

Two new and unusual species of the bee genus *Leioproctus* Smith (Hymenoptera: Colletidae), with notes on their behaviour

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Abstract

Two new species of *Leioproctus sensu stricto*, *L. excubitor* from Western and Central Australia and *L. macmillani* from south-western Australia, are described and figured. Males of both species have extraordinary antennae, *excubitor* having the first flagellar segment greatly attenuated as in stenotritid bees and *macmillani* having most segments highly setose and produced into lobes. Males of *excubitor* have other unusual modifications including a very broad highly depressed metasoma and spend much time perched upside-down on dead tree trunks. Both sexes of *macmillani* have the head peculiarly elongated, doubtless an adaptation to the tubular flowers of their winter-flowering food plant, *Astroloma xerophyllum*.

Introduction

Little is recorded of the ethology of the Australian species of *Leioproctus* Smith *sensu stricto* even though the subgenus is a large one with 126 nominal Australian species and possibly as many undescribed ones.

The two species described here, while not especially closely related, are both aberrant members of the subgenus. Their extraordinary features at first glance might suggest they should be placed in separate genera but closer inspection reveals their affinities with *Leioproctus s. str.* Their behaviour, too, is unusual and worthy of reporting. For these reasons, the species are described ahead of a much needed subgeneric revision.

Terminology and Abbreviations

The morphological terminology employed here follows that of Michener (1965).

Relative dimensions quoted in the descriptions are directly comparable between sexes and species. All were measured using an eye-piece graticule on a stereo-microscope with the zoom objective set to give a head width reading of 50 divisions. By doubling the figure for any given dimension, a percentage of head width is obtained. The methods of obtaining certain measurements were illustrated by Houston (1990) and abbreviations used for them are as follows: AOD Antennocular distance; ASD Diameter of antennal socket; BMW Basal width of mandible (viewed laterally); DMA Distance between anterior mandibular articulations; EL Length of compound eye (top to bottom); FL Flagellum length; FIL Length of first segment of flagellum; HL Head length; HW Head width; IAD Interantennal distance; LID Lower interorbital distance; ML Mandible length; MOD Diameter of median ocellus; MSL Malar space length; OOD Ocellocular distance; SL Scape length; SW Scape width; UFW Upper width of face; UID Upper interorbital distance; WOC Width of ocellar cluster.

LID, UFW and UID are not measurable in some instances when the inner orbits are strongly divergent ventrally or dorsally.

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Other abbreviations: ANIC Australian National Insect Collection, CSIRO, Canberra; HS homestead; TFH author's name; UQIC University of Queensland Insect Collection, Brisbane; WAM Western Australian Museum.

Systematics

Colletidae: Colletinae; Paracolletini

Genus *Leioproctus* Smith

Michener (1965) redefined the genus and its nominate subgenus and listed the species-level taxa which he assigned to them. In his notes, he made no mention of the sorts of extraordinary features which characterize the two species described in this paper although I am sure he would have done had the species been known to him. On this basis, I am confident in describing them as new.

Leioproctus (Leioproctus) excubitor, sp. nov.

Figures 1, 2

Holotype

In WAM (89/520), ♂, East Yuna Reserve, 34 km WNW of Mullewa, Western Australia, 24-26 August 1985, T.F. Houston 617-9, on wooden fence post.

Paratypes

27♂, 11♀ in ANIC; 1♂, 1♀ in UQIC; 12♂, 9♀ in WAM. See Specimens Examined.

Diagnosis

A black, non-metallic species readily recognizable by the following combination of features: first flagellar segment greatly attenuated, more so in male, equal in length to subsequent 3.5 segments (Figure 2 e, f); metasomal terga 2-4 (and 5 in male) with basal bands of white tomentum; metasoma of male markedly broadened and depressed, rather fusiform (Figure 1); fore basitarsi of male expanded dorsally and fringed with long setae (Figures 1, 2 h).

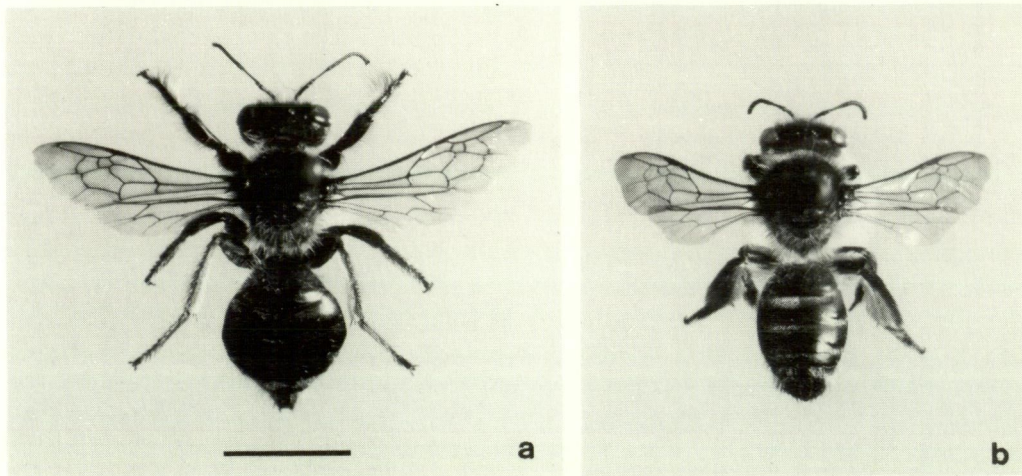


Figure 1 *Leioproctus excubitor*: (a) male and (b) female to same scale (line = 5 mm).

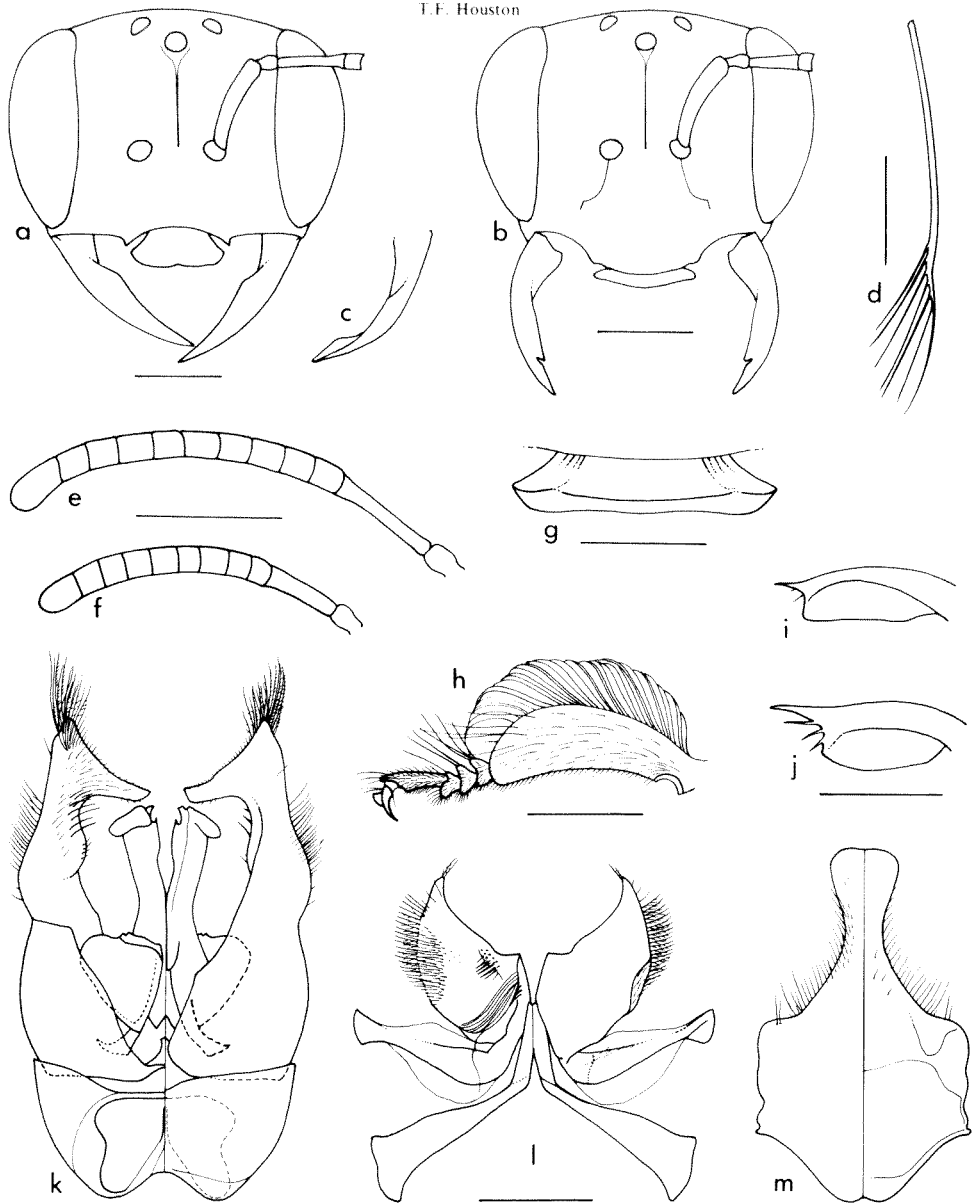


Figure 2 *Leioproctus excubitor*: (a, b) heads of male and female, respectively, anterior view; (c) mandible of male, inner view; (d) seta from outer side of hind tibia of female; (e, f) right antenna (excluding scape) of male and female, respectively, anterior view; (g) labrum of female, anterior view; (h) fore tarsus of male, inner view; (i, j) fore tibial calcar of male and female, respectively; (k-m) genital capsule, 7th and 8th metasomal sterna of male; dorsal view on right, ventral on left. Pubescence omitted in a-c, e-g. Scale lines (a-c, e, f, h) 1 mm; (d, i, j) 0.25 mm, (g, k-m) 0.5 mm.

Description

Male (holotype)

Head width 4.0 mm; body length 12 mm. Relative dimensions: HW 50; HL 35; UID 28; UFW 29; LID -; IAD 7; ASD 3.5; AOD 7; MOD 4; WOC 14; OOD 7; SL 14; SW 3; FL 40; FIL 10; ML 27; BMW 7; MSL 1.

Head form as in Figure 2 a; genae rounded, almost as wide as compound eyes viewed laterally; labrum rather flat, fringed ventrally with long simple bristles; mandible long, slender, simple (lacking subapical tooth), postero-apical margin twisted (Figure 2 a, c); proboscis ordinary; palpi well-developed, ordinary; maxillary palpus exceeding apex of galea; antenna slender (Figures 1, 2 e), first flagellar segment attenuated, about $\frac{1}{4}$ of length of flagellum, equal in length to succeeding 3.5 segments; middle segments about 1.2X as long as wide; terminal segment rounded and strongly compressed apically; propodeal enclosure with steeply sloping dorsal surface about as long as metanotum and rounding evenly onto vertical posterior surface with no separating edge or carina; venation ordinary; second submarginal cell of fore wing $\frac{2}{3}$ as long as third; femora stout; fore basitarsus twice as long as segments 2-5 together, swollen and convex anteriorly (Figure 2 h), slightly concave on inner surface; mid basitarsus strongly broadened and flattened; hind basitarsus straight and slender, 6X as long as high, slightly wider distally than proximally; segments 2-4 of fore and mid tarsi strongly contracted; fore tibial calcar with very short apical spine (Figure 2 i); metasoma strongly depressed, very wide, rather orbicular in dorsal view (Figure 1); third and fourth terga each with a longitudinal furrow margined laterally by a carina on each lateral margin.

Coloration. Integument almost wholly black, nonmetallic; labrum and diffuse areas of metasomal sterna and first tergum dark brown; flagellum mid-brown ventrally; wings lightly suffused with brown apically.

Sculpture. Integument generally finely coriarius; head and thorax dull, metasoma weakly to moderately shining; frons with open, small puncturing; vertex closely, minutely punctured; scutum, scutellum and metanotum like frons but puncturing sparse; propodeal enclosure dull, minutely roughened, with areolate posterolateral margins; metasomal terga with fine setigerous punctures concentrated basally, very sparse apically.

Pubescence. Lower face covered by long, silvery-white, plumose hair, completely obscuring integument; white plumose setae occur more sparsely on genae, posterior of head, mandibles laterobasally, scutum anteriorly, mesosoma laterally, ventrally and posteriorly, metasomal tergum 1, coxae and trochanters; metasomal terga 2-5 with rather diffuse bands of short silvery-white tomentum basally and very short, erect, simple, brown setae posteriorly; frons, vertex, scapes, scutum and scutellum with long, sparse, erect, sooty-brown setae; fore basitarsus densely fringed anteriorly with very long, silvery-white to brownish setae (Figure 2 h); fore femur largely bare ventrally with a regular longitudinal fringe of long black setae; fore and mid tibiae and basitarsi with sparse, simple, black setae on outer surfaces.

Terminalia. See Figure 2 k-m.

Female (paratype WAM 87/1441) Head width 3.45 mm; body length *ca.* 10 mm. Relative dimensions: HW 50; HL 40; UID 28; UFW 32; LID 32; MOD 3.5; WOC 13.5; OOD 7; IAD 6.5; ASD 4; AOD 9; SL 15; SW 2.5; FL *ca.* 30; FIL 7.5; ML 24; BMW 7; MSL 1.

Head form as in Figure 2 b; gena about 0.7X as wide as compound eye viewed laterally; vertex gently depressed between compound eyes and lateral ocelli; clypeus straight in profile, gently convex transversely; supraclypeal-interantennal area elevated, convex, somewhat triangular; antennae slender with first flagellar segment attenuated, about 1/4 as long as flagellum (Figure 2 f); mandible slender, bidentate, subapical tooth subtended by a deep incision; labrum very short with strong transverse carina separating concave anterior surface from flat bare ventral surface (Figure 2 g), postero-ventral margin fringed with simple bristles; proboscis and palpi ordinary as in male; propodeum as in male; fore tibial calcar as in Figure 2 j; inner hind tibial spur coarsely pectinate with 6 long, well-spaced teeth; legs ordinary; metasoma depressed but otherwise ordinary (Figure 1), 3rd and 4th terga with lateral furrows and carinae as in male; pygidial plate rounded apically, flat and granular dorsally; sting very stout and strongly compressed.

Coloration. Integument as in male but labrum black.

Sculpture. Much as in male; clypeus coarsely punctured, weakly shining; supraclypeal area with triangular, impunctate glossy area medially; propodeal enclosure with margins areolate only laterally.

Pubescence. Long, white, plumose setae occur on the following — lower face up to mid frons (dense laterally, sparse medially), posterior of head, scutum anteriorly and posteriorly, pronotal tubercles (densely), metanotum, ventral and lateral areas of thorax (except upper anterior mesepisternum), metasomal tergum 1 (except apically), terga 5 and 6 laterally and sterna 2-4 apically, coxae, trochanters and femora; sparse, long, erect, plumose, sooty brown setae occur on upper frons, vertex, scutum, metanotum and upper anterior mesepisternum; prepygidial fimbria dense, setae highly plumose, black-brown; metasomal pubescence otherwise as in male; fore and mid tibiae and all tarsi with dark brown setae; fore basitarsus with dense, fine, simple bristles on inner and ventral surfaces and coarse bristles along dorsal margin; hind tibial scopa moderately dense, composed of long, coarse, apically pectinate setae (Figure 2 d), setae dark brown except on ventral and posterior surfaces of tibia; hind basitarsus with long, plumose setae proximally and dorsally grading into simple bristles ventrally.

Variation

Minor. Head widths range from 3.5-4.0 mm in males (n 14) and 3.3-3.6 mm in females (n 10). Number of teeth on inner hind tibial spur of female ranges from 5-10 (n 20).

Remarks

L. excubitor belongs to a small group of closely related species none of which has been described until now. All inhabit the arid zone of Western Australia, are black, non-metallic, have the first flagellar segment elongated to some degree and the sting strongly compressed.

L. excubitor is by far the most unusual of these in respect of the following characters of the male: broad lower face; long, sickle-shaped mandibles; greatly attenuated first flagellar segment (occurs also in female); modified, fringed fore and mid tarsi; and very broad, highly depressed metasoma. It is unusual (although not alone) amongst bees in exhibiting reversed sexual size dimorphism (RSSD): males are larger than females whereas in most bees the reverse is the case. RSSD was recently reported in another species-group of *Leioproctus* (Houston 1990).

Attenuation of the first flagellar segment occurs in various members of several bee families but is rare in the Colletinae and is nowhere as pronounced as in *L. excubitor*. It is one of several morphological features characterizing bees which engage in fast hovering and darting flight (Rozen 1968) but *excubitor* does not exhibit such behaviour nor any of the other morphological features.

Etymology

The specific epithet is Latin for 'sentinel' and alludes to the perching habits of males.

Distribution

Arid and semiarid regions of southern Western Australia, extending from coastal areas between Geraldton and Carnarvon inland through the Gibson Desert to the ranges of Central Australia.

Specimens Examined

The holotype and the following paratypes. Western Australia: 2♂, 7♀ (WAM 87/1439-41, 89/514-9), same data as holotype but collected on flowers of *Comesperma scoparium* (1♂, 6♀) and *Acacia* (1♀) and on collector's net (1♂), UQIC, WAM; 1♂ (WAM 89/521), same data as holotype but collected 13-16 Sept. 1984, sitting on collector's trouser leg, WAM; 5♂ (WAM 89/524-8), 11 km ENE of Anketell HS (28.02 S, 118.51 E), 4-6 Sept. 1981, TFH, on flowers of *Eucalyptus oldfieldii* (2♂) and on trunks of dead mulga (3♂), UQIC, WAM; 1♀ (WAM 89/533), Balline Stn, 27.59 S, 114.13 E, 24-25 July 1979, A. M. & M. J. Douglas, WAM; 2♂ (WAM 89/529-30), Boolagoorda, 4 km NW of Hamelin HS, 5 Aug. 1982, B. P. Hanich, on wooden mast on hill, WAM; 1♀ (WAM 89/532), 5-7 km NW of Boolathana HS (24.39 S, 113.42 E), 27 Aug. 1980, C. A. Howard & TFH, on flowers of *Asphodelus fistulosus*, WAM; 26♂, Drummonds Cove nr Geraldton, Sept. 1972, N. McFarland, ANIC; 1♂ (WAM 89/531), NE end of Lake Throssell, 27.22 S, 124.21 E, 13 Sept. 1982, B. Hanich & TFH, on flowers of *Ptilotus*, WAM; 1♂ (WAM 87/1438), 10 km S of Nerren Nerren HS (27.08 S, 114.38 E), 19 Aug. 1980, C. A. Howard & TFH, perched on dead mulga branch, WAM; 1♂, 1♀ (WAM 89/522-3), 13 km S of Wannoo (26.49 S, 114.37 E), (♂, 28-31 July 1985, on flowers of *Dampiera incana* var *incana*; ♀, 21-23 Aug. 1985, on flowers of *Schoenia cassiniana*), WAM. Northern Territory: 3♀, 24.03 S, 133.37 E, 46 km SW by S of Alice Springs, 23 Sept. 1978, J. C. Cardale, ANIC; 1♀, 24.03 S, 133.59 E, 41 km S by E of Alice Springs, 4 Oct. 1978, J. C. Cardale, ANIC; 1♂, 7♀, 23.32 S, 133.38 E, Mt Solitaire, 30 km NW by W of Alice Springs, 29 Sept. 1978, J. C. Cardale, (1♂, 4♀) on flowers of *Ptilotus*, ANIC.

Leioproctus (Leioproctus) macmillani, sp. nov.

Figures 3 a-c, 4, 5

Holotype

In WAM (87/1452), ♂, Gngangara [State Forest], ca. 20 km NNE of Perth, Western Australia, 11 July 1982, R. P. McMillan, on flowers of *Astroloma xerophyllum*.

Paratypes

2♂, 1♀ in ANIC; 1♂, 1♀ in UQIC; 11♂, 6♀ in WAM.

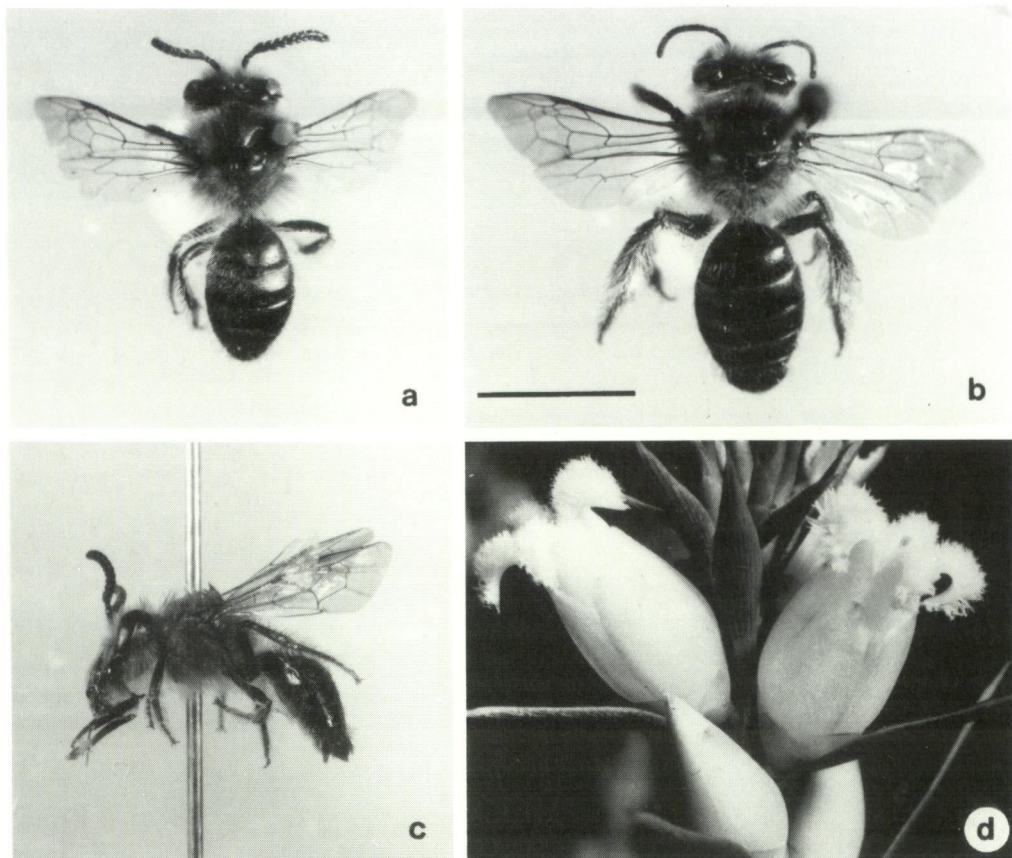


Figure 3 *Leioproctus macmillani*: (a, b) male and female, respectively, in dorsal view and (c) male, lateral view, all to same scale (line = 5 mm); (d) flowers of forage plant, *Astroloma xerophyllum*.

Diagnosis

Both sexes readily distinguishable by the extraordinarily long malar areas, about half as long as compound eyes (Figure 5 a-c); male with antennal flagellum complexly pectinate (Figure 4 a-c).

Description

Male (holotype)

Head width 3.1 mm; body length *ca.* 9.0 mm. Relative dimensions: HW 50; HL 46; UFW 33; LID -; DMA 26; MOD 3.5; WOC 13; OOD 10; IAD 7; ASD 4; AOD 10; EL 26; MSL 12; SL 15; SW 3.5; FL *ca.* 46; ML 21; BMW 6.

Head form as in Figure 5 a, b; gena *ca.* 0.6X as wide as compound eye viewed laterally; vertex slightly depressed between compound eyes and lateral ocelli; supraclypeal-interantennal area and clypeus strongly convex transversely, fairly straight in profile;

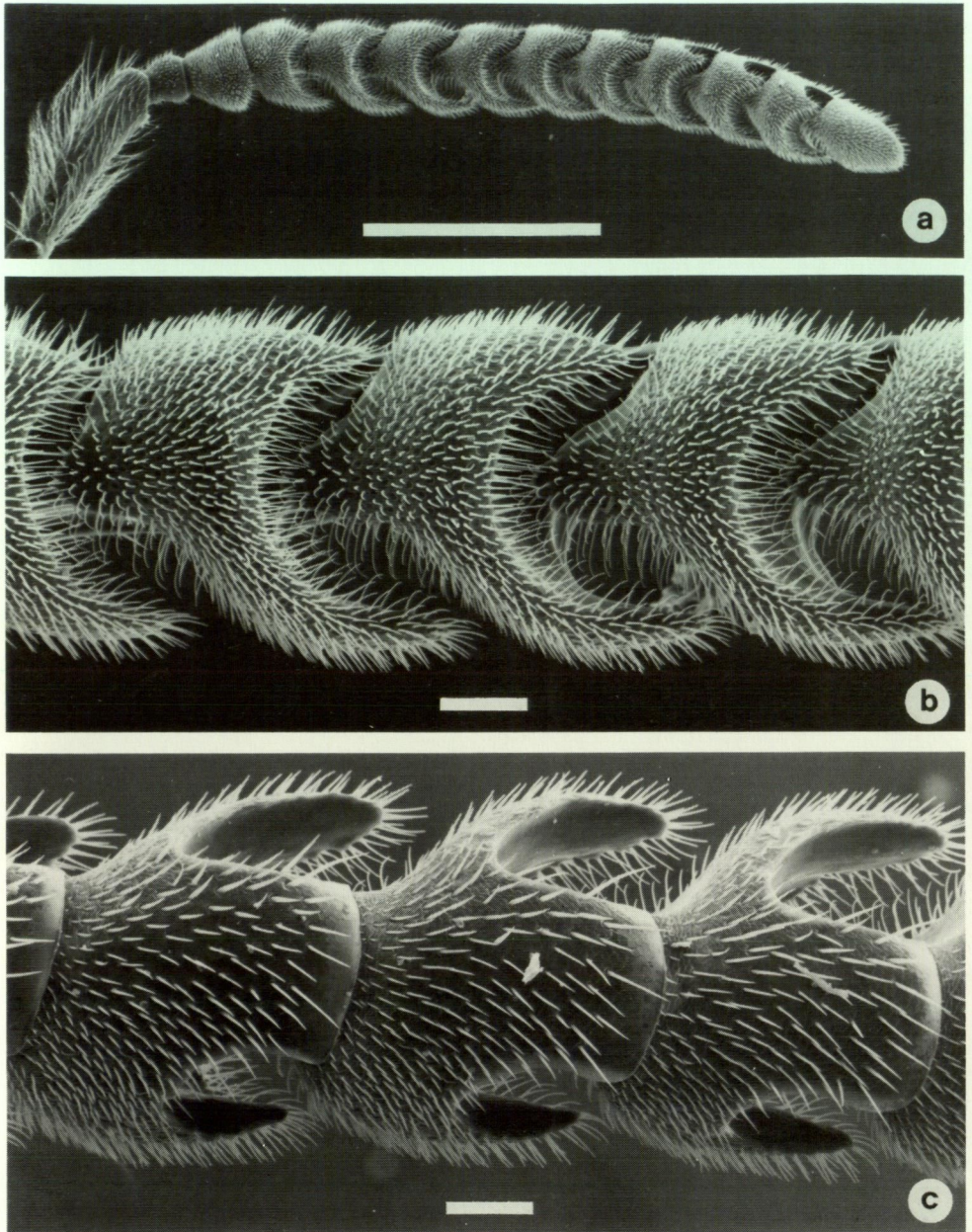


Figure 4 *Leioproctus macmillani*, antenna of male: (a) whole antenna, anterior view; (b) middle flagellar segments, anterior view; (c) same in dorsal view. Scale lines (a) 1 mm; (b, c) 0.1 mm.

labrum 0.8X as long as wide, ventral margin rounded, basal area strongly convex, smooth and bare, apical area flatter, minutely roughened and highly setose (much as in female, Figure 5 d); mandible slender, distinctly bidentate; proboscis elongate (Figure 3 c), prementum 0.56X as long as head width, annulate area of glossa separated from apex of prementum by about twice its own length; palpi well-developed, slender, ordinary; maxillary palpus attaining apex of galea; antennal scape slender, attaining mid ocellus; flagellum (Figure 4 a-c) almost as long as head width, extraordinarily modified, segments 2-10 each with a complex, somewhat cup-shaped ventral lobe projecting basally into concavity of preceding segment and produced apically into a small point anteriorly and a large prong posteriorly, segments 1 and 11 simpler but still lobed ventrally, all segments highly setose on outer surfaces, bare on inner surfaces; metanotum ordinary, not tuberculate although posterior margin bulges slightly; propodeal enclosure with steeply sloping basal area rounding imperceptibly onto vertical posterior surface; metasoma ordinary (Figure 3 a, c), first tergum with fairly abrupt anterior face deeply grooved medially and much longer than dorsal surface; venation ordinary; legs fairly ordinary, slender; fore basitarsus about as long as segments 2-5 combined with concavity of antenna cleaner unusually large (Figure 5 e); fore tibial calcar (Figure 5f) correspondingly large; hind basitarsus fairly straight, slender, *ca.* 8X as long as high.

Coloration. Integument predominantly black, metasoma faintly metallic blue-green except narrow apical margins of terga; labrum apically and mandibles largely orange-brown; inner surfaces of fore tibiae and all tarsi yellow-brown; flagella and wing veins dark brown; wings faintly brown-tinted.

Sculpture. Clypeus and supraclypeal area weakly shining with close, medium puncturing; frons and vertex minutely roughened and punctured, dull; malar areas and lateral margins of clypeus below tentorial pits impunctate, glossy; scutum and scutellum largely glossy centrally, setigerous punctures concentrated more peripherally; genae, thorax laterally and ventrally and propodeum (except enclosure) weakly shining, coriarius with open setigerous puncturing; propodeal enclosure coriarius, some weak transverse striae basally, posterolateral borders areolate; metasomal terga rather dull, foveate-imbricate (grading to imbricate on hind margins) with sparse, indistinct puncturing.

Pubescence. Frons, vertex, scapes, thorax generally, propodeum and legs proximal to apices of femora with moderately dense, long, erect, highly plumose, greyish-buff setae; similar but whiter setae occur on genae and metasomal terga 1 and 2; lower face with similar but shorter, more adpressed, white setae; ventrolateral areas of face also with several very long, blackish, erect, plumose bristles; malar areas bare; tibiae and tarsi with sparse, erect, simple and plumose setae; metasomal tergum 1 apically and terga 2-4 generally with erect, short, fine, simple setae intermixed with longer blackish bristles; terga 5-7 with long, blackish, plumose bristles; metasomal sterna sparsely setose, lacking conspicuous fringes.

Terminalia. See Figure 5 h-j.

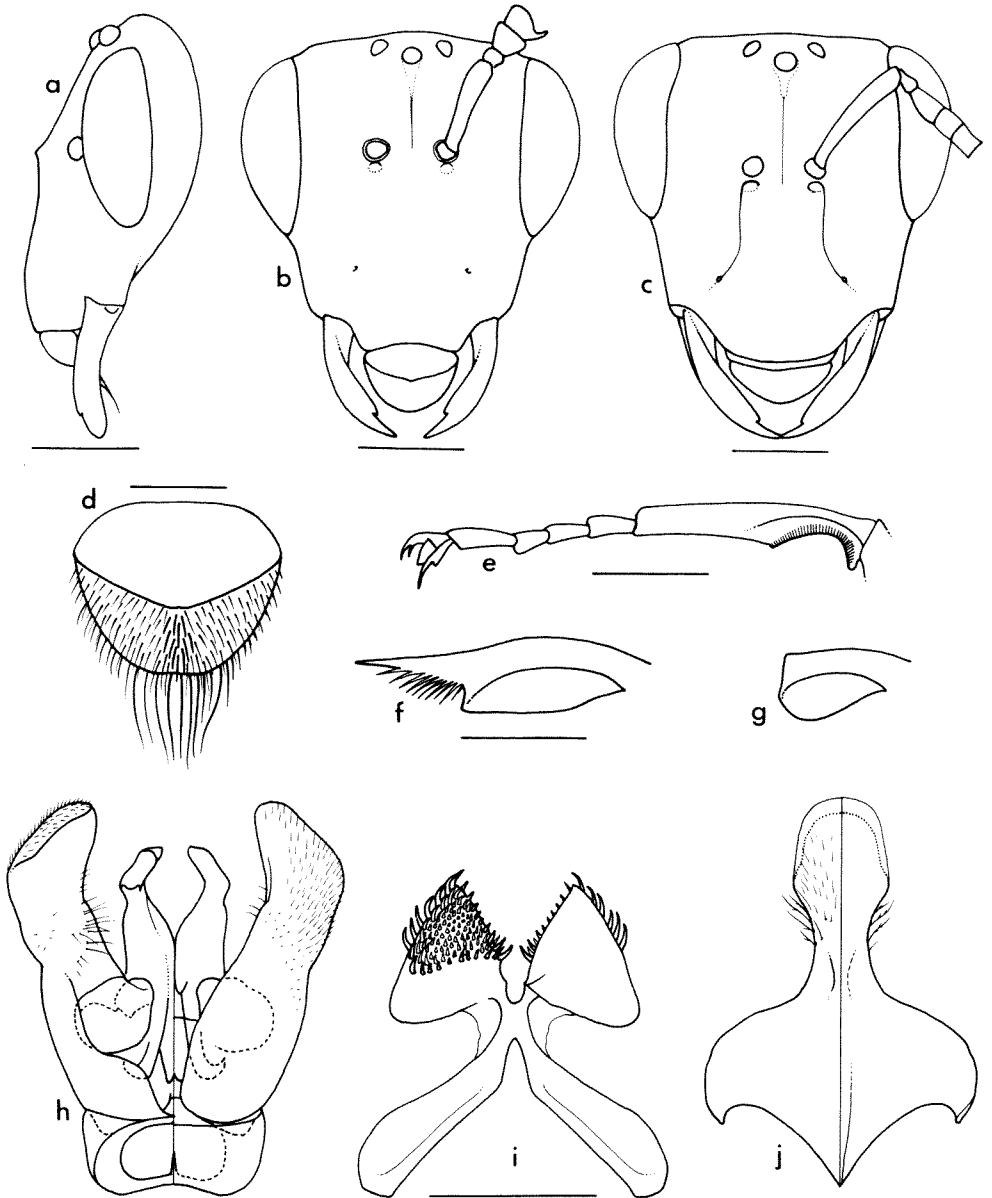


Figure 5 *Leioproctus macmillani*: (a) head of male, left lateral view; (b, c) heads of male and female, respectively, anterior view; (d) labrum of female, anterior view; (e) fore tarsus of male, inner view; (f, g) fore tibial calcar of male and female, respectively; (h-j) genital capsule, 7th and 8th metasomal sterna of male; dorsal view on right, ventral view on left. Pubescence omitted from a-c, e. Scale lines (a-c) 1 mm, (d, e, h-j) 0.5 mm, (f, g) 0.25 mm.

Female (paratype WAM 89/500)

Head width 3.55 mm; body length *ca.* 12 mm. Relative dimensions: HW 50; HL 48; UID 30; UFW 34; LID -; DMA 29; MOD 3.5; WOC 12; OOD 8.5; IAD 5; ASD 4.5; AOD 10; MSL 13; BMW 6.5; ML 25; SL 18; SW 3; FL 36.

Form (Figure 3 c) generally similar to that of male except as follows: head form as in Figure 5 c; flagellum ordinary, slender, first segment 1.5X longer than wide, segments 3-9 1.2X as long as wide, each slightly concave dorsally; prementum 0.72X as long as head width; fore basitarsus straight, slender, 5X longer than greatest width and 1.4X longer than remainder of tarsus, concavity of antenna cleaner occupying only about 1/5 of its length; hind basitarsus slender, *ca.* 5.5X as long as greatest height and 1.9X as long as remainder of tarsus; fore tibial calcar truncate (Figure 5 g); inner hind tibial spur with 5 or 6 slender teeth; pygidial plate notched at apex.

Coloration. As described for male but labrum wholly orange-brown; legs dark brown grading to yellow-brown more distally; hind tibiae yellow-brown.

Sculpture. As described for male except as follows: clypeus and supraclypeal area shining, closely to sparsely punctured; vertex weakly shining between ocelli and compound eyes; metasomal terga 2-4 with indistinct fine punctures grading from close anteriorly to sparse posteriorly; pygidial plate acinose centrally, smooth marginally.

Pubescence. As described for male except as follows: setae of legs chiefly golden but dark brown on outer (dorsal) surfaces of tibiae; fore basitarsus with dense, short, fine setae of inner surface contrasting with sparse, long, curved bristles of dorsal and outer surface (bristles on outer ventral edge especially thick); fore tarsal segments 2-4 also with long curved bristles; scopa of hind legs fairly sparse; metasoma with long, erect white setae, sparse on tergum 1, absent on remainder; terga 2-4 with sparse, short, white tomentum anteriorly (appearing silvery in oblique light); ventrolateral areas of terga and whole sterna (except basally) with long, plumose, golden setae; prepygidial fimbria sparse, of plumose blackish setae.

Variation

Slight. Head widths range from 3.1-3.3 mm in males (n 15) and 3.4-3.5 mm in females (n 8). Number of teeth on inner hind tibial spur of female varies from 5-8 (n 12).

Remarks

The unusually modified antennae of the male of this species are strikingly similar to those of male of *L. (Cladocerapis) bipectinatus* (Smith), the most notable difference being that *macmillani* lacks the sometimes forked or irregular finger-like processes arising from the smooth inner surface of each flagellar segment of *bipectinatus*. As females of *macmillani* possess stiff bristles on the fore tarsi, one of the diagnostic features of *Cladocerapis*, the possibility that *macmillani* should be assigned to that subgenus as a close relative of *bipectinatus* was considered. Certainly the species shares many characteristics with *Cladocerapis* species. However, it does not have the 'clypeus and supraclypeal area flat, at least partly smooth, shining and impunctate' as do *Cladocerapis* species (Michener 1965). Additionally, as far as is known, all species of *Cladocerapis* are oligolectic on *Persoonia* (Proteaceae). Consequently, I regard

macmillani as an aberrant member of the subgenus *Leioproctus* which has independently acquired some of the characteristics of *Cladocerapis* and *bipectinatus* in particular. In any event, as Michener (1965) noted, *Cladocerapis* is closely related to *Leioproctus sensu stricto*.

Etymology

The specific epithet is in honour of Mr R.P. McMillan, an honorary associate of the Western Australian Museum, who collected the first specimens and who has made a significant contribution to the Museum's entomological collections.

Distribution

South-western Australia on the coastal plain north of Perth and in the Jurien Bay—Leeman region.

Specimens Examined

The holotype and the following paratypes. Western Australia: 1♂, 1♀ (WAM 89/500-1), same data as holotype, WAM; 2♀ (WAM 89/512-3), Beekeepers Reserve, Eneabba-Leeman-Jurien area, 2-5 Sept. 1987, M. Lyons, WAM; 4♂, 3♀ (WAM 87/1453-4, 89/495-9), 11 km NE of Wanneroo, 18 July 1982, C.A. Howard & TFH, on flowers of *Astroloma xerophyllum*, ANIC, WAM; Melaleuca Park, 10 and 11 km NE of Wanneroo (6♂, WAM 87/1451, 89/502-6, 11 June 1984; 3♂, 2♀, WAM 89/507-11, 7 Aug. 1989), TFH, on flowers of *Astroloma xerophyllum* (5♂, 2♀) and *Andersonia heterophylla* (4♂), UQIC, WAM.

Observations and Discussion

Leioproctus excubitor

This species inhabits semiarid and arid regions. It exhibits no clear plant preferences, females having been collected from flowers of four plant species representing four families, males from a further three species and families. Both sexes have been collected from late July to late September.

Males are unusual in perching for prolonged periods on prominent erect dead sticks, wooden posts, poles and other slender vertical objects (twice I found males sitting on my trouser leg after I had stood still for several minutes). Males always perch on sunlit surfaces and face vertically downwards. They were observed to occupy sites for up to 2 hrs from mid morning to early afternoon (and may have occupied them longer).

When perched, males have the legs splayed, the wings folded and the abdomen slightly cocked.

Slender dead trunks of mulga *Acacia* trees which have lost all but the main branches and have no bark are common perching sites. Once I encountered two such trees each attended by three or four males at a time. Each bee flew to the base of the tree, then upwards as if inspecting the sunlit side of a main stem. It would then alight on the stem at a height of ca. 2 m, facing upwards and quickly turn 180° to face downwards, remaining settled for a few seconds to several minutes before taking off and repeating the manoeuvre on the same or an adjacent branch. The males occasionally circled one another in flight but no aggressive interactions were observed. The silvery-white facial hair of males is very conspicuous when they are in flight.

The function of this male perching behaviour is unknown. Most probably it is a mating strategy (lekking) but no male-female encounters were observed at perching sites or elsewhere.

Males sometimes (if not regularly) roost in borer holes in dead wood: one live and one dead dry male were found in a vacated borer's gallery in a dead dry branch of a mulga *Acacia* tree.

Leioproctus macmillani

This species is most unusual in terms of its morphology and ecology. First, it appears to be oligolectic on a single species of winter-flowering plant, *Astroloma xerophyllum* (D.C.) Sonder (family Epacridaceae). This is the only species on which females are known to forage. It grows as a low shrub on sand in *Banksia* heaths north of Perth and can be locally abundant. Its flowers are white (Figure 3 d). Males have been observed to patrol this species and to take nectar from the tiny white flowers of *Andersonia heterophylla* Sond. (Epacridaceae). Few other bees are active during June and July on the coastal plain north of Perth (between latitudes 30^o-32^o S) when *macmillani* reaches the peak of its activity. These months are characterized by the frequent passage of cold fronts from the Indian Ocean bringing heavy showers, strong winds and cool temperatures. Flight and foraging appear to be limited to intermittent fine, sunny days.

Second, the peculiar elongation of the lower part of the head below the compound eyes is unparalleled in the Paracolletini although similar or even more exaggerated elongation occurs in certain exotic halictid bees in the genera *Chlerogella* Michener and *Thrincostruma* Saussure (Michener 1978). The cephalic elongation in *macmillani* is

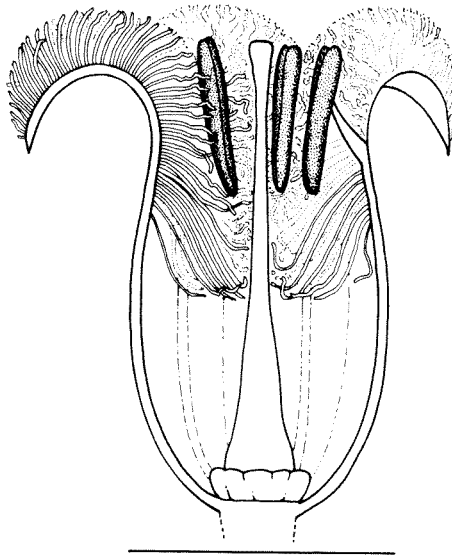


Figure 6 Flower of *Astroloma xerophyllum* (calyx and bracteoles omitted) with corolla tube sectioned to show internal structure. Scale line 5 mm.

associated with elongation of the proboscis and doubtless is an adaptation to the tubular flowers of the food plant. The corolla tube of *A. xerophyllum* is narrowed and densely bearded distally (Figure 6) and the small lumen is almost occluded by the style and anthers. Close observation of several foraging females revealed a consistent pattern of behaviour on flowers of *A. xerophyllum*. On alighting, a female thrusts her fore tarsi into the throat of the corolla and audibly vibrates her flight muscles. Then the fore legs alternately pump up and down drawing pollen out of the tube and the mid legs sweep it back to the scopa. Finally, the proboscis is extended and the female thrusts her head deep into the corolla tube to take nectar. A few times, females were observed to rotate about the long axis of the flower as they took nectar.

The use of vibration to aid pollen collection by bees is common on flowers with poricidal anthers. Bee vibration of non-poricidal anthers is comparatively rare but is recorded for plants having 'shaving brush' clusters of anthers (Buchmann 1985). Flowers of *A. xerophyllum* fit neither of these categories, having only five anthers dehiscing by means of longitudinal slits and wholly enclosed within the corolla tube (Figure 6). *Leioproctus macmillani* thus exhibits a novel variety of buzz pollination.

Third, *macmillani* is unusual in having most segments of the antennal flagellum of the male highly modified. The modifications result in a significantly increased area of plate organs and sensory hairs and may be adaptive in giving males a heightened olfactory sense. This could enable males to be more efficient at locating females by their scent, compensating for relatively lower temperatures and/or the scarcity of suitable flight periods. However, the existence of similar but even more ornate modifications of the antennal flagellum in males of *L. bipectinatus*, a summer-active species inhabiting coastal areas of eastern Australia, does not support this hypothesis.

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