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A new species of genus *Nippononebria* Uéno (Coleoptera, Carabidae, Nebriini) from Changbai Mountain, Jilin Province, China, the first species of the genus confirmed from the Asian mainland

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Abstract

The authors describe a new species, *Nipponebria changbaiensis* **sp. n.** (type locality: Changbai Mountain, 42.034004°N, 128.055854°E, 2000–2600 m, Jilin Province, PR China), which represents the first confirmed record of the genus from the Asian mainland. They also provide a review of the taxonomic history of the genus and a key for distinguishing adults of subgenus *Nipponebria* species.

Keywords

Carabidae, Nebriini, *Nipponebria*, China, Changbai Mountain

Introduction

Nippononebria was first described by Uéno (1955) as a subgenus of *Nebria* Latreille (1802) to include two Japanese species, *Nebria chalceola* Bates (1883) and *Nebria pusilla* Uéno (1955), both from Honshu Island, with the latter designated as type species. Habu (1958) revised *Nippononebria*, recognized it as a distinct genus, and described a new species, *Nippononebria kyushuensis*, from Kyushu Island, and a new subspecies, *Nippononebria pusilla teres*, from Honshu Island. Nakane (1960) described two new subspecies, *Nippononebria chalceola horioi* and *Nippononebria pusilla yatsuana*, and later (Nakane 1979) described a new species, *Nippononebria sawadai*. All three of these taxa were recorded from restricted areas on Honshu Island. Subsequently, *N. pusilla teres* has been recognized as a junior synonym of *N. pusilla pusilla* (Uéno) (Habu 1975), and *N. kyushuensis* has been treated as either a distinct species (Lorenz 2005) or as a subspecies of *N. chalceola* (Nakane 1974; Ledoux and Roux 2005). As a result of this taxonomic history, the known *Nippononebria* fauna, as recently as the mid-1990s, comprised only three or four species, two of them represented by two or three subspecies, all of them restricted to the islands of Japan, and all but one of these taxa (*N. kyushuensis*) restricted to Honshu Island.

Kavanaugh (1995) broadened the generic concept of *Nippononebria* by including three western Nearctic species, *Nebria virescens* Horn (1870), *Nebria altisierrae* Kavanaugh (1984), and *Nebria campbelli* Kavanaugh (1984), in a new subgenus, *Vancouveria*. Although members of these Nearctic species differ from those of species of subgenus *Nippononebria* in some conspicuous features, such as in having antennomere 4 [mistakenly cited repeatedly as "antennomere 3" in Kavanaugh (1995)] without (or with extremely sparse) pubescence on the apical one-third, (the apical one-third of antennomere 4 is distinctly pubescent in members of the nominate subgenus), numerous characters of external and male and female genitalic form and structure suggest very close phylogenetic relationship between these taxa. Ledoux and Roux (2005) recognized this close relationship but ranked these taxa as different subgenera of genus *Nebria*, based on their hypothesis of relationships among *Nebria* subgenera. Lorenz (2005) followed Habu (1958) in treating *Nippononebria* as a genus distinct from *Nebria* and included *Vancouveria* as a subgenus of *Nippononebria*, a classification with which we agree. As thus conceived, *Nippononebria* was a genus with a north-temperate trans-Pacific distribution, with the Nearctic component restricted to the west coast of North America, from southern British Columbia to central California, and the known Palaearctic component restricted to Honshu and Kyushu Islands of Japan.

In 1992, Li and Liang (Li 1992) described a new species of *Nippononebria* from Jilin Province, China under the name *Nipponebria* [sic] *xiaoxinganensis*. Thierry Deuve, of the Museum National d'Histoire Naturelle in Paris, identified the holotype as a specimen of *Diacheila polita* Faldermann, a member of the tribe Elaphrini, in 1999; and Ledoux et al. (2003) formally established this synonymy. So this first record of *Nippononebria* from the Asian mainland proved invalid. However, in 1998, while sorting through undetermined carabid material in the collection of the Institute of Zool-

ogy of the Chinese Academy of Sciences in Beijing, the senior author noticed two unusual *Bembidion*-sized specimens among materials collected by Professor Peiyu Yu and her assistant on remote Changbai Mountain, Jilin Province, in July 1987. Careful examination of these specimens revealed that they are nebriines with nearly all of the external features characteristic of members of *Nippononebria* (*sensu stricto*), but also with several features distinguishing them from members of all previously described species. Subsequent genitalic dissections have confirmed both basic similarities with other *Nippononebria* members and differences from them.

The purpose of this contribution is to describe this new species of *Nippononebria*, provide a key for distinguishing members of this species from those of other known species in subgenus *Nippononebria*, and report this first valid record for the genus on the Asian mainland.

Materials and methods

Specimens examined are housed in the California Academy of Sciences, San Francisco, U.S.A (CAS) and the National Zoological Museum of China, Institute of Zoology, Beijing, China (IOZ).

Methods used in the present study, including dissection techniques and criteria for ranking taxa as distinct species, were as described in Kavanaugh (1979). The only measurements used are: standardized body length (SBL), which equals the sum of the lengths of the head (measured from apex of clypeus to a point on midline at level of posterior margin of compound eye), pronotum (measured from apical margin to basal margin along midline), and elytra (measured along midline from apex of scutellum to apex of the longer elytron); and ratio of pronotal width (transverse width across pronotum measured at the widest point) to pronotal length (distance from anterior margin to posterior margin measured along midline (i.e. not including apical and basal angles)). Digital photographs of dorsal habitus, pronotum, and male genitalia were taken using an Automontage imaging system by Syncroscopy with a Leica M420 dissecting microscope.

Taxonomy

***Nippononebria changbaiensis* Kavanaugh & Liang, sp. n.**
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Figs. 1–5

Type locality. PEOPLES REPUBLIC OF CHINA, Jilin Province, Changbai Mountain, 42.034004°N, 128.055854°E

Type material. Holotype, a male, deposited in IOZ, labeled: "Jilin Province, Changbaishan, Tianchi, waterfall, 2000–2600m, Chinese Academy of Sciences" [part-

Figure 1. Holotype male, *Nippononebria changbaiensis* sp. n., dorsal habitus. Scale line = 1.0 mm.

ly in Chinese]/ "1987.VII.22, Guiyun Deng collector" [partly in Chinese] / "HOLOTYPE *Nippononebria changbaiensis* Kavanaugh & Liang sp. n. designated 2010" [red label] (Fig. 2A). Paratype, a male, deposited in CAS, labeled: "Jilin Province, Changbaishan, Tianchi, 2000m, Chinese Academy of Sciences" [partly in Chinese]/ "1987.VII.22, Peiyu Yu collector" [partly in Chinese]/ "PARATYPE *Nippononebria changbaiensis* Kavanaugh & Liang sp. n. designated 2010" [yellow label] (Fig. 2B).

Etymology. The species epithet is an adjective in the nominative singular derived from the name of the type locality, Changbai Mountain, and referring to it.

Diagnosis. Adults of this species can be distinguished from those of all other species of subgenus *Nippononebria* by the following combination of character states: size very small (SBL of male less than 6.5 mm); head, pronotum, and elytra shiny, with faint but distinct blue-green metallic reflection; pronotum relatively short and broad, distinctly wider than head across eyes, ratio of pronotal width to length = 1.4–1.5,

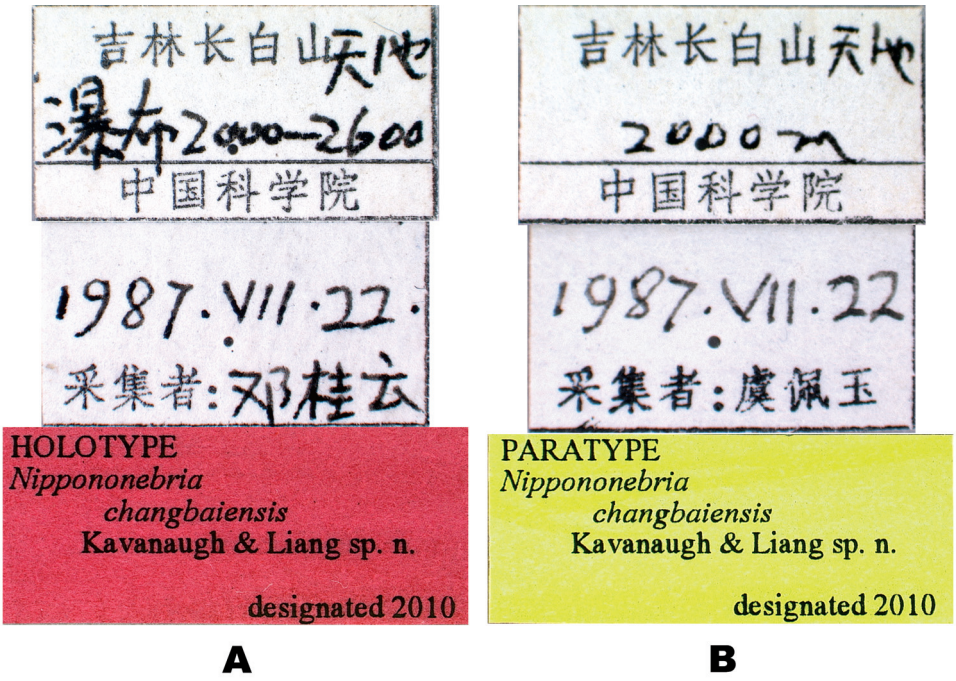

Figure 2. Photographs of labels for type specimens of *Nippononebria changbaiensis* sp. n. **A** Holotype **B** Paratype.

basal margin distinctly wider than apical margin, with basal sinuation of lateral margin long and shallow, basal angles rectangular, lateral explanation narrow anteriorly and at middle, markedly broadened basally; elytral silhouette subovoid, relatively short, widest distinctly anterior to middle, elytral microsculpture comprised of moderately impressed and markedly transverse meshes, humeral carina and tooth slightly developed, striae markedly punctate, intervals very slightly and smoothly convex; hindwings full-sized; thorax coarsely punctate ventrally (most distinctly so on mesepisterna and metepisterna, but also on prosternum and proepisterna anteriorly, on mesosternum, and on metasternum laterally).

Description. Body (Fig. 1) size very small for a *Nippononebria* or a nebriine, SBL males 5.8–6.0 mm; head piceous or reddish brown, without pale spot or spots on vertex, pronotum and elytra piceous or reddish-brown, legs brown or reddish-brown, venter brown or reddish-brown; dorsum with faint but distinct metallic blue-green reflection (most evident on elytra), venter without metallic reflection; frons smooth or slightly punctate laterally, vertex smooth or nearly so; head slightly shiny, pronotum and elytra markedly shiny, microsculpture on frons and pronotum faintly impressed with sculpticells comprised of broken isodiametric meshes, microsculpture on elytra moderately impressed with sculpticells comprised of markedly transverse meshes.

Head. Size and width relative to pronotum average for genus. Genae and occiput not inflated, head very slightly constricted behind eyes. Eyes medium in diameter and

convexity for genus. Vertex with one pair of supraorbital setae. Antennae moderately elongate; scape slightly short and slightly arcuate, markedly narrowed basally, with one anterodorsal seta subapically; pedicel with one ventral seta subapically; flagellar antennomeres moderately elongate, medium width, antennomeres 3 and 5 subequal in length, antennomere 4 with apical one-third distinctly pubescent, antennomeres 5 to 11 distinctly pubescent. Labrum with apical margin truncate or slightly concave, with four or five setae. Clypeus with apical margin truncate or slightly concave. Glossal sclerite (ligula) with apicoventral margin moderately and bluntly toothed, with one pair of ligular setae apicoparamedially; paraglossae separate, minute, dentiform. Labium with penultimate labial palpomere trisetose anteriorly, minutely unisetose posteroapically. Submentum with two pairs of lateral setae and one pair of medial setae.

Pronotum. Size relative to elytra large, markedly wide, and slightly short for genus; shape (Fig. 3) subquadrate, markedly convex, basal margin distinctly wider than apical margin; lateral margins slightly arcuate, with basal sinuation long and shallow; lateral explanation present throughout pronotal length, narrow anteriorly and at middle, markedly broadened basally; basal margin straight; apical angles moderately long, slightly narrow, and moderately rounded; basal angles rectangular or slightly acute, not projected posteriorly, not apically dentate; lateral margination (also called "lateral bead") uniformly present throughout, moderately wide and moderately impressed; anterior margination present in lateral 30–40%, absent medially, moderately wide and moderately impressed; anterior transverse impression broad and slightly shallow; posterior transverse impression narrow and very deep; basal foveae deep, extremely broad, slightly divergent basally, without or with a faint and broad tubercle medially; one pair each of midlateral and basolateral setae present.

Thoracic venter. Prosternal intercoxal process moderately lanceolate, smooth, with margination of intercoxal process present and complete both laterally and apically, asetose. Prosternum and proepisternum sparsely and coarsely punctate anteriorly. Mesosternum sparsely punctate laterally. Metasternum slightly short, sparsely punctate laterally, margination of anterior intercoxal process complete, broad, and deeply impressed. Mesepisternum and metepisternum sparsely and coarsely punctate.

Elytra. Markedly shorter in relation to length of forebody than average for genus, moderately wide, moderately convex laterally and flattened medially; elytral silhouette (Fig. 1) subrectangular, widest near basal one-third; basal marginations very long, straight or slightly concave; humeri angulate, slightly rounded, humeral carinae markedly distinct and sharp, moderately projected, humeral teeth present; subhumeral sinuation absent; subapical sinuation absent or very shallow; elytral apices at midline, bluntly pointed; elytral striae moderately deep, markedly punctate, scutellar striole short, extended independently from basal margination medial to stria 1; elytral intervals slightly convex, smooth, and without catenations, basal (parascutellar) setiferous puncture present, interval 3 with two or three setiferous pores, intervals 5 and 7 without setiferous pores, interval 9 with umbilicate series comprised of five to seven setiferous pores, all elytral setiferous pores barely evident or only faintly foveate.

Hind wings. Full-sized.

Figure 3. Holotype male, *Nippononebria changbaiensis* sp. n., pronotum, dorsal aspect. Scale line = 0.5 mm.

Legs. Medium length for genus; hind coxae with one seta basally and one seta apically. Hind trochanters kidney-shaped, medium length, truncate or broadly rounded apically. Middle tibiae with dorsal sulcus present, extended from near base to apical one-third, with brush of sparse setae present dorsosubapically. Tarsi with very sparse, minute setae dorsally; protarsi of males with basal three tarsomeres broadened and with pads of adhesive setae ventrally; hind tarsi with ventroapical margin of tarsomere 4 truncate.

Abdomen. Sternum II (first visible sternite) sparsely and coarsely punctate, other sterna impunctate; suture between sterna III and IV complete, distinct throughout; sternum III without setae; sterna IV to VI with one pair of posterior paramedial setae, without paralateral setae; sternum VII (last visible sternite) of males with one pair of posterior paramedial ("anal") setae.

Male genitalia. Median lobe of aedeagus (Fig. 4A–B) with basal bulb rounded and markedly closed basally, dorsobasal piece present as a large, simple mid-sagital fin dorsally; mid-shaft moderately thick, slightly narrowed basally, with its axis bent to a slightly acute (< 90 degrees) angle (in lateral aspect), circular (in cross-section), with right face of mid-shaft unmodified; preapical-shaft narrow and moderately tapered apically, ventral margin straight or slightly and smoothly concave (in lateral aspect), broad, slightly tapered basally and apically and faintly deflected right (in dorsal aspect), with apical orifice slightly deflected right (in apical aspect); apical lamella (Fig. 4A) short, narrow, narrowly rounded apically, nearly centered on preapical shaft (in ventral aspect), plane of lamellar face horizontal (in apical aspect). Parameres asymmetrical, with right slightly longer than left; right paramere (Fig. 4C) slender, more fully sclerotized apically but with more faintly sclerotized areas subapically on anterior and posterior margins; left paramere (Fig. 4D) broad, slightly narrowed and only faintly sclerotized apically.

Female genitalia. No female specimens are known.

Figure 4. Holotype male, *Nippononebria changbaiensis* sp. n., genitalia. **A** median lobe (aedeagus), ventral aspect **B** median lobe, left lateral aspect **C** right paramere, lateral aspect **D** left paramere, lateral aspect. Scale line = 0.5 mm.

Geographical distribution. This species is known only from the type locality, on Changbai Mountain, on the border between Jilin Province, China, and North Korea (Fig. 5).

Habitat distribution. According to Professor Peiyu Yu (personal communication), the two known specimens of *N. changbaiensis* likely were collected under stones above treeline on the north slope of Changbai Mountain. There is some difficulty, however, in determining the precise locations where these specimens were collected on the mountain. To the unaided eye, there is little remarkable about adults of this species, and they could readily be mistaken for adults of some *Bembidion* species (which would be both diverse and abundant in this area) rather than a nebriine; hence there would have been little reason for Professor Yu to mark their capture in memory. "Tianchi", which appears on the labels for both specimens, means "mountain lake", suggesting that they were collected near the lake that occupies the summit crater. The holotype label also mentions the "waterfall", which is a well-known feature at the head of the valley leading to the rim of the summit crater and lake. The holotype's label cites an elevation range of 2000–2600 m and the paratype's label cites an elevation of 2000 m. The level of the lake shore is at about 2200 m elevation, the base of the waterfall at about 2000 m, and the top of the waterfall and floor of the upper valley leading directly to the lake at about 2200 m. We conclude that both specimens were probably collected under stones along the stream course that includes the large waterfall, perhaps both above and below that feature. We have used this feature to estimate the geographical coordinates specified in the type locality description.

Phylogenetic relationships. Based on characters of external morphology and form and structure of male genitalia, *N. changbaiensis* is clearly a member of genus *Nippononebria* and of the nominate subgenus. The very small body size, unusual body shape (especially the elytral silhouette), and thoracic venter coarsely punctate laterally

Figure 5. Map of the Sea of Japan and adjacent land areas, showing the known geographical distribution of *Nippononebria* (*sensu stricto*) Uéno and included species: **solid yellow circle** *N. changbaiensis* sp. n. **C** *N. chalceola* (Bates) **P** *N. pusilla* (Uéno) **S** *N. sawadai* Nakane (n.b. Only exemplar localities shown for *N. chalceola and N. pusilla*). Scale line = 400 km.

distinguish members of this species from those of the Japanese species, as well as from members of all *Vancouveria* species. We found no features that suggest a closer relationship of *N. changbaiensis* to any one of the Japanese than to any other; it is probably the sister species to a clade including the three Japanese species of subgenus *Nippononebria*.

Geographical relations with most closely related species. The known geographical range of *N. changbaiensis*, confined to a single locality on the Asian mainland, is allopatric with respect to the ranges of the three other species of subgenus *Nippononebria*, all restricted to Japan (Fig. 5). *Nippononebria pusilla* and *N. sawadai* occur only on Honshu Island (at high elevations in restricted parts of central and northern Honshu, respectively); and *N. chalceola* ranges more widely, and at lower elevations, on both Honshu and Kyushu Islands.

Comparisons

Adults of the four species of *Nippononebria* (*sensu stricto*) are easily distinguished using the key provided below. We have avoided the use of gender-specific characters in distinguishing the species here because females of *N. changbaiensis* are not yet known. We also take this opportunity to correct two crucial errors in Kavanaugh's (1995) key to the subgenera of *Nippononebria*. He incorrectly used the absence or extremely sparse presence of pubescence on "antennomere 3" and the presence of "two pairs of posterior paramedial setae" on abdominal sterna "III to V" (actually sterna IV to VI) to distinguish members of his new subgenus *Vancouveria* from those of subgenus *Nippononebria*. In fact, the antennomere on which the difference in pubescence occurs is antennomere 4; and, as correctly pointed out by Ledoux and Roux (2005), members of both subgenera have only one pair of posterior paramedial setae on the designated sterna. It is only on sternum VII (the so-called "apical" or "anal" sternite) of both males and females of *Vancouveria* spp. that two pairs of setae are seen in most individuals, whereas only females of *Nippononebria* spp. have two pairs of setae and males have only a single pair. We incorporate these features in our new key, couplet 1, which distinguishes the subgenera.

Key for identification of adults of species of *Nippononebria* (*sensu stricto*) Uéno

1. Antennomere 4 without or with only extremely sparse pubescence on apical one-third; elytral apex narrowly oblique, laterally displaced from midline and posteriorly acute, sutural margin angulate at apex; male sternum VII with two pairs of posterior paramedial ("anal") setae [specimens from western Nearctic Region (Pacific Coast of North America)] ..... **subgenus *Vancouveria* Kavanaugh**

– Antennomere 4 with moderately dense pubescence on apical one-third; elytral apex bluntly pointed at midline, sutural margin straight at apex; male sternum VII with only one pair of posterior paramedial ("anal") setae [specimens from eastern Palaearctic Region (Japan and northeastern China)] **subgenus *Nippononebria* Uéno** **2**

2(1). Thorax coarsely punctate ventrally (most distinctly so on mesepisterna and metepisterna, but also on prosternum and proepisterna anteriorly, mesosternum and metasternum laterally); size very small (SBL of male less than 6.5 mm); elytral silhouette (Fig. 1) subovoid, widest distinctly anterior to middle; elytral microsculpture comprised of moderately impressed and markedly transverse meshes; head, pronotum, and elytra with faint but distinct blue-green metallic reflection; hindwings full-sized..... ***Nippononebria changbaiensis* sp. n.**

– Thorax smooth, impunctate ventrally; size larger (SBL of male 6.5 mm or more, of female 6.8 mm or more); elytral silhouette varied, widest at or

slightly to markedly posterior to middle; elytral microsculpture comprised of very faintly to moderately impressed isodiametric, irregular, or slightly transverse meshes; head and pronotum without metallic reflection, elytra without or with faint metallic reflection; hindwings full-sized or reduced to less than half elytral length **3**

3(2). Elytral silhouette ovoid, distinctly narrowed basally and apically, widest at middle or slightly posterior to middle, humeral carina and tooth markedly developed, elytral striae impuncate or very faintly punctate; pronotum relatively long and slender, only slightly wider than head across eyes, ratio of pronotal width to length = 1.20 to 1.35, basal margin only slightly wider than apical margin; elytral microsculpture comprised of moderately impressed broken isodiametric to irregular or slightly transverse meshes; elytra without or with faint greenish metallic reflection; hindwings reduced to small vestigial lobes ..... ***Nippononebria pusilla*** **(Uéno)**

– Elytral silhouette subrectangular or subvoid, widest at middle or slightly to markedly posterior to middle, humeral carina and tooth slightly to moderately developed, elytral striae moderately and distinctly punctate; pronotum relatively broad, distinctly wider than head across eyes, ratio of pronotal width to length = 1.4 or greater, basal margin distinctly wider than apical margin; elytra microsculpture comprised of very faintly (nearly effaced) to moderately impressed irregular or broken isodiametric or slightly transverse meshes; elytra without or with very faint greenish metallic reflection; hindwings full-sized or reduced to less than half elytral length..... **4**

4(3). Elytral silhouette subrectangular, relatively broad, widest at or very slightly posterior to middle, humeral carina and tooth slightly developed; elytral intervals smoothly convex; elytra shiny, with microsculpture comprised of nearly effaced to very faintly impressed irregular to slightly transverse meshes; elytra without or with very faint greenish metallic reflection; hindwings full-sized; pronotum with basal sinuation of lateral margin short and shallow, basal angles slightly obtuse or rectangular, lateral explanation broad throughout.....***Nippononebria chalceola*** **(Bates)**

– Elytral silhouette subovoid, relatively long and narrow, widest distinctly posterior to middle (at apical one-third in some individuals), humeral carina and tooth moderately developed; elytral intervals slightly flattened at middle; elytra slightly dull from moderately impressed broken isodiametric, irregular, or slightly transverse meshes; elytra without metallic reflection; hindwings reduced to less than half elytral length; pronotum with basal sinuation of lateral margin long and shallow to moderately deep, basal angles rectangular or slightly acute, lateral explanation narrow, especially at middle.....
.....***Nippononebria sawadai*** **Nakane**

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Abstract

Since 1970, 203 species of Aleocharinae have been recorded in the Maritime Provinces of Canada, 174 of which have been reported in the past decade. This rapid growth of knowledge of this hitherto neglected subfamily of rove beetles occasions the present compilation of species recorded in the region together with the chronology of their discovery. Sixteen new provincial records are reported, twelve from Nova Scotia, one from New Brunswick, and three from Prince Edward Island. Seven species, including *Oxypoda chantali* Klimaszewski, *Oxypoda perexilis* Casey, *Myllaena cuneata* Notman, *Placusa canadensis* Klimaszewski, *Geostiba* (*Sibiota*) *appalachigena* Gusarov, *Lypoglossa angularis obtusa* (LeConte), and *Trichiusa postica* Casey [tentative identification] are newly recorded in the Maritime Provinces, one of which, *Myllaena cuneata*, is newly recorded in Canada. A preliminary analysis of the composition of the fauna indicates that the percentage of adventive species (18.2%) is consistent with that of other groups of Coleoptera. Both Cape Breton Island and Prince Edward Island are comparatively faunistically under-represented, in all probability as a result of insufficient collecting effort in these areas. A species accumulation curve indicates that it is probable that further species of aleocharines remain to be documented in the region.

Keywords

Coleoptera, Staphylinidae, Aleocharinae, Canada, Maritime Provinces, New Brunswick, Nova Scotia, Prince Edward Island, biodiversity, species accumulation

Introduction

The recent explosion of interest and information with respect to the rove beetle subfamily Aleocharinae in the Maritime Provinces of Canada (New Brunswick, Nova Scotia, and Prince Edward Island) has been remarkable and dramatic, particularly given the long history of neglect of this group in the region. This lack of attention is in many respects unsurprising, given the complex and difficult taxonomy of the group. Even so, in comparison with other groups of Coleoptera in the region, and with interest in aleocharines in other portions of the continent, the historical attention that this group has received in the region in the past has been exceptionally meagre.

The first published report of an aleocharine from the Maritime Provinces was by Howden (1970) who recorded *Falagria dissecta* Erichson on Sable Island, Nova Scotia, along with five other species that were tentatively identified only to genus (three of these have subsequently been determined as *Atheta novaescotiae* Klimaszewski and Majka, *Mocyta breviuscula* (Mäklin), and *Crataraea suturalis* (Mannerheim) (C.G. Majka and J. Klimaszewski, unpublished data). There are no records of any aleocharines from the Maritime Provinces in catalogues such as Leng (1920) and Moore and Legner (1975), nor in any of the historical papers on the Coleoptera of the region. There are voucher specimens of aleocharines from the region collected as early as 1910, however, the unresolved taxonomy of the group prohibited investigators from identifying them.

It was not until studies such as Klimaszewski (1979, 1982a, 1982b, 1984) and Hoebeke (1985) that taxonomists began examining aleocharine specimens from the Maritime Provinces and including such records in taxonomic treatments. Campbell and Davies (1991), a compilation of Coleoptera records from Canada and Alaska, listed only 27 species from the region, based almost entirely on records provided by the above studies.

There was very little further research on this subfamily in the Maritime Provinces for the next decade, until in 2001 a series of papers began that, over the span of the last decade, has dramatically increased knowledge of the aleocharine fauna of the region. One hundred and seventy-four species have been added to the region's faunal list during this time. Due to this very rapid increase in knowledge, it has been difficult to keep track of all the contributions to the region's faunal lists, and even the recent catalogue of Gouix and Klimaszewski (2007) is now substantially out of date.

The purpose of this paper is to add further jurisdictional records of aleocharines to the region's faunal list, provide a compendium of the species that have been recorded in the Maritime Provinces, and the studies that have documented their presence, and briefly examine some aspects of the fauna in general, and of the increase in knowledge of the group in the region.

Methods and conventions

Codens (following Evenhuis 2009) of collections referred to in this study are:

CBU Cape Breton University, Sydney, Nova Scotia, Canada
CGMC Christopher G. Majka collection, Halifax, Nova Scotia, Canada
DHWC David H. Webster collection, Kentville, Nova Scotia, Canada
NSMC Nova Scotia Museum, Halifax, Nova Scotia, Canada
NSNR Nova Scotia Department of Natural Resources, Shubenacadie, Nova Scotia, Canada
STFX St. Francis Xavier University, Antigonish, Nova Scotia, Canada
UMNB Université de Moncton, Moncton, New Brunswick, Canada

In the species treatments, the number of specimens and the collection abbreviation are indicated in parentheses.

Results

Sixteen new provincial records of aleocharines, twelve from Nova Scotia, one from New Brunswick, and three from Prince Edward Island are reported herein. Seven species including, *Oxypoda chantali* Klimaszewski, *Oxypoda perexilis* Casey, *Myllaena cuneata* Notman, *Placusa canadensis* Klimaszewski, *Geostiba* (*Sibiota*) *appalachigena* Gusarov, *Lypoglossa angularis obtusa* (LeConte), and *Trichiusa postica* Casey [tentative identification] are newly recorded in the Maritime Provinces, one of which, *Myllaena cuneata*, is newly recorded in Canada. Specific details of new records are reported below.

Aleochara (*Coprochara*) *bimaculata* Gravenhorst, 1802

NEW BRUNSWICK: Kent County: Buctouche, 13.VI.2007, 18.X.2007, J.P.-Michaud, on decomposing pig (2, UMNB).

Aleochara bimaculata is newly recorded in New Brunswick. In Canada it has been previously recorded in Alberta, British Columbia, Manitoba, Newfoundland and Labrador, Nova Scotia, Northwest Territories, Ontario, Québec, and Saskatchewan. It is found throughout the United States, south to southern Mexico (Klimaszewski 1984). Adults are frequently found at dung, carrion, decomposing mushrooms, and in various kinds of leaf and grass litter (Klimaszewski 1984)

Aleochara (*Xenochara*) *castaneipennis* Mannerheim, 1843

NOVA SCOTIA: Cumberland County: VIII.1965, B. Wright, under sugar maple on mountain slope, pitfall trap (1, NSMC); **Halifax County:** Waverley, 10.VIII.1965, B. Wright, mixed forest, pitfall trap (1, NSMC); Big Indian Lake, 9.VIII.2003, P. Dollin, red spruce forest (80–120 years), pitfall trap (3, NSMC).

Aleochara castaneipennis is newly recorded in Nova Scotia. In Canada it has been previously recorded in Alberta, British Columbia, New Brunswick, Ontario, Québec, and the Yukon (Klimaszewski 1984; Klimaszewski et al. 2005a). In the United States it has been recorded in many jurisdictions in the eastern and western portions of the country, although it is absent in the Great Plains region (Klimaszewski 1984).

Oxypoda chantali Klimaszewski, 2006

NOVA SCOTIA: Antigonish County: Pomquet, IV.1996, R.F. Lauff, leaf litter, male (1, STFX).

Oxypoda chantali is newly recorded in the Maritime Provinces. This species is previously known only from Ontario and Québec (Klimaszewski et al. 2006b). It has been collected in leaf litter in deciduous forests (Klimaszewski et al. 2006b).

Oxypoda perexilis Casey, 1906

NOVA SCOTIA: Colchester County: Bible Hill, 3–9.VII.2007, C.W. D'Orsay, pasture, pitfall trap (4, CBU).

Oxypoda perexilis is newly recorded in the Maritime Provinces. In Canada it has been previously recorded in Ontario and Québec. In the United States it has been recorded in Mississippi, Texas, North Carolina, and Iowa (Klimaszewski et al. 2006b). In other regions it has been collected in dry alvar habitats (Klimaszewski et al. 2006b).

Myllaena arcana Casey, 1911

NOVA SCOTIA: Guysborough County: Melopseketch Lake, 14.V–2.VI.1997, D.J. Bishop, young red spruce forest, flight intercept trap (1, NSMC).

Myllaena arcana is newly recorded in Nova Scotia. In Canada it has been previously recorded in Alberta, New Brunswick, Ontario, and Québec. In the United States it has been found from New Hampshire, west to Iowa and south through Florida and Alabama to Veracruz and Chiapas in Mexico (Klimaszewski 1982a). Specimens have been collected from wet debris near streams, lakes, and ponds (Klimaszewski 1982a).

Myllaena cuneata Notman, 1920

NOVA SCOTIA: Halifax County: Point Pleasant Park, 20.IX.2001, C.G. Majka, coniferous forest, under bark of dead red spruce (2, CGMC).

Myllaena cuneata is newly recorded in Canada. In the United States this species has been found from Florida and Louisiana north to Massachusetts. Specimens have been

collected from organic detritus near a creek and in oak-beech leaf litter (Klimaszewski 1982a).

Eumicrota socia (Erichson, 1839)

PRINCE EDWARD ISLAND: Queens County: Princeton-Warburton Road, 27.VI.2003, C.G. Majka, along small stream in mixed forest (4, CGMC).

Eumicrota socia is newly recorded in Prince Edward Island. In Canada it has been previously recorded in New Brunswick, Nova Scotia, and Québec. It is widely distributed in the central and eastern portions of the United States. (Campbell and Davies 1991; Klimaszewski et al. 2009c). Specimens have been collected in a wide variety of coniferous and deciduous forests, frequently on slightly decayed polypore fungi and gilled fungi of a variety of species (Klimaszewski et al. 2009c).

Gyrophaena (*s. str.*) *gaudens* Casey, 1906

PRINCE EDWARD ISLAND: Queens County: St. Patricks, 17.VIII.2002, C.G. Majka, coniferous forest, on *Cantharellus cibarius* Fr. (1, CGMC).

Gyrophaena gaudens is newly recorded in Prince Edward Island. In Canada it has been previously recorded in New Brunswick, Ontario, and Québec. In the United States it has been recorded in northern regions of the country from Massachusetts and Pennsylvania in the east, west to Michigan and Wisconsin (Klimaszewski et al. 2009c). It is found in mixed and coniferous forests on a variety of gilled and polypore fungi (Klimaszewski et al. 2009c).

Silusa alternans Sachse, 1852

PRINCE EDWARD ISLAND: Queens County: St. Patricks, 17.VIII.2000, C.G. Majka, coniferous forest, on *Cantharellus cibarius* Fr. (1, CGMC).

Silusa alternans is newly recorded in Prince Edward Island. In Canada it has been previously recorded in New Brunswick, Nova Scotia, and Québec. In the United States it has been recorded from Georgia north to New Hampshire (Klimaszewski et al. 2003). It has been collected in deciduous and coniferous forests associated with gilled fungi such as *Clavaria* sp. and *Russula* sp. (Klimaszewski et al. 2003).

Placusa canadensis Klimaszewski, 2001

NOVA SCOTIA: Kings County: North Alton, 2.VI.2005, D.H. Webster, under bark of wind-fallen *Populus grandidentat*a Michx. (4, DHWC).

Placusa canadensis is newly recorded in the Maritime Provinces. In Canada it has been previously recorded in Ontario and Québec; in the United States it is known from Ohio and West Virginia (Klimaszewski et al. 2001). In Québec this species has been found predominantly in sugar maple (*Acer saccharum* Marsh.) stands, occasionally in white spruce (*Picea glauca* (Moench) Voss) forests. They have been collected from under the bark of recently fallen trees and from rotting fungi and tree stumps (Klimaszewski et al. 2001). The specimens in Nova Scotia were found in association with specimens of *Carpophilus sayi* Parsons [Nitidulidae] (abundant), and *Corticeus tenuis* (LeConte) [Tenebrionidae] (infrequent) in the same subcortical habitat.

Acrotona subpygmaea (Bernhauer, 1909)

NOVA SCOTIA: Halifax County: Point Pleasant Park, 20.IX.2001, C.G. Majka, coniferous forest, in bark of dead white pine (1, CGMC).

Acrotona subpygmaea is newly recorded in Nova Scotia. In Canada it has been previously recorded in New Brunswick; in the United States there are records from Massachusetts and Indiana (Klimaszewski et al. 2005a). In New Brunswick it was collected in a red spruce (*Picea rubens* Sarg.) forest (Klimaszewski et al. 2005a).

The status of *Acrotona subpygmaea,* however, is subject to some question. In most respects it appears to be identical to *Acrotona avia* (Casey). There is an unresolved problem in determining the status of these two species names in that while all the external and internal structures of both male and female types of *A. avia* are intact, in the case of the (unpublished) lectotype of *A. subpygmaea* designated by V. Gusarov, the median lobe of the adeagus of the male is missing and the female syntype has a collapsed spermatheca, making it difficult to determine whether these are distinct species or whether *A. avia* should be designated as a junior synonym of *A. subpygmaea*. J. Klimaszewski and collaborators are in the process of revising the eastern Canadian species of the genus *Acrotona*. The present identification should be regarded as tentative, pending this revision.

Atheta (*Microdota*) *particula* (Casey, 1910)

NOVA SCOTIA: Annapolis County: Big Dam Lake, Kejimkujik National Park, 27.VI.–7.VII.2004, H. Love, hemlock forest, pitfall trap (4, CGMC); **Cumberland County:** VIII.1965, B. Wright, under sugar maple in deciduous forest, pitfall trap (1, NSMC); **Digby County:** Pebbleloggitch Lake, Kejimkujik National Park, 13–24. VIII.2004, H. Love, hemlock forest, pitfall trap (4, CGMC); **Halifax County:** Waverley, 10.VIII.1965, B. Wright, mixed forest, pitfall trap (1, NSMC); **Queens County:** Canning Field, Kejimkujik National Park, 26.VI.–6.VII.2004, 14–23.VIII.2004, H. Love, hemlock forest, pitfall trap (18, CGMC); Cobreille Lake, 27.VI–7.VII.2004, H. Love, hemlock forest, pitfall trap (43, CGMC).

Atheta (*Microdota*) *particula* is newly recorded in Nova Scotia. In Canada it has been previously recorded in New Brunswick (Klimaszewski et al. 2005a). In the United States it has been recorded from Rhode Island and New York (Moore and Legner 1975). In New Brunswick it was collected in a red spruce forest (Klimaszewski et al. 2005a). In Nova Scotia they have primarily been found on the forest floor in eastern hemlock (*Tsuga canadensis* (L.) Carr.) forests.

Geostiba (*Sibiota*) *appalachigena* Gusarov, 2002

NOVA SCOTIA: Queens County: Kejimkujik National Park, 24.VIII.1994, B. Wright, hemlock forest, leaf litter (4, NSMC).

Geostiba appalachigena is newly recorded in the Maritime Provinces. In Canada it has been previously recorded in Québec. In the United States it has been collected from Maine to Virginia, west to Wisconsin (Gusarov 2002). It has been found in red spruce and balsam fir (*Abies balsamaea* (L.) Mill) forests, in forest leaf litter (Gusarov 2002).

Lypoglossa angularis obtusa (LeConte, 1866)

NOVA SCOTIA: Cape Breton County: Louisbourg, 28.VI–2.VII.1999, A. Schrage & S.P. Roach, closed spruce woodland, pan trap (2, CBU).

Lypoglossa angularis obtusa is newly recorded in the Maritime Provinces. In Canada it has been previously recorded in Newfoundland and Québec; in the United States it is found in Maine and New Hampshire (Gusarov 2004). The species is common in forest leaf litter and moss in boreal forests; it has also been found on dung in gopher burrows (Gusarov 2004).

Trichiusa postica Casey, 1906

NOVA SCOTIA: Colchester County: Bible Hill, 31.V.2005, S.M. Townsend, cow pasture, sweep net (1, CBU); **Halifax County:** Soldier Lake, 13.VI.2005, J. Gordon, spruce beetle trap (1, NSNR); Petpeswick, 23.VI.1971, B. Wright (1, NSMC).

Trichiusa postica is newly recorded in the Maritime Provinces. In Canada it has been previously recorded in Ontario (Campbell and Davies 1991; Gusarov 2001–2003). The ecology and biology of this species have not been recorded.

This identification should be regarded as provisional. *Trichiusa* is an unrevised genus in North America, and for confirmation, this specimen should be compared with type specimens of this genus. These are on loan from the US National Museum to V. Gusarov and despite efforts we have not been able to obtain them for the purposes of this study.

Zyras obliquus Casey, 1893

NOVA SCOTIA: Lunenburg County: Bridgewater, 1–16.VII.1965, B. Wright, under red oak, pitfall trap (1, NSMC).

Zyras obliquus is newly recorded in Nova Scotia. In Canada it has been previously recorded from British Columbia east to New Brunswick (Klimaszewski et al. 2005b; Webster et al. 2009). In British Columbia this species was found in various coniferous and mixed forests (Klimaszewski et al. 2005b). Note: this species was reported from Nova Scotia by Kehler et al. (1996) [as *Zyras haworthi* (Stephens)] without, however, supplying collection data. In a subsequent examination of this collection by Majka and Bondrup-Nielsen (2006), no voucher specimens of this species were found, rendering the authenticity of the original record moot.

Discussion

Table 1 provides a systematic list of the 203 species of aleocharines that have been found in the Maritime Provinces. Of these, five species [*Phloeopora* sp., *Oligota chrysopyga* Kraatz?, *Oligota* nr. *ruficornis* Sharp, *Acrotona* nr. *smithi* Casey, and *Atheta* nr. *smetanai & campbelli* (Lohse)] are provisional names for species that have not yet been identified to the specific level. Three species (*Philhygra insulivaga* Gusarov, *Philhygra lustrivaga* Gusarov, and *Philhygra riprivaga* Gusarov) are unpublished manuscript names of species which have not yet been formally described. Published references for reports from the Maritime Provinces are arranged in chronological order.

Of the 203 species, 162 (79.8%) are Nearctic in distribution; four (2.0%) have a Holarctic distribution; and 37 (18.2%) are adventive Palaearctic species. A total of 175 species (86.2%) have been recorded in New Brunswick; 125 (61.6%) in Nova Scotia, and 20 (9.9%) in Prince Edward Island. Of the Nova Scotia species, 106 (52.2%) have been recorded on the Nova Scotia mainland, and 57 (28.1%) on Cape Breton Island. There are 19 species recorded on Cape Breton Island that have not been found on the Nova Scotia mainland.

Since the biodiversity of the Maritime Provinces aleocharine fauna is still in an active phase of investigation, it would be premature at present to draw many conclusions from these compositional figures. The overall proportion of adventive species is similar to that of other groups of Coleoptera. For example, in Nova Scotia 15.6% of the province's beetle fauna consists of adventive species (C.G. Majka, unpublished data). The proportion of species recorded to date from both Cape Breton Island (28.1%) and Prince Edward Island (9.9%) appear to be rather low, in all probability indicating a deficit in collection effort for this group in these areas. In the case of the Carabidae, 54.4% of the Maritime Provinces' fauna has been recorded on Cape Breton, and 47.9% on Prince Edward Island (Majka et al. 2007b). Within the Curculionoidea, 35.3% of Maritime Provinces weevils have been recorded on Cape Breton, and 33.2% on Prince Edward Island (Majka et al. 2007a). While there is no *a priori*

reason why these figures should be the same across different taxonomic groups, the data for these better investigated groups in the region appear to underscore the fact that a comparative paucity of collecting effort has under-represented the aleocharine fauna of these two areas.

An indication of the rapid growth of information about the Maritime Provinces' aleocharine composition is provided by Figure 1, a species accumulative curve (based on publication dates) of the region's fauna. Fig. 1 shows that that an asymptote has not yet been approached, suggesting that the fauna of the area is not adequately sampled, and that many additions to it remain to be made. Although the very rapid growth rate of knowledge over the past decade is likely to abate in the future, it is nevertheless clear that more species remain to be documented. Even since the recent publication of Gouix and Klimaszewski (2007), a catalogue of the Aleocharinae of Canada and Alaska, which included records of 96 species from the Maritime Provinces, 107 species have been added to the region's fauna – a 111% increase in the past three years alone.

Aside from sheer numbers of species, an immense amount of work remains to be done on the ecology and biology of most of the species, and on their distribution within the region. For many species, such knowledge is fragmentary and incomplete. Many geographical areas have been little, if at all, sampled and many habitats have been poorly investigated. Nevertheless, in a span of 40 years, knowledge of the Maritime Provinces Aleocharinae fauna has developed from nonexistent to the point where they are the most species rich subfamily of rove beetles in the region.

Table 1. Aleocharinae recorded in the Maritime Provinces of Canada.

Species	NB	mNS	CB	PE	References
ALEOCHARINAE					
Gymnusini					
Gymnusa atra Casey *	1		1		Klimaszewski (1979), Campbell and Davies (1991), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
Gymnusa campbelli Klimaszewski	1				Klimaszewski (1982b), Campbell and Davies (1991), Gouix and Klimaszewski (2007)
Gymnusa grandiceps Casey	1	1			Klimaszewski (1979), Campbell and Davies (1991), Majka and Klimaszewski (2008b), Gouix and Klimaszewski (2007), Webster et al. (2009)
Gymnusa pseudovariegata Klimaszewski	1	1	1		Klimaszewski (1979), Campbell and Davies (1991), Gouix and Klimaszewski (2007)
Deinopsini					
Deinopsis canadensis Klimaszewski	1				Webster et al. (2009)
Deinopsis harringtoni Casey	1	1	1		Klimaszewski (1979), Campbell and Davies (1991), Gouix and Klimaszewski (2007), Bishop et al. (2009)
Deinopsis rhadina Klimaszewski	1				Webster et al. (2009)

Species	NB	mNS	CB	PE	References
Aleocharini					
subtribe Aleocharina					
subgenus *Aleochara* Mulsant and Rey					
Aleochara curtula (Goeze) †	1	1		1	Klimaszewski (1984), Campbell and Davies (1991), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008a), Michaud et al. (2010)
Aleochara gracilicornis Bernhauer	1	1	1		Klimaszewski (1984), Campbell and Davies (1991), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
Aleochara sekanai Klimaszewski	1				Majka et al. (2009), Michaud et al. (2010)
Aleochara tahoensis Casey	1		1		Klimaszewski (1984), Campbell and Davies (1991), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
subgenus *Calochara* Casey					
Aleochara villosa Mannerheim	1				Webster et al. (2009)
subgenus *Coprochara* Mulsant and Rey					
Aleochara bilineata Gyllenhal †	1	1	1	1	Klimaszewski (1984), Campbell and Davies (1991), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
Aleochara bimaculata Gravenhorst	1	1	1		Klimaszewski (1984), Gouix and Klimaszewski (2007), Michaud et al. (2010), present study
Aleochara verna Bernhauer	1	1		1	Klimaszewski (1984), Campbell and Davies (1991), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Michaud et al. (2010)
subgenus *Emplenota* Casey					
Aleochara litoralis (Mäklin)	1	1	1		Klimaszewski (1984), Campbell and Davies (1991), Majka and Ogden (2006), Gouix and Klimaszewski (2007), Majka et al. (2008), Majka et al. (in press)
subgenus *Euryodma*					
Aleochara caseyi Likovsky	1				Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
subgenus *Xenochara* Mulsant and Rey					
Aleochara castaneipennis Mannerheim	1	1			Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Dollin et al. (2008), present study
Aleochara fumata Gravenhorst †	1	1	1	1	Klimaszewski (1984), Campbell and Davies (1991), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Michaud et al. (2010), Majka et al. (in press)
Aleochara inexspectata Klimaszewski	1	1			Klimaszewski (1984), Campbell and Davies (1991), Gouix and Klimaszewski (2007), Webster et al. (2009)
Aleochara lacertina Sharp	1	1	1		Klimaszewski (1984), Campbell and Davies (1991), Gouix and Klimaszewski (2007)

Species	NB	mNS	CB	PE	References
Aleochara lanuginosa Gravenhorst	1	1			Majka and Klimaszewski (2008a), Webster et al. (2009)
Aleochara sculptiventris (Casey)	1				Klimaszewski (1984), Campbell and Davies (1991), Michaud et al. (2010)
Aleochara tristis Gravenhorst †	1				Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
Tinotus morion (Gravenhorst) †	1	1			Klimaszewski et al. (2002, 2005), Gouix and Klimaszewski (2007), Bishop et al. (2009)
Hoplandriini					
Hoplandria lateralis (Melsheimer)	1				Webster et al. (2009)
Oxypodini					
subtribe Oxypodina					
Amarochara formicina Assing	1				Assing (2007), Gouix and Klimaszewski (2007), Webster et al. (2009)
Amarochara inquilina (Casey)	1				Assing (2007), Gouix and Klimaszewski (2007), Webster et al. (2009)
Calodera parviceps (Casey)	1	1	1		Assing (2008), Webster et al. (2009)
Crataraea suturalis (Mannerheim) †	1	1			Klimaszewski et al. (2007), Gouix and Klimaszewski (2007), Webster et al. (2009)
Devia prospera (Erichson)	1				Webster et al. (2009)
Gennadota canadensis Casey	1	1	1		Majka et al. (2006b), Gouix and Klimaszewski (2007), Moseley (2007, 2009), Webster et al. (2009), Michaud et al. (2010)
Hylota ochracea Casey	1	1	1		Majka et al. (2006a), Gouix and Klimaszewski (2007), Webster et al. (2009)
Ilyobates bennetti Donisthorpe †	1	1			Majka and Klimaszewski (2008b), Webster et al. (2009)
Ocyusa asperula Casey	1				Webster et al. (2009)
Oxypoda amica Casey	1	1			Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Dollin et al. (2008)
Oxypoda brachyptera (Stephens) †	1	1			Klimaszewski et al. (2006b), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008a)
Oxypoda chantali Klimaszewski		1			present study
Oxypoda convergens Casey	1	1	1		Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
Oxypoda demissa Casey	1		1		Klimaszewski et al. (2006b), Gouix and Klimaszewski (2007), Webster et al. (2009)
Oxypoda frigida Bernhauer	1		1		Klimaszewski et al. (2006b), Gouix and Klimaszewski (2007)
Oxypoda gnara Casey	1				Webster et al. (2009)
Oxypoda grandipennis (Casey)	1		1		Klimaszewski et al. (2005, 2006b), Gouix and Klimaszewski (2007)
Oxypoda hiemalis Casey	1		1		Klimaszewski et al. (2006b), Gouix and Klimaszewski (2007)
Oxypoda inimica Casey	1				Klimaszewski et al. (2006b), Gouix and Klimaszewski (2007)

Species	NB	mNS	CB	PE	References
Oxypoda lacustris Casey	1	1			Klimaszewski et al. (2005a), Webster et al. (2009)
Oxypoda lucidula Casey	1				Webster et al. (2009)
Oxypoda nigriceps Casey	1	1	1		Klimaszewski et al. (2005, 2006b), Gouix and Klimaszewski (2007), Bishop et al. (2009)
Oxypoda opaca (Gravenhorst) †	1	1			Klimaszewski et al. (2006b), Gouix and Klimaszewski (2007), Webster et al. (2009)
Oxypoda operta Sjöberg †			1		Klimaszewski et al. (2006b), Gouix and Klimaszewski (2007)
Oxypoda orbicollis Casey			1		Klimaszewski et al. (2006b), Gouix and Klimaszewski (2007)
Oxypoda perexilis Casey		1			present study
Oxypoda pseudolacustris Klimaszewski	1	1	1		Klimaszewski et al. (2006b), Gouix and Klimaszewski (2007)
Oxypoda vockerothi Klimaszewski	1				Webster et al. (2009)
Phloeopora sp. [1]		1			Bishop et al. (2009)
subtribe Meoticina					
Alisalia elongata Klimaszewski and Webster	1				Klimaszewski et al. (2009a)
Alisalia minuta Klimaszewski and Webster	1				Klimaszewski et al. (2009a)
Alisalia testacea Casey	1				Klimaszewski et al. (2009a)
Meotica exilis (Erichson) †		1			Majka and Klimaszewski (2008b)
Meotica pallens (Redtenbacher) †		1			Majka and Klimaszewski (2008b)
subtribe Tachyusina					
Gnypeta caerulea (C.R. Sahlberg) †	1		1	1	Klimaszewski et al. (2008a), Majka and Klimaszewski (2008a, 2008b)
Gnypeta carbonaria Mannerheim *	1				Klimaszewski et al. (2008a)
Gnypeta nigrella (LeConte)	1				Klimaszewski et al. (2008a)
Gnypeta saccharina Klimaszewski and Webster	1				Klimaszewski et al. (2008a)
Gnypeta minuta Klimaszewski and Webster	1				Klimaszewski et al. (2008a)
Meronera venustula (Erichson)	1				Majka and Klimaszewski (2008b)
Tachyusa americana Casey	1				Webster et al. (2009)
Tachyusa americanoides Pasnik		1			Pasnik (2006), Gouix and Klimaszewski (2007)
Hypocyphtini					
Oligota chrysopyga Kraatz ? † [1]	1				unpublished
Oligota parva Kraatz				1	Majka et al. (2008)

Species	NB	mNS	CB	PE	References
Oligota nr. ruficornis Sharp † [1]		1			unpublished
Myllaenini					
Myllaena arcana Casey	1	1			Klimaszewski (1982a), Campbell and Davies (1991), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Bishop et al. (2009), present study
Myllaena audax Casey	1				Klimaszewski (1982a), Campbell and Davies (1991), Gouix and Klimaszewski (2007)
Myllaena cuneata Notman		1			present study
Myllaena insomnis Casey	1		1		Klimaszewski (1982a), Campbell and Davies (1991), Gouix and Klimaszewski (2007)
Myllaena kaskaskia Klimaszewski	1				Webster et al. (2009)
Myllaena ludificans Casey	1				Webster et al. (2009)
Myllaena procidua Casey	1				Webster et al. (2009)
Myllaena vulpina Bernhauer	1		1		Klimaszewski (1982a), Campbell and Davies (1991), Gouix and Klimaszewski (2007), Webster et al. (2009)
Dioglottini					
Dioglota mersa (Haliday) †	1				Klimaszewski et al. (2008b)
Autaliini					
Autalia rivularis (Gravenhorst) †	1	1			Klimaszewski et al. (2005a),Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008a)
Homalotini					
subtribe Bolitocharina					
Neotobia alberta Ashe	1				Webster et al. (2009)
Phymatura blanchardi (Casey)	1				Webster et al. (2009)
Silusida marginella (Casey)	1	1	1		Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Dollin et al. (2008), Majka and Klimaszewski (2008b)
subtribe Gyrophaenina					
Eumicrota corruscula Erichson	1				Klimaszewski et al. (2009c)
Eumicrota socia (Erichson)	1	1		1	Klimaszewski et al. (2009c), Dollin et al. (2008), present study
subgenus *Gyrophaena* Mannerheim					
Gyrophaena affinis Mannerheim †	1	1	1		Campbell and Davies (1991), Gouix and Klimaszewski (2007), Klimaszewski et al. (2009c), Majka and Klimaszewski (2008a), Dollin et al. (2008), Majka et al. (in press)
Gyrophaena antennalis Casey	1	1			Campbell and Davies (1991), Gouix and Klimaszewski (2007), Klimaszewski et al. (2009c)
Gyrophaena caseyi Seevers	1				Klimaszewski et al. (2009c)
Gyrophaena chippewa Seevers	1				Klimaszewski et al. (2009c)
Gyrophaena criddlei Casey	1				Klimaszewski et al. (2009c)

Species	NB	mNS	CB	PE	References
Gyrophaena dybasi Seevers	1				Klimaszewski et al. (2009c)
Gyrophaena flavicornis Melsheimer	1	1	1		Klimaszewski et al. (2009c), Dollin et al. (2008)
Gyrophaena fuscicollis Casey	1				Klimaszewski et al. (2009c)
Gyrophaena gaudens Casey	1	1		1	Klimaszewski et al. (2009c), present study
Gyrophaena gilvicollis Casey	1				Klimaszewski et al. (2009c)
Gyrophaena illiana Seevers	1				Klimaszewski et al. (2009c)
Gyrophaena insolens Casey	1				Campbell and Davies (1991), Gouix and Klimaszewski (2007), Klimaszewski et al. (2009c)
Gyrophaena involuta Casey	1				Klimaszewski et al. (2009c)
Gyrophaena keeni Casey	1				Campbell and Davies (1991), Klimaszewski et al. (2005, 2009c)
Gyrophaena laetula Casey	1				Klimaszewski et al. (2009c)
Gyrophaena lobata Casey	1				Klimaszewski et al. (2009c)
Gyrophaena modesta Casey	1	1			Campbell and Davies (1991), Gouix and Klimaszewski (2007), Klimaszewski et al. (2009c)
Gyrophaena pseudocriddlei Klimaszewski and Webster	1				Klimaszewski et al. (2009c)
Gyrophaena sculptipennis Casey	1	1			Klimaszewski et al. (2009c), Dollin et al. (2008)
Gyrophaena uteana Casey	1				Klimaszewski et al. (2009c)
Gyrophaena vitrina Casey	1				Klimaszewski et al. (2009c)
subgenus *Phaenogyra* Mulsant and Rey					
Gyrophaena gracilis Seevers	1				Klimaszewski et al. (2009c)
Gyrophaena meduxnekeagensis Klimaszewski and Webster	1				Klimaszewski et al. (2009c)
Gyrophaena subnitens Casey	1	1			Klimaszewski et al. (2009c)
subtribe Homalotina					
Homalota plana (Gyllenhal) †	1	1			Majka and Klimaszewski (2004), Klimaszewski et al. (2007), Gouix and Klimaszewski (2007)
subtribe Leptusina					
Euvira micmac Klimaszewski and Majka	1	1			Klimaszewski and Majka (2007b), Gouix and Klimaszewski (2007), Webster et al. (2009)
Leptusa incertae sedis					
Leptusa gatineauensis Klimaszewski and Pelletier		1			Klimaszewski et al. (2004), Gouix and Klimaszewski (2007), Bishop et al. (2009)
subgenus *Adoxopisalia* Pace					
Leptusa opaca Casey	1	1	1	1	Klimaszewski et al. (2004, 2005), Gouix and Klimaszewski (2007), Dollin et al. (2008), Bishop et al. (2009)

Species	NB	mNS	CB	PE	References
Leptusa pseudopaca Klimaszewski and Majka		1	1		Klimaszewski et al. (2004), Gouix and Klimaszewski (2007), Dollin et al. (2008)
subgenus *Boreoleptusa* Pace					
Leptusa canonica Casey		1	1		Klimaszewski et al. (2004), Gouix and Klimaszewski (2007), Dollin et al. (2008), Bishop et al. (2009)
Leptusa jucunda Klimaszewski and Majka	1	1			Klimaszewski et al. (2004), Majka and Klimaszewski (2004), Gouix and Klimaszewski (2007)
subgenus *Dysleptusa* Pace					
Leptusa carolinensis Pace	1	1			Klimaszewski et al. (2004), Gouix and Klimaszewski (2007), Bishop et al. (2009), Webster et al. (2009)
subgenus *Eucryptusa* Casey					
Leptusa brevicollis Casey	1	1	1	1	Klimaszewski et al. (2004, 2005), Gouix and Klimaszewski (2007), Dollin et al. (2008), Bishop et al. (2009)
subtribe Silusina					
Silusa alternans Sachse	1		1	1	Klimaszewski et al. (2003, 2005), Gouix and Klimaszewski (2007), present study
Silusa californica Bernhauer	1	1	1		Klimaszewski et al. (2003, 2005), Gouix and Klimaszewski (2007)
Silusa densa Fenyes	1				Webster et al. (2009)
Placusini					
Placusa canadensis Klimaszewski		1			present study
Placusa incompleta Sjöberg †	1		1		Klimaszewski et al. (2001), Gouix and Klimaszewski (2007), Webster et al. (2009)
Placusa tachyporoides (Waltl) †	1	1	1		Klimaszewski et al. (2001), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008a)
Placusa tacomae Casey	1	1			Klimaszewski et al. (2001), Majka and Klimaszewski (2004), Gouix and Klimaszewski (2007), Dollin et al. (2008), Webster et al. (2009)
Placusa vaga Casey	1	1			Webster et al. (2009)
Athetini					
subtribe Acrotonina					
Acrotona avia (Casey)		1			Majka et al. (2008)
Acrotona nr. smithi Casey [1]	1				unpublished
Acrotona subpygmaea Bernahuer	1	1			Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), present study
Mocyta breviuscula (Mäklin)	1	1			Majka and Klimaszewski (2008b), Bishop et al. (2009), Webster et al. (2009)
Mocyta fungi (Gravenhorst) †	1	1	1	1	Gusarov (2003), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008a), Majka et al. (2008), Michaud et al. (2010)
Strigota ambigua (Erichson)		1		1	Majka et al. (2008)

Species	NB	mNS	CB	PE	References
subtribe Athetina					
Aloconota sulcifrons (Stephens) †	1				Webster et al. (2009)
Amischa analis (Gravenhorst) †	1	1	1	1	Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008a), Bishop et al. (2009)
Atheta incertae sedis					
Atheta annexa Casey	1	1			Majka and Klimaszewski (2008b), Webster et al. (2009), Moseley (2009)
Atheta brunswickensis Klimaszewski	1	1			Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008b), Bishop et al. (2009)
Atheta capsularis Klimaszewski	1				Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
Atheta districta Casey	1	1			Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008b), Michaud et al. (2010)
Atheta irrita Casey	1	1	1		Majka et al. (2006a), Gouix and Klimaszewski (2007), Webster et al. (2009)
Atheta novaescotiae Klimaszewski and Majka	1	1	1		Klimaszewski et al. (2006a), Majka and Ogden (2006), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008b), Majka et al. (2008), Webster et al. (2009)
Atheta remulsa Casey	1	1	1		Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Dollin et al. (2008), Majka and Klimaszewski (2008b), Majka et al. (in press)
Atheta strigosula Casey	1				Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
subgenus *Alaobia* Thompson					
Atheta ventricosa Bernhauer	1	1			Gusarov (2003), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008b), Bishop et al. (2009)
subgenus *Atheta* (*s. str.*) Thompson					
Atheta aemula (Erichson)	1				Webster et al. (2009)
Atheta graminicola (Gravenhorst)	1				Webster et al. (2009)
subgenus *Chaetida* Mulsant and Rey					
Atheta longicornis (Gravenhorst) †	1	1			Klimaszewski et al. (2007), Gouix and Klimaszewski (2007), Webster et al. (2009), Michaud et al. (2010)
subgenus *Datomicra* Mulsant and Rey					
Atheta acadiensis Klimaszewski and Majka	1	1	1	1	Klimaszewski and Majka (2007a), Gouix and Klimaszewski (2007), Majka et al. (2008), Majka et al. (in press)
Atheta celata (Erichson) †	1	1	1		Majka et al. (2006a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008a)
Atheta dadopora Thomson †	1	1		1	Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008a, 2008b), Dollin et al. (2008), Bishop et al. (2009)

Species	NB	mNS	CB	PE	References
subgenus *Dimetrota* Mulsant and Rey					
Atheta burwelli (Lohse)	1				Majka and Klimaszewski (2008b)
Atheta crenuliventris Bernhauer	1				Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007)
Atheta hampshirensis Bernhauer	1	1			Klimaszewski and Winchester (2002), Klimaszewski et al. (2005a), Dollin et al. (2008), Majka and Klimaszewski (2008b), Bishop et al. (2009), Webster et al. (2009)
Atheta modesta (Melsheimer)	1	1	1		Gusarov (2003), Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Dollin et al. (2008), Majka and Klimaszewski (2008b)
Atheta prudhoensis (Lohse)	1		1		Majka and Klimaszewski (2008b), Webster et al. (2009)
Atheta pseudocrenuliventris Klimaszewski	1		1		Klimaszewski et al. (2005a), Majka et al. (2006a), Gouix and Klimaszewski (2007), Michaud et al. (2010)
Atheta pseudomodesta Klimaszewski		1			Majka and Klimaszewski (2008b)
Atheta nr. smetanai and campbelli (Lohse) [1]	1				Michaud et al. (2010)
subgenus *Metadimetrota* Klimaszewski and Winchester					
Atheta savardae Klimaszewski and Majka	1	1	1		Klimaszewski and Majka (2007a), Gouix and Klimaszewski (2007), Webster et al. (2009), Michaud et al. (2010)
subgenus *Microdota* Mulsant and Rey					
Atheta amicula (Stephens) †		1			Klimaszewski et al. (2008a)
Atheta particula (Casey)	1	1			Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), present study
Atheta pennsylvanica Bernhauer	1	1	1		Klimaszewski et al. (2005a), Dollin et al. (2008), Majka and Klimaszewski (2008b), Bishop et al. (2009), Majka et al. (in press)
Atheta platanoffi Brundin *	1	1			Klimaszewski et al. (2005a), Majka and Klimaszewski (2008b)
subgenus *Pseudota* Casey					
Atheta klagesi Bernhauer *	1	1		1	Dollin et al. (2008), Majka and Klimaszewski (2008b), Bishop et al. (2009), Webster et al. (2009)
subgenus *Tetropla* Mulsant and Rey					
Atheta frosti Bernhauer	1	1	1		Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008b)
subgenus *Thinobaena* Thomson					
Atheta vestita (Gravenhorst) †	1	1	1		Klimaszewski et al. (2007), Gouix and Klimaszewski (2007), Majka et al. (2008)
Dalotia coriaria (Kraatz) †	1	1			Webster et al. (2009)
Dinarea angustula (Gyllenhal) †	1	1	1	1	Klimaszewski et al. (2007), Gouix and Klimaszewski (2007), Webster et al. (2009)

Species	NB	mNS	CB	PE	References
Dochmonota rudiventris (Eppelsheim) †	1				Webster et al. (2009)
Halobrecta flavipes Thomson †	1				Klimaszewski et al. (2008b)
Liogluta aloconotoides Lohse		1			Majka and Klimaszewski (2008b)
Nehemitropia lividipennis (Mannerheim) †	1	1		1	Klimaszewski et al. (2007), Gouix and Klimaszewski (2007), Michaud et al. (2010)
Philhygra angusticauda (Bernhauer)	1				Webster et al. (2009)
Philhygra botanicarum Muona *	1		1		Klimaszewski et al. (2008a), Webster et al. (2009)
Philhygra clemens (Casey)	1	1			Klimaszewski et al. (2005a), Majka and Klimaszewski (2008b)
Philhygra "insulivaga" [Gusarov] [2]	1				Klimaszewski et al. (2005a)
Philhygra lavicollis (Mäklin)	1	1			Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008b)
Philhygra "lustrivaga" [Gusarov] [2]	1				Gusarov (2001-2003), Gouix and Klimaszewski (2007), Klimaszewski et al. (2005a)
Philhygra "riprivaga" [Gusarov] [2]	1				Gusarov (2001-2003), Gouix and Klimaszewski (2007), Klimaszewski et al. (2005a)
subgenus *Schistoglossa* Kraatz					
Schistoglossa pseudoCampbelli Klimaszewski and Webster	1				Klimaszewski et al. (2009b)
Schistoglossa brunswickensis Klimaszewski and Webster	1				Klimaszewski et al. (2009b)
Schistoglossa hampshirensis Klimaszewski	1				Klimaszewski et al. (2009b)
subgenus *Boreomorpha* Klimaszewski and Webster					
Schistoglossa sphagnorum Klimaszewski and Webster	1				Klimaszewski et al. (2009b)
Schistoglossa blatchleyi (Bernhauer and Scheerpeltz)	1				Gusarov (2003), Gouix and Klimaszewski (2007), Klimaszewski et al. (2009b)
subtribe Geostibina					
Earota dentata (Bernhauer)	1	1	1		Klimaszewski et al. (2005a), Majka and Klimaszewski (2008b), Webster et al. (2009)
subgenus *Geostiba* (*s. str.*) Thomson					
Geostiba circellaris (Gravenhorst) †	1				Webster et al. (2009)
subgenus *Sibiota* Casey					
Geostiba appalachigena Gusarov	1	1			Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), present study

Species	NB	mNS	CB	PE	References
Lypoglossa angularis obtusa (LeConte)			1		present study
Lypoglossa franclemonti Hoebeke	1		1		Hoebeke (1992), Gusarov (2004), Gouix and Klimaszewski (2007), Webster et al. (2009)
Seeversiella globicollis (Bernhauer)			1		Majka and Klimaszewski (2008b)
Strophogastra penicillata Fenyes	1	1			Klimaszewski et al. (2005a), Gouix and Klimaszewski (2007), Majka and Klimaszewski (2008b)
Trichiusa postica Casey		1			present study
Falagriini					
Cordalia obscura (Gravenhorst) †		1			Klimaszewski et al. (2008a)
Falagria dissecta Erichson	1				Howden (1970), Hoebeke (1985), Wright (1989), Campbell and Davies (1991), Gouix and Klimaszewski (2007), Majka et al. (2008)
Myrmecocephalus cingulatus (LeConte)		1			Hoebeke (1985), Campbell and Davies (1991), Gouix and Klimaszewski (2007)
Myrmecocephalus gatineauensis Hoebeke	1				Hoebeke (1985), Campbell and Davies (1991), Gouix and Klimaszewski (2007)
Myrmecopora vaga (LeConte)		1			Majka et al. (2008)
Lomechusini					
subtribe Lomechusina					
Xenodusa reflexa (Walker)	1	1			Majka and Klimaszewski (2008b), Webster et al. (2009)
subtribe Myrmedoniina					
Drusilla canaliculata (Fabricius) †	1	1	1	1	Klimaszewski et al. (2008a), Webster et al. (2009)
Pella gesneri Klimaszewski	1				Klimaszewski et al. (2005a, 2005b)
Pella loricata (Casey)		1			Klimaszewski et al. (2009)
Pella glooscapi Klimaszewski and Majka		1			Klimaszewski et al. (2009)
subgenus *Zyras* (*s. str.*) Stephens					
Zyras obliquus Casey	1	1			Webster et al. (2009), present study
	175	**106**	**57**	**20**	

Notes: NB, New Brunswick; mNS, mainland Nova Scotia; CB, Cape Breton Island; PE, Prince Edward Island; References, arranged in chronological order, consist of those reporting the species from the Maritime Provinces. † adventive Palaearctic species; * Holarctic species; no symbol, native Nearctic species; 1 Identity of species still undetermined or uncertain; 2 Unpublished manuscript name.

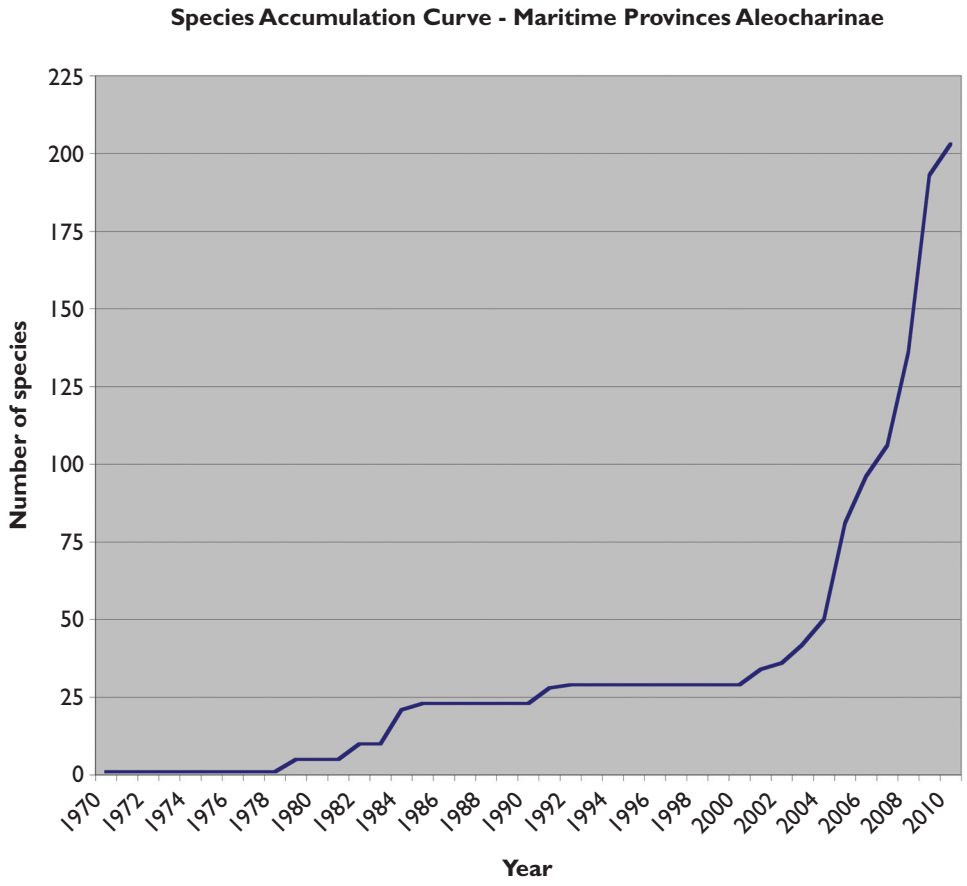

Figure 1. Species accumulation curve of the Maritime Provinces Aleocharinae

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RESEARCH ARTICLE

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Identity of the ailanthus webworm moth (Lepidoptera, Yponomeutidae), a complex of two species: evidence from DNA barcoding, morphology and ecology

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Abstract

During extensive ongoing campaigns to inventory moths of North America and Area de Conservacion Guanacaste (ACG), northwestern Costa Rica, we discovered that morphologically similar yponomeutid moths were assigned two different names, *Atteva ergatica* Walsingham in Costa Rica and *A. punctella* (Stoll) in North America, but had identical DNA barcodes. Combining DNA barcoding, morphology and food plant records also revealed a complex of two sympatric species that are diagnosable by their DNA barcodes and their facies in Costa Rica. However, neither of the names could be correctly applied to either species, as *A. ergatica* is a junior synonym and *A. punctella* a junior homonym. By linking our specimens to type material through morphology and DNA barcoding, we determined that the ACG dry forest species, distributed from Costa Rica to southern Quebec and Ontario, should be called *A. aurea*, whereas the similar and marginally sympatric ACG rain forest species found in Central America should be called *A. pustulella*. Neotypes are designated for *Phalaena Tinea punctella* Stoll, 1781 and *Deiopeia aurea* Fitch, 1857. *Atteva floridana* has identical barcodes to *A. aurea* and provisionally maintained as a synonym.

Keywords

DNA barcoding, integrative taxonomy, synonymy, *Atteva aurea*, *Atteva pustulella*, ACG, Costa Rica, wing pattern

Introduction

The ailanthus webworm moth is a conspicuous member of eastern North American micromoth assemblages and is commonly recorded in checklists and inventories as *Atteva punctella* (Stoll, 1781) (e.g. Heppner and Duckworth 1983; Ding et al. 2006; http://en.wikipedia.org/wiki/Ailanthus_webworm). The colloquial name refers to its association with the tree-of-heaven (*Ailanthus altissima*, Simaroubaceae), an ornamental introduced to Europe and North America from Asia. First planted in Philadelphia in 1784, the plant is now widely distributed across the United States and considered a serious invasive (Ding et al. 2006). The ailanthus webworm moth is native to the New World and its native hosts are trees in the genus *Simarouba* (Simaroubaceae). It is believed that once the expanding range of the tree-of-heaven reached southern Texas, this moth, presumably already present on native hosts, added this new host and expanded north on it (Becker 2009).

The name *Phalaena* (*Tinea*) *punctella* was recognized as a junior homonym almost immediately after its description but has been retained through several major works (Heppner and Duckworth 1983; Covell 1984; Heppner 1984). The two objective replacement names proposed were *Tinea punctella* Fabricius, 1787, and *Crameria subtilis* Hübner, 1822. The oldest valid name to replace *Phalaena punctella* is *Tinea pustulella* but this remained overlooked until recently (Heppner 2003). Over time seven more nominal taxa were synonymized under *Atteva pustulella*: *aurea* Fitch, 1857 (*Deiopeia*), *compta* Clemens, 1861 (*Poeciloptera*), *compta floridana* Neumoegen, 1891 (*Oeta*), *A. edithella* Busck, 1908, *A. exquisita* Busck, 1912, *A. ergatica* Walsingham, 1914, and *A. microsticta* Walsingham, 1914. Interestingly there were early suspicions that *A. aurea* and *A. pustulella* might represent different species, the former distributed in the United States, the latter in South America, but at the time there was insufficient material to support this view (Walsingham 1897). A recent taxonomic review of New World *Atteva* (Becker 2009) introduced several nomenclatural changes and recognized three separate species within the long-standing concept of *A. pustulella*: *A. pustulella*, *A. aurea*, and *A. floridana*. The separation of *aurea* from *pustulella* introduced by Becker was based on data presented here.

Atteva is the sole genus constituting the subfamily Attevinae within the Yponomeutidae. The group has a pantropical distribution but at least one species *(A. aurea*) now has a range that extends into the temperate zone. No consistent hypotheses regarding the relationships, placement, and ranking of Attevinae have been published but the prevalent view is that they likely form a monophyletic group within the Yponomeutidae (Kyrki 1990; Landry and Landry 1998; Dugdale et al. 1998; Regier et al. 2009).

The authors are currently involved in extensive ongoing campaigns to inventory all Lepidoptera species in North America (Hebert et al. 2009; www.lepbarcoding.org) and in Area de Conservacion Guanacaste (ACG), Costa Rica (Janzen et al. 2005; Janzen et al. 2009; Burns et al. 2007; Burns et al. 2008; Burns et al. 2009; http://janzen.sas.upenn.edu/). It was during the course of these inventories that the problem concerning the identity of *A. pustulella* first came to light. Incorporating DNA barcoding into

inventories has been very effective at uncovering cryptic species (Hebert et al. 2004; Janzen et al. 2005; Janzen et al. 2009; Burns et al. 2009; Smith et al. 2007; Smith et al. 2008; Floyd et al. 2009; Hausman et al. 2009) and revealing, then subsequently correcting, taxonomic issues (e.g. the identity of *Taygetis andromeda* in Janzen et al. 2009). This is the case presented here with the ailanthus webworm moth. When identical barcode sequences were recovered for *A. pustulella* in Ontario and *A. ergatica* in ACG, the initial response was to change all records of *A. ergatica* to *A. pustulella*. *Atteva ergatica* was originally described from Central America and was long thought to be a synonym of *A. pustulella* in North America. However, further sampling revealed two adjacent barcode clusters representing two distinct species within ACG and separable by their DNA barcodes, wing patterns, host plant and ecosystem. Through examination of type material and literature investigation, we discovered like Becker (2009), that the name applied to the North American ailanthus webworm was inappropriate, but also that what had been thought to be intraspecific variation in facies across the ACG dry forest and rain forest ecosystems actually represented two species.

The goal of the present study was to determine the correct names for each *Atteva* species for inclusion into our inventories. However, we also view this study as an example of successful integrative taxonomic efforts. Our conclusions were achieved through examination of *Atteva* type specimens, where available and involved a combined genitalia dissection and DNA extraction procedure (Knolke et al. 2005) and the sequencing of mini-barcodes (Hausman et al. 2009; Rougerie et al. personal communication). Where type specimens have been lost, original illustrations were examined. We provide DNA barcode, morphological and ecological diagnostics for the two closely related species in ACG, formerly united under *A. pustulella* and recently separated again (Becker 2009).

Methods

As part of ongoing inventories in ACG (Janzen et al. 2005; Janzen et al. 2009) and Ontario (Hebert et al. 2009), specimens assigned to the genus *Atteva* were submitted to the Canadian Centre for DNA barcoding at the Biodiversity Institute of Ontario at the University of Guelph for molecular analysis. Full-length (658 bp) DNA barcodes (Hebert et al. 2003; Floyd et al. 2009) were recorded for these specimens with standard protocols (www.dnabarcoding.ca).

Reared wild-caught specimens (see Janzen et al. 2009 for rearing methods) from the ACG caterpillar inventory are indicated by voucher codes of the form YY-SRNP-XXXXX, where the suffix contains 1–5 digits. Light-caught ACG BioLep adult specimens have the same voucher code structure, but have 6 digits in the suffix.

After the discovery that specimens identified as *A. ergatica* in ACG and *A. pustulella* in North America had identical DNA barcodes, an effort was undertaken to examine and sequence relevant type material from national collections as well as more freshly collected specimens (see specimen records in Appendix I: Dataset 1). Following the protocol of Knolke et al. (2005) DNA was extracted from old type specimens during

genitalia dissections for those which still had the abdomen intact, otherwise DNA was extracted from a leg. From these old DNA extracts, barcodes were assembled from six PCR amplicons (Hausman et al. 2009; Rougerie et al. in preparation). Wing-patterns and genitalia preparations were qualitatively examined and compared.

All sequences together with collateral information on the specimens were deposited in BOLD (www.barcodinglife.com) (Ratnasingham and Hebert 2008) in project ATTEV (Atteva of the New World). Sequences were also deposited in GenBank under accession numbers GU013569, GU692470-GU692541, HM034026-HM034136. A maximum parsimony tree was constructed in PAUP (Swofford 1998; using PAUPRat, http://users.iab.uaf.edu/~derek_sikes/software2.htm) to demonstrate the presence of diagnostic nucleotides for each species.

Results and discussion

Identical barcode sequences were recovered from so-called *pustulella* in Ontario and *A. ergatica* in ACG. Further sampling in ACG revealed two adjacent barcode clusters, one comprised of specimens entirely from the ACG rain forest and feeding on new shoot tips of *Simarouba amara* (an exclusively rain forest species) and the other of specimens entirely from ACG dry forest and feeding on new shoot tips of *Simarouba glauca* (an exclusively dry forest species). Once this was realized, it became obvious that these two species could be separated by their forewing colour pattern as well as by their barcodes. Further directed sampling then located the dry forest species feeding on both species of *Simarouba* in the several-km-wide dry forest-rain forest intergrade, in some cases on the same plant of *S. amara* side-by-side with the rain forest species. Yet more sampling further into the rain forest ecosystem (to the east of the dry forest) revealed that the dry forest species has now moved at least 20 km into the ACG rain forest ecosystem of *S. amara*, in open pastures and field edges, and under more xeric conditions than would have been the case were the site still covered with original rain forest. In this circumstance, the rain forest species is at present much more abundant than is the dry forest species.

Our conclusion that the ACG specimens comprise two species is based on concordance (Avise and Ball 1990) between morphological, molecular and ecological characters that are diagnostic (Cracraft 1983) for each population, providing evidence for a hypothesis of genetic isolation. There was no divergence in the genitalia among the species examined. This lack of a genital difference is consistent with previous morphological studies of this group (Becker 2009). Based on congruent wing patterns of the *A. punctella* type image (Figure 2A) and the wings of our rain forest cluster, we conclude that the correct name for the rain forest species is *A. pustulella*, which also fits with its rain forest distribution in the Neotropics (Becker 2009). Based on congruent wing patterns and identical DNA barcodes with the type specimens of *A. ergatica* and *A. edithella* (Figure 1), both synonymized under *A. aurea* (Becker 2009), we conclude that the ACG dry forest species, which extends north to southeastern Canada, should

be called *A. aurea* (Figure 2). The two correct names along with synonyms and diagnostic characteristics are listed below, along with two other *Atteva* species included in our inventories.

Interestingly, *A. aurea* is more proximate in barcode to *A. hysginiella* than *A. punctella* (Table 1; Figure 1). *Atteva hysginiella* is geographically disjunct as a Galapagos Islands endemic (Figure 2), strikingly different in coloration, and uses a different host plant. Although intraspecific distances (Table 1) may seem high within these species compared to values reported in other studies (e.g. Janzen et al. 2009), we observed no relationship between genetic distance and geographic distance or morphological differences (Figure 1). Short sequence lengths obtained from older specimens (see specimen records in additional file 1: Datasheet 1) can make phenetic distances seem larger than if a full barcode sequence (658bp) were available for comparison. This is a problem seen when using percentage phenetic distances but it is clear from the maximum parsimony analysis (Figure 1) and the consensus barcodes shown in Table 1, that each species possesses a cohesive cluster of haplotypes with few polymorphisms, and diagnostic characters are present which separate all species.

Atteva pustulella (Fabricius)

Phalaena Tinea punctella Stoll, 1781: 164. Type locality: Costa Rica by neotype designated here. A primary junior homonym of *Phalaena punctella* Linnaeus, 1761.

Tinea pastulella Fabricius, 1787: 241. Objective replacement name for *Phalaena Tinea punctella* Stoll, 1781. The spelling is a printing error for *pustulella*, as is clearly evident from the description.

Tinea pustulella Fabricius, 1794: 292. Justified emendation of *T. pastulella* Fabricius, 1787.

Lithosia pustulata Fabricius, 1798: 462.

Crameria subtilis Hübner, 1822: 168. Objective replacement name for *Phalaena Tinea punctella* Stoll, 1781.

Forewings. The pattern ranging from Uruguay and Argentina northwards to Costa Rica, consists of thick black outlinings around the white spots and the orange spots reduced, with the antemedial and medial orange fasciae divided into two large blotches each (Figure 3B). No other morphological features, either in colouration, other external characters or genitalia, distinguish this species from *A. aurea*.

Habitat and food plants. *Atteva pustulella* caterpillars (400+) have been found only in the ACG rain forest ecosystem and feeding only on new shoots of *Simarouba amara*. Where the ACG rain forest intergrades with ACG dry forest, to date all caterpillars from *S. amara* have been those of *A. pustulella* (while caterpillars of *A. aurea* have been found on both *S. amara* and *S. glauca* in the intergrade zone) (Figure 2).

Ailanthus glandulosa [=*A. altissima*] in Argentina (Berg 1880: 101), *Castela erecta*, in Saint Croix, Antilles (Walsingham, 1914: 331), *C. peninsularis*, *C. polyandra*, *C.*

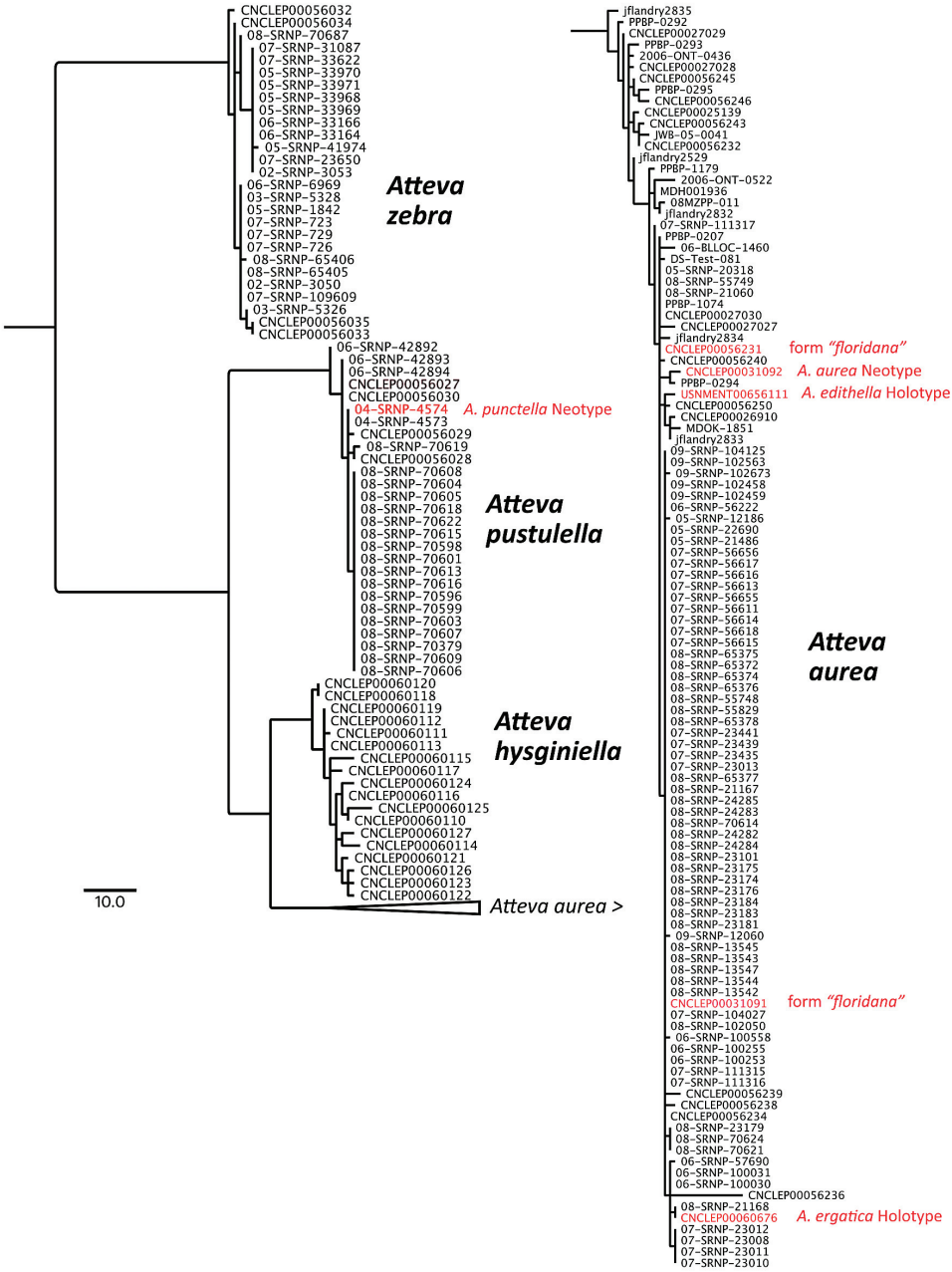

Figure 1. One of 199 most parsimonious trees found by the PAUPRat analysis of Atteva barcodes sequences showing the presence of diagnostic nucleotide differences between the species. The scale bar shows the number of changes. Notable specimens are highlighted in red.

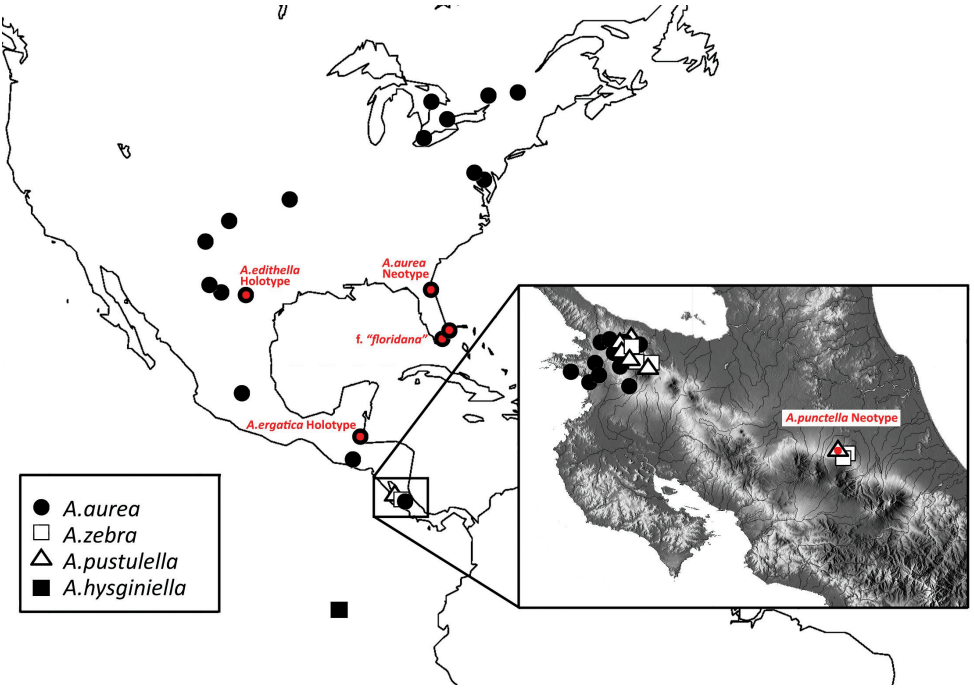

Figure 2. Map showing the distribution of *Atteva* specimens examined as part of this study. Notable specimens are highlighted in red.

emory, in the United States (Powell et al. 1973: 177). These are doubtful records for which either the host or the moth species may be misidentified (Becker 2009).

Distribution. This species ranges from Costa Rica, where it meets *aurea*, southwards to Uruguay and Argentina. It is also present in the Antilles. Becker (2009) reports several specimens from Dominica, Jamaica, Haiti and Martinique in the USNM.

Neotype. *Phalaena Tinea punctella* Stoll, female, here designated, deposited in USNM, labelled: "Voucher: D.H. Janzen & W. Hallwachs | DB: http://janzen.sas.upenn.edu | Area de Conservacion Guanacaste, | COSTA RICA. | 04-SRNP-4574 [white, printed with numbers handwritten]; "LEGS AWAY | FOR DNA" [pale yellow, printed]; genitalia slide [female symbol] | JFL 1680 [pale green, printed]; "NEOTYPE | Phalaena Tinea | punctella | Stoll, 1781 | by J.-F. Landry 2010" [orange, partly printed, partly handwritten]. The specimen is unspread and is missing the right midleg which was removed for DNA extraction, but otherwise is in good condition. Barcode sequence under GenBank accession number HM034113.

Additional specimen data from Janzen's online database: latitude 10.90037º, longitude -85.37254º, elevation 500 m, Anabelle Cordoba leg., collection date 10 Sep 2004 as antepenultimate larval instar feeding on *Simarouba amara*, pupation 16 Sep 2004, adult emergence 25 Sep 2004, ACG voucher code 04-SRNP-4574. Photographs (lateral views of each side) are available in BOLD under the voucher code.

Table 1. DNA barcodes and the nature of intraspecific variation for four species of *Atteva*.

Species	Number of sequences	Number of unique haplotypes	Mean intraspecific distance
Atteva pustullela	23	7	0.19
AACATTATATTTTATTTTTGGAATTTGAAGAGGTATAGTAGGAACTTCTTTA- AGTTTATTAATTCGAGCTGAATTAGGAAATCCTGGTTCTTTAATTGGGAATGAC- CAAATTTATAATACTATTGT**C**ACAGCTCATGCTTTTATTATAATTTTTTTTAT{A,G} GTTATACCTATTATAATTGGAGG{A,G}TTTGGAAATTGACTTGTCCCATTAATATTAG- GAGC**C**CCAGATATAGCCTTTCCCCGAATAAATAA**C**ATAAGTTTTTGATTACTTC- CACCTTCTATTACCCTATTAATTGCAAGAAG**T**ATTGTAGAAAATGGAGCAGGTACAG- GATGAACTGTATACCCACCTTTATCTTC**C**AATATTGCTCATGGAGGTGGTTCAGTT- GATTTAGCTATTTTTTCT**C**T**T**CATTTAGCTGGAATTTCATCTATTTTAGGAGCTATTA- ATTTTATTACTACAATTATTAATATACGAAGTAATGGTATAAATTTTGATCAAATACCTT- TATTTGTTTGAGCTGTAGGAATTACTGCTCTTTTATTATTATTATCTTTACCAGT**A**TTAG- CAGG**G**GCTATTACTATACTTTTAACTGATCGAAATTTAAATACTTCATTTTTTGACCCAG- CAGGTGGTGG{A,G}GATCCAATTTTATACCAACATTTATT**C**			
Atteva aurea	112	44	0.56
AACATTATATTTTATTTTTGGAATTTGA{A,G}{A,G}AGGTATAGTAGGAACTTCTTTA AGTTTATTAATTCGAGCTGAATTAGGAAATCCTGG{C,T}TC{C,T}TTAATTGG{C,T} AATGACCAAATTTACAATACTATTGTTACAGCTCATGCTTTTATTATAATTTTTTT- TATAGTTATACCTATTATAATTGGAGGATT**C**GGAAATTGACTTGTTCCATTA- ATATTAGGAGCTCCAGATATAGCTTTCCC{A,C,T}CGAATAAATAATATAAGTTT{C,T} TGA**C**TACT{C,T}CCACCTTCTATTACCTTATTAATTGCAAGAAGAATTGTAGAAAAT- GGAGCAGGTACAGGATGAACTGTATACCCACCTTTATCATCTAATATTGCT- CACGGAGGTAGTTCAGTTGATTTAGCTATTTTTTCTTTACATTTAGC{C,T} GGAATTTCATCTATTTTAGG{A,G}GCTATTAATTTTATTACTACAATTATTAATATAC- GAAGTAATGGTATAAATTTTGATCAAATACCTTTATTTGTTTGAGCTGTAGGAATTACT- GCTCTTTTATTATTATTATCTTTACCAGTTTTAGC{A,G}GGAGCTATTACTATACTTTTA AC**A**GATCGAAATTTAAATACTTCATTTTTTGACCC{A,G}GC**T**GGTGG{G,T}GG{A,G}{A,G} A{C,T}CCAATTTT{A,G}TA{C,T}CAACATTT{A,G}TTT			
Atteva hysginiella	27	15	0.75
AACATTATATTTTATTTTTGGAATTTGAAGAGGTATAGTAGGAACTTCTTTA- AGTTTATTAATTCGAGCTGAATTAGGAAA{C,T}CC{C,T}GGTTCTTTAATTGG{C,T} AA**C**GATCAAATTTA{C,T}AATACTATTGTTACAGCTCATGCTTTTATTATAATTTTTTT- TATAGTTATACC**A**ATTATAATTGGAGGATTTGG{A,G}AATTGACTTGT{C,T}CCATTAATA TTAGGAGCTCCAGATATAGCCTT{C,T}CCTCG{A,G}ATAAATAATATAAGTTTCTGATTA CTTCCACCTTC{A,T}{A,T}TTACTTTATTAATTGCAAGAAGAATT{G,C}TAGAAAAT{A,G} {A,G}AGCAGG{G,T}ACAGGATGAACTGTATACCCACCTTTATCATCTAATATTGCTCAC{ G,T}G{A,G}GGTAGTTCAGTTGATTTAGCTATTTTTTC{C,T}TTACATTTAGCTGGAATTT CATCTATTTTAGG{A,G}GCTATTAATTTTATTACTACAATTATTAATATACGAAGTAATGG {C,T}ATAAATTTTGATCAAATACCTTTATTTGTTTGAGCTGTAGGAATTACTGCTCTTT- TATTATTATTATCTTTACCAGT{C,T}TTAGCAGGAGCTATTACTATACTTTTAACTGAT CGAAATTTAAATACTTCATTTTT{C,T}GA{C,T}CCAGC{A,G}GGTGG{A,G}GGAGA{C,T} CCAATTTTATA{C,T}CAACATTTATTT			

Species	Number of sequences	Number of unique haplotypes	Mean intraspecific distance
Atteva zebra	18	15	0.39
AACTTTATATTTTATTTTTGGAATTTGAAGAGG{A,G}ATAGTCGGTACCTCATTAA-GATTTTTAATTCGAGCAGAATTAGGTAATCCTGGATTTTTAATTGGAGATGATCAAATT-TATAATACTATTGTAACAGCTCATGCTTTCATTATAATTTTTTTTTAT{A,G}GTTATACCTAT-CATAATTGGAGGATTTGGTAATTGATTAGTTCCTTTAATACTAGGAGCTCCTGATATAG-CATTCCCACGAATAAATAATATAAGTTTTTGATTACTACCCCCATCTCTTACTCTTTTA-ATTTCTAGAAGAATCGTTGAAAATGGAGCAGGAACTGGATGAACAGTTTATCCACCTT-TATCTTCTAATATTGCTCATGGAGGAAGTTCTGTTGATTTAGCTATTTTTTCTTTA-CATTTAGCCGGAATTTCATCTATTTTAGGAGCTATTAATTTTATTACTACAATTAT-TAATATACGAAGTAATGGTATAAATTTTGATCAAATACCTTTATTTGTTTGAGCT-GTAGGTATTACAGCTTTACTTTTATTGTT{A,G}TCATTACCTGTTTTAGC{A,G}GGAGCTATTACTATACTTTTAACTGA{C,T}CG{A,G}AATCTTAATACTTCATTTTTT-GATCCTGCAGGTGGAGGAGACCCAATCCTTTATCAACATTTATTT		

The distance values shown are % Kimura-2-parameter distances as calculated in BOLD. The DNA barcodes for each species is directly below the name and statistics for each species. The bold-face nucleotides highlight those bases that are unique to a species, and the bracketed bases indicate the location and nature of haplotype variants.

Neotype designations. Enquiries at several major institutions (AMNH, ANSP, BMNH, NMNH, NYSM, USNM, ZMUC) failed to locate the type specimens of *A. aurea* and *A. punctella* (=*pustulella*). Similar negative results were indicated by Becker (2009) in his recent taxonomic review of *Atteva*. The primary types of the oldest available names appear to be lost. The evidence brought here strongly supports the occurrence of two distinct species long subsumed under the name *punctella*. The differentiating characters are in forewing coloration, DNA barcodes, larval host plants, and habitats, as described here under each respective species and in the 'Results and Discussion' section. However, wing coloration is the only character that can be used to interpret the old descriptions. The proper application of the two names was enabled retrospectively after differences in life history and barcodes were discovered and superimposed on the differences in forewing pattern.

The original figure of *Atteva punctella* appears on Plate 372 in the fourth volume of Cramer's "*De Uitlandsche Kapellen Asia, Africa en America*" published in Amsterdam in 1780–1782 (copy in the Canadian Agriculture Library, Neatby Building, Ottawa). Following Cramer's death in 1780, the work was completed by his associate Caspar Stoll, who authored the section containing the description of *punctella* (Stoll 1781; ICZN 1958). The original colour illustration of *punctella* shows distinctly the diagnostic thick black lining and reduced orange markings in the forewing characteristic of the rainforest species. Its provenance from Surinam, presumably in the coastal area near or around Paramaribo, in what we deem to have been a primary rainforest area leads us to attribute that name to the rainforest species encountered in ACG. However, the figure in Cramer (Figure 3A) is a very small painting on which watercolours were manually applied on individual copies of the book, so it is not possible to know how accurately

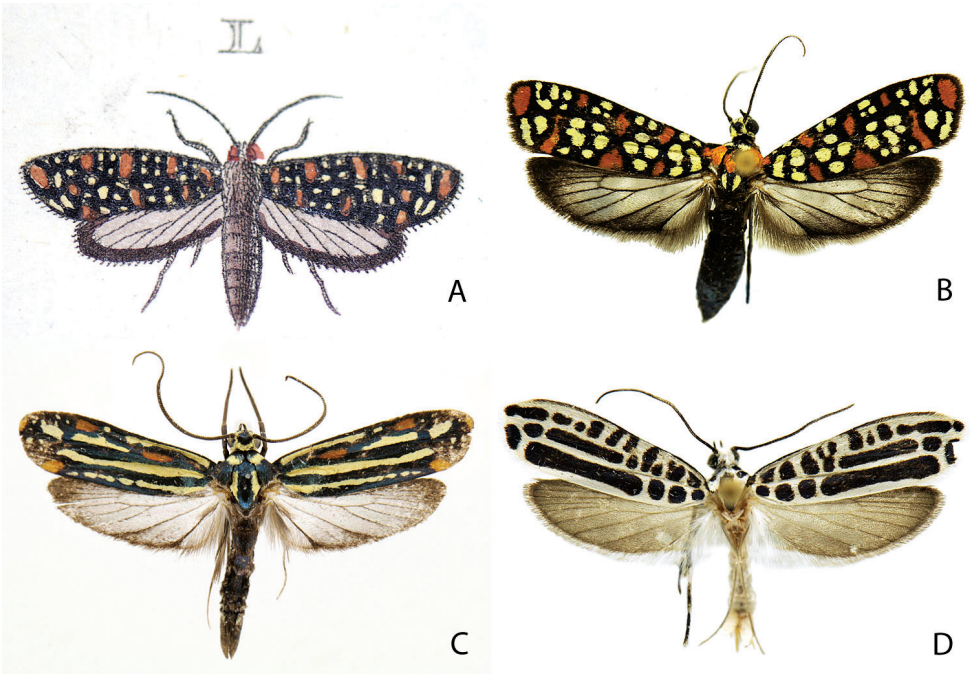

Figure 3. A The original figure of *Atteva punctella* from Plate 372 in Stoll (1781). The illustration is 25 mm wide in the work **B** *Phalaena Tinea punctella* Stoll (= *A. pustulella* Fabricius), specimen USNCN-CLEP00056027 (USNM) **C** *Atteva hysginiella*, specimen CNCLEP00060122 (CNC) **D** *A. zebra*, specimen CNCLEP00056033 (USNM).

the figure represented the specimen on which it was based. It was described from an unspecified number of specimens.

Although we are able to distinguish the two species on forewing pattern, there is enough variation in that character, as well as in larval host and habitat for *A. aurea* to leave open the possibility of misapplication of that name if based on these features alone. On the other hand, the barcodes are unequivocal. Therefore we deem it warranted to designate neotypes for both *punctella* Stoll and *aurea* Fitch in the interest of clarifying the taxonomic status of those nominal species and stabilizing nomenclature. The neotype was selected based on availability of a full barcode without ambiguous bases in addition to matching the forewing pattern of the original illustration of *punctella* and being from a rainforest location. While it would have been desirable to select a specimen from a locality "as nearly as practicable from the original type locality" (ICZN 1999, Art. 75.3.6), none from Surinam was available.

Atteva aurea (Fitch)

Deiopeia aurea Fitch, 1857: 486. Type locality: Marion Co., Florida, USA, by neotype designated below.

Poeciloptera compta Clemens, 1861: 526. Type locality: Texas, USA. Type not located, possibly lost. Synonymized by Berg, 1880: 100 (under *punctella*).

Oeta aurera Stretch, 1873: 240. Misspelling.

Oeta compta var. *floridana* Neumoegen, 1891: 123. Type locality: Upper Indian River, Florida, USA (USNM) [Holotype male examined (Figure 6A); genitalia on slide USNM 15942 prepared by JFL; attempt to recover DNA from abdomen failed]. Synonymized by Heppner and Duckworth, 1983: 26 (under *punctella*). Re-instated as a valid species by Becker (2009). See Remarks below.

Atteva edithella Busck, 1908: 85. Type locality: Maverick County, Texas, USA (J.D. Mitchell collector) (USNM type # 11362) [Holotype female examined (Figure 4A); genitalia on slide USNM 15940 prepared by JFL;DNA recovered from abdomen]. Synonymized by Heppner and Duckworth, 1983: 26 (under *punctella*).

Atteva exquisita Busck, 1912: 86. Type locality: Mobano, Coahuila, MEXICO (R. Muller collector, August) (USNM type # 14528) [Holotype male examined (Figure 4B); genitalia on slide USNM 92745 prepared in 1949]. Synonymized by Heppner and Duckworth, 1983: 26 (under *punctella*).

Atteva ergatica Walsingham, 1914: 328. Type locality: Rio Sarstoon, BELIZE (Blancaneaux collector) (BMNH) [Holotype female examined (Figure 4C); genitalia on slide BMNH-Microlep 31548 prepared by JFL; DNA recovered from abdomen]. Synonymized with *pustulella* by Becker (2009). The type locality is ecotone between dry forest and rain forest, the kind of habitat occupied by ACG *A. aurea* where it overlaps with the distribution of *A. pustulella*.

Atteva microsticta Walsingham, 1914: 330. Type locality: Tehuacan, Puebla, MEXICO (R Muller collector, March 1907) (USNM) [Holotype female examined (Figure 4D); genitalia on slide USNM 92765 prepared in 1940; barcoding attempted using one leg but failed. The species name is spelled "microstigma" on the black-bordered type label in Walsingham's handwriting.] Synonymized with *pustulella* by Becker (2009).

Forewings. The forewings are predominantly orange, with four bands of yellow spots outlined in black. Compared with *pustulella* the orange is more extended and the black outlines surrounding the white spots are thinner (Figure 5A). There is a marked amount of variation in the number and size of pale spots but in spite of this variation *aurea* is clearly separated from *pustulella* (Figures 4–6). See Remarks below.

Habitat and food plants. Caterpillars are commonly encountered in ACG dry forest feeding on *Simarouba glauca* (100+ records) and in the ecotone between dry forest and rain forest, found feeding on both *S. glauca* and *S. amara*. The *aurea* population has extended at least 20 kilometers into ACG rain forest in anthropogenic artificially more xeric conditions, feeding on *S. amara* as well. It is found to the north of Costa Rica in dry forest to semi-desert ecosystems, and north to southeastern Canada, feeding on *Ailanthus altissima*.

Distribution. In North America, distributed wherever its non-native host occurs but vagrant adults are regularly found at its northern limit in eastern Ontario and southwestern Quebec beyond the host range.

Figure 4. A Holotype of *A. edithella*, specimen USNMENT00656111 (USNM) **B** Holotype of *A. exquisita* from Coahuila, Mexico, specimen USNMENT00656112 (USNM) **C** Holotype of *A. ergatica*, specimen CNCLEP00060676 (BMNH); due to markedly drooped wings, two half-photos were joined to show both sides **D** Holotype of *A. microsticta*, specimen USNMENT00656110 (USNM).

Remarks. There is significant variation in forewing coloration as attested by several synonyms. More pronounced variants with reduced forewing black linings (*edithella*, *exquisita*) were described from semi-arid regions of northern Mexico and from Texas. Among barcoded specimens is an aberrant one (CNCLEP00027027 from Maryland) in which the forewing black reticulation failed to develop except asymmetrically in one small area of the right forewing (Figure 5D). That specimen was collected together with many others which displayed the normal coloration (Figure 5B–C). There is evidence that colour features including the relative extent of black reticulation and intensity of orange and pale yellow may be affected by temperature, with the black tending toward reduction at higher temperature (Powell et al. 1973).

Specimens attributable to the *floridana* have barcodes unequivocally belonging to the *aurea* array of specimens (Figure 6C–D). Attempts to barcode the old type specimen of *floridana* failed. We maintain *floridana* as a synonym of *aurea*, consistent with the traditional treatment of other authors (Heppner and Duckworth 1983; Heppner 1984, 2003; Covell 1984), but contrary to Becker (2009). Its status remains debatable, and it is possible for two species to have the same barcode. Barcode sharing is known to occur, albeit infrequently, among some close relatives in Lepidoptera (Hebert et al. 2009). The only evidence for considering *floridana* a separate species is the allegedly distinct forewing colour pattern with reduced spots (Figure 6), which is restricted to southern Florida and seems constant in sympatry with *A. aurea* (Becker 2009), whereas *A. aurea* varies considerably in forewing pattern over its wide geographic range. However, some specimens are nearly intermediate in pattern (Figure 6C) and would be questionably attributed to either *aurea* or form *floridana* from wing pattern alone. Larvae of the *floridana* form feed on *Simarouba glauca* and so overlap in host plant with *aurea*. It was reported

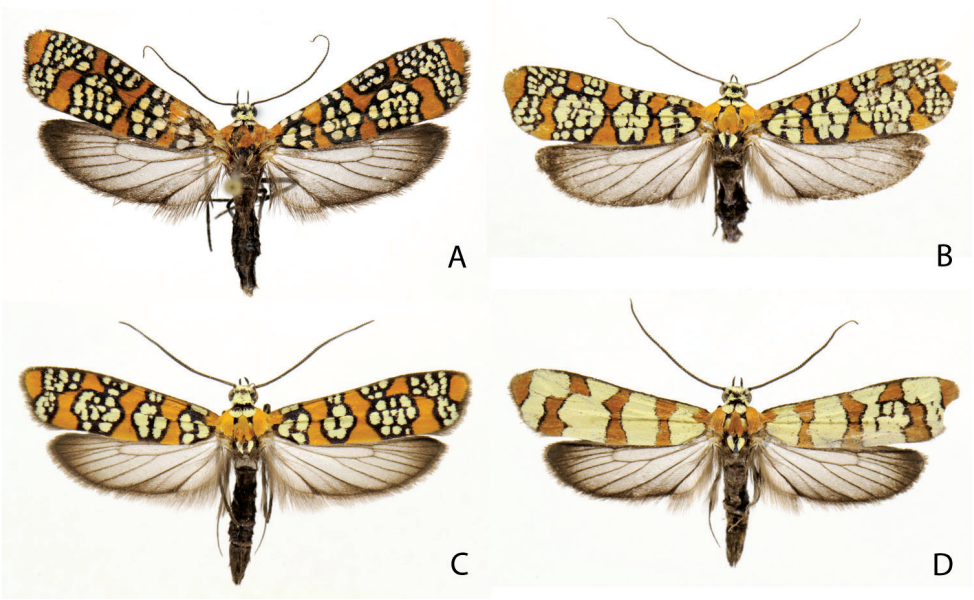

Figure 5. A Neotype of *Deiopeia* [= *Atteva*] *aurea*, specimen CNCLEP00031092 (CNC) **B–C** Barcoded specimens of *A. aurea* from Maryland collected 4 Aug and 31 Jul 2006 respectively (specimens CNCLEP00027030 and CNCLEP00026910, CNC) **D** Aberrant specimen of *A. aurea* from Maryland collected 4 Aug 2006 (specimen CNCLEP00027027, CNC)

that their larvae are distinct (Walsingham 1914: 329; Becker 2009), but this contention seems to be based on incorrectly interpreting a description of the *floridana* larva (Dyar 1897) in which the two species or forms were not actually compared. The alleged difference in larvae remains unverified. Specimens seemingly of the form *floridana* examined by us were all collected early in April and May and it would be interesting to see if the form is seasonally related. Specimens of *A. aurea* were collected at various dates from May to August in the North American part of its range.

Although the type specimen of *A. aurea*, from Savannah, Georgia, appears to be lost, the description matches that of the ailanthus webworm moth and this is the oldest name applicable to North American populations of this *Atteva.* However, the original description is insufficient to determine the thickness of the forewing black lining and relative size of the orange and white spots, and there is no illustration of its type. Our attribution of that name is based on the original type locality which falls within the geographical range of the dry forest species and is far outside the range of the rain forest species. The neotype was selected based on availability of a full barcode without ambiguous bases in addition to matching the original description of the forewing pattern of *A. aurea*. While it would have been desirable to select a specimen from a locality "as nearly as practicable from the original type locality" (ICZN 1999, Art. 75.3.6), none from Georgia was available. The selected neotype is from northern Florida in a region with habitats similar to what occurs around Savannah, Georgia.

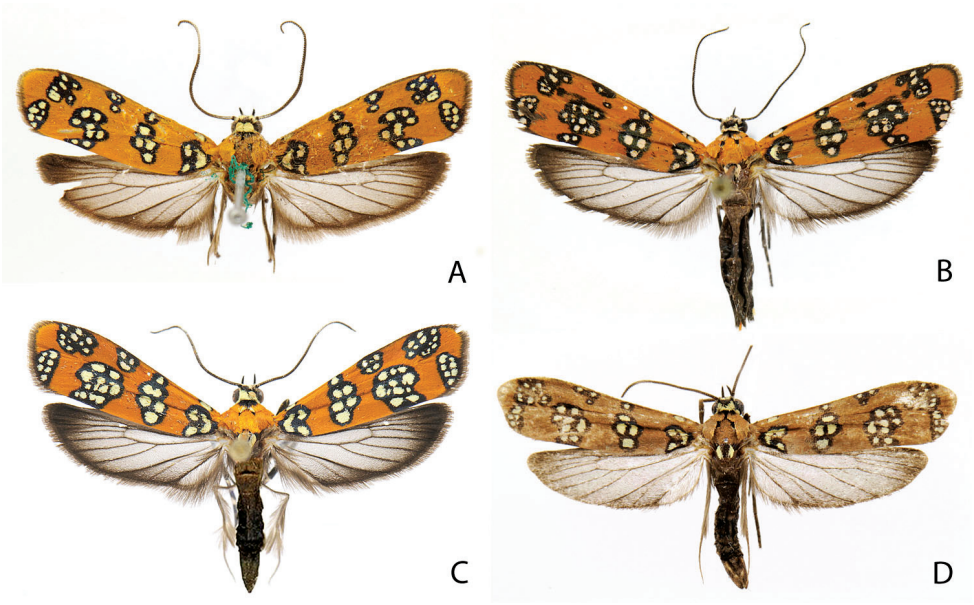

Figure 6.A Holotype of *Oeta* [=*Atteva*] *compta var. floridana*, specimen USNMENT00656113 (USNM) **C–D** Barcoded specimens of *A. aurea* from Dade County, Florida with a wing pattern matching or approaching that of *floridana* (all in CNC) **B** 4 Avr 2007 (CNCLEP00031090) **C** 7 Avr 2007 (CNCLEP00031091) **D** 8 May 1990 (CNCLEP00056231).

Neotype. *Deiopeia aurea* Fitch, female, here designated, deposited in CNC, labelled: "[female symbol]" [printed]; "FLORIDA: Marion Co. | Ocala National Forest | Forest Road 88 | 3.9 Miles SE of SR 316 | Longleaf Pine Sandhills | 7 DEC 2004 MV/BL | TERHUNE S. DICKEL | Database # | CNCLEP | 00031092" [white, printed]; "Barcodes of Life Project | Leg(s) removed | DNA extracted" [blue, printed]; "NEOTYPE | Deiopeia | aurea Fitch, 1857 / by J.-F. Landry 2010" [orange, partly printed, partly handwritten]. The specimen is spread and missing the left fore- and mid-legs which were removed for DNA extraction, but otherwise is in good condition (Figure 5A). Barcode sequence under GenBank accession number HM034047.

Atteva hysginiella (Wallengren, 1861)

Amblothridia hysginiella Wallengren, 1861: 386. Type: PANAMA (NHRS)

Cydosia sylpharis Butler, 1877: [87]. Type: Albermarle Island, Galapagos, ECUADOR (BMNH). Synonymized by Meyrick, 1914: 21.

Atteva monerythyra Meyrick, 1926: 278. Type: Galapagos Islands, ECUADOR (CL Collenette collector, 31st July 1924) (BMNH). Synonymized by Landry and Landry, 1998: 33.

Forewings. The three long, slender yellowish lines on a shiny black background, along the forewings readily distinguish this species from all others in the genus (Figure 3C).

Habitat and food plants. Landry and Landry (1998) gave a detailed description of adults, immatures and life-history, with the caterpillar feeding on *Castela galapageia* (Simaroubaceae).

Distribution. Restricted to the Galapagos Islands (Figure 2). The type locality recorded as being in Panama has its origin in a labeling error (Becker 2009).

Atteva zebra Duckworth

Atteva zebra Duckworth, 1967: 71. Type: Barro Colorado Island, Canal Zone, PANAMA (WD and SS Duckworth collectors, 9th May 1964) (USNM).

Forewings. The zebra pattern makes this species readily distinct from the other species presented here (Figure 3D).

Habitat and food plants. *A. zebra* is the common webworm of shoot tips of *Simarouba amara* saplings and adult trees in ACG rain forest (n = 123) It is more abundant than *A. pustulella*, but may be found on the same individual tree with *A. pustulella* and an occasional *A. aurea* in anthropogenic rain forest habitats. It has never been found on *S. glauca* or in ACG dry forest.

Distribution. Known only from Costa Rica and Panama.

Concluding remarks

This case study demonstrates the value of combining morphological, ecological and DNA barcode information when working with similar species. *Atteva* is an example where seemingly confusing morphological and ecological patterns, can be definitively partitioned in the light of discrete data such as DNA sequences. The integration and synthesis of inventories, each one necessarily regionally focused, is facilitated by DNA barcodes, an efficiently communicated online character system. This was demonstrated by the fact that taxonomic problems surrounding the ailanthus webworm moth persisted in the ACG for 25 years and surfaced only recently. From the starting point of DNA barcode analyses it has been relatively straightforward to reach a taxonomic conclusion by joining taxonomic knowledge in the form of the name-bearing types with ecological and morphological information. The purported difficultly in obtaining barcodes from type material has been viewed as an obstacle to the melding of DNA barcoding information with other taxonomic information. Recent studies (Hausmann et al. 2009), including this one, show that this is not necessarily the case.

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Appendix I

Specimen records (XLS format) of *Atteva* of the New World. File format: Microsoft Excel (1997–2003). doi: 10.3897/zookeys.46.406.app.1.ds.

Citations of the datasets:

Dataset published as Appendix I:

Citation: Wilson JJ et al. (2010) Identity of the ailanthus webworm moth (Lepidoptera: Yponomeutidae), a complex of two species: evidence from DNA barcoding, morphology and ecology. DATASET. File format: Microsoft Excel (1997–2003). doi: 10.3897/zookeys.46.406.app.1.ds. ZooKeys 46: 47–66. doi: 10.3897/zookeys.46.406

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RESEARCH ARTICLE

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The bee genus *Chlerogas* in Bolivia (Hymenoptera, Halictidae)

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Abstract

A new species of *Chlerogas* Vachal (Halictinae, Augochlorini) is described and figured from Bolivia, correcting a past mis-association of sexes for *Chlerogas boliviensis* Brooks & Engel. *Chlerogas aterrimus* **sp. n.** is described from two males and a single female collected in the Department of Santa Cruz (Provinces of Florida and Caballero) and is distinguished from *C. boliviensis*, known only from females, and its other congeners. A revised key to the species of *Chlerogas* is provided along with a new locality record for *C. boliviensis*.

Keywords

Andes, Apoidea, Anthophila, Halictinae, Augochlorini, taxonomy, identification key

Introduction

Bees of the genus *Chlerogas* Vachal occur in the mountains of Colombia and Venezuela, south through Ecuador and Peru, into Bolivia, a distribution in South American perfectly analogous with that of the unrelated, but similarly long-headed, genus

Chlerogella Michener (Engel 2000, Engel 2010). Eleven species have been recognized previously but all are known from a scant few specimens (Brooks and Engel 1999; Engel et al. 2006; Engel and Gonzalez 2009), making this one of the rarer genera of Augochlorini. The genus can be recognized most easily by the combination of its elongate head in males and females (Figs 1–3, 8–10), the reduced number of flagellomeres in males and females, and the pectinate inner metatibial spur in males (Engel 2000).

In February of this year I received for examination three specimens (two females and one male) of *Chlerogas* collected in Santa Cruz Department, Bolivia. While one proved to be a relatively shiny example of a female *C. boliviensis* and the single male a black to dark brown individual clearly conspecific to the male I described in 2009 as the previously unknown male for this same species (Engel 2009a), the third specimen was of a distinctly black to dark brown female. Upon inspection this second female was obviously associated with the male based on observable features and, while close to the female of *C. boliviensis*, was apparently not conspecific. Accordingly, I believe my previous association (Engel 2009a) of a male to *C. boliviensis* was in error. The new series before me demonstrates that the three black *Chlerogas* from Santa Cruz (my original male and the male and female newly revealed) represent an undescribed species, while the actual male of *C. boliviensis* remains elusive and undiscovered. It is ironic that having waited nearly nine years to publish on the specimen I earlier associated with *C. boliviensis* in the hopes of further material becoming available (Engel 2009a), that such specimens which herein help to refine my circumscriptions of these rare species should make their appearance so quickly thereafter. Such a thing highlights the dynamic nature of systematics and that, no matter how patient one may or may not be, at any moment material may become available to revise our understanding and recast our interpretations. I herein provide a description of this species and update the existing key to species in the hope of encouraging those working in the Andean region to seek these rare bees with diligence.

The morphological terminology and format for the descriptions follows that used previously in my studies of *Chlerogas* (Brooks and Engel 1999; Engel et al. 2006; Engel and Gonzalez 2009; Engel 2009a), except following terminological revisions of Engel (2009b). The figures are essentially those of Engel (2009a) with supplements. Table 1 summarizes the information available for the 12 currently recognized species. Abbreviations for collections cited herein are: AMNH, American Museum of Natural History (New York, New York); SEMC, Snow Entomological Collections, Division of Entomology, University of Kansas Natural History Museum (Lawrence, Kansas); NHML, Natural History Museum (London, UK).

Table 1. Revised summary of currently recognized species of *Chlerogas* Vachal (Halictinae, Augochlorini). Known sexes are indicated along with ranges of elevation at which each species has been captured (estimated for three species).

Species	Sex	Elevation	Localities
C. araguaensis Brooks & Engel	♂	2000m	Aragua, Venezuela
C. aterrimus **sp. n.**	♀♂	1800–2030m	Santa Cruz, Bolivia
C. boliviensis Brooks & Engel	♀	2000–2030m	La Paz & Santa Cruz, Bolivia
C. colombiensis Brooks & Engel	♂	– [est. 2100m]	Retiro, Colombia
C. cooperi Engel et al.	♀♂	2100m	Baños, Ecuador
C. cyaneus Brooks & Engel	♀♂	2000–[2400]m	Baeza, Ecuador; central Colombia
C. chlerogas (Vachal)	♀♂	1900m	Callanga & Machu Picchu, Peru
C. hirsutipennis Cockerell	♂	– [est. 2200m]	Huascaray [nr. Lima], Peru
C. nephos Brooks & Engel	♀	– [est. 1500m]	nr. Medellín, Colombia
C. tatamaensis Engel & Gonzalez	♂	2430m	Tatamá, Colombia
C. tiara Brooks & Engel	♀♂	1200m	Tiara, Venezuela
C. townesi Brooks & Engel	♀♂	1510–2400m	Lara, Mérida, & Trujillo, Venezuela

Systematics

Genus *Chlerogas* Vachal

***Chlerogas aterrimus* Engel, sp. n.**
urn:lsid:zoobank.org:act:BA3957B7-CFBF-4402-880E-34F7413912BD
Figs 1–10

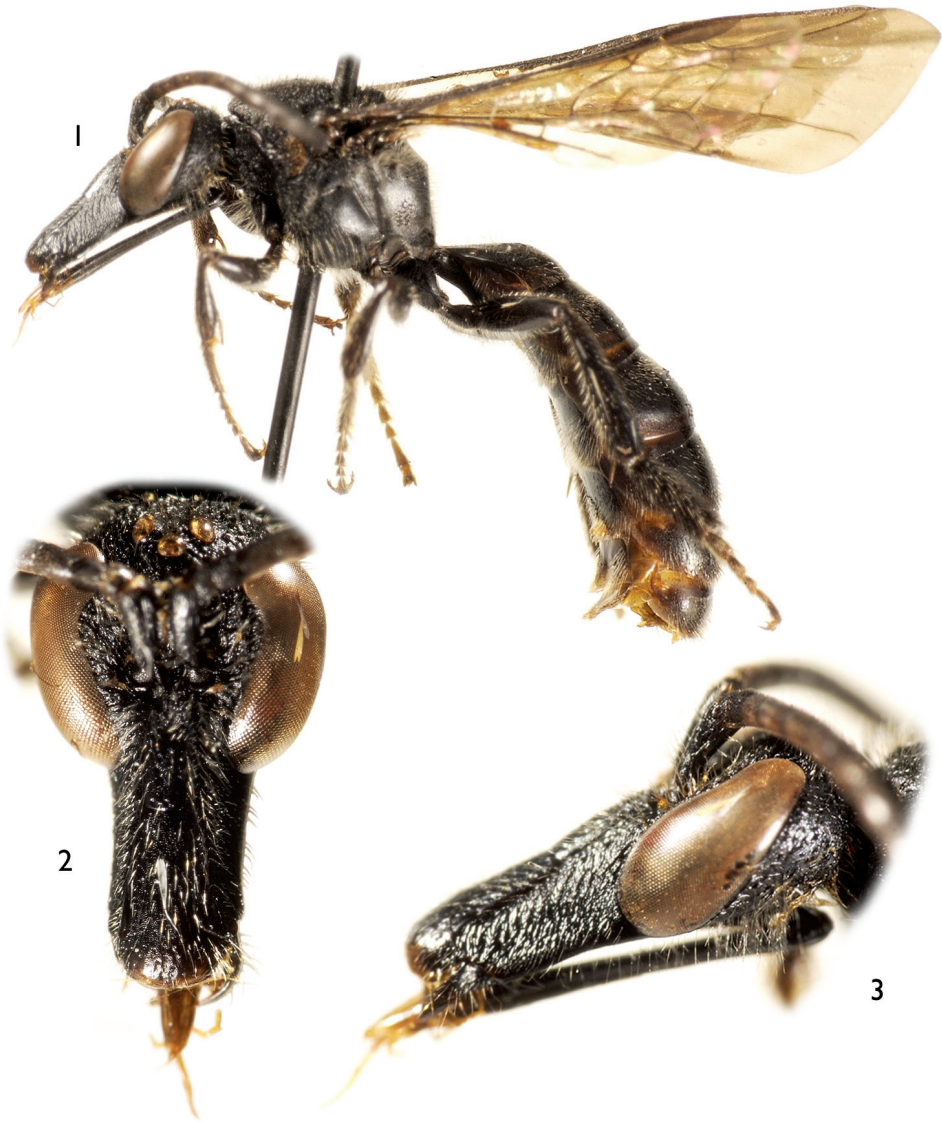
"*Chlerogas boliviensis* Brooks and Engel"; Engel, 2009a: 450 [♂, misidentification].

Holotype. ♂, Bolivia: Santa Cruz [Department], Florida Prov. [Province], 11 km NE Achira, 1800 m, 3-xi-1999 [3 November 1999], C. Porter & L. Stange, cloud forest (SEMC).

Paratypes. 1♂, 1♀, Bolivia: Sta. Cruz Dept. [Santa Cruz Department], Caballero Prov. [Manuel Maria Caballero Province], PN Amboró [Parque Nacional Amboró], 17º50'3"S, 64º23'26"W, 2030 m, X.17–20.2001 [17–20 October 2001], S. Spector & J. Ledezma, flight intercept trap (AMNH).

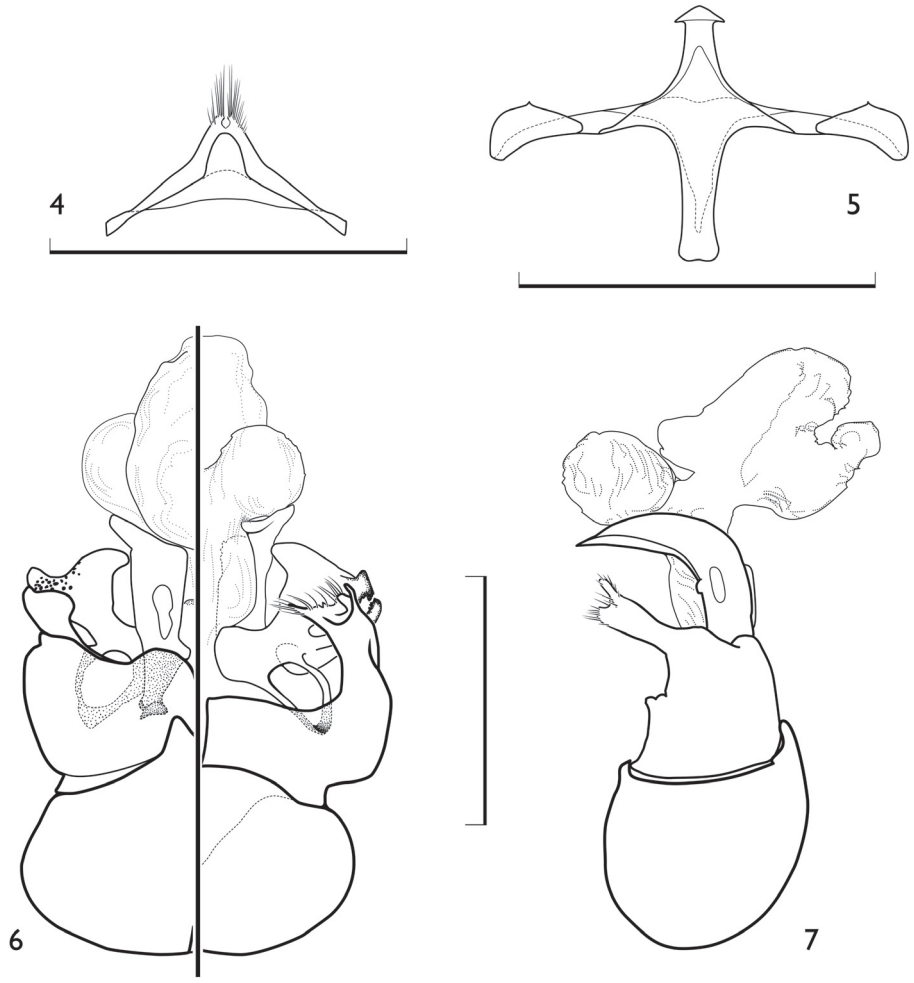
Diagnosis. This species can be most readily recognized for the black to dark brown coloration and the basal area of the propodeum lacking distinct striae reaching to the apical margin. For those species in which males are known the structure of the exposed (*vide infra*) and hidden sterna (Figs 4–5), as well as the genitalia (Figs 6–7) are diagnostic.

Description. *Male*: Total body length 13 mm; forewing length 8.6 mm. Head 1.56 times longer than wide, narrower than mesosoma (length 3.23 mm, width 2.07 mm). Gena nearly as broad as compound eye in profile. Base of clypeus below lower tangent of compound eyes; lower interorbital distance 0.77 mm; upper interorbital



Figures 1–3. Holotype male (SEMC) of *Chlerogas aterrimus* sp. n. **1** Lateral habitus **2** Facial aspect **3** Lateral aspect of head.

distance 0.93 mm; torular-ocular distance 0.20 mm; torular-median ocellar distance 0.65 mm; distance between lateral ocelli 0.23 mm; distance between lateral ocellus and median ocellus 0.08 mm; ocellocular distance 0.22 mm. Scape not reaching to lateral ocellus; pedicel as long as wide; FI as long as wide, about as long as pedicel, length 0.18 mm; remaining flagellomeres (F) longer than wide; FII 0.27 mm in length; FIII–IV each 0.40 mm in length; FV–VII each 0.43 mm in length; FVIII–IX each 0.47 mm in length; FX 0.67 mm in length. Intertegular distance 1.73 mm; mesoscutellum



Figures 4–7. Male terminalia of holotype of *Chlerogas aterrimus* sp. n. (scale bars = 1 mm) **4** Metasomal sternum VII **5** Metasomal sternum VIII **6** Genital capsule and everted endophallus with spicules omitted (left is dorsal aspect, right is ventral aspect) **7** Lateral aspect of genital capsule and endophallus (volsella omitted for clarity, spicules omitted on endophallus).

weakly bituberculate (paramedially). Basal area of propodeum shorter than mesoscutellum, slightly longer than metanotum. Forewing with basal vein distad cu-a by 1.5 times vein width; 1rs-m distad 1m-cu by twice vein width; 2rs-m distad 2m-cu by 7 times vein width; marginal cell length 2.3 mm, width 0.50 mm; first submarginal cell about as long as combined lengths of second and third submarginal cells (as measured along their posterior borders); second submarginal cell slightly narrowed anteriorly; anterior border of second submarginal cell along Rs shorter than anterior border of third submarginal cell; distal hamuli arranged 3-1-3. Inner metatibial spur with 3–4

Figures 8–10. Paratype female (AMNH) of *Chlerogas aterrimus* sp. n. **8** Lateral habitus **9** Facial aspect **10** Lateral aspect of head.

branches, not including apical portion of rachis. Metasomal sternum IV apically with paramedial patches of dense golden setae; metasomal sternum V gently concave medially, with distinct, pale gold setae fringing apical borders except in medial concavity; metasomal sternum VI deeply concave medially, with dark gold to fuscous setae except medially along inner and proximal border of concavity; hidden sterna and genitalia as in figures 4–7.

Clypeus and supraclypeal area colliculate with coarse, shallow punctures separated by a puncture width or less; malar space colliculate; remainder of face with small, well-defined, nearly contiguous punctures, such punctures blending with colliculate integument on vertex; gena and postgena strongly imbricate to colliculate. Pronotum

strongly imbricate; mesoscutum imbricate with small, well-defined punctures separated by less than a puncture width except punctures weak around midline and anteromedially, in such areas punctures separated by a puncture width or slightly more; mesoscutellum imbricate with punctures separated by a puncture width or slightly less, medially between tubercles punctures faint; metanotum faintly imbricate with small punctures separated by a puncture width or less; pleura strongly imbricate to colliculate with coarse, shallow punctures separated by 0.5–2 times a puncture width; lateral and posterior surfaces of propodeum imbricate with scattered small punctures on lateral surfaces, basal area strongly granular to imbricate, without distinct longitudinal striae reaching apical margin, although with exceedingly short, weak strigae at extreme base laterally and sometimes medially. Metasoma weakly imbricate, with scattered minute punctures.

Coloration of head, including scape and pedicel, and mesosoma black to dark brown (Figs 1–3); labrum, mouthparts, antennal flagellum, tegula, legs, and metasoma dark brown. Generally lacking metallic highlights except some scattered, faint, dark metallic blue to purple or coppery highlights on mesosoma and head; wings infumate. Pubescence generally white except as noted above.

Female: As described for the male with the following modifications: Total body length 13.1 mm; forewing length 9.3 mm. Head 1.56 times longer than wide, narrower than mesosoma (length 3.70 mm, width 2.19 mm). Lower interorbital distance 1.04 mm; upper interorbital distance 1.04 mm; torular-ocular distance 0.34 mm; torular-median ocellar distance 0.68 mm; distance between lateral ocelli 0.26 mm; distance between lateral ocellus and median ocellus 0.10 mm; ocellocular distance 0.26 mm. Intertegular distance 1.98 mm; mesoscutellum not tuberculate, faintly bigibbous. Inner metatibial spur with four branches, not including apical portion of rachis.

Pubescence of head and mesosoma intermingled with more erect black setae; setae of scape black; setae of legs black; tergal setae largely fuscous or fuscous golden apically.

Etymology. The specific epithet is based on the Latin term *ater*, meaning "black", and is a reference to the dark coloration of this species relative to its Bolivian congener, *C. boliviensis*.

Chlerogas boliviensis Brooks & Engel

Chlerogas boliviensis Brooks and Engel, 1999: 468 [♀].

"*Chlerogas boliviensis* Brooks and Engel"; Engel, 2009a: 450 [♂, misidentification, actually *C. aterrimus*, sp. n., *vide supra*].

New record. ♀, Bolivia: Sta. Cruz Dept. [Santa Cruz Department], Caballero Prov. [Manuel Maria Caballero Province], PN Amboró [Parque Nacional Amboró], 17º50'3"S, 64º23'26"W, 2030 m, X.17–20.2001 [17–20 October 2001], S. Spector & J. Ledezma, flight intercept trap (AMNH).

Older records. Bolivia: 1♀, La Paz [Department], Chulumani [Sud Yungas Province], cloud forest [17°10'S, 65°19'W], c. 2000 m, 27–29 June 1979, M. Cooper (NHML: holotype); 1♀, La Paz [Department], Chulumani [Sud Yungas Province], cloud forest [17°10'S, 65°19'W], c. 2000 m, 5 April 1979, M. Cooper (NHML: paratype).

Key to species of *Chlerogas*

The key presented here is corrected and updated from that provided by Engel and Gonzalez (2009).

1. Antenna with 10 flagellar articles; medioapical margin of metasomal tergum V entire (males) **2**
– Antenna with nine flagellar articles; medioapical margin of metasomal tergum V with slit (females) **11**
2(1). Metasomal terga metallic green to blue; legs dark brown to black..... **3**
– Metasomal terga and legs largely amber to brown or black, not metallic..... **4**
3(2). Integument between punctures ventrally on mesepisternum polished smooth or very faintly imbricate and shining; basal area of propodeum with weak striae in basal quarter to third (Peru)..... ***C. chlerogas* (Vachal)**
– Integument between punctures ventrally on mesepisternum strongly imbricate and weakly shining; basal area of propodeum with distinct and complete striae (Colombia, Ecuador) ..... ***C. cyaneus* Brooks & Engel**
4(2). Head and mesosoma not metallic, brown to black; leg coloration variable **5**
– Head and mesosoma metallic green to blue, sometimes coloration is rather subdued on mesosoma and face (*i.e.*, *C. tatamaensis*); legs largely amber, never entirely dark brown to black..... **7**
5(4). Legs largely amber; apex of clypeus with transverse amber marking..... **6**
– Legs dark brown to black, without amber podites or markings; apex of clypeus with narrow brown or amber (Bolivia)..... ***C. aterrimus* sp. n.**
6(5). Metasomal sterna I–III brown (Peru) ..... ***C. hirsutipennis* Cockerell**
– Metasomal sterna I–III amber (Ecuador) ..... ***C. cooperi* Engel et al.**
7(4). Metasomal terga I and II amber with transverse dark brown bands **8**
– Metasomal terga I and II entirely amber (Colombia)..... ***C. colombiensis* Brooks & Engel**
8(7). Antennal scape dark brown to black..... **9**
– Antennal scape entirely amber (Venezuela)..... ***C. tiara* Brooks & Engel**
9(8). Apical margin of metasomal sternum V deeply concave **10**
– Apical margin of metasomal sternum V entire (Venezuela)..... ***C. araguaensis* Brooks & Engel**
10(9). Integument around median line of mesoscutum with well defined, small punctures separated by 0.5–1.75 times puncture width and imbricate; metallic green of head and mesosoma brilliant and shining (Venezuela)..... ***C. townesi* Brooks & Engel**

– Integument around median line of mesoscutum granulose and imbricate, with shallow, ill-defined largely contiguous punctures; metallic green of head and mesosoma dark and subdued, particularly on mesosoma where it appears largely as highlights dorsally or as dark metallic green on pleura and propodeum (Colombia) ..... ***C. tatamaensis* Engel & Gonzalez**

11(1). Metasomal terga metallic green to blue, or nearly black with scattered metallic highlights; legs dark brown to black, without amber coloration..... 12

– Metasomal terga without metallic coloration, instead amber and/or brown; legs largely amber, although some with extensive brown markings **15**

12(11). Basal area of propodeum with distinct striae, sometimes only basally..... **13**

– Basal area of propodeum granular, without distinct striae..... **14**

13(12). Basal area of propodeum with distinct and complete striae; integument between punctures ventrally on mesepisternum strongly imbricate and weakly shining; malar space to compound eye length ratio 0.37 (Colombia, Ecuador)..... ***C. cyaneus* Brooks & Engel**

– Basal area of propodeum with weak striae in basal quarter to third; integument between punctures ventrally on mesepisternum polished smooth or very faintly imbricate and shining; malar space to compound eye length ratio 0.48 (Peru)..... ***C. chlerogas* (Vachal)**

14(12). Head and mesosoma dark metallic blue-green or green with blue and purple highlights; metasoma metallic green with scattered to strong blue to purple highlights (Bolivia) ..... ***C. boliviensis* Brooks & Engel**

– Head and mesosoma black to dark brown with faint metallic highlights; metasoma black to dark brown (Bolivia) ..... ***C. aterrimus* sp. n.**

15(11). Face brilliant metallic green or brassy green..... **16**

– Face black or dark brown, with green or gold highlights (Ecuador) .... ***C. cooperi* Engel et al.**

16(15). Mesoscutum with median longitudinal area of dark brown to black, nonmetallic integument, laterally metallic green **17**

– Mesoscutum entirely metallic green (Colombia)..... ***C. nephos* Brooks & Engel**

17(16). Metasomal tergum II almost entirely brown; malar space to compound eye length ratio 0.32 (Venezuela) ..... ***C. tiara* Brooks & Engel**

– Metasomal tergum II entirely amber, or nearly so; malar space to compound eye length ratio 0.41 (Venezuela) ..... ***C. townesi* Brooks & Engel**

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Taxonomic change of two species in the genus *Haploclastus* Simon, 1892 (Araneae, Theraphosidae)

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Abstract

The genus *Haploclastus* is represented by eight species in India. In this paper, we synonymise *Haploclastus robustus* Pocock, 1900 with *H. validus* Pocock, 1899. *H. himalayensis* Tikader, 1977 is transferred to the genus *Chilobrachys* based on a generic character, the presence of enlarged paddle setae on prolateral side of maxillae. We provide additional information on morphometry and photographs of the palp and stridulatory setae that are lacking in the original description.

Keywords

Haploclastus spp., new synonym, transfer, Thrigmopoeinae

Introduction

The genus *Haploclastus* Simon, 1892 of the subfamily Thrigmopoeinae is endemic to India. This genus was established with the description of *H. cervinus* Simon, 1892 from Palni Hills, South India, based on few morphological characters. Later, three more species, *H. nilgirinus* Pocock, 1899, *H. kayi* Gravely, 1915, and *H. tenebrosus*

Gravely, 1935 were described in this genus (Pocock 1899, Gravely 1915, 1935). Raven (1985) synonymised the genus *Phlogiodes* Pocock, 1899 with *Haploclastus* based on the presence and the arrangement of stridulatory setae. With the inclusion of four species of *Phlogiodes*, the genus *Haploclastus* comprises eight species which are restricted to India.

Abbreviations

RJR Robert J. Raven
MCG Museo Civico di Storia Naturale "Giacomo Doria", Genoa, Italy
NHM Natural History Museum, London
MS Manju Siliwal
ZSI Zoological Survey of India, Kolkata

Haploclastus Simon, 1892

Haploclastus Simon 1892, p.152. Type species by original designation, female, *Haploclastus cervinus* Simon 1892 (type in MCG, examined by RJR).
Phlogiodes Pocock 1899, p. 748. Type species by original designation, male, *Phlogiodes validus* Pocock 1899. First synonymised by Raven 1985. (type in NHM, examined by RJR).

Haploclastus validus Pocock, 1899

Phlogiodes validus Pocock, 1899, p. 748; 1900, p. 179.
Phlogiodes robustus Pocock, 1899, p. 748; 1900, p. 180. New synonymy.

Remarks. The species *Haploclastus validus* and *H. robustus* that were previously under *Phlogiodes* were first described by Pocock (1899) from two specimens at the Natural History Museum, London. These specimens, a male and female were originally collected by Phipson from Matheran, presently in the State of Maharashtra, India. Pocock (1899) described the male as *H. validus* and female as *H. robustus*. Another female specimen collected by Master from Jauli, Satara district, Maharashtra (about 150 km from Matheran) was also identified by Pocock (1900) as *H. robustus*. These species descriptions do not provide any details on key characters distinguishing the two species, and only make mention of those characters that are attributable to sexual dimorphism, which is now well established in theraphosid spiders (e.g. Dippenaar-Schoeman 2002). In September 2009 one of us (RJR) visited NHM, and examined *H. robustus* but could

not locate the type of *H. validus* and we assume that specimen is either lost or is deposited in some other European museum. Thereby, we synonymise *H.validus* with *H. robustus* based on the original description (Pocock 1899).

***Haploclastus satyanus* (Barman, 1978)**

Phlogiodes satyanus Barman 1978: 168.

Remarks. The *Haploclastus satyanus* (Barman 1978) was originally described under *Phlogiodes* was also based on a single specimen originally described under *Phlogiodes* was also based on a single specimen. The type specimen was deposited at Zoological Survey of India (ZSI), Kolkata. During a visit to ZSI, Kolkata in September 2007, MS could not locate the type specimen of *H. satyanus*, it was possibly misplaced in the museum or never deposited there by the describing author (Barman 1978).

***Chilobrachys himalayensis* (Tikader, 1977), comb. n.**
Figs. 1–4

Phlogiodes himalayensis. Tikader 1977: 317, f. 36–38; Brignoli 1983: 139.
Haploclastus himalayensis Raven 1985: 157

Material examined. *Type material:* holotype, male, Birch Hill, Darjeeling, Eastern Himalaya, West Bengal, 22-iv-1974, coll. Bijan Biswas, registration number not given, Zoological Survey of India, Kolkata.

Additional information. All measurements in mm. Total length 34. Carapace 17.0 long, 15.0 wide. Legs (femur, patella, tibia, metatarsus, tarsus, total): I: 17.0, 8.0, 18.0, 11.0, 8.0, 62.0. II: 14.0, 7.0, 12.0, 10.0, 8.0, 51. III: 12.0, 7.0, 10.0, 11.0, 8.0, 48.0. IV: 17.0, 7.0, 13.0, 16.0, 8.0, 61.0. Palp: 12.0, 6.0, 10.0,–, 3.0, 31.0. Eye diameter: AME 0.6, PME 0.4, ALE 0.8, PLE 0.7; distance between eyes: AME-AME 0.5, PME-PME 2.0, PME-PLE 0.1, AME-ALE 0.4. Sternum 8.0 long and 7.0 wide, oval, three pairs of sternal sigilla. Twelve promarginal chelicerae teeth. Abdomen 17.0 long, 10.0 wide. Spinnerets: both pairs digitiform, posterior median spinnerets 1.5 long; posterior lateral spinnerets 8.0 long (3.0 basal, 2.0 medial, 3.0 apical). Maxillary lyra and cheliceral spinules as in figs 1–2; male palpal organ as in figs 3–4.

Remarks. On examining the stridulatory setae of the type specimen of *H. himalayensis*, it was found that maxillary lyra had enlarged paddle setae on prolateral side of the maxillae (Fig. 1) and thorn setae on retrolateral side of the chelicerae (Fig. 2), which is a characteristic feature of the genus *Chilobrachys* Karsch, 1891 rather than the genus *Haploclastus* Simon 1892, where the maxillary lyra consists of a transverse row of spinules on the prolateral face of the maxillae (Fig. 5). Therefore, *Haploclastus hima-*

Figures 1–5. *Chilobrachys himalayensis* (Tikader, 1977), male. **1** Prolateral side of left maxilla showing maxillary lyra **2** Retrolateral side of left chelicerae showing spinules **3** Dorsolateral view of left male palp **4** Ventrolateral side of left male palp **5** *Haploclastus kayi* Gravely, 1915, prolateral side of left maxillae showing maxillary lyra.

layensis is transferred here to the genus *Chilobrachys* based on the stridulatory structure on maxillae and chelicerae.

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