JHR 25: 1–14 (2012)
doi: 10.3897/JHR.25.2565
www.pensoft.net/journals/jhr

RESEARCH ARTICLE

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

Trimodal adult emergence in summer generations of the rose sawfly *Arge nigrinodosa* (Hymenoptera, Argidae)

Maya Kawasaki[1,†], Mariko Fujita[1,‡], Atsushi Sakurai[1,§], Kaoru Maeto[1,§]

1 *Graduate School of Agricultural Science, Kobe University, 1-1 Rokkodai, Nada-ku, Kobe 657-8501, Japan*

Corresponding author: *Kaoru Maeto* (maeto@kobe-u.ac.jp)

Academic editor: *Mark Shaw* | Received 19 December 2011 | Accepted 23 February 2012 | Published 23 March 2012

Citation: Kawasaki M, Fujita M, Sakurai A, Maeto K (2012) Trimodal adult emergence in summer generations of the rose sawfly *Arge nigrinodosa* (Hymenoptera, Argidae). Journal of Hymenoptera Research 25: 1–14. doi: 10.3897/JHR.25.2565

Abstract

We explored the variable adult emergence in summer generations of a multivoltine sawfly [*Arge nigrinodosa* (Argidae)], larvae of which feed gregariously on the foliage of *Rosa* spp. (Rosaceae), and its ecological significance. The sawfly showed a trimodal adult emergence under long-day conditions in the laboratory. Following the first and largest cluster of emergence, a small tail of slightly delayed emergence was observed, which most likely was heritable. The third cluster of emergence after nonheritable partial diapause in prepupae seemed to match the synchronous emergence of a portion of adults in September under field conditions, probably as a risk-spreading (i.e., bet-hedging) strategy to cope with food shortage during unpredictable periods of drought in summer.

Keywords

Bet-hedging, partial summer diapause, polymodal emergence, risk-spreading, stochastic polyphenism, voltinism

Introduction

Seasonal life cycles are often variable within a population of herbivores (e.g., Danks 1994), but little is known about the life-history variability of sawflies with the exception of some conifer-feeding species (e.g., Knerer 1993; Maeto and Ozaki 1993). Within the genus *Arge* (Hymenoptera, Argidae), whose larvae feed on various dicotyledon plants (Smith 1989), voltinism is often confusing due to apparently irregular or

polymodal adult emergence, as indicated by field and laboratory observations (Regas-Williams and Habeck 1979; Adachi 1983a; Shinohara et al. 2007, 2008; Shinohara and Hara 2008, 2009; Hara 2010). For example, *Arge suzukii* (Matsumura), which feeds on *Abelia* spp. (Linnaeaceae), exhibits a multivoltine life cycle (Okutani 1956), whereas its actual life history appears quite complicated given that adult emergence is polymodal and irregular under constant rearing conditions (Shinohara and Hara 2008). Additionally, *Arge pullata* (Zaddach) feeding on *Betula* spp. (Betulaceae) probably has two generations a year, but often with adult emergences deviating from this pattern (Hara and Shinohara 2008). Such occurrences led Shinohara and Hara (2008) to hypothesize that the concept of voltinism does not make sense in many *Arge* sawflies. More detailed and experimental studies are necessary to understand the nature and ecological implications of variable life histories in *Arge*.

Arge nigrinodosa (Motschulsky) is a common sawfly that feeds gregariously on the foliage of *Rosa* spp. (Rosaceae) in Japan and the Russian Far East (Tokunaga et al. 1951; Okutani 1967; Shinohara 2005). The females lay an average of ca 40 eggs in several egg masses in young and soft rose shoots. The hatched larvae form compact aggregations on a few leaflets near the tips of the shoots and often cause serious damage to wild and cultivated roses (Tokunaga and Tsujita 1951; Adachi 1981, 1983a). One generation requires approximately 45 days at 25 °C (Adachi 1981). Adult sawflies appear twice in late June and late August in northern Japan (Hokkaido) (Hara 2010), and continuously from late April to October in the lowlands of southern Japan (western Honshu) (Adachi 1983a; Yoshida 2006). Eggs deposited on wild roses can almost always be observed from May to October in western Honshu, but the egg density fluctuates markedly (Fig. 1 in Adachi 1983a), making an assessment of the number of generations per year difficult. Moreover, larval abundance appears to increase in the fall following a summer decline (Osaka Plant Protection Association 2003). The puzzling seasonal patterns in this multivoltine sawfly may be due to partial summer diapause before adult emergence, which is the case for the noctuid *Mamestra brassica* (Masaki and Sakai 1965) as well as some other insects (Masaki 1980), in addition to variable adult emergence of the overwintered generation in spring (Adachi 1983a).

To explore the variable life cycle of *A. nigrinodosa*, we examined the temporal variability of adult emergence, its heritability, and the prepupal development of the sawfly under constant conditions in the laboratory. The ecological significance of variable adult emergence is discussed with reference to changes in the abundance of larval food resources detected in the field.

Materials and methods

Locality and weather conditions

Arge nigrinodosa eggs and larvae were collected at the campus of Kobe University (34°43.7'N, 135°14.1'E; altitude ca. 200 m), Kobe City, Hyogo Prefecture, western Honshu, Japan, and a field census of wild roses [*Rosa multiflora* (Rosaceae)] was con-

ducted in the same place. Insects were reared in the laboratory at Kobe University or under outdoor field conditions at Karatodai (34°47.4'N, 135°12.8'E; altitude ca. 350 m), Kobe City. The monthly mean natural day length including one hour of twilight in this area is about 14.1 h in April, 15.0 h in May, 15.5 h in June, 15.3 h in July, 14.6 h in August, 13.4 h in September, and 12.5 h in October.

Figure 1 shows the monthly mean air temperatures and monthly precipitation from 1981 to 2010 at the Kobe Meteorological Station (34°41.8'N, 135°12.7'E) (Japan Meteorological Agency), indicating that August is the hottest and driest month on average. In August, the monthly precipitation is often less than 25 mm (Fig. 2).

Variability of adult emergence under long-day conditions and its heritability

To record the number of days from cocoon spinning to adult emergence, eggs and young larvae collected in May and June 2006 were reared at 20°C with a 16L–8D photoperiod in transparent plastic boxes (14 cm diameter, 7 cm depth) containing fresh leaves of *R. multiflora*, which were renewed every 5 - 10 days. The emerged virgin female adults were placed individually in the same type of transparent plastic box, each containing a young shoot of *R. multiflora* provided for oviposition, and kept at 25°C with a 16L–8D photoperiod. To record the number of days from cocoon spinning to

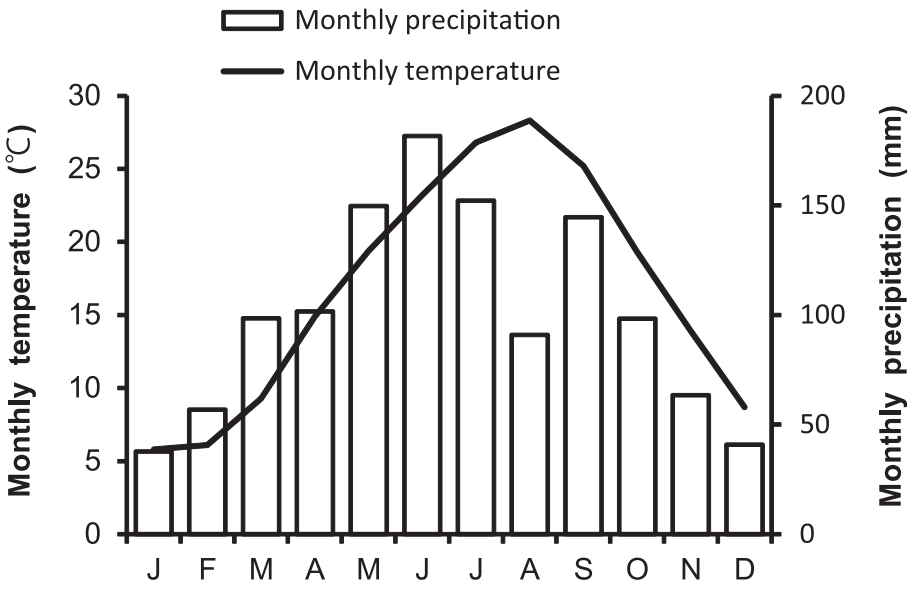


Figure 1. Monthly mean air temperatures and monthly precipitation from 1981 to 2010 at the Kobe Meteorological Station.

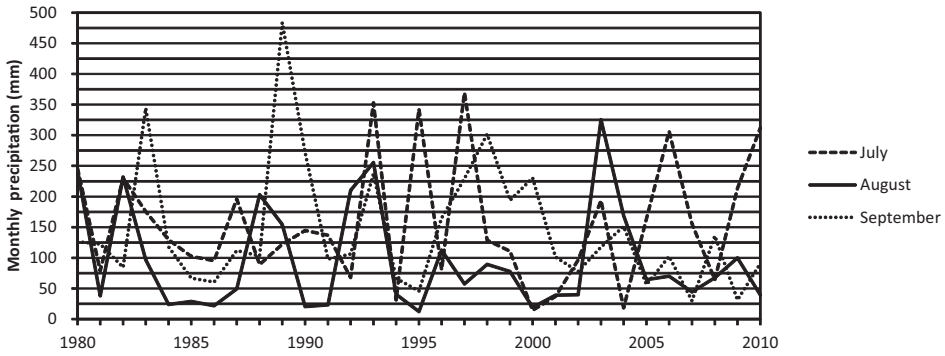


Figure 2. Annual changes in the monthly precipitation in July, August, and September from 1980 to 2010 at the Kobe Meteorological Station.

adult emergence, larvae hatched from deposited eggs (all haploid males) were reared at 20°C with a 16L–8D photoperiod.

Adult emergence under field conditions in summer generations

Eggs or larvae were collected from the foliage of *R. multiflora* on 24 May and 4 July 2007. They were reared outdoors, under shaded conditions, in transparent plastic boxes (14 cm diameter, 7 cm depth) containing fresh leaves of *R. multiflora*, which were renewed whenever wilted. Cocoons spun by larvae were moved to individual small transparent glass tubes (1 cm diameter, 4 cm length), with the opening covered with aluminum foil. The glass tubes were grouped together in transparent plastic boxes (14 cm diameter, 7 cm depth). The dates of cocoon spinning, adult emergence, and sex of the adults were recorded.

Shoot phenology of wild roses.

In early April 2007, 40 stem shoots of the current year's growth of *R. multiflora* were chosen for successive measurements. The shoot lengths were measured and the number of lateral shoots emerging from the stems was recorded every two weeks from late April to early October.

Prepupal development in cocoons

We observed the formation of pupal compound eyes through the translucent prepupal head capsules. The outline of the pupal eye (shaped like an eyebrow) increased in length during the transition from eonymph to pronymph (cf. Hamel et al. 1998).

Eggs collected on 17 May 2008 were reared under field conditions as described above. Using forceps we dissected eight cocoons from which adults had not emerged within 40 days after cocoon spinning, and we measured the length of pupal eye outlines of prepupae every week until pupation with a digital microscope (VH-8000, Keyence, Osaka, Japan).

Eggs collected in June 2008 were reared at 20°C with a long-day (16L–8D) or short-day (13L–11D) photoperiod. Under the long-day photoperiod, most adults emerged by 20 days after cocoon spinning while a portion of individuals entered what was presumably summer diapause. We dissected cocoons immediately after spinning and those remaining 25 days after spinning to measure the length of pupal eye outlines until pupation. Under the short-day photoperiod, all individuals entered what was presumably winter diapause; we dissected cocoons to measure the length of pupal eye outlines from 39 to 61 days after cocoon spinning.

Results

Variability of adult emergence under a long-day condition and its heritability

Under a constant temperature of 20°C with a photoperiod of 16L–8D, adult emergence exhibited a trimodal pattern (Fig. 3). The first and largest cluster of emergence occurred 13–24 (males) and 13–28 (females) days after cocoon spinning, while the second emergence occurred 25–36 (males) and 31–40 (females) days after cocoon spinning. The first and second clusters were distinctly separated for females (Fig. 3a), whereas they were rather continuous for males (Fig. 3b). The third cluster of emergence occurred 45–64 (males) and 49–62 (females) days after cocoon spinning. The first, second, and third clusters of emergence included approximately 2/3, 1/6, and 1/6 of adults, respectively, for both sexes (Fig. 3).

Figure 4 shows adult emergence in the sons of mothers in the first, second, and third clusters of emergence. The sons of all three types of mothers exhibited the three clusters of emergence, except that no second cluster of emergence occurred for the sons of mothers in the first cluster (Fig. 4a). Assuming that the range of an emergence period for the first, second, and third clusters of sons is respectively 12–26 days, 27–40 days, and 41–65 days after cocoon spinning (Fig. 5), the proportion of the second cluster of sons to all sons was significantly different among the clusters of mothers (Fisher's exact probability test, $p < 0.001$), whereas that of the third cluster was not significantly different ($p = 0.277$).

No deaths occurred in the cocoon period in all these experiments, whereas we did not record the mortality of eggs and larvae before cocoon spinning.

Adult emergence under field conditions in summer generations

Of the cohort collected on 24 May 2007 (152 larvae spun cocoons from late May to late June), 99 adults emerged from early June to mid-August, 13 adults emerged around mid-

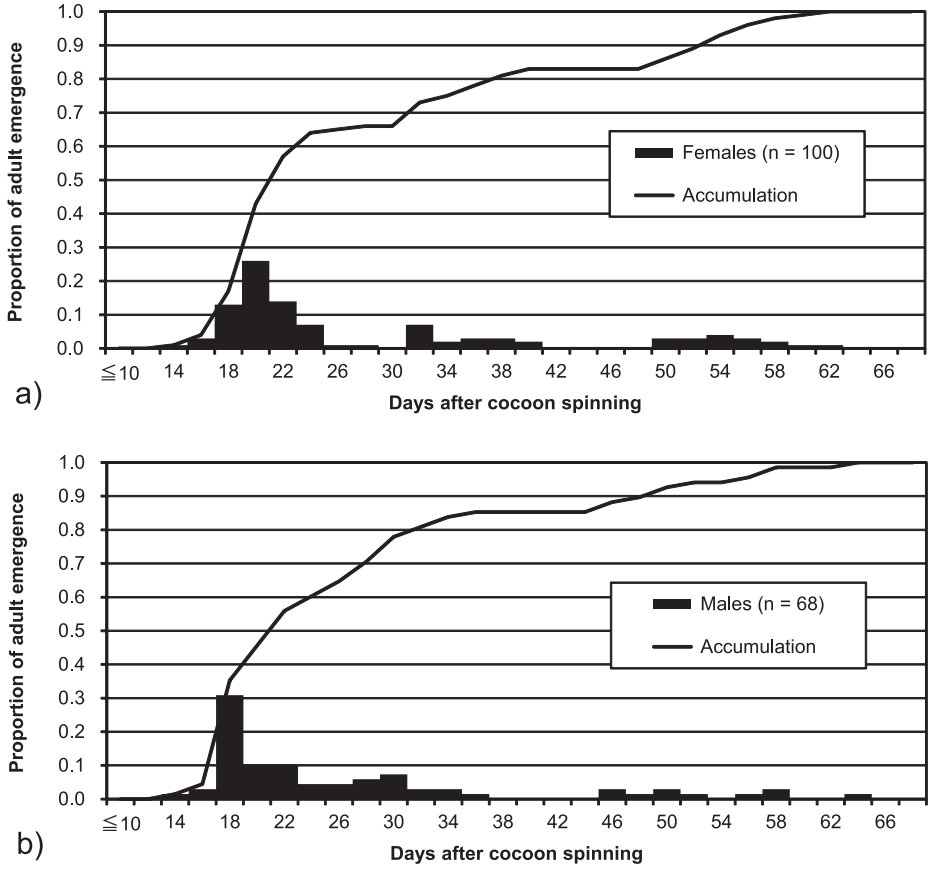


Figure 3. Adult emergence of females (**a**) and males (**b**) at 20°C with a 16L–8D photoperiod.

September (Fig. 6a), and the remaining individuals in cocoons died by the end of 2008, except for one male that emerged in early May 2008. Mortality in the cocoon period was 0.257 (39/152). A peak of adult emergence occurred around 26–30 days after cocoon spinning, following by a long tail of delayed emergence (Fig. 6b), and a cluster of adult emergence over 90 days after cocoon spinning was observed in September (cf. Fig. 6a).

Of the cohort collected on 4 July 2007 (93 larvae spun cocoons from mid- to late July), 38 adults emerged from early to mid-August, nine adults emerged around mid-September (Fig. 7a), and the remaining individuals in cocoons died by the end of 2008. Mortality in the cocoon period was relatively high, 0.495 (46/93). A peak of adult emergence was observed around 12–14 days after cocoon spinning with a short tail of delayed emergence (Fig. 7b), and the cluster of adult emergence over 40 days after cocoon spinning was in September (cf. Fig. 7a), which is the same as observed for the cohort collected in May.

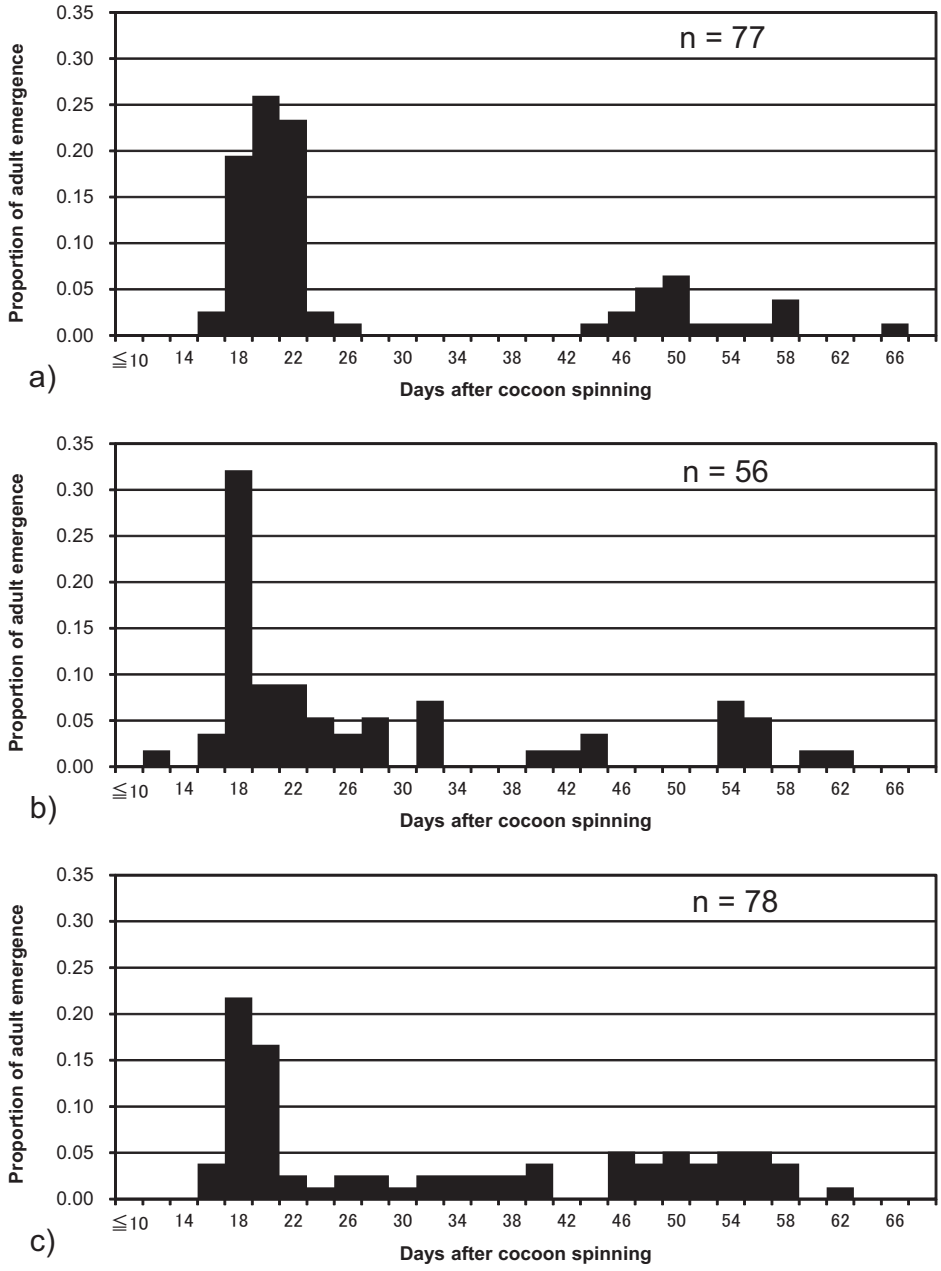


Figure 4. Adult emergence in the sons from mothers in the first (**a**), second (**b**), and third (**c**) clusters of emergence (see Fig. 3a) at 20°C with a 16L–8D photoperiod. The number of mothers in the first (**a**), second (**b**), and third (**c**) clusters of emergence was 16, 10, and 8 respectively.

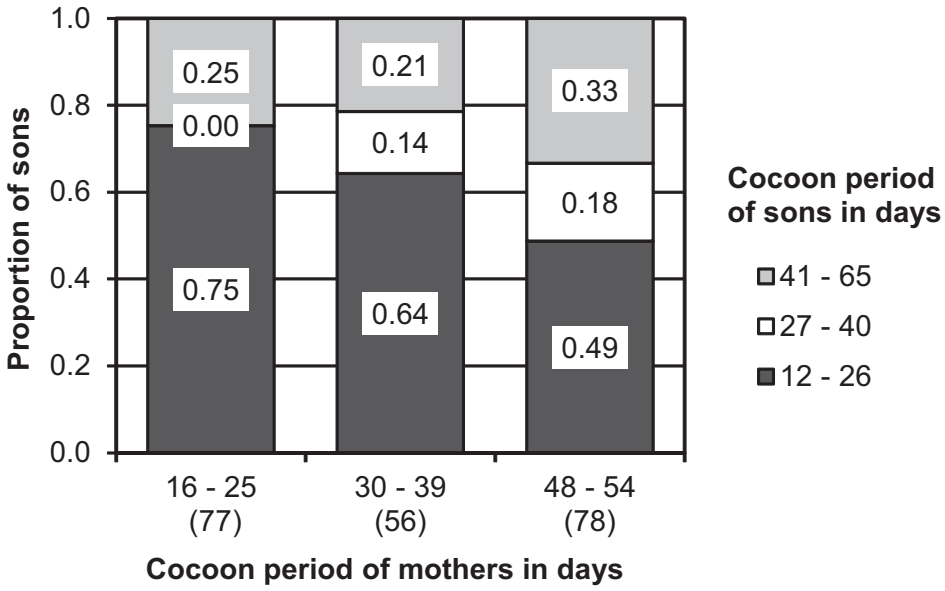


Figure 5. Proportion of the sons emerged after three cocoon periods for the mothers of three cocoon periods at 20°C with a 16L–8D photoperiod. Numbers in parentheses indicate the total numbers of sons that emerged.

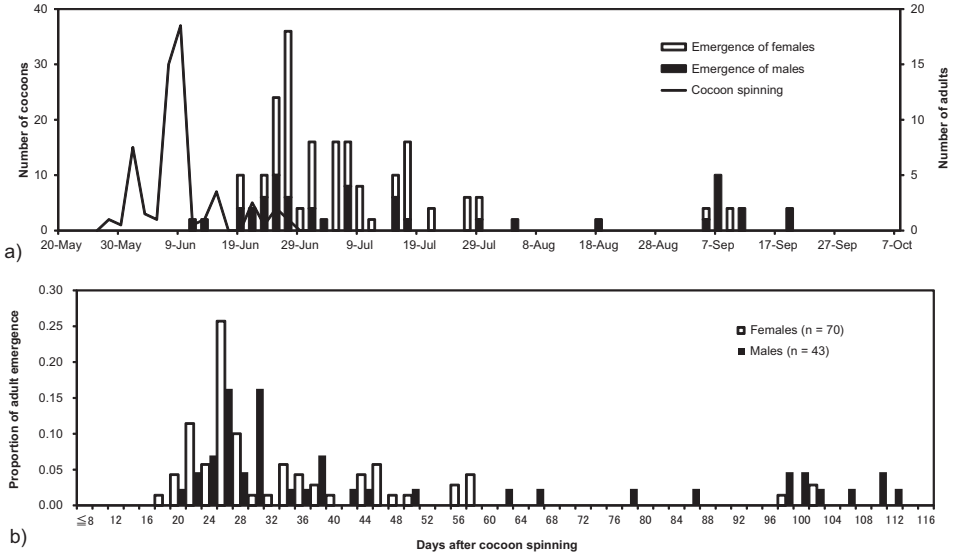


Figure 6. Cocoon spinning and adult emergence on the calendar (**a**) and the period from cocoon spinning to adult emergence (**b**) in the cohort collected on 24 May 2007.

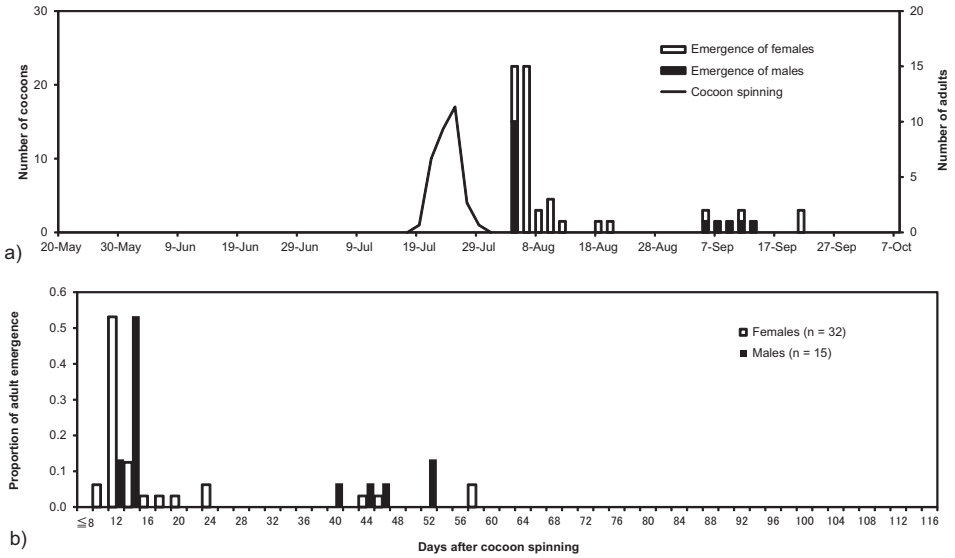


Figure 7. Cocoon spinning and adult emergence on the calendar (**a**) and the period from cocoon spinning to adult emergence (**b**) in the cohort collected on 4 July 2007.

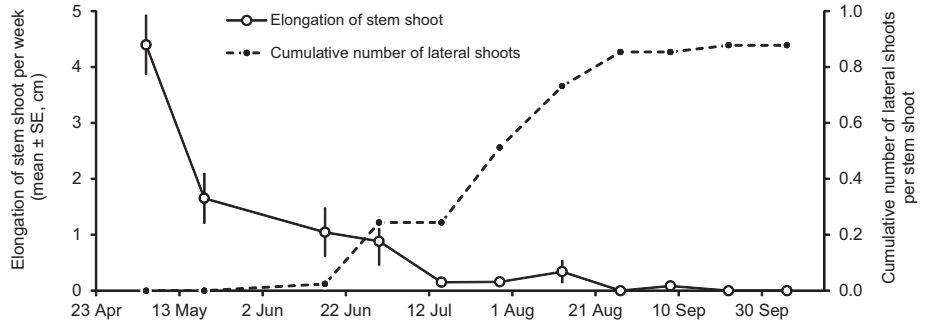


Figure 8. Elongation of the stem shoots of *Rosa multiflora*, along with the accumulation of its lateral shoots in 2007.

Shoot phenology of wild roses

Stem shoot elongation of wild roses started in late April and ceased in July when lateral shoots began to bud from the main shoots (Fig. 8). The accumulated number of the lateral shoots, which would elongate in fall, increased noticeably in July and August and leveled off in early September (Fig. 8).

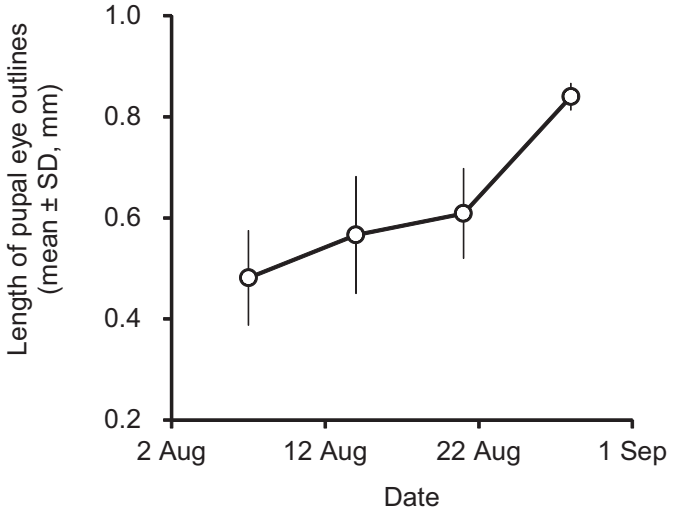


Figure 9. Changes in lengths of pupal eye outlines on prepupae in summer diapause under field conditions in 2008. Values are means ± SD (n = 8).

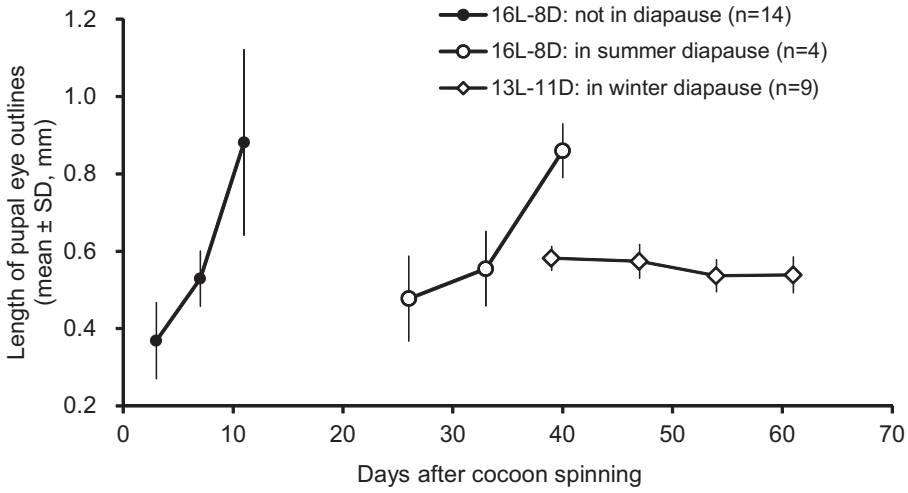


Figure 10. Changes in lengths of pupal eye outlines on prepupae not in diapause, in summer diapause at 20°C with a 16L–8D photoperiod, and in winter diapause at 20°C with a 13L–11D photoperiod. Values are means ± SD.

Prepupal development in cocoons

Under field conditions, the length of pupal eye outlines on the prepupae that remained over 40 days after cocoon spinning increased gradually until pupation in August (Fig. 9). At 20°C with the long-day (16L–8D) photoperiod, the pupal eye outlines of non-

diapause prepupae grew immediately after cocoon spinning, while those of prepupae in summer diapause increased gradually until pupation took place approximately 40 days after cocoon spinning (Fig. 10). At 20°C with the short-day (13L–11D) photoperiod, the length of pupal eye outlines of all prepupae remained short, likely reflecting winter diapauses (Fig. 10).

Discussion

Our laboratory experiments revealed that *Arge nigrinodosa* exhibits trimodal adult emergence under long-day conditions (Fig. 3). Soon after the first and largest cluster of emergence, a smaller second emergence takes place, which is followed by a third emergence after a discrete interval. Although the stage of delayed development to enable the second cluster of emergence was not identified, the third emergence was most likely caused by prepupal summer diapause (aestivation), in which the elongation of pupal eye outlines is temporarily interrupted at approximately the same size as in winter diapause (hibernation) under the short-day conditions (Fig. 10).

We analyzed the genetic background of polymodal adult emergence by comparing the emergence of sons from mothers of different adult emergences. The second cluster of emergence appears to be under genetic control because it was totally absent in the sons (haploid) of the mothers (diploid) in the first cluster of emergence (Fig. 5). In contrast, no heritability of the third cluster of emergence was supported given that its proportion was the same among the sons of mothers of all three clusters of emergence (Fig. 5).

The first cluster of adult emergence in the laboratory clearly corresponds to the early prevailing peak of adult emergence in the field, while the second one most likely represents a tail of delayed emergence after the peak (Figs 6, 7). The cluster of adult emergence occurred in September for both cohorts collected in May and July, and seems to match the third cluster of emergence in the laboratory. Synchronous adult emergence in September after prepupal summer diapause (Fig. 9) appears to be regulated by the changing day length and/or temperature in late summer (Baeza Larios and Ohno 2007), but why does it take place in September?

Given that *A. nigrinodosa* lays a large egg mass on a single rose shoot, the larvae often encounter food shortage (Adachi 1983b). Indeed, the food resources available to larvae drastically decline in summer, then increase again with the elongation of accumulated lateral shoots in fall (Fig. 8). Also, as shown in Figures 1 and 2, August is the most severe and highly variable month in terms of weather conditions. The extremely low rainfall in August, as observed during the last three decades, could be fatal to larvae, or at least severely worsen the food shortage. Therefore, partial summer diapause before adult emergence may be a risk-spreading (i.e., bet-hedging) strategy to cope with such uncertainty (Hopper 1999; Danks 2006). Alternative tactics for risk-spreading tend not to be inherited and are maintained as a stochastic polyphenism (Walker 1986) or adaptive coin-flipping (Cooper and Kaplan 1982). This is probably

the case for *A. nigrinodosa*, in which the third cluster of adult emergence is not heritable, but its proportion is genetically determined.

Conversely, the second cluster of adult emergence, which occurs soon after the first and normal emergence, appeared heritable, indicating genetic polymorphism. Furthermore, it probably takes place too soon after the normal emergence to disperse weather risks. Even though reliable data are lacking to gain a thorough understanding of the adaptive value of a slightly delayed adult emergence, note that a gregariously feeding sawfly such as *A. nigrinodosa* may incur a high risk of producing diploid males after consecutive sib-mating owing to a system of complementary sex determination (CSD) (Cook and Crozier 1995). While the sex determination mechanism of *A. nigrinodosa* has not been elucidated, according to Tikahiko Naito (personal communication), his unpublished data indicate CSD for the species. A slight delay of adult emergence after that of most siblings might be advantageous for reducing the production of sterile, diploid males.

The adult emergence of the rose sawfly *A. nigrinodosa* in summer generations appears to consist of three components as follows: the first emergence (i.e., the normal emergence); a second, slightly delayed genetically determined emergence; and a third emergence that takes place randomly after partial summer diapause. Thus, the concept of voltinism, the number of generations in a year, may not be applicable in the life history of sawflies with polymodal adult emergence, as indicated by Shinohara and Hara (2008). However, what is likely more important is the understanding that the apparently complicated life history of multivoltine sawflies is not random, but that it can be understood as a suite of adaptive tactics for dealing with a variety of environmental factors.

Acknowledgements

We thank Prof. Emeritus T. Naito of Kobe University for his valuable advice and continuous support during this study. Thanks are also due to A. D. Liston and Dr T. Inoue for their helpful comments on the manuscript.

References

Adachi I (1981) Behavioral process of aggregation of the red-striped sawfly, *Arge nigrinodosa* Motschulsky (Hymenoptera: Argidae). Applied Entomology and Zoology 16: 29–36.

Adachi I (1983a) Ecological Studies on the Larval Aggregation of *Arge nigrinodosa.* PhD Thesis, Kyoto University, Kyoto. [in Japanese]

Adachi I (1983b) Economy of food utilization in a gregarious sawfly, *Arge nigrinodosa* Motschulsky (Hymenoptera: Argidae): relative abundance of food in the natural habitat and behavioral pattern of larval feeding. Researches on Population Ecology 25: 130–142. doi: 10.1007/BF02528788

Baeza Larios GL, Ohno K (2007) Larval summer diapause of *Chrysocharis pubicornis* (Zetterstedt) (Hymenoptera: Eulophidae), a pupal parasitoid of agromyzid leafminers: sensitive stage for diapause induction and effects of cool exposure on diapause termination. Applied Entomology and Zoology 42: 587–594. doi: 10.1303/aez.2007.587

Cook JM, Crozier RH (1995) Sex determination and population biology in the Hymenoptera. Trends in Ecology and Evolution 10: 281–286. doi: 10.1016/0169-5347(95)90011-X

Cooper WS, Kaplan RH (1982) Adaptive "coin-flipping": a decision-theoretic examination of natural selection for random individual variation. Journal of Theoretical Biology 94: 135–151. doi: 10.1016/0022-5193(82)90336-8

Danks HV (1994) Diversity and integration of life-cycle controls in insects. In: Danks HV (Ed) Insect Life-cycle Polymorphism: Theory, Evolution and Ecological Consequences for Seasonality and Diapause Control. Kluwer Academic Publishers, Dordrecht, 5–40.

Danks HV (2006) Key themes in the study of seasonal adaptations in insects II. Life-cycle patterns. Applied Entomology and Zoology 41: 1–13. doi: 10.1303/aez.2006.1

Hamel M, Géri C, Auger-Rozenberg MA (1998) The effects of 20- hydroxyecdysone on breaking diapause of *Diprion pini* L. (Hym., Diprionidae). Physiological Entomology 23: 337–346. doi: 10.1046/j.1365-3032.1998.00092.x

Hara H (2010) Sawflies (Hymenoptera, Symphyta) injurious to trees and shrubs in Hokkaido I: Xyelidae, Pamphiliidae, Argidae and Cimbicidae. Bulletin of the Hokkaido Forestry Research Institute 47: 51–68. [in Japanese]

Hara H, Shinohara A (2008) Taxonomy, distribution and life history of *Betula*-feeding sawfly, *Arge pullata* (Insecta, Hymenoptera, Argidae). Bulletin of the National Museum of Nature and Science, Series A (Zoology) 34: 141–155.

Hopper KR (1999) Risk-spreading and bet-hedging in insect population biology. Annual Review of Entomology 44: 535–560. doi: 10.1146/annurev.ento.44.1.535

Japan Meteorological Agency: Climate Statistics. http://www.data.jma.go.jp/obd/stats/data/en/index.html

Knerer G (1993) Life history diversity in sawflies. In: Wagner MR, Raffa KF (Eds) Sawfly Life History Adaptations to Woody Plants. Academic Press, San Diego, 33–59.

Maeto K, Ozaki K (1993) Two-year life cycle of the Red-headed Spruce web-spinning Sawfly, *Cephalcia isshikii* (Hymenoptera: Pamphiliidae). Applied Entomology and Zoology 28: 557–563.

Masaki S (1980) Summer diapause. Annual Review of Entomology 25: 1–25. doi: 10.1146/annurev.en.25.010180.000245

Masaki S, Sakai T (1965) Summer diapause in the seasonal life cycle of *Mamestra brassica* Linné (Lepidoptera: Noctuidae). Applied Entomology and Zoology 9: 191–205. doi: 10.1303/jjaez.9.191

Okutani T (1956) New sawflies from Japan (Studies on Symphyta IV). Insecta Matsumurana 20: 97–99.

Okutani T (1967) Food plants of Japanese Symphyta (I). Japanese Journal of Applied Entomology and Zoology 11: 43–49. [in Japanese with English summary]

Osaka Plant Protection Association (2003) Diseases and Pest Insects of Flowers and Vegetables – An Illustrated Guide to Horticultural Pests in Osaka Prefecture. http://www.epcc.pref.osaka.jp/afr/zukan/ [in Japanese]

Regas-Williams KA, Habeck DH (1979) Life history of a poison-ivy sawfly *Arge humeralis* (Beauvois) (Hymenoptera: Argidae). Florida Entomologists 62: 356–363. doi: 10.2307/3493992

Shinohara A (2005) Sawflies and woodwasps of the Akasaka Imperial Gardens and the Tokiwamatsu Imperial Villa, Tokyo. Memoirs of the National Science Museum, Tokyo 39: 225–238. [in Japanese with English summary]

Shinohara A, Hara H (2008) Taxonomy, distribution and life history of *Abelia*-feeding sawfly, *Arge suzukii* (Hymenoptera, Argidae). Japanese Journal of Systematic Entomology 14: 29–47.

Shinohara A, Hara H (2009) *Arge indicura* n. sp. feeding on *Potentilla* and *Sanguisorba* (Insecta, Hymenoptera, Argidae) from Japan. Bulletin of the National Museum of Nature and Science, Series A (Zoology) 35: 55–71.

Shinohara A, Hara H, Daito T (2008) Taxonomy, distribution and life history of *Sanguisorba*-feeding sawfly, *Arge suspicax* (Hymenoptera, Argidae). Japanese Journal of Systematic Entomology 14: 265–282.

Shinohara A, Yoshida H, Hara H (2007) Distribution records of willow-feeding sawfly, *Arge enodis* (Hymenoptera, Argidae), in Japan, with notes on its immature stages and life history. Japanese Journal of Systematic Entomology 13: 359–366.

Smith DR (1989) The sawfly genus *Arge* (Hymenoptera: Argidae) in the Western Hemisphere. Transactions of the American Entomological Society 115: 83–205.

Tokunaga M, Tsujita M (1951) Biological studies on the rosaceous leaf-feeder sawfly larvae. Scientific Reports of the Saikyo University, Agriculture 1: 77–100. [in Japanese with English summary]

Tokunaga M, Tsujita M, Yamazaki A (1951) Studies on the larvae of the Tenthredinidae (II). Morphological study on a rosaceous leaf-feeder sawfly, *Arge nigrinodosa* Motschulsky. Mushi 22: 17–24.

Walker TJ (1986) Stochastic polyphenism: coping with uncertainty. Florida Entomologist 69: 46–62. doi: 10.2307/3494744

Yoshida H (2006) Symphyta (Hymenoptera) of Osaka Prefecture, Japan. West Japan Hymenopterists' Club, Kakogawa, 128 pp. [in Japanese]

JHR 25: 15–18 (2012)
doi: 10.3897/JHR.25.2903
www.pensoft.net/journals/jhr

SHORT COMMUNICATION

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

Beldonea Cameron (Hymenoptera, Tenthredinidae, Tenthredininae) new to Thailand, and the males of *B. okutanii* and *B. impunctata*

David R. Smith[1]

1 *Systematic Entomology Laboratory, PSI, Agricultural Research Service, U. S. Department of Agriculture, c/o National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, MRC 168, Washington, DC, 20013-7012*

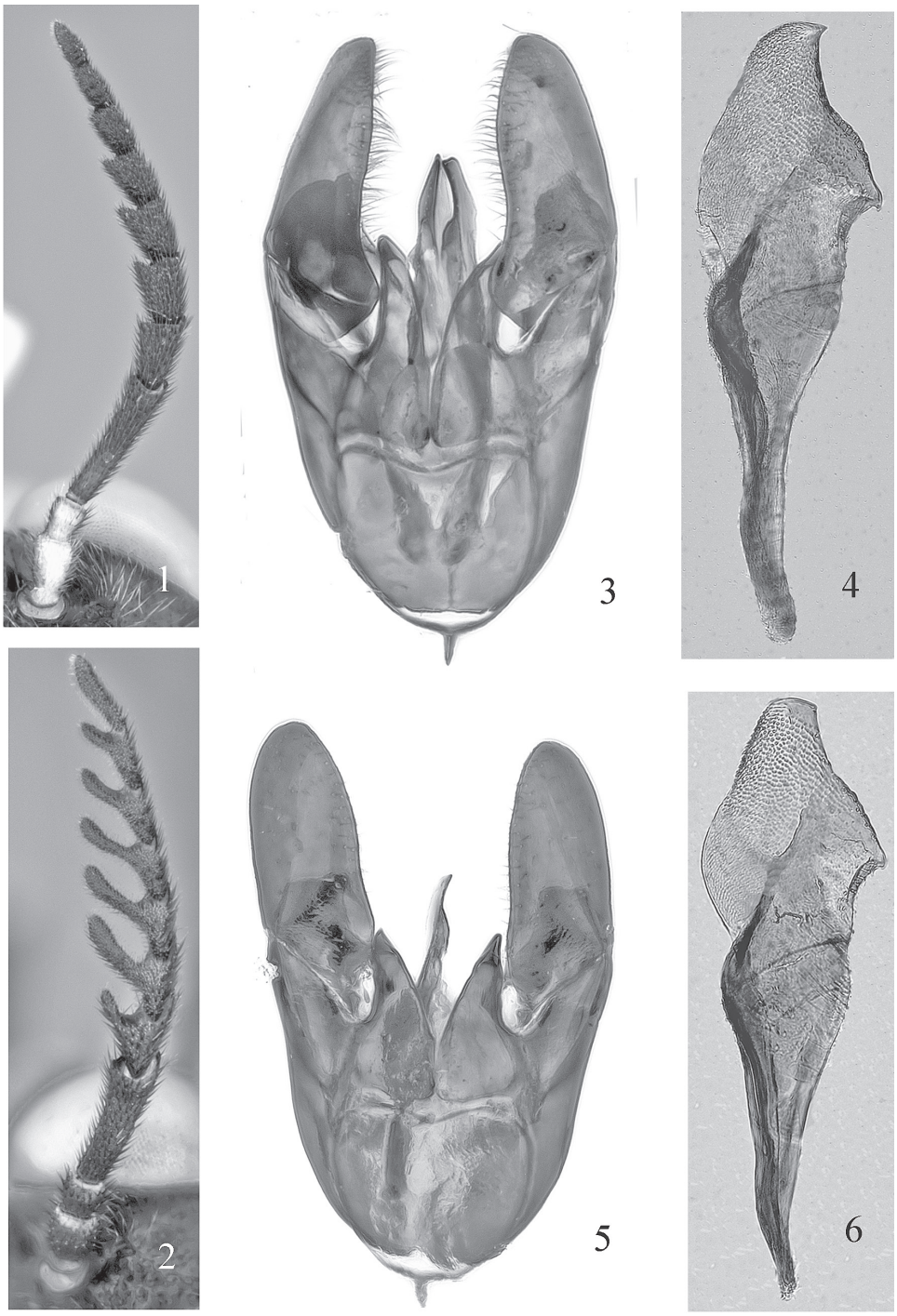
Corresponding author: *David R. Smith* (sawfly2@aol.com)

Academic editor: *S. Schmidt* | Received 13 February 2012 | Accepted 27 February 2012 | Published 23 March 2012

Citation: Smith DR (2012) *Beldonea* Cameron (Hymenoptera, Tenthredinidae, Tenthredininae) new to Thailand, and the males of *B. okutanii* and *B. impunctata*. Journal of Hymenoptera Research 25: 15–18. doi: 10.3897/JHR.25.2903

Beldonea Cameron is an unusual genus of Tenthredininae, which, in part, is distinguished from other genera of the subfamily by the serrate antennae of the female (Fig. 1) and pectinate antennae of the male (Fig. 2). Lacourt (1996) proposed a new subfamily and new tribe of Tenthredininae, Beldoneinae and Beldoneini, for this genus, including only *Beldonea* and synonymizing *Flagellaria* Saini et al. Almost simultaneously, Wei (1997) proposed a new tribe, Beldoneini, including four genera, *Beldonea*, *Flagellaria*, *Cromaphya* Rohwer, and *Oculocornia* Wei. Lacourt's (1996) synonymy of *Beldonea* and *Flagellaria* was followed by Saini et al. (2006), Saini (2007), and Taeger et al. (2010). However, Wei et al. (2006) chose to keep *Flagellaria* as a distinct genus. In different chapters in the same book, *Flagellaria* is treated as a valid genus (Wei et al. 2006) and as a synonym of *Beldonea* (Saini et al. 2006). Here, I follow Lacourt (1996), Saini et al. (2006), Saini (2007), and Taeger et al. (2010), although Wei (1997) makes some good justification for keeping *Flagellaria* valid, e.g., the 10-segmented, serrate antenna (Figs 1, 2), absence of antennal organs, round metepimeral appendage, and impunctate mesopleuron.

The genus and species, *Beldonea impunctata* (Wei), are recorded from Thailand for the first time. The presence of the genus in Thailand is not surprising since it has been recorded from Malaysia (Malay Peninsula), China (Hainan and Yunnan), and northeastern India (as *Flagellaria*, Wei 1997). Five species of *Beldonea* are listed by Taeger et



Figures 1–6. Antennae and male genitalia. **1** Female antenna of *Beldonea impunctata*. **2** Male antenna of *B. impunctata* **3** Male genital capsule, ventral, of *B. impunctata* **4** Penis valve, lateral, of *B. impunctata* **5** Male genital capsule, ventral, of *B. okutanii* **6** Penis valve, lateral, of *B. okutanii*.

al. (2010), *B. lubens* (Konow) and *B. okutanii* (Saini et al.) from India, *B. pendleburyi* (Forsius) from the Malay Peninsula, and *B. impunctata* (Wei) and *B. fumosa* Wei from China. Females of the Thai specimens clearly key to *B. impunctata*, described from Yunnan, in Wei's (1997) key to the four *Flagellaria* species. However, the malar space used by Wei (1997: 6, couplet 2) is invalid because *B. okutanii* has a linear malar space as do the other species, not broad as described by Saini et al. (1985).

The male of *B. impunctata* was unknown, but the series from Thailand associates the sexes, and the male is here separated from that of *B. okutanii* from India. Both are distinguished from *B. fumosa* Wei by the rounded apex of the penis valve (Figs 4, 6) as opposed to the acute apex in *B. fumosa* (Wei 1997, fig. 11). The color and antennal characters for B. *impuntata* and *B. okutanii* are identical and the only notable differences are in the genitalia. The general shape of the penis valve of *B. impunctata* (Fig. 4) is similar to that of *B. okutanii* illustrated by Lacourt (1996, fig. 57), Saini et al. (1985, fig. 15), and Saini (2007, fig. 652), although the illustrations of these authors slightly differ. These authors do not illustrate the genital capsule. The genital capsule and penis valve of both species are compared in Figs 3–6. In *B. impunctata* (Figs 3, 4), the inner margin of the harpe is more strongly indented, the parapenis is somewhat longer and more slender, and the penis valve has a somewhat stronger hook at its apex and longer and more slender valvura. In *B. okutanii* (Figs 5, 6), the inner margin of the harpe is almost straight, the parapenis is somewhat shorter and stouter, and the penis valve has a less defined hook at the apex and the valvura is broadened almost to the base. The punctures on the mesoscutellum also may be of some help. In *B. okutanii*, they are more numerous and as close or closer together than the shiny interspaces, whereas in *B. impunctata*, the punctures are less numerous and farther apart than the shiny interspaces.

New records for *B. impunctata* are as follows: THAILAND: Phetchabun, Khao Kho NP, deciduous forest at Ta Pol river, 16°32,539'N, 101°2.483'E, 242 m, Malaise trap, 26.v-2.vi.2007, Sonchai Chachumnan & Saink Singtong leg, T2558 (1 ♂); Kamphaeng Phet, Mae Wong NP, Chong Yen, 16°5.968'N, 99°6.472'E, 1306 m, Malaise trap, 1–8.x.2007, Chumpol Piluk & Aram Inpuang leg, T2816 (1 ♂); Kamphaeng Phet, Mae Wong NP, Chong Yen, 16°5.212N, 99°6.576'E, 1306 m, Malaise trap, 14–21.iv.2008, Piluek C. leg, T3633 (1 ♂); Kamphaeng Phet, Mae Wong NP, Chong Yen, 16°5.968'N, 99°6.472'E, 1306 m, Malaise trap, 3–10.ix.2007, Chumpol Piluk & Aram Inpuang leg, T2812 (1 ♀, 1 ♂); Chiang Mai, Doi Phahompok NP, Headquarter, 19°57.961'N, 99°9.355'E, 569 m, Malaise trap, 18–25.vii.2007, Seesom. K. leg, T2947 (1 ♂); Chiang Mai, Doi Phahompok NP, Headquarter, 19°57.961'N, 99°9.355'E, 569 m, Malaise trap, 25.vii-1.viii.2007, Wongchai. P. leg, T2951 (1 ♂); Chiang Mai, Doi Chiangdao NP, Pha Tang substation, 19°24.978'N, 98°54.886'E, 526 m, Malaise trap, 4–11.ix.2007, S. Jugsu & A. Watwanich leg, T5682 (1 ♂); Chiang Mai, Doi Phahompok NP, Headquarter, 19°57.961'N, 99°9.355'E, 569 m, Malaise trap, 1–7.viii.2007, Wongchai, P. leg, T2949 (2 ♀). Specimens are deposited in the Queen Sirikit Botanical Garden Entomological Collection, Chiang Mai, Thailand, and the National Museum of Natural History, Washington, D.C., USA (USNM).

I have examined a female and a male of *B. okutanii* collected from the type locality: India, Sikkim, Gangtok, 1750 m, 11-5-86, M. Saini (USNM).

Acknowledgments

Acknowledgments are due to National Science Foundation Grant DEB-0542864, Thailand Biodiversity Survey, to M. J. Sharkey, University of Kentucky, Lexington. Michele Touchet, Systematic Entomology Laboratory, USDA, Washington, D.C. (SEL) helped with the images. I thank J. Prena and T. J. Henry, SEL, Washington, D.C. for reviewing the manuscript. USDA is an equal opportunity provider and employer.

References

Lacourt J (1996) Contribution à une revision mondiale de la sous-famille des Tenthredininae (Hymenoptera: Tenthredinidae). Annales de la Société Entomologique de France (N.S.) 32(4): 363–402.

Saini MS (2007) Indian Sawflies Biodiversity, Keys, Catalogue & Illustrations. (Vol. II) Subfamily Tenthredinidae sans Genus *Tenthredo* L. Bischen Singh Mahendra Pal Singh, Dehra Dun, India, 234 pp.

Saini MS, Blank SM, Smith DR (2006) Checklist of the sawflies (Hymenoptera: Symphyta) of India. In: Blank SM, Schmidt S, Taeger A (Eds) Recent Sawfly Research: Synthesis and Prospects. Goecke & Evers, Keltern, 575–612.

Saini MS, Singh D, Singh M, Singh T (1985) Three new genera of Tenthredinidae from India (Hym. Symphyta). Deutsche Entomologische Zeitschrift 32: 325–334. doi: 10.1002/mmnd.19850320411

Taeger A, Blank SM, Liston AD (2010) World catalog of Symphyta (Hymenoptera). Zootaxa 580: 1–1064.

Wei M (1996) Description on a new species of the genus *Beldonea* Cameron (Hymenoptera: Tenthredinidae) in China. Entomotaxonomia 18: 65-68.

Wei M (1997) Erection of Beldoneini tribe nov. (Hymenoptera: Tenthredinidae) with descriptions of a new genus and three new species from China. Entomotaxonomia 19: 1–10.

Wei M, Nie H, Taeger A (2006) Sawflies (Hymenoptera: Symphyta) of China – checklist and review of research. In: Blank SM, Schmidt A, Taeger A (Eds) Recent Sawfly Research: Synthesis and Prospects. Goecke & Evers, Keltern, 505–574.

JHR 25: 19–33 (2012)
doi: 10.3897/JHR.25.1810
www.pensoft.net/journals/jhr

RESEARCH ARTICLE

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

Trigonalidae (Hymenoptera) from cacao agroforestry systems in northeastern Brazil, with two new species of *Trigonalys* Westwood

Bernardo F. Santos[1,†], Alexandre P. Aguiar[2,‡], Anazélia M. Tedesco[3,§]

1 *Universidade Federal do Espírito Santo, Depto de Ciências Biológicas, Av. Fernando Ferrari, s/n - Goiabeiras, Vitória, ES, 29075–010, Brazil*

† *urn:lsid:zoobank.org:author:9C1440DE-0C44-4F08-A312-2D1220A73E57*
‡ *urn:lsid:zoobank.org:author:6CA248DA-56F5-45C3-9642-5B7B1F2A617A*
§ *urn:lsid:zoobank.org:author:2991B785-A9E3-4776-B7E9-D1BFD0085EA0*

Corresponding author: *Bernardo Santos* (bernardofsantos@gmail.com)

Academic editor: *W. Pulawski* | Received 16 July 2011 | Accepted 16 February 2012 | Published 23 March 2012

urn:lsid:zoobank.org:pub:55222C6B-9348-40E1-A495-04653889F633

Citation: Santos BF, Aguiar AP, Tedesco AM (2012) Trigonalidae (Hymenoptera) from cacao agroforestry systems in northeastern Brazil, with two new species of *Trigonalys* Westwood. Journal of Hymenoptera Research 25: 19–34. doi: 10.3897/JHR.25.1810

Abstract

A survey of Trigonalidae from cacao (*Theobroma cacao* L.) agroforestry systems in southern Bahia, northeastern Brazil, is conducted. A total of 65 specimens were studied, and three species are recognized. *Trigonalys melanoleuca* Westwood is diagnosed and illustrated. Two new species are described and illustrated. *Trigonalys erythrocephala* **sp. n.** has most of head reddish brown; metasomal armature in sternum III conspicuous, Y-shaped; supra-antennal elevation conspicuous; hind coxa with sharp lateral angles, its dorsomesal portion strigate; legs entirely dark brown; and fore wing lightly infuscate, darker towards anterior margin. *Trigonalys gotica* **sp. n.** with body blackish or dark brown and has pale yellow marks; mesopleuron with an oblique mark; female armature absent; frons and vertex punctate-areolate; supra-antennal elevation subtle; propodeal foramen V-shaped; and fore wing vein M arising distinctly basad to 1cu-a.

Keywords

Hyperparasitoid, Trigonalyidae, Trigonaloidea, Malaise

Introduction

Trigonalidae (Hymenoptera, Trigonaloidea) are a remarkable group of parasitoid wasps, with a unique biology (Carmean 1991) and a persistently elusive phylogenetic placement within Hymenoptera (Sharkey 2007). Species of this family are usually considered to be rare or difficult to collect (e.g., Carmean and Kimsey 1998), and most collections worldwide hold only a few specimens. As far as we know, there are no published records of Trigonalidae associated with agricultural systems, even considering specific sampling programs in, e.g., coffee (Perioto et al. 2004, Santos and Pérez-Maluf 2010), cotton (Perioto et al. 2002a), soybean (Perioto et al. 2002b), *Eucalyptus* (Dall'Oglio et al. 2000), and crop rotation (Souza et al. 2006).

In Brazil, cacao (*Theobroma cacao* L., Sterculiaceae) is a major commodity, mostly cultivated in agroforestry systems, using planted shade trees or thinned native forest, the so-called *cabruca*, usually intermingled with untouched forest remnants (Vinha et al. 1983). These systems are both less vulnerable to pest outbreaks and important for conservation of natural habitats (see Nakayama et al. 2008 for an outline). Preliminary assessments of the parasitoid fauna in cacao agroforestry systems were performed by Sperber et al. (2004) and Nakayama et al. (2008), but no specimens of Trigonalidae were collected in those studies.

Here, we present a study of the Trigonalidae from cacao agroforestry systems, and describe two new species of *Trigonalys* Westwood. Very little is known on the biology of this genus. There are two records of species of *Trigonalys* reared from species of Lepidoptera (Schultz 1910, Carmean and Kimsey 1998). Considering the predominantly hyperparasitoid way of life of the Trigonalidae, the *Trigonalys* species may be hyperparasitoids, and the Lepidoptera their primary hosts.

Materials and methods

A total of 128 collecting events were conducted in several private properties, in 19 municipalities in southern Bahia, northeastern Brazil, during 2002–2003 and 2006–2007. These collecting trips were organized and conducted by Julia M. O. Valverde, Kazuiyuki Nakayama, and others at *Comissão de Aperfeiçoamento da Lavoura Cacaueira* (CEPLAC/Brazil). On each collecting trip in 2002–2003, eight Townes' style Malaise traps (Townes 1972) were set to collect continuously for seven days. In 2006–2007, 18 collecting trips were conducted, each using two Malaise traps for seven days. All traps were set in areas of cacao agroforestry systems. Most of the collecting effort was concentrated in the humid season (November to March), but some areas were also sampled during the dry season (April to August). The total sampling effort amounts to 6,412 trap-days.

All observations, including details of sculpturing and color, were made using a Leica M80 stereomicroscope with 10× oculars, and a 9W fluorescent lighting bulb. Measurements were taken with a 10 mm ocular grid with 100 divisions, attached to a

Leica MZ12.5. Images were generated using the extended-focus system by EntoVision (GTVision, Hagerstown, Maryland), including a Leica Z16 zoom lens attached to a JVC KY-75U 3-CCD digital video camera that feeds image data to a desktop computer. The stacks of pictures produced with CARTOGRAPH were combined into a full-focus image with COMBINEZM (http://www.hadleyweb.pwp.blueyonder.co.uk/CZM/combinezm.htm). All images are also available at www.morphobank.org. The respective accession numbers are indicated in the legends of the figures.

Morphological terminology follows Carmean and Kimsey (1998), as adapted from Gauld and Bolton (1988). The hypoepimeron, and the scrobal sulcus which delimits it ventrally, are used here in the same sense as the "hypoepimeral area" and the "scrobal suture", respectively, of Richards (1956). Surface sculpture terminology follows Harris (1979). Genus-level identifications were performed with the key provided by Carmean (2006). All specimens are deposited in the collections of *Universidade Federal do Espírito Santo* (UFES) or CEPLAC.

Results and discussion

A total of 65 specimens of Trigonalidae were collected. Three species of *Trigonalys* Westwood were recognized: *T. melanoleuca* Westwood, and two new species, described below. Most specimens were collected in November, probably because of the higher sampling effort in that month. Specimens were however collected throughout the year, in January, February, April, June, August, November, and December.

The numbers of specimens collected in these events are unusual compared with the well-known rarity of Trigonalidae in general. These wasps have been consistently difficult to obtain in all collecting trips performed by the authors in all major Brazilian ecosystems. Additional evidence to this observation is the absence of trigonalid specimens in most inventory-driven projects (e.g., Noyes 1989, Azevedo et al. 2003, Perioto et al. 2005). Our observations suggest that the usual capture success for Malaise traps, lies around one specimen for each 1,000–2,000 trap-days. The capture success in the cacao agroforestry system, however, yielded an impressive ratio of one specimen for each 98 trap-days, which is about 10 to 20 times higher than expected. Murphy et al. 2009 report the capture of hundreds of specimens in North America, but the high success of capture reported here seems to be an unique record for South America.

Table 1. Number of specimens of Trigonalidae (Hymenoptera) collected in a cacao agroforestry system in southeastern Brazil, with totals for each species, for females, males, and total, followed by the corresponding male/female sex ratio (*m/f Ratio*).

Species	Females	Males	Total	m/f Ratio
T. melanoleuca Westwood	13	28	45	2.15
T. gotica sp. n.	8	10	18	1.25
T. erythrocephala sp. n.	2	0	2	-

The reasons for this unexpectedly high abundance, in this particular environment, have not been investigated. One possibility, however, is that the high concentration of cacao trees might have contributed to maintain high levels of directly or indirectly associated populations of suitable hosts.

Taxonomy

***Trigonalys melanoleuca* Westwood**
http://species-id.net/wiki/Trigonalys_melanoleuca
Figs 1–2

Trigonalys melanoleuca Westwood 1835:53. Lectotype ♀, designated by Carmean and Kimsey (1998), Brazil (BMNH, not examined)

Diagnosis. Black with whitish marks; mesopleuron with large white mark placed just ventrad to scrobal sulcus; legs with extensive white marks; propodeum and metasoma with extensive whitish or yellow marks. Fore wing distinctly infuscated, much darker centrally and antero-apically; metasomal armature absent, posterior margin of tergum I rounded (Fig. 2); propodeum uniformly punctate; propodeal foramen shaped as an inverted U.

Material examined. 13 ♀♀, 28 ♂♂. BRAZIL, Bahia, Malaise trap, JCardoso & JMaia. 1 ♀, Barra do Rocha, Fazenda Iacina, Pt. 1, 19.XI.2002. 3 ♂♂, Buerarema, Fazenda Boa Sorte, Pt. 3, 29.XI.2002; 1 ♂, same data except Pt. 4; 4 ♂♂, same data except Pt. 5; 3 ♂♂, same data except Pt. 6; 1 ♂, same data except Pt. 7. 1 ♂ from Ilhéus, CEPLAC/ESOMI, Borda, Pt. 2, 8.VIII.2001. 1 ♀, Ipiaú, Fazenda Afegan, Pt. 2, 21.XI.2002. 1 ♂, Itacaré, Fazenda Muchirão, Pt. 1, 22.XI.2002; 1 ♀, same data except Pt. 7, 9.IV.2003. 1 ♀, Itororó, Fazenda Bela Vista, Pt. 8, 15.XII.2003 (UFES). 1 ♂, Ubaitaba, Fazenda Casa de Pedra, Pt. 1, 9.IV.2003; 1 ♂, same data except Pt. 3; 1 ♀, same data except Pt. 4, 13.XII.2003; 1 ♀, same data except Pt. 5, 16.VIII.2002; 1 ♂, same data except 9.IV.2003; 1 ♀ 1 ♂, same data except Fazenda Fortaleza, pt. 1, 16.VIII.2002; 1 ♂, same data except Pt. 3; 1 ♂, same data except Pt. 4, 20.XI.2002; 2 ♂♂, same data except XII.2003; 1 ♀ 6 ♂♂, same data except Pt. 5, 20.XI.2002; 1 ♂, same data except 15.VI.2003; 1 ♀, same data except Pt. 6; 1 ♂, same data except 13.XII.2003; 1 ♀, same data except Pt. 8, 9.IV.2003. 1 ♂, Uruçuca, Fazenda Bom Jardim, 12.IV.2003; 1 ♀, same data except Pt. 2, 23.XI.2002; 1 ♂, same data except 9.XII.2003 (CEPLAC); 1 ♀, same data except Pt. 4, 23.XI.2002; 1 ♀, same data except Pt. 8 (UFES).

Comments. *Trigonalys melanoleuca* was one of the first trigonalid species to be described. It may be the most commonly collected species of the family in the Neotropics. In spite of that, its hosts are still unknown. The examined specimens exhibit substantial intraspecific variation, particularly the wing venation. This high variation, however, seems to be the rule for Trigonalidae as a whole (Carmean and Kimsey 1998).

Figures 1–2. *Trigonalys melanoleuca* Westwood. **1** Lateral habitus. Morphobank accession number (M99947) **2** Dorsal habitus. Morphobank accession number (M99948)

***Trigonalys erythrocephala* Santos & Aguiar, sp. n.**
urn:lsid:zoobank.org:act:BB34085C-A5DE-4DEB-98D4-71FDD83E7FE4
http://species-id.net/wiki/Trigonalys_erythrocephala
Figs 3–12

Holotype ♀, Brazil, Bahia, Uruçuca, Fazenda Bom Jardim, Pt 5, 25.XI.2002, Malaise trap, J. Cardoso & J. Maia (UFES). Mounted on a triangle point; in good condition.

Paratype ♀, same data as holotype, except Pt 7, 23.XI.2002 (CEPLAC).

Diagnosis. Frons, most of vertex, and temple, reddish brown; metasomal armature of sternum III conspicuous, Y-shaped; supra-antennal elevation stout, conspicuous; hind coxa dorsally somewhat concave longitudinally, forming two longitudinal edges on each side, throughout its length, dorso-mesal portion strigate; legs entirely dark brown; fore wing nearly uniformly infuscate, except slightly darker along anterior margin.

Description. Holotype: body length 8.5 mm; fore wing length 7.4 mm.

Head (Figs 1, 2–4). Mandible covered with long and moderately dense setae; ventral tooth of right mandible distinctly longest and narrowest, median teeth length subequal, [dorsal tooth not visible; mandibles closed, left mandible not observed].

Figures 3–12. *Trigonalys erythrocephala* Santos et Aguiar, **sp. n.** Holotype female. **3** Lateral habitus (Morphobank accession number M90448) **4** Head, antero-ventral (M90449) **5** Head, antero-dorsal, to show ocelli (M90450) **6** Head, dorsal (M90451) **7** Mesothorax, dorsal (M90452) **8** Propodeum and base of petiole, dorsal (M90453) **9** Apical segments of metasoma, latero-ventral, left, showing metasomal armature and ovipositor; arrow indicates position of longitudinal carina (M90454) **10** Pronotum, left (M90455) **11** Left hind coxa, to show lateral longitudinal carinae (arrows) and dorso-mesal strigation (M90456) **12** Apical tergites, to show abnormal development of tergites (M90457).

Clypeus 2.28 × as wide as maximum length, laterally distinctly pilose, centrally glabrous, faintly punctate. Inner margin of eyes subparallel; interocular distance at narrowest level 1.17 × maximum eye height. Antenna with 25 flagellomeres, about 1.4 × the lateral length of mesosoma; intertoruli distance slightly longer than distance from torulus to inner margin of eye. Supra-antennal elevation conspicuous, laterally a sharp carina (Fig. 5), between antennae with rounded border. Frons pilose, densely punctate; punctation at median portion dorsally sparse, feeble; frons medially with a subtle longitudinal depression; area around and between ocelli slightly concave (Fig. 5). Vertex shiny, densely pilose, moderately punctate. Gena maximum width in lateral view 0.83 × maximum eye height, finely punctate, densely pilose, particularly at ventral 0.4. Occipital carina conspicuous, widest dorsally, narrowest ventrally.

Mesosoma (Figs 3, 7–8). Densely pilose. Pronotum: anterior, neck-shaped portion moderately long, laterally transversally wrinkled (Fig. 3), centrally distinctly concave, anterior margin wide, polished; pronotum lateral area dorsally densely punctate, ventrally sparsely punctate, its posterior margin with distinct longitudinal wrinkles; central portion of lateral area intensely concave, anteriorly with stout oblique carina (Fig. 10). Mesoscutum and scutellum deeply punctate (Fig. 7), almost punctate-reticulate; notaulus deeply impressed, with distinct transverse wrinkles inside; median lobe of mesoscutum progressively raised from lateral lobes, until quite detached at anterior end; median lobe and scutellum with shallow but distinct mid-longitudinal sulcus; scutellum anteriorly with distinct longitudinal crenulation, centrally distinctly projected, subpyramidal; posterior margin shiny and impunctate. Hypoepimeron distinctly projected, subpyramidal, punctate, except small posterior area shiny and impunctate; scrobal sulcus distinct, somewhat crenulate; mesopleuron otherwise mostly punctate to areolate-punctate. Mesopleural suture dorsally deeply carinate. Metanotum (a narrow yellow stripe; Fig. 7) anteriorly moderately punctate, posteriorly impunctate; metapostnotum (the subsequent black stripe) rugose. Metapleuron finely punctate. Transverse sulcus at base of propodeum as long as metapostnotum, shallow, finely crenulate (Fig. 8). Propodeum densely pilose, laterally setae distinctly longer than centrally; antero-lateral corners longitudinally rugose, otherwise mostly punctate-areolate or areolate-rugose, centrally and posteriorly in concentric patterns, anteriorly with shiny and almost impunctate area; propodeal spiracle covered by prominent, tubercle-like flap. Propodeal foramen somewhat M-shaped (Fig. 8). Hind coxa with two sharp lateral angles extending throughout its length (Fig. 11), dorso-mesal portion strigate.

Wings. Fore wing vein M arising almost opposite to crossvein 1cu-a; crossvein 2m-cu distinctly sinuous, with bulla on anterior 0.75; crossveins 2r-m and 3r-m almost straight. Second submarginal cell distinctly petiolate; third submarginal cell subtrapezoidal, slightly wider than high.

Metasoma. Densely covered with short setae. Tergum I slightly concave, short and broad, trapezoidal in dorsal view; 0.45 × as long as maximum width, apical width

1.48 × basal width; mid-basally with a few distinct, somewhat concentric rugulosities; posterior margin nearly straight across, with large but shallow punctures. Terga II–V and sterna I–V densely punctate, densely covered with short setae. Metasomal armature developed on sternum III as single, Y-shaped, very sclerotinized projection, with pointed corners (Fig. 9). Ovipositor sheath shaped as a curved beak, laterally with longitudinal carina (Fig. 9).

Color. Head mostly reddish brown, body mostly black, with yellowish marks. Head: antenna basally ferruginous, otherwise brown or nearly so; palpi dark brown; ventral margin of mandible, teeth apex, clypeal borders, small marks dorsad to toruli, subtriangular mark on vertex and most of gena and occiput, black; mandible except apex, clypeus, area around ventral 0.7 of eye and small marks on gena and around subtriangular black area, pale yellow; subapical portion of mandible between yellow and black areas, frons, most of vertex, and area around dorsal 0.3 of eye, reddish brown; vertex with dark, triangular mark behind ocelli, extending and narrowing posteriorly until it reaches occipital carina; a yellow stripe along each side of dark triangle. Mesosoma: black, except pale yellow to yellow on pronotal collar, dorsal margin of pronotum, margins of median mesoscutal lobe, alongside notaulus, lateral longitudinal marks on scutellum, axilla, metanotum, small central spot on mesopleuron, on apex of pyramidal projection, and J-shaped mark on each side of propodeum. Prominence of propodeal spiracle ferruginous. Legs apically to coxae dark brown. Wings slightly infuscate, fore wing darker towards anterior margin. Metasoma: black; all terga and sterna with posterior pale yellow stripes, on terga II–V also extending laterally; tergum VI brownish; sternum V almost entirely pale yellow.

Male. Unknown.

Variation. Holotype with terga II-IV showing anomalous development (Fig. 12). Paratype body length 9.3 mm; fore wing length 7.7 mm; yellow marks on gena and near subtriangular black mark at vertex, very subtle; propodeum anteriorly more distinctly sculptured, without shiny and almost impunctate area; propodeal foramen U-shaped; second submarginal cell less distinctly petiolate.

Comments. In terms of general morphology, this species is closest to *T. melanoleuca*, from which it can be readily differentiated by its color pattern, with frons, most of vertex, and part of gena, reddish brown (vs. black with whitish marks, without reddish brown areas in *T. melanoleuca*); yellow marks at pronotal collar, dorsal margin of pronotum, mesoscutum, scutellum, and metanotum (vs. marks absent); yellow mark at mesopleuron very small and placed dorsad to longitudinal sulcus (vs. large, placed ventrad to sulcus); legs entirely dark brown (vs. with extensive white marks); and yellow marks on propodeum and metasoma less extensive than in *T. melanoleuca*. Additionally, *T. melanoleuca* has the fore wing more distinctly infuscated, metasomal armature absent, posterior margin of tergum I rounded (vs. nearly straight), propodeum uniformly punctate (vs. laterally areolate, anteriorly coriarious and posteriorly striate) and propodeal foramen always shaped as an inverted U (vs. U- or M-shaped).

The color pattern of *T. erythrocephala* is more similar to that of *T. gotica*, which is also mostly blackish with yellow marks on the pronotal collar, dorsal margin of

pronotum, mesoscutum, scutellum, and metanotum. However, the two species differ markedly in general structure. *Trigonalys gotica* has a subtle supra-antennal elevation (vs. stout, conspicuous in *T. erythrocephala*); vertex deeply punctate-areolate (vs. moderately punctate); pronotal collar very slightly raised (vs. moderately raised), pronotum with a less evident oblique carina; hind coxa laterally with slight, blunt angles and without strigate area; propodeal foramen V-shaped (vs. U- or M-shaped), and female armature absent (vs. well developed).

T. erythrocephala can be differentiated from *T. sanctaecatharinae* mainly by the distinct, Y-shaped female armature (vs. delicate, not distinctly Y-shaped) and by the quite different color pattern (Figs 3, 20).

It can also be distinguished from the other New World species of *Trigonalys* as follows. Both *T. flavescens* Bischoff and *T. maculifrons* Sharp have an elongate body, resembling species of *Orthogonalys* Schulz. Both are also mostly yellow or orange with black marks, including the head yellow with black marks on frons (vs. reddish, without black marks at frons); scutellum yellow with posterior black mark (vs black with sublateral, narrow yellowish lines) and legs mostly yellow (vs. black and dark brown); basal third of tergum I dark brown and remainder yellow (vs. tergum I basal 0.7–0.8 black, apically yellowish). *Trigonalys championi* Cameron, has the antenna entirely black (vs ferruginous to brown); frons, vertex and gena black (vs. mostly reddish); fore wing entirely violaceous (vs. slightly infuscate, darker at anterior margin); propodeum and petiole mostly whitish (vs. propodeum black with sublateral narrow yellowish marks, petiole mostly black with apical 0.2–0.3 yellowish); and other metasomal segments entirely black (vs. with extensive yellowish marks).

Etymology. From the Greek *erythros*, red, and *cephalon*, head, in reference to the somewhat characteristic color of the head capsule.

***Trigonalys gotica* Santos & Aguiar, sp. n.**
urn:lsid:zoobank.org:act:2797E8BF-8824-4875-AE58-0AD9E5547B3B
http://species-id.net/wiki/Trigonalys_gotica
Figs 13–19

Holotype ♀, Ubaitaba, Fazenda Casa de Pedra, Pt. 5, 20.XI.2002 (UFES).

Paratypes. 1 ♀, Barra do Rocha, Fazenda Iacina, Pt. 1, 19.XI.2002. 1 ♂, Buerarema, Fazenda Boa Sorte, Pt. 5, 29.XI.2002; 2 ♂♂, same data except Pt. 7. 1 ♂, Ipiaú, Fazenda Petrolina, Sítio Casca, Oeste, 15.II.2007. 1 ♀, Itacaré, Fazenda Muchirão, Pt. 1, 22.XI.2002; 1 ♂, same data except Pt. 2, 12.XII.2003. 1 ♀, Itororó, Fazenda Santa Cruz, pt. 3, 24.XI.2002 (UFES); 1 ♂, same data except Pt. 7, 24.VIII.2003. 1 ♀ from Ituberá, Fazenda Vale da Juliana, Leste, 26.I.2007. 1 ♂, Ubaitaba, Fazenda Casa de Pedra, Pt. 5, 9.IV.2003; 1 ♂, same data except Fazenda Fortaleza, pt. 1, 16.VIII.2002; 1 ♀, same data except Pt. 4; 1 ♀, same data except XII.2003; 1 ♂, same data except Pt. 7, 20.XI.2002; 1 ♀, same data except Pt. 8, 16.VIII.2002. 1 ♂, Uruçuca, Fazenda Bom Jardim, Pt. 4, 23.XI.2002 (CEPLAC).

Figures 13–19. *Trigonalis gotica* Santos et Aguiar, sp. n. Holotype female except Figure **14**. **13** Lateral habitus (Morphobank accession number M99940) **14** Paratype female, head, antero-ventral (M99941) **15** Head, antero-dorsal (M99942) **16** Head, dorsal (M99943) **17** Mesothorax, dorsal (M99944) **18** Propodeum, dorsal (M99945) **19** Apical segments of metasoma, latero-ventral, left, showing ovipositor (M99946).

Diagnosis. Blackish or dark brown with pale yellow marks; mesopleuron with oblique mark extending from dorsad to ventrad of longitudinal sulcus; female armature absent; frons and vertex punctate-areolate; supra-antennal elevation subtle; propodeal foramen V-shaped; fore wing vein M arising distinctly basad to crossvein 1cu-a.

Description. Holotype: body length 9.9 mm; fore wing length 9.0 mm.

Head (Figs 13, 14–16). Mandible covered with dense and moderately long setae, teeth glabrous; four teeth on right mandible; dorsal tooth of right mandible [*observed in paratypes; right mandible of holotype not visible*] slightly longer than median teeth, distinctly bent upwards; ventral tooth slightly longer and more slender than other teeth; three teeth on left mandible, dorsal tooth dorsally pointed and bent, ventrally round, sharp, ventral tooth slender, pointed, median tooth intermediate between dor-

sal and ventral (Fig. 14). Clypeus 2.60 × as wide as maximum length, densely pilose, deeply punctate. Inner margin of eyes subparallel; interocular distance at narrowest level 1.36 × maximum eye height. Antenna with 23 flagellomeres, about twice the lateral length of mesosoma; intertoruli distance distinctly longer than distance from torulus to inner margin of eye. Supra-antennal elevation subtle, not forming a sharp carina. Frons and vertex densely covered with short hairs, entirely deeply punctate-areolate; frons without any trace of longitudinal depression; posterior ocelli slightly turned laterally so that they are weakly elevated medially while forming a small depression on vertex laterally. Gena width in lateral view, at level of midline of eye, 1.25 × maximum eye height, moderately punctate, densely pilose, particularly at ventral 0.4. Occipital carina conspicuous, slightly widest dorsally.

Mesosoma (Figs 13, 17–18). Densely pilose. Pronotum: anterior, neck-shaped portion short, in dorsal view transversal, about 3.6 × as wide as long, crossed anteriorly by single, stout, transverse carina, centrally nearly smooth, anterior margin sharp, reflexed upwards; a line of tall, erect hairs along anterior margin and another line of same hairs along anterior carina; pronotum lateral area dorsally subareolate-rugulose, ventrally sparsely to densely punctate, its posterior margin with longitudinal wrinkles; central portion of lateral area intensely concave, anteriorly with distinct oblique swelling. Mesoscutum and scutellum foveate-areolate, centrally more coarsely; lateral lobe with narrow, straight, smooth, mid-longitudinal line; notaulus deeply impressed, with a few transverse wrinkles inside; median lobe of mesoscutum progressively raised from base to apex, until moderately detached from lateral lobes at anterior end; scutellum with very shallow but distinct mid-longitudinal sulcus; mesosoma crenulated along its entire width just behind transscutal articulation. Hypoepimeron distinctly projected, subpyramidal, punctate, except small posterior area shiny and impunctate; scrobal sulcus distinct, somewhat crenulate; mesopleuron otherwise mostly punctate to areolate-punctate. Mesopleural suture entirely carinate. Metanotum (a narrow yellow stripe; Fig. 17) with only a few anterior punctures. Metapleuron areolate-rugulose. Transverse sulcus at base of propodeum very narrow, moderately deep. Propodeum densely pilose, laterally setae slightly longer and erect than centrally; areolate-rugulose, laterally more coarsely, medially with very slight longitudinal line, sublaterally with raised lines (perhaps traces of longitudinal carina); propodeal spiracle covered by prominent, convoluted flap. Propodeal foramen shaped as an acute, inverted V. Legs covered with dense whitish pubescence; hind coxa moderately punctate, dorsally with distinct, wide depression, deepest at apex (probably to receive the trochanters).

Wings. Fore wing vein M arising distinctly basad to crossvein 1cu-a; crossvein 2m-cu distinctly sinuous, with bulla on anterior 0.65; crossveins 2r-m and 3r-m almost straight. Second submarginal cell not petiolated; third submarginal cell subrectangular, much wider than high.

Metasoma (Fig. 19). Densely and fully covered with short setae. Tergum I short and broad, trapezoidal in dorsal view, 1.63 × as long as its maximum width, apical width 2.80 × basal width, centrally distinctly concave and with slight transverse wrinkles, tergum otherwise impuctate; posterior margin nearly straight across. Terga II–V

and sterna I–V areolate, densely covered with short setae. Metasomal armature absent. Ovipositor sheath conical, without carinae.

Color. Blackish with pale yellow marks. Head: blackish; antenna mostly dark brown, except flagellomeres 4-8 or so brown, and last 6 apical flagellomeres progressively lighter, last one yellowish brown; palpi brown; dorsal mark on mandible, part of malar space, lateral areas of clypeus and face, small mark on inner margin of torulus, and narrow mark on gena along most of eye length, pale yellow. Mesosoma: mostly blackish, pale yellow on pronotal collar, dorsal margin of pronotum, median mesoscutal lobe antero-laterally on each side, along anterior third of notaulus, axilla almost entirely, scutellum except posterior margin and mid-longitudinally, metanotum, nearly vertical stripe on mesopleuron, metapleuron just ventrad of hind wing, posterior 0.6 of metapleuron and contiguous with sublateral mark on propodeum; shiny brownish on tegula and prominence of propodeal spiracle. Legs mostly dark brown, fore tibia anteriorly mostly yellow, hind trochanters fully and coxa dorsally yellowish. Wings slightly infuscate, fore wing widely infuscate in brown along entire anterior margin. Metasoma: blackish; terga I–V and sterna I–II with posterior margin bearing a narrow pale yellow stripe, on terga II–III stripe also extending longitudinally along ventral margin; tergum VI brownish; sterna III–IV at apical margin with small lateral pale yellow marks.

Male. Essentially identical to female, except by genital features. Antenna with 20–22 flagellomeres.

Variation. Body 5.0–9.9 mm long, small to medium-sized specimens, observed both for males and females; fore wing 5.0–9.0 mm long. Antenna with 20–23 flagellomeres. In many specimens the blackish areas are brownish; some specimens with bright yellow marks instead of pale yellow. Scutellum almost entirely yellow or having slight to distinct posterior blackish mark. Crossvein 2m-cu sometimes only slightly sinuous; second submarginal cell may vary from nearly to distinctly (but shortly) petiolate. Small specimens have lighter/paler color tonalities than large ones.

Comments. This species does not match any of the described New World species of *Trigonalys*. It can be readily differentiated from *T. sanctaecatharinae* (Schulz) by the absence of female armature (*vs*. present, though delicate, on sternum III, on *T. sanctaecatharinae*). The color pattern of the two species is also almost entirely different (Figs 13, 20). It is however important to mention that "melanic" forms are known for *T. sanctaecatharinae* that are more extensively black. Further differences include the vertex areolate-rugulose (vs. punctate in *T. sanctaecatharinae*); anterior, neck-shaped portion of pronotum short (vs. quite long); central lobe of mesoscutum only subtly elevated (vs. distinctly elevated, detached from lateral lobes); and longitudinal groove on mesopleuron straight (vs. curved upwards).

It is distinguished from *T. melanoleuca* by the color pattern, with yellow marks on pronotal collar, dorsal margin of pronotum, mesoscutum, scutellum, and metanotum (vs. marks on those areas absent in *T. melanoleuca*); mesopleuron with an oblique mark extending from dorsad to ventrad of longitudinal sulcus (vs. with large mark placed ventrad to sulcus); mid and hind femora predominantly dark brown (vs. often with

Figure 20. *Trigonalys sanctaecatharinae* (Schulz), lateral habitus (Morphobank accession number M99949). Picture by David Smith (NMNH).

extensive white marks). Additionally, *T. melanoleuca* has the fore wing more distinctly infuscate centrally (cells 1R1, 1M, 2Cu, 1Rs) and antero-apically (cells 2R1, 2Rs) (vs. infuscated along entire anterior margin only), supra-antennal elevation very stout, vertex sculpturing smooth (vs. coarse punctate-areolate), propodeum uniformly punctate (vs. areolate-rugulose) and posterior margin of tergum I rounded (vs. nearly straight).

The color pattern of *T. gotica* is more similar to that of *T. erythrocephala* (see above), but the two species can be easily differentiated by their general structure. *Trigonalys gotica* has subtle supra-antennal elevation (vs. stout, conspicuous in *T. erythrocephala*); vertex deeply punctate-areolate (vs. shiny, finely punctate); pronotal collar very slightly raised (vs. moderately raised), pronotum with a less evident oblique carina (vs. distinct); hind coxa without distinctly deep depression to receive trochanters (vs. distinctly deep); propodeal foramen V-shaped (vs. U- or M-shaped), and female armature absent (vs. well developed).

The diagnostic differences provided above to separate *T. erythrocephala* from the remaining New World species of *Trigonalys* (*T. flavescens*, *T. championi* and *T. maculifrons*) also apply equally well to distinguish them from *T. gotica*.

Etymology. The specific epithet refers to the shape of the petiolar foramen, which reminds the classic design of a Gothic arch.

Acknowledgements

David Carmean (Simon Fraser University, Burnaby, BC, Canada) kindly helped with the literature and provided drafts of identification keys from his own work with Trigonalidae. Maria-Julia O. Valverde and Jacques H. C. Delabie (CEPLAC) received BFS and AMT in a scientific visit, allowing full access to the material collected by the CEPLAC team, and generously donated all relevant specimens to UFES. Celso Azevedo (UFES) and Kazuiyuki Nakayama (CEPLAC) designed the sampling protocol of the collecting trips. David Carmean (Simon Fraser University) kindly helped with literature, suggestions and old drafts of keys. David R. Smith (NMNH), Wojciech Pulawski

(CASC) and two anonymous reviewers revised the original manuscript, contributing with important suggestions. Dave also provided digital pictures of a cotype of *Xanthogonalos fasciatus* Bertoni (=*T. sanctaecatharinae*). One of the anonymous reviewers kindly provided pictures of *T. championi*, *T. flavescens* and *T. maculifrons*. This work benefitted from research funding from FAPES – *Fundação de Amparo à Pesquisa do Espírito Santo*, to Alexandre P. Aguiar (Process 45.440.611/2009).

References

Azevedo CO, Corrêa MS, Gobbi FT, Kawada R, Lanes GO, Moreira AR, Redighieri ES, Santos LM, Waichert C (2003) Perfil das famílias de vespas parasitóides em uma área de Mata Atlântica da Estação Biológica de Santa Lúcia, Santa Teresa, ES, Brasil. Boletim do Museu Biológico Mello Leitão (Nova Série) 16: 39–46.

Cameron P (1897) New species of Hymenoptera from Central America. Annals and Magazine of Natural History 6(19): 261–276, 368–379. doi: 10.1080/00222939708680536

Carmean D (1991) Biology of the Trigonalyidae (Hymenoptera), with notes on the vespine parasitoid *Bareogonalos canadensis*. New Zealand Journal of Zoology 18: 209–214.

Carmean D (2006) 8.3. Família Trigonalidae. In: Hanson PE, Gauld ID (Eds) Hymenoptera de la Región Neotropical. Memoirs of the American Entomological Institute 77: 212–216.

Carmean D, Kimsey L (1998) Phylogenetic revision of the parasitoid wasp family Trigonalidae. Systematic Entomology 23: 35–76. doi: 10.1046/j.1365-3113.1998.00042.x

Dall'Oglio OT, Zanuncio JC, Azevedo CO, Medeiros AGB (2000) Survey of the Hymenoptera Parasitoids in *Eucalyptus grandis* and in a Native Vegetation Area in Ipaba, State of Minas Gerais, Brazil. Anais da Sociedade Entomológica do Brasil 29(3): 583–588. doi: 10.1590/S0301-80592000000300021

Gauld ID, Bolton B (1988) The Hymenoptera. British Museum (Natural History) and Oxford University press, Oxford.

Harris RA (1979) A glossary of surface sculpturing. Occasional Papers in Entomology 28: 1–31.

Murphy SM, Lill JT, Smith DR (2009) A scattershot approach to host location: uncovering the unique life history of the trigonalid hyperparasitoid *Orthogonalys pulchella* (Cresson). American Entomologist 55(2): 82–87.

Nakayama K, Azevedo CO, Valverde MJ, Neves FS, Sperber CF (2008) Sampling parasitoid wasps (Insecta, Hymenoptera) in cacao agroforestry systems. Studies on Neotropical Fauna and Environment 43: 217–226. doi: 10.1080/01650520802019404

Noyes JS (1989) A study of five methods of sampling Hymenoptera (Insecta) in a tropical rainforest, with special reference to the Parasitica. Journal of Natural History 23: 285–298. doi: 10.1080/00222938900770181

Perioto NW, Lara RIR, Santos JCC, Selegatto A (2002a) Himenópteros parasitóides coletados em cultura de algodão (*Gossypium hisurtum* L.) (Malvaceae) no município de Ribeirão Preto, SP, Brasil. Revista Brasileira de Entomologia 46(2): 165–168. doi: 10.1590/S0085-56262002000200008

Perioto NW, Lara RIR, Santos JCC, Silva TC (2002b) Himenópteros parasitóides coletados em cultura de soja (*Glycine max* (L.)) Merril (Fabaceae) no município de Nuporanga, SP, Brasil. Revista Brasileira de Entomologia 46(2): 185–187.

Perioto NW, Lara RIR, Selegatto A, Luciano ES (2004) Himenópteros parasitóides coletados em cultura de café *Coffea arabica* L. (Rubiaceae) em Ribeirão Preto, SP, Brasil. Arquivos do Instituto Biológico 71(1): 41–44.

Perioto NW, Lara RIR, Selegatto A (2005) Himenópteros parasitóides da Mata Atlântica. II. Núcleo Grajaúna-Rio Verde da Estação Ecológica Juréia Itatins, Iguape, SP, Brasil. Arquivos do Instituto Biológico 72(1): 81–85.

Richards OW (1956) Hymenoptera. Introduction and Keys to Families. Handbooks for the Identification of British Insects. Vol. VI. Part I. 94 pp.

Santos MCP, Pérez-Maluf R (2010) Comunidade de parasitóides associada à cultura do café em Piatá, Chapada Diamantina, BA. Revista Ceres 57: 194–197.

Schulz WA (1910) Ein Beitrag zur Kenntnis der Lebensweise systematik und geographischen Verbreitung der Trigonaloiden. Entomologisk Tidskrift 31: 103–108.

Sharkey MJ (2007) Phylogeny and classification of Hymenoptera. Zootaxa 1668: 521–548.

Souza L, Braga SMP, Campos MJO (2006) Himenópteros parasitóides em área agrícola em Rio Claro, SP, Brasil. Arquivos do Instituto Biológico 73(4): 465–469.

Sperber CF, Nakayama K, Valverde MJ, Neves FS (2004) Tree species richness and density affects parasitoid diversity in cacao agroforestry. Basic and Applied Ecology 5: 241–251. doi: 10.1016/j.baae.2004.04.001

Townes HK (1972) A light-weight Malaise trap. Entomological News 83: 239–247.

Vinha SG, Zevallos AC, Santos OM (1983) A fase pioneira de uma sucessão vegetal secundária no sul da Bahia: estrutura e composicão da vegetação. Revista Theobroma 13: 27–34.

Westwood JO (1835) Characters of new genera and species of hymenopterous insects. Proceedings of the Zoological Society of London 3: 51–54.

JHR 25: 35–82 (2012)
doi: 10.3897/JHR.25.2396
www.pensoft.net/journals/jhr

RESEARCH ARTICLE

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

A review of the genus *Larrisson* Menke, 1967, and description of the new genus *Larrissa* (Hymenoptera, Crabronidae)

Wojciech J. Pulawski†

Department of Entomology, California Academy of Sciences, 55 Music Concourse

† *urn:lsid:zoobank.org:author:ADB010F9-1DB3-4FA5-BEB5-6716AB2E0ED4*

Corresponding author: *Wojciech J. Pulawski* (wpulawski@calacademy.org)

Academic editor: *Stefan Schmidt* | Received 20 November 2011 | Accepted 15 December 2012 | Published 23 March 2012

urn:lsid:zoobank.org:pub:BB6375D0-B9C1-448F-BE35-2EF89EECA8E9

Citation: Pulawski WJ (2012) A review of the genus *Larrisson* Menke, 1967, and description of the new genus *Larrissa* (Hymenoptera, Crabronidae). Journal of Hymenoptera Research 25: 35–82. doi: 10.3897/JHR.25.2396

Abstract

Larrisson menkei Pagliano, 1995, is transferred to *Clitemnestra* **comb. n.** and twelve new species of *Larrisson* are described: *armatus*, *carinatus*, *latifrons*, *niger*, *orbitalis*, *punctatus*, *quintus*, *spinosus*, *sulcatus*, *tegularis*, *tibialis*, and *variegatus*, all from Australia. Based on a cladistic analysis of the genus, *Larrisson nedymus* Menke is transferred to *Larrissa* **gen. n.** Additional locality records are provided for *Larrisson abnormis* Turner, *azyx* Menke, *rieki* Menke, and for *Larrissa nedyma* (Menke). An updated key to the species of *Larrisson* and *Larrissa* is provided.

Keywords

Taxonomy, revision, *Larrisson,* new genus, *Larrissa*

Introduction

Larrisson is a little known, rarely collected, strictly Australian genus of the solitary wasp family Crabronidae. It was established for *Sericophorus abnormis* Turner, 1914 by Menke (1967) who in 1979 added three new species, revised the genus, and provided a key to their identification. Pagliano (1995) described another species, *Larrisson menkei*, from a single specimen, that he later generously donated to the California Academy of

Sciences. A study of the holotype revealed that it is actually a member of *Clitemnestra*, a conclusion confirmed by Michael Ohl (Museum für Naturkunde der Humboldt-Universität, Berlin, Germany), who has also examined the specimen. The justification for the new combination is provided below.

Little is known about the habits of *Larrisson*. I collected them in open habitats, exposed to the sun, on light, mainly sandy soils (as in Fig. 15). Certainly they nest in the ground, and the only prey record is a mirid.

Materials and methods

During my recent expeditions to Australia (Northern Territory, 3 March – 27 April 2008; Western Australia, 14 October – 13 December 2008; New South Wales, 1 December 2009 – 15 January 2010; South Australia, 1 December 2010 – 4 February 2011), I collected six new species of *Larrisson*, and visits to the Western Australian Museum, Perth, Western Australia (11-12 December 2008), Australian National Insect Collection, Canberra, Australian Capital Territory (20-24 April 2009), and South Australian Museum, Adelaide, South Australia (1-3 February 2011) revealed additional new species. Descriptions of the undescribed species are given below, as are additional locality records for four previously known species. I have examined specimens of all species of *Larrisson* and provide an updated key to species. I have also performed a cladistic analysis of the species of *Larrisson*, which demonstrates that *L. nedymus* should be placed in a separate genus that I describe below under the name of *Larrissa.* As a result, *Larrisson* now totals 15 species, up from previously known three.

Specimens of *Larrisson* are rarely encountered, but *L. quintus* is described from 100 specimens, the largest series ever collected of the genus. In comparison, Menke (1979) examined seven specimens of *abnormis*, one of *azyx*, five of *nedymus*, and one of *rieki*. The new species recognized here other than *quintus* are described from the following numbers of specimens: *armatus* 3, *carinatus* 3, *latifrons* 2, *niger* 1*, orbitalis* 2, *punctatus* 3, *spinosus* 3*, sulcatus* 1, *tegularis* 11, *tibialis* 1, and *variegatus* 12.

The morphological terminology follows Bohart and Menke (1976) except for gonocoxite (the paired, lateral-most, forceps like part of the male genitalia that they called gonostyle). The term gonocoxite, preferred by most apoid workers, was used for example by Michener (1944), Smith (1970), Melo (1999), and Pulawski and Prentice (2008).

Abbreviations in the text include:

AMS Australian Museum, Sydney, New South Wales, Australia.

ANIC Australian National Insect Collection (CSIRO), Canberra, Australian Capital Territory, Australia.

BMNH The Natural History Museum (formerly British Museum Natural History), London, United Kingdom.

CAS California Academy of Sciences, San Francisco, California, USA.

OHL Michael Ohl, Berlin, Germany (personal collection).
QMB Queensland Museum, Brisbane, Queensland, Australia.
SAM South Australian Museum, Adelaide, South Australia, Australia
USNM United States National Museum of Natural History, Washington, D.C., USA.
USU Utah State University, Logan, Utah, USA.
WAMP Western Australian Museum, Perth, Australia.
WMNP West MacDonnell National Park, Northern Territory, Australia.

Results

***Clitemnestra menkei* (Pagliano), comb. n.**

Larrisson menkei Pagliano, 1995: 385, ♂. Holotype: ♂, Australia: Northern Territory: Litchfield National Park (originally G. Pagliano personal collection, Torino, Italy, now CAS).

NOTE. The holotype has typical gorytine characters (Bohart and Menke 1976): nonemarginate mandible, an omalus, midcoxae adjacent to each other, two midtibial spurs, and a basomedian ridge on sternum I, whereas in *Larrisson* the mandible is emarginate, there is no omalus, the midcoxae are separated, only one midtibial spur is present, and sternum I is simple. The following characters lead to *Clitemnestra*: hindwing media diverging more than one midocellar width beyond cu-a, scutum without oblique posterolateral carina, posterior veinlet of submarginal cell II longer than 0.25 of posterior veinlet of submarginal cell I, frons broader at level of midocellus than below it, omalus a fine seam ending ventrally well before reaching midline, and frons with long median sulcus (unlike most *Clitemnestra,* sternum VIII is emarginate apically). Three other characters that differentiate *menkei* from *Larrisson* are: free margin of clypeal lobe not concave laterally, antennal socket well separated from frontoclypeal suture, and hindocellus nearly touching orbit.

Genus *Larrisson* Menke, 1967
http://species-id.net/wiki/Larrisson

Recognition. In his key to world genera of Miscophini, Menke (1977) differentiated *Larrisson* from *Sericophorus* by the length of the occipital carina, which ends before reaching the hypostomal carina in the former and reaches the hypostomal carina in the latter. This character, however, no longer holds, as the occipital carina effaces before reaching the hypostomal carina in three *Sericophorus* described in Lomholdt and Pulawski (2010): *S. centralis* Pulawski, *S. genalis* Pulawski, and *S. politus* Lomholdt. A useful, although not universal recognition character, is the shape of the posterior

propodeal surface: it has no median carina in *Larrisson*, whereas in the vast majority of *Sericophorus* there is a well-defined carina below the median sulcus (also present in *Lyroda* and *Sphodrotes*). The carina, however, is only one quarter of the posterior surface long in the holotype of *Sericophorus centralis*, and absent in the paratype. The essential difference between the two genera is in two male characters: *Larrisson* have 11 flagellomeres and a well defined volsella, whereas in *Sericophorus* the antenna has 10 flagellomeres and the volsella is absent.

Menke (1979) recognized two species groups in *Larrisson*: the monotypic *nedymus* group and the *abnormis* group that included *abnormis* Turner, *azyx* Menke, and *rieki* Menke (the latter two known from the male sex only). The twelve new species (*armatus*, *carinatus*, *latifrons*, *niger*, *orbitalis*, *punctatus*, *quintus*, *spinosus*, *sulcatus*, *tegularis*, *tibialis*, and *variegatus*) generally agree well with his diagnosis of the *abnormis* group except the inner mandibular margin has a tooth near midlength in *tibialis* (and also in an additional specimen of *rieki*), the metanotum has no spine or tubercle in *armatus*, *carinatus*, *niger*, *punctatus*, and *tegularis* (as in *nedymus*), mesothoracic venter is conspicuously depressed in *punctatus* (as in *nedymus*), the propodeal side is unridged mesally in *armatus* and most *quintus* (as in *nedymus*), male sternum VIII is emarginate apically in *armatus*, *orbitalis*, *quintus*, *tegularis*, and *variegatus* (as in *nedymus*), and gonocoxite has no accessory lobes and no elaborate setal fringe in *tegularis* (as in *nedymus*). The twelve species fit well the *abnormis* group in all other characters: scapal basin present, impunctate or sparsely to densely punctate (frons uniformly punctate in *nedymus*), scape longer than flagellomeres I–III combined (shorter than that in *nedymus*), inner mandibular margin with preapical tooth, with small incision at about midlength in female (without preapical tooth, with two teeth near midlength in *nedymus*), mesopleuron rounded anteriorly (abruptly angular below pronotal lobe in *nedymus*), forewing vein M diverging from M+Cu distad of cu-a or interstitial with cu-a (diverging basad of cu-a in *nedymus*), glabrous area of propodeal dorsum covering entire enclosure except limited to slightly more than median sulcus in *tegularis* and *variegatus* (limited to median sulcus in *nedymus*), male forecoxa and foretrochanter simple (forecoxa with apical spine and foretrochanter emarginate basally in *nedymus*), basolateral carina of tergum I not expanded into lamella (lamella present in *nedymus*), apical tergum of female without a narrow, impunctate and asetose marginal lamella (lamella present in *nedymus*), volsella ending near apex of penis valve or exceeding it (ending at half length of penis valve in *nedymus*); and head of penis valve not dentate (dentate in *nedymus*).

Menke (1979) also claimed that the stipes and prementum are shortened in the *abnormis* group, the prementum being less than twice as long as wide, but not shortened in *nedymus*, with the prementum little more than twice as long as wide. I cannot confirm this difference: the length of these mouthparts is practically identical in *azyx*, *nedymus*, and *rieki*, although definitely smaller in *abnormis*.

Prey of *Larrisson* was unknown until now, but the holotype female of *niger* is pinned with her prey, an adult mirid 3.6 mm long. The specimen has an additional label that reads "Wasp grasped bug on terete-leaved *Acacia*", indicating that the mirid

was not placed on the same pin accidentally. Randall T. Schuh (American Museum of Natural History, New York, New York) kindly identified it as a male of the tribe Orthotylini belonging to an undescribed genus and species.

Phylogenetic analysis. Lomholdt (1985) placed *Larrisson*, together with *Sericophorus*, in the tribe Sericophorini Dalla Torre, that he characterized by a second submarginal cell conspicuously narrowed anteriorly, a synapomorphy. In the following analysis, I have used as outgroups representatives of three other miscophine genera with posteroventrally emarginate mandible that occur in Australia (*Lyroda*, *Sericophorus,* and *Sphodrotes*) and that appear to be more closely related to *Sericophorus* than the non-Australian genera. *Sericophorus* was used below as a sister taxon of *Larrisson*, and *S. relucens* Rayment, a relatively unspecialized species of the genus, was selected as the first outgroup. *Sphodrotes punctuosa* Kohl was selected as the second outgroup, and *Lyroda venusta* Bingham as the root taxon. Since females are known for only nine species of *Larrisson* (out of the total of 15), whereas the males are known for 13 species, the analysis was based entirely on male characters, and *L. latifrons*, *niger*, and *punctatus* (known from the female only) were excluded. Autapomorphies were included. The following is the list of characters.

1. Frons: 0, fully setose. 1, with glabrous scapal basin.
2. Occipital carina: 0, not reaching hypostomal carina. 1, reaching hypostomal carina.
3. Scape: 0, not shortened, length (without radix) at least 1.8 × width. 1, shortened, length about 1.3 × width (Fig. 25a).
4. Length of flagellomere I: 0, at least 1.7 × apical width. 1, about 1.3–1.5 × apical width. 2, about equal to apical width. 3, about 0.8 × apical width.
5. Mandible, inner margin: 0, without tooth at midlength of inner margin. 1, with tooth at midlength of inner margin (Fig. 25a).
6. Mesopleuron: 0, rounded anteriorly. 1, abruptly angular below pronotal lobe.
7. Mesothoracic venter (shape): 0, inconspicuously concave. 1, conspicuously concave.
8. Mesothoracic venter (sculpture): 0, densely punctate. 1, sparsely punctate.
9. Propodeal dorsum (setae): 0, all setose. 1, median sulcus glabrous. 2, median sulcus and adjacent area glabrous. 3, all enclosure (or nearly so) glabrous.
10. Presence of spine or tubercle behind propodeal spiracle: 0, spine or tubercle absent. 1, present (the spine in *Sph. punctuosa* is much further from the spiracle and thus nonhomologous with that of *Larrisson*).
11. Posterior propodeal surface: 0, without medioventral carina. 1, with medioventral carina.
12. Divergence of forewing vein M from M+Cu: 0, diverging distad of cu-a or interstitial with cu-a. 1, diverging basad of cu-a.
13. First recurrent vein: 0, ending on second submarginal cell (Fig. 23) or interstitial with first intersubmarginal vein. 1, ending on first submarginal cell.

14. Hindtibial outer surface: 0, all or largely punctate and setose (at least sparsely so). 1, impunctate and asetose between spines in dorsal half or along dorsal margin, at least in apical half.
15. Basolateral carina of tergum I: 0, not expanded. 1, expanded into lamella.
16. Setae: 0, appressed. 1, erect or suberect on upper frons, gena, vertex, mesothorax, hindcoxal venter, and hindfemoral venter (Fig. 27a, b).
17. Color of gaster: 0, gaster all or largely black 1, gaster all or largely red (Fig. 19e).
18. Presence of yellow fasciae on gaster: 0, fasciae absent. 1, fasciae present.
19. Male flagellum (number of flagellomeres): 0, with 11 flagellomeres. 1, with 10 flagellomeres (10 flagellomeres are found in all *Sericophorus*).
20. Male flagellum (shape): 0, flagellomeres all cylindrical. 1, flagellomeres I–VI convex ventrally (Fig. 22c).
21. Male flagellum (color): 0, black or dark brown or reddish brown ventrally. 1, at least flagellomeres VIII and IX yellow (Figs 22b, c, 24a).
22. Mesopleural precoxal carina of male: 0, low, obtuse. 1, projecting as spine.
23. Male metanotum: 0, simple. 1, with median spine or tubercle (Fig. 16b).
24. Male propodeum (presence of spine or tubercle behind spiracle): 0, spine or tubercle absent. 1, spine or tubercle present (the tubercle in *Sph. punctuosa* is minute, and a lower one, large, is nonhomologous).
25. Male forecoxa and foretrochanter: 0, not modified. 1, modified.
26. Male femora, tibiae, and tarsi: 0, not modified. 1, modified (Fig. 26b-f).
27. Male midfemur: 0, convex ventrally, not carinate. 1, slightly concave ventrally, with obtuse carina along both anterior and posterior margin (Fig. 27b).
28. Male hindfemur: 0, without process. 1, with ventral preapical process (Fig. 27b).
29. Outer surface of male hindtibia (shape): 0, not swollen. 1, swollen in basal third or so (Fig. 21a).
30. Transverse swelling on male sternum II: 0, absent or rudimentary. 1, well defined.
31. Tergum VII: 0, without basolateral tooth. 1, with basolateral tooth (Fig. 2d).
32. Longitudinal carina on male sternum II: 0, carina absent. 1, carina present in basal half (Fig. 22f).
33. Male sternum VIII (apex): 0, not emarginate apicomesally. 1, emarginate apicomesally.
34. Male sternum VIII (apicolateral emargination): 0, absent. 1, present (Fig. 2d, 12e, 19d).
35. Gonocoxite: 0, with simple, short setae. 1, with elaborate, setal fringes (Fig. 5, 14).

36. Volsella: 0, minimal to absent. 1, present, about half length of penis valve. 2, present, about as long as penis valve.
37. Penis valve: 0, not dentate. 1, dentate.

The following data matrix (Table 1) was constructed using Winclada version 1.00.08 (Nixon 2002). Multiple character states were treated as additive.

The above data matrix was analyzed using the Willi Hennig Society edition of TNT (Goloboff et al. 2008) with 1,000 replications and 1,000 trees to be held. An equal weight analysis resulted in 18 equally parsimonious trees, each of 73 steps, consistency index = 0.575, and retention index = 0.613. An implied weight analysis (k = 3) produced three trees, and the strict consensus tree (Fig. 1) had 74 steps, consistency index = 0.568 , and retention index = 0.600. Critical in the analysis was the position of *Larrisson nedymus* that appeared as the sister species of *Sericophorus relucens*, and not a part of the clade encompassing the remaining *Larrisson.* The same position was retained in another analysis, in which *Aha ha* Menke was added as another outgroup. This result demonstrates that *L. nedymus* is not congeneric with the remaining *Larrisson* and that it either should be transferred to *Sericophorus* or that it belongs to a genus of its own. Given the degree of differences between *L. nedymus* and *Sericophorus*, I believe it should be treated as a separate genus. A new genus, *Larrissa* is established below for the species.

Table 1. Character States of *Larrisson* and the Outgroup

Species	Characters			
Lyroda venusta	0000000000	1000000000	0000000000	0010000
Sphodrotes punctuosa	0000000000	1000100000	0001000000	0000000
Sericophorus relucens	0102000011	1110000010	0000000000	0001001
Larrisson abnormis	1002100031	0010000100	0001000000	0000120
Larrisson armatus	1001100030	0014001001	0000000001	0011120
Larrisson azyx	1002100031	0011010000	0011000101	0000120
Larrisson carinatus	1002100130	0011001000	0100000000	0100120
Larrisson nedymus	0012011120	0110100100	0000100000	0011011
Larrisson orbitalis	1001100030	0014001000	0010000001	0011120
Larrisson quintus	1001100031	0010001000	0011010001	0010120
Larrisson rieki	1002100031	0011000100	1101001001	0000120
Larrisson spinosus	1002100131	0011001000	0010000001	0000120
Larrisson sulcatus	1002100030	0011000000	0010000000	0000120
Larrisson tegularis	1003100120	0011001100	0000000000	0011020
Larrisson tibialis	1002100131	0010000000	0001001011	0000120
Larrisson variegatus	1002100030	0001000001	1010001001	0010120

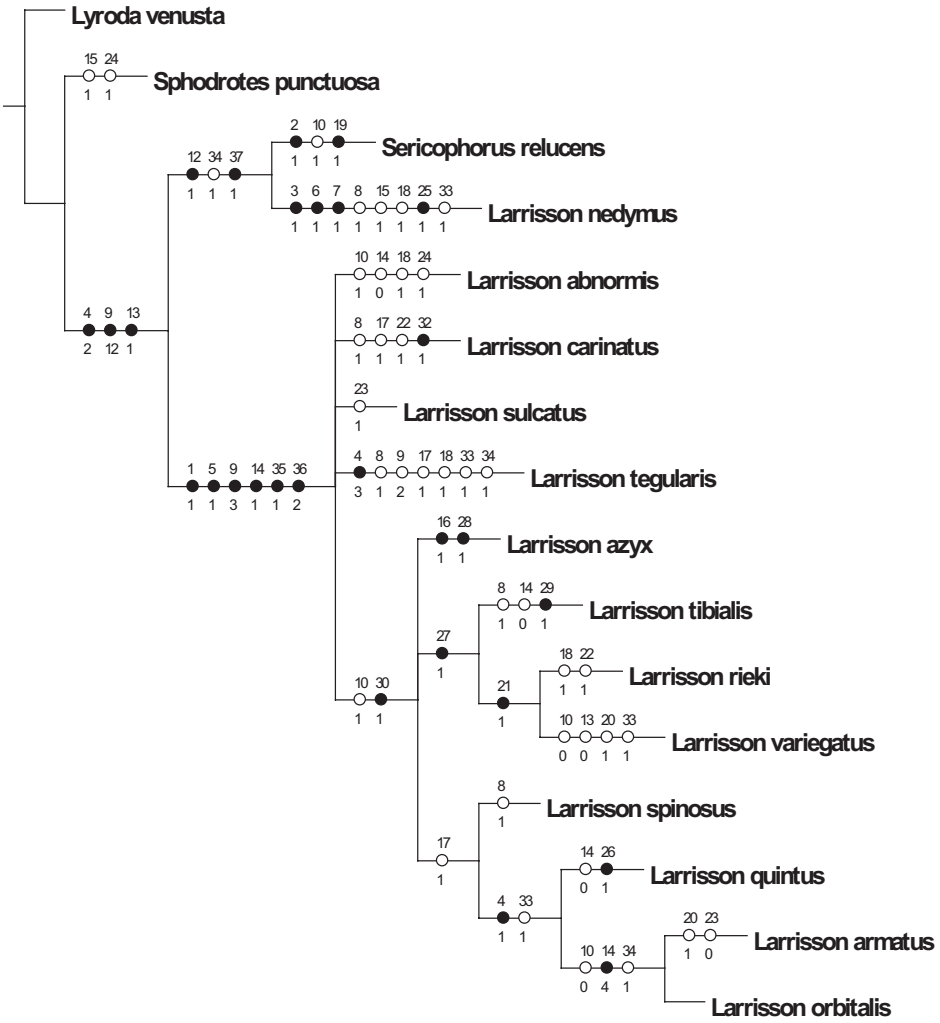


Figure 1. Strict consensus cladogram of the species of *Larrisson* based on male characters (*L. latifrons*, *niger*, *orbitalis*, and *punctatus*, known from the female only, are omitted). Character numbers are placed above circles, with the state number below. Black circles indicate an unambiguous change, open circles indicate homoplastic change.

***Larrisson armatus* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:5982CB82-B235-444D-9312-F6DF05C6EE83
http://species-id.net/wiki/Larrisson_armatus
Figs 2, 3

Name–derivation. *Armatus* is a Latin masculine adjective meaning armed, with reference to the lateral spines on male tergum VII.

Recognition. *Larrisson armatus* is unique in having the impunctate, medioventral area of the clypeus narrow and elongate, extending dorsally to the clypeal midlength of

more. The male is also unique in having tergum I with a gap between the basolateral carina and the lateral ridge that delimits the basal concavity (Fig. 2c) and an anterolateral spine on tergum VII (Fig. 2d). Subsidiary recognition features are: orbital fovea well defined (in female about as wide as 0.8 × ocellocular distance), mesothoracic venter densely punctate throughout, gaster all red, and male sternum VIII emarginate apically, with glabrous basal platform.

Description. Width of face across clypeus and vertex in female = 60:46–50, least interocular distance 44–45; in male 60:48, and 42, respectively. Orbital fovea well defined, in female about as wide as 0.8 × ocellocular distance, in male not quite half ocellocular distance. Clypeal lobe only slightly prominent, its free margin arcuate, slightly angulate laterally; medioventral asetose area narrow, extending to about clypeal midlength in female (Fig. 2a) and slightly higher in male. Scapal basin impunctate, glabrous. Length of scape (excluding radicle) 2.3 × width in female, 2.5 × in male, length equal to flagellomeres I–III combined in female, to flagellomeres I–III + half IV combined in male. Mesopleural with small tooth at top of precoxal declivity in female, with well-defined tooth in male; mesothoracic venter uniformly densely punctate and setose (punctures about one diameter apart, setae concealing integument). Metanotum without median tooth. Propodeal dorsum without spine or tubercle behind spiracle; side

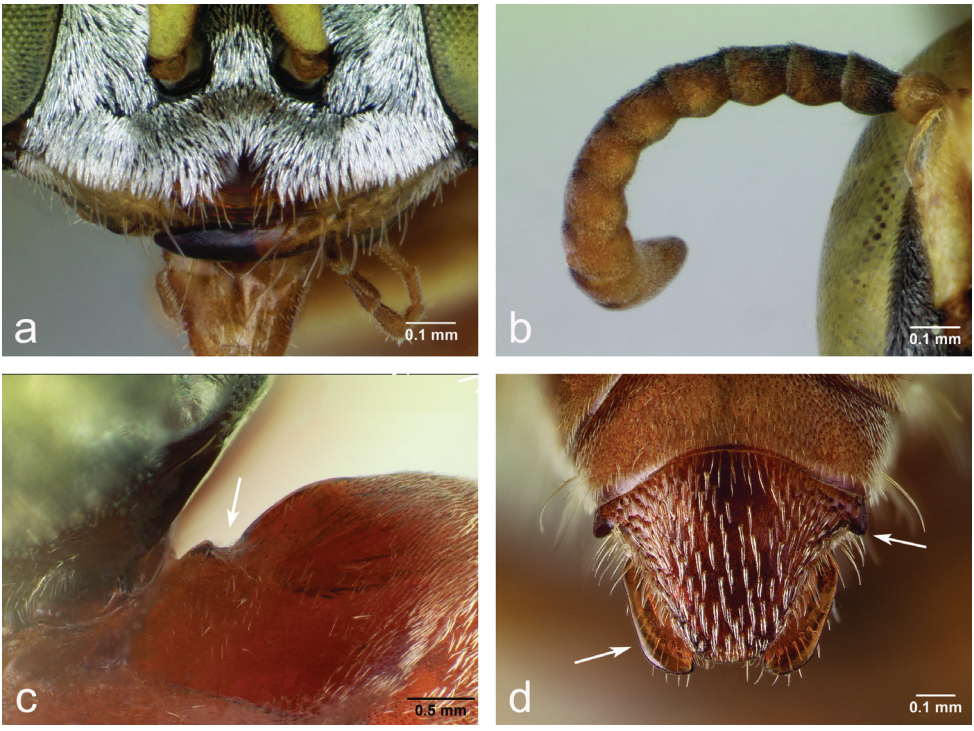


Figure 2. *Larrisson armatus*: **a** female clypeus **b** male antenna **c** male tergum I in dorsolateral view (arrow indicates basolateral emargination) **d** apex of male gaster in dorsal view (upper arrow indicates basolateral tooth of tergum VII, lower arrow indicates sternum VIII).

punctate, minutely ridged below spiracle; posterior surface unsculptured both mesodorsally and mesoventrally. Outer surface of hindtibia impunctate between spines.

Setae all silvery, appressed on head, thorax, propodeum, and legs, concealing integument on clypeus (except mesoventrally), on frons ventrolaterally, mesopleuron, and mesothoracic venter, forming apical fasciae on terga. Hindfemoral ventral and inner (= posterior) surfaces asetose (except inner surface setose preapically).

Head, thorax, and propodeum black, with the following exceptions: clypeus reddish mesoventrally, mandible reddish (dark brown apically), scape yellow (dark dorsally), flagellum brown dorsally, light brown ventrally, pronotal lobe pale yellow. Forefemur reddish anteriorly, pale yellow posteroventrally and apically, black dorsally; midfemur reddish brown anteriorly and posteriorly, yellow ventrally, narrowly black dorsally; hindfemur reddish brown, yellow apically, black dorsally; tibiae yellow dorsally, reddish brown ventrally; tarsi reddish brown. Gaster reddish brown.

Female. Forebasitarsus with four rake spines, apical spine of foretarsomere III about equal to apical basitarsal width. Pygidial plate with punctures that are about one diameter apart. Length 5.4–5.5 mm.

Male. Posterior mandibular margin slightly concave between base and notch. Dorsal length of flagellomere I 1.5 × apical width; flagellomeres I–IV convex ventrally

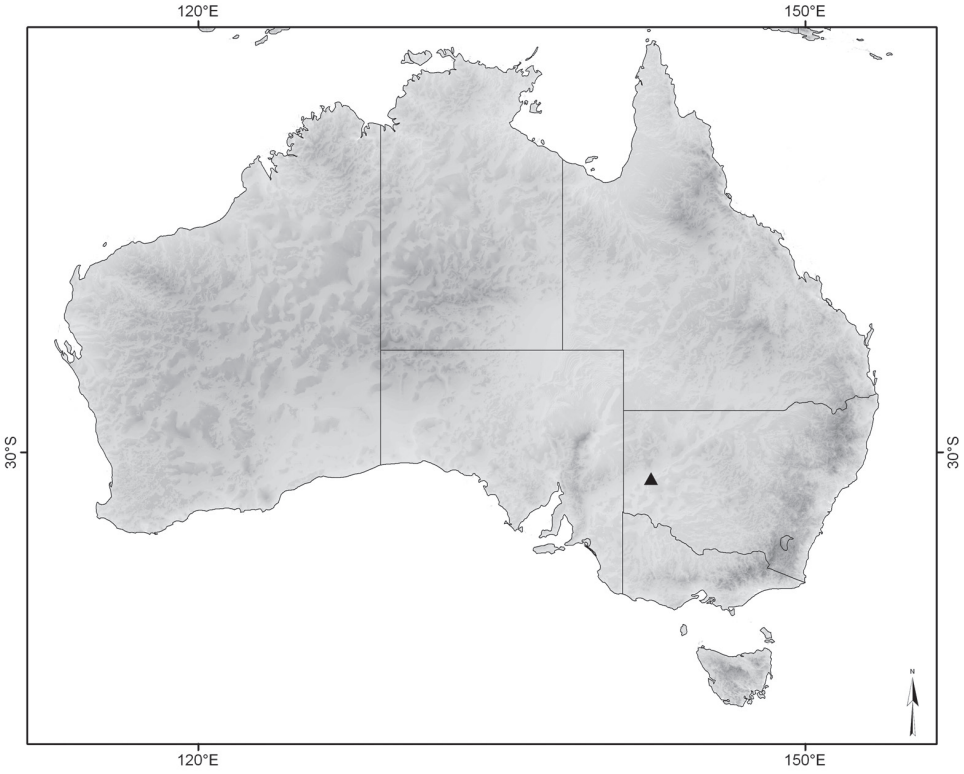


Figure 3. Collecting locality of *Larrisson armatus* and *tegularis*.

(Fig. 2b). Legs unmodified except hindfemur slightly expanded posteroventrally at apex, slightly concave ventrally, not carinate between ventral and posterior (= inner) surfaces; forebasitarsus with four rake spines; apical spine of forebasitarsus III as long as apical basitarsal width. Tergum I with gap between basolateral carina and lateral ridge that delimits basal concavity (Fig. 2c). Tergum VII punctate throughout, rounded apically, with one basolateral spine on each side (Fig. 2d). Sternum II with transverse swelling, concave between swelling and posterior margin. Sternum VIII emarginate apically (Fig. 2d), with glabrous basal platform. Genitalia as in *carinatus* (see Fig. 5). Length 6.8 mm.

Geographic distribution (Fig. 3). Known from one locality in New South Wales.

Specimens examined. *Holotype*: ♀, **AUSTRALIA: New South Wales:** Kinchega National Park at 32°22.8'S, 142°23.6'E, 29 Dec 2009, V. Ahrens and W.J. Pulawski (AMS). *Paratypes*: **AUSTRALIA: New South Wales:** same locality and collectors, 29 Dec 2009 (1 ♀, CAS), 30 Dec 2009 (1 ♂, CAS).

***Larrisson carinatus* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:256A8C85-51E9-4858-8F09-9755D1293A45
http://species-id.net/wiki/Larrisson_carinatus
Figs 4–6

Name–derivation. *Carinatus* is a Latin masculine adjective derived from *carina*, with reference to the longitudinal carina on male sternum II.

Recognition. The male of *carinatus* is unique in having a sharply pointed apically median carina in the basal half of sternum II (Fig. 4c). It can also be recognized by the combination of a largely red gaster, metanotum without a spine or tubercle, propodeum without a spine or tubercle behind the spiracle, presence of a spine in front of the midcoxa, and concave ventral surface of sternum VIII. The female is unknown.

Description. Male. Width of face across clypeus and vertex = 60:52, least interocular distance 40. Orbital fovea well defined, about half as wide as ocellocular distance. Clypeal lobe only slightly prominent, its free margin arcuate, not angulate laterally (Fig. 4a). Length of scape (excluding radicle) 2.8 × width, length equal to flagellomeres I–IV + half V combined. Flagellomeres cylindrical. Mesopleuron with prominent spine in front of midcoxa (Fig. 4b); mesothoracic venter sparsely punctate on each side of median zone (punctures several diameters apart). Metanotum uniformly rounded mesally, without spine or tubercle. Propodeal side ridged; posterior surface ridged mesodorsally, unsculptured mesoventrally. Outer surface of hindtibia impunctate and asetose between spines. Tergum I conspicuously concave basally.

Setae all silvery, appressed on head, thorax, propodeum, and legs, nearly completely concealing integument on clypeus (except glabrous ventral portion of median lobe) and frons (except for glabrous scapal basin), not concealing integument on mesopleuron or mesothoracic venter, forming apical fasciae on terga I–IV. Hindfemoral venter and inner (= posterior) surface asetose.

Figure 4. *Larrisson carinatus* ♂: **a** clypeus and mandible **b** ventral portion of mesopleuron (arrow indicates precoxal spine) **c** sternum II in lateral view **d** tergum VII (arrow indicates sternum VIII).

Head, thorax, and propodeum black except the following are pale yellow: scape, pedicel, mandible (except apically), and pronotal lobe, whereas glabrous portion of clypeal lobe brown, and flagellum yellowish brown (darkened dorsally on at least basal half). Forefemur reddish brown dorsally, yellow ventrally and apically; midfemur reddish brown except yellow apically and ventrally in distal half; hindfemur reddish brown except yellow apically; foretibia yellow on outer side, reddish brown on inner side; mid- and hindtibiae varying from mostly pale yellow to mostly reddish brown; foretarsus reddish brown; mid- and hindtarsi pale yellow except apical tarsomere dark brown. Gaster reddish brown except terga III–VI or IV–V with black basal spots that may be interrupted mesally.

Posterior mandibular margin not expanded between base and notch, inner margin without tooth near midlength (Fig. 4a). Flagellum cylindrical; dorsal length of flagellomere I 1.1 × apical width. Propodeum without spine behind spiracle. Legs unmodified except hindfemur slightly expanded posteroventrally at apex, not concave ventrally and not carinate between ventral and posterior (= inner) surfaces; forebasitarsus with five rake spines; apical spine of forebasitarsus III 1.1 × as long as apical basitarsal width. Tergum VII punctate throughout, rounded apically (Fig. 4d). Sternum II elevated in basal half, concave in distal half, with obtuse median carina in basal half (Fig. 4c), carina pointed apically and projecting over concave portion. Sterna with long, erect setae at bases of apical depressions, sterna VI and VII also with numerous erect setae that

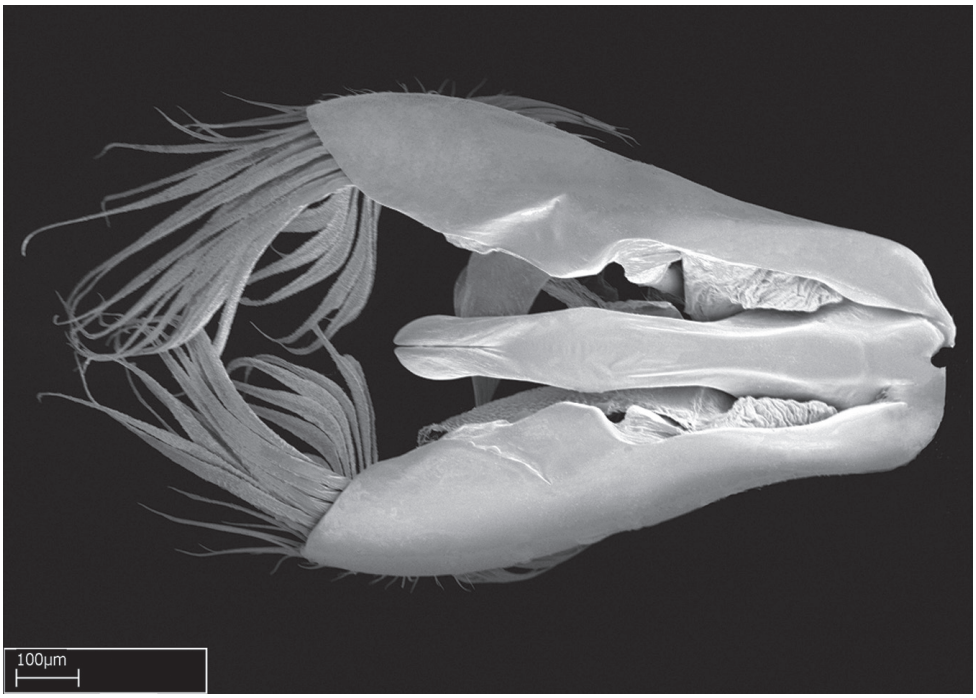


Figure 5. *Larrisson carinatus*: male genitalia dorsally.

are about one midocellar width long. Sternum VIII largely concave, glabrous, rounded apically. Genitalia: Fig. 5. Length 7.5–9.1 mm.

Female. Unknown.

Geographic distribution (Fig. 6). Known from two adjacent localities near the western coast of Australia.

Specimens examined. *Holotype*: ♂, **AUSTRALIA: Western Australia:** 54 km NE Kalbarri at 27°15'20"S114°31'13"E, 5 Oct 1997, T.F. Houston (WAMP). *Paratypes*: **AUSTRALIA: Western Australia:** same data as holotype (1 ♂, CAS); 9 km NNE Eurardy Homestead on North West Coastal Highway at 27°30'S, 114°43'E, 25-28 Oct 1996, T.F. Houston (1 ♂ , ANIC).

***Larrisson latifrons* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:67821D91-8D2B-45F6-A911-0541604F9A5A
http://species-id.net/wiki/Larrisson_latifrons
Figs 6, 7

Name–derivation. *Latifrons* derives from two Latin words, *latus*¸ broad, and *frons*, the forehead; a noun in apposition to the generic name.

Recognition. The female of *latifrons* (the male is unknown) has an all black gaster (without red markings or yellow fasciae), and the setae appressed on the head, thorax,

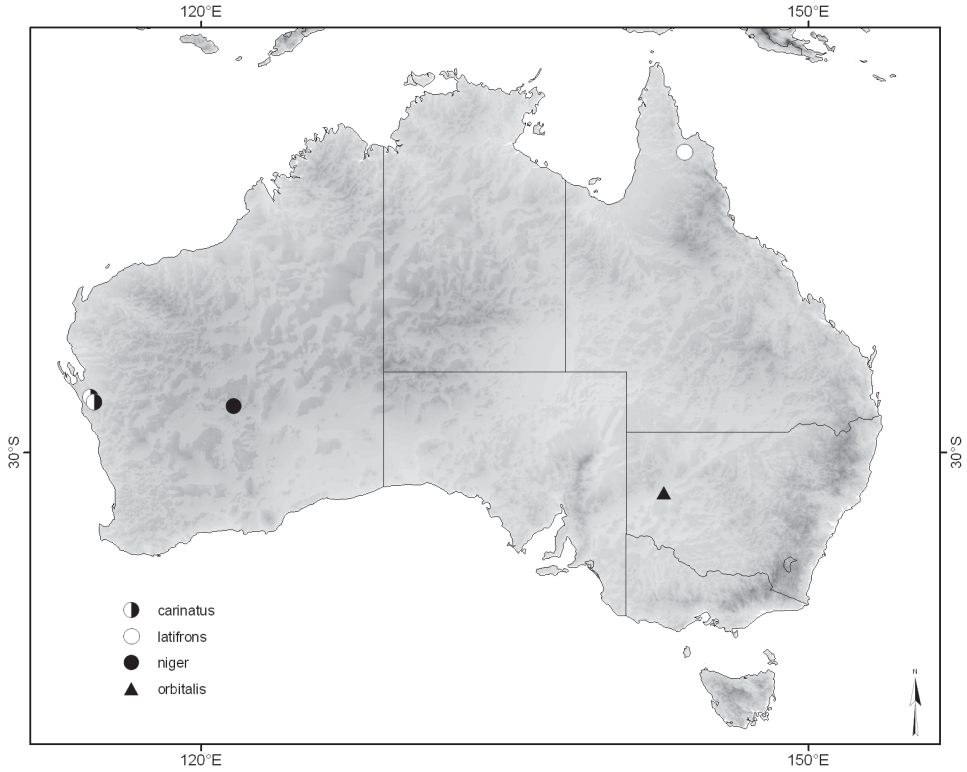


Figure 6. Collecting localities of *Larrisson carinatus*, *latifrons, niger*, and *orbitalis*.

propodeum and legs. *Larrisson niger* is similar, but unlike that species the hindfemoral apex of *latifrons* is simple, not broadened (Fig. 7b), the scutum and mesopleuron are dull, with interspaces between punctures linear, and the setae of the pygidial plate do not conceal the integument.

Description. Female. Width of face across clypeus and vertex = 60:57, least interocular distance 40 or 46. Orbital fovea ill defined, about as wide as half ocellocular distance. Clypeal lobe only slightly prominent (Fig. 7a), its free margin arcuate, slightly angulate laterally. Scapal basin sparsely punctate (punctures several diameters apart). Length of scape (excluding radicle) 2.6 × width, length equal to flagellomeres I–V combined. Scutal punctures less than one diameter apart. Mesopleuron with ill-defined transverse crest in front of midcoxa; mesothoracic venter densely punctate throughout (punctures less than one diameter apart). Metanotum with low, obtuse median tubercle. Propodeum without spine or tubercle behind spiracle; side conspicuously ridged; posterior surface ridged both mesodorsally and mesoventrally. Outer surface of hindtibia impunctate and asetose between spines (except basally and ventrally). Tergum I concave basally.

Setae all silvery, appressed on head, thorax, propodeum, and legs, nearly completely concealing integument on clypeus and frons (on scapal basin markedly shorter than on remaining frons, not concealing integument), not so on mesopleuron, mes-

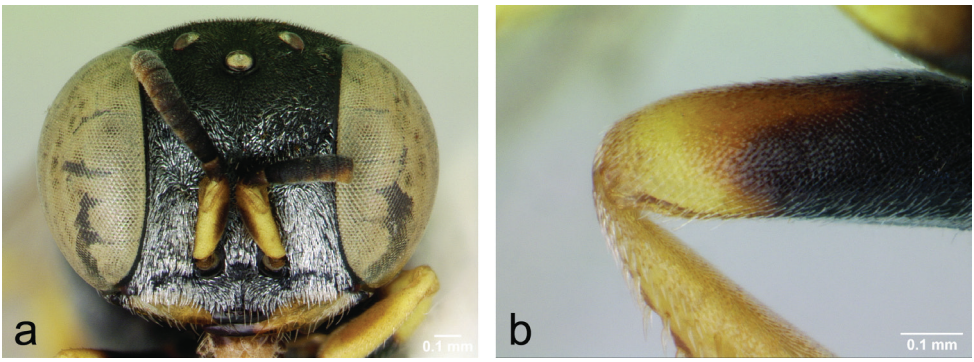


Figure 7. *Larrisson latifrons* ♀: **a** head in frontal view **b** hindfemur and base of hindtibia in lateral view.

othoracic venter, and pygidial plate. Hindfemoral venter setose only basally, inner (= posterior) surface of hindfemur setose (Fig. 7b).

Head, thorax, propodeum, and gaster black except scape, mandible basally (black apically), and pronotal lobe pale yellow; flagellum black dorsally, brown ventrally. Femora black, pale yellow apically, tibiae and tarsi pale yellow, apical tarsomeres yellowish brown.

Forebasitarsus with four rake spines, apical spine of foretarsomere III about equal to apical basitarsal width. Pygidial plate with punctures that are more than one diameter basally, less than one diameter apart apically. Length 4.8–6.1 mm.

Male. Unknown.

Geographic distribution (Fig. 6). Known from one locality in northern Queensland.

Specimens examined. *Holotype*: ♀, **AUSTRALIA: Queensland:** Hann River at 15°11'S, 143°52'E, 26 June 1993, I.D. Naumann and P. Zborowski (ANIC). *Paratype*: same locality, 20 Oct – 17 Nov 1993, P. Zborowski and M. Horak (1 ♀, CAS).

***Larrisson niger* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:4AC0A168-231B-4CAF-8618-6CD3874EE2C8
http://species-id.net/wiki/Larrisson_niger
Figs 6, 8

Name–derivation. *Niger* is a Latin masculine adjective meaning *black*; with reference to the mostly black body.

Recognition. Like *latifrons*, the female of *niger* has an all black gaster, without red markings or yellow apical fasciae on segments, and the setae appressed on the head, thorax, propodeum and legs. Unlike *latifrons*, however, the hindfemoral apex of *niger* is broadened (Fig. 8b) rather than simple, scutal and mesopleural punctures average about one diameter apart and the interspaces are shiny (scutum and mesopleuron dull in *latifrons*, with linear interspaces), and the setae of the pygidial plate are dense, largely concealing the integument (rather than sparse, not concealing integument). The male is unknown.

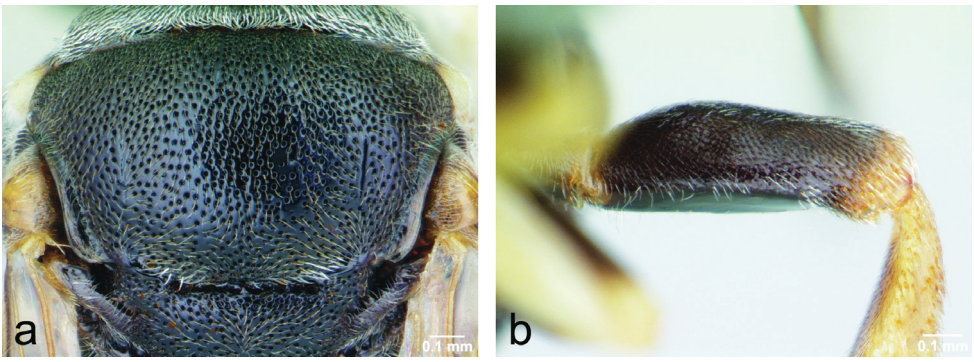


Figure 8. *Larrisson niger* ♀: **a** scutum and scutellum **b** hindfemur in posterior view.

Description (based on holotype only). Female. Width of face across clypeus and vertex = 60:50, least interocular distance 37. Orbital fovea well defined, slightly wider than half ocellocular distance. Clypeal lobe only slightly prominent, its free margin arcuate, not angulate laterally. Scapal basin sparsely punctate (punctures averaging several diameters apart). Length of scape (excluding radicle) 2.8 × width, length equal to flagellomeres I–V combined. Scutal and mesopleural punctures averaging about one diameter apart (Fig. 8a). Mesopleuron with ill-defined transverse crest in front of mid-coxa; mesothoracic venter densely punctate throughout (punctures about one diameter apart). Metanotum with obtuse median carina. Propodeum with minimal, obtuse tubercle behind spiracle; side ridged; posterior surface almost unsculptured mesodorsally, unsculptured mesoventrally. Hindfemoral apex broadened (Fig. 8b). Outer surface of hindtibia with small setigerous punctures, including dorsal half (punctures sparse in distal half or so of dorsal half).

Setae all silvery, appressed on head, thorax, propodeum, and legs, nearly completely concealing integument on clypeus and frons (on scapal basin markedly shorter than on remaining frons, not concealing integument), not so on mesopleuron and mesothoracic venter, nearly completely concealing integument on pygidial plate. Hindfemoral venter asetose, inner (= posterior) surface asetose in ventral half.

Head (including flagellum), thorax, propodeum, and gaster black except the following are pale yellow: scape (black dorsally), basal half of mandible (apical half brown), and pronotal lobe. Femora black, pale yellow apically (hindfemur narrowly so), tibiae and tarsi pale yellow.

Forebasitarsus with five rake spines, apical spine of foretarsomere III minimally shorter than apical basitarsal width. Pygidial plate with punctures that are about one diameter apart basally, less than one diameter apart apically. Length 4.5 mm.

Male. Unknown.

Geographic distribution (Fig. 6). Known from one locality in Western Australia.

Specimen examined. *Holotype*: ♀, **AUSTRALIA: Western Australia:** 9.5 km SE Banjiwarn Homestead at 27°42'S, 121°37'E, 20-28 Feb 1980, T.F. Houston et al. (WAMP).

***Larrisson orbitalis* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:631891E3-24FD-4D9A-ADFA-2B3B6E6F6B17
http://species-id.net/wiki/Larrisson_orbitalis
Figs 6, 9

Name–derivation. *Orbitalis* is a Latin masculine and feminine adjective derived from *orbita*; with reference to the conspicuously convex inner eye orbits of this species.

Recognition. The female of *orbitalis* has a red gastral base and a densely punctate mesothoracic venter, with the integument totally concealed by vestiture. Three other species, *armatus*, *quintus* and *variegatus*, share these characters, but *orbitalis* differs from *quintus* in lacking dense, small punctures on the outer surface of the hindtibia (between the spines); unlike *armatus*, the unsculptured medioventral area of the clypeus does not extend to clypeal midlength; and unlike *variegatus*, the inner eye margins of *orbitalis* are markedly bowed toward the frons midline (Fig. 9a), rather than nearly parallel, and the first recurrent vein is received by the first submarginal cell, rather than the second.

The male of *orbitalis* shares with *quintus* the posterior mandibular margin that is angulate between base and notch (Fig. 9c). Unlike that species, the legs of *orbitalis* are unspecialized: the forefemoral venter is not expanded subbasally and not concave anterobasally, the inner margin of the forebasitarsus is straight, the foretarsomeres II–IV are not expanded on the inner side, and the hindbasitarsus is not convex on outer margin. The emarginate apically sternum VIII, with a glabrous basal platform, is a subsidiary recognition feature of the male *orbitalis*.

Description. Width of face across clypeus and vertex = 60:52, least interocular distance 50 in female, in male, respectively, 60:58 and 40. Orbital fovea ill defined, about as wide as half ocellocular distance in female, less than that in male. Inner eye margin markedly bowed out toward frons midline (Figs 9a, b). Clypeal lobe only slightly prominent, its free margin arcuate, rounded laterally. Scapal basin punctate along margins in female, impunctate in male. Length of scape (excluding radicle) 2.5 × width, length equal to flagellomeres I–IV + half V combined in female, to flagellomeres I–III + half IV combined in male. Scutal punctures less than one diameter apart. Mesopleuron with ill-defined tubercle at top of precoxal declivity in female, with obtuse, transverse carina in front of midcoxa in male; mesothoracic venter densely punctate throughout (punctures less than one diameter apart). Metanotum with low median carina in female, with well-defined median tooth in male. Propodeum with tubercle behind spiracle (tubercle ill defined in female); side conspicuously ridged; posterior surface ridged both mesodorsally and mesoventrally in female, with irregular sculpture mesodorsally and not ridged medioventrally in male. Outer surface of hindtibia impunctate and asetose between spines in dorsal half. Tergum I concave basally.

Setae all silvery, appressed on head, thorax, propodeum, and legs, nearly completely concealing integument on clypeus (except glabrous ventral portion of median lobe), on frons lateroventrally (on scapal basin markedly shorter than on remaining frons and not concealing integument in female, absent in male), on mesopleuron, and in female on mesothoracic venter (not so in male); in female setae of pygidial plate light brown,

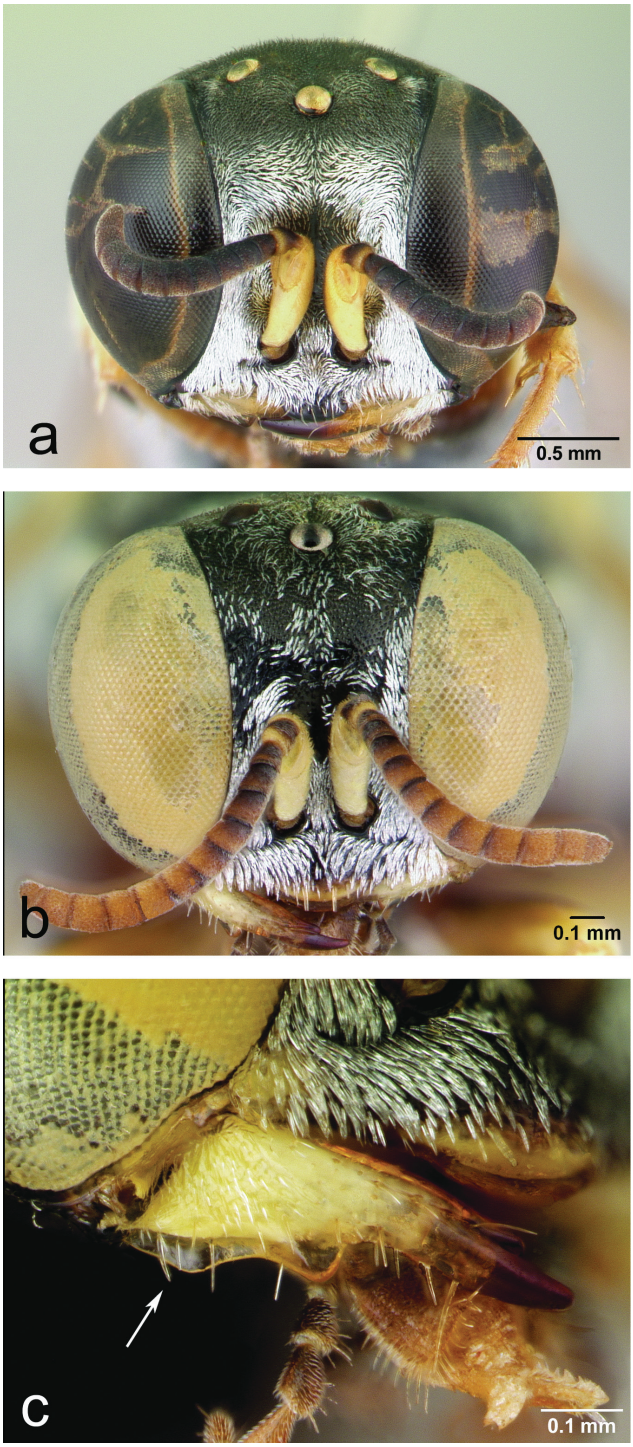


Figure 9. *Larrisson orbitalis*: **a** female head in frontal view **b** male head in frontal view **c** male mandible in lateral view.

not concealing integument. Hindfemoral venter asetose, inner (= posterior) face setose except asetose along dorsal margin in male.

Head, thorax, and propodeum black except the following are pale yellow: scape (only ventrally in male), mandible basally (black apically), and pronotal lobe; flagellum black dorsally, brown ventrally in female, brown dorsally and yellow ventrally in male (dark brown basally, light brown apically, flagellomeres X–XIII all light brown). Color of legs and gaster: see below.

Female. Forebasitarsus with four rake spines, apical spine of foretarsomere III about equal to 0.7 × apical basitarsal width. Pygidial plate with punctures that are more than one diameter basally, less than one diameter apart apically. Length 7.4 mm. Forefemur black basally, yellow apically, mid- and hindfemora reddish brown, yellow apically; foretibia reddish brown on inner surface, yellow on outer surface; midtibia reddish brown except yellow apically; hindtibia reddish brown; forebasitarsus yellowish brown, foretarsomeres II–V brown; mid- and hindtarsi reddish brown. Gastral terga I and VI reddish brown, tergum II reddish brown with black basomedian spot, terga III and V black except reddish brown apically, tergum IV black

Male. Posterior mandibular margin angulate between base and notch, concave adjacent to notch (Fig. 9c). Flagellum cylindrical; dorsal length of flagellomere I 1.4 × apical width. Tergum VII rounded apically. Sternum II with transverse, glabrous swelling behind midlength (swelling higher laterally than mesally). Length 6.3 mm. Fore- and midfemora black basally and dorsally (except at apex), pale yellow ventrally (except near base) and apically; hindfemur black except pale yellow near apex; tibiae and tarsi pale yellow. Gaster black except tergum I and large median part of tergum II reddish brown and except apical depression conspicuously yellowish (inconspicuously so on tergum I).

Geographic distribution (Fig. 6). Known from two localities in western New South Wales.

Specimens examined. *Holotype*: ♀, **AUSTRALIA: New South Wales:** Springs Creek 68 km SW Wilcannia, 29 Nov 1981, J.C. Cardale and I.D. Naumann (ANIC). *Paratype*: **New South Wales:** Kinchega National Park at 32°22.8'S, 142°23.6'E, 30 Dec 2009, V. Ahrens and W.J. Pulawski (1 ♂, CAS).

***Larrisson punctatus* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:7DBA89C1-B896-4E92-9ECA-A89325412667
http://species-id.net/wiki/Larrisson_punctatus
Figs 10, 11

Name–derivation. *Punctatus*, a Latin masculine past participle meaning *punctate*, with reference to the conspicuous gastral punctation of this species.

Recognition. The female of *punctatus* differs from all its congeners by the markedly depressed mesothoracic venter and larger gastral punctures; in particular, the punctures of the basal concavity of tergum I are almost as large as those on the scutum (Fig. 10a, b). In all other *Larrisson* the mesothoracic venter is only slightly depressed

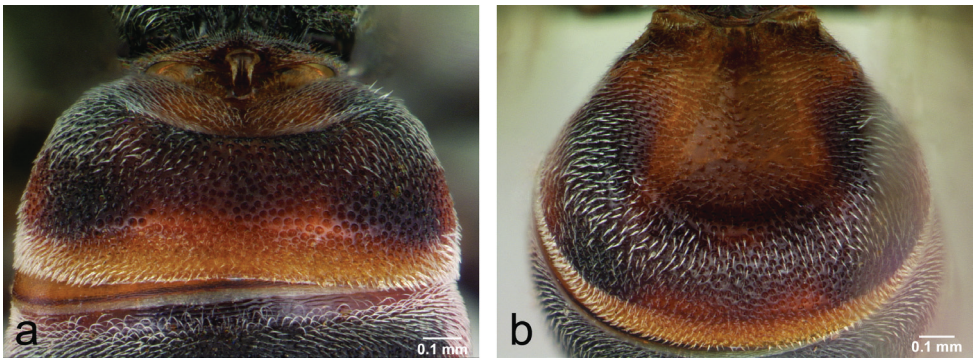


Figure 10. *Larrisson punctatus* ♀: **a** tergum I in dorsal view **b** tergum I in oblique anterodorsal view.

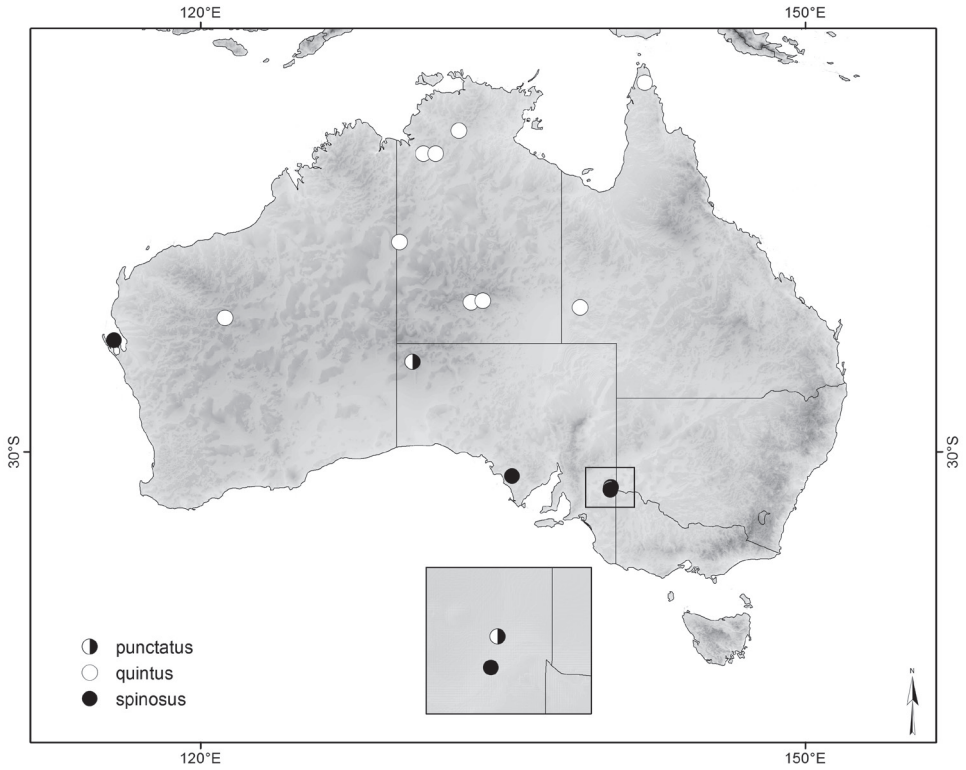


Figure 11. Collecting localities of *Larrisson punctatus*, *quintus*, and *spinosus*.

and the basal concavity of tergum I is either impunctate, or has minute, inconspicuous punctures, or (*niger*) the punctures are visibly smaller than those on the scutum. Also, like *tegularis* and unlike other *Larrisson*, the scapal basin is densely punctate (punctures less than one diameter apart), rather than impunctate or with punctures that average several diameters apart. As in *tegularis*, most of the propodeal enclosure is covered with

setae, only the median sulcus and the adjacent area being glabrous; in all other *Larrisson,* the propodeal enclosure is glabrous (all or nearly so). The absence of a metanotal tubercle or crest is a subsidiary recognition feature. The male is unknown

Description. Female. Width of face across clypeus and vertex = 60:55–58, least interocular distance 28. Orbital fovea narrow, about one quarter width of ocellocular distance. Clypeal lobe only slightly prominent, its free margin arcuate, angulate laterally. Scapal basin punctate, punctures less than one diameter apart. Length of scape (excluding radicle) 2.3–2.4 × width, length equal to flagellomeres I–IV combined. Mesopleuron without transverse crest or tubercle in front of midcoxa; mesothoracic venter conspicuously depressed, densely punctate mesally (punctures about one diameter apart, up to several diameters apart sublaterally). Metanotum without median tubercle or crest. Propodeum without spine or tubercle behind spiracle; side ridged; posterior surface sculptured mesodorsally and mesoventrally. Outer surface of hindtibia with small setiferous punctures, glabrous adjacent to dorsal margin (except in basal half). Tergal punctures (Fig. 10a, b) larger than in other *Larrisson*, those of basal concavity of tergum I (which is well defined) almost as large as scutal punctures.

Setae all silvery, appressed on head, thorax, propodeum, and legs, nearly completely concealing integument on clypeus and lower frons (on scapal basin markedly shorter than on remaining frons, not concealing integument), not concealing integument on mesopleuron, mesothoracic venter, and pygidial plate. Propodeal dorsum setose except median sulcus and adjacent area glabrous, entire enclosure glabrous anteriorly. Hindfemoral venter asetose, inner (= posterior) face asetose in ventral portion (up to half width mesally).

Head (including flagellum), thorax, propodeum, and gaster black except scape and pronotal lobe pale yellow. Femora either black, brown at very apex, or largely reddish brown; tibiae either light brown, yellow at very apex, or all pale yellow; tarsi yellowish brown. Gaster black in specimens from Calperum Station, with the following reddish brown: basal concavity of tergum I largely, narrow preapical stripes on terga, and tergum VI; in specimen from *Grevillea* camp terga I and II reddish brown, terga III and IV reddish brown with black basomedian spot, tergum V black basally, and tergum VI yellow, becoming brownish apically; apical depressions of terga yellowish brown in all three specimens examined.

Forebasitarsus with four rake spines, apical spine of foretarsomere III equal to 1.25 × of apical basitarsal width. Pygidial plate with punctures that are more than one diameter apart except less than one diameter apart near apex. Length 5.3–5.5 mm.

Male. Unknown.

Geographic distribution (Fig. 11). Known from two localities in South Australia.

Specimens examined. *Holotype*: E, **AUSTRALIA: South Australia:** Calperum Station 32 km N Renmark at 33°53'S, 140°44'E, 9 Nov – 12 Dec 1995, K.R. Pullen (ANIC). *Paratypes*: **AUSTRALIA: South Australia:** same data as holotype (1 ♀, CAS); *Grevillea* WAT camp at 27°01'30"S, 129°52'32"E, 18-20 Oct 1996, Pitjantjatjara Land Survey (1 ♀, SAM).

***Larrisson quintus* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:38B16720-1694-444F-82E4-B6B9E420B07A
http://species-id.net/wiki/Larrisson_quintus
Figs 11–15

Name–derivation. *Quintus* is a Latin masculine ordinal numeral meaning *fifth* (also used as a proper name); the species was the fifth *Larrisson* discovered in Australia.

Recognition. Females and most males of *Larrisson quintus* are recognized by the presence of many small setiferous punctures between spines on the dorsal half of the

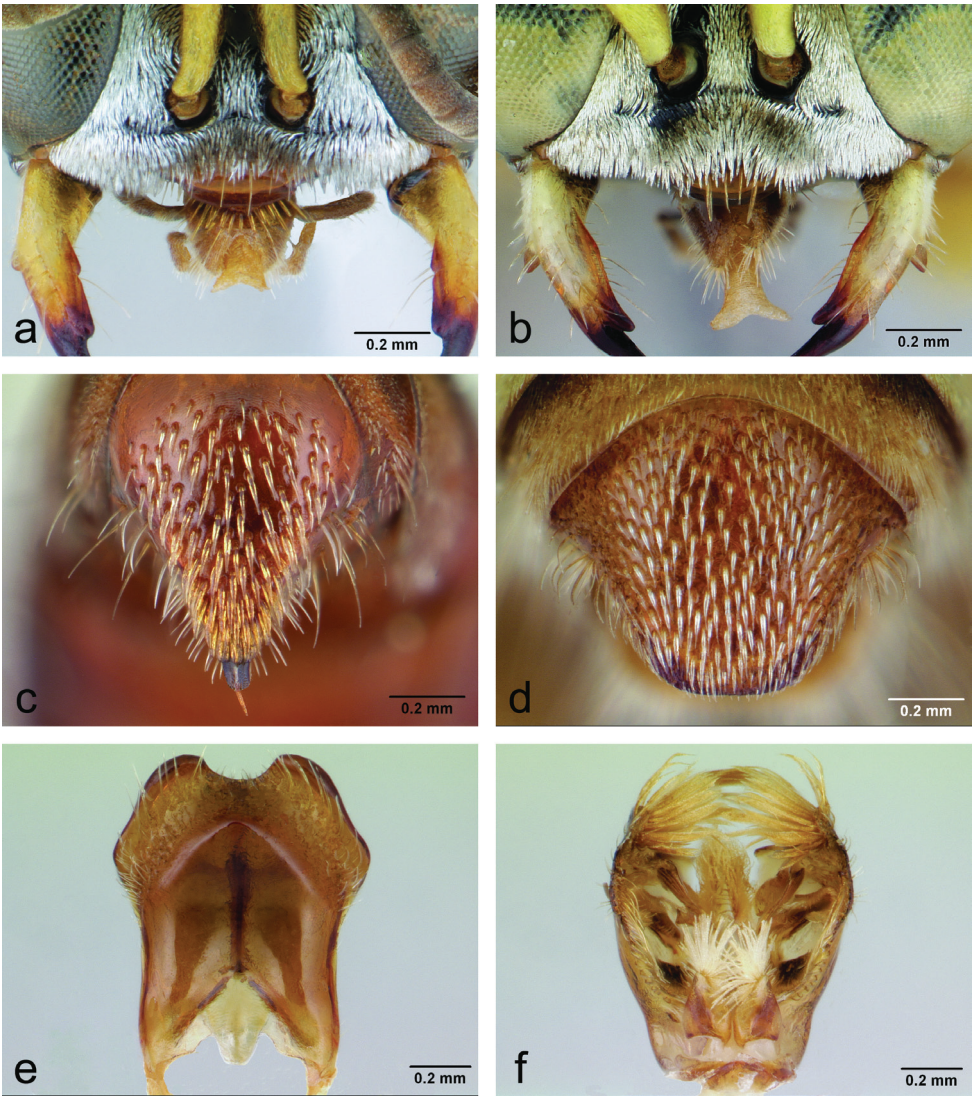


Figure 12. *Larrisson quintus*: **a** female clypeus and mandible **b** male clypeus and mandible **c** female pygidial plate **d** male tergum VII **e** male sternum VIII in ventral view **f** male genitalia in ventral view.

outer surface of the hindtibia. In addition, the mesothoracic venter is densely punctate and setose (punctures about one diameter apart, setae concealing integument), at least tergum I is reddish brown, and in the female most setae of the pygidial plate do not conceal the integument. In most other *Larrisson*, the outer surface of the hindtibia is impunctate at least in dorsal half or has a few, sparse punctures, although it is punctate and setose in *punctatus*, *spinosus*, *niger*, and *tegularis*; in the first two species, the punctures of the mesothoracic venter are 2–3 diameters apart on each side of the median zone, and the setae do not conceal the integument; in *niger*, the gaster is all black and most setae of the female pygidial plate conceal the integument (the male is unknown);

Figure 13. *Larrisson quintus* ♂: **a** mandible **b** forefemur **c** foretarsus **d** hindfemur **e** midtarsus **f** hindtarsus.

Figure 14. *Larrisson quintus*: male genitalia dorsally.

in *tegularis*, gastral terga have apical yellow fasciae and the tegular inner margin is concave (rather than evenly rounded.

The male of *Larrisson quintus* differs from all its congeners in having the legs markedly modified: the forefemoral venter is roundly expanded subbasally (Fig.13b), concave anterobasally, the forebasitarsus concave on the inner margin (Fig. 13c), foretarsomeres II–IV are expanded on the inner side (Fig. 13c), midtarsomeres II–IV wider than long (Fig. 13e), and the hindbasitarsus is convex on the outer margin (Fig. 13f); as in *orbitalis*, the posterior mandibular margin is angulate between base and notch (Fig. 13a); as in *sulcatus* and *tibialis*, the hindfemur is concave ventrally (Fig. 13d).

Description. Width of face across clypeus and vertex in female = 60:50–52, least interocular distance 47–48; in male 60:50, and 45, respectively. Orbital fovea well defined, in female more than half ocellocular distance, in male not quite half ocellocular distance. Clypeal lobe only slightly prominent, its free margin arcuate, rounded laterally in female (Fig. 12a), slightly angulate in male (Fig. 12b). Scapal basin impunctate, glabrous. Length of scape (excluding radicle) 2.2–2.3 × width in female, 2.8–2.9 × in male, length equal to flagellomeres I–IV + half V combined. Precoxal mesopleural declivity simple, not expanded into spine or tubercle; mesothoracic venter uniformly densely punctate and setose (punctures about one diameter apart, setae concealing integument). Metanotum with median tooth that is vestigial in females but well defined (up to about 1.3 × midocellar width) in males. Propodeal dorsum without spine or

Figure 15. A collecting site near Timber Creek in Gregory National Park where most specimens of *Larrisson quintus* were caught (including the holotype).

tubercle behind spiracle in female, with conspicuous tubercle or obtuse spine in male; side minutely ridged adjacent to metapleural sulcus (ridges larger under spiracle), with several punctures near middle, punctate posteriorly and also on posterior surface laterally; posterior surface ridged both mesodorsally and mesoventrally. Outer surface of hindtibia (except in one male from Ellery Creek Big Hole, WMNP) with many small setiferous punctures between spines, including dorsal half.

Setae all silvery, appressed on head, thorax, propodeum, and legs, concealing integument on clypeus and pronotal collar, concealing integument from most angles on lower frons (except for glabrous scapal basin), mesopleuron, and mesothoracic venter, forming apical fasciae on terga. Hindfemoral ventral and inner (= posterior) surfaces asetose (except inner surface setose preapically).

Head, thorax, and propodeum black in most specimens with the following exceptions: clypeus reddish brown ventrally (narrowly so on lateral lobes); mandible yellow basally, dark brown apically; scape yellow (black dorsally), all black in female from Heathlands, Queensland; flagellum reddish brown at least ventrally (all reddish brown in specimens from Victoria River Roadhouse); thorax and propodeum reddish brown to varying degree in several specimens from WMNP (only scutum black in one female). Forefemur in most females black basally, yellow apically, in most males yellow, with black spot in basal three quarter of length on posterior surface (black replaced by

reddish brown in most females and single male from WMNP, forefemur all reddish brown in one female from there); midfemur in most females reddish brown anteriorly and black posteriorly, except yellow apically and ventrally in distal half or third, in most males yellow anteriorly and ventrally, reddish brown posteriorly, dark brown dorsally (midfemur all reddish brown in specimens from WMNP, all black in female from Heathlands); hindfemur in most females reddish brown except black dorsally and yellow at very apex, in most males reddish brown except yellow apically and dark brown on posterior (= inner) surface in distal half, also dorsally in some specimens (hindfemur all reddish brown in specimens from WMNP except yellow apically in single male, all black in female from Heathlands); tibiae yellow (foretibia dark brown on ventral surface, mid- and hindtibiae dark brown on posterior surface); tarsi yellow in most specimens (apical tarsomeres reddish brown, brown in specimen from Heathlands), reddish brown in females from WMNP. Gaster all reddish brown in specimens from WMNP, but terga II and III largely black mesally and terga IV and V (IV–VI in male) black except laterally in those from Gregory National Park and Maud River, and only tergum I reddish brown in specimen from Heathlands; apical depressions of terga II–V (II–VI in male) reddish brown.

Female. Pygidial plate with punctures that are less than one diameter apart in apical half or third (Fig. 12c). Forebasitarsus with four or five rake spines; apical spine of foretarsomere III about 1.3 × as long as apical basitarsal width. Length 5.1–6.5 mm.

Male. Posterior mandibular margin conspicuously expanded near base (Fig. 13a), inner margin without tooth near midlength. Flagellum cylindrical; dorsal length of flagellomere I 1.4 × apical width. Forefemur expanded ventrally (Fig. 13b), concave basally on ventral surface; forebasitarsus concave on inner margin (Fig. 13c), with four rake spines; foretarsomeres II–IV wider than long, expanded on inner side (Fig. 13c); apical spine of foretarsomere III equal to apical spine of basitarsus. Midfemur expanded ventrally, but less so than forefemur; midtarsomeres II–IV wider than long (Fig. 13e). Hindfemur concave ventrally, expanded ventrad at apex (Fig. 13d), carinate between ventral and posterior (= inner) surfaces; hindtibia flattened laterally, carinate dorsally, concave on each side of carina in basal half; hindbasitarsus convex on outer side (Fig. 13f), hindtarsomeres II–IV enlarged, longer than wide (Fig. 13f), with dense, erect setae on venters; hindtarsomere III excavated ventrolaterally. Tergum VII rounded apically (Fig. 12d). Sternum II with transverse, glabrous swelling behind midlength. Apical half of sternum III and sterna IV–VII with dense, erect setae, becoming longer toward gastral apex (in addition to long, erect setae at bases of apical depressions). Sternum VIII emarginate apically, with large, glabrous platform preapically (Fig. 12e), punctate and setose outside platform. Genitalia: Fig. 12f, 14. Length 6.0–8.2 mm, but 10.3 mm in single male from WMNP.

Geographic variation. In specimens from Queensland and from Gregory National Park and Maud River, Northern Territory, the basolateral carina of tergum I is continued mesad by a short, oblique carina, in the female the glabrous, apicomedian portion of the clypeus is convex, the femora are darker, while the male forebasitarsus has a lamellar, translucent expansion on the outer margin in the distal half. In speci-

mens from WMNP, the additional tergal carina is absent, the apicomedian portion of the female clypeus is concave, the legs are more reddish brown, and the male forebasitarsus is not expanded on the outer margin. In females from Western Australia, the additional basolateral carina on tergum I is absent, the glabrous, apicomedian portion of the clypeus is flat, and the femora are more reddish brown in the specimen from Pardoo Roadhouse area.

Geographic distribution (Fig. 11). Northern Australia.

Specimens examined. *Holotype*: ♂, **AUSTRALIA: Northern Territory:** Gregory National Park: Victoria River bank near Timber Creek at 15°37.8'S, 130°28.6'E (Fig. 15), 10 Apr 2008, W.J. Pulawski and G.A. Williams (ANIC). *Paratypes*: Gregory National Park: Victoria River bank near Victoria River Roadhouse at 15°36.8'S, 131°08.7'E, W.J. Pulawski and G.A. Williams, 9 Apr 2008 (1 ♂, CAS) and 14 Apr 2008 (3 ♀, 2 ♂, CAS); same place and collectors as holotype, 10 Apr 2008 (13 ♀, CAS, 15 ♂, CAS; 1 ♀, 1 ♂, QMB), 13 Apr 2008 (1 ♀, 1 ♂, AMS; 1 ♀, ANIC; 1 ♀, 1 ♂, BMNH; 20 ♀, 20 ♂, CAS; 1 ♀, 1 ♂, OHL; 1 ♀, 1 ♂, USNM); Maud River bank 20 km NE Katherine at 14°22.9'S, 132°24.9'E, 7 Apr 2008, W.J. Pulawski and G.A. Williams (1 ♀, CAS); West MacDonnell National Park, V. Ahrens and W.J. Pulawski: Ellery Creek Big Hole 92 km W Alice Springs at 23°46.7'S, 133°04.4'E, 9 Mar 2008 (1 ♀, CAS), 12 Mar 2008 (4 ♀, 1 ♂, CAS), and Simpsons Gap 17 km W Alice Springs at 23°40.7'S, 133°43.1'E, 5 Mar 2008 (1 ♀, CAS), 8 Mar 2008 (2 ♀, CAS). **Queensland:** Heathlands at 11°45'S, 142°35'E, 26 Jan – 29 Feb 1992, P. Feehney (1 ♀, ANIC); Sandringham Station 55 km NW Bedourie at 24°03'S, 139°03', 1979-1980, S. Morton (1 ♀, ANIC). **Western Australia:** 158 km S Newman (= 9 km N Kumarina Roadhouse) at 24°37.8'S, 117°36.8'E [correctly: 119°36.8'E], 24 Apr – 7 May 2003, M.E. Irwin and F.D. Parker (1 ♀, ANIC); 80 km S Pardoo Roadhouse on Shay Gap road at 20°28.3'S, 129°10.0'E, 5 Jan – 14 May 2003, F.D. Parker and M.E. Irwin (1 ♀, USU).

***Larrisson spinosus* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:C9DDFEEF-6F37-4FB5-BC58-A4E704292AE7
http://species-id.net/wiki/Larrisson_spinosus
Figs 11, 16

Name–derivation. *Spinosus* is a Latin masculine adjective meaning *spiny*; with respect to the spine on the metanotum and another behind the propodeal spiracle, the structures that differentiate this species from *carinatus*.

Recognition. The male of *spinosus* resembles *carinatus* and *quintus* in having gastral terga I and II reddish brown rather than black combined with nonemarginate apically sternum VIII. It differs from these species in having a more prominent middle clypeal lobe (Fig. 16a). Unlike *quintus*, the legs are unmodified in *spinosus* (see *quintus* for details), and unlike *carinatus* the mesopleuron has a sharp median tooth in front of the midcoxa (rather than a transverse crest), the metanotum has a sharp middle spine (Fig. 16b, spine absent in *carinatus*), the propodeum has a spine behind the spiracle

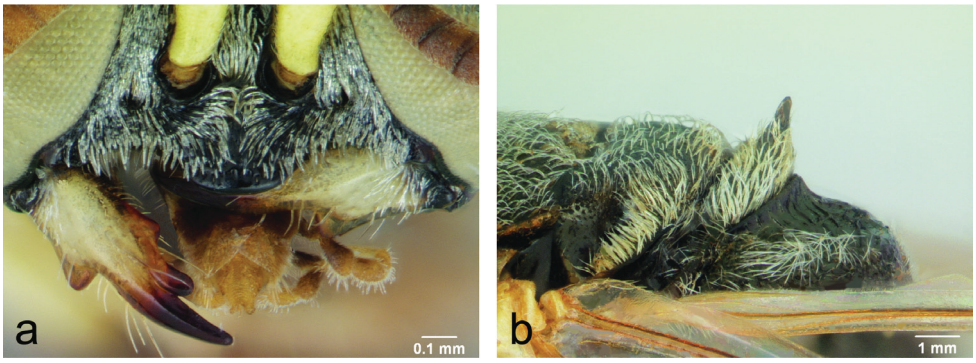


Figure 16. *Larrisson spinosus* ♂: **a** clypeus and mandible **b** metanotum in lateral view.

(spine absent in *carinatus*), and sternum II has a transverse swelling (rather than a median, pointed carina). The female is unknown.

Description. Male. Width of face across clypeus and vertex = 60:58, least interocular distance 30. Orbital fovea rudimentary. Clypeal lobe prominent, its free margin arcuate, not angulate laterally (Fig. 16a). Length of scape (excluding radicle) 2.7 × width, length equal to flagellomeres I–III + half IV combined. Mesopleuron with obtuse, transverse crest in front of midcoxa; mesothoracic venter sparsely punctate on each side of median zone (punctures several diameters apart). Metanotum with conspicuous median spine (Fig. 16b). Propodeal dorsum with conspicuous spine behind spiracle; side ridged; posterior surface ridged both mesodorsally and mesoventrally. Outer surface of hindtibia largely impunctate and asetose between spines in dorsal half.

Setae all silvery, appressed on head, thorax, propodeum, and legs, partly concealing integument on clypeus and pronotal collar, concealing integument from most angles on lower frons except for glabrous scapal basin, concealing or not concealing on mesopleuron, not concealing on mesothoracic venter, forming ill-defined apical fasciae on terga I–III. Hindfemoral ventral surface asetose, inner (= posterior) surface setose except ventrally in holotype and specimen from Calperum Station.

Head, thorax, and propodeum black except the following are pale yellow: scape, pedicel, mandible (except apically), and pronotal lobe, whereas flagellum is light brown ventrally and light brown to black dorsally. Forefemur black basally (reddish brown in specimen from Cocata Conservation Park), pale yellow apically and in apical half ventrally; midfemur reddish brown basally, pale yellow apically and in apical third ventrally; hindfemur reddish brown, pale yellow apically; tibiae pale yellow, partly reddish brown; forebasitarsus pale yellow (reddish brown on inner surface), remaining article yellowish brown; mid- and hindtarsi pale yellow except apical tarsomeres light brown. Gastral terga I, II, and VII reddish brown, remaining terga reddish brown laterally and on apical depressions, otherwise black.

Posterior mandibular margin not expanded between base and notch, inner margin with obtuse tooth near midlength (Fig. 16a). Flagellum cylindrical; dorsal length of flagellomere I about equal to apical width. Metanotum with conspicuous spine (Fig. 16b).

Propodeum with conspicuous spine behind spiracle (spine longer than that on metanotum). Legs unmodified except hindfemur concave ventrally, slightly expanded ventrad at apex, carinate between ventral and posterior (= inner) surfaces; forebasitarsus with four rake spines; apical spine of foretarsomere III equal to apical width of basitarsus. Tergum VII punctate throughout, rounded apically. Sternum II with transverse swelling behind midlength, swelling glabrous, similar to that of *quintus*. Sterna III–VII with long, erect setae at bases of apical depressions, otherwise practically asetose. Sternum VIII flat, glabrous, rounded apically. Length 8.4–9.6 mm. Genitalia similar to those of *quintus*.

Female. Unknown.

Geographic distribution (Fig. 11). South Australia and Western Australia.

Specimens examined. *Holotype*: ♂, **AUSTRALIA: Western Australia:** François Peron National Park ca 10 km NNE Denham at 25°50.3'S, 113°33.3'E, 9 Nov 2008, V. Ahrens and W.J. Pulawski (WAMP). *Paratypes*: **AUSTRALIA: South Australia:** Calperum Station 16 km N Renmark at 34°02.9'S, 140°42.2'E, 3 Dec 2010, V. Ahrens and W.J. Pulawski (1 ♂, CAS); Cocata Conservation Park at 33°17.0'S, 135°19.7'E, 3 Jan 2011, V. Ahrens and W.J. Pulawski (1 ♂, CAS).

***Larrisson sulcatus* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:F92DB495-45B7-45F1-A383-FE5294C23B8F
http://species-id.net/wiki/Larrisson_sulcatus
Figs 17, 18

Name–derivation. *Sulcatus*, a Latin masculine adjective meaning *furrowed*. With reference to a pair of sulci on the posterior propodeal surface of this species.

Recognition. The male of *sulcatus* differs from all other species of *Larrisson* by the presence of a pair of longitudinal sulci on the posterior propodeal surface that are convergent ventrad (Fig. 17a), and a triangular rather than open anteriorly second submarginal cell (Fig. 17b). The female is unknown.

Description (based on holotype only). Male. Width of face across clypeus and vertex = 60:58, least interocular distance 44. Orbital fovea ill defined, narrower than half ocellocular distance. Clypeal lobe only slightly prominent, its free margin arcuate, obtusely angulate laterally. Scapal basin impunctate. Length of scape (excluding radicle) 2.2 × width, length equal to flagellomeres I–IV + half V combined. Mesopleural punctures less than one diameter apart; impunctate, low tubercle present in front of midcoxa; mesothoracic venter densely punctate throughout (punctures less than one diameter apart). Metanotum with median tubercle. Propodeal side with well-defined ridges; posterior surface ridged mesodorsally, finely rugose mesoventrally, with pair of longitudinal sulci that are converging ventrad (Fig. 17a). Forewing vein M diverging from M+Cu distad of cu-a by about 0.5 length of cu-a; second submarginal cell triangular (Fig. 17b). Outer surface of hindtibia impunctate and asetose between spines along dorsal margin. Tergum I concave basally, concavity with well-defined median line.

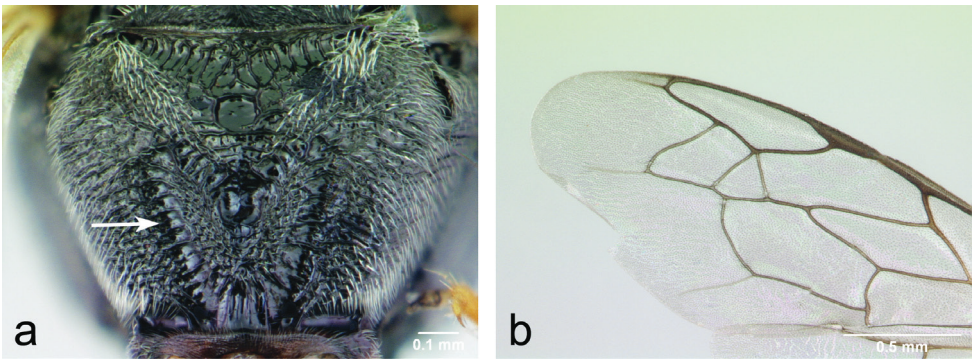


Figure 17. *Larrisson sulcatus* ♀: **a** propodeal posterior surface (arrow indicates sulcus) **b** forewing showing triangular submarginal cell II.

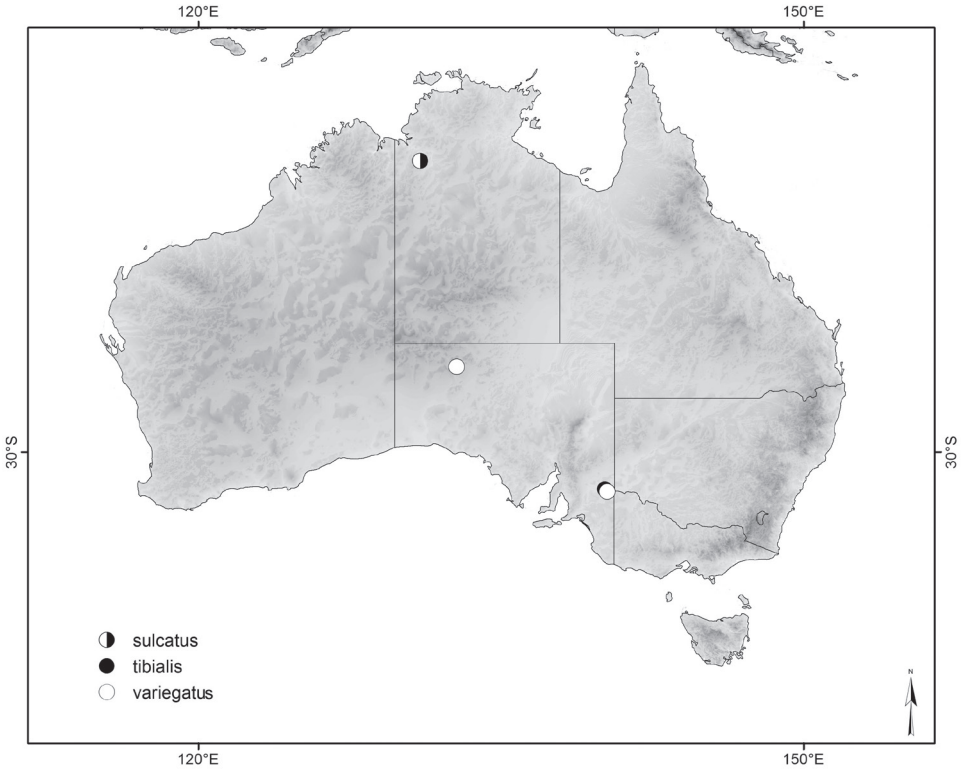


Figure 18. Collecting localities of *Larrisson sulcatus*, *tibialis*, and *variegatus*.

Setae all silvery except golden beneath midocellus, appressed on head, thorax, propodeum, and legs, nearly completely concealing integument on clypeus (except glabrous ventral portion of median lobe) and on ventral half of frons laterally (except for glabrous scapal basin), not concealing integument on mesopleuron or mesothoracic

venter, not forming well-defined apical fasciae on terga. Hindfemoral venter and inner (= posterior) surface setose.

Head, thorax, and propodeum black except the following are pale yellow: scape, part of pedicel, mandible basally (apex dark brown), pronotal lobe, and humeral plate of wing base; flagellum black dorsally, brown ventrally (two apical flagellomeres all brown). Femora black basally, yellow apically; tibiae and tarsi yellow.

Posterior mandibular margin not expanded between base and notch, inner margin with small tooth near midlength. Flagellum cylindrical; dorsal length of flagellomere I about equal to apical width. Propodeum without spine or tubercle behind spiracle. Legs unmodified; forebasitarsus with four rake spines; apical spine of forebasitarsus III as long as apical basitarsal width. Sternum II without transverse swelling, but with low, transverse convexity behind midlength. Sterna III–VII with long, erect setae at bases of apical depressions, sterna V–VII also with erect setae on remaining surface. Sternum VIII punctate and setose along margin, rounded apically. Volsella ending shortly before apex of penis valve. Length 6.4 mm.

Female. Unknown.

Geographic distribution (Fig. 18). Known from one locality in northwestern Northern Territory, Australia.

Specimen examined. *Holotype*: ♂, **AUSTRALIA: Northern Territory:** Gregory National Park: Limestone Gorge at 16°03'01"S, 130°24'07"E, 9-20 June 2001, M.E. Irwin, F.D. Parker, and C. Lambkin (ANIC).

***Larrisson tegularis* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:78C11ED5-F639-4184-A8A6-177AE7C2CCDA
http://species-id.net/wiki/Larrisson_tegularis
Figs 3, 19

Name–derivation. *Tegularis*, a Latin masculine and feminine adjective derived from *tegula*, which is unusual shape in this species.

Recognition. *Larrisson tegularis* has a reddish brown gaster with yellow apical bands on terga, a unique such coloration (yellow bands somewhat obscured by vestiture). It also has a unique tegula: elongate, with concave inner margin (Fig. 19b). In the female, the punctures of the pygidial plate are sparser than in all the congeners, averaging more than one diameter apart mesally, and the setae do not conceal the integument (Fig. 19c). In the male, flagellomere I is shorter than in the congeners (dorsal length equal to 0.8 × apical width, rather than at least equal) and sternum VIII is unique: it is emarginate apicomesally (Fig. 19d), but less so than in *armatus*, *orbitalis*, *quintus*, and *variegatus*, and unlike these species the ventral surface is all flat, punctate throughout (rather than with a glabrous, raised platform basomedially).

Description. Width of face across clypeus and vertex = 60:61–62, least interocular distance 30–31 in female, and 60:60 and 36, respectively, in male. Orbital fovea absent. Clypeal lobe only slightly prominent, its free margin arcuate, not angulate

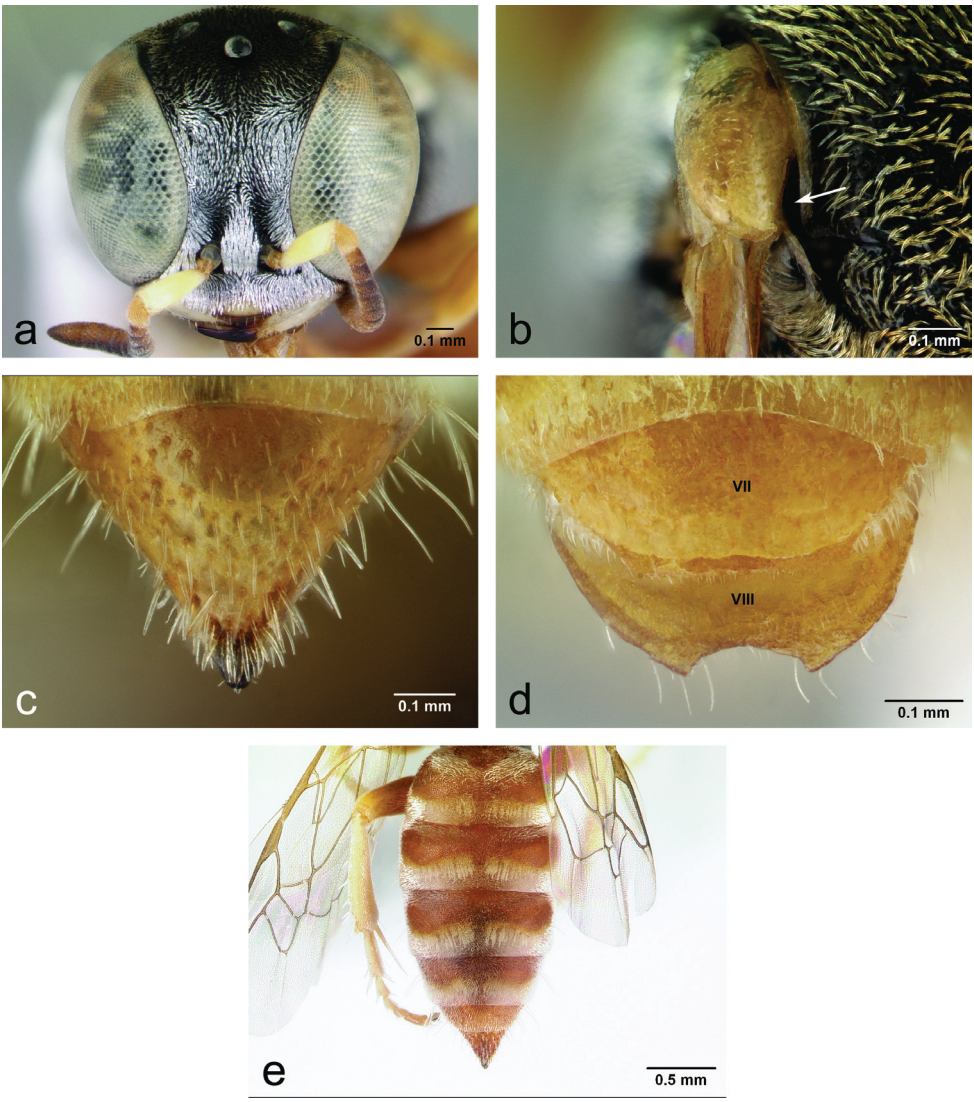


Figure 19. *Larrisson tegularis*: **a** female head in frontal view **b** tegula (arrow indicates concave inner margin) **c** pygidial plate of female **d** apical sterna of male in ventral view **e** female gaster in dorsal view.

laterally. Scapal basin smaller than in other *Larrisson*, all punctate (punctures almost contiguous), setae not concealing integument (Fig. 17a). Length of scape (excluding radicle) 2.7 × width, length equal to flagellomeres I–III + half IV combined. Scutal and mesopleural punctures less than one diameter apart; mesopleuron rounded in front of midcoxa, without tooth or crest; mesothoracic venter densely punctate throughout in some individuals (punctures less than one diameter apart), but sparsely punctate or impunctate on each side in others. Tegula elongate, with concave inner margin (Fig. 19b). Metanotum without tooth or carina. Propodeum without spine or tubercle

Figure 20. *Larrisson tegularis*: male genitalia dorsally.

behind spiracle; side ridged, punctate between ridges, finely ridged and impunctate anteriorly; posterior surface unsculptured or finely ridged mesodorsally, coarsely punctured mesoventrally. Externoventral hindfemoral margin minimally expanded next to apex. Outer surface of hindtibia with small setigerous punctures, including dorsal half.

Setae all silvery, appressed on head, thorax, propodeum, and legs, completely concealing integument on clypeus (except medioventrally), lower frons (except scapal basin), and mesopleuron. Glabrous area of propodeal dorsum limited to slightly more than median sulcus. Hindfemoral venter asetose, inner (= posterior) surface setose, asetose ventrally.

Head, thorax, and propodeum black except the following are yellow: clypeus medioventrally, scape, pedicel, mandible (apical third dark brown), and pronotal lobe; flagellum brown dorsally, yellowish brown ventrally. Forefemur yellow except reddish brown dorsally (light to dark), most of midfemur reddish brown (light to dark), but yellow ventrally and apically, hindfemur reddish brown except yellow apically; tibiae and tarsi yellow. Gaster brownish red, terga with yellow apical bands that are somewhat concealed by appressed vestiture (Fig. 17e).

Female. Punctures of pygidial plate averaging more than one diameter apart mesally, setae not concealing integument. Forebasitarsus with three or four rake spines; apical spine of foretarsomere III about 1.4 × as long as apical basitarsal width. Length 4.2–4.9 mm.

Male. Posterior mandibular margin not expanded between base and notch. Flagellum cylindrical; dorsal length of flagellomere I 0.8 × apical width. Legs unmodified;

forebasitarsus with four rake spines; apical spine of forebasitarsus III as long as apical basitarsal width. Sternum II without transverse swelling; apex of sternum IV and all sterna V–VIII with dense, erect setae; sternum VIII flat, all punctate, shallowly emarginate apically (Fig. 17d). Genitalia unlike those of other *Larrisson*, with broad, rounded gonocoxite and setae invisible from above (Fig. 20). Length 4.2 mm.

Geographic distribution (Fig. 3). Known from one locality in southwestern New South Wales.

Specimens examined. *Holotype*: ♀, **AUSTRALIA: New South Wales:** Kinchega National Park at 32°22.8'S, 142°23.6'E, 29 Dec 2009, V. Ahrens and W.J. Pulawski (AMS). *Paratypes*: same locality and collectors, 29 Dec 2009 (5 ♀, CAS), 30 Dec 2009 (4 ♀, 1 ♂, CAS).

***Larrisson tibialis* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:275782F6-5B98-4316-8241-326A739C5CA1
http://species-id.net/wiki/Larrisson_tibialis
Figs 18, 21

Name–derivation. *Tibialis* is a Latin adjective derived from *tibia*; with reference to the unusual male hindtibia of this species.

Recognition. The male of *tibialis* (the female is unknown) has uniquely modified hindtibia, thickened on the outer side at about one third length (the thickening is best seen in dorsal view, Fig. 21a), and the lateral surface has three unevenly spaced spines: two at the thickening and one near the apex (Fig. 21a, b). In the other *Larrisson*, the hindtibia is not thickened, and the spines on the lateral surface are evenly spaced. Subsidiary recognition characters of *tibialis* are: propodeal dorsum with spine behind spiracle and sternum II with arcuate swelling.

Description (based on holotype only). Male. Width of face across clypeus and vertex = 60:58, least interocular distance 35. Orbital fovea well defined, narrower than half ocellocular distance. Clypeal lobe only slightly prominent, its free margin arcuate, not angulate laterally. Scapal basin impunctate except punctate along inner margin. Length of scape (excluding radicle) 2.8 × width, length equal to flagellomeres I–V combined. Flagellomeres cylindrical. Mesopleuron with convexity in front of midcoxa; mesothoracic venter sparsely punctate on each side of median zone (punctures several diameters apart). Metanotum with small median tooth. Propodeal side ridged; posterior surface ridged both mesodorsally and medioventrally. Outer surface of hindtibia sparsely punctate and setose between spines. Tergum I concave basally.

Setae all silvery, appressed on head, thorax, propodeum, and legs, nearly completely concealing integument on clypeus (except glabrous ventral portion of median lobe) and on ventral half of frons laterally (scapal basin glabrous), largely concealing integument on mesopleuron and mesothoracic venter, not forming apical fasciae on terga. Hindfemoral venter asetose, inner (= posterior) surface setose except asetose along ventral margin in basal half.

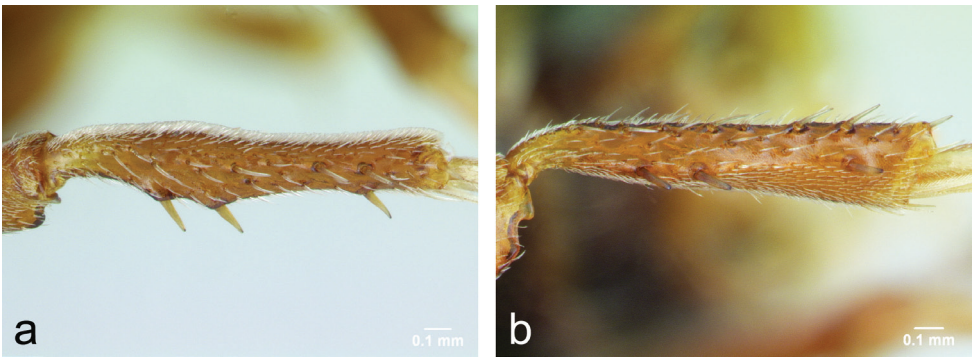


Figure 21. *Larrisson tibialis* ♂: **a** hindtibia in dorsal view **b** hindtibia in lateral view.

Head, thorax, and propodeum black except the following are pale yellow: scape ventrally, pedicel apically, mandible (except apically), and pronotal lobe, whereas flagellum is black dorsally and brown ventrally. Forefemur black, pale yellow in apical third; foretibia and foretarsus pale yellow; midfemur reddish brow, black basoventrally, pale yellow apically; midtibia reddish brown, pale yellow basally and apically; midtarsus pale yellow, apical tarsomere brown; hindfemur reddish brown, black basally; hindtibia reddish brown; hindtarsus yellow, apical tarsomere brown. Gaster black except tergum I and preapical zone on terga II and III reddish brown.

Posterior mandibular margin not expanded between base and notch, inner margin with small tooth near midlength. Flagellum cylindrical; dorsal length of flagellomere I about equal apical width. Propodeal dorsum with spine behind spiracle. Legs unmodified except midtibia slightly curved near basis, hindfemur with small emargination near apex of externoventral (= anteroventral) margin, carinate between ventral and posterior (= inner) surfaces, venter concave; hindtibia thickened on the outer side at about one third length (thickening best seen in dorsal view, Fig. 21a), with densely punctate area on lateral surface between thickening and apex that is gradually enlarging toward apex, and lateral surface with three unevenly spaced spines: two at thickening and one near apex (Fig. 21a, b); forebasitarsus with four rake spines; apical spine of forebasitarsus III as long as apical basitarsal width. Sternum II with arcuate swelling, anterad of swelling with dense, erect setae that are shorter than midocellus width; sterna III–VII with long, erect setae at bases of apical depressions, sterna VI and VII also with numerous erect setae that are about as long as midocellar width. Sternum VIII punctate and setose along margin, rounded apically. Genitalia similar to those of *quintus* except volsella ending shortly before apex of penis valve. Length 9.5 mm.

Female. Unknown.

Geographic distribution (Fig. 18). Known from one locality in South Australia.

Specimen examined. *Holotype*: ♂, **AUSTRALIA: South Australia:** Calperum Station 31 km NW Renmark at 33°59'S, 140°30'E, 7 Nov – 13 Dec 1995, K.R. Pullen (ANIC).

***Larrisson variegatus* Pulawski, sp. n.**
urn:lsid:zoobank.org:act:37FC6D60-2755-46B1-BA23-8AF6EFED7150
http://species-id.net/wiki/Larrisson_variegatus
Figs 18, 22, 23

Name–derivation. *Variegatus* is the perfect past participle (here used as an adjective) of the Latin verb *variegare,* meaning "to make various sorts or colors", with reference to the unusual coloration of the male antenna.

Recognition. Unlike all other *Larrisson*, the first recurrent vein of *variegatus* is received by the second submarginal cell (Fig. 23) rather than the first. The species is further characterized by an all or largely reddish brown gaster and a densely punctate mesothoracic venter, with the integument totally concealed by vestiture, two features shared with *orbitalis* and *quintus*. Unlike *quintus*, *variegatus* lacks small, dense punctures and setae between spines on the outer surface of the hindtibia (except ventrally). Unlike *orbitalis*, the inner eye margin are almost parallel above the level of the antennal socket (Fig. 22a) rather than markedly bowing toward the frons midline. The male has three unique characters: 1. multicolored antenna (Fig. 22b, c), with flagellomeres I–VI convex ventrally (Fig. 22c); 2. an unusually large basal concavity of tergum I that extends to both lateral margins, is largely asetose, and is bordered laterally by the basolateral tergal carina up to its dorsal end (Fig. 22d, e); and 3. sternum II with a transverse swelling that is markedly curved posterad (Fig. 22f). The emarginate apically male sternum VIII is a subsidiary recognition feature, shared with *armatus*, *orbitalis*, *quintus*, *tegularis*, and also with *Larrissa nedyma*.

Description. Width of face across clypeus and vertex in female = 60:49–51, least interocular distance 34–35; in male 60:48–51, and 32–33, respectively. Orbital fovea in female well defined but narrow, less than half ocellocular distance, in male varying from well defined (as narrow as in female) to nearly absent. Clypeal lobe only slightly prominent, its free margin arcuate, not angulate laterally. Length of scape (excluding radicle) 2.7 × width in female, 2.8–2.9 × in male, length equal to flagellomeres I–IV combined. Mesopleuron with obtuse, transverse crest in front of midcoxa; mesothoracic venter uniformly densely punctate, punctures about one diameter apart. Metanotum with rudimentary median carina. Propodeal dorsum without spine or tubercle behind spiracle; side finely, densely ridged; posterior surface unsculptured both mesodorsally and mesoventrally. First recurrent vein received by second submarginal cell (Fig. 23). Outer surface of hindtibia impunctate and asetose between spines (except basally and ventrally).

Setae all silvery, appressed on head, thorax, propodeum, and legs, concealing integument on clypeus, large part of frons in female and most of frons in male (except for glabrous scapal basin), largely concealing integument on mesopleuron and mesothoracic venter in female, totally so in male. Hindfemoral venter asetose, inner (= posterior) surface asetose except setose dorsally.

Head, thorax, and propodeum black except scapal venter and pronotal lobe yellow, also mandibular base in female (yellowish in male). See below for color of flagellum, legs, and gaster.

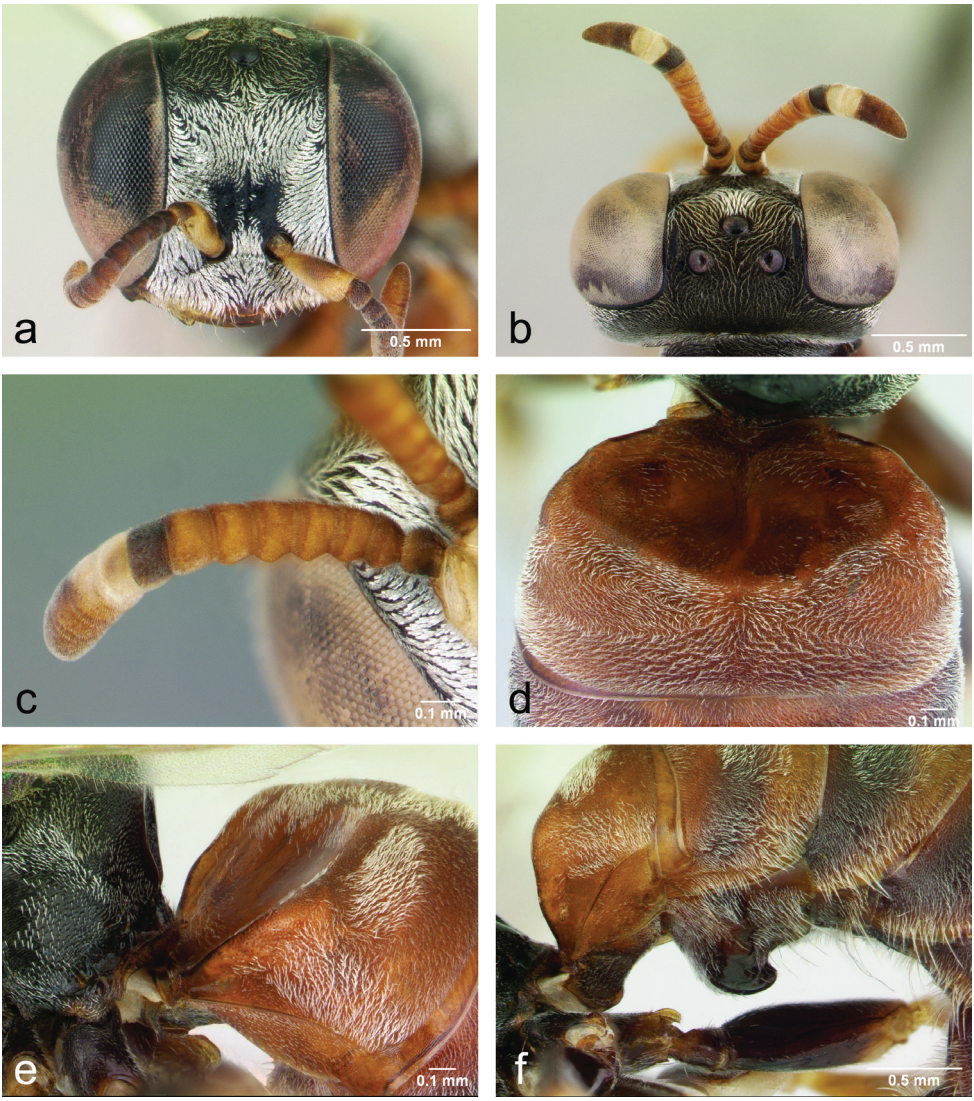


Figure 22. *Larrisson variegatus*: **a** female head in frontal view **b** male head in dorsal view **c** male antenna **d** male tergum I in dorsal view **e** male tergum I in oblique lateral view **f** gastral base of male in lateral view.

Female. Inner eye orbits nearly parallel between antennal socket and midocellus level (Fig. 22a); hindfemoral venter slightly concave near apex and with a few setae. Length 5.0 mm. Flagellum brown dorsally, reddish brown ventrally; fore- and mid-femora reddish brown, pale yellow ventrally (except near base), hindfemur reddish brow, pale yellow at very apex; tibiae reddish brown, pale yellow dorsally; tarsi reddish brown. Gaster all reddish brown.

Male. Flagellomeres I–VI convex ventrally (Fig. 22c), dorsal length of flagellomere I equal to apical width. Posterior mandibular margin slightly concave between base

Figure 23. *Larrisson variegatus*: forewing (arrow indicates first recurrent vein).

and notch. Forefemur flat ventrally. Basal concavity of tergum I unusually large, largely asetose, extending to both lateral margins (Fig. 22d), bordered laterally by basolateral tergal carina attaining concavity's dorsal end (Fig. 22e). Sternum II with transverse swelling that is markedly curved posterad (Fig. 22f); sterna III–VII with long, erect setae at bases of apical depressions and also with shorter, erect setae on remaining surface; sternum VIII emarginate apically, with glabrous, slightly elevated platform that covers most of its surface, punctate and setose along margins outside platform. Length 7.5–8.4 mm. Flagellomeres I–VI reddish brown, VII black, VIII and IX pale yellow, X and XI brown (Fig. 22b, c). Forefemur reddish brown, pale yellow ventrally, with some black areas basodorsally, midfemur black dorsally, pale yellow ventrally, with intermediate areas reddish brown, hindfemur black, pale yellow at very apex; tibiae reddish brown, pale yellow dorsally; tarsi reddish brown. Gaster largely reddish brown, but terga II–VII with lateral spots that become large toward apex (black areas larger on terga V and VI than red median zone).

Geographic distribution (Fig. 18). Known from two localities in South Australia.

Specimens examined. *Holotype*: ♂, **AUSTRALIA: South Australia:** Calperum Station 14 km WNW Renmark at 34°07'S, 140°37'E, mallee, 7 Nov – 13 Dec 1995, K.R. Pullen (ANIC). *Paratypes*: same data but 13 Dec 1995 – 25 Jan 1996 (1 ♀, 6 ♂, ANIC; 1 ♀, 1 ♂, CAS); 4 mi. S Maynards Bore (which is 27°18'37''S, 132°23'40''E) in Everard Park Station, 5 Nov 1970, E. Matthews (1 ♂ , SAM).

***Larrisson abnormis* (R. Turner)**

Sericophorus abnormis R. Turner, 1914: 352, ♂. Holotype: ♂, Western Australia: Yallingup (BMNH). – **As *Larrisson abnormis*:** nec Menke, 1967: 29 (= *Larrisson rieki*); nec Bohart and Menke 1976: fig. 83E, 86B, 87B, 88C-D, 90F (= *Larrisson rieki*); Menke, 1979: 461 (in revision of *Larrisson*); Cardale, 1985: 255 (in catalog of Australian Sphecidae).

Geographic distribution. Listed from three localities by Menke (1979): Edeowie Homestead near Wilpena Pound and 15–25 mi. SE Musgrave Park in South Australia, and from Yallingup (type locality) in Western Australia. I have seen specimens from eight other localities: **New South Wales:** Springs Creek 68 km SW Wilcannia (1 ♀, 2 ♂, ANIC), 41 km SE Wilcannia at 31°38'S, 143°48'E (1 ♂, ANIC). **Northern Territory:** Curtin Springs Homestead 85 km E Yulara (1 ♂, CAS). **South Australia:** Calperum Station 32 km N Renmark at 33°53'S, 140°44'E (1 ♀, ANIC), Markaranka (1 ♀, SAM), near Victory Well in Everard Park, a suburb of Adelaide (1 ♂, CAS). **Western Australia:** 45 km SW Marble Bar at 21°24.4'S, 119°33.4'E (1 ♂, USU), Valentine Rockhole near Kununurra at 15°43'S, 128°39'E (1 ♀, ANIC).

***Larrisson azyx* Menke**

Larrisson sp.: Evans and Matthews 1973: 204 (prey of *Bembix moma*), corrected to *Larrisson azyx* by Menke, 1979: 461.—Cardale, 1985:255 (in catalog of Australian Sphecidae).

Larrisson azyx Menke, 1979b: 460, ♂. Holotype: ♂, Western Australia: Kununurra (ANIC).

Geographic distribution. Known only from the type locality. I have seen one male from South Australia: Calperum Station 14 km WNW Renmark at 34°07'S, 140°37'E, mallee on dune, 13 Dec 1995 – 25 Jan 1996, K.R. Pullen collector (1 ♂, ANIC).

***Larrisson rieki* Menke**

As *Larrisson abnormis* (corrected to *Larrisson rieki* by Menke, 1979: 457): Menke, 1967: 29 (generic characteristics); Bohart and Menke 1976: fig. 83E, 86B, 87B, 88C-D, 90F.

Larrisson rieki Menke, 1979b: 457, ♂. Holotype: ♂, Western Australia: 10 mi W Mullewa (UCD).—Cardale, 1985: 255 (in catalog of Australian Sphecidae).

Geographic distribution. Known only from the holotype. I have seen an additional specimen from South Australia: 9 km ESE Taylorville at 34.075°S 140.04°E, 12 Nov

Table 2. Comparison of the two known males of *Larrisson rieki*

	Western Australia	South Australia
Inner mandibular margin	with inconspicuous tooth	with well-defined tooth (Fig. 24a)
Precoxal mesopleural tubercle	sharp, prominent	low, inconspicuous
Lateral margin of tergum VI	swollen	not swollen
Tergum VII (shape)	broad	narrow (as in *quintus*, Fig. 12d)
Tergum VII (punctation)	sparse	denser

1987, I.D. Naumann and J. C. Cardale (♂, ANIC). These two males are markedly different, as tabulated above:

In spite of these differences, I consider them to be individual or geographic variants of one species, rather than members of two different species, as they share a number of unique characters: yellow antennae (Fig. 24a), dense, directed upward frontal setae, a flattened, concave midfemoral venter, obtusely carinate along both anterior and posterior margins (Fig. 24b), and an anteroventral hindfemoral margin that is slightly expanded preapically, with a row of small setae emerging from the expansion. They also share the following, non-unique characters: metanotum with median tooth, propodeum with prominent spine behind spiracle, and sternum II with transverse swelling.

Genus *Larrissa* Pulawski, gen. n.
urn:lsid:zoobank.org:act:88B8E25A-871A-43AD-9817-C12885597A9E
http://species-id.net/wiki/Larrissa

Type species: *Larrisson nedymus* Menke, 1979. Gender: feminine.

Description. As indicated under Phylogenetic Analysis above, *Larrisson nedymus* does not cluster with either the remaining *Larrisson* or *Sericophorus* and requires a genus of its own.

Like *Larrisson*, *Larrissa* is a member of the tribe Miscophini because of the round, not modified, hind ocellus and the simply attenuate hindfemur in combination with the emarginate posterior mandibular margin. It is characterized by the presence of two discoidal and three submarginal cells, the second submarginal not petiolate but distinctly narrowing toward the front margin, and the first recurrent vein ending on the first submarginal cell.

Larrissa appears most closely related to *Larrisson* and *Sericophorus*. Like *Larrisson*, it differs from *Sericophorus* by the following: the posterior propodeal surface has no medioventral carina (carina present in *Sericophorus*), the male flagellum has 11 articles (10 in *Sericophorus*), a volsella is present (absent in *Sericophorus*), and the occipital carina does not join the hypostomal carina (joins in the vast majority of *Sericophorus*). It also differs in having a mesopleuron abruptly angular below the pronotal lobe, the mesothoracic venter conspicuously concave mesally, and the female gena with an angular bulge near the middle.

Unlike *Larrisson*, *Larrissa* has the following: frons uniformly punctate and setose (without glabrous scapal basin, Fig. 25a); length of scape 1.1–1.3 × maximum

Figure 24. *Larrisson rieki*, ♂ from South Australia: **a** head in frontal view **b** midfemur in ventral view.

width; inner mandibular margin without preapical tooth, but with two teeth near midlength (Fig. 25a); mesopleuron abruptly angular below pronotal lobe; forewing vein M diverging from M+Cu basad of cu-a; basolateral carina of tergum I expanded into lamella; female gena with angular bulge near middle; female tergum VI with impunctate, glabrous marginal lamella (Fig. 26a); male forecoxa with apical spine and foretrochanter excavated basally, volsella ending at half length of penis valve, and head of penis valve dentate. In *Larrisson*, the frons has an impunctate or sparsely to densely punctate scapal basin above each antennal socket (Figs 25b-d); length of scape (excluding radicle) is 2.3–2.8 × maximum width; inner mandibular margin with preapical tooth, at most with one obtuse tooth near midlength; mesopleuron rounded anteriorly, not abruptly angulate; forewing vein M diverging from M+Cu distad of cu-a or interstitial with cu-a; basolateral carina of tergum I not expanded into lamella; female gena without angular bulge; female tergum VI without impunctate, glabrous marginal lamella; male forecoxa and foretrochanter not modified, volsella ending shortly before apex of penis valve or exceeding apex of penis valve, and head of penis valve not dentate.

Larrissa nedyma (Menke), comb. n.

Larrisson nedymus Menke, 1979: 455, ♀, ♂. Holotype: ♀, Western Australia: Nilemah station 50 mi (= 80 km) SSE Denham (ANIC).—Cardale, 1985: 255 (in catalog of Australian Sphecidae).

Geographic distribution. Known only from the type locality. I saw three additional specimens from the following localities: **Queensland:** Dulhunty River 13 km SW Heathland Homestead at 11°50'S, 142°30'E, 17 Mar 1992, G. Daniels and M.A. Schneider (1 ♂, ANIC). **Western Australia:** 57.5 km NE Kalbarri at 27°17'56"S, 114°31'12"E, 19 Nov 1998, T.F. Houston (1 ♀, WAMP), and 8 km N Nerren Nerren Homestead at 29°04'S, 117°45'E, 25 Sept 1985, R.P. Matthews collector, det. Ole Lomholdt (1 ♀, WAMP).

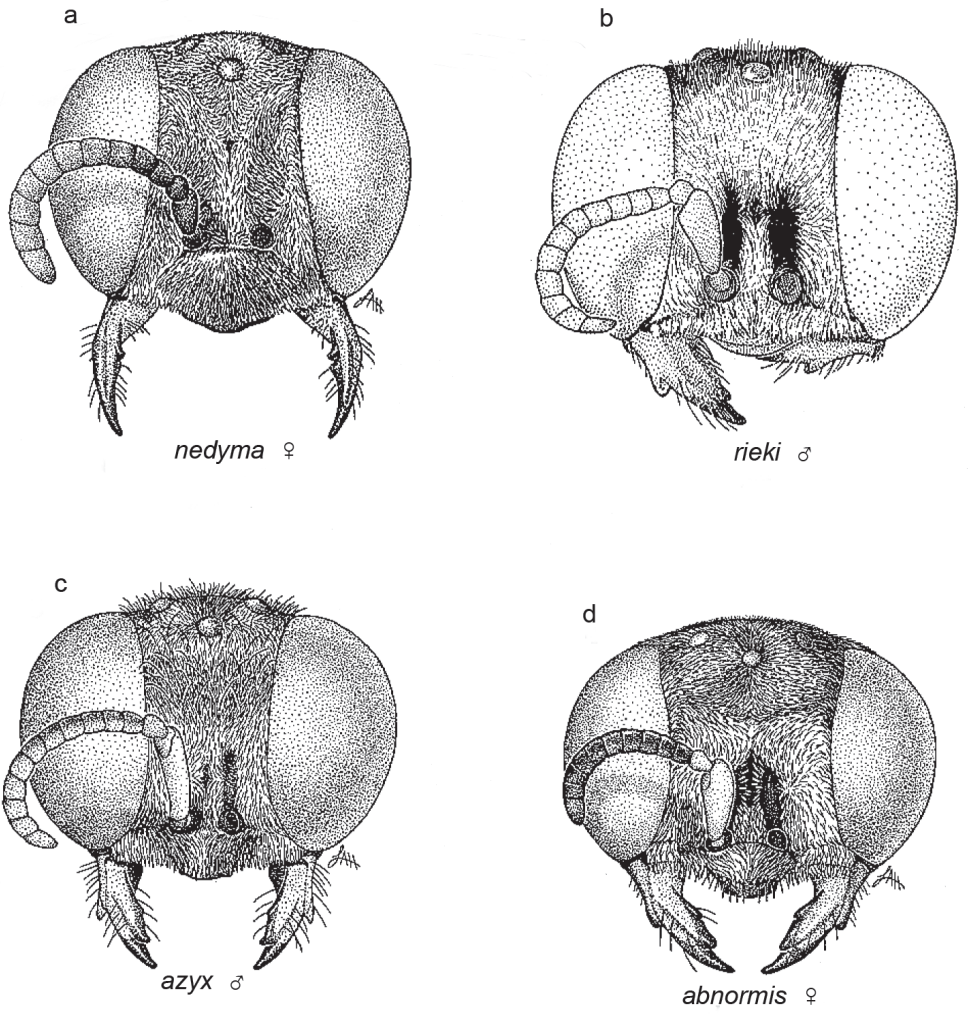


Figure 25. Facial portraits: **a** *Larrissa nedyma* ♀ **b** *Larrisson rieki* ♂ **c** *Larrisson azyx* ♂ **d** *Larrisson abnormis* ♀. From Menke, 1979, reproduced with the author's permission.

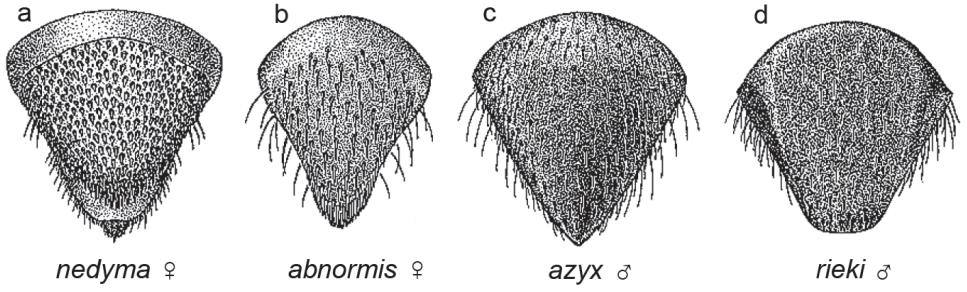


Figure 26. Apical gastral terga: **a** *Larrissa nedyma* ♀ **b** *Larrisson abnormis* ♀ **c** *Larrisson azyx* ♂ **d** *Larrisson rieki* ♂. From Menke, 1979, reproduced with the author's permission.

Key to species of *Larrissa* and *Larrisson*

1 Frons uniformly punctate (Fig. 25a); length of scape (excluding radicle) 1.1–1.3 × maximum width (Fig. 25a); inner mandibular margin without preapical tooth, with two teeth near midlength (Fig. 25a); mesopleuron abruptly angular below pronotal lobe; forewing vein M diverging from M+Cu basad of cu-a; basolateral carina of tergum I expanded into lamella. Female: gena with angular bulge near middle; tergum VI with impunctate, glabrous marginal lamella (Fig. 26a). Male: forecoxa with apical spine, foretrochanter excavated basally..... ***Larrissa nedyma* (Menke)**

– Frons with impunctate or sparsely to densely punctate scapal basin above each antennal socket (Figs 22b-d); length of scape (excluding radicle) 2.2–2.8 × maximum width (Figs 22b-d); inner mandibular margin with preapical tooth (Figs 22b-d), at most with one obtuse tooth near midlength; mesopleuron rounded anteriorly, not abruptly angulate; forewing vein M diverging from M+Cu distad of cu-a or interstitial with cu-a; basolateral carina of tergum I not expanded into lamella. Female: gena without angular bulge; tergum VI without impunctate, glabrous marginal lamella (Fig. 26b-d). Male: forecoxa and foretrochanter not modified. Genus *Larrisson* Menke..... **2**

2 Upper frons, gena, vertex, mesothorax, hindcoxal venter, and hindfemoral venter with conspicuous, erect or suberect setae (Fig. 27a). Male: hindfemur with conspicuous preapical, ventrally oriented process (Fig. 27b); apex of tergum VII triangular (Fig. 26c). Female: unknown..... ***Larrisson azyx* Menke**

– Head and thorax with appressed setae, hindcoxal venter and hindfemoral venter with inconspicuous erect setae. Male: hindfemur without preapical process; apex of tergum VII rounded (Figs 4d, 12d, 26d)..... **3**

3 Females (unknown in *carinatus*, *rieki*, *spinosus*, *sulcatus*, and *tibialis*)..... **4**

– Males (unknown in *latifrons*, *niger*, and *punctatus*)..... **12**

4 Basal concavity of tergum I with punctures almost as large as those on scutum (Fig. 10a,b); mesothoracic venter markedly depressed; glabrous area of pro-

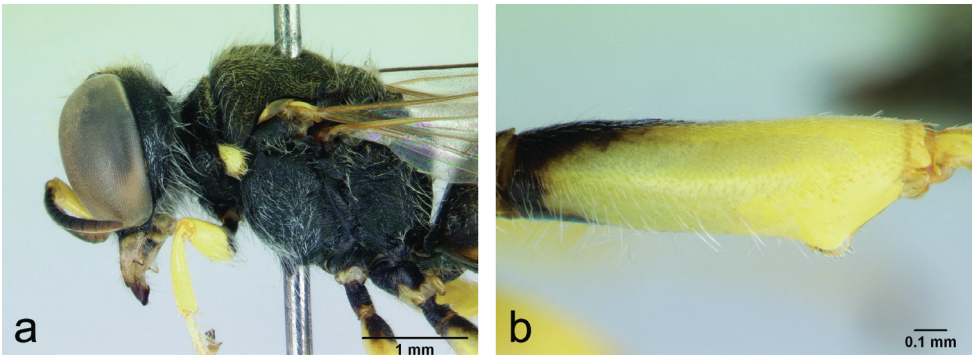


Figure 27. *Larrisson azyx* ♂: **a** head, thorax, and propodeum in lateral view **b** hindfemur in lateral view.

podeal enclosure includes median sulcus and adjacent area .... ***Larrisson punctatus*** **Pulawski, sp. n.**

– Basal concavity of tergum I impunctate or with punctures minute or at least smaller than those on scutum; mesothoracic venter inconspicuously depressed; propodeal enclosure all glabrous or nearly so except only median sulcus and adjacent area glabrous in most *tegularis* **5**

5 Gaster all black, without yellow apical bands **6**

– Gaster all or partly red or (in *abnormis*) black but with apical yellow fasciae on terga **7**

6 Mesopleuron shiny, punctures averaging about one diameter apart; hindfemoral apex broadened ventrally (Fig. 8b); setae of pygidial plate dense, largely concealing integument ..... ***Larrisson niger*** **Pulawski, sp. n.**

– Mesopleuron dull, interspaces between punctures linear; hindfemoral apex not broadened (Fig. 7b); setae of pygidial plate sparse, integument easily visible (as in Fig. 26b) ..... ***Larrisson latifrons*** **Pulawski, sp. n.**

7 Gastral terga black, with yellow apical fasciae .... ***Larrisson abnormis*** **(R. Turner)**

– Gastral terga at least partly red, with yellow apical fasciae only in *tegularis* in which remaining gaster is all red **8**

8 First recurrent vein received by second submarginal cell (Fig. 23); inner eye orbits nearly parallel between antennal socket and below midocellus (Fig. 22a) ..... ***Larrisson variegatus*** **Pulawski, sp. n.**

– First recurrent vein received by first submarginal cell; inner eye orbits markedly bowed out toward frons midline (Fig. 9a, b) **9**

9 Gastral terga with yellow apical fasciae, partly concealed by setae (Fig. 19e); tegula elongate, with concave inner margin (Fig. 19b); most punctures of pygidial plate more than one diameter apart mesally, setae not concealing integument (Fig. 19c) ..... ***Larrisson tegularis*** **Pulawski, sp. n.**

– Gastral terga without yellow fasciae; inner margin of tegula not concave; punctures of pygidial plate less than one diameter apart basomedially, setae largely concealing integument **10**

10 Orbital fovea well defined, about as wide as 0.8 × ocellocular distance; clypeus with narrow medioventral glabrous area that extends almost to clypeal midlength; scutal punctures averaging about one diameter apart..... ..... ***Larrisson armatus*** **Pulawski, sp. n.**

– Orbital fovea ill defined, about as wide as half ocellocular distance; glabrous apicoventral area of clypeus broad, not extending to clypeal midlength; scutal punctures less than one diameter apart **11**

11 Hindtibial lateral surface, in dorsal half, with many small punctures and setae between spines ..... ***Larrisson quintus*** **Pulawski, sp. n.**

– Hindtibial lateral surface, in dorsal half, impunctate or with a few sparse punctures and setae between spines..... ***Larrisson orbitalis*** **Pulawski, sp. n.**

12 Sternum VIII with glabrous preapical platform on ventral surface, deeply emarginate apically (Fig. 12e) **13**

– Sternum VIII without glabrous preapical platform on ventral surface, entire apically except slightly emarginate in *tegularis* **16**

13 Posterior mandibular margin slightly concave between base and notch **14**

– Posterior mandibular margin angulate between base and notch (Figs 9c, 13a) **15**

14 First recurrent vein received by first submarginal cell (as in Fig. 17b); antenna brown (light brown ventrally and apically); flagellomeres cylindrical; tergum I with gap between basolateral carina and lateral ridge that delimits basal concavity (Fig. 2c); tergum VII with basolateral tooth on each side (Fig. 2d); transverse swelling of sternum II not bent posterad..... ***Larrisson armatus*** **Pulawski, sp. n.**

– First recurrent vein received by second submarginal cell (Fig. 23); antenna multicolored: flagellomeres I–VI reddish brown, VII black, VIII and IX pale yellow, X and XI brown; flagellomeres I–IV markedly convex ventrally (Fig. 22b, c); tergum I without gap between basolateral carina and lateral ridge that delimits basal concavity; tergum VII without basolateral tooth; transverse swelling of sternum II markedly bent posterad (Fig. 22f) ..... ***Larrisson variegatus*** **Pulawski, sp. n.**

15 Forefemoral venter roundly expanded subbasally (Fig. 13b), concave anterobasally; inner margin of forebasitarsus concave (Fig. 13c); foretarsomeres II–IV expanded on inner side (Fig. 13c); hindbasitarsus convex on outer margin (Fig. 13f) ..... ***Larrisson quintus*** **Pulawski, sp. n.**

– Forefemoral venter not expanded subbasally, not concave anterobasally; inner margin of forebasitarsus straight; foretarsomeres II–IV not expanded on inner side; hindbasitarsus not convex on outer margin..... ***Larrisson orbitalis*** **Pulawski, sp. n.**

16 Hindtibia in dorsal view thickened at about one third length (Fig. 21a); lateral surface with densely punctate ventral area between thickening and apex, broadening toward tibial apex; lateral surface with two spines on thickening and one spine near apex (Fig. 21a, b)..... ***Larrisson tibialis*** **Pulawski, sp. n.**

– Hindtibia not thickened; lateral surface without densely punctate area, with 3–5 evenly spaced spines..... **17**

17 Gaster all black or with pale yellow or reddish brown apical fasciae..... **18**

– Gaster all or largely red or with pale yellow apical fasciae **20**

18 Antenna all yellow or apical two flagellomeres brownish (Fig. 24a); midfemoral venter impunctate (Fig. 24b); propodeal dorsum with conspicuous spine behind spiracle; sternum II with conspicuous transverse swelling..... ***Larrisson rieki*** **Menke**

– Flagellum black or reddish brown ventrally; midfemoral venter punctate; propodeal dorsum at most with inconspicuous spine behind spiracle; sternum II at most with low transverse convexity **19**

19 Gastral segments with yellow apical fasciae; posterior propodeal surface without longitudinal sulci; second submarginal cell opened anteriorly .... ***Larrisson abnormis*** **(R. Turner)**

– Gastral segments without yellow fasciae; posterior propodeal surface with pair of longitudinal sulci (Fig. 17a), sulci converging ventrad; second submarginal cell triangular, closed anteriorly (Fig. 17b) .... ***Larrisson sulcatus*** **Pulawski, sp. n.**

20 Sternum II simple; sternum VIII setose, emarginate apically (Fig. 19d); tegula elongate, with concave inner margin (Fig. 19b); gastral terga with yellow apical fasciae partly concealed by vestiture (Fig. 19e) .... ***Larrisson tegularis*** **Pulawski, sp. n.**

– Sternum II with swelling or carina; sternum VIII asetose, not emarginate apically; tegula not elongate, inner margin not concave; gastral terga without yellow apical fasciae **21**

21 Mesopleuron with obtuse transverse carina in front of midcoxa; metanotum with conspicuous spine (Fig. 16b); propodeum with conspicuous spine behind spiracle; sternum II with transverse swelling; sternum VIII flat .... ***Larrisson spinosus*** **Pulawski, sp. n.**

– Mesopleuron with spine in front of midcoxa (Fig. 4b); metanotum without spine or tubercle; propodeum without spine or tubercle behind spiracle; basal half of sternum II with median carina that is pointed apically (Fig. 4c); sternum VIII largely concave ..... ***Larrisson carinatus*** **Pulawski, sp. n.**

Acknowledgments

I thank my travel companions to Australia: Veronica E. Ahrens (Northern Territory, 3-30 March 2008; New South Wales, 1 Dec 2009 – 15 Jan 2010; South Australia, 1 December 2010 – 4 February 2011) and Geoffrey A. Williams (Northern Territory, 30 March – 28 April 2008) who helped collect the specimens. I am grateful to Michael Ohl (Museum für Naturkunde der Humboldt-Universität, Berlin, Germany) for his opinion on the taxonomic position of *Larrisson menkei*. April Nobile and Erin Prado took the illustrations using Automontage software package by Syncroscopy, Michele Esposito helped with Photoshop, Lindsay Irving generated the distribution maps using Geographic Information System (GIS) program, Fernando Alvarez-Padilla helped with cladistic analysis and Tamás Szűts with a subsequent version of the analysis, all while working for the California Academy of Sciences. Brian Harris (United States National Museum of Natural History, Washington, D.C.) and Steven L. Heydon (Bohart Museum of Entomology, University of California, Davis, California) kindly sent specimens of previously described species of *Larrisson.* Terry F. Houston helped my visit to the Western Australian Museum, Perth,

Australia (11–12 December 2008), as did John LaSalle and Nicole Fisher for the Australian National Insect Collection, Canberra, Australia (20-24 April 2009), and Peter Hudson for the South Australian Museum, Adelaide, Australia (1-3 February 2011). Robert L. Zuparko (California Academy of Sciences), Arnold S. Menke (Ammophila Research Institute, Bisbee, Arizona), and Michael W. Gates (Systematic Entomology Laboratory, ARS-USDA, Washington, D.C.) meticulously reviewed the manuscript and provided many excellent suggestions. Arnold Menke suggested the name *Larrissa*.

References

Bohart RM, Menke AS (1976) Sphecid Wasps of the World. A generic revision. University of California Press, Berkeley, Los Angeles, London. 1 color plate, IX + 695 pp.

Cardale J (1985) Sphecidae. In: Walton DW (Ed) Zoological Catalogue of Australia, 2. Hymenoptera. Formicoidea, Vespoidea and Sphecoidea. Australian Government Publishing Service, Canberra. i–vi, 218–303.

Evans HE, Matthews RT (1973) Systematics and nesting behavior of Australian *Bembix* sand wasps (Hymenoptera, Sphecidae). Memoirs of the American Entomological Institute 20: i–iv, 1–387.

Goloboff P, Farris J, Nixon K (2008) TNT, a free program for phylogenetic analysis. Cladistics 24: 774–786. doi: 10.1111/j.1096-0031.2008.00217.x

Lomholdt O (1985) A reclassification of the larrine tribes with a revision of the Miscophini of southern Africa and Madagascar (Hymenoptera: Sphecidae). Entomologica Scandinavica 24 (Supplement): 1–183.

Lomholdt O, Pulawski WJ (2010) A revision of the wasp genus *Sericophorus* F. Smith, 1851 (Hymenoptera: Apoidea: Crabronidae). Proceedings of the California Academy of Sciences 61: 1–234.

Melo GAR (1999) Phylogenetic relationships and classification of the major lineages of Apoidea (Hymenoptera), with emphasis on crabronid wasps. Scientific Papers. Natural History Museum. The University of Kansas 14: 1–55.

Menke AS (1967) New genera of Old World Sphecidae (Hymenoptera). Entomological News 78: 29–35.

Menke AS (1977) *Aha*, a new genus of Australian Sphecidae, and a revised key to the world genera of the tribe Miscophini (Hymenoptera, Larrinae). Polskie Pismo Entomologiczne 47: 671–681.

Menke AS (1979) A review of the genus *Larrisson* Menke (Hymenoptera: Sphecidae). Australian Journal of Zoology 27: 453–463. doi: 10.1071/ZO9790453

Michener CD (1944) Comparative external morphology, phylogeny, and classification of the bees (Hymenoptera). Bulletin of the American Museum of Natural History 82: 157–326.

Nixon KC (2002) Winclada, version 1.00.08. Published by the author, Ithaca, N.Y.

Pagliano G (1995) Una nuova specie di *Larrisson* Menke dell'Australia (Hymenoptera: Sphecidae, Larrinae). Bollettino della Società Veneziana di Storia Naturale e del Museo Civico di Storia Naturale 13: 385–388.

Pulawski WJ, Prentice ME (2009) A revision of the wasp tribe Palarini Schrottky, 1909 (Hymenoptera: Apoidea: Crabronidae). Proceedings of the California Academy of Sciences 59: 307–479.

Turner RE (1914) Notes on fossorial Hymenoptera.–XIII. A revision of the Paranyssoninae. The Annals and Magazine of Natural History (Series 8) 14: 337–359.

JHR 25: 83–92 (2012)
doi: 10.3897/JHR.25.2442
www.pensoft.net/journals/jhr

RESEARCH ARTICLE

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

A new species of *Masarina* Richards 1962 from southern Africa, description of the female of *M. ceres* Gess 1997 and supplementary data on three other species of the genus (Hymenoptera, Vespidae, Masarinae)

Friedrich Wolfgang Gess[1,†]

1 *Albany Museum and Rhodes University, Grahamstown, 6140 South Africa*

† *urn:lsid:zoobank.org:author:1C6DF967-9245-4E47-8517-1DE4096D2C6E*

Corresponding author: *Friedrich Wolfgang Gess* (F.Gess@ru.ac.za)

Academic editor: *W. Pulawski* | Received 25 November 2011 | Accepted 30 January 2012 | Published 23 March 2012

urn:lsid:zoobank.org:pub:ECB216DA-48C3-438C-8693-74EB9A8505DA

Citation: Gess FW (2012) A new species of *Masarina* Richards 1962 from southern Africa, description of the female of *M. ceres* Gess 1997 and supplementary data on three other species of the genus (Hymenoptera, Vespidae, Masarinae). Journal of Hymenoptera Research 25: 83–92. doi: 10.3897/JHR.25.2442

Abstract

A new species of *Masarina* Richards, 1961, *M. gabymariae*, associated with *Hermannia* (*Mahernia*) *diffusa* L., Malvaceae: Sterculioideae) is described from a relict patch of Swartland Granite Renosterveld at Darling in the Western Cape Province of South Africa and the hitherto unknown female of *M. ceres* Gess, 1997 is described from Graafwater in the same province. Supplementary collecting data are given for three other species of the genus, *M. hyalinipennis* Richards, 1962, *M. mixta* Richards, 1962 and *M. strucki* Gess, 1988.

Keywords

Southern Africa, taxonomy, floral associations

Introduction

Masarina Richards, 1962 is a genus endemic to the semi-arid to arid western half of South Africa and the south west of Namibia (see Gess and Gess 2010, Fig. 65). When erected by Richards the genus comprised three species, *M. familiaris* Richards, 1962

(the type species), *M. hyalinipennis* Richards, 1962 and *M. mixta* Richards, 1962. Since then ten species have been added: *M. strucki* Gess, 1988, *M. ceres* Gess, 1997, *M. mixtoides* Gess, 1997, *M. namaqua* Gess, 1997, *M. parvula* Gess, 1997, *M. peliostomi* Gess, 1997, *M. tylocodoni* Gess, 1997, *M. aptosimi* Gess, 2005, *M. hermanniae* Gess, 2005 and *M. roberti* Gess, 2005. The presently described species, *M. gabymariae* Gess, constitutes the fourteenth known species of this once seemingly small genus.

The keys to species of *Masarina* Richards given in Gess (2005: 12-14) are here augmented to include the new species.

The notation used for expressing geographic co-ordinates is as in the gazetteer of *The Times Atlas of the World* (1981). The figures before the stop are degrees, those after the stop are minutes; the stop is **not** a decimal point.

Acronyms for institutions in which material is housed are:

AMG Albany, Museum, Grahamstown, South Africa; **BMNH** = Natural History Museum, London, England
FSCA Florida State Collection of Arthropods, Gainesville, United States of America
TMP Transvaal Museum (now known as Ditsong Museum of Natural History), Pretoria, South Africa.

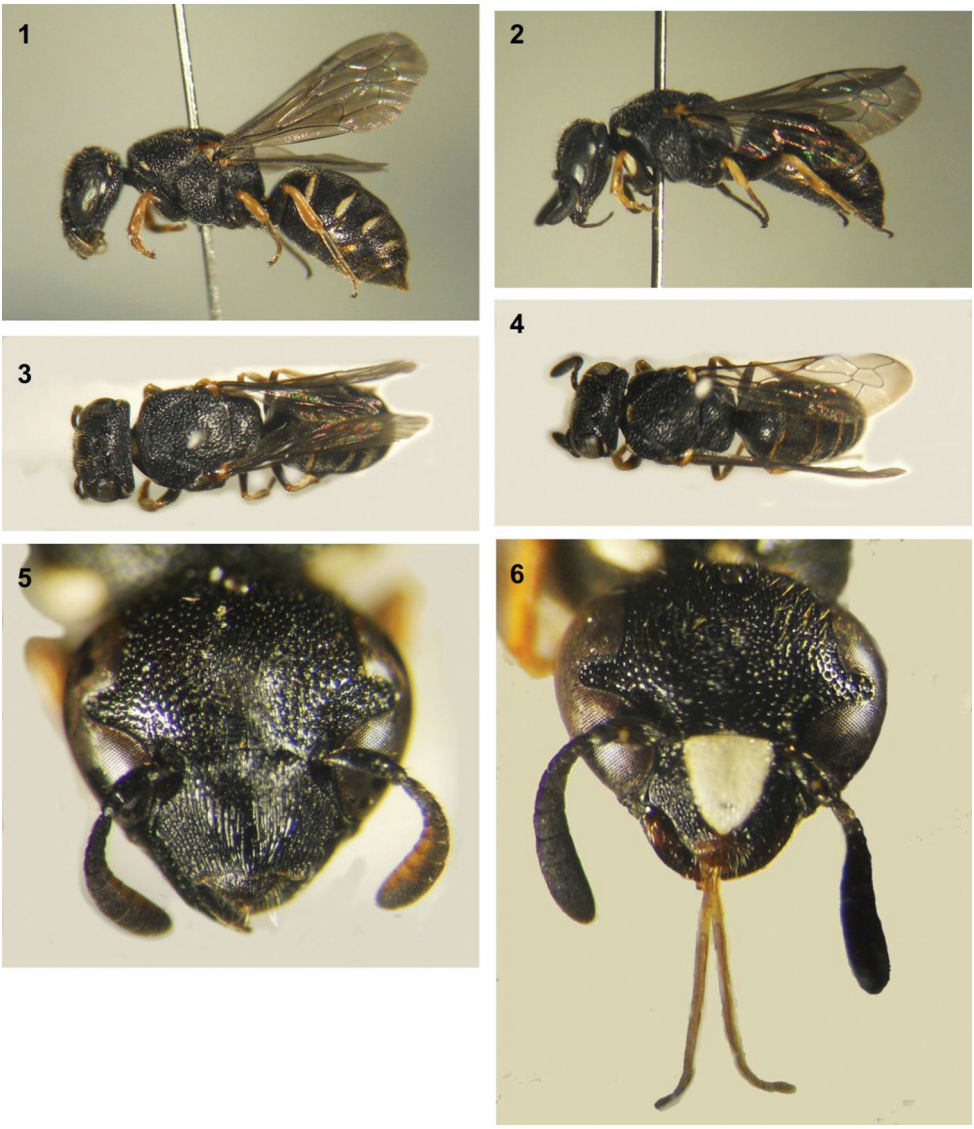
Taxonomy, distributions and floral associations

***Masarina gabymariae* sp. n.**
urn:lsid:zoobank.org:act:3BA97C99-3E82-49E6-B546-D9790ED6E05F
http://species-id.net/wiki/Masarina_gabymariae
Figs 1–6

Holotype. ♀, SOUTH AFRICA: WESTERN CAPE: Darling Renosterveld Reserve, Darling (33.23°S, 18.23°E), 25.ix.2011 (D. W., G. T. and G. M. Gess) (visiting red flowers of *Hermannia* (*Mahernia*) *diffusa* L. f., Malvaceae: Sterculioideae) [AMG].

Paratypes. Same locality and date as holotype, 1 ♀, 18 ♂♂ (1 ♀, 16 ♂♂ visiting red flowers of *Hermannia* (*M.*) *diffusa*; 2 ♂♂ on ground near plants of *Hermannia* (*M.*) *diffusa*); same locality, 1.x.2011, 1 ♀ (on ground near plants of *Hermannia* (*M.*) *diffusa*); same locality, 8.x.2011, 21 ♀♀, 23 ♂♂ (visiting red flowers of *Hermannia* (*M.*) *diffusa*) (all D. W., G. T. and G. M. Gess); same locality, 15.x.2011, 5 ♀♀ and 16.x.2011, 9 ♀♀ (visiting red flowers of *Hermannia* (*M.*) *diffusa* and on ground near plants of *Hermannia* (*M.*) *diffusa*) (all D. W., G. T. , G. M., F. W. and S. K. Gess); same locality, 20.x.2011, 1 ♀ (S. K. Gess) (visiting red flowers of *Hermannia* (*M.*) *diffusa*) – [all AMG].

Diagnosis. Length 6.0 – 6.7 mm. Both sexes with head, thorax and metasoma black with yellowish white markings; male in addition with characteristic shield-shaped marking on disk of clypeus and distal third of fore femur of this colour. Tibiae and proximal tarsomeres light ferruginous. Frons in lower half and disk of clypeus longitudinally aciculate (less markedly so in male than in female).



Figures 1–6. *Masarina gabymariae* **1** ♀, lateral view (actual length 6.7 mm) **2** ♂, lateral view (actual length 6.0 mm) **3** ♀, dorsal view **4** ♂, dorsal view **5** ♀, head, front view (actual width 2.1 mm), tongue not extended **6** ♂, head, front view (actual width 1.9 mm), tongue extended.

Description. *Female* (Figs 1, 3, 5): Black. The following are yellowish white: small streak on temple behind top of eye; small streak anteriorly on humeral angle; posterior bands, not attaining sides, on terga I–III (laterally anteriorly produced, medially either interrupted or very narrow and suffused with ferruginous). Ferruginous are: tip of mandible; tegula laterally and posteriorly (medially black); extreme apex of femur, tibia (except black cloud medially on fore tibia) and tarsomeres of all legs (last tarsomere

of fore leg and all tarsomeres of middle and hind legs, particularly last tarsomeres, darker than tibiae). Wings lightly infuscate; veins brown.

Length 6.7 mm; length of fore wing 4.2 mm; hamuli 6.

Head in front view 1.15 × as wide as long; POL: OOL= 1:1. Clypeus 1.35 × as wide as long; disk of clypeus basally raised above level of frons and of area below antennal insertion but with a longitudinal median depression (most marked on basal half) and with lateral wings depressed (most marked antero-laterally); depressed areas leaving on each side of disk a rounded elevation running obliquely from near antennal insertion to anterior margin and there meeting medially to form an obtuse projection into anterior emargination and effectively dividing it into two; antero-lateral angles of clypeus rounded. Frons in lower half longitudinally aciculate, finely so medially, more coarsely so laterally; clypeus over whole disk similarly longitudinally aciculate, finely so basally (particularly in median depression), more coarsely so elsewhere (particularly on lateral 'wings'). Frons and vertex with moderate, in part subconfluent, punctures; clypeus with a scattering of finer punctures, most discernable on raised areas.

Pronotum, mesoscutum, scutellum and mesopleuron similarly punctured to head but more coarsely so; terga more finely punctured than head.

Setation on head noticable, that on frons longest and mostly porrect, that on pronotum and mesoscutum shorter and mostly semi-decumbent.

Middle tibia with one spur.

Male (Figs 2, 4, 6): Black. The following are yellowish white: small spot at base of mandible (in small minority of specimens only); shield-shaped marking on disk of clypeus; small spot on scape (in small minority of specimens only); small streak on temple behind top of eye; narrow anterior band on pronotum; humeral angle; posterior bands, not attaining sides, on terga I – IV or V (that on tergum I widest, those of terga II – IV or V medially and laterally anteriorly produced; all bands medially suffused with ferruginous); extreme apex of trochanter and distal third of femur of fore leg; distal fifth of middle femur (in some specimens only). Ferruginous are: spot on basal half of mandible (in some specimens only); tegula anteriorly and posteriorly (medially very dark ferruginous to black); tibia and tarsomeres of all legs (last tarsomeres of middle and hind legs darker than others tarsomeres). Wings lightly infuscate; veins brown.

Length 6.0 – 6.4 mm; length of fore wing 4. 1 mm; hamuli 7.

Head in front view 1.14 × as wide as long; POL: OOL= 1: 1. Clypeus 1.4 × as wide as long; disk of clypeus evenly convex; anterior margin shallowly and evenly emarginate; antero-lateral angles narrowly rounded. Frons in lower half and disk of clypeus longitudinally aciculate but less markedly than in female. Punctation and setation as in female. Middle tibia with one spur. Parameres in dorsal view slightly incurved, with sides sub-parallel and with apices slightly down-curved and obliquely rounded.

Etymology. The name, in the genitive singular, is formed from the name of the collector of most of the present specimens, Gaby Maria Gess, my grand daughter, aged

eleven years, in recognition of her enthusiastic and diligent past and present collecting of Masarinae on my behalf.

Geographic distribution. Known only from the type locality, the Darling Renosterveld Reserve. This small municipal reserve is situated at the top (south) of the village and represents a relict patch of the Coastal Renosterbosveld of Acocks (1953) or, more specifically, the Swartland Granite Renosterveld of Mucina and Rutherford (2006). The latter authors note that the largest patch is centred on Darling and state that this is a critically endangered vegetation unit of which almost 80% has already been transformed due to the prime quality of the land for agriculture. Indeed, from the top of the Darling Renosterveld Reserve it may be seen that, apart from the village below, the surrounding countryside, with the exception of the tops of some hills too difficult to plough, is in all directions given over to wheat fields. If *Masarina gabymariae* should be restricted to the Swartland Granite Renosterveld and to the *Hermannia* growing there, it too may be considered as endangered.

Floral association. Malvaceae: Sterculioideae (*Hermannia* (*Mahernia*) *diffusa* L. f.).

Associated insects. Chrysididae: *Allocoelia quinquedens* Edney (unusually small and melanistic individuals), 25.ix.2011, 1 ♀ (on ground near *Hermannia* (*M.*) *diffusa*); 8.x,2011, 3 ♀♀ (1 ♀ visiting flowers of *Hermannia* (*M.*) *diffusa*; 2 ♀♀ on ground near *Hermannia* (*M.*) *diffusa*). All *Allocoelia* species are known to be parasitic exclusively in the cells of Masarinae; *A. quinquedens* has previously been found associated with *Masarina strucki* Gess at Bakleikraal near Kamieskroon, Namaqualand (Gess and Gess fieldnotes, 94/95/166).

Discussion. *Masarina gabymariae* is most akin to *M. strucki* Gess but differs most notably from it in the female by the shape of the clypeus, in the male by the characteristic pale shield-like marking on the same and, in both sexes, by the differently formed and coloured tegula.

The keys to species of *Masarina* Richards given in Gess (2005: 12–14) are here augmented to include the new species.

Key to females

6	Metasoma black with yellowish-white markings	**6b**
–	Metasoma red with yellowish-white markings	***hermanniae* Gess**
6b	Clypeal disk with longitudinal median depression wide and deep from base to anterior margin; anterior margin with a wide, rounded median lobe	***strucki* Gess**
–	Clypeal disk with longitudinal median depression most marked on basal half, narrowing to anterior margin; anterior margin with a narrow, obtuse median lobe	***gabymariae* Gess**

Key to males

5 Metasoma black with yellowish-white markings; scape (usually), mandible (usually), labrum, frons black.....**5b**
– Metasoma with terga roughly transversely banded, black anteriorly, red medially, and yellowish-white posteriorly; scape, mandible, labrum, clypeus, supraclypeal marking and ocular sinus yellowish-white .....***hermanniae* Gess**
5b Scape and mandible black; disk of clypeus black, immaculate....***strucki*** Gess
– Scape and mandible occasionally with pale spots; disk of clypeus with characteristic yellowish-white, shield-shaped marking.....***gabymariae* Gess**

***Masarina ceres* Gess**
http://species-id.net/wiki/Masarina_ceres
Fig. 7

Masarina ceres Gess, 1997: 60, figs 23, 24, ♂; 71–73 (key to *Masarina*). Holotype: ♂, South Africa: Western Cape: 17 km N of Ceres, near top of Gydo Pass (AMG). – Carpenter 2001: 19 (listed); Gess and Gess 2003: 55 (flower visiting); Gess 2005: 11–14 (key to *Masarina*); Gess and Gess 2010: 45 (listed), 107(flower visiting).
Masarina sp. A: Gess S. K., 1996: 245, 293 (flower visiting).

Diagnosis. Length 5.7 – 7.5 mm. Both sexes with clypeus and adjacent part of frons slightly longitudinally depressed, moderately coarsely punctured, non aciculate; clypeus steeply raised from sides and disk markedly broad and short. Head, thorax and gaster yellow-marked.

Description. *Female* (hitherto undescribed) (Fig. 7): Black. The following are yellow: large transverse marking at base of clypeus; spot within ocular sinus; streak on temple behind upper part of eye; elongate transverse streak on humeral angle; mere indication of marking on postero-dorsal angle of pronotum; large mark on upper part of mesopleuron; posterior third of tegula; round spot on disk of scutellum; small median spot and larger, anteriorly convex, lateral spots on terga I – IV (markings progressively smaller from I – IV); large postero-dorsal spot apically on fore femur; streak dorsally on basal half or more (in case of fore tibia) of tibia of all legs. Various shades of ferruginous are: labrum; clypeus antero-laterally; distal half of mandible; antenna (upper surface dark, lower surface light); anterior two thirds of tegula; legs (other than for yellow markings); sterna.

Length circa 7.5 mm; length of fore wing 4.0 mm; hamuli 11.

Head in front view 1.3 × as wide as long; POL: OOL= 1: 1.1. Clypeus strikingly wide, 1.8 × as wide as long (measured to bottom of emargination), markedly raised from sides; disk slightly depressed in basal half, narrowly but more noticeably so antero-medially; anterior margin widely emarginate; lateral angles rounded, lamellate.

Punctation as in male. Setation on clypeus long, fairly dense.

Figure 7. *Masarina ceres,* ♀, head, front view (actual width 2.0 mm)

Material examined. SOUTH AFRICA: WESTERN CAPE: Graafwater [32.09S 18.37E], 15.xi.1990 (R. Miller and L. Stange), 1 ♀ [FSCA].

Discussion. In the keys to species of *Masarina* (Gess 1997, 2005) the female of *M. ceres* Gess, though at the time unknown, is included using presumed characters. Other than that the middle tibia has only one spur, not two as presumed and given as the second character in the last couplet, the characters are correct and the female runs down without difficulty.

***Masarina hyalinipennis* Richards**
http://species-id.net/wiki/Masarina_hyalinipennis

Masarina hyalinipennis Richards, 1961: 268, ♂; 268 (key to *Masarina*). Holotype: ♂, South Africa: Northern Cape: Vanrhynsdorp (as van Rhynsdorp) (TMP), Pretoria); Gess in Gess and Gess 1988: 352 (♀), 354 (key to *Masarina*); Gess S. K., 1996: 243, 297, 298 (flower visiting); Gess 1997: 71–73 (key to *Masarina*); Carpenter 2001: 19 (listed); Gess and Gess 2003: 56 (flower visiting, abbreviated collecting localities); Gess 2005: 11–14 (key to *Masarina*); Gess and Gess 2010: 45 (listed), 108 (flower visiting).

Additional material examined. SOUTH AFRICA: NORTHERN CAPE: Leliefontein (30.23°S, 18.16°E), 17.ix.2003, 1 ♀ (white trap); Leliefontein (30.23°S, 18.14°E), 23.ix.2003), 1 ♂ (yellow + white traps); Remhoogte (30.24°S, 18.17°E), 31.viii.2003, 1 ♂ (yellow trap), 5.ix.2003, 1 ♂ (white trap), 8.ix.2003, 1 ♀ (white trap), 11.ix.2003, 1 ♀, 1 ♂ (yellow trap) – (all C. Mayer) [AMG].

***Masarina mixta* Richards**
http://species-id.net/wiki/Masarina_mixta

Masarina mixta Richards, 1962: 271, ♀; 268 (key to *Masarina*). Holotype: ♀, South Africa: Northern Cape: Nieuwoudtville (BMNH); Gess in Gess and Gess 1988:

353 (key to *Masarina*); Gess S.K.1996: 243, 244, 280, 299, 300, 301 (flower visiting); Gess 1997: 71–73 (key to *Masarina*); Carpenter 2001: 19 (listed); Gess and Gess 2003: 57 (flower visiting, abbreviated collecting localities); Gess 2005: 11–14 (key to *Masarina*); Gess and Gess 2010: 45 (listed), 108 (flower visiting).

Additional material examined. SOUTH AFRICA: NORTHERN CAPE: Leliefontein (30.23°S, 18.16°E), 14.x.2002, 1 ♂ (white trap), 21.ix.2004, 3 ♀♀ (yellow trap); Remhoogte (30.23°S, 18.16°E), 7.x.2002, 1 ♂ (white trap) – (all C. Mayer); Sutherland district, Rooikloof Farm (32.26°S, 20.39°E), 30.ix.2009, 2 ♂♂ (visiting pale violet flowers *Wahlenbergia* near *polyclada* A. DC., Campanulaceae), 1.x.2009, 1 ♀, 2 ♂♂ (on ground between plants of *Wahlenbergia* near *polyclada*), 5.x.2009, 2 ♂♂ (1 ♂ visiting pale violet flowers of *Wahlenbergia* near *polyclada*), 8.x.2009, 2 ♂♂ (visiting pale violet flowers of *Wahlenbergia* near *polyclada*), 9.x.2009, 3 ♀♀, 3 ♂♂ (1 ♀ visiting pale violet flowers of *Wahlenbergia* near *polyclada*; 2 ♀♀, 3 ♂♂ from yellow pan traps associated with *Wahlenbergia* near *polyclada*), 10.x.2009, 2 ♀♀ (visiting pale violet flowers of *Wahlenbergia* near *polyclada*) – (all F. W. and S. K. Gess); same locality, 10.x.2009 (D. W. Gess), 1 ♀ (visiting pale violet flowers of *Wahlenbergia* near *polyclada*) – [all AMG].

Provenance of previously examined specimens as recorded in abbreviated form in Gess and Gess (2003). SOUTH AFRICA: NORTHERN CAPE: Richtersveld National Park; Kamiesberg; Nieuwoudtville. WESTERN CAPE: Clanwilliam; Clanwilliam/Graafwater; Clanwilliam/Citrusdal.

Floral associations. Campanulaceae (*Wahlenbergia*). Previously found associated principally with the flowers of various species of *Wahlenbergia*, less commonly with flowers of Fabaceae: Papilionoideae (*Aspalathus*), Malvaceae (*Hermannia* (*Mahernia*)), and Scrophulariaceae (*Peliostomum*) (see Gess and Gess 2003: 57).

***Masarina strucki* Gess**
http://species-id.net/wiki/Masarina_strucki

Masarina strucki Gess in Gess and Gess 1988: 352, female. Holotype: ♀, South Africa: Northern Cape: Goegap Nature Reserve near Springbok (AMG); Gess 1997: 58, ♂, figs 19–22 (♀ and ♂ head, ♂ genitalia), 71–73 (key to ♀, ♂); Gess (S. K. *et al.),* 1997: 81–86 (flower visiting; nesting); Carpenter 2001: 20 (listed); Gess and Gess 2003: 57 (flower visiting, abbreviated collecting localities); Gess 2005: 12–4 (key to ♀, ♂); Gess and Gess 2010: 45 (listed), 109 (flower visiting), Figs. 67, 70, 71, 72 (nesting).

Additional material examined. SOUTH AFRICA: NORTHERN CAPE: Leliefontein (30.23°S, 18.14°E), 1.x.2003, 1 ♀, 6 ♂♂, 4.x.2003, 1 ♀ (yellow + white pan traps); Witwater (30.23°S, 18.13°E), 4.x.2003, 1 ♀ (yellow + white pan traps), 8.ix.2004, 1 ♂ (white pan trap) – (all C. Mayer) [all AMG]; Nieuwoudtville Flower Reserve East

(31.22°S 19.09°E) (730m),1.ix.2002 (M. Kuhlmann), 1 ♂, 5.ix.2002 (M. Kuhlmann), 1 ♂ [Kuhlmann Collection, London].

Provenance of previously examined specimens. See Gess and Gess (2003: 58).

Acknowledgments

The following individuals are thanked for much appreciated assistance as specified: Sarah Gess of the Albany Museum, Grahamstown, for thirty nine years of happy, productive and synergistic fieldwork, for valuable discussion and encouragement; David, Gaby Theresa and Gaby Maria Gess for their prescient identification of the Darling Renosterveld Reserve, a relict patch of the Swartland Granite Renosterveld, as a site of potential interest, for sending me for determination a sample of the Masarinae caught there, and for enthusiastic collecting on my behalf prior to and during my and Sarah's visit to the locality; Estelle Brink of the Schonland Herbarium, Grahamstown for determining the *Wahlenbergia* species from Sutherland; David Gwynne-Evans of the Department of Botany, University of Cape Town for determining the *Hermannia* (*Mahernia*) species from Darling; Karen Diedricks of the Graphics Services Unit of Rhodes University, Grahamstown for help with the production of the figures; Caroline Mayer of BIOTA-Southern Africa, Hamburg University for the gift to the Entomology Department of the Albany Museum of specimens collected by herself in the course of her studies; Lionel Stange and Jim Wiley of the Florida State Collection of Arthropods, Gainesville, and Michael Kuhlmann, M. Kuhlmann Collection, London for the loan of specimens housed in their respective collections.

Grateful thanks are expressed to those bodies which issued permits for the collection of insects and plant samples, namely: the Department of Nature and Environmental Conservation, Northern Cape; Cape Nature (of the Western Cape Province).

The South African Foundation for Research Development (FRD) and the South African National Research Foundation (NRF) are thanked for running expenses grants awarded to either myself and Sarah Gess or to Sarah Gess and myself for field work during the course of which some of the present material was collected. The Board of Trustees of the Albany Museum is thanked for the Research Contracts granted to myself and Sarah Gess since 2003, which have given us continued use of the museum's facilities since our retirements.

References

Acocks JPH (1953) Veld types of South Africa. Memoirs of the Botanical Survey of South Africa 29: i-iv, 1–92.

Carpenter JM (2001) Checklist of the subfamily Masarinae (Hymenoptera: Vespidae). American Museum Novitates 3325: 1–39. doi: 10.1206/0003-0082(2001)325<0001:COSOTS>2.0.CO;2

Gess FW (1997) Contributions to the knowledge of *Ceramius* Latreille, *Celonites* Latreille, *Jugurtia* Saussure and *Masarina* Richards (Hymenoptera: Vespidae: Masarinae) in South Africa. Journal of Hymenoptera Research 6: 36–74.

Gess FW (2005) Three new species of *Masarina* Richards, 1962 from southern Africa with a key to all species of the genus (Hymenoptera: Vespidae, Masarinae). Journal of Hymenoptera Research 14: 7–14.

Gess FW, Gess SK (1988) A contribution to the knowledge of the taxonomy and ethology of the genus *Masarina* Richards (Hymenoptera: Masaridae). Annals of the Cape Provincial Museums (Natural History) 16: 351–362.

Gess SK (1996) The Pollen Wasps: Ecology and Natural History of the Masarinae. Harvard University Press, Cambridge, Massachusetts, 340 pp.

Gess SK, Gess FW (2003) A catalogue of flower visiting records for aculeate wasps and bees in the semi-arid to arid areas of southern Africa. Department of Entomology, Albany Museum, Grahamstown, 529 pp.

Gess SK, Gess FW (2010) Pollen wasps and flowers in southern Africa. SANBI Biodiversity Series 18. South African National Biodiversity Institute, Pretoria, 147 pp.

Gess SK, Gess FW, Gess RW (1997) Update on the flower associations of southern African Masarinae with notes on the nesting of *Masarina strucki* Gess and *Celonites gariepensis* Gess (Hymenoptera: Vespidae: Masarinae). Journal of Hymenoptera Research 6: 75–91.

Mucina L, Rutherford MC (eds) (2006) The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria. 807 pp.

Richards OW (1962) A revisional study of the masarid wasps (Hymenoptera, Vespoidea). British Museum (Natural History), London, 294 pp.

JHR 25: 93–102 (2012)
doi: 10.3897/JHR.25.2519
www.pensoft.net/journals/jhr

RESEARCH ARTICLE

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

New species of the rare genera *Dentigaster* Zettel, 1990 (Hymenoptera, Braconidae, Cheloninae) and *Minanga* Cameron, 1906 (Sigalphinae) from French Guiana

M. J. Sharkey[1,†], Y. Braet[2,‡]

1 *Department of Entomology, University of Kentucky, Lexington KY 40546-0091, USA* **2** *Département d'entomologie, Institut royal des Sciences Naturelles de Belgique, Rue Vautier 29, B- 1000 Bruxelles, Belgium; Unité d'Entomologie fonctionnelle et évolutive, Gembloux Agro-Bio Tech, Université de Liège, Passage des Déportés 2, B-5030 Gembloux, Belgium*

† *urn:lsid:zoobank.org:author:77B8EC3A-442C-4A7A-AF85-A31C27E257F2*
‡ *urn:lsid:zoobank.org:author:C1A1006D-C170-430D-9D9F-27AB0878DDDD*

Corresponding author: *M. J. Sharkey* (msharkey@uky.edu)

Academic editor: *G. Broad* | Received 7 December 2011 | Accepted 20 February 2012 | Published 23 March 2012

urn:lsid:zoobank.org:pub:0D447DB6-41D3-4FD4-A5FF-2739D8E8EF13

Citation: Sharkey MJ, Braet Y (2012) New species of the rare genera *Dentigaster* Zettel, 1990 (Hymenoptera, Braconidae, Cheloninae) and *Minanga* Cameron, 1906 (Sigalphinae) from French Guiana. Journal of Hymenoptera Research 25: 93–102. doi: 10.3897/JHR.22.2519

Abstract

Two new species, recently discovered in French Guiana, are described. *Minanga angelus* **sp. n.**, is the second species from the New World and the first Neotropical species. *Dentigaster brullei* **sp. n.** is the seventh described species of the genus. Identifications keys for both genera are updated.

Keywords

identification key, French Guiana, insect, Neotropics, parasitoid

Introduction

The genus *Dentigaster* was proposed and included in the tribe Pseudophanerotomini Zettel, 1990 by Zettel (1990). This tribe and its members are found in the New World with all but one species restricted to the Neotropics. Zettel (1990) erected this new ge-

nus on the basis of the following putative apomorphies: antennal sockets in the upper part of head, maxillary palpus long, notauli (nearly) absent, shape of carapace rather vaulted, carapace apically largely emarginated, carapace with apical tooth.

Only four species were described by Zettel (1990, 1992) but their biology is unknown, other than the likelihood that they are egg-larval parasitoids of lepidopteran larvae, as in all known members of Cheloninae. The only previous species recorded from French Guiana is *Dentigaster warana* Braet & Fretey (1997) collected in the coastal area, on grassland between the beach and the mangrove. Our new record comes from the Nouragues Reserve located in the country's interior (4°02'N, 52°41'W).

The genus *Minanga* was unknown in the New World until *M. achterbergi* Sharkey (2004) was discovered in northern Mexico. The species described here represents the second species in the New World and extends the distribution of the genus into the Neotropics. The biology is unknown other than the probability that it is a koinobiont endoparasitoid of larval Lepidoptera, as in other members of the subfamily (Shaw and Quicke 1990; Sharkey and Janzen 1995).

Material and methods

The two species described in this paper were collected in a Malaise trap which was operated during the entomological survey of the Nouragues Reserve (French Guiana) by the "Société Entomologique Antilles-Guyane". The Malaise trap was placed at N4 02.368-W52 40.429 by the SEAG association and run from the 21/VII/2009 – 19/VII/2010. During this year of collecting, 636 specimens of Braconidae were collected but only one specimen of each of our new species.

For the morphological terms used in this paper see van Achterberg (1993). The specimens are deposited in collections of the « Institut Royal des Sciences Naturelles de Belgique, Département d'entomologie, Bruxelles » (IRSNB).

Results

Descriptions

***Dentigaster brullei* Braet & Sharkey, sp. n**
urn:lsid:zoobank.org:act:249B3C88-9CB6-467D-A9DC-0E887313A051
http://species-id.net/wiki/Dentigaster_brullei

Holotype. Female.

Diagnosis. This species is easily distinguished from *D. barbarella* Zettel, 1990 by its whitish basal flagellomeres (vs. yellowish-orange), the head and thorax fully blackish (vs. orange), and the carapace with several coarse, parallel apical carinae (vs. regularly rounded) in dorsal view. The new species is closer to *D. walteri* Zettel, 1990 or *D.*

tenuiventris Zettel, 1990 and it can be distinguished from these by its size (6 mm vs. +/- 4mm), the shape of coarse rugae at the distal apex of the metasoma (with always the same width along their length vs. with some enlargements at their apex), and by the color of the basal flagellomeres (whitish vs. brownish).

Size. Body length 6 mm, fore wing length 4.2 mm.

Color. The first two flagellomeres whitish, the following dark brown. Scapus dorsally brown and ventrally light yellowish. Head fully dark brown; upper part of face and face at the inner margin of eyes lighter (whitish). Mesosoma fully dark brown. Fore wing with strongly infuscate bands; with a transverse white strip at level of parastigma, apex of fore wing and hind wing lightly infuscate. Stigma and veins brown. Fore and mid femur except basally and apically, hind coxa, hind femur, apical 2/3 of hind tibia dark-brown. Outer hind tibial spur, hind tarsomeres 3–5, mid tarsomeres 3–5, all light brown. All remaining parts of legs whitish. Carapace brown except white median patch basally (covering median part of T1 and basal part of T2), apical sternites brown. Ovipositor sheath yellowish.

Head. Head 0.89× as wide as its median length. Antennal socket inserted close to top of eyes in lateral view. Antenna with 37 flagellomeres. Scapus 1.72 times as long as maximally wide, longer than first flagellomere. First flagellomere 3 times as long as wide, longer than second one. Penultimate flagellomere as long as wide, 0.05 times as long as first flagellomere, shorter than apical segment. Flagellomeres gradually decreasing in size from base to apex. Last 10 apical flagellomeres without placodes on all sides. Placodes entirely missing on apical flagellomeres. Eye 1.4 times length of temple (in dorsal view), 1.48 times as high as broad, with short and sparse setae. Clypeus flat in lateral view, with more or less convex lower margin, with two small apical teeth medially, its surface smooth. Upper margin of clypeus with large punctures, dorsal surface of clypeus densely punctate. Malar suture absent. Malar space equal to basal width of mandible, 0.32× eye height. Face strongly convex in lateral view, surface punctate (medially finely punctuate, laterally largely smooth and punctate) with short, sparse setae (long setae present on mandible). Temple not swollen in dorsal view, its surface coarsely rugulose/punctate, with short, sparse setae. Frons transversely striate, concave, with a weak carina between antennal sockets, without lateral carina. POL 1.67× ocellar diameter, 3× OOL. Vertex striate, with faint, weakly transversely rugulose punctures and short sparse setae. Occipital carina present, complete, joining hypostomal carina before mandible.

Mesosoma. Pronotum striate/costate ventrally and dorsomedially, punctate dorsolaterally (large punctures becoming small and very dense at upper margin), dorsally without modifications. Pronotal furrow absent. Mesosoma 1.59× as long as wide in lateral view, 1.51× as long as wide in dorsal view. Mesoscutum sharply raised anteriorly, at right angle with pronotum, medioanteriorly dull (impunctate), median lobe without median groove anteriorly. Mesoscutum with sparse, short setae. Surface of mesoscutum medially, near scutellar sulcus, largely longitudinally punctate, surface rather smooth between punctures. Notauli entirely absent. Scutellar sulcus 4x as long as wide, 1.33× as long as scutellum, its surface smooth. Scutellar sulcus with 7 complete carinae. Scutellum rounded laterally, flattened in lateral view, its surface

smooth and punctate (large punctures widely spaced). Subalar groove punctate. Mesopleuron entirely areolate with sparse, short setae. Sternaulus absent. Ventral surface of mesopleuron more or less punctate (regularly spaced). Propodeum 0.33x as long as mesosoma (in dorsal view), its surface areolate to largely punctate, carinated areas completely absent but mediolongitudinal carina anteriorly present. Propodeum vertical posteriorly, with sparse, short setae. Propodeum with four pointed rounded angles, more developed laterally than medially (rather tuberculate laterally); median tubercles present and short (as high as wide). Lateral tubercles of propodeum 0.5 times their maximum transverse width, propodeal tubercles straight, with rounded apices. Surface of metapleuron largely punctate, with short, sparse setae. Metapleural flange absent. Wings: pterostigma 4.44× as long as wide. Marginal cell of fore wing distally closed. Vein r 0.7× as long as vein 3-SR, 0.16× as long as vein SR1, 0.25× as long as vein 2-SR. Vein 2-SR of fore wing present. Vein 1-SR+M present, straight. First discal cell of fore wing 2.93× as long as wide (measured perpendicularly to vein 1-CU1+2-CU1). Vein r-m of fore wing present with a wide bulla. Vein m-cu postfurcal. Vein cu-a of fore wing present, postfurcal. Vein CU1a (relative to cubital vein (2-CU1) of fore wing) arising behind middle of distal vein of subdiscal cell. Vein CU1b postfurcal with m-cu. First subdiscal cell of fore wing distally closed (vein 2cu-a present). Vein 2–1A long. Hind wing vein 1-SC+R present. Subbasal cell of hind wing medium sized. Hind wing vein M+CU 0.8 times as long as vein 1-M. Hind wing vein r absent, m-cu absent. Basal cell of hind wing closed, vein cu-a present. Legs: Femur not swollen. Hind coxa large, dorsally and ventrally smooth. Hind femur 3× as long as wide. Hind femur with sparse setae, its surface dorsally and ventrally smooth and finely punctate. Hind tibia 6.67× as long as wide, 2.16× as long as the hind basitarsomere length, with dense, stout and rather short setae, apically without any special patch of setae on its inner side. Hind basitarsomere 7.40× as long as maximally wide, 0.9× as long as tarsomeres 2–5.

Metasoma. Metasoma with two sutures on carapace. Carapace fully longitudinally rugose-striate, striae protruding apically. Carapace apically emarginate. First tergite 0.73× as long as apical width, without basolateral process near base. Two median carinae present, less than or equal to a third of petiole length, median carinae widely spaced and strong. First tergite longitudinally striate over entire surface. First and second tergites fused. Surface of second tergite longitudinally striate-rugulose. Median length of second tergite 0.92× times its basal width, 1.27× as long as first tergite. Second metasomal suture straight. Third tergite longitudinally striate and rugose. Fourth to sixth tergites concealed by metasomal carapace. Carapace 2.22× as long as wide in dorsal view; ventral foramen of carapace as long as carapace, fine lamella running laterally on carapace and ending as acute curved tooth apically. Genitalia and ovipositor: ovipositor sheath 0.3× as long as metasoma. Ovipositor sheath with normal, short and thin setae.

Male. Unknown

Etymology. From the name of G.A. Brullé, a French entomologist of the XIX century who described several Neotropical Braconidae, and from the name of my friend Stéphane Brullé, who collected this new species.

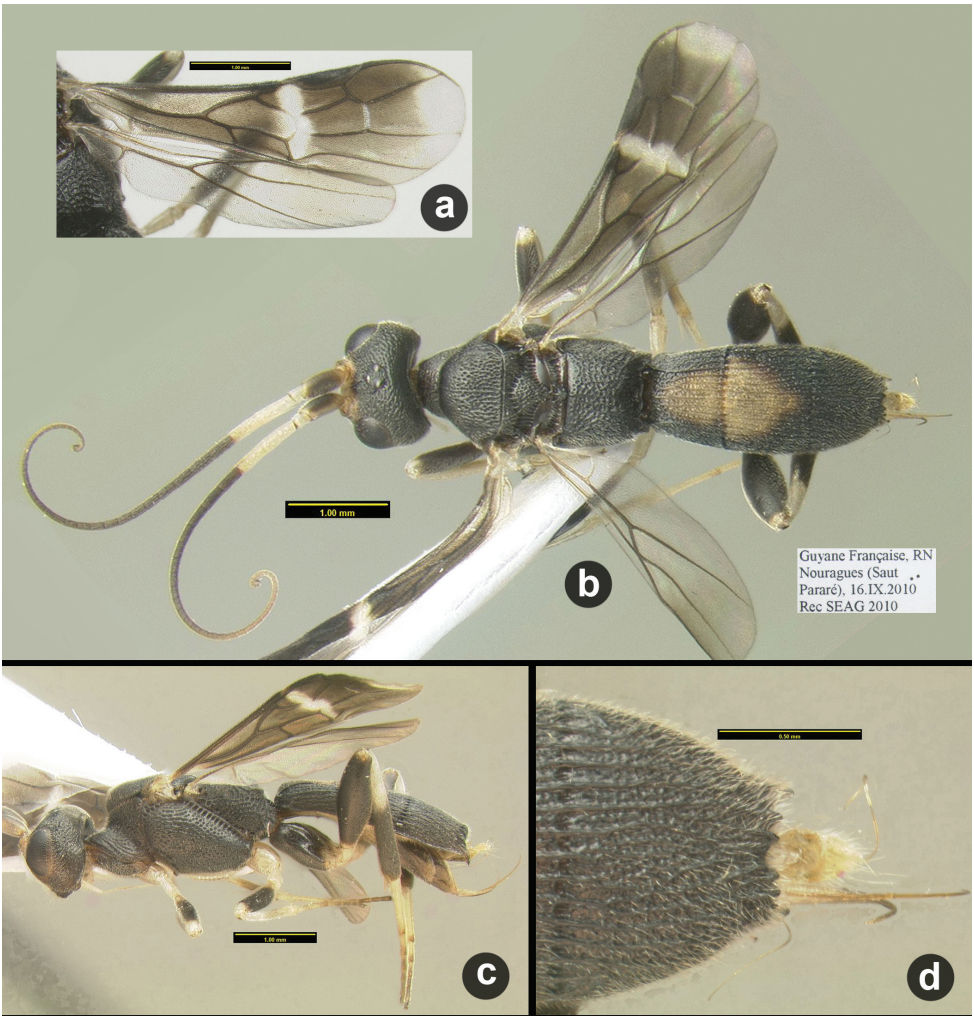


Figure 1. *Dentigaster brullei* **a** Wings **b** Dorsal habitus **c** Lateral habitus **d** Apex of metasoma.

Material Examined. Holotype ♀, «Guyane française, RN Nouragues (Saut Pararé), 16.IX.2010, Rec. SEAG 2010», N4 02.368-W52 40.429. [IRSNB]

Distribution. Neotropical (French Guiana).

Identification key to *Dentigaster* Zettel, 1990 (modified after Zettel, 1992)

1 Carapace comparatively robust, only 2× as long as wide and 1× as long as the thorax; light brown, top of head, mesoscutum, scutellum and tergite 3 of carapace dark to black-brown, 4.2 mm (Argentina) ..... ***D. walteri* Zettel**

– Carapace at least 2.20× as long as broad, only rarely significantly longer than thorax, color variable **2**

2 Carapace very slender, 2.9× as long as wide and 1× as long as thorax; light brown, except posterior corners of mesoscutum black, 4.9 mm (Panama)..... ..... ***D. tenuiventris* Zettel**

– Carapace at most 2.5 times as long as wide, hardly longer than thorax..... **3**

3 Humeral plate yellow or white, head fully or partially black..... **4**

– Humeral plate black, color of head variable **5**

4 Carapace entirely reticulate, head black or brown, often with some lighter patches on face, mesosoma orange, only mesoscutum sometimes partially or entirely black, carapace orange anteriorly, black posteriorly, 4.1–5.4 mm (Brazil)..... ***D. erythrothorax* Zettel**

– Carapace with very long straight striae, head entirely black in male but face and malar space (adjacent to eyes) of female yellow, mesosoma black, except pronotum partially pale, carapace black, first and second tergites medially with one pale yellow spot, 5.0–6.0 mm (Brazil, Ecuador)..... ***D. albifacies* Zettel**

5 Head mostly black, posteroventral rim of carapace absent, apical carina present at apex of carapace, shape of carapace nearly vertical apically in lateral view, apical teeth clearly protruding posteriorly (French Guiana)..... ..... ***D. brullei* sp. n.**

– Head orange, posteroventral rim, apical carina, shape of carapace variable, apical teeth less protruding posteriorly and concealed below carapace in dorsal view **6**

6 Metasoma with long posteroventral rim reaching posterior two thirds of third tergite, four apical carinae present on third tergite (French Guiana)..... ..... ***D. warana* Braet & Fretey**

– Metasoma with short posteroventral rim, apical carinae absent posteriorly (Brazil)..... ***D. barbarella* Zettel**

***Minanga angelus* Sharkey & Braet, sp. n.**
urn:lsid:zoobank.org:act:636EF67E-6F91-4DE6-8D31-F35C2B0A14B7
http://species-id.net/wiki/Minanga_angelus

Holotype. Female.

Diagnosis. This is the only species of *Minanga* lacking horns immediately posteriad the lateral ocelli; it is also the only species with horns on the lateral edges of the occiput. This species is also distinguished from other species of *Minanga* by the lack of fusion of hind wing veins RS and R (or SC depending on vein interpretation) and the presence of crossvein r joining the two longitudinal veins.

Length. 8.2 mm.

Color. Mostly black with some orange and yellow color. Black except as follows: propodeum light orange; fore tarsus yellow; basitarsomeres of mid and hind legs

partly yellow; metasoma orange except apex black. Fore wing infuscate in apical half, yellow in basal half.

Head. Antenna with 43 flagellomeres; lacking horn posteriad lateral ocellus; with long sharp horn on lateral margin of occiput; vertex bulging posterolaterally; occipital carina absent; face with transverse carinae and a median longitudinal elevation; gena forming a flange posteroventrally; antennal insertions bordered by carinae laterally and medially.

Mesosoma. Pronope and subpronope well-developed; notauli smooth and reaching trans-scutal articulation; scutellar sulcus with 3 strong longitudinal carinae; posterior scutellar depression with a row of areolae; propodeum with median and lateral longitudinal carinae, and an anterior transverse carina, stub of posterior transverse carina present laterally; precoxal sulcus deep (less so anteriorly) and smooth; posterior margin of mesopleuron with several deep depressions; ventral transverse ridge present anteriad mid coxal insertions; tarsal claws with acute basal lobe; hind tarsus with long dense setae.

Metasoma. Lateral longitudinal carinae of terga 1 and 2 both narrowing posteriorly; all visible terga (3) mostly rugose, 3rd tergum less rugose posterolaterally; ovipositor short (withdrawn under carapace).

Etymology. Named "angel" for it is the only species of *Minanga* lacking horns posteriad lateral ocelli, though they are cleverly hidden behind the head.

Material examined. Holotype ♀. French Guiana, RN Nouragues (Saut Pararé), 1-30.IX.2010, Rec SEAG, N4 02.368-W52 40.429. [IRSNB].

Distribution. Neotropical (French Guiana).

Phylogenetic considerations. Due to the shared derived character states of lacking an occipital carina, smooth notauli, and compressed apex of the metasoma, *M. angelus* is likely the sister-species of *M. achterbergi* (Sharkey 2004). The latter is from Mexico and is the only other species known from the New World. The new species belongs in the subgenus *Anopliminanga,* which was proposed by Tan and Chen (2010) to include the Chinese species, *M. brevicarinata* Tan & Chen and the Mexican species *M. achterbergi* . The taxon was based on the following character states: "posterior margin of carapace without flange, dentation or depression; lateral carinae of metasomal tergite I weakly converging posteriorly; horns of head rather long, 2.4–3.7× diameter of ocellus, diverging; vein 1-SR + M of fore wing strongly curved". The authors do not support *Anopliminanga* with cladistic arguments. Using other sigalphine genera as outgroups and *Sigalphus* as the sistergroup, following Quicke et al. (2008), the dentation of the metasoma and the degree of convergence of the carinae are plesiomorphic, and the other characters are either variable within both subgenera or continuous in nature. Nonetheless the proposed subgenus appears to be monophyletic based on the nature of the sculpture of the mesopleuron. All three species have a longitudinal ridge defining the ventral margin of the precoxal groove. Likewise, members of the subgenus *Minanga s.s.* are likely to be monophyletic based on the derived state of dentation at the apex of the metasoma.

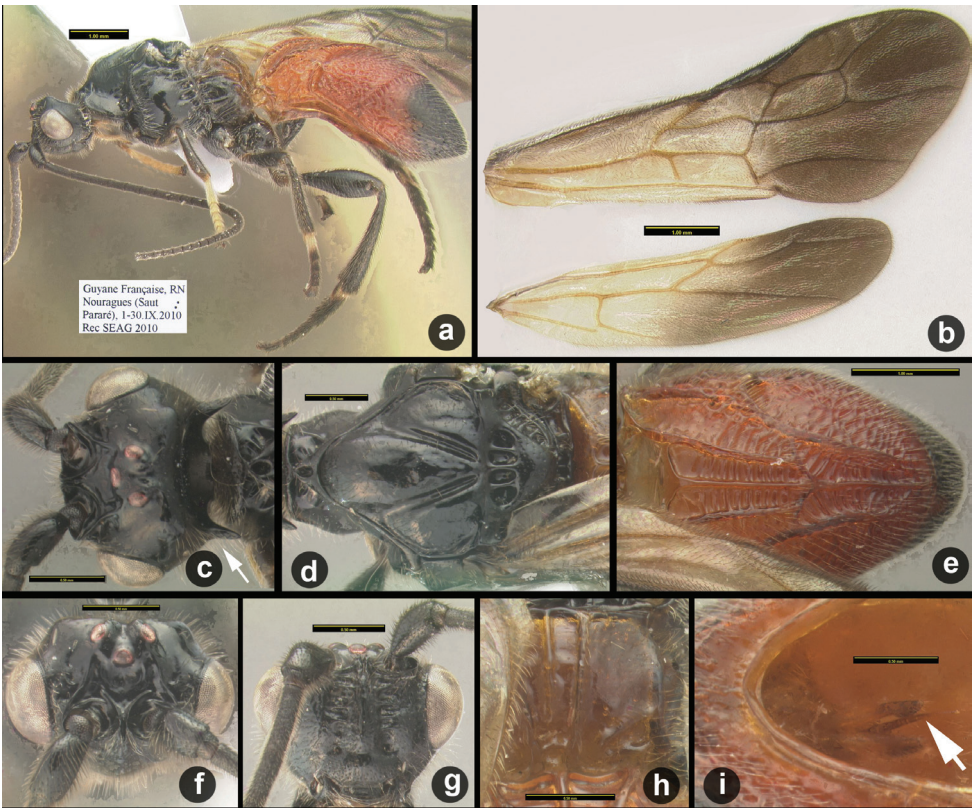


Figure 2. *Minanga angelus*. **a** Lateral habitus **b** Wings **c** Dorsal head, arrow denotes occipital spine **d** Dorsal thorax **e** Dorsal metasoma **f** Anterodorsal head **g** Anterior head **h** Propodeum **i** Ventral metasoma, arrow denotes ovipositor.

Identification key for *Minanga* (modified from the key of Tan et al. 2010)

1 Posterior margin of carapace without flange, dentation or depression (**subgenus *Anopliminanga***, Mexico, South America and China) **2**

– Posterior margin of carapace lamelliform and dentate (**subgenus *Minanga*** s. str., Afrotropical) **4**

2 Occipital carina absent; tergites II and III of carapace tapering to blunt apical point..... **3**

– Occipital carina present laterally; apex of carapace broadened posteriorly, tergites II and III reticulate-rugose; basal submedian carina short (0.3× median length of tergite II). (China) ..... ***M. brevicarinata* Tan & Chen**

3 Spines vertical and positioned immediately posteriad lateral ocelli (usual position for *Minanga*) (Northern Mexico)..... ***M. achterbergi* Sharkey**

– Spines horizontal and positioned on lateral edges of occiput (French Guiana) ..... ***M. angelus* sp. n. Sharkey and Braet**

4 Wings dark, uniformly infuscate..... **5**

– Wings partly or entirely pale **8**
5 Head black; mesonotum smooth **6**
– Head completely or partly reddish orange; mesonotum punctate **7**
6 Postpectal carina distinct and complete; mesosoma black entirely. (Uganda). ..... ***M. phoebea* Quicke**
– Postpectal carina indistinct; mesosoma mostly reddish orange. (South Africa) ..... ***M. serrata* Cameron**
7 Head completely reddish brown; face not transversely rugose; antenna 35 segmented. (Democratic Republic of Congo) ..... ***M. oryx* Saeger**
– Head black medially and reddish brown laterally; face transversely rugose; antenna 43-44 segmented. (Madagascar) ..... ***M. seyrigi* Granger**
8 Head and mesosoma black, metasoma orange; legs mostly yellow; apical margin of carapace not bilobed; median lobe of mesonotum with median furrow. (South Africa) ..... ***M. flavipes* Cameron**
– Color of body not as above; apical margin of carapace bilobed; median lobe of mesonotum without median furrow **9**
9 Apex of hind tibia and tarsi black. (Kenya, Tanzania) ... ***M. capra* (Enderlein)**
– Legs completely reddish brown or tips of tarsi brown **10**
10 Apex of carapace excavate; color of mesonotum uniform; tips of tarsi brown. (Democratic Republic of Congo) ..... ***M. taura* (Brues)**
– Apex of carapace unexcavated; mesonotum reddish brown medially, black laterally; legs entirely reddish brown. (South Africa) ..... ***M. bimaculata* Cameron**

Acknowledgements

Thanks to the Société Entomologique Antilles-Guyane for providing the specimens. Support to MJS was provided by NSF grant EF-0337220.

References

Braet Y, Fretey J (1997) Species of Braconidae (Hymenoptera) collected in French Guiana with descriptions of two new species. Bulletin & Annales de la Société Royale Belge d'Entomologie 133(3): 363–374.

Quicke DLJ, Sharkey MJ, Laurenne NM, Dowling A (2008) A preliminary molecular phylogeny of the Sigalphinae (Hymenoptera: Braconidae), including *Pselaphanus* Szepligeti, based on 28S rDNA, with descriptions of new Afrotropical and Madagascan *Minanga* and *Malasigalphus* species. Journal of Natural History 42(43-44):2703–2719. doi: 10.1080/00222930802364042

Sharkey MJ (2004) Afrotropical - North American disjunct distribution of *Minanga* (Hymenoptera: Braconidae) with the description of a new species and first record for the

New World. Annals of the Entomological Society of America 97: 1198–1203. doi: 10.1603/0013-8746(2004)097[1198:AADDOM]2.0.CO;2

Sharkey MJ, Janzen DH (1995) Review of the world species of *Sigalphus* (Hymenoptera: Braconidae: Sigalphinae) and biology of *Sigalphus romeroi*, new species. Journal of Hymenoptera Research 4: 99–109.

Shaw MR, Quicke DLJ (1990) The biology and early stages of *Acampsis alternipes* (Nees), with comments on the relationships of the Sigalphinae (Hymenoptera: Braconidae). Journal of Natural History 34:611–628. doi: 10.1080/002229300299471

Tan JL, He J-H, Chen XX (2010) The Genus *Minanga* Cameron (Hymenoptera: Braconidae) in China, With Description of a New Subgenus and Species. Annals of the Entomological Society of America 103(3): 360–365. doi: 10.1603/AN10001

van Achterberg C (1993) Illustrated key to the subfamilies of the Braconidae (Hymenoptera: Ichneumonoidea). Zoologische Verhandelingen. No.283. 189 pp.

Zettel H (1990) Eine Revision der Gattungen der Cheloninae (Hymenoptera, Braconidae) mit Beschreibungen neuer Gattungen und Arten. Annalen des Naturhistorischen Museums in Wien. 91B:147–196.

Zettel H (1992) Zwei neue Arten aus der Gattung Dentigaster Zettel (Hymenoptera, Braconidae, Cheloninae). Deutsche Entomologische Zeitschrift 39(1–3): 131–134. doi: 10.1002/mmnd.19920390118

JHR 25: 103–125 (2012)
doi: 10.3897/JHR.25.2319
www.pensoft.net/journals/jhr

RESEARCH ARTICLE

JOURNAL OF Hymenoptera RESEARCH
A peer-reviewed open-access journal
The International Society of Hymenopterists

A new genus and species of Collyriinae (Hymenoptera, Ichneumonidae)

Mao-Ling Sheng[1,†], Gavin R. Broad[2,‡], Shu-Ping Sun[1,§]

1 *General Station of Forest Pest Management, State Forestry Administration, Shenyang, Liaoning, 110034, China* **2** *Department of Entomology, the Natural History Museum, Cromwell Road, London SW7 5BD, UK*

† *urn:lsid:zoobank.org:author:3C0EBDB7-26F7-469B-8DB1-5C7B1C6D9B89*
‡ *urn:lsid:zoobank.org:author:D06689DE-526F-4CFA-8BEB-9FB38850754A*
§ *urn:lsid:zoobank.org:author:974C0354-6118-4EA9-890F-EF5ECE8F257A*

Corresponding author: *Mao-Ling Sheng* (shengmaoling@163.com), *Gavin Broad* (g.broad@nhm.ac.uk)

Academic editor: *S. Schmidt* | Received 4 November 2011 | Accepted 9 January 2012 | Published 23 March 2012

urn:lsid:zoobank.org:pub:B479737A-F0A6-416D-9B63-0FF0E4A18D44

Citation: Sheng M-L, Broad GR, Sun S-P (2012) A new genus and species of Collyriinae (Hymenoptera, Ichneumonidae). Journal of Hymenoptera Research 25: 103–125. doi: 10.3897/JHR.25.2319

Abstract

An enigmatic taxon collected in China is described as *Bicurta sinica* **gen. n.**, **sp. n.** The unique specimen proved difficult to place to subfamily but has features in common with *Collyria*, until recently the sole valid genus of the small Palaearctic subfamily, Collyriinae. A morphological phylogenetic analysis of the pimpliformes group of subfamilies confirms the placement of this genus in the Collyriinae, which is here redefined.

Keywords

new genus, new species, taxonomy, China, Poemeniinae, pimpliformes

Introduction

The speciose family Ichneumonidae is currently divided into about 38 subfamilies (Quicke et al. 2009), although some groupings are treated differently by different authors (see, for example, the website of the American Entomological Institute: http://www.amentinst.org/). This large number of subfamilies has been divided into a num-

ber of subfamily groupings, largely by the pioneering work of Wahl (1986, 1990, 1991) and Gauld (1985), with the details refined by Quicke et al. (2009). Although we are working towards a relatively stable higher classification of the Ichneumonidae, there are many areas of uncertainty, such as the classification of the various Ctenopelmatinae tribes in relation to several other subfamilies (Gauld and Wahl 2006; Quicke et al. 2009). Another area of difficulty is the pimpliformes group of subfamilies. Relationships within this clade (see Wahl 1986, 1990; Wahl and Gauld 1998; Quicke et al. 2009) have proved difficult to reconstruct, partly because of missing biological and larval information for some enigmatic taxa and partly because the 28S D2 ribosomal RNA data do not provide much support for subfamily or tribal relationships in this area. It can be inferred that the pimpliformes underwent a rapid radiation which has resulted in few discrete morphological apomorphies and the recognition of various very small groups of species as discrete subfamilies. One such subfamily is Collyriinae, comprising only one genus, *Collyria* Schiødte, until recently. After this paper was accepted for publication, Kuslitzky and Kasparyan (2011) described a second genus of Collyriinae, *Aubertiella* Kuslitzky and Kasparyan, 2011, which we have not been able to include in the phylogenetic analyses here. Although excluded from the pimpliformes by Gauld (1997) and Wahl and Gauld (1998), *Collyria* shows some clear pimpliform apomorphies, such as the basally elongated propodeum, and clearly grouped with the pimpliformes in Quicke et al.'s (2009) combined morphological and molecular phylogenetic analyses. As the Collyriinae is a subfamily now containing only two genera, defined by some unusual character states within the Ichneumonidae, the current diagnosis of the subfamily was, until Kuslitzky and Kasparyan (2011), the diagnosis of the original genus, *Collyria*, and now requires reassessment with the addition of more plesiomorphic genera.

Two of the authors (M-LS and S-PS) received a single specimen of a distinctive ichneumonid collected in Jiangxi province, P.R. China. Unfortunately, further fieldwork by M-LS and S-PS in the type locality has failed to uncover any further specimens. This specimen proved very difficult to place in any subfamily, with a combination of character states that could almost equally feasibly place it in Poemeniinae or Collyriinae. For example, both subfamilies have an elongate propodeum with the spiracle only a little anterior to the middle; they both often lack transverse carinae on the propodeum; the hind coxa is elongate; the first metasomal segment is usually of a similar, elongate shape; the first abscissa of hind wing vein *cu* is much shorter than vein *cu-a*. This specimen, which obviously represents an undescribed species and genus, lacks the apomorphies of *Collyria*, namely the decurved ovipositor with small serrations along the lower margin and the distinctive claw characters (fore and mid tarsal claws each with a median tooth), although it does have lobate fore and mid claws, in common with several pimpliform taxa. The new specimen lacks the principle apomorphies of the Poemeniinae, namely the ventral continuation of the epomia parallel to the lower margin of the pronotum and the laterally expanded foramen magnum (although this is difficult to see in the single new specimen). As well as the character states that are common to Poemeniinae and *Collyria*, the new specimen shows three characters of

the head that led us to believe that its affinities are closer to *Collyria*, namely the short antennae, the presence of a bifurcate carina from the dorsal half of the face to between the antennae, and a weak median tubercle on the clypeus. After much deliberation, we hypothesised that this specimen represents a new genus of Collyriinae. To test this hypothesis, we coded the specimen of *Bicurta sinica* sp. n. and *Collyria coxator* (Villers) for Wahl and Gauld's (1998) morphological characters, to establish the position of these genera within the pimpliformes.

Materials and methods

For the phylogenetic analyses, codings were based on the matrix of Wahl and Gauld (1998) and on specimens in the Natural History Museum, London and in the Insect Museum, General Station of Forest Pest Management (GSFPM), State Forestry Administration, People's Republic of China (the holotype of *Bicurta sinica* sp. n.).

The character codings for *Bicurta* gen. n. and *Collyria* are shown in Table 1 with the character numbers as in Wahl and Gauld (1998). Given that these genera share some distinctive characters that were not included in Wahl and Gauld's analysis, two additional characters were included in our matrix.

Character 92. Dorsal face (0) lacking a bifurcate carina between the antennal sockets (Fig. 6); (1) possessing a bifurcate carina between the antennal sockets.

Character 93. Antenna length (0) normal, at least 0.8× length of fore wing; (1) short, only about 0.65-0.7× length of fore wing.

Both of these characters were coded as '0' for other taxa in Wahl and Gauld's (1998) matrix. For *Collyria*, characters of internal anatomy, ovipositor and larval morphology were taken from Quicke et al. (2009). Morphological terminology mostly

Table 1. Character codings for *Bicurta* and *Collyria*; characters 1-91 are from Wahl and Gauld (1998)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Bicurta	1	2	0	1	0	0	0	0	0	?	?	1	1	0	0	1	0	0	0	?
Collyria	1	2	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
Bicurta	0	0	0	1	0	0	0	0	1	1	0	1	1	1	0	1	1	0	1	0
Collyria	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	0
	41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Bicurta	0	0	1	0	1	n/a	0	1	1	0	1	1	0	1	0	0	0	0	0	0
Collyria	0	0	1	0	0	n/a	0	1	1	0	0	1	0	1	0	0	0	0	0	0
	61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
Bicurta	1	1	0	0	?	?	0	0	1	0	0	?	?	?	?	?	?	?	?	?
Collyria	1	0	0	0	0	0	0	0	1	0	0	0	?	1	0	0	2	0	0	0
	81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**							
Bicurta	?	?	?	?	?	?	?	?	?	?	?	1	1							
Collyria	?	?	1	0	1	0	0	?	1	?	0	1	1							

follows Gauld (1991). Morphological terms are linked to anatomical concepts in the Hymenoptera Anatomy Ontology (Yoder et al. 2010). URIs are provided in Table 2. Note that, at the time of writing, wing vein nomenclature and several other morphological terms used here have not yet been included in the HAO.

Table 2. Morphological characters and URIs to concepts in the Hymenoptera Anatomy Ontology.

Label	URI
abscissa	http://purl.obolibrary.org/obo/HAO_0000076
antenna, antennae	http://purl.obolibrary.org/obo/HAO_0000101
antennal sockets	http://purl.obolibrary.org/obo/HAO_0001022
anterior tentorial pits	http://purl.obolibrary.org/obo/HAO_0000126
apical teeth	http://purl.obolibrary.org/obo/HAO_0001681
area	http://purl.obolibrary.org/obo/HAO_0000146
areolet	http://purl.obolibrary.org/obo/HAO_0000147
bifurcate carina (upper face)	http://purl.obolibrary.org/obo/HAO_0001929
body	http://purl.obolibrary.org/obo/HAO_0000182
bulla	http://purl.obolibrary.org/obo/HAO_0000184
carina, carinae	http://purl.obolibrary.org/obo/HAO_0000188
clypeus	http://purl.obolibrary.org/obo/HAO_0000212
clypeal suture	http://purl.obolibrary.org/obo/HAO_0000126
clypeal fovea	http://purl.obolibrary.org/obo/HAO_0000126
edge	http://purl.obolibrary.org/obo/HAO_0000285
epicnemial carina	http://purl.obolibrary.org/obo/HAO_0000292
epomia	http://purl.obolibrary.org/obo/HAO_0000307
eye	http://purl.obolibrary.org/obo/HAO_0000217
face	http://purl.obolibrary.org/obo/HAO_0000502
first tergum	http://purl.obolibrary.org/obo/HAO_0000053
first sternum	http://purl.obolibrary.org/obo/HAO_0000035
flagellomere, flagellomeres	http://purl.obolibrary.org/obo/HAO_0000342
fore wing	http://purl.obolibrary.org/obo/HAO_0000351
fore tarsal claw	http://purl.obolibrary.org/obo/HAO_0001925
fourth flagellomere	http://purl.obolibrary.org/obo/HAO_0001896
frons	http://purl.obolibrary.org/obo/HAO_0001044
gena	http://purl.obolibrary.org/obo/HAO_0000371
glymma, glymmae	http://purl.obolibrary.org/obo/HAO_0000378
head	http://purl.obolibrary.org/obo/HAO_0000397
hind tarsal claw	http://purl.obolibrary.org/obo/HAO_0001927
hind coxa	http://purl.obolibrary.org/obo/HAO_0000587
hind femur	http://purl.obolibrary.org/obo/HAO_0001140
hind leg	http://purl.obolibrary.org/obo/HAO_0000399
hind tibia	http://purl.obolibrary.org/obo/HAO_0000631
hind wing	http://purl.obolibrary.org/obo/HAO_0000400
hypopygium	http://purl.obolibrary.org/obo/HAO_0000410
hypostomal carina	http://purl.obolibrary.org/obo/HAO_0000413

Label	URI
inner orbit	http://purl.obolibrary.org/obo/HAO_0001920
interocellar area	http://purl.obolibrary.org/obo/HAO_0000430
labial palpus	http://purl.obolibrary.org/obo/HAO_0000450
labrum	http://purl.obolibrary.org/obo/HAO_0000456
last visible tergum	http://purl.obolibrary.org/obo/HAO_0001508
last flagellomere	http://purl.obolibrary.org/obo/HAO_0000137
lateral lobe	http://purl.obolibrary.org/obo/HAO_0000466
lateral ocellus	http://purl.obolibrary.org/obo/HAO_0000481
lower ovipositor valve	http://purl.obolibrary.org/obo/HAO_0000339
malar space	http://purl.obolibrary.org/obo/HAO_0001393
mandible, mandibles	http://purl.obolibrary.org/obo/HAO_0000506
margin, margins	http://purl.obolibrary.org/obo/HAO_0000510
maxillary palp	http://purl.obolibrary.org/obo/HAO_0000515
median longitudinal suture of mesosternum	http://purl.obolibrary.org/obo/HAO_0000545
median longitudinal carina	http://purl.obolibrary.org/obo/HAO_0001929
mesopleuron	http://purl.obolibrary.org/obo/HAO_0000566
mesoscutum	http://purl.obolibrary.org/obo/HAO_0000575
mesosoma	http://purl.obolibrary.org/obo/HAO_0000576
mesosternum	http://purl.obolibrary.org/obo/HAO_0001710
metapleuron	http://purl.obolibrary.org/obo/HAO_0001271
metasoma	http://purl.obolibrary.org/obo/HAO_0000626
metasternum	http://purl.obolibrary.org/obo/HAO_0001931
mid lobe	http://purl.obolibrary.org/obo/HAO_0000520
mid tarsal claw	http://purl.obolibrary.org/obo/HAO_0001926
notaulus	http://purl.obolibrary.org/obo/HAO_0000647
notch	http://purl.obolibrary.org/obo/HAO_0000648
occipital carina	http://purl.obolibrary.org/obo/HAO_0000653
ocular ocellar line	http://purl.obolibrary.org/obo/HAO_0000662
ovipositor sheath	http://purl.obolibrary.org/obo/HAO_0000680
pleural carina	http://purl.obolibrary.org/obo/HAO_0000609
portion	http://purl.obolibrary.org/obo/HAO_0000146
postero-ocellar line	http://purl.obolibrary.org/obo/HAO_0000759
postscutellum	http://purl.obolibrary.org/obo/HAO_0000568
pronotum	http://purl.obolibrary.org/obo/HAO_0000853
propodeal spiracle	http://purl.obolibrary.org/obo/HAO_0000329
propodeum	http://purl.obolibrary.org/obo/HAO_0001249
pterostigma	http://purl.obolibrary.org/obo/HAO_0000957
puncture, punctures	http://purl.obolibrary.org/obo/HAO_0000885
sculpture	http://purl.obolibrary.org/obo/HAO_0000913
scutellum	http://purl.obolibrary.org/obo/HAO_0001229
second tergum	http://purl.obolibrary.org/obo/HAO_0000056
second valvula	http://purl.obolibrary.org/obo/HAO_0000928
segments	http://purl.obolibrary.org/obo/HAO_0001866
speculum	http://purl.obolibrary.org/obo/HAO_0000944
spiracle	http://purl.obolibrary.org/obo/HAO_0001538

Label	URI
sternaulus	http://purl.obolibrary.org/obo/HAO_0000953
sternum	http://purl.obolibrary.org/obo/HAO_0000955
sternum (second abdominal sternum)	http://purl.obolibrary.org/obo/HAO_0000035
submetapleural carina	http://purl.obolibrary.org/obo/HAO_0000974
subocular sulcus	http://purl.obolibrary.org/obo/HAO_0000504
tarsal claws	http://purl.obolibrary.org/obo/HAO_0000989
tegula	http://purl.obolibrary.org/obo/HAO_0000993
tentorial pits	http://purl.obolibrary.org/obo/HAO_0000999
tergite	http://purl.obolibrary.org/obo/HAO_0000053
tergum, terga	http://purl.obolibrary.org/obo/HAO_0001349
tergum	http://purl.obolibrary.org/obo/HAO_0000053
tergum 3	http://purl.obolibrary.org/obo/HAO_0000057
tergum 6	http://purl.obolibrary.org/obo/HAO_0000060
tooth, teeth	http://purl.obolibrary.org/obo/HAO_0001019
tooth	http://purl.obolibrary.org/obo/HAO_0001219
tooth	http://purl.obolibrary.org/obo/HAO_0001681
third tergum	http://purl.obolibrary.org/obo/HAO_0000057
transverse carina (propodeum)	http://purl.obolibrary.org/obo/HAO_0001930
trochantellus of hind leg	http://purl.obolibrary.org/obo/HAO_0001859
trochanter of hind leg	http://purl.obolibrary.org/obo/HAO_0001139
tubercle	http://purl.obolibrary.org/obo/HAO_0001036
upper face	http://purl.obolibrary.org/obo/HAO_0001044
upper tooth (mandible)	http://purl.obolibrary.org/obo/HAO_0000276
vertex	http://purl.obolibrary.org/obo/HAO_0001077
wing	http://purl.obolibrary.org/obo/HAO_0001089
wing venation	http://purl.obolibrary.org/obo/HAO_0001096

We have also made some changes to the character codings employed by Wahl and Gauld (1998). Wahl and Gauld's character 45 (number of bullae in fore wing vein 2*m-cu*) was re-coded for Agriotypinae (changed to '1') and for Labeninae (to polymorphic), following Bennett (2001); their character 46 (shape of the areolet) has been re-coded as '?', rather than '0', for taxa lacking fore wing vein 3*rs-m*. Following Matsumoto and Broad (2011), *Rodrigama* Gauld has been re-coded for character 19 (occipital carina is dorsally incomplete), 26 (epicnemial carina is present) and 34 (hind coxa is elongate). Note that *Rossemia* Humala is the valid name for Wahl and Gauld's *Sweaterella* (Humala, 2003).

Phylogenetic analyses were carried out in TNT 1.1 (Goloboff et al. 2003), with all characters unordered and using default settings except for the following (as employed by Burks et al. 2011): ratchet weighting probability (up and down) of 5%, 200 iterations, drift of 50 cycles, tree fusing of five rounds, and find minimum length 25 times. Phylogenetic trees were edited in Winclada (Nixon 1999).

SEM images of uncoated specimens were taken using a Leo 1455VP low vacuum scanning electron microscope. Photographs of *Bicurta sinica* sp. n. were taken using a

Canon Power Shot A650 IS and Cool Snap 3CCD attached to a Zeiss Discovery V8 Stereomicroscope and captured with QCapture Pro version 5.1.

Results

Phylogenetic analyses

With characters unordered and unweighted, 12 trees of length 240 were found; the strict consensus is shown in Fig. 1. The relationships betweeen subfamilies are largely unresolved but *Bicurta* and *Collyria* are recovered as a clade, as are all other subfamilies with multiple representatives, except Cylloceriinae. Searching with implied weights of values ranging from k=1 to k=10 resulted in a single topology, shown in Fig. 2. This phylogeny is similar to that obtained by Wahl and Gauld (1998), except that Xoridinae shift to the sister group of the labeniformes plus ichneumoniformes and the genera of Poemeniinae are fully resolved. *Bicurta*+*Collyria* are recovered as a clade and as the sister group to Rhyssinae. As a test of the robustness of the results, characters 72 to 93 (which include both those characters missing for a large number of taxa and the two additional characters included in this study) were excluded and the analysis run using the same parameters. The topology of Collyriinae, Rhyssinae and Poemeniinae remained the same, although relationships within the remaining pimpliformes collapsed in the strict consensus (Fig. 3).

In these analyses, the monophyly of Collyriinae is attested by numerous homoplasies and two synapomorphies: the presence of a bifurcate carina on the upper face extending to between the antennal sockets and the short antennae. The sister group relationship of Collyriinae to Rhyssinae was unexpected and is supported by a single apomorphy, the absence of the posterior transverse carina of the propodeum. The monophyly of Poemeniinae+Rhyssinae+Collyriinae is again weakly supported by one unambiguous apomorphy (the small and subrectangular clypeus) and two homoplasies (hind wing vein 2/*Cu* originating close to vein *M* and the elongate last visible tergite of the female). In contrast, Quicke et al. (2009), in their combined morphological and molecular analyses, found *Collyria* to nest within the Diptera-parasitizing clade of pimpliformes, in a topology that seemed to be overwhelmingly influenced by the morphology dataset.

Definition of Collyriinae

The Collyriinae, now comprising the genera *Aubertiella*, *Bicurta* gen. n. and *Collyria*, can be defined by the following characters, based on the phylogenetic analyses presented here and on the description of *Aubertiella* (Kuslitzky and Kasparyan 2011), although only the first two are autapomorphic for the subfamily: dorsal part of face with bifurcate carina extending between antennal sockets (character not mentioned

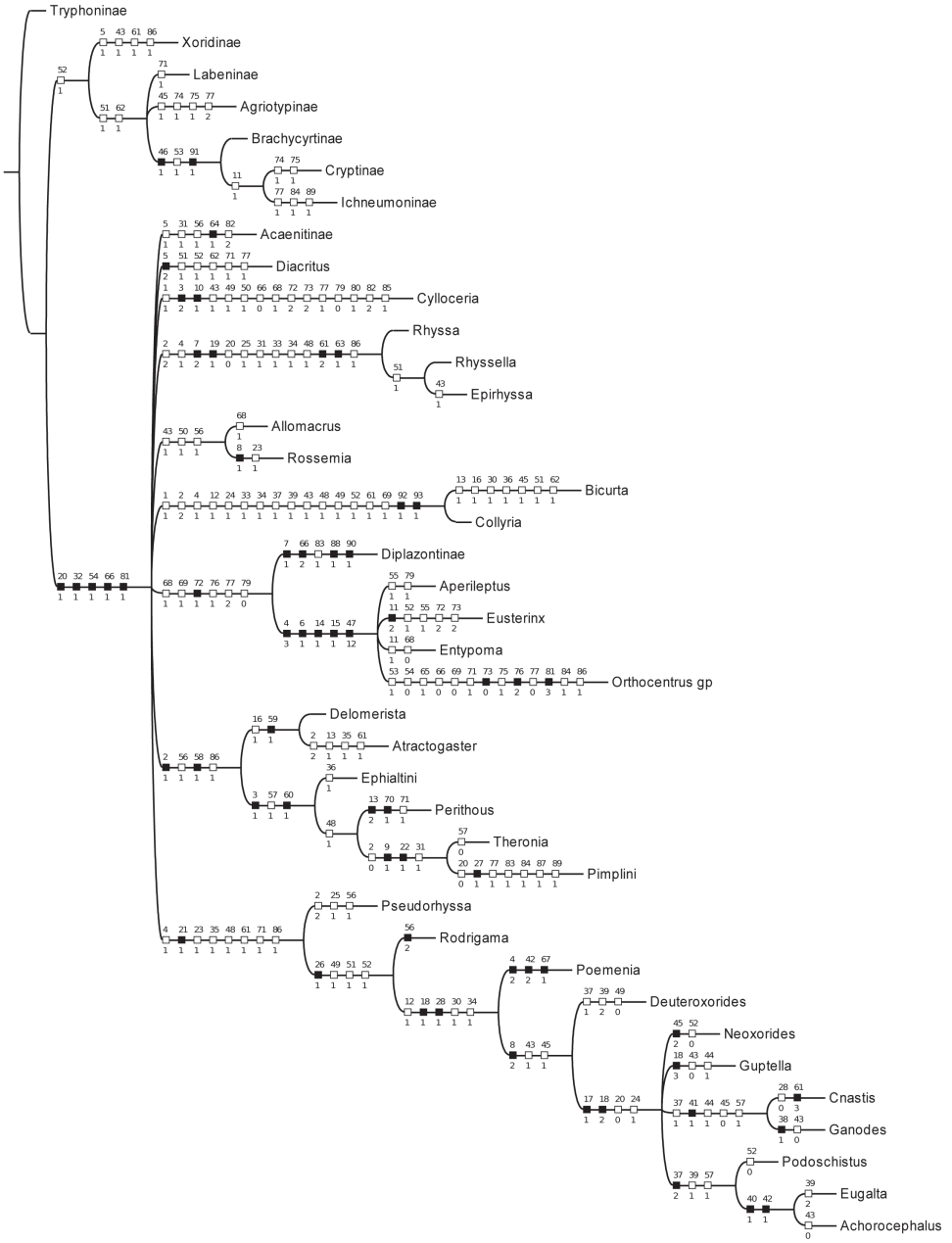


Figure 1. Cladogram of selected pimpliformes taxa. Strict consensus of 12 trees of length 240. Apomorphic characters are indicated by black squares, homoplasies by white squares.

by Kuslitzky and Kasparyan 2011); antennae short; clypeus with median tubercle; posterior transverse carina of propodeum absent; hind coxa elongate; fore and mid claws with teeth; fore wing vein 3*rs-m* absent; hind wing vein *Cu*1 much closer to vein

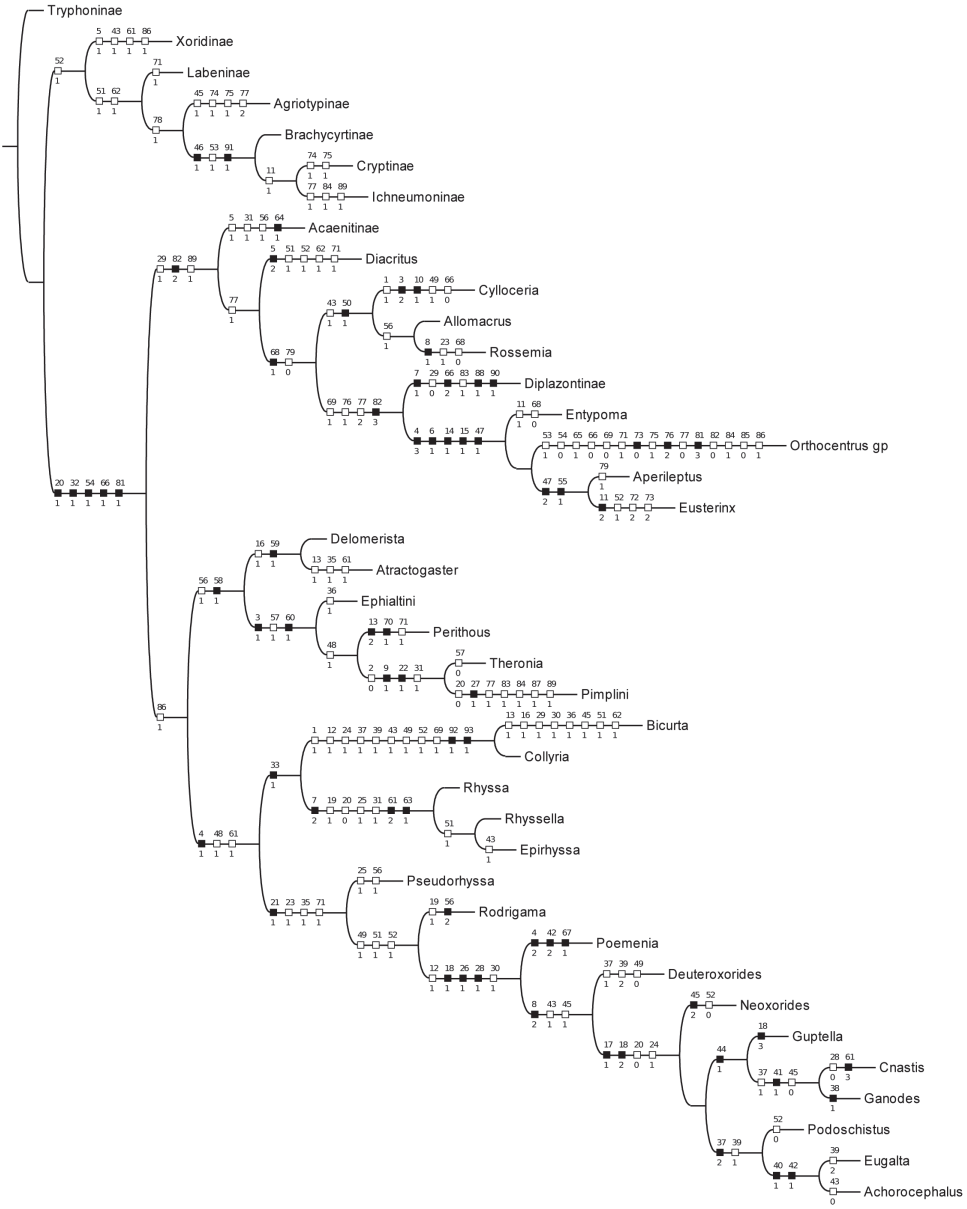


Figure 2. Cladogram of selected pimpliformes taxa obtained by reweighting with implied weights, k=3.

M than to *A*; first tergite lacking longitudinal carinae; glymmae absent; last visible tergite of female elongate (apparently only an apomorphy of *Bicurta* and *Collyria*, not *Aubertiella* – Kuslitzky and Kasparyan 2011); and the ovipositor lacking ventral, apical teeth. The monophyly of *Collyria* is attested to by an autapomorphy not included in the analysis: the ventral ovipositor valve is weakly serrate along the median ~0.5 (which we contend are not 'teeth' as usually defined in the Ichneumonoidea as they are

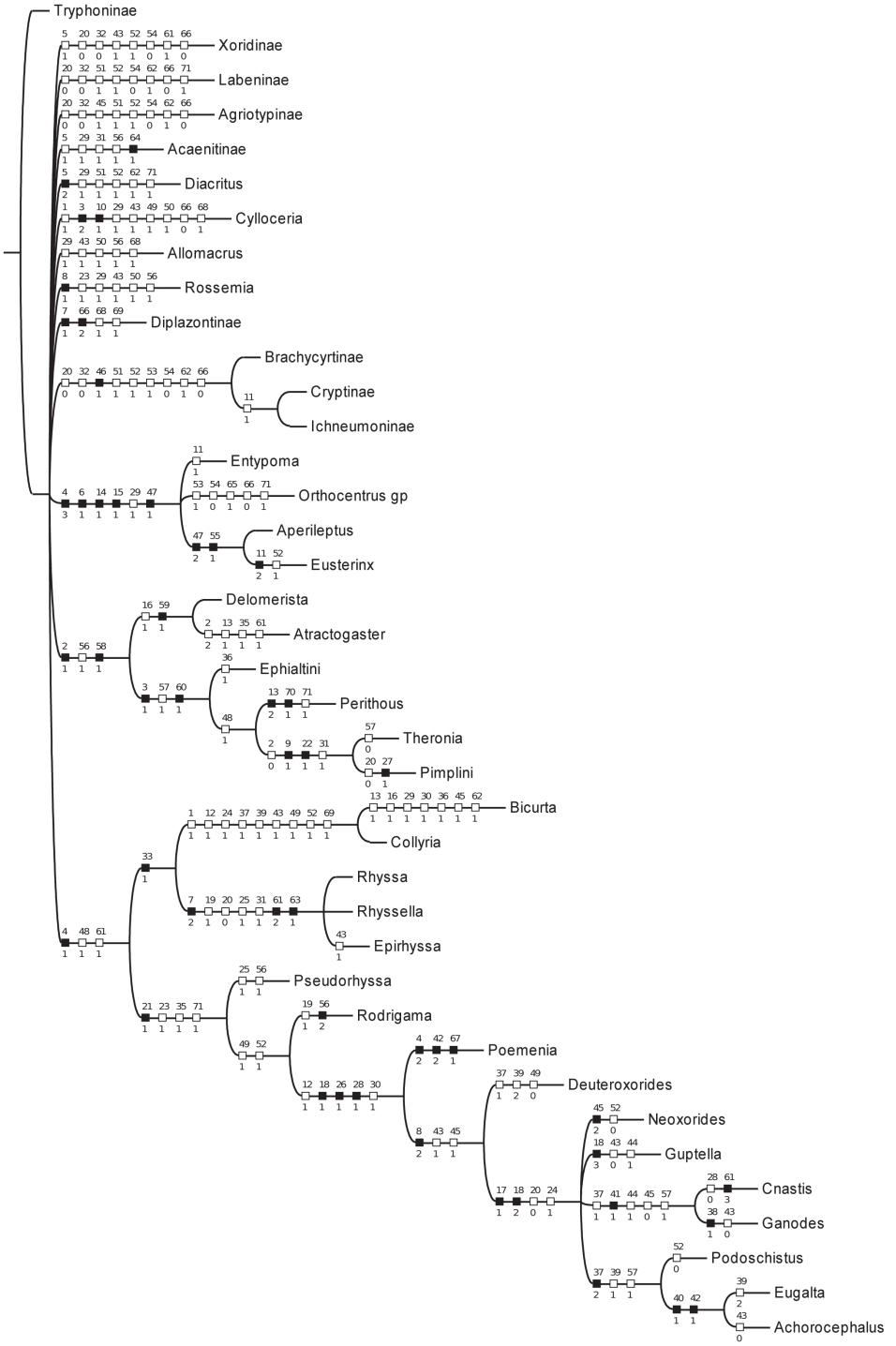


Figure 3. Strict consensus of 89 trees resulting from analysis of reduced data matrix (characters 72–93 excluded).

not ridges across the depth of the apical part of the lower valve). The monophyly of *Bicurta* is supported by some rather weak characters, including the pale markings on the face and malar space; the more posteriorly displaced propodeal spiracle (compared to *Collyria*); the large, lobe-like teeth on the fore and mid tarsal claws (which may be plesiomorphic with respect to the narrower teeth of *Collyria*); fore wing vein 2*m-cu* with one bulla; the first tergite and sternite fused; and the first sternite more than half the length of the tergite.

An expanded phylogenetic matrix, encompassing the genera of Acaenitinae, could reveal some rather different patterns of relationships within the pimpliformes. Several acaenitine genera share character states with collyriines and some poemeniines, such as short antennae, a median tubercle on the clypeus, hind wing vein *Cu*1 originating close to *M* and the propodeum lacking transverse carinae. However, acaenitines have a distinctive apomorphic female hypopygium, very different to that of the Collyriinae, Poemeniinae or Rhyssinae.

Taxonomy

Collyriinae Cushman
http://species-id.net/wiki/Collyriinae

Diagnosis. Collyriinae can be distinguished from all other subfamilies of Ichneumonidae by the following combination of characters: 1) dorsal part of face with a bifurcate carina extending between the antennal sockets and 2) antenna short, only slightly longer than combined length of head and mesosoma, 0.65–0.7× length of fore wing. Additional distinctive characters, in combination (individually, all are shared with other taxa) are the elongate propodeum with strong lateromedian longitudinal carinae, very stout hind femur, elongate hind coxa and the subclavate shape of the metasoma.

As the concept of Collyriinae has now been expanded since Townes's (1971) definition, we provide a modified description of the subfamily below.

Description. Antenna short, c. 0.65–0.7× length of fore wing. Male flagellum without tyloids. Mesosoma subcylindric. Occipital carina complete, evenly arched dorsally. Ventrally reaching hypostomal carina well behind base of mandible. Dorsal part of face with a bifurcate carina extending between antennal sockets. Clypeal suture vestigial between clypeal foveae, clypeus faintly convex, apical margin with median tooth or protruberance. Basal portion of mandible wider, strongly narrowed toward apex, teeth sharp, teeth subequal or lower tooth longer than upper tooth. Maxillary palpus with 5 segments, labial palpus with 4 segments. Foramen magnum not expanded laterally. Anterior slope of mid lobe of mesoscutum approximately vertical. Epomia absent. Notaulus long. Epicnemial carina present. Postpectal carina incomplete. Propodeum long, rather cylindrical, longitudinal carinae developed to varying degrees, transverse carinae absent, juxtacoxal carina absent, propodeal spiracle oval. Apex of fore tibia without a tooth on outer side. Fore and hind tibiae each with two spurs. Fore

and mid tarsal claws each with either tooth at mid-length or basal lobe, hind tarsal claw large, simple, strongly curved. Hind femur stout, 3.0–3.6× as long as maximally deep. Metasoma subclavate, weakly laterally compressed in distal half. First metasomal segment long, narrow, spiracles anterior to middle, sclerotized part of first sternum extending to middle of tergite or anterior to this. Last visible tergite usually elongate. Hypopygium not elongate. Ovipositor slightly to markedly decurved. Fore wing vein 1*cu-a* opposite 1/*M*, vein 3*rs-m* absent. Hind wing with abscissa of *Cu* between *M+Cu* and *cu-a* strongly reclivous, about 0.2× as long as *cu-a*.

Biology. *Collyria coxator* (Villers) is a common parasitoid of *Cephus pygmaeus* (Linnaeus) (Hymenoptera: Cephidae) in Europe and a detailed account of its life history was published by Salt (1931). Another species of *Collyria*, *C. catoptron* Wahl, has been reared from *Cephus fumipennis* Eversmann (Wahl et al. 2007). Little is known about the biology of other species but they are likely to all be parasitoids of Cephidae. The biology of the genus is unusual for Ichneumonidae in that oviposition is into the host egg with emergence from the fully grown host larva after it has spun its cocoon (Salt 1931). Nothing is known of the biology of *Bicurta sinica* sp. n. or of *Aubertiella nigricator* (Aubert 1964).

Geographic range. The nine described *Collyria* species are found across the Palaearctic, although with few published records from the Eastern Palaearctic (Yu et al. 2009). *Collyria coxator* was introduced to Canada (Saskatchewan) (Smith 1931) in an unsuccessful (Carlson 1979) attempt to control the native *Cephus cinctus* Norton. However, it does seem to have become established in North America as a parasitoid of the introduced *Cephus pygmaeus* (Filipy et al. 1985). *Aubertiella nigricator* is known from Israel and Syria (Kuslitzky and Kasparyan 2011).

Included species. *Aubertiella nigricator* (Aubert, 1964) (originally described in *Collyria*), *Collyria catoptron* Wahl, 2007; *Collyria coxator* (Villers, 1789); *Collyria distincta* Izquierdo & Rey del Castillo, 1985; *Collyria fuscipennis* (Kriechbaumer, 1894); *Collyria iberica* Schmiedeknecht, 1908; *Collyria isparta* Gurbuz & Kolarov, 2006; *Collyria orientator* Aubert, 1979; *Collyria sagitta* Kuzin, 1950; *Collyria trichophthalma* (Thomson, 1877); and *Bicurta sinica* sp. n.

Bicurta Sheng, Broad & Sun, gen. n.

urn:lsid:zoobank.org:act:82873255-27E4-4CD0-9742-524EED50BF7B
http://species-id.net/wiki/Bicurta

Type species. *Bicurta sinica* Sheng, Broad & Sun, sp. n.

Diagnosis. *Bicurta* can be distinguished from *Collyria* by any of the following characters (state in *Collyria* in brackets: 1) epicnemial carina not clearly visible dorsal to mesosternum (carina distinct on mesopleuron); 2) ovipositor straight and smooth, without teeth on ventral valve (weakly decurved with weak teeth on ventral valve in most species; 3) fore and mid tarsal claws with acutely lobed tooth (with a weak medial tooth). *Aubertiella* resembles *Bicurta* in the very weak clypeal tubercle and simple ovi-

positor but can be distinguished by the median teeth on the fore and mid tarsal claws (similar to *Collyria*), black face and the apical tergites retracted beneath the sixth tergite.

Description. Clypeus nearly flat in lateral view, about 2.2 × as wide as high in anterior view (Fig. 10), median section of apical margin almost truncate, with an obtuse median tubercle or angulation. Mandible strongly narrowed toward apex, teeth sharp, lower tooth slightly longer than upper tooth. Dorsal part of face with bifurcate carina that extends between antennal sockets (Fig. 6a). Antenna short, 0.66x fore wing length, almost clubbed. Notaulus deep, reaching to middle of mesoscutum level with posterior margin of tegula (Fig. 11b). Epicnemial carina indistinct, not clearly visible dorsal to mesosternum (Fig. 11a) although slight furrow can be traced dorsally, far posterior to front edge of mesopleuron. Sternaulus vestigial on anterior 0.4 of mesopleuron. Scutellum and postscutellum approximately flat. Anterior section of submetapleural carina vestigial. Areolet absent. Fore wing with vein 1*cu-a* opposite 1/*M*; 2*m-cu* slightly inclivous, with one bulla. Hind wing with abscissa of *Cu* between *M*+*Cu* and *cu-a* much longer than *cu-a* (*Cu*1 originating close to vein *M*). Fore and mid tarsal claws elongate with acutely lobed tooth (Fig. 8a). Hind tarsal claw simple (Fig. 8b). Hind coxa elongate, almost as long as first tergite. Hind femur stout, 3.3x as long as maximally deep. Hind leg particularly long, in total 1.9x length of fore wing. Hind coxa elongate, about 0.8 × as long as hind femur, Propodeum elongate, with complete longitudinal carinae, median longitudinal carinae slightly convergent posteriorly, without transverse carinae (Fig. 5a). Propodeal spiracle obliquely elliptical, located at about mid-length of propodeum. Basal portion of metasoma narrow and elongate, apical portion laterally compressed. First tergum approximately 5 × as long as apical width, without longitudinal carinae; sternum reaching half length of tergum, fused with tergum; without glymma; spiracle located at basal 0.42. Ovipositor smooth, without teeth on ventral valve (Fig. 9). Otherwise as in the description of the subfamily.

Etymology. The name of the new genus is based on the short antenna and ovipositor sheath. The gender is feminine.

***Bicurta sinica* Sheng, Broad & Sun, sp. n.**
urn:lsid:zoobank.org:act:5A7C89FD-5BD7-4574-81F0-4517B3B7FCD6
http://species-id.net/wiki/Bicurta_sinica
Figs 4–11

Material examined. Holotype female, CHINA: Guanshan, 430 m, Yifeng County, Jiangxi Province, 20 April 2009, leg. Ling-Li Yi and Yi Li (GSFPM).

Description. Habitus: Fig. 4. Female. Body length 10.5 mm. Fore wing length 7.6 mm. Ovipositor length about 1.5 mm.

Head. Face approximately flat, 1.4 × as wide as long, with even punctures, distance between punctures 0.2 to 1.0 × diameter of puncture, lateral sides (inner orbit) impunctate and with fine granular texture. Clypeus nearly flat, about 2.2 × as wide as long, with fine, sparse punctures, distance between punctures 2 to 4 × diameter of

Figure 4. *Bicurta sinica* Sheng, Broad & Sun, sp. n., habitus.

puncture, apical portion smooth, impunctate. Labrum crescentic, about 0.33 × as long as wide. Malar space with fine leathery texture, without subocular sulcus, approximately 0.4 × as long as basal width of mandible. Gena glossy, with distinct fine punctures, in lateral view approximately 0.66 × as long as width of eye, evenly convergent backward. Posterior portion of vertex with fine punctures, portion between lateral ocellus and eye with fine leathery texture. Interocellar area slightly convex, with fine longitudinal wrinkles. Postero-ocellar line approximately as long as ocular-ocellar line. Dorsolateral part of frons with fine punctures, distance between punctures about as long as diameter of puncture; median portion narrowly smooth longitudinally; ventral portion with weak median longitudinal carina reaching to median protuberance of face. Antenna 5 mm, with 20 flagellomeres, ratio of length of flagellomere 1:2:3:4:5 is 5.5:4.0:3.8:3.7:3.4; last flagellomere 3 × as long as wide, approximately as long as fourth flagellomere. Distance from hypostomal carina to mandible about as long as basal width of mandible.

Mesosoma. Anterior portion of pronotum with fine longitudinal wrinkles; dorsal portion slightly scabrous; near dorsomedian portion with transverse wrinkles, posterior sections of the wrinkles parallel dorsal margin of pronotum; ventral portion with dense transverse wrinkles. Epomia indistinctly differentiated from strong oblique wrinkles. Mesoscutum with fine punctures; punctures on middle lobe denser than on lateral lobe, distance between punctures 0.2 to 2.5 × diameter of puncture; distance between punctures on lateral lobe 0.5 to 3.5 × diameter of puncture; posterior median portion with longitudinal concave and transverse wrinkles. Scutellum with dense punctures, distance between punctures 0.2 to 0.5 × diameter of puncture. Postscutellum with rela-

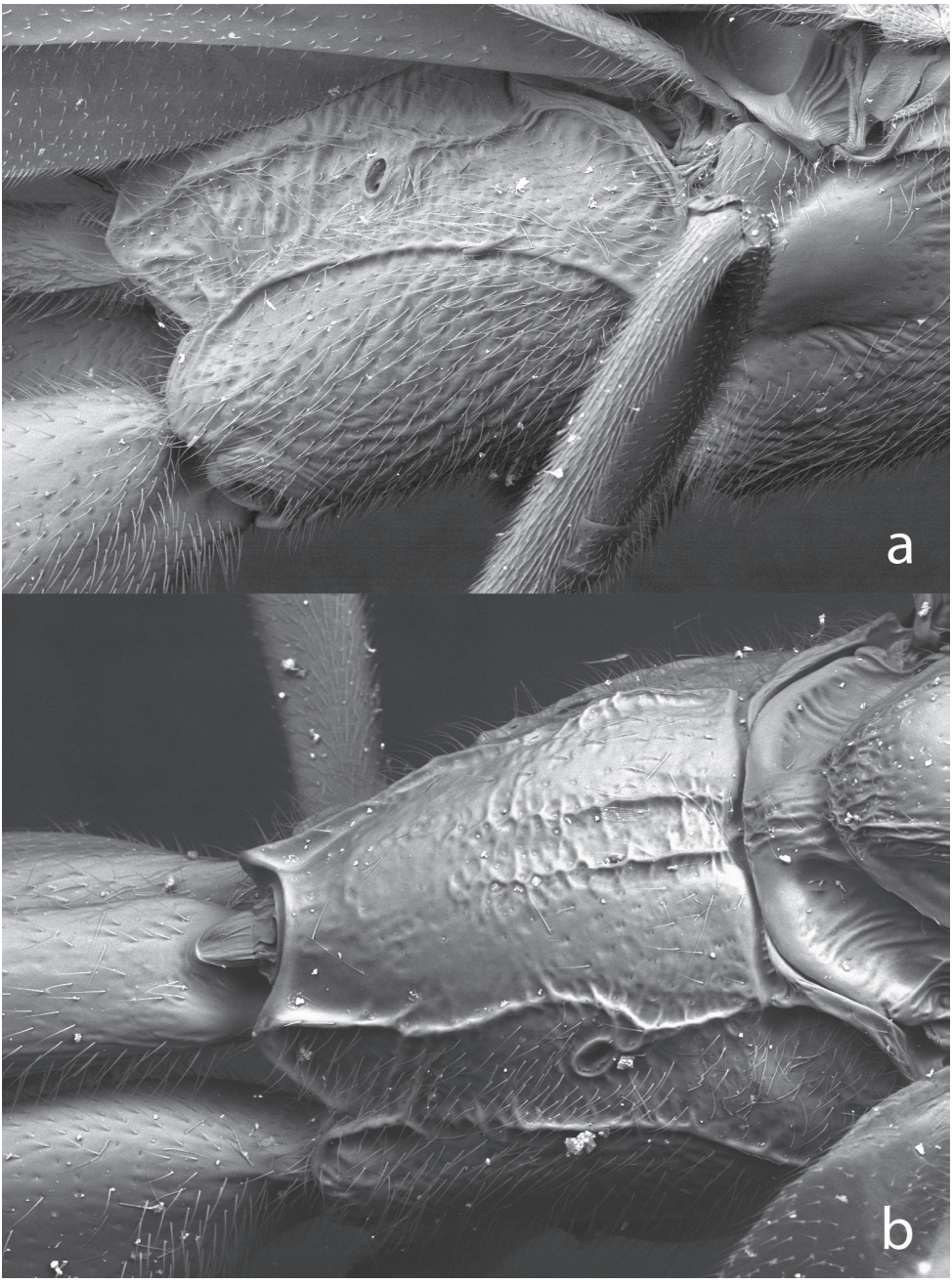


Figure 5. Propodeum of *Bicurta sinica* **a** and *Collyria coxator* **b**. Figs **5–9**, SEMs of uncoated specimens.

tively large, elongate punctures. Lower portion of mesopleuron slightly scabrous, with dense punctures; dorsoanterior portion, in front of subalar prominence, with short longitudinal wrinkles; median portion (anterior to speculum) and ventroposterior por-

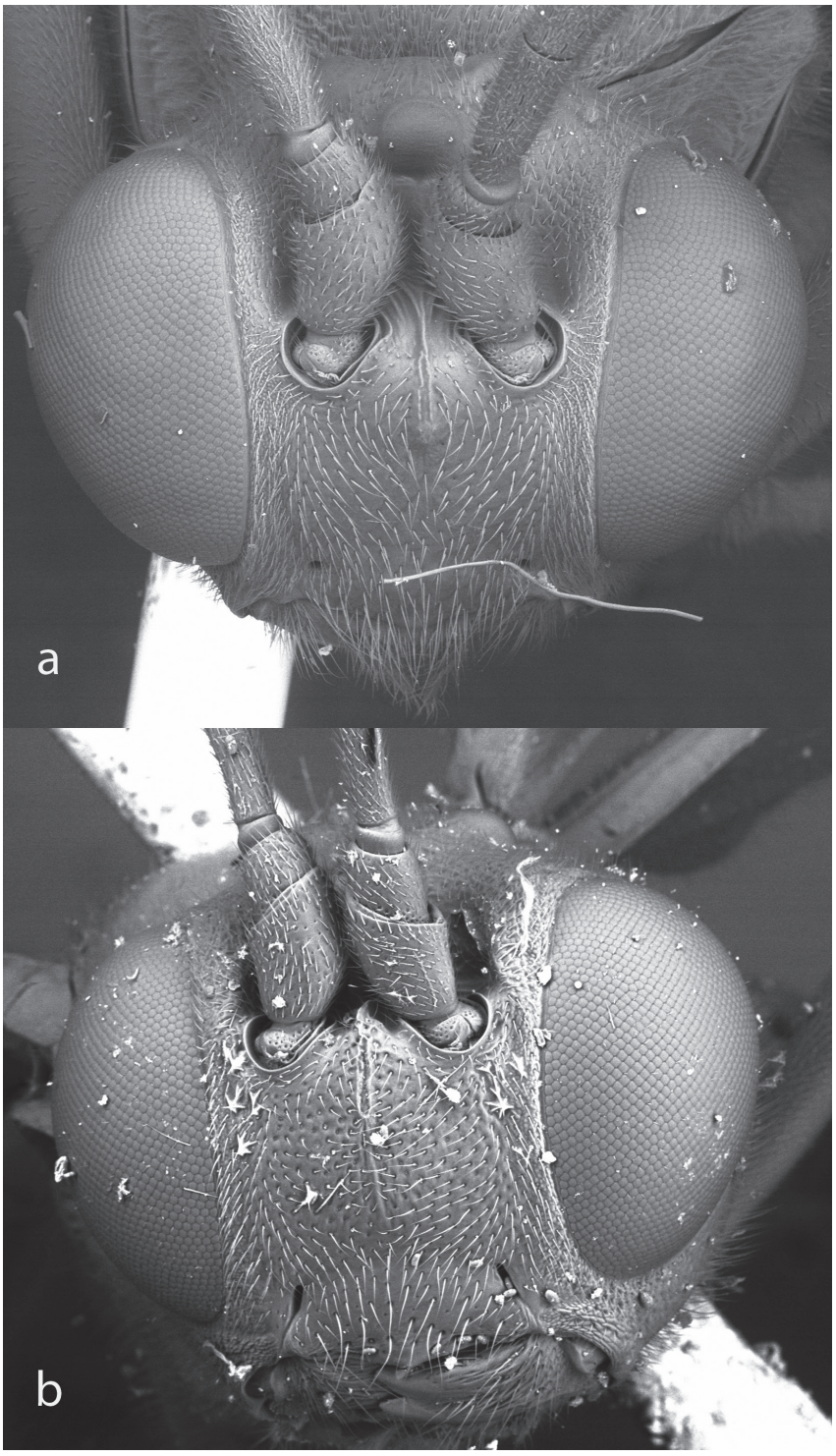


Figure 6. Head, frontal view, of *Bicurta sinica* **a** and *Collyria coxator* **b**.

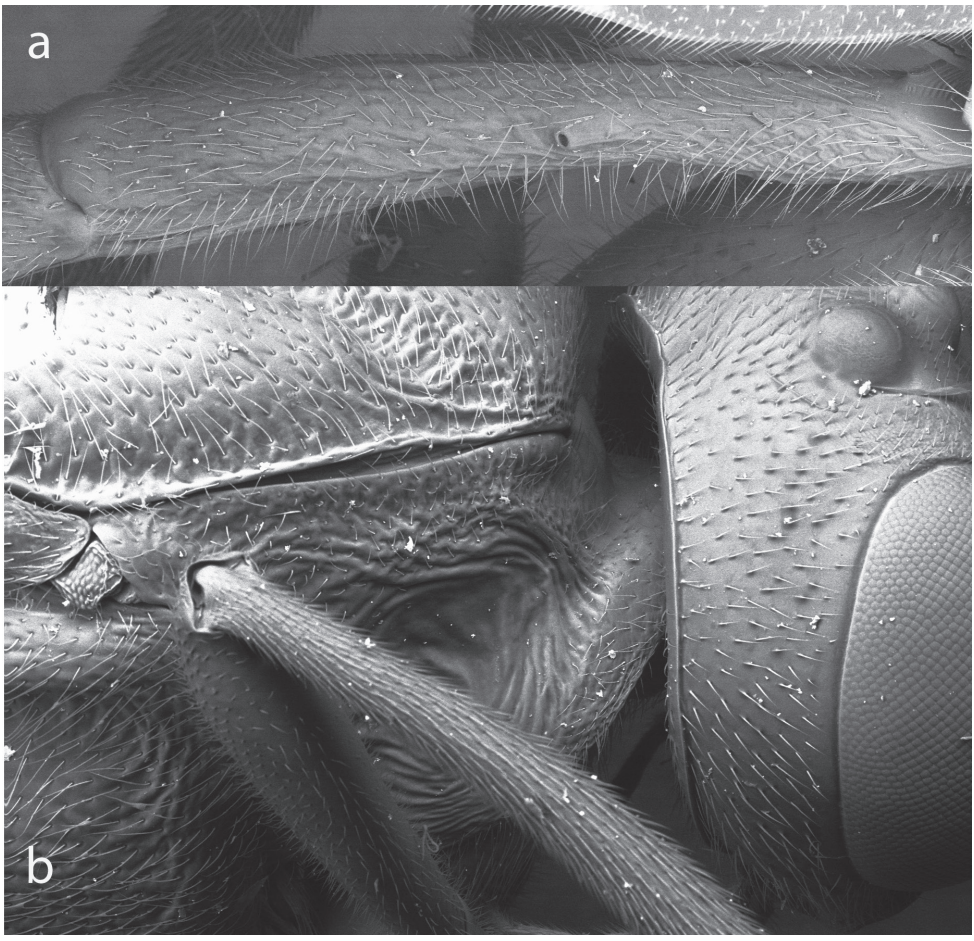


Figure 7. First tergite **a** and pronotum **b** of *Bicurta sinica*.

tion with short transverse wrinkles. Speculum relatively large. Mesosternum densely punctate. Median longitudinal suture of mesosternum distinct, slightly widening posteriorly. Metapleuron scabrous, with irregular, elongate punctures. Metasternum elongate, approximately 0.6 × as long as mesosternum, with distinct median longitudinal carina and irregular transverse wrinkles. Wing hyaline with slight grey tinge. 2*rs-m* basad 2*m-cu* by 0.66 × length of 2*rs-m*. Vein 2-*Cu* as long as 2*cu-a*. Hind coxa with distinct punctures. Ratio of length of hind tarsomeres 1:2:3:4:5 is 10.0:4.2:2.9:2.0:4.2. Propodeum between carinae with distinct transverse wrinkles. Propodeal spiracle 1.4 × as long as maximum width, distance to pleural carina approximately 2.6 × as long as distance to lateral longitudinal carina.

Metasoma. First tergum approximately 5 × as long as apical width, with longitudinal wrinkles, between wrinkles with punctures; without longitudinal carina; spiracle convex, located at basal 0.42. Second tergum about 2.0 × as long as apical width, slightly widened posteriorly, with sparse, indistinct punctures. Third tergum with even,

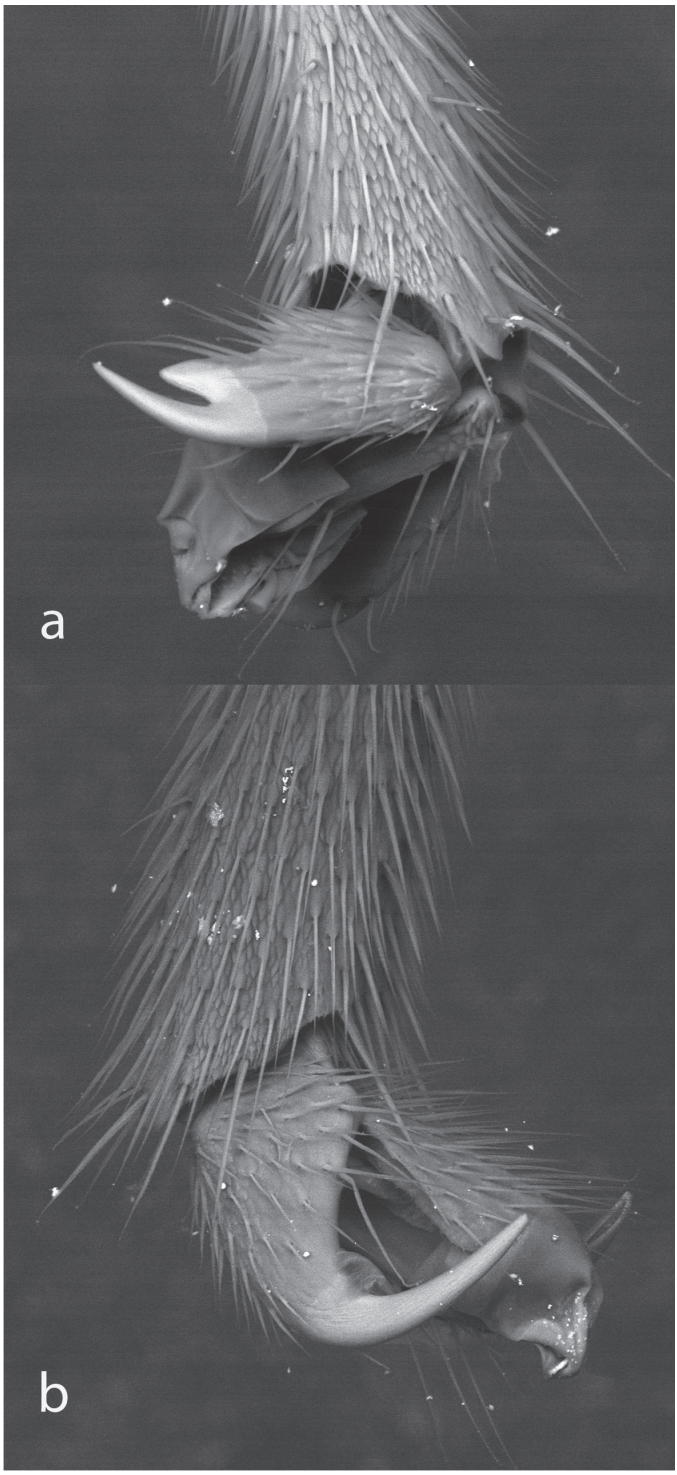


Figure 8. Fore claw **a** and hind claw **b** of *Bicurta sinica*.

Figure 9. Ovipositor of *Bicurta sinica*.

Figure 10. Face of *Bicurta sinica.*

Figure 11. Mesopleuron **a** and mesoscutum **b** of *Bicurta sinica*.

fine hairs, gradually weaker and indistinct posteriorly. Ovipositor sheath about 0.27 × as long as hind tibia. Ovipositor very slightly compressed.

Colour. Black. Ventral, inner orbits, clypeus, stripe passing through anterior tentorial pits, mandible except teeth, yellow; ventral profile of antenna brown to yellowish brown. Labial and maxillary palpi, fore and mid legs, trochantellus of hind leg, hind tarsomeres buff. Apex of hind coxa, ventral profile of trochanter of hind leg, basal and apical portion of hind femur brown. Basal 0.65 of hind tibia dull yellow, fading to dark brown apical 0.35. Tegula dark brown. Hind margins of terga 3 to 6 narrowly yellow. Wing venation, including pterostigma dark brown.

Etymology. Named after the country, China, where the unique specimen was collected.

Diagnosis. A distinctive species with the short, featureless ovipositor, rather massive hind leg, lobate fore and mid claws, short antennae and well-marked facial pattern.

Discussion

Unfortunately, nothing is known of the biology of *Bicurta sinica* sp. n. Where known, species of *Collyria* are koinobiont egg-larval endoparasitoids of stem-sawflies (Hymenoptera: Cephidae) (Salt 1931; Wahl et al. 2007). This is an unusual strategy within Ichneumonidae and presumably accounts for the distinctive ovipositor of *Collyria*; slender, lacking apical teeth or a notch but with serrations on the lower valves for cutting through grass stems. The slender, featureless ovipositor of *Bicurta* could well be indicative of oviposition into insect eggs, but this must remain as speculation for now.

An expanded phylogenetic matrix, encompassing the genera of Acaenitinae, could reveal some rather different patterns of relationships within the pimpliformes. Several acaenitine genera share character states with collyriines and some poemeniines, such as short antennae, a median tubercle on the clypeus, hind wing vein *Cu*1 originating close to *M* and the propodeum lacking transverse carinae, and it is interesting that various older authors included *Collyria* within the Acaenitinae (or equivalent grouping). Obviously, acaenitines have a distinctively apomorphic female hypopygium, very different to that of the Collyriinae, Poemeniinae or Rhyssinae.

Acknowledgements

We are grateful to Ling-Li Yi and Yi Li for their help in the course of exploration in Jiangxi Province. István Mikó (North Carolina State University) was very helpful in 'ontologising' the manuscript, providing the URIs in Table 2, suggesting the concepts that our terms referred to and highlighting various errors we had made. Andrew Bennett and an anonymous referee provided very useful criticism of the manuscript. This research was supported by the National Natural Science Foundation of China (NSFC, No. 30872035; No. 31110103062).

References

Bennett AMR (2001) Phylogeny of the Agriotypinae (Hymenoptera: Ichneumonidae), with comments on the subfamily relationships of the basal Ichneumonidae. Systematic Entomology 26: 329–356. doi: 10.1046/j.0307-6970.2001.00155.x

Burks RA, Heraty JM, Gebiola M, Hansson C (2011) Combined molecular and morphological phylogeny of Eulophidae (Hymenoptera: Chalcidoidea), with focus on the subfamily Entedoninae. Cladistics 27: 1–25. doi: 10.1111/j.1096-0031.2011.00358.x

Carlson RW (1979) Family Ichneumonidae. In: Krombein KV, Hurt PD, Smith DR, Burks BD (Eds) Catalog of Hymenoptera in America north of Mexico, Washington, 315–740.

Filipy FL, Burbutis PP, Fuester RW (1985) Biological control of the European wheat stem sawfly in Delaware (Hymenoptera: Cephidae). Environmental Entomology 14: 665–668.

Gauld ID (1985) The phylogeny, classification and evolution of parasitic wasps of the subfamily Ophioninae (Ichneumonidae). Bulletin of the British Museum (Natural History), Entomology 51: 61–185.

Gauld ID (1991) The Ichneumonidae of Costa Rica, 1. Memoirs of the American Entomological Institute 47: 1–589.

Gauld ID (1997) The Ichneumonidae of Costa Rica, 2. Memoirs of the American Entomological Institute 57: 1–485.

Gauld ID, Wahl DB (2006) The relationship and taxonomic position of the genera *Apolophus* and *Scolomus* (Hymenoptera: Ichneumonidae). Zootaxa 1130: 35–41.

Goloboff P, Farris J, Nixon K (2003) T.N.T.: Tree Analysis Using new Technology. Program and documentation, avaible from the authors, and at www.zmuc.dk/public/phylogeny/TNT (November 2009).

Humala AE (2003) [The Ichneumonid Wasps in the Fauna of Russia and Adjacent Countries: Microleptinae and Oxytorinae (Hymenoptera: Ichneumonidae)] Nauka, Moscow. [In Russian]

Kuslitzky VS, Kasparyan DR (2011) A new genus of ichneumonid flies of the subfamily Collyriinae (Hymenoptera: Ichneumonidae) from Syria and Israel. Zoosystematica Rossica 20: 319–324.

Matsumoto R, Broad GR (2011) Discovery of *Rodrigama* Gauld in the Old World, with description of two new species (Hymenoptera, Ichneumonidae, Poemeniinae). Journal of Hymenoptera Research 20: 65–75. doi: 10.3897/jhr.29.872

Nixon KC (1999) Winclada (BETA) ver. 0.9.9. Published by the author, Ithaca, N.Y.

Quicke DLJ, Laurenne NM, Fitton MG, Broad GR (2009) A thousand and one wasps: a 28S rDNA and morphological phylogeny of the Ichneumonidae (Insecta: Hymenoptera) with an investigation into alignment parameter space and elision. Journal of Natural History 43: 1305–1421. doi: 10.1080/00222930902807783

Salt G (1931) Parasites of the wheat-stem sawfly, *Cephus pygmaeus* Linnaeus, in England. Bulletin of Entomological Research 22: 479–545. doi: 10.1017/S0007485300035355

Smith CW (1931) Colonisation in Canada of *Collyria calcitrator* (Hym. Ichn.), a parasite of the wheat sawfly. Bulletin of Entomological Research 22: 547–550. doi: 10.1017/S0007485300035367

Townes HK (1971) Genera of Ichneumonidae Part IV. Memoirs of the American Entomological Institute 17: 1–372. doi: 10.1111/j.1365-3113.1986.tb00171.x

Wahl DB (1986) Larval structures of oxytorines and their significance for the higher classification of some Ichneumonidae (Hymenoptera). Systematic Entomology 11: 117–127. doi: 10.1080/00222939000770041

Wahl DB (1990) A review of the mature larvae of Diplazontinae, with notes on larvae of Acaenitinae and Orthocentrinae and proposal of two new subfamilies (Insecta: Hymenoptera, Ichneumonidae). Journal of Natural History 24: 27–52.

Wahl DB (1991) The status of *Rhimphoctona*, with special reference to the higher categories within Campopleginae and the relationships of the subfamily (Hymenoptera: Ichneumonidae). Transactions of the American Entomological Society 117: 193–213.

Wahl DB, Gauld ID (1998) The cladistics and higher classification of the Pimpliformes (Hymenoptera: Ichneumonidae). Systematic Entomology 23: 299–303. doi: 10.1046/j.1365-3113.1998.00057.x

Wahl DB, Shanower TG, Hoelmer KA (2007) A new species of *Collyria* Schiødte (Hymenoptera: Ichneumonidae: Collyriinae), a parasitoid of *Cephus fumipennis* (Hymenoptera: Cephidae) in China, and potential biological control agent for *Cephus cinctus* in North America. Journal of the Kansas Entomological Society 80: 43–50. doi: 10.2317/0022-8567(2007)80[43:ANSOCS]2.0.CO;2

Yoder MJ, Mikó I, Seltmann KC, Bertone MA, Deans AR (2010) A gross anatomy ontology for Hymenoptera. PLoS ONE 5: e15991. doi: 10.1371/journal.pone.0015991

Yu D, van Achterberg C, Horstmann K (2009) World Ichneumonoidea 2008. Taxonomy, biology, morphology and distribution. [CD/DVD]. Taxapad®, Vancouver, Canada. [Available at http://www.taxapad.com].