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The genus *Quartinia* Ed. André, 1884 (Hymenoptera, Vespidae, Masarinae) in Southern Africa. Part IV. New and little known species with complete venation

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Abstract

In this publication, the fourth of a projected series revising the Afrotropical species of the genus *Quartinia* Ed. André, 1884 (Hymenoptera: Vespidae: Masarinae), 14 species with complete venation are dealt with.

Ten new species are described: *arenaria*, *atlantica* and *luteomandibulata* from the seaboard of the Western Cape of South Africa, *namibensis* from south-western Namibia and *carolinae*, *frontalis*, *scutellaris*, *setaria*, *setositerminalis* and *upingtonensis* from the Northern Cape of South Africa. The hitherto unknown female of *namaquensis* Gess and the males of *persephone* Richards and *vagepunctata* Richards are described. The identity of the male of *parcepunctata* Richards as described by Richards is confirmed. A key to facilitate the separation of the sympatric and generally similar looking *frontalis*, *scutellaris*, *setositerminalis* and *vagepunctata* is given.

Extensive collection data pertaining to most of the species contribute to the knowledge of their distribution and floral associations.

Keywords

Southern Africa, taxonomy, floral associations

Introduction

The background to the present state of knowledge of the taxonomy of the genus *Quartinia* Ed. André, 1884 has been fully stated in Gess (2007).

Desirable as it might be to undertake a complete revision of the genus, this is at present not practicable. Rather than to get bogged down in a study which might never be completed and published, it is intended to publish a series of papers describing new species as well as reviewing some known species. It is envisioned that a new key to species will complete the series. To date Parts I, II and III have been published as Gess (2007), Gess (2008) and Gess (2009).

Quartinia species range in length from a little over 2 mm to 7 mm. In comparison with the great majority of species of other genera of Masarinae even the largest *Quartinia* are relatively small. In view of the considerable range in size shown by species of *Quartinia* and in order to express relative size, categories based on length have been established for species of the genus. These are minute (1.5–2.5 mm); small (2.5–3.5 mm); medium (3.5–4.5mm); large (4.5–5.5 mm); very large (5.5–6.5 mm) and gigantic (6.5–7.5 mm).

The present paper deals only with species with complete venation (2*m-cu* present and as thick as other veins).

Acronyms for institutions in which material is housed are: AMG = Albany Museum, Grahamstown, South Africa; AMNH = American Museum of Natural History, New York, United States of America; BMNH = Natural History Museum, London, England; NNIC = Namibian National Insect Collection, Windhoek, Namibia; SAM = South African Museum, Cape Town, South Africa; SANC = South African National Collection of Insects, Pretoria, South Africa.

Taxonomy

***Quartinia arenaria* sp. n.**
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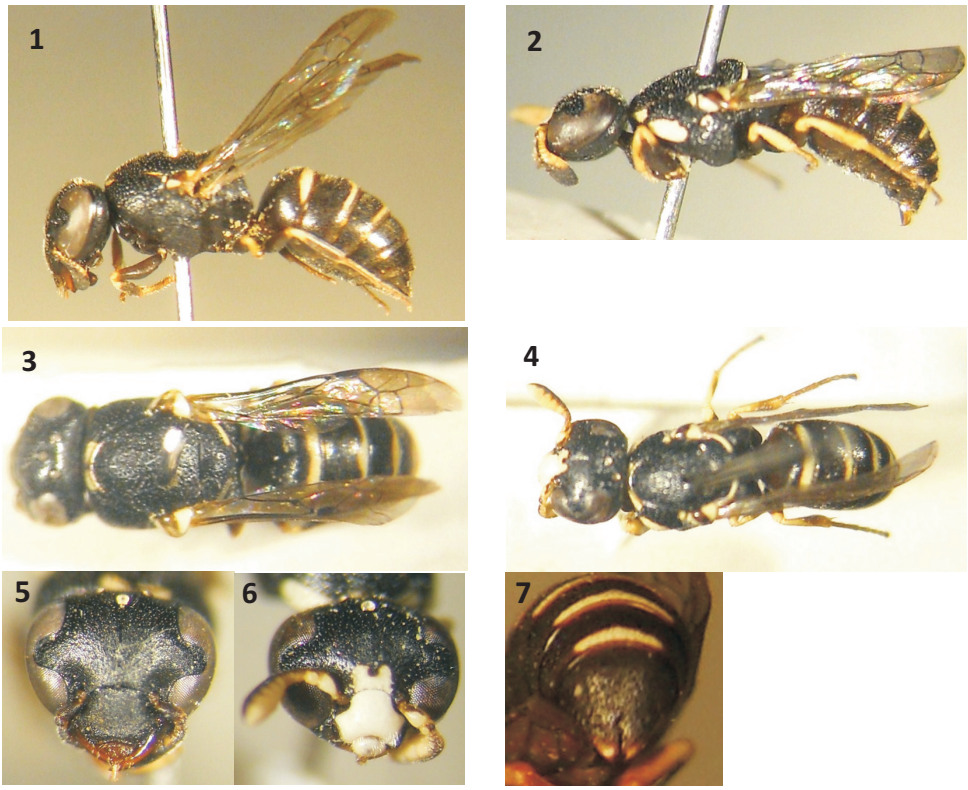
Figs 1–7

Type specimens examined. Holotype ♂, SOUTH AFRICA: WESTERN CAPE: S of Yzerfontein (33.22S 18.11E), 15.x.2006 (D. W., G. T. and G. M. Gess) [AMG].

Paratypes: SOUTH AFRICA: WESTERN CAPE: Lutzville – Vredendal (31.36S 18.23E), 29.ix.2005 (F, W. and S. K. Gess), 6 ♀♀, 1 ♂ (visiting yellow flowers of *Conicosia* sp., Aizoaceae: Mesembryanthema); Donkinsbaai, 10 km S of Doornbaai (31.54S 18.17E), 29.ix.2005) F. W. and S. K. Gess), 3 ♀♀ (visiting pink flowers with white centres of *Drosanthemum* sp., Aizoaceae: Mesembryanthema); Lamberts Bay (32.05S 18.19E), 28.ix.2005 (F. W. and S. K. Gess), 11 ♀♀ (visiting yellow flowers of *Conicosia* sp., Aizoaceae: Mesembryanthema); S of Yzerfontein (33.22S 18.11E),



Figures 1–7. *Quartinia arenaria* **1** ♀, lateral view (× 11) **2** ♂, lateral view (× 13) **3** ♀, dorsal view (× 12) **4** ♂, dorsal view (× 11) **5** ♀, head, front view (× 17) **6** ♂, head, front view (× 20) **7** ♂, tergum VII, dorsal view (× 18).

15.x.2006 (D. W., G. T. and G. M. Gess), 5♀♀, 7 ♂♂; Melkbosstrand (33.42S 18.26E), 10.x.2005 (F. W. and S. K. Gess), 1 ♀, 2 ♂♂ (on sand beneath flowering *Trachyandra* sp., Asphodelaceae) – [all AMG].

Diagnosis. Medium to large (4.2–5.2 mm), gracile (ratio of width to length = 0.27: 1). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Tegula with posterior inner corner inwardly produced. Both sexes black marked with yellowish-white. Head and mesosoma microsculptured (shagreened). Punctures on clypeus and lower half of frons barely discernable; those on upper half of frons and vertex fine, close, increasingly discernable. Punctures on mesosoma larger and more obvious than on head, subconfluent throughout; those on pronotum coarser than those on mesoscutum and scutellum. Male with labrum, clypeus, transverse mark at bottom of frons, and most of scape yellowish-white. Legs unmodified; sterna atuberculate.

Description. *Female* (Figs 1, 3, 5): Black. The following are yellowish-white: band (in some specimens reduced and medially interrupted; in others totally effaced) on anterior margin of pronotum and spot (in some specimens totally effaced) on posterodorsal angle of same; mark (varying from small to totally effaced in majority of speci-

mens) on humeral angle; tegula (except ferruginous median area); scutellar lamella (except postero-medially); posterior bands (not reaching sides and progressively shorter and narrower) on terga I – III, IV or V (most commonly I – IV). Light reddish-yellow are: underside of all flagellomeres (except in some specimens distal flagellomeres of club); apex of femur of all legs, most of tibia (except diffuse ferruginous postero-ventral markings) of fore and middle legs; base of hind tibia; proximal four tarsomeres of fore leg. Various shades of ferruginous are: mandible distally; upper surface of pedicel and proximal flagellomeres; markings on tibia of all legs; ultimate tarsomere of fore leg and all tarsomeres of middle and hind legs. Wings lightly browned; veins brown.

Length: 4.6–5.2 mm (average of 4: 4.9 mm); length of fore wing: 2.7–3.0 mm (average of 4: 2.9 mm); hamuli 4–6.

Head in front view 1.17 × as wide as long; POL: OOL = 1: 0.77. Clypeus 1.55 × as wide as long; anterior margin shallowly emarginate; lateral angles rounded.

Clypeus, frons and vertex finely microsculptured (shagreened); punctures on clypeus and lower half of frons barely discernable; those on upper half of frons and vertex fine, close, increasingly discernable. Mesosoma finely microsculptured (shagreened); punctures larger than those on head, those on pronotum coarser than those on mesoscutum and scutellum, subconfluent throughout. Gaster very finely punctured, shiny.

Male (Figs 2, 4, 6, 7): Black. The following are yellowish-white: small spot near base of mandible (in one specimen from Melkbosstrand only); labrum (except in some specimens testaceous distal margin); clypeus; transverse mark (in some specimens dorsally bilobed) at bottom of frons and contiguous with white clypeus; most of scape (except black streak dorsally); underside of pedicel; band on anterior margin (in some specimens medially interrupted) of pronotum and spot on postero-dorsal angle of same; mark (varying from large to almost totally effaced) on humeral angle; small spot at top of mesopleuron (in some specimens only); tegula (except ferruginous median area); scutellar lamella (except postero-medially); posterior bands (not reaching sides and progressively shorter and narrower) on terga I – VI. Light reddish-yellow are: underside of all flagellomeres; apex of femur of all legs; most of tibia (except diffuse ferruginous postero-ventral markings) of all legs (or of fore and middle legs and base only of hind leg); proximal four tarsomeres of fore leg. Various shades of ferruginous are: mandible distally; upper surface of pedicel and flagellomeres; markings on tibia of all legs; ultimate tarsomere of fore leg and all tarsomeres of middle and hind legs; parameres (generally light ferruginous but with margins narrowly dark ferruginous).

Length: 4.2–4.8 mm (average of 4: 4.5 mm); length of fore wing: 2.6–2.9 mm (average of 4: 2.7 mm); hamuli 5.

Head in front view 1.3 × as wide as long; POL: OOL = 1: 0.67. Clypeus 1.6 × as wide as long; anterior margin shallowly emarginate; lateral angles rounded.

Puncturation of head, mesosoma and gaster as in female. TergumVII more coarsely sculptured than other terga, apico-medially with a short, narrowly V-shaped slit; lobes flanking slit apically acutely pointed. Sterna atuberculate. Parameres almost rounded apically but slightly angular on inner side of curve; without a distinct tooth.

Etymology. Named for the sandy terrain to which the species appears to be restricted.

Geographic distribution. Known from the seaboard of the Western Cape of South Africa, the collecting sites being in the Strandveld of the West Coast of Acocks (1953).

Floral associations. Aizoaceae: Mesembryanthema (*Conicosia*, *Drosanthemum*).

Nesting. Unknown.

Discussion. See under *Quartinia atlantica.*

***Quartinia atlantica* sp. n.**
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Figs 8–10

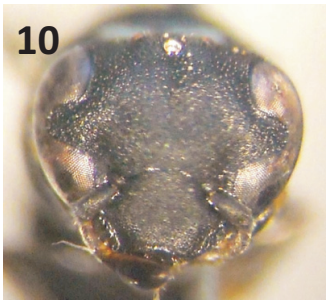
Holotype ♀, SOUTH AFRICA: WESTERN CAPE: Blaauwberg – Melkbosstrand (33.46S 18.27E), 5.x.2005 (F. W. and S. K. Gess) (on sand beneath flowering *Trachyandra* sp., Asphodelaceae) [AMG].

Paratypes. SOUTH AFRICA: WESTERN CAPE: Koeberg Nature Reserve (33.38S 18.24E) (West Coast Strandveld dominated by *Euphorbia* and *Rhus* spp.), 13.vi.–11.vii.1997 (S. van Noort) (yellow pan trap), 1 ♀; same data but dates and number of specimens as follow: 8.vii.– 5.ix.1997, 1 ♀; 5.ix.– 3.x.1997, 27♀♀; 3.x.–31.x.1997, 24 ♀♀; 31.x.–28.xi.1997, 4 ♀♀. – [5 AMG, all others SAM].

Diagnosis. Large (5.25 mm), robust (ratio of width to length = 0.34: 1). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Tegula with posterior inner corner inwardly produced. Female (male unknown) black marked with yellowish-white. Head and mesosoma microsculptured (shagreened). Punctures on clypeus and lower half of frons barely discernable; those on upper half of frons and vertex fine, close, increasing discernable. Punctures on mesosoma larger and more obvious than on head; those on pronotum coarse and subconfluent; those on mesoscutum and scutellum finer and discrete.

Description. *Female* (Figs 8–10): [Based largely on the holotype; the paratypes, having been in alcohol for thirteen years, are somewhat bleached.] Black. The following are yellowish-white: band (in some specimens very narrowly interrupted medially; in one specimen totally effaced) on anterior margin of pronotum and minute spot on postero-dorsal angle of same; streak of varying size (in some specimens effaced) on humeral angle; tegula (except ferruginous median area); scutellar lamella (except postero-medially); posterior bands (not reaching sides and progressively shorter and narrower) on terga I – IV. Light reddish-yellow are: underside of flagellomeres of club; extreme apex of femur and extreme base of tibia of all legs. Various shades of ferruginous are: mandible distally; tarsomeres (particularly underside) of all legs. Wings slightly browned; veins dark brown.

Length of holotype 5.25 mm. [Length of paratypes impossible to establish due to alcohol induced extension and curvature of gaster but likely to have been similar as measurement of mesosoma is same as that of holotype]. Length of fore wing: 3.6 mm; hamuli 5.



Figures 8–10. *Quartinia atlantica* **8** ♀, lateral view (× 10) **9** ♀, dorsal view (× 9) **10** ♀, head, front view (× 15).

Head in front view 1.27 × as wide as long; POL: OOL = 1: 0.7. Clypeus 1.4 × as wide as long; anterior margin shallowly emarginate; antero-lateral angles rounded.

Clypeus, frons and vertex finely microsculptured (shagreened); punctures on clypeus and lower half of frons barely discernable; those on upper half of frons and vertex fine, close, increasing discernable. Mesosoma finely microsculptured (shagreened); punctures larger than those on head, those on pronotum coarse and subconfluent, those on mesoscutum and scutellum finer and discrete. Gaster very finely punctured, shiny.

Male: Unknown.

Etymology. Named for the Atlantic seaboard where the species occurs.

Geographic distribution. Known from the seaboard of Western Cape of South Africa, the collecting sites being in the Strandveld of the West Coast of Acocks (1953).

Floral associations. Unknown.

Nesting. Unknown.

Discussion. *Quartinia atlantica* differs most obviously from *Q. arenaria* in that it is a robust species whereas the latter is a gracile species. This can readily be seen not only by comparing specimens of the two species by eye but by measurement. Two females of equal length (5.25 mm), one of each species (for *atlantica* the unstretched holotype), were measured for head and thorax width (head width = thorax width) which for *Q. atlantica* was 1.78 mm and for *Q. arenaria* a mere 1.42 mm. Expressed as the ratio of width to body length, the values are 0.34: 1 for *atlantica* and 0.27: 1 for *arenaria.*

Yellow pan trapping by S. van Noort at Koeberg Nature Reserve during 1997 yielded not only *Q. atlantica* Gess but also *Q. bonaespei* Gess, the former during the period 13 June to 28 November, the latter during the period 11 July to 28 November. No males of either species were obtained.

***Quartinia carolinae* sp. n.**

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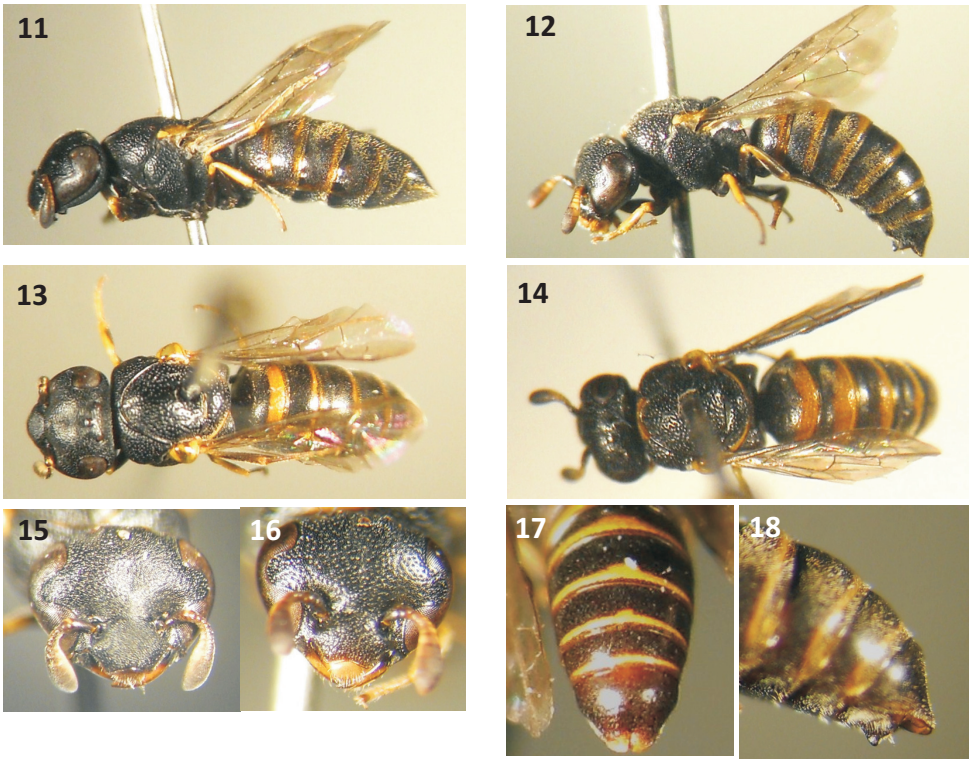
Figs 11–18

Holotype ♂, SOUTH AFRICA: NORTHERN CAPE: Namaqualand, Leliefontein (30.23S 18.16E), 19.ix.2002 (C. Mayer) (yellow trap) [AMG].

Paratypes. SOUTH AFRICA: NORTHERN CAPE: Namaqualand, Leliefontein (30.23S 18.16E), 5.ix.2002, ♀ (white trap); same locality, 19.ix.2002, 1 ♀, 2 ♂♂ (1 ♀, 1 ♂ yellow trap; 1 ♂ white trap); same locality, 21.ix.2002, 2 ♀♀ (1 ♀ yellow trap; 1 ♀ white trap); same locality, 7.x.2002, 1 ♂ (white trap); same locality, 14.x.2002, 1 ♀ (white trap); Namaqualand, Remhoogte (30.23S 18.16E), 12.ix.2002, 1 ♂ (white trap); same locality, 19.ix.2002, 1 ♂ (yellow trap); same locality, 21.ix.2002, 1 ♀ (yellow trap); same locality, 27.ix.2002, 1 ♂ (white trap); Namaqualand, Remhoogte (30.24S 18.17E), 19.ix.2002, 3 ♀♀ (yellow trap); same locality, 21.ix.2002, 1 ♀ (yellow trap) – all C. Mayer [all AMG].

Diagnosis. Large (4.5–5.3 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Tegula with posterior inner corner inwardly produced. Both sexes black marked with various shades of ferruginous. Male with sternum VII raised postero-medially to form a postero-ventrally directed tubercle.

Description. *Female* (Figs 11, 13, 15): Black. The following are yellowish ferruginous: underside of pedicel and flagellomeres (most noticeably underside of antennal club); tegula anteriorly and posteriorly; scutellar lamella laterally; apex of all femora; dorsal and anterior aspects of fore tibia; anterior aspect of middle and hind tibiae; proximal four tarsomeres of fore leg. Ferruginous are: mandible (except base); labrum; upperside of antenna; narrow and short band medially on pronotal dorsum; tegula medially; posterior bands (reaching sides and progressively narrower) on terga I – V; narrow posterior bands on sterna II – V (in some specimens); tibia and tarsomeres (other than for parts listed above) of all legs. Wings lightly browned; veins brown.



Figures 11–18. *Quartinia carolinae* **11** ♀, lateral view (× 10) **12** ♂, lateral view (× 10) **13** ♀, dorsal view (× 10) **14** ♂, dorsal view (× 10) **15** ♀, head, front view (× 17) **16** ♂, head, front view (×18) **17** ♂, tergum VII, dorsal view (× 16) **18** ♂, end of gaster showing tubercle on sternum VII, lateral view (× 22).

Length: 5.0–5.3 mm (average of 3: 5.1 mm); length of fore wing 3.0–3.2 mm (average of 3: 3.1 mm); hamuli 5.

Head in front view 1.3 × as wide as long; finely microreticulate (shagreened), moderately shiny, with shallow, indistinct punctures (more discernable on frons and vertex than on clypeus); POL: OOL = 1: 0.82. Clypeus 1.5 × as wide as long; anterior margin evenly emarginate; antero-lateral angles rounded.

Mesosoma microreticulate (shagreened), moderately shiny, with close punctures much larger than those on head.

Gaster very finely microreticulate, moderately shiny, with a few punctures (smaller than those on mesosoma) postero-medially on terga I and II.

Setae short and fine throughout.

Male (Figs 12, 14, 16–18): Black. Nature and distribution of markings very similar to those of female. Labrum of some specimens (including holotype) yellowish-ferruginous rather than ferruginous and therefore contrasting markedly with black clypeus. Tergum VI with a narrow ferruginous posterior band. Surface sculpture and setation as in female.

Length: 4.5–4.8 mm (average of 3: 4.6 mm); length of fore wing 2.8–3.1 mm (average of 3: 2.95 mm); hamuli 5–6.

Head in front view 1.3 × as wide as long; POL: OOL = 1: 0.82. Clypeus 1.5 × as wide as long.

Tergum VII with disc in proximal third slightly depressed, apico-medially with a narrow, subparallel-sided slit, and with lobes flanking slit rounded. Sternum VII raised postero-medially to form a postero-ventrally directed tubercle.

Etymology. Named for Caroline Mayer of BIOTA-Southern Africa, Hamburg University, who collected the material during her studies in Namaqualand.

Geographic distribution. Known only from two contiguous localities situated in the Macchia (Fynbos) of the Kamiesberg.

Floral associations. Unknown.

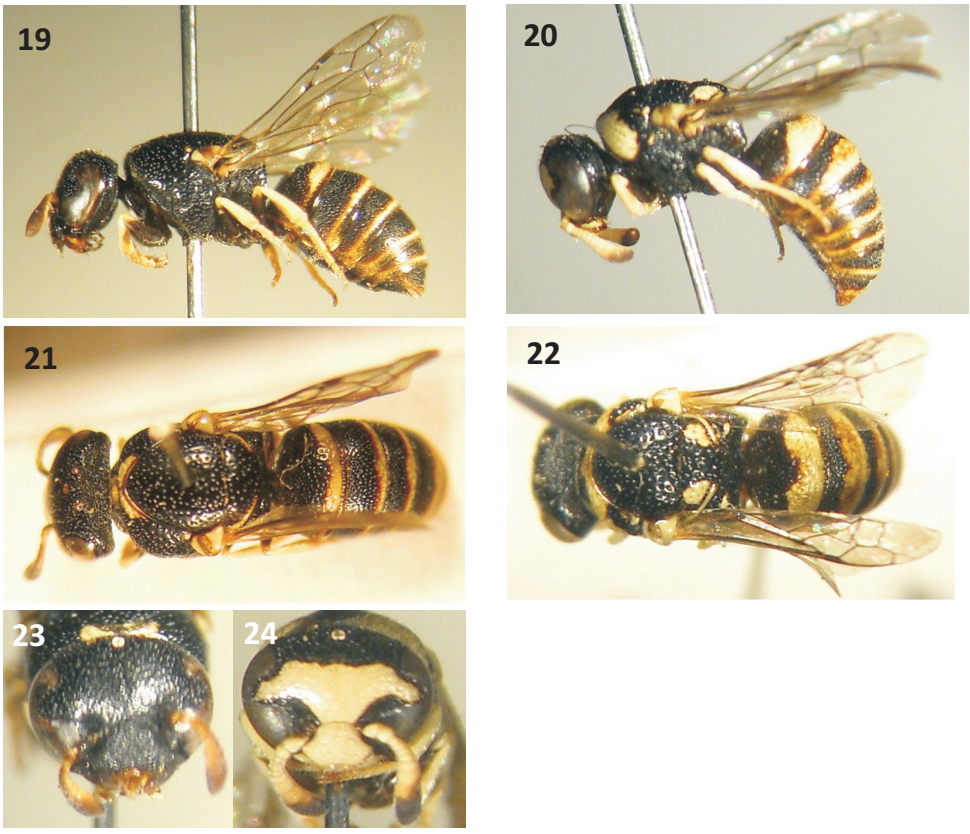
Nesting. Unknown.

***Quartinia frontalis* sp. n.**
urn:lsid:zoobank.org:act:E6384D4B-8E6D-4DE5-851C-EF604D2D2C4C
Figs 19–24

Quartinia sp. E. (Gess, S. K., 1996: 249, flower visiting; Gess and Gess 2003: 66,flower visiting.)

Holotype ♂, SOUTH AFRICA: NORTHERN CAPE: Namaqualand, Springbok, Hester Malan Nature Reserve [Goegap], 10–11.x.1989 (F. W. and S. K. Gess) (visiting fls of *Wahlenbergia pilosa* Buek., Campanulaceae) [AMG].

Paratypes. SOUTH AFRICA: NORTHERN CAPE: Namaqualand, Springbok, Hester Malan Nature Reserve [Goegap], 10–12.x.1988, 1 ♂; same locality, 10–11.x.1989, 5 ♀♀, 1 ♂ (visiting fls of *Wahlenbergia pilosa* Buek., Campanulaceae); Goegap (windmill site) (29.37S 17.59E), 5.x.1994, 1 ♀, 1 ♂ (on yellow fls of *Leysera tenella* A .DC., Asteraceae); same locality, 7.x.1994, 1 ♀ (on/in fls of *Wahlenbergia namaquana* Sond.); Goegap (Kraaiwater site) (29.38S 18.00E), 30.ix.1997, 2 ♀♀ (1 ♀ visiting pale pink fls of *Psilocaulon acutisepalum* (Berger) N. E. Br., Aizoaceae: Mesembryanthema; 1 ♀ visiting dark pink fls of *Galenia sarcophylla* Fenzl, Aizoaceae: non-Mesembryanthema); Namaqualand, Voëlklip (29.45S 17.22E), 2.x.1994, 24 ♀♀ (13 ♀♀ on light violet fls of *Wahlenbergia annularis* A. DC.; 9 ♀♀ on small pinkish-violet fls of *Wahlenbergia namaquana*; 2 ♀♀ on dry sandy ground); same locality, 7.x.1994, 25 ♀♀ (7 ♀♀ on light violet fls of *Wahlenbergia annularis*; 17 ♀♀ on small pinkish-violet fls of *Wahlenbergia namaquana*; 1 ♀ on violet fls of *Wahlenbergia pilosa*); Namaqualand, 25 km N [of] Kamieskroon (30.01S 17.33E), 17.x.2000, 3 ♀♀ (visiting yellow fls of *Leysera tenella*); Namaqualand, Taaiboskraal/Anagas (30.07S 18.01E), 3.x.1995 (F. W., S. K. and R. W. Gess), 3 ♀♀ (1 ♀ in violet flowers of *Wahlenbergia* sp.); Namaqualand, Sors Sors/Taaiboskraal (30.08S 18.01E), 3.x.1995 (F. W., S. K. and R. W. Gess), 1 ♀, 1 ♂ (in violet flowers of *Wahlenbergia* sp.) – (all F. W. and S. K.Gess, unless otherwise stated) [all AMG]; [Namaqualand], Farm Dassiefontein near Kamieskroon (30.09S 17.59E), 1.x.1990 (C. Eardley), 1 ♀ [SANC]; [Namaqualand],



Figures 19–24. *Quartinia frontalis* **19** ♀, lateral view (× 10) **20** ♂, lateral view (× 12) **21** ♀, dorsal view (× 10) **22** ♂, dorsal view (× 12) **23** ♀, head, front view (× 15) **24** ♂, head, front view (× 17).

Farm Arkoep, 6 km N [of] Kamieskroon (30.19S 17.56E), 1–2.x.1990 (C. Eardley), 15 ♀♀, 2 ♂♂ [SANC].

Diagnosis. Medium to large (4.4–5.5 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Both sexes with thorax and gaster subshiny with coarse punctures; scutellum only gently convex medially. Female with scutellum black and lamella pale. Male with mandible white and tip ferruginous; labrum and clypeus wholly white; antennal club black dorsally, white ventrally; frons with white marking expanded laterally into (but not filling) ocular sinus; scutellum with a pair of pale streaks laterally and pale lamella; sternum VII subglabrous and apically with fringe of fine setae.

Description. *Female* (Figs 19, 21, 23): Black. The following are yellowish-white: underside of antenna; pair of streaks (usually joined medially) on pronotal dorsum and minute spot at postero-dorsal angle of same; humeral spot (in minority of specimens); tegula anteriorly and posteriorly; scutellar lamella laterally; posterior bands (not reaching sides and progressively reduced) on terga I – V; apex of femur, most of tibia, all but last tarsomere of all legs. The following are ferruginous: mandible (except base); upper side of antenna; tegula medially; terga I – V narrowly laterally

and posteriorly; sterna narrowly posteriorly; last tarsomere. Wings lightly browned; veins brown.

Length 5.4–5.5 mm (average of 3: 5.4 mm); length of fore wing 3.3–3.4 mm (average of 3: 3.4 mm); hamuli 4–5.

Head in front view 1.3 × as wide as long; with moderately coarse sub-confluent punctures and microreticulate interstices. POL: OOL = 1: 0.85. Clypeus 1.5 × as wide as long (to bottom of emargination); convex, markedly raised laterally and distally, falling steeply to anterior margin; anterior margin very shallowly and widely emarginate; antero-lateral angles rounded.

Mesosoma subshiny with coarse punctures separated by less than their diameter (on the pronotum) or by their diameter or more (on the centre of the mesoscutum and on the scutellum); interstices very finely microreticulate (shagreened). Tegula with inner posterior corner markedly inwardly produced. Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Scutellum medially evenly and gently convex.

Gaster with first and second terga with coarse sub-confluent punctures and shagreened interstices; terga III – VI with puncturation progressively less coarse and closer.

Male (Figs 20, 22, 24): Black. The following are yellowish white: mandible (except tip); labrum; clypeus; large marking on frons with its base immediately above clypeus and dorsally expanded laterally into (but not filling) ocular sinus; scape, pedicel and proximal flagellomeres; broad band across anterior margin of pronotum (carried down to humeral angle) and small spot on postero-dorsal angle of same; a minute to small streak at top of mesopleuron; tegula anteriorly and posteriorly; a pair of lateral spots on scutellum; scutellar lamella laterally; posterior bands (not reaching sides and progressively reduced) on terga I – VI; diffuse area on tergum VII; apex of femur, most of tibia, proximal four tarsomeres of all legs. The following are ferruginous: mandibular tip; antennal club (dark above, light below); lateral margins of terga and posterior bands laterally; irregular narrow band between yellowish-white posterior band and basal black area on terga I – VI; irregular non yellowish-white areas on tergum VII; all sterna; last tarsomere of all legs. Wings very lightly browned; veins brown.

Length 4.4–4.6 mm (average of 3: 4.5 mm); length of fore wing 2.80–2.84 mm (average of 3: 2.8 mm); hamuli 4–5.

Head in front view 1.5 × as wide as long; POL: OOL = 1: 0.9. Clypeus 1.67 × as wide as long (to bottom of emargination), convex, markedly raised laterally and distally, falling steeply to anterior margin; anterior margin very shallowly and widely emarginate; antero-lateral angles rounded. Puncturation of head, mesosoma and gaster similar to that of female.

Gaster with tergum VII with a short median V-shaped slit; lobes flanking slit rounded. Sterna atuberculate; sternum VII subglabrous with only a few scattered, fine setae and apically with fringe of closer fine setae.

Etymology. The name *frontalis* serves to draw attention to the frons which in the male has a characteristic white marking expanded laterally into (but not filling) the ocular sinus.

Geographic distribution. Known from the north-western Northern Cape (Namaqualand; winter rainfall region) of South Africa, the collecting localities being sited in the Namaqualand BrokenVeld and the Mountain Renosterbosveld of Acocks (1953).

Floral associations. Principally Campanulaceae (*Wahlenbergia*); to a lesser extent Asteraceae (*Leysera*) and Aizoaceae (*Galenia* and *Psilocaulon*).

Nesting. Unknown.

Discussion. Sympatric with the generally similar looking *scutellaris*, *setositerminalis* and *vagepunctata.*

***Quartinia luteomandibulata* sp. n.**
urn:lsid:zoobank.org:act:B45854D1-0427-4FD2-80A2-F9151C385992
Figs 25–27

Holotype ♀, SOUTH AFRICA: WESTERN CAPE: Lamberts Bay (32.05S 18.19E), 28.ix.2005 (F. W. and S. K. Gess) (visiting yellow flowers of *Conocosia* sp., Aizoaceae: Mesembryanthema) [AMG].

Paratypes. SOUTH AFRICA: NORTHERN CAPE: Koingnaas Mines (30.10S 17.14E), 12–17.xi.2007 (C. Lyons), ♀ (from pan trap) [AMG]; SOUTH AFRICA: WESTERN CAPE: Lamberts Bay (32.05S 18.19E), 28.ix.2005 (F. W. and S. K. Gess), ♀ (visiting yellow flowers of *Conocosia* sp., Aizoaceae: Mesembryanthema) [AMG].

Diagnosis. Large (5.2–5.6 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Tegula with posterior inner corner inwardly produced. Female (male unknown) with mandible at least in part pale yellow, contrasting strikingly with totally black clypeus.

Description. *Female* (Figs 25–27): Black. The following are pale yellow: basal half of mandible (to variable extent; tending proximally to change to light ferruginous); underside of scape, pedicel and proximal flagellomeres; pair of large quadrangular markings (in paratype from Koingnaas partly fused) on lower half of frons immediately above clypeo-frontal suture; most of ocular sinus; streak of variable length on temple behind top of eye; pair of wedge-shaped markings (meeting or very narrowly separated medially) on anterior margin of pronotum and extreme postero-dorsal angle of same; large mark on humeral angle; mark of variable extent (large or broken up into a number of small spots or totally effaced) on mesopleuron; tegula (except for ferruginous median area); spot basally on each side of scutellum (effaced in paratype from Lamberts Bay); scutellar lamella (interrupted posteriorly); marking on propodeal angle (reduced in paratype from Lamberts Bay to small spot on dorsum of propodeum); posterior bands reaching or not reaching sides on terga I – V; band on tergum I widest; those on terga I – V progressively narrower but medially and laterally slightly anteriorly produced; apex of femur, tibia (except dark area posteriorly at mid length) of all legs. Light ferruginous are: apical half or more of mandible; underside of antennal club; tarsomeres of all legs. Dark ferruginous are: apex of mandible; labrum; upper side of antenna; median area of tegula; claws. Wings very lightly browned; veins brown.

Figures 25–27. *Quartinia luteomandibulata* **25** ♀, lateral view (× 10) **26** ♀, dorsal view (× 11) **27** ♀, head, front view (× 15).

Length 5.2–5.6 mm (average of 3: 5.5 mm); length of fore wing 3.3 mm (average of 3); hamuli 4.

Head in front view 1.3 × as wide as long; POL: OOL = 1: 0.6. Clypeus 1.43 × as wide as long; anterior margin widely V-shaped; antero-lateral corners obtusely rounded.

Clypeus, frons and vertex microreticulate (shagreened) with small, close, not very discernable punctures; mesosoma microreticulate (shagreened) with obvious punctures, larger than those on vertex; punctures on mesonotum with interstices equal to or exceeding puncture width, those on scutellum generally closer; gaster moderately shiny, very finely microreticulate (shagreened), with very small punctures.

Male: Unknown.

Etymology. The name *luteomandibulata* refers to the female's predominantly yellow mandibles which contrast strikingly with the totally black clypeus and in so doing present a most unusual appearance.

Geographic distribution. Known only from two localities on the west coast of the Northern and Western Cape, both being in the Strandveld of the West Coast of Acocks (1953).

Floral associations. Aizoaceae: Mesembryanthema (*Conocosia* sp.).

Nesting. Unknown.

Quartinia namaquensis Gess

Figs 28–34

Quartinia namaquensis Gess, 2007: 220, ♂. Holotype: ♂, South Africa: Northern Cape: Leliefontein (AMG).

Notes. This species was described from three males from Leliefontein, collected by Caroline Mayer and one male from W of Wallekraal, collected by F. W. and S. K. Gess. The female was stated to be unknown, "none of the specimens of several species from the relevant localities being assignable with any degree of confidence to this species".

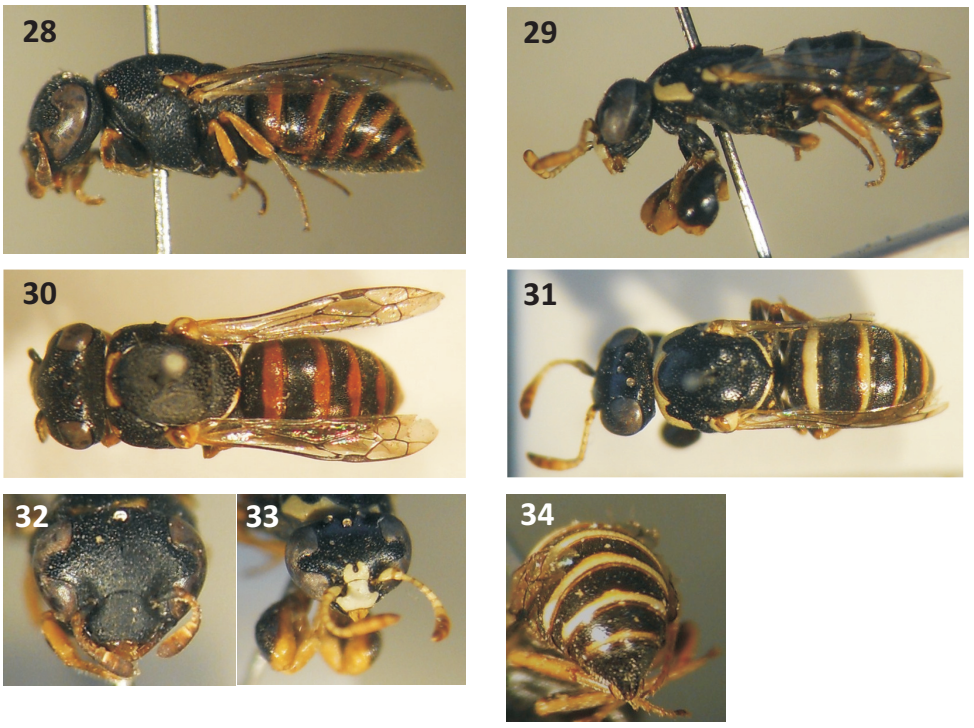
Recent collecting at Rooikloof Farm near Sutherland by F. W. and S. K. Gess and others produced a single male of *Q. namaquensis* and 58 females, believed to be conspecific, the male and the great majority of the females visiting the flowers of *Wahlenbergia* near *polyclada* A.DC (Campanulaceae). The scarcity of males was most likely due to the fact that collecting took place towards the end the species' flight period at that particular locality.

In the light of the above association, the undetermined material collected by Caroline Mayer was re-examined and it was found that four females, two from Leliefontein (the type locality of the male) and two from nearby Remhoogte, were clearly conspecific with the females from Rooikloof Farm, and that these should therefore likewise be assigned to *Q. namaquensis.*

Description. *Female* (hitherto undescribed) (Figs 28, 30, 32): Virtually indistinguishable from the female of *Q. conchicola* Gess, the differences being subtle. Most notable is that the vertex behind the posterior ocelli is rounded, not depressed and somewhat concave. The occipital carina therefore appears less pronounced. Satisfactory identification of the females of both species is, however, dependant upon their association with the relative males which, in their secondary sexual characters, are strikingly distinct (see Gess 2007).

Male (previously adequately described) (Figs 29, 31, 33, 34).

Additional material examined. SOUTH AFRICA: NORTHERN CAPE: Leliefontein (30.23S 18.16E), 11.ix.2003 (C. Mayer), 1 ♀ (yellow trap); same locality, 23.ix.2003 (C. Mayer), 1 ♀ (white trap); Remhoogte (30.23S 18.16E), 11.ix.2003 (C. Mayer), 2 ♀♀ (1 ♀ yellow trap; 1 ♀ white trap); Sutherland district, Rooikloof Farm



Figures 28–34. *Quartinia namaquensis* **28** ♀, lateral view (× 10) **29** ♂, lateral view (× 9) **30** ♀, dorsal view (× 9) **31** ♂, dorsal view (× 9) **32** ♀, head, front view (× 14) **33** ♂, head, front view (× 10) **34** ♂, tergum VII, dorsal view (× 13).

(32.26S 20.39E), 30.ix.2009 (F.W. and S. K. Gess), 12 ♀♀ (5 ♀♀ visiting pale violet flowers of *Wahlenbergia* near *polyclada* A.DC., Campanulaceae; 4 ♀♀ visiting yellow flowers of *Leysera tenella* DC., Asteraceae; 3 ♀♀ visiting pale violet flowers of *Selago* sp., Scrophulariaceae); same locality, 1.x.2009 (F. W. and S. K. Gess), 10 ♀♀, 1 ♂ (6 ♀♀, 1 ♂ visiting pale violet flowers of *Wahlenbergia* near *polyclada*; 3 ♀♀ on ground between plants of *Wahlenbergia* near *polyclada*); same locality, 5.x.2009 (F. W. and S. K. Gess), 16 ♀♀ (10 ♀♀ visiting pale violet flowers of *Wahlenbergia* near *polyclada;* 3 ♀♀ visiting pale violet flowers of *Selago* sp.,); same locality, 8.x.2009 (F. W. and S. K. Gess), 4 ♀♀ (visiting pale violet flowers of *Wahlenbergia* near *polyclada*); same locality, 9.x.2009 (F. W. and S. K. Gess), 11 ♀♀ (9 ♀♀ from yellow pan traps associated with *Wahlenbergia* near *polyclada*; 1 ♀ from yellow pan traps associated with pale violet flowered *Selago* sp.; 1 ♀ from yellow pan traps associated with *Leysera tenella*); same locality, 10.x.2009 (D. W. Gess), 4 ♀♀ (2 ♀♀ visiting pale violet flowers of *Wahlenbergia* near *polyclada*; 2 ♀♀ visiting yellow flowers of *Chrysocoma* sp., Asteraceae); same locality and date (F. W. and S. K. Gess), 1 ♀ associated with *Wahlenbergia* near *polyclada*) – [all AMG].

Geographic distribution. Known from the Northern Cape, the collecting localities being sited in the Succulent Karoo, the Mountain Renosterbosveld and at the in-

terface of the Mountain Renosterbosveld and the Western Mountain Karoo of Acocks (1953).

Floral associations. Asteraceae (*Chrysocoma*, *Leysera*), Campanulaceae (*Wahlenbergia)* and Scrophulariaceae (*Selago*). The floral associations were previously unknown (see Gess, 2007: 221).

Discussion of Nesting. As was recorded previously (Gess 2007: 221) a male was reared from a cell in a sand-filled shell of the desert snail *Trigonephrus* sp. (Mollusca: Gasteropoda: Pulmonata: Dorcasiidae) collected W of Wallekraal. On the basis of this rearing, *Quartinia namaquensis* was grouped together with seven other species characterized as nesting in sand-filled snail shells. One of these other species, *Q. refugicola* Gess, though throughout its presently known distribution found to nest in sand-filled shells, was found at Rosh Pinah to nest in addition in sand-filled cavities in calcrete rocks. Consequently, nesting in snail shells by *Q. rufigicola* must be considered to be facultative rather than obligatory. The same must be true for *Q. namaquensis* (and possibly for the other species nesting in snail shells), for at the site at Sutherland, where the species was so common, no suitable snail shells were present.

Quartinia namibensis sp. n.

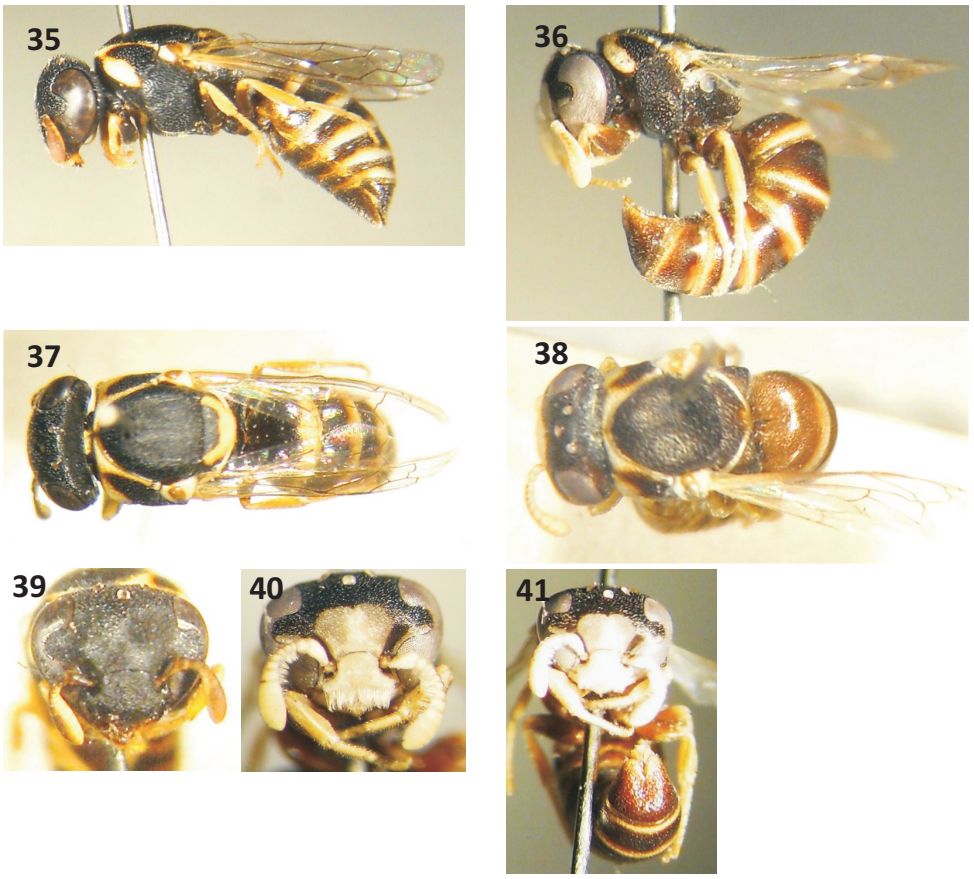
urn:lsid:zoobank.org:act:48F4044D-C087-4B62-88C7-D7E4E9C76ED9
Figs 35–41

Holotype ♀, NAMIBIA: Sperrgebiet, Klinghardtberge, Tsabiam's Camp (27.10S 15.42E), 4.ix.2002 (F. W. and S. K. Gess) [AMG].

Paratypes. NAMIBIA: Sperrgebiet, Klinghardtberge, Nomitsas (27.27S 15.52E), 31.viii.2002 (F. W. and S. K. Gess), ♀ (visiting yellow flowers of *Grielum sinuatum* Licht. ex Burch., Neuradaceae) [AMG]; NAMIBIA: Diamond Area 1: Roter Kamm (27.46S 16.18E), 25–30.vi.1989 (C. S. Roberts), 2 ♂♂ [♂ NNIC; ♂ AMG].

Diagnosis. Large (4.8–5.4 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as the other veins. Tegula whitish-yellow (other than for testaceous median area), with posterior inner corner inwardly produced and acute. Mesosoma and gaster black, richly marked with whitish-yellow. Metanotum of both sexes whitish-yellow. Male with striking and unique, long, pale, apically curved setae on ventral surface of flagellomeres 1–7, on labrum and on distal third of clypeus.

Description. *Female* (Figs 35, 37, 39): Black. The following are various shades of whitish-yellow: underside of antenna; medially interrupted band on anterior margin of pronotum, carried down to and expanded in humeral area, and narrowly extended along hind margin to postero-dorsal angle; tegula (other than for testaceous median area); tri-lobed curved band on disk of scutellum (leaving a bi-lobed black basal area); entire scutellar lamella; metanotum; ill-defined small area dorsally on propodeum (in paratype only); posterior bands attaining sides and somewhat anteriorly widened medially and laterally on terga I – V. Reddish yellow are: narrow subapical posterior bands on sterna II – V; median part of mandible; apex of femur, tibia (except dark brown



Figures 35–41. *Quartinia namibensis* **35** ♀, lateral view (× 10) **36** ♂, lateral view (× 12) **37** ♀, dorsal view (× 10) **38** ♂, dorsal view (× 12) **39** ♀, head, front view (× 14) **40** ♂, head, front view (× 16) **41** ♂, tergum VII, dorsal view (× 12).

streak on fore tibia) and tarsus of all legs. Upper surface of antenna dark reddish-brown; wings sub-hyaline; stigma and veins light brown.

Length 5.4 mm; length of fore wing 3.6 mm; hamuli 4.

Head in front view 1.35 × as wide as long. POL: OOL = 1: 0.55. Clypeus, frons and vertex microreticulate (shagreened) with dense, small, shallow punctures (barely discernable on clypeus and lower half of frons, obvious on upper half of frons and on vertex).

Thorax semi-matt, distinctly microreticulate (shagreened) and punctured; punctures larger and more clearly defined than on head; interstices varying from less than puncture width to more than double puncture width. Tegula with posterior inner corner inwardly produced and acute. Fore wing with Cu1a and 2*m-cu* complete and as thick as the other veins.

Gaster moderately shiny, with small, indistinct punctures.

Male (Figs 36, 38, 40, 41): Black.The following are various shades of whitish-yellow: antenna (except narrow ferruginous mark dorsally on scape, pedicel and proxi-

mal flagellomeres); mandible; labrum; clypeus; paraocular area (streak carried narrowly upwards from mandibular insertion into lower half of ocular sinus where slightly widened); large, median, dorsally bi-lobed marking on frons (extending from clypeo-frontal suture to level of top of ocular sinus); band on anterior margin of pronotum, carried down to and expanded in humeral area, and narrowly extended along hind margin to postero-dorsal angle; tegula (other than for testaceous median area); transverse, postero-median spot on scutellum; entire scutellar lamella; metanotum; posterior bands attaining sides and slightly anteriorly widened medially and laterally on terga I – VI. Reddish-yellow are: apex of femur, tibia (except dark brown streak on fore tibia) and tarsus of all legs. Wings sub-hyaline; stigma and veins light brown.

Length circa 4.8 mm; length of fore wing 3.1 mm; hamuli 4.

Head in front view 1.4 × as wide as long; POL: OOL = 1: 0.6.

Surface sculpture of head, thorax and gaster as in female. Tegula as in female. Flagellomeres 1–7 ventrally, labrum, clypeus on distal third with long, pale, apically curved setae; length of setae on antennae approximating or exceeding width of proximal flagellomeres, that of setae on clypeus longer. Tergum VII somewhat depressed, apico-medially with a V-shaped slit; lobes flanking slit rounded. Sterna atuberculate. Parameres rounded apically, without a tooth.

Etymology. The name, *namibensis*, an adjective, is derived from the Namib Desert, and refers to the provenance of the species.

Geographic distribution. Known only from the Sperrgebiet (Diamond Area 1) of Namibia, that is from the Desert and Succulent Steppe (Winter rainfall area) of Giess (1971).

Floral associations. *Grielum sinuatum* Licht. ex Burch. (Neuradaceae).

Nesting. Unknown.

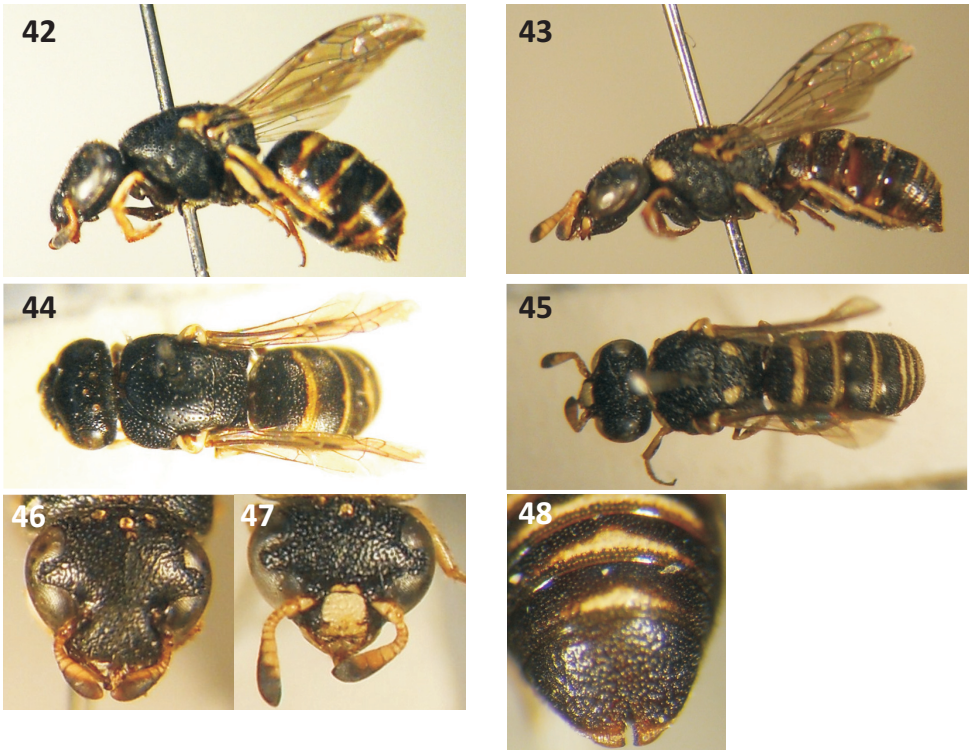
Discussion. The two females from Nomitsas and Tsabiam's Camp (both localities in the Klinghardtberge) and the two males from Roter Kamm (below and south-west of the Aurusberg) are here associated on the basis of general similarity, allowance being made for secondary sexual differences. The association requires confirmation by the study of material of both sexes found flying together in one or more localities.

Quartinia parcepunctata Richards

Figs 42–48

Quartinia parcepunctata Richards 1962: 133 and 135 (key), 167–169, ♀♂. Holotype: ♀, South Africa: Western Cape: Cape Town (United States National Museum). – Gess 1996: 246 (flower visiting); Carpenter 2001: 27 (listed); Gess and Gess 2003: 61 (flower visiting).

Diagnosis. Medium to large (4.3–5.2 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as the other veins. Tegula whitish-yellow (other than for testaceous to ferruginous median area), with posterior inner corner markedly inwardly produced



Figures 42–48. *Quartinia parcepunctata* **42** ♀, lateral view (× 10) **43** ♂, lateral view (× 10) **44** ♀, dorsal view (× 9) **45** ♂, dorsal view (× 9) **46** ♀, head, front view (× 16) **47** ♂, head, front view (× 17) **48** ♂, tergum VII, dorsal view (× 26).

and acute. Head in front view wider than long; angle of propodeum unmodified. Female with mesoscutum sparsely and coarsely punctured; with gaster closely punctured, coarsely so anteriorly. Male with antennal club, legs and tergumVII unmodified (simple); mesoscutum closely and coarsely punctured, gaster closely punctured, coarsely so anteriorly; head with mandibles, labrum and clypeus largely whitish-yellow, frons with small (often bilobed) marking immediately above clypeo-frontal suture.

Description. *Female* (previously adequately described) (Figs 42, 44, 46).

Male (previously adequately described) (Figs 43, 45, 47, 48).

Material examined. SOUTH AFRICA: Western Cape: W[estern] side of Pakhuispas nr Clanwilliam, 2000 ft. [32.08S 18.54E], 3.xi.1966 (J .G. Rozen), 1 ♀ (det. J. M. Carpenter) [AMNH]; Clanwilliam District, 11 km W of Clanwilliam on road to Graafwater (32.09S 18.44E), 2–8.x.1990 (F. W. and S. K. Gess), 2 ♀♀; Clanwilliam District, 5 km W [of] Clanwilliam [on] road to Graafwater (32.10S 18.51E), 5–6.x.1988 (F. W., S.K. and D. W. Gess), 4 ♀♀, 1 ♂ (4 ♀♀ in violet fls of *Microcodon sparsiflorum* A. DC., Campanulaceae); Clanwilliam District, Clanwilliam Dam (32.11S 18.54E), 3–7.x.1988 (F. W., S. K. and D.W.Gess), 35 ♀♀, 12 ♂ (18 ♀♀, 2 ♂♂ in violet fls of *Wahlenbergia paniculata* (Thunb.) A. DC., Campanulaceae); same

locality, 16–20.x.1989 (F. W., S. K. and D. W. Gess), 4 ♀♀, 1 ♂ (3 ♀♀ in violet fls of *Wahlenbergia paniculata*); Clanwilliam Disttrict: Klein Alexandershoek (32.20S 18.46E), 1–2.x.1990 (F. W. and S. K. Gess), 4 ♀♀ (in violet fls of *Wahlenbergia* cf. *constricta* V. Brehmer, Campanulaceae); 29 km ENE of Ceres (Therons Pass) (33.15S 19.35E), 29.xi.1989 (F. W., S. K. and H. W. Gess), 9 ♀♀ (in violet fls of *Wahlenbergia ecklonii* Buek, Campanulaceae). – [all AMG].

Provenance of specimens examined by Richards (1962). SOUTH AFRICA: WESTERN CAPE: Cape Town.

Geographic distribution. Known from the west-central and north-western part of the Western Cape of South Africa, all presently listed collecting sites being in the Macchia (Fynbos) of Acocks (1953). The type locality, given as Cape Town, falls well outside the above distribution and it is therefore open to question whether it is correct.

Floral associations. Campanulaceae (*Microcodon sparsiflorum* A. DC., *Wahlenbergia* cf. *constricta* V. Brehmer, *W. ecklonii* Buek, *W. paniculata* (Thunb.) A. DC.). On four separate occasions and at three localities in the Clanwilliam District *Quartinia parcepunctata* was found together with *Quartinia persephone.* On three of these occasions the two species were visiting the same flowers (*Microcodon* and *Wahlenbergia*).

Nesting. Unknown.

Discussion. Richards (1962: 169) expressed a slight element of uncertainty with regard to the association of the sexes in stating "the male probably belongs to this species although the mesoscutum is very much more closely punctured". The presently examined material confirms the association of the sexes as described by Richards.

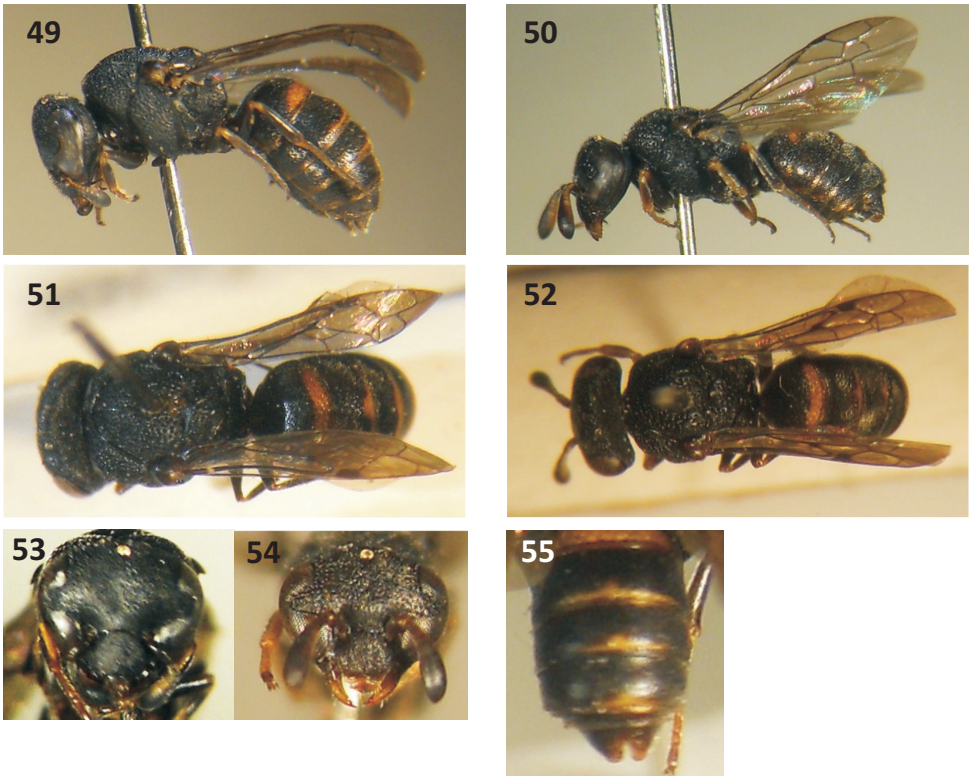
Quartinia persephone Richards

Figs 49–55

Quartinia persephone Richards 1962: 133 (key), 165, ♀. Holotype: ♀, South Africa: Northern Cape: Calvinia (BMNH). – Gess 1996: 246 (flower visiting); Carpenter 2001: 27 (listed); Gess and Gess 2003: 61 (flower visiting).

Diagnosis. Medium to large (3.8–4.6 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as the other veins. Tegula brown (that of female occasionally pale posteriorly) with posterior inner corner markedly inwardly produced and acute. Body black with posterior bands on terga orange-brown. Head in front view wider than long; angle of propodeum unmodified. Female with mesoscutum closely and coarsely punctured; interstices finely reticulate; with gaster closely and finely punctured with some coarser punctures on terga I and II. Male with antennal club, legs and tergum VII unmodified (simple); mesoscutum and gaster with sculpture as in female; head with labrum, mandible distally, scape, pedicel and proximal flagellomeres brown; underside of antennal club light orange-brown.

Description. *Female* (previously adequately described) (Figs 49, 51, 53).



Figures 49–55. *Quartinia persephone* **49** ♀, lateral view (× 12) **50** ♂, lateral view (× 11) **51** ♀, dorsal view (× 12) **52** ♂, dorsal view (× 12) **53** ♀, head, front view (× 15) **54** ♂, head, front view (× 19) **55** ♂, tergum VII, dorsal view (× 20).

Male (hitherto undescribed) (Figs 50, 52, 54, 55): Black. The following are brown: labrum; distal two thirds of mandible; scape, pedicel and proximal flagellomeres; tegula.The following are light orange-brown: underside of antennal club (more proximal flagellomeres of club almost white); posterior bands on terga I – IV (that on I broad but not attaining lateral margins; those on II – IV progressively narrower and shorter); apex of femur, base and apex of tibia, tarsomeres of all legs (fore and middle tibiae anteriorly with a band connecting basal and apical pale areas). Wings lightly infuscate; venation dark brown.

Length 3.8–4.6 mm (average of 3: 4.2 mm; length of front wing 2.8–3.0 mm (average of 3: 2.8 mm); hamuli 4.

Puncturation as in female. Tergum VII with a median slit; lobes flanking slit rounded terminally. Sterna atuberculate.

Material examined. SOUTH AFRICA: NORTHERN CAPE: 15 km N of Nieuwoudtville on road to Loeriesfontein, [Skuinshoogte Pass] (31.16S 19.08E), 3–8.x.1989 (F. W. Gess), 1 ♀ (on yellow rayed *Senecio* sp., Asteraceae); 6 km W [of] Nieuwoudtville on road to Van Rhyns Pass (31.22S 19.03E), 25.ix.1994 (F. W. and

S. K. Gess), 7 ♀♀ (5 ♀♀ in/on pale violet fls of *Wahlenbergia* sp., Campanulaceae; 2 ♀♀ on yellow fls of *Leysera gnaphalodes* (L.) L., Asteraceae); WESTERN CAPE: Olifants River Bridge, Clanwilliam – Klawer (31.50S 18.37E), 27.ix.1985 (F. W. and S. K. Gess), 1 ♀ (det. J. M. Carpenter, 1986) (on white pink fls of *Prenia pallens* (Ait.) N. E. Br., Aizoaceae: Mesembryanthema); Clanwilliam District, 5 km W [of] Clanwilliam [on] road to Graafwater (32.10S 18.51E), 5–6.x.1988 (F. W., S. K. and D. W. Gess), 1 ♀, 3 ♂♂ (in violet fls of *Microcodon sparsiflorum* A. DC., Campanulaceae); Clanwilliam District, Clanwilliam Dam (32.11S 18.54E), 3–7.x.1988 (D.W.Gess), 2♀♀ (in violet fls of *Wahlenbergia paniculata* (Thunb.) A. DC., Campanulaceae); same locality, 16–20.x.1989 (S. K. Gess), 2 ♀♀ (in violet fls of *Wahlenbergia paniculata*); Clanwilliam Disttrict: Klein Alexandershoek (32.20S 18.46E), 1–2.x.1990 (F. W. and S. K. Gess), 1 ♀ (on yellow fls of *Athenasia trifurcata* (L.) L., Asteraceae) – [all AMG].

Provenance of material examined by Richards (1962). SOUTH AFRICA: NORTHERN CAPE: Calvinia.

Geographic distribution. Known from the north-western part of the Western Cape and the adjacent south western part of the Northern Cape of South Africa, many (but not all) of the collecting sites being in the Macchia (Fynbos) of Acocks (1953).

Floral associations. Aizoaceae: Mesembryanthema (*Prenia pallens* (Ait.) N. E. Br.); Asteraceae (*Athenasia trifurcata* (L.) L., *Leysera gnaphalodes* (L.) L., *Senecio* sp.); Campanulaceae (*Microcodon sparsiflorum* A. DC., *Walhlenbergia paniculatum* (Thunb.) A. DC., *Wahlenbergia* sp.). On four separate occasions and at three localities in the Clanwilliam District *Quartinia persephone* was found together with *Quartinia parcepunctata.* On three of these occasions the two species were visiting the same flowers (*Microcodon* and *Wahlenbergia*).

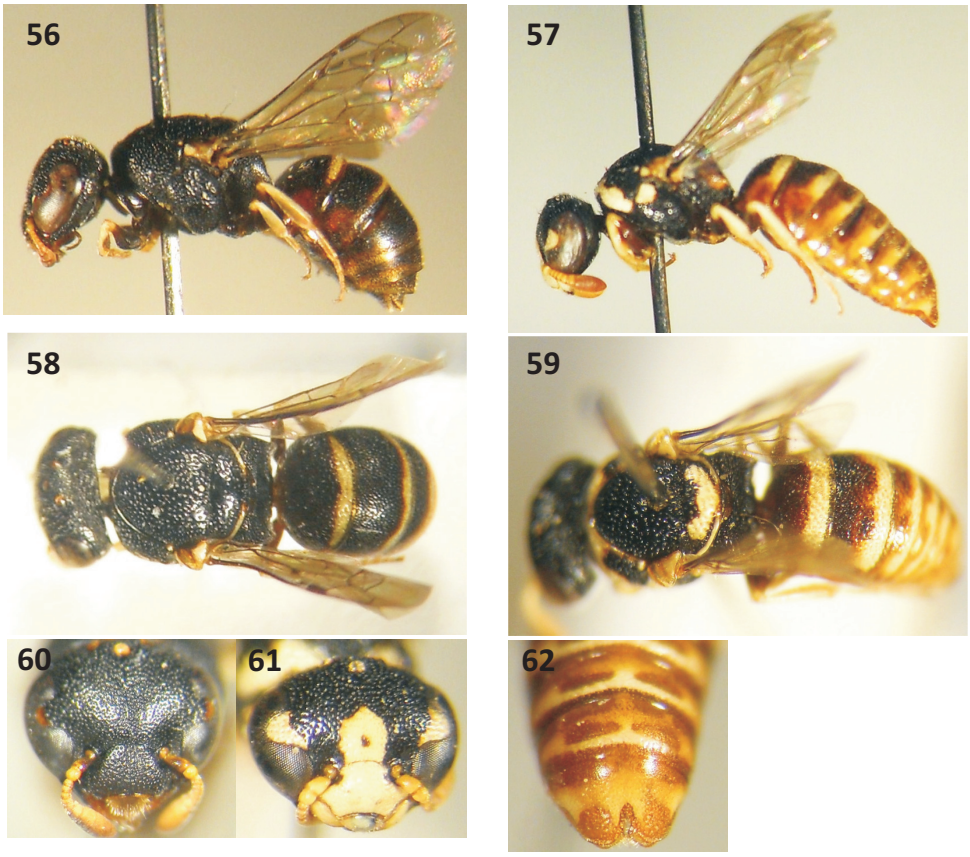
Quartinia scutellaris sp. n.

urn:lsid:zoobank.org:act:D689EBBA-A17B-4D3C-ACBD-7D7C714F2029
Figs 56–62

Quartinia sp. D. (Gess 1996: 249, flower visiting; Gess and Gess 2003: 66, flower visiting.)

Holotype ♂, SOUTH AFRICA: NORTHERN CAPE: Nieuwoudtville Falls, 5 km N of Nieuwoudtville (31.19S 19.07E), 28.ix.1990 (F. W. and S. K. Gess) (on yellow fls of *Leysera gnaphalodes* (L.) L., Asteraceae) [AMG].

Paratypes. SOUTH AFRICA: NORTHERN CAPE: Namaqualand, Springbok, Hester Malan Nature Res[erve] [now Goegap Nature Reserve] (29.37S 18.00E), 10–12.x.1988 (D. W. Gess), 2 ♀♀, 1 ♂; same locality, 10–11.x.1989 (F. W. and S. K. Gess), 5 ♀♀ (3 ♀♀ visiting fls of *Leysera gnaphalodes* (L.) L., Asteraceae); same locality and date (D. W. Gess), 1 ♀; same locality (windmill site) (29.37S 17.59E), 4–8.x.1994 (F. W. and S. K. Gess), 2 ♀♀ (on yellow fls *Leysera tenella* DC, Asteraceae); Namaqualand, Narap (Narab) (29.53S 17.46E), 14.x.1989 (F. W. and S. K. Gess), 5



Figures 56–62. *Quartinia scutellaris* **56** ♀, lateral view (× 12) **57** ♂, lateral view (× 11) **58** ♀, dorsal view (× 12) **59** ♂, dorsal view (× 12) **60** ♀, head, front view (× 17) **61** ♂, head, front view (× 19) **62** ♂, tergum VII, dorsal view (× 20).

♀♀ (visiting fls of *Leysera gnaphalodes*); [Namaqualand], Farm Arkoep, 6 km N [of] Kamieskroon (30.19S 17.56E), 1–2.x.1990 (C. Eardley), 3 ♀♀ [SANC]; 15 km N of Nieuwoudtville on road to Loeriesfontein, [Skuinshoogte Pass] (31.16S 19.08E), 3–8.x.1989 (F. W. and S. K. Gess), 5 ♀♀, 1♂ (4 ♀♀ visiting yellow fls of *Rhynchopsidium pumila* (L. f.) DC., Asteraceae; 1 ♀ visiting fls of *Senecio* sp., prob. *nivea* Less.); same locality and date (D. W. Gess), 1 ♂; same locality, 23–30.ix.1994 (F. W. and S. K. Gess), 1 ♂ (on yellow fls of *Leysera*/*Rhynchopsidium* sp., Asteraceae); Nieuwoudtville Falls, 5 km N of Nieuwoudtville (31.19S 19.07E), 28.ix.1990 (F. W. and S. K. Gess), 22 ♀♀, 5 ♂♂ (20 ♀♀, 4 ♂♂ on yellow fls of *Leysera gnaphalodes*, one pair *in copula*; 2 ♀♀ on yellow fls of *Rhynchopsidium* sp.) – [all AMG unless otherwise stated].

Diagnosis. Medium to large (4.4–5.3 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Both sexes with thorax and gaster subshiny with coarse punctures. Female with scutellum markedly convexly raised medially, black with pale lamella. Male with mandible white and tip ferruginous; labrum and clypeus wholly

white; antennal club light ferruginous; frons in lower half with large median marking and ocular sinus with marked white crescent; scutellum with curved posterior white band and pale lamella; sternum VII subglabrous and apically with fringe of fine setae.

Description. *Female* (Figs 56, 58, 60): Black. The following are yellowish-white: underside of antenna; pair of small streaks on pronotal dorsum and minute spot at postero-dorsal angle of same (these markings effaced in most specimens); tegula anteriorly and posteriorly; scutellar lamella laterally; posterior bands (not reaching sides and progressively reduced) on terga I – IV; apex of femur, most of tibia, and tarsomeres of all legs. The following are ferruginous: mandible (except base); upper side of antenna; bottom of ocular sinus (in most specimens); tegula medially; tergum I basally; terga I – V laterally and narrowly posteriorly; tergum VI entirely; sterna. Wings lightly browned; veins brown.

Length 4.8–5.3 mm (average of 3: 5.1 mm); length of fore wing 3.0–3.3 mm (average of 3: 3.2 mm); hamuli 5.

Head in front view 1.4 × as wide as long; microreticulate (shagreened), moderately shiny, with small punctures separated by less than their diameter; POL: OOL = 1: 0.85. Clypeus 1.8 × as wide as long (to bottom of emargination); anterior margin shallowly and widely emarginate; antero-lateral angles rounded. Mesosoma and metasoma microsculptured (shagreened) with punctures on pronotum, mesopleuron, mesoscutum, scutellum and tergum I coarser than those on head; punctures on mesoscutum and scutellum most distinct; those on gaster progressively smaller from tergum I to VI. Scutellum smoothly, convexly raised above level of hind end of mesoscutum. Tegula with inner posterior corner markedly inwardly produced. Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins.

Male (Figs 57, 59, 61, 62): Black. The following are yellowish-white: mandible (except tip); labrum; clypeus (except small area below antennal socket); large marking on lower half of frons immediately above clypeus; large crescent in ocular sinus; scape, pedicel and proximal flagellomeres; anterior margin of pronotum (carried down to humeral angle) and small spot on postero-dorsal angle of same; large marking on upper half of mesopleuron; tegula anteriorly and posteriorly; curved posterior band (more or less tri-lobed) on scutellum; scutellar lamella (medially interrupted with ferruginous); posterior bands (not reaching sides and progressively reduced) on terga I – VI; some diffuse areas on tergum VII; apex of femur, most of tibia, most of tarsomeres (becoming progressively more ferruginous) of all legs. The following are ferruginous: mandibular tip; antennal club both above and below; propodeal angle laterally; tergum I basally and laterally, tergum II laterally, terga III – VII where not marked with yellowish-white; all sterna; tarsomeres to some degree (as indicated above). Wings lightly browned; veins brown.

Length 4.4–5.1 mm (average of 3: 4.8 mm); length of fore wing 2.6–2.8 mm (average of 3: 2.7 mm); hamuli 5.

Head in front view 1.4 × as wide as long; POL: OOL = 1: 0.96. Clypeus 1.8 × as wide as long (to bottom of emargination); anterior margin shallowly and widely emarginate; antero-lateral angles rounded. Puncturation of head, mesosoma and meta-

soma similar to that of female. Tergum VII with a median slit and with lobes flanking it smoothly rounded apically. Sterna atuberculate; sternum VII subglabrous, apically with a fringe of fine setae.

Etymology. The name *scutellaris* serves to draw attention to the scutellum which in the female is raised medially and in the male has a characteristic curved posterior white band.

Geographic distribution. Known from the north-western part of the Northern Cape (Namaqualand; winter rainfall region) of South Africa, the collecting sites being principally in the Namaqualand Broken Veld of Acocks (1953).

Floral associations. Asteraceae (*Leysera, Rhynchopsidium*).

Nesting. Unknown.

Discussion. Sympatric with the generally similar looking *frontalis*, *setositerminalis* and *vagepunctata.* Association of sexes confirmed by one pair *in copula* (see above).

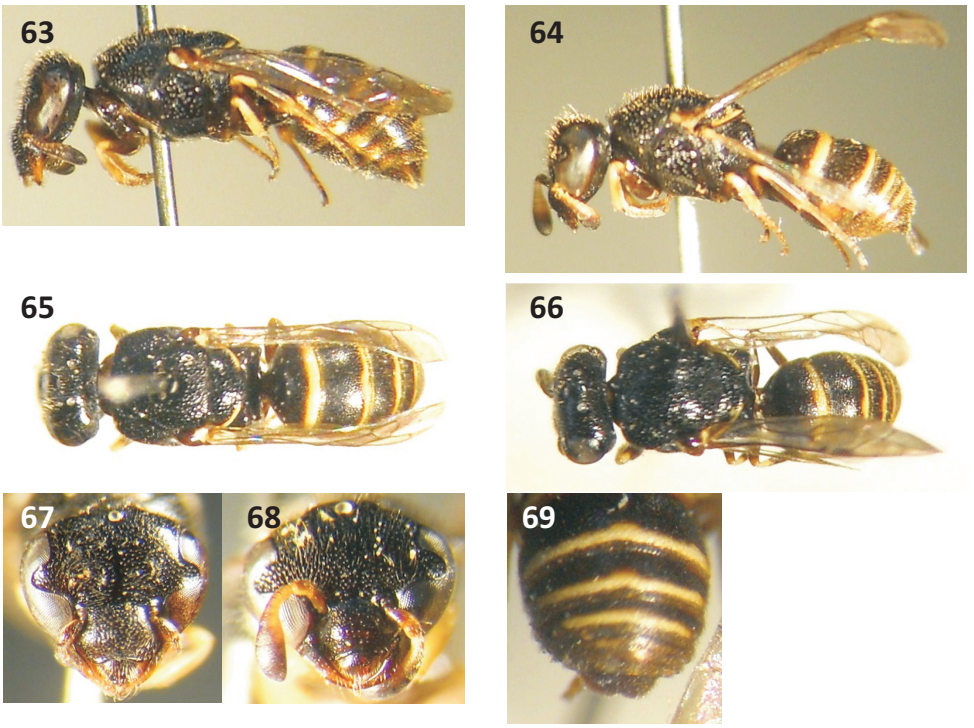
***Quartinia setaria* sp. n.**
urn:lsid:zoobank.org:act:E800A7B5-2057-47EE-944D-68728814B5A5
Figs 63–69

Quartinia sp. G. (Gess and Gess 2003: 67, flower visiting.)

Holotype ♀, SOUTH AFRICA: NORTHERN CAPE: Namaqualand, Sors Sors, 9 km NE of Kamieskroon (30.08S 18.01E), 17.ix.1992 (F. W. and S. K. Gess) (on violet fls of *Wahlenbergia* sp.) [AMG].

Paratypes. SOUTH AFRICA: NORTHERN CAPE: Namaqualand, Springbok, Hester Malan Nature Res[erve] [now Goegap Nature Reserve]] (29.37S 18.00E), 10–11.x.1989 (F. W. and S. K. Gess), 1 ♀ (visiting fls of *Wahlenbergia pilosa* Buek [on label as *Wahlenbergia* cf. *prostrata* A. DC.], Campanulaceae); Namaqualand, Springbok, Goegap [Nature Reserve], windmill [site] (29.37S 17.59E), 4–8.x.1994 (F. W. and S. K. Gess), 1 ♀ (on/in light violet fls of *Wahlenbergia oxyphylla* A. DC.); Namaqualand, Sors Sors, 9 km NE of Kamieskroon (30.08S 18.01E), 17.ix.1992 (F. W. and S. K. Gess), 1 ♀ (on violet fls of *Wahlenbergia* sp.); Namaqualand, Groenekloof, 7.5 km SE of Leliefontein (30.21S 18.07E), 13.ix.1992 (F. W. and S. K. Gess), 1 ♂ – [all AMG].

Diagnosis. Medium sized (3.7–4.3 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Both sexes with tegula yellowish white (other than for ferruginous median area), with posterior inner corner inwardly produced and acute; with head and mesosoma strikingly shiny, without micro sculpturing (shagreening); with head, pronotum, mesoscutum and scutellum with very obvious, mostly porrect, setae; with frons flat or even slightly depressed; clypeus markedly convexly raised; occiput markedly transversely depressed; head, pronotum, mesonotum, mesopleuron and propodeum without any pale markings. Male with tergum VII with only a small median emargination on apical margin (that is lacking a median slit); sterna atuberculate.



Figures 63–69. *Quartinia setaria* **63** ♀, lateral view (× 14) **64** ♂, lateral view (× 13) **65** ♀, dorsal view (× 13) **66** ♂, dorsal view (× 13) **67** ♀, head, front view (× 20) **68** ♂, head, front view (× 22) **69** ♂, tergum VII, dorsal view (× 26).

Description. *Female* (Figs 63, 65, 67): Black. The following are yellowish white: lower surface of scape, pedicel and at least some flagellomeres (if not light ferruginous); tegula (other than for ferruginous median area); scutellar lamella laterally; narrow posterior bands not reaching sides on terga I – IV; apex of femur of all legs; base or more of tibia of fore leg; most of dorsal surface of middle tibia; base of hind tibia. Various shades of ferruginous are: upper surface of scape, pedicel and intermediate flagellomeres and lower surface of same (if not yellowish white); distal half of mandible; tegula medially; coxa, trochanter, femur, parts of tibia, tarsomeres of all legs; terga postero-laterally (including ends of posterior bands); sterna. Wings very lightly browned; veins brown.

Length 3.8–4.3 mm (average of 3: 4.0 mm); length of fore wing 2.6–2.8 mm (average of 3: 2.7 mm); hamuli 5.

Head in front view 1.2 × as wide as long; frons remarkably flat, medially even slightly depressed; POL: OOL = 1: 0.9; occiput markedly transversely depressed. Frons and vertex strikingly shiny, without microreticulation (shagreening) but with regular, small punctures separated by circa puncture width and set with obvious, fine, mostly porrect setae. Narrow area on midline of frons of holotype and one of paratypes without punctures and setae. Clypeus 1.6 × as wide as long, noticeably convexly raised,

moderately shiny, with semi-confluent, small punctures and some limited microreticulation on interstices, with setation as on frons; anterior margin with a very shallow V-shaped emargination; antero-lateral angles very narrowly rounded.

Mesosoma strikingly shiny, without microreticulation; punctures a little larger than on head; setation on pronotum and mesonotum similar to that on head but that on scutellum shorter.

Gaster moderately shiny, with small, close punctures and noticeable, posteriorly decumbent, short, fine setae.

Male (Figs 64, 66, 68, 69): Black. Yellowish-white markings and ferruginous areas as in female (except that tergum V has an indication of a short posterior band).

Length 3.7 mm; length of fore wing 2.6 mm; hamuli 4.

Head in front view 1.3 × as wide as long; POL: OOL = 1: 0.9. Clypeus 1.6 × as wide as long.

Puncturation and setation of head, mesosoma and gaster as in female.

Tergum VII with only a small median emargination on apical margin (that is lacking a median slit); sterna atuberculate.

Etymology. The name *setaria* serves to draw attention to the very noticeable porrect setae on the head and thorax.

Geographic distribution. As far as can be judged, restricted to the part of Namaqualand termed Klipkoppe, the collecting localities being sited in the Namaqualand BrokenVeld and the Mountain Renosterbosveld of Acocks (1953).

Floral associations. *Wahlenbergia* spp. (Campanulaceae).

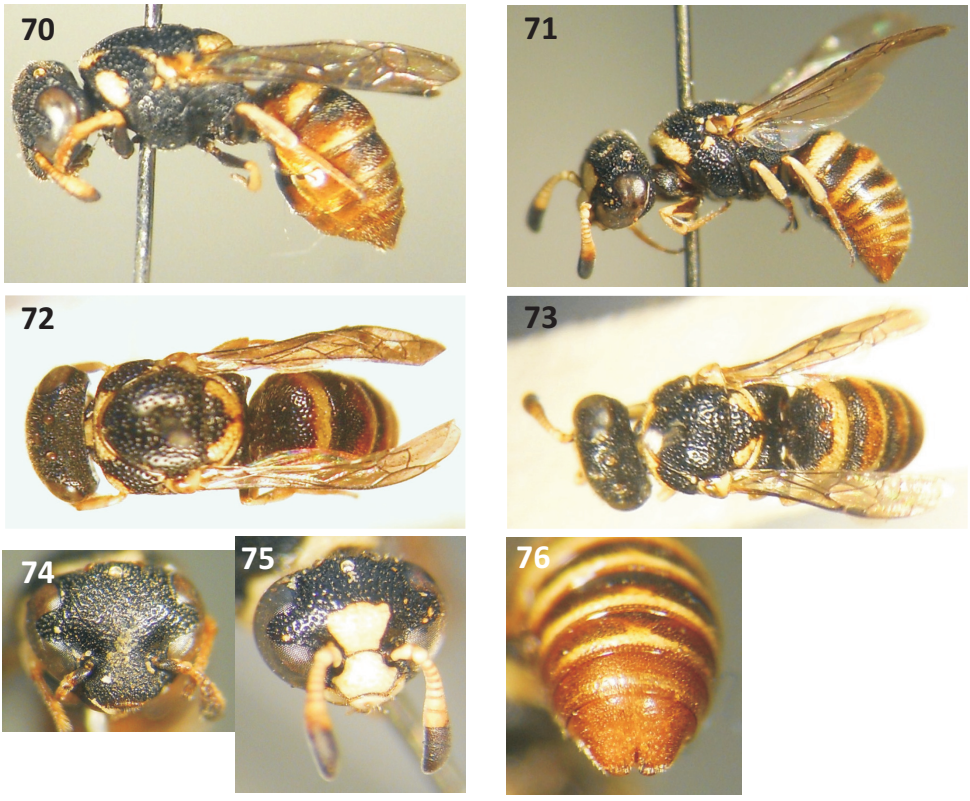
Nesting. Unknown.

***Quartinia setositerminalis* sp. n.**
urn:lsid:zoobank.org:act:07D2247B-34B4-4634-88FB-B3514BF0366F
Figs 70–76

Quartinia sp. F. (Gess 1996: 250, flower visiting; Gess and Gess 2003: 67, flower visiting.)

Holotype ♂, SOUTH AFRICA: NORTHERN CAPE: Namaqualand, Hester Malan Nature Res[erve] [now Goegap Nature Reserve] (29.37S 18.00E), 10–11.x.1989 (D. W. Gess) [AMG].

Paratypes. SOUTH AFRICA: NORTHERN CAPE: Namaqualand, Hester Malan Nature Res[erve] [now Goegap Nature Reserve] (29.37S 18.00E), 10–11.x.1989 (F. W. Gess and S. K. Gess), 2 ♀♀ (1 ♀ visiting minute yellow fls of *Helichrysum* sp., Asteraceae); same locality and date (D. W. Gess), 2 ♀♀, 4 ♂♂ (1 ♀ visiting pink fls of *Leipoldtia* sp., Aizoaceae: Mesembryanthema); Namaqualand, Voëlklip (29.45S 17.22E), 2.x.1994 (F .W. and S. K. Gess), 1 ♀ (on pink fls of *Prenia pallens* (Ait.) N. E. Br., Aizoaceae: Mesembryanthema); Namaqualand, Sors Sors, 9 km NE of Kamieskroon (30.08S 18.01E), 17.ix.1992 (F. W. and S. K. Gess), 1 ♀ (on white fls of



Figures 70–76. *Quartinia setositerminalis* **70** ♀, lateral view (× 12) **71** ♂, lateral view (× 11) **72** ♀, dorsal view (× 11) **73** ♂, dorsal view (× 11) **74** ♀, head, front view (× 15) **75** ♂, head, front view (× 17) **76** ♂, tergum VII, dorsal view (× 26).

Dorotheanthus bellidiformis (Burm. f.) N. E. Br., Aizoaceae: Mesembryanthema) – [all AMG]; [Namaqualand], Farm Arkoep, 6 km N [of] Kamieskroon (30.19S 17.56E), 1–2.x.1990 (C. Eardley), 1♀, 1♂ [SANC]. WESTERN CAPE: Pakhuis Pass (32.08S 19.02E), 7.ix.1987 (C. D. Eardley) 1 ♂ [SANC].

Diagnosis. Medium to large (4.4–5.3 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Both sexes with thorax and gaster subshiny with coarse punctures; scutellum only gently convex medially. Female with scutellum with pair of pale streaks laterally (in some females joined medially) and lamella pale. Male with mandible white and tip ferruginous; labrum and clypeus wholly white; antennal club with last three flagellomeres black both dorsally and ventrally, markedly set off in colour from rest of antenna; frons with large median white marking and with ocular sinus either maculate or immaculate; sternumVII densely set with short, fine setae and apically with fringe of longer setae.

Description. *Female* (Figs 70, 72, 74): Black. The following are yellowish-white: underside of scape, pedicel, proximal flagellomeres and of more proximal flagellomeres of club (if not ferruginous); pronotal dorsum and minute spot at postero-dorsal angle

of same; large humeral spot; tegula anteriorly and posteriorly; lateral streaks on scutellum (in some specimens broadly fused postero-medially); scutellar lamella (in some specimens narrowly interrupted medially); posterior bands (almost reaching sides and progressively reduced) on terga I – V; apex of femur and most of tibia of all legs; all but last tarsomere of mid and hind legs. The following are ferruginous: mandible (except base); underside of more proximal of flagellomeres of club (if not yellowish-white); lateral streaks on scutellum (if reduced and not yellowish-white); scutellar lamella medially (if yellowish-white interrupted); tegula medially; sides of tergum I; broad band between posterior yellowish-white band and black base on terga II – V; entire tergum VI; sterna variously; all tarsomeres of fore leg; last tarsomere of mid and hind leg. Wings lightly browned; veins brown.

Length 5.1–5.3 mm (average of 3: 5.2 mm); length of front wing 3.2–3.3 mm (average of 3: 3.3 mm); hamuli 4–5.

Head in front view 1. 4 × as wide as long; with moderately coarse subconfluent punctures and microreticulate interstices. POL: OOL = 1: 0.9. Clypeus 1.5 × as wide as long (to bottom of emargination); convex, markedly raised laterally and distally; anterior margin very shallowly emarginate; antero-lateral angles rounded.

Mesosoma subshiny with coarse punctures, on the pronotum partly subconfluent and separated by less than their diameter, on the centre of the mesoscutum and on the scutellum separated by their diameter or more; interstices minutely microreticulate (shagreened). Tegula with inner posterior corner markedly inwardly produced. Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Scutellum medially evenly and gently convex.

Male (Figs 71, 73, 75, 76): Black. The following are yellowish-white: mandible (except tip); labrum; clypeus; large marking on lower half of frons immediately above clypeus; macula (variously developed: large, reduced, absent) in ocular sinus; scape (except for small brown streak dorsally), pedicel; proximal flagellomeres and first two flagellomeres of club; anterior margin of pronotum (carried down to humeral angle) and small spot on postero-dorsal angle of same; small triangular spot at top of mesopleuron; tegula anteriorly and posteriorly; lateral streaks on scutellum; scutellar lamella (medially interrupted with ferruginous or black); posterior bands (not reaching sides and progressively reduced) on terga I – VI; distal two thirds of underside and distal half of upper side of fore femur; apex of mid and hind femur; most of tibia of all legs (except for posterior and ventral black streaks. The following are ferruginous: mandibular tip; tegula medially; propodeal angle laterally (in one specimen only); declivous aspect of tergum I (if not black); varying amounts of ground colour of terga II – IV (if not black) and all of ground colour of terga V – VII; all sterna; tarsomeres (progressively darker with ultimate tarsomere dark brown). Wings lightly browned; veins brown.

Length 4.4–4.8 mm (average of 3: 4.6 mm); length of fore wing 3.0–3.1 mm (average of 3: 3.1 mm); hamuli 4–5.

Head in front view 1.4 × as wide as long; POL: OOL = 1: 0.8. Clypeus 1.66 × as wide as long (to bottom of emargination), convex, markedly raised laterally and

distally; anterior margin very shallowly and widely emarginate; antero-lateral angles narrowly rounded (almost subangular).

Gaster with tergum VII with a short, median V-shaped slit; lobes flanking slit rounded. Sterna atuberculate; sternum VII densely set with short, fine setae and apically with fringe of longer setae.

Etymology. The name *setositerminalis* draws attention to the characteristically densely setose last visible sternum of the male.

Geographic distribution. Known from the north-western part of the Northern Cape (Namaqualand; winter rainfall region), the collecting localities being sited in the Namaqualand BrokenVeld and the Mountain Renosterbosveld of Acocks (1953), and from the adjoining Western Cape of South Africa, in Macchia (Fynbos).

Floral associations. Principally Aizoaceae: Mesembryanthema (*Dorotheanthus, Leipoldtia, Prenia*); to a lesser extent Asteraceae (*Helichrysum*).

Nesting. Unknown.

Discussion. Sympatric with the generally similar looking *frontalis*, *scutellaris* and *vagepunctata.*

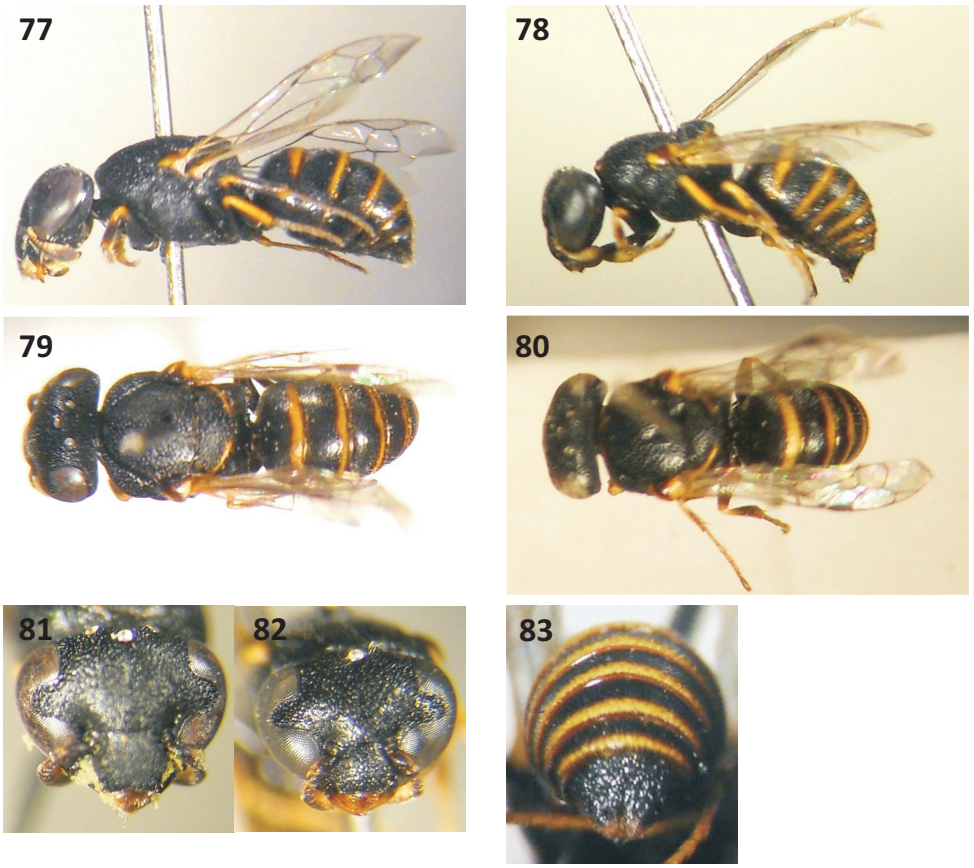
***Quartinia upingtonensis* sp. n.**
urn:lsid:zoobank.org:act:D8AA4B3F-B5C2-4E5D-AE6F-A2EA8F37CDDC
Figs 77–83

Holotype ♀, SOUTH AFRICA: NORTHERN CAPE: c. 10 km W [of] Upington on road to Namibia (28.24S 21.04E), 2.ix.2005 (F. W. and S. K. Gess) (visiting yellow flowers of Asteraceae) [AMG].

Paratypes. SOUTH AFRICA: NORTHERN CAPE: c. 10 km W [of] Upington on road to Namibia (28.24S 21.04E), 2.ix.2005 (F. W. and S. K. Gess), 40 ♀♀, 6 ♂♂ (33 ♀♀, 5 ♂♂ visiting yellow flowers of Asteraceae; 7 ♀♀, 1 ♂ visiting yellow flowers of *Grielum* sp., Neuradaceae) [AMG].

Diagnosis. Medium to large (4.2–4.6 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Tegula with posterior inner corner moderately inwardly produced. Both sexes with thorax finely microsculptured and with obvious coarse punctures, semi-matt; gaster very finely punctured, shiny. Scutellum black with light yellowish-ferruginous lamella.

Description. *Female* (Figs 77, 79, 81): Black. The following are light yellowish-ferruginous: underside of scape, pedicel and flagellomeres; tegula anteriorly and posteriorly; scutellar lamella (except postero-medially); posterior bands (not reaching sides) on terga I – V; band on tergum I wide; those on terga II – V progressively narrower and shorter, slightly anteriorly produced medially; apex of femur of all legs; tibia of front and middle legs (except for dark ferruginous streak on posterior surface; hind tibia (except for dark ferruginous median section). Darker ferruginous are: labrum; apical half of mandible; tegula medially; markings on tibiae; tarsomeres (variably) of all legs. Wings lightly browned; veins brown.



Figures 77–83. *Quartinia upingtonensis* **77** ♀, lateral view (× 13) **78** ♂, lateral view (× 13) **79** ♀, dorsal view (× 13) **80** ♂, dorsal view (× 13) **81** ♀, head, front view (× 20) **82** ♂, head, front view (× 21) **83** ♂, tergum VII, dorsal view (× 27).

Length: 4.3–4.6 mm (average of 3: 4.5 mm); length of fore wing 2.9–3 mm (average of 3: 3 mm); hamuli 5.

Head in front view 1.28 × as wide as long; POL: OOL = 1: 0.63. Clypeus 1.43 × as wide as long; anterior margin shallowly emarginate; antero-lateral angles rounded.

Clypeus, frons and vertex finely microsculptured (shagreened); punctures on clypeus and lower half of frons barely discernable; those on upper half of frons and vertex fine, close, increasingly discernable. Mesosoma finely microsculptured (shagreened); punctures much larger (coarser) than on head, very obvious (particularly on pronotum, mesoscutum and scutellum). Gaster very finely punctured, shiny.

Male (Figs 78, 80, 82, 83): Black. Markings identical with those of female (i.e. head without any markings). Additionally ferruginous are: acute apices of lateral lobes flanking slit of tergum VII; parameres.

Length: 4.2–4.4 mm (average of 3: 4.4 mm); length of fore wing 2.6–3 mm (average of 3: 2.8 mm); hamuli 5.

Head in front view 1.35 × as wide as long; POL: OOL = 1: 0.56. Clypeus 1.5 × as wide as long; anterior margin shallowly emarginate; antero-lateral angles rounded.

Tergum VII with disk markedly depressed, its profile in side view slightly concave; apico-medially with a narrow V-shaped slit; lobes flanking slit acute, narrowly rounded. Sterna atuberculate.

Etymology. Named for the town Upington, in close proximity of which the species was collected.

Geographic distribution. Known only from the type locality at the interface of the Orange River Broken Veld and the Karahari Thornveld and Shrub Bushveld of Acocks (1953).

Floral associations. Unidentified yellow-flowered species of Asteraceae and yellow-flowered *Grielum* sp. (Neuradaceae).

Nesting. Unknown.

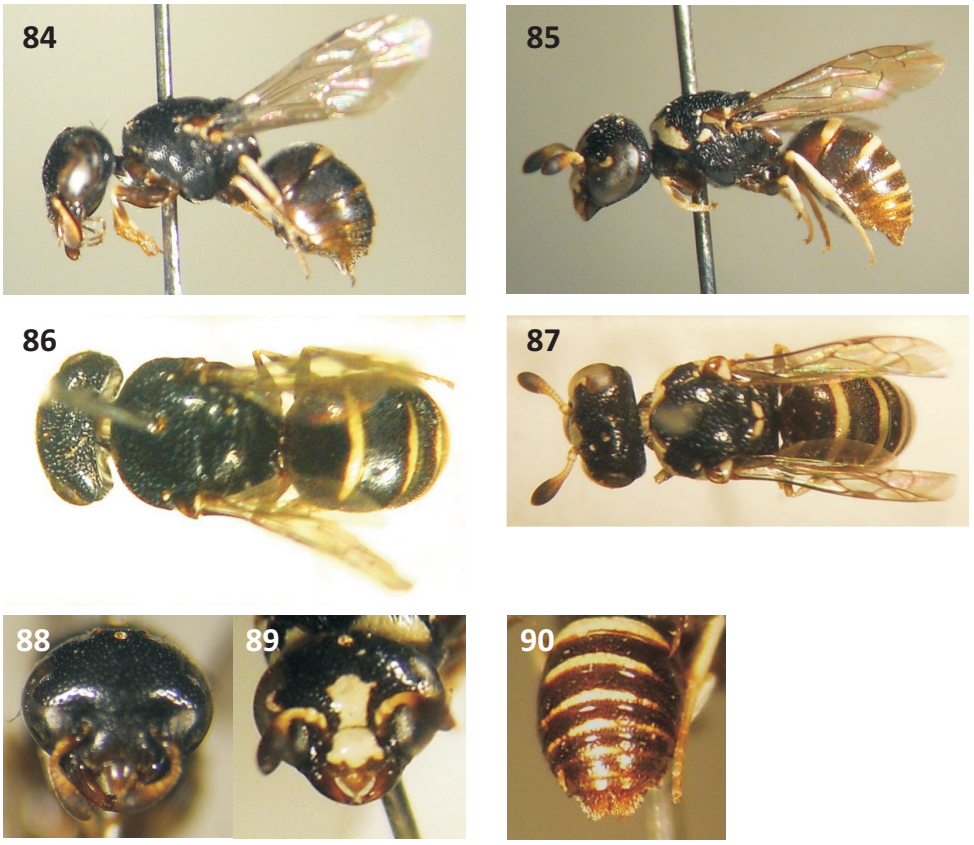
Quartinia vagepunctata von Schulthess

Figs 84–90

Quartinia vagepunctata von Schulthess 1929: 504 (key), 507, ♀. Holotype: South Africa: Little Karroo (*sic*), 38 m[iles] E of Ceres (BMNH). – von Schulthess 1935: 386 (key); Richards 1962: 132 (key), 169 (redescription of female); Gess and Gess 1992 (nesting); Gess 1996 (nesting, flower visiting); Carpenter 2001: 29 (listed); Gess and Gess 2003: 64 (flower visiting).

Diagnosis. Medium to large (3.6–5 .0 mm). Fore wing with Cu1a and 2*m-cu* complete and as thick as other veins. Both sexes with thorax and gaster shiny with fine punctures; scutellum markedly convex. Female with scutellum black with black lamella. Male with mandible black and tip ferruginous; labrum testaceous to black with white spot; clypeus black with white marking; antennal club ferruginous; frons medially on lower half with yellowish-white marking of variable size and shape; scutellum with pair of postero-medial white spots; sternumVII almost glabrous and apically with a few large, curved, golden setae.

This common and widely distributed species shows a considerable variation in colour pattern within a population at any particular locality as well as, in some instances, consistent variations between populations from different localities. This is particularly evident in the males but applies to a lesser extent also to the females. In the descriptions below specimens from the population at 15 km N of Nieuwoudtville on the road to Loeriesfontein [Skuinshoogte Pass] are chosen as representing the "norm" for the following reasons: the females most closely accord with the redescription of females by Richards (1962: 169); the sample size is large; females and males from the sample, submitted to Carpenter in1990 were determined by him as *vagepunctata*; and the locality is where the nesting was studied (Gess and Gess, 1992). Deviations from the characters as expressed in this population are noted, giving the localities at which the deviant specimens occurred.



Figures 84–90. *Quartinia vagepunctata* **84** ♀, lateral view (× 11) **85** ♂, lateral view (× 12) **86** ♀, dorsal view (× 13) **87** ♂, dorsal view (× 12) **88** ♀, head, front view (× 17) **89** ♂, head, front view (× 16) **90** ♂, tergum VII, dorsal view (× 21).

Description. *Female* (previously described) (Figs 84, 86, 88). The specimens from Skuinshoogte are in accord with the redescription of females by Richards. One of the localities from which Richards had material, "Doorn R. Falls", is the same as the presently recorded "Doringrivier N of Nieuwoudtville" and "Nieuwoudtville Falls, 5 km N of Nieuwoudtville" and is a mere seven kilometres in a direct line from the Skuinshoogte site.

In contrast to typical females, females from N of Annis River, in accord with the males from that locality, have the propodeal angles and the greater part of the gaster ferruginous. Females from 16 km S of Rosh Pinah in Namibia are of similar appearance. However, females from Springbok and Anenous are of intermediate coloration.

Male (hitherto undescribed) (Figs 85, 87, 89, 90): Black. The following are yellowish-white: labrum (in part; in a few specimens from N of Annis River only); marking of variable size and shape medially on clypeus (in specimens from Skuinshoogte covering all of disk except narrow testaceous distal margin and lateral parts below antennal insertions but in some reduced to an inverse triangle; in some specimens

from N of Annis River further reduced or totally absent); marking of variable size and form medially on lower half of frons (in specimens from Skuinshoogte wedge-, hour-glass- or mushroom-shaped, mostly but not always rising from clypeo-frontal suture; in specimens from N of Annis River varying from an upwardly widened, tri-pointed, crown-like shape extending to upper level of ocular sinus to, at its greatest reduction, a number of disorientated small spots); small streak (in some specimens ferruginous or totally effaced) margining bottom of ocular sinus; scape, pedicel and underside of proximal flagellomeres; pair of medially separated triangular markings on anterior margin of pronotum joined to or separated from marking of variable size on humeral angle; postero-dorsal angle; spot at top of mesopleuron; tegula anteriorly and posteriorly; pair of small spots (in some specimens fused, in others much reduced to totally absent) postero-medially on scutellum); scutellar lamella (in all specimens from N of Annis River; pale colour well developed, reduced or absent in specimens from Skuinshoogte); posterior bands (becoming progressively shorter and narrower) on terga I – VI; apex of femur, dorsal surface of tibia, proximal tarsomeres of all legs. The following are various shades of ferruginous: apical half of mandible; labrum (generally but see exception above); antero-lateral regions of clypeus (in some specimens only); distal flagellomeres (particularly on underside); tegula medially; propodeal angles (in specimens from N of Annis River, betw. Annis and Dabie Rivers, Springbok, Anenous, Klipfontein,Wildeperdehoek and Nuwerus but not or at most barely indicated in a few specimens from Skuinshoogte); lateral regions of terga I – VI including lateral extremities of posterior bands (to varying extent in specimens from Skuinshoogte; more extensive in specimens from N of Annis River and from betw. Annis and Dabie Rivers in which most of gaster is this colour); tergum VII; parameres; sterna (following trend of terga); distal tarsomeres of all legs.

Length 3.6–4.2 mm (average of 3: 4.0 mm; length of front wing 2.4–2.6 mm (average of 3: 2.5 mm); hamuli 5.

Material examined. NAMIBIA: 16 km S of Rosh Pinah (28.04S 16.51E), 13.x.2000 (F.W. and S. K. Gess), 5 ♀♀ (4 ♀♀ visiting yellow fls with white bracts of *Helichrysum herniarioides* DC, Asteraceae; 1 ♀ visiting yellow fls of *Tripteris microcarpa* Harv., Asteraceae); same locality, 14.x.2000 (F. W. and S. K. Gess), 1 ♀ (visiting yellow fls of *Tripteris microcarpa*); same locality, 15.x.2000 (F. W. and S. K. Gess), 4 ♀♀ (visiting yellow fls with white bracts of *Helichrysum herniarioides*) – [all AMG]. SOUTH AFRICA: NORTHERN CAPE: 24 km N of Annis River crossing by road to Sendelingsdrif (28.14S 16.55E), 21.ix.1997 (F. W. and S. K. Gess), 65 ♀♀, 9 ♂♂ (visiting yellow fls with white bracts of *Helichrysum herniarioides*); on r[oa]d to Richtersveld N[ational] P[ark] bet. Annis and Dabie R[ivers] (28.20S 16.55E), 19.ix.1997 (F. W. and S. K. Gess), 1 ♂ (visiting yellow fls of *Leysera tenella* DC, Asteraceae); 12 Mi[les]W [of] Steinkopf [29.14S 17.35E], 3.xi.1968 (J. G. Rozen and E. Martinex) 2 ♀♀ (det. J. M. Carpenter, 1986) [AMNH]; Namaqualand, Anenous (29.14S 17.35E), 11–13.x.1988 (D. W. Gess), 1 ♀; same locality, 12.x.1989 (F. W. and S. K. Gess), 36 ♀♀, 2 ♂♂ (29 ♀♀, 2 ♂♂ visiting fls of *Leysera gnaphalodes* (L.) L., Asteraceae; 3 ♀♀ visiting minute yellow flowers of ? *Helichrysum* sp., Asteraceae; 2 ♀♀

visiting fls of *Cotula* sp., Asteraceae; 1 ♀ visiting pink fls of *Galenia* sp., Aizoaceae: non Mesembryanthema]; [Springbok], Hester Malan N[ature] R[eserve] [now Goegap Nature Reserve] (29.37S 18.00E), 26.x.1985 (M. Struck), 3 ♀♀; Springbok, Hester Malan Nature Res[erve] [now Goegap Nature Reserve], 10–12.x.1988 (D. W. Gess), 1 ♂; Namaqualand, Springbok, Hester Malan Nature Res[erve] [now Goegap Nature Reserve], 10–11.x.1989 (F. W. Gess and S. K. Gess), 8 ♀♀, 1 ♂ (5 ♀♀ visiting fls of *Leysera gnaphalodes*); same locality and dates (D. W. Gess), 2 ♀♀, 1 ♂; Namaqualand, [Springbok], Goegap Nat[ure] Res[erve], Kraaiwater (29.38S 18.00E), 29.ix.1997 (F. W. and S. K.Gess), 3 ♀♀ (visiting fls of *Leysera gnaphalodes*); same locality, 30.ix.1997 (F. W. and S. K. Gess), 1♀ (visiting fls of *Leysera gnaphalodes*); Namaqualand: Voëlklip (29.45S 17.22E), 2 and 7.x.1994 (F. W. and S. K. Gess), 2 ♀♀ (1 ♀ on yellow fls *Leysera tenella*); Namaqualand: Klipfontein (29.51S 17.47E), 14.x.1989 (F. W. and S. K. Gess), 1 ♂ (visiting fls of *Lebeckia sericea* Thunb., Fabaceae); Namaqualand: Narap (Narab), (29.53S 17.46E), 14.x.1989 (F. W. and S. K. Gess), 5 ♀♀ (visiting fls of *Leysera gnaphalodes*); Namaqualand: W[estern] end of Wildeperdehoek Pass (29.56S 17.38E), 14.x.1989 (F. W. and S. K. Gess) 2 ♀♀, 1 ♂ (visiting fls of *Oncosiphon suffruticosum* (L.) Källersjö, Asteraceae); 6–13 Mi[les] S [of] Mesklip [circa 29.57S 17.54E], 21.x.1968 (J. G. Rozen and E. Martinez), l ♀ [AMNH]; 25 km N [of] Kamieskroon (30.01S 17.53E), 17.x.2000 (F. W. and S. K. Gess), 6 ♀♀ (visiting yellow fls of *Leysera* sp.); Namaqualand: Kamiesberg to Sors Sors (30.11S 18.01E), 9.x.1997 (F. W. and S. K. Gess), 1 ♀ (visiting yellow fls of *Leysera gnaphalodes*); 15 km N of Nieuwoudtville on road to Loeriesfontein (bottom of Skuinshoogte Pass) (31.16S 19.08E), 3–8.x.1989 (F. W. and S. K. Gess), 60 ♀♀, 40 ♂♂ (53 ♀♀, 27 ♂♂ visiting fls of *Rhynchopsidium pumilum* (L. f.) DC, Asteraceae; 5 ♀♀, 5 ♂♂ visiting fls of *Senecio* sp. probably n*ivea* Less., Asteraceae; 1 ♀, 6 ♂♂ visiting fls of *Cotula leptalea* DC, Asteraceae; 1 ♂ visiting fls of *Tripteris oppositifolia* (Ait.) B. Nord., Asteraceae); same locality and date (D. W. Gess and S. K. Gess), 2 ♀♀; same locality and date (D. W. Gess), 2 ♀♀, 1♂; same locality, 27.ix.1990 (F. W. and S. K. Gess), 66 ♀♀, 7 ♂♂ (18 ♀♀, 4 ♂♂ on yellow fls of *Rhynchopsidium pumilum*; 38 ♀♀, 2 ♂♂ on yellow fls of *Oncosiphon suffuticosum* ; 7 ♀♀, 1 ♂ on yellow fls of *Cotula* sp.; 2 ♀♀ in nesting area; 1 ♀ general); Doringrivier N of Nieuwoudtville (31.18S 19.07E), 28.ix.1990 (C. Eardley), 22 ♀♀, 2 ♂♂ [SANC]; Nieuwoudtville Falls, 5 km N of Nieuwoudtville (31.19S 19.07E), 28.ix.1990 (F. W. and S. K. Gess), 3 ♀♀ (on yellow fls of *Leysera gnaphalodes*); Calvinia (31.27S 19.45E, 1050 m), 7.xii.1996 (J. Carpenter and A. Davidson), 1 ♀ (det. J. M. Carpenter) [AMNH]; Nieuwoudtville/Calvinia, 25km E of Nieuwoudtville (31.29S 19.19E), 18.x.2000 (F. W. and S. K. Gess), 6 ♀♀ (5 ♀♀ visiting yellow fls of *Leysera gnaphalodes*; 1 ♀ visiting yellow fls of "*Osteospermum*", Asteraceae). WESTERN CAPE: Nuwerus (31.08S 18.22E), 17.x.2000 (F. W. and S. K. Gess), 1 ♀, 1 ♂ (visiting yellow fls *Pentzia sphaerocephala* DC, Asteraceae); Knersvlakte, Farm Kaap se Drif (31.26S 18.48E), 22.ix.1999 (M. Kuhlmann), 1 ♀, 1 ♂ [Kuhlmann Collection, London] – [all AMG, unless otherwise indicated.]

Geographic distribution. The species is common over an extensive area in the winter rainfall regions of southern Namibia and of the Northern Cape and the north-

ern Western Cape provinces of South Africa. The collecting site in Namibia is located in the Desert and Succulent Steppe of Giess (1971); those in South Africa in the Namaqualand Broken Veld, the Succulent Karoo, the Mountain Renosterbosveld and the Western Mountain Karoo of Acocks (1953).

Floral associations. Very markedly associated with Asteraceae (*Cotula*, *Helichrysum*, *Leysera*, *Oncosiphon*, *Pentzia*, *Rhynchopsidium*, *Senecio* and *Tripteris*). [Note: *Rhynchopsidium pumilum* (L. f.) DC was previously listed as *Relhania* sp. (Gess, 1996) or as *Relhania pumila* Thunb. (Gess and Gess 2003).]

Nesting. Nest a subvertical silk-lined burrow in friable soil, surmounted by a sand and silk turret and having an excavated cell in which is a constructed sand and silk cell. (See: Gess and Gess 1992; Gess 1996: 108–111, 115).

Key to separate *Quartinia frontalis* Gess, *Q. scutellaris* Gess and *Q. setositerminalis* Gess from *Q. vagepunctata* von Schulthess

Males

1 Thorax and gaster shiny with fine punctures; mandible black with ferruginous tip; labrum testaceous to black, with white spot; clypeus with white marking; scutellum with pair of postero-medial white spots; sternum VII with disk almost glabrous but apically with a few large, curved, golden setae ..... ***vagepunctata* von Schulthess**

– Thorax and gaster subshiny with course punctures; mandible white with ferruginous tip; labrum wholly white; clypeus wholly white (except possibly small area below antennal socket); scutellum with pair of lateral white streaks OR with a curved posterior white band; sternum VII with disk glabrous to subglabrous but apically with a fringe of fine setae OR with disk densely set with short setae and apically with a fringe of longer setae..... **2**

2 Scutellum with pair of lateral white streaks; antennal club partially black; frons in lower half (immediately above clypeus) EITHER with large median marking OR with marking expanded laterally into (but not filling) ocular sinus **3**

– Scutellum with a curved posterior white band; antennal club light ferruginous; frons in lower half (immediately above clypeus) with a large median marking; ocular sinus with marked white crescent; sternum VII subglabrous with a fringe of fine setae ..... ***scutellaris* Gess**

3 Antennal club black dorsally, white ventrally; frons with white marking expanded laterally into (but not filling) ocular sinus; sternum VII subglabrous with a fringe of fine setae ..... ***frontalis* Gess**

– Antennal club with last three flagellomeres black both dorsally and ventrally, markedly set off in colour from rest of antenna; frons with large median white

marking; sternumVII with disk densely set with short setae and apically with a fringe of longer setae ..... ***setositerminalis* Gess**

Females

1 Thorax and gaster shiny with fine punctures; scutellum black; scutellar lamella black..... ***vagepunctata* von Schulthess**
– Thorax and gaster subshiny with coarse punctures; scutellum black OR with pair of yellow streaks laterally (sometimes joined); scutellar lamella yellow....**2**
2 Scutellum only gently convex medially **3**
– Scutellum markedly convexly raised medially..... ***scutellaris* Gess**
3 Scutellum black .....***frontalis* Gess**
– Scutellum with pair of yellow streaks laterally (sometimes joined)..... ..... ***setositerminalis* Gess**

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RESEARCH ARTICLE

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Sting microsculpture in the digger wasp *Bembix rostrata* (Hymenoptera, Crabronidae)

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Abstract

The sting microsculpture of the digger wasp *Bembix rostrata* (Fabricius, 1781) (Hymenoptera, Crabronidae) is studied with the scanning electron microscope (SEM) for the first time. As in many other hymenopterans, the second valvifer of *B. rostrata* possesses two fields of styloconic sensilla (hair plates) of proprioceptive function. The presence of two paired fields of campaniform sensilla on the second valvula and second valvifer is first shown in an apoid wasp. The first and the second valvulae bear scattered sensilla-like structures on the external surface, more numerous apically. The first valvula has two subapical barbs externally and a pair of valvilli on its inner surface, whereas the outer surface of the second valvula is smooth. The third valvula is sclerotized externally, consisting of proximal and distal parts, and bearing four sensilla morphotypes of mechanoreceptive and probably chemoreceptive functions. The inner surface of the valvulae and the membranous cuticle that is touching the sting have microstructures of different shapes directed distally. Functional aspects of characters studied are discussed.

Keywords

Morphology, sting apparatus, ovipositor

Introduction

The Hymenoptera are the sole group of endopterygote insects with a well-developed ovipositor, a plesiomorphic retention that has been considered one of the key factors in their diversification (Gauld and Bolton 1988). Besides oviposition, it can perform a number of other functions including sawing a substrate; location, discrimination

and marking of the host; envenomation; stinging etc. (Quicke et al. 1999). In most Aculeata, the ovipositor has lost the primary function of an egg transporting device and is used as a sting to paralyse and rarely to transport the prey or as defense weapon (Rasnitsyn 1980, Radović 1985, Radović and Sušić 1997).

There are numerous classic works on morphology and functions of the hymenopterous ovipositor (e.g., Snodgrass 1956, Oeser 1961, Scudder 1961, Smith 1970, Quicke et al. 1999, Vilhelmsen 2000, Vilhelmsen et al. 2001, Packer 2003). Several publications dealt especially with microsculptural characters which have been used for phylogenetic reconstructions in some groups, mainly parasitic wasps (e.g., Quicke et al. 1992, 1999, Le Ralec et al. 1996, Nénon et al. 1995, Rahman et al. 1998). Both the comparative and functional aspects of the sting apparatus have been investigated extensively throughout some groups of the Apoidea (for review see Radović 1985, Packer 2003, Cardinal and Packer 2007), however only a few species of apoid wasp were explored in this respect (see review in Gadallah 2001). As a sister group of bees, the Crabronidae have gained insufficient attention during the last 10 years (Gadallah 2001, Packer 2003, Gadallah and Assery 2004). Generalizations concerning the sting structure in apoid wasps are still needed, though some attempts to compare sting morphology across several groups of apoid wasps have been made (Gadallah 2001, Gadallah and Assery 2004). Surprisingly, microstructure characters including sensory structures have not been discussed in the literature, except for a few general comments on the presence and distribution of some sensilla (Radović and Sušić 1997, Gadallah and Assery 2004). To the best of my knowledge, more detailed information on the sting microsculpture in apoid wasps is not available. The purpose of this study is to describe sting microsculpture in the digger wasp *Bembix rostrata* (Fabricius, 1781) (Hymenoptera, Crabronidae) using scanning electron microscopy in order to consider its possible functional use.

Materials and methods

Six females of *B. rostrata* were collected in Central Ukraine (Kyiv Province, Vyshgorodsky District, surroundings of village Khotyanivka, July 2008; 50°34'55"N 30°33'51"E). The gaster was removed from the wasp body using forceps, cut open slightly and macerated in 10% KOH. The sting apparatus was subsequently excised from the genital chamber, washed in water and examined in glycerine under a stereo microscope. For SEM study, the cuticular parts were washed in distilled water, dehydrated in a graded ethanol series and acetone, critical point dried (OM CPD 7501), coated with gold-palladium (OM-SC7640) and examined with a Zeiss EVO-50 SEM (Museum of Zoology, Natural History Senckenberg Collections Dresden, Germany).

The terms used are preferably from Vilhelmsen et al. 2001, but also from Quicke et al. 1999, Gnatzy and Volknandt 2000 and Packer 2003. The following abbreviations were used: ap, apical process of inner membranous wall of 3rd valvula; au, aulax;

blb, bulb of the 2nd valvula; dv, ductus venatus (= venom duct); rh, rhachis; rp, rostral process of 2nd valvifer; r1, ramus of the 1st valvula; r2, ramus of the 2nd valvula; T9, tergum 9; vlv, valvilli; 1vf, 1st valvifer; 1vv, 1st valvula; 2vf, 2nd valvifer; 2vv, 2nd valvula; 3vv, 3rd valvula.

Results

General organization of the sting apparatus (Figs 1, 2A, B)**.** The sting apparatus of *B. rostrata* lies within the genital chamber formed by the partial infolding of the 8th and 9th abdominal segments (7th and 8th metasomal segments) into the 7th abdomi-

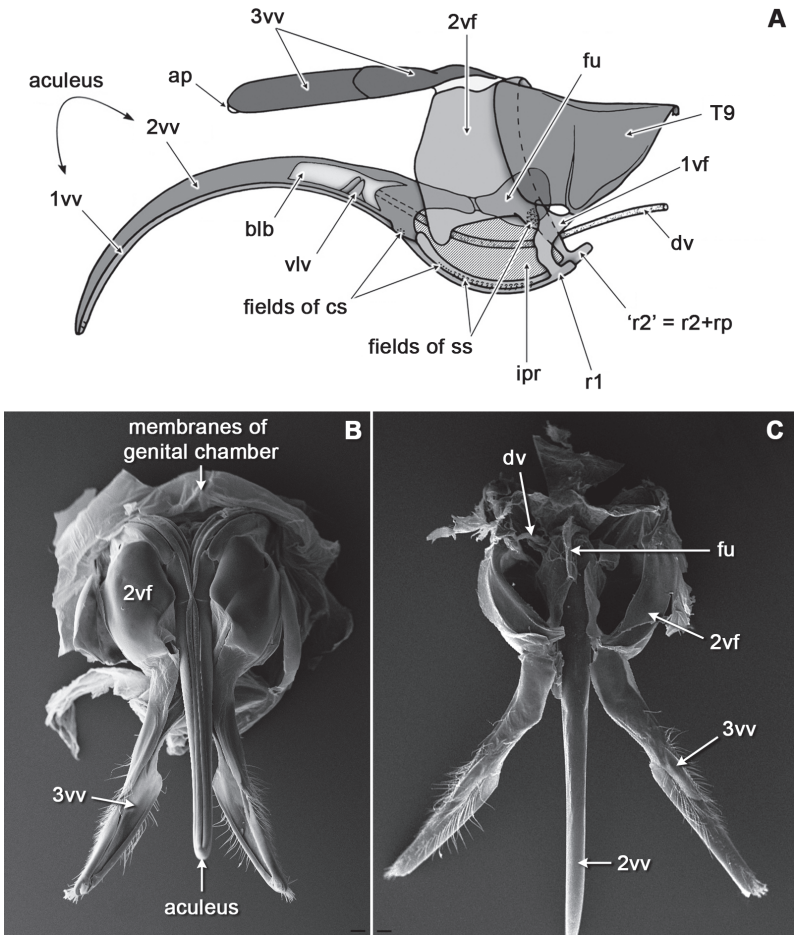

Figure 1. General organization of the sting apparatus in the digger wasp *Bembix rostrata*: **A** diagram showing relative position of main parts in a lateral view (aculeus is extended ventrally, furcula is turned anteriorly; bulb is shown in longitudinal section to show valvilli, the membranous incisura postarticularis is hatched); B-C, SEM micrograph of the sting in ventral **B** and dorsal **C** views. Scale bars: 100 μm.

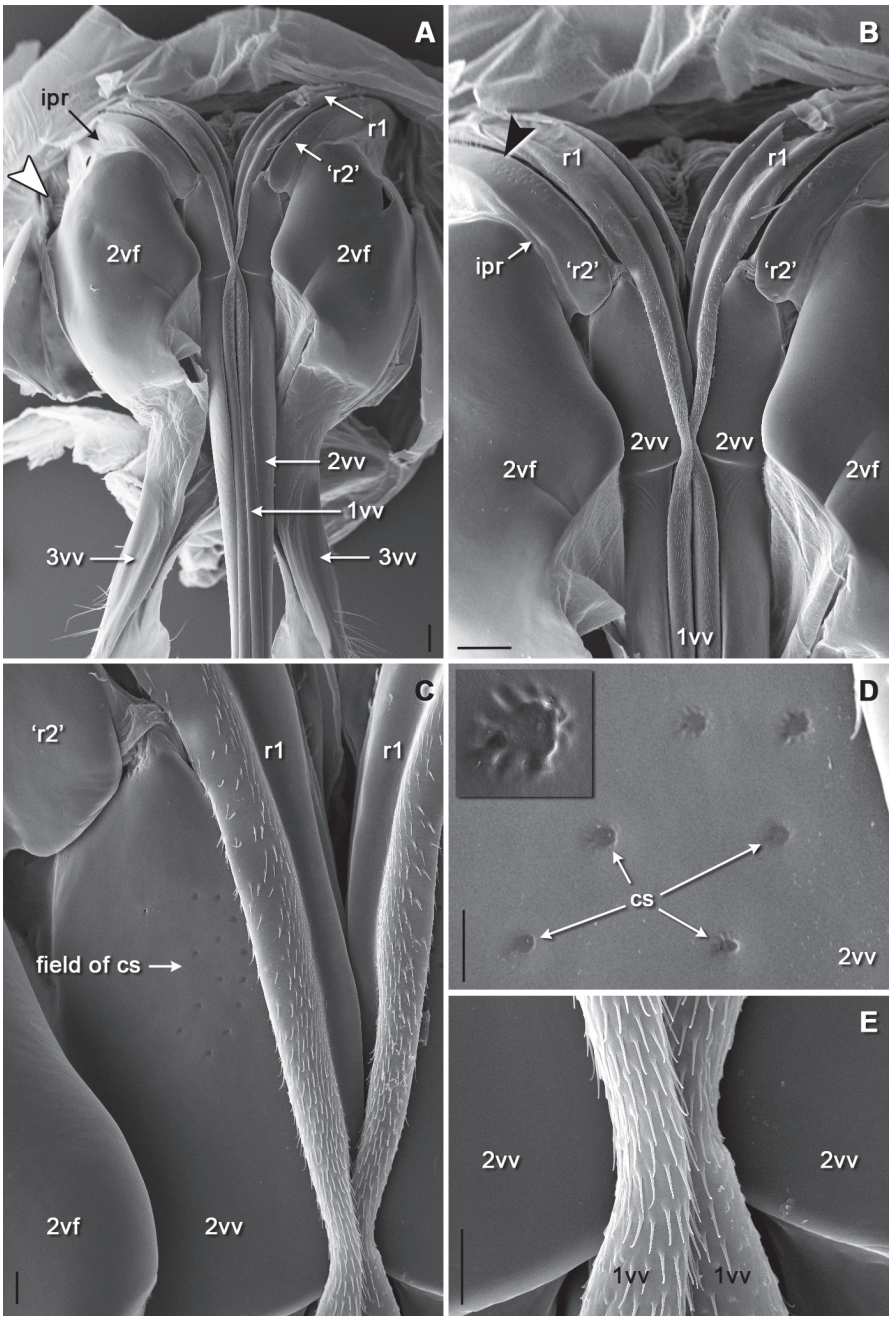

Figure 2. SEM micrographs of the sting basis, ventral view: **A** general aspects **B** basal region of the rami of both valves and of the second valvifera **C** field of campaniform sensilla on basis of the second valve **D** detail of the field of campaniform sensilla on basis of the second valve (one campaniform sensillum enlarged in inset) **E** distally directed microspination on membraneous regions of the first valves. Arrowhead in A shows position of the field of styloconic sensilla on the second valvifer nearby its articulation with the first valvifer (enlarged in Fig. 3B). Scale bars: 100 μm in A and B; 20 μm in C and E; 10 μm in D.

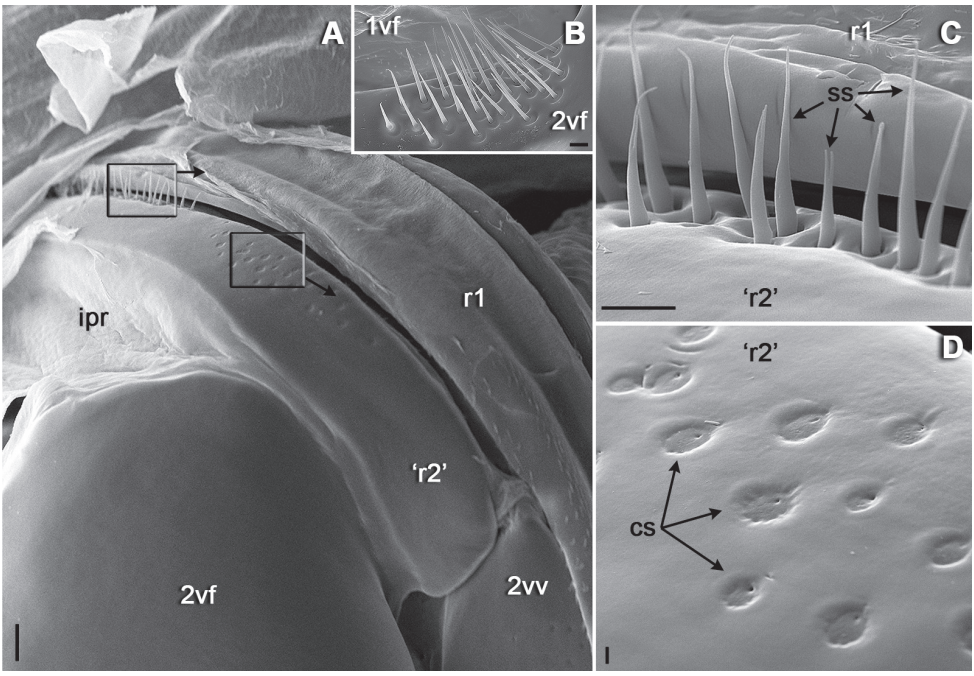

Figure 3. SEM micrographs of the sensilla on the second valvifer: **A** position of two fields of sensilla on the articular process of second valvifer, ventral view **B** field of styloconic sensilla nearby the articulation with first valvifer, lateral view **C** detail of the row of styloconic sensilla on the articular process of the second valvifer **D** detail of the field of campaniform sensilla on the articular process of the second valvifer distally to the row of styloconic sensilla. Insets in A are enlarged in C and D. Scale bars: 30 μm in A; 10 μm in B and C; 2 μm in D.

nal segment, thus only the apical part of the sting is visible outside at rest. The sting shaft itself (= aculeus) is massive, curved ventrally and comprises paired 1st valvulae (= gonapophyses of 8th segment, ventral valves and lancets) and unpaired 2nd valvulae (= medially fused gonapophyses of 9th segment, dorsal valve, and stylet). Basal parts of the 1st and 2nd valvulae are continuous with long curved dorsally processes (rami) which extend to the valvifers: the 1st ramus is connected to the 1st valvifer (= gonangulum; triangular plate), whereas the 2nd ramus is fused laterally with the anterior region of the 2nd valvifer, the region called the rostral process. The 1st and 2nd valvulae (and their rami) form a sliding interlocking mechanism called the olistheter which comprises a groove-like ventral component (= aulax) and a tongue-like dorsal one (= rhachis). The unpaired furcula attaches to the base of the 2nd valvula highly flexibly. The 1st valvifer possesses two articulations: the anterior one is with the modified 9th tergite (= quadrate plate), the posterior one with the 2nd valvifer (= proximal part of 9th gonocoxite). The very elastic membraneous incision (= incisura postarticularis, postincision) separates the anterior rostral process of the 2nd valvifer from its main body. The sting itself is ensheathed by paired 3rd valvulae (= distal part of 9th gonocoxite or sting sheaths) when

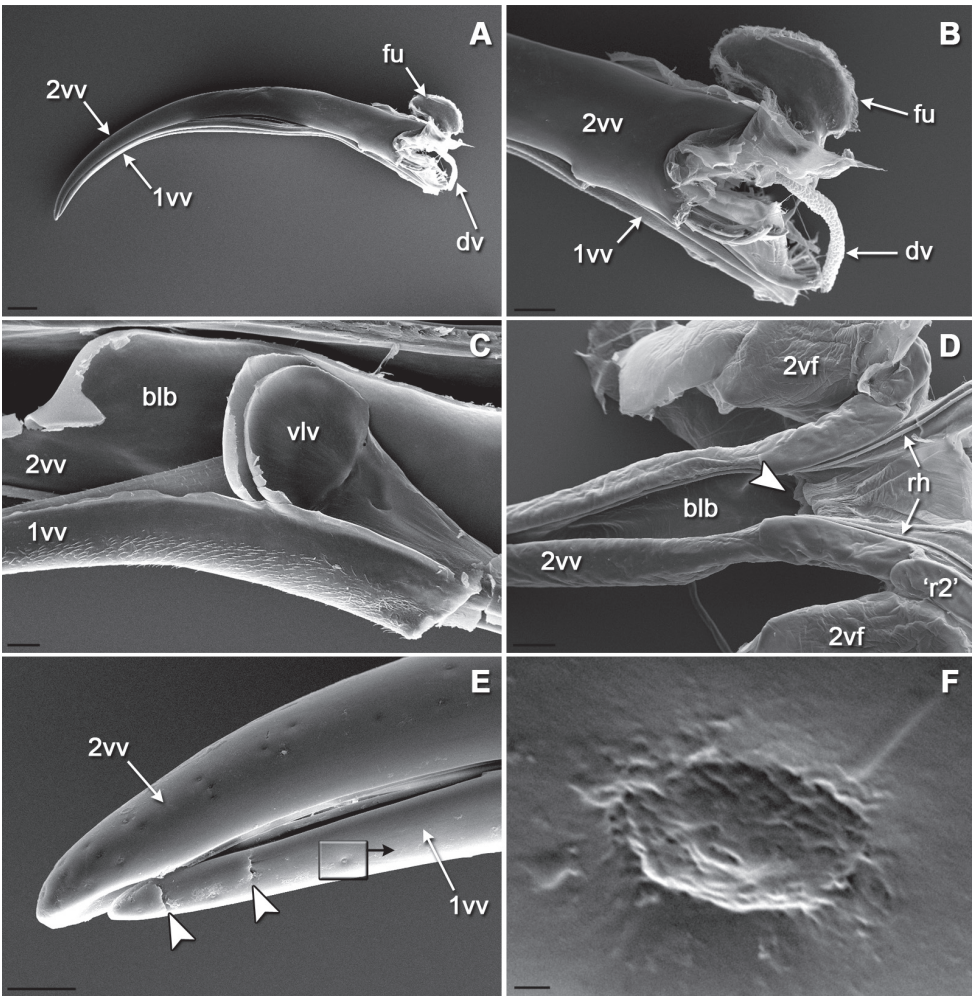

Figure 4. SEM morphology of the sting: **A** lateral view of sting with the furcula and venom duct **B** basal part of the sting **C** valvilli on the first valve positioned in the bulb of the second valve, medial view **D** ventral view of isolated second valve showing the bulb **E** lateral view of sting apex showing scattered sensilla-like structures on both valves and two subapical ridges on the first valve **F** single wrinkled sensilla-like structure that superficially resembles the secretory pores described by Nenon et al., 1995 (note characteristic contamination around the pore). Arrowheads indicate the position of the opening of the venom duct (in D) and the subapical barbs (in E). Scale bars: 200 μm in A; 100 μm in B and D; 30 μm in C and E; 300 nm in F.

not in use. The modified 8th tergite (= spiracle plate) is the outermost part of the sting apparatus and is connected neither with the sting valves nor with the valvifers.

Scanning electron microscopy. The entire external surface of the sting proper is mostly smooth, with only two subapical barbs on the 1st valvula (Figs 4A, E); however, there are numerous sensilla-like structures scattered over the entire surface, these are more numerous apically (Figs 4E, F). The dorsal surface of the 1st valvula forms an

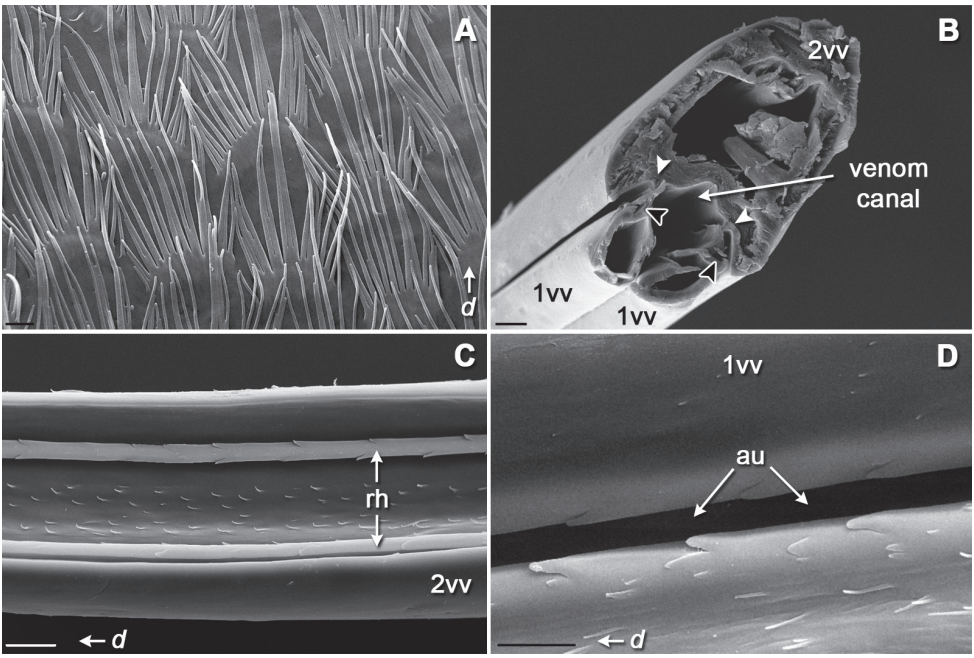

Figure 5. SEM micrographs of internal surfaces of the sting apparatus: **A** setose membrane of the genital chamber that contact the sting basis **B** transverse section of the aculeus showing position of the parts of the olistheter **C** ventral view of isolated second valve showing internal microsculpture between two rhachises **D** dorsal view of aulax of first valve. *d*, distal direction. Arrowheads in B indicate position of rhachises (white) and aulaxes (black) of the olistheter mechanism. Scale bars: 3 μm in A and D; 20 μm in B and C.

anterior swelling where two flaps called valvilli arise (Fig. 4C). These valvilli are housed within a broadened part of the 2nd valvula called the bulb. The venom duct enters the sting base at the anterior margin of the bulb (Figs 4A, B, D). Components of the olistheter are finely serrated, and the inner surface of the 2nd valvula bears distally directed microtrichia (Figs 5B–D). The setose membrane of the genital chamber covers the sting base (Fig. 5A). Three fields of sensilla are found on the 2nd valvifer. A row of styloconic sensilla is situated on the fused 2nd ramus and rostral process (Figs 3A, C). The seta of each sensillum in a row may touch the 1st ramus, and the more the 1st valvula protracts relative to 2nd valvula the more sensilla contact the 1st ramus. A field of 25–28 uniformly directed campaniform sensilla is situated more distally (Figs 3A, D). Another group of at least 35 styloconic sensilla that forms a setal plate is situated on the main sclerite of the 2nd valvifer where it articulates with the 1st valvifer (Figs 2A, 3B). The seta of each sensillum in this field may touch the 1st valvifer. A paired field of ca. 13 uniformly directed campaniform sensilla is also found on the anterolateral surface of the 2nd valvula where it articulates with the rostral process (Figs 2C, D). The well sclerotized 3rd valvula consists of two segments, the proximal and the distal (Figs 6A, C). Its inner wall is mainly membranous with a densely microsetose surface and bears

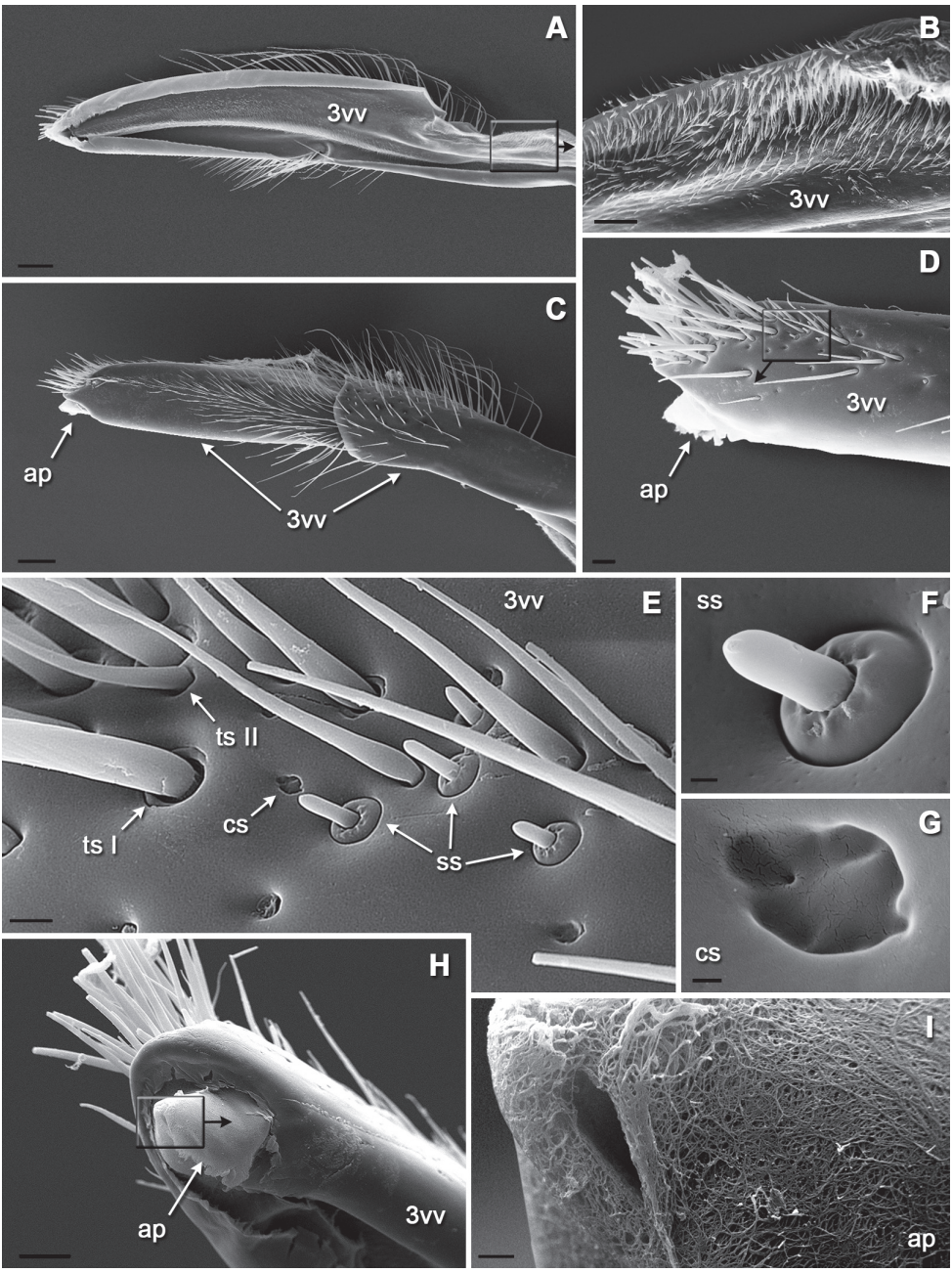

Figure 6. SEM morphology of the third valve: **A** medial view (inset enlarged in B) **B** microspination of membraneous inner wall **C** lateral view **D** apex in lateral view (inset enlarged in E) **E** variety of sensilla on dorsoapical surface **F** socketed styloconic sensillum with apical pore **G** campaniform sensillum **H** apex in mediodorsal view showing membranous process (inset enlarged in I) **I** spongiform cuticle of an apical process. Scale bars: 100 μm in A and C; 20 μm in B and D; 5 μm in E; 1 μm in F; 0.5 μm in G; 30 μm in H; 2 μm in I.

a longitudinal ridge (Figs 6A, B). Apically, the inner membrane of the 3rd valvula forms a cone-shaped process composed of a peculiar spongy cuticle (Figs 6C, H, I). At rest, this apical process abuts closely to the dorsolateral surface of the 2nd valvula. There are at least four morphotypes of sensilla on the 3rd valvula (Figs 6D–G). Trichoid sensillum type I is socketed and has a rounded setal tip; these sensilla are aggregated apically. Trichoid sensillum type II is unsocketed and sharply pointed; these sensilla are the most abundant type, they are located all over the external surface but mostly at the apex and at the margin between proximal and distal parts of the 3rd valvula. Campaniform sensilla are rare and scattered among trichoid ones. Socketed styloconic sensilla bear a distinct pore on their rounded setal tip; these sensilla are found only on the dorsal surface of the 3rd valvulae between trichoid sensilla type I.

Discussion

Bembix rostrata is one of the most widely distributed and remarkable digger wasps species in Europe, and it often forms large colonies of dozen to hundred individuals. It prefers sandy and sunny habitats, where a female digs several burrows. As in most bembicine wasps, *B. rostrata* paralyzes the prey, which are predominantly large tabanid and syrphid flies, by inserting the sting through the venter of the thorax (Nielsen 1945, Evans 1957, Gadallah 2001). At this time, the sting of *B. rostrata* is functioning neither as an egg laying nor prey transporting device.

Radović (1985) has shown that the shape of the sting in apoid wasps is correlated with the degree of sclerotization and mobility of the prey: the wasps which prey on swift flying insects have a more strongly curved sting. This is the case in *B. rostrata* which has a markedly curved sting apparently correlated with the high speed of flight of their dipteran prey. The smooth external surface is a peculiar feature of the sting in most bembicine wasps studied so far (Gadallah and Assery 2004). Rare exceptions are three species of *Bembix* with barbed first valvulae: *B. arenaria* Handlirsch, 1893, *B. oculata* Panzer, 1801 (both after Gadallah and Assery 2004), and *B. rostrata* (this study). Apart from bembicine wasps (Crabronidae: Bembicinae), a barbed sting has been found in *Sericophorus relucens* F. Smith (Crabronidae: Crabroninae) which has barbs on first and second valvulae that may fasten the prey during its transportation on the sting (Radović and Sušić 1997). Interestingly, *S. relucens* also preys on flies. Similarly, species of the genus *Oxybelus* (Crabronidae: Crabroninae) possess spines on the first valvulae and transport their prey (muscid flies) impaled on the sting (Radović 1985). On the other hand, many unrelated species of apoid wasps have a barbed sting that is correlated with their preying on less sclerotized insects like caterpillars, aphids, cockroach nymphs, mantids, etc. (Radović 1985).

Several surfaces of the sting apparatus of *B. rostrata* are covered with unidirectional microstructures. The wall of the venom canal in *B. rostrata* is furnished with small microtrichia that are orientated distad. They are randomly scattered and relatively sparse, and seem to be somewhat reduced if compared with other non-aculeate hymenopter-

ans where they form a comb-like or ctenidial pattern (Quicke et al. 1999). This egg canal microsculpture is not restricted to Hymenoptera, but can be found across several insect orders that possess an ovipositor (Austin and Browning 1981). Here it functions as a "linear ratchet", providing one-way movement of eggs along the ovipositor during longitudinal sliding of the valvulae. However, it is uncertain whether the microsculpture of the venom canal is involved in functioning of the sting in *B. rostrata*, which is not used for egg transport. The distally directed serration on the olistheter elements has been found in the sting of *B. rostrata* and also in the honeybee, *Apis mellifera* L. (Shing and Erickson 1982). The membranous cuticle of the genital chamber in *B. rostrata* that contacts with the sting base, as well as the inner walls of the third valvulae, are also covered with dense, distally directed microsetae of obscure functions. In parasitoid wasps, similar microsculpture on the inner walls of the third valvulae are supposed to be involved in cleaning of the ovipositor sensilla between oviposition episodes (Le Ralec et al. 1996, Quicke et al. 1999). On the other hand, a similar setose membrane in *A. mellifera* is known to produce and accumulate pheromones (Lensky et al. 1995, Martin et al. 2005). Noteworthy is that males of *B. rostrata* are able to differentiate between virgin or freshly copulated females and older females, by means of chemical cues which may be associated with the trunk (Schöne and Tengö 1981). It is not inconceivable that the female sting apparatus and associated structures can be a source of the aforesaid chemical cues.

The sensory equipment of the sting apparatus of *B. rostrata* is diverse. The sensilla can be divided into those that perceive intrinsic stimuli from the insect body (proprioceptors) and those detecting environmental factors (exteroceptors) (Quicke et al. 1999). Sensilla of the first type are represented in *B. rostrata* by two morphotypes, styloconic sensilla and campaniform sensilla, both often aggregated in fields. As in many other hymenopterans, *B. rostrata* possesses two fields of styloconic sensilla (hair plates) on the first valvifer that measure positional relationship of the first and second valvulae (Le Ralec et al. 1996, Quicke et al. 1999, Vilhelmsen et al. 2001, etc.). Two fields of campaniform sensilla have been found on the basal region of the second valvula and on its ramus for the first time in an apoid wasp. With regard to uniform transverse orientation of every sensillum in a field, they most likely function as detectors of lateral stresses and strains arising in the sting during prey penetration. Although campaniform sensilla on the third valvula are scattered, their orientation is also well-ordered. Exteroreceptors are located on the third valvula and are comprised of two morphotypes of trichoid sensilla and one morphotype of styloconic sensilla. Gadallah and Assery (2004) mentioned that trichoid sensilla on the third valvula in apoid wasps have a mechanosensory function. Possibly the differences in morphology of trichoid sensilla reflect some functional differences. The last group of sensilla that are of special interest are socketed styloconic sensilla with an apical pore, detected for the first time on the sting apparatus in an apoid wasp. It was found on the third valvula of *B. rostrata*. The presence of an apical pore implies that these sensilla are not exclusively mechanoreceptive and probably can perceive some chemical stimuli. No chemoreceptores have been recorded on the sting apparatus in apoid wasps so far.

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I am grateful to Dr. Yuri Protsenko (Kyiv National University, Ukraine) for identification of wasps, and to Prof. Neveen Samy Gadallah (Cairo University, Egypt) for her help with the literature. Dr. Wojciech J. Pulawski (California Academy of Sciences, San Francisco) is sincerely thanked for his moral support and his kind improvement of the draft version of the manuscript. I am also indebted to Prof. Laurence Packer (York University, Toronto, Canada) for careful reading of the manuscript and suggested corrections.

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Two new brachypterous species of *Heterospilus* Haliday (Hymenoptera, Braconidae, Doryctinae) from the Nearctic Region

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Abstract

Two new species, *Heterospilus belokobylskiji* Kula, **sp. n.** and *Heterospilus vincenti* Kula, **sp. n.**, from the Nearctic Region are described and differentiated from all other New World species of Doryctinae that exhibit brachyptery or aptery. They are the first brachypterous species of *Heterospilus* Haliday known in the New World and increase the total number of brachypterous species in the genus to four worldwide.

Keywords

Apterous, aptery, brachyptery, parasitoid, taxonomy

Introduction

Of the 1,335 species of Doryctinae listed as valid in Yu et al. (2005), 24 species in 12 genera exhibit brachyptery or aptery. *Heterospilus hemipterus* (Thomson), with the male brachypterous and known only from the neotype (Fischer 1960), and *Nipponecphylus matsumurai* Belokobylskij & Konishi, with males apterous and females macropterous

(Belokobylskij and Konishi 2001), were not listed as such in Yu et al. (2005). Additionally, *Australospathius pedestris* Belokobylskij, Iqbal & Austin (females apterous and males macropterous) and *Doryctopsis neozealandicus* Belokobylskij, Iqbal & Austin (both sexes apterous), as well as *Echinodoryctes lawrencei* Belokobylskij, Iqbal & Austin and *Echinodoryctes tetraspinosus* Belokobylskij, Iqbal & Austin (wings represented by scalelike pads in both sexes) (Belokobylskij et al. 2004, S. Belokobylskij in litt.), were not included in Yu et al. (2005). *Oroceguera andersoni* Seltmann & Sharkey, with the female apterous and known only from the holotype, was described recently (Seltmann and Sharkey 2007). Thirteen species in the New World are known to exhibit brachyptery or aptery: *Aptenobracon formicoides* Marsh, *Ecphylopsis costaricensis* Marsh, *Ecphylus caudatus* Ruschka, *Ecphylus lepturgi* Rohwer, *Ecphylus pacificus* Marsh, *Ecphylus schwarzii* (Ashmead), *O. andersoni*, *Pambolidea yuma* Ashmead, *Psenobolus ficarius* Ramirez & Marsh, *Psenobolus parapygmaeus* Ramirez & Marsh, *Psenobolus triangularis* van Achterberg & Marsh, *Termitobracon emersoni* Brues, and *Ypsistocerus manni* Cushman. Seltmann and Sharkey (2007) provided a key to New World genera with brachypterous or apterous species. They did not include *Termitobracon* Brues and *Ypsistocerus* Cushman in the key likely because they consider Ypsistocerinae a subfamily as in Wharton et al. (1997) rather than a tribe of Doryctinae as in Yu et al. (2005), although they did not state that viewpoint.

Heterospilus Haliday, the richest doryctine genus in the New World considering the number of undescribed species (P. Marsh in litt.), is one genus for which brachypterous and apterous species are not known in the New World. However, *Heterospilus brachyptera* (Jakimavicius), with the female brachypterous and known only from the holotype, and *H. hemipterus* have been reported from the Palearctic Region (Fischer 1960, Jakimavicius 1968, Yu et al. 2005).

The author discovered two new brachypterous species of Doryctinae in the Nearctic Region through a study testing pan trap color preference for selected Hymenoptera. The two species fit *Heterospilus* sensu Marsh (2002) aside from the wings and malar space length and are described herein.

Materials and methods

Specimens were collected using blue, red, and white 12 ounce Solo™ (Urbana, Illinois) party bowls placed in an ~100 m wide power line right-of-way ~two miles east of Prince Frederick, Maryland. The clearing runs roughly north-south and is bordered to the east and west by eastern deciduous forest. The flora within the clearing was not surveyed. Topographically, it contains upland areas primarily with herbaceous plants and lowland areas primarily with woody plants. All traps were placed in upland areas. The bowls were filled with a solution of water and Liqui-Nox (Alconox, Inc., White Plains, New York) detergent; the latter served as a surfactant for the water. Contents of the bowls were collected every other day, and the bowls were refilled with water-detergent solution at that time.

Specimens were dehydrated using hexamethyldisilazane (HMDS) as in Heraty and Hawks (1998). They were examined as in Kula (2009), and their placement in *Heterospilus* was determined through reference to Marsh (2002), Marsh (1997), and Seltmann and Sharkey (2007). Additionally, the following specimens were examined: the holotype and two paratypes of *A. formicoides* in the Smithsonian Institution National Museum of Natural History, Washington, DC (USNM); two paratypes of *Ecphylopsis costaricensis* borrowed from the Canadian National Collection of Insects, Ottawa, Ontario (CNC); the holotype and two paratypes of *Ecphylopsis swezeyi* Beardsley borrowed from the Bernice P. Bishop Museum, Honolulu, Hawaii, as well as a nontype specimen determined by C. F. W. Muesebeck (USNM); the holotype and a paratype of *Ecphylus lepturgi*, as well as nontype specimens determined by P. M. Marsh (USNM); the holotype and 10 paratypes of *Ecphylus pacificus*, as well as nontype specimens determined by P. M. Marsh (USNM); a paratype of *Ecphylus schwarzii* and nontype specimens determined by P. M. Marsh (USNM); the holotype of *Pa. yuma* and nontype specimens determined by P. M. Marsh (USNM); nine paratypes of *Ps. ficarius* (USNM); and four paratypes of *Ps. parapygmaeus* and nontype specimens determined by C. van Achterberg (USNM). The specimens were determined as new species using unpublished morphological data for *H. hemipterus* obtained from S. A. Belokobylskij (Zoological Institute of Russian Academy of Sciences, St. Petersburg). Belokobylskij (in prep.) considers *H. brachyptera* conspecific with *H. hemipterus*. Thus, the diagnoses herein include the name *H. hemipterus* only.

Terminology for morphological features and setation largely follows Sharkey and Wharton (1997). Pronotal collar, pronotal groove, and subalar groove are as in Marsh (2002); posterior mesopleural furrow is as in Kula (2003). Terminology for surface sculpture primarily follows Harris (1979), but Sharkey and Wharton (1997) and Marsh (2002) were also consulted. Crenulate is as in Sharkey and Wharton (1997); carinae and areas of the propodeum are as in Marsh (2002).

Measurements were taken with an ocular micrometer as in Wharton (1977) with the following additions and modifications. Tergum 1 (T1) length is the maximum length of T1 in lateral view, and T1 width is the width of the posterior edge of T1 in dorsal view. Thorax length and thorax height are referred to as mesosoma length and mesosoma height, respectively. Mesonotal width is referred to as mesoscutal width. Malar space height is the distance between the ventral margin of the eye and the middle of the ventral margin of the malar space. Maximum length was measured for the penultimate maxillary palpomere and T2+T3 mesally. The exposed portion of the ovipositor was measured ventrally to estimate ovipositor length.

Abbreviations used in diagnoses and descriptions are as in Kula (2009) with the following additions: malar space height (MSH), penultimate maxillary palpomere length (PMPL), and exposed ovipositor length (EOL). Abbreviations for museums and collections follow Evenhuis (2010). The material examined sections are formatted as in Kula (2009).

Habitus images were obtained using a Visionary Digital imaging system. The system consists of an Infinity Optics K2 long distance microscope affixed to a Canon EOS

40D digital SLR camera. A Dynalite M2000er power pack and Microptics ML1000 light box provided illumination. Image capture software is Visionary Digital's proprietary application with images saved as TIF with the RAW conversion occurring in Adobe Photoshop Lightroom 1.4. Image stacks were montaged with Helicon Focus 4.2.1. Final images were prepared using Adobe Illustrator CS4 and are deposited in Morphbank (image ID numbers 581765, 581772, 581777, and 581782).

Results and discussion

Heterospilus belokobylskiji Kula, sp. n. and *Heterospilus vincenti* Kula, sp. n. can be differentiated from other brachypterous or apterous doryctines in the New World (excluding ypsistocerines) using form of the wings (Table 1). Additionally, the scutellar disc is flat in *H. belokobylskiji* and *H. vincenti*; it is convex in *A. formicoides* and conical in *Ecphylopsis costaricensis*. A tubercle is present at the base of the hind coxa in *H. belokobylskiji* and *H. vincenti*; it is round at the base in *Ecphylopsis costaricensis*, *Ecphylus caudatus*, *Ecphylus lepturgi*, *Ecphylus pacificus*, and *Ecphylus schwarzii*. The propodeal bridge is absent in *H. belokobylskiji* and *H. vincenti*; the metasoma articulates with the mesosoma directly above the metacoxae. The propodeal bridge is present between the metacoxae and petiole in *O. andersoni*; the metasoma articulates with the mesosoma high above the metacoxae resulting in a large gap between those features (cf. cenocoeliine braconids). The femora are not enlarged in *H. belokobylskiji* and *H. vincenti*; all femora are enlarged in *Pa. yuma*, *Ps. ficarius*, *Ps. parapygmaeus*, and *Ps. triangularis*.

Marsh (2002) noted that Beardsley (1961) illustrated a macropterous female holotype of *Ecphylopsis swezeyi*, known from Hawaii, with the forewing 2RS vein absent and suggested it might belong in *Heterospilus*. Three paratypes of *Ecphylopsis swezeyi*

Table 1. Species of Doryctinae in the New World, excluding ypsistocerines, that exhibit brachyptery or aptery.

Species	Female wing form	Male wing form
Aptenobracon formicoides	apterous	apterous
Ecphylopsis costaricensis	scalelike pads	scalelike pads
Ecphylus caudatus	apterous, macropterous	apterous, macropterous
Ecphylus lepturgi	apterous, macropterous	apterous
Ecphylus pacificus	unknown	apterous
Ecphylus schwarzii	apterous	apterous
Heterospilus belokobylskiji Kula, sp. n.	brachypterous	brachypterous
Heterospilus vincenti Kula, sp. n.	brachypterous	brachypterous
Oroceguera andersoni	apterous	unknown
Pambolidea yuma	apterous, macropterous	apterous
Psenobolus ficarius	macropterous	brachypterous
Psenobolus parapygmaeus	macropterous	brachypterous
Psenobolus triangularis	macropterous	brachypterous

have the wings represented by scalelike pads. The author regards the holotype and two brachypterous paratypes examined as conspecific. All of the type specimens of *Ecphylopsis swezeyi* examined are mounted in such a way that the hind coxa is obscured so that the absence or presence of an anteroventral basal tubercle cannot be discerned. However, the hind coxa of a macropterous nontype female at the USNM lacks a tubercle. Further, the scutellar disc is convex in *Ecphylopsis swezeyi* (more strongly so in brachypterous specimens) and similar in shape to that of *Ecphylopsis costaricensis*. Therefore, the author retains *Ecphylopsis swezeyi* in *Ecphylopsis* at this time. The discovery of males to discern the absence or presence of the hind wing stigma might clarify the generic placement of *Ecphylopsis swezeyi*.

Taxonomy

***Heterospilus belokobylskiji* sp. n.**
urn:lsid:zoobank.org:act:09A27F4E-4564-4FA1-95B2-ED283F49D341
Figs 1–2

Holotype female. U.S.A., "MARYLAND:Calvert Co. [;] 2 mi E Prince Frederick [;] 38°33'3.83"N 76°33'3.09"W [;] 14.v.-16.v.2007 SEL Hym Unit [;] pan trap, transect6 treatment B" (USNM).

Paratype. 1 ♂ same data as holotype except 38°32'57.95"N 76°33'1.43"W, transect8 treatment W (USNM).

Diagnosis. The vertex is smooth except a pair of small strigulate areas posterolaterad the lateral ocelli in *H. belokobylskiji*; the vertex is entirely strigate to strigate-coriaceous in *H. hemipterus*, and it is entirely coriaceous in *H. vincenti*. The face is smooth in *H. belokobylskiji*; the face is at least partially strigate in *H. hemipterus*, and it is smooth mesally and coriaceous laterally in *H. vincenti*. The frons is partially strigulate in *H. belokobylskiji*; the frons is entirely coriaceous in *H. vincenti*. The mesopleuron (excluding subalar groove, precoxal sulcus, and posterior mesopleural furrow) is weakly coriaceous with some areas nearly smooth in *H. belokobylskiji*; the mesopleuron is at least partially strigate in *H. hemipterus*. The hind wing stigma of the male is located slightly basad the middle of the wing in *H. belokobylskiji*; the stigma is located at the wing apex in *H. vincenti*. Transverse grooves are absent on T3 in *H. belokobylskiji*; a crenulate transverse groove is present on T3 in *H. hemipterus*. The head (excluding mouthparts and antenna) is brown in *H. belokobylskiji*; the head is yellow in *H. vincenti*.

Description. Female (Fig. 1).

Body length. 2.28 mm.

Head. HL 0.81× HW, HW 1.09× TW, FW 1.92× FH, EL 1.00× EH, MSH 0.80× EH, F1L 0.85× F2L, PMPL 0.45× F1L; antenna broken at eighth flagellomere; mandible with two teeth, tooth closest to labiomaxillary complex shorter than other tooth, setiferous; malar space smooth, setiferous, malar suture absent; clypeus with roughly

Figures 1–2. Lateral habitus images of *Heterospilus belokobylskiji*, scale bars = 1.00 mm. **1** Female **2** Male.

apical 1/2 setiferous and basal 1/2 glabrous; face smooth, glabrous mesally and setiferous laterally; frons partially strigulate and partially smooth, sculpture strongest in depressions dorsad antennal sockets, glabrous except one to two setae along margin of eye; vertex mostly smooth but with pair of small strigulate areas posterolaterad lateral ocelli, setiferous; ocelli present but small (cf. *Heterospilus striatus* Muesebeck & Walkley); gena smooth, setiferous; occiput smooth, glabrous except pair of setae ventrally on both sides of head.

Mesosoma. ML 2.83× MW, ML 1.97× MH, MW 0.70× MH, SSL 0.50× SSW; pronotal collar without transverse carina, anterior portion rugulose and posterior portion smooth mesally and crenulate laterally, anterior and posterior portions both glabrous except setiferous along anterior margins, pronope absent, lateral portion of pronotum (including pronotal groove) rugose, roughly setiferous along margins and glabrous mesally; notauli complete and meeting posteromesally, bearing a few weak crenulae; mesoscutal midpit absent; mesoscutum (excluding lateral margin and notauli) coriaceous, setiferous along margins and notauli; scutellar sulcus with median longitudinal carina and pair of crenulae adjacent to carina; scutellar disc weakly coriaceous, glabrous except five setae along lateral and posterior margins; propodeum strongly carinate, setiferous, carinae forming hastate areola mesally, sculpture within areola areolate-rugose, mesolaterally with transverse carina dividing propodeum into roughly basal and apical halves, dorsal lateral carinae dividing basal 1/2 into median and lateral areas, median area with weak indication of coriaceous sculpture and lateral area areolate-rugulose, apical 1/2 areolate-rugose; subalar groove crenulate; precoxal sulcus present in roughly anterior 1/2 of mesopleuron and crenulate, posterior 1/2 of mesopleuron without impression but with rugosities extending to mesocoxa; posterior mesopleural furrow crenulate; mesopleuron (excluding subalar groove, precoxal sulcus, and posterior mesopleural furrow) weakly coriaceous with some areas nearly smooth, setiferous except glabrous area dorsomesally roughly between subalar groove and posterior mesopleural furrow to level of episternal scrobe; metapleuron areolate-rugose, setiferous; metacoxa with anteroventral basal tubercle.

Forewing. Brachypterous, extending to posterior margin of T2 (including fringe); hyaline; stigma present anterodistally, posterior margin difficult to differentiate from R1 vein; with following veins complete and tubular: C+SC+R, M+CU, 1-1A, 1RS, 1M, and 1CU; (RS+M) and m-cu veins complete but nebulous resulting in distinct 1st discal cell; one wing with 3RS vein minute but tubular and clearly differentiated from stigma and R1 vein.

Hind wing. Brachypterous, extending to posterior margin of T2 (including fringe); hyaline; basal and subbasal cells enclosed by tubular veins, veins enclosing cells differ in width and degree of sclerotization; R1 vein tubular; M+CU vein shorter than 1M vein.

Metasoma. T1L 1.15× T1W; subcylindrical; ovipositor with minute teeth ventrally, EOL about 2.23× T2+T3L; ovipositor sheaths setiferous, setae increasing in density anteriorly to posteriorly; T1 costate, dorsal carinae extending posteriorly about 3/4 length of tergum, setiferous, dorsope present; T2 costate, setiferous; transverse groove between T2+T3 weakly impressed, smooth; T3–T7 smooth, setae forming single transverse row in middle or posterior 1/2 of tergum; T8 smooth, setae in no apparent pattern.

Color. Head (excluding mouthparts and antenna) brown, mouthparts whitish yellow except mandible yellow with teeth brown, scape and pedicel yellow, flagellum yellow proximally transitioning to brown distally; mesosoma orangish brown except pronotum and propleuron yellowish brown; wing venation tan; legs yellow; T1–T2 entirely yellowish brown, T3–T5 mostly brown with posterior edge slightly darker but

all with some irregular yellow coloration, T6 yellow anteromesally but otherwise yellowish brown, T7 yellowish brown, T8 yellow.

Male (Fig. 2). As in female except:

Body length. 2.04 mm.

Head. HL 0.78× HW, HW 1.06× TW, EL 0.93× EH, MSH 0.73× EH, F1L 0.93× F2L, PMPL 0.38× F1L; antenna with 17 flagellomeres; frons glabrous except a few setae along margin of eye.

Mesosoma. ML 2.03× MH, MW 0.72× MH; pronotal collar with anterior portion coriaceous and posterior portion rugulose, scutellar sulcus with median longitudinal carina and pair of shorter longitudinal carinae adjacent to median carina; propodeum with basal and dorsal lateral carinae distinct, basal median area rugulose, remainder of propodeum areolate-rugose, areola (if present) obscured by surrounding sculpture.

Forewing. Extending nearly to end of T3 (including fringe).

Hind wing. Extending nearly to end of T3 (including fringe); stigma slightly basad middle of wing, subelliptical; basal and subbasal cells enclosed by tubular veins except delimited distally by stigma, basal cell delimited ventrally by M+CU vein, 1M vein absent; R1 vein tubular.

Metasoma. T1–T2 costate-rugose; T2 sculpture extending into transverse groove between T2+T3; T3 smooth except band of carinulae anteromesally.

Color. Mesosoma brownish yellow; T1–T2 entirely brownish yellow, T3 brown with posterior edge slightly darker except yellow anteromesally, T4 brown with posterior edge slightly darker, T5–T6 yellow with posterior edge brown, T7–T8 yellow.

Host. Unknown.

Etymology. This species is named in honor of Dr. Sergey A. Belokobylskij for his contributions to braconid systematics and for providing information on brachypterous and apterous doryctines critical to completion of this article.

***Heterospilus vincenti* Kula, sp. n.**

urn:lsid:zoobank.org:act:0C6454A6-4090-4032-8C26-EF5A3A587CCE

Figs 3–4

Holotype female. U.S.A., "MARYLAND:Calvert Co. [;] 2 mi E Prince Frederick [;] 38°33'4.19"N 76°33'3.96"W [;] 30.v.-1.vi.2007 SEL Hym Unit [;] pan trap, transect5 treatment B" (USNM).

Paratype. 1 ♂ same data as holotype except 38°33'15.72"N 76°33'8.73"W, 14.v.-16.v.2007, transect4 treatment R (USNM).

Diagnosis. *Heterospilus vincenti* can be differentiated from *H. belokobylskiji* using the diagnosis for *H. belokobylskiji*. The vertex is coriaceous in *H. vincenti*; the vertex is strigate to strigate-coriaceous in *H. hemipterus*. The face is smooth mesally and coriaceous laterally in *H. vincenti*; the face is at least partially strigate in *H. hemipterus*. The frons is coriaceous in *H. vincenti*; the frons is strigate *H. hemipterus*. Transverse grooves are absent on T3 in *H. vincenti*; a crenulate transverse groove is present on T3 in *H.*

Figures 3–4. Lateral habitus images of *Heterospilus vincenti*, scale bars = 1.00 mm. **3** Female **4** Male.

hemipterus. The head (excluding mouthparts and antenna) is yellow in *H. vincenti*; the head is dark reddish brown except yellowish brown along eye and ventrally in *H. hemipterus*.

Description. Female (Fig. 3).

Body length. 2.36 mm.

Head. HL 0.77× HW, HW 1.09× TW, FW 1.83× FH, EL 1.00× EH, MSH 1.00× EH, F1L 0.93× F2L, PMPL 0.31× F1L; antenna with 17 flagellomeres; mandible with two teeth, tooth closest to labiomaxillary complex shorter than other tooth, setiferous;

malar space coriaceous, setiferous, malar suture absent; clypeus with roughly apical 1/2 setiferous and basal 1/2 glabrous; face smooth mesally and coriaceous laterally, glabrous mesally and setiferous laterally; frons coriaceous, glabrous except a few setae along margin of eye; vertex coriaceous, setiferous; ocelli present but small (cf. *H. striatus*); gena coriaceous, setiferous; occiput smooth, glabrous except pair of setae ventrally on both sides of head.

Mesosoma. ML 3.58× MW, ML 2.27× MH, MW 0.63× MH, SSL 0.57× SSW; pronotal collar with transverse carina, anterior portion smooth and posterior portion rugose, anterior and posterior portions both glabrous except setiferous along anterior margins, pronope absent, lateral portion of pronotum (including pronotal groove) rugose except small coriaceous area dorsally, roughly setiferous along ventral and posterior margins but otherwise glabrous; notauli complete to transscutal articulation and separated by carina posteromesally, more strongly impressed anteriorly than posteriorly, bearing a few weak crenulae; mesoscutal midpit absent; mesoscutum (excluding lateral margin and notauli) coriaceous, setiferous along margins and notauli; scutellar sulcus with median longitudinal carina; scutellar disc coriaceous, glabrous except pair of setae laterally; propodeum strongly sculptured, setiferous, with basal and dorsal lateral carinae distinct, basal median area coriaceous, basal lateral area rugose, remainder of propodeum areolate-rugose, areola absent; subalar groove crenulate; precoxal sulcus complete to mesocoxa, more strongly impressed anteriorly than posteriorly, transitioning from crenulate anteriorly to rugose posteriorly; posterior mesopleural furrow crenulate; mesopleuron (excluding subalar groove, precoxal sulcus, and posterior mesopleural furrow) coriaceous, setiferous with setae largely confined to margins, subalar groove, and precoxal sulcus; metapleuron areolate-rugose, setiferous; metacoxa with anteroventral basal tubercle.

Forewing. Brachypterous, extending to end of mesosoma (including fringe); hyaline; stigma absent; venation limited to tubular vein along anterior margin complete to wing apex and vein along posterior margin transitioning from nebulous proximally to tubular distally and bending anteriorly near wing apex to intersect vein along anterior margin.

Hind wing. Brachypterous, extending to end of mesosoma (including fringe); hyaline; basal cell distinct but open, SC+R vein spectral distally; subbasal cell enclosed by tubular veins; SC+R vein and 1M vein converge distally to form thickening roughly width of two veins.

Metasoma. T1L 1.14× T1W; subcylindrical; ovipositor with minute teeth ventrally, EOL about 3.28× T2+T3L; ovipositor sheaths setiferous, setae increasing in density anteriorly to posteriorly; T1 costate-rugose, dorsal carinae blending with ground sculpture posteriorly, setiferous, dorsope present; T2 carinate-rugulose, setiferous; transverse groove between T2+T3 absent, T2 and T3 indicated by inconspicuous break in sculpture; T3 carinulate in roughly anterior 1/2, smooth in roughly posterior 1/2, setiferous with most setae forming transverse row in middle of tergum; T4–T8 smooth, setae forming single transverse row in middle or posterior 1/2 of tergum.

Color. Head (excluding mouthparts and antenna) yellow, mouthparts whitish yellow except mandible yellow with teeth brown, scape and pedicel yellow, flagellum yellow proximally transitioning to brown distally; mesosoma yellow with pronotum

and propleuron slightly lighter; wing venation and legs yellow; T1–T2 entirely yellow, T3–T4 yellow with posterior edge brownish yellow, T5–T8 entirely yellow.

Male (Fig. 4). As in female except:

Body length. 2.38 mm.

Head. HL 0.80× HW, HW 1.11× TW, FW 1.92× FH, EL 0.94× EH, MSH 0.94× EH, F1L 0.88× F2L, PMPL 0.29× F1L; antenna with 20 flagellomeres; gena weakly coriaceous, sculpture barely discernable in some areas; occiput glabrous except a few setae ventrally on both sides of head.

Mesosoma. ML 3.48× MW, ML 2.29× MH, MW 0.66× MH; pronotal collar without transverse carina, anterior portion coriaceous-rugulose and posterior portion rugulose; notauli weakly impressed but complete and meeting posteromesally, bearing a few rugosities; scutellar sulcus with pair of crenulae; scutellar disc bearing three setae; propodeum largely obscured by hind wings but strongly sculptured, basal carina distinct, outer-most dorsal lateral carina indistinct, inner-most dorsal lateral carina (if present) obscured by hind wings, visible portion of basal median area coriaceous, remaining visible portions areolate-rugose, areola (if present) obscured by hind wings.

Forewing: Additional tubular vein located above vein along posterior margin, additional vein arising at base of wing and terminating into vein along posterior margin roughly at its midpoint.

Hind wing: Base of wing membranous with minute veins along anterior and posterior margins; apex of wing with stigmalike swelling bearing flap of wing membrane at distal end of swelling.

Metasoma: T1L 1.26× T1W; T1 carinate-rugose; T2 carinulate-rugose; transverse groove between T2+T3 weakly impressed, T2 and T3 also indicated by inconspicuous break in sculpture; T3 carinulate-rugose in roughly anterior 1/2, smooth in roughly posterior 1/2; T4 with a few crenulae anteriorly but otherwise smooth.

Color: T3 roughly anterior 1/3 yellow and posterior 2/3 brown, T4 yellow anteriorly and brown posteriorly (partially retracted under T3).

Host. Unknown.

Etymology. This species is named for the author's son, Vincent Marion Kula.

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RESEARCH ARTICLE

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Hilltopping behavior by males of *Tachysphex menkei* Pulawski (Hymenoptera, Crabronidae)

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Abstract

Males of the little known crabronid wasp *Tachysphex menkei* Pulawski engage in hilltopping behavior at the peak of Usery Mountain in central Arizona. Males are active at midday in the late spring at this location. Individuals perch on and launch out and back flights from small rocks near prominent plants growing at the highest parts of the undulating ridgeline that makes up the peak. The same set of sites attracted two generations of males (in 2009 and 2010). If site-faithful males are territorial (and if size influences territorial success), resident males (those that returned to their perches over at least two days) should be larger on average than the males that replace them after the residents have been removed. This expectation was met. In keeping with the hypothesis that hilltopping is a mating system of last resort, only a few males were seen on any given day and no females were observed, suggesting that the population of the species is small and dispersed, at least in central Arizona.

Keywords

Mating system, Arizona

Introduction

Many butterflies, flies and ants employ hilltopping mating systems in which males fly to conspicuous landmarks to await the arrival of receptive females (Skevington 2008). However, only a few wasps have been reported to use this method of mate location (Alcock 1981, Alcock 2007a, Alcock 2007b, Dodson and Yeates 1989). The

apparent scarcity of hilltopping wasps applies strongly to the Crabronidae, which includes the species that were once placed in the Sphecidae. However, hilltopping by a number of crabronids has now been described from a hilltop in central Arizona where males of several species of *Tachytes* and *Astata* engage in defense of scattered perching locations where they appear to be waiting for potential mates (Alcock 2007a, Alcock 2007b).

In this report, I provide an account of the hilltopping behavior of a small and inconspicuous crabronid, *Tachysphex menkei* Pulawski, a little known species from southern California and Arizona (Pulawski 2010). Although the nesting behavior of female *Tachysphex* has been the subject of a number of papers (e.g., Kurczewski 2010), relatively little has been published on the behavior of males of this genus (Kurczewski 1966, Kurczewski and Kurczewski 1987). *Tachysphex menkei* is the first representative of the genus known to exhibit the hilltopping mating system. I will document that its behavior is very similar to that of another crabronid whose males also occur on the same peak during the late spring and summer.

Methods

The study was conducted on 7 days in May 2009 and on 20 days from late April to early June 2010 at Usery Peak, near Mesa, AZ. The site lies within the Upland Sonoran Desert and attracts many hilltopping insects (Alcock 1987, Alcock and Carey 1988). A transect of about 300 m was established along the ridge that forms the top of Usery Mountain. The prominent paloverdes (*Parkinsonia microphylla* Torr.) and creosotebushes (*Larrea tridentata* (DC.) Coville) growing on the ridgetop were numbered, enabling an observer to identify the location of hilltopping insects in relation to these plants. When a male *T. menkei* was found, a record was made of its location and the time of day it was seen. If the individual was selected for marking, it was captured in an insect net, dotted on the thorax with paints from one or two fine point DecoColor paint pens, and then released. Thereafter, when marked males were seen their identity was recorded along with data on their location along the transect.

On May 19, 2009 and on May 16 and May 20, 2010, a total of 6 marked males known to have returned to a particular perching location over a period of at least two days (i.e., "resident" males) were captured and placed in vials within a chilled cooler. The site was then monitored for up to 70 min. If a replacement male arrived and perched on the vacant rock, it too was captured and placed in the cooler. Subsequently, all males taken in this fashion were transported to a home freezer. On a following day, the "residents" and "replacements" were weighed on a Mettler Balance accurate to 0.1 mg. The data collected in this manner were used to test the prediction that resident territory holders should be larger (heavier) than males that had yet to acquire a territory of their own.

Results

In May of both years of the study, males of *T. menkei* were consistently found perched on certain small rocks (Fig. 1) on Usery Peak. From their perches, males launched frequent flights out and back over a distance of no more than 50 cm. Four males watched between May 13 and May 16, 2009 engaged in 10 to 17 such flights per 2 min. Males appeared as early as 1012 and stayed as late as 1525, although the wasps were most often observed between 1100 and 1300. Many individuals were present over periods of 60 min or more, with one male recorded at a site for 2.25 hr.

The small rocks used by males as perch sites (Fig. 1) were found at a total of nine spots scattered along the 300 m ridgeline transect. Although it was common for some of these perch sites to be left unoccupied on any given day, two sites were nearly always taken with a male present on 19 of 20 days of observation at each location in the late spring of 2010.

At one place, two males sometimes perched on rocks separated by only 2 m but the next closest pair of nearest neighboring perch sites was 8 m apart. Each occupied site was near a prominent plant growing on a higher than average point along the ridge.

Figure 1. A male of *Tachysphex menkei* perched on a rock on Usery Peak that attracted a series of territory holders in the spring in two consecutive years (2009 and 2010).

In 2009, a total of six sites were used by perching males over the course of the study; in 2010, the same six sites plus three others were taken on occasion by perching males.

On some days at some sites, more than one male was recorded during the observation period, almost always because a male seen on one census was absent on a subsequent one and in his place was a different individual. In 2009, 21 records of this sort were accumulated with another 31 records gathered in 2010. Thus, the number of male wasps visiting the peaktop on a given day was often greater than the number of occupied perches on that day.

Males did not often interact with other individuals. In 2009, just two chases were seen in which a resident pursued a departing intruder. In 2010, six chases were recorded and one case in which two males grappled together on the ground after one male briefly captured a visitor to his perching area.

Males of *T. menkei* tended to be site faithful. In 2009, 27 males were marked and released; 14 returned on the same or subsequent day up to 7 days after marking. In 2010, 24 males were marked and released; 12 returned on same or subsequent day up to 4 days after marking, all but one to the site where they had been originally marked.

If it is true that at least some males were territorial as suggested both by their site fidelity and by occasional observations of chases between conspecifics, then we can predict that removal of an established resident would lead to his replacement by a smaller male, given that large body size is generally believed to confer an advantage in aggressive competition between male insects and other animals (Blanckenhorn 2000). There is considerable size variation among males of *T. menkei* with recorded weights ranging from 8.7 mg to 24.9 mg. The removal experiments revealed that five of the six resident males were in fact larger than all eight of the replacement males. The mean weight of the residents (21.4 mg) was also significantly greater than the mean weight (14.7 mg) of the replacements ($t = 3.85$; $df = 12$; $p = 0.002$).

Discussion

Although the genus *Tachysphex* contains hundreds of species (Pulawski 2010), only a handful have been studied with respect to mating system. Among those whose male behavior has been described are several species in which males perch on the ground in areas where a considerable number of females nest, thereby supplying the next generation of males and virgin females. This pattern applies to *T. albocinctus* (Lucas), a European species in which females typically nest in groups of several dozen individuals (Asis et al. 1989). The same relationship between male perch location and female aggregation is true for three North American species, including *T. terminatus* (F. Smith). In this species, Kurczewski (1966) documented that mating takes place within emergence areas where males have their perches, which they defend by pursuing intruders and occasionally grappling with them.

In species in which nesting and emerging females are probably dispersed, males either perch by themselves (Kurczewski 1966) or else they travel to a nectar source, as

shown for males of *T. antennatus* W. Fox, which pursue females at flowers (Kurczewski and Kurczewski 1987).

Tachysphex menkei is apparently the first known hilltopping member of the genus with larger males more likely to control lookout perches. The behavior of males of this species is very similar to that of another summer-active species of hilltopping crabronid on Usery Peak, *Astata boharti* F. Parker (Alcock 2007b). Site-faithful males of the two species both defend small landmark territories during the middle of the day at locations near prominent plants growing on the highest parts of the peak. Yet no female of either species has been observed visiting waiting males. This result is almost certainly related to the general rarity of these wasps coupled with the likelihood that their females are monogamous and mate quickly, as is probably true for most crabronids (Ayasse et al. 2001). Many observers have noted that hilltopping insects are often rare or widely dispersed, suggesting that hilltopping is a mating system of last resort for males unable to find receptive females as they emerge or while they forage for nectar or prey (Skevington 2008, Thornhill and Alcock 1983). The crabronid wasp *T. menkei* provides another example in support of this hypothesis.

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