

The millipede family Ammodesmidae (Diplopoda, Polydesmida) in western Africa

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Abstract

Ammodesmidae are represented in western Africa by two species of a single genus, *Ammodesmus* Cook, 1896 (= *Cenchrodesmus* Cook, 1896, syn. n.). The type-species *A. granum* Cook, 1896 (= *Cenchrodesmus volutus* Cook, 1896, **syn. n.**) is redescribed, based on neotype selection, as well as on additional samples, often containing numerous specimens, from Liberia, Guinea and the Ivory Coast. A new species is described from Mount Nimba, Guinea: *A. nimba* **sp. n.**

Keywords

Diplopoda, Polydesmida, Ammodesmidae, *Ammodesmus*, taxonomy, new species, new synonymy, western Africa

Introduction

The small Afrotropical family Ammodesmidae has hitherto been known to comprise only three genera. One of these is *Elassystemma* Hoffman & Howell, 1981, a recently reviewed oligotypic genus currently comprising four species from Kenya, Tanzania and Malawi (Hoffman and Howell 1981, VandenSpiegel and Golovatch 2004). Two fur-

ther genera, both monobasic and both described from western Africa, have remained enigmatic ever since their proposals.

The taxonomic history of the family Ammodesmidae is rather confusing (Jeekel 1970). It was originally introduced invalidly, because it contained two genera, *Ammodesmus*, a nomen nudum, and *Doratodesmus* Cook, 1895, the latter name proposed to replace the preoccupied *Doratonotus* Pocock, 1894 (Cook 1895). Cook (1896a) validated Ammodesmidae only through selecting and diagnosing *Ammodesmus granum* Cook, 1896 as type species. A little later, Cook (1896b) slightly rediagnosed *Ammodesmus* and also described the new genus *Cenchrodesmus* for the sole species *C. volutus* Cook, 1896, he had collected syntopically in Liberia together with *A. granum*. This latter species was said to have been based upon the holotype while *C. volutus* upon three syntypes. Both were first mentioned to have been taken from “the western part of the country”, but the exact locality, Mt Coffee, was soon provided elsewhere (Cook 1896c).

The diagnoses of the two genera and species were rather anecdotal and provided little useful information (Cook 1896b, page 414): “Both genera have the habit of coiling into a sphere. The second segment is enormously enlarged so as to completely conceal the head and the first segment when viewed from the side as well as to cover the space left between the decurved carinae of the other segments when the creatures are coiled. *Ammodesmus* has the dorsum roughened by a transverse row of large papilliform tubercles rising from the posterior part of each segment, while *Cenchrodesmus* has the segments nearly smooth. When disturbed it coils up and lies motionless, and then is perfectly concealed, having exactly the appearance of a grain of sand”. In summary, Cook (1895, 1896a-c) distinguished the family Ammodesmidae, as well as both *Ammodesmus* and *Cenchrodesmus*, by their extremely small size, claimed to be the smallest in Polydesmida (only about 2 mm in length), and their ability to volvate.

As no genital structures had been mentioned, VandenSpiegel and Golovatch (2004) suggested that all type specimens from Liberia might have been females. Furthermore, since the types could not be relocated for revision, *Ammodesmus* and *Cenchrodesmus* have ever since remained “*nomina dubia*” (Hoffman 1980). So even when Hoffman and Howell (1981) described the new genus *Elassystemma* and its sole, and type, species *E. pongwe* Hoffman & Howell, 1981 from Tanzania, the need was again emphasized in revising the two western African genera before unequivocally assigning *E. pongwe* to the family Ammodesmidae. The same uncertain situation has also remained after the latest review of *Elassystemma* which added three further congeners from eastern tropical Africa (VandenSpiegel and Golovatch 2004).

Between 2008 and 2011, a rich material of diplopods was taken or amassed by the first author from Liberia, Guinea and the Ivory Coast. This large collection appears to contain a proportion of Ammodesmidae, fortunately also with males from each locality becoming available for study. Three different morphotypes could be distinguished at once, including the two forms described by Cook (1896a-c), as well as a new one with a very peculiar colour pattern. Moreover, quite unexpectedly, both of Cook’s species happen to be the most common and widespread, in larger samples always co-existing, with all specimens showing the papilliform metatergal tubercles typical of

Ammodesmus granum being males and the samples with nearly smooth tergites representing juveniles or females, i.e. just like the situation described for *Cenchrodesmus volutus*. This striking sexual dimorphism (which somewhat resembles that observed in some volvatory species of *Eutrichodesmus* Silvestri, 1910, a genus of the Australasian family Haplodesmidae - see Golovatch et al. 2009a, b, 2010) allows for the following unequivocal identifications and synonymy to be proposed: *Ammodesmus granum* Cook, 1896 must have been based on a male holotype, while *Cenchrodesmus volutus* Cook, 1896 is its junior subjective synonym which seems to have been based on three female syntypes. The third form appears to be a new species of *Ammodesmus*, taken from a single locality (Mt Nimba) and described below.

The present paper provides a review of *Ammodesmus*, the sole ammodesmid genus that appears to populate western Africa. Its gonopod and numerous other characters are documented here for the first time, and compared to those of *Elassystremma*, the sole eastern Afrotropical counterpart ammodesmid. The type species *Ammodesmus granum* is redescribed, based on neotype designation, and a new species is added to this genus. A distribution map of and a key to the *Ammodesmus* species are also given.

Material and methods

The bulk of material belongs to the collection of the Royal Museum for Central Africa (MRAC), Tervuren, Belgium, with only a few duplicates shared with the collections of the Zoological Museum, State University of Moscow (ZMUM), Russia and the Muséum national d'Histoire naturelle, Paris (MNHN), France, as indicated hereafter. All samples are stored in 70% ethanol. Photographs were made with a Leica digital camera Leica DFC 500 mounted on a Leica MZ16A stereomicroscope. Images were processed with a Leica Application Suite program. Specimens for scanning electron microscopy (SEM) were air-dried, mounted on aluminium stubs, coated with gold and studied in a JEOL JSM-6480LV scanning electron microscope.

Taxonomy

Family Ammodesmidae

<http://species-id.net/wiki/Ammodesmidae>

Emended diagnosis. An oligotypic family of minute polydesmidans (1.4–5.0 mm long) with 18 or 19 body segments in both sexes, capable of rolling into a tight sphere. Conglobation pattern becoming typical from paratergum 4 onwards (Golovatch 2003). Animals usually easily recognizable by having paraterga 2 strongly enlarged, all postcolulum metaterga being clothed with a ceratagument (= cuticular secretion layer) and various tuberculations (sometimes better developed in the male than in the female). Head broader than long. Antennae short, strongly clavate; antennomere 5 longest and larg-

est, distinctly enlarged, about as high as long. Collum small, at best only slightly covering the head from above, only moderately convex. Generally, dorsum highly convex; paraterga very strongly declined ventrad, often deeply incised caudally at base; ventral edge rounded, either not or extremely poorly lobulated, well projecting below venter/coxae. Telson small, fully exposed in dorsal view. Ozopore formula nearly normal, only slightly varying from 5, 7, 9, 10, 12, 13, 15–17(18) (*Ammodesmus*) to 5, 7, 9, 12, 15–17(18) (*Elassystemma*); ozopores opening flush on tergal surface at about anterior third of paraterga, this opening sometimes being concealed by preceding paratergum.

Sterna very narrow, coxae usually subcontiguous medially. Last male legs either modified (*Ammodesmus*) or not (*Elassystemma*). Gonopod aperture rather modest in size, transversely oval, not reaching sides of metazona ventrally.

Gonopods mostly complex; coxae globose, usually but not always strongly enlarged and deeply excavate in the middle (= gonocoel), cannulae very evident. Telopodites basically unipartite, slender or stout, sometimes with a small lateroparabasal outgrowth, only seldom strongly exposed (*Ammodesmus granum*), more usually deeply sunken into gonocoel, leaving only tips exposed. Seminal groove mostly running on mesal face, turning laterad due to telopodite twisting only distally to subapically, with a very evident (*Ammodesmus granum*) or small solenomere either devoid of or supplied with a hairy pulvillus; accessory seminal chamber absent.

Distribution. Liberia, Guinea and Ivory Coast (western Africa), as well as Tanzania, Kenya and Malawi (the African eastern Arc Mountains).

Key to recognized genera of Ammodesmidae

- 1 Last pair of male legs not modified. Eastern tropical Africa... *Elassystemma*
- Last pair of male legs strongly modified (Fig. 23). Western tropical Africa....
..... *Ammodesmus*

Genus *Ammodesmus* Cook 1896

<http://species-id.net/wiki/Ammodesmus>

Ammodesmus Cook, 1896

Cenchrodesmus Cook, 1896 syn. n.

Type species. *Ammodesmus granum* Cook, 1896

Diagnosis. (after Cook 1896b, with modifications) Minute polydesmidans (length 1.4–2.0 mm) with 18 or 19 body segments (16 or 17+1+T), or rings, in both sexes. Head small, epicranium and interantennal region finely and densely granulose, lower half setose. Three labral teeth equal in size and length. Antennae short; antennomere 5 longest and largest, strongly enlarged, about as high as long; antennomeres 5 and 6 each with a distodorsal group of 20 to 30 bacilliform sensilla; antennomeres 4, 5 and 6 each with a single macroseta on dorsal side near apical third; terminal antennomere

with usual four apical cones. Collum rather large and moderately convex, nearly not covering the head from above, surface finely and densely granulose. Tergum 2 with particularly strongly enlarged, spatuliform paraterga, latter of following segments not enlarged; lateral end subtruncate, but rounded; overlap pattern typical from paratergum 4 onward. Ozopore formula: 5, 7, 9, 10, 12, 13, 15–17(18); ozopores opening flush on tergal surface about anterior third of paraterga, the opening sometimes being concealed by preceding paratergum. Limbus smooth. Telson relatively small, its posterior edge with a row of macrosetae, ventrolaterally with 2 macrosetae borne on small knobs; epiproct very short and stout, surmounted by four conspicuous macrosetae in pits (= apparently, a spinning apparatus); hypoproct subtrapeziform with a paramedian pair of macrosetae borne on small knobs. Sterna very narrow, most coxae subcontiguous medially. Legs moderately robust, rather short and setose. First ♂ tarsus with modified setae, each last ♂ tibia showing an elongated process bearing a long apical seta, tarsus reduced, claw vestigial; other legs not modified.

Distribution. Western Africa (Liberia, Guinea and Ivory Coast).

Species included. *Ammodesmus granum* and *A. nimba* sp. n.

Key to *Ammodesmus* species

- 1 Coloration pinkish to brownish with darker metaterga (Fig. 1). Male with metatergal tubercles; gonopod with a small coxa, leaving most of telopodite exposed.....*A. granum*
- 2 Colour pattern of metaterga spotty (Fig. 28). Male devoid of metatergal tubercles; gonopods with strongly enlarged coxae supplied with a prominent gonocoel.....*A. nimba* sp. n.

Ammodesmus granum Cook, 1896

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

Figs 1–27

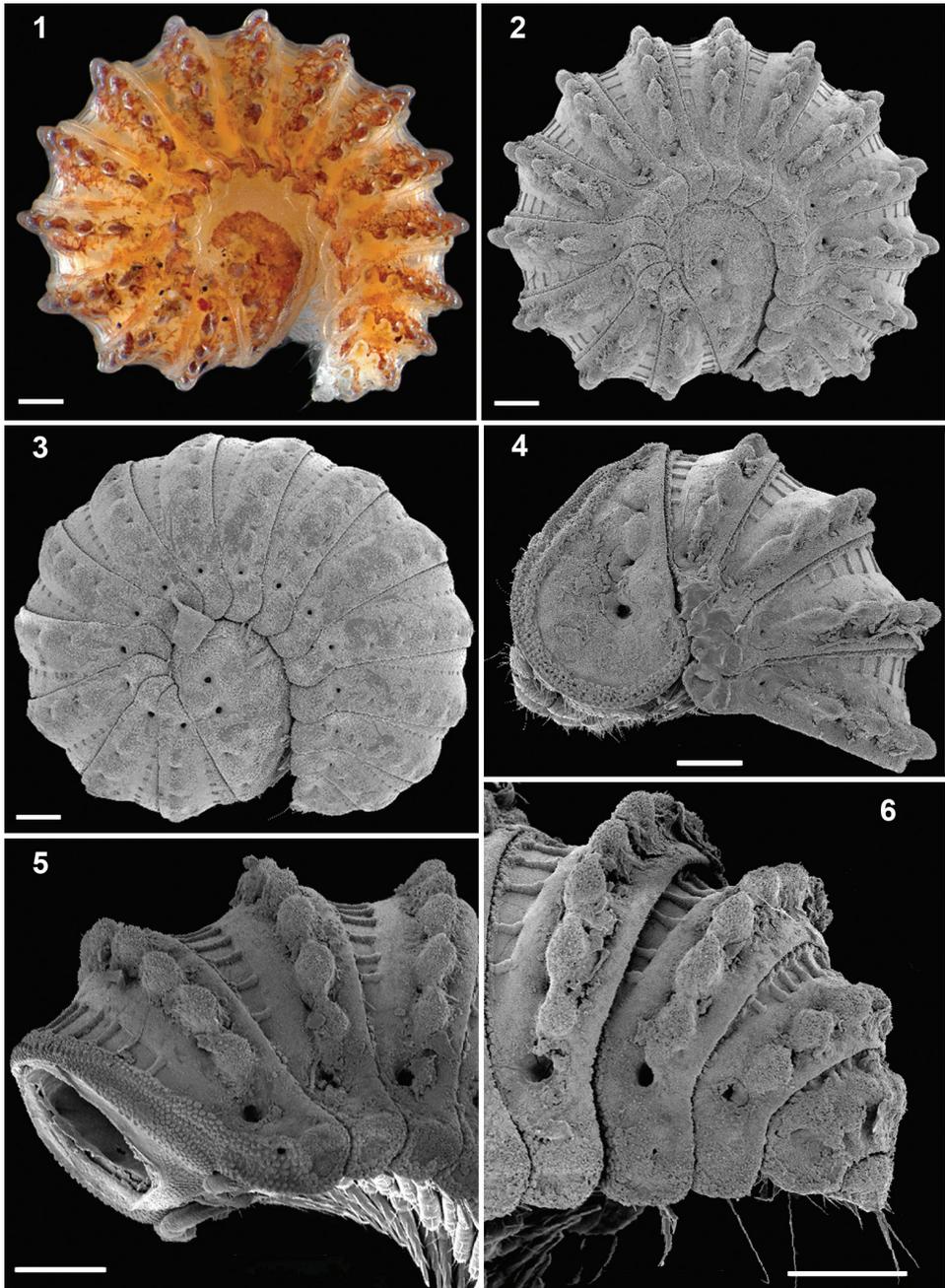
Ammodesmus granum Cook, 1896

Cenchrodesmus volutus Cook, 1896 syn. n.

Type material. Neotype ♂ (MRAC 21667), LIBERIA, Bong Range Forest, 06°49'N, 010°17'W, rainforest, pitfall trapping, 13.III.2005, leg. D. Flomo.

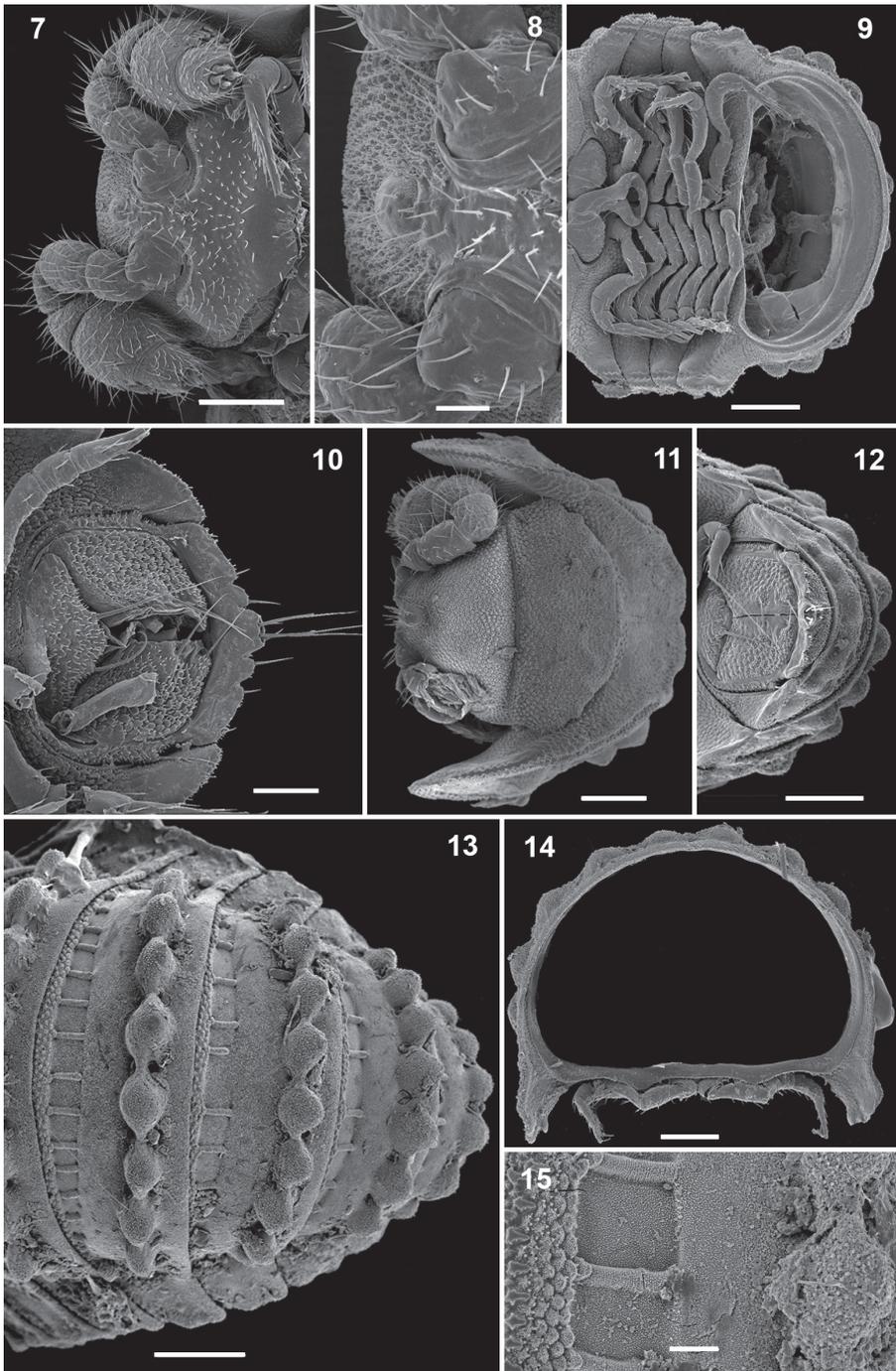
This male specimen has been chosen as neotype, because it is in perfect condition and represents a near-topotype. A neotype of *Cenchrodesmus volutus* has also been selected to substantiate this taxon as well.

Other material. 1 ♂, 2 ♀ (ZMUM), 1 ♂ (MNHN), same locality, date and collector; 6 ex. (MRAC 21966) GUINEA, Mt Nimba, Gouela forest, 07°37'N, 008°21'W, Winkler extraction, 12.X.2008; 39 ex. (MRAC 21981), including a ♀ neotype of *Cenchrodesmus volutus*, same locality, Winkler extraction, 15–17.X.2008;

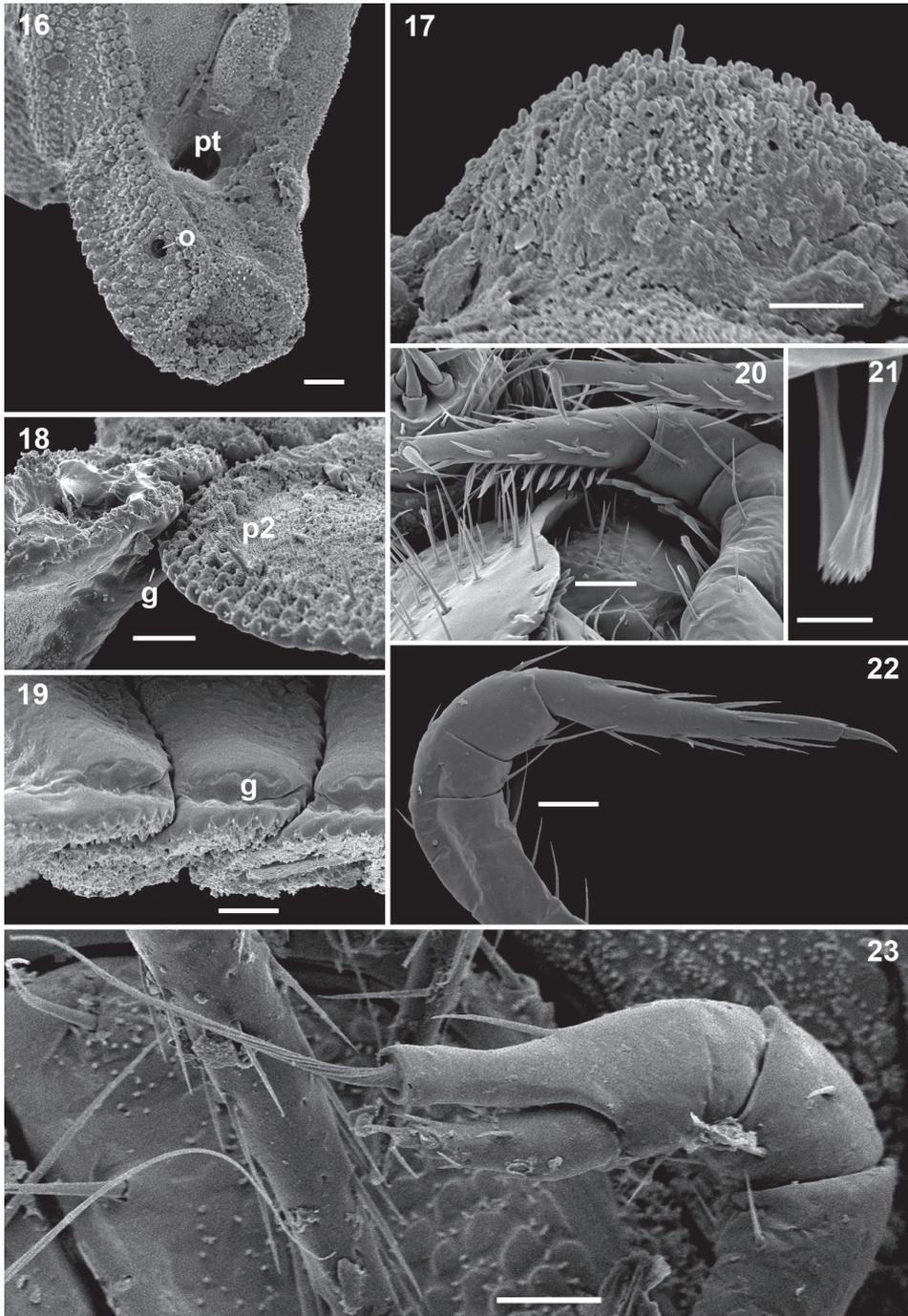


Figures 1–6. *Ammodesmus granum* **1, 2** habitus of male, lateral view **3** habitus of female, lateral view **4–6** male, anterior, middle and caudal parts of body, respectively, lateral view. Scale bars: 100 μ m.

6 ex. (MRAC 21991), same locality, Winkler extraction, 13–15.X.2008; 4 ex. (MRAC 22004), same locality, Winkler extraction, 17–19.X.2008; 12 ex. (MRAC 22045), same locality, Winkler extraction, 13–16.X.2008; 4 ex. (MRAC 22007),



Figures 7–15. *Ammodesmus granum* **7** male head, ventral view **8** interantennal isthmus, ventral view **9** midbody segments, ventral view **10** caudal part of body, ventral view **11** head and collum, dorsal view **12, 13** posterior part of body, caudal and dorsal views, respectively **14** cross-section of a midbody segment, caudal view **15** tegument texture, dorsal view. Scale bars: **7, 9–14**, 100 μm ; **8, 15**, 20 μm .



Figures 16–23. *Ammodesmus granum*, male. **16** midbody paraterga, lateral view **17** metatergal tubercle, lateral view **18, 19** paratergal groove, laterocaudal and ventral views, respectively **20** first left leg, ventral view **21** modified setae of first leg **22** midbody leg, lateral view **23** last right leg, lateral view. Scale bars: **16**, 100 μm ; **17, 23**, 10 μm ; **18, 19, 20, 22**, 20 μm ; **21**, 5 μm (**g**: groove, **o**: ozopore, **pt**: pit, **p2**: paraterga 2).

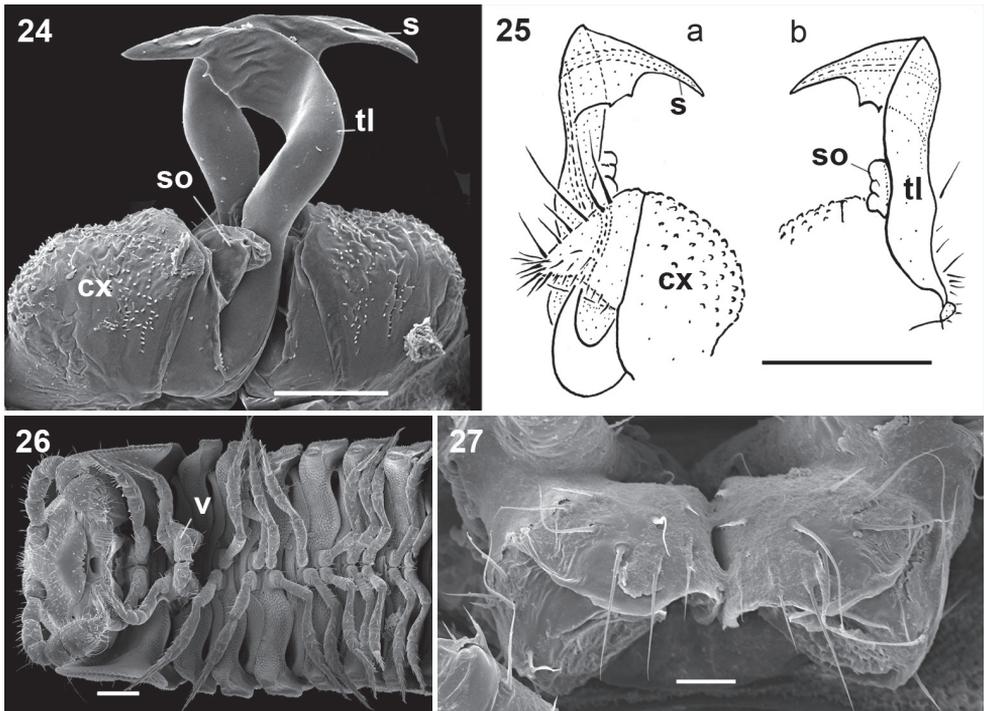
Mt Nimba, Zié forest, 07°40'N, 008°22'W, Winkler extraction, 16–18.X.2008; 2 ex. (MRAC 22040), same locality, Winkler extraction, 14–16.X.2008; 2 ex. (MRAC 22050), Mt Nimba, Ziela forest, 07°43'N, 008°21'W, litter, Winkler extraction, 19.X.2008; all leg. D. VandenSpiegel; 1 ♂, 1 ♀ (MRAC 22284), Tai forest, 05°50'N, 007°21'W, Winkler extraction, 01–03.IX.2010; 1 ex. (MRAC 22285), same locality, Winkler extraction, 13–15.X.2010; 4 ex. (MRAC 22286), same locality, Winkler extraction, 01–03.IX.2010; 2 ex. (MRAC 22288), same locality, Winkler extraction, 01–03.IX.2010; 1 ex. (MRAC 22289), same locality, Winkler extraction, 01–03.IX.2010; 2 ex. (MRAC 22290), same locality, Winkler extraction, 13–15.X.2010, all leg. A. Kablan; 3 ex. (MRAC 22287), same locality, forest on clayey soil, Winkler extraction, 22–24.II.2010; 4 ex. (MRAC 22291), Tai forest, Ecological Research Centre, 05°50'N, 007°21'W, secondary forest, Winkler extraction, 21–22.II.2010, all leg. M. Diarassouba & R. Jocqué.

Diagnosis. Minute polydesmidans (1.4–2.0 mm in length) showing evident sexual dimorphism in tergal structure: ♂ with a transverse row of up to ten ovoid tubercles arising from posterior part of each metatergum, ♀ with nearly smooth metaterga. Gonopod with a small globular coxa reaching in length only about one-third of telopodite; the latter slender, flattened and twisted mesad in distal part, with a small sac-shaped outgrowth laterally at base.

Redescription. ♂ ca 1.9 mm long; maximum width, 0.9 mm. Entire dorsal surface covered with a thin layer of secretions (= cerategument), under which the body integument is light brown to pinkish with metaterga of each segment brownish (Fig. 1). Body with 18 or 19 body rings (16 or 17+1+T), shape as in Figs 1, 2 & 3, with caudal body end tapering towards a relatively small telson not concealed by paraterga (Fig. 6).

Head small, only partly concealed under front edge of collum (Figs 7, 11); preceding half of head densely granular, lower part smooth and densely setose (Figs 7, 8). Interantennal isthmus about as wide as antennomere 1, surmounted by a small tubercle (Fig. 8). Antennae as in Fig. 7. Collum covered with low rounded tubercles (Fig. 11), tergum 2 as usual, hypertrophied, with strongly enlarged, spatuliform paraterga concealing the head in lateral view, ventral edge with a line of granules (Fig. 3). Limbus smooth; 2nd and following metaterga with 7–10 large oblong tubercles along caudal margin (Figs 1, 2, 4, 5, 6, 13). Each tubercle surmounted by a short seta (Fig. 17). Prozona rugose anteriorly, with a row of square areas along anterior edge of metatergum (Figs 13, 15), these square areas being reduced in ♀ or absent in juveniles (Fig. 3). Paraterga set at segments' midheight just below a deep pit (Fig. 16, pt), continuing the highly convex outline of dorsum, their ends rounded, projecting far below venter/coxae (Fig. 14), increasingly angular towards telson (Figs 5, 6). Anteroventral edges of paraterga 3 to 15 with a notch forming a groove for paratergum 2 to hinge into during volvation (Figs 18, 19, g). Ozopore formula: 5, 7, 9, 10, 12, 13, 15, 17; ozopores opening flush on tergal surface about midheight of paraterga, most of openings concealed by preceding paraterga (Fig. 16). Telson small (Fig. 6).

Legs rather slender, but short, barely reaching tips of paraterga (Fig. 14); femoral and tarsal segments longest, subequal in length; claw normal, simple, very slightly



Figures 24–27. *Ammodesmus granum*. **24** gonopods, caudal view **25** drawing of right gonopod, frontal (a) and caudal (b) views, respectively **26** anterior part of female body, ventral view **27** vulvae, ventral view. Scale bars: **24**, 50 μm ; **25**, **26**, 100 μm ; **27**, 20 μm . (cx: coxae, s: solenome, so: sac-shaped outgrowth, tl: telopodite).

curved ventrad (Fig. 22); first pair of legs in σ with modified setae (Figs 20, 21); last pair of σ legs modified, typical of *Ammodesmus* (Fig. 23).

Gonopods (Figs 24, 25) relatively simple. Coxae rather small, globular, scaly, without setae. Telopodite long and well exposed beyond small gonocoxae; apical part of the main body of telopodite (= solenome) smooth, flattened, pointed and twisted medially, devoid of a hairy pulvillus; a small, sac-shaped, lateral outgrowth at base of telopodite.

f usually slightly larger than m , segments rather smooth, without metatergal tubercles. Vulva small, poorly sclerotized, edge of bursa supplied with long setae (Figs 26, 27).

Distribution. Known from Liberia, Guinea and the Ivory Coast. It is noteworthy that at Mt Nimba this species occurs parapatrically with the new congener described below.

Remarks. *A. granum* is striking in being perhaps the only species in Polydesmida in which both sexes vary in the number (18 or 19) of body rings. Intraspecific variations in the number of body segments in this order are usually quite rare, always being stable per sex. Thus, in such cases males always have fewer body rings (18 or 19) than females (19 or 20), a situation not too uncommon, e.g., in Haplodesmidae (Golovatch et al. 2009a, 2009b, 2010) and, especially, Opisotretidae (Golovatch 1988).

Neotype designations for both *A. granum* and *C. volutus* are necessary, because the original types can be presumed as being lost. A special search undertaken among Cook's diplopod collections, currently housed in the Smithsonian Institution, National Museum of Natural History, Washington, D.C., had failed already before the description of *Elassystrema pongwe* by Hoffman and Howell (1981).

***Ammodesmus nimba* sp. n.**

urn:lsid:zoobank.org:act:B0262CE7-D6AC-434D-BC93-A502EAC2D999

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

Figs 28–46

Type material. Holotype ♂ (MRAC 22510), GUINEA, Mt Nimba, Freton forest, 07°37'N, 008°29'W, soil and litter, Winkler extraction, 10.III.2012, leg. A. Henrard, C. Allard, P. Bimou & M. Sidibé. Paratypes: 12 ex. (MRAC 22511), 1 ♂, 1 ♀ (ZMUM), 1 ♂ (MNHN), same locality, together with holotype.

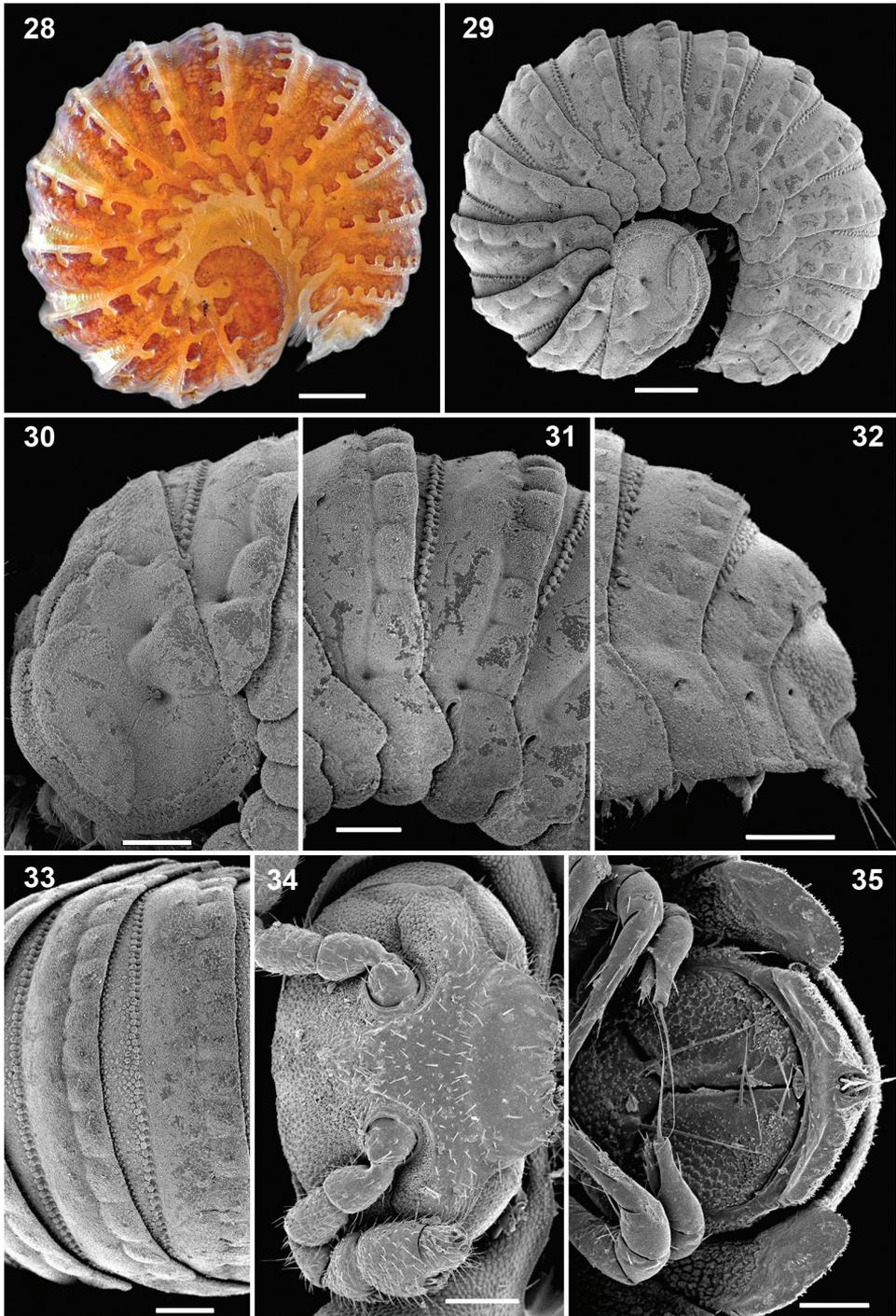
Diagnosis. Minute polydesmidans with a characteristic, spotty colour pattern of the caudal edge of each segment. Gonopods with extremely large coxae concealing the telopodites inside a deep gonocoel.

Description. ♂ ca 2.8 mm long; maximum width, 0.9 mm. Body integument light brown to pinkish. Colour pattern of metaterga characteristic, spotty (Fig. 28). Body with 19 body rings (17+1+T), shape as in Figs 28, 29.

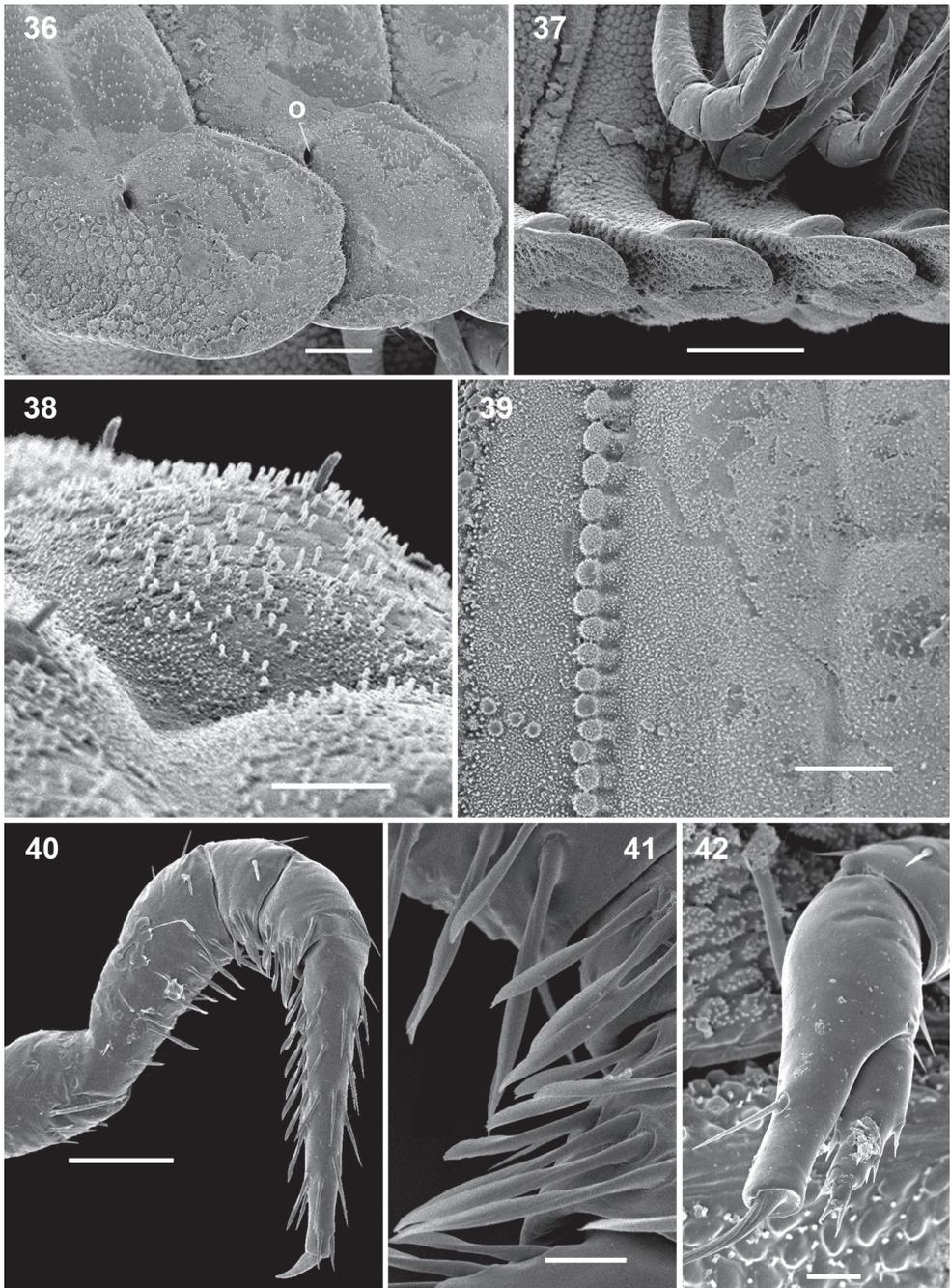
Head small, partly concealed under front edge of collum; upper half of head densely granular, lower half smooth and densely setose. Interantennal isthmus without knob, about as wide as antennomere 1 (Fig. 34). Antennae as in Fig. 34. Collum relatively large, rather convex, surface slightly granular. Tergum 2 as usual, hypertrophied, with strongly enlarged, spatuliform paraterga concealing the head in lateral view (Figs 28, 29, 30), ventral edge with up to 4 rows of granules (Figs 29, 30). Limbus smooth, 2nd and following metaterga with a row of up to 13 low bosses lining the caudal margin; each boss obviously supporting a small apical seta (Figs 30–33, 38). Prozona rugose anteriorly, with a row of small granules along anterior edge of metatergum (Fig. 39). Paraterga set below segments' midheight, continuing the convex outline of dorsum, with a notch basally at posterolateral edge; ends rather regularly rounded, increasingly angular towards telson (Figs 31, 32, 36). Anteroventral parts of paraterga 3 to 15 with a notch forming a groove for paraterga 2 to hinge into during volvation (Fig. 37). Ozopore formula: 5, 7, 9, 10, 12, 13, 15, 17; ozopores opening flush on tergal surface at about anterior third of paraterga, openings oblong and not concealed by preceding paraterga (Fig. 36). Telson small (Figs 32, 36).

Sterna and legs as in *A. granum* (Figs 40, 41, 42). Gonopod aperture relatively modest in size, transversely oval (Fig. 43).

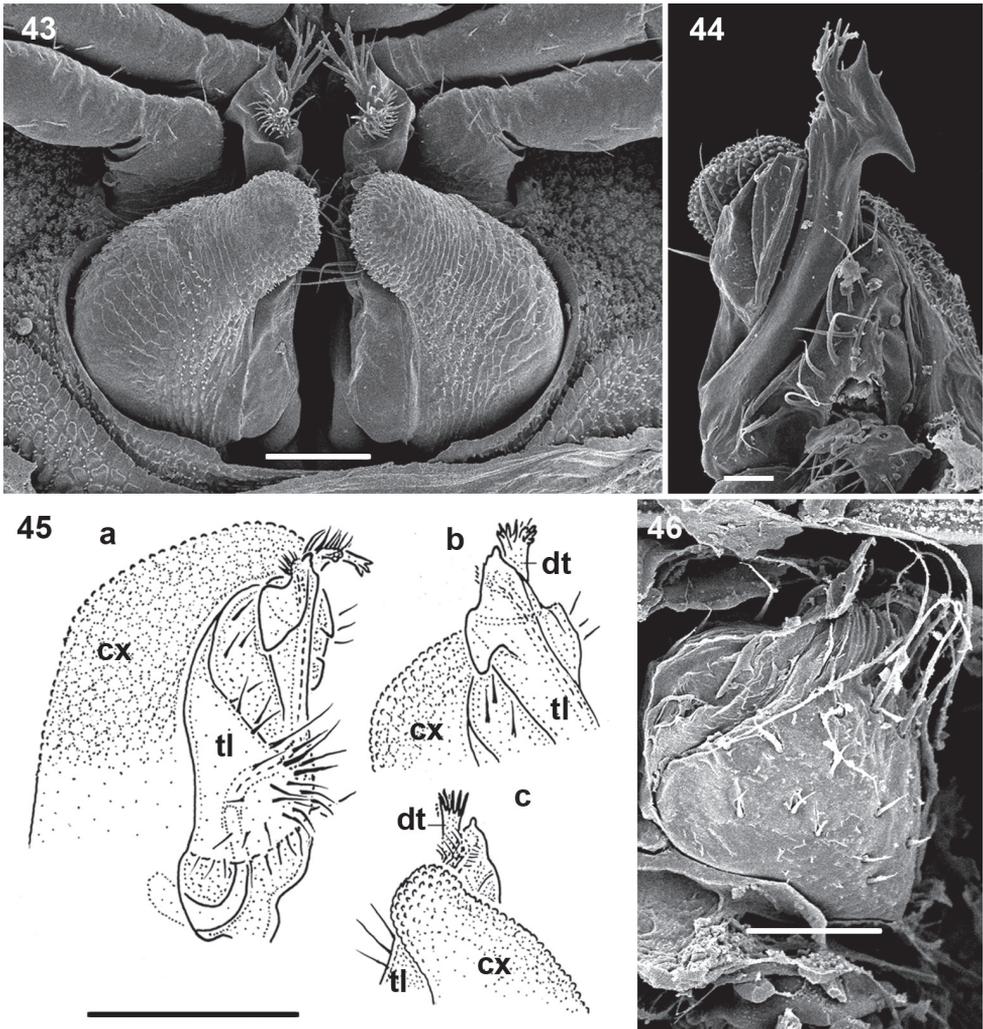
Gonopods highly complex (Figs 43–45); coxae oblong, strongly enlarged to protect telopodites (Figs 43, 45). Telopodite only a little longer than coxa, showing a hook-shaped apical part (Figs 44, 45b) carrying a digitiform tubercle (Figs 43, 44, 45c). Solenomere very small and short, supplied with a distinct hairy pulvillus (Fig. 45a).



Figures 28–35. *Ammodesmus nimba* sp. n., male paratype. **28, 29** habitus, lateral view **30–32** anterior, middle and caudal parts of body, respectively, lateral view **33** midbody segments, dorsal view **34** head, frontal view **35** posterior part of body, ventral view. Scale bars: 100 μ m.



Figures 36–42. *Ammodesmus nimba* sp. n., male paratype. **36, 37** midbody paraterga, lateral and ventral views, respectively **38** metatergal bosses, sublateral view **39** tegument texture, dorsal view **40** first leg **41** modified setae of first leg **42** last right leg, lateral view. Scale bars: **36, 39, 40**, 50 μ m; **37**, 100 μ m; **38**, 20 μ m; **41, 42**, 10 μ m (**o**: ozopore).



Figures 43–46. *Ammodesmus nimba* sp. n. **43** gonopods, caudal view **44** right gonopod, frontal view **45** drawing of left gonopod, frontal view (a), apicofrontal (b) and caudal (c) views, respectively **46** right vulva, ventral view. Scale bars: **43**, **46**, 50 μm ; **44**, 20 μm ; **45**, 100 μm . (cx: coxae, dt: digitiform tubercle, tl: telopodite)

♀ agrees precisely in colour and structural details with ♂, also being (nearly) of the same size and counting 19 body rings. Vulva small, setose, poorly sclerotized, edge of bursa with some particularly long setae (Fig. 46).

Relationships. Superficially, both species of *Ammodesmus* might look sufficiently different to consider them as representing different genera, especially as regards the absence of sexual dimorphism in metatergal structure and the presence of a deep gonocoel in *A. nimba* as opposed to *A. granum*. The main distinctions can also be summarized in a tabular form (Table). However, based on all evidence, we are rather

inclined to recognize only two valid genera in Ammodesmidae, both quite disjunct also geographically (Fig. 47).

Name. Referring to the type locality, a noun in apposition.

Distribution. Known only from the type locality and probably endemic to Mt Nimba.



Figure 47. Distribution of the family Ammodesmidae.

Table. Principal differences between genera of Ammodesmidae

Key characters in genera of Ammodesmidae	<i>Amummodess granum</i>	<i>Ammodesmus nimba</i> sp. n.	<i>Elassystemma</i> spp.
Sexual dimorphism in metatergal structure	yes	no	no
Size	up to 2 mm long	idem	up to 5 mm long
Ozopore formula	5, 7, 9, 10, 12, 13, 15–17(18)	idem	5, 7, 9, 12, 15, 17(18)
First male leg with modified setae	yes	yes	no
Last male leg modified	yes	yes	no
Gonopod telopodite deeply sunken into a very evident gonocoel	no	yes	yes

Conclusion

Despite extensive efforts applying the same collecting techniques in similar habitats in many places, *A. nimba* appears to occur, and to be apparently common, only at the single locality whence it has been taken, whereas *A. granum* has a surprisingly wide

distribution. The vast range of *A. granum*, currently reported from the western part of Liberia, at Mt Nimba in Guinea and in the Taï forest in the western part of Ivory Coast, is rather unusual for such a tiny and hygrophilous animal. Certainly being likewise rather poorly vagile, this species can be assumed to represent a relict which must have been widely distributed in the past when woodlands were continuous in western tropical Africa (Couvreur et al. 2008).

Geographically, the family Ammodesmidae seems to be purely Afrotropical, *Ammodesmus* being obviously confined to western Africa while *Elassystremma* to eastern Africa (Fig. 47). All four *Elassystremma* species (*E. pongwe* Hoffman & Howell, 1981, *E. michielsi* VandenSpiegel & Golovatch, 2004, *E. leave* VandenSpiegel & Golovatch, 2004 and *E. prolaeve* VandenSpiegel & Golovatch, 2004) are slightly larger than *Ammodesmus* (up to 5 mm long), and their gonopods are invariably complex, sunken inside a deep gonocoel (VandenSpiegel and Golovatch 2004). Likewise, only one species, *E. prolaeve*, is widespread, occurring not only in Kenya and Malawi, but obviously also in-between in Tanzania (Fig. 47).

The use of Winkler-Mocsarski apparatuses, or Winkler apparatuses for short, appears to be the most appropriate technique in sampling particularly cryptic soil/litter fauna. This technique has allowed for material to be collected in almost any East and West African tropical forest prospected by the first author and it is most likely that new species will be revealed in the central parts of the continent, if the collecting efforts use appropriate techniques. At least the wide geographical gap between both genera certainly invites further studies (Hoffman 1993). More refinements to the distribution of already known species are also most plausible.

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Redescription of arenicolous dipluran *Parajapyx pauliani* (Diplura, Parajapygidae) and DNA barcoding analyses of *Parajapyx* from China

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Abstract

Littoral dipluran *Parajapyx pauliani* Pagés, 1959 was redescribed based on the specimens collected in Hainan Island, South China. The littoral habitat was confirmed for the species, as the first report of arenicolous dipluran in China. DNA barcoding fragment was sequenced for five *Parajapyx* species (18 individuals) from China, and this is the first report on DNA barcodes used for dipluran identification. The mean intra- and interspecific divergences are 1.9% and 19.1% respectively. Synonymy of *P. paucidentis* and *P. isabellae* was confirmed.

Keywords

Diplura, *Parajapyx*, littoral, DNA barcodes analysis, China

Introduction

The genus *Parajapyx* was erected by Silvestri (1903) with type species *P. isabellae* (Grassi, 1886). It is characterized by the mandible with five teeth and four denticles, absence of labial palpus, maxilla with first lobe slender and others pectinate, two pairs of spiracles on meso- and metanotum, four placoid sensilla on the terminal segment of antenna, subcoxal organ on urosternite I, eversible vesicles on urosternites II and

III, claw with single medial unguis, and symmetrical cerci with 4–5 inner teeth (Pagés 1952, Xie and Yang 1992).

Later, *Parajapyx* was divided into two subgenera (*Grassjapyx* and *Parajapyx*) according to the shape of cerci (inner margin of cerci straight, tooth 1 not separated from others by a sinus in *Grassjapyx* vs. teeth 2–5 or 3–5 on a convexity of the internal margin, tooth 1 is separated from others by a sinus in *Parajapyx*) (Pagés 1952). So far, there are 31 species (16 subspecies) described in subgenus *Grassjapyx*, and 24 species (7 subspecies) in subgenus *Parajapyx* (Sendra 2006, Luan et al. 2007) in the world. Five species of genus *Parajapyx* were reported in China (Xie and Yang 1992, Luan et al. 2007).

In April 2011, during the research of the diversity of basal hexapods in littoral of Asia-Pacific coast, seven specimens of *Parajapyx* were collected from intertidal zone of several beaches of Hainan Island, South China. Those specimens were identified as *Parajapyx pauliani* Pagés, 1959, which was firstly described based on only specimen from intertidal zone of Nosy Be, Madagascar Island, and Pagés doubted about the habitat where the species was collected (Pagés 1959).

In this study, we provided a detailed redescription of this species based on our specimens, and more discussion on its littoral habitat. We analyzed the DNA barcoding sequences (Hebert et al. 2003) of *P. pauliani*, as well as other four *Parajapyx* species living in soil, in order to confirm the validity of species, and provide a useful reference for the identification of *Parajapyx* species.

Materials and methods

Samples collection

With flotation method, the specimens of *P. pauliani* were collected directly from the water surface in Hainan, China, and stored in 80% ethanol. Specimens of other species were extracted by the Tullgren funnels from soil samples (Table 1). For *P. isabellae*, two individuals of its synonym *P. paucidentis* identified from the morphology were also sampled.

Taxonomy of *P. pauliani*

Seven specimens of *P. pauliani* were collected: four of which were mounted in Hoyer's solution for identification, two were morphological identified in the alcohol first and then used for DNA extraction, and one was reserved in pure alcohol. Measurements and photos were taken by the help of a phase contrast microscope NIKON E600. The species was identified by the comparison of characters of all known species of the genus. For the name of chaetotaxy, we used the nomenclature proposed by Pagés (1952, 1996), and made some minor modifications following García-Gómez (2009). Microsetae on the body and the sensilla on the antenna were studied in detail for this species. Each pro-, meso- and metasternum was divided to three areas to designate setae.

Table 1. *Parajapyx* species and outgroups used in the study.

Classification	Species	Locality	Number of individuals	GenBank Accession Numbers
Diplura				
Parajapygidae				
<i>Parajapyx</i>	<i>P. pauliani</i>	Hainan	2	JQ692327, JQ796634
	<i>P. emeryanus</i>	Shanghai	6	JQ796635- JQ796640
	<i>P. isabellae</i>	Shanghai	5	JQ796641- JQ796645
	<i>P. isabellae</i> (Syn. <i>P. paucidentis</i>)	Shanghai	2	JQ796646, JQ796647
	<i>P. hwasanensis</i>	Qinghai	1	JQ796648
	<i>P. yangi</i>	Gansu	2	JQ796649, JQ796650
Japygidae	<i>Occasjapyx japonicus</i>	Shanghai	1	HQ882833
Campodeidae	<i>Lepidocampa weberi</i>	Shanghai	1	HQ882832

Abbreviations. Ant. I-XXI= antenna segments I-XXI; BS= baculiform sensillum; M = macroseta; the position on dorsal of body as: ma = medial anterior, la= lateral anterior, mp = medial posterior, lp = lateral posterior; ms= microsensillum; m = microseta, n* = normal seta; s=sensillum; t1-t5= teeth of cercus.

* including all “s” setae named by Pagés (1952) and all supplemental setae inserted between M.

Molecular experiments

Eighteen individuals from five *Parajapyx* species were used for DNA barcoding analyses (Table 1), and two dipluran specimens from Japygidae and Campodeidae were used as the outgroups. All specimens were morphological identified in the alcohol first and then used for DNA extraction. We followed the experimental procedure for Collembola described in Potapov et al. (2010). Genomic DNA was extracted from one individual using the Wizard SV Genomic DNA Purification System (# 2361). The mitochondrial COI gene sequence was amplified (658 bp) by primer pair LCO (5’ - GGTCAACAAATCATAAAGATATTGG-3’) / HCO (5’- TAAACTTCAGGGT-GACCAAAAAATCA- 3’) (Folmer et al. 1994). PCR products were purified and then sequenced directly using both of the amplification primers.

Sequences analysis

DNA sequences were analyzed with the software DNASTAR (Burland 2000). The genetic divergences (p-distance) were analyzed using MEGA 4.0 (Tamura et al. 2007). The phylogenetic tree was constructed by PAUP 4.0 beta 10 (Swofford 2002) with Neighbour-joining method and 1000 bootstrap replicates.

Results

Parajapyx pauliani Pagés, 1959

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

Figs 1–17, Tables 2, 3

Material examined. 4 females, South China, Hainan Island, Sanya city, shingly beach of Ximaozhou island (samples No. 6 and 8), 18°14'N, 109°22'E, 5-IV-2011; 1 female, from sand beach of the Ximaozhou Island (sample No. 17), 6-IV-2011; 2 female, South China, Hainan Island, Changjiang County, Changhua town, from sand beach of Qizi Bay (sample No. 54), 19°21'N, 108°40'E, 7-IV-2011, coll. Y. Bu, C. W. Huang, M. B. Potapov and N. A. Kuznetsova. All specimens are kept at Institute of Plant Physiology & Ecology, CAS.

Redescription. Body length and width of adult female 2.8–3.0 mm, and 0.3–0.35 mm, respectively (four specimens, antenna and cerci not included). Tegument smooth, without ornamentation (Fig. 1).

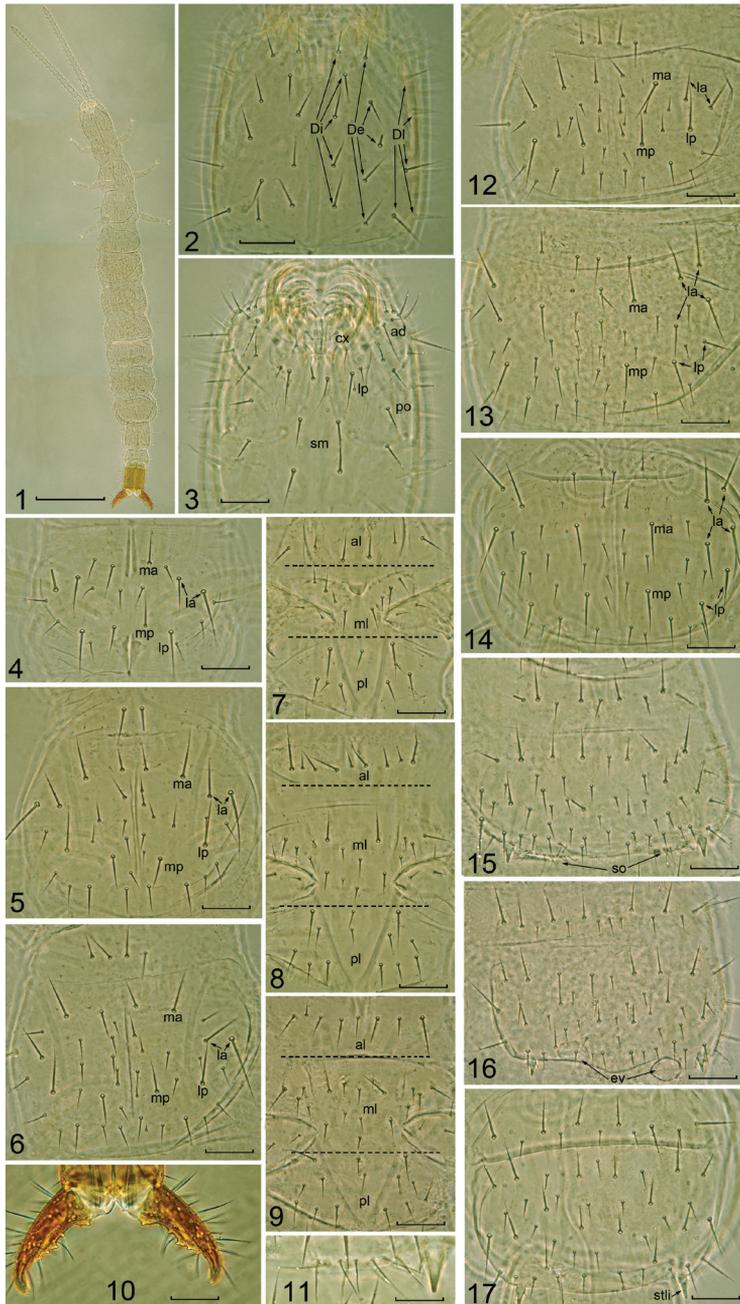
Head. Length 0.23–0.25 mm, width 0.23–0.25 mm. Dorsal side with 5+5 interior (Di), 5+5 exterior (De), and 10+10 lateral setae (Dl) (only show five on the picture), without front setae (Fig. 2). Labrum with two pairs of medial setae (1+1 M and 1+1 n), 6+6 m. On ventral side internal lobe (li) with 1+1 m; external lobe (le) with 9+9 setae; coxae (cx) with 1 M and 3n; labial palpus absent, replaced with 1 M accompanied by two normal seate; admentum with 11 setae, 3 M and 8 n; pli oral region with 4–5 setae; submentum with 2+2 setae (Fig. 3).

Mouthparts. Lacinia composed by five lobes, the first lobe (distal) is very acute and smooth, and the following four larger and pectinate. Mandible with five teeth and three denticles between them. Maxillary palpus with 10 n and 2 m setae.

Antenna with 21 segments, length 0.8 mm. Antenna segment I with seven microsetae dorsally and 5 setae, Ant. II and III each with 9 setae, Ant. IV with 11 setae, Ant. I–IV without sensilla and trichobothria, Ant. V with two bacilliform sensilla (BS) and 14–17 setae, Ant. VI with three BS and 16–18 setae, Ant. VII with three BS and 17–20 setae; Ant. VIII–XIX each with 4 BS and 18–28 setae, Ant. XX with 6 BS and 34–35 setae, Ant. XXI with eight BS and four placoid sensilla, and 55–60 seate. Single microsensillum asymmetrically present on Ant. IX–XIII, XVII, and XIX.

Thorax. Chaetotaxy of thorax as show in Table 2, 3. Pro-, meso- and metanotum each with 5+5 M setae and 6–17 n setae (Figs 4–6). Pro-, meso- and metasternum as show in Figs 7–9. Leg III length 0.3 mm, coxa with 1 M, 3 n and 2 m; trochanter with 1 M and 2 n dorsally, 1 m ventrally; femur with 10 n and 3 m setae; tibia with 8 n; tarsus with 10 n; claw symmetrical and with single medial unguis.

Abdomen. Chaetotaxy of the abdomen as shown in Table 2 and 3. Urotergite I (Fig. 12): prescutum with 4+4 m and 2+2 n, scutum with 6+6 m, 5+5 M and (10–14)+(9–14) n. Urotergites II–VII (Figs 13–14): prescutum with 4+4 m and 2+2 n, scutum with (6–8)+(6–8) m, 8+8 M and (9–18)+(9–19) n. Urotergite VIII with 12+12 m, 8+8 M and (9–10)+2(3)+(7–13) n. Urotergite IX with 7+7 m, 3+3 M and 2+1+2 n. Urotergite X with 4+4 m, 6+1+6 M and (6–8)+(6–8) n.



Figures 1–17. *Parajapyx pauliani* **1** Habitus **2** head, dorsal view (Di= dorsal interior setae; De= dorsal exterior setae; Dl= dorsal lateral setae) **3** head, ventral view (**ad**= admentum **cx**= coxae **lp**= labial palps area **sm**= submentum **po**= pli oral region) **4** pronotum **5** mesonotum **6** metanotum **7** prosternum (**al**= anterior lobe **ml**= middlelobe **pl**= posterior lobe, same for figs 8–9) **8** mesosternum **9** metasternum **10** cerci **11** subcoxal organ of urosternite I, right side **12** urotergite I **13** urotergite II **14** urotergite VII **15** urosternite I (**so**= subcoxal organ) **16** urosternite II (**ev**= eversible vesicles) **17** urosternite VII. Scale bar: 0.5 mm in Fig. 1; 0.1 mm in Figs 2–17.

Table 2. Chaetotaxy of dorsal side of body in adult *P. pauliani*

segments		m	M				n
			ma	mp	la	lp	
Pronotum		6+6	1+1	1+1	2+2	1+1	6+6
Mesonotum	Prescutum	6+6					1+1
	Scutum	3+3	1+1	1+1	2+2	1+1	(8-13)+(8-12)
Metanotum	Prescutum	7+7					2+2
	Scutum	3+3	1+1	1+1	2+2	1+1	(13-17)+(10-16)
Abd. I	Prescutum	3+3					2+2
	Scutum	5+5	1+1	1+1	2+2	1+1	(10-14)+(9-14)
II	Prescutum	4+4					2+2
	Scutum	6+6	1+1	1+1	4+4	2+2	(11-17)+(11-17)
III	Prescutum	4+4					2+2
	Scutum	7+7	1+1	1+1	4+4	2+2	(14-17)+(11+17)
IV	Prescutum	4+4					2+2
	Scutum	7+7	1+1	1+1	4+4	2+2	(11-17)+(11-18)
V	Prescutum	4+4					2+2
	Scutum	7+7	1+1	1+1	4+4	2+2	(12-17)+(13-18)
VI	Prescutum	4+4					2+2
	Scutum	7+7	1+1	1+1	4+4	2+2	(12-14)+(10-16)
VII	Prescutum	4+4					2+2
	Scutum	8+8	1+1	1+1	4+4	2+2	(9-14)+(9-14)
VIII	Scutum	12+12	1+1	1+1	4+4	2+2	(9-10)+2(3)+(7-13)
IX	Scutum	7+7			3+3		2+1+2
X	Scutum	4+4			6+1+6		(6-8)+(6-8)

Urosternite I (Fig. 15): prescutum with 2+2 m and 5 +5 n, scutum with 5+5 m, 10+10 M and (10-18)+1(2)(3)+(11-18) n. Subcoxal organ composed by 10-13 setae, including 6-8 slender glandular setae and 4-5 sensory setae, without medial glandular organ (Fig. 11). Urosternites II to VII (Figs 16-17): prescutum with 4 +4 m and (5-7)+1+(5-7) n setae, scutum with 5 +5 m, 12 +12 M, (7-12) + 2(3)+(6-11) n. Urosternite VIII with 4+4 m, 2 +2 M, (4-5)+(4-5) n. Urosternite IX with 4+4 m, 2 +2 M and 3+3 n. Urosternite X with 4 +4 m, 6+6 M and 3+1+3 n. Eversible vesicles present on the urosternites II-III, diameter 32-37 μm . Styli on urosternites I-III each with one short sensilla and one m seta, on urosternites IV-VII with single seta m. Female genital papilla with 10+2+10 n.

Cerci (Fig. 10) singly segmented, symmetrical, with five distinct internal teeth, crooked; t3 larger than others; interval between t1-t2 as two times as t2-t3 and t3-t4; t2-t4 with shoulder, dorsal side with 9 M, 5 n and 5 m, ventral side with 7 M, 3 n and 3 m; each cercus with 7–8 evaporation plates.

Distribution. So far, the species is known only from two localities: Hainan, China and Madagascar.

Remarks. *Parajapyx pauliani* is characterized by the antenna with 21 segments, nota each with 5+5 M setae and numerous normal setae, urotergites II-VII each with

Table 3. Chaetotaxy of ventral side of body in adult *P. pauliani*

segments		m	M	n
Prosternum	Anterior lobe	3+7+3	2+2	1+1
	Middle lobe	7+7	2+2	2+2
	Posterior lobe	6+6	1+1	2(3)+1+2(3)
Mesosternum	Anterior lobe	3+3	2+2	2+2
	Middle lobe	7+7	4+4	2+2+2
	Posterior lobe	6+6	3+3	3+2+3
Metasternum	Anterior lobe	4+4	2+2	2+1+2
	Middle lobe	5+5	4+4	3+2+3
	Posterior lobe	5+5	3+3	3+2+3
Abd. I	Prescutum	2+2		5+5
	Scutum	5+5	10+10	(10-18)+2(3)+(11-18)
II	Prescutum	4+4		(5-7)+1+(5-7)
	Scutum	5+5	12+12	(8-11)+2(3)+(8-11)
III	Prescutum	4+4		6(7)+1+6(7)
	Scutum	5+5	12+12	(8-9)+2(3)+(8-11)
IV	Prescutum	4+4		6(7)+1+6(7)
	Scutum	5+5	12+12	(8-11)+2(3)+(8-11)
V	Prescutum	4+4		(5-7)+1+(5-7)
	Scutum	5+5	12+12	(7-12)+2+(7-10)
VI	Prescutum	4+4		6+1+6
	Scutum	5+5	12+12	(8-12)+2+(7-10)
VII	Prescutum	4+4		5+1+5
	Scutum	5+5	12+12	(9-10)+2+(6-9)
VIII	Scutum	4+4	2+2	(4-5)+(4-5)
IX	Scutum	4+4	2+2	3+3
X	Scutum	4+4	6+6	3+1+3

8+8 M setae and numerous normal setae, and prescutum of urotergites II-V each with 2+2 normal setae. It has more normal setae than in other congeners. The numbers of M and m setae are relatively stable, but the numbers of normal setae are quite variable in different individuals.

Littoral habitat of *Parajapyx pauliani*

Three intertidal locations where *P. pauliani* was found are shown in Figs 18–20. All habitats are positioned lower than supralittoral, devoid of halophytes, and are directly influenced by sea water. The animal lives in shingly or sand beaches (Figs 18–20), between particles of different size: from 9 mm (with the whole variation from 5 to 16 mm, n=100) to 1.5 mm (1.0–2.3 mm, n=150) in diameter. *P. pauliani* appears to



Figures 18–20. Habitats of *Parajapyx pauliani* in Hainan (S China). **18** shingly beach of Ximaozhou Island, inset shows the size of stone **19** sand beach of Ximaozhou Island, inset show the size of sand granules **20** sand beach of Qizi Bay, inset show the size of sand granules ★ indicates the sample site.

be a dipluran member of a genuine littoral community and is often associated with collembolan species like *Yuukianura* sp., *Isotogastrura trichaetosa* Potapov et al. 2011, *Thalassaphorura* sp., *Oudemansia* sp., *Acherontiella* sp., *Archisotoma* sp.

The DNA barcoding

The DNA barcoding of 18 individuals from five *Parajapyx* species from China were sequenced, and deposited in GenBank (the accession numbers showed in Table 1). The genetic divergence between individuals of the same species is 1.9% in average, with span 1.5–5.3%, and it is 19.1% in average, with span 16.3–21.3% between different *Parajapyx* species.

The Neighbour-joining tree was constructed based on the barcoding sequences (Fig. 21). *P. pauliani* is clustered with *P. isabellae*. *P. isabellae* and *P. emeryanus* are valid species respectively well supported by barcoding analyses. Two individuals of *P. isabellae* (Syn. *P. paucidentis*) (teeth absent on the cerci) clustered together with five individuals of *P. isabellae* (teeth present on the cerci). The genetic divergence between *P. isabellae* (Syn. *P. paucidentis*) and *P. isabellae* is only 1.7% in average (with span 0.8–2.6%). In addition, individuals of *P. yangi* and *P. hwasanensis* clustered together with high support value, and the genetic divergence between them is low (0.2%).

Discussion and conclusion

Littoral records of *Parajapyx*

This is the first record of littoral dipluran in China. When *P. pauliani* was first found in intertidal zone in 1959, Pagés supposed that it is “purely fortuitous, and the single specimen collected was, in fact, might be pulled far away from its normal habitat by runoff” (Pagés 1959). Our records confirm the habitat of the species where it can live in narrow passages between sand particles due to slender and long body.

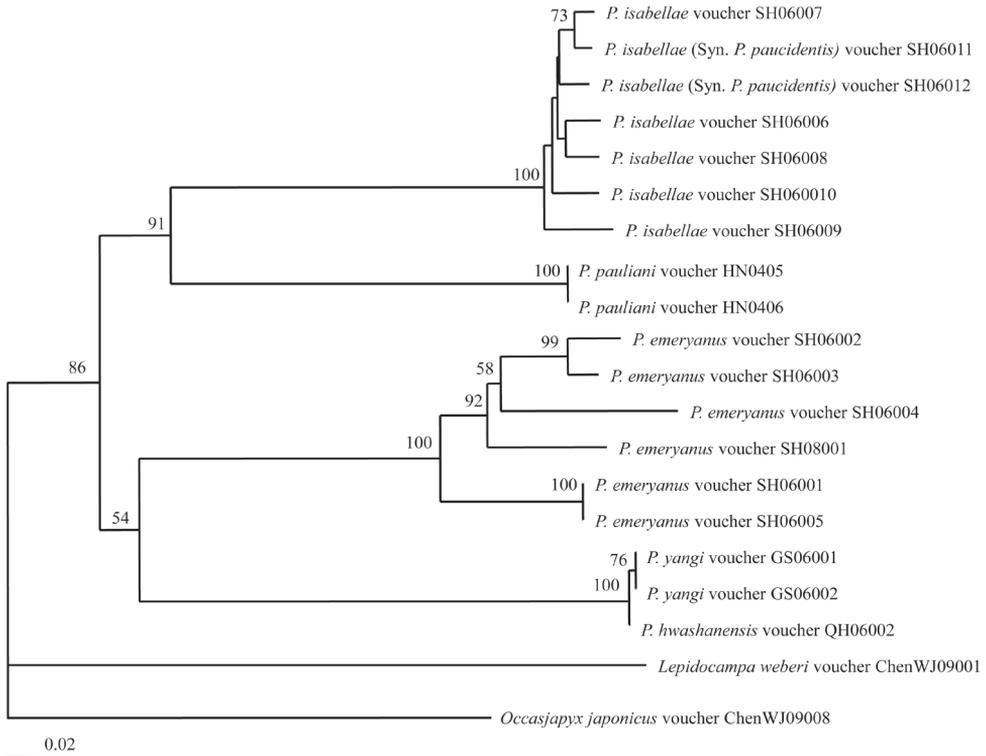


Figure 21. Neighbour-joining tree (p-distance, Bootstrap 1000 replicates) of Chinese *Parajapyx* inferred from COI gene sequences. Numbers on the nodes show the bootstrap values (> 50%).

Numerous normal setae on body of *P. pauliani* are shared with *P. botosaneanui* Pagés, 1975, described from intertidal zone of Caribbean coast of Cuba (Pagés 1975). The two species can be readily distinguished by the number of the segments of antenna (21 in *P. pauliani* vs. 19 in *P. botosaneanui*). More dense setaceous covering probably protects the littoral species of *Parajapyx* against the periodical contact with salt water. Three other *Parajapyx* species *P. gerlachi*, *P. isabellae*, and *P. (G.) brasilianus* were also recorded in intertidal localities (Pagés 1967).

Barcoding analysis

The DNA barcodes have been widely used in identification of microarthropod species, for instance, collembolans (Hebert et al. 2003, Hogg and Hebert 2004). To our knowledge, this is the first report on DNA barcodes of Diplura, which proved to be useful for dipluran identification. Our analyses confirmed the synonymy of *P. paucidentis* and *P. isabellae* proposed by Pagés (1998) and Luan et al. (2007). These species differed only by teeth in cerci, absent vs. present. The genetic divergence between *P. paucidentis* and

P. isabellae is 1.7% in average (with span 0.8–2.6%), which is exactly in the span of the divergence between individuals of the same species.

The formal morphological difference in second problematic couple, *P. yangi* and *P. hwasanensis*, is the number of teeth on the cerci: the former species has four teeth, while the latter has five. Our DNA barcoding data showed only one nucleotide difference between examined individuals of *P. yangi* and *P. hwasanensis*. All individuals, identified formally by us as *P. yangi* were, however, immature that indicated the possible age nature of this differences. The type materials of the two species call for study to make the final conclusions.

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A revision of the *Megachile* subgenus *Litomegachile* Mitchell with an illustrated key and description of a new species (Hymenoptera, Megachilidae, Megachilini)

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Abstract

The species of *Megachile* subgenus *Litomegachile* are revised with a review of the species morphology, biology, and plant associations. A new species, *Megachile pankus*, is described and illustrated. *Megachile mendica snowi* Mitchell is elevated to species. *Megachile* var. *nupta* Cresson and *M. texana* var. *cleomis* Cockerell are synonymized with *Megachile brevis* and *Megachile texana*, respectively. An illustrated key for *Litomegachile* is also provided.

Keywords

Revision, Mexico, leafcutting, bee, *Megachile*, morphology, nomenclature, illustration, key

Introduction

Litomegachile is a subgenus of *Megachile* Latreille, a large genus including leafcutting and resin bees. Leafcutting bees are solitary and get their name from their habit of using leaf pieces and other plant materials to form the lining of their nests (Michener 2007). Although sometimes difficult to separate from other *Megachile*, certain combinations of characters can be useful in identifying *Litomegachile*. For males, the combination of fore

coxal spines present, mandible tridentate, forelegs slender, unmodified and a tomentum of white hair on the sixth metasomal tergum is diagnostic. In females the combination of mandible with face dull in apical half, four-toothed (sometimes with dorsal tooth subtruncate), with distinct cutting edge between 2nd and 3rd teeth, sixth sternum with apical margin not upturned, scopal hairs uniformly covering ventral surface, and metasomal sterna lacking apical fringes of white hair separates them from other *Megachile*.

The subgenus was first described by Mitchell (1935). He provided a key to five species: *Megachile brevis* Say, 1837, *Megachile coquilletti* Cockerell, 1915, *Megachile gentilis* Cresson, 1872, *Megachile mendica* Cresson, 1878, and *Megachile texana* Cresson, 1878, and six infraspecific taxa: *Megachile mendica* var. *snowi* Mitchell, 1927, *Megachile brevis* var. *onobrychidis* Cockerell, 1908, *Megachile brevis* var. *nupta* Cresson, 1872, *Megachile brevis* var. *pseudobrevis* Mitchell, 1936, *Megachile texana* var. *cleomis* Cockerell, 1900, and *Megachile texana* var. *lippiae* Cockerell, 1900. There is a questionable record from Peru, that Mitchell named *Megachile buchwaldi* Mitchell, but it was never described and no type was ever designated (Raw 2004), so it is a *nomen nudum*. Sheffield et al. (2011) published a key to the *Megachile* of Canada in which he raised *Megachile onobrychidis*, *Megachile lippiae* and *Megachile pseudobrevis* to species level. Specimens from Mexico identified as *M. onobrychidis* and other unidentified specimens were found to be a new species, *M. pankus*, described below (Figures 1–2). Ten species are recognized here.



Figure 1. Illustration of *Megachile pankus* dorsal view.

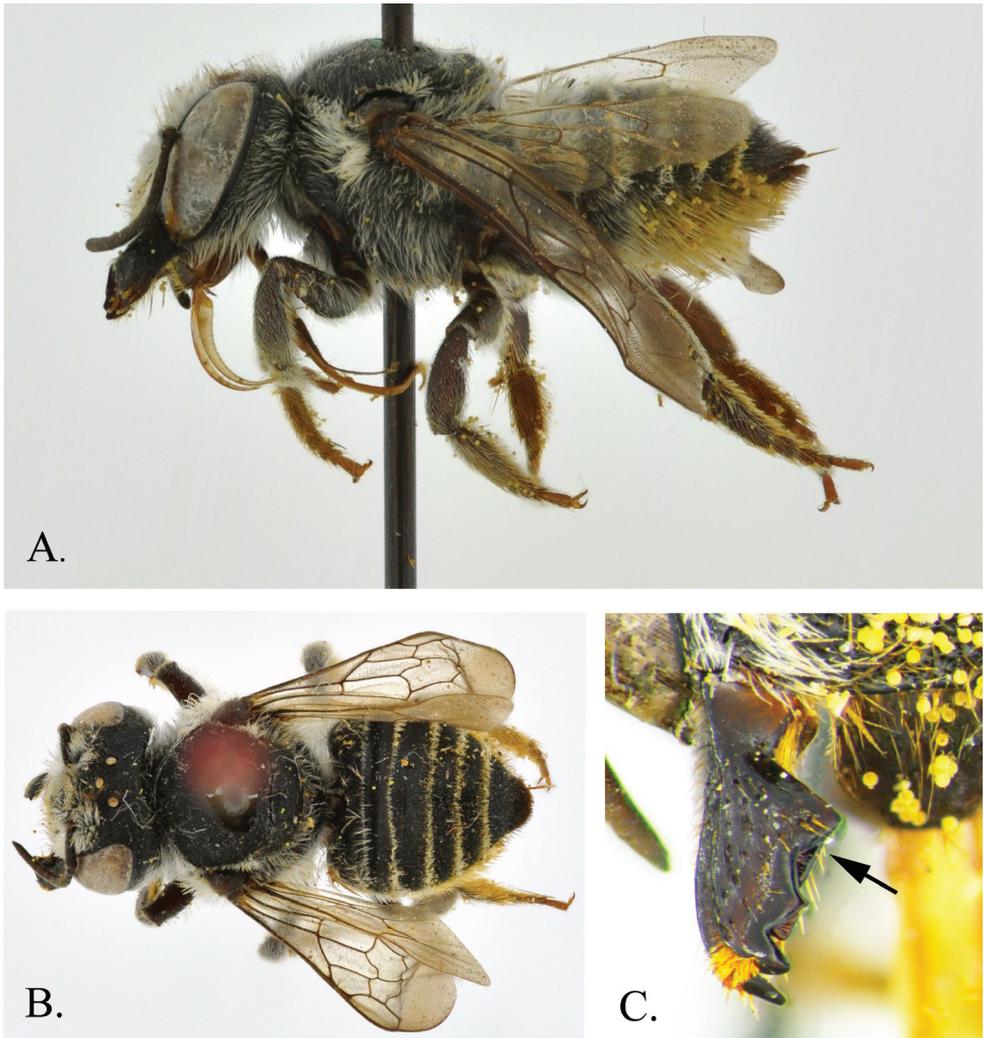


Figure 2. *Megachile pankus* **A** Lateral view **B** Dorsal view **C** Mandible showing angulation.

The life history and nesting biology of *Litomegachile* species is relatively well known (Michener 1953, Krombein 1967, Baker et al. 1985, Packer 1987). These bees are cavity nesters, usually choosing an existing cavity in wood, a plant stem, or the ground, where they construct a nest of several individual cells. The cells are arranged in a linear fashion, and are cylindrically shaped. Leaf or petal pieces are used to form a cup shape, and are often glued together by the female bee biting the edges to create adhesion (Krombein 1967). Kim (1992) found that cell size determines how much pollen is provisioned, which in turn determines the size of the resulting offspring. These bees follow the pattern shown in many other solitary bees which construct a linear nest. The females are larger than the males, and are placed in the rear of the nest behind the males, since they usually take longer to develop and emerge (Kim 1992).

Litomegachile has been considered a Nearctic subgenus (Mitchell 1935). However, at least *M. brevis*, *M. lippiae* and *M. pankus* have ranges that extend into the Neotropical Region. The local distribution of these bees may be strongly tied to favorable floral blooms, and may change throughout the season and from year to year (Michener 1953).

Materials and methods

Type depository collections are given in the text as the following acronyms: AMNH - American Museum of Natural History, New York, New York, USA; ANSP - Academy of Natural Sciences, Philadelphia, Pennsylvania, USA; BBSL - Bee Biology and Systematics Lab, Logan Utah, USA; BMEC - Bohart Museum of Entomology, University of California, Davis, California, USA; BMNH - The Natural History Museum, London, United Kingdom; USNM - U.S. National Museum, Washington, D. C. USA; MCZ - Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA; NCSU - North Carolina State University, Raleigh, North Carolina, USA; UCMC - University of Colorado Museum, Boulder, Colorado, USA. Approximately 1,300 Specimens were examined from the AMNH, BMEC, BBSL, and USNM. Primary type specimens were examined for *Megachile cleomis*, *Megachile coquilletti*, *Megachile cleomis* var. *lippiae*, *Megachile murinella*, *Megachile onobrychidis*, *Megachile pseudobrevis*, *Megachile schismatura*, and *Megachile snowi*. Type specimens of *M. pankus* sp. n. are deposited in BBSL, AMNH, and BMEC.

Distribution maps were created using data from Discover Life's online mapping program (Ascher and Pickering 2011). Records were included from the collections of AMNH, BMEC, BBSL, and USNM, as well as those that were determined by experts from other collections. Other specimen records exist, including those from Kansas University, Berkeley, San Diego, Los Angeles, Riverside and Chamela. Due to funding and time limitations, determinations were not confirmed for many of the records from these collections and therefore were not included in these maps. The book "Biodiversidad, taxonomía y biogeografía de artrópodos de México" provides state level records of *Litomegachile* for Mexico that are not included here (Ayala et al. 1997).

Plant classification and families for flower records follow that of the USDA Plants Database (<http://plants.usda.gov/java/>). Morphological terminology and measurements follows that of Michener (2007). Metasomal tergum 5 is given as "T5", metasomal sternum 6 is given as "S6" and flagellomere 1 as "F1". Head length is measured from the vertex to the apical clypeal margin. Head width is measured from the outer margins of compound eyes when viewed from the front (Figure 3B). Mandible teeth are numbered inward, with most distal tooth being number one. Ratios between width and length are given as a decimal for different dimensions of segments. Ratios of leg segment lengths are measured at the longest point, and compared to the respective femur length (Figure 3C). Antennocular distance is the width of the paraocular area from compound eye to the antennal socket. Interantennal distance is the width of the supraclypeal area between the antennal sockets (Figure 3B). The T6 transverse

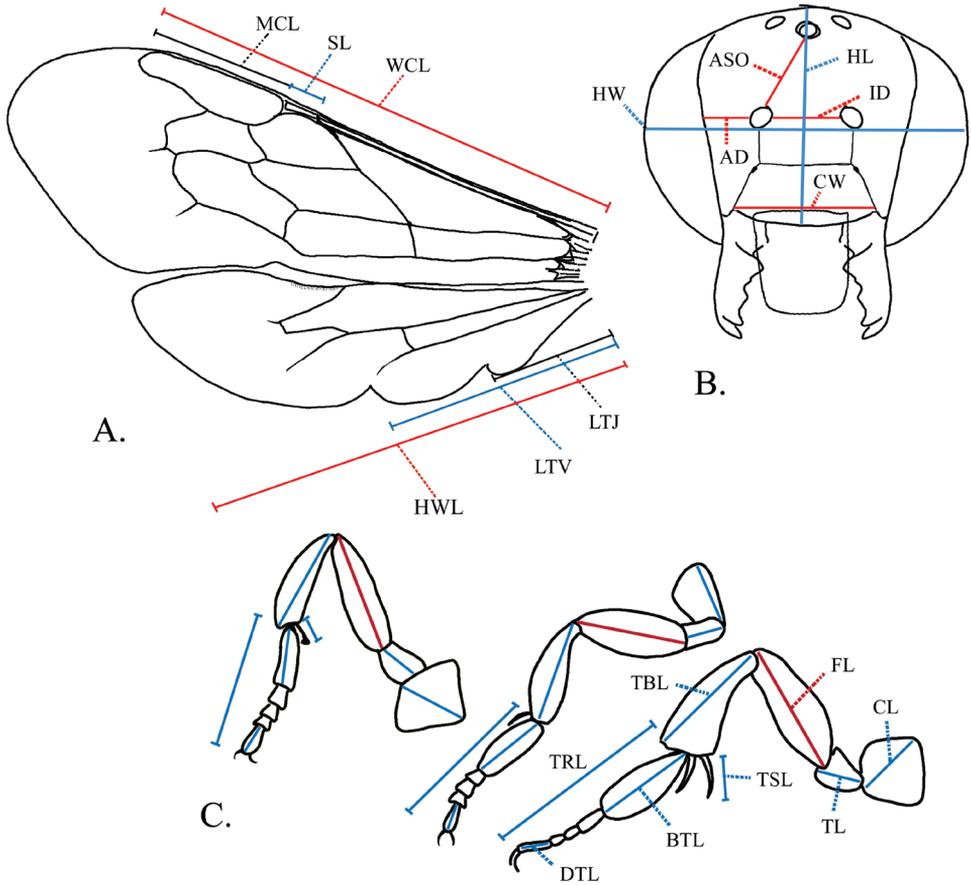


Figure 3. Measurement points for *Megachile pankus* **A** Wing measurements **B** Head measurements **C** Foreleg, midleg and hindleg measurements. Abbreviations: MCL=marginal cell length SL= stigma length WCL= wing cells length HWL=hind wing length LTV=length to vannal lobe LTJ= length to jugal lobe HW= head width HL=head length ASO= distance from antennal socket to anterior ocellus AD= antennocular distance ID= interantennal distance CW=clypeus width DTL=distitarsus length TRL=tarsus length BTL=basitarsus length TSL=tibial spur length TBL=tibia length FL=femur length TL=trochanter length CL=coxa length.

carina is a structure in males at the functional apex of the metasoma. It arises from the medial discal area of T6 and terminates in a notched or irregularly jagged edge (Figure 6C–I). Below the carina of T6, is the true apical margin, with four teeth: two submedial and two lateral (Figure 6A–B). The tomentum is a patch of white hair on T6 of males that is thick enough to hide the discal surface. Pubescence is defined as branched body hairs, such as those found on head, mesosoma, and discal surfaces of metasoma and apical fringes of hair of tergal segments. Setae are those unbranched, “eyelash-like” hairs found on the metasoma along the margins of tergal segments, and that make up the scopa on the sterna of females. Abbreviations used for measurements as illustrated in Fig. 3 are as follows: MCL=marginal cell length, SL= stigma length,

WCL= forewing length in region with cells, HWL=hind wing length, LTV=length to vannal lobe, LTJ= length to jugal lobe, HW= head width, HL=head length, ASO= distance from antennal socket to anterior ocellus, AD= antennocular distance, ID= interantennal distance, CW=clypeus width, DTL=distitarsus length, TRL=tarsus length, BTL=basitarsus length, TSL=tibial spur length, TBL=tibia length, FL=femur length, TL=trochanter length, CL=coxa length.

Key to the species of *Litomegachile*

Females

- 1 Mandible angulate between teeth 3 and 4 (Figure 4B) **2**
 – Mandible evenly concave between teeth 3 and 4 (Figure 4A) **5**
 2(1) S6 scopa entirely black; S5 scopa black apically, rest of scopa ivory (Figure 5C); metasomal terga with complete transverse apical fringes of white hairs ..
 ***M. gentilis* Cresson**
 – S6 scopa partially black, rest of scopa yellow (Figure 5D, 5F, 5H); metasomal terga with partial apical fringes of white hairs..... **3**
 3(2) T6 concave laterally and in profile, with erect setae arising above appressed black pubescence toward base in profile (Figure 5F) ***M. pankus* sp. n.**
 – T6 slightly concave laterally, straight in profile and without erect setae (Figures 5D, 5H) **4**
 4(3) T6 with pale appressed pubescence (Figure 5H) ***M. snowi* Mitchell**
 – T6 with brownish appressed pubescence (Figure 5D) ***M. mendica* Cresson**
 5(1) T6 slightly concave laterally and in profile (Figure 5B)
 ***M. coquilletti* Cockerell**
 – T6 strongly concave laterally and in profile..... **6**
 6(5) T6 with evenly concave slope in profile, with white appressed hair, and black erect setae basally (Figure 5I) **7**
 – T6 convex basally, then concave apically in profile; hair and setae variable (Figures 5A, 5E, 5G) **8**
 7(6) Only T5-T6 with black setae on lateral margins in dorsal view (Figure 5J) ...
 ***M. lippiae* Cockerell**
 – T2-T6 with black setae on lateral margins in dorsal view (Figure 5K).....
 ***M. texana* Cresson**
 8(6) S6 scopa mostly ivory, with few if any black setae apically; T6 with white appressed hair apically (Figure 5A) ***M. brevis* Say**
 – S6 scopa black; T6 with black appressed pubescence **9**
 9(8) S1-S5 scopa ivory; southwestern United States (Figure 5G).....
 ***M. pseudobrevis* Mitchell**
 – S5 bearing apical black hairs; Western United States and Canada (Figure 5E) ***M. onobrychidis* Cockerell**

Males

- 1 Apical margin of T6 (not transverse carina) with submedian teeth closer to each other than to lateral teeth, or distances equal (Figure 6A) **2**
- Apical margin of T6: submedian teeth closer to lateral teeth than each other (Figure 6B) **4**
- 2(1) Punctures on surface of T6 near the edges of tomentum crowded, edges form between depressions (Figure 6C); T2 with apical fringe of white hair (Figure 6J) ***M. gentilis* Cresson**
- Punctures on surface of T6 not crowded, shiny surface apparent between depressions (Figure 6D). T2 with no apical fringe of hair or fringe only present laterally (Figure 6K) **3**
- 3(2) T5 with complete apical fringe of white hair (Figure 6E) ***M. snowi* Mitchell**
- T5 without apical fringe of white hair (Figure 6D) ***M. mendica* Cresson**
- 4(1) Foretarsal segments 2-4 yellow, contrasting with dark basal segment (Figure 4F); T5 with incomplete apical fringe (Figure 6F) ***M. coquilletti* Cockerell**
- Entire front tarsi brown, tarsal segments not contrasting in color (Figure 4E); T5 with complete apical fringe **5**
- 5(4) Ocellular distance equal to ocelloccipital distance (Figure 4D) **6**
- Ocellular distance less than ocelloccipital distance (Figure 4C) **8**
- 6(5) T6 with a white tomentum that obscures the discal surface (Figure 6G) **7**
- T6 without tomentum, or if tomentum present, sparse, tergal surface visible beneath white hairs (Figure 6H) ***M. onobrychidis* Cockerell**
- 7(6) Metasomal pubescence entirely white ***M. brevis* Say**
- T3-T6 with mixed dark and light pubescence on discal surface ***M. pseudobrevis* Mitchell**
- 8(5) Mesonotum with white pubescence, no black hairs ***M. lippiae* Cockerell**
- Mesonotum with black hairs among white hairs ***M. texana* Cresson**

Species treatments

***Megachile (Litomegachile) brevis* Say, 1837**

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

Megachile brevis Say, 1837: 407. Syntypes male and female, USA: Indiana (destroyed).

Megachile lanuginosa Smith, 1853: 190. Syntypes male, female, USA: Florida (BMNH).

Megachile nupta Cresson, 1872: 268. Lectotype female, USA: Texas (USNM).

Megachile perbrevis Cresson, 1878: 127. Lectotype male, USA: Texas (USNM).

Diagnosis. *Megachile brevis* most closely resembles *M. onobrychidis*, *M. pseudobrevis*, and *M. coquilletti*. The female can be separated from these species by the combination of the ivory colored scopa, with a few black setae apically on S6, and with a small

amount of white appressed pubescence apically on T6 (Figure 5A). The comparable species have more black setae and no white appressed pubescence on T6. The male has brown tarsi that distinguish it from *M. coquilletti* (Figure 4E), and a tomentum on T6 which distinguishes it from *M. onobrychidis*.

Female. Body length 9–12 mm. Mandible 4-toothed, with no angulation between teeth 3 and 4 (Figure 4A). Head with white pubescence, vertex with black pubescence. Mesosoma with white pubescence, scutum with black pubescence. T2-3 with deep transverse basal grooves, T4 with shallow groove. T1 with white pubescence, T2 with white pubescence basally and black pubescence apically, T3-5 with black pubescence. T6 convex basally and concave apically in profile, and concave laterally in dorsal view; with black erect setae basally and black appressed pubescence, with some white appressed pubescence apically. S1-5 with ivory setae; S6 with ivory setae and few black setae apically (Figure 5A).

Male. Body length 7–9 mm. Mandible 3-toothed. Ocellocular distance equal to ocellocipital distance (Figure 4D). Head with white pubescence. All mesosomal pubescence white or ivory (may appear yellow in early season specimens). T1-5 with white discal pubescence. T5 with complete apical fringe of white hair that covers marginal zone. T6 with tomentum (Figure 6G); transverse carina variable in shape, but usually with indistinct medial notch and asymmetrical jagged projections; true apical margin with submedial teeth closer to lateral teeth than each other (Figure 6B). Genitalia and hidden sterna shown in Figures 7A1–A4.

Variability. The transverse carina of the male can vary significantly in this species, with some specimens barely showing any medial emargination, but most with jagged projections, where others have a medial notch. Females can have a few black scopal setae on S6 or all ivory colored scopae.

Distribution of material examined. USA: California: Calaveras, Lake, Orange, Placer, Riverside, Sacramento, San Diego, San Joaquin, Siskiyou Tulare and Yolo Counties (May–Oct.); Colorado: Weld County (Sep.); Idaho: Bingham County (Jun.); Nebraska: Dawes County (Aug.); New Mexico: Eddy County (Oct.); Nevada: Churchill County (Jun); New York: Suffolk County (Aug.); Oklahoma: Marshall and Oklahoma Counties (Apr.); Oregon: Jackson County (Sep.); Texas: Gregg and Tyler Counties (Jun.–Sep.); Utah: Garfield and Washington Counties (Apr.–Sep.); 67 females, 68 males.

Ecology. Michener (1953) published a detailed biology of *Megachile brevis* including a description of nest making, provisioning and development. *Megachile brevis* flies during the warmest parts of the year, with two to four generations per year, depending on locality and resources. It disperses widely from its natal site. Michener found that flower sources used by this species are diverse, but female bees tend to have a preference for blue, purple and white flowers, and a general faithfulness to a single type of pollen per collecting trip. *Megachile brevis* nested in a variety of situations, always nesting in preexisting hollows, including stems, burrows of other insects, dense foliage or spaces between rocks (Michener 1953). He also observed that *M. brevis* hunted for nesting sites by flying a few inches above the ground, and tended to nest near the soil surface. Larvae go through at least 4 instars (Baker 1985). *Megachile brevis* nests are parasitized

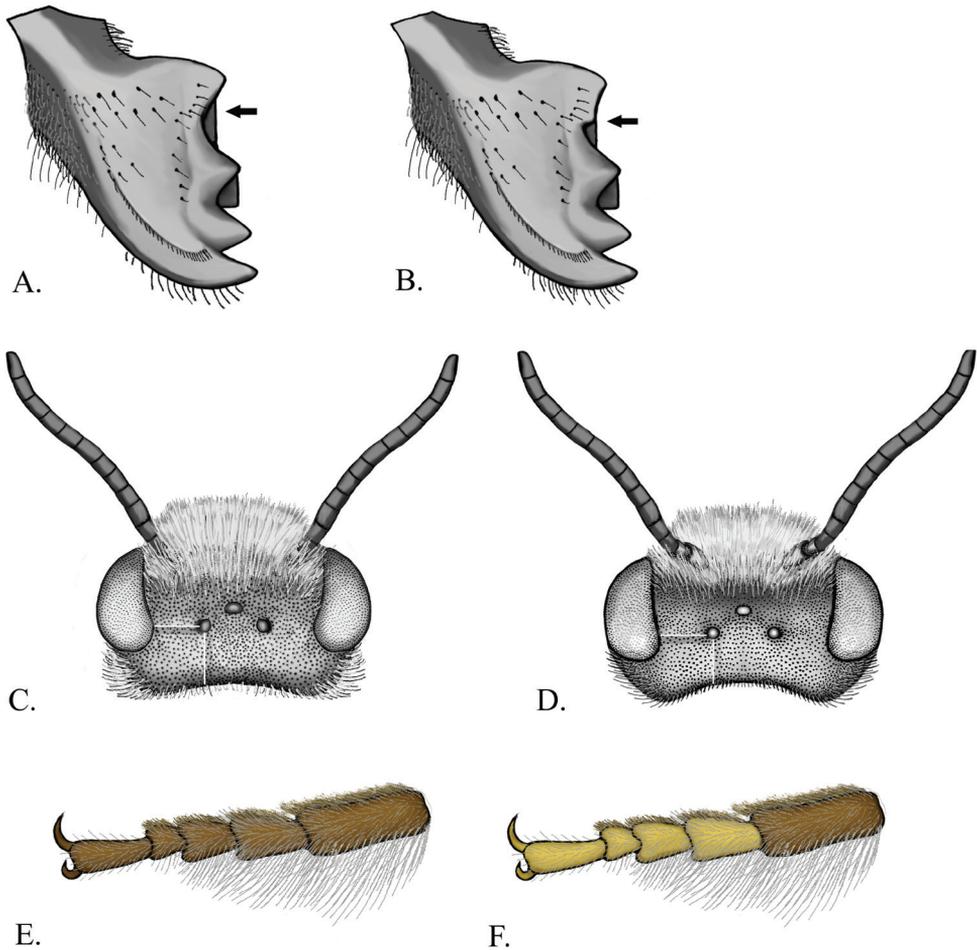


Figure 4. **A** Female mandible with even concavity **B** Female mandible with angulation **C** male *M. texana* head dorsal view of ocelli distances **D** Male *M. brevis* head dorsal view of ocelli distances **E** *M. brevis* front tarsus **F** *M. coquilletti* front tarsus

by a variety of species, including the megachilids *Coelioxys sayi* Robertson and *Coelioxys octodentata* Say, a clerid beetle (*Phyllobeanus* sp.), and wasps, including *Aprostocetus coelioxidis* Burks (Eulophidae), *Leucospis affinis affinis* Say (Leucospidae) and *Melittobia chalybii* Ashmead (Eulophidae) (Baker 1985).

Flower records. *Ailanthus* sp. (Simaroubaceae), *Amorpha canescens* (Fabaceae), *Baptisia* sp. (Fabaceae), *Cassia chamaecrista* (Fabaceae), *Centaurea jacea* (Asteraceae), *Erigeron philadelphicus* (Asteraceae), *Fagopyrum esculentum* (Polygonaceae), *Fallugia paradoxa* (Rosaceae), *Gossypium* sp. (Malvaceae), *Grindelia squarrosa* (Asteraceae), *Helianthus maximiliani* (Asteraceae), *Helianthus tuberosus* (Asteraceae), *Heliopsis scabra* (Asteraceae), *Kuhnistera purpurea* (Fabaceae), *Kuhnistera oligophylla* (Fabaceae), *Lactuca pulchella* (Asteraceae), *Machaeranthera tanacetifolia* (Asteraceae), *Marrubium vul-*

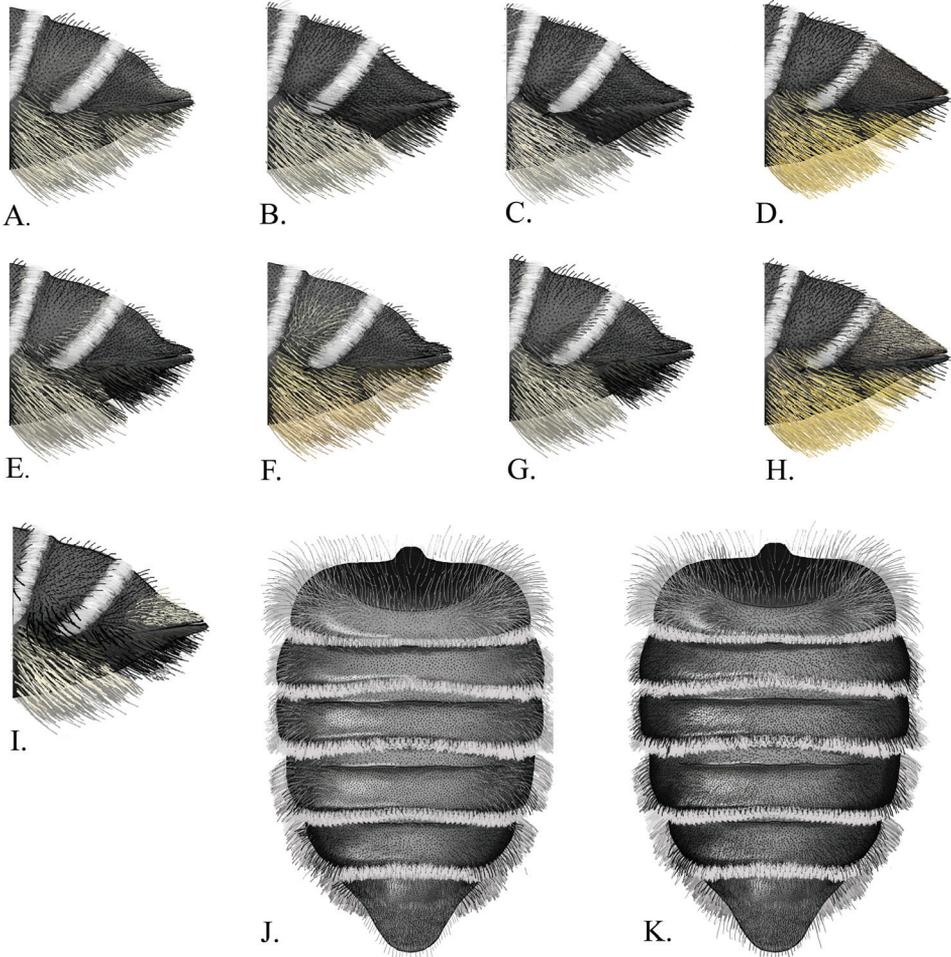


Figure 5. A–I Lateral view of T5-6 **A** *M. brevis* **B** *M. coquilletti* **C** *M. gentilis* **D** *M. mendica* **E** *M. onobrychidis* **F** *M. pankus* **G** *M. pseudobrevis* **H** *M. snowi* **I** *M. texana* **J–K** Dorsal view of metasoma **J** *M. lippiae* **K** *M. texana*.

gare (Lamiaceae), *Medicago sativa* (Fabaceae), *Melilotus alba* (Fabaceae), *Melilotus officinalis* (Fabaceae), *Mentzelia* sp. (Loasaceae), *Meriolix serrulata* (Onagraceae), *Oxalis violacea* (Oxalidaceae), *Phyla incisa* (Verbenaceae), *Polygonum aubertii* (Polygonaceae), *Polygonum hydropiperoides* (Polygonaceae), *Psoralea floribunda* (Fabaceae), *Schrankia uncinata* (Fabaceae), *Solidago canadensis* (Asteraceae), *Solidago nemoralis* (Asteraceae), *Solidago rugosa* (Asteraceae), *Symphoricarpos occidentalis* (Caprifoliaceae), *Trifolium hybridum* (Fabaceae), *Vernonia baldwinii* (Asteraceae).

Comments. *Megachile brevis* is the type species of the subgenus *Litomegachile*. It ranges across North America, north to southern Saskatchewan, Canada, and south into Mexico. There is also a record from as far south as northern Costa Rica (not shown on map) (Ascher and Pickering 2011) (Figure 8).

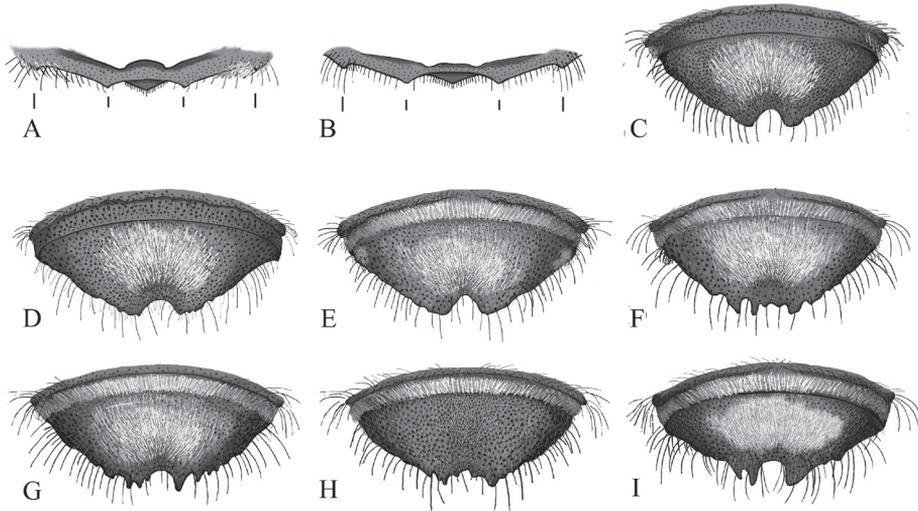


Figure 6. Male metasomal characters **A–B** Ventral view of true apical margin of T6 **A** Submedial teeth closer to each other than to lateral teeth, or distances equal **B** Submedial teeth closer to lateral teeth than each other **C–I** Male T6 posterior view **C** *M. gentilis* **D** *M. mendica* **E** *M. snowi* **F** *M. coquilletti* **G** *M. brevis* **H** *M. onobrychidis* **I** *M. lippiae*. **J, K** Metasoma dorsal view **J** *M. gentilis* **K** male *M. mendica*.

***Megachile (Litomegachile) coquilletti* Cockerell, 1915**

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

Megachile mendica coquilletti Cockerell 1915: 535. Holotype male, USA: Texas (USNM).

Diagnosis. Female *M. coquilletti* can be distinguished by the combination of a mandible with an even concavity in between teeth 3 and 4, and a slightly concave T6. It resembles *M. gentilis*, which has an angulation between teeth 3 and 4 of the mandible, and *M. brevis*, which has a much more concave T6 and much less black scopal setae on S6. Male *M. coquilletti* are easily distinguished from other *Litomegachile* by the foreleg with bicolored tarsomeres; the first 4 apical tarsomeres are yellow, contrasting with the darker basitarsus (Figure 4F). The males of all other species in the subgenus have uniformly brown foretarsi (Figure 4E).

Female. Body length 11–12 mm. Mandible 4-toothed, with no angulation between teeth 3 and 4 (Figure 4A). T2-3 with deep transverse basal grooves, T4 with shallow groove. T1-5 with apical fringes of white hair that covers marginal zone; T1-2 with thin fringes of white hair, with white discal pubescence, T3-5 with black discal pubescence. T6 slightly concave in profile and laterally in dorsal view; with black appressed pubescence and black erect setae basally. S1-5 with ivory setae; S6 with some ivory setae basally, mostly black setae (Figure 5B).

Male. Body length 9–12 mm. Mandible 3-toothed. Ocellocular distance less than ocellocipital distance (Figure 4C). Foretarsus pale yellow, contrasting with

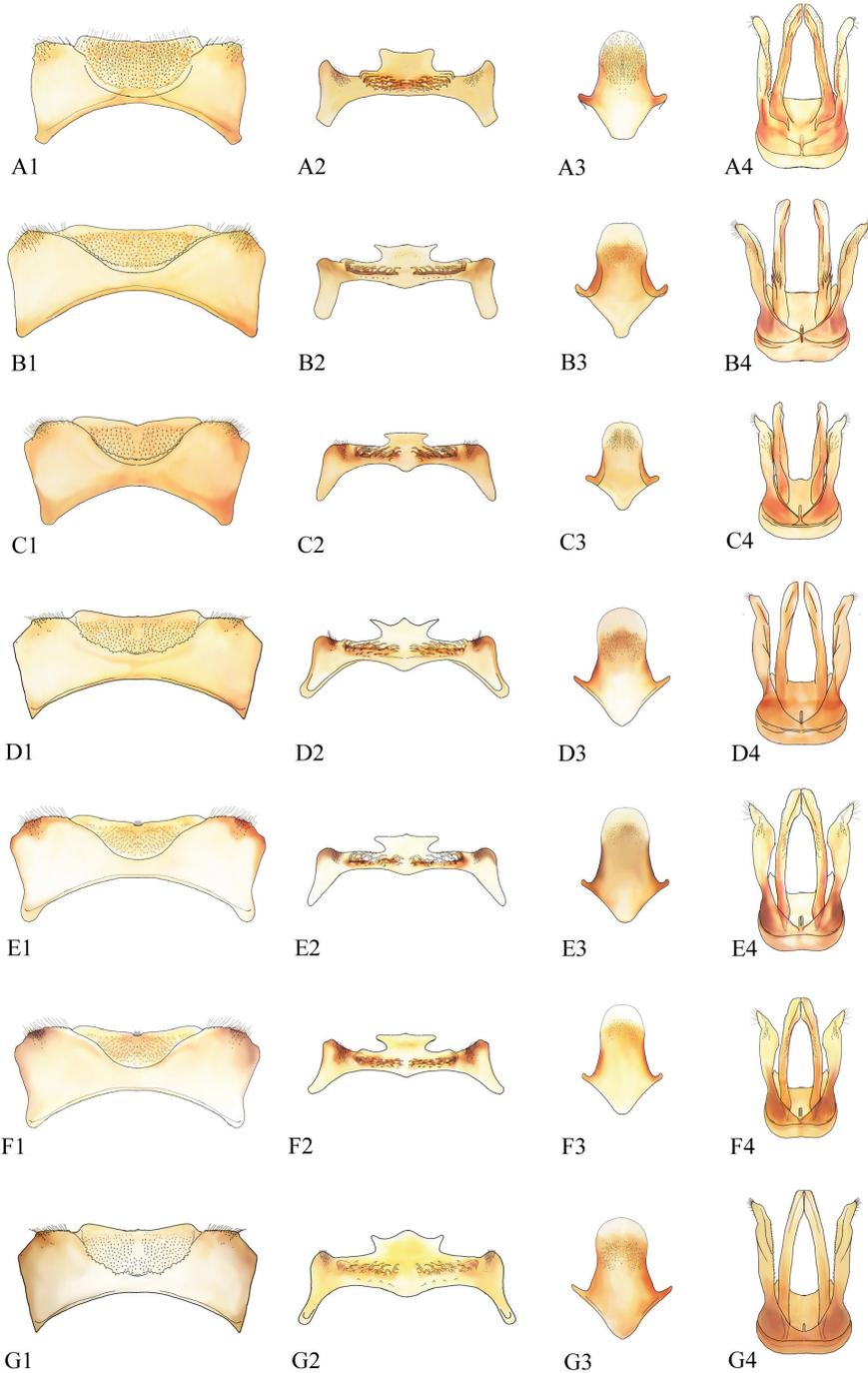


Figure 7. Male hidden sterna and genitalia. **A** *M. brevis*: 1.S5 2.S6 3.S8 4. genitalia **B** *M. coquilletti*: 1. S5 2. S6 3. S8 4. genitalia **C** *M. gentilis*: 1. S5 2. S6 3. S8 4. genitalia **D** *M. lippiae*: 1. S5 2. S6 3. S8 4. genitalia **E** *M. mendica*: 1. S5 2. S6 3. S8 4. genitalia **F** *M. snowi*: 1. S5 2. S6 3. S8 4. genitalia **G** *M. texana*: 1. S5 2. S6 3. S8 4. genitalia.

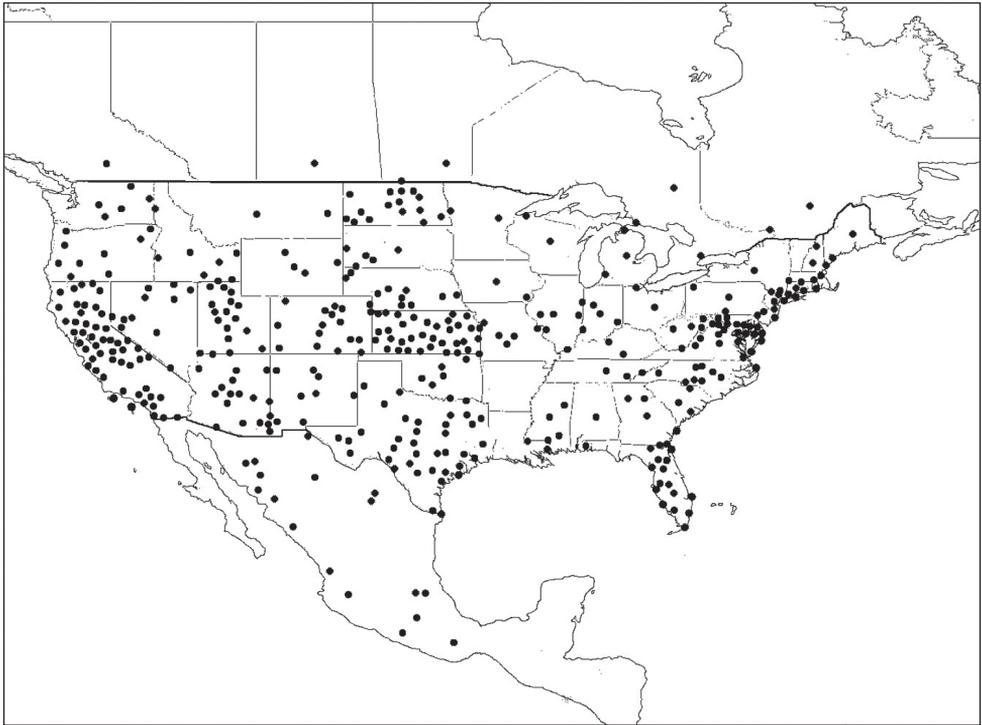


Figure 8. Distribution of *Megachile brevis*.

darker basitarsus (Figure 4F). Head and mesosoma with white pubescence. T5 with apical fringe of white hair that covers marginal zone, interrupted medially. T6 with tomentum (Figure 6F); with transverse carina variable in shape, but usually with distinct medial notch and projections; true apical margin with submedial teeth closer to lateral teeth than each other (Figure 6B). Genitalia and hidden sterna shown in Figures 7B1–B4.

Variability. Male tergal discal pubescence is variable in color. Some female specimens in fresh condition show a slight angulation between mandibular teeth 3 and 4. These may still be differentiated from *M. gentilis* by the lack of black setae on S5.

Distribution of material examined. USA: California: El Dorado and Yolo Counties (Jun.-Aug.); Nevada: Clark, Humboldt and Lincoln Counties (May-Jul.); Texas: Fayetteville County (Sep.); Utah: Cache, Garfield and Washington Counties (May-Aug.); 42 females, 105 males.

Ecology. *Megachile coquilletti* was collected in trap nests along the Cosumnes River south of Sacramento, California (Thorp et al. 1992).

Flower records. *Asclepias speciosa* (Asclepiadaceae), *Cirsium vulgare* (Asteraceae), *Medicago sativa* (Fabaceae), *Polygonum aubertii* (Polygonaceae), *Salix* sp. (Salicaceae), *Salvia* sp. (Lamiaceae), *Solidago* sp. (Asteraceae), *Tamarix* sp. (Tamaricaceae).

Comments. *M. coquilletti* is a western North American species (Figure 9).



Figure 9. Distribution of *Megachile coquilletti*.

***Megachile (Litomegachile) gentilis* Cresson, 1872**

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

Megachile gentilis Cresson, 1872: 267. Holotype male, USA: Texas (ANSP).

Megachile palmarum Perkins, 1899: 114. Syntypes male female, USA: Hawaii (Repository?).

Megachile murinella Cockerell, 1908: 263. Holotype female, USA: New Mexico (USNM).

Diagnosis. *Megachile gentilis* closely resembles *M. mendica*. The males of the two species can only be separated by two characters. In *M. gentilis*, the punctures on T6 are nearly contiguous creating the appearance of small ridges, with shiny surface almost completely obscured, and T2 has an apical fringe of white hair, while the fringe is absent in *M. mendica*. The females are slightly easier to differentiate. *M. gentilis* has a very slightly concave S6, with black pubescence and some erect setae basally. *M. mendica* has brown appressed pubescence and no erect setae. Also, *M. gentilis* has black scopal setae on S6 and basally on S5, while *M. mendica* has black setae only apically on S6. *M. gentilis* females also resemble *M. coquilletti* females. These can be differentiated by the angulate mandible of *M. gentilis* (Figure 4B).

Female. Body length 11–12 mm. Mandible 4-toothed, with surface between teeth 3 and 4 angulate (Figure 4B). T2-3 with deep transverse basal grooves, T4 with shallow groove. T1-5 with apical fringes of white hair that covers marginal zone, T1-2 with thin fringes of white hair. T1-2 with white discal pubescence, T3-5 with black discal pubescence. T6 very slightly concave in profile and laterally in dorsal view; with black appressed pubescence and black erect setae basally. (Figure 5C). S1-5 with ivory setae; S6 with black setae.

Male. Body length 9–11 mm. Mandible 3-toothed. Ocellocular distance less than ocellocipital distance (Figure 4C). Head with white pubescence; vertex with black pubescence. Mesosoma with white pubescence, scutum with black pubescence. T2 with thin apical fringe of white hair (Figure 6J). T5 without complete apical fringe of white hair that covers marginal zone, may have some hair laterally. T6 with tomentum; punctures crowded, nearly contiguous (Figure 6C); transverse carina with distinct medial notch; true apical margin with submedial teeth closer to each other than lateral teeth, or distances equal (Figure 6A). Genitalia and hidden sterna shown in Figures 7C1–C4.

Variability. As with other *Litomegachile* species, individuals that appear early in the flight season may have pubescence that appears yellow instead of white.

Distribution of material examined: USA: Arizona: Cochise, Pima and Santa Cruz Counties (Apr-Sep); California: Contra Costa, Mariposa Mendocino, Tuolumne

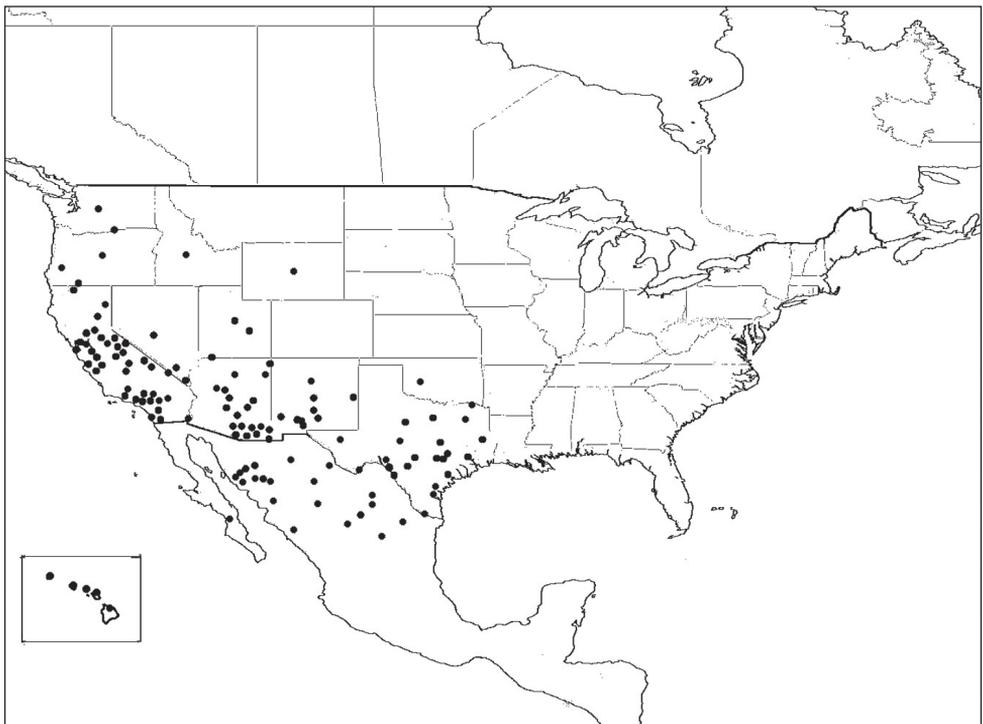


Figure 10. Distribution of *Megachile gentilis*.

and Yolo Counties (Jun.-Sep.); Utah: Washington County (May); Texas: Brewster County (May). MEXICO: Chihuahua and Sonora (Sep.); 103 females, 188 males.

Ecology. *Megachile gentilis* will nest in trap nests. Krombein (1967) recovered nests from trap nests placed under live or dead mesquite branches in open desert. Parasites reared by Krombein (1967) from these traps included *Tetrastichus megachilidis* Burks (Eulophidae), *Trichodes horni* Wolcott & Chapin (Cleridae), *Anthrax atriplex* Marston (Bombyliidae), and *Anthrax irroratus* Say (Bombyliidae).

Flower records. *Clarkia biloba* (Onagraceae), *Eriodictyon* sp. (Boraginaceae), *Gaillardia pulchella* (Asteraceae), *Melilotus alba* (Fabaceae), *Parkinsonia* sp. (Fabaceae), *Polygonum aubertii* (Polygonaceae).

Comments. *M. gentilis* is a western North American species, though records occur from eastern Texas, and populations are established in Hawaii (Snelling 2003) (Figure 10).

Megachile (Litomegachile) lippiae Cockerell, 1900

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

Megachile cleomis var. *lippiae* Cockerell, 1900: 15. Holotype female, USA: New Mexico (CAS).

Megachile schismatura Cockerell, 1908: 267. Lectotype female, USA: New Mexico (USNM). New synonymy.

Diagnosis. Female *M. lippiae* are distinguished from *M. texana* by looking at features of the metasoma in dorsal view. *Megachile lippiae* has black setae laterally only on T5–6 and sometimes a few black setae on T4 (Figure 5J). *Megachile texana* has some black setae on all tergal segments. The male *M. lippiae* has no black pubescence except sometimes on the vertex of the head. *Megachile texana* has black pubescence on the vertex of the head and the center of the mesonotum.

Female. Body length 12–14 mm. Mandible 4-toothed, with no angulation between teeth 3 and 4 (Figure 4A). T2–4 with deep transverse basal grooves. T1–5 with apical fringes of white hair that covers marginal zone; T1 with thin apical fringe of white hair. T1–4 with white discal pubescence, T5–6 with black setae apparent laterally in dorsal view (Figure 5J). T6 deeply and evenly concave in profile and laterally in dorsal view; with black erect setae basally and white appressed pubescence apically. S1–4 with ivory setae; S5 with ivory setae basally, black setae apically; S6 with black setae.

Male. Body length 11–13 mm. Mandible 3-toothed. Ocellocular distance less than ocellocipital distance (Figure 4C). All pubescence white (may appear yellow in early season specimens). T5 with complete apical fringe of white hair that covers marginal zone. T6 with tomentum; transverse carina with deep distinct medial notch and fingerlike projections (Figure 6I); true apical margin with submedial teeth closer to lateral teeth than each other (Figure 6B). Genitalia and hidden sterna shown in Figure 7D1–D4.

Variability. Male tergal discal pubescence is variable in color. Body hair may appear yellow in early season individuals. Females can have black setae that occur laterally on T4.

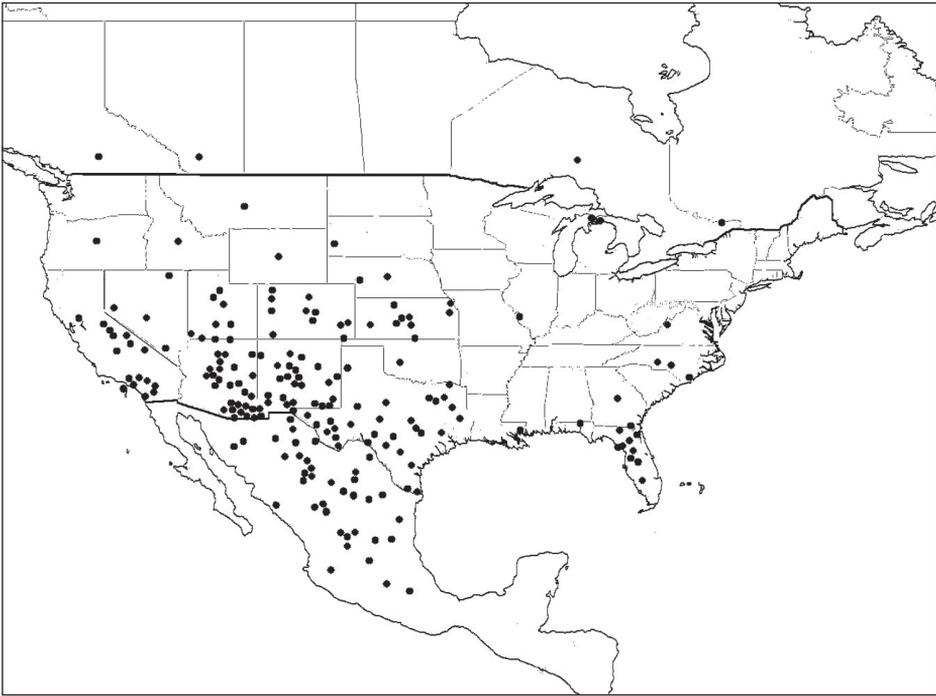


Figure 11. Distribution of *Megachile lippiae*.

Distribution of material examined. USA: Arizona: Cochise, Santa Cruz and Yavapai Counties (Aug.-Sep.); California: Los Angeles, Riverside and Yolo Counties (Jun.-Sep.); New Mexico: Hidalgo County (Aug.); 59 females, 68 males.

Flower records. *Asclepias* sp. (Asclepiadaceae), *Cevallia sinuata* (Loasaceae), *Eriodictyon angustifolium* (Boraginaceae), *Larrea tridentata* (Zygophyllaceae), *Lupinus* sp. (Fabaceae), *Melilotus alba* (Fabaceae), *Prosopis* sp. (Fabaceae), *Verbesina encelioides* (Asteraceae).

Comments. *Megachile lippiae* was originally described as a subspecies of *M. texana* (Mitchell, 1935). It was raised to species level by Sheffield et al. (2011). *Megachile lippiae* is primarily a western North American species, though records exist from eastern localities (Figure 11). *Megachile schismatura* is removed from synonymy under *M. texana* and placed as a synonym of *M. lippiae* herein.

***Megachile (Litomegachile) mendica* Cresson, 1878**

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

Megachile mendica Cresson, 1878: 126 Holotype female, USA: California (ANSP).

Diagnosis. *Megachile mendica* closely resembles *M. gentilis*. The females can be distinguished by difference in the T6 structure and pubescence color, and scopa color. Female *M. mendica* have a very straight T6 in profile, and slightly concave laterally in

dorsal view. The appressed pubescence on T6 is brownish in color. The scopa is yellowish, distinguishing it from other *Litomegachile* females which have a pale ivory colored scopa. An exception is *M. pankus*, which also has a yellow scopa, but it can be separated by its concave T6 in contrast with the straight T6 of *M. mendica*. The male *M. mendica* can be distinguished from *M. gentilis* by the distance between punctures on T6. *Megachile mendica* punctures occur roughly 0.25–0.5 the width of a puncture apart so that you can see the shiny discal surface in between (Figure 6D) Male *M. mendica* also lack the apical fringe of white hair on T2. Males of other species of *Litomegachile* have a complete apical fringe of white hair on T2.

Female. Body length 11–13 mm. Mandible 4-toothed, with surface between teeth 3 and 4 angulate (Figure 4B). T2–4 with shallow transverse basal grooves. T1–5 with apical fringes of white hair that covers marginal zone; T1–2 with medially interrupted fringes of white hair. T1 with white discal pubescence; T2–5 with black discal pubescence. T6 straight in profile and slightly concave laterally in dorsal view; with brown appressed pubescence, without erect setae. S1–5 and 6 with yellow setae, S6 with black setae apically (Figure 5D).

Male. Body length 8–10 mm. Mandible 3-toothed. Ocellocular distance less than ocellocipital distance (Figure 4C) Head with white pubescence, vertex with black pubescence. Mesosoma with white pubescence, scutum with black pubescence. T1–2 pubescence white; T3–5 white pubescence basally, black pubescence apically. T2 without thin apical fringe of white hair (Figure 6K). T5 without complete white hair fringe that covers marginal zone; may have some hair laterally. T6 punctures separated; shiny discal surface visible between; with tomentum; transverse carina with a distinct medial notch (Figure 6D); true apical margin with median teeth closer to each other than to lateral teeth, or distances equal (Figure 6A). Genitalia and hidden sterna shown in Figures 7E1–E4.

Distribution of material examined. USA: Arkansas: Pulaski County (Sep.); Delaware: New Castle County; Florida: Alachua and Monroe Counties (Jul.–Aug.); Georgia: Liberty County (Jun.); Illinois: Cook County (Aug.); Kansas: Douglas County (Aug.); Kentucky: Wayne County (Jul.); Maryland: Anne Arundel and Montgomery Counties (Jul.–Sep.); Missouri: Lapeer County (Jul); Mississippi: Oktibbeha County (Jun.); North Carolina: Pender County (Sep.); New Jersey: Atlantic and Burlington Counties (May.–Aug.); New York: Kings and Westchester Counties (Aug.); Oklahoma: Marshall County (Apr.); South Carolina: Chesterfield County (Sep.); Texas: Maverick County (May); Virginia: Clarke, Loudoun, Page and Shenandoah Counties (Jul.); West Virginia: Hampshire County (Jul.); Washington D.C. (Jun.–Oct.); 25 females, 42 males.

Ecology. *Megachile mendica* seems to be flexible in its choice of nesting sites across different habitats. When it nests in trap nests, it prefers a cavity diameter of around 8 mm, which is also preferred by *Megachile brevis* (Baker et al. 1985). In Texas, *M. mendica* was found to nest in sandy soil, and like *M. texana*, it will also excavate burrows in the soil (Williams et al. 1986). Krombein (1967) reared *M. mendica* from wooden block traps placed on limbs of pine oak and hickory. Generation number and times

differed based on the locality (Krombein 1967). Medler (1965) reared *M. mendica* at 21 degrees Celsius and found that they went from egg to mature larva in one week, spun a cocoon in one day, and took about 3 weeks for pupal development and adult emergence. An *M. mendica* larva was illustrated and described by Baker et al. (1985). In addition to *Coelioxys* sp. and *Leucospis affinis affinis* (Leucospidae), *M. mendica* nests are known to be parasitized by the flies *Anthrax irroratus irroratus* (Bombyliidae) and *Megaselia* sp. (Phoridae) (Baker et al. 1985).

Flower records. *Amorpha fruticosa* (Fabaceae), *Aster paniculatus* (Asteraceae), *Balduina angustifolia* (Asteraceae), *Bidens alba* (Asteraceae), *Calamintha ashei* (Lamiaceae), *Centaurea jacea* (Asteraceae), *Cephalanthus occidentalis* (Rubiaceae), *Chrysanthemum leucanthemum* (Asteraceae) *Pityopsis graminifolia* (Asteraceae), *Conoclinium coelestinum* (Asteraceae), *Eupatoriadelphus maculatus* (Asteraceae), *Flaveria linearis* (Asteraceae), *Helenium amarum* (Asteraceae), *Helianthus divaricatus* (Asteraceae), *Helianthus tuberosus* (Asteraceae), *Lavandula dentata* (Lamiaceae), *Medicago sativa* (Fabaceae), *Melilotus alba* (Fabaceae), *Parthenocissus quinquefolia* (Vitaceae), *Phaseolus* sp. (Fabaceae), *Psoralea floribunda* (Fabaceae), *Polygonum hydropiperoides* (Polygonaceae), *Rhus glabra* (Anacardiaceae), *Rubus* sp. (Rosaceae), *Silybum* sp. (Asteraceae), *Solidago serotina* (Asteraceae), *Tephrosia virginiana* (Fabaceae), *Vicia floridana* (Fabaceae).

Comments. *Megachile mendica* is distributed across North America south to Zacatecas, Mexico, though it was considered more of an eastern species by Mitchell (1934) (Figure 12).

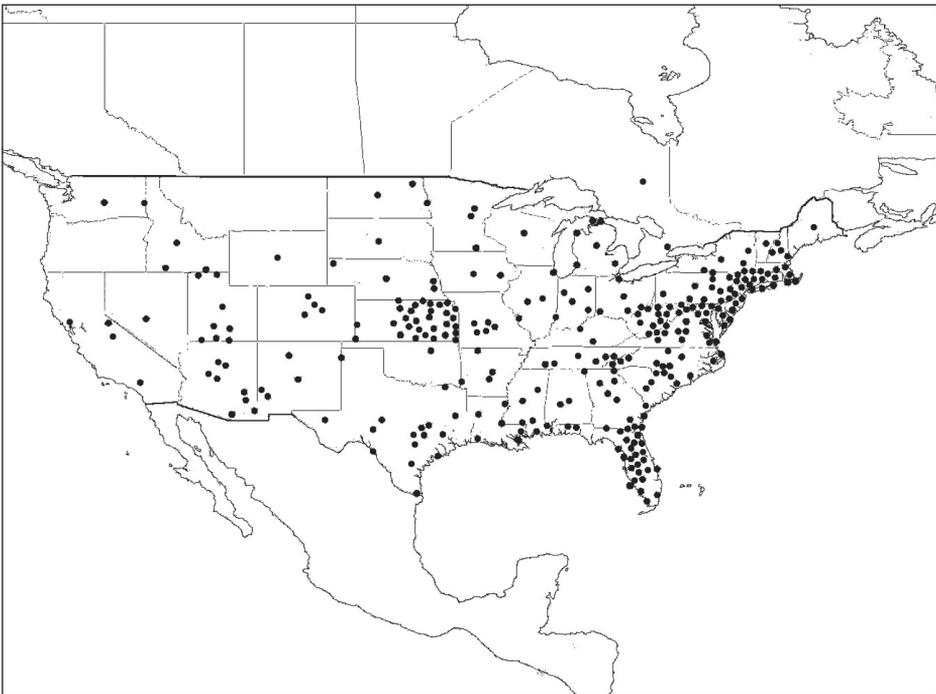


Figure 12. Distribution of *Megachile mendica*.

***Megachile (Litomegachile) onobrychidis* Cockerell, 1908**

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

Megachile onobrychidis Cockerell, 1908: 266 Holotype male, USA: New Mexico (CAS).

Diagnosis. The male *M. onobrychidis* is best distinguished from other species in this subgenus by the lack of a white tomentum on T6. The female *M. onobrychidis* resembles *M. brevis*, but with entirely black setae on S6 and apically on S5, and no pale appressed pubescence on T6.

Female. Body length 9–12 mm. Mandible 4-toothed with no angulation on surface between teeth 3 and 4 (Figure 4A). T2-3 with deep transverse basal groove, T4 with shallow groove. T1-5 with apical fringes of white hair that covers marginal zone; T1-2 with thin or medially interrupted fringes of white hair, and white discal pubescence; T3-5 with black discal pubescence. T6 convex basally and concave apically in profile, and concave laterally in dorsal view; with erect setae basally and black appressed pubescence. S1-4 with ivory setae; S5 with black setae apically, ivory setae basally; S6 with black setae (Figure 5E).

Male. Body length 7-9 mm. Mandible 3-toothed. Ocellocular distance equal to ocellocipital distance (Figure 4D). T1-2 with white discal pubescence; T4-6 with white discal pubescence basally, black pubescence apically. Head and mesosoma with white pubescence (may appear yellow in early season specimens). T5 with complete fringe of white hair that covers marginal zone. T6 without tomentum, hairs sparse and discal surface clearly visible beneath (Figure 6H); transverse carina variable in shape, usually with indistinct medial notch and asymmetrical jagged projections; true apical margin with submedial teeth closer to lateral teeth than each other (Figure 6B). Genitalia and hidden sterna resemble those of *M. brevis* (Figures 7A1-A4).

Variability. Male *M. onobrychidis* are separated from *M. brevis* in part by the lack of a tomentum on T6. Some specimens have no tomentum while others have sparse tomentum type hairs, but as long as these hairs are sparse enough so that the tergal surface is still visible, they are *M. onobrychidis*.

Distribution of material examined. USA: Arizona: Cochise County (Aug.); California: Calaveras, Colusa Contra Costa, Humboldt, Imperial, Lake, Lassen, Los Angeles, Mendocino, Merced, Modoc, Monterey, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Bernardino, Shasta, Siskiyou, Sonoma, Stanislaus, Tehama, Tuolumne, Tulare, Yolo and Yuba Counties (May-Oct.); Idaho: Canyon County (Aug.); Nevada: Churchill, Elko, Humboldt, Lyon and Washoe Counties (Jun.-Aug.); Oregon: Cassia and Jackson Counties (Jun.-Jul.); Utah: Cache and Wasatch Counties (Jun.-Aug.); MEXICO: Sinaloa, Sonora. 126 females, 193 males.

Flower records. *Asclepias speciosa* (Asclepiadaceae), *Calothamnus* sp. (Myrtaceae), *Clarkia biloba* (Onagraceae), *Clarkia dudleyana* (Onagraceae), *Clarkia unguiculata* (Onagraceae), *Dalea polydenia* (Fabaceae), *Daucus* sp. (Apiaceae), *Grindelia campo-*

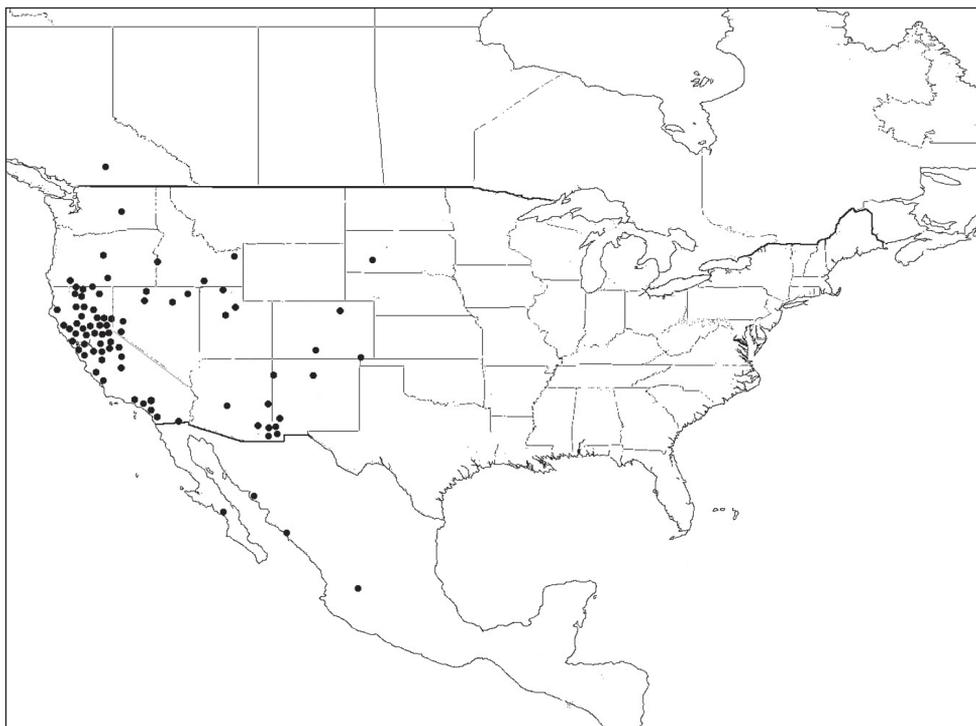


Figure 13. Distribution of *Megachile onobrychidis*.

rum (Asteraceae), *Lactuca pulchella* (Asteraceae), *Mentzelia* sp. (Loasaceae), *Phacelia* sp. (Hydrophyllaceae), *Polygonum aubertii* (Polygonaceae).

Comments. Mitchell (1935) listed this species as a subspecies of *M. brevis*. It was elevated to species level by Sheffield et al. (2011). It is a western North American species extending south to Sinaloa, Mexico. (Figure 13).

***Megachile (Litomegachile) pankus* sp. n.**

urn:lsid:zoobank.org:act:80ED5270-BA6B-42C8-AB4B-AEFA7A531D7A

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

Type material. Holotype female: MEXICO: Hidalgo, Pachuca, 11 Jun 1935, R. M. and G. E. Bohart (BBSL). Paratypes: 1 female: MEXICO: Sonora, Alamos, 4 Sep 1991 (AMNH), 1 female: MEXICO: Sinaloa, Mazatlan 28 Oct 1969 (BBSL); 1 female: MEXICO: Sinaloa, 4 mi NW Choix, 31 Aug 1968 (BMEC); 1 female: MEXICO: Sinaloa, 6 mi NW Choix, 6 Aug 1968 (BMEC).

Diagnosis. *Megachile pankus* is unique among *Litomegachile* species because the female has a mandible with an angulation between teeth 3 and 4, and T6 is basally convex and apically concave. No other species in the subgenus has this combination of characters. The female *M. onobrychidis* has similar metasomal features, but has more



Figure 14. Distribution of *Megachile pankus* (red indicates locality of holotype).

black setae on S6, while *M. pankus* has only a few black setae on T6. It can also be further distinguished from *M. onobrychidis* and *M. brevis* by the angulation between teeth 3 and 4 of the mandible. T6 is convex basally and concave apically in profile, and concave laterally in dorsal view, which distinguishes it from *M. mendica* or *M. gentilis*.

Female description. Body length 10 mm. Forewing length 7 mm. Head: HL $0.7\times$ HW; compound eyes convergent below, with upper inner margins slightly convergent above; lateral ocelli closer to margin of vertex than edge of compound eye; compound eye width $1.1\times$ width of genal area in lateral view; clypeus twice as wide as high (Figure 3B); clypeus and supraclypeal area slightly convex; punctuation fine, with larger punctures on clypeus, becoming smaller on supraclypeal, paraocular area, vertex and rest of head; punctures never separated by more than $0.3\times$ puncture diameter; labrum width $0.8\times$ length; AD $3\times$ width of antennal socket, ID $0.6\times$ ASO; ID $1.36\times$ length of scape; mandible with recessed cutting edges between teeth 3 and 4 and incomplete recessed cutting edge that forms rough right angle between teeth 3 and 2; surface between teeth 3 and 4 angulate (Figure 2C, 4B); scape length $4.3\times$ width, with white setae; pedicel and F1 width $0.8\times$ length; pedicel length $0.8\times$ F1; F2-6 length equal to width; F7-8 length $0.9\times$ width; F9 length $0.8\times$ width; F10 length $0.7\times$ width; Mesosoma: mesepisternum convex, large and pronounced, twice as wide as pronotum; scutum length $0.8\times$ width; scutellum length $0.3\times$ scutum length, scutellum width $0.4\times$ scutellum length; tegula twice as long as wide; scutum $7.2\times$ width of tegula. Wings: forewing length $2.7\times$ width; WCL $0.8\times$ length of wing; SL $0.2\times$ MCL; with two submarginal cells, first submar-

ginal crossvein angled parallel to medial vein, second submarginal crossvein angulate; distance from distal edge of stigma to wing base $0.7\times$ distance from wing base to distal edge of marginal cell; hindwing with jugal lobe that does not extend past cubital cell; LTJ $0.3\times$ HWL; LTV $0.5\times$ HWL (Figure 3A). Legs: ratio of segment length of foreleg (compared to FL): CL $0.6\times$, TL $0.3\times$, FL $1\times$, TBL $0.9\times$, TRL $1.2\times$, BTL $0.5\times$, DTL $0.3\times$; foreleg with tibial spur modified as antennal cleaner, TSL $0.2\times$; midleg segment ratios: CL $0.7\times$, TL $0.4\times$, FL $1\times$, TBL $1\times$, TRL $1.3\times$, BTL $0.7\times$, DTL $0.3\times$; foreleg with tibial spur, TSL $0.3\times$ TBL; hindleg segment ratios: CL $0.5\times$, TL $0.3\times$, FL $1\times$, TBL $0.9\times$, TRL $1.4\times$, BTL $0.7\times$, DTL $0.3\times$; tibia with two spurs, TSL $0.4\times$ TBL; hindleg with basitarsus dilated $4.5\times$ width of distitarsus (Figure 3C). Metasoma: T2-4 with shallow transverse basal grooves; T1-5 with apical fringes of white hair covering marginal zone, T1-2 fringe widths $0.2\times$ width of discal surface medially, T3-5 fringe widths $0.3a$ width of discal surface medially; T1-2 apical fringes of white hair more sparse, marginal zone slightly visible between hairs; T1-5 with white discal pubescence; T6 discal surface with black appressed pubescence and black erect setae; T6 convex basally and concave apically in profile, and concave laterally in dorsal view; S1-5 with yellow setae; S6 with yellow setae and some black setae apically (Figure 5F). Color: Body black, legs brownish distally, wing membrane slightly tinted brown, veins brown (Figure 2A-B). Pubescence: White on head except ocellar region black; paraocular area, supraclypeal area and clypeus with dense pubescence obscuring view of integument; vertex with sparse pubescence with integument visible beneath; genal area with pubescence sparse beginning at dorsal surface, progressively more dense toward malar area. Mesosomal pubescence white; dense around tegula and behind scutellum, sparse on scutum, dense on ventral mesosomal surface.

Male. unknown

Etymology. The species name '*pankus*' is a nonsense combination.

Distribution. *Megachile pankus* has only been collected in Mexico (Figure 14).

Flower records. *Petalostemon* sp. (Fabaceae).

***Megachile pseudobrevis* Mitchell, 1934**

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

Megachile brevis pseudobrevis Mitchell, 1934 Holotype female, USA: Florida (NCSU).

Diagnosis. *Megachile pseudobrevis* closely resembles *M. brevis* and *M. onobrychidis*. The differences between *M. pseudobrevis* and *M. brevis* are slight. Female *M. pseudobrevis* has less black appressed pubescence on T6 than *M. brevis*. Also the scopa of *M. pseudobrevis* has less black setae than *M. onobrychidis*, with black setae being restricted to S6. *Megachile pseudobrevis* has more black setae than *M. brevis*, which has often only a few black setae apically on S6.

Female. Body length 9–11 mm. Mandible 4-toothed, with no angulation between teeth 3 and 4 (Figure 4A). T2-3 with deep transverse basal groove, T4 with shallow basal groove. T1-5 with apical fringes of white hair covering marginal zone; T1-2 with medially



Figure 15. Distribution of *Megachile pseudobrevis*.

interrupted fringes of white hair. T1 with white discal pubescence; T2 discal pubescence white basally, black apically; T3-5 with black discal pubescence. T6 convex basally and concave apically in profile, concave laterally in dorsal view; with black erect setae basally and black appressed pubescence. S1-5 with ivory setae; S6 with black setae (Figure 5G).

Male. Body length 7–9 mm. Mandible 3-toothed. Ocellocular distance equal to ocellocapital distance (Figure 4D). T5 with complete apical fringe of white hair covering marginal zone. T6 with tomentum; transverse carina variable in shape, usually with indistinct medial notch and asymmetrical jagged projections; true apical margin with submedial teeth closer to lateral teeth than each other (Figure 6B). Genitalia and hidden sterna resemble those of *M. brevis* (Figures 7A1–A4).

Distribution of material examined. USA: Florida: Alachua, Duval, Monroe and Orange Counties (Mar.-Sep.); 14 females, 16 males.

Ecology. Packer (1987) observed *Megachile pseudobrevis* nesting in tufts of grass, creating nests of single cells. *Megachile pseudobrevis* preferred the commonest flowering plant *Bidens pilosa* (Asteraceae) at the site as a source for cutting nesting material, but also used petals from *Eustoma exaltatum* (Gentianaceae). Nests were parasitized by the meloid beetle *Nemognatha punctulata* LeConte (Packer 1987).

Flower records. *Balduina angustifolia* (Asteraceae), *Bidens pilosa* (Asteraceae), *Eriogonum tomentosum* (Polygonaceae), *Eustoma exaltatum* (Gentianaceae), *Lupinus cumulicola* (Fabaceae), *Vitex agnus castus* (Verbenaceae).

Comments. *Megachile pseudobrevis* was originally described as a variety of *M. brevis*. It was raised to species level by Sheffield et al. (2011). This species has a limited range occurring in the southeastern United States (Figure 15).

***Megachile (Litomegachile) snowi* Mitchell, 1927, stat. n.**

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

Megachile mendica snowi Mitchell, 1927: 113 Holotype female, USA: Arizona (MCZ).

Diagnosis. *Megachile snowi* is distinguished from *M. mendica* in males by the presence of a complete apical fringe of white hair on T5. *Megachile mendica* has little or no apical fringe of white hair on T5. Female *Megachile snowi* have white appressed pubescence on T6, and the few black scopal setae of S6 are only found apically. *Megachile mendica* has brown pubescence on T6, and S6 has more black setae.

Female. Body length 11–13 mm. Mandible 4-toothed, with surface between teeth 3 and 4 angulate (Figure 4B). T2–4 with shallow transverse basal groove. T1–5 with apical fringes of white hair covering marginal zone; T1–2 with medially interrupted fringes of white hair. T1–2 with white discal pubescence; T3–5 with black discal pubescence. T6 straight in profile and slightly concave laterally in dorsal view; without erect setae, with white appressed pubescence. S1–5 with yellow setae; S6 with yellow setae and few black setae apically (Figure 5H).

Male. Body length 8–10 mm. Mandible 3-toothed. Ocellocular distance less than ocellocapital distance (Figure 4C). Mesosoma with white pubescence. T1–3 with white discal pubescence; T4–5 with white pubescence basally, black apically. T2 with thin apical fringe of white hair. T5 with complete apical fringe of white hair covering marginal zone. T6 with tomentum (Figure 6E); transverse carina with a distinct medial notch; true apical margin with submedial teeth closer to each other than to lateral teeth, or distances equal (Figure 6A). Genitalia and hidden sterna shown in Figures 7F1–F4.

Distribution of material examined. USA: Arizona: Cochise County (Aug.–Sep.); California: *Mariposa County* (May); Colorado: Boulder County (May–Jun.); New Mexico: Catron County (Jul.); Utah: Cache, Garfield, Kane and Salt Lake Counties (May–Aug.); MEXICO: Zacatecas. 17 females, 35 males.

Flower records. *Cirsium* sp. (Asteraceae), *Helianthus* sp. (Asteraceae), *Melilotus alba* (Fabaceae).

Comments. This species was originally described as a subspecies of *M. mendica* (Mitchell, 1935). It is raised to species level herein, based on reliable morphological characters distinguishing it from *M. mendica*, and an overlapping range with the latter (Figures 12, 16). Mitchell (1935) found a male *M. cleomis* cotype to be misidentified, and previously synonymized it under *M. mendica snowi*. See *M. texana* comments. *Megachile snowi* is a southwestern North America species (Figure 16).



Figure 16. Distribution of *Megachile snowi*.

***Megachile (Litomegachile) texana* Cresson, 1878**

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

Megachile texana Cresson, 1878: 125. Holotype male, USA: Texas (ANSP).

Megachile generosa Cresson, 1878: 125. Holotype female, USA: Georgia (ANSP).

Megachile cleomis Cockerell, 1900: 13. Lectotype female (here designated), “USA: NM, E. Las Vegas, July 15 ‘99 Collector: A. Garlick, on Cleome” (UCMC).

Megachile pruinosa Friese, 1903: 246. Syntypes male female, (Repository?). Nec. Perez 1897.

Megachile vernonensis Cockerell, 1912: 354. Holotype male, CANADA: British Columbia (Repository?).

Diagnosis. *Megachile texana* is most similar to *M. lippiae* in size and appearance. The chief differences are pubescence coloration and some structural differences in the transverse carina on T6 of the male. *Megachile texana* females have more black setae and pubescence apparent laterally on T2-T6 than *M. lippiae* which only has black setae on T4-T6. *Megachile texana* males also have black pubescence on the mesonotum and T2, while *M. lippiae* has only white pubescence. Both *M. lippiae* and *M. texana* have a transverse carina on T6 with a distinct deep medial notch and jagged projections.

These carina projections tend to be shorter in *M. texana*, whereas the carina of *M. lippiae* often has long “fingerlike” projections. *M. texana*,

Female. Body length 11–14 mm. Mandible 4-toothed, with no angulation between teeth 3 and 4 (Figure 4A). T2-4 with deep transverse basal grooves. T1-5 with apical fringes of white hair covering marginal zone. T1 with black discal pubescence medially, white pubescence laterally. T2-5 with black discal pubescence and setae (Figure 5K). T6 with pale appressed pubescence and erect black setae basally. T6 deeply and evenly concave in profile and laterally in dorsal view. S1-4 with ivory setae; S5 with ivory setae basally, black setae apically; S6 with black setae (Figure 5I).

Male. Body length 10–12 mm. Mandible 3-toothed. Ocellular distance less than ocellocipital distance (Figure 4C). Head with white pubescence, vertex with black pubescence. Mesosoma with white pubescence, scutum with black pubescence. T5 with complete apical fringe of white hair covering marginal zone. T6 with tomentum; transverse carina with distinct deep medial notch and short jagged projections; true apical margin with submedial teeth closer to lateral teeth than each other (Figure 6B). Genitalia and hidden sterna shown in Figures 7G1-G4.

Variability. Male tergal discal pubescence variable in color. Pubescence of male mesonotum and head can vary, making it occasionally challenging to differentiate this species from *M. lippiae*. Primarily, if there is any black pubescence on the mesonotum,



Figure 17. Distribution of *Megachile texana*.

it is *M. texana*. If there are no black hairs in this area, it is *M. lippiae*. The females of these two species are also sometimes difficult to separate. *Megachile lippiae* can occasionally have black setae laterally on T4 in addition to T5, but if the black setae are present on T3 or T2, then it is *M. texana*. *Megachile texana cleomis* was distinguished by the presence of black setae on T3, but that form is now in synonymy under *M. texana*.

Distribution of material examined. USA: Arizona: Cochise, Gila and Maricopa Counties (May-Aug.); California: Mariposa, Riverside, Tuolumne and Trinity Counties (Apr.-Jul.); Florida: Alachua, Putnam and Duval Counties (Jun.-Oct.); Mississippi: Oktibbeha County (May); New Mexico: Eddy County (Aug.); New York: New York County (Jun.); Nevada: Clarke, Lincoln and Washoe Counties (Jun.); South Carolina: Chesterfield and Dorchester Counties (May); Texas: Brewster County (Apr.); Utah: Cache, Garfield, Tooele and Washington Counties (Jun.-Sep.); MEXICO: Puebla. 46 females, 57 males.

Ecology. *Megachile texana* utilizes existing nesting sites in the ground and under rocks (Krombein 1970). Observations by Eickwort et al. (1981) showed that these bees also excavate their own nests. The cocoons completely fill their cells and are covered with an outer layer of reddish brown threads and an inner layer of brown threads (Eickwort et al. 1981).

Flower records. *Arctostaphylos patula* (Ericaceae), *Asclepias speciosa* (Asclepiadaceae), *Asclepias syriaca* (Asclepiadaceae), *Baptisia* sp. (Fabaceae), *Blephilia ciliata* (Lamiaceae), *Calamintha ashei* (Lamiaceae), *Dalea pinnata* (Fabaceae), *Erigeron divergens* (Asteraceae), *Erysimum asperum* (Brassicaceae), *Hemerocallis* sp. (Liliaceae), *Dalea candida* (Fabaceae), *Marrubium vulgare* (Lamiaceae), *Medicago sativa* (Fabaceae), *Melilotus alba* (Fabaceae), *Mentzelia* sp. (Loasaceae), *Opuntia* sp. (Cactaceae), *Phacelia heterophylla* (Hydrophyllaceae), *Phaseolus limensis* (Fabaceae), *Ptelea trifoliata* (Rutaceae), *Ratibida columnaris* (Asteraceae), *Rhus glabra* (Anacardiaceae), *Streptanthus* sp. (Brassicaceae), *Tephrosia virginiana* (Fabaceae), *Trifolium hybridum* (Fabaceae), *Viguiera stenoloba* (Asteraceae), *Vitex agnus castus* (Verbenaceae).

Comments. *Megachile cleomis* is one of the synonyms of *M. texana*. It was originally described by Cockerell in 1900, based on two cotypes from a locality in New Mexico, a male and a female. The male was later found to be a male *M. snowi*. The female is herein designated as the lectotype for *M. cleomis*, which remains in synonymy with *M. texana*. This situation illustrates the importance of correctly assigning holotypes. *Megachile texana* is a widespread species which is found across North America (Figure 17).

Conclusions and future directions

There is more work to be done with *Litomegachile*. There are issues regarding types that need to be resolved. Locating types is made easier through the databasing of collections, and there is still more to be done. Repositories for *M. palmarum*, *M. pruinosa*, and *M. vernonensis* are unknown. Neotypes were not designated for *M. brevis*, which appears to be missing a holotype, presumed destroyed. The neotype was not designated because of the possibility that it could be in a collection and sim-

ply unaccounted for. A lectotype was designated by Cresson in 1916 for *Megachile mendica* but it was not located and so was not examined. Distribution maps and locality data can be greatly refined and expanded. The maps provided here only represent a portion of available collection data. As material from more collections are reliably identified and databased, records that are accurate and available to researchers will greatly improve this field of study. Knowledge of the nesting behavior, ecology, and plant associations of this group remains incomplete. Again, acquisition of additional data will aid compilation of host plant records and more detailed analysis of plant relationships. Additional collecting trips and review and identification of specimens in collections may reveal more diversity. *Megachile pankus* was uncovered in current collections. The male of *M. pankus* is unknown, and it is likely that there are more species to be discovered in tropical southern ranges of this group. A phylogeny using molecular and morphological data would further clarify the relationships between the species of this group.

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Two new species of *Euglossa* from South America, with notes on their taxonomic affinities (Hymenoptera, Apidae)

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Abstract

Two new species of the genus *Euglossa* Latreille, subgenus *Glossurella* Dressler are here presented. *Euglossa* (*Glossurella*) *embera* **sp. n.**, from the Pacific lowlands of Colombia, and *E. (G.) adiastrala* **sp. n.**, from the Atlantic Forest of Brazil. Their taxonomic association and distinction are discussed, as well as the correct understanding of the subgenus *Glossurella*.

Keywords

Orchid bees, *Glossurella*, taxonomy, Atlantic Forest, Brazil, Colombia

Introduction

The appealing external morphology and interesting behavioral features of orchid bees make them one of the most notorious groups among the Neotropical bee fauna. Males of this group of bees have a characteristic set of secondary sexual morphological features involved

in the collection of aromatic substances from floral and non-floral resources, notably from flowers of Orchidaceae (Dressler 1982a). The aromatic compounds are exposed during mating (Eltz et al. 2005). Of the five genera comprising the group, *Euglossa* Latreille is the most diverse with around 130 species (Nemésio and Rasmussen 2011). Since the discovery of the chemicals involved in the attraction of euglossine males to orchid flowers (Dodson et al. 1969), numerous new species have been described. Revision of historical material, discovery of new suites of morphological features, and access to newly collected sets of specimens in recent years has contributed to the recognition of various new species, particularly in *Euglossa* (e.g., Hinojosa-Díaz and Engel 2007, 2011a, b; Hinojosa-Díaz et al. 2011; Nemésio 2007, 2011b, 2011c; Parra et al. 2006; Ramírez 2005, 2006; Rasmussen and Skov 2006). Here we describe and illustrate two new species of *Euglossa* in the subgenus *Glossurella* Dressler, one from the Pacific lowlands of Colombia and another from the Atlantic Forest of Brazil. We discuss the taxonomic affiliation of both species and one possible re-interpretation of the subgenus *Glossurella* in the light of current phylogenetic hypotheses.

Material and methods

Specimens here examined belong to the following institutions: Division of Entomology, University of Kansas Natural History Museum, Lawrence, Kansas, USA (SEMC), and the Entomological Collection, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil (UFMG). Label information for each specimen is presented enclosed by quotation marks (“”), each label separated by double slash symbols (//), and every row on individual labels separated by a semicolon in italics (;), all of this followed by the number and sex of individuals corresponding to that dataset.

Morphological terminology in general follows that of Engel (2001), Michener (2007), and Hinojosa-Díaz (2008); some procedures for establishing metrics follow those of Brooks (1988). Species descriptions follow the overall format for other *Euglossa* species as presented by Hinojosa-Díaz and Engel (2007, 2011a, b) and Hinojosa-Díaz et al. (2011). Photomicrographs were prepared using a Cannon EOS 7D digital camera and an Infinity K-2 long-distance microscope lens. Multilayer images were produced by using the software CombineZP.

Systematics

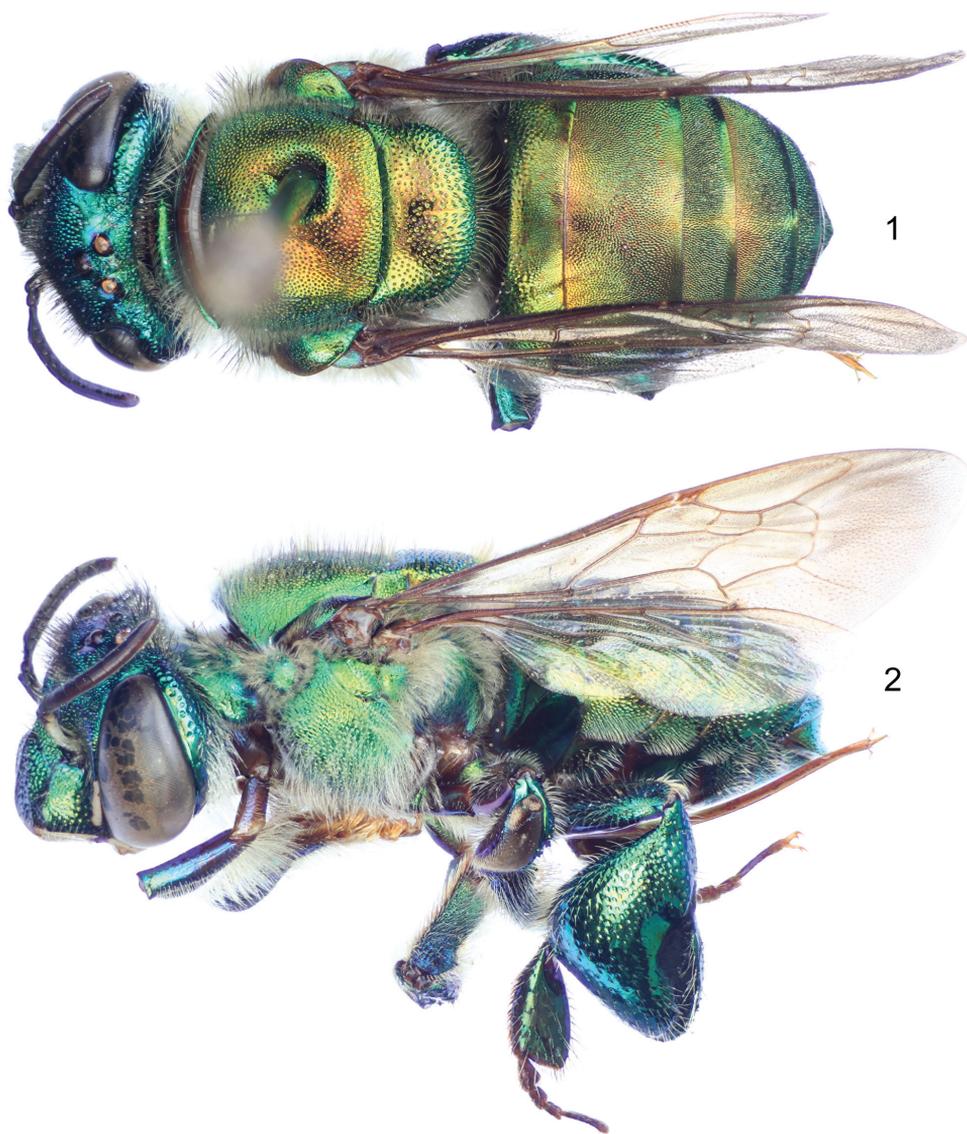
Euglossa (Glossurella) embera sp. n.

urn:lsid:zoobank.org:act:8FC01C8B-6EA5-469D-BAEF-8F258B5EB93B

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

Figs 1–20

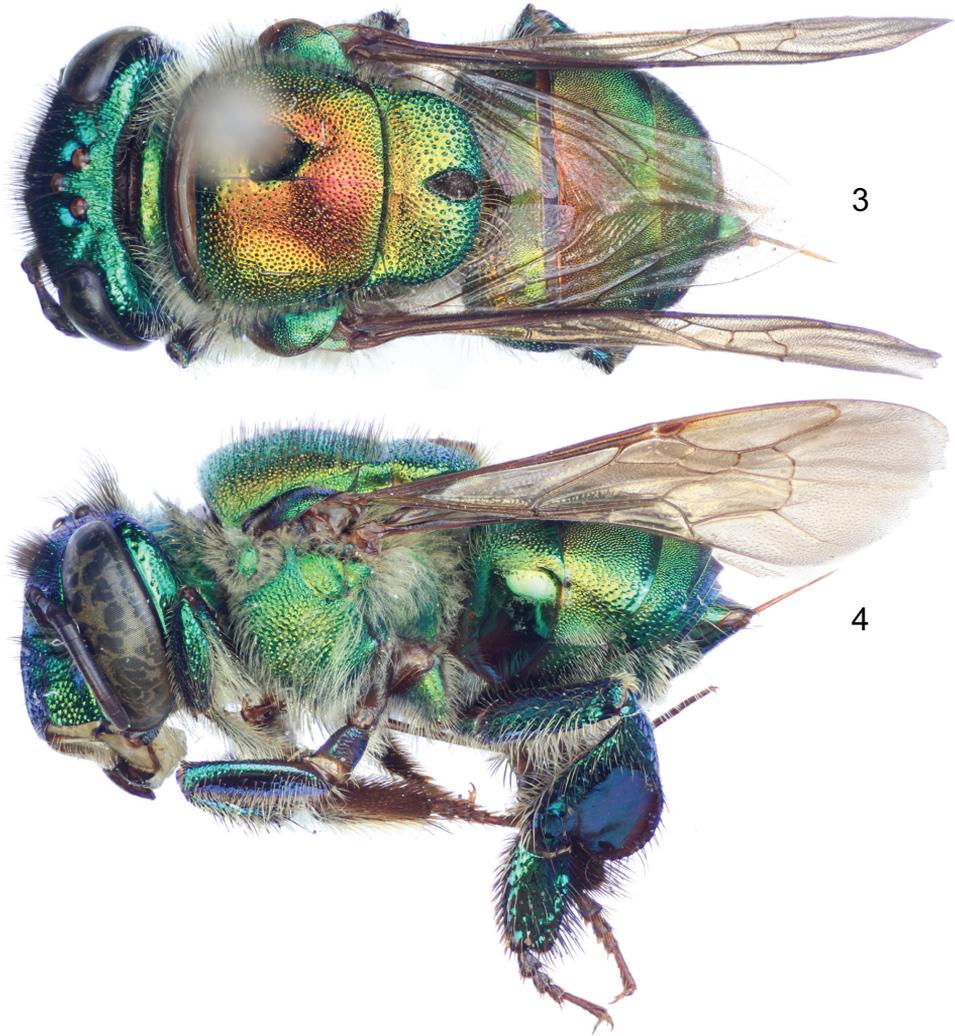
Holotype. ♂, labeled: “COLOMBIA: Prov. Valle; Rio Anchicaya, 400m.; 10 Feb. 1977. M.D.;Breed & C.D.Michener”. The holotype is in SEMC.



Figures 1–2. *Euglossa embera* sp. n., male holotype. **1** Dorsal habitus **2** Lateral habitus.

Paratypes. 3♂♂, 1♀: labeled as follows: data as holotype (1♂); data as holotype plus two extra labels “2 // *Euglossa*; *bursigera* Moure; det. R.L.Dressler 1977” (1♂); label data as holotype except date and collectors “IX-28-76. Bell,; Breed & Michener” (1♂); label data as holotype except date “11 Feb. 1977” (1♀). Paratypes are deposited in SEMC and UFMG.

Diagnosis. Labi-maxillary complex in repose surpassing tip of metasoma by about one metasomal tergum length in the male (Figs 1–2), slightly shorter than metasoma in the female (Figs 3–4); both sexes with integument coloration light blue-green in the



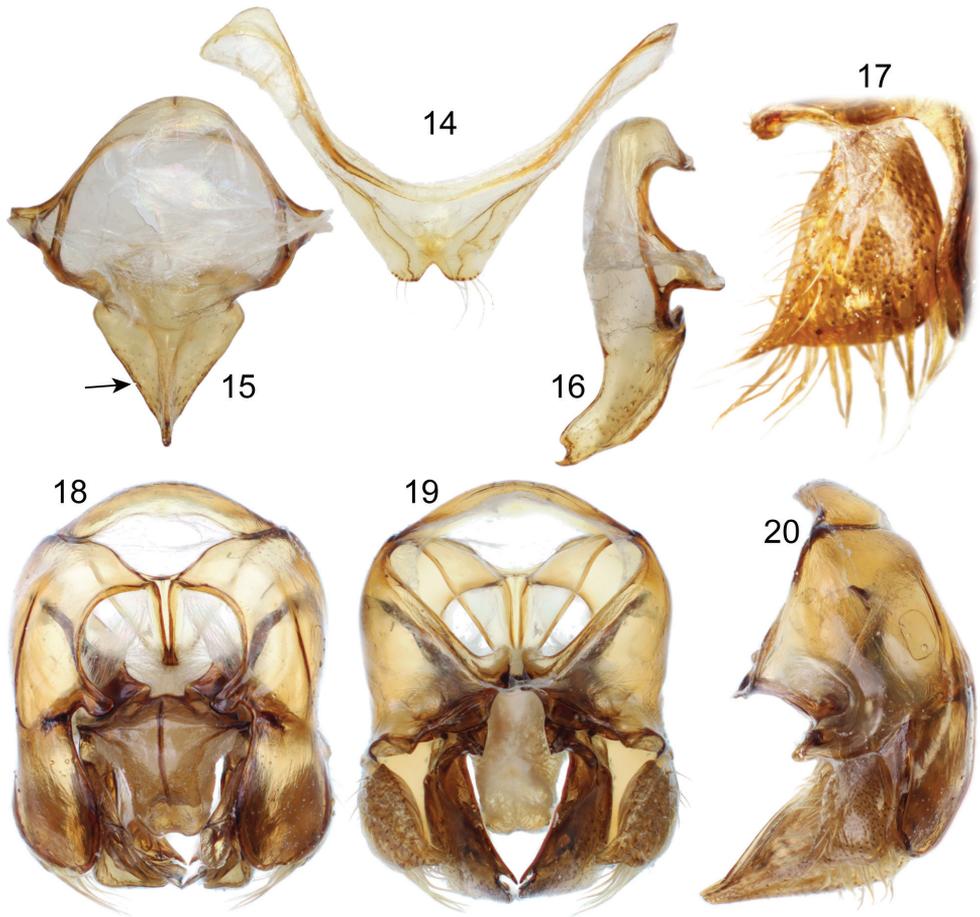
Figures 3–4. *Euglossa embera* sp. n., female paratype. **3** Dorsal habitus **4** Lateral habitus.

head, metasoma and mesosoma green with strong golden-bronzy coloration on dorsal areas as well as on metasomal sterna (Figs 1–4), male paraocular ivory marks narrow, not noticeably widened on lower sections, in most specimens not reaching epistomal sulcus (Figs 2, 5); male mandible tridentate, middle tooth reduced; female mesoscutellar tuft tear-drop shaped, occupying two thirds of mesoscutellar length (Fig. 3); female metabasitarsus trapezoidal with narrower straight distal margin, anterior and posterior margins convex (Fig. 9); metasomal terga in both sexes with dense punctures, becoming slightly shallower towards posterior margin; male mesotibia as follows: microtrichia (velvety area) with anterior margin noticeably sparser, posterior margin obliquely truncate distally (Fig. 7), anterior mesotibial tuft ellipsoidal, proximal margin concave, and posterior mesotibial tuft elongated antero-posteriorly (Fig. 8); male metatibial shape



Figures 5–13. *Euglossa embera* sp. n. **5** Facial aspect of male holotype **6** Facial aspect of female paratype **7** Outer surface of male mesotibia (arrow pointing to oblique truncation of velvety area) **8** Mesotibial tufts of male **9** Outer view of female metatibia and metatarsus **10** Outer view of male metatibia and metatarsus (arrow pointing to distal-most extreme of organ slit) **11** Inner view of male metatibia and metatarsus (arrow pointing to circular depression) **12** Section of male second metasomal sternum **13** Dorsal view of pronotal dorso-lateral angle (arrow) of male.

scalene obtuse triangular, metatibial organ slit of male metatibia with basal section tear-drop shaped, distal section narrow and noticeably elongated, only separated from tibial ventral margin by less than the organ's distal section maximum width (Fig. 10),



Figures 14–20. Male genitalic features of *Euglossa embera* sp. n. **14** Seventh metasomal sternum, ventral aspect **15** Eighth metasomal sternum, ventral aspect (arrow pointing to straight lateral margin) **16** Eighth metasomal sternum, lateral aspect **17** lateral section of gonostylus **18** Genitalic capsule, dorsal aspect **19** Genitalic capsule, ventral aspect **20** Genitalic capsule, lateral aspect.

inner surface with notorious circular depression near metabasitarsal joint (Fig. 11); male second metasomal sternum with two notorious omega-like integumental depressions (Fig. 12); male terminalia features as follows: eighth metasomal sternum with posterior section triangular (Fig. 15); dorsal process of gonocoxite thumb-like, about as long as broad (Fig. 18); lateral area of gonostylar process of gonocoxite projected as a short, broad prong; lateral section of gonostylus large, spoon-like, covered with dense, simple, long setae (Fig. 17). See also Table 1.

Description. ♂: *Structure* (all measurements in millimeters and based on 4 individuals). Total body length 11.62 (11.33–12.02); labiomaxillary complex in repose surpassing tip of metasoma by about one metasomal tergum length (Figs 1–2). Head length 2.54 (2.44–2.59), width 4.31 (4.21–4.43); upper interorbital distance 2.08 (2.04–2.15); lower interorbital distance 2.09 (2.07–2.15); upper clypeal width 1.13

Table 1. Summary of useful male features for the species included in *Glossurella* as here restricted.

	<i>E. prasina</i>	<i>E. bursigera</i>	<i>E. embera</i>	<i>E. augaspis</i>	<i>E. adiaistola</i>
Shape of metatibia	Trapezoidal (posterior angle orthogonal), inflated	Triangular (posterior angle acute)	Triangular (posterior angle acute)	Triangular (posterior angle acute)	Triangular (posterior angle acute)
Shape of scape	Inflated, club-like	Cylindrical	Cylindrical	Cylindrical	Cylindrical
Length of labiomaxillary complex	Reaching but not surpassing tip of metasoma	Reaching or barely surpassing tip of metasoma	Clearly surpassing tip of metasoma (by about half a metasomal segment length)	Reaching or barely surpassing tip of metasoma	Reaching or barely surpassing tip of metasoma
Malar length	About $\frac{1}{3}$ width of mid-flagellomeres	About $\frac{1}{2}$ width of mid-flagellomeres	About $\frac{3}{4}$ width of mid-flagellomeres	About $\frac{1}{2}$ width of mid-flagellomeres	About $\frac{1}{3}$ width of mid-flagellomeres
Separation of tip of metatibial organ slit from ventral margin of metatibia	As long as total length of organ slit (or slightly longer)	Slightly over maximum width of organ slit	Noticeably less than maximum width of organ slit	About $1\frac{1}{2}$ maximum width of organ slit	About $1\frac{1}{2}$ maximum width of organ slit
Mid-mandibular tooth	Well differentiated from outer tooth	Minute, adjacent to outer tooth	Minute, adjacent to outer tooth	Minute, adjacent to outer tooth	Well differentiated from outer tooth
Known distribution	Amazon Basin	Central America	Pacific lowlands of Colombia	Amazon Basin	Coastal areas of northern Atlantic Forest in Brazil

(1.11–1.19); lower clypeal width 1.97 (1.93–2.00); clypeal protuberance 0.87 (0.81–0.93); medial clypeal ridge well developed, wide and blunt, paramedial clypeal ridges diagonal, well developed, sharp along their lower two thirds, obscured by punctation on upper third; labrum wider than long, length 1.09 (1.04–1.15), width 1.19 (1.15–1.22); medial labral ridge sharp; paramedial labral ridges blunt, oblique, running along length of labral windows; labral windows ovoid, occupying proximal two thirds of labrum; interocellar distance 0.34 (0.30–0.37); ocellocular distance 0.61 (0.59–0.65); first flagellomere shorter [0.37 (0.35–0.37)] than second and third flagellomeres combined [0.42 (0.37–0.44)]; length of malar area 0.19 (0.17–0.20). Mandible tridentate, middle tooth reduced, adjacent to inner margin of outer tooth. Pronotal dorso-lateral angle obliquely truncate (truncation appearing subtle, but noticeable), thicker (along the truncate edge) than remainder of posterior pronotal marginal ridge; intertegular distance 3.17 (3.04–3.33); mesoscutal length 2.61 (2.59–2.63); mesoscutellar length 1.19 (1.11–1.26); mesoscutum with no noticeable concavity on mesial area (at most with a thin linear shallow depression on posterior half); posterior margin of mesoscutellum evenly convex, convexity rather blunt on meso-posterior section (Fig. 1); mesotibial length 2.05 (2.00–2.07), mesotibial spur present; mesobasitarsal length 1.85 (1.78–1.93), width 0.71 (0.67–0.74) (as measured at proximal posterior keel), poste-

rior keel projected in a slightly obtuse angle; metatibial shape triangular (scalene obtuse triangular), anterior margin noticeably convex on outer view (Figs 10–11), metatibial anterior margin length 3.11 (2.96–3.26), ventral margin length 2.43 (2.30–2.52), postero-dorsal margin length 4.28 (4.15–4.37), maximum metatibial thickness 1.10 (1.04–1.19); metatibial organ slit narrow, basal section teardrop shaped, anteriorly acute, length 0.67 (0.59–0.81), distal section spur shaped, elongated distally, separated from ventral margin by less than its maximum width, maximum width occupying about one-fourth of metatibial outer surface width (Fig. 10), metatibial inner surface with a notorious circular depression adjacent to joint with metabasitarsus (Fig. 11), metabasitarsal length 2.15 (2.07–2.22), mid-width 0.83 (0.81–0.89); metabasitarsal ventral margin oblique (Fig. 10). Forewing length 8.80 (8.67–8.96); jugal comb with 13–14 blades; hind wing with 16–20 hamuli. Maximum metasomal width 4.19 (4.07–4.30); second metasomal sternum with two shallow omega shaped depressions, lined with setae, located on concave areas of sinuate margin (Fig. 12).

Coloration. Head light blue-green with golden-bronzy iridescence specially on paraocular areas, antennal depressions and preoccipital area; clypeal medial ridge dark brown; paraocular ivory marks thin but well developed, slightly wider below, in most specimens not reaching epistomal sulcus (separated from it by about their width); lower lateral parts of clypeus, labrum, malar area, and mandibles (except teeth) ivory; labral windows amber-translucent; antennal scape with ivory spot covering all lateral surface and part of anterior surface, scape otherwise dark brown as remainder of antenna (Fig. 5). Pronotum green, blue-purple lights on lower ventral areas, golden-bronzy iridescence all over; mesoscutum, mesoscutellum and tegula green with strong golden-bronzy iridescence, dominant (obscuring green coloration) on mesoscutum and mesoscutellum (Figs 1–2); mesepisternum green with golden-bronzy iridescence specially on lateral areas (not as marked as on mesoscutum), preomaular area with brown-brassy spot on upper lateral area (Fig. 15); metepisternum and propodeum concolor with lateral areas of mesepisternum plus some blue-green coloration on areas close to leg joints; legs mainly bottle green on outer surface (except all tarsomeres beyond basitarsa) with moderate golden-bronzy iridescence, inner surface of all podites and entire tarsomeres beyond basitarsi brown-brassy, blue-purple lights on outer-anterior margins of most podites, specially notorious on mesofemur and mesotibia (Figs 2, 7); wings glossy hyaline with brown veins (Figs 1–2). Metasomal terga green with strong golden-bronzy iridescence in a gradient, strong anteriorly (fully bronzy) to weaker posteriorly (green-golden-bronzy) (Fig. 1); sterna with same colors and pattern as terga.

Sculpturing. Face densely areolate-punctate, areole-puncture size around one third of median ocellar diameter on clypeal disc, one eighth on frons (frontal fringe), and somewhere in between in other areas, paraocular groove between paraocular marks and torulus smooth (Fig. 5), gena with areole-punctures comparable in size to those of clypeal disc, well marked above, shallow on lower areas. Mesoscutum with round punctures about one fifth of median ocellar diameter, dense (separated by less than a puncture diameter) on most areas, becoming slightly sparser along median mesoscutal line (separated by one to two puncture diameters), where smaller punctures (about one

fourth of a regular puncture size) are intermixed sparsely; mesoscutellum with punctation as on mesal areas of mesoscutum (sparse punctures intermixed with smaller punctures), punctures becoming denser (contiguous) and bigger (at least double in size) on posterior area along mesoscutal margin (Fig. 1); mesepisternal lateral-facing surface with dense punctures on upper areas as big as punctures on frons, becoming slightly bigger and sparser towards lower areas (separated by one or more puncture diameters on ventral areas); preomalar area with punctation as a continuation of lateral-facing area of mesepisternum, except for impunctate brown-brassy spot; metatibial outer surface with punctures comparable in size to those on posterior margin of mesoscutellum, relatively dense (separated by less than one puncture diameter) on upper half, sparser (separated by two to three puncture diameters) on lower half, smooth (impunctate) on small depression contiguous to organ slit (Fig. 10). Dorsal surface of posterior half of first metasomal tergum and second through fifth terga with dense punctures, around half the size of regular mesoscutal punctures, becoming slightly shallower towards posterior margin, anterior half of first tergum, lateral sections of second through fifth terga, and entire surface of sixth and seventh terga with similar pattern but punctures as big as those on posterior margin of mesoscutellum (Fig. 1); metasomal sterna with relatively dense punctation (punctures of a varied size, but most comparable to those on mesepisternum), leaving large semicircular smooth areas mesally on every sternum.

Vestiture. Frontal fringe with dense setae of two natures, some brown, very minutely branched, straight, as long as two mid-ocellar diameters, the others, amber-golden, with noticeable but short branches, shorter than the brown setae; remainder of the face (except as noted hereafter) with scattered amber-golden setae (as the ones on frontal fringe), shorter on most areas, and noticeably plumose on antennal depressions; posterior section of vertex and mid-ocellar area with long curved brown setae; gena with dense, light, plumose setae, increasing in size towards lower genal section; antenna with scattered amber golden setae (Fig. 5). Mesoscutum and mesoscutellum densely setose, majority of setae amber-golden with few intermixed brown setae (these last notorious on anterolateral corners of mesoscutum) (Figs 1–2, 13); lateral-facing surface of mesepisternum, metepisternum and propodeum with, dense, pale, plumose setae as long as those on lower gena, some brown setae interspaced on pronotal lobe; preomalar area with setae as those on lateral-facing mesepisternal areas, except bare on preomalar spot and contiguous smooth area (Fig. 2); outer surface of all legs with light yellowish setae, moderately dense and short in most areas except as follows: dense, long (as long as those on lower gena) and plumose on posterior surface of foreleg, dense and erect downwards on anterior surface of mesotibia (Fig. 7), dense and appressed on mesobasitarsus, long (as long as those on vertex) and arranged in a fringe on distal half of postero-dorsal margin of metatibia, other leg setal features as follows: inner surface of all basitarsi with dense, hirsute, brown-amber setae, chemical gathering tufts on second through fourth protarsomeres with dense, brown-amber, moderately long, setae, microtrichia on outer mesotibial surface (velvety area) composed of dense, fulvous, simple, minute setae, anterior margin of velvety area noticeably sparser, distal third of posterior margin diagonally truncate (Fig. 7), anterior mesotibial tuft ellipsoidal with

proximal margin concave, composed of dense, fulvous, minutely plumose setae, posterior tuft sitting on a deep cavity elongated antero-posteriorly, with a distinctive semi-circular setose patch on posterior half, anterior inner margin of the cavity covered with a fringe of setae, all setae fulvous (Fig. 8); metatibial organ slit closed with dark brown setae (Fig. 10); inner metatibial depression devoid of setae (Fig. 11). Anterolateral corners of first tergum, with moderately dense, amber-golden, simple setae as long as those on mesoscutum, lateral areas of all terga and posterior margin of seventh tergum with similar setae but rather pale, dorsum of posterior half of first tergum and second through sixth terga with dense, appressed, grayish, minute setae, intermixed with scattered, sturdy, brown, short setae appressed, similar setae but appearing simple, shorter and appressed, on lateral margins of remainder terga, as well as posterior half of fifth tergum and entire surface of sixth to seventh terga; posterior dorsal half of first tergum through anterior half of fifth tergum with dense, dusky, appressed short setae, intermixed with some scattered, darker, longer setae (Figs 1, 2); metasomal sterna with moderately dense setae on punctate areas; integumental omega-like depressions on second sternum lined with amber, appressed, simple setae (Fig. 12).

Terminalia. Seventh metasomal sternum with posterior disc margin deeply emarginated mesally, bearing a row of scattered setae (Fig. 14). Eighth metasomal sternum with posterior section triangular (lateral margins straight) on dorsal or ventral view, covered with scattered, minute setae (Fig. 15). Dorsal process of gonocoxite thumb-like, about as long as broad, basal incision broadly concave (Fig. 18); lateral area of gonostylar process of gonocoxite projected as a short, broad prong; lateral section of gonostylus large, spoon-like, ventral lobe with scattered, short, simple setae on outer surface, inner concave surface covered with dense, simple, long setae (Fig. 17).

♀: *Structure* (all measurements in millimeters). Total body length 9.56; labiomaxillary complex in repose short of metasomal tip by less than one metasomal segment length (Fig. 4). Head length 2.48; head width 4.22; upper interorbital distance 2.11; lower interorbital distance 2.07; upper clypeal width 1.11; lower clypeal width 1.95; clypeal protuberance 0.74; medial clypeal ridge as in male, paramedial ridges weak, almost completely obscured by punctuation, labral ridges as in male, labral windows occupying about four fifths of labral length; labrum rectangular, wider than long, length 1.00, width 1.11; anterior edge of labrum arched outwards; interocellar distance 0.37; ocellocular distance 0.59; length of first flagellomere (0.37) shorter to combined length of second and third flagellomeres (0.41); length of malar area 0.09. Mandible tridentate. Pronotal lateral angle mainly as in male, but not so noticeably thicker than remainder of pronotal posterior ridge; intertegular distance 3.26; mesoscutal length 2.52; mesoscutellar length 1.26; posterior border of mesoscutellum as in male (Fig. 3); mesotibial length 2.00; mesobasitarsal length 1.63, maximum width 0.59; metatibia triangular (scalene right triangular) (Fig. 9), metatibial anterior margin length 2.81; metatibial ventral margin length 1.63; metatibial posterodorsal margin length 3.19; metabasitarsus trapezoidal with narrower straight distal margin, anterior and posterior margins convex (Fig. 9), length 1.70, maximum width 0.89. Forewing length 8.00; hind wing with 18 hamuli. Maximum metasomal width 4.30.

Coloration. As described for male (Figs 3–4). Paraocular marks, antennal scape spot, and preomalar spot absent (Fig. 6).

Sculpturing. As described for male except no differentiation on preomalar area (preomalar spot absent); mesoscutellum with slightly denser punctation (Fig. 3).

Vestiture. As described for male (some setal features on protarsi, meso- and metatibia exclusive of male) except as follows: Mesoscutellar tuft tear-drop shaped, occupying about two thirds of mid mesoscutellar length, composed of dense, dark, erect, multibranched (branches minute) setae (Fig. 3). Foreleg with slightly shorter setae on posterior surface as compared to male (Fig. 6); mesotibial posterior margin with some scattered, dark, sturdy short setae; metatibial corbicula surrounded for the most part by setae as in other leg areas, except by some scattered, dark, sturdy, curved setae (Fig. 9).

Etymology. The specific epithet is a reference to the Emberá, an indigenous people inhabiting the Pacific lowlands of Colombia.

***Euglossa (Glossurella) adiastrata* sp. n.**

urn:lsid:zoobank.org:act:72E3F6A4-847D-40D3-B78E-44AB469DED67

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

Figs 21–28

Holotype. ♂, labeled: “Euglossina da; Hiléia Baiana; REBIO C. Veado; 18289 – 52751 // Pinheiros ES; BRASIL 09/02/2010; A. Nemésio”. The holotype is deposited in UFMG.

Paratypes. 15♂♂: labeled as follows: data as holotype (1♂) except date “07/02/2010” and lacking first label; data as holotype (4♂) except individual file numbers “18240-52566”, “18244-52581”, “18244-52583” and “18270-52685”; “Euglossina da; Hiléia Baiana; REBIO C. Grande; 18059 – 51976 // Conceição Barra ES; BRASIL 02/02/2010; A. Nemésio” (1♂); “Euglossina da; Hiléia Baiana; Res. Nat. Vale; 17096 – 48063 // Linhares ES; BRASIL 10/12/2009; A. Nemésio” (1♂); “Euglossina da; Hiléia Baiana; RPPN Duas Barras; 18680 – 53528 // Sta Maria do Salto MG; BRASIL 12/02/2009; A. Nemésio” (1♂); “Euglossina da; Hiléia Baiana; PN Monte Pascoal; 16456 – 46333 // Porto Seguro BA; BRASIL 05/10/2009; A. Nemésio” (1♂); “Euglossina da; Hiléia Baiana; PN Descobrimento; 16492 – 46415 // Prado BA; BRASIL 07/10/2009; A. Nemésio” (1♂); “Euglossina da; Hiléia Baiana; Res. Ecol. Michelin; 16828 – 47244 // Igrapiúna BA; BRASIL 27/11/2009; A. Nemésio” (1♂); “Euglossina da; Hiléia Baiana; P. E. S. Conduru; 17990 – 51710 // Uruçuca BA; BRASIL 30/01/2010; A. Nemésio” (1♂); “Euglossina da; Hiléia Baiana; RPPN Serra Bonita; 17807 – 51142 // Camacan BA; BRASIL 24/01/2010; A. Nemésio” (1♂); “Euglossina da; Hiléia Baiana; Campus UESC; 18331 – 52871 // Ilhéus BA; BRASIL 20/02/2010; A. Nemésio” (1♂); “Ilhéus BA; BRASIL 27/07/2010; A. Nemésio” (1♂). Paratypes are deposited in UFMG, except the first and the last ones are deposited in SEMC.

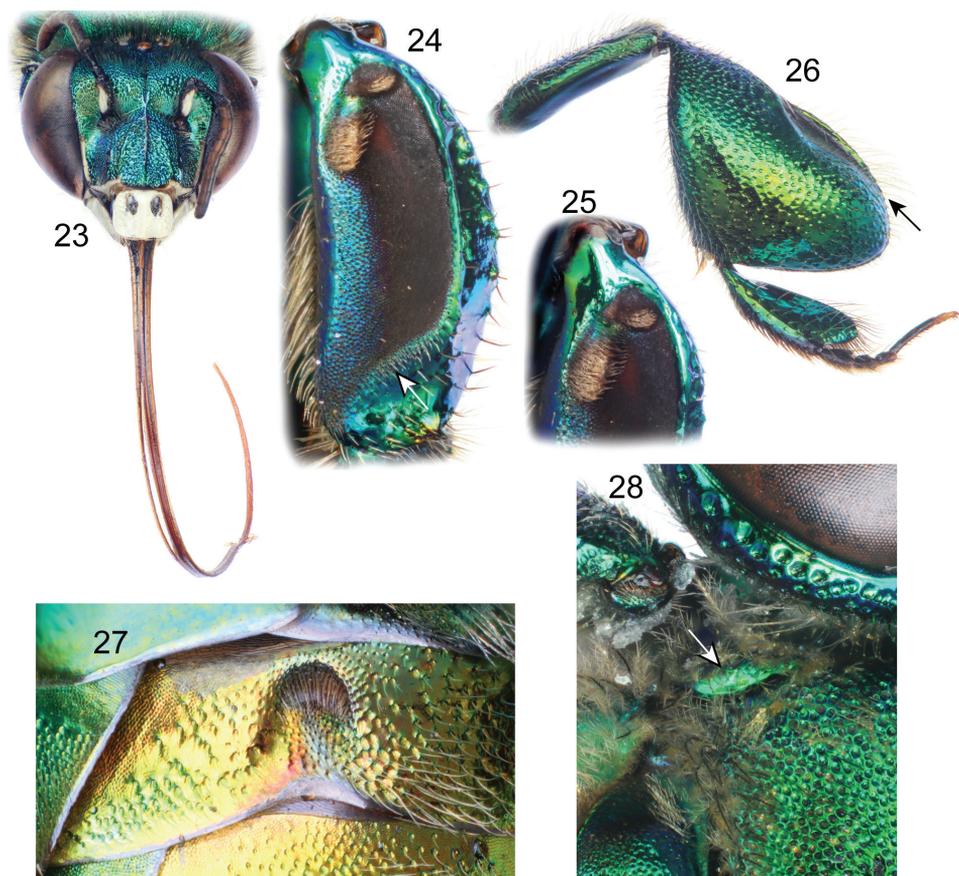
Diagnosis. Labiomaxillary complex in repose reaching tip of metasoma (estimation) (Figs 21–22); integument coloration light blue-green in the head, uniformly bot-



Figures 21–22. *Euglossa adiaastola* sp. n., male holotype. **21** Dorsal habitus **22** Lateral habitus.

tle green on metasoma and mesosoma, moderate golden-bronzy iridescence all over (strong on metasomal sterna) (Figs 21–22), paraocular ivory marks narrow, not noticeably widened on lower sections, reaching epistomal sulcus (Fig. 23); mandible tridentate, middle tooth well developed; mesotibial microtrichia (velvety area) with anterior margin noticeably sparser, posterior margin obliquely truncate distally (concave margin in oblique section) (Fig. 24), anterior mesotibial tuft ellipsoidal, proximal margin concave, posterior mesotibial tuft elongated antero-posteriorly (Fig. 25); metatibial shape scalene triangular, organ slit with basal section tear-drop shaped, distal section very narrow separated from tibial ventral margin by more than its maximum width (Fig. 26); male second metasomal sternum with two notorious omega-like integumental depressions (Fig. 27); male terminalia features as described for *E. embera*. See also Table 1.

Description. ♂: Structure (all measurements in millimeters and based on the holotype). Total body length 12.81; labiomaxillary complex in repose reaching tip of metasoma or even exceeding it by 1–2 mm in some specimens (Figs 21–22). Head length 2.78, width 4.50; upper interorbital distance 2.22; lower interorbital distance 2.15; upper clypeal width 1.19; lower clypeal width 1.96; clypeal protuberance 0.81; clypeal ridges as described for *E. embera*; labrum wider than long, length 0.96, width



Figures 23–28. *Euglossa adiaastola* sp. n. male holotype. **23** Facial aspect **24** Outer surface of mesotibia (arrow pointing to oblique-concave truncation of velvety area) **25** Mesotibial tufts **26** Outer view of metatibia and metatarsus (arrow pointing to distal-most extreme of organ slit) **27** Section of second metasomal sternum **28** Dorsal view of pronotal dorso-lateral angle (arrow).

1.15; medial labral ridge sharp; paramedial labral ridges blunt, oblique, running slightly beyond length of labral windows; labral windows ovoid, occupying proximal half of labrum; interocellar distance 0.44; ocellocular distance 0.59; first flagellomere slightly shorter (0.41) than second and third flagellomeres combined (0.44); length of malar area 0.19. Mandible tridentate, middle tooth well developed and differentiated from outer tooth. Pronotal dorso-lateral angle obliquely truncate, noticeably thicker than remainder of posterior pronotal marginal ridge (Fig. 28); intertegular distance 3.56; mesoscutal length 2.89; mesoscutellar length 1.26; mesoscutellum as described for *E. embera* (Fig. 21); mesotibial length 2.15, mesotibial spur present; mesobasitarsal length 2.00, width 0.74 (as measured at proximal posterior keel), posterior keel projected in a obtuse angle; metatibial shape triangular (scalene triangular), anterior margin rather straight on outer view (Fig. 26), metatibial anterior margin length 2.96, ventral margin length 2.74, postero-dorsal margin length 4.37, maximum metatibial

thickness 1.30; metatibial organ slit narrow (narrower than in *E. embera*), basal section teardrop shaped, anteriorly acute, length 0.59, distal section spur shaped, separated from ventral margin by more than its maximum width, maximum width occupying about one-fifth of metatibial outer surface width (Fig. 26), metatibial inner surface as in *E. embera*, metabasitarsal length 2.30, mid-width 0.81; metabasitarsal ventral margin oblique (Fig. 26). Forewing length 9.48; jugal comb with 13–14 blades; hind wing with 17–18 hamuli. Maximum metasomal width 4.67; second metasomal sternum with two depressions as described for *E. embera* (Fig. 27).

Coloration. Head as described for *E. embera*, except as follows: golden-bronzy coloration not as strong, paraocular ivory marks reaching epistomal sulcus, ivory spot on antennal scape extended on frontal surface (covering most of it) (Fig. 23). Mesosoma uniformly bottle green with golden-bronzy hue (Figs 21–22); legs as described for *E. embera* (Figs 22, 24–26); wings glossy hyaline with dark brown veins (Figs 21–22). Metasomal terga bottle green with golden-bronzy iridescence (accentuated on lateral areas) (Figs 21–22); sterna as in *E. embera*.

Sculpturing. In general as described for *E. embera*, except as follows: punctation along median mesoscutal line not as sparse, although sparser than elsewhere; metatibial outer surface with denser punctation, area along ventral margin with punctures separated by one to two puncture diameters (Fig. 26).

Vestiture. In general as described for *E. embera*, except as follows: setae on meso- and metasoma, evenly fulvous, mesoscutum and mesoscutellum with a noticeable number of intermixed brown sturdy setae; anterior section of velvety area on mesotibia, sparser than in *E. embera*, distal third of posterior margin of velvety area rather concave (Fig. 24).

Terminalia. As described for *E. embera*.

♀: Unknown.

Etymology. The specific epithet is based on the Greek word *adiastolos*, meaning “confused” or “not separated”, as a reference to the confusion between this species and *E. augaspis*.

Discussion

The two new species described here are unequivocally related to *E. bursigera* Moure, *E. augaspis* Dressler, and *E. prasina* Dressler. The males of all of these species have characteristically tridentate mandibles and share a similar habitus, integumental sculpturing, and genitalic features. It is easy to separate *E. prasina* from those species by its distinctive metatibial shape (trapezoidal), and rather enlarged scape (see also Table 1). Before the addition of the species here described, it was relatively easy to distinguish *E. bursigera* and *E. augaspis* based on their distribution because the former is found in Central America (Moure 1970) while the second is found in the Amazon Basin (Dressler 1982b). Both species share a good amount of morphological similarity, and this is also the case for *E. embera* and *E. adiaastola*. *Euglossa embera* is closer to *E. bursigera*, and although not from

Central America, the type material is from a biogeographically related region, the Pacific lowlands of Colombia; *E. adiastrata* on the other hand is more akin to *E. augaspis*.

The four males known for *E. embera* are remarkably uniform in their morphology which is not surprising given that all of them come from the same locality. This species can be differentiated from *E. bursigera* by the noticeably longer labiomaxillary complex of the male (clearly exceeding the metasomal tip while in repose), which does not surpass or barely surpasses the metasomal tip in *E. bursigera*; the slightly longer malar area in the male (length comparable to width of the mid-flagellomeres), which is much narrower than the mid-flagellomeres width in *E. bursigera*; and the posteriorly elongate distal section of the metatibial organ slit (separated from ventral metatibial margin by less than its maximum width), which in *E. bursigera* is separated from the ventral metatibial margin by more than the slit's maximum width (see Table 1). Coloration could also be used to differentiate these two species, although Moure (1970) described a subspecies of *E. bursigera* (*E. bursigera cupreicolor*), based on the dominant bronzy-reddish coloration of specimens found principally (but not exclusively) in the Pacific slope of Costa Rica. Most of the Panamanian specimens of *E. bursigera* are, however, predominantly green. Collection of specimens in the contact areas of both *E. bursigera* and *E. embera* will help clarify the color variation in *E. bursigera*.

Dressler (1982b), when describing *E. augaspis*, addressed the close morphological similarity of this species with *E. bursigera* from which he distinguished it by its distinctively smaller size and denser abdominal punctation. *Euglossa adiastrata*, although definitely closer to *E. augaspis*, is noticeably larger, even slightly larger than *E. bursigera*. Besides size, *E. adiastrata* can be distinguished from *E. augaspis* by the much thicker dorso-lateral angle of the prothorax and the well-developed middle tooth in the mandible.

Euglossa adiastrata has a relatively wide distribution in the northern portion of the coastal Atlantic Forest. It has been listed, and may be found in entomological collections, as *E. augaspis* from the states of Pernambuco (Milet-Pinheiro and Schindwein 2005), Bahia (Nemésio 2009, 2011a), Minas Gerais (Nemésio 2012), and Espírito Santo (Bonilla-Gómez 1999; Nemésio 2011b).

The new species here presented together with *E. bursigera*, *E. augaspis*, and *E. prasina* are assigned to the subgenus *Glossurella*. When Dressler (1982b) originally erected the subgenus, he included a variety of species that share some biological (nesting) and external morphological features. However, currently available phylogenetic information based both on external morphology (Hinojosa-Díaz 2010) and molecular data (Ramírez et al. 2010) indicate that the group as envisioned by Dressler (1982b) is not supported as monophyletic. Since the type species for *Glossurella* is *E. bursigera* we tentatively restrict the use of this subgeneric name herein for those species allied to it. As so conceived, such a restricted *Glossurella* would encompass *E. bursigera*, *E. augaspis*, *E. prasina*, *E. embera*, and *E. adiastrata*. Species formerly included in *Glossurella* but not part of the complex allied to *E. bursigera*, would then be regarded as *incertae sedis* in terms of their subgeneric placement within *Euglossa* and until such time as relationships are further resolved (e.g., Hinojosa-Díaz and Engel 2011b). Naturally, this is one of several classificatory options but is the one which offers the greatest nomenclatural stability for the moment.

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Species of *Adialytus* Förster, 1862 (Hymenoptera, Braconidae, Aphidiinae) in Iran: taxonomic notes and tritrophic associations

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Abstract

The species of *Adialytus* Förster in Iran are taxonomically studied and new data on distribution and host associations are presented. The existence of a species complex, in the case of *A. ambiguus* (Haliday), and the morphological variability in commonly used taxonomic characters has been discussed. In total, four valid species belonging to the genus *Adialytus* including *A. ambiguus* (Haliday), *A. salicaphis* (Fitch), *A. thelaxis* (Stary) and *A. veronicaecola* (Stary) have been identified and recorded from Iran. Also, we recognized two additional phenotypes: “*A. arvicola*” (Stary) and “*Adialytus* cf. *ambiguus*” (Haliday). These phenotypes and *A. veronicaecola* are newly recorded from Iran in association with *Sipha* and *Aphis* species, respectively. An illustrated key for identification of the species and two variable phenotypes is presented.

Keywords

Adialytus, taxonomy, host aphid associations, species complex

Introduction

The genus *Adialytus* Förster is morphologically very close to the genus *Lysiphlebus* Förster from which it can be differentiated by the absence of M & m-cu and r-m veins in the fore wing. It was classified as a subgenus of *Lysiphlebus* (Stary 1975, 1976, 1979), after validation by Mackauer and Stary (1967) and Mackauer (1968). Later, the gener-

ic status of *Adialytus* was also suggested by Shujauddin (1978) and supported in some phylogenetic analyses (Kambhampati et al. 2000). This genus includes a few species with Holarctic distribution extending from the Far East (Starý and Schlinger 1967, Takada 1968, 1979, Shujauddin 1978) to central Asia (Starý 1979), Europe (Kavallieratos et al. 2001, 2004, Starý 2006) and North America (Pike et al. 2000). Until now, seven valid species have been recognized within this genus, including *A. salicaphis* (Fitch), *A. thelaxis* (Starý), *A. ambiguus* (Haliday), *A. balticus* Starý & Rakauskas, *A. veronicaecola* (Starý), *A. kaszabi* Takada and *A. fuscicornis* (Ashmead). The first three species have already been recorded from Iran (Starý et al. 2000, Rakhshani et al. 2007), and they are restricted to Chaitophorinae and Thelaxinae aphid hosts (Mackauer 1965, Starý 1975). Remaining species are associated with different aphids out of these groups (Starý and Rakauskas 1979, Starý and Juchnevič 1978, Pike et al. 2000).

There was considerable ambiguity about *Lysiphlebus confusus* Tremblay & Eady and *A. ambiguus*. The first species name was selected by Tremblay and Eady (1978) for the material from Haliday's collection that was incorrectly named *Lysiphlebus ambiguus* and described by Mackauer (1960). They also synonymized *Lysiphlebus (Adialytus) arvicola* Starý with *Lysiphlebus (Adialytus) ambiguus*. The synonymy has been followed by different authors (Mescheloff and Rosen 1990, Starý 1979).

Here we review the species of *Adialytus* in Iran, together with new data on their host associations and distribution. In addition, the possible existence of species complexes and morphological variability within genus are discussed.

Material and methods

Samples of different host plants including wild and cultivated trees, shrubs and herbs bearing the aphid colonies were gently cut off and placed inside the semi-transparent plastic boxes. The collected material were subsequently transferred to the laboratory and kept under controlled conditions with temperature range of 24–28°C and RH: 60±5%, for 2-3 weeks until the emergence of the adult parasitoids. The rearing boxes were inspected daily to prevent the activity of emerging hyperparasitoids. Once detected, they were immediately removed from the rearing boxes. The emerged parasitoids were also carefully collected using an aspirator and dropped into 75% ethanol for further examination. A few specimens from each sample were carefully dissected and mounted in slides using a Hoyer medium. The ratio measurements were based on these slide-mounted specimens using an ocular micrometer. Additional material from European and central Asian countries were also used for comparison of the morphological variation. The characters of flagellar segments, clypeus, fore wing, first metasomal tergite (=petiole) and female genitalia were used for comparison and differentiation of the species, as well as to find the reliable characters for identification key. The external morphology was studied using a NIKON Eclips E200 microscope equipped with a SONY DSC digital camera.

The morphological terminology for parasitoids used in this paper follows Sharkey and Wharton (1997) and for the aphids Remaudière and Remaudière (1997), respec-

tively. The nomenclature of host plants was based on Flora of Iran (Ghahreman 1978–2006). The specimens were deposited in the collection of the first author. Abbreviations of the names of provinces (Fig 1) are as follows: AL: Alborz, FA: Fars, GL: Golestan, GN: GUILAN, IS: Isfahan, KD: Kordiatan, KE: Kermanshah, KN: Kerman, KR: Khorasane Razavi, MA: Markazi, NK: North Khorasan, SB: Sistan & Baluchistan, TH: Tehran.



Figure 1. Map of the sampling areas at various parts of Iran, indicating 13 provinces.

Results

Four valid species of the genus *Adialytus*, as well as two additional phenotypes: “*A. arvicola*” (Stary) and “*Adialytus* cf. *ambiguus*” (Haliday) (Table 1) were collected and identified in association with 14 aphid species on 15 host plants. Many specimens of *A. ambiguus* (Haliday) were inconsistently different from examined specimens which originated in other countries. We categorized these specimens as “*Adialytus* cf. *ambiguus*”. *Adialytus veronicaecola* (Stary) and “*A. arvicola*” (Stary) are newly recorded from Iran. The latter species was reared from *Sipha* aphids which were also the specific hosts for *A. ambiguus*. We found significant differences between the *A. ambiguus* and “*A. arvicola*” phenotype, based on the characters of fore wing, flagellar segments, hind legs, petiole (Table 2) and coloration. Additionally, a comparison with type specimens of *A. arvicola* from the Czech Republic (Stary 1961a) clearly confirmed the existence of strong differences.

Table 1. A list of aphid-parasitoid associations.

Aphid family	Aphid species	Parasitoid species
Chaitophorinae	<i>Sipha maydis</i> Passerini	<i>Adialytus</i> cf. <i>ambiguus</i> (Haliday) <i>Adialytus arvicola</i> (Starý)
	<i>Sipha elegans</i> del Guercio	<i>Adialytus ambiguus</i> (Haliday) <i>Adialytus</i> cf. <i>ambiguus</i> (Haliday) <i>Adialytus arvicola</i> (Starý)
		<i>Sipha flava</i> (Forbes)
		<i>Chaitophorus</i> spp.
Thelaxinae	<i>Thelaxes suberi</i> (del Guercio)	<i>Adialytus thelaxis</i> (Starý)
Aphidiinae	<i>Aphis craccivora</i> Koch	<i>Adialytus veronicaecola</i> (Starý)
	<i>Aphis gossypii</i> Glover	
	<i>Aphis</i> sp.	

Table 2. The morphometric and meristic data for different characters of *Adialytus* species (Female) in Iran.

	F1† l/w‡	F2 l/w	F3 l/w	F4 l/w	F1/F2 length	F1/F3 length	F1/F4 length	F1 LP§	F2 LP	Pt* l/w	R1 ^{§§} / Pt length	Setae on Clypeus	Petiole l/w	Ovipositor sheath l/w
<i>Adialytus ambiguus</i>	2.10–2.30	2.40–2.60	1.90–2.10	1.80–2.00	1.00–1.10	0.90–1.00	0.90–1.00	0	1–2	2.90–3.00	1.30–1.40	4–5	1.80–2.00	2.90–3.20
<i>Adialytus</i> cf. <i>ambiguus</i>	2.60–2.85	2.70–2.90	2.70–2.85	1.80–2.00	0.90–1.00	0.90–1.10	0.90–1.10	0–1	2–3	2.85–3.10	0.90–1.10	4–5	1.80–2.00	2.80–3.20
<i>Adialytus arvicola</i>	2.50–2.80	2.10–2.45	2.20–2.40	1.70–1.90	0.90–1.10	0.90–1.10	0.95–1.20	0–1	2–4	3.00–3.20	0.70–0.80	6–8	2.00–2.20	2.80–3.10
<i>Adialytus salicaphis</i>	2.70–2.90	2.60–2.90	2.50–2.80	2.30–2.50	1.00–1.20	0.90–1.10	1.00–1.20	3–5	3–5	3.25–3.35	0.90–1.00	8–10	2.20–2.40	2.40–2.50
<i>Adialytus thelaxis</i>	1.60–1.70	1.50–1.60	1.50–1.60	1.60–1.70	1.00–1.20	1.00–1.20	0.90–1.10	3–5	4–6	2.80–3.10	0.90–1.00	8–10	1.80–2.00	2.60–2.70
<i>Adialytus veronicaecola</i>	2.00–2.20	1.90–2.00	1.90–2.00	2.05–2.15	1.00–1.10	1.00–1.10	1.00–1.10	0–1	0–1	3.00–3.20	0.60–0.70	6–8	1.90–2.20	2.15–2.30

†: F1–F4: Flagellomers 1–4

‡ l/w: Length/width ratio

§ LP: Longitudinal placodes

§§ R1: Radial vein 1 (= metacarpus)

*: Pterostigma

Key to *Adialytus* species in Iran (based on adult females)

- 1 Ovipositor sheath considerably elongated, length/width ratio of 2.80–3.20 (Figs 6A–C) **2**
- Ovipositor sheath stout, length/width ratio of 2.20–2.70 (Figs 6D–F) **4**
- 2 Vein R1 (= metacarpus) of fore wing 0.7–0.8 × as long as pterostigma (Fig 3C) **“A. arvicola” (Starý)**
- Vein R1 of fore wing subequal (Fig 3B) or considerably longer (Fig 3A) than pterostigma **3**
- 3 Vein R1 of fore wing 1.3–1.4 × as long as pterostigma, reaching apex of wing (Fig 3A) **A. ambiguus (Haliday)**
- Vein R1 of fore wing 0.9–1.1 × as long as pterostigma, not reaching apex of wing (Fig 3B) **“A. cf. ambiguus” (Haliday)**

- 4 Flagellar segments (Fig 2E) subquadrate, slightly longer than their maximum width, l/w ratio of 1.5–1.6. Flagellar segments (Fig 2E) and hind femur (Fig. 4E) covered with long and prevalently erect setae. Ovipositor sheath sharply angular (Fig 6E).....***A. thelaxis* (Stary)**
- Flagellar segments (Figs 2D, 2F) cylindrical, considerably longer than their maximum width, l/w ratio of 2.0–2.9. Flagellar segments and hind femur covered with adpressed (Figs 2F, 4F) or semi-erect (Fig 2D, 4D) setae. Ovipositor sheath roundly angular (Figs 6D, 6F).....**5**
- 5 First metasomal tergite (petiole) elongate, 2.2–2.4 × as long as wide at level of spiracles (Fig 5D). Flagellar segments covered with prevalently semi-erect setae which are equal to diameter of segment. Flagellomere 1 bearing 3–4 longitudinal placodes (Fig 2D). Hind femur covered with prevalently semi-erect setae (Fig 4D)***A. salicaphis* (Fitch)**
- First metasomal tergite (petiole) short, 1.9–2.1X as long as wide at spiracles (Fig 5F). Flagellar segments covered with adpressed setae which are distinctly shorter than diameter of segment. Flagellomere 1 with 0–1 longitudinal placode (Fig 2F). Hind femur covered with short adpressed setae (Fig. 4F)
..... ***A. veronicaecola* (Stary)**

List of *Adialytus* species and their host associations

***Adialytus ambiguus* (Haliday, 1834)**

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

Figs 2A, 3A, 4A, 5A, 6A

Aphidius ambiguus Haliday, 1834: 104–105.

Material examined. 1♂ 1♀, *Sipha elegans* del Guercio on *Triticum aestivum*, FA, Shiraz (29°34'22"N, 52°41'58"E, 1489 m), 27.IV.2005, 1♂ 1♀, coll.: E. Rakhshani.

Comments: This species is closely related to other parasitoids of *Sipha* aphids, in its elongated ovipositor sheath (Fig 6A) and triangular shape of petiole which bears anterior and spiracular tubercles (Fig 5A). It can be differentiated from other species in having an extremely long vein R1 (= metacarpus) (Fig 3A). The hind femur and tibia are covered with both short and prevalently erect long setae (Fig. 4A).

***Adialytus* cf. *ambiguus* (Haliday, 1834)**

Figs 2B, 3B, 4B, 5B, 6B

Material examined. 22♂ 20♀, *Sipha maydis* Passerini on *Bromus tectorum*, NK, Gharemeidan (37°25'42"N, 56°33'19"E, 1544 m), 14.V.2008, 15♂ 18♀, coll. S. Kazemzadeh; *Sipha elegans* del Guercio on *Gastridium phleoides*, IS, Nazhvan (32°38'25"N, 51°35'48"E, 1582 m), 05.IX.2011, 7♂ 2♀, coll. E. Nader.

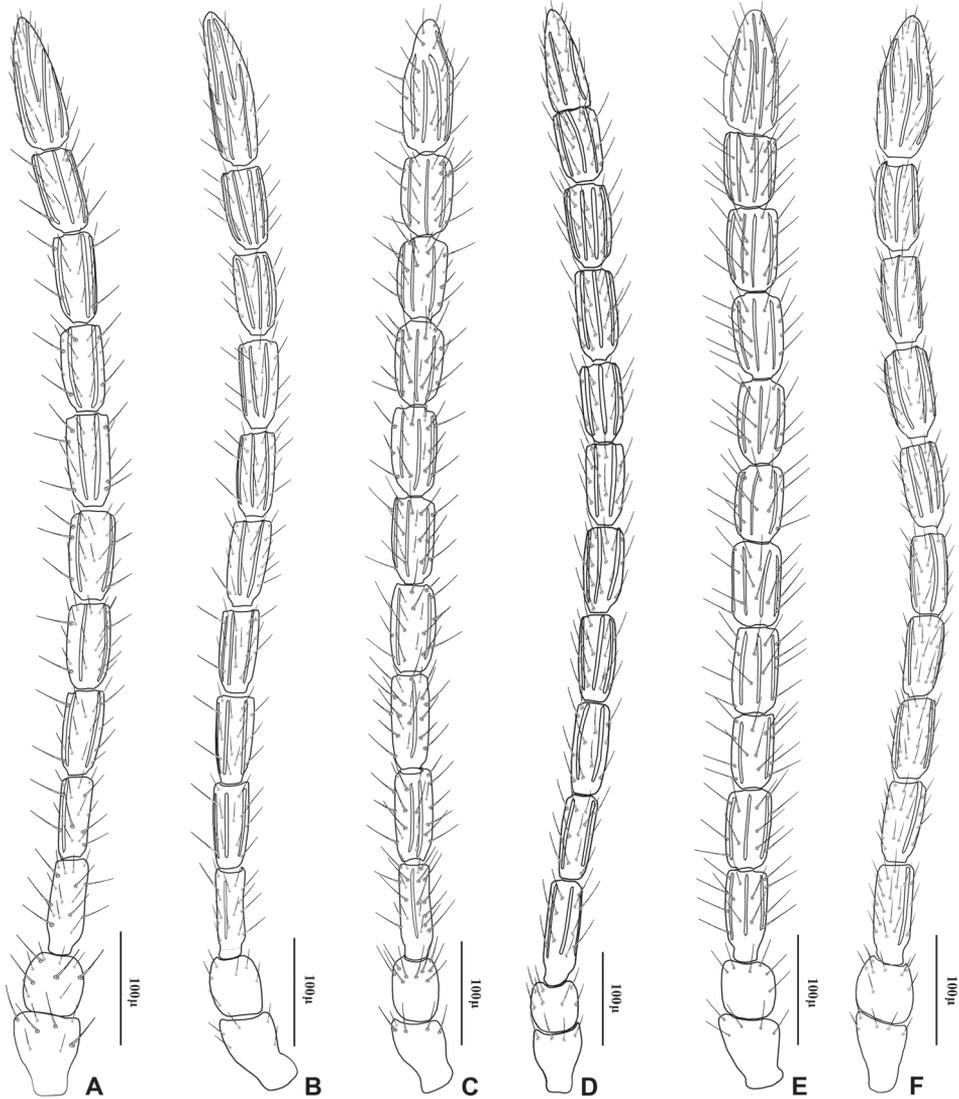


Figure 2. Antenna of *Adialytus* species **A** *Adialytus ambiguus* **B** *Adialytus* cf. *ambiguus* **C** *Adialytus arvicola* **D** *Adialytus salicaphis* **E** *Adialytus thelaxis* **F** *Adialytus veronicaecola*.

Comments. The specimens normally run to *A. ambiguus* according to the general characters of the first metasomal tergite (Fig 5B), ovipositor sheath (Fig 6B), the flagellomeres (Fig 2B) and the setae on the hind femur (Fig 4B). It can be differentiated from *A. ambiguus* by having the shorter vein R1 that is 0.9–1.1 × as long as pterostigma that does not reach the apex of the fore wing (Fig 3B). It can be separated from *A. arvicola* (Fig 3C), by its longer vein R1.

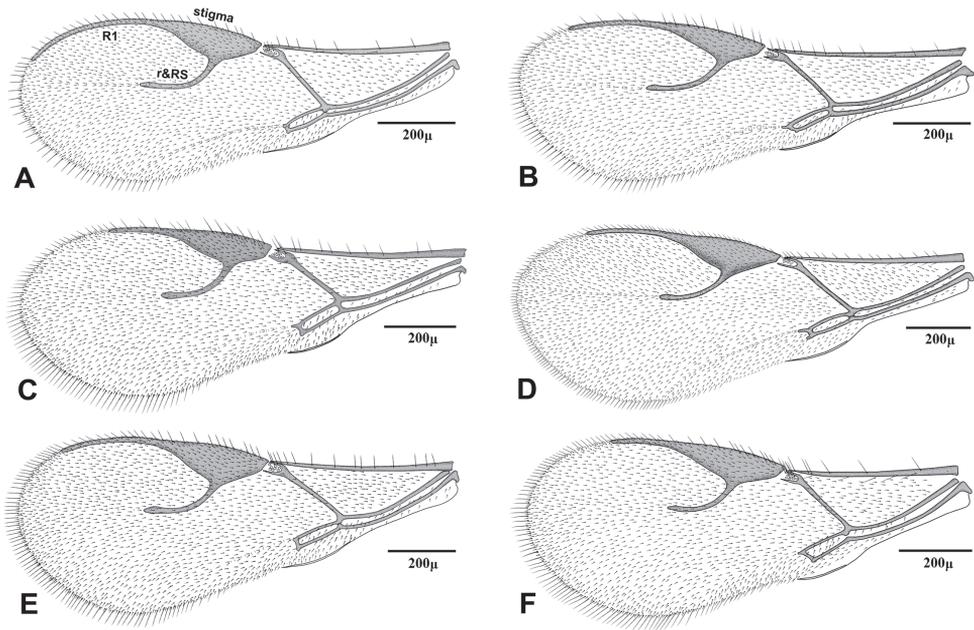


Figure 3. Fore wing of *Adialytus* species **A** *Adialytus ambiguus* **B** *Adialytus* cf. *ambiguus* **C** *Adialytus arvicola* **D** *Adialytus salicaphis* **E** *Adialytus thelaxis* **F** *Adialytus veronicaecola*.

“*Adialytus arvicola* (Starý, 1961)”

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

Figs 2C, 3C, 4C, 5C, 6C

Lysiphlebus arvicola Starý, 1961a: 98–100.

Material examined. 38♂ 63♀, *Sipha flava* (Forbes) on *Agropyrum repens*, KE, Kermanshah (34°19'33"N, 47°05'53"E, 1322 m), 25.VI.2011, 22♂ 55♀, coll. Y. Nazari; *Sipha maydis* Passerini on *Avena fatua*, KE, Kermanshah (34°19'33"N 47°05'53"E, 1322 m), 11.VI.2011, 2♂, coll. Y. Nazari; on *Bromus tectorum*, KE, Sanandaj (35°17'52"N, 46°59'59"E, 1517 m), 16.V.2005, 1♂, coll. E. Rakhshani; on *Cynodon dactylon*, KN, Kerman (30°14'28"N, 57°07'20"E, 1775 m), 22.XI.2007, 6♂ 2♀, coll. H. Barahoei; on *Sorghum halepense*, KE, Kermanshah (34°19'35"N 47°06'00"E, 1320 m), 11.VI.2011, 2♂ 3♀, coll.: Y. Nazari; *Sipha elegans* del Guercio on *Triticum aestivum*, KR, Mashhad (36°15'22"N, 59°28'42"E, 1164m), 12.IV.2012, 5♂ 3♀, coll. J. Karimi.

Comments. Generally this species can be confused with other *Adialytus* species on *Sipha* aphids, but it is immediately distinguishable by its very short vein R1 (0.7–0.8 × as long as pterostigma) (Fig 3C). Also, its petiole has much stronger anterior and spiracular tubercles (Fig 5C). Most of the metasoma is yellowish, while in other *Adialytus* species it is uniformly brown to dark brown.

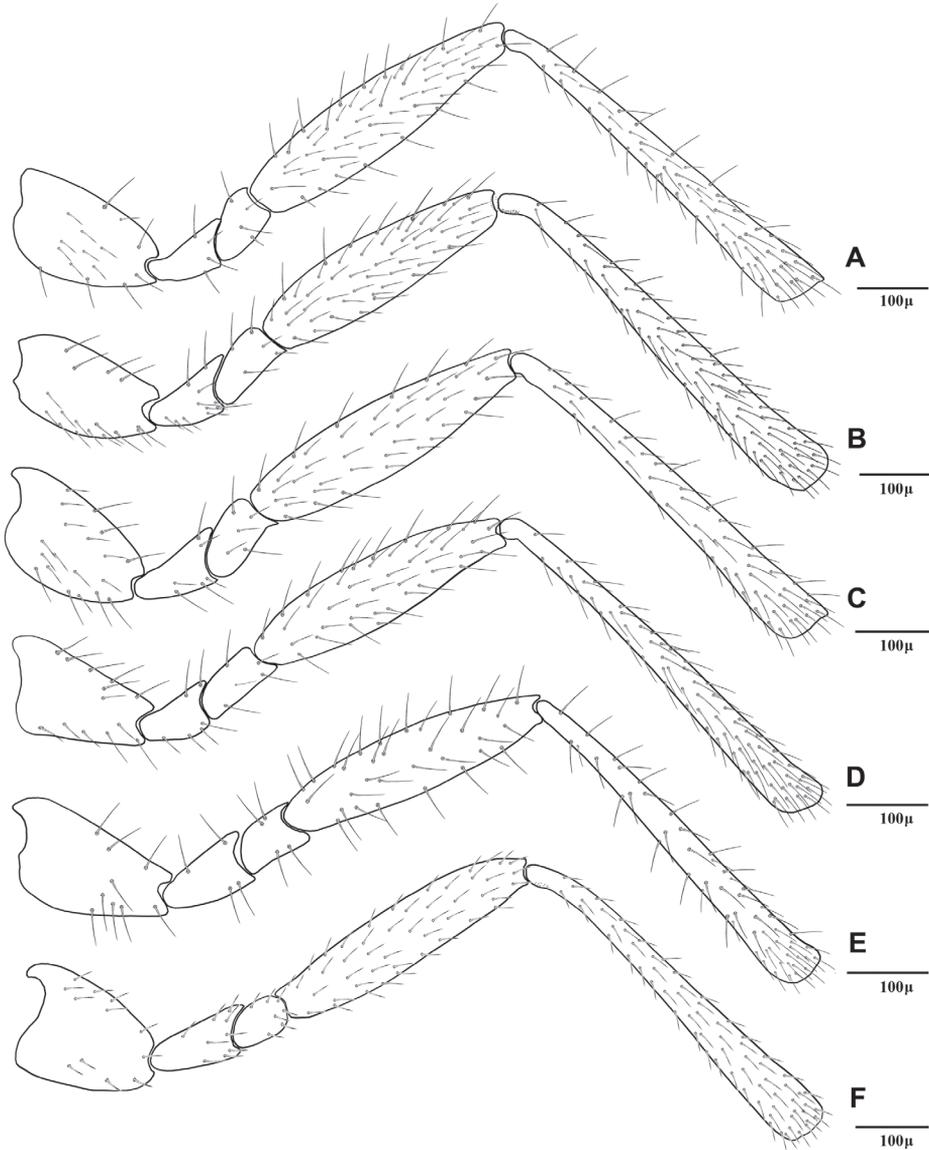


Figure 4. Hind leg of *Adialytus* species, excluding tarsomeres **A** *Adialytus ambiguus* **B** *Adialytus* cf. *ambiguus* **C** *Adialytus arvicola* **D** *Adialytus salicaphis* **E** *Adialytus thelaxis* **F** *Adialytus veronicaecola*.

***Adialytus salicaphis* (Fitch, 1855)**

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

Figs 2D, 3D, 4D, 5D, 6D

Trioxys salicaphis Fitch, 1855: 841.

Material examined. 138♂ 223♀, *Chaitophorus euphraticus* Hodjat on *Populus euphratica*, SB, Zahedan (29°23'27"N, 60°48'49"E, 1498 m), 24.III.2003, 3♂ 7♀, coll. E.

Rakhshani; *Chaitophorus remaudierei* Pintera on *Salix alba*, KD, Marivan (35°31'33"N, 46°09'21"E, 1293 m), 08.X.2004, 4♂ 6♀, coll. E. Rakhshani; *Chaitophorus salijaponicus niger* Mordvilko on *Salix alba*, FA, Sepidan (30°15'55"N, 51°58'43"E, 2244 m), 23.V.2009, 7♂ 9♀, coll. S. Taheri; NK, Shirvan, 24.VI.2008, 32♂ 54♀, coll. S. Kazemzadeh; NK, Esfarayen (37°05'12"N, 57°30'39"E, 1293 m), 17.V.2008, 8♂ 13♀, coll. S. Kazemzadeh; *Chaitophorus populiabae* (Boyer de Fonscolombe) on *Populus alba*, AL, Karadj (35°44'45"N, 51°10'07"E, 1296 m), 09.X.2002, 16♂ 29♀, coll. E. Rakhshani; *Chaitophorus populeti* (Panzer) on *Populus nigra*, TH, Tehran (35°47'52"N, 51°24'08"E, 1650 m), 09.XI.2002; 32♂ 48♀ coll. E. Rakhshani; *Chaitophorus leucomelas* Koch on *Populus nigra*, KN, Lalezar (29°31'05"N, 56°48'59"E, 2845 m), 09.X.2007, 5♂ 15♀, coll. H. Barahoei; AL, Karadj (35°55'06"N 51°05'04"E, 1875 m) 27.VI.2003; 11♂ 18♀, coll. E. Rakhshani; on *Populus* sp. FA, Sepidan (30°15'55"N, 51°58'43"E, 2244 m), 22.V.2009, 8♂ 12♀, coll.: S. Taheri; *Chaitophorus vitellinae* (Schränk) on *Salix alba*, MA, Mahallat (33°53'12"N, 50°27'31"E, 1652 m), 22.IV.2005, 5♂ 4♀, coll.: E. Rakhshani; *Chaitophorus* sp., on *Populus alba*, NK, Shirvan (37°23'35"N, 57°54'40"E, 1082 m), 24.V.2008, 7♂ 8♀, coll. S. Kazemzadeh.

Comments. *A. salicaphis* differs from other congeners in having very elongated first metasomal tergite (petiole) (Fig 5D), and short and dense marginal setae of the fore wing (Fig 3D). It can also be differentiated from *A. arvicola* by the number of longitudinal placodes on flagellomere 1 (3–5 in *A. salicaphis* vs. 0–1 in *A. arvicola*). The specimens of *A. salicaphis* associated with *Salix* spp., especially those reared from *Chaitophorus salijaponicus niger* on *Salix alba*, were slightly different from the specimens that reared from *Chaitophorus* spp. on *Populus*. The major differences were the lesser number of setae on the clypeus (4–5 vs. 8–10), lesser longitudinal placodes on the first flagellomere (1–2 vs. 3–5) and predominantly adpressed and short setae on the flagellomeres and hind femur compared with the long semi-erect to erect setae among the short setae in specimens from *Populus*.

Adialytus thelaxis (Starý, 1961)

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

Figs 2E, 3E, 4E, 5E, 6E

Lysiphlebus thelaxis Starý, 1961a: 100–101.

Material examined. 11♂ 26♀, *Thelaxes suberi* (del Guercio) on *Quercus* sp., GN, Rasht (37°17'24"N, 49°35'43"E, -4 m), 24.V.2004, 4♂ 3♀, coll.: E. Rakhshani; on *Quercus castanifolia*, GL, Gorgan (36°47'33"N, 54°27'02"E, 340 m), 06.IV.2010, 7♂ 23♀, coll. A. Sargazi.

Comments. This species can be easily separated from other congeners by having mainly erect long setae on the flagellomeres (Fig 2E) and the hind femur (Fig 4E). The setae on the postero-dorsal aspect of petiole are similar (Fig 5E). Additionally, *A. thelaxis* is the only species with a sharply pointed ovipositor sheath (Fig 6E).

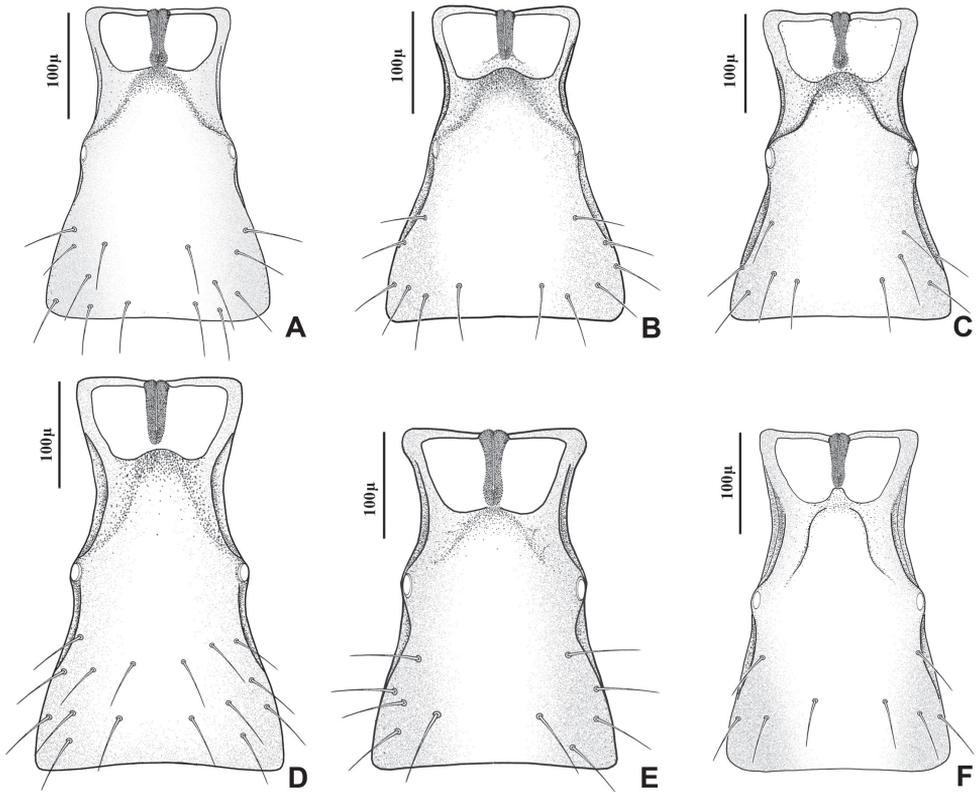


Figure 5. Petiole or first metasomal tergite of *Adialytus* species **A** *Adialytus ambiguus* **B** *Adialytus* cf. *ambiguus* **C** *Adialytus arvicola* **D** *Adialytus salicaphis* **E** *Adialytus thelaxis* **F** *Adialytus veronicaecola*.

***Adialytus veronicaecola* (Stary, 1978)**

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

Figs 2F, 3F, 4F, 5F, 6F

Lysiphlebus veronicaecola Stary, 1978: 528–529.

Material examined. 2♂ 3♀, *Aphis craccivora* Koch on *Phaseolus vulgaris*, IS, Flavarjan (32°30'56"N, 51°29'02"E, 1618 m), 2♀, coll. E. Nader; *Aphis* sp. on *Rubia tinctorum*, IS, Mobarakeh (32°30'56"N, 51°30'17"E, 1658 m), 13.XI.2010, 1♂ 1♀, coll. E. Nader; *Aphis gossypii* Glover on *Cucurbita pepo*, IS, Ghahderijan (32°36'18"N, 51°28'25"E, 1611 m), 05.XI.2010, 1♂, coll. E. Nader.

Comments. This species is unique in that it was reared from *Aphis* species. According to the general characters of the fore wing (Fig 3F), petiole or first metasomal tergite (Fig 5F) and the ovipositor sheath (Fig 6F) it is closely related to *A. salicaphis* from which it can be immediately distinguished in having prevalently short and adpressed setae on the flagellomeres (Fig 2F) and hind femur (Fig 4F). It can also be differenti-

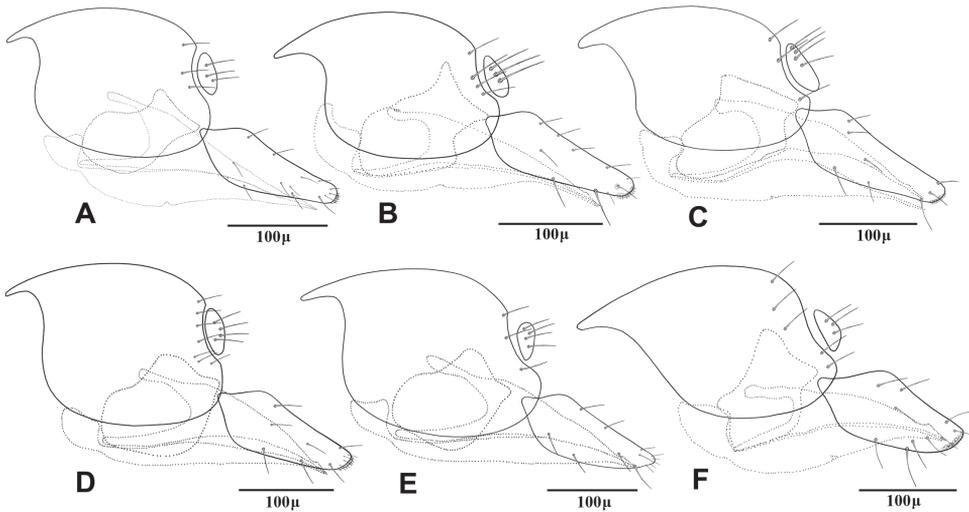


Figure 6. Female genitalia of *Adialytus* species **A** *Adialytus ambiguus* **B** *Adialytus* cf. *ambiguus* **C** *Adialytus arvicola* **D** *Adialytus salicaphis* **E** *Adialytus thelaxis* **F** *Adialytus veronicaecola*.

ated from *A. salicaphis* by having lesser longitudinal placodes on flagellomeres 1 and 2 (0–1 in *A. veronicaecola* vis 3–5 in *A. salicaphis*). In addition, *A. veronicaecola* differs from the other species in having a stout ovipositor sheath with a strongly convex postero-dorsal outline (Fig 6F).

Discussion

In a biological aspect, the host range pattern of *Adialytus* species can be used as an appropriate criterion supporting its generic status as separate from, but closely related to the genus *Lysiphlebus* Förster. Species of the genus *Lysiphlebus* are mostly parasitoids of the genera *Aphis* and *Brachycaudus* (Starý 1999, 2006, Starý et al. 1998) but, exceptionally, include some other aphid groups such as *Metopeurum* (Macrosiphini) in the case of *Lysiphlebus hirticornis* Mackauer (Mackauer 1960, Starý 1961b). On the other hand, about half of the *Adialytus* species are associated with different aphid subfamilies consisting of Thelaxinae and Chaitophorinae, while others attack *Aphis* (Starý and Juchnevič 1978, Pike et al. 2000) and *Dysaphis* (Starý and Rakauskas 1979). It can be suggested here that the members of the latter group are biologically more closely related to the genus *Lysiphlebus*. The Nearctic species, *A. fuscicornis* (Ashmead), a parasitoid of *Aphis* species (Pike et al. 2000) tends also to resemble morphologically the *Lysiphlebus* species except for its more reduced wing venation. Among the recorded species, *A. veronicaecola* manifests two major diagnostic characters including the stout ovipositor sheath and prevalently adpressed setae on the flagellar segments and hind legs. Other species have a more elongated ovipositor sheath and different types of chaetotaxy bearing both semi-

erect and erect setae. In contrast, *A. balticus* Starý has erect and perpendicular setae on the flagellomeres. The habitat and host associations of this species on the root collar of *Anthriscus* sp. (Starý and Rakauskas 1979) might be the reason for having perpendicular setae on the flagellomeres as well as the reduction in length of the segments (Starý et al. 1998). So, we lack clear diagnostic characters for separation of these groups given the present state of knowledge.

Adialytus veronicaecola was originally described from Kazakhstan (Starý and Juchnevič 1978, Starý 1979). The new evidence also supports the original distribution of this species in central Asia, as well as host specificity on *Aphis* species. Three other *Aphis* species are added to the list of its host, of which *A. craccivora* and *A. gossypii* are of economic importance. “*Adialytus arvicola*” phenotype is also newly recorded from Iran, but the earlier records are most probably cited under the synonymy with *A. ambiguus*. While it can be considered as the first evidence of the existence of a species complex in the case of *A. ambiguus*, it sounds to be a rather specific parasitoid of *Sipha* aphids of various subgenera including *Atheroides* Haliday, *Chaetosiphoniella* and *Sipha* Passerini (Mackauer 1965), “*A. arvicola*” seems to be restricted to the later subgenus (Starý 1961a, b). On the other hand, the separation of these two species, as well as the intermediate “*Adialytus* cf. *ambiguus*”, cannot be clearly justified without molecular analyses, since they were collected from almost the same host aphids at the studied area. Generally, *A. ambiguus* seems to be a very rare species in Iran, and it might be replaced by the geographical species/subspecies manifesting significant morphological differences. The most important diagnostic character is in the pattern of the venation of the fore wing.

It is yet unclear which “phenotype” of *A. ambiguus* was used for the phylogenetic analyses (Kambhampati et al. 2000, Sanchis et al. 2000) but, nominally, the genus *Adialytus* was classified as a paraphyletic group due to the arrangement of *A. ambiguus* inside the genus *Lysiphlebus* (Sanchis et al. 2000). On the other hand, “*A. arvicola*” was grouped with the other *Adialytus* species, separated from *Lysiphlebus* spp. (Kambhampati et al. 2000). Differences among the specimens of *A. salicaphis* associated with *Salix* and *Populus* seem to be an intra-specific variation together with some other characters including the length/width ratio of petiole and carination of the propodeum (see Takada 1979). Shujauddin (1978) also found the same difference between the Indian and European specimens. These variations should be considered in further taxonomical studies.

Conclusion

In general, identification of the *Adialytus* species merely based on the morphological characters is rather difficult, since they are very similar and even these characters may be contributed to intraspecific variation. Nevertheless, the host range patterns which are mostly specific can be greatly useful for separation of most species, excluding taxa in the *A. ambiguus* species complex, which have almost the same host range. Further investigations based on the geometric morphometric analysis, as well as suitable mo-

lecular markers might reveal the exact identity of the above-mentioned taxa and status “*A. arvicola*” and “*Adialytus cf. ambiguus*”. Furthermore, a re-classification at a tribal level is necessary to reconstruct the relationships between two groups of *Adialytus* species and their position compared to the genus *Lysiphlebus*.

Acknowledgments

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A taxonomic contribution to the genus *Dolichomitus* Smith (Hymenoptera, Ichneumonidae, Pimplinae) from Brazil

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Abstract

In the present study, two new species of Pimplinae, *Dolichomitus jatai* **sp. n.** and *D. moacyri* **sp. n.** are described, and the distribution range of *Dolichomitus annulicornis* (Cameron, 1886) is extended. The specimens were collected using Malaise traps in areas of Atlantic forest and Brazilian savannah (cerrado) in southeastern Brazil and are deposited in a Brazilian collection (DCBU).

Keywords

Neotropical, new species, savannah, distribution

Introduction

Dolichomitus Smith, 1877 includes 72 species, with 13 recorded from the Neotropics (Gauld et al. 1998; Yu et al. 2005), of which four occur in Brazil: *Dolichomitus annulicornis* (Cameron, 1886), *Dolichomitus megalourus* (Morley, 1914) and the new

species *D. jatai* sp. n. and *D. moacyri* sp. n. This genus is not monophyletic, but some of the component species groups are monophyletic lineages (Gauld et al. 2002). Specimens of *Dolichomitus* are characterized by oblique grooves anterolaterally, which form triangular areas on tergite II of the metasoma, and the lateral expansion of the lower valve of ovipositor. Townes (1975) published a description of the Hymenoptera with the longest ovipositors, describing the neotropical species *Dolichomitus bivittatus* and *D. hypermeces*. Gauld et al. (1998) grouped eight species from Costa Rica into four groups: *longicauda*, *taeniatus*, *irritator* and *zonatus*. Nothing is known about the biology of these groups of species. The purpose of the present paper is to describe the two new species and to update the known distribution of *D. annulicornis*.

Material and methods

The examined specimens were collected using Malaise traps in different localities of southeastern Brazil and are deposited in the DCBU collection (Departamento de Ecologia e Biologia Evolutiva, Universidade Federal de São Carlos, São Carlos, SP, Brazil). The terminology used mostly follows Gauld (1991) and Gauld et al. (1998). Color pictures were taken with a Leica stereomicroscope with LAS software; grayscale pictures were taken with an FEI Quanta 250 SEM under low-vacuum conditions.

Results

Gauld (1991) reported the distribution of *D. annulicornis* as occurring from southern Mexico southward to equatorial South America. Adding to the material from the Natural History Museum of London identified by I. Gauld and reports found in the literature, we identified one male and three female specimens of *D. annulicornis* collected in southeastern Brazil, expanding the distribution of this species southward. These new specimens also constitute the first records of this species in seasonal dry forests (Gauld 1991). We collected *D. annulicornis* in both semideciduous seasonal forest and dry savannah (cerrado). In addition, the morphological features of specimens of two new species of *Dolichomitus* are described and discussed below.

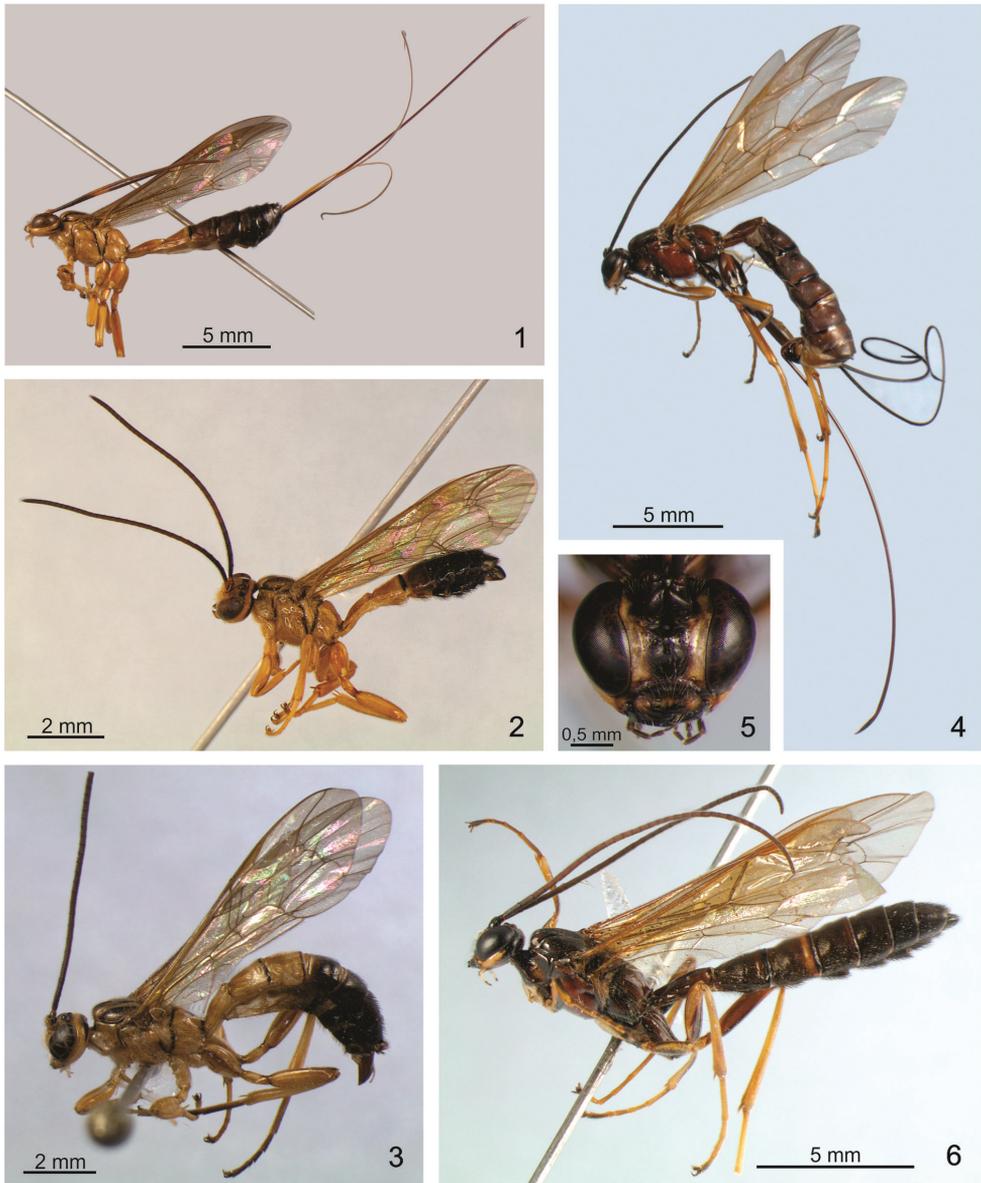
Dolichomitus jatai sp. n.

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

Figures 1–2, 7–13

Material examined. Type locality. Brazil, SP, Luís Antônio, Estação Ecológica de Jataí, 21°35'16.7"S, 47°47'43.9"W; 15.X.2009; Brazilian savannah, N.W. Perieto and team col., Malaise trap.



Figures 1–6. *Dolichomitus jatai* sp. n. female. **1** lateral habitus **2** male, lateral habitus. *Dolichomitus annulicornis* **3** lateral habitus. *Dolichomitus moacyri* sp. n., female **4** lateral habitus **5** head, frontal view **6** male, lateral habitus.

Type specimen. Holotype pinned (DCBU): female, Brazil, SP, Luís Antônio, Estação Ecológica de Jataí, Brazilian savannah, 21°35'16.7"S, 47°47'43.9"W, 15.X.2009, Armadilha Malaise II, N.W. Periotto and team col.

Paratypes (DCBU). 1 female, same as the holotype, 16.IX.2009; 2 females and 1 male, same as the holotype, 21°36'10.2"S, 47°46'47.6"W, 16.IX.2009, 27.V.2009

and 03.IX.2008, respectively; 1 male, Brazil, SP, Macaubal, 20°44'34"S, 49°55'45"W, 03.IV.2008, semideciduous seasonal forest, F. Noll col., Malaise trap; 1 male, Brazil, SP, Itirapina, 22°13'09"S, 47°54'04"W, 6.XII.2008, riparian forest, A.M.P. Dias col., Malaise trap; 1 male, Brazil, SP, São Carlos, Fazenda Pinhal, 22°08' 21.80"S, 47°50' 56.57"W, 20.XI.2004, A.M.P. Dias col., Malaise trap.

Holotype: female (Fig. 1). Body length: 13.7 mm; fore wing length: 9.0 mm. Head (Fig. 7). Antenna with 35 segments, the last flagellomere 2.5x as long as the anterior; mandible with upper tooth more or less equal in length to the lower tooth; clypeus apically bilobate; lower face centrally punctuated with hairs. Occipital carina mid-dorsally dipped; occiput with a mid-dorsal notch (Fig. 8). Anterior margin of pronotum reflexed upward; epomia distinct; mesoscutum with setiferous punctures; notauli very strongly impressed anteriorly (Fig. 9). Mesopleuron smooth and shiny centrally; epicnemial carina very strong ventrally, with a shallow mid-ventral dip; metapleuron punctate with hairs; submetapleural carina complete; propodeum (Fig. 10) dorsally smooth, with setiferous punctures anterolaterally; pleural carina complete.

Metasoma: Tergite I of the metasoma (Fig. 11) with a smooth central area that is defined laterally by carinae convergent posteriorly to the hind margin; tergite II punctate with hairs, 1.1 times as long as posteriorly broad, with a shallow groove anterolaterally, margin posteriorly smooth and polished; tergites III + with setiferous punctures, posterior margin smooth and polished. Ovipositor 5.6 times the length of the hind tibia, more or less straight (Fig. 12).

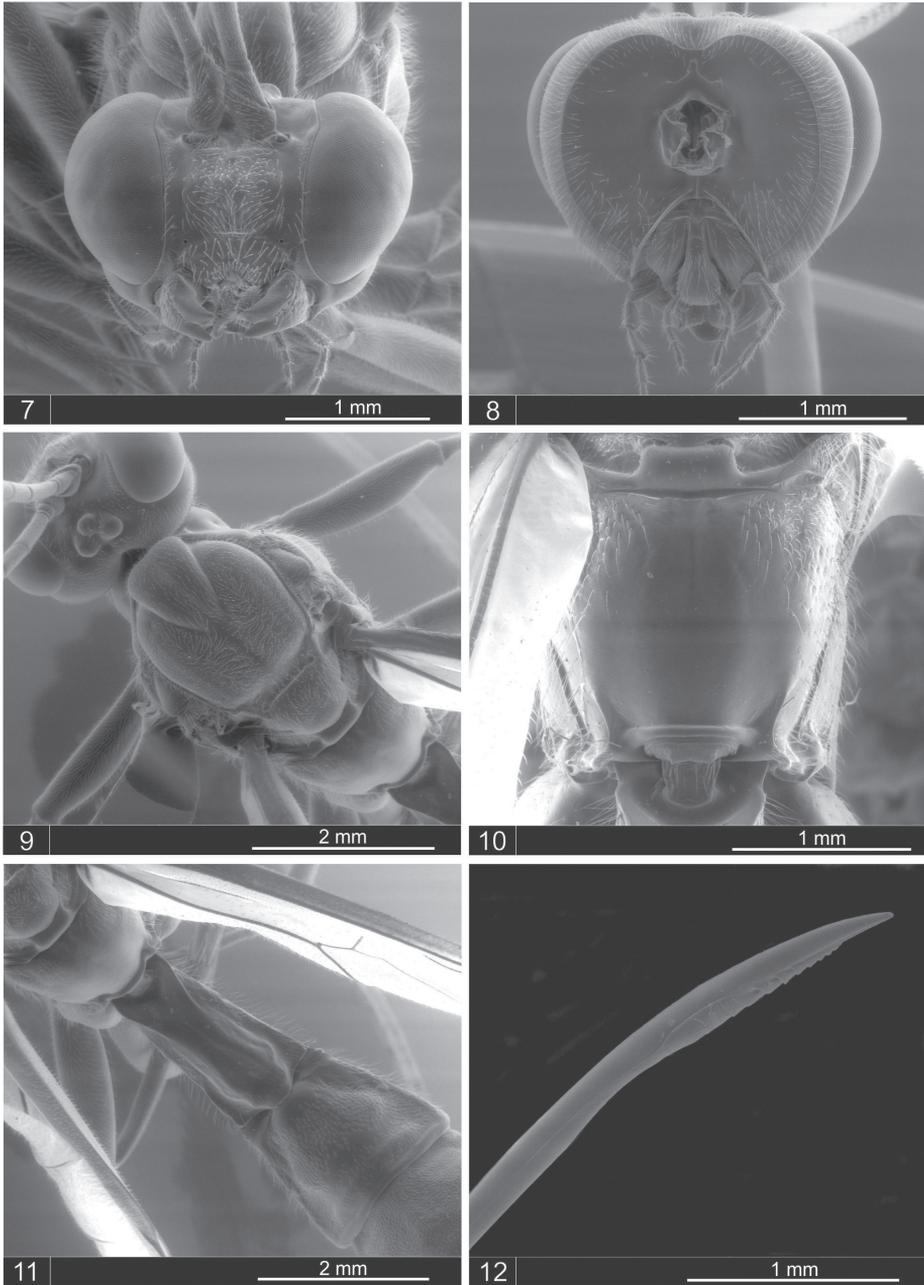
Color: Yellow and black or dark brown; head yellow, tips of mandible and occiput black; antenna with scape and pedicel yellow, proximal five flagellomeres black, the 6th and 7th yellow, the remainder brownish; mesoscutum with three black stripes; the anterior margin and posterior lateral margin of the propodeum with a narrow black stripe; pronotum, mesopleuron and metapleuron with a black posterior margin; the posterior margin of tergites II–VI black; tergites III+ dark brown. Legs yellow, fore-femur black, striped dorsally; tips of all tarsal claws brownish yellow. Ovipositor sheath brownish. Wings yellowish; pterostigma brownish.

Male (Fig. 2). Essentially as the female but with body length 10.9 mm; fore wing all yellowish with length 8.6 mm; antenna with 34 segments, the last flagellomere 1.5x as long as the anterior; the proximal four segments brown, the 5th, 6th and 7th slightly yellowish and the remainder brownish; mid-coxa with surface evenly convex (Fig. 13).

Etymology. The name of the species refers to the locality of collection of the material for study.

Distribution. Brazil.

Dolichomitus jatai sp. n. seems to belong to the *zonatus* species group, which are vespids mimics and are predominantly yellowish with brown or black marks; the wings are yellowish, and the males have shorter bodies. This species is similar to *D. annulicornis* (Fig. 3), differing in the color of the flagellomeres: whereas the proximal five flagellomeres are black and the 6th and 7th yellow in *D. jatai* sp. n., the proximal three or four flagellomeres are black and the next four or five whitish yellow in *D. annulicornis*. The propodeum is dorsally smooth in *D. jatai* sp. n., whereas in *D. annulicornis*, there



Figures 7–12. *Dolichomitus jatai* sp. n., female. **7** head, frontal view **8** head, posterior view **9** mesoscutum, dorsal view **10** propodeum, dorsal view **11** tergites I–II **12** ovipositor tip.

is a smooth and polished area that widens posteriorly. The males of the two species differ in the form of the mid-coxa: in *D. annulicornis*, there are prominences separated by deep concavities (Fig. 14), and in *D. jatai* sp. n., the surface of the mid-coxa is evenly

convex (Fig. 13). In *D. zonatus*, the propodeum is similar to that of *D. annulicornis*, but it is narrower posteriorly. *Dolichomitus cantillanoi* has a narrower median longitudinal groove and distinct lateromedial secondary furrows, which are never present in *D. zonatus*, *D. annulicornis* or *D. jatai* sp. n. *Dolichomitus bivittatus*, Townes, 1975, and *D. hypermeces*, Townes, 1975, are different in color and have longer ovipositors, 12.0× and 21.0× as long as the hind tibia, respectively.

***Dolichomitus moacyri* sp. n.**

urn:lsid:zoobank.org:act:B0EC55E4-559B-42CD-982C-011048779C4C

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

Figures 4–6, 15–18

Material examined. Type locality: Brazil, SP, Poços de Caldas, Sítio da Ferradura, S 21°47'3.4"S, 46°37'22.8"W, 13.X.2006, riparian forest, A.E. de Carvalho col., Malaise trap.

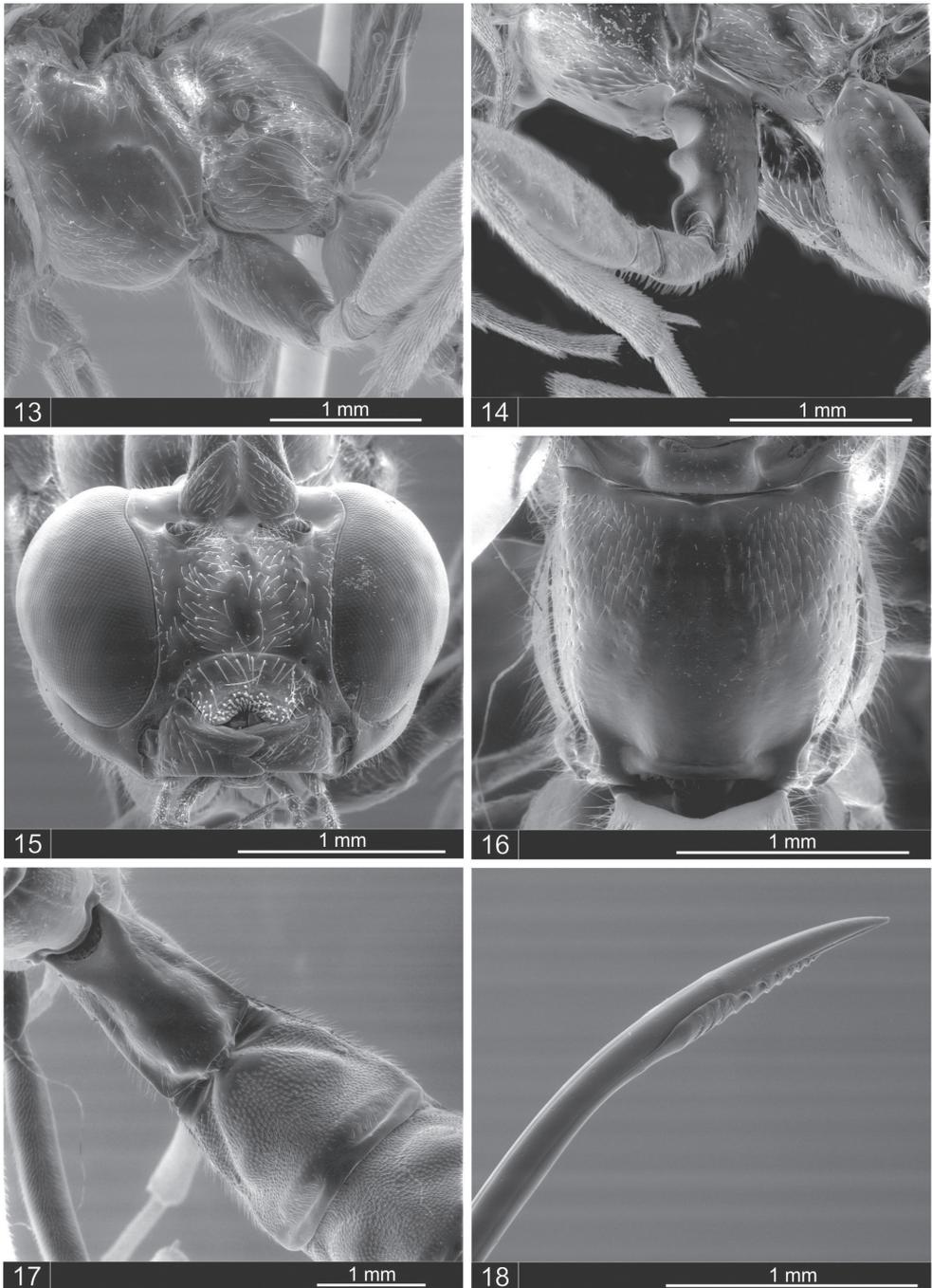
Type specimen. Holotype pinned (DCBU): female, Poços de Caldas, SP, Brazil, Sítio da Ferradura, 21°47'3.4"S, 46°37'22.8"W, riparian forest, 13.X.2006, Malaise trap.

Paratypes (DCBU): 1 female, Brazil, SP, Itapeva, Estação Ecológica de Itapeva, 24°4'10.7"S, 49°4'10"W, 15.IV.2008, Brazilian savannah, A.M.P. Dias col., Malaise trap; 1 male, Brazil, SP, Santa Rita do Passa Quatro, Parque Estadual de Vassununga – Pé-do-gigante, 21°40'56"S, W 47°37'13"W, 08.X.2007, riparian forest, A.M.P. Dias col., Malaise trap.

Holotype: female (Fig. 4). Length: 16 mm; fore wing length: 12 mm. Antenna with 37 segments; the last flagellomere 2.5× as long as the anterior; mandible with upper tooth more or less equal in length to the lower tooth; clypeus apically bilobate; lower face (Fig. 15) centrally punctuated; occipital carina mid-dorsally dipped. Epomia distinct; mesoscutum with setiferous punctures; notauli very strongly impressed anteriorly. Mesopleuron mostly centrally smooth and polished, with setiferous punctures; epicnemial carina weak laterally; metapleuron with setiferous punctures; submetapleural carina complete. Propodeum with vestigial lateromedial longitudinal carinae posteriorly divergent with central area smooth, anterolaterally with setiferous punctures (Fig. 16); pleural carinae complete.

Metasoma: Tergite I (Fig. 17) with a smooth central area defined laterally by carinae convergent posteriorly to the hind margin; tergites II punctate with hairs, 0.8 times as long as posteriorly broad, with a shallow groove anterolaterally; tergites III–V with setiferous punctures and a pair of lateromedial swellings and posterior margin narrow, smooth and polished; tergites VI+ punctate with hairs. Ovipositor 5.0 times the length of the hind tibia, with apex declined (Fig. 18).

Color: Reddish-brown with black and yellow markings. Head yellow with vertex brown; occipital region, central frons and mandible black (Fig. 5); antenna dark brown, three black stripes on mesoscutum; dorselum yellow; propleuron black;



Figures 13–18. *Dolichomitus jatai* sp. n., male **13** mid-coxa, lateral view. *Dolichomitus annulicornis*, male **14** mid-coxa, lateral view. *Dolichomitus moacyri* sp. n., female **15** head, frontal view **16** propodeum, dorsal view **17** tergites I–II **18** ovipositor tip.

tergite I of metasoma brownish, tergite II+ reddish brown; distal tarsomeres dark brown; coxa of first pair of legs black with a whitish spot anteroventrally; trochanter brown, whitish ventrally; trochantelus dark brown; femur and tibia yellow with a black stripe laterally; tarsomeres I–IV yellow, dorsally brown; coxa and trochanter of the second pair of legs dark brown, whitish ventrally; trochantelus brown, femur and tibia yellow with a black stripe laterally; tarsomeres I–IV yellow, dorsally brown; hind leg with coxa orange-brown; trochanter, trochantelus and femur yellow, ventrally brown; tibia and tarsomeres I–II yellow; tarsomeres III–IV and ovipositor sheath dark brown; wings yellowish, fore wing with anterior margin more fuscous; pterostigma yellow.

Male (Fig. 6). Length: 13.3 mm. Fore wing: 11.0 mm; mid-coxa evenly convex. Similar to female, antenna with 40 segments; the last flagellomere 1.5× as long as the anterior.

Variation. One female with the first pair of coxa and trochanter yellowish ventrally.

Etymology. The name of the species is in honor of Moacyr de Carvalho Dias, the owner of the Sitio da Ferradura.

Distribution. Brazil.

Dolichomitus moacyri sp. n. does not seem to belong to any of Gauld et al.'s (1998) species groups. The ovipositor is only 5.0 times the length of the hind tibia; the fore wing does not have black bands, and the male is similar to the female in size and shape. In the *longicauda* species group, the male and female are similar in size and shape, but the fore wing is yellow with black bands. *D. moacyri* sp. n. does not belong to the *taeniatus*, *irritator* or *zonatus* species groups because the male and female are not sexually dimorphic. *D. moacyri* sp. n. is different from the species of the group *taeniatus* because it does not present a yellow dorsal stripe on the pronotum; it differs from species of the group *zonatus* because it does not present a whitish-yellow band on the flagellum of antenna. *Dolichomitus bivittatus* and *D. hypermeceus* are different in color and have longer ovipositors, at 12.0× and 21.0× as long as the hind tibia, respectively.

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