

## REVISION OF THE GENUS *CRASSIFOENUS* CROSSKEY (HYMENOPTERA: GASTERUPTIIDAE), WITH A DESCRIPTION OF A NEW SPECIES FROM WESTERN AUSTRALIA

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### ABSTRACT

The endemic Australian gasteruptiid genus *Crassifoenus* Crosskey is revised and the included species, *C. grossitarsis* (Kieffer) and *C. macronyx* (Schletterer), are redescribed. A striking new species from Western Australia is described and an illustrated key to separate it from the other two species is presented. The taxonomic history, monophyly and biology of the genus are discussed.

### INTRODUCTION

The Gasteruptiidae are among the most easily recognised parasitic Hymenoptera because of their elongate, subclavate metasoma, and very high position of its attachment on the mesosoma. The family comprises two subfamilies, the Gasteruptiinae and Hyptiogastrinae; the former containing only the cosmopolitan and commonly collected *Gasteruption* L., a genus that is readily identified in Australia by having an exerted ovipositor, propleura produced to form a distinct neck between the mesosoma and head, short mandibles, and low position of fore wing vein 1-Rs+M (i.e. in line with M+Cu). Alternatively, the Hyptiogastrinae are collected less often and they have a Gondwanan distribution. The group comprises five valid genera of which *Aulacofoenus* Kieffer is known from both Australia and South America, *Pseudofoenus* Kieffer is restricted to New Zealand, *Crassifoenus* Crosskey and *Hyptiogaster* Kieffer are restricted to Australia, while the predominantly Australian *Eufoenus* Szépligeti with more than 20 described species is also known from Fiji, Vanuatu (Crosskey 1953, 1962), New Guinea and New Caledonia (new records – AEIC, ANIC, BMNH). To date, 39 species of hyptiogastrine wasps are recognised (Crosskey 1953, 1962), of which 32 are from Australia. However, recently available material indicates that this figure represents only about 40% of the true size of the Australian fauna.

As a group, the Hyptiogastrinae is characterised by having long overlapping mandibles, and the trochantellus absent. Also, they usually have the fore wing vein 1-Rs+M intersecting the basal cell about half way between M+Cu and Sc+R+Rs (all genera except *Pseudofoenus*), and a short ovipositor (all genera except *Hyptiogaster*). As for *Gasteruption*, hyptiogastrine wasps are parasitic or predator-inquilines in the nests of bees (Houston 1969, 1984b, 1987; Naumann 1983) and vespid wasps (Houston 1984a; Naumann and Cardale 1987), though the biology of most species is unknown.

Although up to nine genera of hyptiogastrines have been recognised, Crosskey (1953, 1962) provided substantial generic stability after partly revising the subfamily and reducing the

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number of genera to five (Crosskey 1962). However, his study was based on only limited material, and over the last 30 years, particularly with the advent of mass-collecting techniques such as malaise traps, the amount of available material in Australian and other collections has increased by more than ten fold. From this we have recognised a large number of new species and have been able to reassess the limits of described species and genera. Apparent from this work is that the Hyptiogastrinae is probably paraphyletic without the inclusion of *Gasteruption*.

Our overall aim is to revise the genera of the Gasteruptionidae, analyse their relationships to provide a stable classification, and compare the resultant phylogeny to their known distribution to determine whether it can be wholly explained by continental drift theory. This paper revises the smallest of the genera recorded from Australia, *Crassifoenus*, and, at the same time, describes a striking new species from Western Australia. We present an illustrated key to the included species, and discuss the taxonomic history, monophyly, biology and distribution of the genus.

### METHODS, TERMINOLOGY AND ABBREVIATIONS

Specimens used for ovipositor examination were partly dissected prior to the removal from the metasoma, and hydrated in distilled water for up to 24 h. The ovipositor was then teased from the sheaths with a fine needle. Specimens for SEM study were cleaned by removing obvious dirt and other debris with a fine brush; they were sputter-coated with platinum, and then examined under a Cambridge Stereoscan 250 (Mk 3B) scanning electron microscope.

Terminology for morphology, except for wing venation, generally follows Crosskey (1951, 1953, 1962), although a few terms have been changed to standardise them with recent studies on other groups of large-sized parasitic wasps (see Gauld and Bolton 1988; Naumann 1991; Figures 1, 2, 17). As for the most recent taxonomic studies on parasitic Hymenoptera, we used the term 'metasoma' rather than 'gaster' or 'abdomen'. Terminology for wing venation follows the modified Comstock-Needham system after Sharkey (1988), but with some modifications and using the nomenclature of van Achterberg (1979) for cells (Figures 15, 16). Terminology used for surface sculpturing follows Harris (1979).

Abbreviations of institutions follow Arnett *et al.* (1986), except for WARI which is not included in that publication. AEIC, American Entomological Institute, Gainesville; AMSA, Australian Museum, Sydney; ANIC, Australian National Insect Collection, Canberra; BMNH, The Natural History Museum, London; MCZC, Museum of Comparative Zoology, Cambridge, Massachusetts; MHNG, Museum d'Histoire Naturelle, Geneva; QMBA, Queensland Museum, Brisbane; SAMA, South Australian Museum, Adelaide; WAMP, Western Australian Museum, Perth; WARI, Waite Campus Collection, University of Adelaide, Adelaide.

### SYSTEMATICS

#### Gasteruptionidae: Hyptiogastrinae

#### Genus *Crassifoenus* Crosskey

*Crassifoenus* Crosskey, 1953: 355; Muesebeck and Walkley, 1956: 344; Crosskey, 1962: 393; Naumann, 1991: 942.

### Type species

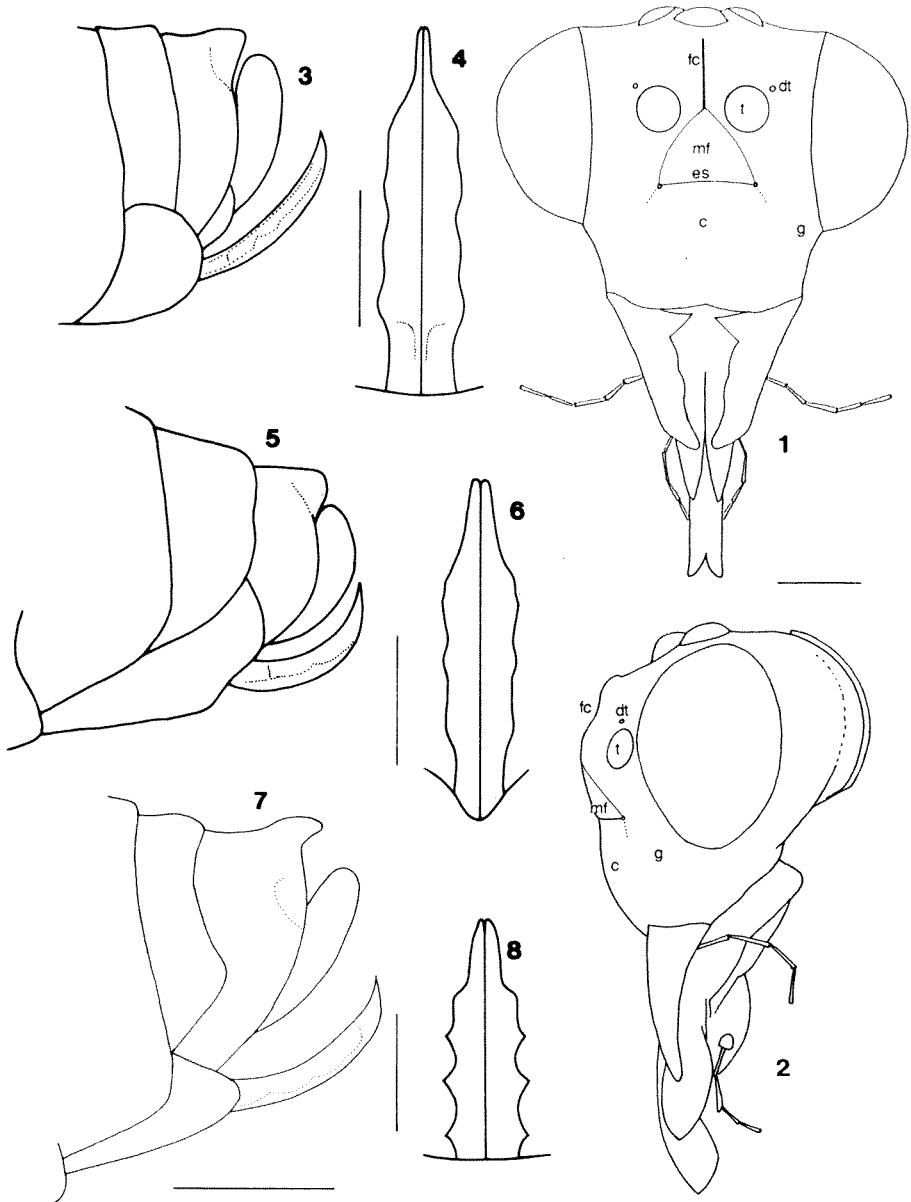
*Gasteruption macronyx* Schletterer, 1889 (by original designation).

### Diagnosis

Gasteruptionid wasps of large, stout form; head about equal in width to or slightly wider than mesosoma; head elongate ventrally, length of malar space plus mandibles about as long or longer than height of eye (Figure 1); lateral epistomal suture absent so that clypeus is continuous with gena; clypeus greater than 0.75 x as high as wide; malar space large, about one-third height of eye; mandibles elongate, about as long as clypeus; labio-maxillary complex elongate, protruding well below mandibles; frontal carina strongly raised; antennal scrobes (beside frontal carina) deeply excavate and reaching almost to level of median ocellus; dorsal tentorial pits present on frons, one each above toruli; subantennal sutures present, indistinct to clearly visible, defining small triangular subantennal area on face (the medial face); first flagellomere longer than second; female antenna 14-segmented, male antenna 13-segmented; pronotum without processes; propleuron with prominent ventro-lateral carina (Figure 17); mesoscutum almost as broad as long, with faint median and admedian lines anteriorly; notauli percurrent, punctate or scrobiculate (Figure 9); parapsidal lines indistinct; pit of metapleural apophysis deep; propodeal spiracle elongate, surrounded by dense pilosity (Figure 12); propodeum separated from metapleuron by carinate furrow, with short or percurrent medial longitudinal carina; inner surface of mid tibia in female with subapical notch, absent in male; outer surface of mid tibia with scattered short stout spines and apical pecten of short teeth; hind trochanter with transverse groove (Figures 13, 14); hind femur and tibia strongly incrassate, about equal in length; outer hind tibial spur shorter and more robust than inner spur; in female first four hind tarsal segments very strongly contracted, deeply bilobed and tightly fitting, fifth segment about equal in length to preceding four combined, strongly swollen apically, hind claws very large, as long as four basal tarsal segments combined (Figures 18, 28, 29); in male first four hind tarsal segments not strongly contracted, fifth segment only slightly larger than each basal segment, much narrower than basal three segments, hind claws small, about equal in length to fourth segment (Figure 19); fore wing vein 1-Rs+M intersecting basal cell about one-quarter to one-third distance from M+Cu (Figure 15); hind wing with 4-7 hamuli, r-m and 2-M pigmented (Figure 16); first metasomal tergum transversely strigate-rugose; ovipositor short, robust, upwardly curved, lateral margins of ventral valves dentate or undulate (Figures 3-8), normally hidden by ovipositor sheaths (Figures 26, 27).

### Comments

*Crassifoenus* was erected by Crosskey (1953) to include two species (*C. grossitarsis* (Kieffer) and *C. macronyx* (Schletterer)) which have a long malar space, the first four hind tarsal segments strongly contracted and deeply bilobed, and the hind femur and tibia incrassate. Not obvious from the original description of the genus is that it is only females that possess modified hind tarsi; in males they are normally elongate and not strongly bilobed. When compared with other gasteruptionid genera these characters are autapomorphic for *Crassifoenus* and define it as a monophyletic group. Although some species of *Hyptiogaster* have the second to fourth hind tarsal segments significantly shortened they are not bilobed, and thus have probably evolved independently of the condition in *Crassifoenus*.



**Figures 1-8** (1-4) *Crassifoenus houstoni*, ♀: (1) anterior view of head; (2) lateral view of head; (3) lateral view of posterior metasoma; (4) ventral view of ovipositor; (5, 6) *Crassifoenus macronyx*, ♀: (5) lateral view of posterior metasoma; (6) ventral view of ovipositor; (7, 8) *Crassifoenus grossitarsis*, ♀: (7) lateral view of posterior metasoma; (8) ventral view of ovipositor. Scale lines: 1.0 mm (1-3, 5, 7); 0.5 mm (4, 6, 8). (c = clypeus, es = epistomal suture, fc = frontal carina, g = gena, mf = medial face, t = torulus, dt = dorsal tentorial pit).

This study has revealed a further three characters that are unique to *Crassifoenus*. These are the presence of a subapical notch on the inner surface of the mid tibia of females, the dentate or undulate lateral margins of the ventral ovipositor valves, and the presence of a distinct ventro-lateral carina on the propleuron. In all other genera of gasteruptiids the mid tibia is tubular, the margin of the ventral ovipositor valves are smooth and straight, and the ventro-lateral propleuron is smoothly rounded. An exception to the latter condition is known only in two species of *Hyptiogaster* (*H. humeralis* (Schletterer) and *H. flavosignata* (Kieffer)). However, these species have paired ventro-lateral carinae which bound a narrow crenulate groove. This groove appears to lock against the sharp anterior margin and ventral process of the lateral pronotum. This is not the case in *Crassifoenus* where the propleuron is more elongate, so that the ventro-lateral carina is distant from the anterior margin of the lateral pronotum.

*Crassifoenus* species all possess small dorsal tentorial pits, one above each torulus, which apparently have not been reported previously for any members of the family. However, our preliminary observations show that this structure exists in all genera of Gasteruptiidae, as well as members of the Aulacidae, but is absent in other families of parasitic Hymenoptera examined, with the exception of some Ichneumonidae (Cryptinae). A more extensive survey of these groups is required but, conditionally, the presence of these pits may represent a synapomorphy for the Gasteruptiidae + Aulacidae.

The sister-group to *Crassifoenus* is not resolved, but superficially it is most similar to *Aulacofoenus* and *Hyptiogaster*. All three genera comprise large robust wasps, possess an elongate labio-maxillary complex and trochanteral groove (a character also shared by *Gasteruption* and Aulacidae, but absent in *Eufoenus* and *Pseudofoenus*; Crosskey, 1962). However, potentially more definitive characters do not provide an unequivocal pattern of relationships. For example, *Crassifoenus* and *Aulacofoenus* possess a short hidden upwardly curved ovipositor, while *Hyptiogaster* has a long exposed ovipositor. Alternatively, *Crassifoenus* and at least some *Hyptiogaster* share greatly shortened hind tarsal segments in females and the presence of carinae on the ventro-lateral propleuron. Also, members of these two genera lack a lateral epistomal suture so that the clypeus and gena are continuous. Hopefully, a more exhaustive search for informative characters in the future will resolve the pattern of relationships among gasteruptiid genera.

### Distribution

*Crassifoenus* species are endemic to the Australian mainland and, with the exception of two records from the Brisbane region, are apparently restricted to the drier central and western regions of the continent (Figure 25).

### Biology

Members of this genus are parasitic or predator-inquilines in the nest of bees, and host records for two species indicate that the genus may be restricted to stenotritine bees. The structure of the labio-maxillary complex, particularly the 'sieve'-like arrangement of the distal glossae (Figures 23, 24), indicate that adult *Crassifoenus* are probably nectar rather than pollen feeders. This is supported by a general paucity or absence of pollen grains on the mouthparts of wasps collected at flowers.

**Key to Species of *Crassifoenus***

1. Mandible strongly curved distally, with two distinct medial teeth (Figures 21, 22); hypopygium in lateral view elongate, either truncate or broadly pointed apically (Figures 5, 7); vertex very finely transversely substrigulate to imbricate or longitudinally strigate to carinate; occipital margin smooth or very faintly crenulate; mat of long setae present on ventral surface of fifth hind tarsal segment; body predominantly red-brown, sometimes with dark markings ..... 2
- Mandible weakly curved distally, with indistinct medial teeth (Figure 20, 23); hypopygium in lateral view short and rounded (Figure 3); vertex coarsely scrobiculate to reticulate punctate, often smooth or finely reticulate-strigate towards occipital carina; occipital margin scrobiculate; without mat of long setae on ventral surface of fifth hind tarsal segment; body uniformly dark, often black with very dark red markings ..... *C. houstoni* sp. nov.
2. Hypopygium in lateral view truncate apically (Figure 5); ventral ovipositor valves with undulate margins (Figure 6); vertex very finely transversely substrigulate to imbricate with minute punctures, sometimes with single row of large punctures directly behind ocelli; median longitudinal carina present in posterior one-third to one-quarter of propodeum ..... *C. macronyx* (Schletterer)
- Hypopygium in lateral view broadly pointed apically (Figure 7); ventral ovipositor valves with dentate margins (Figure 8); vertex longitudinally strigate or carinate, becoming very finely strigate-punctate; median longitudinal carina on propodeum percurrent ..... *C. grossitarsis* (Kieffer)

***Crassifoenus grossitarsis* (Kieffer)**

Figures 7, 8, 22, 25

*Hyptiogaster grossitarsis* Kieffer, 1911: 179; 1912: 194, 197; Hedicke, 1939: 48.

*Crassifoenus grossitarsis* (Kieffer): Crosskey, 1953: 356, 357; 1962: 385, 389.

**Holotype**

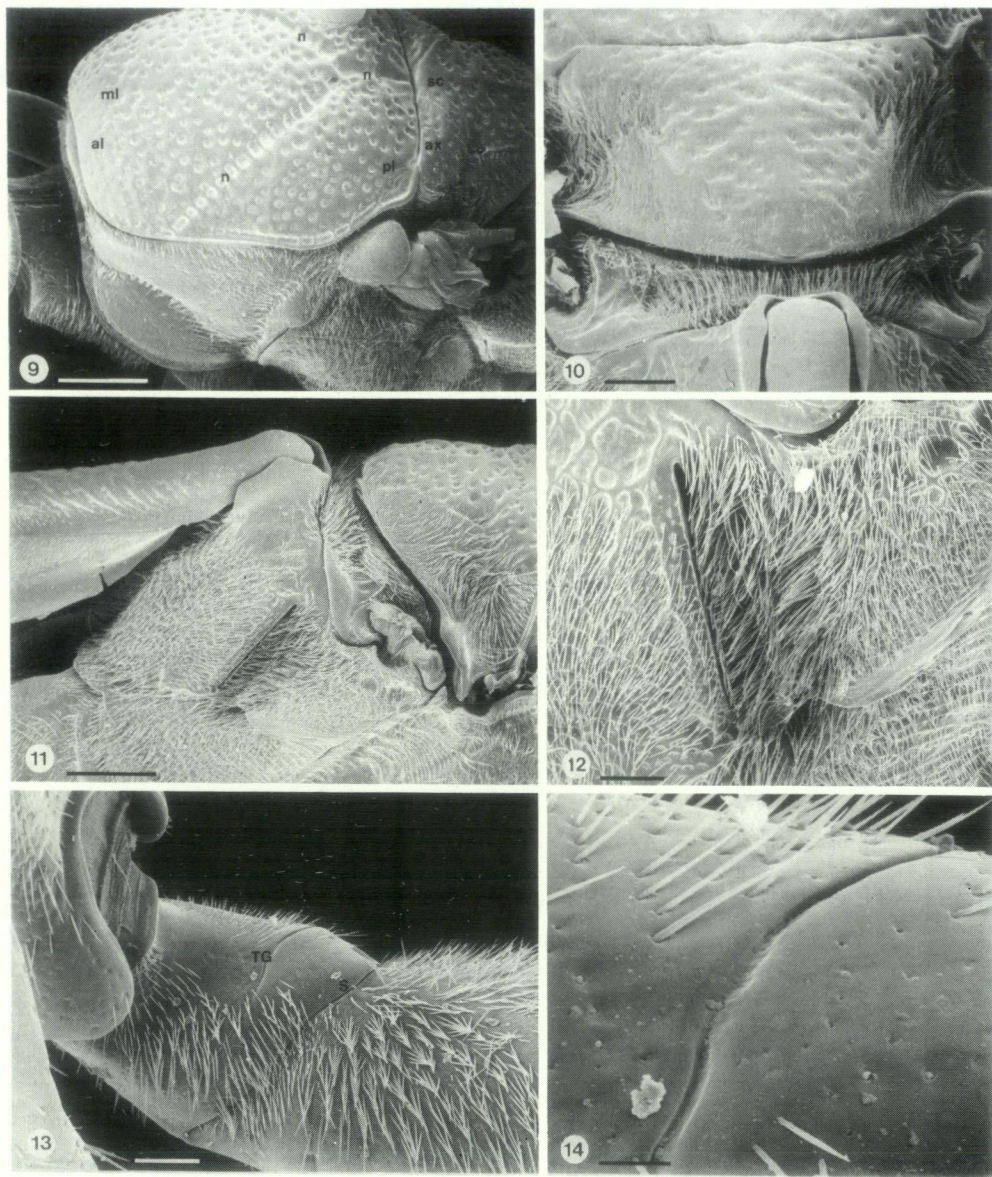
♀, "Western Australia, Swan River", no other data (BMNH).

**Other Specimens Examined**

**Australia: Western Australia:** 1 ♀, Roebourne, 1912-111 (BMNH); 1 ♂, 30 miles W. of Coolgardie, 29.xi.1958, E.F. Riek (ANIC); 1 ♂, Moore River National Park (31.10S, 115.40E), 31.xii.1989, T.F. Houston, on flowers of *Melaleuca* (WAMP). **Northern Territory:** 1 ♀, 33 km W.N.W. of Alice Springs (23.36S, 133.34E), 30.ix.1978, J.C. Cardale (ANIC); 1 ♀, 30 km N.W. by W. of Alice Springs (23.32S, 133.38E), 7.xi.1978, J.C. Cardale (ANIC).

**Female**

**Head:** 1.2 (1.1-1.3) x as wide as mesosoma; frons coarsely strigate to strigate-rugose, punctate-reticulate along lateral margins; distance from posterior ocellus to eye margin 0.8 (0.7 - 0.9) x distance between posterior ocellus and occipital carina; vertex longitudinally strigate medially, becoming very finely strigate-punctate towards occipital carina, finely rugulose laterally; occipital margin smooth or faintly crenulate; gena finely punctate-reticulate; malar space 0.4 x height of eye, 1.2 (1.0 - 1.4) x as long as scape; clypeus finely



**Figures 9–14** *Crassifoenus houstoni*, ♀ paratype: (9) dorso-lateral view of mesosoma; (10) dorso-posterior view of scutellum; (11) lateral view of posterior mesosoma and T1 of metasoma; (12) propodeal spiracle; (13) base of hind leg showing suture between the trochanter and femur, and the trochanteral groove; (14) trochanteral groove on the hind trochanter. Scale lines: 1.0 mm (9, 11); 0.5 mm (10); 250  $\mu$ m (12, 13); 50  $\mu$ m (14). (al = admedian line, ax = axilla, ml = median line, n = notaulus, pl = parapsidal line, sc = dorsal scutellum, S = suture between the trochanter and femur, TG = trochanteral groove).

punctate-reticulate with a few large scattered punctures medially, smoother medially, almost glabrous, with scattered short hairs which become denser laterally; medial face finely rugulose, sometimes with scattered fine punctures in ventral part, lateral face finely punctate-reticulate, face virtually glabrous, with some hairs laterally and around antennal insertions; epistomal suture distinct, not impressed; first flagellomere 1.6 (1.3 – 1.8) x as long as scape, 3.9 (3.7 – 4.3) x as long as pedicel, second flagellomere 1.1 x as long as third flagellomere, terminal flagellomere 2.0 (1.8 – 2.2) x as long as broad; mandible strongly curved distally, with two prominent medial teeth (sometimes slightly worn and indicated by dull surface).

*Mesosoma*: Propleuron finely rugulose, with short dense setae, ventro-lateral carina expanded anteriorly into flange, not reaching to posterior margin of propleuron; lateral pronotum finely punctate-reticulate ventrally, rugose dorsally, with scattered short setae, oblique depression narrow, crenulate; mesoscutum almost as broad as long, median lobe coarsely transversely strigate-rugose, with scattered short hairs; admedian lines indistinct, faintly carinate, short, converging from anterior margin of median lobe; median line virtually absent, indicated by subtle change in sculpturing in anterior half of median lobe; notauli with faint punctate or scrobiculate sculpturing; parapsidal lines faintly carinate, almost reaching to notauli; lateral lobes of mesoscutum coarsely transversely strigate-rugose; axillae and dorsal scutellum transversely strigate-rugose, almost glabrous; lateral scutellum finely punctate; metanotum with dense pubescence; metanotal depression carinate; dorsal part of mesepisternum finely punctate-reticulate, with scattered short hairs, separated from ventral part by carinate depression, ventral part coarsely rugose, with short dense pilosity, grading to smooth and glabrous on ventral surface; mesepimeron deeply concave, scrobiculate in ventral part, transversely strigate above; epicnemium finely transversely strigate, sometimes almost smooth with fine rugose-punctate sculpturing at lateral margins; ventral part of metapleuron rugose to coarsely rugose, sometimes with striate margin, with, dorsal part strongly convex, the anterior half smooth and glabrous, posterior half with fine transverse striae and dense pilosity; propodeum rugose, with scattered short hairs, median longitudinal carina present in posterior one-third to one-quarter.

*Legs*: All tibiae and tarsi with short dense golden pilosity; mid tibial notch slight; outer surface of mid tibia with scattered stout spines; hind coxa finely punctate except for striate dorsal depression; hind femur short and broad, about 3 x as long as wide, equal in length to hind tibia, with short pilosity dorsally and scattered hairs ventrally; inner tibial spur about 1.5 x as long as outer spur; first tarsal segment with ventro-apical pecten of short teeth, second to fourth tarsal segments without ventro-apical pecten but with long stout setae; apical part of fifth hind tarsal segment almost as wide as preceding four segments, with dense mat of setae on ventral surface.

*Wings*: Fore wing with 1-Rs+M intersecting basal cell about 0.3 x distance from M+Cu; 2-Rs+M 4.8 x as long as m-cu; r 2.5 x as long as 2-Rs; hind wing with 5-7 hamuli.

*Metasoma*: 1.8 (1.8 – 2.0) x length of mesosoma; transversely strigate-rugose sculpturing on dorsal part of first tergum becoming rugose-punctate posteriorly; dorsal part of second tergum very finely imbricate-punctate; hypopygium in lateral view elongate and broadly pointed apically; lateral margins of ventral ovipositor valves dentate.

*Colour*: Body generally red-brown or yellow-brown, first metasomal tergum with broad black band; variable amount of black surrounding ocelli, on propleuron, mesopleuron,



mesosternum, posterior half of mesoscutum, metapleuron, and base of hind coxae; tegula and wing bases yellow; vein C, M+Cu and stigma of fore wing yellow-brown, remaining veins brown to dark brown.

*Length:* 15.5 (12.5 – 20) mm.

### Male

Similar to female except as follows: length 18.5 (17 – 20) mm; terminal flagellomere 2.5 (2.3 – 2.6) x as long as broad; dorsal part of lateral pronotum virtually smooth; body more extensively black, including frons to vertex, larger proportion of mesoscutum, axillae, lateral metanotum and posterior margin of propodeum.

### Biology and Distribution

Adults of *C. grossitarsis* have been collected from *Melaleuca* sp. in Western Australia. The host is unknown. The species has so far been recorded from Mediterranean and arid parts of Western Australia and the Northern Territory (Figure 25).

### Comments

This species is closely related to *C. macronyx* but can be readily separated from it by the characters given in the key. In addition to these, *C. grossitarsis* can be distinguished by having a slightly longer malar space, ventro-lateral carina on propleuron expanded anteriorly into a flange, narrow oblique depression on the lateral pronotum, and finely transversely strigate epicnemium.

### *Crassifoenus macronyx* (Schletterer)

Figures 5, 6, 21, 25

*Gasteruption macronyx* Schletterer, 1889: 385, 463–4.

*Hypitiogaster macronyx* (Schletterer): Kieffer, 1903: 94; 1912: 195, 204; Tillyard, 1926: 268; Hedicke, 1939: 49.

*Crassifoenus macronyx* (Schletterer): Crosskey, 1953: 356–7; 1962: 399.

### Holotype

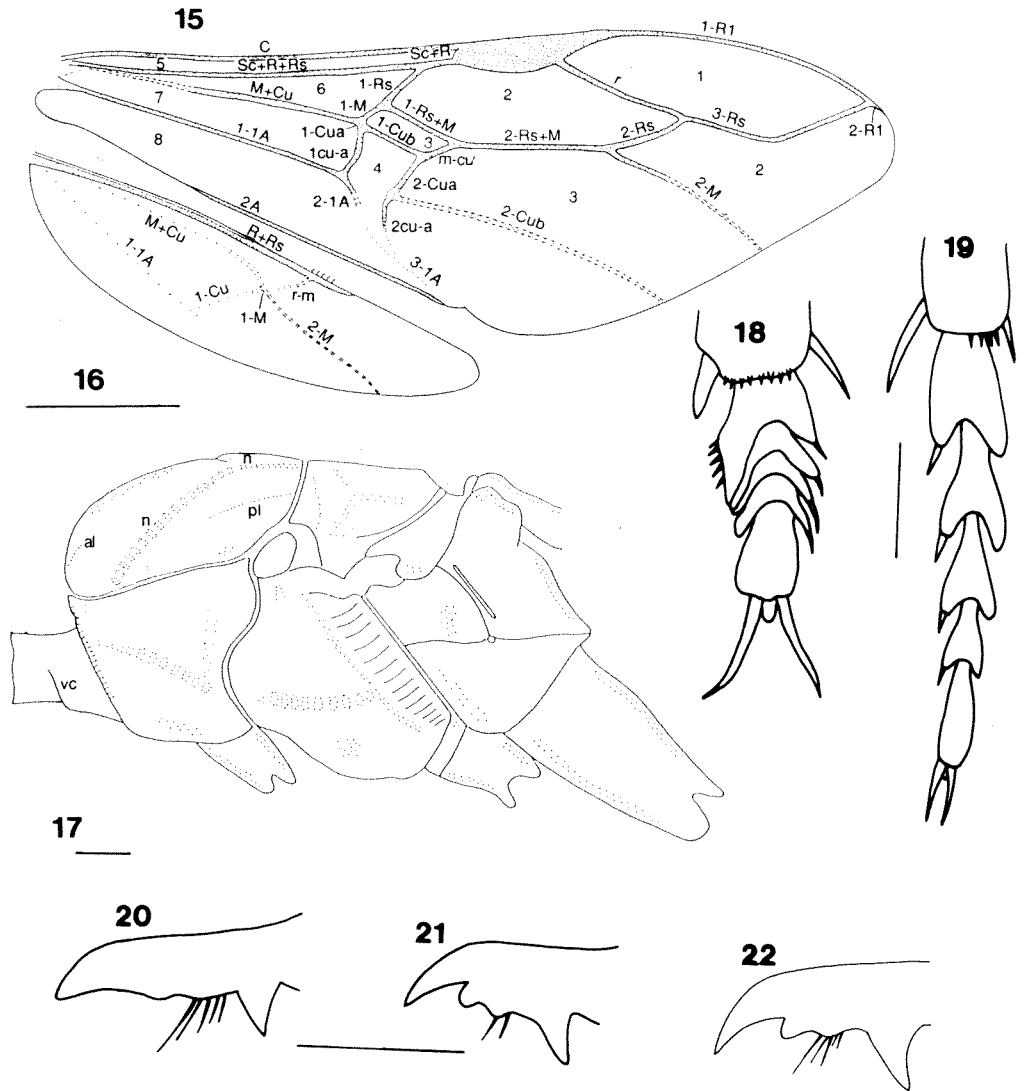
♂, "South Australia", no other data (MHNG).

### Other Specimens Examined

**Australia: Western Australia:** 1 ♀, 1 km N. of Millstream (21.35S, 117.04E), 1.xi.1970, Upton & Feehan (ANIC). **South Australia:** 1 ♀, Blackhon (?), 20.xii.1893, Froggatt (ANIC); 1 ♀, Finnis Creek, W. of Marree, 2.i.1974, T.F. Houston, leaving nest of *Stenotritus* (WARI). **Queensland:** 2 ♀, 3 ♂, Brisbane, 4.xii.1911, H. Hacker (QMBA); 1 ♀, Brisbane, 4.xii.1911, H. Hacker (BMNH); 1 ♂, Enoggera, 3.xii.1913, H. Hacker (QMBA); 1 ♀, 3 ♂, Cunnamulla, Nov., N. Geary coll. (MCZC); 1 ♂, North Queensland (BMNH). **New South Wales:** 1 ♂, Fowlers Gap Res. Stn (31.05S, 141.42E), 29.xi.–2.xii.1981, J.C. Cardale, on flowers of *E. camaldulensis* (ANIC); 1 ♀, Fowlers Gap Res. Stn, 8–9.xii.1982, I.D. Naumann (ANIC); 3 ♂, Fowlers Gap Res. Stn, 8–9.xii.1982, I.D. Naumann & J.C. Cardale (ANIC, WARI). **Locality Unknown:** 1 ♀, 1.iii.[18]82, no collector (BMNH).

### Female

*Head:* 1.1 (1.0 – 1.2) x as wide as mesosoma; frons coarsely strigate-rugose in upper half, becoming more punctate laterally, lower half finely reticulate-punctate; distance between



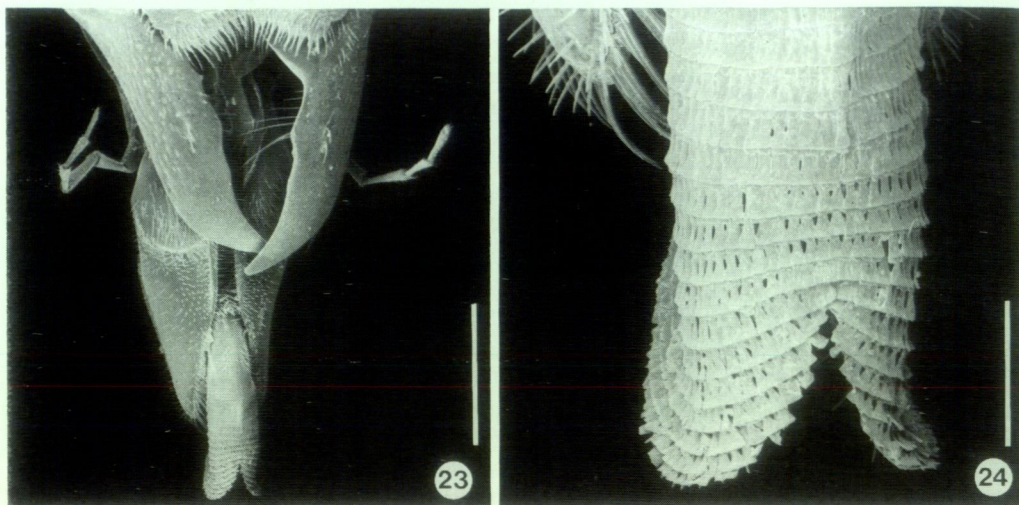
**Figures 15–22** (15–20) *Crassifoenus houstoni*, paratypes: (15) ♂, fore wing; (16) ♂, hind wing; (17) ♀, lateral view of mesosoma; (18) ♀, dorsal view of hind tarsal segments; (19) ♂, dorsal view of hind tarsal segments; (20) *Crassifoenus houstoni*, ♀, lateral view of mandible; (21) *Crassifoenus macronyx*, ♀, lateral view of mandible; (22) *Crassifoenus grossitarsis*, ♀, lateral view of mandible. Scale lines: 1.0 mm. (al = admedian line, n = notaulus, pl = parapsidal line, vc = ventro-lateral carina; fore wing cells: 1 = marginal, 2 = submarginal, 3 = discal, 4 = subdiscal, 5 = costal, 6 = basal, 7 = subbasal, 8 = plical).

posterior ocellus and eye margin  $0.6 (0.5 - 0.7) \times$  distance between posterior ocellus and occipital carina; vertex very finely transversely substrigulate to imbricate with minute punctures, sometimes becoming papillate laterally, and sometimes with single row of large punctures directly behind ocelli; occipital margin smooth or faintly crenulate; malar space  $0.35 \times$  height of eye,  $0.9 (0.8 - 1.1) \times$  as long as scape; gena finely punctate-reticulate; clypeus finely punctate-reticulate laterally, smooth medially with a few scattered punctures, almost glabrous medially, with fine pilosity laterally; medial face finely punctate with short pilosity; lateral face punctate-reticulate with fine pilosity; epistomal suture distinct, not impressed; first flagellomere  $1.6 (1.4 - 1.7) \times$  as long as scape,  $4.2 (3.7 - 4.4) \times$  as long as pedicel, second flagellomere  $1.2 (1.1 - 1.2) \times$  as long as third flagellomere, terminal flagellomere  $2.3 (2.2 - 2.7) \times$  as long as broad; mandible strongly curved distally, with two prominent medial teeth (sometimes slightly worn and indicated by dull surface).

*Mesosoma*: Propleuron finely punctate-reticulate, with short pilosity, ventro-lateral carina even throughout, not expanded anteriorly into a flange, not reaching to posterior margin of propleuron; lateral pronotum finely punctate-reticulate ventrally, rugose-punctate dorsally, covered with short pilosity, oblique depression strongly arched, broad, coarsely scrobiculate; mesoscutum almost as broad as long, medial lobe coarsely transversely strigate-rugose, with scattered short hairs; admedian lines indistinct, faintly carinate, short, converging from anterior margin of median lobe, sometimes virtually absent or indicated only by change in sculpturing pattern; median line virtually absent, indicated by subtle change in sculpturing in anterior half of median lobe, sometimes also discernible in posterior half; notaular depression virtually unsculptured, sometimes with faint punctate or scrobiculate sculpturing; parapsidal lines faintly carinate, almost reaching to notauli; lateral lobes of mesoscutum coarsely transversely strigate-rugose; axillae and dorsal scutellum coarsely strigate-rugose; lateral scutellum finely punctate; metanotum with long hairs; metanotal depressions punctate-carinate; mesepisternum with dense pilosity partly obscuring underlying sculpturing, dorsal part rugulose, ventral part rugose grading to strigate, and then to smooth and glabrous on ventral surface, dorsal and ventral parts separated from dorsal part by a carinate depression; mesepimeron deeply concave, smooth beside scrobiculate margin; epicnemium smooth and glabrous; lower part of metapleuron rugulose, upper part strongly convex, rugose, both areas with dense pilosity; propodeum rugose to rugose-punctate, with scattered short hairs, median longitudinal carina virtually percurrent.

*Legs*: Tibiae and tarsi of fore and mid legs and inner surface of hind tibia and hind tarsi with short golden pilosity; mid tibial notch slight; outer surface of mid tibia with scattered stout spines; hind coxa variable, generally finely punctate-reticulate with covering of fine pilosity, dorsal depression smooth to finely transversely striate; hind femur short and broad,  $3 \times$  as long as wide, about as long as hind tibia, with fine scattered punctures and associated short hairs dorsally, laterally smooth and virtually glabrous; outer surface of hind tibia smooth, virtually glabrous except for scattered punctures and associated setae; inner tibial spur about  $1.5 \times$  as long as outer spur; first tarsal segment with ventro-apical pecten of short teeth, second to fourth tarsal segments without ventro-apical pecten but with long stout setae; apical part of fifth hind tarsal segment almost as wide as third and fourth segments, narrower than first and second segments, with dense mat of setae on ventral surface.

*Wings*: Fore wing with 1-Rs+M intersecting basal cell about  $0.3 \times$  distance from M+Cu; 2-Rs+M  $4.3 \times$  as long as m-cu; r  $3.0 \times$  as long as 2-Rs; hind wing with 5-7 hamuli.



**Figures 23, 24** *Crassifoenus houstoni*, ♀ paratype: (23) mouthparts; (24) surface of distal glossae. Scale lines: 1.0 mm (23); 200 µm (24).

**Metasoma:** 2.1 (1.9 – 2.3) x as long as mesosoma; transversely strigate-rugose sculpturing on dorsal part of first tergum becoming rugulose to rugose-punctate posteriorly; dorsal part of second tergum very finely imbricate-punctate, with narrow smooth medial longitudinal band in anterior half; hypopygium in lateral view elongate and truncate apically; lateral margins of ventral ovipositor valves undulate.

**Colour:** Body red-brown to dark red brown, dorsal metasoma usually darker than rest of body, first metasomal tergum black dorsally, sometimes with area around ocelli or frons to vertex, medial mesoscutum, lower mesepisternum, posterior margin of propodeum, and segment 8 and ovipositor sheaths black; tegula and wing bases brown; vein M+Cu, distal veins and stigma of fore wing yellow-brown, remaining veins brown to dark brown.

**Length:** 17 (16 – 19) mm.

### Male

Similar to female except as follow: length 18 (17 – 20) mm; terminal flagellomere more elongate; dorsal part of lateral pronotum smoother; margins of mesepisternum, metanotum, apico-dorsal coxae also black.

### Biology and Distribution

This species has been collected from flowers of *Eucalyptus camaldulensis* in central New South Wales and has been observed leaving the nest of the stenotritine bee, *Stenotritus* sp. *C. macronyx* has been recorded from a range of habitats in a broad band across Western Australia, South Australia and Queensland (Figure 25).

### Comments

In addition to the characters given in the key, *C. macronyx* can be distinguished from *C.*

*grossitarsis* by the ventro-lateral carina on propleuron lacking an anterior flange, broad oblique depression on the lateral pronotum, smooth epicnemium, and slightly denser pilosity on the lateral mesosoma.

*Crassifoenus houstoni* sp. nov.

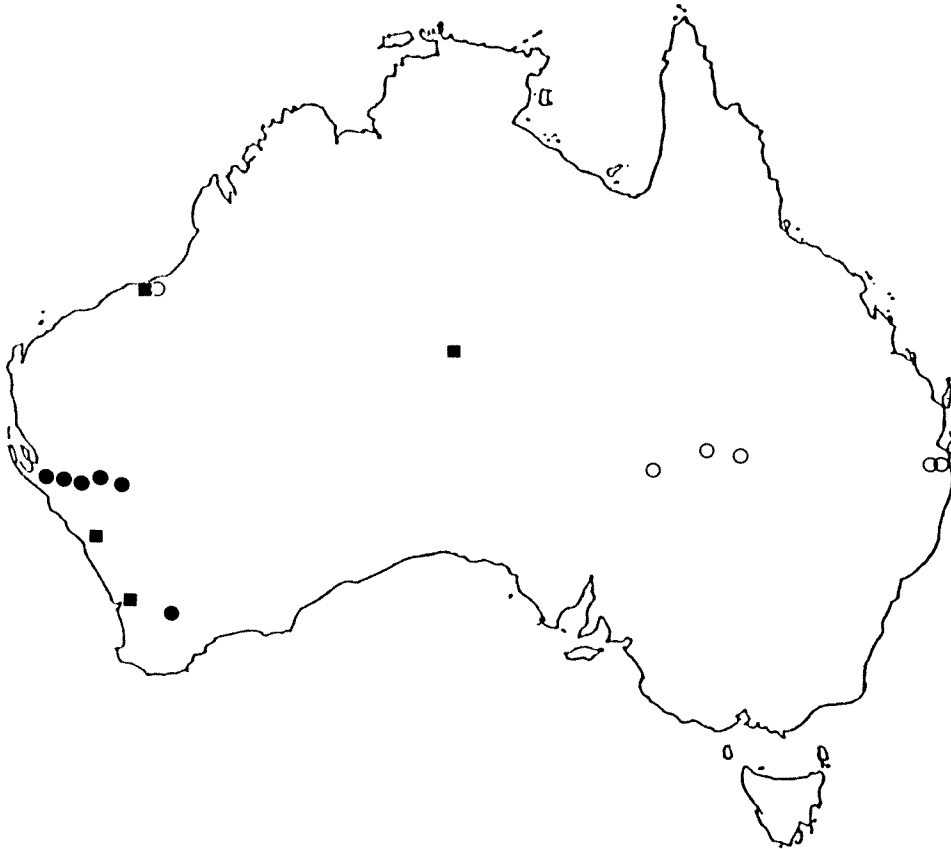
Figures 1–4, 9–20, 23–29

**Holotype**

♀, "75 km E. of Hyden Western Australia 24–27 Oct 1985 T.F. Houston 629–22" "ex nest burrow of bee *Ctenocolletes smaragdinus*" (WAMP)

**Paratypes**

**Australia: Western Australia:** 1 ♀, Sandstone, 28.viii.1974, A.M. & M.J. Douglas (WAMP); 1 ♂, 15 km E. Mullewa (28.32S, 115.31E) 17.viii.1981, P.G. & G.W. Kendrick (WAMP); 7 ♀, 4 ♂, 28 km W. of Yalgoo, 1–2.ix.1981, G.A. Holloway (AMSA, WARI); 2 ♀, 3 ♂, 11 km E.N.E. of Anketell H. S. (28.02 S, 118.51 E), 4–6.ix.1981, T.F. Houston, near nest of *Ctenocolletes ordensis* (WAMP, WARI); 9 ♀, 1 ♂, 13 km S. of Wanoo



**Figure 25** Distribution of *Crassifoenus* spp.: ■ = *C. grossitarsis*; ○ = *C. macronyx*, ● = *C. houstoni*.

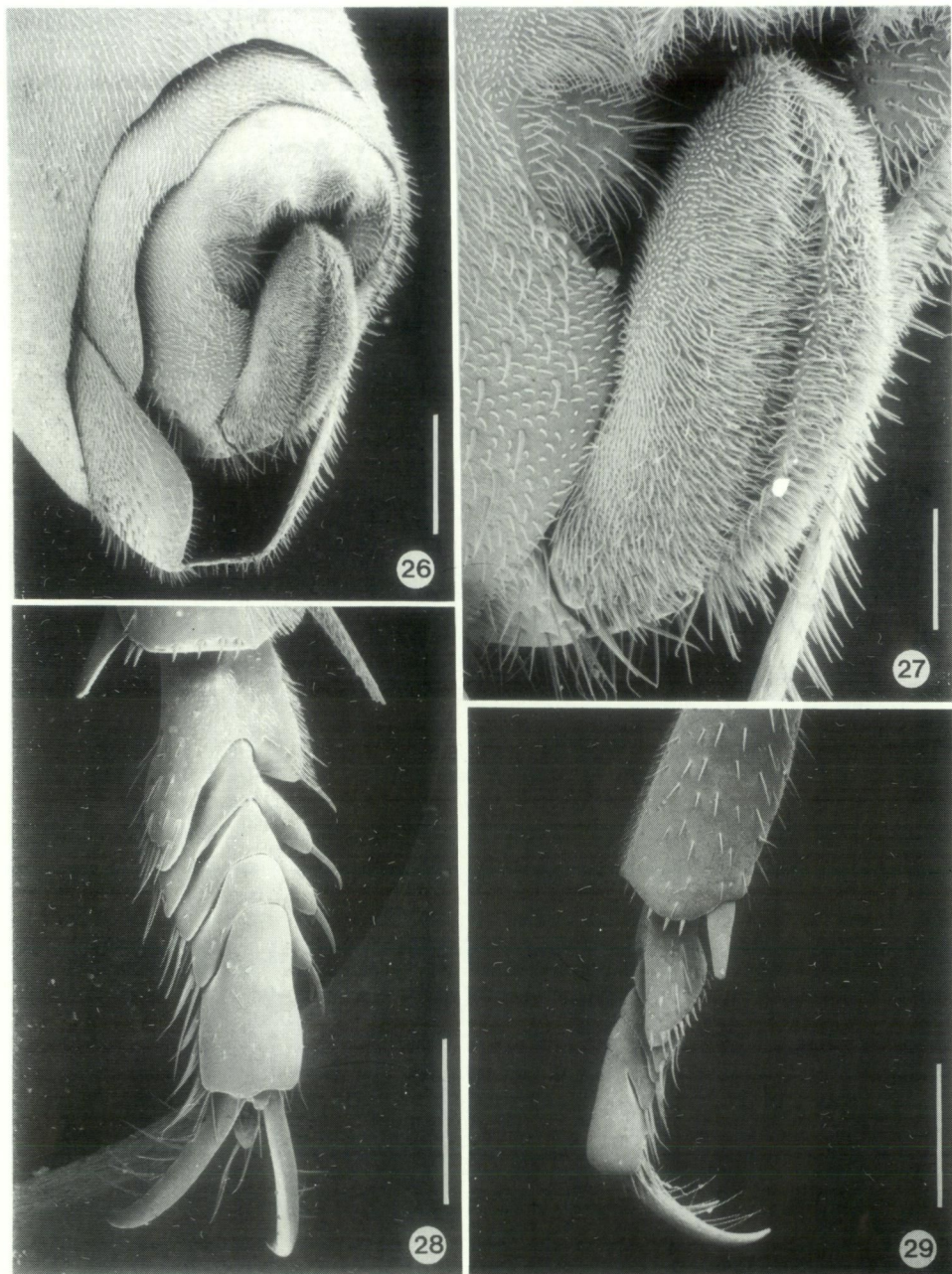
(26.49 S, 114.37 E), 24–28.viii.1984, T.F. Houston & B.P. Hanich, flying over nesting area of *Ctenocolletes nicholsoni* (WAMP, WARI); 1 ♀, East Yuna Reserve, 34 km W.N.W. of Mullewa, 13–16.ix.1984, T.F. Houston, flying over bare sandy ground (WAMP); 2 ♀, 75 km E. of Hyden, 24–27.xi.1985, T.F. Houston, ex nest of bee *Ctenocolletes smaragdinus* (WAMP).

### Female

**Head:** 1.0 (0.9 – 1.0) x as wide as mesosoma; frons coarsely rugose in upper part, punctate laterally, antennal scrobes virtually smooth, with a few scattered fine punctures; distance between posterior ocellus and eye margin 0.8 (0.7 – 0.9) x distance between posterior ocellus and occipital carina; vertex coarsely scrobiculate to reticulate punctate, often smooth or finely reticulate-strigate towards occipital carina; occipital margin scrobiculate; malar space 0.35 x height of eye, 0.9 (0.7 – 1.1) x as long as scape; gena finely punctate-reticulate with a few scattered large punctures, covered with silver pilosity; clypeus finely punctulate-reticulate, with scattered larger punctures and fine white hairs; medial face coarsely punctate-reticulate, sometimes with fine punctate background sculpturing; epistomal suture distinct and slightly impressed; first flagellomere 1.4 (1.3 – 1.7) x as long as scape, 3.4 (3.1 – 3.9) x as long as pedicel, second flagellomere 1.2 (1.0 – 1.3) x as long as third flagellomere, terminal flagellomere 2.3 (2.1 – 2.5) x as long as broad; mandible weakly curved distally, with medial teeth indistinct to virtually absent.

**Mesosoma:** Propleuron strigate-punctate laterally, ventro-lateral carina robust, expanded anteriorly into a sharp flange, reaching almost to posterior margin of propleuron; lateral pronotum finely punctate ventrally, punctate to punctate-reticulate dorsally, with covering of short white hairs, oblique depression shallow, coarsely scrobiculate; mesoscutum as broad as long, surface coarsely punctate-rugose, with scattered minute hairs; admedian lines indistinct, faintly carinate, short, only slightly converging, area between admedian lines smoother than rest of median lobe; median line faintly carinate, about as long as admedian lines; notauli coarsely reticulate-punctate; parapsidal lines faintly carinate, reaching about half distance to notauli; axillae and dorsal scutellum coarsely punctate-rugose, virtually glabrous; lateral scutellum finely punctate, with scattered short hairs; metanotum with long silver pilosity; dorsal part of mesepisternum rugose with scattered white hairs, separated from ventral part by broad coarsely rugose depression with carina along lower margin; ventral part of mesepisternum rugose with dense silver pilosity, grading to smooth and glabrous with a few scattered large puncture on ventral surface; mesepimeron deeply concave, scrobiculate in ventral half, transversely strigate in dorsal half; epicnemium transversely strigate; metapleuron with covering of short silver pilosity, coarsely rugose dorsally above a smooth broad band, strigate ventrally; propodeum rugose-strigate, covered with dense silver pilosity, median longitudinal carina present and percurrent, sometimes indistinct medially due to confusion of surrounding sculpturing.

**Legs:** Femora mostly smooth, with a few scattered punctures and associated hairs; tibiae and tarsi of fore and mid legs with dense covering of light brown hairs; mid tibial notch deep; outer surface of mid tibia with small scattered spines which are not easily discernible from surrounding setae; hind coxa finely punctulate with dense silver hairs laterally, strigate dorsally with only scattered short white hairs; hind femur short and very broad, about 2.5 x as long as wide, slightly shorter than hind tibia; hind tibia with small scattered spines on outer surface among long setae; inner spur about 2.0 x as long as outer spur; first hind tarsal



Figures 26–29 *Crassifoenus houstoni*, ♀ paratype: (26) dorso-posterior view of posterior metasoma; (27) ovipositor sheaths; (28) dorsal view of hind tarsal segments; (29) lateral view of hind tarsal segments and distal tibia. Scale lines: 0.5 mm (26); 200  $\mu$ m (27); 1.0 mm (28, 29).

segment with ventro-apical pecten of short teeth, second to fourth tarsal segments with very stout pecten-like ventro-apical setae; apical part of fifth hind tarsal segment almost as wide as third and fourth segments, narrower than first and second segments, ventrally surface almost glabrous, without dense mat of hairs.

*Wings:* Fore wing with 1-Rs+M intersecting basal cell about 0.25 x distance from M+Cu; 2-Rs+M 6.3 x as long as m-cu; r 1.9 x as long as 2-Rs; hind wings with 4 – 6 hamuli (N.B. 30% of specimens have different numbers on each wing).

*Metasoma:* 2.0 (1.5 – 2.3) x as long as mesosoma; transversely strigate-rugose sculpturing on dorsal part of first tergum sometimes only occupying anterior two-thirds of surface; dorsal part of second tergum reticulate-punctate, sometimes with narrow smooth medial longitudinal band in anterior half; hypopygium in lateral view moderately short and rounded apically; lateral margins of ventral ovipositor valves undulate.

*Colour:* Predominantly black, with two small dark red spots near margin of eye on vertex; variable amounts of dark red on clypeus, propleuron, mesoscutum, scutellum, pronotum, mesepisternum, mesepimeron and metanotum; tegula and wing bases black; venation and stigma black.

*Length:* 17 (15 – 23) mm.

#### Male

Similar to female except as follows: length 20 (18 – 23) mm; flagellomeres slightly longer.

#### Biology and Distribution

*C. houstoni* has been collected from the nests of the following stenotritine bees: *Ctenocolletes albomarginatus* Michener, *C. fulvescens* Houston, *C. nicholsoni* (Cockerell), and *C. smaragdinus* (Smith) (Houston 1987) and *C. ordensis* Michener (Houston 1984b and 1987). It has been recorded from Mediterranean and semi-arid regions of south-western Western Australia (Figure 25).

#### Comments

*C. houstoni* sp. nov. is strikingly different from the other two species. Apart from the characters given in the key, this is the largest and most robust species in the genus. It also has a larger ventro-lateral carina on the propleuron which almost reaches to the posterior margin, the mesoscutum more punctate-rugose, much denser pilosity on the lateral mesosoma and propodeum, transversely strigate epicnemium, much deeper mid tibial notch, longer 2-Rs+M vein compared with m-cu, much shorter r vein compared with 2-Rs, and substantially more robust hind legs and spinose hind tarsi.

This species has been named after Dr Terry Houston, Curator of Entomology at the Western Australian Museum.

#### ACKNOWLEDGEMENTS

We wish to thank the curators of the various collections listed above for their assistance in lending us specimens in their care; Mr S. McClure, CSIRO Division of Soils, Adelaide for assistance with the SEM work; Terry Houston for information on the biology of bees and their



associated parasitoids; and Paul Dangerfield for advice on line drawings and his critical review of the manuscript.

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