez 1996), Estero Elefantes (Reid and Osorio 2000), Puerto Edén and Wellington Island (Dell 1971), Carlos Island (Dell 1971), Levinzon Island (Dell 1971), Piazzini Island (Dell 1971), Melchior Island (Ramírez 1996), and Smyth Channel (Strebel 1907); Strait of Magellan (Húpe 1854, Tryon and Pilsbry 1890, Ramírez 1996): Laredo Bay (Mutschke et al. 1998), Punta Arenas, (Rochebrune and Mabilie 1889, Strebel 1907), Punta Santa Ana (Ríos et al. 2007; this record), Porvenir (Strebel 1907), Punta Santa María (this record), Inútil Bay (Strebel 1907), Carlos III Island (Aldea et al. 2011a), Puerto Churruca (Strebel 1907), Puerto Angosto (Strebel 1907), and Borja Bay (Strebel 1907); Ushuaia (Strebel 1907), Puerto Williams (Dell 1971), Hermite Islands (Dell 1971), Seno Grandi (Dell 1971), Basket Island (Strebel 1907), Picton Island (Strebel 1907), Orange Bay (Rochebrune and Mabilie 1889), and Cape Horn (Rochebrune and Mabilie 1889); Santa Cruz (Osorio 1999), Malvinas/Falkland Islands (Melvill and Standen 1907, Powell 1951) in Port Stanley (Strebel 1907, Strebel 1908), Lively Island (Strebel 1907), and Port Albemarle (Strebel 1908).

***Margarella violacea* (King & Broderip, 1831)**

Fig. 4J

Material examined. 69 spm ($3 \times 2.5 - 9 \times 9$ mm).

Synonymy. See Dell (1971).

Remarks. Rosenfeld et al. (2011) commented that the shell of the similar species *M. expansa* (Sowerby I, 1838) is composed of two well-differentiated layers, with the internal layer being thicker. Also, *M. expansa* have four pairs of epipodial tentacles and frequently present an additional unpaired tentacle (Zelaya 2004). However, the identification between these species is quite complex due to the extreme morphological similarities (see Zelaya 2004, Rosenfeld et al. 2011). In this sense, Troncoso et al. (2001, p. 86) recorded and commented on *M. violacea* for the Kerguelen Islands, but in fact they photographed and mentioned *M. expansa* (Troncoso et al. 2001, p. 89, Fig. 4).

Distribution. Magellanic: Estero Elefantes (Reid and Osorio 2000), Puerto Edén (Dell 1971), Nelson Strait (Linse 2002), Kirke Channel (Linse 2002), and Smyth Channel (Strebel 1905a); Strait of Magellan (King and Broderip 1832, Strebel 1905a): eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Punta Arenas (Strebel 1905a), Agua Fresca (Strebel 1905a), Cape Valentín (Strebel 1905a), Porvenir (Strebel 1905a), Inútil Bay (USNM 2010), Gente Grande Bay (Strebel 1905a), Punta Santa María (this record), Punta Santa Ana (Ríos et al. 2007; this record), Dawson Island (Strebel 1905a, USNM 2010), and Carlos III Island (Aldea et al. 2011a); Elizabeth Island (Strebel 1905a), Beagle Channel (Rochebrune and Mabilie 1889), Ushuaia (Strebel 1905a, 1908), Navarino Island (Strebel 1905a), Puerto Williams (Dell 1971), Róballo Bay (Dell 1971, Ojeda et al. 2010), Basket Island (Strebel 1905a), Puerto Toro (Strebel 1905a), Orange Bay (Rochebrune and Mabilie 1889), Seno Grandi (Dell 1971), Goree Passage (Linse 2002), Picton Island (Strebel 1905a, Linse 2002), Lenox Island (Strebel 1905a), Bertrand Island (Dell

1971), and Cape Horn (Gould 1852, Linse 2002); Malvinas/Falkland Islands (Strebel 1905a, Powell 1951), Burdwood Bank (Melvill and Standen 1907), and Staten Island (USNM 2010).

***Margarella expansa* (Sowerby I, 1838)**

Fig. 4K

Material examined. 1 spm (7.5 × 8 mm).

Synonymy. See Powell (1951).

Remarks. New information about the biology and distribution of the species was presented by Rosenfeld et al. (2011). They noted that the records made by Strebel (1908) for the South Georgia and South Sandwich Islands and the Antarctic Peninsula and records made by Smith (1902) for eastern Antarctica have not been commented by any other author in later studies. Because of this, these authors consider their Antarctic distribution points as dubious records, manifesting that this species would be restricted to Subantarctic regions.

Distribution. Magellanic: Strait of Magellan: Buque Quemado (Aldea and Rosenfeld 2011), Puerto del Hambre (Sowerby 1838), Capitán Aracena Island (Rosenfeld et al. 2011), and Carlos III Island (Aldea et al. 2011a); Ushuaia (Zelaya 2004), Róbalo Bay (Rosenfeld et al. 2011), and Orange Bay (Lamy 1905); Malvinas/Falkland Islands (Melvill and Standen 1898, Strebel 1905a, Castellanos and Landoni 1989), and Burdwood Bank (Melvill and Standen 1907). WTSA: Río de la Plata basin (USNM 2010). SO: Marion and Prince Edward Islands (Watson 1886, Branch et al. 1991), Kerguelen Islands (Smith 1879, Watson 1886, Martens and Thiele 1904, Strebel 1905a, Thiele 1912, Lamy 1915, Powell 1957, Cantera and Arnaud 1985), and Crozet Island (Cantera and Arnaud 1985); probably in South Georgia Island (Strebel 1908), Antarctic Peninsula (Strebel 1908), and Cape Adare (Smith 1902).

***Calliostoma nudum* (Philippi, 1845)**

Fig. 5A

Material examined. 1 spm (13 × 12 mm).

Synonymy. See Morris and Rosenberg (2005).

Remarks. Castellanos and Landoni (1989) commented that this species is a complex variable in which the species *C. kophameli* Strebel, 1905, *C. venustulum* (Strebel, 1908), and *C. falklandicum* (Strebel, 1908) appear to be simply different morphotypes of the species *C. nudum*. Accordingly, a morphological study is required that details the various examples of the species.

Distribution. Magellanic: Strait of Magellan (Castellanos and Fernández 1976): eastern micro-basin of the Strait of Magellan (Ríos et al. 2003) and Punta Santa María (this record); Beagle Channel (Osorio 1999) and Cape Horn (Osorio 1999, Linse 2002);

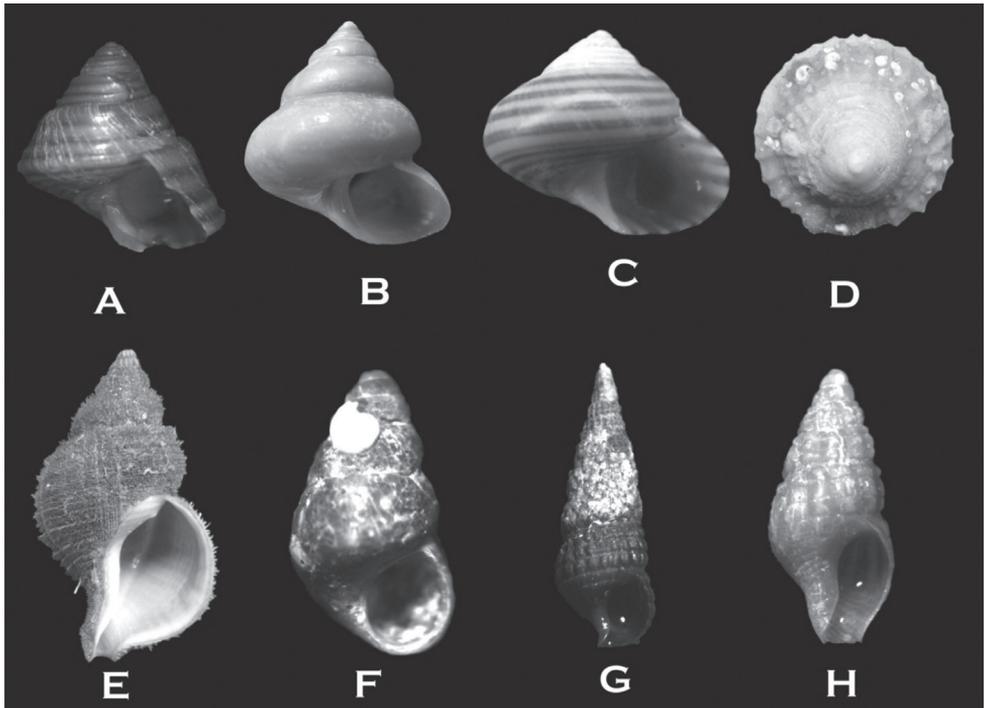


Figure 5. **A** *Calliostoma nudum* (13 × 12 mm) **B** *Calliostoma modestulum* (15 × 13 mm) **C** *Photinastoma taeniatum* (10 × 12 mm) **D** *Trochita pileus* (22 × 10 mm) **E** *Fusitriton magellanicus* (84 × 40 mm) **F** *Eartoniella nigra* (2 × 1 mm) **G** *Eumetula pulla* (7 × 3 mm) **H** *Savatieria meridionalis* (5 × 2 mm).

Malvinas/Falkland Islands (Rochebrune and Mabile 1889, Strebel 1905a, 1908), Port Albemarle (Strebel 1908), Le Maire Strait (Strebel 1905a), and Staten Island (Castellanos and Landoni 1989). WTSA: At 38°S (Castellanos and Fernández 1976).

Calliostoma modestulum (Strebel, 1908)

Fig. 5B

Material examined. 2 spm (13 × 11 – 15 × 13 mm).

Synonymy. *Calliostoma modestulum* (Strebel, 1908): 70, pl. I, figs. 13a–b; Melvill and Standen 1912: 347. Carcelles and Williamson 1951: 263, Castellanos and Landoni 1989: 8, pl. I, fig. 8.

Calliostoma modestula, Castellanos and Fernández 1976: 141, pl. II, figs. 8–9.

Remarks. From a morphological point of view, Melvill and Standen (1912) commented that this species presents similarities to *Photinula crawshayi* (Smith, 1905), although it has more globular whorls. The maximum depth at which it has been recorded is 869 m. However, in this study, a shallower depth was recorded, with specimens found at 10 m in beds of *Gigartina skottsbergii*.

Distribution. Magellanic: Strait of Magellan: Punta Santa Ana (this record) and western entrance of the Strait of Magellan (USNM 2010); Cockburn Channel (Powell 1951); from Chubut (Castellanos and Fernández 1976), Malvinas/Falkland Islands (Strebel 1908, Powell 1951, Castellanos and Fernández 1976), and Burdwood Bank (Melvill and Standen 1912).

***Photinastoma taeniatum* (Sowerby I, 1825)**

Fig. 5C

Material examined. 1 spm (10 × 12 mm).

Synonymy. See Powell (1951).

Remarks. Powell (1951) stated that the subspecies *Photinastoma taeniatum nivea* Cooper & Preston, 1910 presented uncommon characteristics compared to the typical form of the species, not presenting the same color pattern and a higher spire with more globular whorls, but both forms have three spiral whorls in the first whorl of the protoconch. Similarly, Castellanos and Landoni (1989) mentioned that these characteristics had been used by Powell (1951) to identify difference on generic level between those species of *Photinastoma* and *Calliostoma*, which were similar. Given this, they estimated that the species should be included within the genus *Calliostoma*. However, according to Rosenberg (2012), this species should be included under the genus *Photinastoma*.

Distribution. Magellanic: Strait of Magellan (Castellanos and Landoni 1989, Ríos et al. 2003); Punta Arenas (Rochebrune and Mabille 1889), Punta Santa María (this record), and western entrance of the Strait of Magellan (Osorio 1999); Santa Cruz River (Powell 1951) and Malvinas/Falkland Islands (Strebel 1908) in Port Stanley (Strebel 1908, Powell 1951). SO: South Georgia Island (Davolos and Moolenbeeck 2005).

***Trochita pileus* (Lamarck, 1822)**

Fig. 5D

Material examined. 94 spm (2 × 1 – 22 × 10 mm).

Synonymy. See Linse (2002).

Remarks. This species has a very similar external morphology to *Trochita pileolus* (d'Orbigny, 1984). Aldea and Rosenfeld (2011) explained that the most conspicuous external difference is that *T. pileus* has a smoother protoconch while *T. pileolus* has a wrinkled protoconch. Reid and Osorio (2000) denied the presence of the species *Trochita trochiformis* in Tierra del Fuego and the Strait of Magellan, previously reported by Carcelles and Williamson (1951), claiming that this record was probably referring to the species *T. pileus*.

Distribution. WTSP: Santa María Island (Aldea and Valdovinos 2005), Lebu (Aldea and Valdovinos 2005), and Mocha Island (Aldea and Valdovinos 2005). Magellanic: Strait of Magellan (Aldea and Rosenfeld 2011): Laredo Bay (Mutschke et al. 1998, Linse

2002), eastern micro-basin of the Strait of Magellan (Osorio 1999, Linse 2002, Ríos et al. 2003), Cape Froward (Osorio 1999), and Voces Bay (Linse 2002); Punta Rico (Linse 2002), Picton Island (Linse 2002), Gardiner Island (Linse 2002), Brecknock Channel (Linse 2002), Beagle Channel (Osorio 1999), Goree Passage (Linse 2002), and Staten Island (USNM 2010). WTSA: in Buenos Aires Province (Strebel 1908).

***Fusitriton magellanicus* (Röding, 1798)**

Fig. 5E

Material examined. 5 spm (82 × 43 – 84 × 40 mm).

Synonymy. See Powell (1951).

Remarks. Cárdenas et al. (2008) explained that some authors considered *Fusitriton cancellatus* (Lamarck, 1816) as a valid synonym. Concurringly, Zelaya (2009a) reported *F. magellanicus* as a synonym of *F. cancellatus*. However, according to Bouchet (2012), the taxonomically accepted name of the species is *Fusitriton magellanicus*.

Distribution. WTSP: from Los Vilos to Valparaíso (McLean and Andrade 1982). Magellanic: Gulf of Ancud (Cárdenas et al. 2008), Chiloé Archipelago (USNM 2010), Gulf of Corcovado (Cárdenas et al. 2008), Puerto Cóndor (Strebel 1905b), and Smyth Channel (Strebel 1905b); Strait of Magellan (Húpe 1854, Tryon 1881): Río Seco (Strebel 1905b), Punta Arenas (Strebel 1905b), Punta Santa Ana (this record), and Carlos III Island (Aldea et al. 2011a); Beagle Channel (Strebel 1905b), Orange Bay (Rochebrune and Mabilie 1889), and Cape Horn (Powell 1951); Malvinas/Falkland Islands (Powell 1951), and Le Maire Strait (Strebel 1905b). WTSA: from Río Grande do Sul (Smith 1970), and Uruguay (Scarabino 2004). SO: Bellingshausen Sea (USNM 2010). Other sites: South Africa (OBIS 2014), Australia (Rosenberg et al. 2002), and New Zealand (Stocks 2003).

***Eatoniella nigra* (d'Orbigny, 1840)**

Fig. 5F

Material examined. 1 spm (2 × 1 mm).

Synonymy. See Ponder and Worsfold (1994).

Remarks. It was described under the name *Paludestrina nigra* d'Orbigny, 1840 for the north of Chile. Afterwards, Marincovich (1973) described the species *E. latina* being the first representative Eatoniellidae for the Southeast Pacific. However, Ponder and Worsfold (1994), upon revising the shells of both species, found a common morphology, lower, more ovular, and thinner than the other black-colored species present in South America. Thus, *E. latina* is considered a junior synonym of this species. Records from South Africa (Rosenberg et al. 2002, OBIS 2014) likely correspond to *E. afronigra* according to Ponder and Worsfold (1994).

Distribution. WTSP: Iquique (Marincovich 1973, Ponder and Worsfold 1994), and Antofagasta (Ponder and Worsfold 1994). Magellanic: Puerto Montt (Ponder and

Worsfold 1994), Chiloé Archipelago (Ponder and Worsfold 1994), and Coyhaique (Ponder and Worsfold 1994); Strait of Magellan: western entrance of the Strait of Magellan (Ponder and Worsfold 1994) and Punta Santa María (this record); Staten Island (Ponder and Worsfold 1994).

***Eumetula pulla* (Philippi, 1845)**

Fig. 5G

Material examined. 2 spm ($3 \times 1 - 7 \times 3$ mm).

Synonymy. See Cárdenas et al. (2008).

Remarks. Cárdenas et al. (2008) noted that this species is different from the other species in its family because it does not have cords on the base. Morris and Rosenberg (2005) considered *Cerithium caelatum* (Gould, 1849) as a synonym of *Eumetula pulla*. However, Zelaya (2009a) considered it a valid species and suggested a significant revision of this complex of species.

Distribution. Magellanic: Gulf of Corcovado (Cárdenas et al. 2008), Estero Elefantes (Reid and Osorio 2000), and Smyth Channel (Strebel 1905b); Strait of Magellan (Strebel 1905b): Punta Santa María (this record), Punta Santa Ana (this record), Cape Valentín (Strebel 1905b), Dawson Island (Strebel 1905b), Puerto Cóndor, Inútil Bay (Strebel 1905b), and Carlos III Island (Aldea et al. 2011a); Beagle Channel (Strebel 1908), Navarino Island (Strebel 1905b), and Puerto Toro (Strebel 1905b); Malvinas/Falkland Islands (Strebel 1905b, 1908, Powell 1951), Burdwood Bank (Melvill and Standen 1912), and Le Maire Strait (Strebel 1905b). W.T.S.A.: Río de la Plata (Carcelles and Williamson 1951), and Mar del Plata (Castellanos 1971).

***Savatieria meridionalis* (Smith, 1881)**

Fig. 5H

Material examined. 1 spm (5×2 mm).

Synonymy. See Dell (1972).

Remarks. Dell (1972) explained that seven species of the genus *Savatieria* have been described for the Magellan Region and the Malvinas/Falkland Islands. However, this genus is not well studied, and the Magellanic species are slightly different and not well represented in collections (Dell 1972).

Distribution. Magellanic: Strait of Magellan (Smith 1881): Punta Santa María (this record) and Carlos III Island (Aldea et al. 2011a) and Cape Valentín (Strebel 1905b); Beagle Channel (Osorio 1999), Fortescue Bay (Strebel 1905b), Puerto Angosto (Strebel 1905b), Basket Island (Strebel 1905b), Puerto Eugenia (Strebel 1905b), and Picton Island (Strebel 1905b); Santa Cruz (Castellanos 1979) and Malvinas/Falkland Islands (Strebel 1905b, 1908) in Port Stanley (Strebel 1905b).

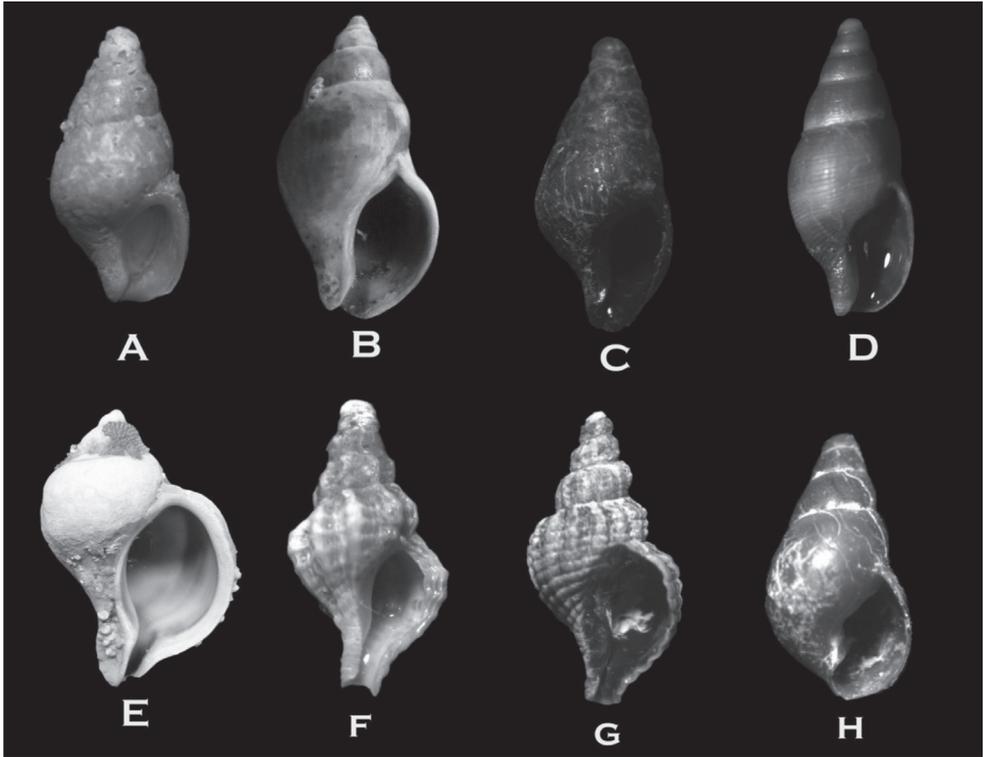


Figure 6. **A** *Pareuthria cerealis* (6 × 3 mm) **B** *Pareuthria plumbea* (25 × 12 mm) **C** *Pareuthria paessleri* (7 × 4 mm) **D** *Pareuthria janseni* (10 × 14 mm) **E** *Trophon gerversianus* (53 × 38 mm) **F** *Fuegotrophon pallidus* (18 × 9 mm) **G** *Xymenopsis muriciformis* (32 × 17 mm) **H** *Acteon biplicatus* (5 × 3 mm).

***Pareuthria cerealis* (Rochebrune & Mabilie, 1885)**

Fig. 6A

Material examined. 6 spm (5 × 2 – 6 × 3).

Synonymy. See Cárdenas et al. (2008).

Remarks. This species presents a ruddy-yellow coloring, and one of its most distinguishable characteristics is its smooth texture with one or two stripes under the sutures of each whorl (Cárdenas et al. 2008). Our specimens presented quite eroded shells.

Distribution. Magellanic: Gulf of Ancud (Cárdenas et al. 2008); Strait of Magellan: Punta Santa María (this record) and Carlos III Island (Aldea et al. 2011a); Beagle Channel (Rochebrune and Mabilie 1889), Orange Bay (Rochebrune and Mabilie 1889), Oglander Bay (Linse 2002), Goree Passage (Linse 2002), and Picton Island (Linse 2002); from 47°S in South Atlantic Ocean (Morris and Rosenberg 2005), and Malvinas/Falkland Islands (Castellanos and Landoni 1993) in Port Stanley (Strebel 1905).

***Pareuthria plumbea* (Philipi, 1844)**

Fig. 6B

Material examined. 20 spm (13 × 6 – 25 × 12 mm).**Synonymy.** See Dell (1971).**Remarks.** Aldea and Rosenfeld (2011) commented that, differing from other species of the family Buccinidae, it is characterized by direct development during its reproductive cycle by depositing egg masses (Pastorino and Penchaszadeh 2002). Dell (1971) explained that Strebel (1905b), when revising the species of the genus *Pareuthria*, observed a great similarity between *P. plumbea* and *P. magellanica*; however, the original figures did not concur with the distinction that was made by Strebel (1905b).**Distribution.** Magellanic: Puerto Edén, Levinson Island, Paso de Indio, and Piazzi Island (Dell 1971); Strait of Magellan (Powell 1951); Buque Quemado (Aldea and Rosenfeld 2011), Laredo Bay (Mutschke et al. 1998, Linse 2002), Punta Arenas (USNM 2010), Punta Santa Ana (Ríos et al. 2007; this record), Cape Froward (USNM 2010), Dawson Island (USNM 2010), and Carlos III Island (Aldea et al. 2011a); London Island (Pelseneer 1903), Beagle Channel (Pelseneer 1903), Ushuaia (Strebel 1908), Puerto Williams (Dell 1971), Róbalo Bay (Dell 1971, Ojeda et al. 2010), Hermite Islands (Dell 1971), Bertrand Island (Dell 1971), and Seno Grandi (Dell 1971); Malvinas/Falkand Islands (Dell 1971, USNM 2010), San Sebastián Bay (USNM 2010), Buen Suceso Bay (USNM 2010), and Staten Island (USNM 2010). WTSA: from 38°S toward south (Morris and Rosenberg 2005).***Pareuthria paessleri* (Strebel, 1905)**

Fig. 6C

Material examined. 1 spm (7 × 4 mm).**Synonymy.** See Powell (1951).**Remarks.** This species is similar to the species *P. cerealis* but differs in that the last whorl is more globular, and it has spiral stripes in the base of the last whorl (Cárdenas et al. 2008). Our examined specimen presented an eroded shell.**Distribution.** Magellanic: Smyth Channel (Powell 1951); Strait of Magellan (USNM 2010): Punta Santa María (this record) and Carlos III Island (Aldea et al. 2011a); Ushuaia (Strebel 1905b) and Puerto Eugenia (Strebel 1905b); Le Maire Strait (Strebel 1905b).***Pareuthria janseni* (Strebel, 1905)**

Fig. 6D

Material examined. 1 spm (10 × 14 mm).**Synonymy.** *Euthria janseni* Strebel 1905b: 622, pl. 21, fig. 7-7a; Strebel 1908: 28.

Pareuthria janseni, Forcelli 2000: 96, fig. 265.

Remarks. The specimen analyzed in this study had light spiral stripes on the whole surface of the shell, which is characteristic of this species. Similarly, Strebel (1905b) commented that the last whorl presented 30 spiral stripes. This species is very similar to the species *P. michaelsoni*, but it can be distinguished by a more globular last whorl, occupying $\frac{3}{4}$ of the total shell length (Forcelli 2000).

Distribution. Magellanic: eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Punta Santa Ana (this record), Ushuaia (Strebel 1905b), Beagle Channel (Osorio 1999), Picton Island (Strebel 1905b), and Cape Horn (Osorio 1999); Puerto Deseado (Forcelli 2000) and Malvinas/Falkland Islands (Strebel 1908).

Trophon geversianus (Pallas, 1774)

Fig. 6E

Material examined. 77 spm (30 × 17 – 53 × 38 mm).

Synonymy. See Pastorino (2005b).

Remarks. *Trophon geversianus* is the most well-known species of the genus *Trophon*. Its morphological variability is evident in the quantity of names proposed for each morphotype of this species (Pastorino 2005b). The rest of the nominal species from the Southern Ocean and adjacent waters displaying a similar morphology were compared by Aldea and Troncoso (2010a).

Distribution. Magellanic: Strait of Magellan (Rochebrune and Mabilie 1889, Lamy 1906b, Powell 1951, Houart 1998, Mutschke et al. 1998, Osorio 1999, Linse 2002, Pastorino 2005b, USNM 2010, Aldea et al. 2011a): Punta Santa María (this record); Ushuaia (Rochebrune and Mabilie 1889, Strebel 1908, Pastorino 2005b), Beagle Channel (Rochebrune and Mabilie 1889, Pelseneer 1903, Dell 1971, Osorio 1999), Róbaló Bay (Ojeda et al. 2010), and Cape Horn (Rochebrune and Mabilie 1889); San Antonio Oeste, Sierra Grande, Puerto Lobos, Puerto Pirámides, Puerto Madryn, San Jorge Gulf, Puerto Deseado, and Punta Peñas (Pastorino 2005b), Santa Cruz River (Powell 1951, Pastorino 2005b), Río Gallegos (Pastorino 2005b), Malvinas/Falkland Islands (Watson 1886, Melvill and Standen 1898, Melvill and Standen 1907, Strebel 1908, Powell 1951, Pastorino 2005b), Burdwood Bank (Melvill and Standen 1912, Pastorino 2005b), and Staten Island (USNM 2010). WTSA: Buenos Aires (Morris and Rosenberg 2005). SO: Heard Island (Watson 1886); records from western Antarctic Peninsula (Lamy 1906b) could correspond to an Antarctic species (Aldea and Troncoso 2010a).

Fuegotrophon pallidus (Broderip, 1833)

Fig. 6F

Material examined. 3 spm (6 × 3 – 18 × 9 mm).

Synonymy. See Houart (2010).

Remarks. The species that was referred to under the genus *Fuegotrophon* by Pastorino (2002) that was originally proposed as a subgenus by Powell (1951) based principally on the characteristics of the protoconch and radula. Currently, the name *Fuegotrophon pallidus* is considered to represent a separate genus (Houart 2010).

Distribution. Magellanic: Gulf of Ancud and Gulf of Corcovado (Cárdenas et al. 2008); Strait of Magellan (Powell 1951, Mutschke et al. 1998, Osorio 1999, Linse 2002): Desolación Island (USNM 2010), Punta Santa María, and Punta Santa Ana (this record); Beagle Channel (Osorio 1999, Linse 2002) and Cape Horn (Rochebrune and Mabille 1889, Linse 2002, USNM 2010); Malvinas/Falkland Islands (Melville and Standen 1907, Powell 1951) and Burdwood Bank (Melville and Standen 1907, Strebel 1908, USNM 2010). WTSA: from 38°S toward south (Morris and Rosenberg 2005). SO: Drake Passage (Powell 1951) and Crozet Island (Cantera and Arnaud 1985).

Xymenopsis muriciformis (King & Broderip, 1832)

Fig. 6G

Material examined. 51 spm (5 × 3 – 32 × 17 mm).

Synonymy. See Pastorino and Harasewych (2000).

Remarks. This species has a similar morphology to *Xymenopsis subnodosus* (Gray, 1839) in that it presents an external crenulate margin of the aperture, 12–16 axial cords on the last whorl, and 22–24 spiral cords (Pastorino and Harasewych 2000). *Xymenopsis muriciformis* has a direct development during its reproductive cycle, depositing its egg masses on rocky substrates (Zelaya 2009a).

Distribution. Magellanic: Chonos Archipelago (Húpe 1854, Rochebrune and Mabille 1889), Puerto Edén (Dell 1971), Traiguén Island (Reid and Osorio 2000), Guarello Island (Pastorino and Harasewych 2000), Paso de Indio (Dell 1971), Madre de Dios Island (Pastorino and Harasewych 2000), and Smyth Channel (Strebel 1904); Strait of Magellan (King and Broderip 1832, Húpe 1854, Tryon 1880, Rochebrune and Mabille 1889, Strebel 1904, Powell 1951, Pastorino and Harasewych 2000): Punta Arenas (Strebel 1904, Pastorino and Harasewych 2000), Punta Santa María (this record), Gente Grande Bay (Strebel 1904), Inútil Bay (Strebel 1904, USNM 2010), Puerto del Hambre (Pastorino and Harasewych 2000), Punta Santa Ana (Ríos et al. 2007; this record), Cape Froward (USNM 2010), Dawson Island (Pastorino and Harasewych 2000, USNM 2010), and Carlos III Island (Pastorino and Harasewych 2000, Aldea et al. 2011a); Cockburn Channel (Pastorino and Harasewych 2000), Ushuaia (Strebel 1904, Pastorino and Harasewych 2000), Puerto Harberton (Strebel 1904, Pastorino and Harasewych 2000), Beagle Channel (Pastorino and Harasewych 2000), Navarino Island (Strebel 1904), Puerto Williams (Dell 1971), Orange Bay (Tryon 1880, Rochebrune and Mabille 1889, Lamy 1906b), and Cape Horn (Strebel 1904); from 41°S toward south in the South Atlantic Ocean (Morris and Rosenberg 2005), Puerto Deseado (Pastorino and Harasewych 2000), Tierra del Fuego (Pastorino and

Harasewych 2000), San Sebastián Bay (Pastorino and Harasewych 2000, USNM 2010), Malvinas/Falkland Islands (Watson 1886, Powell 1951, Castellanos and Landoni 1993, Pastorino and Harasewych 2000, USNM 2010), Cape Buen Tiempo (Pastorino and Harasewych 2000), Port Stanley (Strebel 1904), Lively Island (Pastorino and Harasewych 2000), Staten Island (Pastorino and Harasewych 2000), Puerto Año Nuevo (Pastorino and Harasewych 2000), and Cape San Diego (USNM 2010).

***Acteon biphlicatus* (Strebel, 1908)**

Fig. 6H

Material examined. 2 spm ($4 \times 1.5 - 5 \times 3$ mm).

Synonymy. *Odostomia biphlicata* Strebel 1908: 65, pl. I, fig. 9a.

Acteon biphlicata, Castellanos and Landoni 1986: 297, pl. I, fig. 9.

Acteon biphlicatus, Castellanos et al. 1993: 7, pl. I, fig. 3; Forcelli 2000: 115, fig. 347; Cárdenas et al. 2008: 223, fig. 5.56; Aldea et al. 2011b: 43, fig. 3B.

Remarks. The morphology of this species is similar to *Acteon elongatus* Castellanos, Rolán & Bartolotta, 1987. However, it can be differentiated because *A. elongatus* does not have a columellar tooth and has a wider aperture (Aldea et al. 2011b).

Distribution. Magellanic: Coldita Channel (Cárdenas et al. 2008), Messier Channel, and Wide Channel (Aldea et al. 2011b); Strait of Magellan: eastern micro-basin of the Strait of Magellan (Ríos et al. 2003) and Punta Santa María (this record). South Atlantic Ocean: from 43°S (Morris and Rosenberg 2005), Malvinas/Falkland Islands (Castellanos et al. 1993), and Berkeley Sound (Strebel 1908).

***Aulacomya atra* (Molina, 1782)**

Fig. 7A

Material examined. 3 spm ($8 \times 4 - 14 \times 7$ mm).

Synonymy. See Reid and Osorio (2000).

Remarks. Reid and Osorio (2000) noted that this species is easily distinguishable from the other species of mytilids that exist on the Chilean coast, given its radial ribs on valves. However, specimens less than 40 mm could be confused with *Perumytilus purpuratus* (Lamarck, 1819). But at that size, *A. atra* presents a yellowish or ruddy color, while *P. purpuratus* has a black periostracum and double the radial ribs (Reid and Osorio 2000).

Distribution. WTSP: Callao in Perú (Dall 1909, Soot-Ryen 1955), Iquique (Marincovich 1973), Antofagasta (Guzman et al. 1998), Coquimbo (Húpe 1854, Carcelles 1950), from Punta Pingüeral to Mocha Island (Aldea and Valdovinos 2005), and Valdivia (Zagal and Hermosilla 2001). Magellanic: Coldita Channel (Cárdenas et al. 2008), Estero Elefantes (Reid and Osorio 2000), Puerto Edén (Dell 1971), Levinson

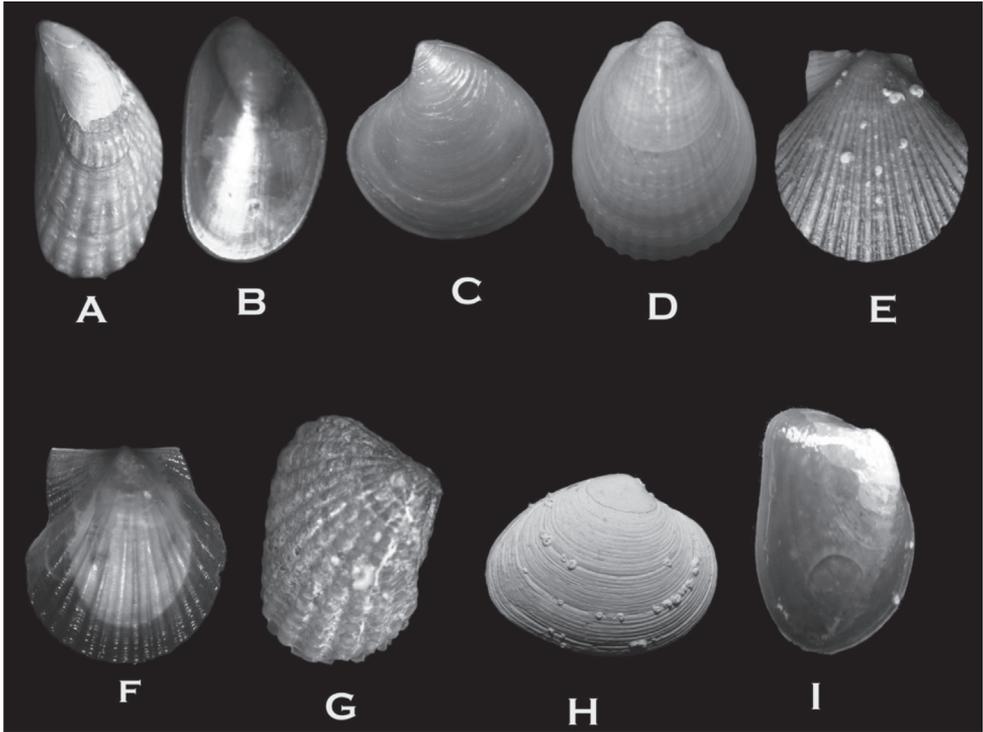


Figure 7. **A** *Aulacomya atra* (8 × 4 mm) **B** *Mytilus edulis chilensis* (4 × 3 mm) **C** *Astarte longirostra* (5 × 5 mm) **D** *Limea pygmaea* (9 × 6 mm) **E** *Zygochlamys patagonica* (14 × 11 mm) **F** *Austrochlamys natans* (7.1 × 6.5 mm) **G** *Carditella naviformis* (5 × 3.5 mm) **H** *Tawera elliptica* (10 × 11 mm) **I** *Gaimardia trapesina* (14 × 7 mm).

Island (Dell 1971), and Piazzzi Island (Dell 1971); Strait of Magellan (Húpe 1854, Rochebrune and Mabilie 1889, USNM 2010); eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Laredo Bay (Mutschke et al. 1998), Punta Santa María (this record), Inútil Bay (USNM 2010), Punta Santa Ana (Ríos et al. 2007; this record), Cape Froward (USNM 2010), Dawson Island (USNM 2010), Carlos III Island (Aldea et al. 2011a), and Desolación Island (USNM 2010); Beagle Channel (Pelseneer 1903), Puerto Williams (Dell 1971), Róbalo Bay (Dell 1971, Ojeda et al. 2010), Puerto Toro (Pelseneer 1903), Hermite Islands (Dell 1971), Bertrand Island (Dell 1971), and Orange Bay (Rochebrune and Mabilie 1889, Lamy 1906a); San José Gulf (Zaico 2004), Cape Penas (USNM 2010), San Sebastián Bay (USNM 2010), Malvinas/Falkland Islands (Húpe 1854, Melvill and Standen 1907, Dell 1964, USNM 2010), and Staten Island (USNM 2010). WTSA: southern Brazil (Soot-Ryen 1955), Uruguay (Scarabino 2003b), and Puerto Quequén (Carcelles 1944). SO: Scotia Sea (USNM 2010), and Kerguelen Islands (Lamy 1906a, Carcelles 1950, Troncoso et al. 2001). Other sites: South Africa (Huber 2013), and New Zealand. Northern Hemisphere: North Sea (Huber 2013).

***Mytilus edulis platensis* (d'Orbigny, 1842)**

Fig. 7B

Material examined. 1 spm (4 × 3 mm).**Synonymy.** See Reid and Osorio (2000).

Remarks. Regarding the current status of this species, Aldea and Rosenfeld (2011) commented that in spite of the genetic and morphological study carried out by Toro (1998), who placed this species in *M. edulis chilensis*, the taxonomic problem is still not resolved. The study carried out by Cárcamo et al. (2005) on specimens from the Chilean Coast was based on allozymes and compared these specimens with European specimens of *M. edulis* and *M. galloprovincialis* (Lamarck, 1819). The authors concluded that the Chilean specimens should rather be considered a subspecies of *M. galloprovincialis* given that it is genetically closer to this species, but having particular and characteristic allele frequencies. Investigating the taxonomy and genetics of Chilean smooth-shelled *Mytilus*, Borsa et al. (2012) concluded that *M. edulis* from the northern hemisphere is different from *M. edulis* from the southern hemisphere in proportion to the nuclear loci and the mitochondrial locus. For this reason they consider them as geographically isolated entities. Thus, the Chilean Blue mussels are considered to represent subspecies of *M. edulis*. Following the principle of priority, the authors stress that *platensis* d'Orbigny, 1842 is the correct subspecific name for the southern hemisphere *M. edulis*, and relegate the name *Mytilus chilensis* Hupé, 1854 into the synonymy of *platensis*. Larrain et al. (2012) applied the Me 15–16 marker to samples from sites between 41°S and 51°S and found that the majority of the mussels corresponded to “*M. chilensis*”, and saw no evidence for an occurrence of *M. edulis*. Additionally, putative hybrids of *M. chilensis* × *M. trossulus* and *M. chilensis* × *M. galloprovincialis* were detected, and the authors stressed that other markers are needed to differentiate between the southern hemisphere *Mytilus* species. Concluding it can be said the the correct taxonomic allocation for the southern-hemisphere *Mytilus* species is still pending. For the time being, we here use the name *platensis* d'Orbigny, 1842 as a subspecies of *M. edulis* for the specimens from our samples.

Distribution. WTSP: Iquique (Soot-Ryen 1959), Valparaíso (Húpe 1854, Dall 1909), from Punta Pingueral to Mocha Island (Aldea and Valdovinos 2005), and Valdivia (Zagal and Hermosilla 2001, Borsa et al. 2012). Magellanic: Puerto Montt (Borsa et al. 2012), Calbuco (Borsa et al. 2012), Gulf of Ancud (Cárdenas et al. 2008), Estero Elefantes (Reid and Osorio 2000), Estero Castro (Dell 1971), Puerto Edén (Dell 1971), and Piazzi Island (Dell 1971); Strait of Magellan (Rochebrune and Mabilille 1889, Dell 1964): eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Buque Quemado (Aldea and Rosenfeld 2011), Laredo Bay (Mutschke et al. 1998), Punta Santa Ana (Ríos et al. 2007), Punta Santa María (this record), Cape Froward (USNM 2010), Dawson Island (USNM 2010), and Carlos III Island (Aldea et al. 2011a); Puerto Williams (Dell 1971), Róbalo Bay (Dell 1971, Ojeda et al. 2010), Hermite Islands (Dell 1971), Bertrand Island (Dell 1971), Seno Grandi (Dell 1971), and Orange Bay (Rochebrune and Mabilille 1889); Chubut (Carcelles 1944), Malvi-

nas/Falkland Islands (Dell 1964), San Sebastián Bay (USNM 2010), and Staten Island (USNM 2010). WTSA: Uruguay (Scarabino 2003b), and Buenos Aires Province (Carcelles 1944).

***Astarte longirostra* (d'Orbigny, 1842)**

Fig. 7C

Material examined. 4 spm ($4.5 \times 4 - 5 \times 5$ mm).

Synonymy. See Dell (1964).

Remarks. Dell (1990) explained that this is the only species from the genus in the Magellan Region, given that the species *Astarte magallenica* (Smith, 1881) constitutes a morphological variation of *A. longirostra* (Dell 1964).

Distribution. Magellanic: Strait of Magellan (Smith 1881, USNM 2010); eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Tierra del Fuego (Dell 1964), Punta Santa María (this record), and Carlos III Island (Aldea et al. 2011a); Hoste Island (USNM 2010), Beagle Channel (Rochebrune and Mabilie 1889), and Cape Horn (USNM 2010); from 45°S toward south in the South Atlantic Ocean (Bigatti 2010), Malvinas/Falkland Islands (Dell 1964, Hain 1990), Le Maire Strait (USNM 2010), and Staten Island (USNM 2010). SO: Marion Island (Hain 1990), Prince Edward Island (Smith 1881), Kerguelen Islands (Powell 1960, Hain 1990), South Georgia Island (Powell 1960, Hain 1990, USNM 2010), South Shetland Islands (Hain 1990, USNM 2010), Ross Sea (USNM 2010), and Weddell Sea (Gutt et al. 2000).

***Limea pygmaea* (Philippi, 1845)**

Fig. 7D

Material examined. 4 spm ($4 \times 2.5 - 9 \times 6$ mm).

Synonymy. See Aldea and Troncoso (2008).

Remarks. Aldea and Troncoso (2010b) commented that this species is similar to *Limatula ovalis* (Thiele, 1912) but smaller and thinner. Both species present direct development through incubation (Linse and Page 2003).

Distribution. Magellanic: Smyth Channel (Thiele 1912); Strait of Magellan, (Húpe 1854, Lamy 1906a, Dell 1990); eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Punta Santa María (this record), and Carlos III Island (Aldea et al. 2011a); Orange Bay (Rochebrune and Mabilie 1889); Malvinas/Falkland Islands (Dell 1964, Linse 1997), and Staten Island (Dell 1990). WTSA: Uruguay (Scarabino 2003b), and Buenos Aires Province (Carcelles 1944). SO: South Shetland Islands (Dell 1990, Narchi et al. 2002, Aldea and Troncoso 2008), Macquaire Island (Powell 1960), Kerguelen Islands (Smith 1879, Smith 1885, Thiele 1912, Thiele and Jaeckel 1931, Powell 1957, Troncoso et al. 2001), Marion and Prince Edward Islands (Smith 1885, Branch et al. 1991).

***Zygochlamys patagonica* (King & Broderip, 1832)**

Fig. 7E

Material examined. 2 spm (12 × 10 – 14 × 11 mm).**Synonymy.** See Cárdenas et al. (2008).**Remarks.** Waloszek (1984) reported that the species has a wide variability in its morphological characteristics, presenting different types of sculpture. Coloration can range from white to dark red and yellow. This species is found in shallow waters and on the front of slopes, where it forms large banks (Zelaya 2009b).**Distribution.** Magellanic: Chiloé Archipelago (Waloszek 1984), Estero Elefantes (Reid and Osorio 2000), and Wellington Island in Puerto Edén (Dell 1971); Strait of Magellan (King and Broderip 1832): eastern micro-basin of the Strait of Magellan (Ríos et al. 2003), Carlos III Island (Aldea et al. 2011a), Punta Santa Ana (Ríos et al. 2007), and Punta Santa María (this record); Beagle Channel (Rochebrune and Mabilie 1889) and Cape Horn (Waloszek 1984); Chubut (Carcelles 1944), Santa Cruz (Carcelles 1944), and Malvinas/Falkland Islands (Grau 1959) toward 55°S (Morris and Rosenberg 2005). WTSA: Uruguay (Scarabino 2003b), and Buenos Aires Province (Carcelles 1944). SO: South Shetland Islands (USNM 2010).***Austrochlamys natans* (Philippi, 1845)**

Fig. 7F

Material examined. 1 spm (7.1 × 6.5 mm).**Synonymy.** See Dell (1971).**Remarks.** Dell (1971) concluded that this species inhabits fronds of the giant kelp *Macrocystis pyrifera* and that juveniles present a thin shell that is semitransparent, due to an adaptation to this environment. In relation to its comparative morphology, it can be differentiated from *Zygochlamys patagonica* because of its globular, delicate shell and wider radial cords (Zelaya 2009b).**Distribution.** Magellanic: Punta Gaviota and Carlos Island (Dell 1971); Strait of Magellan (King and Broderip 1832): Punta Santa Ana (this record), Dawson Island (USNM 2010), and Carlos III Island (Aldea et al. 2011a); London Island (Pelseener 1903) and Puerto Williams (Dell 1971).***Carditella naviformis* (Reeve, 1843)**

Fig. 7G

Material examined. 13 spm (4 × 2 – 5 × 3.5 mm).**Synonymy.** See Güller and Zelaya (2013).**Remarks.** This species is very similar to *Carditella tegulata* (Reeve, 1843), which has a triangular contour, but its shell is equilateral, with a central umbo and straight

upper and lower dorsal margins (Zelaya 2009b). Accordingly, Smith (1881) distinguished the species due to the presence of 14–15 radial ribs and a central umbo. However, the specimens revised by Reid and Osorio (2000) had a corresponding sculpture to *Carditella naviformis*, but the radial ribs were slightly pronounced from 11 to 13 in number, and the margins of the shell were more similar to *C. tegulata*.

Distribution. WTSP: Iquique and Tocopilla (Soot-Ryen 1959), and Valparaíso (Hupé 1854, Dall 1903, Ramorino 1968, Güller and Zelaya 2013). Magellanic: Gulf of Ancud, Comau Fjord and Gulf of Corcovado (Güller and Zelaya 2013), Darwin Channel (Güller and Zelaya 2013), and Estero Elefantes (Reid and Osorio 2000); Strait of Magellan (Carcelles and Williamson 1951, USNM 2010): Carlos III Island (Aldea et al. 2011a) and Punta Santa María (this record); Cockburn Channel (Güller and Zelaya 2013), Beagle Channel (Güller and Zelaya 2013), and Cape Horn (USNM 2010); Malvinas/Falkland Islands (Melville and Standen 1914), Staten Island (USNM 2010, Güller and Zelaya 2013), and Le Maire Strait (USNM 2010).

Tawera elliptica (Lamarck, 1818)

Fig. 7H

Material examined. 9 spm (8 × 10 – 10 × 11 mm).

Synonymy. See Gordillo (2006).

Remarks. The morphology of this species is similar to the smallest specimens of *Retrotapes exalbidus*. Zelaya (2009b) showed that they can be differentiated in that *T. elliptica* has wider cords and finer interspaces and the inside of the shell is either purplish or brownish. All specimens collected during this study had a strong violet coloring on the inside of the valves.

Distribution. WTSP: Valparaíso (Húpe 1854, Osorio and Bahamonde 1970). Magellanic: Gulf of Corcovado (Cárdenas et al. 2008), and Traiguén Island (Reid and Osorio 2000); Strait of Magellan (USNM 2010): Punta Santa María (this record), Dawson Island (USNM 2010), and Carlos III Island (Aldea et al. 2011a); Beagle Channel (Rochebrune and Mabilie 1889), Ushuaia (USNM 2010), Puerto Williams (Dell 1971), Orange Bay (Rochebrune and Mabilie 1889), and Cape Horn (USNM 2010); Malvinas/Falkland Islands (Dell 1964, Linse 1997), and Staten Island (USNM 2010). WTSA: Río Grande do Sul and Uruguay (Gordillo 2006), and Buenos Aires Province (Carcelles 1944).

Gaimardia trapesina (Lamarck, 1819)

Fig. 7I

Material examined. 3 spm (14 × 7 – 14 × 22 mm).

Synonymy. See Morris and Rosenberg (2005).

Remarks. This species is an epibiont of the giant kelp *Macrocystis pyrifera* (Ralph and Maxwell 1977), although it can also be found in blocks and by personal observation. It is an incubating species that retains embryos in the gills until they are completely developed.

Distribution. Magellanic: Strait of Magellan (Hombron and Jacquinot 1854): Punta Santa María (this record), Carlos III Island (Aldea et al. 2011a), and Fuerte Bulnes (pers. obs.); Orange Bay (Rochebrune and Mabile 1889); Malvinas/Falkland Islands (Melvill and Standen 1907, USNM 2010), and Staten Island (USNM 2010). W.TSA: Rio Grande do Sul (Morris and Rosenberg 2005, Dias Passos and Magalhães 2011), Uruguay (Scarabino 2003b), and Buenos Aires Province (Carcelles 1944). SO: South Georgia Island (Martens and Pfeffer 1886).

Biogeography

Of the identified 42 species, 29% have a wide distribution, 9% are distributed in the Warm Temperate South-eastern Pacific-Magellanic provinces, 38% are Magellanic (*sensu stricto*), and 12% present a Warm Temperate Southwestern Atlantic-Magellanic distribution and Magellanic-Southern Ocean distribution, respectively (Fig. 8).

Taking into account the 9 species of the class Polyplacophora recorded in this study, only the species *Callochiton puniceus* and *Plaxiphora aurata* showed a Magellanic-Southern Ocean distribution, while two species were found in the Southeast Temperate Magellanic-Pacific area and four species were distributed only in the Magellan Region (Fig. 8).

Of the 24 species recorded in the class Gastropoda, 25% (6 species) had a wide distribution, 4% (1 species) had a warm temperate southeastern Pacific-Magellanic distribution, and 46% (11 species) presented a Magellanic distribution, while 17% (4 species) presented a warm temperate southwestern Atlantic-Magellanic distribution and 8% (2 species) presented a Magellanic-Southern Ocean distribution (Fig. 8).

Finally, the class Bivalvia presented 56% of the species (5 species) with wide distribution, 11% presented a warm temperate southeastern Pacific-Magellanic distribution, Magellanic, warm temperate southwestern Atlantic-Magellanic, and Magellanic-Southern Ocean distribution, respectively (Fig. 8).

Shared species between sampling sites and the different biogeographic areas assessed showed variable values (Table 3). The highest ratio of similarity was observed in Bivalvia from Atlantic Patagonia (0.89), followed by Gastropoda in the same area (0.71). In third place are the Polyplacophora from the intermediate area of the South-eastern Pacific, Bivalvia from Uruguay and the Southern Ocean (0.56, respectively). However, lower values were observed in Gastropoda from Peru and Polyplacophora from Uruguay (0.00, which indicates no species shared with those areas).

The Simpson similarity coefficient showed the greatest value in Polyplacophora from Antarctica with 0.500 (Table 3). In second and third place are Polyplacophora from the Atlantic Patagonia and intermediate area of South Eastern Pacific with 0.174

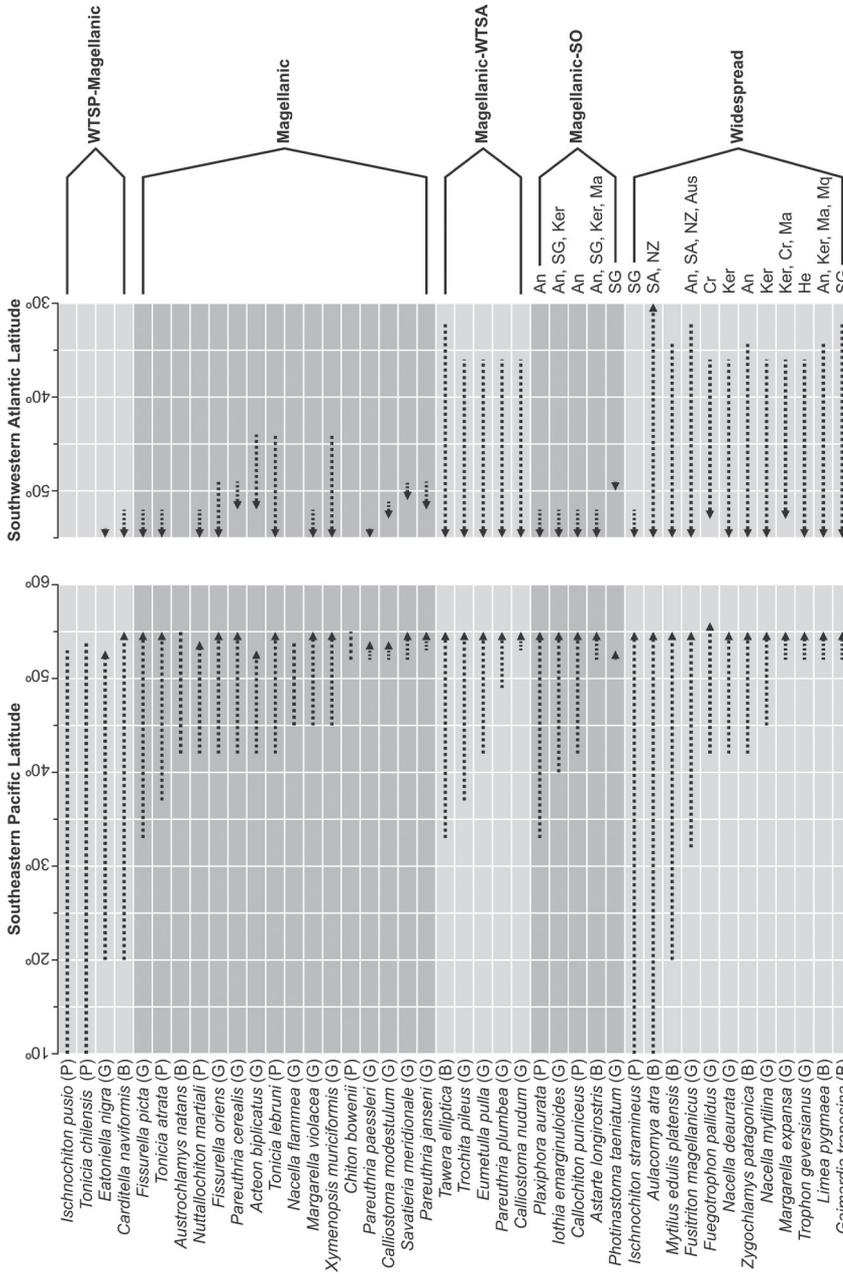


Figure 8. Biogeographic distribution of molluscs associated with natural beds of *Gigartina skottsbergii* in the Strait of Magellan. Biogeographical provinces were taken from Spalding et al. (2007): Warm Temperate South-eastern Pacific (WTSP), Warm Temperate South-western Atlantic (WTSA), and Southern Ocean (SO). Antarctica (An), South Georgia (SG), Kerguelen Island (Ker), Marion Island (Ma), South Africa (SA), New Zealand (NZ), Australia (Aus), Crozet Island (Cr), Heard Island (He), and Macquarie Island (Mq). (P) indicates Polyplacophora, (G) Gastropoda and (B) Bivalvia.

Table 3. Zoogeographic affinities of molluscs recorded in this study: total species present for each area; number of shared species with this study; ratio of similarity and Simpson similarity coefficient. (1) from Ramirez et al. (2003), (2) Valdovinos (1999), (3) Carcelles (1950), (4) Scarabino (2003a), (5) Scarabino (2003b), (6) Scarabino (2004), (7) personal compilation, and (8) Griffiths et al. (2003).

		Total species	Shared species	Ratio of similarity	Simpson similarity coefficient
Perú (1)	Polyplacophora	33	3	0.33	0.091
	Gastropoda	543	0	0.00	0.000
	Bivalvia	357	1	0.11	0.003
Warm Temperate South-eastern Pacific (15°S–30°S), (2)	Polyplacophora	28	3	0.33	0.107
	Gastropoda	224	1	0.04	0.004
	Bivalvia	78	3	0.33	0.038
Intermediate area (30°S–40°S), (2)	Polyplacophora	29	5	0.56	0.172
	Gastropoda	239	5	0.21	0.021
	Bivalvia	84	4	0.44	0.048
Atlantic Patagonia <i>sensu lato</i> (36°S–52°S), (3)	Polyplacophora	23	4	0.44	0.174
	Gastropoda	156	17	0.71	0.109
	Bivalvia	57	8	0.89	0.140
Uruguay (4, 5, 6)	Polyplacophora	5	0	0.00	0.000
	Gastropoda	115	3	0.13	0.026
	Bivalvia	49	5	0.56	0.102
Antarctica (7)	Polyplacophora	6	3	0.33	0.500
	Gastropoda	337	7	0.29	0.021
	Bivalvia	224	4	0.44	0.018
Southern Ocean and adjacent areas (8)	Polyplacophora	–	–	–	–
	Gastropoda	500	8	0.33	0.016
	Bivalvia	287	5	0.56	0.017

and 0.172, respectively (Table 3). Except for areas where there are no shared species, the lowest values were recorded in Bivalvia from Peru with 0.003, and Gastropoda from the Warm Temperate South-eastern Pacific with 0.004 (Table 3).

Discussion

Number and composition of species

The Magellan Region, defined in the database of Linse (1999) such as the Patagonian platform south of 41°S in the Pacific and Atlantic margins of South America, reports 381 marine species: 250 gastropods and 131 bivalves, not including polyplacophorans due to taxonomic problems with the group. Of the total species reported by Linse (1999), 278 inhabit depths less than 30 m, being considered “shallow-water species”: 180 gastropods and 98 bivalves. The 33 species recorded in this study correspond to 12% of the total shallow-water species cited: 13% for Gastropoda and 9% for Bivalvia.

Sirenko (2006) investigated the state of knowledge about the Polyplacophora from the Strait of Magellan and the Malvinas/Falkland Islands, recording a total of 17 species for the Strait of Magellan. However, the author was only able to collect 14 species, due to the rarity of some species, such as *Ischnochiton pusio*. Additionally, there are 11 other species of polyplacophorans cited for the Magellan Region, but Sirenko (2006) noted that these records were probably erroneous, given that these species are usually present in warmer waters. The 9 polyplacophoran species recorded in this study (2 Ischnochitonidae, 1 Callochitonidae, 4 Chitonidae, and 2 Mopaliidae) correspond to less than 47% of the species cited for the Strait of Magellan by Sirenko (2006).

Nevertheless, the percentages given above should be considered only as a reference, since some species could currently be considered junior synonyms of others following the publication of subsequent taxonomic revisions focused on specific groups (e.g. Pastorino 2005a, 2005b, Aranzamendi et al. 2009, Gonzalez-Wevar et al. 2010). Thus, the number of species varies, tending in some cases to decrease (e.g. Schwabe et al. 2006, Zelaya and Geiger 2007, Signorelli and Pastorino 2011). However, there have been descriptions of new species (e.g. Zelaya and Ituarte 2003, 2004), and a complete taxonomic overview is not possible at the time being.

The mollusc species richness recorded in this study represents a value over the average of those reported in other studies in the last 40 years in sublittoral environments in the Strait of Magellan (Table 4). Similarly, the study that presents the highest number of species (Aldea et al. 2011a) reported a total of 101 species of molluscs, but that study boarded a more extensive zone of the western micro-basin of the Strait of Magellan and some adjacent channels, where diverse substrates were studied. The present study is closer in quantity to the number of species carried out by Ríos et al. (2003), which was contained to the eastern micro-basin of the Strait of Magellan, recording 69 species between 30 and 50 meters (see Table 4). Projecting towards the fjord and canal zone in the Magellanic ecoregion, Dell (1971) reported 73 species in an extensive zone between 42°S and 55°S but did not consider the seafloor of the Strait of Magellan. Reid and Osorio (2000) recorded 62 species of molluscs in the sector of Estero Elefantes and Laguna San Rafael (46°S).

From an ecological point of view, it is very difficult to carry out studies on communities and assemblages and be able to establish trophic groups, due to the lack of biologic studies about most of the mollusc species. For example, *Chiton bowenii* and *Nuttallochiton martiali* display unusual autecological aspects (Schwabe 2009). *Savateria meridionale* should be compared with other species of the genus (Dell 1972), *Calliostoma nudum*, *C. modestulum* and *Photinastoma taeniatum* have a generic position that needs to be revised due to their similar characteristics (see Castellanos and Landoni 1989), *Pareuthria paessleri* and *P. janseni* have unknown developmental strategies (Pastorino and Penchaszadeh 2002). Thus, it is very important to conserve this type of environment, given that it shelters species that are considered by some authors to be “rare” or of low frequency (Dell 1971, Sirenko 2006, Ríos et al. 2007). In this sense, algae beds of our sampling sites shelter ~38% of rare species for this habitat (see Table 1).

Table 4. Molluscs recorded in works since 1970 in the Strait of Magellan and adjacent channels. We took into account studies where sublittoral samples were collected.

Source	Latitude and depth	Gastropoda	Bivalvia	Polyplacophora	Total species†
Linse (2002)	52.9–53.7°S; 8–522m	17	1	0	18
Ríos et al. (2003)	52.6–52.8°S; 30–50m	38	21	10	69
Ríos et al. (2005)	52.3–53.9°S; 24–604m	8	6	1	15
Ríos et al. (2007)	53.0–53.6°S; ~8m	9	5	4	18
Thatje and Brown (2009)	52.3–55.2°S; 35–571m	5	15	1	21
Ríos et al. (2010)	52.3–52.5°S; ~16–~61m	1	3	0	4
Aldea et al. (2011a)	53.4–53.9°S; 5–20m	59	31	11	101
		20±8	12±4	4±2	35±13
This record	53°S; ~10m	25	11	9	45

†Morphospecies identified to generic level (“genus” sp.) are included.

Distribution aspects of the molluscs

Natural beds of *G. skottsbergii* are characterized by a high species richness of molluscs. This study showed that the assemblage of molluscs that inhabit beds of *G. skottsbergii* in the Strait of Magellan are species represented in the Magellanic Biogeographic Province, finding 38% of species that are exclusively distributed within this province. Gastropods in this study presented a high percentage of species with Magellanic distribution *sensu stricto* (Gastropoda = 45.8% and Bivalvia = 11.1%; see Fig. 8) contradicting Linse et al. (2006), who mentioned that for the Strait of Magellan, bivalves present a higher level of endemism than gastropods (Gastropoda = 13.3% and Bivalvia = 23.2%).

Other biogeographic studies carried out in the channels and fjords of Southern Chile showed that gastropods and bivalves have a higher similarity to molluscs from the Malvinas/Falkland Islands and South Georgia Islands (31% and 37%; Brandt et al. 1999). However, in our study, 74% of the species are present in the Malvinas/Falkland Islands and only 5 species (11%) are present in the South Georgia Islands. Therefore, the biogeographic study done by Zelaya (2005) for gastropods in the South Georgia Islands found that the affinity between the Magellanic Province and the South Georgia Islands is lower than those proposed by Brandt et al. (1999), finding only a 16% similarity with the Magellanic gastropods. Of the 24 species of gastropods recorded in this study, only *Iothia emarginuloides*, *Photinastoma taeniatum*, and probably *Margarella expansa* are reported for the South Georgia Islands. For that reason the affinity is quite low (13%).

In a complementary manner, upon comparison of the composition of the 16 genera of gastropods recorded in this study with those reported by Zelaya (2005) for the South Georgia Islands, only the genera *Iothia*, *Margarella*, *Photinastoma*, *Eatoniella*, and *Trophon* are present in both sites. In this manner, the low similarity can be observed between gastropod fauna recorded in this study and those from the South Geor-

gia Islands. This low affinity between the Magellanic province and the South Georgia Islands not only occurs in molluscs, but data from other groups also supports the idea of including the South Georgia Islands within the Antarctic Region (De Broyer and Jazdewski 1993, Zelaya 2005, Spalding et al. 2007). The differences in the fauna composition can likely be explained by the difference in temperatures caused by the presence of the Antarctic convergence and the deep waters between the South Georgia Islands and the Magellanic Province (Zelaya 2005). However, in this study, only 42 species of molluscs were evaluated (corresponding to 12% of the shallow-water species from the Magellanic Province), and as a result, a larger number of samples and studies in different sectors of Magallanes could give better comparative information about the distribution of different mollusc species.

It is important to note that none of the biogeographic studies mentioned (Brandt et al. 1999, Linse et al. 2006) included the class Polyplacophora in their analysis. In this study, of the 9 species identified, 4 (44%) had a Magellanic distribution and highest similarity with Antarctica (see Table 3). Thus, it would be important to consider this group in future biogeographic research to better understand its current status.

Other biogeographic studies carried out in the Eastern Ocean of South America have demonstrated that the highest rates of endemism are found at high latitudes, principally in the Magellanic and Scotia Sea provinces (Fortes and Absalao 2011). At the same time, Fortes and Absalao (2011) mentioned that these high rates of endemism present in the Scotia Sea could be explained by the influence on the degree of isolation that the Antarctic creates over communities of this region (Clarke et al. 2004).

In general, the assemblage of molluscs recorded in this study showed low affinity with other provinces or regions in South America (see Table 3), and the largest proportion of similarity was presented in molluscs of Atlantic Patagonia and in the intermediate area of the Pacific (see Table 3), while the Simpson similarity coefficient in general presented low values, except for the Antarctic Polyplacophora. These results are important from the point of view of conservation of these benthic Magellanic ecosystems, given that an overexploitation of natural habitats of *Gigartina skottsbergii* would affect mostly endemic species of the Magellanic biogeographic province as well as other species distributed towards the Atlantic Patagonia and the intermediate area of the Pacific.

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Supplementary material I

Species excluded from the analysis of Table 3

Authors: Sebastián Rosenfeld, Cristian Aldea, Andrés Mansilla, Johanna Marambio, Jaime Ojeda

Data type: species list.

Explanation note: Species excluded from the analysis of Table 3 (biogeographic analysis)

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The morphology of the preimaginal stages of *Squamapion elongatum* (Germar, 1817) (Coleoptera, Curculionoidea, Apionidae) and notes on its biology

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Abstract

Data on the morphology of the egg, mature larva (L₃) and pupa of *Squamapion elongatum* (Germar, 1817) are presented. The development cycle of this species lasts 51–54 days: a 12-day egg period, a 30-day larval period, and a 12-day pupal period, on average. The larvae are attacked by parasitic hymenopterans of the superfamily Chalcidoidea.

Keywords

Weevil, Apionidae, *Squamapion*, egg, mature larva, pupa, life cycle, *Salvia*, Lamiaceae

Introduction

The genus *Squamapion* Bokor, 1923 is distributed in the Palaearctic and Afrotropical regions and includes 33 species (Alonso-Zarazaga 2011). In Poland it is represented by 9 species: *Squamapion atomarium* (Kirby, 1808), *S. cineraceum* (Wencker, 1864), *S. elongatum* (Germar, 1817), *S. flavimanum* (Gyllenhal, 1833), *S. serpyllicola* (Wencker, 1864), *S. mroczkowskii* (Wanat, 1997), *S. oblivium* (Schilsky, 1902), *S. samarense* (Faust, 1891) and *S. vicinum* (Kirby, 1808) (Petryszak 2004; Mokrzycki and

Wanat 2005). These are mono- or oligophagous herbivores feeding on species from the family Lamiaceae, mainly of the genera *Salvia*, *Thymus*, *Thymbra*, *Mentha*, *Origanum*, *Prunella* and *Succocalyx*. Their larvae burrow tunnels inside roots or stems, occasionally causing galls (Alonso-Zarazaga 1990). These insects are quite similar in terms of external morphology, which causes many problems in identification. As yet no attempts have been made to divide the taxon into subgenera or species groups (Wanat 1997).

Squamapion elongatum is a species inhabiting the southern and central part of Europe, as well as East Asia and Algeria. It inhabits lowland and submontane areas. In Poland it is recorded in the Masurian Lake District, the Wielkopolsko-Kujawska Lowland, Upper and Lower Silesia, the Krakowsko-Wieluńska Upland, the Małopolska Upland, the Świetokrzyskie Mountains, the Lublin Upland, Roztocze and Eastern Beskid (Burakowski et al. 1992). This species is characteristic of xerothermic grasslands, where it feeds on plants of the genus *Salvia* – *S. pratensis* and *S. nemorosa* (Cmoluch 1962). Its life cycle has not yet been described.

Material and methods

Squamapion elongatum eggs, larvae, pupae and adults were collected from two patches of xerothermic grasslands in Gródek (50°46'58.18"N, 23°56'47.04"E) near Hrubieszów and in Łęczna (51°18'9.7"N, 22°51'47.8"E) (SE Poland). The material was collected during one growing season from July to September 2011 at 3–7 day intervals between 10 a.m. and 2 p.m. Adults were collected using an entomological net in an association of *Thalictro-Salvietum pratensis*. To obtain the other development stages for breeding, whole plants of the genus *Salvia* were collected. In total 67 specimens of meadow sage were collected. A delicate cut was made along the stem and root of the plants and then they were dissected with needles to find the eggs, larvae, pupae and even adults located inside. Some of the larvae were used to begin breeding and others for microscopic slides, to be used in making drawings showing the morphology of the developmental stages. To prepare the drawings we used an OLYMPUS BX61 microscope at magnifications from 200 × to 400 × and a TESCAN VEGA3LMU scanning microscope at magnifications from 500 × to 4,500 ×. The figures were made based on the biological preparations using Corel Draw 12 software. Metric sizes are the average value of 10 measurements (Table 1).

Larval specimens in successive developmental stages were transferred in vitro to Petri dishes after the larval stadium was determined on the basis of morphological characteristics and the number of exuvia of head capsules. Breeding of larvae was carried out to the L₃ stage. Breeding of preimaginal stages was carried out according to Scherf (1964) and Łętowski (1991). Petri dishes were transferred to a breeding chamber with the following conditions: temperature during the day 30 °C, temperature at night 20 °C, humidity during the day 60%, humidity at night 80%. Adults were kept in glass containers covered with a fine mesh. As in the case of the larvae, filter paper saturated with distilled water was placed at the bottom to maintain humidity and as

Table 1. The measurement values of length and width of larvae (L₃) and pupae bodies.

No	Larva (L ₃)		Pupa	
	length	width	length	width
1	2.80	1.28	2.69	0.93
2	2.76	1.24	2.68	0.95
3	2.81	1.22	2.67	0.96
4	2.75	1.23	2.66	0.92
5	2.78	1.26	2.65	0.93
6	2.77	1.25	2.69	0.98
7	2.79	1.24	2.65	0.95
8	2.81	1.22	2.67	0.94
9	2.75	1.26	2.69	0.93
10	2.78	1.24	2.67	0.95
average	2.78	1.24	2.67	0.94

a possible reservoir of drinking water for the beetles. They were fed with fragments of fresh sage shoots, which were replaced on average every three days. The used stems were examined to search for eggs. Microscope slides with the developmental stages and their morphological structures were prepared according to Łętowski (1991) and Gosik et al. (2010). The terminology of Scherf (1964), May (1993, 1994), Marvaldi (2003) and Wang et al. (2013) was used in the morphological description of the larva and pupa. The morphology of the egg, L₃ and pupa and the developmental cycle from egg to adult were described.

Setae of thorax and abdomen of larva (L₃) and pupa are described for one side only.

Description

Egg (Figure 11)

Length ca. 1.13 mm, width ca. 0.57 mm, oval, smooth, shiny, whitish-yellow.

Mature larva (L₃) (Figures 1, 12)

Length ca. 2.78 mm, width ca. 1.24 mm. Body massive and strongly curved, whitish-yellow, with short setae.

Head (Figures 2, 9, 10): Yellow-brown, oval, with clear frontal suture completely extended to mandibular joint. Epicranium: length ca. 0.72 mm, width ca. 0.56 mm. Endocarina (*enc*) long, extended to 2/3 the length of the frons. One pair of ocelli (*oc*). Antennae (*at*) with conical sensorium and 2 small spinose sensilla (Fig. 10). Clypeus with 1 pair of short setae (*cls1*). Frons with 5 pairs of setae (*fs*) – *fs2* and *fs5* longer, *fs1*, *fs3* and *fs4* much shorter, at the apex of the endocarina, *fs2-4* near the epistoma, *fs5* close to the antennae (Fig. 2). Epicranium with 2 pairs of lateral setae (*les*) – *les1* short, *les2* long, more than 3 times longer than *les1*.; 5 pairs of dorsal setae (*des*) – *des1* very

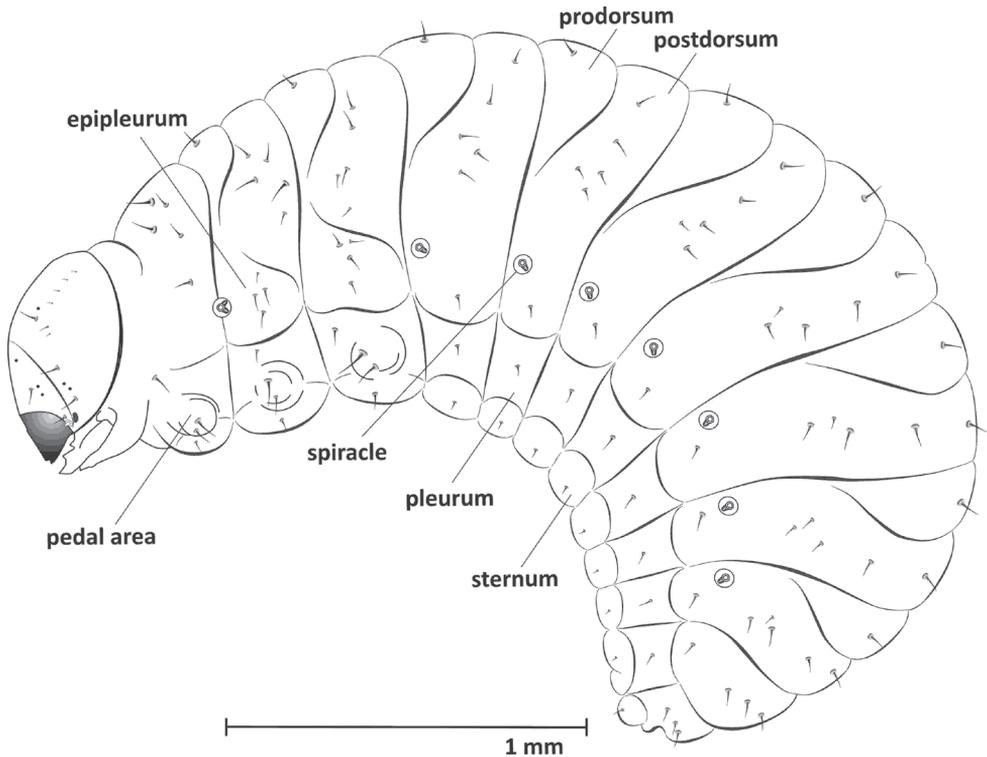


Figure 1. Mature larva (L_3), lateral view.

long, *des2* and *des5* a bit shorter and *des3* and *des4* much shorter; 4 pairs of minute posterior setae (*pes*) (in line with *des2*); 1 sensillum between epicranial suture and *pes* and another sensillum laterally to *des1* and close to *des2*.

Mouthparts (Figures 3–5, 9): Dorsal side of labrum with 3 pairs of setae (*lrms1*–*3*) – *lrms1* and 2 long, *lrms3* nearly half the length of *lrms2*. Epipharynx with 7 pairs of setae (3 *ams*, 3 *als*, 1 *mes*) and rather short labral rods (*lmr*) (Fig. 3a, b). Mandibles massive, dark brown, with 2 mandibular setae (*mds1*, 2) and 2 sensilla (Fig. 4). Maxillae: palpifer with 2 long setae (*pfs1*, 2) – *pfs2* longer than *pfs1*, 1 longer stipital seta (*stps1*) and 2 very short sensilla. Maxillary palpus with 2 segments. Basal segment with digitiform sensorium and 3 very short setae, distal segment cylindrical with 1 short sensilla and 10 conical papillae. Lacinia with 8 robust setae arranged like a comb (*dms*) (Fig. 5, 9). Labium: premental sclerite (*pmsc*) Y-shaped. Mentum-submentum complex with 2 pairs of postmental setae (*pms1*, 3) and 3 pairs of prelabial setae (*prms1*–*3*) – *prms1* short, *prms2* and 3 very short. Additionally, submentum with 3 pairs of sensilla. Labial palpi (*lbp*) 1-segmented, raised, with numerous papillae (Fig. 5).

Thorax. Pronotal shield unsclerotized, meso- and metanotum each with 2 folds: pro- and postdorsum. Thoracic spiracle intersegmental, in membrane between pro-

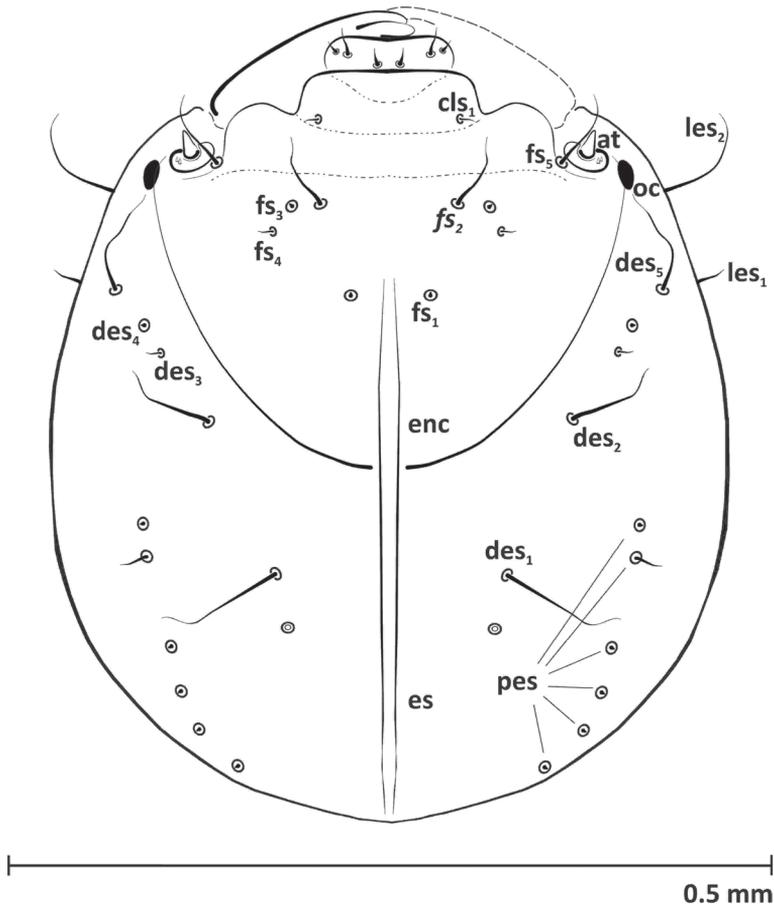


Figure 2. Epicranium (L_3), dorsal view: **les** lateral epicranial setae **fs** frontal s. **des** dorsal s. **pes** posterior epicranial s. **cls** clypeus s. **at** antenna **oc** ocellus **enc** endocarina, **es** endocarina suture.

and mesothorax, bicameral. Prothorax with 7 setae: pronotum with 5, epipleurum indistinct, with 1 seta, sternum with 1 seta. Meso- and metathorax with 12 setae: prodorsum with 1 seta, postdorsum with 5 setae, epipleurum (clearly visible) with 4 clear setae, pleurum and sternum with 1 seta. Pedal area with two long setae for all segments (Fig. 1).

Abdomen. Tergites I-VII with 2 folds, prodorsum with 1 seta on the ridge, postdorsum with 6 setae – 5 dorsally located and 1 seta surrounded by a circle of sparse tubercles. Tergites VIII-IX without folds (single), VIII with 4 setae and XI with 3 setae, reduced. Segments I-VII with unicameral spiracles, others without spiracles. Pleura and sterna I-VIII with 1 short seta, sterna IX with 1 short seta (Fig. 1).

Pupa (Figures 6–8, 13)

Body length: ca. 2.67 mm, width ca. 0.94 mm. Colour whitish-grey.

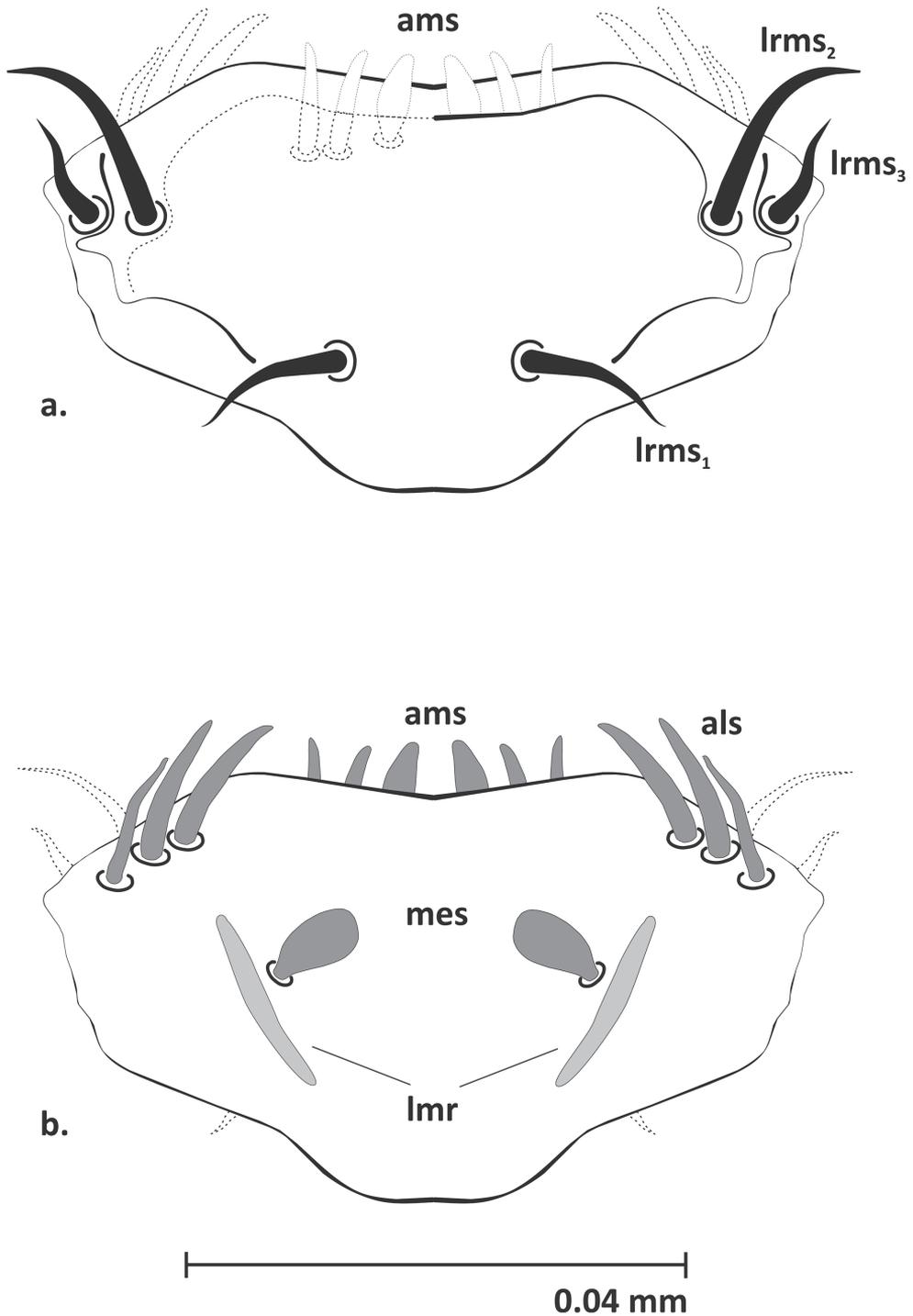


Figure 3. Labrum and epipharynx (L_3) (**a** dorsal **b** ventral view): **a** *lrms* labral setae **b** *mes* median s. *ams* anteromedial s. *als* anterolateral s. *lmr* labral rods.

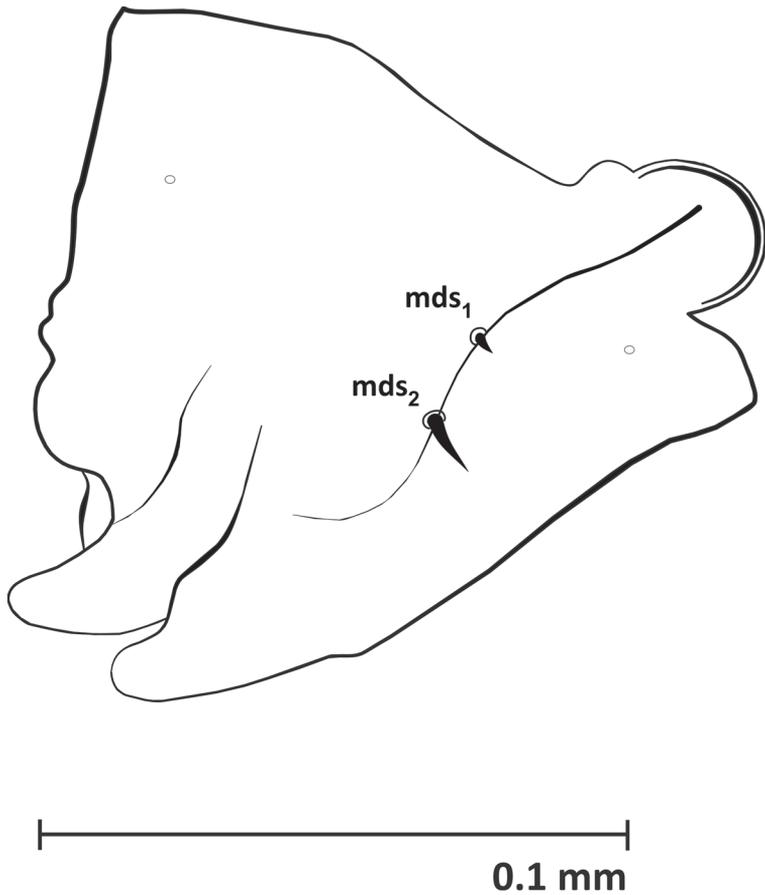


Figure 4. Mandible (L_3), left: **mds** dorsal malae setae.

Head (ventral view). Rostrum reaching ventrite V, with 1 distinct seta (*rs*) at mid-length, in front of the antennal insertion. Antennae relatively long, club with conical papillae. Antennae sub-parallel to protibia. Frons with 1 pair of setae (*vs*), about as long as rostral setae, situated at the level of the hind margin of the eyes (Figs 6, 7). **Pronotum** length greater than width, with 5 pairs of setae (*as1*, *as2*, *sls*, *pls1*, *pls2*) (Figs 6–8). Setae *as1* and *as2* long and located at the apical margin. Setae *sls* a bit shorter, located at the external margin in the middle of the edge. Setae *pls1* and *pls2* as long as *sls*, and located close to the back margin. **Mesonotum** short and **metanotum** two times longer than mesonotum. Mesonotum with clearly visible scutellar shield, metanotum with 3 pairs of short setae, medially located. All femora with 1 long, thin seta (*fes1-3*) located apically (Figs 6–8). **Abdomen.** Abdominal tergites I-III with 7 pairs of setae arranged in two rows – 2 closer to the upper edge of the segment, nearly at the external margin, 5 closer to the base. Tergites IV-VI with 5 pairs of setae arranged in two rows – 1 closer to the upper edge of the segment, nearly at the external margin, 4 closer to

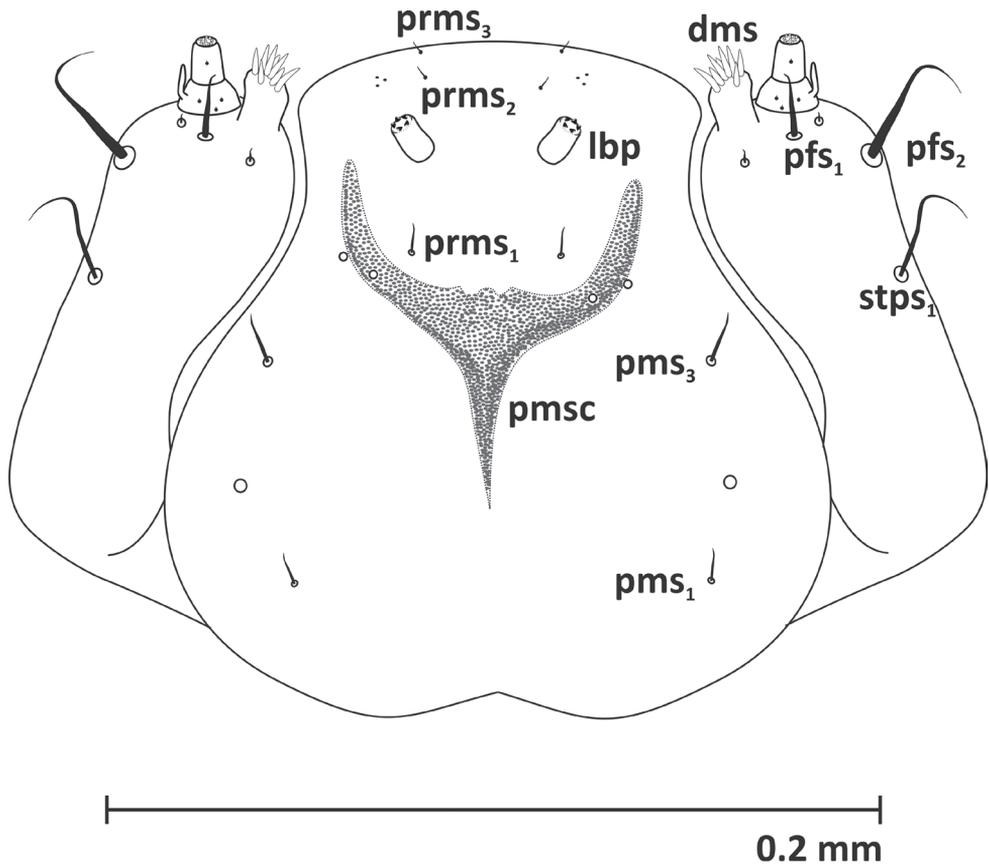


Figure 5. Maxillae and labium (L_3): **dms** dorsal maxillary setae **pfs** palpiferal s. **stps** stipal s. **prms** prelabium s. **pms** postlabium s. **pmsc** premental sclerite **lbp** labial palpus.

the base. Tergite VII with 3 pairs of setae arranged in one row, VIII with one pair. Segment IX without setae. Urogomphi (pseudocerci) (*pc*) on abdominal segment IX, laterally parted, crescent-shaped, narrow. Segment X reduced (Figs 6–8, 14). Spiracles on abdominal segments I–VI functional, well visible, positioned longitudinally on pleura (Fig. 6). Gonotheca visibly divided in female, single in male.

Biological information

According to the available literature, the period of occurrence of adults of *Squamapion elongatum* is April (Cmoluch 1962). During sampling they were found only on meadow sage, although woodland sage was also examined. This confirms Dieckmann's (1977) observations in Central European conditions that meadow sage is the food and breeding plant of this species. It was observed that fertilized females bit out small holes in the

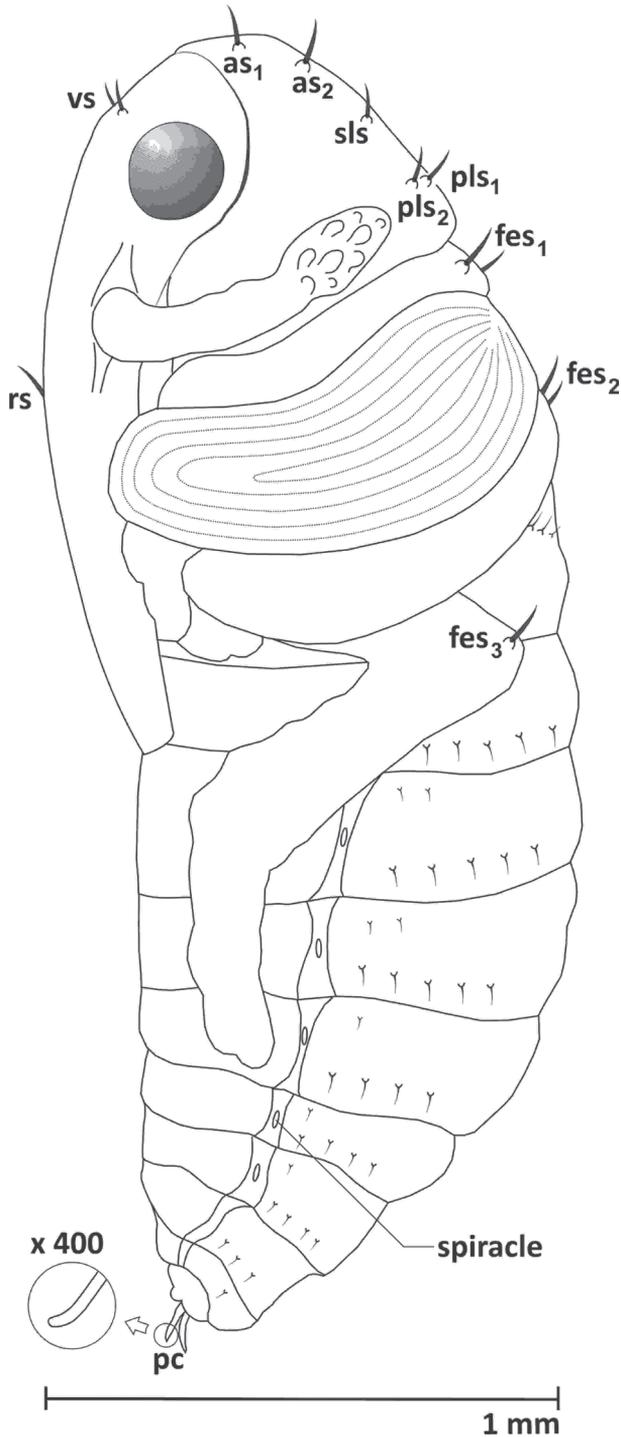


Figure 6. Pupa, lateral view: **as** apical s., **sls** sublateral s., **pls** posterolateral s. **vs** vertical s. **rs** rostral s. **fes** femoral s. **pc** urogomphi.

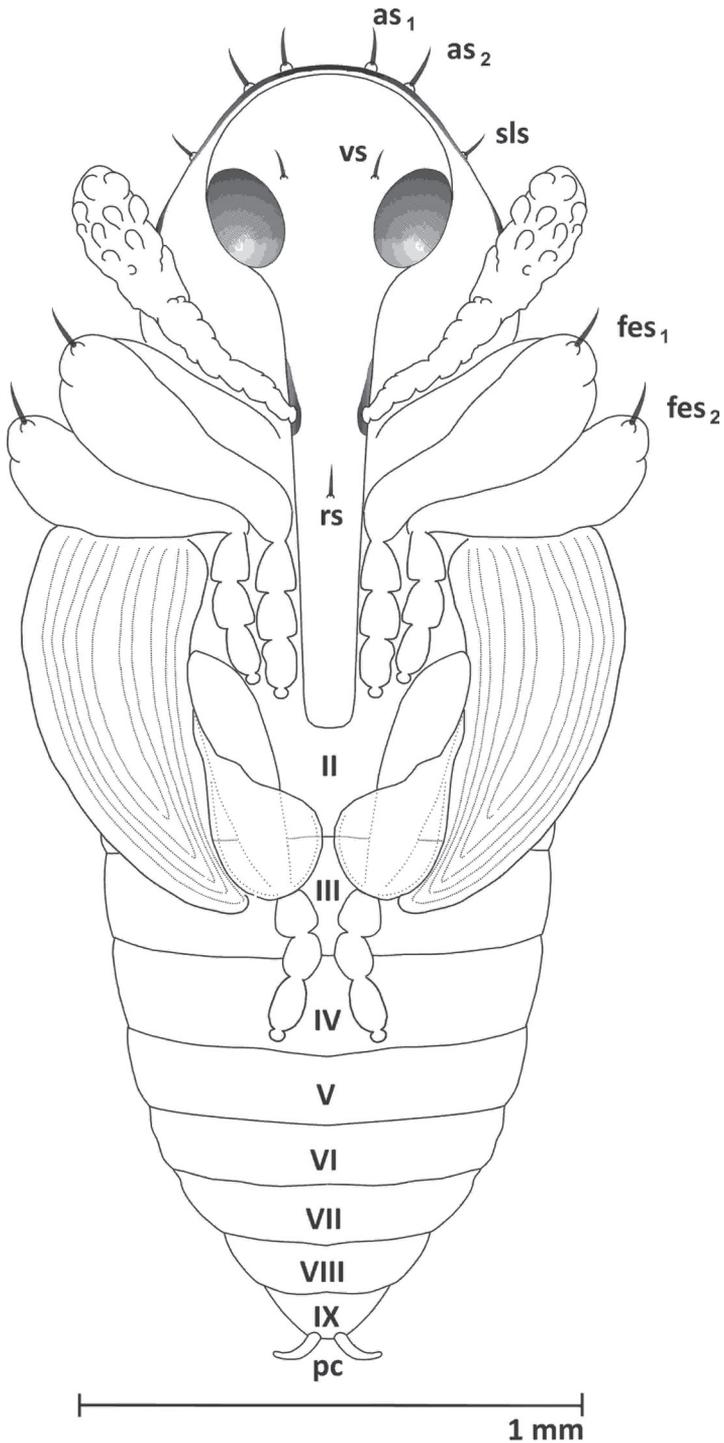


Figure 7. Pupa, ventral view: *as* apical s. *sls* sublateral s. *vs* vertical setae *rs* rostral s. *fes* femoral s. *pc* urogomphi.

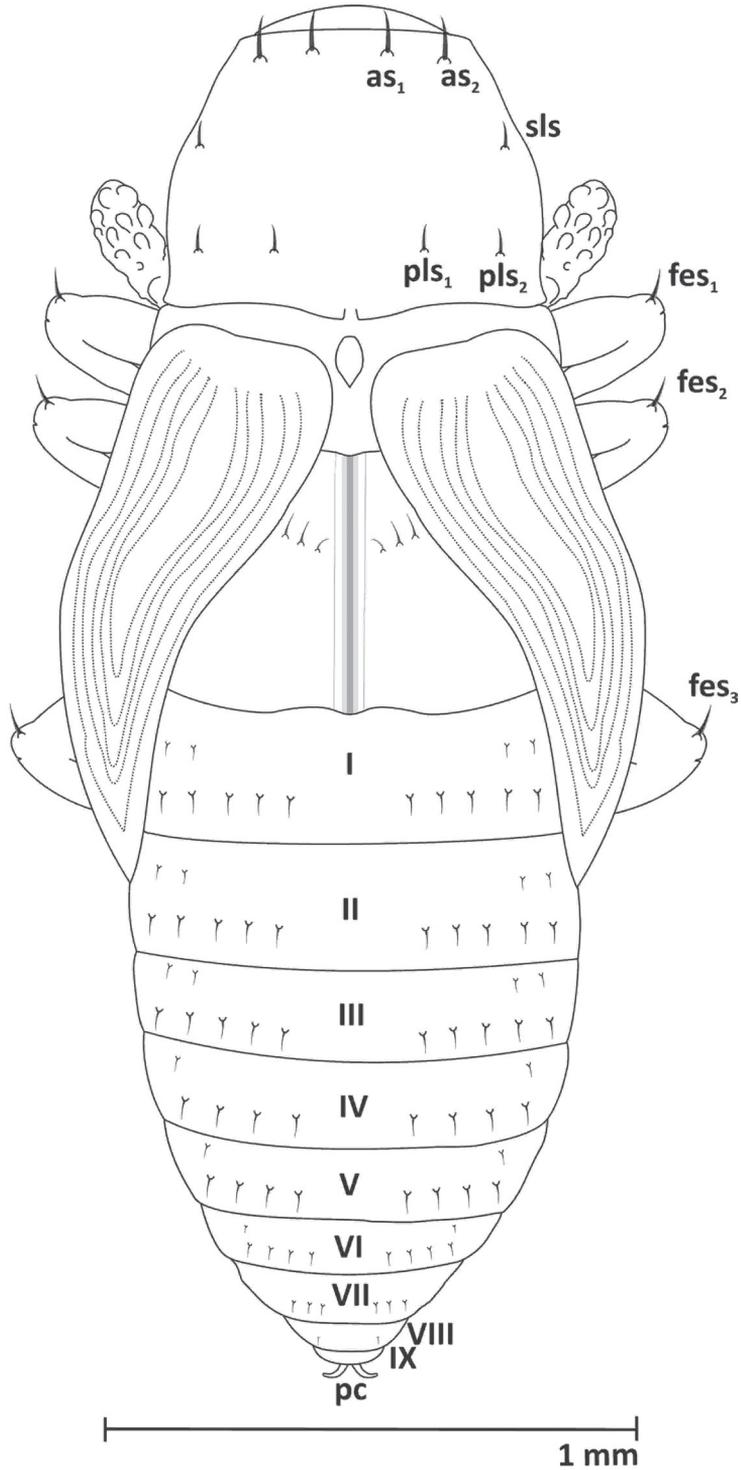
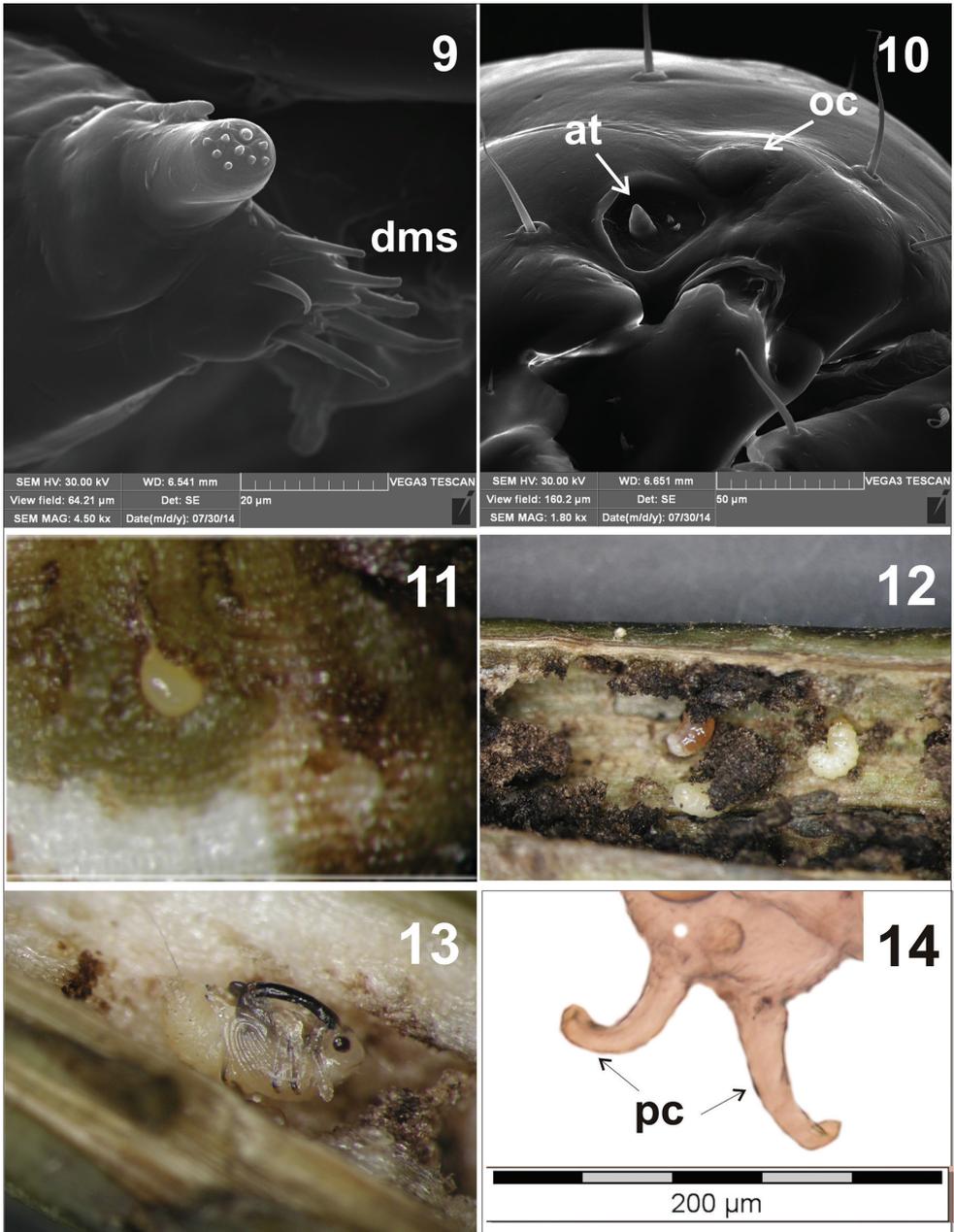


Figure 8. Pupa, dorsal view: **as** apical s. **sls** sublateral s. **pls** posterolateral s. **fes** femoral s. **pc** urogomphi.



Figures 9–14. **9** Maxillary palpus (dms – dorsal robust setae) **10** ocellus (oc) and antenna (at) **11** egg **12** L₃ during construction of the pupal chamber **13** pupa **14** urogomphi (pc).

nodes and internodes of the sage stems, in which they laid eggs. Often there were two or more larvae in one place, suggesting that females can lay several eggs in one hole. The oldest larvae were found on the root of the host plant, while the younger larvae were

observed higher up, to about 2/3 of the plant height. After an average of 12 days (from 10 to 14 days), the larvae of the first instar (L_1) hatched and enlarged the egg chamber, making contact with the pith inside the stem. Here the larvae fed intensively, creating tunnels. After about seven days the larvae finished moulting, leading to L_2 . L_2 fed on average for 10 days, extending the tunnels begun by L_1 . The life span of L_3 ranged from 10 to 13 days (data based on laboratory cultures and field observations). The greatest weight gain in the larvae occurred during this period, as well as preparation for pupation. The larvae dig a tunnel 6-12 mm in length and use loose fibres to build a pupal chamber (Fig. 12). Initially the pupa was white; later it assumed a creamy shade, and as pigmentation progressed it turned grey. The eyes and rostrum took on the colour first, then the femorotibial articulations and tarsi, followed by the secondary pterothecae, and gradually the rest of the body. The pupal period lasted 12 days on average, and the development cycle of one generation from egg to imago lasted on average 51–54 days.

Larvae of this weevil were attacked by parasitic hymenopterans of the Chalcidoidea. Both internal (*Entedon* Dalman, 1820 sp.) and external (*Trichomalus* Thomson, 1878 sp.) parasites from that superfamily were observed.

Discussion

This is the first description of the immature stages of a species of the genus *Squamapion*. The features described were compared with those described by Scherf (1964) for the genus *Apion* Herbst, 1797 *sensu lato*, by Marvaldi (2003) for Apioninae, by Łętowski (1991) for *Stenoptera pion* Bokor, 1923, *Omphalapion* Schilsky, 1906 and *Hemitrichapion* Voss, 1959, by Gosik et al. (2010) for *Diplapion* Reitter, 1916, by Wang et al. (2013) for *Pseudaspidapion* Wanat, 1990 and by Alonso-Zarazaga and Wanat (2014) for Apioninae Schoenherr, 1823.

The morphology of the egg does not differ substantially from the typical characteristics of the eggs of apionid beetles. The localization of eggs on the plant and the duration of this stage are also similar to those of other apionid beetles with the same lifestyle.

In general the body of larval *S. elongatum* does not deviate from representatives of the subfamily Apioninae described by Alonso-Zarazaga and Wanat (2014). It is very similar to that of larvae of species living inside common sainfoin described by Łętowski (1991) or *Diplapion confluens* (Kirby, 1808) living in the roots of *Anthemis tinctoria* L. (Gosik et al. 2010). The larvae of *S. elongatum* have a typical number of spiracles for Apionidae, as described in Emden (1938), Scherf (1964) and Łętowski (1991), the absence of spiracles on abdominal segment VIII being an important apomorphic character defining the group (as Apioninae in Marvaldi 2003). Larvae of different stages differ from one another in some characteristics, mainly changes in the distribution pattern of the setae. However, no change in the colour of the larvae was observed during growth, unless caused by internal parasitic infection. The differences in the chaetotaxy of the larval body are shown using L_3 of *Squamapion elongatum*, *Diplapion confluens* and *Pseudaspidapion botanicum* as examples (Table 2).

Table 2. Character comparison between *Squamapion elongatum*, *Diplapion confluens* and *Pseudaspidapion botanicum*.

Species		<i>Squamapion elongatum</i>	<i>Diplapion confluens</i>	<i>Pseudaspidapion botanicum</i>
arrangement of setae <i>pes</i> on epicranium		4 pairs of minute posterior setae (<i>pes</i> 1–4) separated from one pair of longer setae (<i>pes</i> 5) and 1 pair of sensilla	2 pairs (<i>pes</i> 1, <i>pes</i> 2) short and blunt	6 pairs of setae, <i>pes</i> 1 shortest, <i>pes</i> 2–6 successively longer
number of setae on maxillary palpus	basal segment	3 very short setae	1 long and 1 micro seta	1 short inner seta and 1 sensillum
	distal segment	1 short sensilla	none	1 crenulate seta
length of labral rods (<i>lmr</i>)		rather short	long	long
occurrence <i>pms</i> 2		present	present	absent
number of setae on the mandibles		2	1	1
number of conical papillae	<i>dms</i>	8	5	5
	<i>vms</i>	0	2	4
number of setae (<i>pms</i>) on pronotum (L ₃)		5	4	6

The characteristics of the pupae of this weevil species do not differ from other representatives of Apionidae, except for the presence of a mesofemoral seta, also found in *Diplapion* but not in *Pseudaspidapion*, and the lack of a pair of setae on the 8th abdominal tergite, in contrast to one pair of setae in *Pseudaspidapion* and two in *Diplapion*. Relatively long urogomphi flared to the sides were present, as in *Pseudaspidapion* and *Diplapion* (Gosik et al. 2010; Wang et al. 2013).

The laboratory work confirmed that the food and breeding plant for this species is meadow sage (*Salvia pratensis*). The preimaginal development of *S. elongatum* occurs in the nodes and internodes of the stems, as well as in the basal part of the root.

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Rediscovered parasitism of *Andrena savignyi* Spinola (Hymenoptera, Andrenidae) by *Stylops* (Strepsiptera, Stylopidae) and revised taxonomic status of the parasite

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Abstract

Parasitism of *Andrena* (*Suandrena*) *savignyi* Spinola (Hymenoptera: Andrenidae) by *Stylops* Kirby (Strepsiptera: Stylopidae) has been recorded only once, and from an individual collected in Egypt almost a century ago, with the parasite described as *Stylops savignyi* Hofeneder. The recent rediscovery of this *Stylops* from an individual of *A. savignyi* permits a reinterpretation of the species and its affinities among other *Stylops*. The bee was collected at flowers of *Zilla spinosa* (Turra) Prantl. (Brassicaceae) in Amariah, Riyadh, Kingdom of Saudi Arabia. Based on DNA barcode sequences from material sampled across Africa, Asia, and Europe, it is apparent that *S. savignyi* is conspecific with *S. nassonowi* Pierce, and we accordingly synonymize this name (**syn. n.**), with the latter representing the senior and valid name for the species. A differential diagnosis is provided for *S. nassonowi* and the morphology of the female is described, as well as the first instars.

Keywords

Stylopidae, Apoidea, Anthophila, Andrenidae, parasitoid, taxonomy, morphology

Introduction

Strepsiptera (twisted-wing parasites) are an order of minute entomophagous insects that are found throughout the world. Despite the fact that Strepsiptera comprise relatively few species for a lineage of Holometabola (ca. 600 species), the breadth of hosts is considerable and includes at least seven insect orders (Zygentoma, Blattaria, Mantodea, Orthoptera, Hemiptera, Hymenoptera, and Diptera) (Kathirithamby 2009). There remains considerable debate about their relationship to other holometabolan lineages (e.g., Grimaldi and Engel 2005; Pohl and Beutel 2008, 2013), but most evidence tends to suggest they are near the Coleoptera (e.g., McKenna and Farrell 2010; Ishiwata et al. 2011; Niehuis et al. 2012; Boussau et al. 2014) and some authors in the past have even classified the group as a subordinate among the beetles (e.g., Crowson 1960). The internal phylogeny of Strepsiptera is less controversial in terms of the broader patterns of character transition (e.g., Kinzelbach 1971, 1978, 1990; Pohl 2002; Grimaldi et al. 2005; Pohl and Beutel 2005; Pohl et al. 2005; Bravo et al. 2009; McMahan et al. 2011), although more refined aspects among the ‘higher’ groups and within certain families are in need of revision. There are differences of opinion as to those families recognized, although there are usually 11–13 employed in most summaries of the classification (e.g., Pohl and Beutel 2005; Bravo et al. 2009; Kathirithamby and Engel 2014).

Contributing to the ‘mystery’ of the order is their complex parasitoid life cycle and conspicuous sexual dimorphism, with pronouncedly neotenic females. The male has an ephemeral, free-living adulthood, whereas adult females are obligatory endoparasites, with the sole exception of the basal family Mengenillidae, and are concomitantly tied to their host throughout their maturity (Kathirithamby 1989, 2009; Kinzelbach 1971). In those families more derived than Mengenillidae, adult females have a dramatically reduced body that is largely larviform and is positioned within the host’s body. The more sclerotized cephalothorax of the female extrudes from the host and it is from here that she is able to mate and give birth to her brood. Males seek out parasitized hosts and mate with females who then in turn ultimately produce a large number of free-living first instar larvae, or triungulins (Kathirithamby 2009; O’Connor 1959), that disperse into the surrounding area (Linsley and MacSwain 1957). When the first instars locate a suitable host they attach and eventually invade the body (Kathirithamby 1989, 2009; Kathirithamby et al. 2001). A further complication in the system is found among those first instars of the families Xenidae and Stylopidae which must find a suitable vector that transports them to their new host (Kathirithamby et al. 2012; Linsley and MacSwain 1957). Xenids and stylopids parasitize species of the Euaculeata and they typically position themselves in locations (e.g., among flowers) that will place them into contact with foraging wasps or bees which they can then ride back to the nest and from there invade the brood cells and parasitize the developing immatures (Kinzelbach 1971; Kathirithamby 1989; Pohl and Beutel 2008). Because of this there can at times be disruptions to the developmental process of the host, resulting in noticeable phenotypic alterations (e.g., Smith and Hamm 1914; Salt 1927; Brandenburg

1953; Kathirithamby 1989, 1998; Solulu et al. 1998). Indeed, upon maturity the parasitized host is often sterile or even masculinized such that their ability to collect provisions and provision a new nest is diminished (Smith and Hamm 1914; Salt 1927, 1931), and their behavior altered toward aims other than reproduction (Westwood 1839; Kathirithamby and Hamilton 1995; Hughes et al. 2004; Beani 2006; Linsley and MacSwain 1957; Straka et al. 2011). Accordingly, the newly-emerged first-instar strepsipterans cannot rely on using the host from which they emerged as a vector to a newly established host, and continuing their life cycle requires encounters with new, unparasitized, young individuals (e.g., Kathirithamby et al. 2012). The first instars emerge from their parasitized host on flowers and wait for non-parasitized females of the host species to serve as a vector from the inflorescences to the host's nest. Within the nest the larvae seek fresh offspring as their final host. Understandably, such larvae are quite mobile, as are all strepsipteran triungulins, and well adapted for concealment and affixation to an appropriate host. For example, first-instar larvae of the genus *Stylops* Kirby have a number of morphological adaptations that provide for a stronger attachment to the host, such as structures on the dorsal and ventral surfaces of their body or enlargement of the pro- and mesotarsi (Pohl 2000; Pohl and Beutel 2004, 2008); however, their behavior on flowers is unknown.

The genus *Stylops* is the most diversified lineage of the family Stylopidae. Species are obligate parasites of solitary bees of the genus *Andrena* Fabricius (Kinzelbach 1971; Jůzová et al. 2015). The taxonomy of species in the genus is problematic, plagued by a plethora of ill-defined epithets established by authors but without defined hypotheses of circumscription for the biological units involved (Straka et al. 2015). In the past, host specificity was often used as the principle guide for species determination, sometimes in the absence of characters intrinsic to the parasite. While host association can be a good guideline, it does not apply universally across all species of *Stylops*. While some species are truly specialists, partial generalists do exist within the genus and these complicate matters for identification (Jůzová et al. 2015). In fact, there are useful morphological details in the first-instar larvae that are of considerable importance in identification and which, in combination with DNA sequences, are also known to reveal various cryptic species (Hayward et al. 2011; Nakase and Kato 2013). Some host-parasite associations are found rarely and for these every newly acquired specimen is an aid toward resolving long-standing taxonomic conundrums, and when suitable field observations are made also further information about possible host specializations, behavior, and ecology. Detailed and modern systematic and biological studies are needed across the order, and numerous hypotheses of species circumscription require critical investigation, with many having remained untested for a century or more.

One such taxonomic mystery that has persisted for nearly a century centers on the proper identity of *Stylops savignyi* Hofeneder (1924). Hofeneder (1924) described his species from two stylopized females of *Andrena* (*Suandrena*) *savignyi* Spinola collected in Egypt, each with one female *Stylops*. Since that time the true identity of this species has represented a persistent problem for the taxonomy of *Stylops*. Here we report the first find of stylopized *A. savignyi* from Saudi Arabia, females of which have

been found with their stylopid parasite since 1914 (when Hofeneder's material was collected) and represents a unique opportunity to address the circumscription and identity of *S. savignyi*. The species of *Stylops* collected in Saudi Arabia match those described by Hofeneder (1924) and are further identified using new morphological and DNA barcode sequence data. These data reveal the true identity of the parasite species as a new junior synonym of *S. nassonowi* Pierce (Pierce 1909) and allow for a modern characterization of the taxon.

Material and methods

Individuals of *A. savignyi* were collected mostly from flowers of *Zilla spinosa* (Turra) Prantl. (Brassicaceae) at five localities around Amariah, Riyadh, Saudi Arabia (Al Oyanah, Al Kharj, Rouma, Derab, and Al Amariah, the last of which was where most material was sampled), although the species has also been encountered at various localities throughout Saudi Arabia and the Arabian peninsula (e.g., Dathe 2009; Engel pers. obs.). Details of the collection site are available in Alqarni et al. (2012, 2014a), Engel et al. (2012), and Hannan et al. (2012). At the locality in which the stylopized bee was discovered, general collecting had been underway from September 2010 through September 2012, but all individuals of *A. savignyi* were found between 22 February and 10 March 2011 and with peak bee activities at flowers around 20–25 °C. Although there is a diversity flowers around Al Amariah, *A. savignyi* was only encountered at *Z. spinosa* and to a lesser degree at *Rhaphanus sativus* L. and *Eruca sativa* Mill. (both also of Brassicaceae), indicative of its oligolectic pollen-collecting preferences. The stylopized female was collected from *Z. spinosa*, and she made no attempt to collect pollen from the flowers. The cephalothoraxes of the two female *Stylops* is extruded between the bee's metasomal terga IV and V (Figs 1, 2), with one on either side of the midline (Fig. 4). Such an orientation is typical for a stylopized bee, where even when parasitized by a single female *Stylops*, the cephalothorax always protrudes from a more lateral position and never from the midline. Measurements of the parasite cephalothoraxes are shown in Table 1.

The specimens of *Stylops* examined for the present study (Appendix) were deposited in the King Saud University Museum of Arthropods, Plant Protection Department, College of Food and Agriculture Sciences, King Saud University, Riyadh, Kingdom of Saudi Arabia (KSMA), and the personal collection of Jakub Straka housed at Charles University in Prague, Praha, Czech Republic (JSPC). Material in Saudi Arabia, and from which the new material of stylopized *A. savignyi* was sampled, has been collected as part of ongoing bee surveys throughout the country and undertaken by A.S.A., M.A.H., and M.S.E. (e.g., Alqarni et al. 2012a, 2012b, 2013, 2014a, 2014b, 2014c, 2014d; Engel et al. 2012, 2013, 2014; Hannan et al. 2012; Hinojosa-Díaz et al. in press). Those bees with Strepsiptera from other countries were collected into 90–96% ethanol, or with yellow pan-traps and then transferred to ethanol. Individual parasites were removed from dissected bees and subjected to further preparation. Female strep-



Figures 1–3. Female of *Andrena* (*Suandrena*) *savignyi* Spinola from Riyadh, Saudi Arabia parasitized by *Stylops nassonowi* Pierce **1** Dorsal habitus of bee **2** Lateral habitus of bee (image inverted); one female of parasite observable at apex of tergum IV **3** Detail of setae at bee's metasomal apex showing numerous first instars of the parasite.

sipterans studied for morphology were cleared using proteinase – a mixture of lysis buffer and proteinase K (Quiagen) heated to 56 °C. The lysis procedure took several hours or overnight. Cleared specimens were cleaned in water several times and then stored in vials with glycerol. Females were observed using an Olympus BX40 light microscope. Temporary slides were prepared with glycerol. First instar larvae were carefully removed from the body of the females and prepared for scanning electron microscopy (SEM) with a JEOL 6380 LV scanning electron microscope. Specimens



Figure 4. Metasomal apex of female of *Andrena (Suandrena) savignyi* Spinola from Riyadh, Saudi Arabia parasitized by *Stylops nassonowi* Pierce, and depicting two females of the parasite exposed from under the apex of tergum IV.

were dehydrated using progressively more concentrated (90%, 96%, and then 100%) ethanol, each for 5–10 minutes, and then in acetone for 5 minutes. Subsequently, dehydrated samples were critical point dried and coated with gold.

Morphological terminology of first-instar larvae follows that of Pohl (2000), while terminology for females and female puparia follows that of Kinzelbach (1971) and Straka et al. (2014). The following abbreviations were employed: 1L – first-instar larva, F – female, EMP – empty male puparium. The format for the description generally follows that used elsewhere in studies of stylopid systematics (e.g., Straka et al. 2014). Revised descriptions provide a modern framework for species circumscription and build diverse new character sources for studying bee-parasite evolution and systematics (e.g., Engel 2011; Gonzalez et al. 2013), as well as permit the elaboration of patterns of character variation and distribution, reveal relationships, and contribute to a broader understanding of evolution across a clade (e.g., Grimaldi and Engel 2007).

Table 1. Basic measurements of cephalothoraxes of *Stylops aterrimus* Newport and *S. nassonowi* Pierce (W = width at spiracles; L = length). All measurements in millimeters.

Species	Voucher	W	L	W of head	L of head	Intermandibular diameter
<i>S. aterrimus</i>	SAg1	1.35	1.29	0.77	0.34	0.14
	SBm1a	1.29	1.26	0.67	0.31	0.19
	SBm1b	1.34	1.24	0.69	0.29	0.21
	STig2	1.07	1.10	0.64	0.37	0.19
	Ssp1	1.27	1.20	0.67	0.33	0.21
	SCa7	1.31	1.17	0.70	0.31	0.21
	SCa8	1.20	1.17	0.64	0.31	0.19
	<i>S. nassonowi</i>	SCa1	1.41	1.19	0.76	0.3
SCa4		1.41	1.27	0.74	0.32	0.19
SCa5		1.21	1.19	0.70	0.35	0.19
SCa6		1.09	1.10	0.61	0.31	0.18
SCa9a		1.19	1.17	0.70	0.32	0.20
SCa9b		1.33	1.18	0.70	0.30	0.20
SCa10		1.10	1.11	0.61	0.30	0.18
SSg1		1.05	1.24	0.60	0.30	0.19
SHo1		1.36	1.27	0.67	0.34	0.19
STi2		1.16	1.04	0.70	0.30	0.17
STi4		1.27	1.19	0.69	0.34	0.19
STi6		1.26	1.19	0.69	0.31	0.19
STi5		1.26	1.21	0.73	0.36	0.19

For DNA analysis, the entire body of a female strepsipteran was lysed by Proteinase K (Qiagen). Afterwards, DNA was isolated with a DNA Isolation Kit (Qiagen). Partial DNA sequences were amplified using the primers for Cytochrome oxidase subunit I (COI) (Jůzová et al. in press), and using an annealing temperature of 50 °C. Chromatograms were edited with the program Chromas Lite 2.01 (Technelysium Pty Ltd.) and aligned in BioEdit 7.0.9 (Hall 1999). The online application BLAST was used to reveal any potential contamination in the DNA samples, especially the possibility of amplifying any DNA from the host. Genetic distances were calculated using BioEdit 7.1.3.0 (Hall 1999), under standard computational procedures with the F84 model (Felsenstein 1984).

Distances in DNA base composition were compared pairwise (Table 2). The results show a non-random distribution of genetic distances among individuals in accordance with the published phylogeny of *Stylops* (Jůzová et al. 2015). In the case of material used here, the genetic distance under 2% suggests close relatives. The gap in DNA distance between related individuals within a species and other species is also 2% (1.5–2.5%). Genetic differentiation between the studied populations can be defined according to the present genetic relatedness and the gap.

Table 2. DNA distance matrix among samples of *Stylops nassonowi* Pierce, *S. aterrimus* Newport, and other representative species. Distances below 2% are highlighted yellow, showing closely related individuals; *Stylops* Kirby from *Andrena* (*Suandrena*) *savignyi* Spinola in Saudi Arabia indicated in red.

<i>Stylops</i>	<i>S. m.</i> SFI1	<i>S. neu.</i> SFul	<i>S. spreta</i> SMi1	<i>S. m.</i> SNI1	<i>S. ater</i> SVA2	<i>S. a.</i> SAG1	<i>S. a.</i> SBm1	<i>S. a.</i> STig1	<i>S. a.</i> STig2	<i>S. a.</i> Ssp1	<i>S. a.</i> SCa7	<i>S. a.</i> SCa8
	voucher											
<i>S. nevinsoni</i>	0.1075	-	-	-	-	-	-	-	-	-	-	-
<i>S. spreta</i>	0.1243	0.1456	-	-	-	-	-	-	-	-	-	-
<i>S. melittae</i>	0.0035	0.1081	0.1243	-	-	-	-	-	-	-	-	-
<i>S. ater</i>	0.1440	0.1451	0.1746	0.1453	-	-	-	-	-	-	-	-
<i>S. aterrimus</i>	0.1300	0.1355	0.1511	0.1276	0.1437	-	-	-	-	-	-	-
<i>S. aterrimus</i>	0.1176	0.1353	0.1448	0.1157	0.1337	0.0151	-	-	-	-	-	-
<i>S. aterrimus</i>	0.1300	0.1355	0.1511	0.1276	0.1437	0.0000	0.0151	-	-	-	-	-
<i>S. aterrimus</i>	0.1410	0.1465	0.1632	0.1383	0.1533	0.0017	0.0178	0.0017	-	-	-	-
<i>S. aterrimus</i>	0.1300	0.1374	0.1489	0.1276	0.1415	0.0017	0.0134	0.0017	0.0035	-	-	-
<i>S. aterrimus</i>	0.1155	0.1331	0.1426	0.1136	0.1315	0.0168	0.0017	0.0168	0.0196	0.0151	-	-
<i>S. aterrimus</i>	0.1176	0.1353	0.1448	0.1157	0.1337	0.0151	0.0000	0.0151	0.0178	0.0134	0.0017	-
<i>S. nassonowi</i>	0.1286	0.1387	0.1385	0.1245	0.1484	0.0431	0.0414	0.0431	0.0438	0.0412	0.0433	0.0414
<i>S. nassonowi</i>	0.1265	0.1337	0.1375	0.1242	0.1406	0.0410	0.0394	0.0410	0.0416	0.0393	0.0412	0.0394
<i>S. nassonowi</i>	0.1285	0.1357	0.1394	0.1262	0.1426	0.0428	0.0411	0.0428	0.0434	0.0410	0.0429	0.0411
<i>S. nassonowi</i>	0.1345	0.1418	0.1457	0.1321	0.1492	0.0446	0.0429	0.0446	0.0435	0.0427	0.0448	0.0429
<i>S. nassonowi</i>	0.1265	0.1337	0.1375	0.1242	0.1406	0.0410	0.0394	0.0410	0.0416	0.0393	0.0412	0.0394
<i>S. nassonowi</i>	0.1285	0.1357	0.1394	0.1262	0.1426	0.0428	0.0411	0.0428	0.0434	0.0410	0.0429	0.0411
<i>S. nassonowi</i>	0.1330	0.1401	0.1439	0.1305	0.1428	0.0464	0.0447	0.0464	0.0472	0.0446	0.0466	0.0447
<i>S. nassonowi</i>	0.1262	0.1335	0.1392	0.1240	0.1404	0.0375	0.0358	0.0375	0.0378	0.0357	0.0376	0.0358
<i>S. nassonowi</i>	0.1290	0.1340	0.1397	0.1267	0.1410	0.0411	0.0395	0.0411	0.0417	0.0393	0.0413	0.0395
<i>S. nassonowi</i>	0.1285	0.1357	0.1394	0.1262	0.1426	0.0428	0.0411	0.0428	0.0434	0.0410	0.0429	0.0411
<i>S. nassonowi</i>	0.1285	0.1357	0.1394	0.1262	0.1426	0.0428	0.0411	0.0428	0.0434	0.0410	0.0429	0.0411
<i>S. nassonowi</i>	0.1285	0.1357	0.1394	0.1262	0.1426	0.0428	0.0411	0.0428	0.0434	0.0410	0.0429	0.0411
<i>S. nassonowi</i>	0.1285	0.1357	0.1394	0.1262	0.1426	0.0428	0.0411	0.0428	0.0434	0.0410	0.0429	0.0411
<i>S. nassonowi</i>	0.1265	0.1337	0.1375	0.1242	0.1406	0.0410	0.0394	0.0410	0.0416	0.0393	0.0412	0.0394

Table 2. Continued.

<i>Stylops</i>	voucher	<i>S. mass.</i>													
		SCa1	SCa2	SCa4	SCa5	SCa6	SCa9	SCa10	SHo1	SSa1	SSg1	STi1	STi2	STi4	
<i>S. nevinsoni</i>	SFu1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. spreta</i>	SMi1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. melittae</i>	SNi1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. ater</i>	SVa2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. aterrimus</i>	SAg1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. aterrimus</i>	SBm1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. aterrimus</i>	STi1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. aterrimus</i>	STi2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. aterrimus</i>	Ssp1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. aterrimus</i>	SCa7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. aterrimus</i>	SCa8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. aterrimus</i>	SCa1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. nasonovi</i>	SCa1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. nasonovi</i>	SCa2	0.0035	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. nasonovi</i>	SCa4	0.0017	0.0017	-	-	-	-	-	-	-	-	-	-	-	-
<i>S. nasonovi</i>	SCa5	0.0018	0.0052	0.0035	-	-	-	-	-	-	-	-	-	-	-
<i>S. nasonovi</i>	SCa6	0.0000	0.0033	0.0017	0.0017	-	-	-	-	-	-	-	-	-	-
<i>S. nasonovi</i>	SCa9	0.0017	0.0017	0.0000	0.0035	0.0017	-	-	-	-	-	-	-	-	-
<i>S. nasonovi</i>	SCa10	0.0053	0.0050	0.0033	0.0070	0.0050	0.0033	-	-	-	-	-	-	-	-
<i>S. nasonovi</i>	SHo1	0.0141	0.0134	0.0151	0.0157	0.0134	0.0151	0.0185	-	-	-	-	-	-	-
<i>S. nasonovi</i>	SSa1	0.0106	0.0101	0.0118	0.0123	0.0101	0.0118	0.0152	0.0135	-	-	-	-	-	-
<i>S. nasonovi</i>	SSg1	0.0017	0.0017	0.0000	0.0035	0.0017	0.0000	0.0033	0.0151	0.0118	-	-	-	-	-
<i>S. nasonovi</i>	STi1	0.0017	0.0017	0.0000	0.0035	0.0017	0.0000	0.0033	0.0151	0.0118	0.0000	-	-	-	-
<i>S. nasonovi</i>	STi2	0.0017	0.0017	0.0000	0.0035	0.0017	0.0000	0.0033	0.0151	0.0118	0.0000	0.0000	-	-	-
<i>S. nasonovi</i>	STi4	0.0017	0.0017	0.0000	0.0035	0.0017	0.0000	0.0033	0.0151	0.0118	0.0000	0.0000	0.0000	-	-
<i>S. nasonovi</i>	STi6	0.0000	0.0033	0.0017	0.0017	0.0000	0.0017	0.0050	0.0134	0.0101	0.0017	0.0017	0.0017	0.0017	0.0017

Systematics

Genus *Stylops* Kirby

Stylops nassonowi Pierce

Figs 4–13, 20–26

Stylops nassonowi Pierce 1909: 105 [F]. Resurrected name [previously synonymized with *S. melittae* Kirby by Kinzelbach (1978)].

Stylops savignyi Hofender 1924: 254 [F]. New synonymys.

Diagnosis. Female puparium. The female puparium of *S. nassonowi* is almost indistinguishable from its sibling species, *S. aterrimus* Newport (compare Figures 6–13, with Figures 14–19). There is probably no stable character that could differentiate female puparia of both species in terms of their morphology and coloration. However, the following few characters occur in one of the species with a higher probability, or are more pronounced in one of the two species: *Stylops nassonowi* has the prothoracic flange of the brood opening typically more produced forward, less numerous mandibular sensilla (less than 10), and pigmentation of the prothorax more uniform except a pale apical part to the abdominal segment of the cephalothoracic venter (well visible in Figures 12, 13). By contrast, *S. aterrimus* is more complex in pigmentation than *S. nassonowi*, its dark markings on the ventral surfaces of the meso- and metathorax are usually well-developed and the metathorax has a more or less distinct transverse dark band, ultimately giving its apical half a nuanced darker appearance than the basal half (well visible in Figures 14–16). *Stylops nassonowi* differs from other species (such as when compared to *S. ater* Reichert, *S. melittae* Kirby, *S. nevinsoni* Perkins, *S. spreta* Perkins, and *S. thwaitesi* Perkins) mainly in body and head size (larger than *S. nevinsoni*, *S. spreta*, and *S. thwaitesi*), in the short, dark, basal band (large dark basal band in *S. ater*, *S. nevinsoni*, *S. spreta*, and *S. thwaitesi*), described coloration of the cephalothorax, in the shape of the prothoracic flange of the brood opening (strongly curved in *S. thwaitesi*; straight in *S. spreta*; uniformly curved in *S. melittae*, but slightly curved in *S. aterrimus* and *S. nassonowi*), in the shape of the head corners (strongly curved in *S. spreta*, but only slightly curved in the other species), in the shape and sclerotization of the hypostomal and cephalic ridges (strongly sclerotized and dark in *S. melittae*, but less pronounced in the other species), and the length of the clypeal sensilla.

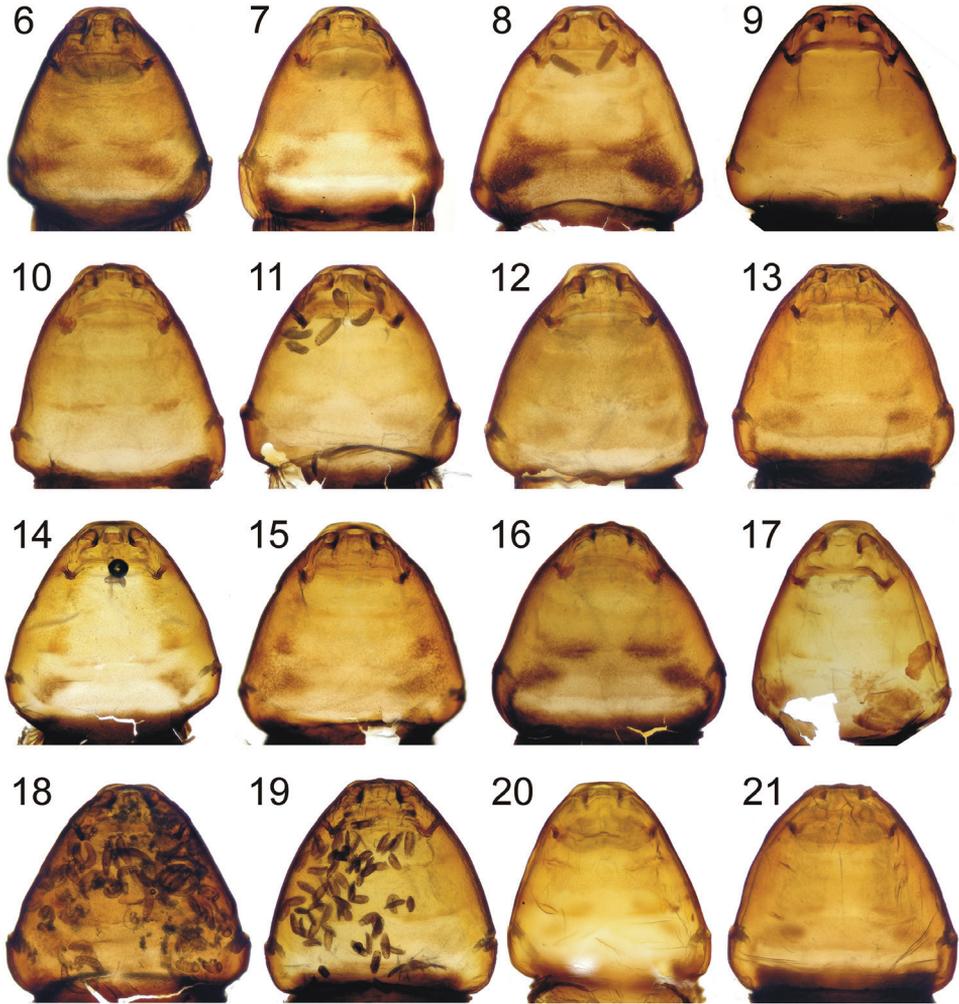
First instar. Body elongate as in other species of *Stylops* except for *S. melittae*, which has wider abdomen. Head dorsally with two olfactory foveae and four pairs of setae in contrast to *S. melittae*, which has seven pairs of setae and no foveae. The frontal margin of the maxillae is not sagging in *S. aterrimus* and *S. melittae*, in contrast to that of *S. nassonowi*. The cervix is indistinct in *S. nassonowi* rather than more defined in *S. melittae*, the latter possessing a narrower head ventrally. The caudal margins of the dorsal segments have spinulae, except for the pro- and mesothoracic segments, which are covered basally (bases are covered by the tergal margin and therefore not visible rather



Figure 5. Detail from Figure 4 showing one female of *Stylops nassonowi* Pierce and numerous emergent first instars.

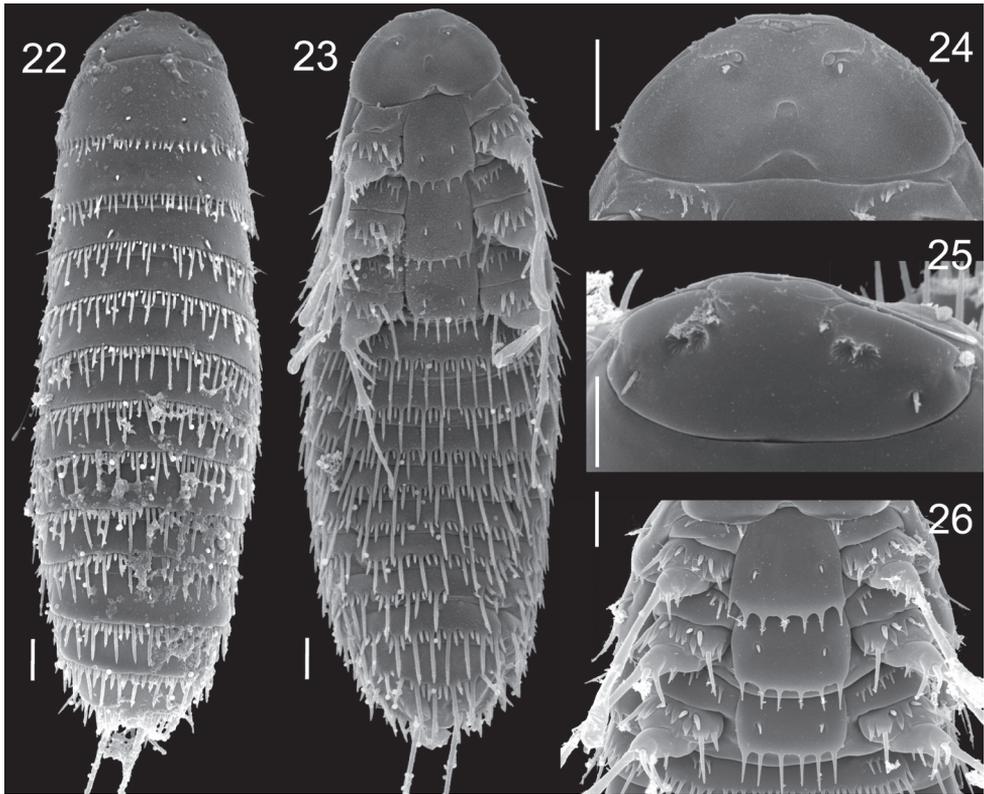
than fully exposed), while in *S. melittae* some spinullae are covered and there is a gap in the center of dorsum where no spinullae are present. The sternal plates are broader than in *S. melittae*.

Redescription. Female and female puparium. Head two times wider than long, width to length 1.97–2.53 ($n = 13$, $\bar{x} = 2.15$ mm), width 0.60–0.76 mm ($\bar{x} = 0.68$ mm), length 0.30–0.36 mm ($\bar{x} = 0.32$ mm); head posteriorly defined by single incomplete or ill-defined cephalic ridge on dorsal surface, paired cephalic ridge on ventral surface and posterior head thickening (lower margin of brood opening). Head corners short and narrow on ventral surface, slightly diverging posteriorly, head corners shorter than head on dorsal surface laterally, but inner posterior extension of ventral cephalic ridge (joint of ventral cephalic ridge and posterior head thickening) extends as far as head posterior margin on dorsal surface; ventral cephalic ridge posteromedially oriented;



Figures 6–21. Ventral (6–19) and dorsal views (20, 21) of cephalothoraxes of female puparia from *Stylops nassowii* Pierce (6–13, 20, 21) and *S. aterrimus* Newport (14–19) **6** Voucher SCa5 (Czech Republic) **7** Voucher SCa6 (Czech Republic) **8** Voucher SHo1 (Turkey) **9** Voucher SSa1 (Saudi Arabia) **10** Voucher SSg1 (Czech Republic) **11** Voucher STi2 (Hungary) **12** Voucher STi4 (Czech Republic) **13** Voucher STi6 (Czech Republic) **14** Voucher SAg1 (Tunisia) **15** Voucher SBm1a (Czech Republic) **16** Voucher SBm1b (Czech Republic) **17** Voucher STig2 (Tunisia) **18** Voucher SCa7 (Switzerland) **19** Voucher Ssp1 (Tunisia) **20** Voucher SCa10 (Czech Republic) **21** Voucher STi6 (Czech Republic).

head corners not produced laterally beyond prothorax, head narrower than prothorax and thus cephalothorax continuously diverging posteriorly. Mandibles large, not extending from head contour in ventral view; inner apical tooth well-developed; apex ventrally with 5–8 sensilla, intermandibular distance 0.17–0.20 mm (\bar{x} = 0.19 mm). Labiomaxillary area about 2–2.5× longer than wide; maxillary area distinctly prominent, overlapping mandible at about one third of its width, maxilla with 7–16 sensilla



Figures 22–26. First instar of *Stylops nassonowi* Pierce **22** Dorsal view **23** Ventral view **24** Detail of head, ventral view **25** Detail of head, dorsal view **26** Thoracic segments, ventral view. Scale bars: 10 μ m.

laterally; labial area without sensilla, more or less prominent and faintly divided into two parts medially (probably postmentum and prementum). Oral ridge (hypopharynx) well developed, rectangular, apically straight, occupying about half of intermandibular area; epipharynx slightly produced, pale, about as long as oral ridge. Hypostomal ridge (from outer margin of mandible to cephalic ridge and separating maxillary area from head corner) slightly sinuous, about as long as intermandibular distance or slightly longer. Labral area well developed, large, arcuate apically, slightly darker than clypeus in most specimens. Clypeus transverse, exceeding mandibles laterally and apically, apex straight or slightly concave, lateral corners prominent, with about 10–30 short sensilla laterally. Brood opening wide, distinctly wider than distance between mandibles; prothoracic flange (dorsal cover of brood opening) sclerotized, arcuate, laterally curved more than medially, apical margin almost straight, in some specimens more produced forward than in others; posterior head thickening (lower margin of brood opening) more uniformly arcuate than flange; overlap of prothoracic flange and posterior head thickening relatively short, about as long as cephalic ridge thick; joint of posterior head thickening and ventral cephalic ridge small, often serrate, slightly lighter than cephalic ridge. Cephalothorax usually slightly wider than long, but longer than

wide in some specimens, width to length 0.85–1.18 (\bar{x} = 1.05), width 1.05–1.41 mm (\bar{x} = 1.24 mm), length 1.04–1.27 mm (\bar{x} = 1.18 mm); cephalothorax compact, all segments fused, pigmentation denser laterally than medially. Pro- and mesothoracic intersegmental ridges distinct medially on ventral surface; paired pro- and mesothoracic ridges variable in size, usually distinct on dorsal surface. Pro- and mesothorax uniformly light yellowish-brown except pale prothoracic ridge and slightly darker surrounding integument, posterior part of mesothorax with pair of dark brown spots variable in size (absent in some specimens), distinct lighter area in center of mesothoracic ridge; metathorax uniformly pigmented with paired posterolateral dark brown spots (absent in some specimens); abdominal part of cephalothorax dichromatic, apical part lightest of cephalothorax, nearly transparent, and basal band dark brown, basal band short, not extending toward spiracles, division between basal band and remainder of cephalothorax nearly straight in all parts. Spiracles not prominent, positioned at widest part of posterior part of cephalothorax. Canalis prolifer on abdominal segments I–VII; single median tuba prolifera positioned on posterior third of segments II–VI.

First instar. Body length 135–192 μm (without caudal setae); caudal setae approximately one half body length; with minute terminal leaf-like structure (“Haftflappen”: *vide* Pohl 2000). Head dorsally with four pairs of setae and two olfactory foveae. Mandibles with short setae. Maxillae distinct; frontal margin of maxillae emarginate; rudimentary maxillary palpi circular; ventral opening of praeoral cavity semicircular and isolated from cervix; labium reduced.

Posterior margin of dorsal tergites with spinullae, all spinullae covered basally by tergal margin except for pro- and mesothoracic segments. Each thoracic tergite with two submedian and lateral rows of setae. Coxae broad; each coxa bearing one coxal bristle and 6–7 cuticular outgrowths distributed among three coxal teeth at anterior part of coxa; coxal bristle on pro- and mesothorax at least two times as long as coxal teeth. Trochanterofemur always with femoral spur and bristle almost as long as coxal bristle, and one cuticular outgrowth. Pro- and mesotarsi elongate and slightly enlarged, metatarsi rod-like. Sternal plates broad, with one pair of setae on each plate, with a few outgrowths (about 6) on their posterior margins. Precoxal pleural membrane with small number of microtrichia (about 3) on prothorax, and with transverse row of microtrichia on meso- and metathorax. Short row of cuticular outgrowths (“Spinulaeplatte” *sensu* Borchert 1963) on sternite I. Posterior margins of abdominal sternites with spinullae, some spinullae covered basally. Abdominal segment X with anus, shortened and fused with segment IX, positioned dorsally; segment XI split in two parts and positioned ventrally, bearing caudal setae.

DNA sequences. *Stylops nassonowi* differs significantly in DNA barcode sequence distance, which is consistently about 4% or more from other species, including *S. aterrimus*. At the same time, the distances within the species are about 1.5% in distance or even less (Table 2). The only exception is an individual collected in eastern Turkey, which differs from all other sequenced individuals of *S. nassonowi* in 1.3–1.9% distance and might represent an isolated population or perhaps different subspecies. Greater sampling is needed across the distribution of the species, particularly the Levant and elsewhere in Arabia.

Discussion

Pierce (1909) described *S. nassonowi* based on a figure provided by Nikolai V. Nasonov (1855–1939) in a comparative morphological study of material the latter ascribed to *S. melittae* and had taken from a female of *A. (Plastandrena) pilipes* Fabricius (Nasonov 1893a, 1893b). In establishing his new species, Pierce (1909) listed both Germany and Egypt as comprising type localities [referring to the host as *A. carbonaria* (Linnaeus), often considered the senior synonym for *A. pilipes*]; however, no specific locality is mentioned by Nasonov (1893a, 1893b), who could have had material from various places across the Palearctic. At the time Pierce was publishing, available records of styloped *A. pilipes* and ascribed by Pierce (1909) to *S. nassonowi* were known from Egypt (Saunders 1872), France (Pérez 1886), and Germany (Friese 1891), and it was from the former and the latter that he likely based his designation. Given this, we consider the type locality to be uncertain and clarification will rely on the eventual designation of a neotype as Nasonov's material is apparently no longer extant. We have hesitated from designating a neotype herein as further investigation into the ultimate disposition and survival of Nasonov's collection is needed.

Phylogenetic analysis of species of *Stylops* sampled from a diversity of hosts (Jůzová et al. 2015) coupled with the new DNA barcode sequences of the present study further demonstrate that the *Stylops* collected in Saudi Arabia belong to the species complex consisting of *S. aterrimus* and *S. nassonowi*. From the results we are able to define an eastern lineage, the oldest available name of which is *S. nassonowi* and a western lineage which accords with *S. aterrimus*. These results further establish the synonymy of *S. savignyi* from *A. savignyi* as a synonym of *S. nassonowi*, and the species appears to be a partial generalist, victimizing multiple species in separate subgenera of *Andrena* (*Plastandrena* Hedicke and *Suandrena* Warncke) (Appendix).

Stylops aterrimus and *S. nassonowi* are close sibling species and are almost indistinguishable morphologically. The two lineages exhibit sequence distances of about 4%, which is quite distinct when compared to many other species. Although we readily admit that there is no definable metric value of percent sequence difference for conferring specific status, 4% is greater than many other closely related species that are easily diagnosed on the basis of additional characters outside of the sequences themselves. Intraspecific variance in the DNA distances of each species is well below 2% and the variability is not overlapping (Table 2), further suggestive of individual evolutionary lineages. Both of these species are more than 10% distant from other common species of *Stylops* in terms of their DNA barcode sequence (Table 2: Jůzová et al. 2015). *Stylops aterrimus* and *S. nassonowi* seem to be largely allopatric across Europe, with their place of contact around the Czech Republic, where both species were recorded although not necessarily from precisely the same locality within that country. The border of contact between the two species is, of course, expected in other countries through Central Europe as well as in northern Africa. This split into a western and eastern species is perhaps a reflection of Pleistocene glaciation across Europe during the Pleistocene, as areas such as western France and Spain were spared from extensive ice coverage, while the same was true for the Italian Peninsula and

Balkans, with some narrow corridors of contact north of the Alps (Ehlers and Gibbard 2004; Ehlers et al. 2011). Naturally, such a pattern of distribution and contact requires further testing through the acquisition of considerably more material, and finer-scale phylogeographic study, ideally coupled with some degree of calibration for purposes of dating. For the moment our limitations largely reflect the infrequent collection of strepsipterans, particularly as many entomologists ignore the presence of such parasites.

The present study demonstrates how a seemingly happenstance and serendipitous encounter with a styloped female of *A. savignyi* permitted a significant shift in a long-standing taxonomic obstacle. Clarification of the identity of *S. savignyi* provides one further step toward a revised classification of *Stylops* supported by both morphological and molecular data. Given the increased awareness of native pollinators (many of which are wild bees) and their importance for ecosystem health, numerous initiatives are underway to study such species. These endeavors are making available new samples from previously under-collected regions and with this increased effort the probability of acquiring fresh material of their parasites, some unseen for decades. Melittologists and pollination biologists should develop an awareness and maintain alertness for styloped females, and where possible obtain data on their impact on the host's behavior and development as it not only makes less known the Strepsiptera but simultaneously enhances our knowledge of the hosts.

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Appendix

Material of species of *Stylops* used for taxonomic comparison

Here we provide specimen and collective event details for the various specimens of species of *Stylops* used in our comparative studies, along with the hosts from which they were sampled. In addition, specimens tied to specific sequences deposited in GenBank are identified and their numbers provided.

Stylops ater Reichert

Stylops ater Reichert 1914: 151 [♂]. Type locality: Merseburg, Germany.

Material examined. Czech Republic: Bohemia: Prokopské údolí, Praha-Jinonice, 1F, host: *A. (Melandrena) vaga* Panzer, 1♂, 13.iii.2007, J. Straka lgt., voucher SVa2, DNA barcode, GenBank: KF803529.

Stylops aterrimus Newport

Figs 14–19

Stylops spencii auctorum (*nec* Pickering 1836).

Stylops aterrimus Newport 1851: 340 [♂]. Type locality: Hampstead, Great Britain.

Material examined. Czech Republic: Bohemia, Velký Luh, sandpit, 2FF+1EMP, host: *A. (Plastandrena) bimaculata* (Kirby), 1♀, 20.iv.2010, J. Straka lgt., voucher SBm1, DNA barcode, GenBank: KP213298. **Switzerland:** Zürich env., 1F, host: *A.*

(*Hoplandrena*) *carantonica* Pérez, 1F, 25.v.2010, collector unknown, voucher SCA7, DNA barcode, GenBank: KP213300; ditto, 1F+1EMP, voucher SCA8, DNA barcode, GenBank: KP213299. **Tunisia:** Gafsa env., 1F, host: *A. (P.) bimaculata*, 1F, 1.iv.2006, J. Batelka et J. Straka lgt., voucher STig2, DNA barcode, GenBank: KF803522; Tamerza env., 1F, host: *A. (Agandrena) agilissima* (Scopoli), 1F, 31.iii.2006, J. Batelka et J. Straka lgt., voucher SAg1, DNA barcode, GenBank: KF803428; ditto, 1F, host: *A. (P.) bimaculata*, 1F, voucher STig1, DNA barcode, GenBank: KF803521; Wadi Raml, 4.5 km E Douz, 1F, host: *A. (H.)* sp., 1F, 4.iv.2006, J. Batelka et J. Straka lgt., voucher Ssp1, DNA barcode, GenBank: KF803504.

***Stylops melittae* Kirby**

Stylops melittae Kirby 1802: 113 [♂]. Type locality: not indicated.

Material examined. Czech Republic: Bohemia, Čelákovice env., 1F, host: *A. (Zonandrena) flavipes* Panzer, 1♂, 1.v.2006, J. Batelka lgt., voucher SFl1, DNA barcode, GenBank: KF803453; Bohemia, Prokopské údolí, Praha-Jinonice, 1F, host: *A. (Melandrena) nigroaenea* (Kirby), 1♀, 6.iv.2009, J. Straka lgt., voucher SNi16, DNA barcode, GenBank: KF803488.

***Stylops nassonowi* Pierce**

Figs 4–13, 20–26

Stylops nassonowi Pierce 1909: 105 [F]. Type locality: ‘Egypt and Germany’ (*vide* Discussion).

Stylops savignyi Hofender 1924: 254 [F]. Type locality: Egypt.

Material examined. Czech Republic: Bohemia, Divoká Šárka, Praha-Liboc, 1F, host: *Andrena (Hoplandrena) carantonica* Pérez, 1♂, 15.iv.2006, J. Straka lgt., voucher SCA2, DNA barcode, GenBank: KF803434; Bohemia, Chvalské skály, Praha-Horní Počernice, 2FF, host: *A. (H.) carantonica*, 1♀, 3.vi.2005, J. Straka lgt., voucher SCA9, DNA barcode, GenBank: KF803436; Bohemia, Sušice env., 1F, host: *A. (Plastandrena) tibialis* (Kirby), 1♀, 9.iv.2007, L. Dvořák lgt., voucher STi1, DNA barcode, GenBank: KF803518; ditto, 2FF, voucher STi6, DNA barcode, GenBank: KP213303; Bohemia, Závišín, Blatná env., 1F, host: *A. (P.) tibialis*, 1♂, 4.iv.2009, P. Bogusch lgt., voucher STi4, DNA barcode, GenBank: KP213302; Moravia, Dolní Dunažovice env., 1F+1EMP, 16.iv.2007, P. Bogusch lgt., voucher SCA10, DNA barcode, GenBank: KP213304; Moravia, Dolní Věstonice env., 1F, host: *A. (H.) carantonica*,

1♂, 5.iv.2008, J. Batelka et J. Straka lgt., voucher SCA5, DNA barcode, GenBank: KP213305; Moravia, Dolní Věstonice env., 1F+1EMP, host: *A. (H.) carantonica*, 1♂, 6.iv.2009, P. Bogusch lgt., voucher SCA6, DNA barcode, GenBank: KF803435; ditto, 3FF, host: *A. (H.) spinigera* (Kirby), 1♂, voucher SSg1, DNA barcode, GenBank: KF803503; Moravia, Lednice env., 1F, host: *A. (H.) carantonica*, 1♀, 13.vi.2006, J. Straka lgt., voucher SCA1, DNA barcode, GenBank: KF803433; **Hungary**: Budaörs, Budapest env., 1F, host: *A. (H.) carantonica*, 1♀, 25.iv.2009, J. Straka et P. Bogusch lgt., voucher SCA4, DNA barcode, GenBank: KP213301; Örkény (puszta), 1F, host: *A. (P.) tibialis*, 1♂, 24.iv.2009, J. Straka et P. Bogusch lgt., voucher STi2, DNA barcode, GenBank: KF803519; **Saudi Arabia**: Riyadh, Al Amariah, Majra Al-gasim, 2FF, host: *A. (Suandrena) savignyi* Spinola, 1♀, 5.iii.2011, M.A. Hannan lgt., voucher Ssa1, DNA barcode, GenBank: KP213306; **Turkey**: Hakkari prov., Gözeldere 25 km E, 1F, host: *A. (P.)* sp., 1♀, 22.vi.2010, Mi. Halada lgt., voucher SHo1, DNA barcode, GenBank: KF803463.

Stylops nevinsoni Perkins

Stylops nevinsoni Perkins 1918: 71 [F]. Type locality: Great Britain.

Material examined. Czech Republic: Bohemia, Chýnec, 1F, host: *A. (A.) fulva* (Müller), 1♀, 22.iv.2006, J. Batelka et J. Straka lgt., voucher SFu1, DNA barcode, GenBank: KF803457.

Stylops spencei Pickering

Stylops spencei Pickering 1836: 168 [F]. Type locality: Great Britain.

Material examined. Czech Republic: Bohemia, Chýnec, 1F, host: *A. (Micrandrena) minutula* (Kirby), 1♀, 22.iv.2006, J. Batelka et J. Straka lgt., voucher SMi1, DNA barcode, GenBank: KF803477.

Stylops thwaitesi Perkins

Stylops thwaitesi Perkins 1918: 70 [♂, F]. Type locality: Great Britain.

Material examined. Spain: Maranchón 3km NW, Castilla-La Mancha prov., 1F, host: *A. (Taeniandrena) albofasciata* Thomson, 1♀, 10.iv.2012, K. Černá, K. Jůzová et J. Straka lgt., voucher SOv3, DNA barcode, GenBank: KF803494.

Rediscovery of *Nuvol umbrosus* Navás (Neuroptera, Chrysopidae, Leucochrysinini): a redescription and discussion

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Abstract

The monotypic leucochrysinine genus *Nuvol* was previously known from three specimens of *Nuvol umbrosus* Navás, collected in the Atlantic Forest region of Brazil. For many years these specimens have been missing, and the genus has remained without a modern description. Here, the species is redescribed based on two newly discovered specimens (females) from the Amazonian region. The female terminalia are relatively simple, except for the subgenitale, which is enlarged, folded into two sections, and heavily sclerotized. Unique aspects of the wing venation and the unusual pattern of banding on the wings support the retention of *Nuvol* as a valid genus within the Leucochrysinini. There are differences between the Amazonian specimens studied here and the earlier descriptions based on specimens from the Atlantic Forest. These differences may indicate the presence of two distinct, geographically separated species within the genus. However, largely because we do not know the sexes of the earlier specimens, we are treating the differences discovered in the two female specimens as expressions of intraspecific variation.

Keywords

Chrysopinae, Leucochrysinini, generic assignment, interspecific variation, intraspecific variation

Introduction

Leucochrysinini (Neuroptera: Chrysopidae) is a large tribe of green lacewings restricted to the New World. Currently, it includes seven genera in varying states of systematic resolution. One of these genera, *Nuvol*, has received no modern taxonomic treatment: accurate drawings of the only included species, *Nuvol umbrosus* Navás, are available solely for the wings; its abdominal and genitalic features have not been described (Brooks and Barnard 1990). As a result, the generic distinction of this genus has remained in need of reevaluation for some time.

At the time of its description, the single type specimen of *N. umbrosus* remained in the Navás collection in Barcelona (Navás 1916); it and one other specimen that Navás (1929a, b) cited later from the Museum in Hamburg are lost (Monserrat 1985). And, unfortunately, the heretofore only known recent specimen of *N. umbrosus* [reported from the Museum of Zoology, São Paulo, Brazil, MZUSP; see Brooks and Barnard 1990] now also appears to be missing (C. A. Tauber & M. J. Tauber, pers. obs.). However, during 2014 the authors independently discovered two additional specimens of *Nuvol* – one (a female) in the collection of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Brazil, and another (a female) in the Utah State University Collection, Logan, Utah. Both specimens are similar, and at this time we are treating them as examples of *Nuvol*'s type species, *Nuvol umbrosus* Navás, 1916 (however, see below).

To help determine whether the genus should be retained as a valid entity within the Leucochrysinini, the newly discovered *Nuvol* specimens are described and their features compared, including the taxonomically important genitalia, with those of other leucochrysinines. Unfortunately, the generic placement of *Nuvol* will remain unresolved largely because our specimens are both females, and the male genitalia, as well as the larvae, are unknown.

Results

Tribe Leucochrysinini

The tribe Leucochrysinini contains the seven genera and two subgenera listed below. Following each genus name are: (i) the number of species currently included in the genus and (ii) references to recent systematic work dealing with the genus.

Berchmansus Navás, 1913 – (two species; Tauber 2007, Tauber and Tauber 2013)

Cacarulla Navás, 1910 – (monotypic; Brooks and Barnard 1990)

Gonzaga Navás, 1913 – (eight species; Brooks and Barnard 1990, Tauber et al. 2008)

Leucochrysa McLachlan, 1868

Subgenus *Leucochrysa* McLachlan, 1868 (41 species; Brooks and Barnard 1990, Tauber et al. 2013a, b)

Subgenus *Nodita* Navás, 1916 – (150 species; Brooks and Barnard 1990, Tauber et al. 2011a)

Neula Navás, 1917 – (monotypic, no specimens known; Brooks and Barnard 1990)

Nuvol Navás, 1916 – (monotypic; Brooks and Barnard 1990)

Santocellus Tauber & Albuquerque, 2008 – (two species; Tauber 2012)

The genus *Vieira* Navás, 1913, which was previously placed in the *Leucochrysinini* (see Brooks and Barnard 1990), is now in the tribe *Belonopterygini* (Tauber 2007).

Genus *Nuvol* Navás, 1916

Monotypic genus. Type-species: *Nuvol umbrosus* Navás, 1916.

Known geographic distribution. Brazil: States of Rio de Janeiro (RJ), São Paulo (SP), Amazonas (AM), Rondônia (RO), as follows. **RJ:** type specimen reported in original description, Rio de Janeiro, II-1912 (Navás collection, specimen missing); subsequent specimen reported from Prov. Rio de Jan., 20.X.1906, Coll. V. Bönninghausen. M. H., (Navás 1929a, b; Hamburg Museum, probably destroyed during WWII); **SP:** Alto da Serra, ii-II (or XII)-28, R. Spitz leg (examined by Adams' at the MZUSP, without abdomen, specimen apparently missing); **AM:** Novo Aripuanã 05°15'53"S / 60°07'08"W. Armadilha Malaise em igarapé; Floresta úmida, ix.2004, Henriques Silva & Pena Leg; **RO:** 62 km SE Ariquemes, 7–18 Nov 1995, W. J. Hanson (USU)].

Nuvol umbrosus Navás [1916.??.]

Brotéria (Zoológica) 14: 14–35 (description). Navás 1929a: 860 (as “*Newol*” *umbrosus*, locality record); Navás 1929b: 319 (locality record); Penny 1977: 28 (species list); Brooks and Barnard 1990: 251 (taxonomy); Oswald 2013 (catalog listing).

Type. The original description states that the type specimen was collected in “Rio de Janeiro, Febrero de 1912” and that it was retained in the Navás collection. The specimen is not reported to be in the Navás collection now (Montserrat 1995).

At some time, a neotype should be designated for this species. However, we are not doing so with either of the two extant specimens because: (1) They are both from the Amazonian region of Brazil, far removed from the type locality – the Atlantic Forest region of Rio de Janeiro. (2) Our specimens are both females; the sexes of the previously described species are unknown. (3) Our specimens both differ significantly from Navás' illustration and description in aspects of the fore and hind wing venation (discussed below). Thus, until male and female specimens from near the type locality are available for comparison, we consider it prudent to withhold from designating a neotype.



Figure 1. *Nuvolet umbrosus* Navás adult: **a** habitus, lateral **b** antennomeres ~ 1/3 distance from base of antenna **c** mesotarsal claw (Brazil, Rondônia, CAT).

Description. General (Fig. 1): Body slender, yellowish or greenish brown, with elongate, slender antennae typical of leucochrysinids, wings hyaline, marked with conspicuous brown to golden bands. **Head** (Figs 1, 2a, b, 3): Vertex yellowish green, with light reddish markings laterally, along eyes; surface slightly rough, somewhat raised posteriorly. Frons, clypeus white with lateral margins dark red; gena dark red. Labial palpus, maxillary palpus cream colored, without marks. Antenna cream colored, without markings. Scape elongate, relatively large, close mesally; flagellar segments (beyond basal section of flagellum) elongate, each with four swirls of robust, acute setae (Fig. 1b). Measurements: head width (dorsal) 1.7 mm, ratio of head width to eye width 2.0; distance between eyes (frontal) 0.78 mm; distance between tentorial pits 0.57 mm; length midantenna to midway between tentorial pits 0.53 mm; antenna length 31–35 mm; scape length 0.48 mm, width, 0.38 mm; basal two flagellomeres 0.1 mm long, 0.1 mm wide; flagellomeres at 1/3 distance to antennal tip 0.21 mm long, 0.07 mm wide. **Thorax** (Fig. 3c, d): Prothorax slightly wider than long (length 0.92 mm, width 1.27 mm), yellowish green mesally, with broad, red to brown longitudinal bands laterally, with elongate, golden setae laterally. Mesothorax, metathorax mostly yellowish green mesally, brown laterally, with fine golden setae dorsolaterally. Legs pale, without markings, with numerous light brown to amber setae; tarsal claws with broad, dilated base, deep narrow cleft (Fig 1c).

Wings (Fig. 4): Forewing 14.8–15.8 mm long, 5.1–5.5 mm wide (at widest point); ratio of length: maximum width = 2.9:1. Costal area relatively narrow; tallest costal cell (#6–8) 0.8 mm tall, 1.4–1.8 times width, height 0.17–0.15 times width of wing (midwing). First intramedian cell ovate, height (along median arculus) 0.33 mm, width 2.5–2.6 times height, 0.65–0.66 times width of third median cell. First radial crossvein distal to origin of radial sector (Rs); radial area (between radius and Rs) with single row of 15 closed cells; tallest cell (#6–8) 1.3–1.5 times taller than wide. Base of subcosta, upper media, lower media slightly crassate, other longitudinal veins robust; 4 b cells (= cells beneath Rs, not including an inner gradate vein). Seven to nine discrete inner gradates in irregular pattern, outer gradates apparently aligned with distal vein-

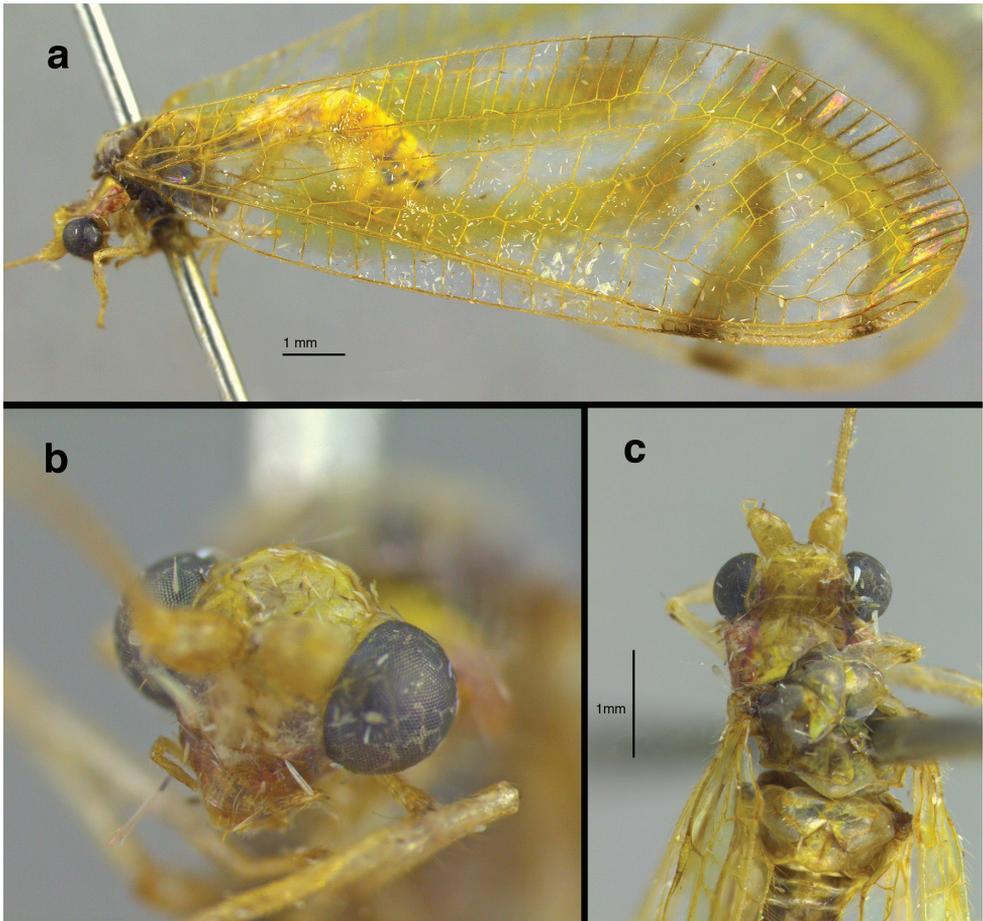


Figure 2. *Nuvol umbrosus* Navás adult: **a** habitus, lateral **b** head, frontolateral **c** head, thorax, dorsal (Brazil, Amazonas, FS).

lets in smooth, curved line paralleling margin of wing from tip of pseudomedia (Psm) to tip of Rs. Height of fourth gradate cell 2.9–3.9 times width. Six to seven b' cells (cells beneath Psm after second intramedian cell). Four intracubital cells (three or four closed). Subcosta, radial sector forked apically; almost all other apical veins unforked. Membrane with four large, conspicuous yellow to brown marks; stigma with dark brown marks basally, distally. Veins mostly pale, except under markings. Hindwing 13.1–13.8 mm long, 4.1–4.3 mm wide. Six discrete inner gradates, outer gradates similar to those of forewing; 13–15 radial cells (counted from origin of radius, not false origin). Five large b cells (no small “t” cell); six b' cells beyond second intramedian cell; two intracubital cells (one closed). Membrane with yellow to light brown marks, similar to those on forewing; stigma with single dark brown mark basally. Veins pale except near stigmal marking.

Male. Unknown.

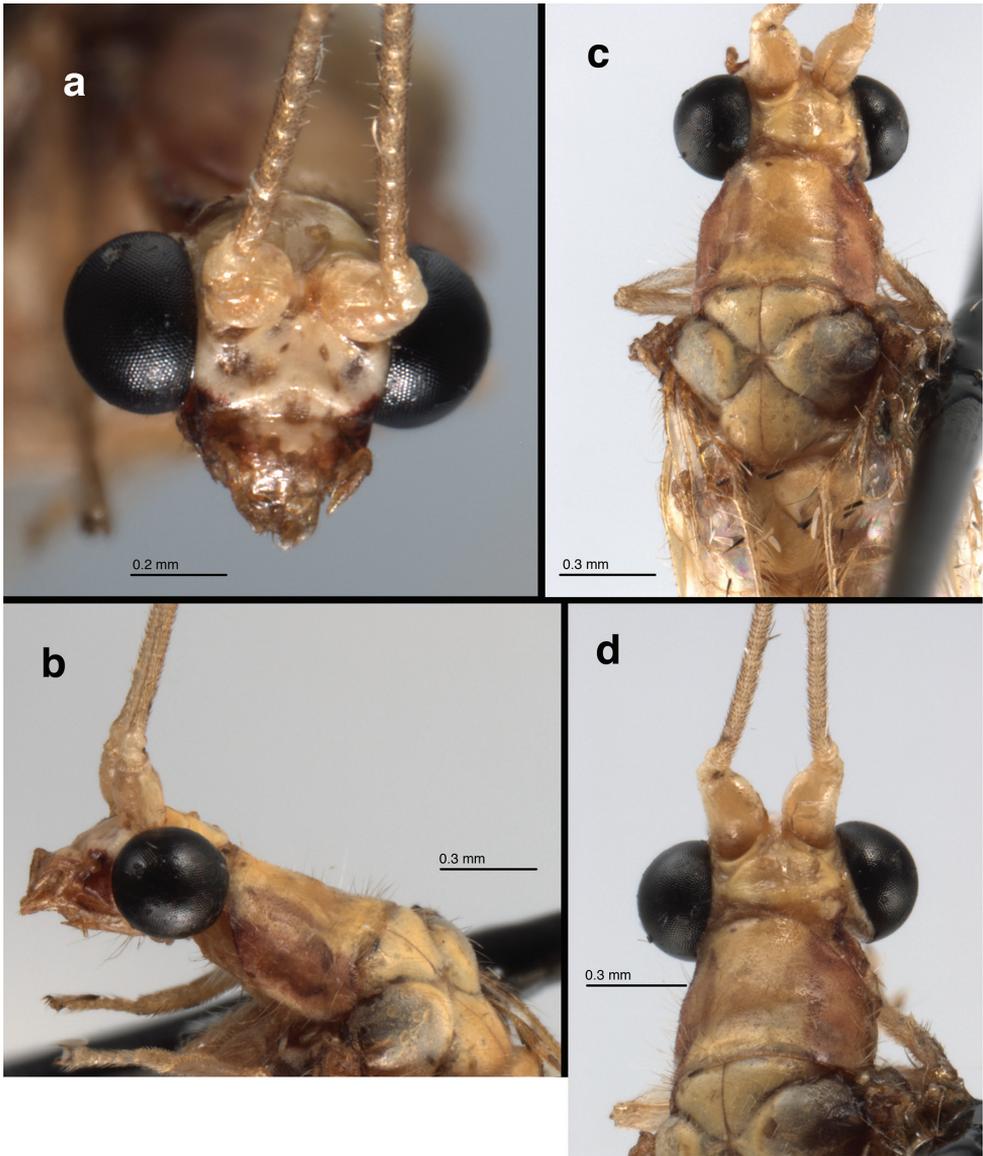


Figure 3. *Nuvolet umbrosus* Navás adult: **a** head, frontal **b** head, prothorax, lateral **c** head, thorax, dorsal **d** head, prothorax, dorsal (Brazil, Rondônia, color faded, CAT).

Female (Figs 5–7): Abdomen with spiracles simple (Fig. 5e); callus cerci round, brown to black, heavily sclerotized (INPA specimen), located dorsally on T9+ect, with 28–32 trichobothria stemming from irregularly spaced sockets (Fig. 5c, f); ninth tergite (T9) and ectoproct fused, but invaginated distally (Fig. 5a); T9+ect completely divided dorsally by deep groove (Fig. 5d). Praegenitale absent. Colleterial complex (Fig. 6b) with elongate, delicate gland, apparently with scattered particles; reservoir

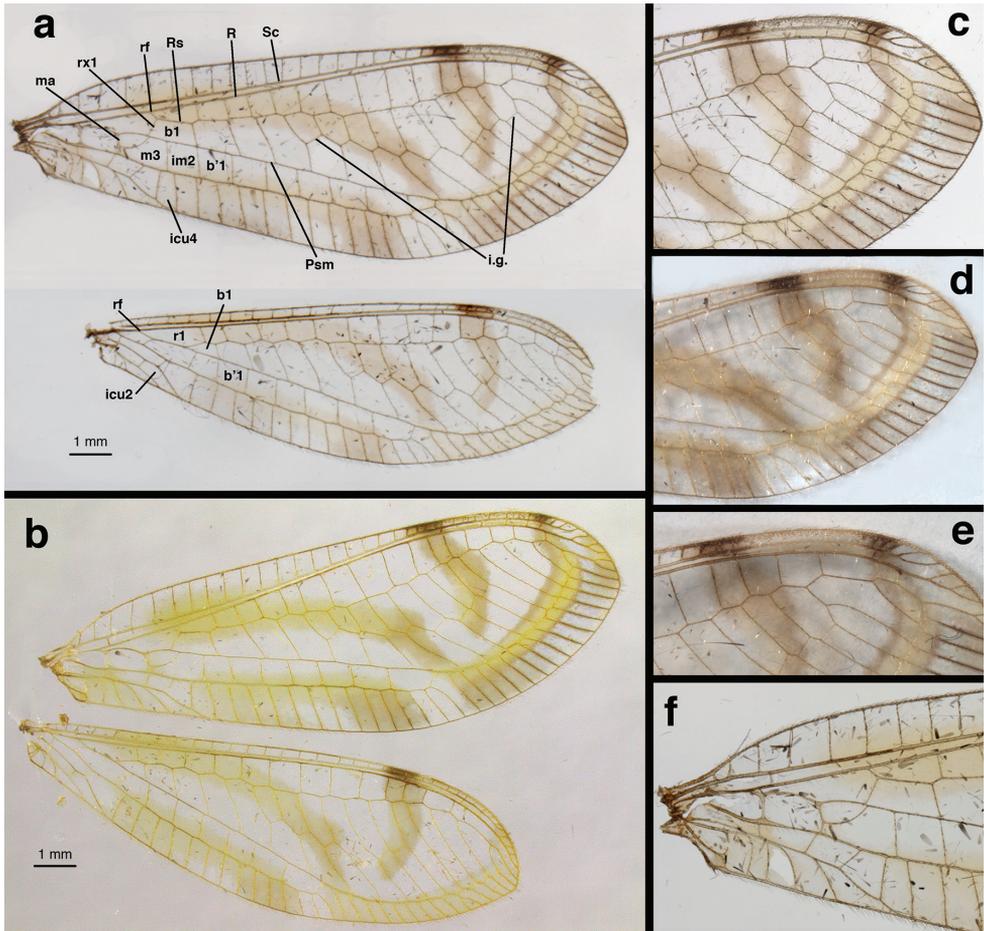


Figure 4. *Nuvol umbrosus* Navás wings: **a, c, d, e, f** Brazil, Rondônia, CAT **b** Brazil, Amazonas, FS. Note the unforked apical veinlets, markings, radius turning downward at tip, forewing with four intracubital cells. **b1** first upper Banksian cell **b'1** first lower Banksian cell **icu2**, **icu4** second and fourth intracubital cells **im2** second intramedian cell **i.g.** inner gradate series **m3** third median cell **ma** median arculus (base of first intramedian cell) **Psm** pseudomedial **R** radius **Rs** radial sector **rf** origin of radial sector **rx1** first radial crossvein **Sc** subcosta.

spherical, with colliculate, membranous surface, extending apically only into ectoproct; transverse sclerite delicate, membranous, with small, elongate teeth. Spermathecal complex (Fig. 6a) simple; spermatheca pillbox-shaped with small to moderate, V-shaped invagination; spermathecal duct elongate (~2.5–3× width of spermatheca), curvy, covered with fine, hair-like, glandular ducts throughout distal ~2/3 of duct, longest and most dense distally, becoming thinner to absent basally; velum small, connecting directly to bursal duct; bursal duct leathery, elongate, bent, extending posteriorly to bursa copulatrix; bursa membranous, with two narrow glands. Subgenitale (Fig. 7) large, leathery, almost as broad as tip of S7, composed of upper and lower sections

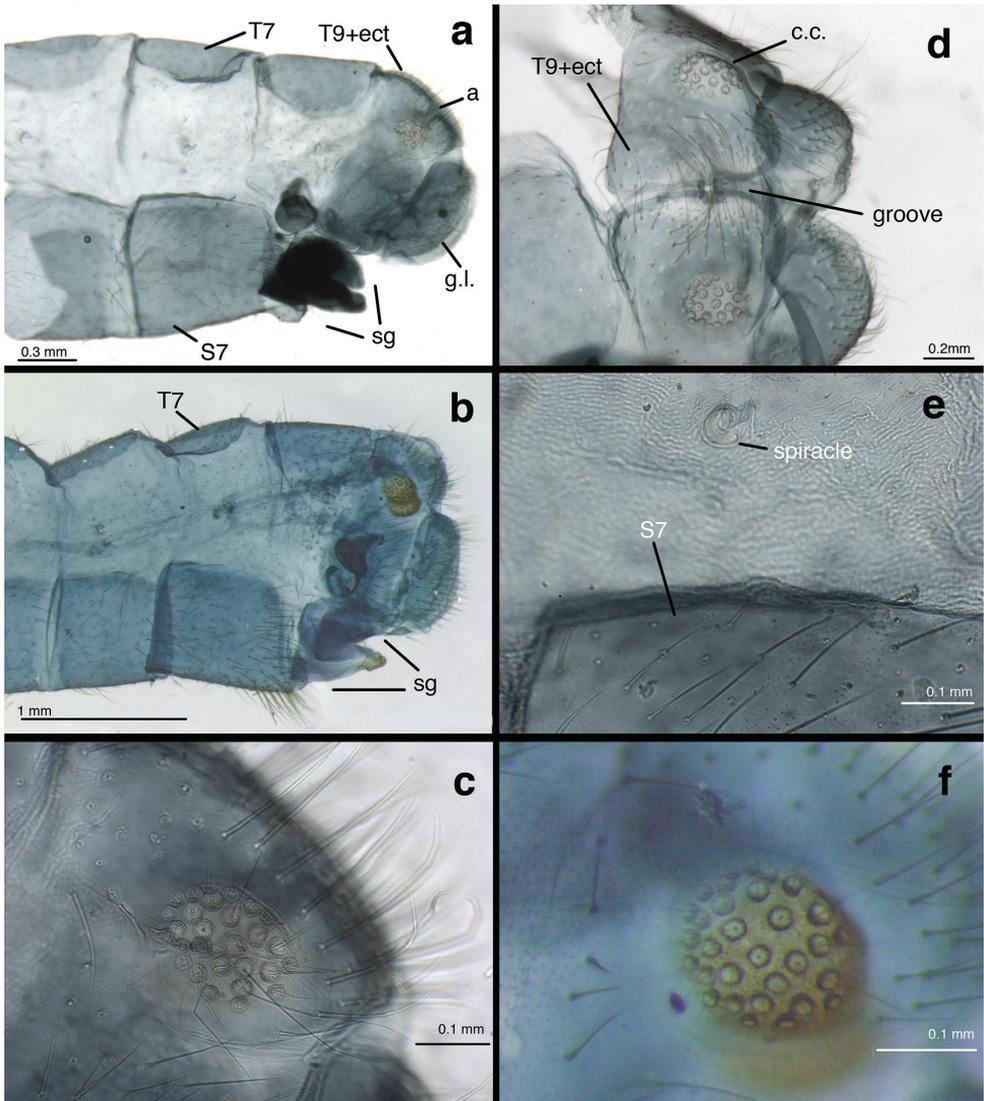


Figure 5. *Nuvolet umbrosus* Navás female abdomen. **a, b** terminal segments, lateral **c** callus cerci and trichobothria **d** ninth tergite and ectoproct, dorsal, divided by deep groove **e** seventh pleuron and sternite, showing spiracle and texture of integument **f** callus cerci [**a, c, d, e**: Brazil, Rondônia, CAT; **b, f**: Brazil, Amazonas, FS]. **a** anus **c.c.** callus cerci **g.l.** gonapophysis lateralis **sg** subgenitale **sp** spermatheca **sp.d.** spermathecal duct **S7** seventh sternite **T7** seventh tergite **T9+e** fused ninth tergite and ectoproct.

extending distally from relatively deep fold at tip of S7, well beyond sternite; lower section triangular (ventral view), slightly concave, with paired distal lobes extending posteriorly as a knob (lateral view), lobes separated by small, mesal groove; upper section of subgenitale dense, especially laterally, slightly convex, folded above and connected basally to lower section.

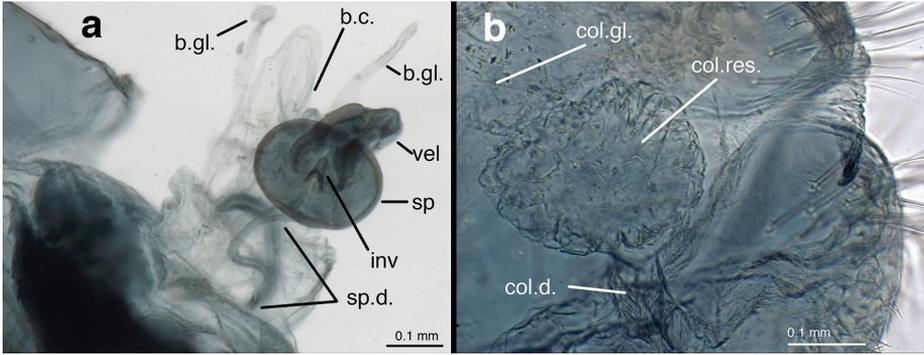


Figure 6. *Nuvol umbrosus* Navás female genitalia. **a** spermathecal complex **b** colleterial complex [Brazil, Rondônia, CAT]. **b.c.** bursa copulatrix **b.gl.** bursal gland **col.d.** colleterial duct **col.gl.** colleterial gland **col.res.** colleterial reservoir **inv** invagination **sp** spermatheca **sp.d.** spermathecal duct **vel** velum.

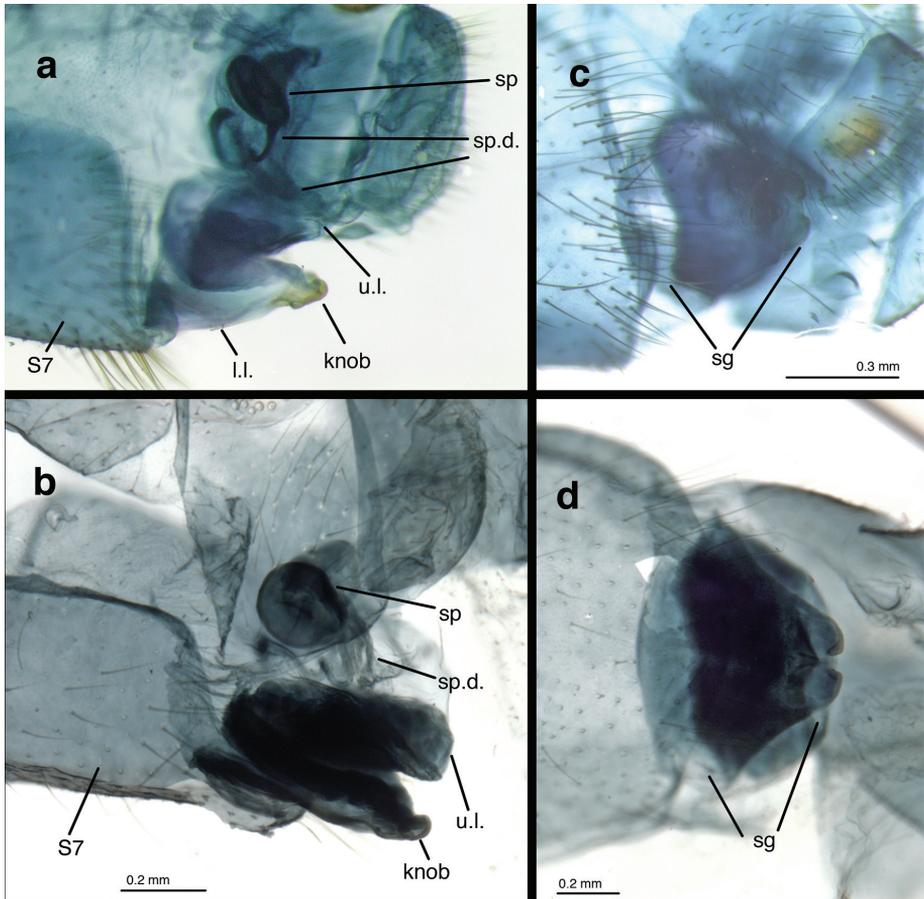


Figure 7. *Nuvol umbrosus* Navás female genitalia. **a, b** spermathecal complex and subgenitale, lateral **c, d** subgenitale, ventral [**a, c** Brazil, Amazonas, FS **b, d** Brazil, Rondônia, CAT]. **l.l.** lower layer of subgenitale **sp** spermatheca **sp.d.** spermathecal duct **S7** seventh sternite **u.i.** upper layer of subgenitale.

Larvae. Unknown.

Biology. Unknown.

Variation. Other than differences in color, the two Amazonian specimens examined are very similar to each other, and we are confident that they are conspecific. The coloration of the specimen from Amazonas (INPA) appears deeper than the one from Rondônia (USU) that might be slightly teneral.

Discussion

***Nuvol*'s generic relationships.** In the original description (Navás 1916) and in subsequent discussion (Brooks and Barnard 1990), *N. umbrosus* was said to resemble *Leucochrysa*, but also to differ from it in several features of the wings: notably an elongate radial vein that parallels the costa and curves posteriorly at the tip of the wing, outer gradates aligned with the bases of the distal veins in a smooth line that parallels the wing edge, an elongate stigma, four intracubital cells in the forewing, and distinctive markings on the fore and hind wings. These characters were all present in the specimens described herein, and, other than the four intracubital cells that also are present in *Berchmansus* (Tauber 2007), they readily distinguish *Nuvol* specimens from those in other leucochry sine genera.

At this time when the anatomy of females from only a small percentage of leucochry sine species has been described, our study does not provide any novel insights into the relationships of this species with other leucochry sines. The internal genitalic structures of the *Nuvol* female are relatively simple, and they lack the complex, coiled bursal duct of *Berchmansus*. Thus, they resemble those known for females in a large number of other leucochry sine species. However, the heavy sclerotization and folding of the subgenitale are conspicuous and may be distinctive among leucochry sines. Thus, at this time, there is no compelling evidence that supports a change in the generic designation of *Nuvol*, and we consider that the external features above provide substantive evidence for a generic difference between *Nuvol* and other leucochry sines. We await the discovery of *Nuvol* larvae and broadly based comparative adult morphological and/or molecular studies of the Leucochry sini before making any generic level changes.

Specific identity. It is noteworthy that the two Amazonian specimens we studied differed somewhat from the images and descriptions of the Atlantic Forest specimens studied by Navás (1916) and Adams (via Brooks and Barnard 1990). Specifically, the degree of suppression in the forking of the apical veinlets is much stronger in the Amazonian than in the Atlantic Forest specimens. Illustrations by Navás (1916, fig. 6) and Adams (fig. 519 in Brooks and Barnard 1990) of the Atlantic Forest species show forewings with 16 and 14 forked apical veinlets; only four or five of the anterior radial veinlets are unforked. However, in the Amazonian specimens none or only one of the apical veinlets is forked. The difference also occurs in the hind wings. In addition, there seem to be some differences in the head and thoracic markings between our specimens and those described by Navás.

Although it is quite possible that the above venational and color differences are expressions of interspecific variation, at this time we cannot exclude intraspecific, i.e., geographic or sex-associated variation. Our two Amazonian specimens are females; whereas the sexes of the specimens from the Atlantic Forest are unknown. And we note that leucochrysinines are notorious for polymorphisms in body color and markings (Mantoanelli et al. 2006, Tauber et al. 2011b, Tauber et al. 2013a, b). Thus, until the discovery of additional specimens, the two studied herein should be considered as variants of one species.

Modifications for Brooks and Barnard's (1990) key to adults of chrysopid genera

In the most recent taxonomic key for chrysopid genera (Brooks and Barnard 1990), *Nuvol* females could be recovered with small alterations to couplets 82 and 83, and the addition of another couplet, as follows below. Please note: Except where noted, the figure numbers below are those of Brooks and Barnard (1990).

- 82 Ectoprocts not fused dorsally, or with deep dorsal groove (Fig. 22; also see Fig. 5d here); forewing usually marked with black spots, particularly on cell *dcc* or with four large, brown bands; longitudinal veins often unforked apically **82A**
- Ectoprocts fused dorsally; forewing usually unmarked; longitudinal veins forked apically **84**
- 82A Ectoprocts separated by dorsal suture; forewing with black spots on *dcc* and pterostigma (Fig. 280); claws with basal dilation (Fig. 11); basal lobe of subgenitale with V-shaped indentation (Fig. 286)..... ***Chrysemosa* Brooks & Barnard**
- Ectoprocts separated by deep dorsal groove; forewing unmarked or marked with numerous small black spots or four large brown bands throughout the wing (Figs. 456, 519); claws with or without basal dilation; basal lobe of subgenitale without V-shaped indentation **83**
- 83 Forewing unmarked or marked with numerous small black spots throughout wing (Fig. 456); claws undilated (Fig. 12); basal lobe of subgenitale elongate (Fig. 460).....***Suarius* Navás**
- Forewing marked extensively with large brown bands (Fig. 519; also see Fig. 4 here); claws dilated (Fig. 11; also see Fig. 1c here); basal lobe of subgenitale broad, flat, heavily sclerotized (Fig. 7 here) ***Nuvol* Navás**

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do Amazonas” (FAPEAM) Edital: N. 011/2013 - COLEÇÕES BIOLÓGICAS, Protocol: 16066.UNI423.6372.29052013 for hosting the visit of FS to the INPA. Thanks to Carol Von-Dohlen, Utah State University, for loaning CAT chrysopid specimens and her patience in awaiting their return. The “Lacewing Digital Library” website, developed by J. D. Oswald (Texas A & M University, College Station), was very useful during this study. CAT’s work has benefitted from funding by the National Science Foundation (DEB 0542373, with MJT), USDA/NRI Competitive Grants Programs (9802447, with MJT), Cornell University, and the Cornell University Library.

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