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First record of adventive species *Micromus variegatus* (Fabricius) from eastern Canada (Neuroptera, Hemerobiidae)

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Abstract
An adventive Palaearctic species, *Micromus variegatus* (Fabricius) (Neuroptera, Hemerobiidae), is reported as new to Québec, eastern Canada. It was recorded for the first time from North America in 1988, from Galiano Island, off the coast of southwestern British Columbia. The present records confirm the occurrence of this species in eastern Canada, which constitutes the second known introduction of *M. variegatus* into North America.

Keywords
Adventive species, Neuroptera, *Micromus*, Canada

Introduction

Klimaszewski and Kevan (1988) revised the species of *Micromus* Rambur from Canada and Alaska. Seven species were reported including the first record of *Micromus variegatus* from North America, on Galiano Island, British Columbia. The authors suspected the possible introduction of this species into Canada from Japan. *Micromus variegatus* is a Palaearctic species occurring in the British Isles and Western Europe (Killington 1936). Aspöck et al. (1980) reported it from most of Europe, Turkey (Anatolia), northern Iran and Japan. Agekyan (1973) reported it from the Black Sea littoral of the former Soviet Union. The present new record from Québec, Canada, most likely represents the second known introduction of this species into North America.

Material and methods

In 2009, 20 yellow pan traps (Fig. 1) were placed in rows of raspberries grown in tunnels (Fig. 2) in Saint-Laurent-de-l'Île-d'Orléans, east of Quebec City, in order to study flea beetles, which could cause problems in this artificial environment. The tunnels were open ended at least occasionally to improve ventilation. Yellow pan traps are attractive to several flying insects and have been successfully used for the study of flea beetles in raspberry fields (Lévesque and Lévesque 1998) and in vineyards (LeSage et al. 2008). One of the main advantages of yellow pan trapping is to collect not only flying insects but also ground insects, both at the same time. Consequently, "collateral" benefits can be obtained by looking at "residues" that may contain interesting species and/or records in groups that were not specifically targeted. The hemerobiids reported here were obtained from residues of samples collected for a survey of flea beetles.

The specimens are deposited in the following collections:

CNC Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, Ottawa, Ontario, Canada

Figure 1. Yellow pan traps used for capturing specimens of *Micromus variegatus*.

LFC Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre, Insectarium R. Martineau, Quebec City, Québec, Canada

IM Insectarium de Montréal, 4581 Sherbrooke est, Montréal, Québec, Canada

Material examined. CANADA, Québec, Saint-Laurent-de-lÎe-d'Orléans, 25.V.2009, *Les Fraises de l'Île d'Orléans Inc*., sur *Rubus idaeus* Autumn Britten, Chapelle 4, Filet fauchoir, V. Fournier, M. Roy & L. LeSage (CNC, LFC, IM), 14 adult specimens.

Discussion

According to the CFIA (2009) Web site, the cultivar 'Autumn Britten' is the result of a controlled cross made in 1974 between 'EM 2806/86' and 'EM 2335/47'. The parentage includes *Rubus strigosus* Michx., *R. arcticus* L., *R. occidentalis* L., and the red raspberry varieties 'Malling Landmark', 'Malling Promise', 'Lloyd George', 'Pyne's Royal', 'Burnetholm' and 'Norfolk Giant'. 'Autumn Britten' was grown at Horticultural Research International in East Malling, United Kingdom and selected in 1976 based on its early fall fruiting, large fruit size and good fruit colour. Initial trials were conducted at the National Fruit Trials in Brogden, United Kingdom from 1977 to 1983. Material was sent to Agriculture and Agri-Food Canada's Research Station in Kentville, Nova Scotia in 1980 and the Pacific Agricul-

Figure 2. The cultivated imported variety of raspberries *Rubus idaeus* 'Autumn Britten' grown in tunnels in Québec where *M. variegatus* specimens were found.

ture Research Centre in Vancouver, British Columbia in 1983. Trials were also conducted at the Horticultural Research Institute of Ontario's Horticultural Experiment Station in Simcoe, Ontario from 1987 to 1991. Plants cultivated in tunnels on Île d'Orléans were purchased in 2006 from Strawberry Tyme Farms, Inc., Simcoe, Ontario.

A first hypothesis is that *M. variegatus* could have been introduced much earlier in the 1980s or 1990s as eggs or other life forms with the raspberry plants imported into Canada from other countries (e.g., United Kingdom or the United States). Or it could be a fairly recent introduction directly into Quebec City through the international commerce of plant material. In this case, the growth tunnels may have served as a "refugium" for this exotic insect.

With an increased volume of commercial goods, we are experiencing many new introductions of exotic insect species into Canada and throughout the world (Majka and Klimaszewski 2008). The occurrence of *M. variegatus* in Québec provides another example of this trend. The British Columbia adults were collected from June through August but no other collecting details are known. Dunn (1956) recorded this species from an alfalfa field infested with pea aphids. Agekyan (1973) found this species on bamboo infested with bamboo aphids in the Black Sea littoral. Killington (1936) reported it from the British Isles occurring on low vegetation in gardens and with at least two generations annually occurring in southern England, the first appearing in April, May and June and the second in August and September. Aspöck et al. (1980) recorded this species from gardens and parks in central Europe. The adults were re-described and illustrated, including the genital structures, by Klimaszewski and Kevan (1988) [Figs 32–35, 42 A, B], and the habitus image is shown in this publication (Fig. 3).

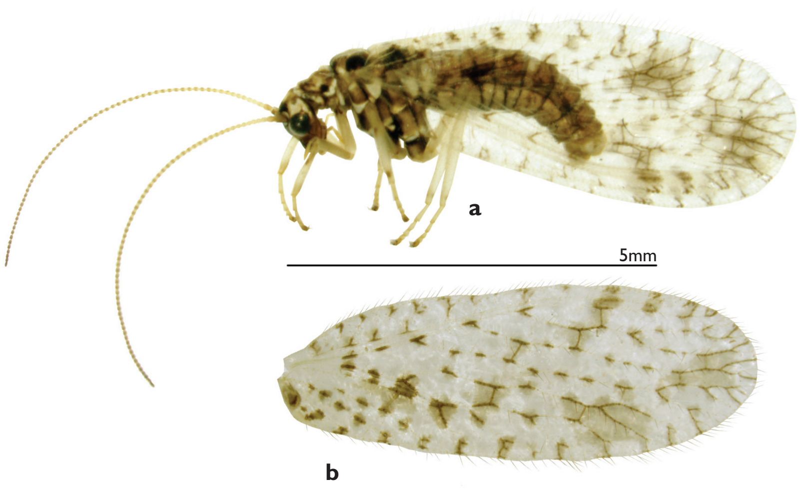

Figure 3. a Lateral image of *Micromus variegatus* (Fabricius), based on a specimen captured in Québec **b** Forewing of *Micromus variegatus* (Fabricius), based on a specimen captured in Québec.

The immature stages have been described by Brauer (1871), Killington (1936), Dunn (1956) and Agekyan (1973). There are three larval instars, all described in detail by Klimaszewski and Kevan (1988), and the same applies to the egg and pupa. The literature review indicates that the species mainly feeds on aphids and the larvae are extremely voracious and feed on both nymphs and adult females of aphids. Due to the known life history of *Micromus variegatus,* there are no direct economic risks posed by the introduction of this species into Canada but its presence may prove not to be beneficial to some of our native species.

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Systematics, host plants, and life histories of three new *Phyllocnistis* species from the central highlands of Costa Rica (Lepidoptera, Gracillariidae, Phyllocnistinae)

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Abstract

Three new species of *Phyllocnistis* Zeller are described from the central highlands of Costa Rica: *Phyllocnistis drimiphaga* **sp. n.**, *P. maxberryi* **sp. n.**, and *P. tropaeolicola* **sp. n.** Larvae of all three are serpentine leaf miners. *Phyllocnistis drimiphaga* feeds on *Drimys granadensis* (Winteraceae), *P. maxberryi* on *Gaiadendron punctatum* (Loranthaceae), and *P. tropaeolicola* on *Tropaeolum emarginatum* (Tropaeolaceae). All specimens were collected as larvae or pupae in their mines and reared in captivity. Parasitoid wasps were reared from *P. drimiphaga* and *P. maxberryi*. Description of the adults, pupae, and life histories are supplemented with photographs, illustrations, and scanning electron micrographs.

Keywords

Drimys, Encyrtidae, Eulophidae, *Gaiadendron*, Neotropical, *Phyllocnistis*, pupal morphology, serpentine leaf miner, taxonomy, *Tropaeolum*

Introduction

Phyllocnistis Zeller includes 87 described species, many of which are very small, with silvery vestiture, and similar in appearance (De Prins and De Prins 2005, 2009). The genus has been generally poorly studied because of its small size and difficulty to identify species. The precise taxonomic placement of the genus has also remained questionable because of a lack of shared adult morphological characters with other microlepidoptera (De Prins and Kawahara, 2009).

Only two species of *Phyllocnistis* were known to occur in Costa Rica (De Prins and De Prins 2005, 2009), one of which is citrus leaf miner, *P. citrella* Stainton, 1856, and the other, the mahogany leaf miner, *P. meliacella* Becker, 1974. *Phyllocnistis citrella*, originally from the Old World, was first reported in the Americas in 1993 (Heppner 1993) and has since become established in nearly every major citrus growing region in the New World. The larva of *citrella* is restricted to the plant family Rutaceae, and the larva of *meliacella* is known to feed only on members of the Meliaceae.

The larva of *Phyllocnistis* is unusual in having three or more sap-feeding instars and one non-feeding, highly specialized cocoon-spinning instar (Davis 1987). The larva creates a long, slender, subepidermal serpentine mine with a characteristic median frass line at the terminus of which a pupal chamber (pupal cocoon fold) is constructed, usually from the curled edge of the leaf (Davis 1994). On the basis of its unique mine, a phyllocnistine fossil has been identified as the oldest fossil in the Ditrysia, dated from leaf impressions from the Cretaceous (Grimaldi and Engel 2005; Labandeira et al. 1994), the bedrock which was recently reevaluated to be ~ 102 million years Ma (Brenner et al. 2000).

In general, larval morphological characters poorly define species of *Phyllocnistis*. From our experience rearing North American *Phyllocnistis* with David Wagner and others, pupal morphology provides the most informative characters for distinguishing species in the genus. In particular, we have found the shape of the frontal ridge (cocoon-cutter) and hooks on the dorsal surface of the abdominal segments to be very useful. These structures are respectively used to cut the cocoon and anchor it during adult emergence. We describe the adults, pupae, and life histories of the three new species of *Phyllocnistis* found in the central highlands of Costa Rica.

Methods

Study sites and habitats. Field studies were conducted at four high elevation sites between 1950–3100 m in the central region of Costa Rica during July 2001, April–May and November 2002, February–April 2003, December 2003–January 2004, March–April 2004, May 2005, September 2008, and July 2009. Three sites were located on Cerro de la Muerte, in the northern to central region of Cordillera de Talamanca (Fig. 1A). This region is cold and humid with 1–2 months of dry season (Herrera and Gómez 1993). According to Kappelle (1996), annual rainfall ranges

Figure 1. Habitats and larval host plants of *Phyllocnistis* species. **A** Cerro de la Muerte, Villa Mills region, 3000 m and below, in Cordillera de Talamanca **B** Volcán Barva, ALAS transect, 2000 m, in Braulio Carillo National Park **C** habitat of *P. drimiphaga* in Cerro de la Muerte, km 70 Pan-American Hwy, road to El Paraíso del Quetzal, 2700 m, arrow pointing to host plant where mines were found **D** young stem shoots and leaves of *Drimys granadensis* of C, growing from base of the tree **E** flowers and leaves of *D. granadensis* **F** habitat of *P. maxberryi* in Cerro de la Muerte, km 95 Pan-American Hwy, trail front of La Georgina in Villa Mills, 3100 m, arrow pointing to host plant where mines were found **G** young growth of *Gaiadendron punctatum* in front, and mature trees with yellow fruits in behind, at ALAS transect in Vara Blanca, 2000 m **H** habitat of *P. tropaeolicola* in Cerro de la Muerte, on km 95 Pan-American Hwy, near La Gegina in Mills, 3100 m, arrow pointing to host plant where mines were found **I** *Tropaeolum emarginatum*, details of host plants that are shown in H.

from 2000 to 3500 mm and average daily temperature is 11°C, with temperatures at night occasionally falling below 0 °C during the dry season. Sleet and heavy frost has been observed at Mills region (Oscar Abarca, pers. comm.). One of the sites on Cerro de la Muerte was near Villa Mills, at the 95 km mark of the Pan-American Highway (09°33'30.0"N, 083°43'25.8"W, 3100 m; Fig. 1, H). Another site was near the road leading to El Paraíso del Quetzal at the 70 km mark of the Pan-American Highway (2774 m, 09°33'45.6"N, 083°50'50.1"W; Fig. 1C). This road divides Parque Nacional Tapantí-Macizo de la Muerte and Parque Nacional Los Quetzales/Reserva Forestal Los Santos of San José Province. The third site on Cerro de la Muerte was on the road to the Genesis II Cloud Forest Preserve, 4 km NE of La Cañón in Cartago Province (09°42'23.4"N, 083°54'35.9"W, 2385 m).

The fourth site was in Cordillera Volcánica Central, 6 km ENE of Vara Blanca, part of Volcán Barva in Parque Nacional Braulio Carrillo (10°10'51"N, 084°06'20"W, 1950–2050 m; Fig. 1B). This collecting site was near the edge of a swampy open field and oak forest. The weather of this locality is consistently cool and humid throughout the year (Herrera and Gómez 1993). Typical weather at this site is rainy and windy, with a few hours of daily sunshine and temperatures ranging from 5–11 °C (Nishida 2006).

Leaf mine sampling and rearing. Leaf mines were collected and placed in transparent plastic bags or vials and larvae were reared at Universidad de Costa Rica, San José (1200 m elevation). Each day, mines were placed in a refrigerator (7.0–8.0 °C) and transferred to ambient temperature (~ 20 °C) to simulate natural conditions at high elevations. Reared parasitoids and samples of the mature larva and pupa of each species were preserved in 75–80 % EtOH. Adult moths were pinned, spread, and double-mounted. All adult specimens in this study were obtained from reared immatures.

Photography and dissection. Photographs of leaf mines were taken primarily in the field using Nikon Coolpix 4500, 8700, and Canon G7 digital cameras. Some pupae were dried and sputter-coated with a 60:40 mixture of gold-palladium for examination with a scanning electron microscope (SEM). SEM photographs were taken using an Amray 1810 SEM with a lanthanum hexaboride (LaB6) source at an accelerating voltage of 10 kV. Illustrations of the genitalia were sketched with a camera lucida attached to a stereomicroscope.

Type deposition, nomenclature, and diagnosis. Type specimens are deposited in the United States National Museum of Natural History, Smithsonian Institution (USNM), Museo de Zoología, Escuela de Biología, Universidad de Costa Rica (UCR), and Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica (INBio). Scientific names of plants follow Missouri Botanical Garden (2009). Adult wing pattern nomenclature is explained in Fig. 3; diagnostic features of the three species are summarized in Table 1.

Table 1. Diagnostic features of the three new *Phyllocnistis* species described in this study.

	Host	**Costal fascia**	**Longitudinal fascia**	**Transverse fascia**	**Costal strigulae**	**Valva**	**Signa**	**Frontal processes of cocoon-cutter**	**Dorsal spine arrangement, A2-A7**
P. drimiphaga	*Drimys granadensis* (Winteraceae)	Slender, margin narrow	Broad, yellow-orange	V-shaped	3	~ 1.8 × length of vinculum, very slender but broadening apically forming a prominent dorsal lobe and a smaller ventral lobe	Paired, dissimilar in shape	Developed, curved, flat	V-shaped
P. maxberryi	*Gaiadendron punctatum* (Loranthaceae)	Oviform, margin broad	Broad, light brown	C-shaped	2	~ 2 × length of vinculum, nearly straight with apex only slightly enlarged	Paired, similar in shape	Reduced, flat	In 2 rows
P. tropaeolicola	*Tropaeolum emarginatum* (Tropaeolaceae)	Slender, margin broad	Slender, brown	V-shaped	3	~ 2.4 × the length of vinculum, nearly straight, ventral lobe of apex slightly recurved dorsad	Single, band-shaped	Developed, conical	V-shaped

Adult, pupa, and life history descriptions

Phyllocnistis drimiphaga **Kawahara, Nishida & Davis, sp. n.**
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Diagnosis (Table 1). *Phyllocnistis drimiphaga* is similar to *P. maxberryi*, but is larger and has slender, sharply angled costal fascia, V-shaped transverse fascia, three costal strigulae, and dissimilar signa. *Phyllocnistis drimiphaga* differs from *P. tropaeolicola* in having broad longitudinal fascia, genital valva that are only ~ 1.8× the length of the vinculum, and paired signa. The pupa has curved, flattened frontal processes, which are reduced in *P. maxberryi* and conical in *P. tropaeolicola*.

Adult (Fig. 2A). Forewing length 2.9–3.5 mm. *Head*. Vestiture consisting of smooth, broad, silvery-white scales that overlap anterior margin of eye. Antenna ~ equal to length of forewing, scape and pedicel enlarged laterally and covered with lanceolate scales, a single row of fine short scales completely encircling each flagellomere. Labial palpus long, slender, ~ 1.0 mm in length, covered with lustrous white scales. *Thorax*. Forewing silvery white; with a long pale yellowish-orange longitudinal fascia with dark-gray margins extending 2/3 length of forewing slightly diagonal from base of costa to strongly oblique, costal fascia of similar color across distal third of wing; apex of forewing with three slender, fuscous, costal strigulae; apical to subapical pale yellowish orange bordered by gray; three apical, fuscous strigulae arising from small black apical spot, and one tornal, fuscous strigula also from apical spot; ventral surface mostly dark brown. Hindwing creamy white. Legs mostly silvery white; foretibia fuscous dorsally; fore- and mid-tarsomeres lightly suffused with cream scales dorsally. *Abdomen*. Length ~ 2.0 mm, covered in long silver scales. Coremata present on segment VIII of male, consisting of a pair of elongate, inflatable tubular extensions bearing a terminal cluster of long slender scales (Fig. 4A). *Male genitalia* (Figs 4A–C). Uncus absent; tegumen complex, consisting of a narrow, sclerotized dorsal arch, continuing caudally, often slightly beyond apex of valva, as an elongate, mostly membranous, basally spinose cylinder that encloses the anal tube; vinculum well developed, ~ 0.6× length of valva, U- to V-shaped with relative narrow anterior end; valva (Fig. 4B) relatively long, ~1.8× length of vinculum, generally slender with a moderately broad base, very slender for most of its length, then broadening apically to form a prominent dorsal lobe and a smaller ventral lobe (Fig. 4A); transtilla arising from mesal base of valva as an elongate, acute process, and continuing mesally to articulate at midline with process from opposite valva. Aedeagus (Fig. 4C) slender, weakly sclerotized, externally finely wrinkled cylinder, ~ equal to length of valva; cornuti absent; phallobase greatly extended as a membranous tube ~ 1.7–2.0× length of aedeagus; terminal hood of phallobase abruptly inflated and curved at right angle to phallobase. Genitalia slide USNM 33208. *Female genitalia* (Figs 4D, E). Oviscapt greatly reduced; posterior apophyses very short, ~ 0.8× length of papillae anales; anterior apophyses slightly longer, ~ 1.3× length of posterior apophyses; ostium bursae opening in

Figure 2. Adults of three new *Phyllocnistis* species from Costa Rica. **A** *Phyllocnistis drimiphaga* sp. n., holotype female **B** *P. maxberryi* sp. n., holotype female (abdomen removed for dissection) **C** *P. tropaeolicola* sp. n., holotype male.

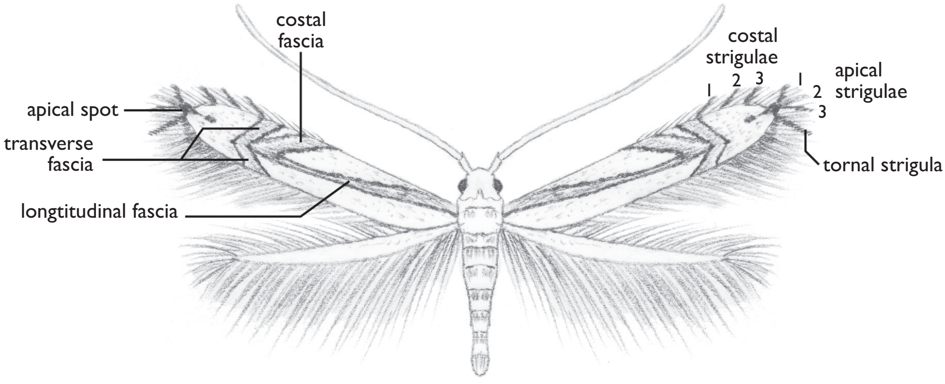

Figure 3. Nomenclature of *Phyllocnistis* forewing fasciae and strigulae.

membrane between sterna 7 and 8; ductus bursae completely membranous, slender, elongate, over 7.5× length of papillae anales and terminating near caudal fifth of corpus bursae; corpus bursae greatly enlarged, ~ 0.7× length of ductus bursae; walls of corpus bursae membranous except for a pair of ligulate and very dissimilar signa; longest signum ~ 3× length of shorter member and with 5 short, acute to rounded, flattened spines projecting from one side of signum; shorter signum with a single, blunt, flattened, rounded spine projecting from middle; length of spines ~ equal to width of signa; ductus seminalis extremely slender, elongate, ~ 2.3× length of corpus bursae and arising from anterior end of corpus bursae. Genitalia slides USNM 33207, 33273.

Larva (Figs 10F, G). Mature sap-feeding larva ~ 6.5 mm long, yellowish white, head capsule translucent pale brown (Fig. 10F). Last instar (cocoon-spinning) larva yellowish white, head capsule yellowish white; ~ 6.2 mm long (Fig. 10G).

Pupa (Figs 7, 10I). Dark brown, up to ~ 3.8 mm long, diameter ~ 0.75 mm. Vertex with a stout, triangular frontal process (cocoon-cutter) transversed by a pair of shorter, curved spines (Figs 7A–E), and single pair of long setae at base of frons (Fig. 7C). Dorsum of A2–A7 with a pair of curved, large spines, arranged roughly in the shape of a V, in between which is a concentration of smaller spines projecting posteriorly (Figs 7F–H); each segment with a pair of long, lateral, sensory setae (Fig. 7K). A10 prominently furcated (Figs 7I, J, L), with a pair of slightly divergent acute processes from caudal apex. Pupal slide USNM 34034.

Types. Holotype (Fig. 2A): ♀, COSTA RICA: Prov. Heredia, 6 km ENE Vara Blanca, 2050 m, 10°10'34"N, 084°06'41"W, 27 Jan 2004, adult emergence, INBio-OET-ALAS transect, col./rear Kenji Nishida, pupa collected 30 Dec 2003, host plant *Drimys granadensis*. Leaf miner on underside (USNM). **Paratypes:** *Immatures:* Prov. Cartago: Cerro de la Muerte, La Cañón, Genesis II Cloud Forest Preserve, 2422 m, 09°42'23.4"N, 83°54'36.1"W: 2 sap-feeding larvae, 1 pupa, 12 Sep 2008, Kenji Nishida, host *Drimys granadensis*; Prov. San José: Cerro de la Muerte,

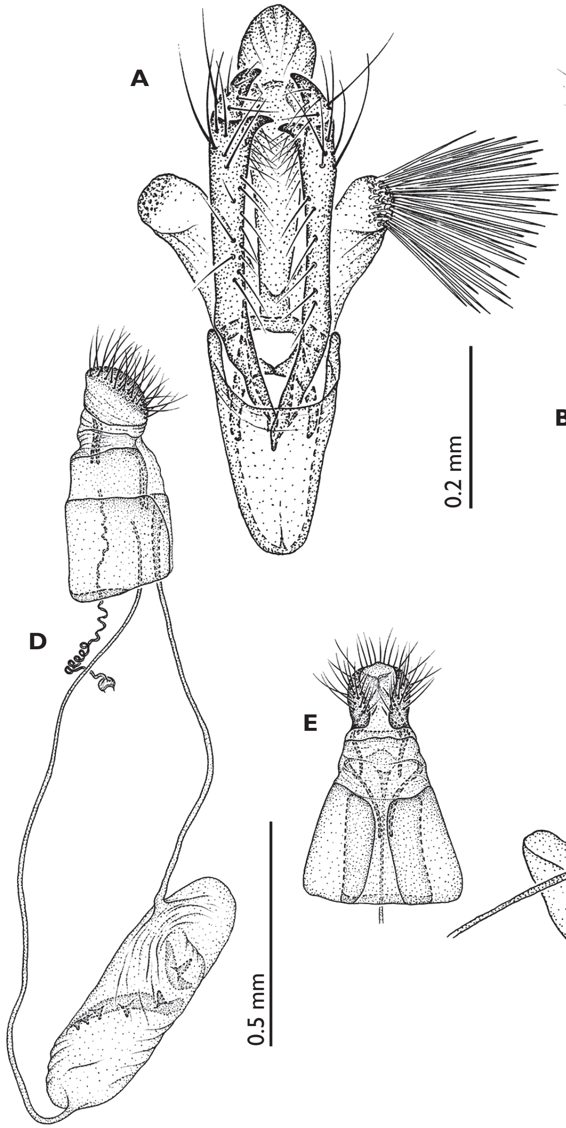

Figure 4. *Phyllocnistis drimiphaga* sp. n., genitalia. **A** Male, ventral view **B** right valva, mesal view **C** aedeagus **D** female, lateral view **E** ventral view of terminal segments. (Scale bar 0.5 mm except for figure B, 0.2 mm.)

Paraíso del Quetzal: 2 pupae, USNM 34034. *Adults:* same locality as holotype: 1♂, 26 Jan 2004, USNM 33208; 1♀, 26 Jan 2004, USNM 33207; 1♂, 1♀ (USNM 33273), 28 Jan 2004. 1♀ adult paratype at INBio and UCR, the remaining paratypes at USNM.

Life history (Fig. 10). Mines are narrow, long, and serpentine, with a brown median frass line (Figs 10A, C, D) covering most areas of the leaf on small leaves (< 6 cm) or half the area in larger leaves. Mines were found on relatively young leaves near the apex of branches, from branches close to the ground up to ~ 3 m on young trees, along shaded areas of forest trails (Fig. 1C) or in the understory. We observed 43 of 48 mines on the abaxial side of the leaf (Fig. 10A), and the remaining mines on the adaxial side (Fig. 10D). Most mines were singly found on a leaf; however seven of 38 mined leaves carried two mines, either two on the abaxial side or one on both sides. All but one adaxial mine began near the mid-vein and extended along it (Fig. 10D). Mature mines are yellowish green in color (Fig. 10C). Mining on small, soft, youngleaves frequently caused the leaf margin to curl. We were unable to study the upper canopy for leaf mines.

Early stage mines were typically in the shape of a whorl (Figs 10A–C). Flat, oval egg shells were found attached to the leaf surface in the middle of an early mine whorl (Fig. 10B). A pupal cocoon fold (~ 6.5 mm long), typical of *Phyllocnistis*, was found along leaf margins (Figs 10A, H, J) both on the adaxial (Fig. 10H) and abaxial sides (Figs 10A, J).

In 70 examined mines, only 20 had a live larva or pupa. Remaining mines either were empty or contained dead, early to middle stage sap-feeding larvae. Mortality of sap-feeding stages was most likely caused by desiccation after rupturing of the epidermal layer and by a cf. *Ceraphron* (Ceraphronidae) parasitoid wasp. In some pupal folds, a pupal shell of an entedonine wasp (Eulophidae) was found with a shrunken *P. drimiphaga* pupal shell. In others, cocoons of *Ageniaspis* sp. (Encyrtidae) were found in a last instar (cocoon-spinning) larval pelt (Fig. 10K).

We also discovered active mines of *Marmara* sp. (Gracillariidae) on the abaxial side of same host along the road to El Paraíso del Quetzal. Compared to those of *P. drimiphaga*, mines were much narrower, whiter, less serpentine, and were typically found near leaf margins.

Host. *Drimys granadensis* L. f. (Winteraceae) (Fig. 1D). *Drimys* Foster & Forster is the only genus in the family Winteraceae found in the New World tropics (Doust and Drinnan 2004). All other genera of Winteraceae are found in the Old World southern hemisphere with a center of diversity in Southeast Asia (Gentry 1996; Hartshorn 1983). *Drimys granadensis*, commonly known as 'chilemuelo' or 'quiebra muelas', has been recorded from central Mexico (~20°N) south through Central America to northern Peru (~ 5°S) (Missouri Botanical Garden 2009). Trees grow to nearly 15 m in height and are characterized by pepper-flavored leaves with white underside surfaces and aromatic bright, white flowers (Fig. 1E), found mostly in primary forest (Alfaro-Vindas 2003). In Costa Rica, the species has been recorded between 1100 and 3700 m elevations on both Pacific and Atlantic slopes. Large young leaves are pale green color, sized ~ 10–15 cm long and 2–4 cm wide (KN, pers. obs.).

Distribution. Known only from cloud forests above 2000 m in Cordillera de Talamanca and Cordillera Volcánica Central. More specifically, specimens have been collected from Heredia Province, 6 km ENE of Vara Blanca; San José Province, Cerro de la Muerte, Paraíso del Quetzal; and Cartago Province, Cerro de la Muerte, Genesis II Cloud Forest Preserve. In February 2009, several additional old leaf mines were observed in Chirripó National Park along the main trail between 2200 and 2700 m elevation.

Etymology. The species name, *drimiphaga*, comes the host plant genus, *Drimys*, and the Greek word *phaga*, meaning “to eat”.

Phyllocnistis maxberryi Kawahara, Nishida & Davis, sp. n.

urn:lsid:zoobank.org:act:598E20A2-D76F-41A2-83A0-CA268EC0DF41

Diagnosis (Table 1). *Phyllocnistis maxberryi* differs from *P. drimiphaga* and *P. tropaeolicola* in having an oviform costal fascia with a broad margin, a C-shaped transverse fascia, two costal strigulae, and paired signa that are similar in shape. Unlike *drimiphaga* and *tropaeolicola*, the pupa of *maxberryi* has less developed frontal processes and two parallel rows of spines on the dorsal surface of abdominal segments. Of the three new *Phyllocnistis* species proposed in this paper, *P. maxberryi* is morphologically most similar to *P. meliacella* Becker. *Phyllocnistis maxberryi* may be distinguished from the latter by its broader apex of the valva and proportionately larger signa.

Adult (Fig. 2B). Forewing length 2.2–3.7 mm. *Head.* Vestiture silvery white, completely covered with smooth, broad, scales that overlap anterior margin of eye; occipital scales cream. Antenna ~ equal or slightly longer than length of forewing, scape and pedicel enlarged laterally and covered in long silvery scales, a single row of slender mostly silvery-white scales completely encircling each flagellomere; dorsal surface of antenna with a pale-golden luster. Labial palpus slender, ~ 0.5 mm in length, with silvery-white scales. *Thorax.* Forewing silvery white, with a single, broad, light-brown longitudinal fascia with a dark brown posterior margin extending slightly diagonal from base of costa joining costal fascia at ~ midway to apex; costal fascia oblique, pale gold, oviform, with a broad, inner dark-brown margin; transverse fascia C-shaped, pale gold with dark margin; apical to subapical area pale yellow; two faint, dark-brown costal strigulae present; a single, small black spot at wing apex from which two dark-brown apical strigulae arise. Hindwing silvery white. Legs mostly silvery white, with a faint suffusion of pale gold dorsally over most segments. *Abdomen.* Length ~1.5–2.0 mm, silvery white; coremata similar to *P. drimiphaga*. *Male genitalia* (Figs 5A–C). Similar to *P. drimiphaga* except vinculum relatively broader and more U-shaped. Valva ~ 2× length of vinculum, nearly straight with apex only slightly enlarged (Fig. 5A). Genitalia slide USNM 33279. *Female genitalia* (Figs 5D–F). Oviscapt greatly reduced as in *P. drimiphaga*; ductus bursae completely membranous, slender, elongate, over 12× length of papillae anales and terminating near middle of corpus bursae; corpus bursae greatly enlarged, ~ 0.7× length of ductus bursae; signa paired, closely similar in shape and size (fusiform), with more posterior signum ~ 1.2–1.5× longer than anterior signum; each signum with a single, acute, flattened spine projecting from middle (Fig. 5F); length of spines slightly more than width of signa; ductus seminalis extremely slender, elongate, ~ 1.9× length of corpus bursae and arising from anterior end of corpus bursae. Genitalia slides USNM 33280, 33286.

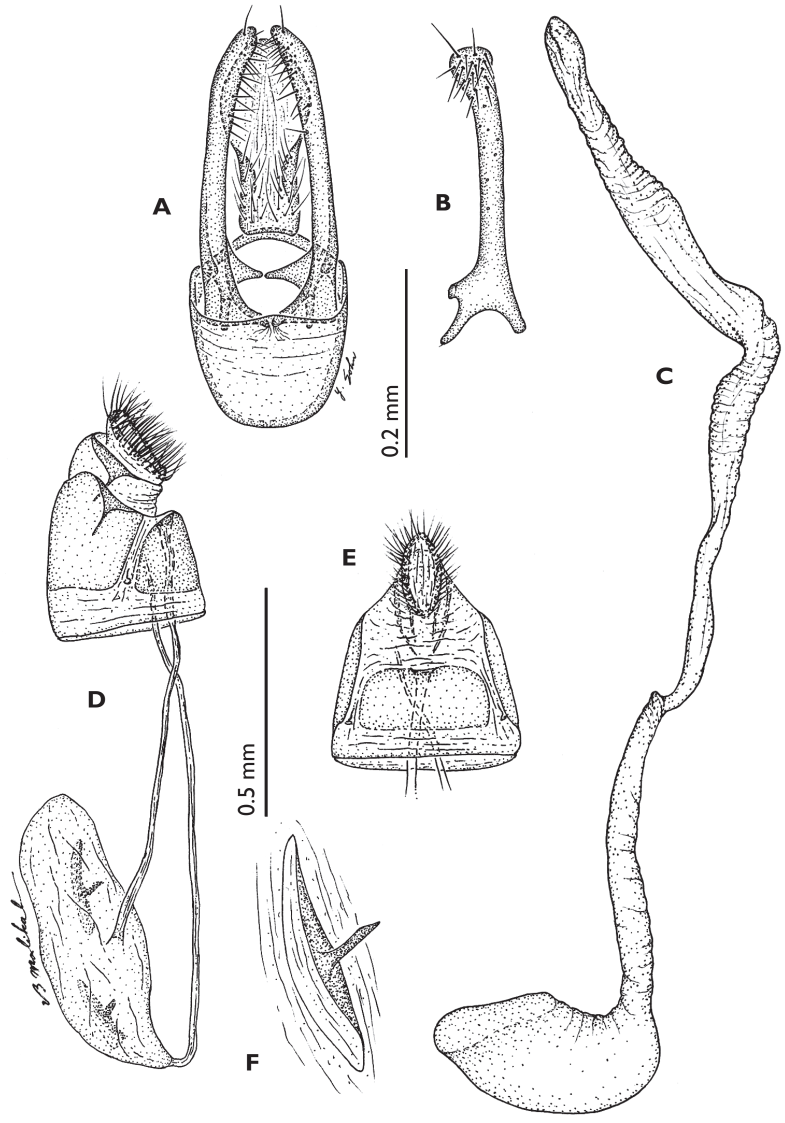

Figure 5. *Phyllocnistis maxberryi* sp. n., genitalia. **A** Male, ventral view **B** right valva, mesal view **C** aedeagus **D** female, lateral view **E** ventral view of terminal segments **F** signa. (Scale bar 0.5 mm except for figure B, 0.2 mm.)

Larva (Figs 11C–F). Mature sap-feeding larva ~ 6.0 mm long, translucent orange, head capsule brown, prothoracic shield brown (Figs 10C–E). Last instar (cocoon-spinning) larva orange, head capsule orange, ~ 6.3 mm long (Fig. 10F).

Pupa (Figs 8; 11H, I). Brown, length up to ~ 4.0 mm; diameter ~ 0.85 mm. Vertex with a long, dorsally curved, spine-like process (cocoon-cutter) (Figs 8A, B, D, E), and two pairs of short setae (Fig. 8C). Dorsum of A2–A7 with a pair of laterally curved, large spines in between which is a concentration of smaller spines, projecting posteriorly that are roughly arranged in two parallel rows (Figs 8F–H); each segment with a pair of long, lateral, sensory setae (Fig. 8K). A10 with a pair of slightly divergent processes from caudal apex (Figs 8I, J, L).

Types. Holotype (Fig. 2B): ♀, Costa Rica: Prov. San José, Cerro de la Muerte, Villa Mills, 3100 m, 13 Mar 2003 (adult emergence), host *Gaiadendron punctatum*, upper leaf miner, col./rear Kenji Nishida, DRD 4474 (USNM). **Paratypes:** *Immatures:* same locality as holotype: 3 pupae (USNM 33732), 5 Mar 2003, K. Nishida; 3 larvae, 2 pupae, 2 Apr 2003, K. Nishida; 1 larva, 21 May 2002, K. Nishida; 3 larvae, 1 pupa (USNM 34024), 10 Mar 2004, K. Nishida. One pupa, Villa Mills, trail front of La Georgina, 3103 m, 12 Sep 2008, K. Nishida, host *Gaiadendron punctatum*. Two larvae, 1 pupa, Prov. Heredia, 6 km ENE Vara Blanca, 10°11'N, 84°07'W, 2050 m, 10 May 2005, K. Nishida; 1 pupa, 23 Nov 2002, K. Nishida. *Adults:* same locality as holotype: 1♂, 22 Mar 2003, K. Nishida; 2♂, 26 Mar 2003, K. Nishida; 2♂, 2♀, Prov. Heredia, 6 km ENE Vara Blanca, 10°11'N, 84°07'W, 1950–2050 m, 2 Feb 2003, K. Nishida; 2♂, 9 Apr 2002, 1900 m, emerged 22–28 Apr 2002, host *Gaiadendron punctatum*, D. and M. Davis. ♂ slide USNM 33279; ♀ slides USNM 33280, 33286. One paratype, unknown sex (missing abdomen) at UCR, remaining paratypes at USNM.

Life history (Fig. 11). Active mines were found on fully open young leaves near the tip of a branch. The smallest leaf with an active mining larva measured 12 × 30 mm. Mines were generally found on young plants about 30 cm to 1.5 m tall, in open fields or along exposed dirt roads or trails. In an open swampy field at the ALAS transect near Vara Blanca, many active mines were found on new leaves on young plants less than 1.5 m tall (Fig. 11A) and very few active mines were found on larger plants bearing flowers or fruit.

Thirty-six of 42 leaves had mines on the adaxial side and the rest had mines on the abaxial side or on both. Up to three mines were observed on a single leaf. These mines were relatively short, serpentine mines with a brown median frass line that became dark brown as the mine widened (Fig. 11C).

We recognize a general mining pattern for *P. maxberryi*: the egg is laid on the mid-vein, near the center of the leaf (Fig. 11C). After hatching, the larva enters the leaf and mines proximally towards the leaf petiole along the mid-vein and turns toward the leaf apex near or at the leaf petiole and mines along the leaf margin. Before reaching the midpoint along the axis of the leaf, the larva travels inward between the mid-vein and leaf margin and travels towards the leaf apex. After nearing the apex, the larva crosses the mid-vein and begins mining the other half of the leaf in a relatively straight line turning back towards the petiole. Once near the petiole, the larva constructs an oval-shaped chamber and molts within. After molting, the cocoon-spinning instar folds the margin while spinning its cocoon. This pupal fold was typically ~ 7.0 mm long (Figs 11B, G). Under rearing conditions, the pupal stage lasts between 21–28 days (n = 7). Five female specimens of *Chrysocharis* sp. (Eulophidae: Entedoninae) were reared from pupal cocoon folds collected at Villa Mills, Cerro de la Muerte.

Host. *Gaiadendron punctatum* (Ruiz & Pav.) G. Don (Loranthaceae) (Fig. 1G). The free-standing root parasite/epiphyte tree genus *Gaiadendron* includes approximately 15 species occurring in the New World (Gentry 1996; Missouri Botanical Garden 2009). *Gaiadendron punctatum* is distributed from Nicaragua through southern Central America to Bolivia (~ 17°50'S) between 600 and 4100 m elevation (INBio 2009; Missouri Botanical Garden 2009). Trees are typically 2–5 m in height with bright yellow/orange flowers (Kappelle 2008). Young leaves are pale green to reddish brown, about 3–6 cm long and 1–3 cm wide (KN, pers. obs.). Among species in the genus, only *G. punctatum* is known from Costa Rica, and it has been recorded above 1500 m in open areas and along trails in cloud forests (INBio 2009; Kappelle 2008).

Distribution. This species appears to have a greater elevational range than the other two, being found between 1950 and 3100 m. Specimens have been collected from Heredia Province, 6 km ENE of Vara Blanca, in the Cordillera Volcánica Central; and Cartago Province, Cerro de la Muerte, Villa Mills, in Cordillera de Talamanca.

Etymology. Named for the Honorable Max N. Berry of Washington, D.C., an honorary member of the Smithsonian National Board.

***Phyllocnistis tropaeolicola* Kawahara, Nishida & Davis, sp. n.**
urn:lsid:zoobank.org:act:E766981C-D9EC-48DF-9C9D-D02EC2AC9744

Diagnosis (Table 1). *Phyllocnistis tropaeolicola* differs from *P. drimiphaga* and *P. maxberryi* in its larger size, having a slender longitudinal fascia, valva that are ~2.4× the length of the vinculum, and a single, band-shaped signa. The pupa of *P. tropaeolicola* has conical frontal processes and dorsal abdominal spines on each segment are arranged in a V.

Adult (Fig. 2C). Forewing length 2.6–5.0 mm. *Head.* Vestiture silvery white, completely covered with smooth, broad, scales slightly overlapping anterior margin of eyes. Antenna ~ equal to length of forewing, scape and pedicel enlarged laterally and covered in long silvery scales, a single row of fine short scales completely encircling each flagellomere. Labial palpus long, slender, ~ 1.0 mm. *Thorax.* Forewing silvery white; with a slender, dark-brown, longitudinal fascia extending 2/3 length of wing to meet distally at junction of brown, costal and transverse fasciae; costal fascia slender and strongly oblique with dark-brown border; transverse fascia V-shaped, with a dark-brown border; apical to subapical area pale yellowish orange with a small black spot; three slender, dark-brown costal strigulae, three slender dark-brown apical strigulae, and one faint brown tornal strigula arising from black apical spot; fringe along tornal margin white with a dark-brown basal band of broad scales. Hindwing mostly white except for a band of pale brown scales extending length of costal margin. Legs similar to *P. drimiphaga*, silvery white except dark brown over dorsal surface of femur, tibia and tarsus of foreleg. *Abdomen.* Length ~ 2.0 mm, mostly brownish gray dorsally, silvery white ventrally. Coremata similar to *P. drimiphaga*. *Male genitalia* (Figs 6A–C). Similar to *P. drimiphaga* except valva relatively longer and more slender, ~ 2.4× the length of vinculum, nearly straight, with ventral lobe of apex slightly re-curved dorsad (Fig. 6A). Genitalia slide USNM 33281. *Female genitalia* (Figs 6D, E). Oviscapt greatly reduced as in *P. drimiphaga*; ductus bursae completely membranous, slender, elongate, ~ 8.5× length of papillae anales and terminating at posterior end of corpus bursae; corpus bursae ~ 0.6× length of ductus bursae; a single elongate signum present as a narrow band partially encircling middle of corpus bursae; signum with 2 acute, flattened spines projecting inwards from

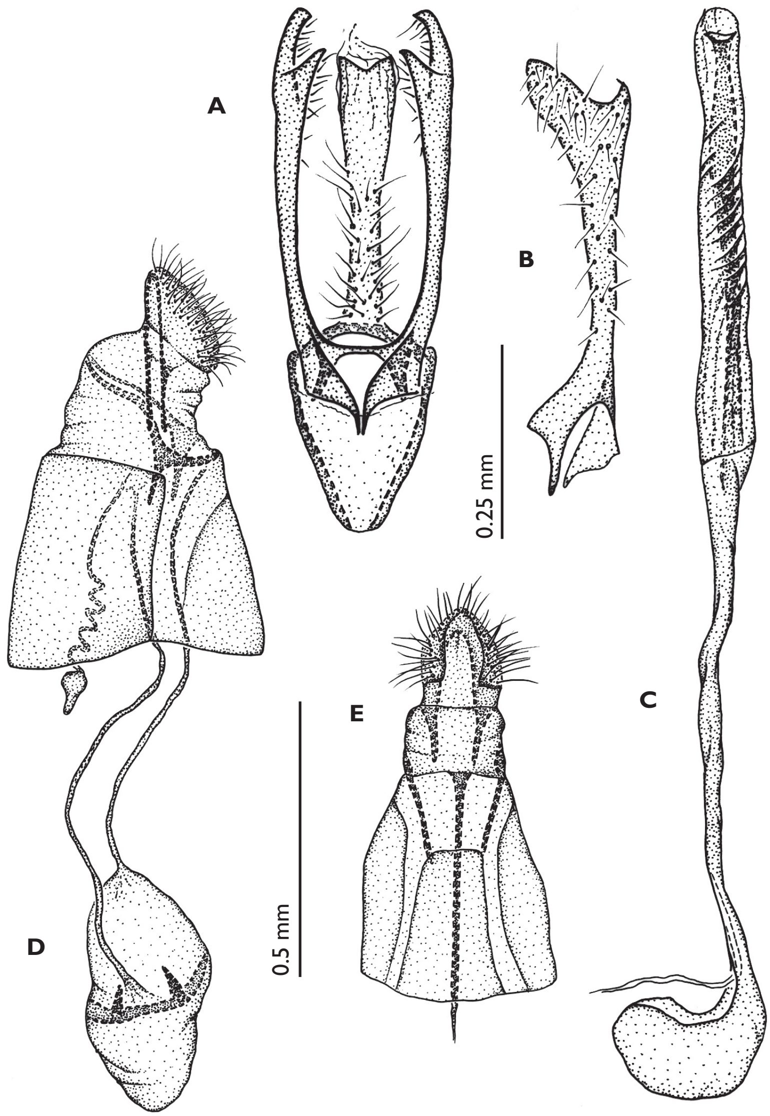

Figure 6. *Phyllocnistis tropaeolicola* sp. n., genitalia. **A** Male, ventral view **B** right valva, mesal view **C** aedeagus **D** female, lateral view **E** ventral view of terminal segments. (Scale bar 0.5 mm except for figure B, 0.25 mm.)

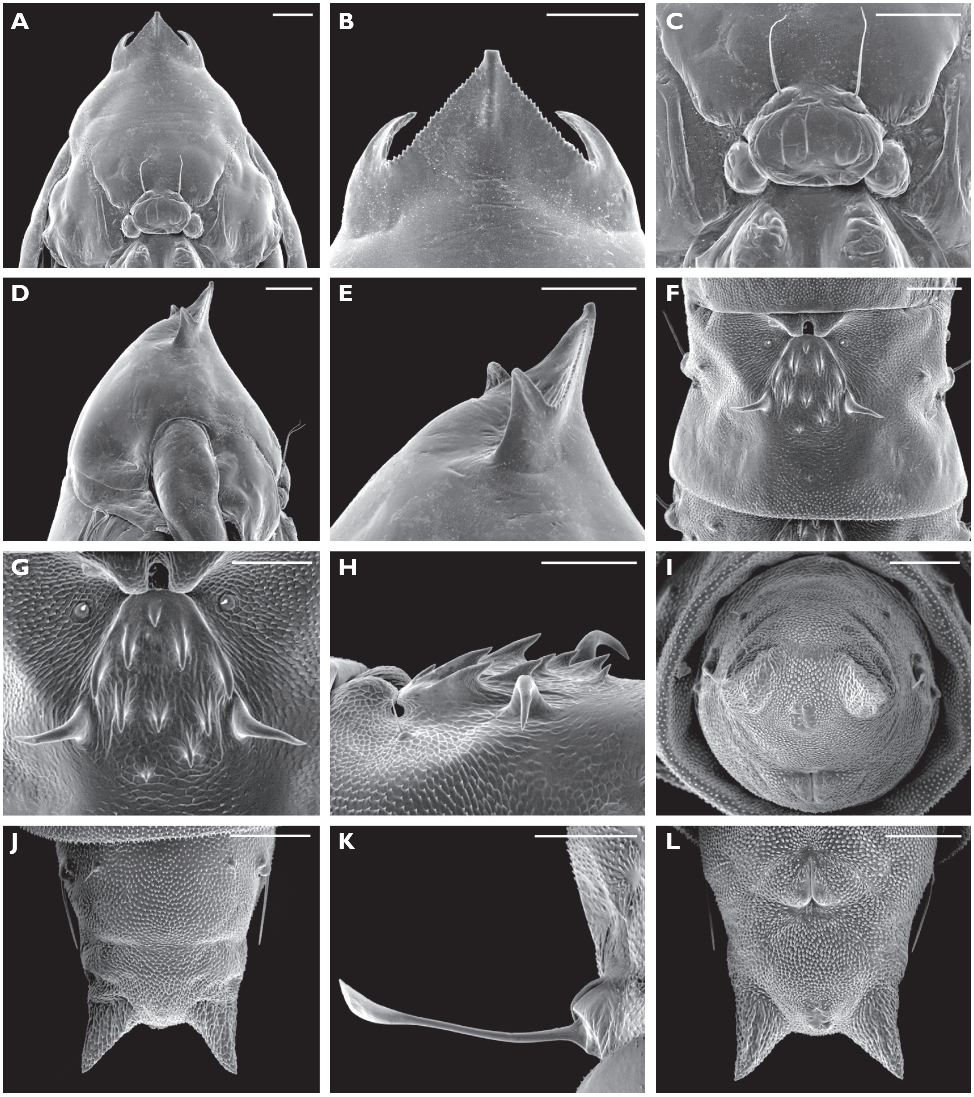

Figure 7. *Phyllocnistis drimiphaga* sp. n., pupa. **A** Ventral view of head **B** ventral view of cocoon-cutter **C** frons **D** lateral view of head **E** lateral view of cocoon-cutter **F** dorsal view of fifth abdominal tergum **G** spines on fifth abdominal tergum **H** lateral view of spines on fifth abdominal tergum **I** view of abdominal tip **J** dorsal view of A9–10 **K** lateral seta on seventh abdominal tergum **L** ventral view of A9–10. Scale bars 100 µm.

band; length of spines slightly more than width of signa; ductus seminalis extremely slender, elongate, ~ 2.4 × length of corpus bursae and arising from near middle of corpus bursae. Genitalia slide USNM 33282, 33285, 33288.

Larva (Figs 12A, C–F). Young sap-feeding larva translucent yellow (Fig. 12A). Mature sap-feeding larva ~7.5 mm long, translucent yellow, head capsule translucent pale brown, prothoracic shield dark brown (Figs 12C–). Cocoon-spinning larva whitish yellow, head capsule pale gray brown; ~ 6.5 mm long (Fig. 12F).

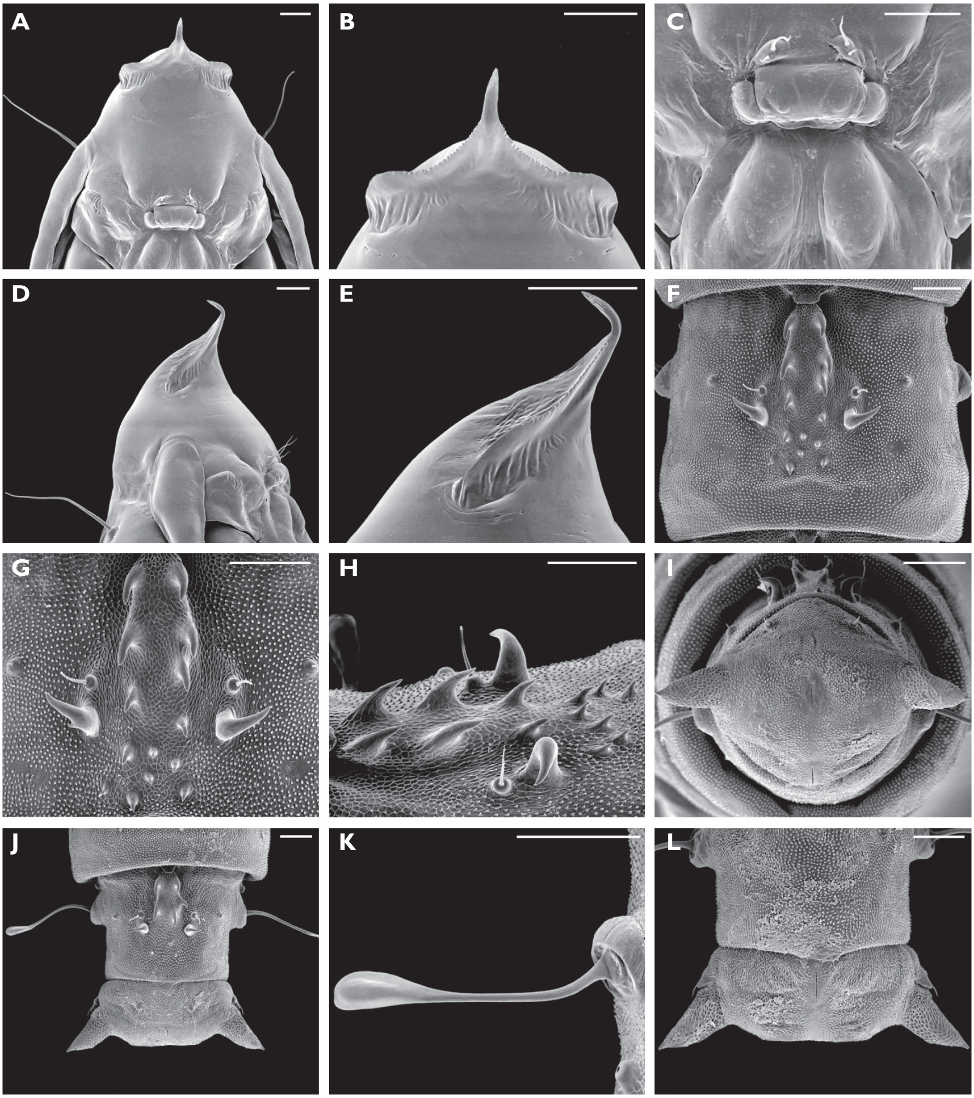

Figure 8. *Phyllocnistis maxberryi* sp. n., pupa. **A** Ventral view of head **B** ventral view of cocoon-cutter **C** frons **D** lateral view of head **E** lateral view of cocoon-cutter **F** dorsal of sixth abdominal tergum **G** spines on sixth abdominal tergum **H** lateral view of spines on seventh abdominal tergum **I** view of abdominal tip **J** dorsal view of A9–10 **K** lateral seta on sixth abdominal tergum **L** ventral view of A9–10. Scale bars 100 µm.

Pupa (Figs 10, 12H). Brown, length up to ~ 5 mm; diameter ~ 1.0 mm. Vertex with a short, stout, process (cocoon-cutter) flanked by two, flattened, slightly longer processes (Figs 9A, B, D, E) and two pairs of short setae (Fig. 9C). Dorsum of A2–A7 with a pair of laterally curved, large spines in between which is a concentration of smaller spines, arranged in a triangular, V-shaped pattern (Figs 9F, G); each segment with a pair of long, lateral, sensory setae (Fig. 9L) that are shortest on A9–10 (Figs 9J, K). A10 with a pair of slightly divergent processes from caudal apex (Figs 9I, J).

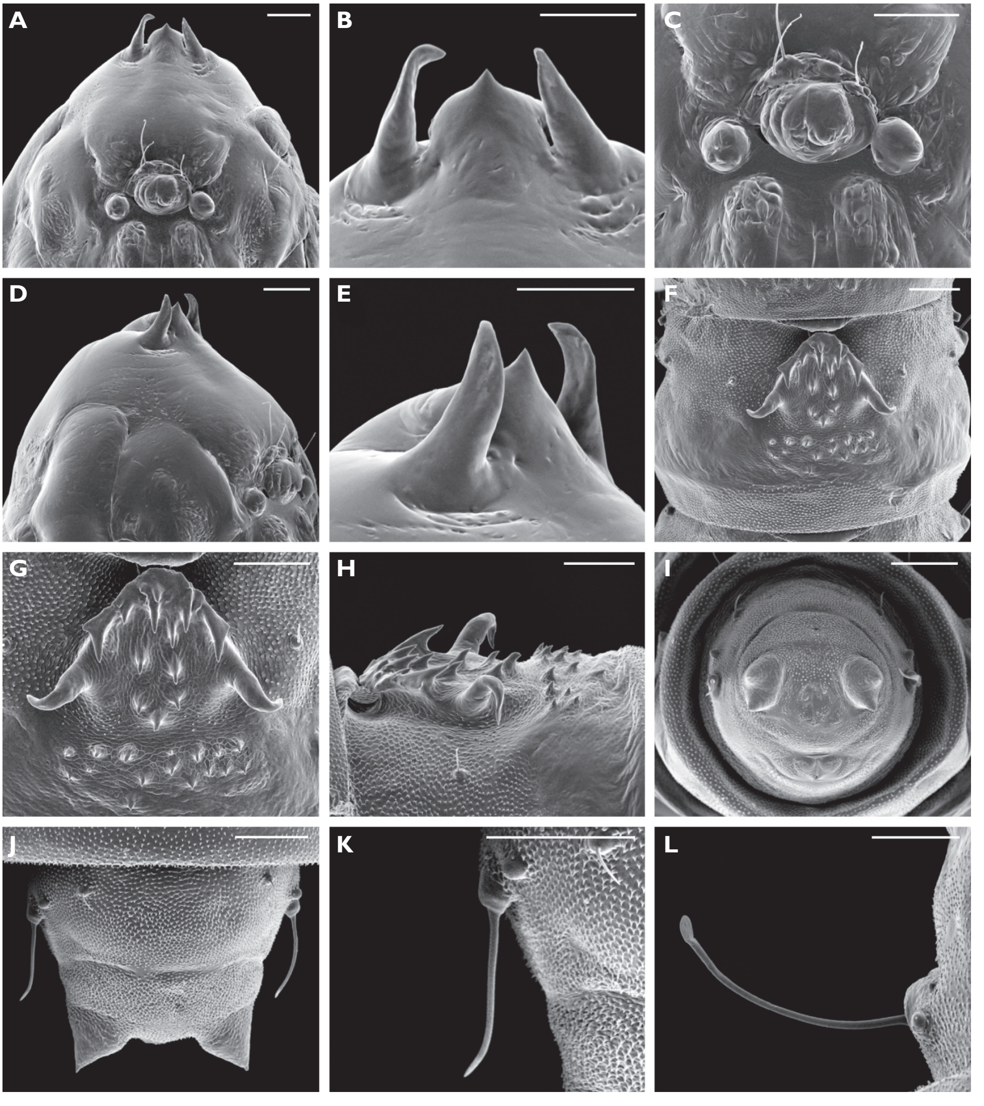

Figure 9. *Phyllocnistis tropaeolicola* sp. n., pupa. **A** Ventral view of head **B** ventral view of cocoon-cutter **C** frons **D** lateral view of head **E** lateral view of cocoon-cutter **F** dorsal view of fourth abdominal tergum **G** spines on fourth abdominal tergum **H** lateral view of spines on fourth abdominal tergum **I** view of abdominal tip **J** dorsal view of A9–10 **K** lateral seta on A9–10 **L** lateral seta on seventh abdominal tergum. Scale bars 100 µm.

Types. Holotype (Fig. 2C): ♂, Costa Rica: Prov. Cartago, Cerro de la Muerte, Villa Mills, 3100 m, 13 Mar 2003 (adult emergence), host *Tropaeolum emarginatum*, col./rear Kenji Nishida, mine with pupal fold collected 6 Mar 2003 (USNM). **Paratypes:** *Immatures:* 1 prepupa, 1 pupa (USNM 34036), Villa Mills, Georgina, 9°33'30"N, 83°43'25.8"W, 3103 m, 12 Sep 2008, K. Nishida, host *Tropaeolum emarginatum*. *Adults:* same locality as holotype, 6♂, 4♀: ♂ slide USNM 33281, ♀ slide USNM

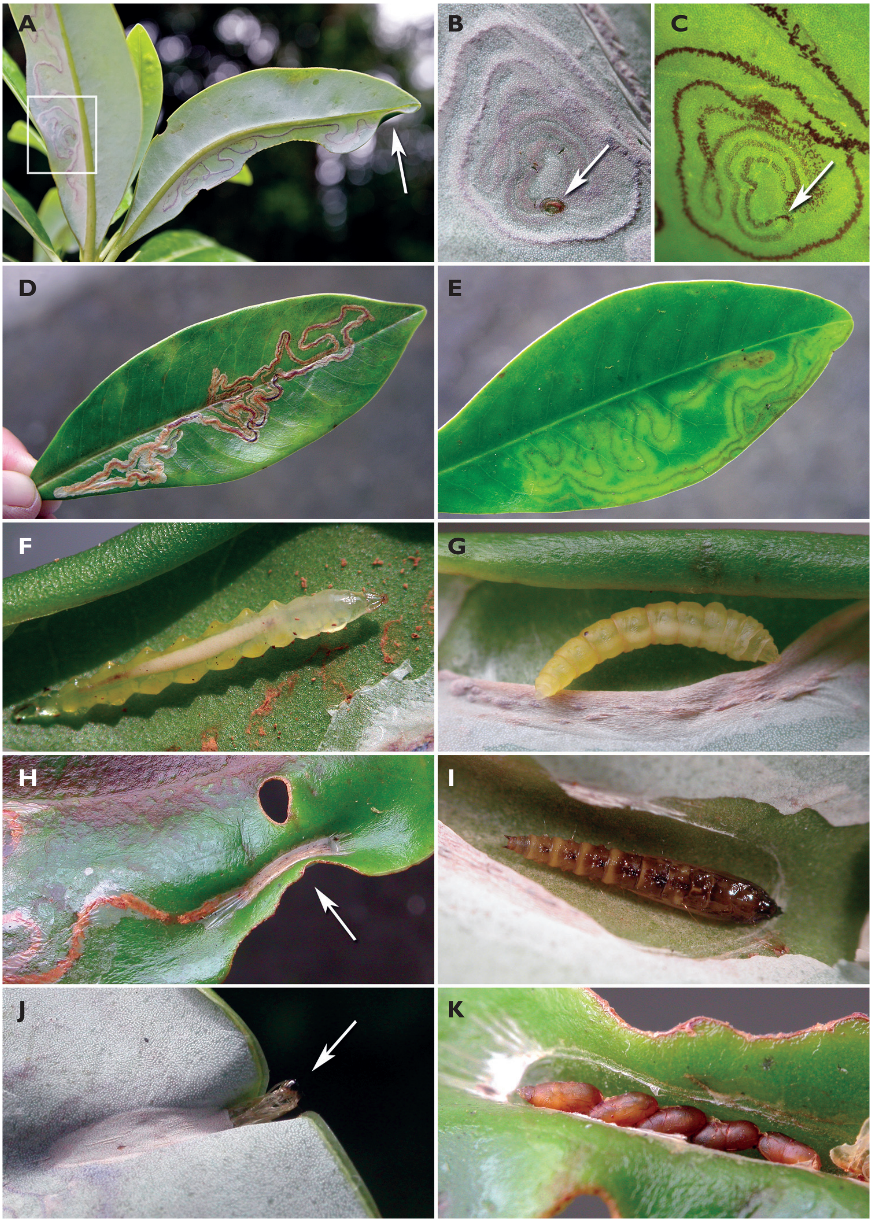

Figure 10. Life history of *Phyllocnistis drimiphaga* sp. n. **A** Leaf mines on abaxial side of leaf surface, white square enclosing early mine, arrow pointing to pupal cocoon fold **B** close-up view of early mine, arrow pointing to egg shell remains **C** same as figure B, but showing frass pattern (photo taken with sunlight projecting through the leaf from behind) **D** nearly mature old mine on adaxial side **E** nearly mature old mine on abaxial side (photo taken from adaxial side) **F** opened mine showing mature sap-feeding larva *in situ* **G** opened young pupal cocoon fold showing cocoon-spinning larva *in situ* **H** pupal cocoon fold on adaxial mine **I** opened pupal cocoon fold showing pupa *in situ* (dorsal view) **J** protruded and attached pupal shell (arrow) on pupal cocoon fold of an abaxial leaf mine **K** opened pupal cocoon fold on adaxial mine showing *Ageniaspis* cocoons *in situ*.

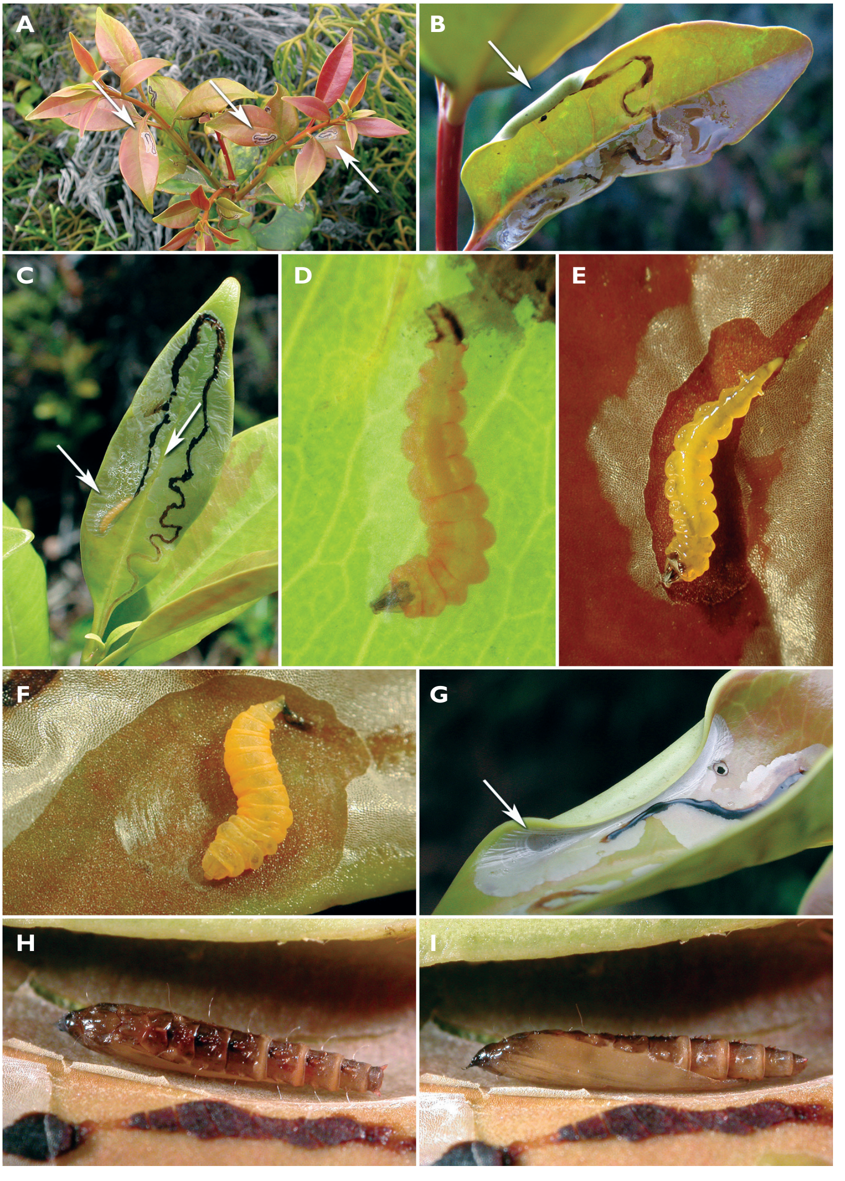

Figure 11. Life history of *Phyllocnistis maxberryi* sp. n. **A** Leaf mines on young growing *Gaiadendron* shoot **B** mature mine with pupal cocoon fold (arrow) **C** nearly mature mine and mature sap-feeding larva (left arrow), and oviposition location (right arrow) **D** close-up view of mature sap-feeding larva **E** opened mine showing mature sap-feeding larva *in situ* **F** opened young pupal cocoon fold showing cocoon-spinning larva *in situ* **G** pupal cocoon fold, arrow pointing at thinner pupal exit **H** opened pupal cocoon fold showing pupa *in situ*, dorsal view **I** pupa *in situ*, lateral view.

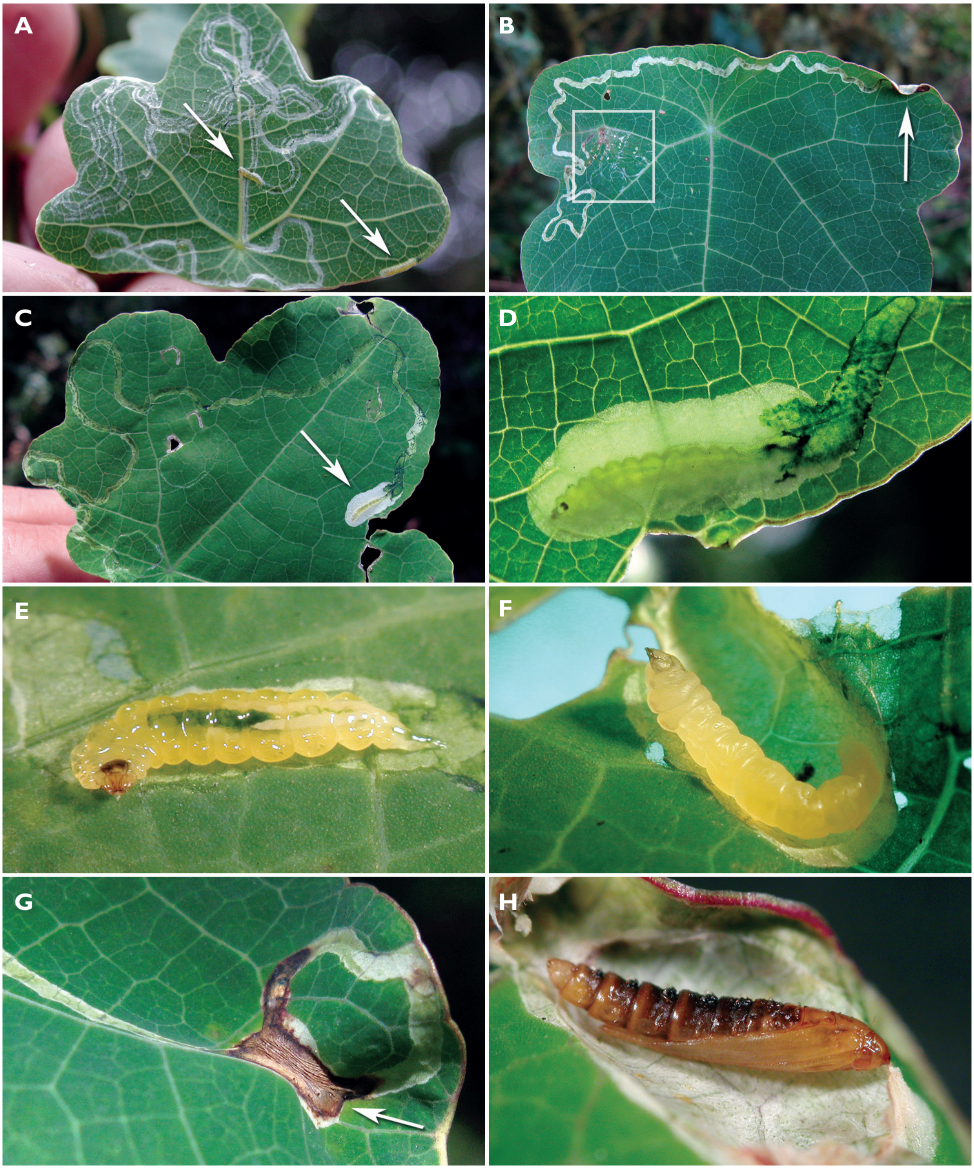

Figure 12. Life history of *Phyllocnistis tropaeolicola* sp. n. **A** Leaf mines on a young leaf, arrows pointing at young to middle instar larvae **B** mature leaf mine with pupal cocoon fold (arrow), white square enclosing early stage mine region **C** mature sap-feeding larva in pre-cocoon chamber **D** detailed view of figure C **E** opened mine showing nearly mature sap-feeding larva *in situ* **F** opened young pupal cocoon fold showing cocoon-spinning instar *in situ* **G** pupal cocoon fold, arrow pointing to the slender exit **H** opened pupal cocoon fold showing pupa *in situ*, dorsolateral view.

33285; 2♂, 2♀ (USNM 33280, 33282) with adult emergence 11 Mar 2003; 1♂, with adult emergence 15 Mar 2003. 1♀ adult paratype at INBio and UCR, the remaining paratypes at USNM.

Life history (Fig. 12). Mines of *P. tropaeolicola* were readily found on plants growing along the Pan-American Highway (Fig. 1H). Most mines occurred on full-grown new leaves (Figs 12B, C) but some were found on developing leaves (Fig. 12A). Thirteen had a single mine, two leaves had two, and one had three. All mines were found on the adaxial side, and the late sap-feeding instar fed on the mesophyll (Fig. 12E).

The mine characteristically begins as a narrow, irregular serpentine gallery (Fig. 12B) that widens as it extends along or near the leaf margin (Figs 12B, C). It is relatively narrow, pale green to white with a less conspicuous dark green median frass line. Pupal cocoon folds were ~ 5.5 mm long and were found near the leaf margin (Figs 12B, G). Adults emerged 5–9 days after pupal cocoon folds were collected.

We found mines of an unidentified fungus gnat (Diptera: Mycetophilidae) at same site on the same plant. The mines, which usually occur several on a single leaf, are irregularly shaped blotch mines with dark-green frass scattered randomly within. The fly larva causes curling, drying, necrosis, and yellowing of the leaves, and was more abundant than *P. tropaeolicola* mines. Several leaves were infested with both mycetophilid and *P. tropaeolicola* larvae.

Host. *Tropaeolum emarginatum* Turcz (Tropaeolaceae) (Fig. 1I). *Tropaeolum*, the only genus recognized in Tropaeolaceae, is Neotropical and contains approximately 90 species, many of which are found in Andean cloud forests (Gentry 1996). Four species occur in Costa Rica, and *T. emarginatum* is present on both the Atlantic and Pacific slopes between 700 and 3200 m (Alfaro-Vindas 2003; INBio 2009). Outside Costa Rica, *T. emarginatum* has been recorded from Chiapas, Mexico to Cotopaxi, Ecuador (Missouri Botanical Garden 2009). The tenuous, soft, and succulent vines of *T. emarginatum* are usually found in forest edges and disturbed areas, and the flowers are red to yellow orange (Alfaro-Vindas 2003; Gentry 1996). Most of the leaves are between 5 and 8 cm wide (KN, pers. obs.).

Distribution. Known only from the type locality, Cerro de la Muerte, Villa Mills, at 3100 m elevation in the Cordillera de Talamanca.

Etymology. The species name, *tropaeolicola*, is formed from its host plant genus name, *Tropaeolum*, and the Latin word *cola*, meaning “inhabitant”.

Acknowledgements

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RESEARCH ARTICLE

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The genus *Atanycolus* Foerster (Hymenoptera, Braconidae, Braconinae) in China, with description of one new species

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Abstract
The species of the genus *Atanycolus* Foerster (Hymenoptera, Braconidae, Braconinae) from China are revised and six species are recognized, including one new species (*A. grandis* Wang & Chen, **sp. n.**), which is described and illustrated in this paper. Three species, i.e. *A. crenulatus* Telenga, 1936, *A. lindemani* Tobias, 1980 and *A. sculpturatus* (Thomson, 1892), are reported from China for the first time. A key to species of this genus is provided.

Keywords
Hymenoptera, Braconidae, Braconinae, *Atanycolus*, new species, new record, Coleoptera, parasitoid, Palaearctic region, Oriental region, China

Introduction

Atanycolus Foerster is a cosmopolitan genus with 59 described species (Yu et al. 2007). Most of species are less than 10.0 mm long. They are ectoparasitoids of the larvae of various species of wood and bark-boring beetles (Coleoptera: Buprestidae, Cerambycidae and Scolytidae), many of which are notorious pests of coniferous and broadleaved trees. The chemical control of these pests is difficult because they live under bark. Therefore, the species of this genus may be important natural control agents of many of these beetles.

This is a part of an on-going study of the subfamily Braconinae (Hymenoptera: Braconidae) of China (Wang et al. 2003a, b, c, d, 2004, 2006a, b, c, d, 2007, 2008). In this study, six species of genus *Atanycolus* were found to occur in China, of which one species is new to science (*A. grandis* sp. n.) and three species are new to China (*A. crenulatus* Telenga, 1936, *A. lindemani* Tobias, 1980 and *A. sculpturatus* (Thomson, 1892)). The new species is described and illustrated below. A key to the Chinese species of the genus is provided. The examined specimens are deposited in the Parasitic Hymenoptera Collection, Zhejiang University, Hangzhou, China (ZJUH), Institute of Plant Physiology and Ecology, the Chinese Academy of Sciences, Shanghai (SIPPE) and the Institute of Zoology, the Chinese Academy of Sciences, Beijing (IZBJ).

The morphological terminology used in this paper follows that of van Achterberg (1979), Harris (1979) and Quicke (1987). All descriptions and measurements were made under a Leica MZ 12.5 stereomicroscope (Wetzlar, Germany), and photos taken by a digital camera (Q-Imaging, Micropublisher 3.3 RTV) attached to a Leica MZ APO stereomicroscope (Wetzlar, Germany) using Synoptics Auto-Montage version 5.0 software.

Key to species of genus *Atanycolus* Foerster in China

1. Second metasomal suture (= groove between second and third metasomal tergites) wide and strongly crenulate; third tergite with strongly raised area antero-laterally **2**

– Second metasomal suture narrow and weakly crenulate medially, and at least laterally smooth; third tergite with weakly raised area antero-laterally **5**

2. Head entirely blackish; longitudinal grooves of second metasomal tergite shallow laterally; first metasomal tergite blackish brown .... ***A. denigrator* (Linnaeus, 1758)**

– Head dark yellow or yellowish red; longitudinal grooves of second metasomal tergite deep laterally; first metasomal tergite black or yellow **3**

3. Triangular area of third and fourth metasomal tergites (except for medio-basally) uniformly sculptured; metasoma pale yellow and head blackish brown .... ***A. sculpturatus* (Thomson, 1892)**

– Third and fourth tergites smooth without any sculpture; metasoma yellowish brown or blackish brown and head reddish yellow **4**

4. Length of body more than 10 mm; ocellar triangular area with blackish spot (Fig. 2); wing membrane infuscated (Fig. 5); third metasomal tergite with strongly raised area antero-laterally (Fig. 7, 8) .... ***A. grandis* Wang & Chen, sp. n.**
– Length of body less than 10 mm; ocellar triangular area reddish yellow; wing membrane yellowish brown; third tergite with weakly raised area antero-laterally .... ***A. crenulatus* Telenga, 1936**
5. Second metasomal tergite with parallel longitudinal impressed grooves laterally, medio-basal smooth triangular area deeply impressed; suture between second and third tergites crenulate medially and smooth laterally; tergites three to six orangish yellow .... ***A. initiator* (Fabricius), 1793**
– Second tergite without parallel longitudinal impressed grooves laterally, medio-basal smooth triangular area without a deep impression; suture between second and third tergites completely smooth; tergites three to six yellowish-white.. ***A. lindemani* Tobias, 1980**

Descriptions

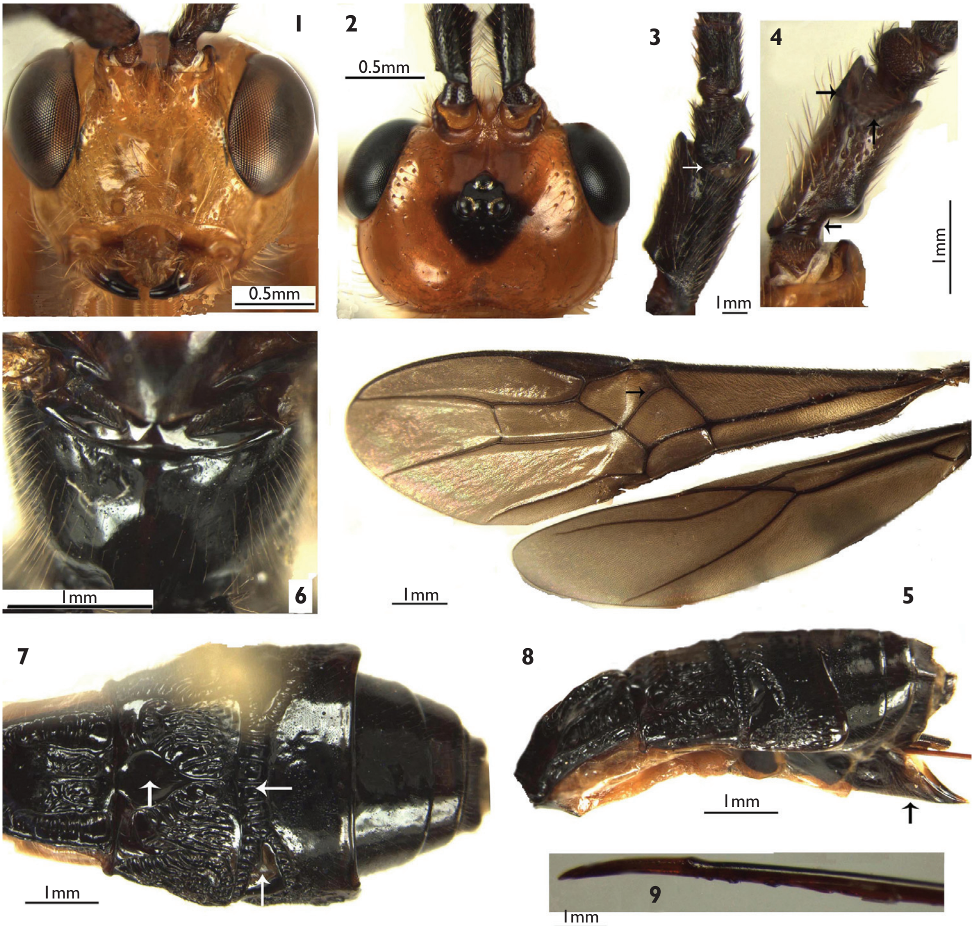
***Atanycolus grandis* Wang & Chen, sp. n.**
urn:lsid:zoobank.org:act:6AA69564-8B04-4CF7-BACE-1C3F865B6C95
Figs 1–9

Length of body 10.0–14.0 mm, fore wing 8.0–12.0 mm, ovipositor sheath 10.0–12.5 mm.

Head. Antenna with 68 segments; terminal flagellomere tapering apically, approximately 1.4 times longer than basal width; first flagellomere parallel-sided but weakly flared basally, 1.2 and 1.5 times longer than the second and third ones, respectively; the latter 1.4 times longer than its maximum width; median flagellomeres as long as its maximum width; transverse medial clypeal carina with a row sparse long setae; height of clypeus: inter-tentorial distance: tentorio-ocellar distance = 5: 9: 6; face with sparse long setae, width of face: width of head: maximum length of eye in dorsal view = 18: 34: 19; frons strongly impressed medially; shortest distance between posterior ocelli: diameter of posterior ocellus: shortest distance between posterior ocellus and eye = 2.5: 2.0: 9; vertex smooth and shiny with dense setae.

Mesosoma. Length of mesosoma 1.8 times as long as its maximum height, smooth and shiny with sparse long setae; notauli deeply impressed anteriorly and shallowly posteriorly, with sparse short setae along entire length; scutellar sulcus relatively narrow and deep, and distinctly crenulate; metanotum with strongly raised area medially; propodeum smooth, with sparse setae, but relatively densely and long setose laterally.

Wing. Length of fore wing veins SR1: 3-SR: r = 64: 45: 12; vein 1-SR+M slightly bent basally; length of fore wing veins 2-SR: 3-SR: r-m = 21: 45: 19; vein cu-a interstitial. Hind wing: length of veins SC+R1: 2-SC+R: 1r-m = 30: 6: 12; vein C+SC+R with three thickened (humular) bristles apically.



Figures 1–9. *Atanycolus grandis* Wang & Chen, sp. n.: **1** head, frontal view **2** head, dorsal view **3** scapus, lateral view **4** scapus, ventral-lateral view **5** wings **6** metanotum and propodeum, dorsal view **7** metasomal tergites, dorsal view **8** metasomal tergites, lateral view **9** apex of ovipositor, lateral view.

Leg. Length of fore femur: tibia: tarsus = 50: 53: 94; length of hind femur: tibia: basitarsus = 15: 25: 9, 3.2, 10.0 and 6.1 times their maximum width, respectively; tibia of hind leg with longitudinal groove medially.

Metasoma. First metasomal tergite 1.2 times longer than its maximum apical width, strong apical dorsal carinae occupying basal 3/4 of its length; second tergite with a glabrous medio-basal triangular area and sublateral longitudinal grooves, the remainder deeply striate; third tergite with distinct carina antero-laterally, smooth and shiny medially, distinctly sculptured postero-laterally; suture between second and third metasomal tergites wide, deep and crenulate; third tergite with transverse deeply impressed groove apically; tergites four to six smooth and shiny;

hypopygium acute apically, slightly extending beyond apex of metasoma; ovipositor sheath as long as fore wing, and ovipositor with ventral teeth sub-apically.

Colour. Antenna blackish; head dark yellow except for ocellar triangular area with blackish spot and maxillary palp reddish-yellow; mesosoma reddish-yellow but mesoscutum with blackish-brown spots laterally; propodeum dark brown; fore leg reddish-yellow, middle and hind legs blackish-brown; wings membrane infuscated and veins blackish brown; metasomal tergites black; ovipositor sheath blackish-brown.

Variation. Paratypes similar to the holotype. Antenna with 66–69 segments. Head in dorsal view 1.6–1.7 times as broad as long. Hind femur 3.1–3.3 times as long as broad medially. Pterostigma somewhat wide, 3.1–3.2 times as long as wide; second submarginal cell of fore wing long, vein 3-SR 2.2–2.3 times as long as the 2-SR. First tergite 1.1 times as long as broad posteriorly. Second tergite distinctly longer than third tergite. Vertex pale yellow or reddish yellow; mesoscutum with blackish brown spots laterally; middle and hind legs pale yellow; ovipositor sheath yellowish brown.

Specimens examined. Holotype, ♀, West Tianmu Mountain (119°23'E, 30°18'N), Zhejiang, 2000.VII.3, Ma Yun, No. 200103596 (ZJUH). Paratypes: 1♀, T'ienmu-Shan (119°23'E, 30°18'N), China, 1937.VII.2, O. Piel., Musee Heude (SIPPE); 1♀, T'ienmu-Shan (119°23'E, 30°18'N), China, 1936.VII.6, O. Piel., Musee Heude (SIPPE); 4♀♀, Songyang (119°29'E, 28°28'N), Zhejiang, China, 1989.VIII.16, He Jun-hua, 1989.VII.11–14, 11–21, No. 895251, 895313, 895448, 895251 (ZJUH); 2♀♀, Zhuchaoguan (119°30'E, 28°29'N), Songyang, Zhejiang, China, 1994.VII.17, Cai Ping, No. 944170, 944172 (ZJUH); 1♀, Zhuchaoguan (119°30'E, 28°29'N), Songyang, Zhejiang, China, 1994.VII.17, Xu Zai-fu, No. 944369 (ZJUH); 1♀, Baishanzu (119°14'E, 27°52'N), Qingyuan, Zhejiang, China, 1993.VII.30, Wu Hong, No. 945161 (ZJUH); 1♀, Wuyi Mountain (118°02'E, 27°46'N), Fujian, China, 1986.VI.16, Wang Jia-she, No. 870644 (ZJUH); 1♀, Huaping (110°2'E, 25°10'N), Longsheng, Guangxi, China, 1982. VI. 25, He Jun-hua, No. 823297 (ZJUH); 1♀, Longgang (108°23'E, 34°19'N), Longzhou, Guangxi, China, 1982.V.20, He Jun-hua, No. 821594 (ZJUH); 1♀, Ziping (114°16'E, 26°56'N), Jinggang mountain, Jiangxi, China, 1981.V.28, Liu Jin, Liu Yao, No. 340041551 (ZJUH); 1♀, Pingba (106°27'E, 26°42'N), Guizhou, China, 19??, Guizhou Forest Acadamy Institute, No. 801723 (ZJUH).

Biology. Unknown.

Etymology. From latin "grandis" meaning for large, referring to large body of type specimens.

Diagnosis. This species is similar to *Atanycolus crenulatus* Telenga, but can be separated from the latter by having the length of body more than 10 mm; the wings infuscated (Fig. 5); ocellar triangular area with a blackish spot (Fig. 2); vein 1-SR+M of fore wing slightly bent basally (Fig. 5); propodeum with relatively dense and long setae laterally (Fig. 6); second tergite deeply striate except for smooth medio-basal triangular area (Fig. 7), and third metasomal tergite with a distinctly raised area antero-laterally (Figs 7, 8).

Atanycolus crenulatus Telenga, 1936

Atanycolus crenulatus Telenga, 1936: 327; Telenga, 1952: 120 (Trans. 1969: 95); Tobias, 1971, 54: 207; Tobias et al., 2000, 4: 183.

Specimens examined: CHINA: GANSU: 1♀, Lanzhou (103°44'E, 36°2'N), 1980. VII.29, Wang Chang-zhong, No. 853597 (ZJUH).

Biology. unknown.

Distribution. China (Gansu) and Russia.

Note. This species is new to China.

Atanycolus denigrator (Linnaeus, 1758)

Ichneumon denigrator Linnaeus, 1758, 10a 1: 563.
Bracon denigrator: Panzer, 1801: 163.
Atanycolus denigrator: Foerster, 1862, 19: 238; Shenefelt, 1978: 1441; Papp, 1998: 147; Sheng, 1990, 12 (1): 56.

Biology. Reported from the following hosts: *Acanthocinus aedilis* L., *Rhagium indagator* F., *R. inquisitor* L., *Saperda populnea* L. and *Tetropium fuscum* L. (Coleoptera: Cerambycidae), *Anthaxia morio* F. and *Chrysobothris chrysostigma* L. (Coleoptera: Buprestidae).

Distribution. China (Inner Mongolia); Austria; Bulgaria; Croatia; Czechoslovakia; Finland; France; Germany; Greece; Hungary; Israel; Italy; Kazakhstan; Korea; Mongolia; Niger; Norway; Poland; Russia; Slovakia; Sweden; Switzerland; Turkey; United Kingdom.

Note. This species has been reported from Daxing'an Mountain (China) by Sheng (1990), but no specimens were available for our study.

Atanycolus initiator (Fabricius, 1793)

Ichneumon initiator Fabricius, 1793, 2: 161.
Bracon (*Coeloides*) *initiator*: Blanchard, 1840, 3: 341.
Bracon (*Vipio*, *Coelobracon*) *genalis* Thomson, 1892, 17: 1800. syn. by Roman, 1912.
Atanycolus initiator: Szepligeti, 1901, 33: 176; Watanabe, 1950, 21(2): 20 (Shanxi of China); Papp, 1998a, 59: 147; Tobias et al., 2000, 4: 183; Sheng, 1990, 1: 33.
Atanycolus mongolicus Telenga, 1936, 5 (2): 92. syn. by Tobias, 1971.
Atanycolus petiolaris Thomson, 1892, 17: 1859. syn. by Tobias, 1986.

Specimens examined. CHINA: HEILONGJIANG: 6♀♀, Dailing (128°54'E, 47°40'N), Yichun, 1956.VI.10, Shi Zhen-hua, No. 5710. 3, Ex. *Monochamus sutor* (L.); 20♀♀, Dailing (128°54'E, 47°40'N), Yichun, 1977.VII.24, He Jun-hua, No. 771811, 771749, 771771, 771786, 771845, 771870, 771680, 771703, 771713, 771710, 771850, 771802, 771887, 771892, 771812, 771687, 771725, 771813, 771726, 771727, 771903 (ZJUH); CHINA: INNER MENGOLIA: 3♀♀2♂♂, Xiao Xing'anling (127°42'E,46°28'N), 1955.VI.1, Collector unknown, No. 5607. 1, Ex. *Ips typographus*, L. (ZJUH); CHINA: SHANXI: 1♀1♂, Taiyuan (112°33'E,37°54'N), 1987.V, Zhao Rui-liang, No. 870074, 870075 (ZJUH); CHINA: SHANGDONG: 1♀, Tai mountain (117°59'E,36°28'N), Tai'an, 1997.VI.17, Li Qiang, No. 200011169 (ZJUH); CHINA: HUBEI: 2♀♀, Jingshan (113°23'E,31°6'N), 1980.VI, Zhan Zhong-cai, No. 824303, 824302 (ZJUH).

Biology. The known hosts are *Monochamus sutor* (L.) (Coleoptera: Cerambycidae) and *Ips typographus* L. (Coleoptera: Scolytidae) according to collecting labels. Other reported hosts are *Semanotus rufipennis* Motschulsky, *Acanthocinus aedilis* L., *Cerambyx scopolii* Fuessly, *Criocephalus rusticus* L., *Rhagium inquisitor* L., *Tetropium castaneum* L. and *T. fuscum* Fabricius (Coleoptera: Cerambycidae), *Aegeria flaviventris* Staudinger and *A. vespiformis* L. belonging to family Sesiidae of Lepidoptera based on the catalogues of Shenefelt (1978) and Yu et al. (2005).

Distribution. China (Heilongjiang, Inner Mongolia, Shanxi, Shandong, Henan and Hubei); Austria; Azerbaijan; Croatia; Czech Republic; Czechoslovakia; Finland; France; Germany; Hungary; Italy; Japan; Latvia; Lithuania; Mongolia; Norway; Poland; Russia; Slovakia; Spain; Sweden; Switzerland; Turkey; Turkmenistan; Ukraine; United Kingdom.

Atanycolus lindemani Tobias, 1980

Atanycolus lindemani Tobias, 1980, 7: 289–295; Tobias and Belokobylskij, 2000, 4: 184.

Specimens examined. CHINA: HEILONGJIANG: 1♂, Dailing (128°54'E, 47°40'N), Yichun, 1956.V.29, Shi Zhen-hua, No. 5710.1 (ZJUH); CHINA: HEILONGJIANG: 1♂, Dailing (128°54'E, 47°40'N), Yichun, 1977.VII.24, He Jun-hua, No. 771808 (ZJUH); CHINA: JILIN: 1♀, Gongzhu Mountain (124°49'E, 43°3'N), 1983.VIII.9, Wang Cheng-lun, No. 840129 (ZJUH); CHINA: XINJIANG: 1♀1♂, Shihezi (86°0'E, 44°18'N), 1981.VI.15, He Fu-de, No. 816488, Ex. *Scolytus seulensis* Murayama (ZJUH); CHINA: SHAANXI: 1♀1♂, Dingbian (107°59'E, 37°60'N), 1981.V.23, Dang Xin-de, No. 815987, Ex. *Xyloterinus politus* Say (ZJUH).

Biology. The known hosts are *Xyloterinus politus* Say and *Scolytus seulensis* Murayama (Coleoptera: Scolytidae) according to collecting labels.

Distribution. China (Heilongjiang, Jilin, Xinjiang and Shaanxi) and Russia.

Note. This species is new to China.

Atanycolus sculpturatus (Thomson, 1892)

Bracon (*Vipio*, *Coelobracon*) *sculpturatus* Thomson, 1892, 17: 1800.
Vipio (*Coelobracon*) *sculpturatus*: Kriechbaumer, 1898, 24: 246.
Coelobracon sculpturatus: Szepligeti, 1896, 19: 168.
Coeloides (*Atanycolus*) *sculpturatus*: Marshall, 1897, 5 bis: 118.
Vipio (*Atanycolus*) *sculpturatus*: Schmiedeknecht, 1897 1: 512.
Atanycolus sculpturatus: Dalla Torre, 1898, 4: 296; Papp, 1998b, 59: 147; Tobias et al., 2000, 4: 183.
Iphiaulax (*Atanycolus*) *sculpturatus*: Hellen, 1927, 56: 11.
Atanycolus signatus Szepligeti, 1901, 33: 176. syn. by Papp, 1960.
Coelobracon signatus: Fahringer, 1926, 1(2–3): 136.

Specimens examined. CHINA: XINJIANG: 1♀, Liudaowan (87°65'E, 43°74'N), 1982.VII.28, No. 860047, collector unknown; 1♀, Shihezi (86°00'E, 44°18'N), 1981. VIII.14, He Fu-de, No. 820018 (ZJUH).

Biology. According to Shenefelt (1978) Yu et al. (2007), the known hosts are *Chrysobothris sorieri* Lap. and *Agrilus biguttatus* F. (Coleoptera: Buprestidae), *Tetropium gabrieli* Weise, *Ruguloscolytus mediterraneus* Egg. and *Leptura rubra* (L.) (Coleoptera: Cerambycidae).

Distribution. China (Xinjiang); Austria; Croatia; Czech Republic; Czechoslovakia; Finland; France; Germany; Greece; Hungary; Italy; Japan; Russia; Slovakia; Switzerland; Ukraine.

Note. This species is new to China.

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RESEARCH ARTICLE

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The genus *Eodendrus* Belokobylskij (Hymenoptera, Braconidae, Doryctinae) from China, with description of a new species

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Abstract

The genus *Eodendrus* Belokobylskij (Hymenoptera: Braconidae, Doryctinae) from China is revised. Three species are recognized, of which a new species, *E. reticulatus* Wang & Chen, **sp. n.**, is described and illustrated, and *Eodendrus hoabinicus* Belokobylskij & Long, 2005 recorded in China for the first time. A key to the species of this genus is updated to include the new species. The type specimens are kept in the Parasitic Hymenoptera Collection, Zhejiang University, Hangzhou (ZJUH).

Keywords

Hymenoptera, Braconidae, Doryctinae, *Dendrosotinus, Eodendrus,* new species, new record, Oriental region, China

Introduction

Eodendrus Belokobylskij was set up as an subgenus of the genus *Dendrosotinus* Telenga (Hymenoptera, Braconidae, Doryctinae) based on the Eastern Palaearctic species *D. eous* Belokobylskij, 1988 (Belokobylskij 1988). Later, *Eodendrus* Belokobylskij was raised to generic status (Belokobylskij et al. 2005). To date eight species of the genus *Eodendrus* Belokobylskij have been known in the world, of which one occurs in the Palaearctic, five in the Oriental, and two in the Afrotropical regions (Granger 1949, Belokobylskij 1988, Belokobylskij et al. 2005). Only one species of the genus - *Eodendrus petiolatus* has been recorded in China, which occurs in Guangxi province. During our study of Chinese materials of the genus *Eodendrus*, we discovered a new species and a species that have hitherto not been recorded from China. In the present paper, the new species is described and illustrated, the new record listed, and the key to the genus *Eodendrus*, as published by Belokobylskij et al. (2005), modified.

Material and methods

The terminology and measurements used follow van Achterberg (1979, 1988). Additional sources for the description of sculpture and setation are Belokobylskij et al. (2005). All descriptions and measurements were made under a Leica MZ 12.5 microscope, and figures made under ZEISS Stemi SV6 microscope. Type specimens and other materials are deposited in the Parasitic Hymenoptera Collection of the Zhejiang University, Hangzhou, China (ZJUH).

Key to the species of the genus *Eodendrus* Belokobylskij
(modified from Belokobylskij et al. 2005)

1. First subdiscal cell widened medially and closed apically almost at level of m-cu vein; hind coxa with small basoventral tubercle; first tergite high (in lateral view); larger, body length 7.0 mm. South Africa .... ***E. africanus* Belokobylskij, 2005**

– First subdiscal cell not or weakly widened medially and usually closed apically distinctly before level of m-cu vein (except *E. conspicuus*); hind coxa without basoventral tubercle; first tergite usually not high (lateral view); smaller, body length 2.4–5.7 .... **2**

2. Length of mesosoma 2.4–2.5 times its height; mesoscutum weakly and roundly raised above pronotum; second and third metasomal tergites widely yellow laterally and brown to reddish brown medially; body length 3.9–4.2 mm. (Male) Vietnam .... ***E. elongatus* Belokobylskij & Long, 2005**

– Length of mesosoma 2.0–2.2 times its height; mesoscutum highly and almost perpendicularly raised above pronotum **3**

3. First tergite with small spiracular tubercles; acrosternite of female 0.35–0.4 times as long as first tergite; length of first tergite 1.4–1.6 times its apical width; lateral depressions of second tergite at most weakly convergent **4**

– First tergite with long spiracular tubercles which are directed somewhat downwards; acrosternite of female 0.45–0.6 times as long as first tergite; length of first tergite 1.6–2.3 times its apical width; lateral depressions of second tergite distinctly convergent.. **5**

4. 3-SR vein of fore wing 0.5–0.6 times SR1, first subdiscal cell apically closed distinctly before m-cu vein; length of second tergite 1.1–1.15 times its basal width; body dark reddish brown; antenna 28–31-segmented; smaller, body length 3.0–3.4 mm. Russia (south of Far East), Japan, Korea...................... ....***E. eous*** **(Belokobylskij, 1988)**

– 3-SR vein of fore wing 0.7 times SR1, first subdiscal cell apically closed almost at level of m-cu vein; length of second tergite 0.8–0.9 times its basal width; body usually light brown with dark spots; antennae 39-segmented; larger, body length 4.1–5.7 mm. Madagascar... .... ***E. conspicuus*** **(Granger, 1949)**

5. Length of second tergite 1.6 times its basal width; length of first tergite 2.3 times its apical width; eyes sparsely, shortly setose. body length 4.2 mm. China (Guangxi)........................... ***E. petiolatus*** **Belokobylskij & Chen, 2005**

– Length of second tergite 0.9–1.3 times its basal width; length of first tergite 1.6–2.1 times its apical width; eyes glabrous **6**

6. Transverse diameter of eye 1.4 times as long as temple (dorsal view); second submarginal cell of fore wing 3.4 times as long as its maximum width; vertex almost smooth medially; third tergite almost entirely smooth, very finely coriaceous laterally; scapus 1.25 times as long as its maximum width; body length 2.4 mm. Vietnam................................... .... ***E. flavus*** **Belokobylskij & Long, 2005**

– Transverse diameter of eye twice as long as temple (dorsal view); second submarginal cell of fore wing 2.6–3.0 times as long as its maximum width; vertex distinctly and densely granulate, partly with dense and fine transverse striation; third tergite always sculpture basally, smooth medioapically............... **7**

7. Lateral furrows of second tergite deep, distinctly carinate along interior margin, strongly posteriorly convergent; basal width of middle area 3.1 times its apical width; POL 2.0 times Od and 0.86 times OOL; dorsal hairs of hind tibia long, 0.8–1.36 times as long as apical width of tibia; scutellum finely granulate-coriaceous; body length 3.2 mm. Vietnam ....***E. convergens*** **Belokobylskij, 2005**

– Lateral furrows of second tergite shallow, not carinate along interior margin, less distinctly posteriorly convergent; basal width of middle area 1.5–2.5 times its apical width; POL 1.4–1.6 times Od and 0.5–0.6 times OOL; dorsal hairs of hind tibia short, 0.5–0.8 times as long as apical width of tibia **8**

8. Length of first tergite 2.1 times its apical width, maximum width of first tergite 2.0 times minimum width; spiracular tubercles of first tergite distinct and long, about 0.4 times basal width of first tergite; second tergite irregularly reticulate; third tergite reticulate in mediobasal 0.55 and the color of this area darker than the rest of third tergite. China (Hainan) .... ***E. reticulatus* sp. n.**

– Length of first tergite 1.6–1.7 times its apical width, maximum width of first tergite 2.3 times minimum width; spiracular tubercles of first tergite relatively shorter; second tergite densely striate, with dense reticulation between striae; third tergite finely striate in mediobasal 0.25 and with the same color as the rest of third tergite. Vietnam, China.. .... ***E. hoabinicus* Belokobylskij & Long, 2005**

Eodendrus petiolatus Belokobylskij & Chen, 2005

Eodendrus petiolatus Belokobylskij et al., 2005: 2740.

Type material. Holotype female (ZJUH): China, Guangxi, Tianlin, 24°17'38"N, 106°13'44"E, 278m elev., 31.V.1982, He Jun-hua, No.822073.

Distribution. China (Guangxi).

Eodendrus hoabinicus Belokobylskij & Long, 2005

Eodendrus hoabinicus Belokobylskij et al., 2005: 2737.

Examined material. Female (ZJUH): China, Hainan, Jianfengling, 18°42'25"N, 108°49'47"E, 1200m elev., 7.VI.2007, Liu Jing-xian, No.200702549.

Distribution. China (Hainan), Vietnam.

Notes. This species is new to the fauna of China. Type specimens are preserved in the Institute of Ecology and Biological Resources, Hanoi, Vietnam (IEBR).

Eodendrus reticulatus Wang & Chen, sp. n.

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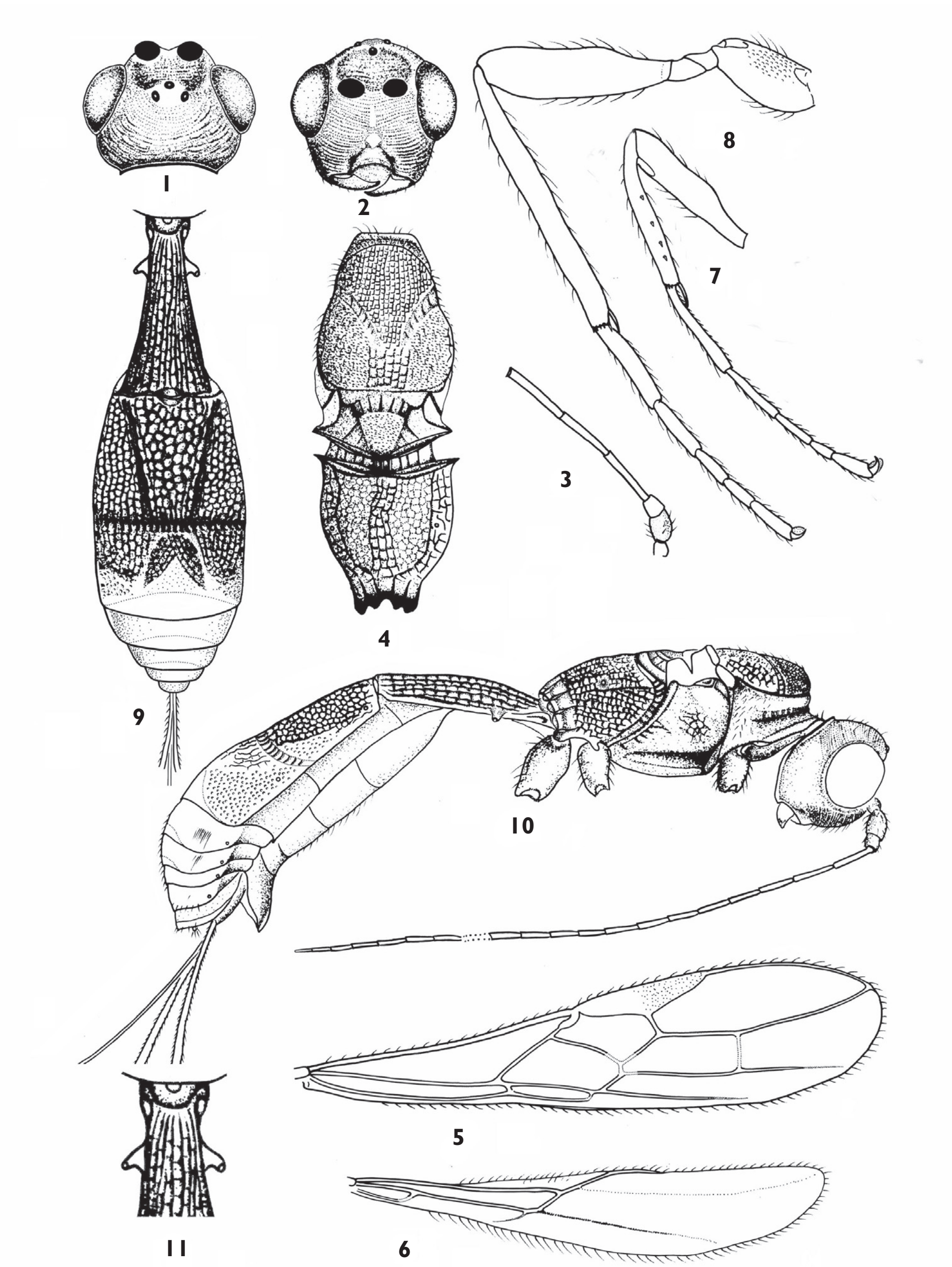
Figs 1–11

Type material. Holotype female (ZJUH): China, Hainan, Jianfengling, 18°42'25"N, 108°49'47"E, 1200m elev., 7.VI.2007, Liu Jing-xian, No.200702509.

Female. Length of body 3.0 mm, of fore wing 2.7 mm.

Head (Figs 1, 2). Antenna broken, remaining antennal segments 27, scapus as long as its maximum width, third segment as long as fourth segment (Fig. 3), length of third and fourth segments 6.0 and 5.0 times their width; length of maxillary palp



Figures 1–11. *Eodendrus reticulatus* Wang & Chen, sp. n. ♀ **1** head, dorsal aspect **2** head, frontal aspect **3** basal five segments of antenna **4** mesosoma, dorsal aspect **5** fore wing **6** hind wing **7** fore leg **8** hind leg **9** metasoma, dorsal aspect **10** habitus, lateral aspect **11** dorsope and spiracular tubercles of first tergite.

1.7 times height of head; OOL: OD: POL = 8: 3: 4, posterior side of stemmaticum longer than lateral sides; eye glabrous; length of eye twice temple in dorsal view; head at level of eyes a little wider than at level of temple in dorsal view and temples behind eyes roundly narrowed; face distinctly transversely striate, densely clothed with long hairs; frons with rather irregular transverse striae and rugae; vertex finely transversely striate and granulate, clothed with short hairs; posterior part of temple finely striate, anterior part of temple almost smooth; length of malar space 1.6 times basal width of mandible and 0.56 times transverse diameter of eye in lateral view; longer diameter of eye 2.0 times length of temple.

Mesosoma (Figs 4, 10). Length of mesosoma 2.0 times its height; pronotal keel indistinct; side of pronotum with obsolescent short crenulation; mesoscutum highly and almost perpendicularly raised above pronotum, completely and densely clothed with short pubescence; medio-posteriorly with much irregular rugosity and the median carinae indistinct; notauli complete, deep in anterior half and shallow in posterior half, finely crenulate; mesopleuron densely granulate with rugae, coriaceous below precoxal sulcus; precoxal sulcus shallow, narrow and finely crenulate; scutellar sulcus shallow, with 4 carinae; scutellum slightly convex and coriaceous; propodeum without areola, with irregular rugae and reticulation; metapleuron with irregular rugosity.

Wings (Figs 5, 6). Fore wing 4.1 times as long as wide; pterostigma 4.2 times as long as wide; r issued submedially from pterostigma; r: 2-SR: SR1: 3-SR: r-m= 5: 10: 25: 14: 8; cu-a short and postfurcal; 1-CU1: 2-CU1= 2: 17; 3-CU1 antefurcal; m-cu postfurcal, shorter than 2-SR; Second submarginal cell 2.6 times as long as its maximum width. Hind wing 5 times as long as wide; M+CU: 1-M= 5: 11; m-cu present and stituated close to 1r-m.

Legs (Figs 7, 8). Fore tibia with 4 spines, fore tarsus 1.7 times as long as fore tibia; fore femur with a blister at basal 1/3 (Fig. 7); hind coxa without a baso-ventral tubercle (Fig. 8), its length 1.7 times maximum width, length of femur, tibia and basitarsus of hind leg 3.7, 8.8 and 6.0 times their width, respectively; hind tibia with short and semi-erect setae dorsally, setae about 0.6 times maximum width of tibia; hind tibia with 5 apical spines laterally; hind tarsus as long as hind tibia, basitarsus 0.5 times combined length of 2nd-5th segments and 1.5 times second tarsus, third tarsal segment 0.8 times as long as telotarsus.

Metasoma (Figs 9, 10). First tergite gradually widened from base to apex, its maximum width 2.0 times its minimum width, its length 2.1 times its apical width and 1.5 times length of propodeum, its surface striate and coarsely granulate, with distinct and long spiracular tubercles at basal 0.24 and directed somewhat downwards, length of spiracular tubercle about 0.4 times basal width of first tergite; dorsope distinct, medium-sized (Fig. 11); acrosternite 0.45 times as long as first tergite; length of T2+3 1.7 times its width (Fig. 9), with a distinct sharp lateral margin; length of second tergite 0.9 times its width, with rather distinct, shallow, almost straight, posteriorly convergent longitudinal furrows; basal width of median area about 2.5 times its apical width (Fig. 9); second metasomal suture distinct, wide, curved and granulate; surface of T2+3 irregularly reticulate with the apical semicircular part smooth; remaining tergites smooth; ovipositor sheath 1.1 times as long as body, 1.2 times as long as fore wing, 3.7 times as long as hind tibia and 1.9 times as long as metasoma.

Colour. Brown; head and basal segments of antenna yellowish brown, apical segments dark brown; palpi pale yellowish; mesoscutum, scutellum and propodeum dark brown; fore coxa and tibia pale brown, tarsus yellowish brown but telotarsus dark brown; middle leg pale brown; hind leg yellowish brown but telotarsus dark brown; wing membrane brownish translucent, basal half of pterostigma pale and apical half dark brown; first tergite of metasoma dark brown, second tergite brown with part between both furrows dark brown, third tergite brown with medio-basal part dark brown, remaining segments of metasoma brown; ovipositor sheath dark brown, ovipositor red with apical part dark brown.

Distribution. China (Hainan)

Male. Unknown.

Diagnosis. The new species is similar to *E. hoabinicus* Belokobylskij & Long, 2005, but can be separated from the latter by having the first tergite more slender (also in lateral view) with more protruding spiracular tubercles, the grooves of the second tergite more convergent, second tergite irregularly reticulate, third tergite reticulate in medio-basal 0.55 and the colour of this area darker than the rest of third tergite.

Biological notes. Nothing is known about the hosts of this species.

Etymology. From “ret” (Latin meaning “net”), because of the irregularly reticulate second and third tergites of metasoma.

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A new species of *Habralictus* (Hymenoptera, Halictidae) from the Island of Grenada (Lesser Antilles) with comments on the insular species of the genus

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Abstract
A new species of the genus *Habralictus* Moure (Apoidea, Halictidae, Caenohalictini), *Habralictus insularis* **sp. n.,** is described from the island of Grenada. A diagnosis of the genus and comments on its taxonomy and patterns of distribution are presented.

Keywords
Apoidea, Halictidae, bees, island, taxonomy, Lesser Antilles

Introduction

The genus *Habralictus* was first defined by Moure (1941) to include a series of Neotropical halictid bee species, many of them then new to science, as well as others previously included in other genera (such as *Augochlora*, *Neocorynura*, and *Halictus*). To date 23 species have been recognized in the genus (Moure and Hurd 1987, Moure 2008), the last described being *Habralictus bimaculatus* Michener from the mountains (at

2000m) of the Departamento of Valle del Cauca in Colombia (Michener 1979). The genus is to this moment unrevised, with many species undescribed. For example, in a survey of a relatively small area in Colombia, Smith-Pardo (1999) found six *Habralictus* species, of which only one was described. The species of *Habralictus* are found only in the Western Hemisphere from the State of Paraná in Brazil to the State of Jalisco in México. Most described species are from the continental mainland; the only previously known insular species is *H. claviventris* (Ashmead, 1900) from the island of Saint Vincent in the Lesser Antilles. This species was described more than a century ago from the so called "Windward" (Eastern) side of the island at 1500 ft (≈ 457m).

Habralictus are characterized by their overall small size (body length around 4–6 mm), sculpturing of the head and mesosoma (minutely granulate and dull); pubescence of the compound eyes (bare or sometimes with scattered, short setae); coloration (head and mesosoma black or dark brown to bright green or coppery, clypeus, pronotal lobe, and legs with yellow maculation); second submarginal cell with anterior margin short, and third submarginal cell almost square; metasoma reddish brown or black sometimes with spots or bands on terga); males with antennae elongate, scape broad, and metasoma petiolate (Moure 1941; Michener 2007).

The species described herein, *H. insularis* sp. n., is similar to *H. claviventris* and is described from the Grenada in the Lesser Antilles. The species is remarkable in that in addition to its insular distribution it encompasses characters of the two subgenera previously described (Michener 2007), supporting the synonymy of these groups advocated by Moure et al. (2007).

Materials and methods

The morphological description and illustrations were made using a Nikon SMZ1500 stereomicroscope, with 1× lens HR Plan Apo 1X WD54. Photographs were taken using a Nikon Digital Sight DS-Fi1 and processed using the software Helicon Focus® vs. 4.03.1. and Photoshop Elements® 6.0. (Adobe). Morphological terminology follows that of Michener (2007) and Harris (1979) for surface sculpturing. Format for the description follows that of Engel (2000) and Smith-Pardo (2005). The abbreviations F, S, T, and OD are used for antennal flagellomere, metasomal sternum and tergum, and ocellar diameter, respectively. Acronyms for collections where specimens are deposited: Department of Entomology, California Academy of Sciences, San Francisco, CA, USA (CAS); American Museum of Natural History, New York, NY, USA (AMNH); and Division of Entomology, University of Kansas Natural History Museum, Lawrence, KS, USA (SEMC).

Systematics

Genus *Habralictus* Moure

Comments. Previous authors have recognized two subgenera – *Habralictus* s.str. and *Zikaniella* – based on characters such as the width of head and genae, the concavity of the clypeus, and the shape of the metatibial spur serrate or pectinate (Michener 2007). The species described herein combines some of these characters (clypeus not concave and flat, genae narrower than compound eyes, and pectinate metatibial spurs), supporting the unification of the subgenera as used by Moure et al. (2007).

Habralictus insularis sp. n.

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Figs 1–2

Type material. *Holotype:* ♀. Grenada: Grand Etang N.P. [National Park]. Mt. Qua Qua trail. IX-7-1991. on: palm flowers. C.W. and L.B. O'Brien Collectors. (CAS)

Paratypes: 9♀♀, 3♂♂, same data as holotype [CAS]; 1♀ 1♂ *idem* [KSEM]; 1♀ *idem* [AMNH]. 1♂ *idem*, except on palm flowers, *Euterpe precatoria* Mart. [CAS].

Diagnosis. Males of *H. insularis* sp. n. are mostly similar to those of *H. claviventris* (also from the Lesser Antilles) but can be recognized by the larger yellow, integumental spot on the clypeus that covers its anterior half, and the presence of a circumocular carina (Fig. 1h); the base of the propodeum granulate medially (Fig. 1g) (striate in *H. claviventris*), and the metafemur and metatibia dark brown (yellow in *H. claviventris*). Females of *H. insularis* sp. n. resemble females of *H. bimaculatu*s in the overall coloration of the metasomal integument but differ from it by not having any spots or bands on the terga (Fig. 1c).

Description. *Female*. Total body length 4.35 mm; forewing length 3.43 mm. Head slightly wider than long. Scape longer than combined length of F1–F6; F10 as long as F9; F2 subequal in length to F1. Clypeus with upper margin above lower tangent of compound eyes, paraocular lobe, 160°. Scutum wider than long; metanotum 0.4× scutellar length. Mid tibial spur serrate, half length of basitarsus; inner hind tibial spur with four teeth (including apex); 1m-cu confluent with second submarginal crossvein; 2m-cu basad to 2rs-m by 3× vein width; first submarginal cell as long as combined lengths of second and third submarginal cells; second submarginal cell with anterior margin shorter than anterior margin of third submarginal cell; hamuli spaced 1-1-1-2. Basal area of propodeum as long as combined length of scutum and scutellum. Metasoma more or less flat and semi-petiolate.

Mandible with weak acetabular groove. Labrum flat without sulcus or central process. Clypeus, supraclypeal, and paraocular areas minutely but strongly granular, punctures present on lower third of clypeus, close together; remainder of face and vertex strongly granulate; gena and postgena imbricate. Scape imbricate, with

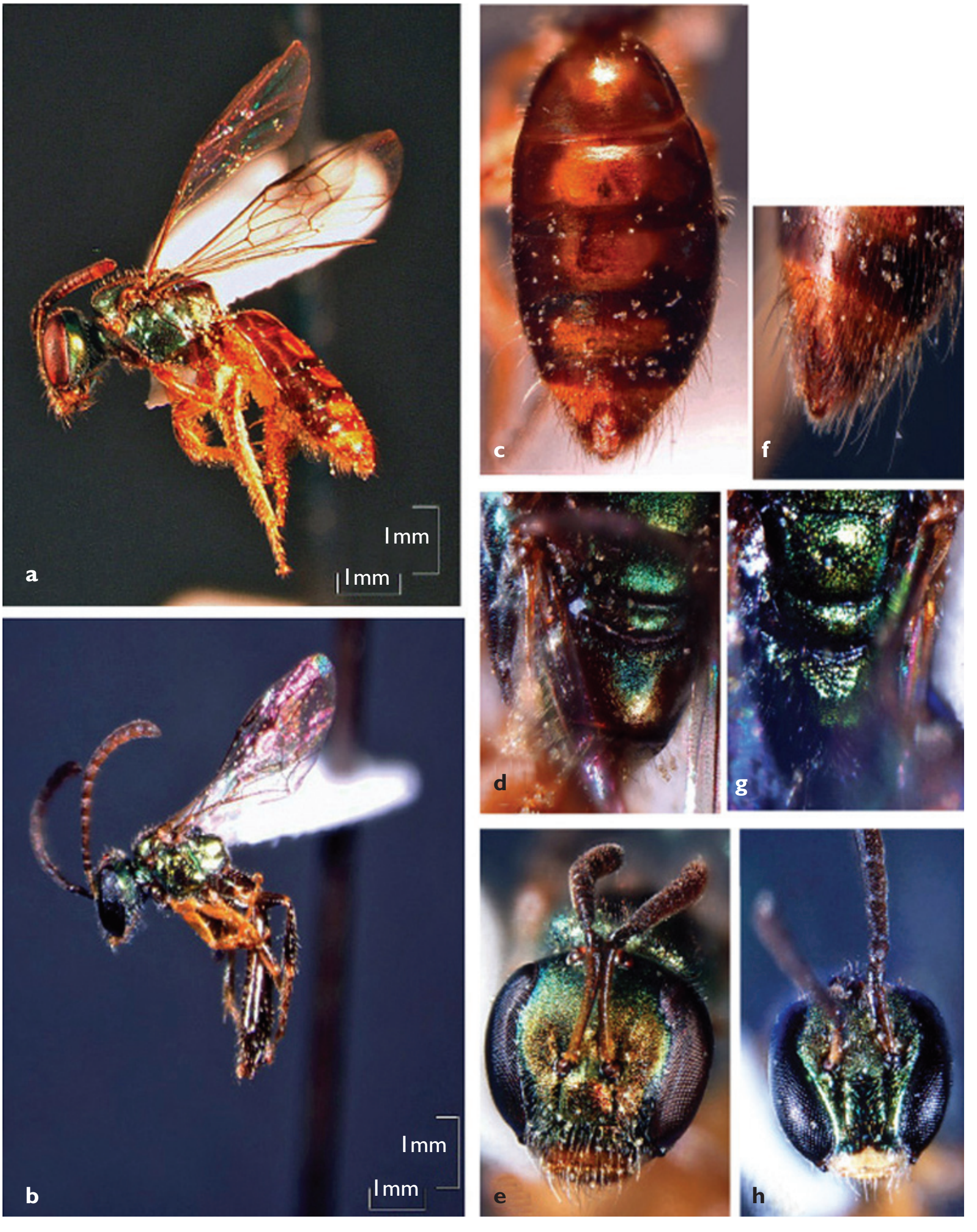

Figure 1. External characters of *H. insularis* sp. n.: **a** habitus female, lateral view **b** habitus male, lateral view **c** female metasoma, dorsal view **d** scutellum, metanotum and base of propodeum (female) **e** female head, frontal view **f** female pygidial plate **g** scutellum, metanotum and base of propodeum (male) **h** male head, frontal view.

few punctures. Pronotum imbricate. Mesoscutum minutely and closely granular with some minute punctures broadly distributed, integument of granules smooth; mesoscutellum and metanotum granular but slightly more coarsely punctate than

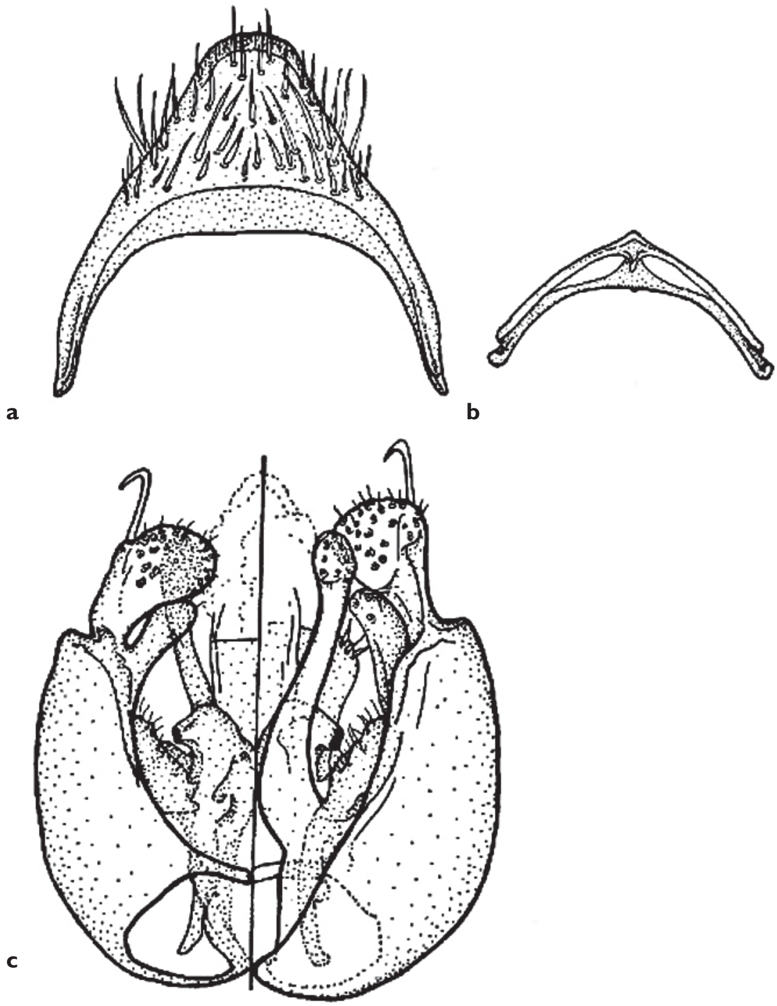

Figure 2. Terminalia of the male of *H. insularis* sp. n.: **a** T6 **b** S7+S8 **c** genital capsule: left, ventral view, right, dorsal view.

mesoscutum. Mesepisternum strongly granular. Tegula imbricate. Basal third of propodeum granular, distal two-thirds imbricate except for granular strip medially. Metasoma imbricate.

Head and mesosoma mainly metallic green except as follows: mandible, labrum, distal half of clypeus yellow; antennae brown, tibiae and tarsi light brown; middle of clypeus brown, supraclypeal area and paraocular area with coppery reflections; reddish on base of clypeus and supraclypeal area. Mesoscutum between parapsidal lines yellowish, with coppery reflections. Pronotal lobe yellow. Tegula light brown and semitranslucent; wing veins and pterostigma dark brown. T1–T3 mostly dark brown with light brown to yellowish spot medially, T4–T5 mostly yellow but light brown laterally. Sterna mostly yellow, light brown on margins.

Head with yellowish, erect branched setae (0.5–2.5 OD), longer on labrum and gena, darker on clypeus and genae, lighter on vertex and postgenae. Mesoscutum, mesoscutellum, and metanotum sparsely covered with brownish, erect short setae (0.5≤ OD) intermingled with some dark brown and longer setae along margins; metanotum with longer setae (1 OD) broadly distributed. Posterior margin of pronotal lobe densely covered with whitish tomentum and with some short setae (0.5 OD) broadly distributed along pronotum. Ventral area of mesepisternum, lateral and posterior surfaces of propodeum, and sides of metanotum with broadly distributed, long (1.5–3 OD), branched, light brown setae, shorter on mesepisternum and metepisternum. Legs mainly with light brown setae. T1 with sparser, long (1–1.5 OD) branched yellowish setae on basal third, shorter on sides, distal half almost bare. T2 with minute, unbranched setae distributed over most of surface, longer (0.5–0.75 OD) and branched on sides. T3–T5 with two types of setae: broadly distributed, appressed, short brownish setae, and longer, branched and more dense distributed setae on sides of terga; setae longest on terminal terga. S1–S4 with long (1–3 OD), yellowish, and poorly branched setae.

Male. As described for the female except for usual sexual characters and the following: total body length 4.15 mm; forewing length 3.1 mm. Head wider than long. Paraocular lobe 130°. Scape as long as combined length of F1 and F2; F1 0.5× length of F2. Inner metatibial spur serrate, 0.4× length of metabasitarsus. Third submarginal cell with anterior margin three times longer than anterior margin of second marginal cell; hamuli spaced 2-1-2. Basal area of propodeum 1.2× mesoscutellar length. Metasoma more elongate than in female, semi-petiolate. T6, S7+S8, and genital capsule as in figure 2.

Mesepisternum and metepisternum imbricate, more weakly imbricate close to sternal area. Basal area of propodeum imbricate, areolate along margin in contact with metanotum. Sides of mesoscutum, mesoscutellum, metanotum, and propodeum with weak coppery to yellowish reflections. Metasoma dark brown.

Pubescence in general longer and more broadly distributed than in female. Sterna broadly covered with setae 1–1.5 OD in length, appressed, and with few branches yellowish setae.

Etymology. The specific epithet refers to the Latin term for “islands”, in reference to the distribution of the species on the Island of Grenada.

Host records. The type series was collected visiting inflorescences of palms (Palmaceae) and, in fact, many of the females still have some of the pollen loads attached. Only one specimen (male) has the species of palm indicated on the collecting label (*Euterpe precatoria* Mart.).

Discussion

This is the only known species of *Habralictus* on the Island of Grenada, and the second species known to inhabit the West Indies. Both species may be endemic to their respective islands: Grenada and Saint Vincent, both in the Lesser Antilles. The discovery of this species is of interest and may well be an example of dispersion followed by speciation on islands. Acccording to current distribution records and the morphological similarities of *H. claviventris*, *H. insularis* sp. n., and *H. bimaculatus* from continental South America, it seems plausible to hypothesize that the common ancestor of the two insular species dispersed from mainland South America into Grenada and from there to the other islands including St. Vincent.

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RESEARCH ARTICLE

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A new species of iguanid lizard (Hoplocercinae, *Enyalioides*) from southern Ecuador with a key to eastern Ecuadorian *Enyalioides*

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Abstract

We describe a new species of *Enyalioides* from mid-elevation rainforests in southeastern Ecuador. This represents the fifth species of *Enyalioides* known to occur east of the Andes in South America; the other four species are *E. cofanorum, E. laticeps, E. microlepis* and *E. praestabilis*. Among other characters, the new species can be distinguished from other *Enyalioides* by having distinct caudal whorls, fewer than 32 longitudinal rows of dorsals at midbody, and bright orange to red gular scales bordered with black in adult males. Morphological similarity suggests that the new species, which we call *E. rubrigularis*, is closely related to *E. praestabilis*.

Keywords

Ecuador, *Enyalioides*, Hoplocercinae, Iguania, lizard, new species

Introduction

The neotropical iguanian lizard clade Hoplocercinae (Torres-Carvajal and de Queiroz 2009) includes 12 species assigned to three taxa traditionally ranked as genera (*Enyalioides*, *Hoplocercus*, and *Morunasaurus*). These lizards are known from elevations below 2000 m on both sides of the Andes between Panama and southeastern Brazil, with most species occurring in Ecuador (10), Colombia (7), and Peru (5).

Several authors have recognized the phylogenetic importance of Hoplocercinae as a possible basal clade within Iguania (Etheridge and de Queiroz 1988; Schulte et al. 1998, 2003). Attempts to infer the phylogeny of Hoplocercinae based on parsimony analyses of morphological characters resulted in several conflicting and weakly supported topologies (Etheridge and de Queiroz 1988; Wiens and Etheridge 2003). However, a recent phylogenetic study based on DNA sequence data yielded a robust phylogenetic tree except for the position of *Morunasaurus*, which was included within *Enyalioides* with low statistical support (Torres-Carvajal and de Queiroz 2009). In addition to these phylogenetic problems, the diversity of Hoplocercinae remains underestimated due to lack of collections from certain areas, or lack of taxonomic work. Wiens and Etheridge (2003) reported two possible new species from Bolivia and Peru, and Torres-Carvajal et al. (2008) recently described a new species of *Enyalioides* from southwestern Ecuador.

All species of *Enyalioides* except for *E. palpebralis* Boulenger 1883 are known from Ecuador (Torres-Carvajal et al. 2008). Of these, three species occur on the western slopes of the Andes and adjacent lowlands (*E. heterolepis* Bocourt 1874, *E. oshaughnessyi* Boulenger 1881, *E. touzeti* Torres-Carvajal et al. 2008) and four occur on the eastern slopes of the Andes and adjacent lowlands (*E. cofanorum* Duellman 1973, *E. laticeps* Guichenot 1855, *E. microlepis* O'Shaughnessy 1881, *E. praestabilis* O'Shaughnessy 1881). Here we describe a new species of *Enyalioides* that was discovered in 2008 on a Smithsonian-funded expedition to the upper basin of Río Zamora on the eastern slopes of the Andes in southern Ecuador. A few additional specimens of the new species were collected in 2009 by scientists from Escuela Politécnica Nacional del Ecuador and Conservation International on the western slopes of Cordillera del Cóndor. This finding highlights the importance of collecting in poorly explored areas of Ecuador and South America.

Materials and methods

Museum acronyms are listed in Leviton et al. (1985) except for the following institutions in Quito, Ecuador: Fundación Herpetológica Gustavo Orcés (FHGO) and Museo de Zoología, Pontificia Universidad Católica del Ecuador (QCAZ). Snout–vent length (SVL) and tail length (TL) measurements were taken with a ruler and recorded to the nearest millimeter. All other measurements were made with digital calipers and recorded to the nearest 0.1 mm. Sex was determined by noting the presence of hemipenes. We follow the terminology of Vitt and de la Torre (1996) for measurements, and Avila-Pires (1995) and Smith (1946) for squamation. Differences in quantitative characters between the new species and *E. praestabilis* were evaluated with t-tests after log-transforming morphometric data. One of the assumptions of the t-test for two samples is that the variances of both samples are equal; therefore, F-tests also were performed for each character to test for equality of variances. Statistical tests were performed in PAST 1.27 (Hammer et al. 2004). Specimens of *E. praestabilis* examined in this study are listed in the appendix.

Results

***Enyalioides rubrigularis* sp. n.**
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Holotype. QCAZ 8483 (Fig. 1), an adult male from finca de Mesías San Martín (3°51'23"S, 78°51'53"W, 1154m), near Piuntza, Provincia Zamora Chinchipe, Ecuador, collected on 23 June 2008 by O. Torres-Carvajal, E. Arbeláez, A. Carvajal-Campos, and D. Salazar.

Paratypes. ECUADOR: Provincia Zamora Chinchipe: QCAZ 8484, same collection data as the holotype; QCAZ 8454, 8456–58, 8460, 8481–82, near Piuntza (3°51'25"S, 78°51'56"W, 1258m), collected between 20–23 June 2008 by same collectors as for the holotype; QCAZ 8459, 8486, near Piuntza (3°51'26"S, 78°51'40"W, 1192m), collected between 22–24 June 2008 by same collectors as for the holotype; QCAZ 8485, near Piuntza (3°51'26"S, 78°51'43"W, 1170m), collected on 24 June 2008 by same collectors as for the holotype; QCAZ 9089, Alto Miazi, upper Río Nangaritza, Cordillera del Cóndor (4°14'46"S, 78°36'59"W, 1318 m), collected on 12 April 2009 by S. Aldás, J.M. Guayasamin, Holger; EPN 11356, Los Encuentros, Bosque Protector el Zarza (3°50'2"S, 78°31'23"W, 1460 m), collected on 7 November 2008 by A. Almendáriz, M. Salazar, M. Angamarca; EPN 12432–33, Los Encuentros, Concesión Cuy (3°48'28"S, 78°36'21"W, 1450 m), collected on 27 March 2008 by A. Almendáriz, P. Vivanco, C. Sarango.

Diagnosis. The new species differs from all other species of *Enyalioides*, except for *E. praestabilis*, in having distinct caudal whorls, smooth or feebly keeled ventrals, fewer than 32 longitudinal rows of dorsals in a transverse line between dorsolateral crests at midbody, and in lacking projecting dorsal and limb scales. Males of the new species can be distinguished from *E. praestabilis* by having larger scales on the ventral surface of the thighs (Fig. 2), and by having gulars with black margins (Fig. 3). The skin between gulars is black in some male specimens of *E. praestabilis*, but gulars lack black margins. In addition, gular scales in males of the new species vary between bright orange and red, and there is no black mark on the gular region posteromedially; males of *E. praestabilis* have cream or yellow gular scales, and some specimens have a black patch covering the gular fold and posteromedial portion of the gular region (Fig. 3). The new species usually has two femoral pores, whereas *E. praestabilis* has normally one

Figure 1. Holotype of *Enyalioides rubrigularis* sp. n. (QCAZ 8483, adult male, SVL = 123 mm). Top: lateral view; middle: close-up of head; bottom: ventral view. Photographs by O. Torres-Carvajal.

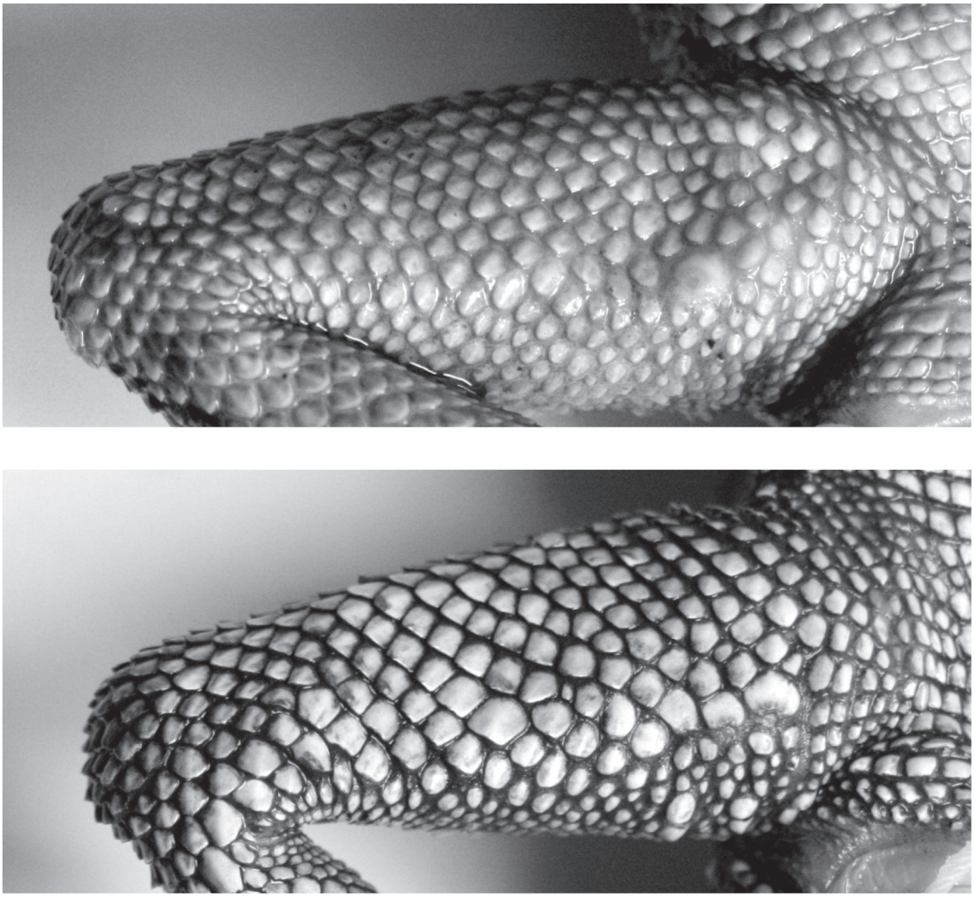

Figure 2. Ventral view of thigh in two species of *Enyalioides*. Top: *E. praestabilis* (QCAZ 8821, adult male, SVL = 110 mm); bottom: *E. rubrigularis* sp. n. (QCAZ 8459, adult male, SVL = 122 mm). Photographs by O. Torres-Carvajal.

femoral pore; otherwise, both species are very similar in scale counts and morphometric characters (Table 1).

Description of holotype. Male (Fig. 1); SVL = 123 mm; TL = 180 mm; maximum head width = 25.96 mm; head length = 32.37 mm; head height = 23.73 mm; dorsal head scales keeled or multicarinate, those on parietal region strongly projected dorsally; scales immediately posterior to supraciliares conical and dorsally projected, forming longitudinal row of seven (left) or six (right) scales that extends posteriorly over supratemporal region; temporal scales small, smooth or keeled, juxtaposed; two large, projected conical temporal scales aligned anterodorsally from anterodorsal aspect of tympanum; one enlarged pretympanic scale; supraciliares 16; canthals five; postrostrals four; left supralabials nine if counted to a point right below middle of eye, and 13 if counted to commisure of mouth (10 and 13 on right side, respectively); rostral (3.67 × 1.64 mm) about twice as wide as adjacent supralabials; single longitudinal row of

Figure 3. Two species of *Enyalioides*. Juvenile (A, B, QCAZ 8454), females (C, D, QCAZ 8457; E, F, QCAZ 8458), and male (G, QCAZ 8460) of *E. rubrigularis* sp. n.; male of *E. praestabilis* (H, KU 169854). Photographs by O. Torres-Carvajal (A-G) and W. E. Duellman (H).

lorilabials between suboculars and supralabials at level of middle of eye, longitudinal rows of lorilabials anterior to this point 2–3; loreal region broken into small, smooth, and juxtaposed scales; nasal at level of supralabial III; left infralabials eight if counted

Table 1. Summary of morphological characters, measurements (mm), and color patterns of *Enyalioides praestabilis* and *E. rubrigularis* sp. nov. For each quantitative character, the *F*-value, *t*-value, and corresponding *P*-values are given. Range (first line), and mean ± standard deviation or mode (second line) are given for quantitative characters.

Character	*E. praestabilis* N = 50	*E. rubrigularis* N = 16	F-value	P	t-value	P
Dorsals in transverse row between dorsolateral crests at midbody	21–39 28.37 ± 3.91	25–32 28.79 ± 2.61	2.249	0.115	0.369	0.714
Ventrals in transverse row at midbody	21–39 28.69 ± 3.87	22–31 26.07 ± 2.37	2.665	0.059	2.381	0.021
Vertebrals from occiput to base of tail	44–66 54.64 ± 5.43	49–58 52.79 ± 2.64	4.243	0.007	1.224	0.226
Gulars	22–34 27.91 ± 2.99	26–34 29.50 ± 2.65	1.274	0.657	1.776	0.081
Infralabials	7–11 8.86 ± 0.88	7–10 8.86 ± 0.66	1.755	0.271	0.025	0.979
Supralabials	8–12 10.34 ± 1.08	9–11 10.14 ± 0.53	4.060	0.008	0.659	0.512
Canthals	4–6 5	4–6 5	1.097	0.895	1.531	0.133
Superciliaries	12–20 15.56 ± 1.87	13–19 15.64 ± 1.39	1.794	0.263	0.144	0.886
Transverse rows of ventrals between fore and hind limb	31–48 37.77 ± 3.36	31–40 36.57 ± 2.65	1.604	0.359	1.213	0.230
Subdigitals Finger IV	17–24 19.82 ± 1.32	17–22 19.50 ± 1.34	1.036	0.998	0.761	0.450
Subdigitals Toe IV	22–28 25.84 ± 1.54	23–29 25.71 ± 1.94	1.586	0.254	0.252	0.802
Femoral pores	1–2 1	1–2 2	1.262	0.420	2.947	<0.005
Head length/Head width	1.20–1.45 1.32 ± 0.07	1.20–1.39 1.28 ± 0.05	1.146	0.827	1.819	0.074
Fore limb length/SVL	0.47–0.61 0.54 ± 0.03	0.38–0.54 0.49 ± 0.04	2.897	0.010	2.931	0.005
Hind limb length/SVL	0.72–0.95 0.82 ± 0.05	0.72–0.86 0.79 ± 0.05	1.888	0.217	0.951	0.346
Tail length/Total length	0.59–0.66 0.62 ± 0.02	0.59–0.62 0.60 ± 0.01	2.812	0.086	2.806	0.007
Dark gular patch	Present (polymorphic)	absent				

to a point right below middle of eye, and 13 if counted to commisure of mouth (eight and 11 on right side, respectively); mental (4.11 × 2.65 mm) wider and higher than adjacent infralabials; postmentals three; gulars ventrally projected; gular fold complete midventrally; neck with several longitudinal and oblique folds.

Vertebral crest strongly projected and decreasing in size posteriorly, with vertebrals on neck at least four times higher than vertebrals between hind limbs; crest bifurcates posteriorly and extends onto tail about ¼ its length; body flanks between fore and hind limbs with dorsolateral and ventrolateral folds, as well as several oblique folds; scales on dorsolateral folds slightly larger than adjacent scales giving the fold the appearance of a crest; dorsal scales between dorsolateral folds and vertebral crest small, prominently keeled, and imbricate; scales on flanks (i.e., ventral to dorsolateral folds) similar in size to dorsal scales, with a few scattered enlarged scales 2–3 times larger than adjacent scales; ventral scales imbricate, smooth, rectangular, with a posterolateral mucron; ventrals more than twice the size of dorsals.

Limb scales keeled dorsally and smooth or slightly keeled ventrally; scales on dorsal and posterior aspects of thighs heterogeneous in size, with most scales less than half the size of those scales on anterior and ventral aspects; subdigitals on Finger IV 21; subdigitals on Toe IV 26; two femoral pores on each side; tail laterally compressed and gradually decreasing in height towards tip; caudal scales strongly keeled and imbricate, increasing in size posteriorly on lateral and dorsal aspects of each autotomic segment; ventral larger than dorsal caudals, with individual autotomic segments being three scales long ventrally and six scales long dorsally.

Coloration in life of holotype (Fig. 1). Scales on dorsal and lateral surfaces of head mostly green or yellow, with black margins causing a reticulate pattern; some head scales entirely black; labials and mental yellowish orange with black margins; rostral green medially and black laterally; gulars orange with black margins, a few lateral gulars green or yellow; skin between gulars black; black gular patch absent; six enlarged greenish-cream scales form a distinct spot posterior to tympanum; paravertebrals and caudals green or dark brown; flanks mottled with lemon-green scales; dorsal limb scales light green, some with dark brown margins; ventral surface of body, limbs, and tail white medially and light green laterally, with irregular light green stripes projecting medially; lining of mouth whitish cream; iris light brown peripherially with dark brown projections originating from the dark brown center.

Color variation. Adult males QCAZ 8456, 8460 differed from the holotype in having a dark brown to black reticulate pattern on dorsal and lateral aspects of body. In addition, male QCAZ 8460 had the dorsal surface of head black with green and yellow dots; loreal and subocular regions with black and red scales; labials red with black margins; gulars red with black margins (Fig. 3). Metachromatism was observed in some individuals, in which the green tones were replaced with yellow or brown tones (Fig. 4).

Adult female QCAZ 8457 (Fig. 3): dorsal background of body, limbs, and tail light brown spotted with yellow scales; dorsal background of head dark brown with scattered black scales; labials yellowish green with grey margins; enlarged pretympanic scale yellow; faint yellowish strip extends longitudinally from tympanum to scapular region; each vertebral yellow anteriorly and grey posteriorly; gular region brown with a few scattered orange scales; ventral surface of body, limbs, and tail brownish cream; iris copper with dark brown reticulations. Adult female QCAZ 8458 (Fig. 3) differed from the latter in having a dark olive green dorsal background, a black stripe extending longitudinally from posterior margin of eye to dorsal margin of tympanum, a black

Figure 4. Metachromatism in *Enyalioides rubrigularis* sp. n. Top left and right: adult male (QCAZ 8460, SVL = 102); bottom left and right: adult male (QCAZ 8456, SVL = 89). Photographs by O. Torres-Carvajal (left) and L. Coloma (right).

stripe extending dorsolaterally from comisure of mouth to eye, and a yellowish cream gular region with scattered black dots.

Juvenile QCAZ 8454 (Fig. 3): dorsal background yellowish green with irregular dark brown marks on head, body, flanks, tail, and black transverse lines on limbs; black stripe extends from posterior margin of eye to dorsal margin of tympanum; another black stripe extends from subocular region to anterior margin of tympanum, from where it extends ventrally into gular region; dorsolateral light green band with brown and black margins extends from temporal to scapular region; vertebrals black and yellowish green; gular region yellowish cream with brown, yellow, and orange scales laterally; ventral surface of body and limbs whitish cream, with faint grey dots; ventral surface of tail similar in color but fainter than dorsal surface; tongue cream with anterior tip grey; lining of mouth whitish cream; iris copper. Juvenile QCAZ 8485 differs from the latter in having a yellowish-brown background, with dark brown transverse bands arranged longitudinally from the scapular region to the tip of the tail.

Natural history. Juvenile QCAZ 8454 was encountered at 5 pm basking in the sun on the ground; when approached it ran quickly into a hole 5 cm wide located 1 m higher in the ground. All other specimens were found sleeping at night (7:00 pm–12:00 am) between 30 cm and 2.5 m above ground. These specimens were found with their heads facing up on vertical stems with diameters varying between 2–10 cm, or lying horizontally on ferns with stems 2–3 cm wide. Most specimens were collected in secondary forest close to pasture.

Distribution. *Enyalioides rubrigularis* inhabits rainforests on the eastern slopes of the Andes and western slopes of Cordillera del Cóndor in southern Ecuador (Fig. 5). It occurs at elevations of 1100–1460 m in the upper basins of the Zamora and Nangaritza rivers, Provincia Zamora Chinchipe. The type locality of *E. rubrigularis* is surrounded by secondary forest, pasture, *Tilapia* ponds, and bullfrog (*Rana catesbeiana*) farms.

Etymology. The name *rubrigularis* is an adjective in the nominative singular and derives from the Latin words *ruber* (=red) and *gula* (=throat). It refers to the characteristic orange or reddish throat and chin of adult males, which distinguishes the new species from other species of *Enyalioides*.

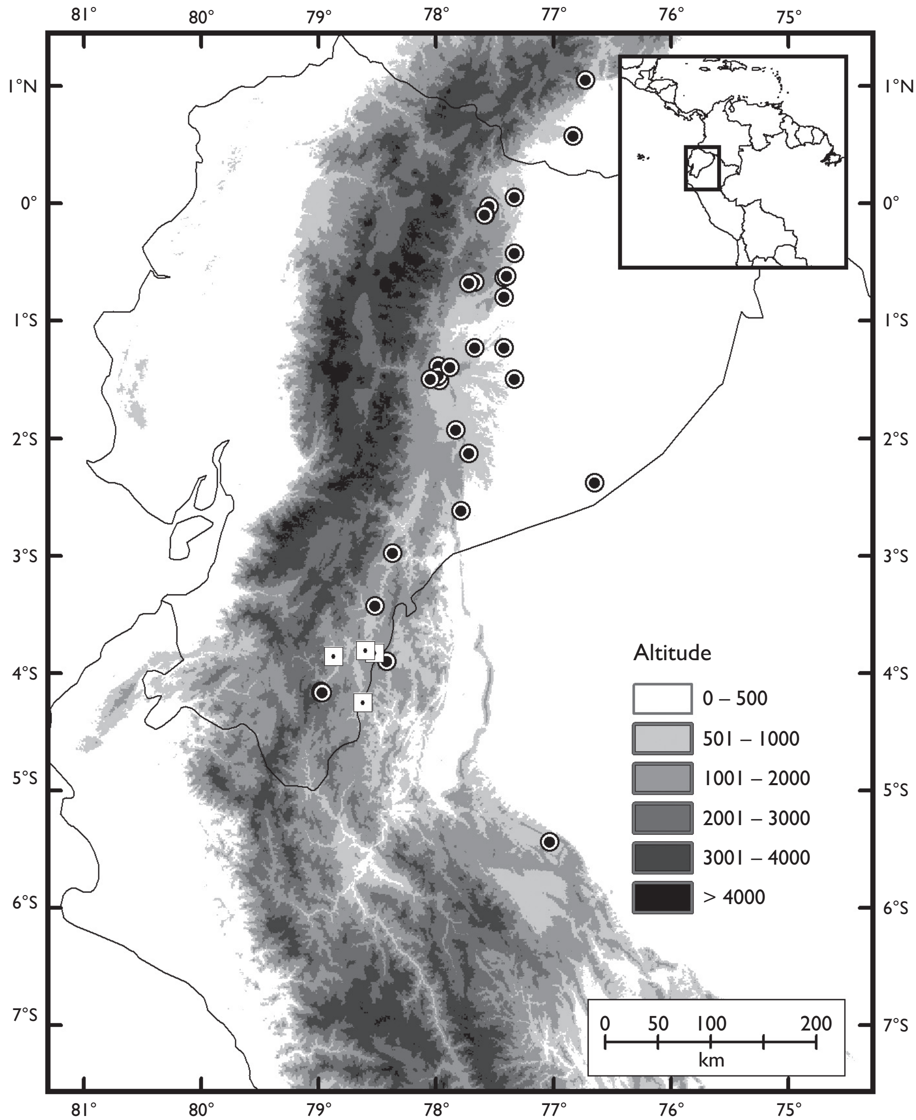

Figure 5. Distribution of *Enyalioides praestabilis* (circles) and *E. rubrigularis* sp. n. (squares).

Key to the species of *Enyalioides* from eastern Ecuador

1. Caudals increase in size posteriorly on each autotomic segment **2**
– Caudals homogeneous in size.. ***E. laticeps***
2. Ventrals strongly keeled; more than 32 dorsals in a transverse line between dorsolateral crests at midbody **3**
– Ventrals smooth or slightly keeled; usually fewer than 32 dorsals in a transverse line between dorsolateral crests at midbody **4**
3. Dorsals heterogeneous in size, with scattered projecting scales (more conspicuous in adult females); dorsolateral crests well developed between hind limbs.. ***E. cofanorum***
– Dorsals homogeneous in size, without projecting scales; dorsolateral crests inconspicuous or absent between hind limbs .... ***E. microlepis***
4. Gulars in males cream or yellow without black margins; usually one femoral pore .... ***E. praestabilis***
– Gulars in males bright orange or red, with black margins; usually two femoral pores.. ***E. rubrigularis***

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Appendix

Specimens examined

Enyalioides praestabilis – COLOMBIA: *Putumayo*: KU 169854, 10.3 km W El Pepino; KU 140394, San Antonio, río Guamez; ECUADOR: *Morona Santiago*: QCAZ 6978, km 6 on road Limón-Macas; USNM 211153–54, Chiguaza; QCAZ 9212; Macas, Macuma, Wisui; USNM 211152, 211155, Miazal; KU 147183, Mision Bomboiza; *Napo*: CAS-SUR 8260, Avila, río Napo; USNM 211156–57, Concepción; MCZ 164901, Lumbaquí; QCAZ 5272–74, Parque Nacional Napo Galeras; EPN 7844, 8043–44, Parroquia Catundo, Huamaní; QCAZ 5580–81, 5611, río Hollín; USNM 211158, río Suno; KU 122116–17, S slope Cordillera del Dué above río Coca; QCAZ 136, 7428, San Rafael; *Orellana*: AMNH 28869, 28874–76, 28894, San José de Sumaco [San José Nuevo]; *Pastaza*: USNM 211161, 5 km SSE Puyo; USNM 211165, Arajuno; QCAZ 3797, Centro Fátima, 9 km N Puyo; USNM 211166, Chichirota; AMNH 37555, Palmira, río Pastaza valley; USNM 211161, Puyo; EPN 6497, Puyo, Santana; USNM 211159–60, río Arajuno; USNM 211163–64, río Villano; QCAZ 4113, Shell-Mera; USNM 211167, upper basin río Curaray; *Zamora Chinchipe*: FHGO 2783, Curintza; FHGO 1757, 2117, La Pituca, río Curintza basin; FHGO 2156, La Pituca, upper basin río Curintza; FHGO 5579–81, Pindo-Mirador research station; PERU: *Amazonas*: USNM 525549, Cordillera del Cóndor, upper río Comainas, Alfonso Ugarte (=puesto de vigilancia 3); *Loreto*: AMNH 56402, northern Peru, front range btw. Moyobamba & Cahuapanas.