RESEARCH ARTICLE



Myrtoessa hyas, a new valvatiform genus and a new species of the Hydrobiidae (Caenogastropoda, Truncatelloidea) from Greece

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Academic editor: <i>M. Haase</i>	Received 28 September 2016 Accepted 30 November 2016 Published 13 December 2016
	http://zoobank.org/B4EA1C64-7EBB-4B89-B46A-360A9CCB11DB

Citation: Radea C, Parmakelis A, Giokas S (2016) *Myrtoessa hyas*, a new valvatiform genus and a new species of the Hydrobiidae (Caenogastropoda, Truncatelloidea) from Greece. ZooKeys 640: 1–18. https://doi.org/10.3897/ zookeys.640.10674

Abstract

A new to science valvatiform hydrobiid, *Myrtoessa hyas* Radea, **gen. n. & sp. n.**, from southern Greece, is described and illustrated. The new genus is a tiny gastropod thriving in a stream and is differentiated from the other known European and circum-Mediterranean valvatiform hydrobiid genera by a unique combination of the male and female genitalia features i.e. penis long, flat, blunt, with wide wrinkled proximal part and narrow distal part with a sub-terminal eversible papilla on its left side, bursa copulatrix well-developed, pyriform, fully protruding from the posterior end of the albumen gland and two seminal receptacles respectively. The new monotypic and locally endemic genus is narrowly distributed and its single known population nearby a coastal bustling village is vulnerable to anthropogenic stressors.

Keywords

Endemicity, freshwater diversity, hydrobiids, taxonomy

Introduction

The freshwater fauna around the Mediterranean Basin comprises a plethora of valvatiform hydrobiids (Bodon et al. 2001). Many of them still have unclear taxonomic status because they were established on the basis of shell characters, which are often convergent, and/or those anatomical characters which are frequently non-diagnostic as for instance, stomach (Arconada and Ramos 2006). However, a more detailed anatomical description of some already known valvatiform taxa initially established from shell characters elucidated their taxonomic status (e.g. Bodon et al. 2001, Arconada and Ramos 2002, 2006).

Moreover, during last ten years, several new valvatiform taxa have been described based on shell and diagnostic anatomical characters and, in several cases, their molecular affinities have been investigated (e.g. Bodon et al. 2001, Arconada and Ramos 2006, Arconada and Ramos 2007, Arconada et al. 2007, Radea 2011, Rolan and Pardo 2011, Falniowski and Szarowska 2011a,b, Callot-Girardi and Boeters 2012, Radea et al. 2013).

In Greece, eight valvatiform-planispiral hydrobiid genera, namely *Daphniola* Radoman, 1973, *Fissuria* Boeters, 1981, *Graecoarganiella* Falniowski & Szarowska, 2011a, *Hauffenia* Pollonera, 1898, *Isimerope* Radea & Parmakelis, 2013, *Islamia* Radoman, 1973, *Prespolitorea* Radoman, 1983 and *Pseudoislamia* Radoman, 1979, have been recorded so far (Schütt 1980, Radoman 1983, Reischütz and Reischütz 2004, Falniowski and Szarowska 2011a, Radea et al. 2013). Three of them, i.e. *Pseudoislamia*, *Graecoarganiella* and *Isimerope*, are Greek endemics with a rather limited distribution in a few localities of Etoloakarnania, Phokida (central Greece), Argolida and Arkadia (Peloponnisos, southern Greek mainland).

Herein, a new genus and a new species of a minute valvatiform hydrobiid gastropod collected from Mount Parnon, Arkadia are described, and an identification key provided for the valvatiform hydrobiid genera of Greece based on the character states of male and female genitalia.

Materials and methods

Snails in question thrived in a stream at Poulithra village, Parnon Mt., Arkadia (Fig. 1); GPS coordinates were taken using a hand-held unit (Magellan Triton 2000). Specimens were collected by hand from stones, gravel, mosses, and dead leaves. Immediately after collection, the specimens were placed into vials filled with water from the collection site and were transported alive to the lab. A digital picture using a camera (Canon EOS 1000D) attached on a stereomicroscope (Stemi 2000-C, Zeiss, Germany), was taken from each sample prior to the addition of any tissue preservation substances.

General and diagnostic shell characters were studied and four shell measurements (shell height and width, aperture height and width) were taken from 14 specimens using the micrometer of the Stemi 2000-C stereomicroscope. Four ratios were generated from the raw data (Sh/Sw, Ah/Aw, Sh/Ah and Sw/Aw).

Ten specimens were dissected and studied anatomically under the stereomicroscope using very fine pins and pointed watchmaker's forceps. Prior to dissection, the shell of each specimen was removed by soaking in Pereny solution. The soft body features were documented using the digital camera as described above.



Figure 1. Map showing the distribution of the locally endemic Truncatelloidea in Peloponnisos, southern Greek mainland. Abbreviations: B.a. *Bythinella atypicos*, B.b. *Bythinella beckmanni*, D.h. *Daphniola hadei*, H.e. *Hauffenia edlingeri*, I.a. *Iglica alpeus*, I.s. *Isimerope semele*, I.w. *Iglica wolfischeri*, M.h. *Myrtoessa hyas* gen. n., sp. n., P.e. *Pseudamnicola exilis*, R.f. *Radomaniola feheri*, R.s. *R. seminula*, R.t. *R. tritonum*.

To remove tissue remaining and debris, the shell, the radula and the operculum were immersed in KOH solution (5g/l) at room temperature, rinsed in distilled water and air-dried before being mounted on stubs. The protoconch, the operculum and the radula were studied using scanning electron microscopy (SEM, Jeol JSM–35 operating at 25 kV) after being dried and spray-coated in gold–palladium.

The authority of the family Hydrobiidae was based on Bouchet and Rocroi (2005). In the description of the morphological characters and their states, the terminology of Hershler and Ponder (1998) was adopted.

A restricted number of specimens (27 specimens in total) was collected from the sampling locality because the population abundance seemed to be low (no specimen was found during the initial 5 min sampling effort). The collected material was deposited in the Zoological Museum (**ZMUA**) of the National & Kapodistrian University of Athens (**UOA**) and in the personal collection of C. Radea deposited in the Department of Ecology & Systematics, UOA.

Abbreviations

Shell characters:

Ah aperture height,
 Aw aperture width,
 CV* (1+1/4n)*SD/x coefficient of variation corrected for sample size (Sokal and Rohlf 1995),

Maxmaximum,Minminimum,nnumber of specimens,SDstandard deviation,Shshell height,Swshell width,xmean.

Anatomical characters:

11/////////////////////////////////////	<i>cm cism m cr ci s</i>
Bc	bursa copulatrix,
Bd	bursal duct,
Cg	capsule gland,
Cm	commissure,
E	eye,
Ec	egg capsule,
Fp	faecal pellets,
In	intestine
Lpg	left pleural ganglion,
Md	mantle
0	renal oviduct,
Oe	oesophagous
Ol	oviduct loop,
Р	penis,
Pd	penial duct,
R	rectum,
Rcg	right cerebral ganglion,
Sbg	suboesophageal ganglion,
Sh	shell,
Sn	snout,
Sp	Sub-terminal penial papilla,
Sr1	distal seminal receptacle,
Sr2	proximal seminal receptacle,
Ss	style sac
St	stomach
Т	tentacle,
V	ventral channel.

Systematic description

Family Hydrobiidae Stimpson, 1865

Myrtoessa Radea, gen. n.

http://zoobank.org/B85FE216-9EB4-46A2-AC80-206D8C5DC296

Type species. *Myrtoessa hyas* sp. n. by original designation.

Diagnosis. Shell minute (maximum height 1.05 mm, maximum width 1.30 mm), valvatiform with more or less depressed spire; operculum without peg; central tooth with one basal cusp on each side; ctenidium and osphradium present; penis long, flat, blunt, with wide wrinkled proximal part and narrow distal part with a sub-terminal eversible papilla; female genitalia with large pyriform bursa copulatrix, renal oviduct non-pigmented, coiled in an ε (Greek)- shape; two seminal receptacles lying parallel on the renal oviduct and rather close to each other, a small distal receptacle (Sr1) and a larger proximal one (Sr2).

Etymology. The generic name derives from the Greek mythology: Myrtoessa (Μυρτώεσσα in Greek) was a naiad nymph in Arkadia. Gender feminine.

Myrtoessa hyas Radea, sp. n.

http://zoobank.org/4811DC7A-037A-4D3A-9F02-36F5F3B2A2BF Figs 2–7

Type-locality. Poulithra, Peloponnese, Greece, 36°6.63'N, 22°53.53'E, 70 m a.s.l, stream, 12/IV/2014, C. Radea, G. Tryfonopoulos legs.

Diagnosis. As for genus.

Etymology. The specific name (in apposition) derives from the Greek mythology: Hyas, (Υάς in Greek), was one of the seven nymphs Hyades (Υάδες in Greek) bringing humidity and rain, daughters of Atlas and Pleione.

Type material. Holotype. Ethanol-fixed specimen, ZMUA 4183.

Paratypes. Two ethanol-fixed specimens, ZMUA 4184. Ten ethanol-fixed specimens dissected for anatomical study and four specimens coated for SEM, the remaining in the personal collection of C. Radea deposited in the Department of Ecology & Systematics, UOA.

Other material examined. Ten specimens, collected from the type locality, Th. Constantinidis, E. Kalpoutzakis legs, 25/IV/2014, in the personal collection of C. Radea deposited in the Department of Ecology & Systematics, UOA.

Description. *Shell* (Fig. 2A–I). Colourless valvatiform shell with up to 3.5 whorls, thin, transparent when fresh, therefore possible to follow the position of rectum; spire more or less depressed; whorls rounded, regularly growing with shallow sutures. Measurements are given in Table 1. Periostracum cream-coloured; aperture adhering to the last whorl, prosocline, roundish to ovate; peristome continuous, thickened at columel-



Figure 2. Shells of *Myrtoessa hyas* gen. n., sp. n. **A–E** Dorsal view **F–G** Ventral view **H-I** Lateral view. Scale bar 1 mm.

lar margin, reflected at columellar margin, the outer margin simple; umbilicus open, deep, wide so that the first whorls can be seen through it, sometimes partially covered by the collumelar margin of aperture (Figs 2F, G, 3B); protoconch microsculpture composed of a dense net of irregularly shaped depressions (Fig. 3A, C, D). The number of protoconch whorls is 1.25. The width of nucleus and protoconch is 102 μ m and 262 μ m, respectively.

Operculum (Fig. 3E, F). Operculum ovate, thin, corneous, paucispiral, yellowishorange, darker at the nucleus, with weakly convex inner face without any peg, nucleus sub-central.

Soft body pigmentation (Fig. 2A–I). Soft body pigmentation of alive specimens extremely variable, the colouration being visible under the transparent shell; many specimens almost totally unpigmented with only a few traces of pigments on walls of visceral sac, several specimens grey pigmented and some others dark grey pigmented; in the last two cases, tentacles with a median grey stripe and snout with grey areas



Figure 3. Scanning electron micrographs of shell, protoconch and operculum of *Myrtoessa hyas* gen. n., sp. n. **A–B** Shell dorsal and ventral view respectively **C** Shell apex showing protoconch **D** Close up of protoconch **E** Operculum, outer side **F** Operculum, inner side. Scale bars **A–D** 200 μm, **E–F** 100 μm.



Figure 4. Nervous system and female genitalia of *Myrtoessa hyas* gen. n., sp. n. A Nervous system **B-C** Female genitalia. Scale bar 0.25 mm. Abbreviations are given in the Material and Method section.

Table 1. Shell morphometry of *Myrtoessa hyas* gen. n., sp. n. Measurements are in mm. Abbreviations are given in the materials and methods.

Type locality		Sh	Sw	Ah	Aw	Sh/Sw	Ah/Aw	Sh/Ah	Sw/Aw
Poulithra	Min	0.60	1.20	0.60	0.60	0.46	0.92	1.00	0.92
	Max	1.05	1.40	0.70	0.70	0.77	1.17	1.67	1.17
A7 1/	x	0.88	1.31	0.63	0.63	0.67	1.02	1.40	1.02
IV = 14	SD	0.12	0.09	0.04	0.05	0.08	0.08	0.19	0.08
	CV*	0.14	0.07	0.06	0.09	0.12	0.08	0.14	0.08

laterally and around eyes; snout longer than wide, parallel-sided with medium distal lobation; eye spots present; tentacles about six times as long as wide (in specimens preserved in ethanol solution 70%).

Nervous system (Fig. 4A). Cerebral ganglia of the same size, white-coloured; supraoesophageal and suboesophageal ganglia of the same size, smaller than cerebral ganglia, white-coloured; supraoesophageal connective about equal to suboesophageal connective; mean RPG ratio 0.39 (three specimens), nervous moderately concentrated.

Ctenidium-Osphradium. Ctenidium with ca 5–7 long lamellae. Osphradium of intermediate width, opposite posterior part of ctenidium.

Radula (Fig. 5). Central tooth trapezoidal, dorsal edge of tooth strongly concave; one pair of medium-sized basal cusps (bc2), basal tongue broadly V-shaped and about equal to lateral margin; median cusp blunt, protruding, broader and longer than laterals, 5 lateral cusps on each side of median cusp, the latter one not well defined (Fig. 5A, B); lateral tooth face taller than wider, basal tongue well developed; outer wing moderately flexed; cutting edge much shorter than outer wing; central cusp longer than lateral cusps, 5 lateral cusps on outer side, 4-5 on inner side (Fig. 5C); inner marginal



Figure 5. Scanning electron micrographs of radula of *Myrtoessa hyas* gen. n., sp. n. **A** Portion of radular ribbon **B** Central teeth **C** Lateral teeth **D** Inner and outer marginal teeth. Scale bars 10 µm.

tooth with *ca*. 24-28 long almost equal in size cusps; outer marginal tooth with *ca*. 27 cusps (Fig. 5D).

Digestive system apart from radula (Fig. 6). Style sac smaller than stomach, not protruding to the intestinal loop (Fig. 6A); rectum V-shaped, V being wider in female specimens (Fig. 6B).

Male reproductive system (Fig. 7A–C). Penis long, tapering, flat, blunt, distal portion being well demarcated from proximal portion, opening through sub-terminal pa-



Figure 6. Digestive system (apart from the radula) of *Myrtoessa hyas* gen. n., sp. n. **A** Stomach, style sac, part of intestine and oesophagous **B** Rectum. Scale bar 0.5 mm. Abbreviations are given in the Material and method section.



Figure 7. Reproductive anatomy of *Myrtoessa hyas* gen. n., sp. n. **A–C** Penis **D** Female genitalia (viewed from the left side) **E** Shell with an egg capsule into the umbilicus. Scale bars: **A**, **B**, **D** 0.5 mm, **C**, **E** 1 mm. Abbreviations are given in the Materials and methods.

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pilla on the left, whitish with a median grey stripe at the distal portion (in the grey pigmented specimens), proximal portion bent upon itself and wrinkled near the base; base usually black pigmented ventrally, its attachment area well behind the right eye; penial duct strongly undulating in base and straight distally, near centrally positioned and opening on the left side of penis; prostate like an elongate bean with mean length 0.44 mm (three specimens).

Female reproductive system (Figs 4B–C, 7D–E). Pallial oviduct glands, i.e. albumen and capsule glands, very small, total mean length 0.53 mm, total mean width 0.24 mm (three specimens); bursa copulatrix large-sized, pyriform, posteriorly positioned and fully protruding from the posterior end of the albumen gland; bursal duct length a little shorter than or equal to bursa copulatrix length; renal oviduct unpigmented and well-developed, tightly coiled in a shape of lower case ε (Greek); two seminal receptacles lying parallel on the renal oviduct and rather close to each other; distal seminal receptacle (Sr1) very small, globular with very short duct; proximal seminal receptacle (Sr2) larger, usually lying tightly over the renal oviduct and against bursa copulatrix; proximal seminal receptacle (Sr2) with a pink pearl shine. In some specimens, an egg capsule with a single egg was found inside the umbilicus (Fig. 7E).

Distribution and habitat. So far the distribution of *Myrtoessa hyas* gen. n. & sp. n., seems to be restricted to the type locality on Parnon Mt., Peloponnisos. At the type locality, the geological substrate is limestone; all the specimens of the new species were found on stones, gravel, mosses and dead leaves of *Platanus orientalis* L. accumulated on the bottom of a stream. Many *Bythinella* sp. individuals were found to share the same stream.

Discussion

Twelve locally endemic truncatelloidean species (see Reischütz and Reischütz 2004, 2008, Falniowski and Szarowska 2011b, Falniowski et al. 2012, Georgiev 2013, Radea et al. 2013a) have been described from Peloponnese so far (Fig 1). The high number of endemic truncatelloideans was being expected since the complex topography and the intense geological history of this mainly mountainous area facilitate and promote the diversity and endemicity of invertebrates (Sfenthourakis and Legakis 2001, Legakis and Maragou 2009).

Myrtoessa hyas gen. n. & sp. n. differs from all the known valvatiform hydrobiids in having a unique combination of shell and anatomical characters that according to the standard hydrobiid taxonomy, does not allow its inclusion in any other known genus of the Hydrobiidae family. Consequently, a new monotypic genus is necessary to accommodate it.

The combination of the features of male and female genitalia followed by Bodon et al. (2001) for distinguishing the known genera of valvatiform Hydrobiidae shows that the new genus is clearly differentiated from the other European and circum-Mediterranean valvatiform genera (Table 2) having bursa copulatrix and two seminal receptacles

eninsula and in the Mediterranean Basin: eleven	
rr valvatiform genera distributed in the Balkan I	r genera are given (based on Radea et al. 2013).
. compared morphologically with othe	nd character-state scores for thirty-four
Table 2. Myrtoessa gen. n	morphological characters a

	Distribution	Bursa copulatrix	Seminal receptacle (s)	Penis	Penial lobe(s)	Penial papilla	Penial stylet	Ctenidium	Eyes	Operculum	Umbilicus	Rectum
Arganiella	Italy, Spain, Montenegro	1	1	0	0	0	0	1	0	0	2	(U) or (S)
Boetersiella	Spain	1	1	0	0	0	0	0	1	0	2	(U)
Bracenica	Montenegro	1	ĸ	1	2	0	0	١	0	1	3	1
Chondrobasis	Spain	1	1	1	1	0	0	0	1	0	2	(U)
Corbellaria	Spain	1	ĉ	1	2	0	0	0	ı	0	2	(SS)
Dabriana	Bosnia	1	1	0	0	0	0	1	0	١	-	١
Daphniola	Greece	1	ĉ	1	2	0	0	1	-	0	0	ı
Fissuria	Greece, Italy, France	1	С	3	1+3	1	0	1	0	0	0, 1, 2, 3	(S)
Gocea	FYROM	1	с	1*	4^*	0	0	١	1	1	2	ı
Graecoarganiella	Greece	1	ĉ	1	1	1	0	0	1	١	2	(S)
Hauffenia	Italy, Greece	1	2	0,1	0,4	0	1	1, 0	0	1a	2	(Z) or (?)
Heraultiella	France	1	1	0	0	0	0	1	0	0	2	(U) or (V)
Horatia	Croatia, FYROM	1	ŝ	1,2	3	0	0	1	-	0	-	(0)
Iberboratia	Spain	1	ĉ	1	2	0	0	1	-	0	2	(U) or (S)
Isimerope	Greece	1	0	1	3	1	0	0	1	0	1	(U)
Islamia	Greece, France, Italy, Spain, Turkey, Israel	0	3	1	4	0	0	1	1	0	0	(U)
Josefus	Spain	0	С	1	4	0	0	0	1	0	1	(U)
Karevia	FYROM	1	3	1	3	0	0	١	1	*0	3	ı
Kerkia	Slovenia	1	1	1	3	0	0	1	0	1	2	(S)
Lybnidia	FYROM	1	2	1^*	4*	0	0	١	1	0	0	ı
Milesiana	Spain	0	С	1	2	0	0	1	1	0	2	(U)
Myrtoessa	Greece	1	Э	0	0	2	0	1	1	0	2	(V)
Ohridohauffenia	FYROM	1	3	1	3	0	0	ı	1	0	1	ı
Ohrigocea	FYROM	1	3	1	3	0	0	-	1	0	2	1
Pezzolia	Italy	0,1	ω	0	0	0	0	0	0	0	2	(S)

	Distrikusion	Bursa	Seminal	Dania	Penial	Penial	Penial	Conidium	L		ITmhilious	Doctor
	Hornnarnstra	copulatrix	receptacle (s)	Lems	lobe(s)	papilla	stylet	Cleman	Eyes	Opercuturi	CINDILICUS	Vecturi
Prespolitorea	Greece, FYROM	1	33	1	3	0	0	١	1	*0	1	1
Pseudohoratia	FYROM	1	2	1	3	0	0	1	-	1	0,1,2	(0)
Pseudoislamia	Greece	1	33	1	4	0	0	١	1	0	2	ı
Sardohoratia	Italy	1	3	0	0	0	0	0	0	0	0	(S)
Sheitanok	Turkey	1	1	0	0	0	0	1**	1	*0	3	ı
Spathogyna	Spain	1	33	1	2	0	0	1	-	*0	2	S
Strugia	FYROM	1	2	1	3	0	0	ı	-	0	2	ı
Tarraconia	Spain	1	0	1	2	0	0	1	1	0	3	(Ŋ
Zaumia	FYROM	1	2	1*	4*	0	0	ı	0	0	1	١
Character states :	and symbols: bursa copula	trix: absent (()), present (1),	semina	al recept:	acles: abse	ent (0), d	istal seminal	recept	acle (1), prox	imal semina	l receptacle
(2), distal and pr	oximal seminal receptacle (3), penis : sim	ple without lol	be(s) (0), with o	ne lobe (1), with t	wo lobes (2),	with r	nore than two	o lobes (3), J	oenial lobe
(s): absent (0), bi	asal lobe (1), medial lobe (2	!), lobe at 2/3	of penis length	1 (3), af	oical lobe	(4), peni :	al papilla	n : absent (0),	presen	t terminal ev	ersible (1), p	resent sub-
terminal eversible	e (2), penial stylet: absent (0), present (1)	, ctenidium: a	bsent ((0), presen	it (1), eye	s: absent	(0), present (1), ope	rculum: simj	ple (0), peg-l	pearing (1),
umbilicus: narro	w (0), medium (1), wide (2	:), very wide (;	3), rectum: wit	thout o	r almost	without b	end (0), 3	Z-like (Z), U	-like (I	J), S-like (S),	V-like (V),	?-like (?); ^a :
not present in all	species *: it was deduced by	y Bodon et al.	. (2001), **: Sc	chütt an	id Şessen,	, 1989, pa	ge 117, f	ig 2B -: no d	ata			

Sources: Arconada and Ramos 2001, 2002, 2006, Arconada et al. 2007, Bodon and Giusti 1986, Bodon et al. 1995, Bodon et al. 2001, Boeters et al. 2014, Callot-Girardi and Boeters 2012, Falniowski and Szarowska 2011a, Girardi 2009, Giusti and Pezzoli 1981, Manganelli et al. 1998, Radea et al. 2013, Radoman 1966, 1983, Ramos et al. 2000, Schütt 1991, Schütt and Şessen 1989. by the penial characters. These genera are further differentiated from *Myrtoessa* gen. n. in having, among others, an operculum with peg (*Bracenica* Radoman, 1973, *Gocea* Hadzišiče 1956), no eyes (*Fissuria*, *Pezzolia* Bodon & Giusti, 1986, *Sardohoratia* Manganelli, Bodon, Cianfanelli, Talenti & Giusti, 1998), different shape of rectum (*Corbellaria* Callot-Girardi & Boeters, 2012, *Fissuria*, *Graecoarganiella*, *Horatia* Bourguignat, 1887, *Iberhoratia* Arconada & Ramos, 2007, *Pezzolia* Bodon & Giusti 1986, *Sardohoratia*).

The opening of penial duct through a sub-terminal papilla is a novel character recorded for the first time in the valvatiform hydrobiids of Europe and Mediterranean Basin since, up to now, only a terminal papilla has been recorded (Table 2). The other valvatiform genera having a penial papilla, i.e. *Fissuria, Graecoarganiella* and *Isimerope*, are distinguished from *Myrtoessa* gen. n. by the position of the papilla, the different overall shape of the penis, the female genitalia (*Isimerope*) and other characters detailed in Table 2.

The new genus inhabits a stream with cold and clear fast running water. The rest known valvatiform genera of Greece thrive in various freshwater systems: *Islamia* and *Pseudoslamia* in lakes, springs and streams, *Isimerope* in springs and rivers, *Fissuria* in subterranean waters, *Daphniola, Hauffenia* and *Graecoarganiella* in springs and *Prespolittorea* in lakes (Radoman 1983, Reischütz 1988, 2004, Bodon et al. 2001, Falniowski and Szarowska 2011a, Radea et al. 2013a,b).

The single population of *Myrtoessa hyas* gen. n. & sp. n. nearby a coastal touristic village is vulnerable to anthropogenic stressors, in particular during the summer period, due to the numerous tourists, visitors, and hikers as well as to the increased demands for water supply and irrigation.

In last three years, one new locally endemic monotypic truncatelloidean genus, i.e. *Isimerope* (Radea et al. 2013), and seven new locally endemic species i.e. *Radomaniola feheri* Georgiev, 2013 (Georgiev 2013), *Daphniola magdalenae* Falniowski, 2015, *Iglica hellenica* Falniowski, 2015 (Falniowski and Sarbu 2015), *Pseudamnicola ianthe* Radea & Parmakelis, 2016, *P. ilione* Radea & Parmakelis, 2016 (Radea et al. 2016), *P. magdalenae* Falniowski, 2016 (Falniowski 2016a), and *Bythinella walensae* Falniowski, 2016 (Falniowski 2016b) were described from Greece. The introduction of one more new locally endemic genus provides clues about the richness and the high endemicity of Greek freshwater bodies, which support some of the most biodiverse and heavily threatened ecosystems of the Mediterranean Basin Biodiversity Hotspot (Szarowska and Falniowski 2004, Darwall et al. 2014).

Key to the Greek valvatiform genera based on genitalia character states

1	Bursa copulatrix present	2
_	Bursa copulatrix absent	Islamia
2	Seminal receptacle(s) present	
_	Seminal receptacle(s) absent	Isimerope

3	Both proximal (Sr2) and distal (Sr1) receptacles present4
_	Only proximal (Sr2) receptacle present Hauffenia
4	Proximal seminal receptacle (Sr2) well developed, much larger than the distal
	one (Sr1)Prespolitorea
_	Not as above
5	Penis with papilla
_	Penis without papilla
6	Penis with terminal papilla7
_	Penis with sub-terminal papilla, without lobe(s), distal portion of penis well
	demarcated from proximal portion
7	Penis pigmented black, long, tapering, cylindrical with one double lobe on its
	proximal portion Graecoarganiella
_	Penis unpigmented, rather short, parallel-sided, flat with more than one glan-
	dular lobes on distal, occasionally on proximal portion too Fissuria
8	Penis with a wide lobe on its distal portionPseudoislamia
_	Penis with a narrow lobe on its proximal portion Daphniola

Acknowledgments

We wish to thank A. Economou-Amilli for the scanning electron micrographs, Th. Constantinidis, E. Kalpoutzakis for collecting additional material, G. Tryfonopulos and the staff of Management Body of Mount Parnon and Moustos wetlands for their help in the field. The fieldwork was done under a collection permit (ref. no. 111704/1686) issued by the Greek Ministry of Environment, Energy and Climate Change. The manuscript was improved by the useful comments and suggestions of Subject Editor M. Haase and two anonymous reviewers.

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RESEARCH ARTICLE



A new species of *Eusirus* from Jeju Island, Korea (Crustacea, Amphipoda, Eusiridae)

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Academiceditor: C.O. Coleman Received 24 September 2016 Accepted 21 November 2016 Published 13 December 2016
http://zoobank.org/29F7ABB3-92B8-4CEE-A89F-6625D7EFEC1D

Citation: Jung TW, Kim M-S, Soh H-Y, Yoon SM (2016) A new species of *Eusirus* from Jeju Island, Korea (Crustacea, Amphipoda, Eusiridae). ZooKeys 640: 19–35. https://doi.org/10.3897/zooKeys.640.10630

Abstract

A new eusirid amphipod, *Eusirus bulbodigitus* **sp. n.**, from Jeju Island, Korea is described with a detailed description and illustrations. *Eusirus bulbodigitus* **sp. n.** shows common features with the five known eusirid amphipods *E. abyssi* Stephensen, 1944, *E. columbianus* Bousfield & Hendrycks, 1995, *E. hirayamae* Bousfield & Hendrycks, 1995, *E. laticarpus* Chevreux, 1906, and *E. parvus* Pirlot, 1934, such as the mandibular palp article 3 bearing a group of setae laterally. However, this new species is differentiated by the combination of the following characteristics: the eyes are poorly developed, the propodus on pereopod 4 is slightly shorter, the inner margin of dactylus on pereopod 4 is swollen, the length of pereopods 5–7 is moderate, the urosomite 1 has a dorsal protrusion distally, and the telson is shallowly cleft. This is the first record of the genus *Eusirus* Krøyer, 1845 from Korean waters.

Keywords

Amphipoda, eusirids, Eusirus bulbodigitus, Korea, new species, taxonomy

Introduction

Members of the genus Eusirus Krøyer, 1845 share several synapomorphies such as the raptorial gnathopods having a lobate carpus and enlarged propodus, well-developed molars, strong and dentate incisors and dentate left lacinia on the mandible, and a strong maxillipedal palp (Bousfield 1978, Barnard and Karaman 1991, Bousfield and Hendrycks 1995). Up to date, this genus contains 27 nominate species worldwide, but the further taxonomic study on the validity of them is needed (Sars 1895, Chevreux 1906, 1911, 1912, Stephensen 1912, 1944, Pirlot 1934, Gurjanova 1951, Schellenberg 1955, Birstein and Vinogradov 1960, Barnard 1961, Andres 1979, Bousfield and Hendrycks 1995, Andres et al. 2002). In the North Pacific, Bousfield and Hendrycks (1995) reviewed the systematics and distributions of the family Eusiridae Stebbing, 1888, but our taxonomic knowledge concerning the fauna of the genus *Eusirus* still remains very poor with the records of six species only: E. cuspidatus Krøyer, 1845 from Alaska and the Bering Sea (Gurjanova 1951, Shoemaker 1955, Bousfield and Hendrycks 1995); E. columbianus Bousfield & Hendrvcks, 1995 from Alaska and British Columbia (Bousfield and Hendrycks 1995); E. hirayamae Bousfield & Hendrycks, 1995 from Japan (Hirayama 1985, Bousfield and Hendrycks 1995); and E. bathybius Schellenberg, 1955, E. fagilis Birstein & Vinogradov, 1960 and E. parvus Pirlot, 1934 from western Pacific regions close to the Equator (Pirlot 1934, Schellenberg 1955, Birstein and Vinogradov 1960, Bousfield and Hendrycks 1995).

Here, we report a new eusirid species, *Eusirus bulbodigitus* sp. n. from Jeju Island, Korea, belonging to the family Eusiridae with a detailed description and illustrations. This is the first record of the genus *Eusirus* from Korean waters.

Material and methods

Sample was collected from subtidal zone using a sledge net (mesh size 300 μ m, mouth size 120 × 45 cm). Specimen was initially fixed with 5% formaldehydeseawater solution and then preserved with 85% ethyl alcohol after sorting in the laboratory. It was stained with lignin pink dyes. Appendages were dissected in Petri dishes filled with glycerol using dissection forceps and a needle under a stereomicroscope (SZH10; Olympus, Tokyo, Japan). Its appendages were mounted on permanent slides using polyvinyl lactophenol solution. Drawings were made under a light microscope (LABOPHOT-2; Nikon, Tokyo) with the aid of a drawing tube. Definition of the term for 'seta' and its types follows those of Watling (1989). Type material was deposited at the National Institute of Biological Resources (NIBR), Incheon, Korea.

Systematic account

Order Amphipoda Latreille, 1816 Suborder Gammaridea Latreille, 1802 Family Eusiridae Stebbing, 1888 Genus *Eusirus* Krøyer, 1845

Eusirus bulbodigitus sp. n. http://zoobank.org/F4F288E6-5704-4F02-BD55-B3ADC5AABE13 Figs 1–6

Type locality. Jeju Island, South Korea, 33°29'12"N, 126°57'17"E, sublittoral (average depth 33 m).

Material examined. Holotype: NIBRIV0000332003, adult male, 11.3 mm, collected from the type locality on 30 Nov 2012 by Prof. H-.Y. Soh.

Etymology. The composite epithet of the specific name, *bulbodigitus*, is a combination of Latin *bulbosus* and *digitus*. This name means 'swollen dactylus', referring to the shape of the dactylus on percopod 4.

Diagnosis. Head, lateral cephalic lobe slightly oblique apically; eyes poorly developed. Antenna 1 stout, with peduncular articles 1–3 in length ratio of 4.4:3.8:1.0; peduncular articles 2–3 with 1 robust seta at posterodistal corner subdistally; accessory flagellum uni-articulate. Antenna 2, peduncular article 4 slightly longer than article 5, with calceoli on posterior margin. Maxilla 1, outer plate with 11 dentate setae. Maxilla 2, inner plate broader and larger than outer plate. Left mandible with bi-dentate incisor and 6-dentate lacinia mobilis; right mandible with bi-dentate incisor, lacinia mobilis not split and with 1 row of small dentations apically; palp article 3 with 1 group of 4 serrate setae on lateral margin proximally. Gnathopods stout, "eusiroidean" in form; capus with narrow posterior lobe covered with long serrate setae mediodistally, posterior margin lateral border with acute protrusion at distal corner; propodus wider than long, broad and very deep, with 1 group of defining setae. Pereopod 3 slender, length ratio of merus:carpus:propodus 1.0:0.7:0.9. Pereopod 4, length ratio of merus: carpus:propodus 1.0:0.6:0.7; dactylus with slightly swollen posterior margin. Pereopods 5-7 slender, basis with strong serrations posteriorly. Pleonites 1-2 with acute protrusion dorsodistally; epimeron 3 with 20 serrations posterodistally. Uropod 1, peduncle with 1 enlarged seta at mediodistal corner subdistally; rami lanceolate; outer ramus 0.9 times as long as inner ramus. Uropod 2 0.9 times as long as uropod 1; outer ramus 0.6 times as long as inner ramus. Uropod 3 shortest. Telson shallowly cleft (approximately 1/6 length).

Description of holotype male. Head (Fig. 1A), rostrum distinct, moderate; lateral cephalic lobe concave and slightly oblique apically; antennal sinus not deep; eyes reniform, poorly developed, with boundary composed of separated ommatids.

Antenna 1 (Fig. 1B–D) stout, with length ratio of 4.4:3.8:1.0 in peduncular articles 1–3; peduncular article 1 stout, anterior margin with 1 row of plumose setae



Figure I. *Eusirus bulbodigitus* sp. n., holotype, male, NIBRIV0000332003, 11.3 mm. Jeju Island, South Korea. A Head B Antenna 1 C Accessory flagellum D Calceoli of flagellum on antenna 1 E Antenna 2
F, G Calceoli of peduncular article 5 and flagellum on antenna 2 H Upper lip I Lower lip J Maxilla 1
K Setae of outer plate on maxilla 1 L Maxilla 2. Scale bars=0.1 mm (C, D, F, G, K), 0.2 mm (H–J, L), 0.5 mm (A, B, E).

proximally, distal margin serrate medially; peduncular article 2 moderate, with groove at anterodistal corner, with 1 robust seta at posterodistal corner subdistally, distal margin serrate; peduncular article 3 short, with 1 robust seta at posterodistal corner; accessory flagellum uni-articulate, as long as 1st proximal article of flagellum, with 2 simple setae subapically and 1 plumose seta apically; flagellum 50-articulate, 1.5 times as long as peduncular articles 1–3 combined, proximal article longest, posterodistal aesthetascs or calceoli present irregularly.

Antenna 2 (Fig. 1E–G) shorter than antenna 1; peduncular articles 4–5 stout, armed with simple, robust and plumose setae of various combinations; peduncular article 4 with 2 calceoli on posterior margin distally, possessing groove at anterodistal corner; peduncular article 5 slightly shorter than peduncular article 4, posterior margin with groups of calceoli and setae; flagellum slightly shorter than peduncular articles 4–5 combined, 32-articulate, with calceoli posteodistally from 1st to 14th articles.

Upper lip (Fig. 1H) globular, apex convex and weakly produced, covered with marginal and submarginal fine setae.

Lower lip (Fig. 1I), inner lobe weak, covered with marginal and submarginal fine setae; outer lobe subovoid, round distally, covered with fine setae on apex and medial margin; mandibular process short.

Maxilla 1 (Fig. 1J, K), outer plate with 11 dentate setae on apical margin; palp long, slender, beyond apical setae of outer plate, palp article 1 elongate, 0.8 times as long as outer plate, palp article 2 with 1 row of 12 setae along apex and mediodistal margin.

Maxilla 2 (Fig. 1L), inner plate ovoid, broader, larger than outer plate, lined with 17 marginal setae from apex to distal half of medial margin, with 4 plumose setae subdistally and 6 facial setae on medial margin; outer plate with 18 setae on apical margin.

Left mandible (Fig. 2A) with bi-dentate incisor and 6-dentate lacinia mobilis; accessory setal row composed of 2 simple and 4 dentate setae; palp 3-articulate, palp article 1 shortest, palp article 2 slightly curved, with 1 row of 11 setae on surface obliquely, palp article 3 1.2 times as long as palp article 2, gradually slender distally, covered with several rows of minute setae on distal surface, with 1 group of 4 serrate setae on lateral margin proximally and longest seta among them reaching apex of palp article 3, lined with simple and serrate setae on medial margin, apex oblique and with 5 long serrate setae. Right mandible (Fig. 2B) with bi-dentate incisor, lacinia mobilis not split and with 1 row of small dentations apically; accessory setal row composed of 3 dentate setae; molar triturative, columnar; palp similar to that of left mandible.

Gnathopod 1 (Fig. 2C, D) stout, strongly subchelate, "eusiroidean" in form; coxa subtriangular, slightly expanded anteroventrally, with 13 submarginal setae on ventral margin irregularly, with 4 small notches bearing 1 minute seta and more expanded backwards posterodistally, with 9 setae on medial surface; basis steady in width, anterior margin lateral border shallowly lobate distally bearing 1 minute seta, with 6 short setae on distal half, medial border weakly lobate unevenly bearing 4 groups of elongate setae on distal 2/3, posterior margin lined with 19 submarginal 4 setae, with 1 group of 3 setae distally; ischium largely lobate, anterior margin lateral border expanded dis-



Figure 2. *Eusirus bulbodigitus* sp. n., holotype, male, NIBRIV0000332003, 11.3 mm. Jeju Island, South Korea. **A** Left mandible **B** Right mandible **C** Gnathopod 1 **D** Setae of posterior margin of propodus on gnathopod 1. Scale bars=0.05 mm (**D**), 0.4 mm (**C**), 0.5 mm (**A**, **B**).

tally, with 3 minute setae, medial border lobate, with 3 minute setae distally, posterior margin with 7 setae; merus subrectangular, as long as ischium, forming groove and broadly lobate on anterior margin, posterior margin lined with serrate setae, with 12 serrate setae on medial surface posterodistally; carpus elongate and slender, 0.8 times as long as basis in length of anterior margin, anterior margin lined with regularly spaced robust and simple setae, carpal lobe narrow, covered with elongate serrate setae medio-distally, posterior margin lateral border with acute protrusion distally, medial border broadly lobate; propodus wider than long, broad, very deep, shorter than that of carpus in length of anterior margin fitting well to distal groove of carpus and with setae distally, with 1 group of 10 defining setae, palm long, convex, lined with numerous crooked setae submarginally, with 1 pair of plumose setae distally; dactylus falcate, stout, long, fitting palm, lined with minute setae along inner margin.

Gnathopod 2 (Fig. 3A, B) similar to gnathopod 1, stout, strongly subchelate, also "eusiroidean" in form; coxa rectangular, with 2 small notches bearing 1 minute seta at posterodistal corner, with 1 robust seta on posterior margin, with 8 setae on medial surface, ventral margin convex, with 10 submarginal setae; basis steady in width, anterior margin lateral border shallowly lobate distally bearing 1 minute seta and with 18 setae, medial border with 1 long and 12 short setae, with 1 pair of elongate setae at anterodistal corner, posterior margin lined with 12 setae on proximal 1/3, remainder just with 6 minute setae, with 1 group of 3 setae at posterodistal corner; ischium largely lobate, expanded distally, anterior margin with 5 minute setae on lateral and medial borders, respectively, posterior margin just with 2 setae, with 1 pair of setae at posterodistal corner; merus subrectangular, slightly longer than ischium, forming groove anteriorly, posterior margin lined with short setae, covered with 7 long serrate setae on posterodistal surface, posterodistal corner weakly produced, with 2 short setae; carpus elongate and slender, 0.7 times as long as basis, anterior margin lined with robust and simple setae regularly, carpal lobe narrow, covered with elongate serrate setae medially, posterior margin lateral border with acute protrusion distally, medial border broadly lobate, with 2 minute setae marginally, with 1 robust seta on medial surface; propodus wider than long, broad, very deep, shorter than that of carpus in length of anterior margin, anterior margin with 2 setae, with 1 plumose and 3 simple setae at anterodistal corner, proximal 2/3 of posterior margin fitting well to distal groove of carpus, with 1 group of 11 defining setae, palm long, convex, lined with numerous crooked setae submarginally, with 1 pair of plumose setae proximally; dactylus falcate, stout, long, fitting palm, lined with minute setae along inner margin.

Pereopod 3 (Fig. 4A, B) slender, length ratio of merus:carpus:propdus 1.0:0.7:0.9; coxa rectangular, convex, with 8 submarginal setae on ventral margin, expanded backwards, with 3 small notches bearing 1 minute seta at posteroventral corner, with 1 robust seta on posterior margin, with 23 setae on medial surface; basis linear and elongate, 1.4 times as long as coxa, anterior margin a little lobate distally, lined with 18 single and 2 pairs of setae on distal 2/3, with 1 pair of setae at anterodistal corner, posterior margin with 5 setae, with 1 long seta at posterodistal corner; ischium lobate



Figure 3. *Eusirus bulbodigitus* sp. n., holotype, male, NIBRIV0000332003, 11.3 mm. Jeju Island, South Korea. **A** Gnathopod 2 **B** Distal setae of posterior margin of propodus on gnathopod 2 **C** Pleonal epimera. Scale bars=0.05 mm (**B**), 0.4 mm (**A**), 0.5 mm (**C**).



Figure 4. *Eusirus bulbodigitus* sp. n., holotype, male, NIBRIV0000332003, 11.3 mm. Jeju Island, South Korea. **A** Pereopod 3 **B** Dactylus of pereopod 3 **C** Pereopod 4 **D** Ischium of pereopod 4 **E** Dactylus of pereopod 4. Scale bars=0.1 mm (**B**, **D**, **E**), 0.5 mm (**A**, **C**).

distally, with 3 minute setae on lateral and medial borders of anterior margin, respectively, with 1 pair of unequal setae at posterodistal corner; merus 0.6 times as long as basis, anterior margin with 7 minute setae, anterodistal corner weakly produced, with 1 pair of unequal setae, posterior margin with 6 pairs of short setae, with 1 group of 3 setae at posterodistal corner; carpus slightly dilated distally, 0.5 times as long as merus, anterior margin with 4 minute setae marginally and 1 seta distally, posterior margin with 5 pairs of unequal setae marginally and 1 pair of setae distally, distal margin obliquely truncated posteriorly, with 2 setae on lateral and medial borders, respectively; propodus, 0.9 times as long as merus, anterior margin with 8 minute setae, with 1 pair of minute setae at anterodistal corner, posterior margin with 11 groups of setae, with 1 pair of locking setae and 1 seta at posterodistal corner; dactylus elongate, 0.3 times as long as propodus, curved distally, with 5 rows of small teeth and 1 subdistal protrusion on distal half of posterior margin.

Pereopod 4 (Fig. 4C–E), length ratio of merus:carpus:propdus 1.0:0.6:0.7; coxa shorter than that of pereopod 3, broadly produced backwards and absent of robust seta on posterior margin; dactylus, posterior margin slightly swollen, parallel to anterior margin until distal 3/4 possessing 3 rows of small teeth, drastically diminished and forming falcation distally; shapes of other articles similar to those of pereopod 3.

Pereopod 5 (Fig. 5A–C), coxa bilobate subequally, anterior lobe slightly larger than posterior lobe, both expanded posteroventrally, posterior lobe with 2 subacute teeth posteroventrally; basis ovoid, convex anteriorly, anterior margin with 4 long setae proximally and lined with 15 setae, with 1 small acute protrusion and paired robust and minute setae at anterodistal corner, posterior margin lateral border moderately expanded and with 22 strong serrations bearing 1 minute seta, medial border with 2 setae distally and with 3 setae at angulate distal corner; ischium short, anterior margin with 1 seta, with 1 small acute protrusion and paired robust and minute setae at anterodistal corner, posterior margin lateral border largely lobate, its apex acute and slightly lurched distally, medial border also lobate but not produced distally; merus 0.7 times as long as basis, anterior margin lined with 3 single setae and 4 groups of setae, with 1 group of 4 setae at anterodistal corner, posterior margin slightly expanded, with 5 setae irregularly, with 1 pair of unequal setae at produced posterodistal corner; carpus as long as merus, anterior margin with 5 groups of setae, anterodistal corner obliquely truncated, with 1 group of 8 setae, posterior margin with several setae and 1 group of 6 setae distally; propodus linear and elongate, 1.8 times as long as carpus, anterior margin with 11 single and 3 paired setae, with 1 pair of locking setae and 1 lateral seta distally, posterior margin setose irregularly, with 3 setae at posterodistal corner; dactylus also elongate, 0.3 times as long as propodus, curved distally, with 7 rows of small teeth and 1 subdistal protrusion on distal 2/3 of anterior margin, with 3 minute setae on posterior margin.

Pereopod 6 (Fig. 5D–H) longer than pereopod 5; coxa bilobate, anterior lobe smaller, posterior lobe more dilated posteroventrally, with 2 small notches bearing 1 minute seta; basis ovoid, anterior margin with 15 setae proximally and lined with 12 setae, with 1 small acute protrusion, 1 robust and 1 simple seta at anterodistal corner, posterior margin lateral border moderately expanded, with 21 strong serrations bear-



Figure 5. *Eusirus bulbodigitus* sp. n., holotype, male, NIBRIV0000332003, 11.3 mm. Jeju Island, South Korea. **A** Pereopod 5 **B** Posterodistal setae of carpus on pereopod 5 **C** Dactylus of pereopod 5 **D** Pereopod 6 **E** Ischium of pereopod 6 **F** Distal part of merus on pereopod 6 **G** Distal part of carpus on pereopod 6 **H** Dactylus of pereopod 6. Scale bars=0.1 mm (**B**, **C**, **E**–**H**), 0.5 mm (**A**, **D**).

ing 1 minute seta, medial border with 10 setae on distal half; ischium short, anterior margin with 1 seta, with 1 seta and 1 small acute protrusion at anterodistal corner, posterior margin lateral border largely lobate, its apex acute and slightly lurched distally, medial border also lobate but not produced distally; merus as long as basis, anterior margin slightly concave, armed with setae of various combination, posterior margin broadly expanded, with 5 setae, posterodistal corner produced, with 1 group of 5 unequal setae; carpus 0.9 times as long as merus, anterior margin with 2 single, 1 paired short setae and 3 groups of setae, anterodistal corner obliquely truncated, with 1 group of 4 robust setae and 1 medial, 2 lateral setae, posterior margin with 2 setae, with 1 group of 4 setae at posterodistal corner; propodus linear and elongate, 1.8 times as long as carpus, anterior margin with 10 single and 7 paired setae, with 1 pair of locking setae and 1 lateral seta at anterodistal corner; dactylus also elongate, 0.2 times as long as propodus, curved distally, with 6 rows of small teeth and 1 subdistal protrusion on distal 2/3 of anterior margin, with 2 minute notches on posterior margin.

Pereopod 7 (Fig. 6A-D) longer than pereopod 6; coxa unilobate, convex ventrally, slightly dilated posteroventrally, with 1 group of minute setae on anterior margin proximally; basis subovoid, anterior margin with 6 setae proximally, lined with 2 minute and 11 robust setae, with 1 small acute protrusion and 2 setae at anterodistal corner, posterior margin lateral border more expanded proximally, with 23 strong serrations bearing 1 minute seta, medial border with 4 setae; ischium short, anterior margin with 1 seta, with 1 seta and 1 small acute protrusion at anterodistal corner, posterior margin lateral border largely expanded, slightly lurched distally bearing acute apex, medial border also lobate but not produced distally, with 3 setae at distal corner; merus as long as basis, anterior margin weakly setose, with 1 group of 4 setae at anterodistal corner, posterior margin broadly expanded, with 7 short and 2 elongate setae, posterodistal corner produced distally, with 1 group of 8 unequal setae; carpus 0.8 times as long as merus, slightly dilated distally, anterior margin setose, anterodistal corner obliquely truncated, with 1 group of 5 setae, 2 lateral and 1 medial setae, posterior margin setose, with 1 group of 5 setae at posterodistal corner; propodus linear, elongate, 1.6 times as long as carpus, anterior margin setose, with 1 pair of locking setae and 1 lateral seta at anterodistal corner, posterior margin densely setose irregularly; dactylus also elongate, 0.2 times as long as propodus, curved distally, with 6 rows of small teeth and 1 subdistal protrusion on distal 2/3 of anterior margin, with 2 minute setae on posterior margin.

Pleon (Fig. 3C), lateral ledge absent; pleonite 1 with acute protrusion dorsodistally, epimeron 1 dilated posteroventrally with subacute corner, with 1 group of 13 setae anteriorly on ventral margin; pleonite 2 also with acute protrusion dorsodistally, epimeron 2 not larger than epimeron 1, convex ventrally, weakly produced posteroventrally; pleonite 3 without acute protrusion on dorsal margin, epimeron 3 largest, flattened ventrally, posterior margin expanded backwards and with 20 serrations bearing 1 minute seta on distal half.



Figure 6. *Eusirus bulbodigitus* sp. n., holotype, male, NIBRIV0000332003, 11.3 mm. Jeju Island, South Korea. **A** Pereopod 7 **B** Posterodistal setae of merus on pereopod 7 **C** Distal part of carpus on pereopod 7 **D** Dactylus of pereopod 7 **E** Uropod 1 **F** Uropod 2 **G** Uropod 3 **H** Telson. Scale bars=0.1 mm (**B–D**), 0.4 mm (**E–H**), 0.5 mm (**A**).

Uropod 1 (Fig. 6E) slender, rami lanceolate; peduncle with 18 lateral and 20 medial setae dorsally, with 1 blunt protrusion and 1 enlarged seta at mediodistal corner subdistally; inner ramus as long as peduncle, medial margin weakly serrate, with 16 short and 4 elongate setae dorsally, lateral margin with more than 19 setae dorsally; outer ramus 0.9 times as long as inner ramus, medial margin weakly serrate, with 15 dorsally, lateral margin with 13 setae dorsally.

Uropod 2 (Fig. 6F) 0.9 times as long as uropod 1, rami lanceolate; peduncle 0.7 times as long as that of uropod 1, with 9 medial setae dorsally, weakly produced mediodistally, with 1 elongate seta at laterodistal corner; inner ramus 1.6 times as long as peduncle, lateral margin with more than 21 setae, medial margin serrate, with 34 setae dorsally; outer ramus 0.6 times as long as inner ramus, with 8 lateral setae dorsally, medial margin weakly serrate, with 12 setae dorsally.

Uropod 3 (Fig. 6G) shortest; peduncle 0.8 times as long as that of uropod 2, with acute protrusion on both laterodistal and mediodistal corners, with 2 medial setae dorsally, with 1 robust seta at both mediodistal and laterodistal corners; rami lanceolate; inner ramus 2.0 times as long as peduncle, with robust and plumose setae medially; outer ramus slightly shorter than inner ramus, with 2 single and 5 paired setae dorsally along lateral margin, medial margin with 15 setae.

Telson (Fig. 6H) shallowly cleft (approximately 1/6 length), each apex acute, with 3 setae medially on obliquely truncated margin, with 1 subdistal plumose seta laterally.

Remarks. *Eusirus bulbodigitus* sp. n. shares the characteristic of a mandibular palp bearing a group of setae laterally on the 3rd article with five known species: *E. abyssi* Stephensen, 1944; E. columbianus Bousfield & Hendrycks, 1995; E. hirayamae Bousfield & Hendrycks, 1995; E. laticarpus Chevreux, 1906; and E. parvus Pirlot, 1934 (Chevreux 1906, Pirlot 1934, Stephensen 1944, Bousfield and Hendrycks 1995). However, E. abyssi is readily discriminated from E. bulbodigitus sp. n. by the absence of eyes, the massive carpal lobes of gnathopods 1 and 2, the elongate articles of percopod 3, and the presence of dorsal teeth on urosomite 1 (Stephensen 1944). Both *Eusirus* columbianus and E. laticarpus can be differentiated from E. bulbodigitus sp. n. by their developed eyes and the protruding apical margin of each lobe on telson (Chevreux 1906, Bousfield and Hendrycks 1995). In addition E. columbianus represents additional differences as follows: (1) the accessory flagellum of E. columbianus is longer than that of E. bulbodigitus sp. n.; (2) the inner plate of maxilla 2 in E. columbianus is smaller than that of *E. bulbodigitus* sp. n.; (3) among the lateral setae on mandibular palp article 3, the longest seta is not reaching at distal end of article 3 in *E. columbianus* (vs. reaching in *E. bulbodigitus* sp. n.); (4) the merus, carpus and propodus of pereopod 4 are slightly longer than those of pereopod 3 in *E. columbianus* (vs. slightly shorter in *E. bulbodigitus* sp. n.); (5) the posterior margin of pleonal epimeron 3 is serrate entirely in *E. columbianus* (vs. partially serrate on distal half in *E. bulbodigitus* sp. n.); and (6) the lateral margin of outer ramus on uropod 3 is lined with single setae in *E. columbi*anus (vs. with paired setae in E. bulbodigitus sp. n.) (Bousfield and Hendrycks 1995). Eusirus bulbodigitus sp. n. is very similar to E. parvus. However, it can be distinguishable from the latter in following characters combined: (1) the eyes are poorly developed

in E. bulbodigitus sp. n. (vs. well-developed in E. parvus); (2) the mandibular palp of E. bulbodigitus sp. n. is slender than that of E. parvus; (3) the longest seta of mandibular palp article 3 is reaching to the end of article in *E. bulbodigitus* sp. n. (vs. not reaching in *E. parvus*); (4) the articles of percopods in *E. parvus* are slightly longer than those of E. bulbodigitus sp. n.; and (5) the inter-ramal process of uropod 1 is absent in E. bulbodigitus sp. n. (vs. present in E. parvus) (Pirlot 1934). Eusirus bulbodigitus sp. n. from Korean waters also closely resembles *E. hirayamae* from Japanese waters. However, it can be clearly distinguished from the latter with the combination of the following characteristic features: (1) the lateral border of carpus on ganthopod 2 is acutely produced posterodistally (vs. not produced and rounded in E. hirayamae); (2) both lengths of the carpus and propodus on pereopod 4 are slightly reduced (merus:carpus:propodus = 1.0:0.6:0.7) compared to those of percopod 3 (merus:carpus:propodus = 1.0:0.7:0.9), but they are not reduced in percopod 4 of E. hirayamae (merus:carpus:propodus = 1.0:0.7:1.0 in both percopods 3 and 4); (3) on percopod 4, the proximal three-quarters of posterior margin of the dactylus is swollen in E. bulbodigitus sp. n. (vs. moderate in E. hirayamae); (4) the dactylus of pereopods 3 and 5-7 is more elongate and slender in E. bulbodigitus sp. n. (vs. shorter and thicker in E. hirayamae); (5) the posterior margin of dactylus on percopods 3–7 has rows of small teeth in *E. bulbodigitus* sp. n. (vs. no teeth in E. hirayamae), (6) the setations of articles on percopods 3–7 in E. bulbodigitus sp. n. are weaker than those in *E. hirayamae*; (7) the lateral surfaces of pleonal epimera 1-3 are not covered with setae anteroventrally in *E. bulbodigitus* sp. n. (vs. densely covered with setae in *E. hirayamae*); and (8), the posterior margin of pleonal epimeron 3 is serrated in the distal half (vs. serrations occur along the whole posterior margin in E. hirayamae) (Bousfield and Hendrycks 1995).

Keys to the North Pacific species of the genus Eusirus

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5	Coxa 1 moderately expanded backwards; uropod 3, inner ramus slightly
	shorter than outer ramus; telson cleft apically approx. 1/2 length
	E. cuspidatus Krøyer, 1845
_	Coxa 1 strongly expanded backwards; uropod 3, rami subequal in length;
	telson cleft apically approx. 1/3 length
	E. birayamae Bousfield & Hendrycks, 1995
6	Antenna 2, peduncular articles slender; pereopod 5, basis broadly expanded
	posteriorly; percopod 7, basis narrowly expanded posteriorly; telson elon-
	gateE. bathybius Schellenberg, 1955
_	Antenna 2, peduncular articles stout; pereopod 5, basis weakly expanded pos-
	teriorly; pereopod 7, basis convex posteroproximally; telson triangular
	<i>E. fragilis</i> Birstein & Vinogradov, 1960

Acknowledgements

We thank the captain and the crew of the R/V Cheong Gyeong Ho of Chonnam National University for their assistance in sampling. This study was supported by the National Institute of Biological Resources of Korea as a part of the 'Survey of indigenous biological resources of Korea (NIBR NO. 2014-01-001)', the research funds from Chosun University (2016) and partly supported by the National Marine Biodiversity Institute of Korea as a part of the 'Molecular ecology of suborder Gammaridea populations in Korea (2016M01400)'.

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RESEARCH ARTICLE



A new species of *Linopherus* (Annelida, Amphinomidae) from Beibu Gulf, South China Sea

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Academic editor: C. Glasby Received 20 June 2016 Accepted 29 November 2016 Published 13 December 2016
http://zoobank.org/F64A8C0C-BDE3-4537-9460-FBB21DC7009F

Citation: Sun Y, Li X (2016) A new species of *Linopherus* (Annelida, Amphinomidae) from Beibu Gulf, South China Sea. ZooKeys 640: 37–43. https://doi.org/10.3897/zookeys.640.9619

Abstract

Linopherus beibuwanensis **sp. n.** is described based on six specimens deposited in the Marine Biological Museum of the Chinese Academy of Sciences, Qingdao, collected from the Beibu Gulf (Tokin Gulf), South China Sea. The new species differs from all other *Linopherus* species by the shape of prostomium and caruncle. The posterior margin of prostomium is bilobed; the caruncle arises medially and confluently from the posterior margin of the prostomium, joining together with prostomium. A key to distinguish the known species of the genus is provided.

Keywords

Fireworm, new species, polychaete, Pseudeurythoe, systematics, taxonomy

Introduction

Polychaetes belonging to the family Amphinomidae are commonly known as fireworms due to the burning sensation caused by the calcareous harpoon notochaetae (Fauchald, 1977). The amphinomids are globally distributed and common in shallow tropical and subtropical waters (Kudenov 1995): *Linopherus abyssalis* (Fauchald, 1972a), *Linopherus hemuli* (Fauchald, 1972b), and *Chloeia kudenovi* Barroso & Paiva, 2011 are examples of recently reported species from abyssal depths and polar areas (Barroso 2011; Fauchald 1972a, b).

Species of the genus *Linopherus* Quatrefages, 1865 have been referred as members of *Pseudeurythoe* Fauvel, 1932. Fauchald (1972a) described a new species from abyssal depths and reviewed the species of *Pseudeurythoe*. In 1977, he treated *Pseudeurythoe* as a synonym of *Linopherus*. Since then *Linopherus* has been accepted by subsequent authors and in the present work (San Martín 1986; Salazar-Vallejo 1987). *Linopherus* differs remarkably from the other genera of the family in having species without caruncle or with a reduced caruncle, and branchiae that are limited to the anterior part of the body. The morphology of the prostomium, the development of prostomial appendages, caruncle, parapodia, and the number of branchiae are important in species identification (Kudenov 1995). To date, six species of *Linopherus* have been reported from the coastal waters of China (Sun, Lei and Zhou 2008): *Linopherus ambigua* (Monro, 1933), *L. paucibranchiata* Fauvel, 1932, *L. hirsuta* (Wesenderg-Lund, 1949), *L. oligobranchia* (Wu, Shen & Chen, 1975), *L. microcephala* (Fauvel, 1932), and *L. spiralis* (Wesenderg-Lund, 1949).

When the authors examined the Amphinomidae archived in the Marine Biological Museum of Chinese Academy of Sciences (MBMCAS), Institute of Oceanology, Chinese Academy of Sciences (IOCAS), six specimens of *Linopherus* were separated out. Careful examination revealed that these specimens represented a new species. The new species is described here, and a key to worldwide species of *Linopherus* is provided.

Material and methods

The specimens were collected during the late 1950s to early 1960s from Beibu Gulf (Tonkin Gulf), northern South China Sea. All specimens are deposited in the **MBMCAS**, preserved in 75% ethanol solution. Microscopy observations and drawings were made using a Zeiss Stemi 2000-C stereomicroscope equipped with an AxioCam MRc 5 digital camera.

Systematics

Family Amphinomidae Lamarck, 1818 Genus *Linopherus* Quatrefages, 1865

Linopherus beibuwanensis sp. n. http://zoobank.org/83C424FA-951B-4F12-8CEC-B6CD6088AD20 Fig.1

Material examined. Holotype, MBM010010, Beibu Gulf, 21°15'N, 108°06'E, 91m, sandy mud, coll. Xiutong Ma, 11 Feb 1959. Paratypes, MBM200142, Beibu



Figure 1. *Linopherus beibuwanensis* sp. n. **A** Anterior end in dorsal view **B** Anterior end in vental view **C** left parapodia of chaetiger 14 in frontal view **D** branchiae of chaetiger 28 **E** harpoon notochaeta **F** forked neurochaeta **G** slender capillary chaeta. Scale bars: **A–B**, 200μm; **C–D**, 250 μm; **E–F**, 50 μm; **G**, 20 μm.

Gulf, 18°30'N, 107°00'E, 66m, sandy beach, coll. Zhengang Fan, 10 Sep 1960; MBM200143, Beibu Gulf, 18°00'N, 107°45'E, 90m, silty mud, coll. Ruiping Sun, 9 Apr1962; MBM200144, Beibu Gulf, 18°00'N, 108°00'E, 93m, sandy mud, coll. Xiutong Ma, 11 Dec 1959; MBM200145, Beibu Gulf, 18°30'N, 107°00'E, 66m, sandy beach, coll. Xiutong Ma, 9 Dec 1962; MBM200122, Beibu Gulf, 18°00'N, 107°00'E, sandy mud, coll. Zhengang Fan, 14 Feb1960.

Diagnosis. Prostomium globular, posterior margin bilobed, with two pairs of eyes, anterior pair semicircular in shape. Medial caruncle conspicuous, arising from and confluent with posterior prostomial margin, medial lobe projecting above paired lateral lobes. Parapodia biramous, rami widely separated, with single dorsal and single ventral cirrus. Branchiae dendritic, present from chaetiger 3 onwards, with more than 40 pairs.

Description. Holotype (MBM010010) incomplete, lacking posterior part, 17 mm long, 2 mm wide excluding chaeta, with 45 chaetigers. Body elongate, nearly rectangular in cross section, tapering posteriorly. Color in alcohol pale yellow, without color pattern.

Prostomium (Fig. 1A) divided into two parts by transverse groove. Anterior lobe rounded, with pair of cirriform antennae dorsally and similar pair of palps laterally, palps with three distinct articulations. Posterior lobe heart-shaped, bilobed along posterior margin, with median antenna and two pairs of reddish eyes. Anterior pair of eye spots semicircular in shape and large, posterior pair of eye spots rounded and small. Median antenna conical, slightly shorter than paired antennae, located at posterior margin of prostomium. Buccal opening occupying two chaetigers (Fig. 1B).

Caruncle rectangular and conspicuous, medial lobe projecting above paired lateral lobes. Caruncle restrict to chaetiger 1, equal in length to posterior prostomial lobe of prostomium, reaching to anterior margin of chaetiger 2, arising medially and confluently with posterior prostomium (Fig. 1A).

All parapodia biramous, with chaetiger 1 greatly reduced, chaetiger 2 forming first dorsally complete ring. Parapodia with slender cirri (Fig. 1A, C), both notopodia and neuropodia well-developed, chaetal sac forming low rounded lobe. First two parapodia with longer and more conspicuous cirri than other parapodia; ventral cirri of chaetiger 2 longest, each with four articulations (Fig. 1A). Succeeding parapodia with tapering and rather short ventral cirri.

Branchiae present from chaetiger 3, located on posterior face of each notopodia (Fig. 1A), arising as tufts, dendritically branched, decreasing along body and disappearing at approximately chaetiger 42; chaetiger 1 branchiae with five terminal filaments, chaetiger 17 branchiae with 29 or 26 terminal filaments, chaetiger 28 branchiae with 15 filaments (Fig. 1D), chaetiger 42 branchiae with 6 or 7 filaments.

Notochaetae of three types: stout harpoon chaetae, numbering 13–24 per fascicle (Fig. 1E); slender capillary chaetae (Fig. 1G), faintly serrated, without basal spur, many broken; notoacicula, numbering 3–4 per fascicle, hastate (Fig. 1C). Neurochaetae of three kinds: forked chaetae, short limb reduced as spur, with thin shafts and long, distally serrated cutting margins (Fig. 1F); slender, capillary chaetae, smooth; neuroacicula, numbering 2–3 per fascicle, slightly hastate, slender than notoacicula (Fig. 1C).

Variations. All specimens examined are incomplete lacking the posterior part. Specimen size varies from 1.9 to 2.5 mm in maximum width. Branchial chaetiger range varies from 3 to 31–40. The maximum number of branchial filaments varies from 20–29. One female paratype (MBM200143) with eggs in posterior coelomic cavity, ranging in diameter from 71µm to 90 µm.

Etymology. The species is named after Beibuwan, the Chinese name for the Beibu Gulf (Tonkin Gulf), South China Sea.

Distribution. Only known from Beibu Gulf, South China Sea.

Remarks. *Linopherus beibuwanensis* sp. n. is referred to *Linopherus* because of the arrangement of branchiae and the reduced but characteristic caruncle. *Linopherus beibuwanensis* sp. n. is unique in this genus for the combined shape of its prostomium

and the caruncle. While the posterior prostomial margin is straight (not bilobed) in most *Linopherus* species, their caruncles are also either absent or reduced. In the latter case, species with reduced caruncles typically exhibit a transverse groove that appears to isolate the caruncle from the prostomium, which is usually partly or completely concealed by the second chaetiger (see Langerhans 1881; Fauvel 1932; Monro 1933, 1937; Treadwell 1941; Wesenberg-Lund 1949; Knox 1960; Fauchald 1972a, b; Kudenov 1975; Wu et al. 1975; Kudenov and Blake 1985; San Martín 1986; Salazar-Vallejo 1987).

Linopherus beibuwanensis sp. n. is similar to *L. abyssalis* in having the posterior prostomial margin bilobed. The new species can be distinguished from the latter by the presence of eyes and arrangement of branchiae; the former has two pairs of eyes and more than 40 pairs of branchiae, while the latter has no externally detectable eyes and only 5-6 pairs of branchiae.

Caruncle morphology appears to be an essential character which can be used to distinguish the species of *Linopherus*. However, *Linopherus* species are small in size, and so their caruncle morphology is imperfectly known since it is usually concealed by constriction of the anterior chaetigers. Clearly, further research on this taxon is necessary.

Key to species of *Linopherus* (modified from Fauchald 1972 and Salazar-Vallejo 1987).

1	Branchiae present from chaetiger 2 continuing to end of body
	<i>L. reducta</i> (Kudenov & Blake, 1985)
-	Branchiae present from chaetiger 3 or 42
2	Branchiae present from chaetiger 33
_	Branchiae present from chaetiger 415
3	Eyes absent
_	Eyes present, one or two pairs
4	Several pairs of branchiae until end of body <i>L. tripunctata</i> (Kudenov, 1975)
_	Only six pairs of branchiae L. oligobranchia (Wu, Shen & Chen, 1975)
5	First pair of eyes semicircular
_	First pair of eyes rounded
6	Posterior margin of prostomium bilobed, more than 40 pairs of branchiae
	L. beibuwanensis sp. n.
_	Posterior margin of prostomium not bilobed, less than 40 pairs of branchiae 7
7	Six pairs of branchiae, caruncle absent L. fauchaldi San Martín, 1986
_	About 23 pairs of branchiae, caruncle present, small and rounded
	<i>L. microcephala</i> (Fauvel, 1932)
8	Anterior lobe of prostomium conical, not expanded anteriorly
_	Anterior lobe of prostomium rounded, anteriorly expanded9
9	One pair eyes10

_	Two pairs of eyes11
10	Caruncle present, cirri of second chaetiger longer than others
	(Fauvel, 1952)
-	Caruncle absent, cirri of second chaetiger as long as others
	<i>L. hirsuta</i> (Wesenberg-Lund, 1949)
11	More than 20 pairs of branchiae present12
-	Maximally 16 pairs of branchiae present14
12	Branchiae present only on anterior chaetigers, eyes indistinct
	<i>L. ambigua</i> (Monro, 1933)
-	Branchiae present in all but first two and last few chaetigers, eyes distinct 13
13	Caruncle absent, eyes inconspicuous <i>L. spiralis</i> (Wesenberg-Lund, 1949)
_	Caruncle present, eyes conspicuous
14	13-16 pairs of branchiae present, caruncle present
	<i>L. annulata</i> (Hartmann-Schröder, 1965)
_	Maximally seven pairs of branchiae present, caruncle absent
	<i>L. canariensis</i> Langerhans, 1881
15	More than 40 pairs of branchiae present, eves distinct, caruncle absent
- /	<i>L. acarunculata</i> (Monro. 1937)
_	Less than 10 pairs of branchize eves absent caruncle present 16
16	Seven pairs of branchiae present, subdistally inflated (bastate) acicular chae
10	tao abaant L minuta (Knov 1060)
	Les then 7 prime of here this approximate while the first detail (hereteter) prime
-	Less than / pairs of branchiae present, subdistally inflated (nastate) acicular
. –	chaetae present
17	Five or six pairs of branchiae present, dorsal cirri absent in branchial chaeti-
	gers, caruncle in deep pocket at posterior margin of prostomium, small and
	rounded <i>L. abyssalis</i> (Fauchald, 1972)
-	Five pairs of branchiae present, dorsal cirri absent in branchial chaetigers,
	caruncle button-shaped

Acknowledgments

We appreciate the assistance of Dr. Sergio I. Salazar -Vallejo (EI Colegio de la Frontera Sur, Chetumal, Mexico) and Dr. Beatriz Yáñez-Rivera (Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México, Unidad Académica Mazatlán, Mexico) for their kind help with our taxonomic research and for providing us with important references. We are grateful to Dr. Paulo Paiva and Dr. Jerry D. Kudenov for their comments and suggestions improving the manuscript. We are also grateful to the managers of the MBMCAS for their assistance in sorting the specimens. This study was supported by the funds of the Ocean Public Welfare Scientific Research Project (No. 201505004-1), the National Natural Science Foundation of China (No. 41406157), and the Strategic Priority Research Program of the Chinese Academy of Sciences (XDA11020303).

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RESEARCH ARTICLE



A new genus and species of Placusini from a high mountain in Mexico

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Academiceditor: J. Klimaszewski Received 26 October 2016 Accepted 29 November 2016 Published 13 December 2016
http://zoobank.org/1E123CCC-E77B-4286-A3E8-8EF74F884DFD

Citation: Santiago-Jiménez QJ, Santiago-Navarro R (2016) A new genus and species of Placusini from a high mountain in Mexico. ZooKeys 640: 45–57. https://doi.org/10.3897/zookeys.640.10911

Abstract

A new genus and species are described from the Cofre de Perote volcano, in the state of Veracruz, Mexico. Although the new genus is very similar to *Placusa*, it presents tergite VIII completely modified to form a horn, in both females and males, in addition to other differences in mouthparts. A map and illustrations are provided, as well as an identification key to the genera of Placusini. No morphological characters are apparent to separate *Kirtusa* Pace from *Euvira* Sharp in our genus key. The specimens of the new genus were collected using Lindgren and cross traps baited with a mix of semiochemicals: ipsenol, ipsdienol and lanierone.

Keywords

Aleocharinae, Nearctic, Pinus forest, semiochemicals

Introduction

The tribe Placusini currently includes four genera: *Euvira* Sharp is known from North America to Argentina, including the Antilles (Ashe and Kistner 1989), *Kirtusa* Pace is only known from Ecuador (Pace 2008), *Speiraphallusa* Pace was described from Malaysia (Pace 2013), and *Placusa* Erichson is distributed worldwide (Newton et al. 2000). The genus *Placusa* Erichson, 1837 has been recorded from every zoogeographical region: five species from the Australian region, 24 species are Afrotropical, nine

species are Nearctic, 44 Neotropical, 51 Oriental, and 13 Palearctic (Newton, pers. comm.). Even within this genus, some species have a wide range of distribution. *Placusa complanata* Erichson, 1839 has a Holarctic distribution (Erichson 1839, Hamilton 1894), *P. tenuicornis* Fauvel, 1878 is found in the Oriental and Australian regions (Fauvel 1878; Bernhauer 1920), and *P. pygmaea* Kraatz, 1859 is distributed throughout the Oriental, Afrotropical and Australian regions, though its type locality is in Sri Lanka (= Ceylon) (Kraatz 1859, Fauvel 1903, Cameron 1939, Pace 1992, Pace 2006). The distribution of the latter species is atypical and requires corroboration.

Here, a new genus of Placusini is proposed based on specimens collected on the Cofre de Perote volcano, Veracruz, Mexico. The new genus is very similar to *Placusa*, according to the *Placusa* diagnosis proposed by Klimaszewski et al. (2001), but can be distinguished from *Placusa* and other Placusini based on several morphological differences.

Materials and methods

From March to May in 2015, 28 specimens of Placusini were collected in the Cofre de Perote volcano, specifically in the locality Agua de los Pescados, Veracruz state, Mexico. The specimens were collected using handmade interception traps, baited with a mix of semiochemicals: ipsenol, ipsdienol and lanierone. Specimens were preserved in ethanol 70%, and later observed and identified using a Stemi DV4 stereoscopic microscope. For the illustrations, photographs were taken using an image processing system (VELAB microscope model VE-633 with Digital LCD model DMS-153). Permanent microscope slides were prepared using the techniques described by Santiago-Jiménez (2010). Habitus photographs were taken through a Nikon SMZ25 stereoscopic microscope. The terminology used here mostly follows Ashe and Kistner (1989), Klimaszewski et al. (2001), and Santiago-Jiménez (2010). The holotype and paratypes were deposited in MUZ-UV—Museo de Zoología, Facultad de Biología Región Xalapa, Universidad Veracruzana, Xalapa, México (Dr. Q. Santiago-Jiménez).

Taxonomy

Placukorna Santiago-Jiménez, gen. n. http://zoobank.org/B4A0BE1A-74D5-4454-B325-BC05958876BB

Diagnosis. Body shape fusiform, broad and strongly flattened; head transverse, with a suture between antennal insertions; sensillae on apical margin of epipharynx arranged in a pattern of anterior or a-sensilla, and lateral or ε -sensilla; prementun with medial pseudopore field present, with at least a few pseudopores in an irregular rectangular array, but pseudopores are extended to the lateral pseudopore field; mandibles with a large velvety patch completely occupying the base, composed of nine to eleven transverse rows of large teeth that are reduced in size to the base; labium with short rounded

ligula, entire, and not divided; pronotum transverse, approximately 1.5 times wider than long, wider on medial third; mesocoxal cavities not separated by meso- and metaventrite processes; mesoventrite process short with apex acuminate; metaventral process medium-sized, marginate and with apex subobtuse; isthmus not present; tergite VII with lateral margin modified to form a structure-like wall on each side, which apparently provides support between tergite and sternite (only visible because of transparency on slides), and with an apical sclerotized plate attached internally (only visible because of transparency on slides) to receive tergite VIII; tergite VIII modified to form a horn (Figs 1–2), in females and males; spermatheca with small and approximately spherical capsule, median and posterior portion of spermathecal stem (duct) sinuate; process of crista apicalis long, almost straight and parallel to median lobe, rounded at the apex.

Description. Body length 2.5–3.0 mm. Body shape fusiform, broad and strongly flattened; pronotum transverse. Tergite VIII modified to form a horn (Figs 1–2) in both, males and females.

Head. Transverse, with a suture between antennal insertions; surface with coarse punctures densely distributed. Antennomeres 4–10 transverse (Fig. 3). Eyes prominent, occupying almost two thirds of head length. Neck absent (Fig. 4). Infraorbital carina present. Coeloconic sensilla absent (Fig. 3).

Mouthparts. Labrum: with 7 setae on each side of the midline; most of the setae on anterior half; with 17-19 sensory pores on each side of midline; sensillae on apical margin of epipharynx, arranged in a pattern of anterior or a-sensilla, and lateral or ε-sensilla (Fig. 5), one on each side of the midline (see Ashe 1984, Santiago-Jiménez, 2010); apicomedial margin of epipharynx not modified to setose or with spinose process; basal region of epipharynx with six pores, more or less in one transverse row; medial region of epipharynx with 35-40 pores in an irregular array (Fig. 5); medial region of epipharynx without a multiporose sensory structure on each side of midline; basal region epipharynx without pores on each side to form a transverse row. Mandibles: asymmetrical; right mandible with a medial tooth, poorly defined; with serration on apical half of mandibles; with a large velvety patch completely occupying the base, composed of nine to eleven transverse rows of large teeth that are reduced in size to the base; prosthecal setae are not bifurcated on medial area. Maxilla: with a row of nine spines (in one specimen only seven were counted) and scarce setae contiguous on apical half of lacinia, basal half almost glabrous, with only five setae; with scarce setae on apical third of galea and two spines, medial and basal third almost glabrous; with pseudopores on the cardo. Labium: with short rounded ligula, entire, and not divided. Prementum with two medial setae insertions widely separated; medial pseudopore field present, with at least a few pseudopores in an irregular rectangular array, but pseudopores are extended to the lateral pseudopore field (Fig. 6); lateral pseudopore field composed of one setose pore, and two asetose pores (Fig. 6); with setae on adoral margin of hypoglossa, but without setae on aboral margin. Mentum without reticulate microsculpture on surface; with scarcely distributed pores on mentum, around fourteen on each side of midline; with a pair of macrosetae on each apico-lateral margin, one macroseta is longer than the other is; surface with eight setae on each side of midline. Labial palpi with only two segments.

Thorax. Pronotum transverse (Fig. 7), approximately 1.5 times wider than long, wider on medial third; surface finely punctured, moderately dense to dense; without reticulate microsculpture; setae dense on surface; apparently without macrosetae on surface. Scutellum with surface smooth, with some punctures, and moderately covered with short setae. Elytra together slightly wider on apical area, but on basal area slightly wider than pronotum; surface punctured moderately dense; without reticulate microsculpture; setae densely distributed, covering the surface; without macrosetae. Hind wings well developed. Mesocoxal acetabula margined posteriorly. Mesocoxal cavities not separated by meso- and metaventrite processes; mesoventrite process short (approx. 0.26 mm) with apex acuminate; metaventral process medium-sized (approx. 0.35 mm), marginate and with apex subobtuse; isthmus not present. Legs with tarsal formula 4–4–5, each apical tarsus with an empodium, one seta on empodium and a pair of tarsal claws, each claw with a subbasal tooth.

Abdomen. Abdomen fusiform (Fig. 1), narrower than elytra, although tergite VIII is modified to form a long horn; tergites with scarce setae; sternites with dense microsetae (Figs 8–9), but slightly less dense than elytra, almost without macrosetae on abdominal segments III-VI except on lateral margins of sternites; tergite VIII modified to form a long horn almost glabrous on dorsal surface, but with long setae on ventral surface, sparsely to slightly densely distributed. Tergite VII (Fig. 10) with lateral margin modified to form a structure-like wall on each side, which apparently provides support between tergite and sternite (only visible because of transparency on slides), and with an apical sclerotized plate attached internally (only visible because of transparency on slides) to receive tergite VIII (Fig. 11). Tergite VII has a small "U" incision on midline to receive the modified tergite VIII.

Remarks. The new genus is very close to *Placusa*; however, it can be distinguished easily by tergite VIII, which is modified completely to form a horn, and the sclerotized lateral internal wall of tergite VII, that apparently supports tergite VIII. Tergite VII has a sclerotized internal plate in the posterior margin that may also support tergite VIII. Moreover, there are some differences in the median lobe of *Placusa* (crista apicalis shorter) and *Placukorna* (crista apicalis longer; Fig. 12) upon comparison. In addition, *Placukorna* shows lateral or ε -sensilla on the epipharynx, the medial field of epipharynx is not flanked by rows of large scales, and prementum with lateral field of pores with pseudopores extended from medial field. The same characters are useful for distinguishing the new genus from other Placusini. Another useful character for distinguishing *Placukorna* from *Placusa* is the absence of spine-like dents on the apex of tergite VIII that are present *Placusa* males.

Type species. Placukorna ipsa Santiago-Jiménez sp. n.

Etymology. The genus name is a combination of "*Placusa*" and "*korna*", from the Greek "Πλαξ" (meaning surface plane) and "*κό*ρνα" (meaning horn), respectively.

Gender. Neuter.

Habitat. Specimens were found in Lindgren and cross traps baited with ipsenol, ipsdienol and lanierone in a mixed pine forest. The forest is composed of *Pinus pseudostrobus*, *P. montezumae* and *P. patula*, located around 3090 m a.s.l.

Distribution. The single described species, *Placukorna ipsa*, is known only from the Cofre de Perote volcano, in the central region of Veracruz state, in Mexico. Apparently, the genus is distributed in montane areas.

Identification key to the genera of Placusini

1	Head transverse; without neck (Fig. 4)2
_	Head quadrate to slightly transverse or transversally sub-orbicular; with neck
	(fig. 9.155 in Navarrete-Heredia et al., 2002)
2	Male tergite VIII with a variable number of small to large spine-dents in the
	apex (figs 33-49 in Klimaszewski et al. 2001)Placusa Erichson, 1837
_	Male and female tergite VIII modified to form a curved horn (Figs 2 and
	11) <i>Placukorna</i> gen. n.
3	Head transversally sub-orbicular; pronotum with distinct anterior angles, poste-
	rior angles indistinct, with a long transverse sulcus; abdomen strongly narrowed
	from base to apex (fig. 1 in Pace 2013) Speiraphallusa Pace, 2013
_	Head quadrate; pronotum with anterior angles broadly rounded, posterior
	angles distinct, without a long transverse sulcus; abdomen more or less paral-
	lel-sided to slightly widened (fig. 2 in Ashe and Kistner 1989; fig. 549 in Pace
	2008)Euvira Sharp, 1883 and Kirtusa Pace, 2008

Placukorna ipsa Santiago-Jiménez, sp. n.

http://zoobank.org/F82847FD-34C8-4AFA-B1C2-0B90A1930258 Figs 1–14

Type locality. México: Veracruz, Perote, Ejido Agua de los Pescados, 3090 m a.s.l., 19°31'30"N, 97°07'00"W, mixed pine forest, Lindgren trap # 14, 08–15.V.2015, P. Domínguez, C. Ruíz and R. Santiago.

Type material. Holotype, male, pinned. Original label: "México: Veracruz, Perote, Agua de los Pescados. B. Pino mixto, 19°31'30"N, 97°07'00"W, 3086 m, tr. Lindgren #14, 08.V–15.V.2015, P. Domínguez, C. Ruíz, R. Santiago"/ "MUZ-UV-COL-00003446"/ HOLOTYPE *Placukorna ipsa* Santiago-Jiménez, 2016" [red label].

Other material. Paratypes, same data as holotype except for: tr. de cruz # 6 (1 specimen \Im); same data except for: tr. de cruz # 8 (1 specimen \Im); same data except for: tr. de cruz # 7, 20.III–27.III.2015 (1 specimen on slide \Im); same data except for: tr. Lindgren # 11, 27.III–03.IV.2015 (6 specimens: 2 \Im on slide; 2 specimens \Im and 2 specimens \Im); same data except for: tr. Lindgren # 13 (1 specimen \Im); same data except for: tr. Lindgren # 14 (2 specimens: 1 specimen \Im and 1 specimen \Im); same data except for: tr. de cruz # 6 (2 specimens \Im); same data except for: tr. de cruz # 7 (2 specimens \Im); same data except for: tr. de cruz # 8 (1 specimen \Im); same data except for: tr. de cruz # 8 (1 specimen \Im); same data except for: tr. de cruz # 8 (1 specimen \Im



Figure 1. Habitus of *Placukorna ipsa* Santiago-Jiménez, gen. n. and sp. n. (Holotype).

data except for: tr. Lindgren # 13 (1 specimen \bigcirc); same data except for: tr. de cruz # 7, 24.IV–01.V.2015 (1 specimen \bigcirc); same data except for: tr. Lindgren # 12 (1 specimen \bigcirc); same data except for: tr. Lindgren # 14 (1 specimen \bigcirc); same data except for: tr. de cruz # 9, 01.V–08.V.2015 (2 specimens \bigcirc); same data except for: tr. Lindgren # 12, 15.V–22.V.2015 (1 specimen \bigcirc). All specimens deposited in MUZ-UV under numbers MUZ-UV-COL-00003447 to 00003473 [yellow label].

Diagnosis. Although for the moment it is the only one known species to the genus, it is distinguished by the following combination of characters: body length 2.5–3.0 mm; head and pronotum dark brown and abdomen black; apical half or apical third of sternites III-VI reddish brown; elytra dark brown to black; coxae dark brown to black; metatrochanter and metafemur dark brown or yellowish brown, remaining legs yellowish brown; antennomeres 1–11 dark brown; surface of tergites and sternites III–VII with reticulate microsculpture, less evident on tergites III–IV; tergites III–VII



Figure 2. Lateral view of Placukorna ipsa Santiago-Jiménez, gen. n. and sp. n. (Holotype).

with basal impression, III–V almost straight, VI posteriorly slightly curved, VII posteriorly evidently curved; tergite VI with a protuberance on each side of midline; spermatheca with small and approximately spherical capsule, median portion of spermathecal stem (duct) narrowly U–shaped, and posterior portion also U–shaped, with accessory gland; median lobe with moderately large bulbus, tubus almost straight, internal sac of median lobe with evident spinules, apex blunt in lateral view, with short compressor plate (less than half of median lobe), basal ridge convex and pointed; flagellum short, without coils in bulbus; process of crista apicalis long, almost straight and parallel to median lobe, rounded at the apex.

Description. Body length 2.5–3.0 mm. Head and pronotum dark brown and abdomen black; apical half or apical third of sternites III-VI reddish brown; elytra dark brown to black; coxae dark brown to black; metatrochanter and metafemur dark brown or yellowish brown, remaining legs yellowish brown. The apical edge of tergite III can be reddish.



Figures 3–14. *Placukorna ipsa* Santiago-Jiménez, gen. n. and sp. n. male (8, 12, 14) and female (9, 13). 3 antenna 4 head 5 epipharynx 6 ligula, prementum, and labial palpi 7 pronotum 8 sternite VIII 9 sternite VIII 10 sternite VIII 11 tergite VIII 12 median lobe, lateral view 13 spermatheca 14 paramere, lateral view. Scale bars: 3–4, 7–11 = 0.2 mm; 5–6, 12–14, = 0.1 mm.

Head. Dorsal surface without impression, protuberance or carina on disc (Fig. 4). Antennomeres 1–11 dark brown. Antennomeres 1–2 very long, 3 long, 4–10 transverse, and 11 long (Fig. 3).

Mouthparts. As described for the genus.

Thorax. As described for the genus.

Abdomen. As described for the genus. Other conspicuous characters are: surface of tergites and sternites III–VII with reticulate microsculpture, less evident on tergites III–IV; tergites III–VII with basal impression, III–V almost straight, VI posteriorly slightly curved, VII posteriorly evidently curved, and tergite VI with a protuberance on each side of midline.

Secondary sexual structures. There are differences between the sexes in the shape of sternite VIII and the number of macrosetae on it (Figs 8, 9). No other visible secondary sexual characters were found.

Female. Spermatheca with small and approximately spherical capsule, median portion of spermathecal stem (duct) narrowly U–shaped, and posterior portion also U–shaped, with accessory gland (Fig. 13).

Aedeagus. Median lobe with moderately large bulbus, tubus almost straight, internal sac of median lobe with evident spinules, apex blunt in lateral view, with short compressor plate (less than half of median lobe), basal ridge convex and pointed; flagellum short, without coils in bulbus (Fig. 12). Process of crista apicalis long, almost straight and parallel to median lobe, rounded at the apex (Fig. 12). Paramere with anterodorsal margin of paramerite with prominent sensory pores present beneath the velar sac (Fig. 14); hinge zone of paramerite evident, extended from dorsal surface to near articulation between condylite and paramerite; apical process of paramerite clearly articulated anterior to edge of velum; condylite with row of sensory pores; velum short (less than half length of paramere).

Remarks. *Placukorna ipsa* is the only described species in the genus. The characters that could be useful at the species level are the shape of the aedeagus, spermatheca, and impressions and protuberances on the abdomen as described above.

Some characters that vary among the specimens collected are: protuberances on each side of midline of tergite VI are inconspicuous to prominent, one specimen had a raised midline from tergite III–VI, and the horn of tergite VIII is as long as tergite VII or tergites VI–VII together.

Etymology. As the specimens were found associated with Scolytinae of the genera *Ips* DeGeer and *Pseudips* Cognato, the name makes reference to *Ips* from Greek "i ψ " (meaning sort of worm), with Greek ending "a".

Gender. Neuter.

Habitat. Specimens of *Placukorna* are possibly living in galleries of *Ips* and *Pseudips* associated with different *Pinus* species of the mixed pine forest (*Pinus pseudostrobus* predominating) where they were collected. Specimens were collected using traps baited with a mix of semiochemicals (ipsenol, ipsdienol and lanierone), in which more than 180 specimens of *Ips* (94) and *Pseudips* (91) were also collected. The semiochemicals are commonly used in those traps to capture bark beetles (Scolytine), therefore, an association of specimens of *Placukorna* with *Ips* and *Pseudips* is plausible.



Figure 15. Collection site of Placukorna ipsa Santiago-Jiménez gen. n. and sp. n. (black square).

Distribution. *Placukorna ipsa* sp. n. is known from the type locality in the central region of Veracruz, Mexico. Twenty-eight specimens of *Placukorna ipsa* sp. n. were captured by handmade intercept traps for bark beetles primed with the semiochemicals mentioned above, in mixed pine forest. The locality Agua de los Pescados is 3090 m a.s.l. on the northeast face of the Cofre de Perote, Veracruz, Mexico (Fig. 15).

Discussion

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Tribe Placusini as proposed by Ashe (1991) has eight synapomorphies, of which two characters are unique to this tribe: mandible with dorsal molar area modified with transverse rows of large teeth, and a similar distribution of dorsal sensory pores on the mandible. Moreover, Placusini possess: a tarsal formula of 4–4–5; labrum rounded medially with a small a-sensillum; epipharynx with longitudinal medial field of small pores flanked on either side with row of large scales; with dorsal velvety patch modified to transverse rows of large teeth; without rows of denticles on molar region of ventral (condylar) side; labium with short, two-articled labial palpi; lateral pseudopores composed of two asetose and one setose pores, among other characteristics. Recently, a diagnosis of the genus *Placusa* was proposed by Klimaszewski et al. (2001), and they recognized 8 species of *Placusa* from Canada. Also, 8 species were mentioned from North America

by Newton et al. (2000); whereas only two species have been described from Mexico, Pace (1990): Placusa flohri and Placusa uhligi, with a Neotropical distribution. Placusa can be distinguished from Euvira by the following characters: head transverse (in Euvira it is quadrate), without a distinct neck (distinct neck in *Euvira*), pronotum with distinct anterior angles (broadly rounded in Euvira), posterior angles indistinct (distinct in Euvi*ra*), base of pronotum evenly arcuate (strongly arcuate in *Euvira*); abdominal tergite VII not longer than VI (much longer in *Euvira*)(Ashe and Kistner 1989; Navarrete-Heredia et al., 2002). In contrast, Kirtusa is close to Placusa in the morphology of the mouthparts, but the body is convex and not flattened, the neck is very narrow, the temples are not sulcate, and the shape of the spermatheca is more similar to that of most of the species of the genus Gyrophaena than to that of the genus Placusa (Pace 2008). Pace (2008) however, said nothing about Euvira, and we found that some of the characters used to distinguish Kirtusa are shared with Euvira (e.g. distinct neck, spermatheca shape). Speiraphallusa can be distinguished from *Placusa* by its very convex body, the great length of the terminal article of the labial and maxillary palpi, the first meso- and metatarsomere very long and secondary sexual characters on the elytra of the male (Pace 2013).

The new genus proposed here matched most of the synapomorphies of Placusini proposed by Ashe (1991), although some characters are slightly different, such as: lateral or ε -sensilla present on the epipharynx, medial field of epipharynx not flanked by rows of large scales, and prementum with lateral field of pores with pseudopores extended from medial field. The new genus is very similar to Placusa and possesses several of the diagnostic characters proposed by Klimaszewski et al. (2001), except for the spine-like dents of tergite VIII. However, the new genus shows strong modifications on the male and female abdomen, mainly in tergite VIII. Male and female tergite VII is also modified to support the long horn of tergite VIII, such that tergite VII has lateral internal walls in the margin that apparently support tergite VIII. Also, tergite VII possesses a sclerotized internal plate in the posterior margin that is probably also supporting tergite VIII. This internal plate could be an intersegmental membrane between tergite VII and VIII that was sclerotized but more studies are necessary to understand this modification. All of these characteristics are useful for distinguishing the new genus from the other Placusini. That being said, we were not able to find any differences between the genera Kirtusa and Euvira when preparing the dichotomous key, so the key does not distinguish them. Pace (2008) discussed some of the differences between Kirtusa and Placusa, but said nothing about Euvira, even though Euvira is widely distributed in the Americas and Kirtusa is only known from Ecuador (Ashe and Kistner 1989; Pace 2008). We therefore think that Kirtusa is probably a junior synonym of *Euvira*; however, that determination is beyond the scope of this work.

Acknowledgments

The authors are grateful to their colleagues at the Facultad de Biología, Universidad Veracruzana and the Instituto de Ecología, A.C. for their support, particularly M.

Morales, R. Ortega and R. Novelo for the use of the microscopes. We also thank A. Newton for sharing information from his database, C. Ruíz for the biological material provided, and P. Domínguez and R. Sánchez who provided the junior author with support in the field. We thank B. Delfosse for her careful correction of the English. We are also grateful to the two anonymous reviewers, who contributed to improve the manuscript with their valuable comments.

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RESEARCH ARTICLE



A new Ecuadorian species of the rare Neotropical caddisfly genus Amphoropsyche Holzenthal (Trichoptera, Leptoceridae)

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Academic editor: P. Stoev	Received 30 August 2016 Accepted 2 December 2016 Published 13 December 2016

Citation: Holzenthal RW, Ríos-Touma B (2016) A new Ecuadorian species of the rare Neotropical caddisfly genus *Amphoropsyche* Holzenthal (Trichoptera, Leptoceridae). ZooKeys 640: 59–67. https://doi.org/10.3897/zookeys.640.10344

Abstract

A new species of the rare long-horned caddisfly genus *Amphoropsyche* Holzenthal is described from Ecuador, bringing the number of species known from the genus to 15. All species are very regional in their distributions and known only from very few specimens. The new species, *Amphoropsyche real*, is similar to a number of previously described species from Colombia (*A. ayura, A. cauca, A. flinti, A. quebrada*, and *A. stellata*) and Ecuador (*A. napo* and *A. tandayapa*). The males can be distinguished from the others by features of segment X of the male genitalia, especially the prominent midlateral and subapicodorsal spinelike setae. An updated taxonomic key to males of the genus is provided.

Keywords

Trichoptera, caddisfly, Neotropics, new species, key to species, rare, endemic, Andes

Introduction

The long-horned caddisfly genus Amphoropsyche Holzenthal, 1985 is endemic to the Neotropical Region where it now contains 15 described species (Table 1), including a new species described herein. While widely distributed, its species are among the rarest of the Neotropical caddisflies. Only a few specimens are known to exist in museum collections and almost all of the specimens known to us are housed in 2 insect drawers, 1 at the University of Minnesota and 1 at the Smithsonian Institution. Whether the species are habitat specialists or do not fly to UV light traps set at dusk (the most common method for collecting adult caddisflies) is unknown. On one occasion, the senior author netted individuals of A. woodruffi woodruffi Flint and Sykora, swarming during mid-day over a small, shallow stream in Venezuela. Otherwise, they are collected 1 or 2 at a time from lights or from Malaise traps. Larvae are known only for one species, A. insularis (Flint), recorded from the sandy bottom of a pool in a small stream on the Lesser Antillean island of Dominica. Larvae build cases of sand grains (Holzenthal 1986). Adults of the other species also seem to be associated with small, gravel-bottomed streams in hilly or mountainous areas. Adult males contain interesting pheromone dispersing structures on the genitalia (Botosaneanu 1991). In this paper we describe the 15th known species in the genus and the 3rd recorded from Ecuador. The new species is known from 1 male and 2 female specimens. The previously most recently described species, A. tandyapa Holzenthal and Rázuri-Gonzales, also from Ecuador, is known from only the male holotype. These discoveries further corroborate Holzenthal's (1986) prediction that the northern Andes harbor a rich fauna of these very rare, enigmatic icons of the Neotropical caddisfly fauna.

Material and methods

This species is based on material collected by the authors and their colleagues during an ongoing inventory of the Trichoptera of Ecuador. Specimens were attracted to a UV light placed over a shallow, white plastic pan filled with 80% ethyl alcohol placed next to a small, gravel stream. Techniques and procedures used in the preparation and examination of the specimen were outlined by Blahnik and Holzenthal (2004) and Blahnik et al. (2007). The illustrations of the genitalia were prepared from pencil sketches made with the aid of a drawing tube mounted on an Olympus BX41 compound microscope. The pencil sketches were then scanned and placed into an Adobe Illustrator (version CC, Adobe Systems, Inc.) document, to serve as a template, and then traced to create a vector graphic illustration. A graphic tablet and pen (IntuousTM, Wacom Technology Co.) facilitated careful tracing of the original image.

Terminology used in describing male and female genitalia follows that of Holzenthal (1985, 1986). The updated taxonomic key is modified from that published by Holzenthal and Rázuri-Gonzales (2011) and is based on published illustrations and descriptions of the male genitalia (Holzenthal 1985, 1986; Botosaneanu 1990; Flint and Sykora 1993,

Species	Distribution	Known individuals in literature	Additional references
aragua Holzenthal, 1985	Venezuela	male HT, 5 male PTs	_
<i>ayura</i> Holzenthal, 1985	Colombia	male HT, 1 female PT	Flint 1991
cauca Holzenthal, 1985	Colombia	male HT	Flint 1991
<i>choco</i> Holzenthal, 1985	Colombia	male HT	-
<i>flinti</i> Holzenthal, 1985	Colombia	male HT	Flint 1991
insularis (Flint, 1968) Brachysetodes *	Dominica, Guadeloupe, Martinique	male HT, 48 male, 21 female PTs, 3 larvae, 1 pupa; 4 additional specimens	Holzenthal 1985, 1986; Flint and Sykora 1993; Botosaneanu 1994; Bo- tosaneanu and Thomas 2005
<i>janstockiana</i> Botosaneanu, 1990	St. Vincent, Mustique[?]	male HT, 3 male PTs	Botosaneanu 1991; Flint and Sykora 1993
napo Holzenthal, 1985	Ecuador	male HT	-
quebrada Holzenthal, 1985	Colombia	male HT, 2 female PTs	Flint 1991
<i>real</i> Holzenthal & Ríos-Touma, sp. n.	Ecuador	male HT, 2 female PTs	_
<i>refugia</i> Holzenthal, 1985	Venezuela	male HT, 1 male, 1 female PTs	_
<i>spinifera</i> Holzenthal, 1986	Bolivia, Peru	male HT, 3 male, 1 female PTs	Flint 1996
<i>stellata</i> Holzenthal, 1985	Colombia	male HT	_
<i>tandayapa</i> Holzenthal & Rázuri-Gonzales, 2011	Ecuador	male HT	_
<i>woodruffi multispinosa</i> Botosaneanu, 1993, in Botosaneanu & Alkins-Koo, 1993	Trinidad	male HT, 3 female PTs; 9 additional specimens	Botosaneanu and Sakal 1992; Flint 1996
woodruffi woodruffi Flint & Sykora, 1993	Grenada, Venezuela	male HT; 40 additional specimens	Flint 1996

Table 1. Species, distributions, and published records of known individuals in the caddisfly genus *Amphoropsyche* (Leptoceridae). HT = holotype, PT = paratype, * = immature stages known.

Botosaneanu and Alkins-Koo 1993; Flint 1996 [these papers can be downloaded from the *Trichoptera Literature Database* at www.trichopteralit.umn.edu to facilitate comparisons]). The types are deposited in the University of Minnesota Insect Collection (UMSP), St. Paul, Minnesota, USA, and the Museo Ecuatoriano de Ciencias Naturales (MECN), Quito, Ecuador. The specimens are preserved in 80% ethyl alcohol.

Systematics

Genus Amphoropsyche Holzenthal

Amphoropsyche Holzenthal, 1985:255 [Type species: Brachysetodes insularis Flint 1968, original designation]. —Holzenthal, 1985:254 [revision]. —Holzenthal, 1986:251 [larva, pupa]. —Holzenthal and Rázuri-Gonzales, 2011:63 [key to species].

Amphoropsyche real Holzenthal & Ríos-Touma, sp. n. http://zoobank.org/4D4D3E54-69B4-4E43-A8BE-3052E60F1F95 Figs 1, 2

Diagnosis. This new species is most similar to *A. napo* and *A. tandayapa*, from Ecuador, and the Colombian species *A. ayura*, *A. cauca*, *A. flinti*, *A. quebrada*, and *A. stellata*. All of these species share tergum X bearing a mesal process and paired, lateral processes of various forms. The new species is the only one with the combination of long, spatulate mesal process and the lateral processes bearing both a prominent midlateral and a prominent subapicodorsal spinelike seta. In addition, *A. ayura*, *A. napo*, *A. quebrada*, *A. stellata*, and *A. tandayapa* have prominent parameres in the phallus, lacking in *A. real*, sp. n., while *A. cauca*, *A. flinti*, and *A. tandayapa* have a baso- or mesoventral process on the inferior appendages not present in the new species.

Description. Male. Forewing length 5.0 mm. Body and legs stramineous, wings light brown, apical 1/5th light cream (specimen preserved in 80% ethyl alcohol). Genitalia as in Fig. 1A-D. Segment IX annular, sternum with anterior part not extended anteriorly (Fig. 1A). Segment X composed of a single mesal process and pair of lateral processes (Fig. 1A-B); mesal process long, spatulate, apex rounded (Fig. 1B); lateral process broadly crescent shaped, bearing large lateral spinelike seta at midlength and large subapicodorsal spinelike seta; apically lateral process with about 6-8 small, but prominent setae (Fig. 1A). Preanal appendages large, oval, fused basally but divided apically to 1/2 their lengths (apical emargination acute); with large reticulate internal gland and small subapicoventral pore (Fig. 1A-B); apically with pair of asymmetrical, membranous dorsomesal processes, left process large bulbous, right process short (Fig. 1B). [It is highly likely that this asymmetry was caused by a malformation of one or the other or both processes. These processes may be prone to developmental abnormalities.] Inferior appendage with 1st article narrow, elongate, without basoventral projection, instead base short, bulbous and at right angle to straight apical portion of 1st article when viewed ventrally, bearing 2 small spinelike setae on posterior face (Fig. 1A, C); 1st article ending in a bulbous apex, bearing subterminal tuft of closely appressed setae emerging from membranous pocket; 2nd article of inferior appendage elongate, thin, slightly curved inwards in ventral view, apex slightly truncate; 2nd article fused to 1st article at base (or articulation not apparent) (Fig. 1C). Phallic apparatus (Fig. 1D) with phallobase well developed, with sclerotized apicolateral projection on each side, bearing stout apical spine; parameres absent; endothecal membranes well developed, apparently capable of articulation at midlength [these membranes were evaginated by the clearing process]; phallotremal sclerite well developed, structure as illustrated in Fig. 1D, but difficult to discern on specimen.

Female. Forewing length 6.0 mm (n=2). Color and structure similar to male's (specimens preserved in 80% ethyl alcohol). Genitalia as in Fig. 2A–D. Abdominal tergum IX + X very slightly excised apicomesally, tergum basally with small mound-like mesal protuberance; dorsomesally slightly excised along length. Appendages of



Figure 1. *Amphoropsyche real*, new species. Male genitalia **A** lateral **B** segments IX-X, dorsal **C** inferior appendages, ventral **D** phallus, lateral. IX = abdominal segment IX.

segment X absent (or highly reduced), apparent only as slightly raised, dorsolateral setose areas. Valves posterolateral, quadrate, covered with short setae. Vulvar scale thin, narrow in lateral view, round in dorsal view with slight mesal excavation. Sternum IX laterally forming pocketlike structure in pleural region (probably receptacle for apex of male inferior appendage). Vaginal apparatus (spermathecal sclerite complex) (see Fig. 2C, D) with broad, posterior base bearing central "keyhole-shaped" structure;



Figure 2. *Amphoropsyche real*, new species. Female genitalia **A** lateral **B** segments IX-X, dorsal **C** vaginal apparatus, lateral **D** vaginal apparatus, ventral. IX = abdominal segment IX, X = abdominal segment X.

middle region to apex with narrow lightly sclerotized plates and 2 dorsal membranous rounded mounds.

Holotype. Male. ECUADOR: Morona-Santiago: Macas, small gravel stream (Wallace/Real property), 02.20299°S, 078.08539°W, el. 1076 m, 27.i.2015, Holzenthal, Huisman, Ríos-Touma, Amigo (UMSP000114167) (UMSP). Paratypes: same data as holotype, 2 females (UMSP, MECN).

Etymology. Named for the family of RhoAnn Wallace and Galo Real and their children, Aster, Diem, and Luna, in recognition of their hospitality, friendship, and stewardship of the land where this species was collected.

Revised key to males of *Amphoropsyche* (modified from Holzenthal and Rázuri-Gonzales 2011)

1	Preanal appendages completely (Holzenthal 1985, figs 8B, 10B; Flint and Sykora 1993, fig. 20) or almost completely fused medially (if the latter, apical emargination shallow, obtuse) (Holzenthal and Rázuri-Gonzales 2011, fig. 1B, Halamathal 1985, fag. 2P)
_	Preanal appendages not fused medially, divided to 1/3 to 2/3 of their length (apical emargination acute) (Fig. 1B: Holzenthal 1985, figs 5B, 6B)
2(1)	Preanal appendages with dorsomesal process or processes (Holzenthal 1985, figs 8B, 10B)
_	Preanal appendages without dorsomesal process or processes (Holzenthal 1985, figs 3A–D)
3(2)	Dorsomesal processes of preanal appendages very short, digitate, not exceed- ing length of preanal appendage (Holzenthal and Rázuri-Gonzales 2011, figs 1A–D); dorsomesal processes of preanal appendages not sclerotized
_	Dorsomesal process or processes of preanal appendages long, ca. length of preanal appendage (Holzenthal 1985, figs 8A, 10A; Flint and Sykora 1993, fig. 18): dorsomesal processes of preanal appendages sclerotized
4(3)	Second article of inferior appendages elongate, narrow (Holzenthal 1985, fig. 8A)
_	Second article of inferior appendages short (Flint and Sykora 1993, figs 18–20; Botosaneanu and Alkins-Koo 1993, figs 97–101)
5(4)	Dorsomesal process of preanal appendages bifid in dorsal view; ventral sub- terminal portion of phallobase serrate (Holzenthal 1985, figs 8A–D)
_	Dorsomesal process of the preanal appendages entire in dorsal view; ventral subterminal portion of phallobase entire (Holzenthal 1985, figs 10A–D)
6(1)	Second article of inferior appendages present (Holzenthal 1985, fig. 5A)7
_ 7(6)	Tergum X with mesal process and paired lateral processes (Holzenthal 1985, figs 5A, 14A)
_	Tergum X without mesal process, lateral processes with apical and subapical spinelike projections (Botosaneanu 1990, figs 1–3)
8(7)	Second article of inferior appendages short (Holzenthal 1985, fig. 14C) or long, but broad (Holzenthal 1985, fig. 6C)9
_	Second article of inferior appendages elongate and narrow (Holzenthal 1985, Fig. 7C)11
9(8)	Phallus without parameres (Holzenthal 1985, fig. 6D)
-	Phallus with parametes (Holzenthal 1985, figs 14A–D)A. quebrada

10(9)	Second article of inferior appendages short, with apical spine-like seta; lateral
	process of tergum X with subapical spine-like seta; phallicata with pair of bifid,
	spiniferous, lateral extensions (Holzenthal 1986, figs 1A-D) A. spinifera
_	Second article of inferior appendages long, but broad, without apical spine-
	like seta; lateral process of tergum X with several apical spine-like setae; phal-
	licata without lateral, bifid extensions, but phallobase with ventral spinelike
	process (Holzenthal 1985, figs 6A–D) A. flinti
11(8)	Phallus with parameres (Holzenthal 1985, fig. 5D) or phallobase with scle-
	rotized apical projection bearing a stout spine12
_	Phallus without parameres (Holzenthal 1985, figs 11A-D)A. choco
12(11)	Inferior appendage with a prominent (Holzenthal 1985, figs 5A, C) to short
	mesoventral lobe (Holzenthal 1985, fig. 7C) when viewed ventrally; phallus
	with parameres (Holzenthal 1985, figs 5D, 7D)13
_	Inferior appendage without mesoventral lobe (Fig. 1C); phallus without par-
	ameres, but phallobase with sclerotized apical projection bearing a stout spine
	(Fig. 1)
13(12)	Lateral process of tergum X U-shaped, tip bifid, bearing small spinelike setae
	(Holzenthal 1985, figs 5A–D) A. napo
-	Lateral process of tergum X tapered to a sharp terminal point, without spine-
	like setae (Holzenthal 1985, figs 7A–D)A. stellata
14(6)	Parameres small; inferior appendage with basoventral lobe (Holzenthal 1985,
	figs 16A–D)
_	Parameres large; inferior appendage without basoventral lobe (Holzenthal
	1985, figs 12A–D)

Acknowledgements

The authors wish to thank the Real-Wallace family for their hospitality and support during our field studies in Ecuador during January of 2015 and for their continued interest in our research. Xavier Amigo, *Nature Experience*, and Jolanda Huisman also provided very generous support in the field. We thank Dr. Desiree Robertson-Thomson, Ernesto Rázuri-Gonzales, and an anonymous reviewer for their useful suggestions on the manuscript and figures. This research was supported by Minnesota Agricultural Experiment Station projects MIN-17-017 and 17-029. Dr. Juan M. Guayasamín and BIOCAMB (Universidad Tecnológica Indoamérica, Quito, Ecuador) provided laboratory support and facilities during fieldwork. The Ministerio del Ambiente, Ecuador, granted the collecting permit (003-14-1C-FAU-FLO-DNB/MA). This support is gratefully acknowledged.

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RESEARCH ARTICLE



Macrosiphoniella remaudierei, a new species of aphid on Helichrysum in Iran (Hemiptera, Aphididae)

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Academic editor: G. Goemans Received 24 May 2016 Accepted 28 November 2016 Published 13 December 2016
http://zoobank.org/87EC2109-F687-428F-8A2C-DD4F96A9D929

Citation: Barbagallo S, Nieto Nafría JM (2016) *Macrosiphoniella remaudierei*, a new species of aphid on *Helichrysum* in Iran (Hemiptera, Aphididae). ZooKeys 640: 69–78. https://doi.org/10.3897/zookeys.640.9329

Abstract

A new species of aphid, belonging to the genus *Macrosiphoniella* Del Guercio, 1911, is described using three samples collected in Iran on *Helichrysum armenium* (Asteraceae, Inuleae) by the late Prof. G. Remaudière. Both apterous and alate viviparous females of the new taxon, *M. remaudierei* **sp. n.**, are described and compared to corresponding morphs of the closely allied *M. aetnensis* and to other congeneric aphid species on *Helichrysum* in the Palaearctic region. Type specimens are now stored in the Muséum national d'Histoire naturelle in Paris.

Keywords

Hemiptera, Sternorrhyncha, new records, Aphididae, Iran

Introduction

The large aphid genus *Macrosiphoniella* Del Guercio, 1911 (Hemiptera Aphididae) currently contains at least eight species from *Helichrysum* (Asteraceae, Inuleae), distributed over much of the old world, ranging from N Europe southwards to Macaronesia and eastwards to Central Asia and West Siberia. See Blackman and Eastop

(2006-2015) for a general key to aphid species on *Helichrysum*. Four species belong to the subgenus Ramitrichophorus Hille Ris Lambers, 1947, and the remaining four (currently attributed to *Macrosiphoniella* nominotypical subgenus) probably represent two distinct genetic lineages. One lineage includes M. helichrysi Remaudière, 1952, and M. madeirensis Aguiar & Ilharco, 2005, which are both brown in colour and very similar to each other. The other lineage contains *M. aetnensis* Barbagallo, 1968, which is green in life and is apparently limited to southern Europe (Italy, France and Spain), to which the taxon described here as a new species is added. Specimens of the new taxon were collected in Iran and are indeed very similar in morphology to those of *M. aetnensis*; they were borrowed from the collection of the late Prof. G. Remaudière, which is stored at the Muséum national d'Histoire naturelle (Paris). The relevant species were detected by the second author together with a few hand-written notes by Prof. G. Remaudière, in which he pointed out the main differences, mostly focussing on the divergent aspects of body pigmentation and appendages from *M. aetnensis*. Prof. Remaudière provisionally labelled the Iranian aphid as a new subspecies of *M. aetnensis*. Further examination of morphological features and collection of biometric data from the available specimens of the new taxon, however, suggest that it is a full species rather than a subspecies. Furthermore, the two compared taxa, as far as is known, have separate distributions (SW Europe for *M. aetnensis* and Iran for *M. remaudierei*, respectively) following their host species Helichrysum (i.e. H. italicum and allied taxa for M. aetnensis and H. armenium for *M. remaudierei*). The range of distribution of the two host plants do not overlap, which would allow different pathways of differentiation for the two strictly allied aphid taxa.

Materials and methods

Available material of the new taxon consists of 53 adult specimens from three samples collected in Iran (for details see Types paragraph). All of the specimens having been mounted on slides. The specimens are mainly apterous except for two alate viviparous females and a few small nymphs. Type specimens of the very similar *M. aetnensis* (see Barbagallo 1968) were compared, including a large sample (containing more than 60 specimens, viviparous apterae and alatae) borrowed from the Muséum national d'Histoire naturelle (Paris). The latter specimens were collected from *Helichrysum* sp. (Le-Grau-du-Roi, Gard, France, 13.IV.1970) by Prof. G. Remaudière. Detailed biometric data were collected using an optical microscope from 20 randomly selected specimens for each of the two aphid taxa and then evaluated. The remaining available specimens of both taxa, though not individually measured, were also morphologically examined. Morphological features were compared to further species borrowed from specimens stored in the authors' collection and/or to published morphological descriptions whenever needed.

Results

A conclusive evaluation of the morpho-biometric data for the species allows the description of the following new aphid taxon.

Macrosiphoniella remaudierei sp. n.

http://zoobank.org/CCEF664C-3A26-47B8-9689-F52E3EC0A32D Figures 1, 3; Table 1

Diagnosis. Body pale in apterae morph with slightly brownish head in macerated specimens; dorsal body setae without pigmented spots at their basis; antesiphunculur sclerites lacking. Legs with coxae slightly pigmented; trochanters pale; tibiae with a pigmented basal part less extensive in length than their brown distal part. Subgenital plate pale. Cauda much less pigmented than siphunculi; their ratio (cauda length/ siphuncular length) 0.7 or less. Antennal joint III with (12)18–37 secondary sensoria, extended over 66–93% of its basal length. Alate morph (two specimens seen) with 36–40 secondary sensoria on III antennal joint; otherwise similar to apterae. This new species resembles very much *M. aetnensis* from which it can be separated as quoted in the taxonomy paragraph.

Description. *Apterous viviparous female* (51 specimens). Macerated body length: 1.65–2.25 mm. Colour in life unknown, but probably green with a waxy secretion, as in the very similar *M. aetnensis*. Head pigmented brown, darker on anterior half and with a deep frontal sinus (0.22–0.35 of the distance between the inner apices of antennal tubercles), median frontal tubercle lacking. Thorax and abdomen pale, lacking any dorsal pigmentation, including the pre-siphuncular sclerites (although the area is quite sclerified) or the scleroids at the base of the dorsal setae. Very small, wart-like tubercles at the base of the setae irregularly present from the metathorax to the 7th urotergite. Dorsal body setae are blunt or faintly flattened at apex, mainly on frons and along the spinal area of the thorax and abdomen, yet becoming gradually more acute on marginal areas of the body and terminal segments of the abdomen. Their maximum lengths are: 62–82 µm (1.80–2.70 of the basal articular diameter of antennal joint III) on the frons, 53–86 µm on the 2nd and 3rd urotergites, and 60–86 µm on the 8th urotergite. The latter urite bears 5–7 (usually 6) quite curved setae.

Antennae 2.37–3.18 mm long, or 1.27–1.57 of body length, are mostly pigmented, except for a more or less extended paler basal part of joints III, IV, and occasionally V. Antennal joint III (0.56–0.76 mm), 0.77–0.98 times the processus terminalis of joint VI (0.69–1.00 mm); the latter is 3.90–5.00 times the length of the basal part (0.16–0.20 mm) of the same joint. Secondary sensoria on joint III only, ranging from 12–37 in number (most frequently 22–30), but only rarely less than 20, and then in smaller specimens, down to 1.65–1.80 mm of the body length. These sensoria are flat or very slightly protruding and of variable size, up to 0.35–0.66 of the basal diameter of joint



Figure 1. a *Macrosiphoniella remaudierei* sp. n., apterous viviparous: body shape and pigmentation **b** hind tibia. Scale bars 0.5 mm.

III; they are distributed on the ventral side of the joint along 0.66–0.95 of its length. Primary rhinaria are regularly ciliated. Antennal setae are quite stout, blunt, or subcapitate at the apex, particularly on the first two joints, then gradually more or less flattened and more acute towards the antennal apex. Those on joint III have a maximum length of 26–40 μ m, or 0.80–1.28 of the basal articular diameter of the same joint.

The *rostrum* extends to behind the posterior margin of the hind coxae and is well pigmented towards its distal part. The ultimate rostral joint is stiletto-shaped, 0.145–0.195 mm long, or 1.10–1.36 of the second joint of hind tarsus (including the unguiferous); it usually bears 6 supplementary hairs (rarely 5 or 7), of which 4 are anterior and 1–3 are dorsal and smaller.


Figure 2. a *Macrosiphoniella aetnensis*, apterous viviparous: body shape and pigmentation **b** hind tibia. Scale bars 0.5 mm.

Legs with coxae moderately pigmented (more or less similar to head capsule); trochanters are usually pale. Femora are also pale at their one-third basal part and well pigmented (darker than the coxae) towards their distal part, where a depigmented macula is more or less evident on all legs. Dorsal femoral hairs are more or less blunt or subcapitate, and the ventral hairs are always more acute at the apex; the former have a maximum length of $32-50 \mu m$, 0.54-0.85 of the trochantro-femoral suture. Tibiae are unpigmented for most of their length, except for the brown basal and distal parts. The basal pigmentation is usually less extensive than the distal brown part and no longer than about 2.0-2.5 of the tibial width at the same basal point on the hind legs. Tibial setae are mostly pointed except for the more proximal on the outer side, which are quite blunt or subcapitate at the apex. Longest tibial hairs reach $34-50 \mu m$, 0.84-1.20 of the median tibial diameter on the hind legs. Tarsi are brown, with their second joint (0.130-0.154 mm) 0.72-0.90 of the basal part of antennal joint VI. First tarsal chaetotaxy is 3:3:3, which is usual for the genus.

Siphunculi (0.34–0.50 mm) are well pigmented, 0.15–0.23 of body length, 3.19–4.30 of their basal diameter, and slightly tapering towards the apex, which is flangeless. They are usually straight, but sometimes slightly curved outwards; reticulated distal area 0.36–0.53 of their total length.

Cauda (0.18–0.30 mm) is pale or very slightly pigmented, digitiform in shape, and faintly constricted, or almost tongue-shaped and not constricted (mostly in smaller specimens); it is 0.53–0.68 of the siphunculi and bears 9–14 (most frequently 10–12) long and quite curved setae.

The *genital plate* is pale and faintly sclerified (although not pigmented), bearing 2–5 discal (2 long and 0–3 much shorter) and 8–12 marginal setae.

Alate viviparous female (from 2 specimens). Colour in life unknown. Head and thorax are pigmented brown; abdomen is pale as in apterae, except for the fairly brownish genital plate. Papillae on abdominal dorsum are not evident. Antennae 2.79–3.43 mm and 1.36–1.44 of body length, darker than in apterae with quite pale basal parts of joints III and IV; joint III has 36–40 secondary sensoria distributed along its length. All veins of the forewings have a narrow brown border, mostly evident on Cu1 and Cu2. Pigmented legs are very similar to apterae, with darker coxae and subdistal parts of the femora. Siphunculi are more slender than in apterae and cover 0.17–0.18 of the body length. Cauda, 0.66–0.70 of the siphunculi, is darker than in apterae but paler than the siphunculi.

All other morphological features are very similar to those of the apterous viviparous female. Body length: 2.05–2.38 mm.

Types. All type specimens came from three samples collected in Iran from *H. armenium* DC. by Prof. G. Remaudière. The holotype is an apterous viviparous female (see table 1, specimen no. 1) collected 25 km east of Tehran (35.48 N/51.34 E), 11.VI.1955, 2000 m a.s.l. (sample no. i 515a). Paratypes are 50 apterous and 2 alate viviparous females collected as follows: 1. locality and date as for the holotype, 13 apterae and 1 alate (sample no. i 515a); 2. Dali Tchahi [from the notes of G. Remaudière], near Yaroud (Qazvin province) (36.31 N/50.20 E), 21.VII.1955, 1900 m a.s.l., 32 apterae and 1 alate (sample no. i 834); 3. fifty km NW of Shahr-e-Babak (Kerman province) (30.24 N/55.05 E), 14.IX.1972, 2400 m a.s.l., 5 apterae (sample no. i 3744). All types have been deposited at the Muséum national d'Histoire naturelle, Paris (France).

Etymology. The new taxon is named in honour of the late Prof. Georges Remaudière, a great leader in aphid taxonomy.

Ecology and distribution. The new aphid species, as far as is known, feeds on the aerial parts of *H. armenium* in Iranian mountainous regions (range of collecting localities: 1900–2400 m a.s.l., co-ordinates as above). Only viviparous morphs (apterae, alatae, and nymphs) were collected, so the aphid life cycle remains unknown. The



Figure 3. *Macrosiphoniella remaudierei* sp. n. **I** third antennal joint of apterous viviparous **2** same of alate viviparous **3** shape of ultimate rostral joint of apterous viviparous **4** head of apt. viv. **5** siphunculus of apt. viv. female **6** cauda of apt. viv. female. Scale bars 0.1 mm.

aphid is probably monoecious and holocyclic, like *M. aetnensis* (Barbagallo, 1969), as it is unlikely to survive winter as viviparous morphs at such high altitudes.

The host plant has a mainly Eastern Mediterranean-Iranian distribution, ranging from its western boundary (Lebanon, Syria) eastwards to Iran, through Turkey, Georgia, Armenia, Azerbaijan, and Iraq. The aphid, unless it can survive on additional congeneric host plants, is therefore likely to have a similar biogeographic distribution.

No.	Bl	Al			Ajl		SrIII	Urj	IIht	Sl	Ca	uda
			III	IV	V	VI					lg.	hs.
1	2.02	3.18	0.77	0.51	0.47	0.20+1.00	28/27	0.195	0.153	0.45	0.27	12
2	1.96	2.89	0.71	0.52	0.44	0.19+0.82	28/30	0.180	0.137	0.43	0.27	10
3	2.25	3.03	0.74	0.58	0.48	0.19+0.81	37/34	0.188	0.144	0.50	0.28	12
4	2.11	2.75	0.68	0.48	0.44	0.16+0.78	24/25	0.172	0.144	0.45	0.26	10
5	2.15	2.87	0.70	0.51	0.46	0.19+0.80	26/24	0.179	0.146	0.45	0.28	14
6	2.06	2.63	0.65	0.44	0.41	0.16+0.76	26/23	0.181	0.144	0.44	0.26	10
7	2.01	2.66	0.65	0.49	0.41	0.16+0.74	25/24	0.186	0.143	0.44	0.25	14
8	2.07	2.75	0.68	0.52	0.41	0.16+0.78	31/28	0.177	0.141	0.46	0.27	12
9	1.65	2.46	0.60	0.41	0.40	16+0.69	13/17	0.145	0.130	0.37	0.20	10
10	1.76	2.46	0.56	0.44	0.38	0.18+0.71	14/15	0.150	0.132	0.34	0.18	11
11	2.38	3.43	0.84	0.58	0.57	0.20+1.00	38/36	0.188	0.152	0.43	0.30	11
12	2.05	2.79	0.68	0.49	0.44	0.18+0.80	36/40	0.173	0.136	0.36	0.24	9

Table 1. *Macrosiphoniella remaudierei* sp. n. – Apterous (ns. 1–10) and alate (ns. 11–12) viviparous females. Measurements in mm of some type specimens. Abbreviations: Bl, body length; Al, Antennal length; Ajl, Antennal joints length; SrIII, Secondary rhinaria on III ant. joint; Urj, Ultimate rostral joint; IIht, second hind tarsomer; Sl, Siphuncular length; lg, caudal length; hs., number of caudal hairs.

No. 1 is the **holotype**, others are **paratypes**; ns. 1–3 and 11 sample no. i 515a; ns. 4–8 and 12 sample no. i 834; ns. 9–10 sample no. i 3744. For samples – data see the text (Types).

Taxonomic remarks

The new taxon is strictly allied to *M. aetnensis*, from which it differs by a small number of morphological features and by the pigmentation of the abdomen, legs, and cauda.

The apterous morph of *M. remaudierei* is characterized by: a. abdomen entirely pale, including the genital plate; b. legs with slightly pigmented coxae and trochanters usually as pale as the basal part of femora; the latter are brown on the distal two-thirds but have a pale subdistal area; tibiae with the pigmented basal part less extensive than the brown distal part; c. cauda much less pigmented than the siphunculi; d. cauda/ siphunculi ratio up to 0.7 (range 0.52–0.68); e. antennal joint III with 12–37 (but usually not less than 18) secondary sensoria, which are distributed over 66–93% of its length.

In contrast, the coxae and trochanters in the apterae of *M. aetnensis* (Fig. 2) are more pigmented. The femora lack a pale subdistal area. Tibiae with their pigmented basal part as long as or longer than the brown distal part. Abdominal tergites usually have small pigmentations (such as rounded spots at the base of dorsal setae, a small ante-siphuncular sclerite, and a narrow bar on the 8th tergite). Genital plate is brownish, and cauda well pigmented (nearly as dark as the siphunculi). Secondary sensoria 7–15, distributed over 49–65% of the length of joint III. Ratio cauda/siphunculi usually more than 0.7 (0.70–0.88).

Alate morphs are more difficult to separate between the two taxa, because the above differences in pigmentation of the body and appendages are much more attenuated. The number of secondary sensoria on antennal joint III are nevertheless 36–40 in two specimens of *M. remaudierei* (compared to 21–32 in *M. aetnensis*), and the cauda/siphunculi ratio is 0.67–0.70 (compared to 0.73–0.87 of the other species). *M. aetnensis* also frequently (48% of 21 specimens) has a few (1–4) secondary rhinaria on antennal joint IV, which are absent in *M. remaudierei* (this difference, however, may not be reliable due to the paucity of specimens examined for the latter species).

Macrosiphoniella remaudierei is not likely to be confused with any other Macrosiphoniella species on Helichrysum. The four known species of the subgenus Ramitrichophorus have very different morphological features, such as a short triangular cauda, a longer ultimate rostral joint, and furcate or ramose setae on the body or appendages (see Hille Ris Lambers 1947; Heie 1995; Blackman and Eastop 2006-2015). M. helichrysi and the very similar M. madeirensis are also quite different, with a dark brown colour in life, extensive pigmentation of the appendages, large dorsal abdominal sclerifications, and other differences (Remaudière 1952; Aguiar and Ilharco 2005). M. olgae, another species sometimes on Helichrysum (recorded on H. punctatum by Nevsky 1951), is also brownish in colour but usually feeds on the allied *Gnaphalium* (= Omalotheca) sylvaticum (Blackman and Eastop 2006–2015; Holman 2009). This rare aphid has only been reported from mountainous regions in Central Asia (Kazakhstan, Uzbekistan) (Nevsky 1929, 1951; Kadyrbekov 2002), even though its main host plant is widespread in western Europe. This aphid is quite different from our new taxon by having (after Nevsky 1929): dark cauda and almost the same length as siphunculi, antennal joint III with 10–20 secondary rhinaria on its basal half, abdomen with small sclerites at the base of the dorsal setae, a well-developed ante-siphuncular sclerite, and other morphological differences.

Among the *Macrosiphoniella* species not found on *Helichrysum* or the allied Inuleae (Asteraceae), *M. usquertensis* Hille Ris Lambers is widespread in Europe on the *Achillea millefolium* group, and the general aspect of the body pigmentation when mounted on slides roughly resembles that of our new taxon. It differs, however, in the conical-shaped last rostral joint, which is shorter than the second joint of hind tarsus, and in other morphological features (see Hille Ris Lambers 1938, Heie 1995).

Acknowledgements

Grateful thanks are given to Dr. Adeline Soulier-Perkins, Département de Systematique et Evolution, Muséum national d'Histoire naturelle, Paris, for the loan of slides with the new described taxon and *M. aetnensis*. Many thanks are also due to our colleague Dr. Andrey Stekolshchikov, St. Petersburg, for the translation from Russian of parts concerning *M. olgae* from Kadyrbekov (2002) and Nevsky (1929). Sincere thanks are also due to Dr. Astrid Jankielsohn and other anonymous reviewers.

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RESEARCH ARTICLE



Two new genera of big-eyed minute litter bugs (Hemiptera, Schizopteridae, Hypselosomatinae) from Brazil and the Caribbean

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Academic editor: L. Livermore Received 28 July 2016 Accepted 29 November 2016 Pub	olished 13 December 2016

Citation: Hoey-Chamberlain R, Weirauch C (2016) Two new genera of big-eyed minute litter bugs (Hemiptera, Schizopteridae, Hypselosomatinae) from Brazil and the Caribbean. ZooKeys 640: 79–102. https://doi.org/10.3897/zookeys.640.9690

Abstract

Charismatic Hypselosomatinae (currently 14 extant and fossil genera; 72 species), the "big-eyed minute litter bugs", are characterized among Schizopteridae (Dipsocoromorpha) by the large eyes, four-segmented labium, and distinctive wing venation. A recent molecular phylogenetic analysis confirmed the monophyly of Hypselosomatinae that were recovered as the sister taxon to the Ogeriinae + Schizopterinae (Weirauch and Štys 2014). Hypselosomatinae occur in the Old and New Worlds, but described species diversity is biased towards the Oriental and Australian regions: only three monotypic genera are currently known from the New World (*Glyptocombus* Heidemann, *Ommatides* Uhler, and *Williamsocoris* Carpintero & Dellapé). Based on 28 male, female, and juvenile specimens from Cuba and the Dominican Republic and a single male specimen from Brazil we here describe two new monotypic genera of Hypselosomatinae, *Hypselosomops pecki* gen. n. and sp. n., and *Hypsohapsis takiyae* gen. n. and sp. n. We provide habitus images, digital illustrations (light, scanning electron, and/or confocal microscope) of wing and male genitalic structures, line drawings of genitalic structures, and a fossil record that dates back to the mid-Cretaceous make the Hypselosomatinae a fascinating group to explore in an effort to understand the evolutionary history of Dipsocoromorpha.

Keywords

Dipsocoromorpha, taxonomy, morphology, Neotropics, Hypselosomops pecki, Hypsohapsis takiyae

Introduction

Schizopteridae are tiny (1-3 mm) yet charismatic Heteroptera, the study of which is hampered by their cryptic habits and small size that make them rare in collections and difficult to examine. Adults display extreme wing polymorphism ranging from apterous to macropterous and elytrous, with the latter being a wing type that is very rare outside of Coleoptera. Wing polymorphism can be sexually dimorphic (Wygodzinsky 1948, Emsley 1969, Hill 2013, Knyshov et al. 2016, Leon and Weirauch 2016), but may also occur amongst individuals of the same sex (Hill 1980; Alexander Knyshov, pers. obs.). In addition, extreme asymmetry of the male genitalia, a feature that is fairly rare in Heteroptera, is widespread in Schizopteridae and often includes modifications of the pre-genital abdomen (Emsley 1969, Štys 1970). With 72 described species, the subfamily Hypselosomatinae, also known as "big-eyed minute litter bugs", is currently the second largest subfamily of Schizopteridae. Diagnostic features include the very large eyes, often overlapping the margins of the prothorax, four-segmented labium, well developed ovipositor, and distinctive wing venation of four closed marginal cells after the costal cell (Emsley 1969, Lionel Hill 1980). Hill (1980) in addition discussed the following characters as potentially diagnostic for the subfamily: anterior sclerites formed from the ninth abdominal segment and forming part of the ovipositor (referred to by Hill (1980) as gonangulum struts) fused to ninth segment; three, six or seven pairs of abdominal spiracles; hind wing, when present, with jugal lobe; and possession of gonoplacs in females. Emsley (1969) recognized Hypselosomatinae as a well-defined group in his schema of proposed relationships among Schizopteridae, and the only published phylogenetic analysis confirmed the monophyly of this group with high branch support, although only four of the currently recognized 14 genera were represented in that analysis (Weirauch and Štys 2014).

The taxonomic history of this group started in the late 19th century with the almost simultaneous description of Old World Hypselosoma oculata Reuter by Reuter (1894) and New World Ommatides insignis Uhler by Uhler (1894). A second New World genus, Glyptocombus Heidemann, was described after the turn of the century (Heidemann 1906) and various scientists added species to the Old World genus Hypselosoma Reuter: Horvath (1905) [1 species], Esaki and Miyamoto (1959) [1 species], McAtee and Malloch (1925) [1 species], and Wygodzinsky (1960) [9 species]. Much later, the hypselosomatine diversity of Australia and adjacent regions was extensively studied by the most prolific taxonomist to focus on this subfamily, Hill, who has described 7 new genera and 53 new species during the past 25 years (Pateena Hill, Macromannus Hill, Ordirete Hill, Lativena Hill, Cryptomannus Hill, Duonota Hill, Rectilamina Hill (Hill 1980, 1984, 1985a, 1985b, 1987, 1991). The third New World genus, Williamsocoris Carpintero and Dellapé, was recently described from Argentina (Carpintero and Dellapé 2006). Together with three monotypic genera that are based on fossils, Libanohypselosoma Azar and Nel, Buzinia Perrichot, Nel and Néraudeau, and Tanaia Perrichot, Nel and Néraudeau (Azar and Nel 2010, Perrichot et al. 2007), 72 species in 14 genera are currently recognized in the Hypselosomatinae.



Figure 1. Map of distribution of all New World Hypselosomatinae (generated using data entered in the American Museum of Natural History's Arthropod Easy Capture Software database (http://www.research.amnh.org/pbi/locality/index.php))

The Hypselosomatinae have a worldwide distribution but are most diverse in the tropics, a pattern similar to those observed in other groups of Dipsocoromorpha. The greatest described diversity is from the Indo–Pacific and Australia, but this may be an artifact due to Hill's focus on that biogeographic region and the lack of research on the Oriental, Afrotropical, and Neotropical regions. Hypselosomatines inhabit cryptic and typically moist microhabitats such as leaf litter, low vegetation, the interstitial zone of streams, and even mangroves (McAtee and Malloch 1925, Emsley 1969, Hill 1984, 1991, Melber and Köhler 1992, Schuh and Slater 1995, Ng et al. 1999). Published distributional data are scarce for Hypselosomatinae beyond the well-documented Indo–Pacific and Australian fauna. Despite the fact that Hill (1984) suspected that new taxa of hypselosomatines are unlikely to be discovered in South America, the recently described *Williamsocoris* was collected in Argentina. Along similar lines, Wygodzinsky (1960) commented on the absence of Hypselosomatinae in Africa despite their presence in Madagascar. Based on examination of schizopterid specimens that we have assembled from various natural history collections and that include ~632 specimens

of Hypselosomatinae, we have discovered a number of undescribed Hypselosomatinae from Central and South America, Africa, and the Indo–Pacific region. In the New World, we have examined Hypselosomatinae from Panama, Suriname, Ecuador, Peru, Dominican Republic, Costa Rica, Mexico, USA [FL, GA, TX, OK, AR, KS, TN, MD, MI], Trinidad and Tobago, French Guiana, Colombia, Cuba, and Brazil (Fig. 1). This publication focuses on a subset of these specimens, specifically specimens from Cuba, the Dominican Republic, and Brazil that represent two new monotypic genera that we here describe and document using light, scanning electron, and confocal microscopy. Future publications will focus on the remaining specimens from other localities that are likely new species of already described genera.

Materials and methods

Material

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A single male specimen collected in Sao Paolo, Brazil (BRAZIL: Sao Paulo: Ubatuba: Picinguata; -23.37743, -44.83733; 1997-2001, Nessimain, J.L. & Takiya, D.M.), loaned to us by Daniela Takiya, will be deposited in the Universidade Federal do Rio de Janeiro (UFRJ). Habitus images were taken and the specimen was then DNA extracted using a non-destructive protocol and Qiagen DNeasy Blood and Tissue Kit (Qiagen, Hilden, Germany) in a solution of ATL buffer and protease K for later sequencing. This resulted in slight clearing of the specimen which allowed further dissection. The abdomen of the specimen was removed and temporarily slide mounted in glycerin gelatin for examination and documentation through images and drawings. The entire specimen was then permanently mounted on a microscope slide using Canada balsam. In addition, 28 specimens (14 adult male, 8 adult female, and 7 juveniles) collected in Cuba and the Dominican Republic loaned to us by the Field Museum of Natural History in Chicago, IL, USA were examined. Seven specimens were imaged for habitus photo plates. The three adult specimens (UCR_ENT 00091115, UCR_ENT 00091116, and UCR_ENT 00091117; see below for explanation of specimen codes) were DNA extracted following the above described protocol. Four specimens were dissected by removing the abdomen, leaving the abdomen intact for males, but removing soft tissue using KOH clearing for females (UCR_ENT 00091115, UCR_ENT 00091117, UCR_ENT 00091118, UCR_ENT 00096904-UCR_ENT 0009607). Two specimens (one male and one female) were dissected in preparation for scanning electron microscopy (UCR_ENT 00096908 and UCR_ENT 00098865).

Imaging, dissections, measurements, databasing and distribution maps

Dorsal, lateral, and ventral habitus images were produced using a Leica DFC 450 C Microsystems system (Leica, Wetzlar, Germany) with a Planapo 1.0x objective. Images of select morphological features were produced using a Leica DFC 450 C Microsystems system (Leica, Wetzlar, Germany) with a Planapo 2.0x objective. Images were stacked using the Leica Application Suite V4.3 software or Zerene stacker V1.02 (Zerene Systems). Confocal images of genitalia were taken on a Leica SP5 Inverted confocal microscope at the Institute for Integrative Genome Biology core facility (http://genomics.ucr.edu/) using cuticular auto fluorescence excited by 488nm and 543nm lasers and collected by detectors in diapasons of 500–535nm (green in figures) and 555–700nm (red in figures). The resulting confocal images were rendered using Imaris V7.6.4 (Bitplane). Specimens used for Scanning Electron Microscopy were sputter coated with a platinum-paladium using a Cressington 108 auto sputter coater (Cressington, Watford, UK) before imaging using a FEI XL30-FEG Scanning Electron Microscope at the UCR Central Facility for Advanced Microscopy and Microanalysis (http://cfamm.ucr.edu/). All images were edited and assembled into image plates in Adobe Photoshop CS4.

To examine male genitalia, the abdomen was separated from the body and either cleared by placing into hot 10% KOH, or prepared for DNA extraction. For study of female genitalia the abdomen was separated from the body, cleared in KOH for ~10 minutes, and placed in Chlorazol Black E for three 30 second intervals. Line drawings were prepared using a Nikon Eclipse 80i compound microscope (Nikon, Tokio, Japan) with camera lucida.

Measurements (see Table 1) were made using habitus images and all measurements are in mm. Total length was measured from the front of head to apex of forewing, body length was measured from the front of head to apex of abdomen, and width between eyes was measured in frontal perspective.

Unique specimen identifier (USI) labels consisting of a matrix-code and prefix plus eight-digit number were associated with each specimen. Specimen information was databased using the American Museum of Natural History's Arthropod Easy Capture (AEC) Software database (http://www.research.amnh.org/pbi/locality/index.php). Specimens for which geographic coordinates were absent from the label were georeferenced using Google Earth. The associated information is available through the Heteroptera Species Pages (http://research.amnh.org/pbi/heteropteraspeciespage/) and the http://www.discoverlife.org/ website. Specimens stored in ethanol and voucher specimens for molecular study were also given an internal identification number. Maps were prepared in SimpleMappr (http://www.simplemappr.net/) using the coordinates exported from the AEC database.

Nomenclatural acts

This publication and the nomenclatural acts it contains have been registered in ZooBank, the online registration system for the ICZN. The ZooBank LSIDs can be resolved by appending them to the Web address http://zoobank.org/. The LSIDs for nomenclatural acts can be found in corresponding sections of this article.

Species			H	pselosomops peck	i			Hypsohapsis takiyae
Sex	Male (macropterous)	Male (brachypterous)	Female	1st instar	2nd instar	4th instar	5th instar	Male
ISU	UCR_ENT 00091116	UCR_ENT 00091117	UCR_ENT 00096912	UCR_ENT 00096916	UCR_ENT 00096917	UCR_ENT 00096918	UCR_ENT 00096919	UCR_ENT 00111639
Total length	1.49	1.03	1.09					1.51
Body length	1.53	1.03	1.38	0.69	0.80	1.03	1.13	1.48
Pronotum width	0.61	0.53	0.54					0.74
Pronotum length	0.16	0.23	0.18					0.26
Pronotal collar length	0.04	0.07	0.05					0.05
LC:LP	0.23	0.28	0.28					0.21
Vertex width	0.36	0.36	0.37	0.28	0.22	0.31	0.33	0.50
Eye width	0.68	0.65	0.67	0.41	0.46	0.60	0.61	0.92
Width between eyes								0.37
Fore femora depth/ height	0.07	0.08	0.08	0.05	0.05	0.07	0.07	0.17
Fore femora length	0.28	0.30	0.28	0.17	0.13	0.24	0.25	0.56
DFF:LFF	0.25	0.26	0.29	0.30	0.41	0.31	0.30	0.30
Hind tibia length	0.61	0.59	0.56	0.24	0.24	0.30	0.42	0.72
LHT:WP	1.00	1.11	1.03					0.97
al length		0.08						
a2 length		0.07						
a3 length		0.28						
a4 length		0.30						
a3:a4		0.93						

Table I. Specimen measurements in mm.

Terminology and abbreviations (for tables and figures)

We use the following abbreviations: 1An, first anal vein; 2An, second anal vein; ac, anal cell; ano, anophore; anop, anophoric process; ag, anterior gonapophysis; at, anal tube; bucc, buccula; ca, conjunctival appendage of vesica; cly, clypeus; clypD, clypeal depression; C, costa; cc, costal cell; Cu, cubitus; cub, cubital cell; dc, discal cell; DFF:LFF, ratio of height (termed depth in Hill (1980)) of fore femora to length of fore femora; g, gonoplacs; ipt8, internal process of tergite eight; 11, first labial segment; 12, second labial segment; 13, third labial segment; 14, fourth labial segment; labr, labrum; LC:LP, ratio of pronotal collar length to pronotum length; LHT:WP, ratio of length of hind tibia to width of pronotum; lp, left paramere; M, media; M1, first branch of media; M2, second branch of media; mdp, mandibular plate; flp, flap like process; mxp, maxillary plate; pg, posterior gonapophysis; R, radius; R1, first branch of radius; R2, second branch of radius; rp, right paramere; s7, sternite seven; s8, sternite eight; s9, sternite nine; Sc, subcosta; spd, spermathecal duct; spgd, spermathecal gland duct; spgl, spermathecal gland; spr, spermathecal reservoir; spth, spermatheca; st, styloid; t1-2, tergite one and two; t3, 4, 5, 6, 7, tergites three, four, five, six, seven; t8, tergite eight; t8p1, anterior most process of tergite eight process; t8p2, posterior most process tergite eight; tc, trapezoidal cell; v, vesica; wc, wing coupling organ.

Hill (2013) used terms including terminal capsule, apical canal, globular body, and duct to describe parts of the female spermatheca. Instead, we here use the terms spermathecal gland, spermathecal gland duct, spermathecal reservoir, and spermathecal duct that are both more descriptive and more widely used. The structure referred to as clypeus by Hill (1984) but later corrected in Hill (2014) and reiterated in Hill (2015) is the labrum and we refer to it accordingly. Hill (1984) used the term postnotum which he defines as a posteriorly "directed flange of the metanotum occupying up to half of the width of the pterothorax at the point where it project freely as a flange," we will use this term as well.

Identification Key

Key to the genera of Hypselosomatinae in the Old and New Worlds (modified from Hill 1984), indicating known distribution of genus (NW, New World; OW, Old World)

	12B & C)
_	First labial segment not dorsally expanded
2	Third and fourth labial segments not distinctly separated, with a sclerotized,
	hornlike or tubular structure occupying both segments (Fig. 12D)

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-	Third and fourth labial segments distinctly separated and without any orna-
3	Males with slightly enlarged first labial segment lacking anterior teethlike se- tae; clypeus of male lacking macrosetae and medially depressed with posterior
_	Haplike expansion (Fig. 5C)
4	Clypeus without macrosetae
_	Clypeus with 1–5 macrosetae: female never macropterous 6
5	Macropterous maior part of <i>Rectilamina</i> Hill (OW)
_	Elvtrous (Fig. 12)
6	Clypeus with 1 macroseta
_	Clypeus with 3–5 macrosetae
7	Vertex deflected 90° at posterior margin, with median furrow; venation nor-
	mal width Cryptomannus Hill (OW)
-	Vertex not sharply deflected, without furrow; elytrous venation very wide
0	Characteristic 5 and an and a construction of the construction of
0	Clypeus with 3 macrosetae
0	Ears famur with long macrosetae Hutsalosom a Wygodzinsky (OW)
_	Fore femur with out macrosetae (Fig. 8)
10	Ratio of propotal collar length to propotum length > 0.29 (elytrous).
10	0.25 (macropterous); Ratio of length of hind tibia to width of pronotum < 0.95
_	Ratio of proposal collar length to proposition length ≤ 0.25 ; ratio of length of
_	hind tibia to width of pronotum > 0.95
11	Body black Pateena Hill (OW)
_	Body brown
12	Pronotal disc with transverse furrow; elvtrous forewing cells with regular rows
	of large ovoid punctures Ordirete Hill (OW)
_	Disc with no furrow; cells not coarsely sculptured
13	First antennal segment with short macrosetae; second hind tarsomere with 2
	short to medium macrosetaemajor part of <i>Duonota</i> Hill (OW)
_	
	First antennal segment without macrosetae; second hind tarsomere with 1 medium macrosetae (ignore long apical ventral seta)
14	First antennal segment without macrosetae; second hind tarsomere with 1 medium macrosetae (ignore long apical ventral seta)
14	First antennal segment without macrosetae; second hind tarsomere with 1 medium macrosetae (ignore long apical ventral seta)
14	First antennal segment without macrosetae; second hind tarsomere with 1 medium macrosetae (ignore long apical ventral seta)
14 _	First antennal segment without macrosetae; second hind tarsomere with 1 medium macrosetae (ignore long apical ventral seta)
14 -	First antennal segment without macrosetae; second hind tarsomere with 1 medium macrosetae (ignore long apical ventral seta)
14 	First antennal segment without macrosetae; second hind tarsomere with 1 medium macrosetae (ignore long apical ventral seta)

Taxonomy

Hypselosomops gen. n.

http://zoobank.org/364FFCA8-2B30-4F67-A09E-E17258ACFDBE Figures 2–7

Type species. Hypselosomops pecki sp. n.

Diagnosis. Distinguished among Hypselosomatinae by males with two wing morphs (macropterous and submacropterous); slightly enlarged and dorsally expanded first labial segment lacking anterior "teeth-like" setae (Fig. 5D); third and fourth labial segments distinctly separated (Fig. 5D); clypeus without macrosetae but with medial apical indentation with small basal flap and a row of five small setae at apex (Fig. 5C); large seta with strongly expanded apex originating dorsoapically on third tarsal segment of all legs; tergite eight with bipartite process on left side (Fig. 4A, D); two conjunctival appendages at base of vesica (Fig. 4A, B). Most similar among New World Hypselosomatinae to *Ommatides* in coloration (Fig. 12). Among Old World hypselosomatine genera similar to *Duonota* and *Rectilamina* (Hill 1984), with which it shares the absence of clypeal macrosetae in males and the presence of three clypeal macrosetae in females, as well as the modifications of tergite eight in males and the presence and shape of the spermatheca in females. Distinguished from all hypselosomatine genera by the structure of the clypeus and the process of tergite eight.

Description. Male: Coloration. Head, thorax, abdomen ventrally, and forewing light to dark brown, with pale transverse band proximally on forewing; legs yellow, coxae brown; abdomen dorsally pale; genital capsule and genitalia light to dark brown. Surface and Vestiture. Clypeus without macrosetae, with a depression in apical half and a row of five small setae at apex; buccula and first labial segment each with a pair of stout ventrolateral macrosetae; second labial segment with pair of lateral macrosetae (Fig. 5C); first antennal segment with five setae; ratio of length of third antennal segment and fourth antennal segment approximately 0.93; fore femur without anterior macroseta; hind tibia with four erect medium-length macrosetae ventrally on distal half; second tarsomere of hind leg with one macroseta anteroventrally (Fig. 5B); projections on left side of tergite eight with distinctive spines at apices, anteriormost process of tergite eight with simple spines, posterior process of tergite eight with spines with differentiated bases; anophore without distinctive setae (Fig. 5H). Structure. First labial segment slightly enlarged, with small frontally converging lobes (Fig. 5C, D); clypeus with medial apical indentation with small basal flap (Fig. 5C); ratio of pronotal collar length to pronotum length 0.23 (macropterous male), 0.28 (submacropterous male); disc steeply declivous, not decurrent anteriorly; collar slightly depressed below pronotum (Fig. 2); postnotum subrectangular (i.e. the freely projecting portion is straight along most of the posterior margin, curving only laterally, as in *Rectilamina* Hill); ratio of height of fore femora to length of fore femora 0.25 in macropterous and submacropterous morph; tarsal formula 2-3-3; large seta with strongly expanded apex



Figure 2. Dorsal, ventral, and lateral habitus of macropterous and submacropterous males, female, and first, second, fourth, and fifth instar juveniles of *Hypselosomops pecki*.

originating dorsoapically on third tarsal segment of all legs; pretarsus with two long, thin parempodia with slightly expanded and flattened apex; inflated arolium absent (Fig. 5B, E, F); ratio of length of hind tibia to width of pronotum 1.00 (macropterous), 1.11 (submacropterous); fore wing polymorphic (macropterous or submacropterous); wing venation as in Fig. 3A, C, D; trapezoidal cell variable; discal cell elongate rectangular; in macropterous form first anal vein not meeting cubitus, in submacropterous form first anal vein meeting cubitus forming cubital cell; macropterous form with full length hind wing, submacropterous form with greatly reduced hind wing; abdomen with two pairs of spiracles (on sternites seven and eight). Genitalia. Posterior margin of sternite seven simple, very slightly asymmetrical (Fig. 4C); right side of tergite eight with small projection, left side with two projections (one short and semi-triangular, and one long, slender and curving dorsad), each with distinctive spines on apices (Fig. 4A, D); sternite eight free of sternite seven and with nearly medial triangular lobe (Fig. 4C); anophoric process long, thick and curving dorsally but without articulations (Fig. 4A); right paramere mitten-shaped with short process at base forming a "thumb"; left paramere scapula-shaped with a large thumb-shaped projection (Fig. 4A, B); vesica



Figure 3. A Macropterous male wing B submacropterous female wing: C, D submacropterous male wing of *Hypselosomops pecki*.

of average length with two bends, and two conjunctival appendages at base, one long and pointed, the other shorter and pointed and with a 90 degree bend just before the point (Fig. 4A, B).

Female. Coloration. Similar to male. Surface and Vestiture. First antennal segment with five macrosetae; ratio of third antennal segment and fourth antennal segment approximately 0.93; clypeus not inflated with three (two basal, one at tip) macrosetae; second labial segment with pair of lateral macrosetae, buccula with pair of lateral macrosetae (Fig. 7A, D); fore femur without anterior macroseta; hind tibia with four erect medium-length macrosetae ventrally on distal half; second hind tarsomere with one macroseta anteroventrally (Fig. 7G); sternite with narrow U-shaped shiny area reaching about 1/3 towards anterior margin (Fig. 2). Structure. Similar to male, but ratio of pronotal collar length to pronotum length 0.18; disc steeply declivous, not decurrent anteriorly; collar slightly depressed below pronotum (Fig. 2); postnotum short and rectangular; ratio of height of fore femora to length of fore femora 0.29; tarsal formula 2-2-3; pretarsus as in male: ratio of length of hind tibia to width of pronotum 1.03; submacropterous; wing venation as in Fig. 3; discal cell elongate rectangular; first anal vein meeting cubitus to form cubital cell; hind wing lacking; tergite eight without posterolateral projections (Fig. 4E, G); abdomen with two pairs of spiracles (on tergite seven and sternite eight). Genitalia. Anterior gonapophysis with three teeth, no subapical serration (Fig. 4E, G, H); posterior gonapophysis with two teeth (Fig. 4E, G, H); median styloid bifurcate (Fig. 4F); gonoplacs round apically (Fig. 4F); spermathecal gland spherical; spermathecal gland duct straight; spermathecal reservoir globular with two bends; spermathecal duct long and straight (Fig. 4I).



Figure 4. *Hypselosomops*: **A** male abdomen in dorsal view **B** male genitalia in dorsal view **C** male abdominal segments seven, eight, nine in ventral view **D** male tergite eight in lateral view **E** left side of female abdomen in lateral view **F** female abdomen in dorsal view **G** right side of female abdomen in lateral view **H** gonapophysis (pg- posterior gonapophysis, ag- anterior gonopophyses) **I** spermatheca including part of duct.



Figure 5. *Hypselosomops* male, SEM images: **A** frontal-lateral-dorsal view of head **B** hind tarsus **C** closeup of frontal mouthparts **D** frontal view of head **E** mid tarsus: **F** fore tarsus **G** ventral view of thorax with head, pronotum and left mid and hind legs removed (showing the peg-like structure between legs hypothesized to be used for jumping) **H** dorsal view of genitalia.

Nymphs: For habitus and size of first, second, fourth, and fifth instar nymphs, see Fig. 2 and Table 1.

Etymology. "*Hypselosom*" from *Hypselosoma*, the type genus of Hypselosomatinae, and "*ops*" which is Greek for "having the appearance of", due to the similarity of this genus to *Hypselosoma*. The gender is feminine.



Figure 6. *Hypselosomops* male, confocal images: **A** dorsal view of genitalia **B** dorsal view of genitalia tilted slightly left **C** dorsal view of genitalia tilted slightly more to the left.



Figure 7. *Hypselosomops* female, SEM images: **A** front-ventral view of head and thorax **B** inner surface of wing **C** outer surface of wing **D** close-up frontal view of mouthparts **E** mid leg **F** front leg **G** hind leg

Notes. The medial apical indentation with small basal flap on the clypeus (Fig. 5C) is a unique character, the likes of which have been described in only one other species, *Hypselosoma oncerochilotum* Hill, from Queensland, Australia (Hill 1987). We suspect that this feature may be associated with an organ of unknown function, however, histological studies would be required to confirm this hypothesis. Also the large seta with strongly expanded apex originating dorsoapically on the third tarsal segment of all legs is a distinctive character similar to the larger dorsal seta on the apical tarsomeres in *Silhouettanus* Hill (Hill 2014).

Distribution. Specimens of this genus have been collected in Cuba and the Dominican Republic.

Hypselosomops pecki sp. n.

http://zoobank.org/5C2ABC84-8700-4E5F-BD7A-4DAD3D1E20D1

Material. Type material. Holotype, male, slide mounted in Canada balsam: CUBA: Santiago, Gran Piedra, Isabelica, 20.08333°N 75.6°W, 1100 m, 07 Dec 1995 - 17 Dec 1995, S. B. Peck (UCR ENT 00091116) (FMNH). Paratypes: CUBA: Santiago: Gran Piedra Co.: Gran Piedra, Isabelica, 20.08333°N 75.6°W, 1100 m, 06 Dec 1995, S. B. Peck, 2 females (UCR_ENT 00098864, UCR_ENT 00098865) (FMNH); 07 Dec 1995 - 17 Dec 1995, S. B. Peck, 1 female (UCR ENT 00091115), 1 male slide mounted in Canada balsam (UCR_ENT 00091117), 5 point mounted males (UCR_ ENT 00091118, UCR ENT 00096904-UCR ENT 00096907) (FMNH); 14 Dec 1995, S. B. Peck, 3 males (UCR_ENT 00096909–UCR_ENT 00096911), 1 female slide mounted in Canada balsam (UCR_ENT 00096912), 3 point mounted females (UCR_ENT 00096913-UCR_ENT 00096915), 7 juveniles (UCR_ENT 00096916-UCR_ENT 00096922) (FMNH). Gran Piedra, Meteo Radar Station, 20.00944°N 75.62722°W, 1100 m, 06 Dec 1995 - 17 Dec 1995, S. B. Peck, 2 males (UCR_ENT 00096908, UCR ENT 00091120) (FMNH). DOMINICAN REPUBLIC: La Vega: 8 km. S. Constanza on Hwy. 41, 18.83538°N 70.71912°W, 02 Sep 1997, P. W. Kovarik, 2 males (UCR_ENT 00094277, UCR_ENT 00094278) (TAMU).

Diagnosis. As in generic diagnosis.

Description. As in generic description.

Measurements. See Table 1.

Etymology. Named in honor of Stewart B. Peck (Carleton University, Ottawa), who collected most known specimens of this species. A noun in genitive case.

Hypsohapsis gen. n.

http://zoobank.org/659AB66E-984D-40EE-9EAE-1119A9D04CD3 Figures 8–11

Type species. Hypsohapsis takiyae sp. n.



Figure 8. Dorsal, ventral, lateral right, lateral left, and frontal habitus of Hypsohapsis takiyae.

Diagnosis. Distinguished among Hypselosomatinae by first labial segment not dorsally expanded; clypeus with five macrosetae; 3 not 1 or 2 pairs of ventrolateral macroseta at base of mouthparts (bucculae and first two labial segments); fore femur without macrosetae; areolate fore wing with only traces of veins (Fig. 8); sternite eight large and capsule like; process of tergite eight looping internally and projecting externally as a long, thin process; a second scale like genitalic process with uncertain origin; sternite nine with a large lobe to the left at end (Figs. 9 and 10).

Description. Male. Coloration. Head, thorax, and forewing brown (including eyes); legs yellow; basal portion of coxae brown, abdomen pale; genital capsule and genitalia brown. Surface and Vestiture. Clypeus with five macrosetae (two basal, three at tip); first labial segment with a pair of stout lateral macrosetae, second labial segment with pair of lateral macrosetae, buccula with pair of lateral macrosetae; fore femora without anterior macroseta; ratio of length of hind tibia to width of pronotum 0.97; hind tibia with five erect macrosetae ventrad on distal half. Structure. ratio of pronotal collar length to pronotum length 0.21; disc steeply declivous, not decurrent anteriorly (Fig. 8); collar slightly depressed below pronotum (Fig. 9); postnotum of unknown shape (requires further dissection of specimen); ratio of height of fore femora to length of fore femora 0.30; tarsal formula 2-3-? (third tarsal segment hind of hind legs missing); pretarsus of front and middle legs with inflated arolia (pretarsus of hind leg unknown); elytrous with areolate and irregular coarse sculpturing; abdomen with seven pairs of spiracles (on sternites two through eight). Genitalia. Hind margin of sternite seven simple; left side of tergite eight with a process that loops around internally and then projects externally as a long thin process; right side of tergite eight with small



Figure 9. *Hypsohapsis takiyae* **A** dorsal view of abdomen **B** closer view of dorsal abdomen **C** ventral view of abdomen **D** closer view of ventral abdomen

projection and large external spiracle; left side with short slender projection that connects to sternite; sternite eight free of sternite seven; sternite eight large and capsule like, with elongated slender left margin that connects to tergite eight left-sided process; a flap like genitalic process (flp) on the left side posteriorly to segment eight is of uncertain origin; anophoric appendage absent; sternite nine lobe shaped to the left (in dorsal perspective) (Figs. 9, 10 and 11).

Female. Unknown.

Etymology. *"Hypso"* from *Hypselosoma*, the type genus of Hypselosomatinae, and *"hapsis"* which is Greek for "net" in reference to the netlike appearance of the fore wing due to their areolate and irregular, coarse sculpturing. The gender is feminine.

Notes. This currently monotypic genus is described from a single male specimen from southern Brazil. It is clearly set apart from all described genera of Hypseloso-



Figure 10. *Hypsohapsis takiyae* **A** dorsal view of abdomen **B** lateral left view of abdomen **C** ventral view of abdomen



Figure 11. *Hypsohapsis takiyae*, confocal images: A dorsal view of abdomen B closer view of dorsal abdomen.

matinae by the unique and complicated structure of the male genitalia. In particular, the seemingly internal process of segment eight is unknown among described Dipsocoromorpha. Flap like processes of the genitalia occur in other Schizopteridae, but the origin of this process in *Hypsohapsis* is unclear. Unfortunately, dissection of the abdo-



Figure 12. *Ommatides insignis* holotype: **A** enlarged first labial segment **B** anterior teeth like setae; *Williamsocoris ornatus* holotype: **C** enlarged first labial segment **D** horn like or tubular structure occupying third and fourth labial segments **E** anterior teeth like setae of first labial segment **F** pronotal collar **G** projection of genital capsule; and *Glyptocombus saltator* non-type: **H** projection of genital capsule

men would be necessary for a detailed study of the above mentioned structures. Since only one specimen of the species was collected, we have limited our observations to studying the intact abdomen.

Distribution. One specimen of this genus has been collected in Brazil.

Hypsohapsis takiyae sp. n.

http://zoobank.org/521348ED-75EC-49B0-9E90-A347853B3281

Material. *Type material.* **Holotype**, male, slide mounted in Canada balsam: BRA-ZIL: Sao Paulo: Ubatuba, Picinguata, -23.37743,-44.83733, 1997–2001, Nessimain, J.L. & Takiya, D.M. (UCR_ENT 00111639) (UFRJ).

Diagnosis. As in generic diagnosis.

Description. As in generic description.

Measurements. See Table 1.

Etymology. Named in honor of Daniela Takiya who collected this specimen and loaned it to us. A noun in genitive case.

Discussion

Based on our extensive specimen sorting efforts of Dipsocoromorpha with emphasis on Schizopteridae as part of the NSF-funded ARTS Litter Bug project, it has become clear that Hypselosomatinae are more widely distributed in the New World than previously documented and that a number of undescribed species remain to be described. The present contribution focuses on two new genus-level taxa, but descriptions of additional species are in progress and the analysis of molecular data will provide a phylogenetic framework for both New and Old World Hypselosomatinae (Hoey-Chamberlain and Weirauch, in prep.). The three previously described New World genera share a number of morphological characters. Ommatides and Williamsocoris both possess dorsally expanded first labial segments, while the male genitalia in Williamsocoris and Glyptocombus are very similar, both with a fingerlike process apically on sternite nine. The males of both Ommatides and Glyptocombus are submacropterous and elytrous. We have not been able to recover additional specimens of Ommatides insignis beyond the male holotype and certain details of the male genitalia therefore remain unknown. We were also unable to locate specimens that Wygodzinsky (1960) suspected to represent an undescribed species of *Glyptocombus* from southeastern Brazil, but for which he did not indicate the depository. Finally, we have discovered female hypselosomatine specimens that derive from the same collection events as males of Williamsocoris and Glyptocombus and we suspect that they represent conspecific females. These females lack the dorsally expanded first labial segment making genus-level identification of unassociated females impossible. We suspect that a more thorough study of described and undescribed species of Williamsocoris and Glyptocombus may lead to the conclusion that the two genera are synonyms. In contrast, the two new genera that we describe here are significantly different from the previously described genera, despite the fact that Hypselosomops possesses a slightly expanded first labial segment similar to Ommatides and Williamsocoris, and Hypsohapsis, Ommatides, and *Glyptocombus* share the elytrous condition of the hemelytron.

In a series of taxonomic publications focusing on Hypselosomatinae, Hill (1980, 1984, 1985, 1987, 1991, 2013) established a set of characters that are useful for distinguishing genera, including the number of macrosetae on the clypeus, tarsal formula, wing venation and number of marginal cells beyond the costal cell, and the presence/ absence or degree of sclerotization and shape of the spermatheca. In the following, we discuss some of these diagnostic features in the context of the two newly discovered and described New World genera. *Hypsohapsis* shares the presence of five macrosetae on the clypeus with *Hypselosoma*, while females of *Hypselosomops* share three macrosetae with the previously described New World genera, the fossil taxa, and four of the Old World genera (*Pateena*, *Duonota*, *Ordirete*, and *Macromannus*) and males lack clypeal macrosetae similar to the Old World genus *Rectilamina*. Among New World genera, the tarsal formula of the males of *Glyptocombus* and *Williamsocoris* is 3-3-3, but it is 2-2-3 in the female of *Glyptocombus*; in contrast, the male of *Hypselosomps* has a tarsal formula of 2-3-3, while the formula of the female is 2-2-3. The tarsal formula of *Ommatides* is unknown (most legs and all tarsi missing in the holotype and single known specimen). Sexual dimorphism in the tarsal formula is fairly common across Schizopteridae (Emsley 1969).

Even though a diagnostic feature of Hypselosomatinae, the default number of four marginal cells can be modified, especially in micropterous and elytrous taxa. Four marginal cells are clearly visible in most macropterous taxa such as *Williamsocoris* and the male, macropterous form of *Hypselosomops*, but *Glyptocombus*, *Ommatides*, and *Hypsohapsis* have reticulate wings and/or reduced wing venation. Wing type in Hypselosomatinae can vary within species, but even within the same sex of the same species. Sexual dimorphism with respect to wing type occurs in taxa in both the Old (e.g., *Rectilamina, Duonota*, and *Hypselosoma*) and New Worlds (undescribed species of *Williamsocoris* and *Glyptocombus*; pers. obs.). Only *Hypselosomops pecki* and *Pateena elimata* Hill (Hill 1980) are currently known to comprise both micropterous and submacropterous wing types in the male.

Carpintero and Dellapé (2006) reported the pronotal collar to be absent in *Williamsocoris*. We argue that the structure indicated by arrow F in Figure 12 represents the collar; a collar is also present in specimens that we have discovered through our sorting efforts and that likely represent undescribed species of *Williamsocoris*. Hill (2013) mentions that in the Old World genus *Cryptomannus* the pronotal disc overlaps the collar. A similar situation in *Williamsocoris* before clearing and slide mounting could have resulted in this misinterpretation.

Although considered to be of value as a diagnostic feature at the genus level, comparative documentation of the spermatheca across Hypselosomatinae is rather incomplete. Females of *Williamsocoris, Glyptocombus, Ommatides*, and *Hypsohapsis* remain unknown and the spermatheca is assumed to be absent or poorly sclerotized in *Hypselosoma* (Hill 1980, 2013). In the few taxa for which the spermatheca has been documented, namely *Rectilamina* (Hill 1980), *Duonota* (Hill 1984) and *Hypselosomops* it is well-sclerotized and pigmented, with a well-defined spermathecal gland, gland duct, reservoir, and duct.

The number of abdominal spiracles can vary dramatically between hypselosomatine genera, although variation can also occur within a genus. Hill (2013) confirmed three abdominal spiracles in species of *Hypselosoma* from Australia, New Zealand and New Caledonia, while Esaki and Miyamoto (1959) reported that the first five spiracles are reduced in *H. hirashimai* Esaki & Miyamoto from Japan, resulting in only three pairs of spiracles. Species of *Pateena* can have five or six (Hill 2013) or even seven abdominal spiracles (on segments two through eight) (Hill 1980). Hill (1980) found six spiracles (on segments two through seven) on a specimen of *Glyptocombus* sp. that Allen and Carlton (1989) later suspected to be *G. saltator* Heidemann. *Hypselosomops* has two pairs of abdominal spiracles, *Hypsohapsis* seven pairs, but the condition remains unknown in *Williamsocoris*. Given that spiracle numbers and arrangement are variable within a genus, this character should probably not used as a diagnostic feature at the genus level unless studied in a broader sample of species.

Phylogenetic hypotheses are currently unavailable for Hypselosomatinae and our understanding of character evolution in the group is therefore limited to speculations. *Hypsohapsis* shares a number of morphological features with *Macromannus* and *Ordirete* including the three clypeal macrosetae, elytrous wings with reticulate/areolate pattern and the simple sternite nine with a rounded lobe. *Hypselosomops* in contrast more closely resembles *Duonota* and *Rectilamina* due to the lack of clypeal macrosetae on males and the three clypeal macrosetae on females, as well as, the modifications of tergite eight in males and the presence and shape of the spermatheca in females. Given some of the extraordinary morphologies of Hypselosomatinae, the worldwide distribution with small endemic species ranges, and the fossil record that dates back to more than 100 my (Perrichot et al. 2007, Azar and Nel 2010), a phylogenetic hypothesis for the group is long overdue and will also allow for ancestral state reconstructions of morphological characters that will improve our understanding of the evolutionary history of this charismatic taxon.

Acknowledgements

We thank curators, collection managers, and research staff at various institutions for their help in facilitating specimen sorting and loans: James Boone, Rebekah Baquiran, and Margaret Thayer (FMNH); Edward Riley (TAMU); and Daniela Takiya (UFRJ). Robin Delapena (FMNH) did a wonderful job in sorting hundreds of bulk samples and recovering many of the specimens used in this study. We thank the Heteropteran Systematics Lab graduate students Eric Gordon, Alexander Knyshov, Sarah Frankenberg, and Paul Masonick for their constructive criticism and feedback on the manuscript. We are grateful to Serguei Triapitsyn and Vladimir Berezovskiy (UCR) for training and help with permanent slide-mounting of specimens and István Mikó (Penn State) for advice on confocal microscopy. This project is part of the "ARTS: Litter Bugs: revisionary and phylogenetic research on the least studied true bug infraorder (Insecta: Hemiptera: Dipsocoromorpha)" project (DEB-1257702) supported by the US National Science Foundation.

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RESEARCH ARTICLE



Review of Afrotropical Cryptopimpla Taschenberg (Hymenoptera, Ichneumonidae, Banchinae), with description of nine new species

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Academic editor: B. Santos	R	Receive	ed 3) Au	1gust 2016	Acce	pted 16 November 2016	Published 13 December 2016
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http://zoobank.org/BC24B851-9E1B-4100-B7E1-04C1B5E24A48

Citation: Reynolds Berry T, van Noort S (2016) Review of Afrotropical *Cryptopimpla* Taschenberg (Hymenoptera, Ichneumonidae, Banchinae), with description of nine new species. ZooKeys 640: 103–137. https://doi.org/10.3897/zooKeys.640.10334

Abstract

The Afrotropical banchine fauna (Hymenoptera: Ichneumonidae) comprises 12 genera. One of these, *Cryptopimpla* Taschenberg, 1863, is a predominately northern hemisphere genus represented by 47 described species of which only one is known from the Afrotropical region. We describe nine new species of this rare Afrotropical genus: *C. elongatus* **sp. n.**, *C. fernkloofensis* **sp. n.**, *C. goci* **sp. n.**, *C. hantami* **sp. n.**, *C. kogelbergensis* **sp. n.**, *C. neili* **sp. n.**, *C. onyxi* **sp. n.**, *C. parslactis* **sp. n.**, and *C. zwarti* **sp. n.** All the Afrotropical species are only known from South Africa. Online interactive Lucid keys to the nine *Cryptopimpla* species are available at: http://www.waspweb.org.

Keywords

Afrotropical region, Hymenoptera, Ichneumonoidea, Lucid identification keys, Atrophini, *rubrithorax* species-group, *goci* species-group, South Africa, systematics, taxonomy

Introduction

The Afrotropical Banchinae are represented by 12 genera: *Apophua* Morley, *Atropatopsis* Sudheer & Narendran, *Atropha* Kriechbaumer, *Cryptopimpla* Taschenberg, *Exetastes* Gravenhorst, *Glyptopimpla* Morley, *Himertosoma* Schmiedeknecht, *Lissonota* Gravenhorst, *Sjostedtiella* Szépligeti, *Spilopimpla* Cameron, *Syzeuctus* Förster, and *Tossinola* Viktorov (Yu et al. 2012). *Cryptopimpla* belongs to the tribe Atrophini and is a predominately northern hemisphere genus represented by 47 described species, with highest species richness in the temperate regions (Yu et al. 2012; Sheng and Zheng 2005; Kuslitzky 2007; Sheng 2011; Takasuka et al. 2011). A single South African species, *Cryptopimpla rubrithorax* Morley is known from the Afrotropical region (Yu et al. 2012). The genus *Cryptopimpla* was defined by Townes (1969) and by Chandra and Gupta (1977).

Over the last 25 years, the temperate winter rainfall region of South Africa encompassing the Cape Floral Kingdom has been fairly extensively sampled by the second author, and large numbers of ichneumonids, including new species of *Cryptopimpla*, have been collected from previously poorly sampled habitats. Sampling inventories have also been conducted in the summer rainfall region of South Africa as well as in other African countries including Central African Republic, Gabon, Kenya, Namibia, Tanzania and Uganda. However, no *Cryptopimpla* species were recorded from these surveys. To our knowledge there are no additional specimens present in historical world collections. In this paper, we describe nine new species from South Africa and provide interactive Lucid identification keys that are available online at http://www.waspweb.org.

Material and methods

The new species were compared and analyzed in the context of the Afrotropical fauna. Where possible species delimitation was assessed in a world context, but many of the descriptions of species from other regions are not comprehensive in their character assessment. These types were not examined and hence strict comparison to species from other regions was not performed, but this should not compromise the taxonomic results since almost all species of *Cryptopimpla* are exclusive of a single biogeographic region (Yu et al. 2012).

Photographs

Specimens were point mounted on black, acid-free cards for examination (using a Leica M205C stereomicroscope with LED light source), photography and long-term preservation. Images were acquired using either the EntoVision[®] multiple-focus imaging system or the Leica LAS 4.4 imaging system. The EntoVision[®] system comprised a

Leica[®] M16 microscope with a JVC[®] KY–75U 3–CCD digital video camera attached that fed image data to a notebook computer. The program Cartograph[®] 5.6.0 was used to manage image acquisition using an automated Z-stepper and merging of the image series into a single in-focus image. The Leica LAS 4.4 system comprised a Leica[®] Z16 microscope with a Leica DFC450 Camera with a 0.63× video objective attached. Leica Application Suite V 4.4 software was installed on a desk top computer. Lighting was achieved using techniques summarized in Buffington et al. (2005), Kerr et al. (2008) and Buffington and Gates (2009). All images presented in this paper are available at http://www.waspweb.org.

Depositories

BMNH	The Natural History Museum, London, England (Gavin Broad);
SAMC	Iziko South African Museum, Cape Town, South Africa (Simon van Noort).

Nomenclature and abbreviations

The morphological terminology mainly follows Wahl and Sharkey (1993), and the wing venation nomenclature follows Gauld (1991). Most morphological terms are also defined on the HymAToL website (http://www.hymatol.org) and HAO website (http://portal.hymao.org/projects/32/public/ontology/). The following morphometric abbreviations are used (in order of appearance in the descriptions):

Body length: from toruli to metasomal apex (mm).

Antenna length: from base of scape to flagellar apex (mm).

Fore wing length: from anterior end of tegula to wing apex (mm).

- CT (clypeal transversality index): maximum width of clypeus : length between base of tentorial pit to apex of clypeal edge.
- ML (malar line index): shortest distance between eye and mandible : basal width of mandible.
- IO (inter-ocellar index): shortest distance between posterior ocelli : ocellus diameter.
- OO (oculo-ocellar index): shortest distance between eye and posterior ocellus : ocellus diameter.
- Fl₁ (length index of flagellomere 1): length : width of flagellomere 1.
- OT (ovipositor sheath-hind tibia index): length of ovipositor sheath : length of hind tibia.

The first three measurements (an absolute measure) were measured on all specimens in the type series, with measurements from the primary type reported separately in brackets if necessary.

Results

Cryptopimpla Taschenberg, 1863

Cryptopimpla Taschenberg, 1893. Zeitschrift für die Gesammten Naturwissenschaften, 21:292. Type-species *Phytodietus blandus* Gravenhorst, 1914.

Diagnosis (updated from Townes 1969, Sheng 2011 and Takasuka et al. 2011). Clypeus small, convex and may have a curved lip on the ventral margin. Occipital carina complete; joining hypostomal carina above base of mandible. Upper tooth of mandible longer than the lower tooth. Apical 0.3-0.4 of flagellum tapered to a slender apex. Pronotum without epomia. Lower half of mesopleuron weakly convex or flat. Hind edge of metanotum with projection absent to well-defined. Posterior transverse carina of propodeum present or absent; pleural carina present or absent; propodeal spiracle round or almost so. Fore wing with areolet present, anteriorly truncate or with short petiole; vein 2m-cu with two closely spaced bullae, or with a single bulla 0.5 to 1.0 times as long as the section of 2m-cu below the bulla. Hind wing with first abscissa of Cu1 weakly reclivous; distal abscissa of Cu1 meeting cu-a distinctly closer to M than to 1A. First tergum evenly and strongly tapered toward base, with a glymma, spiracle anterior to middle of tergum, surface matt to subpolished, with sparse or irregular medium-sized punctures and often some wrinkling; dorsal profile of tergum 1 moderately to strongly convex near base and weakly convex near apex; median dorsal carina absent. Apical portion of metasoma weakly to strongly compressed. Ovipositor sheath approximately 0.6 times as long as hind tibia. Ovipositor straight, sometimes upcurved, its subapical portion with a dorsal notch.

Species-groups

The Afrotropical species cluster in two morphological species-groups:

- *rubrithorax* species-group (*C. elongatus*, *C. fernkloofensis*, *C. hantami*, *C. neili*, *C. onyxi*, *C. parslactis*, *C. rubrithorax*, and *C. zwarti*) is defined by the presence of a weakly convex clypeus with a curved lip on the ventral margin, small tentorial pits, absence of the pleural carinae, and absence of the posterior transverse carina on the propodeum.
- *goci* species-group (*C. goci* and *C. kogelbergensis*) is defined by the presence of a convex and bulbous clypeus with large tentorial pits, pleural carinae, and a distinct and well-defined posterior transverse carina on propodeum.



Key to Afrotropical species of the genus Cryptopimpla



Clypeal profile weakly convex with a curved lip on ventral margin (a). Pleural carinae and posterior transverse carina of propodeum absent (b).....**3**







3 Mesosoma with scutellar and metanotal margins not strongly tapered towards medial area (A). Propodeal anterior margin without defined medial tooth, but may have a blunt medial projection (B)......4




Wings hyaline (A). Mesoscutum moderately punctate (B)5





5 Eye in anterior view narrow to moderately-sized: eye maximum width in anterior view 0.4–0.66 times shortest inter-ocular distance (A). Spiracle of tergum 2 situated at basal 0.25–0.32 of tergum (B)**6**





6 Scuto-scutellar excavation shallow, without deep indentations laterally (a). Metasomal tergum 2 with gastrocoeli small to indistinct (b)......7



Scuto-scutellar groove broad with deep lateral indentations (A). Metasomal tergum 1 with gastrocoeli moderately large and distinct (B)......**8**



7 Head and mesosoma subpolished, sparsely covered in short setae (A). Metasomal tergum 1 with posterior margin medially tapered to a point (B) *C. neili* sp. n.









9 Malar space 0.6 times as long as basal mandibular width (A). Second tergum posteriorly 1.25 times broader than long (B)...... *C. zwarti* sp. n.



 Cryptopimpla elongatus Reynolds Berry & van Noort, sp. n. http://zoobank.org/3BB8B8E3-343B-4CF3-BE7B-6E42D4AC1CE2 Fig. 1

Type material. HOLOTYPE ♀: South Africa, Northern Cape, Hantam National Botanical Garden, 31°24.274'S, 19°09.164'E, 755m, 22 May–12 June 2008, S. van Noort, GL07-DOL1-M39, Malaise trap, Nieuwoudtville-Roggeveld Dolerite Renosterveld, SAM-HYM-P047468 (SAMC).

Description. Body subpolished. Colour. Head black, clypeus and mouthparts dark brown. Body mostly rufescent apart from the mesonotum, black at the wing bases, mesopleuron ventrally black, submetapleural lobe black, fore and mid coxae black (remaining parts of front leg missing), trochanters and trochantellus of mid and hind legs black and terga 5–8 black.

Head. Densely punctate. Frons unarmed. Clypeus profile weakly convex with a curved lip on the ventral margin. Clypeus edge convex. Upper tooth of mandible longer than the lower tooth. Setae on head and clypeus short and sparse. Eye large and bulbous, maximum width in anterior view 0.73 times shortest inter-ocular distance, maximum width in lateral view 0.79 times maximum length. Tentorial pits small and indistinct. Flagellum tapered to a slender apex.

Mesosoma. Mesoscutum moderately punctate. Scuto-scutellar groove broad, with deep lateral indentations. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Propodeum without carinae, its anterior margin with a blunt median projection. Mid coxa posteriorly glossy and smooth. Wings hyaline, base of stigma brown. Fore wing with two bullae close together appearing as one; vein 2m-cu sinuate; areolet anteriorly truncate-shaped. Hind wing with one basal hamulus and six distal hamuli.

Metasoma. Tergum 1 longer than the hind coxae, terga 2 and 3 longer than wide; tergum 1 with dorsolateral carinae substituted by longitudinal wrinkles, densely punctate and with posterior margin weakly convex; second tergum 1.26 times longer than wide posteriorly, spiracle situated at basal 0.36 of tergum (measured in lateral view), gastrocoeli moderately large and circular; terga 4–8 slightly compressed; tergum 6 half as wide as tergum 5. Hypopygium strongly sclerotized. Ovipositor upcurved; sheath striations present.

CT 2.1; ML 0.9; IO 1.9; OO 1.7; Fl_1 5; OT 0.5; body length 6.7 mm; antenna length 8.4 mm; fore wing length 7.0 mm.

Differential diagnosis. *Cryptopimpla elongatus* can be distinguished from all other Afrotropical *Cryptopimpla* by having a more elongated metasoma, where terga 1–3 are longer than wide with the spiracle on tergum 2 situated at basal 0.36 of tergum (measured in lateral view). There are a few species with a rufescent/black colour combination, but *C. elongatus* is the only species to have rufescent legs (trochanter and trochantellus black) and a mostly rufescent metasoma (terga 5–8 black). The eye in anterior view is large, its maximum length 0.73 times the shortest inter-ocular distance, separating the species from all other Afrotropical *Cryptopimpla* whose eye length in anterior view



Figure 1. *Cryptopimpla elongatus.* Holotype. **A** Habitus, lateral view inset: data labels **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E** Metasoma, lateral view **F** Metasomal terga 1 and 2, dorsal view.

is 0.38–0.66 times the shortest inter-ocular distance. A broad scuto-scutellar groove with deep lateral indentations distinguishes *C. elongatus* from closely-related species *C. fernkloofensis*, *C. hantami*, *C. neili*, and *C. parslactis*. The metasomal tergum 1 with dorsolateral carinae substituted with longitudinal wrinkles distinguishes *C. elongatus* from closely-related species *C. fernkloofensis* and *C. neili*. Gastrocoeli on tergum 2 are moderately large and circular, separating *C. elongatus* (and *C. fernkloofensis*) from the remaining closely-related species in the *rubrithorax* species-group.

Etymology. The name refers to the rather elongated metasoma of this species. Noun in apposition.

Distribution. South Africa (Northern Cape).

Comments. This is a rare species known only from one female specimen collected in Nieuwoudtville-Roggeveld Dolerite Renosterveld. Intensive sampling in other areas of the Cape Floral Kingdom has produced no further specimens. The female metasoma is depressed (not slightly compressed) distinguishing *C. elongatus* from the closelyrelated species *C. onyxi*, *C. zwarti*, *C. hantami*, and *C. rubrithorax*. However, no female specimens are available for closely-related species *C. fernkloofensis*, *C. parslactis*, and *C. neili*, so no comparisons could be made with these species.

Cryptopimpla fernkloofensis Reynolds Berry & van Noort, sp. n. http://zoobank.org/EA5022CA-599E-4EA0-B032-0FF1EA108A08 Fig. 2

Type material. HOLOTYPE ♂: South Africa, Western Cape, Fernkloof Nature Reserve, 33°39.941'S, 21°53.505'E, 300–340m, 13 May 1995, S. van Noort, Sweep, Mesic Mountain Fynbos, SAM-HYM-P008237 (SAMC).

Description. Body subpolished. Colour. Body mostly fulvous, mesosoma ventrally black. Head black. Clypeus fulvous. Mandibles fulvous to black at apex. Mesoscutum and mesonotum dorsolaterally black. Submetapleural lobe black with various dark markings on legs. Metasomal terga 6–8 and male genitalia brown.

Head. Densely punctate. Frons unarmed. Setae on head and clypeus short and sparse. Clypeus profile weakly convex with a curved lip on the ventral margin. Clypeus edge convex. Flagellum tapered to a slender apex. Tentorial pits small and indistinct. Eye in lateral view 0.67 times as wide as long, moderately sized in anterior view with maximum width 0.54 times the shortest inter-ocular distance. Upper tooth of mandible longer than the lower tooth.

Mesosoma. Mesoscutum moderately punctate. Scutellar and metanotal margins tapered towards medial area. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Propodeum with carination reduced to medial area, its anterior margin with medial tooth. Wings hyaline. Fore wing with two bullae closely situated appearing as one; vein 2m-cu sinuate; areolet anteriorly truncate-shaped. Hind wing with one basal hamulus and six (left wing) to seven (right wing) distal hamuli.

Metasoma. Depressed; tergum 1 with a single carina ventrad of spiracle, densely punctate with posterior margin weakly convex; tergum 2 as long as it is broad posteriorly, spiracle situated at basal 0.24 of tergum (measured in lateral view), gastrocoeli moderately large and circular.

CT 2.0; ML 0.9; IO 1.7; OO 1.4; Fl₁ 3.5; body length 9.4 mm; antenna length 9.9 mm; fore wing length 7.2 mm.

Differential diagnosis. Cryptopimpla fernkloofensis can be distinguished from all other Afrotropical Cryptopimpla species by having a mostly fulvous body with the



Figure 2. *Cryptopimpla fernkloofensis.* Holotype **A** Habitus, lateral view inset: data labels **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E** Metasoma, lateral view **F** Metasomal terga 1 and 2, dorsal view.

mesosoma black ventrally, the head is black and the clypeus and mouthparts are fulvous in colour; the species is the largest of the *Cryptopimpla* species in the Afrotropical region with a body length of 9.4 mm, compared to other species that have body sizes less than 8.7 mm; the anterior propodeal margin of the species has a medial tooth; the scuto-scutellar groove is narrow, without deep lateral indentations; and the scutellar and metanotal margins distinctly taper towards the medial area. The gastrocoeli on the metasomal tergum 2 are moderately large and circular, which distinguishes *C*. *fernkloofensis* (and *C. elongatus*) from all other closely-related species in the *rubrithorax* species-group. The presence of a single carina ventrad of the spiracle on the metasomal tergum 1, without wrinkles, separates *C. fernkloofensis* from closely-related species in the *rubrithorax* species-group.

Etymology. Named after the type locality. Noun in apposition.

Distribution. South Africa (Western Cape).

Comments. This is a rare species known only from one male specimen collected in Mesic Mountain Fynbos. Intensive sampling in other areas of the Cape Floral Kingdom, including Mesic Mountain Fynbos at various other localities, has produced no further specimens.

Cryptopimpla goci Reynolds Berry & van Noort, sp. n.

http://zoobank.org/DA40C867-142C-483B-8F3C-E3F55BA3BCC0 Fig. 3

Type material. HOLOTYPE 3° : South Africa, Western Cape, Koeberg Nature Reserve, 33°37.622'S, 18°24.259'E, 741m, 3 - 31 October 1997, S. van Noort, KO97-M12, Malaise trap, West Coast Strandveld, SAM-HYM-P0474345 (SAMC).

Description. Body subpolished. Colour. Head white with a median black band on the face, frons, reaching around ocelli and occiput black, not reaching the eyes. Body mostly fulvous, mesoscutum black anteromedially, extending about 0.8 length of mesoscutum.

Head. Finely punctate. Frons unarmed. Setae on head and clypeus short and sparse. Flagellum tapered to a slender apex. Clypeus profile convex, bulbous. Clypeus edge convex. Upper tooth of mandible longer than the lower tooth. Tentorial pits large and distinct. Eye in lateral view 0.69 times as long as wide, narrow in anterior view with maximum width 0.4 times shortest inter-ocular distance.

Mesosoma. Mesosocutum moderately punctate. Scuto-scutellar groove broad. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Propodeum with anterior margin medially straight, carination include pleural carinae and a well-defined posterior transverse carina. Wings hyaline; fore wing with two bullae closely situated appearing as one; vein 2m-cu sinuate; areolet anteriorly truncate-shaped. Hind wing with one basal hamulus and seven distal hamuli.

Metasoma. Depressed; tergum 1 impunctate with distinct dorsolateral carinae present as a carina ventrad of spiracle, with a secondary carina leading from the ventral carina to the spiracle, posterior margin weakly convex; second tergum 1.21 times longer than broad, spiracle situated at basal 0.35 of tergum (measured in lateral view), gastrocoeli elongate.

CT 1.8; ML 0.75; IO 1.6; OO 1.1; $Fl_1 3.9$; body length 7.5 mm; antenna length 7.2 mm; fore wing length 5.3 mm.



Figure 3. *Cryptopimpla goci.* Holotype **A** Habitus, lateral view inset: data labels **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E** Metasoma, lateral view **F** Metasomal terga 1 and 2, dorsal view.

Differential diagnosis. *Cryptopimpla goci* is immediately distinguishable from all other Afrotropical *Cryptopimpla* species by having a colour combination of a largely fulvous body, with a white head. A short distinct carina leads to the spiracle from the base of a single carina ventrad of the spiracle which is unique in this species. *Cryptopimpla goci* is closely-related to *C. kogelbergensis* as both species (*goci* species-group) share a truly distinctive and well-defined posterior transverse carina, possess pleural carinae, a convex and bulbous clypeus without a curved lip on the ventral margin, and large

tentorial pits distinguishing them from all other Afrotropical *Cryptopimpla* species in the *rubrithorax* species-group. The head is finely punctate, the maximum width of the eye in anterior view 0.38 times the shortest inter-ocular distance; the malar space 0.75 times the basal mandibular width; the length of the first flagellomere 3.9 times longer than wide; 2m-cu on the fore wing is sinuate; metasomal tergum 1 with a short distinct carina that leads to the spiracle from the base of a single carina ventrad of the spiracle; the second tergum 1.21 times longer than wide with elongate gastrocoeli separates *C. goci* from *C. kogelbergensis* where the head is smooth, the maximum width of the eye is much broader at 0.6–0.63 times the shortest inter-ocular distance; the malar space is 1.2 times the basal mandibular width; the length of the first flagellomere is 6.1–6.8 times longer than wide; vein 2m-cu on the fore wing is straight; dorsolateral carinae on the metasomal tergum 1 are substituted with longitudinal wrinkles and the second tergum is 1.0–1.04 times as long as wide with the gastrocoeli small and indistinct.

Etymology. Named after the late Nosiphiwo Goci who worked as a research assistant in the Natural History Department of the Iziko South African Museum for over 17 years and whose immense contribution to the curation and digitization of the SAMC Hymenoptera collection warrants recognition. Noun in the genitive case.

Distribution. South Africa (Western Cape).

Comments. A rare species known only from one specimen collected in West Coast Strandveld in the Koeberg Nature Reserve as part of a continuous 13 month sampling inventory of the reserve using a variety of methods including Malaise traps, yellow pan traps and sweeping. Similar intensive sampling in other areas of the Cape Floral Kingdom, including sampling West Coast Strandveld at numerous other localities, produced no further specimens.

Cryptopimpla hantami Reynolds Berry & van Noort, sp. n. http://zoobank.org/68B27C7F-B8E8-4426-959D-FE58A7D6E89D Fig. 4

Type material. HOLOTYPE ♀: South Africa, Northern Cape, Hantam National Botanical Garden, 31°24.182'S, 19°08.587'E, 741m, 17 March - 21 April 2008, S. van Noort, GL07-REN3-M24, Malaise trap, Nieuwoudtville Shale Renosterveld, SAM-HYM-P047467 (SAMC). **PARATYPE** ♂: South Africa, Northern Cape, Hantam National Botanical Garden, 31°24.182'S, 19°08.587'E, 741m, 21 April – 22 May 2008, S. van Noort, GL07-REN3-M31, Malaise trap, Nieuwoudtville Shale Renosterveld, SAM-HYM-P047469 (SAMC).

Description. Body moderately covered in short setae. Colour. Head black, clypeus testaceous; mesosoma dark fulvous; pronotal collar and anterior corner of mesopleuron slightly lighter, propleuron ventrally black, metanotum black at the wing bases, sternum of mesothorax with small black spot; metasoma black, terga 6–8 white at the posterior margins; middle and hind legs black to dark brown with medial dark fulvous longitudinal bands on the coxae, front leg black to testaceous toward apex.



Figure 4. *Cryptopimpla hantami.* Holotype **A** Habitus, lateral view inset: data labels **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E** Metasoma, lateral view **F** Metasomal terga 1 and 2, dorsal view.

Head. Matt. Frons unarmed. Clypeus profile weakly convex with a curved lip on the ventral margin. Clypeus edge convex. Upper tooth of mandible longer than the lower tooth. Head densely punctate. Eye in lateral view 0.73 times as broad as long, maximum width in anterior view half the shortest inter-ocular distance. Tentorial pits small and indistinct. Malar space 0.8–1.0 times basal mandibular width. Flagellum tapered to a slender apex. Mesosoma. Matt. Mesosocutum moderately punctate. Scuto-scutellar excavation shallow. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Propodeum without carinae, its anterior margin with a blunt median projection. Wings hyaline. Fore wing with two bullae close together appearing as one; vein 2m-cu sinuate; areolet anteriorly truncate-shaped. Hind wing with one basal hamulus and six distal hamuli.

Metasoma. Subpolished. Terga 4–8 slightly compressed in female; tergum 1 with dorsolateral carinae substituted with longitudinal wrinkles, densely punctate, posterior margin weakly convex; second tergum 1.06–1.32 times longer than wide, spiracle situated at basal 0.27 of tergum (measured in lateral view), gastrocoeli small and indistinct; tergum 6 half as wide as tergum 5; hypopygium in female strongly sclerotized. Ovipositor upcurved; sheath striations present.

CT 2–2.1; ML 0.8–1; IO 2.3–2.4; OO 1.8–2.1; OT 0.5 (single female); Fl_1 3.7–5.6; body length 8.1–8.9 mm; antenna length 7.9 mm (males antennae intact); fore wing length 5.8–6.2 mm.

Male: Propleuron and pronotum completely black, clypeus testaceous rather than dark brown; colouration of the legs as in female except fulvous bands on mid and hind coxae are lacking and terga 6–8 not white at the posterior margins. Males are more setose; metasoma depressed, tergum 6 half as wide as 5.

Differential diagnosis. Cryptopimpla hantami is distinguishable from all species in the rubrithorax species-group by having a matt head and mesosoma, with the body moderately covered in short setae, rather than possessing a subpolished body sparsely covered in setae. The presence of a shallow scuto-scutellar excavation and small and indistinct gastrocoeli on the metasomal tergum 2 distinguishes C. hantami (and C. neili) from other species in the rubrithorax species-group where a broad groove with or without deep lateral indentations may be present and the gastrocoeli are moderately large and distinct. The metasomal tergum 1 with dorsolateral carinae substituted with longitudinal wrinkles distinguishes C. hantami from closely-related species C. fernkloofensis and C. neili.

Distribution. South Africa (Northern Cape).

Etymology. Named after the type locality. Hantam National Botanical Garden. Noun in apposition.

Cryptopimpla kogelbergensis Reynolds Berry & van Noort, sp. n. http://zoobank.org/38A172D2-39B6-45E6-8C58-0DF55F06EAA9 Fig. 5

Material examined. HOLOTYPE \bigcirc : South Africa, Western Cape, Kogelberg Nature Reserve, 34°16.481'S, 19°01.033'E, 118m, 16 May – 16 June 1999, S. van Noort, KO98-M23, Malaise trap, Mesic Mountain Fynbos, last burnt c. 1988, SAM-HYM-P047475 (SAMC). **Paratypes:** \bigcirc : South Africa, Western Cape, Gamkaberg Nature Reserve, 33°39.504'S, 21°54.947'E, 322m, 30 March 2010 - 24 July 2010, S.



Figure 5. *Cryptopimpla kogelbergensis.* Holotype **A** Habitus, lateral view **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E** Wings inset: data labels **F** Metasoma, lateral view.

van Noort, GB09-SUC04-M38, Malaise trap, Gamka thicket, SAM-HYM-P044551 (SAMC). 29: South Africa, Northern Cape, Hantam National Botanical Garden, 31°24.182'S, 19°08.587'E, 22 May – 23 July 2008, S. van Noort, GL07-REN3-M38, 741m, Malaise trap, Nieuwoudtville Shale Renosterveld, SAM-HYM-P047463 (SAMC, BMNH). South Africa, Western Cape, Gamkaberg Nature Reserve, 33°43.745'S, 21°56.922'E, 1000m, 10 Sept – 4 Nov 2009, S. van Noort, GB09-REN1-Y38, Yellow pan trap, Renosterveld, SAM-HYM-P061546 (SAMC).

Description. Body subpolished. Colour. Head white with a median brown band on the face and brown spots at tentorial pits. Mesoscutum brown dorsolaterally and anteromedially; medially fulvous basad of black colouration; grey or cream stripes medially, extending about 0.8 length of mesoscutum. Mesosoma colour combination brown, white and black; dorsally mostly brown, ventrally black, laterally white. Scutellum and mesonotum black dorsolaterally, testaceous medially. Propodeum mostly brown to yellowish testaceous, black anteriorly. Legs, antennae and metasoma yellowish testaceous with variable dark markings on terga.

Head. Smooth, impunctate. Frons unarmed. Setae on head and clypeus short and sparse. Flagellum tapered to a slender apex. Clypeus profile distinctly convex and bulbous. Clypeus edge convex. Upper tooth of mandible longer than the lower tooth. Tentorial pits large and distinct. Eye in lateral view 0.74–0.76 times as broad as long, maximum width in anterior view 0.6–0.63 times shortest inter-ocular distance.

Mesosoma. Mesosocutum moderately punctate. Scuto-scutellar groove broad. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Propodeum with anterior margin medially straight, but may have a blunt medial projection; carination include pleural carinae and a well-defined posterior transverse carina. Wings hyaline. Fore wing with two bullae closely situated appearing as one or separated; vein 2m-cu straight; areolet anteriorly truncate-shaped. Hind wing with one or two basal hamuli and six to seven distal hamuli.

Metasoma. Depressed; tergum 1 with dorsolateral carinae substituted with longitudinal wrinkles, impunctate, posterior margin weakly convex; second tergum 0.96–1 times as long as wide, spiracle situated at basal 0.21–0.23 of tergum (measured in lateral view), gastrocoeli small to indistinct; tergum 6 half as wide as tergum 5; hypopygium moderately sclerotized. Ovipositor upcurved; sheath striations present.

CT 1.9–2.0; ML 1.2; IO 2.0; OO 1.3; Fl₁ 5.1–6.1; OT 0.5–0.7; body length 4.2–5.6 mm; antenna length 6.3–6.5 mm; fore wing length 4.6–5.1 mm.

Differential diagnosis. *Cryptopimpla kogelbergensis* is immediately distinguishable from all other Afrotropical *Cryptopimpla* species by the distinctive colour combination of the mesopleuron, which is three-banded in brown, white and black; possession of a smooth head; and vein 2m-cu is straight on the fore wing. The maximum width of the eye in anterior view 0.6–0.63 times the shortest inter-ocular distance; the length of the first flagellomere 6.1–6.8 times longer than wide; the metasomal tergum 1 with dorso-lateral carinae substituted with longitudinal wrinkles; and the metasomal tergum 2 as long as wide with small and distinct gastrocoeli distinguishes *C. kogelbergensis* from *C. goci* where the maximum width of the eye in the anterior view is much narrower at 0.38 times the shortest inter-ocular distance; distinct dorsolateral carinae are presented as a short carina leading from a single carina ventrad of the spiracle; the length of the first flagellomere is 3.9 times longer than wide; vein 2m-cu on the fore wing is sinuate; and the second tergum is 1.21 times longer than wide with the gastrocoeli elongate.

Etymology. Named after the type locality. Noun in apposition.

Distribution. South Africa (Western Cape & Northern Cape).

Cryptopimpla neili Reynolds Berry & van Noort, sp. n. http://zoobank.org/E1A7879E-E44A-46E1-8CF2-EC7BD080DCB4 Fig. 6

Material examined. HOLOTYPE ♂: South Africa, Western Cape, Kogelberg Nature Reserve, 34°16.481'S, 19°01.033'E, 118m, 16 March 1999 - 16 April 1999, S. van Noort, KO98-M18, Malaise trap, Mesic Mountain Fynbos, last burnt c. 1988, SAM-HYM-P047436 (SAMC).

Description. Body subpolished. Colour. Head black, clypeus and mandibles white to brown; white markings on either side of toruli. Body mostly fulvous with dark markings on metanotum and metasomal terga 5–8, pronotal collar white.

Head. Densely punctate. Frons unarmed. Setae on head and clypeus short and sparse. Eye in lateral view 0.74 times as wide as long. Shortest inter-ocular distance 1.94 times maximum eye width in anterior view. Flagellum tapered to a slender apex. Clypeus profile weakly convex with a curved lip on the ventral margin. Clypeus edge convex. Upper tooth of mandible longer than the lower tooth. Tentorial pits small or indistinct.

Mesosoma. Mesosocutum moderately punctate. Shallow excavation separates mesoscutum from scutellum. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Anterior propodeal margin with a blunt median projection; carination absent. Wings hyaline. Fore wing with two bullae closely situated appearing as one; vein 2m-cu sinuate; areolet anteriorly truncateshaped. Hind wing with two basal hamuli and six distal hamuli.

Metasoma. Tergum 1 densely punctate, lacking dorsolateral carinae, posterior margin medially tapered to a point; second tergum 1.07 times longer than broad, spiracle situated at basal 0.28 of tergum (measured in lateral view), gastrocoeli small and elliptic; terga 4–8 strongly compressed.

CT 2.0; ML 1.0; IO 2.3; OO 1.6; Fl₁ 5.0; body length 7.5 mm; antenna length 8.5 mm; fore wing 6.9 mm.

Differential diagnosis. Cryptopimpla neili is closely-related to C. hantami because both species exclusively possess a shallow excavation separating the mesosocutum from the scutellum and the presence of small elliptic gastrocoeli on the second tergum, whereas a groove is present and the shape of the gastrocoeli is large or elongate in the other species in the *rubrithorax* species-group. Cryptopimpla neili is immediately distinguishable from all other Afrotropical Cryptopimpla species, including C. hantami, by having a unique colour combination of a fulvous body, white pronotal collar and a clypeus distinguished by two colours; and the metasomal tergum 1 lacking dorsolateral carinae with the posterior margin medially tapered to a point.

Etymology. Named after the first author's father. Noun in the genitive case.

Distribution. South Africa (Western Cape).

Comments. A rare species known only from one specimen. Intensive sampling in other areas of the Cape Floral Kingdom produced no further specimens. The metaso-



Figure 6. *Cryptopimpla neili.* Holotype **A** Habitus, lateral view inset: data labels **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E** Metasoma, lateral view **F** Metasomal terga 1 and 2, dorsal view.

mal terga 4–8 of the male are strongly compressed and this separates the species from the closely-related species *C. fernkloofensis*, *C. hantami*, *C. parslactis*, *C. rubrithorax*, and *C. onyxi*. However, no male specimens are available for the remaining species *C. elongatus* and *C. zwarti* within the *rubrithorax* species-group. Thus, no comparisons could be made with those species.

Cryptopimpla onyxi Reynolds Berry & van Noort, sp. n. http://zoobank.org/E43A6387-8EF2-4629-B688-A58EF7096B45

http://zoobank.org/E43A638/-8EF2-4629-B688-A58EF/096B45 Fig. 7

Material examined. HOLOTYPE ♀: South Africa, Western Cape, Walker Bay Nature Reserve, 34°27.414'S, 19°21.393'E, 57m, 14 May –14 June 1997, S. van Noort, WB97-M01, Malaise trap, South coast Strandveld, SAM-HYM-P047460 (SAMC). Paratypes 7♂: South Africa, Western Cape, Walker Bay Nature Reserve, 34°27.414'S, 19°21.393'E, 57m, 6 September – 4 October 1997, S. van Noort, WB97-M09, Malaise trap, South coast Strandveld, SAM-HYM-P044545, SAM-HYM-P047478, SAM-HYM-P047479, SAM-HYM-P047481 (SAMC, BMNH); ♂: South Africa, Western Cape, Walker Bay Nature Reserve, 34°27.414'S, 19°21.393'E, 57m, 18 Apr – 16 May 1998, S. van Noort, WB97-M30, Malaise trap, South coast Strandveld, SAM-HYM-P048105 (SAMC); ♂: South Africa, Western Cape, Kogelberg Nature Reserve, 34°16.481'S, 19°01.033'E, 16 Mar – 16 Apr 1999, S. van Noort, KO98-M17, Malaise trap, Mesic Mountain Fynbos last burnt c. 1988, SAM-HYM-P47482 (SAMC).

Description. Body subpolished. Body black. Pronotal collar white.

Head. Densely punctate. Frons unarmed. Clypeus profile weakly convex with a curved lip on the ventral margin. Clypeus edge convex. Upper tooth of mandible longer than the lower tooth. Setae on head and clypeus short and sparse. Flagellum tapered to a slender apex. Tentorial pits small or indistinct. Eye in lateral view 0.7–0.72 times as long as wide, maximum width in anterior view 0.4–0.56 times shortest interocular distance.

Mesosoma. Mesosocutum moderately punctate. Scuto-scutellar groove broad with deep lateral indentations. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Propodeum with carination reduced to medial area or absent, its anterior margin with a blunt median projection. Wings hyaline. Fore wing with two bullae closely situated appearing as one; vein 2m-cu sinuate; areolet truncate-shaped. Hind wing with one or two basal hamuli and six to seven distal hamuli.

Metasoma. Tergum 1 punctate with dorsolateral carinae substituted with longitudinal wrinkles, posterior margin weakly convex; second tergum 1.09–1.25 times longer than wide, spiracle situated at basal 0.25–0.26 of tergum (measured in lateral view), gastrocoeli elongate; terga 4–8 moderately compressed in females, no dorsolateral compression in males; female metasomal tergum 5 as wide as tergum 6; hypopygium strongly sclerotized. Ovipositor weakly upcurved; sheath striations present.

CT 1.6–1.8; ML 0.9–0.96; IO 2.1; OO 1.9; Fl₁4.2; OT 0.5 (SAM-HYM-P047460); body length 6–8.4 mm; antenna length 8.1–9.0 mm; fore wing length 6.1–6.8 mm.

Differential diagnosis. Cryptopimpla onyxi is immediately distinguishable from all other Afrotropical Cryptopimpla species by having a unique colour combination of a black body and a white pronotal collar. The clypeus is 1.6–1.8 times broader than high, distinguishing C. onyxi from all other species in the *rubrithorax* species-



Figure 7. *Cryptopimpla onyxi.* Holotype **A** Habitus, lateral view inset: data labels **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E** Metasoma, lateral view **F** Metasomal terga 1 and 2, dorsal view.

group where the clypeus is more than 1.8 times broader than high. The scuto-scutellar groove in *C. onyxi* is broad with deep lateral indentations, distinguishing the species from closely-related species *C. fernkloofensis*, *C. parslactis*, *C. hantami*, and *C. neili*. The metasomal tergum 1 with dorsolateral carinae substituted with longitudinal wrinkles distinguishes the species from *C. fernkloofensis* and *C. neili*. Gastrocoeli on tergum 2 are elongate, separating *C. onyxi* from closely-related species *C. fernkloofensis*, *C. leongatus*, *C. neili*, and *C. hantami*.

Etymology. The species epithet refers to the black colouration of this species. Noun in apposition.

Distribution. Occurs in Strandveld and Mountain Fynbos vegetation types in South Africa (Western Cape).

Comments. The female metasomal tergum 5 as wide as tergum 6 separates the species from closely-related species *C. hantami, C. zwarti, C. elongatus*, and *C. rubrithorax* where tergum 5 is half as wide as high. However, no female specimens are available for *C. fernkloofensis, C. parslactis*, and *C. neili*. Thus, no comparisons could be made with those closely-related species.

Cryptopimpla parslactis Reynolds Berry & van Noort, sp. n. http://zoobank.org/8B2E756B-4869-4E1B-9AD5-89C52092D0D2 Fig. 8

Type material. HOLOTYPE 3: South Africa, Northern Cape, Hantam National Botanical Garden, 31°23.802'S, 19°08.799'E, 752m, 23 July–23 Aug 2008, S. van Noort, GL07-REN1-M43, Malaise trap, Nieuwoudtville Shale Renosterveld, SAM-HYM-P044547 (SAMC).

Description. Body subpolished. Colour. Head and mesosoma mostly black, with the exception of the medial region of the mesopleuron and the propodeum that is orange. Legs with fore and mid coxae, trochanters and trochantellus black. Terga 2–8 mostly black, tergum 2 medially orange and terga 7–8 white posteriorly. Femora 1–2 black to light orange. Tibia and tarsus of front leg light orange. Tibia 2 light orange, tarsus 2 brown. Femora 3 orange, tibia and tarsus of hind leg brown.

Head. Densely punctate. Frons unarmed. Clypeus profile weakly convex with a curved lip on the ventral margin. Clypeus edge convex. Upper tooth of mandible longer than the lower tooth. Setae on head and clypeus short and sparse. Tentorial pits small and indistinct. Flagellum tapered to a slender apex. Eye in lateral view 0.7 times as long as wide, maximum width in anterior view 0.46 times shortest inter-ocular distance.

Mesosoma. Scuto-scutellar groove broad. Mesoscutum with fewer punctures inward of wing base. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Propodeum without carinae, its anterior margin with a weak and blunt medial projection. Wings slightly infuscate, venation dark. Fore wing with two bullae close together appearing as one; vein 2m-cu sinuate; areolet truncate-shaped. Hind wing with one basal hamulus and six distal hamuli.

Metasoma. Depressed. Tergum 1 with dorsolateral carinae substituted with longitudinal wrinkles, densely punctate, with posterior margin weakly convex; tergum 2 of metasoma 1.09 times as long as wide posteriorly, spiracle situated at basal 0.28 of tergum (measured in lateral view), gastrocoeli elongate; tergum 6 as wide as tergum 5.

CT 2.3; ML 0.92; IO 2.6; OO 2.0; body length 7.4 mm; fore wing length 7.0 mm.

Differential diagnosis. Cryptopimpla parslactis is immediately diagnosable from other Afrotropical Cryptopimpla by being the only species to have slightly infuscate



Figure 8. *Cryptopimpla parslactis.* Holotype **A** Habitus, lateral view inset: data labels **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E** Metasoma, lateral view **F** Metasomal terga 1 and 2, dorsal view.

wings with darker venation. *Cryptopimpla parslactis* is distinguishable from closelyrelated species in the *rubrithorax* species-group that have a rufous and black colour combination, by having a completely black mesoscutum and a combination of a mostly black metasoma with tergum 1 completely rufescent. In addition, while punctuation on the mesoscutum in the dorsal view is common amongst all the species, fewer punctures on the mesoscutum exist inward of the wing bases of *C. parslactis*. The metasomal tergum 1 with dorsolateral carinae substituted with longitudinal wrinkles distinguishes *C. parslactis* from closely-related species *C. fernkloofensis* and *C. neili*. Gastrocoeli on tergum 2 are elongate separating *C. parslactis* from closely-related species *C. fernkloofensis*, *C. elongatus*, and *C. hantami*.

Etymology. So named because the wings are not quite hyaline, but rather slightly infuscate with a creamy-brown colour, "pars" meaning wing and "lactis" meaning cream. Noun in apposition.

Distribution. South Africa (Northern Cape).

Comments. A rare species known only from one specimen. Intensive sampling in other areas of the Cape region produced no further specimens.

Cryptopimpla rubrithorax Morley, 1916

Fig. 9

Material examined. HOLOTYPE \bigcirc : South Africa, Western Cape, Elsenberg, 11 October 1914, Mally and Petty, SAM-HYM-P000874 (SAMC). Additional material: \bigcirc South Africa, Western Cape, Kogelberg Nature Reserve, 34°16.481'S, 19°01.033"E, 16 September 1999, S. van Noort, KO98-M40, Malaise trap, Mesic mountain fynbos last burnt c. 1988, SAM-HYM-P044558 (SAMC). 2 \bigcirc , 3 \bigcirc South Africa, Western Cape, Koeberg Nature Reserve, 33°37.622'S, 18°24.259'E, 8 August – 5 September 1997, S. van Noort, KO97-M07, KO97-M08, Malaise trap, West Coast Strandveld, SAM-HYM-P047461 (SAMC, BMNH). 1 \bigcirc South Africa, Western Cape, Koeberg Nature Reserve, 33°37.622'S, 18°24.259'E, 5 September – 3 October 1997, S. van Noort, KO97-M09, Malaise trap, West Coast Strandveld, SAM-HYM-P047461 (SAMC, BMNH). 1 \bigcirc South Africa, SAM-HYM-P047477 \bigcirc , \bigcirc South Africa, Northern Cape, Hantam National Botanical Garden, 31°23.802'S, 19°08.799'E, 752m, 23 July 2008 - 23 August 2008, S. van Noort, GL07-REN1-M43, Malaise trap, Nieuwoudtville Renosterveld Shale, SAM-HYM-P044547 (SAMC, BMNH).

Description (updated from Morley, 1916). Body subpolished. Colour. Head and metasoma black, posterior margins of terga 6–8 white. Clypeus rarely distinguished by colour to the rest of the face. Mesosoma rufescent, black ventrally; mesonotum black at the wing bases.

Head. Densely punctate. Frons unarmed. Setae on head and clypeus short and sparse. Clypeus profile weakly convex with a curved lip on the ventral margin. Clypeus edge convex. Upper tooth of mandible longer than the lower tooth. Flagellum tapered to a slender apex. Tentorial pits small or indistinct. Maximum eye width in anterior view 0.6–0.66 shortest inter-ocular distance, eye large in lateral view with maximum width 0.7–0.75 times maximum length.

Mesosoma. Mesosocutum moderately punctate. Scuto-scutellar groove broad with deep lateral indentations. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Propodeum lacking carinae, its anterior margin medially straight but may have a blunt medial projection. Wings hyaline. Fore wing with two bullae closely situated appearing as one; vein 2m-cu sinuate; areolet truncate-shaped. Hind wing with one basal hamulus and six distal hamuli.



Figure 9. *Cryptopimpla rubrithorax*. Holotype **A** Habitus, lateral view **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E** Metasoma, lateral view inset: data labels **F** Metasomal terga 1 and 2, dorsal view.

Metasoma. Tergum 1 densely punctate with dorsolateral carinae substituted with longitudinal wrinkles, posterior margin weakly convex; second tergum 0.8–1.09 times as broad as long, spiracle situated at basal 0.25–0.32 of tergum (measured in lateral view), gastrocoeli elongate; terga 4–8 slightly compressed; female metasomal tergum 6 half as wide as tergum 5; hypopygium strongly sclerotized. Ovipositor straight or slightly upcurved; sheath striations present.

CT 1.9–2.2; ML 0.9–1.3; IO 1.9–2.4; OO 1.4–2.1; Fl₁ 4.3–5.4; OT 0.6; body length 7–8.6 mm; antenna length 7.9–9.7 mm; fore wing length 6.3–6.9 mm.

Differential diagnosis. Reduction of the dorsolateral carinae to longitudinal wrinkles on the first metasomal tergum distinguishes this species from the closely-related species *C. fernkloofensis* and *C. neili*. Elongate gastrocoeli on tergum 2 separate the species from the closely-related species *C. fernkloofensis*, *C. elongatus*, *C. hantami*, and *C. neili*. The malar space and basal mandibular width are more or less equal in length with the malar space 0.91–1.3 times as long as the basal mandibular width, as opposed to the malar length index being much shorter in the closest related species *C. zwarti*, where the malar space is 0.6 times as long as the basal mandibular width. The shortened malar space in *C. zwarti* produces a more globular head shape, compared to a more lenticular head shape in *C. rubrithorax* due to the longer malar space. *Cryptopimpla rubrithorax* can be further separated from *C. zwarti* by the length of tergum 2 relative to its width. In *C. rubrithorax* tergum 2 is 0.8–1.09 times broader than long compared to 1.25 times as broad as long in *C. zwarti*.

Etymology. The species epithet is likely to refer to the rufescent colour of the metasoma of this species (Morley 1916).

Distribution. South Africa (Northern and Western Cape).

Comments. This species occurs in three vegetation types, Strandveld, Mesic Mountain Fynbos and Renosterveld, and exhibits corresponding intra-specific variation in terms of colouration. The specimen sampled from mesic mountain fynbos, which has a white pronotal collar and tegula as per Morley's original description, whereas the specimens from the Renosterveld have a black pronotal collar and tegula. Molecular sequencing demonstrated that there is no genetic divergence between specimens associated with the two different habitats (0% sequence divergence for COI, 28S, and 18S), with two site changes on the COI gene sequence (Reynolds Berry, Matthee and van Noort unpubl. data). Strandveld specimens also have black pronotal collars and tegulae, but are slightly darker in colour and are blacker ventrally on the mesosoma.

Cryptopimpla zwarti Reynolds Berry & van Noort, sp. n. http://zoobank.org/78719B96-6099-49F3-BADA-39E6ABD03C98 Fig. 10

Type material. HOLOTYPE ♀: South Africa, Eastern Cape, Grahamstown, Faraway Farm 33.19'S, 19°26.31'E, April 1990, I. Crampton, Malaise trap, SAM-HYM-P005220 (SAMC).

Description. Body subpolished. Colour. Head black, clypeus and mouthparts brown. Mesosoma rufescent, small black spot on underside; mesoscutum black only at the wing bases. Front legs: mostly light brown; coxa, trochanter and trochantellus black. Middle and hind legs: coxa to femora mostly black with shades of light brown on the coxa; remaining parts of leg light brown. Metasoma black, terga 6–8 posteriorly white.

Head. Densely punctate. Frons unarmed. Clypeus profile weakly convex with a curved lip on the ventral margin. Clypeus edge convex. Upper tooth of mandible longer



Figure 10. *Cryptopimpla zwarti.* Holotype **A** Habitus, lateral view inset: data labels **B** Head and mesosoma, lateral view **C** Head, anterior view **D** Propodeum, dorsal view **E**) Metasoma, lateral view **F** Metasomal terga 1 and 2, dorsal view.

than the lower tooth. Setae on head and clypeus short and sparse. Tentorial pits small and indistinct. Eye in lateral view 0.71 times as wide as long, maximum width in anterior view 0.66 times shortest inter-ocular distance. Flagellum tapered to a slender apex.

Mesosoma. Mesosocutum moderately punctate. Broad scuto-scutellar groove with deep lateral indentations. Epicnemial carinae present ventrally and dorsally, dorsally converging toward anterior edge of mesopleuron. Propodeum without carinae, its anterior margin with a blunt median projection. Wings hyaline. Fore wing with two bullae close together appearing as one; vein 2m-cu sinuate; areolet truncate-shaped. Hind wing with one basal hamulus and six distal hamuli.

Metasoma. Slightly compressed. Tergum 1 with dorsolateral carinae substituted with longitudinal wrinkles, densely punctate with posterior margin weakly convex; second tergum 1.25 times broader than long, spiracle situated at basal 0.3 of tergum, gastrocoeli elongate; tergum 6 half as wide as tergum 5; hypopygium strongly sclerotized. Ovipositor slightly upcurved; sheath striations present.

CT 2; ML 0.6; IO 2.2; OO 1.6 OT 0.6; Fl_1 4.9; body length 8.3 mm; antenna length 9.4 mm; fore wing length 6.9 mm.

Differential diagnosis. Cryptopimpla zwarti is distinguishable from all other Afrotropical Cryptopimpla species by having a malar space 0.6 times as long as the basal mandibular width, whereas all the other Afrotropical Cryptopimpla species have a ML index of 0.8 or more. A broad scuto-scutellar groove with deep lateral indentations distinguishes C. zwarti from closely-related species C. fernkloofensis, C. neili, C. hantami, and C. parslactis. The metasomal tergum 1 with dorsolateral carinae substituted with longitudinal wrinkles distinguishes C. zwarti from closely-related species C. fernkloofensis and C. neili. Gastrocoeli on tergum 2 are elongate separating the species from closely-related species C. fernkloofensis, C. hantami.

Etymology. Named after the retired agricultural entomologist, K. W. Robert Zwart (Wageningen Agricultural University) who first recognized it as a potentially new species in 1994. Noun in the genitive case.

Distribution. South Africa (Eastern Cape).

Comments. By having a malar space much shorter than the basal mandibular width (malar index of 0.6), the shape of the head is more globular, which in combination with a second tergum that is broader than long, separates *C. zwarti* from its closely-related species *C. rubrithorax*, which have a malar space 0.91–1.3 times as long as the basal mandibular width, creating a more lenticular-shaped head, and a second tergum that is 0.92–1.2 times as long as broad (i.e. no more than 1.09 times broader than long).

Discussion

The review of *Cryptopimpla* in the Afrotropical region allowed for a comparative morphological assessment of these species with *Cryptopimpla* species from other biogeographical regions, highlighting differences in regional suites of character states. The presence of a posterior transverse carina on the propodeum is common in world *Cryptopimpla* species (Townes 1969, Sheng 2011), but usually absent in Afrotropical species, only being present in two of the ten known species. Among the few *Cryptopimpla* species outside of the Afrotropical region that do not possess pleural carinae or a posterior transverse carina are *C. labralis* and *C. escarinata* from North America (Townes 1978). *Cryptopimpla labralis*, like species within the *rubrithorax* species-group, possesses a weakly convex clypeus. *Cryptopimpla labralis* is distinctly different from species within the *rubrithorax* species-group by having an areolet that is petiolate, the fore wing

lengths are 4.3–4.7 mm long and the OO index is 0.42, compared to the *rubrithorax* species-group where the areolet is truncate-shaped, forewing lengths are 5.8–7.2 mm long and the OO index is 0.5–0.6. Unfortunately, the character state for absence/presence of the posterior transverse carinae on the propodeum is not detailed in all of the historical species descriptions and we have not been able to obtain the types to confirm the state of this condition for most of the global species. It is clear, however, that the lack of carinae on the propodeum and a weakly convex clypeus, are character states that are not restricted to African *Cryptopimpla* species assemblages. This should not compromise the taxonomic results since almost all species of *Cryptopimpla* are exclusive of a single biogeographical region (Yu et al. 2012).

Our morphological species-group delimitation is supported by molecular results based on the mitochondrial COI gene (~23% sequences divergence) and the nuclear 28S gene (~4% sequence divergence). Strong support for monophyly of the genus was obtained from a supermatrix analysis using both molecular (18S, 28S, COI) and morphological data (Reynolds Berry, Matthee & van Noort, unpubl. data).

The species C. fernkloofensis, C. goci, C. neili, and C. parslactis are described based on a single male specimen. Without the presence of the diagnostic female character of a shortened ovipositor sheath, male Cryptopimpla are sometimes confused and incorrectly described as the cosmopolitan banchine genus Lissonota (e.g. Gravenhorst 1829, Holmgren 1860). There are, however, a number of morphological characters that can differentiate Cryptopimpla from Lissonota when only males are available. The apical 0.3–0.4 portion of the flagellum is tapered to a slender apex in *Cryptopimpla* (Townes 1969, Takasuka et al. 2011) whereas the flagellum is not tapered or may be only weakly tapered at the apex in Lissonota (Townes 1969). The first metasomal tergum is only moderately narrowed toward the base in Lissonota species as opposed to being evenly and rather strongly narrowed toward the base in *Cryptopimpla* species. Lastly, in all *Cryptopimpla* species the upper tooth is distinctly longer than the lower (Townes 1969; Sheng 2011; Takasuka et al. 2011), whereas it is not a consistent character state for *Lissonota*. While these three character states are useful in distinguishing Cryptopimpla from Lissonota, our placement of C. fernkloofensis, C. goci, C. neili, and C. parslactis in the genus Cryptopimpla is further supported by their overall morphological resemblance to females of their respective species-groups.

Cryptopimpla is only known from South Africa in the Afrotropical region. The genus was previously represented by a single species in the region and the present study has yielded an additional nine species endemic to temperate areas of South Africa. This is unlikely to be a sampling artifact, given the numerous sampling inventories carried out in other African countries, and the absence of additional specimens in international museum collections. *Cryptopimpla* is a predominately northern hemisphere genus, with highest species richness in the temperate regions (Yu et al. 2012; Sheng and Zheng 2005; Kuslitzky 2007; Sheng 2011; Takasuka et al. 2011). This may explain its apparent exclusion from the tropical regions of Africa. Although the winter rainfall Cape region of South Africa has been fairly extensively sampled over the past 25 years, with deployment of numerous long-term (spanning 1 to 5 years) inventory surveys,

ensuring that seasonal variation in species assemblages is encompassed, in effect this effort has only just started scratching the surface with regard to documenting the ichneumonid diversity present in the area. In reality these inventory sites are relatively few and widely spaced, with the implication that the vast majority of the 440 vegetation types (Mucina and Rutherford 2011) in South Africa, Lesotho and Swaziland are still not comprehensively sampled. This fact in combination with the rarity of the genus (only 33 specimens known for the 9 species), with species often represented by a single specimen, suggests that there are still numerous *Cryptopimpla* species to be discovered in South Africa. The current revision has increased the knowledge of African species ninefold and that of the global fauna by ~16%. Further comprehensive sampling will undoubtedly elevate *Cryptopimpla* species richness for the Afrotropical region.

Acknowledgements

Terry Reynolds Berry was funded by the NRF PDP scholarship. Simon van Noort was funded by South African NRF (National Research Foundation) grants: GUN 2068865; GUN 61497; GUN 79004; GUN 79211; GUN 81139; GUN 98115. Part of the South African field work conducted by Simon van Noort was funded by the National Science Foundation under PlatyPBI grant no. DEB-0614764 to N.F. Johnson and A.D. Austin. Cape Nature; the Eastern Cape Department of Environmental Affairs and the Northern Cape Department of Nature and Environmental Conservation provided collecting permits for South Africa. We thank the reviewers for their valuable critique of the paper.

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CHECKLIST



The fishes of Cayo Arcas (Campeche Bank, Gulf of Mexico): an updated checklist

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Academic editor: Kyle Piller	Received 20 October 2016 Accepted 22 November 2016 Published 13 December 2016

Citation: Robertson DR, Perez-España H, Lara EN, Itza FP, Simoes N (2016) The fishes of Cayo Arcas (Campeche Bank, Gulf of Mexico): an updated checklist. ZooKeys 640: 139–155. https://doi.org/10.3897/zookeys.640.10862

Abstract

Cayo Arcas is a small, offshore reef complex on the southwest corner of Campeche Bank, Gulf of Mexico. The only published information (from 2000) on the fishes of that reef refers to 37 species. Here additional information is added, some from unpublished observations during the 1980s, as well as author observations made during 2013 and 2016. These bring the checklist of that reef's fishes up to 162 species. The possible effects of the limited number of fish habitats available at Cayo Arcas on the composition of its fish fauna are discussed. The Indo-Pacific damselfish *Neopomacentrus cyanomos* (Bleeker, 1856) was first recorded in the Atlantic in mid-2013, on shoreline reefs in the southwest corner of the Gulf of Mexico. Recently reviewed underwater photographs show that *N. cyanomos* also was present at Cayo Arcas in mid-2013, 350 km from the first-record site. Hence it evidently had a substantial population in the southwest Gulf of Mexico in 2013, and must have arrived in there long before that year.

Keywords

Endemic species, invasive damselfish species, reef-fishes, reef-habitat, southwest Gulf of Mexico

Introduction

The southwest Gulf of Mexico has relatively few coral reefs. Only a small number of these are offshore reefs on the broad, shallow Campeche Bank that extends 200+ km north from the Yucatan Peninsula. These include Alacran Reef, and a set of about 10 small submerged banks and emergent reefs scattered along the western edge of that bank (http:// www.gulfbase.org/reef/). The reef-fish faunas of most of those offshore reefs are not well documented. Only two of them have substantial published checklists available: Alacran Reef, a large emergent reef in the center of the bank and the largest reef in the region (see Gonzalez-Gandara and Arias-Gonzalez 2001), and Madagascar Reef, a small, shallow, submerged rock bank 40 km offshore from Sisal (see Zarco-Perrello et al. 2014, Robertson et al. 2016). The Cayo Arcas reef complex is located near the outer edge of the southwest corner of Campeche Bank (Figure 1). Currently the only published information available on the fishes of that reef concerns 37 species that were included in an ecological study of fishes on reefs on Campeche Bank and the Mexican Caribbean by Garduño and Chavez (2000).

Here an updated checklist for the fishes of the Cayo Arcas reef complex is presented that draws on both old and new information. The object of publishing this checklist is to improve understanding of the distributions of reef fishes in the southwest Gulf of Mexico, which hosts a number of endemic reef fishes, has a different marine environment to the rest of that gulf (Belanger et al. 2012), and forms a discrete biogeographic subunit within one of three major biogeographic subdivisions of the Greater Caribbean (see Robertson and Cramer 2014).

This updated list is not complete, because the dives on which it is based did not provide comprehensive coverage of fishes across the full range of habitats available. Furthermore, because the list is based on diver observations, cryptic fishes that live within the reef matrix or within fringing soft sediments undoubtedly are under-represented. The only really effective way to comprehensively sample such fishes, which represent as much as half of any reef-associated fauna in the neotropics, is with the use of small ichthyoside stations (Robertson and Smith-Vaniz 2008). Finally, there are many fish species that include Cayo Arcas within their geographic ranges (see www.stri.org/ sfgc), and that might be expected to occur there but have not yet been recorded there.

Methods

Study area

The Cayo Arcas reef complex is situated at 20.21°N, -91.98°W, 145 km from the mainland. This complex comprises reefs fringing a cluster of three sand cays that are spread over an area of ~4 km by ~2.6 km (Figure 2). The largest sand cay, which is 1 km long, has an elongate, 4 km long, crescent-shaped reef that runs along and to the northwest of its eastern side. Between the eastern beach of this cay and the exposed reef crest, there is a narrow, very shallow (~1m deep) sandy lagoon. The smaller eastern cay



Figure 1. Location of Cayo Arcas in the Gulf of Mexico (Base map: NOAA).

has a similar, much smaller lagoon (see Figure 2). On the western side of the main cay there is a large sand-floored semi-lagoon with scattered submerged patch reefs, some with abundant macroalgal growth, that gradually slopes off westwards into deeper water over a distance of ~2 km from the main cay. Reef development apparently extends down to ~25m (see http://www.gulfbase.org/reef/view.php?rid=cac1).

Mangroves and beds of seagrasses (turtlegrass, *Thalassia testudinum* Koenig 1805, and manatee-grass, *Syringodium filiforme* Kutzing in Hohenacker, 1860, represent major ancillary habitats adjacent to many reefs in the tropical northwest Atlantic. Those habitats are used by many reef fishes, often as nursery habitats. While turtlegrass often forms large beds within which dense growths of flat, strip-like blades provide ample shelter for fish, manatee-grass has thin, thread-like blades and a sparser growth pattern that provide lower quality shelter for reef fishes. There are no mangroves at Cayo Arcas. The www.gulfbase. org marine species list for reefs in the Mexican section of the Gulf of Mexico indicates that turtlegrass does occur at Cayo Arcas (see p 27 of http://www.gulfbase.org/checklist/pdfs/marine-spp-list.pdf). That gulfbase list cites Flores (1992) as the source of this infor-



Figure 2. Schematic representation of Cayo Arcas reef complex. Solid lines indicate edges of emergent reef. Solid fill = sand cays. Locations of dives sites for 2013 and 2016 are indicated by symbols.

mation. A copy of Flores (1992) was reviewed, and it was found that, while a table that indicates what terrestrial and marine flowering plants occur at different islands shows turtlegrass as present at Cayo Arcas (and at all the other islands treated in that book), it is not mentioned in the detailed text treatment of plants at Cayo Arcas. Hence that table record may have been an error. Flores (1992) does indicate that there were no mangroves at Cayo Arcas, but does not include any mention of manatee grass at any location. Turtlegrass was not seen by us or any other divers from UNAM-Sisal studying shallow water organisms during expeditions there in April and August 2016. In contrast, manatee grass was found at Cayo Arcas during 2016, and may be restricted to the back-reef lagoon on the eastern side of the main cay, and perhaps a similar lagoon next to the eastern cay (Figure 2). In August 2016 there were windrows of dead seagrass composed exclusively of manatee-grass threads along the entire beach on the eastern side of the main cay. As both T. testudinum and S. filiforme are restricted to shallow water it is unlikely that turtlegrass was present but missed during the 2016 expeditions. Hence two major ancillary habitats available for reef fishes throughout much of the wider Caribbean area are entirely (mangroves) or largely (seagrass) lacking at Cayo Arcas.

Sources of information

The earliest information available on Cayo Arcas fishes comes from an unpublished Master's thesis by Garduño (1988). Part of this information, based on censuses of fish-

es made at depths between 10-42 m at Cayo Arcas during 1984-86, was published in Garduño and Chavez (2000). In 2013 HP-E censused reef fishes on twelve 25mX4m transects at one site on the Arcas reef complex on July 31, while ENL censused 24 such transects at 6-11 m depth, divided among five sites on August 6-7 (Figure 2). Most recently, during August 20-27, 2016, DRR & FPI surveyed the Cayo Arcas reefs to assess the population status and distribution of an exotic Indo-Pacific damselfish, Neopomacentrus cyanomos that has become established in much of the southwest Gulf of Mexico, including Cayo Arcas (see Robertson et al. 2016, Simoes and Robertson 2016). During that period 14 dives were made at 11 sites on that reef complex (Figure 2). Each dive, which ranged from 5-30 m in maximum depth, lasted 1-1.5 hrs, and covered an area of -0.25 ha. In addition, three dives were made to depths of 40 m on a small petroleum-loading platform, located 1.5 km southwest of that reef cluster (see Figure 2, and Simoes and Robertson 2016). That platform is at the northern end of the complex of several hundred platforms that form Mexico's largest offshore oilfield in the Gulf of Mexico. During those dives notes were made of the presence and abundance of different species of reef fishes. Due to the briefness of the 2016 visit, the primary objective of those dives was to gain a broad-brush picture of the abundance and distribution of both *N. cyanomos* and native fishes across a variety of habitats, rather than obtaining quantitative data on densities on small transects such as those used by HP-E and ENL.

Results

Table 1 includes a list of 162 fish species from 41 families, mainly bony fishes, but also including three rays, together with information on their abundances, that were found at Cayo Arcas between the 1980s and 2016. During the 1980s Garduño (Garduño 1988, Garduño and Chavez 2000) recorded a total of 81 species from 28 families. In 2013 HP-E and ENL noted 78 species (including 25 additions) from 25 families. In 2016 151 species (39 families) were seen by DRR and FPI, which included 52 species not previously recorded.

Species Notes

Pterois volitans (Linnaeus, 1758). This invasive Indo-Pacific lionfish was first reported on the USGS invasive species website at an oil platform near Cayo Arcas in late 2012 (http://nas.er.usgs.gov/queries/SpecimenViewer.aspx?SpecimenID=292473. Fewer than a dozen individuals of this species were seen by the group of eight divers during the August 2016 expedition. Those occurred at depths of between 8-20 m on the reef, and at 30 m on the oil platform. Lionfish were first reported at Alacran reef, 350 km northeast of Cayo Arcas, in 2010, and on coastal reefs -450 km west of Cayo Arcas in 2012 (http://nas.er.usgs.gov/queries/collection-info.aspx?SpeciesID=963). At Alacran Reef lionfish seem to be concentrated at

Table 1. Preliminary checklist of fishes observed at Cayo Arcas, Campeche Bank. Abundance and distribution in 2016: Rare (1 seen during expedition); Uncommon (< 5); Occasional (~ 20, at multiple dive sites); Common, widespread (scores, at most/all dive sites); Locally common (scores to hundreds at 1–2 dive sites); Abundant, widespread (hundreds to thousands at most/all dive sites); Platform (present on oilloading platform 1.5 km from reef complex). Abundance 2013: Mean no. fish/transect by HP-E and ENL (see methods); Abundance 1984-86: G&C 2000 = Garduño and Chavez 2000, no. individuals min⁻¹ from their Table 2; G 1988 = Garduño 1988, relative abundance - mean of 10 counts).

Taxon	Abundance and distribution 2016	Abundance 2013 HP-E/ENL	Abundance 1984-86 G&C 2000/ G 1988
UROTRYGONIDAE			
Urobatis jamaicensis	Rare		
DASYATIDAE			
Hypanus americana*	Uncommon		0/0.1
AETOBATIDAE*			
Aetobatus narinari			0/0.1
MEGALOPIDAE			
Megalops atlanticus	Locally common (schools); platform		0/0.2
MURAENIDAE			
Gymnothorax funebris	Uncommon		
Gymnothorax moringa	Rare		0/0.1
ATHERINIDAE			
Atherina harringtonensis *	Locally common (large schools)		
Atherinomorus stipes	Locally common (large schools)		
HOLOCENTRIDAE			
Holocentrus adscensionis	Common, widespread	0.097/0.250	
Holocentrus rufus	Occasional, widespread		0/0.9
Myripristis jacobus	Uncommon		
Neoniphon vexillarium	Uncommon		
AULOSTOMIDAE			
Aulostomus maculatus	Uncommon	0.042/0.125	0/0.2
SCORPAENIDAE			
Pterois volitans	Occasional, widespread; platform (species note)		
SERRANIDAE			
Cephalopholis cruentata	Common, widespread; platform	0.042/0.125	0/0.2
Cephalopholis fulva		0.014/0.042	0/0.3
Epinephelus adscensionis	Common, widespread	0.055/0.083	0/1.1
Epinephelus guttatus	Common, widespread	0.111/ 0.333	0.05/1.0
Hypoplectrus aberrans	Locally common		
Hypoplectrus ecosur	Locally common		
Hypoplectrus gemma		0.014/0	
Hypoplectrus indigo	Uncommon		
Hypoplectrus maculiferus	Rare		
Hypoplectrus nigricans	Occasional, widespread	0.028/0.083	0/0.1
Hypoplectrus puella	Occasional, widespread	0.097/0.250	0/0.4
Hypoplectrus randallorum	Rare		
Hypoplectrus unicolor	Rare		
Mycteroperca bonaci	Common, widespread; platform		0/1.0
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Mycteroperca interstitialis	Locally common		
Mycteroperca microlepis	Uncommon		
Mycteroperca phenax	Uncommon	0.014/0.042	
Mycteroperca tigris	Occasional, widespread	0.014/0.042	0/0.4
Paranthias furcifer	Locally common (aggregations); platform		
Serranus baldwini	Rare		
Serranus tabacarius	Locally common		
Serranus tigrinus	Common, widespread	0.083/0.167	0/0.7
Serranus tortugarum	Locally common (aggregations)		
GRAMMATIDAE			
Gramma loreto	Common, widespread	0.139/ 0.208	0.10/0.7
MALACANTHIDAE			
Malacanthus plumieri			0/0.1
OPISTOGNATHIDAE			
Opistognathus aurifrons	Locally common (aggregations)	0.028/0	
RACHYCENTRIDAE			
Rachycentron canadum	Rare; platform only		
CARANGIDAE			
Caranx bartholomaei	Uncommon (small schools)		
Caranx crysos	Common, widespread (aggregations)		0/0.3
Caranx latus	Common, widespread (aggregations)	0.028/0	
Caranx lugubris	Uncommon (aggregation); platform only		
Caranx ruber	Locally common (aggregations)	0.305/0.208	0.05/0.7
Decapterus macarellus	Locally common (school)		
Trachinotus carolinus	Rare		
LUTJANIDAE			
Lutjanus analis	Locally occasional		0/0.1
Lutjanus apodus	(Species note)		0.05/0.1
Lutjanus buccanella	Occasional (juveniles)		
Lutjanus griseus	Common, widespread; platform		0/1.2
Lutjanus jocu	Common, widespread	0.028/0.083	
Lutjanus mahogoni	Occasional, widespread		0/0.1
Lutjanus synagris	Occasional (juveniles)		
Ocyurus chrysurus	Abundant, widespread; platform	2.619/7.333	0.05/1.1
GERREIDAE			
Gerres cinereus	Uncommon	0.014/0.042	0/0.1
HAEMULIDAE			
Anisotremus virginicus	Locally common (school)		0.05/0
Emmelichthyops atlanticus	Locally common (schools)		
Haemulon aurolineatum	Common, widespread (aggregations)	0.014/0	0.05/0
Haemulon carbonarium	Uncommon		0.05/0
Haemulon chrysargyreum	Locally common (schools)		0.05/0.4
Haemulon flavolineatum	Common, widespread	1.067/1.125	0.73/2.4
Haemulon macrostomum	Uncommon		0/0.7
Haemulon melanurum	Uncommon		

Haemulon plumierii	Uncommon	0.083/0	0.05/0
Haemulon sciurus	Uncommon		0.05/0.4
Haemulon striatum	Locally common (large schools)		
Haemulon vittatum *	Locally common (large schools)	1.386/0	12.83/1.7
SPARIDAE			
Calamus calamus	Common, widespread	0.055/0	
Calamus nodosus	Common, widespread		
SCIAENIDAE	-		
Equetus punctatus	Uncommon		
Pareques acuminatus	Uncommon		
MULLIDAE			
Mulloidichthys martinicus	Common, widespread (schools)	0.014/0.083	0/2.4
Pseudupeneus maculatus	Locally common	0.028/0	
PEMPHERIDAE			
Pempheris schomburgkii	Locally common (aggregations)		
KYPHOSIDAE*		3.672/1.542	
Kyphosus bigibbus	Occasional		
Kyphosus cinerascens	Common, widespread		
Kyphosus sectatrix	Common, widespread		0/0.5
Kyphosus vaigiensis	Common, widespread		
CHAETODONTIDAE	-		
Chaetodon aculeatus			0/0.2
Chaetodon capistratus	Occasional		
Chaetodon ocellatus	Common, widespread	0.194/0.458	0/1.5
Chaetodon sedentarius	Common, widespread	0.152/0.250	
POMACANTHIDAE			
Holacanthus bermudensis	Uncommon		
Holacanthus ciliaris	Common, widespread; platform		0/0.4
Holacanthus tricolor			0.05/0
Pomacanthus arcuatus	Locally common	0.055/0	0/1.2
Pomacanthus paru	Locally common	0.014/0.042	0.05/0.5
CIRRHITIDAE			
Amblycirrhitus pinos	Rare; platform only		
POMACENTRIDAE			
Abudefduf saxatilis	Locally abundant, widespread	1.108/1.167	7.16/2.1
Chromis cyanea	Locally common	0.430/0	0.05/0.2
Chromis insolata	Locally common	0.028/0.083	0/0.2
Chromis multilineata	Abundant, widespread	47.056/ 90.750	28.93/3.2
Chromis scotti	Common, widespread; platform	0.194/0	
Microspathodon chrysurus	Common, widespread	0.152/0.375	1.14/2.3
Neopomacentrus cyanomos	Abundant, widespread (aggregations); platform. (species note)	Present/0	
Stegastes adustus	Abundant, widespread (species note)	0.443/0.167	
Stegastes diencaeus		0.055/0.167	1.14/1.4
Stegastes leucostictus	Locally common	0.222/0.417	0/0.3
Stegastes partitus	Abundant, widespread; platform	3.603/4.667	0.05/0.9
Stegastes planifrons	Abundant, widespread	0.679/1.500	12.93/3.7

Stegastes xanthurus*	Abundant, widespread (species note)	0.679/0.542	0.05/0
LABRIDAE			
Bodianus pulchellus	Locally common; platform only		
Bodianus rufus	Common, widespread	0.651/1.208	0/1.1
Clepticus parrae	Locally common, schools	1.261/3.792	9.73/0.4
Halichoeres bivittatus	Very common, widespread	0.443/0.083	0/0.9
Halichoeres burekae	Abundant, widespread (species note)	5.085/0.083	
Halichoeres garnoti	Common, widespread	2.245/4.452	0.05/0.2
Halichoeres maculipinna	Common, widespread	0.402/1.208	1.36/1.3
Halichoeres poeyi		0.319/0	
Halichoeres radiatus	Common, widespread	0.222/0.083	0/1.0
Lachnolaimus maximus	Uncommon		
Thalassoma bifasciatum	Abundant, widespread; platform	10.752/11.833	1.22/2.1
Xyrichtys splendens	Uncommon; local		
SCARIDAE			
Cryptotomus roseus	Occasional		
Scarus coelestinus	Occasional		0/0.6
Scarus coeruleus	Common, widespread	0.152/0	0.05/1.6
Scarus guacamaia	Occasional, widespread	0.042/0	0/0.3
Scarus iseri	Common, widespread	2.480/3.042	
Scarus taeniopterus	Common, widespread	0.111/0.333	5.40/1.3
Scarus vetula	Common, widespread	1.178/2.875	5.23/3.4
Sparisoma atomarium	Locally common	0.055/0.167	
Sparisoma aurofrenatum	Common, widespread	1.857/2.833	0/0.4
Sparisoma chrysopterum	Occasional, widespread	0.014/0.042	0.05/1.7
Sparisoma radians	Common, widespread		
Sparisoma rubripinne	Locally common	0.291/0.500	0/1.5
Sparisoma viride	Very common, widespread	1.136/1.833	3.63/3.2
TRIPTERYGIIDAE			
Enneanectes boehlkei	Present (species note)		
BLENNIIDAE			
Entomacrodus nigricans	Uncommon: platform only		
Nypsoblennius invemar	Locally common; platform only		
Ophioblennius macclurei *	Common, widespread	0.028/0	0/01.2
Parablennius marmoreus	Locally common; platform		
Scartella cristata	Locally common: platform only		
LABRISOMIDAE	, F, F,		
Malacoctenus aurolineatus	Locally common		
Malacoctenus macropus	Common, widespread		
Malacoctenus triangulatus	Common, widespread	0.097/0.083	
Starksia ocellata	Present (species note)		
GOBIIDAE	, (cF)		
Corvphopterus dicrus	Abundant, widespread		
Corvphopterus olaucofraenum	Abundant, widespread	0.319/0	
Coryphopterus hyalinus/	Abundant, widespread (species note)	4.432/5.625	
personatus		0.000/0.000	
Elacatinus oceanops	Common, widespread	0.222/0.292	

Elacatinus xanthiprora	Uncommon		
Gnatholepis thompsoni	Abundant, widespread	0.249/0.042	
PTERELEOTRIDAE			
Ptereleotris calliura	Locally common (aggregations)		
ACANTHURIDAE			
Acanthurus chirurgus	Common, widespread	0.097/0.167	0.05/0.8
Acanthurus coeruleus	Common, widespread	0.139/0.250	0.05/1.6
Acanthurus tractus *	Common, widespread (species note)	0.291/0.875	1.09/1.2
SPHYRAENIDAE			
Sphyraena barracuda	Occasional, widespread	0.014/0.042	0/1.1
BALISTIDAE			
Balistes capriscus	Rare		
Balistes vetula		0.042/0.125	
Canthidermis sufflamen	Occasional, widespread		0/0.1
Melichthys niger	Locally common		0/0.2
Xanthichthys ringens			0/0.2
MONACANTHIDAE			
Aluterus scriptus	Occasional, widespread		0/0.3
Cantherhines pullus	Rare	0.028/0	
Monacanthus tuckeri	Locally common	0.028/0	
OSTRACIIDAE			
Lactophrys bicaudalis	Rare		0/0.1
Lactophrys triqueter	Occasional, widespread	0.014/0.042	0/0.8
TETRAODONTIDAE			
Canthigaster rostrata	Common, widespread	0.152/0.250	0.05/0.8
Sphoeroides testudineus	Rare		
DIODONTIDAE			
Diodon hystrix	Uncommon		0/0.4

* Taxonomic notes: Hypanus americana: this species has been moved from the genus Dasyatis to Hypanus (see Last et al. 2016). AETOBATIDAE: This family was recently resurrected by White and Naylor (2016). Atherina harringtonensis: Previously known as Hypoatherina harringtonensis, this was reclassified as a species of Atherina by Sasaki and Kimura (2014). Haemulon vittatum: Once known as Inermia vittata, this has been shown to be a Haemulon species (see Rocha et al. 2008). Kyphosus species: Due to morphological similarities and inadequate knowledge of the number and identity of species potentially present in the Greater Caribbean, members of this genus there often have not been accurately identified to species; furthermore, the older literature on Greater Caribbean kyphosids only mentions K. sectatrix and K. incisor. However, the genus recently was comprehensively revised by Knudsen and Clements (2013, 2016), who identified four species in that area: K. bigibbus, K cinerascens, K. sectatrix and K. vaigiensis (see http:// biogeodb.stri.si.edu/caribbean/en/gallery/genus/1571). Accurate descriptions of field characteristics of those four, an extensive database of photographs of them that were identified by those authors, and careful, close-range inspection of fish in the field now enable identification of members of this genus at different locations in that region. All four species were present at Cayo Arcas in 2016. Stegastes xanthurus: Garduño and Chavez (2000), HP-E and ENL all recorded S. variabilis as present at Cayo Arcas. However, S. variabilis is restricted to Brazil, and genetically distinct from the Caribbean form, S. xanthurus. Acanthurus tractus: This was previously recorded as A. bahianus, which is restricted to Brazil. A. tractus is its sister species in the Greater Caribbean. Ophioblennius macclurei: Often recorded in the older literature as O. atlanticus, which is now known to be restricted to the eastern Atlantic.

mesophotic depths (Aguilar-Perera et al. 2016). It is not known how abundant lionfish is in the Cayo Arcas area below 25 m depth.

- *Hypoplectrus nigricans* (Poey, 1852). This species is known to vary geographically in color and shape (Aguilar-Perera 2004). At Cayo Arcas in 2016 all *H. nigricans* were similarly colored, with a translucent, dark blue-black head, body and fins, except the tail fin, which was translucent grey, with darker upper and lower borders.
- Lutjanus apodus (Walbaum, 1792). Garduño (1988) Garduño and Chavez (2000) listed only two snappers, L. apodus and Ocyurus chrysurus (Bloch, 1791) as present at Cayo Arcas. The seven members of this family that were observed during 2016 included six species of Lutjanus, but not L. apodus. L. apodus also was not recorded in 2013. Two of those Lutjanus species, L. griseus (Linnaeus, 1758) and L. jocu (Bloch and Schneider, 1801) were common across on the Arcas reefs in 2016. L. apodus, which is easily recognizable and probably the commonest and most widely distributed shallow-living member of its genus on Caribbean reefs, occurs through much of the Gulf of Mexico (see http://www.iucnredlist.org/details/155152/0, and http://biogeodb.stri.si.edu/caribbean/en/thefishes/species/3684. If currently present in the Arcas reef complex L. apodus must be rare.
- Neopomacentrus cyanomos. During a visit to Cayo Arcas in April 2016 NS found it to occur both on the reefs and the adjacent oil-loading platform, where it was superabundant (Simoes and Robertson 2016). During the August 2016 expedition we found this species in small aggregations (up to ~150 fish, but usually about several dozen, including many juveniles) at all dive sites on the reef complex. It also formed a large, dense aggregation of many tens of thousands of individuals on the oil-loading platform (see Simoes and Robertson 2016). Neither HP-E nor ENL recorded this species in 2013. However, a 2016 review by HP-E of photographs he took during his July 2013 expedition show that this species was present on the Cayo Arcas reef then (Figure 3).
- Stegastes adustus (Troschel in Muller, 1865) and S. diencaeus (Jordan and Rutter, 1897). In 2016 S. adustus, a benthic-feeding, omnivorous damselfish, was common on all hard reef substrata not covered by live corals, at depths of 0.5-7 m. HP-E recorded S. adustus but not S. diencaeus, while ENL recorded both species. In their list Garduño and Chavez 2000 did not include either species by name, but did record Eupomacentrus mellis Emery & Burgess, 1974 which is the juvenile of Stegastes diencaeus (see Robertson and Allen, 1981). Adults of both these Stegastes species are dull brown to blackish fishes with similar shapes and body sizes that are often confused, even in guide books by experts: e.g. figure 287 of Randall (1996) is S. diencaeus, not S. adustus; the lower photo on p. 171 of Allen (1991) is S. diencaeus, not S. adustus; and the image on the bottom of p. 113 of Humann and DeLoach (1994) is S. diencaeus, not S. adustus (an error that was corrected in later editions of that book). In addition, juvenile S. diencaeus displaying the "mellis" coloration look quite similar to juveniles of two other Stegastes species commonly found at Cayo Arcas: S. leucostictus (Muller and Troschel in Schomburgk 1848) and S. xanthurus (Poey, 1860; recorded as S. variabilis (Castelnau, 1855) by



Figure 3. *Neopomacentrus cyanomos* at Cayo Arcas, July 2013 (Photo HP-E); 11 *N. cyanomos* are visible, and can be identified by the presence of a black blotch on the shoulder, and a large white blotch on the rear edge of the dorsal fin; a single *Chromis multilineata* (without the shoulder- and dorsal-fin blotches) is present in the foreground immediately above the brain coral.

Garduño and Chavez (2000); see http://biogeodb.stri.si.edu/caribbean/en/gallery/ specie/3879, and http://biogeodb.stri.si.edu/caribbean/en/gallery/specie/3884). Given the abundance of *S. adustus* at Cayo Arcas in August 2016 and the apparent absence of *S. diencaeus* then, and the similarities between adults and juveniles of *S. diencaeus* and its congeners, differences in those *Stegastes* spp recorded during and prior to 2016 might have been due to misidentifications. In contrast, both *S. adustus* and *S. diencaeus* were recorded at Alacran Reef by González-Gándara and Arias González (2001, 2004) and both were commonly observed by DRR during two weeks of diving there in May 2016.

Halichoeres burekae Weaver & Rocha, 2007. This recently described species is endemic to the southwest and northwest Gulf of Mexico. Its known range extends from Alacran Reef on Campeche Bank to the Flower Garden Banks at the edge of the continental shelf off Texas (see http://biogeodb.stri.si.edu/caribbean/en/thefishes/species/4707; and http://maps.iucnredlist.org/map.html?id=187608). At Alacran Reef, 350 km northeast of Cayo Arcas, Aguilar-Perera and Tuz-Sulub (2009) described this species as occurring in small aggregations of a few dozen fish to as many as 200 fish, and that it is widely distributed there. Observations of the abundance and distribution of *H. burekae* at Alacran Reef made by DRR during May 2016 are consistent with those of Aguilar-Perera and Tuz-Sulub (2009).

This species is relatively uncommon at the Flower Gardens area (http://www.iucnredlist.org/details/187608/0). During August 2016 *H. burekae* was recorded at all dive sites on the Cayo Arcas reefs (but not the oil-loading platform) and was one of the most abundant labrids on that reef complex. It was at least an order of magnitude more abundant than observed by DRR at Alacran Reef during June 2016. Multiple aggregations of scores to hundreds of individuals moving about in the water column 1-3m above the bottom were seen at each dive site. Those aggregations were mainly seen in areas of low relief, over both sandy and coralline-rock bottoms. A large aggregation containing thousands of individuals was seen mass spawning in midwater over a substratum of dense, live gorgonian trees on the forereef off the center of the main-cay reef at ~10m depth during one afternoon dive.

- *Scarus guacamaia* Cuvier, 1829. At Cayo Arcas one or two adults of this species were seen on each of eight of the 14 dives on the reef complex in 2016. *S. guacamaia* also was recorded by Garduño 1988, and by HP-E in 2013. This species has been thought to be dependent on mangroves as habitat for juveniles (http://www.iucnredlist.org/details/19950/0). However Cayo Arcas lacks mangroves, and the nearest mangroves are located on the coast, 145 km away. Although <20 *S. guacamaia* were seen at Cayo Arcas in 2016, a more comprehensive survey across a broad range of habitats would be needed to provide a reliable estimate its total population size there.
- *Enneanects boehlkei* Rosenblatt, 1960 and *Starksia ocellata* (Steindachner, 1876). One individual of each of these two cryptic species was collected as bycatch while using clove oil to anaesthetize *Neopomacentrus cyanomos* for collection.
- *Coryphopterus hyalinus* Bohlke & Robins, 1962, and *C. personatus* (Jordan & Thompson, 1905). This pair of sister species (see Baldwinet al. 2009) apparently have essentially the same external appearance, and are differentiated by the patterns of pores on the top of the head. They also have very similar geographic, habitat and depth ranges (see http://biogeodb.stri.si.edu/caribbean/en/thefishes/species/4119 and http://biogeodb.stri.si.edu/caribbean/en/thefishes/species/4121). We include them as a single unit as, while diving, we were unable to determine whether one or both occurs at Cayo Arcas.

Discussion

The present checklist includes 162 species from 41 families. The great majority of those species are widespread in the Greater Caribbean, with only *Halichoeres burekae* and *Hypoplectrus gemma* Goode and Bean, 1882 representing species that are entirely (or almost so) restricted to the Gulf of Mexico. Most of the geographically widely distributed species that were common in the 1980s and 2013 surveys at Cayo Arcas also were common there in 2016. There are several noteworthy features of the suite of species found at Cayo Arcas: *Chromis multilineata* (Guichenot, 1853), which is a common species widely distributed on reefs throughout the Greater Caribbean, was notably abun-

dant in all surveys made between the 1980s and 2016. *H. burekae*, a western Gulf of Mexico endemic, was (perhaps) the most common labrid at Cayo Arcas, and was more abundant there than has been recorded anywhere else previously. This species is listed as Endangered (i.e. at a high risk of extinction) by the IUCN Red List (http://www. iucnredlist.org/details/187608/0), due to the small size of its geographic range and the paucity of reef habitat in that range. The abundance of this species at Cayo Arcas has substantial conservation significance for this species, as it indicates that the set of small offshore reefs scattered along the western side of Campeche Bank may be essential for its continued existence. None of those reefs is a yet designated a marine protected area.

Neopomacentrus cyanomos was first recorded in the Atlantic by González-Gándara and Cruz-Francisco (2014). In mid-2013 those authors found this species to be common on shoreline reefs near Coatzacoalcos, in the extreme southwest corner of the Gulf of Mexico. In 2014-15 it was found to occur more widely, on center-shelf and shoreline reefs between Madagascar Reef (near Sisal, Yucatan) and Tuxpan, Veracruz state (Cruz-Francisco et al. 2016, Robertson et al. 2016). Figure 3 here demonstrates that its range already spanned at least 350 km when it was first discovered in the Gulf of Mexico. Hence it likely arrived in the Gulf of Mexico long before 2013.

Two species that are commonly found on reefs nearby and more widely within the greater Caribbean were conspicuously absent/rare at Cayo Arcas: Lutjanus apodus and Stegastes diencaeus. L. apodus is one of the species thought to be strongly dependent on mangroves as nursery habitat in the Caribbean area (Nagelkerken et al. 2001, Halpern 2004, Naglekerken 2009). Although there are no mangroves at Cayo Arcas, various other species that make strong usage of mangroves as nursery habitat (Nagelkerken et al. 2001, Naglekerken 2009) are present and not rare at Cayo Arcas (Lutjanus griseus, L. mahogoni (Cuvier, 1828), Ocyurus chrysurus, Haemulon flavolineatum (Desmaret, 1823), Sparisoma chrysopterum (Bloch and Schneider, 1801), and Sphyraena barracuda (Edwards, 1771)), while others are absent to uncommon (Haemulon sciurus (Shaw, 1803), Chaetodon capistratus Linnaeus, 1758, Gerres cinereus (Walbaum, 1792)). Among the species that Nagelkerken (2009) indicates make major use of seagrass as nursery habitat some were common (Acanthurus chirurgus (Bloch, 1787), Scarus coeruleus (Edwards, 1771), Scarus iseri (Bloch, 1798), and Ocyurus chrysurus), but not all (Haemulon plumieri (Lacepede, 1801)). The extent to which manatee-grass and macroalgae can fill the nursery role of turtlegrass beds for some reef fishes clearly needs assessment. While lack of such habitats at Cayo Arcas may account for the absence of L. apodus, the paucity of S. diencaeus cannot so readily be explained, as this species is common at Alacran Reef, 350 km northeast of Cayo Arcas, and it occurs on coastal reefs to the west of Cayo Arcas (see Del Morales-Floreset al. 2013). Variation in species occurrences such as these show that small, isolated offshore reefs such as Cayo Arcas that have a limited range of habitats offer considerable potential for testing ideas about ecological determinants of the abundance and geographic distributions of Greater Caribbean reef fishes.

Future, comprehensive faunal surveys should be made of the reef fish faunas not only of Cayo Arcas but also other, more poorly known emergent reefs and submerged banks near the outer edges of Campeche Bank to assess their reef fish faunas, to gain a better understanding of the biogeography of their fishes, and their importance for conservation, as well as assessing them as natural biogeographical experiments. Those surveys should also involve genetic analyses to determine the extent to which the regional fauna and faunas of individual reefs include cryptic endemic species.

Acknowledgements

Thanks to Quetzalli Hernandez, whose leadership of the Cayo Arcas expedition of August 2016 greatly facilitated work there, and to essential support by the captain (Héctor Agustin Torres Murillo) and crew of the Buque de Investigación Oceanográfico Arm "Hondo" (BI-06), Secretaria de Marina, Estados Unidos Mexicanos. The 2016 expedition was financed by grants to NS from the Harte Institute (Biodiversity of the southern Gulf of Mexico) and CONABIO (NE018; Actualización del conocimiento de la diversidad de especies de invertebrados marinos bentónicos de aguas someras (< 50m) del Sur del Golfo de México. Fieldwork in 2013 was funded by SEP-CONACyt grants 69747 to HP-E and 108083 to ENL.

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