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## **Revision of *Goniocolletes* and seven Australian subgenera of *Leioproctus* (Hymenoptera: Apoidea: Colletidae), and description of new taxa**

GLYNN VIVIAN MAYNARD

*Grains and Forestry Branch, Australian Government Department of Agriculture, Fisheries and Forestry, GPO Box 858 Canberra  
ACT Australia 2601. [Glynn.Maynard@daff.gov.au](mailto:Glynn.Maynard@daff.gov.au)*



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## Abstract

This paper provides a revision of *Goniocolletes* Cockerell, and of Australian subgenera of *Leioproctus* Smith (Hymenoptera: Colletidae: Paracolletini) with three submarginal cells. Seven subgenera were revised: *Leioproctus* s.str., *L. (Ceratocolletes)* Michener, *L. (Cladocerapis)* Cockerell, *L. (Excolletes)* Michener, *L. (Lamprocolletes)* Smith, *L. (Odonocolletes)* Maynard, and *L. (Protomorpha)* Rayment, and seven new subgenera are herein described: *L. (Alokocolletes)* subgen.n., *L. (Charicolletes)* subgen.n., *L. (Exleycolletes)* subgen.n., *L. (Fragocolletes)* subgen.n., *L. (Hadrocolletes)* subgen.n., *L. (Minycolletes)* subgen.n. and *L. (Zosterocolletes)* subgen.n. Seven new species of *Goniocolletes* (*Goinocolletes anthedonus* sp.n.; *Goniocolletes badius* sp.n.; *Goniocolletes ciliatus* sp.n.; *Goniocolletes comatus* sp.n.; *Goniocolletes dasypus* sp.n.; *Goniocolletes parvus* sp.n.; *Goniocolletes rugosus* sp.n.) and 13 new species of *Leioproctus* (*Leioproctus (Minycolletes) aquilus* sp.n.; *Leioproctus (Leioproctus) crinitus* sp.n.; *Leioproctus (Minycolletes) eruditus* sp.n.; *Leioproctus (Minycolletes) exiguus* sp.n.; *Leioproctus (Charicolletes) exleyae* sp.n.; *Leioproctus (Minycolletes) insitus* sp.n.; *Leioproctus (Leioproctus) litotes* sp.n.; *Leioproctus (Minycolletes) paulus* sp.n.; *Leioproctus (Minycolletes) pygmaeus* sp.n.; *Leioproctus (Leioproctus) quadrimaculatus* sp.n.; *Leioproctus (Fragocolletes) rutiliventris* sp.n.; *Leioproctus (Charicolletes) saltus* sp.n., and *Leioproctus (Alokocolletes) sequax* sp.n.) are described. Additionally seven new species-level synonymies are recognized in *Goniocolletes* and 59 new species-level synonymies in *Leioproctus*. Most of the species in *Leioproctus (Leioproctus)* are placed in species groups. One species of *Leioproctus* with three submarginal cells was not assigned to any subgenus and is therefore treated as *incertae sedis* regarding its subgeneric placement: *Leioproctus opaculus* (Cockerell 1929). Additionally some notes on the biology of *Leioproctus* are provided. *Leioproctus* in Australia, as recognised in this paper, has 172 species.

**Key words:** Hymenoptera, Colletidae, Paracolletini, subgenera revise

## Introduction

*Leioproctus* Smith (Hymenoptera: Colletidae) occurs throughout Australia, New Zealand and a few islands of the Pacific as well as South America. *Leioproctus* is one of the largest genera of bees in Australia. As well, it forms the major component of native bee fauna of New Zealand, comprising 18 of the 29 endemic species (Donovan 2007). Species in the subgenus of *Leioproctus* s.str. occur in Australia (69 species), New Zealand (10 species), Misool and New Guinea (two species) (Michener 1965; Cardale, 1993; Almeida 2008). All the other Australian species occur in subgenera that are unique to Australia, with one exception (one species that is recorded from New Caledonia) (Michener 1965).

When the current revision began in 1987 there were 280 nominal species of *Leioproctus* in Australia. Since 1987 more than 30 new Australian species have been described. Both Almeida (2008) and Almeida and Danforth (2009) recognised all of the subgenera of *Leioproctus* from Australia at generic level, based on the phylogenetic results in Almeida and Danforth (2009). Whilst the conclusions of papers of Almeida (2008) and Almeida & Danforth (2009) are interesting, they were based on data from single specimens of 14 species previously all placed in *Leioproctus*. However definition of generic or subgeneric boundaries were not clear with regards to the placement of species nor did these papers consider any specimens from New Zealand where the type species (*Leioproctus imitatus*) occurs. Hence this paper recognises the subgeneric placements of Michener (2007), except for *Goniocolletes* Cockerell, which is recognised here at the genus level. This paper is based on the study of over 6000 specimens including specimens from New Zealand. *Goniocolletes* is raised to genus level as it forms a distinct group of Australian Paracolletini; characters of males, especially those of the legs and metasomal sterna, readily distinguish them from other Paracolletini. Additionally, the majority of species of *Goniocolletes* have the head and mesosoma black and the metasoma orange/red, and at first glance may be confused with honey bees (*Apis mellifera* Linnaeus).

In Australia, *Leioproctus* contains two major groups- those with three submarginal cells (the majority of species) and those with two submarginal cells, although this distinction is somewhat blurred in one species *Leioproctus abnormis* (Cockerell). It should be noted that although *L. abnormis* is a part of the group with three submarginal cells, many specimens of this species have two submarginal cells and some specimens have two submarginal cells in one forewing and three submarginal cells in the other forewing. This revision has only considered species that have three submarginal cells. Here seven new species of *Goniocolletes* are described and 13 new species and seven new subgenera of *Leioproctus* are described. In this revision 59 new species-level synonyms are recognised in *Leioproctus* and seven new species level synonyms in *Goniocolletes*. Hence, as recognised in this

revision, *Leioproctus* in Australia contains 25 subgenera and 172 species. This paper does not cover the subgenera that were revised in previous publications by Maynard (1991, 1992b, 1993, 1994, 1995, 1996, 1997), or the species described by Houston (1989, 1990, 1991), Packer (2006), Almeida (2008), or Houston and Maynard (2012).

In addition to the taxonomic revision, this paper has notes from observations of field behaviour, external morphology and internal anatomy of various *Leioproctus* species.

Information contained in this paper was previously presented in Maynard (1992a). It should be noted that names of some taxa used in this paper differ to those used in Maynard (1992a). The reason for this is that some names assigned to undescribed species in the unpublished thesis by Maynard (1992a) were used as labels for images (not by this author) in a website. Hence, due to the dubious status of the names used as labels in the website, different names have been assigned to those taxa here. The revision presented in this paper was based on all holotypes available at the time and all major collections of *Leioproctus* worldwide (188 holotypes of the 192 nominal Australian species), hence represents the most comprehensive study of this group in Australia undertaken. The revision is based primarily on morphological characters including examination of many male genitalia and hidden sternal characters. I have recognised several species-groups to assist the placement of species within the subgenus *Leioproctus* (*Leioproctus*), however, the distinctions I believe are insufficient to be subgeneric. Indeed it is possible that all of the Australian species should be removed from the subgenus *Leioproctus* as they are reasonably distinct from the New Zealand fauna. There are still many species of *Leioproctus* and *Gonicolletes* in Australia that remain to be described.

## Material Examined

The large collection of *Leioproctus* that was held at the University of Queensland Insect Collection, which has now been incorporated into the Queensland Museum Collection, was used as a basis for study. In addition, material was borrowed from all major collections of Australian native bees throughout the world. Approximately 6000 specimens were examined in this revision.

### *Types*

There were 192 nominal species with three submarginal cells placed by Michener (1965) in *Leioproctus*; the primary types of 188 of these were examined, the only relevant holotypes not examined during the course of this revision were *Andrena alienus* Smith (type not located); *Leioproctus* (*Leioproctus*) *megachaloides* Michener (not revised); *Leioproctus* (*Colletopsis*) *contrarius* Michener (monobasic subgenus not revised), and *Leioproctus* (*Urocolletes*) *rhodurus* Michener (monobasic subgenus not revised). As well, only paratypes of species described by Houston have been seen.

## Terminology

Terminology for descriptive terms generally follows that of Michener (1944, 1965), Gauld and Bolton (1988) and "The Torre-Bueno Glossary of Entomology" (Nichols and Schuh 1989). See Figure 1 for structures of male seventh and eighth sterna and genitalia, and figs 2, 3 for internal structures.

*Sculpture on different areas of the integument is here categorised as:*

**Strong:** punctures with clearly defined margin

**Weak:** shallow and/or the margin ill-defined

**Large:** puncture > 0.2 x width of median ocellus

**Small:** puncture < 0.2 x width of median ocellus

**Coriaceous:** leather-like in texture, with minute cracks like human skin

**Rugose/rugulose:** wrinkled;

**Glabrous:** smooth, hairless

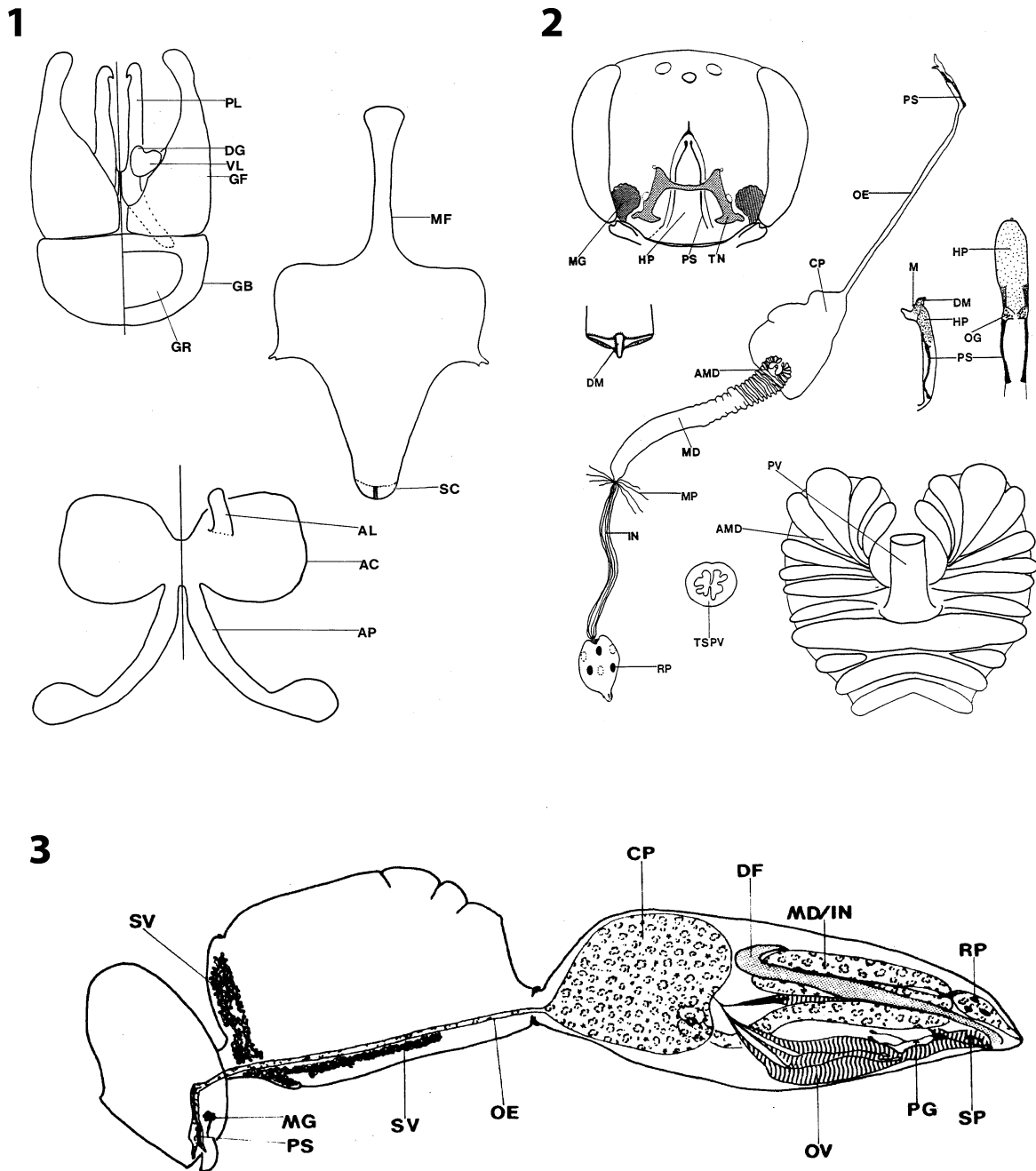
**Granular/granulose:** covered with small granules.

Three categories of vestiture are used:

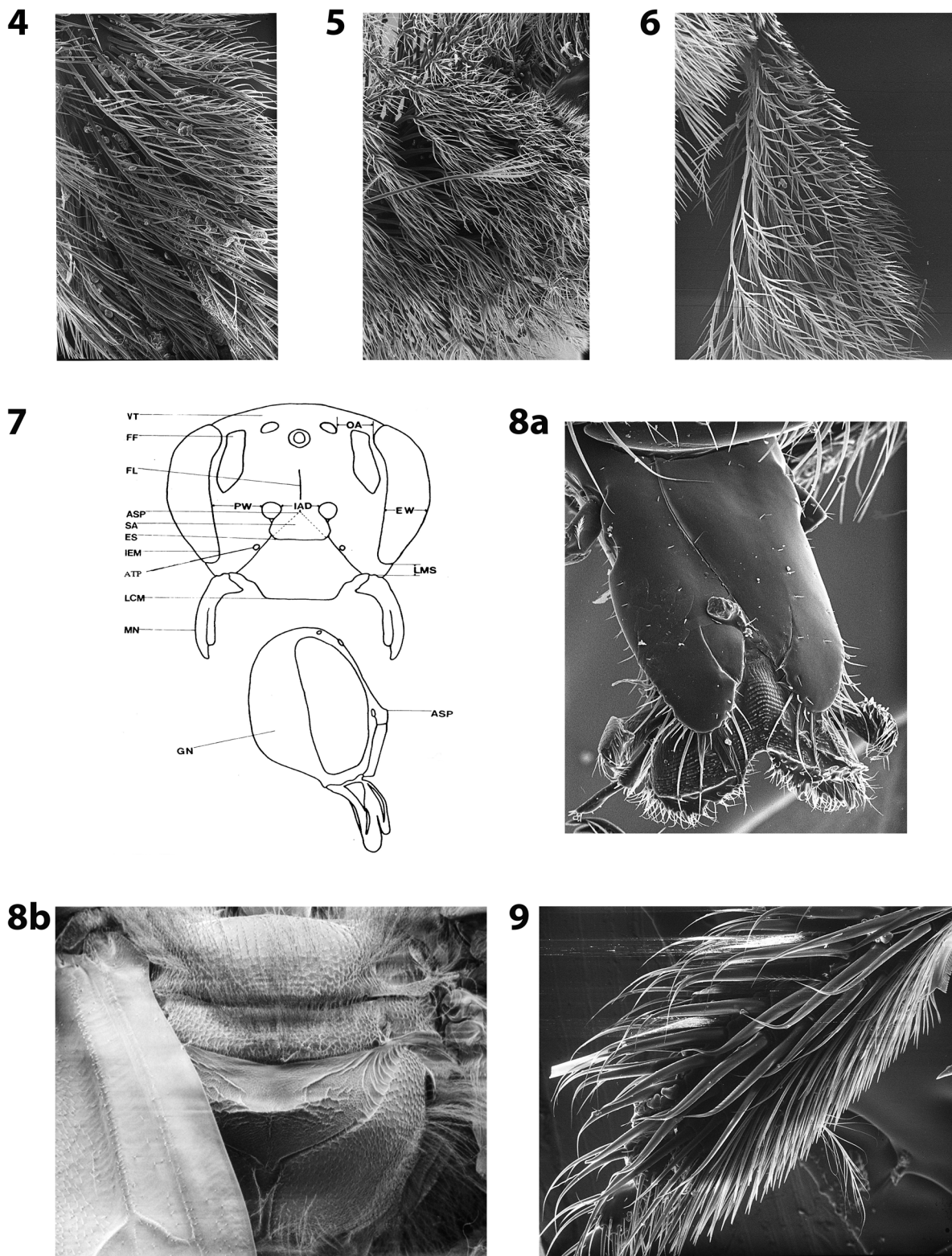
Sparse: a few scattered hairs

Moderately dense: more than a few scattered hairs but the underlying integument is not obscured

Dense: the hair obscures the underlying integument.



**FIGURES 1–3.** *Leioproctus* internal anatomy. Fig. 1 Male genitalia, S7–8. Abbreviations: AC Apical lobe of S7; AL Accessory lobe of S7; AP Apodeme; DG digitus; GB gonobase; GF gonoforceps; GR genital foramen; MF median process of S8; PL Penis Valves; SC spiculum; VL volsella Fig. 2 Head and digestive system of *Leioproctus*. Abbreviations: AMD anterior midgut; CP crop; DM dorsal mouth; HP hypopharyngeal plate; IN intestine; M mouth; MD midgut; MG mandibular gland; MP malpighian tubules; OE oesophagus; OG orifices of hypopharyngeal gland; PS Hypopharyngeal sclerites; PV proventriculus; RP rectal pad; TN tentorium; TSPV transverse section of proventriculus. Fig. 3 Generalised lateral view of whole *Leioproctus* showing female reproductive system and digestive system. Abbreviations: CG dufours gland; CP crop; IN intestine; MD Midgut; MG mandibular gland; OE oesophagus; OV ovaries; PG poison gland; PS pharyngeal sclerite; RP rectal pad; SP spermatheca; SV salivary gland.



**FIGURES 4-9.** *Leioproctus* external features. Fig. 4 SEM of scopal hair of *Leioproctus advena* showing monopodal hair. Fig. 5 SEM of scopal hair of *Gonicolletes* showing plumose hair. Fig. 6 SEM of scopal hair of *Leioproctus (Minycolletes)* showing plumose hair. Fig. 7 Anterior and lateral view of *Leioproctus* head. Abbreviations: ATP Anterior tentorial pit; ASP Apex of supraclypeal area; ES epistomal suture; EW Eye width; FF Facial fovea; FL Frontal line; GN gena; IAD Interantennal distance; IEM Inner orbit (eye margin); LCM Lower margin of clypeus; LMS length of malar space; MN mandible; OA Ocelloccipital area; PW Paraocular width; SA Supraclypeal area; VT Vertex. Fig. 8a SEM of glossa of *Leioproctus tarsalis*. Fig. 8b SEM of propodeal triangle of *Leioproctus amabilis*. Fig. 9 Scanning Electron Micrograph (SEM) of foretibial spines of *Leioproctus (Cladocerapis)*.

*Categories of hairs on the female hind tibial scopa are as follows:*

Monopodal (fig. 4): all branches originate in 1 plane along one side of the hair shaft

Bimodal: branches originate in two planes of the hair shaft

Plumose: branches originate in more than two planes of the hair shaft (figs 5,6)

Palmate: branches originate in more than one plane from almost the same point toward the apex of the hair shaft.

## Methods and materials

**Microscopy**—All examination, drawings and dissections were done with a Wild M3B stereomicroscope with a transmitted light base, 10x & 20x eye pieces and 1x & 2x changeable objective lenses. Incident light was provided by a Volpi Intralux 6000 cold light with a four point ring guide.

**Measurements**—Measurements were made with a calibrated eye piece micrometre in a 10x eyepiece.

**Dissections**—Internal: Dissections for examination of internal anatomy were of freshly killed specimens or specimens preserved in 80% ethanol.

**Males**: Dissections for examination of hidden sterna and genitalia were done from dried, pinned specimens. Specimens were relaxed overnight in a humid chamber, and then the seventh and eighth metasomal sterna and the genitalia were extracted with a hooked micropin. They were then cleared by either (i) placing in a test tube with 10% KOH and gently boiling for approximately ten minutes; (ii) soaking in cold KOH for 12 to 36 hours, or (iii) soaking in Decon 90 for 12 to 36 hours. Following clearing, they were then rinsed with two to three changes of tap water, then soaked in tap water for five to 10 minutes and finally acidified in glacial acetic acid. For study the structures were temporarily mounted in a drop of glycerine on a glass microscope slide, and then permanently mounted in genitalia vials pinned beneath the dried specimen.

**Drawings**—Drawings were made with the aid of a camera lucida on the dissecting microscope. These were then enlarged on a photocopier and drawn in ink on drafting film. All drawings were done with 0.18, 0.25, 0.35 or 0.5 Erograph or Rotring rapidograph with black drawing ink.

**Light Microscope Photographs**—Light Microscope photographs were taken with a MPS 45 Photoautomat and camera attached to a Wild M8 stereomicroscope with a transmitted light base. Incident light was provided by a Schotz KL1500 cold light source with a four point ring guide as well as a Volpi Intralux 4000 cold light source with dual Swan guides.

**Scanning Electron Microscopy (SEM)**—Sputter-coated, air-dried specimens were used for SEM examination and photography. The specimens were attached to 1/2 inch slotted head aluminium SEM stubs with double sided Sellotape or "Tarzans Grip" adhesive. The specimens were then placed in a Naglene vacuum desiccator for at least 24 hours before gold sputter-coating with a Denton evaporative coater. The specimens were examined and photographed with a Philips 505 SEM.

**Species combination authorship**: In listings of synonyms under each species, author of original combination is denoted by an asterix\*.

## Abbreviations

### *Structures*

F1–F11, antennal flagellomeres 1–11.

S1–S8, metasomal sternal segments 1–8.

T1–T7, metasomal tergal segments 1–7.

### *Institutions*

AM: Australian Museum, Sydney, Australia.

AMNH: American Museum of Natural History, New York, USA.

ANIC: Australian National Insect Collection, CSIRO, Canberra, Australia.

BMNH: The Natural History Museum [formerly British Museum (Natural History)], London, UK.

FCT: Forestry Commission of Tasmania, Hobart, Australia.

KU: Snow Entomological Museum, University of Kansas, Lawrence, Kansas, USA.

LAM: Los Angeles County Museum, Los Angeles, USA.  
MV: Museum of Victoria, Melbourne, Australia.  
NCAI: North Coast Agricultural Institute, Wollongbar, New South Wales, Australia.  
NZAC: New Zealand Arthropod Collection, Landcare, Auckland, New Zealand.  
OU: Hope Entomological Collections, Oxford University, Oxford, UK.  
QM: Queensland Museum, Brisbane, Australia.  
SAM: South Australian Museum, Adelaide, Australia.  
UCD: University of California, Davis, USA.  
WADA: Western Australian Department of Agriculture, Perth, Australia.  
WAM: Western Australian Museum, Perth, Australia.  
ZMB: Museum für Naturkunde der Humboldt-Universität zu Berlin, Berlin, Germany.

## Anatomy

### *External morphology*

The genus *Leioproctus* includes small to medium-sized (4–16 mm) robust bees whose males are usually more slender than females. The majority of species are non-metallic, with a brown or black head and mesosoma. Occasionally the head and mesosoma are metallic blue-green and the metasoma black, orange-red or metallic blue, green, golden or reddish.

### *Head*

The generalised morphology of a *Leioproctus* head is shown in fig. 7. A description of the features of the generalised head is given below.

Vertex extended little above or behind the eyes, although there are exceptions. The ocelloccipital area usually flat, but in a few groups such as *L. (Zosterocolletes) subgen.n* it is depressed.

Facial fovea of females present or absent, or indicated by a change in the surface texture. If present their form is characteristic of a group. Few subgenera (e.g. *L. (Odontocolletes)* Maynard) with clearly defined facial foveae that are not impressed and in others (e.g. *L. (Charicolletes) subgen.n*) they are impressed (usually only dorsally). Facial foveae of males, if present, are linear and, unless impressed, very difficult to discern.

Inner orbits almost straight and parallel except where they converge slightly at the upper and lower ends. In a few groups, particularly in the males, (e.g. *L. (Ceratocolletes)* Michener, *L. (Eleganocolletes)* Maynard *subgen.n* and *L. (Exleycolletes)* Maynard *subgen.n.*), inner orbits converge strongly below; orbits rarely diverging at the lower ends.

Frons flat with a carinate frontal line, distinguishable at least at the apex of the supraclypeal area. Supraclypeal area triangular and raised above the frons and antennal sockets, usually sharply at the apex.

Clypeus, usually shallowly convex, may be flat or depressed, rarely strongly protuberant.

Although usually present, malar space normally small, in 3 subgenera: (*L. (Ceratocolletes)*, *L. (Odontocolletes)* and *L. (Minycolletes) subgen.n*), absent. In the *Leioproctus (Leioproctus) macmillani* species-group, malar space at least as long as the basal width of the mandibles, similar to the situation in the endemic New Zealand subgenus *Leioproctus (Nesocolletes)*.

Gena, in lateral view, as wide as or narrower than the eye at the level of the antennal sockets. Males of a few species, e.g. *L. (L.) obscurus* and *L. (Ottocolletes) muelleri* with broad and angulate gena and in males of *L. (Leioproctus) capito* and *L. (Leioproctus) lucanus*, the gena is rounded and considerably broader than the eye.

The closed mandibles usually obscure the labrum. Labrum variable in length and convexity. Its basal area is defined by a carina, and the apical area depressed or evenly rounded. If labrum evenly convex, length less than 0.3 times width except in a few species (e.g. *L. (L.) nasutus*) where the length is 0.5 times the width.

Antennae are usually longer in males than females. In males, if the scape does not reach the median ocellus, each flagellomere usually shorter than or equal to its width, and consequently the antennae shorter than those of females. First flagellomere shorter than wide, except in *L. (Alokocolletes) n. subgen.*; F2 and F3 normally are similar with lengths, being less than or equal to the width. Lengths of F4–F11 in females about equal to the width, in males greater than the width.

Mandibles of both sexes bidentate, with the dorsal tooth small, or occasionally absent. Hair is present in the basal area of the mandibles and along the ventral margin.

Glossal apex truncate and shallowly emarginate, normally with a dense, short apical fringe (fig. 8a); paraglossae small and closely applied to the glossa. Both the labial palps (four-segmented) and maxillary palps (six-segmented) usually extending just beyond the apex of the glossa. Palpomeres well sclerotised and more or less equal in length.

#### *Mesosoma*

Mesosoma laterally densely punctate with coriaceous or granular interspaces; with moderately dense, long hair. Pre-episternal groove broad and ill-defined marginally, extending well below the scrobal groove.

Sculpture of the scutum and scutellum often similar to that of the frons; in females sculpture usually less dense or absent medially on the posterior scutum and anterior scutellum.

Metanotum usually evenly convex and less than half the length of the scutellum; with a medial nodule in some species—*e.g.* *L. (Lamprocolletes)* and *L. (Odontocolletes)*.

In all *Leioproctus* propodeal triangle clearly differentiated from the rest of the propodeum by sulci (fig. 8b), these are usually foveate and extending from the basal margin of the propodeum to the apex. Basal area of the propodeal triangle about as long as the metanotum (except in *L. (L.) irroratus* species-group), clearly defined by a transverse carina in a few groups. Propodeal triangle usually smooth, although the basal area is roughened in some groups—*e.g.* *L. (Protomorpha)* and *L. (Odontocolletes)*.

#### *Legs*

Although structure of the legs is fairly uniform throughout the genus, they are highly modified in some males *e.g.* species of *L. (Protomorpha)*.

Females with the most legs modifications are found in *L. (Cladocerapis)* (fig. 9) [where there are long, thick spines or stiff hairs on the fore basitarsi] and *L. (Filiglossa) filamentosa* (Rayment) [where the fore basitarsi are subspherical and have long, slender spines on the anterior surface].

The malus (the shaft) of the foretibial spur usually extending beyond the velum (membranous lobe on the inner side of the spur) for at least the velar length (fig. 10) and bearing one or more teeth. In a few species, the malus extending little if at all beyond the velum—*e.g.* in *L. (L.) conospermi* Houston.

With few exceptions, basitibial plate on the hind leg (fig. 11) clearly defined and carinate marginally. In females, usually bearing thick and appressed hairs considerably differing from the scopal hairs. Hairs on the basitibial plate of males sparse and fine.

Although the inner hind tibial spur of females varies considerably between groups, teeth always serial (fig. 12), not palmate. Spur sometimes relatively simple—as in *L. (L.) imitatus* Smith—with inner spur similar to the outer hind tibial spur, or as in the majority of Australian species, both spurs pectinate with many long teeth—*e.g.* *L. (Cerato-colletes)*. Shaft sometimes curved with many teeth—as in *L. (Protomorpha)*—or with a few long, thick, widely spaced teeth, as in *L. (Zosterocolletes) advena* Smith.

Tarsal claws of females with inner ramus of moderate size, except in a few species of *Leioproctus* (*Leioproctus*)—*e.g.* *L. maculatus* (Rayment)—in which the inner ramus absent. In males, inner ramus smaller, more slender and diverging little from the main claw.

#### *Wings*

Throughout *Leioproctus* the wing venation is similar, apart for the division into two major groups—those with two submarginal cells (not revised here) and those with three submarginal cells in the forewing. In a few species, *e.g.* *L. (Minycolletes) abnormis*, this character is variable, some specimens having two cells in one wing and three in the other, but the incidence of this is low. Pterostigma always distinct; sometimes small and projecting slightly into the marginal cell, or large and projecting considerably into the marginal cell. Apex of the marginal cell never on wing margin and diverging from the costa to variable extent. Basal vein strongly oblique, except in *L. (Excolletes)*, in which it is almost transverse. In the majority of Australian species, jugal lobe of the hind wing reaching cu-a or surpassing it, this lobe normally broad with a sinuous posterior margin.

### *Metasoma*

Surface sculpture of the metasoma usually weak; few groups, such as *L. (Ceratocolletes)*, with strong, dense punctures.

Pygidial plate of most females weakly convex and smooth with a rounded apex. In some species—e.g. *L. (Protomorpha)*, pygidial plate flat with longitudinal striae, whereas in *L. (Ceratocolletes)* it is narrow and convex. In males pygidial plate generally absent and T7 sparsely haired. In a few groups—e.g. *L. (Odontocolletes)* spp., pygidial area distinct and even carinate laterally, in other groups, e.g. *L. (Fragocolletes)* spp., an ill-defined, hairless, median area present.

The structure of the male genitalia S7 and S8 have proved of considerable importance in grouping species. S7 usually with a pair of apical lobes (Fig. 1). These may be extremely simple, as in *L. (Odontocolletes)*, or very complex, as in *L. (Protomorpha)*. In a few groups, such as *L. (Zosterocolletes)* and *L. (Ceratocolletes)*, four apical lobes present.

S8 (fig. 1) always with a spiculum, median process usually clearly defined. The median process usually with sparse, weakly branched hairs ventrally, although some taxa have thick, long hairs.

Male genitalia (fig. 1) forming a well-sclerotised complex structure. Gonobase normally about 0.25–0.3 x length of the genitalia, with a large genital foramen. Gonoforceps somewhat narrowed apically with at least a few hairs and the dorsal angle absent or strongly developed. Rarely with clearly defined gonocoxae and gonostyles. Penis valves normally reaching the apices of the gonoforceps (=combined gonocoxae and gonostyles), although those of some *L. (Odontocolletes)* extending beyond. Apices of penis valves frequently ventrally angled. Volsellae usually small and rounded with a distinguishable digitus.

### *Vestiture*

*Leioproctus* are generally hairy bees though some, e.g. the *Leioproctus (Leioproctus) irroratus* species-group, are almost hairless, and others e.g. *L. (Lamprocolletes)* are very hairy. Face and gena of males often with more hair, particularly in the lower parts, than the females. In males of several species, the hair on the lower parts of the gena long and plumose.

Dorsal mesosoma of females normally covered with long, moderately dense, much-branched, pale brownish hair. Laterally, pilosity similar but paler. Hairs often shorter in males.

In males, hairs generally sparse and long, with short branches. In a few species, e.g. *L. (Protomorpha) tarsalis* and *L. (P.) palipes*, areas of dense modified hairs noticeable.

Females generally with denser hair on the legs with specialised pollen gathering and manipulating hairs, particularly on the mid and hind legs (figs 4–6). Fore legs in some species (e.g. *L. (Cladocerapis)* spp.) bearing a row of stout hairs on the coxa.

Specialised hair of female hind legs include—long, plumose hairs on the coxae and dense, long hairs with curled branches are curled on the trochanter; anterior femur with long, plumose hair on the dorsal half curling over, ventral area almost bare; posterior part covered in medium length, moderately dense, simple hair; ventral margin of tibia with long plumose hair curving onto the anterior surface, which bears dense long, branched hair—the type of branching varies among groups; posterior surface with a longitudinal band of long, simple hairs with truncate apices (keirotichia fig. 14b). Anterior surface of the hind basitarsus sometimes with simple or plumose hair; posterior surface with dense, stout, simple hairs; the distitarsi usually sparsely haired.

The first tergum of the metasoma bearing long, sparse hair. In males long, sparse, finely branched hairs usually covering the rest of the metasomal terga. Females with short, sparse hairs on T2–T4; with apical hair bands in a few subgenera. At least 60 % of T5 covered by long, dense hair (prepygidial fimbria) usually black in colour, although two species, *L. (Charicolletes) elegans* and *L. (Odontocolletes) callurus*, have bright orange prepygidial fimbriae. S1 with long, branched hairs. There is usually a broad, apical band of simple or branched hairs on S2–5 of females. In males, the sternal hairs are short and simple, in some cases with apical fringes (fig. 13).

### *Internal anatomy*

Although there is considerable literature on the internal structures of the honeybee, little has been published on the internal anatomy of Australian colletids, and very little on the world fauna in general.

The digestive and reproductive systems of both sexes with associated glands of seven species of *Leioproctus* [*L. (L.) imitatus* (Smith); *L. (Ceratocolletes) xanthosus*; *L. (Cladocerapis) incanescens* (Cockerell); *L.*



(*Cladocerapis*) *speculiferus* (Cockerell); *L. (Exleycolletes) tuberculatus* (Cockerell); *L. (Exleycolletes) cristatus* (Smith) and *L. (Charicolletes) elegans* Smith] and a female *Trichocolletes* near *marginatus* (Smith) were examined under 20–100x magnification. A synopsis of these results is presented below.

## Digestive system (fig. 2)

### Head

The mouth is a transverse slit with a triangular dorsal area (fig. 3) and recurved, such that the ventral surface is exposed and forms the epipharynx. It has a ventral longitudinal ridge covered in minute hairs. The entire anterior third of the pharynx is lightly sclerotised. A pair of acinose glands (hypopharyngeal glands) lie on the ventral surface of the pharynx near the hypopharyngeal plate. The slender hypopharyngeal sclerites extend posteriorly beyond the hypopharyngeal plate to the area beneath the apex of the supraclypeal area and support the pharynx laterally. The hypopharyngeal sclerites appear to articulate with the apex of the supraclypeal area. In those species with an external tubercle at the apex of the supraclypeal area the distal ends of the hypopharyngeal sclerites approximate to each other and are appressed internally to the apex of the supraclypeal area. At the base of the hypopharyngeal plate, where the hypopharyngeal glands are situated, there are circular, non-sclerotised areas likely to be the orifices of the glands.

The tentorium is usually heavily sclerotised with a narrow bridge ventral to the epistomal suture. In the two species of *L. (Cladocerapis)* examined, the anterior area of the tentorium and bridge beneath the epistomal suture is broad and lightly sclerotised. The details of the shape of the tentorium varied between the species examined.

Mandibular gland situated at the base of each mandible mesal to the eye (and malar space where present). This gland in *Trichocolletes*, when punctured, emitted a citrus-like smell.

Many of the specimens dissected (both male and female) had pollen granules in the pharynx.

A large trachea extends from the base of the mouthparts to the most anterior of the metasomal air sacs.

### Mesosoma

The oesophagus lies ventrally in the mesosoma, passing above flat sheets of salivary glands. No glands were found posteriorly in the mesosoma around the propodeal region as indicated in *Colletes* and *Hylaeus* by Batra (1980). The major part of the prothorax is occupied by salivary glands above and below the oesophagus.

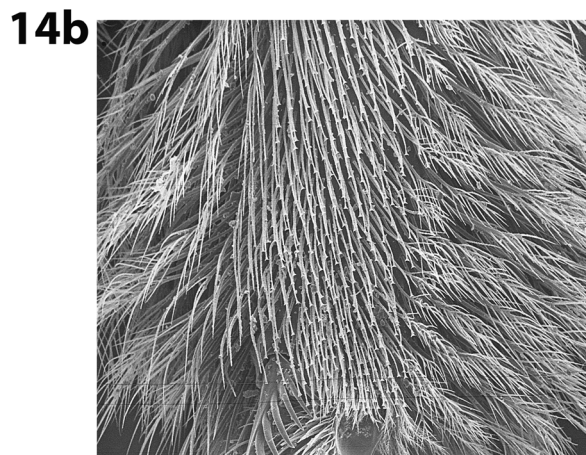
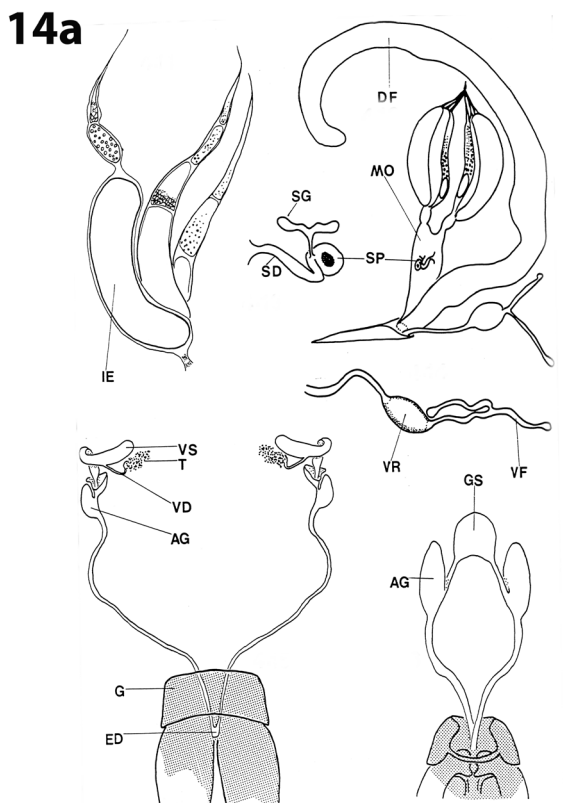
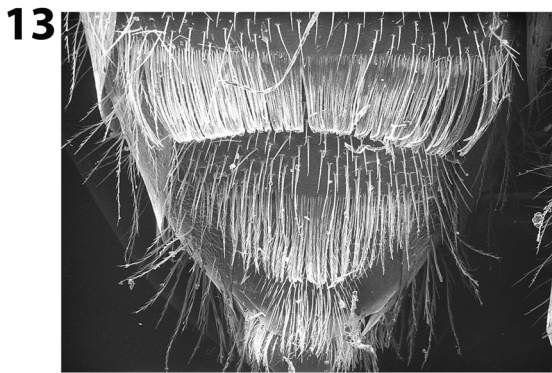
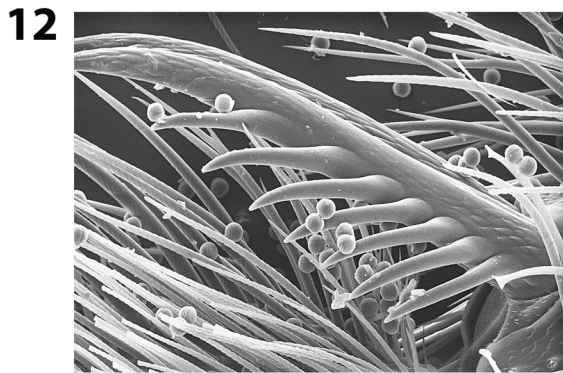
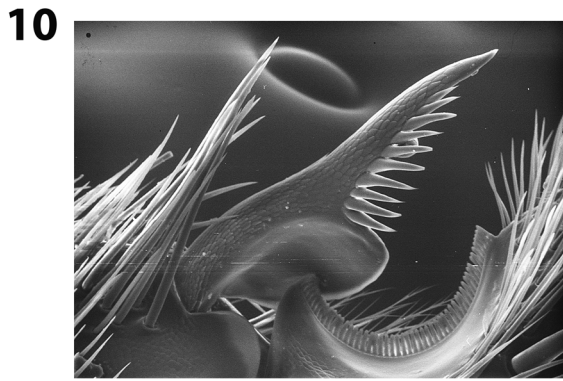
### Metasoma

In all specimens dissected, the crops were engorged and filled with pollen. The crop terminates at the proventriculus and the anterior end of the midgut is lobed. The midgut passing dorsally through the reproductive organs and is coiled with the hindgut dorsal to the gonads. The midgut, hind gut, and the gonads tightly enmeshed in Malpighian tubules. More than 10 pairs of Malpighian tubules in all specimens examined. Rectum with six rectal pads set in two alternate rings.

## Reproductive system (fig. 14a)

### Females

Females with a pair of ovaries, each comprising three ovarioles. One ovariole in each ovary usually containing an almost fully developed egg, another with a less developed oocyte and the oocytes of the third ovariole were little differentiated from oogonia. The nearly mature egg is white and sausage-shaped with no apparent sculpture or operculum. The lateral oviducts very short, joining almost immediately into the median oviduct. Spermatheca situated medially, opening into the median oviduct 0.3–0.6 x along its dorsal surface. Length of the spermathecal duct and the spermathecal glands varying among species. In the *Trichocolletes* examined, spermatheca at the junction of Dufour's gland and the common oviduct. Dufour's gland large, torose, sausage shaped looping around the outside of the coils of the midgut and hindgut. The gland opens into the genital chamber in *Leioproctus*, but in the *Trichocolletes* examined it appears to fuse with the common oviduct before entering the genital chamber. Poison gland small, delicate, and pale brown, consisting of a pair of long, fine distal venom filaments opening into a long, slender duct with a small venom reservoir. The pair of venom filaments were always much entwined with Malpighian tubules.



**FIGURES 10–14.** *Leioproctus* external features and reproductive systems. Fig. 10 SEM of foretibial spur of *Leioproctus*. Fig. 11 SEM of hind basitibial plate of *Leioproctus*. Fig. 12 SEM of Inner Hind Tibial spur of *Leioproctus*. Fig. 13 SEM of Male sternal fringes of *Leioproctus*. Fig. 14a Generalised female (above) and male (below) reproductive systems of *Leioproctus*. Abbreviations: AG Accessory Gland; DF Dufours Gland; ED Ejaculatory Duct; G Genitalia; GS Gonadial sac; IE Immature Egg; MO Median Oviduct; OV Ovary; PG Poison Gland; SD Spermathecal Duct; SG Spermathecal Gland; SP Spermatheca; T Testis; VD Vas Deferens; VF Venom Filament; VR Venom Reservoir; VS Vesicula Seminalis. Fig. 14b SEM of keiotrichia of *Leioproctus*.

### *Males*

A small pair of fused testes, two short vasa deferentia and a contorted pair of vesicula seminales contained in a gonadial sac which lies dorsal to the midgut. A long slender duct commences from each of the posteriolateral corners a short distance along each duct is a moderate-sized accessory gland. Both ducts from the gonadial sac separated when entering the genitalia, and not united to form an ejaculatory duct until in the median area of the penis valves.

### *Biology*

Biological information on Australian *Leioproctus* is scanty and scattered see Michener (1960, 2000), Houston (1983, 1989, 1990, 2000), Houston & Maynard (2012), Rayment (1931a,b, 1935, 1950, 1952, 1954), Maynard & Burwell (1994). A synopsis of the published information on Australian *Leioproctus* is provided here as well original observations on five species are included.

### *Nesting*

The nests of only a very few species of Australian *Leioproctus* have been found Rayment (1931a,b, 1935, 1950, 1952, 1954), Houston (1990), Michener (1960). So far all of these have been in aggregations of moderate to high density and discovery has been largely fortuitous. It is possible that in some species nesting does occur at a much lower density but there are too few observations to confirm this.

*Leioproctus* from Australia and New Zealand all seem to have similar nesting habits. Variation in the depth and diameter of burrow and size of cells is likely to be due to the soil type and the size of each bee species. Donovan & Macfarlane (1984) state that "natural nest sites of Colletinae are bare and semi-bare areas of ground". This appears to be true of most Australian *Leioproctus* so far examined. The same nest site may be used for several seasons. *L. tuberculatus* and *L. cristatus* were observed nesting at the same sites for two years, and *L. nigrofulvus* has been observed using the same nest site for over 10 years until a bush fire destroyed the nest sites. More recently notes on nests of *L. (Ottocolletes) muelleri* were made in Houston & Maynard (2012), the nesting habits of this species is unusual in that the males (which have enlarged heads) were seen guarding the nest entrances from entry by other males and the area in Winter frequently submerged due rains.

### *Leioproctus (Exleycolletes) tuberculatus* (Cockerell)

Nests of *L. tuberculatus* were observed during August to mid October 1987 and 1988. The nests were located on bare sand fully exposed to the sun between clumps of *Leptospermum laevigatum* (Myrtaceae), at the Bogangar Road turn-off on the old coast road about three km north of Cudgen, north-eastern New South Wales (28°19'S 153°33'E). The surface was of loose, dry sand that became moist about 30 cm beneath the surface in an area that had been subject to sand mining. After sand mining, the area had been replanted with *Leptospermum laevigatum*, and now is covered predominantly by this species. There were approximately 40 bee nests per m<sup>2</sup>. About half the nests had a two cm high turret of loose sand. After foraging, bees did not directly enter the holes, but alighted on surrounding vegetation before flying down the hole. Several attempts at excavation of the nests were unsuccessful. The main shafts were followed to a depth of 40 cm before surrounding sand collapsed making it impossible to follow the nests any further. Rayment (1935) described nests of *L. tuberculatus* (under the names of *L. insularis* and *L. facialis*) in coastal Victoria. He found the main shafts went down in sand for 4'6" (=142 cm) with a single cell at the end of each burrow. The nests in Victoria were fully exposed to the sun, as were those observed by myself in northern New South Wales. Rayment's observations concur with mine that this species is only on the wing for about eight weeks between August and October. His report of a single cell at the base of a shaft conflicts with other descriptions of *Leioproctus* nests in which several cells radiate from the base of the entrance burrow. Note the site where my observations were made in northern New South Wales no longer exists—it has been covered by a housing estate.

### *Leioproctus (Exleycolletes) cristatus* (Smith)

This species is in the same subgenus as *L. tuberculatus*. A nesting site was located in a small back garden at Margate (27°15' S 153°06'E), a coastal community near Brisbane, Queensland. The residents of the property had been stung frequently because of the high numbers of females at the peak of nesting season. These bees are not aggressive and stinging was likely to be accidental, especially when the bees became lodged in clothing on a nearby washing line.

The nesting site was about 200 metres away from the beach front and consisted of approximately 4 square metres of mostly bare sand with a sparse covering of carpet grass (*Axonopus* sp. Poaceae). The surface of the site was gently sloping and shaded to varying degrees, but never exposed to full sunlight.

Nest entrances consisted of holes six to seven mm in diameter in fine, moist, compacted sand, up to a density of 55 entrances per square metre (figs 17a, b). Many had a tumulus of loose pale sand (in contrast to the black surface sand) about 35 mm in diameter and 20 mm high. Each burrow was more or less vertical and about 1 m long. The diameter of the tunnel was constant throughout its length. Cells were not located along the length of the tunnel nor at its termination. Possibly few cells had been completed at the time of excavation. There was no indication of any connections between burrows.

During visits to the nesting site on 3 October 1990 and 9 September 1991, female *L. cristatus* flew rapidly to and fro over the nests about 30 cm above the ground. They then landed and walked over the surface of the sand, often testing several nest entrances before entering a burrow. During the September 1991 visit, females were observed constructing burrows, pushing the sand out of the burrows with their heads.

In October 1990, many females were observed carrying pollen into the burrows. These females spent several minutes below ground before re-emerging. In September 1991, only a few females were seen carrying pollen and entering the burrows. Males were not collected at the nest site, but at the flowering *Leptospermum* (Myrtaceae) and *Melaleuca* (Myrtaceae) approximately 200 m away.

#### *Leioproctus (Charicolletes) elegans* Smith

A nesting site of this species was reported from Tangalooma resort, Moreton Island, Queensland (27°11'S 153°22'E). After complaints from visitors to the resort of stings, specimens of this species were collected by the resident medical officer and sent to the Queensland Museum for identification. The bees were reported to be nesting in the couch grass lawn (*Cynodon* sp., Poaceae) just above high tide level.

#### *Leioproctus (Zosterocolletes) advena* (Smith)

Rayment (1931, 1935) reported aggregations of nests of *L. advena* in sandy soil of heathland in Victoria. His observations led him to believe that the bees mated in the nest during August and September.

#### *Leioproctus (Andrenopsis) flavorufus* (Cockerell)

Rayment (1952) described 15–20 burrows scattered over a square metre. Each burrow had a main shaft of about 15 cm with three or four cells being scattered at depths between six and 15 cm below the surface, each cell being closed off from the main shaft. The cells had a cellophane-like lining with a dry sphere of pollen mixture upon which the egg was laid. His observations led him to believe that the bees mate at blossom.

#### *Leioproctus (Leioproctus) eremites* Houston

Houston (1990), described 20 burrows found amongst tussocks of grass on a flat road verge 21 km northwest of Belele homestead (26°22'S, 118°01'E), near Meekatharra, Western Australia in September. The aggregation covered an area of about two m<sup>2</sup> with the females flying to and from the nests. A further three females were found digging under separate pebbles farther north, near Mt Bruce (22°54'S, 118°08'E), in May.

#### *Leioproctus (Cladocerapis) incanescens* (Cockerell)

Both Rayment (1950, 1954) [at Jamberoo New South Wales (34°39'S 150°47'E)] and Michener (1960) [at Binna Burra, Lamington National Park Queensland (28°12'S 153°11'E)] described nests of this species. Rayment described them under the name *Cladocerapis persooniae*. Where Rayment's measurements differ from those of Michener they are given in parenthesis. The burrows described by both were in firm soil fully exposed to the sun. Each was 70–150 mm (250–350 mm) in depth with four to five cells radiating from the bottom. The cells were lined with cellophane-like material and when completed were provisioned with a sphere of moist pollen mixture about 4.5 mm in diameter and flattened on the bottom. A two mm egg was laid on top. Each cell was 13 mm (15 mm) in length with a diameter of six mm (seven mm). Newly dug burrows had tumuli 35–40 mm in diameter. Larvae hatched and consumed the food rapidly. When they became prepupae they were thought to remain quiescent until the following season. In observations made in this study at Beerburum, southeast Queensland this species and *L. (C.) speculiferus* (Cockerell) are on the wing for seven to eight months of the year so it is probable there is more than one generation per year in more northern locations.

*Leioproctus (Cladocerapis) carinatifrons* (Cockerell)

Rayment (1950) described (under the name of *Cladocerapis colmani* at Narrabeen, New South Wales (33°43'S 151°15'E)) an aggregation of about 1000 nests (in 36 m<sup>2</sup>) on a greyish sandy soil on red sub-soil. The nests had tumuli to a height of 30 mm with the entrance steep and not funnel shaped. The burrow was about 5 mm in diameter and about 80 cm deep with several cells at the bottom. The cells were lined with cellophane-like material and then provisioned with a moist pollen mixture upon which the egg was laid before the cell was sealed. The cells were about 12 mm in length and 5–7 mm in diameter. The larvae developed rapidly into the prepupal stage and then remained quiescent until the next season.

*Leioproctus (Leioproctus) nigrofulvus* (Cockerell)

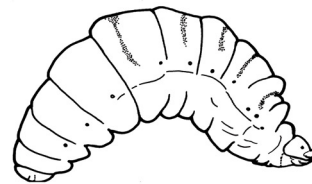
*Leioproctus (Leioproctus) nigrofulvus* nests in the mounds of the termite *Coptotermes lacteus* (Froggatt, 1898) (Isoptera: Rhinotermitidae) (fig. 15). The cells are placed in the wall next to the carton of the mounds but not in the active part of the mound—hence in a thermo-stable environment but not needing to defend against the termites. *Leioproctus nigrofulvus* has only been found nesting in active *Coptotermes lacteus* mounds that are situated in open eucalypt forest with an understorey predominantly of *Daviesia* spp. [Fabaceae]. *C. lacteus* mounds in adjacent pine forests did not have any *L. nigrofulvus* nesting in their walls.

*Coptotermes lacteus* occurs from the Queensland-New South Wales border in a broad band adjacent to the coast, throughout southeastern Australia to South Australia (see fig. 6.26 in Hadlington (1992) and fig. 46 in Watson and Abbey (1993)). The distribution of *Leioproctus nigrofulvus* is broadly similar to that of *C. lacteus* although most of the records of *L. nigrofulvus* are from within in the Australian Capital Territory and southern New South Wales in the vicinity of the Australian Capital Territory. The information provided in this paper is based on studies that were made on mounds in the Brindabella Ranges, Australian Capital Territory (ACT). Termite mounds in these localities frequently are covered in snow in the middle of winter.

15



16a



16b



17a



17b



**FIGURES 15–17.** *Leioproctus* nests and immatures. Fig. 15 Termite (*Coptotermes lacteus*) mound with nests of *Leioproctus nigrofulvus*. Fig. 16a Lateral view of mature larvae of *Leioproctus nigrofulvus*. Fig. 16b Mature larvae of *Leioproctus nigrofulvus* resting next to pollen ball. Figs 17a,b Nests of *Leioproctus cristatus*.



Over 10 years *L. nigrofulvus* specimens were collected regularly from the Brindabella Ranges, ACT in open eucalypt forest that had an understorey mainly of *Daviesia* spp. (Fabaceae). Extensive searching throughout this area for nest sites in other situations failed to find any, despite apparently suitable areas of bare ground or exposed surfaces of road cuttings. *Leioproctus nigrofulvus* nests were found in 25 *Coptotermes lacteus* mounds throughout Uriarra forest and the north-western area of Namadgi National Park ACT (35°32'S 148°57'E). Further active nesting sites were found at two mounds south of Mongarlowe, NSW (35°25'S 149°56'E) and in one very large mound just south the settlement of Monga, NSW (35°35'S 149°55'E).

Nest architecture was discerned from notes and observations made on two termite mounds, in particular, during 22 visits to these sites during spring 1992, 1993 and 1994 with annual follow up visits in all years since except 2005. Other mounds throughout the area were inspected during these visits as well as at non-nesting periods. The tunnel structure was elucidated from (a) puffing plaster of paris powder into tunnels and following the tunnels by excavation (J.Rozen, Jr., pers. comm.) and (b) taking 0.25 m<sup>3</sup> section of the wall of a termite mound and making two cm sequential sections and plotting the position of the tunnels on graph paper. Larvae recovered from the mounds were placed in glass vials with cotton wool plugs, or gelatine capsules and held at room temperature or preserved in alcohol.

Nests were only found in mounds of *Coptotermes lacteus*. No nests were found in walls of the mound-building termite, *Nasutitermes* sp. (Termitidae), in the study area. *C. lacteus* (Froggatt) form domed mounds to three m in height with walls about 30 cm in thickness. The walls of the mounds consist of approximately 27% coarse sand, 13% fine sand, 17% silt and 37% clay with no gravel incorporated and consists entirely of subsoil (Lee & Woods 1971b). The temperature inside active termite mounds, in winter, can be up to 20°C higher than its surrounds (Lee and Woods 1971a).

Active nesting by bees in the mounds was indicated by open entrance holes and freshly dug soil on any non-vertical surface below. Nests were found on all exposed parts of the walls of mounds except the apex. In most termite mounds examined fewer than 20 nest entrances were observed. However, one termite mound had more than 60 active nest entrances. Some areas of the mound had entrances less than one cm apart. Tunnels appeared unconnected despite the close proximity of the tunnels.

The nests consisted of an entrance hole, one vestibule slightly larger than the tunnel width, a tunnel of even diameter throughout, and a series of cells more or less end to end. The tunnels throughout were circular in cross-section. The entrance holes were *ca.* six mm in diameter and smooth. Beyond the entrance, the tunnels widened to seven-eight mm. Early in the nesting season tunnels were up to 30 cm long prior to the first cell, whereas later in the nesting season shorter tunnels were found. A succession of cells was made along the length the tunnel, occasionally a cell was found at an angle to the main direction of the tunnel. In mid-nesting season, the closest sealed cell to the tunnel entrance had an egg on a pollen mass. Further along the cell series there were progressively more mature larvae, with the most mature larva closest to the carton of the mound.

Tunnels commenced with a short section directed towards the centre of the mound, then, within the first four cm there was a vestibule. Vestibules were 9–10 mm in diameter. After the vestibule, tunnels turned at an angle (up to 90°), continued for four to six cm, and then turned more or less toward the centre of the mound. Most cells were found near the carton of the mound. The placement of the inner cells often paralleled the outer wall of the carton of the termite mound.

Cells were six to eight mm in diameter (mean 7.08, n= 40) and 12–14 mm long (mean 12.38, n= 40). The walls of the cells were smooth, but not more compacted than the surrounding earth. The walls of the cells were lined with cellophane like material (fig. 54) that was made up of an irregular, fine network of threads and a clear matrix. The distal end of cells (closest to the carton of the termite mound) was concave and had a lining contiguous with the walls. At the proximal end of the cell was an unlined, oblique disc-like plug (fig. 55) that was comprised of roughly concentric circles of a mixture of faeces, cellophane-like material and dirt. The cell lining continued beyond the innermost surface of the plug and was embedded medially in the side of the plug. The plugs were rough and thickest basally. Between cells was a partition of packed clay of 1–20 mm in length. Up to 10 cells were been encountered, end to end with only one to two mm partitions in between. Within each cell a pollen mass was placed at the rear. The pollen masses were about five mm long and about three mm high. A large single egg was placed on the dorsal surface of each mass. A completed pollen mass was a semi-solid, viscous, yellow-brown globule. An incomplete pollen mass was a stiff, bright yellow sphere. Pollen masses were deliquescent, that became semi-liquid within hours of being exposed to the air.

From one section of the wall of a *Coptermes lacteus* mound about 350 larvae and pupae were excavated. The sex ratio of the male to female pupae was about 5:3 (198 males to 129 females). Larvae (figs 16a,b), when small, sat on top of the pollen mass and fed with the mouthparts immersed in the food. At rest the head was raised up away from the mass. Larger larvae (fig. 16b) sat beside the pollen mass, with the head towards the "outer" edge of the mound. Similarly they raised the head away from the pollen mass when not feeding. In cells of post defecating larvae, a disc of faeces was found plastered in slender strips over the plug-end of the cell. Within six weeks of the last females found actively building nests, all the larvae had become prepupae.

Adults were on the wing from late September to early December, however, live fully active, non-teneral adults were extracted from mounds in late August. The presence of clean, open nest entrances and a small amount of loose dirt on non-vertical surfaces indicated adult activity. The length of time the bees were on the wing appeared to be closely associated with the flowering of *Daviesia* (Fabaceae). In the study area *Daviesia mimosoides* (R.Br.) predominated. The first bees emerged as the buds of *D. mimosoides* began to open and when flowering was finished, only a few females were encountered.

Males emerged before the females and were present throughout the season, though fewer were found in the later part of the season. Males were seen to re-enter the nests on several occasions, but no females were seen to go into the corresponding holes. Males were mostly collected at flowers of *Daviesia*.

In the first few weeks, females returned to the nests without pollen on the scopae. These nests, when excavated, were without cells. Mid- to late September females started returning to nests with scopae packed with pollen. Pollen laden females spent up to an hour in nest, before re-emerging to fly off. Provisioning females (those gathering pollen) would spend two to three hours away from the nests. If the sun was out most activity was noted around 10.00–11.00 am, and 3.00–4.00 pm. If clouds blocked the sun then there was a noticeable reduction in the activity. Activity was confined to a few hours around mid-day early in the season, when morning (ca. 9:00 am) temperatures were cool (below 15°C) and over night frosts occurred.

Upon return to a nest females either flew directly into a tunnel without hesitation, or made one or two passes near the hole and then entered. When a thin layer (<1 cm) from the entrance to a tunnel was removed, the returning female, went immediately down the tunnel, re-emerged and went back down the tunnel several times before going down and staying down. When the bee re-emerged, before flying off, it dabbed the rim of the entrance hole with the tip of its metasoma. When more than 2 cm of a tunnel was removed, females spent half an hour or more flying in horizontal passes near where the nest entrance was, landing occasionally and make a few attempts to dig, then this behaviour sequence of behaviour was repeated.

During construction of tunnels, females were observed pushing dirt out the nest entrances with both their heads and hind legs.

*Leioproctus nigrofulvus* only uses the outer wall of the termite mound, unlike *Megachile pluto* Smith, 1869, which penetrates the inner carton of the mound (O'Toole and Raw 1991). The cells of *L. nigrofulvus* have no significant structural adaptations to living in the termite mounds, whereas *M. pluto* cells have 1.5 mm thick walls of resin and wood chips. The main adaptation of *L. nigrofulvus* to nesting in termite mounds is a moderate enlargement of the mandibles in the adults. The relationship between *L. nigrofulvus* and *C. lacteus* is apparently commensal. It appears that the termites gain no benefit from the presence of these bees nor do the termites harm the bees unless they rupture the outer wall of the carton of the mound. The bees though, gain a nesting site in close proximity to food plants that are somewhat thermo-regulated, as well as they are able to have relatively shallow nesting tunnels relative to other known *Leioproctus* nests. Other bees known to nest in termite mounds include species of stingless bees (eg *Partatoma batesi* Pedro & Carmargo (Apidae) in mounds of *Nasutitermes acangussu* Bandeira & Fontes (Termitidae) (Vit *et. al* 2013) and *Centris (Ptilotopus) scopipes* Friese in *Procornitermes araujoi* Emerson (Termitidae) (Gaglianone 2001).

**Fungal attack**—The remains of dead adults were found in the partially filled in tunnels during the non-nesting season. Approximately 3% cells found, had blackened remains of diseased larvae or cadavers that had sprouted white, fungal-like fruiting bodies. The fungus found in these nests was a species to be closely related to that found in *Leioproctus* nests in New Zealand (Anderson, *pers. comm*). **Parasitism**—Parasites collected from nests in the Brindabellas include a female of an undescribed species and genus of hyptiogastrine wasp (Hymenoptera: Gasteruptionidae: Hyptiogastrinae); as well a different species of hyptiogastrine gasteruptionid female was observed exiting nest entrance holes on two occasions. Additionally three hyptiogastrine gasteruptionid pupae were recovered from approximately 350 cells opened, which indicated a parasitism rate of less than 1%.

### Male Clusters

There are reports of males of at least five species being found in aggregations, possibly forming “sleeping” clusters (Michener 1974: 37). Rayment (1931a, 1935) described a sleeping cluster of 200–300 males of *L. advena* on “a curled dried frond of a bracken fern” at night or when the weather was cold. He also described a cluster of similar size reported to him by Henry Hacker as *L. “thornleighensis”* on the foliage of a small tree at Mount Coot-Tha, Brisbane Queensland (27°29'S 152°58'E). In New Zealand *Leioproctus metallicus* (Smith) has been reported as forming a cluster in the foliage of *Pinus* spp. (Pinaceae) (Rayment 1935). An aggregation of *L. (Protomorpha) tarsalis* (Rayment) males was taken from under bark at St. George, Queensland (28°02'S 148°35'E) (Maynard 1991).

*Goniocolletes subdolos* (Cockerell) males were described by Rayment (1935) as having “remarkable sheltering habits” in congregating at evening in a dense cluster on the branch of a shrub, or even in an “old frond of a fern”. There was apparently no alignment of individuals as they were haphazardly arranged.

There has been no study on these groups of males, and to do so would be extremely difficult as triggers for the occurrence of male clusters are currently unknown.

### Foraging

The following are records of flowers from which species of Australian *Leioproctus* and *Goniocolletes* have been collected. It is compiled from records from this study and Houston (2000). Records for undescribed species in Houston (2000) are not included. These records may reflect true preferences of these bees for particular plant groups or simply be a record of plants from which they have been collected—there have been very few studies with regards this issue in Australia—notes on particular records are included following this summary.

***Leioproctus (Leioproctus) amabilis* (Smith, 1879):** Myrtaceae: *Eucalyptus* spp.; *Melaleuca* spp.

***Leioproctus (Leioproctus) boroniae* (Cockerell, 1921):** Rutaceae: *Boronia ledifolia* J.Gay.

***Leioproctus (Leioproctus) cupreus* (Smith, 1853):** Lamiaceae: *Physopsis viscida*; Myrtaceae: *Eucalyptus* spp., *Eucalyptus conglobata*, *Eucalyptus gracilis*, *Eucalyptus leptopoda*, *Eucalyptus oleosa*, *Malleostemon tuberculatus*, *Melaleuca lanceolata*.

***Leioproctus (Leioproctus) plumosus* (Smith, 1853):** Epacridaceae: *Leucopogon*; Fabaceae: *Daviesia*; Leguminosae: *Acacia*; Myrtaceae: *Eucalyptus*; Solonaceae: *Salpichroa*.

***Leioproctus (Leioproctus) friesellus* Michener, 1965:** Myrtaceae: *Melaleuca*.

***Leioproctus (Leioproctus) irroratus* (Smith, 1853):** Myrtaceae: *Eucalyptus*; Proteaceae: *Lomatia*, *Macadamia*.

***Leioproctus (Leioproctus) bicristatus* (Cockerell, 1929):** Sapindaceae: *Atalaya hemiglauca*.

***Leioproctus (Leioproctus) launcestonensis* (Cockerell, 1914):** Lamiaceae: *Prostanthera lasianthos*; Myrtaceae: *Eucalyptus*, *Leptospermum ericoides*, *Leptospermum* sp.; Pittosporaceae: *Bursaria spinosa*.

***Leioproctus (Leioproctus) litotes* Maynard sp.n.:** Myrtaceae: *Eucalyptus*.

***Leioproctus (Leioproctus) macmillani* Houston, 1991:** Epacridaceae: *Astroloma xerophyllum*, *Andersonia heterophylla*.

***Leioproctus (Leioproctus) crinitus* Maynard sp.n.:** Myrtaceae: *Baeckea*.

***Leioproctus (Leioproctus) nigrofulvus* (Cockerell, 1914):** Fabaceae: *Daviesia*, *Dillwynia*.

***Leioproctus (Leioproctus) platycephalus* (Cockerell, 1912):** Cyperaceae: *Scleria*; Epacridaceae: *Leucopogon*; Fabaceae: *Daviesia mimosoides*, *Pultenaea largiflorens*, *Dillwynia*, *Eutaxia*.

***Leioproctus (Leioproctus) cyaneorufus* (Cockerell, 1930):** Fabaceae: *Aotus*.

***Leioproctus (Leioproctus) maculatus* (Rayment, 1930):** Caesalpiniaceae: *Cassia*; Fabaceae: *Eutaxia*; Myrtaceae: *Eucalyptus*.

***Leioproctus (Leioproctus) nasutus* Houston, 1990:** Goodeniaceae: *Scaevola spinescens*; Scrophulariaceae: *Eremophila longifolia*, *Eremophila gilesii*, *Eremophila scoparia*, *Eremophila drummondii*, *Eremophila patonii*.

***Leioproctus (Leioproctus) spatulatus* (Cockerell, 1905):** Myrtaceae: *Leptospermum*, *Eucalyptus*, *Melaleuca*; Pittosporaceae: *Bursaria spinosa*.

***Leioproctus (Leioproctus) alleynae* (Rayment, 1935):** Myrtaceae: *Eucalyptus*; Pittosporaceae: *Bursaria spinosa*.

***Leioproctus (Leioproctus) obscurus* (Smith, 1853):** Myrtaceae: *Leptospermum rupestre*, *Leptospermum*.

***Leioproctus (Leioproctus) providellus* (Cockerell, 1905):** Myrtaceae: *Leptospermum*

***Leioproctus (Leioproctus) punctatus* (Smith, 1853):** Myrtaceae: *Calytrix tetragona*.



***Leioproctus (Leioproctus) recusus* (Cockerell, 1921):** Myrtaceae: *Leptospermum flavescens*, *Leptospermum*, *Eucalyptus*, *Callistemon salignus*.

***Leioproctus (Alokocolletes) excubitor* Houston, 1991:** Amaranthaceae: *Ptilotus*; Asteraceae: *Rhodanthe charsleyae*, *Schoenia cassiniana*; Fabaceae: *Acacia*, *Senna*; Asphodelaceae: *Asphodelus fistulosus*; Myrtaceae: *Eucalyptus oldfieldii*, *Melaleuca nematophylla*; Proteaceae: *Conospermum*, *Grevillea didymobotrya*; Solanaceae: *Solanum*.

***Leioproctus (Alokocolletes) sequax* Maynard sp.n.:** Amaranthaceae: *Ptilotus*; Araliaceae: *Trachymene glaucifolia*; Fabaceae: *Kennedia prorepens*, *Psoralea patens*; Portulacaceae: *Calandrinia balonensis*.

***Leioproctus (Charicolletes) exleyae* Maynard sp.n.:** Fabaceae: *Acacia*; Myrtaceae: *Eucalyptus argillacea*, *Eucalyptus melanophloia*, *Eucalyptus largiflorens*, *Eucalyptus populnea*, *Eucalyptus intertexta*, *Eucalyptus* spp., *Angophora floribunda*.

***Leioproctus (Charicolletes) saltus* Maynard sp.n.:** Ericaceae: *Leucopogon*.

***Leioproctus (Excolletes) impatellatus* Michener, 1965:** Myrtaceae: *Corymbia terminalis*; Proteaceae: *Grevillea*.

***Leioproctus (Exleycolletes) tuberculatus* (Cockerell, 1913):** Myrtaceae: *Leptospermum laevigatum*.

***Leioproctus (Exleycolletes) cristatus* (Smith, 1853):** Myrtaceae: *Leptospermum*, *Melaleuca*.

***Leioproctus (Exleycolletes) leai* (Cockerell, 1913):** Aizoaceae: *Carpobrotus*; Brassicaceae: *Brassica*; Myrtaceae: *Eucalyptus*, *Melaleuca*; Pittosporaceae: *Bursaria spinosa*.

***Leioproctus (Exleycolletes) microdontus* (Cockerell, 1929):** Myrtaceae: *Melaleuca*.

***Leioproctus (Exleycolletes) pusillus* (Cockerell, 1929):** Myrtaceae: *Baeckea pentagonantha*; Proteaceae: *Hakea erinacea*.

***Leioproctus (Fragocolletes) perminutus* (Cockerell, 1929):** Fabaceae: *Acacia*.

***Leioproctus (Hadrocolletes) macrodontus* (Rayment, 1935):** Proteaceae: *Grevillea*, *Hakea erinacea*, *Banksia*.

***Leioproctus (Lamprocolletes) chalybeatus* (Erichson, 1842):** Proteaceae: *Grevillea biformis*; Mimosaceae: *Acacia*; Myrtaceae: *Verticordia picta*, *Baeckea pentagonantha*, *Eucalyptus*; Goodeniaceae: *Scaevola spinescens*; Ericaceae: *Leucopogon*.

***Leioproctus (Minycolletes) abnormis* (Cockerell, 1916):** Myrtaceae: *Angophora floribunda*, *Eucalyptus largiflorens*, *Eucalyptus*.

***Leioproctus (Minycolletes) aquilus* Maynard sp.n.:** Araliaceae: *Astrotricha longifolia*; Myrtaceae: *Angophora floribunda*.

***Leioproctus (Minycolletes) finkei* Michener, 1965:** Portulacaceae: *Calandrinia balonensis*; Asteraceae: *Xerochrysum bracteatum*.

***Leioproctus (Minycolletes) helichrysi* (Cockerell, 1918):** Asteraceae: *Xerochrysum bracteatum*.

***Leioproctus (Minycolletes) insitus* Maynard sp.n.:** Myrtaceae: *Leptospermum*; daisy blossom.

***Leioproctus (Minycolletes) paulus* Maynard sp.n.:** Portulacaceae: *Calandrinia polyandra*.

***Leioproctus (Minycolletes) pygmaeus* Maynard sp.n.:** Fabaceae: *Acacia*

***Leioproctus (Minycolletes) wahlenbergiae* Michener, 1965:** Campanulaceae: *Wahlenbergia*.

***Leioproctus (Zosterocolletes) ruficornis* (Smith, 1879):** Myrtaceae: *Verticordia serrata*; Rutaceae: *Boronia capitata*.

***Goniocolletes abdominalis* (Smith, 1879):** Myrtaceae: *Eucalyptus largiflorens*, *Eucalyptus*.

***Goniocolletes albopilosus* (Rayment, 1930):** Myrtaceae: *Leptospermum*.

***Goniocolletes anhedonus* Maynard sp.n.:** Myrtaceae: *Eucalyptus camaldulensis*.

***Goniocolletes badius* Maynard sp.n.:** Myrtaceae: *Eucalyptus camaldulensis*, *Eucalyptus populnea*.

***Goniocolletes ciliatus* Maynard sp.n.:** Myrtaceae: *Eucalyptus*.

***Goniocolletes colletellus* (Cockerell, 1905):** Myrtaceae: *Eucalyptus camaldulensis*, *Eucalyptus floribunda*, *Eucalyptus largiflorens*, *Eucalyptus*.

***Goniocolletes comatus* Maynard sp.n.:** Myrtaceae: *Eucalyptus dumosa*, *Eucalyptus brachycalyx*, *Eucalyptus socialis*, *Melaleuca*.

***Goniocolletes dasypus* Maynard sp.n.:** Myrtaceae: *Eucalyptus*, *Angophora floribunda*.

***Goniocolletes fimbriatinus* (Cockerell, 1910):** Myrtaceae: *Eucalyptus*, *Eucalyptus crebra*, *Eucalyptus camaldulensis*, *Leptospermum*.

***Goniocolletes fimbriatus* (Smith, 1879):** Myrtaceae: *Eucalyptus*, *Eucalyptus angulosa*, *Eucalyptus socialis*, *Eucalyptus brachycalyx*.

**Goniocolletes parvus** Maynard sp.n.: Myrtaceae: *Eucalyptus argillacea*, *Eucalyptus oleosa*, *Eucalyptus socialis*, *Eucalyptus brachycalyx*, *Eucalyptus*, *Melaleuca lanceolata*; Scrophulariaceae: *Myoporum platycarpum*.

**Goniocolletes perfasciatus** (Cockerell, 1906): Myrtaceae: *Angophora floribunda*, *Eucalyptus largiflorens*, *Eucalyptus*, mallee.

**Goniocolletes subdolosus** (Cockerell, 1913): Myrtaceae: *Eucalyptus* spp.

The foraging behaviour of six species: *Leioproctus* (*L.*) *nigrofulvus*, *L.* (*Cladocerapis*) *biplectinatus*; *L.* (*Cladocerapis*) *incanescans*, *L.* (*Cladocerapis*) *speculiferus* and *L.* (*Exleycolletes*) *tuberculatus* and *L.* (*Charicolletes*) *saltus* sp.n. was observed. In all cases both males and females forage at the same flowers. Each species appears to have a different manner of flight when approaching and manoeuvring around the bushes. The males appeared earliest in a season, often when flowering had just commenced, and disappeared a few weeks before the end of the nesting season. Females appeared after the males and could still be found at the end of the season when no males were about. A few species-groups and subgenera are apparently oligolectic on particular genera of plants e.g. *L.* (*Cladocerapis*) on *Persoonia* (Proteaceae), *Ceratocolletes* on *Pultenaea* (Fabaceae); *Goniocolletes* on *Eucalyptus* (Myrtaceae) except in one instance; most *Minycolletes* on *Wahlenbergia* (Campanulaceae) but the majority are highly polylectic. *Leioproctus* (*Leioproctus*) in Australia are often found on Myrtaceae or Proteaceae, however these are often the dominant plant families in an area and often comprise, large, obvious flowering trees in Australia. Hence bees are readily collected from them, there are many small to prostrate plants from which bees are less readily collected, however have a significant bee fauna. Often structural specialisations reflect the use of the more closed flowers of non-myrtaceous plants. The pollen loads examined were rarely pure. It is possible that some species specialise in a plant species/genus to collect pollen and seek nectar from open-cup flowers such as *Eucalyptus* (Myrtaceae). Houston (2000) provides an extensive list of collection records for plants associated with bee species in the Western Australian Museum. Collection records may be indicative of which plants on which each bee species is likely to be found, however it is often not possible to draw detailed conclusions from these as they often reflect collecting-effort rather than biological information on the bees. However some papers provide detailed longer term observations and these are listed below for *Leioproctus*.

*Leioproctus* (*Charicolletes*) *saltus* Maynard sp.n.

Both male and female *L.* (*C.*) *saltus* have been collected foraging on *Leucopogon* (Ericaceae). Their flight around this plant is very rapid, and the bees, especially the males, alight the flowers briefly. Though the flowers of this plant are numerous, they are minute and the amount of nectar/pollen in any one flower would be small.

*Leioproctus* (*Exleycolletes*) *tuberculatus* (Cockerell, 1913)

*L.* (*C.*) *tuberculatus* were observed over two seasons on *Leptospermum laevigatum* (Myrtaceae) at Hastings Point, northern New South Wales. Both males and females spend a considerable amount of time at a flower. The males are at times found resting on vegetation near the flowers. P. Bernhardt also collected the bees from *Hibbertia scandens* (Willd.) Dryand. (Dilleniaceae), and when the pollen loads were analysed a mixture of myrtaceous and *Hibbertia* pollen were found. It appears that these bees might use different resources for pollen and nectar. The flowers of *Hibbertia* are nectarless whereas *Leptospermum* (Myrtaceae) are nectariferous (P. Bernhardt pers. comm.).

*L.* (*L.*) *conospermi* Houston, 1989

Houston (1989) described the foraging of *Leioproctus conospermi* and their ability to trigger the explosive pollen dispersing mechanisms on the flowers they visited. The females have very sparse tibial scopae, possibly an adaptation for carrying the coarse *Conospermum* (Proteaceae) pollen.

*Leioproctus* (*Leioproctus*) *capito*-species group

Houston (1983; 1990) described the elongation of the glossae and labial palps as a mechanism by which short-tongued bees can collect nectar from a restricted access point, such as in *Eremophila* (Scrophulariaceae) flowers. *Leioproctus* (*Leioproctus*) *capito* species-group have modified palps and an extended glossa, but they are not the only *Leioproctus* that occur on *Eremophila*. *Leioproctus* (*L.*) *nasutus*, *L.* (*Odontocolletes*) *asper* and *L.* (*Charicolletes*) *exleyae* sp.n. also forage on *Eremophila*. These bees all have elongate mouthparts including the

palps, though they do not show the flattening and desclerotisation of the labial palps that occurs in most *L.* (*L.*) captio-species group. As well as the modifications of the mouthparts most bees that occur on *Eremophila* have mid- and hind tibial spurs that are heavily sclerotised and curved at the apices.

#### *Leioproctus (Cladocerapis)*

The heads (particularly of females) of *L. (Cladocerapis)* species are considerably modified for foraging on *Persoonia* (Proteaceae) flowers; the mouthparts are unmodified, but the frons, clypeus and supraclypeal area are flattened or shallowly depressed and usually polished medially. The female fore basitarsi bear spines used in pollen manipulation. Most observations have been made on *L. (C.) speculiferus* (pers obs). Both male and female *L. (C.) speculiferus* alight on a *Persoonia* flower over the top of the stigma and force their heads down between the anther and style to reach the nectar. The females gather pollen by pushing the spines on the fore basitarsi down the length of an anther, stripping the pollen from the longitudinal slits. The fore basitarsi are then wiped along the middle of the body and the pollen is manipulated with the mid legs along the body to the metasomal and hind leg scopae. Females may repeat this manoeuvre several times on the same anther or just once and then rotate 90° to manipulate the next anther. The number of anthers from which pollen is gathered varies, but the female continues to rotate in a single direction on the same flower. The undersurface of the metasoma rests on the tip of the stigma during these manoeuvres. Pollen is likely to be deposited on the stigma at this time, in particular by the females as they have long, plumose hair on the metasomal sterna that carries loose pollen.

This is in contrast to the way the majority of honey-bees (*Apis mellifera*) forage at the *Persoonia* flowers. They approach the flower over the top of the petal and force their heads down between the anther and style frequently without stigmatic contact. In addition the pollen is carried moist by honey bees whereas *Leioproctus* tend to carry pollen in a dry format such that it is readily available for pollination. Native social bees, *Tetragonula* sp. (Hymenoptera: Apidae), also at the *Persoonia* flowers, were observed to move about on the anthers gathering pollen and occasionally taking nectar with little contact with the stigma. *L. (Cladocerapis)* spp. foraged mainly between 9.30 am and 2.30 pm in the cooler months and before 11 am in the warmer months. Nectar was gathered at most visits and pollen intermittently. The highest incidence of pollen gathering was during the morning. Three species of *L. (Cladocerapis)*—(*L.(C.) bipectinatus*, *L. (C.) speculiferus* and *L.(C.) incanescens*); all have a similar method of foraging. They tend to visit more flowers on the exterior of the plant, in contrast to *Leioproctus (Filiglossa) filamentosa* that tends to visit flowers on the interior of the plant.

#### *Leioproctus (Filiglossa)*

Species of *Leioproctus (Filiglossa)* also visit *Persoonia* (Proteaceae). *Leioproctus (Filiglossa) filamentosa* has grossly elongate palps and hairs on the apices of the maxillae that it uses to gather nectar. To gather nectar this species perches at the right angles formed by the adjoining tepals and inserts the palps and hairs or force their palps into the base of the flower without contacting the anthers or stigma. To gather pollen, the female approaches the flower over the top of the stigma and down the style, where it perches whilst gathering pollen. Females use the fine spines on the subspherical forebasitarsi, and the six thick spines on the posterior margin of the hind basitarsus to gather pollen. Pollen is carried in the ventral metasomal scopa; hence pollen is likely to be deposited while crawling over the style. Batley (pers. comm.) has video film of *Leioproctus (Filiglossa)* at *Persoonia* flowers hence confirming that the species in this subgenus do play a role in the pollination.

There are a few reports of *Leioproctus* on crops, however only limited work has been done in this area in Australia and New Zealand. Donovan (2007) reports an abundance of *Leioproctus boltoni* Cockerell, 1904 and *Leioproctus huakiwi* Donovan, 2007 on kiwi fruit (*Actinidia deliciosa* (Actinidiaceae)) in New Zealand. Donovan *et. al* 2010 reported on the possibility of moving nesting populations of *Leioproctus huakiwi* for potential management and use in commercial pollination situations. In Australia the only records of *Leioproctus* on crops are those of Hogendoorn on carrots and onions (Hogendoorn and Keller 2011)

#### **Mating**

*Leioproctus maculatus* (Rayment, 1930b), and *Leioproctus (Notocolletes) heterodoxus* (Houston, 1973) have both been reported to mate at flowers. Rayment (1931b, 1935) believed mating of *L. advena* took place within the burrows (1935: 178,179). This was assumed because he saw a female then a male descend the same burrow.

Observations have also been made of males interacting with females on flowering plants (pers.obs.) for *Leioproctus* (*Leioproctus*) *nigrofulvus* and *L.* (*Cladocerapis*) spp., it is uncertain if this was part of territorial behaviour or mating behaviour.

The defence of burrows by large headed males has been observed for *L.* (*Ottocolletes*) *muelleri* (Houston & Maynard, 2012). As enlargement of the head of males is very rare in *Leioproctus* it is assumed that burrow entrance defence is similarly uncommon.

### Taxonomic arrangement of Australian *Leioproctus*

The subgeneric arrangement of Australian *Leioproctus* is as follows [in cases of subgenera not included in this paper, reference to species details has been placed in square brackets]:

<i>L.</i> ( <i>Alkocolletes</i> ) <b>subgen.n</b>	2 species, of which 1 is new.
<i>L.</i> ( <i>Andrenopsis</i> ) Cockerell, 1905a	5 species [see Michener (1965); Almeida (2008)]
<i>L.</i> ( <i>Anacolletes</i> ) Michener, 1965	1 species [see Maynard (1997)]
<i>L.</i> ( <i>Baeocolletes</i> ) Michener, 1965	3 species [see Michener, (1965)]
<i>L.</i> ( <i>Ceratocolletes</i> ) Michener, 1965	2 species [see Maynard (1993)]
<i>L.</i> ( <i>Charicolletes</i> ) <b>subgen.n</b>	4 species of which 2 are new
<i>L.</i> ( <i>Cladocerapis</i> ) Cockerell, 1904	9 species [see Maynard (1992b)]
<i>L.</i> ( <i>Colletellus</i> ) Michener, 1965	1 species [see Michener (1965)]
<i>L.</i> ( <i>Colletopsis</i> ) Michener, 1965	1 species [see Michener (1965)]
<i>L.</i> ( <i>Euryglossidia</i> ) Cockerell, 1910b	22 species [see Michener (1965)]
<i>L.</i> ( <i>Excolletes</i> ) Michener, 1965	1 species
<i>L.</i> ( <i>Exleycolletes</i> ) <b>subgen.n</b>	7 species
<i>L.</i> ( <i>Filiglossa</i> ) Rayment, 1959	4 species [see Maynard (1994)]
<i>L.</i> ( <i>Fragocolletes</i> ) <b>subgen.n</b>	2 species, of which 1 is new
<i>L.</i> ( <i>Glossurocolletes</i> ) Michener, 1965	2 species [see Michener (1965)]
<i>L.</i> ( <i>Hadrocolletes</i> ) <b>subgen.n</b>	3 species
<i>L.</i> ( <i>Lamprocolletes</i> ) Smith, 1853	3 species
<i>L.</i> ( <i>Leioproctus</i> ) Smith, 1853	69 species (of which 29 are dealt with here and 3 are new)
<i>L.</i> ( <i>Minycolletes</i> ) <b>subgen.n</b>	11 species of which 6 are new
<i>L.</i> ( <i>Notocolletes</i> ) Cockerell, 1916a	1 species [see Michener (1965)]
<i>L.</i> ( <i>Odontocolletes</i> ) Maynard, 1997	8 species [see Maynard (1997)]
<i>L.</i> ( <i>Ottocolletes</i> ) Houston & Maynard 2012	1 species [see Houston and Maynard (2012)]
<i>L.</i> ( <i>Protomorpha</i> ) Rayment, 1959b	6 species, [see Maynard (1991)]
<i>L.</i> ( <i>Urocolletes</i> ) Michener, 1965	1 species [see Michener (1965)]
<i>L.</i> ( <i>Zosterocolletes</i> ) <b>subgen.n.</b>	3 species

In addition, *Goniocolletes* Cockerell, 1907 (herein treated as a genus independent of *Leioproctus*) is revised and includes 15 species of which seven are described as new.

The following species remain grouped as *Leioproctus* (*Leioproctus*) without placement in a species group. The names in square brackets are the genera under which the species were originally described.

- L.* (*L.*) *alienus* (Smith, 1853) [*Andrena*]
- L.* (*L.*) *apicalis* (Cockerell, 1921) [*Paracolletes*]
- L.* (*L.*) *atronitens* (Cockerell, 1914b) [*Paracolletes*]
- L.* (*L.*) *capillatus* (Rayment, 1935) [*Paracolletes*]
- L.* (*L.*) *castaneipes* (Cockerell, 1914) [*Paracolletes*]
- L.* (*L.*) *cinereus* (Smith, 1853) [*Lamprocolletes*]
- L.* (*L.*) *ibex* (Cockerell, 1914a) [*Paracolletes*]
- L.* (*L.*) *incomptus* (Cockerell, 1921) [*Paracolletes*]

*L. (L.) megachalcoides* Michener, 1965 [*Leioproctus*]  
*L. (L.) moniliformis* (Cockerell, 1916a) [*Paracolletes*]  
*L. (L.) nanus* (Smith, 1879) [*Lamprocolletes*]  
*L. (L.) nicholsoni* (Cockerell, 1929c) [*Paracolletes*]  
*L. (L.) nigriventris* (Friese, 1924) [*Paracolletes*]  
*L. (L.) nitidulus* (Cockerell, 1916) [*Paracolletes*]  
*L. (L.) opaculus* (Cockerell, 1929c) [*Paracolletes*]  
*L. (L.) pavonellus* (Cockerell, 1929c) [*Paracolletes*]  
*L. (L.) rhodopus* (Cockerell, 1914b) [*Paracolletes*]  
*L. (L.) rudis* (Cockerell, 1906a) [*Paracolletes*]  
*L. (L.) semiluscens* (Cockerell, 1929d) [*Paracolletes*]  
*L. (L.) sexmaculatus* (Cockerell, 1914b) [*Paracolletes*]  
*L. (L.) sigillatus* (Cockerell, 1914a) [*Paracolletes*]  
*L. (L.) subminutus* (Rayment, 1934) [*Paracolletes*]  
*L. (L.) subpunctatus* (Rayment, 1935) [*Paracolletes*]  
*L. (L.) thornleighensis* (Cockerell, 1906a) [*Paracolletes*]  
*L. (L.) versicolor* (Smith, 1853) [*Lamprocolletes*]

Fifteen species of *Leioproctus* (*Leioproctus*) described by Houston (1990, 1989), Packer (2006) and Houston & Maynard (2012) are not dealt with further here as they did not require further revision, nor were any new species placed in these groups. The species, which were described in these papers, are listed below:

- *Leioproctus* (*Leioproctus*) *capito*-species group: *L. (L.) canutus* Houston, 1990, *L. (L.) capito* Houston, 1990, *L. (L.) concavus* Houston, 1990, *L. (L.) eremites* Houston, 1990, *L. (L.) eremitulus* Houston, 1990, *L. (L.) kumarina* Houston, 1990, *L. (L.) lanceolatus* Houston, 1990, *L. (L.) longipalpus* Houston, 1990, *L. (L.) lucanus* Houston, 1990, *L. (L.) lucidicinctus* Houston, 1990;
- *Leioproctus* (*Leioproctus*) *conospermi*-species group: *L. (L.) conospermi* Houston, 1989, *L. (L.) papus* Houston, 1989, *L. (L.) tomentosus* Houston, 1989, and
- *Leioproctus* (*Ottocolletes*) *muelleri* Houston & Maynard, 2012.
- *Leioproctus* *idiotroptera* Packer, 2006 remains unplaced.

### New synonyms recognised in this publication

The following synonyms are recognised:

*Leioproctus* (*Zosterocolletes*) *advena* (Smith, 1862) = [*Paracolletes euphenax* Cockerell, 1913b; *Paracolletes scitulus* Cockerell, 1921; *Paracolletes advena phillipensis* Rayment, 1953];  
*Leioproctus* (*Leioproctus*) *amabilis* (Smith, 1879) = [*Paracolletes cupreus semipurpureus* Cockerell, 1905c; *Paracolletes carinatus* Cockerell, 1905c; *Paracolletes melbournensis* Cockerell, 1910a; *Paracolletes mimulus* Cockerell, 1910a; *Paracolletes ornatissimus* Cockerell, 1916b; *Paracolletes semipurpureus frenchi* Cockerell, 1929a; *Paracolletes festivus* Cockerell, 1929a; *Paracolletes amabilis rufipes* Cockerell, 1929a];  
*Leioproctus* (*Leioproctus*) *bicristatus* (Cockerell, 1929d) = [*Paracolletes melanurus* Cockerell, 1930; *Leioproctus* (*Leioproctus*) *melanoproctus* Michener, 1965];  
*Leioproctus* (*Leioproctus*) *cyaneorufus* (Cockerell, 1930) = [*Leioproctus* (*Leioproctus*) *unguidentatus* Michener, 1965];  
*Leioproctus* (*Lamprocolletes*) *dentiger* (Cockerell, 1910a) = [*Paracolletes subvigilans* Cockerell, 1914b];  
*Leioproctus* (*Lamprocolletes*) *chalybeatus* (Erichson, 1842) = [*Leioproctus vigilans* Smith, 1879; *Paracolletes diodontus* Cockerell, 1929c; *Nodocolletes dentatus* Rayment, 1931a: 165; *Nodocolletes subdentatus* Rayment, 1931a: 166];  
*Leioproctus* (*Leioproctus*) *cupreus* (Smith, 1853) = [*Paracolletes plumosellus* Cockerell, 1905c; *Paracolletes roseoviridis* Cockerell, 1905d; *Paracolletes nigroclypeatus* Cockerell, 1910a; *Paracolletes chalcurus* Cockerell, 1921; *Paracolletes nigroclypeatus hardyi* Cockerell, 1929d];  
*Leioproctus* (*Charicolletes*) *elegans* Smith, 1853 = [*Paracolletes caeruleotinctus* Cockerell, 1905c; *Paracolletes turneri* Cockerell, 1910a; *Paracolletes pictus* Rayment, 1930a];

*Leioproctus (Hadrocolletes) fulvus* (Smith, 1879) = [*Paracolletes megachalceus* Cockerell, 1913c];  
*Leioproctus (Leioproctus) irroratus* (Smith, 1853) = [*Dasycolletes humerosus* Smith, 1879];  
*Leioproctus (Exleycolletes) leai* (Cockerell 1913b) = [*Paracolletes humerosus cyanurus* Cockerell 1914c;  
*Paracolletes simillimus* Cockerell, 1916c; *Leioproctus (Leioproctus) simulator* Michener, 1965];  
*Leioproctus (Leioproctus) metallescens* (Cockerell, 1914b:44) [*Paracolletes atronitens* Cockerell, 1914b: 48];  
*Leioproctus (Leioproctus) nanus* (Smith, 1879) = [*Paracolletes nigrifulvus* Cockerell, 1916c];  
*Leioproctus (Leioproctus) nigrofulvus* (Cockerell 1914a) = [*Paracolletes franki* Cockerell, 1929a; *Leioproctus (Leioproctus) frankiellus* Michener, 1965];  
*Leioproctus (Leioproctus) obscurus* (Smith, 1853) = [*Paracolletes semilautus* Cockerell, 1905c; *Paracolletes hobartensis* Cockerell, 1906; *Paracolletes stewarti* Rayment, 1947];  
*Leioproctus (Leioproctus) opaculus* (Cockerell, 1929c) = [*Paracolletes semiviridis* Cockerell, 1930];  
*Leioproctus (Leioproctus) platycephalus* (Cockerell, 1912a) = [*Paracolletes truncatulus* Cockerell, 1913b;  
*Dasycolletes rufoaeneus* Friese, 1924; *Paracolletes nigropurpureus* Rayment, 1935];  
*Leioproctus (Leioproctus) plumosus* (Smith, 1853) = [*Lamprocolletes metallicus* Smith, 1879; *Lamprocolletes bicolor* Smith, 1879; *Paracolletes eucalypti* Cockerell, 1916a];  
*Leioproctus (Leioproctus) providellus* (Cockerell, 1905c) = [*Paracolletes obscuripennis* Cockerell, 1905c;  
*Paracolletes plebius* Cockerell, 1921; *Paracolletes providellus caeruleus* Cockerell, 1929a; *Paracolletes regalis* Cockerell, 1921];  
*Leioproctus (Leioproctus) providus* (Smith, 1879) = [*Paracolletes viridicinctus* Cockerell, 1905c; *Paracolletes helmsi* Cockerell, 1929c];  
*Leioproctus (Leioproctus) recusus* (Cockerell, 1921) = [*Paracolletes subviridis illawaraensis* Rayment, 1954];  
*Leioproctus (Zosterocolletes) ruficornis* (Smith, 1879) = [*Paracolletes velutinus* Cockerell, 1929c];  
*Leioproctus semiviridis* (Cockerell, 1929c) = [*Paracolletes semiviridis* Cockerell, 1930];  
*Leioproctus (Leioproctus) spatulatus* (Cockerell, 1905c) = [*Paracolletes providellus bacchalis* Cockerell, 1914a;  
*Paracolletes subviridis* Cockerell, 1915c; *Paracolletes pallidicinctus* Rayment, 1953];  
*Leioproctus (Exleycolletes) tuberculatus* (Cockerell, 1913b) = [*Paracolletes fascialis* Cockerell, 1921;  
*Paracolletes tuberculatus insularis* Cockerell, 1913b];  
*Goniocolletes abdominalis* (Smith, 1879) = [*Goniocolletes morsus* Cockerell, 1907; *Goniocolletes pallidus* Cockerell, 1915a, *Dasycolletes curvipes* Friese, 1924; *Goniocolletes simillimus* Rayment, 1935; *Goniocolletes proximus* Rayment, 1935; *Leioproctus (Goniocolletes) ruficaudus* Michener, 1965; *Leioproctus (Goniocolletes) similior* Michener, 1965];  
*Goniocolletes fimbriatus* (Smith, 1879) = [*Paracolletes clarus* Rayment, 1935];  
*Goniocolletes subdolosus* (Cockerell, 1913b) = [*Leioproctus (Goniocolletes) dolosus* Michener, 1965].

### New species and subgenera described in this publication

New species of *Leioproctus*: *Leioproctus (Minycolletes) aquilus* Maynard, sp.n.; *Leioproctus (Leioproctus) crinitus* Maynard, sp.n.; *Leioproctus (Minycolletes) eruditus* Maynard, sp.n.; *Leioproctus (Minycolletes) exiguus* Maynard, sp.n.; *Leioproctus (Charicolletes) exleyae* Maynard, sp.n.; *Leioproctus (Minycolletes) insitus* Maynard, sp.n.; *Leioproctus (Leioproctus) litotes* Maynard, sp.n.; *Leioproctus (Minycolletes) paulus* Maynard, sp.n.; *Leioproctus (Minycolletes) pygmaeus* Maynard, sp.n.; *Leioproctus (Leioproctus) quadrimaculatus* Maynard, sp.n.; *Leioproctus (Fragocolletes) rutiliventris* Maynard, sp.n.; *Leioproctus (Charicolletes) saltus* Maynard, sp.n.; *Leioproctus (Alokocolletes) sequax* Maynard, sp.n.

New species of *Goniocolletes*: *Goniocolletes anthedonus* Maynard, sp.n.; *Goniocolletes badius* Maynard, sp.n.; *Goniocolletes ciliatus* Maynard, sp.n.; *Goniocolletes comatus* Maynard, sp.n.; *Goniocolletes dasypus* Maynard, sp.n.; *Goniocolletes parvus* Maynard, sp.n.; *Goniocolletes rugosus* Maynard, sp.n.

New subgenera of *Leioproctus* described in this paper: *Leioproctus (Alokocolletes)* Maynard, subg.n.; *Leioproctus (Charicolletes)* Maynard, subg.n.; *Leioproctus (Exleycolletes)* Maynard, subg.n.; *Leioproctus (Fragocolletes)* Maynard, subg.n.; *Leioproctus (Hadrocolletes)* Maynard, subg.n.; *Leioproctus (Minycolletes)* Maynard, subg.n.; and *Leioproctus (Zosterocolletes)* Maynard, subg.n.

### Major characters used

Grouping of species into genera, subgenera and species-groups was based on a broad range of characters.

The major characters used include the following:

- Female facial foveae: When present, they are usually broad and diffuse. They are impressed in *Goniocolletes* and 2 subgenera of *Leioproctus*—*L. (Protomorpha)* and *L. (Charicolletes)*. No *Leioproctus (Leioproctus)* have impressed facial foveae.
- Antennal flagellar length of males: Usually F4–F11 are longer than wide. However in *Leioproctus (Odontocolletes)*, *Leioproctus (Excolletes)*, *Leioproctus (Minycolletes)*, *Leioproctus (Leioproctus) capito*-species group and most species in *Leioproctus (Protomorpha)* the length of each flagellomere is less than or equal to the width. In these groups as well as in *Leioproctus (Fragocolletes)* the scape does not reach the median ocellus.
- Structure of the clypeus: In two groups the clypeus is significantly different. In *Leioproctus (Cladocerapis)* the clypeus is shallowly depressed and often polished medially with the frons depressed either side of the frontal line. In *Leioproctus (Ceratocolletes)* the clypeus bears a weak, longitudinal median ridge.
- Malar space: There is at least a small malar space present in *Goniocolletes* and in all *Leioproctus (Leioproctus)* except for a few species in the *irroratus* and *spatulatus* species-groups. A malar space is absent in other subgenera except in *L. (Exleycolletes)*, *L. (Hadrocolletes)*, and *L. (Lamprocolletes)*.
- Labial palps: Both the maxillary and labial palps of *Leioproctus* usually reach to about the apex of the extended glossa. In a few cases, the palps are much longer than this; such as in *Leioproctus (Leioproctus) capito*-species group; *Leioproctus (Odontocolletes) asper* and *Leioproctus (Filiglossia) filamentosa*. The elongation of the palps is usually associated with feeding on a flower with restricted access to the nectaries.
- Sculpture of the frons: The frons usually has dense, small, weak punctures with granular or coriaceous interspaces. In the *Leioproctus (Leioproctus) amabilis*, *macmillani*, *platycephalus*, *spatulatus* species-groups, several species in the *irroratus* species-group and *L. (Cladocerapis)* the frons is rugulose (*i.e.* there are many fine longitudinal wrinkles at times intersecting). The head and usually the dorsal mesosoma have strong punctures with smooth interspaces in *L. (Odontocolletes)*, *L. (Ceratocolletes)*, *L. (Exleycolletes)*, *L. (Hadrocolletes)*, *L. (Charicolletes)*, *L. (Excolletes)*, *L. (Lamprocolletes)*, *L. (Protomorpha)*, *L. (Fragocolletes)* and the majority of species in *L. (Minycolletes)*.
- Vestiture of the face: Most groups have moderately dense, long, semi-erect, weakly branched, whitish hair. In the males of some groups, the hair is useful in indicating affinities, *e.g.* in *Leioproctus (Protomorpha)* and *Leioproctus (Exleycolletes)*, it is dense and appressed on some areas of the face; whereas in *Ceratocolletes* particularly on the clypeus, it is dense, golden and erect.
- Metanotal tubercle: A metanotal tubercle is present in seven subgenera of *Leioproctus*—*L. (Odontocolletes)*, *L. (Exleycolletes)*, *L. (Hadrocolletes)*, *L. (Charicolletes)*, *L. (Lamprocolletes)*, *L. (Protomorpha)* and *L. (Fragocolletes)*, but is absent in all *Leioproctus (Leioproctus)*. Within these groups the tubercle is not always of the same proportion, it may be very small or moderately large within the one group.
- Structure of the propodeal triangle: In a few species-groups of *Leioproctus (Leioproctus)* (*e.g.* *amabilis* and *platycephalus* species-groups) as well as several subgenera (*Odontocolletes*, *Exleycolletes*, *Protomorpha* and *Fragocolletes*) the basal area of the propodeal triangle is clearly defined by a transverse carina. When the basal area is clearly defined, frequently it is somewhat more strongly sculptured than the rest of the propodeal triangle.
- Forewing: In most groups the pterostigma is broad and longer than 0.5 x length of the costal margin of the forewing. In the genus *Goniocolletes*, the subgenus *L. (Zosterocolletes)*, and one species-group of *Leioproctus (Leioproctus)*, there is a narrow, parallel-sided pterostigma that is less than half the length of the costal margin of the marginal cell.
- Hindwing: The jugal lobe reaches to or beyond cu-a in the majority of Australian *Leioproctus*. In the *platycephalus* species-group, *L. (Ceratocolletes)*, *L. (Lamprocolletes)*, and the type species from New Zealand [*Leioproctus (Leioproctus) imitatus*] the jugal lobe does not reach cu-a.
- Hind basitibial plates (females): All groups, except *L. (Excolletes)* and *L. (Lamprocolletes) dentiger*, have a basitibial plate in which the margin is completely carinate. The length of the basitibial plate is usually between 0.2–0.25 x length of the tibia. In the *nigrofulvus* species-group and *L. (Zosterocolletes)* the basitibial plate is less than 0.2 x length of the tibia. The *platycephalus* species-group, *L. (Minycolletes)*, *L. (Odontocolletes)*, *L. (Ceratocolletes)*, *L. (Leioproctus) capito* species-group, *L. (Lamprocolletes)*, *L. (Protomorpha)* and *Goniocolletes* have a hind basitibial plate 0.25–0.3 x the length of the tibia. The hind basitibial plate is present in nearly males, except *L. (Lamprocolletes) dentiger* where the carina is incomplete.
- Hair type of female hind tibial scopa—Although there are often several regions of hair types within the scopa, most of the hair is of a single type and is consistent throughout a group.
- Female inner hind tibial spur: The majority of Australian species of *Leioproctus* have a strongly toothed, inner hind tibial spur. Although the precise number of teeth on a spur varies, not only within a group but also within a species, the variation is not so great that the number of teeth on a spur is irrelevant. The type of teeth arrangement, *i.e.*, long, slender and closely approximated or stout and broadly spaced, is consistent within a group.
- Pygidial plate: Normally in males the pygidial area is undifferentiated from the rest of T7. Where a differentiated pygidial area is present it is usually a bare, longitudinal area. In some *L. (Odontocolletes)* the area is defined by a carinate margin. All females have a distinct pygidial plate sculpture and at times its width is indicative of a group. It is rugulose in two subgenera, *L. (Protomorpha)* and *L. (Charicolletes)* and narrow in four subgenera (*L. (Zosterocolletes)*, *L. (Ceratocolletes)*, *L. (Hadrocolletes)*, *L. (Excolletes)*), and one species-group (*nigrofulvus* species-group).
- Male sternal fringes: Although most male *Leioproctus* do not have apical fringes on the metasomal sterna, in those that do the combination and type of fringes of S3–S5 indicate group affinities.
- Length of gonobase (males). In all *Leioproctus (Leioproctus)*, except *L. (L.) nigrofulvus*, the dorsal length of the gonobase is about 0.2–0.25 x the length of the genitalia; in *L. (Odontocolletes)* and *L. (Lamprocolletes) dentiger* the dorsal length of the gonobase is about 0.1 x length of the genitalia.
- Shape and vestiture of the gonoforceps (males): *L. (Charicolletes)* is unique in having the dorsal angle of the gonoforceps

strongly produced, usually in the form of a spine. In *Leioproctus* (*Leioproctus*) the apices of the gonoforceps are about half the width of the basal area; in some species of the subgenera *L. (Cerato-colletes)* and *L. (Lampro-colletes)* they are narrower.

- Male penis valves: The penis valves of *Leioproctus imitatus*, the *Leioproctus (Leioproctus) amabilis, irroratus, spatulatus* species-groups and *L. (Cladocerapis)* have a ventral lobe or spine. The penis valves of *L. (Odontocolletes)* and *L. (Lamprocolletes) dentiger* project well beyond the apices of the gonoforceps. Shape and direction of the apices, as well as the type of ornamentation of the penis valves are usually characteristic of a group or subgenus.
- Volsellae (males): *L. (Odontocolletes)*, *L. (Cerato-colletes)* and *L. (Lamprocolletes) dentiger* have the digitus expanded posteriorly, whereas in *L. (Charicolletes)* the digitus is expanded dorsally.
- Male S7: The number of lobes is consistent within a group. *L. (Leioproctus)* only have two apical lobes whereas *L. (Zosterocolletes)*, *L. (Alokocolletes)*, *L. (Cerato-colletes)* and *L. (Excolletes)* have four apical lobes; similarly the shape and ornamentation is of similar type throughout a group, some more so than others. In the *Leioproctus (Leioproctus) platycephalus* species-group apical lobes vary only in the number of hairs and spines, in *L. (Protomorpha)* they are complex and differ between species.
- Male S8: Although the majority of groups have a median process that is moderately broad and readily differentiated from the rest of the sclerite, in a few groups, such as *L. (Charicolletes)*, it is poorly differentiated. *Goniocolletes* spp. have long, dense, thick, often plumose hair from the apical area of the median process.

Other characters that occur uniquely within a group, such as F1 being longer than the following two flagellomeres in *L. (Alokocolletes)* are used, but are not of significance throughout the rest of the *Leioproctus* revised.

### Key to Australian genera of Paracolletini

This key omits the monobasic *Hesperocolletes*, it is reputedly distinguished by the nature of the claws. This key is based on those previously provided by Michener (1965, 2007)

- |   |   |                                       |
|---|---|---------------------------------------|
| 1 | Hind basitibial plate clearly defined laterally, carinate and/or pterostigma broad . . . . .  | 2                                     |
| – | Hind basitibial plate ill-defined, not carinate laterally; pterostigma narrow, parallel sided . . . . .   | 7                                     |
| 2 | Metasoma with yellow integumental markings; antennal scape of male expanded . . . . .   | <i>Neopasiphae</i> Perkins, 1912      |
| – | Metasoma without yellow integumental markings; antennal scape of male not expanded . . . . .  | 3                                     |
| 3 | Apex of the marginal cell of forewing on wing margin; wings reaching apex of metasoma . . . . .   | <i>Callomelitta</i> Smith, 1853       |
| – | Apex of the marginal cell of forewing divergent from wing margin; wings reaching middle of metasoma . . . . .   | 4                                     |
| 4 | Female hind basitibial plates covered in dense fine, branched hairs; median process of S8 of males confluent with the rest of segment . . . . .   | <i>Goniocolletes</i> Cockerell, 1907  |
| – | Female hind basitibial plates not covered in dense, fine, branched hairs; median process of S8 of males distinctly narrower than the rest of segment . . . . .  | 5                                     |
| 5 | Surface of metasoma sericeous, with fine appressed golden hair, apical tergal margins opaque, pale in contrast to dark basal area . . . . .   | <i>Chrysocolletes</i> Michener, 1965  |
| – | Surface of metasoma not sericeous, apical tergal margins not opaque and pale or contrasting to basal area, but may be translucent . . . . .   | 6                                     |
| 6 | Ocelli not at summit of vertex; body hair short, fine and appressed; hair on the posterior region of female hind tibia short; female inner hind tibial spur with short, widely spaced, stout teeth . . . . .  | <i>Phenacolletes</i> Cockerell, 1905  |
| – | Ocelli almost at summit of vertex (except for a few males of <i>L. (Leioproctus) capito</i> species-groups); body hair long, branched; hair on posterior region of female hind tibia long; female inner hind tibial spur with ciliate or pectinate teeth (teeth longer than diameter of spur) . . . . . | <i>Leioproctus</i> Smith, 1853        |
| 7 | Labrum as long as or longer than width; female inner hind tibial spur with several long, fine teeth originating from more or less the 1 point (almost palmate); female mandibles bidentate; apex of glossa strongly emarginate . . . . .  | <i>Trichocolletes</i> Cockerell, 1912 |
| – | Labrum shorter than width; female inner hind tibial spur ciliate, teeth originating individually along the length of the shaft (serial); female mandibles tridentate; apex of glossa more or less truncate . . . . .  | <i>Paracolletes</i> Smith, 1853       |

### Key Australian subgenera of *Leioproctus* with three submarginal cells and *Leioproctus opaculus* (subgenus *incertae sedis*)

This key is based on those previously provided by Michener (1965, 2007)—it includes one species (*Leioproctus opaculus* that is *incertae sedis* for subgeneric placement)

- |   |  |   |
|---|--|---|
| 1 | Jugal lobe of hind wing not reaching level of cu-a . . . . .                       | 2 |
| – | Jugal lobe of hind wing reaching level of cu-a . . . . .                           | 5 |
| 2 | Surface texture of metasoma with strong punctures and smooth interspaces . . . . . | 3 |



–	Surface texture of metasoma with weak punctures and granular or coriaceous interspaces . . . . .	<i>Leioproctus s.str.</i> Smith, 1853 (part)
3	Malar space absent; female metasoma with apical tergal hair bands . . . . .	<i>Leioproctus (Ceratocolletes)</i> Michener 1965
–	Malar spaces present; female metasoma without apical tergal hair bands . . . . .	4
4	Metanotal tubercle present . . . . .	<i>Leioproctus (Lamprocolletes)</i> (Smith, 1853)
–	Metanotal tubercle absent . . . . .	<i>Leioproctus opaculus</i> (Cockerell, 1929)
5	Stigma less than half the length of costal margin of marginal cell . . . . .	6
–	Stigma greater than or equal to half the length of costal margin of marginal cell . . . . .	7
6	Frons not rugulose; female metasoma with apical hair bands; male S7 with 4 apical lobes . . . . .	<i>Leioproctus (Zosterocolletes)</i> subgen.n.
–	Frons rugulose; female metasoma without apical hair bands; male S7 with 2 apical lobes . . . . .	<i>Leioproctus s.str.</i> (part)
7	Head and mesosoma with strong punctures and polished interspaces . . . . .	8
–	Head and mesosoma weak punctures and polished interspaces . . . . .	15
8	Malar space present; female tibial scopal hairs monopodally branched . . . . .	9
–	Malar space absent; female tibial scopal hairs plumose . . . . .	10
9	Propodeal triangle vertical, coriaceous or granular . . . . .	<i>Leioproctus (Hadrocolletes)</i> subgen.n.
–	Propodeal triangle with transversely-rugose, sloping basal area . . . . .	<i>Leioproctus (Exleycolletes)</i> subgen.n.
10	Facial foveae impressed . . . . .	11
–	Facial foveae absent or not impressed . . . . .	12
11	Female T2–T4 with narrow apical hair bands; male scape not reaching median ocellus . . . . .	<i>Leioproctus (Protomorpha)</i> (Rayment, 1959)
–	Female T2-4 without hair bands; male scape reaching median ocellus . . . . .	<i>Leioproctus (Charicolletes)</i> subgen.n.
12	Propodeal triangle with areolate basal area . . . . .	13
–	Propodeal triangle without areolate basal area . . . . .	14
13	Labrum with depressed apical area; male F4–10 length about equal to width; metasomal apical tergal margins translucent . . . . .	<i>Leioproctus (Odontocolletes)</i> Maynard, 1997
–	Labrum without depressed apical area; male F4–F10 length greater than width; metasomal apical tergal margins opaque . . . . .	<i>Leioproctus (Fragocolletes)</i> subgen.n.
14	Basal vein almost transverse; female metasoma with apical hair bands; female inner hind tibial spur ciliate; male S7 4 apical lobes . . . . .	<i>Leioproctus (Excolletes)</i> Michener, 1965
–	Basal vein oblique; female metasoma without apical hair bands; female inner hind tibial spur pectinate; male S7 2 apical lobes . . . . .	<i>Leioproctus (Minycolletes)</i> subgen.n.
15	F1 length much greater than width . . . . .	<i>Leioproctus (Alokocolletes)</i> subgen.n.
–	F1 length less than or equal to width . . . . .	16
16	Clypeus and supraclypeal area flat to shallowly depressed, often polished medially . . . . .	<i>Leioproctus (Cladocerapis)</i> Cockerell, 1904
–	Clypeus and supraclypeal area convex, not polished medially . . . . .	17
17	Arolia absent . . . . .	<i>Leioproctus (Urocolletes)</i> Michener, 1965
–	Arolia present . . . . .	18
18	Dorsolateral angles of pronotum much elevated above adjacent scutal surface so that pronotal margin between them is concave . . . . .	<i>Leioproctus (Colletopsis)</i> Michener, 1965
–	Dorsolateral angles of pronotum weak or absent, dorsal margin of pronotum not concave . . . . .	19
19	S8 of male with two flat, delicate, apical processes, longer than body of sternum; supraclypeal area with longitudinal, strongly elevated, impunctate, shining carina or broad ridge extending from frontal carina down to upper margin of clypeus; distal three antennal segments of male modified . . . . .	<i>Leioproctus (Glossurocolletes)</i> Michener, 1965
–	Eighth metasomal sternum of male ending in a single, heavily sclerotized, apical process; supraclypeal area broadly convex, median area sometimes impunctate; antennal segments rarely modified . . . . .	<i>Leioproctus s.str.</i> Smith, 1853 (part)

Couplets 17, 18 are adopted from Michener 1965 and 19 from Michener 2007. Specimens of *Urocolletes* and *Colletopsis* were not examined. The four species contained in these subgenera are only known from the type material. The species descriptions provided by Michener (1965) are very detailed and the only known material is that which Michener (1965) saw at the time of description. Therefore it is considered that redescribing the species and subgenera from this material would make no further contribution.

### ***Leioproctus (Leioproctus)* Smith**

*Leioproctus* Smith, 1853: 8; Michener, 1965: 39; Michener, 1990: 641. Type species: *Leioproctus imitatus* Smith, 1853: 9, by designation of Cockerell, 1905a: 348.

*Dasycolletes* Smith, 1853: 14. Type species: *Dasycolletes metallicus* Smith, 1853 by designation of Cockerell,

1905a: 347. [synonymised under *Paracolletes*, along with *Leioproctus*, by Cockerell (1905a); removed from synonymy under *Paracolletes*, but still synonymised under *Leioproctus* by Michener, (1965)]

### Diagnosis

Female facial foveae not impressed; scape reaching median ocellus; male flagellum long, male facial hair not appressed; metanotum not produced; apical hair bands absent.

*Body*—Length *ca.* 4–16 mm; integument usually black or brown non-metallic, although some species are metallic blue, red, green to cupreus, particularly the metasoma. *Head*—Ocelloccipital area flat; female facial foveae present, at times weak, but never absent; frons flat with a carinate frontal line; clypeus shallowly convex; malar space small. *Mesosoma*—Metanotum not protuberant; propodeal triangle usually without defined basal area. Legs without structural ornamentation of integument with segments straight; margin of hind basitibial plate entirely carinate; inner hind tibial spur ciliate or pectinate. Wings with 3 submarginal cells, first recurrent vein entering second submarginal cell usually basally or medially; pterostigma broad, length half the costal margin of marginal cell or more; jugal lobe of hind wing reaching cu-a or not. *Metasoma*—Surface weakly sculptured; female prepygidial fimbria broad, dense; male without carinate pygidium; males usually without apical sternal fringes. Male S7 with 2 apical lobes. S8 with clearly defined median process. Genitalia with gonobase 0.2–0.3 x length of genitalia; gonoforceps relatively simple; volsellae small, digitus not extended.

*Note.* Although *Leioproctus opaculus* is presently placed in *Leioproctus (Leioproctus)*, it is likely that it will eventually be placed elsewhere. It is very different from other *Leioproctus (Leioproctus)*. Some of the distinguishing characters include a very short anal lobe and a distinctive surface texture. *Leioproctus semiviridus* is a synonym of *Leioproctus opaculus*.

It has been possible to divide *Leioproctus (Leioproctus)* into several species groups. The six of these that include the most commonly collected *Leioproctus* in Australia are described here. Those groups with ciliate hind tibial spurs, as in *Leioproctus (L.) imitatus*, are not included (a detailed description of *Leioproctus (Leioproctus) imitatus* can be found in Donovan (2007)).

### Key to species-groups of Australian *Leioproctus (Leioproctus)* revised in this study

- |   |   |   |
|---|---|---|
| 1 | Pterostigma less than half length of costal margin of marginal cell . . . . .   | <i>macmillani</i> species- group          |
| – | Pterostigma more than half length of costal margin of marginal cell . . . . .   | 2   |
| 2 | Propodeal triangle with basal area defined by a carina . . . . .  | 3   |
| – | Propodeal triangle with basal area not defined by a carina . . . . .  | 4   |
| 3 | Jugal lobe of hind wing reaching cu-a . . . . .   | <i>amabilis</i> species-group             |
| – | Jugal lobe of hind wing not reaching cu-a . . . . .   | <i>platycephalus</i> species-group        |
| 4 | Basal area of propodeal triangle longer than length of metanotum; small to medium-sized, slender, sparsely haired bees . . . . .  | <i>irroratus</i> species-group            |
| – | Propodeal triangle vertical or basal area shorter than length of metanotum; medium-sized to large, hairy bees. . . . .  | 5   |
| 5 | Female pygidial plate narrow, almost convex; malar space absent; male S5 with fringe . . . . .  | <i>nigrofulvus</i> species-group          |
| – | Female pygidial plate broad, flat; malar space usually present; short, male S5 without fringe . . . . .   | 6   |
| 6 | Small to medium-sized (7–11 mm) black or dark brown bees; general body sculpture of small, dense, distinct punctures with smooth to coriaceous interspaces; vestiture of long, fine hair with many, moderately long branches. Males with spine subapically on inner margin of gonoforceps . . . . . | <i>spatulatus</i> species-group           |
| – | General body sculpture with punctures medium to large, or punctures small and moderately to widely spaced or small and dense with interspaces shiny. Males without spine subapically on inner margin of gonoforceps . . . . .   | <i>Leioproctus (Leioproctus) unplaced</i> |

#### *Leioproctus (Leioproctus) amabilis*-species group

This group of seven species is found throughout Australia with some species having very wide distributions. They are frequently collected from *Eucalyptus* spp. Recognition that different colour forms in a single species are common has resulted in much synonymy. All have a metallic blue/green head and mesosoma, unlike the majority of Australian *Leioproctus*, in which the head and mesosoma are non-metallic black.

*Diagnosis*—Moderate-sized bees with head and mesosoma metallic blue-green, and metasoma metallic coloured; female with clearly defined facial foveae; frons with weak longitudinal ridges; propodeal triangle with clearly defined basal area; male genitalia with penis valves with ventral hooks.

*Description*—Length 5–15 mm, hair long, fine, much-branched with long branches. *Head*—Vertex not extended dorsally; frons with weak longitudinal striae with moderate sized, shallow punctures between; frontal line, if depressed, only so dorsally, carinate on lower 0.5; inner eye margins parallel except where they converge slightly at level of ocelli; width of paraocular area and interantennal distance about equal; male F1–2 with length less than width, F3–11 length greater or equal to width; scape reaching beyond median ocellus; apex of supraclypeal area sharply raised; epistomal suture distinct; clypeus weakly convex with moderately dense to dense, large punctures with smooth to granulose interspaces; malar space glabrous, length up to half width of base of mandible; maxillary and labial palpal segments subequal in length, well sclerotised; labrum with short triangular basal area, with narrow depressed apical strip. *Mesosoma*—General sculpture of scutum and scutellum small, dense punctures with granulose interspaces, often with posterior medial area of scutum and anterior medial area of the scutellum impunctate and sparsely haired; propodeal triangle with basal area subhorizontal, clearly defined usually by transverse carina, basal area as long as metanotum, surface strongly coriaceous. Forewings: Marginal cell with slender apex curved from costal margin for about 0.1 length of costa; membrane clear. Legs of female with hind tibial scopa dense to very dense, hair of posterior area with branches from 1 side, usually with 1 row, occasionally with two rows; female inner hind tibial spur with 5–10 long, slender, closely approximated teeth; fore tibial spur with apex about as long as velum; female claws with moderate to large, basal to medial inner ramus; male claws with large, medial inner ramus; female hind basitibial plate 0.2–0.25 length of tibia, moderately to densely covered by long, thick, simple hairs; male legs unmodified, slender with moderately dense hairs and no scopae. *Metasoma*—punctuation dense and small, with coriaceous interspaces; apical margin opaque with sparse punctures and coriaceous interspaces; female pygidial plate coriaceous; males without pygidial plate, a couple of species with T7 denudate medially; males without sternal fringes; female sternal hair long, moderately dense, plumose. Male genitalia with gonobase about 0.2 x length of genitalia, genital foramen large; gonoforceps simple without spines or teeth; volsellae small (0.2–0.25 x length of genitalia), cusp and digitus not expanded; penis valves relatively simple with at least 1 ventral median hook; apices of penis valves reaching to, but not beyond, apices of gonostyles. S8 with simple median lobe and sparse hair dorsally. S7 with moderately large, flat to strongly arched apical lobes; attachment of apical lobes moderately broad; median area moderate (about a quarter length of apical lobes); anterior apodemes angled with broad bases.

### Key to species in the *Leioproctus (Leioproctus) amabilis* species-group

- |   |   |   |
|---|---|---|
| 1 | Scutellar hair orange . . . . .   | <i>Leioproctus (Leioproctus) friesellus</i> Michener, 1965  |
| – | Scutellar hair white, yellow or pale brown . . . . .  | 2   |
| 2 | Metasomal terga with long, branched hair, particularly on T2 (and T1) . . . . .   | <i>Leioproctus (Leioproctus) cupreus</i> (Smith, 1853)      |
| – | Metasomal terga with short, simple hair, particularly on T2 . . . . .   | 3   |
| 3 | Female with apical margin of pygidial plate rounded or truncate; male legs all dark . . . . .   | 4   |
| – | Female with apical margin of pygidial plate emarginate; males with at least anterior surfaces of fore tibia yellow to pale brown (i.e., distinctly paler than rest of leg) . . . . .  | 5   |
| 4 | Metasoma olive-brown; female with posterior tibial scopa whitish; male S7 apical lobes flat, with an apical patch of fine hairs . . . . .   | <i>Leioproctus (Leioproctus) clarki</i> (Cockerell, 1929)   |
| – | Metasoma dark metallic blue; female with entire tibial scopa black; male S7 apical lobes arched with long, spines on the interior . . . . .   | <i>Leioproctus (Leioproctus) carinatus</i> (Smith, 1853)    |
| 5 | Length of female about 9 mm; Length of male about 7 mm; female scutellar hair yellow, moderate length; male T7 with scattered hairs; male S7 apical lobes with ventral, apical patch of hair; metasoma red, gold, green or blue . . . . .                                   | <i>Leioproctus (Leioproctus) amabilis</i> (Smith, 1879)     |
| – | Length of female about 11 mm; Length of male about 7 mm; female scutellar hair whitish to pale brown, long; male T7 with denudate median area; male S7 apical lobe bare with small dorsal, apical tubercle; metasomal entirely and exclusively dark metallic blue . . . . . | 6   |
| 6 | Malar space length more than a third width of mandible . . . . .  | <i>Leioproctus (Leioproctus) boroniae</i> (Cockerell, 1921) |
| – | Malar space length less than a third width of mandible . . . . .  | <i>Leioproctus (Leioproctus) plumosus</i> (Smith, 1853)     |

### *Leioproctus (Leioproctus) amabilis* (Smith, 1879)

*Lamprocolletes amabilis* \*Smith 1879: 9; Dalla Torre 1896: 47.

*Paracolletes amabilis* (Smith). Cockerell 1905a: 345; 1905c: 481; 1906: 28; 1916b: 200; 1929c: 199; 1934: 21.

*Paracolletes cupreus semipurpureus* \*Cockerell 1905c: 479; 1906: 28; 1910a: 203, 205. **syn.n.**  
*Paracolletes semipurpureus*; Cockerell 1910a: 206; 1914c: 139; 1916b: 200; 1934: 35; Rayment, 1953: 5.  
*Paracolletes carinatus* \*Cockerell 1905c: 481; 1906: 28; 1934: 23. **syn.n.**  
*Paracolletes melbournensis* \*Cockerell 1910a: 205, 206; 1913a: 599; 1913b: 281; 1914a: 140; 1915c: 104; 1921: 91, 97; 1929b: 10; 1929d: 308; 1934: 29. Rayment 1935: 182; 1939: 276; 1953: 3. **syn.n.**  
*Paracolletes mimulus* \*Cockerell 1910a: 206; 1934: 30. Rayment 1953: 3. **syn.n.**  
*Paracolletes ornatissimus* \*Cockerell 1916b: 200. **syn.n.**  
*Paracolletes semipurpureus frenchi* \*Cockerell 1929a: 1; 1934: 35. **syn.n.**  
*Paracolletes festivus* \*Cockerell 1929a: 6; 1934: 26. **syn.n.**  
*Paracolletes amabilis rufipes* \*Cockerell 1929c: 199; 1934: 21. **syn.n.**  
*Paracolletes semipurpureus ornatissimus* Cockerell 1934: 35.  
*Leioproctus (Leioproctus) amabilis* (Smith). Michener 1965: 50.  
*Leioproctus (Leioproctus) carinatus* (Cockerell). Michener 1965: 50.  
*Leioproctus (Leioproctus) festivus* (Cockerell). Michener 1965: 50.  
*Leioproctus (Leioproctus) frenchi* (Cockerell). Michener 1965: 50.  
*Leioproctus (Leioproctus) melbournensis* (Cockerell). Michener 1965: 51.  
*Leioproctus (Leioproctus) mimulus* (Cockerell). Michener 1965: 51.  
*Leioproctus (Leioproctus) ornatissimus* (Cockerell). Michener 1965: 51.  
*Leioproctus (Leioproctus) rufipes* (Cockerell). Michener 1965: 52.  
*Leioproctus (Leioproctus) semipurpureus* (Cockerell). Michener 1965: 52, figs 80–82.

#### Types

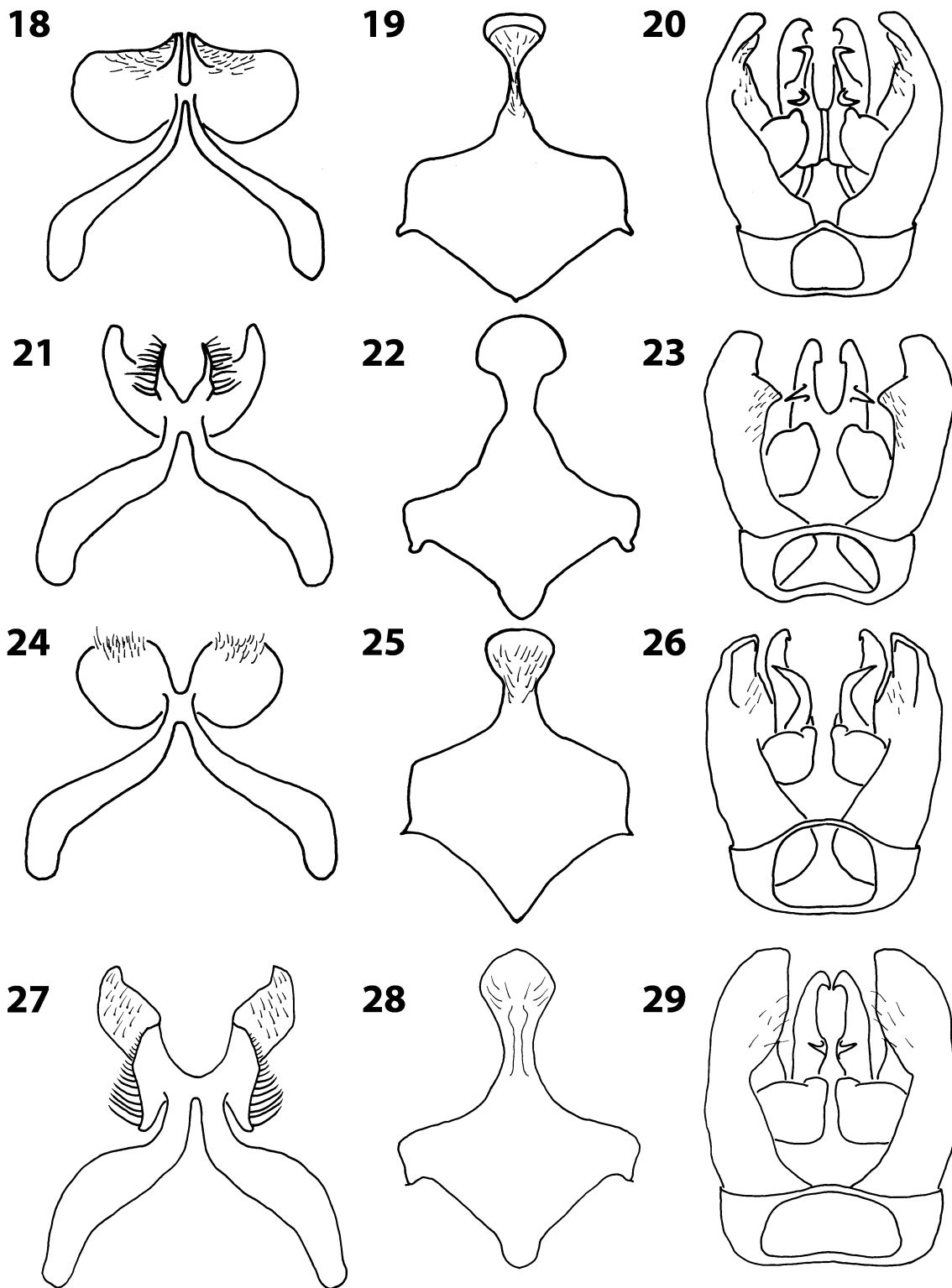
*Lamprocolletes amabilis*—holotype ♀, N. Holl.(sic) [= New Holland] (BMNH 17a.515).  
*Paracolletes cupreus semipurpureus*—Queensland: holotype ♀, Ridge N98, Mackay, G. Turner (BMNH 17a.490).  
*Paracolletes carinatus*—Queensland: holotype ♂, Mackay, G. Turner (BMNH 17a. 425).  
*Paracolletes festivus*—New South Wales: holotype ♂, Sydney, 14.ix.1906, Frank (AMNH).  
*Paracolletes mimulus*—Victoria: holotype ♀, (BMNH 17a.442).  
*Paracolletes melbournensis*—Victoria: holotype ♀, Melbourne, Rolle (ZMB).  
*Paracolletes ornatissimus*—Queensland: holotype ♀, Oxley, Brisbane, 24.ix.1914, H. Hacker (BMNH 17a.483).  
*Paracolletes frenchi*—Victoria: holotype ♀, Rutherglen, French, 1904 (BMNH 17a.491).  
*Paracolletes rufipes*—New South Wales: holotype ♂, Berowa, near Hawkesbury River, 11.xii.1923, T.G. Campbell (AM).

The holotypes of *Lamprocolletes amabilis*, *Paracolletes melbournensis*, *Paracolletes frenchi*, *P. mimulus*, *P. ornatissimus*, and *P. semipurpureus* are all females and show no significant morphological variation. The types of *Paracolletes carinatus*, *P. festivus* and *P. rufipes*, which are all males, are the same as those males associated with *Lamprocolletes amabilis* by morphological similarity and coincident collection data. Undoubtedly the large number of synonymies are the result, in part, of the abundance and extensive distribution and variability in the colour of the metasoma.

**Additional material examined:** 111♀, 135♂ **Queensland:** Timberlea via Atherton; Herberton Range SF 8 miles (12.8 k) from Atherton; Mareeba; 26 miles (41.6 k) W Mt Garnet; 9 miles (14.4 k) W Paluma; 20 miles (32 k) S Bowen; Mt Moffat Summit; Mackay; Ridge N98, Mackay; 12 k S Capella; 16 k W Yeppoon; 11 k W Emerald; Silver Valley; 40 miles (64 k) W Rockhampton; 45 k S Rockhampton; 87 k S Rockhampton; 5 k NE Springsure; 25 k S Biloela; 38 k S Monto; 28 k S Maryborough; Noosa Heads; Bluff Range, Biggenden; Bunya Mts; Morven; near Pomona; Eumundi; 15 k W Biggenden; Wooroolin, 16 k N Kingaroy; Yuleba, 38 miles (60.8 k) E Roma; Yuleba, 38 miles (60.8 k) E Roma; 6 miles (9.6 k) W Chinchilla; 7 k N Kingaroy; 1 k N Memerambi via Kingaroy; Landsborough; Caloundra; 2 miles (3.2 k) W Maidenwell; 1 k N Condamine; 1 mile (1.6 k) N Caboulture; Bribie I.; 13 k NW Crows Nest; Brisbane; Oxley, Brisbane; Sunnybank, Brisbane; Corinda, Brisbane; St. Lucia, Brisbane; Mt Gravatt; Capalaba; Taringa; Ipswich; Toowoomba; Amiens; Cunninghams Gap; Gatton; 29 k E Texas; 26 k W Stanthorpe; Barney Ck; Leyburn; Warwick; Mt Lindsay; Stanthorpe; Mt Emilesyn; Leyburn via Warwick; 37 k W Warwick; 25 k E Bollon; 15 k S Leyburn; Milmerran; 65 k SW Brisbane; Milmerran; 15 k SW Stanthorpe; Dalveen; Wybera NP. **New South Wales:** Legume; Nyngan; 2 k W Nyngan; 55 k NW Nyngan; 21 k E Narrabri; Liston; Mt Boppy; Sutherland; Epping; 1 mile (1.6 k) S Mt Tindery; Sydney; Berowra, near Hawksbury R; Como; Frenchs Forest Sydney; 10 miles (16 k) Bowning; Caldwell; Bargo; Mt Gosford; Laguna; 6 miles (9.6 k) W Amosfield; 4 miles (6.4 k) W Amosfield; 4-Mile Ck, W of Wollomombi; Coonabarabran; Gilgandra; Cobar; Wisemans Ferry. Australian Capital Territory: Black Mountain. **Victoria:** Murray River, 15 miles (24 k) NE Hattah; Murrabit; Kerang; Normanville; Quantong; Rutherglen. **South Australia:** Wilpena. **Northern Territory:** 27 k NW Alice Springs.

**Collection months:** This species has been collected in every month of the year.

**Floral visitations:** Myrtaceae: *Eucalyptus* spp., *Melaleuca* spp.



**FIGURES 18–29.** Male S7–8 and genitalia *Leioproctus* (*Leioproctus*). Figs 18–20 *L.(L.) amabilis* S7, S8, genitalia. Figs 21–23 *L.(L.) carinatus* S7, S8, genitalia. Figs 24–26 *L.(L.) clarki* S7, S8, genitalia. Figs 27–29 *L.(L.) cupreus* S7, S8, genitalia.

*Femal*—Length ca 8 mm. *Head*—Frontal line weakly carinate at upper area; flagellum pale anteriorly; clypeus with polished interspaces; length of malar space about 0.25 x width of base of mandible. *Mesosoma*—Hair yellow, moderate length with short, dense branches; propodeal triangle with very weak to moderate transverse carina delimiting basal area. First recurrent vein enters second submarginal cell slightly basal to middle. Scopa pale with dorsal median area dark, hair with branches on 1 side from 2 closely approximated rows; inner hind tibial spur with

4–6 teeth; distal extremities of legs paler than basal area. *Metasoma*—metallic blue, gold, reddish or greenish pygidial plate with broadly emarginate apex. *Male*—As for female except as follows: Length ca 6 mm. *Head*—Hair darker, brownish; F4–11 length greater than width. *Mesosoma*—All tibiae and tarsi, apex of fore and mid femora, and all of hind femora pale brown to yellow, basal areas of mid and fore femora black. Hair of scutum and scutellum pale brown, long, fine with long, open branches. *Metasoma*—T7 almost entirely hairless. Penis valves each with a large, thick, ventral spine parallel to the penis valve, and a second large, thick spine at right angles to the first (fig. 18). For genitalia, S7–8 see figs 18–20.

#### Notes

This species is widespread in eastern Australia, it is highly variable in the colour of the metasoma, and is relatively common. It is one of the few species of Australian *Leioproctus* that is on the wing for most of the year although the majority of specimens have been collected in late spring and early summer. It is most frequently found on *Eucalyptus* spp.

#### *Leioproctus (Leioproctus) boroniae* (Cockerell, 1921)

*Paracolletes boroniae* \*Cockerell 1921: 92, 97; 1934: 22.

*Leioproctus (Leioproctus) boroniae* (Cockerell). Michener 1965: 50.

#### Type

*Paracolletes boroniae*—Queensland: holotype ♀, Birkdale, Brisbane, 5.ix.1916, H. Hacker off *Boronia ledifolia* blossom (QM).

**Collection months:** September.

**Floral visitations:** Rutaceae: *Boronia ledifolia*.

*Female*. Length ca 11 mm; green metallic metasoma. *Head*—Ocelloccipital distance strongly depressed; frontal line depressed on upper fifth; anterior flagellum pale; interspaces on clypeus very narrow, smooth; malar space a little longer than half width of base of mandible. *Mesosoma*—Scutal and scutellar interspaces smooth to granular; propodeal triangle without transverse carina; first recurrent vein of forewing enters second submarginal cell basal to middle. Scopa black dorsally, pale ventrally; posterior area with hairs with 2 closely opposed rows of branches; inner hind tibial spur with 8 teeth. *Metasoma*—Pygidial plate obscured. *Male*.—Unknown.

**Notes.** This species is known only from the female holotype. The malar space is longer than in other species in this group. It is very similar to *L. plumosus* and the 2 species key out together. Until more specimens, including males, are available, differentiation of the species will be difficult.

#### *Leioproctus (Leioproctus) carinatus* (Smith, 1853)

*Lamprocolletes carinatus* \*Smith 1853: 11.

*Paracolletes carinatus* (Smith). Cockerell 1905a: 346; 1905c: 482; 1913a: 597, 599; 1913b: 281; 1921: 97; 1929a: 10; 1929d: 307; 1934: 23.

*Leioproctus carinatus* (Smith). Michener 1965: 50.

#### Type

*Lamprocolletes carinatus*—holotype ♀, New Holland (BMNH 17a.488).

**Additional material examined:** 35♀, 18♂ **Queensland:** Kuranda; Montville; Bribe I.; Stanthorpe; Sunnybank, Brisbane; Mt Tamborine. **New South Wales:** Whites R Hut; Catherine Hill Bay; Boonoo Boonoo Falls. **Victoria:** Upwey; Hamilton; Gorae West; Sandringham; Black Rock; Ferntree Gully; St Kilda; Seaford; Stafford; Dingley; Carnegie; Geelong; Corryong; Nunawading; Woori Yallock; Ringwood; Bunyip; Healesville; Frankston; Croydon. **Tasmania:** Freycinet NP; Maria I.

**Collection months:** January, February, March, April, August, September, October, November, December.

**Floral visitations:** Unknown.

*Female*—Length ca 13 mm; integument of the entire body metallic blue. *Head*—Frontal line flattish with frons in dorsal area; flagellum dark; clypeal puncture interspaces very narrow, smooth; length of malar space about 0.2 x

width of base of mandible. *Mesosoma* Puncture interspaces of scutum and scutellum granular; propodeal triangle with strong transverse carina, which is depressed medially, that delimits basal area. First recurrent vein of forewing enters second submarginal cell slightly basal to middle; hind tibial scopa entirely black, posterior dorsal area with bimodal hairs; inner hind tibial spur with 7–9 teeth. *Metasoma*—Pygidial plate with apex truncate. *Male*—As for female except as follows: *Length*—ca 10 mm. *Head*—Vertex extended posteriorly from upper eye margin for about 1 ocellar width; F3–11 length greater than width. *Metasoma*—T7 hairless medially. Gonoforceps with a subapical protuberance on inner margin. For S7–8 and genitalia see figs 21–23.

### ***Leioproctus (Leioproctus) clarki* (Cockerell, 1929)**

*Paracolletes melbournensis clarki* \*Cockerell 1929d: 308; 1934: 30; Rayment 1931: 160.

*Leioproctus (Leioproctus) clarki* (Cockerell). Michener 1965: 50.

#### **Type**

*Paracolletes melbournensis clarki*—Western Australia: holotype ♀, Perth, J. Clark (QM T4089).

**Additional material examined:** 283 ♀, 183 ♂ **New South Wales:** 10 miles (16 k) Bowning; Caldwell; Dobroyd Pt North Harbour Sydney. **Australian Capital Territory:** Canberra; Black Mountain. **Victoria:** Ringwood; Ringwood; Bellgrave; Woori Yallock; 3 miles (4.8 k) E. Colac; Healesville; 7 miles (11.2 k) E Colac; 4 miles (6.4 k) E Colac; 14 miles (22.4 k) SE Colac; 8 miles (12.8 k) SE Colac; 1 miles E Wye River; Woori Yallock; Lorne; Alexandra; Driffield; Victoria Vall; Warburton District; Murray NE Hattah; 20 miles (32 k) SE Mildura; Healesville; 5 miles (8 k) N Torquay; Flowerdale; Ferntree Gully; Kiata; Warburton; Edenhope; Kerang; Melton; Ararat; Rye; 4 miles (6.4 k) E Angelsea; Tidal River; Normanville; Gunbower; Croydon; St. Kilda; Hamilton; Hattah; Murrabit; Gorae West; 37 k N Hwy1 on Pinnaroo Rd; Dingley; Buxton; Eltham. **Tasmania:** 15 miles (24 k) S Launceston; Perth; 6 miles (9.6 k) E Campbell Town; Georgetown; Bothwell; Cressy; 4 miles (6.4 k) E Launceston; Nunamara; 8 miles (12.8 k) S Upper Blessington. **South Australia:** Kangaroo I; 25 miles (40 k) NE Eucla; Botanic Park; 9 miles (14.4 k) NE Oodla Wirra; Th urgla Stn; Waite institute, Adelaide; Robe; Mt Lofty; West side of L. Eliza. **Western Australia:** Perth; Swan R; Bunbury; 12 miles (19.2 k) N Margaret R on Yallingup Rd; Busselton; Darling Range; 12 miles (19.2 k) SW Katanning; Cape Naturaliste; Beelerup; Gingin; Lesmurdie-Kalamunda; Albany; Capella; Collie; Great Eastern Hwy Greemount; 11 miles (17.6 k) SE Salmon Gums; 65 k N Albany; Stirling Ra; Yandeyarra; Beverley; Ravensthorpe; 44 k s Yallingup; 31 k W Balladonia; Wembley; Glen Ford; Bushmead; Gonwangerup; Beelerup; Bullsbrook; 25 k S Norseman; 9 miles (14.4 k) N New Norcia.

**Collection months:** January, February, March, April, November, December.

**Floral visitations:** Not known.

*Female*—Length ca 11 mm; head and mesosoma metallic green-blue; metasoma metallic olive. *Head*—Ocellocipital distance flat; frontal line immediately below the median ocellus absent; flagellum dark anteriorly except at the apex, where it is pale; puncture interspaces on clypeus very narrow, smooth; length of malar space about 0.25 x width of base of the mandibles. *Mesosoma*—Hair long, pale brown; propodeal triangle with a complete strong transverse carina. First recurrent vein of forewing enters second submarginal cell medially. Hind tibial scopa dark dorsally, white ventrally with 2 closely opposed rows, each with about 6 branches; hind basitibial plate about 0.25 x length of tibia; inner hind tibial spur with 6–8, long, fine teeth. *Metasoma*—Pygidial plate with apex slightly emarginate. *Male*—As for female except as follows: *Length* ca 8 mm. *Head*—Flagellum entirely dark, F3–11 length greater than width. *Mesosoma*—Legs entirely dark. *Metasoma*—T7 hirsute, without bare median area. Penis valves with 1 large ventral spine parallel to the length of the penis valves; gonostyles truncate apically. For S7–8 and genitalia see figs 24–26.

### ***Leioproctus (Leioproctus) cupreus* (Smith, 1853)**

*Lamprocolletes cupreus* \*Smith 1853: 13; Dalla Torre 1896: 48.

*Paracolletes cupreus* (Smith). Cockerell 1905a: 345; 1905c: 479; 1934: 25.

*Paracolletes plumosellus* \*Cockerell 1905c: 480; 1906: 28; 1910a: 200; 1934: 33; Rayment 1930: 50 (*plumosella* sic). **syn.n**

*Paracolletes roseoviridis* \*Cockerell 1905d: 270; 1934: 34. **syn.n**.

*Paracolletes nigroclypeatus* \*Cockerell 1910a: 204, 207; 1934: 31; Rayment 1935: 676. **syn.n**.

*Paracolletes chalcurus* \*Cockerell 1921: 92; 1934: 23. **syn.n.**  
*Paracolletes nigroclypeatus hardyi* \*Cockerell 1929d: 310; 1934: 31. **syn.n.**  
*Leioproctus (Leioproctus) chalcurus* (Cockerell). Michener 1965: 50.  
*Leioproctus (Leioproctus) cupreus* (Smith). Michener 1965: 50.  
*Leioproctus (Leioproctus) hardyi* (Cockerell). Michener 1965: 51.  
*Leioproctus (Leioproctus) nigroclypeatus* (Cockerell). Michener 1965: 51.  
*Leioproctus (Leioproctus) roseoviridis* (Cockerell). Michener 1965: 52.

#### Types

*Lamprocolletes cupreus*—South Australia: holotype ♀, Adelaide (BMNH 17a.489).  
*Paracolletes plumosellus*—holotype ♂, New Holland (BMNH 17a.426).  
*Paracolletes roseoviridis*—Western Australia: holotype ♂ (BMNH 17a.441).  
*Paracolletes nigroclypeatus*—Victoria: holotype ♀ (BMNH 17a.441).  
*Paracolletes chalcurus*—Western Australia: holotype ♀, Cunderdin, xi.1913, R. Illidge (QM T2400).  
*Paracolletes nigroclypeatus hardyi*—Western Australia: holotype ♀, Perth (QM T.4088).

The holotypes of *Lamprocolletes cupreus*, *Paracolletes nigroclypeatus*, *P. chalcurus* and *P. nigroclypeatus hardyi* are all females and show no significant morphological variation. The types of *P. plumosellus* and *P. roseoviridis*, which are males and are identical to males associated with *Lamprocolletes cupreus* by morphological similarity and coincident collection data.

**Additional material examined:** 47♀, 76♂ **Queensland:** Edungalba; 39.6 k W Thargominda. **New South Wales:** Como; Broken Head; Keera; 53 k NW Cobar. **Victoria:** 117 k N Highway 1 on Pinnaroo Rd; Gorae West; 19 k S Murrayville; Prisley CF; Mt Talyor; Portland; Bot. Garden, Melbourne. **South Australia:** 25 miles (40 k) E Kyancutta; 21 k NW Minnipa; Moorlands; Dissappointment Caves, Nullabor Plain; 73 k W Emu; Morgan; L. Gilles NP; (vehicle net) 145–170 k N Cook; 48 k NNE Minnipa; 0.5 k S Morganvale Homestead; 1.5 miles (2.4 k) S Illbillee, Everhard Reserve; 8 miles (12.8 k) SW Kimba; Robe near Sea; Eudunda; Illinawortina Pound, N. Flinders Range; Thurlga Stn; Corny Pt; Crofer; 7 k w Sherlock; Botanic Park, Adelaide; Botanic Park, Adelaide; 25 k NE Eucla. **Western Australia:** Moir's Rock, 42 k NNW Salmon Gums; 35 miles (56 k) W Esperance; 30 miles (48 k) W Coolgardie; 14 miles (22.4 k) E Eucla; 496 Great eastern Hwy, Greenmount; 31 k W Balladonia; 66 k NW Ballaconia; Cundejdin; Weebubbe cave Area WNW Eucla; 496 Great Eastern Hwy, Greenmount. **Northern Territory:** Corroboree Rock; 30 miles (48 k) N Erldunda.

**Collection months:** January, February, March, April, August, September, October, November, December.

**Floral visitations:** Myrtaceae: *Eucalyptus* spp.

*Female*—Length ca 10 mm; metasoma metallic gold, purple, blue or olive. *Head*—Ocellocipital distance depressed; frontal line weakly carinate in dorsal area; flagellum paler anteriorly; clypeus with polished interspaces; malar space length about 0.3 x width of base of mandible. *Mesosoma*—Interspaces of scutum and scutellum granular; hair of scutum and scutellum pale brown with long, fine branches; transverse suture of propodeal triangle strong, but depressed medially. First recurrent vein of fore wing enters second submarginal cell slightly basal to middle. Scopa pale except around basitibial plate, hair on posterior area bimodal; inner hind tibial spur with 5–9 teeth. *Metasoma*—Pygidial plate with apex rounded. *Male*—Length ca 8 mm. *Head*—F3–11 length greater than width, anterior surface of flagellum dark, except at apex. *Mesosoma*—All tarsi, apex of hind tibia, hind femur, yellow to pale brown. *Metasoma*—Median area of T7 hairless. Penis valves each with a single large, median ventral spine. S8 median lobe about half total length of segment. S7 apical lobes arched with long, fine spines on inner surface. For S7–8 and genitalia see figs 27–29.

#### *Leioproctus (Leioproctus) friesellus* Michener, 1965

*Paracolletes fervidus* \*Friese 1924: 220.

*Paracolletes friesei* \*Cockerell 1929d: 306, 1929c: 211; 1929b: 2; 1934:27. [Replacement name for *P. fervidus* Friese 1924, which is a homonym of *P. fervidus* Smith, 1879].

*Leioproctus friesellus* \*Michener 1965: 50 [Replacement name for *Leioproctus friesei* (Cockerell, 1929) which is a homonym of *L. friesei* Ducke, 1912].

#### Type

*Paracolletes fervidus*—Western Australia: holotype ♀, King George Sound (QM T.4027).



**Additional material examined:** 5♀ **Victoria:** 19 k S. Murrayville; Rye. **South Australia:** 48 k S of Pinnaroo; 7 k W Sherlock.

**Collection months:** January, February, March.

**Floral visitations:** Myrtaceae: *Melaleuca* spp.

*Female*—Length ca 11 mm. Scutum and scutellum with dense, moderately long, orange hair. *Head*—Anterior flagellum pale; interspaces on clypeus narrow, smooth; length of malar space about 0.25 x width of base of mandible. *Mesosoma*—Propodeal triangle with strong transverse carina depressed medially, defining basal area. First recurrent vein of forewing enters second submarginal cell medially. Scopa dark except for white posterior edge; hair on posterior area of hind tibial scopa bimodal; inner hind tibial spur with 5 teeth. *Metasoma*—Pygidial plate yellow, flat, truncate apically. *Male* Unknown.

### ***Leioproctus (Leioproctus) plumosus (Smith, 1853)***

*Lamprocolletes plumosus* \*Smith 1853: 12; Dalla Torre, 1896: 48.

*Lamprocolletes metallicus* \*Smith 1879: 8; Dalla Torre, 1896: 48. **syn.n.**

*Lamprocolletes bicolor* \*Smith 1879: 10; Dalla Torre, 1896: 47. **syn.n.**

*Paracolletes metallicus* (Smith). Cockerell 1905a: 346.

*Paracolletes plumosus* (Smith). Cockerell 1905a: 346; 1910a: 200; 1916b: 200; 1921: 91, 97; 1929c: 205; 1929d: 308; 1930: 48; 1934: 33; Rayment 1930a: 50 (*Paracolletes plumosa* (sic)); 1931: 160; 1935: 180–182.

*Paracolletes bicolor* (Smith). Cockerell 1905a: 346; 1910a: 201; 1914c: 47; 1916b: 200; 1929c: 205; 1934: 22; Rayment 1931a: 160.

*Paracolletes eucalypti* \*Cockerell 1916a: 51; 1934: 25. **syn.n.**

*Leioproctus (Leioproctus) bicolor* (Smith). Michener 1965: 50.

*Leioproctus (Leioproctus) eucalypti* (Cockerell). Michener 1965: 50.

*Leioproctus (Leioproctus) metallicus* (Smith). Michener 1965: 51.

*Leioproctus (Leioproctus) plumosus* (Smith). Michener 1965: 51.

#### **Types**

*Lamprocolletes plumosus*—holotype ♀, New Holland (BMNH 17a.493).

*Lamprocolletes metallicus*—holotype ♂, Australia (BMNH 17a.513).

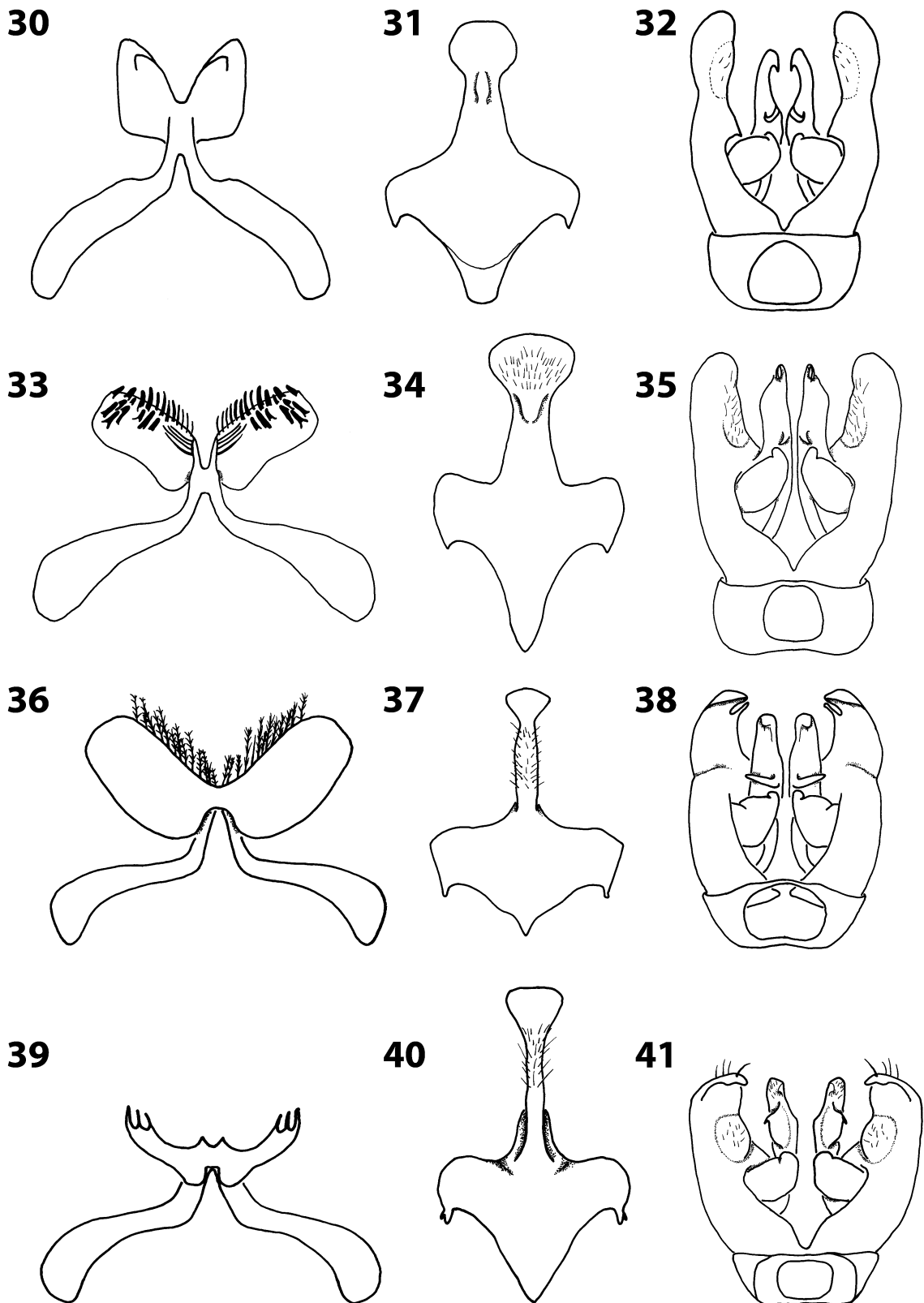
*Lamprocolletes bicolor*—Western Australia: holotype ♂, Swan River (BMNH 494a).

*Paracolletes eucalypti*—Victoria: holotype ♂, Mt. Yule, Healesville, 20.ii.1915, R. Kelly, off *Eucalyptus rosea* blossom (BMNH 17a.433).

The holotypes of *Paracolletes eucalypti*, *Lamprocolletes metallicus* and *Lamprocolletes bicolor*, which are males and are identical to those males associated with *Lamprocolletes plumosus* by morphological similarity and coincident collection data.

**Additional material examined:** 108♀, 179♂ **New South Wales:** Sydney; Tubrabucca. Australian Capital Territory: Black Mtn. **Victoria:** Kallista; Nelson; Black Rock; Toorak; Cranbrook; 5 miles (8 k) N. Torquay; Maranoa Gardens, Melbourne; Kiata; Kerang; Healesville; Cygnet R.; Hamilton; Kallista; Bogong Plains; Melton; Bamawm; Kiata; Rye; Frankston; Edenhope; Sth Yarra; Bendoc; Dingley; Lorne; 37 k N Hwy 1 on Pinnaroo Rd.; 117 k N Hwy 1 on Pinnaroo Rd.; Sandringham; Gorae West; Hamilton. Tasmania: Condaminion Ck; Cambridge; Murdunna, Forestier Pen.; Georgetown. **South Australia:** 7 k W Sherlock; between Monarto and Murray Bridge; Mylor; Meninge; West Beach; 10 k N. Keith; Mt Gambier; 24 k SW Swan Reach; Lincoln N.P.; Kangaroo Is.; Port Lincoln; Narkonelta; 48km S Pinnaroo; Stokes Bay, Kangaroo Is; Naracoorte; Kongal; Meninge. **Western Australia:** Mt Narryer; triangle between Perth, Collie and Bunbury; Nannup; Northampton; Bridgetown; Beelerup; 6 miles (9.6 k) W Brookton; West Midlands; Collie; West Midlands; 496 Great Eastern Hwy. Greenmount; Donnybrook; Moora; Yallingup; 44 k S Yallingup; Bunbury; National Park; Darling Range; 12 miles. S.W. Katanning; Greenmount, Perth; Cape Naturaliste; Busselton; Perth; Beverley; Capella; Deep Dene, Karridale; Toodyay; Flinders Bay, 2.5 miles E. Leewin Light; 35 miles W. Esperance; Katanning; Wembley; Bushmead; Stirling Range; Manjump.

**Collection months:** January, February, March, April, May, July, August, October, November, December.



**FIGURES 30–41.** Male S7–8 and genitalia *Leioproctus* (*Leioproctus*). Figs 30–32 *L.(L.) plumosus* S7, S8, genitalia. Figs 33–35 *L.(L.) irroratus* S7, S8, genitalia. Figs 36–38 *L.(L.) bicristatus* S7, S8, genitalia. Figs 39–41 *L.(L.) launcestonensis* S7, S8, genitalia.

**Floral visitations:** Fabaceae: *Acacia*, *Daviesia*; Ericaceae: *Leucopogon*; Myrtaceae: *Eucalyptus*; Solanaceae: *Salpichroa*.

*Female*—Length ca 12 mm; head, mesosoma and metasoma metallic blue. *Head*—Ocelloccipital area shallowly depressed; frontal line weakly depressed in dorsal area; flagellum paler anteriorly than posteriorly; interspaces on clypeus very narrow (less than half a puncture width), smooth; length of malar space about 0.25 x width of base of mandible. *Mesosoma*—Scutal and scutellar hair long, fine with many branches; interspaces granular; propodeal triangle with strong, transverse carina depressed medially. First recurrent vein enters second submarginal cell slightly basal to middle. Scopa dark dorsally, pale ventrally; hair on posterior part of dorsal surface with about 7 long branches from single side (monopodal); inner hind tibial spur with 5–6 teeth. *Metasoma*—Apex of pygidial plate emarginate. *Male*—As for female except as follows: *Length* ca 9mm. *Head*—Vertex extended posteriorly behind upper eye for about 1 ocellar width. F3 length about equal to width, F4–11 length greater than width. *Mesosoma*—Anterior fore tibia yellowish. *Metasoma*—T7 entirely hirsute. Penis valves with a single, large, ventral spine medially. For S7–8 and genitalia see figs 30–32.

#### Notes

This species is externally extremely similar to *L. cupreus*, the females differ in the shape of the apex of pygidial plate and the vestiture of the metasomal terga. The males are readily distinguishable by the genitalia, S7–8.

### *Leioproctus (Leioproctus) irroratus* species-group

This group of 6 species is readily distinguished from other *Leioproctus (Leioproctus)* by the long basal area of the propodeal triangle and the relatively hairless, small, slender, wasp-like females. Several species have distinct hair patches such as *L. (L.) irroratus*, which have bright yellow patches of short dense hair over the antero-lateral corners of the scutum and female *L. (L.) bicristatus* that have dense patches of hair on the lateral part of the metanotum. The group is unusual in that 4 of 6 species have been collected in northern areas of Australia.

*Diagnosis*—Small (4–10 mm) mostly dark bees, metasoma usually narrowed at the base; basal area of propodeal triangle long (longer than metanotum), subhorizontal; integument generally minutely roughened with scattered, weak punctures.

*Description*—Length ca 4–10 mm; colour black, brown or dull metallic-green. *Head*—Facial foveae absent or only vaguely indicated; frontal line weak; inner eye margins curved, converging dorsally and ventrally; frons sculpture weak at times with weak longitudinal striae; scape reaching median ocellus; apex of supraclypeal area sharply raised; clypeus slightly elevated, rounded with large, widely spaced punctures; malar space short or absent; labrum short, smooth, shiny; mandibles slender; gena equal to or less than width of eye when head viewed laterally. *Mesosoma*—Hair sparse, short; sculpture with weak, sparse punctures and granular interspaces; propodeal triangle with subhorizontal basal area longer than metanotum; pterostigma broad; marginal cell slender apically divergent from costa for short distance; first recurrent vein enters second submarginal cell towards the base; female basitibial plate sharply pointed apically, more than 0.2 x length of tibia; female tibial scopa densely plumose. *Metasoma*—Surface sculpture similar to metanotum; pygidial plate raised medially, broadly rounded apically; female sterna with broad apical fringe of plumose hairs; prepygidial fimbria short, dense, black; male sternal hair sparse.

### Key to species of *Leioproctus (Leioproctus) irroratus* species-group

- 1 Antero-lateral area of scutum with short dense yellow hair ..... 2
- Antero-lateral area of scutum almost bare ..... 4
- 2 Hair on antero-lateral area very dense totally obscuring integument, extending posteriorly beyond level of tegulae; no dense yellow hair on scutellum ..... *Leioproctus (Leioproctus) irroratus* (Smith, 1853)
- Hair on antero-lateral area not extending beyond level of tegulae ..... 3
- 3 Metasomal terga with yellow apical integumental bands; clypeal integument yellow; scutellum and metanotum covered in short, dense, yellow hair ..... *Leioproctus (Leioproctus) nomadiformis* (Cockerell, 1921)
- Metasomal terga without yellow integumental bands (uniformly brown); clypeus black to brown; scutellum with lateral tufts of yellow hair; metanotum without yellow hair ..... *Leioproctus (Leioproctus) quadrimaculatus* Maynard, sp.n
- 4 Tegulae orange ..... *Leioproctus (Leioproctus) launcestonensis* (Cockerell, 1914)

–	Tegulae brown .....	5
5	Scutellum with lateral tufts of pale to yellow hair; head and mesosoma with metallic hue .....	<i>Leioproctus (Leioproctus) bicristatus</i> (Cockerell, 1929)
–	Scutellum without lateral tufts of hair; head and mesosoma non-metallic brown .....	<i>Leioproctus (Leioproctus) litotes</i> Maynard, sp.n

### *Leioproctus (Leioproctus) irroratus* (Smith, 1853)

*Lamprocolletes irroratus* \*Smith 1853: 12.

*Dasycolletes humerosus* \*Smith 1879: 11. **syn.n.**

*Paracolletes humerosus* (Smith). Cockerell 1905a: 348; 1926: 661; 1934: 28.

*Paracolletes irroratus* (Smith). Cockerell 1925: 496; 1926: 661; 1934: 28.

*Leioproctus (Leioproctus) humerosus* (Smith). Michener 1965: 51.

*Leioproctus (Leioproctus) irroratus* (Smith). Michener 1965: 51.

#### Types

*Lamprocolletes irroratus*—holotype ♀ (Ox). [no data on specimen, but description states—Victoria: Port Philip].

*Dasycolletes humerosus*—Victoria: holotype ♀, Melbourne (BMNH 17a.521).

**Additional material examined:** 41 ♀, 20 ♂

**Queensland:** Herberton Ra. St. For., 8 miles (12.8 k) Atherton; 4 miles (7 k) W Paluma, 3000 ft; Wallaville; The Pinnacles, Mt Walsh NP; Bunya Mtn NP; Brisbane; Springbrook; Stanthorpe. **New South Wales:** Bald Rock NP; Nadgee Beach Reserve, S Newtons Beach; White Swamp. **Victoria:** Mackeys Mt Buffalo; Emerald; Lilydale; Healesville; Warburton; Woori Yallock; Croydon; Ferntree Gully.

**Collection months:** January, February, March, April, September, October, November, December.

**Floral visitations:** Myrtaceae: *Eucalyptus*; Proteaceae: *Lomatia*, *Macadamia*.

*Female*—Length about 9 mm; integument black with dense, yellow humeral hair patches. *Head*—Frons with fine but distinct longitudinal ridges; facial fovea vaguely indicated by lack of striations; paraocular area with sparse punctures; F4–11 length about equal to width; malar space short, polished; gena about as wide as eye when head viewed laterally; hair sparse, brown, branched, medium length. *Mesosoma*—Yellow hair of scutum very dense, short, densely branched; elsewhere on dorsal scutum hair black mostly short with a few long hairs; laterally except for spiracle cover lobe hair long, fine and very sparse; tegulae opaque black. Wings with membrane darkened. Legs with hind tibial scopa entirely black on the outside, pale inside; femoral scopa black ventrally; inner hind tibial spur with 5 coarse teeth. *Metasoma*—Slender, strongly constricted towards the base of T1. *Male*—As for female except as follows: *Length* ca 8 mm. *Head*—Hair moderately dense, white; inner eye margin almost straight; distal flagellar segments longer than wide. *Mesosoma*—Legs long and slender, almost bare of hair; anterior fore basitarsus and tibia dark yellow. *Metasoma*—For S7–8 and genitalia see figs 33–35.

#### Notes

This species is very wasp-like in appearance; the females are more slender than is usual in *Leioproctus* and the hair is sparse. The sparsity of hair and sculpture of integument have some similarities to *L. (Euryglossidia)*, a subgenus with 2 submarginal cells in the forewing. As well many of the collections are apparently from wet (rainforest) forest localities.

### *Leioproctus (Leioproctus) bicristatus* (Cockerell, 1929)

*Paracolletes bicristatus* \*Cockerell 1929d: 307; 1934: 22.

*Paracolletes melanurus* \*Cockerell 1930: 47; 1934: 29. **syn.n.**

*Leioproctus (Leioproctus) bicristatus* (Cockerell). Michener 1965: 50.

*Leioproctus (Leioproctus) melanoproctus* Michener 1965: 51. [Replacement name for *Paracolletes melanurus*]

#### Types

*Paracolletes bicristatus*—Queensland: holotype ♀, Tooloom, i.1926, H. Hacker (QM T.4098).

*Paracolletes melanurus*—Queensland: holotype ♀, Tooloom, i.1926, H. Hacker (QM T.4029).

When *Leioproctus bicristatus* was described 2 females from Tooloom were mentioned; now only 1 female, the

holotype can be located in the Queensland Museum. It appears the second female specimen was described 1 year later as a new species (*Paracolletes melanurus*). When Michener transferred these 2 nominal species into *Leioproctus*, the name "*melanurus*" was preoccupied by a South American species, so he replaced the name with "*melanoproctus*". The holotypes of *Paracolletes bicristatus* and *Paracolletes melanurus* are identical, although the latter has lost the lateral tufts of hair on the scutellum—the most distinctive feature of this species.

**Additional material examined:** 42♀, 4♂ **Queensland:** 37 k N Gympie; 32 k N Gympie; Ma Ma Ck; Lamington NP.

**Collection months:** March, September, November.

**Floral visitations:** Sapindaceae: *Atelaya hemiglaucata*.

*Female*—Length ca 6 mm. *Head*—Frons weakly punctate with minutely roughened interspaces, slightly metallic in appearance; clypeus brown with smooth shiny punctures between large punctures about a puncture width apart; gena about equal to width of eye when head viewed laterally; hair sparse, white, moderate length, branched. *Mesosoma*—Scutum with short, dark hair dorsally, pale long, sparse hair laterally; scutum slightly metallic; pronotal spiracle cover lobe with dense, short, pale yellow hair; scutellum with very dense yellow, moderate length hair, medially with moderately sparse black hair; tegulae translucent brown; metanotum with very sparse hair. Legs: fore basitarsus with smooth fringed area forming a small corbicula-like area, outer hair of fore tarsus curled; hind tibial scopa mostly dark on the outside; femoral scopa entirely pale; inner hind tibial spur with 8 teeth. *Metasoma*—Integument brown to black, hair on sterna sparse. *Male*—As for female except as follows: Length ca 5 mm. *Head*—Hair of clypeus slightly denser than female; distal flagellar segments longer than wide. *Metasoma*—For S7–8 and genitalia see figs 36–38.

### ***Leioproctus (Leioproctus) launcestonensis* (Cockerell, 1914)**

*Paracolletes launcestonensis* \*Cockerell 1914c: 305; 1934: 28.

*Leioproctus (Leioproctus) launcestonensis* (Cockerell). Michener 1965: 51.

*Leioproctus (Leioproctus) otautahi* \*Donovan 2007: 59; Donovan and Maynard 2010: 17

#### **Types**

*Paracolletes launcestonensis*—Tasmania: holotype ♀, Launceston, 25.i.1914, F.M. Littler (BMNH 17a.185).

*Leioproctus (Leioproctus) otautahi*—New Zealand: holotype ♂, Christchurch, 16–18.xii.1959 (NZAC)

**Additional material examined:** 52♀, 65♂ **Queensland:** Springbrook. **New South Wales:** Huonbrook nr Mullumbimby; New England NP via Ebor; Cheltenham. **Victoria:** Mt Buffalo (4500ft); Mt St Bernard (4000 ft); Lake Mountain; Acheron Way (Warburton-Marysville); Cumberland Falls; Healesville; Cement Ck; Mt Donna Buang (4080ft); Warburton; Woori Yallock; Mt Baw Baw (4000ft); Tanjil Bren; Ferntree Gully; 12 miles (19.2 k) W Neerim; 1 miles (1.6 k) E Wye Riv.; Blackburn. **Tasmania:** St Patricks Riv.; Launceston; Mt Arthur.

**Collection months:** January, February, March, October, December.

**Floral visitations:** Lamiaceae: *Prostanthera lasianthos*; Myrtaceae: *Eucalyptus*, *Leptospermum ericoides*, *Leptospermum* sp.; Pittosporaceae: *Bursaria spinosa*.

*Female*—Length ca 8 mm; integument entirely black except orange-brown tegulae. *Head*—Face almost flat, minutely tessellate with weak punctures; antennae black; antennal sockets slightly depressed; gena about as wide as eye when head viewed laterally; hair whitish, very sparse, branched. *Mesosoma*—Hair sparse, more dense over humeral area; hind tibial scopa pale on outside as well as inside; inner hind tibial spur with about 11 moderately spaced, medium length teeth; wing membrane dark, first recurrent vein enters second submarginal cell medially; basal area of costa and tegula orange. *Metasoma*—Sternal fringe moderately dense. *Male*—As for female except as follows: Length about 6 mm. *Head*—Hair of face long, moderately dense. *Mesosoma*—Legs simple, almost hairless; apex of basitibial plate acutely pointed; hair pale, long, fine, branched, sparse. *Metasoma*—For S7–8 and genitalia see figs 39–41.

#### **Notes**

This species is immediately recognisable by the orange tegulae. One specimen of this species was described as being from New Zealand under the species name *L. (L.) otautahi*. It was recognised as being a specimen of the Australian species *L. (L.) launcestonensis* that some how was placed in a New Zealand collection with a New Zealand collection locality (Donovan & Maynard 2010).

## *Leioproctus (Leioproctus) litotes* sp.n.

### Types

*Leioproctus (Leioproctus) litotes*—Queensland: holotype ♂, 8 k W Babinda, 16.xi.1988, K.L.Walker, off *Eucalyptus* blossom (MV); paratypes, 1♂, Cairns, F.P. Dodd (SAM); 23♂, same data as holotype (MV, QM); 3♂, 17 k S Millaa Millaa, 19.xi.1988, K.L. Walker off *Eucalyptus* blossom (MV).

**Collection months:** November.

**Floral visitations:** Myrtaceae: *Eucalyptus*.

*Female*—Unknown. *Male*—Length about 6 mm; small, slender with integument brown except yellow tarsi, relatively hairless. *Head*—Face covered with semierect, moderately dense, open branched, pale brown hair; frons weakly coriaceous with weak punctures; frontal line weak; inner eye margins curved, converging dorsally and ventrally; scape reaching median ocellus; apex of supraclypeal area sharply raised; clypeus slightly elevated, rounded with large, widely spaced punctures; palps extend well beyond apex of glossa; gena equal to or less than width of eye when viewed laterally. *Mesosoma*—Scutum and scutellum coriaceous with scattered weak punctures; hair fine, brown, open branched, denser on humeral areas and lateral scutellum; basal area of propodeal triangle longer than metanotum minutely roughened with small, scattered weak punctures; metanotum with longer dark hair. Wings, densely hairy; first recurrent vein enters second submarginal cell slightly basal to middle; pterostigma broad, marginal cell slender and divergent from costa apically. Legs with coxa, trochanter, femur and tibia brown with tarsi contrastingly yellow. *Metasoma*—Metasoma narrowed basally; hair black, fine, sparse simple except on T1; surface with sparse punctures and granular interspaces. For S7–8 and genitalia see figs 42–44.

### Notes

This is a very plain, small, black bee distinguished from the other species in this group by the lack of contrasting patches of hair or integument as well as the male genitalia.

*Etymology*—Litotes is Greek for plain, simple, for this nondescript little bee.

## *Leioproctus (Leioproctus) nomadiformis* (Cockerell, 1921)

*Paracolletes nomadiformis* \*Cockerell 1921: 95; 1934: 31.

*Leioproctus (Leioproctus) nomadiformis* (Cockerell). Michener 1965: 51.

### Type

*Paracolletes nomadiformis*—Queensland: holotype ♂, Kuranda, Dodd (QM T.2406).

**Additional Material examined:** 1♀, **Queensland:** Mt Lewis—Platypus Scientific area

**Collection months:** October.

**Floral visitations:** none recorded.

*Female*—Length ca 9mm. *Head*—integument mostly black; face almost flat; frons with dense, small punctures; scape yellowish to pale brown, reaching beyond median ocellus; flagellum pale brown, most segments about wide as long; upper frons with sparse, short, pale yellow hair, area around antennal bases with dense, semi-erect moderate length, yellow hair; paraocular area as same level as eyes, with dense, yellow, moderate length hair; inner eye margins converging dorsally and ventrally; supraclypeal area integument yellowish, slightly raised, smooth with sparse hirsute punctures, hair fine, moderate length, yellow; clypeus integument yellowish, with sparse hirsute punctures, hair fine, yellow, moderate length; malar space almost non-existent; mandibles with integument mostly yellowish with dark tips; gena width less than width of eye when viewed laterally. *Mesosoma*—integument mostly black; short, sparse, dense, short pale hair scattered throughout; humeral area and posterior lateral area of scutum, lateral area of scutellum and metanotum with short very dense, yellow hair. Legs with tibia and tarsi yellow; inner hind tibial spur with 6 coarse widely spaced teeth; inner hind tibial plate with thick, short simple hair, carinate; hind tibial scopae with medium-length, dense, yellowish, branched hair. Wings with darkened anterior margin; pterostigma large, length about as long as costal margin of costal cell. *Metasoma*—slender anteriorly, almost hairless dorsally, with long, scopal-like hairs ventrally, wasp-like in coloration, T1 broad, integument broadly yellow apically with 2 patches of dark integument basally; T2–3 broad, integument broadly

dark brown basally with narrow, yellow apical margin, no hair bands; T2 narrowest basally, T3 narrowest apically; T4 integument yellow or brownish with narrow, dark sub-basal band, with dense, narrow basal band of short, yellow hair; T5 translucent integument with long, moderately sparse brown, branched prepygidial fimbria; pygidial plate well defined, broad, brownish, rounded apically; S2–5 with broad band of moderately dense, long, branched, brownish hair. *Male*—Length about 7 mm. *Head*—Face almost flat; frons flat, minutely roughened; antennae yellow; clypeus translucent yellow, shallowly raised, rounded; malar space short; hair of head including vertex pale, moderate length and density, branched. *Mesosoma*—Sparse, dense, short pale hair scattered throughout; humeral area of scutum, entire scutellum and metanotum covered in short very dense, pale hair. Legs simple, yellow almost hairless; apex of basitibial plate sharply pointed; hind tibial spurs about equal. Wing membrane clear, first recurrent vein enters second submarginal cell medially. *Metasoma*—Terga with integument dark brown, apical margins broadly translucent yellow. Base of metasoma strongly constricted, first and second segments considerably narrower than third segment. Genitalia and hidden sterna were not available for examination.

### Notes

This species is only known from the male holotype and a single female specimen collected 80 years apart, however there is no doubt about the association.

### *Leioproctus (Leioproctus) quadrimaculatus* sp.n.

#### Types

*Leioproctus (Leioproctus) quadrimaculatus*—Queensland: holotype ♀, Kuranda, 1916, F.P. Dodd (BMNH); paratypes, 2♀, 2♂, same data as holotype.

**Collection months:** Unknown.

**Floral visitations:** Unknown.

*Female*—Length ca 8 mm; small, slender wasp-like. *Head*—Frons rugulose; facial fovea vaguely indicated by broad lateral area lacking ridges; F1–2 shorter than long; F4–11 length about the same as width; scape reaching median ocellus; paraocular area with small, weak punctures with minutely roughened interspaces; supraclypeal area raised with a few scattered punctures; clypeus slightly elevated with large punctures with smooth, shiny interspaces; mandibles slender; gena about the same width as eye when viewed laterally; hair white, of moderate length and density, branched. *Mesosoma*—Dorsal scutum brown with patch of short, yellow hair on antero-lateral area and beneath tegulae; lateral scutellum with patch of dense, short, yellow hair; pronotal spiracle cover lobe with dense, yellow hair; wing membrane clear; pterostigma broad; tegulae dark brown; marginal cell slender apically divergent from costa for short distance; first recurrent vein enters second submarginal cell towards the base; propodeal triangle with subhorizontal basal area longer than metanotum. Legs with outer hind tibial scopa yellow and darker area below basitibial plate; inner hind tibial spur with about 5 long, moderately thick teeth. *Metasoma*—Sternal hair sparse;—surface sculpture with sparse punctures with granular interspaces pygidial plate raised medially, broadly rounded apically; prepygidial fimbria short, dense, black. *Male*—As for female except as follows. Length ca 7 mm. *Head*—Antennal sockets not depressed; first flagella segment length about half width; F2–11 length greater than width; flagellum paler than scape. *Mesosoma*—Legs slender, hair short, simple; tibia and tarsi yellow; basitibial plate small, apically rounded. *Metasoma*—For S7–8 and genitalia see figs 45–47.

### Notes

This species is distinguished from other species in this species-group and other *Leioproctus* by the females with 4 distinctive patches of hair on the dorsal mesosoma [anterolateral corners of the scutum and lateral area of the scutellum]. Males have orange legs and less developed hair patches.

*Etymology*—Quadri is Latin for four and macula is Latin for spot—for the four "spots" of hair on the dorsal mesosoma.

## *Leioproctus (Leioproctus) macmillani* species-group

*Leioproctus (Leioproctus) macmillani* Houston was named as an aberrant member of the subgenus because of extraordinary long malar areas of both sexes and modified antennal flagella of males. Both of these characters are found in a species here described and placed with *L. (L.) macmillani* in this species-group. The shape of the flagellar segments is considered convergent with those of *L. (Cladocerapis) bipectinatus*; other examples of males from different groups having similar types of antennal flagella modifications occur within *Leioproctus*. The 2 species that occur in this group are from central and Western Australia. None has yet been found in eastern Australia.

This species-group has characters in common with at least 2 subgenera of *Leioproctus*; it shares similarities with *Leioproctus (Cladocerapis)* both male and female. The females of both of these groups have spines on the fore basitarsi—those in female *Leioproctus (Cladocerapis)* are dorsal whereas those in *L. macmillani* are ventral with stiffened hairs dorsal and polished space between anteriorly, which forms a corbicula-like area; the similarities are quite superficial. *Leioproctus (Filiglossa)* females also have thickened spines on the distal dorsal fore basitarsus.

*Leioproctus (Nesocolletes)*, found only in New Zealand, also have an enlarged malar space. This subgenus is densely hairy as is the *L. (L.) macmillani* species-group, but females have no teeth on the inner hind tibial spur and the hind tibial scopa is densely plumose. Male S7–8 and genitalia of both groups are quite different.

*Diagnosis*—Ocellocular area strongly depressed, malar space at least as long as the width of the base of the mandibles; males very hairy.

## Key to species in *Leioproctus (Leioproctus) macmillani* species-group

- Malar space greater than one and half times width of base of mandible. . . . . *Leioproctus (Leioproctus) macmillani* Houston, 1991
- Malar space less than one and half times width of base of mandible . . . . . *Leioproctus (Leioproctus) crinitus* Maynard, sp.n

## *Leioproctus (Leioproctus) macmillani* Houston, 1991

*Leioproctus (Leioproctus) macmillani* \*Houston 1991: 88.

### Types

*Leioproctus (Leioproctus) macmillani*—Western Australia: holotype ♂, Gnangara [State Forest], ca 20 k NNE Perth, 11.vi.1982, R.P. McMillan, off *Astroloma xerophyllum* blossom (WAM 87/1452) [not seen]; paratypes, 1♀, 1♂, Melaleuca Park, 11 k NE Wanneroo, 7.viii.1989, T.F. Houston off *Astroloma xerophyllum* and *Andersonia heterophylla* blossom (QM).

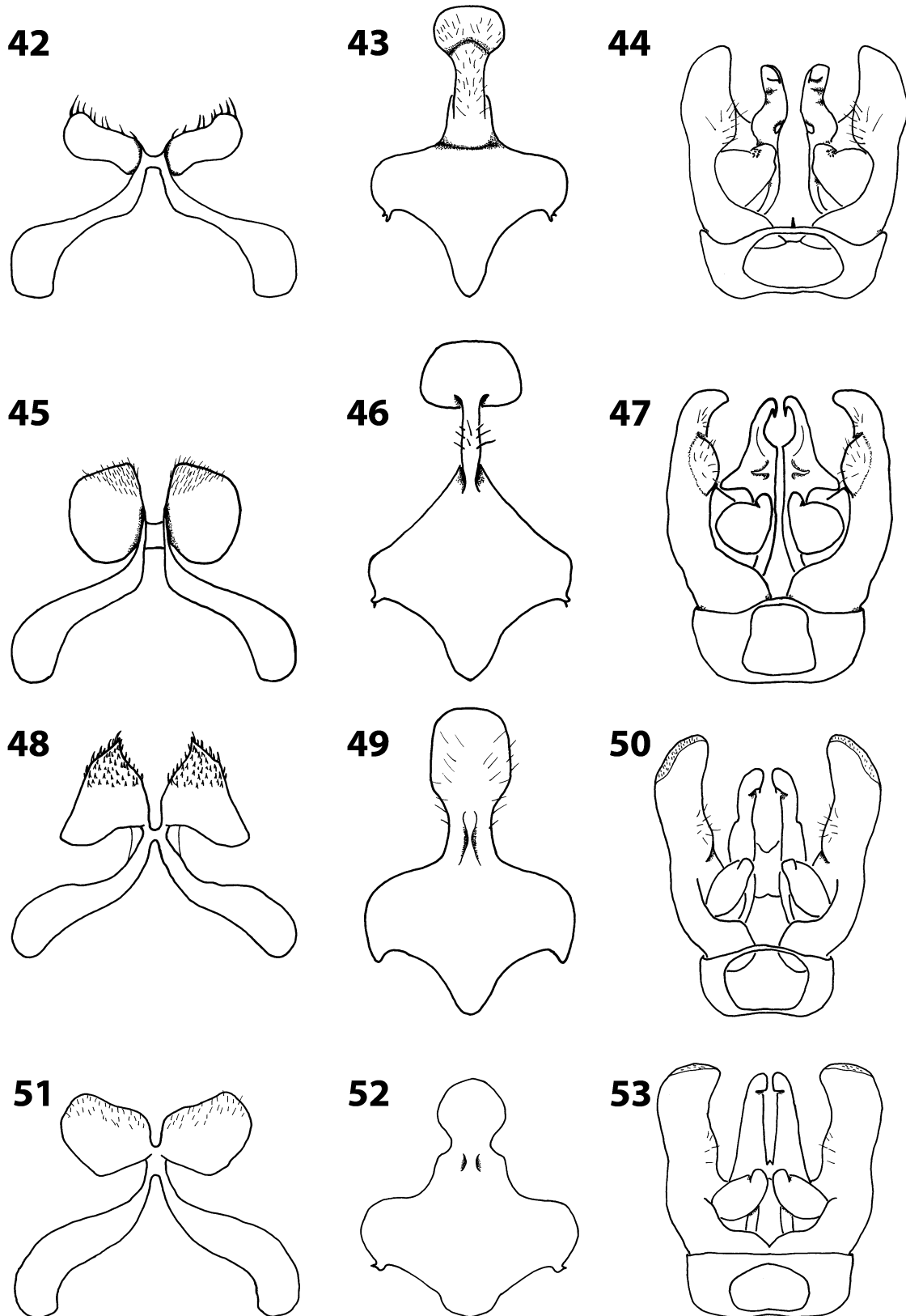
**Collection months:** June, August.

**Floral visitations:** Ericaceae: *Astroloma xerophyllum*, *Andersonia heterophylla*.

*Female*—Length ca 12 mm; head and mesosoma black, metasoma vaguely metallic; hair long, fine, whitish.

*Head*—Flagellum simple, F1–11 length about equal to width; clypeus strongly protuberant; area around subantennal suture and tentorial pit glabrous; malar space glabrous length nearly 3 x width of base of mandible; epistomal suture vague; labrum length 0.75 x width, contrastingly yellow; mandibles broad, apical fringe of glossa long; maxillary palps apical 2 segments shorter than basal four, basal four subequal in length, maxillary palps reaching apex of extended glossa; gena about as wide as eye when head viewed laterally; hair of clypeus moderately dense, branched. *Mesosoma*—Hair of scutum and scutellum white interspersed with black; fore basitarsus with long, thick spines ventrally and stiff hairs dorsally curving anteriorly, forming a corbicula-like area anteriorly; claws with large, basal inner ramus. *Metasoma* T2–4 with hair long, fine moderately dense; female prepygidial fimbria coarse, black; female pygidial plate broad, flat emarginate apically; female sternal hair long, moderately dense with few branches. *Male*—As for female except as follows: *Length* ca 9 mm. *Head*—Flagellar segments bipectinate; gena wider than eye, when head viewed laterally. *Mesosoma*—Legs simple, fore tibial spur with malus extended beyond velum; fore basitarsus not spinose. *Metasoma*—T7 with a narrow, median hairless area; S7 with one pair of simple lateral lobes covered apically with short, thick spines; for details of S7–8 and genitalia see figs 48–50.





**FIGURES 42–53.** Male S7–8 and genitalia *Leioproctus* (*Leioproctus*). Figs 42–44 *L.(L.) litotes* S7, S8, genitalia. Figs 45–47 *L.(L.) quadrimaculatus* S7, S8, genitalia. Figs 48–50 *L.(L.) macmillani* S7, S8, genitalia. Figs 51–53 *L.(L.) crinitus* S7, S8 genitalia.

## *Leioproctus (Leioproctus) crinitus* sp.n.

### Types

*Leioproctus (Leioproctus) crinitus*—Northern Territory: holotype ♂, 11 miles (17.6 k) S Angas Downs HS, 20.vi.1971 T.F. Houston off *Baeckea* blossom (SAM); paratypes 5♂, same data as holotype (SAM, ANIC, QM).

**Collection months:** June.

**Floral visitation:** Myrtaceae: *Baeckea*.

*Female*—Unknown. *Male*—Length ca 8 mm; integument black; hair long, fine and white; small, weak punctures and coriaceous interspaces; hair whitish, long with many fine branches. *Head*—Eyes protuberant; ocelloccipital area as well as area posterior to eye strongly depressed; frontal line carinate from apex of supraclypeal area to just below median ocellus where there is a shallow depression; frons rugulose; antennal sockets not depressed; scape reaching median ocellus; F1 length less than width, F2–11 bipectinate, each segment expanded laterally with extensions curving anteriorly; apex of supraclypeal area tuberculate; lower paraocular area and clypeus with small, strong dense punctures and polished interspaces; dense, long, semierect, densely branched hair; epistomal suture vague; clypeus shallowly protuberant; labial palps reaching apex of extended glossa, segments subequal in length; labrum length about 0.3 x width, apically depressed, base strongly convex, polished; gena about as wide as eye, when head viewed laterally. *Mesosoma*—Hair dense, long, white; propodeal triangle with basal area faintly rugulose, longer than metanotum. Scutum and scutellum with dense, small punctures, interspaces coriaceous or polished; posteriomedially impunctate and hairless; metanotum densely haired; propodeal triangle with steep basal area not defined by transverse carina. Wings with stigma narrow almost parallel sided, less than half length of costal margin of marginal cell; apex of marginal cell divergent from costal margin for short distance; first recurrent vein enters second submarginal cell towards base; wings hairy; membrane clear; jugal lobe of hind wing just reaching cu-a. Legs simple with a lot of long hair. *Metasoma*—Integument black with apical margin white; hair long, erect, fine, white; T7 hairless; S5 with sparse apical fringe; weakly punctate with coriaceous interspaces; male sternal hair sparse and S5 apical margin with weak fringe. S7 with a pair of simple lobes that are sparsely hairy. Genitalia with simple gonoforceps and penis valves. For details of S7–8 and genitalia see figs 51–53.

### Notes

Distinguished from other males of *Leioproctus* by malar space about as long as width of base of mandibles, flagellum of male with segments bipectinate. *Leioproctus crinitus* is distinguished from *Leioproctus macmillani* by its shorter malar space and sparsely haired lateral lobes on S7.

*Etymology*—Crinitus is latin for hairy.

## *Leioproctus (Leioproctus) nigrofulvus* species-group

This species-group at present contains 1 large species of *Leioproctus*. The genitalia of males and the mandibles of females warrant placement in a separate species-group. This species is unique amongst Australian *Leioproctus* in that it nests in the walls of mounds of the termite *Coptermes lacteus*. Perhaps the enlarged mandibles of the females are possibly an adaptation to a life style of nesting in the very hard walls of termite mounds.

## *Leioproctus (Leioproctus) nigrofulvus* (Cockerell, 1914)

*Paracolletes nigrofulvus* \*Cockerell 1914a: 137; 1934: 31.

*Paracolletes franki* \*Cockerell 1929a: 5; 1934: 27.

*Leioproctus (Leioproctus) frankiellus* \*Michener 1965: 50. [Replacement name for *Paracolletes franki* Cockerell]

*Leioproctus (Leioproctus) nigrofulvus* (Cockerell). Michener 1965: 51.

The holotype of *Paracolletes franki*, which is female, is identical to those females associated with *Paracolletes nigrofulvus* by coincident collection data and morphological similarity.

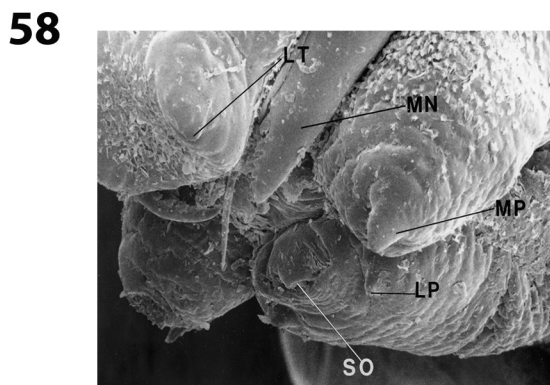
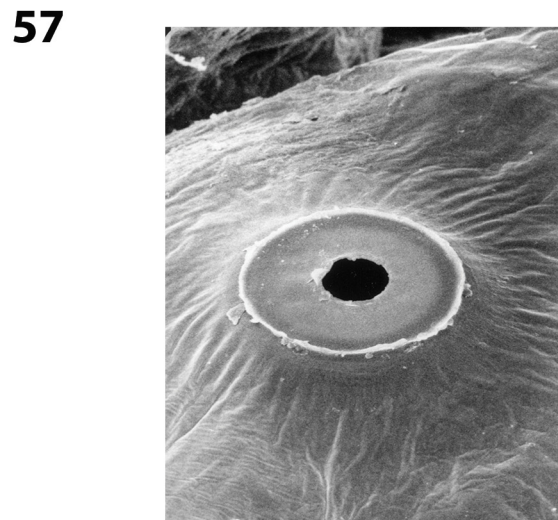
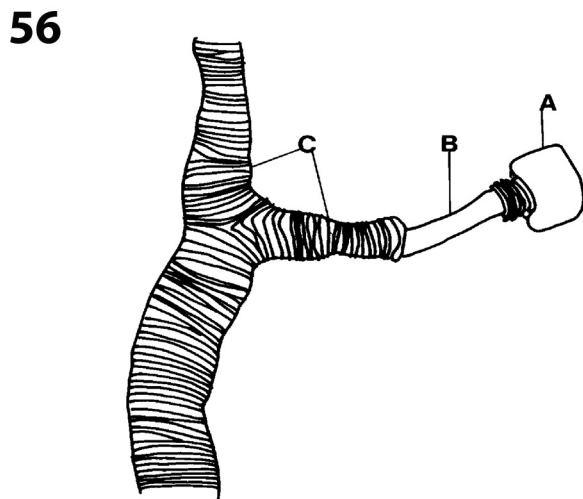
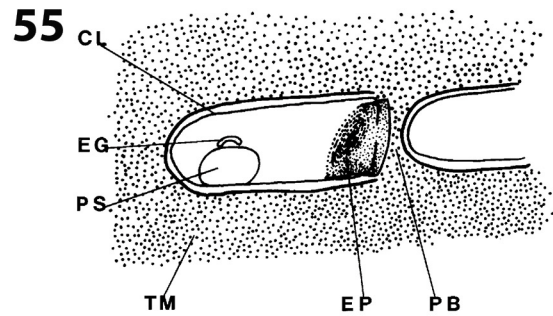
### Types

*Paracolletes nigrofulvus*—New South Wales: holotype ♂, Shoalhaven, 9.xi.1894, W.W. Froggatt (BMNH 17a.479).

*Paracolletes franki*—South Australia: holotype ♀, Adelaide, 21.xi.1906, Frank (AMNH 26840)

**Additional material examined:** 68♀, 36♂, 354 larvae & pupae **Queensland:** S Eukey. **New South Wales:** Mt Clyde; Braidwood; 1.5km W Mongarlowe; Monga. **Australian Capital Territory:** nr Canberra; Five Crossings, Condor Ck; Coree Ck; near Canberra; Brindabella Ra., in red soil at base of large termite mound, dry sclerophyll, 2500ft; Piccadilly Circus, Brindabella Ra; 1.39km Condor Ck bridge, Brindabella Rd; Blundell's farm turnoff, Brindabella Road; Cattle Grid, Warks Rd; 3.19km SW Condor Ck bdg, Brindabella Rd. **Victoria:** Noorinbee.

**Collection months:** August, September, October, November



**FIGURES 54–59.** *Leioproctus nigrofulvus* larval features. Fig. 54. Cellophane-like cell lining of two adjoining cells *in situ*. Fig. 55 Larval cell with egg on food ball, CL cellophane-like lining of cell; EG egg; TM termite mound; PS pollen ball; EP cell plug; PB partition between cells. Fig. 56 *Leioproctus nigrofulvus* larval spiracle and trachea lateral view, A atrium, B subatrium, C tracheal trunk. Fig. 57 SEM external view of larval spiracle. Fig. 58: SEM larval head showing mouth, LT labral tubercle, MN mandible, MP maxillary palp, LP labial palp, SO salivary opening. Fig. 59 SEM larval mandible.

**Floral visitations:** Fabaceae: *Davesia*, *Dillwynia*.

*Egg*—White, ca 2 mm wide and 5 mm long, even diameter throughout, gently curved c-shape, matt and smooth when viewed under the light microscope or scanning electron microscope, no distinct micropyle apparent and it is laid on top of the pollen ball. (fig. 55).

*Larva*—Holopneustic and apodous with a well defined, but weakly sclerotised head capsule. In smaller larvae there is no sclerotisation; in larger larvae, the distal margin of the anal plate, the spiracles, the antennae and the apices of the mandibles are sclerotised. They have 10 spiracles, spiracles are absent on the first thoracic and last two abdominal segments (see figs 56–57 for detail of spiracle).

There is poor differentiation between segments in post-defaecating larvae. The spiracles are in line with the body wall and are simple, cup-shaped without any spines or other ornamentation in the atrium they open medially on each segment. The anus opens as a slit just below the apex of the last abdominal segment and there is a band of spicules ventrally (fig. 61). The head is evenly rounded to the level of the labrum; the antennae are produced, rounded and moderately sclerotised apically. There are no apparent spicules on the frons area. The clypeus is somewhat bulbous; the clypeo-labral suture poorly defined. The epistomal suture is weakly defined. The labrum is relatively narrow and covered with small, spicules. Apically the labrum is produced into two large lobes that project as far out as the mandibles and maxillary palps; these lobes are moderately sclerotised and spiculate (figs 58, 60)

The mandibles have a single, large curved, apical tooth that has serrations on the dorsal and ventral margins, the tooth is grooved on the inner surface; the base is broad with a sclerotised, spiculate cusp (fig. 59). The mouth is a transverse slit between the mandibles and beneath the labrum. The anterior tentorial pits are poorly defined and slightly medial to the inner dorsal articulation of the mandibles, they are weakly sclerotised with slender posteriorly projecting arms. The posterior tentorial pits are deep, clearly defined and near the base of the postmentum. The hypopharynx is a large, fleshy, non spiculate lobe beneath the mouth; it is separated from the salivary opening. A small, slit-like salivary opening is situated dorsal to, but closely associated with the labium. On the dorsal margin of the salivary opening there is a small area of sclerotisation. The labium is fleshy, and non-sclerotised with a pair of small, lateroventral palps that do not project beyond the labium. The maxillae are large and produced beyond the labium. The maxillary palps are large with sclerotised apices, they are situated laterally and slightly ventral to the mid-line of the maxillae. There are a few spicules around the base of the palps.

*Pupa* (figs 62–63)—*Male*—head has two protuberances either side of the mid-line of the median ocellus; frons is flat, with a median groove, and is depressed around the antennal bases. Antennal segmentation on the clear outer sheath is well defined. The clypeus is smooth and convex. The labium is triangular and convex. The mandible sheath has a large, lateroventral protuberance about two-thirds the distance from the base. The apical tooth of the mandible is clearly visible. Maxillae palpal sheath is without clear segmentation; broad basally, tapering to a narrow apex. Glossal sheath has a strong medial indent, and a broad, rounded paraglossal sheath. Labial palp sheath is broad basally and tapers to a narrow apex. Pronotum has a broad, smooth band dorsally with a dorsolateral protuberance on each side. Posterior and adjacent to the pronotal protuberance is a second protuberance about twice as large. The tegulae are clearly defined. The scutum is convex with a median groove. The scutellum also has a deep median groove and as well a large, lateral protuberance on each side. Lateral and immediately adjacent to the hind wing is a large spiracle opening. The wings are housed in broad lateral sheaths. The coxae, trochanters and tibiae (except the hind tibiae) have large, median, apical protuberances, the femora have a basal protuberance and the hind tibiae have one dorsal and two ventral apical protuberances. The second to sixth metasomal terga have an apical band of pustules. The first and seventh terga are weakly rugulose and lack an apical band of pustules. The third to fifth sternal apical margins have apical bands of pustules, are sinuous and project from the body. The margin of the sixth sternum is the same but entire; the first and second sternal margins are entire and have no pustules. The first sternum has a median, longitudinal ridge. The "hidden sterna" and the genitalia are projecting. *Female*—the same as the male pupae except that they are more robust and the third to fifth sternal margins are entire with a small, median indent, and the details of the genitalia are different.

*Adults*—*Female*—Length ca 12 mm. *Body*—hair whitish to brown; integument brown to black. *Head*—Ocellular area flat; facial foveae absent; frons flat with dense, small, strong punctures and interspaces slightly granular; frontal line carinate; supraclypeal area shallowly raised, covered in yellowish hair; epistomal suture distinct; subantennal suture distinct; anterior tentorial pits distinct; clypeus with small, strong, moderately dense punctures and polished interspaces, except for a broad ventral margin which is glabrous; malar space glabrous,

length ca. 0.3 x width of base of mandible; labrum large, glabrous, convex, length about 0.5 x width. Mandibles large, when new, mandible almost as long as lower interorbital distance; apical tooth nearly a third length of mandible, long and narrowly pointed; pollex almost unrecognisable, instead replaced with a broad dorsal flange on mandible, hair on mandible long and simple. Maxillary palp extending beyond apex of extended glossa; labial palp just extending to apex of glossa, all segments of both types of palps subequal in length; glossa grooved medially, apical fringe short; inner eye margins straight, parallel, converging slightly dorsally; gena about as wide as eye when head viewed laterally; hair yellowish, long, moderately dense, much branched. *Mesosoma*—Scutum and scutellum with small, weak, moderately dense punctures and coriaceous interspaces; hair black except yellow patches on humeral areas; metanotum not tuberculate, with moderately dense, yellow hair; propodeal triangle rounded imperceptibly onto vertical area, coriaceous, basal area longer than length of metanotum. Jugal lobe of hind wing just reaching cu-a; fore wing with pterostigma large, about two-thirds the length of the costal margin of the marginal cell, not parallel sided; apex of marginal cell strongly divergent from costa; first recurrent vein enters second submarginal cell medially. Foretibial spur with thick teeth; hind basitibial plate less 0.2 x length of tibia, apex acute, covered in thick, dense black hair; hind tibial scopa with coarse, long, monopodal hair with three to six, long, apical branches; inner hind tibial spur with about five, long, thick, widely spaced teeth; claws with a small, medial tooth. *Metasoma*—Coriaceous with weak punctures, without apical band of pustules on terga; hair brown, fine, short; prepygidial fimbria coarse, black; pygidial plate with long, dense, branched hair. *Male*—As for female except as follows: Length ca 9 mm; hair whitish to golden. *Head*—First and second flagellar segments with length less than width; third to eleventh flagellar segments with length greater than width; hair dense. *Mesosoma*—Foretibial spur with fine teeth; other spurs simple, legs slender without scopae. *Metasoma*—Pygidial plate and prepygidial fimbria absent, sixth and seventh tergal segments with coarse, long, black hair; seventh tergal segment bare medially; eighth sternum projects strongly beyond seventh sternum, lateral lobes seventh sternum with spines, eighth sternum with tuft of hair on median apical process; sterna with sparse hair except apex of fifth sternum, which has an apical fringe that is shortest medially. The male genitalia are strongly convex with a large spiny process ventrally on the gonostylus; the penis valves are strongly ventrally projected. For S7–8 and genitalia see figs 64–66.

### ***Leioproctus (Leioproctus) platycephalus* species-group**

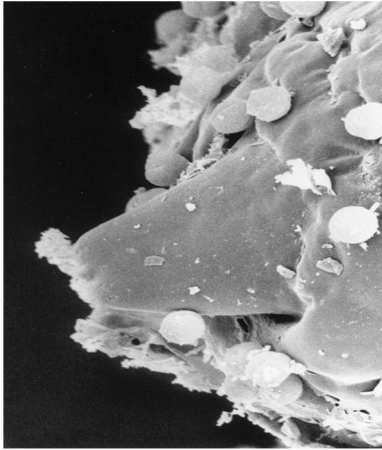
Five species are recognised in this group, all are very similar, and in several cases the intraspecific variation is almost as great as the variation between species.

*Diagnosis*—Frons rugulose; scutum surface granulose with weak punctures; propodeal triangle with transverse carina, basal area rugulose, about equal in length to vertical area; jugal lobe of hind wing not reaching cu-a; S7 with 2 simple, flat, apical lobes bearing branched hairs; apices of gonoforceps tapering to a blunt point.

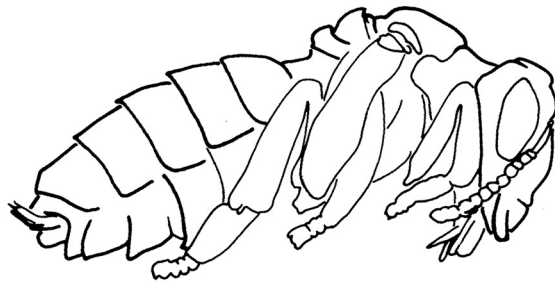
*Description*—Length ca 7–10 mm; head and mesosoma black, metasoma non-metallic, black, brown or reddish. *Head*—Vertex sparse, erect, open-branched hair; eyes protuberant; inner eye margin almost parallel; facial fovea not depressed, marked by change in surface sculpture; scape black, reaches median ocellus or beyond; flagellum black, in males F1 length about 0.5 width, F2 length about equal to width, F3–11 length about 1 and half width, in female F1–10 length less than width; frons flat, rough, rugulose; supraclypeal area strongly raised, polished with a few punctures; clypeus polished with a few punctures; epistomal suture usually distinct; malar space polished, short, length less than 0.5 x width of base of mandibles. *Mesosoma*—Surface granular with weak punctures, hair erect, sparse, usually black on scutum and scutellum; propodeal triangle usually with a strong transverse carina marking basal area and a few weak longitudinal ridges in basal area. Wings: first recurrent vein enters second submarginal cell apically; jugal lobe of hind wing not reaching cu-a. Legs: female usually with large basitibial plate greater than 0.2 x length hind tibia; tibial scopa with coarse, monopodal hair. *Metasoma*—T2 usually with clearly defined lateral foveae; female caudal fimbria coarse, dark; female pygidial plate rounded apically, slightly raised medially, coriaceous; S2–4 female, with broad, apical band of branched hairs; male S2–6 with only sparse, short hair. Male S7 lobes rounded and ventral branched hair patch; S8 median apical process about equal in length to basal area; genitalia: gonoforceps acute apically with spine medially on inner margin; volsella small; penis valves with apices ventrally directed.



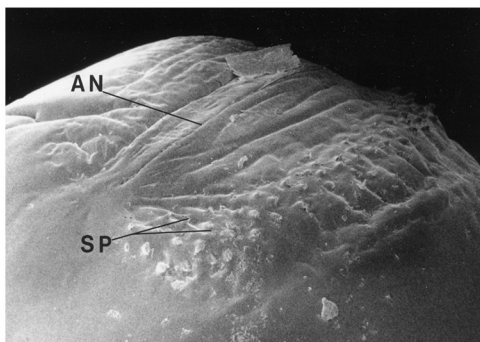
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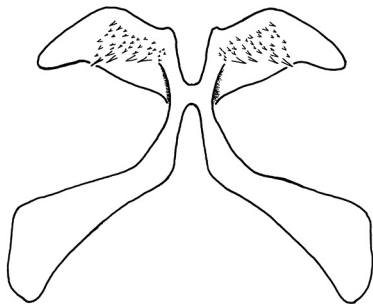
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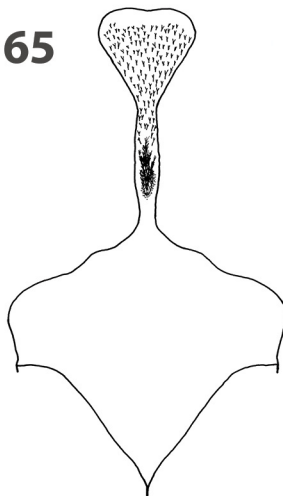
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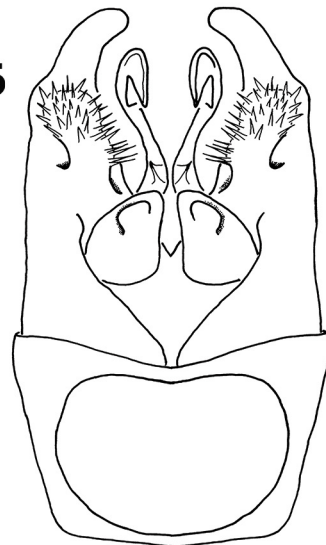
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**FIGURES 60–66.** *Leioproctus (Leioproctus) nigrofulvus*. Fig. 60 SEM larval maxillary palp. Fig. 61 SEM larval anus, AN anal slit, SP spicules. Fig. 62 Drawing lateral view of pupa lateral. Fig. 63 lateral view of pupa *in situ*. Figs 64–66 Male S7, S8, genitalia.

**Key to species of *Leioproctus (Leioproctus) platycephalus* species-group**

[Note: The separation of females without inner ramus of claws is difficult]

- |   |  |  |
|---|--|--|
| 1 | Mid tibial spur strongly hooked . . . . .        | <i>Leioproctus (Leioproctus) nasutus</i> Houston, 1990 |
| – | Mid tibial spur straight, or almost so . . . . . | 2  |
| 2 | Male (without hind tibial scopa) . . . . .       | 3  |
| – | Female (with hind tibial scopa) . . . . .        | 5  |

3	Hair of clypeus fine and branched .....	<i>Leioproctus (Leioproctus) maculatus</i> (Rayment, 1930)
–	Hair of clypeus thick, twisted, somewhat flattened .....	4
4	Inner margin of gonoforceps expanded to overlap penis valve, rarely with a small spine at apex of protuberance, not known from coastal south-east Queensland .....	<i>Leioproctus (Leioproctus) platycephalus</i> (Cockerell, 1912)
–	Inner margin of gonoforceps almost straight, with large median spine, only known from coastal south-east Queensland .....	<i>Leioproctus (Leioproctus) cyaneorufus</i> (Cockerell, 1930)
5	Claws with inner ramus absent or small .....	6
–	Claws with large inner ramus .....	7
6	Body length about 7 mm; claw occasionally with small inner ramus; only known from coastal south-east Queensland .....	<i>Leioproctus (Leioproctus) cyaneorufus</i> (Cockerell, 1930)
–	Body length about 8 mm; claw never with inner ramus; not known from coastal south-east Queensland .....	<i>Leioproctus (Leioproctus) platycephalus</i> (Cockerell, 1912)
7	Basitibial plate 0.2 x length hind tibia .....	<i>Leioproctus (Leioproctus) rubellus</i> (Smith, 1862)
–	Basitibial plate 0.25–0.3 x length tibia .....	<i>Leioproctus (Leioproctus) maculatus</i> (Rayment, 1930)

### *Leioproctus (Leioproctus) platycephalus* (Cockerell, 1912)

*Paracolletes platycephalus* \*Cockerell 1912a: 379, 381; 1913b: 276; 1934: 32; Rayment 1953: 5.

*Paracolletes truncatulus* \*Cockerell 1913b: 275; 1934: 37. **syn.n.**

*Dasycolletes rufoaeneus* \*Friese 1924: 219. **syn.n.**

*Paracolletes rufoaeneus* (Friese). Cockerell 1929a: 4; 1934: 35.

*Paracolletes nigropurpureus* \*Rayment 1935: 140. **syn.n.**

*Leioproctus (Leioproctus) nigropurpureus* (Rayment). Michener 1965: 51.

*Leioproctus (Leioproctus) platycephalus* (Cockerell). Michener 1965: 51.

*Leioproctus (Leioproctus) rufoaeneus* (Friese). Michener 1965: 52.

*Leioproctus truncatulus* (Cockerell). Michener 1965: 52.

The holotypes of *Paracolletes truncatulus*, *Paracolletes rufoaeneus*, and *Paracolletes platycephalus* which are female, show no significant morphological differences. The holotype of *Paracolletes nigropurpureus*, which is male is identical to those males associated with *Paracolletes platycephalus* by morphological similarity and coincident collection data.

#### Types

*Paracolletes platycephalus*—Victoria—holotype ♀, 7.ii.1907 (BMNH 17a.476).

*Paracolletes truncatulus*—Victoria: holotype ♀, Blackwood, 16.x.1891 (BMNH 17a.484).

*Paracolletes rufoaeneus*—South Australia: holotype ♀, Adelaide, 21.ix.1906, Frank (AMNH 26849).

*Paracolletes nigropurpureus*—Victoria: holotype ♂, Heathmont, ix, Rayment (ANIC); paratype ♀, same data as holotype.

**Additional material examined:** 42♀, 23♂ **Queensland:** S Eukey. **New South Wales:** Cheltenham. **Australian Capital Territory:** Black Mtn; Piccadilly Circus, Brindabella Ra. **Victoria:** Sandringham; Yanac; Halls Gap; Grampians; Montrose; Ringwood; Black sands; Lorne; Heathmont; Black Rock. **South Australia:** Hincks NP; South Para Reservior; South Para Reservior, 45 k NE Adelaide; Kyeema NP, nr Meadows; Mt Lofty; Mt Lofty summit; Willunga; Stokes Bay, Kangaroo Is; Rocky Riv., Kangaroo Is; 11 k S Clare. **Western Australia:** Drummond Cove, 7 miles (11.2 k) N Geraldton; 11 miles (17.6 k) New Norcia; Darlington (450 ft); Kings Park; Bridgetown.

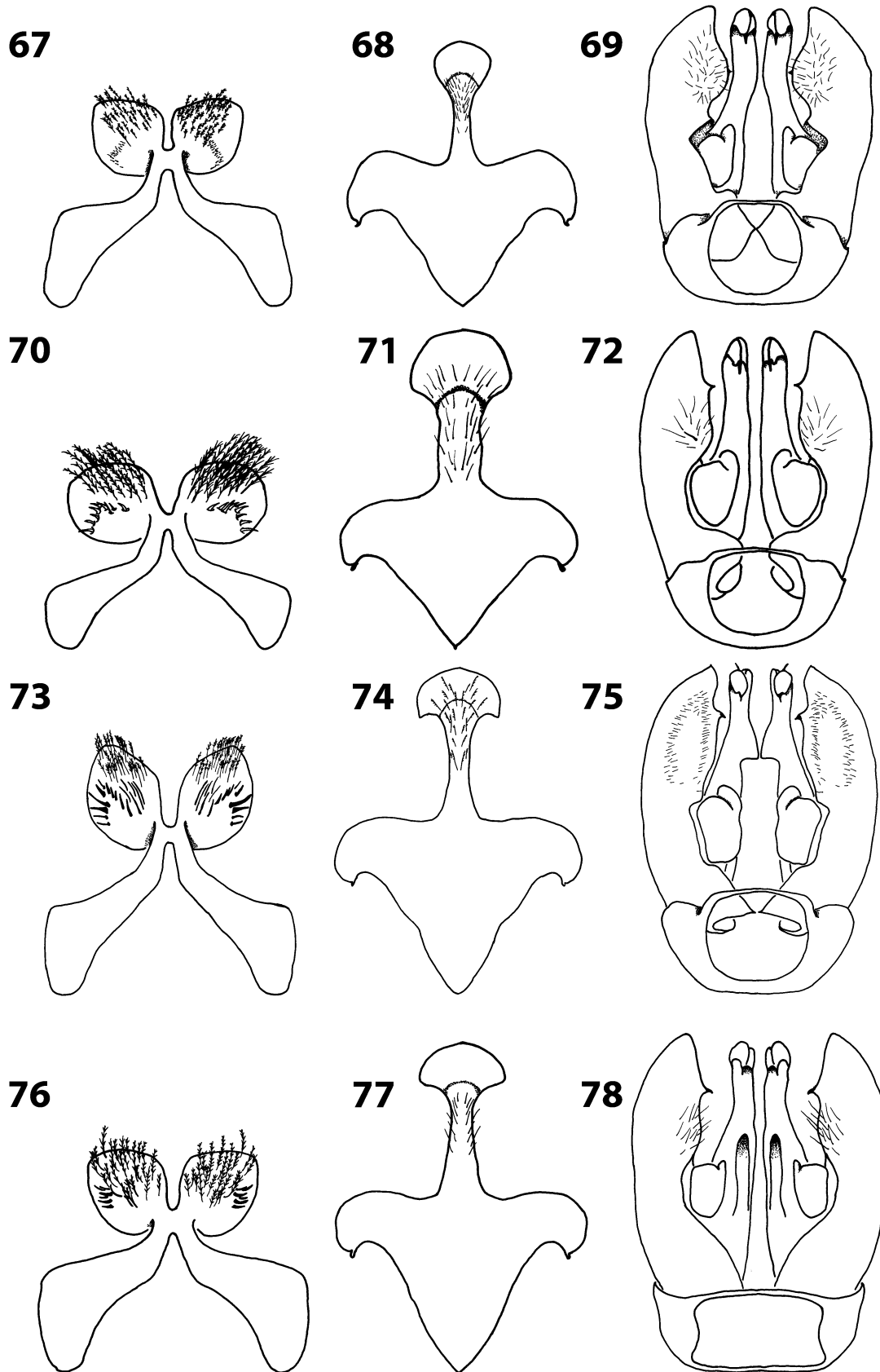
**Months collected:** July, September, October, November, December, February.

**Floral visitations:** Ericaceae: *Leucopogon*; Fabaceae: *Daviesia mimosoides*, *Pultanaea largifrons*, *Dillwynia*, *Eutaxia*.

**Description**—As for the general description of *platycephalus*-group except as follows: length ca 8 mm (females), 7 mm (males); male clypeus with erect, twisted, flattened hair; claws without inner ramus (females); scopa black. Males with gonoforceps with inner margin expanded medially. For S7–8 and genitalia see figs 67–69.

#### Notes

The hair on the males is distinctive. The only species with similar hair is *L. cyaneorufus*. At present, these 2 species are separated on the male genitalia and the female claws. One of the females collected at Eukey had an elongate labial palp on 1 side and a normal palp on the other.



**FIGURES 67–78.** Male S7–8 and genitalia *Leioproctus* (*Leioproctus*). Figs 67–69 *Leiop*L.(L.) *roctus platycephalus* S7, S8, genitalia. Figs 70–72 *L.*(L.) *cyaneorufus* S7, S8, genitalia. Figs 73–75 *L.*(L.) *maculatus* S7, S8, genitalia. Figs 76–78 *L.*(L.) *nasutus* S7, S8, genitalia.



### ***Leioproctus (Leioproctus) cyaneorufus* (Cockerell, 1930)**

*Paracolletes cyaneorufus* \*Cockerell 1930: 47; 1934: 25.

*Leioproctus (Leioproctus) cyaneorufus* (Cockerell). Michener 1965: 50.

*Leioproctus (Leioproctus) unguidentatus* \*Michener 1965: 44, 247–248, figs 32, 48, 52. **syn.n.**

#### **Types**

*Paracolletes cyaneorufus*—Queensland: holotype ♀, Bribie I., 29.viii.1920, H. Hacker (QM T.4028).[Metasoma missing]

*Leioproctus unguidentatus*—Queensland: holotype ♀, Dunwich, Stradbroke Is., 21.viii.1958, C.D. Michener (ANIC).

The holotypes of *Paracolletes cyaneorufus* and *Leioproctus (Leioproctus) unguidentatus* show no significant morphological differences.

**Additional material examined:** 44♀, 7♂ **Queensland:** 2 miles (3.2 k) W Central Station, Fraser Is; S Lake Benaroon, Fraser Is.; Lake Birrabreen, Fraser Is; Lake Jennings and Lake Birrabreen, Fraser Is; Cooloola; Mapleton; Beerwah; Tibrogargan Ck, Glasshouse; Stradbroke Is; Brisbane.

**Months collected**—July, August, September.

**Floral visitations:** Fabaceae: *Aotus*.

*Description*—As for the general description of *platycephalus* group except as follows: length ca 7 mm; males with clypeus with white, flattened, erect, twisted hairs; female claws with inner ramus absent to moderately small. Males with inner margin of gonostyles straight with a strong tooth medially. For S7–8 and genitalia see figs 70–72.

#### **Notes**

Michener considered *L. (L.) unguidentatus* a separate species because of the small inner ramus on each claw of the female and the metasoma was "dark blue rather than red" (Michener 1965). Within the series of specimens collected at Fraser Island there are some females that have no inner ramus and others with a small inner ramus. Although the metasoma of *L. (L.) cyaneorufus* holotype is missing, Cockerell described it as "...abdomen dusky chestnut red with a delicate purple suffusion". In the Fraser Island series mentioned above, the female metasomas range from red to almost completely black. Most specimens have been taken from the sandy islands close to mainland south-east Queensland.

### ***Leioproctus (Leioproctus) maculatus* (Rayment, 1930)**

*Paracolletes maculatus* Rayment 1930b: 48; 1935: 153; Cockerell 1934: 29.

*Leioproctus maculatus* (Rayment). Michener 1965: 51.

#### **Types**

*Paracolletes maculatus*—New South Wales: holotype ♀, Sandringham, Rayment (ANIC); paratypes: 1♀, 1♂, same data as holotype (ANIC, BMNH); ♂, Sandringham, 9.ix.1928, Rayment (MV).

**Additional material examined:** 25♀, 10♂ **Victoria:** Little Desert; Hattah; Hattah Lake; Sandringham; Mitta Mitta Riv.; 8 k NW Dartmouth Dam; Kalorama; Bendigo; Port Phillip; Mordialic; Carrum; Frankston; Balcombe.

**South Australia:** Hincks NP; Mairland; Kyeema NP meadow; Adelaide Hills; Stokes Bay, Kangaroo Is; Cape St. Albans, Kangaroo Is. **Western Australia:** 4 miles (4.8 k) NE Menzies; Warren Riv.

**Months collected:** August, September, October, November.

**Floral visitations:** Fabaceae: *Cassia*, *Eutaxia*; Myrtaceae: *Eucalyptus*.

*Description*—As for the general description of *platycephalus* group except as follows: length ca 8 mm (female), length ca 7 mm (male); males with clypeus with fine, brown, branched hair; females with claws with large inner ramus; basitibial plate 0.25–0.3 x length of tibia. Males with gonostyles with large tooth on inner margin, inner margin more or less straight. For S7–8 and genitalia see figs 73–75.

### ***Leioproctus (Leioproctus) nasutus* Houston, 1990**

*Leioproctus (Leioproctus) nasutus* \*Houston 1990: 612

#### **Types**

*Leioproctus nasutus*—Western Australia: holotype ♂, Meleya Well (28°58'S 117°12'E), Thundelara Station, 28.viii.–2.ix.1981, T.F. Houston (WAM 89/345) [not seen]; paratypes 1♀, 1♂, Meleya Well, 28°58'S 117°12'E, Thundelarra Stn, 28.vii.–2.ix.1981, T.F. Houston off *Eremophila longifolia* blossom (WAM 89/364, 89/357).

**Additional material examined:** 2♀, 5♂ **Queensland:** 10 miles (16 k) SW Charleville. **South Australia:** N Middleback Ra. **Western Australia:** 34 k NW Bullfinch.

**Months collected:** August, September, October.

**Floral visitations:** Scrophulariaceae: *Eremophila longifolia*, *Eremophila gilesii*, *Eremophila scoparia*, *Eremophila drummondii*.

*Female*—As for the general description of *platycephalus* group including the following. Length ca 10 mm. *Head*—Clypeus strongly protuberant; labrum large length half width, strongly convex (no membranous area); labial and mandibular palps not proportionately any longer than usual. *Mesosoma*—Fore tibial spur apex very short with only 1–2 teeth; mid tibial spur very thick and strongly hooked; hind basitibial plate a quarter length of tibia. *Metasoma*—Very dark reddish to black. *Male*—As for female except as follows: Length ca 10 mm, covered in long, fine white hair. *Head*—Gena with long white beard. *Mesosoma*—Propodeal triangle basal area sculptured with a weak or no defining carina, basal area coriaceous; outer hind tibial spur thick; outer apical edge of fore, mid and hind tibia thick and out turned; tarsi laterally flattened, with long outer fringe. *Metasoma*—For S7–8 and genitalia see figs 76–78.

#### Notes

This species has unusual mid tibial spurs—very thick and hooked as is often found in other *Leioproctus* that visit *Eremophila* in both males and females. The holotype of this species was not examined.

#### *Leioproctus (Leioproctus) rubellus* (Smith, 1862)

*Dasycolletes rubellus* \*Smith 1862: 58; Dalla Torre, 1896: 49.

*Paracolletes rubellus* (Smith). Cockerell 1934: 34.

*Leioproctus rubellus* (Smith). Michener 1965: 48, 52.

#### Type

*Dasycolletes rubellus*—Holotype: ♀, Australia (BMNH 17a.524) [Locality in original description "South Australia - Lower Plenty"].

**Additional material examined:** 2♀ same data as holotype.

**Months collected:** Not known.

**Floral visitations:** None recorded.

*Description*—As for the general description of *platycephalus* group except as follows: length ca 9 mm; claws with large inner ramus; basitibial plate about 0.2 x length of tibia.

#### Notes

This species is extremely similar to *L. maculatus*. No males have yet been associated, nor fresh material identified, and the true status of this species remains unresolved.

#### *Leioproctus (Leioproctus) spatulatus* species-group

This group of black to brown, rather nondescript species is difficult to separate from other black *Leioproctus* (*Leioproctus*) they are placed tentatively as a species-group due to the lack of strong external characters however based on their over-all facies it is useful to place these as a species group. The most readily identifiable character of this group is the male genitalia which all possess a subapical spine on the inner margin of each gonoforceps.

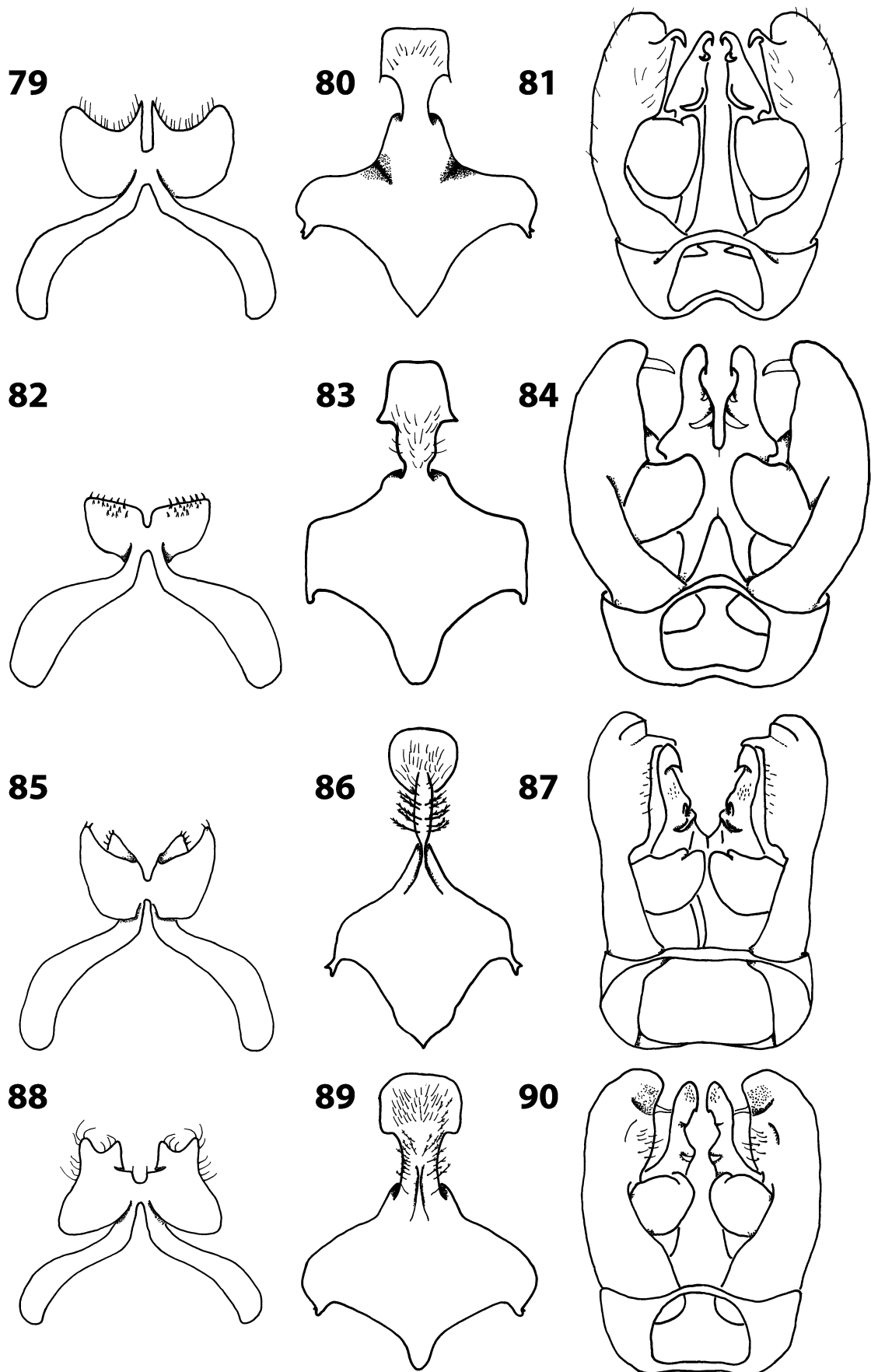
This group is found in eastern Australia with the greatest concentration being in Victoria and Tasmania. The species are all very similar and are separated mainly by colour characters of the integument and nature of the hair. *Diagnosis*—Malar space short or absent, propodeal triangle coriaceous; jugal lobe of hind wing reaching cu-a; male F1 the length is less than the width; female with hind tibial scopa branched bimodal and inner hind tibial spur with

4–9 long, slender teeth; male genitalia with gonoforceps with a subapical tooth on inner margin and penis valves often with a double, ventral spine.

*Description*—Small to medium-sized (7–11 mm) black or dark brown bees; general body sculpture of small, dense, distinct punctures with smooth or coriaceous interspaces; vestiture of long, fine hair with many, moderately long branches. *Head* Inner eye margins parallel except where they converge slightly at level of ocelli, and ventral ends; facial foveae vaguely indicated by slight change in surface texture; frontal line with dorsal part weakly carinate or absent, ventral part weakly carinate; frons sculpture of dense, weak punctures with coriaceous interspaces; male F1 length less than width, F2 length about equal to width, F3–11 length greater than width, sub antennal suture about as long as diameter of antennal bases; clypeus with small punctures with smooth or coriaceous interspaces; maxillary and labial palps with segments well sclerotised, all about equal in length; malar space short, or absent; labrum short, totally convex, no depressed apical area; scape reaching median ocellus. *Mesosoma*—Scutum and scutellum with small, ill-defined punctures with smooth to coriaceous interspaces, posterior median area often polished; hair long, fine, much branched; metanotum not protuberant; propodeal triangle convex with no clearly defined basal area, coriaceous. Forewings with marginal cell long, slender, apex curved from costal margin of the marginal cell; basal vein strongly sloping; membrane often darkened towards the apex; jugal lobe of hind wing reaching cu-a; wings hairy. Legs of female with dense scopa, in dorsal posterior area, hairs with 2 rows of branches; inner hind tibial spur with 4–9 long, slender teeth; inner rami of claws large; female hind basitibial plate 0.2–0.25 length of tibia, densely covered in long, stiff thick hairs. *Metasoma*—Metasoma with small, dense, weak punctures with coriaceous interspaces; female pygidial plate rounded apically, weakly coriaceous; male without pygidial area or sternal fringes; female sterna with much branched hair. Male genitalia with gonobase 0.2–0.25 x length of genitalia, genital foramen large; gonostyles large with a tooth subapically on inner lateral margin; volsellae about 0.25 x length of genitalia. S7 with 2 broadly rounded, simple, apical lobes.

### Key to *Leioproctus (Leioproctus) spatulatus* species-group

1	Male (without hind tibial scopa) . . . . .	2
–	Female (with hind tibial scopa) . . . . .	8
2	Ventral hind margin of gena extended to an obtuse angle that approximates 90° . . . . .	3
–	Ventral hind margin of gena rounded . . . . .	4
3	Apical margins of T3–5 translucent . . . . .	<i>Leioproctus (Leioproctus) punctatus</i> (Smith, 1853)
–	Apical margins of T3–5 opaque . . . . .	<i>Leioproctus (Leioproctus) obscurus</i> (Smith, 1853)
4	Legs all brown or black . . . . .	5
–	Legs with hind tibiae orange . . . . .	6
5	Wings clear; hair of scutum and scutellum whitish . . . . .	<i>Leioproctus (Leioproctus) providellus</i> (Cockerell, 1905)
–	Wings dark; hair of scutum and scutellum brownish . . . . .	<i>Leioproctus (Leioproctus) providus</i> (Smith, 1879)
6	Only hind tibiae and tarsi orange; S7 with a single row of marginal hairs . . . . .	<i>Leioproctus (Leioproctus) spatulatus</i> (Cockerell, 1905)
–	All tibiae and tarsi orange . . . . .	7
7	Scutal and scutellar hair orange (or white) . . . . .	<i>Leioproctus (Leioproctus) alleynae</i> (Rayment, 1935)
–	Scutal and scutellar hair brownish . . . . .	<i>Leioproctus (Leioproctus) recusus</i> (Cockerell, 1921)
8	Hind tibial scopa with hair anteriorly yellow . . . . .	<i>Leioproctus (Leioproctus) philonesus</i> (Cockerell, 1929)
–	Hind tibial scopa with hair anteriorly dark, posteriorly pale . . . . .	9
9	Apical margins T3–5 translucent . . . . .	<i>Leioproctus (Leioproctus) punctatus</i> (Smith, 1853)
–	Apical margins T3–5 opaque . . . . .	10
10	Clypeus with simple hairs medially . . . . .	11
–	Clypeus with branched hairs medially . . . . .	13
11	Wings hyaline, all tibiae and tarsi orange . . . . .	<i>Leioproctus (Leioproctus) alleynae</i> (Rayment, 1935)
–	Wings darkened, all tibiae and tarsi brown to black . . . . .	12
12	Inner hind tibial spur with about 9 fine teeth, ventral hind margin of gena rounded . . . . .	<i>Leioproctus (Leioproctus) providus</i> (Smith, 1879)
–	Inner hind tibial spur with about 5 moderately coarse teeth, ventral hind margin of gena obtusely angulate . . . . .	<i>L. obscurus</i> (Smith, 1853)
13	Inner hind tibial spur with about 5 thick teeth, all tibiae and tarsi orange . . . . .	<i>Leioproctus (Leioproctus) recusus</i> (Cockerell, 1921)
–	Inner hind tibial spur with about 9 fine teeth, all tibiae and tarsi brown to black. . . . .	14
14	Metasoma weakly metallic . . . . .	<i>Leioproctus (Leioproctus) spatulatus</i> (Cockerell, 1905)
–	Metasoma black . . . . .	<i>Leioproctus (Leioproctus) providellus</i> (Cockerell, 1905)



**FIGURES 79–90.** Male S7–8 and genitalia *Leioproctus* (*Leioproctus*). Figs 79–90 *L.(L.) spatulatus* S7, S8, genitalia. Figs 82–84 *L.(L.) alleynae* S7, S8, genitalia. Figs 85–87 *L.(L.) obscurus* S7, S8, genitalia. Figs 88–90 *L.(L.) providellus* S7, S8, genitalia.

### ***Leioproctus (Leioproctus) spatulatus* (Cockerell, 1905)**

*Paracolletes spatulatus* \*Cockerell 1905c: 483; 1906: 29.

*Paracolletes providellus bacchalis* \*Cockerell 1914a: 138; 1934: 33. **syn.n.**

*Paracolletes subviridus* \*Cockerell 1915c: 103; 1934: 36. **syn.n.**

*Paracolletes pallidicinctus* \*Rayment 1953: 4. **syn.n.**

*Leioproctus (Leioproctus) bacchalis* (Cockerell). Michener 1965: 50.

*Leioproctus (Leioproctus) pallidicinctus* (Rayment). Michener 1965: 51.

*Leioproctus (Leioproctus) spatulatus* (Cockerell). Michener 1965: 52.

*Leioproctus (Leioproctus) subviridus* (Cockerell). Michener 1965: 52.

The holotypes of *P. spatulatus*, *P. bacchalis* and *P. pallidicinctus*, which are all male, show no significant morphological variation. That of *P. subviridus*, which is a female, is the same as those females associated by morphological similarity and coincident collection data.

#### **Types**

*Paracolletes spatulatus*—New South Wales: holotype ♂, Blackheath, 1895, W.W. Froggatt (BMNH 17a.430).

*Paracolletes providellus bacchalis*—Victoria: holotype ♂, Bacchus Marsh, 2.i.1906 (BMNH 17a.428).

*Paracolletes subviridus*—Tasmania: holotype ♀, Bridport, 30.x.1913, F.M. Littler (BMNH 17a.418).

*Paracolletes pallidicinctus*—Victoria: holotype ♂, Emu hill, 16.i.1952, C. Beauglehole (ANIC).

**Additional material examined:** 4♀, 110♂ **Queensland:** Springbrook; Amiens; 3 miles (4.8 k) E Stanthorpe. **New South Wales:** 4 miles (6.4 k) W Amosfield; 6 miles (9.6 k) W Amosfield; Canobolas; Mt Wilson; Mt Victoria; Leura; Olgives Ck, Round Mtn, Kosciusko NP; Wilson Valley. Australian Capital Territory: Black Mtn; Bendora. **Victoria:** Mt Hotham; Flowerdale; Kinglake; Wannon; Buxton; Broadmeadows; Woori Yallock; Heathmont; Silven Reservoir, Monbulk; Powelltown; Ferntree Gully; Mt Dandenong; Dromana; Gellibrand; 1 mile (1.6 k) E Wye Riv; Mt Sabine, Otway Ra; Cockatoo; Mt Buffalo; Wilsons Prom. **Tasmania:** Murchison Hwy; Tullah; 33 miles (52.8 k) E Queenstown; Arthur Plains; Port Arthur. **Western Australia:** Cape Naturaliste.

**Months collected:** September, October, November, December, January, February, March.

**Floral visitations:** Myrtaceae: *Leptospermum*, *Eucalyptus*, *Melaleuca*; Pittosporaceae: *Bursaria spinosa*.

*Description*—The females of this species are difficult to identify if not collected with males, they are small (ca 8 mm) with a dark scopa, branched hair on the clypeus, inner hind tibial spur with about 8 teeth and with metasoma vaguely metallic. The most distinctive character of males, apart from the genitalia, is the orange colour of the hind tibiae and tarsi. For male S7–8 and genitalia see figs 79–81.

### ***Leioproctus (Leioproctus) alleynae* (Rayment, 1935)**

*Paracolletes alleynae* \*Rayment 1935: 668, 1954: 46.

*Leioproctus (Leioproctus) alleynae* (Rayment). Michener 1965: 50.

#### **Type**

*Paracolletes alleynae*—Victoria: holotype ♂, Croydon, 3.i.1939 (ANIC).

**Additional material examined:** 14♀, 6♂ **Victoria:** 16 k W Genoa; Reefton; Macedon; Box Hill, Melbourne; Parkville, Melbourne; Powelltown. **South Australia:** Millicent.

**Months collected:** December, January, February.

**Floral visitations:** Myrtaceae: *Eucalyptus*; Pittosporaceae: *Bursaria spinosa*.

*Description*—*L. alleynae* can be distinguished from *L. recusus* by the orange hair on the scutum and scutellum (whitish in *L. recusus*), the orange mid femur in *L. alleynae* (black in *L. recusus*) and male genitalia and hidden sterna. This species is most similar to *L. recusus*. Both are readily distinguished from other species in the group by the orange colour of all tibiae and tarsi and the hind femora, in contrast to the black basal areas. For male S7–8 and genitalia see figs 82–84.

### ***Leioproctus (Leioproctus) obscurus* (Smith, 1853)**

*Lamprocolletes obscurus* \*Smith 1853: 11; Dalla Torre, 1896: 48.

*Paracolletes semilautus* \*Cockerell 1905c: 485; 1906: 29; 1934: 35. **syn.n.**

*Paracolletes hobartensis* \*Cockerell 1906: 23, 29; 1934: 28. **syn.n.**

*Paracolletes obscurus* (Smith). Cockerell 1929d: 310; 1934: 31.

*Paracolletes stewarti* \*Rayment 1947: 102. **syn.n.**

*Leioproctus hobartensis* (Cockerell). Michener, 1965: 51.

*Leioproctus obscurus* (Smith). Michener 1965: 51.

*Leioproctus semilautus* (Cockerell). Michener 1965: 52.

*Leioproctus stewarti* (Rayment). Michener 1965: 52.

The holotypes of *Paracolletes semilautus* and *Paracolletes stewarti*, which are male, are the same as those males associated with *Lamprocolletes obscurus* by morphological similarity and coincident collection data. The holotypes of *Lamprocolletes obscurus* and *Paracolletes hobartensis*, are female, and show no significant morphological differences.

#### Types

*Lamprocolletes obscurus*—Tasmania: holotype ♀, Van Diemensland (BMNH 17a.499).

*Paracolletes semilautus*—holotype ♂, Australia (BMNH 17a.420)

*Paracolletes hobartensis*—Tasmania: holotype ♀, Hobart (BMNH 17a.446)

*Paracolletes stewarti*—Victoria: holotype ♂, Mt Buffalo, 6.ii.1949 (ANIC); paratype, 1♀, same data as holotype.

**Additional material examined:** 23♀, 77♂ **Victoria:** Mt Buffalo; Bogong Plains; Mt William, Grampian Ra; Mt Buffalo; Mt Donna Buang via Healesville. **Tasmania:** Murchinson Hwy; Mt Barrow, via Launceston; Cradle; 20 miles (32 k) E Queenstown.

**Months collected:** January, February, March.

**Floral visitations:** Myrtaceae: *Leptospermum repustre*; *Leptospermum*.

*Description*—The males of this species are readily identifiable by the angulate ventral margin to the gena. Females have a somewhat expanded, slightly angulate lower gena, but the angle is not as acute as in males. For male S7–8 and genitalia see figs 85–87.

#### Notes

The name *Leioproctus* (*Leioproctus*) *chalybeatus* (Erichson, 1842) has often been mistakenly applied to specimens of this species.

#### *Leioproctus* (*Leioproctus*) *philonesus* (Cockerell, 1929)

*Paracolletes philonesus* \*Cockerell 1929c: 201.

*Leioproctus* (*Leioproctus*) *philonesus* (Cockerell). Michener 1965: 51.

#### Type

*Paracolletes philonesus*—New South Wales: Holotype ♀, Mt Gower, Lord Howe I., 19.i.1922, A.R. McCulloch (AM).

**Additional material examined:** 2♀ **New South Wales:** Lord Howe Island.

**Months collected:** November, December.

**Floral visitations:** not recorded.

*Description*—*Female*—Length ca 10 mm; clypeus with smooth interspaces; hair pale brown; genal hair whitish; 6–8 teeth on inner hind tibial spur; hair of tibial scopa yellow. *Male*—unknown.

#### Notes

This is the only species of *Leioproctus* known from Lord Howe Island.

#### *Leioproctus* (*Leioproctus*) *providellus* (Cockerell, 1905)

*Paracolletes providellus* \*Cockerell 1905c: 483; 1934: 33.

*Paracolletes obscuripennis* \*Cockerell 1905c: 484; 1934: 31. **syn.n.**

*Paracolletes plebius* \*Cockerell 1921: 94; 1934: 32. **syn.n.**

*Paracolletes regalis* \*Cockerell 1921:93 **syn.n.**

*Paracolletes providellus caerulescens* \*Cockerell, 1929a: 2; 1934: 33. **syn.n.**

*Leioproctus* (*Leioproctus*) *caerulescens* (Cockerell). Michener 1965: 50.

*Leioproctus* (*Leioproctus*) *obscuripennis* (Cockerell). Michener 1965: 51.

*Leioproctus* (*Leioproctus*) *plebius* (Cockerell). Michener 1965: 51.

*Leioproctus (Leioproctus) providellus* (Cockerell). Michener 1965: 52.

The holotypes of *Paracolletes providellus*, *Paracolletes obscuripennis* and *Paracolletes providellus caerulescens*, which are all male have no significant morphological variation. That of *Paracolletes plebius*, which is female, is identical to those females associated by coincident collection data and morphological similarity.

#### Types

*Paracolletes providellus*—holotype ♂, Australia (BMNH 17a.427).

*Paracolletes obscuripennis*—Tasmania: holotype ♂, (BMNH 17a.436).

*Paracolletes plebius*—Victoria: holotype ♀, Bright, H.W. Davey (QM T.2403).

*Paracolletes providellus caerulescens*—New South Wales: holotype ♂, Como, 1.xi.1902, W.W.F (AMNH 26839). [There is a second locality label attached—Sydney, Australia, 14.ix.1906].

**Additional material examined:** 38♀, 56♂ **Queensland:** Amiens. **New South Wales:** Ebor; Gibraltar Ra. NP; Tubrabucca; Mt Wilson; Mt Victoria; Sydney; Alpine Ck, Kiandra.

**Months collected:** January, October, November, December.

**Floral visitations:** Myrtaceae: *Leptospermum*.

*Female*—length ca 9 mm; face with whitish hair; clypeus with branched hair; gena rounded; mesosoma with hair brownish; scopa pale with dark hair around the basitibial plate; inner hind tibial spur with about 8 teeth; wings clear; metasoma with T3–5 apical margins translucent. *Male*—length ca 7 mm; mesosoma with legs all dark brown. For S7–8 and genitalia see figs 88–90.

### *Leioproctus (Leioproctus) providus* (Smith, 1879)

*Lamprocolletes providus* \*Smith 1879: 8; Dalla Torre 1896: 48.

*Paracolletes viridicinctus* \*Cockerell 1905c: 482; 1934: 38. **syn.n.**

*Paracolletes helmsi* \*Cockerell 1929c: 209; 1934: 28. **syn.n.**

*Paracolletes providus* (Smith). Cockerell 1934: 33.

*Leioproctus (Leioproctus) helmsi* (Cockerell). Michener 1965: 51.

*Leioproctus (Leioproctus) providus* (Smith). Michener 1965: 51.

*Leioproctus (Leioproctus) viridicinctus* (Cockerell). Michener 1965: 52.

The holotype of *Paracolletes viridicinctus*, which is female, has no significant morphological variation from that of *Lamprocolletes providus*. The holotype of *Paracolletes helmsi*, which is male, is identical to those males associated with *Lamprocolletes providus* by coincident collection data and morphological similarity.

#### Types

*Lamprocolletes providus*—holotype ♀, Australia (BMNH 17a.510).

*Paracolletes viridicinctus*—Tasmania: holotype ♀, E Tasmania, 12.ii.–13.iii.1913, R.E. Turner (BMNH 17a.437).

*Paracolletes helmsi*—New South Wales: holotype ♂, Kosciusko (5000 ft = 1600 m), .iii.1889, Helms (AM K48305).

**Additional material examined:** 18♀, 28♂ **Victoria:** Kallista; Woori Yallock; Mt Donna Buang; Cement Ck. **Tasmania:** Franklin Riv., 20 k SW Derwent Bridge; Zeehan; Condamine Ck; Lake Dobson; Derwent Br; Huon-Picton river jctn.

**Months collected:** February, March.

**Floral visitations:** not recorded.

*Description*—This species has distinctive dark wing apices. The subapical spur of the male genitalia is very small and on the dorsal surface; S7 has 2 quite large, heavily sclerotized lobes that have only 1–2 hairs. For male S7–8 and genitalia see figs 91–93.

### *Leioproctus (Leioproctus) punctatus* (Smith, 1853)

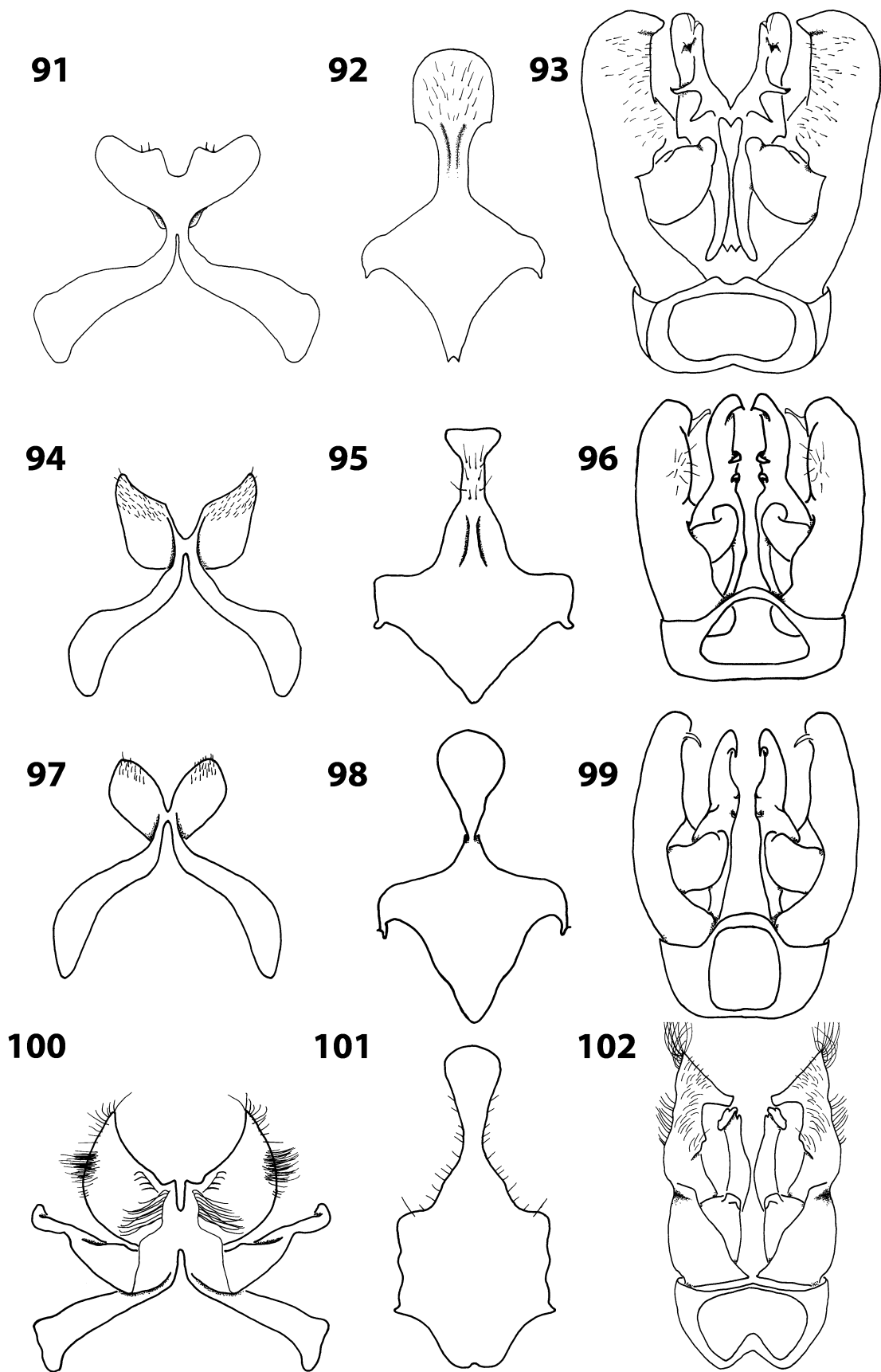
*Lamprocolletes punctatus* \*Smith 1853: 14.

*Paracolletes punctatus* (Smith). Cockerell 1905a: 346; 1934: 33.

*Leioproctus (Leioproctus) punctatus* (Smith). Michener 1965: 51.

#### Type

South Australia: ♀, Adelaide [No locality data with specimen] (BMNH 17a.512)



**FIGURES 91–102.** Male S7–8 and genitalia *Leioproctus*. Figs 91–93 *L. (Leioproctus) providedus* S7, S8, genitalia. Figs 94–96 *L. (Leioproctus) punctatus* S7, S8, genitalia. Figs 97–99 *L. (L.) recusus* S7, S8, genitalia. Figs 100–102 *Leioproctus (Alokocolletes) excubitor* S7, S8, genitalia.



**Additional material examined:** 7♀, 11♂ **Queensland:** Cunninghams Gap. **New South Wales:** Snowy Riv., Mt Kosciusko. Australian Capital Territory: Bendora; Brindabella Ra., Corin Dam Area. **Victoria:** same data as holotype. **South Australia:** Black Hill Con. Park, 2.5 k SE Athelstone.

**Months collected:** January, March, November, December.

**Floral visitations:** Myrtaceae: *Calytrix tetragona*.

*Description*—Female *L. punctatus* have faint apical hair bands and are usually brown rather than black in colour. Males of this species are distinguishable from most species of *Leioproctus* by the angulate ventral area of the gena, a feature shared by *L. obscurus*. *L. punctatus* is usually larger and paler than *L. obscurus*. The genitalia, S8 and in particular S7 distinguish the 2 species. For male S7–8 and genitalia see figs 94–96. The known distribution overlaps in part that of *L. obscurus*, collections of both have been mostly at similar times of the year.

### *Leioproctus (Leioproctus) recusus* (Cockerell, 1921)

*Paracolletes recusus* \*Cockerell 1921: 94; 1934: 34.

*Paracolletes subviridus illawaraensis* \*Rayment 1954: 48. **syn.n.**

*Leioproctus illawaraensis* (Rayment). Michener 1965: 51.

*Leioproctus recusus* (Cockerell). Michener 1965: 52.

The holotype of *Paracolletes recusus* and *Paracolletes subviridus illawaraensis* are both female and show no significant morphological variations.

#### **Types**

*Paracolletes recusus*—Queensland: holotype ♀, Tamborine Mountain, 27.x.1912, H. Hacker (QM T.2398).

*Paracolletes subviridus illawaraensis*—New South Wales: holotype ♀, Jamberoo, 20.i.1950 (ANIC).

**Additional material examined:** 4♀, 68♂ **Queensland:** Kuranda, F.P. Dodd; Bunya Mts; Mt Pleasant; Dunkeld; Brisbane; Toowoomba; Dunwich; Stanthorpe; swarming near nests, Canungra; Springbrook; Glen Aplin; Girraween; Palen Ck; Lamington NP. **New South Wales:** Bald Rock NP, 25 k SE Stanthorpe; Boonoo Boonoo; SE Bourke; 14 k SW Ebor; New England NP via Ebor; Gibraltar Range NP; Sydney; Loftus. **Victoria:** foot of Mt William, Grampians; Healesville; Belgrave; Lorne; Croydon; Warburton; Emerald; Mt Donna Buang. Tasmania: Junction Ck.

**Months collected:** January, February, March, October, November, December.

**Floral visitations:** Myrtaceae: *Leptospermum flavescens*; *Leptospermum*; *Eucalyptus*; *Calistemon saligans*.

*Description*—This species is readily distinguished by the hind femora and all the tibiae and tarsi being orange. S7 has 2 small lobes with apical patches of hair, quite unlike those of *L. alleynae*. For male S7–8 and genitalia see figs 97–99.

### *Leioproctus (Alokocolletes) subgen.n.*

This subgenus is erected for 2 species from inland Australia. In his description of the first species recognised, Houston (1991) commented "*L. excubitor* belongs to a small group of closely related species none of which has been described until now" and "...inhabit the arid zone of Western Australia". The second species described here, extends the range of the subgenus to the Northern Territory and western Queensland.

Type species: *Leioproctus (Leioproctus) excubitor* Houston, 1991.

*Diagnosis*—Medium-sized black bees with apical tergal, white hair bands in females; first flagellar segment much elongated; T4 with lateral furrows; male S7 with 4 apical lobes; female sting compressed laterally. The lateral furrows on T4 are unique in *Leioproctus*.

*Description*—Length ca 10 mm; integument black with white hair. *Head*—Ocelloccipital area flat; facial fovea vaguely impressed; frons moderate size, dense to very dense punctures with smooth interspaces; antennal sockets shallowly depressed; scape reaching median ocellus or beyond; F1 as long as or longer than the following 2.5 segments, female F2–3 length less than width; female F4–11 length about equal to width; male F2–3 length about equal to width; F4–11 length greater than width; supraclypeal area raised; epistomal suture distinct; inner eye margins parallel, male lower margin slightly divergent; palps reaching beyond apex of extended glossa, segments well sclerotized and subequal in length; malar space absent. *Mesosoma*—Scutum and scutellum with moderately

dense to very dense small punctures with granular interspaces; propodeal triangle broad rounded onto posterior vertical area carina separating basal area from ventral area absent. Wings with membrane slightly darkened; covered in dense, dark microtrichia; stigma slender, parallel sided, more 0.5 length of costal margin of marginal cell; marginal cell elongate, apex of marginal cell strongly divergent from costal margin; first recurrent vein enters second submarginal cell basally; jugal lobe of hind wing reaching beyond cu-a. Legs of female slightly swollen; fore tibial spur with a few small teeth on apex of velum; hind basitibial plate about 0.2 length of tibia, carinate marginally with thick, dense, flattened, simple hair; hair of hind tibial scopa open monopodally branched; inner hind tibial spur with 4–8 long, thick teeth; hind basitarsus with weak posterior fringe. *Metasoma*—Brown to black with dense, short, fine hair; base of T1 with longer hair, apical margins T1–4 with dense, apical fringe, mostly broadly interrupted medially; caudal fimbria coarse, black; female pygidial plate moderately wide, granular basally, smooth apically; apical margin rounded; female sternal hair sparse, white, mostly simple; female sting flattened laterally; T3–4 laterally depressed; no gradulus, males without apical hair bands, with basal hair bands; male with pygidial plate bare, rounded apically; sternal hair as for female, S4 with lateral fringe, S5 with full apical fringe.

*Etymology*—Alokos is Greek for furrow, it refers to the lateral furrows of T3–4.

### Key to species in *Leioproctus* (*Alokocolletes*)

- 1 First flagellar segment longer than the length of F2–4 combined . . . . . *Leioproctus* (*Alokocolletes*) *excubitor* Houston, 1991  
 – First flagellar segment less than the length of F2–4 combined . . . . . *Leioproctus* (*Alokocolletes*) *sequax* Maynard, sp.n

### *Leioproctus* (*Alokocolletes*) *excubitor* Houston, 1991

*Leioproctus* (*Leioproctus*) *excubitor* \*Houston 1991: 84.

#### Types

*Leioproctus* (*Leioproctus*) *excubitor*—Western Australia: holotype ♂, East Yuna Reserve, 34 k WNW of Mullewa, 24–26.viii.1985, T.F. Houston (WAM 89/520); paratypes, 1♂, 11 k ENE Anketell HS (28°02'S 188°51'E), 4–6.ix.1981, T.F. Houston, on trunks of dead mulga (QM); 1♀, East Yuna nature Reserve, 34 k WNW Mullewa, 24–26.viii.1985, T.F. Houston off *Conosperma scoparium* blossom (QM).

**Additional material examined:** 1♀ South Australia: 50 k W Emu.

**Months collected:** August, September, October.

**Floral visitations:** Amaranthaceae: *Ptilotus*; Asphodelaceae: *Asphodelus fistulosus*; Asteraceae: *Rhodanthe charsleyae*, *Schoenia cassiniana*; Fabaceae: *Acacia*, *Senna*; Proteaceae: *Conospermum scoparium*, *Grevillea didymobotrya*; Solanaceae: *Solanum costiliferum*; Myrtaceae: *Eucalyptus oldfieldii*, *Melaleuca nematophylla*.

*Female*—Length ca 11 mm. *Head*—Hair of vertex and upper frons black, long, sparse, open branched; lower frons and paraocular area with moderately dense, white long, branched hair; clypeus with white, sparse, fine, weakly branched hair; F1 length more than 3 x maximum width; lower clypeal margin evenly convex; labrum with basal area shallowly depressed medially, strong ridge dividing from apical area, apical area strongly depressed with a row of strong apical setae, mandibles slender with pollex weakly defined apically; gena wider than eye when head viewed laterally. *Mesosoma*—Hair long, white, sparse, fine branched, propodeal triangle coriaceous; inner hind tibial spur with 6 long, coarse, well spaced teeth. *Metasoma*—Metasoma covered in long, dense, white and black hair; T3–4 with furrows that extend from base to apical margin. *Male*—Length ca 12 mm. *Head*—F1 more than 4 x maximum width; hair of vertex and frons black, sparse, finely branched; paraocular and clypeus with dense, appressed, long, white hair; ventral clypeal margin strongly concave; labrum length, half width, basal area polished not defined by carina or ridge, ventral margin concave, margin fringed with long, thick setae. *Mesosoma*—Fore femur and tibia tumid; fore basitarsus flattened and broadened, anterior with a dense fringe of long, thick hair; malus of fore tibial spur not extended beyond apex of velum; mid legs modified in a similar fashion to fore legs, but to a lesser extent with anterior fringe; hind legs slightly swollen. *Metasoma*—very broad and flat medially; narrow basally and apically. For S7–8 and genitalia see figs 100–102.

## *Leioproctus (Alokocolletes) sequax* sp.n

### Types

*Leioproctus (Alokocolletes) sequax*—Queensland: holotype ♀, 8 miles (12.8 k) NE Windorah, 18.viii.1968, J.C. & T.F. Houston off *Calandrinia balonensis* blossom (QM); paratypes, 3♀, same data as holotype (QM).

**Additional material examined:** 7♀ **Queensland:** 8 miles (12.8 k) NE Windorah. Western Australia: 30 miles (48 k) SE Roebourne. **Northern Territory:** Plenty Hwy 268 k ENE Alice Springs; 47 k WSW Finke; Arthur Creek, 209 k WSW Urandangi; Amadeus Basin.

**Months collected:** August, September, October.

**Floral visitations:** Amaranthaceae: *Ptilotus*; Araliaceae: *Trachymene glaucifolia*; Fabaceae: *Kennedia prorepens*, *Psoralea patens*; Portulacaceae: *Calandrinia balonensis*.

*Female*—Length ca 9 mm. *Head*—Hair pale brown, sparse; frons and clypeus with moderately dense, long, white, short-branched hair; paraocular with similar hair to frons but much denser; lower clypeal margin medially protuberant; labrum, basal area depressed medially with strong ridge separating apical area, apical margin fringes with long, thick setae, mandibles slender, apex of pollex not free, gena as wide as eye when head viewed laterally; ocellocipital area flat; facial fovea vaguely impressed; frons moderate size, dense to very dense punctures with smooth interspaces; antennal sockets shallowly depressed; scape reaching median ocellus or beyond; F1 as long as or longer than the following 2.5 segments, F2–3 length less than width; F4–11 length about equal to width; supraclypeal area raised; epistomal suture distinct; inner eye margins parallel; palps reaching beyond apex of extended glossa, segments well sclerotized and subequal in length; malar space absent. *Mesosoma*—Hair moderately dense, fine, white; propodeal triangle surface coriaceous with fine transverse lines basally; legs slightly swollen; fore tibial spur with a few small teeth on apex of velum; hind basitibial plate about 0.2 length of tibia, carinate marginally with thick, dense, flattened, simple hair; hair of hind tibial scopa open monopodally branched; hind basitarsus with weak posterior fringe; inner hind tibial spur with four; coarse well separated teeth; scutum and scutellum with moderately dense to very dense small punctures with granular interspaces; propodeal triangle broad rounded onto posterior vertical area carina separating basal area from ventral area absent; wings with membrane slightly darkened; covered in dense, dark microtrichia; stigma slender, parallel sided, more 0.5 length of costal margin of marginal cell; marginal cell elongate, apex of marginal cell strongly divergent from costal margin; first recurrent vein enters second submarginal cell basally; jugal lobe of hind wing reaching beyond cu-a. *Metasoma*—Lateral furrows on T3–4 extend half length of terga; brown to black with dense, short, fine hair; base of T1 with longer hair, apical margins T1–4 with dense, apical fringe, mostly broadly interrupted medially; caudal fimbria coarse, black; pygidial plate moderately wide, granular basally, smooth apically; apical margin rounded; sternal hair sparse, white, mostly simple; sting flattened laterally. *Male*—Unknown.

### Notes

This species differs from other species in this subgenus by the length of first flagellar segment less than the length of F2–4 combined.

*Etymology*—Sequax is Latin noun meaning follower or following referring to the species following *excubitor*. It is meant as a noun in apposition.

## *Leioproctus (Charicolletes) subgen.n.*

This new subgenus is erected for 4 species of *Leioproctus*, two of which are described as new and the other two species were previously placed by Michener (1965) in the subgenus *Leioproctus (Nodocolletes)*. They are separated from the latter by having impressed facial foveae, the jugal lobe of hind wing reaching cu-a and male genitalia.

*Type species:* *Leioproctus elegans* Smith, 1853

*Description:* Small to moderate-sized, hairy, strongly punctate bees. *Head* Ocellocular area flat; frontal line carinate on lower part of frons, absent on upper part of frons; inner eye margin slightly converging in females, strongly converging below antennal sockets in males; scape reaches median ocellus; apex of supraclypeal area raised; epistomal suture weak to moderately distinct; surface sculpture with very dense, sharply defined punctures

with polished interspaces. *Mesosoma* Surface sculpture of scutum as for face, punctation less dense posteriomediaally; median metasomal tubercle small to moderate size; propodeal triangle almost vertical, mostly polished. fore wings with pterostigma parallel sided, about 0.5 x length of costal marginal of marginal cell, apex of marginal cell blunt, not strongly divergent from costa; jugal lobe of hind wing reaching cu-a. Legs with fore tibial spur with several fine teeth on apex; female basitibial plate with thick, branched hairs; female inner hind tibial spur with several, stout teeth. *Metasoma* Surface sculpture as for mesosoma; covered in fine, short hairs; male T7 with polished median area not carinate laterally; females T5 with dense, prepygidial fimbria; pygidial plate broad, flat, with a few, irregular, longitudinal striae; female sterna with apical marginal band of long, hair, mostly simple with some branched laterally; male S3–4 with apical fringe. Genitalia with dorsal angle at least angulate, usually produced; apices of gonoforceps broad, rounded; volsellae with enlarged cusp and digitus, strongly toothed.

### Notes

Distinguished from other subgenera by metallic blue metasoma; impressed facial fovea; jugal lobe of hind wings reaching cu-a and male genitalia with dorsal angle at least angulate, usually produced; apices of gonoforceps broad, rounded; volsellae with enlarged cusp, and digitus strongly toothed.

*Etymology.* Chari is Greek for loveliness, referring to the metallic blue colour of the type species.

### Key to species of *Leioproctus* (*Charicolletes*)

- |   |  |   |
|---|--|---|
| 1 | Female with orange or pale prepygidial fimbria; males covered in orange hair .....   | <i>Leioproctus</i> ( <i>Charicolletes</i> ) <i>elegans</i> Smith, 1853          |
| – | Female with black prepygidial fimbria; males not covered in orange hair .....  | 2   |
| 2 | Black, non metallic; males with very elaborate, long, apical sternal fringe on S4, that on S3 very short; gonoforceps with dorsal angle angulate, produced, but not into a spine ..... | <i>Leioproctus</i> ( <i>Charicolletes</i> ) <i>saltus</i> Maynard, sp.n         |
| – | Metallic blue or non metallic brown/orange males with apical fringes on both S3 and S4 short and simple; gonoforceps with dorsal angle produced into a spine .....                     | 3   |
| 3 | Metallic blue base of propodeal triangle polished or at most minutely roughened .....  | <i>Leioproctus</i> ( <i>Charicolletes</i> ) <i>megadontus</i> (Cockerell, 1913) |
| – | Dark orange/brown, non metallic; base of propodeal triangle with many transverse ridges .....  | <i>Leioproctus</i> ( <i>Charicolletes</i> ) <i>exleyae</i> Maynard, sp.n        |

### *Leioproctus* (*Charicolletes*) *elegans* Smith, 1853 n.comb

*Leioproctus elegans* \*Smith 1853: 9; Dalla Torre, 1896: 47.

*Paracolletes elegans* (Smith). Cockerell 1905a: 348; Cockerell 1910a: 203; 1934: 25.

*Paracolletes caeruleotinctus* \*Cockerell 1905c: 480; 1906: 28; 1910a: 207; 1934: 23. **syn.n.**

*Paracolletes turneri* \*Cockerell 1910a: 203, 206; 1912b: 177; 1934: 37. **syn.n.**

*Paracolletes pictus* \*Rayment 1930a: 47; Cockerell 1934: 32. **syn.n.**

*Leioproctus* (*Nodocolletes*) *caeruleotinctus* (Cockerell). Michener 1965: 63, figs 129–131.

*Leioproctus* (*Nodocolletes*) *elegans* Smith. Michener 1965: 63.

*Leioproctus* (*Nodocolletes*) *pictus* (Rayment). Michener 1965: 63.

*Leioproctus* (*Nodocolletes*) *turneri* (Cockerell). Michener 1965: 63.

The holotypes of *Leioproctus elegans*, *Paracolletes pictus* and *Paracolletes turneri*, which are female show no significant morphological differences. The holotype of *Paracolletes caeruleotinctus*, which is male, is the same as the males associated with *Leioproctus elegans*.

### Types

*Leioproctus elegans*—South Australia: holotype ♀ Adelaide (BMNH 17a.495).

*Paracolletes caeruleotinctus*—Queensland: holotype ♂, Seaforth, nr Mackay, .i.1891, G. Turner (BMNH 17a.434).

*Paracolletes turneri*—Queensland: holotype ♀, Mackay, .i.1891 (BMNH 17a.440).

*Paracolletes pictus*—Queensland: holotype ♀, Charleville, 14.xi.1927 (ANIC).

**Additional material examined:** 61 ♀, 62 ♂ **Queensland:** Kuranda; Babinda; 10 miles (16 k) S Bowen; Mackay, 1892; Rockhampton; Westwood; Yelba Ck, Yuleba; Charleville; Noosa; 1 k N Condamine; 10 miles (16 k) S Condamine; Undula; Brisbane; Millmerran; 8k W Cunnamulla; Lake Broadwater nr Dalby; 25 k W Inglewood; 13 k W Warwick; Leyburn via Warwick; nr Mt. Barney; Leslie Dam, 13 k W Warwick. **New South Wales:** 2 k SW

Goondiwindi; 15 k SE Moree; 20 k S Narrabri; Gilgandra; 80 k NNE Wentworth; 34 k NNE Wentworth; 10 k W Wentworth; Murray R 50 miles (80 k) W Wentworth; Caldwell; Hay; Barrigun; 7 mile Beach. **Victoria:** 20 miles (32 k) SE Mildura; Murraybridge; Gunbower; Echuca; Quantong; Edenhope. **South Australia:** Morgan; 24 k SW Swan Reach; Hartley; South Para; Sherlock.

**Months collected:** January, February, September, October, November, December.

**Floral visitations:** None recorded.

*Female*—Length ca 9 mm; entire body covered in dense, strong, close punctures. *Head*—Facial foveae mostly obscured by hair; face covered with moderately dense, long, white hair; apex of supraclypeal area with tubercle; clypeus moderately raised rounded; exposed part of labrum triangular, depressed medially; malar space short, hair covered; gena about as wide as eye when head viewed laterally. *Mesosoma*—Hair white, moderate length; metanotum with a small median tubercle. Legs with apex of hind basitibial plate acute; inner hind tibial spur with 6–8 moderately coarse teeth. Wings densely hair, membrane of wings mostly clear, darkened towards apex of fore wing. *Metasoma*—Prepygidial fimbria bright orange; S2–4 with moderately dense, long, white, simple hair. *Male*—As for females except as follows: Length about 8mm. *Head*—Face densely covered in long, yellow hair; flagellum long, F3–11 length about 2x width. *Mesosoma*—Legs long, slender; hind basitibial plate very small. *Metasoma*—Hair towards apex black; T7 with triangular bare median area; S3–4 with long, thick, apical fringes; S5 short; S6 long, polished. For S7–8 and genitalia see figs 103–105.

### Notes

The male genitalia, S7–8 showed no variation in specimens examined from South Australia through to northern Queensland.

This species seems most closely related to *L. (E.) megadontus*. The two species can be readily distinguished by the colour of the prepygidial fimbria in females and by general body hair as well as S7–8 and genitalia in males.

### *Leioproctus (Charicolletes) exleyae* sp.n.

#### Types

*Leioproctus (Charicolletes) exleyae*—South Australia: holotype ♂, 120 k N Innamincka (27°10'S 140°15'S) 15.iv.1990, L. Jansen off *Portulaca oleacea* & *Tribulus occidentalis* blossom (QM T); paratypes, 6♀, 10♂, same data as holotype (SAM).

**Additional material examined:** 161♀ **Queensland:** Lake Moondarra via Mt Isa; 20 k E Mt Isa; 5 k E Mt Isa; Edungalba; Glenmorgan; 17 k N St George; 25 k E Bollon; 2 k W St George; 38 k E Cunnamulla; 5 k Nocatunga. **New South Wales:** 27 k N Bourke; 15 k SE Moree; 21 k E Narrabri; 3 k S Narrabri; 30 miles (42 k) W Cobar; 55 k NW Nyngan; Nyngan; 2 k W Nyngan; 25 miles (40 k) W Nyngan; 17 miles (27.2 k) N Broken Hill; 50 miles (80 k) W Wentworth. **Australian Capital Territory:** Black Mountain. **Victoria:** Lake Bael Bael; Kerang; Lake Meran; Melton. **South Australia:** 34k S Wilpena; Gawler Range, Kolay Dam (32°33'S 135°36'E). **Western Australia:** Newman; 7 k SE Newman. Northern Territory: 91 k N Elliott; 19 k N Daly Waters.

**Months collected:** January, February, November, December.

**Floral visitations:** Fabaceae: *Acacia*; Myrtaceae: *Eucalyptus argillacea*, *Eucalyptus melanopholia*, *Eucalyptus largiflorens*, *Eucalyptus populnea*, *Eucalyptus intertexta*, *Eucalyptus* spp., *Angophora floribunda*.

*Female*—Length ca 10 mm; colour orange to mottled orange or black. *Head*—Facial foveae weakly impressed; frons covered with moderately dense, long, white hair; ocellular area flat; frontal line carinate on lower part of frons, absent on upper part of frons; inner eye margin slightly converging; scape reaches median ocellus; apex of supraclypeal area raised; epistomal suture weak to moderately distinct; surface sculpture with very dense, sharply defined punctures with polished interspaces; clypeus with sparse hair; labrum polished, with a shallow median depression. *Mesosoma*—Scutum covered in moderately dense, short, whitish, branched hair; sculpture of scutum as for face, punctation less dense posteriomedially; metanotum with a low rounded median tubercle; propodeal triangle almost vertical, basally with several fine transverse striae, elsewhere polished; fore wings with pterostigma parallel sided, about 0.5 x length of costal marginal of marginal cell, apex of marginal cell blunt, not strongly divergent from costa; jugal lobe of hind wing reaching cu-a. Legs with fore tibial spur with several fine teeth on apex; basitibial plate with thick, branched hairs; hind tibial scopa white with monopodally branched hair on dorsal

posterior area; inner hind tibial spur with 4–5 thick teeth. *Metasoma*—Surface sculpture as for mesosoma; covered in fine, short hairs; T5 with dense, dark prepygidial fimbria; pygidial plate broad, flat, with a few, irregular, longitudinal striae; sterna with apical marginal band of long, hair, mostly simple with some branched laterally. *Male*—As for female except as follows: Length ca 9 mm. *Head*—Clypeus with moderately dense, branched hair. *Mesosoma*—Scutum with long hair, hind leg with sparse, long branched hair. *Metasoma*—Tergal hair long, whitish, shaggy; S3–4 with dense, long, white apical fringes. T7 bare medially; for S7–8 and genitalia see figs 106–108.

#### Notes

This species occurs throughout the drier areas of Australia. Even though many females have been collected from *Angophora* and *Eucalyptus*, no males have been taken there. Males have been caught from the non-myrtaceous plants of *Portulaca* and *Tribulus*. It is distinguished from other species in this subgenus by the following combination of characters: colour nonmetallic brownish orange with basal area of propodeal triangle with many transverse ridges; female with black prepygidial fimbria; males not covered in orange hair with apical fringes on both S3 and S4 short and simple; gonoforceps with dorsal angle produced into a spine.

*Etymology*—Exley is a noun in apposition, after Dr Elizabeth Exley who supervised my PhD thesis on *Leioproctus*, Dr Exley worked on another group of Colletidae—Euryglossinae that are as naked and tiny as opposed to *Leioproctus* that are generally hairy and moderate to large sized. As well she supervised many bee projects throughout her career.

#### *Leioproctus (Charicolletes) megadontus* (Cockerell, 1913) n.comb.

*Paracolletes megadontus* \*Cockerell 1913c: 375; 1934: 29.

*Leioproctus (Nodocolletes) megadontus* (Cockerell). Michener 1965: 63.

#### Types

*Paracolletes megadontus*—Queensland: holotype ♀, Caloundra, 30.x.1912, H. Hacker (QM Hy. 4081); paratypes, 3♀, same data as holotype (QM 5320, 5321, 5322).

**Additional material examined:** 38♀, 16♂ **Queensland:** Fraser I; 6 miles (9.6 k) S Noosa; Noosa-Coolum; Nambour; 2 miles (3.2 k) N Perigian; Caloundra; Bribe I; Brisbane; Stradbroke I; Southport.

**Months collected:** January, February, March, April, May, November, December.

**Floral visitations:** None recorded.

*Female*—Length ca 9 mm. *Head*—Sparsely covered in fine, white hair; apex of supraclypeal area raised but not tuberculate; labrum strongly medially; mandible large, broad. *Mesosoma*—Metanotum with strongly produced median tubercle. Wings with forewing membrane slightly darkened anteriorly. Legs with hind basitibial plate broad, apex acute; scopa with monopodally branched hairs on posterior margin; inner hind tibial spur with about 6 thick, widely spaced teeth. *Metasoma*—Prepygidial fimbria coarse, dense and black; S2–4 with apical fringe of sparse, simple hairs; S5 with dense apical fringe; S6 bare medially. *Male*—As for female except as follows: Length ca 7 mm. *Head*—Hair of paraocular area moderately dense, appressed, white; flagellum little longer than female; hair of clypeus branched moderately sparse. *Mesosoma*—Hair dorsally long; metanotal tubercle small; legs brown. *Metasoma*—Rounded as in female; T7 bare medianly; hair dorsally mostly dark, longer than female; S3–4 long, dark apical fringe; S5 short; S6 long, centrally smooth and shiny. For S7–8 and genitalia see figs 109–111.

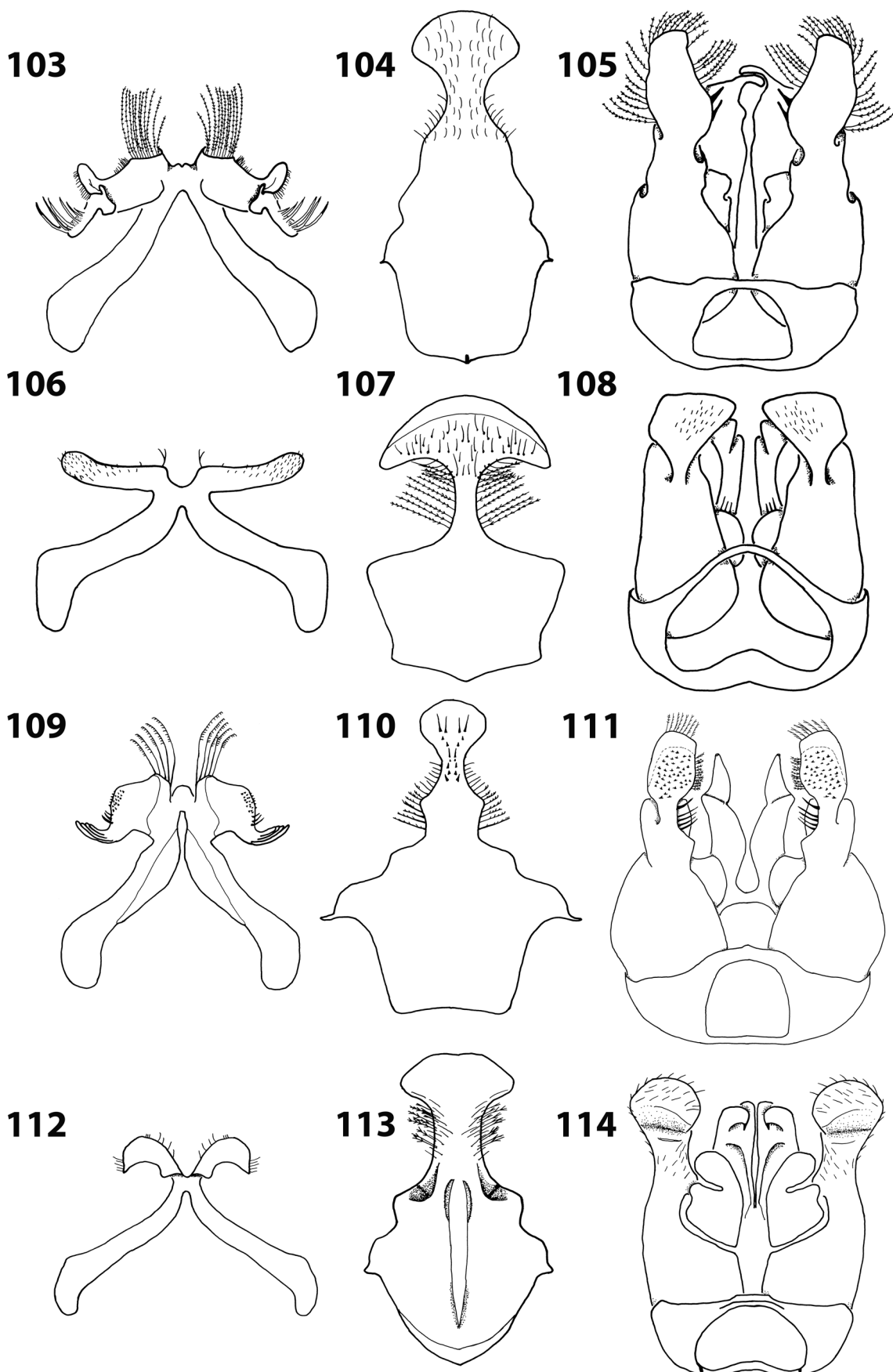
#### Notes

*Leioproctus (C.) megadontus* has a very restricted distribution; it only occurs on the mainland and off shore islands of coastal southeastern Queensland. The distribution of *L. (C.) megadontus* is completely overlapped by a small section in the distribution of *L. (C.) elegans*.

#### *Leioproctus (Charicolletes) saltus* sp.n.

#### Types

*Leioproctus (Charicolletes) saltus*—Queensland: holotype ♂, Stradbroke I., 7–8.iv.1967. J.C. Cardale (QM); paratypes, 1♂, same data as holotype (QM); 3♀, 1♂, Dunwich, Stradbroke I., 7–8.v.1966. J.C. Cardale (QM)



**FIGURES 103–114.** Male S7–8 and genitalia *Leioproctus* (*Charicolletes*). Figs 103–105 *L.(C.) elegans* S7, S8, genitalia. Figs 106–108 *L. (C.) exleyae* S7, S8, genitalia. Figs 109–111 *L. (C.) megadontus* S7, S8, genitalia. Figs 112–114 *L. (C.) saltus* S7, S8, genitalia.

**Additional material examined:** 5♀, 1♂ **Queensland:** Stradbroke I.; Brown Lake, Nth Stradbroke I; 15 k NW Dunwich, Nth Stradbroke I.

**Months collected:** March, April, May.

**Floral visitations:** Ericaceae: *Leucopogon*.

*Female*—Length about 8 mm. *Head*—Flagellum short, F1, F3 little less long as wide, F2 just over half as long as wide; F4–11 as long as wide or as little longer than wide; apex of supraclypeal area moderately raised, not tuberculate at apex, medially smooth and shiny; clypeus moderately elevated, rounded; labrum short with strong median depression; mandibles broad; ventral glossa with moderately dense, short hairs, smooth and shiny; gena narrower than eye when head viewed laterally. *Mesosoma*—Hair, dorsally and on upper lateral area sparse, dark generally, white marginally; lower lateral and ventral hair white; metanotum medially with low, sharp tubercle; propodeal triangle with subhorizontal basal area not defined by transverse striae. Wings with membrane clear; first recurrent vein enters second submarginal cell medially. Legs hind basitibial plate large, rounded apically with a few, fine, branched hairs basally; tibial scopa with hair white apically, dark basally; inner hind tibial spur straight with 4–5 long, moderately thick teeth; claws with moderately small inner ramus. *Metasoma*—Basal T1 with sparse, fine, long, white branched hairs; rest of T1 and T2–4 with fine, short, moderately dense hairs, longer on apical margin; prepygidial fimbria moderately dense, black, coarse, branched; S2–4 with apical fringe narrow, long, pale, simple; S5 with dark, branched fringe. *Male* As for female except for the following: Length ca 6 mm. *Head*—Paraocular area next to antennal bases narrow; ventral glossa bare medially; labrum shallowly depressed medially; scape not reaching median ocellus. *Mesosoma*—First recurrent vein enters second submarginal cell slightly basal to middle; legs all simple, basitarsi slender. *Metasoma*—T7 medially bare; S3 with short, simple fringe, S4 with elaborate apical fringe. For S7–8 and genitalia see figs 112–114.

### Notes

Males of this species are readily distinguished from those of other species by the very elaborate, long, apical sternal fringe on S4; S3 very short; gonoforceps with dorsal angle angulate, produced, but not into a spine. These males fly rapidly from flower to flower, spending very little time at any single blossom; the females have a black metasoma with the subgeneric characters. To date, this species has only been found on Stradbroke Island in the first half of the year. *Leioproctus megadontus* occurs in the same area, but has been taken in December.

*Etymology*—Saltus is Latin for leap or dance in reference to the males dancing from flower to flower.

### *Leioproctus (Excolletes) Michener, 1965*

This subgenus was erected by Michener (1965) for the species *Leioproctus (Excolletes) impatellatus*. No further species are included. Upon examination of more specimens it has been shown that although the female holotype has apparently simple claws, all other females examined have a small to moderate sized inner ramus. Even though the basitibial plate is not carinate marginally, it is indicated by shorter, darker, thicker hair. The other unusual characters found in this subgenus are the low position of the antennal bases on the head; fore wing with a nearly transverse basal vein and the female pygidial plate more or less spatulate.

*Type species*—*Leioproctus (Excolletes) impatellatus* Michener, 1965

*Diagnosis*—Small, dark bees with white metasomal hair bands in females, basitibial plate of female absent.

### *Leioproctus (Excolletes) impatellatus* Michener, 1965

*Leioproctus (Excolletes) impatellatus* \*Michener 1965: 251

#### Types

*Leioproctus (Excolletes) impatellatus*—NEW SOUTH WALES: holotype ♀, 95 miles (152k) N Tibbooburra, 3.xi.1949, S.J. Paramonov (ANIC); "allotype" (= paratype), ♂, same data as holotype (ANIC), paratype, 1♂, Clifton Downs, 31.x.1949, S.J. Paramonov (ANIC).

The species name on the labels of the types is incorrect—it is written as "apatellus" not "impatellatus" (the published name). Many more specimens are now known.



**Additional material examined:** 30♀, 2♂ **Queensland:** 15km W Windorah. **Northern Territory:** 34km E Curtin Springs.

**Months collected:** September, October, November, December.

**Floral visitations:** Proteaceae: *Grevillea*; Myrtaceae: *Corymbia terminalia*.

*Female*—Length ca 7mm; integument dark brown to black with white hair; Small, dark, non-metallic bees; antennal bases on lower half of the face. *Head*—Vertex rounded above ocelli; facial foveae vaguely indicated by change in surface texture, usually totally obscured by hair; frons flat with dense, small strong punctures and polished interspaces; inner eye margins converging at ocellar level and at malar area; antennal sockets on lower half of face depressed; frontal line carinate on lower half; scape not reaching median ocellus; flagellar segments all the same length; supraclypeal area not raised, medially glabrous; epistomal suture and subantennal suture absent, anterior tentorial pit only vaguely indicated; central half of clypeus sparsely haired and punctate ventral margin with 1–2 long, thick hairs; labrum polished convex subrectangular area; malar space absent; mandibles with large apical tooth and distinct pollex; apical three segments of maxillary palps extending beyond the apex of extended glossa; apex of glossa truncate, with long apical fringe; basal labial palp segment flattened, apical 2 segments shorter than basal 2 segments, not extending beyond the apex of extended glossa; gena narrower than eye width when head viewed laterally. *Mesosoma*—Scutum and scutellum polished with a few sparse punctures and laterally with short, dense marginal fringe; metanotum very narrow, convex, polished with a few, sparse hairs; propodeal triangle polished, basal area twice length of metanotum and longer than vertical area; area immediately lateral to propodeal triangle polished with a few sparse hairs; lateral margins of propodeal triangle foveolate. Fore wing with large pterostigma, more than 0.5 x length of costal margin of marginal cell; apex of marginal cell strongly divergent from costa for at least 0.2 x length of the costal marginal cell; first recurrent vein enters second submarginal cell towards the apex; wings almost hairless in veined area; membrane clear; jugal lobe of hind wing reaching beyond cu-a. Legs with paler brown apical segments; fore tibia spur with apex of malus almost as long as velum and a few fine teeth at base of spine; tarsomeres with long, fine, simple hairs dorsally; midtibial spur very long, fine and poorly sclerotised; hind basitarsus with long, posterior, simple fringe; hind basitibial plate lacking marginal carina, covered by pale brown hair; hind basitibial plate absent, hair of dorsal surface of tibial scopa almost palmate with 4, long, branches from median shaft of the hair; inner hind tibial spur without large teeth, ciliate; claws with or without an inner ramus. *Metasoma*—Integument brown T1–4 with dense, small, weak punctures with minutely granular interspaces; T2–3 with dense, apical band of hair broadly interrupted medially; T5 completely covered by a dense, pale brown prepygidial fimbria; pygidial plate constricted just above the base to a narrow, somewhat spatulate plate, bluntly rounded apically; T6 with dense pale yellow hair either side of the plate; S2 with broad apical band of moderate length hair that is weakly branched; S3–6 with narrow, apical band of simple hair. *Male*—As for female except as follows: Length ca 5mm. *Head*—All flagellar segments with length about equal to width; dorsal tooth broadly separated from apical tooth (resembling a can opener). *Mesosoma*—Hind basitibial plate small, but clearly defined; all claws with an inner ramus. *Metasoma*—Apical bands absent; covered in mostly short appressed hair; apical margins vaguely translucent; T7 denudate; apical lobes of S7 broadly joined; S8 strongly protuberant; sterna covered in fine, sparse hair; for S7–8 and genitalia see figs 115–117.

### ***Leioproctus (Exleycolletes) subgen.n.***

This subgenus is erected for 7 species, 1 species was placed in *Leioproctus (Lamprocolletes)* by Michener 2007, 3 species placed in *L. (Leioproctus)* by Michener 1965, 1 species placed in *Leioproctus (Microcolletes)* by Michener, 1965 and 2 placed in *L. (Goniocolletes)* in 1965. They are small to moderate-sized, black bees and compared to other *Leioproctus* have a slender metasoma. Some of them have a low tubercle on the metanotum.

*Type species*—*Paracolletes tuberculatus* Cockerell, 1913b.

*Description*—*Head* Inner eye margins converging below antennal sockets; facial fovea vaguely indicated by change in surface texture; antennal sockets depressed; scape reaches median ocellus; apex of supraclypeal area sharply raised; epistomal suture distinct; malar space short and polished; both pairs of palps well sclerotised, extending beyond apices of glossa and maxillae; surface sculpture of dense punctures with smooth interspaces; females with long, whitish hair; males with dense hair, appressed on at least the lower paraocular area. *Mesosoma*—Surface sculpture of shallow, small punctures with smooth interspaces; metanotum with minute to

moderate sized, median tubercle; propodeal triangle strongly sculptured. Wings hairy; stigma blunt, more than 0.5 x length of costal margin of marginal cell; apex of marginal cell separated from costa for very short distance; first recurrent vein enters second submarginal cell towards the base; jugal lobe of hind wing reaching beyond cu-a. Legs simple, female with hind basitibial plate sparsely covered in short, thick hairs; hind tibial scopa with open monopodally branched hairs; inner hind tibial spur with 5–10 moderate length, slender teeth. *Metasoma*—Slender; surface sculpture as for dorsal mesosoma; hair sparse; prepygidial fimbria dense, thick-haired; female pygidial plate strongly sculptured basally; males with bare median area on T7; S4 with long, thick fringe; S7 with complex lateral lobes; genitalia with gonoforceps with apices weakly sclerotised, ventral penis valves with a sclerotised ridge.

### Notes

Distinguished from other subgenera by metanotum with minute to moderate sized, median tubercle; head and mesosoma with strong punctures and polished interspaces, jugal lobe of hind wing reaching level of cu-a; stigma greater than or equal to half length of costal margin of marginal cell; and propodeal triangle with subhorizontal, strongly sculptured; female scopa with hairs coarse and branched only on one side.

*Etymology*—Exley is a noun in apposition, after Dr Elizabeth Exley who supervised my PhD thesis on *Leioproctus*, and who worked on another group of colletids as well as supervising many bee projects throughout her career.

### Key to species of *Leioproctus* (*Exleycolletes*)

1	Female (with scopa on hind tibia) .....	2
–	Male (without scopa on hind tibia) .....	5
2	Scutellum densely covered in orange hair .....	3
–	Scutellum not covered in orange hair .....	4
3	Metasomal foveae impressed, particularly basally and laterally .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>cristatus</i> (Smith, 1853)
–	Metasomal foveae not impressed, flush with surface .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>flavomaculatus</i> (Cockerell, 1905)
4	Anterolateral corner of the scutum and spiracle cover lobe covered in dense orange or black hair .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>leai</i> (Cockerell, 1913)
–	Anterolateral corner of the scutum and spiracle cover lobe not covered in dense orange or black hair .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>tuberculatus</i> (Cockerell, 1913)
5	Frons with median area of whitish hair surrounded by dark hair .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>flavomaculatus</i> (Cockerell, 1905)
–	Hair of frons uniform in colour .....	6
6	Median area of S6 with long, curly hair .....	9
–	Median area of S6 more or less glabrous .....	7
7	Apical fringe of S5 with longest hair medially .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>tuberculatus</i> (Cockerell, 1913)
–	Apical fringe of S5 with hairs of similar length .....	8
8	S4 with apical fringe .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>microdontus</i> (Cockerell, 1929)
–	S4 without apical fringe .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>pusillus</i> (Cockerell, 1929)
9	Scutellum densely covered in whitish hair .....	10
–	Scutellum almost bare, hair sparse .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>leai</i> (Cockerell, 1913)
10	S5 with whitish apical fringe .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>argentifrons</i> (Smith, 1879)
–	S5 with dark apical fringe .....	<i>Leioproctus</i> ( <i>Exleycolletes</i> ) <i>cristatus</i> (Smith, 1853)

### *Leioproctus* (*Exleycolletes*) *tuberculatus* (Cockerell, 1913) n.comb.

*Paracolletes tuberculatus* \*Cockerell 1913b: 274; 1934:37; Rayment 1935: 146,147.

*Paracolletes tuberculatus insularis* \*Cockerell 1913b: 275; 1934:37; Rayment 1935: 163, 247. **syn.n.**

*Paracolletes fascialis* \*Cockerell 1921: 93; 1934: 26. **syn.n.**

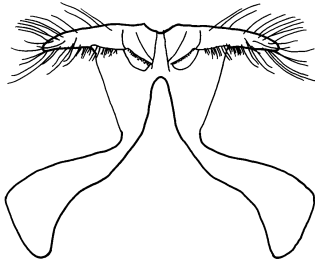
*Leioproctus* (*Leioproctus*) *fascialis* (Cockerell). Michener 1965: 50.

*Leioproctus* (*Leioproctus*) *insularis* (Cockerell) Michener 1965: 51.

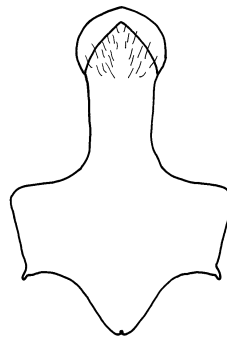
*Leioproctus* (*Nodocolletes*) *tuberculatus* (Cockerell) Michener 1965: 63.

The holotypes of *Paracolletes tuberculatus* and *Paracolletes fascialis* are both males and show no significant morphological differences. The holotype of *Paracolletes tuberculatus insularis*, which is female is the same as those females associated with *Paracolletes tuberculatus* by morphological similarity and coincident collection data.

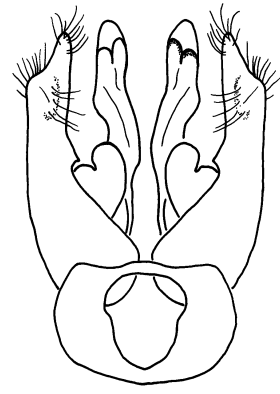
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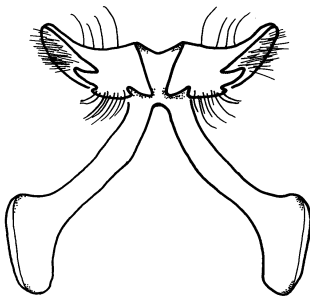
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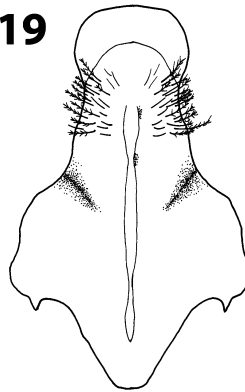
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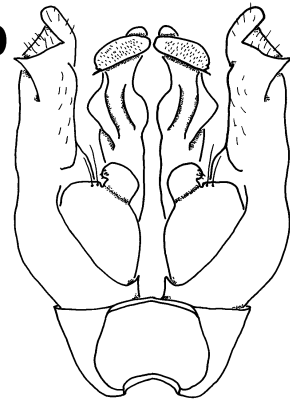
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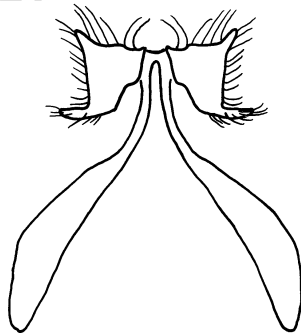
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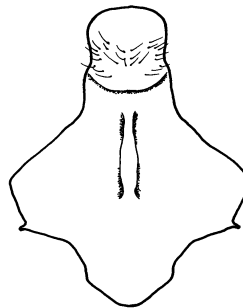
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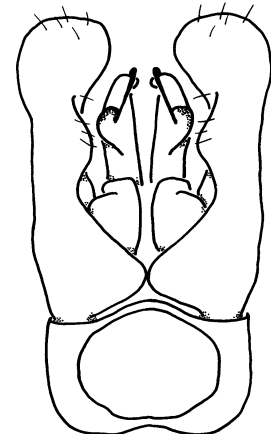
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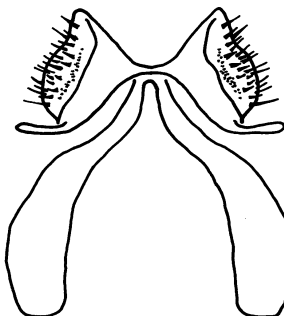
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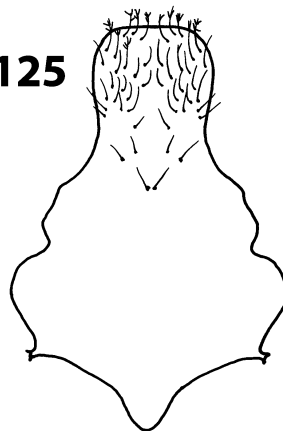
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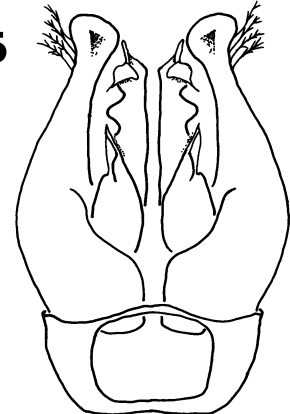
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125



126



**FIGURES 115–126.** Male S7–8 and genitalia *Leioproctus*. Figs 115–117 *L. (Excolletes) impatellus* S7, S8, genitalia. Figs 118–120 *L. (Exleycolletes) tuberculatus* S7, S8, genitalia. Figs 121–123 *L. (Exleycolletes) argentifrons* S7, S8, genitalia. Figs 124–126 *L. (Exleycolletes) cristatus* S7, S8, genitalia.

## Types

*Paracolletes tuberculatus* Cockerell—Victoria: holotype ♂, Cheltenham, Victoria, French (USNM).

*Paracolletes tuberculatus insularis* Cockerell—Queensland: holotype ♀, Stradbroke Is., 2.x.1911, H. Hacker (QM T.4082).

*Paracolletes fascialis* Cockerell—Queensland: holotype ♂, Coolangatta, 15.viii.1916 (QM T.2404).

**Additional material examined:** 108♀, 39♂ **Queensland:** Cooloola; Noosa; Noosa–Coolool; Bribie I.; Dunwich, North Stradbroke Is; Stradbroke Is; Dunwich; Tara; Brisbane; Burleigh. **New South Wales:** 10 k S Kingscliffe; Inverell. **Victoria:** Little Desert; Mt Arapiles; Grampians; Ferntree Gully; Mordialloc; Tidal river. **Tasmania:** Wedge Bay; George Town. **South Australia:** West beach, Adelaide; Meningie.

**Months collected:** January, February, August, September, October, November, December.

**Floral visitations:** Myrtaceae: *Leptospermum leavigatum*.

*Female*—Length ca 10 mm. *Head*—Frons flat; supraclpeal area smooth and shiny, not tuberculate at the apex; clypeus with large, close punctures; labrum short with strong median depression; gena narrower than eye when head viewed laterally. *Mesosoma*—Dark, very short, moderately dense hair dorsally; white, sparse, long hair laterally; metanotum short, with small median tubercle; propodeal triangle with subhorizontal basal area with many fine transverse striae. Legs with inner hind tibial spur with 5–7 long, fine teeth. *Metasoma*—Metasomal foveae indicated by change in surface texture; prepygidial fimbria black; pygidial plate broad, flat, striate basally. *Male*—As for female except as follows: Length ca 8 mm. *Head*—Paraocular area obscured by dense appressed hair; inner eye margins very strongly converging at lower ends; mandibles short and slender. *Mesosoma*—Scutum and scutellum with long, fine, sparse hair. *Metasoma*—T7 flat, bare; sterna with sparse hair; S4 with dense, thick white fringe; S5 curved, thick, black fringe, hair shortest medially. For S7–8 and genitalia see figs 118–120.

## *Leioproctus (Exleycolletes) argentifrons* (Smith, 1879) n.comb.

*Lamprocolletes argentifrons* \*Smith 1879: 11; Dalla Torre 1896: 47.

*Paracolletes argentifrons* (Smith). Cockerell 1905a: 346; 1934: 22.

*Leioproctus (Goniocolletes) argentifrons* (Smith). Michener 1965: 66.

## Type

*Lamprocolletes argentifrons*—Western Australia: holotype ♂, Swan R. (BMNH 17a.577)

**Additional material examined:** 2♂ **Victoria:** Gunbower. **Western Australia:** no further data.

**Months collected:** March.

**Floral visitations:** None known.

*Female*—Unknown. *Male*—Length ca 11mm. *Head*—Face below median ocellus covered in dense, white hair, appressed on lower paraocular area; F1, F2 length less than width; F3–11 length greater than width. *Mesosoma*—Hair long, black dorsally; metanotum with low median tubercle; propodeal with basal area rough, not clearly defined. Legs orange-brown except for hind tibia, coxa and trochanter; fore tibia with long, white, posterior fringe. *Metasoma*—Tergal margins translucent; T2–3 with broad basal band of short, white hair; T7 broad, flat, rounded apically, more or less hairless with no clearly defined pygidial plate; S3–5 with long, thick, dense, apical fringe; S5 apical fringe shorter than of S3–4; S6 with median tuft of moderate length hair. For S7–8 and genitalia see figs 121–123.

## Notes

This species is only known from a few male specimens; it is similar to *L. (C.) tuberculatus* but is larger and lacks the long, black fringe of S5. It was removed from *Goniocolletes* because of the form of S7–8 and the genitalia and the form of the propodeal triangle.

## *Leioproctus (Exleycolletes) cristatus* (Smith, 1853) n.comb.

*Lamprocolletes cristatus* \*Smith 1853: 11; Dalla Torre 1896: 47.

*Paracolletes cristatus* (Smith). Cockerell 1925:495; 1934: 240.

*Leioproctus (Leioproctus) cristatus* (Smith) Michener 1965: 50.

## Type

*Lamprocolletes cristatus*—♀, New Holland, no date (OU)

**Additional material examined:** 24♀, 9♂ **Queensland:** Stradbroke Island; 3 miles (4.8 k) N. Perigian Beach; Bribie I; Margate Parade, Margate. **Victoria:** Buchan; Tarrawarra; Phillip Island.

**Months collected:** January, September, October.

**Floral visitations:** Myrtaceae: *Leptospermum*, *Melaleuca*.

*Female*—Length ca 10 mm. *Head*—Paraocular area densely covered in whitish hair below the level of the median ocellus; labrum convex with apical area not flat. *Mesosoma*—Spiracle cover lobe and anterolateral area of mesosoma covered in sparse, black hair; scutellum and metanotum with dense, erect, dark orange hair; metanotum with a broad low, median tubercle; propodeal triangle with a distinct carina defining sculptured basal area. Legs with fore tibial spur with several fine teeth on apical malus; basitibial plate about 0.2 x length of tibia, covered with sparse, short, thick spines; inner hind tibial spur with about 8, long, fine teeth; basitarsus with long, plumose hair on posterior margin. *Metasoma*—Gradulus weak; pregradular area with small, shallow, dense punctures with minutely roughened interspaces; postgradular area with sparse, punctures with smooth interspaces; T2 with depressed metasomal fovea with the anterior margin, in particular, most strongly depressed; prepygidial fimbria dense, black; pygidial plate flat, apex truncate with weak longitudinal carina basally. *Male*—As for female except as follows: Length ca 9 mm. *Head*—Hair white, appressed on lower paraocular area; eye width about 2 x paraocular width at the level of antennal sockets; flagellum with F1–2 length less than width; F3 length about equal to width, F4–11 length greater than width; scape just reaching antennal sockets. *Mesosoma*—Hair of scutum and scutellum pale yellow to white; propodeal triangle with a few fine, transverse carinae below on vertical area. Legs with sparse, simple hair. *Metasoma*—T1–7 with translucent brown apical margins; metasomal foveae small, weakly impressed; T7 without bare median area; S4 with long, thick protruding apical fringe; S5 with weak apical fringe; S6 covered with medium length branched hair with curled apices. For S7–8 and genitalia see figs 124–126.

## Notes

This species is extremely similar to *L. (C.) flavomaculatus*; *L. (C.) flavomaculatus* females do not have depressed metasomal foveae and their males have orange facial hair. *Leioproctus (C.) cristatus* is found from south-east Queensland to Victoria, whereas *L. (C.) flavomaculatus* is found throughout coastal Queensland. The discovery of the nests of *L. (C.) cristatus* (see Maynard & Burwell, 1994) confirmed that it was distinct from *L. (C.) flavomaculatus*, because until then only one *L. (C.) cristatus* had been collected with males.

## *Leioproctus (Exleycolletes) flavomaculatus* (Cockerell, 1905) n.comb.

*Paracolletes flavomaculatus* \*Cockerell 1905c: 479; 1910a: 201; 1934: 27.

*Leioproctus (Leioproctus) flavomaculatus* (Cockerell). Michener 1965: 50.

## Type

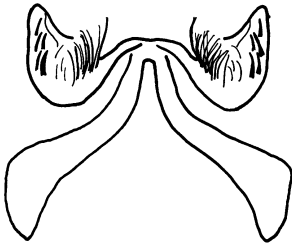
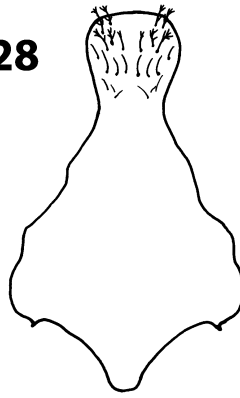
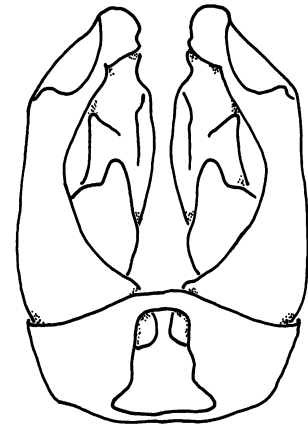
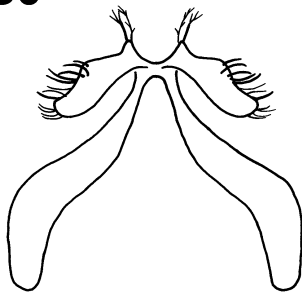
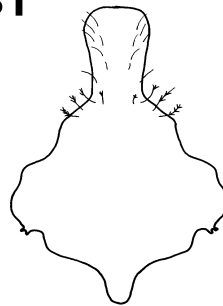
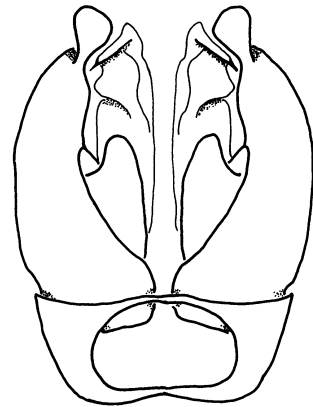
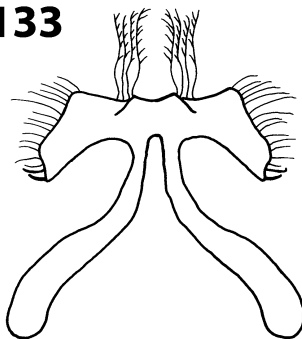
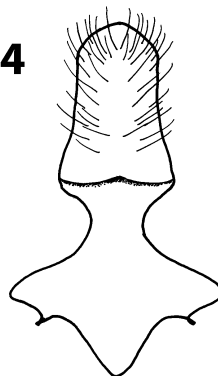
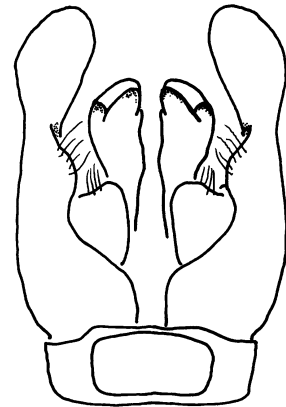
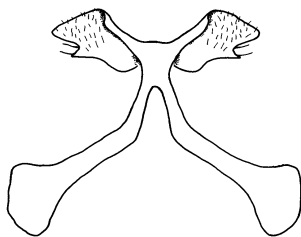
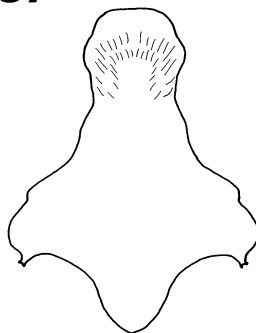
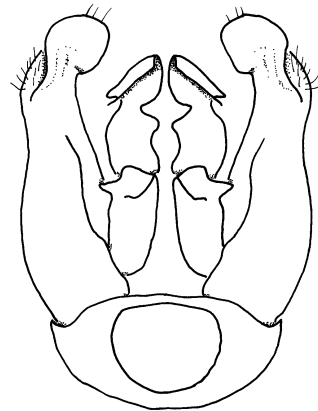
*Paracolletes flavomaculatus*—holotype ♂, Australia (BMNH 17a.435).

**Additional material examined:** 9♀, 8♂ **Queensland:** Kuranda; Poona Lake, Cooloola; Bunya Mountains.

**Months collected:** March, November.

**Floral visitations:** None recorded.

*Female*—Length ca 9 mm, head and mesosoma black with black to brown mesosoma and legs. *Mesosoma*—Scutellum covered in dense yellow hair; tubercle on metanotum minute; propodeal triangle with basal area clearly defined, transverse carina delimiting basal area depressed medially. *Metasoma*—Metasomal foveae not depressed, flush with the surface. *Male*—Length ca 8 mm. *Head*—Frons partly or completely covered in dense yellow hair; paraocular area with dense, appressed pale to dark yellow hair. *Mesosoma*—Hair of scutum and scutellum dense, orange. *Metasoma*—Fovea vaguely indicated; S4 with moderate length fringe. For details of S7–8 and genitalia see figs 127–129.

**127****128****129****130****131****132****133****134****135****136****137****138**

**FIGURES 127–129.** Male S7–8 and genitalia *Leioproctus (Exleycolletes)*. Figs 127–129 *L. (E.) flavomaculatus* S7 S8, genitalia. Figs 130–132 *L. (E.) leai* S7, S8, genitalia. Figs 133–135 *L. (E.) microdontus* S7, S8, genitalia. Figs 136–138 *L. (E.) pusillus* S7, S8, genitalia.

***Leioproctus (Exleycolletes) leai* (Cockerell, 1913) n. comb.**

*Paracolletes leai* \*Cockerell 1913b: 597; 1934: 28.

*Paracolletes humerosus cyanurus* \*Cockerell 1914c:140; 1934:28. **syn.n.**

*Paracolletes simillimus* \*Cockerell 1916c: 48; 1934:36. **syn.n.**

*Leioproctus (Leioproctus) cyanurus* (Cockerell). Michener 1965:50

*Leioproctus (Leioproctus) leai* (Cockerell). Michener 1965: 51.

*Leioproctus (Leioproctus) simulator* \*Michener 1965: 52 [Replacement name for *Paracolletes simillimus* Cockerell, 1916]. **syn.n.**

The holotypes of *Paracolletes leai* and *Paracolletes humerosus cyanurus* which are both female show no significant morphological differences. The holotype of *Paracolletes simillimus* which is male are identical to males associated with *Paracolletes leai* by coincident collection data and morphological similarities.

**Types**

*Paracolletes leai*—Tasmania: holotype ♀, Ulverstone, Lea (USNM 55287).

*Paracolletes humerosus cyanurus*—Victoria: holotype ♀, Oakley, French, 1909 (BMNH 17a.522).

*Paracolletes simillimus*—Western Australia: holotype ♂, Yallingup, .xi.1913, R.E. Turner (BMNH 17a.464).

**Additional material examined:** 13♀, 9♂ **New South Wales:** New England N.P. **Tasmania:** Launceston; Georgetown; Nubeena. **South Australia:** Port MacDonnell; Millicent. **Western Australia:** 55km E. Karridale; Hamelin Bay, 8km SW Karridale.

**Months collected:** January, February, March, November, December.

**Floral visitations:** Aizoaceae: *Carpobrotus*; Brassicaceae: *Brassica*; Myrtaceae: *Eucalyptus*, *Melaleuca*; Pittosporaceae: *Bursaria spinosa*.

*Female*—Length ca 12mm. *Head*—Hair long, fine, whitish and sparse; labrum all convex, apical area not flat. *Mesosoma*—Antero-lateral areas of scutum, including pronotal cover lobe covered in long, dense, usually dark orange (occasionally paler) hair; rest of scutum with long, sparse, black hair; metanotum with small tubercle; propodeal triangle with many fine transverse striae, posterior edge of basal area depressed medially. Hind basitibial plate 0.2 x length of tibia, apex blunt covered with sparse, short, thick hairs; hind tibia scopa of coarse, dark, monopodal hair; inner hind tibial spur with 6 well-spaced, slender, long teeth; posterior lateral area of basitarsi with long, plumose hair. *Metasoma*—Metasomal fovea vaguely indicated by change in sculpture laterally; pygidial plate flat, broad rough and basally with vague, longitudinal ridges; ventral moderate density apically with mostly, long simple hairs. *Male*—As for female except as follows: Length ca 10mm. *Head*—Hair below median ocellus dense, erect, except on lower paraocular area where it is appressed; flagellum with F1–3 length less than width; F4–11 length greater than width. *Mesosoma*—Hair covering antero-lateral areas of scutum at times, not as dense as in females; legs entirely black with sparse hair. *Metasoma*—T7 with distinct bare median area, clearly defined laterally; S4 with long, thick, protruding, apical fringe; S5 apical fringe weak; S6 covered with long, curled, branched hair. For S7–8 and genitalia see figs 130–132.

**Notes**

The holotype of *Paracolletes leai* has whitish patches of hair on the anterolateral areas of the scutum; this condition is found in few other specimens, in the majority of specimens the hair is dark orange.

***Leioproctus (Exleycolletes) microdontus* (Cockerell, 1929) n. comb.**

*Paracolletes microdontus* \*Cockerell 1929d: 309.

*Leioproctus (Goniocolletes) microdontus* (Cockerell). Michener 1965: 66.

**Type**

*Paracolletes microdontus*—Western Australia: holotype ♀, Perth, J. Clark (QM T.4085)

**Additional material examined:** 3♂ **Western Australia:** Bullsbrook; Mt. Narryer; Beelerup.

**Months collected:** February, May, December.

**Floral visitations:** Myrtaceae: *Melaleuca*.

*Female*—Length ca 10 mm; dark brown to black. *Head*—Hair dense, long, white; inner eye margins almost parallel; labrum convex. *Mesosoma*—Scutum with sparse, long, dark branched hair; metanotum with moderate

sized, rounded tubercle; propodeal triangle with basal area clearly defined by carina. Legs with fore tibial spur with several fine teeth on the apex; basitibial plate 0.25 x tibia with a few, branched hairs; dense, long, branched hair on posterior margin of basitarsus; inner hind tibial spur with 6 long, fine teeth. *Metasoma*—Apical margins of T2–4 with dense, basal band of short, white hair; metasomal foveae not distinct; pygidial plate with a few weak, longitudinal carina, apex blunt, with a small indent medially. *Male*—As for female except as follows: Length ca 8mm. *Head*—Dense, white hair; inner eye margins straight converging below the antennal sockets; F1,2 with length less than width; F3 length about equal to width; F4–11 length greater than width. *Mesosoma*—Anterior fore tibia yellow, rest of legs black. *Metasoma*—T7 with distinct bare, median area which is clearly defined laterally, but not carinate; S3–4 almost bare. For S7–8 and genitalia see figs 133–135.

#### Notes

Although males and females have not been collected together, they have been associated by morphological similarity.

#### *Leioproctus (Exleycolletes) pusillus* (Cockerell, 1929) n.comb.

*Paracolletes pusillus* \*Cockerell 1929c: 208; 1934: 33.

*Leioproctus (Microcolletes) pusillus* (Cockerell). Michener 1965:55.

#### Type

*Paracolletes pusillus*—Western Australia: holotype ♂, Geraldton, 4.ix.1926, Nicholson (AM).

**Additional material examined:** 36♂ **Western Australia:** Watheroo Dist; Bolgart; 126 miles (201.6 k) N. Geraldton; between Coorow and Marchangee; N. New Norcia; 83 miles (132.8 k) S Newman, 29.viii.1971.

**Months collected:** August, September, November

**Floral visitations:** Myrtaceae: *Baeckea pentagonantha*; Proteaceae: *Hakea erinacea*

*Female*—Unknown. *Male*—Length ca 7mm. *Head*—Hair white, fine, sparse, except on lower paraocular area where it is dense and appressed; flagella with F1–3 length less than width; F4–11 length greater than width. *Mesosoma*—Hair sparse, fine, white; metanotum with minute tubercle; propodeal triangle without distinct transverse carina delimiting basal area, many fine transverse carinae on both basal and vertical areas. Legs with anterior fore femora and tibiae yellow. *Metasoma*—Hair fine, white, erect; T7 without median bare area; S4 with dense, white, apical fringe; S5 with weak apical fringe; S6 almost bare, with sparse, short, white hair. For details of S7–8 and genitalia see figs 136–138.

#### *Leioproctus (Fragocolletes) subgen.n.*

This small subgenus is for 2 species, *Leioproctus (Fragocolletes) perminutus* (which was previously placed in *Leioproctus (Microcolletes)*) and *L. (F.) rutiliventris*, a new species. This subgenus has an areolate basal area of the propodeal triangle, similar to that in *L. (Protomorpha)*, the structure of the genitalia and seventh sternum among other characters exclude them from that subgenus.

*Type species:* *Paracolletes perminutus* Cockerell.

*Diagnosis*—Moderate to small non-metallic bees; strongly punctate with polished interspaces; facial foveae distinct not impressed; F1–F2 length less than width, F3–F11 length about equal to width; basal area of propodeal triangle areolate; male T7 denudate medially; male S5 with short, dense apical fringe.

*Description*—Length ca. 5–10mm; hair mostly white, moderately dense, medium length. *Head*—Scape of male not reaching median ocellus; flagellum long; inner eye margins of males straight converging slightly below; female inner eye margin almost straight, slightly converging at upper and lower margins; clypeus shallowly rounded; labrum narrow, polished; malar space absent; palps moderately sclerotised, length of each palpal segment at least 2 x width. *Mesosoma*—Scutum and scutellum with dense, small strong punctures with polished interspaces; hair fine, moderate length, branched; lateral scutellum in females with short, dense, tuft of hair. Wings with marginal cell broad at apex, widely separated from margin; first recurrent vein enters second submarginal cell almost medially; stigma large about 0.6 x length of costal margin, broadly rounded; jugal lobe of hind wing reaches



beyond cu-v; wings hairy; clear to slightly milky; basal vein of forewing strongly sloping. Legs with scopa white, darker around basitibial plate; inner hind tibial spur of female with four or five, long, thick, well spaced teeth; other spurs simple; hind tibial plate about a quarter length of tibia with thick black simple hair. *Metasoma*—Metasoma with small, dense punctures except on T1; female pygidial plate flat, broadly rounded apically, rough; female sterna with long, densely branched hair; male T7 hairless medially; S5 with a short, dense, apical fringe; S7 with large lobes.

*Etymology*—Fragosus is Latin for rough referring to the roughened propodeal triangle

### Key to species of *Leioproctus* (*Fragocolletes*)

- 1 Scutellum with lateral, dense tufts of hair . . . . . *Leioproctus* (*Fragocolletes*) *perminutus* (Cockerell, 1929)  
- Scutellum without lateral, dense tufts of hair . . . . . *Leioproctus* (*Fragocolletes*) *rutiliventris* Maynard, sp.n.

### *Leioproctus* (*Fragocolletes*) *perminutus* (Cockerell, 1929) n.comb

*Lamprocolletes minutus* \*Friese 1924: 221 [junior homonym of *Paracolletes minutus* Cockerell, 1916a].

*Paracolletes perminutus* \*Cockerell 1929b: 2–3; 1934: 32.

*Leioproctus* (*Microcolletes*) *perminutus* (Cockerell). Michener 1965: 55.

#### Type

*Paracolletes perminutus*—Western Australia: holotype ♀, Fremantle, August, 1906, Frank (AMNH).

**Additional material examined:** 1 ♀ **Western Australia:** Port Headland.

**Months collected:** February.

**Floral visitations:** Fabaceae: *Acacia*.

*Female*—Length ca 8 mm, hair white. *Head*—Facial fovea indicated by lateral polished areas; hair moderately dense, medium length, denser on paraocular area near the antennal sockets; mandibles orange basally with large apical tooth; palps just reaching apex of maxillae, subequal in length. *Mesosoma*—Hair similar to that on face, except on lateral scutellum where there is a dense patch; metanotum is protuberant medially with a tuft of long hair; propodeal triangle steep; inner hind tibial spur with 4 widely spaced teeth. *Metasoma*—Dark brown; T7 polished with few punctures; T2–5 with fine, short, white hair; apical margin of terga vaguely translucent; prepygidial fimbria narrow, dense, brown; pygidial plate bluntly rounded apically, rugose basally; S2–4 with broad, apical band of dense, long, branched hair. *Male*—Unknown.

### *Leioproctus* (*Fragocolletes*) *rutiliventris* sp.n.

#### Types

*Leioproctus* (*Fragocolletes*) *rutiliventris*—Queensland: holotype ♂, Knob Lagoon, 30 miles (42 k) NW Doomadgee Mission, 22.v.1972, G.B. and S.R. Monteith (QM); paratypes, 3 ♂, same data as holotype (QM).

**Months collected:** May.

**Floral visitations:** None recorded.

*Female*—Unknown. *Male*—Length ca 6 mm; strongly punctuate with polished interspaces; head and mesosoma black, metasoma T1–3 usually orange, hair white. *Head*—Frons with sparse, fine white hair; frons strongly punctuate with polished interspaces; antennal sockets depressed; supraclypeal area raised; flagellum pale; inner eye margins straight converging slightly below; scape not reaching median ocellus; F1–2 length less than width, F3–11 length about equal to width; epistomal suture strong, distinct; clypeus almost flat with sculpture similar to that of frons; malar space absent; mandibles yellow with orange tips; apex of glossa with long fringe; palps long, slender reaching well beyond apex of extended glossa, both maxillary and labial palps segments similar to each other in length. *Mesosoma*—Scutum, scutellum and metanotum with dense, small, strong punctures and polished interspaces; hair fine, moderate length, branched; metanotum with low median pustule; base of propodeal triangle strongly aerolate; tegulae almost transparent; wings hairy with marginal cell broad at apex, widely

separated from margin; first recurrent vein enters second submarginal cell almost medially; stigma large about 0.6 x length of costal margin, broadly rounded; jugal lobe of hind wing reaches beyond cu-v; basal vein of forewing strongly sloping; legs with femur black with orange apices; tibia orange with black median spot; tarsi orange. *Metasoma*—Surface with small, dense punctures except on T1; basal T1–3 usually orange apical terga brown to black; hair moderately dense, short, appressed; T7 hairless medially; sternal hair short; S5 with short, dense apical fringe. For S7–8 and genitalia see figs 139–141.

### Notes

This species is distinguished from others in this subgenus by scutellum without lateral dense tufts of hair.

*Etymology*—*Rutilus* is Latin for red and *ventris* for abdomen referring to the red colour of the abdomen

### *Leioproctus (Hadrocolletes) subgen.n*

There are 3 species of large *Leioproctus* included in this new subgenus. All were placed by Michener (1965) in the subgenus *Nodocolletes*. Two are only known from a few specimens from Western Australia.

*Type species*—*Lamprocolletes fulvus* Smith

*Description*—Broad-bodied, moderate to large (11–13.5 mm) *Leioproctus*. *Head*—Ocellular area strongly depressed; facial foveae absent; inner eye margins straight, parallel except for short distance dorsally, where they converge slightly; supraclypeal area strongly raised; eye width about the same as paraocular width; epistomal suture weak; malar space short to moderate length; surface sculpture of small, dense, clearly defined punctures with polished interspaces. *Mesosoma*—Surface sculpture as for face; vestiture of dense, long much branched hair; metanotum with a broad, low to moderate sized pustule; propodeal triangle vertical, coriaceous. Wings with stigma slender, parallel sided, about half the length of the costal margin of the marginal cell; apex of marginal cell blunt but not strongly divergent from the costa; first recurrent vein enters the second submarginal cell basal to middle; jugal lobe of the hind wing reaches cu-a. Legs, simple; basitibial plate of female with dense hair, obscuring the carinate margin; hair of the dorsal female hind tibial scopa dense, monopodially branched; inner hind tibial spur with several long, slender moderately spaced teeth on the middle of the spur; claws with large inner ramus. *Metasoma*—Broad, males similar to females; sculpture similar to face; males with ill-defined bare area on T7; female S2–4 with long, fine, mostly branched hairs on margin; males with fringes on S4–5.

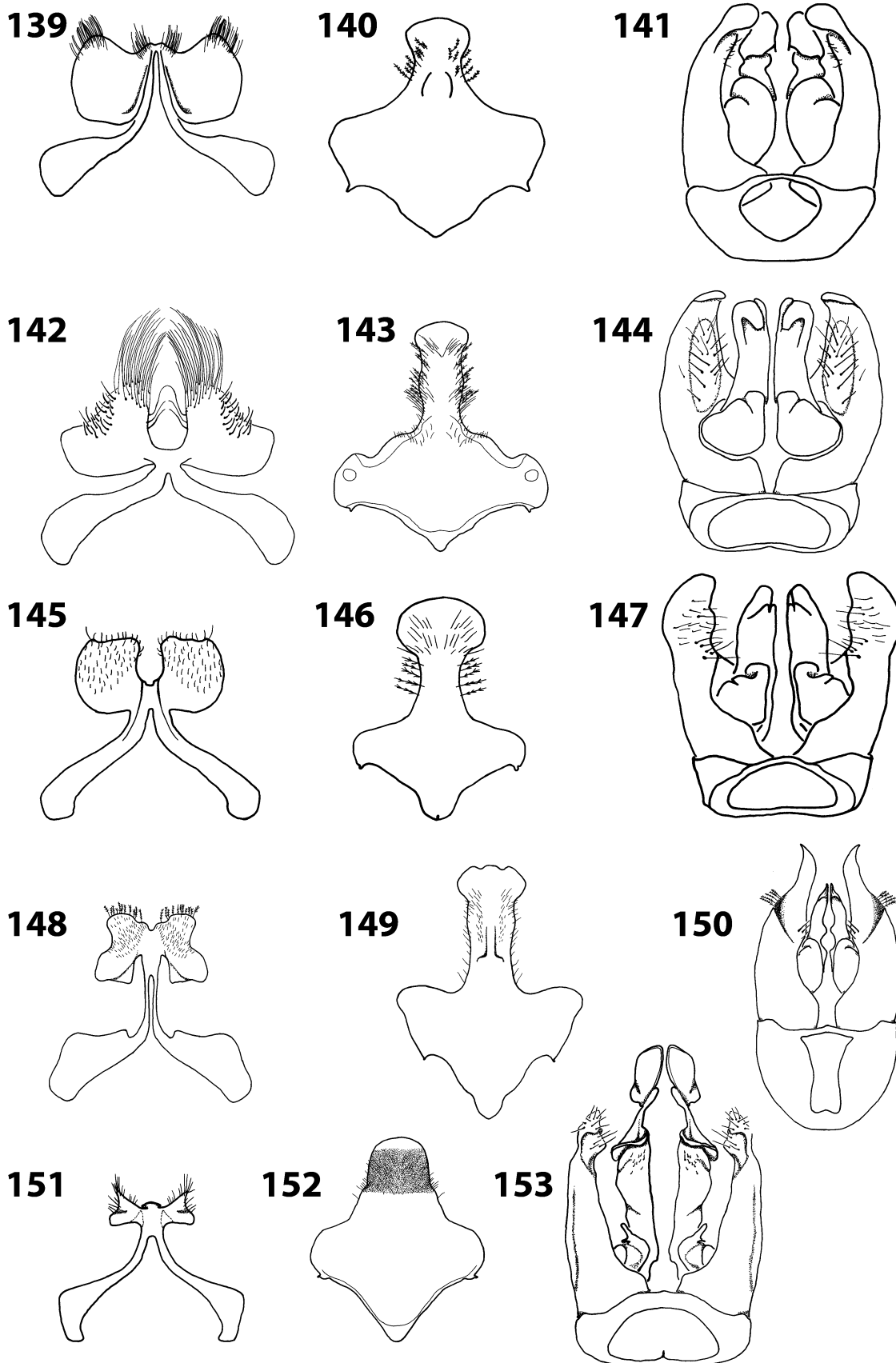
### Notes

The species are distinguished from other subgenera by characters of the male genitalia and hidden sterna, the general body appearance and the depressed area between the lateral ocelli and the inner eye margin. In several characters *L. (Hadrocolletes)* appear like *L. (Zosterocolletes)* but are distinguishable by the lack of apical tergal hair bands in females and male S7 with only 2 apical lobes. *L. (Hadrocolletes)* has several characters in common with *L. (Zosterocolletes)* externally, but S7–8, and the genitalia as well as the form of the inner hind tibial spur readily distinguish these groups.

*Etymology*—*Hadros* is Greek for stout, referring to the broad metasoma of the males.

### Key to species of *Leioproctus (Hadrocolletes)*

- 1 Metanotal protuberance low; integument of head and mesosoma metallic blue green and metasoma bronze. . . . . *Leioproctus (Hadrocolletes) fulvus* (Smith, 1879)
- Metanotal protuberance large; integument non-metallic or only very faintly so . . . . . 2
- 2 Female pygidial plate strongly constricted subapically, not sculptured . . . . . *Leioproctus (Hadrocolletes) macrodontus* (Rayment, 1935)
- Female pygidial plate narrowed, but gradually; punctate . . . . . *Leioproctus (Hadrocolletes) phanerodontus* (Cockerell, 1929)



**FIGURES 139–153.** Male S7–8 and genitalia *Leioproctus*. Figs 139–141 *Leioproctus (Fragocolletes) rutiliventris* S7, S8, genitalia. Figs 142–144 *Leioproctus (Hadrocolletes) fulvus* S7, S8, genitalia. Figs 145–147 *Leioproctus (Hadrocolletes) macrodontus* S7, S8, genitalia. Figs 148–150 *Leioproctus (Lamprocolletes) chalybeatus* S7, S8, genitalia. Figs 151–153 *Leioproctus (Lamprocolletes) dentiger* S7, S8, genitalia.

### ***Leioproctus (Hadrocolletes) fulvus* (Smith, 1879)**

*Lamprocolletes fulvus* \*Smith 1879: 9; Dalla Torre, 1896: 48.

*Paracolletes megachalceus* \*Cockerell 1913c: 374, 1934: 29. **syn.n.**

*Paracolletes fulvus* (Smith). Cockerell 1934: 27.

*Leioproctus (Nodocolletes) fulvus* (Smith). Michener 1965: 63.

*Leioproctus (Nodocolletes) megachalceus* (Cockerell). Michener 1965: 63.

#### **Types**

*Lamprocolletes fulvus*—Queensland: holotype ♀, Queensland (BMNH 17a.502).

*Paracolletes megachalceus*—New South Wales: holotype ♀, Clarence R., Wilson (BMNH 17a.470).

**Additional material examined:** 11♀, 4♂ **Queensland:** Cooloola. **New South Wales:** Clarence R. **South Australia:** 8.5 k E Keith; Meningie.

**Months collected:** March, June, September.

**Floral visitations:** None recorded.

*Female*—Length about 11 mm; head and mesosoma brown; clypeus, legs pronotum and anterior scutum orange; metasoma orange with slight metallic purple tinge. *Head*—Frons flat, mostly obscured by dense long, whitish hair; F3–11 with segments little longer than wide, F1–2 a little shorter than wide; supraclypeal area with branched hairs laterally; clypeus orange, elevated, flat with strong, large punctures; malar space very broad, length about 0.6 x width of base of mandibles, basally covered in dense, short fine, hair, apically glabrous; mandibles large, thick, orange; gena about as wide as eye rounded with dense weak punctures with shiny interspaces. *Mesosoma*—Scutum with hair very dense around base of tegulae and spiracle cover lobe; lateral mesosoma as for scutum but hair white; metanotum with broad rounded protuberance. Wings with hair sparse, particularly basally; membrane of wings clear; tegulae translucent. Fore tibial spur with 4–6 moderately thick teeth; inner hind tibial spur long, slender with about 6 well-spaced teeth; basitarsus with long posterior fringe. *Metasoma*—Gradulus absent; apical margins transparent; hair of dorsal surface orange, long, moderately dense with many short branches; prepygidial fimbria very dense coarse, orange hair; pygidial plate large, broad, flat; metasomal fovea indicated by large brown spot on T2; sterna with very dense, long, pale plumose hair. *Male*—As for female except as follows: Length ca 12 mm. *Head*—Flagellum simple, F1–2 length less than or equal to width, F3–11 length greater than width; clypeal hair semierect, dense, branched, yellow. *Mesosoma*—Metanotum with a small median nodule; hind basitibial plate apically pointed, anterior margin less clearly defined than posterior margin. *Metasoma*—Width of metasoma broad, moderately dense with long shaggy hair, apical tergal margins clear, T7 bare medially; sternum covered in long, dense branched hair, S5 with apical fringe S6 with lateral tufts of hair. For S7–8 and genitalia see figs 142–144.

### ***Leioproctus (Hadrocolletes) macrodontus* (Rayment, 1935)**

*Paracolletes macrodontus* \*Rayment 1935: 674.

*Leioproctus (Nodocolletes) macrodontus* (Rayment). Michener 1965: 63.

#### **Type**

*Paracolletes macrodontus*—Western Australia: holotype ♂, Cottesloe, 11.viii.1912, W.B.A (ANIC).

**Additional material examined:** 7♀, 18♂ **Western Australia:** 8 k S Yellowdine; 9 miles (14.4 k) N New Norcia; 10 miles (16 k) E Southern Cross.

**Months collected:** August, September.

**Floral visitations:** Proteaceae: *Grevillea*, *Hakea perinacea*, *Banksia*.

*Female*—Length ca 13.5 mm; integument dark brown to black. *Head*—Hair immediately dorsal to the antennal sockets white, above this dark brown, erect; clypeus with moderately sparse, white and black, branched hairs; malar space short; mandibles slender. *Mesosoma*—Integument and vestiture similar to that of face; hair long, white and brown, plumose; metanotum with moderate sized median pustule. Wings with membrane clear, wings densely hairy except for basal area of sub-basal and anal cells of the fore wing. Inner hind tibial spur with 6 moderately slender teeth. *Metasoma*—T1 hair long, white and short branched; T2–4 short, moderately dense hair; prepygidial fimbria coarse, black; pygidial plate sharply constricted before the apex. *Male*—As for female except as follows:

Length ca 11 mm. *Head*—Flagellar segments strongly protruding ventrally, dorsal apical margin slightly produced; clypeal hair moderately dense. *Mesosoma*—Protuberance of metanotum long, stout; apex of hind basitibial plate rounded with fine hair. *Metasoma*—Broad; T7 bare, rough; S4–5 with long, apical fringe with the shortest hairs in the middle. For S7–8 and genitalia see figs 145–147.

#### Notes

The holotype of this species is in poor condition; the females are associated on morphological similarity.

#### *Leioproctus (Hadrocolletes) phanerodontus* (Cockerell, 1929)

*Paracolletes phanerodontus* \*Cockerell 1929c: 207; 1934: 32.

*Leioproctus (Nodocolletes) phanerodontus* (Cockerell). Michener 1965: 63.

#### Type

*Paracolletes phanerodontus*—Western Australia: holotype ♀, King George Sound (AM).

**Months collected:** Not known.

**Floral visitations:** Not recorded.

*Female*—Length 13 mm; integument vaguely metallic blue. *Head*—Hair long, pale brown, moderately dense; malar space length about 0.3 x width. *Mesosoma*—Hair as for face; pustule on metanotum long, upturned; propodeal triangle obscured by glue. Wings, hairy except on basal area. Hind legs missing. *Metasoma*—Punctures fairly weak with coriaceous interspaces; hair sparse; pygidial plate narrow apically, but not constricted subapically, punctate. *Male*—Unknown.

#### Notes

The only specimen is the holotype which is in very poor condition; so the identity of this species is in some doubt.

#### *Leioproctus (Lamprocolletes) (Smith, 1853)*

This subgenus contains 3 species placed by Michener (1965) in *Leioproctus (Nodocolletes)*. The type species of *Lamprocolletes* was designated as *Andrena chalybeata* by Cockerell in 1905 and the type species of *Nodocolletes* was designated as *Nodocolletes dentatus* by Rayment in 1931 but *N. dentatus* is a synonym of *A. chalybeata*, hence *Nodocolletes* is a synonym of *Lamprocolletes*. Michener 2000 & 2007 placed all the species that were placed in *Leioproctus (Nodocolletes)* (Michener 1962) into *Leioproctus (Lamprocolletes)* in 2000 & 2007 and it was an artificial unit. In this publication the situation is clarified. Previously those placed in the subgenus *Leioproctus (Lamprocolletes) sensu* Michener 2007 and the subgenus *Leioproctus (Nodocolletes) sensu* Michener 1965 comprised 17 species names; all but three of these been placed in several different subgenera. Here *Leioproctus (Lamprocolletes)* contains 3 species and includes *Leioproctus (Lamprocolletes) pacificus* from New Caledonia. No specimens of *L. pacificus* have been examined and it possibly differs considerably from the other 2 species placed in *Leioproctus (Lamprocolletes)* hence its placement is tentative pending examination of specimens. *Leioproctus (Lamprocolletes) pacificus* is not dealt with further here.

#### *Lamprocolletes* Smith, 1853: 10

*Nodocolletes* Rayment, 1931a: 164; 1931b: 128–129; 1935: 206, 207.

*Leioproctus (Nodocolletes)* (Rayment). Michener, 1965: 61.

*Type species*—*Andrena chalybeata* Erichson, 1842 by designation of Cockerell, 1905a: 345; *Leioproctus (Lamprocolletes)* Michener 2007: 155.

*Description*—Large, black or dark metallic blue, strongly punctate colletid bees. *Head*—Ocellocipital area flat; facial fovea not impressed, vaguely indicated by change in surface texture or colour; frons flat; antennal

sockets strongly depressed; scape reaching median ocellus; male F1,–2 length less than width, F4–11 length greater than width; supraclypeal area strongly raised, epistomal suture clearly defined; malar space short, inner eye margin converging below antennal sockets except at upper where they converge slightly; surface sculpture of dense, large clearly defined punctures; punctures on clypeus larger than those on frons. *Mesosoma*—Surface sculpture generally as for frons, posteriomediaally impunctate; metanotum with large, protuberance; propodeal triangle vertical. Wings with pterostigma long, parallel sided; apex of marginal cell strongly divergent from costa; first recurrent vein enters second submarginal cell basal to middle. *Metasoma*—Strongly punctate; female sterna with long hair most of which is branched.

### Key to species of *Leioproctus* (*Lamprocolletes*)

- 1 Protuberance on metanotum bilobed . . . . . *Leioproctus* (*Lamprocolletes*) *chalybeatus* (Erichson, 1842)  
 – Protuberance on metanotum not bilobed . . . . . 2  
 2 Protuberance on metanotum very long and slender . . . . . *Leioproctus* (*Lamprocolletes*) *pacificus* Michener, 1965  
 – Protuberance on metanotum large and thick . . . . . *Leioproctus* (*Lamprocolletes*) *dentiger* (Cockerell, 1910)

### *Leioproctus* (*Lamprocolletes*) *chalybeatus* (Erichson, 1842)

*Andrena chalybeatus* \*Erichson 1842: 268.

not *Lamprocolletes chalybeatus* Smith 1853: 11; Dalla Torre 1896: 47.

not *Lamprocolletes chalybeatus* Sichel 1867: 144.

*Leioproctus vigilans* (sic = *Leioproctus*) \*Smith 1879: 7; Dalla Torre 1896: 47.

not *Paracolletes chalybeatus* (Smith). Cockerell 1905a: 344, 346.

*Paracolletes vigilans* (Smith). Cockerell 1905a: 348; 1910a: 199, 206; 1934:37. **syn.n.**

*Paracolletes diodontus* \*Cockerell 1929c: 206; Rayment 1931a: 166, 167, pl.xix figs 6, 6a, 6b. **syn.n.**

*Nodocolletes dentatus* \*Rayment 1931a: 165–166 pl. xix, figs 1–5, 8, 8a, 8b; Cockerell 1934: 25.

*Nodocolletes subdentatus* \*Rayment 1931a: 166–167, pl. xix, figs 7, 7a, 7b; Cockerell 1934: 36. **syn.n.**

Not *Leioproctus* (*Leioproctus*) *chalybeatus* (Erichson). Michener 1965: 50 placement based on misidentified specimens.

*Leioproctus* (*Nodocolletes*) *dentatus* (Rayment). Michener 1965: 63.

*Leioproctus* (*Nodocolletes*) *diodontus* (Cockerell). Michener 1965: 63.

*Leioproctus* (*Nodocolletes*) *subdentatus* (Rayment). Michener 1965: 63.

*Leioproctus* (*Nodocolletes*) *vigilans* (Rayment). Michener 1965: 63.

The holotypes of *Nodocolletes dentatus*, *Paracolletes diodontus*, *Nodocolletes subdentatus* and *Leioproctus vigilans*, are all females from south Western Australia and show no significant difference from the holotype of *Andrena chalybeatus*.

The identity of this species has been misunderstood because specimens in the British Museum of Natural History and the Hope Entomological museum were misidentified and subsequent identifications relied on comparison with these specimens. No one apparently referred to the holotype. Additional confusion has resulted from its distribution. The type locality is "Van Diemensland" (Tasmania), but all subsequent specimens have been collected in Western Australia.

The species was named by Erichson from a collection of insects sent to him by Adolphus Schayer from Woolnorth (north west corner of Tasmania). There are several species in various orders of insects that have Woolnorth as a type locality.

#### Types

*Andrena chalybeatus*—Tasmania: holotype ♀, Woolnorth, Van Diemensland, Schayer (ZMB 2304).

*Nodocolletes dentatus*—Western Australia: holotype ♀, Moora, L. Newman (WADA); paratype, same data as holotype (ANIC).

*Paracolletes diodontus*—Western Australia: holotype ♀, Eradu nr Geraldton, 8.ix.1926, Nicholson (AM).

*Nodocolletes subdentatus*—Western Australia: holotype ♀, Quairading (ANIC).

*Leioproctus vigilans*—Western Australia: holotype ♀, Swan River (BMNH 17a.496).

**Additional material examined:** 31 ♀, 5 ♂ **Western Australia:** Yarloop; 60 miles (96 k) N Bullfinch; 30 miles (48 k) E Southern Cross, 350 m; Deep Dene, Karridale; Peak Charles NP, 102 k SW Norseman; Boorabbin Rock, 98 k E Southern Cross (31°23' 118°45'); 29 k ne Bullfinch; 75 k E Hyden, Forestania Corners; 10 k S Collie; 29 k SE Perth; 28 k WSW Leinster (27°55'S 20°41'E); 8 k S Yellowdine; 126 miles (200.2 k) N Geraldton; 35 miles (56 k) W Esperance; 4 miles (6.4 k) NE Menzies; Stirling Ra; Pingering.

**Months collected:** August, September, October, November, December

**Floral visitations:** Ericaceae: *Leucopogon*; Fabaceae: *Acacia*; Goodeniaceae: *Scaevola spinescens*;

Myrtaceae: *Bakaea pentagonantha*, *Eucalyptus* sp., *Verticordia picta*; Proteaceae: *Grevillea biformis*.

**Female**—Medium-sized robust bees, strongly punctate with smooth interspaces, metanotal protuberance double pronged; length about 13 mm; dark brown to metallic blue-green, entirely covered with dense, strong, large punctures. **Head**—Facial fovea vaguely indicated by smoother non-metallic area; apex of supraclypeal area raised to a small pustule; lower face covered in moderately dense, long, white, open-branched hair; clypeus flat; hair on scape short sparse, thick branched on median edge; mandibles broad; labrum shallowly depressed medially; ventral glossa covered in minute hairs; gena narrower than eye viewed laterally, hair of gena like that of lower face. **Mesosoma**—Scutum and upper lateral mesosoma have sparse, long, black, open-branched hair; upper surface of protuberance of metanotum, pronotal lobe, area lateral to propodeal triangle and lower lateral mesosoma with white hair; metanotum with a strongly produced, bifid, median nodule; tegula smooth and shiny. Wings, membrane brown, densely covered in macrotrichia; pterostigma about 0.5 x length of costal margin of marginal cell; jugal lobe of hind wing broad sinuous reaching only half way to cu-a. Hind legs with long, plumose white hair on coxa, trochanter and ventral tibia; dorsal tibia and tarsi black; basitibial plate moderate size (about 0.2 x length of tibia), pointed apex, integument obscured by thick, black hairs; inner hind tibial spur straight with 4–6 straight, thick, widely spaced teeth; inner ramus of claws large. **Metasoma**—T1 with sparse, long, fine, short branched hairs; T2 with metasomal foveae indicated by lateral non metallic integument covered with dense patch of hair; hair of dorsal metasoma sparse, short, white; prepygidial fimbria coarse, dense, black, much branched; pygidial plate flat, narrowly rounded apically with a few basal ridges; S1–4 with broad band of white branched hair, hair dark on S5–6. **Male**—As for female except as follows: Length ca 10 mm. **Head**—Lower face densely covered in long, simple, appressed hair; frons and gena depressed below eye level. **Mesosoma**—Legs simple, if body non metallic then colour orange, if metallic then legs black; basitibial plate small, not obscured by hair; metanotal protuberance more slender than in female. **Metasoma**—Hair dorsally moderately dense, long, fine; T7 broad, bare; S4–5 long white apical fringes. For details of S7–8 and genitalia see figs 148–150.

### Notes

Only four males of this species have been collected; three of these were taken with females that have the bidentate metanotal tubercle. The genitalia show no significant differences although two males are metallic and the other two are black—a possibility is that they have been exposed to different chemicals whilst being killed or preserved.

### *Leioproctus (Lamprocolletes) dentiger* (Cockerell, 1910)

*Paracolletes dentiger* \*Cockerell 1910a: 199–200, 206; 1914b: 41; 1934: 25.

*Paracolletes subvigilans* \*Cockerell 1914b: 45; 1934: 36. **syn.n.**

*Leioproctus (Nodocolletes) dentiger* (Cockerell). Michener, 1965: 63, figs 123–125.

*Leioproctus (Nodocolletes) subvigilans* (Cockerell). Michener, 1965: 63.

The holotype of *Paracolletes subvigilans* is the female of *Paracolletes dentiger*. The sexes have been associated by morphological similarity (they both lack a defined anterior margin to the hind basitibial plate, amongst other characters) and coincident collection data.

### Types

*Paracolletes dentiger*—holotype ♂, New Holland (ZMB 1952).

*Paracolletes subvigilans*—Western Australia: ♀, Yallingup, Cape Naturaliste, 14.ix.–31.x.1913, R.E. Turner (BMNH 17a.448).

**Additional material examined:** 3♀, 1♂ **Western Australia:** Bunbury; Yallingup; Yallingup.

**Months collected:** September, October, November.

**Floral visitations:** None recorded.

**Female**—Length ca 12 mm; entire body strongly punctate; dark metallic blue. **Head**—Facial fovea indicated by smooth area, margins distinct; vertex short, supraclypeal area strongly raised but not apically tuberculate; paraocular area about equal to width of eye at level of antennal sockets; scape reaching beyond median ocellus; clypeus strongly rounded; the exposed labrum is almost as long as wide, shallowly depressed medially; gena wider than eye viewed laterally; lower paraocular and lateral supraclypeal area with moderately dense, white, open branched hair; clypeus with sparse, long, simple hair. **Mesosoma**—Dorsally hair mostly short, black, white around margins of scutum and scutellum; laterally hair mostly white; metanotum with large, thick nodule with black upper and white lower hair; basal area of propodeal triangle indicated by several short, transverse ridges. Wings with

membrane darkened, hind wing with jugal lobe reaching beyond cu-v; pterostigma slender, long about 0.2 x length of costal margin of marginal cell. Legs with anterior margin of hind basitibial plate not clearly defined, hair of basitibial plate branched; hair of anterior hind tibial scopa monopodal; inner hind tibial spur straight with 6 fine teeth. *Metasoma*—T1 with sparse, long, branched hair; other segments with short, simple hair; prepygidial fimbria dense, thick, black; pygidial plate broad flat, straight apically with a few basal striae; ventral surface with moderately dense, long, white, branched hairs. *Male*—As for female except as follows: Length ca 11 mm. *Head*—Lower paraocular area with appressed, dense, white hair; flagellum moderate length. *Mesosoma*—Legs black.

*Metasoma*—Sternal fringes absent. For details of S7–8 and genitalia see figs 151–153.

### Notes

This species is unusual in that the anterior margin of the basitibial plate is not carinate. The only other Australian *Leioproctus* without a clearly defined hind basitibial plate are females of *Leioproctus (Excolletes) impatellatus*. In *L. impatellatus* females the marginal carina of the hind basitibial plate is lacking all together; the males though have a small, but clearly defined hind basitibial plate.

### *Leioproctus (Minycolletes) subgen.n.*

The subgenus *Minycolletes* is erected to accommodate 11 species of small, non-metallic, densely hairy *Leioproctus* in which the antennal scape does not reach the median ocellus. Lack of facial foveae and a smooth propodeal triangle distinguish them from 2 closely related subgenera, *Protomorpha* and *Fragocolletes*, both of which possess impressed facial foveae and an areolate propodeal triangle.

*Minycolletes* has a wide distribution throughout Australia, however it seems few occur in coastal areas.

*Type species*—*Leioproctus (Minycolletes) microsomus* Michener, 1965.

*Description*—*Body*—Length 5–9 mm; hair densely plumose; integument dark brown to black. *Head*—Vertex slightly curved above lateral ocelli; facial foveae absent; inner eye margins of males, straight, converging below; in females almost straight, converging slightly dorsally and ventrally; surface sculpture of dense, small, clearly defined punctures with polished interspaces; facial hair in males dense, semierect to erect, much branched; in females similar to males above and lateral to antennal sockets, elsewhere on face fine and sparse; male interantennal distance greater than width of paraocular area at level of antennal sockets; flagellum males usually short, F1,4–11 length about equal to width, F2,3 length less than width, in four species males F4–11 length greater than or equal to the width; female flagella F1,4–11 length about equal to width, F2–3 length less than width; epistomal suture weak; clypeus almost flat; malar space absent; labrum short polished, length less than 0.25 x width; width of gena less than eye width, when head viewed laterally. *Mesosoma*—Scutum and scutellum with small, clearly defined punctures and polished interspaces; hair of scutum and scutellum long, fine and sparse (males); hair short to long, moderately dense (females); metanotum short, not tuberculate; propodeal triangle without a defined basal area, smooth. Wings with stigma large, about 0.6 x length of costal margin of marginal cell; marginal cell broad, apex strongly divergent from costa; jugal lobe of hind wing narrow, reaching beyond cu-a; wing membrane clear. Female inner hind tibial spur with 6 or more long, fine, moderately spaced teeth; claws with inner ramus moderate to small; female hind basitibial plate about 0.25 x length of tibia covered in dense, simple hairs. *Metasoma*—Gradulus weak or absent; pregradular area with minute punctures with granular interspaces; postgradular area similar but with fewer punctures; females with at most very weak apical hair bands, apical margins of terga translucent, female pygidial plate usually narrowly rounded apically, granular; males with or without a bare median area on T7; females with long, fine, usually branched hair S2–4. Male genitalia with gonobase about 0.25 x length of genitalia and large gonofossa; gonoforceps unornamented; vosellae somewhat enlarged. S7 with very large apical lobes.

**Notes.** This subgenus is distinguished by the following characters: small body length (5–9 mm); non-metallic bees with scape not reaching median ocellus; facial foveae absent; propodeal triangle usually polished, strongly curved without defined basal area; metasoma with translucent apical tergal margins.

*Etymology.* Minys is Greek for little, small, or short, referring to small size of these species.



## Key to species of *Leioproctus* (*Minycolletes*)

1	Male (without scopa on hind tibia) . . . . .	2
–	Female (with scopa on hind tibia) . . . . .	11
2	Propodeal triangle polished . . . . .	3
–	Propodeal triangle coriaceous . . . . .	8
3	Male with apical fringe on S5 . . . . .	4
–	Male without apical fringe on S5 . . . . .	7
4	Labial palp long with apical segment projecting beyond apex of extended glossa; flagellum long . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>pygmaeus</i> Maynard, sp.n.
–	Labial palp short, with apical segment not projecting beyond apex of glossa; flagellum short . . . . .	5
5	Apical fringe of S5 with shortest hair medially . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>finkei</i> Michener, 1965
–	Apical fringe of S5 with hair all the same length . . . . .	6
6	Anterior fore tibia black; hair of scutum white and sparse . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>insitus</i> Maynard, sp.n.
–	Anterior fore tibia yellow (in contrast to black femur); hair of scutum yellow, moderately dense . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>helichrysi</i> (Cockerell, 1918)
7	Supraclypeal area flat to shallowly depressed, polished; length of antennal flagellar segments less than width . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>microsomus</i> Michener, 1965
–	Supraclypeal area shallowly raised, polished; length of flagellar segments greater than width . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>aquilus</i> Maynard, sp.n.
8	Supraclypeal area flat . . . . .	9
–	Supraclypeal area shallowly raised . . . . .	10
9	Hair of T2–4 short, fine, appressed . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>paulus</i> Maynard, sp.n.
–	Hair of T2–4 long, erect . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>exiguus</i> Maynard, sp.n.
10	S5 with apical fringe . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>abnormis</i> (Cockerell, 1916)
–	S5 without apical fringe . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>wahlenbergiae</i> Michener, 1965
11	Propodeal triangle polished . . . . .	12
–	Propodeal triangle coriaceous . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>wahlenbergiae</i> Michener, 1965
12	Supraclypeal area polished . . . . .	13
–	Supraclypeal area punctate . . . . .	15
13	Supraclypeal area flat to shallowly depressed . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>microsomus</i> Michener, 1965
–	Supraclypeal area shallowly raised . . . . .	14
14	Hair of hind basitibial plate whitish; labial palps reaching beyond apex of glossa . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>eruditus</i> Maynard, sp.n.
–	Hair of hind basitibial plate black, thick; labial palps just reaching apex of glossa . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>aquilus</i> Maynard, sp.n.
15	Scutum with short, white appressed hair . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>finkei</i> Michener, 1965
–	Scutum with long, erect, brown hair . . . . .	16
16	Basal labial palp segment long, slender, about twice length of second segment . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>helichrysi</i> (Cockerell, 1918)
–	Basal labial palp segment little longer than second segment . . . . .	<i>Leioproctus</i> ( <i>Minycolletes</i> ) <i>insitus</i> Maynard, sp.n.

### *Leioproctus* (*Minycolletes*) *microsomus* Michener, 1965 n.comb

*Leioproctus* (*Microcolletes*) *microsomus* \*Michener 1965: 55, 248–249, plate 1 (fig.10).

#### Types

*Leioproctus* (*Microcolletes*) *microsomus*—Queensland: holotype ♀, 17 miles (27.2 k) S Dalby, 20.x.1958, C.D. Michener (ANIC); "allotype" (=paratype), ♂, same data as holotype (ANIC); paratypes: 1♂, same data as holotype (QM T.6237); 1♀, Jondaryan, 10.x.1958, C.D. Michener (QM T.6236).

**Additional material examined:** 2♀, 2♂ Queensland: Helidon; St. Ruth; Kogan.

**Months collected:** October.

**Floral visitations:** None recorded.

*Female*—Length ca 6 mm; integument dark brown, hair whitish. *Head*—Supraclypeal area polished; clypeus flat, shallowly depressed medially, polished with only a few weak punctures, with moderately dense, much branched hair except medially; maxillary palp segments more or less equal in length; labial palp with basal segment slender, longer than following 2 combined; apical segment as long as medial 2 segments combined. *Mesosoma*—Hair of scutum and scutellum short, moderately dense, branched; propodeal triangle polished with lateral foveae extending well below basal area. Basitibial plate pointed apically, hair black thick, dense; inner hind

tibial spur with about 6, large, slender teeth. *Metasoma*—Hair moderately long; prepygidial fimbria restricted to apex of T5, pale brown. *Male*—As for female except as follows: Length ca 5mm. Head—Scape with moderately dense, long hair; flagellum very short, F1–3 length much less than width, F4–11 length barely same as width. *Mesosoma*—Hair of scutum and scutellum long. *Metasoma*—T7 with bare, polished median area; S5 apical fringe with dense white, hair length about 0.5 x width of S5. For S7–8 and genitalia see figs 154–156.

***Leioproctus (Minycolletes) abnormis* (Cockerell, 1916) n.comb.**

*Paracolletes abnormis* \*Cockerell 1916a: 46; 1934: 21.

*Leioproctus (Leioproctus) abnormis* (Cockerell). Michener, 1965: 50.

**Type**

*Paracolletes abnormis*—Northern Territory: holotype ♂, Alexandria, 6.i.1907, W. Stalker (BMNH 17a.462).

**Additional material examined:** 10♂ **Queensland:** 38 k E Cunnamulla. **New South Wales:** 2 k W Nyngan; 27 k N Bourke. **Victoria:** L. Bael Bael. **Northern Territory:** same data as holotype.

**Months collected:** January, December.

**Floral visitations:** Myrtaceae: *Angophora floribunda*, *Eucalyptus largiflorens*, *Eucalyptus* spp..

*Female*—known but not examined; Michener (1965) mentions the hind tibial scopa and inner hind tibial spur of females of this species. *Male*—Length ca 7 mm; integument black with antennae mostly orange. *Head*—Hair white, lying flat, not appressed, short dense over entire surface; scape only reaching about 0.5 x way to median ocellus; F1–2, length about 0.5 x width, F3–11 length greater than width; palps long; supraclypeal area shallowly raised, punctate; palp segments subequal in length. *Mesosoma*—Hair of scutum and scutellum moderately dense and long, white. First recurrent vein enters second submarginal cell slightly basal to medial, the vein defining the second submarginal cell often absent. *Metasoma*—Hair fine, dense, erect hairs; T7 bare; S5 with long, dense white fringe, length about same as width of S5. For details of S7–8 and genitalia see figs 157–159.

***Leioproctus (Minycolletes) aquilus* sp.n.**

**Types**

*Leioproctus (Minycolletes) aquilus*—New South Wales: holotype ♀, Pilliga Scrub, 64 k S Narrabri, 4.xii.1976, E.M. Exley and T. Low off *Astrotricha longifolia* blossom (QM); paratypes, 32♀, 2♂, same data as holotype (QM).

**Additional material examined:** 1♀, 1♂ **Queensland:** Amiens; 38 k E of Cunnamulla.

**Months collected:** November, December.

**Floral visitations:** Araliaceae: *Astrotricha longifolia*; Myrtaceae: *Angophora floribunda*.

*Female*—Length ca 7 mm; integument black to dark brown, flagellum orangish; hair white, densely plumose; integument dark brown to black. *Head*—Supraclypeal area shallowly raised, polished; labial palps just reaching apex of extended glossa, segments subequal in length; antennal sockets shallowly depressed. Vertex slightly curved above lateral ocelli; facial foveae absent; inner eye margins almost straight, converging slightly dorsally and ventrally; surface sculpture of dense, small, clearly defined punctures with polished interspaces; facial hair dense, semierect to erect, much branched above and lateral to antennal sockets, elsewhere on face fine and sparse; flagella F1, 4–11 length about equal to width, F2–3 length less than width; epistomal suture weak; clypeus almost flat; malar space absent; labrum short polished, length less than 0.25 x width; width of gena less than eye width, when head viewed laterally. *Mesosoma*—Scutum and scutellum with small, clearly defined punctures and polished interspaces; hair of scutum and scutellum sparse, fine white; propodeal triangle polished; lateral foveae extend along margin of basal area. First recurrent vein enters second submarginal cell slightly apical to middle. Basitibial plate about 0.25 x length of tibia, covered in thick dark, simple hairs; inner hind tibial spur with about 6 fine teeth; metanotum short, not tuberculate; propodeal triangle without a defined basal area, smooth. Wings with stigma large, about 0.6 x length of costal margin of marginal cell; marginal cell broad, apex strongly divergent from costa; jugal lobe of hind wing narrow, reaching beyond cu-a; wing membrane clear; inner hind tibial spur with 6 or more long, fine, moderately spaced teeth; claws with inner ramus moderate to small. *Metasoma*—Gradulus weak or

absent; pregradular area with minute punctures with granular interspaces; postgradular area similar but with fewer punctures; with at most very weak apical hair bands, apical margins of terga translucent; S2–4 with long, fine, branched hair; Hair of terga, short, fine, appressed; prepygidial fimbria whitish, narrow; pygidial plate granular, moderately wide apex, rounded. *Male*—As for female except as follows: Length ca 6 mm. *Head*—Inner eye margins straight, converging below; male interantennal distance greater than width of paraocular area at level of antennal sockets; flagellum males usually short, F1–2 length much less than width; F3–11 length greater than width; hair on face dense, semierect to erect, much branched. *Mesosoma*—hair of scutum and scutellum long, fine and sparse (males). *Metasoma*—T7 with bare median area; S5 without an apical fringe. Male genitalia with gonobase about 0.25 x length of genitalia and large gonofossa; gonoforceps unornamented; vosellae somewhat enlarged. S7 with very large apical lobes, for details of S7–8 and genitalia see figs 160–162.

### Notes

Distinguished from other species in this subgenus by propodeal triangle and supraclypeal area polished; supraclypeal area shallowly raised; females with hind basitibial plate with thick, black hair and labial palps reaching apex of extended glossa; males with length of antennal flagella segments greater than width, S5 without apical fringe and the male genitalia.

*Etymology*—Aquilus is Latin for dark-coloured.

### *Leioproctus (Minycolletes) eruditus* sp.n.

#### Types

*Leioproctus (Minycolletes) eruditus*—New South Wales: holotype ♀, 40 miles (64 k) E Broken Hill 20.viii.1969, G.B. Monteith (QM); paratypes 17♀, same data as holotype (QM).

**Months collected:** August.

**Floral visitations:** None recorded.

*Female*—Length ca 7 mm; integument black to dark brown; hair mostly white. *Head*—Hair moderately dense, long much branched hair; supraclypeal area shallowly raised, punctate; labial palps reach beyond apex of extended glossa, segments subequal in length; vertex slightly curved above lateral ocelli; facial foveae absent; inner eye margins almost straight, converging slightly dorsally and ventrally; surface sculpture of dense, small, clearly defined punctures with polished interspaces; female flagella F1, 4–11 length about equal to width, F2,3 length less than width; epistomal suture weak; clypeus almost flat; malar space absent; labrum short polished, length less than 0.25 x width; width of gena less than eye width, when head viewed laterally. *Mesosoma*—Hair of scutum and scutellum moderately sparse, whitish brown; with small, clearly defined punctures and polished interspaces; propodeal triangle polished, without a defined basal area lateral foveae not extending beyond basal area; metanotum short, not tuberculate. Wings with first recurrent vein entering second submarginal cell medially, stigma large, about 0.6 x length of costal margin of marginal cell; marginal cell broad, apex strongly divergent from costa; jugal lobe of hind wing narrow, reaching beyond cu-a; wing membrane clear. Hind legs with hind basitibial plate with dense, thick, whitish hair, apex pointed, 0.25 x length of tibia covered in dense, simple hair; inner hind tibial spur with about 11 fine teeth; claws with moderate to small inner ramus. *Metasoma*—Hair, short, dense, fine white hair; Gradulus weak or absent; pregradular area with minute punctures with granular interspaces; postgradular area similar but with fewer punctures; pygidial plate narrow apex with a granular surface; prepygidial fimbria whitish, dense, plumose hair; integument dark brown to black; S2–4 with long, fine branched hair. *Male*—Unknown.

### Notes

Distinguished from other species in this subgenus by polished supraclypeal area and propodeal triangle; supraclypeal area shallowly raised; hair of hind basitibial plate whitish and labial palps reaching beyond apex of glossa.

*Etymology*—Eruditus is Latin for polish and is used because of the polished supraclypeal area and propodeal triangle.

## *Leioproctus (Minycolletes) exiguus* sp.n.

### Types

*Leioproctus (Minycolletes) exiguus*—Western Australia: holotype ♂, near Carnarvon, 6.ix.1954, A. Snell (MV); paratypes, 1♂, same data as holotype; 1♂, Yuin Station, 30 miles (42 k) NE Mullewa, 7.viii.1954, A. Snell (ANIC).

**Months collected:** August, September.

**Floral visitations:** None recorded.

*Female*—Unknown. *Male*—Length ca 6 mm; integument black with brown legs and densely plumose, white hair. *Head*—Face densely covered in long, white, much branched hair; surface sculpture of dense, small, clearly defined punctures with polished interspaces; vertex slightly curved above lateral ocelli; facial foveae absent; inner eye margins straight, converging below; F1–3 length less than width; F4–11 length about equal to width; interantennal distance greater than width of paraocular area at level of antennal sockets; epistomal suture weak; clypeus almost flat; supraclypeal area flat, punctate; labial palps just reaching apex of extended glossa, segments subequal in length; malar space absent; labrum short polished, length less than 0.25 x width; width of gena less than eye width, when head viewed laterally. *Mesosoma*—Scutum and scutellum covered in long, white hair; with small, clearly defined punctures and polished interspaces; metanotum short, not tuberculate; propodeal triangle without a defined basal area, coriaceous; first recurrent vein enters second submarginal cell slightly basal to middle, pterostigma large, about 0.6 x length of costal margin of marginal cell; marginal cell broad, apex strongly divergent from costa, jugal lobe of hind wing narrow, reaching beyond cu-a; wing membrane clear; legs covered in long, white hair; joints paler than surrounding integument. *Metasoma*—Terga covered in long, white hair; T7 bare medially, S5 with a dense, apical fringe; for S7–8 and genitalia see figs 163–165.

### Notes

Distinguished from other species in this subgenus by males with coriaceous propodeal triangle; details of genitalia, S8 & S7; supraclypeal area shallowly raised and hair of T2–4 long, erect.

*Etymology*—Exiguus is Latin for small.

## *Leioproctus (Minycolletes) finkei* Michener, 1965 n.comb.

*Leioproctus (Microcolletes) finkei* \*Michener 1965: 55, 248, plate 1 (fig.11).

### Types

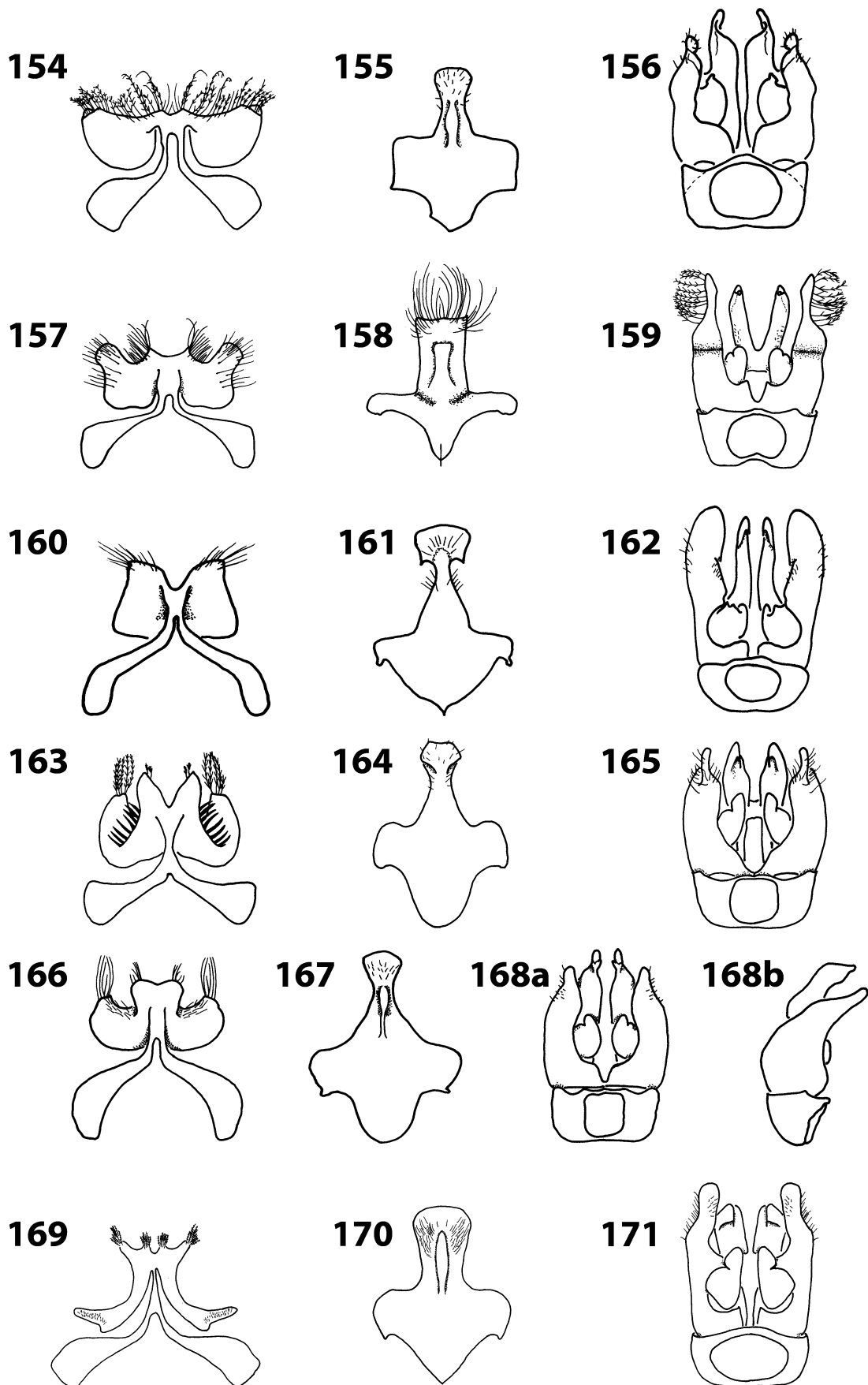
*Leioproctus (Microcolletes) finkei*—Northern Territory: holotype ♀, Finke Crossing, 1933, J.W. Rose (ANIC); paratypes, 2♀, same data as holotype (ANIC).

**Additional material examined:** 16♀, 6♂ **Queensland:** 3 miles (4.8 k) W Windorah; 2 miles (3.2 k) NE Windorah; 8 miles (12.8 k) NE Windorah. **South Australia:** 3–8 k N Ooldea; 29 miles (46.4 k) ESE Amala (Musgrave Park). **Western Australia:** Perth. **Northern Territory:** 30 k S of Alice Springs.

**Months collected:** April, August, October, November.

**Floral visitations:** Asteraceae: *Xerochrysum bracteatum*; Portulacaceae: *Calandrinia balonensis*.

*Female*—Length ca 7.5 mm; integument of head and thorax black, metasoma orange or mottled orange/brown; hair whitish. *Head*—Hair moderate length, moderately dense, lying flat but not appressed; supraclypeal area shallowly raised, punctate; labial palps not reaching apex of extended glossa, segments about as long as broad. *Mesosoma*—Tegulae transparent; hair of scutum short, lying flat; propodeal triangle polished. First recurrent vein enters second submarginal cell towards the apex. Hind basitibial plate with brownish, short, thick, dense hair; inner hind tibial spur with 6 fine teeth; legs yellowish. *Metasoma*—Hair of terga short, white, appressed; prepygidial fimbria whitish. *Male*—As for female except as follows: Length ca 6 mm. *Head*—F2–3 length less than 0.5 x width, F1, 4–11 length as most as great as width, scape with much long, white hair. *Mesosoma*—Hair of scutum and scutellum moderate length, moderately dense. Tibiae and tarsi yellowish. *Metasoma*—T7 with broad, polished, hairless median area; S5 with apical fringe with hair thick, white, laterally greater than 2 x length of median hair. For S7–8 and genitalia see figs 166–168a,b.



**FIGURES 154–171.** Figs 154–156 Male S7–8 and genitalia *Leioproctus* (*Minycolletes*). Figs. L. (*M. microsomus* S7, S8, genitalia. Figs 157–159 L. (*M. abnormis* S7, S8, genitalia. Figs 160–162 L. (*M. aquilus* S7, S8, genitalia, Figs 163–165 L. (*M. exiguus* S7, S8, genitalia. Figs 166–168 L. (*M. finkei* S7, S8, genitalia. Figs 169–171 L. (*M. helichrysi* S7, S8, genitalia.

***Leioproctus (Minycolletes) helichrysi* (Cockerell, 1918) n.comb.**

*Paracolletes helichrysi* \*Cockerell 1918: 112; 1934: 27.

*Leioproctus (Microcolletes) helichrysi* (Cockerell). Michener 1965: 55.

**Type**

*Paracolletes helichrysi*—Queensland: holotype ♀, Tamborine Mountain, 23.x.1917\*, H.H. Hacker off *Helichrysum bracteatum* blossom (BMNH 17a.474). (\* No date written in description.)

**Additional material examined:** 4♀, 2♂ **Queensland:** Tamborine Mountain. **New South Wales:** Ben Lomond. **Victoria:** Kiata.

**Months collected:** February, October, November.

**Floral visitations:** Asteraceae: *Xerochrysum bracteatum*.

*Female:* Length ca 7.5 mm. *Head*—Hair moderately dense, branched, semierect; supraclypeal area shallowly raised, punctate; mandibles with apical tooth large with clearly defined small, dorsal tooth; labial palps not reaching apex of extended glossa, basal segment as long as following 2 segments combined. *Mesosoma*—Hair of scutum and scutellum pale brown, erect, moderate length; propodeal triangle polished; tegulae translucent brown. First recurrent vein enters second submarginal cell apical to middle. Basitibial plate about 0.25 x length of tibia, covered in dense, whitish, thick hair, apex blunt; scopa all white; inner hind tibial spur with 8 fine teeth. *Metasoma*—Hair fine, short, appressed; prepygidial fimbria pale about 0.5 x width of T5; pygidial plate granular, narrowly rounded apically. *Male*—As for female except as follows: Length ca 7 mm. *Head*—Hair dense; F2–3 length less than width, F1, 4–11 length about equal to width; mandibles narrow, dorsal tooth indistinct. *Metasoma*—S5 with long truncate white fringe; T7 with bare median area. S7–8 and genitalia see figs 169–171.

***Leioproctus (Minycolletes) insitus* sp.n.**

**Type**

*Leioproctus (Minycolletes) insitus*—Queensland: holotype ♀, 2 miles (3.2 k) S Nanango, 7.x.1978, T.F. Houston off daisy blossom (SAM); paratypes 1♀, 3♂, Amiens, 4.xi.1965, J.C. Cardale (QM).

**Additional material examined:** 1♀ **Queensland:** N of Caloundra.

**Months collected:** October, November.

**Floral visitations:** Myrtaceae: *Leptospermum*; daisy blossom.

*Female*—Length ca 7 mm; integument brown to black; hair mostly white. *Head*—Hair moderately dense, white moderately long, semierect; ventral flagellum yellow, antennal sockets shallowly depressed; supraclypeal area shallowly raised, punctate; apical tooth of mandible large, dorsal tooth clearly defined; labial palp just reaching apex of extended glossa, segments subequal in length. *Mesosoma*—Hair pale brown, long, moderately dense; propodeal triangle polished, lateral foveae not extending into basal area, tegulae translucent brown, first recurrent vein enters second submarginal cell towards the apex. Basitibial plate a little less than 0.25 x length of tibia, covered in thick black hairs; apex pointed; hind tibial scopa pale brown dorsally; inner hind tibial spur with about 11 fine teeth. *Metasoma*—Hair of terga short, fine, appressed; prepygidial fimbria brown, covering about 0.75 x width of T5; pygidial plate granular, apex narrow. *Male*—As for female except as follows: Length ca 6 mm. *Head*—All flagella segments with length less than width. *Mesosoma*—Hair sparse. *Metasoma*—T7 bare medially; S5 with a long, apical fringe, with truncate apical margin. For S7–8 and genitalia see figs 172–174.

**Notes**

This species is distinguished from others in this subgenus by the following combination of characters- propodeal triangle polished; females with basal segment of labial palp less than twice length of second segment; scutum with long, erect, brown hair; supraclypeal area punctate, and males with anterior fore tibia black, hair of scutum sparse, white; apical fringe of S5 with hair all same length; antennal flagellum short; labial palp not extending beyond extended glossa and male genitalia.

*Etymology*—*Insitus* is Latin for border or flounce referring the marginal fringe on the male S5.

### *Leioproctus (Minycolletes) paulus* sp.n.

#### Types

*Leioproctus (Minycolletes) paulus*—Western Australia: holotype ♂, 22 k NE Tamala HS (26°42'S 113°43'E), 21–23.viii.1980, C.A. Howard and T.F. Houston on *Calandrinia polyandra* (WAM 89/599); paratype, 1♂, same data as holotype (WAM 89/600).

**Additional material examined:** 2♂ Western Australia: 10 k S Nerren HS; 10 k ESE Meedo HS.

**Months collected:** August.

**Floral visitations:** Portulacaceae: *Calandrinia polyandra*.

*Female*—Unknown. *Male*—Length ca 7 mm; integument black, fore leg orange, hair white with extremely short branches. *Head*—Hair long, dense with branches short such that hair looks simple; supraclypeal area flat, punctate; antennal socket not depressed; F2–4 length less than width, F1,5–11 length almost as long as width; mandibles with long, slender, apical tooth and large pollex, long branched hair to level of dorsal tooth; maxillae constricted at bases of maxillary palps; labial palps not reaching apex of extended glossa, segments short, subequal in length. *Mesosoma*—Hair of scutum and scutellum long, moderately sparse; tegulae translucent brown; propodeal triangle coriaceous. First recurrent vein enters second submarginal cell almost at apex. Fore and mid tibia with posterior apical tufts of hair; apex of fore femur and anterior fore tibia orange; fore and mid legs with short hair on legs, hind legs with long hair. *Metasoma*—Hair of terga short, fine appressed; T7 medially bare. S5 with long, dense apical fringe with longest hair laterally (emarginate). For details of S7–8 and genitalia see figs 175–177.

#### Notes

This species is distinguished from others in this subgenus by hair of T2–4 short, fine appressed; propodeal triangle coriaceous and male genitalia.

*Etymology*—Paulus is Latin for little.

### *Leioproctus (Minycolletes) pygmaeus* sp.n.

#### Types

*Leioproctus (Minycolletes) pygmaeus*—Western Australia: holotype ♂, 7 k SE Newman, 23.xii.1975, E.M. Exley and R.I. Storey off *Acacia* blossom (QM); paratypes 2♂, same data as holotype (QM).

**Months collected:** December.

**Floral visitations:** Fabaceae: *Acacia*.

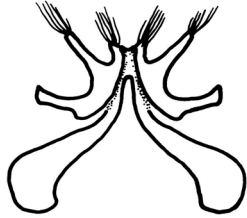
*Female*—Unknown. *Male*—Length ca 7 mm; integument black to dark brown, legs paler; hair white. *Head*—Vertex slightly curved above lateral ocelli; facial foveae absent; inner eye margins straight, converging below; surface sculpture of dense, small, clearly defined punctures with polished interspaces; hair dense, lying flat, strongly branched; supraclypeal area punctate, apex shallowly raised; interantennal distance greater than width of paraocular area at level of antennal sockets; F1,2 length less than width, whitish; dorsal tooth indistinct; epistomal suture weak; clypeus almost flat; malar space absent; labrum short polished, length less than 0.25 x width; width of gena less than eye width, when head viewed laterally; labial palps just longer than extended glossa, basal 3 segments subequal in length, apical segment 2 x long as other segments. *Mesosoma*—Scutum and scutellum with small, clearly defined punctures and polished interspaces; hair long, moderately dense; propodeal triangle polished without a defined basal area, tegulae transparent. Wings with stigma large, about 0.6 x length of costal margin of marginal cell; marginal cell broad, apex strongly divergent from costa; first recurrent vein enters second submarginal cell medianly; jugal lobe of hind wing narrow, reaching beyond cu-a; wing membrane clear. Legs with long, fine hair. *Metasoma*—Hair of terga moderately long, erect; gradulus weak or absent; pregradular area with minute punctures with granular interspaces; postgradular area similar but with fewer punctures; T7 bare medially; S5 with a short, dense, truncate apical fringe. Genitalia with gonobase about 0.25 x length of genitalia and large gonofossa; gonoforceps unornamented; vosellae somewhat enlarged. S7 with very large apical lobes for details of S7–8 and genitalia see figs 178–180.

## Notes

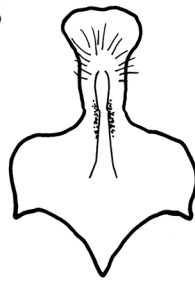
This species is distinguished from others in this subgenus by male with apical sternal fringe on S5, labial palps long apical segment projecting beyond the apex of extended glossa and long flagellum.

*Etymology*—Pygmaeus is Latin for dwarf or little referring to the small size of this bee species.

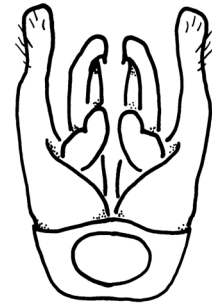
172



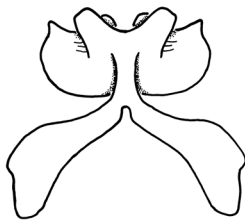
173



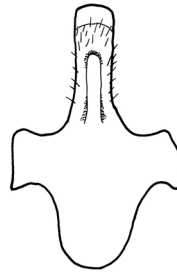
174



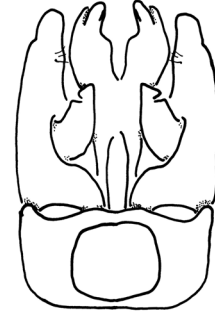
175



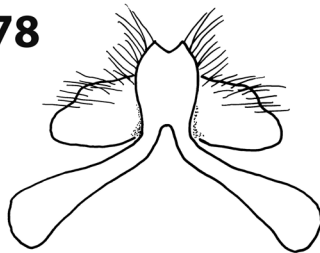
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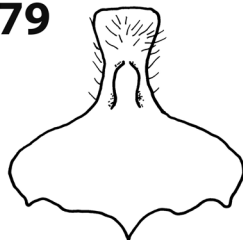
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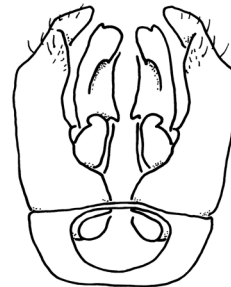
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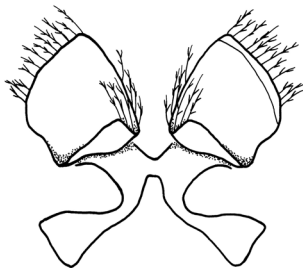
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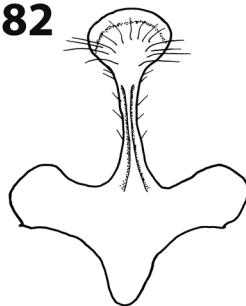
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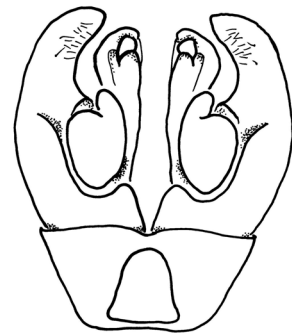
181



182



183



**FIGURES 172–183.** Male S7–8 and genitalia *Leioproctus* (*Minycolletes*). Figs 172–174 *L. (M.) insitus* S7, S8 genitalia. Figs 175–177 *L. (M.) paulus* S7, S8 genitalia. Figs 178–180 *L. (M.) pygmaeus* S7, S8, genitalia. Figs 181–183 *L. (M.) wahlenbergiae* S7, S8, genitalia.

### *Leioproctus* (*Minycolletes*) *wahlenbergiae* Michener, 1965 n.comb.

*Leioproctus* (*Microcolletes*) *wahlenbergiae* \*Michener 1965: 56, 250; figs 96–98; Plate 1 (8,9).

#### Types

*Leioproctus* (*Microcolletes*) *wahlenbergiae*—Queensland: holotype ♀, 17 miles (27.2 k) S Dalby, 20.x.1958, C.D. Michener



(ANIC); "allotype" (= paratype), ♂, same data as holotype; paratypes, 1♀, same data as holotype (QM T.6235); 1♂, Jondaryan, 20.x.1958, C.D. Michener, on *Wahlenbergia* (QM T.6234).

**Additional material examined:** 2♀, 4♂ **Queensland:** Helidon; St. Ruth; Kogan.

**Months collected:** October.

**Floral visitations:** Campanulaceae: *Wahlenbergia*.

*Female*—Length ca 8.5 mm; integument dark brown to black with white hair. *Head*—Hair fine, moderately sparse, erect; supraclypeal area is polished, apex shallowly raised; epistomal suture distinct; labial palps not reaching apex of extended glossa, basal segment is as long as distal 3, 3 distal segments are as long as wide. *Mesosoma*—Hair moderately sparse, long, fine; tegulae translucent brown; propodeal triangle coriaceous. First recurrent vein enters second submarginal cell medially. Fore and mid legs with relatively dense, almost appressed hair; hind basitibial plate covered in dense white hair, about 0.25 x length of tibia, apex broadly rounded; hind tibial scopa white; inner hind tibial spur with 7–8 teeth. *Metasoma*—Hair sparse, short, fine, erect; prepygidial fimbria white, short, dense; pygidial plate rough, broadly rounded apically. *Male*—As female except as follows: Length ca 7.5 mm. *Head*—Hair below antennal sockets moderately dense; F1–11 length less than width, F2 and 3 shortest segments. *Mesosoma*—All legs with moderately dense, long white hairs. *Metasoma*—T7 bare medially; S5 lacking apical fringe. For details of S7–8 and genitalia see figs 181–183.

### ***Leioproctus (Zosterocolletes) subgen.n.***

This subgenus is erected for 3 species placed by Michener (1965) in *Leioproctus (Leioproctus)*. At that time, he considered them part of a group of species that might, in future warrant subgeneric status. The main characters that distinguish the subgenus are: the seventh metasomal sterna of the males with 4 apical lobes; ocelloccipital area depressed; sternal fringes in males and apical tergal hair bands in females.

*Type species*—*Andrena advena* Smith, 1862.

*Diagnosis*—Ocelloccipital area strongly depressed; vertex depressed below eye level, propodeal triangle vertical; fore wing with small, parallel sided pterostigma; female inner hind tibial spur with 1–2 strong, broadly separated teeth; female metasomal terga with narrow, complete hair bands; male S7 with 4 apical lobes.

*Description*—*Head*—Hair, white, very dense in males, obscuring integument; facial foveae in females indicated by change in surface texture; frons flat; scape reaching beyond median ocellus; female F1 with length greater than width, longer than F3; F3–10 with length about equal to width and F2 with length less than width; male F1 with length about equal to width, F3–11 with length greater than width; apex of supraclypeal area raised above frons level; frontal line ending in a small tubercle at apex of supraclypeal area; epistomal suture weak, straight; clypeus convex, shallow; malar space polished, distinct, length about 0.5 x width of base of mandibles; gena about same width as eye, steeply sloping from eye in males, rounded in females; male mandibles long and slender; female mandibles broad throughout; labrum short; glossa with short apical fringe; maxillary palps reaching just beyond apex of glossa; labial palps short, not reaching apex of extended glossa. *Mesosoma*—Surface sculpture of scutum and scutellum small, weak punctures on smooth surface; hair long, moderately dense to dense, branched; metanotum without nodule, hair not differentiated from that of surrounds. Wings with dense hair over entire wing; membrane darkened in most species; first recurrent vein enters second submarginal cell about the middle. Legs of female with hind basitibial plate less than 0.2 x length of tibia, covered with stiff, simple hairs; tibial scopa dense, with coarse, monopodal hair. *Metasoma*—Weakly punctate and broadly rounded in both sexes; T1 with moderately dense, long, fine hair; female T2–4 with short, simple hair and narrow apical hair bands; female prepygidial fimbria coarse, sparse; Male T2–6 with fine, long hair; female sterna with long, fine, simple hair, except on apical margins where it is branched; male with sparse, fine, long, simple hair except for fringes of S4–5.

*Etymology*—Zoster is Greek for banded, referring to the bands on the female metasoma.

## Key to species of *Leioproctus* (*Zosterocolletes*)

1	Female (with hind tibial scopa) .....	2
–	Male (without hind tibial scopa) .....	4
2	Caudal fimbria orange .....	<i>Leioproctus</i> ( <i>Zosterocolletes</i> ) <i>ruficornis</i> (Smith, 1879)
–	Caudal fimbria black .....	3
3	Western Australia .....	<i>Leioproctus</i> ( <i>Zosterocolletes</i> ) <i>worsfoldi</i> (Cockerell, 1906)
–	Eastern Australia .....	<i>Leioproctus</i> ( <i>Zosterocolletes</i> ) <i>advena</i> (Smith, 1862)
4	Flagellum yellow, at least anteriorly; scutal hair orange .....	<i>Leioproctus</i> ( <i>Zosterocolletes</i> ) <i>ruficornis</i> (Smith, 1879)
–	Flagellum black entirely; scutal hair yellow to white .....	5
5	Hair of T2 long and shaggy, legs all black .....	<i>Leioproctus</i> ( <i>Zosterocolletes</i> ) <i>advena</i> (Smith, 1862)
–	Hair of T2 short; tibiae and tarsi yellow .....	<i>Leioproctus</i> ( <i>Zosterocolletes</i> ) <i>worsfoldi</i> (Cockerell, 1906)

## *Leioproctus* (*Zosterocolletes*) *advena* (Smith, 1862)

*Andrena advena* \*Smith 1862: 60.

*Paracolletes euphenax* \*Cockerell 1913b: 279; 1934: 26; Rayment 1935: 174; 1953: 2. **syn.n.**

*Paracolletes advena* (Smith). Cockerell, 1913b: 279; 1915c: 104; 1929c: 204; 1929d: 308; 1934: 21; Rayment 1931a: 161; 1935: 174; 1953: 2.

*Paracolletes scitulus* \*Cockerell 1921: 97, 98; 1934: 35. **syn.n.**

*Paracolletes advena phillipensis* \*Rayment 1953: 2. **syn.n.**

*Leioproctus* (*Leioproctus*) *advena* (Smith). Michener 1965: 47, 48, 50, figs: 74–76.

*Leioproctus* (*Leioproctus*) *euphenax* (Cockerell). Michener 1965: 47, 48, 50.

*Leioproctus* (*Leioproctus*) *phillipensis* (Rayment). Michener 1965: 51.

*Leioproctus* (*Leioproctus*) *scitulus* (Cockerell). Michener 1965: 52.

The holotypes of *Andrena advena* and *Paracolletes advena phillipensis* are female and show no significant morphological differences. The holotypes of *Paracolletes euphenax* and *Paracolletes scitulus* are male and are the same as those males associated with the holotype of *Andrena advena* by morphological similarities and coincident collection data.

### Types

*Andrena advena*—holotype ♀, Australia (BMNH 17a.500).

*Paracolletes euphenax*—Queensland: holotype ♂, Brisbane, 4.ix.1911, H. Hacker (QM T.4083).

*Paracolletes advena phillipensis*—Victoria: holotype ♀, Sandringham, 11.ix.1929, T. Rayment (ANIC).

*Paracolletes scitulus*—Queensland: holotype ♂, Brisbane, 25.ix.1919, H. Hacker (QM T.2397).

**Additional material examined:** 64♀, 36♂ **Queensland:** 20 miles (32 k) S Bundaberg; Caloundra; Dunwich, Stradbroke Is; Stradbroke Is; Brisbane; Cleveland. **New South Wales:** Hawkesbury Riv; Cowan; Cheltenham; Mt Ku-ring-gai. **Victoria:** Warburton; Sandringham; Cheltenham; Mordialloc; Black Rock; Frankston; Gorae West; Balcombe. **South Australia:** 4 miles (6.4 k) E Koongawa; 8.5 k E Keith.

**Months collected:** April, August, September, October.

**Floral visitations:** None recorded.

*Female*—Length ca 11 mm. *Head*—Hair of clypeus moderately sparse. *Mesosoma*—Hair of scutum and scutellum sparse, dark brown, marginally whitish; tibial scopa relatively open, mostly white, except around area of basitibial plate where it is dark; hair laterally sparse, brown; basitibial plate pointed with a broad, flat margin; inner hind tibial spur with 2–3 very widely spaced teeth. *Metasoma*—T2–4 with narrow complete bands of white hair; prepigidial fimbria coarse, black; pygidial plate triangular, apex narrow, rounded; sternal hair long, whitish, simple, except on apical margin. *Male*—As for female except for the following: Length ca 8 mm. *Head*—Face covered in dense, whitish hair; antennae long, orange-brown; mandibles slender throughout. *Mesosoma*—Legs black except paler area on anterior fore tibia. *Metasoma*—Apical tergal hair bands absent; S3–4 with apical fringes. For S7–8 and genitalia see figs 184a,b–186.

### Notes

Although males and females from Queensland and Victoria are externally indistinguishable, S7 of males is consistently different. In males from Queensland S7 has a broader dorsal, apical lobe (fig. 184b) than in those from New South Wales, Victoria and South Australia (fig. 184a).

## *Leioproctus (Zosterocolletes) ruficornis* (Smith, 1879)

*Lamprocolletes ruficornis* \*Smith 1879: 10.

*Paracolletes ruficornis* (Smith). Cockerell 1905a: 347; 1934: 35. Rayment 1935: 672.

*Paracolletes velutinus* \*Cockerell 1929c: 208; 1934: 37. **syn.n.**

*Leioproctus (Leioproctus) ruficornis* (Smith). Michener 1965: 52.

*Leioproctus (Goniocolletes) velutinus* (Cockerell). Michener 1965: 66.

### Types

*Lamprocolletes ruficornis*—holotype ♂, Western Australia (BMNH 17a.516).

*Paracolletes velutinus*—Western Australia: holotype ♂, Eradu, 8.ix.1926, Nicholson (AM).

The holotypes of *Lamprocolletes ruficornis* and *Paracolletes velutinus*, which are both male, show no significant morphological differences.

**Additional material examined:** 46♀, 17♂ **South Australia:** Culburra. **Western Australia:** Yuin station NE Mullewa; Mt Singleton; Bolgart; Newdegate; Tutanning Reserve 18–25km E of Pingelly; North Eneabba Reserve 30 km N of Eneabba; south Eneabba Reserve; Arrowsmith R, Robb Rd 22 km N of Eneabba

**Months collected:** August, September, October, November.

**Floral visitations:** Myrtaceae: *Verticordia cerrata*; Rutaceae: *Boronia capitata*.

*Female*—Length ca 11 mm. *Head*—Inner eye margins straight, parallel; face covered in off-white semierect, much-branched hair; F2 slightly short than others; middle labial palp segments shorter than apical or basal segments. *Mesosoma*—Scutum mostly covered in dark hair with subcentral bare polished area; propodeal triangle vertical. Legs with basitibial plate broad and short with a wide, flat border, covered in short thick hairs; hind tibial scopa mostly whitish with outer darker median area; inner hind tibial spur with only 2 very widely spaced teeth. *Metasoma*—Dorsal integument with small very dense punctures; T1 with sparse, erect, plumose, long, whitish hairs; T1–4 with complete narrow apical bands of white hair; T5 densely covered in orange hair; pygidium apically rounded and flat; sterna with moderately dense, long white hair, branched and simple. *Male*—Length ca 10 mm. *Head*—Densely covered in yellow hair; flagellum yellow; gena covered in dense yellow hair; labrum moderately wide; mandibles slender. *Mesosoma*—Hair moderately dense, long, yellow; all tibiae and tarsi pale yellow; coxae, trochanters and proximal femora black. *Metasoma*—Sternal fringes yellow. For S7–8 and genitalia see figs 187–189.

### Notes

This species superficially looks like a species of *Goniocolletes* but is distinguished by male S7–8 and genitalia as well as strongly depressed area between inner eye margins and lateral ocelli, propodeal triangle without a transverse carina, and hair of female hind basitibial plate being unbranched. S7–8 and genitalia are almost identical those of *L. (Zosterocolletes) advena*, but externally the males are readily separated by the type and colour of hair of the antennae and legs. The association of female of *L. ruficornis* is tenuous; it is based on one female and the males and females have not yet been collected together. The female associated with this species is very similar to *L. advena* except for its bright orange pygidium.

## *Leioproctus (Zosterocolletes) worsfoldi* (Cockerell, 1906)

*Paracolletes worsfoldi* \*Cockerell 1906: 24, 29; 1929d: 308; 1934: 38; Rayment, 1953: 3.

*Leioproctus (Leioproctus) worsfoldi* (Cockerell). Michener 1965: 47, 52.

### Type

Western Australia—holotype ♀, Western Australia, 1903 (BMNH 17a.423)

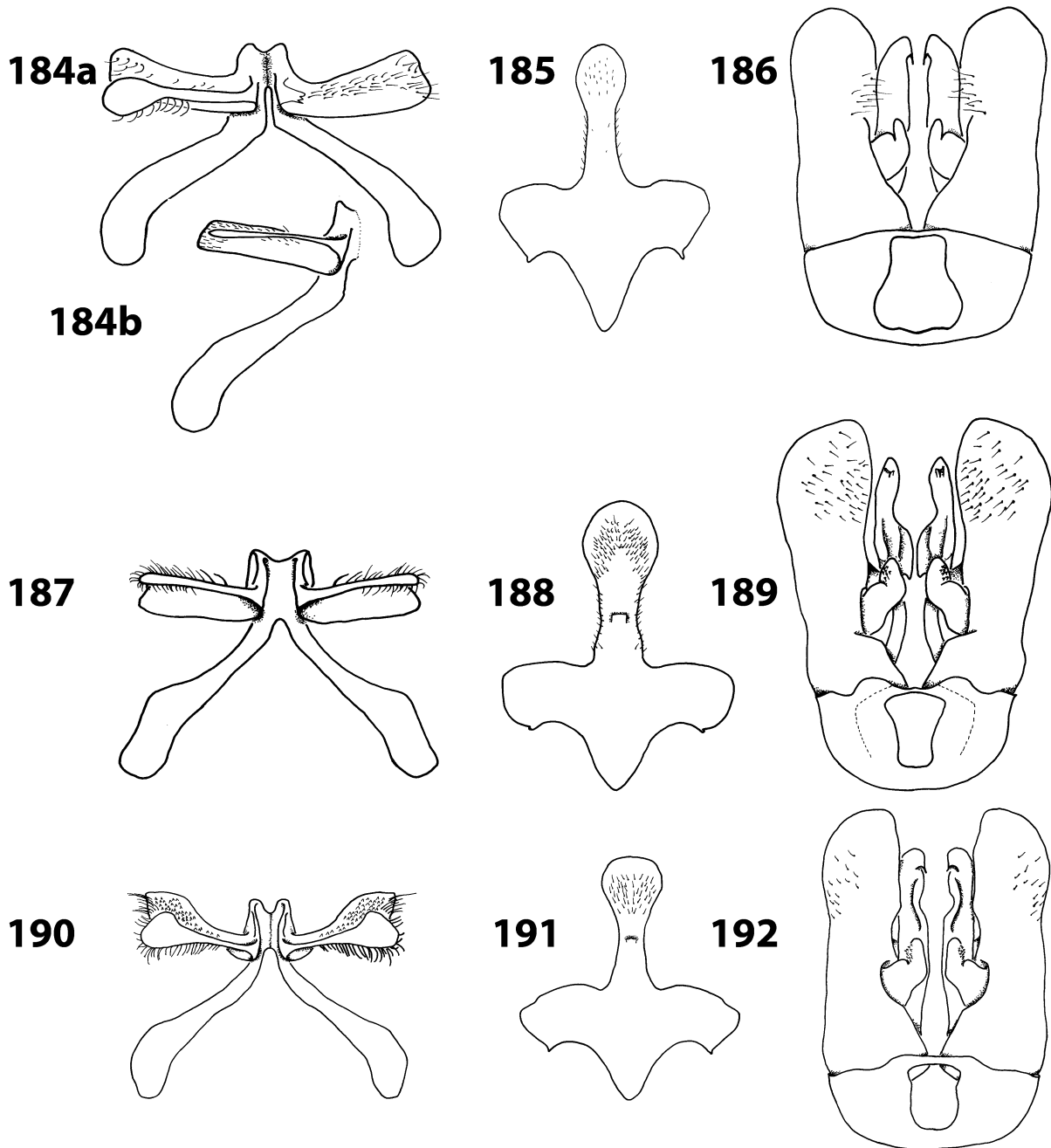
**Additional material examined:** 15♀, 21♂ **Western Australia:** 126 miles (201.6 k) N Geraldton; Northampton; Eradu; Kojarena, N Geraldton; Moora; 29 k NE Bullfinch; 9 miles (14.4 k) N New Norica; 30 miles (48 k) E Southern Cross; Moorine Rock; Darlington (450ft); Yallingup; Mt Barker; King George Sound (QM).

**Months collected:** August, September, October, November.

**Floral visitations:** None recorded.

*Female*—Length ca 11mm. *Head*—Hair of dorsal frons dark, elsewhere whitish; inner eye margins parallel;

mandibles slender; maxillary palps reaching beyond apex of maxillae; labial palps not reaching apex of glossa. *Mesosoma*—Dorsal mesosoma weakly punctate; long, pale brown hair; propodeal triangle rough basally, no transverse carina delimiting area; inner hind tibial spur with about 3 thick, widely spaced teeth. *Metasoma*—T2–4 with narrow, white apical hair bands; caudal fimbria black; pygidial plate narrow, surface smooth; sterna with long, branched hair mostly on band along apical margin. *Male*—Length ca 10 mm; entirely black except for tibia and tarsi, hair of head and mesosoma orange, metasomal hair dark orange. *Head*—Inner eye margins curved, converging at lower orbitals; lower clypeus impunctate and bare; hair yellow and strongly branched; gena slightly constricted behind eyes; malar area polished. *Mesosoma*—Integument weakly punctate with interspaces slightly roughened; scutellum with anterior area polished; dorsal mesosoma covered in long orange hair; all tibia and tarsi yellow; tegulae translucent. *Metasoma*—Integument weakly punctate with rough interspaces; T1–6 with long, shaggy hair with short hair in between; T7 with bare median area; apices of segments paler than rest of segments; S4–5 with long, thick emarginate fringes; S6 broad and flat. For S7–8 and genitalia see figs 190–192.



**FIGURES 184–192.** Male S7–8 and genitalia *Leioproctus* (*Zosterocolletes*). Figs 184–186 *L. (Z.) advena* S7 narrow accessory lobe, S7 wide accessory lobe, S8, genitalia. Figs 187–189 *L. (Z.) ruficornis* S7, S8, genitalia. Figs 190–192 *Leioproctus (Zosterocolletes) worsfoldi* S7, S8, genitalia.

## **Goniocolletes Cockerell, 1907**

Bees of this genus form a distinct group of Australian Paracolletini. Characters of males, especially those of the legs and metasomal sterna, readily distinguish them from other Paracolletini. The majority of species have the head and mesosoma black and the metasoma orange/red. This genus was erected by Cockerell (1907) for a *Goniocolletes morsus*, based on a single male specimen. Michener placed *Goniocolletes* as a subgenus of *Leioproctus*. As now understood, the genus contains 14 species, seven of which are described as new. Only one sex is recognised for five species. Females can be distinguished, from those of other genera, by the branched hairs on the basitibial plate and impressed facial foveae. The species of females within *Goniocolletes* are not easily separated from one another. Some species in this genus are superficially similar to honey bees, and may be confused with honey bees (*Apis mellifera* L. 1758) them on the wing.

The genus appears widespread in Australia although no specimens have been taken in the northern parts of the country or along the very well collected east coast. Most species have been collected at blossoms of Myrtaceae, especially of *Eucalyptus* in drier areas.

*Goniocolletes* Cockerell. Cockerell, 1907: 231; 1934: 8; Rayment, 1935: 210–212.

*Leioproctus* (*Goniocolletes*) (Cockerell). Michener, 1965: 64–66.

*Goniocolletes* Cockerell. Almeida & Danforth, 2009: 305

*Type species.* *Goniocolletes morsus* Cockerell, 1907 by original designation.

*Diagnosis.* Facial foveae impressed, linear (males), almost as wide as ocellular distance (females); face with dense, appressed hair (males); propodeal triangle with basal area shorter than metanotum and separated from vertical area by a carina; basitibial plate with dense branched hair (female); eighth metasomal sternum of males with very large apical process; seventh metasomal sternum of males with broad apodeme bases and usually spines on the apical lobes.

*Description.* Length 7–15 mm, head and mesosoma black, metasoma usually orange.

*Female—Head—*Vertex with small, dense, punctures; extends about 1 ocellar width behind upper eye margin; ocellular area flat; scape reaching median ocellus, tapering basally; F1–10 length equal to, or less than width (female); antennal sockets not depressed or only shallowly so; supraclypeal area strongly raised above frons level, flat; clypeus at same level as supraclypeal level, flat; epistomal suture distinct, straight; labial palps just reaching apex of extended glossa; maxillary palps reaching just beyond apex of extended glossa; inner eye margin straight converging below. *Mesosoma—*Hair white to orange, dense, branched, short; claws large with inner basal ramus; fore tibial spur with a few teeth; inner hind tibial spur with several long, strong, close teeth. *Metasoma—*Hair dorsally short, sparse; postgradular area with weaker sculpture than pregradular area.

*Male.* As for females including the following: *Head—*F1–2 about as long as wide, F3–11 length 1.5 x width (males); gena about as wide as eye, with ventral beard. *Mesosoma—*Hair of scutum usually long in males. *Metasoma—*Long, shaggy hair dorsally; bare median area on T7 clearly defined laterally.

### **Key to species of *Goniocolletes***

1	Male (without hind tibial scopa) . . . . .	2
–	Female (with hind tibial scopa) . . . . .	13
2	Legs modified . . . . .	3
–	Legs simple . . . . .	5
3	Mid tibial apex with a tuft of long white hair obscuring the small tibial spur; mid and hind legs simple . . . . .	
–	Mid tibial apex without a tuft of long, white hair obscuring tibial spur; mid tibia and trochanter enlarged, triangular; hind legs modified . . . . .	4
4	Mid coxa with inner apical spine; mid tibia not excavated basally; hind femur broad, flattened. . . . .	
–	Mid coxal spine absent; mid tibia swollen medially, excavated basally with a large tooth consisting of conglomerated hairs . . . . .	
5	Scape yellow . . . . .	<i>Goniocolletes dasyptus</i> Maynard, sp.n.
–	Scape black . . . . .	<i>Goniocolletes perfasciatus</i> (Cockerell, 1906)
6	Metasomal sternal fringes absent . . . . .	<i>Goniocolletes abdominalis</i> (Smith, 1879)
–	Metasomal sternal fringes present. . . . .	<i>Goniocolletes colletellus</i> (Cockerell, 1905)
6	Metasomal sternal fringes absent . . . . .	<i>Goniocolletes parvus</i> Maynard, sp.n.
–	Metasomal sternal fringes present. . . . .	7

7	S3–S4 with lateral apical fringes, with shortest hairs towards the middle . . . . .	<i>Goniocolletes subdolos</i> (Cockerell, 1913)	
–	S3–S4 or S4,5 with apical fringes across the entire width of the segment, hair length more or less even throughout . . . . .		8
8	Metasoma entirely black . . . . .		9
–	Metasoma orange, or orange mottled with black . . . . .		10
9	Legs all black . . . . .	<i>Goniocolletes albopilosus</i> (Rayment, 1930)	
–	Legs black with orange coxae and trochanters . . . . .	<i>Goniocolletes comatus</i> Maynard, sp.n.	
10	Malar space smooth and shiny, length about half width of the base of the mandibles. . . . .	<i>Goniocolletes aurifrons</i> (Smith, 1853)	
–	Malar space essentially absent . . . . .		11
11	Basal area of propodeal triangle distinctly polished; metasomal sternal fringes weak . . . . .	<i>Goniocolletes fimbriatus</i> (Smith, 1879)	
–	Basal area of propodeal triangle dull, slightly roughened; metasomal sternal fringes strong . . . . .		12
12	Scutal hair orange . . . . .	<i>Goniocolletes fimbriatinus</i> (Cockerell, 1910)	
–	Scutal hair whitish . . . . .	<i>Goniocolletes badius</i> Maynard, sp.n.	
13	Metasoma with apical tergal hair bands . . . . .		14
–	Metasoma without apical tergal hair bands . . . . .		17
14	Pygidial plate raised medially . . . . .	<i>Goniocolletes abdominalis</i> (Smith, 1879)	
–	Pygidial plate flat . . . . .		15
15	Metasoma black . . . . .	<i>Goniocolletes perfasciatus</i> (Cockerell, 1906)	
–	Metasoma orange . . . . .		16
16	Supraclypeal area covered in dense, branched hair . . . . .	<i>Goniocolletes colletellus</i> (Cockerell, 1905)	
–	Supraclypeal area polished with a few simple hairs laterally . . . . .	<i>Goniocolletes ciliatus</i> Maynard, sp.n.	
17	Pygidial plate raised medially . . . . .		18
–	Pygidial plate flat . . . . .		20
18	Supraclypeal area polished medially. . . . .	<i>Goniocolletes parvus</i> Maynard, sp.n.	
–	Supraclypeal area punctate medially . . . . .		19
19	Supraclypeal covered in branched hair . . . . .	<i>Goniocolletes rugosus</i> Maynard, sp.n.	
–	Supraclypeal area covered in simple hair . . . . .	<i>Goniocolletes fimbriatinus</i> (Cockerell, 1910)	
20	Supraclypeal area covered in mostly branched hair . . . . .		21
–	Supraclypeal area covered in sparse, simple hair . . . . .		22
21	Metanotum with short, dense, golden hair . . . . .	<i>Goniocolletes subdolos</i> (Cockerell, 1913)	
–	Metanotum with long, whitish hair . . . . .	<i>Goniocolletes badius</i> Maynard, sp.n.	
22	Basal area of propodeal triangle polished . . . . .		23
–	Basal area of propodeal triangle with several carinae . . . . .		24
23	Median area of supraclypeal area polished . . . . .	<i>Goniocolletes dasyptus</i> Maynard, sp.n.	
–	Median area of supraclypeal area rough . . . . .	<i>Goniocolletes fimbriatus</i> (Smith, 1879)	
24	Median area of supraclypeal area polished . . . . .	<i>Goniocolletes comatus</i> Maynard, sp.n.	
–	Median area of supraclypeal area punctate . . . . .	<i>Goniocolletes anthedonus</i> Maynard, sp.n.	

### ***Goniocolletes abdominalis* (Smith, 1879)**

*Paracolletes abdominalis* \*Smith 1879: 5; Dalla Torre 1896: 46; Cockerell 1905a: 344; 1934: 21.

*Goniocolletes morsus* \*Cockerell 1907:231; 1915a:345; 1934:9,10; Rayment 1935:211, 687 **syn.n.**

*Goniocolletes pallidus* \*Cockerell 1915a: 345; 1934: 9, 10. **syn.n.**

*Dasycolletes curvipes* \*Friese 1924: 217; Cockerell, 1934: 9. **syn.n.**

*Dasycolletes rufiventris* \*Friese 1924: 219. **syn.n.**

*Paracolletes rufiventris* (Friese). Cockerell 1934: 35.

*Goniocolletes simillimus* \*Rayment 1935: 686. **syn.n.**

*Goniocolletes proximus* \*Rayment 1935: 687. **syn.n.**

*Leioproctus* (*Goniocolletes*) *morsus* (Cockerell). Michener 1965: 64, 66, figs 133–135, pl.2, fig. 12.

*Leioproctus* (*Goniocolletes*) *abdominalis* (Cockerell). Michener 1965: 66.

*Leioproctus* (*Goniocolletes*) *curvipes* (Friese). Michener 1965: 66.

*Leioproctus* (*Goniocolletes*) *pallidus* (Cockerell). Michener 1965: 66

*Leioproctus* (*Goniocolletes*) *proximus* (Rayment). Michener 1965: 66.

*Leioproctus* (*Goniocolletes*) *ruficaudus* \*Michener 1965: 66. [replacement name for *rufiventris*, preoccupied by *Leioproctus rufiventris* Spinola, 1852]. **syn.n.**

*Leioproctus* (*Goniocolletes*) *similior* \*Michener 1965: 66 [replacement name for *Goniocolletes simillimus* (Rayment,1935), preoccupied by *Euryglossa similla* Smith, 1879, now in *Leioproctus* (*Euryglossidia*), and *Paracolletes simillimus* Cockerell, 1916c now in *Leioproctus* (*Leioproctus*)] **syn.n.**

The holotypes of *Goniocolletes morsus*, *Goniocolletes pallidus*, *Dasycolletes curvipes*, *Goniocolletes simillus* and *Goniocolletes proximus* are all male and are the same as those males associated with *Paracolletes abdominalis* by coincident collection data and morphological similarity. The holotype of *Dasycolletes rufiventris* is female and shows no significant difference to that of *Paracolletes abdominalis*.

## Types

*Paracolletes abdominalis*—Western Australia: holotype ♀, Champion Bay (BMNH 17a.416).

*Goniocolletes morsus*—New South Wales: holotype ♂ (AMNH).

*Goniocolletes pallidus*—Northern Territory: holotype ♂, Hermannsburg, H.J. Hillier (BMNH 17a.398).

*Dasycolletes curvipes*—South Australia: holotype ♂, Adelaide, 21.xi.1906, Frank (ZMB).

*Dasycolletes rufiventris*—South Australia: holotype ♀, Adelaide, 21.xi.1906, Frank (AMNH 26846) [N.B. the metasoma glued to the type is from a different species, likely to be a *Paracolletes*.]

*Goniocolletes simillius*—New South Wales: holotype ♂, Wentworth (ANIC).

*Goniocolletes proximus*—Western Australia: holotype ♂, Swan River (ANIC).

**Additional material examined:** 7♀, 34♂ **New South Wales:** Gnalta Station, 100 miles (160 k) NW Broken Hill; 17 miles (27.2 k) N Broken Hill; 80 k NE Wentworth; 20 miles (32 k) E Euston. **Victoria:** Wilkur. **South Australia:** 28 k NE Wirrulla; 9 miles (14.4 k) NE Oodlawirra; Morgan. **Western Australia:** Collie. **Northern Territory:** Macdonald Downs.

**Months collected:** February, March, October, November, December.

**Floral visitations:** Myrtaceae: *Eucalyptus largiflorens*, *Eucalyptus* spp..

*Female*—Length 12–15 mm, head and mesosoma black, metasoma orange. *Head*—Facial fovea strongly impressed dorsally, ill-defined ventrally; scape black; mandibles black, slightly reddened towards the tip malar space narrow length about 0.3 x width of base of mandible; hair of face white; frons hair brown. *Mesosoma*—Hair pale brown; propodeal triangle with rough basal area, several transverse carina most about the same strength and incomplete medially, vertical area not polished; 7–8 long teeth on inner hind tibial spur; basitibial plate completely obscured by dense, branched hairs. *Metasoma*—Gradulus indistinct; postgradular area translucent; hair white, T1 hair long, moderately dense, branches weak; T2–4 with complete apical hair bands; caudal fimbria very dense, pale brown; pygidial plate broad, rounded apically, median area raised. *Male*—As for female except as follows: Length 11–14 mm. *Head*—Face completely covered in golden appressed hair, scape black, polished, almost hairless; flagellum yellow ventrally, black dorsally, segments simple; mandibles pale yellow with reddened tips, labrum pale yellow with darkened medial area, no defined apical area, shallowly convex; beard dense, long, golden. *Mesosoma*—Integument black, legs pale yellow and black; hair golden. Legs highly modified; fore femur thickened with anterior longitudinal depression; fore tibia shallowly arcuate; fore basitarsus elongate, anterior surface flattened and shallowly arcuate; fore tibial spur with very short apex with one or no teeth; mid trochanter swollen and triangular, shallowly depressed anteriorly; mid femur swollen, triangular with broad basal tooth composed of aggregated hairs; mid basitarsus elongate strongly arcuate; hind femur swollen; hind tibia strongly arcuate; hind basitarsus inflated with large, subapical tooth; hind distitarsus with all segments elongate. *Metasoma*—Black with clear apical margins to terga; hair of T1–6 long, golden and shaggy; pygidial plate large, triangular, clearly defined laterally; sterna almost hairless, lacking sternal fringes; S8 strongly protuberant (see fig. 194a for lateral view); S6 with sharp median apical, longitudinal ridge; for details of S7–8, and genitalia see figs 193–195.

## *Goniocolletes albopilosus* (Rayment, 1930)

*Paracolletes albopilosa* (sic) \*Rayment 1930a: 50.

*Paracolletes albopilosus* (Rayment). Cockerell 1934: 22.

*Leioproctus (Goniocolletes) albopilosus* (Rayment). Michener 1965: 66.

### Type

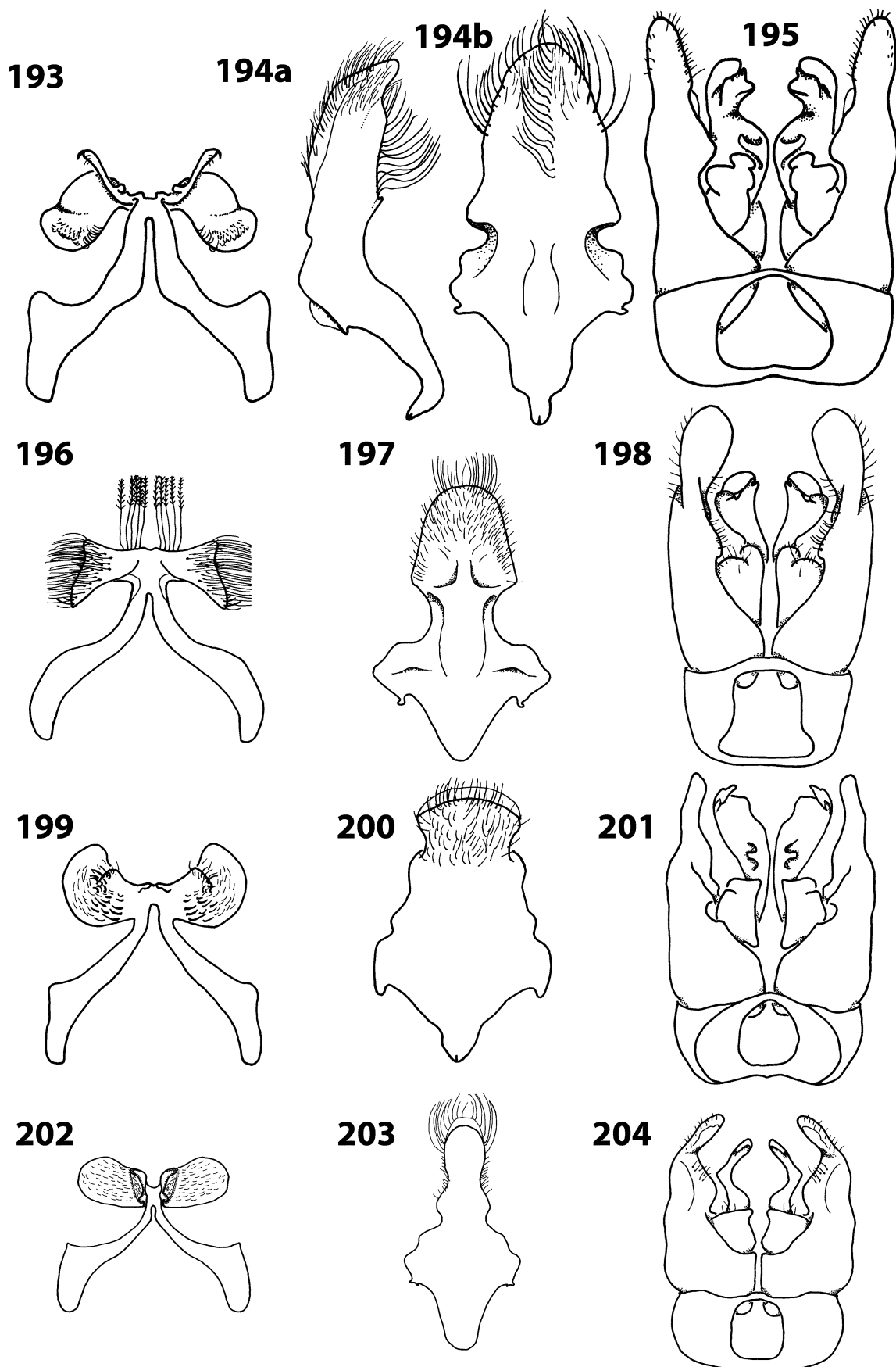
*Paracolletes albopilosus*—Western Australia: holotype ♂, Perth, 14.x.1929 (ANIC).

**Additional material examined:** 1♂ **Western Australia:** 16 k W Albany.

**Months collected:** January.

**Floral visitations:** Myrtaceae: *Leptospermum*.

*Female*—Unknown. *Male*—Length ca 9 mm; head and mesosoma black; metasoma black. *Head*—Hair white, appressed on supra-clypeal area, clypeus and lower paraocular area; F1,2 length less than width; F3–11 length greater than or equal width; labrum black, strongly convex; beard long, white. *Mesosoma*—Legs black, simple; hair white on outer margin, black medially. *Metasoma*—Hair white, short; S3–4 with long black fringes; T7 completely bare. For details of S7–8 and genitalia see figs 196–198.



**FIGURES 193–204.** Male S7–8 and genitalia *Goniocolletes*. Figs 193–195 *G. abdominalis* S7, S8 lateral, S8 ventral, genitalia. Figs 196–198 *G. albopilosus* S7, S8, genitalia. Figs 199–201 *G. badius* S7, S8, genitalia. Figs 202–204 *G. colletellus* S7, S8, genitalia.



### ***Goniocolletes anthedonus* sp.n.**

#### **Type**

*Goniocolletes anthedonus*—New South Wales: holotype ♀, 10 k W Wentworth, 6.i.1977, C.A. & T.F. Houston off *Eucalyptus camaldulensis* blossom (SAM).

**Additional material examined:** 1f South Australia: Sherlock.

**Months collected:** January, December.

**Floral visitations:** Myrtaceae: *Eucalyptus camaldulensis*.

*Female*—Length ca 10 mm; head and mesosoma black; metasoma orange, mottled with black. *Head*—Facial fovea clearly defined all round, impressed; hair on face white, densest on paraocular area; vertex with small, dense, punctures; extends about 1 ocellar width behind upper eye margin; ocellular area flat; scape black, reaching median ocellus, tapering basally; F1–10 length equal to, or less than width; antennal sockets not depressed or only shallowly so; supraclypeal area strongly raised above frons level, flat; clypeus at same level as supraclypeal level, flat; epistomal suture distinct, straight; mandibles reddish with darker tips; malar space almost non-existent; labial palps just reaching apex of extended glossa; maxillary palps reaching just beyond apex of extended glossa; inner eye margin straight converging below. *Mesosoma*—Hair white, short, dense, branched; basal area of propodeal triangle with several fine carinae, vertical area slightly granular; fore tibial spur with a few teeth; inner hind tibial spur with 6 long, strong, close, fine teeth; basitibial plate densely covered in hair, marginal carina not obscured by hair; claws with large inner, basal ramus. *Metasoma*—Apical tergal margins translucent, hair bands absent; hair sparse, fine, short; pygidial plate flat, broadly rounded apically; gradulus absent. *Male*—Unknown.

#### **Notes**

This bee is distinguished from other bees in this genus by females with median area of supraclypeal area punctate, basal area of propodeal triangle with several carinae, supraclypeal area covered in sparse, simple hair, pygidial plate flat and metasoma without tergal bands.

*Etymology*—Anthedon is Greek for a bee.

### ***Goniocolletes aurifrons* (Smith, 1853) n.comb**

*Lamprocolletes aurifrons* \*Smith 1853: 13; Dalla Torre, 1896: 47.

*Paracolletes aurifrons* (Smith). Cockerell 1905a: 347; 1934: 22.

*Leioproctus (Goniocolletes) aurifrons* (Smith). Michener 1965: 66.

#### **Type**

*Goniocolletes aurifrons*—South Australia: holotype ♂, Adelaide (BMNH 17a.509).

**Months collected:** Not known.

**Floral visitations:** Not recorded.

*Female*—Unknown. *Male*—Length ca 10 mm, head and mesosoma black, metasoma black. *Head*—Face with appressed, yellow hair; F1–2, length about equal to width; F3–11, length greater than length; malar space polished length about 0.5 x width; gena with long yellow hair. *Mesosoma*—Legs orange, simple; propodeal triangle mostly smooth and simple with no transverse carina delimiting the base. *Metasoma*—Integument with long, orange shaggy hair; no hair bands; gradulus not defined; S4–5 with apical sternal fringes. Hidden sterna and genitalia not available for study.

### ***Goniocolletes badius* sp.n.**

#### **Types**

*Goniocolletes badius*—Queensland: holotype ♂, 5 k NE Springsure, 29.x.1977, T. Low & E.M. Exley, off *Eucalyptus camaldulensis* (QM); paratypes 7♀, 2♂, same data as holotype (QM).

**Additional material examined:** 17♀, 1♂ Queensland: Bungeworgorai Creek, 12 k W Roma; 1 k NE Springsure; 10 k E Macalister.

**Months collected:** October, November.

**Floral visitations:** Myrtaceae: *Eucalyptus camaldulensis*, *Eucalyptus populnea*.

*Female*—Length ca 9 mm; head and mesosoma black; metasoma orange with black patches. *Head*—Facial fovea well defined on lower margin, less so on upper margin; vertex with small, dense, punctures; extends about 1 ocellar width behind upper eye margin; inner eye margin converging below; ocellocular area flat; scape reaching median ocellus, tapering basally with hair white, otherwise dark brown to black; F1–10 length equal to, or less than width; antennal sockets not depressed; supraclypeal area strongly raised above frons level, flat with sparse, simple hair, punctate; clypeus at same level as supraclypeal level, flat; epistomal suture distinct, straight; mandible reddish with black tips; malar space absent; labial palps just reaching apex of extended glossa; maxillary palps reaching just beyond apex of extended glossa. *Mesosoma*—Hair short, white, dense, branched; propodeal triangle with several fine carinae basally, polished vertically; claws large with inner basal ramus; fore tibial spur with a few teeth; inner hind tibial spur with 8 long, fine teeth; basitibial plate densely covered in branched hair. *Metasoma*—Hair dorsally short, sparse; postgradular area with weaker sculpture than pregradular area; apical hair bands absent; tergal margins translucent; prepygidial fimbria white; hair white; pygidial plate flat, rough, broadly rounded apically; gradulus absent. *Male*—As for female except as follows: *Head*—Hair pale yellow, not appressed on supraclypeal area; flagellar segments F1–2 length less than or equal to width, F3–11 length greater than width; mandibles black with reddish tips; labrum arrow, strongly convex; beard sparse, white. *Mesosoma*—Legs brown, simple; hair long, pale yellow. *Metasoma*—Hair short, white; S3–4 with short, strong pale fringes; T7 shiny, clearly defined. For details of S7–8 and genitalia see figs 199–201.

### Notes

This species is distinguished from other species in this subgenus by females with long, branched, whitish hair on the metanotum, pygidial plate flat and metasoma without hair bands; males with scutal hair in males orange, basal area of propodeal triangle dull, slightly roughened; S3–4 with strong apical fringes; malar space essentially absent; metasoma orangish; black scape and legs simple.

*Etymology*—*Badius* is Latin for reddish referring to the orange red of the metasoma.

### *Goniocolletes ciliatus* sp.n.

#### Types

*Goniocolletes ciliatus*—South Australia: holotype ♀, 34 k S Wilpena, 4.i.1980, R.M. Bohart, off Eucalyptus blossom (UCD); paratypes, 3♀, same data as holotype (UCD, QM).

**Months collected:** January.

**Floral visitations:** Myrtaceae: *Eucalyptus*.

*Female*—Length ca 10 mm; head and mesosoma black; metasoma orange. *Head*—Facial fovea defined on all margins, more shallowly depressed on lower margin; vertex with small, dense, punctures; extends about 1 ocellar width behind upper eye margin; ocellocular area flat; scape reaching median ocellus, tapering basally; F1–10 length equal to, or less than width (female); antennal sockets not depressed or only shallowly so; supraclypeal area strongly raised above frons level, flat; clypeus at same level as supraclypeal level, flat; epistomal suture distinct, straight; labial palps just reaching apex of extended glossa; maxillary palps reaching just beyond apex of extended glossa; inner eye margin straight converging below; hair white, dense, appressed on paraocular area, simple on clypeus; supraclypeal area polished medially with a few sparse, simple hairs laterally; scape black; mandibles mottled red and black; malar space absent. *Mesosoma*—Hair off white; propodeal triangle slightly roughened basally, polished on vertical area; inner hind tibial spur with 8, long, slender, well spaced teeth; basitibial plate covered in dense, dark hair not obscuring marginal carina. *Metasoma*—Hair dorsally short, sparse; apical tergal hair bands present; gradulus weak; postgradular area with weaker sculpture than pregradular area hair white, short; pygidial plate flat, rough narrowly rounded apically. *Male*—Unknown.

### Notes

This species is distinguished from other members of this genus by females with ciliate hind tibial spur, metasoma with apical tergal hair bands, pygidial plate flat, metasoma orange and medial area of supraclypeus polished with a few simple hairs laterally.

*Etymology*: *Ciliatus* is Latin for ciliate referring to the inner hind tibial spur of the female.

## ***Goniocolletes colletellus* (Cockerell, 1905)**

*Paracolletes colletellus* \*Cockerell 1905c: 485; 1906: 29; 1934: 24.

*Leioproctus (Goniocolletes) colletellus* (Cockerell). Michener 1965: 66.

### **Types**

*Paracolletes colletellus*—Northern Territory: holotype ♂, Adelaide River (BMNH 17a. 431); paratype, ♂, same data as holotype (BMNH).

**Additional material examined:** 4♀, 11♂. **Queensland:** 7 miles (11.2k) W Charleville; 4 miles (6.4k) W Charleville; Dulbydilla Ck, 29k E Morven; 8 k W Cunnamulla. **New South Wales:** 80 k NE Wentworth. **Victoria:** 20 miles (32k) SE Mildura. **Western Australia:** Great Northern Highway, 9 k N Newman turnoff; 10 k E Carnarvon.

**Months collected:** January, November, December.

**Floral visitations:** Myrtaceae: *Eucalyptus camaldulensis*, *Eucalyptus floribunda*, *Eucalyptus largiflorens*, *Eucalyptus* spp..

*Female*—Length ca 10 mm, head and mesosoma dark brown to black. *Head*—Clypeus often mottled orange; mandibles orange with dark tips; facial fovea impressed, most strongly above, clearly defined all round; scape yellow, denudate; flagellum yellow ventrally, darker dorsally; hair appressed on supraclypeal area and clypeus; malar space length about 0.16 x width at the base of the mandibles, polished. *Mesosoma*—Propodeum often paler than surrounding area, legs pale orange; propodeal triangle with basal area clearly defined smooth to slightly roughened; inner hind tibial spur obscured by dense, fine branched hairs. *Metasoma*—Integument pale orange with occasional black patches; apical tergal margins translucent; T2–4 with short appressed apical and basal hair bands; T1 basally with moderately long, dense hair; caudal fimbria dense, pale brown; pygidial plate flat, rough, broadly rounded apically; gradulus indistinct. *Male*—As for female except as follows: Length ca 9 mm. *Head*—Malar space almost non-existent; entire face covered in pale yellow dense, appressed hair; long, white to pale yellow beard. *Mesosoma*—Legs simple, brown, with femoral-tibial joints yellow. *Metasoma*—Most with a definite black apex; hair bands weak; pygidial plate clearly defined triangular area; S3–5 with short, white sternal fringes; S5 fringe weak. For details of S7–8 and genitalia see figs 202–204.

## ***Goniocolletes comatus* sp.n.**

### **Types**

*Goniocolletes comatus*—South Australia: holotype ♂, Lake Gilles NP., 3.ii.1975, C.A. & T.F. Houston off *Eucalyptus* blossom (SAM).

**Additional material examined:** 9♀, 39♂ **South Australia:** Lake Gilles NP.; 7 k W Sherlock; 31 k N Pinaroo; Sherlock; 28 k NE Wirrulla; Ororoo; 20 miles (32km) NE Eucla. **Western Australia:** 1 miles (17.6 k) S Salmon Gums; Darling Range; Gnowangerup; Weebubbe Cave area, WNW.

**Months collected:** January, February, March, April, December.

**Floral visitations:** Myrtaceae: *Eucalyptus dumosa*, *Eucalyptus brachycalyx*, *Eucalyptus socialis*, *Melaleuca* spp..

*Female*—Length ca 11 mm. *Head*—Integument black with dark orange to black clypeus; vertex with small, dense, punctures; extends about 1 ocellar width behind upper eye margin; ocellular area flat; inner eye margin straight converging below; scape reaching median ocellus, tapering basally; hair white, densest on the lower paraocular area; scape almost naked, black; flagellum yellow beneath, black above; F1–10 length equal to, or less than width (female); antennal sockets not depressed or only shallowly so; supraclypeal area strongly raised above frons level, polished, flat; clypeus at same level as supraclypeal level, flat; epistomal suture distinct, straight; labrum basally strongly produced, apically flat; mandibles black, mottled orange medially; malar space smooth length about 0.16 width; labial palps just reaching apex of extended glossa; maxillary palps reaching just beyond apex of extended glossa. *Mesosoma*—Integument black; hair white; scutum glabrous posteriomedially; propodeal triangle with several fine transverse carina, basal area narrower than metanotum; midtibial spur long, slender; hind basitibial plate with dense, fine hair apparently not branched, not obscuring marginal carina; inner hind tibial spur with 6 long, slender teeth; hind basitarsus with posterior fringe of long branched hair, as well as a basal patch.

*Metasoma*—Integument orange, darker apical margins; caudal fimbria black; hair dorsally short, sparse; postgradular area with weaker sculpture than pregradular area; pygidial plate broadly rounded apically, flat, smooth. *Male*—As for female except as follows: Length ca 10 mm. *Head*—Integument black; hair yellow to orange, mostly appressed; F3–11 length greater than width; malar space almost obsolete; mandibles slender, strongly emarginate at base of preapical tooth; labrum shallowly convex with no distinct apical tooth; labrum shallowly convex with no distinct apical area; beard moderate length. *Mesosoma*—Hair dense, long, orange; legs black with coxae and trochanters orange; hind coxa with small, apical tooth; hind tibial spurs subequal. *Metasoma*—Integument black; hair long, orange; pygidium clearly defined laterally; S8 strongly projecting, thick laterally at apex; S3–4 very short, dense fringe. For details of S7–8 and genitalia see figs 205–207.

#### Notes

This species is distinguished from other species in this genus by males with black metasoma; simple, black legs with orange coxae and trochanters; scape black, and very short dense apical fringe on S3 & S4; females with median area of supraclypeal area polished with a few sparse hairs, basal area of propodeal triangle with several carinae, pygidial plate flat and metasoma without hair bands.

*Etymology*—Comatus is Latin for shaggy for the shaggy hair on the metasoma of the males.

#### *Goniocolletes dasypus* sp.n.

##### Types

*Goniocolletes dasypus*—South Australia: holotype ♂, 28 k NE Wirrulla, 7.iii.1976, C.A. & T.F. Houston, off *Eucalyptus* blossom (SAM); paratypes, 4♀, 5♂, same data as holotype.

**Additional material examined:** 16♀, 14♂ **Queensland:** 25 k E Bollon. **New South Wales:** 80 k NE Wentworth. **Victoria:** 19 k S Murrayville. **South Australia:** Lake Gilles NP; 40 k W Kimba; 4 miles (6.4 k) E Hartley; 31 k N Pinaroo; 48 k S Pinaroo; Meningie. **Western Australia:** Yellowdine; Dedari.

**Months collected:** January, February, March, December.

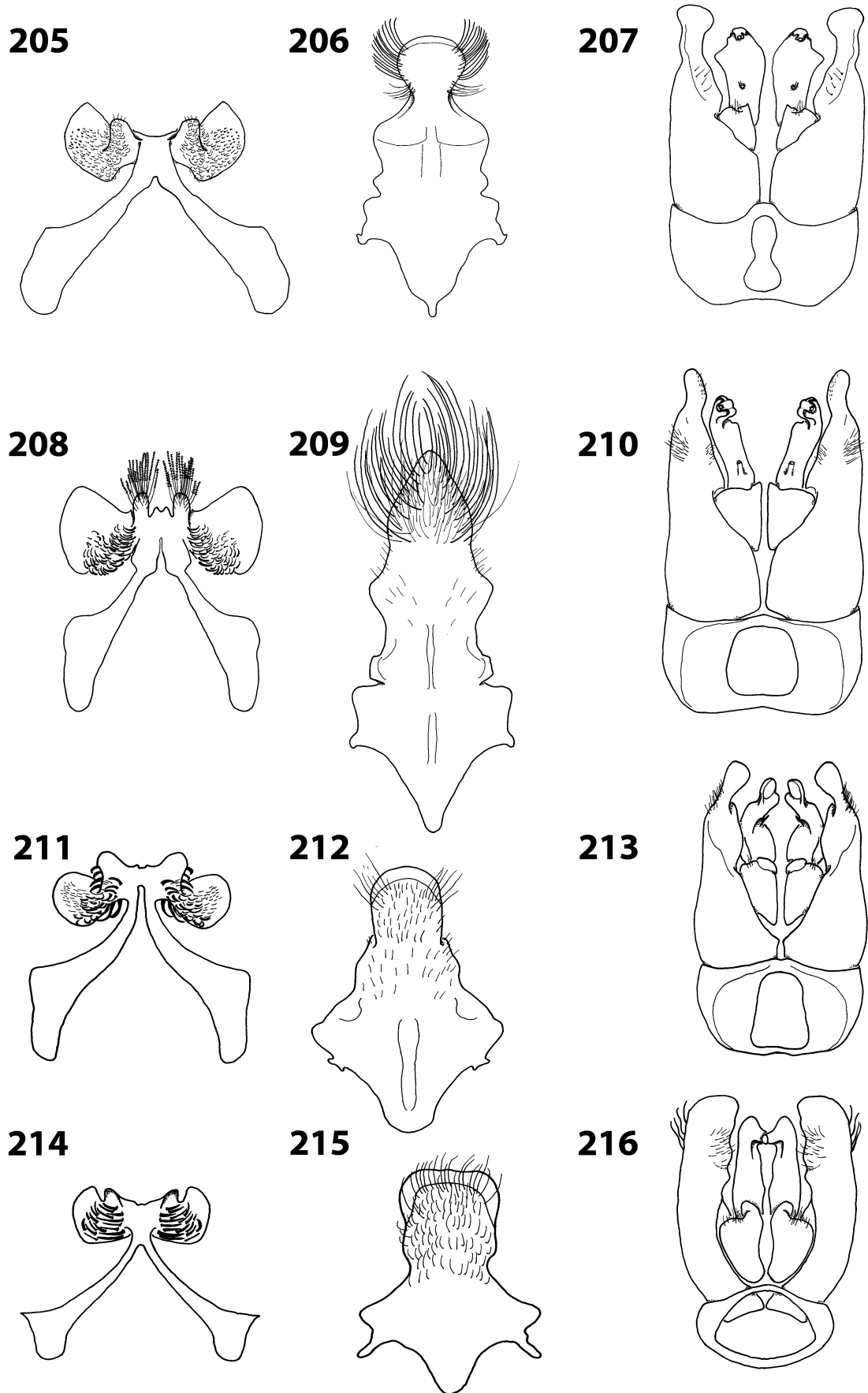
**Floral visitations:** Myrtaceae: *Eucalyptus* spp., *Angophora floribunda*.

*Female*—Length ca 12 mm; head and mesosoma black; metasoma orange. *Head*—Facial fovea clearly defined throughout; inner eye margin straight converging below; hair white, sparse on clypeus and supraclypeal area; vertex with small, dense, punctures; extends about 1 ocellar width behind upper eye margin; ocellular area flat; scape black; supraclypeal area polished medially with a few sparse simple hairs laterally; area strongly raised above frons level, flat; clypeus at same level as supraclypeal level, flat; epistomal suture distinct, straight; mandibles red with black base and tips; malar space narrow, polished, length 0.16 x width; labial palps just reaching apex of extended glossa; maxillary palps reaching just beyond apex of extended glossa. *Mesosoma*—Hair white; propodeal triangle smooth basally, polished vertically; short; claws large with inner basal ramus; fore tibial spur with a few teeth; inner hind tibial spur with 7 long, fine teeth; basitibial plate with dense, pale, branched hair, partly obscuring marginal carina. *Metasoma*—Apical tergal margins translucent, hair bands absent; hair white fine sparse; pygidial plate flat, rough, broadly rounded apically; prepygidial fimbria black; gradulus absent. *Male*—As for female except as follows: Length ca 11 mm. *Head*—Hair white; F1–2 length about equal to width; F3–11 length greater than width; mandibles black; labrum black, strongly convex; beard long, white. *Mesosoma*—Legs black, fore legs yellow anteriorly; fore leg simple, mid femur and tibia and hind femur swollen, mid tibia with apical tuft of hair obscuring spur. Hair of scutum and scutellum long, white to pale yellow. *Metasoma*—Hair long, fine white, shaggy; hair of S8 protruding; S3–4 with moderate length brown fringes; pygidium clearly defined, polished. For details of S7–8 and genitalia see figs 208–210.

#### Notes

This species is distinguished from other species in this genus by females with median area of supraclypeal area polished and covered with sparse simple hair; basal area of propodeal triangle polished; flat pygidial plate, and metasoma without hairbands; males with modified legs and mid tibial apex with a tuft of long, white hair obscuring the small tibial spur and hind legs simple.

*Etymology*—Dasys is Greek for hairy and pous is Greek for foot for the hair on the male mid tibia.



**FIGURES 205–216.** Male S7–8 and genitalia *Goniocolletes*. Figs 205–207 *G. comatus* S7, S8, genitalia. Figs 208–210 *G. dasypus* S7, S8, genitalia. Figs 211–213 *G. fimbriatus* S7, S8, genitalia. Figs 214–216 *G. fimbriatus* S7, S8, genitalia.

## ***Goniocolletes fimbriatus* (Cockerell, 1910)**

*Paracolletes fimbriatus* \*Cockerell 1910a: 202; 1934:26.

*Leioproctus (Goniocolletes) fimbriatus* (Cockerell). Michener 1965:66, figs 139–141.

### **Type**

*Paracolletes fimbriatus*—Victoria: ♂, holotype (BMNH 17a.443).

**Additional material examined:** 4♀, 18♂ **Queensland:** Rockpool Gorge, Bluff Ra. via Biggenden; 10 miles (16 k) W Charleville; 37 k W Warwick; 29 k E Texas; Amiens; Stanthorpe. **New South Wales:** Blue Mtns. **Victoria:** Melton; Boundary Ck Rd 33k W Cann River; East Rosanna; Collquhoun Sf, N of Lakes Entrance. **Western Australia:** Frank Hann NP, 56k E Lake King. **Northern Territory:** Barrow Creek.

**Months collected:** January, February, October, November, December.

**Floral visitations:** Myrtaceae: *Eucalyptus* spp., *Eucalyptus crebra*, *Eucalyptus camaldulensis*, *Leptospermum*.

**Female**—Length ca 11 mm. *Head*—Integument black; hair pale yellow to white, appressed; facial foveae impressed and distinct for entire margin; supraclypeal area punctate; malar space smooth length about 0.1 width; mandibles large, black reddish towards tip; basal area of labrum raised triangular. *Mesosoma*—Integument black; hair dense, short, orange, no bare area; propodeal triangle with basal area narrower than metanotum; basal area smooth; legs orange with black patches; midtibial spur long, slender; hind basitibial plate with moderately coarse, dense hair, not obscuring surrounding carina; inner hind tibial spur with 7 long, slender teeth; hind basitarsus with margin of short, branched hairs; anal area of forewing with microtrichia especially apically. *Metasoma*—Integument dark orange; hair orange, T1 with long, sparse branched hair T2–4 with short, white hair; caudal fimbria dense, pale brown; pygidial plate apically emarginate, medially convex with broad, flat margin. **Male**—As for female except as follows: Length ca 9 mm. *Head*—Hair yellow, very dense, appressed below antennal sockets; F3–11 length greater than width; mandibles slender; beard moderate length and density. *Mesosoma*—Hair long, dense, yellow; propodeal triangle with weak carinae above and below main strong transverse carina; tibia and tarsi orange with black patches. *Metasoma*—Hair long, moderately dense; pygidial clearly defined, triangular; integument black on apical segment; S3–4 with thick, apical fringe; S5 with a weaker fringe. For details of S7–8 and genitalia see figs 211–213.

## ***Goniocolletes fimbriatus* (Smith, 1879)**

*Leioproctus fimbriatus* \*Smith 1879: 6; Dalla Torre, 1896: 47.

*Paracolletes fimbriatus* (Smith). Cockerell 1905a: 348; 1934: 26.

*Paracolletes clarus* \*Rayment 1935: 669. **syn.n.**

*Leioproctus (Goniocolletes) clarus* (Rayment). Michener 1965: 66.

*Leioproctus (Goniocolletes) fimbriatus* Smith. Michener 1965: 66.

The holotype of *Paracolletes clarus* is female and shows no significant variation to that of *Leioproctus fimbriatus*.

### **Types**

*Leioproctus fimbriatus*—Australia, holotype ♀ (BMNH 17a.501).

*Paracolletes clarus*—Victoria: holotype ♀, Sea Lake, xii.1916, Gouldie (ANIC).

**Additional material examined:** 29♀, 6♂ **Queensland:** Angellala Creek, 23 k W Morven (26° 25' 146° 53'E). **New South Wales:** Barham; Cobar; Caldwell. **Victoria:** Hattah; Normanville; Ararat; Emerald; Cranbourne. **South Australia:** 1.5 miles (2.4 k) SE Mt Illbillee, Everard Reserve; 31 k N Pinaroo; 8 miles (12.4 k) SW Kimba; 0.5 k S Morgan Vale HS; Hartley; 4miles (6.2k) E Hartley; Sherlock; 7 k W Sherlock. **Western Australia:** 18 k S Cataby via Dandargan.

**Months collected:** January, March, April, October, November, December.

**Floral visitations:** Myrtaceae: *Eucalyptus* spp., *Eucalyptus angulosa*, *Eucalyptus socialis*, *Eucalyptus brachycalyx*.

**Female**—Length ca 12 mm; head and mesosoma black, metasoma orange. *Head*—Facial fovea strongly impressed on dorsal margin, weakly defined on ventral margin; supraclypeal and clypeus black to orange; hair white; mandibles dark red; malar space polished red, length about 0.25 x width; labrum with median ridge. *Mesosoma*—Integument black to dark orange; hair dense, pale brown; inner hind tibial spur with 5–8 thick, widely

space teeth; hind basitibial plate obscured by dense, moderately coarse, mostly unbranched hair; propodeal triangle with basal area smooth, narrower than length of metanotum, delimited by strong carina, vertical area mostly polished with dorsal lateral area roughened with weak lines. *Metasoma*—Integument pale to dark orange occasionally with black patches; hair sparse at most with weak, white hair bands on T3,4; caudal fimbria coarse, dense, black; apical margins translucent; gradulus weak; pygidial plate broadly rounded apically with convex median area, smooth but not polished. *Male*—As for female except as follows: Length ca 9 mm. *Head*—Malar space length about 0.2 x width of base of mandible; scape almost hairless; flagellum simple, yellow below, darker above; hair yellow mostly appressed below, above not appressed; long, white hair on lower gena. *Mesosoma*—Integument black, legs dark, orange tarsi. *Metasoma*—Integument orange with usually black apex to the metasoma and black patches; S3–4 with short white, apical fringe; pygidium often orange, lateral margins clearly defined, triangular. For details of S7–8 and genitalia see figs 214–216.

### ***Goniocolletes parvus* sp.n.**

#### **Types**

*Goniocolletes parvus*—South Australia: holotype ♂, 20 miles (32 k) NE Eucla, 21.i.1970, T.F. Houston, off *Eucalyptus oleosa* (SAM); paratypes, 5 ♀, same data as holotype (SAM).

**Additional material examined:** 3 ♀, 9 ♂ **Queensland:** 5km E Mt Isa. Victoria: 19km S Murrayville. **South Australia:** Ororoo; Mt Pleasant; Hartley; Sherlock; 6 k N Rendelsham.

**Months collected:** January, February, March, December..

**Floral visitations:** Myrtaceae: *Eucalyptus argillacea*, *Eucalyptus oleosa*, *Eucalyptus socialis*, *Eucalyptus brachycalyx*, *Eucalyptus* spp., *Melaleuca lanceolatum*; Scrophlariaceae: *Myoporum platycarpum*.

*Female*—Length ca 11 mm; head and mesosoma black; metasoma orange with dark patches. *Head*—Facial fovea clearly defined on upper margin, weakly defined on lower margin; vertex with small, dense, punctures; extends about 1 ocellar width behind upper eye margin; ocellular area flat; scape reaching median ocellus, tapering basally; F1–10 length equal to, or less than width; antennal sockets not depressed or only shallowly so; supraclypeal area polished, strongly raised above frons level, flat; clypeus at same level as supraclypeal level, flat; epistomal suture distinct, straight; mandibles red with black tips; malar space very narrow polished; hair white; scape black; supraclypeal area polished medially, with moderate length branched hair laterally. *Mesosoma*—Hair long, yellow to brown; propodeal triangle polished basally, with strong transverse carina; inner hind tibial spur with about 7, long slender teeth; basitibial plate black, thick hairs obscuring marginal carina. *Metasoma*—Hair dorsally short, sparse; postgradular area with weaker sculpture than pregradular area. *Male*—As for female except as follows: Length ca 9 mm. *Head*—Hair yellow appressed; F1 length about equal to width; F2–11 length greater than width; mandibles black with red tips; labrum polished, convex narrow; beard long, white. *Mesosoma*—Legs simple yellow with dark patches; hair yellow, long. *Metasoma*—Hair long, yellow to dark, sparse; fringes absent; pygidium clearly defined. For details of S7–8 and genitalia see figs 217–219.

#### **Notes**

This species is distinguished from other species in this genus by males with simple hind legs, black scape, and no sternal fringes; females with raised pygidial plate, metasoma without apical tergal hairbands and supraclypeal area polished medially.

*Etymology*—Parvus is Latin for little.

### ***Goniocolletes perfasciatus* (Cockerell, 1906)**

*Paracolletes perfasciatus* \*Cockerell 1906: 25; 1934:32.

*Leioproctus* (*Goniocolletes*) *perfasciatus* (Cockerell). Michener 1965: 66.

#### **Type**

*Paracolletes perfasciatus*—Western Australia: holotype ♀ (BMNH 17a.424).

**Additional material examined:** 18♀, 20♂ **Queensland:** 38 k E Cunnamulla. **New South Wales:** 80 k NE Wentworth; Caldwell. **Victoria:** 20 miles (32 k) SE Mildura; Lake Hattah; Normanville; 19 k S Murrayville. **South Australia:** 7 k W Sherlock; 0.5 k S Morganvale HS; Makaranka, Morgan; 7 miles (11.2 k), E Taylorville; Hartley; 6.5 k W Lameroo; 13 k S Geranium. **Western Australia:** 7 k N Wannoo; 13 k SE Dongara; 23 k S Mingenew.

**Months collected:** January, February, March, April, December.

**Floral visitations:** Myrtaceae: *Angophora floribunda*, *Eucalyptus largiflorens*, *Eucalyptus* spp., Mallee.

*Female*—Length ca 11 mm; head and mesosoma black; metasoma black. *Head*—Facial fovea clearly defined on all margins; mandibles reddish with darkened tips; malar space with length about 0.3 x width, covered in white hair; hair white, densely branched on paraocular and frons, simple on clypeus and supraclypeal area. *Mesosoma*—Hair white to off-white; propodeal triangle with basal area polished with a few carinae, vertical area with carinae dorsolaterally; inner hind tibial spur with about 7 long, slender teeth; basitibial plate covered in dense, dark branched hair, marginal carina obscured. *Metasoma*—Apical tergal margins translucent; strong white apical hair bands present on T2–4; prepygidial fimbria black; hair sparse, fine short, white; pygidial plate flat, rough, broadly rounded apically; gradulus weak. *Male*—As for female except as follows: Length ca 11 mm. *Head*—Hair yellow, appressed around marginal areas, erect medially; flagellar segments expanded on posterior surface, yellow except for dorsal black stripe; mandibles black, slender with reddish tips; labrum broad, shallowly convex, polished; beard, long, pale yellow. *Mesosoma*—Legs brown, with tarsi, anterior fore tibiae and hind tibiae yellow, mid trochanter with ventral projection; all femora, mid and hind tibiae swollen, basitarsi flattened, hind basitarsi broad; hair of scutum and scutellum pale yellow long, dense. *Metasoma*—Hair pale yellow; T1 with long, dense hair; T2–5 with pale, short hair; T2–5 with narrow apical hair bands, margins transparent; S2–4 with short, dense fringes; S6 with an apical tuft; T7 completely bare; S8 projects strongly. For details of S7–8 and genitalia see figs 220–222.

### ***Goniocolletes rugosus* sp.n.**

#### **Type**

*Goniocolletes rugosus*—Western Australia: holotype ♀, Balladonia, 1935, A.E. Baesjou (SAM).

**Additional material examined:** 2♀ **Western Australia:** Beelerup.

**Months collected:** February.

**Floral visitations:** None recorded.

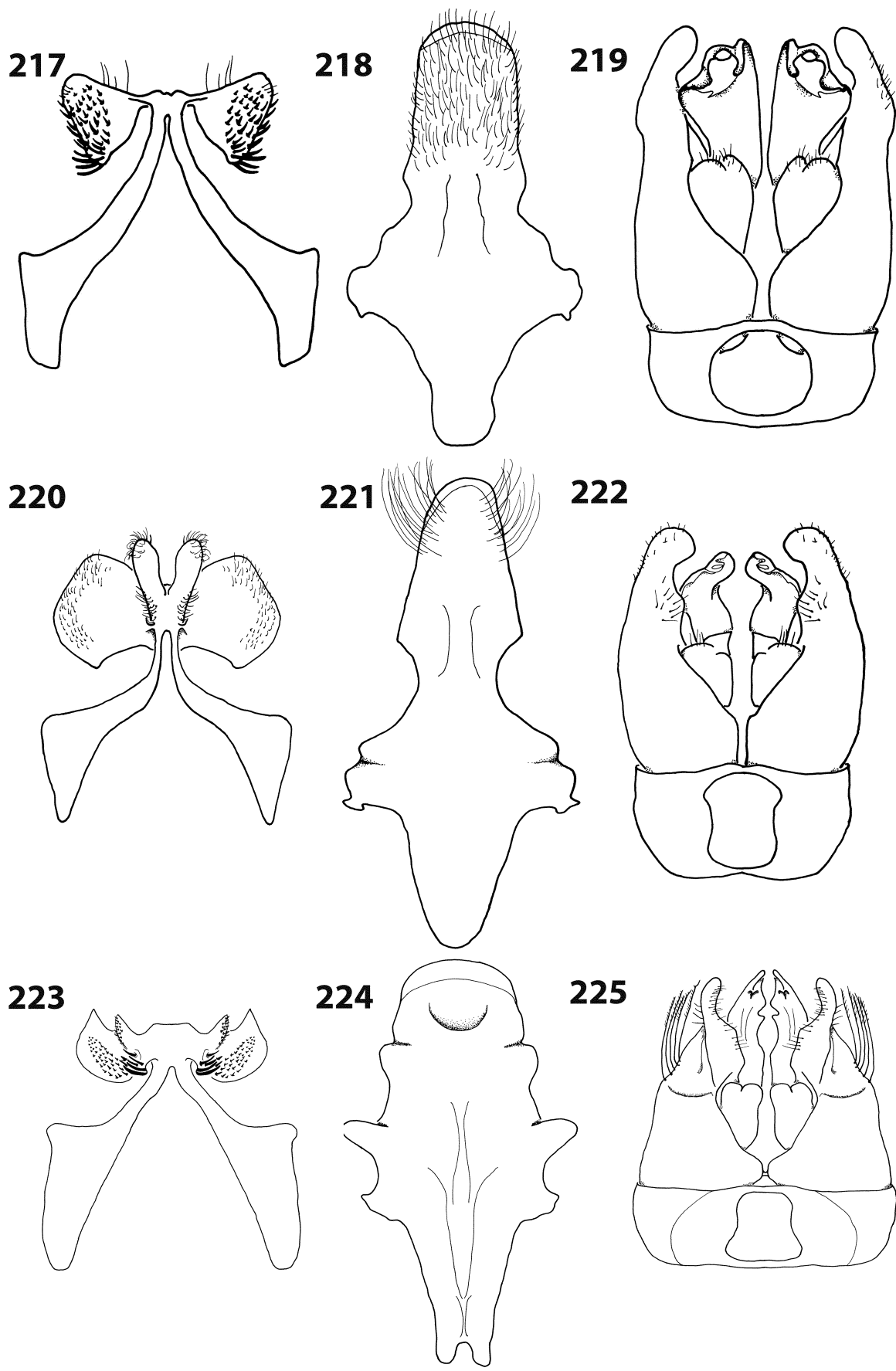
*Female*—Length ca 12 mm; head and mesosoma black with paler clypeus and supraclypeal area; metasoma orange. *Head*—Facial fovea poorly defined ventrally; vertex with small, dense, punctures; extends about 1 ocellar width behind upper eye margin; ocellocular area flat; scape reaching median ocellus, tapering basally; inner eye margin straight converging below; F1–10 length equal to, or less than width (female); antennal sockets not depressed or only shallowly so; supraclypeal area strongly raised above frons level, flat; clypeus at same level as supraclypeal level, flat; epistomal suture distinct, straight; hair white, dense on paraocular area and frons; moderately dense, simple on clypeus, branched on supraclypeal area; scape black, supraclypeal area punctate covered with moderately long branched hair; mandible dark reddish; malar space polished, length about 0.2 x width; labial palps just reaching apex of extended glossa; maxillary palps reaching just beyond apex of extended glossa. *Mesosoma*—Hair off white to pale brown; propodeal triangle rough basally with strong transverse carina; claws large with inner ramus basal; fore tibial spur with a few teeth; inner hind tibial spur with about 8 long, fine teeth; basitibial plate obscured by dense, dark, branched hair, marginal carina obscured. *Metasoma*—Hair bands absent; hair fine, sparse, white; pygidial plate strongly raised medially, broad, blunt apically; prepygidial fimbria black; gradulus absent. *Male*—Unknown.

#### **Notes**

This species is distinguished from other species in this genus by females with metasoma with pygidial plate raised medially; metasoma without hair bands; supraclypeal area punctate medially and covered in branched hair. Only known from 2 localities in southern Western Australia.

*Etymology*—Rugosus is Latin for skinny referring to the relatively slender metasoma of the females.





**FIGURES 217–225.** Male S7–8 and genitalia *Goniocolletes*. Figs 217–219 *G. parvus* S7, S8, genitalia. Figs 220–222 *G. perfasciatus* S7, S8, genitalia. Figs 223–225 *G. subdulus* S7, S8, genitalia

## ***Goniocolletes subdolos* (Cockerell, 1913)**

*Paracolletes fervidus subdolos* \*Cockerell 1913b: 279–280; 1934: 26.

*Paracolletes subdolos* Cockerell. Rayment 1949: 33–36.

*Leioproctus (Leioproctus) subdolos* (Cockerell), Michener 1965: 52.

*Leioproctus (Goniocolletes) dolosus* Michener 1965: 66, 256–257, figs 44, 56, 139–141, Plate 3 (1,2).

The holotype of *Leioproctus (Goniocolletes) dolosus* is male and is the same as those males associated with *Paracolletes fervidus subdolos* by morphological similarity and coincident collection data.

### **Types**

*Paracolletes fervidus subdolos*—Victoria: holotype ♀, Cheltenham, French (BMNH 17a.415).

*Leioproctus (Goniocolletes) dolosus*—Victoria: holotype ♂, Tooradin, 11.i.1946, O. Dawson (ANIC); paratypes, 1 ♀, Tooradin, 5.ii.1946, O. Dawson (ANIC); 1 ♂, Cranbourne, 15.i.1946, O. Dawson (ANIC).

**Additional material examined:** 7 ♀, 5 ♂ **New South Wales:** Blue Mts. **Australian Capital Territory:** Tidbinbilla; Black Mt. **Victoria:** Colquhoun State Forest, N Lakes Entrance; Seaforth.

**Months collected:** January, February, November.

**Floral visitations:** Myrtaceae: *Eucalyptus* spp.

*Female*—Length ca 12mm, head and mesosoma black, metasoma black with mottled orange patches. *Head*—Mandible black to dark red; facial foveae impressed strongly for the entire margin; hair yellow not appressed; scape black, flagellum brown, darker above; malar space length about a seventh width, polished. *Mesosoma*—Legs paler towards apices, densely haired; scutum and scutellum with dense, short golden hair; propodeal triangle with basal area slightly roughened, shorter than length of metanotum; defined by distinct transverse carina; mid tibial spur long, and slender; hind basitibial plate obscured by dense, fine branched hair; inner hind tibial spur with 6–8, widely spaced teeth. *Metasoma*—Hair bands absent; gradulus distinct only on T2–3; caudal fimbria very dense, and dark brown; pygidial plate apically emarginate, broad, with broad median convex ridge. *Male*—As for female except as follows: Length ca 12 mm. *Head*—Hair golden, dense, appressed; mandibles black; flagellum simple, black; hair of ventral gena yellow. *Mesosoma*—Scutum and scutellum covered with dense, long, golden hair; legs black except anterior fore tibia which is yellow; basal area of propodeal triangle very rough. *Metasoma*—Hair T1–7 long, orange and moderately dense; pygidial plate clearly defined, rounded apically, rough; S3–4 with apical fringe discontinued medially, hair longest laterally; S6 with median tuft of hair; S8 strongly protruding; for details of S7–8 and genitalia see figs 223–225. Known from coastal south eastern Australia rather than the drier inland like most of the other species in this genus.

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