

## **A new *Leioproctus* with unique wing venation in males (Hymenoptera: Colletidae: Paracolletinae) with comments on unusual wing modifications in bees**

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### **ABSTRACT**

*Leioproctus idiotropoptera* Packer, new species, is described on the basis of one male and two females from the Northern Territory, Australia. The male has modifications of the venation and setation of the forewing that are unparalleled among the bees and also possesses highly modified mandibles and fore- and midlegs. The new species does not fall easily into any of the presently named subgenera of *Leioproctus*, but, given the great need for revision of this group, an additional subgeneric name is not presented at this time. Some comments on unusual wing modifications in bees are made.

### **Key words:**

### **INTRODUCTION**

The colletid genus *Leioproctus* is diverse, speciose, and found primarily in Australasia and temperate regions of South America (Michener, 2000). Although it is divided into numerous subgenera, its systematics badly needs clarification. It seems highly probable that a global revisionary study will result in some subgenera being raised to generic status (as has already been suggested for some Australian groups by Maynard (1992, 1996)) and the sinking of others. This is especially true for the South American species and also the Australian ones with two submarginal cells: Australian species with three submarginal cells have been studied in detail by Maynard (1992).

The purpose of this paper is to describe a new species of *Leioproctus*, remarkable in the male for the secondary sexual modifications of the mandibles, legs, and especially the forewings.

## METHODS

Standard terminologies are used for descriptive morphology (Michener, 2000), and terms for the sting apparatus follow Packer (2003). The following commonly used abbreviations are incorporated into the descriptions: MOD for diameter of the median ocellus, UOD and LOD for upper interocular and lower interocular distances respectively, OOD and IOD for ocell-ocular and interocellar distances respectively. The relative diameter and spacing for punctures is given by  $d$  and  $i$  respectively, such as  $i < d$ , or  $i = 2d$ , for example. The apparent segments of the flagellum (antenna minus scape and pedicel) are referred to as flagellomeres and numbered 1 to 10 in the female, 1 to 11 in the male. Metasomal terga and sterna are denoted by T or S followed by a number. When the term abdomen is used, it is meant to refer to the metasoma plus the propodeum; similarly, when the term thorax is used, it refers to the mesosoma minus the propodeum.

Because the subgeneric placement of this bee remains uncertain (see discussion), the description includes characters that are known to vary among species within subgenera and species groups in addition to those that vary among Australian genera of Paracolletini, subgenera of *Leioproctus* (Maynard, 1992; Michener, 2000) and species groups of the nominate subgenus (Maynard, 1992).

The specimens had been preserved in 70% ethanol prior to drying and mounting. This resulted in some deformation of the forewings of the male. In order to photograph the flattened wing, the following procedure was adopted. The bee was relaxed to permit movement of the wing which was oriented between two square glass cover slips which were held in place adjacent to the bee by a piece of plasticene that was in turn held in place with entomological pins. The cover slips were approximated using fine forceps to flatten the wing.

***Leioproctus idiotropoptera* Packer, new species**

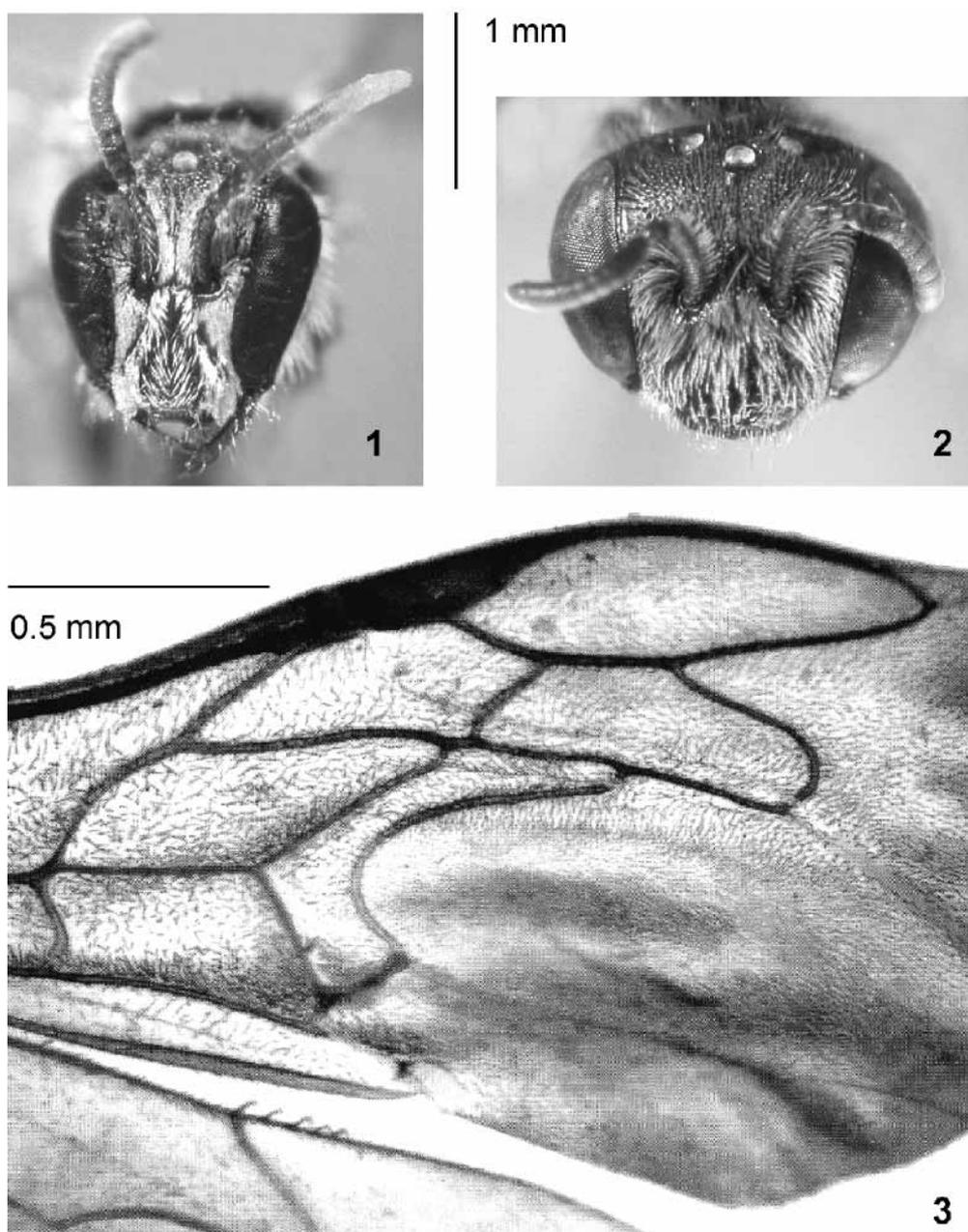
*Diagnosis:* Males of the new species can easily be differentiated from all other bees by the unusual modification of the forewings with the 2<sup>nd</sup> recurrent vein being deeply concave outwardly, at its closest, being separated from the first recurrent vein by only slightly more than two vein widths. The females are not so distinctive but the following combination of characters would seem to separate them from females of any other Australian *Leioproctus*: two submarginal cells, dorsal surface of propodeum distinct (although short), jugal lobe of hind wing extending well beyond vein cu-v and inner hind tibial spur pectinate with 5 long, narrow teeth.

**Description**

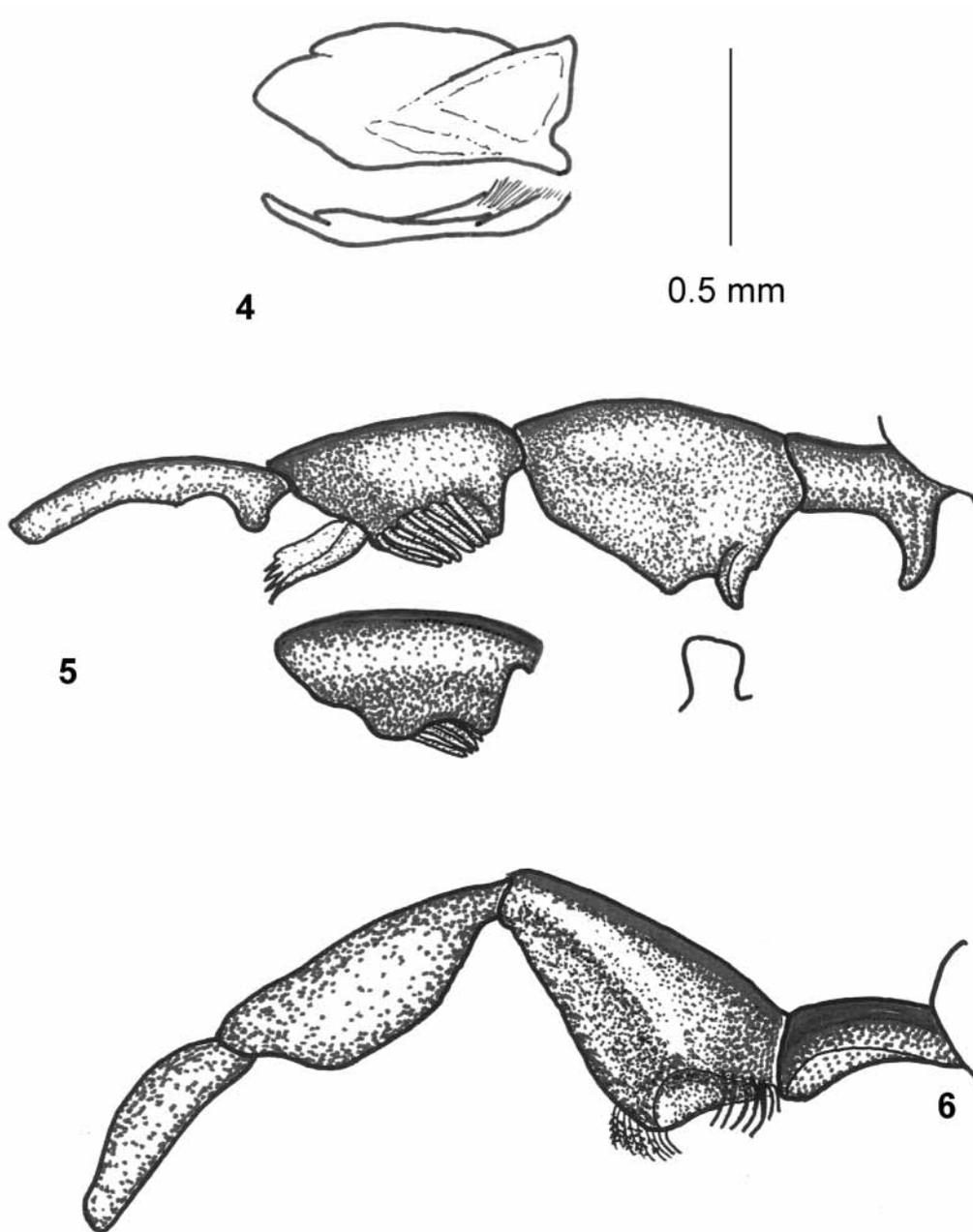
*Male:* Body length 6.3mm, forewing length 3.8mm, head width, 1.7mm.

*Colouration:* Black, lacking any areas of metallic colouration and yellow or red markings on metasoma; metasoma and legs dark brown; following parts testaceous:

mandibles (except basal  $\frac{1}{4}$  dark brown and apical margin reddish), anterior surface of flagellomeres 8–9 and all of flagellomeres 10–11 and apical impressed areas of metasomal terga; tegula and wing veins pale amber; forewing with complex pattern of dusky markings which also extends to some portions of wing venation (fig. 3).



**FIGURES 1–3** *L. idiotropoptera*, Fig. 1. Face of male, frontal view. Fig. 2. Face of female, frontal view. Fig. 3. Forewing of male.



**FIGURES 4–6** *L. idiotropoptera*, Fig. 4. Male mandible, outer and dorsal views. Fig. 5. Male foreleg from trochanter to basitarsus, outer view with inner view of tibia and basal view of femoral process. Fig. 6. Male midleg from trochanter to basitarsus, outer view.

*Pubescence*: white, with numerous short branches, appearing woolly especially on gena, areas of appressed golden hairs or tufts of dense pubescence are entirely lacking; labrum with apical row of strong setae  $\leq 2\text{MOD}$ ; hairs mostly matted on face of sole specimen, but erect, pale brown and moderately long ( $1.5\text{MOD}$ ) on vertex; genal beard

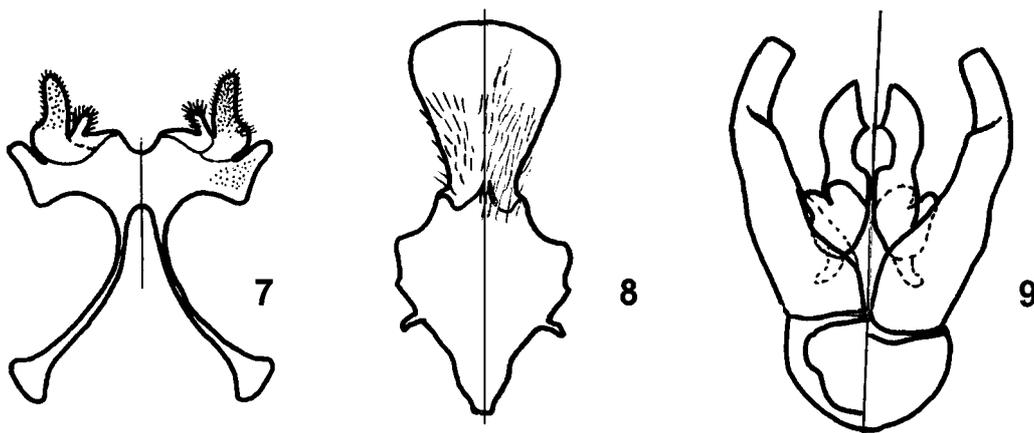
long, 2MOD throughout; anterior margin of mesoscutum, lateral margins of mesoscutellum, entire metanotum, dorsolateral portions of propodeum and anterior (declivous) surface of T1 with long hairs, 2MOD; rest of mesoscutum, mesoscutellum and propodeum with shorter hairs 1MOD; lateral surface of thorax with hairs of intermediate length, 1.5MOD; foretibia with double row of very robust, closely appressed, testaceous bristles, ~1MOD, 6 in inner row, 3 in outer row, bristles in each row converge apically; basal concavity of mesofemur with short row of curved, stiff hairs proximally, more normal, but similarly curved hairs on distal margin of concavity; mesotibia with dense tuft of apically directed hairs near base of tibial spur; hairs of forewing dense, dark and robust, of normal length except beyond apical cells where they are extremely short, hairs especially dense around first recurrent vein and towards apex of 2<sup>nd</sup> medial cell; disc of T1 with hairs strongly curved posteriorly, 1MOD anteriorly, becoming gradually shorter posteriorly to 0.5MOD; erect hairs on T2–4 short, 0.5MOD; those of T5 and T6 longer and suberect ~1MOD; terga with submarginal hair row of long, weakly branched hairs 1.5MOD; S3 and S4 with subapical row of dense, long, pale brown hairs, 1.5MOD, that completely obscure underlying integument.

*Surface sculpture:* surface shiny, microsculpture weak on head and abdomen, lacking on thorax; labrum impunctate; clypeus with dense, deep punctures,  $i \sim d$ ; supraclypeal area with longitudinal ridges; frons with dense, deep punctures,  $i \sim 0.5d$ , becoming sparser but larger on vertex; gena distinctly and irregularly punctate,  $i = 0.2-1d$ ; mesoscutum, mesoscutellum and lateral surface of thorax with punctures irregular in size  $i \sim d$ ; metanotum densely punctate; ventral surface of thorax almost impunctate; dorsal area of propodeum reticulate, posterior surface punctate,  $i \sim d$ , lateral surface with smaller, more widely spaced punctures  $i > d$ ; metasomal terga distinctly punctate,  $i < d$  on disk of T1 with punctures becoming smaller and less dense posteriorly both on each segment and among segments; apical impressed areas narrowly impunctate.

*Structure: head:* length and width equal, but due to widest point being just below median ocellus, appearing somewhat elongate; glossa not deeply bilobed, labial palps 4 segmented, maxillary palps 6 segmented; labrum 3.5 times broader than medial length, with apical margin of basal box concave, sharply set off from narrow marginal area; mandible very deep, depth at midlength almost half maximum length (17:40), but thin and comparatively flat; clypeus longer than broad (36:26), somewhat protruding with longitudinal ridge parallel to epistomal suture laterally, these ridges extending onto supraclypeal area where they meet; epistomal suture separating clypeus and supraclypeal area poorly defined; supraclypeal area with median narrow ridge; subantennal suture as long as diameter of antennal socket; malar space entirely absent; compound eyes strongly converging below UOD:LOD 60:40; OOD=IOD; ocelli at summit of vertex; facial fovea a long narrow groove close to upper inner eye margin; hypostomal carinae strongly developed into diverging flanges; breadth of gena less than that of compound eye (24:28); scape slightly more than three times as long as greatest breadth, not extending beyond  $\frac{3}{4}$

distance to lower margin of median ocellus; pedicel and F1 slightly shorter than broad, dorsoventrally flattened, F2 almost twice as broad as long, remaining flagellomeres slightly longer than broad, apex of F11 conical.

*Mesosoma*: dorsal surface of pronotum poorly developed, lacking horizontal collar, but with anterior declivous portion more horizontally oriented than usual; anterior portion of mesoscutum strongly raised above level of pronotum; mesoscutum broader than long (67:60); mesoscutellum very large, fully half as long as mesoscutum; metanotum half as long as mesoscutellum; dorsal surface of propodeum slightly longer than metanotum; metanotum strongly convex but not markedly produced; ventral surface of thorax concave; fore- and midlegs highly modified as follows: foretrochanter with elongate beak-like ventral projection; forefemur short and deep with strong basal projection truncate in apical view, with semicircular concavity beyond projection and rounded convexity beyond; foretibia short and robust with bigibbous ventral surface, cavity between convexities bearing two rows of strong bristles; forebasitarsus somewhat dorsoventrally flattened, remaining foretarsomeres unmodified; mesotrochanter long and narrow, length 3 times median depth; mesofemur swollen just basal to midpoint, almost triangular with transverse basal concavity; mesotibia swollen ventrally; mesobasitarsus robust, slightly curved; hind leg robust but otherwise unmodified, two hind tibial spurs, inner spur ciliate, half as long as basitarsus; basitibial plate entire, defined by strong carinae, with a few, fine, simple hairs; tarsal claws with strong inner tooth; arolia present; stigma half as long as marginal cell; marginal cell with apex rounded and separated from costal margin by three vein widths; basal vein at an angle of less than  $30^\circ$  to costal margin; 2 submarginal cells; first recurrent vein slightly basal to first submarginal cross-vein; 2<sup>nd</sup> recurrent vein very long and strongly outwardly concave, arising near middle of second submarginal cell; Cu1 reduced in length to accommodate development of 2<sup>nd</sup> recurrent vein; jugal lobe of hind wing 4/5 as long as vannal lobe.



**FIGURES 7–9** *L. idiotropoptera*, Fig. 7. S7 of male, dorsal view on left, ventral view on right. Fig. 8. S8 of male, dorsal view on left, ventral view on right. Fig. 9. Genital capsule of male, dorsal view on left, ventral view on right.

*Metasoma*: broadest at second segment, gradually tapering posteriorly; first segment large with anterior (declivous) surface longer than dorsal horizontal portion; pygidial plate not defined by ridges or carinae but apicomedial portion of T7 glabrous; S7 with 4 apical lobes but seemingly with 6 due to bifid nature of apical lobe with inner portion of this lobe narrower than its outer one; anterior lobe broad and flat with posteriorly oriented apical angulation; S8 with lateral lobes very short, anterior apodemes elongate and apical process broad, narrowed towards base, strongly hirsute, with apex somewhat rounded and membranous; gonobase long,  $\frac{3}{4}$  as long as greatest width, gonostylus long, well sclerotised, and slightly medially oriented.

**Female**: as in male except for usual secondary sexual characteristics and as follows:

*Colouration*: antennal flagellum with anterior surface of annuli 4–10 pale orange; wing veins uniformly testaceous; tegula somewhat darker than in male; apical impressed areas of metasomal terga paler.

*Pubescence*: somewhat shorter than in male except on dorsolateral portion of propodeum, 3MOD, and metasomal sterna which bear long, branched scopal hairs >4MOD on S2 and S3, 3MOD on S4 and 2MOD on S5; hind leg with long scopal hairs, up to 3MOD on coxa and trochanter, up to 4MOD on femur and tibia, these hairs branched on one side only; all hairs whitish except on dorsal margin of hind tibia where they are dark brown.

*Surface Sculpture*: finer, more even in size and density than in male,  $i \leq d$ ; punctures shallower and somewhat effaced on lateral surface of mesosoma; dorsal surface of propodeum with irregular longitudinal striae.

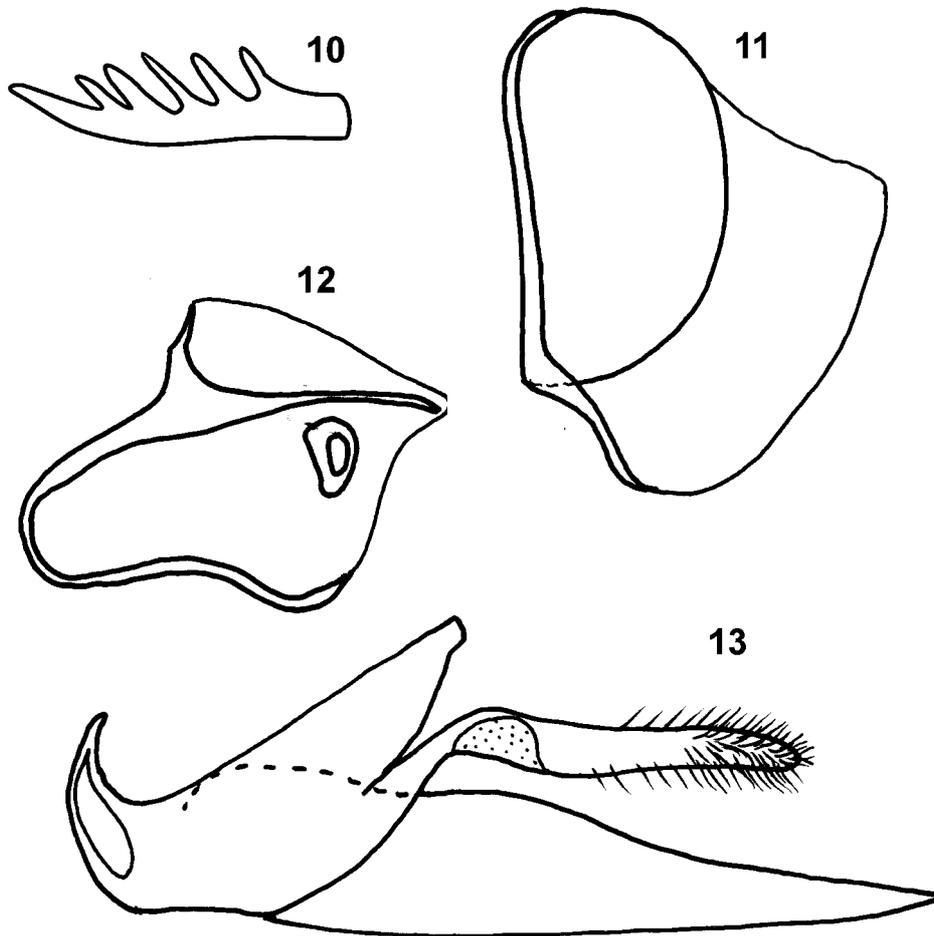
*Structure: head*: broader than long (58:47); glossa deeply bilobed; labrum more than 4 times as broad as medial length; mandibles unmodified; clypeus with distinct apical rim, evenly rounded, lacking lateral ridge, length to breadth 30:49; epistomal suture clearly separating clypeus from supraclypeal area; compound eyes less convergent below, UOD:LOD 36:30; facial fovea not impressed, represented by broad shiny area almost devoid of punctures; gena one-third as broad as compound eye; hypostomal carina not unusually developed but divergent; scape not attaining median ocellus; flagellomeres broader than long except F1 and F10 with length and breadth subequal;

*Mesosoma*: mesoscutellum normal in size, one-third length of mesoscutum; dorsal surface of propodeum shorter than in male, subequal in length to metanotum; wings and legs unmodified, hind tibial spur with 5 long, narrow teeth;

*Metasoma*: with well developed pygidial plate; apical margin of S6 narrowly and shallowly concave;

*Sting apparatus*: 7<sup>th</sup> hemitergite with median portion of marginal ridge outwardly concave, lateral portion of ridge somewhat divergent, hemitergite somewhat expanded posteriorly, posterior margin sinuate, lateral process short, at slightly obtuse angle to lateral portion of marginal ridge basally, somewhat posteriorly curved, spiracle closer to lateral ridge and apical margin of lamina spiracularis than its shortest diameter; 8<sup>th</sup>

hemitergite with apodeme deeply semicircular, body of plate strongly shifted medially in comparison to apodeme with apodeme extending laterally beyond plate for  $\frac{1}{4}$  of its length and plate extending beyond apodeme medially for  $\frac{1}{3}$  of length of plate; first valvifer triangular with ventral angle much longer than dorsal one; second valvifer with postarticulatory portion of anterior ridge slightly convex, apodeme shallowly semicircular, incisura postarticularis parallel-sided, pars articularis weakly expanded in comparison to rostral process; gonostylus digitiform without transverse membranous region with setae denser towards apex and equal in length to subapical diameter of gonostylus; furcula Y-shaped with dorsal and ventral arms subequal in length; sting shaft with basal bulb strongly swollen, dorsal margin of bulb concave, ventral margin of shaft weakly curved dorsally.



**FIGURES 10–13** Fig. 10. Inner hind tibial spur of female. Fig. 11. Hemitergite 7 of female. Fig. 12. Hemitergite 8 of female. Fig. 13. Sting shaft and second valvifer of female, the second valvifer is foreshortened from the perspective of this drawing.

*Etymology:* The specific name combines idiotropos, Greek for bizarre or whimsical, with ptera, from pteron: wing. The name refers to the unusual form of the forewing of males.

*Material studied:* holotype male, allotype and one paratype female: AUSTRALIA, N[orthern] T[erritory]; Litchfield National Park, 20.i.1998, A. Zwich. All three specimens are in good condition, although the male is missing the left hind wing, the right foreleg is glued to the pin separately beneath the rest of the body, the hairs are somewhat matted in places, and a muddy substance covers much of the lower portions of the pronotum. The holotype and allotype are to be housed in the CSIRO collection, Canberra, Australia, the paratype female will remain in the authors collection but will be bequeathed to CSIRO.

## DISCUSSION

The genus *Leioproctus* is very diverse and is currently divided into 32 subgenera; 15 found only in Australasia and 16 only in South America while one, the nominotypical subgenus, is found on both continents (Michener, 2000). The group badly needs revisionary study on a global scale, as has been begun for the Australian taxa (e.g. Maynard, 1992, 1997).

*Leioproctus idiotropoptera* is a distinctive new species that does not readily fall within any of the currently named subgenera of *Leioproctus*. In using Michener's (2000) key to Australasian subgenera, it fails to key out at couplet 4 because it has the long jugal lobe of the first half of the couplet (that leading to the subgenus *Coletellus*) but the females have the inner hind tibial spur of the second half of the couplet (leading to the subgenera *Filiglossa* and *Euryglossidia*). The species clearly lacks the highly apomorphic mouthparts of *Filiglossa* however, and most species of *Euryglossidia* are comparatively impunctate, which is certainly not the case for *L. idiotropoptera*.

Maynard (1992) revised Australian *Leioproctus* with three submarginal cells, raising some subgenera to generic status (e.g. Maynard, 1996, 1997). While some other bee genera have two and three submarginal celled taxa that are closely related, she states that this is not the case with Australian *Leioproctus* as other morphological features suggest that the two groups form different cohesive subsets within the genus. Nonetheless, there remains one species that is polymorphic for this character—*L. (Leioproctus) abnormis* (Cockerell) (Michener, 2000). Consequently, I attempted to key out the new species as if it had three submarginal cells using both Michener (2000) and Maynard (1992). The species could not be easily categorized using either key and it failed to match the diagnoses given for any of the subgenera it came closest to using Maynard (1992). Consequently, I am confident that this species does not fall within any of the currently named subgenera of *Leioproctus*. Nonetheless, given the uncertain status of even generic level units within the genus, description of another subgenus for this highly autapomorphic species seems premature.

Unusual wing modifications are not very common among bees (Danforth, 1989; Danforth and Michener, 1988), although wing vein reduction is a synapomorphy for the Meliponini (Michener 1990) and is also found, albeit in a very different form, in some very small bees such as *Euryglossina*, *Perdita* and *Neolarra* (Michener, 2000). Michener (1942) described the andrenid *Calliopsis anomoptera* Michener in which the male forewing is very strongly falcate (see Michener, 2000, fig. 57.6, p. 299). Slightly falcate wings are found in males of some species of other subgenera of *Calliopsis*. The allodapine *Allodape mirabilis* Schulz has a highly modified forewing venation as part of numerous secondary sexual characteristics found in its male (Michener, 2000). In this species the costal margin is bowed anteriorly, most strongly towards the apex of the stigma, and the posterior margin of the marginal cell is strongly developed posteriorly such that the 1<sup>st</sup> submarginal cross-vein is almost absent (see Michener, 2000, figure 88-7a). Among the Halictidae, two of the three subgenera of *Thrincostruma* have unusual patches of dense hairs around the second submarginal cross-vein (Michener, 1978). The wings of the colletid genus *Eulonchopria* are longitudinally folded as part of the close mimetic resemblances exhibited between these bees and epiponine wasps (Danforth and Michener, 1988). Neither of the last two modifications are limited to the male sex however. The wing modifications of *L. idiotropoptera* are different from all of these. Superficial observation of the surface of the wing reveals, in addition to the highly modified apical venation and mottled colour pattern, strong variation in setation. The setae on the cells of the forewing are mostly denser and more robust than in the female. They are particularly dense and also somewhat elongate around the first recurrent vein and towards the apex of the second cubital cell and approach the appearance of the modified wing hairs of *Thrincostruma* in these areas. The region beyond the cells of the forewing possesses mostly very short, but still dense, setae. The setae are especially short in the area that would normally be part of the second medial cell if it were not for the basally curved 2<sup>nd</sup> recurrent vein. That the wing modifications of the sole male of this species do not result from a developmental aberration is indicated by their perfect bilateral symmetry. It would be of interest to watch male female interactions in this species to see if these wing modifications have courtship significance.

#### ACKNOWLEDGEMENTS

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