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Neotropical species of *Meteorus* Haliday (Hymenoptera: Braconidae: Meteorinae) parasitizing Arctiinae (Lepidoptera: Noctuoidea: Erebidae)

HELMUTH AGUIRRE[1] & SCOTT R. SHAW[2]
U.W. Insect Museum, Department of Ecosystem Science & Management (3354), University of Wyoming, 1000 East University Avenue, Laramie, Wyoming 82071, U.S.A. E-mail: [1]haguirre@uwyo.edu, [2]braconid@uwyo.edu

Abstract

Three new species of *Meteorus* parasitoids of Arctiinae are described: *Meteorus anuae* **n. sp.**, *M. juliae* **n. sp.** and *M. mirandae* **n. sp.** The first biological record for *M. cecavorum* Aguirre & Shaw as well as its cocoon description is reported. A comprehensive key for the Neotropical *Meteorus* attacking Arctiinae is provided. A total of nine *Meteorus* species have been reared from Arctiinae in the Neotropical Region. Six of them are gregarious and three solitary. The biological information about host and food plants concurs with the hypothesis of specialist parasitoids preferring "nasty" caterpillars.

Key words: Caterpillar, gregarious, solitary, generalist, specialist, host plant, Andean forest

Introduction

The Ecuadorian Andean Forest is one of the hot spots for the Arctiinae moth richness (Hilt & Fiedler 2005), and their relevance is far more than the mere number of species. They display a wide spectrum of mechanisms to avoid or defeat their natural enemies: chemical sequestration from feeding on toxic plants, dense stiff setae, aposematic colors, sudden and fast movements to curl up the body, drop to the ground or get into the dense vegetation, group warning behavior and defecating upon themselves (Wagner 2009) are just a selection of their complex defensive repertoire. Such characteristics set them up as a key group in complex trophic interactions. Parasitoid wasps utilizing these caterpillars as hosts have to deal with this arsenal of strategies. The most common parasitoids of arctiines in the Eastern Ecuador are members of the families Braconidae, Ichneumonidae, Eulophidae (Hymenoptera) and Tachinidae (Diptera) (Rab Green *et al*. 2011). Among the Braconidae the genera *Aleiodes* Wesmael*, Apanteles* Foerster and *Meteorus* Haliday are the most commonly reared (Wagner 2009).

Three hundred twenty six species of the genus *Meteorus* have been described worldwide (Yu 2012; Jones & Shaw 2012; Stigenberg & Ronquist 2011). Sixty-two are reported from the Neotropical region; biological records are available for 28, and all of them develop as koinobiont endoparasitoids of Lepidoptera. From these, six have been reared from caterpillars of the subfamily Arctiinae: *Meteorus arizonensis* Muesebeck, *M. laphygmae* Viereck, *M. margarita* Jones, *M. oreo* Jones, *M. porcatus* Jones and *M. quasifabatus* Jones. *Meteorus* species feeding on these caterpillars seem to be more prevalent at elevations above 2000 m (typical for Andean cloud forests) than in lowland and wet forest since the revisionary work of Zitani *et al*. (1998), based on a considerable percentage of samples below this elevation, mainly from Area de Conservación Guanacaste (Janzen & Hallwachs 2013), did not record any of them from Costa Rica, but Jones & Shaw (2012) described *M. margarita, M. oreo*, *M. porcatus* and *M. quasifabatus* from the Ecuadorian Andean Forest of Yanayacu, and Aguirre *et al.* (2011) described *M. cecavorum* from an Andean forests at Sierra Nevada de Santa Marta National Natural Park at the North of Colombia.

This paper describes three new species of *Meteorus*, provides the first biological record of *M. cecavorum* as well as its expanded distribution toward the Ecuadorian Andes, and presents a concise key for the Neotropical *Meteorus* species parasitoids of Arctiinae caterpillars.

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Materials and methods

Taxonomy. Morphological terminology follows Huddleston (1980), Sharkey & Wharton (1997) and Zitani *et al*. (1998). For explanative illustrations consult Aguirre *et al*. (2011). Sclerite surface sculpturing terminology follows Harris (1979). To consult color related terminology, refer to Nichols (1989). Metasomal tergites were referred as T1, T2, T3 and so on. The specimens were measured using a Leica M80 stereomicroscope with micrometer on a 10x ocular. Images were captured with a Leica M205 C stereomicroscope with digital Leica DFC295 camera kit and processed with Leica Application Suite Version 3.8.0 auto-montage software. Descriptions were made with the DELTA software (Dallwitz 1974, 1980). The software version for windows 8 was downloaded from http://code.google.com/p/open-delta/. Holotypes and paratypes are deposited at the University of Wyoming Insect Museum (UWIM).

Biology. The caterpillars were collected during the "Caterpillars and Parasitoids of the Eastern Andes of Ecuador" project (Dyer *et al*. 2012) based at the Yanayacu Biological Station and Center for Creative Studies (00°35.9'S 77°53.4'W, elevation 2163 m). Yanayacu is categorized as tropical montane moist forest based on Holdridge (1967). Eighty percent of the land around the station comprises primary forest; the remaining land is abandoned cattle pasture (Greeney 2012). Details about the rearing techniques are provided in Shaw & Jones (2009) and Jones & Shaw (2012).

Results

Key for the Neotropical species of the genus *Meteorus* parasitoids of caterpillars of Arctiinae
(Lepidoptera: Noctuoidea: Erebidae)

1. Notauli deeply impressed and distinct (Fig 30) 2
- Notauli shallow and not distinct (Fig. 7). 3
2(1). Ventral borders of first tergite joined completely along anterior ½ of segment, pronotum orange, wings hyaline . . . . . *M. mirandae* **n. sp.** (Figs. 19–22)
- Ventral borders of first tergite separated basally and joined apically, pronotum black, wings infuscated. . . . . *M. oreo* Jones (Figs. 29 and 30)
3(1). Occipital carina incomplete dorsomedially. 4
- Occipital carina complete dorsomedially 5
4(3). Mesonotal lobes black-dark brown; notauli, scutellum and area between lobes, yellow; mesopleuron laterally yellow, ventrally dark brown. . . . . *M. juliae* **n. sp.** (Figs. 13–16)
- Mesonotal lobes and mesopleuron totally yellow. 6
5(3). Propodeum orange or yellow 7
- Propodeum black-dark brown or ferruginous 8
6(4). Vein m-cu of forewing antefurcal, head height 1.4–1.5 x eye height, ovipositor length 1.7–1.8 x first tergite length. . . . . *M. margarita* Jones (Fig. 28)
- Vein m-cu of forewing interstitial, head height 1.6–1.7 x eye height, ovipositor length 2–2.2 x first tergite length . . . . . *M. quasifabatus* Jones (Fig. 32)
7(5). Mandibles twisted, temple length 0.3–0.5 x eye length in dorsal view, ocellus ocular distance 0.8–1.2 x ocellar diameter . . . . . *M. laphygmae* Viereck (Fig. 27)
- Mandibles moderately twisted, temple length 0.6–0.7 x eye length in dorsal view, ocellus ocular distance 1.4 x ocellar diameter . . . . . *M. porcatus* Jones (Fig. 31)
8(5). Tarsal claw simple, longitudinal and transversal carinae on propodeum present . . . *M cecavorum* Aguirre & Shaw (Figs. 5–8)
- Tarsal claw with a large lobe, longitudinal and transversal carinae on propodeum absent. 9
9(8). Pronotum, mesonotum, mesopleuron and metapleuron mostly ferruginous. . . . . *M. arizonensis* Muesebeck (Fig. 26)
- Pronotum dorsally black, ventrally yellow; mesonotum mostly black-dark brown; mesopleuron and metapleuron mostly yellow. . . . . *M. anuae* **n. sp.** (Figs. 1–4)

Meteorus anuae Aguirre & Shaw n. sp.
(Figs. 1–4)

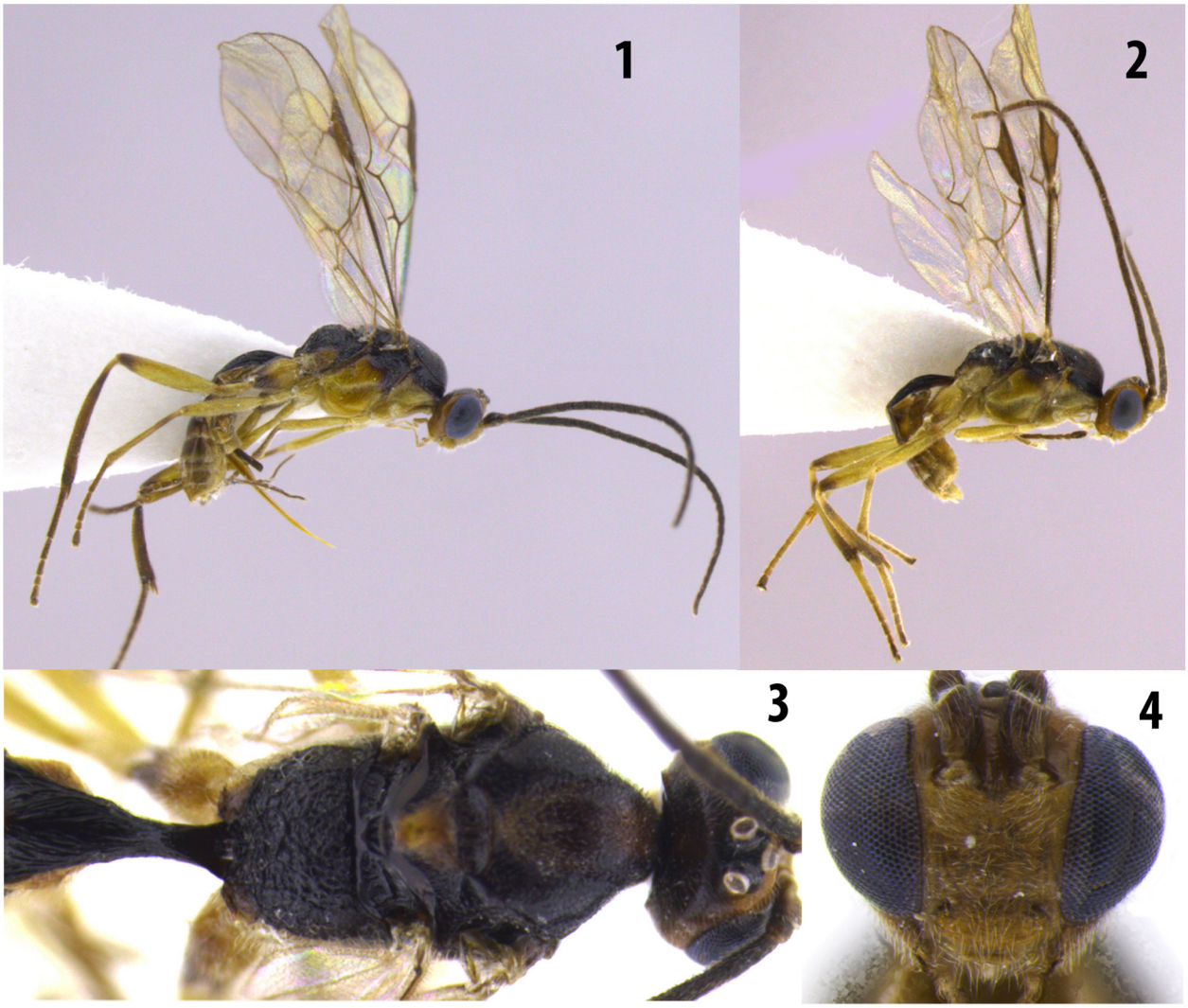
Diagnosis. Mandibles twisted, occipital carina complete, notauli not distinctive, mesonotum mostly black-dark brown, pronotum dorsally black and ventrally yellow, propodeum aerolate-rugose, tarsal claw with large lobe, vein

m-cu of forewing antefurcal, propodeum aerolate-rugose, dorsope and laterope absent, T1 totally black, ventral borders of first tergite joined completely along 1/2 of segment.

Body color. Antenna dark brown; annulus absent; head orange except vertex, occiput and area between ocelli dark brown; propleuron orange-yellow; pronotum dorsally black, ventrally yellow; mesonotum black-dark brown except a faint patch on the anterior part of the median mesonotal lobe and scutellum light brown; mesopleuron yellow except the area close to the tegula dark brown; metapleuron yellow; propodeum black-dark brown; prothoracic legs yellow except tarsus light brown; mesothoracic legs with coxa, trochanter, trochantellus, femur and tibia yellow; tarsus light brown; metathoracic legs with coxa yellow basally and brown apically, trochanter and trochantellus yellow, femur yellow except brown apically, tibia and tarsus brown; T1 black; T2–T3 black except a small patch near the anterior border of T2; T4 dark brown basally and yellow apically; remaining terga yellow; sterna yellow; wings hyaline.

Body length. 4 mm.

Head. Antenna with 29 flagellomeres; flagellar length/width ratios as follows: F1 = 3, F2 = 2.6, F3 = 2.4, F 27 = 1.7, F 28 = 1.7. F 29 = 2.7; head 1.2 x wider than high; occipital carina complete; ocelli ocular distance 0.8 x ocellar diameter; head height 1.4 x eye height; temples length 0.6 x eyes length in dorsal view; vertex in dorsal view not descending vertically behind the lateral ocelli; frons smooth and polished; maximum face width 1.2 x minimum face width; face strigulate; minimum face width equal to clypeus width; clypeus strigulate; malar space lenght 0.5 x mandible width basally; mandibles twisted.



FIGURES 1–4. *M. anuae* **n. sp.** 1) Female, habitus lateral view, 2) male, habitus lateral view, 3) female, habitus dorsal view, 4) female, head in frontal view.

Mesosoma. Pronotum in lateral view carinate and rugose; propleuron smooth; notauli not distinctive and rugose; mesonotal lobes not well defined; central lobe of mesoscutum puncticulate; scutellar furrow with five distinctive carinae; mesopleuron smooth and polished; sternaulus long, narrow and rugose; metapleuron rugulose; propodeum aerolate-rugose; longitudinal and transversal carinae on propodeum absent; median depression on propodeum absent.

Legs. Hind coxa strigate; tarsal claw with large lobe.

Wings. Wing length 3.7 mm; second submarginal cell of forewing not strongly narrowed anteriorly; length of vein r 0.9 x length of 3Rsa; length of vein 3RSa equal to length of rm; length of vein m-cu of forewing antefurcal; length of vein 1M 1.3 x length of cu-a; length of vein 1M 0.9 x length of 1r-m.

Metasoma. Dorsope and laterope absent; ventral borders of first tergite joined completely along 1/2 of segment; first tergite with costae parallel; ovipositor 1.6 x longer than first tergite; ovipositor shape thickened basally and sinuous.

Cocoon. Unknown.

Female variation. Body length 3.5-4 mm; maximum face width 1.1–1.2 x minimum face width; ocelli ocular distance 0.8–1 x ocellar diameter; vein r 0.6–0.9 x length of 3Rsa; vein 3RSa 0.9–1 x length of rm; ovipositor 1.6–1.7 x longer than first tergite.

Male variation. Head orange except area between ocelli black; propleuron completely yellow; prothoracic legs yellow; mesothoracic legs yellow; T2–T4 brown laterally and yellow medially, T5–T8 yellow or light brown; minimum face width 1.2 x clypeus width; malar space length 0.7 x mandible width basally.

Comments. *M. anuae* resembles *M. juliae* in having the following combination of characters: mandibles twisted, notauli not distinctive, propodeum aerolate rugose, tarsal with large lobe, dorsope and laterope absent, and ventral borders of first tergite joined completely along ½ of segment. However, *M. anuae* differs from *M. juliae* by having vertex and occiput dark brown (orange in *M. juliae*), pronotum dorsally black (completely yellow in *M. juliae*), mesopleuron yellow ventrally (black-dark brown in *M. juliae*), antenna with 29 flagellomeres (31–32 in *M. juliae*), occipital carina complete and vein m-cu of forewing antefurcal (intersticial in *M. juliae*).

Holotype. Female (point mounted) **ECUADOR, Napo** Province, Yanayacu Biological Station, S 00°35.9' W 77°53.4', 2163 m, collected 3 June 2010 as cocoon, host: larva of Arctiinae on *Boehmeria pavonni* Wedd. (Urticaceae), parasitoid emerged 24 June 2010, YY 48650 (rearing code). Deposited at UWIM.

Paratypes. Seven females and seven males, same data as the holotype. Deposited at UWIM.

Distribution. ECUADOR, Napo Province, Yanayacu Biological Station, High Andean Cloud Forest, 2163 m.

Biology. Reared from cocoons associated with an arctiine larva on *Boehmeria pavonni* (Urticaceae). Based on the collecting and emergence dates, the duration of the pupal stage is 21 days.

Etymology. This species is named after our entomologist colleague Anu Veijalainen whose research has centered on the overwhelming diversity and biogeography of Ichneumonidae of Peru.

***Meteorus cecavorum* Aguirre & Shaw 2011**
(Figs. 5–8)

Diagnosis. Mandible strongly twisted; occipital carina complete; wings hyaline; propodeum carinate-rugose; hind coxa strigate; tarsal claw simple; dorsopes and lateropes absent; ventral borders of first tergite joined completely along basal 1⁄2 of segment; short ovipositor; body mostly black-dark brown.

Cocoon (Figs. 11–12). Length 4.5 mm; width 2 mm; brown with cap's apex silver; oval-shape, densely wrapped by silk, anterior end rounded, posterior end nipple-shaped, emergence hole border neat; 23 cocoons attached by their individual threads to an axial and thicker rope-like thread.

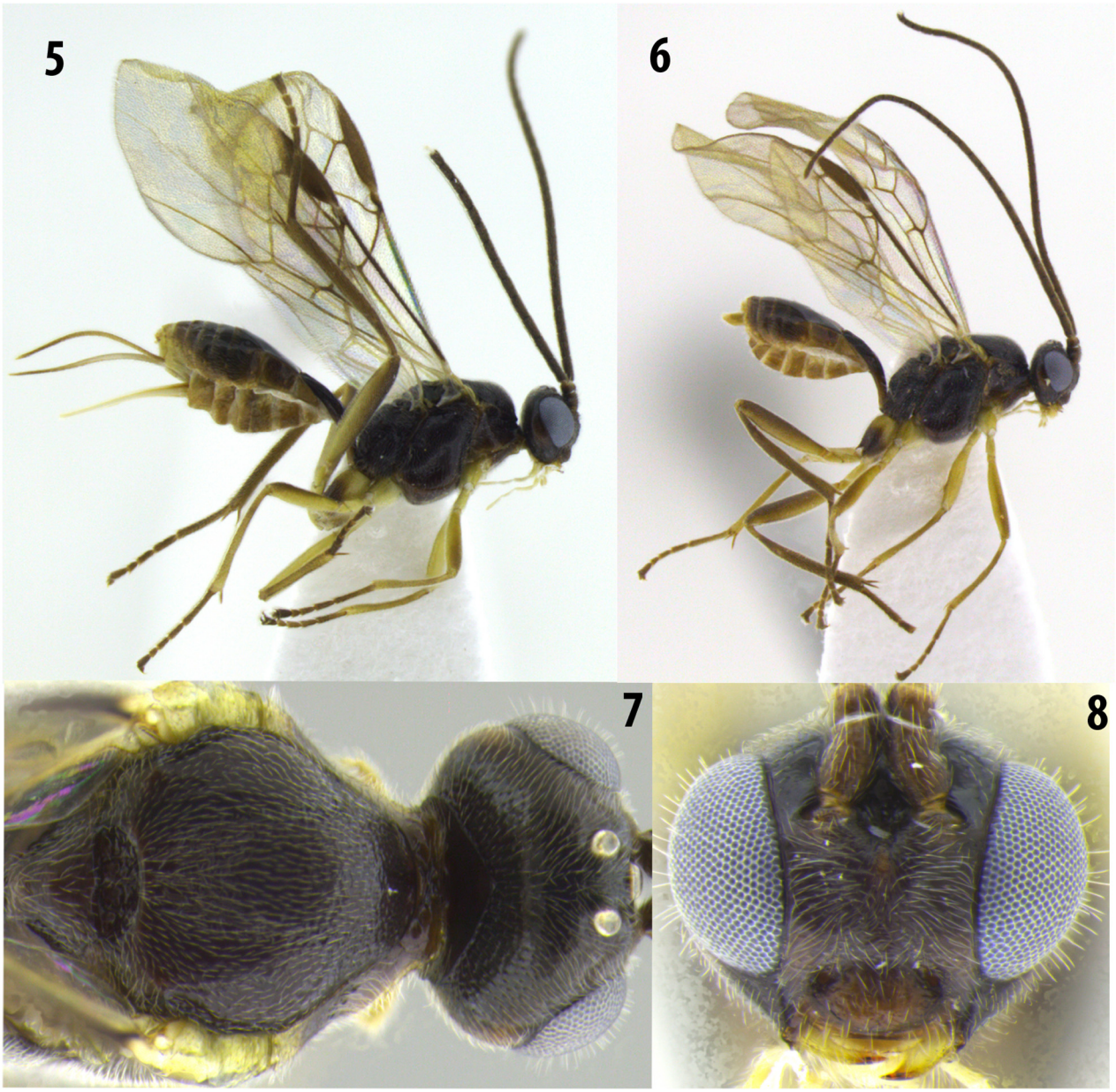
Description of the male. Body length 4.2–4.5 mm; antenna with 29–31 flagellomeres; ocelli ocular distance 1.2–1.6 x ocellar diameter; head height 1.5–1.6 x eye height; temples length 0.6–0.7 x eyes length in dorsal view; frons rugulose or smooth and polished; minimum face width 1.2–1.5 x clypeus width; malar space length 0.8–1.2 x mandible width basally; central lobe of mesoscutum densely punctate or coarsely rugulose; scutellar furrow with three or four carinae; median depression weakly present or absent; length of vein r 0.5–0.6 x length of 3Rsa; length of vein 3RSa 0.8–0.9 x length of rm; vein m-cu antefurcal, postfurcal or intersticial; length of vein 1M 1.2–1.4 x length of cu-a; length of vein 1M 1.1–1.3 x length of 1r-m; first tergite with costae parallel or with costae

convergent. The original description was based just on females. Except for the obvious lacks of an ovipositor, there is no significant difference between males and females.

Comments. *M. cecavorum* is morphologically close to *M. coffeatus* Zitani 1998, but differs in having mandibles twisted (mandibles moderately twisted in *M. coffeatus*), notauli not distinct and rugose (notauli distinct and linear in *M. coffeatus*), hind coxa strigate (punctate and polished in *M. coffeatus*), ventral borders of first tergite joined completely along basal 1⁄2 of segment (ventral borders of first tergite separated basally, joined apically in *M. coffeatus*).

Distribution. *M. cecavorum* was previously recorded from Colombia, Magdalena Department, Sierra Nevada de Santa Marta National Natural Park, at subandean and andean wet forests, 1700–2200 m altitude. The new record from Yanayacu, at the Napo province of Ecuador, seems to indicate a distribution across to Andean cloud forests.

Biology (Figs. 9–10). Reared from an Arctiinae third instar larva feeding on *Passiflora* sp. (Passifloraceae).



FIGURES 5–8. *M. cecavorum*. 5) Female, habitus lateral view, 6) male, habitus lateral view, 7) female, mesonotum and head dorsal view, 8) female, head frontal view.

FIGURES 9–12. 9 and 10) Arctiinae 3th instar larva, 11) cocoons, 12) cocoon close up.

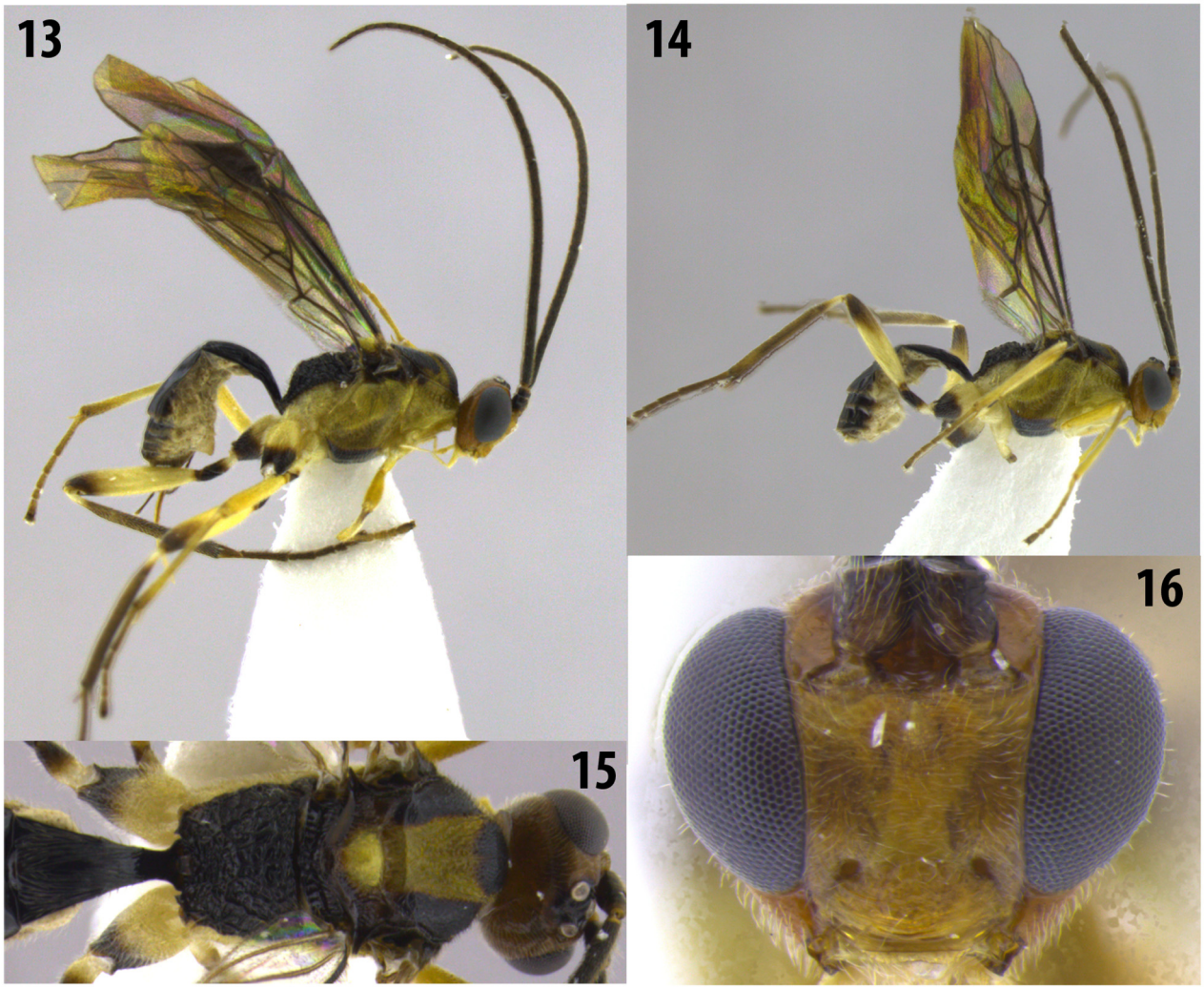
Material examined. 1 female, 2 males, **ECUADOR, Napo** Province, Yanayacu Biological Station, S 00°35.9' W 77°53.4', 2163 m, Camino a Sierra Azul, collected 23 April 2009 as 3th instar larva parasitoid of Arctiinae on *Passiflora* sp. (Passifloraceae), parasitoid pupated 22 May 2009, parasitoid emerged 12 June 2009, YY 38424 (rearing code). 18 females, 5 males, **ECUADOR, Napo** Province, Yanayacu Biological Station, S 00°35.9' W 77°53.4', 2163 m, collected 22 August 2009 as cocoon on *Piper baezanum* (Piperaceae), parasitoid emerged 12 September 2009, YY 41887 (rearing code). Deposited at UWIM.

***Meteorus juliae* Aguirre & Shaw n. sp.**
(Figs. 13–16)

Diagnosis. Mandibles twisted, occipital carina incomplete, ocelli ocular distance equal to ocellar diameter, vertex in dorsal view descending vertically behind the lateral ocelli, notauli not distinctive, vein m-cu of forewing intersticial, tarsal claw with large lobe, propodeum aerolate and rugose, dorsope and laterope absent, T1 totally black, ventral borders of first tergite joined completely along 1/2 of segment.

Body color. Antenna dark brown; annulus absent; head orange except area between ocelli black; propleuron yellow; pronotum yellow; mesonotal lobes black-dark brown; notauli, scutellum and area between lobes yellow; mesopleuron medially yellow, ventrally black-dark brown; metapleuron yellow; propodeum black; prothoracic legs yellow; mesothoracic legs yellow except trochantellus dark-brown; metathoracic legs with coxa yellow basally and dark brown apically, trochanter yellow basally and brown apically, trochantellus brown, femur yellow except brown apically, tibia and tarsus light brown; T1 black; T2–T8 black-dark brown; sterna yellow-cream; wings hyaline.

Body length. 4.4 mm.



FIGURES 13–16. *M. juliae* **n. sp.** 13) Female, habitus lateral view, 14) male, habitus lateral view, 15) female, habitus dorsal view, 16) female, head frontal view.

Head. Antenna with 31 flagellomeres; flagellar length/width ratios as follows: F1 = 2.7, F2 = 2.7, F3 = 2.3, F29 = 2, F30 = 2.4, F31 = 4.5; head 1.2 x wider than high; occipital carina incomplete; ocelli ocular distance equal to ocellar diameter; head height 1.4 x eye height; temples length 0.6 x eyes length in dorsal view; vertex in dorsal view descending vertically behind the lateral ocelli; frons smooth and polished; maximum face width 1.1 x minimum face width; face strigulate; minimum face width 1.1 x clypeus width; clypeus strigulate; malar space length 0.6 x mandible width basally; mandibles twisted.

Mesosoma. Pronotum in lateral view carinate and rugose; propleuron with disperse punctures; notauli not distinctive; notauli rugose with a pronounced longitudinal carina; mesonotal lobes not well defined; central lobe of mesoscutum rugulose with a faint longitudinal carina; scutellar furrow with three clearly marked carinae; mesopleuron punctate; sternaulus long, narrow and carinate-foveate; metapleuron rugulose; propodeum aerolate-rugose; longitudinal and transversal carinae on propodeum absent; median depression on propodeum absent;

Legs. Hind coxa strigate and punctate; tarsal claw with large lobe;

Wings. Wing length 4 mm; second submarginal cell of forewing not strongly narrowed anteriorly; length of vein r 0.7 x length of 3Rsa; length of vein 3RSa 0.8 x length of rm; vein m-cu of forewing intersticial; length of vein 1M 1.5 x length of cu-a; length of vein 1M 0.9 x length of 1r-m.

Metasoma. Dorsope and laterope absent; ventral borders of first tergite joined completely along 1/2 of segment; first tergite with costae parallel; ovipositor 1.3 x longer than first tergite; ovipositor thickened basally and sinuous.

FIGURES 17–18. 17) Arctiinae 3th instar larva, 18) cocoons.

Cocoon (Fig. 18). Length 5.5 mm; width 2.1 mm; honey-brown translucent except apex cap golden. Cocoons loosely clumped around an axis composed of twisted shared suspending threads. The thread is approximately 2.5 cm long. Each cocoon is elongate-oval, loosely wrapped by silk, the edge of the emergence hole and the cap is smooth and neat, the posterior end is nipple-shaped.

Female variation. Antenna with 31-32 flagellomeres; head 1.1–1.2 x wider than high; maximum face width 1.1–1.2 x minimum face width; malar space length 0.6–0.8 x mandible width basally; length of vein r 0.6–0.8 x length of 3Rsa; length of vein 1M 1.2–1.5 x length of cu-a; wing length 4–4.3 mm; ovipositor 1.3–1.6 x longer than first tergite.

Male variation. Prothoracic legs yellow except telotarsus brown; mesothoracic legs yellow except trochantellus and telotarsus brown; body length 4.2 mm.

Comments. *M. juliae* shares with *M. quasifabatus* and *M. anuae* the following combination of characters: mandibles twisted, notauli not distinctive, tarsal with large lobe, dorsope and laterope absent, and ventral borders of first tergite joined completely along ½ of segment. *M. juliae* can be easily separated from *M. quasifabatus* by having mesonotal lobes dark brown (yellow in *M. quasifabatus*), antenna with 31–32 flagellomeres (29 in *M. quasifabatus*), ocelli ocular distance equal to ocellar diameter (1.3–1.6 x in *M. quasifabatus*), head height 1.4 x eye height (1.6–1.7 x in *M. quasifabatus*), ovipositor 1.3–1.6 x longer than first tergite (2–2.2 x in *M. quasifabatus*). *M. juliae* can be differentiated from *M. anuae* by having antenna with 31–32 flagellomeres (29 in *M. anuae*), occipital carina incomplete, malar space length 0.6–0.8 x mandible width basally (0.5 x in *M. anuae*) and vein m-cu of forewing intersticial (antefurcal in *M. anuae*).

Holotype. Female (point mounted), **ECUADOR, Napo** Province, Yanayacu Biological Station, S 00°35.9' W 77°53.4', 2163 m, host collected 4 March 2010, as parasitoid of Arctiinae larva 3th instar on *Dendrophorbium iloense* (Hieron.) C. Jeffrey (Asteraceae), pupated 10 March 2010, adult parasitoid emerged 29 March 2010, YY 45650 (rearing code). Deposited in UWIM.

Paratypes. Three females and 5 males, same data as the holotype. Deposited at UWIM.

Distribution. ECUADOR, Napo Province, Yanayacu Biological Station, High Andean Cloud Forest, 2163 m.

Biology (Fig. 17). Reared from Arctiinae 3th instar larva feeding on *Dendrophorbium lloense*. Based on the collecting, pupation and emergence dates the minimum development time as larva is 6 days and the development time in the pupal stage is 19 days.

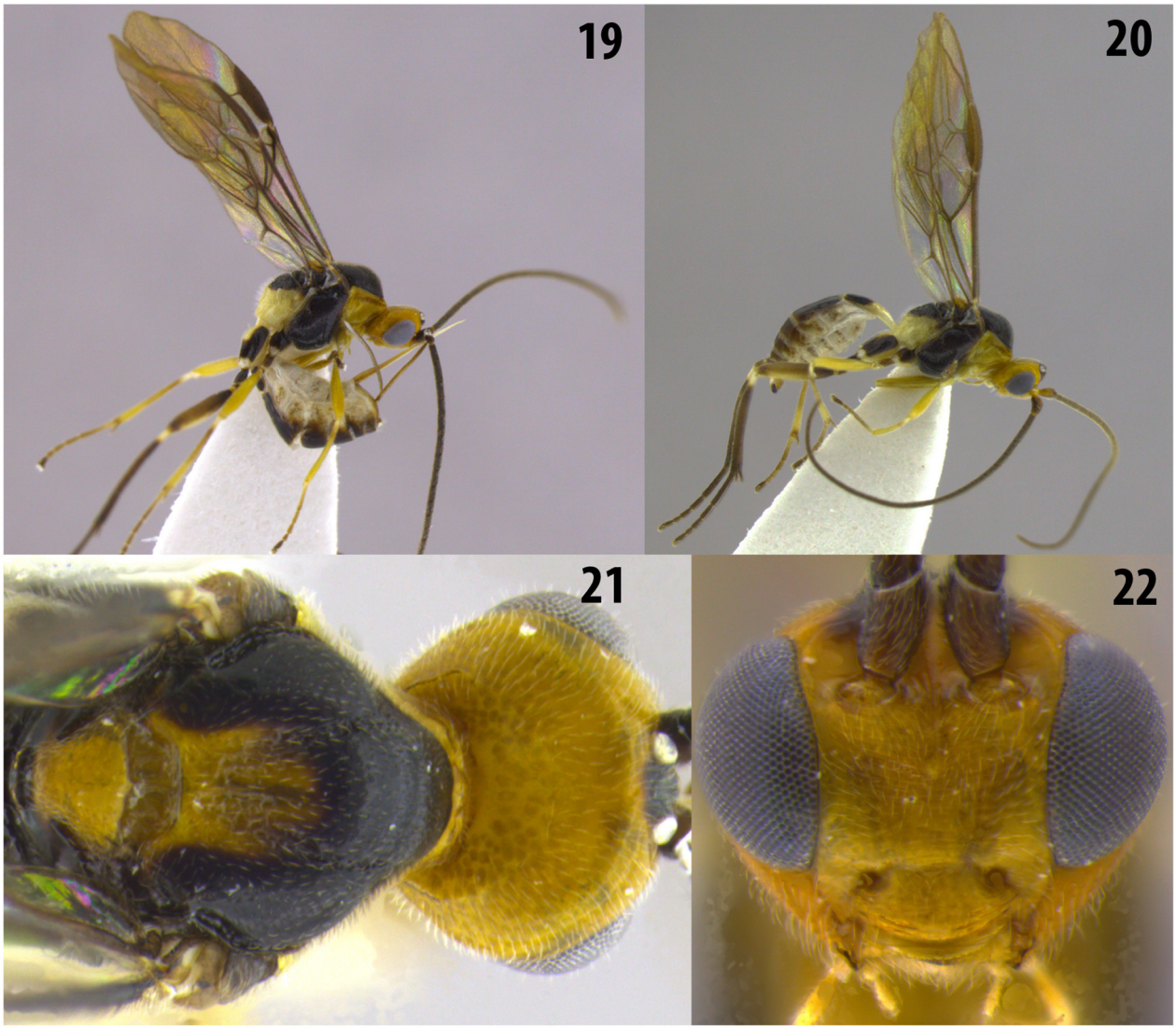
Etymology. This species is named after our entomologist colleague Julia Stigenberg whose valuable research has shed light on the complex phylogenetic relationships for the *Meteorus* species from the Palearctic region.

***Meteorus mirandae* Aguirre & Shaw n. sp.**
(Figs. 19–22)

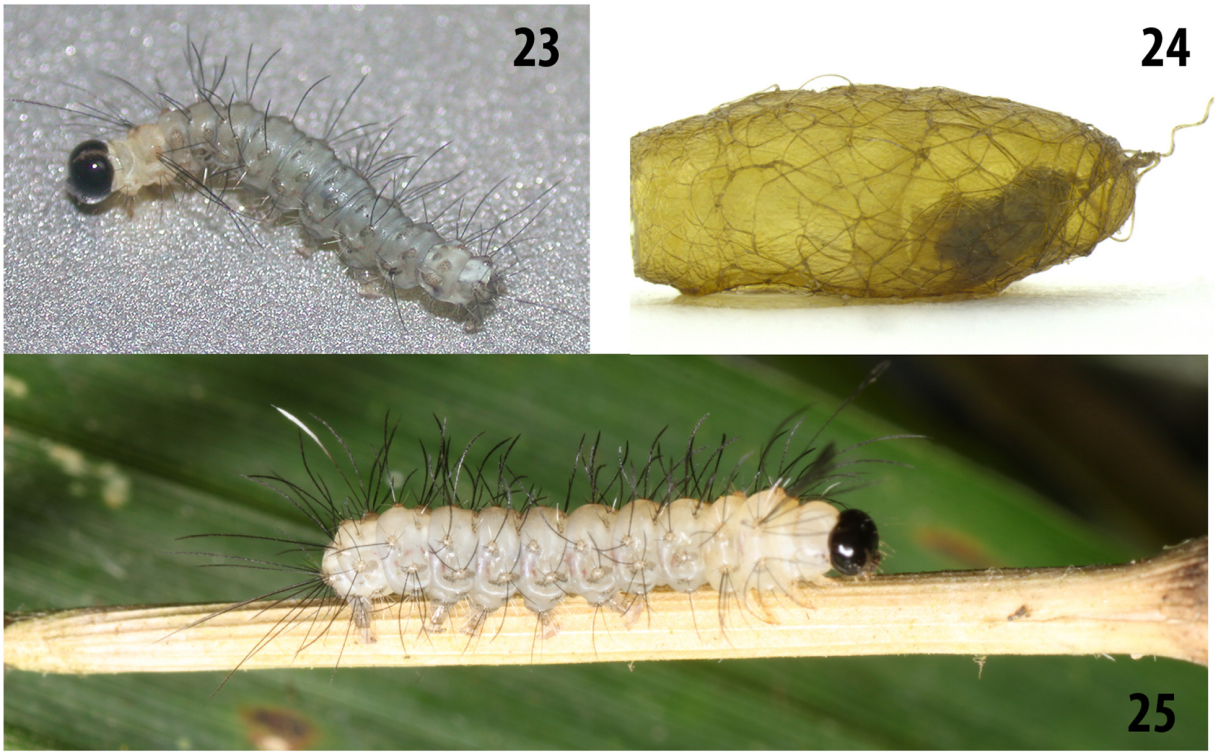
Diagnosis. Mandibles twisted; occipital carina incomplete; notauli distinctive; propodeum aerolate-rugose; hind coxa punctate and polished; tarsal claw with large lobe; vein m-cu of forewing posfurcal; ventral borders of first tergite joined completely along ½ of segment.

Body color. Antenna dark brown; annulus absent; head orange except area between ocelli black and a couple of longitudinal dark brown patches on the frons behind each scape; propleuron yellow; pronotum orange; mesonotum black except both a patch between mesonotal lobes and scutellum yellow; mesopleuron black; metapleuron yellow-white; propodeum black dorsally and white posteriorly; prothoracic legs yellow except telotarsus brown. Mesothoracic legs with coxa black dorsally and yellow ventrally; trochanter and trochantellus brown; femur yellow; tibia basally yellow-white, medially light brown and apically yellow; tarsus with tarsomeres 1–4 brown, telotarsus dark brown. Metathoracic legs with coxa black dorsally and yellow-white ventrally, on the posterior edge both colors touch to each other along a sinuated line; trochanter and trochantellus black; femur basally black, medially brown, close to the apex light brown and a small dark brown ring around the apical border; tibia apically white, brown the rest; tarsus brown; T1 basally and medially white, apically the white area narrows and becomes flanked laterally by black patches; T2–T8 black dorsally, white-cream laterally; sterna white; wings hyaline.

Body length. 4.1 mm.



FIGURES 19–22. *M. mirandae* **n. sp.** 19) Female, habitus lateral view, 20) male, lateral view, 21) male, mesonotum dorsal view, 22) male, head frontal view.



FIGURES 23–25. 23 and 25) *S. mosca* 3th instar larva, 24) cocoon close up.

Head. Antenna with 29 flagellomeres; flagellar length/width ratios as follows: F1 = 3; F2 = 3; F3 = 2.8; F27 = 2; F28 = 2; F29 = 2.7; head 1.2 wider than high; occipital carina incomplete; ocelli ocular distance 1.6 x ocellar diameter; head height 1.6 x eye height; temples length 0.7 x eyes length in dorsal view; vertex in dorsal view descending vertically behind the lateral ocelli; frons smooth and polished; maximum face width 1.2 x minimum face width; face strigulate; minimum face width 1.2 x clypeus width; clypeus rugulose-strigulate; malar space length equal to mandible width basally; mandibles twisted.

Mesosoma. Pronotum in lateral view carinate on the dorsal and posterior borders; propleuron smooth and polished; notauli distinctive and rugose; mesonotal lobes well defined; central lobe of mesoscutum puncticulate; scutellar furrow with three carinae; mesopleuron puncticulate; sternaulus short, narrow and foveate; metapleuron punctate dorsally and foveate ventrally; propodeum aerolate-rugose; longitudinal and transversal carinae on propodeum absent; median depression on propodeum slightly present.

Legs. Hind coxa punctate and polished; tarsal claw with large lobe.

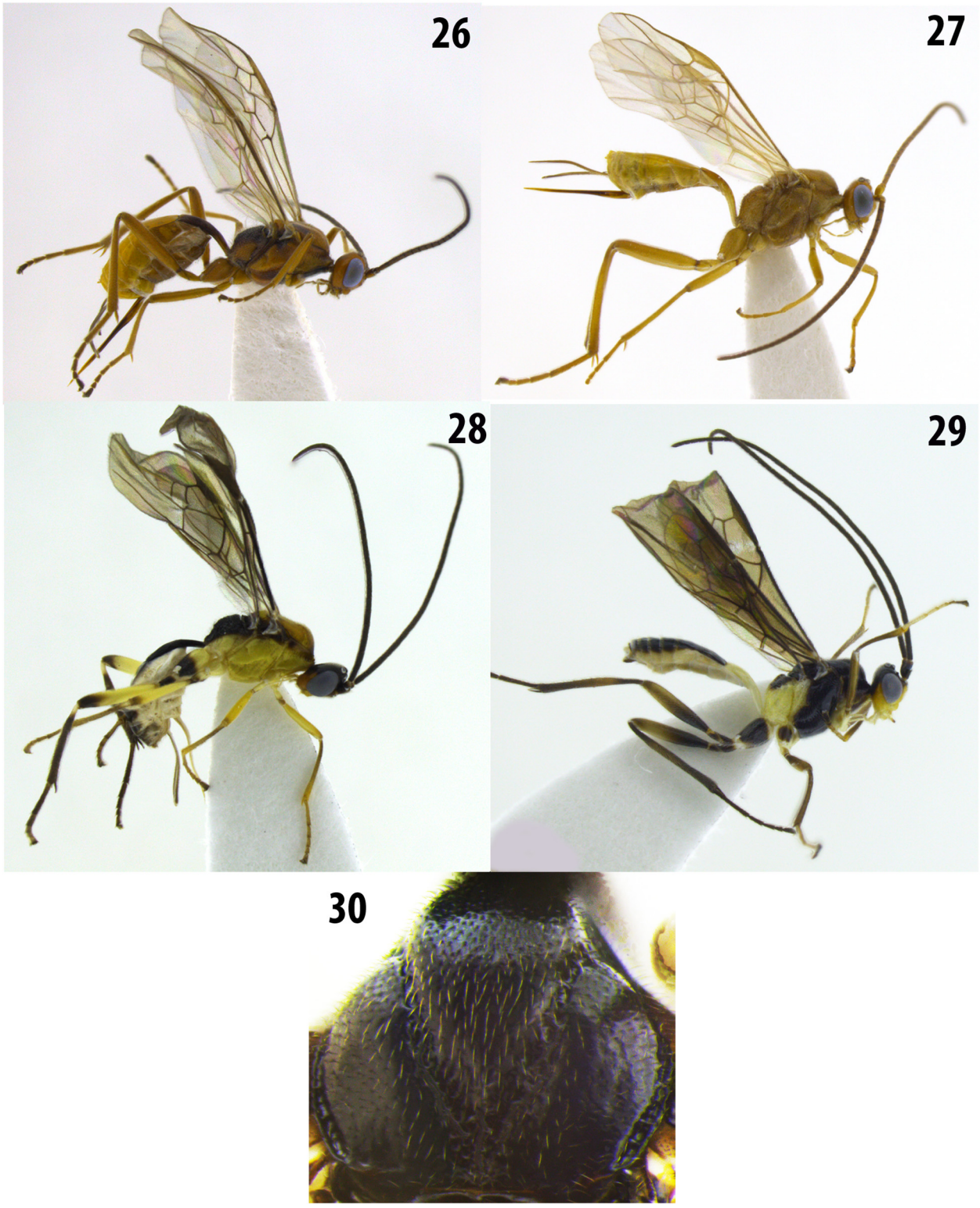
Wings. Wing length 4 mm; second submarginal cell of forewing not strongly narrowed anteriorly; length of vein r 0.6 x length of 3Rsa; length of vein 3RSa 0.9 x length of rm; length of vein m-cu of forewing postfurcal; length of vein 1M equal to length of cu-a; length of vein 1M equal to length of 1r-m.

Metasoma. Dorsope and laterope absent; ventral borders of first tergite joined completely along 1/2 of segment; first tergite smooth basally and medially, with convergent costae apically; ovipositor 1.9 x longer than first tergite; ovipositor thickened basally and straight.

Cocoon (Fig. 24). Length 3.9 mm; width 1.7 mm; honey translucent; length of thread attached at the cocoon's anterior end 11–24 mm, cocoon loosely enveloped by thread, anterior end rounded, emergence hole border neat, cap missed.

Female variation. Body length 3.7–4.1 mm; head 1.1–1.2 wider than high; maximum face width 1.1–1.2 x minimum face width; minimum face width 1.2–1.3 x clypeus width; wing length 3.9–4 mm; length of vein r 0.6–0.8 x length of 3Rsa; length of vein 1M 1–1.5 x length of cu-a; length of vein 1M 0.8–1 x length of 1r-m.

Male variation. Mesopleuron black to dark brown; antenna with 29–30 flagellomeres; temples length 0.6–0.8 x eyes length in dorsal view; malar space length 1–1.3 x mandible width basally; ocelli ocular distance 1.3–1.4 x ocellar diameter; notauli rugose or rugose and carinate; T1 smooth basally, with convergent costae medially and apically.



FIGURES 26–30. 26) *M. arizonensis* female lateral habitus, 27) *M. laphygmae* female lateral habitus, 28) *M. margarita* female lateral habitus, 29) *M. oreo* male lateral habitus, 30) *M. oreo* mesonotum with distinct notauli.

FIGURES 31 & 32. 31) *M. porcatus* female lateral habitus, 32) *M. quasifabatus* female lateral habitus.

Comments. Following the key published by Jones and Shaw (2012) *Meteorus mirandae* matches *M. caritatis* Jones, but can be separated by the complete occipital carina, strigate face (smooth in *M. caritatis*) and short, narrow and foveate sternaulus (*M. caritatis* lacks of sternaulus). *Meteorus mirandae* shares with *M. oreo* an incomplete occipital carina, twisted mandibles, distinctive notauli, punctate and polished hind coxa, and similar ovipositor relative length. However, *M. mirandae* is easy to separate from *M. oreo* by the characters provided in the key.

Holotype. Female (point mounted) **ECUADOR, Napo** Province, Yanayacu Biological Station, San Isidro Forest, S 00°35.9' W 77°53.4', 2163 m, collected 17 July 2009 as 3th instar larva parasitoid of *Saurita mosca* (Arctiinae: Ctenuchinae) on *Diplazium costale* var *robustum* (Dryopteridaceae), parasitoid pupated 20 July 2009, parasitoid emerged 6 August 2009, YY 40047 (rearing code). Deposited at UWIM

Paratypes. One female, **ECUADOR, Napo** Province, Yanayacu Biological Station, Las Palmas parte alta, S 00°35.9' W 77°53.4', 2163 m, collected 1 November 2005 as cocoon hanging from leaf of Araceae, adult wasp emerged 6 November 2005, YY 54420 (rearing code); 1 male, **ECUADOR, Napo** Province, Yanayacu Biological Station, S 00°35.9' W 77°53.4', 2163 m, Sendero stream trail, collected 26 January 2011 as 3th instar larva parasitoid of Arctiinae on *Chusquea scandens* (Poaceae), parasitoid pupated 24 February 2011, parasitoid emerged 11 March 2011, YY 29866 (rearing code). 1 male, **ECUADOR, Napo** Province, Yanayacu Biological Station, S 00°35.9' W 77°53.4', 2163 m, collected 10 June 2009 as 3th instar larva parasitoid of *Saurita mosca* Dognin (Arctiinae: Ctenuchinae) on *Chusquea scandens* (Poaceae), parasitoid pupated 16 June 2009, parasitoid emerged 15 July 2009, YY 39076 (rearing code). 1 male, **ECUADOR, Napo** Province, Yanayacu Biological Station, S 00°35.9' W 77°53.4', 2163 m, collected 28 February 2008 as 3th instar larva parasitoid of *Saurita mosca* Dognin (Arctiinae: Ctenuchinae) on *Chusquea scandens* (Poaceae), parasitoid pupated 24 March 2008, parasitoid emerged 15 April 2008, YY 9158 (rearing code).

Distribution. ECUADOR, Napo Province, Yanayacu Biological Station, High Andean Cloud Forest, 2163 m.

Biology (Figs. 23 and 25). Parasitoid of 3th instar larva of *Saurita mosca* (Arctiinae: Ctenuchinae) feeding on *Diplazium costale* var *robustum* (Dryopteridaceae) and *Chusquea scandens* (Poaceae). At Las Palmas location cocoons of *M. mirandae* were found hanging on a leaf of Araceae. Based on the collecting, pupation and

emergence dates, the minimum average larval development time is 16 days and the average time inside the cocoon is 21 days.

Etymology. This species is named after our enthusiastic entomologist colleague, Miranda Bryant Talluto, who is currently working on the taxonomy and ecology of Braconidae at the Ecuadorian cloud forest of Yanayacu.

Discussion

Currently nine *Meteorus* species are known to be Arctiinae parasitoids in the Neotropical Region. A tenth species, *M. arizonensis*, is not reported attacking this subfamily in the tropics but Stireman & Singer (2002) reared it as solitary parasitoid from *Grammia geneura* Stecker (Arctiinae) in Arizona. Since its distribution range is from Canada (Strickland 1946) to Colombia (Aguirre *et al*. 2011), the possibility to record *M. arizonensis* from Arctiinae in the Neotropics depends upon future rearings. It is also known as parasitoid of *Spodoptera frugiperda* Smith (Maes 1989, Cave 1993) and *Helicoverpa zea* Boddie (Lepidoptera: Noctuidae) (Puterka *et al*. 1985).

M. laphygmae, another solitary parasitoid, is recorded as polyphagous on Erebidae, Geometridae, Nymphalidae, Noctuidae and Pieridae (Yu 2012). It was reared in Colombia from *Ceramidia viridis* (Druce) (Arctiinae) in banana crops (Aguirre *et al*. 2011). This species is one of the most commonly collected in Neotropical countries. It displays nocturnal behavior and is frequently captured in light traps. *M. laphygmae* is relatively easy to recognize by its uniform yellow body, and big eyes and ocelli (head height 1.3–1.5 x eye height; ocelli ocular distance 0.8–1.2 x ocellar diameter). Nevertheless, some populations present extreme variability in the size of both structures, as well as some faint, brown patches on the terga, factor that challenges the correct identification.

In contrast to the generalist feeding habits of *M. laphygmae* and *M. arizonensis*, *M. oreo* and *M. mirandae* have just one host each one. *Dysschema palmeri* Druce, host of *M. oreo*, feeds on eight plant families, and *Saurita mosca* Dognin, host of *M. mirandae* **n. sp.**, feeds upon 12 plant families. Jones & Shaw (2012) remarked that *M. oreo* is only reared from *D. palmeri* feeding on *Psychotria ferreyrae* (Rubiaceae), despite the broad food spectrum of this caterpillar. This observation suggests a strong specificity for *M. oreo* in this tri-trophic interaction. The tri-trophic interaction of *M. mirandae* seems to reflect a similar situation, since this wasp has only been recorded from *S. mosca* feeding on *D. costale* var *robustum* and *C. scandens*, despite each one of these plants supporting caterpillars from 14 and 22 Lepidoptera families, respectively (Lee Dyer pers. comm.).

Six other Arctiinae parasitoids are gregarious: *M. anuae* **n. sp.**, *M. cecavorum, M. juliae* **n. sp.**, *M. margarita, M. porcatus* and *M. quasifabatus*. *M. juliae* **n. sp.** and *M. porcatus* were reared from a caterpillar species that lack of generic and specific identification but the parataxonomist team working at Yanayacu Biological Station identified it with the common name "hh arctiid"; under this name 42 plants in 21 families are recorded as food. A similar feeding pattern is observed in *Praeamastus minerva* Dognin, host of *M. quasifabatus*, associated with 12 plant families and *Amastus* nr. *vitripennis* Hampson, host of *M. margarita*, associated with six plant families. *M. cecavorum* was reared from one caterpillar called "*Alnus* arctiid 2" just feeding on *Passiflora* sp. (Passifloraceae). No dietary information could be provided for the host of *M. anuae* because it lacks of both specific identification and common name. Interestingly, despite the polyphagous nature of the most of these caterpillars, their *Meteorus* parasitoids were present just when feeding on one or at most two plant species (Lee Dyer pers. comm.). Although Dyer *et al*. (2007) showed that the caterpillars dwelling in Andean cloud forests tend to be specialized toward a particular taxonomic group of plants, the broad range displayed by the caterpillars targeted by *Meteorus* is a common pattern for Arctiinae in the Ecuadorian Andes (Rab Green *et al*. 2011). Singer & Stireman (2003) studied the factors influencing plant selection in the Arctiinae caterpillar *G. geneura* and found that the mixing of different plants with low nutritional value, but harboring toxins, provide higher caterpillar survival when facing the attack of *Exorista mella* Walker (Diptera: Tachinidae). Since many tachinid flies are generalist parasitoids, specialist ones (such is the case of many *Meteorus*) could take advantage of both decreases in competition and higher efficiency by exploiting the host caterpillar while performing the attack on just one or few food plants. The mechanisms behind this complex association could involve specific chemical interactions between plant, herbivore and parasitoid. However, the trade-off between being an efficient specialist parasitoid and an effective generalist one has been studied for aphids and their parasitoids in more simplified and less diverse systems than tropical cloud forests (Straub *et al*. 2011), and the tachinid fauna known from Ecuadorian Andes seems to be relatively more specialized than their Nearctic relatives (Stireman *et al*. 2009).

Jones & Shaw (2012) provided statistical support about the bias of *Meteorus* to attack exposed hosts. Based on the tendency of day-active caterpillars to be "nasty" for many natural enemies, they found that solitary and gregarious parasitoids tend to use these hosts more than concealed ones. Unfortunately the most of the wasps were reared just once and additional rearings are necessary to draw stronger conclusions.

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