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A new species of the genus *Mesobuthus* Vachon, 1950 (Scorpiones, Buthidae) from Xinjiang, China

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Abstract
A new species of the genus *Mesobuthus* Vachon, 1950 is described, based on specimens collected in the northern piedmont of the Tianshan Mountains, Xinjiang. It is characterized by a slender chela, general coloration yellow to pale brownish-yellow, elongate aculeus and 2–4 markedly large and moderately extroversive lobed granules of the ventrolateral carinae of metasoma segment V. With the description of this new species, the number of known Chinese species of *Mesobuthus* is raised to five.

Keywords
Buthidae, *Mesobuthus*, new species, Xinjiang, China

Introduction

The genus *Mesobuthus* Vachon, 1950 currently includes 12 species (Fet and Lowe 2000; Gantenbein et al. 2000; Lourenço et al. 2005; Kovařík 2007), and it is widespread in the Palearctic region, from Balkans to China and Korea Peninsula. It is distributed in different habitats, but especially in the arid deserts, from Gobi to Central Asia and to Northwest China and Mongolia. The first species of *Mesobuthus* described from

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China was *Mesobuthus martensii martensii* by Karsch (1879), originally described in the genus *Buthus* as *Buthus martensii*. After the description of *M. martensii martensii* two other species, *Mesobuthus caucasicus przewalskii* and *Mesobuthus eupeus mongolicus* were described by Birula (1897, 1911). Moreover, Birula (1904) also described a new subspecies, *Mesobuthus martensii hainanensis*, based on one specimen of unknown sex, and labeled from Hainan Island. This subspecies remains, however, of dubious validity mainly because it was never found again in the Island of Hainan or from adjacent areas, but also because no species of *Mesobuthus* was ever found inhabiting evergreen rain forest. *Mesobuthus eupeus thersites* and *Mesobuthus caucasicus intermedius* have also been recorded from China (Fet 1994; Fet and Lowe, 2000). More recently, Lourenço et al. (2005) described the fourth species of this genus from China, *Mesobuthus songi*, based on old preserved specimens from the northern piedmont of Himalayas, Xizang (Tibet).

In comparison with scorpion faunas in adjacent regions (e. g. Vachon 1958; Tikader and Bastawade 1983; Fet 1989), the diversity of scorpions in Xinjiang appear to be rather poor. Having in account that this region of China remained inaccessible during the past several decades and considering its very important surface, it is quite possible that this fauna has been largely underestimated. In fact, scorpion taxonomy and biogeography in China remains yet a considerably poorly known subject of study, and this until very recently (Zhu et al. 2004). All studies in Xinjiang were done by foreign experts (Birula, 1897, 1904, 1911, 1917; Schenkel, 1936). Since then, no other experts have been involved in the study of Xinjiang scorpions. As a part of a research project on the entire Chinese scorpion fauna, a research team is conducting field work in Xinjiang. Among the scorpions found in the region, there are several specimens of *Mesobuthus*, which were collected in the northern piedmont of the Tianshan Mountains and correspond to a distinct new species. It represents the fifth known species of this genus from China.

Material and methods

Specimens were examined and measured under a Leica M165c stereomicroscope with an ocular micrometer. Illustrations were produced using a Leica M165c stereomicroscope with a drawing tube. All measurements follow Stahnke (1970) and are given in millimetres (mm), except for the chela (Vachon, 1952). Trichobothrial notations follow Vachon (1974) and morphological terminology mostly follows Hjelle (1990). Specimens used in this taxonomic work come from the Museum of Hebei University, Baoding (MHBU) and the American Museum of Natural History, New York (AMNH).

Taxonomy

Family Buthidae C. L. Koch, 1837
Genus *Mesobuthus* Vachon, 1950

***Mesobuthus caucasicus intermedius* (Birula, 1897)**
Figs 2, 11–13

Buthus caucasicus forma γ *intermedia* Birula, 1897: 387.
Mesobuthus caucasicus intermedius: Vachon, 1958: 150, Fig. 31.
Olivierus caucasicus intermedius: Farzanpay, 1987: 156.

Material examined. Type material not examined. Kazakhstan: Almaty Area, Kurty District, Taukum Desert, 25.5 km SE of Topar, 44°53.002'N, 75°17.138'E, 373 m alt., 9/V/2003, L. Prendini & A. V. Gromov leg., 4 females and 3 males (AMNH); South Kazakhstan Area, Chardara District, 3 km W of Chardara, 41°16.106'N, 67°53.228'E, 287 m alt., 20/VI/2003, L. Prendini & A. V. Gromov leg., 1 female and 3 males (AMNH).

Diagnosis. *Coloration*. Basically brownish-yellow; all carinae and posterior edges of carapace and tergites with blackish-brown to black pigments; dorsal surfaces of segments I–IV on metasoma and each surface of segment V with irregular netlike dark pigments. Pedipalps: brownish-yellow; femur and patella with dark pigments, especially around carinae; manus with irregular netlike dark pigments; rows of granules on dentate margins of the fingers blackish-brown. Legs: pale yellow to yellow; tip of femur and base of patella with some dark spots.

Morphology. Total length 66–77 mm in females and 55–60 mm in males. Prosoma: anterior margin with a weak median concavity, not serrate; all carinae moderately strong, granular, and granules moderately developed; Mesosoma: Tergite: I to VI tricarinate; carinae on I weak, and carinae on II–VI moderately to strong, granular; the intercarinal surfaces relatively smooth, except for the segments I–III with sparse and fine granules; exterior surfaces coarsely granular. Pectinal teeth number 20–25 in females and 26–30 in males. Metasoma: Segments I–V with 10-8-8-8-5 complete carinae; median lateral carinae complete on segment I, only with sparse granules and covered 1/3 length of segment on II, and obsolete, remaining 1–3 granules at distal end on III; ventrolateral carinae on segment V strong, serrate, becoming stronger gradually from anterior to posterior; lateral surfaces smooth, dorsal with some fine granules and ventral with sparse large granules. Aculeus longer than a half of telson length. Pedipalps: Trichobothrial pattern: Orthobothriotaxic A-β (Vachon, 1974, 1975). Dentate margins of movable and fixed fingers with 12 and 11 oblique rows of granules respectively; outer accessory denticles becoming smaller from base to tip markedly, and obviously smaller than inner accessory denticles on the tip. Legs: Tarsus ventrally with two moderate to long longitudinal rows of setae.

Distribution. China (Xinjiang Uygur Autonomous Region), Iran (northwest), Kazakstan, Kirghizstan, Tajikistan, Turkmenistan, Uzbekistan (Fet and Lowe, 2000).

Note. Although our field works in Xinjiang are going along in past four years, and we got a large amount of specimens, we could not find any evidence to support the distribution of *Mesobuthus caucasicus intermedius* in China. But here, we decide to refer to Fet and Lowe (2000) before our completing the investigations.

Mesobuthus caucasicus przewalskii **(Birula, 1897)**
Figs 3, 14–16

Buthus caucasicus przewalskii Birula, 1897: 387–388.
Buthus przewalskii: Kishida, 1939: 44.
Mesobuthus caucasicus intermedius: Vachon, 1958: 150, Fig. 31.
Olivierus caucasicus intermedius: Farzanpay, 1987: 156.

Material examined. Type material not examined. China: Xinjiang Uygur Autonomous Region: Tuokexun County, Xia Village, 4/VIII/2008, M. S. Zhu & D. Sun leg., 9 females, 6 males and 10 juveniles (MHBU); Turpan City, near the Flaming Mountain scenic spot, 4/VIII/2008, M. S. Zhu & D. Sun leg., 1 female, 1 male (MHBU); Shanshan County, Lianmuqin Town, Vineyard, 4/VIII/2008, M. S. Zhu & D. Sun leg., 3 males (MHBU); Hami City, 10 km S of downtown area, Huayuan Village, 2/VIII/2008, M. S. Zhu & D. Sun leg., 6 females, 1 male (MHBU); Hami City, 5 km E of downtown area, under stover in a village, 1/VIII/2008, M. S. Zhu & D. Sun leg., 1 juvenile (MHBU); Shanshan County, 18 km E of country town, 3/VIII/2008, M. S. Zhu & D. Sun leg., 2 juveniles (MHBU); Shanshan County, 4 km W of county town, Vineyard, 3/VIII/2008, M. S. Zhu & D. Sun leg., 2 females (MHBU); Korla City, near the downtown area, 12/IV/2008, C. L. Zhang leg., 1 female, 1 male, 1 juvenile (MHBU); Luntai County, in the *Populus euphratica* Forest Park, 12/VIII/2006, F. Zhang & H. X. Ma leg., 8 females, 6 males (MHBU); Ruoqiang County, near the county town, 30/VII/2006, F. Zhang & H. X. Ma leg., 5 females, 4 males, 1 juvenile (MHBU); Qiemo County, near the county town, 1/VIII/2006, F. Zhang & H. X. Ma leg., 1 female, (MHBU); Turpan City, 7.5 km SW of the downtown area, Vineyard, 8/VIII/2007, D. Sun & L. Zhang leg., 3 females, 22 juveniles (MHBU); Turpan City, near the Flaming Mountain scenic spot, 27/VII/2006, F. Zhang & H. X. Ma leg., 1 female, 1 male (MHBU); Tuokexun County, Xia Village, 6/VIII/2007, D. Sun & L. Zhang leg., 33 females, 18 males, 10 juveniles (MHBU); Kuqa County, near the county town, 11/VIII/2006, F. Zhang & H. X. Ma leg., 1 female, 1 male (MHBU); Luntai County, Lunnan Town, near the Tarim River Bridge, 27/V/2009, D. Sun & Y. W. Zhao leg., 1 female, 1 male (MHBU); Kuqa County, Tarim Village, the Second Brigade site, 31/V/2009, D. Sun & Y. W. Zhao leg., 5 females, 2 males (MHBU); Hami City, Xiheba site in the downtown area, 5/V/2009, D. Sun & Y. W. Zhao leg., 7 females, 6 males (MHBU).

Diagnosis. Coloration. Basically brownish-yellow; all carinae and posterior edges of carapace and tergites with blackish-brown to black pigments; dorsal surfaces of segments I–V on metasoma and ventral surface of segment V with irregular netlike dark pigments. Pedipalps: brownish-yellow; femur and patella with dark pigments, especially around carinae; manus with irregular netlike dark pigments; fingers without pigment, rows of granules on dentate margins of the fingers blackish-brown. Legs: pale yellow to yellow; tip of femur with some dark spots.

Morphology. Total length 68–78 mm in females and 50–68 mm in males. Prosoma: anterior margin with a weak median convexity, finely serrate; all carinae strong, granular and granules markedly biggish; Mesosoma: Tergite: I to VI tricarinate; all carinae strong, granular, except the median carina on I, weak; the intercarinal surfaces relatively smooth, except for the segments I–III with sparse and fine granules; exterior surfaces coarsely granular. Pectinal teeth number 15–19 in females and 19–23 in males. Metasoma: Segments I–V with 10-8-8-8-5 complete carinae; median lateral carinae complete on segment I, only with sparse granules and covered 1/2 length of segment on II and 1/3 on III; ventrolateral carinae strong, serrate, becoming stronger gradually from anterior to posterior; lateral and dorsal surfaces with some fine granules and ventral with sparse large granules. Aculeus about equal to a half of telson length. Pedipalps: Orthobothriotaxic A-β (Vachon, 1974, 1975). Manus of chela relatively robust. Dentate margins of movable and fixed fingers with 11 and 10 oblique rows of granules respectively; outer accessory denticles becoming smaller from base to tip, and smaller than inner accessory denticles on the tip. Legs: Tarsus ventrally with two moderate to long longitudinal rows of setae.

Distribution. China (Xinjiang Uygur Autonomous Region), Mongolia, Tajikistan, Uzbekistan (Fet and Lowe, 2000).

Mesobuthus longichelus **sp. n.**

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Figs 1, 4–10, 17–21

Type material. Holotype female (MHBU), China: Xinjiang, northern piedmont of the Tianshan Mountains, 10km S of Jinghe County, 44°31'N, 82°54'E, 7 Aug. 2008, M. S. Zhu, F. Zhang, G. X. Han and D. Sun leg.; 1 juvenile female (MHBU) and 1 juvenile male (MHBU) paratypes, all the same as for holotype.

Diagnosis. Species of moderate size, with respect to the genus. General coloration yellow to pale brownish-yellow; ventral and lateral surfaces of metasoma segment V with inconspicuous variegated black pigment. Chela smooth without carinae, long and slender. The metasoma segments elongate; median lateral carinae complete on segment I, only with sparse granules and covered 1/2–2/3 length of segment on II and obsolete, remaining 1–2 granules at distal end on III; ventrolateral carinae of segment V strong, serrate, becoming strongly marked posteriorly and with 2–3 markedly large and extroversive lobed granules; aculeus markedly longer than a half of telson length.

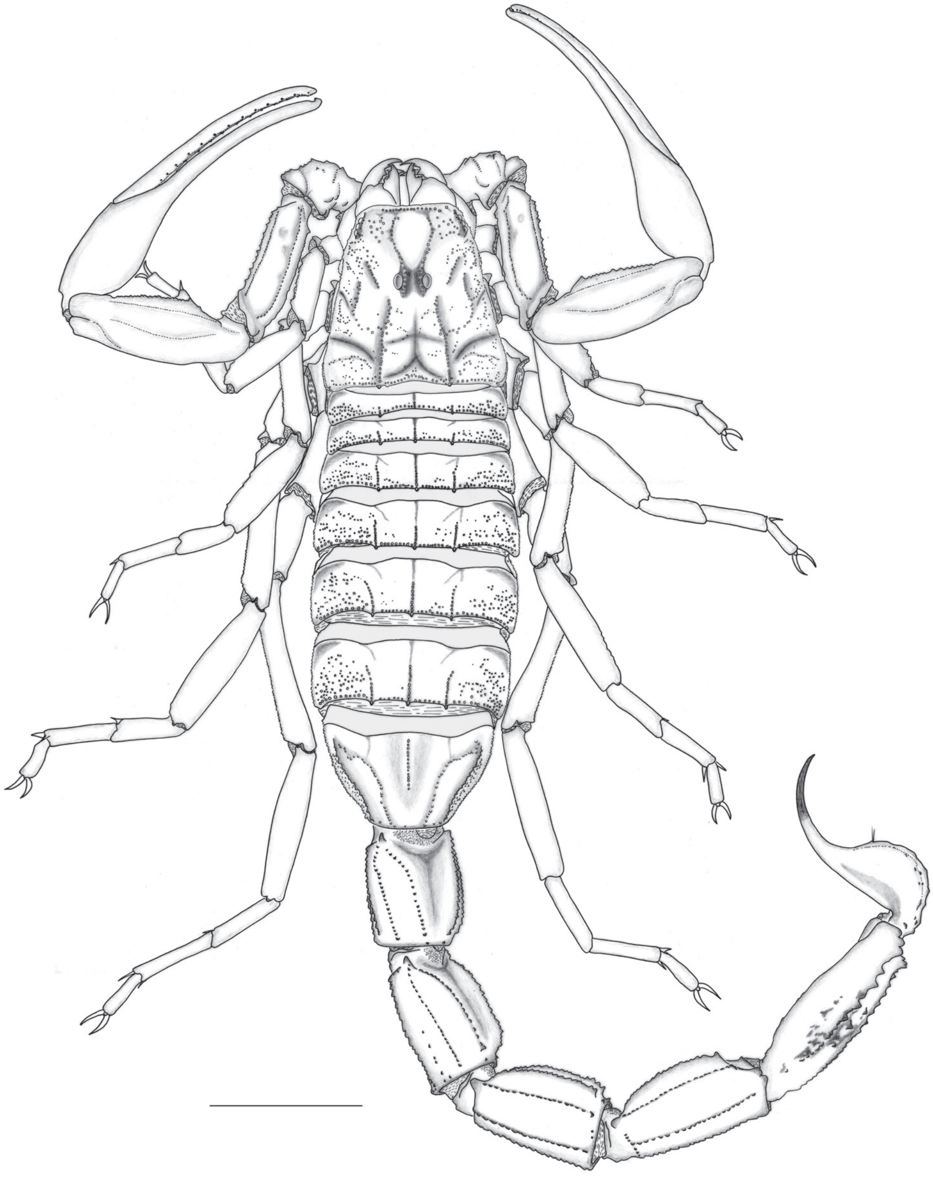
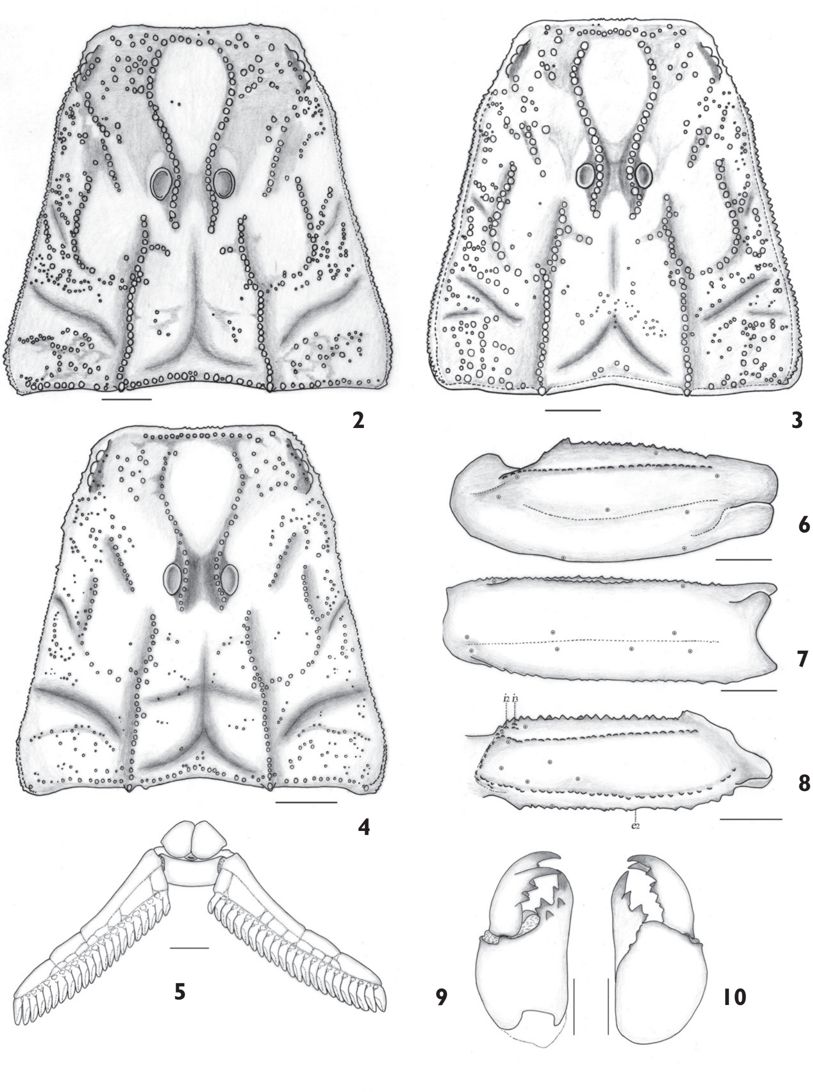


Figure 1. *Mesobuthus longichelus* sp. n. Female holotype. Dorsal view. Scale bar = 5.0 mm.

Dentate margins of movable and fixed fingers with 12 and 11 oblique rows of granules. Pectinal tooth count 22–23 in females and 27–28 in male. *Mesobuthus longichelus* sp. n. is undoubtedly associated with *Mesobuthus caucasicus intermedius* and *Mesobuthus caucasicus przewalskii*, but it can be distinguished by above features, and especially by these three characters: the shape of chela, the median lateral carinae of segment II and III on metasoma, and the shape of ventrolateral carinae of segment V on metasoma.

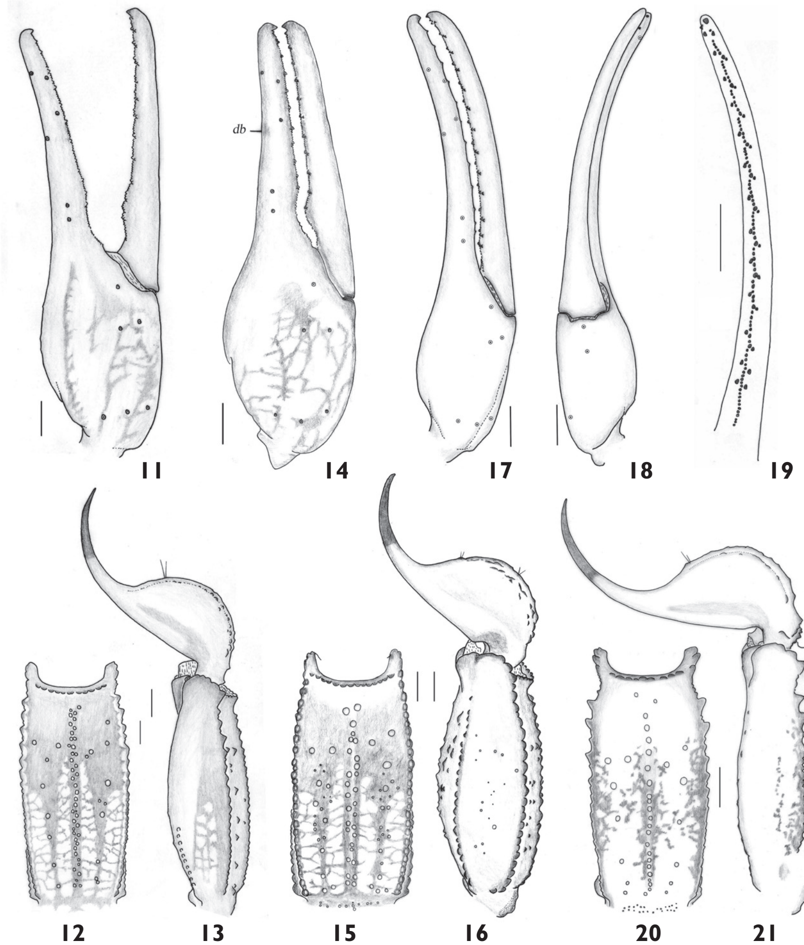


Figures 2–10. 2 *Mesobuthus caucasicus intermedius* (Birula, 1897). Female **3** *Mesobuthus caucasicus przewalskii* (Birula, 1897). Female **4–10** *Mesobuthus longichelus* sp. n. Female holotype. **2–4** Carapace, dorsal aspect **5** Genital operculum and pectines, ventral aspect **6–7** Patella (6. dorsal, 7. external) **8** Femur, dorsal aspect **9–10** Chelicera (9. ventral, 10 dorsal). Scale bar = 1.0mm.

Etymology. The specific name derives from the Latin "*longi + chel*", meaning long and chela, referring to the long and slender chela, especially the manus.

Description. Based on female holotype.

Coloration. Basically brownish-yellow. Prosoma: carapace brownish-yellow, with only blackish anterior median carinae, other carinae without pigment; eyes surrounded by black pigment. Mesosoma: brownish-yellow; segments I to VI with a distinct black-



Figures 11–21. 11–13 *Mesobuthus caucasicus intermedius* (Birula, 1897). Female. **14–16** *Mesobuthus caucasicus przewalskii* (Birula, 1897). Female. **17–21** *Mesobuthus longichelus* sp. n. Female holotype. **11, 14, 17** Chela, dorso-external aspect **12, 15, 20** Metasomal segment V, ventral aspect **13, 16, 21** Metasomal segment V and telson, lateral aspect **18** Chela, ventral aspect **19** Disposition of granulations on the dentate margins of the pedipalp chela movable finger, dorsal aspect. Scale bar = 1.0mm.

ish longitudinal stripe in the middle, lateral carinae without pigment. Metasoma: segment I pale brownish-yellow; segments II to V yellow; ventral and lateral surfaces of segment V with inconspicuous variegated black pigment; vesicle yellow and aculeus dark reddish to blackish on its extremity. Venter pale brownish-yellow, except for the pectines which are pale yellow. Chelicerae: pale brownish-yellow without any variegated pigmentation; teeth dark reddish to brownish. Pedipalps: femur, patella and manus reddish-yellow, without pigment; fingers yellow; rows of granules on dentate margins of the fingers blackish-brown. Legs: pale yellow without pigment.

Morphology. Prosoma: anterior margin with a very weak median concavity; carinae moderately strong, granular and granules relatively minor; central median carinae directly connected with posterior median carinae and lateral median carinae by a row of sparse granules; posterior median carinae terminating distally in a small spinoid process which extends slightly beyond the posterior margin of the carapace; intercarinal surfaces smooth, except for the surfaces between central median carinae and posterior median carinae, which are globally, sparsely and finely granular; the extercarinal surfaces with sparse small granules; the surfaces between anterior median carinae and lateral eyes coarsely granular; furrows moderate. Median ocular tubercle slightly anterior to the centre of carapace; median eyes separated by almost 1.75 ocular diameters; three pairs of lateral eyes.

Mesosoma: Tergite: I to VI tricarinate; lateral carinae on I–VI moderate, granular; the median carina on I weakly, median carinae on II–VI moderate, granular; each carina on I–VI terminating distally in a small spinoid process which extends beyond the posterior margin of tergite, except the median carina on I; the intercarinal surfaces relatively smooth, except for the posterior margins with sparse and fine granules; exterior surfaces moderately to coarsely granular; VII pentacarinate; two pairs of lateral carinae moderate to strong; median carinae present on proximal half, moderate; the intercarinal surfaces smooth. Sternites: III-VII smooth; lateral margins slightly serrate; VII with four weakly marked carinae, granular. Pectines: moderately long; pectinal teeth 22–23 (see variation on table I).

Metasoma: Segments I with 10 complete carinae, segment II–IV with 8 complete carinae; all carinae moderately strong, granular, except the dorsal carinae, serrate; median lateral carinae complete on segment I, only with sparse granules and covered 1/2–2/3 length of segment on II and obsolete, remaining 1–2 granules at distal end on III. Intercarinae surfaces on segments I to IV smooth, except the surfaces between dorsal and dorsolateral carinae on segment I, which are weakly granular. Segment V pentacarinate; ventral carina moderate, granular; ventrolateral carinae strong, serrate, becoming strongly marked posteriorly and with 2–3 markedly large and extroversive lobed granules; dorsolateral carinae weakly developed, obsolete posteriorly; dorsal and lateral surfaces smooth, ventral surface with sparse large granules. Telson smooth dorsally and weakly granular ventrolaterally; aculeus long, markedly more than a half of telson length (see variation on table I).

Chelicerae: Dentition as defined by Vachon (1963) for the family Buthidae.

Pedipalps: Trichobothrial pattern: Orthobothriotaxic A-β (Vachon, 1974, 1975). Femur pentacarinate, moderately to strongly granular; ventrointernal carina with spinoid granules. Patella with seven carinae, very weakly to moderately granular. Intercarinal surfaces on both segments smooth. Chela smooth without carinae; long and slender (table I). Dentate margins of movable and fixed fingers with 12 and 11 oblique rows of granules respectively; outer accessory denticles becoming smaller from base to tip, and smaller than inner accessory denticles on the tip.

Legs: Tarsus ventrally with two long longitudinal rows of setae; tibial spurs present on legs III and IV, moderately marked; pedal spurs present and moderately developed on all legs.

Ecology. The new species was found mainly in habitats composed of very arid and strongly desertified grassland, under very big and oval rocks. This region is constituted by alluvial plains, and is located about 10 km north of the Tianshan Mountains. The area is quite droughty during the whole year, and even during summer. The vegetation is composed of scarcely shrubs, and is strongly xerophytic.

A key to related species

1. Ventrolateral carinae of segment V on metasoma strong, serrate, becoming strongly marked posteriorly and with several markedly large and extroversive lobed granules **2**

– Ventrolateral carinae of segment V on metasoma strong, serrate, becoming gradually stronger posteriorly, and without any markedly large and extroversive lobed granules **3**

2. Ventral carinae of segment II and III on metasoma gradually stronger posteriorly; chela podgy .... ***Mesobuthus eupeus***

– Ventral carinae of segment II and III on metasoma not stronger posteriorly; chela long and slender .... ***Mesobuthus longichelus* sp. n.**

3. Dorsal surfaces of segments I–IV on metasoma and each surface of segment V with irregular netlike dark pigments **4**

– Only surfaces of segment V on metasoma with irregular netlike dark pigments, dorsal surfaces of segments I–IV without .... ***Mesobuthus martensii***

4. Pectinal teeth number 20–25 in females and 26–30 in males; dentate margins of movable and fixed fingers with 12 and 11 oblique rows of granules respectively .... ***Mesobuthus caucasicus intermedius***

– Pectinal teeth number 15–19 in females and 19–23 in males; dentate margins of movable and fixed fingers with 11 and 10 oblique rows of granules respectively .... ***Mesobuthus caucasicus przewalskii***

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The genus *Chaerilus* Simon, 1877 (Scorpiones, Chaerilidae) in the Himalayas and description of a new species

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Abstract

A new species is described belonging to the genus *Chaerilus* Simon, 1877. *Chaerilus annapurna* **sp. n.** was discovered in the high plateaux of the Himalayas in Central-Western Nepal. For comparative purposes a precise re-diagnosis is proposed for *Chaerilus truncatus* Karsch, 1879, originally described from an imprecise locality in Himalaya. This species has recently been discussed by several authors: nevertheless, it has sometimes been the subject of misidentification.

Keywords

Scorpion, Chaerilidae, *Chaerilus*, new species, Himalayas, Nepal

Introduction

The family Chaerilidae with its single genus *Chaerilus* remains among the least known taxa of extant scorpions. In the Catalog of Scorpions of the World (Fet 2000), 21 species have been listed in the genus *Chaerilus* Simon, 1877. In a very approximate revision of the genus, Kovařík (2000) defined 18 species as valid. He

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subsequently added two new species (Kovařík 2005). More recently, other new species from China, Indonesia, Laos, the Philippines and Vietnam have been described (Qi et al. 2005; Lourenço and Zhu, 2008; Lourenço and Ythier, 2008; Zhu et al. 2008; Lourenço 2009). A precise historical account of the group can be found in Lourenço and Zhu (2008).

The family Chaerilidae is distributed only in the Oriental Region, mainly in South and Southeast Asia. It was suggested (Lamoral 1980) that the ancestors of the chaerilids originated in Pangaean times as an eastern Laurasian relic that moved into the Oriental Region after the Indian plate become connected with Laurasia. The group became isolated in the Oriental Region as the Himalayas were raised up.

Although the type species of the genus, *Chaerilus variegatus* was described by Simon (1877) from Java, several species have subsequently been described from the Himalayas and nearby regions. The species from India, Nepal, Bangladesh and China, have proved to be extremely uniform in their morphology, and most were defined on the basis of weak diagnostic characters. The main reason for this comes from the fact that specimens are globally rare and poorly represented in collections. In several cases, species are represented by only one of the sexes or by juveniles of both sexes. Type material is frequently old and poorly preserved. This lead Kovařík (2000) to place several of the old Himalayan species in synonymy with *Chaerilus truncatus* Karsch, 1879, the first to be described. Although the revision by Kovařík (2000) is rather poor, we concluded that these synonymies should be confirmed with the aid of the available samples we had. It is quite possible that several old Himalayan species have been diagnosed on the basis of intra-specific variability. One exception is *Chaerilus pictus* (Pocock 1890) from Bangladesh which presents very marked sexual dimorphism in the shape of the telson. As a result, *Chaerilus truncatus* now appears to have a widespread distribution in the Himalayas. Even so, this rather 'common species', discussed by several authors, has also been the subject of subsequent misidentifications. In many cases, females have been identified as males. Our conclusion is that males have never been clearly described. At present, a precise re-diagnosis is proposed for *Chaerilus truncatus* and a new associated species is described from Central Western Nepal.

Methods

Illustrations and measurements were made with the aid of a Wild M5 stereo-microscope with a drawing tube (camera lucida) and an ocular micrometer. Measurements follow Stahnke (1970) and are given in mm. Trichobothrial notations follow Vachon (1974) and morphological terminology mostly follows Hjelle (1990).

Taxonomic treatment

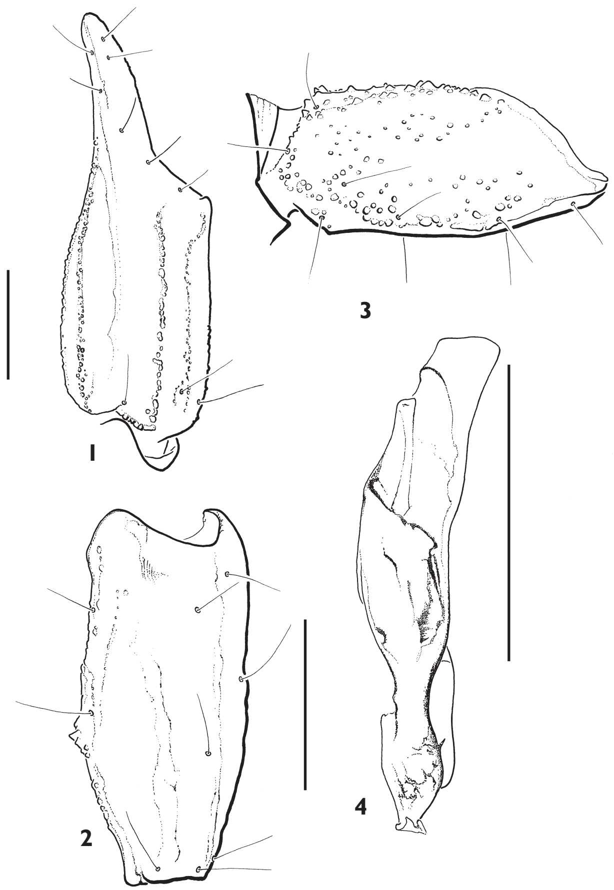
Chaerilidae Pocock, 1893
Chaerilus Simon, 1877

Chaerilus truncatus Karsch, 1879
Figs 1–11

Revised diagnosis. Scorpions of moderate to large size in relation to the other species of the genus, with a total length of 41 to 45 mm for males and 52 to 66 for females. General coloration reddish-yellow to reddish-brown with granulations and carinae somewhat more blackish on metasomal segments and pedipalps. This pattern of pigmentation proves to be invariably in preserved males, females and juveniles.

Anterior margin of carapace with a minute concavity in males; tegument smooth; straight and moderately granular in females; presence of two longitudinal carinae in both sexes; furrows moderately deep; two pairs of lateral eyes; one pair of small median eyes, about 1.5 times the size of lateral eyes; median eyes only slightly anterior to the centre of the carapace. Tergites smooth in males, intensely granulated in females; carinae obsolete. Sternum pentagonal, longer than wide; genital operculum plates with a sub-triangular shape. Pectinal tooth count 5–6 in males, 4–4 in females. Sternites smooth with spiracles small and oval-shaped; only VII weakly granulated in females. Metasoma: Carinae weakly granular in males, better marked in females; ventral carinae reduced or absent on segment I. Vesicle elongated with a pear-like shape in both sexes, smooth, with a short aculeus. Pedipalps slightly narrower in males; carinae well marked in both sexes; granulations more intensely marked in females. Fixed and movable fingers shorter than manus in both sexes with 9(10)–10(11) rows of granules on the dentate margins. Chelicerae characteristic of the family Chaerilidae (Vachon 1963). Trichobothriotaxy of type B; orthobothriotaxic (Vachon 1974); femur with 9 trichobothria, patella with 14, and chela with 14. Legs with pedal spurs moderately developed. Tarsi with two rows of spiniform setae. Hemispermatophore of Fusiform Type, with the distal lamina short and straight.

Material used for the diagnosis. India, Himalaya-Koollao, 1 female, MNHN-RS-0605; Himalaya-Dehra-Dun, 3 males, MNHN-RS-0606; W. Himalaya-Katta (Kalta) Pani, 1 male, MNHN-RS-0598; W. Himalaya-Kalta Pani, 1 male; Himachal Pradesh, 2010 m, between McLeod & Dharamk ot, near Dharamsala, under wet stone in forest, 13.VIII.1977 (A. Dubois & D. Payen), 1 female, MNHN-RS-8337; Himachal Pradesh, by Lake Dal, near to Dharamsala, 1850 m, under wet stones 11.VIII.1977 (A. Dubois & D. Payen), 3 males, 1 female, MNHN-RS-8338. Nepal, W. Kathmandu, 1400 m, Station n°6, 13/IX/1969 (J. Martens), 2 males juveniles; Naudara-Grates, W. Pokhara, 1200 m, Station n°3, 17.III.1970 (J. Martens), 1 male, 2 females juveniles (JM Collection).



Figures 1–4. *Chaerilus truncatus*, male from India. **1–3** Trichobothrial pattern. **1** Chela, dorso-external aspect. **2–3** Patella and Femur dorsal aspect **4** Hemispermatophore, external aspect (scales = 3 mm).

Chaerilus annapurna sp. n.

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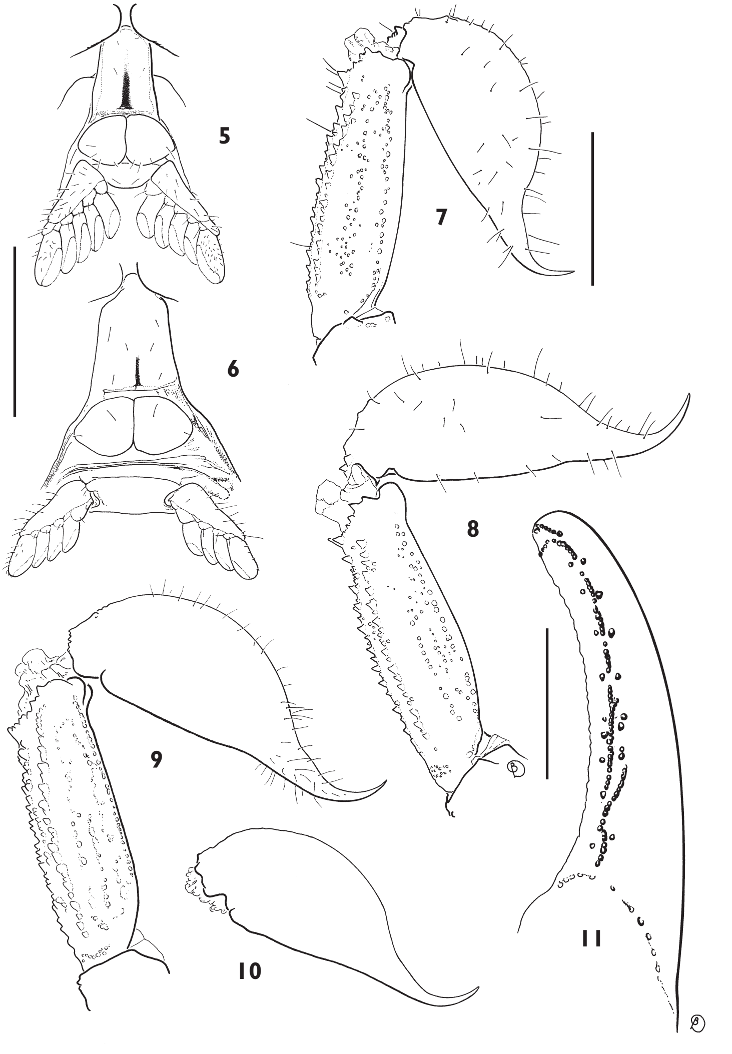
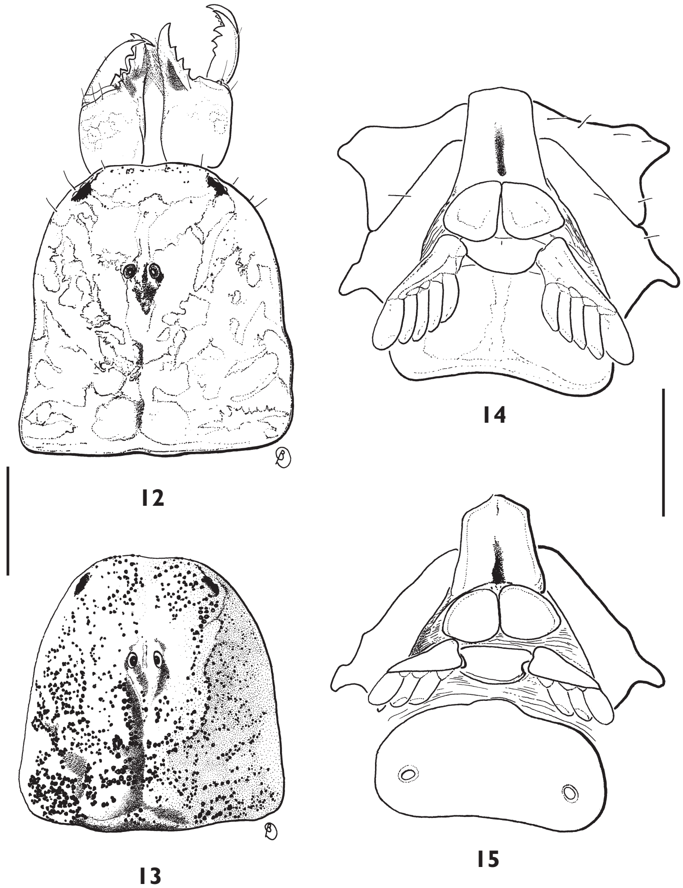
Figs 12–29

Diagnosis. Species of moderate size in relation to that of the other species in the genus, 49 to 55 mm in total length. General coloration reddish-yellow, marked intensely with variegated brownish spots. The exocuticular pigmentation becomes darker with age and finally turns blackish. This phenomen has already been observed in several other groups of scorpions (Lourenço and Cloudsley-Thompson 1996). However, in the present case, it was also observed among juveniles. This would suggest that intermolt periods are rather long. Carapace moderately narrowed toward the anterior edge; better marked in females; acarinate and smooth in males; moderately granulated in females; anterior margin straight; furrows shallow in males, moderately deep in females.



Figures 5–11. *Chaerilus truncatus* from India. **5–6** Sternum, genital operculum and pectines, male and female **7–8** Metasomal segment V and telson, lateral aspect, male and female. **9–11** *Chaerilus anthracinus* Pocock (= *C. truncatus*), male lectotype and female paralectotype. **9–10** Metasomal segment and telson, lateral aspect, male and female **11** Cutting edge of movable finger with rows of granules, male (scales = 3 mm).

Metasomal carinae moderately marked in males; strongly marked in females; ventral carinae obsolete on segment I, weakly marked on segment II; latero-ventral and ventral carinae on segments IV–V composed of strong spinoid granules; other carinae with moderately marked spinoid granules. Telson with an elongated pear-like shape; dorsal surface strongly depressed in males, only slightly in females. Male pedipalps strongly elongated in comparison with female pedipalps; chela fingers strongly granulated in males, in particular on the ventral surface of movable finger; dentate margins of fixed

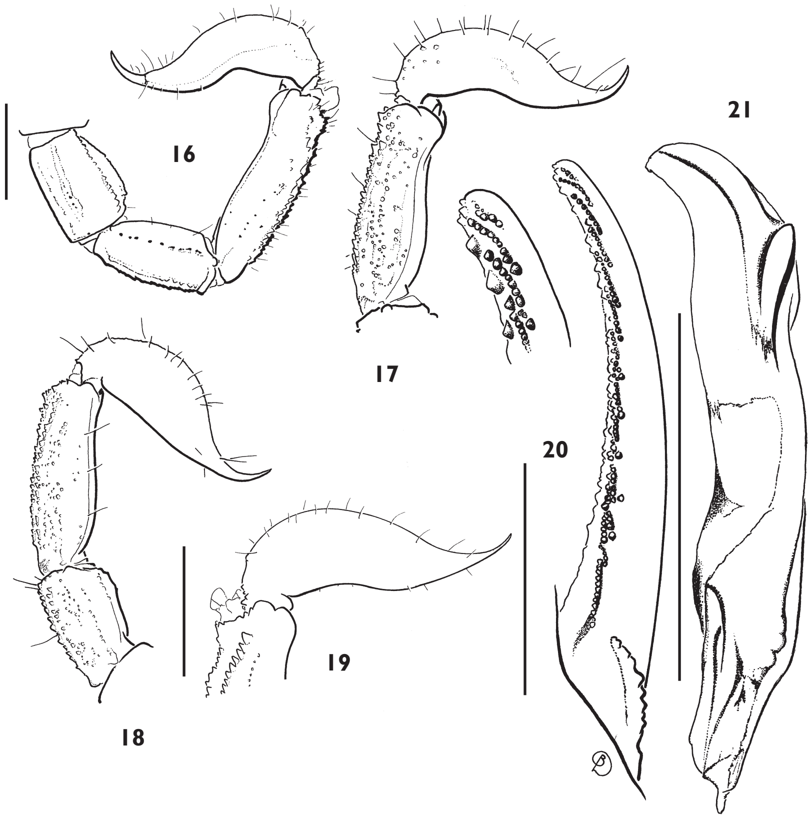


Figures 12–15. *Chaerilus annapurna* sp. n. **12–13** Carapace, dorsal aspect, male holotype and female paratype **14–15** Sternum, genital operculum, pectines and sternite 3. Idem 12–13 (scales = 3 mm).

and movable fingers with 10–12 (11–13) rows of granules. Pectinal tooth count 4–5 in males, 3–4 in females. Genital operculum plates have a sub-oval shape. Trichobothriotaxy of type B, orthobothriotaxic. Hemispermatophore of fusiform type, with the distal lamina short and curved on its distal portion.

Etymology. The specific name is placed in apposition to the generic name, and refers to the Annapurna Mountain, in the vicinity of which the new species was found, and seems to be endemic.

Material. Nepal, Region of Naudanda, N. of Lakhne, Kaski Gandaki, 2150 m, under large flat stones, 26/V/1996 (H. Tillak), 1 male holotype; Rice fields, 1450 m, under large flat stones, VI/1997 (H. Tillak), 1 male (pre-adult) paratype; 1350–1450 m, under large flat stones, VIII/1999 (H. Tillak), 1 male, 1 female paratypes. NW. of Gorkha, 2000 m, 25/VIII/1980 (B. Lasale), 1 male (juvenile) paratype. Pokkara, 1100 m, station n°4, 31/VII/1970 (J. Martens), 1 female (juvenile), paratype. Holotype and

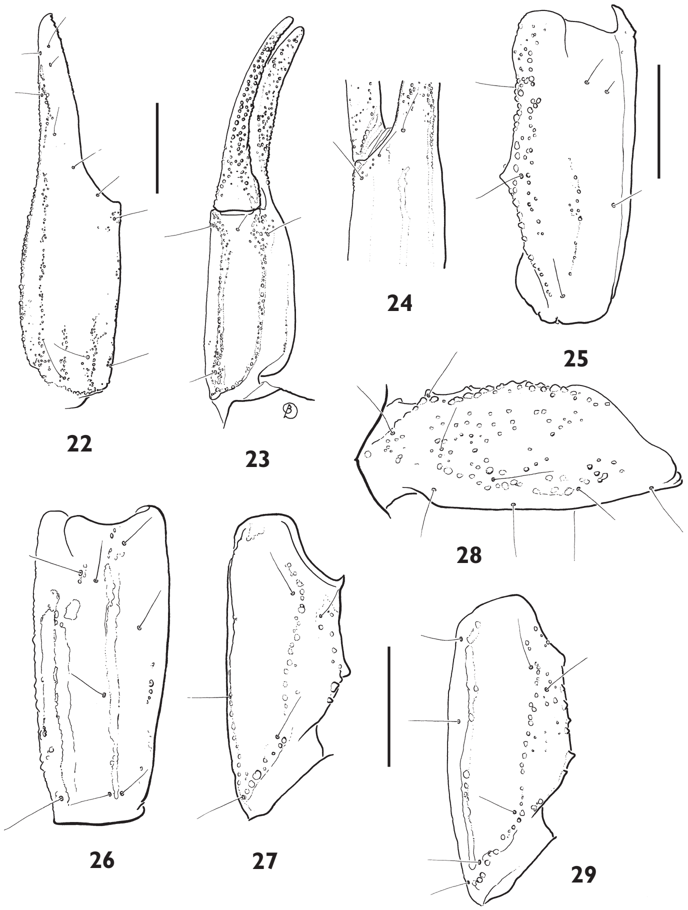


Figures 16–21. *Chaerilus annapurna* sp. n. **16–19** Metasomal segments and telson, lateral aspect. **16–17** Male holotype and male (juvenile) paratype **18–19** Female paratype and female (juvenile) paratype **20–21** Cutting edge of movable finger with rows of granules (extremity in detail) and hemispermatophore, male holotype (scales = 3 mm).

paratypes deposited in the Muséum national d'Histoire naturelle, Paris (MNHN). Female paratype from Pokkara deposited in the collection of J. Martens.

Description. Coloration: Basically reddish-brown, intensely marked with variegated brownish spots, before tegumental sclerification (see diagnosis). Carapace reddish-yellow. Tergites of the same colour as carapace; both with variegated spots. Metasomal segments yellowish to reddish-yellow; carinae reddish. Telson yellowish; tip of aculeus reddish. Chelicerae yellowish with diffused variegated spots; fingers and teeth reddish. Pedipalps reddish; chela fingers with the carinae dark to blackish; dentate margins of fingers almost blackish. Legs reddish-yellow with diffused brownish spots. Venter and sternites yellowish; pectines pale yellow. Once tegumental sclerification has taken place general appearance is blackish and only pectines remain pale yellow.

Morphology: Carapace moderately narrowed anteriorly in males, more strongly marked in females; anterior margin straight, almost acarinate; smooth in males, moderately granulated in females; furrows shallow in males, moderately deep in females. Two



Figures 22–29. *Chaerilus annapurna* sp. n. Trichobothrial pattern. **22–24** Chela, dorso-external, ventral and internal aspects **25–27** Patella, dorsal, external and ventral aspects, male holotype **28–29** Femur, dorsal aspect and patella ventral aspect, female paratype (scales = 3 mm).

pairs of lateral eyes, and one pair of moderate median eyes, about 1.5 times the size of lateral eyes; median eyes anterior to the centre of the carapace. Tergites smooth in males with moderately marked granulations females; carinae obsolete in both sexes. Sternum pentagonal, longer than wide; genital operculum plates with sub-oval shape. Pectinal tooth count 5–5 in male holotype, 3–3 in female paratype. Sternites smooth with spiracles small and oval-shaped; carinae absent from VII. Metasoma: Segments I and II wider than long; segments III to V longer than wide. All the carinae moderately to strongly granular; ventral carinae obsolete on I, weakly marked on II; segments IV and V with latero-ventral and ventral carinae composed of strong spinoid granules. Vesicle very elongated with a pear-like shape, smooth; strongly dorsally depressed in males, only weakly depressed in females; aculeus moderately short. Pedipalps strongly elongated in males in comparison with females; femur with five carinae; internal with spinoid granules. Patella with seven carinae;

dorso-external weakly granular; dorso and basal-internal with spinoid granules. Chela with eight carinae, moderately to strongly granular; ventral median carinae moderate. Tegument moderately granular. Fixed and movable fingers longer than manus, strongly granular with 10–12(11–13) rows of granulations on the dentate margins. Chelicerae characteristic of the family Chaerilidae (Vachon 1963). Trichobothriotaxy of type B; orthobothriotaxic (Vachon 1974); femur with 9 trichobothria, patella with 14, and chela with 14. Legs with pedal spurs strongly developed. Tarsi with two rows of spiniform setae. Hemispermatophore of Fusiform Type, with the distal lamina short and curved on its distal portion.

Relationships

Chaerilus annapurna sp. n., shows morphological similarities with *Chaerilus truncatus* Karsch, 1879, also described from the Himalayas. The new species can, however, be readily distinguished by the following features: (i) the shape and structure of the telson, strongly depressed dorsally in males, (ii) male pedipalps much more elongated than female pedipalps (see Table I), (iii) movable finger of chela with very strongly marked granulation.

Conclusions

Although this study is only preliminary, some insights have been gained concerning the species of *Chaerilus* found in the Himalayas and nearby regions of India and Tibet.

Chaerilus truncatus is undoubtedly a rather common species, presenting intra-specific variations that led to the description of several 'closely associated' species. Consequently we agree with the decisions of previous authors (Kraepelin 1899; Kovařík 2000) who placed several of these species in synonymy of *C. truncatus*.

Chaerilus insignis Pocock, 1894, remains poorly characterized. Very few specimens are known and the type specimen, originally stored dry, is poorly preserved. The study of more material may show that this species is also conspecific with *C. truncatus*.

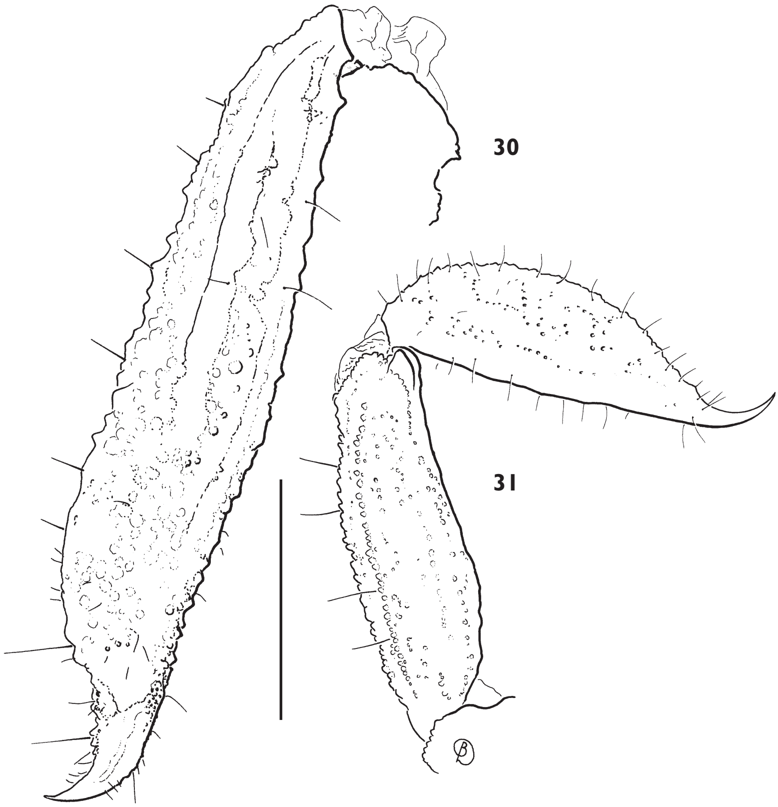
Chaerilus assamensis Kraepelin, 1913, described from Assam in India, remains poorly known. The type specimen is housed in NZSI, Calcutta, India, and its study by foreign experts is not possible. The recently described *Chaerilus tryznai* Kovařík, 2000 from China (Tibet), presents few differences from the species described by Kraepelin and may prove to be conspecific. Although Zhu et al. (2008) recently redescribed and properly illustrated *C. tryznai*, without the study of the type of *C. assamensis* a final decision cannot be taken in relation to these two species.

Chaerilus pictus (Pocock, 1890) is one of the most peculiar species in the genus (Figs 30–31). *Chaerilus gemmifer* Pocock, 1894, is unquestionably a synonym of *C. pictus*, as already suggested on several museum labels (by Kraepelin and Simon; results not published) for the material deposited in Hamburg and Paris. Kovařík (2000) confirmed this synonymy.

Table 1. Morphometric values (in mm) of *Chaerilus truncatus*, male and female from India and *Chaerilus annapurna* sp. n., male holotype and female paratype.

	C. truncatus		*C. annapurna* sp. n.	
	♂	♀	♂	♀
Total length*	41.2	51.8	53.1	49.1
Carapace:				
- length	6.7	7.5	8.2	7.6
- anterior width	3.3	4.0	4.5	4.2
- posterior width	6.5	8.1	8.2	7.6
Metasomal segment I:				
- length	2.0	2.5	3.3	2.5
- width	3.5	3.9	4.2	3.9
Metasomal segment II:				
- length	2.8	3.3	3.8	3.0
- width	3.0	3.5	3.7	3.2
Metasomal segment III:				
- length	3.0	3.6	4.1	3.2
- width	2.9	3.2	3.5	3.0
Metasomal segment IV:				
- length	3.4	4.0	4.5	3.5
- width	2.7	2.9	3.3	2.7
Metasomal segment V:				
- length	6.0	7.2	7.4	6.1
- width	2.4	2.6	2.8	2.5
- depth	2.0	2.5	2.4	2.1
Vesicle:				
- width	2.6	2.8	2.8	2.4
- depth	2.5	2.7	1.8	2.1
Pedipalp:				
- Femur length	6.2	6.2	8.2	5.9
- Femur width	2.8	3.0	3.4	2.6
- Patella length	6.6	6.6	8.0	6.0
- Patella width	2.7	3.1	3.2	2.6
- Chela length	12.7	12.8	15.6	12.0
- Chela width	3.4	4.3	3.5	3.6
- Chela depth	4.4	5.0	3.8	3.9
Movable finger:				
- length	6.3	6.7	8.1	6.7

*Including telson



Figures 30–31. *Chaerilus pictus* from India. Metasomal segment V and telson. **30** Male **31** Female (scales = 3 mm).

In conclusion, in the present state of our knowledge, only the following species can be retained as valid for the Himalayas and nearby regions:

Chaerilus truncatus Karsch, 1879
Chaerilus pictus (Pocock, 1890)
Chaerilus assamensis Kraepelin, 1913
Chaerilus tessellates Qi, Zhu & Lourenço, 2005
Chaerilus conchiformus Zhu, Hav & Lourenço, 2008
Chaerilus annapurna sp. n.

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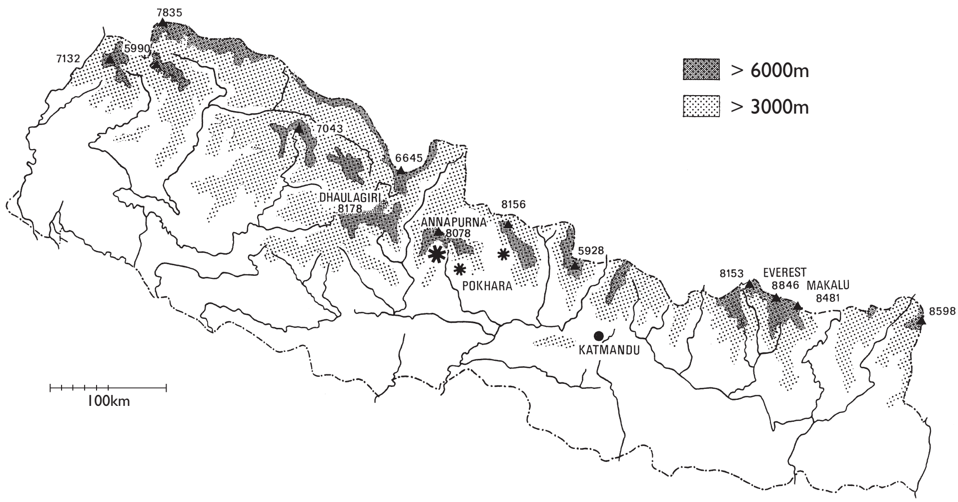

Figure 32. Map of Nepal showing the type locality of the new species (black asterisk). The largest asterisk indicates the site where the holotype was collected.

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RESEARCH ARTICLE

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A new species of *Hersiliola* Thorell, 1870 (Araneae, Hersiliidae) from Turkey

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Abstract
A new species *Hersiliola turcica* **sp. n.** is described on the basis of both sexes from Southeast Turkey. Males of the new species have an extraordinarily long embolus and females have very long insemination ducts.

Keywords
Hersiliidae, *Hersiliola*, new species, Turkey

Introduction

Hersiliidae is a rather small, globally distributed entelegyne spider family that currently includes 167 species belonging to 15 genera (Platnick 2010). The majority of hersiliid species are found in tropical and subtropical regions. The family was the subject of several revisions for the Australian, Oriental, Neotropical, and Afrotropical faunas (Baehr and Baehr 1987, 1993, 1998; Rheims and Brescovit 2004a–b; Rheims et al. 2004;

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Foord and Dippenaar-Schoeman 2005a-b, 2006). Recently, the most speciose genus in the Palaearctic, *Hersiliola* Thorell, 1870, was revised by Marusik and Fet (2009). It was shown that the genus is distributed from western Africa to Xinjiang, NW China and in Asia was reported from Afghanistan, Israel, Iran, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan and Yemen. Currently *Hersiliola* contains 9 species (Marusik and Fet 2009). In Turkey , *Hersiliola macullulata* (Dufour, 1831) was recently reported from southernmost Hatay Province (Yağmur et al. 2008).

When the revision of the genus (Marusik and Fet, 2009) was published, it became clear that the specimens from Turkey belonged to an undescribed species with a very peculiar male palp. The aim of this paper is the description of the new species of *Hersiliola*.

Material and methods

A total of 15 specimens of *Hersiliola turcica* sp. n. (6 ♂♂, 7 ♀♀ and 2 juveniles) were collected between 2004 and 2008 from Gaziantep, Hatay, Kahramanmaraş, Kilis and Şanlıurfa Provinces which are located in the southeastern part of Turkey. The specimens were collected from irregular webs under stones by means of a hand aspirator.

Specimens were photographed using an Olympus Camedia E-520 camera attached to an Olympus SZX12 stereomicroscope. The images were montaged using "CombineZM" image stacking software. Specimens were photographed in dishes of different sizes with paraffin wax in the bottom. Holes were made in the paraffin wax to keep the specimens in the right position. All measurements are given in mm.

Material treated herein is deposited in the Senckenberg Museum (SMF, Frankfurt am Main, Germany), the Museum of Turkish Arachnological Society (MTAS, Ankara, Turkey) and in the Zoological Museum of the Moscow State University (ZMMU, Moscow, Russia).

Taxonomy

Hersiliola turcica sp. n.

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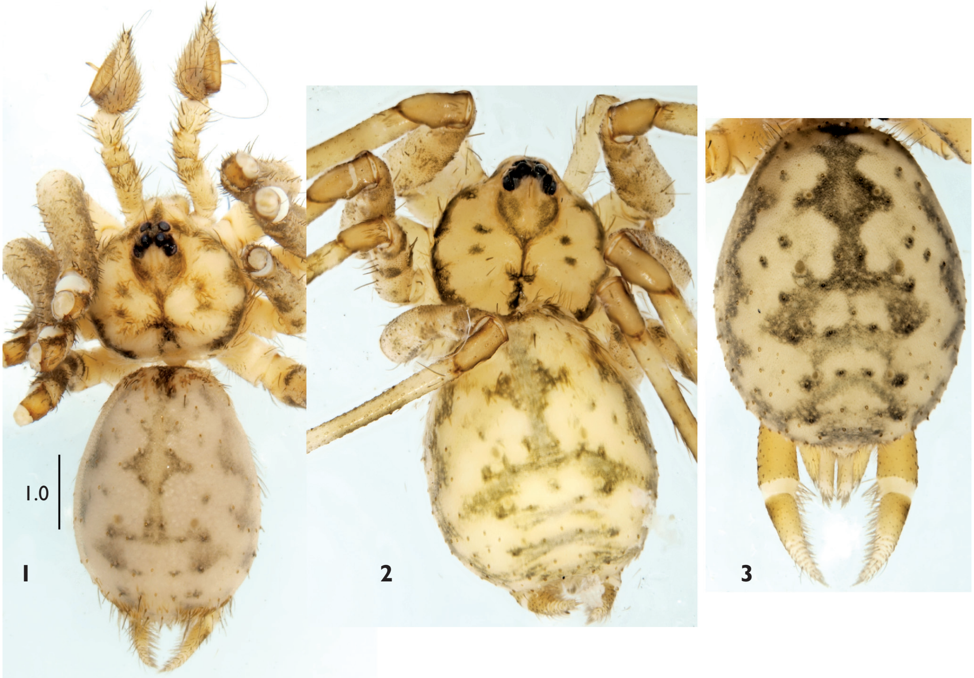
H. macullulata: Yağmur et al., 2008: 63, f. 2a–b (figures belong to *H. macullulata*).

Material: Holotype ♂ (SMF) **Kahramanmaraş Province**, Nurhak District, Yeşilkent (Kullar) Town [37°58'54.39"N; 37°30'56.01"E], 9.07.2006 (E.A. Yağmur & S. Anlaş). Paratypes: 1♀ 1juv. (SMF), **Kahramanmaraş Province**, Türkoğlu District [37°30'10.51"N; 36°51'07.60"E], 4.06.2006 (E.A. Yağmur & M. Özkörük);



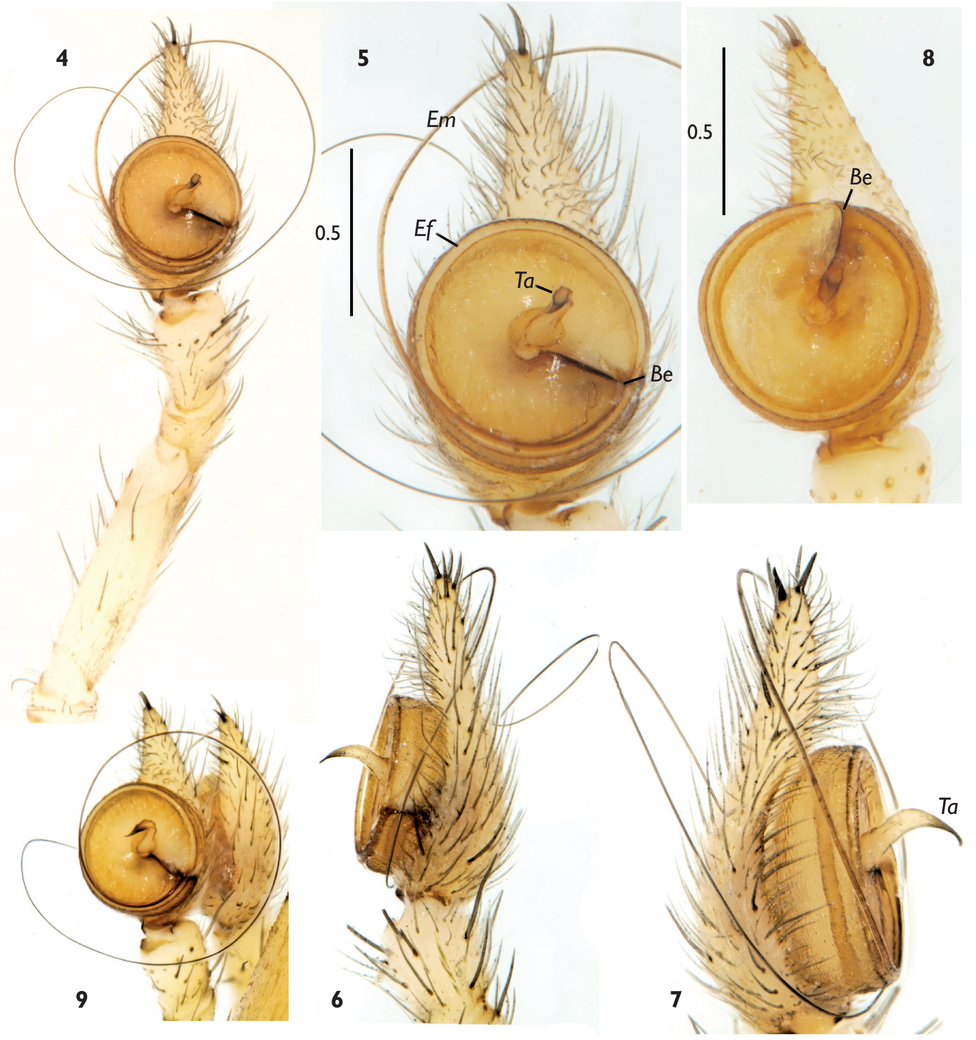
Figures 1–3. Habitus and pattern of *Hersiliola turcica* sp. n. **1** holotype male, dorsal **2** female from Nizip District **3** female abdomen from Harran Town.

1♀ 1juv. (SMF), **Kahramanmaraş Province**, Elbistan District, Taşburun Village [38°10'03.68"N; 37°12'06.07"E], 17.06.2006 (E.A. Yağmur & M. Yalçın); 1♀ (ZMMU), **Gaziantep Province**, Nizip District, Türkyurdu Village [37°00'05.21"N; 37°38'44.54"E], 20.01.2008 (E.A. Yağmur & Gökhan Katırcı); 1♂ (ZMMU), **Şanlıurfa Province**, Birecik District, Birecik (Kelaynak) Valley [37°02'49.72"N; 37°59'28.88"E], 5.06.2004 (E.A. Yağmur & A. Akkaya); 1♂ (without embolus) (ZMMU), Şanlıurfa Province, Birecik District, Birecik (Kelaynak) Valley [37°02'49.72"N; 37°59'28.88"E], 5.06.2004 (E.A. Yağmur & A. Akkaya); 1♀ (ZMMU), **Şanlıurfa Province**, Harran Town [36°51'51.62"N; 39°01'54.54"E], 6.04.2006 (E.A. Yağmur & M.Z. Yıldız); 1♀ (ZMMU), **Kilis Province**, Musabeyli District, Kürtüncü Village [36°55'37.83"N; 36°58'41.30"E], 17.05.2006 (E.A. Yağmur & M. Özkörük); 3♂♂ 2♀♀ (MTAS), **Hatay Province**, Yayladağı District, Güveççi Village [(35°53'36.63"N, 36°09'38.10"E], 29.04.2007 (E.A. Yağmur & H.Koç).

Etymology. The specific name refers to the area of distribution.

Diagnosis. Males of the new species differ from all other congeners by the extremely long embolus with 3.5 coils, the position of embolic base, and the long tegular apophysis. Females of *H. turcica* sp. n. are similar to those of *H. macullulata*, *H. afghanica* and *H. sternbergsi* in the shape of epigynal plate, but can be distinguished by its proportions (height/width ratio). The vulva of new species is similar to that in *H. afghanica* in having numerous coils, but the two species can be easily separated by the shape of the epigynal plate (which has no transverse part in *H. afghanica*) and the smaller receptacula in the new species.

Description. *Male* (holotype). Total length 5.65. Carapace 2.13 long, 2.25 wide, femur I 4.8, femur I/carapace length ratio 2.25. Pattern distinct, carapace with dark marginal bands, four pairs of dots and thin median stripe, cephalic area dark. Abdomen with rhomboidal cardiac spot and four pairs of transverse bands. The upper transverse band originates from the cardiac spot. Sides of abdomen with dark band. Legs with wide annulations.



Figures 4–9. Male palp of *Hersiliola turcica* sp. n. **4–5, 8–9** ventral **6** retrolateral **7** prolateral. **4–7** holotype **8–9** from Birecik. **8** palp with broken embolus. Abbreviations: ***Be*** base of embolus ***Ef*** tegular furrow for embolus ***Em*** embolus ***Ta*** tegular apophysis.

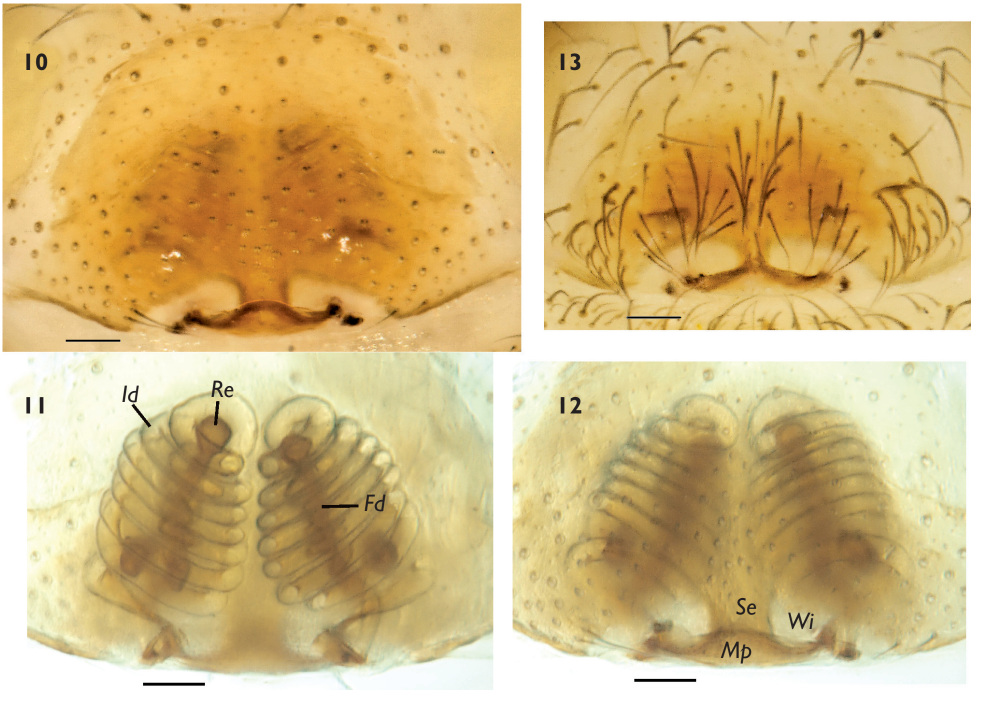
Palp as in Figs 4–9. Cymbium 1.43 long; tegulum round, its diameter 0.74; tegular apophysis (*Ta*) long, claw like, its length almost equal to tegular radius; base of embolus (*Be*) located at 4 o'clock, embolus (*Em*) very long and thin, with approximately 3.5 coils, in resting position located in furrow (*Ef*) running around edge of tegulum. Number of coils is unclear because in all specimens examined, embolus either broken or removed from the tegular furrow.

Female. Total length 5.75–6.75. Carapace 2.25–2.38 long, 2.18–2.43 wide, femur I 30.8–3.75, femur I/carapace length ratio 1.37–1.58. Coloration variable from light to dark. Dark specimens with indistinct abdominal pattern.

Epigyne as in Figs 10–13, size slightly variable; with a distinct median plate (*Mp*) and windows, proportions of median plate and atria slightly variable; septum (*Se*) as wide as height of epigynal plate, insemination duct (*Id*) very long, with seven coils around fertilization duct (*Fd*); receptacula (*Re*) small and round, diameter equal to that of insemination duct.

Note. One male from Birecik District has totally broken embolus (Fig. 8) and a rotated tegulum that caused translocation of the position of embolic base.

Distribution. The specimens were collected from several provinces in Southeastern Turkey (Gaziantep, Hatay, Kahramanmaraş, Kilis and Şanlıurfa) (Fig.14).



Figures 10–13. Epigyne of *Hersiliola turcica* sp. n. **10, 12–13** ventral **11** dorsal. **11, 12** after maceration in lactic acid. **10–12** from Kahramanmaraş Province **13** from Nizip District. Scale = 0.1 mm. Abbreviations: ***Fd*** fertilisation duct ***Id*** insemination duct ***Mp*** median plate ***Re*** receptaculum ***Se*** septum ***Wi*** window.

Figure 14. Distribution of *Hersiliola turcica* sp. n. Numbers correspond to localities on the map: **1** Kahramanmaraş Province, Nurhak District **2** Kahramanmaraş Province, Türkoğlu District **3** Kahramanmaraş Province **4** Gaziantep Province **5** Şanlıurfa Province, Birecik District **6** Şanlıurfa Province, Harran Town **7** Kilis Province **8** Hatay Province.

During the field trips, we observed that the new species was common between the west of the Fırat (=Euphrates) River and the Mediterranean region. However, the new species was also collected from the east side of the Fırat River. This suggests that the distribution range of the new species extends to eastern Turkey which has a Mediterranean climate.

Discussion

With the new species described here, *Hersiliola* now contains 10 valid species occurring in West and North Africa and the western half of the Palaearctic region. It includes *H. afghanica* Roewer, 1960 (Afghanistan); *H. turcica* sp. n. (Turkey), *H. esyunini* Marusik & Fet, 2009 (Uzbekistan); *H. foordi* Marusik & Fet, 2009 (southern Iran), *H. lindbergi* Marusik & Fet, 2009 (Afghanistan); *H. macullulata* (Dufour, 1831) (from Spain to Yemen); *H. simoni* (O.P.-Cambridge, 1872) (from Morocco to Israel); *H. sternbergsi* Marusik & Fet, 2009 (Turkmenistan, Uzbekistan); *H. versicolor* (Blackwall, 1865) (Cape Verde); and *H. xinjiangenis* (Liang & Wang, 1989) (Xinjiang, China). Although *H. macullulata* was reported from Turkey (Yağmur et al. 2008), this record refers to *H. turcica* sp. n., and correspondingly only one species of *Hersiliola* is documented from the country.

Key to the *Hersiliola* species

1.	Male	**2**
–	Female	**7**
2.	Embolus very long, with about 3.5 coils, embolic base at about 4 o'clock, tegular apophysis sharply pointed	***H. turcica* sp. n**
–	Embolus shorter, embolic base at different position	**3**
3.	Embolic base at about 12–12:30 o'clock	**4**
–	Embolic base at different position	**5**
4.	Embolus makes less than one coil, tegular apophysis blunt, tip of cymbium is about one radius of the tegulum	***H. esyunini***
–	Embolus makes almost one coil, tegular apophysis not blunt, tip of cymbium is about one diameter of the tegulum	***H. sternbergsi***
5.	Tegular apophysis blunt	***H. xinjiangensis***
–	Tegular apophysis not blunt	**6**
6.	Embolic base at about 11 o'clock	***H. simoni***
–	Embolic base at about 5:30 o'clock	***H. macullulata***
7.	Epigyne without distinct windows and/or without distinct median plate	**8**
–	Epigyne with distinct windows and plate	**9**
8.	Median plate absent, receptacula round, insemination duct makes at least 7 coils	***H. lindbergi***
–	Median plate present, receptacula oval, insemination duct makes only 1 coil	***H. foordi***
9.	Insemination duct with 5 or more coils	**10**
–	Insemination duct with less than 5 coils	**11**
10.	Insemination duct with 7 coils	***H. turcica* sp. n.**
–	Insemination duct with 5–6 coils	***H. macullulata***
11.	Septum thinner than median plate height part of the median plate rounded	***H. esyunini***
–	Septum wider than median plate height	**12**
12.	Size > 5.5 mm	***H. xinjiangensis***
–	Size < 5.5 mm	**13**
13.	Median plate triangle shaped	***H. versicolor***
–	Median plate transversal	**14**
14.	Receptaculum droplet shaped	**15**
–	Receptaculum with conical terminal outgrowth	***H. simoni***
15.	Receptaculum thinner than window	***H. sternbergsi***
–	Receptaculum wider than window	***H. afghanica***

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RESEARCH ARTICLE

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A revision of the westwoodiine genus *Pergaphaga* (Hymenoptera, Ichneumonidae, Ctenopelmatinae)

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Abstract
Pergaphaga Gauld, a genus of ctenopelmatine Ichneumonidae endemic to Australia, is revised. The only previously described species, *Pergaphaga nigra* Gauld, is redescribed. Three additional species are newly described: *Pergaphaga iangauldi* Cammack & Wharton, **sp. n.** from New South Wales, ACT, and Victoria, *P. leaski* Wharton, **sp. n.** from Victoria, and *P. xanthops* Wharton, **sp. n.** from New South Wales and ACT. Keys to species and a phylogenetic analysis are presented. Morphological terms are linked to the Hymenoptera Anatomy Ontology.

Keywords
Pergidae, Australia, parasitoid, multikey, ontology

Introduction

Townes (1970) described the tribe Westwoodiini as part of his revised classification of the Ctenopelmatinae, and included four genera (*Westwoodia* Brullé, *Scolobatina* Roman, *Hypopheltes* Cushman, and *Megaceria* Szépligeti), at that time known only from Australia. Gauld (1984) listed four characteristics shared by members of the Westwoo-

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diini and the more widespread but extralimital Scolobatini (which included *Scolobates* Gravenhorst, *Onarion* Townes, and *Physotarsus* Townes). On the basis of these shared features, Gauld (1984) combined all of the genera in a single tribe, the Scolobatini. Gauld (1984) removed considerable confusion regarding the Australian fauna by describing three new genera within his expanded concept of Scolobatini, transferring *Megaceria* Szépligeti, which had been misidentified by Townes (1970), to Euryproctini, and treating *Scolobatina* as a synonym of *Westwoodia*. Zhaurova and Wharton (2009) retained Westwoodiini and Scolobatini as separate tribes based on a reassessment of morphological characters, described one new genus, and removed *Tasmabates* Gauld from Westwoodiini. The Westwoodiini, as delimited by Zhaurova and Wharton (2009), is one of the smallest tribes of the ichneumonid subfamily Ctenopelmatinae, consisting of five genera but only nine described species (Townes 1970, Gauld 1984, Gupta 1987, Wharton et al. 2008, Zhaurova and Wharton 2009). Gauld (1984) indicated that this group of genera was endemic to Australia. Zhaurova and Wharton (2009) subsequently recorded a single specimen of one of these genera, *Hypopheltes*, from southern Papua New Guinea, a logical range extension for westwoodiines. Host records are available for all five genera, including *Pergaphaga* Gauld, and are summarized by Townes (1970), Gauld (1984), Wharton et al. (2008), and Zhaurova and Wharton (2009). All recorded hosts are in the subfamily Perginae of the sawfly family Pergidae (Hymenoptera).

When Gauld (1984) transferred *Megaceria* to Euryproctini, he noted that material previously misidentified as *Megaceria* represented an undescribed genus, which he then described as *Pergaphaga*. Townes (1970) and Short (1978), both using the name *Megaceria*, provided figures of the adult and larval mouthparts, respectively, of the type species of *Pergaphaga*, *P. nigra* Gauld. Carne (1969), under the name "?*Hypopheltes*," recorded *P. nigra* as a parasitoid of *Perga affinis* Kirby. Elliot and Bashford (1995) reared an undetermined species of *Pergaphaga* from *Pergagrapta bella* (Newman) in Tasmania. Although the plant host was not identified for this rearing record, Elliot and Bashford (1995) list *Eucalyptus amygdalina* Labill., *E. pauciflora* Sieber ex Spreng., and *E. viminalis* Dehnh. as the only plant hosts of *P. bella* in Tasmania. Aside from host records from label data reported by Gauld (1984) and repeated in Zhaurova and Wharton (2009), these are the only published data on the biology of *Pergaphaga* of which we are aware. *Pergaphaga* is thus far known only from southeastern Australia.

Gauld (1984) described only one species in *Pergaphaga*, but stated that he had seen three others that differed from the type species in coloration as well as venation. Gauld (1984) also stated that *Pergaphaga* is most closely related to *Hypopheltes*. Although Gauld (1984) did not provide any supporting data for this relationship, these two appear together in the last couplet of his key to Australian ctenopelmatine genera. Quicke et al. (2009) showed *Pergaphaga* as the sister-group to *Hypopheltes* in a larger analysis of ichneumonid relationships, but they did not have *Dictyopheltes* Gauld in their analysis. Zhaurova and Wharton (2009) noted that *Pergaphaga* more closely resembles *Dictyopheltes* than *Hypopheltes*, based on the more heavily sculptured body and the reduced glymma. *Pergaphaga* was paraphyletic relative to *Dictyopheltes* in the two strict consensus trees that Zhaurova and Wharton (2009) presented but they considered their analyses preliminary because so many species were undescribed. Our objective is to present comparative descriptions for all known *Pergaphaga* and thereby facilitate a better understanding of relationships among the Westwoodiini.

Materials and methods

Specimens. We borrowed specimens from the following institutions for use in this study: Australian National Insect Collection, Canberra (ANIC), The Natural History Museum, London (BMNH), Museum of Victoria, Melbourne (MVMA), and Queensland Museum, Brisbane (QMBA).

In the materials examined section under each species description, we record label data for the holotype exactly as they appear on the labels. We use a more standardized format for paratypes, additional specimens examined, and published data for specimens not examined. Detailed label data are available on the taxon pages via the website http://peet.tamu.edu/projects/8/public/site/ich/home/otus_by_taxon/27303.

Figures. Most images were acquired digitally using Syncroscopy's AutoMontage® software, in combination with a ProgRes 3008 digital camera mounted on a Leica MZ APO dissecting microscope. Figures 1 and 2 are modified from Townes (1969). All images were further processed using various minor adjustment levels in Adobe Photoshop® such as image cropping and rotation, adjustment of contrast and brightness levels, color saturation, and background enhancement. Automontage images are available in color and high resolution at http://peet.tamu.edu/projects/8/public/site/ich/home/otus_by_taxon/27303. Several of the images were previously published in a companion paper by Zhaurova and Wharton (2009).

Database management, digital dissemination, and ontology reference. Character by OTU matrices, illustrations, keys, and free-text diagnoses for morphospecies were assembled in mx, a web-based content management system that facilitates data management and dissemination for taxonomic and phylogenetic works (e.g. Yoder et al. 2006). The mx project is open source, with code and further documentation available at http://sourceforge.net/projects/mx-database/. Data pertinent to this work, including interactive matrices, specimen-level data, and a multiple entry key, are available at http://peet.tamu.edu/projects/8/public/site/ich/home/otus_by_taxon/27303.

Hyperlinks on terms reference anatomical entities in the Hymenoptera Anatomy Ontology (HAO, version "06:11:2009 15:48"; Yoder et al. 2009, see http://hymao.org). The HAO is a hierarchy of logically related entities (morphological parts). It allows multiple labels or terms (e.g. "propodeum") to point to the definition of a morphological feature. This allows synonymous or otherwise confusing labels to unambiguously reference a morphological feature. Note that hyperlinked terms may resolve to a feature that itself has another label. This does not imply synonymy or preference of a given label, it is simply how the internal logical structure of the ontology is managed. Hyperlinked terms point to the HAO as archived in BioPortal (Musen et al. 2008). Labels and terms have further meaning in the context of the larger ontology, as such their meaning is specific to the cited version. This versioning further allows for the precise encapsulation of meaning at a specific reference point. All versions of the HAO are archived at the OBO Foundry (http://obo.svn.sourceforge.net/viewvc/obo/ontologies/trunk/HAO/, Smith et al. 2007).

Phylogenetic analysis. Based on Zhaurova and Wharton (2009), we used *Dictyopheltes* as the outgroup for analyzing relationships among the four known species of *Pergaphaga*. Two species of *Dictyopheltes* were used to encompass variation within the genus. Characters and character states are presented under the results and discussion section. Characters 4 (notauli), 9 (propodeum), and 14 (wing color) were included because of purported (Gauld 1984, Zhaurova and Wharton 2009) or potential value in supporting monophyly of either *Dictyopheltes* or *Pergaphaga*. We employed alternative character state codings for the propodeal carination, as explained below, to explore the impact of different hypotheses of character evolution on our overall assessment of relationships. We also explored the effect of adding and deleting a character as noted below under the results section. The morphological dataset was analyzed under parsimony with NONA using the WinClada interface (Nixon 2002). For comparison, we also used PAUP version 4.0b10. In all analyses, all multistate characters were treated as unordered. Bootstrap values were generated using 200 replicates, with 10 searches per replicate, holding 1 tree per search.

Terminology and measurements. Terminology (Figs 1–4) is essentially that used in Wharton et al. (2008) and Zhaurova and Wharton (2009), and is generally adapted from Gauld (1991, 1997) and more selectively from Townes (1969, 1970). We provide brief explanations in the following paragraphs where usage varies from or is in addition to that of Gauld (1991), or where elaboration may be helpful, a hyperlinked reference to the HAO.

Body length and antennal length, as given in the descriptions, are approximations of total length because of varying positions of the head and postmortem differences in telescoping and position of the metasoma. Wing length is measured from the base of the Costa to the apex of the wing and thus does not include the humeral plate and tegula. Abscissae are measured from the middle of their junctions. Length of the first flagellomere does not include the basal annellus, and all widths (flagellomeres and tarsomeres) are taken at midlength.

The face is the area between the anterior margin of the toruli and the anterior tentorial pits. We treat the face as separate from the clypeus (unlike Gauld 1991), with an epistomal sulcus, extending between the anterior tentorial pits, dividing the two. The antennal sockets are called toruli and the antennal tyloid on the lateral part of flagellomere 1 (Figs 14, 15) is a distinctive patch of placoid sensilla (= placode or multiporous plate sensilla) used by Gauld (1984) to characterize his Scolobatini s. l. (= West-

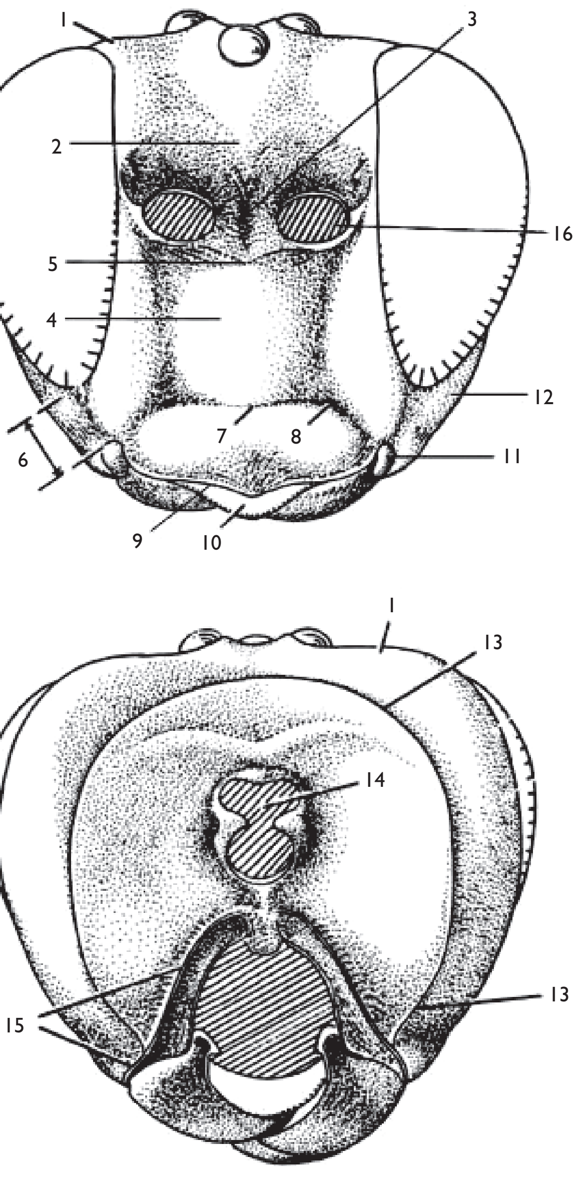


Figure 1. Head of an ichneumonid (anterior and posterior views). **1** Vertex **2** Frons **3** Inter-antennal area (or ridge) **4** Face **5** Apical tooth on face **6** Malar space **7** Epistomal sulcus **8** Anterior tentorial pit **9** Clypeal margin **10** Labrum **11** Mandibular base **12** Gena **13** Occipital carina **14** Foramen magnum **15** Hypostomal carina **16** Torulus.

woodiini + Scolobatini of Zhaurova and Wharton 2009). An interantennal process (in the form of an elevated flange) extends posteriorly onto the frons from between the antenna in many westwoodiines and in two of the four species of *Pergaphaga*. Names for propodeal carinae (Fig. 2) and wing veins (Figs 3, 4) follow Gauld (1991). Gauld

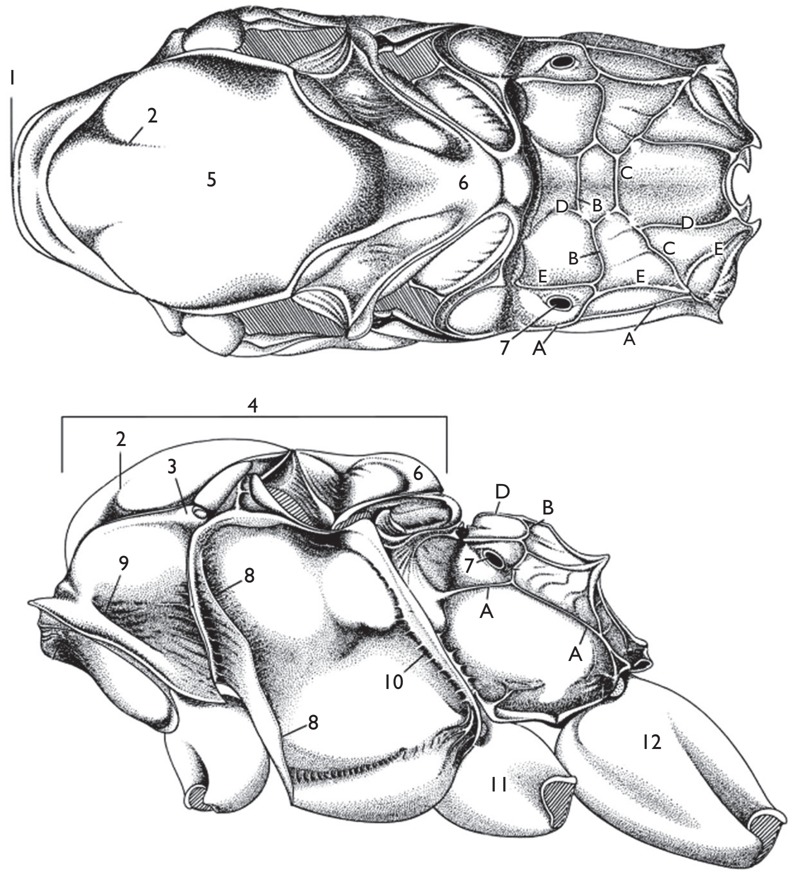
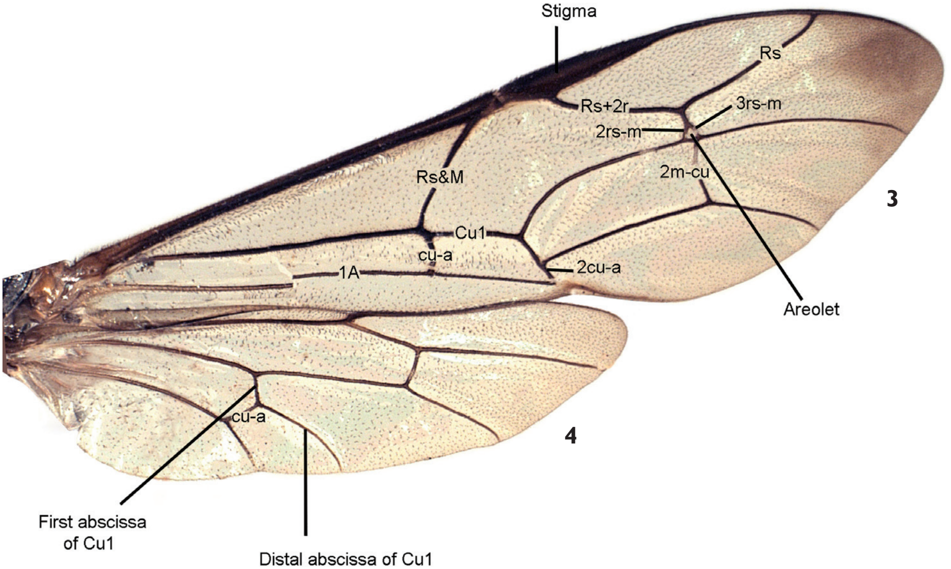


Figure 2. Mesosoma of an ichneumonid (dorsal and lateral views). **1** Anterior pronotal margin **2** Notaulus **3** Lateral corner of pronotum **4** Mesonotum **5** Mesoscutum **6** Scutellum **7** Propodeal spiracle **8** Epicnemial carina **9** Lateral groove of pronotum **10** Hind margin of mesopleuron **11** Mesocoxa. **12**. Metacoxa **A–E** Propodeal carinae: **A** Pleural carina **B** Anterior transverse carina **C** Posterior transverse carina **D** Median longitudinal carina **E** Lateral longitudinal carina.

(1991, 1997) did not label the first abscissa of Cu1 in the hind wing, but we have done so in Fig. 4 for clarification since the length of this abscissa relative to the length of cu-a is used in the descriptions. Townes (1969) referred to the two abscissae combined as the nervellus. The mesopleuron in *Pergaphaga* and other westwoodiines has a broad, longitudinal impression for reception of the mid femora similar to the feature used by Townes (1970) to define the perilissine genera *Opheltes* Holmgren and *Metopheltes* Uchida. This is different from the sternaulus (Wharton 2006) and is referred to in the descriptions below as the mesopleural depression (best illustrated in Fig. 27, somewhat below the arrow), following the usage of Townes (1970). We treat the metasoma as consisting of the petiole (T1 + its sternite, S1) and the gaster (remainder of metasoma posteriorad petiole). Use of the term gaster follows Sharkey and Wharton (1997) and



Figures 3–4. Wings of *Pergaphaga iangauldi* Cammack and Wharton, sp. n., paratype male, Murrumbeena. **3** Fore wing **4** Hind wing.

facilitates descriptions of color patterns. We refer to the apical, expanded part of T1 as the postpetiole following Gauld (1991). T2 and T3 refer to the second and third metasomal terga, respectively. We use the term epipleura for the enlarged, membranous region between the tergum and sternum on the first two metasomal segments, as described in some detail in Zhaurova and Wharton (2009). The definition of the following terms can be found in the HAO by following the associated hyperlinks: malar space[1], orbital bands[2], occipital carina[3], hypostomal carina[4], epicnemial carina[5], mesoscutum[6], notauli[7], scuto-scutellar groove[8], fore wing areolet[9], bulla[10], basitarsus[11], trochantellus[12], and glymma[13]. Note that the HAO is a hierarchy of classes, or things, and that multiple labels (or terms, e.g. "scuto-scutellar groove") can point to the same

1 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000503
2 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000673
3 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000653
4 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000413
5 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000292
6 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000575
7 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000647
8 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000919
9 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000147
10 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000184
11 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000178
12 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0001033
13 http://bioportal.bioontology.org/visconcepts/40660/?id=HAO:0000378

class, or definition of a part. For example, we prefer to use the label “scuto-scutellar groove“ for the concept in the HAO which has the label “scutoscutellar sulcus”.

Results and discussion

Characters and character states. The following characters and character states were used to assess relationships among the species of *Pergaphaga* in the phylogenetic analyses presented in Figs 47–48. Brief explanations are provided in most cases after descriptions of the character states.

1. Facial contour. (0) nearly flat; (1) slightly more elevated along eye margin, especially noticeable ventrally (Fig. 16).

The difference between the two character states is subtle, and difficult to assess without side by side comparisons. The difficulty is compounded by the fact that the face is entirely black in *P. nigra* but has yellow orbital bands, often contrasting with darker coloration medially, in the other three species of *Pergaphaga*.

2. Frons laterally. (0) distinctly elevated (Fig. 24); (1) flat or nearly so.

The anterior portion of the frons adjacent the compound eye is distinctly elevated in some species, with the elevation delimited medially by a weak to strong post-antennal depression. This character co-varies with character 1 in most species, but not in *P. nigra*.

3. Frons medially. (0) without an interantennal process (= elevated flange) (Figs 23, 26), though sometimes with traces of a low, median carina; (1) with strongly elevated interantennal process/flange (Figs 21–22).

In some species of *Pergaphaga*, as in many other westwoodiines, an interantennal process in the form of an elevated median flange extends between the antennae onto the median part of the frons, where it usually bifurcates or trifurcates posteriorly. In westwoodiines, maximum elevation is usually immediately posteriorad the posterior margins of the toruli. In one of the species of *Dictyopheltes*, the median part of the flange is nearly absent, but the bifurcating arms are well developed (Zhaurova and Wharton 2009) and thus both species of *Dictyopheltes* have been coded as having strongly elevated flanges.

4. Notauli. (0) deeply impressed throughout, particularly well-developed at base (Fig. 27); (1) deeply impressed but incomplete, absent or nearly so at extreme base (Fig. 28).

5. Ventral part of mesopleural depression. (0) rugulose (Figs 29, 31); (1) distinctly punctate, at least medially (Fig. 30).

The mesopleural depression is usually extensively punctate in *Pergaphaga*, with the punctures tending to coalesce anteroventrally and the sculpture often becoming rugulose posteroventrally. The ventral part of the mesopleural depression is more heavily sculptured throughout in *P. nigra* (Fig. 29) but is clearly and distinctly punctate medially in the other three species (e. g. Fig. 30), with the punctures discrete but with punctation varying in density among species.

6. Rounded lobe of mesopleuron forming anterodorsal margin of mesopleural depression. (0) finely, densely punctate (Figs 27, 29); (1) more deeply and less densely punctate.

7. Pleural carina. (0) complete, well-developed throughout, passing laterad propodeal spiracle, and easily distinguished from posterior portion of lateral longitudinal carina (Fig. 31); (1) incomplete or apparently so, extending as a distinct carina from anterior margin to spiracle, then either barely distinguishable or lost posteriorly (Fig. 30).

The pleural carina is always well developed anteriorly in *Pergaphaga*. In most species of *Pergaphaga*, however, it is greatly reduced posteriorly, either completely lost, replaced by a shallow groove, or present in the normal position as a very faint carina. In some specimens, the pleural carina appears to fuse with the lateral-most portion of the anterior transverse carina, curving medially around the ventral side of the spiracle to join the lateral longitudinal carina. This short transverse section is shown in Fig. 2 connecting the pleural and lateral longitudinal carinae, but the pattern of propodeal carinae in *Pergaphaga* is otherwise very different than what is shown in this figure. A clear carina is present in one of the three specimens of *P. xanthops* Wharton, sp. n., and it has been coded as variable for this reason.

8. Base of propodeum on either side of median depression. (0) heavily sculptured, usually rugose, more rarely deeply punctate (Fig. 33); (1) polished, smooth to finely shagreened (Fig. 34).

9. Pattern of propodeal carination. (0) strong, somewhat rugose transverse carina extending between spiracles (Figs 31, 33); (1) transverse carina partially replaced by weak, transverse striae (Fig. 32); (2) transverse carina not evident, replaced by weak, transverse striae (Fig. 34) (3) propodeum entirely rugose, with no transverse carinae (Fig. 35).

The distinctly elevated anterior transverse carina of *P. nigra* is variously replaced by weaker, irregular, transverse ridges in the other three species of *Pergaphaga*. In *P. iangauldi* Cammack and Wharton, sp. n., however, traces of a more distinct carina are often visible, and the basal median depression, in particular, is usually margined posteriorly by a carina. We coded *P. iangauldi* separately (state 1, Table 1) for our initial analysis, but also performed an analysis with this species coded either as in *P. nigra* or as in *P. xanthops* + *P. leaski* Wharton, sp. n.

10. Fore wing areolet. (0) large (Figs 36–37); (1) small (Figs 38–39); (2) absent (Fig. 40).

Examination of a series of specimens from Murrumbeena (see remarks under *P. iangauldi*), suggests that in *Pergaphaga*, state 2 is derived from state 1. No such intermediates were apparent in *Dictyopheltes* (the outgroup), and character states were left unordered in all analyses.

11. Color pattern of flagellum. (0) flagellum entirely black; (1) black basally, pale apically (Fig. 12); (2) black apically, pale basally (Fig. 10).

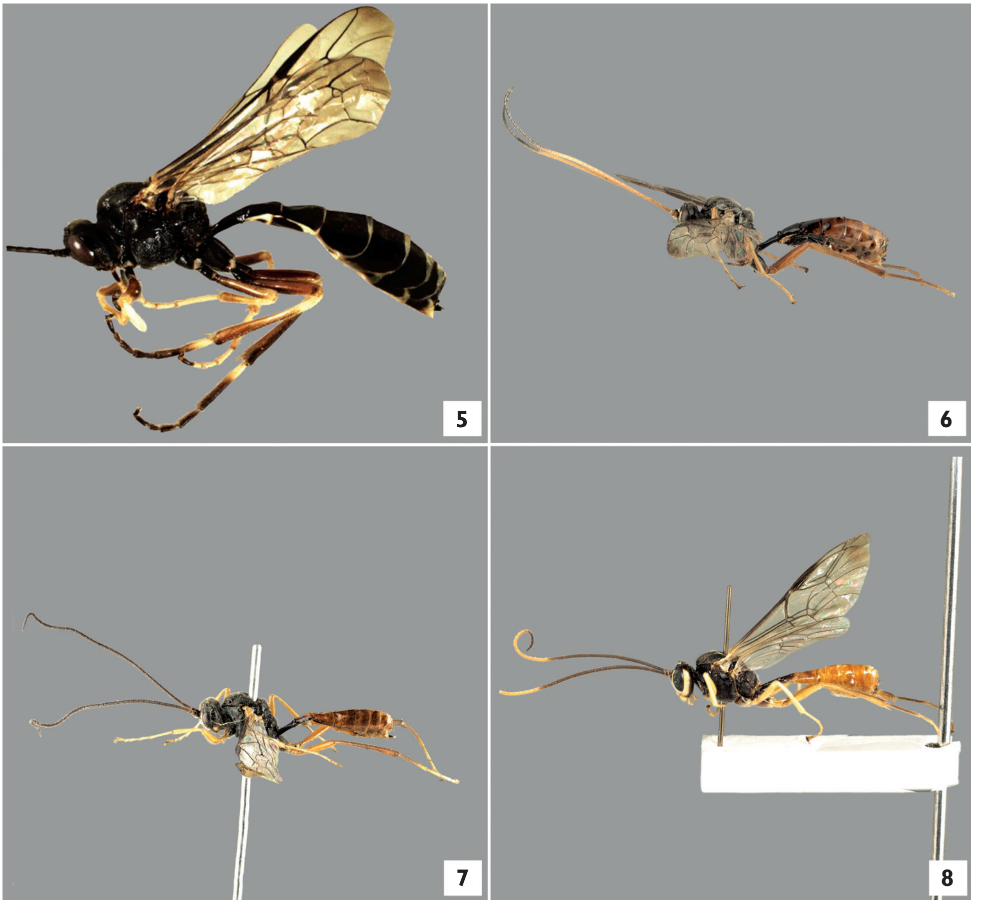
12. Color pattern of hind tibia. (0) hind tibia without sharply contrasting pale basal ring; (1) tibia with sharply contrasting pale (yellow to light orange) basal ring (Fig. 9).

Pergaphaga nigra and the species of *Dictyopheltes* tend to have darker legs than the other three species of *Pergaphaga*, with the pale basal ring thus strongly contrasting.

The hind tibia is yellow to orange in the other three species of *Pergaphaga* (Figs 42–44), though not always uniformly so.

13. Color pattern of female gaster. (0) all terga predominantly dark (Figs 5, 9, 41); (1) all terga predominantly brownish orange (Fig. 43); (2) at least some terga brownish orange, others predominantly black (Fig. 42).

In *P. nigra*, the petiole and all terga of the gaster are somewhat variable, but usually very dark brown to black anteriorly grading to dark reddish brown posteriorly, with pale apical margin, this margin tending to be broader in females than males. In the other three species of *Pergaphaga*, the gaster and parts of the petiole (especially postpetiole) are much lighter in coloration for the most part (Fig. 43). *Pergaphaga iangauldi* is slightly more variable (Fig. 42), and we have attempted to reflect this variation in the coding for this species. In those species for which more than one male was available for examination, males were somewhat more variable in coloration than females, but our sample is very small.



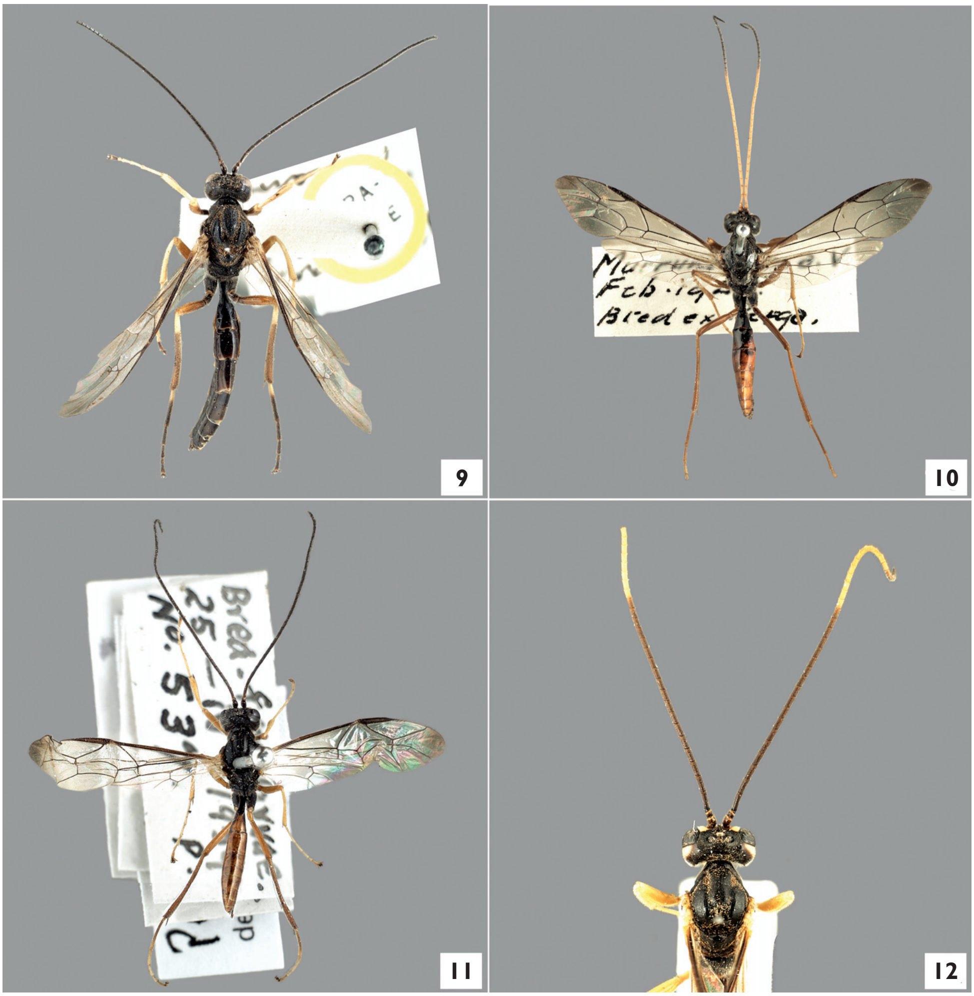
Figures 5–8. *Pergaphaga* spp., lateral habitus, female. **5** *Pergaphaga nigra* Gauld, paratype, Murrumbateman **6** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., holotype **7** *Pergaphaga leaski* Wharton, sp. n., holotype **8** *Pergaphaga xanthops* Wharton, sp. n., holotype.

14. Color pattern of fore wing. (0) weakly infumate anteriorly, fading to hyaline posteriorly, without infumate apical spot (Fig. 36); (1) hyaline with infumate apical spot (Fig. 39).

The infumate apical spot is present in all known specimens of *Pergaphaga*, as best illustrated in Fig. 39. The spot does not show up as prominently in some of the other figures because of background contrast.

15 Hind basitarsus, female. (0) Less than 9 times longer than wide; (1) More than 10 times longer than wide.

As indicated below in the redescription of *P. nigra*, there is some evidence for sexual dimorphism in proportions of the hind tibia, but the sample size is small.



Figures 9–12. *Pergaphaga* spp., dorsal habitus, female. **9** *Pergaphaga nigra* Gauld, paratype, Canberra **10** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., holotype **11** *Pergaphaga leaski* Wharton, sp. n., holotype **12** *Pergaphaga xanthops* Wharton, sp. n., holotype.

Assessment of relationships. All initial analyses produced a single tree (length = 21, CI = 90, RI = 86) with *P. nigra* as the sister group to the remaining species of *Pergaphaga* (Figs 47, 48). Heuristic and exact searches produced trees of the same length. The clade comprising *P. xanthops* + (*P. iangauldi* + *P. leaski*) is characterized by weaker mesopleural and propodeal sculpture, longer hind basitarsus, and distinctly paler coloration. Loss of the interantennal flange and slight differences in facial features unite *P. leaski* and *P. iangauldi* relative to *P. xanthops* within this clade. The results suggest a single loss of the interantennal flange, but a complete loss followed by a gain of the fore wing areolet. The homoplasy resulting from minor incongruencies among characters is reflected in the bootstrap values shown in Fig. 48. Bootstrap values shown in Fig. 48 were generated using WinClada. Those generated via PAUP were equal to or very slightly higher for the *P. xanthops* + (*P. iangauldi* + *P. leaski*) clade and the *P. iangauldi* + *P. leaski* clade. There was virtually no effect when changing the coding of the propodeum in *P. iangauldi* to match that of *P. xanthops* and *P. leaski*. When the coding was changed so that *P. iangauldi* had the same character state as *P. nigra*, the relationships remained the same, but bootstrap support values for the *P. iangauldi* + *P. leaski* clade not surprisingly dropped.

We were hesitant about using the epipleura as a character in our analyses despite the possibility that it may be phylogenetically informative (Townes 1970, Gauld 1984, 1997, Zhaurova and Wharton 2009). As noted by Zhaurova and Wharton (2009), there are problems in interpretation of this feature because its appearance varies with state of preservation. The epipleura appear to be better developed in *P. nigra* and *P. iangauldi* than in the other two species, though this is not evident in all specimens. In *P. leaski* and *P. xanthops*, which are smaller species, the epipleura are generally not apparent, or in some specimens only weakly indicated, but we are unable to determine if this is simply a preservation artifact. For these reasons, we excluded the epipleura from our initial analyses and delineation of characters and character states. We did, however, explore the effect this character might have on assessment of relationships within *Pergaphaga* by coding it for a separate PAUP analysis, assuming no preservation artifacts. Relationships remained the same as those presented in Fig. 48, but support for the *P. iangauldi* + *P. leaski* clade was greatly reduced.

There is relatively weak support for the monophyly of *Pergaphaga*, though bootstrap values were distinctly higher (75 vs. 58) in the PAUP analysis. However, demonstration of the monophyly of *Pergaphaga* was not a goal of this analysis. Monophyly of *Pergaphaga* and *Dictyopheltes* is treated in the next section, under the diagnosis for *Pergaphaga*.

Descriptive taxonomy

Pergaphaga Gauld, 1984

Pergaphaga Gauld, 1984: 231. Type species: *Pergaphaga nigra* Gauld, 1984 by monotypy and original designation.

Pergaphaga: Gupta 1987: 355 (catalog); Yu and Horstmann 1997: 455 (catalog); Zhaurova and Wharton 2009: 34, 39–41, 62–65, 67, 69–77 (key to genera of Westwoodiini, redescription, figures, relationships).

Megaceria auct. (misidentified, not *Megaceria* Szépligeti, 1908): Townes 1970: 57–58, 224 (key, description, figure); Short 1978: 62–64, 259 (larva).

Diagnosis: Clypeus similar in outline in all species (Figs 17–20), with ventral margin broadly truncate or nearly so medially, sharply angled dorsally near lateral margin. First flagellomere with large tyloid containing numerous (>20) placoid sensilla (Figs 14, 15). Occipital and hypostomal carinae meeting ventrally well before base of mandible (Fig. 25). Mesoscutum densely punctate throughout; notauli deep throughout, including at anterior margin (Fig. 27), V-shaped, converging posteriorly in broad, shallow depression separated from scuto-scutellar groove by a weak elevation; mesopleural depression broad and distinct. Propodeum varying from partially and weakly to extensively and strongly rugose (Figs 33–34), but always with some carination visible. Inner hind tibial spur almost twice length of outer spur. Fore wing 2m-cu with a single bulla. Petiolar tergosternal sulcus located ventrally when viewed in profile. Glymma represented by a shallow dorsal depression anteriorly (Fig. 45). S1 extending more than half distance to spiracle, usually to or nearly to level of spiracle. Metasomal segments 1–2 and more rarely 3 with epipleura bare and membranous when visible, often collapsed and extending outwardly as fleshy protrusions in dried specimens. Female gaster laterally compressed apically from middle of T3. In lateral view, cerci attached ventrad middle of posterior aspect of gaster. All four of the known species have hyaline wings with an infumate spot at the tip of the fore wing.

Pergaphaga can be differentiated from other Ctenopelmatinae by a combination of characters specific to Westwoodiini, including fore wing RS+2r arising from or near the base of the stigma (Figs 36–40), cerci of females ventrally displaced, and first flagellomere with a large tyloid laterally. The tyloid is in the form of a bare patch of numerous (> 20), irregularly arranged placoid sensilla (Figs 14–15).

As noted by Zhaurova and Wharton (2009), *Pergaphaga* is perhaps the least readily characterized of the known westwoodiines, and the species most closely resemble those currently placed in *Dictyopheltes*. The species of *Pergaphaga* and *Dictyopheltes* are characterized relative to other westwoodiine genera by the shallow to indistinct glymma (Fig. 45), with the petiole thus resembling that of certain Euryproctini. Gauld (1984), in fact, stated that *Pergaphaga* and *Dictyopheltes* lacked a glymma, and he used this feature in his key to the Australian genera of ctenopelmatines. A glymma-like depression is present in nearly all individuals that we examined, but is much different in appearance than the deeper glymma of *Westwoodia*, *Gauldia*, and *Hypopheltes*. It is narrow, shallow, and almost slit-like in some specimens, and never as distinct as it is in these other genera.

The sternite of the petiole is longer in *Pergaphaga* relative to that in *Dictyopheltes*. Additionally, the species of *Pergaphaga* are less heavily sculptured than those of *Dictyopheltes*, and retain at least some visible carination on the propodeum (Figs 33–

34). The most distinctive feature of the propodeum is the presence of a straight to very weakly arched transverse carina or series of low, transverse ridges extending between the propodeal spiracles that is not found in other westwoodiines, and which is variously developed in the new species described below. The monophyly of *Pergaphaga* is thus largely supported by the patterns of propodeal carination and wing coloration.

Monophyly of *Dictyopheltes* is supported primarily by two character states: notauli absent at base and propodeum rugose, without distinct carinae (Gauld 1984, Zhaurova and Wharton 2009).

Biology. The species of *Pergaphaga* have been reared from pergine sawflies feeding on *Eucalyptus*, and specifically from *Perga affinis* (Carne 1969), *Pergagrapta bella* (Elliot and Bashford 1995) and *Pergagrapta gravenhorstii* (Westwood). The latter record is based solely on label data from the type series of *P. leaski*. There are collection or rearing records from every month except September and November, but the vast majority are from February through June.

Pergaphaga is known only from southeastern Australia, ranging from South Australia, through Victoria and north about midway through New South Wales. In addition to the specimens recorded below under the species descriptions there are published records of *Pergaphaga* from Tasmania (Elliot and Bashford 1995), but we have not seen this material. The specimens of *P. nigra* labeled as South Australia (BMNH) have no additional data, and we are unable to pinpoint the locality further.

Remarks. *Pergaphaga* is similar in size and general appearance to species of *Megaceria*, a more commonly encountered ctenopelmatine in the tribe Euryproctini (Gauld 1984). Both are Australian endemics, and the two have been confused in the past, prior to the detailed study of the Australian fauna by Gauld (1984). The species of *Megaceria* lack the distinct tyloid at the base of the outer side of the first flagellomere. The first flagellomere also tends to be longer in *Megaceria*, with RS generally arising more distally from the stigma and terminating closer to the wing tip. Additionally, the petiole is more completely tubular in *Megaceria*, with no obvious sulcus between the fused tergum and sternum, the spiracle is more anteriorly displaced, and there is a broader, more distinct bridge separating the foramen of the petiole from the coxal cavities. The shape of the forewing areolet is distinctive in *Megaceria*, unlike the various forms seen in *Pergaphaga*. In *Megaceria*, ornamentation on the frons varies, as does the development of lateral carinae on the scutellum and there's an unusual amount of variation in the trough and associated carinae and projections along the margin of the propodeum and metanotum. According to Gauld (1984), there are three described species of *Megaceria* and at least 10 undescribed species.

Key to species of *Pergaphaga*

(multiple entry key available at: http://peet.tamu.edu/projects/8/public/clave/list)

1. Face black, without yellow orbital bands (Fig. 17); hind tibia dark with contrastingly pale (yellow to orange) ring basally (Fig. 9); base of propodeum

heavily sculptured (Fig. 33); hind basitarsus of females less than 9 times longer than wide; fore wing areolet large (Fig. 37) .... ***P. nigra* Gauld**
– Face either entirely or almost entirely yellow (Fig. 20) or dark medially with yellow orbital bands (Figs 18–19); hind tibia orange to yellow, without obviously contrasting pale basal ring (Figs 42–44); base of propodeum polished, unsculptured (Fig. 34); hind basitarsus more than 10 times longer than wide; fore wing areolet nearly always small or absent (Figs 38–40) **2**
2. Frons medially with elevated flange extending posteriorly from between antennae (Fig. 22); antenna dark basally, yellow to orange distally, with apical flagellomeres often black .... ***P. xanthops* Wharton sp. n.**
– Frons medially without elevated flange (Figs 23, 26); antenna either entirely black, or orange basally and black apically.. **3**
3. Antenna entirely black (Fig. 11) .... ***P. leaski* Wharton, sp. n.**
– Antenna partly yellow to orange over at least basal half (Fig. 10)................. ....***P. iangauldi* Cammack & Wharton, sp. n.**

Pergaphaga nigra Gauld
Figs 5, 9, 13, 17, 21, 24, 27, 29, 31, 33, 37, 41, 45, 46

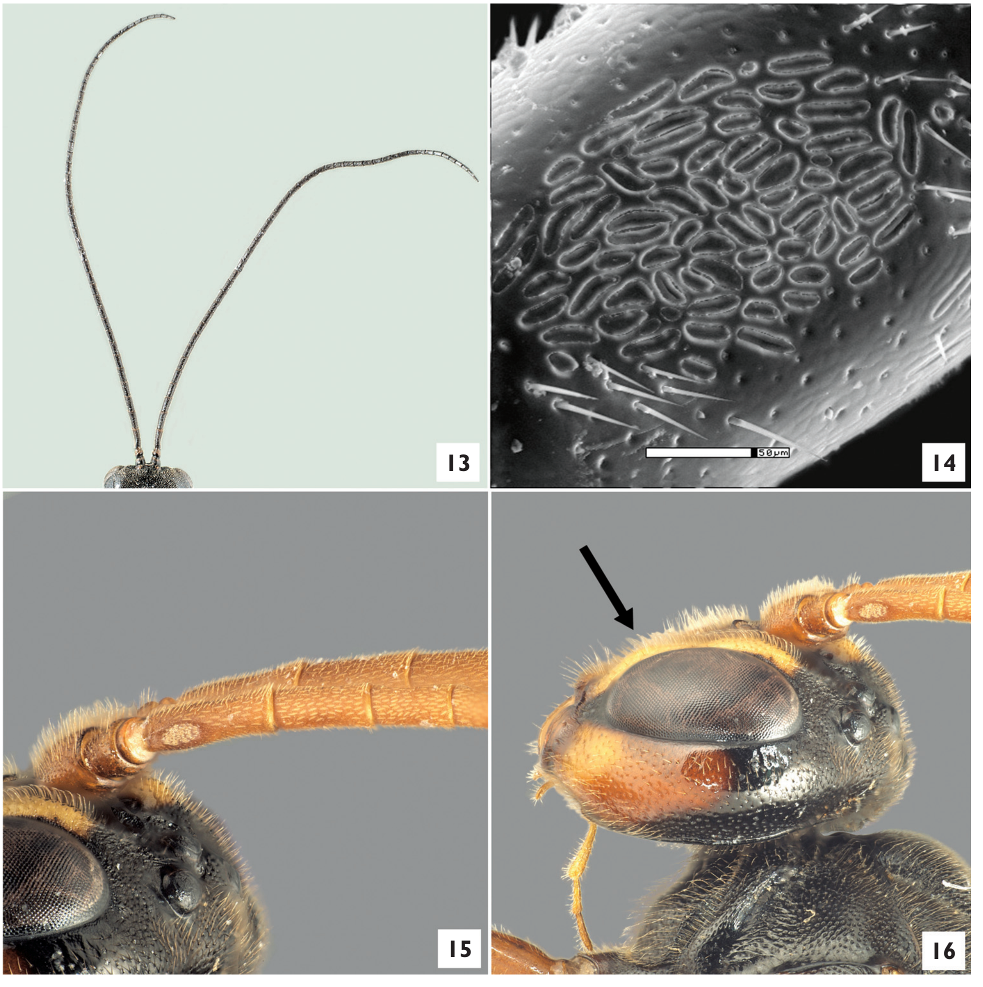
Type locality. Australia, New South Wales, Murrumbateman, -34.967S, 149.033E.

Type material. Holotype. Female (ANIC), Australia, New South Wales, Murrumbateman, emerged III.1974 ex. *Perga* cocoon collected III.1973, R.B. McInnes [not seen]

Material examined. Paratypes: 6 females, 5 males, same data as holotype except emergence dates of 5.III, 2.VI., and 8.V.1973 and 21.II, 27.II., and 8.III.1974 (ANIC, BMNH); ACT, 1 female, Canberra, 12.V.1959, P.B. Carne (ANIC); 2 males, Duntroon, emerged 8–22.V.1960, parasite of *Perga affinis* (ANIC, BMNH); NEW SOUTH WALES, 1 male, Cookardinia, emerged 29.II.1960, ex culture 223, parasite of *Perga affinis* (BMNH); SOUTH AUSTRALIA, 2 females, no additional data (BMNH); VICTORIA, 2 females, Avoca, 220, emerged 10.VI.1957, parasite of Symphyta on Eucalyptus sp., M.F. Leask (BMNH).

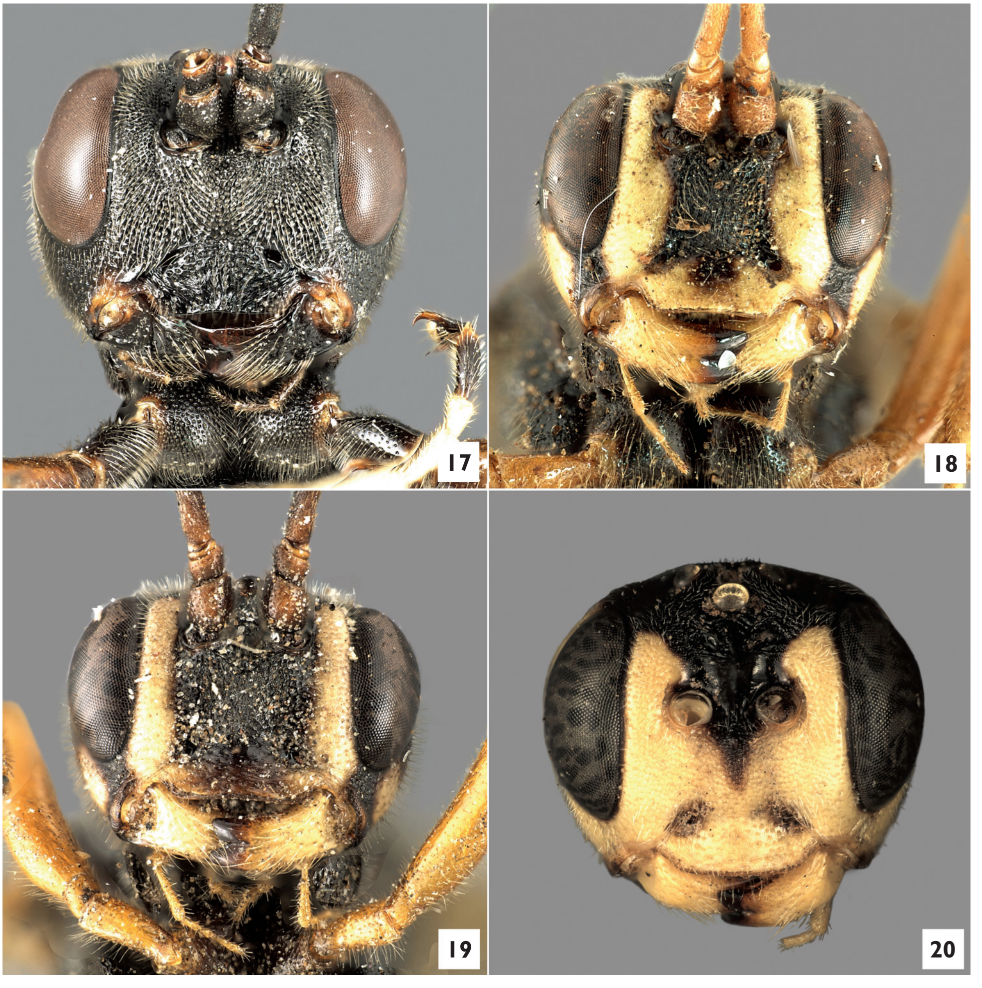
Other specimens examined: ACT, 1 female, Canberra, 24.IV.1959, W. Vestjens (MVMA); 10 females, 2 males, Duntroon, emerged 8–22.V.1959 and IV–V.1960 from *P. affinis* cocoons collected 1958, P.B. Carne (ANIC); 2 females, same data except cocoons collected 24.II.1958, dissected 28.II.1959; VICTORIA, 1 male, 6.6 mi W. of Bonnie Doon, 7.III.1973, R.S. McInnes, emerged ex. *Perga* cocoons 31.I.1975 (ANIC); 1 male, Hamilton, 10.X.1947, G. Stephens, collection A. N. Burns (MVMA); 1 female, 15 mi ESE Wangaratta, emerged 16.VII.1974 ex *Perga* cocoon collected 8.III.1973, R.S. Mclnnes (ANIC); 1 female, no locality, ex culture, emerged 25.VIII.1934, vide 20 (BMNH); 1 male, no additional data (MVMA).

Description. Female (Figs 5, 9). *Length of body* (exclusive of antenna) 12.5–21.3mm; of fore wing 11.0–15.7mm; of antenna 15.0–20.0mm.



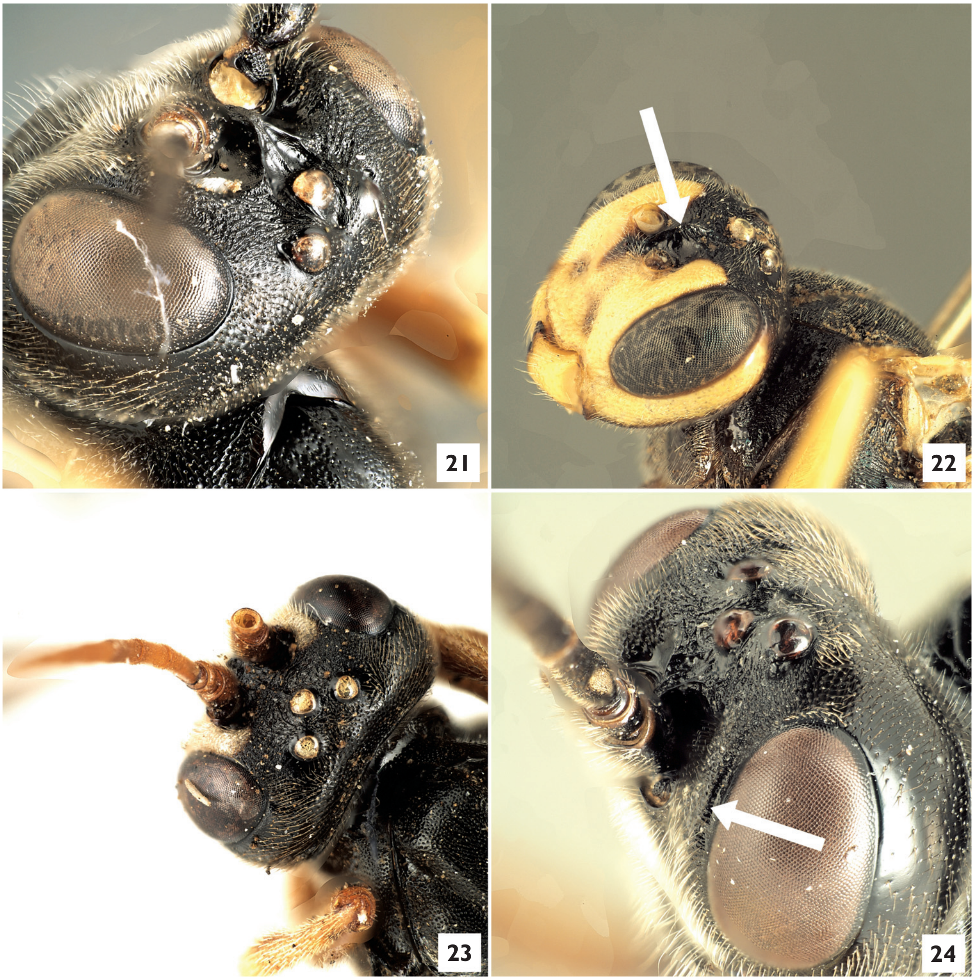
Figures 13–16. *Pergaphaga* spp., antenna and tyloid, female. **13** *Pergaphaga nigra* Gauld, antenna, non-paratype from Duntroon **14** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., paratype, Murrumbeena, SEM of tyloid **15** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., paratype, Canberra, relative size of tyloid and basal flagellomeres **16** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., paratype, Canberra, arrow = weakly bulging region of face.

Head. Clypeus (Fig. 17) 2.5–2.7 times as broad as long; slightly undulating; convex dorsomedially and along midline, impressed ventrolaterally, except raised and thickened at extreme lateral margin; ventral margin broadly truncate, slightly thickened medially; surface punctate and weakly rugulose on shagreened background, punctures coalescing, especially ventrally; epistomal sulcus indistinct. Malar space 0.6–0.7 times basal width of mandible, coarsely granular and shagreened. Lower gena deeply and densely punctate on finely shagreened background, becoming more sparsely punctate and polished dorsally, upper gena with punctures separated by 2–3 times their diameter, more densely punctate along occipital carina, more sparsely punctate adja-



Figures 17–20. *Pergaphaga* spp., face, female. **17** *Pergaphaga nigra* Gauld, paratype, Murrumbateman **18** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., holotype **19** *Pergaphaga leaski* Wharton, sp. n., holotype **20** *Pergaphaga xanthops* Wharton, sp. n., holotype.

cent eye at mid eye height. Face (Fig. 17) deeply and densely punctate, varying from rugose punctate to more densely granular rugose medially, surface slightly undulating transversely, weakly elevated medially, distinctly depressed near ventrolateral margin of toruli, nearly flat between anterior tentorial pit and eye. Frons with median, elevated flange (Fig. 21) extending posteriorly beyond posterior margin of toruli, bifurcating posteriorly, the resulting depressions between flange and toruli and between bifurcating arms and median ocellus polished and often weakly striate; frons densely granular on flattened portion between ocellar field and eye, rugose punctate on distinctly elevated portion between antenna and eye (Fig. 24). Antenna with 40–46 flagellomeres; first flagellomere at most 1.2 times longer than second, 3.0–3.7 times longer than wide, second flagellomere 2.5–3.1 times longer than wide, tenth 1.8–2.2 times longer



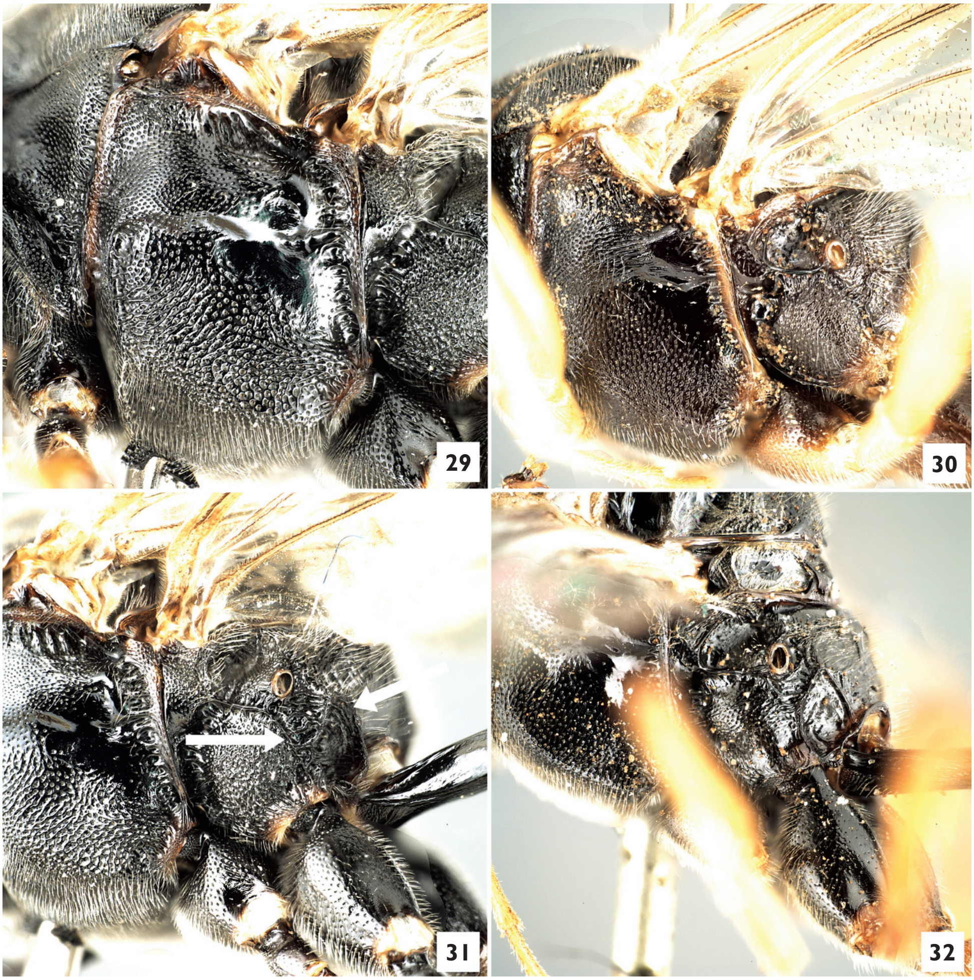
Figures 21–24. *Pergaphaga* spp., head, female. **21** *Pergaphaga nigra* Gauld, showing interantennal flange extending onto frons, non-paratype from Duntroon **22** *Pergaphaga xanthops* Wharton, sp. n., holotype, arrow = interantennal flange extending onto frons **23** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., paratype, Murrumbeena, showing absence of interantennal flange **24** *Pergaphaga nigra* Gauld, paratype, Murrumbateman, arrow = lateral bulge on frons.

than wide; tyloid of first flagellomere large, oval, extending 0.25–0.35 length of first flagellomere.

Mesosoma. Pronotum laterally densely punctate (Fig. 27). Mesopleural depression rugulose punctate ventrally (Fig. 29), the punctures large, deep, coalescing; rounded lobe forming anterodorsal margin of mesopleural depression very finely, densely punctate, the punctures discrete but often touching or nearly so, much smaller than punctures on ventral part of mesopleural depression. Scutellum coarsely punctate. Posteromedian plate of metanotum densely, coarsely punctate to rugose punctate, never polished. Metapleuron medially densely rugose to rugose punctate. Propodeum

Figures 25–28. Head and thorax **25** *Pergaphaga xanthops* Wharton, sp. n., holotype, back of head showing occipital and hypostomal carinae meeting above base of mandible **26** *Pergaphaga leaski* Wharton, sp. n., holotype, top of head **27** *Pergaphaga nigra* Gauld, paratype male, Murrumbateman, showing notauli deep at extreme base; arrow = sculpture on anterior bulge above mesopleural depression **28** *Dictyopheltes robustus* Gauld, male, showing notauli incomplete, not extending to extreme base.

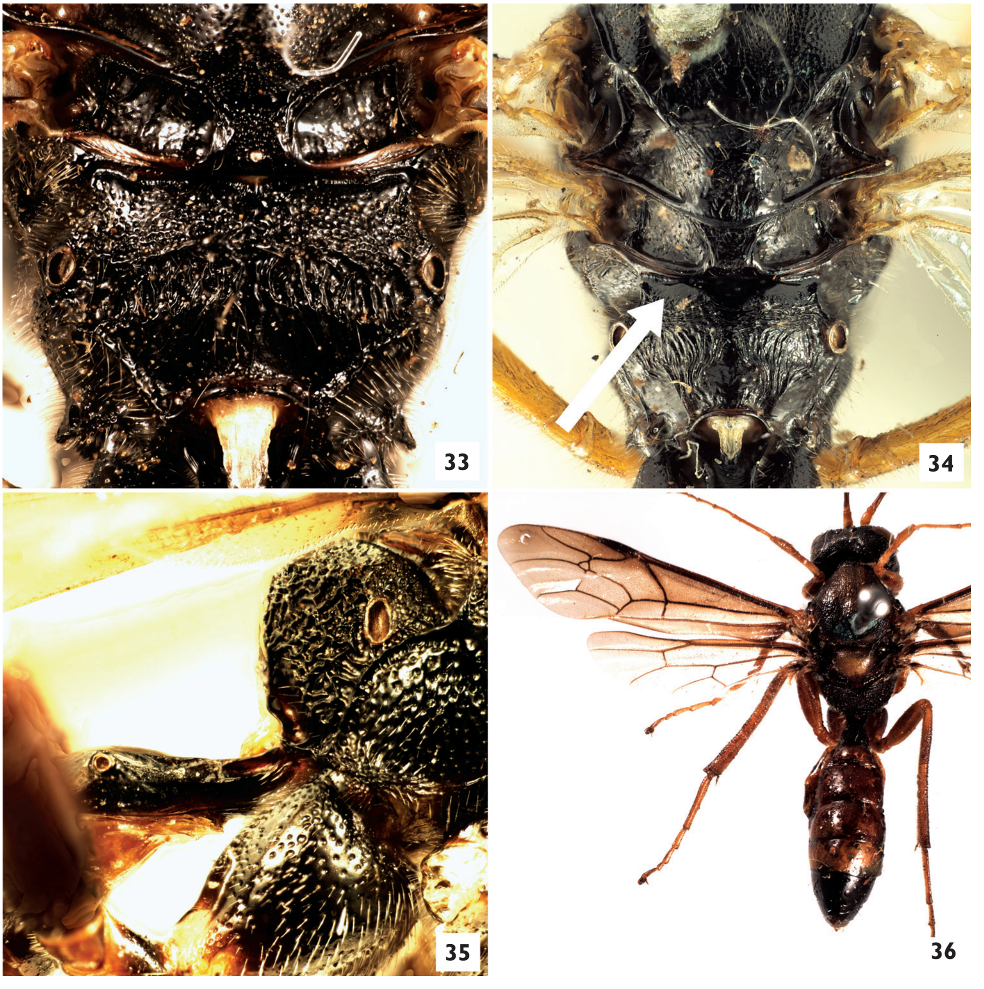
in profile (Fig. 31) with anterior and sharply declivous posterior fields distinctly separated by prominent anterior transverse carina extending between spiracles, the carina somewhat irregular, often rugose medially; base of propodeum, on either side of median depression, heavily sculptured as in surrounding areas (Fig. 33); pleural carina complete (Fig. 31): strongly elevated anterior portion extending posteromedially toward spiracle, then angled posteriorly near spiracle, less strongly elevated posteriorly, never touching spiracle; lateral longitudinal carina distinct posteriorly, absent or difficult to distinguish anteriorly; lateromedian portions of posterior transverse carinae often weakly indicated as elevated rugosities, forming a low to prominent tubercle at



Figures 29–32. *Pergaphaga* spp., mesosoma, female. **29** *Pergaphaga nigra* Gauld, paratype, Murrumbateman **30** *Pergaphaga xanthops* Wharton, sp. n., holotype **31** *Pergaphaga nigra* Gauld, paratype, Murrumbateman, left arrow = posterior portion of pleural carina, right arrow = tubercle at junction of propodeal carinae **32** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., paratype, Murrumbeena.

junction with lateral longitudinal carina; a longitudinal carina usually present along midline posteriorly. Hind basitarsus 7.2–8.7 times longer than wide. Fore wing areolet broad, rhombic, petiolate above, the stalk less than length of areolet (Fig. 37); 2m-cu arising from distal half of areolet, sometimes at, or rarely distad, extreme apex. Hind wing with 1st abscissa of Cu1 0.35–0.55 times length of cu-a; cu-a strongly reclivous.

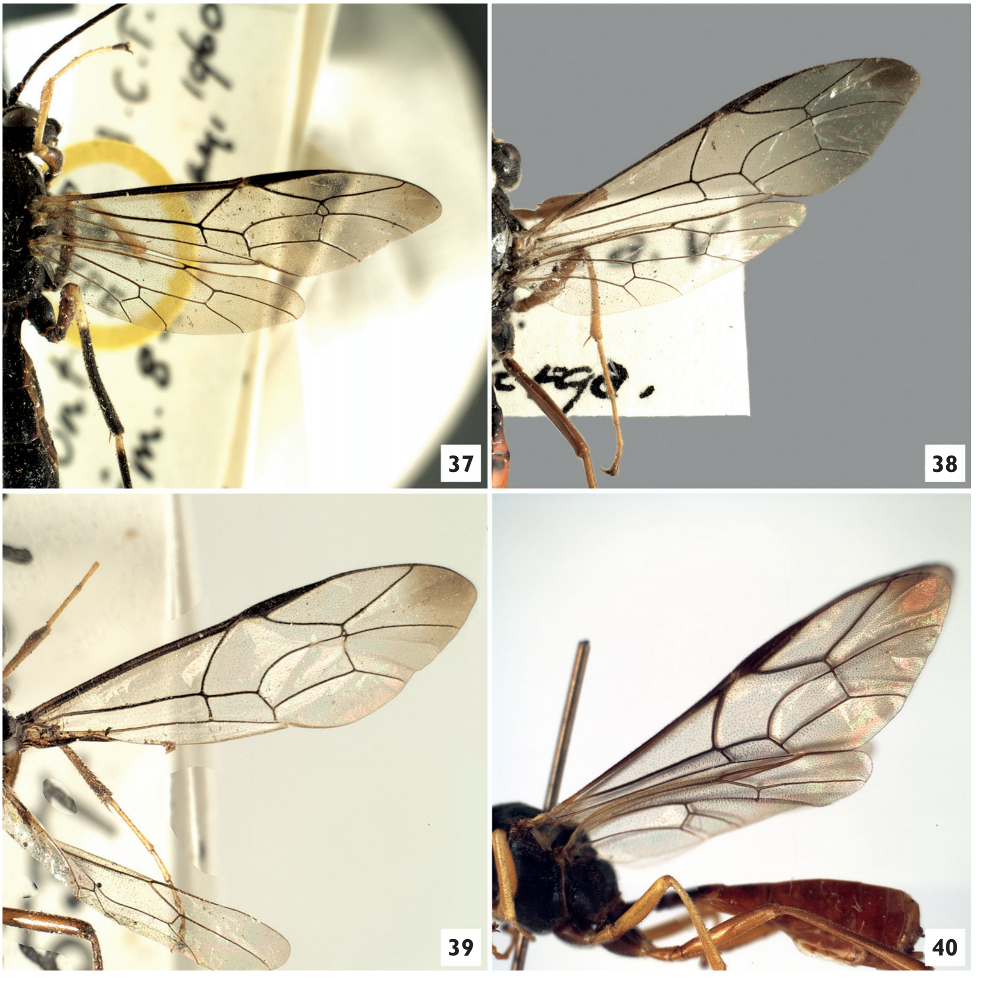
Metasoma. Petiole (Figs 45, 46) with S1 not extending to level of spiracle. Apical 0.5–0.6 of postpetiole (posteriad spiracle) punctate and setose. T2 densely punctate and short setose over posterior 0.5, with impunctate, bare, transverse line or ellipsoid medially, setose with weaker punctation anteriorly except bare and impunctate along



Figures 33–36. 33–34. *Pergaphaga* spp., propodeum, dorsal view **33** *Pergaphaga nigra* Gauld, non-paratype from Duntroon **34** *Pergaphaga leaski* Wharton, sp. n., paratype female, arrow = polished basal area **35–36** *Dictyopheltes robustus* Gauld, male **35** Propodeum in profile, showing sculpture **36** Dorsal habitus showing wing venation.

anterior margin. T3 and T4 often uniformly densely punctate and short-setose, occasionally with median bare, impunctate line on T3.

Color (Figs 5, 9, 13, 17, 41). Head and body black, antenna entirely black; mandibles dark basally and apically, often reddish brown medially; metasoma with petiole and terga of gaster black basally, becoming reddish brown apically in half specimens examined, posterior margin always pale yellow, with yellow markings expanded along midline on laterally compressed terga; all coxae black, trochanters and trochantelli nearly always black; femora transitioning gradually or somewhat abruptly from darker ventrally to paler mid dorsally as follows: from dark brown ventrally and orange brown dorsally to orange ventrally and yellow orange dorsally, rarely uniformly colored, fore and mid

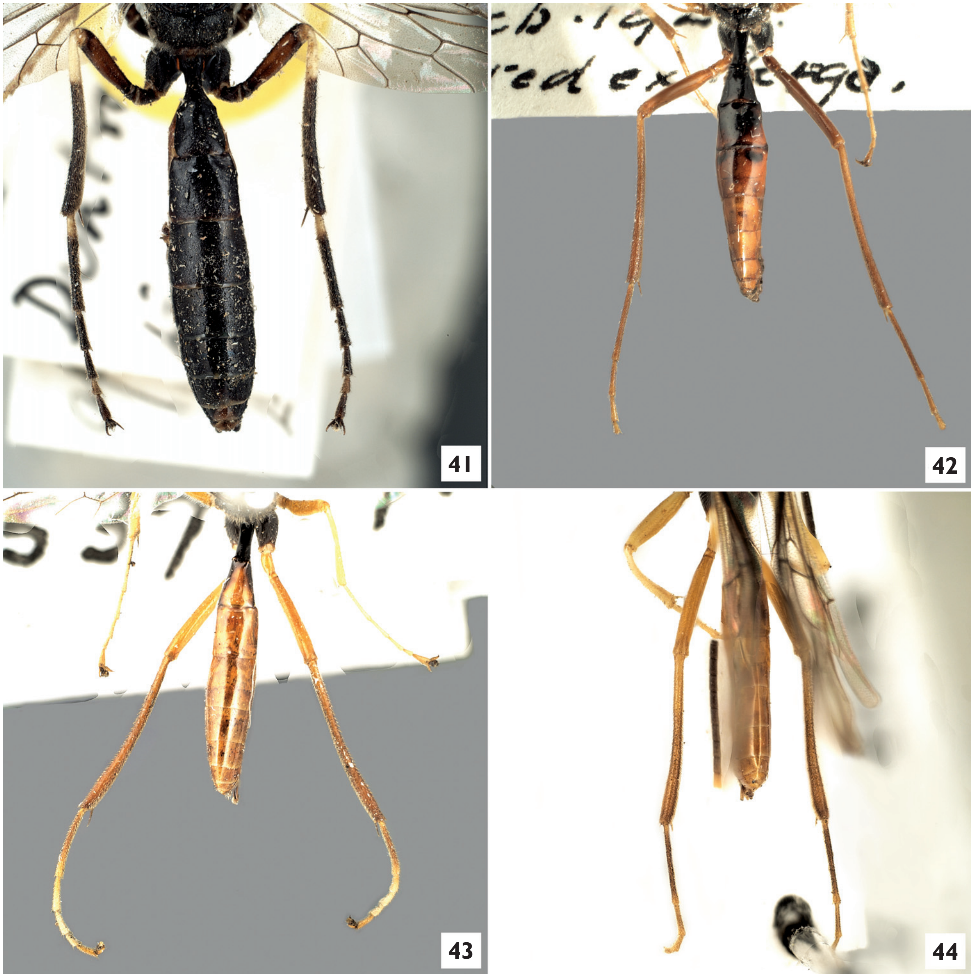


Figures 37–40. *Pergaphaga* spp., fore wing. **37** *Pergaphaga nigra* Gauld, paratype male, Duntroon **38** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., holotype **39** *Pergaphaga leaski* Wharton, sp. n., paratype female **40** *Pergaphaga xanthops* Wharton, sp. n., holotype.

femora yellow at extreme apex; fore and mid tibiae and tarsi mostly pale yellow, with orange stripe ventrally on tibiae expanding dorsally towards apex; apical tarsomeres of all legs dark brown to black dorsally with pale spot at extreme apex; hind tibia varying from black to dark orange dorsally, with basal 0.2–0.3 pale yellow, yellow extending along ventral midline over basal 0.5, ventral midline varying from orange to black over distal 0.5; hind tarsi dark reddish brown to black with basitarsus yellow over basal 0.2–0.3.

Male. Essentially as in female except as follows: Hind basitarsus often slightly narrower, 8.5–10.0 times longer than wide; terminal segments of gaster not as laterally compressed; fore trochanter more frequently (30%) brownish than in female.

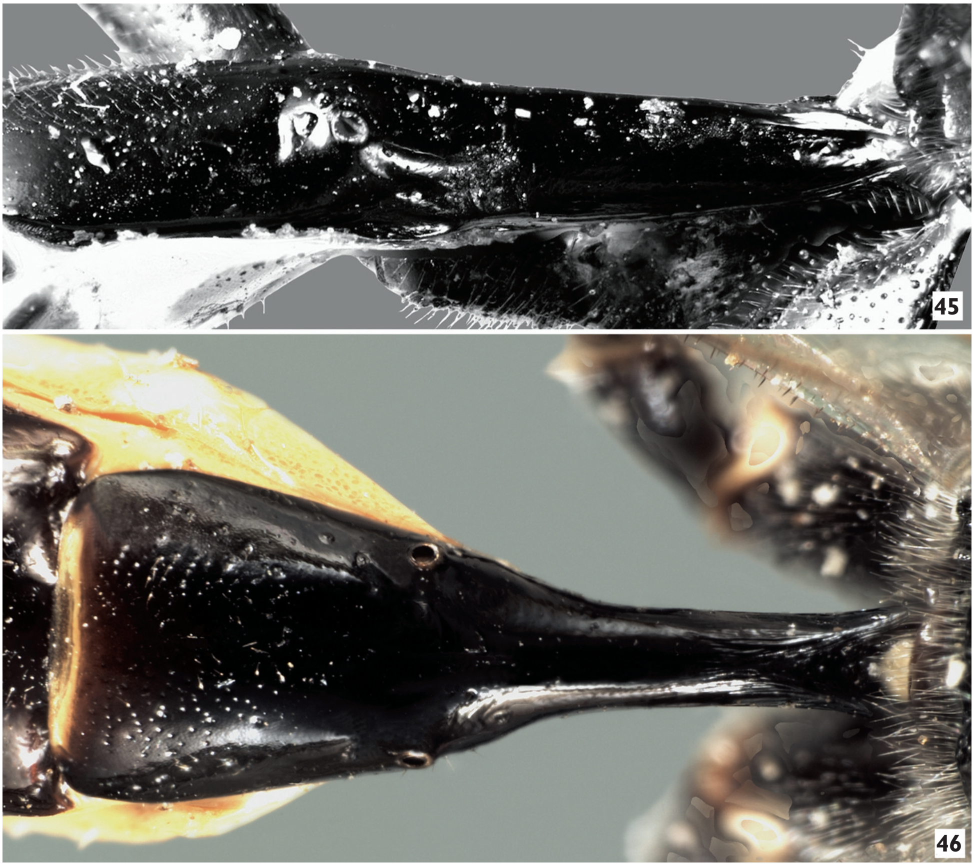
Distribution and biology. This species is known only from southeastern Australia, with the known range of this species extending from South Australia through



Figures 41–44. *Pergaphaga* spp., metasoma and leg coloration. **41** *Pergaphaga nigra* Gauld, paratype male, Duntroon **42** *Pergaphaga iangauldi* Cammack and Wharton, sp. n., holotype **43** *Pergaphaga leaski* Wharton, sp. n., holotype. **44** *Pergaphaga xanthops* Wharton, sp. n., holotype.

Victoria and New South Wales, coincident with the primary range of its host (Carne 1969, Schmidt and Smith 2006), *Perga affinis*. Unfortunately, the only specimens from South Australia (the two paratypes noted above) lack specific locality data. Collection and emergence dates for *P. nigra* range primarily from February through June, with one specimen each collected in January, July, August, and October. Based on material reared from *P. affinis* in ANIC, the specimens mentioned by Carne (1969) as an undescribed species of "?Hypopheltes," are *Pergaphaga nigra*. Carne (1969) provides additional information on the host, which is active during winter, and Gauld (1984) also noted that most specimens of *P. nigra* that he examined were taken late in the season.

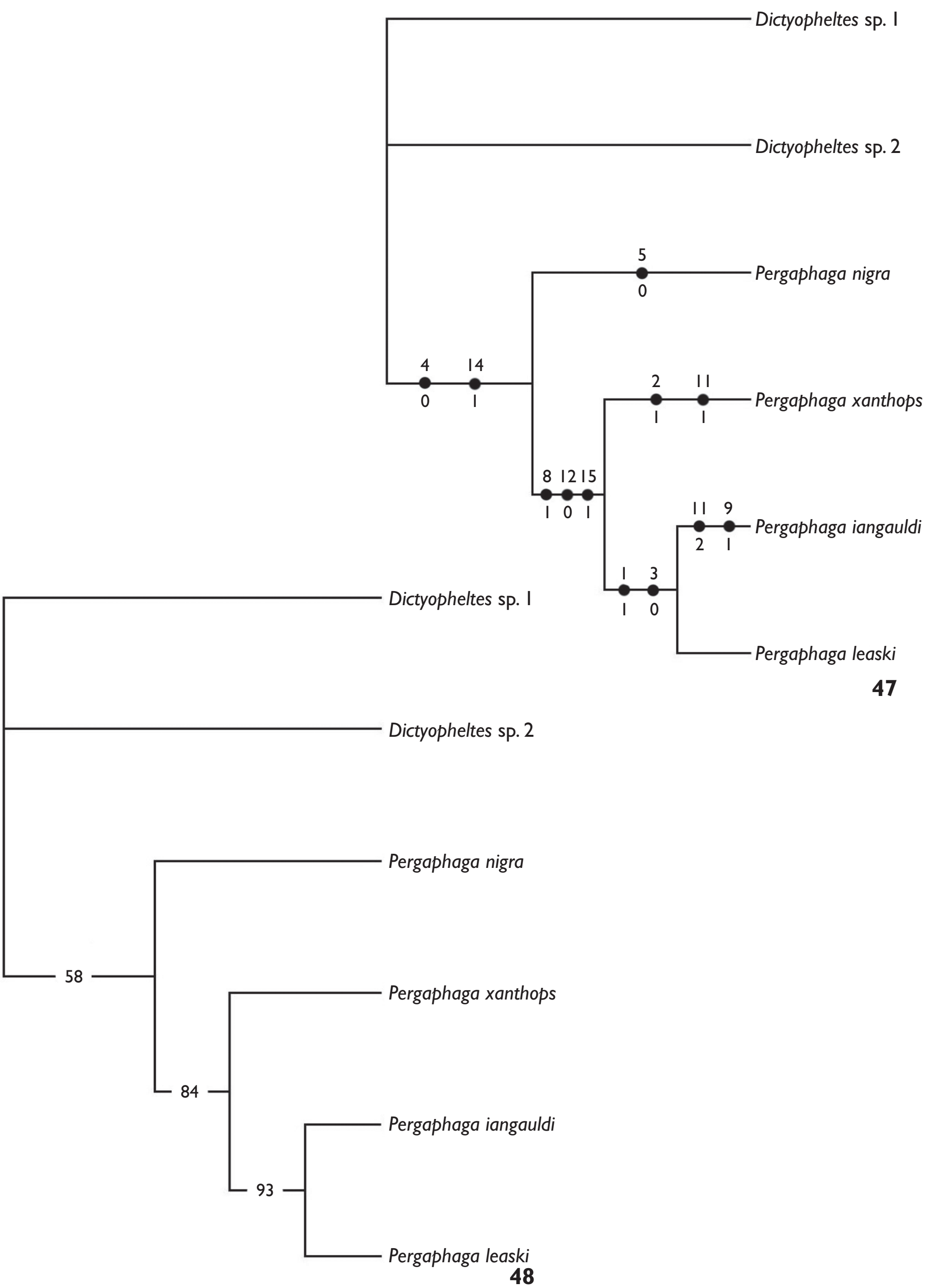
Diagnosis. *Pergaphaga nigra* differs in several respects from the three new species described below. It is readily recognized by its dark coloration and distinctively



Figures 45–46. *Pergaphaga nigra* Gauld, petiole **45** Lateral, showing weak glymma near base **46** Dorsal, non-paratype from Duntroon.

bicolored hind tibia and basitarsus. Unlike the other three species, the face is entirely black and the gastral terga are black with pale apical margins. The hind basitarsus is also shorter and broader in female *P. nigra*, the fore wing areolet is larger, and the propodeum more heavily sculptured, with a distinct transverse carina at the level of the spiracles. As in *P. xanthops*, there is an elevated, Y-shaped flange extending between the antenna.

Remarks. The male specimen from Duntroon listed above as a paratype has a paratype label and an Ian Gauld det. label, but does not exactly match the information on paratypes provided in Gauld's (1984) original description. The specimen from Cookardinia, though listed by Gauld as a paratype, lacks a paratype label. Handwritten labels correctly give R.S. for initials of McInnes, but those typed labels with emergence dates of 1973 incorrectly give initials as R.B. Gauld (1984) lists an additional 10 female and 10 male paratypes from Murrumbateman (ANIC) that we did not see. Gauld also noted that one of the paratypes from Avoca bears a label indicating that it was the specimen figured by Townes (1970) as *Megaceria*.



Figures 47–48. Results of parsimony-based phylogenetic analysis, generated from WinClada, producing single tree of length 21. Branches with no unambiguous state changes are collapsed. **47** Unambiguous state changes mapped onto tree as dark circles **48** Same tree, showing bootstrap support values, 200 replicates, 10 searches per replicate.

Observed variation was as great within populations as between them. Sculpture of the median part of the face varied from rugose punctate to more densely granular rugose and the hind tibia varied from black to orange in both Duntroon and Murrumbateman series. The female specimen from Duntroon shown in Fig. 5 illustrates the maximum extent of pale coloration on the apical margins of the terga among the material available for study. In one of the 10 females measured, the hind basitarsus was 10.0 times longer than wide; in one of the nine males examined, the areolet was not petiolate.

In addition to a generally more heavily sculptured propodeum relative to other species of *Pergaphaga*, *P. nigra* has the anterior transverse propodeal carina not only better developed but also generally more posteriorly displaced.

Pergaphaga iangauldi **Cammack & Wharton, sp.n.**
urn:lsid:zoobank.org:act:0D8E1628-A583-4E9C-8BCC-FE1E25F2DB9A
Figs 3, 4, 6, 10, 14–16, 18, 23, 32, 38, 42

Type locality. Australia, Victoria, Murrumbeena, -37.900S,145.067E

Type material. Holotype. Female (MVMA), with labels as follows: "Murrumbeena. V./ Feb. 1948./ Bred ex Perga." [handwritten] "Collection/ A. N. Burns" [printed] "ENT – 935" [printed] "MUS. VIC./ ENT-1089" [printed] "HOLOTYPE/ Pergaphaga/ iangauldi/ Cammack & Wharton" [red, handwritten]

Paratypes: 3 females, 2 males, same data as holotype, one of these with an additional Certonotus identification label (MVMA); 1 female, New South Wales, Windsor, Bred by B. A. Hill, 29.XII.97, Ex. Coll. Nat. Mus. (MVMA); 1 female, ACT, Canberra, The Pinnacle, Hawker, 35°16'S, 149°02'E, 6–23.X.2002, K.P. Bland (ANIC).

Other specimen examined (not a paratype): 1 female, Victoria, Bright, H.W. Davey (QMBA).

Description. Female (Fig. 6, 10). *Length of body* (exclusive of antenna) 13.5–16.0mm; of fore wing 13.7–15.0mm; of antenna 16.5–17.0mm.

Head. Clypeus (Fig. 18) 2.6–2.7 times as broad as long; weakly and uniformly convex to nearly flat in profile, very weakly thickened along lateral margin; ventral margin broadly truncate to very weakly concave, very slightly thickened; surface punctate on weakly shagreened background, punctures deep, separated from one another by their diameter; epistomal sulcus weak medially but distinct. Malar space 0.45–0.55 times basal width of mandible, strongly shagreened to finely granular-matt/punctate. Lower gena punctate, with punctures separated by 0.5–1.0 times their diameter, usually weakly shagreened, upper gena more polished and very slightly more sparsely punctate except more densely punctate along occipital carina. Face (Fig. 18) deeply and densely punctate, varying from punctate and weakly shagreened to more densely granular punctate medially, surface distinctly undulating transversely, elevated medially and laterally, distinctly depressed near ventrolateral margin of toruli, convex between anterior tentorial pit and eye (Fig 16). Frons lacking distinctly elevated interantennal flange of *P. nigra*, with at most a low, very short, weak, median carina (Fig. 23); frons distinctly elevated adjacent eye, the elevated area punctate and somewhat crescent-shaped, frons otherwise flat with post-antennal area adjacent elevated lateral margin appearing weakly concave; surface often polished immediately behind scape, finely matt punctate posteriorly between posterior ocelli and eye, otherwise variously rugulose to rugose to densely granular. Antenna with 42–44 flagellomeres; first flagellomere at most 1.2 times longer than second, 3.6–3.7 times longer than wide, second flagellomere 2.8–3.1 times longer than wide, tenth 2.0–2.2 times longer than wide; tyloid of first flagellomere (Figs 14, 15) large, oval, extending 0.30–0.35 length of first flagellomere.

Mesosoma. Pronotum laterally densely punctate. Mesopleural depression densely punctate to weakly rugulose or strigose punctate anteroventrally, the punctures large, deep, coalescing at least in part anteriorly but usually discrete though nearly adjacent medially; rounded lobe forming anterodorsal margin of mesopleural depression with similarly large, deep punctures, but with punctures often more widely spaced. Scutellum coarsely punctate. Posteromedian plate of metanotum varying from unsculptured to nearly so, polished. Metapleuron densely punctate with additional strigose sculpture in some individuals. Propodeum varying from weakly convex to nearly flat in profile, with very narrow anterior and elongate posterior fields often differentiated; base of propodeum, on either side of median depression, smooth, polished (as in Fig. 34); pleural carina nearly always incomplete: sharply defined anteriorly, touching ventrolateral corner of propodeal spiracle, discontinuous or nearly so between spiracle and weaker posterior fragment; anterior transverse carina often poorly differentiated among narrow band of transverse strigose sculpture, though sometimes distinct as a low ridge; median basal depression margined posteriorly with what may represent the median portion of anterior transverse carina; distinctly arched lateral portion of posterior transverse carina and posterior portion of lateral longitudinal carina forming large, polished, apicolateral area (Figs 32), junction of lateral longitudinal and posterior transverse carinae not tuberculate. Hind basitarsus 12.2–14.7 times longer than wide. Fore wing areolet very small, petiolate above, the stalk equal to or longer than both length and width of areolet (Fig. 38); 2m-cu variable, arising from middle (rarely) to extreme apex (more commonly) of areolet. Hind wing with 1st abscissa of Cu1 0.80–0.85 times length of cu-a; cu-a reclivous.

Metasoma. Petiole with S1 not extending to level of spiracle. Postpetiole and T2–4 polished, almost completely bare and impunctate, with a few scattered punctures and setae, the latter concentrated laterally.

Color (Figs 6, 10, 16, 18, 42). Mostly black; mandible (except dark apical teeth), broad orbital bands on face extending onto anterior part of frons, clypeus (except small, irregular dark spot dorsomedially) and variously sized spot on lower gena bright yellow; scape, pedicel, and basal 19–21 flagellomeres, tegula, legs from trochanter to apex, and most of gaster orange, with fore and mid legs often yellow orange; petiole completely, T2 extensively (holotype) to completely and base of T3 at least partially black in 3 specimens; gaster completely orange and petiole with irregular orange markings posteriorly in 2 specimens.

Male. Essentially as in female except as follows: Antenna with 41–43 flagellomeres, first flagellomere 3.1–3.2 times longer than wide; hind wing with 1st abscissa of Cu1 0.65–0.85 times length of cu-a; anterior transverse carina less evident than in most females; terminal segments of gaster not laterally compressed; face medially and clypeus dorsomedially pale orange instead of black, basal 22–23 flagellomeres orange, coxae, especially on fore leg, partly orange, gaster almost completely black in one specimen, almost completely orange in the other.

Distribution and biology. Known only from Victoria, ACT, and central New South Wales. Reared from an undetermined species of *Perga* (based on label data).

Diagnosis. This species is most readily recognized by the distinctively bicolored antenna, which is pale basally and dark apically. *Pergaphaga xanthops* also has bicolored antennae, but the pattern is reversed. *Pergaphaga iangauldi* lacks the elevated median flange on the frons as found in *P. nigra* and *P. xanthops*, and is thus more similar to *P. leaski* in this regard. In addition to differences in antennal color pattern, *P. iangauldi* has a more heavily sculptured mesopleuron than *P. leaski*.

Remarks. The female specimen from Bright is larger than members of the type series, with 46 flagellomeres, the first 30 of which are orange. The fore wing areolet is also distinctly larger (roughly intermediate in size between that of *P. nigra* and those from the type series of *P. iangauldi*), and the metapleuron is distinctly strigose in this specimen. Although considered a member of this species, it is not included as a paratype because of this variation. The following additional variation was noted among members of the type series: in one female, the flagellum is brown basally rather than orange, the epicnemial carina does not extend dorsally to the level of the ventral corner of the pronotum in several specimens, and in the left wing of one of the females, Cu1 is 1.15 times longer than cu-a. The female paratype from Canberra has a slightly different color pattern than the series from Murrumbeena, but unlike the specimen from Bright, sculpture and venation are the same and it is therefore included in the paratype series to emphasize color variation in this species. In the Canberra specimen, all terga of the gaster are black medially, face and clypeus are brownish yellow medially, fore and mid coxae are orange ventrally, and first 32 flagellomeres are orange.

One male specimen lacks a fore wing areolet in both wings. In the left wing, it is easier to see that that the absence of an areolet is due to the fusion of 2rs-m and 3rs-m rather than the loss of one or the other of these. This suggests that within *Pergaphaga*, at least, there is a trend toward gradual loss of the areolet through reduction in size and fusion of the adjacent cross veins.

The first two labels on the paratype from Windsor are handwritten. The first is difficult to read, with the month, day, and locality legible, but the remainder difficult to decipher and possibly misinterpreted. The second label is completely illegible. This and the specimen from Bright bear Pergaphaga det. labels by I. D. Gauld dated 1984.

The paratype from Canberra is also the voucher specimen for the *Pergaphaga* sequence reported in Quicke et al. (2009).

This species is named for Ian Gauld for his significant contribution to the understanding of this genus and the Westwoodiini in general.

Pergaphaga leaski **Wharton, sp.n.**
urn:lsid:zoobank.org:act:20C7D974-B61E-4870-879A-EA0F7D055435
Figs 7, 11, 19, 26, 34, 39, 43

Type locality. Australia, Victoria, Ballarat, -37.567S,143.850E

Type material. Holotype. Female (BMNH), with handwritten labels as follows: "Bred. from. larvae./ 25-iv-1959/ No. 537. P." "Australia./ Victoria./ Ballarat./ M.F. Leask." "Glen. Park. S.F./ at. Wayne's./ Sawfly/larvae." "adult.recog. Leask./ pergagrapta ♂/gravenhorstii/ Westwood.1880" "Pergaphaga/ det. I.D. Gauld, 1984" [partially printed] "HOLOTYPE/ Pergaphaga/ leaski/ Wharton" [red, handwritten]

Paratypes: 2 females, same data as holotype (BMNH); 1 female, 1 male, same data except 1.VII.1959 and without Glen Park label. All paratypes have an additional British Museum 1959–460 accession label.

Description. Female (Figs 7, 11). *Length of body* (exclusive of antenna) 10.7mm; of fore wing 10.2–11.9mm; of antenna 12.5–14.8mm.

Head. Clypeus (Fig. 19) 2.7 times as broad as long; weakly and evenly convex in profile, very weakly thickened at lateral margin; ventral margin broadly truncate, slightly thickened; surface punctate on weakly shagreened background, punctures separated from one another by their diameter; epistomal sulcus distinct. Malar space 0.45–0.50 times basal width of mandible, granular-matt. Gena as in *P. iangauldi*, distinctly punctate. Face (Fig. 19) deeply and densely punctate laterally, granular rugose medially, surface distinctly undulating as in *P. iangauldi*. Frons lacking distinctly elevated interantennal flange of *P. nigra* (Figs 23, 26), with a low short, weak, median carina; frons distinctly elevated adjacent eye, elevated area punctate, frons otherwise flat; surface polished immediately behind scape, densely granular on flat portion between ocellar field and eye. Antenna with 39–41 flagellomeres; first flagellomere 1.2 times longer than second, 3.3–3.6 times longer than wide, second flagellomere 2.8–3.0 times longer than wide, tenth 2.0–2.6 times longer than wide; tyloid of first flagellomere large, oval, extending 0.35–0.40 length of first flagellomere.

Mesosoma. Pronotum punctate laterally on shagreened background, punctation slightly less dense than in *P. nigra* and *P. iangauldi*, punctures separated by 1.0–1.5 times their diameter. Mesopleural depression more sparsely punctate ventrally than in *P. nigra* and *P. iangauldi*, punctures widely separated, not coalescing medially to form either strigose or rugulose sculpture; rounded lobe forming anterodorsal margin of mesopleural depression with similarly large, well-spaced punctures. Scutellum slightly more finely punctate than in *P. nigra* and *P. iangauldi*. Posteromedian plate of metanotum polished, varying from distinctly punctate anteriorly to sparsely, indistinctly punctate throughout. Metapleuron medially finely granular-matt and sometimes weakly punctate. Propodeum weakly convex in profile, anterior and posterior fields not differentiated; base of propodeum, on either side of median depression, smooth, polished (Fig. 34); pleural carina incomplete: sharply defined anteriorly, extending to propodeal spiracle, usually absent posteriorly; anterior transverse carina not distinguishable from surrounding narrow band of transverse ridges; distinctly arched lateral portion of posterior transverse carina and posterior portion of lateral longitudinal carina forming apicolateral area similar to but usually weaker than in *P. iangauldi*, junction of lateral longitudinal and posterior transverse carinae not tuberculate. Hind basitarsus 10.6–12.0 times longer than wide. Fore wing areolet very small, triangular, petiolate above, the stalk equal to length and longer than width of areolet (Fig. 39); 2m-cu arising near but distad middle. Hind wing with 1st abscissa of Cu1 0.75–0.85 times length of cu-a; cu-a reclivous.

Metasoma. Petiole with S1 extending to level of spiracle. Apical 0.3–0.4 of postpetiole (posteriad spiracle) sparsely punctate and setose. T2 mostly bare and polished, with a few scattered punctures and a patch of short setae posterolaterally. T3 and T4 extensively setose and very faintly punctate, T4 somewhat uniformly setose, T3 decidedly less so, especially posteromedially.

Color (Figs 7, 11, 19, 43). Mostly black, antenna dark brown to black; mandible (except dark apical teeth), broad orbital bands on face extending onto anterior part of frons, at least lateral corners of clypeus, lower gena, tibia and tarsi of fore and mid legs, and tarsomeres 2–4 of hind legs bright yellow; tegula, trochanters, trochantelli, and femora of fore and mid legs darker yellow; trochanter, trochantellus, femur, and apical tarsomere of hind leg orange, hind tibia orange brown basally becoming orange over distal 0.25, hind basitarsus orange brown basally, yellow over distal 0.25; postpetiole, except along lateral margins, and entire gaster orange; middle of gena with small, dark reddish brown spot posteriorly.

Male. About as in female, but only known specimen in poor condition.

Distribution and biology. Known from a single series of specimens reared from *Pergagrapta gravenhorstii* (Westwood) in Ballarat, Victoria.

Diagnosis. This species is readily recognized by the combination of orange gaster and entirely dark antenna. As in the larger-bodied *P. iangauldi*, an elevated median flange is absent on the frons. As noted above, *P. iangauldi* also has a more heavily sculptured mesopleuron than *P. leaski*.

Remarks. There is some minor variation in color in the type series. The clypeus is mostly reddish brown in the holotype but extensively yellow in the paratypes, with a small reddish brown spot dorsomedially.

The species is named for Maurice Leask, who reared numerous westwoodiines from various pergid sawflies, including all of the members of the type series. This species is referred to as *Pergaphaga* sp. 1 in Gauld (1984).

Pergaphaga xanthops Wharton, sp.n.

urn:lsid:zoobank.org:act:63AFE351-ADC6-48FF-A095-93601A1D9691
Figs 8, 12, 20, 22, 25, 30, 40, 44

Type locality. Australia, ACT, Canberra, -35.283S, 149.217E

Type material. Holotype. Female (ANIC), with labels as follows: “Canberra ACT/ 11 Apr 1958/ E F Riek” [printed] “Pergaphaga/ det. I.D. Gauld, 198” [partially printed] “HOLOTYPE / Pergaphaga/ xanthops/ Wharton” [red, handwritten]

Paratypes: 1 female, same data as holotype except 15.IV.1958 (BMNH); 1 male, New South Wales, Dainers Gap, 36.12S, 148.43E, 1585 m, 6.III.1974, P Morrow, *Eucalyptus pauciflora*, *stellulata*, and *perriniana* forest, Ex *Eucalyptus pauciflora* (ANIC).

Description. Female (Figs 8, 12). *Length of body* (exclusive of antenna) 10.7–11.0mm; of fore wing 9.7–10.5mm; of antenna 12.0–12.8mm.

Head. Clypeus (Fig. 20) 2.5–2.6 times as broad as long; weakly and uniformly convex to nearly flat in profile; ventral margin broadly truncate to very weakly concave, broadly but weakly thickened medially; surface punctate on weakly shagreened background, punctures deep, separated from one another by their diameter dorsally, nearly coalescing ventrally; epistomal sulcus distinct. Malar space 0.40–0.45 times basal width of mandible, shagreened or polished, punctate near mandible, weakly granular near eye. Gena weakly to distinctly shagreened and punctate ventrally, polished or nearly so dorsally, punctures separated by 0.5–1.0 times their diameter ventrally, more finely punctate dorsally with punctures 1–2 times their diameter. Face (Fig. 20) deeply punctate laterally, densely granular punctate to granular rugose medially, surface very slightly undulating transversely, weakly elevated medially, weakly depressed near ventrolateral margin of toruli, nearly flat between anterior tentorial pit and eye. Frons with median flange (Fig. 22) extending posteriorly beyond posterior margin of toruli, indistinctly bifurcating posteriorly, the resulting depressions between flange and toruli polished; frons rugose between posterior end of flange and median ocellus, strigose and finely granular to partly polished on flattened portion between ocellar field and eye, punctate on weakly elevated portion between antenna and eye. Antennal flagellum with 36 flagellomeres; first flagellomere 1.1 times longer than second, 3.1 times longer than wide, second flagellomere 2.6 times longer than wide, tenth 2.2 times longer than wide; tyloid of first flagellomere large, oval, extending 0.4 length of first flagellomere.

Mesosoma. Pronotum laterally densely punctate around margins, finely granular-matt to granular rugulose medially. Mesopleural depression more densely punctate ventrally (Fig. 30) than in *P. leaski*, but punctures discrete, not coalesing to form either strigose or rugulose sculpture as in *P. nigra*, and anteroventrally as in *P. iangauldi*; rounded lobe forming anterodorsal margin of mesopleural depression very finely, densely punctate, the punctures discrete but often touching or nearly so. Scutellum finely punctate. Posteromedian plate of metanotum sparsely punctate, polished. Metapleuron medially granular-matt. Propodeum weakly convex in profile, anterior and posterior fields very weakly differentiated; base of propodeum, on either side of median depression, smooth, polished (as in Fig. 34); pleural carina incomplete in one specimen, complete in the other: sharply defined anteriorly, extending to propodeal spiracle, absent or very weak posteriorly; anterior transverse carina not readily distinguishable within band of transversely strigose sculpture; posterior portion of lateral longitudinal carina arched medially to form nearly complete apicolateral area with portions of posterior transverse carina, junction of lateral longitudinal and posterior transverse carinae not tuberculate. Hind basitarsus 11.6–14.0 times longer than wide. Fore wing areolet absent (Fig. 40). Hind wing with 1st abscissa of Cu1 0.70 times length of cu-a; cu-a reclivous.

Metasoma. Petiole with S1 almost extending to level of spiracle. Apical 0.5 of postpetiole (posteriad spiracle) sparsely punctate and setose. T2–4 very faintly punctate; T2 setose throughout, T3 and T4 with a few, scattered setae medially, sparsely setose laterally.

Color (Figs 8, 12, 20, 44). Mostly dark brown to black; mandible (except dark apical teeth), face (except small triangle extending anteriorly from between antennae), clypeus, malar space, broad band on gena adjacent eye, fore and mid legs (except coxae and apical tarsomere), and subapical flagellomeres 19–31 bright yellow; mid and hind coxae dark brown dorsally, brown ventrally, fore coxa partly yellow ventrally; hind legs distad coxa light yellow brown, a little darker dorsally, with hind basitarsus and apical tarsomeres on all legs a little darker; gaster and apical margin of petiole orange.

Male. Essentially as in female except as follows: Clypeus punctate, polished, without shagreened sculpture; antenna with 39 flagellomeres; face with black vertical band, the band narrower than adjacent yellow orbital bands; frons more polished, with less extensive rugose sculpture medially between median ocellus and most elevated portion of flange; apical flagellomere weakly infumate, otherwise yellow from flagellomere 19 to apex.

Distribution and biology. Australia; known only from ACT and a nearby locality in NSW. *Eucalyptus pauciflora* is listed on the label as the host plant for the male paratype from NSW. Morrow et al. (1976) collected four species of Perginae (Pergidae), representing four different genera, from this plant host at this locality. It is unclear from the label data whether this specimen was reared or simply collected from this plant, but no parasitoid rearings were indicated in Morrow et al. (1976).

Diagnosis. This species is readily recognized by the absence of a fore wing areolet and the bicolored antenna which is dark basally and pale apically/subapically. As in *P. nigra* and unlike the other two species, there is an elevated, Y-shaped flange extending between the antenna and onto the frons in *P. xanthops*.

Remarks. The apical teeth of the mandible are slightly shorter and more bluntly rounded in this species relative to the other three. This may be due to wear, however, as indicated by slight variation in size and shape of the teeth in the longer series of *P. nigra* available for study. Additionally, the epipleura are not as fleshy in appearance in this species as they are in *P. nigra* and *P. iangauldi*. It is difficult to determine whether this is a true difference or a preservation artifact. The epicnemial carina is also weaker in this species than in the other three, and the dorsal extent is particularly difficult to discern. The clypeus appears somewhat different in shape when Fig. 20 is compared to the figures of the other three species shown on the same plate. This is almost entirely due to the angle of view, with the face angled more ventrally in Fig. 20.

The underlying sculpture of the female paratype is not as finely granular or shagreened as it is in the holotype. This is especially noticeable on the malar space, lower gena and area extending between the eye and ocellar field.

The species name is in reference to the extensively yellow face of the females.

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RESEARCH ARTICLE

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The bee genus *Caenaugochlora* (Hymenoptera, Apoidea) and its constituent subgenera, with new species of *Caenaugochlora* s.str. from Ecuador

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Abstract

Two new species of *Caenaugochlora* Michener are described and figured from Ecuador. *Caenaugochlora quichua* **sp. n.** and *C. bennetti* **sp. n.** are both remarkable for the presence of carinate preoccipital carinae, setose compound eyes, strongly rimmed metabasitibial plate, normally pectinate inner metatibial spur, metapostnotal striae not reaching the apical margin, and the male fourth metasomal sterna with lateral projections. The combination of these features intermingle attributes of the presently recognized subgenera, while others are unique to the genus as a whole. A revised diagnosis is provided for the genus and its two subgenera, with *Caenaugochlora* s.str. accommodating *C. bennetti* and *C. quichua*, and brief comments made regarding the implications of the characters exhibited by the aforementioned species.

Keywords

Hymenoptera, Apoidea, Anthophila, Augochlorini, *Caenaugochlora*, taxonomy, Ecuador, Halictidae

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Introduction

Caenaugochlora was proposed by Michener (1954) for *Augochlora*-like bees with setose compound eyes, as a replacement for *Caenohalictus* Cameron which had been misapplied at the time various unrelated bees. Michener based his description on a pectinate inner metatibial spur, reduced preoccipital carina, setose compound eyes, and the fourth metasomal sternum with a medioapical notch bordered by areas with specialized setae. At that time Michener (op. cit.) included *Pseudaugochlora* Michener as a second subgenus but subsequent authors have considered the group as a separate genus (Eickwort 1969; Engel 2000; Michener 2007; *vide* Almeida 2008, for a comments regarding *Pseudaugochlora*). Later, Eickwort (1969) described the subgenus, *Ctenaugochlora*, to include a distinctive species related to *Caenaugochlora*. He considered *Caenaugochlora* proper to include those species with the fourth metasomal sternum with one or two median patches of setae on raised tubercles to either side of a medioapical depression, while *Ctenaugochlora* was described for a species with a densely pectinate inner metatibial spur, a metabasitibial plate only defined posteriorly, and the male fourth metasomal sternum with a V-shaped patch of setae bordering a slight median depression. Engel (2000) updated the number of species of both genera and diagnosed the subgenera of *Caenaugochlora* based on the same characters.

Moure (2007) listed 15 described species for *Caenaugochlora* s.str., while Engel (2007, 2009a) added two additional species and removed another to elsewhere in the Augochlorini. Species of *Caenaugochlora* s.str. described to date occur in México to Ecuador (Table 1), although unstudied and undetermined material is known from Nicaragua, Venezuela, and Trinidad. *Ctenaugochlora* presently includes five species in Costa Rica and Panamá, with a single putative record from Bolivia (Engel and Gonçalves, in press). Nothing is known about their natural history except for the ground-nesting biology and semisocial behavior of *C. costaricensis* described by Michener and Kerfoot (1967).

The purpose of the present study is to describe two new species of *Caenaugochlora* s.str. from Ecuador which have diagnostic characteristics of both subgenera as currently recognized and share a peculiar structure of the fourth metasomal sternum, different from that of other *Caenaugochlora* s.l. Both species may prove critical for illuminating the phylogenetic placement of *Caenaugochlora* s.l. among Augochlorini.

Methods

Material considered herein is deposited in the following institutions: Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (**MZSP**) and Snow Entomological Collection, Division of Entomology, University of Kansas Natural History Museum, Lawrence, Kansas, USA (**SEMC**). Quotation marks surround exact transcriptions of individual labels, while the reverse solidus (\) indicates different lines on the same la-

Table 1. Knwon records for *Caenaugochlora* s.str. species.

Species	Known records						
	México	Guatemala	Honduras	Costa Rica	Panamá	Colombia	Ecuador
C. aequilanx (Vachal)	X						
C. chaetops (Vachal)	X						
C. cupriventris (Vachal)	X						
C. flagrans (Vachal)	X						
C. fulgur (Vachal)	X						
C. inermis (Vachal)	X						
C. tonsilis (Vachal)	X		X				
C. amatitlana (Cockerell)		X	X				
C. gemmella (Cockerell)		X		X			
C. wilmattae (Cockerell)		X	X				
C. cyanella Engel			X				
C. costaricensis (Friese)				X			
C. elisabethae Engel				X	X		
C. macswaini Michener					X		
C. jeffreyi Engel						X	
C. silvicola Engel							X
C. bennetti sp. n.							X
C. quichua sp. n.							X

bel. Morphological terminology follows that of Eickwort (1969) and Michener (2007) except in that, following Engel (2001), we use “mesoscutum” in place of “scutum” and a revised venational nomenclature. In addition, we here use “metapostnotum” for the “basal area of the propodeum” and following Engel (2009b) we refer to the “teeth” of the pectinate spurs as “branches”. Species descriptions loosely follow those of Engel (1997, 2007), while generic and subgeneric diagnoses and descriptions follow that of Engel (2000), with new interpretations of particular characters as revealed by the new species described herein highlighted in bold.

Systematics

Genus *Caenaugochlora* Michener

Diagnosis. Most species of *Caenaugochlora* are similar in general appearance to those of the genus *Pseudaugochlora*; however, the latter genus has a strong ridge on the vertex and a pointed galeal apex. From the related genus *Augochloropsis*, *Caenaugochlora* differs in the absence of a notch on the tegula, the non-lamellate pronotal dorsal ridge, and the orthogonal epistomal sulcus.

Description. *Female*: Mandible with subapical tooth variously defined. Labral distal process narrowly triangular; basal elevation orbicular; teeth absent. Prementum not greatly elongate. Galeal apex rounded; galeal comb absent; galeal base extending to stipital base. Hypostomal ridge carinate; anterior angle rounded. Length of malar space less than basal mandibular width except in *C. silvicola* malar space as long as basal mandibular width. Epistomal sulcus orthogonal. Ocelli not greatly enlarged; ocellar furrow absent. Vertex not expanded or ridged behind ocelli. Preoccipital ridge **sharply** angled or carinate. Pronotal dorsal ridge carinate; lateral ridge rounded to carinate. Mesoscutal anterior border rounded; mesoscutal lip rounded. Tegula oval. Probasitarsal brush present; inner metatibial spur pectinate. Apex of marginal cell truncate; distal hamuli with irregular spacing pattern. Propodeal pit narrow. *Male*: Mandible simple. Labrum with distal process narrowly triangular as in the female; basal area notched. Antennae extending back to mesoscutellum; second flagellomere about as long as first flagellomere. Inner metatibial spur serrate. Metasoma oval. Apical margin of metasomal sternum III variable, straight, arcuate, or notched; apical margin of metasomal sternum IV variable, lateral projections present or not; apical margins of metasomal sterna V and VI emarginate; apical margin of metasomal sternum VII with median projection; spiculum narrow; proctiger unmodified. Gonobasal bridge narrow; dorsal lobes weak; basal process of gonostylus and parapenial lobe present or absent; dorsal process partly membranous; ventral surface of penis valve with prong.

Subgenus *Caenaugochlora* Michener

Caenaugochlora Michener, 1954: 76. Type species: *Caenaugochlora macswaini* Michener, 1954, original designation.

Diagnosis. *Caenaugochlora* s.str. is distinguished from *Ctenaugochlora* by the normal pectination of the inner metatibial spur (with less than 10 long branches), frequent presence of long compound eye setae, strong anterior border of the metabasitibial plate, and metapostnotal striae not reaching to the apical margin.

Description. As for the genus with the following additions: *Female*: Compound eyes usually with long setae. Preoccipital ridge carinate (as in *C. macswaini*) or sharply angled (most species). Pronotal lateral angle usually produced, angle slightly acute to obtuse. Metabasitibial plate bordered anteriorly and posteriorly; inner metatibial spur pectinate. Metapostnotum with basal striae, not reaching apical margin. *Male*: Apical margin of metasomal sternum III variable, straight, arcuate, or notched; apical margin of metasomal sternum IV variable, straight to notched with some apical setal patches surrounding medial notch; lateral projections present or not; apical margin of metasomal sternum VIII with median projection, sometimes bilobed at apex. Volsella indented on inner margin (except in *C. bennetti* sp. n.).

Distribution. Species of *Caenaugochlora* s.str. occurs from México to Ecuador, including Venezuela and Trinidad.

Caenaugochlora (_Caenaugochlora_) _bennetti_, sp. n.
urn:lsid:zoobank.org:act:FB2CE682-B684-4BFF-BF1C-F27ADECB83BD
Figs 1, 3, 5, 7, 9, 11, 13

Holotype. ♂, "Ecuador:\ 3 mi. W. of Paute, Azuay\ 17-II-1965" "E.I. Schlinger\ & E.S. Ross\ collectors " (SEMC).

Paratypes. 3♂♂, 1♀, with same label data as that of holotype; 2♂♂, 1♀ (SEMC) and 1♂, 1♀ (MZSP) labeled, "Ecuador, Cuenca\ Azuay Prov.\ III-13-1965" "L.E. Pena\ collector".

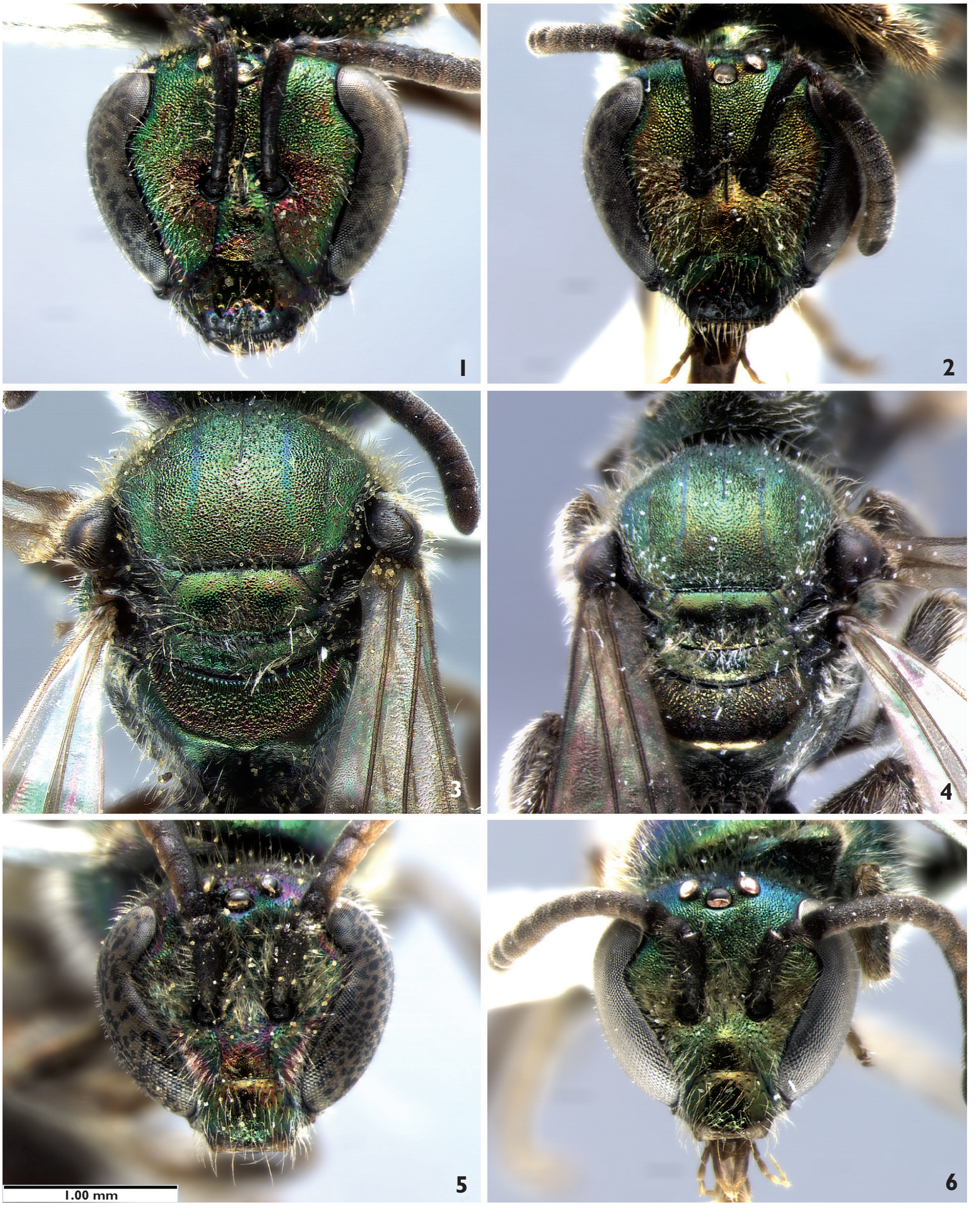
Diagnosis. Both sexes with preoccipital ridge carinate; female metabasitibial plate well rimmed; female metapostnotum with striations weakly reaching posterior margin where they become difficult to discern among strongly granular integument (Fig. 3); male face almost straight above antennal alveoli, setae on this portion long and weakly branched; apical margin of metasomal sternum III not notched; apical margin of metasomal sternum IV straight, subapical margin with a distinct median patch of erect setae, length of lateral projections less than sternum length (Fig. 7).

Description. *Female*: Total body length 7.0 mm; forewing length 5.2 mm; distance between compound eye notches 1.3 mm; maximum head length 1.7 mm; intertegular distance 1.33 mm. Head slightly triangular (Fig. 1); mandible with weak subapical tooth; malar space very short, less than basal mandibular width; compound eyes with minute setae; preoccipital ridge carinate. Mesoscutum anterior border slightly acuminate. Inner metatibial spur pectinate, with four branches excluding apical portion of rachis. Forewing with 1m-cu confluent with 1rs-m; maximal length of third submarginal cell more than twice maximal length of second submarginal cell. Metapostnotum as long as mesoscutellum, broadly rounded posteriorly. Metasoma broadly rounded; terga not depressed; sterna unmodified.

Head punctate, punctures contiguous on upper parocular area, those punctures on frons stronger than elsewhere on face. Mesoscutum densely punctate, punctures irregular in diameter, contiguous around parapsidal lines and posteriorly, separated by less than a puncture width centrally, blending to strongly imbricate integument medioanteriorly. Mesepisternum densely punctate and rugulose. Metapostnotal striations longitudinal and partly irregular, striations covering entire surface, apically weaker and difficult to discern among strongly granular integument (Fig. 3). Metasomal terga lineolate with small puncures, those of tergum I smaller in diameter than those on other terga.

Integument of head and mesosoma brilliant metallic green with some cupreous reflections. Mandible, labrum, malar space, and apical one-half of clypeus dark brown; antenna, all leg podites, tegula, and sterna light brown. Wing veins brown; membrane lightly fuscous. Terga mostly brilliant metallic green with small brown areas on median surface of metasomal terga I and II, apical marginal areas translucent brown, abruptly demarcated from remainder of terga.

Pubescence on head, mesosoma, and sterna pale yellow, on legs dark amber, on terga light amber. Setae short on terga, long and erect on sterna; metasomal sternum II and III with long setae with recurved apices.



Figures 1–6. Face and mesosoma of new species of *Caenaugochlora* (*Caenaugochlora*). **1** Facial aspect of *Caenaugochlora* (*C.*) *bennetti*, sp. n., female **2** Facial aspect of *C.* (*C.*) *quichua*, sp. n., female **3** Female mesosoma of *C.* (*C.*) *bennetti*, sp. n. **4** Female mesosoma of *C.* (*C.*) *quichua*, sp. n. **5** Facial aspect of *C.* (*C.*) *bennetti*, sp. n., male **6** Facial aspect of *C.* (*C.*) *quichua*, sp. n., male (scale bar = 1 mm).

Male: as described for female except as follows: Total body length 6.0 mm; forewing length 4.8 mm; distance between compound eye notches 1.2 mm; maximum head length 1.8 mm; intertegular distance 1.1 mm. Head longer than wide; not strongly depressed (Fig. 5). Mesoscutal median line well impressed. Metapostnotum as long as mesoscutellum, slightly depressed. Lateral projection of metasomal sternum IV as long as sternum length (Fig. 7); metasomal sternum VI strongly emarginate; metasomal sternum VII and VIII as depicted in Figure 9; genital capsule as depicted in Figure 11.

Clypeus and supraclypeal area with fewer punctures than lower parocular area, with imbricate microreticulations. Mesoscutum strongly punctate, punctures separated by less than a puncture width, integument between (where perceptible) with imbricate microreticulations. Metapostnotal striae dense, almost entirely longitudinal, extending along entire surface, weaker apically and difficult to discern among strongly granular integument. Terga irregularly punctuate and lineolate.

Integument of head and mesosoma brilliant metallic green with some dark reflections. Apical margin of clypeus narrowly pale amber. Coxae to femora with metallic highlights, tibiae and remaining podites dark amber. Metasoma entirely brown.

Pubescence on face long and plumose, especially above supraclypeal area. Lateral projection of metasomal sternum IV bearing four setae at apex, sternal apical margin with a central patch of setae (Fig. 7). Genital capsule as depicted in Figure 11.

Etymology. The specific epithet is a patronym honoring Mr. Daniel J. Bennett, leading student of the systematics of crabronine wasps.

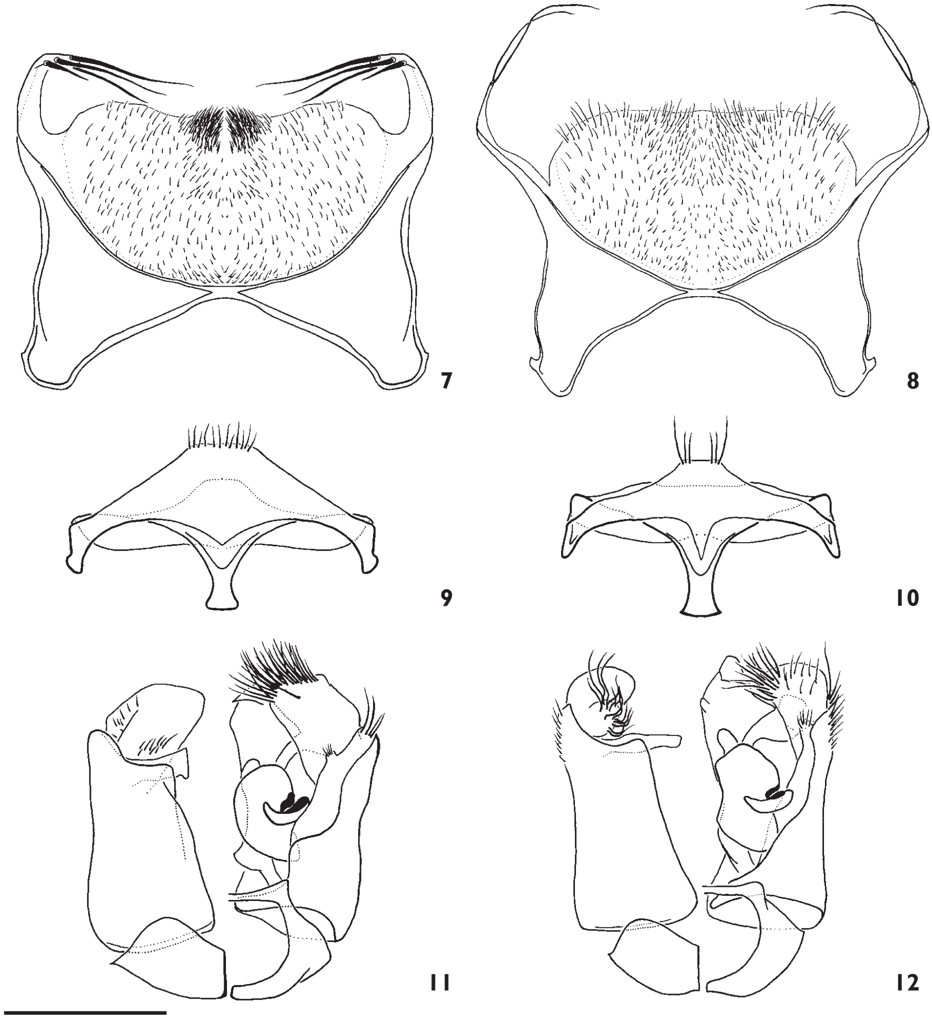
***Caenaugochlora* (*Caenaugochlora*) *quichua*, sp. n.**
urn:lsid:zoobank.org:act:749D7746-D785-4090-84E5-7EB5F00881F9
Figs 2, 4, 6, 8, 10, 12, 13

Holotype. ♂, "Ecuador: Pich\ above Tandapi, 8 Feb.\ 1983, 2300m, Masner\ Sharkey" (SEMC).

Paratypes. 1♀, 2♂♂, with same label data as holotype (SEMC); 1♂♀, with same label data as holotype (MZSP); 1♀, "Ecuador, Imbaura:\ N. Perucho near\ Otavalo, I-7-1971\ 2000 m., L. Pena" (SEMC).

Diagnosis. Both sexes with preoccipital ridge carinate; female metabasitibial plate well rimmed; female metapostnotum with striations not reaching the posterior margin; male face concave above the antennal alveolus with a stripe of short, strongly plumose setae; medioapical margin of metasomal sternum III not notched; apical margin of metasomal sternum IV straight, subapical margin with pubescence distributed as on metasomal sternum III, lateral projections, including setae, as long as sternum.

Description. *Female*: Total body length 5.95 mm; forewing length 4.6 mm; distance between compound eye notches 1.17 mm; maximum head length 1.55 mm; intertegular distance 1.2 mm. Head rounded (Fig. 2); mandible with weak subapical tooth; malar space very short, less than basal mandibular width; compound eyes with minute setae; preoccipital ridge carinate. Mesoscutum anterior border slightly acuminate. Inner metatibial spur pectinate, with three branches excluding apical portion of rachis. Forewing with 1m-cu confluent with 1rs-m; maximal length of third



Figures 7–12. Male sterna and genital capsule of new species of *Caenaugochlora* (*Caenaugochlora*). **7** Metasomal sternum IV of *Caenaugochlora* (*C.*) *bennetti*, sp. n. **8** Metasomal sternum IV of *C.* (*C.*) *quichua*, sp. n. **9** Metasomal sterna VII and VIII of *C.* (*C.*) *bennetti*, sp. n. **10** Metasomal sterna VII and VIII of *C.* (*C.*) *quichua*, sp. n. **11** Genital capsule of *C.* (*C.*) *bennetti*, sp. n. **12** Genital capsule of *C.* (*C.*) *quichua*, sp. n. (scale bar = 0.5 mm).

submarginal cell less than two times maximal length of second submarginal cell. Metapostnotum as long as mesoscutellum, broadly rounded posteriorly. Metasoma broadly rounded; terga not depressed; sterna unmodified.

Head punctate, punctures contiguous in upper parocular area and on frons, imbricate microreticulations evident. Mesoscutum granular, punctures irregularly distributed with microreticulations evident among punctures. Mesepisternum more granular than mesoscutum. Metapostnotal striations irregular, extending to two-thirds length, remainder of surface strongly imbricate (Fig. 4). Terga lineolate with small punctures, those on terga III–V with greater diameter.

Integument of head and mesosoma brilliant metallic green with some dull blue reflections. Mandible, labrum, malar space, and apical one-half of clypeus dark brown; antenna, all leg podites, tegula, and sterna light brown. Wing veins brown; membrane lightly fuscous. Terga mostly brilliant metallic green with some dark brown areas on median surface of discs, apical marginal areas blending to translucent brown.

Pubescence on head, mesosoma, and metasomal sterna pale yellow; setae on legs dark amber, on terga light amber; setae short on terga, long and erect on sterna; sternum II with long setae with recurved apices.

Male: as described for female except as following: Total body length 5.82 mm; forewing length 4.4 mm; distance between compound eye notches 1.1 mm; maximum head length 1.62 mm; intertegular distance 1.0 mm. Head longer than wide (Fig. 6); surface between supraclypeal area and frons depressed. Mesoscutal median line well impressed. Metapostnotum longer than mesoscutellum, with depressed striate surface. Metasomal sternum IV with lateral projections longer than sternum length (Fig. 8); metasomal sternum VI strongly emarginate; metasomal sterna VII and VIII as depicted in Figure 10; genital capsule as depicted in Figure 12.

Clypeus and supraclypeal area with few punctures, without evident microreticulations. Mesoscutum sparsely punctate, punctures fine and separated by more than three times a puncture diameter. Metapostnotal striae mostly longitudinally oriented, forming a triangle of ornamentation, not reaching posterior border, especially at corners. Terga finely punctate.

Integument of head and mesosoma brilliant metallic green with some blue reflections. Apical border of clypeus yellow. Coxae to femora with metallic highlights, tibiae brown, remaining podites light brown. Metasoma entirely dark brown.

Depressed surface of head with short, dense, plumose setae. Projection of metasomal sternum IV bearing long setae, apical margin not bearing short specialized setae. Genital capsule pubescence as depicted in Figure 12.

Etymology. The specific epithet is a noun in apposition and honors the Native American language Quichua, still spoken today in the Andes.

Subgenus *Ctenaugochlora* Eickwort

Caenaugochlora (*Ctenaugochlora*) Eickwort, 1969: 435. Type species: *Neocorynura perpectinata* Michener, 1954, monobasic and original designation.

Diagnosis. Refer to the diagnosis for *Caenaugochlora* s.str. (*vide supra*).

Description. As for the genus with the following additions: *Female*: Compound eyes with minute setae. Preoccipital ridge carinate. Pronotal lateral angle not produced, obtuse. Metabasitibial plate bordered posteriorly, margin obsolete anteriorly; inner metatibial spur densely pectinate, with more than 10 long branches. Metapos-

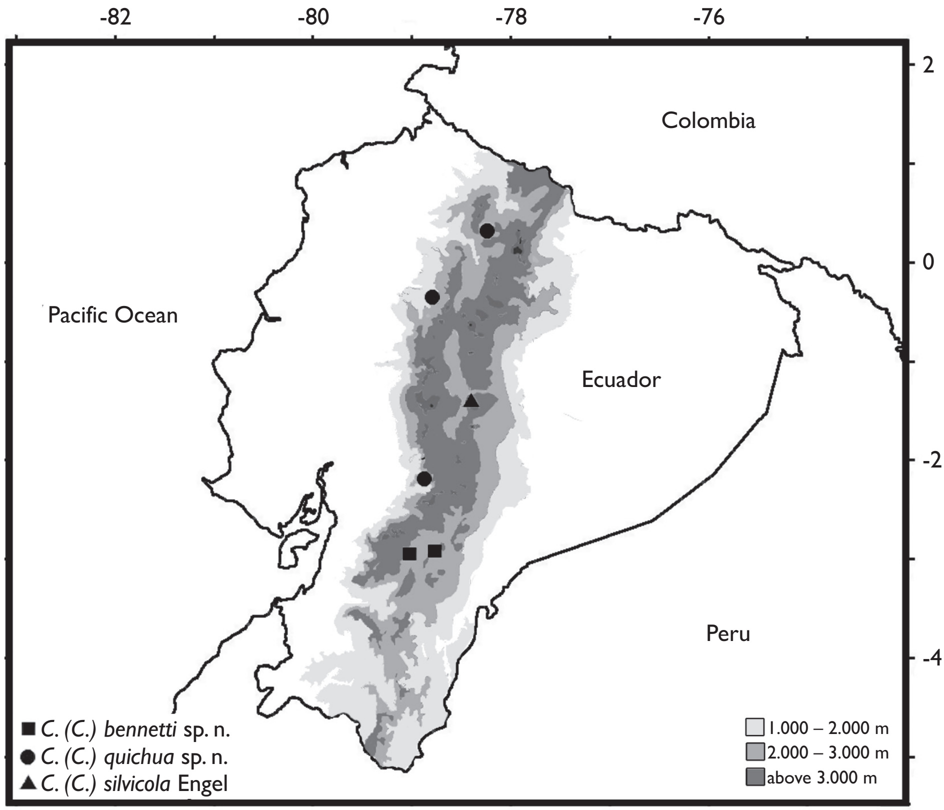


Figure 13. Distribution map of known *Caenaugochlora* s.str. from Ecuador.

tnotum with strong striae radiating from basal margin to apex. *Male*: Apical margin of metasomal sternum IV concave, with dense triangular setal patch, patch not raised on tubercles; apical margin of metasomal sternum VIII unmodified. Inner margin of volsella rounded.

Distribution. Species occur predominantly in Costa Rica and Panamá, with a single putative record from Bolivia (Engel and Gonçalves in press).

Discussion

Neither *C. bennetti* nor *C. quichua* fit precisely the description of either subgenus in *Caenaugochlora*. Both species are unique among the genus by combining setose compound eyes, a carinate preoccipital ridge, and male fourth metasomal sternal projections. As previously understood, the carinate preoccipital ridge is presently only in species of *Ctenaugochlora*, while in *Caenaugochlora* s.str. the ridge is distinctly sharply angled but not carinate. On the other hand the setose compound eyes and metapostnotal ornamentation (not radiating) are typical of *Caenaugochlora* s.str. The body shape and size is reminiscent of small *Caenaugochlora* s.str. such as *C. gemmella* and *C. macswaini* both from southern Central America. Lastly, the presence of a broad parapenial lobe and the lateral projections of the fourth metasomal sterna are unique among *Caenaugochlora* s.l. Both subgenera can have median patches of setae on the fourth metasomal sternum which are frequently associated with a median notch, while the third metasomal sternum is also frequently notched and bears setae. The distribution of characters may suggest that they are sister to *Ctenaugochlora* but they may also represent a basal branch of the genus. Rather than create a third subgenus we chose to alter the delimitation of *Caenaugochlora* s.str. to provisionally include these new species. Together these species may prove important for understanding the phylogeny of *Caenaugochlora*, particularly given that the lateral projections of the male fourth metasomal sterna are similar to those found in *Augochloropsis* Cockerell, *Augochlorodes* Moure, *Neocorynura joannisi* (Vachal) and *Thectochlora* Moure. These projections in *Caenaugochlora* are formed by sclerotized extensions of pregradular and postgradular areas as present in some *Augochloropsis* (*vide* Eickwort 1969: 468, Figs 243, 244). For species of *Thectochlora, Augochlorodes turrifaciens* Moure (Eickwort 1969: 469, Figs 248, 249) and *N. joannisi* (Smith-Pardo & Gonzalez 2009: 120, Fig. 13) the projections are formed principally by extension of postgradular integument, while pregradular integument does not extend along the projection. This trait may favor Engel's (2000) cladistic hypothesis in which *Augochloropsis* s.l. and *Caenaugochlora* s.l. were sister taxa. Modifications of the male sterna, especially those on the fourth sternum, are common in halictines (Michener 2007) and such lateral projections can often be convergent. Further cladistic work is needed in order to more thoroughly evaluate the precise relationship of these new species and their implications for understanding affinities of *Caenaugochlora* s.l.

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RESEARCH ARTICLE

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A revision of *Ganaspidium* Weld, 1952 (Hymenoptera, Figitidae, Eucoilinae): new species, bionomics, and distribution

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Abstract
The New World eucoiline genus *Ganaspidium* is revised. Species in this genus are parasitoids of some of the most pestiferous species of leaf-mining Agromyzidae (Diptera), including the notorious *Liriomyza trifolii* (Burgess). The following new species are described: *Ganaspidium didionae*, *G. eldiablo, G. flemingi*, *G. kolmaci,* and *G. konzaensis*. *Ganaspidium navajoe* (Miller), **comb. n.**, is recognized as junior synonym of *G. pusillae* Weld (**syn. n.**). *Ganaspidium nigrimanus* (Kieffer) and *G. utilis* Beardsley are removed from synonymy, and together with *G. hunteri* (Crawford), are now in *Banacuniculus* Buffington. Species of *Ganaspidium* are recorded from a wide geographic area within North America, and several species appear to be adapted to arid environments. New distribution data, new host records, and a key to known species are provided.

Keywords
Eucoilinae, *Liriomyza*, Agromyzidae, new species, genus revision, species revision, parasitoid

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Introduction

Weld (1955) established the genus *Ganaspidium* to accommodate the type species *G. pusillae* Weld (Hymenoptera: Figitidae: Eucoilinae) based on specimens sent to the United States National Museum (USNM) from the 'Winter Garden Area' of Texas. This species was reared as a koinobiont endoparasitoid (Godfrey, 1994) of the leaf miner *Liriomyza pusilla* (Meigen) (Diptera: Agromyzidae) taken off black-eyed peas (*Vigna unguiculata* (L.) Walp., Fabaceae) in Monte Alto, Texas. The species that was to become *G. pusillae* was referred to in Weld's (1952) key as 'new genus E'. This genus went ignored until Beardsley (1986) determined that *Eucoila hunteri* Perkins belonged in *Ganaspidium*; and, thus, created the combination *Ganaspidium hunteri*. *Ganaspidium hunteri* was discovered to parasitize multiple species of *Liriomyza* Mik in Hawaii on species as diverse as chrysanthemum, cucumber, tomato, and 'unspecified hosts' (Beardsley, 1986). In a follow-up paper, Beardsley (1988) provided a key to all eucoiline agromyzid parasites recorded at that time from Hawaii and described a third new species of *Ganaspidium*, *G. utilis* Beardsley. This species has been shown to be instrumental in controlling certain pest species of *Liriomyza*, including *L. trifolii* (Burgess) and *L. huidobrensis* (Blanchard) (Johnson 1987; Lynch and Johnson 1987; Mason and Johnson 1988; Rathman et al. 1991; Rathman et al. 1995).

Ganaspidium is easily confused with several closely related genera of Eucoilinae. One paratype of *G. pusillae* is actually *Disorygma pacifica* (Yoshimoto). Several collections I have examined consistently had specimens of *Agrostocynips* Diaz mixed with series of both *Ganaspidium* and *Disorygma* Förster. Miller (1989) assigned two new eucoilines described from North America to the Afrotropical genus *Nordlanderia* Quinlan. Unfortunately, the precise location of the holotypes is unknown, so Buffington (2004) left the following species as *nomina dubia*: *Nordlanderia merickeli* Miller and *N. najavoe* Miller. Comparison of the holotypes of the known species of *Ganaspidium* and many specimens of *Ganaspidium* at the USNM with the scanning electron micrograph images in Miller (1989), however, has allowed me to determine that one of his species belongs in *Ganaspidium*, while the second does not.

Buffington (2004) erroneously synonymized *Ganaspidium nigrimanus* (Kieffer 1907) with *G. utilis* because of the limited material available at the time. This action is now corrected and *G. utilis* is resurrected as a valid species, based on examination of material from the Canadian National Collection of Insects (CNCI, Ottawa, Canada), Texas A&M Insect Collection (TAMU, College Station, TX), the Entomology Research Museum, UC Riverside (Riverside CA), and the USNM (Washington, DC).

In Buffington et al. (2007), *Ganaspidium utilis* and *G. hunteri* were recovered in a clade separated from *G. pusillae*; this clade is sister-group to the Afrotropical lineage *Ealata* Quinlan and Palearctic lineage *Microstilba* Förster. Additional morphological studies of borrowed specimens, as well as those housed at the USNM, revealed that *G. hunteri*, *G. nigrimanus*, and *G. utilis* share very few character states with *G. pusillae*, but do share several states found within *Disorygma* Hartig, *Gronotoma* Förster and *Microstilba*. Because no other eucoiline genus could accommodate these species, Buffington

(2010) described *Banacuniculus* and created the combinations *Banacuniculus hunteri* (Crawford), *B. nigrimanus* (Kieffer) and *B. utilis* (Beardsley). The need for a redefinition of the generic boundaries of *Ganaspidium* is critically needed given that several closely related leafminer-parasitizing genera are typically confused with this genus.

Considering that species of this genus are distributed over a broad geographic range in North, Central, and South America, and its species are parasites of agromyzids of considerable economic importance (Johnson 1987), this paper is presented to help clarify confusion in this important and fascinating genus. This paper contains a redescription of *Ganaspidium* and *G. pusillae*, as well as the description of five species new to science: *Ganaspidium didionae*, *G. eldiablo, G. flemingi*, *G. kolmaci,* and *G. konzaensis*. *Nordlanderia navajoe* Miller, is recognized as junior synonym of *G. pusillae* Weld (new synonym). A key to all known species is included and the biology, when known, is included in each description.

Materials and Methods

List of Repositories

CASC California Academy of Sciences, San Francisco, CA, USA (R. Zuparko).
CNCI Canadian National Collection of Insects, Ottawa, Canada (J. Read).
KSCU Kansas State University, Manhattan, KS (G. Zolnerowich).
TAMU Texas A&M University Insect Collection, College Station, TX, USA (E. Riley).
UCDC Bohart Museum, University of California at Davis, Davis, CA, USA (L. Kimsey).
UCRC University of California at Riverside, Riverside, CA, USA (S. Triapytsin).
USNM National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (M. Buffington).

Additional sources of specimens. Extensive collections were made available from Texas by Ricardo Hernandez (Department of Entomology, TAMU) and Kansas by Robert Kula (Systematic Entomology Laboratory (SEL), ARS/USDA, Washington, DC) and Gregory Zolnerowich (Kansas State University, Manhattan, KS). Several specimens of *Ganaspidium* were taken via sweep net in Arizona and Nevada by Michael Gates (SEL) and myself during routine collecting trips. Sweeping low, placate vegetation, with a triangular sweep net (Noyes 1982), resulted in a significant number of specimens from each location.

Specimen illustration and observation. Methods for the imaging of specimens using light microscopy follow those of Buffington and van Noort (2007, 2009). An environmental scanning electron microscope (ESEM) was used as well; specimens were shot uncoated in a Philips XL-30 ESEM machine, with lanthanum hexaboride electron source (LaB6). The instrument was operated in low vacuum mode with water vapor as the imaging gas and backscatter imaging with one-half of the diode active. Specimen mounting and lighting techniques follow Buffington and Gates (2009). Slide mounts were prepared with PVA mounting medium, cured for 72 hours at 43ºC. Original drawings were done in pencil, scanned, and digitally edited using Adobe Photoshop CS2 (original drawings prepared by Theadore Buffington). Specimens were examined with a Leica M10 stereomicroscope, illuminated with a pair of fluorescent desk lights. This type of light is essential for the examination of *Ganaspidium*, since these lights produce an extremely diffuse illumination, preventing the obscuring of fine sculpture by glare.

Descriptive format

Diagnoses focus on features that are easily recognizable by other observers, and closely related species that may have similar gross morphologies are distinguished. Terminology for all descriptive characters, as well as phylogenetic characters, are defined in Buffington (2009) and are not repeated here; surface sculpture terminology follows that of Harris (1979). Following the descriptions are summaries of general distribution, biology and comments on nomenclatural issues (when applicable). The species descriptions are generated by a database application, vSysLab (Johnson 2008), designed to facilitate the generation of taxon by character data matrices and to export the data both as text and as input files for other applications. Exact label data is reported for holotypes. A link to a distribution map is included in each species description.

Systematic treatment

Ganaspidium Weld, 1955: 274

Type species: *Ganaspidium pusillae* Weld, by original designation.

Diagnosis. Malar space and ventral clypeal margin with distinct conical protuberances. Notauli absent. Parascutal impression incomplete. Scutellar plate narrow with paired conical protuberances anterior of midpit; midpit positioned in posterior one-third of plate. Setal band at base of syntergum of metasoma complete. Similar to *Disorygma*, *Microstilba,* and *Nordlanderia*, but distinguished by the absence of notauli and the presence of a hairy ring at the base of the syntergum; also similar to *Agrostocynips*, but with the pronotal plate less than one-half the width of the head, the genal carina absent, and the presence of clypeal and malar protuberances. Similar to *Banacuniculus*, but differing in the morphology of the scutellar plate (conical protuberances present in *Ganaspidium*, absent in *Banacuniculus*) and the incomplete parascutal impression (complete in *Banacuniculus*).

Redescription. *Head*. Nearly glabrous with a few scattered setae on lower face, clypeus, inner margins of compound eyes, and gena; ocellar hair patches absent. Ventral one-fourth of lower face with admedial clypeal furrows converging towards the clypeus; point of convergence resulting in the formation of a distinct conical protuberance protruding from anterior margin of clypeus. Orbital furrows absent. Malar sulcus ranging from simple to compound. Malar space smooth to distinctly strigose, with large conical protuberance present. Genal carina absent.

Antennae. Female: 13 segments, moniliform, clavate; segments 3–13 sub-equal in length; rhinaria present only on the last 7 segments. Male: 15 segments; segments 3–15 sub-equal in length; rhinaria present on segments 3–15. Segment 3 modified, curved outwardly, excavated laterally.

Pronotum. Pronotal plate narrow, with setae present along posterior margin; dorsal margin rounded; pronotal fovea open. Lateral pronotal carina absent. Pronotal triangle absent. Pronotal impression absent. Lateral aspect of pronotum smooth, glabrous in most species.

Mesoscutum. Glabrous and smooth. Parascutal impression incomplete. Notauli, mesoscutal keel, parapsidal ridges, and parapsidal hair lines absent.

Mesopectus. Upper and lower part of mesopleuron ranging from completely smooth to longitudinally striate; glabrous. Mesopleural triangle present, faintly indicated (often only visible in the space immediately anterior to the mesopleural spiracle). Mesopleural carina simple; mesopleural hair patch present to absent. Precoxal carina of lower part of mesopleuron present anteriorly and posteriorly, absent ventrally. Surcoxal depression reduced, smooth.

Scutellum. Scutellar plate small, narrow; scutellar midpit positioned posteriorly, typically on posterior one-third of plate (MP, Fig. 1A); rim of plate translucent; dorsal surface of plate with pair of tubercles (TUB, Fig. 1A, B). Dorsal surface of the scutellum reticulate to smooth; rounded posteriorly and laterally; posterior carina present or absent. Laterodorsal and posterior projections absent. Lateral bar as long as wide; ventral lobe absent. Scutellar fovea oval, smooth and deep.

Metapectal-propodeal complex. Posterior one-third to one-fourth of metapectus setose. Spiracular groove with a well-defined dorsal margin and reduced ventral margin. Posterior margin of metapectus smooth, not ridged. Metapleural ridge and submetapleural ridge absent. Anterior impression of metepimeron absent; anterior impression of metepisternum reduced. Anteroventral cavity rounded, setose. Propodeum covered in dense, appressed setae. Lateral propodeal carinae semiparallel, bowed at junction with auxiliary propodeal carinae; auxiliary propodeal carinae distinct. Nucha glabrous, reticulate.

Wings. Hyaline; setose. R complete, pigmented along anterior margin of wing; marginal cell truncate, typically deeper than long (Fig. 1C). Apical fringe short.

Legs. Fore and mid coxa sub equal in size, hind coxa twice the size of either fore or mid coxa. Fore coxa variously setose; mid and hind coxa with distinct anterior and posterior dorsoventral setal bands. Femora with sparse setal lines; tibiae and tarsomeres with dense, appressed setae. Length of hind tarsomere 1 equal to 0.5x the combined length of remaining hind tarsomeres.

Metasoma. Female: Sub equal in size to mesosoma. Base of syntergum with hairy ring, comprised of dense appressed setae and a ring of thin, erect setae; remainder of metasoma glabrous. Micropunctures present on posterior one-third of syntergum and remaining terga. Terga posterior to syntergum gradually directed ventrally, resulting

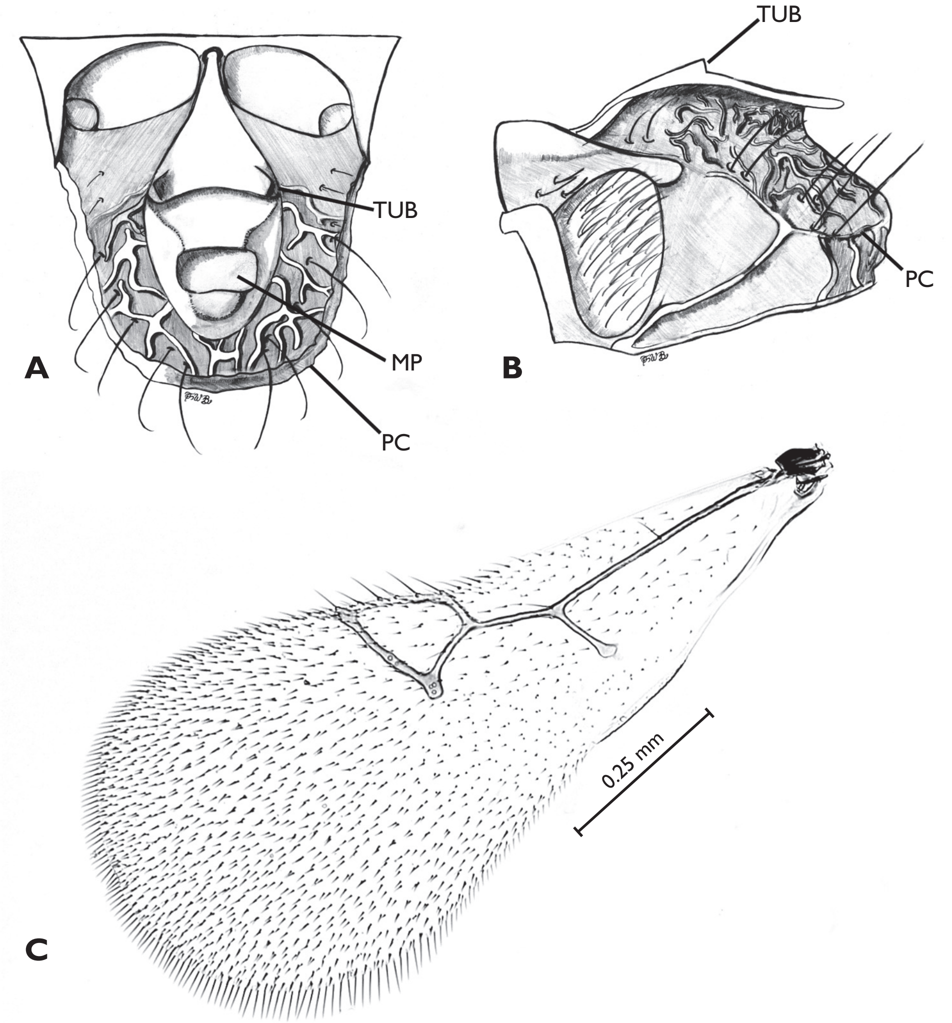

Figure 1. Diagnostic features of *Ganaspidium*. **A** scutellum, dorsal view **B** scutellum, lateral view **C** forewing, dorsal view. All illustrations of *Ganaspidium pusillae*. Abbreviations: **MP** midpit of scutellar plate **PC** posterior carina of scutellum **TUB** tubercles of scutellar plate.

in 70 degree angle between syntergum and remaining terga. Ovipositor with series of sub apical serrations (seen only in large specimens). Male: as in female, with the terga posterior to syntergum abruptly angled ventrally, resulting in 90 degree angle between syntergum and remaining terga.

Distribution. Figure 5.

Neotropical Region: Chile, Costa Rica; Nearctic Region: northern Mexico, continental United States, southern Canada.

Biology. Several species of *Liriomyza* have been recorded as hosts (Weld 1955; Harding, 1965, present study). Species of this genus can be found in nearly biogeographic region and have been recovered from hosts in 25 families of Asteraceae (CABI 1992). This incredibly broad geographic and host range helps explain the presence of this host from lush agroecosystems to arid desert habitats.

Comments. Miller (1989) described two species of eucoiline wasps that were placed in *Nordlanderia* Quinlan. Although the type specimens for these two species are apparently lost (Miller, pers. comm.), it is clear from the scanning electron micrographs accompanying the original descriptions that these two species do not belong in *Nordlanderia*. One species, *N. navajoae* Miller, bears diagnostic features of *Ganaspidium* and is transferred below; the second species, *N. merickeli* Miller, belongs in *Banacuniculus*, and is formally transferred in Buffington (2010). One paratype of *Ganaspidium pusillae* is actually a specimen of *Disorygma pacifica* (Yoshimoto), reared from *Liriomyza pusilla*. This specimen bears the label "*Disorygma*" in Nordlander's hand.

Species included in *Ganaspidium* Weld

G. didionae Buffington, new species.
G. eldiablo Buffington, new species.
G. flemingi Buffington, new species.
G. kolmaci Buffington, new species.
G. konzaensis Buffington, new species.
G. pusillae Weld, 1955: 274, holotype in USNM. *Ganaspidium navajoae* (Miller), syn. n., holotype lost.

Species formerly placed in *Ganaspidium*, now placed in *Banacuniculus* (Buffington, 2010):

Banacuniculus hunteri (Crawford), Buffington (2010). *Ganaspidium hunteri* (Crawford) Beardsley (1986); *Eucoila hunteri* Crawford, 1913: 310, holotype in USNM.
B. nigrimanus (Kieffer). *Eucoela nigrimanus* Kieffer, 1907:138, holotype in CAS. New combination by Buffington (2004).
B. utilis Beardsley, 1988: 44–46, holotype in BPBM, removed from synonymy; synonymized with *G. nigrimanus* (Kieffer) in Buffington (2004).

Key to species of *Ganaspidium*

Note: Diffuse light, such as that produced by fluorescent lights or fiber optic lights with light dispersing film, is absolutely essential to effectively use this key.

1. Frons smooth, malar space, and mesopleuron smooth (Fig. 2B); if malar space striate, striations restricted to ventral margin and not extending to ventral margin of compound eye; if mesopleuron with some striations, these striations restricted to the postero-dorsal margin of the sclerite **2**
– Frons, malar space and the majority of the mesopleuron distinctly longitudinally striate Figs 3A & B); frons typically striate from mandibular base to ventral margin of compound eye...............***G. konzaensis* Buffington, sp. n.**

2. Dorsal surface of scutellar plate with a pair of distinct tubercles present on the anterior half of the plate (Fig. 1A) **3**
– Dorsal surface of scutellar plate nearly flat, with a slight hump where in other species the scutellar plate tubercles are present (Fig. 4A)............................... .... ***G. kolmaci* Buffington, sp. n.**
3. Dorsal surface of the scutellum entirely smooth, occasionally with weak wrinkles along the margin of posterior carina (Fig. 4D) **4**
– Dorsal surface of scutellum distinctly rugulose to strigose, never smooth (Fig. 2B)..**5**
4. Posterior margin of scutellum without a distinct carina differentiating the dorsal surface from the postero-lateral surface; dorsal surface of scutellum totally smooth..***G. eldiablo* Buffington, sp. n.**
– Posterior margin of scutellum with a distinct and well-developed posterior carina, differentiating the dorsal surface of the scutellum from the postero-lateral surface; dorsal surface of scutellum smooth, with occasional weak wrinkles posteriorly along the posterior carina.............***G. flemingi* Buffington, sp. n.**
5. Dorsal surface of scutellum distinctly rugulose with a large, distinctly cleft, posterior carina (Fig. 4C); tubercles of the scutellar plate massive, height of tubercle equal to the width of the tubercle base; malar space striate............. ....***G. didionae* Buffington, sp. n.**
– Dorsal surface of scutellum more delicately sculptured, with fine strigae radiating from the underside of the scutellar plate (Fig. 2 B); posterior carina very thin and not cleft; tubercles of the scutellar plate smaller, height of each tubercle equal to one-half to one-third length of tubercle base; malar space occasionally striate but much more typically smooth......... ***G. pusillae* Weld**

Ganaspidium didionae Buffington, sp. n.

urn:lsid:zoobank.org:act:23635553-5CB6-4747-8C9C-793E9EBECBF9
urn:lsid:biosci.ohio-state.edu:osuc_concepts:253200
Figure 4C

Description. Malar sulcus compound. Malar space partially striate, striations extending one-half to two-thirds distance from ventral margin of malar space to base of compound eye. Malar protuberance smooth, elongate, extending beyond length of ventral margin of malar space. Clypeal protuberance elongate, overhanging anterior margin of clypeus. Tubercles of scutellar plate present, distinct, large, length of tubercle equal to or greater than width of tubercle base. Dorsal surface of scutellar plate concave around midpit, two setal bearing pits at base of each tubercle. Carina along posterior margin of scutellum present, distinctly cleft, defining transition from dorsal surface of scutellum from posterior surface. Dorsal surface of scutellum entirely rugulose/wrinkled. Midpit of scutellar plate in posterior half of plate; plate small, revealing dorsal surface of scutellum when viewed dorsally. Mesopopleural setal patch absent. Mesopleuron

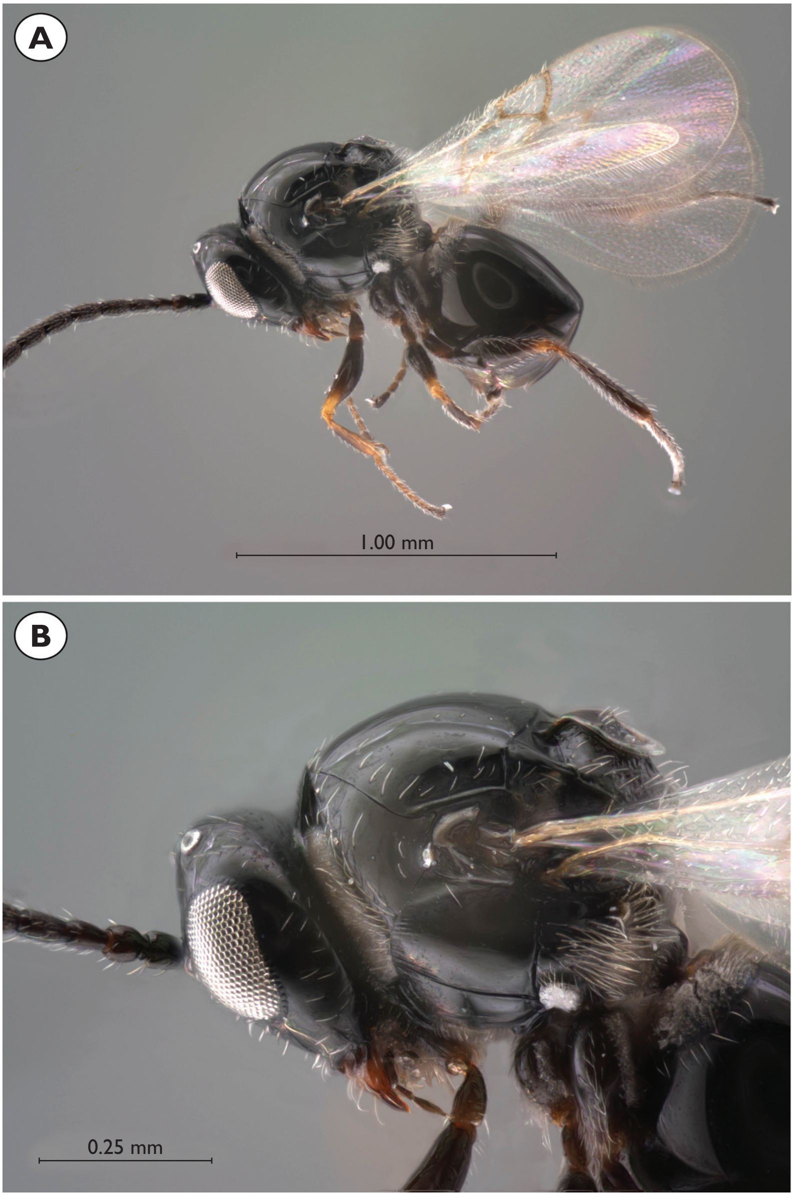

Figure 2. *Ganaspidium pusillae* Weld. **A** habitus, female **B** head and mesosoma, lateral view, female.

entirely smooth; smooth anteriorly, striate along the postero-dorsal margin. Lateral aspect of pronotum anteriorly with some short setae, remainder glabrous. Marginal cell of forewing distinctly deeper than long. Metasoma of sub-equal size to mesosoma in lateral view.

Diagnosis. This species is unique within *Ganaspidium* as it is the only species with a horizontally striate scutellar plate. The strongly reticulate dorsal surface of the scutellum is also rather unique, only shared with *G. konzaensis* and *G. kolmaci*; *G. didionae*

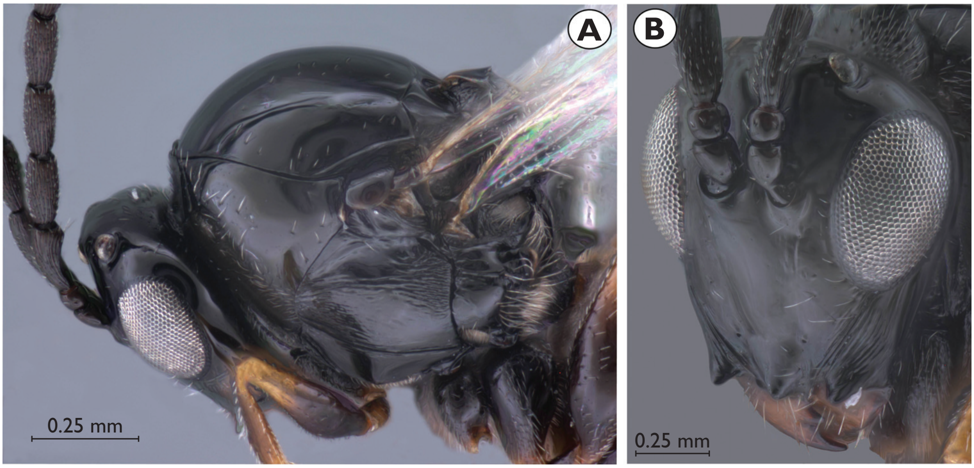

Figure 3. *Ganaspidium konzaensis* Buffington, sp. n. **A** head and mesosoma, lateral view **B** head, ¾ anterior view. Note the striations on both the mesopleuron in 3A and on the malar space in 3B.

is separated from these two by the horizontally striate scutellar plate as well as a limited degree of striation on the malar space (fully striate in *G. konzaensis*) and distinct tubercles on the scutellar plate (significantly reduced in *G. kolmaci*).

Etymology. Named in honor of author Joan Didion. Several fiction and non-fiction pieces by Ms. Didion focus on the desert Southwest of the United States. The gender is feminine.

Link to distribution map. http://hol.osu.edu/map-full.html?id=253200

Material examined. Holotype, male: **UNITED STATES:** *NEVADA.* White Pine Co., 45km SSE Eureka, 19.VII.1995, S. L. Heydon & R. M. Bohart, USNM ENT 00655512 (deposited in UCDC). *Paratypes*: (4 females) **ARGENTINA:** Neuquén Prov., 21km WNW Junín de los Andes, hwy 62, 3km inside park, Lanín National Park, 19.II-24.II.1999, S. L. Heydon & J. Ledford (1 female, USNM ENT 00655516 (UCDC)). **CHILE:** Región Metropolitana de Santiago, 1km W Farellones, 2125m, 11.XII.1994, S. L. Heydon & E. Arias (1 female, USNM ENT 00655464 (UCDC)). **UNITED STATES:** *ARIZONA*. Cochise Co., Chiricahua Mts., Portal, 20.VIII.1958, R. H. James (1 female, USNM ENT 00655432 (CASC)); Pima Co., Santa Rita Mts., G96/045, Box Canyon, 3.VII.1996, M. W. Gates (1 female, UCRC ENT 197002 (UCRC)).

Ganaspidium eldiablo Buffington, sp. n.

urn:lsid:zoobank.org:act:7564C834-EEF1-4BCD-B809-A21707B77987
urn:lsid:biosci.ohio-state.edu:osuc_concepts:253202
Figure 4D

Description. Malar sulcus compound. Malar space smooth. Malar protuberance smooth, elongate, extending beyond length of ventral margin of malar space. Clypeal

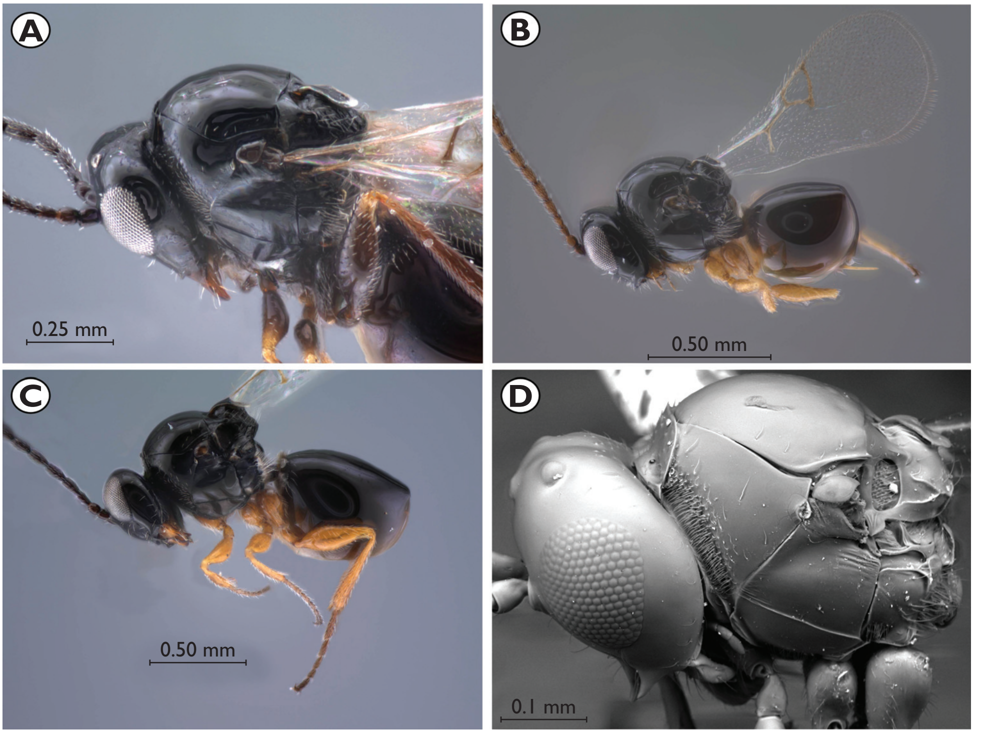

Figure 4. New species of *Ganaspidium*: *G. didionae* Buffington, *G. flemingi* Buffington, *G. kolmaci* Buffington, and *G. eldiablo* Buffington. **A** head and mesosoma, lateral view, of female *G. kolmaci* **B** habitus female of *G. flemingi* **C** habitus female of *G. didionae* **D** habitus female of *G. eldiablo*.

protuberance elongate, overhanging anterior margin of clypeus. Tubercles of scutellar plate extremely reduced, hardly distinguishable. Dorsal surface of scutellar plate concave around midpit, two setal bearing pits at base of each tubercle. Carina along posterior margin of scutellum absent. Dorsal surface of scutellum smooth anteriorly, gently striate posteriorly. Midpit of scutellar plate in posterior half of plate; plate small, revealing dorsal surface of scutellum when viewed dorsally. Mesopopleural setal patch absent. Mesopleuron entirely smooth. Lateral aspect of pronotum anteriorly with some short setae, remainder glabrous. Marginal cell of forewing distinctly deeper than long. Metasoma of sub-equal in size to mesosoma in lateral view.

Diagnosis. This species can be separated from all other *Ganaspidium* by having the dorsal surface of the scutellum smooth anteriorly, striate posteriorly, and lacking the posterior carina of the scutellum. This species is most easily confused with *G. pusillae* and *G. flemingi*, both of which possess a distinct posterior carina of the scutellum.

Etymology. Name refers to the type locality along the 'El Camino Diablo Real' in southwestern Arizona. The gender is neuter.

Link to distribution map. http://hol.osu.edu/map-full.html?id=253202

Material examined. Holotype, female: **UNITED STATES:** *ARIZONA*. Pima Co., 17mi E Papago Well, Camino del Diablo, along wash, Organ Pipe Cactus Na-

Figure 5. General distribution map of all species of *Ganaspidium*.

tional Monument, 29.VIII.2006, sweeping, Gates & Buffington, USNM ENT 00655307 (deposited in USNM). *Paratypes*: (17 females, 4 males) **UNITED STATES:** *ARIZONA*. Pima Co., 17mi E Papago Well, Camino del Diablo, along wash, Organ Pipe Cactus National Monument, 29.VIII.2006, sweeping, Gates & Buffington (14 females, 3 males, USNM ENT 00655297, 00655298, 00655299, 00655301-00655306, 00655308, 00655309, 00655310-00655315 (USNM)). *CALIFORNIA*. Riverside Co., Thousand Palms, 26.IV.1955, W. R. M. Mason (1 female, USNM ENT 00655546 (CNCI)); Riverside Co., Whitewater Canyon, 310m, 2.VI.1998 (1 female, UCRC ENT 196990 (UCRC)). *OREGON*. Lake Co., 13.5mi SW Christmas Valley, 5.VIII.1995, sweeping, J. D. Pinto (1 male, UCRC ENT 196979 (UCRC)). *WASHINGTON*. Grant Co., Potholes State Park, 26.VII.1985, Moss, Finnamore & Thormin (1 female, USNM ENT 00655556 (CNCI)).

***Ganaspidium flemingi* Buffington, sp. n.**
urn:lsid:zoobank.org:act:8A5BDA75-2ADB-42CF-920E-69D6F855F7CF
urn:lsid:biosci.ohio-state.edu:osuc_concepts:253203
Figure 4B

Description. Malar sulcus compound. Malar space smooth. Malar protuberance smooth, elongate, extending beyond length of ventral margin of malar space. Clypeal protuberance elongate, overhanging anterior margin of clypeus; short, not overhanging anterior margin of clypeus. Tubercles of scutellar plate distinct, small, length of tuber less than one-half width of tubercle base. Dorsal surface of scutellar plate concave around midpit, two setal bearing pits at base of each tubercle. Carina along posterior margin of scutellum present, delicate, defining transition from dorsal surface of scutellum from posterior surface. Dorsal surface of scutellum smooth except for faint wrinkles along posterior carina. Midpit of scutellar plate in posterior half of plate; plate small, revealing dorsal surface of scutellum when viewed dorsally. Mesopopleural setal patch absent. Mesopleuron entirely smooth. Lateral aspect of pronotum anteriorly with some short setae, remainder glabrous. Marginal cell of forewing distinctly deeper than long. Metasoma of sub-equal in size to mesosoma in lateral view.

Diagnosis. This species can be separated from all other species of *Ganaspidium* by having an entirely smooth dorsal surface of the scutellum, with only a few gentle wrinkles present along the posterior carina of the scutellum, and having a completely smooth malar space. Most easily confused with *G. pusillae*, which will often have a smooth anterior half, but distinctly wrinkled/striate posterior half of the dorsal surface of the scutellum.

Etymology. Named in honor of Ian Fleming, author and creator of the British secret agent *James Bond 007*, and long time resident of The Bahamas. The gender is masculine.

Link to distribution map. http://hol.osu.edu/map-full.html?id=253203

Material examined. Holotype, female: **BAHAMAS:** Ragged Island Dist., 2008R103, Buena Vista Cay Island, 9.I-14.I.2008, malaise trap/yellow pan trap, L. S. Kimsey, USNM ENT 00655526 (deposited in UCDC). *Paratypes*: (10 females, 1 male) **BAHAMAS:** Ragged Island Dist., 2008R103, Buena Vista Cay Island, 9.I-14.I.2008, malaise trap/yellow pan trap, L. S. Kimsey (1 female, USNM ENT 00655527 (UCDC)). Ragged Island Dist., 2008R103, Buena Vista Cay Island, 9.I-14.I.2008, L. S. Kimsey (2 females, USNM ENT 00655528, 00655529 (UCDC)). **UNITED STATES:** *ARIZONA*. Coconino Co., Moenkopi Wash, 2mi SE Tuba City, 31.VIII.1986, A. S. Menke (1 female, USNM ENT 00653499 (USNM)). *CALIFORNIA*. Inyo Co., Indian Ranch Road, tamarisk / mesquite, warm sulfur springs, 21.III-22.III.2002, A. Owens & J. George (1 female, UCRC ENT 196973 (UCRC)); Inyo Co., white flowers, 14km NW Darwin, 25.V.1994, S. L. Heydon (1 female, USNM ENT 00655496 (UCDC)); Riverside Co., 5mi E Cabazon, 27.IX.1978, G. Gordh (1 female, UCRC ENT 196977 (UCRC)). *IDAHO*. Twin Falls Co., #5A, Hollister, 5.VI.1931, D. E. Fox (1 female, USNM ENT 00653489 (USNM)). *KANSAS*. Geary

Co., watershed, Konza Prairie Biological Station, 16.VIII-26.VIII.2005, malaise trap (1 female, USNM ENT 00655618 (USNM)); Geary Co., watershed, Konza Prairie Biological Station, 27.VI-8.VI.2005, malaise trap (1 male, USNM ENT 00655619 (USNM)). *NEW MEXICO.* Valencia Co., 20mi W Los Lunas, along streambed, Carrizo Creek, 23.VIII.1977, malaise trap, S. Peck & J. Peck (1 female, USNM ENT 00655555 (CNCI)).

Comments. The presence of this taxon in The Bahamas is intriguing. Most eucoiline leafminer parasites from the Caribbean belong to the Zaeucoilini (Buffington, 2009). It is likely that this species is a North American native that has been introduced to The Bahamas via human activity, as has occurred with *B. utilis* and *Disorygma pacifica* (Yoshimoto) in the Hawaiian Islands.

Ganaspidium kolmaci Buffington, sp. n.

urn:lsid:zoobank.org:act:F0845DF2-5656-4366-9FEC-31C25F034005
urn:lsid:biosci.ohio-state.edu:osuc_concepts:253205
Figure 4A

Description. Malar sulcus simple. Malar space partially striate, striations extending one-half to two-thirds distance from ventral margin of malar space to base of compound eye. Malar protuberance smooth, elongate, extending beyond length of ventral margin of malar space. Clypeal protuberance elongate, overhanging anterior margin of clypeus. Tubercles of scutellar plate extremely reduced, hardly distinguishable. Dorsal surface of scutellar plate flat, smooth, setal bearing pits present surrounding midpit. Carina along posterior margin of scutellum absent; present, delicate, defining transition from dorsal surface of scutellum from posterior surface. Dorsal surface of scutellum smooth anteriorly, reticular/strigate posteriorly. Midpit of scutellar plate in posterior half of plate; plate small, revealing dorsal surface of scutellum when viewed dorsally. Mesopopleural setal patch absent. Mesopleuron entirely smooth; smooth anteriorly, striate along the postero-dorsal margin. Lateral aspect of pronotum anteriorly with some short setae, remainder glabrous. Marginal cell of forewing as deep as long. Metasoma of sub-equal in size to mesosoma in lateral view.

Diagnosis. This species can be separated from all other *Ganaspidium* by the presence of reduced tubercles on the scutellar plate. This character requires careful observation because the tubercles are difficult to observe. In all other species of *Ganaspidium*, the paired tubercles are well developed and easily seen in profile (e.g. Fig. 1B).

Etymology. Named in honor the doctors and staff of the Kolmac Clinic, Washington, DC. The gender is masculine.

Link to distribution map. http://hol.osu.edu/map-full.html?id=253205

Material examined. Holotype, female: **UNITED STATES:** UT, Wayne Co., 8mi W Caineville, Moki Ruin, 4920ft, 14.X.2002, sweeping, J. D. Pinto, USNM ENT 00655300 (deposited in USNM). *Paratypes*: (28 females, 18 males) **ARGENTINA:** Neuquén Prov., 21km WNW Junín de los Andes, hwy 62, 3km inside park, Lanín National Park, 21.VII.1994, S. L. Heydon & J. Ledford (1 female, 1 male, USNM ENT 00655517, 00655518 (UCDC)). **CANADA:** AB, W of Dinosaur Prov. Park, hwy 876, Red Deer River, 5.VII-6.VII.1991, malaise trap, J. H. O'Hara (1 female, USNM ENT 00655560 (CNCI)). AB, flowery prairie, Waterton Lakes National Park of Canada, 8.VII.1991, H. Goulet (2 females, USNM ENT 00655552, 00655563 (CNCI)). AB, montaine prairie, Waterton Lakes National Park of Canada, 6.VII.1991, H. Goulet (1 male, USNM ENT 00655551 (CNCI)). AB, montaine prairie, Waterton Lakes National Park of Canada, 8.VII.1991, H. Goulet (1 male, USNM ENT 00655564 (CNCI)). BC, 57km N Princeton, hwy. 5, pine / grass, Kentucky-Alleyne Park, 10.VII.1986, H. Goulet (8 females, 1 male, USNM ENT 00655550, 00655553-00655554, 00655558, 00655559, 00655561-00655562, 00655565, 00655569 (CNCI)). SK, Dunblane, 10.IX.1959, J. R. Vockeroth (1 male, USNM ENT 00655567 (CNCI)). **NICARAGUA:** Rivas Dept., San Juan del Sur, 11°15'N 85°52'W, 21.VII.1994, L. J. Clark (1 male, USNM ENT 00655505 (UCDC)). **UNITED STATES:** *ARIZONA*. Cochise Co., Chiricahua Mts., swimming pool, Southwestern Research Station (SWRS), 5.V.1980, V. Roth (1 female, USNM ENT 00655547 (CNCI)); Coconino Co., 13mi S Jacob Lake, 6600ft, 26.VI.1993, J. D. Pinto (4 females, 3 males, UCRC ENT 196981-196987 (UCRC)); Coconino Co., pine / aspen / fir, 36km S Jacob Lake, 2650m, 14.VII-15.VII.1967, B. V. Brown (1 female, UCRC ENT 196980 (UCRC)). *CALIFORNIA*. Lake Co., Lakeport, 8.VII-20.VII.1994 (1 male, USNM ENT 00655483 (UCDC)). *NEVADA*. Churchill Co., 61mi W Austin, desert scrub, "Shoetree", hwy 50, 9.V.2002, Buffington & Munro (2 females, UCRC ENT 196974, 56822 (UCRC)); Nye Co., Rock Valley, 20.IV.1976 (1 female, USNM ENT 00655426 (CASC)). *OREGON*. Lake Co., Alkali Lake, 21.VII.1994, S. L. Heydon (7 females, 5 males, USNM ENT 00655476, 00655478, 00655479, 00655480, 00655481, 00655482, 00655489, 00655490, 00655491, 00655493, 00655494, 00655495 (UCDC)); Union Co., Mount Emily, 5mi N La Grande, 15.VII-18.VII.1984, malaise trap, T. R. Torgersen (1 male, USNM ENT 00653503 (USNM)). *UTAH*. Wayne Co., 6mi W Caineville, along Fremont River, 4700ft, 29.VI.1993, J. D. Pinto (1 male, UCRC ENT 196988 (UCRC)). *WASHINGTON*. Whitman Co., Festuca / Symphoricarpos, Colton, 15.VII.1960 (1 male, USNM ENT 00653496 (USNM)).

Ganaspidium konzaensis Buffington, sp. n.

urn:lsid:zoobank.org:act:58ECBA6A-14F8-4763-A41C-C2B3E631DC5C
urn:lsid:biosci.ohio-state.edu:osuc_concepts:253206
Figures 3A–B

Description. Malar sulcus compound. Malar space completely striate from ventral margin of malar space to base of compound eye. Malar protuberance smooth, elongate, extending beyond length of ventral margin of malar space. Clypeal protuberance elongate, overhanging anterior margin of clypeus. Tubercles of scutellar plate present, distinct, large, length of tubercle equal to or greater than width of tubercle base. Dorsal surface of scutellar plate concave around midpit, two setal bearing pits at base of each tubercle. Carina along posterior margin of scutellum present, distinctly cleft, defining transition from dorsal surface of scutellum from posterior surface. Dorsal surface of scutellum entirely rugulose/wrinkled. Midpit of scutellar plate in posterior half of plate; plate small, revealing dorsal surface of scutellum when viewed dorsally. Mesopopleural setal patch absent. Mesopleuron distinctly striate along the anterior, posterior margins; often entire sclerite striate. Lateral aspect of pronotum anteriorly with some short setae, remainder glabrous. Marginal cell of forewing as deep as long. Metasoma of sub-equal in size to mesosoma in lateral view.

Diagnosis. This species is separated from all other species of *Ganaspidium* by the distinctly striate mesopleuron and fully striate malar space. In some *G. pusillae* and *G. kolmaci*, the postero-dorsal corner of the mesopleuron can be striate, as well as the ventral one-half to one-third of the malar space, but in neither case is the entire surface striate as in *G. konzaensis*.

Etymology. Named for the type locality of the holotype, Konza Prairie Biological Reserve, Geary County, Kansas. The gender is neuter.

Link to distribution map. http://hol.osu.edu/map-full.html?id=253206

Material examined. Holotype, female: **UNITED STATES:** KS, Geary Co., watershed, Konza Prairie Biological Station, 16.VIII-26.VIII.2005, malaise trap, USNM ENT 00655616 (deposited in USNM). *Paratypes*: (4 females, 7 males) **CANADA:** *ALBERTA*. Drumheller, 14.VI.1946, W. R. M. Mason (1 female, USNM ENT 00655568 (CNCI)). **UNITED STATES:** *CALIFORNIA*. Alpine Co., Hope Valley, 11.VII.1972, R. M. McMaster (1 female, USNM ENT 00655484 (UCDC)); Inyo Co., Eureka Valley Sand Dunes, 14.V.1979, N. J. Smith (1 male, USNM ENT 00655485 (UCDC)); Inyo Co., Goodale Creek, 3.IV.1953, H. B. Leech (1 male, USNM ENT 00655427 (CASC)). *COLORADO*. Park Co., 6km S Lake George, along Fish Creek, 21.VII.1994, S. L. Heydon (4 males, USNM ENT 00655471-00655474 (UCDC)); Weld Co., Greeley, 8.VIII.1929, W. J. Zaumeyer (1 female, USNM ENT 00653596 (USNM)). *KANSAS*. Riley Co., Konza Prairie Biological Station, 25.V-29.V.2001, G. Zolnerowich & R. Kula (1 male, USNM ENT 00655615 (USNM)); La Crosse Co., 27.VII.1960, L. A. Stange (1 female, USNM ENT 00655425 (CASC)).

Ganaspidium pusillae Weld, 1955

urn:lsid:biosci.ohio-state.edu:osuc_concepts:251125
Figures 1A–C, 2A–B

Nordlanderia navajoae Miller, 1989, new synonymy

Redescription. Malar sulcus simple. Malar space partially striate, striations extending one-half to two-thirds distance from ventral margin of malar space to base of compound eye. Malar protuberance smooth, elongate, extending beyond length of ventral margin of malar space; smooth, short, not extending beyond length of ventral margin of malar space. Clypeal protuberance elongate, overhanging anterior margin of clypeus; short, not overhanging anterior margin of clypeus. Tubercles of scutellar plate distinct, small, length of tuber less than one-half width of tubercle base. Dorsal surface of scutellar plate concave around midpit, two setal bearing pits at base of each tubercle. Carina along posterior margin of scutellum present, delicate, defining transition from dorsal surface of scutellum from posterior surface. Dorsal surface of scutellum smooth anteriorly, reticular/strigate posteriorly. Midpit of scutellar plate in posterior half of plate; plate small, revealing dorsal surface of scutellum when viewed dorsally. Mesopopleura setal patch absent. Mesopleuron entirely smooth; smooth anteriorly, striate along the postero-dorsal margin. Lateral aspect of pronotum anteriorly with some short setae, remainder glabrous. Marginal cell of forewing distinctly deeper than long. Metasoma of sub-equal size to mesosoma in lateral view.

Diagnosis. Differs from other species of *Ganaspidium* by having moderately developed tubercles on the scutellar plate, dorsal surface of scutellum smooth anteriorly and delicately sculptured posteriorly, and a complete posterior scutellar carina; other species in the group either lack the posterior carina, have an entirely smooth dorsal surface of the scutellum, indistinct or very well-developed tubercles on the scutellar plate.

Biology. Recorded from *Liriomyza huidobrensis* (Blanchard) (present study), *L. pusilla* (Meigen) (Weld, 1955), and *L. munda* Frick (Harding, 1965).

Link to distribution map. http://hol.osu.edu/map-full.html?id=251125

Material examined. Holotype, female: **UNITED STATES:** *TEXAS*. Hidalgo Co., Monte Alto, 30.V.1953, USNM ENT 00655718 (deposited in USNM). *Paratypes*: **UNITED STATES:** *TEXAS.* Hidalgo Co., Monte Alto, 30.V.1953 (3 females, 1 male, 1 unknown, USNM ENT 00655428, 00655429, 00655430-00655431 (CASC); USNM ENT 00653497 (USNM)). *Other material*: 40 females, 4 males, 110 unknowns) **CANADA:** AB, no date (1 female, USNM ENT 00655566 (CNCI)). AB, W of Dinosaur Prov. Park, hwy 876, Red Deer River, 5.VII-6.VII.1989, malaise trap, J. H. O'Hara (1 female, USNM ENT 00655570 (CNCI)). **MEXICO:** TAMPS, 3mi S Ciudad Victoria, 1.XI.1982, screen sweeping, A. Gonzalez & J. T. Huber (7 females, UCRC ENT 196991-196997 (UCRC)). **UNITED STATES:** *ARIZONA.* Coconino Co., Moenkopi Wash, 31.VIII.1986, A. S. Menke (1 female, USNM ENT 00653487 (USNM)); Pima Co., Tucson, no date, Baker (2 males, USNM ENT 00653502, 00653601 (USNM)); Santa Cruz Co., Sonoita, 25.VIII.2006, malaise trap, E. E. Grissell (1 female, USNM ENT 00655346 (USNM)). *CALIFORNIA*. Inyo Co., Darwin Falls, 21.III-22.III.2002, George & Owens (1 female, UCRC ENT 56867 (UCRC)); Inyo Co., white flowers, 14km NW Darwin, 25.V.1994, S. L. Heydon (1 female, USNM ENT 00655497 (UCDC)); San Bernardino Co., 1.4mi N of crossing of 2N93 Service Road and hwy 38, pine scrub, San Bernardino Mountains, 2450m, 24.VI.1997, M. Buffington (1 female, UCRC ENT 196989 (UCRC)); San Bernardino Co., Helendale, 21.V.1955, W. R. M. Mason (1 female, USNM ENT 00655557 (CNCI)). *COLORADO*. El Paso Co., Colorado Springs, 1.VII.1915 (1 female, 1 male, USNM ENT 00653486, 00653611 (USNM)); Larimer Co., Cameron Pass, 30.VII.1896, Baker (1 female, USNM ENT 00653524 (USNM)). CO, Park Co., 6km S Lake George, along Fish Creek, 7.VII.1992, S. L. Heydon (1 female, USNM ENT 00655468 (UCDC)). *IDAHO*. Woodbury Co., Sioux City, 8.IX.1927, C. N. Ainslie (1 female, USNM ENT 00653517 (USNM)). *KANSAS.* Geary Co., watershed, Konza Prairie Biological Station, 27.VI-8.VI.2005, malaise trap (1 female, USNM ENT 00655617 (USNM)). *NEW MEXICO*. Bernalillo Co., Albuquerque, 18.VI.2000 (1 female, USNM ENT 00653506 (USNM)); Doña Ana Co., Mesilla, no date, C. N. Ainslie (1 female, USNM ENT 00653523 (USNM)); Doña Ana Co., Mesilla, no date (1 female, USNM ENT 00653594 (USNM)). *NEVADA*. 4.VII.1924, Timberlake (1 female, UCRC ENT 196975 (UCRC)). *OREGON*. Klamath Co., 10mi out Medford Road, Crater Lake National Park, ~5500ft, 10.IX.1930, H. A. Scullen (1 female, USNM ENT 00653595 (USNM)). *TEXAS.* 3.VI.1924, Timberlake (1 female, UCRC ENT 196976 (UCRC)); Cameron Co., TAM Veracruz hot pepper, La Feria, 19.IX.2007, Hernandez (1 female, USNM ENT 00655157 (USNM)); Dimmit Co., East Guajalote, pasture 15, 90/077, Chaparral Wildlife Management Area, 30.IX.1990, J. B. Woolley (1 female, USNM ENT 00655345 (USNM)); Hidalgo Co., Jalapeño M hot peppers, Weslaco, 1.IV.2008, Hernandez (5 females, USNM ENT 00655094, 00655095, 00655103, 00655114-00655115 (USNM)); Hidalgo Co., tormenta hot pepper, Pharr, 28.VI.2008, Hernandez (3 females, USNM ENT 00655013, 00655028, 00655033 (USNM)); McLennan Co., cotton, Waco, 21.VII.1949, Glick (1 female, USNM ENT 00653592 (USNM)); Uvalde Co., roadside flowers, 1985-002S, 13mi NW Uvalde, 15.IV.1985, Schaffner (2 females, USNM ENT 00655326-00655327 (USNM)); Zavala Co., cantaloupe, Crystal City, no date (1 unknown, USNM ENT 00653500 (USNM)). *UTAH*. Emery Co., nr. Goblin Valley State Park, Wild Horse Creek, 2.VIII-7.VIII.1997, malaise trap, M. Wasbauer & J. Wasbauer (1 female, USNM ENT 00655452 (UCDC)). *WYOMING*. Sweetwater Co., 11.6mi E Point of Rocks, 30.VII.1983, J. D. Pinto (1 female, UCRC ENT 196978 (UCRC)).

Discussion

Buffington et al. (2007) considered *Ganaspidium pusillae* to be the sister-group to what was referred to then as the *Gronotoma* group of genera. Forshage and Nordlander (2008) resurrected Diglyphosemini Belizin, 1961, and referred to taxa formally included within the *Gronotoma* group, based on Fontal-Cazalla et al. (2002) and Buffington et al. (2007), as members of this tribe; hence, *Ganaspidium* is included within Diglyphosemini. This tribe will be formally circumscribed in a subsequent paper that will be a companion to Buffington (2009). Although the morphology of *Ganaspidium* could be considered rather derived within Eucoilinae (e.g. scutellar plate small, tubercles present on the scutellar plate, mostly Nearctic distribution; Fontal-Cazalla et al. 2002), it appears that these characters are instead autapomorphies for the genus as a whole. The host preference for Agromyzidae, as well as the presence of conical protuberances on the anterior margin of the clypeus and malar spaces, appears to be the ground plan for the Diglyphosemini; the protuberances are shared with *Banacuniculus*, *Ealata*, *Microstilba*, *Nordlanderia* Quinlan, and *Tobiasiana* Kovalev (Buffington et al. 2007; Buffington 2010). The arid habitats in which some species of *Ganaspidium* appear to thrive is another peculiar aspect of this genus (Fig. 5) and is linked to the broad distribution of *Liriomyza* species (CABI 1992). The shrub *Larrea tridentata* (Sesse' and Moc. Ex DC.) Coville (Zygophyllaceae) possesses a similar distribution to many *Ganaspidium* species (Runyan 1934; Marshall 1995), and may be a critical host reservoir for agromyzids attacked by *Ganaspidium*. Specimens have been swept off what appears to be completely dormant (Runyan 1934) or dead shrubs *L. tridentata* in the Great Basin of North America. Exactly how these wasps survive and what hosts they are utilizing are unknown. Further fieldwork and careful rearing protocols are needed to learn more about this small yet effective natural enemy of agromyzid flies.

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