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Ovicides paralithodis (Nemertea, Carcinonemertidae), a new species of symbiotic egg predator of the red king crab *Paralithodes camtschaticus* (Tilesius, 1815) (Decapoda, Anomura)

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Abstract

Ovicides paralithodis **sp. n.** is described from the egg mass of the red king crab *Paralithodes camtschaticus* (Tilesius, 1815) from the Sea of Okhotsk, off Hokkaido, Japan, and Alaska, USA. Among four congeners, *O. paralithodis* can be distinguished from *O. julieae* Shields, 2001 and *O. davidi* Shields and Segonzac, 2007 by having no eyes; from *O. jonesi* Shields and Segonzac, 2007 by the presence of basophilic, vacuolated glandular lobes in the precerebral region; and from *O. jasoni* Shields and Segonzac, 2007 by the arrangement of the acidophilic submuscular glands, which are not arranged in a row. *Ovicides paralithodis* represents the third described species of egg-predatory nemertean from *P. camtschaticus*, the second described carcinonemertid species from Japan, and the 21st described species in the family. The intensity of infestations may exceed 24,000 worms per a single egg-bearing pleopod of *P. camtschaticus*. A preliminary molecular phylogenetic analysis based on sequences of 28S rRNA and cytochrome *c* oxidase subunit I genes among selected monostiliferous hoplonemertean species supported the monophyly of Carcinonemertidae, suggesting that within the lineage of the family, evolution of the unique vas deferens, Takakura's duct, preceded loss of accessory stylets and accessory-stylet pouches.

Keywords

Nemertini, Crustacea, *Paralithodes camtschatica*, symbiont, egg predator

Introduction

Nemerteans in the monostiliferous hoplonemertean family Carcinonemertidae are ectosymbiont egg predators of decapod crustacean hosts (Humes 1942, Jensen and Sadeghian 2005). The family is comprised of two genera, *Carcinonemertes* Coe, 1902 and *Ovicides* Shields, 2001, each containing 16 (Sadeghian and Santos 2010) and four (Shields and Segonzac 2007) species, respectively. They are known from approximately 70 host species (Sadeghian and Santos 2010), but the actual diversity of carcinonemertids is likely to be much greater (Kuris 1993). Crustacean-egg predatory nemerteans other than Carcinonemertidae include *Alaxinus oclairi* Gibson, Wickham and Kuris, 1990 and *Pseudocarcinonemertes homari* Fleming and Gibson, 1981.

The red king crab, *Paralithodes camtschaticus* (Tilesius, 1815), is a commercially important anomuran decapod, native to the Bering Sea, the Sea of Japan, the Sea of Okhotsk, and the North Pacific from the Kamchatka Peninsula to Alaska. Wickham and Kuris (1985) listed three undescribed species of egg-predator nemerteans on *P. camtschaticus* in Alaska, and Wickham and Kuris (1988) recognized five undescribed forms. Later, Forms 1 and 2 *sensu* Wickham and Kuris (1988) were respectively described as *C. regicides* Shields, Wickham and Kuris, 1989 and *A. oclairi*, while Forms 3–5 remained undescribed.

A survey of egg masses of *P. camtschaticus* in Hokkaido, northern Japan, yielded specimens that correspond to Form 4 of Wickham and Kuris (1988) from Alaska, which is herein described as a new species belonging to *Ovicides*.

Methods

Twenty female specimens of the red king crab *P. camtschaticus* were obtained in the Sea of Okhotsk, off Abashiri, Hokkaido, Japan, at 44°06'N, 144°32'E, from 215 m in depth, by crab cages set from 28 November 2011 to 15 December 2011. Of these female crabs, 16 were ovigerous, from three of which we procured a single nemertean specimen. The worms were anaesthetized in $MgCl_2$ solution isotonic to seawater. The anterior halves of the worms were fixed in Bouin's solution for histological preparation; the posterior halves were preserved in 99% ethanol for DNA extraction. Histological preparation follows that of Kajihara et al. (2011a, b). The type slides are deposited in the Hokkaido University Museum, Sapporo, Japan (ZIHU).

DNA extraction, PCR amplification, and sequencing of the nuclear 28S rRNA gene and mitochondrial cytochrome *c* oxidase subunit I gene (COI) largely follow those of Kajihara et al. (2011a, b). Sequences from the holotype, the egg strand laid by the holotype, and the allotype were exactly the same ($p = 0.0$), with respect to both 28S rRNA (1141 bp) and COI (658 bp).

A preliminary analysis was carried out to assess the phylogenetic affinities of the new species, including 16 species of Distromatonemertea, in addition to two outgroup species, for which 28S rRNA and COI sequences were available in GenBank

(Table 1). Alignment of the sequences was carried out by MUSCLE (Edgar 2004a, b) implemented in MEGA ver. 5.05 (Tamura et al. 2011). Model selection and a maximum likelihood analysis using nearest-neighbour interchange tree rearrangement in heuristic search were also performed by MEGA ver. 5.05 (Tamura et al. 2011), based on the general time-reversible model (Tavaré 1986) with gamma-distributed rate heterogeneity and a proportion of invariant sites (GTR + G + I) selected by Akaike Information Criterion (Akaike 1974) as the best-fit substitution model; a bootstrap analysis (Felsenstein 1985) with 1000 replications was performed to evaluate nodal supports. The concatenated matrix of 28S rRNA and COI sequences comprised 1851 bp (excluding gap positions) after alignment of each submatrix.

Observations on abundance and geographic distribution in Alaska were conducted from 1983 to 1985, as described in Kuris et al. (1991). Observations of living specimens were made on worms from red king crabs collected near Homer, Seward and Juneau, Alaska.

Table 1. List of species included in the phylogenetic analysis, with GenBank accession numbers.

Species	28S rRNA	COI	Sources
Amphiporus imparispinosus Griffin, 1898	HQ856878	HQ848612	Andrade et al. (2012)
Amphiporus lactifloreus (Johnston, 1828)	HQ856876	HQ848611	Andrade et al. (2012)
Antarctonemertes varvarae Chernyshev, 1999	AJ436845	AJ436900	Thollesson and Norenburg (2003)
Argonemertes australiensis (Dendy, 1892)	HQ856892	HQ848601	Andrade et al. (2012)
Carcinonemertes carcinophila (Kölliker, 1845)	HQ856893	HQ848619	Andrade et al. (2012)
Carcinonemertes cf. *carcinophila imminuta* Humes, 1942	AJ436846	AJ436901	Thollesson and Norenburg (2003)
Emplectonema gracile (Johnston, 1837)	HQ856883	HQ848620	Andrade et al. (2012)
Gononemertes parasita Bergendal, 1900	HQ856889	HQ848607	Andrade et al. (2012)
Leptonemertes chalicophora (Graff, 1879)	HQ856898	HQ848596	Andrade et al. (2012)
Nemertellina yamaokai Kajihara et al., 2000	AJ436852	AJ436907	Thollesson and Norenburg (2003)
Oerstedia dorsalis (Abildgaard, 1806)	AY210465	AY791971	Thollesson and Norenburg (2003)
Oerstedia venusta Iwata, 1954	AJ436856	AJ436911	Thollesson and Norenburg (2003)
Ovicides paralithodis sp. n.	AB704416	AB704417	Present study
Paranemertes peregrina Coe, 1901	AJ436860	AJ436915	Thollesson and Norenburg (2003)
Paranemertes sanjuanensis Stricker, 1982	AJ436862	AJ436917	Thollesson and Norenburg (2003)
Zygonemertes simoneae Corrêa, 1961	AJ436867	AJ436922	Thollesson and Norenburg (2003)
Zygonemertes virescens (Verrill, 1879)	AJ436868	AJ436923	Thollesson and Norenburg (2003)
Outgroups			
Nipponnemertes punctatula (Coe, 1905)	AJ436855	AJ436910	Thollesson and Norenburg (2003)
Paradrepanophorus crassus (Quatrefages, 1846)	HQ856867	HQ848603	Andrade et al. (2012)

Results

Ovicides paralithodis sp. n.

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http://species-id.net/wiki/Ovicides_paralithodis
Figs 1–5

Carcinonemertidae Form 4: Wickham and Kuris (1988).

Material examined. Holotype: female, ZIHU 4271, serial transverse sections (8 µm thick) of anterior body fragment, stained with Mallory's trichrome method, 5 slides. Allotype: male, ZIHU 4272, serial transverse sections (8 µm thick) of anterior body fragment, stained with Mallory's trichrome method, 3 slides. The other specimen obtained (female) was destroyed and lost during preparation.

Diagnosis. An *Ovicides* without eyes; vacuolated, basophilic glandular lobes extending pre- and post-cerebrally; acidophilic submuscular glands scattered among basophilic lobes, not arranged in row; sexes separate; female and male about 1 cm and 5 mm in length, respectively.

Type host. *Paralithodes camtschaticus* (Tilesius, 1815) (Decapoda, Anomura).

Description. *External features*. In life, holotype (female) about 1 cm long, 0.9 mm wide; pale orange in colour (largely due to alimentary canal), except whitish tip of head (Fig 1A). Allotype (male) about 5 mm in length, 0.3 mm in width; cream white in colour (Fig. 1B). Living in thin, transparent mucous tube.

Proboscis apparatus. Rhynchodaeum opening to dorsal wall of oesophagus (Fig. 2A). Anterior proboscis chamber 136 µm (unknown in allotype) long by 100 µm (82 µm in allotype) diameter; central stylet basis 48 µm (56 µm in allotype) long by 20 µm (20 µm in allotype) diameter (Figs 2B, 3); central stylet 16 µm (12 µm in allotype) in length (all measured from transverse sections); stylet to basis ratio 0.21–0.33; two accessory stylet pouches each containing two accessory stylets (Fig. 2C). Middle proboscis chamber 80 µm (54 µm in allotype) in diameter. Posterior proboscis chamber 240 µm (unknown in allotype) long by 130 µm (94 µm in allotype) wide. Proboscis almost same length as rhynchocoel, extending posteriorly behind pylorus-intestine junction; musculature of rhynchocoel wall uncertain in light microscopy.

Alimentary canal. Oesophagus opening ventrally at tip of head. Stomach wall containing circular muscle fibres (Fig. 2D).

Glandular system. Vacuolated, basophilic glandular lobes filling much space of precerebral region between body-wall musculature and oesophagus (Fig. 2A), extending post-cerebrally in intestinal region, but gradually less distinct posteriorly (Fig. 4A). Acidophilic submuscular glands scattered among basophilic lobes (Fig. 2A), not arranged in row beneath body-wall musculature.

Excretory system. Flame cells, nephridioducts, and nephridiopores not found.

Nervous system. Dorsal and ventral brain commissures 13 µm (9 µm in allotype) and 10 µm (7 µm in allotype) in thickness, respectively (Fig. 3).

Figure 1. *Ovicides paralithodis* sp. n., photographs taken in life. **A** holotype, female, ZIHU 4271 **B** allotype, male, ZIHU 4272.

Vascular system. Pair of cephalic vessels meeting above rhynchodaeum, posteriorly passing through cerebral ring (Fig. 3), extending further backward as lateral vessel on each side, situated near lateral nerve cord (Fig. 4A).

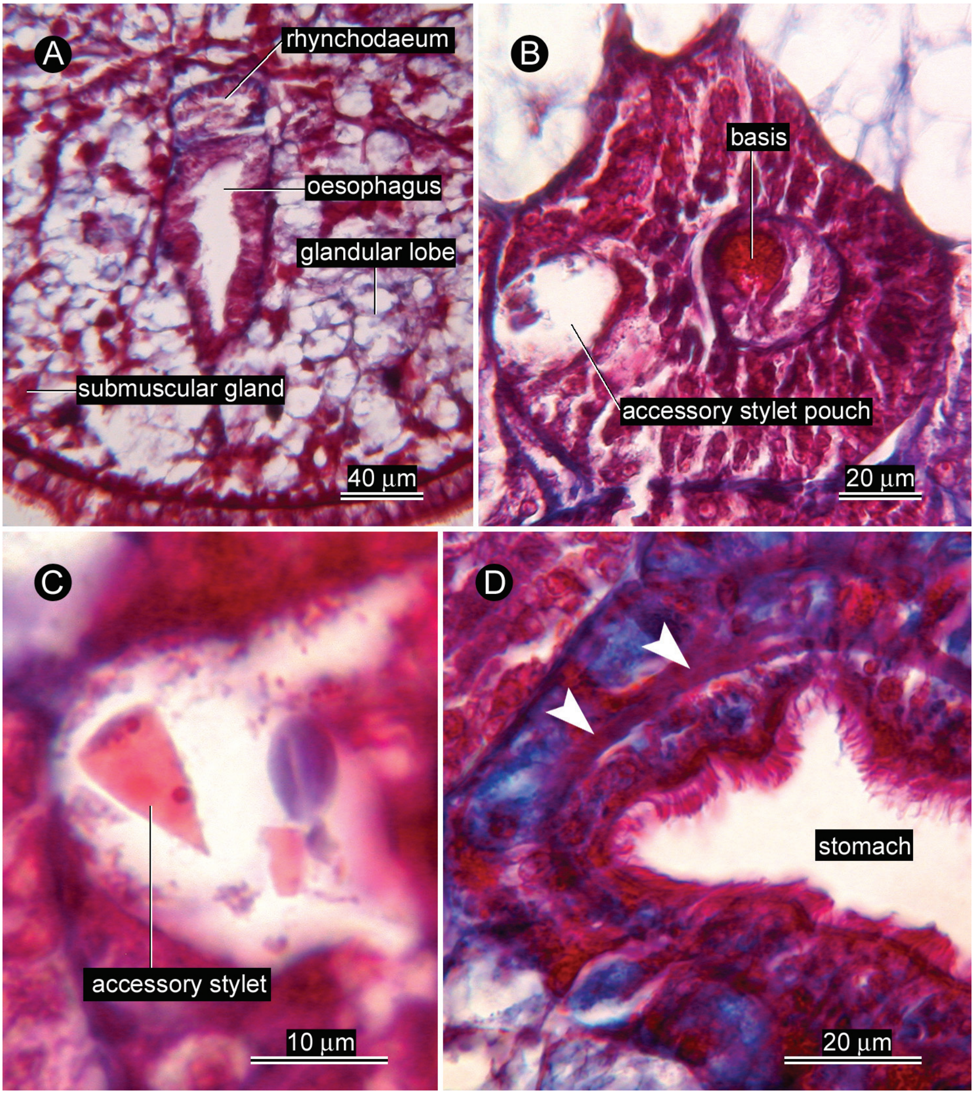

Figure 2. *Ovicides paralithodis* sp. n., photomicrographs of transverse sections. **A** precerebral region, showing rhynchodaeum just after branched off from oesophagus **B** anterior proboscis chamber showing stylet basis and one of the two accessory stylet pouches **C** accessory stylet **D** stomach, showing circular muscle fibres (indicated by arrowheads). A, C, D, allotype, male, ZIHU 4272; B, holotype, female, ZIHU 4271.

Sensory system. No eyes. No cerebral organs. No frontal organ.

Reproductive system. Ovaries more or less regularly interspersed with intestinal lateral diverticula, arranged in row on each side of body; single oviduct from each ovary extending dorsally (Fig. 4B). Single egg string found in the same crab egg mass about 1 cm in length, containing pink eggs (Fig. 5A, B). Takakura's duct present in male, about 40 µm in diameter (Fig. 4A).

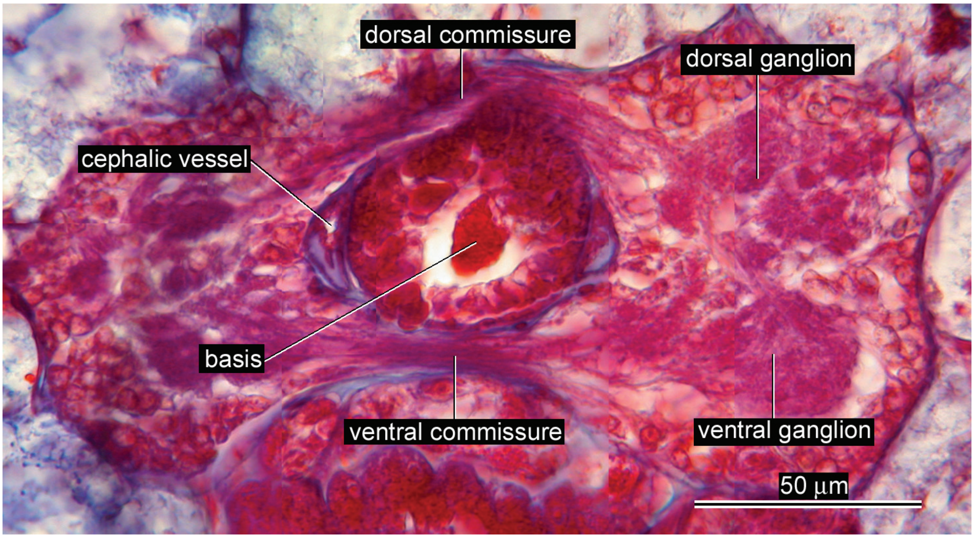

Figure 3. *Ovicides paralithodis* sp. n., photomicrograph of transverse section through brain ring, allotype, male, ZIHU 4272.

Behaviour. Fed on *P. camtschaticus* eggs *in vitro*, piercing the egg membrane with its stylet and consuming the contents of the ruptured eggs. *In vivo* feeding confirmed by frequent observations of gut contents containing crab egg yolk and eye placodes. Juvenile worms were recovered from two of 30 male and non-ovigerous female crabs collected at Juneau and Seward, Alaska. The presence of juvenile worms on hosts lacking eggs suggests that the life cycle of *Ovicides paralithodis* may be more similar to carcinonemertids such as *Carcinonemertes errans* Wickham, 1978 where worms can transfer from males to females, and from premoult to postmoult cuticles of non-ovigerous crabs (Wickham et al. 1984, Kuris 1993) than to *C. regicides* of the red king crab for which transmission only occurs among brooding female crabs (Kuris et al. 1991). A life cycle involving non-ovigerous hosts may be common among *Ovicides* spp. since Shields and Segonzac (2007) described the other known species of *Ovicides* from non-ovigerous crabs.

Ecology. The proportion of infested crabs exceeded 50 percent at 13 localities in Alaska, reaching 100 percent at five localities. At six localities the intensity of infestations exceeded 1,000 worms per pleopod (red king crabs have six egg-bearing pleopods), with the highest reported intensity at Terror Bay, Kodiak Island, >24,000 worms per pleopod (Kuris et al. 1991) (voucher specimens are deposited in the Santa Barbara Museum of Natural History, CA, USA). At most locations sampled in Alaska it co-occurred with *Carcinonemertes regicides*, but it was usually less abundant than *C. regicides*. It was the only symbiotic egg predator nemertean present on red king crabs along the Alaska Peninsula and it was rare at Cook Inlet where *C. regicides* caused up to 95% brood mortality.

Etymology. The specific name, *paralithodis*, is a noun in the genitive case, derived from the generic name of the host crustacean, *Paralithodes camtschaticus*.

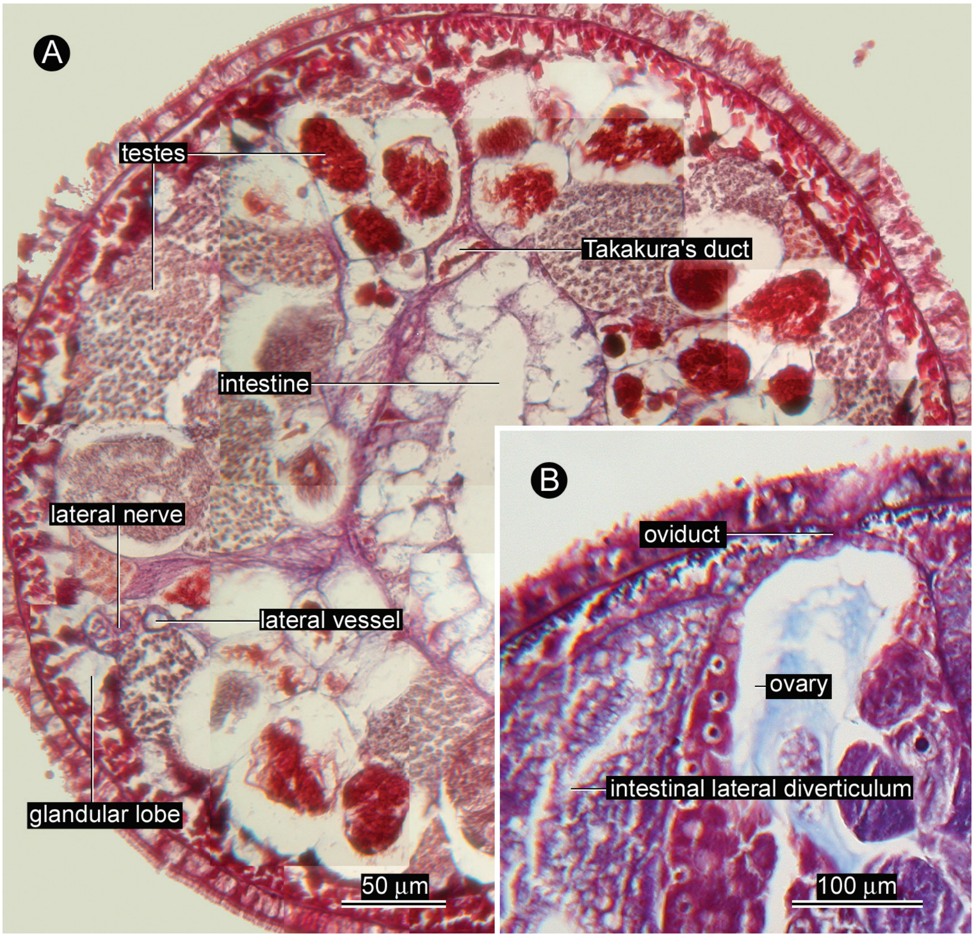

Figure 4. *Ovicides paralithodis* sp. n., photomicrographs of transverse sections through intestinal region. **A** testes and Takakura's duct, allotype, male, ZIHU 4272 **B** gonopore opening dorsally, holotype, female, ZIHU 4271.

Distribution. In addition to the type locality, the Sea of Okhotsk, off Abashiri, Hokkaido, Japan, *O. paralithodis* has been reported from Adak, Dutch Harbor, Morshovoi Bay, Pavlof Bay, Kodiak Island, Resurrection Bay, Seward, Cook Inlet and Southeastern Alaska (Barlow Cove, Deadman's Reach, Gambier Cove, and Pybus Cove, Juneau) by Kuris et al. (1991) as Form 4. The distribution of *O. paralithodis*, may generally overlap the native range of its host, *P. camtschaticus* although it is apparently absent over some large areas such as Bristol Bay and Norton Sound, Alaska. The red king crab was intentionally introduced into the Barents Sea, northern Europe, from the northern Pacific in 1961–1969 (Orlov and Ivanov 1978), and its distribution now extends westward beyond the Kola Peninsula to the Norwegian coast (Falk-Petersen et al. 2011) and north to the Svalbard archipelago (Kirby 2003). Surveys of the introduced Atlantic population of *P. camtschaticus* for epifauna and parasites

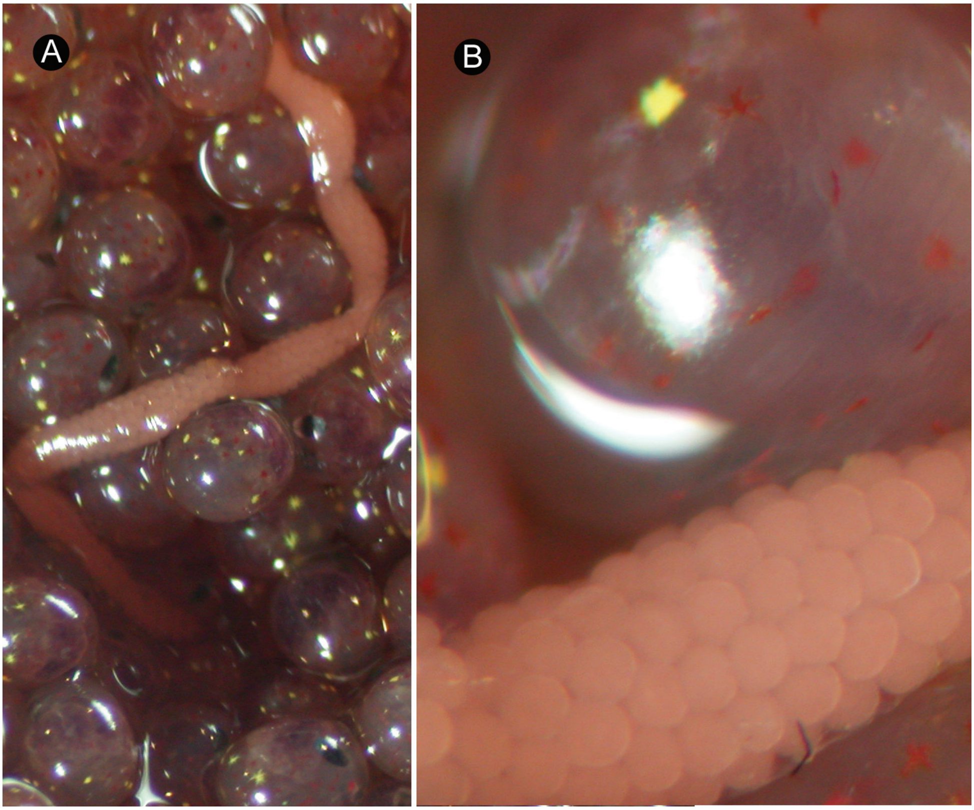

Figure 5. *Ovicides paralithodis* sp. n. **A** egg strand laid by holotype **B** magnification of **A.**

have not recovered any symbiotic egg predator nemerteans (Dvoretsky and Dvoretsky 2010, Falk-Petersen et al. 2011). Apparently the introduced crabs were not infested with these important natural enemies. This lack of infectious natural enemies may contribute to their rapid population growth and geographic expansion in the northeastern Atlantic Ocean (Torchin et al. 2003, Falk-Petersen et al. 2011).

Taxonomic remarks. Of the four currently recognised congeners in *Ovicides*, *O. paralithodis* is distinguished from *O. julieae* and *O. davidi* by the absence of eyes. *Ovicides jasoni* and *O. jonesi* are eye-less as is the new species. *Ovicides jasoni* can be distinguished from *O. paralithodis* in having densely arranged submuscular glands (Shields and Segonzac 2007, fig. 3E). *Ovicides jonesi* differs from the new species in that it lacks vacuolated glandular lobes in the precerebral region (Shields and Segonzac 2007, fig. 6B–D). The new species differs from *O. julieae* also in that the lateral vessels fuse above the oesophagus (seemingly postcerebrally, cf. Shields 2001, fig. 1) in the latter, while *O. paralithodis* has a pair of precerebral cephalic vessels, which meet above the rhynchodaeum, posteriorly passing through the cerebral ring. The markedly different habitats of the hosts (hydrothermal vents and tropical coral reef for the previously described species of *Ovicides* versus boreal continental shelf waters for *O. paralithodis*) and the very different types of hosts (brachyuran crabs versus an anomuran) add to the distinctive nature of the present species. The dorsal position of the ovarian pore in *O. paralithodis* seems to be unique in Carcinonemertidae.

Ovicides paralithodis has only been confirmed from *P. camtschaticus*. However, a similar eyeless form with accessory stylet pouches is common on tanner crab, *Chionoecetes bairdi* Rathbun, 1924 and has also been found on the Dungeness crab, *Cancer magister* Dana, 1852 in Alaskan waters (AMK, unpublished observations).

Molecular phylogeny. In the maximum-likelihood tree (*ln* L = –9804.30) (Fig. 6), *O. paralithodis* appeared as a sister taxon to the clade comprised of *C. carcinophila* (Kölliker, 1845) of Andrade et al. (2012) and *C.* cf. *c. imminuta* Humes, 1942 of Thollesson and Norenburg (2003). The clade comprised of these three species (family Carcinonemertidae) was supported by 100% bootstrap value.

Discussion

One may infer from the present tree topology that the acquisition of Takakura's duct and the loss of cerebral organs occurred in the common ancestor of the family, prior to the loss of accessory stylet pouches or stylets, which happened only in the lineage lead-

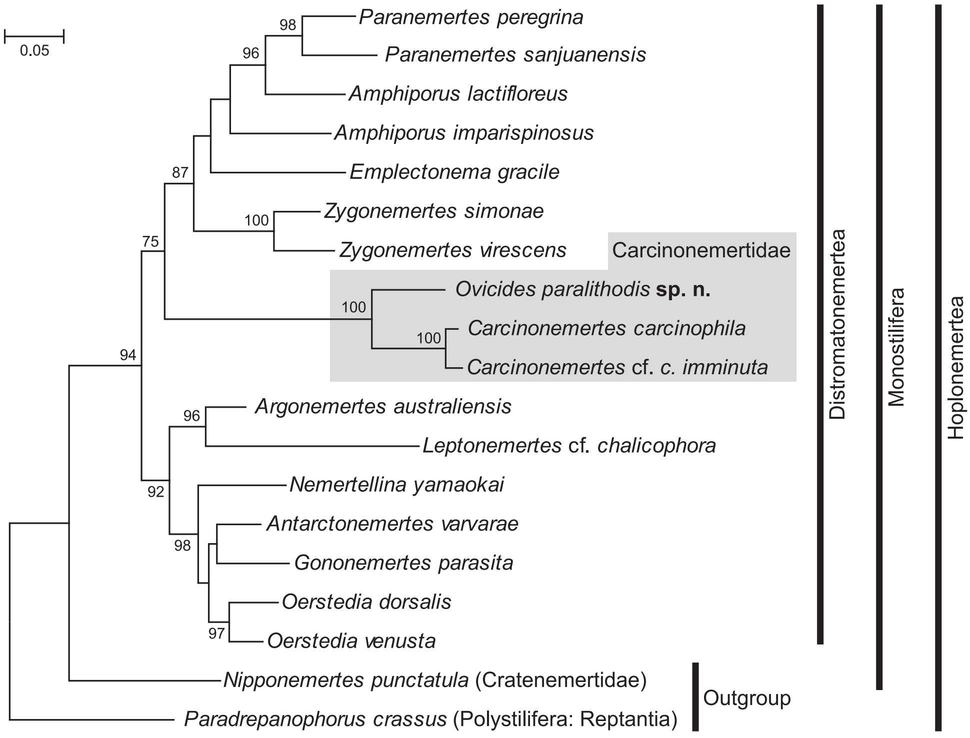

Figure 6. Phylogenetic tree resulting from maximum likelihood analysis of combined 28S rRNA and COI (*ln* L = –9804.30). Numbers above/below nodes indicate bootstrap support values >50%.

ing to *Carcinonemertes*, but not in *Ovicides*. We conclude so because 1) Takakura's duct is possessed by all carcinonemertids, and is otherwise unique in the phylum, 2) with a few exceptions, monostiliferans generally possess cerebral organs, and 3) accessory stylets and their pouches are widespread features among Hoplonemertea, including *Ovicides*, but are absent in *Carcinonemertes*. An implication of this character-evolution scenario is that the genus *Ovicides*, currently diagnosed as a nemertean egg predator having accessory stylets (a plesiomorphy for Carcinonemertidae), may not be monophyletic.

This study supports monophyly of Carcinonemertidae, in agreement with the views of Wickham and Kuris (1988) and Shields et al. (1989). In addition to the characters commonly found among carcinonemertids such as the absence of cerebral organs or the presence of Takakura's duct, Humes' (1942) original diagnosis of the family also included 1) one central stylet, 2) no accessory stylet pouches or stylets, 3) anterior proboscis chamber small and non-glandular, and 4) excretory apparatus absent. Wickham and Kuris (1988) pointed out a necessity to loosen the familial diagnosis, because their Form 4, herein described as *O. paralithodis*, did possess accessory stylet pouches (and accessory stylets) and Takakura's duct. Upon the discoveries of the excretory system in *C. regicides* and *C. epialti* Coe, 1902, as well as the large anterior proboscis chamber in *C. regicides*, Shields et al. (1989) emended the diagnosis by removing the above-mentioned four characters about stylets, anterior proboscis chamber, and excretory system. Shields et al. (1989) regarded the following five characters as diagnostic for the family: 1) symbiotic relationship with a decapod crustacean, 2) short proboscis, 3) absence of cerebral organs, 4) presence of Takakura's duct, and 5) a "rhabdocoel-like" [sic] hoplonemertean larva [i.e., planuliform larva]. But for the last character, which is not ascertained in *Ovicides*, all of these apply to *O. paralithodis*. Presence of Takakura's duct, however, is not confirmed in any other congeners, because no adults are known for *O. davidi*, *O. jasoni*, and *O. jonesi* (Shields and Segonzac 2007); as to *O. julieae*, which is a simultaneous hermaphrodite, Shields (2001: 305) stated that "Takakura's duct may be present but not observed".

The sister-taxon relationship of Carcinonemertidae among Monostilifera remains uncertain, although the search for it would have a fundamental significance in divergence-time estimates within the phylum. So far, all the carcinonemertids are symbiotic egg predators of Achelata, Anomura, and Brachyura (Jensen and Sadeghian 2005), suggesting that the ancestors of Carcinonemertidae acquired their egg-predatory life style after the host reptantic decapods split from other pleocyemates (i.e., Caridea and Stenopodidea, after Bracken et al. 2009). Fossil records indicate that a radiation of decapods occurred in Triassic–Jurassic (Schram and Dixon 2004). Therefore, carcinonemertids may also have radiated in this period at the earliest.

The position of Carcinonemertidae is likely to be susceptible to long-branch attraction. *Carcinonemertes* cf. *carcinophila imminuta* appeared as sister to all the rest of Distromatonemertea included in the analysis by Thollesson and Norenburg (2003). On the other hand, Andrade et al. (2012) showed the phylogenetic position of *C. carcinophila* was method-sensitive, being either the sister to Distromatonemertea (in direct optimization method) or nested among Distromatonemertea (in maximum likelihood and Bayesian analysis), with low nodal support values in both cases. In the present analysis, Carcinonemertidae was nested among Distromatonemertea, appearing to be more closely related to *Amphiporus* than to *Oerstedia* (Fig. 6).

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RESEARCH ARTICLE

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A redescription of *Rhysida celeris* (Humbert & Saussure, 1870), with a proposal of eight new synonyms (Scolopendromorpha, Scolopendridae, Otostigminae)

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Abstract

Seven species of the genus *Rhysida* Wood, 1862 from Venezuela and one subspecies from Peru described by Manuel Angel González Sponga and Wolfgang Bücherl respectively, are revised. *R. caripensis* González-Sponga, 2002, *R. neoespartana* González-Sponga, 2002, *R. guayanica* González-Sponga, 2002, *R. maritima* González-Sponga, 2002, *R. monaguensis* González-Sponga, 2002, *R. porlamarensis* González-Sponga 2002, *R. sucupanensis* González-Sponga, 2002 and *Rhysida celeris andina* Bücherl, 1953 are junior synonyms of *R. celeris* (Humbert & Saussure, 1870), which is redescribed and illustrated for the first time. Its geographic distribution is updated and a map showing its distribution is presented.

Keywords

Neotropic, Venezuela, Taxonomy, Chilopoda, *Rhysida*

Introduction

Rhysida is the second largest genus of the Otostigminae with circa 40 species in the Neotropics, the Indo-Malayan region and west, central and east Africa (Bonato et al. 2011). Its phylogenetic position within the tribe Otostigminae is uncertain, but Koch (1983, 1985) pointed out that *Rhysida* is closer to *Ethmostigmus* Pocock, 1898 than *Otostigmus* Porat, 1876. The Australian species of *Rhysida* were revised by Koch (1985), but the remaining species of the genus still require study. In the Neotropics, *Rhysida* is represented by 14 species and two subspecies (Minelli et al. 2006) distributed throughout Central and South America and the Greater and Lesser Antilles. Twelve species and the two subspecies are known only from the Neotropical region, however *R. immarginata* (Porat, 1876) and *R. longipes* (Newport, 1845) are widely distributed and can also be found in the Indo-Malayan and African regions. The species *R. nuda* (Newport, 1845) has been reported as occurring in the Neotropics by several authors, namely Kraepelin (1903), Attems (1930) and Bücherl (1939, 1942, 1974). It has also been recorded from Indo-Australian region and West Africa (Attems 1930), but Koch (1983) stated that this species is exclusive to Australia and that the name *R. immarginata* (Porat, 1876) appears applicable to some or even most of the overseas forms previously recorded as *R. nuda.*

In a paper on myriapods from Venezuela, González-Sponga (2002) described seven new species of *Rhysida*, and redescribed *R. longipes* based on four specimens from an urban area of Caracas. As the descriptions of the seven new species are brief and the illustration presented by González-Sponga (2002) didn't explicitly show the diagnostic features that separate the new species from *R. celeris,* known to Venezuela, their type specimens have been herein revised. *Rhysida celeris andina* from Peru is also revised. As no illustrations are known for *R. celeris* and its geographical variation is unknown, I redescribe and illustrate it for the first time. The redescription of *R. celeris* is based in 44 specimens from several localities of Antilles and Central and South Americas. This work is the first of a series that are in progress on species of Scolopendromorpha from Venezuela described by Manuel Ángel González Sponga. Repository acronyms are as follows: BMNH—Natural History Museum, London, UK; ICN—Intituto de Ciencias Naturales de La Universidad Nacional de Colombia, Bogotá, Colombia; IAVH—Colección Zoológica – Instituto de Investigación de Recursos Biológicos – Alexander Von Humboldt, Villa de Leyva, Colombia; MIZA—Museo del Intituto de Zoología Agrícola Francisco Fernández Yèpez, Maracay, Venezuela; NMNH—National Museum of Natural History, Smithsonian Institution, Washington, D. C., USA; QCAZ—Museo de Zoología de La Pontificia Universidad Católica del Ecuador, Quito, Ecuador; ZMH—Zoologisches Museum Hamburg, Hamburg, Germany; ZMUC—Natural History Museum of Denmark (Zoologisk Museum), Copenhagen, Denmark. Descriptive terminology follows Bonato et al. (2010).

Taxonomy

***Rhysida celeris* (Humbert & Saussure, 1870)**
http://species-id.net/wiki/Rhysida_celeris
Figures 1–10

Branchiostoma celer Humbert & Saussure, 1870: 202; Saussure & Humbert, 1872: 122; Kohlrausch, 1881: 69; Meinert, 1886: 183.
Rhysida celeris Pocock, 1896: 27; Kraepelin, 1903: 149 (+*R. aspera*); Attems, 1930: 188; Bücherl, 1942: 315; 1974: 119.
Trematoptychus celeris Chamberlin, 1914: 181.
Rhysida celeris andina Bücherl, 1953: 112; 1974: 119. Syn. n.
Rhysida caripensis González-Sponga, 2002: 51. Syn. n.
Rhysida neoespartana González-Sponga, 2002: 52. Syn. n.
Rhysida guayanica González-Sponga, 2002: 53. Syn. n.
Rhysida maritima González-Sponga, 2002: 54. Syn. n.
Rhysida monaguensis González-Sponga, 2002: 55. Syn. n.
Rhysida porlamarensis González-Sponga, 2002: 56. Syn. n.
Rhysida sucupanensis González-Sponga, 2002: 58. Syn. n.

Type material examined. Venezuela – ***R. caripensis*** – Holotype (MIZA0015958, ex. MAGS 680a) and paratype (MIZA0015958, ex. MAGS 680b), Edo. Monagas, Caripe, Caripe (10°12'00"N, 63°30'00"W), ix.1991, Dora Padrón de García leg.; ***R. neoespartana*** – Holotype (MIZA0015954, ex. MAGS 319a) and paratype (MIZA0015954, ex. MAGS 319b), Edo. Nueva Esparta, La Asunción, Marcano (11°02'00"N, 63°51'46"W), 1988–1989–1991, Dora Padrón de Garcia leg.; ***R. guayanica*** – Holotype (MIZA0015961, ex. MAGS 738a) and paratype (MIZA0015961, ex. MAGS 738b), Edo. Bolívar, Los Pijiguaos, Cedeño (06°35'20"N, 66°45'12"W), 01.v.1992, José Manuel Ayala leg.; ***R. maritima*** – Holotype (MIZA0015957, ex. MAGS 580a), Edo. Carabobo, Goaigoaza, Puerto Cabello (10°29'36"N, 68°02'48"W) in 19.iii.1990, and paratype (MIZA0015963, ex. MAGS 1002), Edo. Carabobo, San Esteban, Puerto Cabello, in 18.x.1998, both collected by A. R. Delgado de González & Manuel Ángel González Sponga; ***R. monaguensis*** – Holotype (MIZA0016084, ex. MAGS 970a) and paratype (MIZA0016084, ex. MAGS 970b), Edo. Monagas, Uverito, Sotillo (08°42'10"N, 63°22'00"W), 30.iv.1998, Oswaldo Fuentes leg.; ***R. porlamarensis*** – Holotype (MIZA0015953, ex. MAGS 315a and paratype MIZA0015953, ex. MAGS 315b), Edo. Nueva Esparta, Porlamar, Calle San Rafael, Porlamar (10°57'30"N, 63°51'00"W), 30.iii.1988, Carlos Contreras leg.; ***R. sucupanensis*** – Holotype (MIZA0015908, ex. MAGS 63a) and paratype (MIZA0015908, ex. MAGS 63b), Edo. Delta Amaruco, Sucupana, Casacoima (08°41'N, 61°48'W), 16.ix.1987, Pedro Delgado leg.

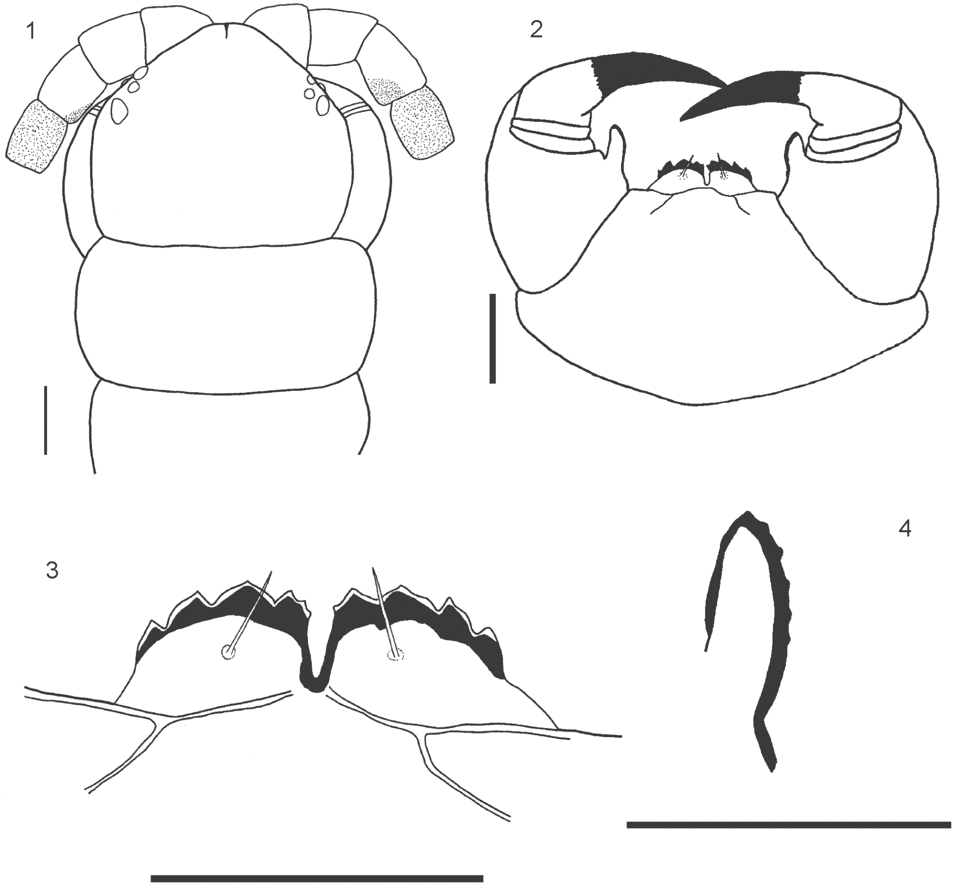

Figure 1–4. 1 *Rhysida celeris* from Ecuador. Cephalic plate **2** Forcipular Coxosternum **3** Tooth plates **4** Forcipular trochanteroprefemur process. Scale bars 1 mm.

Additional material examined. Jamaica – BMNH – 1 specimen; **Dominican Republic** – ZMH – 4 specimens, Sánchez, 5.vii.1905, C. Gagzol; ZMH – 1 specimen, Sánchez, Bay V. Samaná, xii.1894, Bock; **Haiti** – ZMH – 4 specimens, Port au Prince, 29.v.1901, Dr. Rouch; **Montserrat** – BMNH – 1 specimen, B.W.I., ii.1932; **Costa Rica** – ZMH – 1 specimen, Puerto Simón, 19.xi.1899, R. Mull; **Suriname** – ZMH – 2 specimens, Paramaribo, 28.v.1910, C. Hellesl; **Colombia** – IAVH – 1 specimen, Vichada, Cumaribo, Cgto. Santa Rita, PNN El Tuparro, 14-16-II-2004, I. Quintero, E. Gonzalez; IAVH – 1 specimen, Vichada, Cumaribo, Selva de Mataven, 31-III-02-IV-2007, L.E. Franco; IAVH – 1 specimen, Vichada, Gaviotas, 31-VI-1995; IAVH – 1 specimen, Caquetá, Solano, PNN Chiribiquete, 24-26-II- 2000, M. Ospina & E. González; ICN-M.Ch-0005, 1 specimen, Amazonas, Leticia, Via Torame, X-2000, Sist. Animal; ICN-M.Ch-0035, 1 specimen, Sucre, San Onofre, Boca cerrada, canal del dique, 1-IV-2000, E. Ulloa; ICN-M.Ch-0037, 1 specimen, Sucre, Galeras, Vereda corozera, 14-I-1999, E. Hernández; ICN-M.Ch-0039, 1 specimen, Meta, Vereda

Apiay, sector el bosque villa Lolé , 23-XII-2001, M. Rojas; ICN-M.Ch-0097, 1 specimen, Casanare, Aguazul, Vda. El Charte, Finca Namaste, 20-IX-1996, Estudiantes Biol UN; ICN-M.Ch-0100, 1 specimen, Tolima, San Luis, 13-VI-1992, A. Castillo; ICN-M.Ch-0136, 1 specimen, Meta, San Martin, 1–15 -IV-2011, W. Galvis; ICN--M.Ch-0138, 1 specimen, Vaupés, Est. Biol. Caparù, 2002–2004, J. Pinzón; **Ecuador** – QCAZ – 3 specimens, Francisco Orelanna, La Joya de Los Sachas, 3.vi.2006, J. Mideros; QCAZ – 1 specimen, Francisco Orelanna, PN Yasumi, M.J. Tamariz; QCAZ – 1 specimen, Napo, Tena, 19.ix.2004; **Argentina** – ZMUC – 11 specimens, Riacho del Oro, 17.06.1899, W. Sorensen; ZMUC – 2 specimens, 19.08.1895.

Diagnosis. General body color light blue or olive green, sternites and legs light blue or yellowish; prefemur and femur of the ultimate legs light blue, sometimes tibiae and tarsi are pale. Antennae with 17 to 21 articles, first two articles, dorsal surface and ¾ of ventral surface of third articles glabrous. Cephalic plate smooth, without sutures or depressions; tooth plates wider than high, 4+4, 4+5 or 5+5 teeth. Tergites smooth; complete paramedian sutures present from tergites 3–5 to 19–20, margination from tergites 5–9 to 21. Posterior border of tergite 21 ending in an obtuse angle. A pair of spiracles at 7th leg -bearing segment. Sternites 2, 3 or 4 to 19 with anterior incomplete paramedian sutures, but without depressions. Coxopleuron not prolonged, very short process with two small apical spines. Legs 1 to 16 (or 17) or 2 to 18 (sometimes 17) with two tarsal spurs, 19 (or 20) with one and 21 without; ultimate legs long, prefemur without spines.

Redescription. Body length from 40 to 70 mm. General body color light blue or olive green, sternites and legs light blue or yellowish; prefemur and femur of the ultimate legs light or dark blue, but sometimes tibia and tarsi are pale or light blue. Antennae with 17 to 21 articles, first two and dorsal surface and ¾ of the ventral surface of the third article are glabrous; antennae reaching the posterior margin of tergite 5. Cephalic plate smooth, with a median sulcus but without sutures or depressions (Fig. 1), wider than long. Anterior margin of cephalic plate right-angled, with four ocelli in each side, posterior margin slightly rounded (Fig. 1). Forcipular coxosternum without depressions (Fig. 2); tooth plates with 4+4, 4+5 or 5+5 teeth; the inner two teeth are closer to each other than to the external teeth (Fig. 3). Each tooth plate with a long seta in the center; the tooth plates with obtuse angled basal suture. Trochanteropreforal process well-developed, long and ending as a point, with three to five denticles laterally, these sometimes not visible (Fig. 4). Tergites smooth, wider than long. Tergite 1 without sutures, its anterior border overlapping the posterior border of the cephalic plate. Tergites 3–5 to 19–20 with complete paramedian sutures (Fig. 5). Tergites 5 to 21 marginate, usually from tergite 11 (Fig. 5), but sometimes also from tergite 16. The margination is clearly visible in the anterior part of the tergites; tergite 21 with a slight posterior depression and triangular posterior margin (Fig. 7). A pair of spiracles on the 7th leg -bearing segment. Sternites smooth, wider than long. Sternites 2 (4)-19 with short incomplete anterior sutures (Fig. 6). However, sometimes, they are overlapped by the posterior margin of the previous sternite and visible only at sternites 5–18. Sternite 21 longer than wide; converging caudad and with straight or slightly concave posterior margin (Fig. 8). Coxopleural pores of several sizes, and numerous; the pore-field occupies nearly all surface of

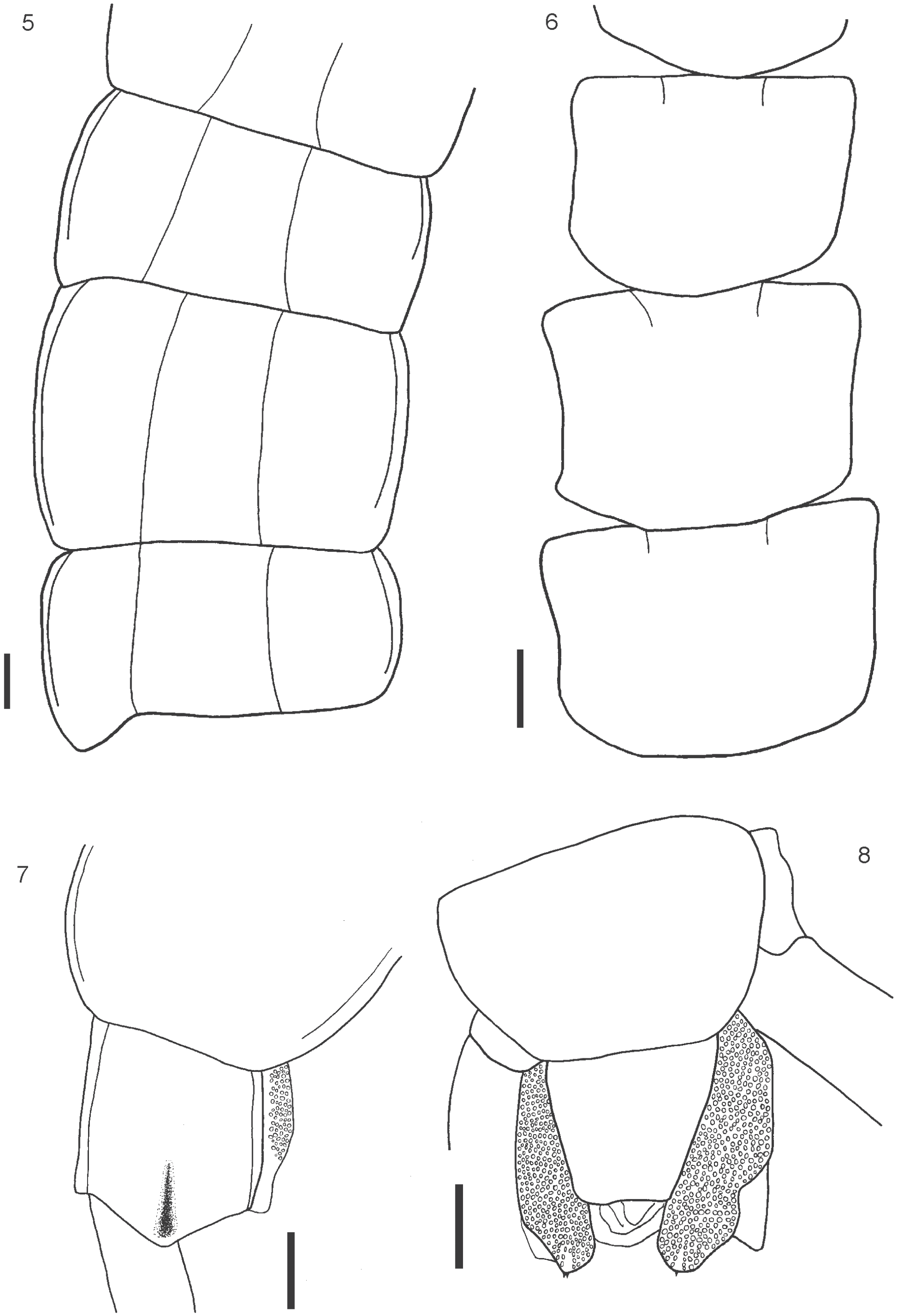

Figure 5–8. 5 Tergites 11, 12 and 13 **6** Sternites 4, 5 and 6 **7** Tergite 21 **8** Segment 21 showing sternite 21 and coxopleuron. Scale bars 1 mm.

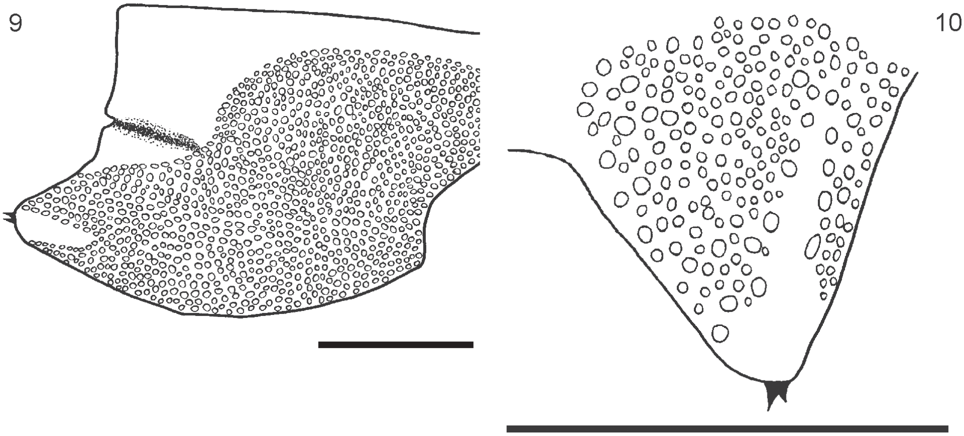

Figure 9–10. 9 Segment 21 showing the coxopleuron **10** Detail of the terminal part of the coxopleuron showing the spines. Scale bar 1 mm.

coxopleuron except for its dorsal and posterior parts, which are free of pores, posterior part of coxopleuron with a longitudinal depression (Fig. 9); very short coxopleural process with two apical spines (Fig. 10); apical spines may be combined as 1+2 or 2+3. Leg 1 with one femoral spur and legs 1 and 2 with one tibial spurs; legs 1 to 16, 17 or from 2 to 18 with two tarsal spurs, 19 and 20 with one and 21 without. Sometimes legs 20 lack spurs. Pretarsi of all legs with two accessory spines. Ultimate legs long and slender (12 mm to 22 mm). Prefemur without spines.

Taxonomic remarks. Except for *R. maritima* where the holotype and paratype were separated and given different numbers (e.g., holotype, MAGS 580a, and, paratype, MAGS 1002), the type specimens of all other species described by González-Sponga (2002) were left united and were labeled with identical numbers (e.g., holotype, MAGS7400, and a paratype, MAGS740b). The acronym MAGS in the collection numbers stands for 'Manuel Ángel Gonzalez Sponga' and indicates that the specimens belong to his private collection, which after his death was transferred to the myriapodological collection of Museo del Intituto de Zoología Agrícola Francisco Fernández Yèpez, Maracay, Venezuela. The type series of *R. caripensis*, *R. neoespartana*, *R. monaguensis* and *R. porlamarensis* consists of more than two specimens. The recognition of the holotype is only possible by measuring the total body length, cephalic plate and ultimate legs and by checking them against the original publication (González-Sponga 2002).

The results of the review of the type-material described by González-Sponga (2002) are summarized in Table 1. The type of *R. celeris andina* was not examined, but all characters (number of antennal articles, complete paramedian sutures and the margination of the tergites, sternite sutures, forcipular tooth-plates and tarsal spurs) fall within the intraspecific variation found in *R. celeris*. Therefore, *R. celeris andina* was also included in this revision, but the proposed synonymy is based solely on critical analysis of the published information (Bücherl 1953).

Table 1. Characters of the species considered in this study. Information based on personal examination of types and original data (in parentheses) as published by González-Sponga (2002) and Bücherl (1939, 1953). ? = not described.

	R. caripensis	*R. neoespartana*	*R. guayanica*	*R. maritima*	*R. monaguensis*	*R. porlamarensis*	*R. socupanensis*	*R. celeris andina*
Numbers of antenna articles	19, (20) and 21	(17), 19, 20, and 19+20	18, 19, 20 and (21)	19, (20-21) and , 21	18, (19), 20 and 21	19, 20, 19+20 (17)	20, (Not described)	(20)
Complete paramedian sutures on tergites	3 to 20 (3 to 20)	3 to 20 (2-3 to 20)	3 to 20 (3 to 20)	4 to 20 (4 to 20)	7 to 20 (7 to 20)	5 to 20 (5 to 20)	3 to 20 (3 to 20)	(6 to ?)
Marginate tergites	13 to 21 (16 to 21)	16 to 21 (Posterior tergites)	14 to 21 (Posterior tergites)	16 to 21 (Posterior tergites)	17 to 21 (Posterior tergites)	18 to 21 (Posterior tergites)	15 to 21 (16 to 21)	(16-19 to 21)
Incomplete sternite paramedian sutures	2 to 18 (Without)	1 to 18 (Without)	2 to 18 (Without)	4 to 17 (Without)	3 to 17 (Without)	3 to 18 (Without)	2 to 18 (Without)	(1 to 20)
Tooth plates	4+5 (5+5)	(4+4) 5+5	4+4, 4+5 and 5+5 (Not described)	4+4 (4+4)	(3+3), 4+4, 4+5 and 5+5	4+4, 4+5 and 5+5 (Not described)	5+5 (5+5)	(0+5 (damage))
2 spurs on tarsus 1 of legs	1 to 17 and 18 (Not described)	1 to 16, 17 and 18 (Not described)	2 to 17 (Described only to leg 2)	1 to 18 (Not described)	1 to 18 (On all legs)	1 to 18 (On all legs)	1 to 18 (Not described)	(1 to 19)
1 spur on tarsus 1 of legs	18, 19 and 20 (Not described)	17, 18, 19 and 20 (Not described)	1, 19 and 20 (Described only to leg 1)	19 and 20 (Not described)	19 and 20 (Not described)	19 and 20 (Not described)	19 and 20 (Not described)	(20)
No tarsal spurs on legs	21 (21)	21 (21)	21 (21)	21 (21)	21 (21)	21 (21)	21 (21)	(21)
Terminal spines on coxopleura	2 (1)	2 (2)	2 (2)	2 (2)	1+2, (2) and 2+3	1+2 (2)	2 (2)	(1)
Distribution	Venezuela	Venezuela	Venezuela	Venezuela	Venezuela	Venezuela	Venezuela	Peru

His descriptions are based only on the holotypes, and he did not describe the variation of some characters, such as the number of antennal articles, the distribution of paramedian sutures and the margination of tergites and the number of teeth of forcipular tooth-plates. For example, complete paramedian sutures are present in all of the González-Sponga's (2002) species, however, the distribution of sutures vary. The complete paramedian sutures on tergite 3 are not as evident as on tergite 4, but the sutures always end at tergite 20. The number of teeth in forcipular tooth-plates also vary from 3+3 to 5+5.

Two other important characters that were omitted or were poorly described by González-Sponga (2002) are the incomplete paramedian sutures on the sternites and the distribution of tarsal spurs on the legs. The incomplete paramedian sutures were not mentioned in his paper, although they are clearly visible from sternites 1 to 18, being more evident on sternites 6-15. The tarsal spurs were only described for *R. guayanica*, *R. monaguensis* and *R. porlamarensis*, but their distribution were not indicated.

Rhysida celeris was originally described from 'Carolina' (Humbert and Saussure 1870, Saussure and Humbert 1872, Underwood 1887) and later on recorded also from Georgia, USA (Pocock 1893, Kraepelin 1903, Attems 1930). Crabill (1960) stated that the North American records were not corroborated, and Shelley (2002) deleted *R. celeris* from the list of Scolopendromorpha of United States. Carolina is a common toponym in several countries in the Neotropical region. It exists in Puerto Rico, Cuba, Colombia (in the departments of Cesar, Antioquia and Magdalena), in Ecuador (in the departments of Guayas and Imbabura) and in Brazil. There is also a state of Carolina in the U.S. Virgin Islands, and also "La Carolina" in both, Mexico and Argentina. I did not examine the holotype of *R. celeris*, but it is hosted (in alcohol) at the Myriapodological collection of Museum of Natural History of Genève, Switzerland. The specimen is labeled "*Branchiostoma celer* Humbert & Saussure, type, from Caroline". A second label reads "revision R. E. Crabill, back 1970" (Peter Schwendinger, personal communication). I do not know any other additional information on the type locality, therefore, the exact whereabouts of the type locality remains uncertain. However, it is more likely that the specimen had been collected somewhere in Antilles, Central or South America rather than in the USA.

Distribution. Jamaica, Dominican Republic, Haiti, Nicaragua (Meinert 1886), Venezuela (Bücherl 1942, 1959), Mexico (Kraepelin 1903, Attems 1930, Bücherl 1942), Bolivia (Silvestri 1897), Argentina (Bücherl 1942), Brazil (Kraepelin 1903, Attems 1930, Bücherl 1942, Schileyko 2002), Colombia (Chamberlin 1921), Ecuador, Peru (Bücherl 1950, Kraus 1957), Suriname and Paraguay (Silvestri 1895).

Discussion

After reviewing the type material of the genus *Rhysida* described by González-Sponga (2002), it was verified that *R. caripensis*, *R. neoespartana*, *R. guayanica*, *R. maritima*, *R. monaguensis*, *R. porlamarensis* and *R. sucupanensis* are junior synonyms of *R. celeris*.

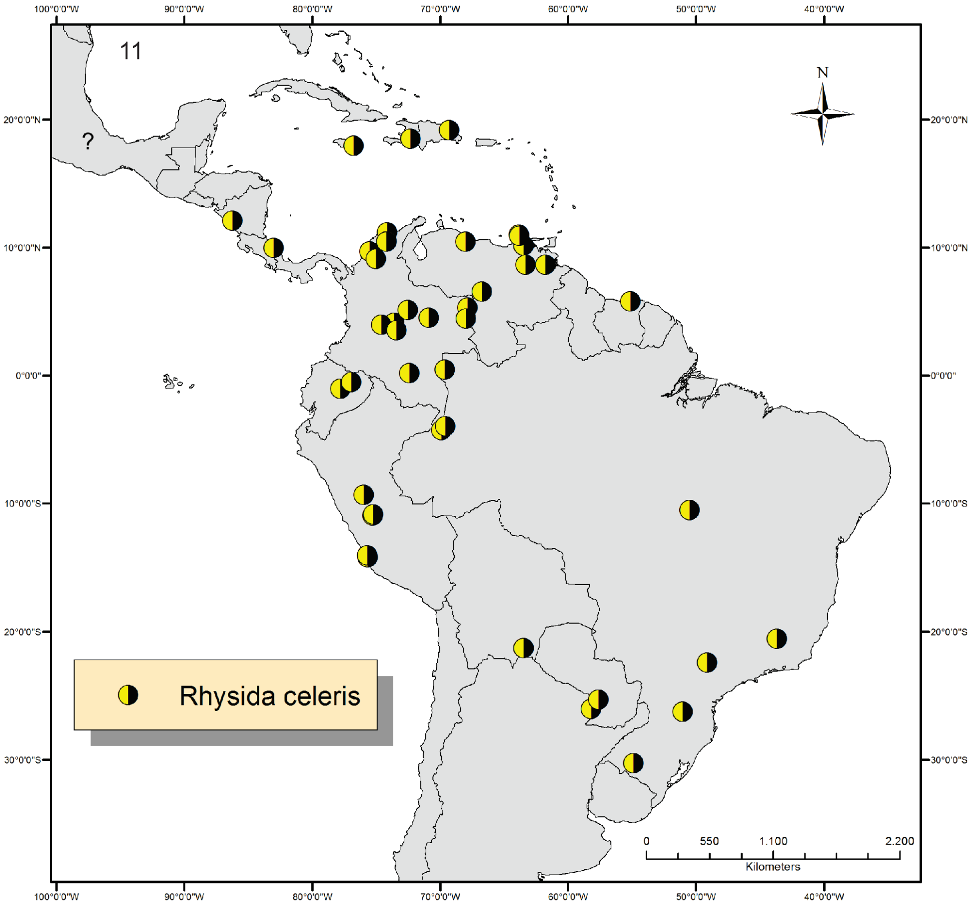

Figure 11. Map showing the distribution of *Rhysida celeris* in the Neotropical Region. Question mark indicates unspecified locality in Mexico.

Rhysida celeris andina described by Bücherl (1953) is also considered to be junior synonym of *R. celeris*.

All taxa analyzed in this study are conspecific with *R. celeris* which is redescribed and illustrated based on specimens from the Antilles, Central and South America. The characters used to determine *R. celeris* and their variation are summarized in Table 2. *R. celeris* is the most widespread species of the genus in the Neotropical Region and is found from the sea level up to1250 meters in the mountains. The species is herewith recorded from the Dominican Republic, Haiti, Montserrat, Suriname and Ecuador for the first time (Fig. 11). Morphologically, *R. celeris* is close to *R. brasiliensis* Kraepelin, 1903, but differs from the latter by having complete paramedian sutures on segments 3-19/20 (vs. incomplete and short ones on segments 4-19 in *R. brasiliensis*;) shorter ultimate legs (18–22 mm vs. 20–32 mm in *R. brasiliensis*). With present paper, the

Table 2. Characters of *Rhysida celeris* showing the geographical variation.

	R. celeris	***R. celeris***	***R. celeris***	***R. celeris***
Numbers of antennal articles	17 to 21	18 to 21	17 to 21	19 to 20
Complete paramedian sutures on tergites	3 to 20	4 to 19	4 (5) to 19	3, 4 or 5 to 20
Marginates tergites	13 (14) to 21	5 to 21	10, 11, 12, 13 to 21	16 to 21
Incomplete paramedian sutures on sternites	3 (4) to 18 (19)	4 to 19	4 to 19	2, 3 or 4 to 19
Coxosternal Teeth	4+4, 4+5 and 5+5	4+4, 4+5 and 5+5	4+4, 4+5 and 5+5	4+4, 4+5 and 5+5
2 spurs on tarsus 1 of legs	1 to 16 (17 or 18)	1 to 19 or 2 to 20	2 to 18	1 to 18
1 spur on tarsus 1 of legs	19 and 20	1, 19 and 20	19 and 20	19
No tarsal spurs on legs	21	20 and 21	21	20 and 21
Terminal spines on coxopleura	1, 2 or 3	2	2	2
Specimens studied	Venezuela	Colombia	Ecuador	Costa Rica, Jamaica, Dominican Republic, Haiti, Montserrat, Suriname, and Argentina

valid species of *Rhysida* in the Neotropical Region were reduced to seven, of which five indigenous (*R. celeris*, *R. brasiliensis*, *R. rubra* Bücherl, 1939, *R. riograndensis* Bucherl, 1939 and *R. chacona* Verhoeff, 1944) and two introduced (*R. immarginata* and *R. longipes*). Both, *Rhysida riograndensis*, from southern Brazil, and *R. chacona*, from Paraguay, resemble in many aspects *R. celeris*, but the lateral tergal margins are absent in both species. As the presence of lateral margins is considered an important character in Neotropical *Rhysida* and since I have not seen yet the type-material of these two species, I prefer to keep them as a valid species.

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RESEARCH ARTICLE

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Initial responses of rove and ground beetles (Coleoptera, Staphylinidae, Carabidae) to removal of logging residues following clearcut harvesting in the boreal forest of Quebec, Canada

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Abstract

Increased interest in biomass harvesting for bioenergetic applications has raised questions regarding the potential ecological consequences on forest biodiversity. Here we evaluate the initial changes in the abundance, species richness and community composition of rove (Staphylinidae) and ground beetles (Carabidae), immediately following 1) stem-only harvesting (SOH), in which logging debris (i.e., tree tops and branches) are retained on site, and 2) whole-tree harvesting (WTH), in which stems, tops and branches are removed in mature balsam fir stands in Quebec, Canada. Beetles were collected throughout the summer of 2011, one year following harvesting, using pitfall traps. Overall catch rates were greater in uncut forest (Control) than either stem-only or whole-tree harvested sites. Catch rates in WTH were greater than SOH sites. Uncut stands were characterized primarily by five species: *Atheta capsularis, A. klagesi, A. strigosula*, *Tachinus fumipennis/frigidus* complex (Staphylinidae) and to a lesser extent to *Pterostichus* *punctatissimus* (Carabidae). Increased catch rates in WTH sites, where post-harvest biomass was less, were attributable to increased catches of rove beetles *Pseudopsis subulata*, *Quedius labradorensis* and to a lesser extent *Gabrius brevipennis*. We were able to characterize differences in beetle assemblages between harvested and non-harvested plots as well as differences between whole tree (WTH) and stem only (SOH) harvested sites where logging residues had been removed or left following harvest. However, the overall assemblage response was largely a recapitulation of the responses of several abundant species.

Keywords

Biomass removal, tree harvesting, boreal forest, Coleoptera, Staphylinidae, Carabidae

Introduction

Increased interest in the use of forest biomass for bioenergy production has been met with concerns related to potential negative impacts of increased biomass harvesting on biodiversity (Abbas et al. 2011, Berch et al. 2011). Relative to forest harvesting for traditional wood products such as veneer, lumber and pulp, biomass harvesting relies on exploiting a larger diversity of biomass feedstock sources, such as previously non-commercial trees and/or parts of trees. Increased use of a greater variety of biomass feedstock sources including logging residues (i.e. tree tops and branches from harvested trees) will likely reduce potential sources of deadwood and may have direct and indirect ecological repercussions for biodiversity (Stokland 2001).

Litter dwelling beetles have been recognized as useful indicators of forest change and ecosystem functioning (Rainio and Niemelä 2003, Niemelä 2000, Pohl et al. 2007). In some cases, reductions in deadwood have negative effects, particularly on species that are closely associated with deadwood as a developmental substrate for larvae or as a food resource (Siitonen 2001, Martikainen and Kouki 2003, Simila et al. 2003, Jonsson et al. 2005, Work and Hibbert 2011). For certain saproxylic species, reductions in deadwood stemming from forest management, and presumably from biomass harvesting, result in the direct loss of a necessary resource (Jonsell and Weslien 2003, Johansson et al. 2007). For other organisms, such as leaf litter invertebrates, which may possess broader habitat and feeding preferences, evidence for the relation with volumes of woody debris has been limited or not yet well documented (Pearce et al. 2003, Work et al. 2004) or absent (Pearce et al. 2004, Paradis and Work 2011). Reductions in deadwood volume following biomass harvesting could affect leaf litter invertebrates in multiple, non-exclusive ways. Residual deadwood could serve as an important microhabitat that buffers organisms from the increased temperature and reduced humidity that often accompanies the removal of the overstory canopy (Pearce et al. 2003). In this way, deadwood may only become a critical habitat for leaf litter organisms after overstory removal, and would not necessarily be detected in studies where volumes of woody debris between treatments are not drastically different. As many leaf-litter invertebrates are characterized as generalist predators, loss of deadwood caused by biomass harvesting could also signify a loss of potential prey items and possibly truncation of food webs (Komonen et al. 2000).

Such responses would likely only be observed through longer-term biomonitoring efforts, whereby any initial reorganization of species assemblages following removal of the overstory could be separated from later community-level effects resulting from debris removal. However, long-term responses of invertebrate assemblages to deadwood will likely be dependent on the initial species filtering that occurs immediately following harvest.

Here we present initial responses of rove and ground beetles to removal of logging residues following clearcut harvesting. As with any study examining a relatively high number of species, we expected to observe a variety of species-specific responses. However as an initial starting hypothesis, we speculated that removal of forest overstory combined with removal of residual forest biomass in the form of logging debris would result in lower abundances of individual species compared with sites where only overstory was removed. We further expected that these would translate to overall assemblage-level differences between harvested sites where additional biomass had been removed and sites that had experienced only clearcut harvesting.

Methods

Sampling sites

We sampled beetles using pitfall traps within the Montmorency Teaching and Research Forest (47°13' and 47°22'N, and 71°05' and 71°11'W) approximately 70 km north of Quebec City, Quebec (Fig. 1). This project is part of a long-term national study on monitoring of the effects of biomass harvesting on forest ecosystem functioning (Thiffault et al. 2011a, Venier at al. 2012). This site is part of a 60-year-old boreal balsam fir/white birch dominated forest in the Laurentian Mountains. The experimental layout was a randomized block design, with four replicates of the following treatments: 1) conventional stem-only harvesting (SOH) (Fig. 2), where all trees with a diameter at breast height (dbh) greater than 9.1 cm were felled, delimbed and topped at the stump and only the stems hauled to the roadside and non-merchantable material such as tops and branches were left distributed evenly throughout the site, 2) whole-tree harvesting (WTH) (Fig. 2), that is, felling of trees with a dbh of 9.1 cm and greater and hauling of stems, tops and branches to the roadside, and 3) uncut forests (Control) (Fig. 2). Treatments were randomly assigned to each experimental plot within a block. Permanent sampling plots were established in each block and consisted of circular plots with a radius of 20 m and situated within 40 × 40 m blocks (Thiffault et al. 2011b). In each circular subplot, three pitfall traps were installed at distances of 10 to 12 m from the centre of the plot, except in two control plots in which six traps were installed in transect configurations spaced at the same distance as in the treatment plots. We used a greater number of traps in control plots to better account for the larger diversity of microhabitats and species in the uncut forest immediately surrounding the experimental plots.

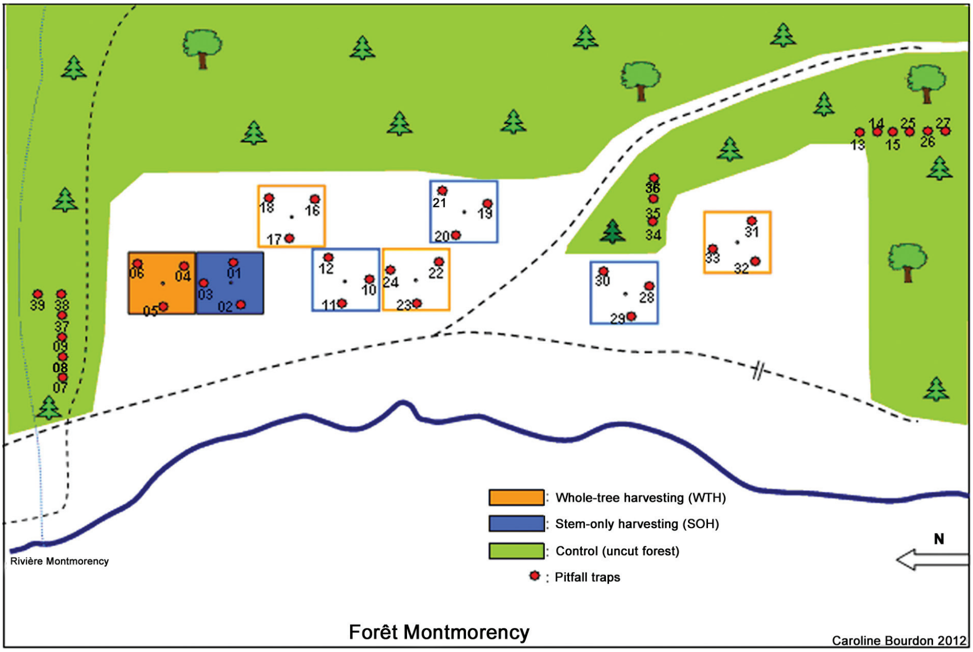

Figure 1. Schematic representation of treatments with pitfall trap locations, Forêt Montmorency, Quebec.

Figure 2. Photographs of experimental plots taken one year following harvest (2012) **A, B** photos of uncut forests (Control) **C** stem-only harvested plot (SOH) (operational level) **D** whole-tree harvested plot (WTH).

Estimating woody debris volume

Woody debris volumes were estimated from two 20-m-long perpendicular transects intercepting the centre of each plot using the line intersect method (Thiffault et al. 2011b). Two categories of debris were counted: (1) fine woody debris (FWD), defined as debris from 1.1 to 3 cm in diameter; (2) coarse woody debris (CWD), which includes debris greater than 3 cm in diameter. FWD was counted for the first and the last 5-m section of each transect. The total number of pieces in each 5 m section was tallied. For CWD, the diameter was recorded for each piece along the whole length of the transects.

Beetle sampling

We used commercially produced pitfall traps 12 cm in diameter (Bio-Control Inc., Quebec City) with rain covers spaced 10-15 m apart (see details of trap design in Klimaszewski et al. 2007). As a killing solution in pitfalls we used 70% ethanol with a few drops of commercially available vinegar to prevent muscle stiffness when mounting specimens. Beetles were collected continuously between June 9 and August 25, 2011. We emptied traps approximately every week during this period. The number of traps was not identical between experimental parcels. In all harvested stands, three pitfall traps were used. For uncut plots, we used three traps in one replicate, and six traps in the remaining two uncut plots. All beetles were sorted by specialist technicians and in the case of rove beetles, mounted and dissected as needed prior to identification. All rove beetles were identified by J. Klimaszewski, and ground beetles by Y. Bousquet. Most aleocharine staphylinid specimens were verified using genitalic characters. Colour images of the most abundant rove and ground beetle species and the lists of all species per family are shown in the Appendix (Figs 7, 8, Tables 4, 5).

Statistical analysis

Debris volumes for both small and coarse woody material were compared separately among treatments using linear models where the stem-only harvesting (SOH) treatment was chosen as a reference. Abundances were converted to catch rates to account for differences in trapping effort between sites, which varied due to infrequent disturbances to particular traps by vertebrates over the course of the sampling season and the total number of traps placed within each experimental parcel. Abundances at individual traps were pooled to calculate catch rates for each experimental plot. Thus in harvest plots, catch rates reflect the combined trapping effort of three traps over the course of the season (231 trap days/plot). The number of traps per control plot varied between 3 and 6, corresponding to 203 and to 462 total trap days. We compared overall catch rates among silvicultural treatments using simple linear regression where total catch rate was square root transformed to meet assumptions of normality. We also compared catch rates of the 19 most abundant species (those that comprised more than 2% of the total catch rate) among treatments using non-parametric Kruskal-Wallis rank sum tests.

We analyzed differences in beetle species composition using multivariate regression tree (MRT) analysis (De'ath 2002). Multivariate regression trees are used to classify objects (typically sample sites) by maximizing the deviance between splits based on explanatory variables (typically environmental or treatment variables). This method makes a few assumptions regarding the underlying relationship between species and environmental variables and also provides the advantage of visualizing complex interactions among environmental variables (De'ath 2002). For our analysis we used the same matrix of square-root transformed catch rates to create a sum of squares regression tree. We chose a final tree based on a 1000 fold cross-validation procedure. A final tree with two splits was selected 934/1000 times. We used R (2.12.2) for all statistical analysis.

Results

Volumes of both fine and coarse debris were higher in clearcuts following harvest as compared with uncut stands (fine debris ANOVA $F_{2,8}$=12.73, P=0.003, coarse debris ANOVA $F_{2,8}$=8.12, P=0.011; Fig. 3). Whereas volumes of fine debris were greater in clearcuts, there was no difference in FWD volumes between stem-only and whole-tree harvested plots (β=-0.06 (0.35), Wald t-value = -0.173, p= 0.867). For coarse debris (CWD), whole-tree harvested plots had reduced volumes as compared with stem-only harvested plots (β=-34.20 (17.74), Wald t-value = -1.927, p= 0.090), although these differences could only be characterized as nearly significant with alpha = 0.05.

We collected 70 species of rove and ground beetles representing 1665 individuals between June 9 and August 25, 2011 (Appendix Tables 4 and 5). Of the total number of individuals collected, 1278 (53 species) were rove beetles and 387 (17 species) were ground beetles (Table 1). Harvesting reduced overall catch rates in both SOH sites (β=-0.33 (0.041), Wald t-value= -8.01, p<0.001) and WTH (β=-0.14 (0.041), Wald t-value= -3.39, p=0.009) as compared with control stands (ANOVA $F_{2,8}$=33.15, P<0.001) (Fig. 4). The high overall abundances in uncut stands is attributable to three species of *Atheta* (*A. capsularis, A. klagesi* and *A. strigosula*), *Tachinus fumipennis/frigidus* complex and to a lesser extent *Pterostichus punctatissimus* (Table 2, Fig. 5). Increased catch in whole-tree harvested plots was observed for three species: *Pseudopsis subulata*, *Quedius labradorensis* and to a lesser extent *Gabrius brevipennis* (Table 2, Fig. 5). With the exception of these species, we were unable to detect statistically significant differences in catch rates between whole-tree and stem-only harvested plots.

The sum-of-squares multivariate regression tree divided 11 sites into three nodes which explained 64.5% of the total variance (Table 3, Fig. 6). The initial split explained 46.5% of the variance. This split is attributable to either the treatment difference between uncut and harvested sites or sites that had more than 9 m^3/ha fine woody debris, both of which offered equal improvement for the multivariate regression tree (improve-

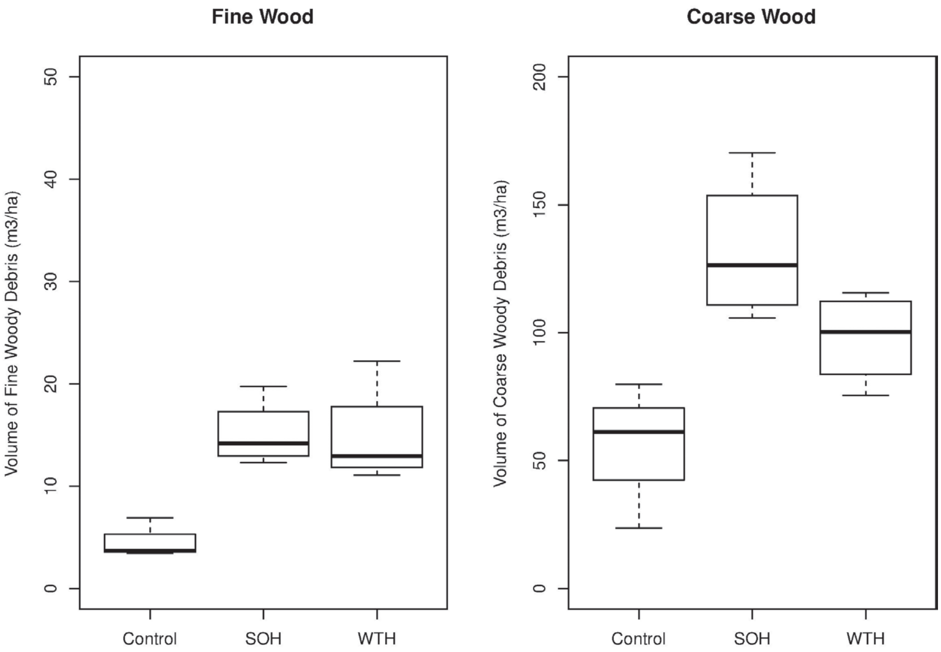

Figure 3. Boxplots showing volume of fine and coarse woody debris in stem-only harvested plots (SOH), whole-tree harvested plots (WTH), and in uncut forest (Control). Bold line depicts median value, box denotes 25–75% quantile range, whiskers correspond to 1.5 times the interquartile range.

Table 1. Abundance of beetle species in dead wood reduced plots (WTH), and in deadwood intact plots (SOH), and in uncut forest (Control). Rove and ground beetle species mixed and listed alphabetically.

Species	WTH	SOH	Control
Acidota quadrata	0	0	1
Agonum gratiosum	0	0	1
Agonum retractum	0	0	3
Aleochara sp. n.	1	1	0
Aleochara verna	0	1	0
Aleochara fumata	1	0	0
Atheta ventricosa	2	2	15
Atheta regisalmonis	0	0	1
Atheta remulsa	0	1	1
Atheta terranovae	0	0	3
Atheta (Microdota) sp.	1	0	1
Atheta klagesi	4	7	52
Atheta capsularis	40	31	334
Atheta sp.	1	0	1
Atheta strigulosa	1	0	66
Atrecus macrocephalus	10	17	3
Bembidion grapii	2	0	0
Bembidion wingatei	7	5	6
Bisnius cephalicus	1	1	1
Calathus advena	0	1	1

Species	**WTH**	**SOH**	**Control**
Calathus ingratus	19	4	12
Eusphalerum pothos	0	0	1
Gabrius brevipennis	29	16	2
Gabrius sp.	0	1	0
Harpalus laticeps	0	1	0
Harpalus rufipes	4	0	0
Harpalus solitaris	3	0	0
Ischnosoma fimbriatum	33	25	12
Ischnosoma pictum	5	3	1
Lathrobium washingtoni	1	2	0
Leptusa opaca	1	0	0
Liogluta aloconotoides	9	0	11
Lordithon fungicola	0	1	0
Lypoglossa franclemonti	27	12	1
Megarthrus sp.	0	0	1
Mocyta breviuscula	0	0	3
Mocyta fungi	0	1	0
Mycetoporus americanus	5	3	13
Mycetoporus consors	0	2	0
Omalium rivulare	0	1	0
Oxypoda frigida	1	1	1
Oxypoda grandipennis	0	1	18
Oxypoda lacustris	0	0	3
Oxypoda operta	1	0	0
Oxypoda pseudolustrica	8	5	2
Phloeostiba lapponica	7	2	0
Placusa incompleta	0	0	2
Platynus decentris	1	2	7
Proteinus sp.	2	1	3
Pseudopsis subulata	109	32	40
Pterostichus adstrictus	91	47	52
Pterostichus brevicornis	1	0	1
Pterostichus coracinus	24	19	30
Pterostichus punctatissimus	6	5	17
Quedius densiventris	14	1	5
Quedius fulvicollis	4	0	1
Quedius labradorensis	9	2	10
Quedius plagiatus	0	1	0
Seeversiella globicollis	3	2	0
Sphaeroderus nitidicollis	0	1	1
Stenus austini	2	0	0
Tachinus fumipennis	6	4	120
Tachinus luridus	0	1	1
Tachinus quebecensis	0	0	11
Tachyporus nitidulus	9	5	1
Tachyporus sp.	1	1	0
Trechus apicalis	5	5	1
Trechus crassiscapus	0	1	1
Zyras obliquus	0	0	1

Table 2. Kruskal-Wallis comparison of abundant rove and ground beetle species that responded to harvest.

Species	Kruskal-Wallis Chi-Square	df	p-value
Negatively Affected by Harvesting			
Atheta capsularis	6.13	2	0.047
Atheta klagesi	6.18	2	0.046
Atheta srigulosa	8.29	2	0.016
Tachinus fumipennis	6.78	2	0.034
Pterostichus punctatissimus	6.51	2	0.039
Positively Affected by Harvesting			
Pseudopsis subulata	7.00	2	0.030
Quedius labradorensis	6.30	2	0.043
Gabrius brevipennis	8.68	2	0.013

Table 3. Species variance associated with splits in the multivariate regression tree model.

Species	Splits		Total Variance Explained	Species totals
	Harvested vs Control	SOH vs WTH		
Atheta capsularis	15.44	0.04	15.48	16.65
Tachinus fumipennis	9.63	0.12	9.74	12.45
Atheta strigulosa	6.55	0.03	6.58	6.80
Pseudopsis subulata	0.68	2.38	3.06	5.82
Lypoglossa franclemonti	1.01	0.33	1.33	5.23
Atheta klagesi	2.49	0.00	2.49	3.87
Pterostichus adstrictus	0.46	1.05	1.52	3.41
Gabrius brevipennis	2.02	0.25	2.27	2.62
Pterostichus coracinus	0.02	0.06	0.07	2.51
Atrecus macrocephalus	0.51	0.12	0.63	2.37
Ischnosoma fimbriatum	1.27	0.07	1.34	2.25
Calathus ingratus	0.04	1.02	1.06	2.17
Quedius densiventris	0.03	0.92	0.94	2.11
Liogluta aloconotoides	0.47	0.70	1.17	1.92
Oxypoda grandipennis	0.86	0.03	0.89	1.80
Atheta ventricosa	0.45	0.00	0.45	1.77
Mycetoporus americanus	0.08	0.06	0.14	1.53
Platynus decentris	0.29	0.03	0.32	1.41
Tachyporus nitidulus	0.33	0.01	0.34	1.27
Trechus apicalis	0.13	0.01	0.14	1.27
Oxypoda pseudolustrica	0.11	0.13	0.24	1.24
Tachinus quebecensis	1.02	0.00	1.02	1.08
Phloeostiba lapponica	0.39	0.26	0.66	1.07
Species with < 1% of species totals combined	2.19	2.35	4.54	17.40
Totals	46.47	9.96	56.43	100.00

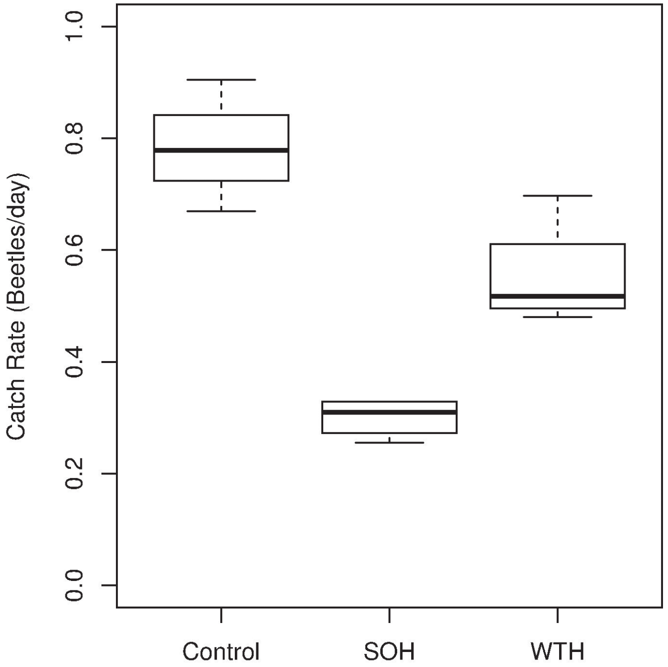

Figure 4. Boxplots depicting overall catch rates (beetles/day) where forest was **a** clearcut and deadwood was left intact (SOH) **b** clearcut with quantity of deadwood reduced (WTH), and **c** uncut forest (Control). Bold line depicts median value, box denotes 25–75% quantile range, whiskers correspond to 1.5 times the interquartile range.

ment by 0.4646). This split was defined by three species of *Atheta* (*A. capsularis, A. klagesi* and *A. strigosula*) and *Tachinus fumipennis/frigidus* complex commonly collected in uncut sites and *Gabrius brevipennis*, which was commonly collected in harvested sites. The second split explained an additional 8% of the total variance. This split is attributable to treatment differences between whole-tree and stem-only harvested sites or to sites with more than 112 m^3/ha of coarse woody debris. Both of these factors provided similar improvement in the overall tree (improvement by 0.2389 and 0.2381 respectively) and could be judged to be nearly equivalent. The second split was defined primarily by *Pseudopsis subulata* commonly collected in sites with reduced volumes of debris.

Discussion

We were able to detect differences in beetle assemblages among harvested and unharvested plots (Control), and between stem-only (SOH) (i.e. logging residues left on site) and whole-tree (WTH) (i.e. logging residues removed) harvesting treatments. By far the most common species response that we observed was a reduction in abundance in response to removal of the overstory by harvesting, suggesting that at least initially,

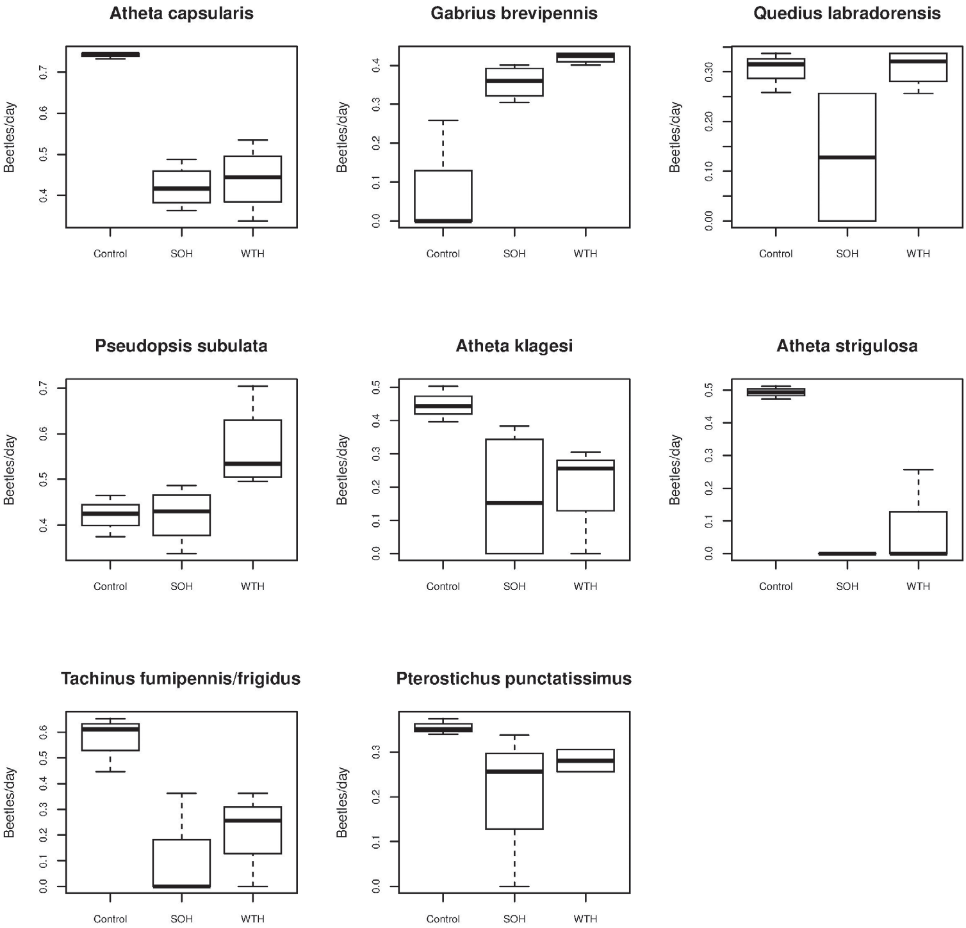

Figure 5. Boxplots depicting catch rates (beetles/day) for eight abundant species collected from experimental plots where forest was **a** clearcut and deadwood was left intact (SOH) **b** clearcut with quantity of deadwood reduced (WTH), and **c** uncut forest (Control). Bold line depicts median value, box denotes 25–75% quantile range, whiskers correspond to 1.5 times the interquartile range.

removal of forest overstory is more important than depletions in the overall volumes of downed deadwood. Of the species with clear responses to harvesting in general, three *Atheta* species and *T. fumipennis/frigidus* complex had abundances roughly half of those observed in unharvested plots. Similar trends in reduction of abundance caused by harvesting occurred in a yellow birch/balsam fir forest study in Quebec (Klimaszewski et al. 2008). Likewise abundance of several *Atheta*, *Bisnius* and *Gabrius* species was reduced several fold in harvested sites in comparison with uncut forest (Klimaszewski et al. 2008). Similar negative responses to harvesting have been reported for other *Tachinus* species (Pohl et al. 2007).

While we were able to distinguish assemblages in stem-only harvested (SOH) stands from those in whole-tree harvested (WTH) stands, this split was defined primarily on

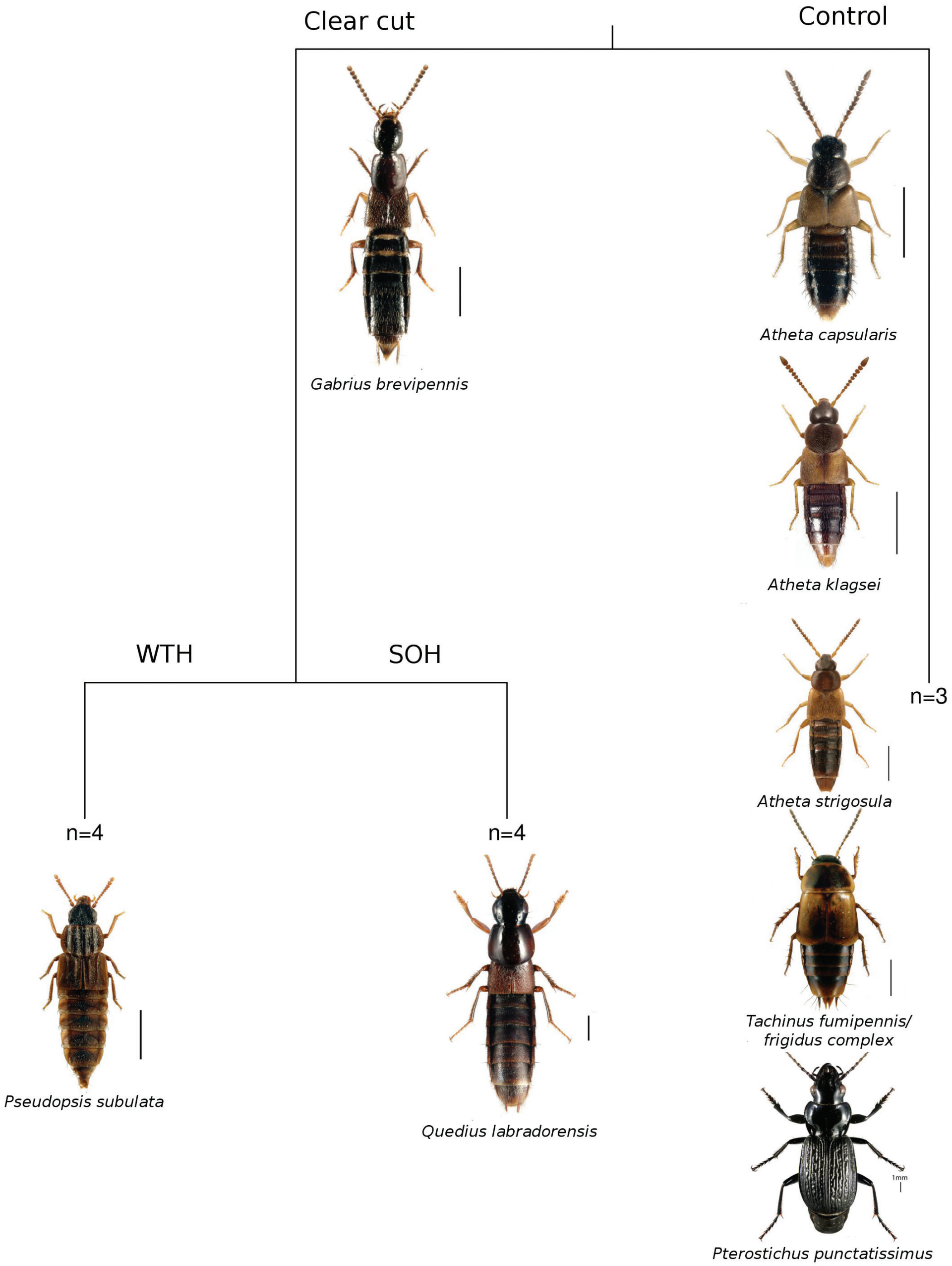

Figure 6. Multivariate regression tree based on sum-of-squares depicting differences in beetle assemblages among experimental plots where forest was **a** clearcut with stem-only harvested (SOH) **b** clearcut with whole-tree harvested (WTH), and **c** uncut forest (Control). The tree was selected based on 935/1000 cross-validations and explains 64% of the variance. Both experimental treatment and deadwood volumes provided equivalent improvement at each split. We have labelled splits using experimental treatments.

increased catches of *P. subulata.* This in itself is interesting as this species was shown to prefer older forests rather than freshly harvested sites in Newfoundland, Canada (McCarthy 1996). Apparently, this species has wider habitat range preferences and can tolerate drier and hotter conditions possibly due to heavy sclerotization of its body integument.

Numerous hypotheses can be advanced to explain these responses, including changes in microclimate (for all species) or loss of potential feeding sites such as decaying mushrooms infested with dipteran larvae (for *Tachinus*). Significant changes in microclimatic conditions occur at the soil surface following removal of harvest residues because the soil becomes more directly exposed to sun radiation and air movement, which cause increased soil temperature and reduce soil moisture (Proe and Dutch 1994, Zabowski et al. 2000, Roberts et al. 2005). Removal of residual slash has also been shown to affect species richness of particular aspects, ground beetles, of the epigaeic fauna (Nitterus 2007). Currently we are not able to positively verify any of these explanations. This is in part because detailed natural history data do not exist for these species beyond extremely broad habitat preferences such as found in leaf litter in forests (Herman 1975). Despite advances in taxonomy, particularly within the Staphylinidae, morphological details published in phylogenetic or taxonomic treatments of small, cryptic beetles like rove beetles have yet to be successfully incorporated into plausible, ecological explanations for species responses. Longer-term monitoring of beetle responses would likely yield clearer species-specific responses, as biodiversity in recently disturbed sites can still reflect a mix of closed canopy and open-habitat species (Buddle et al. 2006, Work et al. 2010).

Conclusion

Based on 1 year of sampling, we were able to characterize differences in beetle assemblages between clearcut sites (SOH, WTH) and mature stands (Control), as well as differences between clearcut sites where harvest residues had been removed (WTH) or left on site (SOH). The overall assemblage response was largely a recapitulation of the responses of several abundant species. While community-level analysis represents the response of abundantly captured species, we believe that we are likely unable to detect the full extent of the effects of residue removal based on a 1-year experiment. While the MRT allowed us to distinguish different assemblages that were attributable to experimental plots, we were unable to definitively explain assemblage differences on the basis of volumes of either coarse (CWD) or fine woody debris (FWD). This does not necessarily preclude conclusions as to the effect of the silvicultural treatments and the biomass removals, but it does to an extent preclude finer scale mechanistic explanations of changes in particular species. The long-term monitoring studies should allow us to better understand the influence of various levels of postharvest debris removal on biodiversity, nutrient production and circling and eventually tree growth.

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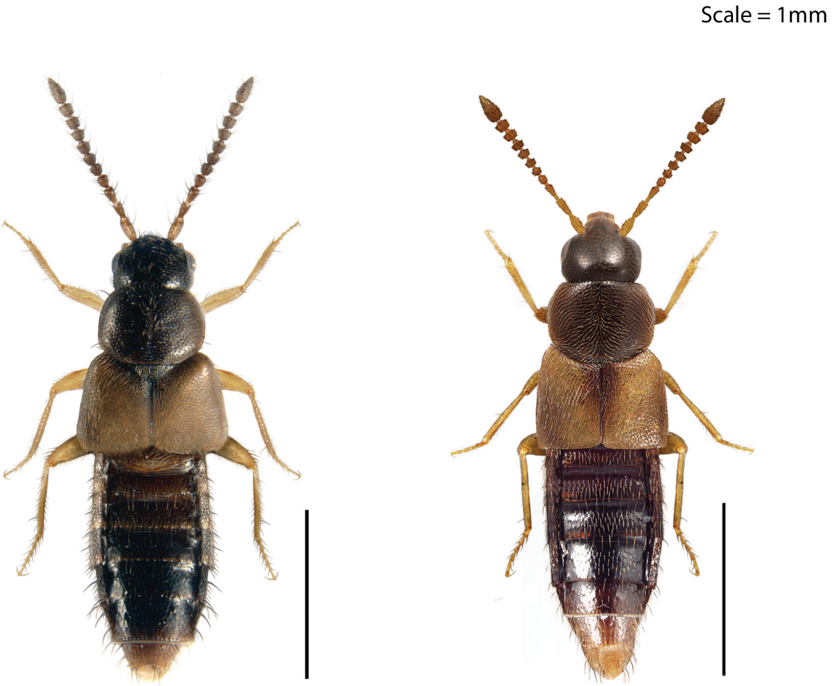
Appendix

Colour images of the most abundant rove and ground beetles, and detailed list of specimens examined.



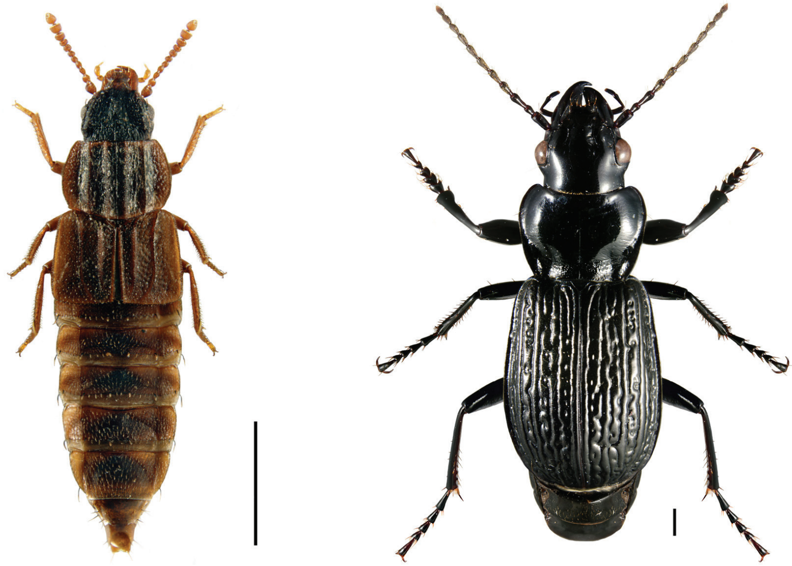
7a. *Atheta capsularis* 7b. *Atheta klagesi*

76c. *Atheta strigosula* 7d. *Tachinus fumipennis*

Figure 7. a–d Colour images of abundant species: **a** *Atheta capsularis* Klimaszewski **b** *Atheta klagesi* Bernhauer **c** *Atheta strigosula* Casey **d** *Tachinus fumipennis* (Say).

8a. *Quedius labradorensis*

8b. *Gabrius brevipennis*



8c. *Pseudopsis subulata*

8d. *Pterostichus punctatissimus*

Figure 8. a–d Colour images of abundant species: **a** *Quedius labradorensis* Smetana **b** *Gabrius brevipennis* (Horn) **c** *Pseudopsis subulata* Herman **d** *Pterostichus punctatissimus* (Randall).

Table 4. List of rove beetle species (Staphylinidae) reported from the balsam fir/white birch dominated forests (2011) north of Quebec City, organized by subfamily, tribe, subtribe [when available], and species name. All specimens were captured in unbaited pitfall traps. Uncut forest = control (CO); Clearcut with debris (SOH); Clearcut with reduced debris (WTH); Total catch (Σ); Percentage of total catch (%); relative dominance rank (RDR).

Taxon	June			July			August			Catch		
	WTH	SOH	CO	WTH	SOH	CO	WTH	SOH	CO	Σ	%	RDR
OMALIINAE	0	1	0	7	2	2	0	0	0	12	0.9	
Omaliini	0	1	0	7	2	0	0	0	0	10	0.8	
1. *Omalium rivulare* (Paykull) (*)	0	0	0	0	1	0	0	0	0	1	0.1	20
2. *Phloeostiba lapponica* (Zetterstedt)	0	1	0	7	1	0	0	0	0	9	0.7	15
Eusphalerini	0	0	0	0	0	1	0	0	0	1	0.1	
3. *Eusphalerum pothos* (Mannerheim)	0	0	0	0	0	1	0	0	0	1	0.1	20
Anthophagini	0	0	0	0	0	1	0	0	0	1	0.1	
4. *Acidota quadrata* (Zetterstedt)	0	0	0	0	0	1	0	0	0	1	0.1	20
PROTEININAE	0	0	0	1	1	1	1	0	3	7	0.5	
Proteinini	0	0	0	1	1	1	1	0	3	7	0.5	
5. *Megarthrus* sp.	0	0	0	0	0	1	0	0	0	1	0.1	20
6. *Proteinus* sp.	0	0	0	1	1	0	1	0	3	6	0.5	16
TACHYPORINAE	6	5	17	13	4	42	2	8	87	184	14.4	
Tachyporini	5	2	16	9	3	39	2	6	78	160	12.5	
7. *Tachinus fumipennis* (Say)	**0**	**0**	**11**	**2**	**0**	**16**	**0**	**1**	**17**	**47**	**3,7**	**7**
8. *Tachinus frigidus* Erichson	**0**	**0**	**5**	**2**	**0**	**20**	**1**	**2**	**46**	**76**	**6,0**	**3**
9. *Tachinus luridus* Erichson	0	1	0	0	0	0	0	0	1	2	0.2	19
10. *Tachinus quebecensis* Robert	0	0	0	0	0	0	0	0	11	11	0.9	14
11. *Tachyporus* sp.	0	0	0	1	1	0	0	0	0	2	0.2	19
12. *Tachyporus nitidulus* (Fabricius)	5	1	0	3	2	1	1	2	0	15	1.2	13
Mycetoporini	1	3	1	4	1	3	0	2	9	24	1.9	
13. *Lordithon fungicola* Campbell	0	1	0	0	0	0	0	0	0	1	0.1	20
14. *Mycetoporus consor* LeConte	0	1	0	0	0	0	0	1	0	2	0.2	19
15. *Mycetoporus americanus* Erichson	1	1	1	4	1	3	0	1	9	21	1.6	10

Taxon	June			July			August			Catch		
	WTH	SOH	CO	WTH	SOH	CO	WTH	SOH	CO	Σ	%	RDR
Bolitobini	16	6	2	17	18	8	5	4	3	79	6.2	
16. *Ischnosoma fimbriatum* Campbell	**13**	**5**	**2**	**16**	**16**	**8**	**4**	**4**	**2**	**70**	**5.5**	**4**
17. *Ischnosoma pictum* (Horn)	3	1	0	1	2	0	1	0	1	9	0.7	15
ALEOCHARINAE	34	13	23	14	6	56	53	46	437	682	53.4	
Aleocharini	0	0	0	0	0	0	2	2	0	4	0.3	
18. *Aleochara* (*Xenochara*) *fumata* Gravenhorst (*)	0	0	0	0	0	0	1	0	0	1	0.1	20
19. *Aleochara* (*Coprochara*) *verna* Say (*)	0	0	0	0	0	0	0	1	0	1	0.1	20
20. *Aleochara* sp. n. [undescribed]	0	0	0	0	0	0	1	1	0	2	0.2	19
Oxypodini	7	2	2	2	3	3	1	2	19	41	3.2	
21. *Oxypoda frigida* Bernhauer	0	0	0	1	1	0	0	0	1	3	0.2	18
22. *Oxypoda grandipennis* (Casey)	0	0	0	0	0	0	0	1	18	19	1.5	12
23. *Oxypoda lacustris* Casey	0	0	1	0	0	2	0	0	0	3	0.2	18
24. *Oxypoda operta* Sjöberg	1	0	0	0	0	0	0	0	0	1	0.1	20
25. *Oxypoda pseudolacustris* Klimaszewski	6	2	1	1	2	1	1	1	0	15	1.2	13
Homalotini	1	0	0	0	0	0	0	0	0	1	0.1	
26. *Leptusa opaca* Casey	1	0	0	0	0	0	0	0	0	1	0.1	20
Placusini	0	0	0	0	0	2	0	0	0	2	0.2	
27. *Placusa incompleta* Sjöberg	0	0	0	0	0	2	0	0	0	2	0.2	19
Athetini	26	11	21	12	3	51	50	42	417	633	49.5	
28. *Atheta capsularis* Klimaszewski	**0**	**0**	**0**	**3**	**0**	**13**	**37**	**31**	**321**	**405**	**31.7**	**1**
29. *Atheta klagesi* Bernhauer	**0**	**0**	**9**	**0**	**2**	**28**	**4**	**5**	**15**	**63**	**4.9**	**6**
30. *Atheta regisalmonis* (Lohse)	0	0	0	0	0	0	0	0	1	1	0.1	20
31. *Atheta remulsa* Casey	0	0	0	0	0	0	0	1	1	2	0.2	19
32. *Atheta strigosula* Casey	0	0	0	0	0	2	1	0	64	67	5.2	5
33. *Atheta terranovae* Klimaszewski & Langor	0	0	0	0	0	0	0	0	3	3	0.2	18
34. *Atheta ventricosa* Bernhauer	0	0	11	0	1	3	2	1	1	19	1.5	12
35. *Atheta* sp.	1	0	0	0	0	0	0	0	1	2	0.2	19
36. *Atheta* (*Microdota*) sp.1	1	0	0	0	0	0	0	0	1	2	0.2	19

Taxon	June			July			August			Catch		
	WTH	**SOH**	**CO**	**WTH**	**SOH**	**CO**	**WTH**	**SOH**	**CO**	**Σ**	**%**	**RDR**
37. *Liogluta aloconotoides* Lohse	0	0	0	7	0	5	2	0	6	20	1.6	11
38. *Lypoglossa franclemonti* Hoebeke (*)	22	10	1	2	0	0	3	2	0	40	3.1	8
39. *Mocyta fungi* (Gravenhorst)	0	1	0	0	0	0	0	0	0	1	0.1	20
40. *Mocyta breviuscula* (Mäklin)	0	0	0	0	0	0	0	0	3	3	0.2	18
41. *Seeviersiella globicollis* (Bernhauer)	2	0	0	0	0	0	1	2	0	5	0.4	17
Geostibini	0	0	0	0	0	0	0	0	1	1	0.1	
42. *Zyras obliquus* (Casey)	0	0	0	0	0	0	0	0	1	1	0.1	20
STENINAE	1	0	0	1	0	0	0	0	0	2	0.2	
43. *Stenus austini* Casey	1	0	0	1	0	0	0	0	0	2	0.2	19
PSEUDOPSINAE	10	6	11	40	16	11	59	10	18	181	14.2	
44. *Pseudopsis subulata* Herman	10	6	11	40	16	11	59	10	18	181	14.2	2
PAEDERINAE	1	2	0	0	0	0	0	0	0	3	0.2	
Paederini	1	2	0	0	0	0	0	0	0	3	0.2	
45. *Lathrobium washingtoni* Casey	1	2	0	0	0	0	0	0	0	3	0.2	18
Staphylininae	34	28	5	21	10	12	12	1	5	128	10	
Xantholinini	2	10	2	8	7	1	0	0	0	30	2.3	
46. *Atrecus macrocephalus* (Nordman)	2	10	2	8	7	1	0	0	0	30	2.3	9
Staphylinini	32	18	3	13	3	11	12	1	5	98	7.7	
Quediina	11	3	1	8	1	10	8	0	5	47	3.7	
47. *Quedius densiventris* (Casey)	4	1	0	4	0	2	6	0	3	20	1.6	11
48. *Quedius (Raphirus) fulvicollis* (Stephens)	2	0	0	1	0	1	1	0	0	5	0.4	17
49. *Quedius(Quedius) labradorensis* Smetana	5	1	1	3	1	7	1	0	2	21	1.6	10
50. *Quedius(Quedius) plagiatus* Mannerheim	0	1	0	0	0	0	0	0	0	1	0.1	20
Philonthina	21	15	2	5	2	1	4	1	0	51	4	
51. *Bisnius cephalicus* (Casey)	1	1	0	0	0	1	0	0	0	3	0.2	18
52. *Gabrius brevipennis* (Horn)	**20**	**14**	**2**	**5**	**1**	**0**	**4**	**1**	**0**	**47**	**3.7**	**7**
53. *Gabrius* sp.	0	0	0	0	1	0	0	0	0	1	0.1	20

Table 5. List of ground beetle species (Carabidae) reported from the balsam fir/white birch dominated forests (2011) north of Quebec City, organized by subfamily, tribe, subtribe [when available], and species name. All specimens were captured in unbaited pitfall traps. Uncut forest = control (CO); Clearcut with debris (SOH); Clearcut with reduced debris (WTH); Total catch (Σ); Percentage of total catch (%); relative dominance rank (RDR); abundantly captured species in bold.

Taxon	June			July			August			Catch		
	WTH	SOH	CO	WTH	SOH	CO	WTH	SOH	CO	Σ	%	RDR
CARABINAE	0	0	0	0	0	0	0	1	1	2	0.5	
Cychrini	0	0	0	0	0	0	0	1	1	2	0.5	
1. *Sphareoderus nitidicollis* (Guérin-Ménenville)	0	0	0	0	0	0	0	1	1	2	0.5	10
TRECHINAE	4	5	2	8	6	6	2	0	0	33	8.5	
Trechini	2	2	0	3	4	2	0	0	0	13	3.4	
2. *Trechus apicalis* (Motschulsky)	**2**	**1**	**0**	**3**	**4**	**1**	**0**	**0**	**0**	**11**	**2.8**	**6**
3. *Trechus crassiscapus* (Lindroth)	0	1	0	0	0	1	0	0	0	2	0.5	10
Bembidiini	2	3	2	5	2	4	2	0	0	20	5.2	
4. *Bembidion grapii* (Gyllenhal)	1	0	0	0	0	0	1	0	0	2	0.5	10
5. *Bembidion wingatei* (Bland)	1	3	2	5	2	4	1	0	0	18	4.7	5
HARPALINAE	75	38	69	48	27	44	26	14	11	352	91	
Pterostichini	72	34	57	30	25	36	20	12	7	293	75.7	
6. *Pterostichus adstrictus* (Eschscholtz)	**58**	**27**	**35**	**21**	**12**	**17**	**12**	**8**	**0**	**190**	**49.1**	**1**
7. *Pterostichus brevicornis* (Kirby)	0	0	1	0	0	0	1	0	0	2	0.5	10
8. *Pterostichus coracinus* (Newman)	**10**	**4**	**15**	**9**	**12**	**10**	**5**	**3**	**5**	**73**	**18.9**	**2**
9. *Pterostichus punctatissimus* (Randall)	**4**	**3**	**6**	**0**	**1**	**9**	**2**	**1**	**2**	**28**	**7.2**	**4**
Harpalini	0	0	0	5	0	0	2	1	0	8	2.1	8
10. *Harpalus laticeps* (LeConte)	0	0	0	0	0	0	0	1	0	1	0.3	11
11. *Harpalus ruficeps* (DeGeer)	0	0	0	3	0	0	1	0	0	4	1	8
12. *Harpalus solitaris* (Dejean)	0	0	0	2	0	0	1	0	0	3	0.8	9
Platynini	3	4	12	13	2	8	4	1	4	51	13.2	
13. *Agonum gratiosum* (Mannerheim)	0	0	1	0	0	0	0	0	0	1	0.3	11
14. *Agonum retractum* (LeConte)	0	0	2	0	0	1	0	0	0	3	0.8	9
15. *Calathus adrena* (LeConte)	0	0	1	0	1	0	0	0	0	2	0.5	10
16. *Calathus ingrathus* (Dejean)	**2**	**2**	**3**	**13**	**1**	**5**	**4**	**1**	**4**	**35**	**9**	**3**
17. *Platynus decentris* (Say)	1	2	5	0	0	2	0	0	0	10	2.6	7

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Hispaniolan Hemilophini (Coleoptera, Cerambycidae, Lamiinae)

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Abstract

The Tribe Hemilophini (Lamiinae) is reviewed for Hispaniola and an identification key is provided. Fifteen species are now known from the island, including one new species of *Adesmus* (*A. fortunei* from Pedernales and La Vega Provinces, Dominican Republic), one new species of *Oedudes* (*O. anulatus* from Peravia and La Vega Provinces, Dominican Republic), and five new species of *Calocosmus* (*C. contortus* from San Cristóbal Province, *C. punctatus* from Peravia Province, *C. rawlinsi* from Elías Piña Province, *C. robustus* from La Vega Province, and *C. thonalmus* from La Altagracia Province, all in the Dominican Republic). *Oedudes* and *Adesmus* are new island and country records for Hispaniola and Dominican Republic, respectively. *Calocosmus holosericeus* Gahan is a new synonym of *Calocosmus janus* Bates. In addition to the new species, five new country records and four new island records are presented for *Calocosmus*.

Keywords

Longhorned woodborers, Hispaniola, Haiti, Dominican Republic, endemic, Batesian mimicry

Introduction

The Hemilophini of Hispaniola are recognized by their deeply bifid tarsal claws, very broadly expanded prosternal intercoxal process, very deeply notched eyes, vestiture of very dense, short, often scale-like pubescence over much of the body, and typically bright,

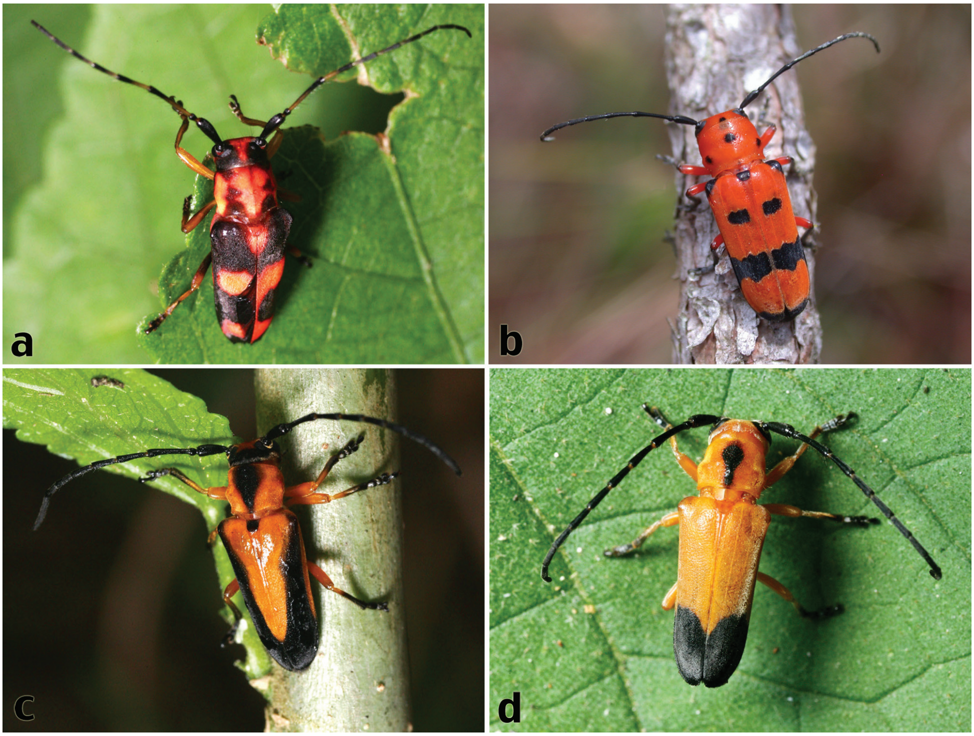

Figure 1. Live habitus photos of Hispaniolan Hemilophini: **a** *Oedudes anulatus* Lingafelter, sp. n. (La Vega Province) (photo by Rick Stanley) **b** *Calocosmus magnificus* Fisher (Pedernales Province) (photo by Kelvin Guerrero) **c** *Calocosmus nigritarsis*, unusual morphotype (La Vega Province) (photo by Rick Stanley) **d** *Calocosmus nigritarsis*, typical morphotype (Independencia Province) (photo by Gino Nearns).

aposematic colors (Fig. 1a–d). Many of the species, along with *Trichrous* species (Cerambycinae: Heteropsini) (Fig. 2a), are presumably Batesian mimics of *Thonalmus* Bourgeois (Fig. 2b), a genus of Lycidae that is common on Hispaniola and is noxious to lizards (Darlington 1938). The Hemilophini are diverse in the Neotropics with species most abundant in Central and South America. The tribe is represented by three extant genera (*Adesmus* Lepeletier, *Oedudes* Thomson, and *Calocosmus* Chevrolat) and one extinct genus (*Paleohemilophus* Martins & Galileo) on the island of Hispaniola (Monné and Bezark 2011). *Calocosmus*, a genus endemic to the West Indies (Peck and Perez-Gelabert 2012), has radiated in Hispaniola, with 13 of the 18 species (72%) (including 5 new ones) occurring there (Perez-Gelabert 2008; Monné and Bezark 2011). *Adesmus* and *Oedudes* are recorded for Hispaniola for the first time with one new species each, described herein.

Methods

Specimens from the following institutional and private collections (with acronyms used in this paper) were examined for this study:

Figure 2. Members of the Batesian mimicry complex with Hispaniolan Hemilophini: **a** *Trichrous terminalis* (White) **b** *Thonalmus* sp. (Lycidae). Photos by Rick Stanley.

ACMT	American Coleoptera Museum, San Antonio, TX, U.S.A. (J. Wappes)
BMNH	The Natural History Museum, London, England (M. Barclay)
CMNH	Carnegie Museum of Natural History, Pittsburgh, PA, U.S.A. (J. Rawlins, R. Davidson, R. Androw)
DRMC	Museo Nacional de Historia Natural, Santo Domingo, Dominican Republic (G. de los Santos)
EFGC	Edmund F. Giesbert Collection, Gainesville, FL, U.S.A. (at FSCA, M. Thomas)
ENPC	Eugenio Nearns Private Collection, Albuquerque, NM, U.S.A.
FSCA	Florida State Collection of Arthropods, Gainesville, FL, U.S.A. (M. Thomas)
CRAAG	Centre de Recherches Agronomiques Antilles-Guyane, Duclos (Petit-Bourg), Guadeloupe (ex-collections Fortuné Chalumeau)
MNHN	Museum National d'Histoire Naturelle, Paris, France (G. Tavakilian)
RHTC	Robert H. Turnbow, Jr. Private Collection, Ft. Rucker, AL, U.S.A.
TAMU	Texas A&M University Collection, College Station, TX, U.S.A. (E. Riley)
USNM	National Museum of Natural History, Smithsonian Institution, Washington, DC, U.S.A. (S. Lingafelter)
WIBF	West Indian Beetle Fauna Project, Bozeman, MT, U.S.A. (M. Ivie)

Photographs of primary types from the following institutions were also examined:

AMNH	American Museum of Natural History, New York, NY, U.S.A. (Lee Herman)
BMNH	The Natural History Museum (London, United Kingdom) (M. Barclay)
MCZC	Museum of Comparative Zoology, Harvard University, Cambridge, MA, U.S.A. (B. Farrell, P. Perkins)
MNHN	Museum National d'Histoire Naturelle, Paris, France (G. Tavakilian)

Holotypes of the new species are deposited in USNM and CMNH. Label data is semi-verbatim with line spaces separated by commas and abbreviated localities and dates spelled out for clarity. Measurements were made using Axiovision software (version 4.8.2) on images taken with a Zeiss AxioCam HRc camera attached to a Zeiss Discovery.V20 stereomicroscope with Sycop motorized zoom and focus control and a PlanApo S 0.63× objective. Diagnoses, figures, distributional and phenological records are presented for all Hispaniolan Hemilophini, along with full descriptions for the new species.

Key to Hemilophini of Hispaniola

(does not include the extinct *Paleohemilophus dominicanus* Martins & Galileo)

1 Third antennomere and base of fourth yellow, remainder dark purple to black; pronotum without any visible punctation, covered in dense vestiture of pale greenish-white pubescence....... ***Adesmus fortunei*** **Lingafelter, sp. n.**

– Antennomeres differently colored; pronotum with at least a few obvious punctures.. **2**

2(1) Elytral apex bidentate or subspinose, with an acute projection at suture and outer angle....................................... ***Oedudes anulatus*** **Lingafelter, sp. n.**

– Elytral apex broadly or narrowly rounded, lacking any spines or acute projections (*Calocosmus*)... **3**

3(2) Elytron mostly uniformly black or purplish-black; fulvous or orange regions (if present) along suture, base, and/or lateral margin.................................. **4**

– Elytron not mostly uniformly black or with purplish tinge; bicolored with dark black or blue and orange or red maculae; fulvous regions in different pattern than above... **7**

4(3) Humerus prominent (elytron noticeably wider at base than apex) **5**

– Humerus not prominent (elytron not noticeably wider at base than apex) ... **6**

5(4) Antenna completely black, without basal annulations of gray pubescence; elytron completely dark purplish-black, with moderately well defined or poorly defined punctures .... ***Calocosmus janus*** **Bates**

– Antenna with basal annulations of gray pubescence on most antennomeres; elytron black except at base, along anterior part of suture, a small spot at middle, and part of lateral margin which are fulvous; elytral punctures dense and well-defined except at extreme apex .... *Calocosmus punctatus* **Lingafelter, sp. n.**

6(4) Elytral suture not pale colored; pronotum transversely bisulcate (not always obvious) .... ***Calocosmus nigripennis*** **Chevrolat**

– Elytral suture pale colored; pronotum not transversely bisulcate .... ***Calocosmus semimarginatus*** **Bates**

7(3) Apex of elytron strongly modified with two elevated, longitudinal ridges lined with bristly pubescence **8**

– Apex of elytron without elevated, pubescent, longitudinal ridges. **9**

8(7) Antennae uniformly black, without annulations; scutellum without black setae; eye of male small; lower eye lobe removed from genal margin by over two-thirds of its height.............. ***Calocosmus thonalmus*** **Lingafelter, sp. n.**

– Antennae with antennomeres 4–7 orange annulate at the base; scutellum with numerous, short, black setae; eye of male large; lower eye lobe removed from genal margin by less than one-third of its height .... ***Calocosmus contortus*** **Lingafelter, sp. n.**

9(7) Apical macula of elytron restricted to tip, very small, less than apical one-eighth; pronotum dorsally with three small, dark maculae (one at center, and one at each side of center), also a small dark macula laterally on each side; humerus with small, isolated macula............***Calocosmus magnificus*** **Fisher**

– Apical fourth to half of elytron with large, black or purplish macula; pronotum either without dark macula, or macula restricted to middle; humerus without isolated macula (if dark, part of a larger maculate region extending over more of elytral base than just humerus) **10**

10(9) Apex of elytron with dark macula mostly shiny, iridescent, and glabrous .... ***Calocosmus hispaniolae*** **Fisher**

– Apex of elytron with dark macula mostly pubescent, not shiny, with or without an iridescent luster **11**

11(10) Humerus not prominent (not projecting anterolaterally; usually without glabrous region; elytron approximately parallel-sided); pronotum with weak lateral and dorsal swelling at middle; relatively delicate species (specimens < 4 mm wide); pronounced hair patches present on posteromedial part of metasternum in males **12**

– Humerus prominent (projecting anterolaterally; usually with small glabrous region at apex; elytron often noticeably wider at base than apex); pronotum with pronounced lateral and dorsal swelling at middle; robust species (most specimens, particularly females, > 4 mm broad); conspicuous hair patches absent on posteromedial part of metasternum in males **13**

12(11) Elytral base, including scutellum, nearly completely dark; legs nearly completely dark reddish-brown to black; apical black macula of elytron without punctures except at extreme anterior margin... .... ***Calocosmus rawlinsi*** **Lingafelter, sp. n.**

– Elytral base fulvous, or if black macula present at base, it does not extend to suture or scutellum; scutellum fulvous; femora fulvous, tibiae and tarsi variable, either fulvous or dark reddish-brown; apical black macula of elytron with punctures present except at extreme posterior margin .... ***Calocosmus chevrolati* Fisher**

13(11) Tibiae fulvous; tarsi fulvous or slightly darkened; venter fulvous; base of elytron never with dark macula; antennomeres (4–7 at least) with fulvous basal annulation, otherwise black; dorsum of pronotum and elytron with a short, dense vestiture of pale, ashy pubescence visible from some angles but inconspicuous from other angles (more pronounced on fresh specimens) .... ***Calocosmus melanurus* Gahan**

– Tibiae and tarsi partially or completely dark brown to black; venter variably colored, but rarely all fulvous; metasternum typically with a black macula, sometimes most of venter brown to black; base of elytron with or without dark macula; antennae variably colored, either all black or with basal fulvous annulations; distinctive ashy pubescence of elytron and pronotum absent............. **14**

14(13) Antenna all black (occasionally antennomeres 4–6 with narrow basal fulvous annulation); pronotum with large, dark macula in center, broader anteriorly, in most specimens (occasionally reduced to small anteromedial spot) .... ***Calocosmus nigritarsis* Fisher**

– Antenna with most antennomeres (usually 3–9, at least) with basal fulvous annulation; pronotum entirely fulvous or with very small anteromedial dark macula ....***Calocosmus robustus* Lingafelter, sp. n.**

Taxonomy

***Adesmus fortunei* Lingafelter, sp. n.**
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http://species-id.net/wiki/Adesmus_fortunei
Fig. 3a; Map 1

Diagnosis. This species is unlike any other species in the Caribbean Islands. It is very similar to *A. nigrocinctus* Gahan, from Brazil, in the overall form, proportions, and antennal and elytral pubescence. It is distinguished from all other Hispaniolan hemilophines by the very long third antennomere, which, along with the basal half of the fourth is yellow, the densely pubescent pronotum without evident punctures, and the unique pattern of alternating white and black transverse fasciae on the elytra.

Description. Size: 9.7–13.8 mm long; 3.5–5.1 mm wide between humeri. *Head* with dense vestiture of appressed off-white setae, thickened at base, almost scale-like; most dense on frons, less dense around eyes, base of antennal tubercles and vertex. Punctures indistinct or hidden by pubescence. Frons not bulging, level to slightly convex between eyes with exception of small medial impression extending to vertex. Gena

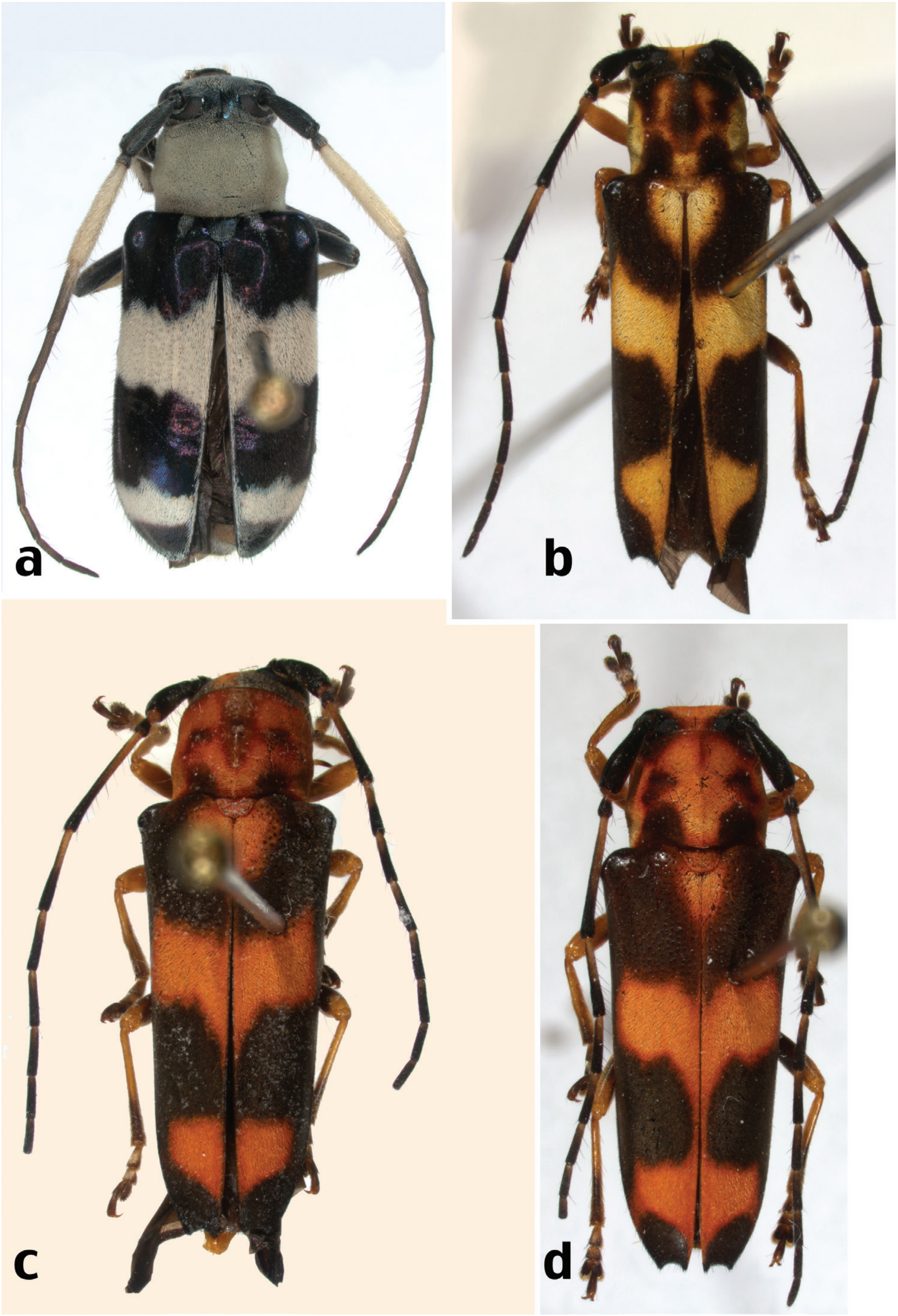
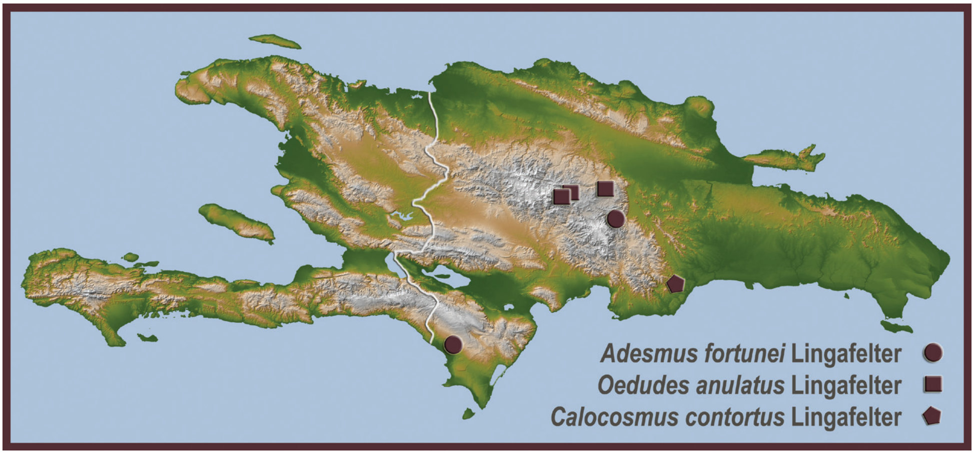


Figure 3. New species of Hispaniolan Hemilophini: **a** *Adesmus fortunei* Lingafelter, sp. n., holotype **b** *Oedudes anulatus* Lingafelter, sp. n., holotype **c** *Oedudes anulatus* Lingafelter, sp. n., paratype **d** *Oedudes anulatus* Lingafelter, sp. n., paratype.



Map 1. Distributional locality records for new species of Hispaniolan Hemilophini.

below lower eye lobe and mandibular base a little more than one-third height of lower eye lobe; frontal-genal ridge incomplete, not extending to eye margin; ante-clypeal sulcus transverse, but mostly hidden by pubescence. Eye large, bulging laterally on lower lobe, finely faceted, upper lobe connected to lower lobe by 3–4 facets at narrowest point, lower lobe much larger than upper lobe, occupying most of head from lateral view. Interantennal region moderately impressed with antennal tubercles moderately elevated. Antenna of female extending beyond elytral apex by 2 antennomeres (by 3–4 antennomeres in males). Antenna with fringe of denser, short pubescence of two colors, white and black, and scattered, less dense, longer setae. Antennomeres black with exception of third and basal one-fourth to one-half of fourth which are yellow. Antennomere 3 very long (longer than scape + 2, nearly as long as 4+5), subsequent antennomeres gradually decreasing in length. *Prothorax* cylindrical, much broader than long (1.8–2.8 mm long; 2.8–3.8 mm wide), distinctly narrower than elytral base, with very slight lateral swelling, densely covered with very pale green (nearly white) scale-like pubescence covering integument and any punctures; pronotum without dorsal calli or tubercles. Pronotum about one-fifth length of body. Prosternum densely pubescent with short, appressed, off-white setae; prosternal process broadly expanded at apex, closing procoxal cavities posteriorly. *Elytron* with distinct punctures on basal third, becoming shallow at middle, and inconspicuous or absent at apical third, bold, transverse purplish-black fasciae at basal fourth, just posterior to middle, and at apex. These transverse areas covered with narrow, suberect, non-scale-like black setae. Between and around the purplish-black fasciae are broad, transverse areas covered with short, dense, scale-like white or off-white setae. Humeri not projecting. Elytral apices narrowly rounded to suture, without spines. Elytron 7.2–9.7 mm long; 1.7–2.7 mm wide; elytral length/width: 3.7–4.2. *Scutellum* narrowly rounded posteriorly, with sparse pale green or white pubescence. *Legs* with femora and tibiae sublinear, only weakly thickened apically. Metafemur short, extending to about third ventrite, with moderately dense white and black pubescence not obscuring surface. Legs bicolored with protibia and venter of profemur yellow, mesotibia and metatibia yellow, and base of tarsomeres 1 and 2 yellow, all remaining portions of legs black. *Venter* mostly densely pubescent with metathorax and last 3 ventrites mostly covered in short, white pubescence, elsewhere mostly covered in black pubescence. Apex of fifth ventrite of males and females broadly truncate with small median notch.

Etymology. The species epithet is a genitive patronym in honor of Fortuné Chalumeau (CRAAG) for his extensive and important work in Cerambycidae of the Lesser Antilles and for collecting the first known specimen.

Notes. *Adesmus* is represented by more than 50 species in Central and South America, but this species represents the first occurrence of the genus in Hispaniola and only the third one known from the Caribbean Islands. It is known from two specimens.

Material. Holotype (female): Dominican Republic: Pedernales Province, N. of Cabo Rojo; Parque Nacional Sierra de Bahoruco; km 26 on Carretera Arcoa [sic]; transitional forest (between dry and pine forests); elev. 691 m; 18.113500°, -71.621100°, 11 May 2010, coll. G.J. Svenson (ENPC, transferred to USNM). Paratype (male): Dominican Republic: Cordillera Central: Constanza, 1300 m, 12 July 1978, Fortuné Chalumeau (CRAAG).

Oedudes anulatus Lingafelter, sp. n.

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http://species-id.net/wiki/Oedudes_anulatus
Figs 1a; 3b-d; Map 1

Diagnosis. This species is easily distinguished from all other Hispaniolan hemilophines by the bidentate elytral apices and bold red or orange pattern of pubescence on the pronotum and elytra. This species is similar to the Cuban *O. ramsdeni* (Fisher), but differs in having the pronotal black spots at the middle and posterior portions of the pronotum (not concentrated only at the base as in *O. ramsdeni*); the legs, including the femora, most of the tibiae, and most of the tarsi pale reddish (not dark reddish-brown to black as in *O. ramsdeni*); the black fascia at the base of the elytron is large and extends to the suture and laterally down the length of the elytron (in *O. ramsdeni*, it is relatively small and does not extend to the suture or lateral margin); and in having the antennae bicolored with pale annulations at the bases of at least antennomeres 2–6 (uniformly black in all other species of *Oedudes*).

Description. Size: 9.0–12.0 mm long; 2.9–4.2 mm wide between humeri. *Head* with dense vestiture of appressed yellow, orange, or red setae, thickened at base, almost scale-like, dense throughout except on gena and posterior to upper eye lobes. Punctures indistinct or hidden by pubescence except on fronto-clypeal margin. Frons not bulging, level to slightly convex between eyes, without medial impression. Gena below lower eye lobe and mandibular base about one-half height of lower eye lobe; frontal-genal ridge absent; ante-clypeal sulcus obsolete. Eye large, slightly bulging laterally on lower lobe, finely faceted, upper lobe connected to lower lobe by 3–4 facets at narrowest point, lower lobe much larger than upper lobe, occupying about one-half of head from lateral view. Interantennal region not impressed, antennal tubercles weakly elevated. Antenna slender, extending beyond elytral apex by 1 antennomere in females (males unknown). Antenna with moderately dense, appressed, short pubescence of two colors, white and black, and scattered, sparse, long setae on venter of basal segments. Antennomeres mostly black with pale yellow or orange annulations on basal portions of at least 2–6. Antennomere 3 very long (longer than scape + 2; nearly as long as 4+5), subsequent antennomeres gradually decreasing in length. *Prothorax* cylindrical, slightly broader than long (1.8–2.5 mm long; 2.1–3.0 mm wide), distinctly narrower than elytral base, with very slight lateral protuberance at middle, densely covered with red or orange scale-like pubescence (fading to yellow in some pinned specimens) covering most of integument, sparse punctures visible in regions with black maculae around middle and base; pronotum without dorsal calli or tubercles, about one-fifth length of body. Prosternum integument dark brown, with sparse, short, white and translucent setae. Prosternal process broadly expanded at apex, closing procoxal cavities posteriorly. *Elytron* with distinct punctures strongest at base, becoming shallower at middle, mostly absent at apical third, dense, scale-like red or orange pubescence (fading to yellow in some dried specimens) present in bold pattern around scutellum and in transverse, slightly posteriorly angled fascia at middle and near apex, otherwise, elytra black. Humerus strongly projecting anterolaterally, often with extreme apex glabrous. Elytral apices bidentate, with concavity between sutural and apicolateral points. Elytron 6.8–9.0 mm long; 1.5–2.1 mm wide; elytral length/width: 4.2–4.5. *Scutellum* broadly rounded posteriorly, densely covered in orange or red (fading to yellow). *Legs* with femora and tibiae sublinear, only weakly thickened apically. Metafemora short, extending to about third ventrite. Moderately dense, translucent or pale pubescence on tibiae; femora sparsely pubescent. Legs pale orange or pale testaceous throughout except meso- and metafemur, tibial apices, and apices of tarsomeres which are dark brown to black. *Venter* mostly densely pubescent and dark brown or yellow-orange with denser patches of reddish-orange (fading to yellow in some dried specimens) pubescence on posterolateral margins of metasternum and ventrites 2–4 or 2–5. Apex of fifth ventrite of females broadly truncate with small median notch (males unknown).

Etymology. The specific epithet is a Latin adjective, nominative case, masculine gender, meaning ringed, and refers to the pale basal annulations on most antennomeres.

Notes. The genus *Oedudes* is now represented by 8 species in the Neotropics and this is the first record for the genus in Hispaniola. It is known from 3 specimens.

Material. Holotype (female): Dominican Republic: Peravia Prov., 5 km W of road to El Rio, S. of Pedregal, 19°05.092'N, 70°35.864'W, 52 m, 23 June 2005, Steven W. Lingafelter (USNM). Paratypes (2 females): Dominican Republic, Pico Duarte Trail, 3300’, Los Tablones - day coll., 19°08.222'N, 70°27.736'W, 29 June 2004, D. Perez (USNM); Dominican Republic, La Vega Province, Parque Nacional Armando Bermudez, 1–3 km along trail W of La Cienaga, 900–1100 m, June 22, 2005, Specimen ID 7643, Nearns & Lingafelter (ENPC).

Calocosmus contortus **Lingafelter, sp. n.**

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http://species-id.net/wiki/Calocosmus_contortus
Fig. 4a-d; Map 1

Diagnosis. This species, like *C. thonalmus*, is very distinctive since it has a similarly contorted elytral apex. It differs in having the middle antennomeres (4–7) fulvous annulate at the basal one-fourth to one-half (the antennae are uniformly black in *C. thonalmus*); the lower eye lobe much larger, the genal region below it is less than one-third height of lower eye lobe (nearly as high as the lower eye lobe in *C. thonalmus*);

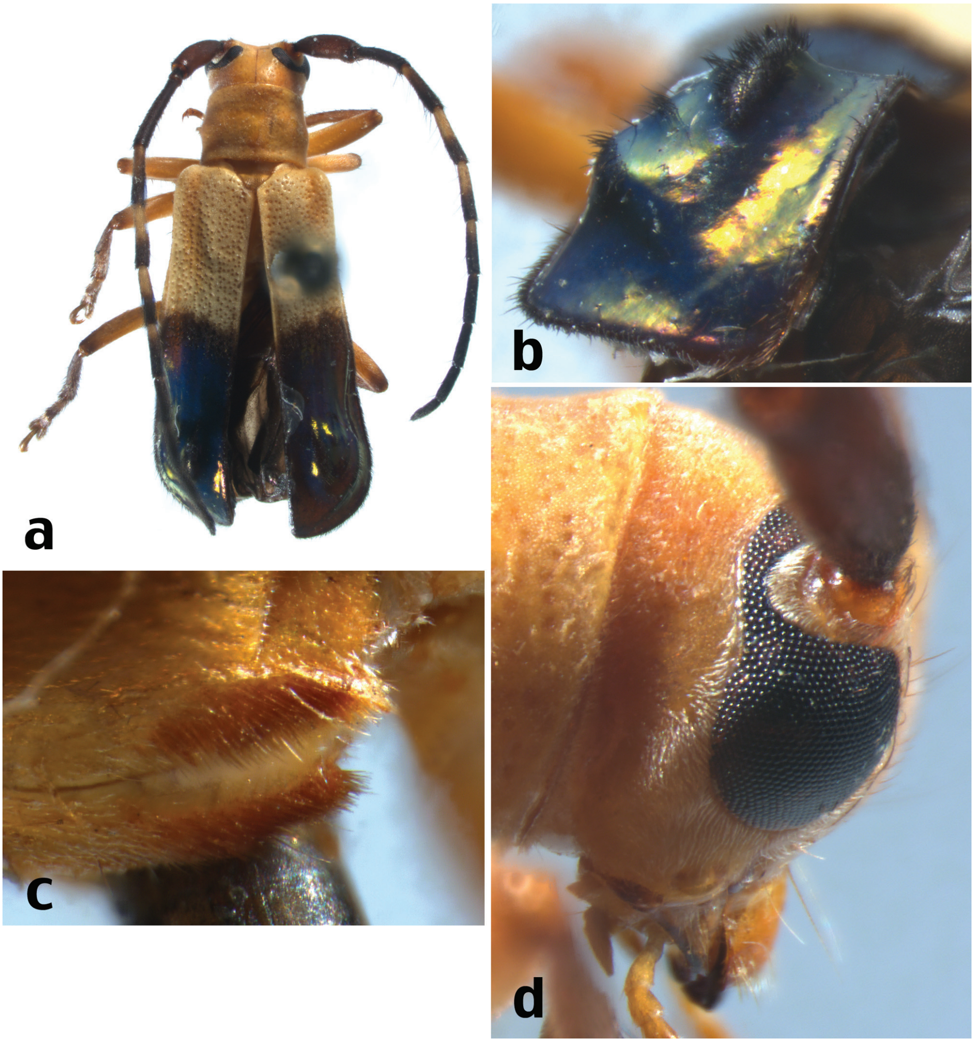


Figure 4. *Calocosmus contortus* Lingafelter, sp. n., holotype: **a** dorsal habitus **b** elytral apex **c** metasternal pubescent tufts **d** lateral view of head.

in having the elytral apex with a minor pubescent ridge between the two major costal ridges (*C. thonalmus* has a simple glabrous depression between the two major costal ridges); a relatively long metasternal setal brush (this setal brush, apparently only developed in males of some species of *Calocosmus*, is much shorter in *C. thonalmus*); and in having longer and more slender femora and tibiae (the metafemur extends to the posterior margin of the third ventrite in *C. contortus* but only to the anterior margin of third ventrite in *C. thonalmus*).

Description. Size: 8.2 mm long; 2.5 mm wide between humeri. *Head* with dense vestiture of very short, ashy-white setae, slightly thickened at base, but not obscuring surface, along with scattered long, dark setae on frons. Sparse, mostly non-contiguous punctures scattered throughout head. Frons not bulging, moderately concave between eyes, with division by median groove extending to vertex. Gena below lower eye lobe and mandibular base about one-third height of lower eye lobe; frontal-genal ridge very short, extending vertically for a short distance toward eye margin from genal margin. Anteclypeal sulcus absent. Eye large, bulging laterally on lower lobe beyond plane of head, finely faceted, upper lobe connected to lower lobe by 3 facets at narrowest point, lower lobe much larger than upper lobe, occupying nearly one-half of head from lateral view. Interantennal region impressed, antennal tubercles slightly elevated. Antenna moderately stout, short, surpassing elytral apex by about 2 antennomeres in males (females unknown). Antenna with vestiture of semi-appressed, dense, short, black pubescence and scattered, sparse, long, dark setae, especially at antennomere apices and mesal margins. Antennomeres black, except scape which is reddish-brown and 4–7 which have orange basal annulations. Antennomere 3 longer than scape + 2 but shorter than 4+5, subsequent antennomeres short and gradually decreasing in length or subequal. *Prothorax* cylindrical, broader than long (1.3 mm long; 1.8 mm wide), distinctly narrower than elytral base, with only slight middle swelling, densely covered with short whitish-gray setae, however inconspicuous and not obscuring integument. Pronotum with overall orange appearance, without maculae. Pronotum with distinct, large, scattered, non-contiguous punctures. Pronotum about one-sixth length of body. Prosternum inconspicuously pubescent with short, orange or translucent setae. Prosternal process very narrow between protuberant procoxae, broadly expanded at apex, closing procoxal cavities posteriorly. *Elytron* with distinct, dense punctures that terminate at anterior margin of dark, apical macula, with areas of dense, short, erect, velvety white, pubescence that does not obscure surface and sparse, longer, erect, black setae scattered on basal two-thirds. Elytron bicolored: basal one-half orange, apical one-half iridescent purplish-black. Purplish-black elytral apex highly modified and contorted with 2 elevated costae at middle with crest of erect, short, black setae. Intercostal region between them is level, with small region of erect, black setae. Humerus not projecting anterolaterally, with pubescence similar to adjacent regions. Elytral apices narrowly rounded to suture, without spines. Elytron 5.9 mm long; 1.3 mm wide; elytral length/width: 4.5. *Scutellum* narrowly subtruncate posteriorly, with short, black setae and orange ground color. *Legs* with tibiae weakly thickened apically. Femora and tibiae slender, elongate; metafemur surpassing third ventrite. Legs with white and translucent pubescence not obscuring surface, becoming most dense and darker on tibiae. Femora orange; tibiae dark reddish-brown; tarsomeres dark reddish-brown at apices. *Venter* mostly sparsely and inconspicuously pubescent (not obscuring surface). Venter orange throughout except for apex of fifth ventrite of male which is darkened. Apex of fifth ventrite of males broadly truncate with small median notch (females unknown).

Etymology. The species epithet is a Latin noun, nominative case, masculine gender that refers to the contorted elytral apex.

Notes. This species, along with *C. thonalmus*, is among the most highly morphologically evolved members of the Batesian mimicry complex with the lycid beetle genus *Thonalmus* (Fig. 2b). It is known from one specimen.

Material. Holotype (male): Dominican Republic, [San Cristóbal Province], Colonia Ramfis, 3 April 1953, J. A. Ramos (USNM).

Calocosmus punctatus Lingafelter, sp. n.

urn:lsid:zoobank.org:act:428B2358-139A-490C-8177-A4525D6A330F
http://species-id.net/wiki/Calocosmus_punctatus
Fig. 5a; Map 2

Diagnosis. This species is distinct from other species of *Calocosmus* (and other Hispaniolan hemilophines) by the distinct, dense punctures throughout the elytra, the all black antennae with very narrowly white annulate antennomeres, and the nearly completely black elytra except for the pattern of orange maculae as described below.

Description. Size: 12.3 mm long; 4.9 mm wide between humeri. *Head* with dense vestiture of very short, appressed off-white setae, thickened at base, almost scale-like but not obscuring surface, most dense on frons and around antennae, less dense elsewhere. Large, well-defined, non-contiguous punctures scattered throughout head. Frons not bulging, level between eyes with division by a median groove extending to vertex. Gena below lower eye lobe and mandibular base a little more than one-half height of lower eye lobe; frontal-genal ridge incomplete, extending briefly at 45 degree angle between eye margin and clypeal margin. Anteclypeal sulcus absent. Eye not large, not bulging laterally on lower lobe beyond plane of head, finely faceted, upper lobe connected to lower lobe by 3 facets at narrowest point, lower lobe larger than upper lobe, occupying about one-fourth of head from lateral view. Interantennal region not impressed, antennal tubercles very slightly elevated. Antenna moderately stout, short, not attaining elytral apex in female (males unknown). Antenna with vestiture of appressed, dense, short pubescence of two colors, white and black, and scattered, sparse, long setae, especially at antennomere apices and mesal margins. Antennomeres black with exception of extreme bases that are annulate with appressed, white, setae. Antennomere 3 not very long (shorter than scape + 2; nearly as long as 4+5, which are short), subsequent antennomeres very short and subequal or gradually decreasing in length. *Prothorax* cylindrical, slightly broader than long (2.7 mm long; 4.0 mm wide), distinctly narrower than elytral base, with small post-lateral protuberance, densely covered with appressed, short,

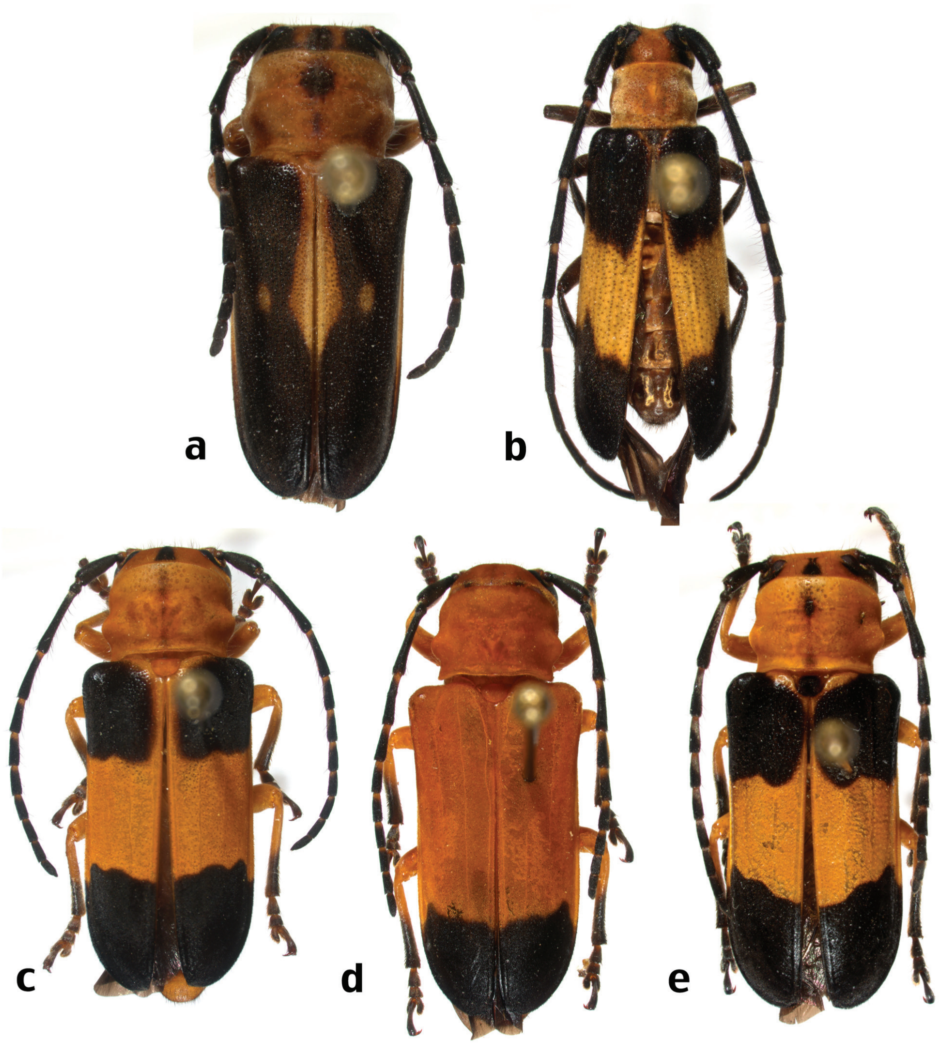
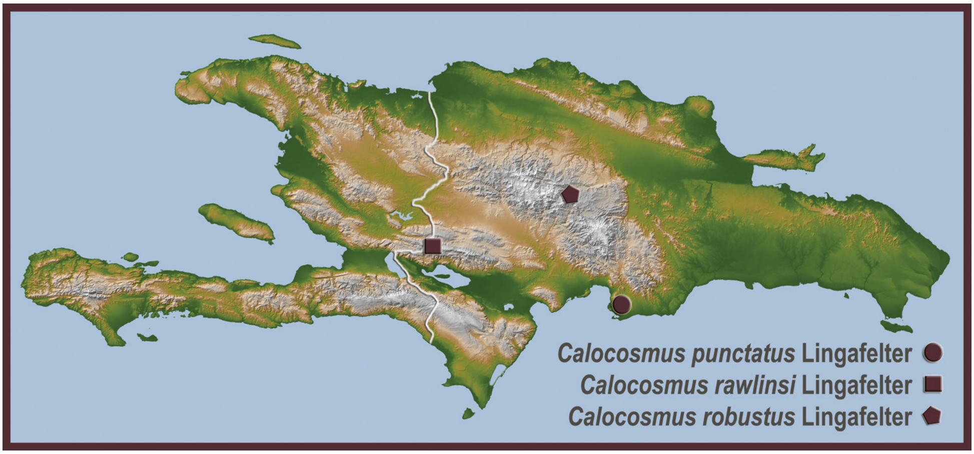


Figure 5. New species of Hispaniolan Hemilophini (not to scale): **a** *Calocosmus punctatus* Lingafelter, sp. n., holotype **b** *Calocosmus rawlinsi* Lingafelter, sp. n., holotype **c** *Calocosmus robustus* Lingafelter, sp. n., holotype **d** *Calocosmus robustus* Lingafelter, sp. n., paratype **e** *Calocosmus robustus* Lingafelter, sp. n., paratype.

yellowish-orange scale-like pubescence, however not obscuring integument. Pronotum with overall orange appearance with ovate, black divided macula at middle and slightly darker patches anterior to elytral base. Pronotum with distinct, large, non-contiguous punctures, without dorsal calli or tubercles, but with swelling posterior to middle. Pronotum a little less than one-fourth length of body. Prosternum inconspicuously pubescent with short, appressed, orange or yellow setae. Prosternal process broadly expanded at apex, closing procoxal cavities posteriorly. *Elytron* with distinct, dense punctures throughout except on extreme apex, covered in dense, short pubescence, but not obscuring surface. Elytral color black, except for orange pattern as follows: base around



Map 2. Distributional locality records for new species of Hispaniolan Hemilophini.

scutellum, along suture to middle, along part of epipleuron, and small antemedial spot. Humerus moderately projecting anterolaterally, with extreme apex glabrous. Elytral apices broadly rounded to suture, without spines. Elytron 8.9 mm long; 2.5 mm wide; elytral length/width: 3.6. *Scutellum* broadly rounded posteriorly, with dense but inconspicuous pubescence that does not obscure orange ground color. *Legs* with femora and tibiae weakly thickened apically. Metafemora short, just barely extending to third ventrite. Legs with white and translucent pubescence not obscuring surface, becoming most dense at apex of tibiae. Legs orange except for apical one-half of tibiae and all of tarsi which are black. *Venter* mostly densely but inconspicuously pubescent (not obscuring surface). Venter orange throughout except for dark spot on metasternum, part of metepisternum, and lateral margin of ventrites 1–3. Apex of fifth ventrite of females broadly truncate with very small median notch (males unknown).

Etymology. The specific epithet is a Latin adjective, nominative case, masculine gender that refers to the dense, conspicuous elytral punctures.

Notes. This species is known from a single specimen.

Material. Holotype (female): Dominican Republic: Peravia Prov., 12.4 km E. Rio Ocoa, 3 July 1992, M. A. & R. O. Ivie, collectors (WIBF, transferred to USNM).

Calocosmus rawlinsi Lingafelter, sp. n.

urn:lsid:zoobank.org:act:CB50E9D9-2BD8-408B-B971-9A1BB583EC0F
http://species-id.net/wiki/Calocosmus_rawlinsi
Fig. 5b; Map 2

Diagnosis. This slender species is distinguished from all other Hispaniolan hemilophines by the combination of having the legs nearly completely dark reddish-brown to black, base of elytron, including scutellum, nearly completely dark, apical region of elytron dark, mostly pubescent and impunctate, and humeri not projecting. It is most similar to *C. chevrolati* Fisher, but in that species the femora and scutellum are fulvous-orange and the apical black elytral macula is mostly punctate.

Description. Size: 9.6 mm long; 2.7 mm wide between humeri. *Head* with dense vestiture of very short, appressed yellow-orange setae, not thickened at base, not obscuring surface, most dense on frons and antennal tubercles, less dense elsewhere. Scattered long, black setae present on frons. Large, well-defined, non-contiguous punctures scattered throughout head. Frons not bulging, slightly concave between eyes with poorly defined median groove extending to vertex. Gena below lower eye lobe and mandibular base about one-half height of lower eye lobe; frontal-genal ridge incomplete, extending dorsally but not contacting eye margin. Anteclypeal sulcus absent. Eye large, slightly bulging laterally on lower lobe beyond plane of head, finely faceted, upper lobe connected to lower lobe by 3 facets at narrowest point, lower lobe larger than upper lobe, occupying about one-third of head from lateral view. Interantennal region weakly impressed, antennal tubercles weakly elevated. Antenna moderately slender, exceeding elytral apex by a little more than 2 antennomeres in male (females unknown). Antenna with vestiture of appressed, dense, short, black pubescence and fringe of long setae, especially at antennomere apices and mesal margins. Antennomeres black with exception of extreme bases of 3–7 that are orange-fulvous annulate. Antennomere 3 not very long (only slightly longer than scape + 2; shorter than 4+5), subsequent antennomeres subequal or gradually decreasing in length. *Prothorax* cylindrical, broader than long (1.5 mm long; 2.0 mm wide), distinctly narrower than elytral base, with small lateral protuberance at middle, densely covered with appressed, short, yellowish-orange scale-like pubescence, however not completely obscuring integument. Pronotum with overall orange appearance, without maculae. Pronotum with distinct, large, non-contiguous punctures on most of disc, without dorsal calli or tubercles. Pronotum a little less than one-sixth length of body. Prosternum inconspicuously pubescent with short, appressed, orange or yellow setae. Prosternal process between strongly protuberant procoxae, broadly expanded at apex, closing procoxal cavities posteriorly. *Elytron* with distinct, dense punctures throughout but absent from most of apical black maculate region, covered in dense, short pubescence of two colors, black and yellow-orange, but not obscuring surface. Elytral color with black and orange pattern as follows: most of basal third black, most of middle third orange, most of apical third black. Humerus not projecting anterolaterally, without glabrous region. Elytral apices narrowly rounded to suture, without spines. Elytron 7.3 mm long; 1.4 mm wide; elytral length/width: 5.2. *Scutellum* broadly rounded posteriorly, with moderately dense, black pubescence and dark ground color. *Legs* with tibiae weakly thickened apically. Metafemur extending to third ventrite. Legs mostly covered with black setae, not obscuring surface, becoming most dense at apex of tibiae. Legs black throughout except for coxa and anterior face of profemur which are reddish-brown. *Venter* mostly densely but inconspicuously pubescent (not obscuring surface). Venter mostly orange throughout, but suffused with darker areas on some thoracic and abdominal sclerites. Apex of fifth ventrite of male rounded, without median notch (females unknown).

Etymology. The species epithet is a genitive patronym in honor of John Rawlins (CMNH) for leading important expeditions to the Dominican Republic and collecting the holotype.

Notes. This species is known from a single specimen.

Material. Holotype (male): Dominican Republic: Elias Pina Prov., Sierra de Neiba, 9.1 km WSW Hondo Valle, 18°41'38"N, 71°46'56"W, 1856 m, 30 April 2006, J. Rawlins, J. Hyland, R. Davidson, C. Young, D. Koenig, J. Fetzner, wet montane forest, pine, hand collected, Sample 31246, Carnegie Museum Specimen Number CMNH-532,987 (CMNH).

Calocosmus robustus Lingafelter, sp. n.

urn:lsid:zoobank.org:act:B1DCD724-CEB3-4D9A-9CDF-A9091E8109A3
http://species-id.net/wiki/Calocosmus_robustus
Fig. 5c-e; Map 2

Diagnosis. Like *C. nigritarsis*, this is a highly polymorphic species with regard to maculations of the head, pronotum, scutellum, and elytron. This robust species is most similar to *C. melanurus* and *C. nigritarsis* in its large size and proportions. It differs from *C. melanurus* in having at least part of the tibiae and tarsi darkened (entirely fulvous in *C. melanurus*). It differs from *C. nigritarsis* in having most antennomeres with basal fulvous annulations and a pronotum either entirely fulvous or with a very small anteromedial dark macula (antennae black and most antennomeres without basal annulations; pronotum usually with a large anteromedial black macula in *C. nigritarsis*).

Description. Size: 13.4–15.4 mm long; 5.2–5.9 mm wide between humeri. *Head* with dense vestiture of very short, orange pubescence that does not obscure surface, maculae of similar black pubescence present on vertex and/or posterior to upper eye lobes in some specimens. Scattered long, black setae present on frons. Large, well-defined, non-contiguous punctures scattered throughout frons and posterior to upper eye lobes. Frons not bulging, either level or slightly convex between eyes, with division by median groove extending to vertex. Gena below lower eye lobe and mandibular base about one-half height of lower eye lobe; frontal-genal ridge incomplete, extending for a short distance at 45 degree angle between eye margin and clypeal margin. Anteclypeal sulcus absent. Eye small, not bulging laterally on lower lobe beyond plane of head, finely faceted, upper lobe connected to lower lobe by 2–3 facets at narrowest point, lower lobe larger than upper lobe, occupying about one-fourth of head from lateral view. Interantennal region not impressed, antennal tubercles not or very slightly elevated. Antenna moderately stout, short, not attaining elytral apex in females (males unknown). Antenna with vestiture of appressed, dense, short, translucent pubescence (also white pubescence in one specimen) and scattered, sparse, long black and translucent setae, especially at antennomere apices and mesal margins. Antennomeres black with exception of extreme bases that are orange-fulvous annulate (sometimes with appressed, white setae). Antennomere 3 short (only slightly longer than scape + 2; subequal to or slightly longer than 4+5 which are short), subsequent antennomeres subequal or gradually decreasing in length. *Prothorax* cylindrical, broader than long (2.8–3.1 mm long; 4.0–4.5 mm wide); distinctly narrower than elytral base, with pronounced lateral protuberance at middle, densely covered with short orange-red setae, however not obscuring integument. Pronotum with overall orange appearance, immaculate or with small, ill-defined black macula at center of disc. Pronotum with distinct, large, mostly non-contiguous punctures throughout, without dorsal calli or tubercles, but with swelling at middle. Pronotum about one-fifth length of body. Prosternum inconspicuously pubescent with short, orange or red setae. Prosternal process between strongly protuberant procoxae, broadly expanded at apex, closing procoxal cavities posteriorly. *Elytron* with distinct, dense punctures, becoming shallow or absent by apical third, covered in dense, separate regions of short, velvet-like orange or red pubescence, but not obscuring surface. Elytral color variable, with black and orange or red regions as follows: basal and apical one-third black with middle one-third orange or red, or basal two-thirds orange or red with apical one-third black. Humerus moderately or weakly projecting anterolaterally, partially denuded of pubescence at apex. Elytral apices broadly rounded to suture, without spines. Elytron 9.9–11.3 mm long; 2.6–3.0 mm wide; elytral length/width: 3.7–3.8. *Scutellum* broadly rounded posteriorly, with inconspicuous pubescence that does not obscure orange or black ground color. *Legs* with tibiae weakly thickened apically. Metafemur short, barely reaching third ventrite. Legs with white and translucent pubescence not obscuring surface, becoming most dense at apex of tibiae. Legs orange except for apical one-half of tibiae and all or part of tarsi which are black. *Venter* mostly densely but inconspicuously pubescent, not obscuring surface. Venter orange throughout or with dark spot on metasternum and occasionally metepisternum. Apex of fifth ventrite of females rounded, with median notch (males unknown).

Etymology. The species epithet is a Latin adjective, nominative case, masculine gender that refers to the robustness of the individuals.

Notes. This species is known from 3 female specimens.

Material. Holotype (female): Dominican Republic, La Vega Province, Parque Nacional Armando Bermudez, km 1–3 along trail W of La Ciénaga, 900–1100 m, 19°01.753'N, 70°54.654'W, 2 July 2010, N. E. Woodley (USNM). Paratypes (2 females): Dominican Republic, La Vega Province, Parque Nacional Armando Bermudez, km 1–3 along trail W of La Ciénaga, 900–1100 m, [no coordinates], 7 June 2005, SpecID: 7062, Gino Nearns (ENPC); same data but 24 June 2005, SpecID: 7608, Nearns & Lingafelter (USNM).

Calocosmus thonalmus Lingafelter, sp. n.

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http://species-id.net/wiki/Calocosmus_thonalmus
Fig. 6a-d; Map 3

Diagnosis. This species is very distinctive since it, along with *C. contortus*, are the only ones with a highly modified elytral apex with elevated, pubescent ridged costae and deep

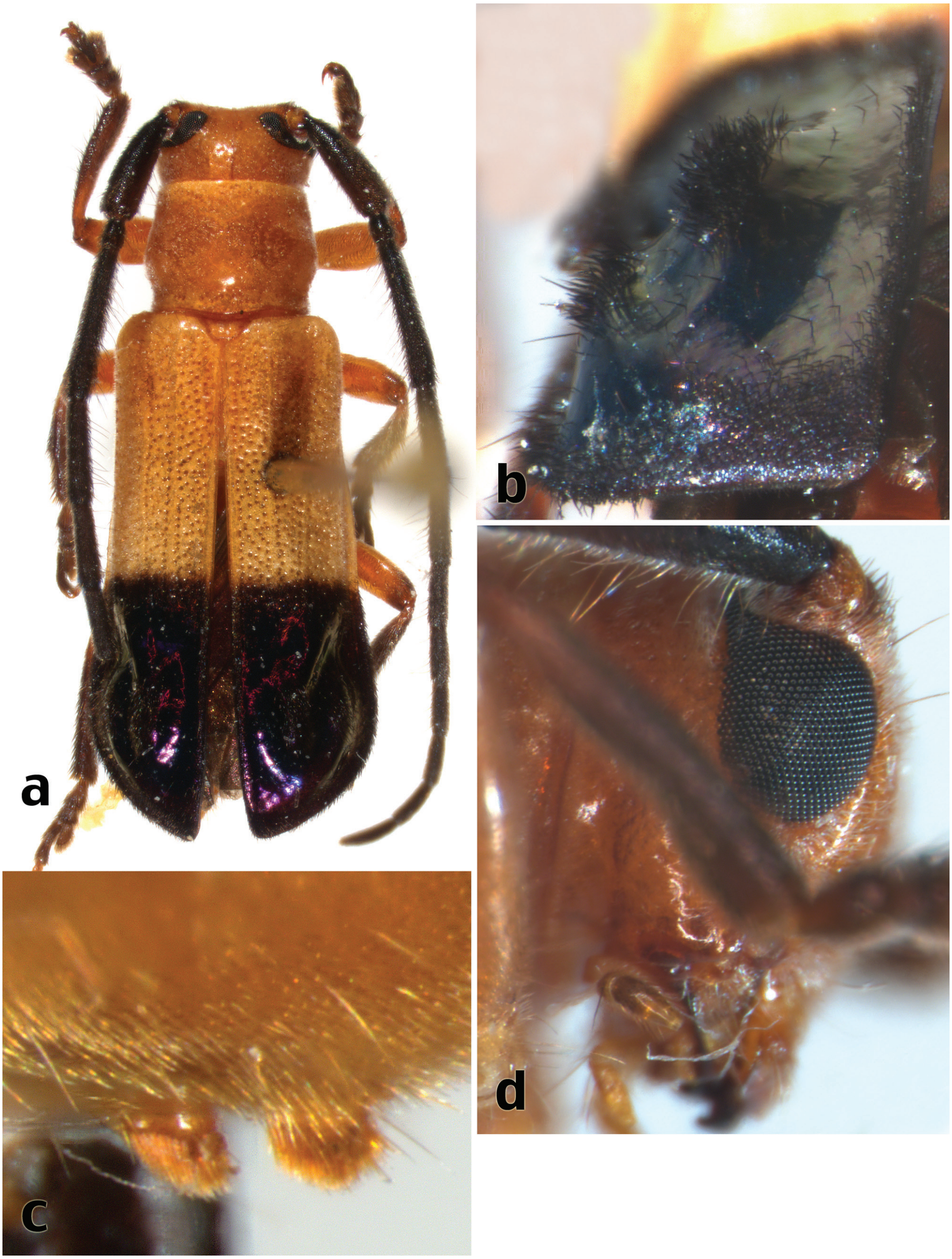
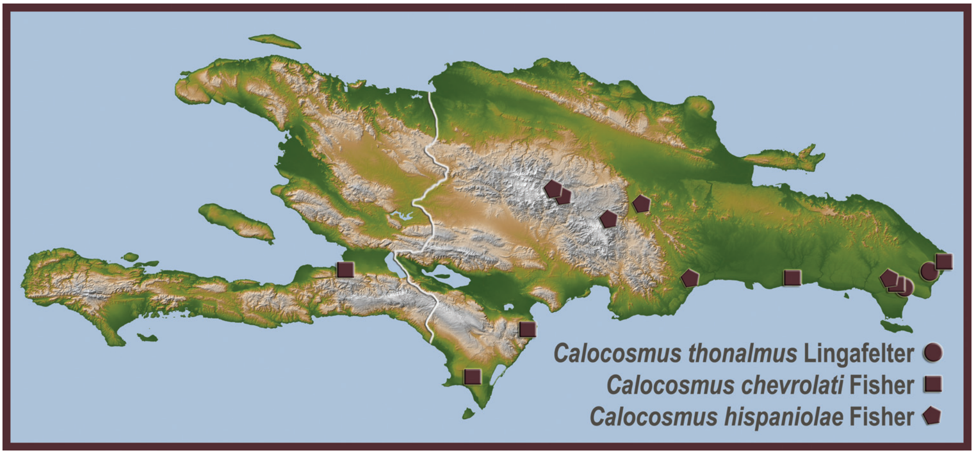


Figure 6. *Calocosmus thonalmus* Lingafelter, sp. n., holotype: **a** dorsal habitus **b** elytral apex **c** metasternal pubescent tufts **d** lateral view of head.

intercostal spaces, giving a contorted appearance. It is distinguished from *C. contortus* by its uniformly black antennae (antennomeres 4–7 fulvous at the base in *C. contortus*); smaller lower eye lobe that is far removed from the genal base (gena is about one-third of



Map 3. Distributional locality records for new species and new distributional records for previously described Hispaniolan Hemilophini.

the height of the lower eye lobe in *C. contortus*); elytra with two apical pubescent costae separated by a concave depression (a third minor costa is present between the two major ones in *C. contortus*); relatively short metasternal setal brush (this setal brush, apparently only developed in males of some species of *Calocosmus*, is much longer in *C. contortus*); and in its much shorter, thickened legs with the metafemur barely reaching the third ventrite (extending to the posterior margin of the third ventrite in *C. contortus*.) It is also superficially similar to some specimens of *C. hispaniolae* since both species possess a dark, shiny apical area of the elytron (with elevated costae in some specimens of *C. hispaniolae*), but they are never convoluted with pubescent crests as in *C. thonalmus*.

Description. Size: 7.0–7.9 mm long; 2.1–2.7 mm wide between humeri. *Head* with dense vestiture of very short, ashy-white setae, slightly thickened at base, but not obscuring surface, along with scattered long, translucent or dark setae on frons. Numerous well-defined, mostly non-contiguous punctures scattered throughout head. Frons not bulging, either level or slightly concave between eyes, with division by median groove extending to vertex. Gena below lower eye lobe and mandibular base about two-thirds height of lower eye lobe; frontal-genal ridge very short, extending for a short distance vertically toward eye margin from genal margin. Anteclypeal sulcus absent. Eye small to moderate sized, very weakly bulging laterally on lower lobe beyond plane of head, finely faceted, upper lobe connected to lower lobe by 2–3 facets at narrowest point, lower lobe larger than upper lobe, occupying about one-fourth of head from lateral view (slightly smaller in females). Interantennal region not impressed, antennal tubercles not elevated. Antenna moderately stout, short, surpassing elytral apex by less than 1 antennomere in females and a little more than 2 antennomeres in males. Antenna with vestiture of semi-appressed, dense, short, black pubescence and scattered, sparse, long setae, especially at antennomere apices and mesal margins. Antennomeres black, without annulations. Antennomere 3 longer than scape + 2 but shorter than 4+5, subsequent antennomeres short and gradually decreasing in length. *Prothorax* cylindrical, broader than long (1.3–1.6

mm long; 1.6–2.0 mm wide), distinctly narrower than elytral base, with middle swelling and lateral protuberance, densely covered with short yellowish-orange setae, however not obscuring integument. Pronotum with overall orange appearance, without maculae. Pronotum with distinct, large, mostly non-contiguous punctures throughout. Pronotum about one-fifth length of body. Prosternum inconspicuously pubescent with short, orange or translucent setae. Prosternal process broadly expanded at apex, closing procoxal cavities posteriorly. *Elytron* with distinct, dense punctures that terminate at anterior margin of dark, apical macula, with areas of dense, short, erect, velvety white, pubescence that does not obscure surface and sparse, longer, erect, black setae scattered on basal two-thirds. Elytron bicolored: slightly more than basal one-half orange, slightly less than apical one-half iridescent purplish-black. Purplish-black elytral apex highly modified and contorted with 2 elevated costae at middle with crest of erect, short, black setae. Intercostal regions concave and mostly glabrous. Humerus not projecting anterolaterally, partially denuded of pubescence at apex. Elytral apices narrowly rounded to suture, without spines. Elytron 4.8–5.7 mm long; 1.0–1.4 mm wide; elytral length/width: 4.0-4.8. *Scutellum* broadly subtruncate posteriorly, mostly glabrous with orange ground color. *Legs* with tibiae weakly thickened apically. Femora and tibiae short; metafemur barely reaching third ventrite. Legs with white and translucent pubescence not obscuring surface, becoming most dense at apex of tibiae. Femora orange; tibiae orange to black; tarsi dark orange to black. *Venter* mostly sparsely and inconspicuously pubescent, not obscuring surface. Venter orange throughout except for apex of fifth ventrite of both sexes which is piceous. Apex of fifth ventrite of females broadly truncate with very small median notch, broadly rounded with relatively larger notch in males.

Etymology. The species epithet is a Latin noun, nominative case, masculine gender that refers to the similarity of this species to members of the lycid genus, *Thonalmus* Bourgeois.

Notes. This species, along with *C. contortus*, is a highly modified member of the Batesian mimicry complex with the lycid beetle genus *Thonalmus* (Fig. 2b). It is known from two specimens.

Material. Holotype (male): Dominican Republic, La Altagracia Province, El Veron, road to Hoyo Azul, 25–40 m, beating, SpecID: 6701, Nearns & Lingafelter, 26 June 2005 (ENPC, transferred to USNM). Paratype (1 female): Dominican Republic, La Altagracia Province, Parque Nacional del Este, 2.9 km SW Boca de Yuma, 18°21'51"N, 68°37'05"W, 11 m, 28 May 2004, C. Young, J. Rawlins, J. Fetzner, C. Nunez, semi-humid dry forest, limestone, UV light, Sample 52114, CMNH 396,805 (CMNH).

Calocosmus chevrolati Fisher

http://species-id.net/wiki/Calocosmus_chevrolati
Fig. 7a-b; Map 3

Diagnosis. This species is variable with regard to the presence or absence of dark maculae at the elytral base and or humerus. It is similar to *C. hispaniolae* in size and proportions,

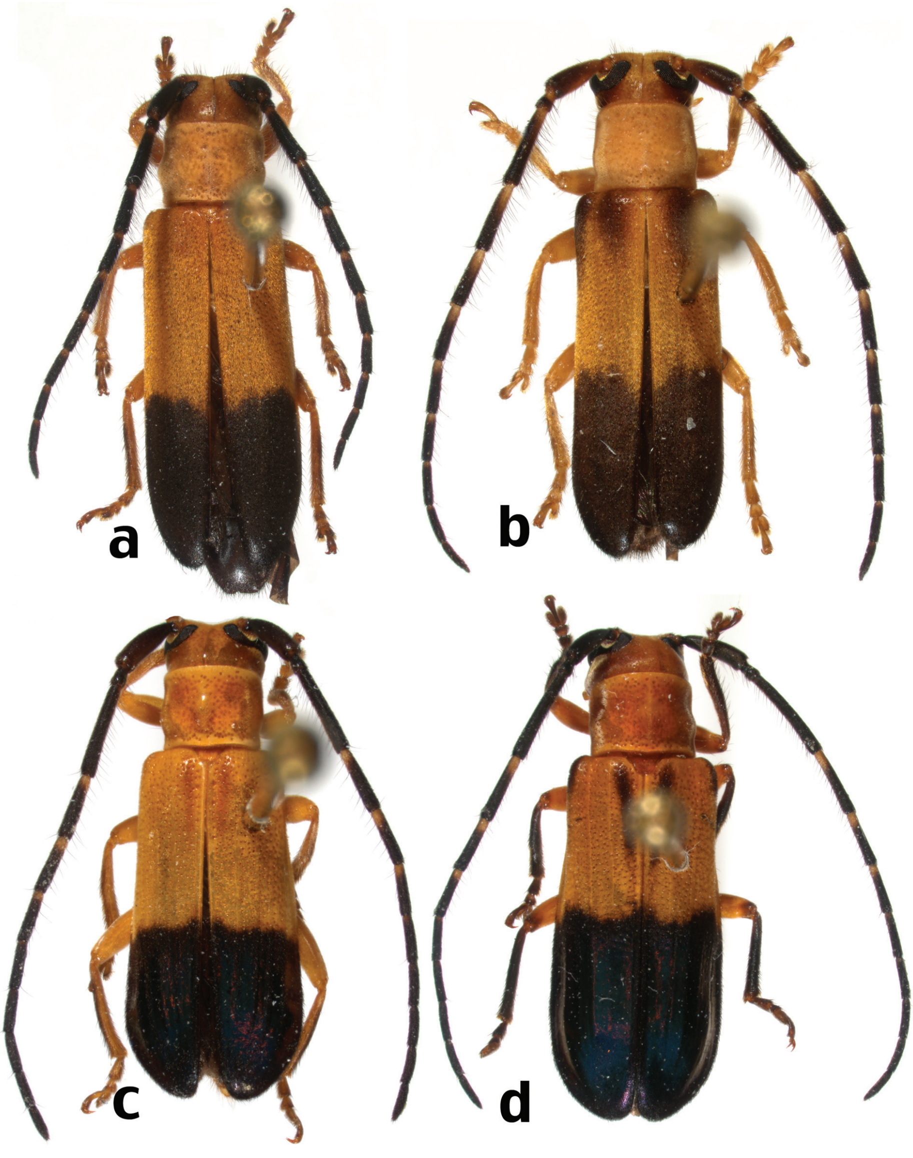


Figure 7. Dorsal habitus of *Calocosmus* species: **a** *C. chevrolati* Fisher (morphotype 1) **b** *C. chevrolati* Fisher (morphotype 2) **c** *C. hispaniolae* Fisher (morphotype 1) **d** *C. hispaniolae* Fisher (morphotype 2).

but the apical black elytral macula is matte and lacks the metallic purple iridescence that is present in *C. hispaniolae*. This region is also very pubescent and punctate while in *C. hispaniolae*, large areas are devoid of pubescence and punctation. It is somewhat similar to *C. rawlinsi*, but differs in having punctures in the apical dark portion of the elytron and in having the femora fulvous (dark reddish-brown to black in *C. rawlinsi*).

Notes. This species, previously known only from Cuba, is here recorded for Hispaniola, a new island record. Haiti and the Dominican Republic represent new country records.

New distributional data. Haiti, Port au Prince, 1899, R. D. Crew (1 specimen, USNM); Dominican Republic, La Altagracia Province, Parque Nacional del Este, Boca de Yuma, 18°21.508'N, 68°36.956'W, 19 July 2004, N. Woodley, S. Lingafelter & 20 July 2004, D. Perez, S. Lingafelter (2 specimens, USNM); Dominican Republic, La Altagracia Prov, Punta Cana, near Ecological Reserve, 0-5 meters, 18°30.477'N, 68°22.499'W, 14 June 2005, S. Lingafelter & 2 July 2006, S. Lingafelter (2 specimens, USNM); Dominican Republic, Barahona Province, 11 km S. Barahona, May 6–17, 1985, E. Giesbert, coll. (FSCA); Dominican Republic, Pedernales, PN Jaragua, 99 m, UV light, 3 km S Los Tres Charcos, Spec. ID 7034, Nearns and Lingafelter, 16 June 2005 (1 specimen, ENPC); Dominican Republic, San Pedro de Macorís Province, 12 km W. San Pedro de Macorís, 5–19 May, 1985, E. Giesbert, coll. (FSCA).

Calocosmus hispaniolae Fisher

http://species-id.net/wiki/Calocosmus_hispaniolae
Fig. 7c-d; Map 3

Diagnosis. In size and proportions, this species is similar to *C. chevrolati*. It is easily distinguished by having the dark apex of the elytron with a shiny, metallic purple iridescence (black with a matte finish in *C. chevrolati*). Also, this apical region has areas lacking pubescence and punctures (densely punctate and pubescent in *C. chevrolati*). The metallic elytral apex sometimes has elevated costae making specimens similar to *C. thonalmus* and *C. contortus*, however, the elytral apex is never contorted to that extreme and lacks the costal pubescent ridges characteristic of those species.

Notes. This species is known only from Hispaniola.

New distributional data. Dominican Republic, La Altagracía Province, Parque Nacional del Este, Boca de Yuma, 18°21.508'N, 68°36.956'W, 20 July 2004, N. Woodley, S. Lingafelter (1 specimen, USNM); Dominican Republic, La Vega Province, Parque Nacional Armando Bermudez, km 1–3 along trail west of La Ciénega, 1100 m, 22 June 2005, A. Konstantinov (1 specimen, USNM); Dominican Republic, Santiago Province, Parque Nacional Armando Bermudez, Rio Bao, 1212 m, 10 July 1992, M A. & R. O. Ivie (1 specimen, WIBF); Dominican Republic, La Altagracia Province, Parque del Este, 2.9 km southwest of Boca de Yuma, 18°21.51'N, 68°37.05'W, 11 m, 28 May 2004, C. Young, J. Rawlins, J. Fetzner, C. Nunez, semihumid dry forest, limestone, hand collected, 52114, CMNH 327,105 (1 specimen, CMNH); Dominican Republic, La Vega Province, 4.1 km southwest El Convento, 18°50.37'N, 70°42.48'W, 1730 m, 31 May 2003, J. Rawlins, R. Davidson, C. Young, C. Nuñez, P. Acevedo, dense secondary evergreen forest with pine, hand collected, sample 22242, CMNH 319,721 (1 specimen, CMNH); Dominican Republic, San Cristóbal Province, 10 miles north San Cristóbal, 27 August, 1967, J. C. Schaffner (1 specimen, TAMU); Dominican Republic, La Vega Province, 8 miles west Jayaco, 3 August, 1967, J. C. Schaffner (1 specimen, TAMU).

Calocosmus janus Bates

http://species-id.net/wiki/Calocosmus_janus
Fig. 8a; Map 4

Calocosmus holosericeus Gahan, 1889: 395, syn. n.

Diagnosis. This species is easily distinguished from all other Hispaniolan Hemilophini by the uniformly purplish-black elytra, black antennae without annulations, and pronounced elytral humeri. The only other species with mostly dark elytra are *Calocosmus punctatus*, *C. semimarginatus*, and *C. nigripennis*. *Calocosmus punctatus* is distinguished easily by having the antennae with basal annulations of gray pubescence on most antennomeres, the elytra with scattered fulvous regions, and having the elytral punctures far more dense and well defined than in *C. janus*. *Calocosmus semimarginatus* and *C. nigripennis* are easily distinguished by lacking humeral projections and by their small size (most specimens less than 8 mm long while most specimens of *C. janus* are greater than 10 mm long).

Notes. *Calocosmus holosericeus* Gahan is a new synonym of *Calocosmus janus* Bates. Photos of the holotypes show they are nearly identical, as are the original Latin descriptions for each. *Calocosmus holosericeus* was described from Hispaniola and *C. janus* was described from Cuba. The Dominican Republic and Hispaniola therefore represent new country and island records for *C. janus*.

New distributional data. Dominican Republic, Pedernales Province, Parque Nacional Sierra de Baoruco, Las Abejas, 18°09.011'N, 71°37.342'W, 1150 m, 18 June 2005, S. Lingafelter (1 specimen, USNM); Dominican Republic, Barahona Province, 4.5 km S. Barahona, 23 May 1992, R. Turnbow (1 specimen, RHTC).

Calocosmus magnificus Fisher

http://species-id.net/wiki/Calocosmus_magnificus
Figs 1b, 8b; Map 4

Diagnosis. This large species is easily recognized by its striking, bold red or orange coloration with black maculae on the elytra and pronotum. It is the only species with the apical black macula of the elytron restricted to less than the apical one-eighth, a small, humeral macula, and the pronotum dorsally with three small, dark maculae (one at center, and one at each side of center). The postmedial black macula can range in size from a spot less than half the width of the elytron to a transverse band extending the full width of the elytron.

Notes. This is perhaps the most strikingly colored *Calocosmus* known. In life, specimens have a vivid red color with bold, black maculae. Unfortunately, this fades to pale orange or yellow in most pinned specimens. This species was described from Haiti, and recorded herein from the Dominican Republic for the first time.

New distributional data. Dominican Republic, Pedernales Province, 13 May 2010, 1 km N. of Banano, Rio Molito, 18°09.256'N, 71°45.384'W, 290 m, Kelvin

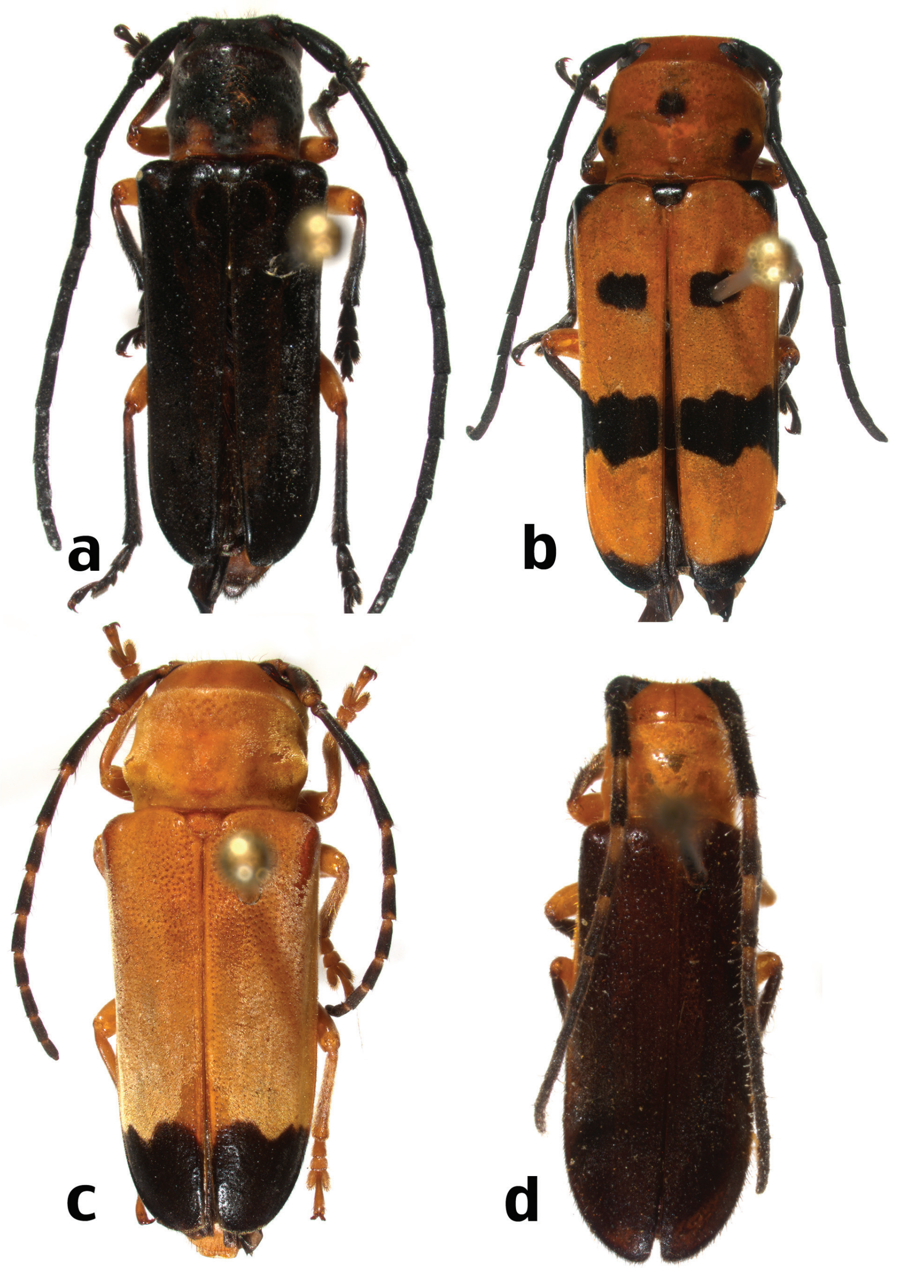
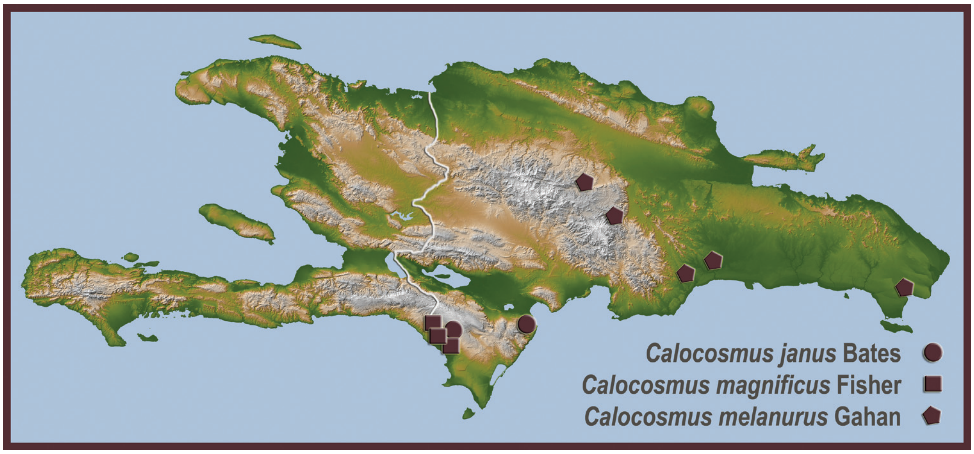


Figure 8. Dorsal habitus of *Calocosmus* species (not to scale): **a** *C. janus* Bates **b** *C. magnificus* Fisher **c** *C. melanurus* Gahan **d** *C. nigripennis* Chevrolat.

Guerrero (1 specimen, USNM); Dominican Republic, Pedernales Province, 25 km N. Cabo Rojo, 18°06.769'N, 71°37.245'W, 679 m, Kelvin Guerrero (1 specimen, USNM); Dominican Republic: Pedernales, Sierra de Baoruco, Aceitillar, 23.6 km NE



Map 4. New distributional locality records for previously described Hispaniolan Hemilophini.

Pedernales, 18°09'23"N, 71°34'09"W, 1560 m., 14 June 2003, C. Young, J. Rawlins, C. Nunez, R. Davidson, P. Acevedo, M. de la Cruz, open pine forest with grassland, hand collected sample 42142, Carnegie Museum Specimen Number 318,968 (1 specimen, CMNH).

Calocosmus melanurus Gahan

http://species-id.net/wiki/Calocosmus_melanurus
Fig. 8c; Map 4

Diagnosis. This species is very similar to some specimens of *C. nigritarsis* and *C. robustus* with regard to dorsal coloration, size, and proportions. It is distinguished from them by having fulvous tibiae and mostly fulvous tarsi (tibial apex and tarsi, at least, dark reddish-brown to black in *C. nigritarsis* and *C. robustus*); more distinctly fulvous annulate antennomeres (at least 4–7), and a dense vestiture of ashy pubescence on the pronotum and elytra of fresh specimens (less conspicuous or absent in other species).

Notes. This species has some external sexual dimorphism. Females are broader, have more pronounced lateral and dorsal pronotal swelling, and have less pronounced elytral humeri than males.

New distributional data. Dominican Republic, Santo Domingo Province, Puerto Vaca, Sierra Prieta, 18°38'N, 69°57'W, 27 May 2004, R. H. Bastardo (1 specimen, USNM); Dominican Republic, La Altagracía Province, Parque Nacional del Este, Boca de Yuma, 18°21.508'N, 68°36.956'W, 3–20 m, 27 June 2005, M. L. Chamorro (1 specimen, USNM); Dominican Republic, San Cristóbal Province, Las Desanparados, San Cristóbal, August, 1987 (1 specimen, USNM); Dominican Republic, La Vega, 5.1 km. N. Manabao, 5 June 1994, R. Turnbow (1 specimen, RHTC); Dominican Republic, La Vega Province, Constanza, 17 July 1996, R. Turnbow (1 specimen, RHTC); Dominican Republic, La Vega, 2 km. N Jarabacoa, 25 May 1992, R. Turnbow (1 specimen, RHTC).

Calocosmus nigripennis Chevrolat

http://species-id.net/wiki/Calocosmus_nigripennis
Fig. 8d; Map 5

Diagnosis. This species, like *C. janus*, *C. punctatus*, and *C. semimarginatus*, typically has nearly completely black elytra. It is immediately distinguished from *C. janus* and *C. punctatus* by its slender form, without projecting humeri, and small size, less than 8 mm long (more than 10 mm long and much broader in *C. janus* and *C. punctatus*). Chevrolat (1862), in his original description, indicates that *C. nigripennis* can be recognized by having the pronotum transversely bisulcate, although this feature is less pronounced in the Haiti specimen than in the holotype.

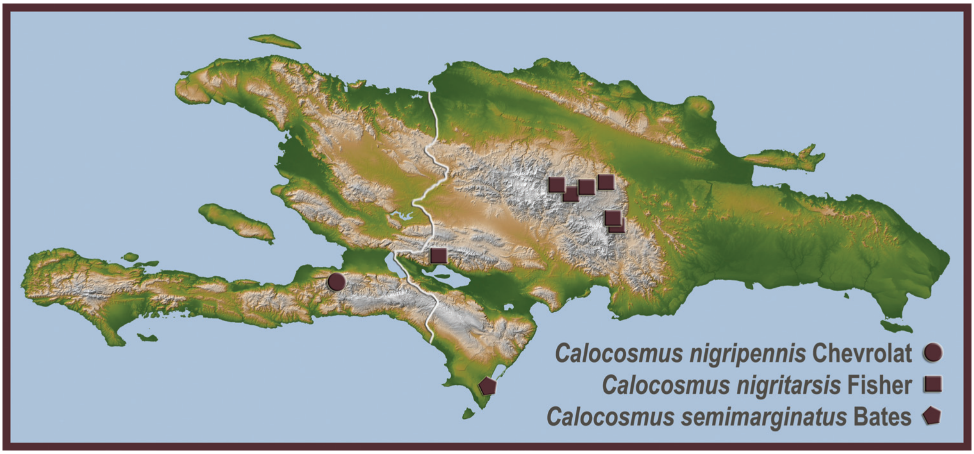
Notes. This species, previously known only from Cuba, is now recorded from Haiti (new country and island record). Other specimens examined from Cuba, while similar in most other features, have the elytral base varying from all black to pale orange. Additional material is needed to fully understand the level of variation of this species.

New distributional data. Haiti, Ouest Department, Kenscoff, 1200 m, May 25, 1984, M. Thomas (1 specimen, FSCA).

Calocosmus nigritarsis Fisher

http://species-id.net/wiki/Calocosmus_nigritarsis
Figs 1c-d, 9a-c; Map 5

Diagnosis. Like *C. robustus*, this is a highly polymorphic species with regard to maculations of the head, pronotum, scutellum, and elytron. It is allied with the group of large, robust species that include *C. robustus* and *C. melanurus*. It is distinguished from *C. melanurus* by having the tibiae partially and tarsi completely piceous (the tibiae are completely and the tarsi are at least partially fulvous in *C. melanurus*). The antennae



Map 5. New distributional locality records for previously described Hispaniolan Hemilophini.

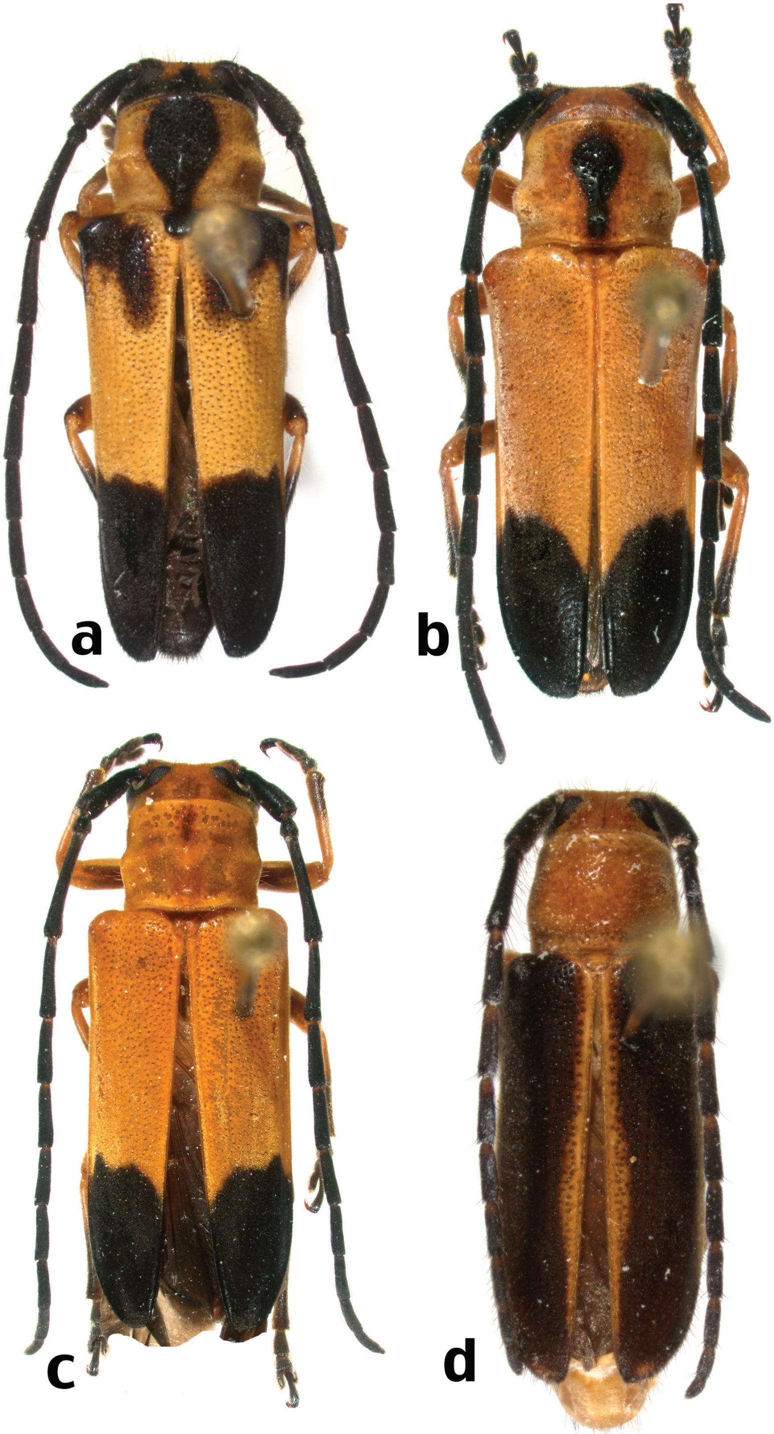


Figure 9. Dorsal habitus of Hispaniolan Hemilophini species (not to scale): **a** *C. nigritarsis* Fisher (morphotype 1) **b** *C. nigritarsis* Fisher (morphotype 2) **c** *C. nigritarsis* Fisher (morphotype 3) **d** *C. semimarginatus* Bates.

of *C. nigritarsis* are nearly completely black with, at most, only the extreme bases of a few antennomeres fulvous (*C. melanurus* and *C. robustus* have the antennal fulvous annulations more pronounced). In almost all specimens of *C. nigritarsis*, the pronotum has a large, anteromedial black macula (at most a small spot in *C. robustus* and absent in *C. melanurus*.

Notes. This species was previously known from only a few specimens. Fieldwork in the Dominican Republic has produced many additional specimens that have better elucidated the level of polymorphism of the elytral and pronotal maculations.

New distributional data. Dominican Republic, La Vega Province, Parque Nacional Armando Bermudez, km 1–3 along trail west of La Ciénega, 900-1100 m, Specimen ID 7609, 24 June 2005, Nearns & Lingafelter (1 specimen, USNM); Dominican Republic, Independencia Prov., Road 47, between Los Pinos and Ángel Félix, 760 meters, 18°36.986'N, 71°46.556'W, 20 June 2005, N. Woodley (1 specimen, USNM); same data, but Nearns & Lingafelter (1 specimen, ENPC); Dominican Republic, La Vega Province, Jarabacoa, La Joya, 537 m, Rancho Baiguate, 10 June 2005, G. Nearns (1 specimen, ENPC); Dominican Republic, La Vega Province, 4.1 km southwest El Convento, 18°50.37'N, 70°42.48'W, 1730 m, 31 May 2003, J. Rawlins, R. Davidson, C. Young, C. Nuñez, P. Acevedo, dense secondary evergreen forest with pine, hand collected, sample 22242, CMNH 329,960 (1 specimen, CMNH); Dominican Republic, Santiago Province, Parque Nacional Armando Bermudez, La Guacara, 19°07'N, 71°02'W, 1124 m, 10 July 1992, M. A. & R. O. Ivie (1 specimen, WIBF); Dominican Republic, La Vega Province, 5.1 km N. Manabao, 5 June 1994, R. Turnbow (1 specimen, RHTC); Dominican Republic, La Vega Province, Constanza, 17 July 199, R. Turnbow (1 specimen, RHTC).

Calocosmus semimarginatus Bates

http://species-id.net/wiki/Calocosmus_semimarginatus
Fig. 9d

Diagnosis. This small, slender species is most similar to *C. fulvicollis* Fisher, a Cuban species, in that it has nearly uniformly dark elytra with a fulvous suture. Fisher (1925) suggested that *C. fulvicollis* could be a synonym of *C. semimarginatus*, however, the head is dark in *C. fulvicollis* but light in *C. semimarginatus* and the antennae are all black in *C. fulvicollis* but at least antennomeres 4-5 are fulvous annulate at the base in *C. semimarginatus*. Among the Hispaniolan species, *C. semimarginatus* is most similar to *C. nigripennis*, but is easily distinguished by having the elytral suture pale colored and the pronotum not transversely bisulcate.

Notes. The first male specimen of this species was found in the FSCA collection. This species, formerly known only from Cuba, is here recorded for the Dominican Republic and Hispaniola (new country and island records).

New distributional data. Dominican Republic, Pedernales Province, S. end of Lago de Oviedo, 26 May 1986, R. B. Miller, and L. Stange (1 specimen, FSCA).

Paleohemilophus dominicanus **Martins & Galileo**
http://species-id.net/wiki/Paleohemilophus_dominicanus

Diagnosis. Although similar in size and proportions to the larger *Calocosmus* species, such as *C. robustus* and *C. nigritarsis*, it is easily distinguished from all other species and genera of Hispaniolan Hemilophini by having antennomeres 3 and 4 swollen (Martins and Galileo 1999).

Notes. Known only as a fossil in Dominican amber that is at least 14 million years old, this species is extinct (Martins and Galileo 1999).

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Cochylis Treitschke in China: one new species and five new records (Lepidoptera, Tortricidae, Cochylini)

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Abstract

Six species of *Cochylis* Treitschke, 1829 are recorded for China. Among them, *C. triangula* **sp. n.** is described as new; *C. atricapitana* (Stephens, 1852), *C. discerta* Razowski, 1970, *C. dubitana* (Hübner, [1799]), *C. faustana* (Kennel, 1919) and *C. posterana hyrcana* (Toll, 1948) are recorded for the first time for China. The female of *C. discerta* Razowski, 1970 is described for the first time. Adults and genitalia are illustrated, a key is given for the identification of Chinese species based on male genitalia.

Keywords

Lepidoptera, Tortricidae, Cochylini, *Cochylis*, new species, new record, China

Introduction

The genus *Cochylis* Treitschke, 1829 belongs to the tribe Cochylini of the subfamily Tortricinae. *Cochylis* was erected by Treitschke (1829) for the type species *Tortrix roseana* Haworth, 1811. Brown (2005) listed 68 species and five subspecies. Subsequently, Brown (2006) described a new species from Argentina; Razowski and Wojtusiak (2006) described a new species from Venezuela; Razowski and Becker (2007a,

b) described a new species from Argentina and Cuba respectively; Metzler and Forbes (2012) described a new species from the USA. *Cochylis nana* (Haworth, 1811) and *C. voxcana* (Kearfott, 1907) were transferred to the genus *Thyraylia* Walsingham, 1897 (Gilligan et al. 2012). Currently, *Cochylis* consists of 71 species and five subspecies, distributed in the Holarctic, Oriental and Neotropical regions; 26 of these occur in the Palaearctic and Oriental regions.

Liu and Li (2002) recorded six *Cochylis* species from China, of which *C. nana* (Haworth, 1811) was subsequently transferred to the genus *Thyraylia*. In this paper, we describe one new species and record five additional species for the Chinese fauna.

Material and methods

This study is based on the examination of specimens collected by light traps. Morphological terminology follows Razowski (1987). Genitalia were prepared and mounted according to the methods introduced by Li (2002). Photos of the adults were taken with a Nikon D300 digital camera plus macro lens, and illustrations of the genitalia were prepared by using an Olympus C-7070 digital camera attached to an Olympus BX51 microscope. The examined specimens, including the types of the new species, are deposited in the Insect Collection, College of Life Sciences, Nankai University, Tianjin, China (NKUM). Type locality is abbreviated as TL.

Taxonomy

Cochylis Treitschke, 1829

http://species-id.net/wiki/Cochylis

Cochylis Treitschke, 1829: 233. Type species: *Tortrix roseana* Haworth, 1811.
Chochylis Duponchel, 1836: 409. [misspelling of *Cochylis*]
Conchylis Sodoffsky, 1837: 93. [unjustified emendation of *Cochylis*]
Pontoturania Obraztsov, 1943: 97. Type species: *Cochylis defessana* Mann, 1861.
Acornutia Obraztsov, 1944: 68. Type species: *Tortrix nana* Haworth, 1811.
Cochylichroa Obraztsov & Swatschek, 1958: 233. Type species: *Eupoecilia atricapitana* Stephens, 1852.
Brevicornutia Razowski, 1960: 317. Type species: *Cochylis pallidana* Zeller, 1847.
Longicornutia Razowski, 1960: 314. Type species: *Tortrix (Cochylis) phaleratana* Herrich-Schäffer, 1851 sensu Razowski, 1960 [=*Cochylis epilinana* Duponchel, 1842]
Neocochylis Razowski, 1960: 316. Type species: *Conchylis calavrytana* Rebel, 1906.
Paracochylis Razowski, 1960: 316. Type species: *Cochylis amoenana* Kennel, 1899.

Diagnostic characters. *Cochylis* is characterized by the combination of the following characters: adult small to medium; forewing with all veins separate, Sc reaching middle of the costal margin, basal distance between R_1–R_2 about three times of between R_2–R_3, R_5 to the costal margin; hindwing with costal fold in male, Rs and M_1 arising from the same point or long stalked, M_3 and CuA_1 separate, female hindwing usually with two spines in the frenulum; male genitalia: tegumen short and broad; uncus and gnathos absent; socius separate, drooped, connected with distal part of tegumen at base; median process of the transtilla mostly developed and dentate distally (absent in a few species); sacculus developed with a hook-shaped process basally in some species, with or without terminal process; slender vinculum separate ventrally; phallus without cornutus or with cornutus composed of a bundle of spines; female genitalia: sterigma varied in size and sclerotized diversely; antrum developed and heavily sclerotized; ductus bursae short, indistinctly distinguished from the corpus bursae; corpus bursae membranous, densely suffused with tiny spines.

Biology. In the Palaearctic Region, there are one or two generations annually, and over-wintering occurs in the larval stage. Larvae are oligophagous and feed mainly on plants belonging to Asteraceae (Razowski 1987).

Distribution. All species are distributed in the Holarctic, Oriental and Neotropical regions.

Key to Chinese species of *Cochylis* based on male genitalia

1 Phallus uniformly slender **2**
– Phallus stout basally, slender distally **6**
2 Phallus with cornutus (Razowski 1970: Taf. 106, Fig. 270).. ***C. atricapitana***
– Phallus without cornutus **3**
3 Transtilla without median process (Fig. 7)........................ ***C. discerta***
– Transtilla with median process **4**
4 Phallus slightly sinuate (Razowski 1970: Taf. 104, Fig. 260) .... ***C. roseana***
– Phallus curved orthogonally distally.. **5**
5 Sacculus extended to a hook-shaped process basally (Razowski 1970: Taf. 105, Fig. 268_{1-4}) .... ***C. hybridella***
– Sacculus not extended basally (Fig. 8) .... ***C. dubitana***
6 Transtilla without median process (Razowski 1970: Taf. 109, Fig. 283) .... ***C. psychrasema***
– Transtilla with median process **7**
7 Valva with a spine-shaped process at basal 1/3 near outer margin (Fig. 11) .... ***C. triangula* sp. n.**
– Valva without process near out margin.. **8**
8 Median process nearly triangular (Fig. 10) .... ***C. posterana hyrcana***
– Median process short stripe-shaped, nearly parallel-sided........................ **9**
9 Socius about 1/2 length of median process (Razowski 1970: Taf. 108, Fig. 279).. ***C. defessana***
– Socius almost same length as median process **11**

11 Valva with outer margin slightly protruded distally, costa straight (Fig. 9)..... .... ***C. faustana***

– Valva with outer margin nearly straight distally, costa slightly concave (Razowski 1970: Taf. 108, Fig. 277_{1-2}) .... ***C. piana***

Cochylis atricapitana (Stephens, 1852)

http://species-id.net/wiki/Cochylis_atricapitana
Figs 1, 12

Eupoecilia atricapitana Stephens, 1852: 80. TL: England.
Cochylis atricapitana (Stephens, 1852): Razowski, 1960: 317.

Material examined. CHINA: Xinjiang Uyghur Autonomous Region: 6 ♀♀, Buerjin (47°41'N, 86°59'E), 21.vii.2007, leg. Xinpu Wang.

Diagnosis. Adult (Fig. 1) with wingspan 10.5–13.0 mm. This species is very similar to *C. hybridella* (Hübner, [1813]), but *C. atricapitana* can be distinguished by the pocket formed by the seventh sternum sclerotized on dorsal surface, the antrum composed of two connected rectangular plates and not bearing cylinder-shaped structure in the female genitalia (Fig. 12). In *C. hybridella*, the pocket formed by the seventh sternum is membranous, the antrum is semicircular and bears a nearly cylinder-shaped structure in the female genitalia.

Distribution. China (Xinjiang), Europe.

Cochylis discerta Razowski, 1970

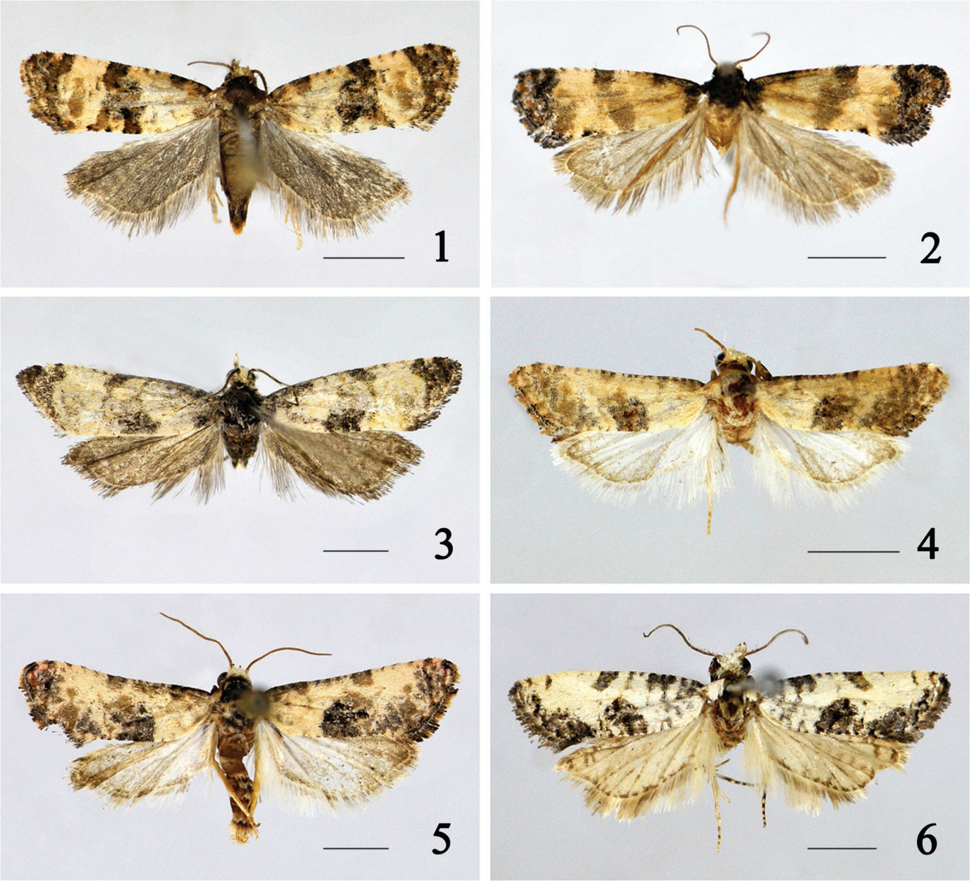
http://species-id.net/wiki/Cochylis_discerta
Figs 2, 7, 13

Cochylis discerta Razowski, 1970: 431. TL: Mongolia (Cantral [Tov] Province, 11 km S Zosijn Davaa Pass).

Material examined. CHINA: Shanxi Province: 1 ♀, Xiyao Village, Ningwu County (39°00'N, 112°18'E), 1475 m, 21.vii.2011, leg. Shulian Hao and Jiayu Liu. **Inner Mongolia:** Mt. Helan, Azuoqi (38°48'N, 105°52'E), 2200 m, 10.viii.2011, leg. Lixia Li and Yinghui Mou. **Gansu Province:** 2 ♂♂, 2 ♀♀, Sunan Autonomous County (38°50'N, 99°36'E), 2251 m, 16.viii.2007, leg. Feng Yang and Hanguang Gao.

Description. Adult (Fig. 2) with wingspan 10.0–14.5 mm.

Female genitalia (Fig. 13). Papilla analis gradually narrowed posteriorly, about 1/3 length of apophysis posterioris. Apophysis anterioris about 3/5 length of apophysis posterioris. Sterigma a heavily sclerotized ring. Antrum heavily sclerotized, about 1/4 length of corpus bursae, anterior 1/3 curved in hook shape; ductus bursae extremely short, membranous. Corpus bursae elongate oval, membranous, densely



Figures 1–6. Adults of *Cochylis* spp. **1** *C. atricapitana* (Stephens), female (Buerjin, Xinjiang) **2** *C discerta* Razowski, female (Sunan, Gansu) **3** *C. dubitana* (Hübner), male (Tahe, Heilongjiang) **4** *C. faustana* (Kennel), male (Beitun, Xinjiang) **5** *C. posterana hyrcana* (Toll), male (Tacheng, Xinjiang) **6** *C. triangula* sp. n., holotype, male (Daozhen, Guizhou). (scales = 2.5 mm).

suffused with tiny spines; ductus seminalis arising from posterior part of corpus bursae.

Diagnosis. This species can be distinguished from its congeners by the broad transtilla and the absence of a median process in the male genitalia (Fig. 7), and the ring-shaped sterigma and heavily sclerotized antrum in the female genitalia. *Cochylis discerta* Razowski, 1970 is very similar to *C. psychrasema* (Meyrick, 1937), but *C. discerta* can be distinguished by the ventral margin of the valva without a distal process in the male genitalia and the ductus bursae about 1/3 length of the corpus bursae in the female genitalia. In *C. psychrasema*, the ventral margin of the valva bears a long spine-shaped process in the male genitalia and the ductus bursae is about 1/7 length of the corpus bursae in the female genitalia.

Distribution. China (Gansu, Inner Mongolia, Shanxi), Mongolia.

Note. The female is described here for the first time.

Cochylis dubitana **(Hübner, [1799])**

http://species-id.net/wiki/Cochylis_dubitana
Figs 3, 8

Tortrix dubitana Hübner, [1799]: pl. 12, fig. 71. TL: Europe.
Tortrix ambiguana Frölich, 1828: 53. TL: Germany (Würtemberg).
Lobesia baseirufana Bruand, 1850: 99. TL: France.
Simaethis albidana Walker, 1866: 1807.
Cochylis dubitana (Hübner, [1799]): Razowski, 1960: 316.
Cochylis islandicana Björnsson, 1968: 24. TL: Iceland (Öraefum and Hreoarvatn).

Material examined. CHINA: Heilongjiang Province: 2 ♂♂, Yongan Village, Tahe County (45°21N, 131°25'E), 28–29.vii.2009, leg. Weichun Li and Jiayu Liu.

Diagnosis. Adult (Fig. 3) with wingspan 15.5 mm. This species is similar to *C. hybridella*, but *C. dubitana* can be distinguished by the sacculus not extended basally and the juxta slightly concave on the posterior margin in the male genitalia (Fig. 8). In *C. hybridella*, the sacculus is extended to a hook-shaped process at the base and the posterior margin of the juxta is protruded posterolaterally in the male genitalia.

Distribution. China (Heilongjiang), Europe.

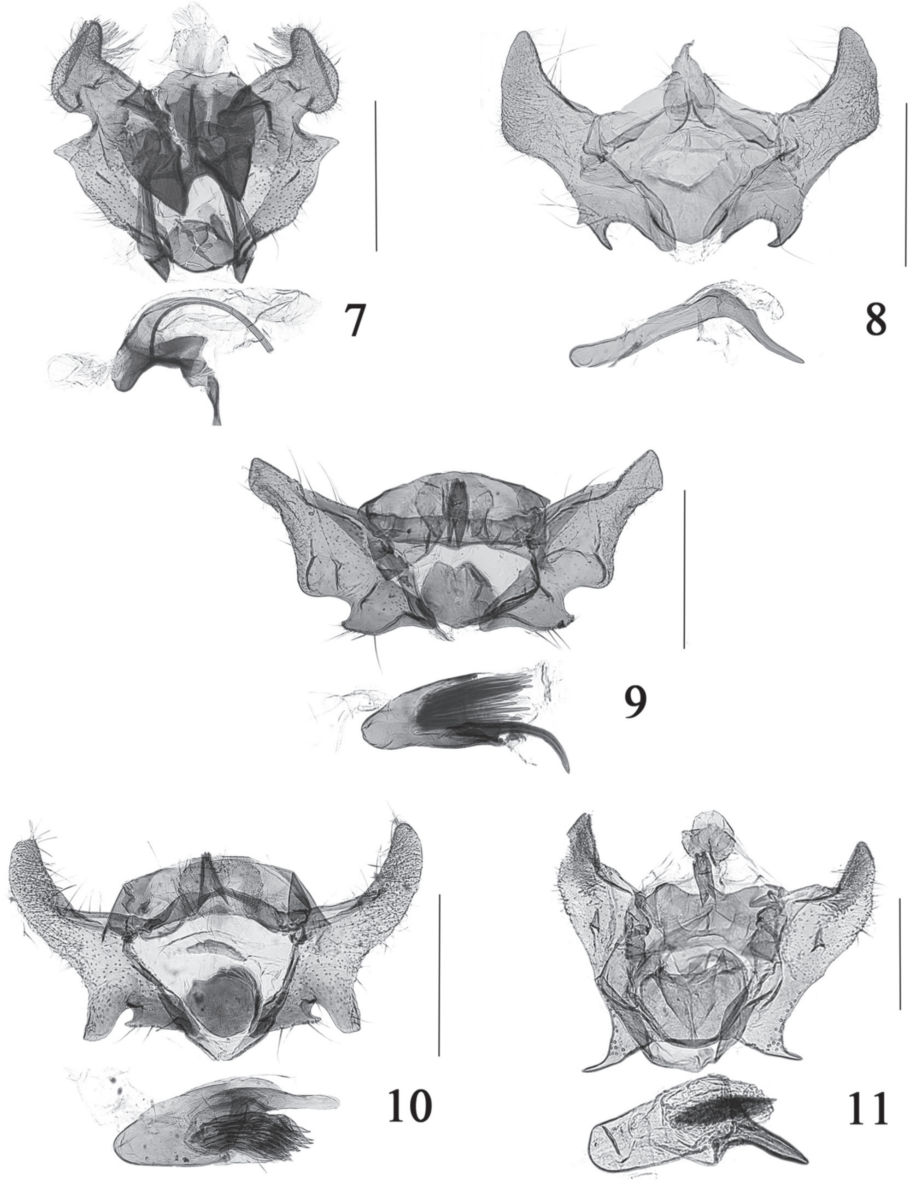
Cochylis faustana **(Kennel, 1919)**

http://species-id.net/wiki/Cochylis_faustana
Figs 4, 9, 14

Phalonia faustana Kennel, 1919: 73. TL: Dscharkent [Russia] (Illi-Gebiet).
Cochylis faustana (Kennel, 1919): Razowski, 1968: 143.

Material examined. CHINA: Inner Mongolia: 2 ♀♀, Erdaoqiao, Ejinaqi (41°58'N, 101°04'E), 927 m, 17–18.vii.2006, leg. Xinpu Wang and Xiangfeng Shi. **Xinjiang Uyghur Autonomous Region:** Beitun (47°18'N, 87°48'E): 5 ♂♂, 1 ♀, 530 m, 20.vii.1994, leg. Houhun Li and Hongyan Qin, 2 ♂♂, 512 m, 20.vii.2007, leg. Xinpu Wang; 1 ♂, Jinghe County (44°39'N, 82°56'E), 22.viii.1994, leg. Duoliken.

Diagnosis. Adult (Fig. 4) with wingspan 8.0–9.5 mm. This species is similar to *C. hybridella*, but *C. faustana* can be distinguished by the short stripe-shaped median process of the transtilla about 1/3 length of the transtilla, and the phallus with more than ten cornuti in the male genitalia (Fig. 9); the seventh sternum not forming a membranous pocket, the antrum almost as long as wide, without cylinder-shaped structure at middle in the female genitalia (Fig. 14). In *C. hybridella*, the median process of the transtilla is somewhat broad on basal 3/4 and slender on the distal 1/4, about 1/2 the length of the transtilla, and the slender phallus curves orthogonally and does not have cornutus in the male genitalia; the seventh sternum forms a membranous pocket, the



Figures 7–11. Male genitalia of *Cochylis* spp. **7** *C. discerta* Razowski, slide No. SYH11644 **8** *C. dubitana* (Hübner), slide No. SYH10244 **9** *C. faustana* (Kennel), slide No. SYH11447 **10** *C. posterana hyrcana* (Toll), slide No. SYH11434 **11** *C. triangula* sp. n., paratype, slide No. SYH10200. (scales: 0.5 mm).

length of the antrum is about 2/3 of width and bears a nearly cylinder-shaped structure at middle in the female genitalia.

Distribution. China (Inner Mongolia, Xinjiang), Russia.

Cochylis posterana hyrcana (Toll, 1948)

http://species-id.net/wiki/Cochylis_posterana_hyrcana
Figs 5, 10, 15

Phalonia posterana hyrcana Toll, 1948: 112. TL: Iran (Kuh i Mirabi-Gebirge).
Cochylis posterana hyrcana (Toll, 1948): Razowski, 1970: 419.

Material examined. CHINA: Gansu Province: 1 ♀, Mt. Xinglong, Yuzhong County (35°53'N, 104°06'E), 2178 m, 21.viii.2007, leg. Feng Yang and Hanguang Gao. **Xinjiang Uyghur Autonomous Region:** 20 ♂♂, 9 ♀♀, Abudula Village, Tacheng County (46°46'N, 82°59'E), 30.vii–23.viii.1990, leg. Jinfu Li; 1 ♀, Kuerdening, Gongliu County (43°28'N, 82°13'E), 1480 m, 4.viii.2007, leg. Xinpu Wang; 5 ♂♂, 2 ♀♀, Shirengou, Miquan City (43°58'N, 87°41'E), 1121 m, 11.viii.2007, leg. Xinpu Wang; 2 ♀♀, Nalati, Xinyuan County (43°21'N, 84°01'E), 1562 m, 6.viii.2007, leg. Xinpu Wang.

Diagnosis. Adult (Fig. 5) with wingspan 12.0–15.0 mm. This species is similar to *C. dubitana*, but *C. posterana hyrcana* can be distinguished by the median process of the transtilla nearly triangular, the sacculus with a small terminal process, and the phallus with more than ten cornuti in the male genitalia (Fig. 10). In *C. dubitana*, the median process of the transtilla is nearly triangular on basal 3/4 and slender on distal 1/4, the sacculus does not bear terminal process, and the phallus does not have cornutus in the male genitalia. The female genitalia (Fig. 15) are similar to those of *C. hybridella*, but *C. posterana hyrcana* can be distinguished by the antrum consisting of two rounded plates close to each other and the absence of a cylinder-shaped structure at middle. In *C. hybridella*, the antrum is a nearly rounded plate bearing an approximately cylinder-shaped structure at middle in the female genitalia.

Distribution. China (Gansu, Xinjiang), Iran. The nominate subspecies occurs in Europe.

Remarks. The type locality of *Cochylis posterana posterana* Zeller, 1847 is Hungary. Then it was reported to occur in different countries of Europe. *Cochylis posterana hyrcana* can be distinguished from *C. posterana posterana* by the forewing with median fascia conspicuous anteriorly, the median process of the transtilla nearly triangular in the male genitalia. In *C. posterana posterana*, the median fascia is invisible anteriorly in the forewing (Razowski 1970: Taf. 26, Fig. 273), and the median process of the transtilla is uniform in width in the male genitalia (Razowski 1970: Taf. 106, Fig. 273).

Cochylis triangula sp. n.

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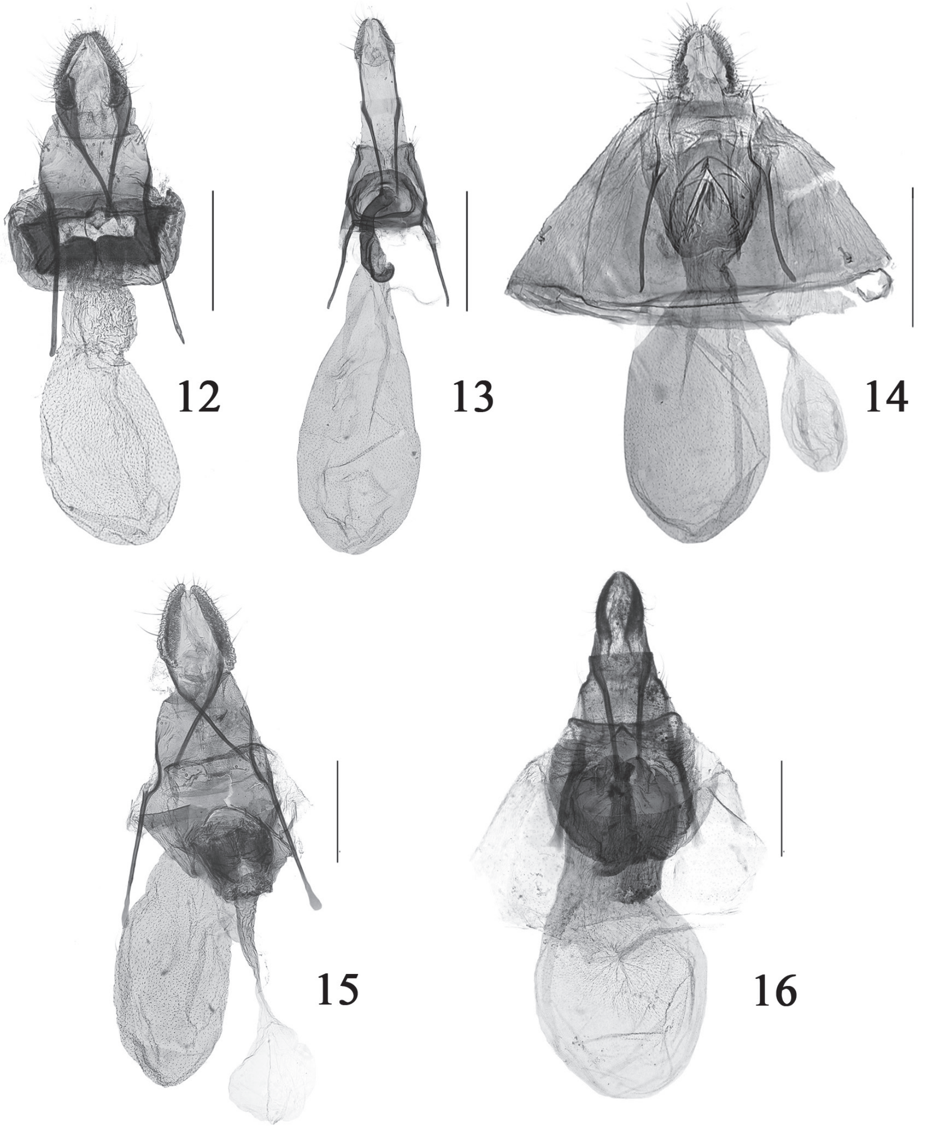
http://species-id.net/wiki/Cochylis_triangula
Figs 6, 11, 16

Type material. CHINA: Holotype ♂, Guizhou Province: Guocun Village, Daozhen County (28°53'N, 107°36'E), 1300 m, 21.viii.2004, leg. Yunli Xiao, genitalia slide No. SYH10220.



Figures 12–16. Female genitalia of *Cochylis* spp. **12** *C. atricapitana* (Stephens), slide No. SYH11456 **13** *C. discerta* Razowski, slide No. SYH11573 **14** *C. faustana* (Kennel), slide No. SYH10228 **15** *C. posterana hyrcana* (Toll), slide No. SYH11445 **16** *C. triangula* sp. n., paratype, slide No. SYH11700. (scales: 0.5 mm).

Paratypes: 1 ♀, same data as for holotype. **Yunnan Province:** 2 ♂♂, Xiaoheishan, Longling County (24°35'N, 98°41'E), 2300 m, 10.viii.2005, leg. Yingdang Ren.

Description. Adult (Fig. 6) with wingspan 15.5–17.0 mm. Vertex and frons pale yellowish white. Antenna yellowish brown, mixed with brownish black scales. Labial palpus slender, about 1.5 times length of eye's diameter, yellowish brown on outer surface, yellowish white on inner surface. Thorax and tegula pale yellowish white, tegula with a brownish black spot at base. Forewing with costal margin straight, apex protruded, termen oblique. Ground color pale yellowish white; costal margin mixed with small brownish black spots on basal half, with brownish black spots at base and at basal 1/4, with a short and thin stripe at distal 1/6; basal patch occupying basal 1/4 of forewing, consisting of thin grayish black stripes; median fascia from middle of costal margin extending obliquely to middle of dorsum, grayish black with sparse ochreous yellow, anterior 1/4 oblique outward, somewhat narrow, anterior 1/4 to 1/2 disappeared, posterior half somewhat broad, oblique inward; subapical fascia a brownish black stripe along termen, mixed with ochreous yellow scales; tornus with a large brownish black patch; dorsum with small brownish black spots; cilia pale brown. Hindwing and cilia grayish white. Fore- and midlegs brownish black, with yellowish white rings; hindleg yellowish white. Abdomen grayish brown.

Male genitalia (Fig. 11). Socius about 2/3 length of median process of transtilla. Valva short and broad, outer margin slightly convex, dorsal corner slightly pointed, with a spine-shaped process at basal 1/3 near outer margin; costa concave; transtilla broad, gradually narrowed from base to middle, median process about 1/3 length of transtilla. Sacculus heavily sclerotized, almost same length as costa, dorsal margin straight, ventral margin protruded subtriangularly, apex pointed and hook-shaped; vinculum slender, connected with membrane ventrally. Juxta nearly semicircular, anterior margin rounded, posterior margin straight. Phallus about two times length of costa, basal 3/5 stout, distal 2/5 thick thorn-shaped; cornutus a cluster short thin spines, about 2/5 length of phallus.

Female genitalia (Fig. 16). Papilla analis somewhat small, about 1/2 length of apophysis posterioris. Apophysis anterioris slightly shorter than apophysis posterioris. Sterigma weakly sclerotized, weakly defined. Seventh sternum forming a special membranous pocket, surrounding antrum. Antrum heavily sclerotized, nearly rectangular, with a heavily sclerotized vertical band at middle. Ductus bursae short and broad, about 1/2 length of antrum, weakly sclerotized, with vertical wrinkles. Corpus bursae oval.

Diagnosis. This species is similar to *C. posterana hyrcana*, but *C. triangula* sp. n. can be distinguished by the sacculus with ventral margin protruded triangularly, and the cornutus being a cluster of short and thin spines in the male genitalia; the nearly rectangular antrum with a heavily sclerotized vertical band at middle in the female genitalia. In *C. posterana hyrcana*, the ventral margin of the sacculus is straight, and the cornutus consists of a bundle of more than ten thin spines in the male genitalia; the antrum is composed of two rounded plates close to each other and the absence of the sclerotized vertical band at middle in the female genitalia.

Distribution. China (Guizhou, Yunnan).

Etymology. The specific name is the feminine form of the Latin adjective *triangulus*, meaning triangular, referring to the triangular sacculus.

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