Systematics and host associations of the Australian *Gasteruption* (Gasteruptiidae: Evanioidea)

Gasteruption longicolle Schletterer

Ben A. Parslow

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ABSTRACT

The wasp genus *Gasteruption* (Gasteruptiidae: Gasteruptiinae) is found in all biogeographical regions with approximately 514 described species world-wide. Their larvae are considered predator-inquilines in the nest of aculeate Hymenoptera, but these records are often conflicting isolated observations. The Australian fauna is considered the most diverse with 114 described species, however, little taxonomic work exists for the genus since the last formal revision in 1957. Additionally, there has been a paucity of molecular research on the genus with no exploration into evolutionary relationships. In this thesis of work, I summarise all available information on the biology and host association of the *Gasteruption*, providing insights into the specialisation and patterns of host utilisation across the world-wide distribution of the genus. Correct identification of both parasite and host are extremely important to further explore relationships; this was evident when reviewing the literature as the majority of Australian records are without species identification due to the current state of the taxonomy. A revision of the Australian fauna was conducted to allow further identification of Australian species. Here I redescribe 90 species, including descriptions for three new species and provide an identification key to treated species. Unfortunately, there are many missing type specimens and some species are only known from males, making identification difficult. To provide additional identification tools I assembled a DNA barcode dataset of 187 sequences from a combination of publicly available sequences and newly sequenced material for the Gasteruptiidae. I tested six molecular species delimitation methods and found tree-based methods effective at delineating species. However, there is still a large unknown Australian diversity, with many species represented by only a single specimen. These single gene trees effectively informed species boundaries among closely related species but have limited reliability for deeper phylogenetic relationships. To explore the evolutionary relationships within the family, I used three gene fragments with an emphasis on the *Gasteruption*. These results suggest the crown age for *Gasteruption* is younger than previously suggested with support indicating the group initially radiated from the Australasian region and coincides with the radiation of their known bee hosts. There are limitations with the produced multilocus phylogeny with low support recovered within the main *Gasteruption* clade. To improve resolution, I used target capture of ultraconserved elements and increased taxon sampling across biogeographic regions and within the Gasteruptiinae. These data produced a better resolved phylogeny with increased support at basal nodes, providing a robust framework for future exploration of evolutionary relationships within the *Gasteruption*. This research provides the first major contribution to the Australian *Gasteruption* in over 60 years, with a complete review of biology, a treatment of species and the exploration of evolutionary relationships.

DECLARATION

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university. To the best of my knowledge and belief, this thesis does not contain any material previously published or written by another person except where due reference is made in the text.

I acknowledge that copyright of published works contained within this thesis resides with the copyright holder(s) of those works.

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Ben Allan Parslow

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I wish to thank all the entomological collections and their managers who throughout my chaotic journey through the Gasteruptiidae where able to host me and support me in the collections. Of all the collections where I spent time, most importantly, I would like to thank the South Australian Museum, where in my eyes I became a real entomologist and was able to make the collection my second home.

I am grateful for the friendship, support and encouragement from the members of the LEGS research group (Flinders University), the Austin Lab (University of Adelaide) and Paton lab (University of Adelaide), in particular Hayley Merigot, Robert O'Reilly, James Dorey and Lucas Hearn, who have continued to tolerate my constant chats and joining me for a regular lunch made the harder days bearable. I wish to thank the wonderful entomologists who have inspired me to be a better scientist, Olivia Davies, my office mate and friend, who without I would never have solved the problems of the world through idle chat at our desks. Erinn Fagan-jeffries for being an inspiring scientist and supportive friend, when I grow up, I want to be just like you. Maddi Giannotta, the original Austin spy who always believed in the project. Remko Leijs, your mentoring during fieldwork and lengthy chats about host associations helped me to think about bees as more than just hosts, and Ritchard Glatz, an inspiration in the field and who's personal collection contains the best curated selection of Gasteruptiidae I will ever see.

If I am giving credit for support and aid during my PhD, it would be amiss not to mention the No Sleep Podcast (Creative Reason Media inc.), without it I would have surely gone mad examining hundreds of wasps in quiet rooms of museums and been lost in my thoughts during long commutes.

I wish to thank my parents, Janine and Wayne, for the support and encouragement throughout my journey. You have from the start, nurtured my passion for entomology and through countless pet insects and a freezer full of insect specimens, provided the best starting point I could have ask for. A huge thanks to Tina and Kevin, my partners family, for all the identification requests and the continued support throughout the research project.

Most importantly I would like to thank my beautiful partner Nadia Meakin, you have been through the worst of it, putting up with my strange work hours, the regular hikes and dog walks where I stop every five minutes to collect an insignificant wasp. I have appreciated everything you have done during this time; this thesis is for you.

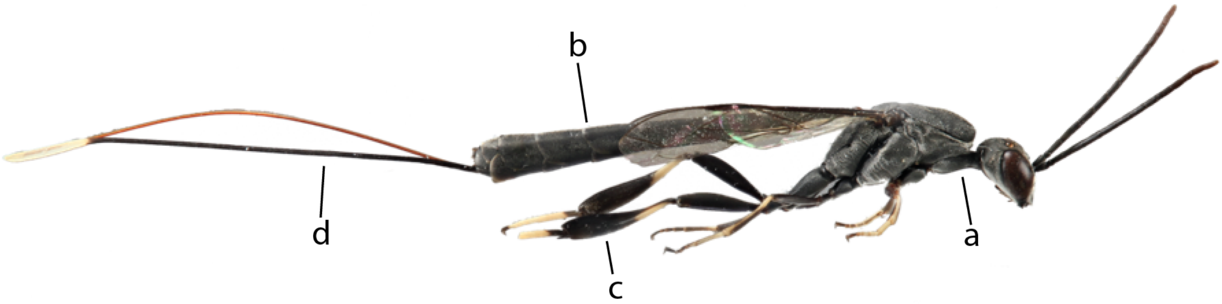
CHAPTER I: GENERAL INTRODUCTION

The Hymenoptera is an incredibly diverse order of insects containing sawflies, ants, bees and wasps. It is currently considered the most specious order of animals on Earth (Forbes *et al.* 2018) with over 150,000 species formally described (Huber 2009; Aguiar *et al.* 2013). Within the Hymenoptera, the paraphylum Parasitica (commonly referred to as ‘parasitic wasps’) are some of the most diverse and arguably most important assemblages of Hymenoptera, preforming ecological roles as pollinators, predators and parasitoids. An important aspect of their life histories are their associations with specific hosts and how this is reflected in their overall life cycle and morphological adaptations. Despite their ecological importance many families of parasitoid wasps are often understudied leading to an underestimation of their biodiversity and biology.

The Gasteruptiidae are a distinctive family within the superfamily Evanioidea, comprised of two extant subfamilies, Hyptiogastrinae and Gasteruptiinae, and the extinct subfamily Kotujellitinae (Rasnitsyn 1991). The family has a cosmopolitan distribution and 514 described species; however, the estimated true diversity of the family is likely closer to ~1500 species (Jennings and Austin 2002). The subfamily Hyptiogastrinae has been subject to extensive taxonomic revision resulting in two stable monophyletic genera, *Hyptiogaster* Kieffer and *Pseudofoenus* Kieffer (Jennings and Austin 1997; Jennings and Austin 2002; Parslow and Jennings 2018). The subfamily Gasteruptiinae comprises four genera; three small genera restricted exclusively to the Neotropical region, *Plutofoenus* Kieffer, *Spinolafoenus* Macedo, *Trilobitofoenus* Macedo (Macedo 2009) and the larger cosmopolitan genus *Gasteruption* Latreille (418 spp. worldwide) (Aguiar *et al.* 2013; Tan *et al.* 2016; Parslow *et al.* 2018).

Gasteruption adults are easily recognised when compared to other hymenopterans, by the combination of the superficial characters, a elongate neck-like propleura (Fig. 1a), slender subclavate metasoma inserted high on the propodeum (Fig. 1b), clavate hind tibia (Fig. 1c) and in females, an exserted ovipositor (Fig. 1d) (Jennings and Austin 2002). Allthough there has been limited exploration of morphology across the genus, characters which have been proposed as autapomorphies for the group are;

clavate hind tibia (Crosskey 1962; Macedo 2009), occipital carina complete, encircles foramen magnum (Vilhelmsen 2011) and position of insertion point of



metasoma on propodeum adjacent to antecostal sulcus (Vilhelmsen *et al.* 2010). Although they have been extensively collected with an abundance of material available in collections, they have been poorly studied. From the literature there is conflicting information on the biology of the genus, their taxonomy is outdated in Australia, and the genus has been underrepresented in molecular studies.

Figure 1. *Gasteruption peregrinum* Schletterer. a, elongate neck-like propleura. b, slender subclavate metasoma inserted high on the propodeum. c, clavate hind tibia. d, exserted ovipositor.

Our knowledge of the biology and host associations in *Gasteruption* is sparse, with often brief, conflicting observations on hosts with no information of mating behaviour. From published records, larvae are considered predator-inquilines (larvae act as predators in the nest of a host) in the nest of aculeate Hymenoptera (Jennings and Austin 2002). Host records are available for bees in the families Apidae, Colletidae, Halictidae and Megachilidae and wasp from the families Crabronidae**,** Vespidae, and a single record for Sphecidae. There is no current consensus on the specifics of host use, if patterns exist across the genus distribution or if wasps are truly a host for the genus.

Added to the sparsity of host information; the taxonomic history of *Gasteruption* has been convoluted, initially separated into five genera (*Dolichofoenus* Kieffer*,* *Rhydinofoenus* Bradley, *Trichhofoenus* Kieffer, *Plutofoenus* Kieffer) based on morphological characters without sufficient validity to separate them from *Gasteruption* (Crosskey 1962). Crosskey (1962) considered the morphological variation among the species to be continuous and synonymised the additional genera. Macedo's (2009) work revalidated *Plutofoenus* Kieffer and erected the two small genera *Spinolafoenus* Macedo and *Trilobitofoenus* Macedo exclusively from the Neotropical region. The majority of the *Gasteruption* fauna was originally described during the 19^{th} century by naturalists with revisions of North America (Townes 1950; Smith 1996), Sub-Saharan Africa (Pasteels 1958b, 1962), Eastern Europe (East Germany (Oehlke 1984), Austria (Madl 1987), Yugoslavia (Madl 1989) Greece (Madl 1990)), South-eastern Asia (Pasteels 1958a), Melanesia (Pasteels 1956) and New Zealand (Pasteels 1957a). More recent taxonomic works have increased our knowledge of South and Central America (Macedo 2011), Western Europe (Netherlands (van Achterberg 2013) Yugoslavia (Zikic *et al.* 2014)), Western Asia (Iran and Turkey (van Achterberg and Talebi 2014) and the United Arab Emirates (Saure *et al.* 2017)), Eastern Asia (China (Zhao *et al.* 2012; Tan *et al.* 2016), Melanesia (New Caledonia (Jennings *et al.* 2015) and Fiji (Parslow *et al.* 2018)). However, the Australian *Gasteruption* fauna is currently in a state of neglect with the last taxonomic treatment of the genus in Australia conducted by Pasteels (1957). The current diversity is 114 described species (Pasteels 1957b; Jennings and Parslow 2014) with a large number of undescribed species expected as large parts of Australia were not explored during Pasteels work, who commented on the Northern Territory fauna being less known than the nearby Melanesian fauna (Pasteels 1957b).

Although the taxonomy of the genus has steadily been resolved there has been little exploration of the evolutionally relationships. The few studies with any resolution of *Gasteruption* have been purely morphology-based cladistic analyses based on the family (Jennings and Austin 2000; Macedo 2009), highlighting the paucity of phylogenetic studies for the genus. The genus has been largely neglected in molecular phylogenetic research, with the current literature restricted to several taxa often used as outgroups in examination of other families (e.g. Deans *et al.* 2006; Klopfstein *et al.* 2018; Sharanowski *et al.* 2019) or in large scale datasets examining higher hymenopteran relationships (e.g. Carpenter 1999; Dowton and Austin 2001; Heraty *et al.* 2011; Klopfstein *et al.* 2013; Peters *et al.* 2017). There is great potential to apply modern molecular techniques to provide a robust phylogeny and further explore the evolutionary relationships of the genus.

This thesis aims to address these gaps in the systematics and host associations of the Australian *Gasteruption* by concatenating information of the host associations in the genus, reviewing the Australian fauna and exploring the evolutionary relationships of the genus using molecular techniques.

Organisation of this thesis

This thesis contains five data chapters (Chapter 2–6), each chapter was written as a stand-alone publication; therefore, an individual bibliography is presented at the end of each chapter instead of at the end of the thesis. Formatting of each chapter has been standardised for the journal of publication. Figures are included in the text where appropriate for readability and supplementary material included at the end of each chapter. Due to the stand-alone nature of each chapter, naturally there will be some unavoidable repetition in introductory and methodological components.

The following paragraphs summarise each data chapter, detail author contributions and the current state of publication.

CHAPTER II: Review of the biology and host associations of the wasp genus *Gasteruption* (Hymenoptera: Evanioidea: Gasteruptiidae)

There is a clear lack of information on the host associations in *Gasteruption* with often conflicting observations of host identification and confidence in observations. This chapter aimed to review all available literature on the biology, larval development and host associations for the genus across its cosmopolitan distribution. These data highlight *Gasteruption* host use of the major bee families, Apidae, Colletidae, Halictidae and Megachilidae; and wasp families Crabronidae, Vespidae and Sphecidae. The vast majority of records are bee hosts when compared to wasps, with hosts nesting mainly in stems and wood compared to ground nests. I reveal a bias in observations from the Palaearctic region were the majority of the research on the genus has been conducted with a severe absence of observations from other regions.

The project was conceptualised by Ben Parslow (BAP) who reviewed the literature and concatenated the data and prepared the manuscript. The work was performed under the supervision of Michael Schwarz (MPS) and Mark Stevens (MIS). A version of this chapter has been published in the Zoological Journal of the Linnean Society (doi:10.1093/zoolinnean/zlaa005.)

CHAPTER III: Review of the Australian *Gasteruption* (Hymenoptera: Evanioidea: Gasteruptiidae) with description of three new species

The Australian *Gasteruption* fauna has not been formally revised since its original treatment by Pasteels in 1957. The current available descriptions are considered brief by modern standards with the key and description only available in French. In this chapter I aim to review the Australian *Gasteruption* fauna with the description of three new species. I also provide an updated diagnosis for the genus, an identification key to adult females and redescriptions of 90 species.

The projects conceptualisation, data collection and analysis were done by BAP under the guidance of John Jennings (JTJ), MPS and MIS. Manuscript preparation was done by BAP. The work was performed under the supervision of MPS and MIS. A version of this chapter has been formatted and will be submitted for publication in *Zootaxa.*

CHAPTER IV: Molecular diversity and species delimitation in the family Gasteruptiidae (Hymenoptera: Evanioidea)

Extreme morphological uniformity of *Gasteruption* has been suggested to make identification difficult, therefore, I wanted to examine the utility of *COI* barcoding fragments for species delimitation and explore molecular diversity between genera in the family. Using a dataset of 187 sequences and six molecular species delimitation methods I determined that tree-based species delimitation methods preformed the best for separating species across the group. I suggest that molecular species delimitation is a powerful tool to assist in the discovery of new species and help direct informed decisions with taxonomic uncertainty in the family.

The project was initially conceptualised by BAP and MIS, data collection and analyses were done by BAP with the guidance of all authors at different stages. Manuscript preparation was done by BAP. The work was performed under the supervision of MPS and MIS. A version of this chapter has been published in *Genome* (doi:10.1139/gen-2019-0186).

CHAPTER V: Phylogeny and divergence estimates for the Gasteruptiidae (Hymenoptera: Evanioidea) reveals a correlation with hosts

There has been minimal molecular research on the family and as a result limited understanding of the evolutionary relationships within the genus. This chapter presents the first multilocus phylogeny for the family with an emphasis on the Australian *Gasteruption* fauna. We explore the monophyly of the genera, estimate divergence ages for major clades and make suggestions for the ancestral biogeography of the family.

The project was initially conceptualised by BAP and JTJ. Data collection and analysis was done by BAP with guidance from all co-authors. Manuscript preparation was done by BAP. The work was performed under the supervision of MPS and MIS. A version of this chapter has been published in *Invertebrate Systematics* (doi:https://doi.org/10.1071/IS19060).

CHAPTER VI: Phylogenomics of the family Gasteruptiidae (Hymenoptera: Evanioidea)

I found limitations with the produced multilocus phylogeny presented in Chapter V, with low support recovered for many basal nodes within the main *Gasteruption* clade, and lack of taxa representation for some biogeographical regions. I explore the phylogenetic relationships within the family using phylogenomic techniques, provide a well-supported tree with more extensive sampling in an attempt to better resolve the evolutionary history of the group compared to Chapter V. We also discuss the utility of ultraconserved elements (UCEs) for museum material which may have degraded DNA not suitable for other sequencing techniques.

The project was initially conceptualised by BAP in addition to manuscript preparation and the majority of data collection. Emily A. Sadler conducted the wet lab protocols and assisted with bioinformatics, with Juanita Rodriguez assisting with phylogenetic tree construction and analysis. The work was performed under the supervision of MPS and MIS. A version of this chapter has been formatted and will be submitted for publication in *Systematic Entomology.*

I conclude the thesis with a general discussion, exploring the primary findings and suggestions for future research.

APPENDICES

Three additional published manuscripts were undertaken during my doctorate and are included in the Appendices. Although not included in the thesis these publications provide additional knowledge for the biology and systematics of Gasteruptiidae.

Appendix I. Comprises the manuscript 'First record of *Gasteruption* Latreille (Hymenoptera: Evanioidea: Gasteruptiidae) from Fiji with the description of a new species' published in the journal *Zootaxa* (4407, 111–116.). This manuscript was the result of the discovery of the first record of the genus *Gasteruption* from the Fijian archipelago, my familiarity with the Australian fauna allowed us to describe it as a new species.

Appendix II. Includes the manuscript 'A new species of the endemic Australian genus *Hyptiogaster* Kieffer (Hymenoptera: Gasteruptiidae)' published in the journal *Zootaxa* (4379, 145–150.), which was the description of a unique species of *Hyptiogaster* from the Northern Territory found during examination of *Gasteruption* material from the Museum and Art Gallery of the Norther Territory.

Appendix III. Consists of the manuscript 'Reproductive ethology of the Fijian predator-inquiline wasp *Pseudofoenus extraneus* (Hymenoptera: Gasteruptiidae: Hyptiogastrinae)' published in the journal *Transactions of the Royal Society of South Australia* (142, 122–129.) which was a result of a Flinders University 3rd year student research project based in Fiji and focused on parasite host relationships.

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CHAPTER II: REVIEW OF THE BIOLOGY AND HOST ASSOCIATIONS OF THE WASP GENUS *GASTERUPTION* (HYMENOPTERA: EVANIOIDEA: GASTERUPTIIDAE)

BEN A. PARSLOW[1*], MICHAEL P. SCHWARZ[1], MARK I. STEVENS[2, 3]

[1] *Biological sciences, College of science and engineering, Flinders University, Adelaide, SA 5042, Australia.*

[2] *South Australian Museum, North Terrace, GPO Box 234, Adelaide, SA 5000, Australia.*

[3] *School of Pharmacy and Medical Sciences, University of South Australia, Adelaide, SA, Australia*

[*] *Corresponding author:* ben.parslow3@gmail.com

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Abstract.

Gasteruption is an easily recognized genus of wasps whose larvae are predator-inquilines in the nests of cavity-nesting solitary bees (Apidae, Colletidae, Halictidae and Megachilidae) with some records for solitary wasp hosts (Crabronidae**,** Vespidae and Sphecidae). There is conflicting information about the biology and host associations for the genus with a lack of information for the majority of the world's biogeographical regions. Here we concatenate all available literature records pertaining to the biology of adults, host associations and larval development. We conclude that bee hosts are more readily utilized when compared to wasp hosts (71 bee, 13 wasp species), with the majority of wasp observations without sufficient data to be confident of the host association. The majority of known records are for hosts nesting in cavity nests (76 species) over ground nests (8 species) with most species recorded from a single host association. From data available, approximate rates of host nests with parasitised brood is low, between 4-7%. We also provide suggestions for improving the quality of future observations in the group.

Introduction

Parasitoid wasps are some of the most diverse and arguably important assemblages of Hymenoptera, playing important ecological roles as pollinators, predators and parasitoids. An important aspect of their life histories are their associations with specific hosts and how this is reflected in their overall life cycle and morphological adaptations. Our knowledge of host association in well studied groups like Ichneumonoidea (Gauld 2008) and Chalcidoidea (Heraty 2003) is extensive yet, there are still many hymenopteran groups with limited information on biology and host associations. Such data are important when parasitoids are associated with hosts of high economic (e.g. Aphids (Hǻgvar & Hofsvang 1991)) and ecological (e.g. cavity nesting pollinators (Tscharntke *et al.* 1998)) significance.

Gasteruptiidae is a distinctive family of wasps, that can be easily recognized by the combination of a slender, subclavate metasoma inserted high on the mesosoma, elongate, neck-like propleuron, and clavate hind tibia (Jennings & Austin 2002; Mikó *et al.* 2019). Their larvae are considered predator-inquilines in the nests of solitary bees and wasps (Jennings & Austin 2004). The family Gasteruptiidae is comprised of two extant monophyletic subfamilies: the Hyptiogastrinae with two genera *Hyptiogaster* Kieffer (11 species) (Jennings & Austin 1997; Parslow & Jennings 2018) and *Pseudofoenus* Kieffer (78 species) (Jennings & Austin 2002), and the Gasteruptiinae with four genera - *Plutofoenus* Kieffer (3 species), *Spinolafoenus* Macedo (1 species), *Trilobitofoenus* Macedo (3 species) (Macedo 2009), and *Gasteruption* Latreille. *Gasteruption* is the most speciose genus, found in all zoogeographical regions (excluding Antarctica) with 509 described species (Jennings *et al.* 2015; Saure *et al.* 2017; Parslow *et al.* 2018). Recent taxonomic treatments of regional fauna have greatly increased our knowledge of the biodiversity of the genus *Gasteruption* (van Achterberg & Talebi 2014; Johansson & van Achterberg 2016; Tan *et al.* 2016) but there is limited and often conflicting information about their biology and life histories.

The biology and host associations of the Gasteruptiidae has been previously reviewed by Jennings and Austin (2004) but since then significant new information has been collected. This review summarizes available *Gasteruption* host association information, collating data on biology, larval development and rates of parasitism. Finally, we provide suggestions for future work to better document host associations in the genus.

Adult biology

Adult *Gasteruption* species can be locally abundant during active seasons, where they can be encountered near host nesting sites and collected visiting floral resources with easily accessible nectar, especially Myrtacceae in Australia and Apiacae in the Palaearctic region (Crosskey 1962; Jennings & Austin 2004). Jennings & Austin (2004) examined *Gasteruption* mouthparts for pollen and noted it is likely that adults feed on both nectar and pollen, although more field observation and/or gut contents analyses are needed to see if this is widespread. As adult wasps are usually collected while feeding at floral resources, directly swept roosting on foliage or using mass collection techniques (Jennings & Austin 2004), there is limited information on the biology and no published information on the mating behavior of *Gasteruption.* A number of species-specific studies suggest that *Gasteruption* can be multivoltine, for example *G. caffrarium* (Skaife 1953)*,* and *G. nigrescens*, *G. freyi*, *G. merceti* , *G. assectator, G. jaculator* (Malyshev 1964, 1966) have all been recorded as having two generations per year (but several of the species identified by Malyshev (1964, 1966) have since been synonymized, see Table 1). Voltinism will likely vary with latitude and host biology, but this has not been explored in comparative studies.

Host Associations

Host associations in *Gasteruption* are poorly documented, but all available records indicate their larvae are predator-inquilines in the nests of cavity nesting solitary bees and wasps (Jennings & Austin 2004). The larvae predate the host egg or developing larvae before consuming the provisions (pollen stores in the case of bee hosts or paralyzed invertebrates for wasp hosts) which the host has provided for its developing young (Höppner 1904; Crosskey 1962). Available host records for *Gasteruption* are cavity nesting bees from the families Apidae (*Ceratina* and *Xylocopa*), Colletidae (*Amphylaeus*, *Callomelitta*, *Colletes*, *Euryglossa, Euryglossina*, *Euryglossula, Heterohesma*, *Hylaeus*, *Hyleoides*, *Meroglossa, and Pachyprosopis*), Halictidae (*Lasioglossum, Rophites* and *Systropha*) and Megachilidae (*Ashmeadiella*, *Chelostoma*, *Heriades, Hoplitis, Megachile*, *Osmia*, and *Pseudoanthidium*) with records for solitary wasp hosts including Crabronidae (*Lestica*, *Lestiphorus, Passaloecus*, *Pemphredon* and *Trypoxlon*), Vespidae (Eumeninae: *Antepipona, Eumenes, Odynerus, Paralastor*, and *Symmorphus*) and a single record for Sphecidae (*Sceliphron*). Summarised in table 1 we have collated host records for 40 described species of *Gasteruption* associated with 84 host species from 158 records. Unsurprisingly, there is a regional bias of number of host records towards the biogeographical locations where historically the majority of

Gasteruption research has been undertaken (Table 2). The vast majority of host observations are from the Palaearctic region with 48 described host species from 101 records, followed by the Australian region with 17 described species from 24 records and Afrotropical region with 11 described species from 21 records. There are five described species for eight records from the Nearctic region with four described species from five records in the Neotropical region. This highlights the deficiency of information for biogeographical regions with high species diversity (Australian and Afrotropical regions with 114 and 77 described species, respectively) and complete absence of data for the Indian subcontinent, South-eastern Asia and the Indo-Papuan region. There is also a bias towards specific host groups in different regions, for example there are extensive records of Xylocopinae hosts from the Afrotropical region because of the extensive work on this bee subfamily (Daly *et al.* 1967; Daly 1988; Eardley & Daly 2007). Regional biases in research effort are a potentially major problem when trying to understand the evolution of the host range of *Gasteruption*.

Bees as hosts

From the data it is clear bees from the four large families, Apidae, Colletidae, Halictidae and Megachilidae make up the majority of *Gasteruption* host records, with a total of 71 species of bee hosts compared to 13 species of wasp hosts (see Table 2). Host use of colletid bees is the most abundant with 36 host species (70 records), while the subfamily Hylaeinae representing the majority of these records (26 described host species) and only 10 species recorded for other colletid subfamilies. A potential reason for the large number of *Hylaeus* records is the ease of observations and ability to check stem nests for parasitoid larvae and host remnants. In comparison, most other colletid bees are ground-nesting, therefore the excavation of nest sites and often sifting of soil to obtain larval material increased the difficulty to validate observations. Megachilidae are the next most utilized hosts with 17 described species (from 32 records), followed by Apidae with 14 species (from 23 records). *Ceratina* is the main apid host genus representing 11 described species (from 13 records) with the other three described host species (from four records) in the genus *Xylocopa*. The bee family Halictidae has the smallest number of records with only four species (from four records), all restricted to a single *Gasteruption* species (*G. hastator*). This species has been observed flying slowly at ground level above nests of a large aggregation (>1,000 nest) of *Lasioglossum malachurum* in Italy (Polidori *et al.* 2009; C. Polidori 2018, pers. comm.). These reports did not however indicate whether other hymenopteran species were nesting at this site, so it is possible that *L. malachurum* was not the actual host. There have been observations of *G. hastator* at nesting aggregations of the halictid bees *Systropha curvicornis, Systropha planidens* and *Rophites algirus*. In all cases the wasps were observed flying low over the nesting site and roosting overnight in the vicinity (Westrich 1989; Westrich *et al*. 1992), but no direct observations of nest entering were recorded. It is important to note that there have been observations of an undetermined *Gasteruption* species at low abundances (5-6 individuals) in Spain flying above nests of species of *Lasioglossum* (aggregation ~200 nests), but with no record of nest entry or parasitism (C. Polidori 2018, pers. comm.). It is unusual that *G. hastator* is the only species of *Gasteruption* to utilize halictine bees as they are readily parasitised by other hymenopterans (e.g. *Myrmilla*: Mutillidae and *Sphecodes*: Halictidae (Polidori *et al.* 2009)) and gasteruptiids (*Pseudofoenus*:

Hyptiogastrinae (Grieve *et al.* 2018)). More observations of adult wasps at nesting aggregations and nest excavations will be needed to check the validity of Halictidae as a host for *Gasteruption* as all current observation lack conclusive detail.

Wasps as hosts

The wasp families Crabronidae and Vespidae have both been recorded as hosts for *Gasteruption*, although some authors have suggested there is only indirect evidence for wasps as hosts (; Malyshev 1964; Oehlke 1984; Saure 2006; Zhao *et al.* 2012; van Achterberg 2013; van Achterberg & Talebi 2014; van Breugel 2014; Zikic *et al.* 2014; Tan *et al.* 2016; Bogusch *et al.* 2018). Malyshev (1964) examined artificial trap nests inhabited by bees and solitary wasps (*Trypoxylon*, *Ancistrocerus*, *Microdynerus, Cemonus*, *Psenulus* and *Pseudagenia*) and found no indication of *Gasteruption* larvae in wasp cells, suggesting wasp host records could be based on chance observations that are frequently contradictory. Similarly, research on *Lipara*-induced galls in reeds (*Phragmites australis*) initially suggested *Pemphredon fabricii* as a host for three species of *Gasteruption* (*G. assectator, G. nigrescens and G. phragmiticola*) (Bogusch *et al.* 2016), but further recent observations of these galls suggest observations of host use of *P. fabricii* by *Gasteruption* are coincidental where bee host nests have been superseded inside the same gall (Bogusch *et al.* 2018). It should be noted there is a tendency for *Gasteruption* larvae to consume all remnants of host larvae and nesting provisions (Bogusch *et al.* 2018). This behavior combined with observations of larvae invading neighboring cells could result in the larvae consuming wasp hosts as secondary provisions, leading to mistakes based on where the larvae are found in a host nest. The uncertainty of wasps as a host for

Gasteruption indicate that caution should be taken with observations from mixed nesting assemblages, as misidentified host associations due to nest supersession can be confounding. Misidentification of hosts has potentially important consequences for understanding larval development: for *Gasteruption* species that are predator-inquilines of bees, larvae require adaptations that allow feeding on pollen, whereas species that utilize wasp hosts would require adaptations for feeding on arthropod provisions only. It is unknown if the switch between a pollen diet and an arthropod diet is evolutionarily difficult, but better knowledge of host associations combined with a robust phylogeny would allow this to be explored.

Cavity versus ground nesting hosts

Published hosts records for *Gasteruption* suggest a preference for hosts nesting in cavities above ground (e.g. unused borer holes in dead wood, pithy plant stems and reed galls) with only a small number (10 of 149 recorded hosts) of hosts nesting in the ground (e.g. vertical loess or sand walled burrows in friable soil and horizontal burrows in clay banks) (Table 1). However, as previously discussed there may be a regional bias towards above ground cavity nesting hosts; nearly all ground nesting hosts are recorded from the Palaearctic region (where the majority of total host association are recorded), with a single published record from Australia (*G. youngi* attacking the euryglossine bee *Euryglossula microdonta*; Jennings & Parslow 2014). Published ground nesting host records from the Palaearctic region are restricted to Halictidae (*Lasioglossum malachurum*, *Rophites algirus*, *Systropha curvicornis* and *Systropha planidens*), Colletidae (*Colletes daviesanus*) with single observations for Crabronidae (*Lestica subterranea*) and Vespidae (*Antepipona laevigata*).

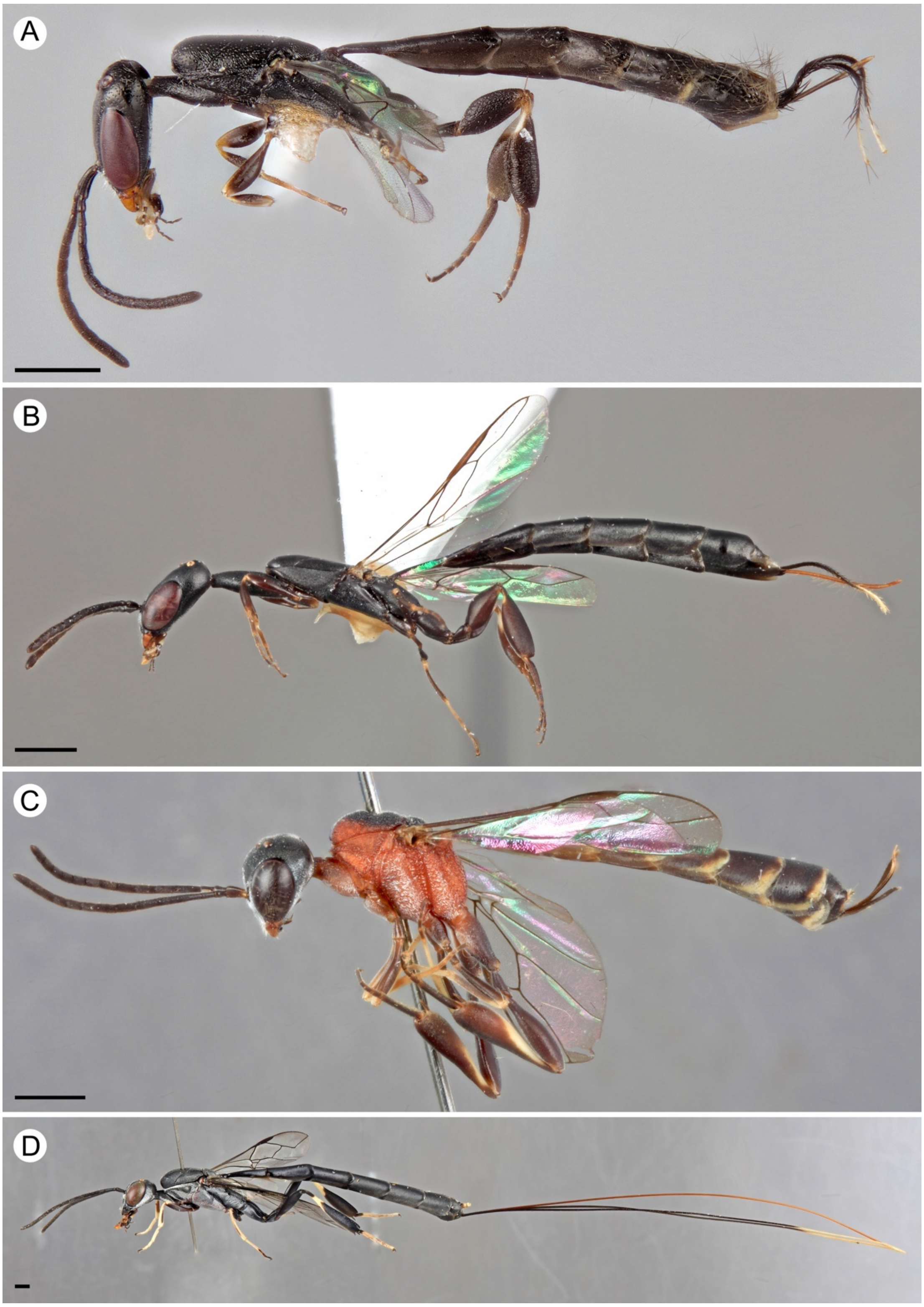

Figure 1. Lateral habitus of four Australian species of *Gasteruption* to comparing general body shape. A, *Gasteruption youngi* Jennings & Parslow, B, *Gasteruption cylindricum* Turner, C, *Gasteruption zebroides* Pasteels, D, *Gasteruption primotarsale* Pasteels. Scale bar = 1.0mm

Several species (*G. assectator, G. nigritarse, G. minutum* and *G. laticeps*) have been observed searching for nests on loess sand walls (P. Bogusch 2019, pers. comm.). These host records entail limited information with only the records for Halictidae and the species *Colletes daviesanus* detailing females observed at nesting sites with direct interaction. In general, there is very limited information for observations of *Gasteruption* utilizing ground nesting hosts with all observations only pertaining to wasps being in the vicinity of nesting sites.

There is distinct contrast between host nesting biology within the family Gasteruptiidae. Records suggest *Gasteruption* mainly attack cavity nesting hosts, while the sister subfamily Hyptiogastrinae (genera *Hyptiogaster* and *Pseudofoenus*) are restricted to ground nesting Hymenoptera (bees: Colletidae, Halictidae, Stenotritidae, and wasps: Masarinae) with their larvae considered to be predator-inquilines of the host eggs, larvae and nest provisions, similar to *Gasteruption* (Jennings & Austin 2004; Grieve *et al.* 2018). With a clear difference in host nesting biology, we suggest based on morphological differences between the subfamilies, that Hyptiogastrinae are more suited to exploit ground nesting hosts. As an example, *Pseudofoenus* and *Hyptiogaster* have long overlapping mandibles, well developed tibial spurs and claws (Jennings & Austin 2002) which we suggest are used for digging. In *Pseudofoenus*, a concealed ovipositor at rest allows the parasitoid increased mobility in ground nests, where nest structure can be highly variable in nest depth and topology (Jennings & Austin 2002; Grieve *et al.* 2018). In comparison, most species of *Gasteruption* have short non-overlapping mandibles, tarsus without elongated claws or spurs and always have exserted ovipositors (in many species greater than the length of the metasoma) (Crosskey 1962; Jennings & Austin 2002). The differences in morphology may suggest a host switching event involving the divergence between Hyptiogastrinae and Gasteruptiinae, with a transition between ground nesting and cavity nesting hosts. This event might help explain the broad difference in biodiversity and distribution of *Gasteruption* (506 spp. with a worldwide distribution) and Hyptiogastrinae (88 spp. with a Gondwanan distribution) based on hosts' dispersal abilities.

Specialization

The collated host associations (Table 1) shows 32 species of *Gasteruption* are recorded from a single host species, with 24 *Gasteruption* species being polyphagous. The extent of polyphagy varies from generalist species utilizing multiple hosts from bee and wasp families to multiple species in a single host family. Examples of generalist species based on breadth of host use are *G. assectator s.l.* (21 host species from Colletidiae, Megachilidae, Crabronidae and Vespidae) and *G. jaculator* (20 host species from Colletidiae, Megachilidae, Apidae, Crabronidae, Vespidae). Although these records indicate generalist species, these are some of the most commonly studied with widespread distributions so may have a large number of erroneous observations. Observations from some other species are restricted to bee families, such as *G. erythrostomum* (six species from Colletidiae, Megachilidae and Apidae) and *G. caucasicum* (five species from Colletidae and Megachilidae). Some species are restricted to a single genus (e.g. *G. minutum*, *G. nigritarse*, *G. freyi*, *G. huangshii* and *G. hungaricum* only utilize *Hylaeus* hosts), but some records are only from a single observation (e.g. *G. huangshii* and *G. hungaricum*). Caution must be taken when extrapolating the specialization of the genus from these data as *Gasteruption* species observed attacking a single host may be from a lack of addition observations in different habitats during different seasons. Therefore, it is possible that these species may be polyphagous, and with additional comprehensive observations including rearing events, our understanding of specialization in the genus may change.

There is considerable morphological specialization in *Gasteruption* when considering body morphology and host nesting biology. Two species from Australia, *G. youngi* and *G. cylindricum* (Fig. 1A and B) have very unique body morphologies when compared to other species of *Gasteruption* (e.g. *G. zebroides*, Fig 1C; *G. primotarsale*, Fig 1D). Their heads and mesosoma are extremely elongated with a cylindrical body shape. Host records for these species are restricted to the Australian bee subfamily Euryglossinae (Table 1) often minute bees that nest in both ground and cavity nests (Kayaalp *et al.* 2017). More accurate information on host associations and biology across different *Gasteruption* species will further our understanding of the role morphological variation plays in host use.

Oviposition

The oviposition behavior of *Gasteruption* females has been observed at artificial cavity nesting sites (commonly called 'bee hotels') but there is limited published observations of the specifics of this process. Adult wasps can often be observed in a 'searching flight' behavior for nest entrances by engaging in a bouncing hovering flight at nesting sites (Naumann 1983; Jennings & Austin 2004; Bogusch 2005), and a vertical and horizontal leg swinging motion while attenuating nest openings. This behavior is suggested to be a combination of detection of olfactory cues using antennal contact with the substrate and detection of host vibrations using large subgenual organs located in the hind tibia (Mikó *et al.* 2019). Adult wasps inspect the nest closely by landing within proximity to the nest entrance and attenuating the opening (Fig. 2A), presumably to assess olfactory cues. It is unknown what cues the wasps are responding too, although research examining the antennae sensilla and structures suggests there is a variety of different sensory setae in *Gasteruption* that occur in multiple configurations for different species of Gasteruptiidae (J.T. Jennings 2018, pers. comm.). Oviposition has been observed into incomplete cells during nest construction while hosts have left the nest unattended (Macedo *et al.* 2012), or into completed nests through plugged entrances (Fig 2B). Observations of *Gasteruption* oviposition differ between species, with wasps either thrusting the length of the ovipositor into the nest (species with long ovipositors e.g. *G. primotarsale* (Fig 1D), and *Gasteruption* sp. (Fig 2B)), ovipositor length ~1.9 times length metasoma (Morley 1916), or entering backwards into the nest, sometimes completely disappearing from view (species with shorter ovipositors e.g. *G. brachychaetum*, ovipositor length 0.21–0.35 times metasomal length, Macedo *et al.* (2012). Similar observations with different length ovipositors were observed by van Achterberg (2013) and van Breugel (2014). There is little information on the time taken to oviposit with a general observation of up to several minutes (Macedo *et al.* 2012; van Breugel 2014). This would be highly variable based on nest architecture and host biology. Species with longer ovipositors (Fig 1D) ovipositing from outside the nest entrance may take longer to steer the ovipositor and locate the correct oviposition site, whereas species that enter the host nest backwards may need to maneuver inside the cell for a suitable oviposition site.

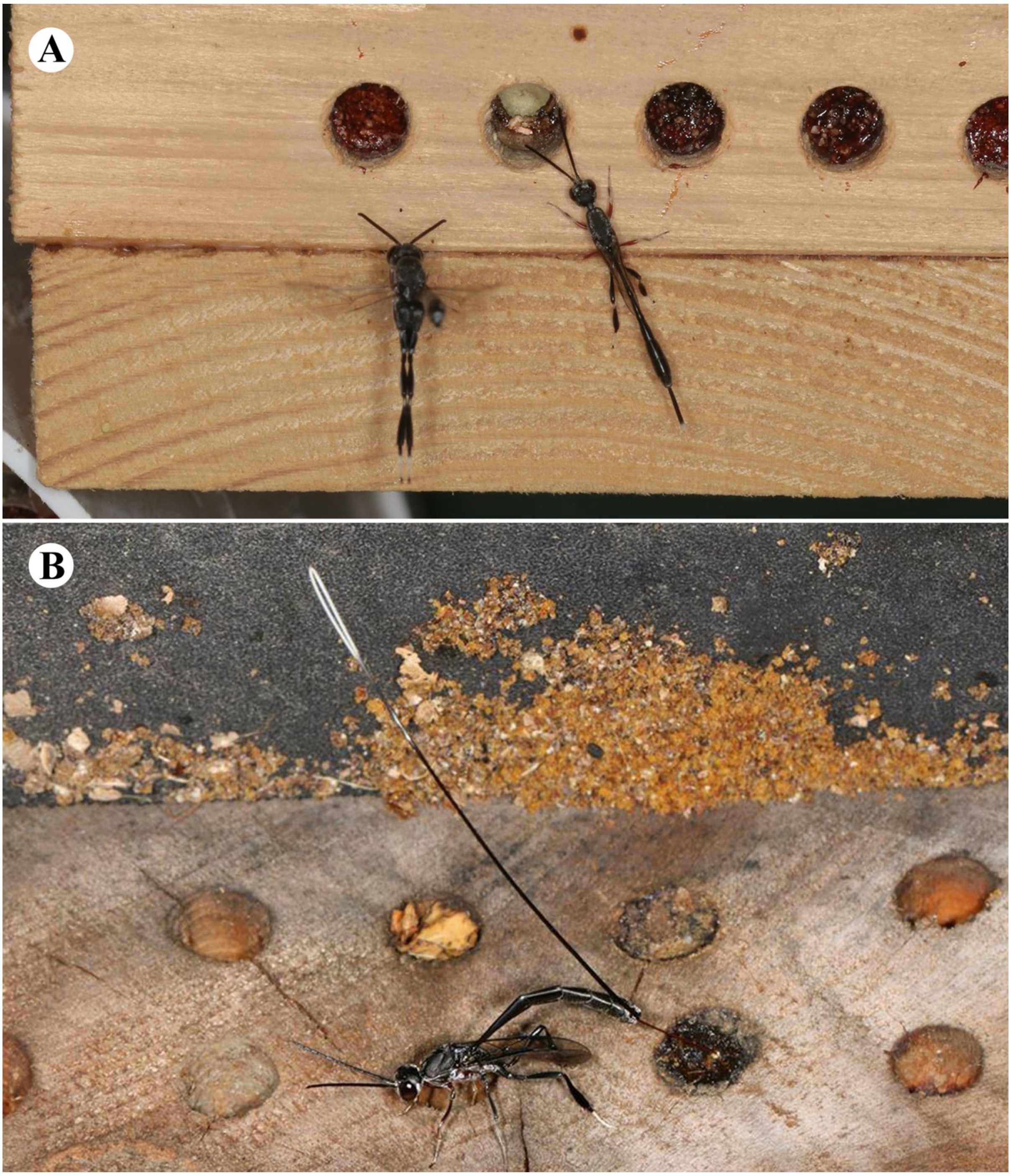

Figure 2. *Gasteruption* wasp behavior at artificial nesting blocks. A, two female *Gasteruption* sp. inspecting open *Megachile* sp. host nest, Brisbane, Australia [photo credit Marc J. Newman 2018]. B, *Gasteruption* sp. ovipositing through resin plug at entrance to *Megachile* sp. host nest, Brisbane Australia [photo credit Jenny A. Thynne 2018].

Larval Development

Information about *Gasteruption* larval development is scarce in the literature, with most observations limited to a single larval instar or brief observations during host nest examination. The most comprehensive research has been done by Malyshev (1964) who documented the complete development of eight species of *Gasteruption*. Recent research by Bogusch *et al.* (2018) describes in detail the late instar larvae of three species, *G. assectator*, *G. nigrescens* and *G. phragmiticola*. For these species there was variation in the oviposition site and development of larvae, however all observations are consistently predator-inquiline. An egg is laid directly onto the host egg (*G. nigrescens* (Malyshev 1964), *G. assectator* (Westrich 2018)), within close proximity to the host egg, on the food provisions (*G. merceti*) or on the cell wall (*G. jaculator* and *G. freyi*) (Malyshev 1964, 1966). *Gasteruption assectator* has also been observed to oviposit underneath the membrane lining of the cell wall of a *Hylaeus* sp. (Malyshev 1964; Malyshev 1966; Westrich 2018). All observations describe an elongated cylindrical shaped egg that is smaller than the host egg. The newly eclosed first instar larvae is eruciform with slender pointed mandibles and are mobile, making them easily distinguishable from host larvae. The first instar larvae orient lengthwise along the host egg and consume the host egg (*G. nigrescens*, *G. merceti* and *G. assectator* (Malyshev 1964)). Second instar larvae are scaphoid in appearance and feed directly on the host provisions. Third instar larvae are tuberculate in appearance and continue development by consuming the host provisions. Larval development has been observed in some species to be limited to the contents of a single host cell (Spessa *et al.* 2000), with observations of larvae consuming the contents of multiple cells by breaching the thin partitions of adjacent host cells (Höppner 1904, Malyshev 1966, P. Bogusch 2019, pers. comm.).

Documented examples are *G. exsectum* destroying three to four cells of *Ceratina aloes* (Eardley & Daly 2007; Westrich 2018), an unknown *Gasteruption* sp. consuming the provisions of at least two cells of *Hylaeus relehatus* (Donovan 2007) and *G. erythrostomum* in the nests of *Chelostoma campanulorum* (van Breugel 2014). Observations from northern hemisphere suggest that *Gasteruption* larvae mostly consume all the contents of the nest, resulting in difficulties in identifying hosts (P. Bogusch 2019, pers. comm.). Once feeding has completed the larvae isolate themselves using anal secretions to construct dark semi-cocoons above and below the larvae in a cleared part of the cell (Eardley & Daly 2007; Grandi 1954; Malyshev 1966; Skaife 1953; Westrich 2018; Whatmough 1974). The late instar larvae either eclose and emerge as adults or over winter as late instar larvae before emerging in the spring (He *et al.* 2004). Observations in south eastern Australia have found over-wintering late stage larvae of *G. primotarsale* in nests of *Amphyaleus morosus* (L. R. Hearn & O. K. Davies 2017, pers. comm.). Developmental time is highly variable with observations by Macedo *et al.* (2012) for *G. brachychaetum* (Brazil) completing development between 33 to 299 days (4 – 42 weeks) and Malyshev (1964) observed *G. freyi* and *G. merceti* having a shorter developmental time of 28 to 35 days (4 – 5 weeks).

Rates of parasitism

There is high variation in documented parasitism rates with most of the records for unknown species of *Gasteruption* collected as an artifact of rearing from host nests. Spessa *et al.* (2000) quantified rates of parasitism for *G. primotarsale* (published as *Gasteruption* sp.) that was the primary parasitoid in *Amphylaeus morosus* populations. The parasitoids preferred new nests with a single provisioning female over older nests with multiple active females. The observed mean proportion of brood parasitised per nest was 0.07 for new single female nests, 0.06 for reused single female nest and 0.03 for reused two female nests. *Gasteruption* was only observed in the first cell of each parasitised nest, with similar observations of cell preference (L.R. Hearn 2017, pers. comm.). Paini (2004) collected nesting data on an undescribed species of *Megachile* and found that over a two-year period 1.3% (15/1176 nests) of nests were parasitised by an unknown species of *Gasteruption*. Bürger (2004) found a higher rate of parasitism of *Hylaeus communis* by *G. assectator* with 7.1% (4/42 nests). Eardley & Daly (2007) recorded the *Gasteruption* parasitism rates for three species of South African *Ceratina*; *G. exsectum* in *Ceratina aloes* (3.4%, 8/42 nests), *G. pedicillatum*, *G. exsectum*, *G. fulvivagina*, and an unknown species, in *Ceratina subquadrata* (4.7%, 9 parasitised out of 52 total) and a single *G. fulvivagina* in a nest of *Ceratina braunsi*. Bogusch (2018) found the highest rates of parasitism for *G. nigrescens* with 16% (34/210 nests) and *G. phragmiticola* with 31.5% (51/162 nests), but also highlights considerable interannual variability (P. Bogusch 2019, pers. comm.). These values reflect a relatively variable parasitism rate of 4 – 31%, but these data only represent a very small number of known hosts and difficulties in qualitatively comparing rates due to variation in methodologies used to collect information.

Future work and conclusions

The literature from this review highlights large gaps in our understanding of *Gasteruption* biology and their host associations, with the majority of observations based from a single stage of development with limited information on the variation between species. Greater detail is needed when observing *Gasteruption* in the field to obtain more accurate observations of biology and rearing information for host associations.

We have highlighted the brief and often contradictory observations of host association in *Gasteruption* and recommend the following practices to increase the quality of records. When recording observations of gasteruptiids at host nesting sites, more detailed information is necessary to confidently associate the wasp with the host. A common example is observations of gasteruptiids in the vicinity of large mixed nesting aggregations, some of these records fail to provide detail if the wasp is inspecting nest openings directly or simply flying across the substrate. More specific observations of wasp behavior will provide better interpretation of host associations. The best possible data come from rearing information. Hosts nesting in stems can be readily removed and observed in a laboratory environment, allowing accurate data collection of larval development and host association. For hosts nesting in ground substrate it can be difficult to obtain parasitised cells. An effective way to collect reared parasitoids from these nests may be the use of emergence traps, allowing *in situ* monitoring of the host nest. Although care should be taken to correctly identify the host to avoid erroneous associations if placed over multiple burrows at a mixed nesting aggregation.

More work needs to be done across other biogeographical regions as comparatively very little is known in areas of high biodiversity. Further taxonomic treatments of the Australasian and Afrotropical regions are needed as they have the highest recorded species diversity. However, these also contain large amounts of material that have remained undescribed because keys remain outdated, and the group is in need of revision. The genus is in need of a modern phylogenetic treatment to resolve the biogeography of the group and update the taxonomy in neglected regions. A robust phylogenetic framework would allow for meaningful examination of internal relationships, the assessment of species diversity while allowing mapping of behavior and host associations to explore trait evolution.

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Table 1: Worldwide host records for *Gasteruption*. The following abbreviations are used for host family: Coll = Colletidae, Apid = Apidae, Hali = Halictidae, Mega = Megachilidae, Crab = Crabronidae, Vesp = Vespidae. Letters are used to indicate the type of record: A = rearing events/ found as larvae/ pupae in host nest, B = reared from mixed nesting assemblage, C = Observations of oviposition at nest site, female observed inspecting nest site, D = Author is unsure of observation, E = Unknown observation. Host nesting biology abbreviations are: cav = cavity, gro = ground.

Gasteruption species name	Host family	Host species name	Type of record	Nesting biology	Reference
		Australasia			
G. bicarinatum Pasteels	Mega	*Megachile ignita* Smith	A	cav	Prendergast 2018
G. brachyurum Schletterer	Coll	*Callomelitta picta* Smith	C	cav	Jennings 1999
G. cylindricum (Turner)	Coll	*Euryglossina lynettae* (Rayment)	A	cav	Rayment 1955: *Gasteruption* sp.
G. dewitzi Schletterer	Vesp	*Paralastor* sp.	E	cav	New record
	Sphe	*Sceliphron* sp.	E	cav	Jennings 1999: *G. deivitsi* Schletterer
G. primotarsale Pasteels	Coll	*Amphylaeus morosus* (Smith)	A	cav	Spessa *et al.* 2000: *Gasteruption* sp.
G. youngi Jennings &	Coll	*Euryglossula microdonta* (Rayment)	C	gro	Jennings & Parslow 2014

Parslow

G. varians Pasteels	Mega	*Megachile kuehni* Friese	C	cav	Pasteels 1956a
Gasteruption sp.	Coll	*Amphylaeus* (*Agogenohylaeus*) *nubilosellus* (Cockerell)	E	cav	Jennings 1999
Gasteruption sp.	Coll	*Amphylaeus morosus* (Smith)	E	cav	Jennings 1999: *Amphylaeus* (*Prosopis*) *sculptifrons* Cockerell
Gasteruption sp.	Coll	*Callomelitta* sp.	E	cav	Jennings 1999
Gasteruption sp.	Coll	*Euryglossa* (*Euhesma*) sp.	E	cav	Jennings 1999
Gasteruption sp.	Coll	*Euryglossina pulchra* Exley	A	cav	Houston 1969
Gasteruption sp.	Coll	*Heterohesma weiri* Exley	E	cav	Jennings 1999: *Herohesma weiri* Exley
Gasteruption sp.	Coll	*Hylaeus (Euprosopis) honestus* (Smith)	E	cav	Jennings 1999: *Hylaeus chrysognatha* Cockrell
Gasteruption sp.	Coll	*Hylaeus (Euprosopoides) obtusatus* (Smith)	E	cav	Jennings 1999
Gasteruption sp.	Coll	*Hylaeus (Hylaeorhiza) nubilosus* (Smith)	E	cav	Jennings 1999

Gasteruption sp.	Coll	*Hylaeus (Prosopisteron) quadratus* (Smith)	E	cav	Jennings 1999
Gasteruption sp.	Coll	*Hylaeus relegatus* (Smith)	A	cav	Donovan 1980; Donovan 2007
Gasteruption sp.	Coll	*Hyleoides zonalis* Smith	E	cav	Jennings 1999
Gasteruption sp.	Coll	*Meroglossa* sp. Smith	E	cav	Jennings 1999
Gasteruption sp.	Coll	*Pachyprosopis haematostoma* Cockerell	C	cav	Houston 1969
Gasteruption sp.	Mega	*Megachile aethiops* (Smith)	C	cav	Naumann 1983
Gasteruption sp.	Mega	*Megachile* sp.	E	cav	Jennings 1999: *Chalicodoma* sp.
			Afrotropical		
G. caffrarium Schletterer	Coll	*Hylaeus (Nothylaeus) heraldicus* (Smith)	A	cav	Taylor 1962;1965;1968
	Coll	*Hylaeus* sp.	E	cav	Skaife 1953
	Mega	*Pseudoanthidium junodi* (Friese)	E	cav	Prins 1978
G. exsectum Schletterer	Apid	*Ceratina (Ctenoceratina) penicillata*	A	cav	Daly 1988

		(Friese)			
	Apid	*Ceratina aloes* Cockerell	A	cav	Eardley & Daly 2007
G. fulvivagina Kieffer	Apid	*Ceratina subquadrata* Smith	A	cav	Eardley & Daly 2007
G. jaculator (Linnaeus)	Apid	*Ceratina calcarata* Robertson	A	cav	Sandra Rehan 2016, pers. comm.
	Apid	*Ceratina subquadrata* Smith	A	cav	Daly 1988
G. pedicillatum Brues	Apid	*Ceratina penicillata* Friese	E	cav	Daly 1988; Eardley & Daly 2007; Eardley & Urban 2010; Friese 1905
	Apid	*Ceratina subquadrata* Smith	A	cav	Eardley & Daly 2007
	Coll	*Hylaeus heraldicus* (Smith)	E	cav	Smith 1853
G. punctulatum Schletterer	Coll	*Hylaeus (Nothylaeus) heraldicus* (Smith)	E	cav	Prins 1978; Skaife & Ledger 1979
G. robustum Kieffer	Apid	*Xylocopa scioensis* Gribodo	A	cav	Eardley & Urban 2010; Gess 1981
	Apid	*Xylocopa sicheli* Vachal	A	cav	Eardley & Urban 2010; Whatmough 1974
	Apid	*Xylocopa* sp.	C	cav	Prinsloo 1985

G. trigonum Pasteels	Apid	*Xylocopa hottentotta* Smith	B	cav	Madl 2013; Pasteels 1956b; Prins 1978; Smith 1853
	Apid	*Xylocopa sicheli* Vachal	E	cav	Prins 1978; Prinsloo 1985; Vachal 1898
G. vicinum Pasteels	Apid	*Ceratina armata* Smith	E	cav	Daly 1988; Smith 1853
	Apid	*Ceratina braunsi* Eardley and Daly	A	cav	Eardley & Daly 2007
G. xylocopae Kieffer	Apid	*Xylocopa sicheli* Vachal	E	cav	Kieffer 1911; Pasteels 1956b; Prins 1978
Nearctic					
G. assectator s.l. (Linnaeus)	Crab	*Passaloecus cuspidatus* F.Smith	A	cav	Bradley 1908: *G. incertus*
	Crab	*Pemphredon* sp.	E	cav	Townes 1950
	Mega	*Hoplitis sambuci* Titus	E	cav	Carlson 1979
	Mega	*Megachile rotundata* (Fabricius)	E	cav	Carlson 1979
G. kirbii (Westwood)	Coll	*Hylaeus modestus* Say	E	cav	Carlson 1979
	Mega	*Hoplitis sambuci* Titus	E	cav	Carlson 1979

	Mega	*Megachile rotundata* (Fabricius)	E	cav	Carlson 1979
Gasteruption sp.	Mega	*Ashmeadiella timberlakei* Michener	A	cav	Parker & Bohart 1968: *Rhydiofoenus* sp.
			Neotropical		
G. brachychaetum Schrottky	Coll	*Hylaeus guaraniticus* (Schrottky)	C	cav	Macedo *et al.* 2012
G. floridanum (Bradley)	Coll	*Hylaeus mesillae* (Cockerell)	E	cav	Carlson 1979; Macedo 2011
	Crab	*Trypoxylon frigidum* F.Smith	E	cav	Walkley 1967
G. kaweahense (Bradley)	Apid	*Ceratina pacifica* H.S.Smith	A	cav	Carlson 1979; Daly *et al.* 1967; Parker & Bohart 1968
G. visaliae (Bradley)	Coll	*Hylaeus mesillae* (Cockerell)	A	cav	Parker & Bohart 1968
			Palaearctic		
G. assectator s.l. (Linnaeus)	Coll	*Hylaeus annularis* (Kirby)	C	cav	Höppner 1904; Jakubzik & Cölln 1997
	Coll	*Hylaeus brevicornis* Nylander	A	cav	Danks 1971; Höppner 1904; Wall 1994; Wolf 1953

Coll	*Hylaeus communis* Nylander	A	cav	Brechtel 1986; Bürger 2004; Jakubzik & Cölln 1997; Orlovskytė *et al.* 2018; Pereira-Peixoto *et al.* 2016; Wall 1994; Westrich 1979
Coll	*Hylaeus confusus* Nylander	A	cav	Tscharntke *et al.* 1998
Coll	*Hylaeus pectoralis* Förster	A	cav	Höppner 1904: *Prosopis kriechbaumeri*; Wagner 1907
Coll	*Hylaeus rinki* (Górski)	E	cav	Höppner 1904
Coll	*Hylaeus* spp.	C	cav	Malyshev 1964: *G. rugulosum;* Oehlke 1984; van Achterberg & Talebi 2014
Crab	*Passaloecus cuspidatus* F.Smith	E	cav	Bradley 1908: *Foenus incertus*
Crab	*Pemphredon fabricii* (M.Müller)	A	cav	Bogusch *et al.* 2018: sceptical of observation.
Crab	*Pemphredon lethifer* (Shuckard)	D	cav	Gyorfi & Bajari 1962; Habermehl 1921
Crab	*Trypoxylon figulus* (Linnaeus)	C	cav	Fahringer 1922; Ferrière 1946; Gyorfi & Bajari 1962; Höppner 1904

	Crab	*Typoxylon* sp.	D	cav	Oehlke 1984
	Mega	*Chelostoma florasomne* (Linnaeus)	E	cav	Jakubzik & Cölln 1997; Nicholson 1928, Lindemans 1921: *Heriades florisomne*
	Mega	*Chelostoma rapunculi* (Lepeletier)	A	cav	Westrich 2018
	Mega	*Heriades truncorum* (Linnaeus)	E	cav	Tscharntke *et al.* 1998; van Breugel 2014
	Mega	Megachilinae sp.	E	cav	van Achterberg & Talebi 2014
	Mega	*Osmia caerulescens* (Linnaeus)	C	cav	Petrischak 2014
	Vesp	*Odynerus spinipes* (Linnaeus)	D	cav	Gyorfi & Bajari 1962; Oehlke 1984: *Vespa spinipes*
G. caucasicum (Guérin-Ménéville)	Coll	*Colletes daviesanus* Smith	E	gro	van Achterberg & Talebi 2014; van Breugel 2014
	Coll	*Hylaeus soror* (Pérez)	E	cav	Ferton 1910: *G. pedemontanum;* Ferton 1914: *G. terrestre*
	Coll	*Hylaeus* sp.	E	cav	Malyshev 1964: *G. pedemontanum;* van Achterberg & Talebi 2014; van Breugel

					2014
	Mega	*Heriades truncorum* (Linnaeus)	A	cav	Wall 1994: *G. pedemontanum*
	Mega	*Osmia versicolor* Latreille	E	cav	Fahringer 1922; Ferrière 1946: *G. pedemontanum;* Crosskey 1951: *G. pedemontanum*; Sedivy 1958; Gyorfi & Bajari 1962; Oehlke 1984
G. diversipes (Abeille de Perrin)	Coll	*Hylaeus communis* Nylander	E	cav	Jakubzik & Cölln 1997
	Coll	*Hylaeus deceptorius* (Benoist)	E	cav	Ferton 1910: *Hylaeus deceptoria*
	Coll	*Hylaeus* sp.	E	cav	Oehlke 1984
	Mega	*Heriades* sp.	E	cav	Ferrière 1946; Jakubzik & Cölln 1997
	Mega	*Osmia* sp.	E	cav	Ferrière 1946; Jakubzik & Cölln 1997
	Vesp	*Eumenes* sp.	D	cav	Ferrière 1946; Gyorfi & Bajari 1962; Oehlke 1984; Sedivy 1958
	Vesp	*Odynerus* sp.	D	cav	Ferrière 1946; Gyorfi & Bajari 1962; Oehlke 1984; Sedivy 1958

G. dolichoderum Schletterer	Coll	*Hylaeus pectoralis* Förster	C	cav	Wall 1994
G. erythrostomum (Dahlbom)	Coll	*Hylaeus communis* Nylander	E	cav	Windschnurer 1997
	Coll	*Hylaeus hyalinatus* Smith	D	cav	Jakubzik & Cölln 1997
	Coll	*Hylaeus pectoralis* Förster	A	cav	Malyshev 1964; Oehlke 1984
	Coll	*Hylaeus punctatus* (Brullé)	D	cav	Jakubzik & Cölln 1997
	Mega	*Chelostoma campanularum* (Kirby)	C	cav	van Achterberg 2013; van Breugel 2014
	Mega	*Chelostoma rapunculi* (Lepeletier)	A	cav	van Achterberg 2013; van Breugel 2014
G. freyi (Tournier)	Coll	*Hylaeus pectoralis* Förster	C	cav	Ferrière 1946; Malyshev 1966; Oehlke 1984; Orlovskytė *et al.* 2018; Westrich 1989
	Coll	*Hylaeus* spp.	E	cav	van Achterberg & Talebi 2014
G. hastator (Fabricius)	Coll	*Hylaeus* spp.	E	cav	Malyshev 1966; van Achterberg & Talebi 2014
	Coll	*Hylaeus variegatus* (Fabricius)	E	cav	Höppner 1904; Oehlke 1984; Pagliano &

					Scaramozzino 2000
	Crab	*Lestica subterranea* (Fabricius)	E	gro	Höppner 1904; Oehlke 1984; Pagliano & Scaramozzino 2000
	Hali	*Lasioglossum malachurum* (Kirby)	C	gro	Polidori et al. 2009: *G. rubricans*
	Hali	*Rophites algirus* Pérez	C	gro	Westrich *et al.* 1992
	Hali	*Systropha curvicornis* (Scopoli)	C	gro	Westrich 1989
	Hali	*Systropha planidens* Giraud	C	gro	Westrich 1989
	Mega	*Hoplitis tridentata* (Dufour & Perris)	C	cav	Crosskey 1951: *G. rubricans*; Oehlke 1984; Pagliano & Scaramozzino 2000
	Mega	*Osmia* sp.	E	cav	Ferrière 1946; Gyorfi & Bajari 1962; Sedivy 1958; van Achterberg & Talebi 2014
	Vesp	*Antepipona laevigata* (Blüthgen)	E	gro	Crosskey 1951: *G. rubricans*; Oehlke 1984; Pagliano & Scaramozzino 2000
	Vesp	*Odynerus* sp.	E	cav	Ferrière 1946; Sedivy 1958
G. huangshii Tan & van	Coll	*Hylaeus* sp.	C	cav	Tan et al. 2016

Achterberg

G. hungaricum Szepligeti	Coll	*Hylaeus confusus* Nylander	A	cav	Malyshev 1966
G. jaculator (Linnaeus)	Coll	*Colletes daviesanus* Smith	C	gro	Höppner 1904; Oehlke 1984; van Breugel 2014
	Coll	*Colletes* spp.	E	gro	van Achterberg & Talebi 2014
	Coll	*Hylaeus* (*Hylaeus*) *miyakei* (Matsumura)	A	cav	Orlovskytė *et al.* 2018
	Coll	*Hylaeus communis* Nylander	A	cav	Orlovskytė *et al.* 2018; Westrich 1979
	Coll	*Hylaeus difformis* (Eversmann)	A	cav	Orlovskytė *et al.* 2018
	Coll	*Hylaeus leptocephalus* (Morawitz)	A	cav	Wall 1994
	Coll	*Hylaeus pectoralis* Förster	C	cav	Oehlke 1984
	Coll	*Hylaeus* sp.	A	cav	Malyshev 1964: *G. thomsoni*
	Coll	*Hylaeus* spp.	E	cav	Oehlke 1984; van Achterberg & Talebi 2014
	Crab	*Pemphredon lugubris* (Fabricius)	*D*	cav	Morley 1937; Oehlke 1984

	Crab	*Trypoxylon* sp.	*D*	cav	Oehlke 1984
	Crab	*Trypoxylon figulus* (Linnaeus)	C	cav	Höppner 1904
	Crab	*Lestiphorus bicinctus* (Rossi, 1794)	E	cav	Oehlke 1984: *Hylaeus bicinctus*
	Mega	*Chelostoma florisomne* (Linnaeus)	E	cav	Crosskey 1951; Oehlke 1984
	Mega	*Heriades truncorum* (Linnaeus)	E	cav	Höppner 1904; Malyshev 1966: *G. thomsoni*; Oehlke 1984,
	Mega	*Hoplitis tridentata* (Dufour & Perris)	E	cav	Höppner 1904; Malyshev 1966: *G. thomsoni*; Oehlke 1984,
	Mega	*Osmia bicornis* (Linnaeus)	E	cav	Höppner 1904; Oehlke 1984
	Mega	*Osmia leaiana* (Kirby)	A	cav	Morley 1916
	Vesp	*Symmorphus murarius* (Linnaeus)	D	cav	Oehlke 1984: *Vespa murarius*
G. laticeps (Tournier)	Coll	*Hylaeus* sp.	A	cav	Malyshev 1964
	Coll	*Hylaeus angustatus* (Schenck)	E	cav	P. Bogusch 2019, pers. comm.
	Crab	*Pemphredon* sp.	E	cav	Gyorfi & Bajari 1962
G. merceti Kieffer	Apid	*Ceratina callosa* (Fabricius)	A	cav	Malyshev 1964: *G. pyrenaicus*

	Apid	*Ceratina chalybea* Chevrier	A	cav	Malyshev 1966: *G. pyrenaicus*
	Apid	*Ceratina cyanea* (Kirby)	A	cav	Malyshev 1966: *G. pyrenaicus*
	Apid	*Ceratina* sp.	A	cav	Malyshev 1964: *G. pyrenaicus*; P. Bogusch, M. Mikát and J. Straka, unpublished record cited in Bogusch *et al.* 2018: *G. erythrostomum*
	Crab	*Pemphredon lethifer* (Shuckard)	D	cav	Ferrière 1946
	Crab	*Pemphredon rugifera* (Dahlbom)	C	cav	Höppner 1904: *G.* pyrenaicum; Sedivy 1958: *G.* pyrenaicum; Ferrière 1946; Gyorfi & Bajari 1962: *G. pyrenaicum*
G. minutum (Tournier)	Coll	*Hylaeus communis* Nylander	C	cav	Jakubzik & Cölln 1997; Orlovskytė *et al.* 2018; Wall 1994
	Coll	*Hylaeus hyalinatus* Smith	E	cav	Esser & Cölln 2002
	Coll	*Hylaeus punctatus* (Brullé)	C	cav	Jakubzik & Cölln 1997; Wall 1994
	Coll	*Hylaeus* sp.	E	cav	Wall 1994
G. nigrescens Schletterer	Crab	*Pemphredon fabricii* (M.Müller)	D	cav	Bogusch *et al.* 2018: likely an error

	Mega	*Heriades rubicola* Pérez	A	cav	Bogusch *et al.* 2018
	Mega	*Hoplitis leucomelana* (Kirby)	A	cav	Malyshev 1964: *G.* caudatum; Bogusch *et al.* 2018
G. nigritarse (Thomson)	Coll	*Hylaeus communis* Nylander	A	cav	Orlovskytė *et al.* 2018
	Coll	*Hylaeus difformis* (Eversmann)	A	cav	Johansson & van Achterberg 2016; Orlovskytė *et al.* 2018
	Coll	*Hylaeus pictipes* Nylander	C	cav	Johansson & van Achterberg 2016
G. opacum (Tournier)	Crab	*Trypoxylon figulus* (Linnaeus)	E	cav	Magretti 1882: questioned by Oehlke Ferrière 1946; Gyorfi & Bajari 1962; Oehlke 1984; Sedivy 1958
G. phragmiticola Saure	Apid	*Ceratina cyanea* (Kirby)	A	cav	Malyshev 1964
	Coll	*Hylaeus pectoralis* Förster	C	cav	Bogusch *et al.* 2018; Saure 2006; Wall 1994
	Coll	*Hylaeus* spp.	A	cav	Westrich 2008
	Crab	*Pemphredon fabricii* (M.Müller)	A	cav	Bogusch *et al.* 2016; Bogusch *et al.* 2018: likely an error

	Crab	*Pemphredon rugifera* (Dahlbom)	E	cav	Gyorfi & Bajari 1962; Oehlke 1984: *Pemphredon unicolor*
G. tournieri Schletterer	Coll	*Hylaeus* sp.	D	cav	Jakubzik & Cölln 1997; Wall 1994
	Mega	*Chelostoma* sp.	D	cav	Wall 1994
	Mega	*Heriades* sp.	D	cav	Wall 1994
	Mega	*Osmia* sp.	D	cav	Wall 1994
G. variolosum (Abeille de Perrin)	Crab	*Pemphredon lethifer* (Shuckard)	B	cav	Grandi 1954

Table 2: Number of host species for families recorded across biogeographic regions (additional unidentified host species are indicated in brackets).

	Australasia	Afrotropical	Nearctic	Neotropical	Palaearctic	Total species	Grand total
Colletidae	14(3)	1(1)	1	2	18(13)	36(17)	53
Megachilidae	2	1	3	0	12(7)	18(7)	25

Apidae	0	9(1)	0	1	3(2)	13(3)	16
Crabronidae	0	0	1(1)	1	7(3)	9(4)	13
Vespidae	0(1)	0	0	0	3(3)	3(4)	7
Halictidae	0	0	0	0	4	4	4
Sphecidae	0(1)	0	0	0	0	(1)	1
Total species	16(5)	11(2)	5(1)	4	48(28)		
Grand totals	21	13	6	4	76		

CHAPTER III: REVISION OF THE WASP GENUS *GASTERUPTION* (EVANIOIDEA: GASTERUPTIIDAE) FROM AUSTRALIA WITH DESCRIPTION OF THREE NEW SPECIES

BEN A. PARSLOW[1,3,5], JOHN T. JENNINGS[2], MICHAEL P. SCHWARZ[1], MARK I. STEVENS[3,4]

[1]Biological Sciences, College of Science and Engineering, Flinders University, Adelaide, SA 5001, Australia.

[2]Centre for Evolutionary Biology and Biodiversity, and School of Biological Sciences, The University of Adelaide, SA 5005, Australia.

[3]South Australian Museum, North Terrace, GPO Box 234, Adelaide, SA 5000, Australia.

[4]School of Pharmacy and Medical Sciences, University of South Australia, Adelaide, SA 5001, Australia.

[5]Corresponding author: ben.parslow3@gmail.com

Abstract

Gasteruption is the largest genus within the family Gasteruptiidae and has a world-wide distribution. The larvae are considered predator-inquilines in the nests of other aculeate Hymenoptera. There are previously 114 species described from Australia of which we redescribe 90, however, nine species are known only from males what we have not redescribed. We add three new species; *G. species 1* **sp. nov.**, *G. species 2* **sp. nov.** and *G. species 3* **sp. nov**, two synonymy: *Gasteruption genale* Schletterer, 1890 is synonymised with *Gasteruption coriaceum* Schletterer, 1890, and *G. valvulare* Schletterer 1980 with *G. valens* Kieffer 1911. 10 species are *incertae sedis: G. automnale* Turner, 1918, *G. hollandiae* (Guèrin-Mèneville, 1843), *G. hyalipenne* Szèpligeti, 1903, *G. longinotum* Pasteels, 1957, *G. pectorale* Pasteels, 1957, *G. rogenhoferi* Schletterer, 1885, *G. rugosissimum* (Turner, 1918), *G. sordidum* Taschenberg, 1891, *G. steindachneri* (Schletterer, 1885) and *G. tardivum* Pasteels, 1957. A key to separate the Australian species is provided, along with a discussion of the systematics of *Gasteruption* and a general diagnosis.

Keywords: Review, Hymenoptera, taxonomy, key

Running Head: Systematics of *Gasteruption* from Australia

Introduction

The wasp family Gasteruptiidae comprises two monophyletic subfamilies, Hyptiogastrinae with two genera; *Hyptiogaster* Kieffer 11 spp., and *Pseudofoenus* Kieffer 78 spp. (Jennings and Austin 2000, 2002; Parslow and Jennings 2018), and Gasteruptiinae with four genera; *Gasteruption* Latreille (418 spp.), *Plutofoenus* Kieffer (3 spp.), *Spinolafoenus* Macedo (1 sp.) and *Trilobitofoenus* Macedo (3 spp.) (Macedo 2009). *Gasteruption* is by far the largest genus (Aguiar *et al.* 2013; Tan *et al.* 2016; Parslow *et al.* 2018) and is found in all zoogeographical regions. It was suggested by Pasteels (1962) that the genus was more abundant in subtropical and temperate regions, a pattern also seen in Australian Hyptiogastrinae (Jennings and Austin 2002). Adult *Gasteruption* are easily recognised by the combination of a elongated propleuron, clavate hind tibia, and high insertion of the metasoma on the mesosoma. Host records for *Gasteruption* indicate larvae are predator-inquilines in the nests of cavity nesting solitary bees from the families Apidae, Colletidae, Halictidae and Megachilidae, and solitary wasp hosts including Crabronidae, Vespidae and a single record for Sphecidae (Jennings & Austin 2004, Parslow *et al.* chapter II).

The taxonomy of *Gasteruption* outside of Australia has been examined recently in several regional revisions, for example, Neotropics (Macedo 2011), China (Zhao *et al.* 2012; Tan *et al.* 2016), Iran and Turkey (van Achterberg and Talebi 2014), Yugoslavia (Zikic *et al.* 2014), and United Arab Emirates and Yemen (Saure *et al.* 2017). In contrast the most recent work in Australasia has been the revision of the faunas of Melanesia (Pasteels 1956), New Zealand (Pasteels 1957a), South-eastern Asia (Pasteels 1958), New Caledonia (Jennings *et al.* 2015), and the description of the first species from Fiji (Parslow *et al.* 2018).

Initial taxonomic work on the Australian fauna consisted of individual species descriptions (Guérin-Méneville 1843; Westwood 1851; Szèpligeti 1903) and a larger contribution by Schletterer (1885) who described 14 species. Kieffer (1912) added 12 Australian species and formed several new genera, but this created taxonomic instability in the family with his broad concepts of genera which have been considered unusable by several authors (Pasteels 1957b; Crosskey 1962; Jennings and Austin 2002). To further complicate matters, Turner (1918) described six additional Australian species without any concern for their integration into Kieffer's taxonomic framework, thus causing further difficulties when considering the Australian fauna. Crosskey's (1962) revision of Gasteruptiidae synonymised the genera created by Kieffer and provided taxonomic stability that is still in use today. Pasteels' (1957) revision has been the most comprehensive treatment of the Australian fauna to date with an additional 76 species described. He also suggested that the Australia fauna has the highest recorded diversity [of any zoogeographic zone]. Although Pasteels (1957) suggested a high level of endemism in the Australian fauna, he also found several species collected in both Australia and Melanesia, suggesting dispersal between the regions. The only recent taxonomic work on the Australian fauna since Pasteels has been the description of a distinctive new species from South Australia (Jennings & Parslow 2014). The Australian *Gasteruption* fauna currently comprises 114 described species (Pasteels 1957b; Jennings 2010; Jennings and Parslow 2014), all belonging to *Gasteruption*.

This work is part of a project which continues the exploration of the Australian Gasteruptiidae and the revision of Australian *Gasteruption*. We present redescription for 90 previously described species, three new species, two synonym and 10 species are inserde sedis. A key to separate the Australian species is provided, along with a discussion of the systematics of *Gasteruption*, a general diagnosis and host associations.

Materials, terminology and abbreviations

Specimens were examined under stereo dissection microscopes using a LED ring light for illumination. Images were taken using a Visionary Digital LK imaging system (Dun, Inc.) with Canon EOS 5DsR camera and concatenated using Zerene Stacker 1.04 software. Image plates were constructed using Adobe Photoshop CS v19.1. Images of the holotypes of *G. angulare* Pasteels*, G. malaicum* Schletterer, and *G. novae-hollandiae* Schletterer are © Geoff Thompson, Queensland Museum. Material marked with an asterisk in the material examined sections indicate imaged specimens.

Descriptions were created initially using CSIRO Open DELTA (Dallwitz *et al.* 1999) and terminology for morphology follows Jennings and Austin (2002) and

Jennings and Parslow (2014), that for wing venation follows the modified Comstock-Needham system after Sharkey (1988), but with some modifications and using the nomenclature of van Achterberg (1979) for cells (see Jennings and Austin 1994a, 1994b, 2002) (Fig. 1a). Terminology for surface sculpturing follows (Harris 1979). Descriptive characters used are based on characters originally used by Pasteels (1957) and more recent regional treatments of Gasteruption (see van Achterberg 2014).

A number of specimens housed at the Natural History Museum (Vienna, Austria) and Museum of Victoria (Melbourne, Victoria, Australia) were unavailable for close examination, so we have relied on lateral and dorsal habitus images of the relevant type specimen to revise the description.

Descriptions are based on females, so for species known exclusively from males (*G. basiantennale* Pasteels, *G. curtigena* Pasteels, *G. fraternum* Pasteels*, G. gibbosum* Pasteels, *G. griseum* Pasteels, *G. luteonasum* Pasteels *G. pasteelsi* Macedo, *G. tricoloripes* Kieffer and *G. victor* Pasteels) we have chosen not to include their descriptions until females can be associated with them. Where morphometric measurements are based on more than one specimen, data are presented as the mean followed by the range. The descriptions of each species were made considering the morphological variation of all the specimens examined. The malar space is the measurement of the shortest distance between the ventrolateral eye margin to the base of the mandible in lateral view, the postocular space is the distance between the posterior margin of the eye measured medially across to the occipital carina posterior margin in lateral view (Fig. 1b). Measurements of the prototegular distance or length of the mesoscutum in front of the tegulum *sensu stricto* Tan *et al.* (2016), are made from the anterior edge of the tegula to the anterior corner of the mesoscutum in lateral view (Fig. 1c). The pronotum is here divided into ventral, dorsal and lateral lobes. The Length of the hind femur includes the prefemur and the length of the ovipositor sheath are measured from the tip of the metasoma.

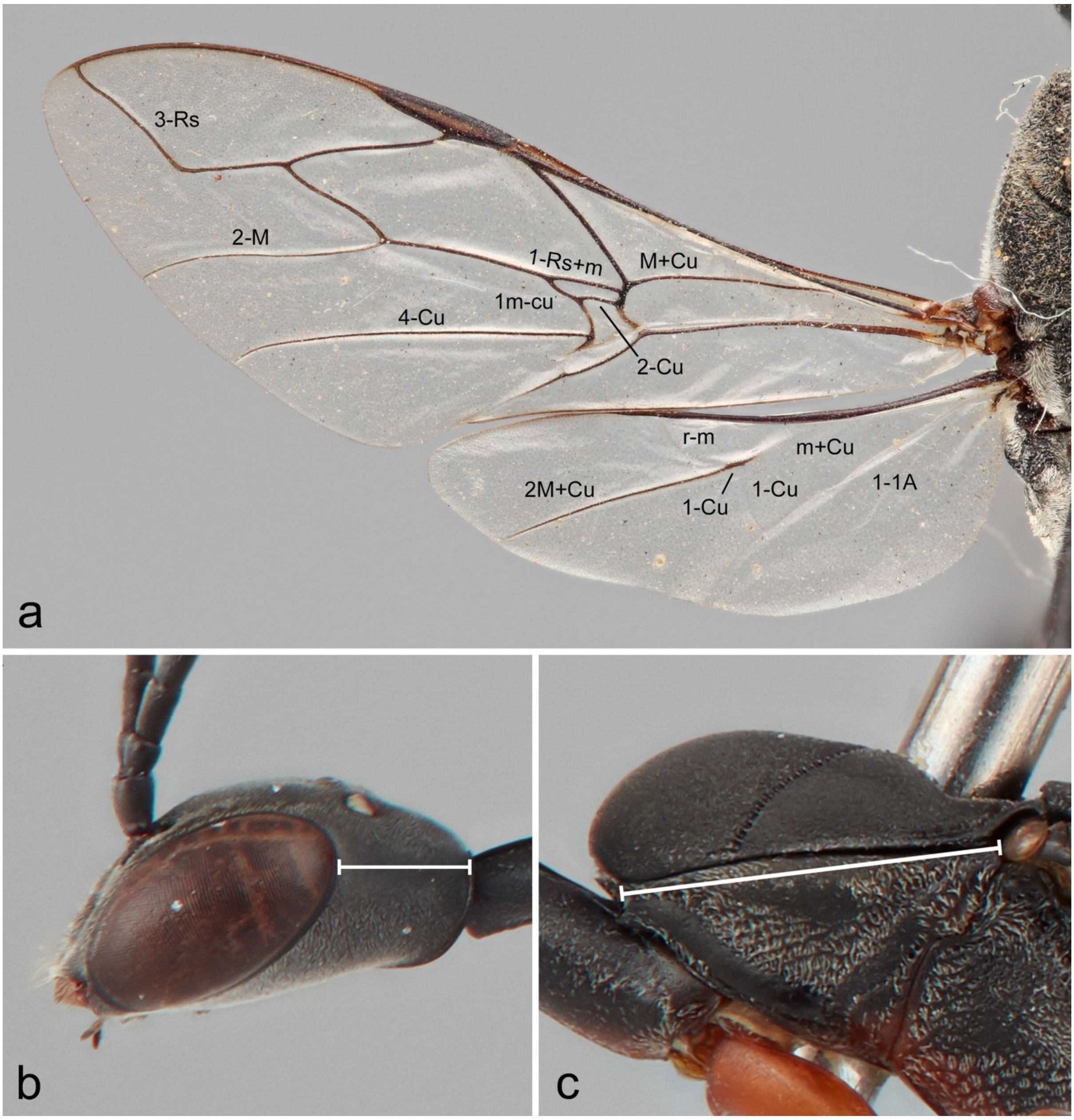

Figure 1. a, Left fore and hind wing of *Gasteruption bicarinatum*, b, Head of *Gasteruption platycephala* in lateral view, white bar indicating measurement for postocular space. b, Lateral mesosoma of *Gasteruption platycephala*, white bar indicating measurement for prototegular distance.

Cream colouration present subbasally on the tibia of some species is defined as either a patch, when not completely encircling the tibia, or as a band when encircling the tibia and meeting on dorsal face. It should be noted that among the specimens there is variation in colouration due to the method of collection (e.g. cyanide, ethyl acetate or ethanol) and storage (light exposure) so, for example, white may appear cream in older specimens and black can fade with age to a dark brown.

The criterial for selection of specimens for imaging was based on complete specimens with the majority of charcters visible for imagaing. In cases where only the holotype material was avalible it was used.

The Australian states are abbreviated as Queensland = QLD, New South Wales = NSW, Victoria = VIC, Australian Capital Territory = ACT, Tasmania = TAS, South Australia = SA, Western Australia = WA, and Northern Territory = NT.

The abbreviations for the institutions that are the repository of the specimens referred to in this paper are:

AMS	Australian Museum, Sydney, New South Wales
BPC	B.A. Parslow research collection (pers. coll.), Adelaide, South Australia. To be deposited in the South Australian Museum, Adelaide, South Australia.
HNHM	Hungarian Natural History Museum, Budapest, Hungary
MHNG	National Museum of Natural History (Museum d'Histoire Naturelle), Geneva, Switzerland
MVMA	Museum of Victoria, Melbourne, Victoria, Australia
NHMUK	The Natural History museum, London, United Kingdom
NHMW	Natural History Museum (Naturhistorisches Museum Wien), Vienna, Austria
NHRS	Swedish Royal Museum of Natural History (Naturhistoriska Riksmuseet), Stockholm, Sweden
OUMNH	Oxford University Museum of Natural History, Oxford, United Kingdom
QDPC	Department of Primary Industries, Brisbane, Queensland, Australia
QM	Queensland Museum, Brisbane, Queensland, Australia
RBINS	Royal Belgian Institute of Natural Sciences (Institut Royal des Sciences

	Naturalles de Belgique), Brussels, Belgium
RGC	R. Glatz research collection, Kangaroo Island, Adelaide (pers. coll.)
RMNH	Naturalis Biodiversity Centre (Nationaal Natuurhistorisch Museum), Leiden, Netherlands
SAMA	South Australian Museum, Adelaide, South Australia, Australia
SDEI	Senckenberg German Entomological Institute (Senckenberg Deutsches Entomologisches Institut), Müncheberg, Germany
SMNS	The State Museum of Natural History Karlsruhe (Staatliches Museum für Naturkunde), Stuttgart, Germany
USNM	US National Museum, Smithsonian Institution, Washington DC, United States of America
WADA	Agriculture Western Australia, Perth, Western Australia, Australia
WAM	Western Australian Museum, Perth, Western Australia, Australia
ZMBD	Museum of Natural History at the University of Humboldt zu Berlin (Museum für Naturkunde an der Universität Humboldt zu Berlin), Berlin, Germany

Systematics Gasteruptiidae

Gasteruptiidae Ashmead, 1900

See Jennings and Austin (2002) for taxonomic history and list of synonyms.

Gasteruptiinae Ashmead, 1900

Gasteruptioninae (in part) Ashmead, 1900: 7.

Gasteruptiinae (in part): Schulz, 1906: 133 [emendation].

See Crosskey (1962) for taxonomic history and list of synonyms, and Macedo (2009) for recent taxonomic changes.

Gasteruption Latreille, 1796

Gasteruption Latreille, 1796: 113 [description].

Type species: *Ichneumon assectator* Linnaeus, 1758, by monotypy (Latreille, 1802: 329, assignment of single species to *Gasteruption*).

See Crosskey (1962) and Carlson (1979) for taxonomic history and list of synonyms.

Diagnosis. The diagnosis is based on the Australian fauna and is modified from Jennings & Austin (2002) with additional characters from Macedo (2009).

Medium to large in size (5.71–26.30 mm); head wider than long (Fig. 3) or longer than wide in dorsal view (Fig. 25), length of malar space plus mandibles about as long or longer than height of eye; mandibles short, not overlapping when closed (rarely medium length and slightly overlapping when closed), inner margin with medial tooth; labio-maxillary complex elongate, protruding well below mandibles; frontal medial carina present between antennae, raised, a shallow groove or indistinct posteriorly; pronotum with distinct or indistinct processes at dorso-anterior corner; mesoscutum longer than wide, rarely wider than long in dorsal view; notauli scrobiculate; propodeum separated from metapleuron by carinate furrow, with short or percurrent medial longitudinal carina; prefemur on hind leg; hind trochanter with transverse groove; first discal cell formed by fore wing vein 1-Rs+M joining M+Cu, with vein 2-Cu not totally fused or totally fused with 1-Rs+M (Fig. 1a). Female hypopygium notched or slit like; ovipositor exserted beyond apex of metasoma (Fig.5).

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Key to Australian *Gasteruption* Latreille (females only)

A total of 98 species are treated in the following key; 95 described, three new species and 9 known only from males and excluded. This key is based on adult females and should be treated with some caution due to the limited number of specimens available for some species during the construction of the key.

1. Hind tibia with white/cream patch or band subbasally (e.g., Fig. 2). 2

- Hind tibia without white/cream patch or band subbasally (e.g., Fig. 10) (tibia mostly yellow-brown for *G. species 3* **sp. nov.**, Fig. 100). 3

2 (1). Head in dorsal view sub-conical (e.g., Fig. 6). 4

- Head in dorsal view sub-rectangular e.g., (Fig. 8). 5

3 (1). Lateral ocelli anterior of postocular line in dorsal view. 78

- Lateral ocelli in-line or posterior of postocular line in dorsal view. 79

4 (2). Single fore wing first discal cell open (e.g., Fig. 39)..6

- Two fore wing discal cells (Fig. 1a). 7

5 (2). Lateral ocelli anterior of postocular line in dorsal view....................................35

- Lateral ocelli in-line or posterior of postocular line in dorsal view. 36

6 (4). All hind wing veins spectral (e.g., Fig. 8). 8

- Hind wing vein 2m+Cu and/or 1-m pigmented (Fig. 1a). 9

7 (4). All hind wing veins spectral (e.g., Fig. 8). 11

- Hind wing vein 2m+Cu and/or 1-m pigmented (Fig. 1a). 12

8 (6). 1st flagellomere length 0.75 (0.71–0.79) × length of scape; propleuron length 1.15 (1.13–1.17) × prototegular distance; mesoscutum in lateral view truncated (Fig. 39). .... *G. fluviale* Turner

- 1st flagellomere length 1.07 × length of scape; propleuron length 2.37 × prototegular distance; mesoscutum in lateral view rounded (Fig. 49). ....*G. isthmale* (Turner)

9 (6). Notauli incomplete; lateral ocelli anterior of postocular line in dorsal view. ....*G. jocosum* Pasteels

- Notauli U-shaped; lateral ocelli in-line or posterior of postocular line in dorsal view. 10

10 (9). Mesosoma completely black; metasoma length 5.10 × mesosoma length; ovipositor sheath 1.39 × metasoma length. ....*G. cephalotes* Pasteels

- Mesosoma orange-brown ventrally; metasoma length 2.74 (1.88–3.22) × mesosoma length; ovipositor sheath 0.42 (0.41–0.42) × metasoma length ....*G. curticauda* Pasteels

11 (7). Ovipositor sheath ≤ 1.00 × metasoma length (e.g, Fig. 6). 13

- Ovipositor sheath > 1.00 × metasoma length (e.g., Fig. 2). 14

12 (7). Mesosoma with reddish-brown or brown colouration (e.g., Fig. 15, 23). 21

- Mesosoma completely black (e.g., Fig. 10)...22

13 (11). Notauli U-shaped; mesosoma length 2.98 (2.17–3.32) × width in dorsal view; metasoma with light brown bands on apical margin of sternites and tergites. .... *G. angusticeps* Kieffer

- Notauli incomplete; mesosoma length < 2.00 × width in dorsal view; metasoma black/ dark brown...15

14 (11). 1st hind tarsomere > 3.00 × length of 2nd hind tarsomere; lateral ocelli in-line or anterior of postocular line in dorsal view. 16

- 1st hind tarsomere < 3.00 × length of 2nd hind tarsomere; lateral ocelli posterior of postocular line in dorsal view. 17

15 (13). Propleuron length 1.71 (1.60–1.83) × width (Fig. 31); 1.03 (0.96–1.10) ×

prototegular distance; ovipositor sheath apex flared. ....*G. exile* (Turner)

- Propleuron length 2.45 (2.32–2.57) × width (Fig. 81); 1.41 (1.35–1.51) × prototegular distance; ovipositor sheath uniform width. .... *G. raphidioides* (Westwood)

16 (14). Mesosoma with reddish-brown or brown colouration (e.g., Fig. 56). 18

- Mesosoma completely black (e.g., Fig. 27). 19

17 (14). Postocular space in lateral view distinctly tapering to sub-conical shape; ovipositor sheath uniform width (e.g., Fig. 60). 20

- Postocular space in lateral view not sub-conical in shape; ovipositor sheath slightly flared. ....*G. longipes* Pasteels

18 (16). Minimal width of malar space 0.04 × length of pedicel; 1st flagellomere length 1.26 × length of scape; metasoma length 3.18 × mesosoma length...... *G. longicolle* Schletterer

- Minimal width of malar space 0.11 × length of pedicel; 1st flagellomere length 0.63 × length of scape; metasoma length 1.99 × mesosoma length; hind coxa and femur distinctly swollen. ....*G. mirabilifemorale* Pasteels

19 (16). Clypeus width ~1.45 × height; lateral ocelli anterior of postocular line in dorsal view; mesosoma length 2.95 (2.93–2.97) × height. ....*G. albicuspis* Kieffer

- Clypeus width ~2.30 × height; lateral ocelli in-line of postocular line in dorsal view; mesosoma length 2.20 (2.18–2.23) × height. .... *G. differens* Pasteels

20 (17). Clypeus width 2.42 × height; propleuron length 1.60 × width; length of cream/white apex of ovipositor sheath 3.33 × length of 1st hind tarsomere ....*G. luteidens* Pasteels

- Clypeus width 1.76 × height; propleuron length 2.19 × width; length of cream/white apex of ovipositor sheath 2.57 × length of 1st hind tarsomere. .... *G. prolongatum* Pasteels

21 (12). Fore wing vein SR1 distinctly bent (e.g., Fig. 12). 23

- Fore wing vein SR1 weakly bent, sinuate or straight (e.g., Fig. 16). 24

22 (21). Minimal width of malar space 0.88 × length of pedicel; ovipositor sheath 1.28 × metasoma length; apex flared. ....*G. erythrarthrum* Pasteels

- Minimal width of malar space 0.26 × length of pedicel; ovipositor sheath 0.72 × metasoma length; apex uniform width. . ... *G. uniform* Pasteels

23 (21). Ovipositor sheath apex flared (e.g., Fig. 31). 25

- Ovipositor sheath apex uniform width (e.g., Fig. 81)..26

24 (21). 1st flagellomere length < 0.50 × 2nd flagellomere (e.g., Fig. 27). 27

- 1st flagellomere length > 0.50 × 2nd flagellomere (e.g., Fig. 42). 28

25 (23). Minimal width of malar space 0.86 (0.73–1.00) × length of pedicel; ovipositor sheath 0.60 × metasoma length; length of cream/white apex of ovipositor sheath ~1.20 × length of 1st hind tarsomere.
....*G. dewitzi* Schletterer

- Minimal width of malar space ~0.37 × length of pedicel; ovipositor sheath ~1.65 × metasoma length; length of cream/white apex of ovipositor sheath ~2.38 × length of 1st hind tarsomere.
.... *G. granulare Pasteels*

26 (23). Distinctive species with body mostly reddish-brown, large horn like medial carinae, distinct in lateral view; ovipositor sheath 2.15 (2.11–2.19) × metasoma length; length of cream/white apex of ovipositor sheath 3.28 (3.10–3.40) × length of 1st hind tarsomere. . ... *G. cornutum* Pasteels

- Ovipositor sheath 1.55 (1.13–1.76) × metasoma length; length of cream/white apex of ovipositor sheath 2.26 (2.09–2.54) × length of 1st hind tarsomere.
.... *G. novae-hollandiae* Schletterer

27 (24). Propleuron length ~0.70 × prototegular distance; tibia length ~4.8 × width; Lateral ocelli anterior of postocular line in dorsal view.

....*G. combinatum* Pasteels

- Propleuron length 1.33 (1.29–1.36) × prototegular distance; tibia length 5.45 (5.32–5.61) × width; Lateral ocelli posterior of postocular line in dorsal view.
.... *G. platycephala* Pasteels

28 (24). Minimal width of malar space > 1.00 × length of pedicel (Fig. 75); 3rd hind tarsomere < 2.00 × length of 4th hind tarsomere............... *G. plicatulum* Pasteels

- Minimal width of malar space < 1.00 × length of pedicel; 3rd hind tarsomere > 2.00 × length of 4th hind tarsomere. 29

29 (28). Scape length < 2.00 × pedicel length; 1st hind tarsomere < 3.00 × length of 2nd hind tarsomere; Ovipositor sheath 0.89 (0.81–0.98) × metasoma length; length of cream/white apex of ovipositor sheath 2.27 (2.04–2.50) × length of 1st hind tarsomere. ....*G. genale* Schletterer

- Scape length > 2.00 × pedicel length; 1st hind tarsomere > 4.00 × length of 2nd hind tarsomere; Ovipositor sheath ~1.60 × metasoma length; length of cream/white apex of ovipositor sheath ~1.60 × length of 1st hind tarsomere.
....*G. longipleurale* Pasteels

30 (5). Minimal width of malar space < 0.10 × height of eye (e.g., Fig. 11). 32

- Minimal width of malar space > 0.10 × height of eye (e.g., Fig.78). 40

31 (5). Lateral ocelli posterior of postocular line in dorsal view. 45

- Lateral ocelli in-line with postocular line in dorsal view. 46

32 (30). Mesonotum with reddish-brown or brown colouration (e.g., Fig.47). 33

- Mesonotum completely black (e.g., Fig. 22, sometimes will feint brown colouration on lateral margin e.g., Fig. 30). 34

33 (32). Fore wing vein r-m absent. (Fig. 1a) 35

- Fore wing vein r-m spectral (Fig. 87)..36

34 (32). Clypeus lateral corners distinctly protruding forward of margin; distance from lateral ocellus to eye margin equal distance between lateral ocelli; fore wing vein SR1 weakly bent. .... *G. nervosum* (Kieffer)

- Clypeus lateral corners barley protruding forward of margin; distance from lateral ocellus to eye margin 0.50 × distance between lateral ocelli: fore wing vein SR1 distinctly bent. 38

35 (33). 1st hind tarsomere long, < 8.00 (8.50–9.19) × length of 2nd hind tarsomere (Fig. 11); length of cream/white apex of ovipositor sheath 0.66 (0.62–0.69) × length of 1st hind tarsomere. ....*G. brachyurum* Schletterer

- 1st Hind tarsomere long, < 4.00 × length of 2nd Hind tarsomere; length of cream/white apex of ovipositor sheath > 4.00 × length of 1st hind tarsomere…37

36 (33). Minimal width of malar space 0.80 (0.60–1.00) × length of pedicel; single fore wing first discal cell open.
.... *G. primotarsale* Pasteels

- Minimal width of malar space < 0.30 × length of pedicel; two fore wing discal cells
.... *G. tenellum* Schletterer

37 (35). Hind tarsus dark brown with no cream colouration (Fig. 63); ovipositor sheath ~0.90 × metasoma length; apex flared.............. *G. melanopoda* Pasteels

- Hind tarsus cream (often dark brown/black basally and apically) (Fig. 92); ovipositor sheath 1.12 (1.01–1.24) × metasoma length; apex uniform width.
....*G. variegatum* Schletterer

38 (34). Mesoscutum length ~2.95 × width in dorsal view; notauli V-shaped.
....*G. inferius* Pasteels

- Mesoscutum length < 1.50 × width in dorsal view; notauli U-shaped. 39

39 (38). Pronotum black; clypeus width ~1.90 × height; scape length ~1.76 × pedicel length. .... *G. cribatum* Pasteels

- Pronotum brown (Fig.30); clypeus width ~2.50 × height; scape length ~2.20 ×

pedicel length. .... *G. species 1* **sp. nov.**

40 (30). Ovipositor sheath < 1.00 × metasoma length (e.g., Fig. 98). 41

- Ovipositor sheath > 1.00 × metasoma length (e.g., Fig. 17). 42

41 (45). Body black; length 4th hind tarsomere > 1.00 × length of 5th hind tarsomere (Fig. 98); hind wing veins spectral; ovipositor sheath < 0.30 × metasoma length; metasoma with apical margins of tergites and sternites light brown/brown. .... *G. zebriforme* Pasteel

- Body black with reddish-brown; length 4th hind tarsomere < 1.00 × length of 5th hind tarsomere (Fig. 7); hind wing veins with 2m+Cu pigmented; ovipositor sheath > 0.80 × metasoma length; metasoma tergites and sternites without apical colouration. ....*G. apicale* Pasteels

42 (40). Length of cream/white apex of ovipositor sheath < 2.00 × length of 1st hind tarsomere (e.g., Fig. 4). 43

- Length of cream/white apex of ovipositor sheath > 2.00 × length of 1st hind tarsomere (Fig. 15). 44

43 (42). Length 1st hind tarsomere ~2.65 × length of 2nd hind tarsomere; metasoma length ~1.96 × mesosoma length...................................... *G. amoenum* Pasteels

- Length 1st hind tarsomere 3.50 (3.15–3.80) × length of 2nd hind tarsomere; metasoma length 2.70 (2.60–2.80) × mesosoma length .... *G. cinerescens* Pasteels

44 (42). Distinctive species, body mostly reddish-black, head black (Fig. 78); length of cream/white apex of ovipositor sheath 5.47 (5.31–5.63) × length of 1st hind tarsomere; apex uniform width...........................*G. quinquemaculatum* Pasteels

- Body mostly black with variable amounts of red/brown (e.g., Fig. 55); length of cream/white apex of ovipositor sheath < 4.00 × length of 1st hind tarsomere; apex flared. 72

45 (31). Ovipositor sheath < 1.00 × metasoma length (e.g., Fig. 25). 47

- Ovipositor sheath > 1.00 × metasoma length (e.g., Fig. 19). 48

46 (36). Fore wing vein SR1 distinctly bent. 52

- Fore wing vein SR1 weakly bent or straight. 53

47 (45). Distinctive species, body and head extremely elongated, cylindrical in shape (Fig. 25); mesoscutum length 3.39 (3.25–3.50) height in dorsal view; ovipositor sheath with cream/white apex... *G. cylindricum* (Turner)

- Mesoscutum length < 2.00 height in dorsal view; ovipositor sheath without cream/white apex. 49

48 (45). Hind tarsus dark brown with no cream colouration (e.g., Fig. 33). 50

- Hind tarsus cream/white (often with black/dark brown basally and apically) (e.g., Fig 69). 51

49 (47). Body mostly reddish-brown (Fig. 97); notauli U-shaped. ....*G. zebraithos.* **sp. nov.**

- Body mostly orange-brown, head black (Fig. 99); notauli V-shaped. ....*G. zebroides* Pasteels

50 (48). Minimal width of malar space ~0.10 × length of pedicel; propleuron length ~0.85 × prototegular distance. .... *G. compressiceps* Pasteels

- Minimal width of malar space 0.03 (0.02–0.04) × length of pedicel; propleuron length 1.18 (1.10–1.30) × prototegular distance. ....*G. fibula* Pasteels

51 (48). Pronotum with brown colouration; mesosoma length ~1.30 × height in lateral view; pronotal process short and rounded; all hind wing veins spectral; ovipositor sheath ~1.30 × metasoma length. ....*G. elegans* Pasteels

- Pronotum with brown colouration; mesosoma length 2.29 (2.23–2.35) × height in lateral view; pronotal process indistinct; hind wing vein 2m+Cu pigmented; ovipositor sheath 2.90 (2.69–3.10) × metasoma length...........*G. nobile* Pasteels

- Pronotum black; mesosoma length > 3.00 × height in lateral view; pronotal process absent. ....*G. mixtum* Pasteels

52 (46). Posterior margin of vertex emarginate medially...54

- Posterior margin of vertex rounded medially..55

53 (46). Ovipositor sheath < 1.00 × metasoma length (e.g., Fig. 32). 67

- Ovipositor sheath > 1.00 × metasoma length (e.g., Fig. 34). 68

54 (52). Length of cream/white apex of ovipositor sheath > 3.00 × length of 1st hind tarsomere (e.g., Fig. 2). 56

- Length of cream/white apex of ovipositor sheath < 3.00 × length of 1st hind tarsomere (e.g., Fig. 44). 57

55 (52). Scape length < 2.00 × length of pedicel (e.g., Fig. 73). 62

- Scape length > 2.00 × length of pedicel...64

56 (54). Head length > 1.00 × width in dorsal view. 58

- Head length < 1.00 × width in dorsal view. 92

57 (54). 1st flagellomere length < 1.00 × length of scape (e.g., Fig 72). 59

- 1st flagellomere length > 1.00 × length of scape (e.g., Fig. 41). 60

58 (56). Minimal width of malar space ~0.45 × length of pedicel; mesosoma length ~1.95 × height; hind wing hamuli spacing equidistant. ..... *G. acuticeps* Pasteels

- Minimal width of malar space 0.75 (0.70–0.80) × length of pedicel; mesosoma length 2.35 (2.10–2.60) × height; hind wing hamuli spacing, distance between basal and middle hamuli greater than distance between middle and apical. .... *G. malaicum* Schletterer

59 (57). Minimal width of malar space 0.40 (0.03–0.05) × height of eye; ovipositor sheath 0.94 × metasoma length; length of cream/white apex of ovipositor sheath 2.00 × length of 1st hind tarsomere; apex flared..... *G. globiceps* Pasteels

- Hind coxa, femur and tibia distinctly swollen (Fig. 72); minimal width of malar space 0.15 × height of eye; ovipositor sheath 0.58 × metasoma length; length of cream/white apex of ovipositor sheath 1.26 × length of 1st hind tarsomere; apex uniform width; distinctly enlarged hind coxa and femur. ... *G. pachypus* Pasteels

60 (57). Minimal width of malar space ~0.20 × height of eye; propleuron length >2.00 × prototegular distance. .... *G. lampropleurum* (Kieffer)

- Minimal width of malar space 0.40 × height of eye; propleuron length < 2.00 × prototegular distance 61

61 (60). Pronotum completely black; propleuron length < 2.00 × prototegular distance.. *G. atrinerve* (Kieffer)

- Pronotum brown; propleuron length > 2.00 × prototegular distance. .... *G. terminale* (Westwood)

62 (55). Minimal width of malar space 0.80 × length of pedicel; clypeus width > 2.00 × height. .... *G. peregrinum* Schletterer

- Minimal width of malar space 0.50–0.55 × length of pedicel; clypeus width < 2.00 × height. 63

63 (62). Pronotum brown; pronotal process acute (Fig. 21); ovipositor sheath apex cream/white... *G. crassitibale* Pasteels

- Pronotum completely black; pronotal process indistinct (Fig. 71); ovipositor sheath completely black/ dark brown...*G. oculare* Schletterer

64 (55). Minimal width of malar space 0.06–0.08 × height of eye; 0.43–0.83 × length of pedicel...65

- Minimal width of malar space 0.11–0.12 × height of eye; 1.00–1.14 × length of pedicel...66

65 (64). Mesonotum completely black; clypeus width 2.48 (2.46–2.50) × height. .... *G. fuscipes* Pasteels

- Mesonotum anterior corners reddish-brown (Fig. 88); clypeus width ~1.80 × height.

.... *G. trianguliceps* Pasteels

66 (64). Ovipositor sheath with cream/white patch subapically (dark brown apex) (Fig. 8); 1st flagellomere length 0.67 × length of scape; mesoscutum length 1.19 × width in dorsal view; length of cream/white apex of ovipositor sheath 3.04 × length of 1st hind tarsomere. .... *G. apicomaculatum* Pasteels

- Ovipositor sheath apex cream/white (Fig. 94); 1st flagellomere length 1.00 × length of scape; mesoscutum length 2.65 × width in dorsal view; length of cream/white apex of ovipositor sheath 2.19 × length of 1st hind tarsomere. .... *G. villosulum* Pasteels

67 (53). Hind femur orange-brown, apex black (Fig. 32); hind wing vein 2m+Cu and/or 1-m pigmented; hypopygium Y-shaped. .... *G. femorale* Pasteels

- Hind femur black/ dark brown; All hind wing veins spectral; hypopygium V-shaped. 69

68 (53). Scape length > 2.00 × pedicel length. 70

- Scape length < 2.00 × pedicel length. 71

69 (67). Mesosoma length 2.10 × height; notauli U-shaped; hind tarsus black/ dark brown. .... *G. fibuloides* Pasteels

- Mesosoma length 1.55 (1.53–1.60) × height; notauli V-shaped; hind tarsus cream/white; metasoma with light brown bands on apical margin of sternites and tergites (Fig. 96). .... *G. zebra* Pasteels

70 (68). Minimal width of malar space ~0.70 × length of pedicel; femur length ~0.70 × tibia length .... *G. fibuliforme* Pasteels

- Minimal width of malar space ~0.33 × length of pedicel; hind coxa distinctly elongated; femur length ~1.47 × tibia length...................... *G. leptothecus* Kieffer

71 (68). 1st flagellomere length ~1.06 × length of scape; length of cream/white apex of ovipositor sheath ~2.90 × length of 1st hind tarsomere. *G. leucostictum* Kieffer

- 1st flagellomere length ~0.58 × length of scape; length of cream/white apex of ovipositor sheath ~1.40 × length of 1st hind tarsomere. ....*G. quadraticeps* Pasteels

72 (44). Mesonotum completely reddish-brown; minimal width of malar space > 0.30 × length of pedice (Fig. 15)l; four equidistant hamuli. ....*G. capitale* Pasteels

- Mesonotum completely black/dark brown; minimal width of malar space 0.15 (0.13–0.16) × length of pedicel (Fig. 55); five hamuli, basal three hamuli close together, separated from distal pair. ....*G. lineatum* Pasteels

73 (3). Mesonotum completely black/dark brown. 75

- Mesonotum with reddish-brown or yellow colouration. 76

74 (3). Clypeus margin sinuate. 82

- Clypeus margin concave. 83

75 (73). Ovipositor sheath < 1.00 × metasoma length (e.g., Fig. 68). 77

- Ovipositor sheath > 1.00 × metasoma length (e.g., Fig. 37). 78

76 (73). Distinctive yellowish-orange species (Fig. 100); ovipositor sheath > 1.00 × metasoma length. .... *G. species 3* **sp. nov.**

- Ovipositor sheath < 1.00 × metasoma length. 81

77 (75). Mesosoma length 1.46 × height; length of cream/white apex of ovipositor sheath 0.60 × length of 1st hind tarsomere ....*G. nigridens* Pasteels

- Mesosoma length 2.00–2.25 × height; length of cream/white apex of ovipositor sheath 1.90–2.16 × length of 1st hind tarsomere 79

78 (75). Clypeus margin sinuate; tibia length ~8.0 × width. ....*G. varians* Pasteels

- Clypeus margin concave; tibia length 5.53–5.73 × width. 80

79 (77). Mesoscutum in lateral view truncated; notauli incomplete; hind wing veins spectral; cream/white ovipositor sheath apex distinctly flared. ....*G. longiscapum* Pasteels

- Mesoscutum in lateral view rounded; notauli U-shaped; hind wing vein 2m+Cu pigmented; cream/white ovipositor sheath apex indistinctly flared. .... *G. rubripes* Pasteels

80 (78). Scape length 2.50 × pedicel length; length of cream/white apex of ovipositor sheath ~3.30 × length of 1st hind tarsomere. .... *G. flavicans* Pasteels

- Scape length 1.75 × pedicel length; length of cream/white apex of ovipositor sheath ~5.70 × length of 1st hind tarsomere. ....*G. melanostoma* Pasteels

81 (76). Scape length 1.85 × pedicel length; distance from lateral ocellus to eye margin 0.91 × distance between lateral ocelli; 5th hind tarsomere cream. .... *G. burnsi* Pasteels

- Scape length 2.26 (2.18–2.40) × pedicel length; distance from lateral ocellus to eye margin 0.46 (0.39–0.52) × distance between lateral ocelli; 5th hind tarsomere dark brown. ....*G. spinigerum* Schletterer

82 (74). Lateral ocelli posterior of postocular line in dorsal view; hind tarsus black/dark brown (e.g., Fig 95). 84

- Lateral ocelli in-line of postocular line in dorsal view; hind tarsus cream/white (e.g., Fig. 53). 85

83 (74). Posterior margin of vertex emarginate medially, clypeus lateral corners distinctly protruding forward. 90

- Posterior margin of vertex rounded medially; clypeus lateral corners barely protruding forward. 91

84 (82). Distinctive species, body and head extremely elongated (Fig. 95); clypeus width 0.32 × height; scape length 2.64 (2.35–2.84) × pedicel length; notauli U-shaped. ....*G. youngi* Jennings & Parslow

- Clypeus width 2.36 (2.21–2.50) × height; scape length 1.47 (1.40–1.54) × pedicel length; notauli incomplete. ....*G. filiforme* Pasteels

85 (82). Mesonotum with reddish-brown colouration. 86

- Mesonotum completely black/dark brown. 87

86 (85). Mesosoma length 1.77 (1.70–1.83) × height; ovipositor sheath 3.55 (0.41–0.42) × metasoma length; ovipositor sheath with very long cream/white apex 14.68 (11.56–17.06) × length of 1st hind tarsomere. .... *G. calothecus* Kieffer

- Mesosoma length 2.16 × height; ovipositor sheath < 3.00 × metasoma length; ovipositor sheath cream/white apex < 10.00 × length of 1st hind tarsomere. .... *G. leucopus* Schletterer

87 (85). Ovipositor sheath < 1.00 × metasoma length; hind wing hamuli spacing equidistant. 88

- Ovipositor sheath > 1.00 × metasoma length; hind wing hamuli spacing, distance between basal and middle hamuli greater than distance between middle and apical. 89

88 (87). Minimal width of malar space ~0.03 × height of eye; 1st hind tarsomere 2.20 × length of 2nd hind tarsomere. .... *G. fuscimanus* Kieffer

- Minimal width of malar space ~0.11 × height of eye; 1st hind tarsomere 3.32 (3.29–3.36) × length of 2nd hind tarsomere. ....*G. secundum* Pasteels

89 (87). Minimal width of malar space ~0.03 × length of pedicel; tibia length ~6.70 × width; ovipositor sheath ~1.90 × metasoma length; body covered in medium dense setose. .... *G. angulare* Pasteels

- Minimal width of malar space 0.75 (0.70–0.80) × length of pedicel; tibia length 5.20 × width; ovipositor sheath 1.56 × metasoma length....... *G. malaicum* Schletterer

90 (83). Minimal width of malar space 1.35 (1.33–1.38) × length of pedicel; ovipositor sheath 0.90 × metasoma length. .... *G. bicarinatum* (Turner)

- Minimal width of malar space 0.58 (0.50–0.67) × length of pedicel; ovipositor sheath 3.60 × metasoma length. ....*G. flavitarse* (Guerin-Menevile)

91 (83). Minimal width of malar space 0.12 (0.10–0.16) × height of eye; length of cream/white apex of ovipositor sheath 4.98 (4.68–5.29) × length of 1st hind tarsomere. .... *G. breviscutum* Kieffer

- Minimal width of malar space ~0.05 × height of eye; length of cream/white apex of ovipositor sheath ~8.00 × length of 1st hind tarsomere. .. *G. nigerrimum* Pasteels

92 (56). Scape length 1.86 × pedicel length; 1st flagellomere length 0.85 × length of scape; mesoscutum length 1.33 × width in dorsal view........*G. inflatum* Pasteels

- Scape length 2.31 × pedicel length; 1st flagellomere length 0.67 × length of scape; mesoscutum length 2.71 × width in dorsal view ....*G. simillimum* Schletterer

Descriptions of species

Gasteruption acuticeps Pasteels, 1957

Fig. 2.

Gasteruption acuticeps Pasteels 1957: 81, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Pine Is[land Reserve], Murrumbidgee R[iver], Fed. Cap. Territ. [ACT] 26.x.[19]30, L.GRAHAM" (ANIC).

Specimen damage. Left fore wing damaged, in gelatine capsule, ovipositor sheaths are broken at apex of metasoma but still attached to ovipositor.

Redescription. *Female*. Body length 13.11 mm; ovipositor length 11.43 mm.

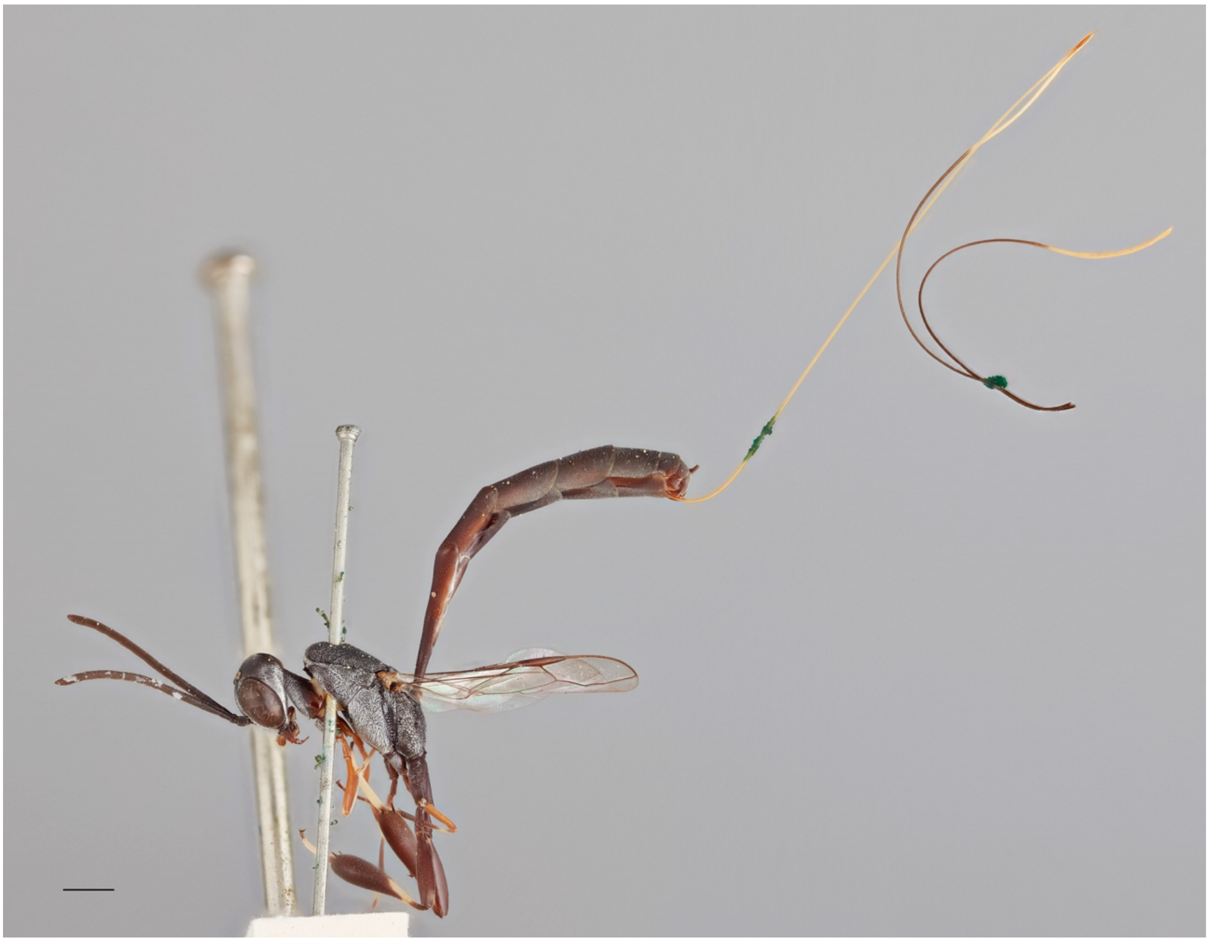

Figure 2. *Gasteruption acuticeps* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Colour. Black; antenna and mandibles dark brown; propleuron lighter posteriorly, tegula light brown; fore leg mostly brown, coxa dark brown, tibia with cream stripe on anterior face, 1st to 3rd tarsomere cream; mid leg similar to for leg with only 1st tarsomere cream; hind leg mostly dark brown, tibia with cream patch sub-basally mainly on posterior face, tarsus cream, base of 1st, 5th tarsomere and claw dark brown; metasoma dark brown; ovipositor sheath dark brown with cream apex 3.88 × length of 1st tarsomere; ovipositor light brown; wings hyaline, wing veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.86 × width, postocular space dorsally tapering behind eye to occipital carina; head in lateral view postocular space medium length, 0.40 × height of eye; eye setae present; face rugulose with long dense shiny setae; frons rugulose with short scattered setae, denser sub laterally on eye margin; medial frontal carina present between antennal scrobes, absent posteriorly; vertex rugulose with short setae; narrow lamelliform occipital carina, becoming wider ventro-laterally; depression broad, emarginate medially; gena rugulose with dense shiny setae; minimal width of malar space 0.05 × height of eye; 0.45 × length of pedicel; clypeus punctulate, 2.46 × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression present anteriorly, long dense shiny setae; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.58 × distance between lateral ocelli; scape 1.70 × length of pedicel, 1st flagellomere 0.94 × length of scape; 0.59 × length of 2nd flagellomere.

Mesosoma. Mesosoma length 1.95 × height; propleuron length 1.33 × width; 0.88 × prototegular distance, rugose with scattered shallow punctures on dorso-lateral posterior surface, shiny long setae, denser lateral-ventrally; pronotal process in dorsal view small, acute and pointed outwards; pronotum rugose, groove between pronotum lobes crenulate, long dense shiny setae; mesoscutum length 1.46 × width in dorsal view rounded in lateral view, rugose with short scattered setae; admedial lines distinct converging slightly; 0.23 × medial lobe; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugose with scattered punctures and scattered short setae; mesepisternum rugose with long dense shiny setae; mesepimeron depression beginning as glabrous, becoming crenulated; metapleuron areolate with long dense shiny setae; propodeum areolate, medial carinae flattened, long dense setae.

Legs. Hind coxa rugulose tending to strigate-rugulose posterior-apically, femur short; 0.70 × length of tibia; tibia length 4.60 × width; short dense setae with scattered stout raised setae on anterior face; 1st tarsomere 3.20 × length of 2nd tarsomere; 2nd tarsomere 1.40 × length of 3rd tarsomere; 3rd tarsomere 1.70 × length of 4th tarsomere; 4th tarsomere 0.55 × length of 5th tarsomere; tarsal claw 0.55 × length of 5th tarsomere.

Wings. Fore wing with single rectangular discal cell, vein r-m absent, vein SR1 distinctly bent, vein 2-M tubular in basal third with node, pigmented remaining two thirds; hind wing vein 1-m lightly pigmented, the apical third of 2m+Cu on right hind wing in the type is pigmented, others veins spectral, three equidistant hamuli.

Metasoma. Metasoma 2.87 × mesosoma length; hypopygium Y-shaped;

ovipositor sheath 1.47 × metasoma length, short appressed setae.

Male. Unknown

Distribution. This species is known only from the holotype locality of Pine Islands Reserve, ACT.

Biology. Unknown.

Comments. *Gasteruption acuticeps* keys out with *G. malaicum* and can be separated by the minimal width of malar space 0.45 × length of pedicel, mesosoma length 1.95 × height and hind wing hamuli spacing equidistant. *G. acuticeps* is known only from Pine Island Reserve, ACT where *G. malaicum* I known from various localities across QLD.

Gasteruption albicuspis **Kieffer, 1911**
Fig. 3.

Figure 3. *Gasteruption albicuspis* Kieffer, holotype female, lateral habitus, scale bar = 1.00 mm.

Gasteruption albicuspis Kieffer, 1911: 190, ♀, ♂; Kieffer, 1912: 341, ♀, ♂; Pasteels 1957: 71, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀*, "Mackay [QLD] 3, 04" "45/" "*Gasteruption albicuspis* Kieffer 1911" (NHM: 3a. 184).

Specimen damage. Left antenna 4th flagellomere to tip missing, right antenna 5th flagellomere to tip missing.

Other material examined. **QLD:** 1♀, Palmis N.Q., 20.xii-i.1930, I.M. Mackerras (ANIC), 1♀, Meringa, 26.xii.1946, J. Rosser (QM). 1♀, Iron Range, Cape York Pesinsula, 28.iv–4.v.1968, G. Monteith (QM). 1♀, Gap creek, Mt Finnigan, 13-16.v.1981, I.D. Naumann (ANIC: 32 101331).

Redescription. *Female*. body length 12.60 (12.20–13.00) mm; ovipositor length 11.00 (10.50–11.50) mm.

Colour. Head mainly black with dark brown body; antenna dark brown, base of scape, clypeus medially and malar space brown, lateral corners of clypeus lighter, mandibles light brown with darker teeth apex; propleuron light brown apex and base, pronotum brown, darker dorsally; mesepisternum lighter posterior ventral corner, metapleuron lighter ventrally; fore and mid leg mostly brown, femur lighter apically, fore tibia lighter at base, mid tibia lighter apically, fore tarsus cream, 4th tarsomere to tip light brown, mid tarsus cream, 3rd tarsomere to tip brown; hind leg mostly dark brown, tibia with cream patch subapically on interior face, tarsus cream with the base of 1st tarsomere and 4th tarsomere to claw dark brown; metasoma light brown, darker dorsally, T1 and most of T2 dark brown; ovipositor sheath dark brown, ovipositor apex 2.48 (2.37–2.59) × length of hind 1st tarsomere, ovipositor light brown; wings hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; length 0.71 (0.71–0.72) × width, sharply tapering directly behind eye; head in lateral view face elongated with short postocular space; 2.00 (0.18–0.26) × height of eye; malar space long, minimal width 0.12 × height of eye; 0.77 (0.77–0.78) × length of pedicel; eye setae absent; face and frons with fine granular sculpturing, short shiny dense setae; medial frontal carina present as a indistinct shallow groove; vertex fine granular sculpturing, scattered fine puncture between ocelli with short scattered setae; occipital carina narrow, lamelliform, depression deep and rounded; gena fine granular sculpturing with short dense shiny setae; clypeus punctate; 1.46 (1.43–1.5) × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression indistinct, short shiny setae, longer along margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.55 (0.54–0.57) × distance between lateral ocelli; scape 1.53 (1.47–1.6) × length pedicel; 1st flagellomere 1.35 (1.23–1.47) × as long as scape; 0.58 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.95 (2.93–2.97) × height; propleuron length 1.36 (1.34–1.38) × width; 0.99 (0.96–1.03) × prototegular distance; propleuron fine granular sculpturing with medium (compared to face) dense shiny setae; pronotal process large and acute; pronotum fine rugulose dorsally, coarser on posterior and anterior lobes, medium dense shiny setae, groove between pronotum lobes broad consisting of large fovea with scattered carinae on margins; mesoscutum length 2.95 (2.93–2.97) rounded in lateral view; medial and lateral lobes lacunose with scattered punctures, short scattered setae; admedial lines indistinct and converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla punctulate with scattered carinae posteriorly, short scattered setae; mesepisternum areolate with medium dense shiny setae; mesepimeron carinate with scattered foveate; metapleuron areolate, lacunose along anterior margin, medium dense shiny setae; propodeum areolate, medium dense shiny setae, medial carina in dorsal view flattened.

Legs. Hind coxa imbricate with fine striations dorsally; femur 0.75 (0.75–0.76) × length of tibia; tibia length 5.53 (5.28–5.78) × tibia width; short dense setae, scattered stout emergent setae on anterior face; 1st tarsomere 3.66 (3.65–3.68) × length of 2nd tarsomere; 2nd tarsomere 1.56 (1.55–1.58) × length of 3rd tarsomere; 3rd tarsomere 1.91 (1.83–2.00) × length of 4th tarsomere; 4th tarsomere 0.40 (0.38–0.43) × length of 5th tarsomere; tarsal claw 0.51 (0.50–0.53) × length of 5th tarsomere.

Wings. First discal cell of fore wing small, tapering sharply apically to form a point; fore wing vein r-m absent; SR1 weakly sinuate; 2-M basal quarter tubular with node, remaining pigmented; hind wing veins spectral, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Imbricate, 2.95 (2.93–2.97) × mesosoma length; hypopygium Y shape; ovipositor sheath 1.32 (1.30–1.35) × metasoma length, short appressed setae.

Male. No male specimens were examined but described by Pasteels (1957) as having the same characters as female.

Distribution. The species is known from various localities in QLD.

Biology. Host associations unknown.

Comments. *Gasteruption albicuspis* is a distinctive species with a short rounded mesosoma and head that is wider than long with a long malarspace. Pasteels (1957) commented that species with similar are abundant and varied in Papua New Guinea.

Gasteruption amoenum Pasteels, 1957

Fig. 4.

Figure 4. *Gasteruption amoenum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NMV (Fig. 3), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Gasteruption amoenum, Pasteels, 1957: 104, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, “Kuranda. NQ 3-1-[19]53. G B” “Collection A.N. Burns” “*Gasteruption amoenum* n. sp. J. Pasteels det., 1956” (NMV: T-7437) [examined from photos].

Redescription. *Female.* Body length 13.50 mm; ovipositor length 6.80 mm.

Colour. Brown and black; antenna dark brown with flagellomere 11 and 12 light brown, head mostly black, malar space and mandibles brown; propleuron black, mesosoma brown, pronotum with spot dorso-medally, ventrally on mesepisternum, posterior corner of metapleuron, medially and around parapsidial line on mesonotum, mesoscutellum, axilla and propodeum black; fore and mid legs brown, apex of femur and longitudinal stripe on anterior face of tibia cream; tarsus cream, 4th tarsomere to tip brown; hind leg brown, coxa dark brown dorsally, femur and tibia black dorsally, tibia with cream band subbasally; tarsus cream, base of 1st tarsomere and claw dark brown; metasoma dark brown darker basally and apically; ovipositor sheath dark brown with cream apex 1.24 × length of hind 1st tarsomere; ovipositor brown; wings hyaline, veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; postocular space tapering behind eye to occipital carina; head in lateral view, frons and vertex convex, posterior of gena convex; postocular space 0.30 × height of eye; short scattered eye setae; head with short setae, scattered posteriorly; narrow lamelliform occipital carina; shallow rounded depression; minimal width of malar space 0.11 × height of eye; 0.75 × length of pedicel; clypeus margin sinuate; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.65 × distance between lateral ocelli; scape 1.50 × length pedicel; 1st flagellomere 1.30 × as long as scape; 0.64 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.69 × height; propleuron length 0.87 × prototegular distance; pronotal process indistinct, mesosoma sculpturing a fine and dense reticulation, tending to form concentric wrinkles, short scattered setae; mesoscutum truncated in lateral view, parapsidial lines distinct; notauli U-shaped, scrobiculate; propodeum longitudinal medial carina raised.

Legs. Hind coxa strigate-rugulose, striations in coxal groove; femur 0.77 × length of tibia; tibia length 5.15 × tibia width, short dense setae with scattered stout spines on anterior face; 1st tarsomere 2.65 × length of 2nd tarsomere; 2nd tarsomere 1.65 × length of 3rd tarsomere; 3rd tarsomere 1.63 × length of 4th tarsomere; 4th tarsomere 0.53 × length of 5th tarsomere; tarsal claw 0.63 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, tapering apically; vein r-m absent; vein SR1 distinctly bent, vein 2-M basal quarter tubular with apical node, remainder of vein pigmented; hind wing vein 2m+Cu pigmented, other veins spectral; three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma 1.96 × mesosoma length; ovipositor sheath 1.11 × metasoma length; apex flared.

Male. Unknown.

Distribution. The species is only known from the type locality of Kuranda, QLD.

Biology. Unknown.

Comment. This species is known only from the type specimen which we have been unable to examine in detail. The species keys out with *G. cinerescens* and can be separated based on a shorter hind 1st tarsomere (2.65 × length of 2nd tarsomere) and longer mesoscutum.

Gasteruption angulare Pasteels, 1957

Fig. 5.

Gasteruption angulare Pasteels, 1957: 70, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. 1♀, "Mundaring W. Australia J. Clark" (QM: T5488).

Figure 5. Gasteruption angulare *Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm (© Geoff Thompson, QM).*

Redescription. *Female*. Body length 22.00 mm; ovipositor length 28.00 mm.

Colour. Black; malar space dark brown, tegula brown; fore leg mostly brown, coxa dark brown, trochantellus with thin cream apical margin, tibia dark brown with cream stripe on anterior face, tarsus with cream band on anterior face of 1st tarsomere to 3rd tarsomere, 4th tarsomere to claw dark brown; mid leg similar to fore leg but darker; hind leg mostly black, prefemur lighter, tarsus pale, basal half of 1st tarsomere, claw and apical half of 5th tarsomere black; metasoma dark brown, apical margins of tergites lighter; ovipositor sheath dark brown, cream apex 3.16 × length of 1st tarsomere, ovipositor brown; wing hyaline, wing veins brown with pterostigma darker.

Head. Head shape sub-conical when viewed dorsally; 0.82 × longer than wide, postocular space sharply tapering to occipital carina; head in lateral view frons and vertex convex with posterior corner of gena distinctly widening, postocular space 0.41 × height of eye; short and scattered eye setae; face and frons coarsely reticulate-rugulose with long dense setae; medial frontal carina distinct; vertex strigate with long dense setae; narrow lamelliform occipital carina becoming distinctively wider ventral-laterally, shallow medially emarginate depression; gena reticulate with medium dense shiny setae, scattered long setae; minimal width of malar space 0.14 × height of eye; 0.13 × length of pedicel; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.80 × distance between lateral ocelli; scape 2.50 × length pedicel; 1st flagellomere 0.92 × as long as scape; 0.66 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.70 × height; propleuron length 0.85 × prototegular distance; propleuron rugulose dorsally, becoming reticulate-rugose laterally, long dense shiny setae; pronotal process rounded; pronotum anterior and posterior lobe reticulate-rugulose, dorsal lobe rugose, groove between pronotum lobes carinate, long dense shiny setae across groove, anterior and posterior lobes, dorsal lobe with scattered short setae; mesoscutum length 1.32 × width in dorsal view; truncated in lateral view, strigose with medium scattered shiny setae; admedial lines present; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum rugose, axillae reticulate-rugose; both with short reflective setae; mesepisternum coarsely reticulate-rugose with long dense shiny setae; mesepimeron carinate with shallow depressions; metapleuron reticulate-rugulose dorsally, coarser laterally and ventrally; anterior margin of mesepimeron reticulate-rugulose with long dense reflective setae; propodeum in lateral view distinctly convex, coarsely reticulate-rugulose, medial carina flattened in dorsal half; long dense setae;

Legs. Hind coxa reticulate dorsally, strigate posterior, imbricate laterally; femur 0.69 × length of tibia; tibia length 6.70 × tibia width; short setae with scattered robust short spines on anterior face; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.50 × length of 2nd tarsomere; 2nd tarsomere 1.18 × length of 3rd tarsomere; 3rd tarsomere 1.70 × length of 4th tarsomere; 4th tarsomere 0.30 × length of 5th tarsomere; tarsal claw 0.58 × length of 5th tarsomere.

Wings. Fore wing first discal rectangular, wider apically and ventrally; vein r-m pigmented; vein SR1 distinctly bent; vein 2-M basal third tubular with node, remaining two thirds pigmented; hind wing vein 2m+Cu pigmented, other veins spectral, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma length 2.57 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.9 × metasoma length; short appressed setae.

Male. Unknown.

Distribution. The species is known only from the holotype locality of Mundaring, WA.

Biology. Unknown.

Comments. *Gasteruption angulare* is a large species (22.00 mm body length) with a setose body. The head is distinct in lateral view with the posterior corner of the gena distinctly widening. It is only known from south-western WA.

Gasteruption angusticeps (Kieffer), 1911

Fig. 6.

Trichofoenus angusticeps Kieffer, 1911: 185, 186, ♂; Kieffer, 1912: 220, ♂.

Gasteruption angusticeps (Kieffer): Pasteels, 1957: 29, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♂, "*Trichofoenus angusticeps* Kieffer." "Mackay 3.[?].5" "Australia. R.E.Turner. 1907–244" "Determined by Dr. Kieffer" (BMNH: 3.a.223).

Figure 6. *Gasteruption angusticeps* (Kieffer), lateral habitus, scale bar = 1.00 mm

Other material examined. **QLD:** 1♀, Townsville, G.F. Hill (SAMA). 1♀, Mareeba, 30.x.1967, E.M. Exley (QM)*. 1♀, Brisbane, 1.iii.1962, B. Willson (QM). 1♀, Brisbane, 28.iix.1957, G. Swartz (QM). 1♀, Brisbane, 29.iii.1983, I. Yeo (QM). 1♀, Mt Finnigan summit, 1100 m 28-30.x.1985, Cook & Roberts (QM). **NT:** 1♀, Wollogurrang Station, 9.ix.1930, T.G. Campbell (ANIC).

Redescription. *Female*. Body length 10.13 (8.25–12.45) mm; ovipositor length 2.07 (1.80–2.30) mm.

Colour. Black; antenna dark brown, base of scape light brown, occipital carina, clypeus anterior margin, malar space and mandibles light brown (darker tooth apex); tegula brown; fore leg mostly brown; trochantellus with cream band on apex, prefemur lighter, femur cream apex, tibia dark brown, cream stripe on anterior face, tarsus cream stripe on anterior face of basal two thirds of 1st tarsomere; mid leg mostly dark brown; trochantellus with cream band on apex, prefemur light brown, femur paler towards apex, tibia with cream stripe on anterior face, tarsus cream stripe on anterior face of 1st tarsomere; hind leg mostly dark brown; trochantellus apex lighter, prefemur light brown, tibia with cream band sub basally, tarsus with cream base of 1st tarsomere; metasoma brown, darker basally and apically with distinctive light brown bands on apical margin of sternites and tergites; ovipositor sheath dark brown, cream apex 0.41 (0.39–0.45) × length of hind 1st tarsomere; ovipositor light brown; wings hyaline, veins and pterostigma brown.

Head. Head shape conical when viewed dorsally; 1.11 (1.06–1.14) × longer than wide; postocular space long, distinctly trapezoid, tapering strongly to occipital carina; head in lateral view, malar space short, large frons, postocular space tapering strongly towards occipital carina; postocular space 0.61–0.66–0.76 × height of eye; eye setae absent; face punctate with short dense shiny setae; frons punctate, short shiny setae; medial frontal carina indistinct in anterior half, absent posteriorly; vertex punctate around ocelli, posteriorly strigate-rugulose with short shiny setae; medium width occipital carina mostly lamniform with some light striations laterally, shallow rounded depression; gena punctate with short dense shiny setae; minimal width of malar space 0.03 (0.02–0.03) × height of eye; 0.18 (0.10–0.25) × length of pedicel; clypeus punctate; 2.33 (2.18–2.48) × wide as high, margin sinuate, lateral corners barely protruding forwards, depression only present anteriorly, short dense shiny setae, longer along margin; lateral ocelli posterior of postocular line, distance from lateral ocellus to eye margin 0.77 (0.68–0.86) × distance between lateral ocelli; scape 1.45 (1.33–1.60) × length pedicel; 1st flagellomere 0.82 (0.75–0.90) × as long as scape; 0.53 (0.44–0.60) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.61 (1.56–1.68) × height; propleuron length 1.89 (1.77–2.00) × width; 1.23 (1.13–1.32) × prototegular distance; propleuron rugulose with short dense shiny setae, pronotal process small rounded, pointing outwards; pronotum anterior lobe areolate-rugulose, dorsal and posterior lobe granular, granular-rugulose in some specimens, ventral lobe areolate, groove between pronotum lobes broad carinate with scattered fovea, short dense shiny setae, antesternal carina short, non-lamniform; mesoscutum length 2.98 (2.17–3.32) × width in dorsal view; rounded in lateral view, areolate with short scattered setae; admedial lines distinct, converging; 0.30 (0.23–0.38) × length of medial lobe; parapsidial lines distinct; notauli U-shaped, broad scrobiculate; mesoscutellum and axilla areolate; short scattered setae. mesepisternum granular-areolate, short dense shiny setae; mesepimeron scrobiculate ventral half, remaining carinate with some fovea; metapleuron granular-areolate with short dense shiny setae; propodeum granular-areolate, medial carina flattened, short dense shiny setae.

Legs. Hind coxa granular, rugulose dorsally, coarser ventrally, stations in coxal groove; femur 0.83 (0.80–0.86) × length of tibia; tibia length 3.83 (3.64–4.09) × tibia width, short dense setae with scattered stout spines on anterior face and on tarsus apex; 1st tarsomere 3.15 (3.00–3.32) × length of 2nd tarsomere; 2nd tarsomere 1.45 (1.42–1.50) × length of 3rd tarsomere; 3rd tarsomere 1.97 (1.71–2.14) × length of 4th tarsomere; 4th tarsomere 0.41 (0.35–0.47) × length of 5th tarsomere; tarsal claw 0.60 (0.50–0.67) × length of 5th tarsomere.

Wings. Fore wing first discal cell tapering sharply to point apically; vein r-m absent; vein SR1 weakly bent, almost straight, vein 2-M basal third tubular, without a node, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma 2.98 (2.75–3.32) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.34 (0.33–0.37) × metasoma length, short appressed setae.

Male. Same characters as female with paramere apex cream.

Distribution. This species has been recorded from QLD with one specimen collected in the NT.

Biology. Unknown.

Comments. *Gasteruption angusticeps* keys out with *G. exile* and *G. raphidioides*. All three species have extremely elongated sub-conical shaped heads but *G. angusticeps* can be separated from the other species based on a U-shaped notauli and light brown bands on apical margin of sternites and tergites.

Gasteruption apicale Pasteels, 1957

Fig. 7.

Gasteruption apicale Pasteels, 1957: p. 73, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀ "G. H. Hardy Goondiwindi Nov. 1935" "*Gasteruption apicale* n. sp. J. Pasteels det., 1954" (SDEI).

Paratype. QLD: ♂, same data as holotype (SDEI).

Figure 7. *Gasteruption apicale* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* Body length 14.00 mm; ovipositor length 7.00 mm.

Colour. Black with reddish-brown; antenna brown, darker 1st flagellomere; head mostly black except clypeus and malar space and mandibles (tooth apex darker) brown; mesosoma mostly black, ventral corner and posterior margin of pronotum and large patch on anterior corners, along the lateral margin and inside of parapsidial lines brown, tegula brown; fore and mid legs mostly orange-brown, apical margin of trochantellus and longitudinal stripe on anterior face of tibia cream, fore leg tarsus cream, 5th tarsomere and claw brown, mid leg tarsus dark brown with basal two thirds of 1st tarsomere cream; hind leg mostly brown, coxa dorsally, trochantellus and prefemur dark brown; tibia dark brown dorsally with cream band basally, tarsus cream with basal third of 1st tarsomere and claw dark brown; metasoma dark brown with brown patches laterally on T2–T4; ovipositor sheath dark brown with cream apex 0.50 × length of hind basitarsus; wing hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.81 × width; postocular space gently tapering behind eye; head in lateral view, face long with angular vertex and posterior of gena wider; short postocular space, 0.24 × height of eye; head punctate anteriorly becoming reticulate-rugulose, short dense setae; medial frontal carina anterior half raised, becoming flattened posterior half; vertex becoming strigose posteriorly; medium width lamelliform occipital carina; shallow broad, rounded depression; minimal width of malar space 0.21 × height of eye; 1.75 × length of pedicel; clypeus punctate; 0.57 × wide as high; margin sinuate; lateral corners barely protruding forwards; medium depression present anteriorly, short dense setae, longer on margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.62 × distance between lateral ocelli; scape 1.80 × length pedicel; 1st flagellomere 1.11 × as long as scape; 0.63 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.60 × height; propleuron length 1.11 × width; 0.57 × prototegular distance; propleuron rugulose dorsally becoming reticulate-rugulose, medium dense setae; pronotal process acute; pronotum reticulate-rugulose; groove between pronotum lobes carinate, short dense setae, mesoscutum length 1.00 × width in dorsal view; rounded in lateral view; reticulate-rugulose medially, rugose laterally; admedial and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum rugulose, axilla finer rugulose, short dense setae; mesepisternum reticulate-rugose becoming areolate lateral-ventrally, medium dense setae; mesepimeron transverse carinate creating fovea in ventral two thirds, dorsal third rugose; metapleuron dorsal lobe reticulate-rugose, becoming coarser ventrally medium dense setae; propodeum areolate, longitudinal medial carina raised, short dense shiny.

Legs. Hind coxa coarsely strigate dorsally, becoming imbricate laterally and ventrally; femur 0.69 × length of tibia; tibia length 6.67 × tibia width; short dense setae with short robust emergent spines scattered on anterior face; tarsus with short robust spines on ventral surface and apically; 1st tarsomere 3.50 × length of 2nd tarsomere; 2nd tarsomere 1.60 × length of 3rd tarsomere; 3rd tarsomere 1.67 × length of 4th tarsomere; 4th tarsomere 0.38 × length of 5th tarsomere; tarsal claw 0.50 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider sub apically at junction with 3-Cu; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal quarter tubular with apical node, remainder of vein pigmented; hind wing vein apical two thirds of 2m+Cu and 1-m pigmented, remainder of veins spectral; three hamuli distance between middle and apical hamuli greater than distance between middle and basal.

Metasoma. Metasoma 2.53 × mesosoma length; hypopygium Y shape; ovipositor sheath 0.86 × metasoma length, covered in short appressed setae, apex slightly flared.

Male. Mesonotum with less extensive brown colouration on lateral faces, mesepimeron darker brown.

Distribution. The species is only known from the type locality of Goondiwindi, QLD.

Biology. Unknown.

Comment. *Gasteruption apicale* superficially resembled other black and redish-brown species like *G. amoenum* and *G. cinerescens*. It can be separated based on a longer malar space (>1.50 × length of pedicel) shorter ovipositor sheath (0.86 × metasoma length) and short cream apex (0.50 × 1st hind tarsomere).

Gasteruption apicomaculatum Pasteels, 1957

Fig. 8.

Gasteruption apicomaculatum Pasteels, 1957: 54, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Yallingup [WA] XII-I R. E. Turner" (BMNH: 3a.358).

Paratype. TAS: 1♂, Dunalley, G.H. Hardy (SDEI).

Redescription. *Female*. Body length 10.00 mm; ovipositor length 13.00 mm.

Figure 8. *Gasteruption apicomaculatum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Colour. Black; antenna dark brown, mandibles cream, with tooth apex darker; propleuron dorsal-posterior corner, pronotum posterior lobe and mesepimeron posterior margin lighter, tegula light brown; fore leg mostly light brown, coxa brown, tibia with cream stripe on anterior face, tarsus cream, 4^{th} tarsomere to claw dark brown; mid leg same as fore leg but 2^{nd} tarsomere brown, 3^{rd} tarsomere to claw dark brown; hind leg mostly brown, coxa dark brown, prefemur and femur base light brown, tibia darker dorsally with long cream patch on ventral face sub-basally, tarsus cream, basal quarter of 1^{st}, 5^{th} tarsomere and claw dark brown; metasoma brown, T1 and T4 to tip darker, lateral apex of T2 and T3 light brown; ovipositor sheath dark brown with cream patch sub-apically, 3.04 × length of hind 1^{st} tarsomere; ovipositor brown, wing hyaline, fore wing veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.63 × longer than wide; postocular space long, bulbous; head in lateral view, occipital carina longer ventrolateral corner, face and frons raised slightly; postocular space 0.40 × height of eye; short scattered eye setae; face punctate with short dense shiny setae; frons punctate-reticulate anteriorly, becoming reticulate-rugulose posteriorly, short setae, denser and shiny on eye margin and medially around medial carina; medial frontal carina raised in anterior third; vertex reticulate-rugulose, with punctate-rugulose sculpturing between ocelli and strigate-rugulose posteriorly, short setae; occipital carina short, lamelliform, wider ventro-laterally, depression broad, shallow and rounded; gena reticulate-rugulose with short dense shiny setae; minimal width of malar space 0.12 × height of eye; 1.14 × length of pedicel; clypeus punctate; 2.00 × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression present anteriorly, medium dense shiny setae, longer along margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.66 × distance between lateral ocelli; scape 2.14 × length pedicel, 1^{st} flagellomere 0.67 × as long as scape; 0.40 × length 2^{nd} flagellomere.

Mesosoma. Mesosoma length 2.0 × height; propleuron length 1.0 × width; 0.73 × prototegular distance; propleuron rugulose, becoming reticulate-rugulose laterally, medium dense shiny setae; pronotal process large and rounded; pronotum dorsal lobe reticulate-rugose, anterior and posterior lobes rugulose, dorso-posterior lobe smooth with scattered punctures, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.19 × width in dorsal view; rounded in lateral view, rugose, reticulate-rugulose around parapsidial lines, short dense shiny setae; parapsidial lines distinct; notauli U-shaped, scrobiculate; Mesoscutellum and axilla rugulose with short shiny setae; mesepisternum rugulose dorsally, becoming areolate ventrally; medium dense shiny setae; mesepimeron carinate forming fovea; some scattered setae present dorsally on posterior margin; metapleuron areolate with medium dense shiny setae; propodeum areolate with medium dense shiny setae, longitudinal medial carina flattened.

Legs. Hind coxa rugulose, coarser dorsally, becoming finer ventrally, strigate in coxal grooves; femur 0.76 × length of tibia; tibia length 4.90 × tibia width; short dense setae, scattered emergent setae on anterior face; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.00 × length of 2nd tarsomere; 2nd tarsomere 1.54 × length of 3rd tarsomere; 3rd tarsomere 1.63 × length of 4th tarsomere; 4th tarsomere 0.53 × length of 5th tarsomere; tarsal claw 0.53 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, vein r-m absent; SR1 distinctly bent; 2-M basal third tubular with node, remaining pigmented; hind wing veins spectral, three hamuli equidistant.

Metasoma. Metasoma 2.89 × mesosoma length; hypopygium Y-shaped with a broad slit; ovipositor sheath 1.58 × metasoma length, short appressed setae.

Male. Hind legs and metasoma darker, malar space slightly longer than the pedicel.

Distribution. The species is known from WA and TAS.

Biology. Host associations unknown.

Comments. The species name *apicomaculatum* is derived from a combination of *apico* L. the prefix for apex and *macula* L. for spotted. This name describes the distinctive ovipositor sheath with a long cream band subapically and dark brown spot at the apex. The species has been collected mainly in WA with only a single male specimen collected from Tasmania. Due to the large geographic distance between localities, it is uncertain if the male specimen belongs to this species.

Gasteruption atrinerve **(Kieffer, 1911)**

Fig. 9.

Figure 9. *Gasteruption atrinerve* (Kieffer), lateral habitus, scale bar = 1.00 mm.

Trichofoenus atrinervis Kieffer 1911: 188, ♀; 1912: 219, ♀. (syn. Pasteels 1957: 107).

Gasteruption atrinerve (Kieffer): Pasteels 1957: 107, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "*Trichofoenus atrinervis* n.sp. Kieffer" "44 4" "58" (BMNH: 3.a.224).

Specimen damage. Left antenna 8th flagellomere to tip, right hind 5th tarsomere and claw missing, right fore wing damaged.

Redescription. *Female*. Body length 14.00 mm; ovipositor length 12.00 mm.

Colour. Black; antenna and mandibles dark brown (tooth apex darker), propleuron lighter posteriorly; pronotum lighter posterior corner, tegula brown; fore leg mostly brown, coxa dark brown, trochantellus with cream on apical margin, femur with cream stripe on anterior face, tibia dark brown with cream stripe on anterior face, tarsus dark brown with cream stripe on anterior face of 1st to 3rd tarsomere; mid leg similar colour to fore leg except tarsus dark brown, cream two thirds of basal 1st tarsomere; hind leg dark brown, tibia with cream patch sub-basally, not meeting on anterior face, tarsus cream, basal quarter, apical half of 5th tarsomere and claw dark brown; metasoma black, dark brown lateral T2–4; ovipositor sheath dark brown with cream apex 2.48 × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.93 × longer than wide, postocular space bulbous; head in lateral view wedge like with clypeus and frons convex and gena straight; postocular space short; 0.40 × height of eye; short scattered eye setae; head finely granular with short dense setae, shiny on eye margin; medial frontal carina present in anterior third, remaining shallow groove; occipital carina distinctive, lamelliform, depression broad, medially pointed; minimal width of malar space 0.06 × height of eye; 0.40 × length of pedicel; clypeus finely granular; 1.73 × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression present anteriorly, short dense shiny setae, longer on margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.42 × distance between lateral ocelli; scape 1.54 × length pedicel; 1st flagellomere 1.10 × as long as scape; 0.73 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.89 × height; propleuron length 1.27 × width; 0.79 × prototegular distance; propleuron granular, coarser dorsally, short dense shiny setae; pronotal process broad and rounded; pronotum granular with faint rugulose sculpturing on anterior lobe, groove between pronotum lobes carinate, short dense setae, longer in groove; mesoscutum length 1.35 × width in dorsal view, rounded in lateral view, granular, coarser carinate groove medially between notauli and posterior margin, short dense shiny setae; admedial lines indistinct, gently converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular with short setae; mesepisternum granular-rugulose dorsally, becoming granular-areolate with short dense shiny setae; mesepimeron carinate; metapleuron dorsal lobe, granular-rugulose, becoming granular-areolate, short dense shiny setae; propodeum areolate-rugulose with flattened medial carina, short dense shiny setae;

Legs. Coxa rugulose dorsally, strigate in coxal groove, reticulate laterally; femur 0.74 × length of tibia; tibia length 4.19 × width; short dense setae; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.12 × length of 2nd tarsomere; 2nd tarsomere 1.31 × length of 3rd tarsomere; 3rd tarsomere 1.86 × length of 4th tarsomere; 4th tarsomere 0.39 × length of 5th tarsomere; tarsal claw 0.50 × length of 5th tarsomere.

Wings. Fore wing first discal cell broader at apex, tapering towards base; fore wing vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular, remaining pigmented; hind wing veins apical half of 2m+Cu and 1-m pigmented; three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma 2.63 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.04 × metasoma length, short appressed setae with cream apex dilated.

Male. Male not examined but described by Pasteels (1957) as having the same characters as the female.

Biology. Unknown.

Distribution. The holotype is missing a locality label but Pasteels (1957) examined material from QLD, NSW and south-western WA.

Comments. *Gasteruption atrinerve* is similar to *G. terminale* based on general head and body shape. *G. atrinerve* has a smaller body size (14.00 mm), ovipositor sheath length (12.00 mm) and finer cuticle sculpturing. The colour of the pronotum can easily separate the species as *G. atrinerve* is completely black/dark brown compared to brown in *G. terminale.*

Gasteruption basiantennale Pasteels, 1957

Gasteruption basiantennale Pasteels 1957: 21, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♂, "Brisbane H. Hacker 17.3.14", (QM: T5494).

Specimen damage. Left hind leg tarsus missing.

Comments. The original species description is based entirely on a single male specimen, and until we can associate females, we have refrained from redescribing this species.

***Gasteruption bicarinatum* (Turner, 1918)**

Fig. 10.

Figure 10. *Gasteruption bicarinatum* (Turner), female, lateral habitus, scale bar = 1.00 mm.

Foenus bicarinatus Turner 1918: 203, ♀. (syn. Pasteels 1957: 83).

Gasteruption bicarinatum (Turner): Pasteels 1957: 83, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "*Foenus bicarinatus* Type Turner." "43 14" (BMNH: 3.a.214).

Specimen damage. Left antenna 3rd flagellomere to tip and right antenna 4th flagellomere to tip missing, left fore leg tarsus and right fore leg 3rd tarsomere to tip missing, right hind leg 5th tarsomere and claw missing.

Paratype. NSW: 1♂, Mount Boppy, E.F. Reik (ANIC)*.

Redescription. *Female*. body length 21.60 (20.00–23.20) mm; ovipositor length 14.55 (11.70–17.40) mm.

Colour. Black; mandible (tooth apex darker) and tegula dark brown; fore leg mostly brown, coxa dark brown, trochantellus with cream stripe on apical margin, femur with cream patch at apex, tibia dark brown with cream longitudinal stripe on anterior face, tarsus dark brown, cream stripe along anterior face of 1st to 4th tarsomere; mid leg similar to fore leg, tarsus with cream stripes on anterior face of 1st to 3rd tarsomere; hind leg black, prefemur lighter, tarsus cream, base of 1st tarsomere and apical half of 5th tarsomere and claw black; metasoma T2 and 3 dark brown laterally; ovipositor sheath dark brown with cream apex 1.68 (1.48–1.88) × length of hind 1st tarsomere; ovipositor brown; wing hyaline, veins dark brown, pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 1.03 (1.00–1.05) × longer than wide, postocular space tapering to occipital carina; head in lateral view with distinctive shape, head generally wedge shape with long face with raised vertex shelf; postocular space slightly elongated, 0.43 (0.43–0.44) × height of eye; face punctate with short shiny dense setae, frons reticulate-rugulose with short dense shiny setae; medial frontal carina raised between antennal scrobes, indistinct towards medial ocelli; vertex reticulate rugulose around ocelli, becoming strigate-rugulose posteriorly and on raised part of vertex, some scattered punctures, short shiny setae; occipital carina short, wider ventro-laterally, lamelliform, depression shallow, faintly medially pointed; gena reticulate with short dense shiny setae; minimal width of malar space 0.12 (0.12–0.13) × height of eye; 1.35 (1.33–1.38) × length of pedicel; clypeus punctate, 1.62 (1.60–1.64) × wide as high, margin concave with lateral corners distinctly protruding forwards, medial depression absent, short shiny setae with a distinctive pecten of long setae medially; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.37 (0.36–0.38) ×

distance between lateral ocelli; scape 1.92 (1.83–2.00) × length pedicel, 1st flagellomere 0.90 (0.90–0.91) × as long as scape, 0.39 (0.38–0.40) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.68 (1.61–1.74)× height; propleuron length 1.22 (1.16–1.29) × width; 0.93 (0.89–0.96) × prototegular distance; propleuron rugulose with short dense setae, some longer scattered setae; pronotal process small broad, rounded; pronotum rugulose, groove between pronotum lobes carinate, medium (compared to face) dense shiny setae; mesoscutum length 1.12 (0.98–1.25) × width in dorsal view; rounded in lateral view; medial lobe rugulose, becoming strigate-rugulose between admedial lines, lateral lobe rugulose with short shiny setae; admedial lines; distinct, converging, 0.26 (0.23–0.30) × length of medial lobe; parapsidial lines distinct; notauli V-shaped, scrobiculate; mesoscutellum and axilla rugulose with short shiny setae; mesepisternum areolate, coarser posterior-ventrally; short dense shiny setae; mesepimeron medially lacks sculpturing, transverse carinae dorsally and ventrally; metapleuron areolate dorsally, coarser ventrally, a smooth groove with transverse carinae between propodeal spiracle and hind coxa, short dense shiny setae; propodeum areolate, medial carina convex in lateral view, short dense shiny setae;

Legs. Hind coxa smooth with some shallow punctures dorsally, strigate in coxal groove, punctate laterally; femur 0.69 (0.61–0.71) × length of tibia; tibia length 6.92 (6.85–7.00) × tibia width; short dense setae with scattered stout spins on anterior face, tarsus with ventro pecten of short robust spines, with several stout spines apically; 1st tarsomere 6.92 (2.92–3.20) × length of 2nd tarsomere; 2nd tarsomere 1.36 (1.25–1.47) × length of 3rd tarsomere; 3rd tarsomere 1.71 (1.70–1.71) × length of 4th tarsomere; 4th tarsomere 0.41 (0.40–0.41) × length of 5th tarsomere; tarsal claw 0.59 (0.59–0.60) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated and oblong; vein r-m spectral; vein SR1 distinctly bent; vein 2-M basal third tubular, node present, remaining pigmented; hind wing vein 2m-Cu and 1-m pigmented, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma length 2.58 (2.50–2.67) × mesosoma length;

hypopygium Y-shaped; ovipositor sheath 0.90 × metasoma length, short appressed setae with flared cream apex.

Male. Same characters as female except for cream spot on the last tergite and apex of paramere.

Distribution. The species is known from NSW with material examined by Pasteels (1957) from WA.

Biology. *Gasteruption bicarinatum* has been reared from artificial cavity nests with *Megachile ignita* Smith (Megachilidae) (Prendergast 2018: as *Gasteruption* sp.) in WA.

Comments. This species is similar to *G. breviscutum, G. nigerrimum* and *G. flavitarse* based on anterior margin of clypeus concave and hind tibia black. *Gasteruption bicarinatum* and *G. flavitarse* are separated from the proceeding species based on posterior margin of vertex emarginate medially and clypeus lateral corners distinctly protruding forward. *Gasteruption bicarinatum* and *G. flavitarse* can be easily distinguished based on the large angular projection on the vertex in *bicarinatum* (in lateral view) and a shorter ovipositor sheath (0.90 × metasoma length).

Gasteruption brachyurum Schletterer, 1885

Fig. 11.

Gasteruption brachyurum, Schletterer, 1885: 293, ♀; Pasteels, 1957: 72, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype*.* 1♀, Vandiemensland [Tasmania]. “*Brachyurum* det. Schlett” (NHMW) [examined from photographs].

Paratype. 1♀, “Australia” “*Brachyurum* det. Schlett” (NHMW) [examined from photographs].

Other material examined. **QLD:** 2♀, 4♂, Kroombit Tops 45 km SSW Calliope, 9–19.xii.1983, G. Monteith and G. Thompson (QM)*. **SA:** 1♀, Belair National Park, Adelaide, no collector or date (SAMA); 1♀, Belair National Park, Adelaide, 25.iii.1965, T.F. Houston, flying around flower of vine (SAMA); 2♂, Mt Lofty summit, Mount Lofty, 8.iv.1965, T.H. Houston (SAMA); 1♀, Deep Creek near Montacute, 12.xii.1972, T.F. Houston (WAMA); 1♀, Heathfield, 20.iii.2008, S. Mantel (SAMA).

Redescription. *Female*. Body length 13.77 (13.00–14.30) mm; ovipositor length 2.92 (2.85–3.00) mm.

Figure 11. *Gasteruption brachyurum* Schletterer, lateral habitus, scale bar = 1.00 mm.

Colour. body mostly brown; head black except for anterior margin of clypeus, malar space and mandibles (tooth apex darker) brown; propleuron black, lighter anteriorly and posteriorly; pronotum ventral lobe darker; black posterior half of mesepisternum, patch on posterior margin of metapleuron, mesoscutum medial lobe, lateral lobe medially, mesoscutellum, axilla and metanotum, tegula light brown, propodeum with variable amount of black; fore and mid leg mostly brown, coxa dark brown; trochantellus dark brown with cream apical margin, prefemur lighter, tibia with cream longitudinal stripe on anterior face, fore 1st to 3rd tarsomere cream and mid 1st tarsomere cream; hind leg mostly dark brown, prefemur lighter, femur brown, tibia with cream patch sub basally; most of 1st, 2nd and 3rd tarsomere cream; metasoma dark brown; ovipositor sheath dark brown with cream apex 0.66 (0.62–0.69) × length of hind 1st tarsomere; ovipositor light brown; wings hyaline, wing veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.74 (0.71–0.78) × longer than wide; postocular space in dorsal view short, gently tapering to occipital carina; face in lateral view, face long, medial carina visible in profile, gena convex; postocular space 0.29 (0.27–0.34) × height of eye; eye setae absent; face punctate-reticulate with medium shiny setae, denser on margins; frons reticulate with some scattered shallow punctures posteriorly, medium dense shiny setae; medial frontal carina distinct, raised between antenna scrobes, becoming a shallow groove posteriorly; vertex punctate-rugulose with some carinae, posteriorly, transverse strigate with scattered shallow punctures, short scattered setae; occipital carina short, wider ventro-laterally; depression shallow, medially emarginate, lamelliform; gena punctate with medium dense shiny setae; minimal width of malar space 0.07 × height of eye; 0.47 (0.42–0.50) × length of pedicel; clypeus 1.84 (1.80–1.88) punctate, punctate rugulose in anterior-medial depression, margin sinuate with lateral corners barely protruding forwards, medial depression present anteriorly, medium dense shiny setae, longer on margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.64 (0.62–0.67) × distance between lateral ocelli; scape 2.10 (2.00–2.20) × length pedicel; 1st flagellomere 1.00 × as long as scape; 0.79 (0.78–0.80) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.42 (1.40–1.44) × height; propleuron length 0.92 (0.87–0.98) × width; 0.79 (0.74–0.87) × prototegular distance; propleuron rugulose dorsally, reticulate-rugulose laterally, medium dense shiny setae; pronotal process large, pointed outwards; pronotum anterior lobe rugulose, dorsal lobe and dorsal posterior lobe reticulate, ventral posterior lobe smooth with carinae on posterior margin, groove between pronotum lobes broad, course carinate, medium dense shiny setae, denser setae posterior margin; mesoscutum length 1.12 (1.09–1.15) × width in dorsal view; rounded in lateral view; medial lobe strigate, lateral lobe strigate medially, rugose laterally, a distinctive rugose emarginated depression on posterior margin, short scattered setae; admedial lines and parapsidial lines distinct;

notauli V-shaped, scrobiculate; mesoscutellum strigate-rugulose and axilla reticulate, both with short scattered setae; mesepisternum rugulose dorsally, strigate-areolate ventrally, medium dense shiny setae; mesepimeron smooth dorsally, carinate ventrally; metapleuron with course striations, medium dense shiny setae; propodeum course areolate, medially carinate, imbricate at metasomal insertion, medium dense shiny setae.

Legs. Hind coxa finely strigate dorsally, imbricate laterally; femur 0.74 (0.72–0.77) × length of tibia; tibia length 4.92 (4.60–5.23) × width; short dense setae with scattered stout spines on anterior face; 1st tarsomere with several stout spines ventro-posterior apically; 1st tarsomere 8.81 (8.50–9.13) × length of 2nd tarsomere; 2nd tarsomere 1.29 (1.25–1.33) × length of 3rd tarsomere; 3rd tarsomere 1.27 (1.20–1.33) × length of 4th tarsomere; 4th tarsomere 0.29 (0.28–0.30) × length of 5th tarsomere; tarsal claw 0.68 (0.67–0.70) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongate, vein 2-cu concave, wider at junction of 2-cu, 3-cu and 1m-cu; fore wing vein r-m absent; SR1 distinctly bent; 2-M basal third tubular with node, remaining pigmented; hind wing vein apical 2/3 of 2m+Cu and 1-m pigmented, remaining veins spectral; three equidistant hamuli.

Metasoma. Metasoma length 2.76 (2.51–3.06) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.32 (0.32–0.34) × metasoma length, short appressed setae.

Male. Same as female with cream apical margins of T9 and tips of paramere.

Biology. The species has been collected around nesting aggregations of the bee *Callomelitta picta* Smith (Colletidae) in SA.

Distribution. The species is known from QLD and SA, with material examined by Pasteels (1957) from VIC and TAS.

Comments. Two specimens labelled as 'Type' are held at the NHMW, but Schletterer (1885) only mentions a specimen from "Vandiemensland" so we assume this is the holotype. Pasteels (1957) described *G. brachyurum* as having the same colour, general body shape and sculpturing as *G. quadrilineatum* but differs based on a shorter ovipositor sheath length (0.32–0.34 × metasoma length) and malar space 0.07 × height of eye.

Gasteruption breviscutum Kieffer, 1911

Fig. 12.

Figure 12. *Gasteruption breviscutum* Kieffer, lateral habitus, scale bar = 1.00 mm.

Gasteruption breviscutum Kieffer 1911: 213, ♀, ♂; Kieffer 1912: 324, ♀, ♂; Pasteels 1957: 92, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. Location unknown.

Other material. **NSW:** 1♀, Sydney, C. Gibbons (AM: K279879); 1♀, French's Forest N. of Sydney, 14.xii.1923, T.G. Campbell (AM: K 279881); 1♀, Lake George, 10.iii.1953 (AM: K 279880). **VIC:** 1♀, Timboon, V.H.W. Davey (QM); 1♀, 1♂, Bright, V.H.W. Davey (QM); 1♀, Musk, 29.xii.2010, R. Leijs (BPC)*. **TAS:** 1♀, Bracknell 41.65S, 146.9667E, R. Bashford (TMAG: FT43677).

Redescription. *Female.* body length 22.01 (21.08–22.94) mm; ovipositor length 31.10 (28.40–33.80) mm.

Colour. Black; mesepisternum with lighter anterior margin, mesepimeron red, tegula dark brown; fore leg mostly dark brown, trochantellus brown with pale apical margin, femur with pale apex, tibia with pale stripe on anterior face, tarsus pale with 4th tarsomere to claw brown; mid leg mostly dark brown, tibia with pale basal tip, 1st tarsomere cream (apex darker); hind leg mostly dark brown, coxa and trochantellus black, tarsus cream, basal quarter of 1st tarsomere, apical half of 5th tarsomere and claw dark brown; metasoma dark brown, ovipositor sheath dark brown with large pale apex 4.98 (4.68–5.29) × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing veins dark brown and pterostigma brown.

Head. Head shape rectangular when viewed dorsally; 0.90 (0.76–1.03) × longer than wide; postocular space boubous; head in lateral view, frons and vertex convex, postocular space 0.47 (0.47–0.48) × height of eye; eye setae absent; face reticulate with short dense shiny setae; eye; frons granular with short dense shiny setae; medial frontal carina distinct in anterior third; vertex reticulate-rugulose with short dense setae; narrow lamelliform occipital carina, wider ventro-laterally, shallow rounded depression; gena granular with short dense shiny setae; minimal width of malar space 0.12 (0.10–0.16) × height of eye; 0.88 (0.73–1.00)× length of pedicel; clypeus granular; 2.20 (1.98–2.50) × wide as high; margin concave with lateral corners barely protruding forwards, medial depression indistinct, short dense shiny setae, longer along margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.53 (0.51–0.57) × distance between lateral ocelli; scape 1.70 (1.55–1.79) × length pedicel. First flagellomere 0.74 (0.71–0.80) × as long as scape; 0.36 (0.32–0.40) × length second flagellomere.

Mesosoma. mesosoma length 1.77 (1.60–2.00) × height; propleuron length 1.07 (1.00–1.14) × width; 0.92 (0.88–0.98) × prototegular distance; propleuron reticulate-rugulose coarser dorsally, medium dense shiny setae; pronotal process acute; pronotum anterior lobe reticulate-rugulose, dorsal and posterior lobe reticulate, groove between pronotum lobes carinate, medium dense shiny; mesoscutum length 1.11 (1.07–1.14)× width in dorsal view; truncated in lateral view; reticulate with short shiny setae; admedial lines converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate with short shiny setae; mesepisternum reticulate-rugulose dorso-lateral, coarsely rugulose laterally and ventro-laterally, medium dense shiny setae; mesepimeron smooth apical quarter, becoming carinate with shallow depressions; metapleuron reticulate-rugose dorso-lateral, becoming coarser ventro-laterally with medium dense shiny setae; propodeum areolate with medial carina absent, medium dense shiny.

Legs. Hind coxa strigate-rugulose dorsally, becoming reticulate laterally and ventrally; femur 0.71 (0.68–0.73) × length of tibia; tibia short dense setae with scattered short robust spines on anterior face; tarsus with ventro pecten of short robust spines; tibia length 6.53 (6.36–6.70) × tibia width; 1st tarsomere 3.60 (2.70–4.69) × length of 2nd tarsomere; 2nd tarsomere 1.31 (1.08–1.60) × length of 3rd tarsomere; 3rd tarsomere 1.80 (1.70–2.00) × length of 4th tarsomere; 4th tarsomere 0.38 (0.35–0.40) × length of 5th tarsomere; tarsal claw 0.55 (0.50–0.60) × length of 5th tarsomere.

Wings. Fore wing first discal cell wider apically; fore wing vein r-m indistinct, only notable due to pigmented junction at 3-Rs; vein SR1 distinctly bent; vein 2-M basal quarter tubular with node, remaining vein pigmented; hind wing vein 2m+Cu, 1-m pigmented, other veins spectral, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma 2.59 (2.44–2.75) × mesosoma length; hypopygium Y-shaped; ovipositor sheath covered in short dense setae; ovipositor sheath 2.71 (2.65–2.77) × metasoma length.

Male. Large cream spot on T9 and apex of paramere.

Distribution. The species is knowns from various localities in NSW, VIC and TAS. Pasteels (1957) commented that this species is very widespread throughout southern Australia from WA to southern QLD.

Biology. Specimens reared from *Megachilie* sp. (Megachilidae) in artificial nesting blocks, VIC.

Comments. The type specimen for *G. breviscutum* has been lost. This species is similar to *G. nigerrimum* but can be separated on the length of the malar space being longer in *G. breviscutum* (0.12 × height of eye) and cream/ white apex of ovipositor sheath shorter (4.68–5.29 × length of 1st hind tarsomere). *Gasteruption nigerrimum* is only known from Cannington, WA whereas *G. breviscutum* has a wide distribution including localities in WA.

Gasteruption burnsi **Pasteels, 1957**

Fig. 13.

Figure 13. *Gasteruption burnsi* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NMV (Fig. 11), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Gasteruption burnsi, Pasteels, 1957: 98, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, “Kuranda. NQ 7/14 -1-50 G B.” “Collection A. N. Burns” (NMV: T-7431) [examined from photos].

Specimen damage. Left hind leg 5th tarsomere to tip and ovipositor sheaths missing.

Redescription. *Female.* Body length 18.60 mm; ovipositor length 11.70 mm.

Colour. Black with reddish brown; head black, antenna dark brown, malar space and mandibles brown; mesosoma reddish-brown with black patches on pronotum, medially and on parapsidial lines of mesonotum, mesoscutellum, axilla and propodeum black; tegula light brown; fore and mid legs brown with cream longitudinal stripes on the anterior face of tibia and fore leg 1st to 3rd tarsomere and mid leg basal half of 1st tarsomere; hind leg dark brown, coxa and dorsal surface of tibia black, tarsus cream with basal half of 1st tarsomere and claw dark brown; metasoma dark brown; ovipositor sheath missing from type but described by Pasteels (1957) as dark brown with cream apex; ovipositor light brown; wings hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; postocular space tapering behind eye; head in lateral view, vertex angular; postocular space short; Head with short scattered setae; narrow occipital carina, shallow rounded depression; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.91 × distance between lateral ocelli; scape 1.85 × length pedicel; first flagellomere 1.22 × as long as scape; 0.66 × length second flagellomere.

Mesosoma. Mesosoma short, length 1.48 × height; propleuron short, pronotal process broad and rounded, setae scattered dorsally, denser laterally; mesoscutum length 0.95 × width in dorsal view; notauli U-shaped, scrobiculate; propodeum areolate-rugulose with indistinct longitudinal medial carina.

Legs. femur 0.67 × length of tibia; tibia length 6.14 × tibia width; 1st tarsomere 3.75 × length of 2nd tarsomere; 2nd tarsomere 1.33 × length of 3rd tarsomere; 3rd tarsomere 1.50 × length of 4th tarsomere; 4th tarsomere 0.50 × length of 5th tarsomere; tarsal claw 0.50 × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated; vein r-m absent; vein SR1 distinctly bent, vein 2-M basal third tubular with apical node, remaining veins pigmented; hind wing vein 1-m and 2M+Cu pigmented, spectral at junction with 1-m; others spectral.

Metasoma. Metasoma 0.95 × mesosoma length; ovipositor sheath 0.88 × metasoma length.

Male. Unknown.

Distribution. The species is known only from the type locality of Kuranda, QLD.

Biology. Unknown.

Comments. This species is known only from the type specimen which we have been unable to examine in detail. The species keys out with *G. spinigerum* but can be separated based on the scape length shorter and the 5th hind tarsomere cream in *G. bursi.*

Gasteruption calothecus **Kieffer, 1911**

Fig. 14.

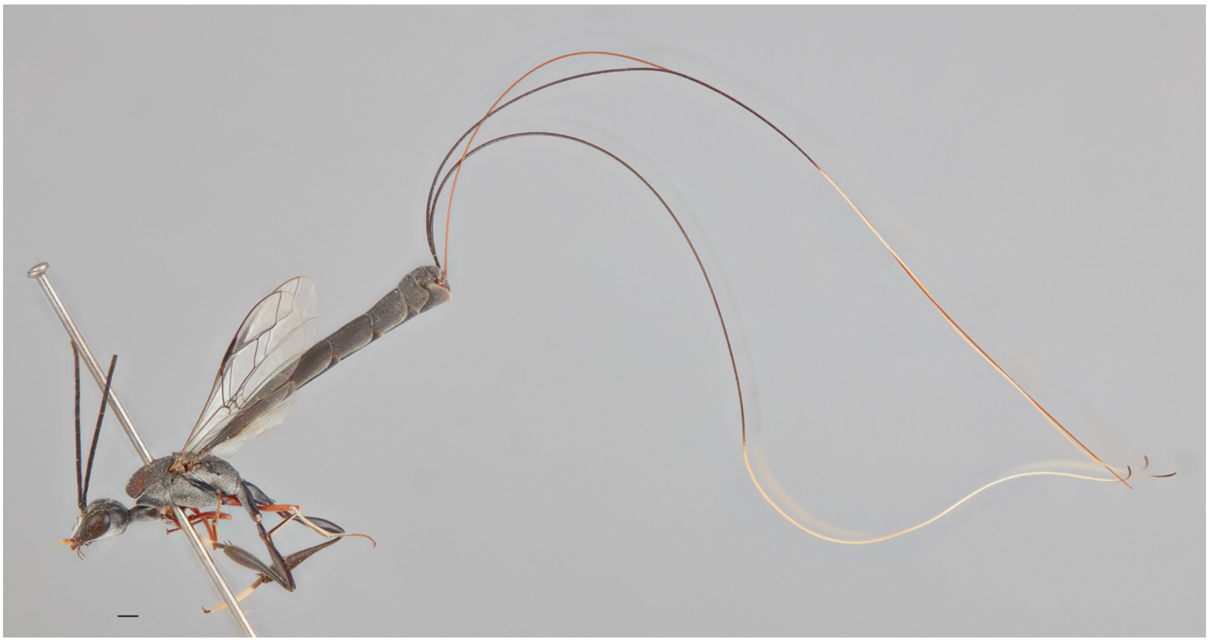

Figure 14. *Gasteruption calothecus* Kieffer, lateral habitus, scale bar = 1.00 mm.

Gasteruption calothecus Kieffer, 1911: 198, ♀; Kieffer, 1912: 320, ♀.

Foenus calothecus Turner, 1918: 202, ♀.

Gasteruption calothecus Pasteels 1957: 93, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "[WA] Dongara x.19933, R. E. Turner" (NHM: 3a. 169)

Paratype. WA: same data as holotype (NHM) [Not examined].

Other material examined. **QLD:** 1♀, Reik, 9.44, (QDPC); 4♀♀, Leyburn -27.966667, 151.633333, 12.xi.1985, G. Daniels (QM)*. **SA:** 1♀, 26 km N. by W. of Bordertown, 26.x.1983, D.C.F Rentz & M.S. Harvey (ANIC: 32 113789); 1♀, Flinders Rangers NP, Brachina Gorge, -31.333889, 138.552778, 8.x.1997, S. Winterton, J. & A. Skevington, C. Lambkin. **WA:** 1♀, Kelmscott, Perth, -32.116667, 116.016667, 29.ix.1985, P. Hutchinson, (QM); 1♀, 28 km W. Yalgoo, 2.ix.1981, G.A. Holloway.

Redescription. *Female*. body length 21.08 (19.60–22.60) mm; ovipositor length 56.25 (50.00–65.00) mm.

Colour. Black; clypeus lateral corners, malar space and mandibles dark brown (tooth apex darker); mesoscutum black with broad red stripes on margin of notauli on median lobe, tegula light brown; fore and mid leg mostly brown, trochantellus with cream apical margin, tibia dark brown with cream stripe on anterior face, tarsus dark brown with cream stripe on anterior face of 1st to 4th tarsomere; hind leg mostly black, prefemur lighter, tarsus cream, basal third of 1st tarsomere, apical half of 5th tarsomere and claw black; ovipositor sheath dark brown with large cream band 14.68 (11.56–17.06) × length of hind 1st tarsomere; ovipositor brown; wing hyaline, veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; 1.02 (1.00–1.08) × longer than wide, postocular space slightly bulbous behind eyes and tapering at occipital; head in lateral view rounded frons and vertex, postocular space 0.46 (0.45–0.47) × height of eye; eye setae absent; face punctate with short dense shiny setae; frons rugulose with short shiny setae; medial frontal carina distinct anterior two thirds becoming groove like posteriorly; vertex rugulose, transverse strigate-rugulose posteriorly, short shiny setae; occipital carina short, wider ventro-laterally, lamelliform, depression shallow and broad, rounded; gena punctate with short dense shiny setae; minimal width of malar space 0.09 (0.09–0.10) × height of eye; 0.72 (0.70–0.75) × length of pedicel; clypeus punctate, punctate-rugulose medially, 1.90 (2.05–1.82) × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression indistinct, present anteriorly, short dense shiny setae, longer on margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.65 (0.60–0.73) × distance between lateral ocelli; scape 2.08 (1.92–2.25) × length pedicel, 1st flagellomere 1.07 (1.03–1.11) × as long as scape, 0.47 (0.46–0.48) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.77 (1.70–1.83) × height; propleuron length 1.21 (1.20–1.21) × width, 0.81 (0.71–0.88) × prototegular distance, propleuron dorsally punctate-reticulate, laterally punctate-rugulose, medium (compared to face) dense shiny setae; pronotal process small rounded, pointing outwards; pronotum anterior lobe areolate, dorsal and posterior lobes rugulose, groove between pronotum lobes carinate, medium dense shiny setae; mesepisternum anterior lobe rugulose, coarser becoming areolate ventrally, medium dense shiny setae; mesepimeron mostly smooth, fovea medially and ventrally, smaller shallower fovea on posterior margin; metapleuron areolate, coarser ventrally with medium dense shiny setae, patches without setae dorsal posterior lobe near propodeal spiracle and anterior ventral corner near coxa; propodeum areolate, medial carina absent, medium shiny setae; mesoscutum length 2.96 (2.86–3.08) × width in dorsal view; rounded in lateral view, medial lobe strigate-rugulose medially, rugulose laterally, lateral lobe rugulose, short shiny setae; admedial lines distinct, converging; 0.19 (0.18–0.25) × length of medial lobe; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum rugulose, axillae rugulose with scattered punctures both short scattered shiny setae.

Legs. Hind coxa punctate with smooth patch dorso-laterally near coxal groove, strigate in coxal groove; femur 0.73 (0.71–0.77) × length of tibia; tibia length 6.27 (6.13–6.40) × tibia width; short dense setae with scattered stout emergent setae on anterior face; 1st tarsomere 3.59 (3.32–4.17) × length of 2nd tarsomere, 2nd tarsomere 1.28 (1.25–1.32) × length of 3rd tarsomere, 3rd tarsomere 1.89 (1.67–2.00) × length of 4th tarsomere, 4th tarsomere 0.36 (0.30–0.40) × length of 5th tarsomere, tarsal claw 0.51 (0.50–0.52) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongate, pointed at apex, wider ventrally at junction with vein 3-cu; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular, node present, remaining pigmented; hind wing vein apical half of 2m+Cu and 1-m pigmented, other veins spectral, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical (two specimens from SA with four equidistant hamuli on right hind wing).

Metasoma. Metasoma 2.83 (2.76–2.86) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 3.55 (3.42–3.73) × metasoma length; with short appressed setae.

Male. Male specimen not examined but described by Pasteels (1957) as having reduced red colouration on head and mesonotum, the pedicel is shorter in the male when compared to the female.

Distribution. A widely distributed species from QLD, SA and WA. Pasteels (1957) commented that this species seems very common and he examined additional material from VIC.

Biology. Collected September and October on *Myoporum* (Scrophulariaceae).

Comments. *Gasteruption calothecus* can be easily distinguished from other species based on the extremely long ovipositor sheath (50.00–65.00 mm) and large apical cream band (11.56–17.06 × length of 1st hind tarsomere).

***Gasteruption capitale* Pasteels, 1957**

Fig. 15.

Gasteruption capitale Pasteels, 1957: 100, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Oct 1935, Q[LD] Mungindi G. H. Hardy" "*Gasteruption capitale* n. sp. J. Pasteels det., 1954" (SDEI).

Specimen damage. Left hind leg missing.

Paratypes. VIC: 1♀, Bright, V.H.W. Davey, (QM: T5493). Unknown: 1♀, "48–2802 Kukerin" (WAM).

Other material examined. **QLD:** 1♀ 35 km N Cunnamulla, 27.x.1979, H.E. & M.A. Evans & A. Hook (QM). 1♀, 35 km SW Moura, 24.48S, 149.46E, 22–25.x.1992, P. Mancnicol (ANIC: 32 115648). NSW: 1♂, Wilcannia, 23.xi.1949, E.F. Riek (ANIC). 1♀, Fowlers Gap Reserve Station, 29.xi–2.xii.1981, I.D. Naumann (ANIC:32 113638, 32 113634). **SA:** 1♀, Scorpion Springs Conservation Park, 16.xii.1983, no collector (SAMA)*.

Figure 15. *Gasteruption capitale* Pasteels, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female*. body length 19.27 (17.23–20.59) mm; ovipositor length 21.06 (16.44–26.53) mm

Colour. Mostly black; clypeus dark brown, malar space and mandibles brown (black tooth apex); pronotum posterior margin brown, mesoscutum red, mesoscutellum with red patch medially, axilla red, tegula pale brown; fore and mid leg mostly brown, trochantellus with cream apical margin, tibia dark with cream stripe on anterior face, fore leg tarsus mainly cream, darker ventrally, mid leg tarsus dark brown with dorsal 1st tarsomere cream, gold setae; hind leg dark brown, tibia with cream band sub-basally, tarsus cream, basal half of 1st, 5th tarsomere and claw dark brown; metasoma dark brown, darker at base and apex; ovipositor sheath dark brown with cream apex 2.52 (2.40–2.60) × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing veins dark brown, pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.87 (0.84–0.90) × longer than wide, postocular space short, tapering to occipital carina; head in lateral view flattened with short postocular space and elongated face; postocular space 0.29 (0.28–0.31) × height of eye; face punctate with short dense shiny setae, denser laterally on eye margin; frons reticulate-rugulose with short scattered shiny setae, denser laterally along eye margins; medial frontal carina distinct in lower half, indistinct in posterior half; vertex reticulate-rugulose, rugulose medially behind anterior ocelli, strigose posterior of lateral ocelli, short scattered setae; occipital carina short, lamelliform, depression broad, shallow and rounded; gena reticulate-rugulose with short dense shiny setae; minimal width of malar space 0.15 (0.13–0.16) × height of eye; 1.10 (1.00–1.20) × length of pedicel; clypeus punctate with larger scattered punctures medially, 1.63 (1.21–1.90) × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression indistinct anteriorly, short scattered setae, longer along ventral margin; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.65 (0.52–0.60) × distance between lateral ocelli; scape 2.46 (2.20–2.70) × length pedicel, 1st flagellomere 1.14 (1.13–1.15) × as long as scape, 0.71 (0.70–0.72) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.78 (1.67–1.80) × height; propleuron length 1.30 (1.29–1.30) × width; 0.84 (0.75–0.94) × prototegular distance; propleuron rugulose dorsally becoming reticulate-rugulose laterally, medium dense shiny setae; pronotal process large and acute; pronotum anterior and posterior lobe reticulate-rugulose, dorsal lobe reticulate-rugose, dorsal part of posterior lobe lightly punctate, groove between pronotum lobes carinate, medium dense shiny setae, longer in groove; mesoscutum length 1.25 (1.13–1.31) × width, rounded in lateral view, coarsely strigose with short scattered setae, admedial lines parapsidial lines distinct, notauli U-shaped, scrobiculate; mesoscutellum coarsely strigose, short scattered setae, axillae rugulose, short scattered setae; mesepisternum reticulate-rugose dorsally, becoming areolate ventrally, medium dense shiny setae; mesepimeron broad carinate (holotype) in a paratype lower two thirds carinate remaining smooth; metapleuron areolate dorsal lobe, becomes strigate-areolate laterally, medium dense shiny setae; propodeum areolate with raised medial carina, medium dense shiny setae.

Legs. Hind coxa strigate-rugulose anteriorly dorsally, strigate posteriorly dorsally becoming rugulose laterally; femur 0.75 (0.73–0.76) × length of tibia; tibia length 6.55 (6.40–6.70) × tibia width; short dense setae with scattered stout spines on anterior face; tarsus with short robust spines ventro-apically, and along ventro surface, 1st tarsomere 3.41 (3.33–3.50) × length of 2nd tarsomere; 2nd tarsomere 1.34 (1.30–1.39) × length of 3rd tarsomere, 3rd tarsomere 1.85 (1.80–1.90) × length of 4th tarsomere, 4th tarsomere 0.36 (0.33–0.40) × length of 5th tarsomere, tarsal claw 0.71 (0.67–0.75) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongate, slightly wider at apex, vein r-m absent; SR1 distinctly bent, vein 2-M first quarter tubular with node, remainder of vein pigmented; hind wing vein 1-m and apical 2/3rd of 2m+Cu pigmented, other veins spectral, five hamuli, basal three hamuli close together, separated from distal pair.

Metasoma. Metasoma 2.70 (2.68–2.72) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.38 (1.31–1.42) × metasoma length; with short dense appressed setae, cream apex flared

Male. Males specimens not examined but described by Pasteels (1957) as head entirely black, three black spots on the mesonotum and 1st flagellomere shorter than female.

Distribution. The species has a broad distribution ranging from QLD, NSW and SA. Pasteels (1957) examined additional material from NSW and VIC.

Biology. Unknown.

Comments. The head shape of *Gasteruption capitale* groups it with *G. terminale* but can easily be distinguished based on its distinctive black body and completely reddish-brown mesonotum.

Gasteruption cephalotes Pasteels, 1957

Fig. 16.

Gasteruption cephalotes Pasteels, 1957: 100, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "[QLD] Caloundra 28.9.13 H Hacker" "*Gasteruption cephalotes* n.sp. J. Pasteels det., 1955" (QM: T5486).

Specimen damage. Left antenna pedicel to tip and entire right antenna missing, left fore leg claw missing, metasoma broken and reattached with glue obscuring most of mesoscutellum and propodeum.

Paratypes. NSW: 1♀, Como, Sydney 14.xi.1922, T.G. Campbell (AM: K47016) [not examined]; 1♀, Australia (BMNH) [not examined].

Figure 16. *Gasteruption cephalotes* Pasteels, lateral habitus, scale bar = 1.00 mm (© Geoff Thompson, QM).

Redescription. *Female*. Body length 17.50 mm; ovipositor length 16.70 mm.

Colour. Black; mandibles brown with dark tooth apex, tegula dark brown; fore leg and mid leg mostly brown, trochantellus with cream apical margin, tibia with cream stripe on anterior face, fore leg tarsus cream with brown claw and mid leg tarsus cream with apical half of 4th tarsomere to claw brown; hind leg mostly dark brown, coxa lighter ventro laterally, prefemur and femur brown, darker in prefemur groove and posterior face of femur; tibia brown, darker posterior face, cream band sub-basally on anterior face; tarsus cream, basal third of 1st tarsomere and 4th tarsomere to claw dark brown; metasoma mostly dark brown, darker apically and basally; ovipositor sheath dark brown with cream apex 0.42 × 1st tarsomere; ovipositor brown; wing hyaline, veins brown and pterostigma darker.

Head. Head shape conical when viewed dorsally; 0.97 × longer than wide, postocular space tapering sharply to occipital carina; head in lateral view distinctly elongated and rounded on frons, vertex and gena; short scattered eye setae; face finely granulate with short dense shiny setae; frons finely granulate, short dense shiny setae; medial frontal carina raised in anterior third; vertex finely granular with short dense shiny setae; narrow lamelliform occipital carina, shallow emarginate depression; gena finely granular with short dense shiny setae; minimal width of malar space 0.12 × height of eye; clypeus finely granular, 1.94 × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression shallow, present anteriorly, short dense shiny setae with long setae along ventral margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.70 × distance between lateral ocelli.

Mesosoma. Mesosoma length 2.00 × height; 1.25 × prototegular distance; propleuron reticulate with short shiny setae, denser ventro-lateral; pronotal process rounded, pointing outwards; pronotum granulate, groove between pronotum lobes carinate, short dense shiny setae; mesepisternum areolate, coarser ventro-laterally, short dense shiny setae; mesepimeron carinate with shallow depressions; metapleuron areolate with short dense shiny setae; propodeum areolate with short dense setae, medial carina flattened; mesoscutum rounded in lateral view; granular; short dense setae; admedial and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axillae obscured in type specimen.

Legs. Hind coxa reticulate-rugulose dorsally, becoming imbricate laterally and ventrally; femur length 0.70 × length of tibia; tibia length 5.60 × width, short setae with scattered robust spines on anterior face; 1st tarsomere 3.33 × length of 2nd tarsomere; 2nd tarsomere 1.50 × length of 3rd tarsomere; 3rd tarsomere 2.00 × length of 4th tarsomere; 4th tarsomere 0.50 × length of 5th tarsomere; tarsal claw 0.50 × length of 5th tarsomere.

Wings. Fore wing first discal cell open; vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular with node, remaining pigmented; hind wing vein 1-m pigmented, other veins spectral, four equidistant hamuli.

Metasoma. Imbricate, length 5.10 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.39 × metasoma length, short dense appressed setae.

Male. Unknown.

Distribution. This species is recorded from QLD and NSW.

Biology. Unknown.

Comment. *Gasteruption cephalotes* keys out with *G. curticauda* and *G. jocosum*. All three have a long propleuron and sub-conical head shapes in dorsal view. *Gasteruption cephalotes* can be separated from *G. jocosum* by a U-shaped notauli (see key couplet 9) then from *G. curticauda* based on a completely black mesosoma and longer ovipositor sheath (1.39 × metasoma length), see key couplet 10.

Gasteruption cinerescens Pasteels, 1957

Fig. 17.

Gasteruption cinerescens Pasteels, 1957: 102, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, " G. H. Hardy Goondiwindi [QLD] Oct 1930, Q" "*Gasteruption cierescens* [sic.] n. sp. J. Pasteels det., 1954" (SDEI).

Specimen damage. complete left antenna and right antenna pedicle to tip missing.

Paratypes. QLD: 1♀, 1♂, Brisbane, 20.xii.1917, 8.ix.1915, H. Hacker (QM: T5495, T5496). **WA:** 1♀, Cannington, 14.i.1953, R.P. McMillan (WAM); 1♀, Dansborough, 42–97, no other details (WAM); 1♀, Midlands, 37–11, no other details (WAM).

Figure 17. *Gasteruption cinerescens* Pasteels, holotype female, lateral habitus, scale bar = 1.0 mm.

Redescription. *Female*. body length 17 mm; ovipositor length 13 mm

Colour. Mostly black; antenna dark brown, clypeus anterior half, malar space and mandibles brown (darker tooth apex); pronotum base of anterior and posterior lobe brown, mesepisternum brown, black ventro-laterally, mesepimeron brown, mesoscutum brown with black patches medially and around parapsidial lines, tegula dark brown; fore and mid legs mostly brown, coxae dark brown, trochantelli with cream apical margin, femora with cream spot on apex, tibiae with wide cream band on anterior face, fore leg 1st tarsomere cream, 2nd–4th tarsomere brown, 5th tarsomere to claw dark brown, mid leg tarsus dark brown, basal half of 1st tarsomere cream; hind leg mostly dark brown, coxa dark basally-ventrally brown, tibia with cream band sub-basally, tarsus cream, basal third of 1^{st} tarsomere and claw dark brown; metasoma dark brown, lighter laterally T2–T4; ovipositor sheath dark brown with cream apex 1.51 (1.52–1.50) × length of hind 1^{st} tarsomere; ovipositor brown; wing hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.80 (0.77–0.84) × longer than wide, postocular space short, tapering behind eyes in dorsal view; head in lateral view, wedge shape, face flat with frons and vertex convex; postocular space 0.27 × height of eye; face reticulate-rugulose, scattered shallow punctures towards antennal scrobes, short dense setae; frons reticulate-rugulose with short dense setae; medial frontal carina distinct in anterior third, remaining slightly raised; vertex reticulate-rugulose, rugulose around vertex, becoming strigose posteriorly, short dense setae; occipital carina narrow, lamelliform, depression shallow and rounded; gena reticulate-rugulose scattered shallow punctures along eye margin, short dense shiny setae; minimal width of malar space 0.16 (0.14–0.18) × height of eye, 0.92 × length of pedicel; clypeus punctate, 1.75 × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression indistinct anteriorly, medium dense shiny setae, longer along margin; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.60 (0.57–0.64) × distance between lateral ocelli; scape 2.00 × length pedicel, 1^{st} flagellomere 1.13 × as long as scape, 0.64 × length 2^{nd} flagellomere.

Mesosoma. Mesosoma length 1.65 × height; propleuron length 1.20 × width; 0.98 (0.96–1.00) × prototegular distance; propleuron reticulate-rugulose dorsally, becoming punctate-reticulate laterally and ventrally, medium dense shiny setae; pronotal process distinct, acute; pronotum anterior and posterior lobe reticulate-rugulose, with dorsal lobe coarser, punctures on pronotal lobe, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.08 (1.08–1.09) × width in dorsal view, anterior rounded in lateral view, rugose with short shiny setae, admedial lines long and converging; parapsidial lines distinct, notauli U-shaped, scrobiculate; mesoscutellum and axilla rugose with short dense setae; mesepisternum reticulate-rugulose dorsally and along anterior margin of mesepimeron, coarser ventro-lateral, short dense shiny setae; mesepimeron carinate forming shallow depressions; metapleuron areolate becoming coarser laterally and dorso-lateral, medium dense shiny setae; propodeum areolate, medial carina flattened, medium dense shiny setae;

Legs. Hind coxa strigate-rugulose dorsally, strigate in coxal groove, becoming reticulate laterally and ventrally; femur 0.69 (0.69–0.70) × length of tibia; tibia 7.35 (6.70–8.00) × tibia width; short dense setae with scattered stout spines on anterior face, tarsus with several stout spins apically with short stout spines along ventral face; 1st tarsomere 3.50 (3.15–3.80) × length of 2nd tarsomere, 2nd tarsomere 1.56 (1.43–1.70) × length of 3rd tarsomere, 3rd tarsomere 1.95 (1.90–2.00) × length of 4th tarsomere, 4th tarsomere 0.40 × length of 5th tarsomere, tarsal claw 0.60 × length of 5th tarsomere.

Wings. First discal cell rectangular, slightly wider apically and ventrally; fore wing vein r-m absent; vein SR1 distinctly bent, vein 2-M basal quarter tubular with node, remaining pigmented; hind wing vein most of 2m+Cu (apically section near 1-m not pigmented) and 1-m pigmented, other veins spectral, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma 2.70 (2.60–2.80) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.34 (1.32–1.36) × metasoma length, with short appressed setae, apex slightly flared.

Male. Metasomal T9 and apex of paramere cream, one specimen with brown axilla. hind tibia entirely black or with small spot of cream subbasally.

Variation. Some specimens with browner on posterior lobe of pronotum.

Distribution. The species has been collected in QLD and WA with material examined by Pasteels (1957) from NSW.

Biology. Unknown.

Comments. This species is superficially similar to *G. variegatum* Schletterer but can be separated based on a longer malar space in G. cinerescens (0.92 × length of pedicel) and less brown colouration on the pronotum and metapleuron.

Gasteruption combinatum Pasteels, 1957

Fig. 18.

Figure 18. *Gasteruption combinatum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Gasteruption combinatum Pasteels, 1957: 88, ♀, ♂; Jennings 2010 [on-line checklist].

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NMV (Fig. 16), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Material examined.

Holotype. ♀, “Yeppoon, Q[LD]. 6-1-[19]35 A. N. Burns” “Collection A. N. Burns” (NMV: T-7423) [examined from photos].

Paratype. QLD: 1♂, Burleigh Heads, A.N. Burns (NMV) [not examined].

Redescription. *Female.* Body length 21.20 mm; ovipositor length 19.20 mm.

Colour. Black and reddish-brown; Head mostly black, antenna dark brown, malar space reddish-brown; mesosoma mostly black, anterior margin of propleuron, anterior and posterior lobes of pronotum, mesepisternum, mesepimeron and metapleuron reddish-brown, mesonotum reddish-brown with black patches medially and around parapsidial lines, tegula light brown; fore and mid legs dark brown, patch apically on femur, longitudinal stripe on anterior face of tibia and basal two thirds of 1st tarsomere cream; hind leg dark brown, ventral face of coxa, trochantellus and femur reddish-brown, broad cream band subbasally on tibia, tarsus cream, basal third of 1st tarsomere, apical half of 5th tarsomere and claw dark brown; metasoma brown with T1 and T5 to tip black; ovipositor sheath dark brown with cream apex 2.60 × length of hind 1st tarsomere; wings hyaline, veins and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; postocular space tapering sharply to occipital carina; head in lateral view rounded with frons, vertex and gena convex; postocular space short; head punctate with short scattered setae, denser ventro-laterally on gena; narrow lamelliform occipital carina, slightly wider ventro-laterally, shallow rounded depression; malar space long; lateral ocelli anterior of postocular line; scape 2.00 × length pedicel; 1st flagellomere 0.75 × as long as scape; 0.43 × length 2nd flagellomere.

Mesosoma. Propleuron length 0.72 × prototegular distance; mesosoma with medium dense shiny setae laterally, pronotal process large and hooked; mesoscutum length 1.23 rounded in lateral view; admedial and parapsidial lines distinct; notauli U-shaped, scrobiculate; propodeum with flattened longitudinal medial carina.

Legs. Femur 0.77 × length of tibia; tibia length 4.78 × tibia width; tarsus with short spines on anterior face and apically; 1st tarsomere 3.75 × length of 2nd tarsomere; 2nd tarsomere 1.33 × length of 3rd tarsomere; 3rd tarsomere 1.50 × length of 4th tarsomere; 4th tarsomere 0.50 × length of 5th tarsomere; tarsal claw 0.50 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, 1m-cu tapering; vein r-m indistinct spectral; vein SR1 weakly bent, vein 2-M basal third tubular with node apically, remainder of vein pigmented; hind wing veins apical two thirds of 2M+CU and 1-M pigmented, three equidistant hamuli.

Metasoma. Metasoma 2.85 × mesosoma length; ovipositor sheath 1.30 × metasoma length.

Male. Not examined.

Distribution. The species is known from two localities in QLD.

Biology. Unknown.

Comments. This species is known only from the female holotype and male paratype specimens which we have been unable to examine in detail. From the visible characters *G. combinatum* keys out with *G. platycephala* and can be separated by a shorter propleuron length (~0.70 × prototegular distance), more clavate tibia (~4.8 × width) and lateral ocelli anterior of postocular line in dorsal view.

Gasteruption compressiceps Pasteels ,1957

Fig. 19.

Gasteruption compressiceps Pasteels, 1957: 44, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "G. H. Hardy Maria Isl[and] [TAS] 31.12 15/12" "*Gasteruption compressiceps* n. sp. J. Pasteels 1955" (SDEI).

Specimen damage. Right antenna 7th flagellomere to tip missing, left hind leg 5th tarsomere to tip missing.

Redescription. *Female*. Body length 10.58 mm; ovipositor length 7.15 mm.

Colour. Black; antenna dark brown, malar space lighter, mandibles light brown with black tooth apex; pronotum lighter along anterior margin, tegula light brown; fore leg mostly light brown, coxa dark brown, tibia brown with cream longitudinal stripe on anterior face. tarsus dark brown, cream stripe anterior face of 1st and 2nd tarsomere; mid leg mostly dark brown, prefemur light brown, tibia with cream longitudinal stripe on anterior face, tarsus with cream stripe on anterior of 1st tarsomere and apex of 2nd tarsomere; hind legs dark brown, prefemur lighter, tibia lighter ventrally with cream patch sub-basally on ventral surface; metasoma dark brown, darker dorsally T4 to tip; ovipositor sheath dark brown with cream apex 2.82 × length of hind 1st tarsomere, ovipositor brown; wing hyaline with brown fore wing veins and pterostigma.

Figure 19. *Gasteruption compressiceps* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Head. Head shape sub-rectangular when viewed dorsally; 1.05 × longer than wide; postocular space rectangular with slightly convex sides; head in lateral view, flattened with longer postocular space, face slightly rounded; postocular space 0.38 × height of eye; head granular with short dense setae; medial frontal carina indistinct anterior third, absent remaining, occipital carina very narrow and lamelliform; depression shallow and rounded; minimal width of malar space 0.11 × height of eye; 0.71 × length of pedicel; clypeus 1.63 × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression absent, short dense setae, long setae along margin; lateral ocelli posterior of postocular line, distance from lateral ocellus to eye margin 0.58 × distance between lateral ocelli; scape 1.57 ×

length pedicel, 1st flagellomere 0.73 × as long as scape; 0.57 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.00 × height; propleuron length 1.39 × width; 0.86 × prototegular distance; propleuron granular with short dense setae; pronotal process short and acute; pronotum granular with middle of dorsal lobe rugulose, groove between pronotum lobes carinate, short dense setae, longer in groove; mesoscutum length 1.55 × width in dorsal view; truncated in lateral view; granular laterally, strigose medially, short scattered setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum punctate-rugulose, axillae punctate, both with short scattered setae; mesepisternum granular dorsally, areolate laterally and ventrally with short dense setae; mesepimeron carinate with scattered shallow foveae; metapleuron areolate, anterior lobe finer, short dense setae; propodeum areolate, medial dorsal carina flattened, short dense setae.

Legs. Hind coxa strigate in dorsal groove, becoming granular for remaining surface; femur length 0.67 × length of tibia; tibia length 4.18 × tibia width; short dense setae; tarsus indistinct dense pecten of short robust spines; 1st tarsomere 3.33 × length of 2nd tarsomere; 2nd tarsomere 1.50 × length of 3rd tarsomere; 3rd tarsomere 2.00 × length of 4th tarsomere; 4th tarsomere 0.33 × length of 5th tarsomere; tarsal claw 0.56 × length of 5th tarsomere.

Wings. Fore wing first discal cell tapering at apex, wider basally, vein r-m absent, vein SR1 weakly sinuate, vein 2-M tubular basal third, remaining two-thirds pigmented; hind wing veins spectral, four equidistant hamuli.

Metasoma. Imbricate, 2.67 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.07 × metasoma length; with short appressed setae;

Male. Unknown

Distribution. The species is known only from the type locality of Maria Island, TAS.

Biology. Unknown.

Comments. *Gasteruption compressiceps* keys out with *G. fibula*. Both species have dark brown hind tarsus without any cream colouration. *Gasteruption compressiceps* has a longer malar space and shorter propleuron, see key couplet 55.

Gasteruption cornutum Pasteels 1957

Fig. 20.

Gasteruption cornutum Pasteels, 1957: ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "W.AUSTRALIA: Perth. 26–28.i.1936. R.E.Turner. B.M. 1936–28" "*Gasteruption cornutum* n.sp. J. Pasteels det., 1954" (BMNH: 3a.357).

Paratypes. WA: 2♀, Applecross, 10.iii.1935, K.R. Norris (ANIC); 1♀, Fremantle, 9.ii.1936, K.R. Norris (ANIC); 1♂, Perth, 10–18.ii.1936, R.E. Turner (BMNH).

Figure 20. *Gasteruption cornutum* Pasteels, lateral habitus, scale bar = 1.00 mm.

Other material examined. **WA:** 1♀, Walkaway, 3.i.1972, K.T. Richards, (WADA: 87085)*; 1♀, Whoogarup Range, Fitzgerald River National Park, 1-3.i.1979, T.F. Houston (WAM: E 97824); 1♀, Southern Cross, x.1981, R.P. McMillan (WAM: E 97822); 1♂, Melaleuca Park, 10.xi.1982, T.F. Houston (WAM: E 97820); 1♂, Cape Le Grand National Park, 33º58'S, 122º07'E, 11.i.1987, G and A. Daniels (QM); 1♀, Hopetoun, 33º55'S, 120º08'E, 13.i.1987, G. and A. Daniels (QM); 1♀, Tarin Rock

Reserve, 33.06S, 118.13E, 19-21.xii.1987, T.F. Houston (WAM: E 97823); 1♀, Tarin Rock Reserve, 20.ii.1996, T.F. Houston & C.K. Boase (WAM: E 97821).

Redescription. *Female*. body length 20.53 (19.90–21.10) mm; ovipositor length 24.33 (18.50–28.20) mm.

Colour. Reddish-brown; antenna dark brown, head with darker spot medially on vertex behind ocelli and medial carina, mandibles (black tooth apex) and tegula light brown; fore and mid leg mostly dark brown, trochantellus with cream apical margin, femur cream apex, tibia with pale stripe on anterior face, 1st tarsomere 5th cream; hind leg mostly red-brown. femur darker dorsally; tibia darker dorsally with cream patch sub basally, tarsus cream with basal half of 1st tarsomere, apical half on 5th tarsomere and claw brown; metasoma darker dorso-apically; ovipositor sheath dark brown with cream apex 3.28 (3.10–3.40) × length of hind 1st tarsomere; wing hyaline; wing veins and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; 0.99 (0.96–1.04) × longer than wide; postocular space gently tapering towards occipital carina; head in lateral view wedge like with distinctive medial carina forming a horn like projection above antennal scrobes; postocular space 0.53 (0.51–0.56) × height of eye; eye setae absent; face rugulose with short shiny setae, denser laterally near eye margin; frons rugose with short scattered setae; medial frontal carina distinct, horn like anteriorly, a distinct groove posteriorly to anterior ocellus; vertex rugulose around ocelli, postocular space strigose with a wide longitudinal groove posterior of ocelli, short scattered setae; occipital carina wide and carinate, depression shallow medially pointed; gena punctulate with shiny short scattered setae; width of malar space 0.18 (0.15–0.24) × height of eye; 1.39 (1.10–1.70) × length of pedicel; clypeus punctulate; 1.53 (1.48–1.58) × wide as high; margin sinuate with lateral corners distinctly protruding forwards, medial depression absent, short with long setae along margin and scattered; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.63 (0.40–0.74) × distance between lateral ocelli; scape 1.88 (1.80–2.00) × length pedicel; 1st flagellomere 0.99 (0.90–1.06) × as long as scape; 0.60 (0.56–0.65) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.70 (1.64–1.75) × height; propleuron length

1.35 (1.23–1.48) × width; 0.98 (0.90–1.09) × prototegular distance; propleuron reticulate-rugulose; short dense shiny setae; pronotal process large, hook like; pronotum rugose with wide carinate groove between pronotum lobes, shiny short setae; mesoscutum length 1.21 (1.18–1.23) × width in dorsal view; rounded in lateral view; rugose with short scattered setae; admedial and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugose with short scattered setae; mesepisternum areolate, coarser ventrally with shiny short setae; mesepimeron with horizontal carinae in ventral half, smooth dorsal half; metapleuron and propodeum areolate; short dense setae.

Legs. Hind coxa strigate dorsally and in coxal depression, becoming reticulate laterally and ventrally; femur length 0.74 (0.70–0.76) × length of tibia; tibia length 6.23 (6.00–6.38) × tibia width; short scattered setae with stout spines on anterior face; 1st tarsomere 3.60 (3.50–3.79) × length of 2nd tarsomere; 2nd tarsomere, 1.42 (1.33–1.60) × length of 3rd tarsomere; 3rd tarsomere, 2.02 (1.75–2.33) × length of 4th tarsomere; 4th tarsomere, 0.38 (0.33–0.42) × length of 5th tarsomere; tarsal claw 0.58 (0.50–0.65) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongate, wider at junction of vein 3-cu; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular with node, pigmented remaining two thirds; hind wing vein 1-m and 2M+Cu pigmented, others spectral; three equidistant hamuli.

Metasoma. Metasoma length 2.83 (2.60–3.15) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 2.15 (2.11–2.19) × metasoma length; with short appressed setae.

Variation. There is variation in the amount of black colouration with some specimens with blacker on the dorsal parts of the head and mesosoma.

Male. Males have more extensive black colouration dorsally on the vertex, mesonotum and metasoma, T9 and paramere apex cream.

Distribution. The species is restricted to south-western WA.

Biology. Unknown.

Comments. *Gasteruption cornutum* is a distinctive species, large in size (19.90–21.10 mm) with body almost completely reddish-brown (Fig. 19). The species also has a large longitudinal medial carina that protrudes like a horn in lateral view. The species has only been recorded from south-western Australia.

Gasteruption crassitibale Pasteels, 1957

Fig. 21.

Gasteruption crassitibale Pasteels 1957: 105, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "W.AUSTRALIA: Merredin. 12–13.xii.1935. R E. Turner. B.M.1936–28." (BMNH: 3a.363).

Specimen damage. Right fore tibia 2nd tarsomere to tip and left hind tibia 4th tarsomere to tip missing.

Figure 21. *Gasteruption crassitibale* Pasteels, holotype female, lateral habitus, scale bar = 1.0 mm.

Redescription. *Female*. body length 10.00 mm; ovipositor length 11.00 mm.

Colour. Head black, body mostly brown; antenna brown, scape, pedicel and basal third of 1st flagellomere dark brown, malar space, lateral corners and anterior margin of clypeus brown, mandibles light brown, tooth apex darker; propleuron brown, darker laterally sub basally; pronotum anterior lobe darker towards ventral, mesepisternum, dorsal third of mesepimeron, raised lobes on the metapleuron, mesoscutum, mesoscutellum and axilla black, tegula light brown; fore leg mostly brown, coxa, trochantellus and femur lighter, trochantellus with cream apical margin, tibia with cream stripe on anterior face, fore leg tarsus with cream stripe on anterior face of 1st and 3rd tarsomere; mid leg mostly brown, femur darker dorsally, tibia dark brown with cream stripe on anterior face; tarsus dark brown, cream 1st tarsomere; hind leg dark brown, coxa brown, darker apex, tibia with cream patch sub basally, tarsus cream, basal half of 1st tarsomere and 3rd tarsomere to claw dark brown; metasoma dark brown, lighter T2–T4 laterally; ovipositor sheath dark brown with cream apex 2.50 × length of hind 1st tarsomere, ovipositor brown; wing hyaline, wing vein and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 1.13 × longer than wide, postocular space tapering in dorsal view, head in lateral view elongated with convex frons and vertex; postocular space elongate, 0.43 × height of eye; short scattered eye setae; face granular with short shiny setae, frons granular with several scattered punctures, short shiny setae; medial frontal carina present in anterior third, indistinct remaining; vertex granular with several shallow scattered punctures, posteriorly becoming granular-strigulate, short shiny setae; occipital carina narrow, lamelliform, depression indistinct; gena granular with short dense shiny setae; minimal width of malar space 0.07 × height of eye; 0.50 × length of pedicel; clypeus granular, 1.80 × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression shallow, present anteriorly, short setae, longer along margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.35 × distance between lateral ocelli; scape 1.50 × length pedicel, 1st flagellomere 1.13 × as long as scape, 0.81 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.07 × height; propleuron length 1.43 × width; 0.93 × prototegular distance; propleuron reticulate-rugulose, rugulose dorsally, medium dense shiny setae; pronotal process small and acute, pointing outwards; pronotum granular, anterior lobe granular-rugulose, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.39 × width in dorsal view; rounded in lateral view; granular-rugulose, with some scattered punctures medially; lateral lobe sculpturing coarser along posterior margin, short scattered setae; admedial lines indistinct, gently curved, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum granular with scattered punctures anteriorly, finely rugulose posteriorly, short scattered setae, axillae granular with short scattered setae; mesepisternum granular-rugulose dorsally, becoming areolate-rugose, medium dense shiny setae; mesepimeron carinate forming small fovea; metapleuron and propodeum areolate-rugulose, propodeum medial carina absent, represented by a broad, shallow groove, short shiny setae.

Legs. Hind coxa rugulose dorsally becoming finer laterally, strigate in coxal groove; femur wide; 3.55 × length of tibia, tibia, short dense setae with scattered emergent setae on anterior face; ventro-apical pecten of short robust spines; tibia length 3.55 × width; tarsus with ventro pecten and apical pecten of short robust spines; 1st tarsomere, 2.92 × length of 2nd tarsomere, 2nd tarsomere, 1.33 × length of 3rd tarsomere, 3rd tarsomere, 1.80 × length of 4th tarsomere, 4th tarsomere, 0.33 × length of 5th tarsomere, tarsal claw 0.67 × length of 5th tarsomere.

Wings. Fore wing first discal cell elongate, tapering at apex; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal quarter tubular, remaining pigmented; hind wing veins spectral, three hamuli, distance between second and apical hamuli greater than distance between basal and middle hamuli.

Metasoma. Imbricate, length 2.42 × mesosoma length; hypopygium V-shaped; ovipositor sheath covered in short appressed setae, flared cream apex.

Male. Unknown

Biology. Unknown.

Distribution. The species is only known from the type locality of Merredin, WA.

Comments. *Gasteruption crassitibale* is known only from the holotype, the species has distinctive brown and black colouration, swollen femora and flared ovipositor sheath apex.

Gasteruption cribatum Pasteels, 1957

Fig. 22.

Gasteruption cribatum Pasteels, 1957: 47, ♀;

Material examined.

Holotype. ♀, "Cunnamulla. Q[LD]. Oct. 1944 N. Geary" "*Gasteruption cribatum* n.sp J. Pasteels det., 1955" (AM: K67840).

Specimen damage. Head dislodged, left antenna completely missing and right antenna 6th flagellomere to tip missing, left fore leg 4th tarsomere to tip missing, mid legs trochanter to tip missing, hind legs missing, metasoma missing, left forewing discal cell to margin missing, right fore wing margin missing.

Figure 22. *Gasteruption cribatum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* Pasteels (1957) described body length 13.00 mm; ovipositor length 8.00 mm.

Colour. Black; antenna dark brown, clypeus anterior margin brown and malar space anterior margin brown, mandibles brown with darker tooth apex; posterior corner of pronotum and tegula brown; fore leg mostly brown, trochantellus apical margin, femur apex and longitudinal stripe on anterior face of tibia cream, 1st to 3rd tarsomere cream, other tarsomeres missing, Pasteels (1957) describes the hind leg as mostly black with the anterior surface of the coxae, the base of the femurs, the anterior surface of the tibia brown, a cream patch subbasally on the tibia, and on 1st and 2nd tarsomere; Metasoma black; wing hyaline, wing veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.87 × width; postocular space convex behind eyes, tapering to occipital carina; head in lateral view, frons and vertex convex with flattened gena; face, frons and gena reticulate with medium dense shiny setae, becoming shorter towards vertex; medial frontal carina distinct between antennal scrobes, absent posteriorly; vertex reticulate-rugulose medially with short scattered shiny setae; narrow lamelliform occipital carina, becoming wider ventro-laterally; minimal width of malar space 0.08 × height of eye; 0.67 × length of pedicel; clypeus reticulate; 1.90 × wide as high; margin sinuate, lateral corners barely protruding forwards with indistinct medial depression, short dense shiny setae, longer along margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.49 × distance between lateral ocelli; scape 1.76 × length pedicel; 1st flagellomere 0.83 × as long as scape; 0.50 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.81 × height; propleuron length 0.96 × prototegular distance; rugulose with medium dense shiny setae, denser ventro-laterally; pronotal process small and acute; pronotal anterior lobe rugose, dorsal and posterior lobe rugulose, groove between pronotum lobes carinate; medium dense shiny setae; mesoscutum length 1.09 × width in dorsal view; rounded in lateral view; areolate-rugulose with short scattered setae; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugulose with short scattered setae; mesepisternum reticulate-rugose, medium dense shiny setae; mesepimeron carinate with shallow fovea; metapleuron areolate with medium dense shiny setae; propodeum areolate with flatten longitudinal medial carina, short dense shiny setae.

Legs. Missing from type specimen.

Wings. Fore wing first discal cell rectangular, vein 2-Cu concave apically at junction of 3-Cu; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular with remaining pigmented; hind wing vein 1-m pigmented, other veins spectral; three hamuli distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Missing from type specimen.

Male. Male specimens not examined but described by Pasteels (1957) as having the same characters as female.

Distribution. The species is known from QLD with material examined by Pasteels (1957) from QLD and VIC.

Biology. Unknown.

Comments. Pasteels (1957) grouped *G. cribatum* and *G. tenellum* together based on a strongly rounded postocular space and rugose sculpturing on the mesosoma. *G. cribatum* can be separated based on the length of the malar space, (0.67 × length of pedicel), hind tibia with cream/ white patch subbasally and the distance between basal and middle hamuli greater than distance between middle and apical.

Gasteruption curticauda Pasteels, 1957

Fig. 23.

Gasteruption curticauda Pasteels 1957: 22, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "G. H. Hardy Garden Isl[and] [TAS] 27.12 16/1" "*Gasteruption curticauda* n. sp. J Pasteels det., 1954" "Type" (SDEI).

Specimen damage. Left antenna pedicel to tip and entire right antenna missing, complete metasoma and ovipositor missing.

Figure 23. *Gasteruption curticauda* Pasteels, lateral habitus of, scale bar = 1.00 mm

Paratypes. TAS: 1♀, Hobart, 21.iii.1915/12, G.H. Hardy (SDEI). 1♀, Miena, 17.i.1951, E.F. Riek (ANIC).

Other material examined. **TAS:** 1♀, Lake St. Clair, 13.ii.1955, T.E. Woodward (QM)*; 1♀, Manuka Road, 43.1007S, 146.6909E, 01.iii.2001, R. Bashford (TMAG). **VIC:** 1♀, Jackass Fern Gully Campground, Cobboboonee National Park, 27.ii.2019, B.A. Parslow (SAMA).

Redescription. *Female.* Body length 11.90 (11.00–12.80) mm; ovipositor length 3.05 (3.00–3.10) mm.

Colour. Mostly black; antenna, clypeus lateral corners and malar space dark brown, 11th and 12th flagellomere light brown, mandibles brown; pronotum dark brown dorsally, orange-brown ventrally, mesepisternum orange-brown, dorsal corner black, mesepimeron orange-brown, dorsal third black, metapleuron orange-brown, dorsal lobe black, tegula dark brown; fore leg brown, coxa dark brown, trochantellus dark brown with cream on apical margin, prefemur lighter, tibia with cream stripe on anterior face, 1st tarsomere cream; mid leg dark brown, prefemur lighter, tibia with cream stripe longitudinal on anterior face, tarsus brown, basal three quarters of 1st tarsomere cream; hind leg dark brown, coxa lighter ventro-anteriorly, prefemur lighter, tibia with large cream patch sub basally on ventral surface, tarsus cream, base of 1st tarsomere and 4th tarsomere to claw dark brown; metasoma dark brown, ovipositor sheath dark brown with cream apex 0.92 (0.75–1.00) × length of hind 1st tarsomere, ovipositor light brown; wings hyaline, tubular and pigmented veins dark brown, pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; length 1.19 (1.04–1.26) × width, gently tapering behind eyes; head in lateral view, frons and vertex convex, gena flattened, postocular space; 0.35 (0.33–0.36) × height of eye; minimal width of malar space 0.03 (0.02–0.04) × height of eye; 0.19 (0.17–0.27) × length of pedicel; short scattered eye setae; face reticulate with short dense shiny setae, denser medially and along eye margins; frons reticulate with short scattered setae; medial frontal carina raised in anterior third becoming indistinct; vertex reticulate with short scattered setae; occipital carina short and lamelliform, depression broad deep and rounded; gena reticulate with short dense shine setae; clypeus reticulate, shallow punctures medially; 2.06 (2.00–2.14) × wide as high, margin sinuate, lateral corners distinctly protruding forwards, medial depression indistinct, short dense setae, longer along margin; mandible with distinct punctures; lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 0.76 (0.71–0.81) × distance between lateral ocelli; scape 1.24 (1.14–1.33) × length pedicel; 1st flagellomere 1.33 (1.25–1.38) × as long as scape; 0.77 (0.74–0.82) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.35 (2.24–2.58) × height; propleuron length 2.16 (1.95–2.27) × width; 1.11 (0.92–1.36) × prototegular distance; propleuron reticulate with short scattered setae; pronotal process indistinct and broad; pronotum dorsal lobe reticulate-rugulose, other lobes reticulate, groove between pronotal lobes carinate, short dense setae, longer in groove; mesoscutum length 1.50 (1.43–1.58) × width in dorsal view; rounded in lateral view, reticulate with scattered shallow punctures, short scattered setae; admedial lines distinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate with short scattered setae; mesepisternum reticulate-rugulose with short dense setae; mesepimeron carinate, smoother in dorsal third with faint carinae; metapleuron reticulate-rugulose, coarser on dorsal anterior margin, appearing smooth on the ventro-anterior corner; short dense shiny setae, setae absent at ventro-anterior corner; propodeum areolate-rugose, flattened medial carina reticulate, short dense setae.

Legs. Hind coxa reticulate, strigate in coxal groove; femur 0.67 (0.66–0.69) × length of tibia; tibia length 4.78 (4.53–5.00) × tibia width; short dense setae; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.50 (3.26–3.82) × length of 2nd tarsomere; 2nd tarsomere 1.54 (1.38–1.67) × length of 3rd tarsomere; 3rd tarsomere, 1.82 (1.57–2.00) × length of 4th tarsomere; 4th tarsomere, 0.39 (0.33–0.40) × length of 5th tarsomere; tarsal claw 0.51 (0.44–0.56) × length of 5th tarsomere.

Wings. Fore wing first discal cell open; vein r-m absent, vein SR1 straight, 2-M basal third tubular without node, remainder of vein pigmented; hind wing vein 1-m slightly pigmented, remaining veins spectral; three equidistant hamuli.

Metasoma. Imbricate, length 2.74 (1.88–3.22) × mesosoma length; hypopygium shallow V-shaped; ovipositor sheath 0.42 (0.41–0.42) × metasoma length; short appressed setae, cream apex flared.

Variation. Mesosoma with variable amounts of orange-brown on pronotum and mesepisternum.

Male. Males specimens not examined but described by Pasteels (1957) as having the same characters of the female except first flagellomere of antenna shorter.

Distribution. The species has been recorded from TAS with one specimen from VIC.

Biology. Unknown.

Comment*.* *Gasteruption curticauda* keys out with *G. cephalotes.* Both species have a long propleuron and sub-conical head shapes in dorsal view. *Gasteruption curticauda* can be separated from *G. cephalotes* based on orange-brown colouration on the mesosoma and a shorter ovipositor sheath (0.41–0.42 × metasoma length), see key couplet 10.

Gasteruption curtigena Pasteels, 1957

Fig. 24.

Figure 24. *Gasteruption curtigena* Pasteels, holotype male, lateral habitus. Scale bar = 1.00 mm

Gasteruption curtigena Pasteels, 1957: 82, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♂, "W. AUSTRALIA: Dongarra. 20–25.ix.1935. R.E. Turner. B.M. 1935–240" "*Gasteruption curtigena* n. sp J.Pasteels., 195" (BMNH: 3.a.360).

Specimen damage. Left antenna 4th flagellomere to tip and right antenna 8th flagellomere to tip missing, right fore leg 2nd tarsomere to tip missing, right mid leg 5th tarsomere and claw missing, damage to right forewing apex, metasoma broken off and glued to main card.

Comments. The original species description is based entirely on a single male specimen, and until we can associate females, we have refrained from redescribing this species.

***Gasteruption cylindricum* (Turner, 1918)**

Fig. 25.

Pseudofoenus cylindricus Turner 1918: 197, ♀ (comb. Pasteels 1957: 23).

Gasteruption cylindricum (Turner), Pasteels 1957: 23, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "*Pseudofoenus cylindricus* Type Turner." "S.W.Australia. Kalamunda. 9–28 Feb.1914. R.E.Turner. 1914–258" (BMNH: 3.a.216).

Other material examined. **QLD:** 1♀, Kuranda, ii.1952, J. Brooks (AM); 1♀, Indooroopilli, 26.x.1933, no other details (DAP). NSW: 1♀, Catherine Hill, 12.ix.1949, E.F. Riek (ANIC); 1♀, Barrington Tops via Salisbury, 29–30.xii.1965, T. Weir (QM); 1♀, Sawpit creek, Snowy Mountains, 10.ii.1979 D.K. McAlpine & B.J. Day (AM: K420865); 1♀, Pilliga Scrub, 48 km N. of Coonabarabran, 4.xii.1979, on *Leptospermum*, E.M. Exley & T. Low (QM); 1♀, Clarence, Blue Mountains, 15.xii.1982, N.W. Rodd (AM: K420868). **VIC:** 1♀, Coranderrk Res. Healesville, 3.iii.1980, M.S. Harvey (ANIC). **SA:** 1♀, Mount Lofty, 1280 m, 19.i.1973, P.B. McQuillian (SAMA)*; 1♀, Near Willson River, Mouth Flat, SE Kangaroo Island. 17.ii.2007, R.V. Glatz (RGC: 5173). **TAS:** 1♀, Warra LTER site: Manuka Road: SST small forestry coupe: 43.0972S, 146.6967E, 19.i.2001, R. Bashford (TMAG:

F33258); 1♀, George Town: 41.09S, 146.81E, on *Eucalyptus camaldulensis*, 07.iii.2001, R. Bashford (TMAG); 1♀, Pittwater (Hobart Airport), 147.52 E, 42.84, 31.xii.2002, R. Bashford (TMAG: F33199); 1♀, Pittwater (Hobart Airport): 42.8367 S, 147.5106, 18.ii.2003, R. Bashford (TMAG: FT14983).

Figure 25. *Gasteruption cylindricum* (Turner), lateral habitus. Scale bar = 1.00 mm

Redescription. *Female*. Body length 9.69 (8.35–11.05) mm; ovipositor length 1.68 (1.56–2.00) mm.

Colour. Black; mandibles (apex lighter) and tegula dark brown; fore leg trochantellus with cream on apex; prefemur light brown; femur dark brown; tibia dark brown, light brown base and apex; tarsus dark brown, light brown base of 1st tarsomere; mid leg, coxa, trochantellus, prefemur, femur, tibia and tarsus dark brown (light brown basally); hind leg, femur with small light brown patch ventro-posteriorly; tibia small cream patch subapically on ventral face; tarsus dark brown, small cream spot at base; ovipositor sheath dark brown with cream apex 1.07 (0.90–1.19) × length of hind 1st tarsomere, ovipositor light brown; wings hyaline, wing veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; length 1.68 (1.43–2.0) × width; postocular space almost straight, tapering slightly; head in lateral view distinctive elongated rectangular, malar space short, minimal width 0.03 (0.02–0.03) × height of eye; 0.15 (0.10–0.17) × length of pedicel; postocular space elongate, 0.57 (0.45–0.63) × height of eye; eye setae absent; face punctate laterally with longitudinal strigate-rugulose medially, short setae; frons granular with scattered shallow punctures denser medially with short setae; medial frontal carina weak carina in anterior third; vertex granular with shallow punctures between lateral ocelli, fine striations posterior of lateral ocelli, short scattered setae; occipital carina very short and lamelliform, depression broad, shallow and rounded; gena punctate with short setae; clypeus punctate, finer laterally; 2.23 (2.19–2.33) × wide as high; margin sinuate with lateral corners barely protruding forwards; medial depression absent, short setae, longer on margin; lateral ocelli posterior of postocular line, distance from lateral ocellus to eye margin 1.55 (0.95–1.87) × distance between lateral ocelli; scape 1.44 (1.33–1.50) × length pedicel; 1st flagellomere 0.49 (0.45–0.53) × as long as scape; 0.68 (0.62–0.77) × length 2nd flagellomere.

Mesosoma. Mesosoma length 3.39 (3.25–3.50) × height; propleuron length 2.52 (2.36–2.73) × width; 1.06 (1.00–1.17) × prototegular distance; propleuron granular becoming punctate-imbricate posteriorly with short setae; pronotal process absent; pronotum reticulate, anterior lobe finer, ventro-posterior lobe punctate, groove between pronotum lobes absent, short dense setae; mesoscutum length 1.82 (1.73–1.96) × width in dorsal view; rounded in lateral view; granular, becoming reticulate laterally, scattered punctures medially with short dense setae; admedial lines distinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate laterally becoming a fine groove medially; mesoscutellum imbricate medially, rugulose laterally, short setae; axilla punctate with short setae; mesepisternum punctate with short dense setae; mesepimeron carinate ventral two thirds, remaining smooth; metapleuron granular with short dense setae; propodeum granular with a distinctive scrobiculate groove on anterior margin, distinctive wide medial groove, flattened medially with deep scrobiculate margins, short dense setae;

Legs. Hind coxa imbricate dorsally, granular laterally, fine striations in coxal groove; femur 0.67 (0.64–0.68) × length of tibia; tibia length 3.31 (2.79–3.52) × tibia width; single tibial spur; tarsus with ventro pecten of short robust spines and apically; 1st tarsomere 2.62 (2.42–2.89) × length of 2nd tarsomere; 2nd tarsomere 1.45 (1.33–1.60) × length of 3rd tarsomere; 3rd tarsomere 1.78 (1.67–1.88) × length of 4th tarsomere; 4th tarsomere 0.45 (0.42–0.47) × length of 5th tarsomere; tarsal claw 0.58 (0.53–0.67) × length of 5th tarsomere.

Wings. Fore wing first discal cell open; vein r-m absent; SR1 weakly bent; 2-M spectral; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma length 2.60 (2.51–2.69) × mesosoma length; metasomal segment T1 constricted; S9 distinctive V shape, extending past metasomal apex; hypopygium Y-shaped and slit like; ovipositor sheath 0.41 (0.39–0.45) × metasoma length; sheath covered in long appressed setae, ovipositor with long spaced setae on lateral faces;

Male. Male specimens not examined but described by Pasteels (1957) as differing from females based on the pedicel approximately same length of 1st flagellomere and hind leg the femurs are longer and less claviform.

Distribution. The species has a wide distribution with records from QLD, NSW, VIC, TAS, SA and WA.

Biology. A species with the same characters of *G. cylindricum* was observed ovipositing into nests of *Euryglossina Lynetta* Rayment (Colletidae) (see comment).

Comments. Rayment (1954) observed an unidentified species of *Gasteruption* ovipositing into *Euryglossina lynetta* nests. Although Rayment did not deposit any of the specimens in a museum collection, using the images in his paper (page 67), we have identified the species as *Gasteruption cylindricum* based on the distinctive elongated rectangular shaped head and body, ninth metasomal sternite V-shaped, extending past metasomal apex and open fore wing first discal cell. This species is similar to *G. youngi* but lacks trochoid sensilla along the ovipositor sheath and transverse striations on the anterior face of the hind tbia.

Gasteruption dewitzi Schletterer, 1889

Fig. 26.

Gasteruption dewitzi Schletterer 1889: 442, ♀; Pasteels 1957: 116, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Neu-Holland [Australia] Schultz" "17023" (ZMBD).

Other material examined. **QLD:** ♂. Brisbane, 14.xi.12, H. Hacker (QM); 1♀, 1♂, 1?, Mt Tamborine, 1923, W.M. Davidson (QM)*; 1?, Strabroke Island, 17.x.1915, H. Hacker (QM). NSW: 2♀, 1♂, Woollahra N.S.W., 5.ii.1941 (AM: K279911-K279913); ♂, Sydney, 25.x.1924, (QM).

Figure 26. *Gasteruption dewitzi* Schletterer, lateral habitus. Scale bar = 1.00 mm

Redescription. *Female.* body length 15.81 mm; ovipositor length 6.51 mm.

Colour. Black and brown; head black, antenna dark brown, scape lighter at base; clypeus, malar space and mandibles (darker tooth apex) brown; mesosoma mostly brown, propleuron black dorsally; dorsal and posterior pronotal lobes, ventro-lateral section of metapleuron, mesoscutum medially and around parapsidial line, mesoscutellum, axilla, metanotum black, tegula brown, propodeum dark brown with brown transverse band medially; fore and mid legs brown, coxae darker, trochantelli with cream apical margin, prefemur with dark brown groove, tibiae with longitudinal cream stripe on anterior face, fore leg 1st tarsomere and mid leg basal two thirds of 1st tarsomere cream; hind leg brown, coxa, femur and tibia dark brown dorsally, tibia with tibiae with cream band subbasally, tarsus cream with base of 1st tarsomere and claw brown; metasoma brown, dark brown basally and apically; ovipositor sheath dark brown with cream apex 1.18 × length of hind 1st tarsomere, ovipositor brown; wings hyaline, wing veins dark brown with brown pterostigma.

Head. Head shape sub-conical when viewed dorsally; length 0.73 (0.70–0.78) × width; tapering sharply to occipital carinae; head in lateral view rounded with large eye, short postocular space; 0.26 × eye height; face and frons reticulate with short dense shiny setae; medial frontal carina indistinct; vertex reticulate-rugulose with short dense shiny setae; narrow lamelliform occipital carina, wider ventro-laterally, shallow depression, pointed medially; gena reticulate with short dense shiny setae; minimal width of malar space 0.12 (0.10–1.14) × height of eye; 0.86 (0.73–1.00) × length of pedicel; clypeus reticulate, 1.82 (1.55–2.10) × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression shallow depression, short dense shiny setae, longer along margin; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.66 (0.60–0.70) × distance between lateral ocelli; scape 1.97 (1.70–2.20) × length pedicel, 1st flagellomere 1.08 (1.10–1.14) × as long as scape, 0.57 (0.52–0.63) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.69 (1.68–1.70) × height; propleuron length 1.05 × width; 0.93 × prototegular distance; propleuron reticulate with medium dense shiny setae; pronotal process acute; pronotum anterior lobe reticulate-rugulose, dorsal and posterior lobe reticulate, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.10 × width in dorsal view; truncated in lateral view; reticulate-rugose, short dense setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum reticulate-rugulose with short scattered setae, axilla reticulate with short setae; mesepisternum reticulate-rugulose dorsally, areolate-rugulose ventrally with medium dense shiny setae; mesepimeron carinate with shallow depressions; metapleuron areolate, coarser posteriorly with medium dense shiny setae; propodeum areolate, medial carinal absent, medium dense shiny setae.

Legs. Hind coxa strigate-rugulose dorsally, becoming reticulate laterally and ventrally; femur length 0.68 (0.67–0.68) × length of tibia; tibia length 6.71 × tibia width; tibia with short dense setae with scattered stout emergent setae on anterior face; 1st tarsomere 3.10 (3.00–3.20) × length of 2nd tarsomere, 2nd tarsomere 1.34

(1.25–1.39) × length of 3rd tarsomere, 3rd tarsomere 1.93 (1.80–2.00) × length of 4th tarsomere.

Wings. Fore wing first discal cell rectangular, vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular with node with remainder of vein pigmented; hind wing vein 1-m and most of the 2m+Cu pigmented except near 1-m, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma length 3.21 (3.11–3.32) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.60 × metasoma length; short dense setae, flared cream apex.

Male. Mesonotum medial lobe and propodeum black, metasomal T9) and paramere apex cream.

Distribution. The species is known from QLD and NSW.

Biology. Unknown.

Comments. Pasteels (1957) mention this species has identical colouration and sculpturing as G. cinerescens (see description). *Gasteruption dewitzi* keys out with *G. granulare* but can be easily separated based on a longer malar space (0.73–1.00 × length of pedicel) and shorter ovipositor sheath (0.60 × metasoma length).

Gasteruption differens Pasteels, 1957

Fig. 27.

Gasteruption differens Pasteels 1957: 85 ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "G. H. Hardy, Blackheath [N.S.W] 24 Nov.1919" "*Gasteruption differens* n. sp. J. Pasteels det., 1954" "Holotype" (SDEI).

Specimen damage. Right antenna 3rd flagellomere to tip missing, left forewing missing, left hind leg trochanter to tip missing, right ovipositor sheath missing.

Other material examined. **WA:** 1♀, Nornalup National Park, 34º57’S, 116º45’E, 8.i.1986, G. & A. Daniels (QM)*.

Figure 27. *Gasteruption differens* Pasteels, lateral habitus. Scale bar = 1.00 mm

Redescription. *Female*. Body length 13.50 (12.30–14.70) mm; ovipositor length 13.18 (10.35–16.00) mm.

Colour. Dark brown; head and mesosoma darker dorsally, brown malar space and margin of clypeus, mandibles light brown with dark brown tooth apex; tegula brown; fore leg mostly brown, trochantellus with cream apical margin, femur with cream apex, tibia with cream stripe on anterior face, tarsus cream, 5th tarsomere and claw brown; mid leg similar to fore leg but darker; hind leg mostly brown, prefemur dark brown, tibia with cream patch sub-basally on inside face, tarsus cream, dark brown basal tip of 1st tarsomere, 5th tarsomere and claw; metasoma dark brown, ovipositor sheath dark brown with cream apex, 2.43 × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing veins and pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; 0.94 × longer than wide, postocular space rounded, gently tapering; head in lateral view flattened, gena convex, medium length postocular space, 0.32 (0.31–0.32) × height of eye; short scattered eye setae; face granular with short dense setae; frons reticulate with short dense setae; medial frontal carina raised indistinctly in anterior third, absent remain two thirds; vertex reticulate with scattered punctures around ocelli, becoming reticulate-rugulose posteriorly, short dense setae; occipital carina narrow, lamelliform, depression shallow and rounded; gena reticulate-rugulose, becoming punctate-rugulose, short dense setae; minimal width of malar space short, 0.03 (0.03–0.04) × height of eye, 0.23 (0.20–0.25) × length of pedicel; clypeus granular, 2.35 (2.33–2.36) × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression indistinct, short dense setae, longer and scattered on margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.81 (0.63–1.00) × distance between lateral ocelli; scape 1.71 (1.63–1.80) × length pedicel, 1st flagellomere 0.97 (0.94–1.00) × as long as scape, 0.76 (0.71–0.81) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.20 (2.18–2.23) × height; propleuron length 1.61 × width; 0.93 (0.91–0.94) × prototegular distance; propleuron reticulate-rugulose with short dense setae; pronotal process indistinct, rounded; pronotum dorsal lobe punctate with anterior and posterior lobes reticulate-rugulose, groove between pronotum lobes carinate, short dense setae, longer in groove; mesoscutum length 1.44 (1.41–1.46) × rounded in lateral view; reticulate-rugulose, short scattered setae, admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla punctate with short scattered setae; mesepisternum dorsally reticulate-rugulose, becoming areolate lower part, short dense setae; mesepimeron carinate in lower half, remaining half with a few shallow scattered punctures; metapleuron reticulate-rugulose dorsal lobe, becoming areolate ventrally, short dense setae; propodeum areolate, medial carinae flattened, short dense setae.

Legs. Hind coxa strigose dorsally, becoming punctate-rugulose laterally; femur length 0.71 (0.69–0.74) × length of tibia; tibia length 5.12 (5.00–5.23) × tibia width; short dense setae, tarsus with dense short spines on ventral surface; 1st tarsomere 3.29 (3.25–3.33) × length of 2nd tarsomere, 2nd tarsomere 1.35 (1.25–1.45) × length of 3rd tarsomere, 3rd tarsomere 1.99 (1.57–2.40) × length of 4th

tarsomere, 4th tarsomere 0.83 (0.50–1.17) × length of 5th tarsomere, tarsal claw 0.88 (0.60–1.17) × length of 5th tarsomere.

Wings. Forewing first discal cell rectangular, wider sub apically on ventral side of cell, fore wing vein r-m absent, vein SR1 weakly sinuate; vein 2-M basal third tubular with apical node, remainder of vein pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma length 2.73 (2.63–2.81) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.39 (1.20–1.58) × metasoma length, covered in short appressed setae.

Male. Unknown.

Distribution. The species is known from NSW and WA.

Biology. Unknown.

Comments. *Gasteruption differens* keys out with *G. albicuspis* but are easily separated based on clypeus width (2.33 × height) and lateral ocelli in-line of postocular line in dorsal view, see key couplet 19.

Gasteruption elegans Pasteels 1957

Fig. 28.

Gasteruption elegans Pasteels, 1957: 37, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "S.W. Australia. Yallingup 1–12 Dec.1913. R.E.Turner. 1914 – 190." "*Gasteruption elegans* n.sp. J.Pasteels det., 1954" (BNHM: 3a.356).

Specimen damage. Right antenna 3rd flagellomere to tip missing.

Paratypes. TAS: 1♀, Hobart, 4.i.1951, E.F. Reik (ANIC)*. **WA:** 2♀, Yallingup, R.E. Turner (NHM) [not examined].

Redescription. *Female*. Body length 13.20 mm; ovipositor length 12.70 mm

Colour. Mostly black; antennae and clypeus dark brown, mandibles brown with dark tooth apex; ventral margin and posterior margin of pronotum, ventral mesepisternum and mesepimeron metapleuron ventral margin and tegula brown; fore leg mainly brown, femur with cream stripe on apical two thirds of anterior face, tibia dark brown with cream stripe on anterior face, tarsus cream; mid leg mostly dark brown, trochantellus brown, prefemur brown, tibia with cream stripe on anterior face, most of 1st tarsomere cream, 2nd and 3rd tarsomere brown; hind leg mostly brown, coxa and trochantellus dark brown, prefemur lighter, tibia with cream patch sub basally, mainly on ventral face, tarsus cream with base of 1st tarsomere and apex of 5th tarsomere dark brown; metasoma brown, darker basally and apically; ovipositor sheath mostly dark brown with cream apex 3.26 (3.18–3.33) × length of hind 1st tarsomere; ovipositor brown; wing hyaline, veins and pterostigma brown.

Figure 28. *Gasteruption elegans* Pasteels, paratype lateral habitus, scale bar = 1.00 mm

Head. Head shape sub-rectangular when viewed dorsally; 1.09 × longer than wide; with postocular space gently tapering; head in lateral view, frons and vertex convex with slightly elongated postocular space, 0.38 (0.37–0.40) × height of eye; short scattered eye setae; malar space short, minimal width 0.03 (0.02–0.03) ×

height of eye; 0.21 (0.13–0.29) × length of pedicel; face reticulate, scattered shallow punctures around medial carinae, short dense setae, shiny on eye margin and medially; frons reticulate-rugulose, reticulate-strigate medially, short scattered setae; medial frontal carina raised in anterior third; vertex reticulate-rugulose, strigate between lateral ocelli, short scattered setae; occipital carina short, lamelliform, depression broad shallow and rounded; gena reticulate-rugulose with short dense shiny setae; clypeus reticulate-punctate, 2.30 (2.20–2.40) × wide as high, margin sinuate with lateral corners barely protruding forwards, depression present in anterior half, not distinct, short dense setae, longer along margin; lateral ocelli posterior of postocular line, distance from lateral ocellus to eye margin 0.98 (0.90–1.07) × distance between lateral ocelli; scape 1.64 (1.42–1.86) × length pedicel; 1st flagellomere 1.54 (1.08–2.00) × as long as scape; 0.64 (0.58–0.69) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.33 (2.25–2.42) × height; propleuron length 2.13 (2.06–2.21) × width; 1.21 (1.19–1.22) × prototegular distance; propleuron reticulate rugose, becoming reticulate-rugulose posteriorly, short dense setae; pronotal process short and rounded; pronotum dorsal lobe punctate, anterior lobe reticulate-rugulose, posterior lobe rugulose, groove between pronotum lobes carinate with some large fovea, medium dense setae; mesoscutum length 1.34 (1.29–1.40) × width in dorsal view; rounded in lateral view, punctate-rugulose, punctate around parapsidial lines, short scattered setae; admedial lines gently converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla punctate with short scattered setae; mesepisternum reticulate-rugulose anterior lobe, areolate remaining, medium dense setae; mesepimeron carinate, creating fovea, metapleuron areolate with medium dense setae; propodeum areolate with short dense setae; medial carina flattened.

Legs. Hind coxa reticulate-rugulose, coarser dorsally, strigate in coxal depression, femur 0.68 × length of tibia; tibia length 6.12 (6.00–6.23) × tibia width, short dense setae and scattered stout spines on anterior face, tarsus with ventro pecten of short dense spines; 1st tarsomere 2.82 (2.52–3.13) × length of 2nd tarsomere; 2nd tarsomere 1.56 (1.45–1.67) × length of 3rd tarsomere; 3rd tarsomere 1.85 (1.83–1.88) × length of 4th tarsomere; 4th tarsomere 0.61 (0.60–0.62) × length of

5^{th} tarsomere; tarsal claw 0.61 (0.60–0.62) × length of 5^{th} tarsomere.

Wings. Fore wing first discal cell elongated, wider ventrally at 3-cu; vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular, remaining pigmented, node present at basal third; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma length 2.34 (3.08–3.59) × mesosoma length; hypopygium V-shaped; ovipositor sheath 1.28 × metasoma length, covered in short dense setae;

Male. Male specimens not examined but described by Pasteels (1957) as having a thorax almost entirely black and pedicle shorter than female.

Distribution. The species has been collected from NSW and WA, Pasteels (1957) examined additional material from TAS.

Biology. Unknown.

Comments. The species keys out with *G. nobile*, they can be distinguished based on the absence of hind wing veins in *G. elegans,* and ovipositor sheath shorter, see key couplet 56.

Gasteruption erythrarthrum **Pasteels, 1957**

Fig. 29.

Gasteruption erythrarthrum Pasteels, 1957: 96, ♀; Jennings 2010 [on-line checklist].

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NMV (Fig. 27), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Material examined.

Holotype. ♀, “Kerang, V[IC]. 4-1-[19]47. RT.” “Collection A. N. Burns” (NMV: T-7417) [examined from photos].

Redescription. *Female.* Body length 13.10 mm; ovipositor length 6.31 mm.

Colour. Black; antenna dark brown, mandibles orange-brown; tegula brown; fore and mid legs orange-brown, apical margin of trochantellus cream, tibia and tarsus dark brown with longitudinal stripe on anterior face of tibia and 1st tarsomere cream; hind leg dark brown, coxa black, prefemur and base of femur orange-brown, large cream patch on ventral face, subbasally on tibia, tarsus dark brown, apical three quarters of 1st tarsomere cream; metasoma dark brown laterally on T2 and T3; ovipositor sheath dark brown with short cream apex 0.99 × length of hind 1st tarsomere; wings hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; postocular space slightly bulbous behind eyes, tapering at occipital carina; head in lateral view, vertex angular, gena wider posteriorly; elongate postocular space, 0.41 × height of eye; head villous, more scattered on vertex; mesosoma with dense shiny villous, denser laterally; medial frontal carina raised between antennal scrobes; short lamelliform occipital carina; shallow rounded depression; minimal width of malar space 0.04 × height of eye; 0.26 × length of pedicel; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.67 × distance between lateral ocelli; scape 1.72 × length pedicel; 1st flagellomere 0.85 × as long as scape; 0.58 × length 2nd flagellomere.

Figure 29. *Gasteruption erythrarthrum* Pasteels, holotype, lateral habitus, scale bar = 5.00 mm.

Mesosoma. Mesosoma length 1.92 × height; pronotal process short and pointed outwards; mesoscutum length 2.63 × width in dorsal view; truncated in lateral view; notauli U-shaped, scrobiculate; mesepimeron carinate forming shallow fovea; propodeum with raised longitudinal medial carina.

Legs. femur 0.84 × length of tibia; tibia length 4.25 × tibia width, short setae with scattered stout emergent spines on anterior face; short spines on anterior face of tarsus and apically.

Wings. Fore wing first discal cell rectangular, vein 1m-cu tapering; vein r-m absent; vein SR1 weakly sinuate, vein 2-M basal third tubular with apical node, remainder of vein pigmented; hind wing veins apical two thirds of 2m+Cu pigmented, other veins spectral, three equidistant hamuli.

Metasoma. Metasoma 2.63 × mesosoma length; ovipositor sheath 0.72 × metasoma length.

Male. Unknown.

Distribution*.* Known only from the type locality of Kerang, VIC.

Biology*.* Unknown.

Comments. This species is known only from the type specimen which we have been unable to examine in detail *Gasteruption erythrarthrum* keys out with G. uniform but can be separated based on malar space length (0.88 × length of pedicel) and ovipositor sheath length (1.28 × metasoma length), see key couplet 22.

Gasteruption species 1 **sp. nov.**

Fig. 30.

Material examined.

Holotype. ♀, "23.59S 133.56E Ewaninga. 31km E by SE of Alice Springs 1.xi.1974 N.T. T. Weir & T. Angeles" (MAGNT).

Specimen damage. Left antenna pedicel to tip missing, right mid and hind leg trochantellus to tip missing.

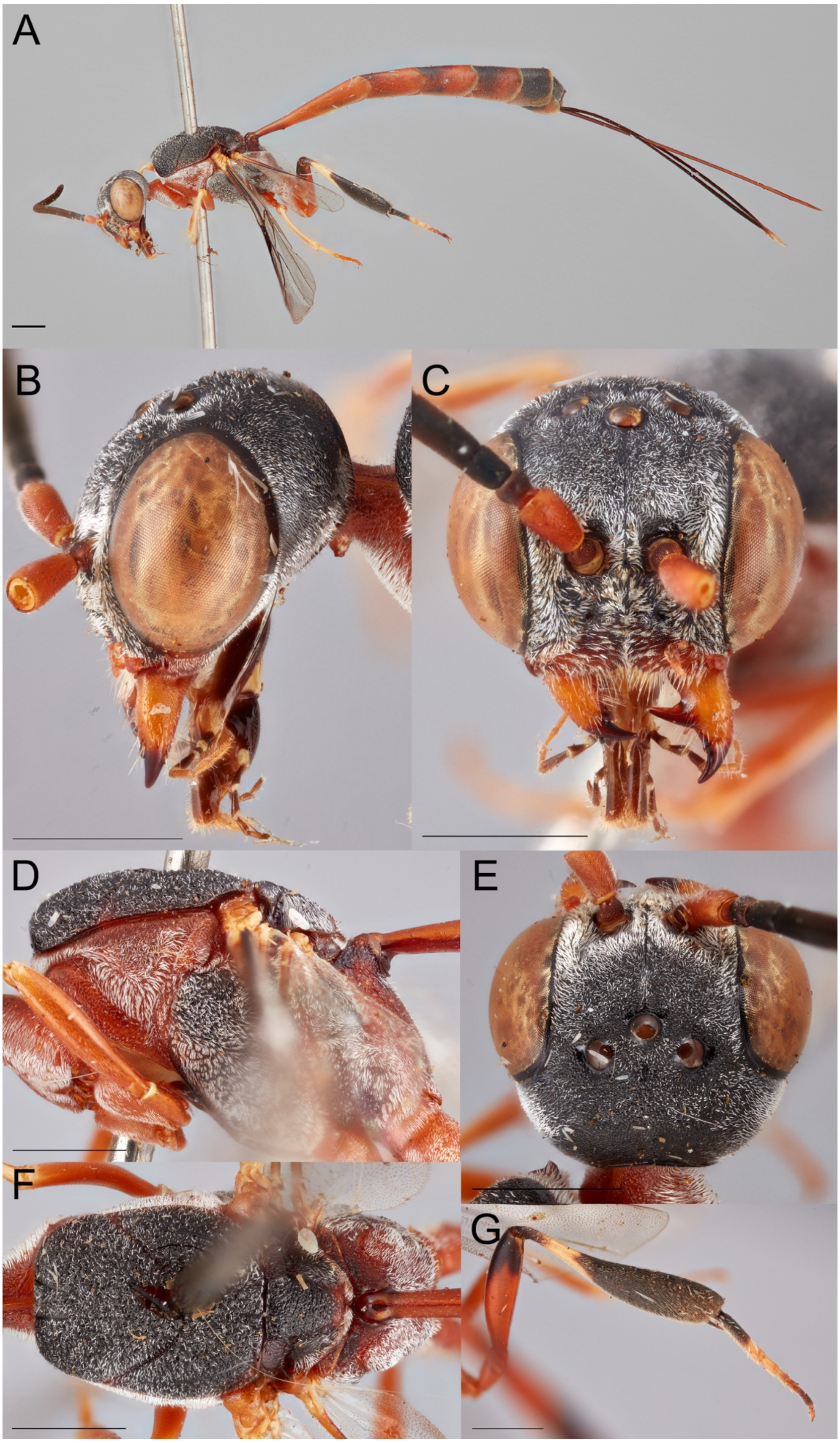

Figure 30. *Gasteruption species 1* **sp. nov.**, holotype female. A, lateral habitus. B, Lateral head. C, frontal head. D, lateral mesosoma. E, dorsal head. F, dorsal mesosoma, G, lateral hind leg. Scale bars = 1.00 mm.

Diagnosis. This species is easiy distinguished from other species based on the combination of its black and brown general body colouration, distinctive orange-brown metasoma colouration and head shape, which is strongly rounded anteriorly similar to *G. femorale.*

Description. *Female*. Body length 14.9 mm. Ovipositor 9.5 mm.

Colour. Head black, antenna scrobe light brown, mandible cream with dark brown apex, malar space lighter; mesosoma mostly black, propleuron, pronotum, ventral half of mesepimeron and propodeum orange-brown, tegula light brown; fore and mid leg mostly orange brown with apical margin of trochantellus, apex of femur and longitudinal stripe on anterior face of tibia cream, tarsus cream, darkening towards apex; hind leg coxa and basal 2/3rds of femur orange-brown, femur apex black, tibia black with cream band sub-basally, tarsus cream, basal half of 1st, 5th tarsomere and claw black; metasoma mostly orange-brown, T5-T6 black with orange-brown patches laterally; ovipositor sheath dark brown with cream apex 1.00 × length of hind 1st tarsomere, ovipositor brown; wing hyaline, wing vein and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.83 × width; postocular space bulbous; frons and vertex in lateral view strongly rounded; postocular space 0.41 × height of eye; eye setae absent; face and frons rugose with medium dense shiny setae; medial frontal carina raised anteriorly becoming indistinct posteriorly; vertex rugulose around ocelli, strigate-rugulose posteriorly with several shallow scattered punctures medially, short dense setae; occipital carina narrow, wider ventro-laterally, lamelliform, depression shallow, emarginate; gena reticulate with short dense shiny setae; minimal width of malar space 0.03 × height of eye; 0.20 × length of pedicel; clypeus punctate; 2.53 × wide as high, margin sinuate, lateral corners barely protruding forwards, depression present anteriorly, medium dense shiny setae, longer along margin; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.59 × distance between lateral ocelli; scape 2.21 × length pedicel. 1st flagellomere 0.58 × as long as scape; 0.51 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.61 × height; propleuron length 1.02 × width; 0.87

× prototegular distance; propleuron reticulate, courser dorsally, medium dense shiny setae; pronotal process small, rounded and pointing outwards; pronotum rugose, dorsal part of posterior lobe granular, groove between pronotum lobes carinate, short dense shiny setae, setae longer in groove, anterior lobe without setae; mesoscutum length 1.14 × width in dorsal view; truncated in lateral view; rugose with short shiny setae; admedial lines distinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugose, finer than mesoscutum, short scattered setae; mesepisternum rugose dorsally becoming areolate ventrally, medium dense shiny setae; mesepimeron carinate creating shallow fovea; metapleuron coarsely areolate, medium dense shiny setae; propodeum areolate, medial carinae convex, short dense shiny setae.

Legs. Hind coxa reticulate-rugulose, transverse striations in coxal groove; femur 0.68 × length of tibia; tibia length 4.71 × tibia width; short dense setae with scattered stout emergent spines; tarsus with dense short robust spines on ventral face and apically on each tarsomere; 1^{st} tarsomere 3.20 × length of 2^{nd} tarsomere; 2^{nd} tarsomere 1.30 × length of 3^{rd} tarsomere; 3^{rd} tarsomere 1.43 × length of 4^{th} tarsomere; 4^{th} tarsomere 0.37 × length of 5^{th} tarsomere; tarsal claw 0.58 × length of 5^{th} tarsomere.

Wings. Fore wing first discal cell rectangular, tapering slightly apically; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular with apical node, reminder of vein pigmented; hind wing vein apical 2/3rds of 2m+Cu and 1-m pigmented, four equidistant hamuli.

Metasoma. Metasoma 2.63 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.94 × metasoma length, short appressed setae.

Male. Unknown.

Biology. Unknown.

Etymology. *Gasteruption species 1* is known only from the type locality of Ewaninga, 31km E by SE of Alice Springs, NT. This area is of great cultural significance to the early Arrernte people of the region.

Comments. The species is known from a single type specimen collected in remote NT.

Gasteruption exile (Turner, 1918)

Fig. 31.

Figure 31. *Gasteruption exile* (Turner), lateral habitus, scale bar = 1.00 mm

Foenus exilis Turner 1918: 201, ♀; (comb. Pasteels, 1957).

Gasteruption exile Pasteels 1957: 21, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "*Foenus exile* Type Turner." "Mt. Wellington, S. Tasmania. 15 Jan, 6 Feb.1913" "1,300–2,300 ft. R.E.Turner. 1913–212." (BMNH: 3.a.178).

Specimen damage. Right antenna 9th flagellomere to tip missing.

Paratype. 1♂, same data as holotype (BMNH) [not examined].

Other material examined. **SA:** 1♀, 900m W of Point Ellen, Vivonne Bay, Kangaroo Island, 35º59.988 S, 137º11.005 E, 9.xi.2007, D.A. Young (WINC); 2♀, Boobook Hill Reserve, SE Kangaroo Island, 35’50.380’S 137’56.370’E, On blossom, or flying near blossom, of *Eucalyptus diversifolia*, 29.xi.2008, R.V. Glatz (RG: 10541)*; 1♀, Ravine des Casoars WPA, N headland of West Bay, Kangaroo Island ≈750m ENE Vennachar Point, 35’53.041’S 136’32.586’E, in flight near blossom of

Melaleuca gibbosa in wind-stunted coastal cliff-top vegetation; 5.09pm, 16.xi.2015, R.V. Glatz (RG: 3963);

Redescription. *Female*. body length 9.90 (9.50–10.60) mm; ovipositor length 2.83 (2.75–3.00) mm.

Colour. Dark brown; antenna, clypeus, malar space and mandibles brown (tooth apex darker); tegula brown; fore leg brown, femur with cream stripe on apex anterior face; tibia with cream stripe on anterior face basally; tarsus brown, 5th tarsomere and claw darker; mid leg brown, tibia with cream stripe on anterior face; 5th tarsomere and claw darker; hind leg brown, tibia with cream patch subbasally on posterior face; 4th tarsomere to claw darker; lateral surface of T2 and T3 of metasoma brown; ovipositor sheath dark brown, cream apex 0.90 (0.71–1.03) × length of hind 1st tarsomere; ovipositor light brown; wings hyaline, wing veins and pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; 1.21 (1.07–1.31) × longer than wide, postocular space tapering, funnel like; head in lateral view elongated with long postocular space, ventro-posterior corner wider; postocular space 0.54 (0.52–0.56) × height of eye; minimal width of malar space 0.03 (0.02–0.03) × height of eye; 0.18 (0.15–0.20) × length of pedicel; face punctate-reticulate with short setae, shiny along eye margins and medially; frons punctate-reticulate with short setae, shiny on eye margin; medial frontal carina present in anterior third, absent remaining; vertex punctate-rugulose, becoming finely strigate posteriorly, short setae; occipital carina narrow, lamelliform, depression broad, rounded; gena punctate-rugulose with short dense shiny setae; clypeus punctate, 2.53 (2.26–2.69) × wide as high, margin sinuate, lateral corners barely protruding forwards, depression indistinct anteriorly, short setae, longer scattered setae along margin: lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 0.92 (0.85–0.95) x distance between lateral ocelli; scape 1.48 (1.38–1.60) × length pedicel; 1st flagellomere 0.83 (0.64–1.20) × as long as scape; 0.54 (0.47–0.59) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.13 (2.12–2.14) × height; propleuron length

1.71 (1.60–1.83) × width; 1.03 (0.96–1.10) × prototegular distance; propleuron reticulate-rugulose, coarser dorsally, medium dense shiny setae; pronotal process broad and rounded; pronotum dorsal lobe punctate-reticulate, anterior lobe rugulose and posterior lobe punctate, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.51 (1.48–1.57) × width in dorsal view; rounded in lateral view, medial lobe punctate-reticulate, lateral lobe punctate-rugulose medially, short scattered setae; notauli incomplete, scrobiculate; mesoscutellum and axillae punctate-rugulose, short scattered setae; mesepisternum punctate-reticulate with carinae on posterior margin dorsally, medium dense shiny setae; mesepimeron carinate; metapleuron reticulate-rugulose dorsal lobe, coarser ventrally, medium dense shiny setae; propodeum areolate-rugulose, wide flattened medial carinae; short scattered setae.

Legs. Hind coxa reticulate-rugulose, strigate in coxal groove; femur 0.77 (0.76–0.78) × length of tibia; tibia length 3.67 (3.67–3.86) × tibia width; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.61 (3.50–3.85) × length of 2nd tarsomere; 2nd tarsomere 1.45 (1.43–1.50) x length of 3rd tarsomere; 3rd tarsomere 1.58 (1.50–1.75) × length of 4th tarsomere; 4th tarsomere 0.44 (0.36–0.50) × length of 5th tarsomere; tarsal claw 0.55 (0.53–0.58) × length of 5th tarsomere.

Wings. First discal cell rectangular, vein r-m absent, vein SR1 weakly bent, vein 2-M basal third tubular, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma 2.60 (2.42–2.72) × mesosoma length; hypopygium short Y-shaped; ovipositor sheath 0.44 (0.41- 0.45) × metasoma length, covered in short appressed setae, flared cream apex.

Male. Male specimens not examined but described by Pasteels (1957) as being significantly different to the female with a shorter postocular space, propleuron roughly equal to the postocular space.

Distribution. The species is known from the type specimen from TAS and additional material collected on Kangaroo Island, SA.

Biology. Unknown.

Comments. *Gasteruption exile* keys out with *G. raphidioides* but can be easily separated based on a shorter propleuron length (0.96–1.10 × prototegular distance) and a flared ovipositor sheath apex.

Gasteruption femorale Pasteels, 1957

Fig. 32.

Gasteruption femorale Pasteels 1957: 51 ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. "Kiata. Vic. 09.10.[19]29 F. E. Wilson" "*Gasteruption femorale* n.sp. J Pasteels det., 1956" (NMV: T-7455) [examined from photographs]

Paratype. NSW: 1♂, 10 miles W. from Mount Boppy, E.F. Reik (ANIC)

Figure 32. *Gasteruption femorale* Pasteels, lateral habitus, scale bar = 1.00 mm

Other material. **QLD:** 1♀, Noose-Coolum, 14.ix.1967, T.F. Houston (SAMA); 1♀, Morven, -26.416667, 146.550000, 10.ix.1989, E. Exley, G. Daniels and C. Burwell (QM); 1♀, Dynevor Lakes, -28.083333, 144.200000, 150 m asl, 27.ix.1991, G. Daniels (QM); 1♀, Moreton Island, Mount Tempest, 285 m, 20.ix.1997, J. & A. Skevington (QM). **ACT:** 1♀, Blundells [likely to be in the vicinity of Blundells Cottage, Wendouree Dr, Parkes ACT 2600], 31.i.1970, E.F. Riek (ANIC: 32 101263)*. NSW: 1♂, Mount Boppy, 24.xi.1949, E.F. Riek (ANIC); 1?, Paddy's River Bago S.F, 15.i.1980, C.N. Smithers (AM: K420871). **NT:** Alice Springs, 23.36S, 133.34E, 30.ix.1978 (ANIC: 32 113610).

Redescription. *Female*. body length 13.97 (13.00–15.80) mm; ovipositor length 8.97 (4.40–11.50) mm.

Colour. Body and head black; clypeus lateral corners and tegula brown, mandibles dark brown, lighter medially; fore and mid legs mostly orange-brown, coxa black, trochantellus with cream band on apex, femur with cream spot on apex, tibia dark brown with cream stripe in anterior face and lighter ventral face, tarsus dark brown with cream stripe on anterior face of 1st and 2nd tarsomere; hind leg mostly black, trochantellus dark brown, prefemur and basal half of femur orange-brown with apical half black, tibia black with cream patch band basally, tarsus cream with base of 1st, 5th tarsomere and claw black; metasoma black with variable orange-brown laterally on T2 and T3; ovipositor sheath dark brown with cream apex 2.21 (1.06–2.92) × length of hind basitarsus; ovipositor brown; wings hyaline, veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.87 (0.81–0.94) × longer than wide, postocular space bulbous; head in lateral view, face flat, long postocular space, large mandibles; postocular space 0.44 (0.35–0.54) × height of eye; short scattered eye setae; head rugulose-granular, transverse strigate-rugulose posteriorly on vertex, medium dense shiny setae; medial frontal carina distinct raised anterior two thirds, absent posterior third; occipital carina short, wider ventro-laterally, lamelliform, depression broad and shallow; minimal width of malar space 0.03 (0.03–0.04) × height of eye; 0.25 (0.20–0.29) × length of pedicel; clypeus rugulose, 2.81 (2.67–3.08) × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression present anteriorly, long shiny setae; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.66 (0.56–0.82) × distance between lateral ocelli; scape 1.99 (1.73–2.23) × length pedicel; first flagellomere 0.58 (0.53–0.62) × as long as scape, 0.42 (0.37–0.45) × length second flagellomere.

Mesosoma. Mesosoma length 1.64 (1.54–1.70) × height; propleuron length 0.97 (0.81–1.06) × width, 0.80 (0.69–0.88) × prototegular distance; propleuron rugulose with medium dense setae; pronotal process in dorsal view short and pointed outwards; pronotum granular with anterior lobe rugulose, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.18 (1.17–1.19) × width in dorsal view; truncated in lateral view; rugulose-granular with short shiny setae; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular with short setae; mesepisternum reticulate-rugulose dorsally, becoming areolate, medium dense shiny setae; mesepimeron shallow scrobiculate with smooth section along posterior margin, scattered shallow fovea dorsally; metapleuron areolate, coarser ventrally with medium dense shiny setae; propodeum areolate with flattened medial carinae, short shiny setae.

Legs. Hind coxa rugulose, strigate in coxal groove; femur length 0.70 (0.69–0.72) × length of tibia; tibia length 4.86 (4.58–5.33) × tibia width; tibia with short dense setae, scattered stout spines on anterior face; tarsus with stout spines ventro-apex; 1st tarsomere , 3.23 (3.00–3.50) × length of 2nd tarsomere; 2nd tarsomere, 1.42 (1.33–1.50) × length of 3rd tarsomere; 3rd tarsomere, 1.72 (1.50–2.00) × length of 4th tarsomere; 4th tarsomere, 0.40 (0.38–0.43) × length of 5th tarsomere; tarsal claw 0.54 (0.50–0.63) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated, tapering apically; fore wing vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular with node, remaining pigmented; hind wing vein apical two thirds of 2m+Cu and 1-m pigmented, three (four in some specimen) equidistant hamuli.

Metasoma. Metasoma length 2.83 (2.67–3.01) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.41 × metasoma length, short appressed setae.

Male. Similar to female with larger cream patch on hind tibia sub basally.

Distribution. The species is known from various localities in QLD, NSW, ACT and the NT.

Biology. Unknown.

Comments. The species is superficially similar to *G. rubripes* based on the general body shape and distinctive colouration on femurs. The two species can be differentiated based on cream/white patch subbasally on hind tibia in *G. femorale* and Pasteels (1957) described the postocular space as sub rectangular and shorter laterally.

Gasteruption fibula **Pasteels, 1957**

Fig. 33.

Gasteruption fibula Pasteels, 1957: 38, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, [no location information] "*Gasteruption fibula* n. sp. J. Pasteels det., 1954" (SDEI).

Paratypes. TAS: 3♀♀, Geeveston and Dunalley, no other information (SDEI).

Other material examined. **QLD:** 1♀, Sunday Creek Environmental Studies centre, Jimma, -26.712778, 152.536944, 18.ii.1997, G. Daniels (QM)*. **TAS:** 1♀, Warra, Malaise trap, 11.ii.2003, R. Bashford (TMAG: FT28964).

Redescription. *Female*. Body length 11.43 (10.00–12.30) mm; ovipositor length 10.10 (8.60–11.60) mm.

Colour. Black; antenna dark brown, mandibles brown, apex darker; tegula dark brown; fore and mid leg mostly brown, coxa and trochantellus dark brown, cream longitudinal stripe on anterior face of tibia, wider basally and apically, tarsus brown with cream stripe on anterior face, covering most of 1st tarsomere; hind leg dark brown, coxa black, tibia with cream band subbasally; metasoma dark brown; ovipositor sheath dark brown, cream apex 2.30 (2.10–2.50) × length of hind 1st tarsomere; ovipositor light brown; wings hyaline, veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.97 (0.86–1.17) × longer than wide; postocular space gently tapering behind eyes; distinctive head in lateral view, frons, vertex and gena convex, creating a rounded head shape;

postocular space short, 0.27 (0.22–0.32)× height of eye; short scattered eye setae; face punctate with short dense shiny setae; frons reticulate with short shiny setae; medial frontal carina indistinct in anterior half, absent posteriorly; vertex reticulate with several shallow punctures medially, posteriorly strigate-reticulate with short scattered shiny setae; narrow lamelliform occipital carina, shallow rounded depression; gena reticulate with short dense shiny setae; minimal width of malar space 0.03 (0.02–0.04) × height of eye; 0.17 (0.13–0.23) × length of pedicel; clypeus punctate; 2.61 (2.50–2.81) × wide as high, margin sinuate, lateral corners barely protruding forwards, medial depression indistinct, short dense shiny setae, longer along margin; lateral ocelli posterior of postocular line, distance from lateral ocellus to eye margin 1.26 (0.60–2.57) × distance between lateral ocelli; scape 1.81 (1.57–2.25) × length pedicel; 1st flagellomere 0.92 (0.86–1.00) × as long as scape; 0.61 (0.45–0.71) × length 2nd flagellomere.

Figure 33. *Gasteruption fibula* Pasteels, lateral habitus, scale bar = 1.00 mm

Mesosoma. Mesosoma length 2.16 (2.02–2.30) × height; propleuron length 2.27 (2.00–2.50) × width; 1.18 (1.10–1.30) × prototegular distance; propleuron rugulose with medium dense shiny setae, pronotal process broad and rounded; pronotum anterior lobe imbricate, dorsal and posterior lobe reticulate-rugulose, groove between pronotum lobes carinate with scattered fovea, medium dense shiny setae; mesoscutum length 1.52 (1.43–1.61) × width in dorsal view; rounded in lateral view, strigulate-reticulate becoming strigate-rugose between posterior margin of notauli and posterior margin, short scattered setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate-rugulose with short scattered setae; mesepisternum areolate-rugulose, coarser ventrally, medium dense shiny setae; mesepimeron broad scrobiculate in ventral half, remaining with shallow carinate with some fovea; metapleuron areolate-rugulose with medium dense shiny setae; propodeum areolate-rugulose, medial carina flattened, short dense shiny setae.

Legs. Hind coxa strigate-reticulate dorsally becoming reticulate ventro-laterally, stations in coxal groove; femur 0.67 (0.64–0.71) × length of tibia; tibia length 4.76 (4.61–5.00) × tibia width, short dense setae with scattered stout emergent spines on anterior face; Tarsus with stout spine on ventral face and apically; 1st tarsomere 2.83 (2.76–2.90) × length of 2nd tarsomere; 2nd tarsomere 1.54 (1.53–1.55) × length of 3rd tarsomere; 3rd tarsomere 1.86 (1.83–1.88) × length of 4th tarsomere; 4th tarsomere 0.52 (0.50–0.54) × length of 5th tarsomere; tarsal claw 0.59 (0.50–0.54) × length of 5th tarsomere.

Wings. Fore wing first discal cell tapering to point apically; vein r-m absent; vein SR1 weakly bent, almost straight, vein 2-M basal third tubular, without a node, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma 2.97 (2.62–3.15) × mesosoma length; hypopygium broad Y-shaped; ovipositor sheath 1.28 (1.13–1.41) × metasoma length, short appressed setae.

Male. Same characters as female with paramere apex cream.

Distribution. The species has been recorded from TAS and QLD.

Biology. Unknown.

Comments. *Gasteruption fibula* keys out with *G. compressiceps*. Both species have dark brown hind tarsus. *Gasteruption fibula* has a shorter malar space (0.02–0.04 × length of pedicel) and longer propleuron (1.10–1.30 × prototegular distance), see key couplet 55.

Gasteruption fibuliforme Pasteels, 1957

Figs 34.

Gasteruption fibuliforme Pasteels, 1957: 43, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Canberra A C T, 5 Dec 1954, E F Riek" "*Gasteruption fibuliforme* n.sp., J. Pasteels det., 1954" (ANIC).

Specimen damage. Both antenna 6th to 12th flagellomere missing, right fore wing missing, ovipositor sheaths broken at metasoma apex but still attached at ovipositor apex.

Paratypes. NSW: 1 ♀, Blackheath, G.H. Hardy (SDEI); 2 ♂, Dunalley, G.H. Hardy (SDEI). **WA:** 1 ♂, Cannington, R. P. Millan (WAMA) [not examined].

Figure 34. *Gasteruption fibuliforme* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm

Redescription. *Female.* Body length 13.30 mm; ovipositor sheath 12.60 mm.

Colour. Black; antenna dark brown, mandibles orange; tegula light brown; fore leg mostly brown, coxa dark brown, tibia with pale stripe on anterior face, tarsus pale, 4th tarsomere pale brown with 5th tarsomere and claw brown; mid leg mostly dark brown, tibia dark with pale anterior stripe, tarsus 1st tarsomere pale; hind leg mostly dark brown, coxa black, tibia with large pale patch sub-basally on posterior face, tarsus pale with dark brown base of 1st tarsomere, 5th tarsomere and claw; metasoma dark brown, tending to black; ovipositor sheath black with cream apex 2.40 × hind tibia 1st tarsomere, ovipositor brown; wing hyaline with fore wing veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 1.00 × longer than wide, postocular space gently tapering, sharper posteriorly near occipital carinae; head shape laterally, gena convex ventrally, postocular space short, 0.34 × height of eye; short scattered eye setae; face reticulate with medium dense shiny setae, denser medially and sub laterally along eye margin; medial frontal carina indistinct; vertex reticulate with short scattered setae; occipital carina short, lamelliform, depression broad, medially rounded; gena reticulate with short shiny setae, denser ventrally; minimal width of malar space 0.11 × height of eye; 0.71 × length of pedicel; clypeus reticulate; 2.94 × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression shallow and present anteriorly, short setae with longer setae on margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.50 × distance between lateral ocelli; scape 2.25 × length pedicel, 1st flagellomere 1.11 × as long as scape, 0.80 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.48 × height; propleuron length 1.44 × width; 0.94 × prototegular distance; propleuron reticulate-rugulose with medium setae denser ventrally; pronotal process broad and rounded; pronotum reticulate becoming reticulate-rugulose ventro-laterally, groove between pronotum lobes crenulate, short setae, longer and denser in groove; mesoscutum length 1.34 × width in dorsal view; rounded in lateral view, rugulose with short scattered setae; notauli U-shaped, carinate; mesoscutellum reticulate-rugulose, becoming punctate-imbricate posteriorly, short scattered setae; axilla reticulate-punctate; rugulose punctate; mesepisternum rugulose tending rugose ventro-laterally with short dense shiny setae; mesepimeron crenulate; metapleuron rugose tending to areolate posteriorly with dense short shiny setae; propodeum strigate-rugose medially becoming areolate laterally, short scattered setae, longitudinal medial carinae flattened in dorsal view.

Legs. Hind coxa reticulate, strigate-rugulose posteriorly; femur 0.71 × length of tibia; tibia length 5.70 × width; with ventro-apical pecten of short robust spines; 1st tarsomere 3.38 × length of 2nd tarsomere; 2nd tarsomere 1.30 × length of 3rd tarsomere; 3rd tarsomere 2.00 × length of 4th tarsomere; 4th tarsomere 0.55 × length of 5th tarsomere; tarsal claw 0.66 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, vein r-m absent, vein SR1 weakly bent, vein 2-M tubular basal third with small node, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma 2.59 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.49 × metasoma length, covered in short appressed setae;

Male. Males specimens not examined but described by Pasteels (1957) as having the same characters of the female

Distribution. The species has been recorded from south-western WA, ACT, NSW and TAS.

Biology. Unknown.

Comments. *Gasteruption fibuliforme* keys out with *G. leptothecus* from which it is difficult to separate. The species differ in malar space length and femur length are shorter in *G. fibuliforme*, see couplet 75.

Gasteruption fibuloides Pasteels, 1957

Fig. 35.

Gasteruption fibuloides Pasteels, 1957: 42, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "G. H. Hardy Melbourne [VIC] 10.3.18" "*Gasteruption fibuloides* n. sp. J. Pasteels det., 1954" (SDEI).

Specimen damage. Left antenna, 9th flagellomere to tip missing,

Paratypes. QLD: 2♂, National Park, x.1919, Q.H. Hacker (QM: T5470, T5471).

Figure 35. *Gasteruption fibuloides* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm

Redescription. *Female.* body length 10.40 mm; ovipositor length 11.40 mm.

Colour. Dark brown; head darker dorsally, mandibles light brown with dark tooth apex; pronotum lighter anterior pronotal lobe, tegula brown; fore and mid leg mostly brown, tibia with cream longitudinal stripe on anterior face, tarsus brown with 1st tarsomere and 2nd tarsomere lighter; hind leg mostly brown, tibia with cream patch sub basally on interior face, tarsus brown, becoming darker towards apex, gold reflective setae on tarsus; metasoma dark brown, becoming darker dorsally; ovipositor sheath dark brown with cream apex 3.17 × length of hind 1st tarsomere, ovipositor light brown; wing hyaline, wing vein and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.87 × longer than wide. postocular space gently tapering behind eyes to posterior; head in lateral view rounded with a short postocular space; postocular space short 0.31 × height of eye; face and frons granular with short dense setae, frons with scattered punctures; medial frontal carina anterior half indistinctly raised, remaining indistinct; vertex punctate becoming punctate-rugulose posteriorly, short dense setae; occipital carina short, lamelliform, depression very shallow; gena punctate with short dense setae; minimal width of malar space 0.05 × height of eye, 0.25 × length of pedicel; clypeus granular, 3.00 × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression indistinct, short dense setae, longer along margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.45 × distance between lateral ocelli; scape 1.50 × length pedicel; 1st flagellomere

0.92 × as long as scape, 0.69 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.10 × height; propleuron length 1.94 × width, 1.11 × prototegular distance; propleuron reticulate-rugulose with short dense setae; pronotal process short and blunt; pronotum granular, P2 glabrous, groove between pronotum lobes carinate, short dense setae; mesoscutum length 1.41 × width in dorsal view; rounded in lateral view; medial lobe reticulate-rugulose with scattered puncture medially, lateral lobe reticulate-rugulose laterally around parapsidial lines, rugose medially, short scattered setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum with scattered shallow punctures anteriorly, axilla reticulate-rugulose, short scattered setae; mesepisternum granular dorsally, becoming areolate ventrally, short dense setae; mesepimeron carinate ventral half and along posterior margin, remaining glabrous; metapleuron dorsal lobe granulate-rugulose, becoming areolate ventrally, short dense setae; propodeum areolate, medial carinae flattened, short scattered setae.

Legs. Hind coxa granular, rugulose dorsally basally; femur length 0.67 × length of tibia; tibia length 5.45 × tibia width; short dense setae with scattered stout spines on anterior face; 1st tarsomere 3.00 × length of 2nd tarsomere; 2nd tarsomere 1.50 × length of 3rd tarsomere; 3rd tarsomere 2.00 × length of 4th tarsomere; 4th tarsomere 0.44 × length of 5th tarsomere; tarsal claw 0.56 × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated, tapering at apex slightly; vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular, node present, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma length 3.05 × mesosoma length; hypopygium V-shaped; ovipositor sheath 0.60 × metasoma length, covered in short appressed setae.

Male. Having the same characters as the female except 1st flagellomere approximately same length as pedicel.

Distribution. The species is known from QLD, VIC with material examined by Pasteels (1957) from NSW.

Biology. Unknown.

Comments. *Gasteruption fibuloides* can be easily distinguished based on the combination no cream colouration on the hind tarsus, an elongated mesosoma (length 2.10 × height), propleuron (length 1.94 × width) and angular head shape.

Gasteruption filiforme **Patseels, 1957**

Fig. 36.

Gasteruption filiforme Pasteels, 1957: 26, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "G. H. Hardy Brisbane Oct: 1957" "*Gasteruption filiforme* n. sp. J. Pasteels det., 1954" (SDEI).

Figure 36. *Gasteruption filiforme* Pasteels, lateral habitus, scale bar = 1.00 mm

Specimen damage. Specimen heavily damaged, right antenna 3rd flagellomere to tip missing, left fore leg tarsus five to tip missing, left and right mis leg trochanter to tip missing, right forewing and apex of hind wing missing, right hind leg missing, left hind leg tarsus to tip missing.

Other material examined. **NSW:** Lawsons, Blue Mountains, 16.xi.1962, D.K. McAlpine (AM: K420864).

Redescription. *Female. Body length* 7.20 mm; ovipositor length 1.60 mm.

Colour. Black; antenna dark brown; clypeus lateral corners and mandibles brown (darker tooth apex); tegula dark brown; fore and mid legs brown, coxa dark brown, basal half of 1st tarsomere cream; hind leg dark brown; ovipositor sheath dark brown with cream apex 0.57 × length of hind 1st tarsomere; wing hyaline; wing vein and pterostigma brown.

Head. Head shape rectangular when viewed dorsally; length 1.08 (1.02–1.13) × width; postocular space short, gently tapering to occipital carinae; head in lateral view, distinctive rectangular flattened head, with large eye, face convex, postocular space 0.33 (0.28-0.38) × height of eye; eye setae absent; minimal width of malar space 0.06 (0.03–0.08) × height of eye; 0.31 (0.20–0.42) × length of pedicel; head reticulate with short dense shiny setae; medial frontal carina present in anterior third, becoming indistinct posteriorly; narrow lamelliform occipital carina; deep rounded depression; clypeus punctate; 2.36 (2.21–2.50) × wide as high; margin sinuate; lateral corners distinctly protruding forwards; medial depression indistinct, short dense setae, longer along margin; lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 0.76 (0.67–0.86) × distance between lateral ocelli; scape 1.47 (1.40–1.54) × length pedicel; 1st flagellomere 0.54 (0.50–0.57) × as long as scape; 0.84 (0.57–1.11) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.33 (2.12–2.53) × height; propleuron length 2.91 (2.71–3.12) × width; 1.48 (1.39–1.56) × prototegular distance; propleuron reticulate with short scattered setae; pronotal process indistinct; pronotum dorsal lobe reticulate with anterior and posterior lobes imbricate; groove between pronotum lobes carinate; short dense setae, anterior lobe without setae; mesoscutum length 1.49 (1.42–1.56) × width in dorsal view; rounded in lateral view; reticulate with short scattered setae; admedial lines and parapsidial lines distinct; notauli incomplete, scrobiculate; mesoscutellum and axilla imbricate with short scattered setae; mesepisternum reticulate, punctate ventrally, short dense setae; mesepimeron carinate with wide fovea; metapleuron reticulate-areolate anteriorly, becoming areolate posteriorly, short dense setae; propodeum areolate with broad flattened medial carinae; short scattered setae.

Legs. Hind coxa imbricate, reticulate dorsally with striations in the coxal groove; femur 1.44 × length of tibia; tibia length 2.74 × tibia width, short dense setae with scattered stout emergent spines on anterior face; tarsus with stout spine on ventral face and apically; 1st tarsomere 3.40 × length of 2nd tarsomere; 2nd tarsomere 1.50 × length of 3rd tarsomere; 3rd tarsomere 1.67 × length of 4th tarsomere; 4th tarsomere 0.40 × length of 5th tarsomere; tarsal claw 0.47 × length of 5th tarsomere.

Wings. Fore wing first discal cell tapering to point apically; vein r-m absent; vein SR1 almost straight, vein 2-M apical two thirds pigmented, spectral basal third and at apical margin; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma 3.58 × mesosoma length; hypopygium broad V-shaped; ovipositor sheath 0.37 × metasoma length, short appressed setae.

Male. Unknown.

Distribution. The species is known from QLD and NSW.

Biology. Unknown.

Comments. *Gasteruption filiforme* keys out with *G. youngi* based on both having lateral ocelli posterior of postocular line in dorsal view. They can easily be separated based on *G. filiforme* having an incomplete notauli where as it is a connected U-shaped in *G. youngi.*

Gasteruption flavicans Pasteels, 1957

Fig. 37.

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by MNHN (Fig. 35), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Gasteruption flavicans, Pasteels, 1957: 78, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, “Museum Paris DET. De Torres Ile Thursday LIX 1891” “*Gasteruption flavicans* s.sp. J. Pasteels det., 1955” (MNHN) [examined from photos].

Specimen damage. left antenna 5th flagellomere to tip and right antenna 3rd flagellomere to tip missing.

Figure 37. *Gasteruption flavicans* Pasteels*,* holotype female, lateral habitus.

Redescription. *Female*. Body length 16.00 mm; ovipositor length 35.00 mm.

Colour. Back; Pasteels (1957) described reddish-brown along thoracic sutures; fore and mid legs mostly brown, coxae and trochantelli reddish-brown, tarsus cream; hind leg dark brown, tarsus cream with base of 1st tarsomere dark brown; reddish yellow metasoma; ovipositor sheath dark brown, with large cream apex 5.68 × length of hind 1st tarsomere; wing hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; postocular space, tapering straight back towards occipital carinae; head in lateral view; front convex, postocular space 0.44 × height of eye; eye setae absent; frons reticulate with dense short shiny setae (denser along eye margins); medial frontal carina indistinct between antennal scrobes, becoming shallow groove towards anterior ocelli; vertex reticulate near ocelli, becoming finer posteriorly, short scattered setae; Occipital carina short, lamelliform, depression shallow and rounded; gena with short dense shiny setae; minimal width of malar space 0.04 × height of eye; 0.38 × length of pedicel; clypeus 2.21 × wide as high, margin concave, lateral corners distinctly protruding forwards, medial depression absent, short dense shiny setae, longer along margin; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.68 × distance between lateral ocelli; scape 1.75 × length pedicel; 1st flagellomere 0.57 × as long as scape; 0.29 × length 2nd flagellomere.

Mesosoma. propleuron length 1.11 × prototegular distance; propleuron with medium dense shiny setae, pronotal process indistinct; pronotum, mesepisternum and metapleuron with short dense shiny setae; mesoscutum length 0.98 × width in dorsal view; rounded in lateral view, reticulate with transverse striations medially on medial lobe, short scattered setae; admedial lines distinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla with short dense setae.

Legs. femur 0.74 × length of tibia; tibia length 5.53 × tibia width; 1st tarsomere

3.16 × length of 2nd tarsomere; 2nd tarsomere 1.45 × length of 3rd tarsomere; 3rd tarsomere 1.59 × length of 4th tarsomere; 4th tarsomere, 0.54 × length of 5th tarsomere; tarsal claw 0.57 × length of 5th tarsomere.

Wings. Fore wing first discal cell convex dorsally, wider at junction; forewing vein r-m absent; vein SR1 distinctly bent, vein 2-M basal quarter tubular with apical node, remaining pigmented.

Metasoma. Ovipositor sheath distinctly longer then metasoma length.

Male. Unknown.

Distribution. The species is only known from the type locality of Thursday Island in the Torres Strait Islands archipelago.

Biology. Unknown.

Comments. This species is known only from the type specimen which we have been unable to examine in detail. *Gasteruption flavicans* keys out with *G. melanostoma* but can be separated based on scape length longer (2.50 × pedicel length) and length of cream/white apex of ovipositor sheath shorter (3.27 × length of hind 1st tarsomere). The species is only known from the type locality of Thursday Island in the Torres Strait Islands archipelago. Due to the proximity of this location to Papua New Guinea, it may have a wider distribution across both these areas.

Gasteruption flavitarse (Guerin-Menevile, 1843)

Fig. 38.

Foenus flavitarsis Guerin-Menevile 1844: 407, ♀ (comb. Pasteels, 1957).

Foenus macrocephalus Turner 1918: 201, ♀.

Gasteruption flavitarse Pasteels 1957: 82, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype *Foenus flavitarsis* Guerin-Menevile. ♀, "F. Honchi count. New Holland [Australia]" "*Foenus flavitarsis*. (Type) n. holl. Swan river [WA]" (RMNH). *Specimen damage*. complete right antenna, left 8th flagellomere to tip missing, left fore leg, trochanter to tip, right mid leg, apical half of 1st tarsomere to tip, left hind 2nd tarsomere to tip and right hind 5th tarsomere to tip missing, ovipositor apex broken.

Holotype *Foenus macrocephalus* Turner. ♀, "*Foenus macrocephalus* Type. Turner." " 7.2.07 Victoria" "Australia R.E.Turner. 1907–244." (BMNH: 3.a.179). *Specimen damage*. Both antenna 3rd flagellomere to tip missing, left fore 2nd tarsomere to tip and right fore 5th tarsomere and claw missing, hind left 4th tarsomere to tip, tip of left ovipositor sheath missing.

Figure 38. *Gasteruption flavitarse* (Guerin-Menevile*,* lateral habitus*, s*cale bar = 1.00 mm

Other material examined. **WA:** 1♀, Waurarga, 1931, A. Goerling (ANIC)*.

Redescription. *Female*. body length 30.00 mm; ovipositor length 45.00 mm.

Colour. Black; malar space and mandibles dark brown (dark tooth apex), tegula dark brown; fore leg mostly dark brown, trochantellus with cream apical margin, prefemur lighter; femur with cream patch apically, tibia and tarsus with cream stripe on anterior face; mid leg the same as fore leg except coxa darker, tarsus with cream band on anterior face of 1st, 2nd and 3rd tarsomere; hind leg mostly dark brown, coxa and trochantellus black, tarsus cream with basal third of 1st tarsomere, 5th tarsomere and claw dark brown; metasomal segments T2–T3 lighter laterally; ovipositor sheath dark brown with cream apex 3.60 × length of hind basitarsus; ovipositor brown; wing hyaline, veins and pterostigma dark brown.

Head. shape rectangular when viewed dorsally; 1.06 (1.05–1.07) × longer than wide, postocular space bulbous in dorsal view, head in lateral view large postocular space, convex behind ocelli, postocular space 0.50 (0.46–0.61) × height of eye; eye setae absent; face punctate-reticulate with short dense shiny setae on eye margin and medially; frons punctate-reticulate with short scattered shiny setae; medial frontal carina distinct between antennal scrobes, indistinctly raised anterior half; vertex punctuate around ocelli, punctate-rugulose posteriorly, short dense shiny setae; occipital carina short, wider lateral-ventrally, lamelliform, shallow depression pointed medially; gena punctate-rugulose with short dense shiny setae; minimal width of malar space 0.07 (0.06–0.08) × height of eye; 0.58 (0.50–0.67) × length of pedicel; clypeus punctate, 2.05 (1.96–2.14) × wide as high, margin concave with lateral corners distinctly protruding forwards, medial depression absent, short scattered setae, denser medium length on margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.60 (0.55–0.64) × distance between lateral ocelli; scape 2.37 (2.33–2.4) × length pedicel; first flagellomere 0.93 × as long as scape, 0.50 × length second flagellomere.

Mesosoma. Mesosoma length 1.72 (1.69–1.75) × height, propleuron length 1.22 (1.20–1.24) × width, 0.88 (0.86–0.90) × prototegular distance; propleuron rugulose dorsally, reticulate-rugulose laterally, medium dense shiny setae; pronotal process short stout rounded; pronotum anterior lobe coarsely rugose, dorsal lobe and ventral part of posterior lobe rugulose, dorsally granular, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.25 (1.22–1.29) × width in dorsal view; rounded in lateral view, granular with strigate sculpturing anterior-laterally and several scattered puncture posterior-laterally, short shiny setae; admedial lines converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular-rugulose with short shiny setae; mesepisternum rugose dorsally, striate ventrally, medium dense shiny setae; mesepimeron carinate with patch of medium dense shiny setae posteriorly along dorsal margin; metapleuron areolate-rugulose dorsally lobe, strigate ventral lobe, medium dense shiny setae; propodeum areolate-rugulose, medial carinae convex, propodeum raised and bulbous in lateral view, medium dense shiny setae.

Legs. Hind coxa strigate-rugulose, strigate in coxal groove; femur 0.70 (0.69–

0.71) × length of tibia; tibia length 6.33 (5.77–6.89) × width; short dense setae with scattered emergent spines on anterior face; tarsus with short robust spines on ventral face with several stout spines on apex of tarsus; 1st tarsomere 2.92 (2.80–3.04) × length of 2nd tarsomere; 2nd tarsomere 1.41 (1.35–1.47) × length of 3rd tarsomere; 3rd tarsomere 1.89 (1.89–1.89) × length of 4th tarsomere; 4th tarsomere 0.43 × length of 5th tarsomere; tarsal claw 0.48 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of 3-cu vein; vein r-m spectral; vein SR1 distinctly bent; vein 2-M basal third tubular, remining pigmented, hind wing vein 2m+Cu and 1-m tubular, remaining veins spectral, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Imbricate, length 2.79 (2.73–2.85) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 2.46 (2.30–2.62) × metasoma length, covered in short dense setae.

Male. Unknown

Distribution. The species is known from VIC and WA.

Biology. Unknown.

Comments. *Gasteruption flavitarse* is the largest species of Australian *gasteruption* with a body length of 30.00 mm and ovipositor length 45.00 mm. This species keys out with *G. bicarinatum* but can be easily distinguished from it based on the absence of a large angular projection on the vertex (in lateral view, see *G. bicarinatum)* and a longer ovipositor sheath (3.60 × metasoma length).

Gasteruption fluviale **(Turner, 1918)**

Fig. 39.

Pseudofoenus fluvialis Turner, 1918: p. 198, ♀.

Gasteruption fluviale (Turner), Pasteels, 1957: p. 26, ♀, ♂; Jennings 2010 [on-line checklist]

Material examined.

Holotype. ♀, "*Pseudofoenus fluvialis* Type Turner." "S.W.Australia. Perth. 1–7 Feb. 1914. R.E.Turner. 1914–258" (BMNH: 3.a.218).

Specimen damage. Head missing.

Other material examined. **SA:** University of Adelaide, Waite Campus, 11.xi.2006 R.V. Glatz (RGC: 4797)*.

Figure 39. *Gasteruption fluviale* (Turner), lateral habitus, scale bar = 1.00 mm.

Redescription. *Female*. Body length 11.00 mm; ovipositor length 5.90 mm.

Colour. Black; antenna dark brown; tegula brown; fore and mid leg mostly dark brown, fore leg tibia with cream patch on apex and base, tarsus brown except for 1st tarsomere cream with brown apex; hind leg dark brown, tibia black dorsally with cream patch sub basally on ventral side, tarsus dark brown, apical two thirds of 1st tarsomere cream; metasoma black with T3 and T3 dark brown laterally; ovipositor sheath dark brown with cream apex 2.44 (2.39–2.50) × length of hind 1st tarsomere;

ovipositor light brown; wing hyaline, wing veins and pterostigma brown.

Head. Head shape conical when viewed dorsally; length 1.11 (1.06–1.15) × width, tapering straight behind eye; head in lateral view elongated, postocular space; 0.39 (0.37–0.41) × height of eye; short scattered eye setae; head with granular sculpturing, short shiny dense setae, becoming less dense on vertex; medial frontal carina short along frons, becoming indistinct posteriorly towards anterior ocelli; occipital carina short, wider ventro-laterally, lamelliform, depression shallow and rounded; minimal width of malar space 0.04 (0.02–0.05) × height of eye; 0.23 (0.15–0.31) × length of pedicel; clypeus punctate, 2.57 × wide as high, margin concave with lateral corners distinctly protruding forwards, medial depression absent, short shiny setae, longer along margin; lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 0.91 (0.89–0.93) × distance between lateral ocelli; scape 1.47 (1.45–1.00) × length pedicel; 1st flagellomere 0.75 (0.71–0.79) × as long as scape; 0.54 (0.52–0.55) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.42 (2.32–2.52) × height; propleuron length 2.07 × width; 1.15 (1.13–1.17) × prototegular distance; propleuron granular, short shiny setae, denser towards posterior ventrally; pronotal process short non acute; pronotum granular with scattered punctures on anterior lobe; groove between pronotum lobes carinate, short dense shiny setae; mesoscutum length 1.18 (0.72–1.64) × width in dorsal view; truncated in lateral view; granular with short shiny setae; admedial lines straight; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla punctate-rugulose with short scattered setae; mesepisternum granular-rugulose dorsally, short dense shiny setae; mesepimeron carinate, creating shallow fovea, smooth patch dorso-anteriorly; metapleuron areolate-rugulose, short dense shiny setae; propodeum granular-rugose, becoming areolate near medial carinae, short setae, medial carina flattened.

Legs. Hind coxa granular-rugulose, strigate in coxal groove; femur 0.73 × length of tibia; tibia length 3.55 (3.14–3.69) × tibia width; short dense setae with scattered emergent setae on anterior face; tarsus with short robust spines on anterior face; 1st tarsomere 3.26 (2.86–3.65) × length of 2nd tarsomere; 2nd tarsomere 1.60 (1.44–1.75) × length of 3rd tarsomere; 3rd tarsomere 1.61 (1.60–1.63) × length of 4th tarsomere; 4th tarsomere 0.40 (0.35–0.45) × length of 5th tarsomere; tarsal claw

0.65 (0.64–0.66) × length of 5th tarsomere.

Wings. Fore wing first fiscal cell open; vein r-m absent; SR1 weakly sinuate; 2-M basal third tubular with node, remaining pigmented; hind wing veins spectral; three equidistant hamuli.

Metasoma. Imbricate, length 2.73 (2.72–2.74) × mesosoma length; hypopygium Y shape; ovipositor sheath 0.98 (0.93–1.03) × metasoma length, with short appressed setae; flared cream apex.

Male. Same characters as female

Variation. Pasteels (1957) mentions variation in the postocular space shape, more rounded and the hind tarsus which can have varying amounts of cream coloration.

Distribution. The species is known from WA with a specimen examined from SA, Pasteels (1957) examined material from NSW, ACT and TAS.

Biology. Unknown.

Comments. The species keys out with *G. isthmale* with both having all hind wing veins spectral. The species can be easily separated based on *G. fluviale* mesosoma completely black compared to ventrally brown in G. *isthmale* see key couplet 8.

***Gasteruption fraternum* Pasteels, 1957**

Gasteruption fraternum Pasteels, 1957: 20, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♂, "Mackay, Q 15.3.73 A. N. Burns" "Collection A. N. Burns" "*Gasteruption fraternum* n.sp. J. Pasteels det., 1956" (NMV: T-7376).

Specimen damage. Head, propleuron and fore legs dislodged from specimen and glued to label.

Comments. The original species description is based entirely on male specimens, and until we can associate females, we have refrained from redescribing this species.

Gasteruption fuscimanus Kieffer, 1911

Fig. 40.

Gasteruption fuscimanus, Kieffer 1911: 202, ♀; Pasteels, 1957: 68, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "*Gasteruption fuscimanus* Kieff." "Hermannsberg, Cent[ral]. Australia. H.J. Hillier. 1909–125." (BMNH: 3.a.202).

Figure 40. *Gasteruption fuscimanus* Kieffer, holotype female, lateral habitus, scale bar = 1.00 mm.

Specimen damage. Both antennae pedicel to tip missing, both fore legs and right mid leg broken and glued to mount, left tarsus 2nd tarsomere to tip missing.

Redescription. *Female.* body length 17.00 mm; ovipositor length 5.00 mm.

Colour. Black; antenna dark brown, malar space and mandibles brown (darker tooth apex), light brown tegula; fore leg mostly orange-brown; trochantellus with cream on apical margin, tibia dark brown with cream stripe on anterior face, tarsus dark brown with cream stripes on anterior face of 1st tarsomere to 4th tarsomere; most of mid leg orange-brown; tibia dark brown with cream stripe on anterior face, tarsus dark brown with cream stripe on anterior of 1st tarsomere, apex of 2nd to 5th tarsomere brown; hind leg coxa, trochantellus, and prefemur black, femur dark brown, tibia black, tarsus cream, base of 1st tarsomere and apical half of 5th tarsomere and claw black; metasoma black, brown T2-T4 laterally; ovipositor sheath dark brown with cream apex 1.00 x length of hind basitarsus, ovipositor brown; wing hyaline, veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.89 × longer than wide, postocular space bulbous in dorsal view; head in lateral view, face to vertex rounded, postocular space large; postocular space 0.51 × height of eye; face punctate-reticulate with medium dense shiny setae; frons reticulate-rugulose with short dense setae; medial frontal carina present anterior half becoming shallow groove for posterior half; vertex reticulate-rugulose, strigate-rugulose posteriorly, short dense setae; occipital carina short, wider latero-ventrally, lamniform, depression shallow medially pointed; gena reticulate-rugulose with medium dense shiny setae; minimal width of malar space 0.03 × height of eye; clypeus punctate, 2.50 × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression present anteriorly, medium dense shiny setae, longer on margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.59 × distance between lateral ocelli; antenna pedicel to tip missing in type specimen.

Mesosoma. Mesosoma length 1.78 × height; propleuron length 1.25 × width; 0.83 × prototegular distance; propleuron reticulate-rugulose with medium dense shiny setae; pronotal process short and rounded; pronotum anterior lobe rugose, dorsal lobe reticulate-rugulose with posterior lobe finer, groove between pronotum lobes carinae, medium dense shiny setae; mesoscutum length 1.25 × width in dorsal view; rounded in lateral view, rugulose, coarser medially between notauli and posterior margin, short dense shiny setae; admedial lines convergent; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugulose with short dense shiny setae; mesepisternum reticulate-rugulose dorsally, areolate-rugose, medium dense shiny setae; mesepimeron carinate; metapleuron areolate-rugose with medium dense shiny setae; propodeum areolate-rugulose, medial carina convex, posteriorly depressed, short dense shiny setae.

Legs. Hind coxa rugulose, strigate in coxal groove; femur 0.73 × length of tibia; tibia length 4.73 × width; short dense setae with scattered emergent stout spines on anterior face; tarsus ventro pecten of short robust spines; 1st tarsomere 2.20 × length of 2nd tarsomere; 2nd tarsomere 1.39 × length of 3rd tarsomere; 3rd tarsomere 1.80 × length of 4th tarsomere; 4th tarsomere 0.38 × length of 5th tarsomere; tarsal claw 0.50 × length of 5th tarsomere.

Wings. Fore wing first discal cell oval; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular, remaining pigmented; hind wing vein apical half 2m+Cu and 1-m pigmented, three equidistant Hamuli.

Metasoma. Imbricate, length 2.61 × mesosoma length; hypopygium V-shaped; ovipositor sheath 0.44 × metasoma length; with short appressed setae.

Male. Unknown

Distribution. The species is only known from the type locality of Hermannsburg, NT.

Biology. Unknown.

Comments. Pasteels (1957) mentioned this species is very similar to *G. lampropleurum* Kieffer but distinguished by indistinct pronotal spines, hind tibia black with cream tarsus (black base and apex) and ovipositor short. He suggests that more material needs to be examined to really determine if they are different species. Pasteels (1957) mention four ♂ from Dunsborogh, Yallingup, Wanneroo and Swanbourne in WAM but it is unclear if they are associated as the specimens locations are known. Antenna were missing in the original description by Kieffer (1911).

Gasteruption fuscipes Pasteels, 1957

Fig. 41.

Gasteruption fuscipes Pasteels, 1957: 55, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "G. H. Hardy, Blackheath [NSW] 23 Nov., 1919" "*Gasteruption fuscipes* n. sp. J. Pasteels det., 1954" (SDEI).

Specimen damage. Left antenna 7th flagellomere to tip and right antenna 8th flagellomere to tip missing, both ovipositor sheaths missing.

Paratypes. QLD: 2♂, 1?, Goondiwindi, Sept 1986, G. H. Hardy (SDEI). NSW: 2?, Blackheath 16.xi.1919, G.H. Hardy (SDEI).

Redescription. *Female.* body length 18.00 mm; ovipositor length 20.00 mm.

Colour. Black; malar space dark brown, mandibles brown with tooth apex darker; posterior corner of pronotum lighter, tegula brown; fore and mid leg mostly brown, trochantellus with cream apical margin, tibia dark brown with cream longitudinal stripe on anterior face, tarsus cream, 5th tarsomere and claw dark brown; hind leg mostly dark brown, prefemur lighter, tibia with cream patch sub-basally on inside face, tarsus cream with dark brown basal quarter of 1st tarsomere and apical half of 5th tarsomere and claw; metasomal segments T2-T3 laterally dark brown; ovipositor sheath missing on holotype and other examined specimens; ovipositor brown; wing hyaline; wing veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.93 (0.87–1.00) × longer than wide; postocular space bulbous, tapering sharply before occipital carinae; head in lateral view, frons and vertex convex, postocular space slightly elongated, 0.41 (0.34–0.47) × height of eye; short scattered eye setae; face rugulose with short dense setae; frons rugose with short dense setae; medial frontal carina distinct anteriorly becoming indistinct groove posteriorly; vertex rugose around ocelli, strigose posteriorly with short dense setae; occipital carina narrow, wider ventro-laterally, lamelliform, depression shallow, wide and rounded; gena rugulose with short dense setae; minimal width of malar space 0.07 (0.06–0.08) × height of eye; 0.55 (0.43–0.83) × length of pedicel; short scattered eye setae; clypeus reticulate-rugulose, 1.65 (2.46–2.50) × wide as high, margin sinuate with lateral corners distinctly protruding forwards; medial depression indistinct, short dense setae, with long setae along margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.66 (0.53–0.80) × distance between lateral ocelli; scape 2.37 (2.00–2.67) × length pedicel; 1st flagellomere 0.71 (0.63–0.79) × as long as scape, 0.45 (0.40–0.50) × length 2nd flagellomere.

Figure 41. *Gasteruption fuscipes* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Mesosoma. Mesosoma length 1.84 (1.77–1.90) × height, propleuron length 1.08 (0.85–1.25) × width, 0.81 (0.68–0.97) × prototegular distance; propleuron rugose with medium dense setae; pronotal process large and rounded; pronotum rugose, groove between pronotum lobes carinae, medium dense setae; mesoscutum length 1.20 (1.14–1.27) × width; truncated in lateral view; rugose with short dense setae, admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugose with short dense setae, scattered on axilla; mesepisternum rugose dorsally, becoming areolate, medium dense setae; mesepimeron carinae with; metapleuron areolate, finer dorsally, medium dense setae; propodeum areolate with transverse carinae, medial carinae flattened, medium dense setae.

Legs. Hind coxa strigate dorsally; femur length 0.73 (0.71–0.77) × length of tibia; tibia length 5.38 (5.00–5.82) × tibia width; short dense setae with scattered stout emergent spines on anterior face; tarsus with short robust spines along ventral surface of tarsus; 1st tarsomere 3.08 (3.00–3.20) × length of 2nd tarsomere; 2nd tarsomere 1.35 (1.23–1.47) × length of 3rd tarsomere; 3rd tarsomere 1.94 (1.83–2.14) × length of 4th tarsomere; 4th tarsomere 0.42 (0.39–0.49) × length of 5th tarsomere; tarsal claw 0.61 (0.56–0.67) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, slightly wider ventro-apical; vein r-m spectral; vein SR1 distinctly bent; vein 2-M basal third tubular with node, remainder of vein pigmented; hind wing veins apical 2/3rds of 2m+Cu and 1-m pigmented, remaining spectral, three equidistant hamuli.

Metasoma. Imbricate, length 1.88 × mesosoma length; hypopygium Y-shaped.

Male. Hind leg completely black, lateral projections of clypeus lighter, cream spot on apex of T9.

Distribution. The species is known from QLD and NSW.

Biology. Unknown.

Comments. *Gasteruption fuscipes* keys out with *G. trianguliceps* but are easily separated based on mesosoma completely black, compared to with reddish-brown anterior corners in *G. trianguliceps* and a wider clypeus (2.46–2.50 × height).

Gasteruption genale Schletterer, 1890

Fig. 42.

Gasteruption genale Schletterer 1890: 436, ♂; Pasteels, 1957: p. 104, ♀, ♂; Jennings 2010 [on-line checklist].

Gasteruption coriaceum Schletterer, 1890: 443, ♀, ♂; Pasteels, 1957: 118, ♀;

Jennings 2010 [on-line checklist]; (**syn. nov**).

Figure 42. *Gasteruption genale* Schletterer, lateral habitus, scale bar = 1.00 mm.

Material examined.

Holotype, *Gasteruption coriaceum* Schletterer. ♀, "Sidney Dämel." "22142" "*coriaceum* Schlett" (ZMBD).

Holotype, *Gasteruption genale* Schletterer. ♂ "Rockhampton Queensland" "Cn de saussure" (MHNG: 00008966). *Specimen damage*. complete metasoma and ovipositor missing.

Paratype. NSW: ♀, same data as holotype of *G. coriaceum* (SDEI).

Other material examined. **QLD:** 1♀, 6 km E of Mt Isa, 5.xii.1974, R.I. Storey (QM); 1♀, Taroom, 25º36'S, 149º46'E, 26.xi.1992, G. Daniels (QM)*. NSW: 12 km SW of Bourke, 14.xii.1976, E.M Exley and T. Low (QM); 1♀, Mendooran, 31º50'S, 149º06'E, 28.x.1987, G. & A. Daniels (QM). **WA:** 1♀, 79 km E of Southern Cross, 28.i.1973, E.M. Exley (QM); 2♀, Moir's Rock 42 km NNW Salmon Gums, 32º39'S, 121º25'E, 1–2.i.1986, G. & A. Daniels (QM). **NT:** 1♂, Boooroooloola Road, 15.xi.1974, E.M. Exley & R.I. Storey (QM).

Redescription. *Female.* Body length 12.57 (12.20–13.20) mm; ovipositor length 7.35 (12.20–13.20) mm.

Colour. Black; antenna dark brown, malar space and margin of clypeus brown; mandibles light brown with dark brown tooth apex; ventro-anterior margin, posterior corner of pronotum and tegula brown; fore and mid legs brown, femur with cream apex, tibia with cream longitudinal stripe on anterior face, tarsus cream, 4th tarsomere to tip brown; hind leg dark brown, Coxa lighter brown ventrally, trochantellus with cream apical margin, prefemur brown, tibia with large cream band subbasally, tarsus cream, base of 1st tarsomere and 4th tarsomere to claw dark brown; metasoma dark brown, lighter laterally T2–T4; ovipositor sheath dark brown with cream apex 2.27 (2.04–2.50) × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing vein and pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; 0.94 × longer than wide; postocular space gently tapering from posterior of eyes, relatively short; distinct flattened head in lateral view, short postocular space, 0.28 (0.28–0.29) × height of eye; short very dense eye setae; face and frons reticulate-rugulose with short dense setae, denser laterally towards eye margin; medial frontal carina present anterior third, absent remaining two thirds; vertex reticulate-rugulose around ocelli, becoming strigate-rugulose posteriorly, short dense setae; narrow lamelliform occipital carina, shallow rounded depression; gena punctate with short dense shiny setae; minimal width of malar space 0.05 (0.04–0.06) × height of eye; 0.39 (0.30–0.50) × length of pedicel; clypeus reticulate-rugulose; 1.69 (1.59–1.76) × wide as high; margin sinuate; lateral corners barley protruding forward; medial depression present anteriorly; medium dense setae, longer along margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.29 (0.28–0.32) × distance between lateral ocelli; scape 1.73 (1.67–1.82) × length pedicel; 1st flagellomere 1.14 (1.12–1.16) × as long as scape; 0.82 (0.79–0.86) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.72 (1.72–1.73) × height; propleuron length 1.38 (1.36–1.40) × width; 0.88 (0.87–0.90) × prototegular distance; propleuron reticulate-rugulose with medium dense setae; pronotal process large and acute; pronotum rugulose, anterior lobe coarser, groove between pronotum lobes carinate, short dense setae; mesoscutum length 1.31 (1.29–1.33) × width in dorsal view; rounded in lateral view; rugulose, rugose posterior-medially, short dense setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum rugulose, scrobiculate groves on sides; short setae; axillae rugulose with short setae; mesepisternum dorsally strigate-rugulose, becoming areolate ventrally, short dense setae; mesepimeron carinate creating large fovea; metapleuron areolate with short dense setae; propodeum areolate-rugulose, medial longitudinal carina flattered with granulate sculpturing, short dense setae.

Legs. Hind coxa rugulose dorsally, transverse strigate interior face of dorsal depression, becoming reticulate-rugulose; femur 0.76 (0.75–0.77) × length of tibia; tibia length 4.37 (4.28–4.48) × tibia width; short dense setae, scattered stout spines on anterior face; tarsus with short spines on ventral face and apically; 1st tarsomere 2.89 (2.78–3.00) × length of 2nd tarsomere; 2nd tarsomere 1.46 (1.38–1.58) × length of 3rd tarsomere; 3rd tarsomere 1.67 (1.50–1.86) × length of 4th tarsomere; 4th tarsomere 0.35 (0.35–0.36) × length of 5th tarsomere; tarsal claw 0.60 (0.59–0.62) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of vein 3-cu; vein r-m absent; vein SR1 weakly sinuate; vein 2-M basal quarter tubular with node, remaining pigmented; hind wing veins 1-m pigmented with others spectral; three hamuli distance between basal and middle hamuli greater than distance between middle and apical hamuli.

Metasoma. Metasoma 2.67 (2.67–2.68) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.89 (0.81–0.98) × metasoma length, with short appressed setae, apex distinctly flared.

Male. Males with pronotum entirely black.

Distribution. The species is known from various locations in QLD with material examined by Pasteels (1957) from WA, VIC and NSW.

Biology. Collected on *Eucalyptus argillacea* W.Fitzg (Myrtaceae) in NSW.

Comments. The type specimens of *G. coriaceum* and *G. genale* are similar in both general colour, sculpturing patterns and morphometric ratios, we hereby synonymise *G. coriaceum* with *G. genale.*

Gasteruption gibbosum **Pasteels, 1957**

Fig. 43.

Gasteruption gibbosum Pasteels, 1957: 59, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♂, "Brisbane: H. Hacker 26.10.15" "*Gasteruption gibbosum* n.sp. J. Pasteels det., 1955" (QM: T5487).

Specimen damage. Left and right antenna 3rd flagellomere to tip missing, metasoma dislodged and glued to main label.

Figure 43. *Gasteruption gibbosum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Comments. The original species description is based entirely on male specimens, and until we can associate females, we have refrained from redescribing this species.

Gasteruption globiceps Pasteels, 1957

Figs 44.

Gasteruption globiceps Pasteels, 1957: 65, #f; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "G. H. Hardy Brisbane [QLD]. Nov 1931.," "*Gasteruption globiceps* n.sp J.Pasteels det., 1954" (DEIB).

Specimen damage. Complete left antenna missing, left hind leg 2nd tarsomere to tip missing.

Paratypes. QLD: 1 #f, Brisbane, H. Hacker, 16.x.1911 (QM: T5491). **NSW:** 1♀, Batemans Bay, 21.ix.1952, E.F. Riek (ANIC). **WA:** 1♀ Maylands, A. Douglas (WAMA) [not examined]; 1♀, Wembley, A. Douglas (WAMA) [not examined].

Other material examined. **QLD:** 5 km WSW of Point Lookout North Stradbroke Island, 27º26'S, 153º30'E, 28.iii.1993, G. Daneils and C.J. Burwell (QM)*.

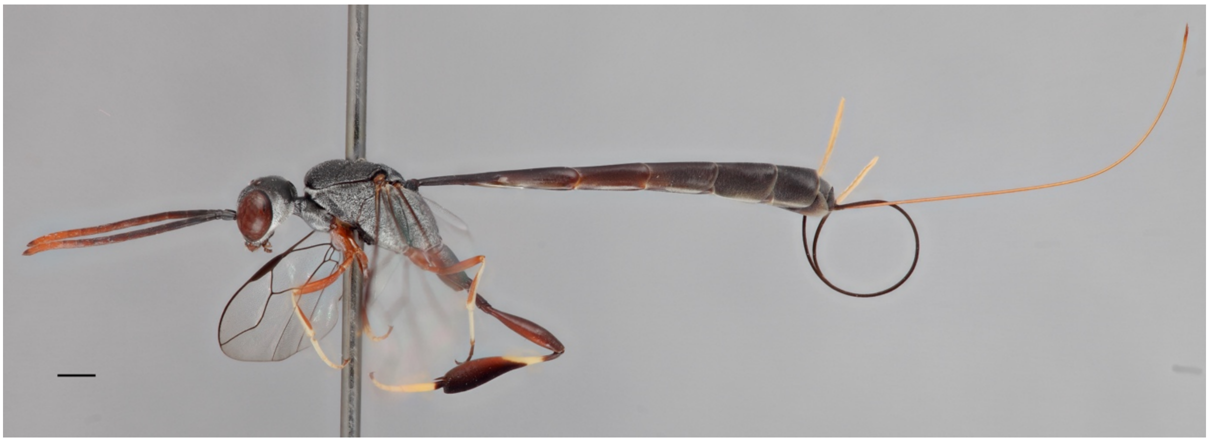

Figure 44. *Gasteruption globiceps* Pasteels, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* body length 17.50 mm; ovipositor length 14.30 mm.

Colour. Black; antenna 10th to 12th flagellomere orange-brown; mandibles brown with darker tooth apex; propleuron lighter at apex and base, mesepisternum with coxa insertion and tegula brown; fore and mid leg mostly brown, trochantellus apical margin and longitudinal stripe on anterior face of tibia cream, tarsus cream with 4th flagellomere to tip dark brown; hind leg mostly dark brown, prefemur lighter, femur brown, darker apically, tibia brown, darker dorsally with cream patch subbasally on ventral side, tarsus cream, basal third of 1st tarsomere and apical half of 5th tarsomere and claw dark brown; metasoma dark brown, lateral sides of T2 and T3 lighter; ovipositor sheath dark brown with cream apex 2.00 × length of hind 1st tarsomere, ovipositor brown; wing hyaline, wing vein and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.83 (0.80–0.87) × longer than wide, postocular space bulbous, gently rounding behind eyes; head in lateral view angular; postocular space 0.38 × height of eye; short scattered eye setae; face granular with short dense setae; frons reticulate with scattered punctures laterally and posteriorly with short dense setae; medial frontal carina raised anterior half, remaining indistinct; vertex granular with scattered punctures, becoming granular-rugulose with scattered puncture posteriorly, short scattered setae; occipital carina short, lamelliform with shallow depression pointed medially; gena granular with scattered punctures, shiny short setae; minimal width of malar space 0.04 (0.03–0.05) × height of eye; 0.36 (0.30–0.43) × length of pedicel; clypeus granular with scattered punctures laterally; 2.42 (2.33–2.55) × wide as high; margin sinuate with lateral corners distinctly protruding forwards, depression indistinct, shiny short setae, longer along margin; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.71 (0.5–0.92) × distance between lateral ocelli; scape 2.17 (2.14–2.20) × length pedicel; 1st flagellomere 0.62 (0.53–0.70) × as long as scape; 0.37 (0.33–0.41) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.04 (1.88–2.20) × height; propleuron length 1.20 × width; 0.73 (0.70–0.75) × prototegular distance; propleuron rugulose with medium dense setae; pronotal process blunt; pronotum anterior lobe reticulate-rugulose, other lobes granular, groove between pronotum lobes broad and carinate, medium dense setae, longer in groove; mesoscutum length 1.23 × width in dorsal view; truncated in lateral view; medial lobe finely strigose with scattered shallow punctures, lateral lobe granular-rugulose with scattered punctures, short scattered setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate;

mesoscutellum rugulose with scattered punctures, short scattered setae; axilla granular with some scattered punctures, short scattered setae; mesepisternum rugulose dorsally, areolate ventrally with short shiny setae; mesepimeron carinate; metapleuron areolate with short dense setae; propodeum areolate-rugose, medial carina flattened, short scattered setae.

Legs. Hind coxa dorsally strigose, strigate in coxal depression; femur 0.63 (0.55–0.70) × length of tibia; tibia length 4.90 (4.80–5.00) × tibia width; short setae with scattered stout emergent setae on anterior face; tarsus with short robust spines along ventral face; 1^{st} tarsomere 3.67 (3.50–3.85) × length of 2^{nd} tarsomere; 2^{nd} tarsomere 1.50 (1.30–1.70) × length of 3^{rd} tarsomere; 3^{rd} tarsomere 1.75 (1.50–2.00) × length of 4^{th} tarsomere; 4^{th} tarsomere 0.39 (0.38–0.40) × length of 5^{th} tarsomere; tarsal claw 0.61 (0.60–0.62) × length of 5^{th} tarsomere.

Wings. Fore wing first discal cell elongated, wider ventrally at junction with vein 3-cu; vein r-m absent; vein SR1 distinctly bent, vein 2-M basal third tubular with node, remaining pigmented; hind wing veins spectral with 1-M pigmented; four equidistant hamuli.

Metasoma. Imbricate, length 2.97 (2.90–3.04) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.94 × metasoma length; short appressed setae, flared cream apex.

Male. Unknown

Distribution. The species is known from Queensland, NSW with material examined by Pasteels (1957) from southern Western Australia.

Biology. Unknown.

Comments. *Gasteruption globiceps* keys out with *G. pachypus* but can be easy separated based on *G. pachypus* having distinctly enlarged hind coxa and femur, and *G. globiceps* a longer ovipositor (0.94 × metasoma length).

Gasteruption granulare Pasteels, 1957

Fig. 45.

Gasteruption granulare Pasteels, 1957: 111, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "17 m[i]l[e]s. NW, Ross, Tas[mania]., 2 Feb. 49, E.F.Reik" "*Gasteruption granulare* n.sp., J.Pasteels set., 1954" (ANIC).

Specimen damage. Left antenna 3rd flagellomere to tip missing.

Paratype. TAS: ♂, same data as holotype (ANIC).

Figure 45. *Gasteruption granulare* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* Body length 16.50 mm; ovipositor length 19.80 mm.

Colour. Mostly dark brown; face and clypeus with brown patches; pronotum lighter ventro laterally, mesepisternum lighter brown dorso-laterally, mesepimeron brown, mesoscutum almost black dorsally, lighter laterally with brown posterior corner, mesoscutum almost black, mesoscutellum lighter anterior near base of notauli; fore and mid leg brown, femur with cream apex, tibia with pale stripe on anterior face, fore leg 1st, 2nd and 3rd tarsomere cream, mid leg most of 1st tarsomere cream; hind leg mostly dark brown, prefemur and femur brown, tibia with cream patch subbasally, tarsus pale with dark brown base of 1st tarsomere and claw; metasoma T1 dark brown, metasoma becoming lighter towards apex; ovipositor sheath dark brown with cream apex 2.38 × hind 1st tarsomere; ovipositor brown; wing hyaline; wing veins dark brown with pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; length 1.34 × width; postocular space tapering towards occipital carinae; head in lateral view wedge shape, convex dorsally; postocular space 0.31 × height of eye; eye setae absent; face rugulose with short scattered setae, becoming longer and denser ventrally; frons reticulate with short scattered setae; medial frontal carina raised in anterior third becoming indistinct posteriorly; vertex reticulated anteriorly around vertex tending rugulose posteriorly, short setae; occipital carina short, lamelliform with broad shallow rounded depression; gena rugulose with short shiny setae, becoming denser ventrally; minimal width of malar space 0.11 × height of eye; 0.37 × length of pedicel; clypeus rugulose; 1.94 × wide as high, margin sinuate with lateral corners barley protruding forwards, medial depression shallow only present anteriorly, short setae, denser and longer medially and along margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 1.62 × distance between lateral ocelli; scape 2.13 × length pedicel; 1st flagellomere 1.00 × as long as scape; 0.68 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.79 × height; propleuron length 1.22 × width; 1.00 × prototegular distance; rugose with longer shiny setae, when compared to face setae, becoming denser ventrally; pronotal process broad and rounded; pronotum reticulate, groove between pronotum lobes crenulate, dense shiny setae; mesoscutum length 1.19 × width in dorsal view; rounded in lateral view; rugose becoming strigate-rugose anterior medially, short shiny setae; admedial lines distinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum reticulate-rugulose with short scattered setae; axilla rugulose with short scattered setae; mesepisternum rugose dorso-laterally becoming areolate ventrally, short shiny setae denser ventrally; mesepimeron crenulate with shallow depressions; metapleuron areolate with long shiny dense setae; propodeum areolate with short scattered setae; medial carinae flattened.

Legs. Hind coxa reticulate, strigate-rugulose posteriorly; femur 1.49 × length of tibia; tibia length 6.79 × width; short dense setae; 1st tarsomere 3.33 × length of 2nd tarsomere; 2nd tarsomere 1.80 × length of 3rd tarsomere; 3rd tarsomere 1.70 × length of 4th tarsomere; 4th tarsomere 0.50 × length of 5th tarsomere; tarsal claw 0.58 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, slightly wider ventrally at vein 3-cu; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal quarter tubular with node, apical three quarters pigmented; hind wing vein apical half of 2m+Cu pigmented; three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Imbricate, length 2.70 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.65 × metasoma length, short appressed setae, cream apex dilated.

Male. Males specimens not examined but described by Pasteels (1957) as having less brown colouration on the pronotum, mesepisternum and 1st flagellomere shorter.

Distribution. The species is known only from a male and female specimen collected North West of the town Ross, TAS.

Biology. Unknown.

Comments *Gasteruption granulare* keys out with *G. dewitzi*. The species can be easilyseparate based on a shorter malar space (~0.37 × length of pedicel), a longer ovipositor sheath (~1.65 × metasoma length) and cream/white apex of ovipositor sheath (~2.38 × length of 1st hind tarsomere), see key couplet 25.

Gasteruption griseum Pasteels, 1957

Fig. 46.

Gasteruption griseum Pasteels, 1957: 99, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♂, "Silver Valley. NQ. 24-9-50. GB" "*Gasteruption griseum* n.sp. J. Pasteels det., 1956" (NMV: T-7432).

Specimen damage. Left and right antenna 3rd flagellomere to tip missing, metasoma dislodged and glued to main label.

Figure 44. *Gasteruption griseum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Comments. The original species description is based entirely on male specimens, and until we can associate females, we have refrained from redescribing this species.

Gasteruption inferius Pasteels, 1957

Fig. 47.

Gasteruption inferius Pasteels, 1957: 89, ♀; Jennings 2010 [on-line checklist]

Material examined.

Holotype. ♀, "Blundell's, F.C.T [A.C.T], 19-I-35, M.Fuller" "*Gasteruption inferius* n.sp. J. Pasteels det., 1954" (ANIC).

Collection locality is likely to be Blundell’s Cottage, Wendouree Drive, Parkes, ACT 2600.

Specimen damage. Both antennae pedicel to tip missing.

Paratypes. QLD: ♂, Brisbane, 18.ix.1914, H. Hacker, (QM: T5497). **TAS:** ♂, Hobart, 15.xii.1917, G. H. Hardy (SDEI).

Figure 47. *Gasteruption inferius* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* Body length 20.70 mm; ovipositor length 18.10 mm.

Colour. Mostly black; antenna scape and pedicle dark brown; malar space lighter; mandibles cream with darker apex; propleuron light brown posteriorly, pronotum ventral half of anterior and posterior lobe brown, mesepisternum brown ventrally, mesepimeron posterior margin brown, metapleuron lighter posterior margin, tegula light brown; fore and mid leg mostly brown, coxa dark brown, light brown posteriorly, trochantellus with cream apical margin, femur with cream apical margin, tibia cream, brown patch on posterior face, tarsus cream, 4th tarsomere to tip brown; hind leg mostly dark brown, femur and tibia dorsal face darker, tibia with cream band sub basally, tarsus cream, basal third 1st tarsomere, 5th tarsomere and claw dark brown; metasoma dark brown, ovipositor sheath dark brown with cream apex 0.46 × length of hind 1st tarsomere, ovipositor brown; wing hyaline, wing vein and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.89 × longer than wide, postocular space bulbous tapering sharply at the occipital carinae posteriorly, head in lateral view with a short postocular space, gently rounded frons, vertex angular; postocular space 0.31 × height of eye; eye setae absent; face reticulate-rugulose, short dense shiny setae; frons reticulate-rugulose, short scattered setae; medial frontal carina present in anterior half becoming indistinct posteriorly; vertex reticulate-rugulose with short setae; occipital carina short, lamelliform, depression shallow, rounded, gena reticulate-rugulose, short shiny setae becoming denser and longer ventro laterally, minimal width of malar space 0.06 × height of eye, Pasteels (1957) mentions malar space equalling the pedicel; clypeus reticulate-rugulose; 1.74 × wide as high; margin sinuate with lateral corners barely protruding forwards; anterior depression indistinct, short dense shiny setae, longer on anterior margin, lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.50 × distance between lateral ocelli; type specimen antenna missing.

Mesosoma. Mesosoma length 1.31 × height; propleuron length 1.08 × width; 0.72 × prototegular distance, propleuron rugulose with medium shiny dense setae, pronotal process large and rounded, pointing outwards; pronotum anterior and posterior lobes reticulate, dorsal lobe rugulose, groove between pronotum lobes carinate, short dense shiny setae, denser in groove; mesoscutum length 2.95 × width in dorsal view; rounded in lateral view; medial lobe strigate-rugulose, lateral lobe reticulate dorso-lateral, becoming strigate-rugulose, coarser striations medially posteriorly, short scattered setae, admedial lines distinct, gently converging; parapsidial lines distinct, notauli V-shaped; scrobiculate, mesoscutellum strigate-rugulose, short dense setae, axillae reticulate-rugose with short scattered setae; mesepisternum reticulate rugulose becoming areolate ventro-laterally, short dense shiny setae; mesepimeron with several fovea in ventral half, faintly carinate on dorsal margin, short setae present in ventral half and along margins; metapleuron areolate, short dense shiny setae; propodeum coarsely areolate-rugose, short shiny setae, medial carinae in dorsal view flattened.

Legs. Hind coxa strigate on posterior face, becoming reticulate rugulose laterally; femur 0.70 × length of tibia, tibia length 7.00 × tibia width; short dense setae; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.80 × length of 2nd tarsomere; 2nd tarsomere 1.20 × length of 3rd tarsomere; 3rd tarsomere 2.00 × length of 4th tarsomere; 4th tarsomere 0.40 × length of 5th tarsomere; tarsal claw 0.52 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular; vein r-m spectral, slight pigmentation on margin; vein SR1 distinctly bent; vein 2-M basal third tubular with node, remaining pigmented; hind wing vein 1-m and apical two thirds of 2m+Cu pigmented, remaining third spectral; three hamuli, distance between second and apical hamuli greater than distance between basal and middle hamuli.

Metasoma. Metasoma 2.90 × mesosoma length; hypopygium Y shape; ovipositor sheath 1.35 × metasoma length, short appressed setae, cream apex slightly dilated.

Male. Same characters as female with 1st flagellomere shorter.

Distribution. The species is known from QLD and ACT, with material examined by Pasteels (1957) from TAS.

Biology. Unknown.

Comments. The species keys out with *G. species 1* **sp. nov** and *G. cribatum* Pasteels. *Gasteruption inferius* can be separated based on a V-shaped notauli and longer mesosoma, see key couplet 43.

Gasteruption inflatum Pasteels, 1957

Fig. 48.

Gasteruption inflatum Pasteels, 1957: 66, ♀; Jennings 2010 [on-line checklist].

Material examined

Holotype. ♀, "Canberra 7 Feb18 E. F. Riek" (ANIC).

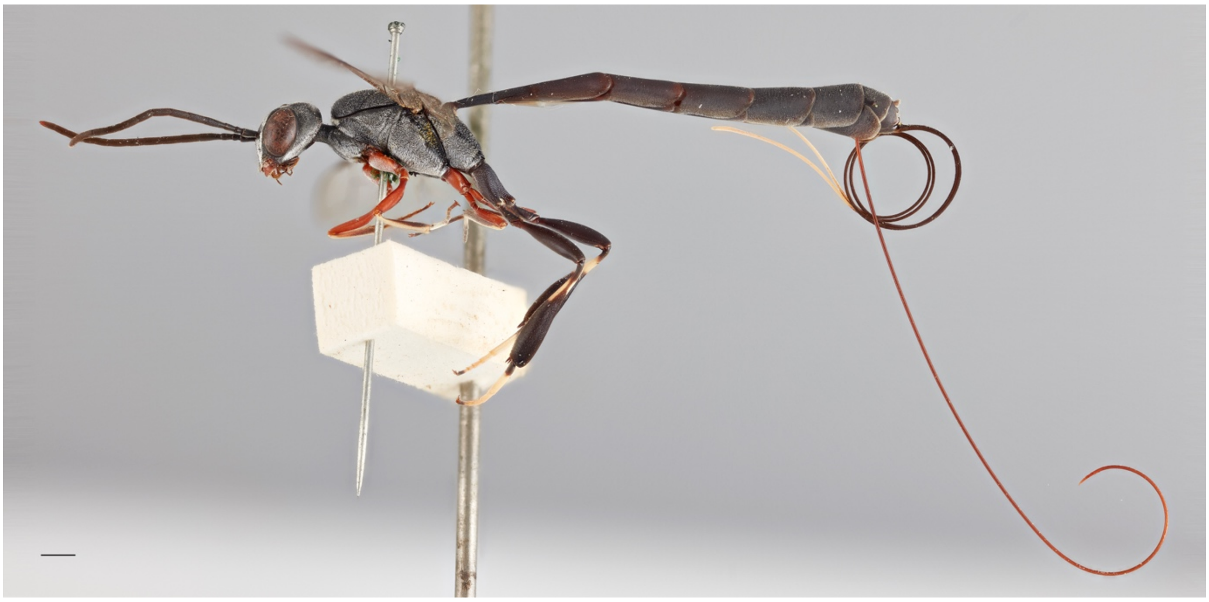

Figure 48. *Gasteruption inflatum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female. Body length* 20.20 mm; ovipositor length 21.50 mm.

Colour. Black; malar space lighter, mandibles orange-brown, tooth apex darker; tegula dark brown; fore and mid leg mostly orange-brown, trochantellus with cream apical margin, femur with cream spot on apex, tibia dark brown with cream stripe on anterior face, tarsus dark brown, cream stripe on the anterior face of 1st tarsomere, gold coloured setae; hind leg mainly black, prefemur lighter, tibia with cream patch sub basally, tarsus cream, basal quarter of 1st tarsomere, apical half of 5th tarsomere and claw dark brown, metasoma dark brown, darker apically and basally; ovipositor sheath dark brown, cream apex 3.85 × length of hind 1st tarsomere, ovipositor dark brown; wing hyaline, wing vein dark brown, pterostigma brown.

Head. Head shape rectangular when viewed dorsally; length 1.00 × width, postocular space bulbous, tapering gently posteriorly to occipital carinae; head in lateral view, medium length postocular space, frons and vertex convex; postocular space 0.51 × height of eye; eye setae absent; face reticulate, short shiny setae; frons granular-rugulose, short dense shiny setae; medial frontal carina distinct along face and frons, becoming an indistinct shallow groove posteriorly along vertex; vertex granular-reticulate around ocelli, becoming granular-strigate posteriorly, short scattered shiny setae; occipital carina short, lamelliform, depression shallow, pointed medially; gena granular-reticulate, short dense shiny setae; minimal width of malar space 0.05 × height of eye; 0.36 × length of pedicel; clypeus reticulate; 2.32 × wide as high; margin sinuate with lateral corners barely protruding forwards, medial depression indistinct anteriorly, medium dense shiny setae, longer along margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.6 × distance between lateral ocelli; scape 1.86 × length pedicel; first flagellomere 0.85 × as long as scape; 0.54 × length second flagellomere.

Mesosoma. Mesosoma length 1.82 × height; propleuron length 1.05 × width; 0.69 × prototegular distance; propleuron rugulose, medium (when compared to head) dense shiny setae; pronotal process broad rounded and pointing outwards; pronotum anterior lobe and dorsal section of the posterior lobe granular, dorsal lobe and ventral part of posterior lobe rugulose, groove between pronotum lobes broad carinate, medium dense shiny setae; mesoscutum length 1.33 × width in dorsal view; rounded in lateral view; medial and lateral lobes granular-striate, short dense setae; admedial lines distinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum granular-rugulose, short scattered shiny setae; axillae granular with short shiny setae; mesepisternum rugulose dorsally, becoming areolate ventrally, medium dense shiny setae; mesepimeron foveate; metapleuron areolate, medium dense shiny setae; propodeum areolate with convex medial carinae, groove like towards posterior margin, short dense shiny setae.

Legs. Hind coxa rugulose dorsal and laterally, becoming reticulate ventrally, striate in coxal groove; femur 0.69 × length of tibia; tibia covered in short dense setae with scattered emergent stout setae; tibia length 5.20 × tibia width; tarsus with ventro pecten of short robust spines; tarsomere 1, 2.96 × length of 2nd tarsomere; 2nd tarsomere 1.59 × length of 3rd tarsomere; 3rd tarsomere 1.70 × length of 4th tarsomere; 4th tarsomere 0.43 × length of 5th tarsomere; tarsal claw 0.57 × length of 5th tarsomere.

Wings. First discal cell rectangular, slightly wider at apically; fore vein r-m spectral; vein SR1 weakly sinuate; vein 2-M basal third tubular with node, remaining pigmented; hind wing vein 1-m and apical 2/3rds of 2m+Cu pigmented; three hamuli equidistant.

Metasoma. Metasoma 3.03 × mesosoma length; hypopygium Y shape; ovipositor sheath 1.51 × metasoma length, short appressed setae.

Male. Unknown.

Distribution. The species is known from ACT with material examined by Pasteels (1957) from QLD, VIC and WA.

Biology. Unknown

Comments. *Gasteruption inflatum* keys out with *G. simillimum* and can be separated based on a shorter scape length (1.86 × pedicel length) and shorter mesoscutum length in dorsal view (1.33 × width).

Gasteruption isthmale (Turner 1918)

Fig. 49.

Pseudofoenus isthmale Turner, 1918: 199, ♀.

Gasteruption isthmale Pasteels, 1957: 18, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "*Pseudofoenus isthmalisis* Type: Turner" "Eaglehawk Neck, S.E. Tasmania. Feb.12-Mch.3,1913. R.E.Turner. 1913–212" (BMNH: 3a.217).

Specimen damage. Left antenna 3rd flagellomere to tip missing, whole metasoma missing.

Figure 49. *Gasteruption isthmale* (Turner), holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* body length according to Pasteels (1957) 10.00 mm; ovipositor length 9.00 mm.

Colour. Head and body mostly black; malar space, mandibles and ventral margin of clypeus brown; ventro-posterior corner of propleuron, pronotum posterior lobe, ventral anterior lobe brown, mesepisternum brown dorsally with a black spot, mesepimeron and metapleuron brown ventrally, mesoscutum posterior margin and mesoscutellum posterior corners brown, tegula light brown; fore and mid leg mostly brown, trochantellus with cream apical margin, femur with cream stripe on apical third, tibia with cream longitudinal stripe on anterior face, fore leg tarsus cream with 3rd tarsomere to claw brown, mid leg tarsus 1st tarsomere and base of 2nd tarsomere cream; hind leg mostly dark brown, coxa brown, darker dorsally, prefemur lighter, tibia with cream patch subbasally on ventral face, tarsus cream, base of 1st tarsomere and 5th tarsomere to claw dark brown; metasoma missing in type specimen; wing hyaline, wing veins dark brown, pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; length 0.94 × width; postocular space long, straight, tapering at the occipital carinae; head in lateral view distinctively wedge shape, anterior of gena flattened, concave posteriorly, vertex and frons convex; postocular space 0.49 × height of eye; minimal width of malar space 0.06 × height of eye; 0.50 × length of pedicel; face reticulate-rugulose, short dense shiny setae; frons strigate-rugulose with short scattered shiny setae; medial frontal carina basal third raised, remaining indistinct; vertex strigulate-rugulose, punctures near eye margin, small smooth patch in front of anterior ocelli and side of lateral ocelli; short dense shiny setae; occipital carina narrow; depression broad, deep, pointed medially, lamelliform; gena punctate-reticulate with short dense shiny setae; clypeus punctate; 1.82 × wide as high; margin sinuate; lateral corners barely protruding forwards; medial depression absent, short dense setae, longer on margin; lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 1.25 × distance between lateral ocelli; scape 1.88 × length pedicel; 1st flagellomere 1.07 × as long as scape; 0.64 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.37 × height; propleuron length 3.61 × width; 2.37 × prototegular distance; propleuron reticulate-rugulose, coarser dorsally with medium dense shiny setae; pronotal process short and rounded; pronotum anterior lobe punctate-reticulate, dorsal lobe punctate posterior lobe rugulose becoming smooth dorsally; medium dense shiny setae, broad groove between pronotum lobes carinate, setae longer in groove; mesoscutum length 1.43 × width in dorsal view; rounded in lateral view, medial lobe strigate-rugulose, lateral lobe reticulate-rugulose, punctate-rugulose around parapsidial lines, short dense setae; admedial lines gently converging, parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla punctate-rugulose; short scattered setae; mesepisternum punctate-reticulate, becoming punctate-rugulose ventrally; medium dense shiny setae; mesepimeron carinate with some short scattered setae ventrally and towards dorsal-posterior corner; metapleuron reticulate-rugulose dorsal lobe, more rugulose ventrally, medium dense shiny setae; propodeum areolate-rugulose, medial carina flattened with medium dense shiny setae.

Legs. Hind coxa reticulate-rugulose, coarser dorsally, strigate in coxal groove; femur 0.73 × length of tibia; tibia length 5.00 × tibia width; short dense setae with scattered stout emergent spines on anterior face; short spines on ventro-apex of tibia and ventral surface of tarsus; 1st tarsomere 2.73 × length of 2nd tarsomere; 2nd tarsomere 1.47 × length of 3rd tarsomere; 3rd tarsomere 1.88 × length of 4th tarsomere; 4th tarsomere 0.57 × length of 5th tarsomere; tarsal claw 0.57 × length of 5th tarsomere.

Wings. Fore wing first discal cell open; vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma missing from type specimen.

Male. Unknown

Distribution. The species is known only from the type locality of Eaglehawk Neck, TAS.

Biology. Unknown.

Comments. The species keys out with *G. fluviale* with both having all hind wing veins spectral. The species can be easily separated based on *G. isthmale* mesosoma being brown ventrally compared to completely dark brown in *G. fluviale.*

Gasteruption jocosum Pasteels, 1957

Fig. 50.

Gasteruption jocosum Pasteels, 1957: 19, ♀; Jennings 2010 [on-line checklist].

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NMV (Fig. 48), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Material examined.

Holotype. ♀, “Cairns. NQ[LD]. 1-1-[19]53 GB.” “Collection A. N. Burns” (NMV: T-7375) [examined from photos].

Figure 50. *Gasteruption jocosum* Pasteels, holotype female, lateral habitus, scale bar = 4.00 mm.

Redescription. *Female.* Body length 9.75 mm; ovipositor length 9.56 mm.

Colour. Black; antenna dark brown, malar space and mandibles (tooth apex darker) brown, lateral occipital carina light brown; tegula light brown; for and mid legs orange-brown, longitudinal cream stripe on anterior face of tibiae, tarsus brown with cream longitudinal stripe on anterior face of 1st tarsomere; hind leg dark brown, prefemur and base of femur brown, tibia with cream patch subbasally on anterior face, tarsus cream, basal quarter of 1st tarsomere, 5th tarsomere and claw dark brown; metasoma dark brown, orange-brown patches laterally at apex of T1–T5, base and apex darker brown; ovipositor sheath dark brown with cream apex 2.41 × length of hind 1st tarsomere; wings hyaline, veins and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; postocular space almost straight, tapering to occipital carinae; head in lateral view, frons and vertex convex, gena almost straight; postocular space long; short scattered eye setae; head with fine sculpturing and short scattered setae; narrow lamelliform occipital carina, distinctly wider ventro-laterally, medium rounded depression; lateral ocelli anterior of postocular line; scape 1.48 × length pedicel; 1st flagellomere 0.91 × as long as scape; 0.41 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.77 × height; propleuron length 1.22 × prototegular distance; propleuron reticulate with short scattered setae; mesosoma with short scattered setae, pronotal process indistinct; mesoscutum length 1.23 × width in dorsal view; rounded in lateral view, reticulate-rugulose; admedial and parapsidial lines distinct; notauli incomplete, scrobiculate; mesepisternum and metapleuron areolate; mesepimeron carinate forming shallow fovea; propodeum with raised longitudinal medial carina.

Legs. Femur 0.85 × length of tibia; tibia length 3.70 × tibia width, short dense setae with scattered stout emergent spines on anterior face; 1st tarsomere 3.61 × length of 2nd tarsomere; 2nd tarsomere 1.21 × length of 3rd tarsomere; 3rd tarsomere 1.72 × length of 4th tarsomere; 4th tarsomere 0.43 × length of 5th tarsomere; tarsal claw 0.56 × length of 5th tarsomere.

Wings. Fore wing first discal cell open; vein r-m absent; vein SR1 weakly sinuate, vein 2-M basal third tubular with apical node, remainder of vein pigmented; hind wing veins not visible, at least apical half of 2m+Cu pigmented; three equidistant hamuli.

Metasoma. Metasoma 2.98 × mesosoma length; ovipositor sheath 1.50 × metasoma length.

Male. Unknown.

Distribution*.* The species is known only from the type locality of Cairns, QLD.

Biology*.* Unknown.

Comments. This species is known only from the type specimen which we have been unable to examine in detail. *Gasteruption jocosum* keys out with two other species, *G. cephalotes* and *G. curticauda*. All three have a long propleuron and sub-conical head shapes in dorsal view. *Gasteruption jocosum* can be separated by an incomplete notauli and lateral ocelli anterior of postocular line in dorsal view, see key couplet 9.

Gasteruption lampropleurum **(Kieffer, 1911)**

Fig. 51.

Gasteruption lampropleurum Kieffer, 1911: 207, ♀; Pasteels, 1957: 68, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "*Gasteruption lampropleuron* - Kieffer" "Victoria 2.7.9.07" "Australia. R.E. Turner. 1907–244" "Determined by Dr. Kieffer" (BMNH: 3.a.206).

Redescription. *Female.* body length 15.00 mm; ovipositor length 15.00 mm.

Colour. Black; malar space and tegula lighter; mandibles orange, tooth apex darker; fore and mid leg mostly orange-brown, trochantellus with cream apical margin, tibia dark brown with longitudinal cream stripe on anterior face, tarsus dark brown with cream on anterior face of 1st tarsomere; hind leg mostly dark brown, prefemur lighter, tibia with cream patch subbasally on ventral face, tarsus cream with base of 1st tarsomere and 5th tarsomere to claw dark brown; metasoma lighter laterally on segments T2-T4; ovipositor sheath dark brown with cream apex 2.36 × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing veins and pterostigma brown.

Figure 51. *Gasteruption lampropleurum* Kieffer, holotype female, lateral habitus, scale bar = 1.00 mm.

Head. Head shape sub-rectangular when viewed dorsally; length 0.92 × width, postocular space bulbous, tapering sharply at occipital carinae; head in lateral view, front of face rounded, postocular space long, 0.51 × height of eye; short scattered eye setae, face reticulate-rugulose with short dense shiny setae; frons reticulate-rugulose around antennal scrobes, remaining granular, short scattered shiny setae, denser on eye margin; medial frontal carina present in anterior half, becoming indistinct flattened line remaining; vertex granular, reticulate-rugulose on eye margin, scattered shallow punctures on posterior margin medially, short scattered shiny setae; occipital carina short, lamelliform, depression shallow, pointed medially; gena granular, reticulate near eye margin, short dense shiny setae; minimal width of malar space 0.04 × height of eye; 0.20 × length of pedicel; clypeus reticulate-rugulose, scattered punctures medially; 2.33 × wide as high; margin sinuate with lateral corners distinctly protruding forwards; medial depression present anteriorly, short dense shiny setae, longer on margin; lateral ocelli in line with postocular line; distance from lateral ocellus to eye margin 0.67 × distance between lateral ocelli; scape 1.10 × length pedicel; 1st flagellomere 1.36 × as long as scape; 0.60 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.91 × height; propleuron length 3.90 × width; 2.73 × prototegular distance; propleuron rugose dorsally, becoming rugulose laterally, medium dense shiny setae; pronotal process blunt, hook like; pronotum dorsal lobe and dorsal corner of posterior lobe granular, anterior lobe rugose, becoming carinae ventrally, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.14 × width in dorsal view; rounded in lateral view, granular with coarser fovea on posterior margin, short scattered shiny setae; admedial lines straight; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular with short scattered setae; mesepisternum dorsally granular-rugose, ventrally course areolate-rugose, medium dense shiny setae; mesepimeron carinate; metapleuron areolate-rugose with medium dense shiny setae; propodeum areolate-rugose with transverse carinae, short dense setae.

Legs. Hind coxa strigate in coxal groove, strigate-rugulose dorsally, laterally rugulose; femur 0.72 × length of tibia; tibia length 4.47 × width of tibia; short dense setae with scattered stout spines on anterior face, dense spines ventro-apically; tarsus with short robust spines along ventral surface; 1st tarsomere 3.06 × length of 2nd tarsomere; 2nd tarsomere 1.38 × length of 3rd tarsomere; 3rd tarsomere 1.86 × length of 4th tarsomere; 4th tarsomere 0.37 × length of 5th tarsomere; tarsal claw 0.63 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider ventrally at junction of 3-cu; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular, remaining 2/3 pigmented; hind wing vein apical half of 2m+Cu and 1-m pigmented, three equidistant hamuli.

Metasoma. Imbricate, length 2.50 × mesosoma length; hypopygium Y-shaped; ovipositor length (used as an approximate proxy for ovipositor sheath length) 1.49 × metasoma length. Pasteels (1957) mentioned the apex of the ovipositor sheath flared.

Male. Unknown.

Distribution. The species is only known from the type locality of VIC without further designation.

Biology. Unknown.

Comment. Pasteels (1957) mentioned this species head is very similar to *G. malaicum* but with a shorter malar space. He describes the mesosoma and the antennae as identical to *G. angulare*. This species keys out with *G. atrinerve* and *G. terminale* based on the Length of the cream/white ovipositor sheath apex < 3.00 × length of 1st hind tarsomere and 1st flagellomere length > 1.00 × length of scape. It can be separated based on the malar space length 0.20 × height of eye and propleuron length 2.73 × prototegular distance.

Gasteruption leptothecus Kieffer, 1911

Fig. 52.

Figure 52. *Gasteruption leptothecus* Pasteels, lateral habitus, scale bar = 1.00 mm.

Gasteruption leptothecus Kieffer, 1911: 198, ♀; Kieffer, 1912: 323, ♀; Pasteels, 1957: 95, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, [no locality] "*Gasteruption leptothecus* Kieffer" "5/53" "Determined by Dr. Kieffer" (BMNH: 3.a.199).

Specimen damage. Left antenna, 3rd flagellomere to tip and complete right antenna, left mid leg tibia to tip and both hind tibiae missing.

Other material examined. **ACT:** 1♀, Blundell's Cottage, 28.ii.1952, H.M. Cane (ANIC)*.

Redescription. *Female*. Body length 13.10 mm, ovipositor length 16.30 mm.

Colour. Black; antenna, mandibles dark brown, darker tooth apex, tegula brown; fore and mid leg mostly brown, tibia with cream stripe on anterior face, tarsus cream with 4th, 5th tarsomere and claw dark brown; hind leg coxa brown, darker dorsally and posteriorly; trochantellus dark brown, cream on apical margin inner face; prefemur and femur brown, with groove darker; tibia dark brown, large cream patch sub basally; tarsus mostly cream, darker towards tip; metasoma dark brown, T2-T4 lighter laterally; ovipositor sheath dark brown with long cream apex 3.13 × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing veins brown and pterostigma darker.

Head. Head shape sub-rectangular when viewed dorsally; 0.90 (0.89–0.91) × longer than wide, postocular space bulbous, head in lateral view, face rounded, postocular space short; 0.31 (0.29–0.34) × height of eye; short indistinct eye setae; face reticulate-rugulose with short dense shiny setae; frons rugulose with short setae, shiny along eye margin and medially; medial frontal carina indistinct in anterior third; vertex reticulate-rugulose around ocelli, strigate-rugulose posteriorly, short setae; occipital carina short, longer ventro-laterally, lamelliform, depression medium, broad and rounded; gena reticulate-rugulose with short dense shiny setae; minimal width of malar space 0.03 (0.03–0.04) × height of eye; 0.24 (0.15–0.33) × length of pedicel; clypeus punctate; 1.89 (1.83–1.96) × wide as high; margin sinuate with lateral corners distinctly protruding forwards, medial depression present anteriorly, short dense shiny setae, longer on margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.64 (0.62–0.67) × distance between lateral ocelli; scape 1.94 (1.63–2.25) × length pedicel; 1st flagellomere 1.18 (1.08–1.28) × as long as scape; 0.58 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.13 (2.10–2.15) × height; propleuron length 1.43 (1.39–1.47) × width; 0.91 (0.86–0.96) × prototegular distance; rugulose dorsally, becoming reticulate-rugulose laterally, medium dense shiny setae; pronotal process short and acute; pronotum anterior lobe strigate, dorsal lobe punctate, posterior lobe rugulose, groove between pronotum lobes carinae, short dense shiny setae, denser in groove; mesoscutum length 1.47 × width in dorsal view; rounded in lateral view; reticulate-rugulose with short scattered setae; admedial lines converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate-rugulose with short dense setae; mesepisternum dorsal lobe, punctate-rugulose, lower portion areolate-rugulose, short dense shiny setae; mesepimeron carinate in lower half creating fovea, smooth upper portion; metapleuron rugulose with short dense shiny setae; propodeum areolate-rugulose, coarser towards medial carinae, medial carinae flattened, short dense setae.

Legs. Coxa strigate dorsally, reticulate-rugulose laterally; femur 1.47 × length of tibia; tibia length 4.21 × width; short dense setae with scattered short stout emergent spines; 1st tarsomere 3.08 × length of 2nd tarsomere; 2nd tarsomere 1.47 × length of 3rd tarsomere; 3rd tarsomere 1.89 × length of 4th tarsomere; 4th tarsomere 0.47 × length of 5th tarsomere; tarsal claw 1.00 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular tapering towards apex; vein r-m absent; vein SR1 weakly bent, vein 2-M basal third tubular with node, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Imbricate, length 3.22 × mesosoma length; hypopygium distinctive broad Y-shaped; ovipositor sheath 1.66 × metasoma length, short appressed setae.

Distribution. The species is known from the ACT with additional material examined by Pasteels (1957) from TAS.

Biology. Unknown.

Comments. *Gasteruption leptothecus* keys out with *G. fibuliforme*. The malar space and femur length are longer in *G. leptothecus*. This species has distinctly long hind legs.

Gasteruption leucopus (Schletterer, 1980)

Fig. 53.

Gasteruption anale Kieffer, 1911: 212, ♂ (syn. Pasteels, 1957).

Gasteruption leucopus Schletterer, 1890: 450, ♀; Pasteels, 1957: 99, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Victoria" (ZMBD).

Paratype. NSW: ?, Sydney (SDEI).

Figure 53. *Gasteruption leucopus* Schletterer, holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* Body length 20.00 mm; ovipositor length 20.00 mm.

Colour. Black with reddish-brown; head black except for dark brown antenna, reddish-brown malar space and mandibles (tooth apex darker); mesosoma mostly black, ventral corner of pronotum, anteriorly and medially of mesepisternum, posterior margin of mesepimeron, ventral margin of metapleuron, patch laterally anterior of notauli, posteriorly between notauli and posterior margin, lateral margin reddish-brown; metasoma black; ovipositor sheath dark brown with cream apex; wings hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; length 1.01 × width, postocular space sub-rectangular; head in lateral view, flattened with long face, face and frons convex, postocular space 0.40 × height of eye; eye setae absent; head reticulate-rugulose with medium dense shiny setae on face, frons and gena, becoming short and scattered on vertex; medial frontal carina distinctly raised, becoming a shallow groove anteriorly; narrow but distinct lamelliform occipital carina; shallow rounded depression; minimal width of malar space 0.10 × height of eye, 0.83 × length of pedicel; clypeus punctate, 1.70 × wide as high; margin sinuate; lateral corners distinctly protruding forwards; medial depression indistinct; short dense setae, longer on margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.36 × distance between lateral ocelli; scape 2.17 × length pedicel, 1st flagellomere 1.00 × as long as scape, 0.58 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.16 × height; propleuron length 1.29 × width; 0.78 × prototegular distance; propleuron reticulate-rugulose with medium dense shiny setae; pronotal process large and acute; pronotum anterior lobe areolate-rugulose, dorsal and posterior lobes granular-rugulose, broad groove between pronotum lobes carinate, medium dense setae; mesoscutum length 1.36 × width in dorsal view; truncated in lateral view; strigate-rugulose, short scattered setae; admedial lines slightly converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum strigate-rugulose, axilla reticulate-rugulose; short scattered setae; mesepisternum dorsally areolate-rugulose, becoming strigate-areolate, medium dense shiny setae; mesepimeron transverse carinate forming shallow fovea in ventral two thirds, dorsally becoming more rugose; metapleuron granular-areolate, medium dense shiny setae; propodeum areolate-rugulose, longitudinal medial carinae raised, short dense shiny setae.

Legs. Hind coxa dorsally strigate, reticulate-rugulose laterally and ventrally; femur 0.72 × length of tibia; tibia length 6.83 × tibia width; short dense setae with short scattered emergent spines on anterior face; 1st tarsomere 3.27 × length of 2nd

tarsomere; 2nd tarsomere 1.37 × length of 3rd tarsomere; 3rd tarsomere 1.85 × length of 4th tarsomere; 4th tarsomere 0.40 × length of 5th tarsomere; tarsal claw 0.59 × length of 5th tarsomere.

Wings. Fore wing first discal cell, widening apically; vein r-m absent; SR1 distinctly bent; 2-M basal third tubular, remaining pigmented; 2-M present; node vein 2-M basal third. Hind wing vein apical half of 2m+Cu and 1-m pigmented, remaining spectral; four equidistant hamuli.

Metasoma. Metasoma length 2.58 (2.50–2.67) × mesosoma length; hypopygium Y shape; tip flared slightly.

Male. Male specimens not examined, described by Pasteels (1957) as having a longer malar space.

Biology. Unknown.

Comment. This species keys out with *G. calothecus* based on the presence of cream/ white on the hind tibia, red colouration on the anterior corners of the mesonotum and clepeal margin sinuate. The species are easily separated as *G. leucopus* has a shorter ovipositor sheath (< 3.00 × metasoma length), cream/white apex (<10.00 × length of 1st hind tarsomere) and more extensive red coluration on the lateral mesosoma, see key couplet 91.

Gasteruption leucostictum Kieffer, 1911

Fig. 54.

Gasteruption leucostictum Kieffer, 1911: 207, ♀; Pasteels, 1957: 42, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "*Gasteruption leucostictum* Kieff." "Mackay [QLD] 5.00" "Australia. R.E.Turner. 1907–244." (BMNH: 3.a.186).

Specimen damage. Right fore leg 2nd tarsomere to tip missing.

Paratype. WA: 1♂, Perth, R.E. Turner (BMNH).

Redescription. *Female.* body length 13.00 mm; ovipositor length 16.00 mm.

Colour. Black; antenna dark brown, malar space lighter, mandibles dark brown with darker tooth apex, tegula brown; fore and mid leg mostly brown, coxa darker, trochantellus with cream apical margin, femur with cream patch apically, tibia with cream stripe on anterior face, tarsus cream, 5th tarsomere and claw dark brown; hind leg mostly dark brown, prefemur and femur brown, tibia darker dorsally with cream patch sub basally on posterior face, tarsus cream with base of 1st tarsomere, 5th tarsomere and claw brown; metasoma dark brown lateral T3-T4; ovipositor sheath dark brown with cream apex 2.90 × length of hind 1st tarsomere; ovipositor brown; wing hyaline; wing vein and pterostigma brown.

Figure 54. *Gasteruption leucostictum* Kieffer, holotype female, lateral habitus, scale bar = 1.00 mm.

Head. Head shape rectangular when viewed dorsally; length 1.07 × width, postocular space gently tapering in dorsal view; head in lateral view, frons and vertex angular; postocular space 0.36 × height of eye; face and frons punctate-reticulate with short dense shiny setae; medial frontal carina absent; vertex punctate-reticulate around ocelli, becoming strigate-reticulate posteriorly, short setae; occipital carina narrow, lamelliform, depression deep and rounded gena reticulate-rugulose with short dense shiny setae; minimal width of malar space 0.03 × height of eye; 0.20 × length of pedicel; clypeus punctate-reticulate; 2.35 × wide as high; margin sinuate with lateral corners distinctly protruding forwards; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.53 × distance between lateral ocelli; scape 1.70 × length pedicel; 1st flagellomere 1.06 × as long as scape; 0.72 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.48 × height; propleuron length 1.60 × width; 0.93 × prototegular distance; propleuron rugulose dorsally, becoming reticulate-rugulose, medium dense shiny setae; pronotal process short and rounded; pronotum dorsal and posterior lobe punctate-rugulose, anterior lobe coarser with smooth patch on anterior margin, groove between pronotum lobes carinate, medium dense shiny setae, longer in groove; mesoscutum length 2.76 × width in dorsal view; rounded in lateral view; medial lobe reticulate-rugulose; lateral lobe reticulate-rugulose medially, punctulate-rugulose laterally, short scattered setae; admedial lines gently converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla punctate-rugulose with short scattered setae; mesepisternum punctate-rugulose, areolate-rugulose medio-laterally-posteriorly, medium dense shiny setae; mesepimeron carinate, creating fovea with smooth patch dorsally; metapleuron areolate-rugulose, coarser in posterior lobe; medium dense shiny setae; propodeum areolate-rugulose with flattened medial carinae, medium dense setae;

Legs. Hind coxa rugulose dorsally, strigate in coxal groove, becoming reticulated ventrally; femur length 0.70 × tibia length; tibia length 4.81 × width; short dense setae with scattered emergent setae on anterior face; 1st tarsomere 3.44 × length of 2nd tarsomere; 2nd tarsomere 1.50 × length of 3rd tarsomere; 3rd tarsomere 2.00 × length of 4th tarsomere; 4th tarsomere 0.50 × length of 5th tarsomere; tarsal claw 0.67 × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated, pointed apex: fore wing vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular, remaining pigmented; hind wing vein spectral; three equidistant hamuli.

Metasoma. Imbricate, length 2.76 × mesosoma length; hypopygium Y-shaped; short appressed setae.

Male. Same characters as female.

Distribution. The species is known from QLD and WA, Pasteels (1957) examined material from NSW.

Biology. Unknown.

Comment. This species is characterised by an elongated thorax **(**length 2.48 × height), enlarged tibia (length 4.81 × width) and a flattened head with a short postocular space (0.36 × height of eye). The species keys out with *G. quadraticeps* but can be separated based on 1st flagellomere length 1.06 × length of scape and the length of cream/white apex of ovipositor sheath 2.90 × length of 1st hind tarsomere.

Gasteruption lineatum **Pasteels, 1957**

Fig. 55.

Gasteruption lineatum Pasteels, 1957: 90, ♀, ♂; Jennings 2010 [on-line checklist].

Figure 55. *Gasteruption lineatum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Material examined.

Holotype. ♀, "S.W.Australia. Yallingup. 1–12.Dec.1913. R.E.Turner. 1914–190" "*Gasteruption lineatum* n.sp. J. Pasteels det., 1954" (BMNH: 3a.362).

Specimen damage. Complete right hind leg missing.

Redescription. *Female*. body length 18.00 mm; ovipositor length 19.00 mm.

Colour. Black; antenna and mandible dark brown; ventral corner and posterior margin of pronotum, patch medially on mesepisternum reddish-brown; for and mid legs dark brown, apex of femora and longitudinal stripe on anterior face cream, tarsus cream with 5th tarsomere and claw dark brown; hind leg dark brown, large cream band subbasally, tarsus cream with base of 1st tarsomere and claw ark brown; metasoma dark brown, apically and basally black; ovipositor sheath dark brown, cream apex 2.24 × length of hind 1st tarsomere; wings hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.87 × width, postocular space bulbous in dorsal view; head in lateral view gently rounded face and vertex, postocular space 0.36 × height of eye; face reticulate-rugulose with short dense shiny setae, denser on eye margin and medially; frons reticulate-rugulose with short setae; medial frontal carina raised in anterior half, remaining present as a shallow groove; vertex reticulate-rugulose, strigate-rugulose posteriorly, small raised bulge behind ocelli, short scattered setae; narrow lamelliform occipital carina, wider ventro-laterally, deep, broad depression, medially emarginate; gena reticulate-rugulose with short dense shiny setae; minimal width of malar space 0.36 × height of eye; 0.10 × length of pedicel; clypeus punctate-rugulose; 1.97 × wide as high; margin sinuate with lateral corners distinctly protruding forwards, medial depression present anteriorly, medium shiny setae, longer on margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.52 × distance between lateral ocelli; scape 2.00 × length pedicel; 1st flagellomere 1.00 × as long as scape; 0.54 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.88 × height; propleuron length 1.15 × width; 0.79 × prototegular distance; propleuron rugulose, coarser dorsally, medium dense shiny setae; pronotal process large, truncated; pronotum rugulose, coarser anteriorly, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.09 × width in dorsal view; rounded in lateral view; reticulate-rugulose, scrobiculate groove medially between notauli and posterior margin, carinae on posterior margin, short scattered setae; admedial lines gently converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla punctate-rugulose with short scattered setae; mesepisternum rugulose becoming coarser ventrally, medium dense shiny setae; mesepimeron scrobiculate, dorsally and posterior margin smooth; metapleuron areolate-rugulose dorsal lobe, coarser posterior lobe, medium dense shiny setae; propodeum areolate-rugulose, medial carinae flattened, medium dense setae.

Legs. Hind coxa reticulate-rugulose, strigate dorsally and in coxal groove; femur 0.76 × length of tibia; tibia length of tibia 4.67 × width; short dense setae with scattered emergent stout setae on anterior face and ventro-apical pecten of short robust spines; tarsus with stout spines on anterior face and apically; 1^{st} tarsomere 3.06 × length of 2^{nd} tarsomere; 2^{nd} tarsomere 1.20 × length of 3^{rd} tarsomere; 3^{rd} tarsomere 2.50 × length of 4^{th} tarsomere; 4^{th} tarsomere 0.40 × length of 5^{th} tarsomere; tarsal claw 0.60 × length of 5^{th} tarsomere.

Wings. Fore wing first discal cell elongated, gently rounded dorsally, wider at junction of 3-cu; fore wing vein r-m indistinct spectral, vein SR1 distinctly bent; vein 2-M basal third tubular, remaining pigmented; hind wing vein apical 2/3rds 2m+Cu pigmented, and 1-m tubular, four equidistant hamuli.

Metasoma. Metasoma 2.84 × mesosoma length; hypopygium V-shaped; ovipositor sheath 1.44 × metasoma length; short appressed setae, cream apex flared.

Male. Not examined but according to Pasteels' (1957) description, same as the female with 1^{st} flagellomere the same length as the pedicel.

Distribution. Only known from the type locality in WA.

Biology. Unknown.

Comments. The species is superficially similar to *G. primotarsale* but can be distinguished based on the presence of two discal cells in the fore wing and 1st flagellomere longer, discal cell open and 1st flagellomere shorter in *G. primotarsale.*

Gasteruption longicolle Schletterer, 1889

Fig. 56.

Gasteruption longicolle Schletterer, 1890: 446, ♂; Pasteels, 1957: 29, ♂,♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, “Sidney Neusüdwales” “*longicolle* det. Schlett. (NMV) [examined from photos].

Other material examined. **QLD:** 5♀, Mt Williams Nation Park, 40º52’S, 148º10’E, 21.i.1992, G. & A. Daniels (QM). **TAS:** ♀, Mount Weld, 43.0321S, 146.7006E, 27.ii.2001, R. Bashford (TMAG); 4♀, 6♂ Warra, Malaise trap, date range i.2001–iv.2005, R. Bashford (TMAG: FT6703, FT6958, FT28956, FT28965, FT30576, FT35148, FT35149, FT35417). **SA:** ♀, S coast road, Kangaroo Island, 35º57’43.07S, 135º48’36’.00E, 10.i.2017, B.A. Parslow, swept on *Eycalyptus* blossums (BPC)*.

Redescription. *Female*. Body length 15.80 (15.10–16.30) mm; ovipositor length 16.77 (16.50–17.00) mm.

Colour. Reddish-brown, head black, antenna dark brown, malar space reddish-brown, clypeus margin and mandible (darker tooth apex) orange-brown; dorsal propleuron, posterior lobe of propleuron, ventral mesepisternum, dorsal corner of metapleuron, large patches dorsally and posteriorly on propodeum, medially and around parapsidial lines on mesonotum , mesoscutellum and axilla black, tegula light brown; for and mid legs mostly dark brown, coxae orange-brown with dark brown patch on anterior face, longitudinal cream stripe on anterior face on tibiae and apical half of femora, tibia brown, tarsus cream with 5th tarsomere and claw dark brown; hind leg reddish-brown, darker brown dorsally on coxa, trochantellus and apically on femur, tibia dark brown with cream band subbasally, tarsus cream with 1st tarsomere base and claw dark brown; metasoma reddish-brown laterally, black dorsally; ovipositor dark brown with cream apex 3.15 (2.45–3.68) × length of hind 1st tarsomere; wing hyaline, wing veins and pterostigma dark brown.

Figure 56. *Gasteruption longicolle* Schletterer, lateral habitus, scale bar = 1.00 mm.

Head. Head shape sub-conical when viewed dorsally; 0.95 (0.93–1.00) × longer than wide; postocular space tapering straight behind eyes and late before occipital carinae; head in lateral view, frons an vertex convex, gena ventro-posteriorly slightly concave; postocular space 0.35 (0.32–0.41) × height of eye; eye setae absent; face punctate with medium dense shiny setae; frons and vertex transverse strigate-rugulose, short scattered setae; medial frontal carina indistinctly raised between antennal scrobes, absent posteriorly; narrow lamelliform occipital carina, wider ventro-laterally, shallow depression, faintly emergent medially; gena punctate with medium dense shiny setae; minimal width of malar space 0.04 (0.04–0.05) × height of eye; 0.30 (0.29–0.33) × length of pedicel; clypeus punctate; 2.02 (1.81–2.15) × wide as high, margin sinuate, lateral corners barely protruding forwards, medial depression absent, medium dense setae, longer along margin; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 1.09 (1.00–1.18) × distance between lateral ocelli; scape 1.66 (1.54–1.80)× length pedicel; 1^{st} flagellomere 1.24 (1.16–1.29) × as long as scape; 0.68 (0.67–0.69) × length 2^{nd} flagellomere.

Mesosoma. Mesosoma length 2.08 (2.00–2.13) × height; propleuron length 2.37 (2.29–2.43) × width; 1.48 (1.43–1.56) × prototegular distance; propleuron rugulose dorsally becoming reticulate laterally, short scattered shiny setae; pronotal process large and rounded; pronotum anterior and posterior lobe rugulose-reticulate, dorsal lobe granular; groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.28 (1.21–1.36) × width in dorsal view; rounded in lateral view, strigate-rugulose, posterior of notauli coarsely rugose, reticulate around parapsidial lines, short scattered setae; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate-rugulose with short scattered setae; mesepisternum granulate dorsal half, ventrally areolate with transverse striation, medium dense shiny setae; mesepimeron shallow foveate, with glabrous patch dorso-anteriorly; metapleuron areolate-rugulose with medium dense shiny setae; propodeum areolate-rugulose with medium dense shiny setae, longitudinal medial carina flattened and glabrous.

Legs. Hind coxa dorsally strigate-rugulose, striations in coxal groove, ventrally imbricate; femur 0.68 (0.66–0.69) × length of tibia; tibia length 6.54 (6.27–6.89) × tibia width, short setae with scattered stout emergent spines on anterior face; 1^{st} tarsomere 3.11 (3.05–3.20) × length of 2^{nd} tarsomere; 2^{nd} tarsomere 1.51 (1.47–1.57) × length of 3^{rd} tarsomere; 3^{rd} tarsomere 2.09 (1.89–2.45) × length of 4^{th} tarsomere; 4^{th} tarsomere 0.52 (0.41–0.58) × length of 5^{th} tarsomere; tarsal claw 0.57 (0.52–0.62) × length of 5^{th} tarsomere.

Wings. Fore wing first discal cell rectangular, vein 2-Cu convex; vein r-m absent; vein SR1 almost straight, vein 2-M basal third tubular with apical node, remainder of vein pigmented; hind wing veins apical two thirds of 2m+Cu and 1-m pigmented, other veins spectral, three equidistant hamuli.

Metasoma. Metasoma 3.36 (3.18–3.48) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.40 (1.03–1.58) × metasoma length, short appressed setae.

Male. Same characters as female, less reddish-brown on mesonotum.

Distribution. The species is known from QLD, NSW and SA. Pasteels (1957) examined material from VIC.

Biology. Unknown.

Comments. *Gasteruption longicolle* can be distinguished from other species based on the body being mostly reddish-brown and having a long propleuron and long cylindrical hind tibia.

Gasteruption longipes Pasteels, 1957

Fig. 57.

Gasteruption longipes Pasteels, 1957, 36, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "G. H. Hardy Dunally [TAS] 21.2.18 /6" "*Gasteruption longipes* n. sp. J Pasteels det., 1954" (SDEI).

Specimen damage. Left antenna, 8th flagellomere to tip missing.

Paratypes. TAS: 1♀, 1♂, Dunally, 24.ii.1918, 9.xii.1918, G. H. Hardy (SDEI)*.

Figure 57. *Gasteruption longipes* Pasteels, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* body length 13.00 mm; ovipositor length 13.00 mm.

Colour. Dark brown; antenna lighter basally, mandibles brown; pronotum light brown on anterior and posterior margin, mesepisternum light brown, dark brown dorso-posteriorly; mesepimeron ventral half light brown, metapleuron light brown, with dorsal lobe darker, tegula light brown; fore leg brown, coxa darker, femur with cream longitudinal stripe on apical two thirds of anterior face, tibia with cream longitudinal stripe on anterior face, tarsus cream, 4th tarsomere to claw brown; mid leg coxa brown, prefemur lighter, tibia with cream stripe on anterior face, 1st tarsomere cream with apex brown; hind leg brown, tibia with cream patch subbasally on ventral face, tarsus cream, base of 1st tarsomere, 5th tarsomere and claw brown; metasoma dark brown, lighter laterally T2-T4; ovipositor sheath dark brown with cream apex 3.39 (3.33–3.44) × length of hind 1st tarsomere; ovipositor brown, wing hyaline, wing veins and pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; length 1.09 (1.07–1.11) × width; postocular space almost straight tapering behind eyes; head in lateral view flattened, face to vertex gently curved; postocular space 0.37 (0.36–0.39) × height of eye; face reticulate with short dense shiny setae, denser on eye margins and medially; frons strigate-rugulose with short scattered setae; medial frontal carina present in anterior third, absent remaining; vertex strigate-rugulose becoming strigate between ocelli, short scattered setae; occipital carina short, lamelliform, shallow depression rounded; gena strigate-rugulose, reticulate-rugulose along eye margin, short dense shiny setae; minimal width of malar space 0.02 (0.01–0.03) × height of eye; 0.20 × length of pedicel; clypeus punctate, 2.23 (2.06–2.40) × wide as high, margin sinuate with lateral corners barely protruding forwards, depression present only anteriorly, short dense setae, longer on margin; lateral ocelli posterior of postocular line, distance from lateral ocellus to eye margin 0.96 (0.86–1.05) × distance between lateral ocelli; scape 1.40 × length pedicel; 1st flagellomere 1.36 × as long as scape; 0.70 × length 2nd flagellomere.

Mesosoma. Mesosoma length 3.20 (3.15–3.24) × height; propleuron length 2.20 (2.10–2.30) × width; 1.20 × prototegular distance; propleuron strigate-rugulose anteriorly becoming reticulate-rugulose posteriorly, short dense setae; pronotal process acute but stout appearance; pronotum dorsal and posterior lobe reticulate-rugulose with anterior lobe reticulate-rugulose dorsally becoming strigate ventrally, groove between pronotum lobes carinate, medium dense setae, longer in groove; mesoscutum length 1.45 (1.41–1.49) × width; rounded in lateral view; medial lobe anterior-medially strigate-rugulose, remaining reticulate-rugulose; lateral lobe reticulate-rugulose, tending punctate-reticulate near parapsidial lines and medially, short scattered setae; admedial lines long, gently converging, parapsidial lines distinct; notauli U-shape, scrobiculate; mesoscutellum and axilla punctate-reticulate with short dense setae; mesepisternum reticulate-rugulose with medium dense shiny setae; mesepimeron carinate forming foveae; metapleuron dorsally areolate-rugulose, becoming areolate, medium dense shiny setae; propodeum areolate-rugulose dorsally, becoming areolate-strigate, medial carinae flattened, short dense setae;

Legs. Hind coxa strigate-rugulose dorsally, strigate in coxal groove, becoming reticulate-rugulose laterally; femur 0.68 (0.67–0.68) × length of tibia; tibia length 6.07 (6.06–6.07) × tibia width; short dense setae with scattered short stout emergent spines on anterior face; tarsus with short stout spine on ventral face; 1^{st} tarsomere 2.67 (2.63–2.70) × length of 2^{nd} tarsomere; 2^{nd} tarsomere 1.56 (1.54–1.58) × length of 3^{rd} tarsomere; 3^{rd} tarsomere 2.08 (2.00–2.17) × length of 4^{th} tarsomere; 4^{th} tarsomere 0.52 (0.50–0.55) × length of 5^{th} tarsomere; tarsal claw 0.44 (0.42–0.45) × length of 5^{th} tarsomere.

Wings. Fore wing first discal cell elongated and thin, wider subapically; vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. 3.20 (3.15–3.24) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.47 × metasoma length; covered in short appressed setae, cream apex slightly flared;

Male. Mesosoma tend to be darker, with the mesepisternum dark brown with light brown on the anterior margin, Pasteels (1957) remarked there is variation in the darkness of the males.

Distribution. The species has been recorded from TAS with material examined by Pasteels (1957) from NSW and VIC.

Biology. Unknown.

Comment. This species is superficially similar to *G. elegans, and G. longicolle*, which all have short postocular spaces (0.33–0.37 × height of eye), long propleurons (>2.00 × width) and long ovipositor sheaths (1.28–1.58 × metasoma length). *Gasteruption longipes* can be distinguished based on a longer mesosoma (3.20 × height) and a shorter 1st hind tarsomere (2.63–2.70 × length 2nd hind tarsomere)

Gasteruption longipleurale Pasteels, 1957

Fig. 58.

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NMV (Fig. 56), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Gasteruption longipleurale, Pasteels, 1957: 116, ♀; Jennings 2010 [on-line checklist].

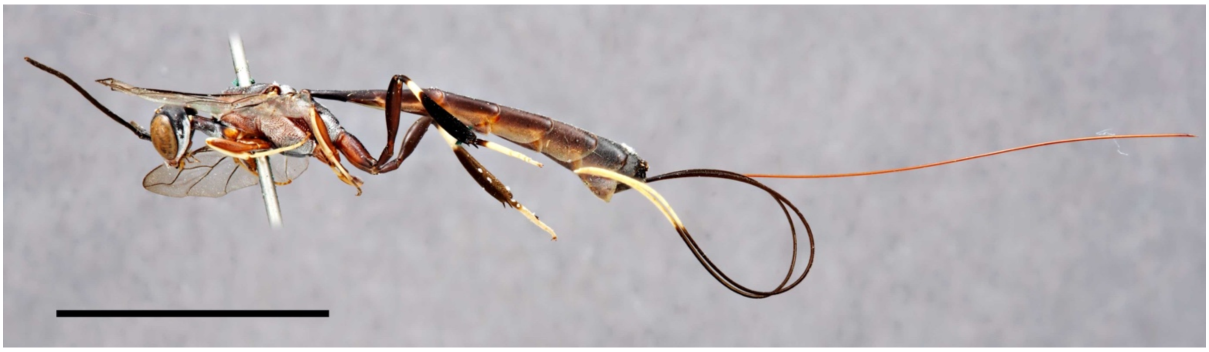

Figure 58. *Gasteruption longipleurale* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Material examined.

Holotype. ♀, “Wardell, NSW. 10 Jan. 1933. A. N. Burns” “Collection A. N. Burns” (NMV: T-7454) [examined from photos].

Redescription. *Female.* Body length 19.00 mm; ovipositor length 21.60 mm.

Colour. Head black, body mostly reddish-brown; malar space brown, mandibles cream with dark apex; propleuron dark brown, lighter posteriorly, mesosoma with black patches on posterior lobe of pronotum, latero-ventral mesepisternum, metapleuron and propodeum, medially and on lateral lobes of mesoscutum; fore and mid leg mostly red-brown with cream spot on femur apex and longitudinal stripe on anterior face, tarsus cream, tarsomere 5 and claw brown; hind leg mostly dark brown, coxa red-brown, darker dorsally, tibia darker with cream band sub basally, tarsus cream with base of tarsomere 1 dark brown; wings hyaline, wing veins and pterostigma dark brown; metasoma dark brown, base and apex black; ovipositor dark brown with cream apex 1.64 × length of hind basitarsus.

Head. Head shape trapezoid when viewed dorsally; postocular space tapering sharply to occipital carina; head in lateral view frons and vertex rounded; postocular space 0.35 × height of eye; vertex with short scattered shiny setae; occipital carina medium width, lamelliform, depression shallow and medially emarginated; gena with short dense shiny setae; minimal width of malar space 0.06 × height of eye; 0.50 × length of pedicel; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 1.50 × distance between lateral ocelli; scape 2.50 × length pedicel; 1st flagellomere 1.00 × as long as scape; 0.71 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.64 × height; propleuron length 1.00 × prototegular distance; propleuron with short dense shiny setae, pronotal process short; mesoscutum length 1.10 × width in dorsal view; rounded in lateral view; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesosoma with short dense shiny setae, mesepimeron with no setae; propodeum with indistinct medial carina.

Legs. Femur 0.80 × length of tibia; tibia length 5.9 × tibia width; 1st tarsomere 4.67 × length of 2nd tarsomere; 2nd tarsomere 1.50 × length of 3rd tarsomere; 3rd tarsomere 1.00 × length of 4th tarsomere; 4th tarsomere 0.50 × length of 5th tarsomere; tarsal claw 0.50 × length of 5th tarsomere.

Wings. First discal cell rectangular, wider at junction of 2-Cu and 1m-cu; forewing vein r-m absent; vein SR1 weakly sinuate, vein 2-M basal quarter tubular with apical node, remaining pigmented; hind wing veins 1-m and 2m+Cu pigmented.

Metasoma. Metasoma 2.64 × mesosoma length; ovipositor sheath 164 × metasoma length.

Male. Unknown.

Distribution. The species is known from the type locality of Wardell, NSW.

Biology. Unknown.

Comments. This species is known only from the type specimen which we have been unable to examine in detail. From the visible characters *G. longipleurale* keys out with *G. genale* based on the inimal width of malar space < 1.00 × length of pedicel; 3rd hind tarsomere > 2.00 × length of 4th hind tarsomere. The species can be separated by a longer scape (> 2.00 × pedicel length), 1st flagellomere length (0> 4.00 × 2nd flagellomere), Ovipositor sheath (~1.60 × metasoma length).

Gasteruption longiscapum Pasteels, 1957

Fig. 59.

Gasteruption longiscapum Pasteels, 1957: 84, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "N.Queensland. Kuranda. F.P Dodd. 1916 – 27." (ANIC).

Specimen damage. Left antenna 3rd flagellomere to tip and right antenna 4th flagellomere to tip missing, right fore leg 3rd tarsomere to claw missing, left mid leg 5th flagellomere to claw and right mid leg tarsus missing.

Paratype. QLD: 1♂, same data as holotype (ANIC).

Redescription. *Female.* body length 12.40 mm; ovipositor length 7.90 mm.

Colour. Head and body mostly black; clypeus brown laterally, mandibles brown with tooth apex darker; propleuron, mesepisternum and propodeum dark brown, pronotum dark brown becoming lighter posteriorly and ventro-laterally, metapleuron dark brown becoming lighter posteriorly, tegula and mesepimeron brown; fore and mid leg brown, tibia with cream longitudinal stripe on anterior face, tarsus brown with apex of 1st tarsomere lighter; hind leg dark brown, tarsus cream with basal third of 1st tarsomere and 5th tarsomere and claw dark brown; metasoma dark brown, lighter ventrally; ovipositor sheath dark brown with cream apex 2.16 × length hind 1st tarsomere; ovipositor brown; wing hyaline, wing vein and pterostigma brown.

Figure 59. *Gasteruption longiscapum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Head. Head shape sub-conical in dorsal view; length 0.86 × width, postocular space 0.31; head in lateral view frons and vertex convex with short postocular space, 0.31 × height of eye; eye setae absent; face and frons reticulate with short dense setae, denser laterally; medial frontal carina raised above antennal scrobes, becoming indistinct posteriorly; vertex reticulate with short scattered setae; occipital carina narrow, lamelliform, depression shallow, medially pointed; gena reticulate with shiny medium length setae, becoming denser ventrally; minimal width of malar space 0.03 × height of eye; 0.25 × length of pedicel; clypeus reticulate; 2.00 × wide as high; margin sinuate with lateral corners barley protruding forward, depression indistinct, present anteriorly, short setae, longer along margin; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 1.26 × distance between lateral ocelli; scape 1.92 × length pedicel; 1st flagellomere 1.85 × as long as scape; 0.65 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.25 × height; propleuron length 1.58 × width; 0.98 × prototegular length; propleuron rugulose with short reflective setae; pronotal process broad and rounded; pronotum anterior and dorsal lobes reticulate, posterior lobe rugose, groove between pronotum lobes carinate, short dense setae, denser in groove; mesoscutum rounded in lateral view; reticulate with short scattered setae; parapsidial lines indistinct; notauli incomplete, scrobiculate; mesoscutellum rugulose with short setae; axilla reticulate with short setae; mesepisternum reticulate antero-lateral becoming areolate ventro-laterally, short shiny setae, becoming denser ventro-laterally; mesepimeron crenulate with shallow depression; metapleuron areolate with short setae; propodeum areolate with flattened medial carinae, short scattered setae.

Legs. Hind coxa rugulose dorsally tending reticulate ventrally; femur length 0.70 × length of tibia; tibia length 1.41 × tibia width; 1st tarsomere 3.06 × length of 2nd tarsomere; 2nd tarsomere 1.50 × length of 3rd tarsomere; 3rd tarsomere 1.60 × length of 4th tarsomere; 4th tarsomere 0.46 × length of 5th tarsomere; tarsal claw 0.53 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, tapering at apex; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular with node, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Imbricate, length 4.03 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.96 × metasoma length; short appressed setae, cream apex slightly flared.

Male. Male not examined but described by Pasteels (1957) as having a darker mesosoma with brown on the posterior edge of pronotum and mesepisternum.

Distribution. The species is known only from the type locality of Kuranda, QLD.

Biology. Unknown.

Comment. This species groups with *G. nigridens* and *G. rubripes* based on hind tibia without cream/ white coloration subbasally and an ovipositor sheath ≤ 1.00 × metasoma length. It can be distinguished based on an incomplete notauli and spectral hind wing veins.

Gasteruption luteidens Pasteels, 1957

Fig. 60.

Gasteruption luteidens Pasteels, 1957: 35, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "S.W. Australia [WA]. Yallingup. 1–12 Dec.1913. R.E. Turner. 1914–190." "*Gasteruption luteidens* n.sp. J. Pasteels det., 1954" (BMNH: 3a. 355).

Specimen damage. Complete right antenna missing and one ovipositor sheath missing.

Paratypes. WA: 12♀, same data as holotype (NHM) [not measured].

.

Redescription. *Female.* Body length, 10.00 mm; ovipositor length 12.00 mm

Colour. Dark brown; malar space lighter, mandibles cream with dark tooth apex, tegula light brown; fore leg mostly light brown, coxa and trochantellus darker, femur with cream spot at apex, tibia with cream longitudinal stripe on anterior face, joining on posterior face at apex and base, tarsus cream, 4th tarsomere to claw brown; mid leg same as fore leg but darker and 2nd tarsomere to 4th tarsomere brown, 5th tarsomere and claw dark brown; hind leg dark brown, tibia with cream band subbasally, tarsus cream, basal half of 1st tarsomere, 5th tarsomere and claw dark brown; metasoma dark brown, lighter laterally T4 to apex; ovipositor sheath dark brown with long cream apex 3.33 × length of hind 1st tarsomere; ovipositor brown; wing hyaline, fore wing veins and pterostigma brown.

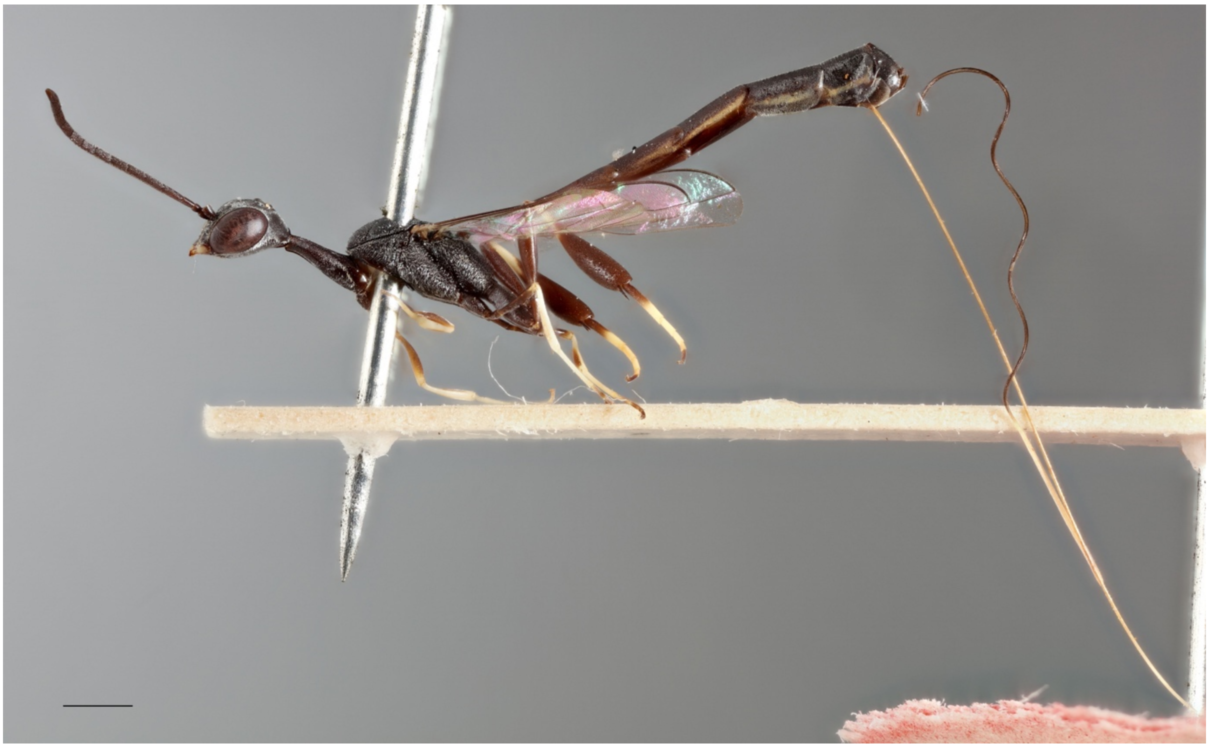

Figure 60. *Gasteruption luteidens* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm

Head. Head shape sub-conical when viewed dorsally; length 1.02 × width; postocular space sharply tapering behind eyes; distinct head in lateral view, frons, vertex and gena strongly rounded, postocular space long, distinctly tapering; 0.47 × height of eye; short scattered eye setae; face and frons reticulate-rugulose with short dense shiny setae, frons becoming reticulate-strigulate posteriorly; medial frontal carina present anteriorly, absent posteriorly; vertex reticulate-rugulose anteriorly, becoming reticulate-strigulate posteriorly, short dense setae; gena reticulate-rugulose with short dense shiny setae; minimal width of malar space 0.02 × height of eye; 0.20 × length of pedicel; clypeus punctate, 2.42 × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression indistinct, short dense shiny setae, longer on margin; lateral ocelli posterior of postocular line, distance from lateral ocellus to eye margin 1.00 × distance between lateral ocelli; scape 1.50 × length pedicel; 1st flagellomere 1.11 × as long as scape; 0.67 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.41 × height; propleuron length 1.60 × width; 1.33 × prototegular distance; propleuron reticulate-rugulose with short dense shiny setae; pronotal process blunt; pronotum reticulate-rugulose, ventral lobe reticulate-rugose becoming smooth along ventral margin, posterior lobe with coarser ventral margin, groove between pronotum lobes carinate, medium length dense shiny setae; mesoscutum length 1.41 × width in dorsal view; rounded in lateral view, reticulate-rugose, coarser medially-posteriorly, short scattered setae; admedial lines converging, parapsidial lines distinct, notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate-rugulose with short scattered setae; mesepisternum areolate-rugose with medium dense shiny setae; mesepimeron transverse carinate with several shallow fovea; metapleuron areolate-rugose with medium dense shiny setae; propodeum areolate with short dense shiny setae, medial carina flattened.

Legs. Hind coxa reticulate-rugulose dorsally, strigate in coxal groove, laterally reticulate; femur 0.68 × length of tibia; tibia length 4.95 × tibia width, short dense setae with scattered stout emergent spines on anterior face, ventro-apical pecten of short robust spines; short spines on ventral surface of tarsus; 1st tarsomere 2.69 × length of 2nd tarsomere; 2nd tarsomere 1.44 × length of 3rd tarsomere; 3rd tarsomere 1.80 × length of 4th tarsomere; 4th tarsomere 0.56 × length of 5th tarsomere; tarsal claw 0.56 × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated tear shape, apex tapering; vein r-m absent; SR1 weakly bent; 2-M basal third tubular, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Imbricate, length 3.02 × mesosoma length; hypopygium short Y-shaped; ovipositor sheath 1.45 × metasoma length; covered in short appressed setae.

Male. Males same characters as female but postocular space shorter.

Distribution. The species is restricted to WA.

Biology. Unknown.

Comments. *Gasteruption luteidens* is very similar to *G. prolongatum* and they key out together based on their postocular space in lateral view distinctly tapering to sub-conical shape. The species are difficult to separate but differ in clypeal width and length of ovipositor sheath cream apex, see key couplet 20.

Gasteruption luteonasum Pasteels, 1957

Fig. 61.

Gasteruption luteonasum Pasteels, 1957: 97, ♂; Jennings, 2010 [on-line checklist].

Material examined.

Holotype. ♂, "Brock Creek Burnside, N.Aust. 23 April 1929 T. G. Campbell" "*Gasteruption luteonasum* n.sp J. Pasteels det., 1954" "Type" (ANIC).

Specimen damage. Left antenna 7th flagellomere to tip missing.

Comments. The original species description is based entirely on male specimens, and until we can associate females, we have refrained from redescribing this species.

Figure 61. *Gasteruption luteonasum* Pasteels, holotype male, lateral habitus, scale bar = 1.00 mm

Gasteruption malaicum Schletterer, 1885

Fig. 62.

Gasteruption malaicum Schletterer 1885: 320, ♀; Schletterer 1890: 455, ♀; Pasteels, 1957: 67, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Thoru N. Holl, 1858" "*malaicum* det Schlett." "*Gasteruption malaium* Schlett J. Pasteels det., 1955" (QM).

Specimen damage. Left antenna 10th flagellomere to tip missing, left tarsus missing, midleg 5th tarsomere to tip missing, ovipositor sheaths broken at base but still attached.

Paratype. QLD: 1♂, Brisbane, 8.ix.1915, H. Hacker (QM: T5472).

Other material examined. **QLD:** 2♀, Brisbane, 15.i.1912, H. Hacker (QM); 1♀, Stradbroke Island, 17.x.1915, H. Hacker (QM).

Figure 62. *Gasteruption malaicum* Schletterer, holotype female, lateral habitus, scale bar = 5.00 mm (© Geoff Thompson, QM).

Redescription. *Female.* Body length 15.00 mm; ovipositor: 17.00 mm.

Colour. Black; clypeus lateral corners and malar space brown, mandibles brown with darker tooth apex; propleuron lighter posteriorly, tegula brown; fore and mid leg brown, tibia with cream longitudinal stripe on anterior face, tarsus dark brown, 1st tarsomere and 2nd tarsomere with pale stripe on anterior face; hind leg dark brown, trochantellus lighter apically, tibia with cream patch subbasally, tarsus cream with basal third of 1st tarsomere and apical half of 5th tarsomere and claw dark brown; metasoma dark brown, darker apically; ovipositor sheath dark brown with long pale apex; ovipositor brown; wing hyaline, wing vein dark brown and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.85 (0.80–0.90) × width, postocular space bulbous, tapering late to occipital carinae; head in lateral view, frons and vertex convex, postocular space 0.41 × height of eye; short scattered eye setae; face reticulate; short dense shiny setae; frons reticulate-granular with short dense shiny setae; medial frontal carina raised between antennal scrobes, shallow depression posteriorly; vertex rugulose-granular with short dense shiny setae; occipital carina narrow lamelliform with shallow depression, medially emarginate; gena rugulose-granular with short dense shiny setae; minimal width of malar space 0.10 (0.09–0.11) × height of eye; 0.75 (0.70–0.80) × length of pedicel; clypeus reticulate; 2.30 (2.00–2.60) × wide as high; margin sinuate; lateral corners barely protruding forwards; medial depression present anteriorly, short dense setae, longer along margin and medially; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.60 (0.41–0.70) × distance between lateral ocelli; scape 1.71 (1.43–2.00) × length pedicel; 1st flagellomere 1.00 (0.62–1.10) × as long as scape; 0.52 (0.50–0.70) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.35 (2.10–2.60) × height; propleuron length 1.30 × width; 0.88 (0.80–0.96) × prototegular distance; propleuron reticulate-rugulose with medium dense shiny setae; pronotal process short and rounded; pronotum anterior lobe reticulate-rugulose with dorsal and posterior lobe rugulose-granular, groove between pronotum lobes carinate; short dense shiny setae, longer in groove; mesoscutum length 1.27 × width in dorsal view; truncated in lateral view; rugulose-granular with short dense shiny setae; admedial and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugulose-granular with short dense setae; mesepisternum rugulose-granular top lobe, areolate ventro laterally, short dense shiny setae; mesepimeron carinate, becoming coarsely reticulate with transverse carinae dorsally; metapleuron and propodeum areolate with short dense shiny setae, medial carina flattened.

Legs. Hind coxa strigate-rugulose dorsally, reticulate-rugulose laterally and ventrally; femur 0.70 × length of tibia; tibia length 5.20 × width; short dense setae with scattered short robust spines apically; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.20 (2.90–3.30) × length of 2nd tarsomere; 2nd tarsomere 1.50 (1.43–1.60) × length of 3rd tarsomere; 3rd tarsomere 1.75 (1.70–2.00) × length of 4th tarsomere; 4th tarsomere 0.40 (0.30–0.50) × length of 5th tarsomere; tarsal claw 0.60 (0.50–0.70) × length of 5th tarsomere.

Wings. Fore wing first discal cell slightly wider at apex; vein r-m spectral; vein SR1 distinctly bent; vein 2-M basal third tubular with apical node, remainder of vein pigmented; hind wing vein apical half of 2m+Cu pigmented, all other veins spectral; three hamuli distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Imbricate, length 2.65 (2.60–2.70) × mesosoma length; hypopygium broad Y-shaped; short appressed setae.

Male. Same characters as female.

Distribution. The species is known from various location in QLD.

Biology. Unknown.

Comment. *Gasteruption malaicum* keys out with *G. acuticeps* and can be separated by minimal width of malar space 0.75 (0.70–0.80) × length of pedicel; mesosoma length 2.35 (2.10–2.60) × height; hind wing hamuli spacing, distance between basal and middle hamuli greater than distance between middle and apical. *G. malaicum* is known from various localities in QLD compared to *G. acuticeps* which is known only from Pine Island Reserve, ACT.

Gasteruption melanopoda Pasteels, 1957

Fig. 63.

Figure 63. *Gasteruption melanopoda* Pasteels, holotype female, lateral habitus, scale bar = 5.00 mm.

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NMV (Fig. 60), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Gasteruption melanopoda Pasteels, 1957: 114, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "W. Warburton 22.4.18/14 Vic *C. G. Cole*" (NMV: T-7453) [examined from photos].

Specimen damage. Left 4th tarsomere to tip missing.

Redescription. *Female.* Body length 13.70 mm; ovipositor length 8.70 mm.

Colour. Head black, body mostly red-brown; antennae and malar space brown, mandibles cream; propleuron dark brown, lighter basally, mesoscutellum, axillae and patch in pronotal groove, medially and laterally on mesoscutum dark brown; fore and mid leg mostly brown, femur with cream apex, tibia with cream stripe on anterior face, tarsus cream with 4th tarsomere to claw brown; hind leg mostly brown, darker dorsally, black spot dorsally at prefemur groove, large cream band subbasally on tibia, tarsus dark brown; Wings hyaline, wing veins and pterostigma dark brown; metasoma dark brown with lighter apical margins; ovipositor brown, ovipositor sheath dark brown with cream apex 1.83 × length of hind basitarsus.

Head. Head shape rectangular when viewed dorsally; postocular space gently tapering behind eye; head in lateral view frons and vertex convex; postocular space short; frons with short scattered setae; vertex with short scattered setae; occipital carina short lamelliform, depression broad and shallow, rounded; gena with short dense shiny setae; minimal width of malar space 0.03 × height of eye; 0.25 × length of pedicel; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.82 × distance between lateral ocelli; scape 1.94 × length pedicel; first flagellomere 1.16 × as long as scape; 0.46 × length second flagellomere.

Mesosoma. Mesosoma length 1.79 × height; 1.09 × prototegular distance; propleuron with medium (compared to frons) dense setae, pronotal process indistinct; pronotum with short shiny setae, longer in groove; mesoscutum length 1.25 × width; rounded in lateral view, with short scattered setae; admedial lines distinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axillae with short dense shiny setae; mesepisternum and metapleuron with short shiny dense setae; mesepimeron with no setae; propodeum described by Pasteels (1957) as being areolate with raised medial carina, short shiny dense setae;

Legs. Femur 0.71 × length of tibia; tibia length 5.92 × tibia width; 1st tarsomere 3.32 × length of 2nd tarsomere; 2nd tarsomere 1.68 × length of 3rd tarsomere; 3rd tarsomere 1.69 × length of 4th tarsomere; 4th tarsomere 0.72 × length of 5th tarsomere; tarsal claw 0.67 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of 2-Cu and 1m-cu; vein r-m absent; vein SR1 weakly bent, vein 2-M basal quarter tubular with apical node, remaining pigmented; hind wing veins 1-m and 2m+Cu pigmented.

Metasoma. Metasoma 3.05 × mesosoma length; ovipositor sheath 0.87 × metasoma length; with flared cream apex

Male. Unknown.

Distribution. The species is only known from the holotype locality of Warburton in Victoria.

Biology. Unknown.

Comments. This species is known only from the type specimen which we have been unable to examine in detail. The species is very similar to *G. variegatum* differing only by the hind tarsus being dark brown in *G. melanopoda*, ovipositor sheath shorter (0.87 × metasoma length) and cream apex flared.

Gasteruption melanostoma Pasteels, 1957

Fig. 64.

Gasteruption melanostoma Pasteels, 1957: 65, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Victoria c.7." "R. E. Turner. 1910–223." "*Gasteruption melanostoma* s.sp. J. Pasteels det., 1955" (BMNH: 3a. 359).

Specimen damage. Left and right antenna 11th flagellomere to tip, missing, metasoma broken, glued to mounted card, one ovipositor sheath missing, the other broken but positioned on metasoma.

Redescription. *Female.* Body length 20.00 mm; ovipositor length 23.00 mm.

Colour. Black; malar space, mandibles (darker tooth apex) and tegula dark brown; fore and mid leg mostly dark brown, prefemur lighter, tibia with cream stripe on anterior face, tarsus with cream stripe on anterior face of 1st tarsomere to 3rd tarsomere; hind leg mostly dark brown, prefemur lighter, tarsus cream basal third of 1st tarsomere and 5th tarsomere to claw dark brown; metasoma lighter laterally in middle segments; ovipositor sheath dark brown with cream apex 3.27 × length of hind 1st tarsomere; ovipositor brown; wing hyaline; wing veins and pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; 0.92 × longer than wide, postocular space bulbous but tapering sharply towards occipital carinae; head in lateral view with elongated postocular space, 0.47 × height of eye; short scattered eye setae; face and frons reticulate-punctate with short dense shiny setae; medial frontal carina distinct in anterior half; vertex reticulate-rugulose around ocelli, becoming strigate-punctate posteriorly, transverse depression behind posterior ocelli, short dense shiny setae; occipital carina short, lamelliform, depression indistinct and medially pointed; gena reticulate-punctate with short dense shiny setae; minimal width of malar space 0.07 × height of eye; 0.63 × length of pedicel; clypeus punctate; 2.08 × wide as high; margin concave with lateral corners distinctly protruding forwards, medial depression indistinct, short dense shiny setae, long setae on margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.65 × distance between lateral ocelli; scape 2.50 × length pedicel; first flagellomere 0.75 × as long as scape; 0.45 × length second flagellomere.

Figure 64. *Gasteruption melanostoma* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Mesosoma. Mesosoma length 1.73 × height; propleuron length 1.22 × width; 1.00 × prototegular distance; propleuron reticulate-rugulose, finer posteriorly and ventrally, medium dense setae shiny; pronotal process indistinct and broad; pronotum anterior lobe reticulate-rugose, dorsal and posterior lobe reticulate-rugulose, dorso-posterior part of posterior lobe granular, groove between pronotum lobes carinate, medium dense setae, longer in groove and on anterior margin, anterior lobe with scattered setae; mesoscutum length 1.18 × width; rounded in lateral view; anteriorly strigate-rugulose becoming granular-strigate, short scattered shiny setae; admedial lines converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular-rugulose, short scattered setae; mesepisternum dorsally and posteriorly strigate, rugulose remaining dorsal, ventrally rugulose with transverse strigose, medium dense setae; mesepimeron with fine transverse carinae; metapleuron areolate-rugulose in dorsal lobe, becoming rugose with transverse striations, medium dense shiny setae; propodeum areolate-rugose, areolate-strigate medially, medial carinae indistinct, medium dense shiny setae.

Legs. Hind coxa strigate-rugulose dorsally, strigate in coxa groove, becoming reticulate-punctate; femur 0.69 × length of tibia; tibia length 5.73 × tibia width; tarsus with stout spines on ventral face; 1st tarsomere 3.32 × length of 2nd tarsomere; 2nd tarsomere 1.58 × length of 3rd tarsomere; 3rd tarsomere 1.71 × length of 4th tarsomere; 4th tarsomere 0.35 × length of 5th tarsomere; tarsal claw 0.55 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of 3-cu; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular with node, remaining part of vein pigmented; hind wing vein 2m+Cu and 1-m tubular, remaining spectral; three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Imbricate, length 2.78 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.65 × metasoma length; short appressed setae.

Male. Unknown.

Distribution. The species is only known from the type locality of VIC without details.

Biology. Unknown.

Comments. *Gasteruption melanostoma* keys out with *G. flavicans* based on the combination of black mesonotum, hind tibia without cream/ white colouration, concave clypeal margin. They can be separated by *G. melanostoma* having a longer malar space (0.63 × length of pedicel) and cream ovipositor sheath apex shorter (3.27 × 1st hind tarsomere). The species have a disjunct distribution with *G. melanostoma* known only from Victoria and *G. flavicans* collected on Thursday Island in the Torres Strait Islands archipelago.

Gasteruption mirabilifemorale **Pasteels, 1957**

Fig. 65.

Figure 65. *Gasteruption mirabilifemorale* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by WAM (Fig. 62), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Gasteruption mirabilifemorale Pasteels, 1957: 76, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "36–1052 Midland [WA]" "*Gasteruption mirabilifemorale* J. Pasteels det., 1955" (WAM: E 88820) [examined from images].

Specimen damage. Left hind leg 5^{th} tarsomere to tip and ovipositor sheaths missing.

Paratype. ♀, same data as holotype (WAM) [not examined].

Redescription. *Female.* Body length 11.89 mm; ovipositor length 12.46 mm.

Colour. Black; antenna dark brown, malar space and mandibles brown (tooth apex darker); anterior-lateral corners of mesonotum and anterior margin of pronotum reddish-brown; fore and mid legs light brown, apical margin of trochantelli, spot on apex of femora, longitudinal stripe on anterior face of tibiae cream and 1^{st} to 3^{rd} tarsomere cream; hind leg mostly dark brown, lateral femur lighter brown, small cream band subbasally on tibia, tarsus cream with basal third of 1^{st} tarsomere dark brown; metasoma dark brown; ovipositor sheath dark brown with cream apex 3.00 × length of hind 1^{st} tarsomere; wings hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; postocular space sharply tapering behind eyes to occipital carinae; head in lateral view wedge like, vertex convex, gena wider posteriorly; postocular space elongate, 0.48 × height of eye; eye setae absent; face reticulate with medium dense shiny setae; frons punctate-reticulate, short dense shiny setae, denser laterally along eye margins; medial frontal carina raised between antennal scrobes; vertex punctate-reticulate with short scattered shiny setae; narrow lamelliform occipital carina, wider ventro-laterally; medium depth rounded depression; gena punctate with medium dense shiny setae; minimal width of malar space 0.11 × height of eye; 0.76 × length of pedicel; clypeus punctate, denser laterally, margin sinuate; medial depression shallow, medium scattered shiny setae, longer along ventral margin; lateral ocelli in-line with postocular line; scape 2.24 × length pedicel; 1^{st} flagellomere 0.63 × as long as scape; 0.65 × length 2^{nd} flagellomere.

Mesosoma. Mesosoma length 1.89 × height; propleuron length 1.04 × prototegular distance; propleuron rugulose dorsally with medium dense shiny setae; pronotal process indistinct; mesosoma laterally with medium dense shiny setae; mesoscutum length 1.24 × width in dorsal view; rounded in lateral view, punctate-rugulose with short scattered setae; admedial and parapsidial lines distinct; notauli U-shaped, scrobiculate; propodeum areolate-rugulose with raised longitudinal medial carina, short dense setae.

Legs. Femur length 0.69 × length of tibia; tibia length 4.25 × tibia width, medium dense setae; tarsus with short spines on ventral face and several apically; 1^{st} tarsomere 3.58 × length of 2^{nd} tarsomere; 2^{nd} tarsomere 1.82 × length of 3^{rd} tarsomere; 3^{rd} tarsomere 1.42 × length of 4^{th} tarsomere.

Wings. Fore wing first discal cell rectangular; vein r-m absent; vein SR1 weakly bent, vein 2-M basal third tubular with apical node, remainder of vein pigmented; hind wing veins spectral.

Metasoma. Metasoma 1.99 × mesosoma length; ovipositor sheath 1.74 × metasoma length, short appressed setae.

Male. Males not examined but described by Pasteels (1957) as femur and tibia less dilated.

Distribution. The species is known only from the locally of Midland, WA.

Biology. Unknown.

Comment. The species name *mirabilifemorale* is derived from a combination of *mirabilis*, L. for wonderful and *femoralis* L. for the form of a thigh, in reference to distinctly enlarged hind coxae and femurs which can be used to distinguish *G. mirabilifemorale.*

Gasteruption mixtum Pasteels, 1957

The following brief description is based on details provided in the original description (Pasteels, 1957).

Gasteruption mixtum Pasteels, 1957: 39, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. Location unknown.

Paratype. VIC: 2♀, Mildura (NMV) [not examined].

Redescription. *Female.* Body length 9.00 mm; ovipositor 12.00 mm.

Colour. Black; fore and mid legs dark brown, anterior face of 1st and 2nd tarsomere cream; hind leg dark brown, patch subbasally on tibia and 2nd and 3rd tarsomere cream.

Head. Fine sculpturing with short scattered setae; head sub-rectangular in dorsal view; head in lateral view rectangular, similar to *G. filiforme* Pasteels, postocular space long; malar space very short; lateral ocelli posterior of postocular line; 1st flagellomere almost as long as 2nd flagellomere.

Mesosoma. Mesosoma elongate and cylindrical, length greater than 3.00 × height; propleuron long, slightly shorter than prototegular distance; pronotal process indistinct; mesonotum greater than 1.50 × width in dorsal view, rounded in lateral view; notauli incomplete; propodeum finely reticulate with longitudinal medial groove.

Legs. Hind leg elongated, femur greater than 1.50 × tibia length, tibia slightly claviform, length greater than 3.00 × tibia width;

Wings. Fore wing first discal cell rectangular.

Male. The male of the species was described by Pasteels (1957) as having the same characters as females.

Distribution. The species was described as being widespread by Pasteels (1957) from QLD, VIC and WA.

Biology. Unknown.

Comment. The authors have been unable to examine material associated withthis species but have compiled a description based on details provided in the original description (Pasteels, 1957). The head of the species was described by Pasteels (1957) in lateral view similar to *G. filiforme* Pasteels (Fig. 36) and having a extremely long mesosoma (>3.00 × height). Using the available characters this species keys out at couplet 56 with *G. elegans* and *G. nobile*, where it can be provisionally separated based on pronotum completly black, mesosoma length >3.00 × height in lateral view and pronotal process absent.

Gasteruption nervosum **Kieffer, 1911**

Fig. 66.

Figure 66. *Gasteruption nervosum* Kieffer, holotype female, lateral habitus, scale bar = 1.00 mm.

Gasteruption nervosum Kieffer, 1911: 203, ♀: Kieffer, 1912: 322, ♀: Pasteels, 1957: 94 ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "*Gasteruption nervosum* N.sp.Kieffer." "452 Hy" "Mackay" "Australia. R.E.Turner. 1907–244." (BMNH: 3.a.168).

Specimen damage. Left and right antenna 9th flagellomere to tip missing, left wing forewing apex damaged, metasoma T3 to tip missing.

Redescription. *Female.* body length 25.00 mm; ovipositor length 26.00 mm.

Colour. Black; antenna dark brown, clypeus lateral corners, malar space and mandibles brown (darker tooth apex); propleuron lighter posteriorly, pronotum ventral corner, posterior corner and dorsal margin reddish-brown, mesepimeron reddish-brown, dorsal-posterior black, mesoscutum lateral corners of notauli reddish-brown, tegula light brown, propodeum reddish-brown on side of metasoma insertion; fore and mid leg brown, trochantellus with cream apical margin, femur with cream patch on apex, tibia with longitudinal cream stripe on anterior face, tarsus brown, 1st tarsomere cream, 5th tarsomere to claw dark brown; hind leg black, coxa lighter in coxal groove, trochantellus apical margin cream, prefemur brown; femur dark brown, tibia dark brown with cream band subbasally, tarsus cream, base 1/2 of 1st tarsomere and claw dark brown; metasoma dark brown dorsally, T2 light brown laterally; wing hyaline; wing vein dark brown, pterostigma brown; Pasteels describes ovipositor sheath as apical ¼ cream.

Head. Head shape sub-rectangular when viewed dorsally; length 0.87 × width; shallow transverse depression posterior of lateral ocelli with rounded postocular space; head in lateral view wedge like; postocular space short, 0.27 × height of eye; face and frons punctate-reticulate with short dense shiny setae, denser laterally and medially; medial frontal carina present in anterior half becoming a shallow groove posteriorly; vertex rugulose-punctate, strigate-rugulose with scattered reticulation posteriorly, short scattered setae; occipital carina short, lamelliform, depression indistinct; gena punctate-rugulose with short dense shiny setae; minimal width of malar space 0.08 × height of eye; 0.71 × length of pedicel; clypeus punctate; 1.83 × wide as high; margin sinuate with lateral corners distinctly protruding forwards; indistinct depression in anterior half, short scattered medial, denser laterally with longer setae on margin; lateral ocelli anterior of postocular line;

distance from lateral ocellus to eye margin 1.0 × distance between lateral ocelli; scape 1.86 × length pedicel; 1st flagellomere 0.92 × as long as scape; 0.52 × length 2nd flagellomere.

Mesosoma. Propleuron rugulose, coarser dorsally, medium dense shiny setae; pronotal process large, distinctly hooked; pronotum anterior lobe rugulose, dorsal and dorso-posterior lobe punctate with carinae, groove between pronotum lobes carinate, medium dense shiny setae, anterior lobe with scattered setae; mesoscutum length 0.96 × width; rounded in lateral view; medial lobe strigate-punctate with coarse strigate-rugose anterior corners; lateral lobe punctate-rugulose, short scattered shiny setae; admedial lines gently converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axillae punctate-rugulose with short scattered setae; mesepisternum areolate-rugulose, coarser laterally and ventrally, medium dense shiny setae; mesepimeron carinate ventral third, smooth patch sub dorsally; metapleuron areolate-rugulose with medium dense shiny setae; propodeum areolate-rugulose, medial carina convex, medium dense shiny setae.

Legs. Hind coxa strigate dorsally, strigate-rugulose laterally; femur 0.66 × length of tibia; tibia length 7.90 × tibia width; short dense setae; 1st tarsomere 4.00 × length of 2nd tarsomere; 2nd tarsomere 1.40 × length of 3rd tarsomere; 3rd tarsomere 1.67 × length of 4th tarsomere; 4th tarsomere 0.40 × length of 5th tarsomere; tarsal claw 0.40 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of 3-cu; vein r-m spectral; vein SR1 weakly bent; vein 2-M basal third tubular, remaining pigmented; hind wing vein 2m+Cu and 1-m tubular, r-m lightly pigmented; three hamuli, distance between basal and middle hamuli greater than distance between idle and apical.

Metasoma. Metasoma T3 to tip missing in the type.

Male. Unknown.

Distribution. The species is only known from the type locality of Mackay, QLD.

Biology. Unknown.

Comment. This species is known only from the type specimen which is missing the majority of the metasoma. It is superficially similar to *G. breviscutum* but differs on the basis of *G. nervosum* having a *strongly* rounded head with a shallow transverse depression posterior of lateral ocelli, and short postocular space (0.27 × height of eye) compared to a more elongated postocular space (0.47–0.48 × height of eye) in *G. breviscutum. G. nervosum* tibia has cream/ white band subbasally compared to completely tibia completely dark brown/ back in *G. breviscutum*.

Gasteruption nigerrimum Pasteels, 1957

Fig. 67.

Gasteruption nigerrimum Pasteels, 1957: p. 92, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "R. P. McMillan Cauiuglon [WA] 18.1.53" "53–366" "*Gasteruption nigerrimum* n.sp J. Pasteels det., 1955" (WAM: E 88829).

Specimen damage. Metasoma segment 4 and 5 missing, segments 6 to tip broken and mounted on point.

Redescription. *Female.* Body length 16.00 mm; ovipositor length 25.00 mm.

Colour. Black; mandibles dark brown with black apex; mesepimeron brown; fore leg dark brown, tibia with cream longitudinal stripe on anterior face, tarsus dark brown with longitudinal cream stripe on anterior face of 1st tarsomere to 3rd tarsomere; mid leg mostly dark brown with cream patch on apex of tibia; hind leg dark brown, tarsus cream, basal quarter of 1st tarsomere, distal half of 5th tarsomere and claw brown; metasoma dark brown; ovipositor sheath dark brown with long cream apex 8.05 × hind 1st tarsomere; ovipositor brown; wing hyaline, wing vein and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; length 1.10 × width, postocular space tapering; head in lateral view, frons and vertex convex with elongated post ocular space, 0.46 × eye height; face punctate with short dense shiny setae; frons strigate-reticulate becoming laterally reticulate, short scattered setae; medial frontal carina distinct, in anterior half becoming shallow groove posteriorly; vertex reticulate-rugulose with short scattered setae; occipital carina narrow, wider ventro-laterally, lamelliform, rounded shallow depression; gena reticulate and short dense shiny setae; long malar space, minimal width 0.05 × height of eye; 0.50 × length of pedicel; clypeus punctate; 1.70 × wide as high; margin concave with lateral corners barely protruding forwards; depression indistinct shallow medially, short dense setae, longer along ventral margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.50 × distance between lateral ocelli; scape 1.60 × length pedicel; 1st flagellomere 0.70 × as long as scape; 0.30 × length 2nd flagellomere.

Figure 67. *Gasteruption nigerrimum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Mesosoma. Mesosoma length 1.90 × height; propleuron length 0.94 × prototegular distance; propleuron with medium dense shiny setae; pronotal process indistinct; pronotum anterior and posterior lobes reticulate-rugose, dorsal lobe and dorso-posterior part of posterior lobe punctate-reticulate, groove between pronotum lobes carinate, short scattered shiny setae; mesoscutum length 1.04 × width in dorsal view; rounded in lateral view; reticulate-rugulose with short scattered setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate-rugulose with short scattered setae; mesepisternum reticulate-rugulose dorsally becoming areolate ventrally, short dense shiny setae; metapleuron areolate with short dense shiny setae; propodeum areolate, medial carinae convex, short scattered setae.

Legs. Hind coxa strigulate-rugulose anterior dorsally, becoming strigate posterior dorsally, reticulate laterally and ventrally; femur 0.72 × length of tibia; tibia skinny, length 6.00 × tibia width; short dense setae with scattered emergent robust spines; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.00 × length of 2nd tarsomere; 2nd tarsomere 1.70 × length of 3rd tarsomere; 3rd tarsomere 1.50 × length of 4th tarsomere; 4th tarsomere 0.50 × length of 5th tarsomere; tarsal claw 0.75 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of 3-cu; vein r-m absent; vein SR1 sinuate; vein 2-M basal quarter tubular with node, remaining three quarters pigmented; hind wing veins not visible; three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma length 2.99 × mesosoma length; ovipositor sheath 2.18 × metasoma length; with short dense setae

Male. Unknown

Distribution. Species only known from the type collected in Cannington, WA.

Biology. Unknown.

Comments. This species is known only from the type specimen and is similar to *G. nigerrimum*. The species can be separated on the length of the malar space being shorter in *G. nigerrimum* (0.05 × height of eye) and cream/ white apex of ovipositor sheath longer (8.05 × length of 1st hind tarsomere). *Gasteruption nigerrimum* is only known from Cannington, WA whereas *G. breviscutum* has a wide distribution including localities in WA.

***Gasteruption nigridens* Pasteels, 1957**

Fig. 68.

Gasteruption nigridens Pasteels, 1957: 108, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Blundells, [ACT] 3 Feb 48, E F Riek" "*Gasteruption nigridens* n.sp. J. Pasteels det., 1954" (ANIC).

Collection locality is likely to be Blundells Cottage, Wendouree Dr, Parkes ACT 2600.

Figure 68. *Gasteruption nigridens* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* body length 16.00 mm; ovipositor length 2.04 mm.

Colour. Black; mandibles dark brown (tooth apex darker); pronotum with lighter ventral corner, tegula dark brown; fore and mid leg mostly brown, coxa darker, trochantellus with cream apical margin, tibia dark brown with longitudinal cream stripe on anterior face, 1st tarsomere with cream anterior stripe; hind leg mostly dark brown, trochantellus with cream apical margin, tarsus cream with base of 1st tarsomere and 5th tarsomere dark brown; metasoma dark brown; ovipositor sheath dark brown with cream apex 0.60 × length hind 1st tarsomere; ovipositor brown; wing hyaline, wing veins and pterostigma brown.

Head. Head shape sub-rectangular in dorsal view; length 0.70 × width; postocular space short bulbous, tapering to occipital carinae in dorsal view; head in lateral view wedge like, convex frons and vertex with gena almost straight, postocular space short, 0.37 × height of eye; eye setae absent; face and frons reticulate with shiny short dense setae; medial frontal carina indistinct between antennal scrobes, becoming indistinct groove along frons and vertex; vertex reticulate with shiny short dense setae; occipital carina narrow, lamelliform with shallow depression, medially emarginated; gena reticulate with shiny short setae, becoming longer and denser ventro-laterally; malar space long, minimal width 0.13 × height of eye; 0.90 × length of pedicel; clypeus reticulate; 1.90 × wide as high; margin sinuate with lateral corners barley protruding forwards, medial depression present anteriorly and indistinct, short setae with longer on margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 1.00 × distance between lateral ocelli; scape 1.78 × length pedicel; 1st flagellomere 1.12 × as long as scape; 0.70 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.46 × height; propleuron length 1.77 × width; 0.66 × prototegular distance; propleuron rugulose, short dense setae, shiny ventro-laterally; pronotal process broad and rounded; pronotum anterior lobe rugulose, with dorsal and posterior lobes rugulose, groove between pronotum lobes scrobiculate, shiny short setae, longer in pronotal groove; mesoscutum length 1.24 × width in dorsal view; rounded in lateral view; rugulose with short shiny setae; admedial lines converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugulose with short shiny setae; mesepisternum rugulose tending areolate ventro-laterally, shiny short dense setae; mesepimeron crenulate with shallow depression; several short scattered apically; metapleuron areolate with shiny dense short setae; propodeum areolate, small patch rugulose around metasomal insertion, medial carinae convex, short shiny setae.

Legs. Hind coxa rugulose, tending rugulose-strigate dorsally; femur 0.77 × length of tibia; tibia length 4.28 × width; short setae with ventro-apical pecten of short robust spines; 1st tarsomere 3.27 × length of 2nd tarsomere; 2nd tarsomere 1.25 × length of 3rd tarsomere; 3rd tarsomere 2.00 × length of 4th tarsomere; 4th tarsomere 0.43 × length of 5th tarsomere; tarsal claw 0.57 × length of 5th tarsomere.

Wings. Fore wing first discal cell elongate, wider at junction of vein 3-cu, vein r-m absent, vein SR1 distinctly bent; vein 2-M tubular basal third with node, pigmented remaining two thirds; hind wing vein 2m+Cu spectral, vein 1-m pigmented; three equidistant hamuli.

Metasoma. Metasoma length 3.53 × mesosoma length; hypopygium Y-shaped; ovipositor sheath short, 0.24 × metasoma length; with short dense setae.

Male. Males specimens not examined.

Distribution. The species is known from the ACT with material examined by Pasteels (1957) from NSW and TAS.

Biology. Unknown.

Comments. This species can be distinguished from all other Australian species based on hind tibia without cream patch subbasally and ovipositor sheath very short (2.04 mm).

Gasteruption nobile **Pasteels, 1957**

Fig. 69.

Gasteruption nobile Pasteels, 1957: 30, ♀, ♂; Jennings 2010 [on-line checklist].

Figure 69. *Gasteruption nobile* Pasteels, lateral habitus, scale bar = 1.00 mm.

Material examined.

Holotype. ♀ "Canberra [ACT] 17 Feb [19]48, E F Riek" "*Gasteruption nobile* n. sp. J. Pasteels det., 1954" "Type" (ANIC).

Paratype. TAS: 1♀, St. Patricks road, 6.ii.1914, F.M. Littler (QM: T5498).

Other material examined. **NSW:** 1♀, Canberra, ACT, 5.xii.1966, E.F. Riek (ANIC: 101261). Tasmania: 1?, Tasmania, 1.i.1942, J.W. Evans, (TMAG: F3639). 1♂, Mt. barrow road, -41.345000, 147.352778, 12–14.xii.1998, Malaise trap, D. Yeates (QM)*.

Redescription. *Female*. Body length 14.95 (14.80–16.20) mm; ovipositor length 29.50 (24.00–35.00) mm.

Colour. Head and body black; malar space brown (darker tooth apex); brown posterior margin and ventral corner of pronotum, patch on anterior face touching ventral pronotum corner of mesepisternum; mesepimeron with brown on posterior margin; tegula light brown; fore leg mostly brown, coxa anterior face black, trochantellus dark brown with cream apical margin, tibia with cream stripe on anterior face, tarsus brown, cream stripe on anterior face of 1st and 2nd tarsomere, 4th, 5th tarsomere and claw dark brown; mid leg the same as fore leg, except for coxa brown and tarsus brown, 1st tarsomere mostly cream; hind leg coxa black, trochantellus and prefemur dark brown, femur brown, darker towards apex, tibia brown, darker dorsally with cream patch subbasally on posterior face, tarsus cream with apical half of 2nd tarsomere to tip dark brown, metasoma dark brown, ovipositor sheath dark brown with cream apex 2.98 (2.50–3.73) × length of hind 1st tarsomere, ovipositor brown, wing hyaline, wing vein and pterostigma brown.

Head. Head shape sun-rectangular when viewed dorsally; 1.10 (1.03–1.21) × longer than wide; postocular space in dorsal view long, almost straight, tapering suddenly at occipital carinae; head in lateral view flattened, wider ventrally bellow eye; postocular space long, 0.45 (0.45–0.46) × height of eye; short scattered eye setae; face reticulate with short shiny setae; frons reticulate-punctate with short shiny setae; medial frontal carina raised in anterior third, absent towards vertex; vertex punctate, punctate-strigate posterior of ocelli, short shiny setae; occipital carina narrow, wider ventro-lateral, lamelliform, shallow depression broad and rounded; gena punctate with short shiny setae; minimal width of malar space 0.08 (0.07–0.08) × height of eye; 0.54 (0.50–0.58) × length of pedicel; clypeus punctate; 1.72 (1.59–1.86) × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression absent, short dense setae, longer on margin; lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 1.05 (1.04–1.12) × distance between lateral ocelli; scape 1.58 (1.48–1.60) × length pedicel; 1st flagellomere 1.13 (1.05–1.21) × as long as scape; 0.70 (0.67–0.73) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.29 (2.23–2.35) × height; propleuron length 2.18 (2.08–2.25) × width; 1.38 (1.30–1.42) × prototegular distance; propleuron reticulate-rugulose in anterior half, punctate posteriorly, short dense setae; pronotal process indistinct, rounded; pronotum dorsal lobe punctate-rugulose, anterior lobe punctate with scattered fovea, posterior lobe with large fovea ventrally, groove between pronotum lobes carinate; short dense setae; mesoscutum length 1.40 (1.37–1.44) × height in dorsal view; rounded in lateral view; punctate becoming punctate-rugulose posterior-medially, short scattered setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate, shallower medially; mesoscutellum and axilla punctate with short scattered setae; mesepisternum punctate anteriorly, areolate ventrally and posteriorly; short dense setae; mesepimeron transverse carinae; metapleuron anterior lobe areolate-rugulose, remaining areolate, short shiny dense setae; propodeum areolate with flattened medial carina, short scattered setae.

Legs. Hind coxa punctate, reticulate dorsally with striations in coxal depression; femur length 0.64 (0.64–0.65) × length of tibia; tibia length 4.67 (3.57–4.83) × tibia width; short dense setae with scattered robust spines on anterior face; tarsus with dense stout spins on ventral face and apically; 1st tarsomere 2.89 (2.62–3.10) × length of 2nd tarsomere; 2nd tarsomere 1.52 (1.40–1.75) × length of 3rd tarsomere; 3rd tarsomere 1.91 (1.20–2.14) × length of 4th tarsomere; 4th tarsomere 0.65 (0.42–0.88) × length of 5th tarsomere; tarsal claw 0.97 (0.67–1.25) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated, vein 2-cu concave; vein r-m absent; SR1 weakly bent; 2-M basal third tubular with node, remainder of vein pigmented; hind wing vein 2m+Cu pigmented, all others spectral, four equidistant hamuli.

Metasoma. Imbricate, length 3.21 (3.11–3.29) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 2.90 (2.69–3.10) × metasoma length; with short appressed setae.

Male. Male with lighter hind tibia.

Biology. Unknown.

Distribution. The species is known form the ACT and TAS.

Comments. The species keys out with *G. elegans*, they can be distinguished based on the presence of hind wing veins in *G. nobile* and ovipositor sheath almost three times the length of metasoma, see key couplet 56.

Gasteruption novae-hollandiae Schletterer, 1885

Fig. 70.

Gasteruption novae-hollandiae Schletterer, 1885: 297, ♀; Schletterer, 1890: 449, ♀: Strand, 1911: 132, ♀, ♂; Pasteels, 1957: 113, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, “Foenus novae-holl” “Cn de Saussure” “*G. novae-hollandiae* Schlett” (MHNG).

Other material examined. **QLD:** 1♀, Brisbane, 25.x.1914, H. Hacker (QM). **ACT:** 1♀, Black Mountain, Canberra, 15.i.1934, W. Refferty (ANIC). **SA:** 1♀, Visitors center, Seal Bay Conservation Park, Kangaroo Island, over *Melaleuca,* 3.iii.2008, D.A. Young (WINC). **WA:** 1♀, no other details, 54–1142 (WAM).

Figure 70. *Gasteruption novae-hollandiae* Schletterer, holotype female, lateral habitus, scale bar = 1.00 mm (© Geoff Thompson, QM).

Redescription. *Female.* body length 18.75 (17.70–19.80) mm; ovipositor length 17.00 mm

Colour. Head and body black; inner surface of scape brown, clypeus lateral corners, malar space and mandibles brown (black tooth apex); propleuron brown posteriorly, pronotum dorsal lobe, dorsal posterior pronotal lobe and ventral corner brown, mesepisternum anterior margin, tegula and metanotum brown, propodeum lighter around propodeal spiracle and metasoma insertion; fore leg brown, trochantellus with cream apical margin, tibia dark brown with cream longitudinal stripe on anterior face, tarsus dark brown with cream longitudinal stripe on anterior face of 1st and 2nd tarsomere; hind leg mostly brown, coxa with varying amounts of black on lateral face, trochantellus, prefemur and apex of femur dark brown, tibia dark brown with cream band subbasally, tarsus cream with basal half of 1st tarsomere and apical half of 5th tarsomere and claw dark brown; metasoma brown, darker basally and apically, ovipositor sheath dark brown with cream apex 2.26 (2.09–2.54) × length of 1st tarsomere; ovipositor brown; wing hyaline, wing vein dark brown and pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; length 1.06 (1.01–1.16) × width; postocular space tapering sharply towards occipital carinae; head in lateral view distinctive wedge shape, face long with vertex slightly raised; postocular space 0.38 (0.32–0.41) × height of eye; head mostly granular with vertex becoming finely reticulate medially, short dense shiny setae; medial frontal carina raised in anterior half, becoming a indistinct groove posteriorly; occipital carina short, wider ventro-laterally, lamelliform, shallow depression medially emarginate; minimal width of malar space 0.10 (0.07–0.11) × height of eye; 0.67 (0.46–0.83) × length of pedicel; clypeus granular; 1.80 (1.63–1.95) × wide as high; margin sinuate with lateral corners barely protruding forwards; medial depression shallow anteriorly, short dense shiny setae, longer setae along margin and medial in shallow groove; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.32 (0.27–0.36) × distance between lateral ocelli; scape 1.91 (1.85–2.00) × length pedicel; 1st flagellomere 1.40 (1.38–1.41) × as long as scape; 0.83 (0.77–0.90) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.55 (2.00–2.90) × height; propleuron length 1.35 (1.24–1.42) × width; 0.92 (0.83–1.00) × prototegular distance; propleuron granular, rugulose dorsally, short dense shiny setae; pronotal process distinct and rounded; pronotum anterior lobe granulate-rugulose, dorsal lobe granulate and posterior lobe carinate; groove between pronotum lobes carinate, short dense shiny setae; mesoscutum length 1.36 (1.27–1.44) × width in dorsal view; rounded in lateral view; granular with scattered shallow punctures; larger punctures medially, short dense gold shiny setae; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular with short scattered shiny setae; mesepisternum areolate with anterior corner granular, medium dense shiny setae; mesepimeron carinate with reticulate shallow depressions in the middle; metapleuron areolate with medium dense shiny setae; propodeum areolate-rugulose, medial carinae convex, medium dense shiny setae;

Legs. Hind coxa strigate-rugulose dorsally, reticulate-rugulose laterally; femur length 0.72 (0.70–0.75) × tibia length; tibia length 5.42 (4.88–6.00) × tibia width; short dense setae with scattered short robust spines and anterior face; tarsus with short dense spines on ventral face; 1st tarsomere 3.05 (2.74–2.32) × length of 2nd tarsomere; 2nd tarsomere 1.68 (1.36–2.20) × length of 3rd tarsomere; 3rd tarsomere 1.57 (1.11–2.00) × length of 4th tarsomere; 4th tarsomere 0.43 (0.35–0.50) × length of 5th tarsomere; tarsal claw 0.56 (0.50–0.60) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of vein 3-cu;

vein r-m absent; vein SR1 distinctly bent; vein 2-M tubular basal quarter with node, remaining pigmented; hind wing vein 1-m pigmented, other veins spectral; three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma length 2.55 (2.00–2.90) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.55 (1.13–1.76) × metasoma length; short appressed setae.

Male. Males specimens not examined but described by Pasteels (1957) as having the same characters as the female.

Distribution. The species is distributed widely from QLD, ACT, SA and WA

Biology. Unknown.

Comment. The species is superficially similar to *G. peregrinum* based on the elongated face and short postocular space (0.39–0.40 × height of eye). *G. novae-hollandiae* is easily separated from *G. peregrinum* by having a sinuate anterior clypeus and brown mandibles (concave margin and black mandibles in *G. peregrinum*).

Gasteruption oculare **Schletterer, 1890**

Fig. 71.

Gasteruption oculare Schletterer, 1890: 437, ♀; Pasteels, 1957: 79, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, “Sydney” ‘Cn de saussure" (MHNG).

Specimen damage. Right antenna 7th flagellomere to tip, left antenna 6th flagellomere to tip missing, metasoma T4 to tip missing.

Other material examined. **NSW:** 1♀, Nyrgan, ii.1933, J. Armstrong (AM: K

279884).

Figure 71. *Gasteruption oculare* Schletterer, holotype female, lateral habitus, scale bar = 1.00 mm

Redescription. *Female.* body length 14.90 mm; ovipositor length 8.10 mm.

Colour. Black; antenna, mandibles and tegula dark brown; fore and mid leg mostly dark brown, tibia with cream longitudinal stripe on anterior face, tarsus 1st tarsomere and 2nd tarsomere cream; hind leg mostly dark brown, tibia with cream patch subbasally on ventral face, 1st tarsomere to 4th tarsomere cream; metasoma dark brown; wing hyaline; wing veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; length 1.05 (0.93–1.17) × width; postocular space bulbous, gently tapering at occipital carinae; head in lateral view elongated with large eye, convex frons and vertex; postocular space 0.35 × height of eye; eye setae absent; head finally granular with short dense setae; medial frontal carina indistinct; occipital carina narrow, wider ventro-laterally, lamelliform, broad, shallow depression, rounded; minimal width of malar space 0.07

(0.07–0.08) × height of eye; 0.55 × length of pedicel; clypeus 1.6 × wide as high; margin sinuate with lateral corners distinctly protruding forwards; medial depression indistinct, short dense setae, longer along margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.41 (0.31–0.52) × distance between lateral ocelli; scape 1.6 × length pedicel; 1st flagellomere 1.14 × as long as scape; 0.78 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.57 × height; propleuron length 1.57 × width; 0.83 × prototegular distance; propleuron reticulate-rugulose dorsally, becoming granular laterally, short setae; pronotal process indistinct; pronotum granular, posterior lobe coriaceous, groove between pronotum lobes carinate, short scattered setae, longer in groove; mesoscutum length 1.43 × width in dorsal view; rounded in lateral view; granular with short scattered setae; admedial lines present; parapsidial lines indistinct; notauli U-shaped, scrobiculate; mesoscutellum areolate with short setae; axilla granular with short setae; mesepisternum reticulate-rugulose with some scattered shallow punctures, short scattered setae; mesepimeron bottom half carinate with broad depressions, top half almost smooth with faint carinae; metapleuron reticulate-rugose, short scattered setae; propodeum areolate-rugulose, medial carina flattened, short scattered setae.

Legs. Hind coxa granular with striations in dorsal depression; femur length 0.63 × length of tibia; tibia length 4.09 × tibia width; short dense setae with scattered stout spines on anterior face; tarsus with short robust setae on ventral face and apically; 1st tarsomere 3.56 × length of 2nd tarsomere; 2nd tarsomere 1.50 × length of 3rd tarsomere; 3rd tarsomere 1.71 × length of 4th tarsomere; 4th tarsomere 0.44 × length of 5th tarsomere; tarsal claw 0.63 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of vein 3-cu; fore wing vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular with apical node, remainder of vein pigmented; hind wing veins spectral, three equidistant hamuli.

Male. Unknown.

Distribution. The species is known from two localities in NSW.

Biology. Unknown.

Comments. This species keys out with *G. crassitibale* from which it is easily separated from by pronotum completely black, pronotal process indistinct and ovipositor sheath completely black/ dark brown.

Gasteruption pachypus Pasteels, 1957

Fig. 72.

Gasteruption pachypus Pasteels, 1957: 75, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "17 m[i]l[e]s. NW. Ross, Tas. 2 Feb.'49, E.F.Riek" (ANIC).

Specimen damage. Left antenna 7th flagellomere to tip and right antennae 3rd flagellomere to tip missing.

Figure 72. *Gasteruption pachypus* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* body length 14.70 mm; ovipositor length 5.00 mm.

Colour. Head and body black; antennae dark brown, clypeus with brown lateral corners, mandibles brown with black tooth apex; pronotum posterior margin dark brown, mesepisternum dorsal, anterior and ventral margins and mesepimeron ventral corner brown, tegula dark brown; fore and mid leg mostly brown, femur with cream apex, tibia with longitudinal cream stripe on anterior face, tarsus brown with cream stripe on anterior face of 1st tarsomere to 3rd tarsomere; hind leg mostly brown, coxa apex, trochantellus posterior and prefemur dark brown, femur darker dorsally, tibia brown, black dorsally with cream patch subbasally, tarsus cream with base of 1st tarsomere, 4th tarsomere to claw dark brown; metasoma dark brown, darker basal half of T1, and apically; ovipositor sheath dark brown with cream apex 1.26 × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing vein and pterostigma dark brown.

Head. Head sub-rectangular when viewed dorsally; length 0.95 × width; postocular space short and convex; head in lateral view, frons and vertex convex; postocular space short, 0.39 × height of eye; short scattered eye setae; head reticulate with scattered punctures between lateral ocelli, short dense shiny setae; medial frontal carina raised between antennal scrobes, indistinct groove remaining, occipital carina short, lamelliform, shallow depression, medially emarginate; minimal width of malar space 0.15 × height of eye; 0.41 × length of pedicel; clypeus reticulate; 2.33 × wide as high; margin sinuate with lateral corners distinctly protruding forwards; medial depression distinct anteriorly, short shiny setae, longer on margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.73 × distance between lateral ocelli; scape 1.75 × length pedicel; 1st flagellomere 0.86 × as long as scape; 0.75 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.75 × height; propleuron length 1.00 × width; 0.80 × prototegular distance; propleuron rugulose with short dense shiny setae; pronotal process indistinct and rounded; pronotum reticulate dorsally becoming rugulose ventrally, groove between pronotum lobes carinate, short dense shiny setae; mesoscutum length 1.15 × width in dorsal view; rounded in lateral view, reticulate posterior margin with irregular shallow depressions, short scattered setae; admedial lines indistinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate with short scattered setae;

mesepisternum carinate anterior corner, rugulose becoming coarser ventro-laterally, short dense shiny setae; mesepimeron carinate with shallow depression, rugulose anterior margin; metapleuron areolate, coarsely reticulate posterior corner, short dense shiny setae; propodeum coarsely strigo-reticulate, medial carina flattened, short dense setae.

Legs. Hind coxa reticulate anteriorly becoming rugulose posteriorly; femur 0.72 × length of tibia. tibia length 3.91 × tibia width; short dense setae; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.67 × length of 2nd tarsomere; 2nd tarsomere 1.5 × length of 3rd tarsomere; 3rd tarsomere 1.25 × length of 4th tarsomere; 4th tarsomere 0.53 × length of 5th tarsomere; tarsal claw 0.67 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of vein 3-cu; vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular with node, remaining two thirds pigmented; hind wing vein 2m+Cu spectral; three equidistant hamuli.

Metasoma. Metasoma 2.36 × mesosoma length, hypopygium Y-shaped; ovipositor sheath 0.58 × metasoma length; short appressed dense.

Male. Male specimens not examined but described by Pasteels (1957) as having hind legs less clavate and T9 with cream patch.

Distribution. The species is known only from type locality near the town Ross, TAS.

Biology. Unknown.

Comments. *Gasteruption pachypus* is superficially similar to *G. mirabilifemorale* based on the distinctly enlarged hind coxa, femur. The species can be separated based on *G. pachypus* having longer scape (2.24 × pedicel length), hind wing veins spectral and a shorter ovipositor sheath (0.58 × metasoma length).

Gasteruption pasteelsi Macedo, 2011

Gasteruption tenue Pasteels, 1957: 24, ♀; Jennings 2010 [on-line checklist].

Gasteruption pasteelsi Macedo, 2011: 59 (n. name).

Material examined.

Holotype. #m, "Brisbane : H. Hacker. 19.11.13" "*Gasteruption tenue* n.sp. J. Pasteels det., 1955" (QM: T5466).

Specimen damage. Right mid leg claw missing.

Paratype. #m, Same data as holotype (QM: T5467).

Comments. The original species description is based entirely on a single male specimen, and until we can associate females, we have refrained from redescribing this species.

Gasteruption peregrinum Schletterer, 1885

Fig. 73.

Figure 73. *Gasteruption peregrinum* Schletterer, lateral habitus.

Gasteruption lativalva Kieffer, 1904: 554, ♂ (syn. Pasteels, 1957).

Gasteruption peregrinum Schletterer, 1885: 321, ♀; Pasteels, 1957: 96, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype *Gasteruption lativalve* Kieffer. ♀, "Australia" "*Gasteruption lativalve*" (NHRS: 000004932) [examined from photos]. *Specimen damage.* Both antennae, 5th flagellomere to tip broken and glued in place, left fore leg 5th tarsomere to tip missing, right hind leg 4th tarsomere to tip missing, metasoma broken and glued to specimen, T2 to tip missing.

Holotype *Gasteruption peregrnum* Schletterer. ♀, "*peregrum* det. Schlett" (NHMW: 0002803) [examined from photos]. *Specimen damage.* Left and right antennae 5th flagellomere to tip missing.

Other material examined. **SA:** ♀, Waite Arboretum, 34º58'128'S, 138º37'983'E, 9.xi.2011, R.V. Glatz (RGC: 14076)*; ♀, Waite Arboretum, 34º57'910'S, 138º37'702'E, 22.xi.2012, R.V. Glatz (RGC: 14088).

Redescription. *Female.* Body length 20.57 (18.60–22.40) mm; ovipositor length 16.60 (15.90–17.30) mm.

Colour. Black; antenna dark brown, apical flagellomeres orange-brown; tegula brown; fore and mid legs brown, apical margin of trochantellus and longitudinal stripe on anterior face of tibia cream, tarsus dark brown with anterior face of 1st, 2nd and 3rd tarsomere cream; hind leg dark brown, coxa black, tibia with cream patch subbasally on ventral face, tarsus cream, basal third of 1st, 5th tarsomere and claw dark brown; metasoma black; ovipositor sheath dark brown with cream apex 1.78 (1.66–1.89) × length of hind basitarsus; wings hyaline, wing veins and pterostigma dark brown.

Head shape sub-rectangular when viewed dorsally; length 0.94 (0.90–0.99) × width; postocular space bulbous, gently tapering at occipital carina; head in lateral view elongated with short postocular space, 0.40 (0.39–0.40) × height of eye; eye setae absent; face and frons punctate, becoming granular-rugulose towards vertex, medium dense shiny setae; medial frontal carina raised between antennal scrobes, becoming shallow groove posterior half; vertex granular-rugulose, directly behind lateral ocelli transverse strigate-rugulose, vertex raised, posteriorly rugulose with several scattered shallow punctures, short scattered shiny setae; narrow lamelliform occipital carina, wider ventro-laterally, shallow depression, medially emarginate; gena punctate with medium dense shiny setae; minimal width of malar space 0.09 (0.07–0.10) × height of eye; 0.76 (0.71–0.80) × length of pedicel; clypeus punctate; 1.93 (1.76–2.10) × wide as high, margin sinuate, lateral corners distinctly protruding forwards, medial depression distinct in anterior two thirds, medium dense shiny setae, longer on margin; lateral ocelli in-line of postocular line, distance from lateral ocellus to eye margin 0.42 (0.39–0.44) × distance between lateral ocelli; scape 1.86 (1.82–1.89) × length pedicel; 1st flagellomere 1.34(1.31–1.38) × as long as scape; 0.69 (0.68–0.70) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.86 (1.83–1.90) × height; propleuron length 1.31 (1.27–1.35) × width; 0.78 (0.73–0.81) × prototegular distance; propleuron rugulose-reticulate with medium dense shiny setae, pronotal process large and hooked outwards; pronotum anterior lobe reticulate-rugulose, dorsal and posterior lobe granular, broad carinate groove between pronotum lobes, medium dense shiny setae; mesoscutum length 1.35 (1.22–1.48) × width in dorsal view; truncated in lateral view, rugulose-granular with short scattered shiny setae; notauli U-shaped, scrobiculate; mesoscutellum and axillae rugulose-granular with short scattered setae; mesepisternum areolate-granular dorsally becoming broadly transverse strigose, medium dense shiny setae; mesepimeron with distinct transverse carinae creating elongated fovea ventral half, becoming less defined medially, glabrous patch dorso-anteriorly, short scattered setae in dorsal corner; metapleuron areolate with distinct raised striations, medium dense shiny setae; propodeum areolate-rugulose, longitudinal medial carina raised, medium dense shiny setae.

Legs. Hind coxa strigate dorsally, laterally imbricate; femur 0.69 (0.61–0.77) × length of tibia; tibia length 5.69 (5.46–5.92) × tibia width, short setae with scattered stout emergent spines on anterior face; 1st tarsomere 2.98 (2.96–3.00) × length of 2nd tarsomere; 2nd tarsomere 1.43 (1.42–1.44) × length of 3rd tarsomere; 3rd tarsomere

1.87 (1.78–1.97) × length of 4th tarsomere; 4th tarsomere 0.44 (0.43–0.45) × length of 5th tarsomere; tarsal claw 0.45 (0.44–0.45) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular; vein r-m absent; vein SR1 distinctly bent, vein 2-M basal quarter tubular with apical node, remainder pigmented; hind wing vein apical two thirds of 2m+Cu and 1-m and apical quarter of r-m pigmented, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma 2.68 (2.68–2.69) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.22 (1.20–1.24) × metasoma length, short appressed setae, cream apex distinctly dilated.

Male. Not examined but described by Pasteels (1957) as same as female.

Distribution*.* The species is known from SA with material examined by Pasteels (1957) from QLD, NSW, TAS and WA.

Biology. Unknown.

Comment. The species is superficially similar to *G. atrinerve*, *G. novae-hollandiae,* and *G. villosulum* based on the elongated face and short postocular space (0.39–0.40 × height of eye). They can be separated by *G. peregrinum* having a concave anterior clypeus margin (sinuate in the other three species), and a shorter cream ovipositor apex (1.66 × 1st hind tarsomere, >2.00 in the other three species). The completely black mesosoma and dark brown mandibles helps to separate *G. peregrinum* from *G. novae-hollandiae* which has brown patches on the mesosoma and mandibles. *G. atrinerve* and *G. villosulum* are smaller in size (9.00–14.00 mm) compared to *G. peregrinum* which is larger (18.60–22.40).

Gasteruption platycephala Pasteels, 1957

Fig. 74.

Figure 74. *Gasteruption platycephala* Pasteels, lateral habitus, scale bar = 1.00 mm.

Gasteruption platycephala Pasteels, 1957: 33, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Blundells, [A.C.T] 19 Apr [19]48, E F Riek" (ANIC).

Collection locality is likely to be in the vicinity of Blundells Cottage, Wendouree Dr, Parkes ACT 2600.

Specimen damage. Left antenna 8th flagellomere to tip missing, complete metasoma missing.

Paratypes. TAS: 1♀, Hobart, 19.x.1913, G.H. Hardy (SDEI); 1♀, Cradle Mountain 17.i.1917, G.H. Hardy (SDEI).

Other material. **TAS:** 1♀, Glen Huon, 19.ix.1973, M. Bouffard (TMAG: F33230); 1♀, Seven Mile Beach, Pittwater Road, 21.iii.1985, R. Bashford (TMAG:

F33213); 1♀, Warra LTER site, Malaise Trap, 13.i.1999, R. Bashford (TMAG: F33372)*; 1♀, George Town, 41.09 S, 146.81 E, sticky trap on *Acacia dealbata*, 10.i.2001, R. Bashford (TMAG: F33244); 2♀, 1♂, Warra LTER site, Malaise trap 118, ii.2001, R. Bashford (TMAG: F33367 - F33369); 1♀, 2♂, Warra LTER site: Mount Weld: Transect A: 43.0321 S, 146.7006 E, 27.ii.2001, R. Bashford (TMAG: F33305, F33309, F33308); 1♀, Warra LTER site: Manuka road, WR008H: 43.0965 S, 146.6848 E, Malaise Trap, 1.iii.2001, R. Bashford (TMAG: F33281); 2♀, George Town, 41.09 S, 146.81 E, Sticky trap on *Eucalyptus globulus*, 07.iii.2001 and 03.i.2002, R. Bashford, (TMAG: F33253; F33242); 1♀, Warra, MT, iv.2004, R. Bashford (TMAG: F33374); 1♀, Long Hill, 21.ii.2006, R. Bashford (TMAG: F33225); 3♀, Bracknell, Volatiles trail 41.65 S, 146.9667 E, 14.iii.2007 and 11.iii.2009, R. Bashford (TMAG: FT43663; FT43664' FT43700); 1♂, Warra LTER site: Manuka Road, SST control Forestry coupe WR008J: Transect A: 43.1008 S, 146.6834 E, 12.ii.2008, R. Bashford (TMAG: F33304).

Redescription. *Female*. Body length 15.22 (12.45–16.8) mm; ovipositor length 11.25 (11.00–11.50) mm.

Colour. Body black; mandible pale brown with darker tooth apex; orange brown on pronotum ventro-posterior corner, mesepisternum ventrally and posteriorly at mid coxa insertion, mesepimeron ventral 2/3, metapleuron with patch ventrally and posteriorly, propodeum posterior margin orange-brown; tegula light brown; fore and mid legs mostly dark brown, coxa orange-brown, prefemur and femur brown, tibia dark brown with longitudinal cream stripe on anterior face, tarsus cream, 3rd tarsomere to tip dark brown; hind leg mostly dark brown, coxa orange-brown laterally and ventrally, prefemur lighter brown, tibia with cream patch sub basally, apical 2/3 of 1st tarsomere, 2nd tarsomere and basal half of 3rd tarsomere cream; metasoma dark brown, darker basally and apically; ovipositor sheath dark brown with cream apex 2.31 (2.15–2.50) × length of hind 1st tarsomere; ovipositor light brown; wings hyaline, veins and pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; 1.20 (1.15–1.28) × longer than wide, postocular space almost straight, tapering towards occipital carina;

head in lateral view elongated and flattened, with long postocular space; postocular space 0.52 (0.47–0.59) × height of eye; short scattered eye setae; face reticulate with short shiny setae; frons reticulate becoming granular posteriorly, short shiny setae; medial frontal carina distinct between antennal scrobes, absent posteriorly, in some specimens a short indistinct groove; vertex granular with short scattered setae; occipital carina short, wider ventro-laterally, depression shallow, medially pointed, lamelliform; gena granular with short shiny setae, longer and denser ventro-laterally; minimal width of malar space 0.03 × height of eye; 0.19 (0.17–0.20) × length of pedicel; clypeus reticulate; 2.26 (2.17–2.40) × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression absent, short shiny setae, longer on ventral margin; lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 1.09 (1.00–1.22) × distance between lateral ocelli; scape 1.22 (0.68–1.53) × length pedicel; 1st flagellomere 1.03 (1.00–1.05) × as long as scape; 0.45 (0.44–0.46) × length 2nd flagellomere.

Mesosoma. length 2.32 (2.29–2.35) × height; propleuron length 2.54 (2.42–2.77) × width; 1.33 (1.29–1.36) × prototegular distance; propleuron reticulate with short shiny dense setae; pronotal process large and acute; dorsal and anterior lobes of pronotum reticulate, posterior lobe coriarious becoming coarser ventrally; groove between pronotal lobes carinate, short scattered shiny setae, longer in groove; mesoscutum length 2.96 (2.86–3.08) × width in dorsal view; rounded in lateral view; granular with short scattered setae; admedial lines converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular with short scattered setae; mesepisternum reticulate-rugulose dorsally, ventral half areolate, short shiny dense setae; mesepimeron wide, carinate with scattered fovea medially, some specimens with a smooth glabrous patch dorsally; metapleuron areolate-rugulose dorsally, areolate ventrally, short dense shiny setae with a large glabrous area on anterior-ventral corner; propodeum areolate, medial carina flattened and almost smooth, short scattered setae.

Legs. Hind coxa strigate dorsally, reticulate laterally; femur 0.68 (0.67–0.69) × length of tibia; tibia length 5.45 (5.32–5.61) × width; short dense setae; tarsus with short pecten of spines on ventral face; 1st tarsomere 3.19 (3.00–3.39) × length of 2nd tarsomere; 2nd tarsomere 1.38 (1.35–1.42) × length of tarsomere 3; tarsomere 3 1.96

(1.89–2.0) × length of tarsomere 4; tarsomere 4 0.53 (0.50–0.56) × length of tarsomere 5; tarsal claw 0.53 (0.50–0.56) × length of tarsomere 5.

Wings. Fore wing first discal cell rectangular, tapering at junction of vein 3-cu; fore wing vein r-m absent; vein SR1 straight; 2-M basal third tubular with a node, remainder pigmented; hind wing vein 2m+Cu and 1-m lightly pigmented; three hamuli equidistant.

Metasoma. Metasoma length 2.96 (2.86–3.08) × mesosoma length; hypopygium Y-shaped ovipositor sheath 1.04 (0.97–1.13) × metasoma length; short appressed seta.

Variation. One paratype female has more orange-brown coloration on ventral mesosoma.

Male. Similar to female except first flagellomere same length as pedicel.

Biology. Unknown.

Distribution. The species is known various localities TAS.

Comments. This species is superficially similar to *G. elegans, G. longicolle*, and *G. longipes* which all have short postocular spaces (0.33–0.37 × height of eye), long propleurons (>2.00 × width) and long ovipositor sheaths (1.28–1.58 × metasoma length). *Gasteruption platycephala* can be distinguished based on a longer postocular space (0.52 × height of eye), and a shorter ovipositor sheath (0.97–1.13 × metasoma length). Pasteels (1957) commented that Kieffer (1912) erroneously described this species as *G. Steindachneri* Schletterer and separated the two species based on the presence of a closed forewing discal cell. The whereabouts of the type for G. *Steindachneri* is unknown so we are unable to compare the species.

Gasteruption plicatulum Pasteels, 1957

Fig. 75.

Gasteruption plicatulum Pasteels, 1957: 101, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Collubri Nyngan. N.S.W Feb. 1933 J. Armstrong" "*Gasteruption plicatulum* n.sp J. Pasteels det.. 1955" (AM: K66699).

Specimen damage. Complete right antenna and left antenna pedicel to tip missing, left fore leg tarsus and mid legs trochanter to tip missing. Right hind leg 4th tarsomere to tip missing, left hind leg tibia to tip broken and mounted to card bellow specimen. Metasoma segments 1–3 missing, remaining metasoma is broken and glued to card beneath specimen.

Paratypes. NSW: 1 ♀, Ballina, A.N. Burns (NMV) [not examined]; **VIC:** 1♀, Quantong, A.D. Selby (NMV) [not examined].

Other material. **QLD:** 1♀, Inskip Ave, Inskip point, -25.5405547, 153.0357909, 01.vii.2016, B.A. Parslow & O.K. Davies (SAMA)*.

Figure 75. *Gasteruption plicatulum* Pasteels, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female*. Body length 12.80 (10.60–15.00) mm; ovipositor length 6.30 (5.70–7.00) mm.

Colour. Black and Red-brown; antenna dark brown; head mostly black, clypeus and malar space red-brown, more black on type specimen, golden setae on vertex, brown between antennal scrobes and along eye margins, mandibles light brown with darker tooth apex; pronotum anterior lobe and dorso-posterior corner, mesepisternum anterior lobe and on posterior margin, ventral lobe of mesepimeron, patch medially bellow dorsal lobe of metapleuron red- brown, mesoscutum mostly red-brown with black medially and patches around parapsidial lines; tegula brown; posterior margin of propodeum red-brown; fore and mid legs mostly brown, coxa dark brown, trochantellus with cream apical margin, femur brown with cream spot apically, tibia with longitudinal cream stripe on anterior face, tarsus brown with 1st to 3rd tarsomere to cream; hind leg coxa red-brown, black dorsally, trochantellus black, prefemur and femur brown, black dorsally, tibia dark brown, lighter ventrally with cream patch subbasally, tarsus cream, basal third of 1st tarsomere, base of 5th tarsomere and claw dark brown; metasoma dark brown, lighter laterally; ovipositor sheath dark brown with apex 0.94 (0.50–1.37) × length of hind 1st tarsomere; wings hyaline, wing veins dark brown, pterostigma light brown.

Head. Head shape sub-conical when viewed dorsally; length 1.49 (1.48–1.50) × width; postocular space very short and convex; head in lateral view face long; postocular space short, 0.26 × height of eye; eye setae absent; face and frons reticulate-rugulose with short dense setae; medial frontal carina indistinct; vertex and gena rugulose with short scattered setae on the vertex and dense shiny setae on the gena; occipital carina narrow, wider ventro laterally, lamelliform, shallow rounded depression; malar space long, minimal width 0.21 (0.20–0.23) × height of eye; clypeus reticulate-rugulose; 1.63 (1.50–1.75) × wide as high; margin sinuate with lateral corners barley protruding forwards, medial depression indistinct, short dense setae, longer setae along margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.61 (0.53–0.68) × distance between lateral ocelli; scape 1.89 × length pedicel, 1st flagellomere 1.18 × as long as scape, 0.80 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.63 (1.45–1.80) × height; propleuron length 1.03 × width; 0.87 (0.82–0.92) × prototegular distance; propleuron rugulose with short dense setae, becoming longer ventro-laterally; pronotal process long and acute in dorsal view; pronotum reticulate with groove between pronotal lobes carinate, short dense setae; mesoscutum length 1.63 (1.45–1.80) × height in dorsal view;

truncated in lateral view; medial lobe rugose with short dense setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugose with short scattered setae; mesepisternum coarsely rugose becoming areolate ventro-laterally, short dense setae; mesepimeron carinate with shallow depression; metapleuron areolate dorso-lateral, becoming coarsely areolate-rugose, short dense setae; propodeum areolate, medial carina flattened, short dense setae.

Legs. Hind coxa rugulose dorsally, tending imbricate laterally; femur length 0.66 (0.64–0.68) × length of tibia; tibia length 5.94 × width; short setae with scattered emergent short robust spines; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.42 (3.15—3.68) × length of 2nd tarsomere; 2nd tarsomere 1.24 (1.06–1.42) × length of 3rd tarsomere; 3rd tarsomere 2.90 (2.00–3.80) × length of 4th tarsomere; 4th tarsomere 0.27 (0.17–0.38) × length of 5th tarsomere; tarsal claw 0.39 (0.37–0.47) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated, wider at junction of 2-Cu, 3-cu and 1m-cu; vein r-m absent; vein SR1 weakly sinuate; vein 2-M basal third tubular with node, remaining pigmented; hind wing vein apical 2/3rds of 2m+Cu and 1-m pigmented; three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma length 2.31 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.85 × metasoma length; with covered in appressed setae with flared cream apex.

Male. Male specimens were not examined but described by Pasteels (1957) as having a shorter pedicel compared to the female.

Biology. The specimen collected at Inskip (QLD) point by B.A. Parslow & O.K. Davies (SAMA) was reared from the nest of *Meroglossa striaticeps* (Friese, 1924) (Colletidae: Hylaeinae) in a *Xanthorrhoea* sp. flower scape.

Distribution. The species is known from localities in QLD and NSW with material examined by Pasteels (1957) from VIC.

Comments. *Gasteruption plicatulum* can be distinguished from other species by the elongated face with long malarspace (1.60 × length of pedicel) and extremally short postocular space (0.26 × height of eye) and mesosoma (1.63 × height).

Gasteruption primotarsale Pasteels, 1957

Fig. 76.

Gasteruption primotarsale Pasteels, 1957: 74, ♀, ♂; Jennings 2010 [on-line checklist].

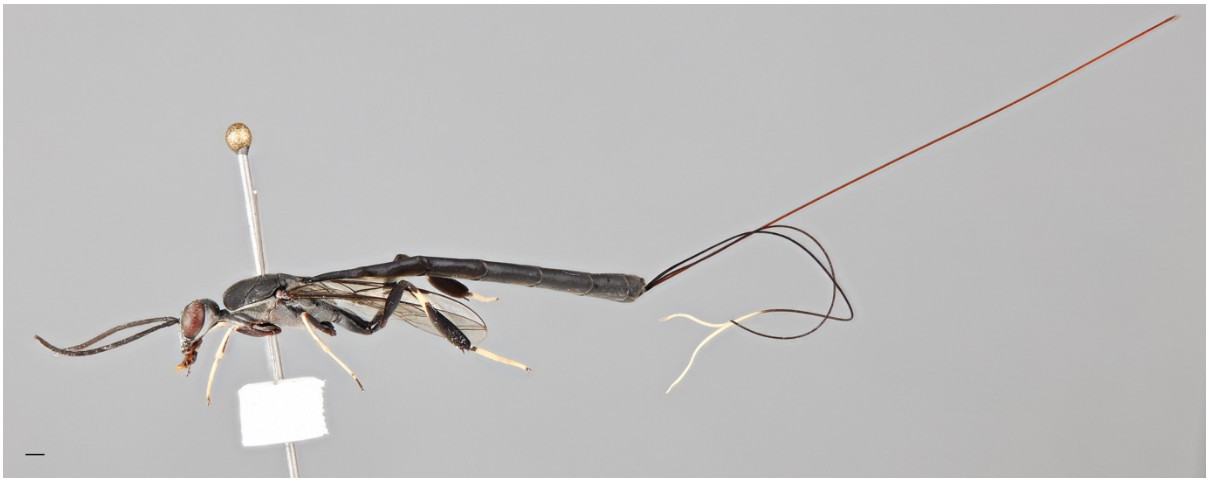

Figure 76. *Gasteruption primotarsale* Pasteels, lateral habitus, scale bar = 1.00 mm.

Material examined.

Holotype. ♀, "Kiandra N S W, 23 Feb 1952, B Given" (ANIC).

Paratypes. NSW: 1♀,1♂, Kiandra, 23.ii.1952, B. Given (ANIC). **ACT:** 1♀, Blundell's, 19.i.1935, M. Fuller (ANIC). **TAS:** ♀, Maria Island, 30.xii.1915, G. H. Hardy (SDEI).

Other material examined. **QLD:** 1♀, Canungra Creek, 4 miles S of Canungra, 26.xii.1971, G. B. Monteith (QM)*; 1♀, 15 km SW of Stanthorpe, 5.xi.1981 E.M. Exley & J. King, on *Eucallyptus* (QM). NSW: 1♀, 6km N.E. Bilpin, Blue Mountains, 17.iv.1984, N.W. Rodd (AM). **VIC:** 1♀, Belgrave, 2.iix.2016 (BPC). **TAS:** 1♀, Bracknell, E Bracknell Volatiles Trail, -41.650000, 146.966700, Malaise trap, 14.i.2009, R. Bashford (TMAG: FT43695). Unknown: 1♀, Hy199, 9901 (QDPI).

Redescription. *Female.* Body length 21.00 (20.00–23.00) mm; ovipositor length 27.43 (26.80–28.00) mm.

Colour. Black; pronotum ventral corner and mesepisternum with a patch along anterior of lobe to coxa insertion brown, mesepimeron dark brown, black dorsally, tegula brown; fore and mid legs brown, coxa and trochantellus darker brown, femur with cream patch on apex, tibia dark brown with longitudinal cream stripe on anterior face, tarsus cream, 5th tarsomere and claw dark brown; hind leg dark brown, tibia with cream band subbasally, tarsus cream, basal third of 1st tarsomere and claw dark brown; metasoma dark brown; ovipositor sheath dark brown with cream apex 4.74 (4.36–5.07) × length of hind 1st tarsomere; ovipositor brown; wings hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.95 (0.80–1.10) × width, postocular space gently convex; head in lateral view wedge shape, convex frons and vertex with ventro-posterior corner wider; postocular space 0.35 (0.30–0.40) × height of eye; short scattered eye setae; face reticulate with shiny setae, denser laterally; frons reticulate becoming reticulate-rugulose posteriorly, short scattered setae; medial frontal carina raised in anterior third, absent posteriorly; vertex reticulate-rugulose with short scattered setae; narrow lamelliform occipital carina, wider ventro-laterally; shallow rounded depression; gena reticulate-rugulose with short shiny setae; minimal width of malar space 0.08 (0.07–0.09) × height of eye; 0.80 (0.60–1.00) × length of pedicel; clypeus reticulate with scattered punctures; 1.87 (1.84–2.00) × wide as high; margin sinuate; lateral corners distinctly protruding forwards; medial depression indistinct, short shiny setae, longer along margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.65 (0.40–1.10) × distance between lateral ocelli; scape 2.20 (2.10–2.30) × length pedicel. 1st flagellomere 1.22 (1.10–1.35) × as long as scape; 0.70 (0.60–0.81) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.95 (1.90–2.00) × height; propleuron length 1.27 (1.25–1.31) × width; 0.75 (0.70–0.80) × prototegular distance; propleuron rugulose with medium dense shiny setae; pronotal process acute, anterior lobe of pronotum rugulose with dorsal and posterior lobes reticulate, groove between pronotum lobes carinate, medium shiny setae; mesoscutum length 1.45 (1.42–1.48)

× width in dorsal view; truncated in lateral view; reticulate-rugulose, coarser patch medial-posteriorly, short scattered setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum reticulate-rugulose with short setae; axilla reticulate with short setae; mesepisternum rugulose laterally, becoming areolate ventro-laterally, dense medium shiny setae; mesepimeron carinate; metapleuron coarsely rugulose laterally becoming areolate ventro-laterally, dense medium shiny setae; propodeum areolate-rugose, tending areolate ventro-laterally with medium dense shiny setae; medial carina flattened.

Legs. Hind coxa reticulate-rugulose laterally, strigate posterior face; femur 0.66 (0.64–0.68) × length of tibia; tibia length 5.45 (5.30–5.60) × tibia width; short setae; tarsus with short robust spines on ventral face; 1st tarsomere 3.40 (2.90–3.90) × length of 2nd tarsomere; 2nd tarsomere 1.39 (1.25–1.53) × length of 3rd tarsomere; 3rd tarsomere 1.45 (0.79–2.10) × length of 4th tarsomere; 4th tarsomere 0.37 × length of 5th tarsomere; tarsal claw 0.58 (0.56–0.60) × length of 5th tarsomere.

Wings. Fore wing first discal cell open; vein r-m indistinct spectral; vein SR1 distinctly bent; vein 2-M basal third tubular with node apically, remainder of vein pigmented; hind wing vein 1-m, basal r-m and 2m+Cu pigmented, Four equidistant hamuli (most specimens have 4 hamuli with XX specimens with 5).

Metasoma. Metasoma length (2.67–3.21) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.84 (1.78–1.90) × metasoma length, short appressed setae.

Male. Mesepisternum with less brown, restricted to dorso-anterior corner, mesepimeron black, apex of T9 and paramere cream.

Distribution. The species is known from QLD, NSW, VIC and TAS.

Biology. The species has been reared from stem nests of *Amphylaeus morosus* Smith (Colletidae: Hylaeinae) in VIC. The species has been collected on *Eucalyptus* sp. (Myrtaceae) in QLD.

Comment. The species is superficially similar to *G. lineatum* but can be distinguished based on a single open fore wing discal cell and 1st flagellomere shorter.

Gasteruption prolongatum Pasteels, 1957

Fig. 77.

Gasteruption prolongatum Pasteels, 1957: 32, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, " W.AUSTRALIA: Perth. 10–18.ii.1936. R.E.Turner. B.M.1936–28." "*Gasteruption prolongatum* n.sp. J. Pasteels det., 1954" (BMNH: 3a . 354).

Specimen damage. Complete right antenna missing, right hind leg 5th tarsomere and claw missing.

Paratypes. Western Australia: 1♀, Rottnest, 31–1343, (WAM).

Figure 77. *Gasteruption prolongatum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* body length 12.00 mm; ovipositor length 12.00 mm.

Colour. Black; antenna dark brown, ventral corners of malar space and clypeus ventral margin brown, mandibles light brown with darker tooth apex; dorsal and posterior lobe of pronotum, mesepisternum anterior margin and ventral corner, mesepimeron lower posterior margin brown, metapleuron lighter brown around dorsal spiracle, tegula light brown, propodeum medial carinae and posterior margin lighter brown; fore and mid legs mostly brown, trochantellus with cream apical margin, femur cream apically, tibia with broad cream stripe on anterior face covering apex and base, 1st tarsomere with cream stripe on anterior face; hind leg mostly dark brown, coxa black with brown base, trochantellus black, tibia with cream patch subbasally on ventral face, tarsus cream with base of 1st tarsomere and apical half of 5th tarsomere and claw dark brown; metasoma dark brown, lighter laterally on T2–T4; ovipositor sheath dark brown with cream apex 2.57 × length of hind 1st basitarsus; ovipositor brown; wing hyaline and forewing veins and pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; length 1.09 × width; postocular space straight tapering sharply behind eye; head in lateral view, frons, vertex and gena strongly rounded, postocular space long, distinctly tapering; 0.53 × eye height; face punctate-reticulate with short dense shiny setae, denser on eye margins and medially; frons punctate-reticulate anteriorly, becoming reticulate-rugulose with short dense setae; medial frontal carina distinct in anterior third; vertex reticulate-rugulose, punctate around ocelli with strigate-rugulose between lateral ocelli, tending more strigate-rugulose posteriorly, short dense setae: occipital carina narrow, lamelliform with medium depression medially emarginate; gena punctate-reticulate with short dense shiny setae; minimal width of malar space 0.04 × height of eye; 0.20 × length of pedicel; clypeus punctate; 1.76 × wide as high, margin sinuate with lateral corners distinctly protruding forwards, medial depression absent, short scattered shiny setae, longer on margin; lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 1.00 × distance between lateral ocelli; scape 1.78 × length pedicel; 1st flagellomere 1.06 × as long as scape; 0.59 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.08 × height; propleuron length 2.19 × width;

1.53 × prototegular distance; propleuron rugulose dorsally, becoming reticulate-rugulose laterally, short dense shiny setae; pronotal process short stout; pronotum anterior lobe punctate with reticulate-rugulose dorsal lobe and rugulose posterior lobe, groove between pronotum lobes carinate, short dense shiny setae; mesoscutum length 1.19 × width in dorsal view; rounded in lateral view; rugose-punctate, coarser towards lateral parts of notaulus, short scattered setae, denser around notaulus; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugose-punctate with short scattered setae; mesepisternum areolate-rugulose with short dense shiny setae; mesepimeron scrobiculate ventral half, smooth patch above becoming carinate dorsally; metapleuron areolate-rugulose (not as uniform) with short dese shiny setae; propodeum areolate-rugulose, medial carinae broad and flattened, short dense shiny setae.

Legs. Hind coxa rugose, strigate in coxal groove, becoming rugulose laterally and ventrally; femur 0.76 × length of tibia; tibia length 5.54 × width of tibia; short dense setae with scattered stout spines on anterior face; ventro-apical pecten of short spines; tarsus with short spine on ventral face; 1st tarsomere 2.73 × length of 2nd tarsomere; 2nd tarsomere 1.69 × length of 3rd tarsomere; 3rd tarsomere 1.63 × length of 4th tarsomere; 4th tarsomere 0.67 × length of 5th tarsomere; tarsal claw 0.50 × length of 5th tarsomere.

Wings. Fore wing first discal cell tapering apically, vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular, remining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma length 3.08 × mesosoma length; hypopygium Y-shaped; with short appressed setae.

Male. Males specimens not examined but described by Pasteels (1957) as having antennae 1st flagellomere, postocular space, and prototegular shorter.

Distribution. The species is restricted to WA.

Biology. Unknown.

Comments. *Gasteruption prolongatum* is very similar to *G. luteidens* keying out together based on their postocular space in lateral view distinctly tapering to sub-conical shape. The species are difficult to separate but differ in clypeal width and length of ovipositor sheath cream apex, see key couplet 20.

Gasteruption quinquemaculatum Pasteels, 1957

Fig. 78.

Gasteruption quinquemaculatum Pasteels, 1957: 87, ♀; Jennings 2010 [on-line checklist].

Material examined.

Hollotype. ♀, "H. H. HARDY, 20-12 Perth, W.A" "*Gasteruption quinquemaculatum* n.sp J, Pasteels det., 1954" (SDEI).

Specimen damage. Left antenna 4th flagellomere to tip and right antenna pedicel to tip missing, right fore wing missing.

Other material examined. **WA:** Pickering brook 19.xii.1977, S.J. Curry (WADA).

Figure 78. *Gasteruption quinquemaculatum* Pasteels, holotype, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* body length 17.15 (17.00–17.30) mm; ovipositor length 30.20 (29.00–31.40) mm.

Colour. Body red-brown; head mainly black, malar space and clypeus red-brown, mandibles brown with black apex; propleuron black, lighter posteriorly, pronotum dorsal lobe dark brown, patch medially on the mesoscutum and mesoscutellum dark brown; fore and mid legs coxa dark brown, trochantellus dark brown with cream margin apically, prefemur brown, femur brown with cream patch apically, tibia brown with longitudinal cream stripe on anterior face, tarsus light brown with cream longitudinal strip one anterior face of 1st tarsomere; hind leg mostly brown, coxa red-brown with darker apex, trochantellus dark brown, tibia with cream band subbasally, tarsus cream, basal quarter of 1st tarsomere and tarsal claw dark brown; metasoma dark brown, lighter basally; ovipositor sheath black with large cream apex 5.47 (5.31–5.63) × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.92 (0.91–0.93) × width; postocular space convex behind eyes, tapering sharply at occipital carinae; head in lateral view, long rounded face; postocular space 0.41 (0.36–0.46) × height of eye; short scattered eye setae; face rugulose-reticulate with short setae, denser medially and along eye margins; frons rugulose with short dense setae; medial frontal carina raised in anterior half, becoming a shallow groove in posterior half; vertex reticulate-rugose around ocelli, becoming strigulate-rugulose posteriorly, short dense setae; occipital carina shallow, lamelliform, shallow depression, medially emarginate; gena punctate with short dense setae; minimal width of malar space 0.17 (0.15–0.19) × height of eye; 1.63 × length of pedicel; clypeus punctate, strigate-rugulose medially with fait longitudinal carinae; 1.92 (1.83–2.00) × wide as high; margin sinuate with lateral corners distinctly protruding forwards, depression indistinct, short dense setae with longer scattered setae along margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.79 (0.76–0.81) × distance between lateral ocelli; scape 2.30 × length pedicel; 1st flagellomere 0.78 × as long as scape; 0.72 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.60 (1.53–1.66) × height; propleuron length 1.21 (1.13–1.29) × width; 0.88 (0.85–0.90) × prototegular distance; propleuron reticulate-rugulose, becoming finer posteriorly, short dense setae; pronotal process blunt; pronotum rugulose with scattered reticulate-rugulose sections, groove between pronotum lobes carinate, short dense setae, longer in groove; mesoscutum length 0.85 × width in dorsal view; truncated in lateral view; strigose with short dense setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum strigose with short setae; axilla punctate-rugulose with short setae; mesepisternum reticulate-rugose dorsally becoming areolate ventrally, short dense setae; mesepimeron carinate ventral two thirds becoming glabrous dorsal third; metapleuron areolate with short dense setae; propodeum areolate with raised medial carina, short dense setae;

Legs. Hind coxa transverse striate dorsally becoming finely punctate latero-ventrally; femur length 0.74 (0.74–0.75) × length of tibia; tibia length 5.93 (5.86–6.00) × tibia width; tarsus with dense short robust spines on ventral face; 1st tarsomere 3.27 (3.21–3.32) × length of 2nd tarsomere; 2nd tarsomere 1.61 (1.56–1.67) × length of 3rd tarsomere; 3rd tarsomere 1.73 (1.67–1.80) × length of 4th tarsomere; 4th tarsomere 0.35 (0.33–0.36) × length of 5th tarsomere; tarsal claw 0.70 (0.67–0.72) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of vein 3-cu; vein r-m absent, vein SR1 distinctly bent, vein 2-M tubular basal third with node, remaining pigmented; hind wing vein 1-m and apical half of 2m+Cu pigmented, remaining veins spectral; three hamuli, (type with four hamuli on one wing), distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma 2.29 (2.22–2.35) × mesosoma length; hypopygium plate large with Y-shaped incision; ovipositor sheath 2.79 (2.76–2.83) × metasoma length; short appressed setae.

Male. Unknown

Distribution. The species is known from two localities in WA.

Biology. Unknown.

Comments. *Gasteruption quinquemaculatum* is a distinctive species that can be distinguished from other species based on body reddish-brown with a patch medially on mesonotum and head black and long ovipositor (2.76–2.83 × metasoma length).

Gasteruption quadraticeps Pasteels, 1957

Fig. 79.

Gasteruption quadraticeps Pasteels, 1957: 62, ♀; Jennings 2010 [on-line checklist].

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NMV (Fig. 75), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Material examined.

Holotype. ♀, "Redcliffs. Vic 4.10.48 C. AKE" (NMV: T-7416) [examined from photos].

Specimen damage. Right antennae 7th flagellomere to tip missing, hind wings damaged, left 5th tarsomere to tip missing, metasoma broken and glued to main label.

Figure 79. *Gasteruption quadraticeps* Pasteels, holotype female, lateral habitus, scale bar = 5.00 mm.

Redescription. *Female.* Body length 12.00 mm; ovipositor length 10.80 mm.

Colour. Black; flagellomere 11 to tip light brown, mandibles cream (darker tooth apex), fore leg mostly brown, coxa black, cream apex on femur, cream stripe on anterior face tibia, tarsus cream with claw darker; mid leg same as fore leg but darker; hind leg mostly black, prefemur lighter, cream band sub basally on tibia, tarsus cream with base of tarsomere one, 5th tarsomere and claw dark brown; wings hyaline, wing veins and pterostigma dark brown; ovipositor light brown, ovipositor sheaths dark brown with cream apex 1.40 × length of hind 1st tarsomere.

Head. Head shape rectangular when viewed dorsally; postocular space elongated; head in lateral view frons and vertex convex, postocular space elongated, 0.48 × height of eye; eye setae present as short scattered setae; face with short dense shiny setae; frons with short shiny setae; medial frontal carina raised in anterior half becoming indistinct posteriorly; vertex granular with short scattered setae. Occipital carina short, wider ventro-lateral corners, lamelliform, depression shallow and rounded; gena granular with short dense shiny setae; minimal width of malar space 0.07 × height of eye; 0.47 × length of pedicel; lateral ocelli in-line with postocular line, distance from lateral ocellus to eye margin 0.75 × distance between lateral ocelli; scape 1.82 × length pedicel; first flagellomere 0.58 × as long as scape; 0.42 × length second flagellomere.

Mesosoma. Mesosoma length 2.12 × height; 0.79 × prototegular distance; propleuron sculpturing coarser dorsally with short dense shiny setae, pronotal process short hook like; pronotum with groove between pronotum lobes, short dense shiny setae; mesepisternum with short dense shiny setae; mesepimeron without setae; mesoscutum length 2.49 × width in dorsal view; rounded in lateral view; notauli U-shaped, scrobiculate.

Legs. femur 0.71 × length of tibia; tibia length 4.90 × tibia width, without scattered stout spines on anterior face and tarsus apex; tarsomere 1 3.48 × length of ts2; ts2 1.67 × length of ts3; ts3 1.50 × length of ts4; ts4 0.71 × length of ts5; tarsal claw 0.79 × length of ts5.

Wings. First discal cell rectangular; forewing vein r-m absent; vein SR1 weakly bent, vein 2-M basal third tubular; hind wing veins not visible.

Metasoma. Metasoma 2.49 × mesosoma length; ovipositor sheath 1.40 × metasoma length, short appressed setae.

Male. Unknown

Distribution*.* The species is known from VIC.

Biology*.* Unknown.

Comment. The species keys out with *G. leucostictum* which it can be easily separated by the length of the 1st flagellomere, which is shorter (0.58 × length of scape) and the length of the cream/ white apex of the ovipositor sheath shorter (1.40 × length of hind 1st tarsomere) in *G. quadraticeps*.

Gasteruption quadrilineatum Pasteels, 1957

Fig. 80.

Gasteruption quadrilineatum Pasteels, 1957: 71, ♂, ♀; Jennings 2010 [on-line checklist].

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NHMW (Fig. 76), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Material examined.

Holotype. ♀, “Australiens Steindachner” “*Gasteruption quadrilineatum* s.sp. J. Pasteels det., 1954” (NMV: T-7454) [examined from photos].

Redescription. *Female.* Body length 13.00 mm; ovipositor length 16.00 mm.

Colour. Reddish-brown: head black, malar space and mandibles brown; posterior margin of mesepisternum, medial lobe of mesonotum, mesoscutellum, axilla, and longitudinal bands on propodeum black; fore and mid legs brown, tibiae with longitudinal cream stripe on anterior margin, tarsus dark brown with 1st tarsomere cream; hind leg coxa and femur reddish-brown, dark brown dorsally, tibia dark brown with cream band subbasally, tarsus cream with base of 1st tarsomere, 4th, 5th and claw dark brown; metasoma black; ovipositor sheath dark brown, apical quarter cream; wings hyaline, wing veins and pterostigma dark brown.

Figure 80. *Gasteruption* quadrilineatum Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Head. Head shape sub-conical when viewed dorsally; postocular space tapering sharply to occipital carinae; head in lateral view flattened; head punctate with short dense shiny setae, becoming scattered on vertex; medial frontal carina raised between antennal scrobes; narrow occipital carina, shallow depression, medial emarginate; malar space long; lateral ocelli anterior of postocular line.

Mesosoma. Mesosoma and propleuron short, pronotal process stout;

mesonotum with transverse striation; rounded in lateral view; propodeum areolate with raised longitudinal medial carinae.

Legs. Tibia with short setae and scattered stout spines on anterior face; 1st tarsomere longer than other tarsomeres combined.

Wings. Fore wing first discal cell rectangular; vein r-m absent; vein SR1 distinctly bent; hind wing veins 1-m and apical two thirds of 2m+Cu pigmented, other veins spectral; three equidistant hamuli.

Male. Male not examined but described by Pasteels (1957) as same characters as female.

Distribution. Type locality is Australia without further details.

Biology. Unknown.

Comments. Pasteels (1957) described *G. brachyurum* as having the same colour, general body shape and sculpturing as *G. quadrilineatum*, differing based on the ovipositor sheath longer and malar space shorter. The 1st tarsomere is elongated like *G. sordium*.

Gasteruption raphidioides (Westwood, 1851)

Fig. 81.

Foenus raphidioides Westwood, 1851: 220, ♂.

Gasteruption dolichocephalum Schletterer, 1890: 445, ♀ (syn. Pasteels, 1957).

Dolichofoenus raphidioides Kieffer, 1910: 77, ♀.

Dolichofoenus leptotrachelus Kieffer, 1911: 213, ♂ (syn. Pasteels, 1957).

Gasteruption raphidioides Pasteels, 1957: 27, ♀, ♂; Pagliano, 2008: 162; Jennings 2010 [on-line checklist].

Material examined.

Holotype *Gasteruption dolichocephalus* Schletterer. ♂, "South Australia" "Cn de saussure" "*Gasteruption dolichocephalus* Schh." (MHNG: 00008969). *Specimen damage*. Right antenna 5th flagellomere to tip missing, left antenna 4th flagellomere to tip missing. Right fore leg femur to tip, right mid leg 2nd tarsomere to tip, left mid leg 5th tarsomere and claw, most of margin on right forewing missing, metasoma broken.

Figure 81. *Gasteruption raphidioides* Pasteels, lateral habitus, scale bar = 1.00 mm.

Holotype *Dolichofoenus leptotrachelus* Kieffer. ♂, Launceston, Tasmania (BMNH: 3a.185)

Other material examined. **QLD:** 1♀, Blunder crescent, Brisbane, 1–7.xi.1979, H. Evans, A. Hook (QM); 1♀, Lake Broadwater near Dalby, 27º21'S, 151º06'E, 22.iii.1987, G. and A. Daniels (QM); 1♂, Maryborough, 25º39'18'S, 152º40'31'E, 13.xi.1994. G. and A. Daniels (QM). NSW: 1♀, Bogan River, xi.1933, J. Armstrong (AM: K 279910); 1♀, Valla Beach, 23.ix.1981, D.K. McAlpine, B.J. Day (AM: K420872); 1♂, Moir's Rock, 42 km NNW Salmon Gums, 32º39'S, 121º25'E, 2.i.1987 (QM); 1♀,3♂, Warrumbungle National Park, 31º16'17'S, 148º57'42'E, 17.x.1997, malaise trap, J. Skevington, A. Winterton, C. Lambkin (QM). **SA:** 1♂, Mt, Barker summit reserve, 18.iii.2000, R.V Glatz (RGC: 863)*; 1♀,1♂, Flinders Chase National Park, Kangaroo Island, -35.950786, 136.732795, 15.x.2017 (BPC). **VIC:** 1♂, Big

Desert State Forrest, Murrayville-Nihil Road, 35º22.707'S, 141º13.023'E, 25.i.2009, R.V. Glatz (RGC: 14053); 1♂, Mafeking Picnic Area, Grampians National Park, 11.ii.2009 (RGC). **WA:** 3♂, Dedari, A. Douglas (WAM); 1♀, Doodlakine, A. Douglas (WAM).

Redescription. *Female.* Body length 9.10 (8.25–10.60) mm; ovipositor length 2.21 (1.65–2.70) mm.

Colour. Antenna dark brown, clypeus anterior margin and malar space orange-brown; two colour variations exists, mesosoma black, anterior margin of pronotum and tegula dark brown, tarsus dark brown, or mesosoma black and brown; ventral and dorsal lobes of pronotum, posterior margin of mesepimeron and anterior ventral corner and propodeum light brown; hind tarsus dark brown with base 1st tarsomere cream; fore and mid leg dark brown, prefemur, femur apex light brown, tibia with cream longitudinal stripe on anterior face, hind leg dark brown, coxa black, tibia with cream patch subbasally; metasoma dark brown; ovipositor sheath dark brown with cream apex 0.51 (0.32–0.63) × length of hind 1st tarsomere; ovipositor light brown; wings hyaline, veins and pterostigma brown.

Head. Head shape conical when viewed dorsally; length 1.24 (1.17–1.30) × width; postocular space tapered; head in lateral view, elongated and flattened; long postocular space 0.51 (0.49–0.55) × height of eye; short scattered eye setae; face and frons imbricate with short dense shiny setae medially and along eye margin; medial frontal carina indistinct, present as shallow groove in anterior half, absent posterior half; vertex imbricate around ocelli, posteriorly strigate-punctate with short scattered shiny setae; medium lamelliform occipital carina, wider ventro-laterally, medium depth, rounded depression; gena punctate with short dense shiny setae; minimal width of malar space 0.02 (0.02–0.03) × height of eye; 0.16 (0.14–0.18) × length of pedicel; clypeus punctate; 2.51 (2.27–2.67) × wide as high, margin sinuate, lateral corners barely protruding forwards, medial depression distinct anteriorly, short dense shiny setae, longer along margin; lateral ocelli posterior of postocular line, distance from lateral ocellus to eye margin 0.79 (0.75–0.83) × distance between lateral ocelli; scape 1.77 (1.57–2.09) × length pedicel; 1st flagellomere 0.56 (0.50–0.64) × as long as scape; 0.54 (0.48–0.61) × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.18 (2.09–2.25) × height; propleuron length 2.45 (2.32–2.57) × width; 1.41 (1.35–1.51) × prototegular distance; propleuron imbricate, rugulose dorsally, short dense shiny setae, longer ventro-posteriorly; pronotal process indistinct; pronotum anterior lobe rugulose, dorsal and posterior lobes granular, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.40 (1.30–1.46) × width in dorsal view; rounded in lateral view, granular-reticulate medial lobe, coarser with several shallow scattered punctures medially, lateral lobe reticulate-rugulose medially, granular-reticulate laterally, short scattered shiny setae; admedial lines indistinct, converging; parapsidial lines distinct; notauli incomplete, scrobiculate; mesoscutellum and axilla imbricate with scattered shallow punctures; short scattered setae; mesepisternum dorsal lobe granular, a punctate patch on posterior margin of black variants, ventral half areolate, medium dense shiny setae; mesepimeron broad, carinate creating shallow fovea; metapleuron areolate-rugulose with medium dense shiny setae, absent on ventro-posterior corner; propodeum areolate-rugulose, medial carina flattened, short dense shiny setae.

Legs. Hind coxa reticulate-rugulose dorsally, imbricate laterally, strigate in coxal groove; femur 0.77 (0.76–0.78) × length of tibia; tibia length 3.64 (3.48–3.74) × tibia width, short dense setae with scattered emergent spines on ventro-anterior face; tarsus with stout spines on anterior face and apically; 1st tarsomere 3.11 (2.95–3.37) × length of 2nd tarsomere; 2nd tarsomere 1.45 (1.37–1.58) × length of 3rd tarsomere; 3rd tarsomere 1.56 (0.89–1.90) × length of 4th tarsomere; 4th tarsomere 0.61 (0.39–1.06) × length of 5th tarsomere; tarsal claw 0.57 (0.50–0.67) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular; vein r-m absent; vein SR1 almost straight, vein 2-M basal third tubular, with node, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma 2.75 (2.67–2.87) × mesosoma length; hypopygium shallow Y-shaped; ovipositor sheath 0.51 (2.67–2.87) × metasoma length, short appressed setae.

Male. Same characters as female with paramere apex cream.

Distribution. The species is known from QLD, NSW, VIC, SA and WA.

Biology. Specimens have been collected flying low at ground level.

Comments. *Gasteruption raphidioides* keys out with *G. exile* but can be easily separated as G. *raphidioides* has a longer propleuron and ovipositor sheath apex is uniform width, see key couplet 15.

Gasteruption rubripes Pasteels, 1957

Fig. 82.

Figure 82. *Gasteruption rubripes* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Gasteruption rubripes Pasteels, 1957: 63, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Bogan River N.S.W., 1934 J. Armstrong" "*Gasteruption ribripes* n. sp J. Pasteels det., 1955" (AM: K67841).

Specimen damage. Head missing, right foreleg broken, glued on point below specimen, 5th tarsomere and claw missing. right mid leg 4th tarsomere to claw missing, left hind leg 4th tarsomere to claw missing.

Paratype. WA: 1♀, Waroona, Samson's Brook Dam, G.F. Berthoun (MNHN) [not examined].

Redescription. *Female*. body length 22.00 mm; ovipositor length 7.00 mm.

Colour. Black; posterior pronotal lobe and tegula brown; fore and mid leg mostly brown, coxa black trochantellus with pale apical margin femur brown darker ventrally, tibia darker anterior face with a pale band at basally, Tarsus dark brown, claw and each segment apex lighter. hind leg mostly black, trochantellus brown with black groove, prefemur brown, femur brown in basal two thirds, tarsus cream, basal third, T5 and claw black; ovipositor sheath dark brown with cream apex 1.90 × length of hind 1st tarsomere; ovipositor brown; wings hyaline, veins and pterostigma dark brown.

Head. Missing from holotype.

Mesosoma. Mesosoma length 2.02 × height; propleuron length 1.71 × width; 0.95 × prototegular distance; propleuron rugulose with short dense shiny setae; pronotal process acute; pronotum rugulose with groove between pronotum lobes carinate, short dense shiny setae, longer in groove and on anterior-lateral margin; mesoscutum length 1.33 × width in dorsal view; truncated in lateral view; rugulose with dense shiny short setae; admedial lines and parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugulose with short dense shiny setae; mesepisternum rugulose with short dense shiny setae with scattered medium setae; mesepimeron carinate; metapleuron rugulose tending areolate ventro-laterally, short dense shiny setae; propodeum rugose dorso-laterally becoming areolate, medial carina flattened, short dense shiny setae, with scattered medium setae.

Legs. Hind coxa rugulose; femur length 0.59 × length of tibia; tibia length 5.11 × tibia width; short setae with scattered short robust spines on anterior face; tarsus with short robust spines on ventral face and apically; 1st tarsomere 3.00 × length of 2nd tarsomere; 2nd tarsomere 1.70 × length of 3rd tarsomere; 3rd tarsomere 1.50 × length of 4th tarsomere; 4th tarsomere 0.40 × length of 5th tarsomere; tarsal claw 0.40

× length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular; fore wing vein r-m absent; vein SR1 distinctly bent;

vein 2-M basal third tubular with node, remaining pigmented; hind wing vein 2m+Cu pigmented, four hamuli equidistant.

Metasoma. 2.82 × mesosoma length; hypopygium Y shape; ovipositor sheath 0.55 × metasoma length; short appressed setae, flared cream apex.

Male. Unknown.

Distribution. The species is known from NSW and WA.

Biology. Unknown.

Comments. The species is superficially similar to *G. femorale* based on the general body shape and distinctive colouration on femurs. The two species can be differentiated based on no cream/white patch subbasally on hind tibia in *G. rubripes* and Pasteels (1957) described the postocular space as tapering more dorsally and longer laterally.

Gasteruption secundum Pasteels, 1957

Fig. 83.

Gasteruption secundum Pasteels, 1957: 109, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Gibralter P[ar]k [NSW] 25 Feb 18 E. F. Riek" "*Gasteruption secundum* n. sp. J. Pasteels det., 1954" (ANIC).

Paratype. **QLD:** ?, (QM), "Brisbane, 4.xi.1913, H. Hacker (QM: T5477); 4♂♂, Brisbane, 4.ix.1914, H. Hacker (QM: T5474, T5475, T5478, T5485); 3♀♀, Brisbane, 16.ii.1915, H. Hacker (QM: T5473, T5480, T5481, T5482, T5484); ♀, Stradbroke Island, 17.ix.1915, H. Hacker (QM: T5479); ♀, Tambourine Mountain, W.H. Davidson (QM :T5476) **ACT:** ♀, Blundells, 3.ii.1948, E.F. Riek (ANIC); ♀, Canberra, 17.ii.1948, E.F. Riek (ANIC); ♀, Tidbinbilla 22.i.1953. R. Mykytowycz (ANIC). **NSW:** ♀, Braidwood, 19.iii.1952, E.F. Riek (ANIC).

Figure 83. *Gasteruption secundum* Pasteels, holotype, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female*. Body length 14.35 (12.30–16.80) mm; ovipositor length 5.30 (4.50–6.10) mm.

Colour. Black; antenna dark brown, malar space, and mandibles dark brown (tooth apex darker), golden setae dorsally on head, tegula brown; fore and mid legs brown, longitudinal cream stripe on anterior face of tibia, tarsus dark brown with cream longitudinal stripe on 1st tarsomere; hind leg dark brown, ventral face of coxa brown, tarsus cream, basal third of 1st tarsomere, 5th tarsomere and claw dark brown; golden setae dorsally on mesoscutum; metasoma dark brown, lateral face of T2 and T3 lighter brown; ovipositor sheath dark brown, cream apex 0.96 (0.92–1.00) × length of hind 1st tarsomere; ovipositor brown; wings hyaline, veins and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.97 (0.90–1.03) × width; postocular space gently tapering to occipital carina; head in lateral view, frons and verted convex, postocular space short 0.40 (0.34–0.46) × height of eye; eye setae absent; face punctate with short dense shiny setae; frons reticulate with short shiny setae; medial frontal carina indistinct between antennal scrobes, small raised node halfway up frons becoming a shallow grove posteriorly; vertex reticulate around ocelli, posteriorly strigate-rugulose with short shiny setae; narrow lamelliform occipital carina, wider ventro-lateral, shallow depression, medially emarginate; gena reticulate with short dense shiny setae; minimal width of malar space 0.11 × height of eye; 0.67 (0.64–0.70) × length of pedicel; clypeus punctate, punctate-reticulate medially; 1.92 (1.83–2.00) × wide as high, margin sinuate, lateral corners barely protruding forwards, medial depression indistinct, short dense shiny setae, longer along margin; lateral ocelli in-line of postocular line, distance from lateral ocellus to eye margin 0.59 (0.59–0.60) × distance between lateral ocelli; scape 1.76 (1.75–1.77) × length pedicel; 1st flagellomere 1.00 × as long as scape; 0.80 (0.60–1.00) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.61 (1.58–1.64) × height; propleuron length 1.13 (1.00–1.25) × width; 0.83 (0.74–0.92) × prototegular distance; propleuron reticulate-rugulose laterally, coarser dorsally with medium dense shiny setae, pronotal process large and rounded, pointing outwards; pronotum anterior lobe rugulose, dorsal and posterior lobe reticulate, groove between pronotum lobes broad carinate, medium dense shiny setae; mesoscutum length 1.26 (1.25–1.27) × width in dorsal view; truncated in lateral view, rugulose-granular with carinate groove on posterior margin and medially on lateral lobe, short scattered shiny setae; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate with short scattered setae; mesepisternum dorsally granular, ventrally areolate, medium dense shiny setae; mesepimeron ventral two thirds with large fovea, dorsal third with faint dense strigate; several scattered short setae on anterior margin and dorsal-posterior corner; metapleuron areolate-rugulose dorsally, coarser ventrally, medium dense shiny setae; propodeum areolate-rugulose, medial carina raised, short dense shiny setae.

Legs. Hind coxa strigate dorsally, imbricate laterally; femur 0.79 (0.78–0.79) × length of tibia; tibia length 4.81 (4.75–4.88) × tibia width, short dense setae with scattered emergent stout spines on anterior face; tarsus with short spines on ventral face and apically; 1st tarsomere 3.32 (3.29–3.36) × length of 2nd tarsomere; 2nd tarsomere 1.48 (1.47–1.50) × length of 3rd tarsomere; 3rd tarsomere 1.81 (1.75–1.88) × length of 4th tarsomere; 4th tarsomere 0.41 (0.40–0.42) × length of 5th tarsomere;

tarsal claw 0.56 (0.55–0.58) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular; vein r-m absent; vein SR1 weakly sinuate, vein 2-M basal third tubular, with apical node, remaining pigmented; hind wing vein 1-m pigmented, others spectral, three equidistant hamuli.

Metasoma. Metasoma 2.82 (2.80–2.83) × mesosoma length; short Y-shaped hypopygium; ovipositor sheath 0.54 × metasoma length; short appressed setae.

Male. Same characters as female with paramere apex cream.

Distribution. The species has been recorded from QLD, NSW and ACT.

Biology. Unknown.

Comments. *Gasteruption secundum* keys out with *G. fuscimanus*. The two species can be separated by *G. secundum* with a longer malar space and 1st hind tarsomere, see couplet 93.

***Gasteruption simillimum* Schletterer, 1890**

Fig. 84.

Gasteruption simillimum Schletterer, 1890: 451 ♀; Pasteels, 1957: 59; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, “South Western Australia” (ZMBD).

Other material examined. **WA:** ♀, Swanbourne, no other details (WAM); ♀, Nedlands, 24.i.1941, K.R. Norris (ANIC)*.

Redescription. *Female.* Body 21.50 mm; ovipositor length 22.20 mm.

Colour. Black: malar space and mandibles (darker apex and base) dark brown; tegula dark brown; fore and mid legs brown, trochantelli with cream apical margin, tibiae and tarsus dark brown with longitudinal cream stripe on anterior face of tibia, 1st and 2nd tarsomere; hind leg coxa and trochantellus black, prefemur and femur brown, tibia dark brown, cream band subbasally, tarsus cream base of 1st tarsomere, apical 5th tarsomere and claw dark brown; metasoma dark brown; ovipositor sheath dark brown with cream apex 3.67 × length of hind 1st tarsomere; ovipositor dark brown; wing hyaline, wing vein dark brown, pterostigma brown.

Figure 84. *Gasteruption simillimum* Schletterer, lateral habitus, scale bar = 1.00 mm

Head. Head shape sub-rectangular when viewed dorsally; length 1.02 × width; postocular space bulbous; head in lateral view, frons and vertex convex, postocular space long 0.56 × height of eye; face reticulate with medium dense shiny setae; frons rugulose with medium dense setae; medial frontal carina distinct ventral half becoming shallow groove dorsally; vertex granulate-rugulose with scattered shallow punctures, between ocelli rugulose, medium scattered setae; narrow lamelliform occipital carina, wider ventro-laterally; shallow depression medially emarginate; gena granulate-reticulate with scattered shallow punctures, more reticulate along eye margin, medium dense shiny setae; minimal width of malar space 0.07 × height of eye; 0.57 × length of pedicel; clypeus 2.43 × height; reticulate; margin sinuate; lateral corners distinctly protruding forwards; medial depression shallow; medium dense shiny setae, longer on margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.73 × distance between lateral ocelli; scape 2.31 × length pedicel; 1st flagellomere 0.67 × as long as scape; 0.48 × length second flagellomere.

Mesosoma. Mesosoma length 1.83 × height; propleuron length 1.23 × width; 0.84 × prototegular distance; propleuron reticulate-rugulose, finer dorso-ventrally, medium dense shiny setae; pronotal process large and acute; pronotum anterior lobe rugose, dorsal lobe reticulate-rugulose, posterior lobe granulate, groove between pronotum lobes carinate; medium dense shiny setae; mesoscutum length 2.71 × width in dorsal view; mesoscutum rounded in lateral view; medial lobe granulate-rugulose; lateral lobe rugulose medially becoming granulate-rugulose laterally; short scattered shiny setae; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugulose with short scattered setae; mesepisternum reticulate-rugulose dorsally becoming areolate-strigate laterally and ventrally, medium dense shiny setae; mesepimeron carinate with shallow fovea dorsally and along upper posterior margin; short scattered setae along dorso-posterior corner; metapleuron areolate-strigate, medium dense shiny setae; propodeum areolate-rugose, longitudinal medial carinae raised, short scattered setae.

Legs. Hind coxa strigate-rugulose dorsally, strigate in coxal groove, becoming reticulate laterally; femur 0.72 × length of tibia; tibia length 5.12 × width; short dense setae with scattered stout spines on anterior face; 1st tarsomere 3.35 × length of 2nd tarsomere; 2nd tarsomere 1.54 × length of 3rd tarsomere; 3rd tarsomere 1.63 × length of 4th tarsomere; 4th tarsomere 0.40 × length of 5th tarsomere; tarsal claw 0.55 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction 3-cu. vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular with apical node, remainder of vein pigmented; hind wing vein 2m+cu apical two thirds and 1-m pigmented, all other veins spectral, three equidistant hamuli.

Metasoma. Metasoma 2.71 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.49 × metasoma length; short appressed setae.

Distribution. The species is known from WA with material examined by Pasteels (1957) from QLD, ACT and VIC.

Biology. Unknown.

Comments. Pasteels (1957) considered this species as part of a complex of species that included *G. automnale*, *G. hollandiae*, *G. hyalipenne* and *G. valvulare*. These species according to Pasteels vary based on colour of the mandibles and hind legs, length of malar space and ovipositor. The examination of additional material is needed to determine if they are indeed valid species or a single widespread species with high levels of polymorphism. *Gasteruption simillimum* keys out with *G. inflatum* and can be separated based on a longer scape length (2.31 × pedicel length) and shorter mesoscutum length in dorsal view (2.71 × width).

Gasteruption spinigerum Schletterer, 1890

Fig. 85.

Gasteruption spinigerum Schletterer, 1890: 441, ♂; Pasteels, 1957: 96, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "South Australia" "Cn de saussure" "*Gasteruption spinigerum* Schlett" (MHNG).

Specimen damage. Left antenna 7th flagellomere to tip and right antenna 4th flagellomere to tip missing, left foreleg 2nd tarsomere to tip, left mid leg prefemur to tip missing.

Other material examined. **QLD:** 2♀, Amby, 22-27.xi.1979, H.E. & M.A. Evans and A. Hook (QM)*; 1♂, Lake Broadwater, Dalby, 27º21'S, 151º06'E, ex *leptospermum flavescens* [syn. *polygalifolium*] blossom, 25.x.1986, G. and A. Daniels (QM); 1♀, 6 km N Taroom, 25º36'E, 149º46'S, 15.i.1991, G. and A. Daniels (QM). NSW: 8 km S Mendooran, 31º53'S, 149º03'E, 12.ii.1992, G. Daniels and C.J. Burwell (QM) **WA:** 1♀, 57 km S Norseman, 32º38'S, 121º32'E, G. and A. Daniels (QM); 1♂, 48–2619, Tarin Rock, (WAM), 1♀, 1♂, Dudinin, no other details (WAM); Unknown: 1♀, 37–516, A. Douglas, no other details (WAM).

Redescription. *Female.* body length 21.27 (20.00–23.30) mm; ovipositor length 8.07 (8.00–8.20) mm.

Colour. Body mostly back; malar space margin, ventral corner and posterior margin of pronotum, medially and dorso-anterior lobe of mesepisternum, ventro-lateral posterior margin and dorso-anterior corner of mesepimeron, anterior ventro-lateral margin and posterior corner of metapleuron and a wide stripe along the notauli, medio-posteriorly and along margin of lateral lobe red-brown, tegula brown; fore and mid leg mostly dark brown, trochantellus with cream band on apical margin, femur with cream apex, tibia with longitudinal cream stripe on anterior face, 1st to 3rd tarsomere cream; hind leg dark brown, tarsus mostly cream, base of 1st tarsomere and 5th tarsomere and claw dark brown; metasoma dark brown; ovipositor sheath dark brown with cream apex 1.18 (1.17–1.19) × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing vein and pterostigma dark brown.

Figure 85. *Gasteruption spinigerum* Schletterer, lateral habitus, scale bar = 1.00 mm

Head. Head shape sub-rectangular when viewed dorsally; length 0.84 (0.83–0.86) × width; postocular space tapering directly behind eyes in dorsal view; head in lateral view wedge shape with a long face; postocular space short 0.34 (0.32–0.37) × height of eye; eye setae absent; face punctate with medium dense shiny setae; frons rugulose with short dense shiny setae; medial frontal carina indistinct anteriorly with a small raise node half way, posteriorly shallow groove; vertex reticulate-rugulose, coarser between ocelli, strigate-rugulose posterior medially, short scattered setae; occipital carina short, wider ventro-laterally, lamelliform, shallow rounded depression; gena reticulate-rugulose, with short dense shiny setae; minimal width of malar space 0.14 × height of eye; 1.07 (1.00–1.10) × length of pedicel; clypeus punctate; 1.41 (1.35–1.49) × wide as high; margin sinuate with lateral corners barely protruding forwards; medial depression shallow, medium scattered shiny setae, longer on margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.46 (0.39–0.52) × distance between lateral ocelli; scape 2.26 (2.18–2.40) × length pedicel; 1st flagellomere 1.60 (1.00–1.09) × as long as scape; 0.79 (0.77–0.80) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.57 (1.55–1.59) × height; propleuron length 1.23 (1.17–1.29) × width; 0.80 (0.77–0.83) × prototegular distance; propleuron dorsally rugose becoming reticulate laterally and ventrally; pronotal process large and acute; pronotum anterior lobe rugulose, dorsal and posterior lobe rugose, groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.18 (1.02–1.30) × width in dorsal view; rounded in lateral view; strigate-rugose, becoming areolate-rugose medially, short scattered shiny setae, admedial lines long; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum areolate-rugose with short scattered setae; axilla rugulose with short scattered setose; mesepisternum areolate becoming coarser strigate-areolate ventral-laterally, medium dense shiny setae; mesepimeron foveolate with carinae; metapleuron areolate, dorsal lobe sculpturing finer, medium dense shiny setose; propodeum areolate, medial carinae is large convex section, medium dense shiny setae.

Legs. Hind coxa strigate dorsally becoming reticulate; femur length 0.75 (0.75–0.76) × length of tibia; tibia length 7.05 (6.92–7.15) × tibia width; short dense shiny setae with scattered stout robust spines on anterior face; tarsus with short robust spines on ventro face and apically; 1st tarsomere 3.70 (3.53–3.82) × length of 2nd tarsomere; 2nd tarsomere 1.52 (1.42–1.60) × length of 3rd tarsomere; 3rd tarsomere 1.83 (1.67–2.00) × length of 4th tarsomere; 4th tarsomere 0.36 (0.32–0.43) × length of 5th tarsomere; tarsal claw 0.68 (0.58–0.79) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, wider at junction of vein 3-cu;

vein r-m spectral; vein SR1 distinctly bent; vein 2-M basal third tubular with node, remainder of vein pigmented; hind wing vein 1-m and apical half pigmented; three hamuli, distance between basal and middle hamuli greater than distance between middle and apical hamuli.

Metasoma. Imbricate, length 3.06 (3.03–3.08) × mesosoma length; hypopygium Y-shaped, distinctly shallow; ovipositor sheath 0.57 (0.53–0.59) × metasoma length; covered in short appressed setae, cream apex flared.

Male. Male generally darker, less brown on mesoscutum, pronotum and mesepimeron, T9 and apex of paramere cream.

Distribution. The species is known from QLD, NSW, SA and WA.

Biology. Collected on *leptospermum polygalifolium* Salisb (Myrtaceae) in QLD.

Comments. The species keys out with *G. burnsi* but can be separated based on the scape length longer and the 5th tarsomere dark brown in *G. spinigerum.*

***Gasteruption subconicum* Pasteels, 1957**

Fig. 86.

Gasteruption subconicum Pasteels, 1957: 44, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "37–4519 Narrogin [WA]" "*Gasteruption subconicum* n.sp J. Pasteels det., 1955" (WAM: E 88830).

Paratypes. **WA:** 1♀, 47–2160, Swanbourne (WAM); 1♀, 44–702, Yallingap (WAM).

Other material examined. **WA:** 1♀, Bluff Knoll, Stirling ranges National Park, 21.xi.2011, D.A. Young, on *leptospermum* (WINC)*.

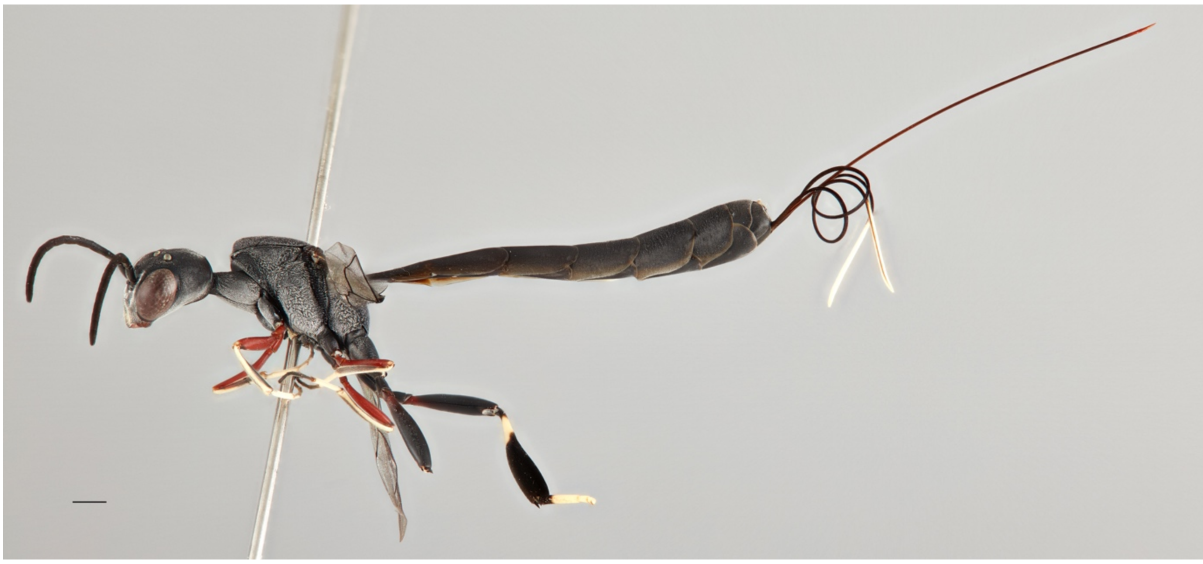

Figure 86. *Gasteruption subconicum* Pasteels, lateral habitus, scale bar = 1.00 mm

Redescription. *Female*. Body length 17.95 (17.90–18.00) mm; ovipositor length 12.60 (12.20–13.00) mm.

Colour. Black; malar space and mandibles brown (tooth apex darker), tegula dark brown, fore and mid leg mostly brown, coxa dark brown, tibia dark brown with longitudinal cream stripe on anterior face, 1st tarsomere and anterior face of 2nd tarsomere and 3rd tarsomere cream; hind leg mostly dark brown, prefemur and femur brown basally, tibia with cream patch subbasally on ventral face, tarsus cream with basal quarter of 1st tarsomere, 5th tarsomere and claw dark brown; metasoma dark brown; ovipositor sheath dark brown with cream apex 1.93 × length of hind 1st tarsomere; ovipositor brown, wing hyaline, wing vein and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; length 1.08 (1.06–1.10) × width; postocular space long, becoming concave before occipital carinae; head in lateral view, convex frons and vertex; postocular space 0.56 × height of eye; eye setae absent; face and frons rugose with scattered shallow depressions, short scattered setae; medial frontal carina distinct anterior half, visible as a shallow groove posteriorly; vertex reticulate-rugulose, strigate-rugulose medially, short scattered shiny setae; occipital carina short, wider medially and ventro-laterally, lamelliform, shallow broad depression, medially emarginate; gena reticulate rugulose with scattered shallow punctures along eye margin, short dense shiny setae; minimal width of malar space 0.10 (0.07–0.13) × height of eye; 0.56 × length of pedicel; clypeus punctate; 2.24 × wide as high; margin sinuate with lateral corners distinctly protruding forwards, medial depression shallow, long dense shiny setae, denser along ventral margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.50 (0.40–0.61) × distance between lateral ocelli; scape 2.17 (2.00–2.33) × length pedicel; 1st flagellomere 0.96 (0.81–1.11) × as long as scape; 0.70 (0.65–0.75) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.53 (1.25–1.80) × height; propleuron length 1.23 × width; 0.95 (0.93–0.97) × prototegular distance; propleuron rugulose-lacunose dorsally, becoming rugose, medium dense shiny setae; pronotal process distinct, acute: pronotum anterior and posterior lobes rugulose, dorsal lobe granulate, groove between pronotum lobes carinate, short dense shiny setae; mesoscutum length 1.22 × width in dorsal view; truncated in lateral view, granulate-rugulose with scattered small shallow depressions, short scattered shiny setae; admedial lines present; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granulate-reticulate with short scattered setae; mesepisternum reticulate-rugulose dorsally and along posterior margin, remaining areolate, short dense shiny setae; mesepimeron broad, carinate with scattered shallow depressions dorsally, with short scattered setae on dorso-posterior corner; metapleuron areolate, coarser ventro-laterally, short dense shiny setae; propodeum areolate, medial carinae flattened, short scattered setae.

Legs. Hind coxa rugulose anterior-dorsally becoming more strigate-rugulose posteriorly and reticulate laterally-ventrally; femur length 0.74 (0.73–0.75) × length of tibia; tibia length 5.22 (4.94–5.50) × tibia width; short dense setae with scattered emergent short stout setae; short robust spines on apex of each tarsomere, dense stout setae on ventral face; 1st tarsomere 3.38 (3.16–3.60) × length of 2nd tarsomere; 2nd tarsomere 1.30 (1.25–1.36) × length of 3rd tarsomere; 3rd tarsomere 2.00 × length of 4th tarsomere; 4th tarsomere 0.50 × length of 5th tarsomere; tarsal claw 1.25 × length of 5th tarsomere.

Wings. Fore wing first discal cell wider at apex; vein r-m spectral; vein SR1 distinctly bent; vein 2-M basal third tubular with node, remainder of vein pigmented; hind wing vein 1-m and apical two thirds of 2m+Cu pigmented, spectral at wing apex; three equidistant hamuli.

Metasoma. Metasoma length 2.36 (2.35–2.38) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 0.99 (0.90–1.07) × metasoma length; short appressed setae.

Male. Same description as female with apical margin of T9 cream.

Distribution. The species is known only from WA.

Biology. Collected on *leptospermum* (Myrtaceae) in WA.

Comments. *Gasteruption subconicum* is superficially similar to *G. simillimum* based on the general body shape and colour. Both species are black in colour and have a short, bulbous propleuron (length 1.23 × width) and long postocular space (0.56 × height of eye). They can be separated by the length of the ovipositor sheath, 0.99–1.49 × metasoma length in *G. subconicum* compared to 1.49 × metasoma length in *G. simillimum*, and shorter cream/ white apex length 1.93 × length 1st hind tarsomere compared to 3.67 × length 1st hind tarsomere respectively.

Gasteruption tenellum **Schletterer, 1889**

Fig. 87.

Gasteruption leucobrachiurn Kieffer, 1911: 204, ♀. (syn. Pasteels, 1957)
Gasteruption leucochirurn Kieffer, 1911: 209, ♂. (syn. Pasteels, 1957)
Gasteruption tenellum Schetterer 1800: 437, ♀; Pasteels, 1957: 46, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Mackay [QLD] 12.99" "Australia. R.E.Turner. 1907–244" "*Gasteruption leucobrachium* Kieffer." (BMNH: 3.a.205).

Specimen damage. Left antenna 4th flagellomere to tip and right 6th flagellomere to tip missing, metasoma broken and glued to label.

Other material examined. **NSW:** 3♀, 1♂, Bogan River, xi.1933-5, J. Armstrong (AM: K 279889, K 279892).

Redescription. *Female.* body length 11.53 (11.28–11.78) mm; ovipositor length 10.80 (9.20–12.4) mm.

Figure 87. *Gasteruption tenellum* Schetterer, holotype female, lateral habitus, scale bar = 1.00 mm.

Colour. Black; antenna dark brown, mandibles brown with dark tooth apex; faint reddish-brown on anterior corners of pronotum; tegula brown; fore and mid leg mostly brown, trochantellus brown cream apex, femur cream spot apically, tibia with cream longitudinal stripe on anterior face, tarsus cream, 4th tarsomere to claw brown; hind leg mostly dark brown, prefemur and femur brown, becoming dark brown apically, tibia with cream band subbasally, tarsus cream, 4th tarsomere to claw brown, with basal quarter of 1st tarsomere dark brown; metasoma basal half dark brown, becoming darker apically; ovipositor sheath dark brown with cream apex 2.38 × length of hind 1st tarsomere, ovipositor dark brown; wing hyaline, wing veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.75 (0.72–0.78) × longer than wide; postocular space tapering; head in lateral view; frons and vertex rounded; postocular space 0.39 × height of eye; eye setae absent; face and frons reticulate with short dense shiny setae; medial frontal carina indistinct in anterior quarter; vertex reticulate-rugulose, becoming strigate-rugulose behind lateral ocelli, short dense shiny setae; occipital carina short, wider ventro-laterally, lamelliform, broad rounded depression; gena reticulate-rugulose, short dense shiny setae;

minimal width of malar space 0.04 × height of eye; 0.25 × length of pedicel; clypeus punctate; 2.11 (1.92–2.30) × wide as high; margin sinuate with lateral corners barley protruding forwards, medial depression indistinct, short dense setae, longer along margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.59 (0.50–0.68) × distance between lateral ocelli; scape 1.79 (1.58–2.00) × length pedicel; 1st flagellomere 1.02 (1.00–1.05) × as long as scape; 0.60 (0.60–0.61) × length second flagellomere.

Mesosoma. Mesosoma length 1.75 (1.65–1.87) × height; propleuron length 1.30 ×width; 0.91 × prototegular distance; propleuron reticulate-rugose with short dense shiny setae, denser ventro-lateral; pronotal process acute; pronotum reticulate-rugose; groove between pronotum lobes carinate, short dense shiny setae; mesoscutum rounded; areolate-rugose with short scattered shiny setae; notauli U-shaped, scrobiculate; mesoscutellum areolate-rugose and axilla rugulose, both with scattered short setae; mesepisternum areolate coarser ventro-lateral with short dense shiny setae; mesepimeron carinate with shallow depressions; metapleuron areolate with short dense shiny setae; propodeum coarsely areolate; short dense shiny setae; medial carina flattened.

Legs. Coxa rugulose-reticulate; femur length 0.78 (0.77–0.79) × length of tibia; tibia length 5.33 × width; short setae with scattered short robust spines on anterior face; tarsus with short spines on ventral face and apically; 1st tarsomere 3.26 (3.20–3.33) × length of 2nd tarsomere; 2nd tarsomere 1.33 (1.25–1.38) × length of 3rd tarsomere; 3rd tarsomere 2.17 (1.70–2.22) × length of 4th tarsomere; 4th tarsomere 0.39 (0.36–0.40) × length of 5th tarsomere; tarsal claw 0.60 (0.30–0.67) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated; vein r-m spectral; vein SR1 distinctly bent; vein 2-M basal third tubular with node, remaining vein pigmented; three hamuli equidistant.

Metasoma. Metasoma length 2.92 (2.90–2.94) × mesosoma length; hypopygium Y-shaped; short appressed setae.

Male. Same characters as female.

Distribution. The species is known from QLD and NSW.

Biology. Unknown.

Comments. Pasteels (1957) grouped *G. cribatum* and *G. tenellum* together based on a strongly rounded postocular space and rugose sculpturing on the mesosoma. *G. tenellum* can be separated based on the length of the malar space, (0.25 × length of pedicel), hind tibia without cream/ white patch subbasally and equidistant hamuli spacing. Pasteels (1957) considered the Schetterer type of *G. tenellum* to be lost.

Gasteruption terminale (Westwood, 1841)

Figs 88.

Foenus terminalis Westwood, 1841: 537, ♀.

Gasteruption himantophorum Kieffer, 1911: 206, ♀(syn. Pasteels, 1957); Kieffer, 1912: 326, ♀.

Gasteruption pallidiscuspis Kieffer, 1911: 202, ♀ (syn. Pasteels, 1957); Kieffer 334, ♀.

Gasteruption terminale (Westwood) Pasteels, 1957: 112, ♀, ♂; Jennings 2010 [on-line checklist].

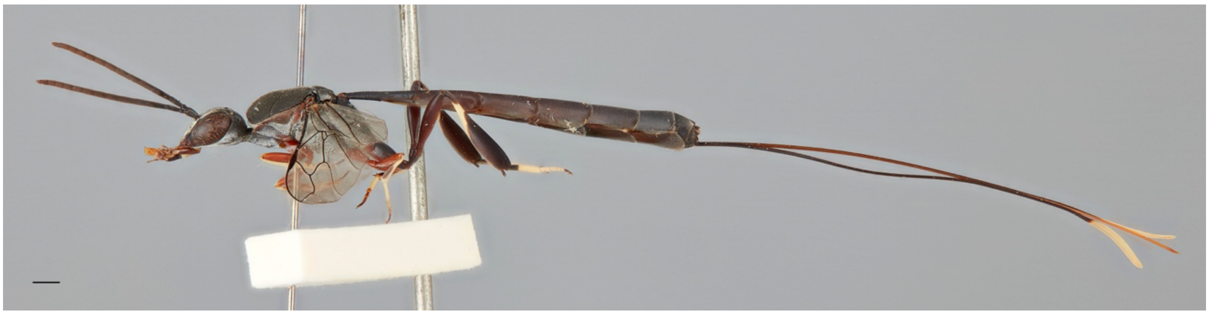

Figure 88. *Gasteruption terminale* (Westwood), lateral habitus, scale bar = 1.00 mm.

Material examined.

Holotype *Gasteruption himantophorum* Kieffer. ♀, "*Gasteruption* *himantophorum* n.sp. Kieff." "3236" "Hobart 91–155." (BMNH: 3.a.175). *Specimen damage*. Left antenna, 7th flagellomere to tip and right antenna 9th flagellomere to tip missing, left fore wing missing, right hind 4th tarsomere to tip missing.

Holotype *Gasteruption pallidiscuspis* Kieffer. ♀, "*Gasteruption pallidiscuspis* Kieffer." "Australia. R.E. Turner. 1907–244" (BMNH: 3.a.171). *Specimen damage*. Left antenna 7th flagellomere to tip, right 4th flagellomere to tip, right fore leg prefemur to tip, right midleg tarsus and left hindleg 4th tarsomere to tip and right hind tarsus missing.

Holotype *Foenus terminalis* Westwood. ♀, Nova Hollandia (OUMNH) [examined from photos].

Other material examined. **QLD:** ♀, Brisbane, 24.ii.1962, B. Willson (QM); 2♀, Mount Williams National Park, 21,I,1992, G. & A. Daniels (QM)*; ♀, Girraween National Park, 1–2.xii.1981, G. Daniels &M.A. Schneider (QM). **NSW:** Warrumbungle National Park, 17.x.1997, S. Winterton, C. Lambkin & J. Skevington (QM). **TAS:** ♀, Hobart, 9.iii.1940, D.C. Pearse (TMAG: F3641); ♀, Cambridge, ii.1967, J.H. Varley (TMAG: F33180); ♀, Cambridge, 12.ii.1979, R. Bashford (TMAG: F33187). **SA:** ♀, 6 km W Auburn, 22–29.iii.1991, J.T. Jennings (WINC).

Redescription. *Female*. body length 21.23 (19.20–22.70) mm; ovipositor length 18.63 (18.40–18.90) mm.

Colour. Body mostly black; malar space and mandibles dark brown (darker tooth apex); posterior of propleuron, pronotum dorsal lobe and patch ventrally and tegula brown; fore and mid legs mostly brown, trochantellus with cream apical margin, femur with cream patch apically; tibia dark brown with longitudinal cream stripe on anterior face; 1st tarsomere and anterior face of 2nd and 3rd tarsomere cream; hind leg mostly dark brown, coxa brown, prefemur and femur brown, tibia brown ventrally with cream band sub basally, tarsus cream, base of 1st tarsomere and apical half of 5th tarsomere and claw dark brown; metasoma dark brown, lateral face of T2–T3 lighter brown; ovipositor sheath dark brown with cream apex 2.36 (2.00–2.65) × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing vein and pterostigma dark brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.94 (0.88–1.00) × width, postocular space bulbous in dorsal view; head in lateral view wedge like, rounded face, and frons, gena flattened; postocular space 0.41 (0.34–0.47) × height of eye; eye setae absent, face and frons granular with short dense shiny setae, denser on eye margin and medially; medial frontal carina raised in anterior half, indistinct groove remaining; vertex granular-punctate around ocelli, becoming granular-strigulate posteriorly, short scattered setae; occipital carina short, lamelliform, depression broad, shallow, medial pointed; gena granular with short dense shiny setae; minimal width of malar space 0.05 (0.05–0.06 × height of eye; 0.38 (0.38–0.40) × length of pedicel; clypeus punctate; 1.90 (1.57–2.13) × wide as high; margin sinuate with lateral corners barely protruding forwards, medial depression indistinct anteriorly, short dense shiny setae, scattered long setae on margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.41 (0.27–0.60) × distance between lateral ocelli; scape 1.54 (1.0–1.88) × length pedicel; 1st flagellomere 1.32 (1.27–143) × as long as scape; 0.76 (0.72–0.79) × length second flagellomere.

Mesosoma. Mesosoma length 1.82 (1.78–1.84) × height; propleuron length 1.34 (1.26–1.38) × width; 0.83 (0.79–0.89) × prototegular distance; propleuron rugulose dorsally, becoming reticulate-rugulose, medium dense shiny setae; pronotal process distinctive, broad slightly hooking outwards dorsally; pronotum anterior lobe reticulate-rugulose, dorsal and posterior lobe granular, groove between pronotum lobes carinate, medium dense shiny setae, longer in groove; mesoscutum length 1.33 (1.29–1.39) × width in dorsal view; rounded in lateral view; granular-reticulate, carinate groove medially and on posterior margin; short scattered setae; notauli U-shaped, scrobiculate; Mesoscutellum and axilla granular-reticulate with short scattered setae; mesepisternum dorsally reticulate-rugulose, areolate-rugose ventrally, medium dense shiny setae; mesepimeron carinate, with shallow fovea; metapleuron dorsal lobe areolate-rugulose, coarser ventrally, medium dense shiny setae; propodeum areolate-rugulose, with transverse carinae radiating from the medial carinae, medium dense setae, shiny dorsally; medial carinae flattened.

Legs. Hind coxa rugulose, coarser dorsally, strigulate in coxal groove; femur

0.68 (0.58–0.72) × length of tibia; tibia length 5.06 (4.88–5.20) × width; short dense setae with scattered stout spines on anterior face; tarsus with short dense spines on ventral face and apically; 1st tarsomere 3.18 (2.96–3.33) × length of 2nd tarsomere; 2nd tarsomere 1.39 (1.25–1.45) × length of 3rd tarsomere; 3rd tarsomere 1.53 (1.09–1.78) × length of 4th tarsomere; 4th tarsomere 0.53 (0.45–0.73) × length of 5th tarsomere; tarsal claw 0.54 (0.53–0.55) × length of 5th tarsomere.

Wings. First discal cell elongated, wider at junction of vein 3-cu; fore wing vein r-m absent; vein SR1 distinctly bent; vein 2-M basal quarter tubular with node, remainder of vein pigmented; hind wing vein apical third 2m+Cu and 1-m pigmented; three hamuli, distance between second and apical hamuli greater than distance between basal and middle hamuli.

Metasoma. Metasoma 2.89 (2.81–3.02) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.27 (1.20–1.39) × metasoma length; short appressed setae, cream tip flared.

Male. Same characters as female.

Distribution. The species is known from QLD, NSW, ACT, SA and WA.

Biology. Unknown.

Comments. Pasteels mention this species is a commonly occurring species. It keys out with *G. atrinerve* but can be separated by *G. terminale* having a brown pronotum and a shorter propleuron.

Gasteruption trianguliceps Pasteels, 1957

Fig. 88.

Gasteruption trianguliceps Pasteels, 1957: 86, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Mackay [QLD] 11.91" "80" "Australia. R.E. Turner 1907 –244." "*Gasteruption trianguliceps* n.sp J. Pasteels det., 1995" (BMNH: 3a . 361).

Specimen damage. Left antenna 8th flagellomere to tip and right antenna 4th flagellomere to tip missing, metasoma broken at T5 and glued to card bellow specimen, ovipositor sheaths missing.

Redescription. *Female*. body length 18.5 mm; ovipositor length 15.40 mm.

Colour. Body mostly black; head black except for malar space and mandibles dark brown; fore and mid legs mostly dark brown, femur with cream patch apically, tibia with longitudinal cream stripe on anterior face covering apex and base, fore leg tarsus 1st tarsomere to 3rd tarsomere cream, mid leg 1st tarsomere cream; hind leg mostly dark brown, coxa, trochantellus, femur and tibia brown ventrally, tibia with cream band subbasally, tarsus cream with basal third of 1st tarsomere and apical half of 5th tarsomere dark brown; metasoma dark brown, brown laterally from T2 to tip; ovipositor sheaths missing in the type; ovipositor brown; wing hyaline; wing veins dark brown and pterostigma brown.

Figure 88. *Gasteruption trianguliceps* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Head. Head shape sub-rectangular when viewed dorsally; length 0.86 ×

width; postocular space short and rounded in dorsal view; head in lateral view wedge like, face and frons rounded with carinae visible above antennal scrobes; postocular space 0.30 × height of eye; face and frons reticulate-punctate with short dense shiny setae, denser on eye margins and medially, becoming scattered posteriorly; medial frontal carina present in anterior half, distinct above antennae insertion; vertex punctate-reticulate around ocelli, becoming reticulate-rugulose posteriorly, short scattered setae; narrow lamelliform occipital carina, wider ventro-laterally, shallow broad, rounded depression; gena reticulate-rugulose; short dense shiny setae; minimal width of malar space 0.08 × height of eye; 0.67 × length of pedicel; clypeus punctate; 1.79 × wide as high; margin sinuate with lateral corners barely protruding forwards, medial depression present anteriorly, short dense shiny setae, longer along margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.54 × distance between lateral ocelli; scape 2.17 × length pedicel; first flagellomere 0.77 × as long as scape; 0.50 × length second flagellomere.

Mesosoma. Propleuron length 1.50 × width; 1.18 × prototegular distance; propleuron reticulate-rugulose, coarser dorsally, medium dense shiny setae; pronotal process distinct, hook like dorsally; pronotum anterior lobe areolate-rugulose, dorsal lob reticulate-punctate and posterior lobe rugulose, groove between pronotum lobes carinate, medium dense setae, longer in groove; mesoscutum length 1.25 × width in dorsal view; truncated in lateral view; medial lobe strigate-rugulose, lateral lobe reticulate-rugulose, reticulate-punctate around parapsidial lines, short dense setae; admedial lines gently converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate-rugulose with scattered punctures medially, short scattered setae; mesepisternum areolate-rugulose dorsally, becoming coarsely areolate-rugose, medium dense shiny setae; mesepimeron ventral half scrobiculate becoming carinate; metapleuron areolate-rugulose dorsal lobe, coarsely areolate-rugose, medium dense shiny setae; propodeum areolate-rugose with transverse carinae, medial carina flattened, medium dense shiny setae, very shaggy appearance.

Legs. Hind coxa strigate in coxal groove, strigate-rugulose dorsally, becoming punctate-rugulose; femur length 0.72 × length of tibia; tibia length 5.31 × tibia width; short dense setae with scattered stout emergent spines on anterior face; 1st

tarsomere 3.67 × length of 2nd tarsomere; 2nd tarsomere 1.5 × length of 3rd tarsomere; 3rd tarsomere 2.0 × length of 4th tarsomere; 4th tarsomere 0.33 × length of 5th tarsomere; tarsal claw 0.53 × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated, wider at junction of vein 3-cu; vein r-m absent; SR1 distinctly bent; 2-M basal third tubular with node, remaining pigmented; hind wing vein, middle of 2m+Cu and 1-m pigmented, four equidistant hamuli.

Metasoma. Metasoma 2.93 × mesosoma length; hypopygium Y-shaped; ovipositor length (used in place of ovipositor sheath) 1.33 × metasoma length.

Male. Unknown.

Distribution. The species is known only from the type locality of Mackay, QLD.

Biology. Unknown.

Comment. This species is superficlly similar to *G. combinatum* based on reddish-brown and black colouration, general body shape and 1st flagellomere length (0.75–0.77 × length of scape). From avalible characters for *G. combinatum* the two species can be separated by *G. trianguliceps* having a distinctly bent SR1 fore wing vein and a longer mesoscutum (2.93 × width in dorsal view).

Gasteruption tricoloripes Kieffer, 1911

Fig. 89.

Figure 89. *Gasteruption tricoloripes* Kieffer, holotype male, lateral habitus, scale bar = 1.00 mm.

Gasteruption tricoloripes Kieffer, 1911: 212, ♂; Pasteels, 1957: 56, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♂, "Type" "*Gasteruption tricolouripes* Kieffer." "44. 4" "Determned by Dr. Kieffer" (BMNH: 3.a.174).

Specimen damage. Left and right antennae, 8th flagellomere to tip, left ts2-tip missing, left hind wing apex damaged, metasoma damaged but intact.

Comments. The original species description is based entirely on a single male specimen, and until we can associate females, we have refrained from redescribing this species. The species can be distinguished based on coarse areolate sculpturing on the mesoscutum and head and longitudinal striations dorsally on T1.

Gasteruption uniform Pasteels, 1957

Fig. 90.

Figure 90. *Gasteruption uniform* Pasteels, holotype female, lateral habitus, scale bar = 4.00 mm.

Gasteruption uniform Pasteels, 1957: 114, ♀; Jennings 2010 [on-line checklist].

The following description is based on a combination of the original description (Pasteels, 1957) and holotype images provided by NMV (Fig. 87), the quality of the images does not allow for detailed descriptions of surface sculpturing and some body measurements.

Material examined.

Holotype. ♀, "Kuranda. NQ. 3-1-[19]53. GB" "Collection A. N. Burns" "*Gasteruption uniforme* n.sp. J. Pasteels det., 1956" (NMV: T-7452) [examined from photos].

Redescription. *Female.* Body length 16.60 mm; ovipositor length 15.45 mm.

Colour. Black; antenna dark brown, anterior margin of malar space reddish-brown, mandible brown; fore and mid legs orange brown, tibia and tarsus dark brown with longitudinal cream stripe on anterior face of tibia and 1st tarsomere; hind leg mostly dark brown, coxa reddish-brown, lateral face black, tibia with cream patch subbasally, tarsus cream with basal half of 1st, 5th tarsomere and claw dark brown;

metasoma dark brown; ovipositor sheath dark brown with cream apex 1.78 × length of hind basitarsus; wings hyaline, veins and pterostigma dark brown.

Head. Head shape sub-conical when viewed dorsally; postocular space slightly bulbous behind eyes, tapering sharply before occipital carina; head in lateral view wedge like, frons and vertex convex, gena wider posteriorly; postocular space 0.39 × height of eye; short scattered eye setae; head granular short scattered setae, occipital carina is clear, narrow lamelliform, shallow rounded depression; minimal width of malar space 0.12 × height of eye; 0.88 × length of pedicel; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.41 × distance between lateral ocelli; scape 1.62 × length pedicel; 1st flagellomere 1.16 × as long as scape; 0.77 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.76 × height; mesosoma covered in granular sculpturing, pronotal process broad, rounded, pointing outwards; mesoscutum length 1.39 × width in dorsal view; rounded in lateral view; notauli U-shaped, scrobiculate; propodeum with clear longitudinal medial carina, in lateral view convex.

Legs. Femur 0.71 × length of tibia; tibia length 5.17 × tibia width, short dense setae with scattered stout emergent spines on anterior face; 1st tarsomere 3.03 × length of 2nd tarsomere; 2nd tarsomere 1.46 × length of 3rd tarsomere; 3rd tarsomere 2.91 × length of 4th tarsomere; 4th tarsomere 0.43 × length of 5th tarsomere; tarsal claw 0.63 × length of 5th tarsomere.

Wings. Fore wing first discal cell tapering basally, wider subapically; vein r-m absent; vein SR1 distinctly bent, vein 2-M basal third tubular with apical node, remainder of vein pigmented; hind wing veins not completely visible with apical parts of vein 2m+Cu pigmented, other veins spectral, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma 2.74 × mesosoma length; ovipositor sheath 1.28 × metasoma length, cream apex distinctly flared.

Male. Unknown.

Distribution. The species is known only form the type locality of Kurandra, QLD.

Biology. Unknown.

Comments. *Gasteruption* uniform keys out with G. *erythrarthrum*. The species can be separated based on malar space length and ovipositor sheath length, see key couplet 22.

***Gasteruption valvulare* Schletterer, 1890**

Fig. 91.

Figure 91. *Gasteruption valvulare* Schletterer, holotype female, lateral habitus, scale bar = 1.00 mm.

Gasteruption valens Kieffer, 1911: 59, ♀, (syn. Pasteels, 1957).

Gasteruption valvulare Schletterer, 1890: 438 ♀; Pasteels, 1957: 59; Jennings 2010 [on-line checklist].

Material examined.

Holotype *Gasteruption valvulare* Schletterer. ♀, “Goondiwindi X G. H. Hardy” (SDEI). *Specimen damage*. Left and right antenna 7th flagellomere to tip missing, left mid leg 4th tarsomere to tip and right mid leg 5th tarsomere to tip missing, left hind leg tibia to tip missing.

Holotype *Gasteruption valens* Kieffer. ♀, "*Gasteruption valens* Kieffer." "68.6" (BMNH: 3.a.176). *Specimen damage*. complete left antenna, right 10th flagellomere to tip, left fore and mid leg trochanter to tip, right 4th tarsomere to tip, full left hind leg and right hindleg trochanter to tip missing.

Redescription. *Female.* Body length 16.00 mm; ovipositor 4.15 mm.

Colour. Black; head mainly black with lateral corners of clypeus and malar space orange-brown, mandibles (with darker tooth apex) and tegula brown; fore and mid legs mostly orange-brown, trochantellus with cream band on apical margin, femur with cream patch apically, tibia dark brown with cream longitudinal stripe on anterior face, tarsus cream with 5th tarsomere and claw brown; hind leg dark brown, coxa black with dark brown interior face, tibia with cream patch subbasally, tarsus cream with basal third of 1st tarsomere and apical two thirds of 5th tarsomere and claw dark brown; metasoma dark brown, darker brown at base and apex; ovipositor sheath dark brown with cream apex 0.70 × length of hind 1st tarsomere; ovipositor brown; wing hyaline, wing veins dark brown, pterostigma light brown.

Head. Head shape sub-rectangular when viewed dorsally; 1.04 × longer than wide; postocular space mainly rectangular, gently tapering from posterior of eye, posterior third tapering more towards occipital carinae; head in lateral view, long postocular space, bulging behind ocelli, rounded front of face; postocular space 0.46 × height of eye; face reticulate with short dense setae, longer along eye margin; frons granular with short scattered setae; medial frontal carina present in anterior half; vertex granular with transverse granular-strigate with short dense setae; narrow occipital carina, lamelliform, shallow depression medially emarginate; gena reticular-punctate with short dense setae with scattered long setae; minimal width of malar space 0.04 × height of eye; 0.30 × length of pedicel; clypeus 1.60 × wide as high; margin sinuate; lateral corners distinctly protruding forwards; medial depression present anteriorly, short dense setae, longer along clypeus margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.43 × distance between lateral ocelli; scape 2.00 × length pedicel; 1^{st} flagellomere 0.83 × as long as scape; 0.58 × length 2^{nd} flagellomere.

Mesosoma. Mesosoma length 1.72 × height; propleuron length 1.11 × width; 0.80 × prototegular distance; propleuron rugose laterally becoming reticulate-rugulose posteriorly; short dense setae; pronotal process rounded; pronotum anterior lobe rugose, dorsal lobe granular, posterior lobe granular, coarser ventrally, groove between pronotum lobes carinate, short dense setae, longer in groove; mesoscutum length 1.39 × width in dorsal view; rounded in lateral view; granular with short scattered shiny setae; admedial lines indistinct, parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular with short scattered setae; mesepisternum reticulate-rugulose becoming areolate laterally and ventrally with short dense setae; mesepimeron carinate, finer dorsally; metapleuron and propodeum areolate with short dense setae; medial longitudinal carinae flattened.

Legs. Hind coxa reticulate-rugulose laterally, strigate dorsally and in coxal groove; femur 0.73 × length of tibia; tibia length 4.71 × tibia width; short dense setae with scattered stout emergent setae on anterior face; 1^{st} tarsomere 3.33 × length of 2^{nd} tarsomere; 2^{nd} tarsomere 1.41 × length of 3^{rd} tarsomere; 3^{rd} tarsomere 1.89 × length of 4^{th} tarsomere; 4^{th} tarsomere 0.41 × length of 5^{th} tarsomere; tarsal claw 0.59 × length of 5^{th} tarsomere.

Wings. Fore wing first discal cell rectangular; vein r-m absent; vein 2-M basal third tubular, apical two thirds pigmented; vein 2-M present; vein 2-M basal third; hind wing vein 1-m pigmented, all other veins spectral; three equidistant hamuli.

Metasoma. Metasoma 2.62 × mesosoma length; hypopygium Y shape; ovipositor sheath with flared apex, short appressed setae.

Male. Unknown.

Distribution. The species is known from QLD. Pasteels (1957) examined forms from ACT and WA.

Biology. Unknown.

Comments. The type specimens of *G. valvulare* and *G. valens* are similar in both general colour, sculpturing patterns and morphometric ratios, we hereby synonymise *G. valvulare* and *G. valens.* Pasteels (1957) considered this species as part of a complex of species that included *G. automnale*, *G. hollandiae*, and *G. hyalipenne*. These species according to Pasteels vary based on colour of the mandibles and hind legs, length of malar space and ovipositor. The examination of additional material is needed to determine if they are indeed valid species or a single widespread species with high levels of polymorphism.

***Gasteruption varians* Pasteels, 1956**

Gasteruption varians Kieffer, 1912: 336, ♀ (*G. flavitarse*, nec Guérin-Méneville, 1843); Pasteels, 1956: 248, ♀, ♂ (nomen novum: *G. varians*); 1957: 78, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "MISOOL, i[slan]d. (W.) 0–75m. Fakal 8.ix - 20.x.1948. M.A. Lieftinck" "*Gasteruption flavitarse* Guérin J. Patseels det., 1955" "*Gasteruption varians* Past. set. J. Pasteels 1956 [hand written label]" (RMNH).

Specimen damage. Right antenna 7th flagellomere to tip missing, metasoma from T2 broken and reattached with glue.

Redescription. *Female.* body length 19.00 mm; ovipositor length 44.00 mm.

Colour. Black; antenna dark brown, scape and malar space reddish-brown; clypeus brown laterally, mandibles orange-brown with darker tooth apex; posterior corner of the propleuron, posterior ventral lobe of the pronotum, anterior ventral margin of mesepisternum and mesepimeron reddish-brown, tegula dark brown; fore and mid legs orange-brown, trochantellus with cream apical margin, tarsus brown, lighter brown at base of 1st tarsomere; brown; hind leg dark brown, tibia black dorsally, tarsus cream, base of 1st tarsomere and apical half of 5th tarsomere and claw black; metasoma dark brown, brown ventro laterally; ovipositor sheath dark brown with cream apex 2.62 × length of hind 1st tarsomere; ovipositor dark brown; wings hyaline, wing veins and pterostigma dark brown.

Head. Head sub-rectangular when viewed dorsally, length 0.81 × width; postocular space rounded; head in lateral view wedge like, postocular space 0.30 × height of eye; short scattered setae on eye; face punctate-reticulate with short dense setae, longer on eye margin and medially; frons punctate-rugulose, coarser dorsally, short setae; medial frontal carina present anteriorly, a shallow groove posteriorly; vertex punctate-reticulate with several scattered punctures, short scattered setae; narrow lamelliform occipital carina, shallow round depression; gena punctulate-rugulose with short dense shiny setae; minimal width of malar space 0.10 × height of eye, 1.00 × length of pedicel; clypeus punctate-reticulate becoming punctulate medially; 1.88 × wide as high, margin sinuate with lateral corners barely protruding forwards, medial depression present anteriorly, short dense setae, longer on margin; mandible with a wide medial tooth; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.63 × distance between lateral ocelli. Scape 2.00 × length pedicel; 1st flagellomere 0.44 × as long as scape, 0.18 × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.59 × height; propleuron length 1.13 × width, 0.85 × prototegular distance, rugose dorsally, becoming reticulate-rugulose laterally and ventrally, medium dense shiny setae, pronotal process indistinct and rounded; pronotum anterior lobe areolate-rugose medially, rugose dorsally and ventrally; dorsal lobe rugulose and posterior lobe reticulate-rugulose, groove between anterior and dorsal lobes broad carinate with distinct transverse carinae, groove between posterior and dorsal narrow carinate, medium dense setae; mesoscutum length 1.00 × width in dorsal view; rounded in lateral view; punctate-rugulose, carinate groove medially between notauli and posterior margin, medium scattered setae; notauli U-shaped, scrobiculate; mesoscutellum punctate-rugulose axilla punctate, more punctate-rugulose near mesoscutellum, short scattered setae; mesepisternum rugose with dorsal lobe becoming strigate towards posterior margin, areolate ventral lobe, medium dense setae, shiny laterally and ventrally; mesepimeron broad with large course fovea, a smooth patch along dorso-posterior margin and medially along posterior margin, short scattered setae on dorsal-posterior margin and along ventral-anterior margin; metapleuron areolate with medium dense shiny setae; propodeum areolate-rugose with medial longitudinal carinae absent, medium dense setae.

Legs. Hind coxa strigate-rugulose dorsally, strigate in coxal groove, becoming punctate-rugulose laterally, femur 0.70 × length of tibia; tibia long and cylindrical, length 8.18 × width; short dense setae with scattered emergent setae on anterior face, ventro-apical pecten of short robust spines, tarsus with ventro pecten of short robust spines apically and along ventral face; 1st tarsomere 2.90 × length of 2nd tarsomere, 2nd tarsomere 1.50 × length of 3rd tarsomere, 3rd tarsomere 2.00 × length of 4th tarsomere, 4th tarsomere 0.40 × length of 5th tarsomere, tarsal claw 0.52 × length of 5th tarsomere.

Wings. Fore wing first discal cell, elongated; vein r-m absent with pigmented apex and base; vein SR1 distinctly bent, vein 2-M basal quarter tubular, remaining pigmented; hind wing vein 2m+cu and 1-m tubular, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma 3.00 × mesosoma length; hypopygium Y-shaped; ovipositor sheath covered in short appressed setae.

Male. Not examined but described by Pasteels (1956) as being identical to female.

Distribution. The type is known from Misool Island in West Papua with Pasteels (1957) suggesting a wide distribution across Australian from WA, NSW and QLD.

Biology. The species has been recorded around nests of *Megachile kuehni* Friese (Pasteels 1956a).

Comments. *Gasteruption varians* keys out with *G. flavicans* and *G. melanostoma* but can be separated based on a sinuate clypeal margin and elongated cylindrical tibia (8.18 × width). Pasteels' (1957) commented that this species is the only Australian species to also found in Papua New Guinea.

Gasteruption variegatum Schletterer, 1885

Fig. 92.

Gasteruption annulitibiale Strand, 1911: 163, ♀ (syn. Pasteels, 1957).

Gasteruption variegatum Schletterer, 1885: 325, ♀; 1890: 453, ♂; Pasteels, 1957: 115, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype *Gasteruption variegatum* Schletterer. ♀, Sydney (NHMW) [not examined].

Holotype *Gasteruption annulitibiale* Strand. ♀, "N.S. Wales" "*Gasteruption annulitibiale* Strand det. ♀" (ZMBD).

Other material examined. **QLD:** 1♀, Atherton, H. James (QM)*. ♀, Eidsvoldq, 10.29-4.30 T.A. Bancroft (QM).

Figure 92. *Gasteruption variegatum* Schletterer, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female*. Body length 19.50 (18.50–19.70) mm; ovipositor length 17.70 (16.80–18.60) mm.

Colour. Black and reddish-brown; head mostly black, antenna brown, malar space and clypeus orange-brown; Mesosoma mostly reddish-brown, propleuron, dorsal lobe of pronotum, medially on the mesoscutum, mesoscutellum, axilla and propodeum black; fore and mid legs brown, longitudinal cream stripe on anterior face of tibia and 1st tarsomere; hind leg coxa and femur reddish-brown, darker brown dorsally, trochantellus and prefemur dark brown, tibia dark brown with cream band subbasally, tarsus cream, basal third of 1st tarsomere and claw dark brown; metasoma dark brown, lighter brown laterally on T2–T4; ovipositor sheath dark brown with cream apex 1.72 (1.62–1.82) × length of hind 1st tarsomere; ovipositor light brown; wings hyaline, veins brown and pterostigma light brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.93 (0.78–1.07) × longer than wide; postocular space gently tapering to occipital carinae; head in lateral view, wedge shape with frons and vertex convex, gena flattened; short postocular space, 0.28 (0.28–0.29)× height of eye; eye setae absent; face punctate with short dense shiny setae; frons punctate-reticulate with short shiny setae; medial frontal carina indistinct in anterior half, shallow indistinct groove posteriorly; vertex punctate-reticulate around ocelli, posteriorly strigate-reticulate medially with short shiny setae; narrow lamniform occipital carina, wider ventro-laterally, shallow rounded depression; gena punctate-reticulate with short dense shiny setae; minimal width of malar space 0.06 (0.05–0.07) × height of eye; 0.47 (0.44–0.50) × length of pedicel; clypeus punctate, denser laterally; 1.76 (1.73–1.79) × wide as high, margin sinuate, lateral corners barely protruding forwards, medial depression indistinct, short dense shiny setae, longer along margin; lateral ocelli anterior of postocular line, distance from lateral ocellus to eye margin 0.84 (0.47–1.21) × distance between lateral ocelli; scape 2.04 (2.00–2.08) × length pedicel; 1st flagellomere 1.07 (1.05–1.08) × as long as scape; 0.69 (0.68–0.70) × length 2nd flagellomere.

Mesosoma. Mesosoma length 3.44 (3.89–3.98) × height; propleuron length 1.16 (1.09–1.23) × width; 0.84 (0.83–0.86) × prototegular distance; propleuron reticulate-rugulose with medium dense shiny setae, pronotal process large rounded, pointing outwards; pronotum anterior lobe rugose, dorsal and posterior lobe punctate, broad groove between pronotum lobes carinate, medium dense shiny setae; mesoscutum length 1.22 (1.20–1.24) × width in dorsal view; rounded in lateral view, strigate-rugulose anteriorly around admedial lines, becoming reticulate-rugulose, course rugose depression present on posterior margin short scattered setae; admedial lines distinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla reticulate-rugulose; short scattered setae. mesepisternum rugulose dorsally, areolate-rugose ventrally, medium dense shiny setae; mesepimeron ventral two thirds foveate becoming smooth dorsal third, scattered short setae on dorso-posterior corner; metapleuron areolate-rugose with course transverse striations ventral half, medium dense shiny setae; propodeum areolate-rugose, medial carina raised, medium dense shiny setae.

Legs. Hind coxa strigate-rugulose dorsally, imbricate ventro-laterally, strigate in coxal groove; femur 0.72 (0.72–0.73) × length of tibia; tibia length 7.09 (6.85–7.33) × tibia width, short dense setae with scattered stout spines on anterior face; tarsus with stout spines on ventral face and apically; 1st tarsomere 3.63 (3.60–3.67) × length of 2nd tarsomere; 2nd tarsomere 1.46 (1.43–1.50) × length of 3rd tarsomere; 3rd tarsomere 1.71 (1.67–1.75) × length of 4th tarsomere; 4th tarsomere 0.49 (0.47–0.50) × length of 5th tarsomere; tarsal claw 0.51 (0.50–0.53) × length of 5th tarsomere.

Wings. Fore wing first discal cell elongated, slightly wider at junction of 3-Cu; vein r-m absent; vein SR1 distinctly bent, vein 2-M basal third tubular, with distinct apical node, remainder of vein pigmented; hind wing r-m and apical half of 2m-Cu pigmented, other veins spectral, three hamuli, distance between basal and middle hamuli greater than distance between middle and apical.

Metasoma. Metasoma 3.44 (2.89–3.98) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.12 (1.01–1.24) × metasoma length, short appressed setae.

Male. Same characters as female with paramere apex cream.

Distribution. The species is known from QLD and NSW.

Biology. Unknown.

Comments. The species is very similar to *G. melanopoda* differing only by the hind tarsus dark brown with no cream colouration; ovipositor sheath shorter than metasoma and cream apex flared.

Gasteruption victor Pasteels, 1957

Fig. 93.

Figure 93. *Gasteruption victor* Pasteels, holotype female, lateral habitus, scale bar = 2.00 mm.

Gasteruption victor Pasteels, 1957: 87, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♂, “Victoria” “Foenus new sp.” (NMV: T-7422) [examined from photographs].

Specimen damage. 9th flagellomere to tip missing on both antennae, complete left fore leg, left mid leg tarsomere five to tip, left hind tarsomere four to tip and right hind tarsus missing.

Comments. The original species description is based entirely on a single male specimen, and until we can associate females, we have refrained from redescribing this species.

Gasteruption villosulum Pasteels, 1957

Fig. 94.

Figure 94. *Gasteruption villosulum* Pasteels, holotype female, lateral habitus, scale bar = 1.00 mm.

Gasteruption villosulum Pasteels, 1957: 106, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "W. Australia: Dongara. 11–28.x.1935. R.E.Turner. B.M.1935–240" "*Gasteruption villosulum* n.sp. J. Pasteels det., 1954" (BMNH: 3a. 364).

Specimen damage. Both antenna 3rd flagellomere to tip missing.

Redescription. *Female*. body length 9.00 mm; ovipositor length 6.00 mm.

Colour. Body black; antenna dark brown; mandibles brown with tooth apex and outside face darker, tegula brown; fore and mid legs mostly brown, trochantellus with cream apical margin, femur with cream spot apically, tibia with cream stripe on anterior face, tarsus with cream anterior face of 2/3rds of 1st tarsomere and base of 2nd tarsomere; hind leg mostly brown, coxa dark brown, tibia with cream patch subbasally on inside face, tarsus cream, basal third of 1st tarsomere, apical half of 5th tarsomere and claw brown; metasoma brown, darker apically; ovipositor sheath dark brown with cream apex 2.19 × length of hind 1st tarsomere; ovipositor brown; wing hyaline; wing vein and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; 0.96 × longer than wide; dorsally postocular space rounded; head in lateral view wedge shape, face and frons rounded, postocular space short; 0.33 × height of eye; short scattered eye setae; face punctulate with short dense shiny setae; frons granular with short setae; medial frontal carina present in anterior third, remaining indistinct groove; vertex granular, becoming strigate-granular posteriorly, short shiny setae; narrow lamelliform occipital carina, indistinct rounded depression; gena granular with short dense shiny setae; minimal width of malar space 0.11 × height of eye; 1.00 × length of pedicel; clypeus punctate, smooth around anterior groove; 2.07 × wide as high; margin sinuate with lateral corners barely protruding forwards, medial depression present anteriorly, short scattered shiny setae, longer scattered setae on margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.47 × distance between lateral ocelli; scape 2.40 × length pedicel; 1st flagellomere 1.00 × as long as scape; 0.75 × length 2nd flagellomere.

Mesosoma. Mesosoma length 2.03 × height; propleuron length 0.80 × prototegular distance; punctate-reticulate with short dense shiny setae; pronotal process large and rounded; pronotum granular-rugulose, narrow groove between pronotum lobes carinate, short dense shiny setae; mesoscutum length 2.65 × width in dorsal view; rounded in lateral view, granular-rugose, reticulate-rugulose medially, coarser posterior margin and medially between notaulus and posterior margin, short scattered shiny setae; admedial lines straight; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular-rugulose with short scattered setae; mesepisternum granular-rugulose, short dense shiny setae; mesepimeron carinate; metapleuron areolate-rugulose, short dense shiny setae; propodeum areolate-rugulose with longitudinal medial carinae convex, short scattered shiny setae.

Legs. Hind coxa rugulose, strigate in coxal groove; femur length 0.73 × length of tibia; tibia length 4.33 × width of tibia; tarsus with short spines apically and along ventral face; 1st tarsomere 3.00 × length of 2nd tarsomere; 2nd tarsomere 1.22 × length of 3rd tarsomere; 3rd tarsomere 1.50 × length of 4th tarsomere; 4th tarsomere 0.55 × length of 5th tarsomere; tarsal claw 0.64 × length of 5th tarsomere.

Wings. Fore wing first discal cell tapering basally, becoming wider apically;

vein r-m absent; vein SR1 distinctly bent; vein 2-M basal third tubular, remaining pigmented; hind wing veins apical 2/3rds of 2m+Cu pigmented; three equidistant hamuli.

Metasoma. Metasoma length 2.65 × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.08 × metasoma length; short appressed setae.

Male. Unknown.

Distribution. The species is known only from the holotype locality of Dongara, WA.

Biology. Unknown.

Comment. This species is superficially similar to *G. atrinerve* based on general body colour, black or dark brown, and head wedge shape. *Gasteruption villosulum* can be distinguished by a longer malar space (equal to length of pedicel), and a longer mesoscutum (2.63 × width in dorsal view).

Gasteruption youngi Jennings & Parslow, 2014

Fig. 95.

Gasteruption Gasteruption youngi, Jennings & Parslow, 2014: 96, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "S. AUST. Wirrabara Forest, Sweeping, 7.iv.2007 J.T. Jennings." (SAM).

Paratypes. SA: 3♀♀ Melaleuca Cottage, Vivonne Bay, Kangaroo Island. 35°58.690S 137°10.870E, hovering above open ground, 15.ii.2010, D.A. Young. Associated with bee host (WINC) [♀ bee with same locality data separately pin mounted].

Other material examined. **SA:** 2♀♀, Great Victoria Desert, B.A. Parslow

(SAMA)

Comments. This species was described recently by Jennings & Parslow (2014) from SA. We add to the distribution two specimens collected near the border of SA and WA far from its previous collection localities. In addition to the description provided in Jennings & Parslow (2014), we add the postocular space 0.45 × height of eye; narrow lamelliform occipital carinae, shallow rounded depression; minimal width of malar space 0.04 × height of eye; 0.25 × length of pedicel; lateral ocelli posterior of postocular line; propleuron length 1.47 (1.43–1.51) × width; 0.87 (0.79–0.94) × prototegular distance; mesoscutum length 1.63 (1.62–1.65) × width in dorsal view; femur length 0.67 (0.60–0.73) × tibia length; tibia length 3.43 (3.41–3.44) × tibia width; Fore wing vein r-m absent, vein SR1 sinuate; ovipositor sheath 0.51 (0.43–0.59) × metasoma length; cream apex 0.94 (0.89–1.00) × length of hind basitarsus.

Figure 95. *Gasteruption youngi* Jennings & Parslow, paratype female, lateral habitus, scale bar = 1.00 mm.

Gasteruption zebra Pasteels, 1957

Fig. 96.

Gasteruption zebra Pasteels, 1957: 56, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "PINETS. Murrumbidgee R., Fed. Cap. Territ. [ACT] 26.x.30 L.Graham." (ANIC).

Specimen damage. Right antenna 7th flagellomere to tip and left antennae 9th flagellomere to tip missing, metasoma segment 3 to tip missing.

Other material examined. **SA:** 4♀, Simpson Desert, 16.ix.1971, T.F. Houston (SAMA)*. NSW: 1♀, Balranald, 6.x.2005, M. Batley, on *Frankenia* (AM: K420876).

Figure 96. *Gasteruption zebra* Pasteels, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female*. Body length 6.0 (5.30–6.65) mm; ovipositor length 1.05 (0.95–1.15) mm.

Colour. Body mostly black with variable amounts of brown; head black with antenna dark brown, mandibles light brown with darker tooth apex; fore and mid leg mostly brown, femur light brown basally and apically, tibia pale base and apex with cream stripe on anterior face, tarsus light brown with 3rd tarsomere to claw darker; hind leg mostly brown, coxa darker brown, prefemur and femur apex lighter, tibia with large cream patch subbasally on posterior face, base of 1st tarsomere lighter; metasoma dark brown, light brown apical margins of metasomal tergites; ovipositor sheath dark brown; wing hyaline; wing veins and pterostigma brown.

Head. Head shape sub-rectangular when viewed dorsally; length 0.73 (0.64–0.86) × width, postocular space short, convex, tapering sharply to occipital carina; head in lateral view, face flattened, ocelli raised with convex vertex; postocular space 0.32 (0.20–0.38) × height of eye; eye setae present; face and frons granular with shiny short setae; medial frontal carina raised medially, becoming a shallow groove posteriorly, indistinct in some specimens; vertex granular tending rugulose posteriorly, scattered short shiny setae; narrow occipital carina becoming wider ventro-laterally, shallow rounded depression; gena granular with medium dense shiny setae; minimal width of malar space 0.08 (0.06–0.10) × height of eye; 0.38 (0.33–0.45) × length of pedicel; clypeus reticulate; 2.03 (1.70–2.40) × wide as high; margin sinuate with lateral corners distinctly protruding forwards; medial depression present in anterior half; medium dense shiny setae, longer on margin; lateral ocelli in-line with postocular line; distance from lateral ocellus to eye margin 0.75 (0.72–0.79) × distance between lateral ocelli; scape 1.63 (1.40–1.90) × length pedicel; 1st flagellomere 0.66 (0.60–0.68) × as long as scape; 0.70 (0.60–0.87) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.55 (1.53–1.60) × height; propleuron length 1.08 (1.04–1.17) × width; 1.00 (0.93–1.05) × prototegular distance; propleuron rugulose, coarser dorsally, long dense shiny setae; pronotal process indistinct; pronotum mostly granular dorsally, rugulose ventrally (finer in some specimens), groove between pronotum lobes carinate-reticulate, short to medium shiny setae; mesoscutum length 0.98 (0.85–1.07) × width in dorsal view; rounded in lateral view; granular with short scattered setae; admedial lines indistinct, converging; parapsidial lines distinct; notauli V-shaped, scrobiculate; mesoscutellum and axilla granular with short scattered setae; mesepisternum granular dorsal lobe, becoming areolate ventrally, some specimens with course transverse striations ventrally, medium to long dense shiny setae; mesepimeron transverse carina with some scattered fovea; metapleuron areolate, coarser ventrally, medium dense shiny setae; propodeum areolate-granular, medial carina absent, medium dense shiny setae.

Legs. Hind coxa granular; femur 0.75 (0.72–0.75) × length of tibia; tibia length 3.72 (3.25–4.29) × width; tarsus with ventro-apical pecten of short robust spines; 1st tarsomere 3.86 (2.92–4.90) × length of 2nd tarsomere; 2nd tarsomere 1.32 (1.25–1.43) × length of 3rd tarsomere; 3rd tarsomere 1.07 (1.00–1.14) × length of 4th tarsomere; 4th tarsomere 0.46 (0.39–0.50) × length of 5th tarsomere; tarsal claw 0.56 (0.53–0.60) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, apex tapering; vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular, remaining two thirds pigmented; hind wing veins spectral; three equidistant hamuli.

Metasoma. Metasoma 2.37 (2.31–2.56) × mesosoma length; hypopygium V-shaped; ovipositor sheath 0.27 (0.25–0.29) × metasoma length; short appressed setae.

Male. Not examined but described by Pasteels (1957) as having thorax completely black, and first flagellomere shorter than pedicel.

Distribution. The species is known from SA, ACT and NSW with material examined by Pasteels (1957) from TAS.

Biology. Collected on *Frankenia* sp. (Frankeniaceae).

Comments. *Gasteruption zebra* is superficially similar to *G. species 2* **sp. nov.**, *G. zebriforme* and *G. zebroides*. It can be separated from *G. zebriforme* by its shorter malar space and mesosoma with brown colouration. It can be separated from *G. species 2* and *G. zebriforme* by lateral ocelli in-line with postocular line.

Gasteruption species 2 sp. nov.

Fig. 97.

Material examined.

Holotype. ♀, "23.59S 133.56E Ewaninga, 31km E by SE of Alice Springs 1.xi.1974 N.T. T. Weir & T. Angeles" (MGNT).

Paratype. ♀, same data as holotype (MGNT).

Diagnosis. This species can be separated from other species based on the small size (8.80–9.80) and the reddish-brown colouration. The body colouration seperates it from *G. zebra* and *G. zebriforme*. It is superficially similar to *G. zebroides* but can be separated by having U-shaped notauli.

Description. *Female*. *Body length* 9.30 (8.80–9.80) mm; ovipositor length 1.2 mm.

Colour. Mostly red-brown; antenna dark brown, scape and pedicle light brown, head darker anterior of ocelli and eye margin, mandibles cream with dark brown tooth apex; mesoscutellum with dark brown patch; fore and mid leg mostly brown, trochantellus margin, femur apex and longitudinal stripe on anterior face of tibia cream, fore 1st tarsomere cream, 5th tarsomere and claw dark brown; mid 2nd tarsomere to claw dark brown; hind leg dorsal surface of trochantellus and femur dark brown, tibia dark brown with large cream patch subbasally on posterior face, tarsus dark brown with base of 1st tarsomere cream; metasoma dark brown with black spot dorsally on T1, apical margin of each tergite and sternite light brown; ovipositor sheath dark brown; wing hyaline; fore wing veins and pterostigma brown.

Head. Head shape sub-conical when viewed dorsally; length 0.87 (0.85–0.88) × width; postocular space rounded gently tapering to occipital carinae, ventral gena with convex depression; postocular space 0.38 × height of eye; short scattered eye setae; face and frons granular with short dense setae anteriorly becoming scattered posteriorly; medial frontal carina indistinct above antennal scrobes; vertex granular, becoming granular-rugulose posteriorly, short scattered setae; occipital carina narrow medially, longer vento-laterally, lamelliform; depression shallow, emarginate; gena granular with short dense shiny setae; minimal width of malar space 0.06 (0.05–0.06) × height of eye; 0.34 (0.30–0.38) × length of pedicel; clypeus granular, smooth in medial depression; 1.93 (1.91–1.95) × wide as high; margin sinuate; lateral corners barely protruding forwards; medial depression present anteriorly, short scattered setae, longer along margin; lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 0.74 (0.74–0.75) × distance between lateral ocelli; scape 1.65 (1.63–1.67) × length pedicel; first flagellomere 0.80 (0.80–

0.81) × length of scape; 0.66 (0.64–0.69) × length second flagellomere.

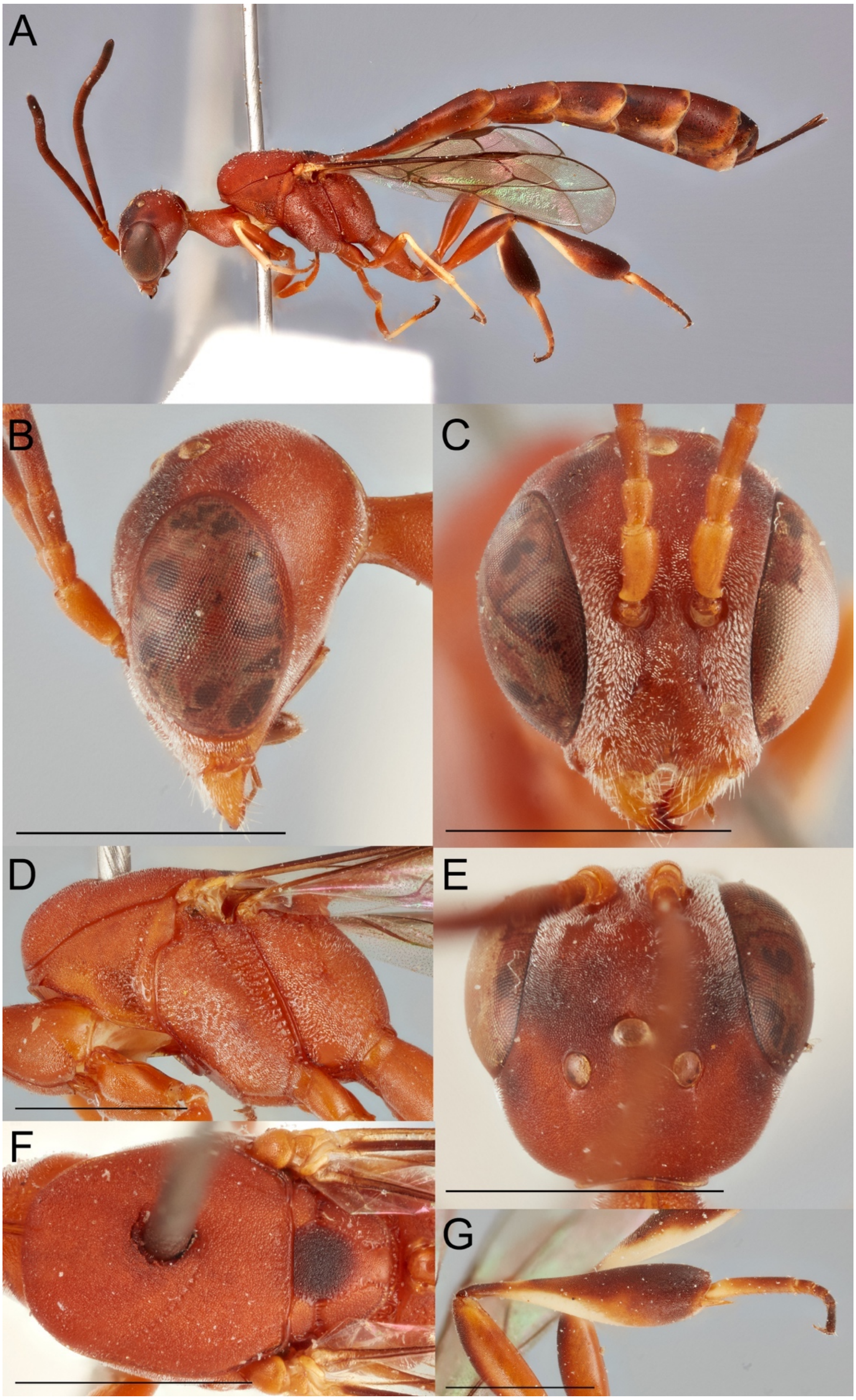

Figure 97. *Gasteruption* species 2 **sp. nov.**, holotype female. A, lateral habitus. B, Lateral head. C, frontal head. D, lateral mesosoma. E, dorsal head. F, dorsal mesosoma, G, lateral hind leg. Scale

bars = 1.00 mm.

Mesosoma. Mesosoma length 1.55 (1.53–1.57) × height; propleuron length 1.30 (1.27–1.33) × width; 1.05 (1.03–1.07) × prototegular distance; propleuron rugulose-granular dorsally, becoming finer laterally, short shiny setae, denser laterally and ventrally; pronotal process indistinct and rounded; pronotum granular, ventral posterior lobe with fovea, groove between pronotum lobes shallow and carinate, short scattered setae; mesoscutum length 1.11 (1.08–1.14) × width in dorsal view; rounded in lateral view; granular with short scattered setae; admedial lines indistinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla granular with short scattered setae; mesepisternum granular in dorsal half, ventral half areolate-granular, short dense setae, shiny in ventral half; mesepimeron carinate with scattered fovea, with several short setae on dorsal margin; metapleuron granular-areolate, granular-rugulose along dorsal lobe, short dense shiny setae; propodeum granular with faint rugulose sculpturing, short scattered setae; medial longitudinal carinae absent.

Legs. Hind coxa granular; femur 0.74 × length of tibia; tibia with short dense setae; tibia length 4.17 (4.11–4.24) × tibia width; tarsus with several short stout spines ventro apically; 1st tarsomere 4.87 (4.83–4.91) × length of 2nd tarsomere; 2nd tarsomere 1.29 (1.20–1.38) × length of 3rd tarsomere; 3rd tarsomere 1.38 (1.33–1.43) × length of 4th tarsomere; 4th tarsomere 0.35 (0.32–0.39) × length of 5th tarsomere; tarsal claw 0.57 (0.53–0.61) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, vein 2-Cu slightly convex; vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular, remainder of vein pigmented; hind wing vein 1-m pigmented, other veins spectral; three equidistant hamuli.

Metasoma. Imbricate; 3.05 × mesosoma length; hypopygium V-shaped; ovipositor sheath 0.18 (0.18–0.19) × metasoma length, with short dense appressed setae.

Male. Unknown.

Distribution. The species is only known from the type locality of Ewaninga, 31km E by SE of Alice Springs, NT.

Biology. Unknown.

Etymology. The species name is is derived from the combination of *Zebra*, the name of a striped equine of Africa, relating to the "stripes" along the metasoma and *aithos* G. meaning reddish-brown, referring to the general colour of the species.

Comments. This species resembles three smaller species of *Gasteruption* that belong to an artificial 'zebra' speaces group defined by Pasteels (1957) which includes *G. zebra* and *G. zebriforme* and *G. zebroides*. Pasteels' suggested these species resemble the 'assectator' species complex of the Holarctic regions.

Gasteruption zebriforme Pasteel, 1957

Fig. 98.

Gasteruption zebriforme Pasteels, 1957: 56, ♀; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Katanning W.A. 12 oct 19XX K.R.Norris" "*Gasteription zebriforme* n. sp J. Pasteel set., 1954" (ANIC).

Other material examined. **WA:** 3♀, 3♂, Minnivale, no other details (WAM: E 97837–97841)*.

Redescription. *Female*. Body length 9.0 mm; ovipositor length 2.00 mm.

Colour. Body black; antenna brown, mandibles apex lighter, tegula light brown; fore leg mostly brown, coxa dark brown, tibia with longitudinal cream stripe on anterior face, 5th tarsomere to claw dark brown; mid leg mostly dark brown, prefemur and tibia brown, 1st tarsomere brown; hind leg mostly dark brown, prefemur light brown, femur brown, tibia brown with cream patch subbasally on posterior face, apical margin of each tarsomere lighter; metasoma dark brown with dorsal surface of T2–T4 lighter brown, distal margins of tergites cream; ovipositor sheath dark brown; ovipositor pale brown; wing hyaline; wing veins and pterostigma brown.

Figure 98. *Gasteruption zebriforme* Pasteels, lateral habitus, scale bar = 1.00 mm.

Head. Head shape sub-rectangular when viewed dorsally; length 0.80 × width; postocular space in dorsal view convex, tapering sharply to occipital carina; head in lateral view, face long and flat, short postocular space, 0.36 height of eye; eye setae absent; minimal width of malar space 0.14 × height of eye; 0.83 × length of pedicel; face and frons granular with short shiny setae, denser laterally; medial frontal carina indistinct, raised node medially; vertex granular around ocelli, becoming strigate-rugulose posteriorly; scattered short setae; narrow occipital carina, lamelliform, depression wide and deep; rounded; gena granular with short scattered setae; clypeus reticulate; 2.27 × wide as high; margin sinuate with lateral corners distinctly protruding forwards, medial depression indistinct anteriorly, short scattered setae, with long setae along margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.70 × distance between lateral ocelli; scape 1.90 × length pedicel; 1st flagellomere 0.60 × as long as scape; 0.50 ×

length 2nd flagellomere.

Mesosoma. Mesosoma length 1.71 × height; propleuron length 1.13 × width; 0.96 × prototegular distance; propleuron reticulate-rugulose, medium shiny setae; pronotal process blunt and rounded, pointing outwards; pronotum reticulate, lower half of posterior lobe rugulose, groove between pronotum lobes carinate, short dense setae, denser in groove; mesoscutum length 1.10 × width in dorsal view; rounded in lateral view; granular with scattered short setae; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum granular with short scattered setae; axilla with coarser sculpturing with scattered punctures dorsally, short scattered setae; mesepisternum rugose becoming areolate laterally and ventro-laterally, short dense shiny setae; mesepimeron carinate with shallow depressions; metapleuron areolate with dense shiny setae; propodeum areolate with flattened, medial carina with reticulate sculpturing, short scattered setae.

Legs. Hind coxa reticulate with striations in coxal depression; femur length 0.80 × length of tibia; tibia length 3.70 × tibia width; tarsus with short stout spines on ventral apex of tarsus; 1st tarsomere 3.80 × length of 2nd tarsomere; 2nd tarsomere 1.25 × length of 3rd tarsomere; 3rd tarsomere 1.60 × length of 4th tarsomere; 4th tarsomere 1.60 × length of 5th tarsomere; tarsal claw 0.60 × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, tapering apically; vein r-m absent; vein SR1 weakly bent, almost straight; vein 2-M basal quarter tubular with node, remaining three quarters pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. length 2.80 × mesosoma length; hypopygium V-shaped; ovipositor sheath 0.21 × metasoma length; covered in short appressed setae.

Male. Unknown.

Distribution. The species is only known from the type locality of Katanning Western Australia.

Biology. Unknown.

Comments. *G. zebriforme* can be easily distinguished from *G. zebra, G.*

species 2 **sp. nov.**, and *G. zebroides* based on colour. This species is black with the other three species either with brown or reddish-brown.

Gasteruption zebroides Pasteels, 1957

Fig. 99.

Gasteruption zebroides Pasteels 1957: 57, ♀, ♂; Jennings 2010 [on-line checklist].

Material examined.

Holotype. ♀, "Brisbane [QLD] H. Hacker 15.2.16" "*Gasteruption zebroides* n.sp. J. Pasteels det., 1955" (QM: T5464).

Specimen damage. Left antenna 5th flagellomere to tip and right antennae 6th flagellomere to tip, ovipositor sheaths missing.

Paratypes. QLD: 5♀, 4♂, Brisbane, collection dates 17.ii.1914 – 16.ii.1916, (QM: T5450, T5453–4, T5457–60, T5462–64); 1♀, Brisbane, v.1937, G.H. Hardy (SDEI).

Other material examined. **QLD:** 6♀, 4♂, Beerburrum State Forrest, 26º56'S, 152º51'E, 18.xi.1991, G. Daniels (QM)*. NSW: 1♀, Boonoo Boonoo Falls, 12.xii.1981, G. & A. Daniels (QM).

Figure 99. *Gasteruption zebroides* Pasteels, lateral habitus, scale bar = 1.00 mm.

Redescription. *Female.* Body length 8.35 (8.25–8.80) mm; ovipositor length 1.60 (1.32–1.75) mm.

Colour. Body orange-brown; head black, antenna dark brown with varying amounts of light brown, clypeus lateral corners, malar space and mandibles (tooth apex darker) light brown; propleuron dorso-anteriorly, mesoscutellum, axilla and metanotum black, tegula brown; fore and mid leg mostly dark brown, coxa orange-brown, femur with cream apical margin, tibia with cream longitudinal stripe on anterior face, 1st tarsomere to 3rd tarsomere cream; hind leg mostly dark brown, coxa dark brown with variable amounts of orange-brown, prefemur lighter, femur lighter apically, tibia anterior face darker, large cream patch subbasally on posterior face; metasoma dark brown, darker towards T1 and T5 to tip, posterior margin of each tergite and sternite with cream apical band; ovipositor sheath dark brown; ovipositor light brown; wing hyaline, vein and pterostigma brown.

Head. Head shape sun-rectangular when viewed dorsally; length 0.84 (0.82–0.86) × width, postocular space convex, gently tapering posteriorly to occipital carina; head in lateral view, face flat, postocular space short, 0.40 (0.39–0.42) × height of eye; minimal width of malar space 0.04 (0.03–0.05) × height of eye; 0.20 (0.14–0.25) × length of pedicel; short scattered eye setae; face and frons reticulate-rugulose with short dense shiny setae; medial frontal carina indistinct, raised above antennal scrobes; vertex reticulate-rugulose around ocelli with scattered punctures laterally on eye margins, raised process posterior of lateral ocelli, postocular space strigate-rugulose, short dense setae; narrow lamelliform occipital carina, shallow depression, medially emarginate; gena reticulate-rugulose with short dense shiny setae; clypeus punctate, smoother in anterior medial groove; 2.12 (2.00–2.25) × wide as high; margin sinuate with lateral corners barely protruding forwards, medial depression present anteriorly, short dense shiny setae, longer on margin; lateral ocelli posterior of postocular line; distance from lateral ocellus to eye margin 0.78 (0.72–0.81) × distance between lateral ocelli; scape 1.80 (1.80–1.81) × length pedicel; 1st flagellomere 0.71 (0.70–0.72) × as long as scape; 0.58 (0.58–0.60) × length 2nd flagellomere.

Mesosoma. Mesosoma length 1.44 (1.42–1.49) × height; propleuron length 1.23 (1.18–1.36) × width; 1.07 (1.00–1.13) × prototegular distance, rugulose dorsally, reticulate-rugulose laterally, short dense shiny setae; indistinct pronotal process; pronotum anterior lobe rugulose, dorsal and posterior lobes mostly granular, ventral lobe with scattered fovea, groove between pronotum lobes carinate, short scattered setae; mesoscutum length 1.04 (1.00–1.10) × width in dorsal view; rounded in lateral view; granular-rugulose, coarser medially between admedial lines and posteriorly, short scattered setae; admedial lines indistinct, converging; parapsidial lines distinct; notauli V-shaped, scrobiculate; mesoscutellum and axilla granular-rugulose with short scattered setae; mesepisternum areolate with short dense shiny setae; mesepimeron carinate with some large fovea in dorsal half; metapleuron areolate, sculpturing smaller dorsally, short dense shiny setae; propodeum areolate, medial carina flattened with imbricate like sculpturing; short scattered setae.

Legs. Hind coxa granular, becoming granular-rugulose dorsally with several striations in coxal groove; femur 0.80 (0.80–0.81) × length of tibia; tibia length 3.86 (3.72–4.05) × tibia width; several short robust spines on tarsus apex; 1st tarsomere 4.29 (4.17–4.58) × length of 2nd tarsomere; 2nd tarsomere 1.26 (1.20–1.33) × length of 3rd tarsomere; 3rd tarsomere 1.51 (1.43–1.67) × length of 4th tarsomere; 4th tarsomere 0.41 (0.38–0.44) × length of 5th tarsomere; tarsal claw 0.52 (0.50–0.56) × length of 5th tarsomere.

Wings. Fore wing first discal cell rectangular, slightly wider at posterior corner; vein r-m absent; vein SR1 weakly bent; vein 2-M basal third tubular with no node, remaining pigmented; hind wing veins spectral, three equidistant hamuli.

Metasoma. Metasoma 2.84 (2.78–2.89) × mesosoma length; hypopygium shallow V-shaped; ovipositor sheath 0.20 × metasoma length; covered with short adpressed setae.

Variation. There is variation in the amount of black colouration on the mesonotum, mesoscutellum, pronotum and hind coxa in females. The type specimen has less colouration on the mesonotum with paratypes having more colouration.

Male. Black colouring is more extensive covering more of the mesonotum and hind femur.

Distribution. The species is known form QLD, Pasteels (1957) examined a single specimen from TAS.

Biology. Specimens have been collected flying low at ground level.

Comment. *Gasteruption zebroides* can be easily distinguished from *G. zebra, G. species 2* **sp. nov.**, and *G. zebriforme* based on colour. This species is orange-brown with head and a patch on mesonotum black.

Gasteruption species 3 sp. nov.

Fig. 100.

Material examined.

Holotype. ♀, "Murrays Spring, 7 km W, Musselbrook Resource Centre, Lawn Hill Nat. Pk, Qld 200 m, 18'35'15'S 138'04'28'E, 29.ix.l 1995, G Daniels M.A. Schneider" (QM).

Paratypes. QLD: 2♀♀, same data as holotype (QM); ♀. Mount Garnet, 4.xii.1999, J & P. Hasenpush (QM). **WA:** ♀, Kununurra, 15.46S, 128.39E 26.iv.1996, G.R. Brown (MAGNT). **NT:** ♀, Katherine Gorge National Park, on escarpment

1.ix.1981 M. Mallpatil & J. Hawkins (MAGNT).

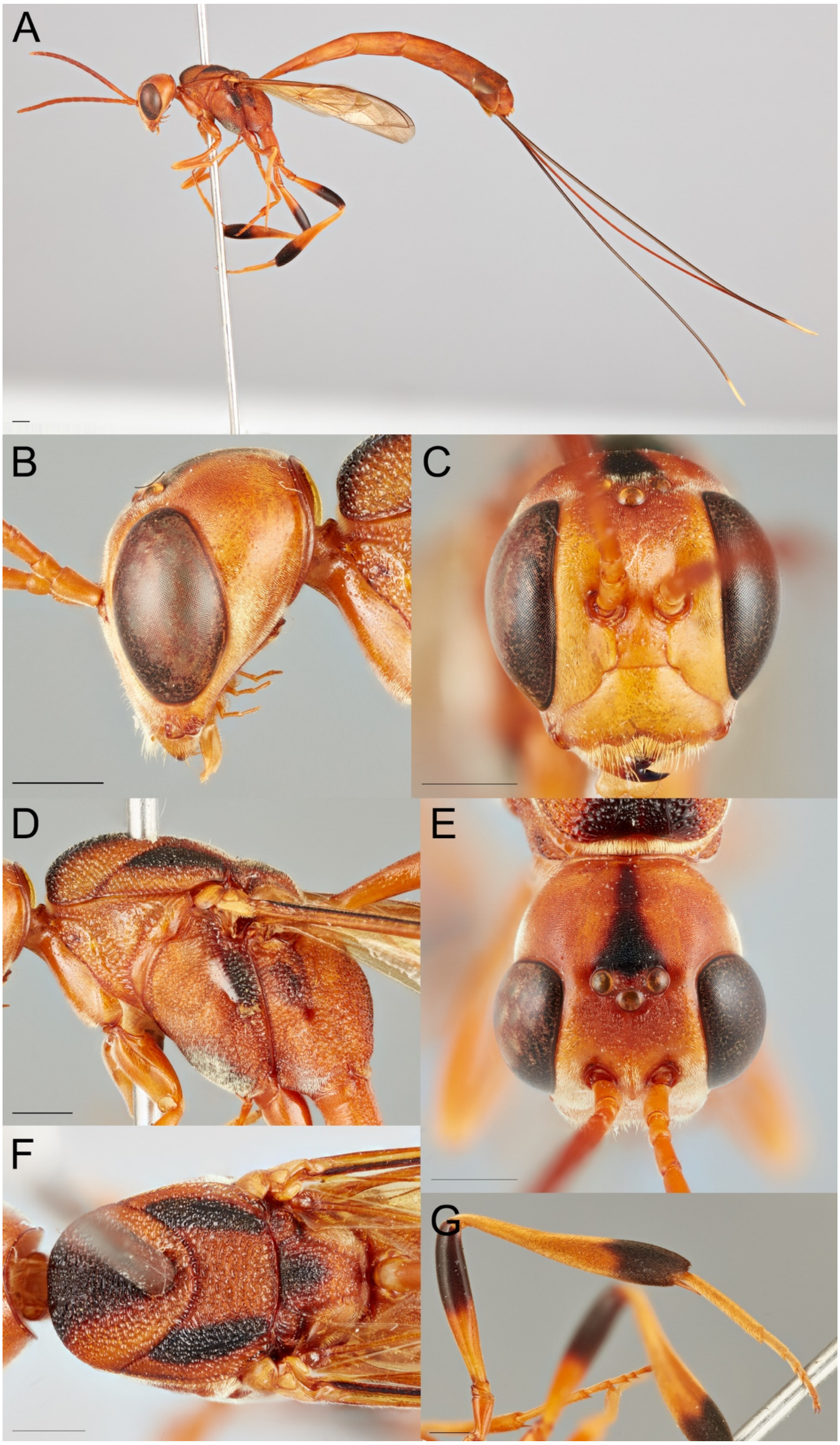

Figure 100. *Gasteruption species 3* **sp. nov.**, Holotype female. A, lateral habitus. B, Lateral head. C,

frontal head. D, lateral mesosoma. E, dorsal head. F, dorsal mesosoma, G, lateral hind leg. Scale bars = 1.00 mm.

Diagnosis. This distinctive species can be easily separated based on the large body size (24.70–28.60 mm) and unique yellow-orange colouration.

Description. *Female.* Body length 26.30 (24.70–28.60) mm; ovipositor length 25.85 (22.80–28.90) mm.

Colour. Body yellow-orange; yellow clypeus and frons, with variable amounts of black medially on vertex, frons and laterally on eye margin, clypeus and mandibles orange with black tooth apex; ventral half of mesepisternum, dorsal half of mesepimeron, spot above propodeal spiracle and ventral corner on metapleuron black, mesoscutum with broad black stripes medially on medial lobe and along parapsidial lines, mesoscutellum and axilla black anteriorly, tegula light brown; fore and mid leg mostly yellow-orange, yellow longitudinal stripe on anterior face of tibia, and tarsus, trochantellus, 1st tarsomere to 4th cream with 5th tarsomere and claw yellow-orange; hind leg mostly yellow-orange, apical half of femur and apical third of tibia black, apical half of femur black, tibia apical third black, tarsus pale with orange 5th tarsomere and claw, metasoma yellow-orange, becoming dark brown apically, ovipositor sheath black with cream apex 0.95 (0.95–0.96) × length of hind 1st tarsomere, ovipositor dark brown, wing yellow, wing veins mostly brown, Sc+R+Rs, 1-Cu, 4-Cu and 2A black, pterostigma yellow-orange; setae on head, mesoscutum, mesoscutellum, gold, black setae on metasoma.

Head. Head shape sub-conical when viewed dorsally; 0.95 (0.95–0.96) × longer than wide; dorsally postocular space gently convex; head in lateral view face and vertex convex, gena bellow eye convex; postocular space elongated, 0.49 (0.41–0.55) × height of eye; eye setae absent; face punctate, punctate-rugulose medially, short dense shiny setae; frons punctate-rugulose with scattered large punctures, short scattered shiny setae; medial frontal carina raised in anterior half, becoming a shallow groove posteriorly; vertex rugulose with scattered shallow punctures around ocelli, reticulate on eye margin, strigate-rugulose posterior of ocelli, short scattered setae; occipital carina narrow, wider ventro-laterally, shallow depression, medially emarginate; gena finely punctate with larger scattered shallow punctures, short dense shiny setae; malar space short almost separated from gena, minimal width of malar space 0.90 × height of eye; 0.70 (0.64–0.73) × length of pedicel; clypeus smooth with scattered shallow punctures; 1.89 (1.82–1.96) × wide as high; margin sinuate with lateral corners distinctly protruding forwards, medial depression indistinct anteriorly, scattered short shiny setae with dense longer setae on margin; lateral ocelli anterior of postocular line; distance from lateral ocellus to eye margin 0.74 (0.65–0.86) × distance between lateral ocelli; scape 1.78 (1.63–1.88) × length pedicel; first flagellomere 0.9 (0.88–0.94) × as long as scape; 0.60 (0.58–0.62) × length second flagellomere.

Mesosoma. Mesosoma length 1.60 (1.58–1.61) × height; propleuron length 1.12 (1.10–1.14) × width; 0.92 (0.91–0.94) × prototegular distance; propleuron rugulose dorsally becoming smooth with scattered shallow punctures, short scattered dorsally becoming dense ventro-laterally; pronotal process broad short hook like when viewed dorsally; pronotum anterior and dorsal lobe rugulose-lacunose, posterior lobe fine reticulate, groove between pronotum lobes broad, scrobiculate, scattered short setae; mesoscutum length 1.07 (0.89–1.17) × width in dorsal view; rounded in lateral view; medial lobe areolate-rugose with transverse carinae medially, lateral lobe areolate-rugulose, short scattered setae; admedial lines distinct, converging; parapsidial lines distinct; notauli U-shaped, scrobiculate; mesoscutellum and axilla rugulose with short scattered setae; mesepisternum rugulose-areolate dorsally, areolate ventrally, short dense shiny setae; mesepimeron broad, crenulate with scattered fovea; metapleuron areolate with short dense shiny setae; propodeum areolate-rugulose, rugulose at metasomal insertion, medial longitudinal carinae not distinctive but raised medially, short scattered setae.

Legs. Hind coxa punctate posteriorly, rugulose laterally, striations in coxal groove; femur length 0.68 (0.60–0.75) × length of tibia; tibia with short dense setae; length 6.31 (5.70–7.22) × tibia width; tarsus with ventro pecten of short robust spines; 1st tarsomere 3.03 (2.92–3.09) × length of 2nd tarsomere; 2nd tarsomere 1.61 (1.57–1.67) × length of 3rd tarsomere; 3rd tarsomere 1.85 (1.67–2.00) × length of 4th tarsomere; 4th tarsomere 0.40 (0.37–0.43) × length of 5th tarsomere; tarsal claw 0.62 (0.58–0.65) × length of 5th tarsomere.

Wings. First discal cell ellipsoid in shape; fore wing vein r-m absent; vein SR1 weakly bent; vein 2-M basal 5th tubular with apical node, remainder of vein pigmented; hind wing vein 2m+Cu and 1-m pigmented, remaining veins spectral; three hamuli, distance between second and apical hamuli greater than distance between basal and middle hamuli.

Metasoma. Imbricate, 3.52 (2.90–4.47) × mesosoma length; hypopygium Y-shaped; ovipositor sheath 1.32 (1.22–1.43) × metasoma length, short appressed setae.

Male. Same as female, except tergite 9 and paramere apex cream.

Distribution. The species has been collected from the northern parts of QLD, WA and NT.

Biology. Unknown.

Etymology. The species name is derived from the word *xanthos* G. for golden, in reference to the unique colour of this species.

Comments. A distinctive species, large in body size (24.70–28.60 mm) and yellow-orange colouration makes this species easily distinguished from other species of *Gasteruption*. The species appears to have a northern distribution, being restricted to localities across northern WA, NT and QLD.

Incertae sedis

The following 24 species are treated as *insertae sedis* because the whereabouts of type material is unknown and/or the original description is insufficient to associate extant material with the species.

Gasteruption aequal **Schletterer, 1889**

Gasteruption aequal Schlettere, 1889: 455, ♀; Pasteels, 1957: 119; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts is unknown. Suggested by Pasteels (1957) to be in the Finnish Museum of Natural History, Helsinki, Finland.

Gasteruption andrei **Kieffer, 1903**

Gasteruption andrei Kieffer, 1903: 384, ♀; Pasteels, 1957: 119; Jennings, 2010 [on-line checklist].

Trichofoenus andrei Kieffer, 1910: 77.

Comments. Holotype whereabouts unknown.

Gasteruption automnale **Turner, 1918**

Gasteruption automnale Turner, 1918; 200, ♀; Pasteels, 1957: 59 ♀; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Gasteruption braunsi **Kieffer, 1911**

Pseudofoenus braunsi Kieffer*, 1911: 304, ♀; 1912: 412 ♀;* Jennings, 2010 [on-line checklist].

Gasteruption braunsi (Kieffer); Pasteels, 1957: 119.

Comments. Holotype whereabouts unknown.

Gasteruption dubium Schletterer, 1885

Gasteruption dubium Schletterer, 1889: 318, ♂; 1890: 440, ♀, ♂; Pasteels, 1957: 119; Jennings, 2010 [on-line checklist].

Comments. Pasteels (1957) mentions the holotype at the NHMW does not match the description of the species provided by Schletterer. Pasteels suggested the labelled male specimen is associated with females of *G. inferius* Pasteels.

Gasteruption hollandiae (Guèrin-Mèneville, 1843)

Foenus hollandiae Guèrin-Mèneville, 1843: 407, ♀.

Gasteruption hollandiae (Guérin-Méneville), Pasteels, 1957: 59, ♀; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Gasteruption hyalipenne Szèpligeti, 1903

Gasteruption hyalipenne Szépligeti, 1903: 374, ♂: Pasteels, 1957: 59, ♀; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Gasteruption laminatum Kieffer, 1911

Trichofoenus laminatum Kieffer, 1911*: 186, ♀;* Jennings, 2010 [on-line checklist].

Gasteruption laminatum (Kieffer): Pasteels 1957: 119.

Comments. Holotype whereabouts unknown.

Gasteruption longiceps Kieffer, 1904

Gasteruption longiceps Kieffer, 1904: 29 ♀*;* Pasteels 1957: 119; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Gasteruption longinotum Pasteels, 1957

Gasteruption longinotum Pasteels, 1957: 79, ♀; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Gasteruption noxiosum Kieffer, 1907

Gasteruption noxiosum Kieffer, 1907: 275 ♀*;* Pasteels 1957: 119; Jennings 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Gasteruption pectorale Pasteels, 1957

Gasteruption pectorale Pasteels, 1957: 91, ♂; Jennings 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Gasteruption schraderi Kieffer, 1907

Gasteruption schraderi Kieffer, 1907: 274 ♀; Pasteels 1957: 119; Jennings 2010 [on-line checklist].

Gasteryption novae-hollandia pleural Kieffer, 1907*: 276* ♀*.*

Gasteruption schraderi pleural Kieffer, 1912: 326 ♀*;* Pasteels 1957: 120.

Comments. Holotype whereabouts unknown. *Gasteruption novae-hollandia pleural was* originally described as *a variety of G. schraderi* Kieffer*.*

Gasteruption poller Kieffer, 1907

Gasteryption poller Kieffer, 1907: 275 ♀;

Gasteruption poller (Kieffer)*;* Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Gasteruption rogenhoferi Schletterer, 1885

Gasteruption rogenhoferi Schletterer, 1885: 322, ♀; Pasteels, 1957: 52, ♀; Jennings*,* 2010 [on-line checklist].

Comments. Holotype whereabouts is unknown.

Gasteruption rugosissimum (Turner, 1918)

Foenus rugosissimum Turner, 1918: 413, ♀, ♂.

Gasteruption rugosissimum (Turner); Pasteels, 1957: 50 ♀; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts is unknown.

Gasteruption scrutator Kieffer, 1907

Gasteruption scrutator Kieffer, 1907: 273 ♀; Pasteels, 1957.

Comments. Holotype whereabouts unknown.

Gasteruption scutilicauda Kieffer, 1907

Gasteruption scutilicauda (Kieffer 1907): 275; Pasteels 1957: 119; Jennings, 2010 [on-line checklist].

Trichofoenus scutilicauda (Kieffer), 1911: 221 ♀.

Comments. Holotype whereabouts unknown.

Gasteruption sordidum Taschenberg, 1891

Gasteruption sordidum Taschenberg (1891)*: 16, ♀, ♂; Pasteels, 1957: 73;* Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts is unknown.

Gasteruption steindachneri (Schletterer, 1885)

Foenus steindachneri Schletterer, 1885: 300, ♀.

Gasteruption steindachneri (Schletterer); Pasteels, 1957: 17 ♀; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts is unknown.

***Gasteruption subfiliform* Kieffer, 1905**

Gasteruption subfiliform (Kieffer 1905): 89 ♀; Pasteels, 1957: 120; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

***Gasteruption tardivum* Pasteels, 1957**

Gasteruption tardivum Pasteels, 1957: 32, ♀; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Gasteruption tomentiferum Strand, 1911

Gasteruption tomentiferum (Strand 1911): 132, ♀; Pasteels, 1957: 118; Jennings, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

***Gasteruption xanthopus* Kieffer, 1911**

Gasteruption. Leucobrachium var. *xanthopus* (Kieffer 1911)*: 205, ♀.*

Gasteruption xanthopus Kieffer*:* Pasteels, 1957: 120; *Jennings*, 2010 [on-line checklist].

Comments. Holotype whereabouts unknown.

Discussion

This work continues the exploration of the Australian Gasteruptiidae and provides the most up to date revision of the Australian fauna. We describe three new species (*G. species 1* **sp. nov.** *G. species 2* **sp. nov.**, *G. species 3,* **sp. nov.**) and redescribe 90 species. The total number of Australian species has been reduced to 102 with the synonymy of *G. coriaceum* Schletterer into *G. genale* Schletterer, and *G. valvulare* Schletterer 1980 with *G. valens* Kieffer 1911, and the following taxa moved into *incertae sedis*; *G. automnale* Turner, *G. hollandiae* (Guèrin-Mèneville), *G. hyalipenne* Szèpligeti, *G. longinotum* Pasteels, *G. pectorale* Pasteels, *G. rogenhoferi* Schletterer, *G. rugosissimum* (Turner), *G. sordidum* Taschenberg, *G. steindachneri* (Schletterer) and *G. tardivum* Pasteels. The three new species were described from for northern and central regions of Australia, this is unsurprising as collection efforts have been less intensive in remote parts of Australia. Pasteels (1957) commented that the northern Australian fauna is less known than the Melanesian fauna, suggesting more undescribed material is expected from these areas. From the material examined there are some interesting biogeographical patterns with some species exhibiting broad distributions e.g. *Gasteruption terminale* which can be found across southern parts of Australia (material examined from QLD, NSW, ACT, SA and WA). Other species appear to be extremely restricted in their distribution, e.g. *G. albicuspis* and *G. angusticepts* which are only found in parts of north QLD. Some species restricted to south-western Australia exhibit unique morphology e.g. *G. cornutum* (Fig. 20) and *G. quinquemaculatum,* which is the only Australian species with a general reddish-brown body colour. Unfortunately, a large number of treated species are only known from singletons, which means in-depth analysis of biogeographical distributions is unreliable until more material is examined. It was highlighted in chapter II that there is a lack of biological information for the Australian fauna with a total of eight identified records and 16 without identification. This paucity in data is due to the lack of interest in the genus since its original revision and the difficulty in using the original key for identification. The presented work is the most recent research on the Australian *Gasteruption* fauna in over 60 years. We hope this addition to the knowledge of *Gasteruption* will make future identification of material easier and provide a stable backbone to describe new species and associate biological information.

Acknowledgments

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CHAPTER IV: MOLECULAR DIVERSITY AND SPECIES DELIMITATION IN THE FAMILY GASTERUPTIIDAE (HYMENOPTERA: EVANIOIDEA) BASED ON MITOCONDRIAL DNA (C01)

BEN A. PARSLOW[1,2,5], MICHAEL P. SCHWARZ[1], MARK I. STEVENS[2,3]

[1]Biological Sciences, College of Science and Engineering, Flinders University, Adelaide, SA 5001, Australia.

[2]South Australian Museum, North Terrace, GPO Box 234, Adelaide, SA 5001, Australia.

[3]School of Pharmacy and Medical Sciences, University of South Australia, Adelaide, SA 5001, Australia

[5]Corresponding author: ben.parslow3@gmail.com

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Abstract

Gasteruptiidae Ashmead is an easily recognised family of wasps with circa 589 described species worldwide. Although well characterised by traditional taxonomy, multiple authors have commented on the extreme morphological uniformity of the group, making species-level identification difficult. This problem is enhanced by the lack of molecular data and molecular phylogenetic research for the group. We used 187 cytochrome *c* oxidase subunit I (COI) barcodes to explore the efficiency of sequence data to delimitate species in Gasteruptiidae. We undertook a graphical and discussion-based comparison of six methods for species delimitation, with the success of methods judged based on known species boundaries and morphology. Both distance-based (ABGD and jMOTU threshold analysis) and tree-based (GMYC and PTP) methods compared across multiple parameters recovered variable molecular operational taxonomic units (MOTU's), ranging from 55 to 123 MOTU's. Tree-based methods tended to split known morphological species less than distance-based methods, with the single-threshold GMYC method the most concordant with known morphospecies. Our results suggest that the incorporation of molecular species delimitation techniques provides a powerful tool to assist in the interpretation of species and help direct informed decisions with taxonomic uncertainty in the family.

Key Words: DNA barcode, ABGD, GMYC, COI, Hymenoptera

Running Head: Diversity and species delimitation in Gasteruptiidae

1. Introduction

There are multiple different methods for species delimitation that are used to assess the species richness of understudied and highly diverse invertebrate taxa. The use of the COI barcode gene fragment is a well-established tool used for species identification (Trivedi et al. 2018), species discovery (Dorey et al. 2019; Packer and Ruz 2016; Wang et al. 2018), detection of invasive species (Groom et al. 2014; Shell and Rehan 2019), biological control (Peixoto et al. 2018; Petrović et al. 2019), species conservation (Trivedi et al. 2018), and identification of associated hosts (Smit et al. 2018). But different species delimitation methods often recover variable molecular operational taxonomic units (MOTU's), which suggest different putative species boundaries (Hofmann et al. 2019). This can lead to ambiguity, making the choice of algorithms to analyse DNA barcode data important. For the analysis of single-locus datasets, the most commonly used methods can be split into two types; distance-based methods and tree-based methods. Distance-based methods use the level of differences between sequences to calculate intraspecific and interspecific thresholds, with tree-based methods using a phylogenetic tree to calculate the variation in branches to delimitate species. The use of COI barcode fragments has been readily used for species delimitation in multiple hymenopteran families, including hyper diverse groups such as Braconidae (Microgastrinae (Fagan-Jeffries et al. 2018), Doryctinae (Zaldívar-Riverón et al. 2010)) and Formicidae (Oberprieler et al. 2018).

The family Gasteruptiidae Ashmead (Hymenoptera: Evanioidea) comprises two extant monophyletic subfamilies, Gasteruptiinae Ashmead and Hyptiogastrinae Crosskey (Crosskey 1962; Jennings and Austin 2002). The smaller subfamily Hyptiogastrinae consists of two stable monophyletic genera, *Hyptiogaster* Kieffer (11 species) and *Pseudofoenus* Kieffer (78 species) (Jennings and Austin 1997, 2002; Parslow and Jennings 2018). In contrast, the larger subfamily Gasteruptiinae comprises four genera, with most of its members belonging to the large cosmopolitan genus *Gasteruption* Latreille (c. 500 species) (Aguiar et al. 2013; Parslow et al. 2018; Tan et al. 2016), with three small genera restricted to the Neotropical region; *Plutofoenus* Kieffer (3 species), *Spinolafoenus* Macedo (1 species), and *Trilobitofoenus* Macedo (3 species) (Macedo 2009). The Gasteruptiidae exhibit interesting biologies and are considered parasitoids, with their larvae being predator-inquilines in the nest of solitary bees and wasps (Grieve et al. 2018; Jennings and Austin 2004; Parslow et al. 2020*a*). Systematic research on the family using molecular data is scarce, with the current literature restricted to isolated taxa in large-scale phylogenetic datasets (e.g. Carpenter 1999; Deans et al. 2006; Dowton and Austin 2001; Heraty et al. 2011; Klopfstein et al. 2013; Klopfstein et al. 2018; Li et al. 2018; Peters et al. 2017; Tang et al. 2018), and only a single study using COI barcoding for species delimitation and species discovery (Saure et al. 2017). Additionally, publicly available COI barcode sequences across BOLD systems (Ratnasingham and Hebert 2007) and Genbank (Clark et al. 2016) are restricted to 190 public records; of these 87 have species names but only represent 25 individual species. Although the genera are well characterised by traditional taxonomy, multiple authors have commented on the extreme morphological uniformity, making species-level identification difficult (Crosskey 1962; Jennings and Austin 2002; Saure et al. 2017). When we consider the current number of described species, the difficulty in identification and the paucity of material in molecular studies suggests there is a need to expand molecular databases and explore molecular species delimitation techniques. The objective of this study was to explore the utility of a large-scale DNA barcode analysis of the Gasteruptiidae, including all publicly available sequences. We compare commonly used molecular delimitation techniques using a graphical and discussion based comparison. Successful species boundary delimitation was based on the recognition of morphologically known species in the group. This approach was used to suggest putative MOTU's that are likely to represent species under the general lineage species concept (de Querioz 1998). Our study examining the diversity within Gasteruptiidae adds to those highlighting DNA barcodes to better inform future taxonomic and phylogenetic research.

2. Material and methods

2.1 Specimen collection

A total of 187 sequences were included in the study, with 77 sequences newly generated in this study and 109 sequences mined from publicly available databases (Supplementary Table S1.). We attempted to sample across all biogeographical regions, with 100 sequences from the Australasian region, 21 from the Palearctic, 12 from the Afrotropical, 46 from the Nearctic, seven from the Neotropical and one from the Indomalayan region. Australasian *Gasteruption* material was identified where possible to species level using Pasteels's (1957) key to Australian *Gasteruption*. All newly sequenced Palearctic species were determined by C. van Achterberg (Naturalis Biodiversity Centre, Leiden), with South African material not identified to species as type material is unavailable for examination, and the only available key is currently out of date (Pasteels 1962). Newly sequenced Hyptiogastrinae specimens where identified where possible using Jennings & Austin (2002) identification key to *Pseudofoenus*. Specimens that were not able to be identified using published keys were designated as morphospecies based on morphological variation. A total of 68 morphospecies were identified and given ‘G’ series numbers. All publicly available Gasteruptiidae sequences were initially examined (190 sequences), with sequences duplicated across public databases; sequences with over 2% ambiguous nucleotides and contaminated sequences that were misidentified and not in Gasteruptiidae (checked against the NCBI BLAST database) were removed from further analysis. In total 104 sequences were obtained from BOLD systems (Ratnasingham and Hebert 2007) (BOLD search for “Gasteruptiidae” in the public data portal, using the API search method, conducted on 21 July 2018) with six from Genbank (Clark et al. 2016) (search for “Gasteruptiidae” in the nucleotide database, using the API search method, conducted on 21 July 2018) (accession numbers and metadata for samples included in Supplementary Table S1). Sequences were coarsely identified where possible to genus using photos associated with the sequences provided by BOLD systems. The final publicly available dataset contained 73 *Gasteruption* sequences and 37 Hyptiogastrinae sequences (32 *Pseudofoenus* and 5 *Hyptiogaster* sequences).

2.2 Sequencing and data alignment

77 new sequences were generated, covering a 654 bp fragment of the cytochrome *c* oxidase subunit I (COI) gene were generated using universal primers (LCOI490 (Fwd) – GGTCAACAAATCATAAAGATATTGG and HCO2198 (Rev) – TAAACTTCAGGGTGACCAAAAAATCA) (Folmer et al. 1994). In addition to these sequences obtained through Sanger sequencing, we mined the same COI barcode fragment from non-targeted regions in a preliminary ultraconserved element dataset

set based on Evanioidea (15 species from Parslow et al. unpublished data). DNA was extracted either non-destructively from full specimens or destructively from the right mid leg of specimens using the Qiagen Gentra Puregene kit, following the manufacturer's protocol with the following changes; samples were incubated overnight at 55°C and centrifuged for 15 minutes after protein precipitation. Final elution volume was 50.0 µl. Extraction of DNA was conducted at the South Australian Regional Facility for Molecular Ecology and Evolution (SARFMEE).

For sequences generated using the Sanger sequencing method the polymerase chain reaction (PCR) amplification was carried out in an Eppendorf thermal sequencer, 25 µl volume reactions of 16.5 µl of DNAase/RNAase-free water, 5.0 µl of 5x Immolase buffer, 1.2 µl of both forward and reverse primers (5.0 µM), 0.1 µl of Immolase enzyme and 1.0 µl of neat DNA. PCR conditions were as follows, initial denatured at 95°C (9 min), thirty-five cycles of 94°C (30 sec), 47°C (30 sec), 72°C (1 min), single cycle of 72°C (6 min) and 24°C (3 min). Purification and bidirectional Sanger sequencing was carried out at Macrogen (Seoul, South Korea).

To mine the C0I Barcode sequences from the preliminary ultraconserved element dataset, extracted DNA was sheared to a length of ~600 bp, with generation of DNA libraries using a specialized Tru-seq style dual indexing adaptor system allowing for multiplexing and hybridization to enrich libraries. Quantification of adapter-ligated fragments post enrichment was performed via quantitative polymerase chain reaction (qPCR) to capture UCE loci. A library of all individuals was combined into one pool and submitted to one lane on an Illumina sequencer at the University of Utah, USA. To process and align the sequence data we used the PHYLUCE v1.6.6 pipeline (Faircloth 2015) with the following programs to process the raw target capture data and extract the targeted loci. We used the program ILLUMIPROCESSOR (Faircloth 2013), a wrapper around TRIMMOMATIC, to remove adaptor contamination and low-quality reads. We assembled the read using the wrapper (phyluce_assembly_assemblo_spades) around SPADES genome assembler v3.13.0 on a combination of computational resources at the University of Utah, USA and Flinders University, Adelaide, Australia. After assembly we used the program (phyluce_assembly_match_contigs_to_barcodes) to extract loci from the completed pool of contigs. Extracted contigs from the exon capture dataset were checked against the NCBI BLAST database to screen for contamination. Sequences were examined in Geneious v10.2.2 (https://www.geneious.com) for stop codons before being pooled with our newly sequenced Sanger sequences and publicly available sequence data. The final alignment was concatenated with the overall length of the sequences trimmed to 654 bp to exclude missing characters in the final matrix. All new sequences are deposited in NCBI's GenBank with accession numbers listed in Supplementary Table S1.

2.3 Phylogenetic tree construction

Ultrametric trees required for tree-based species delimitation methods were estimated using BEAUTi and BEAST 1.10.4 (Drummond et al. 2002). A single model of evolution, GTR + I + Γ, was applied across all codon partitions as suggested by PartitionFinder v2.1.1 (Lanfear et al. 2016). The choice of tree prior has been shown to affect tree-based species delimitation results (Ceccarelli et al. 2012), with the Yule tree prior recommended for species-level data and the Coalescent tree prior for population-level data (Drummond et al. 2006). We used a strict molecular clock to calculate trees with empirical frequency-based priors starting from a random tree and two different tree priors: speciation: Yule process tree prior and the Coalescent: constant size tree prior. Analyses were completed on the CIPRESS science Gateway (Miller et al. 2010) with each analysis run for 10^7 generations, sampling every 10,000 trees. Convergence and stationarity of model parameters was assessed with Tracer v1.7.1 (Rambaut et al. 2018) with 10% of sampled trees discarded as burn-in, and the maximum credibility tree was generated using Tree Annotator v1.10.4.

2.4 Species delimitation

2.4.1 Distanced-based methods

Two different distance-based species delimitation methods were tested, the automatic barcode gap discovery method (ABGD) (Puillandre et al. 2012a) and jMOTU (Jones et al. 2011). ABGD is a distanced-based method that detects clusters of sequences using the distribution of pairwise distances. This computationally efficient technique recursively partitions the data and compares the difference between sequences to identify a "barcode gap" that may indicate species boundaries. The method requires an input in the form of an alignment to generate a distance matrix. We calculated the number of clusters for all genera combined (*Gasteruption*, *Hyptiogaster* and *Pseudofoenus*) using the ABGD web server (Puillandre et al. 2012a: available at https://bioinfo.mnhn.fr/abi/public/abgd/abgdweb.html), using the default priors, Pmin = 0.001, Pmax = 0.1, Steps 10, and with barcode relative gap width = 1.00. To check if distances between genera influenced the clustering of species, we calculated the number of clusters for each genus separately, which recovered no variation compared to the combined analysis.

The program jMOTU uses several predefined thresholds to calculate the genetic differences within the average sequence length. This is a common method with thresholds ranging from 1–3% (Hebert et al. 2003). We ran the analysis on the full dataset with all genera combined using threshold values initially from 1–20 bp with a low BLAST identity filter of 97% and percentage of minimum sequence length of 60% as per the manual's suggestions (Jones et al. 2011). From the program's outputs we compared sequence differences for three threshold values, 1% = 7 bp, 2% = 14 bp and 3% = 20 bp differences.

2.4.2 Tree-based methods

We analysed the sequence data using four tree-based methods for species delimitation, two thresholds using the generalized mixed Yule coalescent (GMYC) analysis (Pons et al. 2006) and two versions of the Poisson tree processes model (PTP) (Zhang et al. 2013). The generalized mixed Yule coalescent (GMYC) analysis is a coalescent based phylogenetic method that sets thresholds between coalescent and species-level processes to delimit species (Fujisawa and Barraclough 2013; Fontaneto et al. 2015). Being a tree-based method, the only input needed is an ultrametric phylogenetic tree. For our analysis the maximum credibility tree obtained from BEAST was used as the input for the GMYC analysis using the SPLITS package in the R platform (Team (2019): available from http://r-forge.r-project.org/projects/splits/). The tree was analysed separately using the default single-threshold (sGMYC) (Pons et al. 2006) and the multiple-threshold (mGMYC)

(Monaghan et al. 2009), which was developed to take into account the different branching patterns and rates across an ultrametric input tree.

The PTP analysis models speciation events relative to the number of substitutions in a given branch, which equates to a higher expected number of substitutions between species than within species (Zhang et al. 2013). The advantage of the original PTP method is it doesn't need an ultrametric tree, which can be computationally intensive to create. For our analysis we used the BEAST tree created for the GMYC analysis so we could compare the outputs generated. We used the newly developed Bayesian version of the PTP model (bPTP) which was run using the online web servers (Zhang et al. 2013): available at https://species.h-its.org/ptp/) with default parameters. We also tested the Multi-rate Poisson tree process (mPTP) with default parameters (available at https://mptp.h-its.org/#/tree), which incorporates different values of intraspecific divergence caused by differences in the evolutionary history or sampling of the species (Kapli et al. 2017). To visualise species delimitation outputs on the phylogenetic tree in figure 1, we used FigTree (ver. 1.4.4, http;www.beast.community/figtree) before adding the graphical representation of species delimitation methods in Adobe Illustrator (Adobe Systems, Inc., San Jose, CA).

2.4.3 Comparing concordance between MOTU's

To assess the outputs between species delimitation methods we graphically compared the clustering of sequences to morphologically known species boundaries. We used this to inform our comparisons in terms of the degree that each method "split" or "lumped" the sequences. We were unable to further explore the clustering results through a quantitative metric of concordance patterns (e.g. Young et al. 2018) due to the large number of singleton sequences included in our analysis.

3. Results

3.1 Phylogeny and sequence analysis

The 187 aligned sequences of Gasteruptiidae had a maximum length of 654 bp with two taxa, *Gasteruption_albicuspis*_G50 and *Pseudofoenus*_sp.BP342 with a sequence length of 428 and 491 bp respectively. In total there were 322 variable sites (49.31%), with 285 (43.82%) parsimoniously informative sites (Table 1). The sequences were AT-biased at 72.7%, and with an extreme AT bias (92.5%) at 3rd codon positions. The mean pairwise distance (Kimura 2-parameter model) between genera is 0.17 (0.16–0.18), while the mean distance among different species within genera was lower for *Gasteruption* (0.13), *Hyptiogaster* (0.10) and *Pseudofoenus* (0.07) (Table S3). The recovered COI phylogram provides high support for the monophyly of the Gasteruptiinae (*Gasteruption*) and Hyptiogastrinae (*Hyptiogaster* and *Pseudofoenus*) (Fig. 1, Nodes A and B both with PP = 1). Support for relationships at apical nodes in the tree were generally high (>98 PP); however, basal nodes had varying levels of low support (0.01–0.95 PP).

3.2 Species delimitation analyses

In general, most of the six tested methods recovered similar grouping of MOTU’s (Fig. 1 and Table 1), with the mPTP method being the most conservative, lumping the sequences into fewer MOTU’s and the jMOTU 1% method the most relaxed, lumping the sequences into several MOTU’s.

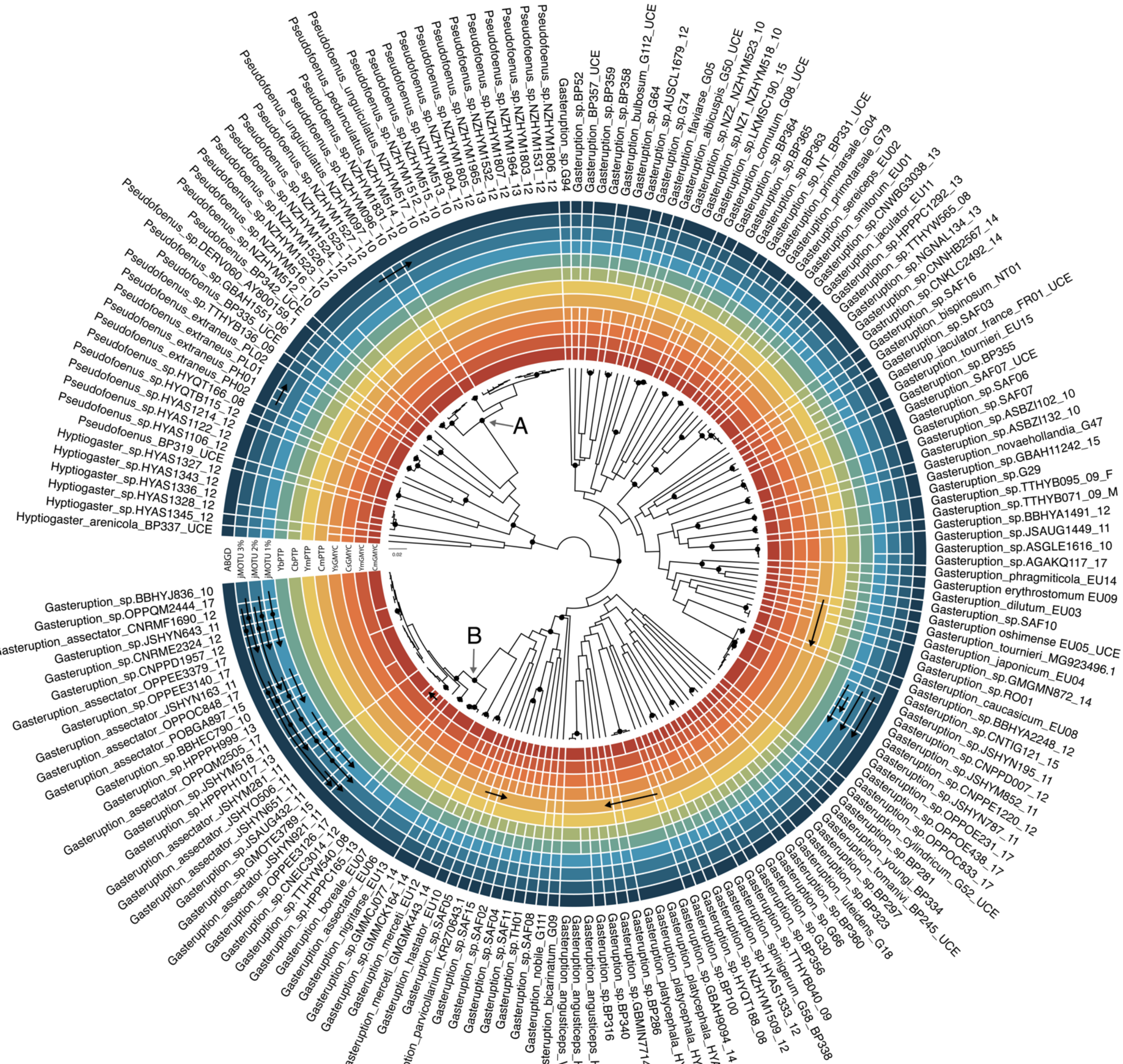

Figure 1. Phylogram of 187 Gasteruptiidae COI sequences showing different results of species delimitation methods. Colours rings represent each method with bars representing molecular

operational taxonomic units (MOTUs), ABGD 1.0 gap = 87 MOTUs, jMOTU 3% = 105 MOTUs, jMOTU 2% = 109 MOTUs, jMOTU 1% = 123 MOTUs, YbPTP = 104 MOTUs, CbPTP = 105 MOTUs, YmPTP = 58 MOTUs, CmPTP = 55 MOTUs, YsGMYC = 96 MOTUs, CsGMYC = 96 MOTUs, YmGMYC = 108 MOTUs and CmGMYC = 111 MOTUs. Black arrows represent variation in the membership of individual clusters compared to the presented tree. Black dots on nodes represent posterior probability >0.98. letters identify nodes discussed in the text.

Table 1. Summary the number of recovered molecular operational taxanomi units (MOTUs) of each species delimitation technique for the examined Gasteruptiidae genera.

Genus	ABGD	jMOTU 3%	jMOTU 2%	jMOTU 1%	YbPTP	CbPTP	YmPTP	CmPTP	YsGMYC	CsGMYC	YmGMYC	CmGMYC
Gasteruption	75	87	93	103	87	88	44	41	81	81	92	92
Pseudofoenus	9	14	12	16	14	14	12	12	12	12	12	14
Hyptiogaster	3	4	4	4	3	3	2	2	3	3	4	5
Total MOTUs	87	105	109	123	104	105	58	55	96	96	108	111

3.2.1 Distance-based methods

The two distance-based methods recovered vastly different numbers of MOTU’s, with ABGD being more conservative in its delimitation compared to jMOTU. The ABGD analysis returned a total of 87 MOTU’s (*Gasteruption* = 75, Hyptiogastrinae = 12) at a prior intraspecific divergence of 0.021544, whereas a total of 123, 109 and 105 MOTU’s were delimited by the jMOTU analysis at thresholds of 1%, 2% and 3% respectively (Table 1). There was a large difference in clustering of MOTU’s compared to the topology of the Bayesian phylogram estimated with BEAST and the Yule process. These disagreements are marked as arrows representing modification of taxa placement in the rings jMOTU 1% rings, jMOTU 2% and jMOTU

3%.

3.2.2 Tree-based methods

In general, a similar number of MOTU's was recovered between the two different tree-building methods (Yule and Coalescent) (Table 1), with only four disagreements in topology between the two tree priors (Fig. 1). The two GMYC methods, single (sGMYC) and multiple (mGMYC), recovered similar MOTU's across both tree priors, with the results for sGMYC for both tree priors both recovering 96 MOTU's compared to mGMYC with 108 using the Yule prior and 111 for the coalescent prior. A single sequence placement disagreement for the taxa *Gasteruption*_sp.OPPEE3126_17 in the Coalescent mGMYC result is represented in Fig.1. Ring CmGMYC.

There was a vast difference in the number of MOTU's delimited between the two different PTP methods (bPTP and mPTP) but only a small difference in the MOTU's between Yule and Coalescent tree models. bPTP delimited 104 and 105 MOTU's for the Yule and Coalescent priors, respectively, compared to 58 and 55 for the mPTP method using the Yule and Coalescent tree priors (Table 1). There were three disagreements in topology between the Coalescent tree mPTP results and the Yule tree (Fig. 1, arrows in ring CmBPTP), with two singleton taxa and a pair being moved to create MOTU's not recovered by other methods.

4. Discussion

The objective of this study was to explore the utility of a large-scale DNA barcode analysis of the Gasteruptiidae to examine the molecular diversity of the family and to compare the suitability of molecular delimitation techniques. Our results found that tree-based methods were more concordant with MOTU's that are likely to represent species under the general lineage species concept (de querioz 1998). This success was judged based on the known species boundaries and morphology in the family and how the techniques either lumped or split sequences according to these.

4.1 Sampling

Quantitative species delimitation methods require species to be adequately sampled (Dopheide et al. 2019) with sufficient sampling across generic and geographical ranges to improve delimitation methods. In practice this is difficult for Gasteruptiidae with the known worldwide diversity of ~589 described species (Jennings and Austin 2002; Aguiar and Lohrmann 2013; Tan et al. 2016; Parslow and Jennings 2018; Parslow et al. 2018) and the expected number including undescribed species closer to three times that (Jennings and Austin 2002). Recent taxonomic treatments of regional fauna have been undertaken, for example Western Asia (van Achterberg and Talebi 2014; Saure et al. 2017), Eastern Asia (Zhao et al. 2012; Tan et al. 2016), Western Europe (van Achterberg 2013; Zikic et al. 2014; Johansson and van Achterberg 2016) and South America (Macedo 2011). Despite these, there are large regions that are in need of modern taxonomic treatments, for example Australia (Pasteels 1958*a*), Africa (Pasteels 1958*b*) and Papua New Guinea (Pasteels 1956). Because of the potentially large number of undescribed species, it is difficult to estimate the level of sampling completeness across the genus.

Our study included all publicly available COI sequences for Gasteruptiidae but was biased towards Australasian (53.5 %) and Nearctic (24.6 %) taxa, with a limited representation of Palearctic (11.2 %), Afrotropical (6.4%), Neotropical (3.7%) and a single species from Indomalaya (0.5%). All species delimitation methods detected a high number of species represented by only a single sequence (CmGMYC – 77 singletons, YmGMYC – 76, CsGMYC - 64, YsGMYC – 64, CmPTP – 19, YmPTP – 20, CbPTP – 76, YbPTP – 74, jMOTU 1% - 96, jMOTU 2% - 77, jMOTU 3% - 80, ABGD – 59), which is a typical result for understudied taxa (Velasco-Castrillón et al. 2014; Zhang et al. 2018). COI gene trees can be good at informing species boundaries and relationships among closely related species but have limited reliability for deeper phylogenetic relationships. Given this, and the reduced support medially within the tree, the deeper structure of the recovered tree is not robust. However, our phylogeny did support the monophyly of both subfamilies, Hyptiogastrinae (Fig. 1, Node A) and Gasteruptiinae (Fig. 1, Node B), which has been recovered by previous studies (Jennings and Austin 2002; Macedo 2009; Parslow et al. 2020*b*).

4.2 Comparison of parameters

Because the number of MOTU's in a dataset will vary depending on the method used and threshold value used, we tested six different methods with variation in parameters to explore what might be an appropriate technique for species delimitation in Gasteruptiidae. The parameters for distance-based methods are priors that effect the sensitivity of the analysis. ABGD results are sensitive to the variation in the gap width used, with recent studies often using the default value of

1.5 (Tang et al. 2012; Kekkonen and Hebert 2014). However, for our analyses we were forced to use a finer relative barcode gap value of 1.00 as coarser values above 1.05 group all sequences into a single partition. This might be indicative of a rapid speciation event within the group, with recent research by Parslow et al. (2020*b*) suggesting a crown age for the family during the Paleocene at 60.23 MYA, which correlates with diversification of their hosts. Schwarzfeld et al. (2015) compared a 1.5 and 0.75 barcode gap when delimitating species of *Ophion* Fabricus (Ichneumonidae) and found that by reducing the barcode gap the number of putative species increased. We tested three thresholds for the jMOTU analysis, which recovered a similar delimitation of MOTU's for the 2% and 3% threshold with 109 and 105, respectively. The 1% threshold recovered 123 MOTU's, which was the highest number for all methods. The lowest threshold also divided sequences identified as species (based on morphology) into separate units; for example, the *Pseudofoenus extraneus* clade consisting of four sequences (two sequences from specimens collected at higher elevations, and two from lower elevations in Fiji) were separated into four individual MOTU's. Although the separation in the clustering of the sequences could be due to cryptic species diversity, which is often found in Hymenoptera (e.g Csősz et al. 2014; Li et al. 2010), more extensive examination of these clusters is required. The 2% threshold is commonly used as a threshold for species delimitation (Hebert et al. 2003), but there is little consistency with this value as other taxonomic groups use both higher and lower thresholds (e.g. 1.6% Smith et al. 2009, 2% Smith et al. 2012, and 3% Tang et al. 2012).

Tree-based methods were tested using two different tree priors, and two types of analysis for each technique. The selection of the tree prior and analysis type affected the number of returned MOTU's in all methods except the sGMYC analysis.

It is generally considered that Yule priors are appropriate for speciation-level data, whereas coalescent priors are often used for intraspecific population-level data (Drummond et al. 2006). Based on these assumptions we would expect the trees constructed with the Yule prior to be more accurate with these data given large number of singletons sampled (Ceccarelli et al. 2012). Schwarzfeld et al. (2015) found in their study of palearctic *Ophilion* (Ichneumonidae: Ophioninae) that the ability to delimit species and the number of estimated species were unaffected by the change in tree priors between Yule and Coalescent. We recovered only a small difference in MOTU's between tree priors, with the Yule prior delimitation a lower number of MOTU in the mGMYC (yule prior = 108, coalescent prior = 111) and bPTP (yule = 104, coalescent = 105) analyses, but recovering the opposite for the mPTP analysis which recovered more MOTU's using the coalescent prior (yule prior = 58, coalescent prior = 55).

The mGMYC method was developed to take into account the different branching patterns and rates across an ultrametric input tree, although it has been found it to be less accurate when compared to the sGMYC method (Fujisawa and Barraclough 2013) with it tending to overestimate putative species (Esselstyn et al. 2012; Schwarzfeld and Sperling 2015). Our dataset found a similar pattern with it over splitting groups; for example the New Zealand *Pseudofoenus* clade (Node A) was split into 4 MOTU's and the *Gasteruption assectator* clade (Node B) into eight MOTU's.

For these data there was a large difference between recovered MOTU's between bPTP methods. There was a 46 MOTU difference between the mPTP and bPTP methods using the Yule tree prior and a 50 MOTU difference for the coalescent tree prior. mPTP was the most conservative and regularly underestimated species by grouping singleton species (represented in the tree by long-isolated branches) into MOTU's. Similar to our results, other studies found these methods lead to a lower number of recovered species when compared with other methods (e.g. da Silva et al. 2018).

4.3 Comparison of species delimitation methods

We suggest that tree-based methods are more reliable than distanced-based because they are able to incorporate evolutionary theory and therefore don't need arbitrary thresholds (Schwarzfeld et al. 2015). The trade off in increased reliability is the computationally demanding task of constructing a phylogenetic tree and incorporating more tree-building assumptions. The GMYC method has been suggested to overestimate species but is suitable for large numbers of singleton taxa (Talavera et al. 2013). In contrast, PTP methods are often favoured when analysing large datasets, as this method does not require an ultrametric tree for input, so is less computationally intensive. In addition, previous studies have found only small differences between the results of a maximum likelihood tree and Bayesian inference tree when using PTP (Dumas et al. 2015) and that this method generally performs better when compared to GMYC, except when using a BEAST tree (Tang et al. 2014). In our analysis the bPTP methods tended to be less accurate compared to our GMYC results; this can be probably be attributed to both methods using an ultrametric tree created in BEAST. The accuracy of PTP relies on the quality of the phylogenetic tree input; taxon sampling is important to help with the accuracy of the tree reconstruction (Tang et al. 2014). The sGMYC method was considered to be most accurate to our species concept with a total 96 putative species, and the correct delimitation of 68 putative species where morphology was known.

The ABGD method was more reliable compared to the jMOTU method we tested as the program determines the sequence divergence threshold given the dataset instead of using arbitrary values. It gave reliable results, correctly delimitating species in most cases where morphology was known, however was the most conservative when grouping sequences in the New Zealand *Pseudofoenus* clade (Node A) and *Gasteruption assectator* clade (Node B). ABGD tended to group all members in these clades into a single MOTU; in contrast all other methods separated these clades into multiple clusters. Although the ABGD method is computationally efficient and for our dataset shows good utility at delimiting MOTU's, there are some limitations with the method. If the data lack gaps between species (i.e. taxa which have recently speciated and have minimal variation between sequences), then the method doesn't work well for species delimitation (Reid and Carstens 2012). It is also recommended to include three to five sequences per species, providing enough information within and between species to delimit species accurately (Puillandre et al. 2012b).

The jMOTU results were consistent when delimiting singletons but tended to over split species groups at all thresholds when compared to other methods; in addition this method produced the largest number of disagreements in cluster number and membership. The 2% and 3% thresholds recovered MOTU's similar to the mGMYC and bPTP results with the 1% threshold delineating the largest number of MOTU's at 123.

All the tested methods used in this study rely on a single locus to delimit species. It is generally considered that the analysis of additional loci increases average delimitation accuracy (Dupuis et al. 2012), for example nuclear and ribosomal RNA fragments such as 28s (Nugnes et al. 2017) and ITS2 (Schwarzfeld and Sperling 2015; Fagan-Jeffries et al. 2018). We did not explore the delimitation results with an additional fragment as a large portion of sequences included in these data were mined from publicly available sequences, which are often restricted to a single fragment. We suggest to increase the robustness of species delimitation it would be a beneficial to explore additional fragments or with the increasing accessibility of high-throughput sequencing methods, multilocus species delimitation methods (Waichert et al. 2019), such as Bayesian Phylogenetics and Phylogeography (Lin *et al.* 2018; Yang 2015).

Our study assessed the outputs between species delimitation methods by graphically comparing the clustering of sequences to known species boundaries and morphology where available. The lack of confident identification for a large portion of the included sequences made it difficult to quantitively validate the clustering results against known species boundaries. Young et al. (2018) suggested a more thorough method to further explore the clustering results by calculating a quantitative metric of concordance patterns. They compared the concordance of two independent datasets using an adjusted Wallace coefficient (Wall 1983). To avoid singleton sequences from biasing the results towards concordance, any species represented by a single sequence was removed from the analysis. Because our sequences with known morphology consist almost entirely of singletons (47 singletons out of 68 morphospecies) we were unable to uses this technique, but recommend future studies use internal methods for cluster validation to provide greater support for the interpretation of species boundaries (Young et al. 2018).

4.5 Diversity of Gasteruptiidae

The inclusion of publicly available sequences is a common method to group known morphospecies with unidentified specimens for coarse identification purposes or to highlight taxa for further detailed analysis (Song et al. 2018). Our dataset includes 106 sequences mined from BOLD + Genbank and 77 newly sequenced specimens, with the known morphologies suggesting 68 morphospecies. There was some success with associating individual morphospecies with unidentified sequences, but overall there are minimal sequences available for Gasteruptiidae that represent the true diversity. In addition, regions with high biodiversity (e.g. Australasian and Afrotropical region) are often underrepresented in publicly accessible data. Although our data represent a limited sample of the overall Australian fauna, which is currently at 114 described species (Pasteels 1957; Jennings and Parslow 2014), our study suggests that we have been able to sequence many previously unknown morphospecies.

The species delimitation methods correctly grouped known species into clusters in most cases, for example, *Gasteruption platycephala* Pasteels where three known BOLD sequences and one unknown sequence were grouped, *Gasteruption angusticeps* Kieffer with three known sequences and *Gasteruption primotarsale* Pasteels with two sequences. But the techniques were not always successful in some cases, with identified species being recovered separately, *Gasteruption tournieri* Schletterer, a GenBank COI fragment mined from a partial mitochondrial genome was recovered separately from our sequenced individual; in addition the species delimitation techniques found our sequence for *Gasteruption tournieri* grouped with a *Gasteruption jaculator* specimen. These failures to associate the determined species is probably due to misidentification of specimens and is a limitation of incorporating sequence data when specimens are not available for morphological examination (Collins and Cruickshank 2013).

The species *Gasteruption assectator* (Linnaeus) is considered a very common species with a Holarctic distribution and wide intraspecific variation. A recent review of the complex in the palearctic region, divided it into three distinct species based on morphology, *G. assectator*, *G. boreale* (Thomson) and *G. nigritarse* (Thomson) (Johansson and van Achterberg 2016). Although the authors found morphological and distributional differences in the three species, our analyses consistently recovered the three species as a single MOTU. When we look at the distribution of sampled sequences, the three sequences are from the Palearctic region, with all other sequences within node B from the Nearctic region. The high support separating these clades could suggest further geographic structure based on genetic divergence, but further examination of material is necessary.

The Hyptiogastrinae was underrepresented in the study with only a single identified species of *Hyptogaster* and four *Pseudofoenus* morphospecies. The current known diversity for the group is 89 described species (11 *Hyptiogaster* and 78 *Pseudofoenus* species) but with approximately 50 undescribed species from Australia (J. Jennings 2019, pers. comm.). There were inconsistences recovered in the clustering of some sequences from BOLD (Fig. 1, Node A), with different identified sequences being grouped into the same cluster. Among the unidentified species in this clade there are two sequences determined as *P. uniculatus* and one as *P. pedunculatus*. The structure suggested from the species delimitation analyses also separates these species, suggesting there is either more complexity in the species or that the specimens has been misidentified. These examples highlight the need to increase both species sampling effort but also duplication of individuals to obtain representation of groups with variability across populations.

Our results suggest that there is a high diversity of Gasteruptiidae with barcode-based MOTU's likely to represent evolutionarily distinct species, for future research additional information in the form of molecular, morphological and ecological information should be considered before formal taxonomic revisions are supported (Collins and Cruickshank 2013).

5. Conclusion

Molecular species delimitation techniques are powerful tools, but multiple techniques should be used in conjunction with traditional morphology for the best results. We evaluated several methods for species delimitation in the Gasteruptiidae using a single locus and found that sGMYC methods split known morphological species less than other tested methods. We suggest increased taxon sampling and the use of additional molecular data for greater resolution when using molecular species delimitation techniques for the Gasteruptiidae. Our results highlight the already large sequenced diversity for the Gasteruptiidae, and with more regional sampling the incorporation of species delimitation techniques will provide a powerful tool to assist in the discovery of new species and help direct informed decisions with taxonomic uncertainty in the family.

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Table 1. Variable and informative sites, and average nucleotide composition for each codon position in the aligned COI gene sequences.

Nucleotide position	variable sites (%)	Informative sites (%)	A	C	G	T	AT	GC
1st	38.5	32.6	33.0	10.9	23.7	32.5	65.5	34.6
2nd	15.6	9.6	15.2	22.4	17.2	45.2	60.4	39.6
3rd	93.6	88.5	42.5	1.1	6.5	49.8	92.3	7.7
All	49.2	43.6	30.2	11.5	15.8	42.5	72.7	27.3

Supplementary table S1. Specimen information. Species identification, voucher numbers, biogeographic region, collection localities, GenBank accession numbers and voucher location for all material used in this study. Abbreviations for voucher location are BPC = Research Collection of B. A. Parslow, to be deposited in SAMA, CBG = Centre for Biodiversity Genomics, GVC = Research Collection of Graeme V. Cocks, NZAC = New Zealand, Auckland, Landcare Research, New Zealand Arthropod Collection, RMNH = Netherlands, Leiden, Naturalis Biodiversity Centre, SAMA = Australia, South Australia, Adelaide, South Australian Museum, SAMC = South Africa, Cape Town, Iziko Museum of Capetown, TMAG = Australia, Tasmania, Hobart, Tasmanian Museum & Art Gallery, WAM = Australia, Western Australia, Perth, Western Australian Museum, WINC = Adelaide University, Waite Campus, Waite Insect & Nematode Collection.

Species name	Voucher number	Region	locality	Accession number	Voucher repository
			Gasteruptiinae		
Gasteruption albicuspis Kieffer, 1911	G50_UCE	Australasia	Australia, Queensland, Daintree N.P., Cape Tribulation		
Gasteruption angusticeps (Kieffer, 1911)	HYQT158_08	Australasia	Australia, Queensland, Townsville	HYQT158-08	GVC
Gasteruption angusticeps (Kieffer, 1911)	HYQTB020_11	Australasia	Australia, Queensland, Townsville	HYQTB020-11	CBG
Gasteruption angusticeps (Kieffer, 1911)	VAQT391_09	Australasia	Australia, Queensland, Townsville	VAQT391-09	GVC
Gasteruption assectator (Linnaeus, 1758)	EU06	Palearctic	Bulgaria, Banya		RMNH
Gasteruption assectator (Linnaeus, 1758)	JSHYM281_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYM281-11	CBG

Gasteruption assectator (Linnaeus, 1758)	JSHYN163_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYN163-11	CBG
Gasteruption assectator (Linnaeus, 1758)	JSHYN651_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYN651-11	CBG
Gasteruption assectator (Linnaeus, 1758)	JSHYN921_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYN921-11	CBG
Gasteruption assectator (Linnaeus, 1758)	JSHYO506_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYO506-11	CBG
Gasteruption assectator (Linnaeus, 1758)	OPPEE3379_17	Nearctic	Canada, Ontario, Warsaw	OPPEE3379-17	CBG
Gasteruption assectator (Linnaeus, 1758)	OPPOC848_17	Nearctic	Canada, Ontario, Warsaw	OPPOC848-17	CBG
Gasteruption assectator (Linnaeus, 1758)	OPPQM2505_17	Nearctic	Canada, Ontario, Thorold	OPPQM2505-17	CBG
Gasteruption assectator (Linnaeus, 1758)	POBGA897_15	Nearctic	Canada, Quebec, Montreal	POBGA897-15	CBG
Gasteruption bicarinatum (Turner, 1981)	G09	Australasia	Australia, Western Australia, Piney Lakes Reserve, Winthrop		BPC
Gasteruption boreale (Thomson, 1883)	EU07	Palearctic	Netherlands, Duiven, Gelderland		RMNH
Gasteruption brachyurum Schletterer, 1885	BP323	Australasia	Australia, Tasmania, Geeveston		BPC
Gasteruption caucasicum (Guérin-Ménéville, 1844)	EU08	Palearctic	Bulgaria, Banya		RMNH
Gasteruption cornutum Pasteels, 1957	G08_UCE	Australasia	Australia, Western Australia, Tarin Rock Nature Reserve		WAM
Gasteruption cylindricum (Turner, 1918)	G52_UCE	Australasia	Australia, Queensland, St Lucia campus, University of Queensland		WINC
Gasteruption dilutum Semenov, 1892	EU03	Palearctic	Iran: Zabol, Sistan & Baluchestan		RMNH
Gasteruption erythrostomum (Dahlbom, 1831)	EU09	Palearctic	Netherlands, Duiven, Gelderland		RMNH
Gasteruption flavitarse (Guérin-Méneville, 1843)	G05	Australasia	Australia, Victoria, Musk		BPC

Gasteruption hastator (Fabricius, 1804)	EU10	Palearctic	Spain, Castilla & Leon, Valdemierque,		RMNH
Gasteruption jaculator (Linnaeus, 1758)	EU11	Palearctic	Gendtsche Polder, beg. Gebied		RMNH
Gasteruption jaculator (Linnaeus, 1758)	FR01_UCE	Palearctic	France, La Ciotat, Bouches Du Rhōne		WINC
Gasteruption japonicum Cameron, 1888	EU04	Palearctic	China, Xi'an, Shaanxi		RMNH
Gasteruption luteidens Pasteels, 1957	G18	Australasia	Australia, Queensland, Taroom		QM
Gasteruption merceti Kieffer, 1904	EU12	Palearctic	Hungary, Törökbálint		RMNH
Gasteruption merceti Kieffer, 1904	GMGMK443_14	Palearctic	Germany, Rhineland-Palatinate, Kreis Ahrweiler	GMGMK443-14	CBG
Gasteruption nigritarse (Thomson, 1883)	EU13	Palearctic	Turkey, Subatuk, Erzurum		RMNH
Gasteruption nobile Pasteels, 1957	G111	Australasia	Australia, Tasmania		TMAG: F3639
Gasteruption novaehollandiae Schletterer, 1885	G47_BP295	Australasia	Australia, South Australia, Point Elen, Kangaroo Island		WINC
Gasteruption oshimense Watanabe, 1934	EU05_UCE	Palearctic	China, Qinling Mountains, Shaanxi		RMNH
Gasteruption parvicollarium Enderlein, 1913	KR270643.1	Palearctic	China, Beijing	KR270643	unknown
Gasteruption phragmiticola Saure, 2006	EU14	Palearctic	Czech Republic, Doksy, Bohemia		RMNH
Gasteruption platycephala Pasteels, 1957	HYAS139_11	Australasia	Australia, Tasmania, Hobart	HYAS139-11	CBG
Gasteruption platycephala Pasteels, 1957	HYAS140_11	Australasia	Australia, Tasmania, Hobart	HYAS140-11	CBG
Gasteruption platycephala Pasteels, 1957	HYAS141_11	Australasia	Australia, Tasmania, Hobart	HYAS141-11	CBG
Gasteruption primotarsale Pasteels, 1957	G04	Australasia	Australia, Queensland, Mout Moffat National Park		QM
Gasteruption primotarsale Pasteels, 1957	G79_296	Australasia	Australia, South Australia, Kangaroo Island,		WINC

			Emu Bay		
Gasteruption sericeipes Kieffer 1911	EU02	Palearctic	United Arab Emirates, Al Wathba Wetland Reserve, Abu Dhabi		RMNH
Gasteruption smitorum van Achterberg & Talebi, 2014	EU01	Palearctic	Turkey, Çamlıbel, Erzurum		RMNH
Gasteruption spinigerum Schletterer, 1889	G58_BP338	Australasia	Australia, South Australia, Mount Remarkable National Park		BPC
Gasteruption tomanivi Parslow, Stevens & Schwarz	BP245_UCE	Australasia	Fiji, Viti levu, Mount Tomanivi		SAMA: 32-035928
Gasteruption tournieri Schletterer, 1885	EU15	Palearctic	Bulgaria, Banya, Plovdiv		RMNH
Gasteruption tournieri Schletterer, 1885	MG923496.1	Palearctic	China, Qinling, Shaanxi	MG923496	Unknown
Gasteruption youngi Jennings & Parslow 2014	BP334	Australasia	Australia, South Australia, Great Victoria Desert Nature Reserve, Mamungari		BPC
Gasteruption sp.	AGAKQ117_17	Nearctic	Canada, Ontario, Guelph	AGAKQ117-17	CBG
Gasteruption sp.	ASBZI102_10	Neotropical	Belize, Lamanai	ASBZI102-10	CBG
Gasteruption sp.	ASBZI132_10	Neotropical	Belize, Lamanai	ASBZI132-10	CBG
Gasteruption sp.	ASGLE1616_10	Nearctic	Canada, Ontario, Guelph	ASGLE1616-10	CBG
Gasteruption sp.	AUSCL1679_12	Australasia	Australia, South Australia	AUSCL1679-12	CBG
Gasteruption sp.	BBHEC790_10	Nearctic	Canada, Nova Scotia, Cape Breton Highlands National Park	BBHEC790-10	CBG
Gasteruption sp.	BBHYA1491_12	Nearctic	United States, California, San Onofre State Beach	BBHYA1491-12	CBG
Gasteruption sp.	BBHYA2248_12	Nearctic	United States, California, Mono Lake State Park	BBHYA2248-12	CBG

Gasteruption sp.	BBHYJ836_10	Nearctic	Canada, Saskatchewan, Prince Albert National Park	BBHYJ836-10	CBG
Gasteruption sp.	BP01_UCE	Australasia	Costa Rica, Escazu		USU
Gasteruption sp.	BP100	Australasia	Australia, South Australia, Yalanda street, Eden Hills		WINC
Gasteruption sp.	BP281	Australasia	Australia, South Australia, Waite Campus, The University of Adelaide		WINC
Gasteruption sp.	BP286	Australasia	Australia, South Australia, Ferries Mcdonald Conservation Park		WINC
Gasteruption sp.	BP297	Australasia	Australia, South Australia, Glen Osmond Road		WINC
Gasteruption sp.	BP316	Australasia	Australia, South Australia, Kingscote, Kangarood Island		BPC
Gasteruption sp.	BP340	Australasia	Australia, Western Australia, Salmon Gums, Goldfields highway		BPC
Gasteruption sp.	BP355	Australasia	Africa, Bheki, Gumbi Wildlife reserve		WINC
Gasteruption sp.	BP356	Australasia	Australia, Victoria, Authors Creek		
Gasteruption sp.	BP357_UCE	Australasia	Australia, South Australia, Morgan-Burra road, Winterton		
Gasteruption sp.	BP358	Australasia	Australia, Western Australia, Kings Park		BPC
Gasteruption sp.	BP359	Australasia	Australia, Western Australia, Piney lakes Reserve, Winthrop		BPC
Gasteruption sp.	BP360	Australasia	Australia, Western Australia, Manbina Reserve		BPC
Gasteruption sp.	BP363	Australasia	Australia, South Asutralia, Waite Campus, The University of Adelaide		WINC

Gasteruption sp.	BP364	Australasia	Australia, South Australia, Flinders Chase National Park, Kangaroo Island		WINC
Gasteruption sp.	BP365	Australasia	Australia, South Australia, Waite Campus, The University of Adelaide		WINC
Gasteruption sp.	BP52	Australasia	Australia, South Australia, Kangaroo Island, Harveys Return		WINC
Gasteruption sp.	CNEIC3014_12	Nearctic	Canada, Alberta, Elk Island National Park	CNEIC3014-12	CBG
Gasteruption sp.	CNKLC2492_14	Nearctic	Canada, Yukon Territory, Kluane National Park	CNKLC2492-14	CBG
Gasteruption sp.	CNNHB2567_14	Nearctic	Canada, Northwest Territories, Nahanni National Park	CNNHB2567-14	CBG
Gasteruption sp.	CNPPD007_12	Nearctic	Canada, Ontario, Point Pelee National Park	CNPPD007-12	CBG
Gasteruption sp.	CNPPD1957_12	Nearctic	Canada, Ontario, Point Pelee National Park	CNPPD1957-12	CBG
Gasteruption sp.	CNPPE1220_12	Nearctic	Canada, Ontario, Point Pelee National Park	CNPPE1220-12	CBG
Gasteruption sp.	CNRME2324_12	Nearctic	Canada, Manitoba, Riding Mountain National Park	CNRME2324-12	CBG
Gasteruption sp.	CNRMF1690_12	Nearctic	Canada, Manitoba, Riding Mountain National Park	CNRMF1690-12	CBG
Gasteruption sp.	CNTIG121_15	Nearctic	Canada, Ontario, Thousand Islands National Park	CNTIG121-15	CBG
Gasteruption sp.	CNWBG3038_13	Nearctic	Canada, Alberta, Wood Buffalo National Park	CNWBG3038-13	CBG
Gasteruption sp.	DERV060	Australasia	Australia, Canberra	AY800159	unknown
Gasteruption sp.	G112_UCE	Australasia	Australia, South Australia, Auburn		WINC
Gasteruption sp.	G29	Australasia	Australia, New South Wales, Bunjalung National Park		QM

Gasteruption sp.	G30	Australasia	Australia, Queensland, Dayboro		QM
Gasteruption sp.	G64	Australasia	Australia, Victoria, Musk		WINC
Gasteruption sp.	G66	Australasia	Australia, Tasmania, Warra		TMAG
Gasteruption sp.	G74	Australasia	Australia, Tasmania, Manuka Road, Oyster Cove		TMAG: F33302
Gasteruption sp.	G94	Australasia	Australia, South Australia, Mulgathing Station		SAMA
Gasteruption sp.	GBAH11242_15	Australasia	Australia, South Australia, Auburn	KJ619460	unknown
Gasteruption sp.	GBAH9094_14	Australasia	Australia, (No location)	GBAH9094-14	NHRS
Gasteruption sp.	GBMIN77143_17	Australasia	Australia, South Australia, Mt. Torrens	KY082427	unknown
Gasteruption sp.	GMGMN872_14	Palearctic	Germany, Rhineland-Palatinate, Kreis Ahrweiler	GMGMN872-14	CBG
Gasteruption sp.	GMMCJ077_14	Neotropical	Mexico, Jalisco	GMMCJ077-14	CBG
Gasteruption sp.	GMMCK164_14	Neotropical	Mexico, Jalisco	GMMCK164-14	CBG
Gasteruption sp.	GMOTE3789_15	Nearctic	Canada, Yukon Territory, N of Whitehorse	GMOTE3789-15	CBG
Gasteruption sp.	HPPPC1292_13	Nearctic	Canada, Nova Scotia, Halifax	HPPPC1292-13	CBG
Gasteruption sp.	HPPPC165_13	Nearctic	Canada, Nova Scotia, Halifax	HPPPC165-13	CBG
Gasteruption sp.	HPPPH1017_13	Nearctic	Canada, Nova Scotia, Halifax	HPPPH1017-13	CBG
Gasteruption sp.	HPPPH999_13	Nearctic	Canada, Nova Scotia, Halifax	HPPPH999-13	CBG
Gasteruption sp.	HYAS1333_12	Australasia	Australia, South Australia	HYAS1333-12	CBG
Gasteruption sp.	HYQT188_08	Australasia	Australia, Queensland, Townsville	HYQT188-08	GVC
Gasteruption sp.	JSAUG1449_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSAUG1449-11	CBG

Gasteruption sp.	JSAUG432_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSAUG432-11	CBG
Gasteruption sp.	JSHYM518_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYM518-11	CBG
Gasteruption sp.	JSHYM852_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYM852-11	CBG
Gasteruption sp.	JSHYN195_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYN195-11	CBG
Gasteruption sp.	JSHYN643_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYN643-11	CBG
Gasteruption sp.	JSHYN787_11	Nearctic	Canada, Ontario, Leeds and Grenville	JSHYN787-11	CBG
Gasteruption sp.	LKMSC190_15	Australasia	New Zealand, Auckland	LKMSC190-15	NZAC
Gasteruption sp.	NGNAL134_13	Nearctic	Canada, British Columbia, Kamloops	NGNAL134-13	CBG
Gasteruption sp.	NT_BP331_UCE	Australasia	Australia, Western Australia, Stirling Range N.P.		BPC
Gasteruption sp.	NZ1_NZHYM518_10	Australasia	New Zealand, WO	NZHYM518-10	NZAC
Gasteruption sp.	NZ2_NZHYM523_10	Australasia	New Zealand, WO	NZHYM523-10	NZAC
Gasteruption sp.	NZHYM1509_12	Australasia	New Zealand, DN	NZHYM1509-12	NZAC
Gasteruption sp.	OPPEE3126_17	Nearctic	Canada, Ontario, Warsaw	OPPEE3126-17	CBG
Gasteruption sp.	OPPEE3140_17	Nearctic	Canada, Ontario, Warsaw	OPPEE3140-17	CBG
Gasteruption sp.	OPPOC833_17	Nearctic	Canada, Ontario, Warsaw	OPPOC833-17	CBG
Gasteruption sp.	OPPOE231_17	Nearctic	Canada, Ontario, Warsaw	OPPOE231-17	CBG
Gasteruption sp.	OPPOE438_17	Nearctic	Canada, Ontario, Warsaw	OPPOE438-17	CBG
Gasteruption sp.	OPPQM2444_17	Nearctic	Canada, Ontario, Thorold	OPPQM2444-17	CBG

Gasteruption sp.	RO01	Palearctic	Moldova Comāneşti, Bacāu		WINC
Gasteruption sp.	SAF02	Afrotropical	South Africa, Dwarsriviershoek Farm, Banghoek valley		SAMC: P087058
Gasteruption sp.	SAF03	Afrotropical	South Africa, Elandsberg Tankwa Natinal Park		SAMC: P087013
Gasteruption sp.	SAF04	Afrotropical	South Africa, (No location)		SAMC: P087012
Gasteruption sp.	SAF05	Afrotropical	South Africa, Dwarsriviershoek Farm, Banghoek valley		SAMC: P087028
Gasteruption sp.	SAF06	Afrotropical	South Africa, Dwarsriviershoek Farm, Banghoek valley		SAMC: P087043
Gasteruption sp.	SAF07	Afrotropical	South Africa, Dwarsriviershoek Farm, Banghoek valley		SAMC: P087050
Gasteruption sp.	SAF07_UCE	Afrotropical	South Africa, Dwarsriviershoek Farm, Banghoek valley		SAMC: P087050
Gasteruption sp.	SAF08	Afrotropical	South Africa, (No location)		SAMC: P086991
Gasteruption sp.	SAF10	Afrotropical	South Africa, Dwarsriviershoek Farm, Banghoek valley		SAMC: P087175
Gasteruption sp.	SAF11	Afrotropical	Mozambique, Gorongosa N.P., Sofala		SAMC
Gasteruption sp.	SAF15	Afrotropical	South Africa, (No location)		SAMC: P087016
Gasteruption sp.	SAF16	Afrotropical	South Africa, Dwarsriviershoek Farm, Banghoek valley		SAMC: P087164
Gasteruption sp.	TH01	Indomalaya	Thailand, (No location)		WINC
Gasteruption sp.	TTHYB040_09	Australasia	Australia, Victoria, Kings Lake	TTHYB040-09	CBG

Gasteruption sp.	TTHYB071_09_M	Neotropical	Argentina, Catamarca	TTHYB071-09	CBG
Gasteruption sp.	TTHYB095_09_F	Neotropical	Argentina, Catamarca	TTHYB095-09	CBG
Gasteruption sp.	TTHYB136_09	Neotropical	Argentina, Catamarca	TTHYB136-09	CBG
Gasteruption sp.	TTHYW540_08	Nearctic	Canada, Alberta, Waterton Lakes N.P.	TTHYW540-08	CBG
Gasteruption sp.	TTHYW565_08	Nearctic	Canada, Alberta, Waterton Lakes N.P.	TTHYW565-08	CBG
			Hyptiogastrinae		
Hyptiogaster arenicola Turner, 1918	BP337_UCE	Australasia	Australia, Western Australia, Kings Park, Perth		WINC
Hyptiogaster sp.	HYAS1327_12	Australasia	Australia, South Australia	HYAS1327-12	CBG
Hyptiogaster sp.	HYAS1328_12	Australasia	Australia, South Australia	HYAS1328-12	CBG
Hyptiogaster sp.	HYAS1336_12	Australasia	Australia, South Australia	HYAS1336-12	CBG
Hyptiogaster sp.	HYAS1343_12	Australasia	Australia, South Australia	HYAS1343-12	CBG
Hyptiogaster sp.	HYAS1345_12	Australasia	Australia, South Australia	HYAS1345-12	CBG
Pseudofoenus extraneus (Turner, 1918)	PH01	Australasia	Fiji, Viti levu		BPC
Pseudofoenus extraneus (Turner, 1918)	PH02	Australasia	Fiji, Viti levu		BPC
Pseudofoenus extraneus (Turner, 1918)	PL01	Australasia	Fiji, Viti levu		BPC
Pseudofoenus extraneus (Turner, 1918)	PL02	Australasia	Fiji, Viti levu		BPC
Pseudofoenus mitchellae Jennings & Austin 2002	BP319_UCE	Australasia	Australia, South Australia, Great Victoria Desert Nature Reserve, Mamungari		BPC
Pseudofoenus pedunculatus (Schletterer, 1889)	NZHYM514_10	Australasia	New Zealand, Auckland	NZHYM514-10	NZAC

Pseudofoenus unguiculatus (Westwood, 1841)	NZHYM097_10	Australasia	New Zealand, CO	NZHYM097-10	NZAC
Pseudofoenus unguiculatus (Westwood, 1841)	NZHYM517_10	Australasia	New Zealand, Auckland	NZHYM517-10	NZAC
Pseudofoenus sp.	BP335_UCE	Australasia	Australia, Western Australia, Kalbarri National Park		BPC
Pseudofoenus sp.	BP342_UCE	Australasia	Australia, South Australia, Javis Hills road, Hawker		BPC
Pseudofoenus sp.	GBAH1551_06	Australasia	Australia	GBAH1551-06	unknown
Pseudofoenus sp.	HYAS1106_12	Australasia	Australia, South Australia	HYAS1106-12	CBG
Pseudofoenus sp.	HYAS1122_12	Australasia	Australia, South Australia	HYAS1122-12	CBG
Pseudofoenus sp.	HYAS1214_12	Australasia	Australia, South Australia	HYAS1214-12	CBG
Pseudofoenus sp.	HYQT166_08	Australasia	Australia, Queensland, Townsville	HYQT166-08	GVC
Pseudofoenus sp.	HYQTB115_12	Australasia	Australia, Queensland, Townsville	HYQTB115-12	CBG
Pseudofoenus sp.	NZHYM096_10	Australasia	New Zealand, CO	NZHYM096-10	NZAC
Pseudofoenus sp.	NZHYM1512_12	Australasia	New Zealand, Auckland	NZHYM1512-12	NZAC
Pseudofoenus sp.	NZHYM1523_12	Australasia	New Zealand, DN	NZHYM1523-12	NZAC
Pseudofoenus sp.	NZHYM1524_12	Australasia	New Zealand, DN	NZHYM1524-12	NZAC
Pseudofoenus sp.	NZHYM1525_12	Australasia	New Zealand, DN	NZHYM1525-12	NZAC
Pseudofoenus sp.	NZHYM1526_12	Australasia	New Zealand, DN	NZHYM1526-12	NZAC
Pseudofoenus sp.	NZHYM1527_12	Australasia	New Zealand, DN	NZHYM1527-12	NZAC
Pseudofoenus sp.	NZHYM1531_12	Australasia	New Zealand, OL	NZHYM1531-12	NZAC

Pseudofoenus sp.	NZHYM1532_12	Australasia	New Zealand, OL	NZHYM1532-12	NZAC
Pseudofoenus sp.	NZHYM1803_12	Australasia	New Zealand, OL	NZHYM1803-12	NZAC
Pseudofoenus sp.	NZHYM1804_12	Australasia	New Zealand, OL	NZHYM1804-12	NZAC
Pseudofoenus sp.	NZHYM1805_12	Australasia	New Zealand, OL	NZHYM1805-12	NZAC
Pseudofoenus sp.	NZHYM1806_12	Australasia	New Zealand, OL	NZHYM1806-12	NZAC
Pseudofoenus sp.	NZHYM1807_12	Australasia	New Zealand, OL	NZHYM1807-12	NZAC
Pseudofoenus sp.	NZHYM1831_12	Australasia	New Zealand, Auckland	NZHYM1831-12	NZAC
Pseudofoenus sp.	NZHYM1964_13	Australasia	New Zealand, CO	NZHYM1964-13	NZAC
Pseudofoenus sp.	NZHYM1965_13	Australasia	New Zealand, CO	NZHYM1965-13	NZAC
Pseudofoenus sp.	NZHYM512_10	Australasia	New Zealand, ND	NZHYM512-10	NZAC
Pseudofoenus sp.	NZHYM513_10	Australasia	New Zealand, Auckland	NZHYM513-10	NZAC
Pseudofoenus sp.	NZHYM515_10	Australasia	New Zealand, WO	NZHYM515-10	NZAC
Pseudofoenus sp.	NZHYM516_10	Australasia	New Zealand, ND	NZHYM516-10	NZAC

CHAPTER V: MULTIGENE PHYLOGENY AND DIVERGENCE ESTIMATES FOR THE GASTERUPTIIDAE (HYMENOPTERA: EVANIOIDEA)

BEN A. PARSLOW[A,C,E], JOHN T. JENNINGS[B], MICHAEL P. SCHWARZ[A], MARK I. STEVENS[C,D]

[A] Biological Sciences, College of Science and Engineering, Flinders University, Adelaide, SA 5001, Australia.

[B] Centre for Evolutionary Biology and Biodiversity, and School of Biological Sciences, The University of Adelaide, SA 5005, Australia.

[C] South Australian Museum, North Terrace, GPO Box 234, Adelaide, SA 5000, Australia.

[D] School of Pharmacy and Medical Sciences, University of South Australia, Adelaide, SA 5001, Australia.

[E] Corresponding author: ben.parslow3@gmail.com

Ben A. Parslow: https://orcid.org/0000-0003-2339-6012

John T. Jennings: https://orcid.org/0000-0003-3031-6316

Michael P. Schwarz: https://orcid.org/0000-0001-7212-6655

Mark I. Stevens: https://orcid.org/0000-0003-1505-1639

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Abstract

The Gasteruptiidae are an easily recognized family of wasps whose larvae are considered predator-inquilines in the nests of solitary bees and wasps. There has been minimal molecular research on the family and as a result little understanding of the evolutionary relationships within the group. We present the first molecular phylogeny focused on Gasteruptiidae, generated using three molecular fragments (mitochondrial *C01* and nuclear markers *EF1-α* and *28s*) and estimate the divergence times of Evanioidea based on three secondary calibration points. The analyses included 142 specimens of gasteruptiidae and five outgroup taxa from Aulacidae and Evaniidae. The monophyly of the Gasteruptiidae and its subfamilies Gasteruptiinae (*Gasteruption*) and Hyptogastrinae (*Hyptiogaster* and *Pseudofoenus*) are confirmed. Our results indicate Evanioidea diverged during the late Jurassic at 151.3 (171.99–136.15) mya with Evaniidae during the early Cretaceous at 137.33 (140.86–133.67) mya, and Gasteruptiidae during the Paleocene at 60.23 (83.78–40.02) mya. The crown age of Hyptiogastrinae was estimated to be during the mid-Eocene 40.72 (60.9–22.57) mya and for *Gasteruption* during the early Eocene at 47.46 (64.7–31.75) mya which corresponded to their host divergence ages. We anticipate that more extensive taxon sampling combined with the use of phylogenomic data will help resolve low support within the *Gasteruption* clade.

Key Words: *Gasteruption*, Gasteruptiidae, Aulacidae, Evaniidae*, Hyptiogaster*, *Pseudofoenus*, *CO1*, *EF1-α*, *28s.*

Running title: Phylogeny and divergence estimates for Gasteruptiidae.

Introduction

The family Gasteruptiidae Ashmead (Hymenoptera: Evanioidea) comprises two extant monophyletic subfamilies, Gasteruptiinae Ashmead and Hyptiogastrinae Crosskey (Crosskey 1962; Jennings and Austin 2002). The smaller subfamily Hyptiogastrinae has been subject to extensive taxonomic and phylogenetic research resulting in two stable monophyletic genera, *Hyptiogaster* Kieffer (11 spp.) and *Pseudofoenus* Kieffer (78 spp.) (Jennings and Austin 1997, 2002; Parslow and Jennings 2018). In contrast, the larger subfamily Gasteruptiinae comprises four genera, with most of its members belonging to the large cosmopolitan genus *Gasteruption* Latreille (418 spp. worldwide) (Aguiar and Lohrmann 2013; Tan *et al.* 2016; Parslow *et al.* 2018). Three small genera, *Plutofoenus* Kieffer (3 spp. southern South America), *Spinolafoenus* Macedo (1 sp. Chile), *Trilobitofoenus* Macedo (3 spp. Central and South America), are restricted to the Neotropical region and are rarely collected (Macedo 2009). Gasteruptiidae exhibit an interesting biology with their larvae being predator-inquilines in the nests of mass provisioning bees and wasps (Jennings and Austin 2004; Grieve *et al.* 2018). Despite the wide distribution of the family and the implied importance of their host associations there is little research aimed at understanding their evolutionary relationships.

The majority of research focused on the phylogenetic relationships within Gasteruptiidae has been from two cladistics analyses using morphological data sets. Jennings and Austin (2002) examined the Gasteruptiidae with an emphasis on Hyptiogastrinae (42 spp. of Hyptiogastrinae, and five spp. of *Gasteruption*) and Macedo (2009) who examined 40 species of Gasteruptiinae and four species of Hyptiogastrinae. There has been no molecular phylogenetic treatment of the Gasteruptiidae examining the internal relationships of the family. The current literature is restricted to DNA barcoding of individual taxa for species delimitation using a single mitochondrial gene fragment (Saure *et al.* 2017), or isolated taxa in large scale datasets examining higher hymenopteran relationships (e.g. Carpenter 1999; Dowton and Austin 2001; Deans *et al.* 2006; Heraty *et al.* 2011; Klopfstein *et al.* 2013; Peters *et al.* 2017; Klopfstein *et al.* 2018; Li *et al.* 2018; Tang *et al.* 2018), with most Gasteruptiidae not identified to species level. These molecular studies highlight the paucity of phylogenetic studies of Gasteruptiidae.

Although Gasteruptiidae is considered monophyletic, a larger molecular treatment of the family is needed to provide a robust framework for future work assessing pathways for the development of host relationships and specialisation. The aim of our current study was to test the monophyly of Gasteruptiidae, its internal subfamilies and genera and estimate the divergence ages of the main groups within the Evanioidea. Analyses of these data also allows us to explore the monophyly of the regional fauna and examine biogeographical relationships. This study provides the groundwork for future detailed taxonomic treatments and systematic research aimed at exploring the evolutionary relationships within the family.

Material and methods

Taxon sampling

We sampled 142 specimens of Gasteruptiidae selected on the basis of specimen availability, morphological and geographical variation (Table S1). Representatives of Australasian *Gasteruption* were identified where possible to species level using Pasteels (1957; 1956) key to *Gasteruption* and compared with type specimens. Palaearctic species were determined by C. A. van Achterberg (Naturalis Biodiversity Centre, Leiden) with South African material not identified to species as type material was unavailable for examination and the only available key is currently out of date (Pasteels 1962). Specimens that could not be identified to species are referred to as morphospecies and are likely to represent undescribed species. Ten specimens of Hyptiogastrinae were included and identified using Jennings and Austin (2002) key for *Pseudofoenus* and Jennings and Austin (1997) key for *Hyptiogaster*. Five outgroup sequences were included (Table S1), three Aulacidae consisting of *Aulacus brabyi* Jennings & Austin, two species from Genbank, *Aulacus impolitus* Smith and *Pristaulacus strangaliae* Rohwer (Heraty *et al.* 2011), and two species of Evaniidae, *Evaniella semaeoda* (Bradley) (Heraty *et al.* 2011) and *Brachygaster minuta* (Olivier) (Deans *et al.* 2006). We used Evaniidae as the outgroup for the analysis based on its placement at the root of the Gasteruptiidae + Aulacidae complex (Klopfstein *et al.* 2013; Tang *et al.* 2018; Sharanowski *et al.* 2019).

DNA extraction and sequencing

To maximise the number of taxa for the analysis we used a combination of Sanger sequencing and sequence capture methods (Ultraconserved Elements) to generate sequence data that were concatenated to build the final dataset. DNA was extracted either non-destructively from full specimens or destructively from the right mid leg of specimens using the Qiagen Gentra Puregene kit, following the manufacturer's protocol with the following changes; samples were incubated overnight at 55°C and centrifuged for 15 minutes after protein precipitation.

For sequence data collected using Sanger sequencing methods, we targeted three gene fragments, the mitochondrial DNA fragment *CO1* (cytochrome *c* oxidase subunit 1,820 bp), two nuclear fragments, *EF1-α* (F2 copy of elongation factor alpha, 556 bp), and *28s rDNA* (473 bp) were amplified using published general Hymenoptera mitochondrial and nuclear primers (Supplementary Table S2).

Polymerase chain reaction (PCR) amplification was carried out in an Eppendorf thermal sequencer, 25 µl volume reactions of 16.5 µl of

DNAase/RNAase-free water, 5.0 µl of 5x Immolase buffer, 1.2 µl of both forward and reverse primers (5.0 µM), 0.1 µl of Immolase enzyme and 1.0 µl of neat DNA. PCR conditions varied for each loci as follows: *CO1* was initially denatured at 95°C (9 min), annealed for thirty-five cycles of 94°C (30 sec), 47°C (30 sec), 72°C (1 min), single cycle of 72°C (6 min) and 24°C (3 min); *EF1-α* was initially denatured for 95°C (10 min), annealed for thirty-five cycles at 94°C (1 min), 59°C (1 min), 70°C (1 min), single cycle of 70°C (10 min), 25°C (1 min); and *28S* was initially denatured for 96°C (5 min), annealed for 40 cycles at 96°C (45 sec), 48°C (1 min), 72°C (1 min), single cycle of 72°C (10 min), 25°C (1 min).

We were able to mine the targeted loci (Supplementary Table S2) from a preliminary Ultraconserved Element (UCE) dataset. To prepare these sequences, extracted DNA was sheared to a length of ~600 bp with generation of DNA libraries using a specialized Tru-seq style dual indexing adaptor system allowing for multiplexing and hybridization to enrich libraries. Quantification of adapter-ligated fragments post enrichment was performed via quantitative Polymer Chain Reaction (qPCR) to ensure capture of UCE loci. A library of all individuals was combined into one pool and submitted to one lane on an Illumina sequencer at the University of Utah. To process and align the sequence data we used the PHYLUCE v1.6.6 pipeline (Faircloth 2015) to process the raw target capture data and extract the loci data. We used the program ILLUMIPROCESSOR (Faircloth 2013) (a wrapper around TRIMMOMATIC (Bolger *et al.* 2014) to remove adaptor contamination and low quality reads, we assembled the read using the wrapper (phyluce_assembly_assemblo_spades) around SPAdes genome assembler v3.13.0 on a combination of computational resources at the University of Utah, USA and Flinders University, Adelaide, Australia. After assembly we used the program (phyluce_assembly_match_contigs_to_barcodes) with publicly available sequences from Genbank (*C01*: HM414412.1, *EF1-α*: GQ410729.1 and *28s*: AF379918.1) to extract loci from the completed pool of contigs. Extracted contigs were filtered for sequence length and checked for contamination using the Basic Local Alignment Search Tool (BLAST) (Altschul *et al.* 1990) before being concatenated with the Sanger sequence data.

Sequence alignment

Sequences were edited and aligned in Geneious v10.2.2 (Drummond *et al.* 2011), with the 28s fragment aligned on the MAFFT online server (Katoh *et al.* 2017) using the Q-INS-1 algorithm, gaps where removed using GapStreeze v2.1.0 on the HIV sequence database online server (https://www.hiv.lanl.gov/content/sequence/GAPSTREEZE/gap.html) using default settings. The concatenated sequence alignment of the three gene fragments was 1,849 bp after trimming. Genbank accession numbers are indicated in Table S1.

Phylogenetic analyses

PartitionFinder2 (Lanfear *et al.* 2016) was used to determine appropriate partitions and models of nucleotide substitution for the three molecular fragments. Two partitions (*P1*: C01_3, *P2*: C01_1, C01_2, EF1-α_1, EF1-α_2, EF1-α_3 and 28s) where chosen based on the greedy algorithm (Lanfear *et al.* 2012) and Bayesian Information criterion (BIC). The model of nucleotide substitution chosen for partition P1 was GTR + I + Γ and for partition P2 was SYM + I + Γ. The concatenated dataset was analysed using Bayesian inference with BEAST v1.10.4 (Suchard *et al.* 2018) with all partitions estimated with the lognormal relaxed clock (uncorrelated) and the speciation: Yule process tree prior (Gernhard 2008). The MCMC was run for 2.5 x 10^7 generations, sampling every 10,000th tree. Stationarity was assessed from examination of log likelihood scores and estimated sample size (ESS) between runs in Tracer v.1.7.1 (Rambaut *et al.* 2018), with trees recovered prior to stationarity discarded. The remaining trees were used to calculate the maximum credibility tree generated in TreeAnnotator v1.10.4 (Drummond *et al.* 2012) before being visualized and modified using FigTree v1.4.4 and Adobe Illustrator (Adobe Systems, Inc. San

Jose, CA).

Biogeographic reconstruction

The biogeographic reconstruction was implemented in RASP v4.2 (Yu *et al.* 2015) using the ultrametric trees constructed in the previous step. We used the S-DIVA method (Yu *et al.* 2010) with the following areas defined for the analysis, Australasia, Indomalaya, Palaearctic, Afrotropical and Neotropical (Olson *et al.* 2001). 25001 trees total were used in the analysis with ancestral states restricted to two regions at each node, all other settings where kept at the defaults.

Divergence time estimations

To estimate divergence times for the Gasteruptiidae we used a log-normal uncorrelated relaxed clock in BEAST v1.10.4 (Suchard *et al.* 2018) with the same partitioning and models of evolution applied as in the phylogenetic analysis. We chose three nodes (Evanioidea, Aulacidae and Evaniidae) for secondary calibration points inferred from Sharanowski et al. (2019), using the mean age and 95% highest priority density interval (95% HDP) spanning the range from the minimum and maximum bound. We used normal distributions for the following crown groups: Evanioidea (Aulacidae + Evaniidae + Gasteruptiidae) at 167.45 (155.9–199.0) mya, Evaniidae at 151.3 (135.9–166.7) mya, and Aulacidae at 48.45 (23.3–73.6) mya. Aulacidae and Evaniidae were constrained to be monophyletic based on previous molecular studies (Heraty *et al.* 2011; Klopfstein *et al.* 2013; Peters *et al.* 2017; Sharanowski *et al.* 2019).

Results and Discussion

Phylogenetic analysis and divergence time estimations

Bayseian analysis (Figure 1) of the concatenated dataset recovered a tree with well resolved nodes (PP =1) for all family level relationships. Although not the primary focus of our study due to limited sampling of outgroup taxa, we recovered the Evanioidea at a divergence age during the late Jurassic at 151.3 million years ago (mya) (171.99–136.15, 95% HDP). Our estimates were similar to those of Sharanowski *et al.* 2019 at 168 (199.0–135.9) mya, although other authors estimate the divergence age closer to the start of the Jurassic or late Triassic (Peters *et al.* 2017, 178 (216–137) mya, Tang *et al.* 2018, 184.8 (192.6–176.7) mya and Li *et al.* 2018, ~237–~174 mya).

Our divergence estimate for Evaniidae was during the early Cretaceous at 137.33 (140.86–133.67) mya, which is similar to the estimates recovered by Tang *et al.* (2018) at 130.1 (132.82–129.4) mya and Sharanowski *et al.* (2019) at 136.8 (141.4–134.1) mya.

We recovered the divergence age of Aulacidae during the early Eocene at 52.43 (56.77–47.9) mya. This age is slightly older than known Aulacidae fossils that are from deposits aged ~46–34mya (Turrisi & Ellenberger 2019). However, there are fossils of extinct genera closely related to the crown group Aulacidae from late Cretaceous deposits estimated to be 98.79 mya (Shi *et al.* 2012; Engel 2017; Li *et al.* 2018; Turrisi and Ellenberger 2019).). To adequately explore the divergence age of the Aulacidae further taxon sampling would be needed in future studies of the Evanioidea.

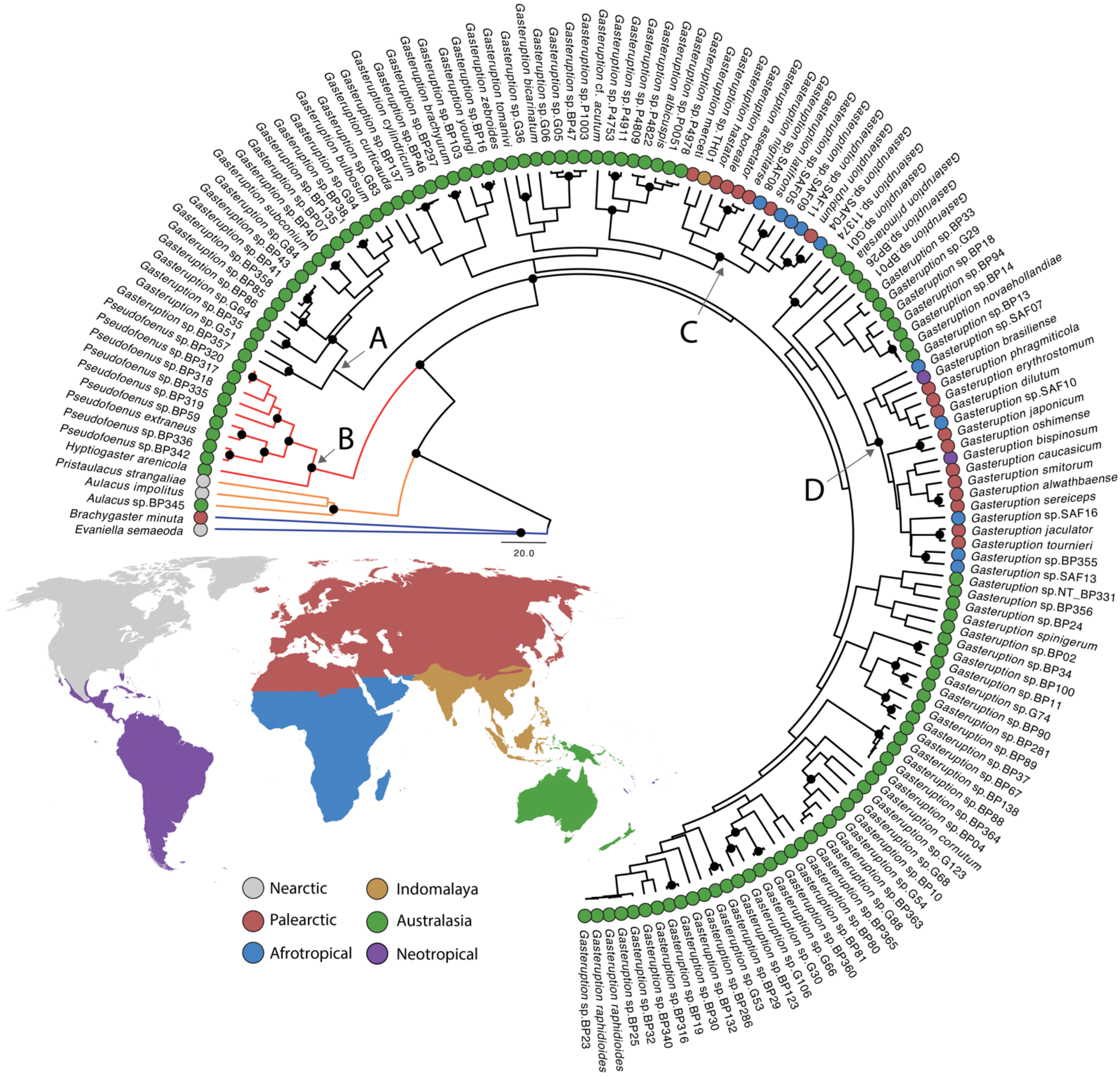

Figure 1. Bayesian analysis of phylogenetic relationships and biogeography among the Evanioidea. Biogeography is colour coded to the map, posterior probabilities >98% are shown by black circles at nodes. Main nodes discussed in the text are labelled with a letter. Tree branch colour represents taxonomic groups, blue = Evaniidae, orange = Aulacidae, and within Gasteruptiidae red = Hyptiogastrinae and black = Gasteruptiinae.

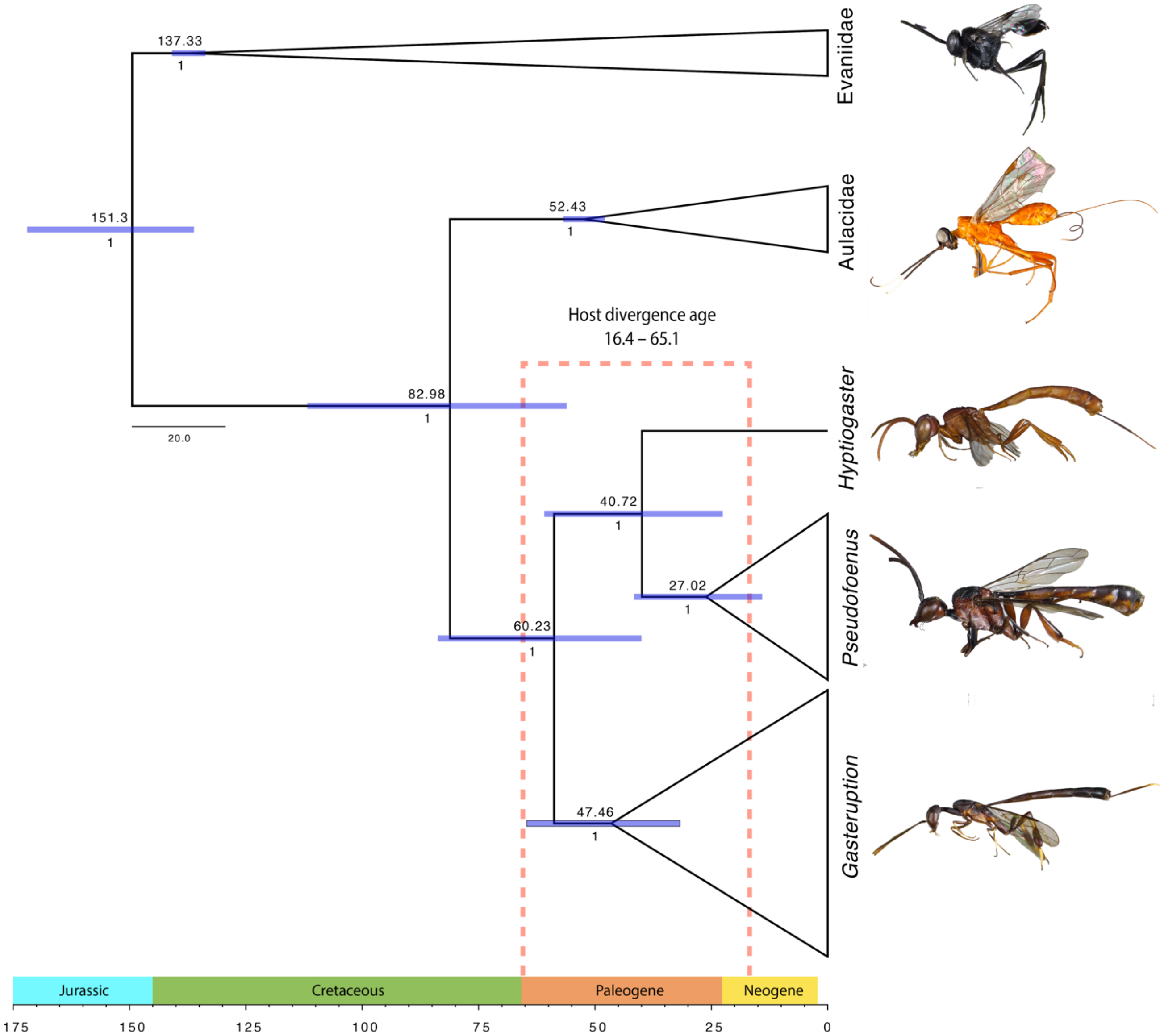

Figure 2. Ultrametric chronogram showing estimated divergence ages for the Evanioidea based on three secondary calibrations points under a lognormal distribution. Monophyletic groups have been collapsed for better visualisation of the major clades. Mean divergence times is listed above nodes with posterior probabilities bellow. Blue bars correspond to the 95% highest posterior density interval (HDP). Red dashed box represents host divergence age based on values from Table 2.

Gasteruptiidae

Our analyses recovered Gasteruptiidae as monophyletic with high support (PP = 1) in all analyses. This is corroborated by previous studies based on cladistics (Jennings and Austin 2002; Macedo 2009) and recent phylogenomic datasets (Peters *et al.* 2017; Tang *et al.* 2018). We recovered the divergence age of Gasteruptiidae during the Paleocene at 60.23 (83.78–40.02) mya, which is significantly younger than the estimates by Tang *et al.* (2018) who recovered the crown age during the early Cretaceous at 140.8 (142.2–139.9) mya. However, Tang *et al.* (2018) used the fossil of *Manlaya anglica* (Rasnitsyn *et al.* 1998) as the calibration point for the Gasteruptiidae, which is currently placed in the extinct family Baissidae, a sister family to Aulacidae (Li *et al.* 2018), but it has been recently suggested to have an uncertain affinity within the Evanioidea (Turrisi and Ellenberger 2019). It is difficult to determine an appropriate calibration age for extant Gasteruptiidae as there are no fossils presently known in the geological record, with available fossils belonging to extinct genera (*Kotujellites* Rasnitsyn, and *Kotujisca* Rasnitsyn) from the early Cretaceous (Engel 2006).

The biogeographical state reconstruction strongly recovered Australasia as the ancestral region for the entire family (Fig. S3. Node A, Table S3). This is not surprising as the Hyptiogastrinae, which were recovered as basal to the Gasteruptiinae (Figure 1. Node B), have an almost exclusively Australasian distribution; 87 Australian species, with the exception of two Neotropical species (Jennings and Austin 2002).

The host associations of Gasteruptiidae are generally poorly documented with available host records comprising species in the bee families Apidae, Halictidae and Megachilidae, and with records for solitary wasp hosts including Crabronidae**,** Vespidae and a single dubious record for Sphecidae (Jennings and Austin 2004; Grieve *et al.* 2018). When comparing published crown age estimates for known host genera (Table 1) with the recovered divergence age of Gasteruptiidae (Fig. 2), we see very similar divergence times (Fig. 2, dashed red box). This could suggest the Gasteruptiidae and their hosts diverged during the same time period (~65–13 mya), which could be the driver of speciation of the group. However, these conclusions are only speculative as we were unable to include specific host data for taxa included in the tree as most of these relationships are unknown or crown ages for the hosts are not available. With an increase in knowledge about host associations in Gasteruptiidae and a more extensive and robust phylogeny we will be able to better explore the evolutionary relationships and examine questions relating to co-evolution with hosts.

Hyptiogastrinae

Our study presents the first crown age estimate of the subfamily Hyptiogastrinae during the mid-Eocene at 40.72 (60.9–22.57) mya, with *Pseudofoenus* recovered during the Miocene at 27.02 (41.59–14.07) mya. We were unable to estimate the crown age for *Hyptiogaster* as only a single species was included in the analysis. Our analysis found high support (PP = 1) for the monophyly of Hyptiogastrinae and the placement of *Hyptiogaster* as a sister genus to *Pseudofoenus* (Figure 1). This placement is corroborated by all analyses that have included both *Hyptiogaster* and *Pseudofoenus* taxa (Jennings and Austin 2000; Dowton and Austin 2001; Jennings and Austin 2002; Deans *et al.* 2006; Klopfstein *et al.* 2013). The only study that failed to recover Hyptiogastrinae and Gasteruptiinae as monophyletic was the recent analysis by Li *et al.* (2018), where *Pseudofoenus manilense* was recovered within the Gasteruptiinae instead of Hyptiogastrinae. However, this is due to an error in identification – *Pseudofoenus manilense* is in fact a synonym of *Gasteruption manilense* (Keiffer) from the Philippines (see Baltazar (1966)), therefore the monophyly of both the Hyptiogastrinae and Gasteruptiinae in Li *et al.*'s analysis is supported.

Gasteruption

We recovered *Gasteruption* as monophyletic with high support (Fig. 1, PP = 1), with the crown age during the early-Eocene at 47.46 (31.75 - 64.7) mya. The crown estimate was similar to previous estimates by Sharanowski *et al.* (2019), who recovered the crown age of *Gasteruption* to be during the late Eocene at 38.6 (59.3–18.5) mya. The medial nodes of the *Gasteruption* clade have low support (Fig. 1, PP = < 0.98) so the internal topology is not robust; however, we can draw some conclusions based on highly supported nodes in the tree to explore the monophyly of the regional fauna and examine biogeographical relationships among taxa.

Most of the *Gasteruption* included in our analyses were Australasian species (111/142) with a small sample of Palaearctic fauna (18/142), Afrotropical fauna (10/142), two Neotropical species and a single species from the Indomalayan region (Fig. 1). We were unable to sequence any taxa from the Nearctic region so are unable to infer any distributional relationships from this region. The biogeographical state reconstruction (Fig. S1) recovered the Australasian *Gasteruption* as paraphyletic with several clades separated by two well supported clades consisting of non-Australasian fauna. In our analysis the most basal clade of *Gasteruption* consists of Australasian taxa (Fig. 1. Node A, Fig. S1), agreeing with Macedo's (2009) cladistic analysis which also recovered two species of *Gasteruption* from mainland Australia as basal species to other regional fauna. The two clades consisting of non-Australasian taxa may suggests two dispersal events from our inferred ancestral region. The first clade (Fig. S1, Table S3, Node C) was recovered as 53.15% Australasia + Palaearctic, 45.05% Australasia + Afrotropical and 1.8% Australasia + Indomalayan, but a dispersal directly from Australasia to the Palaearctic is unlikely without first establishing a dispersal path through the Indomalayan region. Further evidence for this scenario might come from the fact that this clade includes the single sampled Indomalayan taxon (TH01), and that basal clade consists of nearly exclusively Papua New Guinea taxa. A dispersal event along the Indian pacific rim is likely but more extensive sampling throughout the

Indomalayan region is needed to explore this hypothesis. The second non-Australasia clade (Fig. S1, Table S3, Node D) was recovered as 69.93% Australasia + Palaearctic, 29.17% Australasia + Afrotropical and 0.91% Australasia + Neotropical. This clade includes the two Neotropical taxa (NT01 and NT03) suggesting a dispersal event from Australasia into both the Afrotropical and Neotropical regions. Dispersal between these regions is rare and often problematic due to water barriers and would be restricted to dispersal via the Kerguelen and Crozet plateaus, or through Antarctica. The patterns we recovered are most likely caused by a lack of regional sampling from the Indomalayan and Neotropical region. Although our phylogeny provides insights into the dispersal of the genus it is important to remember parasitoids can have highly specialised host relationships, their historical biogeography is going to depend on either their ability to track the geographical spread of their existing hosts, or switch to new hosts in new regions, or both. While our taxon sampling has been the most comprehensive for the family to date, there is a clear need to increase coverage for under sampled biogeographical regions, particularly the Nearctic, Neotropical and Indomalayan areas, which should further resolve biogeographic relationships.

Conclusions

The monophyly of Gasteruptiidae, the subfamily Hyptiogastrinae and the genera *Gasteruption, Hyptiogaster* and *Pseudofoenus* are confirmed in our analyses, with the subfamily Gasteruptiinae recovered as monophyletic excluding representatives of the three Neotropical genera (*Plutofoenus, Spinolafoenus, Trilobitofoenus*). Our results suggest Australia as the ancestral dispersal location for the family with two potential dispersal events from Australasia, but more extensive sampling of intermediate biogeographical regions are necessary to explore these patterns further. We estimate Gasteruptiidae diverged around ~60 mya during the Palaeocene, with *Gasteruption* and Hyptiogastrinae during the Eocene around ~47 and ~40.72 mya respectively. Our results suggest the crown ages of these groups have coincided with their host divergences, around ~65–13 mya, however this need to be explored further. Larger taxon sampling covering under-represented biogeographical regions, and the use of phylogenomic data, will assist in resolving both the internal relationships within *Gasteruption* as well as deeper relationships within the group.

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Supplementary material

Table 1. Estimated crown age for several known Gasteruptiidae host genera.

Family	Genera	Crown age (95% HDP) mya	Reference
		ANTHOPHILA	
Apidae	*Ceratina*	43.6	Rehan *et al.* 2012
	Xylocopa	41.7	Rehan *et al*. 2012
Colletidae	*Amphylaeus*	16.4 (11–22)	Almeida *et al*. 2012
	Callomelitta	60 (43.4–77.7)	Almeida *et al*. 2012
	Colletes	24 (18–30)	Almeida *et al*. 2012
	Euryglossina	48.4 (38.1–60.5)	Almeida *et al*. 2012
	Hylaeus	30 (23–37)	Almeida *et al*. 2012
	Hyleoides	45.3 (35.6–55.4)	Almeida *et al*. 2012
	Leioproctus	27 (21.2 - 32.8)	Almeida *et al*. 2012
	Meroglossa	16.4 (11–22)	Almeida *et al*. 2012
	Neopasiphae	13	Almeida *et al*. 2012
	Paracolletes	65.1 (51.6 - 80)	Almeida *et al*. 2012
Halictidae	*Rophites*	38	Almeida *et al*. 2012
	Systropha	35.3	Almeida *et al*. 2012
Megachilidae	*Ashmeadiella*	21.5 (13–26.6)	Gonzalez *et al.* 2019
	Chelostoma	56.7 (34–64.6)	Gonzalez *et al.* 2019
	Heriades	34.8 (23.4–42.6)	Gonzalez *et al.* 2019
	Hoplitis	21.7 (13.1–28.9)	Gonzalez *et al.* 2019
	Megachile	27.4 (16–33.4)	Gonzalez *et al.* 2019
	Osmia	25.3 (16–32)	Gonzalez *et al.* 2019
	Pseudoanthidium	32.7 (19.7–39.8)	Gonzalez *et al.* 2019
Stenotritidae	*Stenotritus* + *Ctenocolletes*	18.4 (11.7 - 25.3)	Almeida *et al*. 2012
		SPHECIFORMES	
Crabronidae	*Lestica*	22.24	Sann *et al.* 2018

	Passaloecus	44.8	Sann *et al.* 2018
	Pemphredon	49	Sann *et al.* 2018
	Pison	21.6	Sann *et al.* 2018
	Trypoxylon	29.9	Sann *et al.* 2018
Vespidae	*Vespa*	27	Huang *et al.* 2019

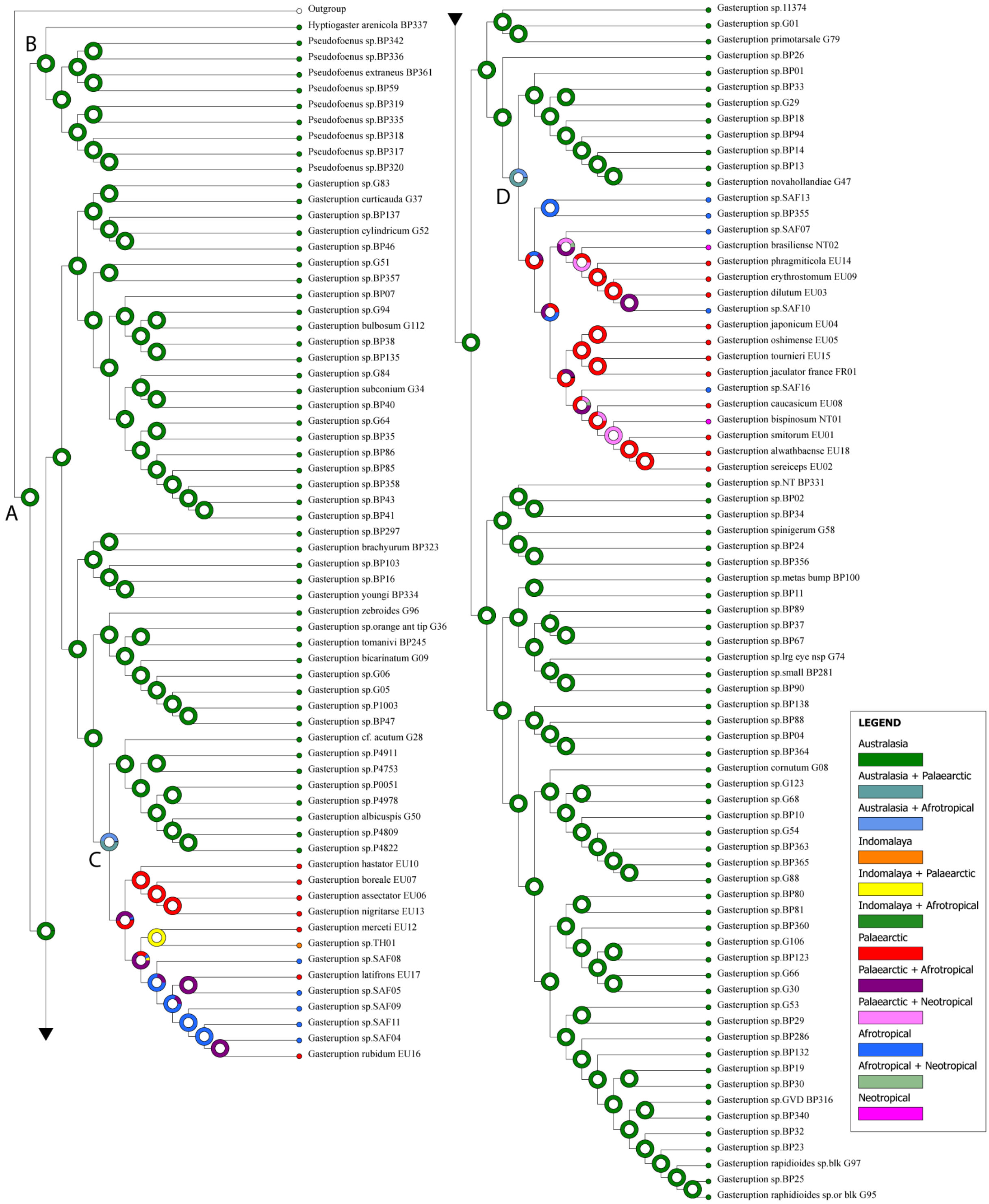

Figure S2. Reconstruction ancestral state in phylogenies (RASP) analysis result, showing ancestral-state reconstruction of biogeography for all nodes. Main nodes discussed in the text are labelled with a letter.

Table S1. Voucher numbers, species identification, GenBank accession numbers for C01, EF1-α and 28s gene fragments, collection localities and voucher location for all material used in this study are given. Abbreviations for collection locations are: N.P., national park; C.P., conservation park; SA, South Australia; WA, Western Australia; QLD, Queensland; TAS, Tasmania; VIC., Victoria, PNG, Papua New Guinea. Abbreviations for voucher location are: AMS, Australian Museum, Sydney, Australia; BPC, Ben A. Parslow personal collection, Adelaide, Australia; to be deposited in SAMA; EMUS, Utah State University Insect Collection, Utah, USA; QM, Queensland Museum, Brisbane, Australia; MNHN, Muséum National d'Histoire Naturelle, Paris, France; RMNH, Naturalis Biodiversity Centre, Leiden, Netherlands; SAMA, South Australian Museum, Adelaide, Australia; SAMC, Iziko South African Museum, Cape Town, South Africa; TMAG, Tasmanian Museum & Art Gallery, Hobart, Australia; WAM, West Australian Museum, Perth, Australia; WINC, Waite Insect & Nematode Collection, Adelaide, Australia

Species name	Voucher number	C01	EF1-α	28s	Collection locality	Voucher location
GASTERUPTIINAE						
Gasteruption albicuspis Kieffer, 1911	G50	–	MT265213	MT228042	**Australia**, Daintree N.P., Cape Tribulation, QLD	QM
Gasteruption alwathbaense Saure, Schmid-Egger & van Achterberg, 2017	EU18	–	MT265196	MT228025	**Yemen**, Lahj	RMNH
Gasteruption assectator (Linnaeus, 1758)	EU06	MT218480	MT265112	–	**Bulgaria**, Banya	RMNH
Gasteruption bicarinatum (Turner, 1918)	G09	MT218476	MT265108	MT227949	**Australia,** Piney Lakes Reserve, Winthrop, WA	BPC
Gasteruption bispinosum Kieffer, 1904	NT01	MT218475	MT265106	MT227947	**Costa Rica**, Escazu, San José	USU
Gasteruption boreale (Thomson, 1883)	EU07	–	MT265206	MT228035	**Netherlands,** Duiven, Gelderland	RMNH
Gasteruption brachyurum Schletterer, 1885	BP323	–	MT265186	MT228015	**Australia,** Geeveston, TAS	BPC
Gasteruption brasiliense (Blanchard, 1840)	NT02	–	MT265201	MT228030	**Brazil**, Teodoro Sampaio, San José	USU
Gasteruption breviscutum Kieffer, 1911	G05	MT218473	MT265104	MT227945	**Australia**, Musk, VIC	WINC
Gasteruption caucasicum (Guérin-Méneville, 1844)	EU08	MT218450	MT265081	MT227928	**Bulgaria**, Banya	RMNH
Gasteruption cf. *acutum* (Pasteels 1956)	G28	MT218502	–	MT227972	**Australia**, Garners Beach, Bingil Bay, QLD	AM: K420869
Gasteruption cornutum Pasteels, 1957	G08	MT218458	MT265089	MT227934	**Australia,** Tarin Rock Nature Reserve, WA	WAM
Gasteruption curticauda Pasteels, 1957	G37	–	MT265191	MT228020	**Australia**, Manuka Road, Oyster Cove, TAS	WINC
Gasteruption cylindricum (Turner, 1918)	G52	MT218486	MT265118	MT227957	**Australia**, St Lucia campus, University of Queensland, QLD	WINC
Gasteruption dilutum Semenov, 1892	EU03	MT218451	MT265082	–	**Iran**: Zabol, Sistan & Baluchestan	RMNH
Gasteruption erythrostomum (Dahlbom, 1831)	EU09	MT218511	MT265141	–	**Netherlands,** Duiven, Gelderland	RMNH

Species name	Voucher number	C01	EF1-α	28s	Collection locality	Voucher location
Gasteruption fibuliforme Pasteels, 1957	BP11	MT218542	MT265168	–	**Australia**, Mount Barker Summit, Mount Barker, SA	WINC
Gasteruption hastator (Fabricius, 1804)	EU10	MT218481	MT265113	MT227953	**Spain**, Castilla & Leon, Valdemierque,	RMNH
Gasteruption jaculator (Linnaeus, 1758)	FR01	MT218467	MT265098	–	**France**, La Ciotat, Bouches Du Rhōne	WINC
Gasteruption japonicum Cameron, 1888	EU04	–	MT265199	MT228028	**China,** Xi’an, Shaanxi	RMNH
Gasteruption latifrons Saure, Schmid-Egger & van Achterberg, 2017	EU17	MT218508	MT265138	MT227978	**Yemen**, Manakhah, Sana’a	RMNH
Gasteruption longicolle Schletterer, 1889	G53	MT218461	MT265092	–	**Australia**, Tin Can Bay, QLD	BPC
Gasteruption merceti Kieffer, 1904	EU12	MT218514		MT227982	**Hungary**, Törökbálint	RMNH
Gasteruption nigritarse (Thomson, 1883)	EU13	MT218479	MT265111	MT227952	**Turkey**, Subatuk, Erzurum	RMNH
Gasteruption novaehollandiae Schletterer, 1885	G47	MT218453	MT265084	MT227929	**Australia**, Vivonne Bay C.P., Point Elen, Kangaroo Island, SA	WINC
Gasteruption oshimense Watanabe, 1934	EU05	MT218490	MT265122	MT227960	**China,** Qinling Mountains, Shaanxi	RMNH
Gasteruption phragmiticola Saure, 2006	EU14	MT218452	MT265083	–	**Czech Republic,** Doksy, Bohemia	RMNH
Gasteruption platycephala Pasteels 1957	G54	MT218454		MT227930	**Australia,** Geeveston, TAS	BPC
Gasteruption primotarsale Pasteels, 1957	G79	–	MT265190	MT228019	**Australia**, Emu Bay, Kangaroo Island, SA	WINC
Gasteruption raphidioides (Westwood, 1851)	BP25	MT218556	MT265181	MT228011	**Australia**, Coromandel Valley, SA	WINC
Gasteruption raphidioides (Westwood, 1851)	G95	MT218471	MT265102	MT227943	**Australia**, Flinders Chase N.P., Kangaroo Island, SA	WINC
Gasteruption raphidioides (Westwood, 1851)	G97	MT218472	MT265103	MT227944	**Australia**, Flinders Chase N.P., Kangaroo Island, SA	WINC
Gasteruption rubidum Saure, Schmid-Egger & van Achterberg, 2017	EU16	MT218509	MT265139	MT227979	**Yemen**, Manakhah, Sana’a	RMNH
Gasteruption sericeipes Kieffer 1911	EU02	MT218478	MT265110	MT227951	**United Arab Emirates**, Al Wathba Wetland Reserve, Abu Dhabi	RMNH
Gasteruption smitorum van Achterbergan Achterberg & Talebi, 2014	EU01	–	MT265200	MT228029	**Turkey,** Çamlıbel, Erzurum	RMNH
Gasteruption spinigerum Schletterer, 1889	G58	MT218474	MT265105	MT227946	**Australia,** Mount Remarkable N.P., SA	BPC
Gasteruption subconicum Pasteels 1957	G34	MT218464	MT265095	MT227938	**Australia**, Bluff Knoll, Stirling Range N.P., WA	WINC
Gasteruption terminale (Westwood, 1841)	BP103	MT218533	MT265159	MT227998	**Australia**, Seal Bay, Kangaroo Island, SA	WINC
Gasteruption tomanivi Parslow, Stevens & Schwarz 2018	BP245	MG932556	MT265107	MT227948	**Fiji**, Mount Tomanivi, Viti Levu	SAMA
Gasteruption tournieri Schletterer, 1885	EU15	–	MT265197	MT228026	**Bulgaria**, Banya, Plovdiv	RMNH
Gasteruption youngi Jennings & Parslow 2014	BP334	MT218493	MT265125	MT227963	**Australia,** Great Victoria Desert Nature Reserve, Mamungari, SA	BPC
Gasteruption zebroides Pasteels 1957	G96	MT218487	MT265119	–	**Australia**, Witchelina Station, SA	WINC

Species name	Voucher number	C01	EF1-α	28s	Collection locality	Voucher location
Gasteruption sp.	11374	MT218498	MT265130	MT227968	**PNG**, Wanang, Madang	MNHN
Gasteruption sp.	BP01	MT218523	MT265150	MT227990	**Australia**, Stirling Range N.P., WA	WINC
Gasteruption sp.	BP02	MT218529	MT265156	MT227994	**Australia**, Stirling Range N.P., WA	WINC
Gasteruption sp.	BP04	MT218537	MT265163	–	**Australia**, Belair N.P., Belair, SA	WINC
Gasteruption sp.	BP07	MT218521	–	MT227988	**Australia**, Hiltaba Station, SA	WINC
Gasteruption sp.	BP10	MT218534	MT265160	MT227999	**Australia**, Kangaroo Island, SA	WINC
Gasteruption sp.	BP13	MT218524	MT265151	MT227991	**Australia**, Seal Bay, Kangaroo Island, SA	WINC
Gasteruption sp.	BP14	MT218525	MT265152	MT227992	**Australia**, Port Ellen, Kangaroo Island, SA	WINC
Gasteruption sp.	BP16	MT218532	MT265158	MT227997	**Australia**, Wirrabara Forest, Wirrabara, SA	WINC
Gasteruption sp.	BP18	MT218527	MT265154	MT227993	**Australia**, Flinders Chase N.P., Kangaroo Island, SA	WINC
Gasteruption sp.	BP19	MT218544	MT265170	–	**Australia,** Vivonne Bay C.P., Kangaroo Island, SA	WINC
Gasteruption sp.	BP23	MT218554	MT265179	MT228010	**Australia**, Flinders Chase N.P., Kangaroo Island, SA	WINC
Gasteruption sp.	BP24	MT218531	MT265157	MT227996	**Australia**, Belair N.P., Belair, SA	WINC
Gasteruption sp.	BP26	MT218528	MT265155	–	**Australia**, Hiltaba Station, SA	WINC
Gasteruption sp.	BP29	MT218543	MT265169	–	**Australia**, Seal Bay, Kangaroo Island, SA	WINC
Gasteruption sp.	BP30	MT218545	MT265171	–	**Australia**, Vivonne Bay C.P., Kangaroo Island, SA	WINC
Gasteruption sp.	BP32	MT218555	MT265180	–	**Australia**, Waite Campus, The University of Adelaide, SA	WINC
Gasteruption sp.	BP33	MT218549	–	MT228005	**Australia**, Stirling Range N.P., WA	WINC
Gasteruption sp.	BP34	MT218530	–	MT227995	**Australia**, Canaan Creek, QLD	WINC
Gasteruption sp.	BP35	MT218550	MT265175	MT228006	**Australia**, Mt Moffatt, Carnarvon N.P., QLD	WINC
Gasteruption sp.	BP37	MT218540	MT265166	–	**Australia**, Christmas Tree Well, Flint, WA	WINC
Gasteruption sp.	BP38	MT218516	MT265145	MT227984	**Australia**, Women's College, University of Queensland, QLD	WINC
Gasteruption sp.	BP40	MT218522	MT265149	MT227989	**Australia**, Bluff Knoll, Stirling Range N.P., WA	WINC
Gasteruption sp.	BP41	MT218517	MT265146	MT227985	**Australia**, King's Park, Perth, WA	WINC
Gasteruption sp.	BP43	MT218519	MT265147	–	**Australia**, Nanutarra, Pilbara region, WA	WINC
Gasteruption sp.	BP46	MT218546	MT265172	MT228003	**Australia**, St Lucia Campus, University of Queensland, Qld	WINC
Gasteruption sp.	BP47	MT218552	MT265177	MT228008	**Australia**, Musk, VIC	WINC
Gasteruption sp.	BP67	MT218538	MT265164	MT228001	**Australia**, Kingswood, SA	WINC

Species name	Voucher number	C01	EF1-α	28s	Collection locality	Voucher location
Gasteruption sp.	BP80	–	MT265203	MT228032	**Australia**, Coromandel Valley, SA	WINC
Gasteruption sp.	BP81	MT218553	MT265178	MT228009	**Australia**, Belair N.P., Belair, SA	WINC
Gasteruption sp.	BP85	MT218520	MT265148	MT227987	**Australia**, Belair N.P., Belair, SA	WINC
Gasteruption sp.	BP86	MT218518	–	MT227986	**Australia**, Belair N.P., Belair, SA	WINC
Gasteruption sp.	BP88	MT218536	MT265162	–	**Australia**, Flinders Chase N.P., Kangaroo Island, SA	WINC
Gasteruption sp.	BP89	MT218539	MT265165	MT228002	**Australia**, Flinders Chase N.P., Kangaroo Island, SA	WINC
Gasteruption sp.	BP90	MT218548	MT265174	MT228004	**Australia**, Waite Campus, The University of Adelaide, SA	WINC
Gasteruption sp.	BP94	MT218526	MT265153	–	**Australia**, Stirling Linear Park, Mt Lofty, SA	WINC
Gasteruption sp.	BP100	–	MT265189	MT228018	**Australia**, Yalanda St, Eden Hills, SA	WINC
Gasteruption sp.	BP123	MT218551	MT265176	MT228007	**Australia**, Women's College, University of Queensland, QLD	WINC
Gasteruption sp.	BP132	MT218541	MT265167	–	**Australia**, Waite Campus, The University of Adelaide, SA	WINC
Gasteruption sp.	BP135	–	MT265204	MT228033	**Australia**, St Lucia Campus, University of Queensland, QLD	WINC
Gasteruption sp.	BP137	MT218547	MT265173	–	**Australia**, Waite Campus, The University of Adelaide, SA	WINC
Gasteruption sp.	BP138	MT218535	MT265161	MT228000	**Australia**, Auburn, SA	WINC
Gasteruption sp.	BP281	MT218513	MT265143	MT227981	**Australia**, Waite Campus, The University of Adelaide, SA	WINC
Gasteruption sp.	BP286	MT227982	MT265144	MT227983	**Australia,** Ferries Mcdonald C.P., SA	WINC
Gasteruption sp.	BP297	–	MT265185	MT228014	**Australia,** Glen Osmond Road, SA	WINC
Gasteruption sp.	BP316	MT218470	MT265101	MT227942	**Australia,** Great Victoria Desert Nature Reserve, Mamungari, SA	BPC
Gasteruption sp.	BP331	MT218455	MT265086	MT227931	**Australia**, Stirling Range N.P., WA	WINC
Gasteruption sp.	BP340	MT218469	MT265100	MT227941	**Australia,** Salmon Gums, Goldfields Highway, WA	BPC
Gasteruption sp.	BP355	MT218466	MT265097	–	**Africa**, Gumbi Wildlife Reserve, Bheki	WINC
Gasteruption sp.	BP356	MT218457	MT265088	MT227933	**Australia**, Authors Creek, VIC	BPC
Gasteruption sp.	BP357	MT218459	MT265090	MT227935	**Australia,** Morgan–Burra Road, Winterton, SA	QM
Gasteruption sp.	BP358	MT218462	MT265093	MT227936	**Australia**, Kings Park, WA	BPC
Gasteruption sp.	BP360	MT218512	MT265142	–	**Australia**, Manbina Reserve, WA	BPC

Species name	Voucher number	C01	EF1-α	28s	Collection locality	Voucher location
Gasteruption sp.	BP363	–	MT265193	MT228022	**Australia**, Waite Campus, The University of Adelaide, SA	WINC
Gasteruption sp.	BP364	MT218484	MT265116	–	**Australia**, Flinders Chase N.P., Kangaroo Island, SA	WINC
Gasteruption sp.	BP365	–	MT265194	MT228023	**Australia**, Waite Campus, The University of Adelaide, SA	WINC
Gasteruption sp.	G01	MT218503	–	MT227973	**Australia**, Lawn hill N.P., QLD	QM
Gasteruption sp.	G06	–	MT265187	MT228016	**Australia**, Stapylton, Yatala, QLD	QM
Gasteruption sp.	G29	–	MT265202	MT228031	**Australia**, Bundjalung N.P., NSW	QM
Gasteruption sp.	G30	MT218488	MT265120	MT227958	**Australia**, Authors Creek, VIC	BPC
Gasteruption sp.	G36	–	MT265184	MT228013	**Australia**, Waite Campus, The University of Adelaide, SA	WINC
Gasteruption sp.	G51	MT218460	MT265091	–	**Australia**, Alice Springs, NT	ANIC
Gasteruption sp.	G64	MT218477	MT265109	MT227950	**Australia**, Musk, VIC	WINC
Gasteruption sp.	G66	MT218489	MT265121	MT227959	**Australia**, Warra, TAS	TMAG: F33377
Gasteruption sp.	G68	–	MT265192	MT228021	**Australia**, Cox Scrub N.P., SA	BPC
Gasteruption sp.	G74	MT218485	MT265117	MT227956	**Australia**, Manuka Road, Oyster Cove, TAS	TMAG: F33302
Gasteruption sp.	G83	MT218507	MT265137	MT227977	**Australia**, Manuka Road, TAS	TMAG: F33303
Gasteruption sp.	G84	MT218465	MT265096	MT227939	**Australia,** Kangaroo Island, SA	BPC
Gasteruption sp.	G88	–	MT265195	MT228024	**Australia**, Taroom, QLD	QM
Gasteruption sp.	G94	MT218463	MT265094	MT227937	**Australia**, Mulgathing Station, SA	SAMA
Gasteruption sp.	G106	–	MT265183	MT228012	**Australia**, Inskip point, QLD	BPC
Gasteruption sp.	G112	MT218500	MT265132	MT227970	**Australia**, Auburn, SA	WINC
Gasteruption sp.	G123	MT218468	MT265099	MT227940	**Australia**, Tinderry Mountains, NSW	ANIC: 32 114661
Gasteruption sp.	P0051	–	MT265211	MT228040	**PNG**, Wanang, Madang	MNHN
Gasteruption sp.	P1003	–	MT265188	MT228017	**PNG**, Mount Wilhelm, Madang	MNHN
Gasteruption sp.	P4753	–	MT265209	MT228038	**PNG**, Mount Wilhelm, Madang	MNHN
Gasteruption sp.	P4809	MT218505	MT265135	MT227975	**PNG**, Mount Wilhelm, Madang	MNHN
Gasteruption sp.	P4822	–	MT265210	MT228039	**PNG**, Mount Wilhelm, Madang	MNHN
Gasteruption sp.	P4911	MT218501	MT265133	MT227971	**PNG**, Wanang, Madang	MNHN
Gasteruption sp.	P4978	–	MT265212	MT228041	**PNG**, Mount Wilhelm, Madang	MNHN

Species name	Voucher number	C01	EF1-α	28s	Collection locality	Voucher location
Gasteruption sp.	SAF04	MT218482	MT265114	MT227954	**South Africa,** (no location)	SAMC: P087012
Gasteruption sp.	SAF05	–	MT265207	MT228036	**South Africa,** Dwarsriviershoek Farm, Banghoek valley	SAMC: P087028
Gasteruption sp.	SAF07	MT218456	MT265087	MT227932	**South Africa**, Dwarsriviershoek Farm, Banghoek valley	SAMC: P087050
Gasteruption sp.	SAF08	–	MT265205	MT228034	**South Africa,** (no location)	SAMC: P086991
Gasteruption sp.	SAF09	MT218499	MT265131	MT227969	**South Africa,** Dwarsriviershoek Farm, Banghoek valley	SAMC: P087169
Gasteruption sp.	SAF10	MT218506	MT265136	MT227976	**South Africa,** Dwarsriviershoek Farm, Banghoek valley	SAMC: P087175
Gasteruption sp.	SAF11	MT218483	MT265115	MT227955	**Mozambique**, Gorongosa N.P., Sofala	SAMC
Gasteruption sp.	SAF13	MT218504	MT265134	MT227974	**Mozambique**, Gorongosa N.P., Sofala	SAMC: P087059
Gasteruption sp.	SAF16	–	MT265198	MT228027	**South Africa,** Dwarsriviershoek Farm, Banghoek valley	SAMC: P087164
Gasteruption sp.	TH01	–	MT265208	MT228037	**Thailand,** (No location)	WINC
HYPTIOGASTRINAE						
Hyptiogaster arenicola Turner, 1918	BP337	MT218496	MT265128	MT227966	**Australia**, Kings Park, Perth, WA	WINC
Pseudofoenus extraneus (Turner, 1918)	BP361	–	MT265214	MT228043	**Fiji**, Viti Levu	BPC
Pseudofoenus fallax (Schletterer, 1889)	BP317	MT218491	MT265123	MT227961	**Australia**, Kingscote, Kangaroo Island, SA	BPC
Pseudofoenus inaequalis (Turner, 1918)	BP320	MT218492	MT265124	MT227962	**Australia**, Glass Gorge Road, Oratunga Station, SA	BPC
Pseudofoenus mitchellae Jennings & Austin, 2002	BP319	MT218495	MT265127	MT227965	**Australia,** Great Victoria Desert Nature Reserve, Mamungari, SA	BPC
Pseudofoenus morganensis Jennings & Austin, 2002	BP318	MT218494	MT265126	MT227964	**Australia**, Waldana Well, Great Victoria Desert, SA	BPC
Pseudofoenus sp.	BP59	MT218557	MT265182	–	**Australia**, Lashmar C.P., Kangaroo Island, SA	WINC
Pseudofoenus sp.	BP335	MT218497	MT265129	MT227967	**Australia,** Kalbarri N.P., WA	WINC
Pseudofoenus sp.	BP336	–	MT265215	MT228044	**Australia,** Credo Station Reserve, WA	WINC
Pseudofoenus sp.	BP342	MT218510	MT265140	MT227980	**Australia,** Javis Hills Road, Hawker, SA	BPC
AULACIDAE						
Aulacus brabyi Jennings & Austin, 2018	BP345	MT218449	–	MT227927	**Australia**, Flinders Chase N.P., Kangaroo Island, SA	WINC
Aulacus impolitus Smith, 1991	Aul_01	GQ374652	JQ519541	GQ374745	Unknown ex GenBank	Unknown

Species name	Voucher number	C01	EF1-α	28s	Collection locality	Voucher location
Pristaulacus strangaliae Rohwer, 1917	Aul_02	KY082429	GQ410728	GQ374742	Unknown ex GenBank	Unknown
EVANIIDAE						
Evaniella semaeoda (Bradley, 1908)	Eva_01	GQ374648	GQ410727	GQ374740	Unknown ex GenBank	Unknown
Brachygaster minuta (Olivier, 1792)	Eva_02	AY800156	JQ519543	AY817528	**France,** Le Bois Noir, Lans-en-Vercors	Unknown

Table S2. Primers used to amplify gene regions in the present study.

Gene region	Primers	Sequence	Reference
C01	M200 (fwd)	GGATTTGGAAATTGATTAGTTCC	Simon *et al.* 1994
	M205 (rev)	ACTGTAAATATATGATGAACTCA	Simon *et al.* 1994
	LCO1490 (fwd)	GGTCAACAAATCATAAAGATATTGG	Folmer *et al.* 1994
	HCO2198 (rev)	TAAACTTCAGGGTGACCAAAAAATCA	Folmer *et al.* 1994
EF1- α	G1044 (fwd)	AGATGGGYAARGGTTCCTTCAA	Belshaw & Quicke 1997
	G1045 (rev)	AACATGTTGTCDCCGTGCCATCC	Belshaw & Quicke 1997
28s	G0748 (fwd)	AGAGAGAGTTCAAGAGTACGTG	Dowton & Austin 1998
	G1386 (rev)	TTGGTCCGTGTTTCAAGACGGG	Dowton & Austin 1998

Table S3. Relative probability values for ancestral distributions for four nodes discussed in the text. The node values indicate the probability of any particular region being ancestral for that node

	Nodes (probabilities in percentage values)		
	A	C	D
Australasia	100	0	0
Australasia + Indomalaya	0	1.8	0
Australasia + Palaearctic	0	53.15	69.93
Australasia + Afrotropical	0	45.05	29.17
Australasia + Neotropical	0	0	0.91

CHAPTER VI: PHYLOGENOMICS OF THE FAMILY GASTERUPTIIDAE (HYMENOPTERA: EVANIOIDEA)

BEN A. PARSLOW[1,2,6], EMILY A. SADLER[3], JUANITA RODRIGUEZ[4], MICHAEL P. SCHWARZ[1], MARK I. STEVENS[2,5]

[1]Biological Sciences, College of Science and Engineering, Flinders University, Adelaide, SA 5041, Australia.

[2]South Australian Museum, North Terrace, GPO Box 234, Adelaide, SA 5000, Australia

[3]Department of Biology, Utah State University, 5305 Old Main Hill, Logan, UT 84322-5305, USA

[4]Australian National Insect Collection, CSIRO, Canberra, Australian Capital Territory, Australia

[5]School of Pharmacy and Medical Sciences, University of South Australia, Adelaide, SA 5001, Australia

[6]Corresponding author: ben.parslow3@gmail.com

Abstract

The Gasteruptiidae are an easily recognized family of wasps whose larvae are considered predator-inquilines in the nests of solitary bees and wasps. There has been minimal molecular research on the family and as a result limited understanding of the evolutionary relationships within the group. We sought to generate the first genome-scale dataset (1,238 loci, 351,275 bp) for 135 species of Gasteruptiidae. Our study increased taxon sampling across the family compared to previous studies, comprising 118 species of *Gasteruption*, single species of *Spinolafoenus* and *Plutofoenus*, and eleven Hyptiogastrinae species. Both maximum likelihood and coalescent species trees supported the monophyly of the subfamily Hyptiogastrinae and the genus *Gasteruption*, but the recovery of *Spinolafoenus* and *Plutofoenus* was uncertain. Our results are concordant with previous studies but improved on their phylogenies with increased taxon sampling and node support across the tree. Our results confirm it is possible to use UCE's from museum insect specimens, which allowed a significant increase in sampling effort and the inclusion of often rare or singleton species. Our study provides a strong foundation for future research on the relationships within the Gasteruptiidae and the exploration of diversification of the group.

Running head. Phylogenomics of the family Gasteruptiidae

Keywords. *Gasteruption*, Ultraconserved elements, UCE, ASTRAL

AUTHOR CONTRIBUTIONS

BAP, MPS and MIS Conceived the study,

BAP conducted specimen collection, DNA extraction, bioinformatics and manuscript preparation.

EAS conducted the Library prep and helped with bioinformatics.

JR assisted with phylogenetic analysis of data matrix.

Introduction

The family Gasteruptiidae Ashmead is a globally distributed family of wasps that are easily recognised based on the combination of an elongate neck-like propleura, slender subclavate metasoma inserted high on the propodeum, and clavate hind tibia (Jennings and Austin 2002). The family has a puzzling distribution where the subfamily Hyptiogastrinae comprises eleven species of *Hyptiogaster* Kieffer restricted to mainland Australia, and *Pseudofoenus* Kieffer consists of 76 species from Australasia and two Neotropical species. The remaining subfamily, Gasteruptiinae, has four genera: *Gasteruption* with 418 species across a cosmopolitan distribution and the smaller genera *Plutofoenus* Kieffer with three species restricted to southern South America, the monotypic genus *Spinolafoenus* Macedo known from Chile, and *Trilobitofoenus* Macedo with three species from Central and South America. The group is ecologically important as larval stages are considered predator-inquilines inside the nests of aculeate Hymenoptera (Jennings and Austin 2004; Grieve *et al.* 2018; Parslow *et al.* chapter II). Recent research has suggested that the family diverged during the early Eocene, which corresponds to known host genera divergence ages (Parslow *et al.* chapter V). Despite the general interest in the group and the extensive collection of material, phylogenetic research on the family until recently had been limited to two cladistics analyses (Jennings and Austin 2000; Macedo 2009), or analyses including isolated taxa in large scale datasets examining higher hymenopteran relationships (e.g. Peters *et al.* 2017; Klopfstein *et al.* 2018; Sharanowski *et al.* 2019). Recent work by Parslow *et al.* (chapter V) has been the most comprehensive molecular phylogeny of the family, incorporating representatives from multiple biogeographical regions and a large number of Australian species. However, the study lacked several key taxa and internal support within the Gasteruptiidae was highly variable, suggesting the three genetic markers used were not adequate for resolving some internal relationships within the family.

A possible solution to improving phylogenetic support would be to take advantage of high throughput genomic techniques to increase the number of sampled loci. Additionally, increased taxon sampling to represent biogeographical regions that were under-sampled in previous work would assist in exploring the historical biogeography of the family. Because of the paucity of genome level data for the Gasteruptiidae, we chose to explore the sequence capture of ultraconserved elements (UCEs) which does not require a reference genome, making it suitable for non-model organisms. UCEs are highly conserved regions within the genome that are shared among evolutionarily distant taxa (Zhang *et al.* 2019). The conserved core region of UCEs has been shown to have little variability but flanking regions are highly variable and have been used to explore both phylogenetic questions at deep time scales (Faircloth *et al.* 2015; Kulkarni *et al.* 2019) as well as population level studies across shallow time scales (Smith *et al.* 2013; Harvey *et al.* 2016; Zarza *et al.* 2018). UCE's have been recovered from degraded and fragmented DNA and have successfully amplified loci from existing museum material to explore evolutionary relationships (e.g. Blaimer *et al.* 2016; McCormack *et al.* 2016). Because UCE's can avoid the demands for specific preservation protocols that other genomic approaches may require, they are ideal for exploring the phylogenetic relationships of groups where large amounts of pinned material are only available in collections. Rare and singleton species are common for Gasteruptiidae, which makes historically collected or pinned material the only option to include specific representatives.

We aim to address the incongruence across the current phylogeny of the Gasteruptiidae presented by Parslow *et al.* (chapter V) by increasing taxon sampling and loci coverage using UCE's. Here we test the application of a set of general enrichment baits designed to enrich UCE's across Gasteruptiidae, generating the largest phylogenomic dataset for the family to date. We use the resulting phylogenomic data to further explore the phylogeny of the Gasteruptiidae, with an emphasis on resolving internal relationships.

Methods and materials

Taxon Sampling

Our taxon sampling was focused on increasing the number of biogeographical regions above those in previous studies and to include representatives from all genera within the Gasteruptiidae. The majority of the taxon sampling was focused on *Gasteruption* with 118 species covering the following biogeographical regions, Australasia (72 spp.), Indomalaya (3 spp.), and the Palaearctic (18 spp.), Afrotropical (12 spp.), Neotropical (3 spp.), and Nearctic (5 spp.) regions. We were able to sequence single specimens of *Spinolafoenus ruficornis* Macedo and *Plutofoenus paraguayensis* Schrottky to represent the smaller Gasteruptiinae genera but no specimens from *Triolobitiofoenus* Keiffer were available for the study as all accessible specimens were restricted to type material. Eleven species of Hyptiogastrinae were sampled covering a single species of *Hyptiogaster* (*Hyptiogaster arenicola* Turner) and 10 species of *Pseudofoenus* (nine species from Australasia, one from the Neotropics). Two families considered close to the Gasteruptiidae (Peters *et al.* 2017; Tang *et al.* 2018) were included as outgroups: three Aulacidae (two *Aulacus* species and a single *Pristaulacus*) and two Stephanidae (*Foenatopus* sp. and *Megischus texanus* Cresson) were included as outgroups. Material extracted covered 64 ethanol specimens and 58 specimens from dried pinned material and varied in age from 1967 to 2018 (Table S1).

Representatives of Australasian *Gasteruption* were identified where possible to species level using Pasteels' (1956) and Parslow *et al*.'s (chapter III) keys for *Gasteruption* and compared with type specimens. Palaearctic species were determined by C. A. van Achterberg (Naturalis Biodiversity Centre, Leiden) with South African material not identified to species as type material was unavailable for examination and the only available key is currently out of date (Pasteels 1962). Specimens that could not be identified to species are referred to as morphospecies and are likely to represent undescribed species. Hyptiogastrinae representatives were identified using Jennings and Austin (2002) key for *Pseudofoenus* and Jennings and Austin (1997) key for *Hyptiogaster*. Three Aulacidae specimens were identified using the Jennings *et al.* (2018) key for *Aulacus*. The Stephanidae specimens were identified by B.F. Santos (Smithsonian National Museum of Natural History, Washington)

DNA sequence generation

Specimens were sampled destructively from a single mid leg or, where possible, with non-destructive full body extractions performed for small or singleton specimens (Table S1). DNA was extracted using the Qiagen Gentra Puregene kit (Qiagen Inc., Valencia, CA), following the manufacturer's protocol with the following modifications; samples were incubated overnight at 55°C. For full body extractions, the specimen was removed after incubation and the lysate centrifuged for 15 minutes after protein precipitation. Extractions were quantified using a Qubit fluorometer (Life Technologies, Carlsbad, CA, U.S.A.).

Extracted DNA was mechanically sheared to a length of ~600 bp. DNA libraries were generated to be used with a specialized Tru-seq style dual indexing adapter system allowing for multiplexing and hybridization to enrich libraries. Quantification of adapter-ligated fragments post enrichment was performed via quantitative Polymerase Chain Reaction (qPCR) to ensure capture of UCE loci. Due to the short fragment size, and specialised indexing system allowing each individual to be uniquely tagged, libraries were pooled. A library of all individuals was combined into one pool and sequenced on an Illumina HiSeq 2500 lane at the University of Utah. For UCE enrichment we used the "uce-hym-v2" principal bait set developed initially for ants to enrich 2590-targeted UCE loci across Hymenoptera (Branstetter *et al.* 2017). This bait set has been used for other hymenopteran groups to resolve phylogenetic relationships (e.g. (Branstetter and Longino 2019; Cruaud *et al.* 2019; Santos *et al.* 2019).

UCE data processing and alignment

We used the PHYLUCE v1.6.6 pipeline (Faircloth 2015) to process the raw UCE data (Supplementary material 1) with the following variations. The cleaned reads were assembled using the SPAdes genome assembler v3.13.0 (Bankevich *et al.*

2012) and poorly aligned regions of each alignment were removed using the program GBLOCKS (Castresana 2000) with the following settings: b1=0.5, b2 =0.5, b3=12, b4=7. We created two datasets based on the “default” prob match settings of min-identity 80 and min-coverage 80 (80-80) and “best” as min-identity 75, min-coverage 70 (75-70) which recovered on average the most loci (table S2). Both supermatrices were filtered for 80% taxa completeness.

Four additional exons (*C0I, EF1α-F1*, *EF1α-F2 and* RPS23) and two ribosomal RNA genes (*18S and 28S*) that were present in the off-target regions were extracted using publicly available sequences (Table S3). The program (phyluce_assembly_match_contigs_to_barcodes) in the PHYLUCE v1.6.6 pipeline was used to extract the loci from the completed pool of contigs. Extracted contigs were filtered for sequence length and checked for contamination using the Basic Local Alignment Search Tool (BLAST) (Altschul *et al.* 1990) before being concatenated with the UCE loci supermatrices in Geneious v10.2.2 (https://www.geneious.com).

Phylogenomic Analyses

Partition schemes were determined using the Sliding-Window site Characteristics (SWSC) based on site entropy (Tagliacollo and Lanfear 2018), with the best model for nucleotide substitution determined using Partition Finder2 (Lanfear *et al.* 2016) using the “*rcluster*” command (Lanfear *et al.* 2014) and the “*--raxml*” command line option to use RaxML v8.0 for calculations (Stamatakis 2006). Phylogenetic inference for each dataset was performed using a concatenated loci maximum likelihood (ML) framework using IQ-TREE v1.5.5 (Nguyen *et al.* 2015). For all super matrices we specified a partition file allowing individual evolution rates (“-*spp*” command) and performed 1,000 ultrafast bootstrap replicates (“-*bb*” command).

To account for limitations like incomplete lineage sorting (Liu *et al.* 2015) in the concatenated ML inference we also conducted a coalescent-based species tree analysis using Accurate Species TRee ALgorithm (ASTRAL-III) (Zhang *et al.* 2017).

We created a gene tree for each locus using IQ-TREE v1.5.5 with MODELFINDER (Kalyaanamoorthy *et al.* 2017) ('-m MFP' command), the AICc model selection criterion, and 1,000 ultrafast bootstrap replicates. Generated gene trees were used to perform a standard ASTRAL analysis. Individual gene tree inference was performed on the Pearcey High Performance Computer cluster hosted by CSIRO.

Results

UCE data characteristics

Data filtering of the different contig match setting produced two supermatrices. The 75-70 "best" comprising on average 1,238 loci and 351,275 bp across 135 taxa, and an 80-80 "default" alignment with an average of 1,169 loci and 397,135 bp. There was large variation in the number of loci captured across specimen ages and between preservation types (Fig. 1). For pinned material from an age range of 1967–2017 we captured on average 1,297 (173–1,698) loci, compared to ethanol preserved material within an age range of 1991–2018, where on average 1,502 (1,315–1,875) loci were captured.

Phylogenetic analyses

The phylogenetic trees inferred using two different probe matching settings recovered similar topologies, with only small differences in support values and taxon placement (Figs S1–S2). The singleton representative of *Spinolafoenus* was recovered with high support (BS = 100) as basal to the Aulacidae in all analyses (Figs S1–S3), and the position of *Plutofoenus* as basal to the Hyptiogastrinae and sister to the Gasteruptiinae (Figs 2 and 3, node A). This relationship has poor support (BS = 64) in the 75-70 tree (Fig. 2) but is highly supported (BS = 100) in the 80-80 tree (Fig. S2).

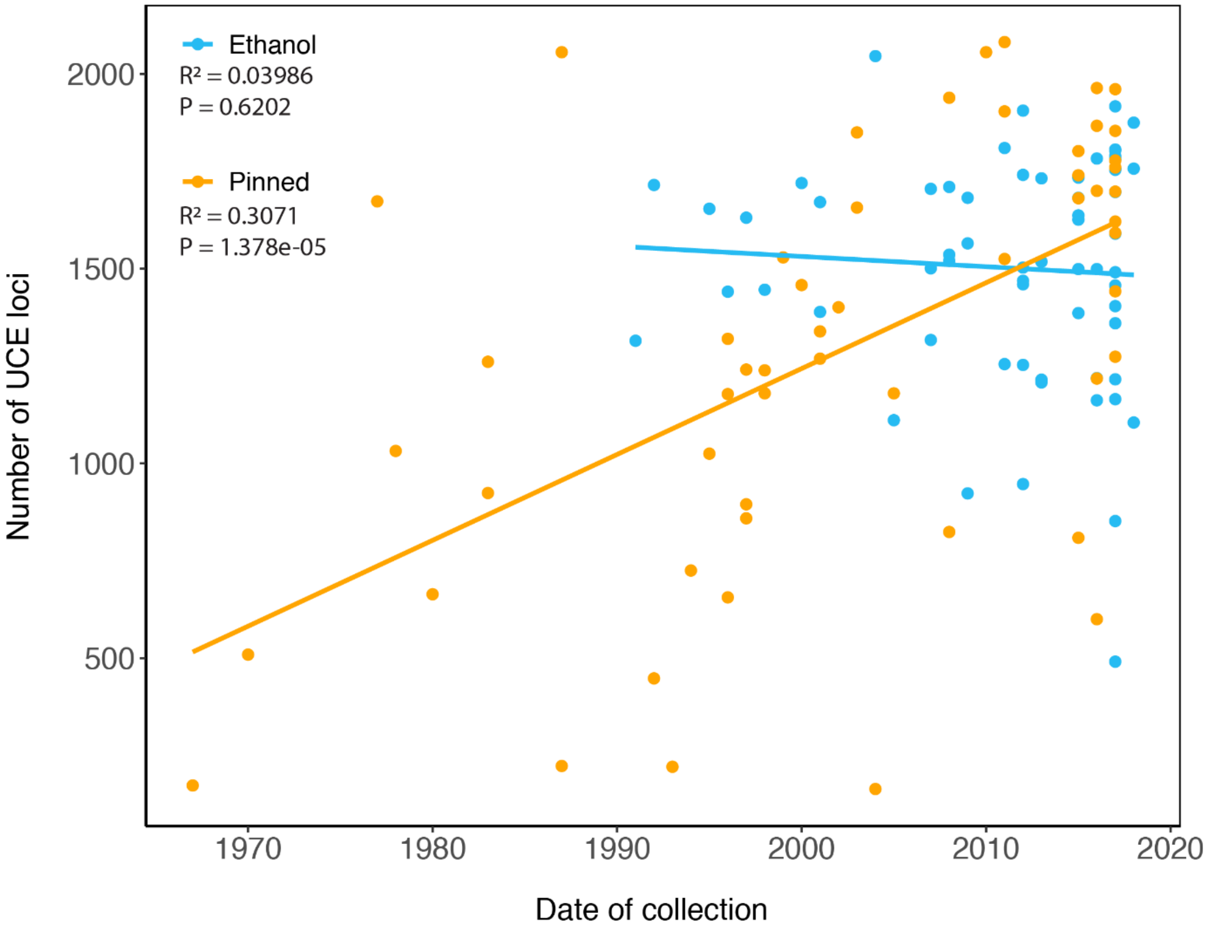

Figure 1. Scatterplot of number of UCE loci (for best match setting of 75-70) against the date of specimen collection. Plot shows a general trend for pinned material where fewer UCE loci were captured for older specimens and for ethanol stored material where there is very little change with age in the number of captured UCE loci.

The Hyptiogastrinae (Fig. 1, node B) and *Gasteruption* (Fig. 1, node C) were both recovered as monophyletic with high support (BS = 100) in all analyses. There were minimal topological changes between trees with an obvious difference in the recovered position of "*Gasteruption_youngi*_BP334" in the 80-80 trees (fig. S2) at the base of the *Gasteruption* clade with high support. In the 75-70 trees the taxa was recovered medially within the clade with "*Gasteruption cylindricum*_G52" which is a morphologically similar species (Parslow *et al.* chapter III).

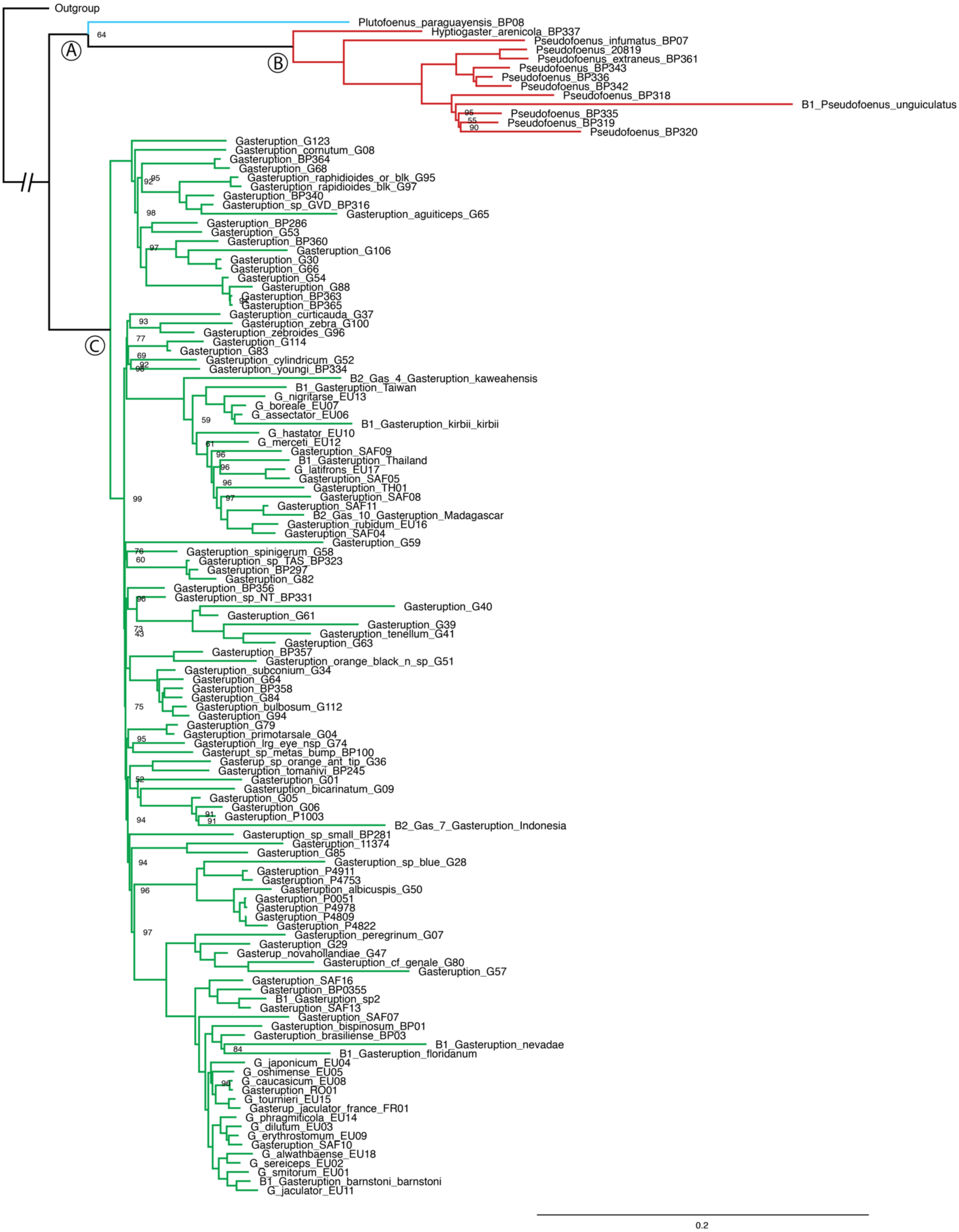

Figure 2. Maximum-likelihood phylogeny of Gasteruptiidae inferred from 80% complete taxa supermatrix using 75-70 probe match settings, all nodes are 100% bootstrap support unless otherwise indicated. Branches are colour coded as *Plutofoenus* – Blue, Hyptiogastrinae – Red and *Gasteruption* – green. Outgroups are collapsed to allow visualisation of main clades.

The ASTRAL species trees recovered similar topologies between supermatrices but varied in their support across nodes (Figs S3–S4). When node support was compared between the tree building methods, the ASTRAL 75-70 tree had lower support compared to the IQ 75-70 tree. The ASTRAL 80-80 tree recovered a higher node support when compared to the IQ 80-80 tree. Topology remained relatively constant between the trees with minimal shifts occurring at some apical nodes within the tree. The 80-80 ASTRAL tree recovered "*Gasteruption_youngi*_BP334" in the same position as the 75-70 trees, with "*Gasteruption cylindricum*_G52" within the main *Gasteruption* clade.

Discussion

We present the first phylogeny for the Gasteruptiidae based on ultraconserved elements. Our study currently represents the most comprehensive phylogeny to date, with extensive taxon sampling for genera within the family. Our results are broadly consistent with previous work on Gasteruptiidae (Jennings and Austin 2002; Macedo 2009), except for our recovered placement of the two smaller Gasteruptiinae genera (*Plutofoenus* and *Spinolafoenus*). *Spinolafoenus* was recovered in all analyses outside of the Gasteruptiidae clade, sister group to Aualacidae. *Spinolafoenus ruficornis* has previously been placed within Gasteruptiinae based on morphological synapomorphies (Macedo 2009), suggesting our placement as potentially erroneous. Similarly, the position of *Plutofoenus paraguayensis* Macedo as a sister group to the Hyptiogastrinae conflicts with previous morphological studies that placed it within Gasteruptiinae (Macedo 2009). The recovery of of these taxa at the base of the tree might suggest a Neotropical origin for the Gasteruptiidae, but we consider this unlikely as none of the sampled Neotropical Gasteruption taxa are recovered as sister groups. The unexpected placement for these genera may be due to thin taxonomic sampling, viz. the inclusion of single specimens, or varying levels of missing data (*Spinolafoenus*: 89.7% missing data, *Plutofoenus*: 58.9% missing data) which can bias topological placement towards the root of the tree (Hosner *et al.* 2016). However, other taxa also had high levels of missing data (e.g. BP07: 86.1% missing data and G63: 70.0% missing data) but were recovered within the main *Gasteruption* clade. Short contig lengths combined with a lack of informative sites could be influencing the recovered position of the two genera (Andersen *et al.* 2019). Currently the placement of the two genera within our phylogeny should be considered uncertain and more specimens should be incorporated into future work to further resolve these relationships.

When comparing the IQ trees inferred between the two different probe match setting used to create the supermatrices, the 80-80 dataset produced better supported trees when compared to the 75-70 dataset. However, we considered the 75-70 tree topology (Fig 2 and S1) more reliable compared to the 80-80 tree topology, based on the erroneous placement of the taxa "*Gasteruption_youngi*_BP334" at the base of the main *gasteruption* clade, and separate to the morphologically similar taxa "*Gasteruption cylindricum*_G52" (Parslow *et al.* chapter III). We expect the two taxa to group together phylogenetically based on their distinctive elongated, cylindrical morphology (Parslow *et al.* chapter II, fig, 1A and B) and the only species to utilise Euryglossinae bee hosts (Parslow *et al.* chapter II, table 1). Overall, the ML trees outperformed the ASTRAL species trees in producing better resolved trees, but not all nodes were well supported, with lower support basally in the trees. The highly supported incongruence in topologies between our ML and ASTRAL trees could be caused by characteristics of our dataset, like incomplete lineage sorting (Bravo *et al.* 2019) or missing data (Hosner *et al.* 2016) which have both been shown to affect coalescent methods (Meiklejohn *et al.* 2016). In contrast, there are arguments for the trade-off of building a larger data matrix by including taxa with missing data to increase resolution (Streicher *et al.* 2015).

The short inferred basal branches of the *Gasteruption* clade (fig. 1 and 2, node C) may be indicative of a rapid diversification event. These events are difficult to resolve and are often identified as low support at nodes leading to short branch lengths in phylogenetic trees. It is therefore difficult to identify "true" rapid radiation events as the short inferred branch lengths can obscure phylogenetic signal or can be a symptom of low or conflicting phylogenetic signals (Whitfield and Lockhart 2007).

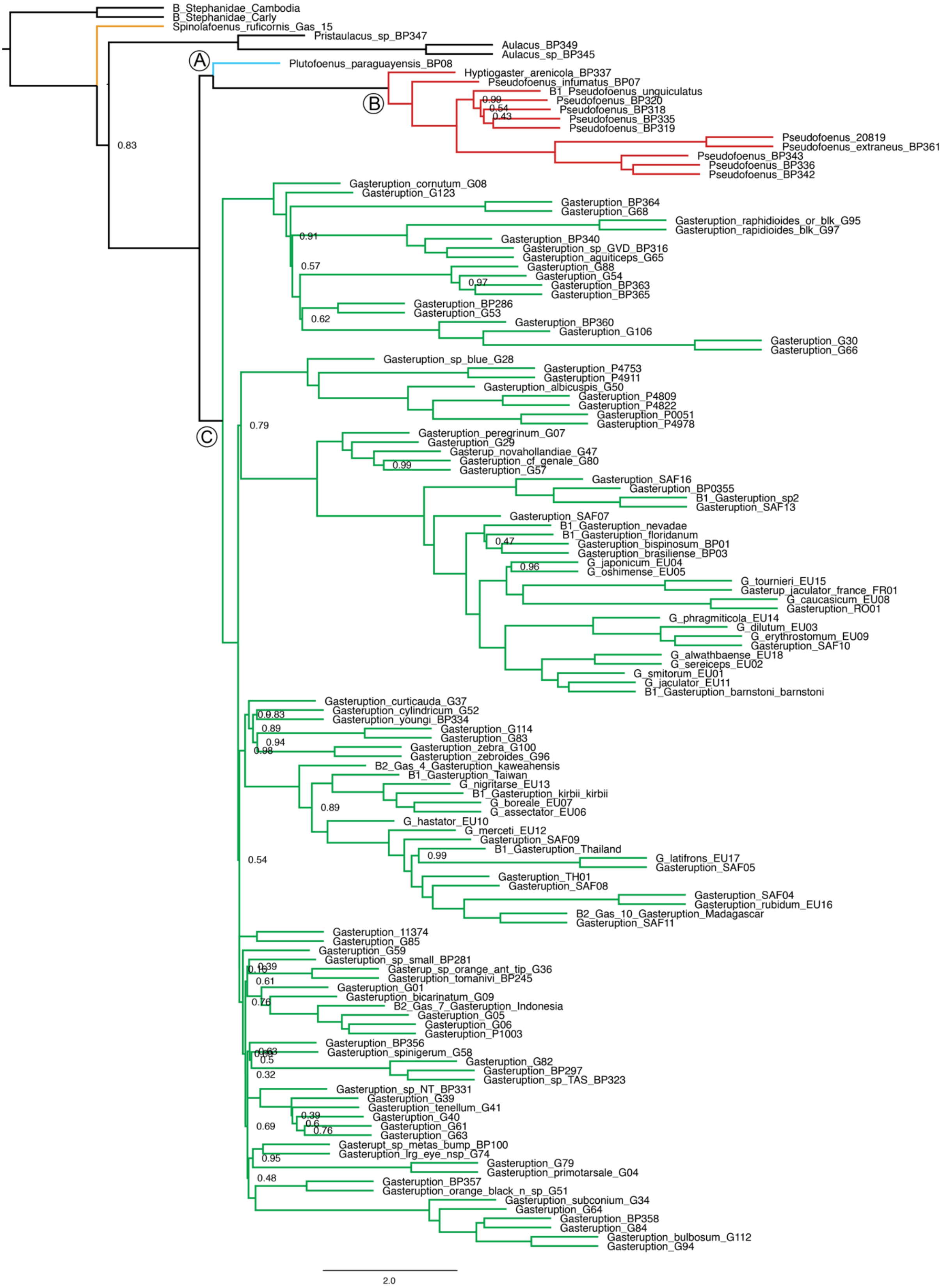

Figure 2. AUSTRAL species tree of Evanioidea. inferred from an 80% complete taxa supermatrix using 75-70 probe match settings. Bootstrap support for nodes is 100% unless otherwise indicated. Branches are colour coded as *Spinolafoenus* – orange, *Plutofoenus* – Blue, Hyptiogastrinae – Red and *Gasteruption* – green.

Rapid diversification events have been suggested for other groups of parasitic wasps (e.g. Chalcidoidea, Peters *et al.* 2018; Braconidae, Whitefield *et al.* 2018; Ichneumonidae, Klopfstein *et al.* 2018; and Platygastroidea, Murphy *et al.* 2007) and may be a response to formation of host niches through host switching or diversification (Banks and Whitfield 2006). At a rough estimation using the crown age for the genus recovered by Parslow *et al.* (chapter V), *Gasteruption* began diversifying during the late Eocene at ~47 (31.75 - 64.7) mya. This would suggest *Gasteruption* experienced a large, rapid radiation event shortly after the Cretaceous–Paleogene (K–Pg) boundary, but a better resolved and calibrated tree is necessary to further address the questions about when this rapid radiation occurred in *Gasteruption*.

Our recovered phylogenies are concordant with previous work on Gasteruptiidae that recovered *Gasteruption*, Hyptiogastrinae, *Hyptiogaster* and *Pseudofoenus* as monophyletic taxa. Parslow *et al.* (chapter V) is the only molecular study with resolution within the *Gasteruption*, other studies have focused mainly on family level relationships with sparse *Gasteruption* taxon sampling (Peters *et al.* 2017; Tang *et al.* 2018; Sharanowski *et al.* 2019). Our phylogeny recovered a similar topology to the phylogenetic hypothesis proposed by Parslow *et al.* (chapter V), with the inclusion of additional data increasing basal support within the phylogeny and retained many of the previously proposed relationships. Like all previous studies we recovered the Hyptiogastrinae as the sister clade to the *Gasteruption* (Jennings and Austin 2002). However, our placement of some internal taxa varied, for example *P. infumatus* (Schletterer), one of the two included species of Neotropical *Psudofoenus*, was recovered, with high support, as sister group to the other sampled *Psudofoenus*. Previous cladistic studies including representatives from outside of Australasia have recovered them apically (Jennings and Austin 2002; Macedo 2009).

UCE loci capture from pinned material

There was a clear difference in the success of capturing loci between ethanol preserved material and pinned material, with age contributed significantly to loci recovery for pinned material (Fig 1). Our results suggest a decline in UCE recovery with the increase in age since specimens were sampled, which is consistent with other studies working on preserved museum material (Blaimer *et al.* 2016; van Dam *et al.* 2017). We were unable to determine why some pinned museum specimens performed better for loci capture than others, but unknown factors associated with collection method or storage are likely the cause. van Dam *et al.* (2017) discussed the preservation method of beetle specimens and suggested increased drying time of specimens could further degrade DNA. In addition, commonly used killing agents like ethyl acetate have been suggested to denature DNA and reduce yield in insect material (Dillon *et al.* 1996). Our study, however, confirms it is possible to use UCE's from museum insect specimens, which allowed a significant increase in sampling effort and the inclusion of often rare or singleton species.

Conclusion

It has long been suggested that simply throwing more sequence data at a phylogenetic problem will not solve it (Salichos and Rokas 2013; Kimball and Braun 2014). We experienced difficulties producing a fully resolved phylogeny of Gasteruptiidae, despite the massively increased number of loci and taxon sampling compared to Parslow *et al.* (chapter IV). However, our phylogeny of the Gasteruptiidae is the best supported to date. Future work is necessary to explore the data further by filtering captured loci for informativeness (Gilbert *et al.* 2018) and identifying conflicting gene trees based on partitioned coalescence support (PCS) (Gatesy *et al.* 2019) which we anticipate to further increase the support within the *Gasteruption* clade. To further explore and begin to understand the relationships within the Gasteruptiidae, increased taxon sampling of neglected genera is important. Our study has been the first to include molecular data for *Spinolafoenus* and *Plutofoenus*, but representatives of *Trilobitiofoenus* are still unavailable due to the paucity of non-type material. Additionally, relationships within the Hyptiogastrinae are still relatively unknown, for example *Hyptiogaster* is regularly represented by only the single species *Hyptiogaster arenicola* Turner. Although many questions relating to the evolutionary relationships of the Gasteruptiidae remain unanswered, we have provided a stable framework for future systematic research which may resolve these uncertainties.

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Supplementary material

Figure S1. Maximum-likelihood phylogeny of Evanioidea. inferred from 80% complete taxa supermatrix using 75-70 probe match settings, bootstrap support is indicated at each node.

Figure S2. Maximum-likelihood phylogeny of Evanioidea. inferred from 80% complete taxa supermatrix using 80-80 probe match settings, bootstrap support is indicated at each node.

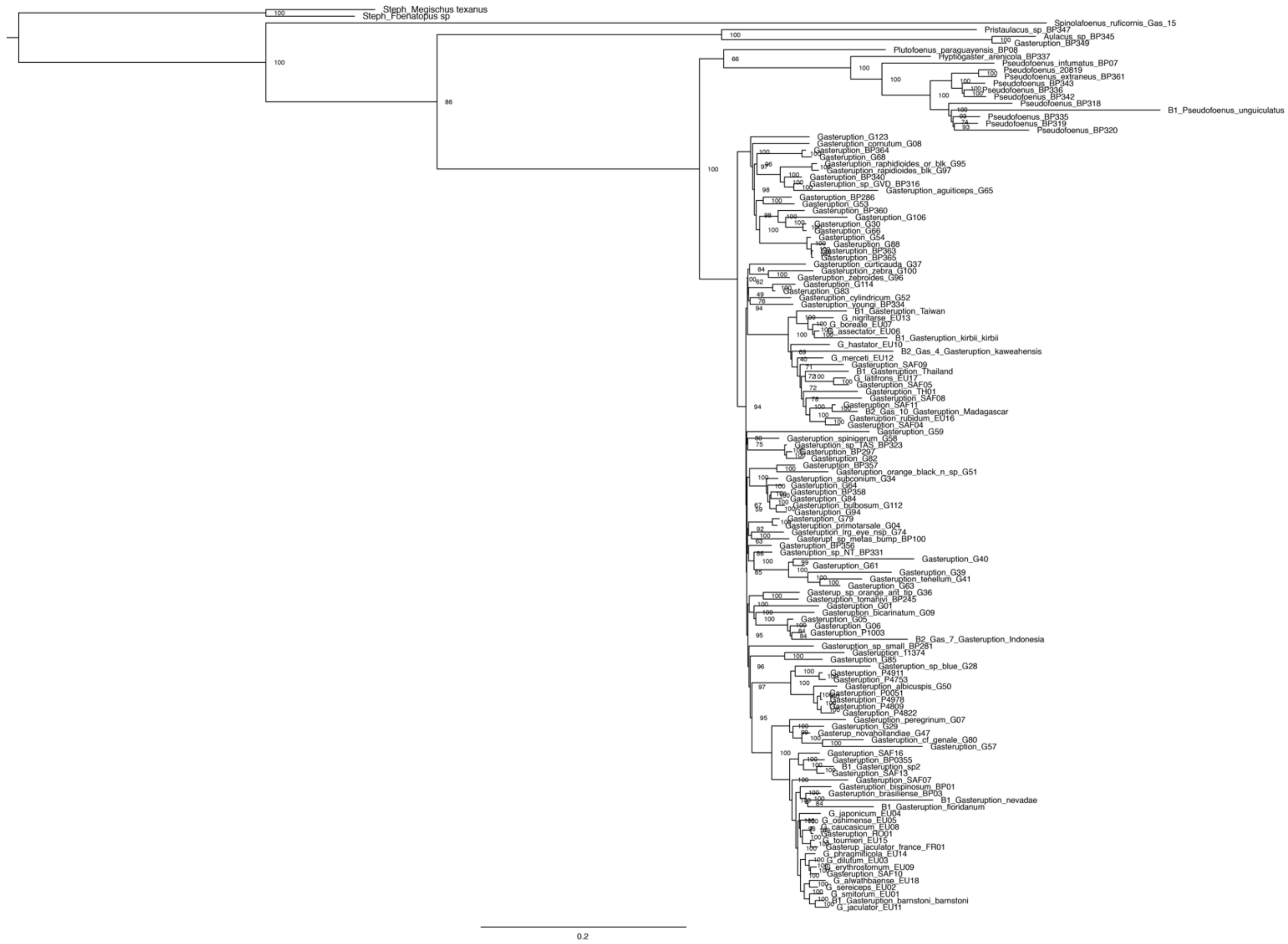

Figure S3. AUSTRAL species tree of Evanioidea. inferred from 80% complete taxa supermatrix using 80-80 probe match settings, bootstrap support is indicated at each node.

Supplementary table S1. Specimen information. Species identification, voucher numbers, collection localities, voucher location, data of collection and preservation method for all material used in this study. Abbreviations for collection locations are PNG = Papua-New-Guinea. Abbreviations for voucher location are AMS = Australian Museum, Sydney, Australia, BPC = Ben A. Parslow personal collection, to be deposited in SAMA, EMUS = Utah State University Insect Collection, Utah, USA, QM = Queensland Museum, Brisbane, Australia, MNHN = Muséum National d'Histoire Naturelle, Paris, France, RMNH = Naturalis Biodiversity Centre, Leiden, Netherlands, SAMA = South Australian Museum, Adelaide, Australia, SAMC = Iziko South African Museum, Cape Town, South Africa, TMAG = Tasmanian Museum & Art gallery, Hobart, Australia, WAM = West Australian Museum, Perth, Australia, WINC = Waite Insect & Nematode Collection, Adelaide, Australia.

Species name	Voucher number	Location	Voucher location	Date Collected	Preservation Method
		Gasteruptiinae			
Gasteruption albicuspis Kieffer	G50	Australia, Queensland, Daintree National Park	QM	1997	Pinned
Gasteruption alwathbaense Saure, Schmid-Egger & van Achterberg	EU18	Yemen, Lahj	RMNH	2002	Pinned
Gasteruption angusticeps (Kieffer)	G65	Australia, Queensland, Captain Billy Landing Road	QM	1992	Pinned
Gasteruption assectator (Linnaeus)	EU06	Bulgaria, Banya	RMNH	2017	Pinned

Gasteruption barnstoni (Westwood)	B1_barnstoni	Unknown	USNM	n/a	Pinned
Gasteruption bicarinatum Pasteels	G09	Australia, Piney Lakes, WA	KIT	2017	Ethanol
Gasteruption bispinosum Kieffer	BP01	Costa Rica, Escazu	EMUS	1987	Pinned
Gasteruption bispinosum Kieffer	BP03	Brazil, Teodoro Sampaio	EMUS	1977	Pinned
Gasteruption boreale (Thomson)	EU07	Duiven, tuin	RMNH	2017	Pinned
Gasteruption brachyurum Schletterer	BP323	Australia, Tasmania, Geeveston	BPC	2017	Ethanol
Gasteruption brachyurum Schletterer	G82	Australia, South Australia, Heathfield	SAMA	2008	Pinned
Gasteruption breviscutum Kieffer	G05	Australia, Victoria, Musk	WINC	2011	Pinned
*Gasteruption caucasicu*m (Guérin-Ménéville)	EU08	Bulgaria, Banya	RMNH	2017	Pinned
Gasteruption cornutum Pasteels	G08	Australia, Western Australia, Tarin Rock Nature Reserve	WAM: E97821	1996	Pinned
Gasteruption curticauda Pasteels	G37	Australia, Tasmania, Manuka Road	WINC	2001	Pinned
Gasteruption cylindricum Turner	G52	Australia, Queensland, St Lucia campus, University of Queensland	BPC	2007	Ethanol
Gasteruption dewitzi	G122	Australia, Queensland, Toowoomba	QM	1949	Pinned

Schletterer					
Gasteruption dilutum Semenov	EU03	Iran, Zabol, Sistan and Baluchestan Province	RMNH	2015	Pinned
Gasteruption erythrostomum (Dahlbom)	EU09	Netherlands, Duiven, Gelderland	RMNH	2017	Pinned
Gasteruption fibula Pasteels	G74	Australia, Tasmania, Manuka Road	TMAG: F33302	2003	Pinned
Gasteruption floridanum Bradley	B1_floridanum	Unknown	USNM	n/a	Pinned
Gasteruption genale Schletterer	G80	Australia, New South Wales, Warrumbungl Natation Park	QM	1997	Pinned
Gasteruption hastator (Fabricius)	EU10	Spain, Castilla & Leon, Valdemierque,	RMNH	2017	Pinned
Gasteruption jaculator (Linnaeus)	EU11	Gendtsche Polder, beg. Gebied	RMNH	2016	Pinned
Gasteruption jaculator (Linnaeus)	FR01	France, La Ciotat, Bouches Du Rhōne	HBP52	2008	Ethanol
Gasteruption japonicum Cameron	EU04	China, Xi'an, Shaanxi	RMNH	2017	Pinned
Gasteruption kirbii Townes	B1_kirbii	Unknown	USNM	n/a	Pinned
Gasteruption latifrons Saure, Schmid-Egger & van Achterberg	EU17	Yemen, Manakhah, Sana‘a	RMNH	2000	Pinned
Gasteruption longicolle Schletterer	G53	Australia, Queenalnd, Tin Can Bay	BPC	2016	Ethanol

Gasteruption longipes Pasteels	BP286	Australia, South Australia, Ferries Mcdonald Conservation Park	WINC	1995	Ethanol
Gasteruption merceti Kieffer	EU12	Hungary, Törökbálint	RMNH	2016	Pinned
Gasteruption nevadae Bradley	B1_nevadae	Unknown	USNM	n/a	Pinned
Gasteruption nigritarse (Thomson)	EU13	Turkey, Subatuk, Erzurum	RMNH	1999	Pinned
Gasteruption nova-hollandia Schletterer	G47	Australia, South Australia, Kangaroo Island, Point Elen	BPC	2007	Ethanol
Gasteruption oshimense Watanabe	EU05	China, Qinling Mountains, Shaanxi	RMNH	2017	Pinned
Gasteruption peregrinum Schletterer	G07	Australia, New South Wales, Boonoo Boonoo	QM	1980	Pinned
Gasteruption phragmiticola Saure	EU14	Czech Republic, Doksy, Bohemia	RMNH	2015	Pinned
Gasteruption platycephala Pasteels	G54	Australia, Tasmania, Geeveston	BPC	2009	Ethanol
Gasteruption primotarsale Pasteels	G04	Australia, Victoria, Authors Creek	BPC	2016	Ethanol
Gasteruption raphidioides (Westwood): orange/black	G95	Australia, South Australia, Kangaroo Island, flinders Chase Nation Park	BPC	2018	Ethanol
Gasteruption rapidioides (Westwood): Black	G97	Australia, South Australia, Kangaroo Island, flinders Chase Nation Park	BPC	2018	Ethanol
Gasteruption rubidum Saure, Schmid-Egger & van	EU16	Yemen, Manakhah, Sana'a	RMNH	2003	Pinned

Achterberg					
Gasteruption sericeipes Kieffer 1911	EU02	United Arab Emirates, Al Wathba Wetland Reserve, Abu Dhabi	RMNH	2015	Pinned
Gasteruption smitorum van Achterbergan Achterberg & Talebi	EU01	Turkey, Subatuk, Erzurum	RMNH	2001	Pinned
Gasteruption sp.	11374	PNG, Wanang, Madang	MNHN	2012	Ethanol
Gasteruption sp.	B1_sp2	Unknown	USNM	n/a	Pinned
Gasteruption sp.	B1_Taiwan	Unknown	USNM	n/a	Pinned
Gasteruption sp.	B1_Thailand	Unknown	USNM	n/a	Pinned
Gasteruption sp.	B2_Gas_10_ Madagascar	Unknown	USNM	n/a	Pinned
Gasteruption sp.	B2_Gas_4_ kaweahensis	Unknown	USNM	n/a	Pinned
Gasteruption sp.	B2_Gas_7_ Indonesia	Unknown	USNM	n/a	Pinned
Gasteruption sp.	BP297	Australia, South Australia, Glen Osmond Road	WINC	1991	Ethanol
Gasteruption sp.	BP355	Africa, Bheki, Gumbi Wildlife reserve	WINC	2009	Ethanol
Gasteruption sp.	BP357	Australia, South Australia, Morgan-Burra road, Winterton	WAM: E 97810	1998	Pinned
Gasteruption sp.	BP358	Australia, Western Australia, Kings Park	BPC	2017	Ethanol
Gasteruption sp.	BP360	Australia, Western Australia, Manbina Reserve	BPC	2017	Ethanol

Gasteruption sp.	BP363	Australia, South Australia, Waite Campus, The University of Adelaide	BPC	2017	Ethanol
Gasteruption sp.	BP364	Flinders Chase NP, Kangaroo Island, SA, Australia	BPC	2007	Ethanol
Gasteruption sp.	BP365	Australia, South Australia, Waite Campus, The University of Adelaide	BPC	2000	Ethanol
Gasteruption sp.	BP340	Australia, Western Australia, Salmon Gums, Goldfields highway	BPC	2017	Ethanol
Gasteruption sp.	BP356	Australia, Victoria, Authors Creek	BPC	2017	Pinned
Gasteruption sp. blue	G28	Australia, Queensland, Garners Beach	AMC: K420869	1983	Pinned
Gasteruption sp. GVD	BP316	Australia, South Australia, Kingscote, Kangaroo Island	BPC	2017	Ethanol
Gasteruption sp. metasoma bump	BP100	Australia, South Australia, Eden Hills	WINC	2017	Ethanol
Gasteruption sp. nov	G01	Australia, Queensland, Murry Springs	QM	1995	Pinned
Gasteruption sp. orange antennae tip	G36	Australia, South Australia, Waite Campus, The University of Adelaide	WINC	1996	Ethanol
Gasteruption sp. small	BP281	Australia, South Australia, Waite Campus, The University of Adelaide	WINC	2001	Ethanol
Gasteruption sp.NT	BP331	Australia, Western Australia, Stirling Range Nation Park	BPC	2017	Ethanol
Gasteruption spinigerum Schletterer	G58	Australia, South Australia, Mount Remarkable National Park	BPC	1997	Ethanol
Gasteruption subconium Pasteels	G34	Australia, South Australia, Kangaroo island, Bluff Knoll	BPC	2012	Ethanol

Gasteruption tenellum Pasteels	G41	Australia, Queensland, Lake Broadwater	QM	1987	Pinned
Gasteruption tenue Kieffer	BP07	Argentina, Tucuman, San Pedrode	EMUS	1967	Pinned
Gasteruption tomanivi Parslow, Stevens & Schwarz	BP245	Fiji, Viti Ievu, Mount Tomanivi	SAMA: 32-035928	2016	Ethanol
Gasteruption tournieri Schletterer	EU15	Bulgaria, Banya	RMNH	2017	Pinned
Gasteruption youngi Jennings & Parslow	BP334	Australia, South Australia, Great Victoria Desert Nature Reserve, Mamungari	BPC	2017	Ethanol
Gasteruption zebra Pasteels	G100	Australia, New South Wales, Balranald	AM: K420876	2005	Pinned
Gasteruption zebroides Pasteels	G96	Australia, South Australia, Wichalena Station	WINC	2011	Ethanol
Gasteruption sp.	G06	Australia, Queensland, Stapylton, Yatala	QM	2001	Ethanol
Gasteruption sp.	G106	Australia, Queensland, Inskip point	BPC	2016	Pinned
Gasteruption sp.	G112	Australia, South Australia, Auburn	BPC	1992	Ethanol
Gasteruption sp.	G114	Australia, Tasmania, Wayatinah	ANIC: 32 113712	1983	Pinned
Gasteruption sp.	G29	Australia, New South Wales, Bundjalung Nat Park near Evans Head	QM	1998	Pinned
Gasteruption sp.	G30	Australia, Queensland, Dayboro	BPC	2016	Pinned
Gasteruption sp.	G39	Australia, Queensland, Canaan Creek, Barkaula Forrest Station	QM: 52068	2004	Pinned

Gasteruption sp.	G40	Australia, Queensland, Coen	QM	1993	Pinned
Gasteruption sp.	G51	Australia, Norther Territory, Alice Springs	ANIC	1978	Pinned
Gasteruption sp.	G57	Australia, Western Australia, Moir Rock, Salmon Gums	QM	1994	Pinned
Gasteruption sp.	G59	Australia, South Australia, Gibralter National Park,	QM	1996	Pinned
Gasteruption sp.	G61	Australia, Queensland, Capricorn Coast National Park	QM	1997	Pinned
Gasteruption sp.	G63	Australia, Victoria, Musk	WINC	2010	Pinned
Gasteruption sp.	G64	Australia, Victoria, Musk	WINC	2010	Pinned
Gasteruption sp.	G66	Australia, Tasmania, Warra	TMAG: F33377	2011	Pinned
Gasteruption sp.	G68	Australia, South Australia, Cox Scrub National Park	BPC	2016	Pinned
Gasteruption sp.	G79	Australia, South Australia, Kangaroo Island, Emu Bay	BP296	2005	Ethanol
Gasteruption sp.	G83	Australia, Tasmania, Manuka Road	TMAG: F33303	2008	Pinned
Gasteruption sp.	G88	Australia, Queensland, Taroom District, Boggonoss	QM	1996	Pinned
Gasteruption sp.	G94	Australia, Mulgathing Station, SA	SAMA	2015	Pinned
Gasteruption sp.	P0051	PNG, Wanang, Madang	MNHN	2012	Ethanol
Gasteruption sp.	P1003	PNG, Mount Wilhelm, Madang	MNHN	2012	Ethanol
Gasteruption sp.	P4753	PNG, Mount Wilhelm, Madang	MNHN	2013	Ethanol
Gasteruption sp.	P4809	PNG, Mount Wilhelm, Madang	MNHN	2013	Ethanol
Gasteruption sp.	P4822	PNG, Mount Wilhelm, Madang	MNHN	2013	Ethanol

Gasteruption sp.	P4911	PNG, Wanang, Madang	MNHN	2012	Ethanol
Gasteruption sp.	P4978	PNG, Mount Wilhelm, Madang	MNHN	2013	Ethanol
Gasteruption sp.	RO01	Moldova Comāneşti, Bacāu, Romania	WINC	2012	Ethanol
Gasteruption sp.	SAF04	South Africa, (No location)	SAMC: P087012	??	Ethanol
Gasteruption sp.	SAF05	South Africa, Dwarsriviershoek Farm, Banghoek valley	SAMC: P087028	2015	Ethanol
Gasteruption sp.	SAF07	South Africa, Dwarsriviershoek Farm, Banghoek valley	SAMC: P087050	2015	Ethanol
Gasteruption sp.	SAF08	South Africa, (No location)	SAMC: P086991	2009	Ethanol
Gasteruption sp.	SAF09	South Africa, Dwarsriviershoek Farm, Banghoek valley	SAMC: P087169	2015	Ethanol
Gasteruption sp.	SAF10	South Africa, Dwarsriviershoek Farm, Banghoek valley	SAMC: P087175	2015	Ethanol
Gasteruption sp.	SAF11	Mozambique, Sofala, Gorongosa National Park	SAMC	2017	Ethanol
Gasteruption sp.	SAF13	Mozambique, Sofala, Gorongosa National Park	SAMC: P087059	2017	Ethanol
Gasteruption sp.	SAF16	South Africa, Dwarsriviershoek Farm, Banghoek valley	SAMC: P087164	2015	Ethanol
Gasteruption sp.	TH01	Thailand, (No location)	HBP48	2012	Ethanol
Plutofoenus paraguayensis Schrottky	BP08	Brazil, Santa Catarina, Nova teutonia	EMUS	1970	Pinned

Spinolafoenus ruficornis Macedo	SP01	Chile, (no location)	USNM	n/a	Pinned
		Hyptiogastrinae			
Hyptiogaster arenicola Turner	BP337	Australia, Western Australia, Kings Park, Perth	WINC	2008	Ethanol
Pseudofoenus	BP343	Australia, Western Australia, Browns Dam	BPC	2017	Ethanol
Pseudofoenus extraneus (Turner)	BP361	Fiji, Viti levu	BPC	2018	Ethanol
Pseudofoenus inaequalis (Turner)	BP320	Australia, South Australia, Oratunga Station	BPC	2017	Ethanol
Pseudofoenus mitchellae Jennings & Austin, 2002	BP319	Australia, South Australia, Great Victoria Desert Nature Reserve, Mamungari	BPC	2017	Ethanol
Pseudofoenus morganensis Jennings & Austin, 2002	BP318	Australia, South Australia, Great Victoria Desert Nature Reserve, Mamungari	BPC	2017	Ethanol
Pseudofoenus sp.	20819	PNG, Mount Wilhelm, Madang	MNHN	2013	Ethanol
Pseudofoenus sp.	BP335	Australia, Western Australia, Kalbarri National Park	BPC	2016	Ethanol
Pseudofoenus sp.	BP336	Australia: Western Australia, Credo Station Reserve	WINC	2011	Ethanol
Pseudofoenus sp.	BP342	Australia, South Australia, Javis Hills road, Hawker	BCP	2017	Ethanol
Pseudofoenus unguiculatus (Westwood)	B1_ unguiculatus	Unknown	USNM	n/a	Pinned
		Aulacidae			
Aulacus brabyi Jennings & Austin	BP345	Australia, South Australia, Kangaroo Island, Flinders Chase	WINC	2004	Ethanol

Aulacus sp.	BP349	Australia, Queensland, Mt. Glorious	WINC	1998	Ethanol
Pristaulacus sp.	BP347	Australia, South Australia, Kangaroo Island, Flinders Chase, Hanson bay	WINC	2008	Ethanol
		Stephanidae			
Foenatopus sp	Step_ Foenatopus sp	Cambodia, Ratankiri Provence, Veun Sai-Siem Nationa Park	USNM	2016	Ethanol
Megischus texanus Cresson	Step__ Megischus texanus	United states, Texas, Marble Falls	USNM	2016	Ethanol

Supplementary material 1

PHYLUCE v1.6.6 pipeline scripts used for the generation of these data.

#Match contigs to probes

phyluce_assembly_match_contigs_to_probes --contigs ./3.combined_run_PRINCIPLE_BAITS/spades/contigs_2/ --probes ./1.Combined_run/3.match-contigs-to-probes/probes/hymenoptera-v2-PRINCIPAL-bait-set.fasta --output ./3.combined_run_PRINCIPLE_BAITS/3.match-contigs-to-probes/lastz/lastz_80-80 &

#80-80

phyluce_assembly_get_match_counts --locus-db ./3.combined_run_PRINCIPLE_BAITS/3.match-contigs-to-probes/lastz/lastz-80-80/probe.matches.sqlite --taxon-list-config ./4.re_run_taxa_remove/4.get-match-counts/combined_135t.config --taxon-group samples --output ./4.re_run_taxa_remove/4.get-match-counts/80-80_incomplete.conf --incomplete-matrix &

#75-70

phyluce_assembly_get_match_counts --locus-db ./3.combined_run_PRINCIPLE_BAITS/3.match-contigs-to-probes/lastz/lastz-75-70/probe.matches.sqlite --taxon-list-config ./4.re_run_taxa_remove/4.get-match-counts/combined_135t.config --taxon-group samples --output ./4.re_run_taxa_remove/4.get-match-counts/75-70_incomplete.conf --incomplete-matrix &

#Get fasta match counts.

#80-80

phyluce_assembly_get_fastas_from_match_counts --contigs ./3.combined_run_PRINCIPLE_BAITS/spades/contigs_2/ --locus-db ./3.combined_run_PRINCIPLE_BAITS/3.match-contigs-to-probes/lastz/lastz-80-80/probe.matches.sqlite --match-count-output ./4.re_run_taxa_remove/4.get-match-counts/80-80_incomplete.conf --incomplete-matrix ./4.re_run_taxa_remove/5.get-fasta-match-counts/80-80_incomplete-matrix.out --output ./4.re_run_taxa_remove/5.get-fasta-match-counts/80-80_output.fasta &

#75-70

phyluce_assembly_get_fastas_from_match_counts --contigs ./3.combined_run_PRINCIPLE_BAITS/spades/contigs_2/ --locus-db ./3.combined_run_PRINCIPLE_BAITS/3.match-contigs-to-probes/lastz/lastz-75-70/probe.matches.sqlite --match-count-output ./4.re_run_taxa_remove/4.get-match-counts/75-70_incomplete.conf --incomplete-matrix ./4.re_run_taxa_remove/5.get-fasta-match-counts/75-70_incomplete-matrix.out --output ./4.re_run_taxa_remove/5.get-fasta-match-counts/75-70_output.fasta &

#Aligning the dataset

#80-80

phyluce_align_seqcap_align --fasta ./4.re_run_taxa_remove/5.get-fasta-match-counts/80-80_output.fasta --output ./4.re_run_taxa_remove/6.aligning-the-dataset/80-80_align-fasta --taxa 135 --aligner mafft --output-format fasta --no-trim --incomplete-matrix --min-length 20 --cores 20 &

#75-70

phyluce_align_seqcap_align --fasta ./4.re_run_taxa_remove/5.get-fasta-match-counts/75-70_output.fasta --output ./4.re_run_taxa_remove/6.aligning-the-dataset/75-70_align-fasta --taxa 135 --aligner mafft --output-format fasta --no-trim --incomplete-matrix --min-length 20 --cores 20 &

#Trimming the alignment

#80-80

phyluce_align_get_gblocks_trimmed_alignments_from_untrimmed --alignments ./4.re_run_taxa_remove/6.aligning-the-dataset/80-80_align-fasta --output ./4.re_run_taxa_remove/7.trim-alignment/80-80_align-nexus-gblocks/ --input-format fasta --output-format nexus --b1 0.5 --b2 0.5 --b3 12 --b4 7 --cores 20 &

#75-70

phyluce_align_get_gblocks_trimmed_alignments_from_untrimmed --alignments ./4.re_run_taxa_remove/6.aligning-the-dataset/75-70_align-fasta --output ./4.re_run_taxa_remove/7.trim-alignment/75-70_align-nexus-gblocks/ --input-format fasta --output-format nexus --b1 0.5 --b2 0.5 --b3 12 --b4 7 --cores 20 &

#Removing locus name from alignment

#80-80

phyluce_align_remove_locus_name_from_nexus_lines --alignments *./4.re_run_taxa_remove/7.trim-alignment/80-80_align-nexus-gblocks/ --output ./4.re_run_taxa_remove/8.remove-locus-names/80-80_align-nexus-gblocks-names --cores 20 &*

#75-70

phyluce_align_remove_locus_name_from_nexus_lines --alignments ./4.re_run_taxa_remove/7.trim-alignment/75-70_align-nexus-gblocks/ --output ./4.re_run_taxa_remove/8.remove-locus-names/75-70_align-nexus-gblocks-names --cores 20 &

#Filter alignments for missing data

#80-80

phyluce_align_get_only_loci_with_min_taxa --alignments ./4.re_run_taxa_remove/8.remove-locus-names/80-80_align-nexus-gblocks-names/ --taxa 135 --output ./4.re_run_taxa_remove/9.filter-alignments-missing-data/80-80_80/ --percent 0.80 --cores 20

#75-70

phyluce_align_get_only_loci_with_min_taxa --alignments ./4.re_run_taxa_remove/8.remove-locus-names/75-70_align-nexus-gblocks-names/ --taxa 135 --output ./4.re_run_taxa_remove/9.filter-alignments-missing-data/75-70_80/ --percent 0.80 --cores 20

#Create final supermatrix

#80-80_80%

phyluce_align_format_nexus_files_for_raxml --alignments ./4.re_run_taxa_remove/9.filter-alignments-missing-data/80-80_80/ --output ./4.re_run_taxa_remove/10.create-matrix/80-80/80-80-146t-f80-phy –charsets

#75-70_80%

phyluce_align_format_nexus_files_for_raxml --alignments ./4.re_run_taxa_remove/9.filter-alignments-missing-data/75-70_80/ --output ./4.re_run_taxa_remove/10.create-matrix/75-70/75-70-149t-f80-phy --charsets

CHAPTER VII: GENERAL CONCLUSIONS

The underestimation of biodiversity and lack of interpretation for evolutionary relationships is common for understudied invertebrate groups (e.g. Trigonalidae (Vilhelmsen 2003; Weinstein & Austin 1991). A lack of taxonomic resources further compounds these problems by impeding correct identification, making incorporation of species into wider fields of research difficult (Thomson *et al.* 2018). *Gasteruption* is one such genus where knowledge of the biodiversity and systematics is still poor. This is surprising considering their distinct morphology, widespread distribution, and ecological importance as predator-inquilines in the nest of aculeate Hymenoptera. The aim of this research was to address the gaps in the systematics and host associations of the Australian *Gasteruption* by concatenating information of the host associations in the genus, reviewing the Australian fauna, and exploring the evolutionary relationships of the genus using molecular techniques.

The biology of the genus is relatively well documented in regions where the majority of historic *Gasteruption* research has been conducted (e.g. Palaearctic realm (Bogusch *et al.* 2018; van Achterberg & Talebi 2014)), but these records are often conflicting, with isolated observations leading to uncertainties of host use and biology. In chapter II, I summarise all available information on the biology and host association of *Gasteruption*, providing insights into the specialisation and patterns of host utilisation of the genus. My results highlighted the paucity of accurate host observations but provides a much-needed review of host associations in the genus, extending on the earlier work of Jennings and Austin (2004). *Gasteruption* larvae are predator-inquilines in the nest of the bee families Apidae, Colletidae, Halictidae and Megachilidae, Records from the families Crabronidae**,** Vespidae and Sphecidae are still uncertain (Bogusch *et al.* 2018; van Achterberg & Talebi 2014; van Breugel 2014). I discovered *Gasteruption* use bee hosts much more than wasp hosts (71 bee species, 13 wasp species) and nesting biology associated with cavity nests (e.g. stems and borer holes) are much more common than ground burrows (76 cavity nesting species, 8 ground nesting species). In total, host records for 40 described *Gasteruption* species out of the known 418 species world-wide are known, equivalent to only 9.4% of total species diversity. To put this into perspective, for the Australian fauna, hosts are known for only seven described species out of the known 102 described species, representing only 6.8%. These figures are very low when the environmental and economic importance of their main host group, bees, are considered. More research into understanding the complex relationships between gasteruptiid wasps and their hosts will assist in our understanding of the diversification and evolution of the group.

A trend emerged while exploring host association that a major limitation for accurate records is the ability to correctly identify either *Gasteruption* or their hosts. Without correct identifications or the availability of voucher specimens, host records can often only be associated at the genus level. In general terms, the huge diversity of the Australian insect fauna, combined with the inability to identify taxa correctly, represents a significant hurdle for future research (Hutchings 2019). In chapter III, I reviewed the Australian fauna, describing three new species, redescribing 90 species, synonymising two species and moving ten species into *incertae sedis*. The resulting total number of valid species for Australia is now 104. Unsuprisingly, the three new species are described from northern Australia (*G. species 3,* **sp. nov.**) and central Australia (*G. species 1* **sp. nov.** and *G. species 2* **sp. nov.**), the regions Jean J Pasteels (1957) highlighted as relatively unknown. Collecting efforts are much less intense in remote parts of Australia, so I anticipate more undescribed species from these regions as material becomes available. Although missing type specimens and several species known only from males has caused impediments in our understanding of the Australian fauna, our revision provides a significant step forward for *Gasteruption* taxonomy providing the necessary tools and framework for future work on the group.

While DNA barcoding has been extensively used in other hymenopteran groups (e.g., Fagan-Jeffries *et al*. 2018; Zhang *et al*. 2017), there is only a single study on *Gasteruption* that has used it for species delimitation (Saure *et al*. 2017). Given the difficulties matching numerous species to type material in chapter III, I explored the used of molecular identification methods to assist in species delimitations of *Gasteruption* used in Chapter IV. Using a DNA barcode dataset of 187 sequences from a combination of all publicly available sequences and newly sequenced material, six molecular species delimitation methods were tested. I found tree-based methods were most effective at delineating species within Gasteruptiidae when compared to distance-based methods, which consistently underrepresented species. Although our results found *C0I* suitable for identifying species boundaries, the reliance on a single gene fragment may lead to unreliable results in some instances (Dupuis *et al*. 2012). Future barcoding work would benefit from the inclusion of additional gene fragments to increase the reliability of species delimitations. Although our data represents a conservative sample of the overall Australian fauna (39/104 species), this contribution will greatly assist further species discovery within Australia as more morphospecies are sequenced and described.

Single loci trees are effective at informing species boundaries among closely related species but have limited reliability for deeper phylogenetic relationships. A major focus of the research was to explore the evolutionary relationships within the family using molecular phylogenetics. Using three gene fragments (*C01*, *EF1-α* and *28s*) in chapter V, I produced the first multilocus phylogeny for the family with a focus on *Gasteruption*. By calibrating the phylogeny with three secondary calibration points I recovered the crown age for Gasteruptiidae during the Paleocene (83.78–40.02 mya), and the *Gasteruption* during the early Eocene (64.7–31.75 mya). When compared to known host genera crown ages, these divergence dates suggest that Gasteruptiidae diverged during the same time periods as their known bee and wasp hosts. Furthermore, the biogeography of the family was examined, and the results suggest the likely ancestral radiation point for the family as Australasia, with two independent transitions out of this region into the Palaearctic and Neotropical realms. Interestingly, Jennings and Austin (2002) concluded that the sister subfamily Hyptiogastrinae also originated in Australia. Although the phylogeny had high level of support for the monophyly of the subfamilies and for apical nodes, there were large parts of the trees backbone that were poorly supported.

To improve resolution across the phylogeny, in chapter VI I explored target capture of ultraconserved elements (Blaimer *et al*. 2015) and increased taxon sampling across both biogeographic regions and within the Gasteruptiidae. This produced a phylogeny with increased support across the tree using ~1,238 UCE loci. The recovered topology remained similar to the previous multilocus tree but there were uncertainties with the placement of the smaller South American Gasteruptiinae genera, *Spinolafoenus* and *Plutofoenus.* The extremely short branch lengths present at the base of the *Gasteruption* clade may suggest *Gasteruption* experienced a large rapid radiation event early after its genesis, but a better resolved and calibrated tree is necessary to further address the questions about when this rapid radiation occurred. This tree provides the most robust phylogeny available to date for the Gasteruptiidae and provides a useful basis for future exploration of evolutionary relationships within *Gasteruption*.

This research provides the first major contribution to the Australian *Gasteruption* in over 60 years, with an up to date review of biology and host associations, an initial revision of the

Australian fauna, and the exploration of evolutionary relationships.

Future research directions:

The main limitation on examining host associations in the genus is the ability to correctly identify both the wasps and hosts. The identification key (chapter III) and molecular delimitation techniques (chapter IV) have greatly enhanced the ability to correctly identify species, but an increased effort is needed to record accurate and detailed observations. A large number of host records are collected by researchers working specifically on bees, in these cases the observations and voucher specimens can be valuable to document often unknown relationships between parasitoids and hosts. By qualitatively increasing the reliability of observations with detailed information and voucher material, we will be able to further explore important host-parasitoid relationships.

The Australian *Gasteruption* fauna is still the most diverse of the biogeographic regions with 104 described species, although this number will increase with the description of specimens in various museum collections and with additional collecting effort in disproportionately collected regions like the Northern Territory, arid locations in central Australia, and the Pilbara in Western Australia. The distribution of *Gasteruption* is almost cosmopolitan, with the morphological uniformity of the genus (Crosskey 1962; Jennings and Austin 2002; Saure *et al.* 2017) it would be ideal to compare fauna across this distribution to explore if fauna is shared across regions. A world catalogue of Gasteruptiidae is under construction (D.R. Smith pers. comm. May 2016), but large regions are in need of updated revisions and expanded keys (e.g. New Zealand (Pasteels 1957), Melanesia (Pasteels 1956), South-eastern Asia (Pasteels 1958a) and sub Saharan Africa (Pasteels 1958b; 1962). Regions where the fauna is either unknown or poorly known are Micronesia, Polynesia, Southern Asia, and Northern Africa. In addition to further genus level work, the Gasteruptiinae should be examined in context of the variation in the world fauna. There is some doubt of the validity of the three smaller genera restricted to the Neotropical region (Macedo 2009), with a preliminary examination of material suggesting that some of the synapomorphies used to define these genera are also present across the genus *Gasteruption*. Therefore, more material needs to be examined to assess these genera.

Largely due to the increase in taxon sampling and molecular information, our understanding of evolutionary relationships with the Gasteruptiidae have improved from our multilocus phylogeny to our phylogenomic phylogeny. However, poor support in the final trees may be due to conflicting signal from missing data and/or incongruence between loci (Hosner *et al*. 2016). Therefore, further analyses of the current data to determine which loci are producing conflicting topologies, and the identification and isolation of informative loci will improve support. Further research into the relationships within the Gasteruptiidae should be priorities for future taxon sampling. To date, Hyptiogastrinae and the smaller Gasteruptiinae genera tend to be critically under sampled in phylogenetic studies (Deans *et al*. 2006; Klopfstein *et al*. 2013). Additionally, exploration of superfamily relationships is much needed, as other studies have had very sparse taxon sampling and have recovered conflicting results (Peters *et al*. 2017; Tang *et al*. 2018).

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APPENDICES

APPENDIX I. FIRST RECORD OF GASTERUPTION LATREILLE (HYMENOPTERA: EVANIOIDEA: GASTERUPTIIDAE) FROM FIJI WITH THE DESCRIPTION OF A NEW SPECIES

BEN A. PARSLOW[1], MARK I. STEVENS[2, 3], MICHAEL P. SCHWARZ[1]

[1] *Biological Sciences, College of Science and Engineering, Flinders University, Adelaide, SA 5001, Australia. Corresponding author: ben.parslow3@gmail.com*

[2] *South Australian Museum, North Terrace, GPO Box 234, Adelaide, SA 5000, Australia*

[3] *School of Pharmacy and Medical Sciences, University of South Australia, Adelaide, SA 5001, Australia*

Abstract:

A new *Gasteruption* (Gasteruptiidae: Gasteruptiinae) species, *G. tomanivi*, is described from Viti Levu, Fiji. The new species is the first record of the genus for Fiji and can be distinguished from other Oceanian *Gasteruption* species by the length of the mesosoma and the large malar space compared with the length of the pedicel. DNA Barcode (mtDNA – COI) sequence is provided.

Keywords: Evanioidea, Gasteruptiinae, taxonomy, Viti Levu, Mt Tomanivi, *Gasteruption tomanivi*, DNA barcode

Running Head: New species and first record of *Gasteruption* from Fiji.

Introduction

The Gasteruptiidae is a distinctive family of wasps comprising two monophyletic subfamilies, Hyptiogastrinae with two genera (*Hyptiogaster* 11 spp.) and *Pseudofoenus* 78 spp. (Jennings & Austin 2000, 2002, 2005; Parslow & Jennings 2018), and Gasteruptiinae with four genera (Macedo 2009). *Gasteruption* Latreille is the largest genus and is found in nearly all zoogeographical regions and contains circa 500 described species (Aguiar *et al.* 2013, Jennings & Parslow 2014, Tan *et al.* 2016). Three smaller genera are recorded exclusively from the Neotropical region and are uncommonly encountered; *Plutofoenus* Kieffer (three species in southern South America), *Spinolafoenus* Macedo (one species in Chile), and *Trilobitofoenus* Macedo (three species in Central and South America) (Macedo 2009).

Gasteruptiidae is represented across the Oceanian region (Holt *et al.* 2012) by three species of *Pseudofoenus,* restricted to New Caledonia, Vanuatu, and Fiji (Jennings & Austin 2002, 2005) and 28 species of *Gasteruption* (Pasteels 1956). Adding to this fauna, three new species of *Gasteruption* were described recently from New Caledonia (Jennings *et al.* 2015). None of the previous research has encountered *Gasteruption* in the Fijian archipelago with revisions of Fijian Hymenoptera by Turner (1919), Brues (1922) and Fullaway (1956) recording only three species of Evaniidae and a single species of *Pseudofoenus*, *P. extraneus* (Turner) (Jennings & Austin 2002, Evenhuis 2007).

Here we present the first record of the genus *Gasteruption* from Fiji, describe and illustrate the new species and provide a molecular barcode.

Methods and terminology

A single specimen was collected close to the summit of Mount Tomanivi, Viti Levu, at an elevation of 1268 m asl; Mount Tomanivi is the highest mountain in the Fijian archipelago with a peak elevation of 1324 m asl. Images were taken using a Visionary Digital BK+ imaging system with Canon EOS 7D camera (Waite Insect and Nematode Collection, The University of Adelaide - WINC). Images were produced using Zerene Stacker, Zerene Systems LLC, software and cropped and resized in Photoshop CS5.

Terminology for adult body morphology follows Jennings & Parslow (2014) and the Hymenoptera Anatomy Consortium (2018) with measurements following (Macedo 2009).

The term ‘glabrous’ is used to indicate a lack of setae. Wing venation follows the modified Comstock-Needham system after Sharkey (1988), but with some modifications and using the nomenclature of van Achterberg (1979) for cells (see Jennings & Austin 2002). Terminology for surface sculpturing follows Harris (1979).

A 615 base-pair (bp) fragment of the mitochondrial (mt) DNA cytochrome *c* oxidase I (COI) gene (DNA barcode) was sequenced following methodology detailed in Dew *et al.* (2018) from the holotype specimen and the resulting sequence has been deposited in GenBank. The type specimen is deposited in the South Australian Museum, Adelaide (SAMA).

Systematics of Gasteruptiidae from Fiji

Family Gasteruptiidae Ashmead, 1900

Subfamily Gasteruptiinae Ashmead, 1900

Gasteruptioninae Ashmead, 1900: 7–8.

Gasteruptiinae Schulz, 1906: 133 [emendation].

Gasteruption Latreille, 1796.

See Crosskey (1962) for taxonomic history and list of synonyms, and Macedo (2009) for recent taxonomic changes.

***Gasteruption tomanivi* Parslow, Stevens & Schwarz sp. nov.**

(Figs 1–2)

Type material.

Holotype ♀, Fiji, Viti Levu, Mount Tomanivi (Mt. Victoria), 1268 m asl, -17.614683, 178.017783, C. S. Matthews, General sweep before ridge leading to mountain summit. **SAMA Database No. 32-035928**.

Specimen damage: Right apical flagellomere missing. Left mid leg femur, tibia and tarsus in gelatine capsule below specimen (removed for DNA extraction).

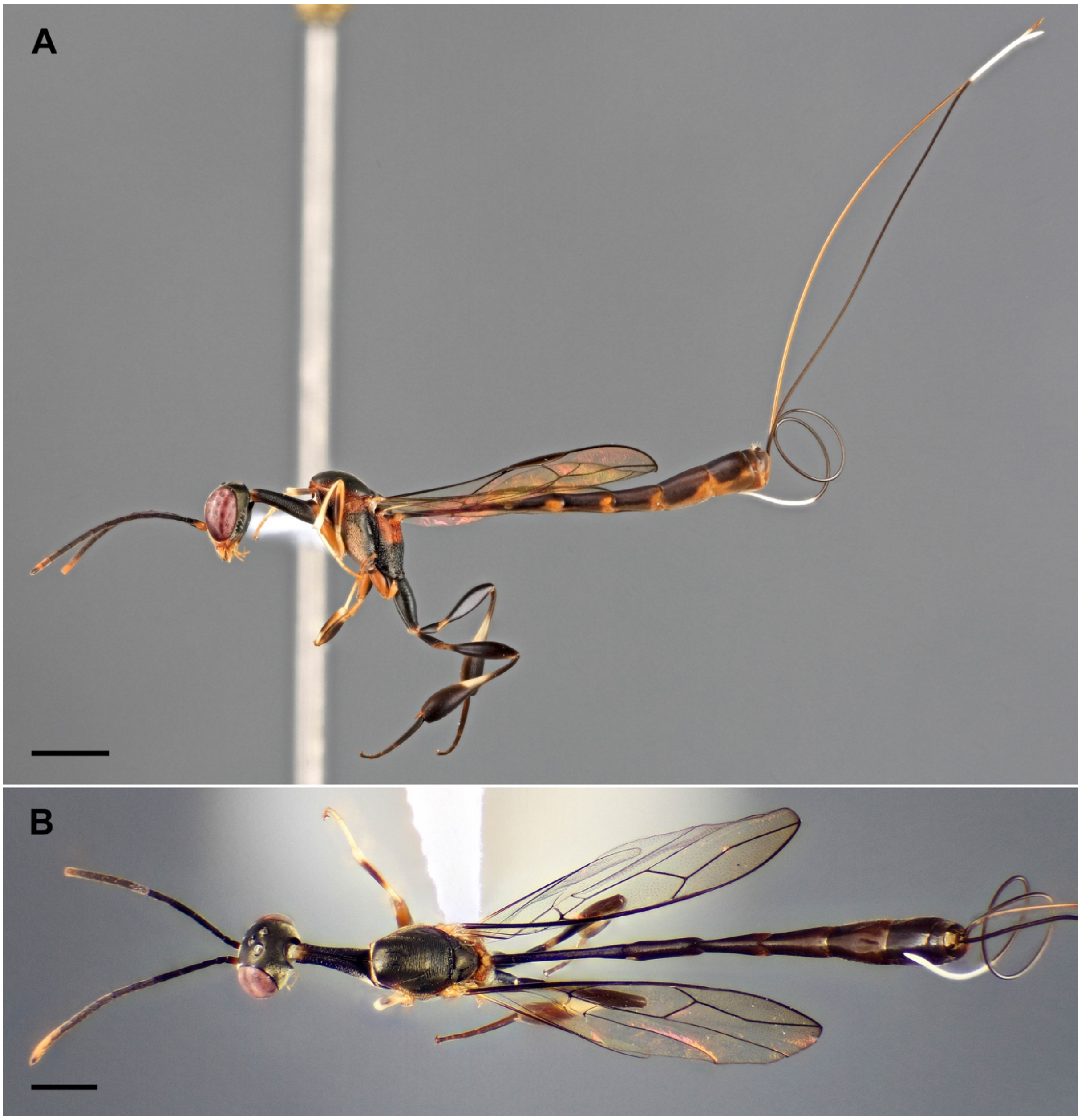

Figure 1. *Gasteruption tomanivi* sp. nov. holotype ♀. A lateral habitus. B dorsal habitus. Scale bars = 1.0 mm.

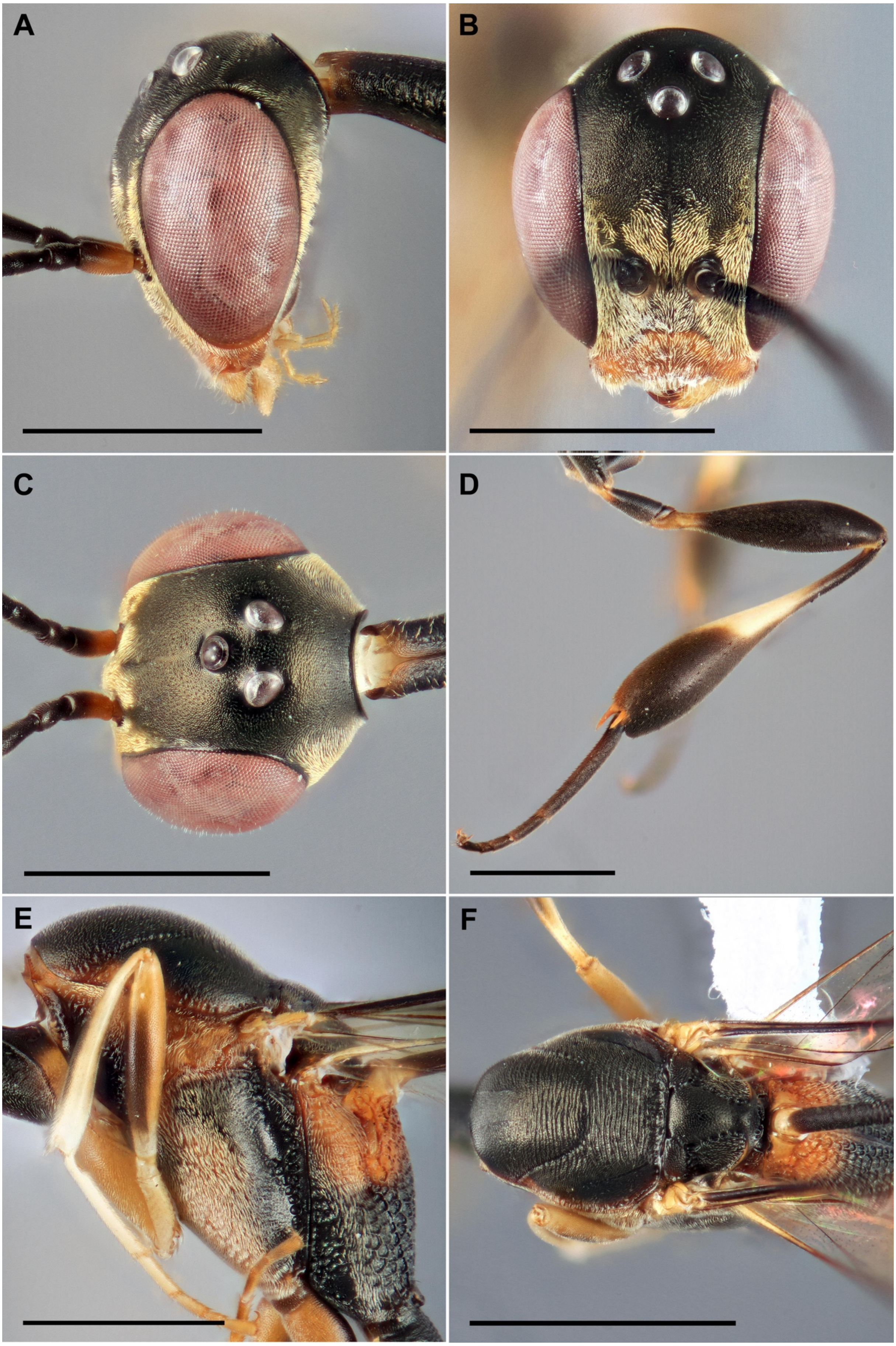

Figure 2. *Gasteruption tomanivi* sp. nov. holotype ♀. A, lateral head. B, frontal head. C, dorsal head. D, lateral hind leg. E, lateral mesosoma. F, dorsal mesosoma. Scale bars = 1.0 mm.

Description.

FEMALE*. Body length*. 10.2 mm, excluding ovipositor.

Colour. Antenna black, basal half of scape, flagellomeres 10, 11 and base of 12 light brown. Head black, clypeus, malar space, maxilla and mandibles light brown, with mandible tooth apex darker (Fig. 2A–C). Setae on clypeus, frons and gena gold. Propleuron black, light brown at proximal and distal ends. Mesosoma black with dorsal part of pronotum, ventro-lateral face of mesepisternum, dorsal third of mesopleuron, lateral margin and patch on anterior corner of lateral lobes of mesoscutum, tegula and dorsal third of propodeum light brown (Fig. 2E–F). Fore leg light brown except femur with dark brown patch on inside face, tibia dark brown, basitarsus and tarsomere two cream. Mid leg light brown except coxa darker posteriorly, femur dark brown, lighter anterior face, tibia cream with dark brown patch on inside face, basitarsus cream. Hind leg dark brown except coxa black with light brown apex, prefemur light brown, tibia with cream patch sub apically on anterior face, apical spines light brown (Fig. 2D). Metasoma dark brown, metasomal insertion on first tergite and patches ventro-posterior of each tergite light brown. Ovipositor sheaths dark brown, cream apex 0.16 × length. Ovipositor light brown (Fig. 1A). Wings hyaline with slight brown tinge. Wing veins and pterostigma dark brown.

Head. Trapezoid in dorsal view, 0.9 × longer than wide, (Fig. 2C). Face reticulate-rugulose, with short dense setae. Frons reticulate-rugulose with scattered punctures posteriorly, imbricate around ocelli, setae short. Medial frontal carina indistinct, slightly raised in anterior third (Fig. 2C). Vertex reticulate-rugulose, with scattered punctures, short setae. Occipital carina lamelliform, (Fig. 2C). Gena reticulate, short dense setae. Minimal width of malar space 0.03 × height of eye; 0.5 × length of pedicel (Fig. 2A). Clypeus reticulate; 2.2 × wide as high, margin sinuate with lateral corners distinctly protruding forwards (Fig. 2B), setae short, longer along margin. Lateral ocelli elliptical in shape, positioned anterior of postocular line, distance from lateral ocellus to eye margin 1.1 × distance between lateral ocelli (Fig. 2C). Scape 1.47 × length pedicel. First flagellomere 0.9 × as long as scape; 0.62 × length second flagellomere.

Mesosoma. Propleuron 1.4 × pronotum length (distance between anterior margin of pronotum and tegula), reticulate-rugulose, transverse strigate laterally, short dense setae. Pronotum reticulate, anterior lobe imbricate with a few scattered punctures, groove between pronotal lobes carinate, pronotal process present, short dense setae. Mesepisternum areolate, becoming reticulate dorso-posteriorly, short dense setae. Mesepimeron areolate medially, dorsal third and anterior margin imbricate, glabrous. Metapleuron areolate, dorsal third rugose, short setae (Fig. 2E–F). Propodeum areolate, flattened medial carina with imbricate sculpturing, short setae. Mesoscutum rounded in lateral view, medial lobe punctate becoming strigose in posterior half; lateral lobe punctate, strigose medially between parapsidal lines, short setae. Admedial lines present, parapsidial lines indistinct. Notauli incomplete, carinate (Fig. 2F). Mesoscutellum and axilla punctate-rugulose, with short scattered setae. Mesosoma length 2.0 × height (Fig. 2F).

Legs. Hind coxa reticulate, except strigate dorsally and dorso-laterally, short setae; trochanter and prefemur reticulate, short setae; femur and tibia imbricate, short setae; femur 0.7 × length of tibia; tibia dense short setae with scattered robust spines on anterior face; tibia length 4.7 × width; tarsomeres with ventral pecten of short spines; basitarsus 2.9 × length of tarsomere 2; tarsomere 2 1.6 × length of tarsomere 3; tarsomere 3 2.0 × length of tarsomere 4; tarsomere 4 0.45 × length of tarsomere 5; tarsal claw 0.54 × length of tarsomere 5 (Fig. 2D).

Wings. Fore wing: first discal cell absent, sub discal cell formed by fore wing vein 1-Rs+M forming a node at 1-Rs, M+Cu and 1-Cu, veinr-m absent, vein 2-M tubular in basal third. Hind wing: vein 1–1A spectral; three equidistant hamuli.

Metasoma. 2.9 × mesosoma length. First metasomal tergite coriaceous basally becoming imbricate dorsally, remaining tergites imbricate; scattered setae becoming denser posteriorly. Hypopygium Y-shaped when viewed ventrally. Ovipositor 9.1 mm, sheath with short dense setae.

Male. Unknown.

Host/associations. Unknown.

Etymology. Gasteruption tomanivi is known only from the type locality Mount Tomanivi on the main island of Fiji, Viti Levu. This area is of great biodiversity significance as it is the highest mountain in Fiji (1324 m) containing a significant proportion of montane forest with high endemism and concentrations of endemic taxa (Olson *et al.* 2010).

Comments.

Gasteruption tomanivi sp. nov. is clearly placed in *Gasteruption* based on several characters highlighted by Jennings & Austin (2002): short mandibles not overlapping when closed, prefemur present on hind leg, exserted ovipositor (female), and subdiscal cell formed by fore wing vein 1-Rs+M joining M+Cu.

The closest described *Gasteruption* fauna geographically are three species from New Caledonia. *Gasteruption tomanivi* is clearly different from these three species, for example, the propleuron which is much longer than the New Caledonian species (1.4 × pronotum length in *G. tomanivi*, compared with 0.88 × in *G. lacoulee* Jennings, Krogmann & Parslow, 2015, 0.80 × in *G. maquis* Jennings, Krogmann & Parslow, 2015, and 1.64 × in *G. sarramea* Jennings, Krogmann & Parslow, 2015). Variation in colour also clearly separates the species, for example, mesosoma is black and light brown in *G. tomanivi* compared to mainly black in *G. lacoulee* and *G. maquis*, and hind tarsus entirely dark brown in *G. tomanivi* compared to cream in the three New Caledonian species.

In Pasteel's (1956) key to Melanesian species, *G. tomanivi* fails at the second key couplet based on mesosoma length (short, clearly less than twice as long as it is high) and malar space (very short, only equivalent to 1/4 of the length of pedicel). *Gasteruption tomanivi* has a mesosoma length 2.0 × height and the malar space 0.5 × length of the pedicel. The closest species according to Pasteel's key is *G. acutum* (Pasteels) from the Indonesian island of Misool and from New Guinea, which differ on several characters: mesosoma black and light brown in *G. tomanivi* compared with completely black with blueish metallic reflections in *G. acutum*; hind basitarsus dark brown in *G. tomanivi* compared with mainly cream with black base in *G. acutum*; malar space 0.5 × length of pedicel in *G. tomanivi*, 0.25 × length of pedicel for *G. acutum*; short setae over the postocular space in *G. tomanivi*, without setae on postocular space in *G. acutum*; length of mesosoma 2.0 × its height in *G. tomanivi* compared with less than 2.0 × longer than high in *G. acutum*; propleuron 1.4 × pronotal distance in *G. tomanivi* compared with subequal in *G. acutum.*

Acknowledgements

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APPENDIX II. A NEW SPECIES OF THE ENDEMIC AUSTRALIAN GENUS *HYPTIOGASTER* KIEFFER (HYMENOPTERA: GASTERUPTIIDAE)

BEN A. PARSLOW[1] & JOHN T. JENNINGS[2]

[1] *Biological Sciences, College of Science and Engineering, Flinders University, Adelaide SA 5001. Corresponding author: ben.parslow3@gmail.com*

[2] *Centre for Evolutionary Biology and Biodiversity, and School of Biological Sciences, The University of Adelaide, SA 5005, Australia. john.jennings@adelaide.edu.au*

Abstract

Hyptiogaster arafura **sp. nov.** is described from Arafura Swamp, Northern Territory, Australia, as the eleventh species of *Hyptiogaster* Kieffer (Hymenoptera: Gasteruptiidae). A revised diagnosis of *Hyptiogaster* is given based on the new species.

Keywords: Evanioidea, Hyptiogastrinae, new species, taxonomy, Northern Territory, Arafura Swamp.

Introduction

The Hyptiogastrinae (Evanioidea: Gasteruptiidae) have a restricted Gondwanan distribution (Jennings & Austin 2002). The subfamily consists of two genera, *Hyptiogaster* Kieffer with ten species restricted to mainland Australia (Jennings & Austin 1994a, 1997), and *Pseudofoenus* with 77 species—Australia (65 spp.), New Guinea and New Britain (5 spp.), south-west Pacific (3 spp.), New Zealand (2 spp.), and South America (2 spp.) (Jennings &

Austin 2002, 2005).

As a group, the Hyptiogastrinae are characterised by having long overlapping mandibles, trochantellus absent, and they usually have the fore wing vein 1-Rs+M intersecting the basal cell about half way between M+Cu and Sc+R+Rs, except for two species of *Pseudofoenus* from New Zealand in which veins 1-Rs+M and 1-Cu(b) are fused to form Rs+M+Cu(b) (Jennings & Austin 2002). *Hyptiogaster* is readily distinguished from *Pseudofoenus* by its exserted ovipositor.

Hyptiogaster was erected without description by Kieffer (1903), with *Gasteruption crassiceps* Schletterer 1895 designated as the type species and included 11 species. Crosskey (1962) revised the genus but recognised just five species. More recently Jennings & Austin (1997) revised the group, including ten species, seven of which were described as new, and two synonymies.

As with all hyptiogastrine wasps, little is known of the biology of *Hyptiogaster*. They are apparently parasitic or predator-inquilines in the nests of pollen wasps (Vespoidea: Masaridae) (Naumann & Cardale 1987; Houston 1995). The structure of the labio-maxillary complex, particularly the "sieve"-like arrangement of the distal glossae (see Jennings & Austin 1994a), indicates that adult *Hyptiogaster* are probably nectar feeders, although they probably also feed on pollen.

Here, we add a new species of *Hyptiogaster* from Arafura Swamp, Northern Territory.

Material and methods

Specimen images were taken using a Visionary Digital BK+ imaging system with Canon EOS 7D camera. Images were produced using Zerene Stacker, Zerene Systems LLC, software and cropped and resized in Photoshop CS5.

Terminology for morphology follows Jennings & Austin (1994a, 2002), and that for wing venation follows the modified Comstock-Needham system after Sharkey (1988), but with some modifications and using the nomenclature of van Achterberg (1979) for cells (see Jennings & Austin 1994a, 1994b, 2002). Terminology for surface sculpturing follows Harris (1979).

Specimens are deposited in the *Museum and Art Gallery of the Northern Territory*

(MAGNT).

Results

***Hyptiogaster* Kieffer**

Hyptiogaster Kieffer, 1903: 93. Type species: *Gasteruption crassiceps* Schletterer, 1889, by original designation (junior synonym of *Foenus rufus* Westwood) [not *Gasteruption antennale* Schletterer, 1889, by erroneous subsequent designation of Bradley, 1908 or *Foenus australis* Westwood, 1835, by erroneous designation of Crosskey, 1953]; Bradley, 1908: 108; Kieffer, 1912: 194; Hedicke, 1939: 47; Crosskey, 1962: 393; Jennings & Austin, 1997: 1534; Jennings & Austin, 2002: 744.

Odontofoenus (in part) Kieffer, 1910: 77; synonymy by Crosskey, 1962: 393.

Carinafoenus Crosskey, 1953: 104; synonymy by Crosskey, 1962: 393.

Diagnosis

The following diagnosis of Jennings & Austin (2002) has been modified to accommodate the new species.

Medium to large, length 12–20 mm; malar space very short, length of malar space plus mandible less than eye height; epistomal suture indistinct medially, absent laterally so clypeus continuous with gena; clypeus wider than high, margin either sinuate or with truncate medial lobe; mandibles usually with 2 but sometimes 1 or 3 medial teeth; frontal carina usually distinct; first flagellomere about same length as second; pronotum with or without antero-dorsal and antero-lateral processes; propleuron with ventro-lateral carina usually present; mesoscutum slightly longer than broad, with or without medial lines; notauli percurrent, mostly scrobiculate, sometimes indistinct and hidden by coarse sculpture; propodeum separated from metapleuron by carinate furrow; inner surface of mid tibia without subapical notch; hind trochanter usually with distinct trochanteral groove (absent from *H. arafura*); hind tarsomeres 1–4 with ventro-apical pecten of short spines; fore wing with 2 discal cells, first discal cell formed by vein 1-Rs+M intersecting basal cell; hind wing with 4–8 hamuli, 1-Cu and 1-M absent, r-m present; metasoma 2.0 length of mesosoma; ovipositor elongate, at least 0.25× length of metasoma, apex slightly curved upwards; lateral margins of ventral ovipositor valves smooth.

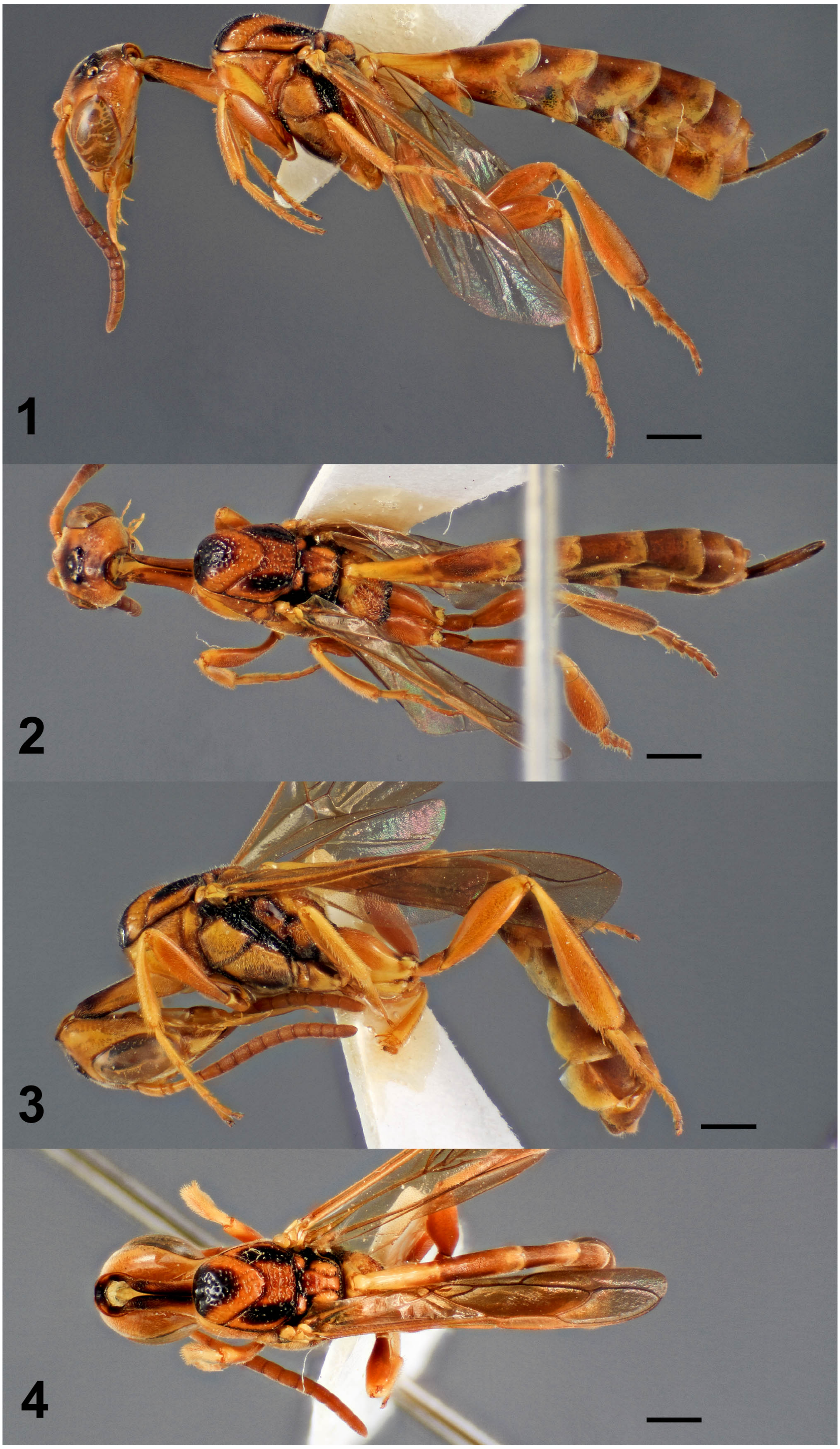
Hyptiogaster arafura *Parslow & Jennings sp. nov.*

(Figs 1–13)

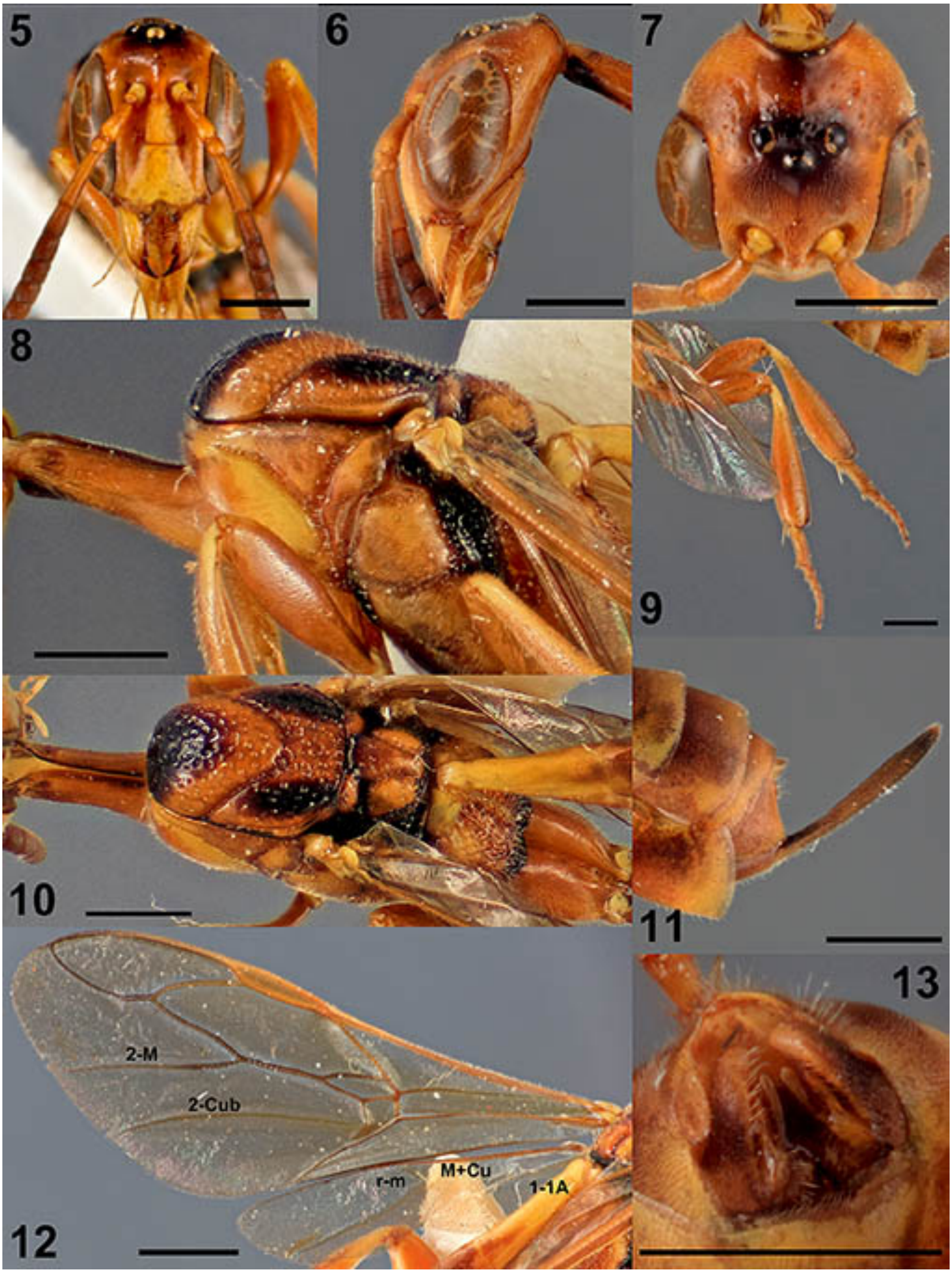
Type material. Holotype f#, NT Arafura Swamp, 12.16S, 134.59E, 9 June 1996, G.R. Brown (MAGNT; NTM I005020), Paratype m#, NT Arafura Swamp, 12.16S, 134.59E, 9 June 1996, G.R. Brown (MAGNT; NTM I005021)

Description. FEMALE*. Length*. 14.3 mm, excluding ovipositor.

Colour. Head pale brown, clypeus and face yellowish except for dark brown patch around ocelli and medially anterior of occipital carina. Mouthparts yellowish, except apex of mandible and basal tooth dark brown. Antennal scape, pedicel and first flagellomere pale brown, remainder brown. Propleuron pale brown except darker dorsally and dark brown ventro-apically. Pronotum pale brown except anterior lobe yellowish and furrow pale brown. Mesepisternum yellowish except dark brown ventrally. Mesepimeron black. Metapleuron pale brown. Propodeum brown, lighter dorsally, dark brown at coxal insertion. Mesoscutal medial lobe brown, dark brown patch antero-medially; notaulus dark brown; lateral lobes brown with dark brown patch around admedial lines. Mesoscutellum pale brown, lighter posteriorly. Fore and mid legs pale brown, anterior face of tibiae and basitarsi lighter brown. Hind leg pale brown, ventral face of coxa and base of tibia lighter brown, distal apex of basitarsus and claw darker brown. Wings hyaline with veins and pterostigma pale brown. Metasoma pale brown except T1 and apical margin of tergites and sternites yellowish. Ovipositor sheath dark brown.



Figures 1–4. *Hyptiogaster arafura* sp. nov. 1, lateral habitus, holotype f#. 2, dorsal habitus, holotype f#. 3, lateral habitus, paratype m#. 4, dorsal habitus, paratype m#. Scale bars = 1.0 mm



Figures 5–13. *Hyptiogaster arafura* sp. nov. 5, frontal head, holotype f#. 6, lateral head, holotype f#. 7, dorsal head, holotype f#. 8, lateral mesosoma and propleuron, holotype f#. 9, hind legs, holotype f#. 10, dorsal mesosoma and propleuron, holotype f#. 11, lateral metasoma apex and ovipositor, holotype f#. 12, left wing, paratype m#. 13, ventral view genitalia, paratype m#. Scale bars = 1.0 mm

Head. Face with a few scattered punctures and short pubescence; antennal scrobes vertical, shallow. Frons largely smooth, with short pubescence, weak frontal carina and medial groove (Fig. 5). Vertex smooth except with scattered punctures laterally and near ocelli, with pubescence denser and longer laterally. Occipital carina broad and smooth. Distance from lateral ocellus to eye about 0.4× distance from lateral ocellus to occipital carina (Fig. 7). Gena with scattered punctures, and short, dense pubescence. Malar space 0.08× eye height, 0.26× as long as scape (Fig. 6). Clypeus about 1.3× as wide as high, with scattered punctures and indistinct broad medial groove, and with short, dense pubescence; clypeal margin sinuate, with long setae on margin (Fig. 5). Scape 2.4× as long as pedicel; first flagellomere 1.3× as long as scape, 1.8× as long as second flagellomere (Fig. 5); flagellomeres 3–11 short, almost quadrate; apical flagellomere 1.6× as long as wide. Mandible long, narrow, with single broad medial tooth and acute basal tooth (Fig. 5).

Mesosoma. Propleuron finely punctate, pubescent, without propleural ventro-lateral carina. Pronotum smooth with V-shaped carinate furrow, pronotal processes absent (Fig. 8). Medial and lateral lobes of mesoscutum punctate, almost glabrous, with short setae associated with punctures (Fig. 10). Admedial lines groove-like, slightly curved, wider anteriorly. Notaulus crenulate. Parapsidal line distinct. Scutellum and axilla punctate, almost glabrous, with short setae associated with punctures. Metanotum narrow, smooth. Mesepisternum with dorsal part smooth with a few scattered punctures, separated from ventral part by carinate groove, ventrally with scattered punctures, and with pubescence denser on ventral lobe. Mesepimeron broad, deep, carinate (Fig. 8). Metapleuron obscured by wings. Propodeum rugose except carinate on posterior margin, and with short median longitudinal carina, and long, scattered setae. Propodeal spiracle elongate, not fringed with long setae. Hind coxa finely punctate, pubescent, smooth, glabrous in coxal depression. Hind trochanter finely punctate, trochanteral groove absent. Hind femur 3.3× as long as wide, 0.7× length of hind tibia, finely punctate, with short pubescence. Hind tibia punctate-imbricate, pubescence dense, ventro-apical pecten of short robust spines present. Hind tarsomere one 2.7× length of tarsomere two, tarsomere two 1.2× length of tarsomere three and 1.3× length of tarsomere four, tarsomere four 0.5× length of tarsomere five (Fig. 9). Hind tarsal claw about 0.7× length of hind tarsomere five (Fig. 9).

Wings. Hind wing with 4 equidistant hamuli. Fore wing vein 2-M tubular in basal third, pigmented in remaining two-thirds, vein 2-Cub pigmented (Fig. 12). Hind wing, M+Cu, r-m and M pigmented, 1-1A spectral.

Metasoma. Metasoma 2.0× length of mesosoma. First tergum smooth except for a few shallow punctures laterally, remaining tergites imbricate with a few scattered punctures, pubescent. Ovipositor 0.23× length of metasoma.

MALE. *Length*. 14.0 mm. Similar to female except more extensively dark brown from ocelli to occipital carina, and apically and dorso-medially on propleuron. Digitus 0.6× length of basiparamere; basiparameres imbricate, with a few long setae in inner margin (Fig. 13).

Host/associations*.* Unknown.

Etymology*. Hyptiogaster arafura* is known only from the type locality Arafura Swamp in the Northern Territory, Australia. This area is of great cultural significance to the Yolngu people.

Comments. *Hyptiogaster arafura* is clearly placed in *Hyptiogaster* based on several characters, particularly the fore wing venation (two discal cells, first discal cell formed by vein 1-Rs+M intersecting basal cell) and exserted ovipositor (not present in *Pseudofoenus*—see Jennings & Austin 2002), although it lacks the groove on the hind trochanter that is present in all other described *Hyptiogaster*. The new species also differs from other *Hyptiogaster* in having an elongate propleuron (Figs 8, 10) similar to that found in many *Gasteruption* species (see, for example, Crosskey 1951, fig. 10).

This new species also differs from other *Hyptiogaster* in its distinct yellow-brown colouration. *Hyptiogaster arafura* keys out to *H. weowaniensis* Jennings & Austin in the key of Jennings and Austin (1997), but differs in body colouration (red-brown in *H. weowaniensis*), dark brown ovipositor sheath (apical one-third cream coloured in *H. weowaniensis*), a shorter metasoma (2.0× length mesosoma compared to 2.5× in *H. weowaniensis*), and the face punctate (finely rugulose with a few scattered punctures in *H. weowaniensis*).

Hyptiogaster arafura. is known only from the type locality, Arafura Swamp, Northern Territory. Most *Hyptiogaster* species have been described from southern Australia, particularly south-west Western Australia, but this new species occurs much further north than the published distribution for other species (see Jennings & Austin 1997).

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APPENDIX III. REPRODUCTIVE ETHOLOGY OF THE FIJIAN PREDATORINQUILINE WASP *PSEUDOFOENUS EXTRANEUS* (HYMENOPTERA: GASTERUPTIIDAE: HYPTIOGASTRINAE)

Alice C. Grieve[a]*, Bridgette L. Barnden[a]*, Ruby M. Howell[a]*, Aurelie M. Kanishka[a]*, Mark I. Stevens[bc], Michael P. Schwarz[a] & Ben A. Parslow[a]

[a] *Biological Sciences, College of Science and Engineering, Flinders University, GPO Box 2100, Adelaide SA 5001;* [b] *South Australian Museum, North Terrace, GPO Box 234, Adelaide, SA 5000, Australia;* [c] *University of South Australia, GPO Box 2471, Adelaide, SA 5001, Australia*

Corresponding author: ben.parslow3@gmail.com
Social media handle: @ParslowBen

* Equal first authors

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We declare no conflicts of interest and no financial interest or benefit that has arisen from this research.

Abstract

Parasitoid wasps of the subfamily Hyptiogastrinae (Gasteruptiidae) are known to lay eggs in the nests of solitary bees and wasps. Their larvae are considered predator-inquilines, consuming the host's eggs and larvae and then the nest provisions. *Pseudofoenus extraneus* is endemic to Fiji, and the only member of the subfamily Hyptiogastrinae known to have colonised the archipelago. The host relationships and oviposition sequence of this species have not been previously reported. We show the primary host is the halictine bee *Homalictus fijiensis* and describe *P. extraneus* behaviour around *Homalictus* nest aggregations and the entering of host nests. Wasps were observed entering *Homalictus* nests on nine occasions, as well as perching near nests and antennating nest entrances. The high abundance of *H. fijiensis* in Fiji may help to explain how a parasitoid was able to successfully invade such a remote oceanic archipelago as Fiji.

Keywords: Oviposition; *Homalictus fijiensis*; predator-inquiline; Fiji.

Introduction & background

The wasp subfamily Hyptiogastrinae (Gasteruptiidae) has a restricted Gondwanan distribution (Jennings and Austin 2002; Crosskey 1962), containing two genera; *Hyptiogaster* with 11 species (Jennings and Austin 1997; Parslow and Jennings 2018) which is restricted to Australia, and *Pseudofoenus* containing 65 described species that occur in Australia and 14 occurring elsewhere (New Guinea, New Zealand, south-west Pacific, South America) (Jennings and Austin 2002, 2005). There are three *Pseudofoenus* species recorded in the south-west Pacific, *P. ritae* from New Caledonia and Vanuatu, *P. caledonicus* from New Caledonia, and *P. extraneus* from Fiji (Jennings and Austin 2002, 2005; Evenhuis 2007). Until recently the genus *Pseudofoenus* was the only representative of Gasteruptiidae in Fiji (Pasteels 1956; Evenhuis 2007; Jennings *et al.* 2015), with a single species of *Gasteruption* now known (Parslow *et al*. 2018). All records suggest *Pseudofoenus* as parasitoids in the nests of ground nesting bees where their larvae are assumed to be predator-inquilines of the host eggs, larvae and nest provisions. There are limited host records for three bee families (Colletidae, Halictidae, and Stenotritidae) in Australia and New Zealand (see Table 1), with no host records from other regions.

The halictine genus *Homalictus* is the only endemic bee recorded from Fiji, and is common throughout south-east Asia, the Australo-Papuan region and also in the south-west Pacific, including New Caledonia, Vanuatu and Samoa (Michener 1979, 2000; Groom *et al*. 2014). *Homalictus* is highly abundant in Fiji and ranges from sea level to > 1,300 m asl (Groom *et al.* 2013). There are four described *Homalictus* species in Fiji, though other undescribed species from the genus are known to occur, and all form a monophyletic clade that has resulted from a single long-distance dispersal event in the mid-Pleistocene (Groom *et al.* 2013, 2014; Dorey 2017).

Here we report a host bee species for *P. extraneus* and describe the behaviour of this wasp in areas containing bee nesting aggregations.

Methods

Study sites

This study was carried out on Viti Levu, the largest island of Fiji. Four observation sites were used, namely the University of the South Pacific (USP), Suva (-18.150°, 178.447°), roadside banks along the Serea-Laselevu Road (-17.811°, 178.194°), Monasavu Road (-17.738°, 178.066°), and roadside banks in the highlands near Nadarivatu (-17.583°, 177.936°).

Pseudofoenus extraneus is highly abundant across Viti Levu with the authors encountering active adults feeding at flowers and at suitable host nesting sites across the Suva, Monasavu dam, Navai, Nandaruvatu, Nadrau, Koroyanitu National Heritage Park and Pacific Harbour regions. Prior to our research the only published information on *P. extraneus* distribution has been from the holotype locality of Curvu (south-western side of Viti Levu) (Turner 1919; Jennings and Austin 2002).

Pseudofoenus extraneus was readily located by searching around *Homalictus* nest aggregations. This was done along roadsides and known areas of *Homalictus* distribution for exposed soil/clay banks where both bees and wasps could be seen flying. An example of a *Homalictus* nest entrance is shown in Figure 1B.

Observation methods

Following a pilot study of observations carried out on Serea-Laselevu Road, operational definitions of behaviours and an ethogram were developed (see Table 2). The ethogram was developed following methods from Dinesh & Venkatesha (2013), and previously described hyptiogastrine behaviours were sourced from the literature (Houston 1969; 1984a; 1984b; 1995; Jennings & Austin 2004) to inform the operational definitions.

Figure 1. A, Students observing nesting aggregation in drainage bank along Serea-Laselevu Road, Viti Levu (image taken by B. A. Parslow 2017). B, *Homalictus fijiensis* nest opening, marked with a red circle (image taken at University of the South Pacific Upper Campus, Suva, Fiji by A. Grieve 2017). C, *Pseudofoenus extraneus* wasp ♀ (image taken at University of the South Pacific Upper Campus, Suva, Fiji by Nikki Francis 2017).

Once a bee nesting aggregation site had been identified, focal sampling was carried out on one wasp at a time, and a total of 45 observations were made. This included 38 observations on the USP campus, five observations were made near Nadarivatu, and one observation was made along Monasavu Road. Observations were carried out between 16 to 20 of April 2017, during sunny weather between 9am and 3pm. Each site was visited at least twice during the sampling period.

All behaviours observed were recorded during the focal sampling period, which lasted between 20 seconds to 15 minutes and which was usually curtailed when the observer lost sight of the wasp. Observations were taken by five observers and were documented using voice recordings before being transcribed into ethograms. Observation ethogram data were collated; each occurrence of designated behaviours was scored against the ethogram, and each occurrence was marked with both time and duration of behaviour. The duration of behaviours was used to calculate a mean number of seconds (± standard deviation) female wasps spent inside nests. We assumed that wasps entered bee nests in order to oviposit and we recorded this entry behaviour as “nest-invasion”.

Results

Homalictus nest aggregations were found in areas of bare soil, such as that caused by human activity or landslides. In lowland areas, *Homalictus* nest aggregations were located in friable soil, while in highland areas nesting sites were more often found in sloped banks of red clay.

A total of 45 focal observations were carried out, in which nine nest-invasion events were observed. When observing wasp behaviour, we could often discriminate between male and female wasps on the basis of morphology, which allowed us to identify behavioural differences between sexes. Males were smaller and had darker metasomal colouration than females, shown in Figure 1C. Males were often observed to aggregate on vegetation adjacent to nest zones (within approximately 5 m), while females were usually observed much closer to bee nests (as close as approximately 5 mm and as far as approximately 2 m).

The sequence of behaviours witnessed surrounding nest-invasion events were generally similar among observations (see Table 2). These events were initiated with a female wasp exhibiting a zig-zag flight (side-to-side flight behaviours in a slight semi-circle) within close proximity to nest openings (within approximately 5–50 mm), before antennating a nest entrance either while in flight or by perching at the nest opening, then entering the nest head-first, remaining inside the nest for a highly variable amount of time (3–220 seconds), often exiting head-first (66% occurrence rate), and finally either flying to a perch nearby to preen metasoma and antennae, or flying out of sight. The mean (± standard deviation) amount of time female wasps spent in host nests was calculated to be 71.11 ± 77.56 seconds. Head-first nest entry and exit was not seen uniformly, as in one event a wasp was seen entering a nest head-first, exiting tail-first, then turning around and entering the same nest tail-first and later exiting head-first.

Discussion

This study provides the first reports of *Pseudofoenus* host association in the south-west Pacific region. Furthermore, this is the first report of any *Pseudofoenus* host from the bee subfamily Halictinae. This is surprising given that Halictinae is one of the largest bee subfamilies in the world, with over 2,400 described species and has also been intensively studied because of its range in forms of social organization. This study is also the first to describe the behaviours surrounding likely oviposition events by any hyptiogastrine species in the south-west Pacific region, as all other published observations have been restricted to Australia and New Zealand (Houston, 1969, 1984a, 1984b, 1995; Jennings & Austin, 2002, 2004).

Our findings are unusual because *Pseudofoenus* was very common around nesting aggregations of *H. fijiensis*, and yet no *Pseudofoenus* have been recorded from halictine species in the Australasian region, despite extensive studies on their nesting biology.

These studies include numerous halictine species whose nests have been excavated and examined over many decades; for example, studies by Rayment (1935, 1953), Michener (1960), Knerer and Schwarz (1977), Kukuk (2002), and Kukuk *et al.* (1998). Of other reported wasp parasites of halictines, neither mutillids nor the ichneumonid genus *Labium* (Rayment 1935; 1939), are recorded in Fiji (Evenhuis 2007). It is possible that *Pseudofoenus* is a poor competitor to these other wasp parasites, but has escaped competition in Fiji due to the strong filter of long range dispersal required to colonize remote islands. This could be especially important for escaping competition with mutillid wasps, where mutillid females are flightless and airborne dispersal depends on being carried by males during copulation. This mode of dispersal may be very difficult over very long-range distances, but anthropogenic dispersal for Hymenoptera has been shown to be possible (e.g. Groom *et al*. 2015, 2017).

Homalictus arrived in Fiji via a single dispersal event during the middle to late Pleistocene, after which they exploded both in terms of population size and species diversity (Groom *et al.* 2013, 2014; Dorey *et al.* 2017). We do not know when *Pseudofoenus* dispersed into Fiji, but this could be examined using DNA sequence data from *P. extraneus* combined with species from the Australo-Papuan fauna. Being obligate parasitoids, their successful dispersal into new regions would depend on the pre-existence of suitable hosts. It is possible that the abundance of *Homalictus* in Fiji enabled successful dispersal, and that long-distance dispersal has allowed them to escape competition from other bee parasites. The combination of rare dispersal events as ecological filters, along with host-parasite dependencies, creates an opportunity to understand island biogeography processes for species with highly dependent niches.

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Table 1. Reported hosts for *Pseudofoenus* species, all of which are ground nesting bees.

Host family	Host subfamily	Host species	Parasitoid species	Geographical region	Reference
Halictidae	Nomiinae	*Nomia australica*	*P. asymmetricus*	Australia	Jennings and Austin 2002
Halictidae	Nomiinae	*Nomia australica*	*P. thoracicus*	Australia	Jennings and Austin 1997b
Halictidae	Nomiinae	*Nomia australica*	*P. cardaleae*	Australia: WA	Jennings and Austin 2002
Stenotritidae	n/a	*Ctenocolletes ordensis*	*P. cardaleae*	Australia: WA	Houston 1984
Stenotritidae	n/a	Unknown species	*P. houstoni*	Australia	Houston 1984
Stenotritidae	n/a	*Stenotritus* sp.	*P. macronyx*	Australia	Jennings and Austin 2002
Colletidae	Euryglossinae	*Euryglossula chalcosoma*	*Pseudofoenus* sp.	Australia: QLD	Houston 1969
Colletidae	Euryglossinae	*Euryglossa* sp.	*P. crosskeyi*	Australia: WA	Jennings and Austin 2002
Colletidae	Colletinae	*Cladocerapsis persoonaiae*	*P. inaequalis*	Australia	Parrott 1953
Colletidae	Colletinae	*Neopasiphae* sp.	*P. nalbarraensis*	Australia	Jennings and Austin 2002
Colletidae	Colletinae	*Leioproctus nigrofulvus*	*P. thoracicus*	Australia	Jennings and Austin 1997b
Colletidae	Colletinae	*Leioproctus metallicus*	*P. pedunculatus*	New Zealand	Gourlay 1930, Valentine

					and Walker 1991
Colletidae	Colletinae	*leioproctus metallicus*	*P. nocticolor*	New Zealand	Valentine and Walker 1991
Colletidae	Colletinae	*Leioproctus monticola*	*P. unguiculatus*	New Zealand	Jennings and Austin 1994
Colletidae	Colletinae	*Paracolletes* spp.	*P. crassipes*	New Zealand	Jennings and Austin 1994
Colletidae	Colletinae	*Paracolletes* spp.	*P. unguicularis*	New Zealand	Jennings and Austin 1994

Table 2: Ethogram of *Pseudofoenus extraneus* behaviours in proximity of *Homalictus fijiensis* nesting aggregations.

Behaviour	Description
General (both sexes) Behaviours	
Flight	Any time that the wasp was in flight.
Perch	When the wasp landed from flight or was standing without other movement.
Walk	When the wasp walked or moved across the substrate without taking flight.
Preen (antennae)	When the wasp carried out a wiping motion over the head and antennae using the front legs.
Preen (metasoma & wings)	When the wasp carried out a wiping motion over the metasoma and/or wings using the hind legs.
Interaction (passive)	Any time two or more wasps were within 10 cm of each other without any sudden change in direction, movement or behaviour following the interaction.
Interaction (aggressive)	Any time two or more wasps were within 10 cm of each other with sudden change in direction, movement or behaviour following the interaction.
Female-specific behaviours	
Zig-zag flight	A flight pattern similar to a back-and-forth crescent moon, when females inspect bee aggregations for nests.
Antennate nest	A wasp perching or hovering at the mouth of a nest opening and examining the nest using the antennae, either by touching the nest opening or waving the antennae within 1mm.
Enter nest	When the wasp enters the bee nest with all or part of the body. Direction of movement (head- or tail-first) is recorded.
Exit nest	When the wasp leaves the bee nest. Direction of movement (head- or tail-first) is recorded.