

# Redescription of *Platygyndes* Roewer 1943, a false Gonyleptidae, (Arachnida, Opiliones, Cosmetidae)

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## Abstract

*Praelibitia* Roewer, 1956 and its type species, *Praelibitia titicaca* Roewer, 1956, are respectively synonymized with *Platygyndes* Roewer, 1943 and its type species *Platygyndes titicaca* Roewer, 1943, and furthermore the genus is transferred from the Gonyleptidae to the Cosmetidae. On the basis of domed and unarmed ocularium, increased number of granules on scutal areas, unarmed dorsal scutum and general body shape, *Platygyndes* seems to be closely related to *Moselabius* Roewer, 1956 and *Caracarana* Roewer, 1956. External morphological characters that are useful to revealing relationships among cosmetid genera are discussed.

## Keywords

Andes; Neotropical fauna; systematics; taxonomy; harvestmen

## Introduction

Cosmetidae is a highly diverse Laniatores family with over 700 described species distributed from southern USA to southern Patagonia, including the Greater and Lesser Antilles (Kury 2003; Pinto-da-Rocha and Kury 2007; Hallan 2011). The family is easily diagnosed by the pedipalps, which cover the frontal part of the chelicerae: pedipalpal femur is strongly compressed laterally, pedipalpal tibia is spoon-shaped and

unarmed or weakly armed (Kury and Pinto-da-Rocha 2007). Despite the impressive richness (the third most speciose family of Opiliones), only a few attempts, such as Ferreira and Kury (2010), have been made to review its classification using alternative characters compared to those used by Rower. Some recent works, e.g. Townsend et al. (2010), are only an extension of Roewer's system, enriched by images of male genitalia, of which characters were not used in the generic classification. Other rich Neotropical families, such as the Sclerosomatidae and the Gonyleptidae, have received much more attention in the last decade. Several subfamilies of the Gonyleptidae have been revised (Pinto-da-Rocha 2002; Yamaguti and Pinto-da-Rocha 2009; DaSilva and Gnaspini 2009; DaSilva and Pinto-da-Rocha 2010; Pinto-da-Rocha and Bragagnolo 2010), as well as the South American Sclerosomatidae (Tourinho and Kury 2001, 2003; Tourinho 2003, 2004a, 2004b). Yet, the Cosmetidae remains the biggest challenge for the laniatorid systematics of the 21<sup>st</sup> century.

This paper is a first step in tackling this challenge, and it is based on our current investigations relevant to a revision of the Gonyleptidae. Here we redescribe *Platygyndes titicaca* Roewer, 1943, so far considered in the Gonyleptidae (Pachylinae), and propose its transfer to the Cosmetidae. Indeed, this species possesses some features unusual for the cosmetids: viz., (i) pedipalpal femur is moderately flattened and not projected dorsally; (ii) pedipalpal tibia is moderately flattened laterally; and (iii) evident scutal grooves I–V present. It is possible that these features would have misled Roewer who placed *Platygyndes* in the Gonyleptidae. Finally, based on its external morphology, *P. titicaca* Roewer, 1943 is found to be a senior synonym of *Praelibitia titicaca* Roewer, 1956; it is another example of the same species described by Roewer twice, with its male and female placed in different families.

## Methods

The nomenclature follows Acosta et al. (2007), with some modifications adapted specifically to the studied group. Carapace refers to the part of dorsal scutum that covers the prosoma. The scutal area V is referred to as posterior margin of dorsal scutum. SMF stands for the depository of Naturmuseum Senckenberg, Frankfurt am Main, Germany (curator: P. Jäger). In synonymic lists, we adopted the following abbreviations: cat=catalogue; juv=juvenile(s); rdes=redescription. Only the different characteristics regarding the male were mentioned in the female redescription. The illustrations of the external morphology were made under a stereomicroscope using camera lucida with the material immersed in 70% ethanol. The genitalia were prepared according to Pinto-da-Rocha (1997) and illustrated using a compound microscope with camera lucida. Measurements are in millimeters.

We have also examined the type materials of ten laniatorid species from the genera which may be phylogenetically close to *Platygyndes*: *Eulibitia annulipes* Roewer, 1912 (male holotype; SMF 447); *E. maculata* Roewer, 1912 (male holotype; SMF 471); *E. sexpunctata* Roewer, 1919 (male holotype; SMF 473); *Caracarana inermis* Roewer, 1956 (male holo-

type; SMF 9730); *Metalibitia adunca* (Roewer, 1927) (male holotype; SMF 143/9); *Metalibitia borelli* (Roewer, 1925) (male paratype; SMF 121/3); *Metalibitia maculata* (Roewer, 1914) (1 male and 1 female paratypes; SMF 1060); *Metalibitia tibialis* (Roewer, 1925) (2 males; SMF 122/4); *Moselabius albipunctatus* Roewer, 1956 (6 males and 14 females; SMF 1394/297); *Syncynorta longipes* Roewer, 1947 (female holotype; SMF 5865/207).

## Systematics

### Cosmetidae, Cosmetinae

#### *Platygyndes* Roewer, 1943, new familial and subfamilial assignment

<http://species-id.net/wiki/Platygyndes>

*Platygyndes* Roewer, 1943: 16; Soares and Soares 1954: 291 (rdes, cat). Type species *Platygyndes titicaca* Roewer, 1943, by monotypy.

*Praelibitia* Roewer, 1956: 442 (type species *Praelibitia titicaca* Roewer, 1956, by original designation). new synonymy.

**Diagnosis.** *Platygyndes* is a Cosmetidae having the domed and narrow ocularium, instead of the depressed medially and widened one, which is common in eastern and several Andean species. Moreover, this genus possesses the well-marked scutal grooves I–V; the moderately flattened, not dorsally projected pedipalpal femur; and the moderated, laterally flattened pedipalpal tibia which strongly contrast with the typical type observed in the family (strongly flattened and spoon-shaped). On the basis of unarmed domed ocularium and dorsal scutum, the genus seems to be more closely related with *Moselabius* Roewer, 1956 and *Caracarana* Roewer, 1956. *Moselabius* known only after a female can be distinguished from *Platygyndes* by larger and sparser tubercles on the dorsal scutum and a paramedian pair of the enlarged tubercles on free tergites I–III and thickened tibiae IV. *Caracarana* differs from *Platygyndes* by the incrassate femur IV, the pedipalpal tibia with a ventral projection, the thickened and basally constricted tibia IV, the thickened and curved metatarsus IV and the long tarsal process.

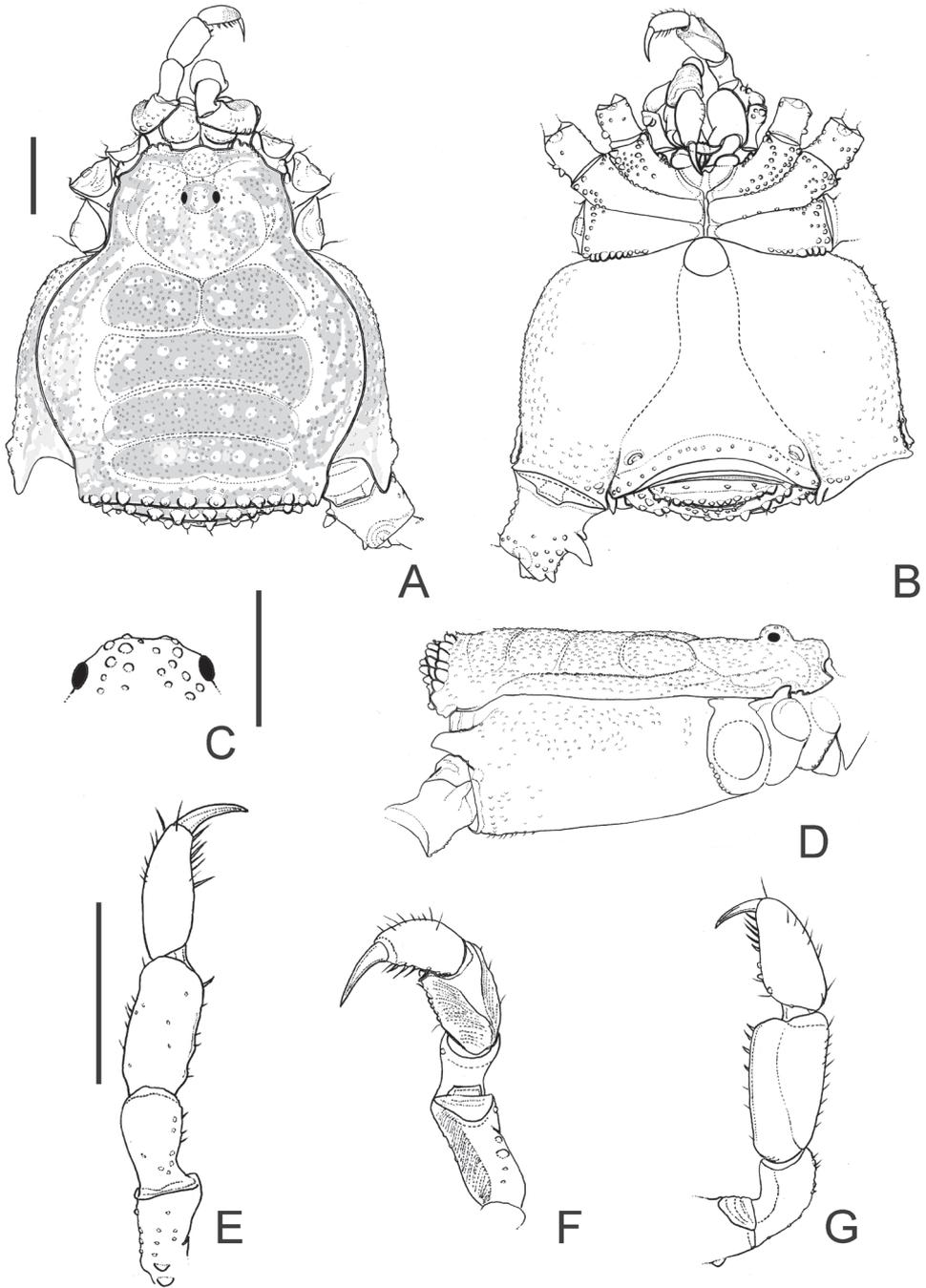
#### *Platygyndes titicaca* Roewer, 1943

[http://species-id.net/wiki/Platygyndes\\_titicaca](http://species-id.net/wiki/Platygyndes_titicaca)

Figs 1–3

*Platygyndes titicaca* Roewer, 1943: 16, pl. 1, fig 1; Soares and Soares 1954: 291 (cat); Acosta 1996: 222 (cat); Kury 2003: 187 (cat) (Peru [“Titicaca Seeufer”], male holotype, SMF RII 7736/112, examined).

*Praelibitia titicaca* Roewer, 1956: 442; Kury 2003: 82 (cat) (Peru [“bei Chucuito am Titicaca See, 3900 m”], female holotype, 11.III.53, H.W. Koepcke leg., SMF RII



**Figure 1.** *Platygyndes titicaca* Roewer. Male (holotype): **A** habitus, dorsal view **B** ditto, ventral view **D** ditto, right lateral view **C** ocularium, anterior view **E** left pedipalp, dorsal view **F** ditto, ventral view **G** retrolateral view **A, B, D** at the same scale **E–G** at the same scale. Scale bar 1 mm except for **C** which is 0.5 mm.

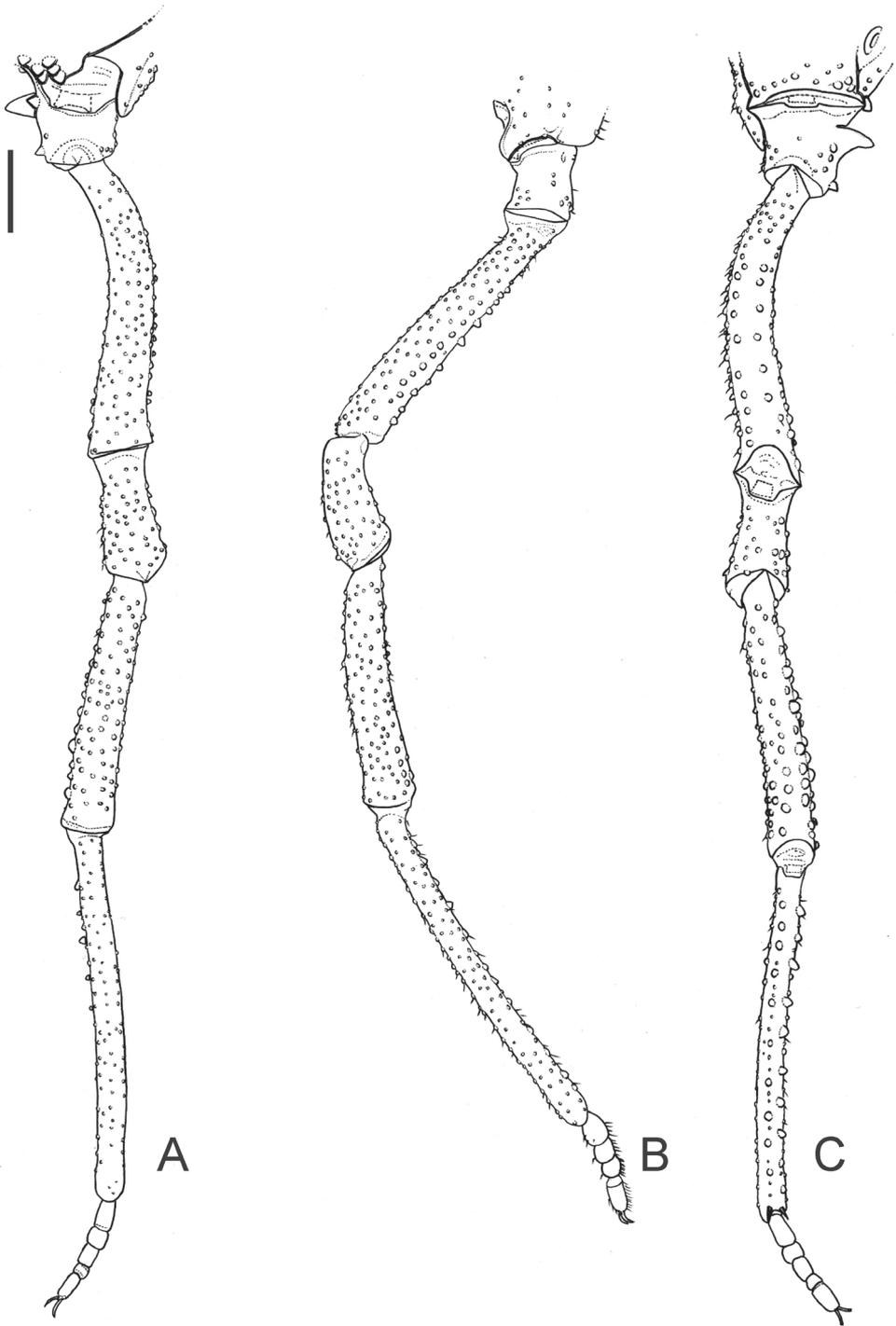
9726; idem, 1 female & 4 juv. paratypes [however only 1 female & 2 juv. in vial], SMF 9727, examined). NEW SYNONYMY

**Type locality.** Peru: Puno (shores of Titicaca Lake).

**Note.** The label of type material of *Platygyndes titicaca* has no data beyond “Titicaca-Seeufer” (shores of Titicaca Lake), although Roewer (1943) clearly states Peru as the type locality of this species. Kury (2003) argued that the department of Puno (the sole department close to Titicaca Lake in the Peruvian side) seems to be a more precise type locality of the species; he also indicated that the correct country could be Bolivia. We agree with the latter suggestion of Kury (2003).

**Material examined.** PERU. Puno: without further data on locality (“Titicaca Seeufer” [shores of Titicaca Lake]), male holotype of *Platygyndes titicaca*, without more precise locality, name of collectors or date, SMF RII 7736/112; Chucuito (“bei Chucuito am Titicaca See” [near Chucuito at Titicaca Lake], 3900 m), female holotype of *Praelibitia titicaca*, 11.III.53, H.W. Koepcke leg., SMF RII 9726; idem, 1 female & 2 juv. paratypes of *Praelibitia titicaca*, SMF RII 9727.

**Description.** Male (holotype; SMF RII 7736/112). Measurements: carapace maximum length 1.8; carapace maximum width 2.1; dorsal scutum maximum length 4.6; dorsal scutum maximum width 4.1; femur IV length 3.1; legs I–IV length 6.8; 10.9; 9.9; 13.9. Dorsum (Fig. 1A, C, D): dorsal scutum shape type gamma (Kury et al. 2007), flattened, granulated, widest at scutal area II. Paracheliceral projections not conspicuous, rounded. Anterior margin of dorsal scutum with three enlarged and fused together tubercles on each corner. Ocularium domed (without median depression), narrow (around a fifth of carapace width), densely minute-tuberculate. Lateral margin of dorsal scutum with less granules than scutal areas. Scutal grooves I–V clearly visible, delimiting four scutal areas. Scutal areas I–IV unarmed, I divided by a longitudinal groove. Posterior margin of dorsal scutum with a row of 14 conical, enlarged tubercles. Free tergites I–III granulated, each with a row of 11, 9 and 10 conical, enlarged minute tubercles, respectively. Anal opercle with anterior row of 6 and a group of 16 tubercles. Venter (Fig. 1B): coxae I–IV granulated, distal half of coxae I, distal posterior of coxae II–III with enlarged tubercles. Posterior margin fused to the stigmatic area slightly concave. Mesotergal sternites each with a row of minute tubercles. Anal opercle with one anterior and one posterior row of tubercles. Chelicera (Fig. 1A): not swollen. Bulla dorsally covered by tubercles. Movable and fixed fingers each with 4 tooth. Pedipalps (Fig. 1E–G): trochanter with three ventral tubercles. Femur moderately flattened, not projected dorsally, with five dorsal wide tubercles, four ventral tubercles (subdistal one largest). Tibia spatulate, moderately projected ventrally, tibia–tarsus with lateral setae. Legs (Figs 1A, 2, 3A–E): coxa I with one prolateral apophysis, this blunt, large and one retrolateral bifid apophysis; II with one prolateral apophysis, this large, obliterating ozopore and curved frontwards and one retrolateral apophysis, this fused with prolateral apophysis of coxa III; III with one prolateral, one retrolateral apophyses; IV anteriorly with a shoulder-like shape in dorsal view, reaching scutal groove IV, densely granulated, one prolateral apical apophysis with capitate apex directed backwards, one



**Figure 2.** *Platygynodes titicaca* Roewer. Male (holotype): Right leg IV **A** dorsal view **B**, prolateral view **C** ventral view. Scale bar: 1 mm.

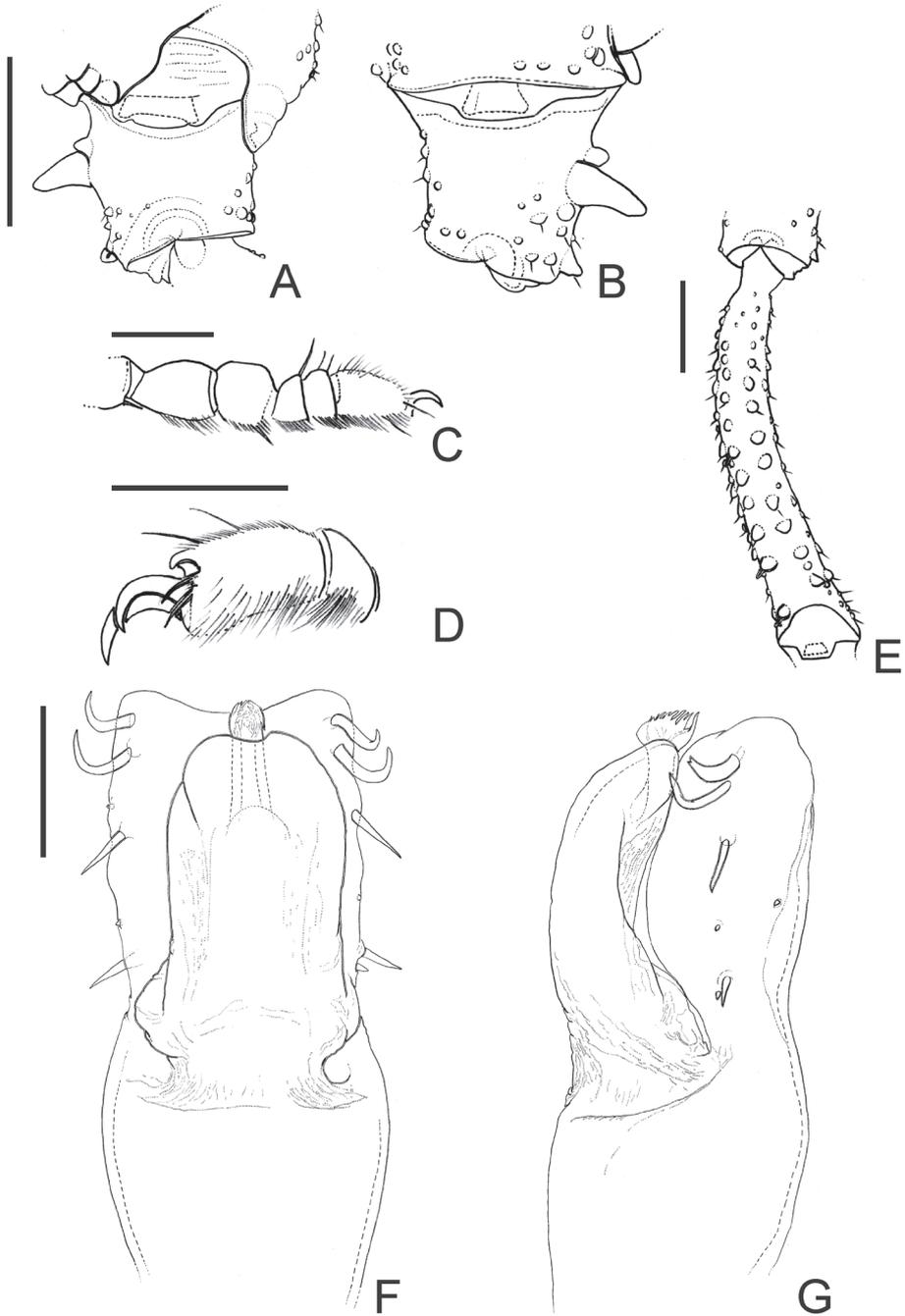
retrolateral apical large tubercle. Trochanters I–IV granulate; I–II with two retrolateral enlarged tubercles; III with one retrolateral enlarged tubercle; IV retrolaterally with a median apophysis, this conical, its length half of the podomere width, one submedian and one apical enlarged tubercles. Femora and tibiae I–IV tuberculate and roughly arranged in longitudinal rows. Femora III–IV slightly curved, with two ventral rows of tubercles slightly increasing in size apicad, more conspicuous in femur III. Tibia–metatarsus IV ventrally with enlarged tubercles. Tarsi I with globose and short tarsomeres; III–IV with smooth claws, short tarsal process (around a fifth of tarsal claw length). Tarsal formula: 5(3), 5–6(3), 5, 5. Penis (Fig. 3F, G): glans elongated, covering most of stylus dorsally. Stylus with inflated apex and thin projections in distal margin dorsoventrally. Ventral plate rectangular, thick, with two pairs of curved distal setae, one pair of straight submedian setae, two pairs of basal setae (the basalmost one shortest), two pairs of very small setae (placed between the main groups of setae on the left or between submedian and basal group of setae on the right).

Female (holotype of *Praelibitia titicaca*; SMF RII 9726). Measurements: carapace maximum length 1.8.; carapace maximum width 2.0; dorsal scutum maximum length 5.2; dorsal scutum maximum width 4.3; femur IV length 3.1; leg I–IV length 7.2; 10.9; 9.4; 12.9. Dorsum: dorsal scutum shape type alpha, wider at scutal groove II, narrowed at scutal area III. Posterior margin of dorsal scutum and free tergites I–III each with a row of 13, 9, 11 and 10 conical, enlarged tubercles, respectively. Legs: coxa IV only visible apically (in dorsal view), reaching groove III, with prolateral apical apophysis shorter than male. Trochanters I–IV without enlarged tubercles or apophyses. Femur and tibia–metatarsus IV ventrally with tubercles of similar size. Tarsal formula: 5(3), 5(3), 5, 5.

**Remarks.** *Platygyndes titicaca* possesses the moderately flattened pedipalpal femora which are not projected dorsally and the moderated, laterally flattened pedipalpal tibia compared to the spoon-shaped (flattened and concave) in the majority of cosmetids; besides, it has the unusually well-marked scutal grooves I–V. These unusual features might have led Roewer to assign it to the Gonyleptidae, Pachylinae. It is worth mentioning that the male genitalia of *P. titicaca* are undoubtedly of the cosmetid groundplan, not of that of the Gonyleptidae. We have examined the Andean material deposited in the SMF and realized that *Praelibitia titicaca* described from a female was also collected close to the type locality of the monotypic *Platygyndes*. Considering the sexual dimorphism in cosmetids, the general body shape, ocularium and pedipalpal shape, dorsal scutum ornamentation and the remaining colour pattern, we have conclude that both names are synonyms. Thus the same species was classified by Roewer in different families, indicating once more that the Roewerian system of Opiliones is hardly reliable.

## Discussion

Due to poor taxonomic characterization of the genera included in Cosmetidae, this family is among the least understood Neotropical Laniatores. Most genera are still diagnosed



**Figure 3.** *Platygyndes titicaca* Roewer. Male (holotype): **A** right trochanter IV, dorsal view **B** ditto, ventral view **C** right tarsomeres I, retrolateral view **D** distalmost right tarsomere IV, proteral view **E** right femur III, ventral view **F** penis, dorsal view **G** ditto, right lateral view **A, B** at the same scale **F–G** at the same scale. Scale bars **A–E** 1 mm **F, G** 0.1 mm.

by the Roewerian combination of armature on dorsal scutum and number of tarsal segments (e.g., Townsend et al. 2010). The Roewerian system relied on a limited set of characters and therefore highlighted predominantly the differences among species/specimens and resulted in many artificial groupings and monotypic genera. In the 1950s, certain attempts to resolve this situation were undertaken by the authors (e.g., Mello-Leitão 1945, Soares 1943, Soares and Soares 1954) who began to take into account an intraspecific variation. In the Cosmetidae, for instance, Goodnight and Goodnight (1953) proposed synonymies for many genera, arguing that the observed differences were due to an intraspecific variation. Such tendency to synonymize the opilionid taxa described by Roewer had lasted until the end of the XX century, although in a more argumentative way.

Recently, Kury et al. (2007) advocated in using characters of the dorsal scutum. In *Platygyndes*, the shape of dorsal scutum is similar to the gamma-type: viz., the scutum convexity is much wider and displaced posteriorly, and there is a well-marked anterior constriction (as in *Metalibitia*) (see Table 1). However, the posterior constriction is well-marked as well, differing from the original definition and being more similar to the alpha-type (see Kury et al. 2007). Townsend et al. (2010) also reported on difficulties in classifying the alpha or gamma types. Having examined the female of *Platygyndes titicaca*, we can confirm that its dorsal scutum shape is clearly of the alpha-type. These data suggest that the shape of dorsal scutum may vary due to sexual dimorphism and such intraspecific variation should be considered while classifying its shape. Thus, we are of the opinion that the alpha-type should also include those dorsal scuta which present a well-marked posterior constriction and the strikingly widened part at rear. A practical option would be just merging the alpha- and gamma-types in a single category. Another structure that seems to be useful in delimitating genera is the male coxae IV: viz., its length (reaching the grooves III, IV, or the posterior margin of dorsal scutum), its visible extension in dorsal view (hidden or not under the dorsal scutum), its shape (parallel or apically divergent) and its apical armature. Additionally, the dorsal and ventral armature of tubercles on pedipalpal femora and the shape of pedipalpal tibia are also useful for a generic delimitation.

We have also found the ocularium to be very informative, although overlooked by many authors. Having examined the cosmetids from Andes and the eastern part of South America, we have confirmed the existence of at least two very distinct types of the ocularium: (i) the widened and medially depressed one, as in *Cynorta* (Kury et al. 2007, fig. 1), a condition which is indeed typical for the majority of cosmetids (Kury and Pinto-da-Rocha 2007; Ferreira and Kury 2010); and (ii) the narrow and domed one, as in *Platygyndes* (see Fig. 1A) and *Caracarana*. On the basis of the similarity both of the body shape and of the narrow ocularium, we consider *Metalibitia*, *Eulibitia*, *Moselabius* and *Syncynorta* as likely to be closely related to *Platygyndes* (Table 1); yet those genera possess the depressed ocularium. Furthermore, the pedipalp considered to date as a very conservative character of the family seems to be also useful for phylogenetic assessments. *Platygyndes* stands out as a cosmetid genus with moderate modifications of its pedipalps: viz., of femora and tibia, which are moderately flattened instead of strongly flattened laterally, and the typical spoon-shaped tibia are poorly-marked (this is why Roewer should have assigned this genus in the Gonyleptidae). Reasoning from the fact that cosmetid juveniles possess cylindrical pedipalps

**Table 1.** Comparison of the genera of Cosmetidae with narrow ocularium. Body shape according to Kury et al. (2007). ? = refers to unknown male.

Genera	Body shape	Male coxa IV	Ocularium shape	Body dorsal armature	Dorsal pedipalpal tibia shape	Dimorphic chelicera
<i>Platygyndes</i>	γ (male), α (female)	Entirely visible in dorsal view, reaching groove IV	Domed	Scutal areas unarmed; posterior margin of dorsal scutum and free tergites with a row of conical, enlarged tubercles	Almost rectangular	Absent
<i>Caracarana</i>	α	Entirely visible in dorsal view, reaching groove III	Domed	Scutal areas unarmed; posterior margin of dorsal scutum and free tergites with a row of conical, enlarged tubercles	Much wider at apex	Absent
<i>Eulibitia</i>	α	Visible only apically in dorsal view, reaching groove III	Depressed medially	Entirely unarmed	Much wider at apex	Absent
<i>Metalibitia</i>	γ	Visible only apically in dorsal view, reaching groove IV	Depressed medially	Scutal areas I–III unarmed or with a pair of tubercles; IV with two large tubercles	Almost rectangular	Absent
<i>Moselabius</i>	α	Visible only apically in dorsal view; reaching groove IV	Depressed medially	Posterior margin of dorsal scutum and free tergites with a pair of enlarged tubercles	?	Present
<i>Syncnorta</i>	α	?	Domed	Scutal areas I–IV and posterior margin of dorsal scutum with a pair of enlarged tubercles; free tergites with row of large tubercles	Rectangular	?

before gaining it of the typical shape in adults, it is safe to conclude that *Platygyndes* may belong to a basal cosmetid lineage in which the spoon-shaped tibia are fully developed.

The aforementioned characters are likely to be useful in revealing phylogenetic relationships within the speciose Cosmetidae. A high number of the described species, as well as their poor descriptions and illustrations, and past failures in resolving the taxonomic status of confusing species and genera definitely present a serious challenge (even more serious than that posed by the Gonyleptidae 20 years ago). Although being time and resource consuming, the most reliable option to tackle this challenger seems to be a re-examination of available type material and a further search for reliable characters in order to better resolve phylogenetic relationships within the family.

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# A new species of the genus *Hydrodroma* Koch, 1837 (Acari, Hydrachnidia, Hydrodromidae), with a key to the hitherto known six species of the genus in Australia

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## Abstract

The genus *Hydrodroma* Koch, 1837 in Australia consists of six species, the newly described *H. meridionalis* sp. n. included. The new species is described from 45 sampling sites from running waters in Queensland, Victoria, New Southern Wales, Western Australia, Northern Territory and South Australia. Furthermore, a key for the identification of species of *Hydrodroma* occurring in Australia is given.

## Keywords

water mites, new species, taxonomy

## Introduction

The genus *Hydrodroma* Koch, 1837 has been found in all biogeographic regions except Antarctica. However, the taxonomy and systematics of the genus is difficult (Pešić and Smit 2007a, b). The adult and nymphal stages are characterized primarily by the number and distribution of swimming setae, body colour, morphology and chaetotaxy of the genital field and idiosoma structure (Wiles 1985, Di Sabatino et al. 2010).

Recently, Pešić and Smit (2007a, b) showed that Australian populations of the genus *Hydrodroma*, formerly reported as *H. despiciens* (Müller, 1776), *H. monticola* (Piersig, 1906), *H. sp. A sensu* Cook, 1986 and *H. sp. B sensu* Cook, 1986 (see: Lundblad 1947, Szalay 1953, Cook 1986 and Harvey 1998) represent several clearly distinct species. Thus far, five species have been described from Australia (Pešić and Smit 2007a, b), i.e. *Hydrodroma kununurra* Pešić & Smit, 2007, *H. australis* Pešić & Smit, 2007, *H. kakadu* Pešić & Smit, 2007, *H. wilesi* Pešić & Smit, 2007 and *H. cooki* Pešić & Smit, 2007.

This paper gives the description of a new species and a key for the identification of *Hydrodroma* species occurring in Australia.

## Materials and methods

Water mites were collected by hand netting, sorted on the spot from the living material, preserved in Koenike-fluid and dissected as described by Davids et al. (2007). The holotype and some of the paratypes will be deposited in Queensland Museum in Brisbane (QM), other paratypes and non-type material in the Netherlands Centre for Biodiversity Naturalis in Leiden (RMNH). Unless stated otherwise, all material has been collected by the junior author and this is not repeated in the text.

The composition of the material is given as: males/females/deutonymphs or adults/deutonymphs. All measurements are given in micrometers ( $\mu\text{m}$ ). The following abbreviations are used: Cx-I = first coxae, dL = dorsal length, H = height, L = length, I/II/III/IV-Leg-1-6 = first to sixth segments of leg I/II/III/IV, IV-Leg-5a = anterior surface of leg IV, segment 5; IV-Leg-5p = posterior surface of leg IV, segment 5; P-1 to P-5 = palp segments 1 to 5,  $\bar{x}$  = mean values, n = number of specimens examined, NP = National Park, vL = ventral length, W = width.

## Systematics

### Hydrodromidae K. Viets, 1936

#### Genus *Hydrodroma* Koch, 1837

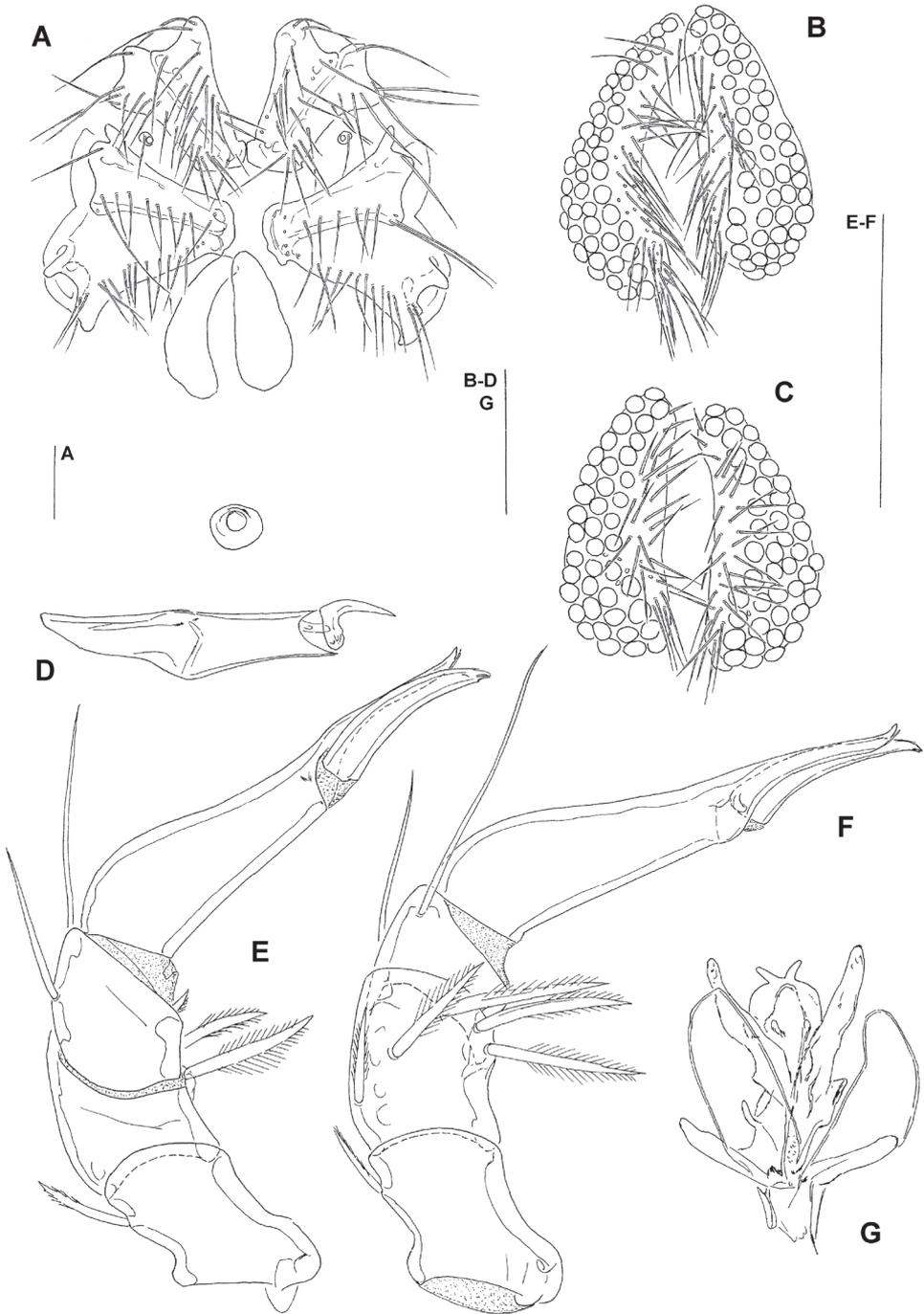
#### *Hydrodroma meridionalis* sp. n.

urn:lsid:zoobank.org:act:07CBCA67-AB0B-4191-A7E2-15744527AAE2

[http://species-id.net/wiki/Hydrodroma\\_meridionalis](http://species-id.net/wiki/Hydrodroma_meridionalis)

Figs 1A–G, 2B, 3A; Tables 1–3

**Type series.** Holotype male, dissected and slide-mounted, Queensland, Lawn Hill Creek, cascades, Lawn Hill NP, 10.v.2005, 18°41.806S, 138°29.138E (QM). Paratypes: 12 males, 8 females, same data as holotype, one male and one female of them dissected and slide-mounted in Hoyer's fluid (QM); 35/33/0, Lawn Hill Creek at



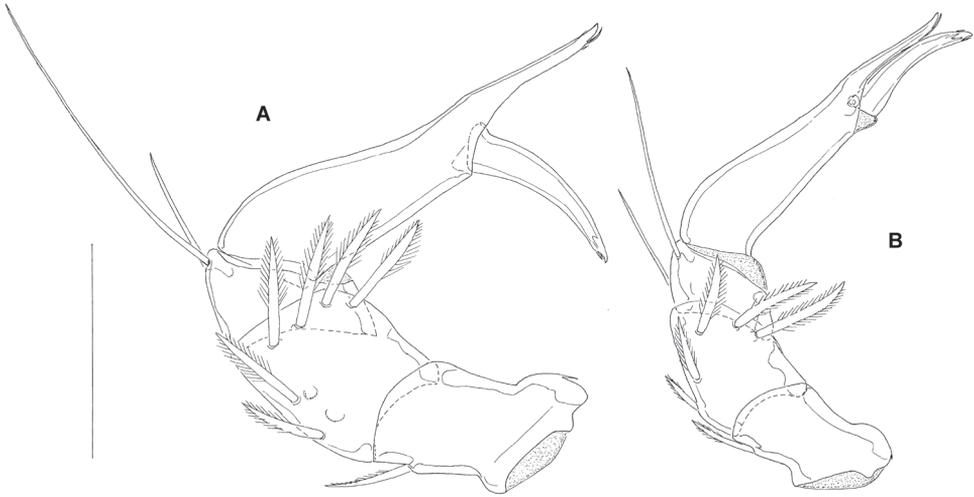
**Figure 1.** A–G *Hydrodroma meridionalis* sp.n. (A–B, D, G = male holotype, C, E, F = female paratype) A = coxal and genital field B–C = genital field D = chelicera E = palp, lateral view F = palp, medial view G = ejaculatory complex. Scale Bars = 100 µm.

**Table 1.** Morphometric data for the genital plate, palp and leg segments (2–6) for *H. meridionalis* sp. n. Numbers (n) and length in  $\mu\text{m}$  (L) are given.

	MALE		FEMALE
	holotype	paratype (n =5, in parentheses $\bar{x}$ )	paratype (n =3)
genital acetabula, n	47–46	42–51 (49)	37–52 (45)
genital setae, n	32–46	35–43 (38)	27–33 (31)
genital plate, L	191–195	184–200 (192)	175–195 (185)
dL P-1	39	43–47 (45)	46–63 (53)
dL P-2	65	63–65 (65)	64–70 (66)
dL P-3	44	35–48(42)	43–52 (48)
dL P-4	158	163–168 (165)	168–182 (176)
dL P-5	67	62–67 (66)	69–72 (70)
Palp, total L	373	376–390 (383)	390–428 (413)
H P-4	32	32–34 (33)	35–39 (36)
L/H P-4 ratio	4.9	4.8–5.1 (5.0)	4.6–5.2 (4.9)
dL I-Leg-2	68	72–75 (74)	73–86 (80)
dL I-Leg-3	94	97–100 (99)	95–109 (103)
dL I-Leg-4	141	143–147 (145)	144–172 (157)
dL I-Leg-5	184	184–194 (189)	194–222 (207)
dL I-Leg-6	172	166–184 (179)	178–194 (189)
dL II-Leg-2	88	91–97 (93)	97–103 (100)
dL II-Leg-3	116	116–122 (118)	119–137 (128)
dL II-Leg-4	191	197–203 (201)	203–234 (220)
dL II-Leg-5	234	238–250 (245)	244–281 (261)
dL II-Leg-6	203	200–220 (214)	191–226 (214)
dL III-Leg-2	91	94–103 (98)	100–116 (109)
dL III-Leg-3	109	111–119 (116)	115–131 (125)
dL III-Leg-4	176	185–191 (189)	192–222 (208)
dL III-Leg-5	219	222–234 (229)	234–267 (249)
dL III-Leg-6	198	191–217 (208)	210–229 (220)
dL IV-Leg-2	122	128–141 (132)	134–159 (146)
dL IV-Leg-3	159	159–178 (169)	175–200 (187)
dL IV-Leg-4	244	244–259 (252)	259–294 (276)
dL IV-Leg-5	261	259–281 (272)	281–322 (299)
dL IV-Leg-6	239	231–252 (245)	255–275 (266)

campground, Lawn Hill NP, 10.v.2005, 18°42.011S, 138°29.235E, four males and two females of them dissected and slide-mounted in Hoyer's fluid (RMNH).

**Further records.** QUEENSLAND: Nankin Creek, Rockhampton, 04.v.1981, leg. A.P. Mackey, 2/3/0; *ibid.*, 20.vii.1981, 2 [damaged]/2 [damaged]/0; *ibid.*, 06.ii.1982, 1/1 [damaged] /0; Innot Hot Springs, 11.viii.1989, 1/0/0; Broken River near Conical Pool, Eungella NP, 18.ix.2000, 1/2/0; Crediton Creek, Eungella NP, 18.ix.2000, 2/7/0; The Millstream, upstream of Millstream Falls, Millstream NP, 16.ix.2000, 0/10/0; Wenlock River at crossing with road to Iron Range NP, 06.ix.2000, 1/1/0; Little Yabba Creek,

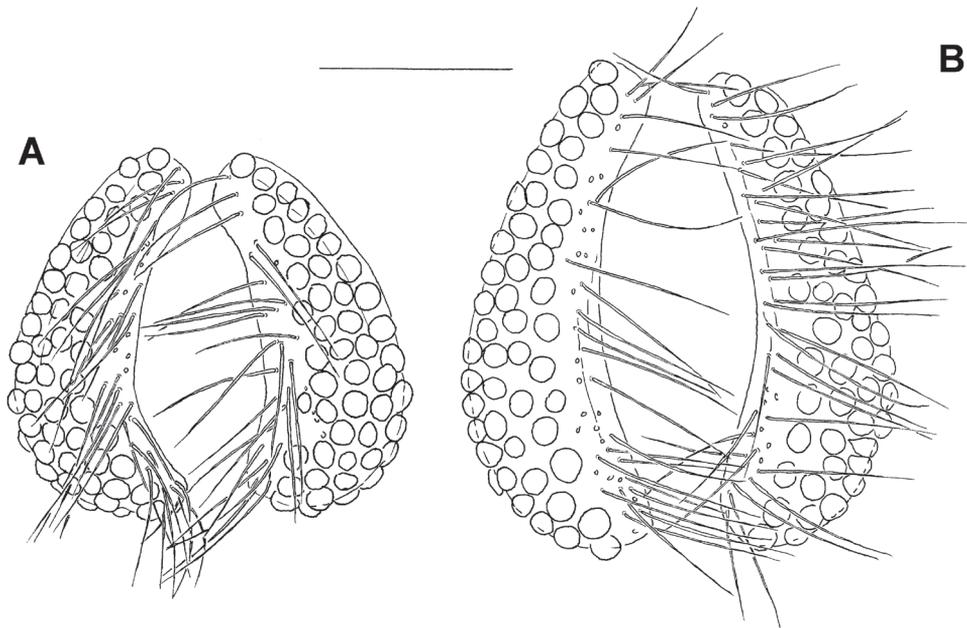


**Figure 2.** **A** *Hydrodroma torrenticola* (Walter, 1908), male (Croatia, Ombla spring): palp, medial view **B** *Hydrodroma meridionalis* sp. n., male holotype: palp, medial view. Scale bar = 100  $\mu$ m.

**Table 2.** Number of swimming setae of *H. meridionalis* sp. n., from Lawn Hill Creek (type series).

	<i>H. meridionalis</i> sp. n.	
	male holotype (paratype, n = 7)	female (n = 5)
II-Leg-5p	1 (1)	1
III-Leg-4p	8 (8–9)	7–9
III-Leg-5p	6 (5–7)	5–7
IV-Leg-4a	8–9 (8–10)	9–10
IV-Leg-4p	8–9 (8–9)	8–10
IV-Leg-5a	2–3 (2–3)	1–3
IV-Leg-5p	4–5 (4–6)	3–6

S of Kenilworth, 20.ix.2000, 2/9/0; Cattle Creek at crossing with road to Finch Hatton Gorge, W of Mackay, 19.ix.2000, 0/6/1; Fletcher Creek, Dalrymple NP, 22.x.2005, 19°49.125S, 146°03.771E, 6/7/0; Alligator Creek, Bowling Green Bay NP, 22.x.2005, 19°26.192S, 146°56.862E, alt. 32 m a.s.l., 5/10/0 (0/1/0 mounted); Gregory River at Gregory Downs, 11.x.2005, 8°38.811 S; 139°15.008 E, alt. 68 m a.s.l., 30/0; Water-view Creek at Jourama Falls, Paluma Range NP, 20.x.2005, 18°51.729S, 146°07.650E, 1/0/0; Davies Creek, Davies Creek NP, 13.x.2005, 17°00.212S, 145°34.180E, 1/2/0; Little Yabba creek at Charlie Moreland Campground, Kenilworth, 02.xi.2005, 26°36.928S, 152°39.105E, 11/15/0. NEW SOUTH WALES: School Creek near Morton NP, 05.xi.2001, 0/1/0; Upper Kangaroo River, N of Kangaroo Valley, 07.xi.2001, 1/1/0; Wattamolla Creek, Royal NP, 08.xi.2001, 0/2/0; tributary of Sawyers Creek, S of Kangaroo Valley, 06.xi.2001, 2/2/0; Bugong Creek near border of Morton NP,



**Figure 3.** **A** *Hydrodroma meridionalis* sp. n., male paratype: genital field **B** *Hydrodroma torrenticola* (Walter, 1908), male (Serbia, Kozjak Mt., stream): genital field. Scale bar = 100  $\mu$ m.

05.xi.2001, 6/9/1; Nymboida River at Platypus Flat, Nymboi-Binderay NP, 09.xi.2003, 30°11.146S, 152°41.499E, alt. 443 m a.s.l., 2/1/0; Urumbilum River, Bindarri NP, 7.xi.2003, 30°15.966S, 152°57.042E, alt. 137 m a.s.l., 3/2/0 (1/0/0 mounted); Mann River at Mann River Nature Reserve, 20.xi.2003, 29°41.291S, 152°05.815E, alt. 403 m a.s.l., 2/2/0 (1/0/0 mounted); Towamba River at Big Jack Rest Area, South East Forests NP, 11.xii.2003, 31°53.885S, 149°27.807E, alt. 271 m a.s.l., 1/6/0; Wog Wog River at crossing with Wog Way, 10.xii.2003, 37°04.986S, 149°29.027E, alt. 332 m a.s.l., 1/0/2; Bellinger River at Gordanville Crossing, 22.xi.2003, 30°25.067S, 152°50.845E, alt. 20 m a.s.l., 1/1/0; Minnemurra River at Minnemurra Rainforest, 18.xii.2003, 34°38.183S, 150°43.272E, 0/2/2; NORTHERN TERRITORY: Douglas River at Douglas Hot Springs, 01.viii.1994, 13°46S, 131°26E, 3/1/0 (1/1/0 mounted); Pond Chinaman Creek, 16 km S of Katherine, 29.vii.1994, 7/7/1; Pool near Jim Jim Falls, Kakadu NP, 23.vii.1994, 2/0/0; Katherine River near Visitors Centre, Katherine Gorge NP, 28.vii.1994, 4/1/0; 17 Mile Creek, tributary of Katherine River, Katherine Gorge NP, 28.vii.1994, 0/2/0. WESTERN AUSTRALIA: Pool Lennard River, Windjana Gorge NP, 09.ix.1998, 1/1/0; Plunge pool, The Grotto, S of Wyndham, 20.ix.1998 1/0/0; Pool Lennard Gorge, The Kimberley, 1.ix.1998, 2/1/0; Pool Valentine Springs, W of Kununurra, 18.ix.1998, 0/2/0; Plunge Pool Black Rock Falls, W of Kununurra, 18.ix.1998, 0/1/0; pools 3 km W of Lennard Gorge, The Kimberley, 10.ix.1998, 1/1/0; unnamed creek at crossing with Windjana Gorge road, 38 km N of Great Northern Highway, 30.ix.1998, 2/9/0; pool west of Tunnel Creek, Tunnel Creek NP, 30.ix.1998,

**Table 3.** Number of swimming setae of *H. meridionalis* sp. n. (Victoria: Stony Creek 1♀, Rockpool Buandik Falls 2♀, Jump Creek 1♂; Queensland: Gregory River 2♂, 2♀, Fletcher Creek 3♀, Cattle Creek 1♀, Waterview Creek 1♂, Davies Creek 1♂, 1♀, Alligator Creek 1♀, Broken River 2♀; New South Wales: Kangaroo Valley 1♂, 1♀, Bugong Creek 2♂, 1♀, Towamba River 1♀, Wog Wog River 1♂; Western Australia: Plunge pool, The Grotto, S of Wyndham, 1♂, Pool Lennard River 2♀, 1♂, S of Kununnura 2♀, pool W of Tunnel Creek 2♂, 1♀, unnamed creek at crossing with Windjana Gorge road 1♀; Northern Territory: Douglas River 1♂, 1♀, Chinaman Creek 2♂, 3♀).

	Victoria		Queensland		New Southern Wales		Western Australia		Northern Territory	
	male (n = 1)	female (n = 3)	male (n = 4)	female (n = 10)	male (n = 4)	female (n = 3)	male (n = 4)	female (n = 7)	male (n = 3)	female (n = 4)
II-Leg-5p	1	1	1	1	1	1	1	1	1	1
III-Leg-4p	8	9–12	8–9	8–9	8–12	10–12	7–11	6–9	8–9	7–12
III-Leg-5p	6	6–9	6–5	4–6	7–10	8–11	3–6	3–7	5–6	5–8
IV-Leg-4a	8	8–12	7–10	6–11	7–10	9–11	7–9	6–9	7–8	7–9
IV-Leg-4p	8	9–11	6–9	7–11	7–11	10–12	7–10	7–10	7–9	7–10
IV-Leg-5a	2	3–4	2–3	1–3	2–3	3–4	0–2	1–2	2–3	0–2
IV-Leg-5p	5–6	7–8	3–5	3–5	4–8	5–6	4	3–4	4–5	2–6

6/6/0. VICTORIA: Crystal Brooke at Hospice Plain, Mt Buffalo NP, 10.x.1997, 0/1/0; Stony Creek downstream of Turret Falls, Grampians NP, 17.iii.2008, 37°09.662S, 142°29.789E, alt. 517 m a.s.l., 0/1/0; Mt Williams Creek, downstream of Kalymna Falls, Grampians NP, 18.iii.2008, 37°19.034S, 142°36.212E, 1/0/0; Rockpool Buandik Falls, 16.iii.2008, 37°14.803S, 142°16.914E, 1/2/0; Stringers Creek upstream of Walhalla, 09.iii.2008, 37°56.006S, 146°26.926E, alt. 360 m a.s.l., 0/1/0; Jump Creek, Mt Buffalo NP, 11.iii.2008, 36°46.350S, 146°47.636E, alt. 1468 m a.s.l., 1/1/0;. SOUTH AUSTRALIA: Onkaparinga River at Sundews Trail, Onkaparinga NP., 06.iv.2008, 35°09.478S, 138°34.791E, alt. 95 m a.s.l., 5/3/0.

**Diagnosis.** Genital plate with 37–52 acetabula in 3–4 longitudinal rows; palp segments narrow (L/H ratio P-4 4.6–5.2, in both sexes); number of swimming setae: II-Leg-5 1; III-Leg-4p 7–9, III-Leg-5p 5–7, IV-Leg-4a 6–12, IV-Leg-4p 6–12, IV-Leg-5a 2–4, IV-Leg-5p 2–8.

**Description.** Male. (holotype; in parentheses measurements of paratypes, if not given otherwise n = 5): Idiosoma L/W (800–994/680–813); integument papillae bluntly pointed. Coxal field: L Cx-I+II, 208 (206–226,  $\bar{x}$  = 215), Cx-III+IV, 244 (241–263,  $\bar{x}$  = 252), total number of coxal setae: 15–18 (18–22,  $\bar{x}$  = 20) on Cx-I, 18–19 (16–21,  $\bar{x}$  = 18) on Cx-II, 14 (11–16,  $\bar{x}$  = 14) on Cx-III, 17 (15–19,  $\bar{x}$  = 17) on Cx-IV. Genital plate (Fig. 1B, 3A): setae more numerous than in females, for measurements, Ac and setae numbers see Table 1; ejaculatory complex L 163 (163–177, n = 3,  $\bar{x}$  = 169). Capitulum vL 183 (188–203,  $\bar{x}$  = 195); chelicera (Fig. 1D) total L 247 (265–275,  $\bar{x}$  = 270), basal segment L 194 (209–216,  $\bar{x}$  = 213), claw L 51 (52–55,  $\bar{x}$  = 54). Palp as in female, for chaetotaxy see Fig. 2B, for measurements see Table 1. Number of swimming setae on legs are presented in Table 2.

Female. (paratypes, n = 3): Idiosoma L/W 840–1044/750–938. Coxal field: L Cx-I+II, 219, Cx-III+IV, 247; number of coxal setae: 18–23 ( $\bar{x}$  = 21) on Cx-I, 14–23 ( $\bar{x}$  = 19) on Cx-II, 12–16 ( $\bar{x}$  = 14) on Cx-III, 14–19 ( $\bar{x}$  = 17) on Cx-IV. Shape of genital plate as in Fig. 1C, for measurements, Ac and setae numbers see Table 1. Capitulum vL 203–225 ( $\bar{x}$  = 217); chelicera total L 269–286 ( $\bar{x}$  = 278), basal segment L 214–235 ( $\bar{x}$  = 224), claw L 54–60 ( $\bar{x}$  = 56). Palp: For chaetotaxy see Fig. 1E, for measurements see Table 1. Numbers of swimming setae on legs are presented in Table 2.

**Remarks.** *Hydrodroma meridionalis* sp. n. is most similar to the European *H. torrenticola* (Walter, 1908), in the presence of one swimming seta on II-Leg-5, IV-Leg-5 anteriorly with 2–5 swimming setae and the presence of relatively large-sized leg claws.

*Hydrodroma torrenticola* (in parentheses data combined from Wiles 1986, Di Sabatino et al. 2010 and our material from Croatia and Serbia) differs from *H. meridionalis* sp. n., in larger dimensions of the genital plates in the both sexes (L 225–275  $\mu$ m), a more slender genital plate in the male (compare Figs 3A with 3B), a longer ejaculatory complex (L > 200  $\mu$ m), stouter palp segments, especially P-4 (compare Figs 2A with Fig. 2B) and generally a lower number of swimming setae on III-Leg-4 (5–8 swimming setae).

**Variability.** We found variability in the number of swimming setae (Table 3). The populations from Western Australia are characterized by generally lower number of swimming setae on anterior IV-Leg-5 (1–2 swimming setae, occasionally setae reduced on one side).

**Etymology.** Named for its southern occurrence.

**Habitat.** Most specimens were taken from pools of low order streams or from lotic areas of slow flowing streams. Like *H. torrenticola*, the new species is obviously rheophilous.

**Distribution.** Widespread in Australia (Queensland, Victoria, New Southern Wales, Western Australia, Northern Territory, South Australia).

### Key to the Australian species of *Hydrodroma* Koch, 1837

- 1 II-Leg-5 with more than four swimming setae ..... **2**
- II-Leg-5 with one or without swimming setae..... **4**
- 2 IV-Leg-5 anteriorly without swimming setae ***H. kakadu* Pešić & Smit, 2007**  
additional characters: genital plates with 28–47 Ac in 3–4 rows, number of swimming setae: II-Leg-5p 3–8, III-Leg-4 8–10, III-Leg-5 5–9, IV-Leg-4a, 7–9 IV-Leg-4p 7–9, IV-Leg-5p 3–6
- IV-Leg-5 anteriorly with 2–5 swimming setae; number of Ac and swimming setae various..... **3**
- 3 Genital plate with < 50 Ac in 3–4 rows..... ***H. australis* Pešić & Smit, 2007**  
additional characters: ejaculatory complex L < 210, number of swimming setae: II-Leg-5p 4–6, III-Leg-4 9–14, III-Leg-5 7–10, IV-Leg-4a 7–12, IV-Leg-4p 7–12, IV-Leg-5a 2–4, IV-Leg-5p 4–8

- Genital plate > 70 Ac in 5–6 rows..... ***H. kununurra* Pešić & Smit, 2007**  
additional characters: ejaculatory complex L > 210, number of swimming  
setae: II-Leg-5p 6–9, III-Leg-4 12–19, III-Leg-5 10–12, IV-Leg-4a 11–14,  
IV-Leg-4p 13–18, IV-Leg-5a 4–6, IV-Leg-5p 9–12
- 4 IV-Leg-5 anteriorly with 2–4 swimming setae (usually with two swimming  
setae, occasionally with a single seta, or setae are reduced on one side; the num-  
ber of setae should be checked in more specimens) ..... ***H. meridionalis* sp. n.**  
additional characters: genital plates with 37–52 Ac in 3–5 rows, number of  
swimming setae: III-Leg-4p 7–9, III-Leg-5p 5–7, IV-Leg-4a 6–12, IV-Leg-  
4p 6–12, IV-Leg-5p 2–8
- IV-Leg-5 anteriorly without swimming setae, number of Ac and swimming  
setae various..... **5**
- 5 Genital plate with < 60 Ac in 4–5 rows; legs with a relatively large-sized  
claw .....  
..... ***H. wilesi* Pešić & Smit, 2007**  
additional characters: number number of swimming setae: III-Leg-4 1–2, III-  
Leg-5 1–3 rather short, IV-Leg-4a 2–3, IV-Leg-4p 2–4, IV-Leg-5p 1
- Genital plate with > 110 Ac in 5–9 rows; legs with a relatively small-sized  
claw ..... ***H. cooki* Pešić & Smit, 2007**  
additional characters: number of swimming setae: III-Leg-4 > 10, III-Leg-5  
7–13, IV-Leg-4a 8–14, IV-Leg-4p 10–16, IV-Leg-5p 6–11

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# Nine eriophyoid mite species from Iran (Acari, Eriophyidae)

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|| [urn:lsid:zoobank.org/author:1A8DAF3A-28DE-46B2-A4EC-A9F50EE64158](http://urn:lsid:zoobank.org/author:1A8DAF3A-28DE-46B2-A4EC-A9F50EE64158)

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## Abstract

Nine eriophyoid mites, including two new species and five new records, from Iran are described and illustrated. They are *Aceria acroptiloni* Shevchenko & Kacalev, 1974, **rec. n.** on *Rhaponticum repens* (L.) Hidalgo (Asteraceae); *Aceria anthocoptes* (Nalepa, 1892), **rec. n.** on *Cirsium arvense* (L.) Scop. (Asteraceae); *Aceria lactucae* (Canestrini, 1893), **rec. n.** on *Lactuca virosa* L. (Asteraceae); *Aceria pulicaris* **sp. n.** on *Pulicaria gnaphalodes* (Vent.) Boiss. (Asteraceae); *Aceria tosichella* Keifer, 1969 on *Setaria viridis* (L.) Beauv. (Poaceae); *Eriophyes rotundae* Mohanasundaram, 1983 on *Cyperus rotundus* L. (Cyperaceae); *Aculops maroccensis* Keifer, 1972, **rec. n.** on *Mentha piperita* L. (Lamiaceae); *Aculus medicager* **sp. n.** on *Medicago sativa* L. (Leguminosae); *Tetra lycopersici* Xue & Hong, 2005, **rec. n.** on *Solanum nigrum* L. (Solanaceae).

## Keywords

New species, new records, Eriophyoidea, taxonomy, Iran

## Introduction

During growth season 2010, field surveys were conducted by the second and forth authors in the north eastern provinces of Iran. A variety of locations mainly in Mash-

had region were surveyed and sampled for potential eriophyoid symptoms and species presence. Among the eriophyoid mites that were identified, two species were found to be new to science and five species are reported for the first time from Iran. By this study, the total number of Eriophyoidea mites of Iran increased to 95 species (Xue et al. 2009; Xue et al. in press).

## Materials and methods

The specimens were recovered from plant materials by means of direct observations under a dissecting microscope. Collected mites were preserved in 70 % ethyl alcohol and later mounted or freshly collected specimens were placed in lactophenol solution for 5–7 days in room temperature then mounted in Hoyer's medium. Slide mounted specimens were identified by the first and third authors. The morphological terminology used herein follows Lindquist (1996) and the generic classification is made according to Amrine et al. (2003). Slides were mounted and specimens were measured following de Lillo et al. (2010). Specimens were examined with a Zeiss A2 (Germany) research microscope with phase contrast and semi-schematic drawings were made. Photos of slide mounted mites were taken with the same microscope (100× oil immersion objective with 10× eyepieces), connected to a computer using Axiovision image analysis software. It was not possible to provide illustrations of the lateral views for some of the species described here because of the mounting position on slides. For each species, the holotype female measurement precedes the corresponding range for paratypes (given in parentheses). All measurements are in micrometers (µm), and are lengths when not otherwise specified.

## Taxonomy

### Family Eriophyidae Nalepa, 1898

### Subfamily Eriophyinae Nalepa, 1898

### Tribe Aceriini Amrine & Stansy, 1994

### Genus *Aceria* Keifer, 1944

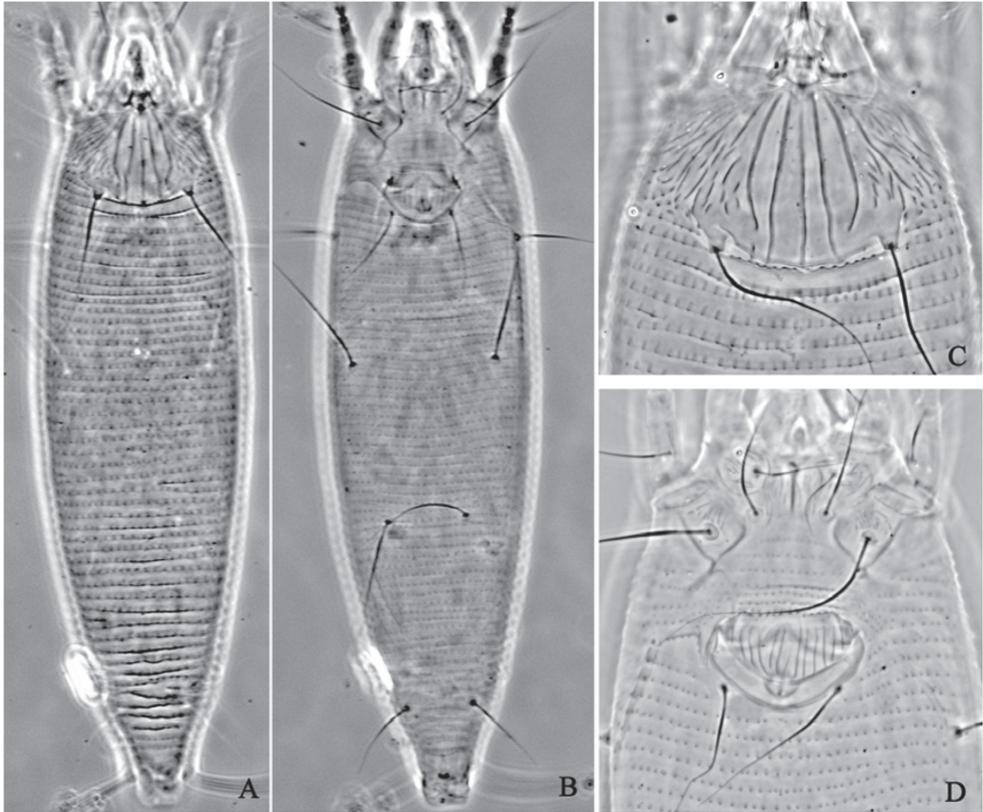
#### *Aceria acroptiloni* Shevchenko & Kacalev, 1974, **rec. n.**

[http://species-id.net/wiki/Aceria\\_acroptiloni](http://species-id.net/wiki/Aceria_acroptiloni)

Figure 1

*Aceria acroptiloni* Shevchenko & Kacalev, 1974; Kacalev et al. 1974: 25–34, figures 1–4.  
*Aceria acroptiloni*; Amrine & Stansy 1994: 18.

**Material examined.** 2 females and 1 male (slide number IRAN210), from *Rhaponticum repens* (L.) Hidalgo (Asteraceae), Ferdowsi University campus, Mashhad, Razavi Kho-



**Figure 1.** *Aceria acroptiloni* Shevchenko & Kacalev, 1974, rec. n. **A** dorsal view of female **B** ventral view of female **C** prodorsal shield **D** coxae and female genitalia.

rasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 23-VIII-2010, coll. Samira Sinaie, deposited as slide mounted specimens in the Arthropod/Mite Collection of the Department of Entomology, NJAU, Jiangsu Province, China; 7 females and 2 males (slide number 210), from *Rhaponticum repens* (L.) Hidalgo (Asteraceae), Shirvan, North Khorasan Province, Iran, 37.4500°N, 57.9000°E, elevation 1093m, 4-VI-2010, coll. Hussein Sadeghi, deposited as slides in the Department of Plant Protection, FUM, Iran.

**Host.** *Rhaponticum repens* (L.) Hidalgo (Asteraceae).

**Relation to host.** In flowers, flower buds, floral deformation.

**Distribution.** Russia, Uzbekistan, Iran.

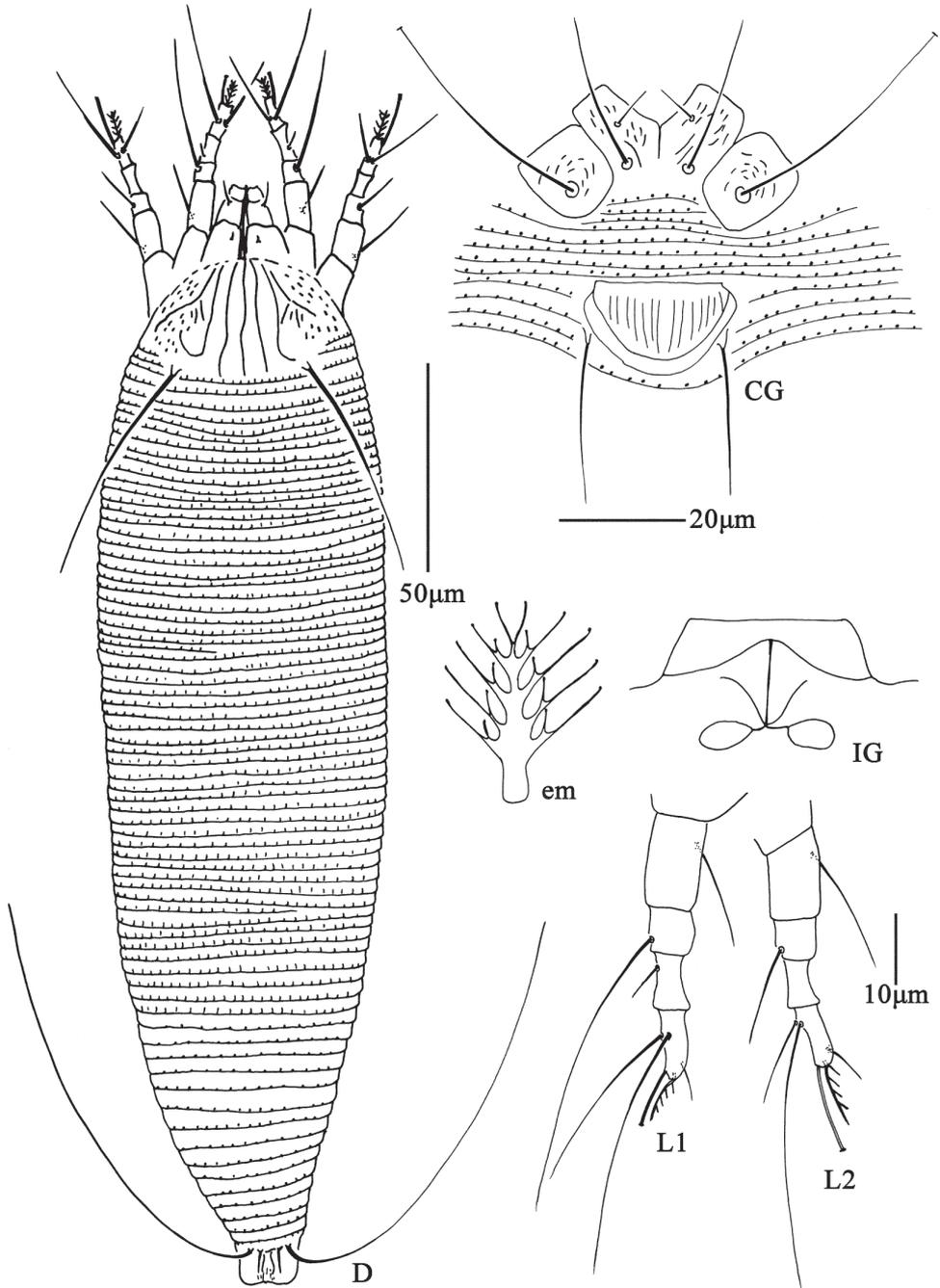
***Aceria anthocoptes* (Nalepa, 1892), rec. n.**

[http://species-id.net/wiki/Aceria\\_anthocoptes](http://species-id.net/wiki/Aceria_anthocoptes)

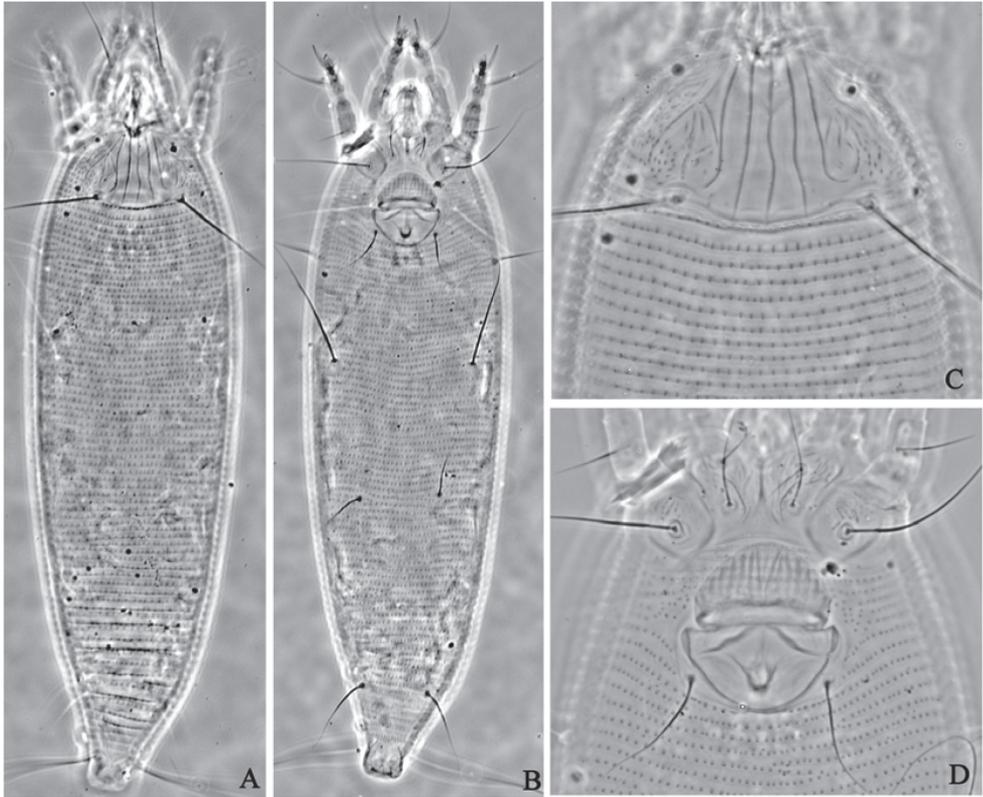
Figures 2–3

*Phytoptus anthocoptes* Nalepa 1892: 120.

*Eriophyes anthocoptes*; Nalepa 1898: 42.



**Figure 2.** *Aceria anthocoptes* (Nalepa, 1892), rec. n. **D** dorsal view of female **CG** coxae and female genitalia **em** empodium **L1** leg I **L2** leg II **IG** female internal genitalia.



**Figure 3.** *Aceria anthocoptes* (Nalepa, 1892), rec. n. **A** dorsal view of female **B** ventral view of female **C** prodorsal shield **D** coxae and female genitalia.

*Aceria anthocoptes*; Roivainen 1950: 2.

*Eriophyes (Aceria) anthocoptes*; Liro & Roivainen 1951: 81, figure 45–4.

*Aceria anthocoptes*; Farkas 1965: 51, figure 35a–c.

*Aceria anthocoptes*; Amrine & Stasny 1994: 22.

*Aceria anthocoptes*; Skoracka et al. 2005: 42.

**Description.** Female (n = 11, dorsal view): Body vermiform, 256 (256–282), 67 (67–68) wide; light yellow. **Gnathosoma** 22 (22–23), projecting obliquely downwards, pedipalp coxal seta (*ep*) 3 (2–3), dorsal pedipalp genual seta (*d*) 5 (5–6), cheliceral stylets 20 (20–21). **Prodorsal shield** 28 (28–33), 37 (37–38) wide, median, admedian and submedian lines complete and parallel, with many short lines and granules at lateral; anterior shield lobe absent. Scapular tubercles near rear shield margin, 28 (28–29) apart, scapular setae (*sc*) 52 (52–56), projecting posteriorly. **Coxigenital region** with 7 (7–9) microtuberculated annuli. Coxisternal plates with short lines, anterolateral setae on coxisternum I (*lb*) 7 (7–8), 12 (12–13) apart, proximal setae on coxisternum I (*la*) 25 (25–27), 8 (8–10) apart, proximal setae on coxisternum II (*2a*) 58 (53–58), 25 (25–26) apart, tubercles *lb* and *la* apart 7 (6–7), tubercles *la* and *2a* 8 (8–8) apart.

Prosternal apodeme 7 (7–8). **Legs** with usual series of setae. Leg I 38 (38–41), femur 12 (12–13), basiventral femoral seta (*bv*) 12 (12–13); genu 5 (5–6), antaxial genual seta (*l'*) 30 (30–33); tibia 6 (6–7), paraxial tibial seta (*l*) 5 (5–6), located at 1/3 from dorsal base; tarsus 8 (7–8), seta *ft'* 18 (18–19), seta *ft''* 26 (26–27), seta *u'* 5 (5–6); tarsal empodium (*em*) 7 (7–8), simple, 5-rayed, tarsal solenidion ( $\omega$ ) 8 (8–9), knobbed. Leg II 37 (37–39), femur 9 (9–10), basiventral femoral seta (*bv*) 13 (13–14); genu 4 (4–5), antaxial genual seta (*l'*) 10 (10–12); tibia 6 (5–6); tarsus 7 (6–7), seta *ft'* 8 (8–9), seta *ft''* 28 (28–30), seta *u'* 5 (5–6); tarsal empodium (*em*) 7 (7–8), simple, 5-rayed, tarsal solenidion ( $\omega$ ) 11 (11–12), knobbed. **Opisthosoma:** opisthosoma dorsally with 71 (71–75) annuli, with elliptical microtubercles on rear annular margins, ventrally with 79 (79–83) annuli, with round microtubercles on rear annular margins. Setae *c*2 23 (23–25) on ventral annulus 15 (15–16), 62 (57–62) apart; setae *d* 73 (73–76) on ventral annulus 29 (28–29), 50 (45–50) apart; setae *e* 23 (23–25) on ventral annulus 46 (45–46), 30 (22–30) apart; setae *f* 32 (32–35) on 7th ventral annulus from rear, 23 (23–23) apart. Setae *h1* 5 (5–6), *h2* 96 (96–98). **Female genitalia** 15 (15–16), 25 (25–26) wide, coverflap with 14 longitudinal ridges, setae *3a* 23 (23–25), 21 (18–21) apart.

**Male.** Not seen.

**Material examined.** 3 females (slide number IRAN212), from *Cirsium arvense* (L.) Scop. (Asteraceae), Torghabeh, Mashhad, Razavi Khorasan Province, Iran, 36.3167°N, 59.3500°E, 26-VIII-2010, elevation 980m & Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 6-IX-2010, coll. Samira Sinaie, deposited as slide mounted specimens in the Arthropod/Mite Collection of the Department of Entomology, NJAU, Jiangsu Province, China; 8 females (slide number 212), from *Cirsium arvense* (L.) Scop. (Asteraceae), Torghabeh, Mashhad, Razavi Khorasan Province, Iran, 36.3167°N, 59.3500°E, 26-VIII-2010, elevation 980m, coll. Samira Sinaie, deposited as slides in the Department of Plant Protection, FUM, Iran.

**Host.** *Cirsium arvense* (L.) Scop., *Cirsium calcareum* (M.E. Jones) Woot. & Standl., *Cirsium canescens* Nutt., *Cirsium helenioides* (L.) Hill, *Cirsium scariosum* Nutt., *Cirsium scopulorum* (Greene) Cockerell ex Daniels, *Cirsium undulatum* (Nutt.) Spreng., *Cirsium vulgare* (Savi) Tenore (Asteraceae); *Lolium perenne* L. (Poaceae).

**Relation to host.** Leaf curl, erineum, rust, vagrant.

**Distribution.** Iran, Austria, Bulgaria, Croatia, Denmark, France, Finland, Germany, Hungary, Italy, Poland, Serbia, Sweden, Turkey, USA.

***Aceria lactucae* (Canestrini, 1893), rec. n.**

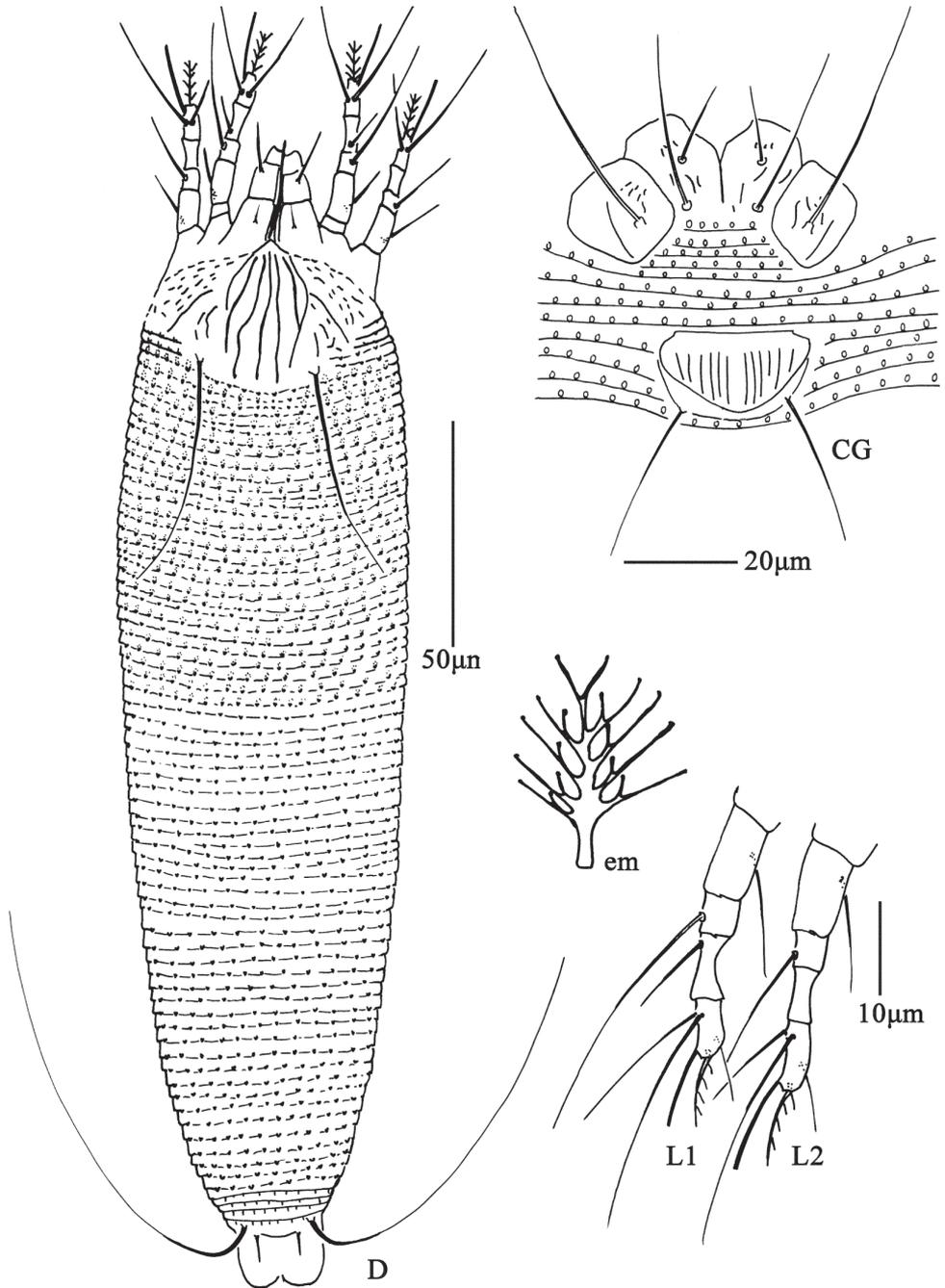
[http://species-id.net/wiki/Aceria\\_lactucae](http://species-id.net/wiki/Aceria_lactucae)

Figures 4–5

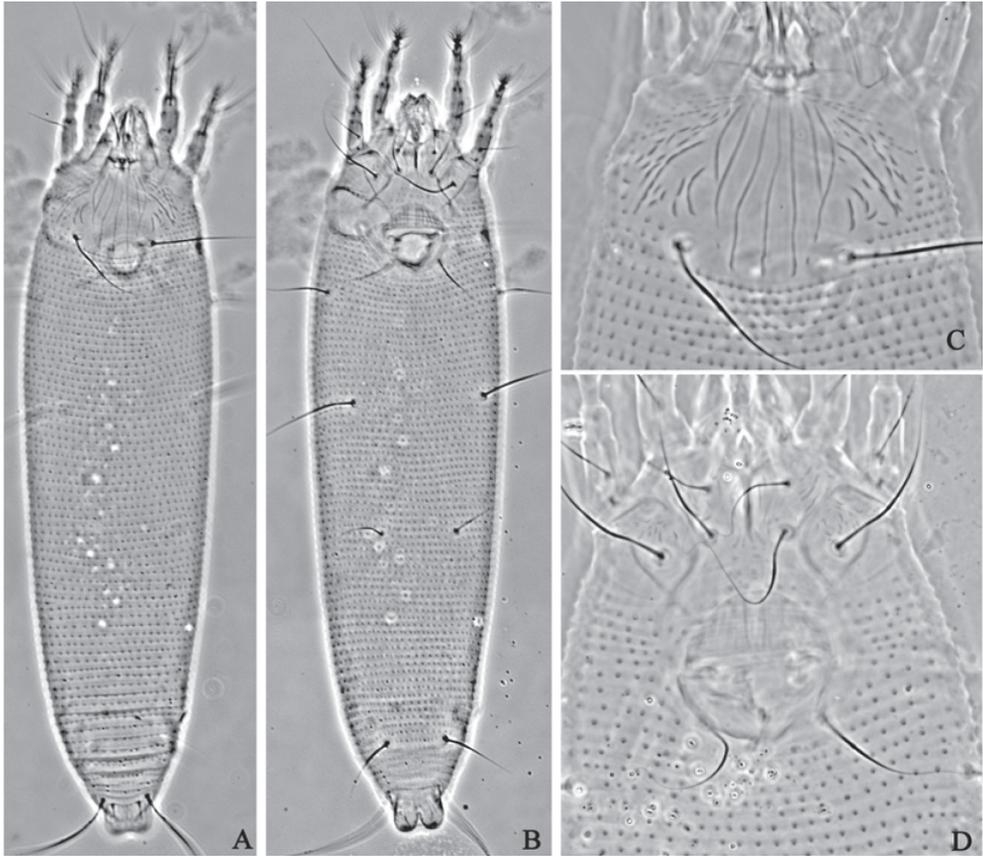
*Phytoptus lactucae* Canestrini 1893: 153.

*Eriophyes lactucae*; Nalepa 1898: 43.

*Aceria lactucae*; Farkas 1965: 42, figure 34c.



**Figure 4.** *Aceria lactucae* (Canestrini, 1893), rec. n. **D** dorsal view of female **CG** coxae and female genitalia **em** empodium **L1** leg I **L2** leg II.



**Figure 5.** *Aceria lactucaae* (Canestrini, 1893), rec. n. **A** dorsal view of female **B** ventral view of female **C** prodorsal shield **D** coxae and female genitalia.

*Aculus lactucaae*; Amrine & Stasny 1994: 135.

*Vasates lactucaae*; Petanovic & Stankovic 1999: 80.

**Description.** Female (n = 14, dorsal view): Body vermiform, 273 (242–273), 62 (62–63) wide; light yellow. **Gnathosoma** 20 (20–21), projecting obliquely downwards, pedipalp coxal seta (*ep*) 2 (2–3), dorsal pedipalp genual seta (*d*) 6 (6–7), cheliceral stylets 18 (17–18). **Prodorsal shield** 35 (35–37), 45 (45–46) wide, median, admedian and submedian lines complete and parallel, with many short lines at lateral; anterior shield lobe acuminate. Scapular tubercles near rear shield margin, 25 (25–26) apart, scapular setae (*sc*) 42 (45–45), projecting posteriorly. **Coxigenital region** with 8 (8–9) microtubercled annuli. Coxisternal plates with short lines, anterolateral setae on coxisternum I (*lb*) 14 (14–16), 13 (12–13) apart, proximal setae on coxisternum I (*la*) 28 (28–30), 11 (10–11) apart, proximal setae on coxisternum II (*2a*) 42 (42–45), 26 (26–27) apart, tubercles *lb* and *la* apart 7 (6–7), tubercles *la* and *2a* 8 (8–9) apart. Prosternal apodeme 10 (10–11). **Legs** with usual series of setae. Leg I 40 (40–42),

femur 10 (9–10), basiventral femoral seta (*bv*) 13 (13–14); genu 5 (4–5), antaxial genual seta (*l'*) 31 (31–33); tibia 8 (7–8), paraxial tibial seta (*l*) 10 (10–11), located at 1/3 from dorsal base; tarsus 7 (7–8), seta *ft'* 19 (16–19), seta *ft''* 27 (27–28), seta *u'* 7 (7–8); tarsal empodium (*em*) 9 (9–10), simple, 5-rayed, tarsal solenidion ( $\omega$ ) 10 (10–11), tapered. Leg II 36 (36–38), femur 8 (7–8), basiventral femoral seta (*bv*) 13 (13–14); genu 4 (4–5), antaxial genual seta (*l'*) 15 (14–15); tibia 6 (5–6); tarsus 7 (6–7), seta *ft'* 12 (12–13), seta *ft''* 31 (31–33), seta *u'* 6 (5–6); tarsal empodium (*em*) 10 (10–11), simple, 5-rayed, tarsal solenidion ( $\omega$ ) 11 (11–12), tapered. **Opisthosoma:** opisthosoma dorsally with 68 (68–72) annuli, with round obscure microtubercles on rear annular margins, ventrally with 78 (78–80) annuli, with round microtubercles on rear annular margins. Setae *c2* 30 (29–30) on ventral annulus 15 (15–16), 61 (58–61) apart; setae *d* 62 (62–66) on ventral annulus 27 (27–29), 46 (46–48) apart; setae *e* 21 (21–25) on ventral annulus 44 (44–45), 26 (26–27) apart; setae *f* 27 (27–30) on 7th ventral annulus from rear, 20 (20–21) apart. Setae *h1* 5 (5–6), *h2* 83 (83–85). **Female genitalia** 20 (20–22), 25 (25–26) wide, coverflap with 12 longitudinal ridges, setae *3a* 23 (23–25), 17 (17–18) apart.

**Male:** Not seen.

**Material examined.** 3 females (slide number IRAN216), from *Lactuca virosa* L. (Asteraceae), Kang, Mashhad, Razavi Khorasan Province, Iran, 36.3167°N, 59.2333°E, elevation 1050m, 26-VII-2010 & Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, 20-X-2010, coll. Samira Sinaie, deposited as slide mounted specimens in the Arthropod/Mite Collection of the Department of Entomology, NJAU, Jiangsu Province, China; 11 females (slide number 216), from *Lactuca virosa* L. (Asteraceae), Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 9-X-2010, coll. Samira Sinaie, deposited in the Department of Plant Protection, FUM, Iran.

**Host.** *Lactuca saligna* L., *Lactuca serriola* L., *Lactuca virosa* L. (Asteraceae).

**Relation to host.** Bract and leaf deformation.

**Distribution.** Iran; Hungary; Italy.

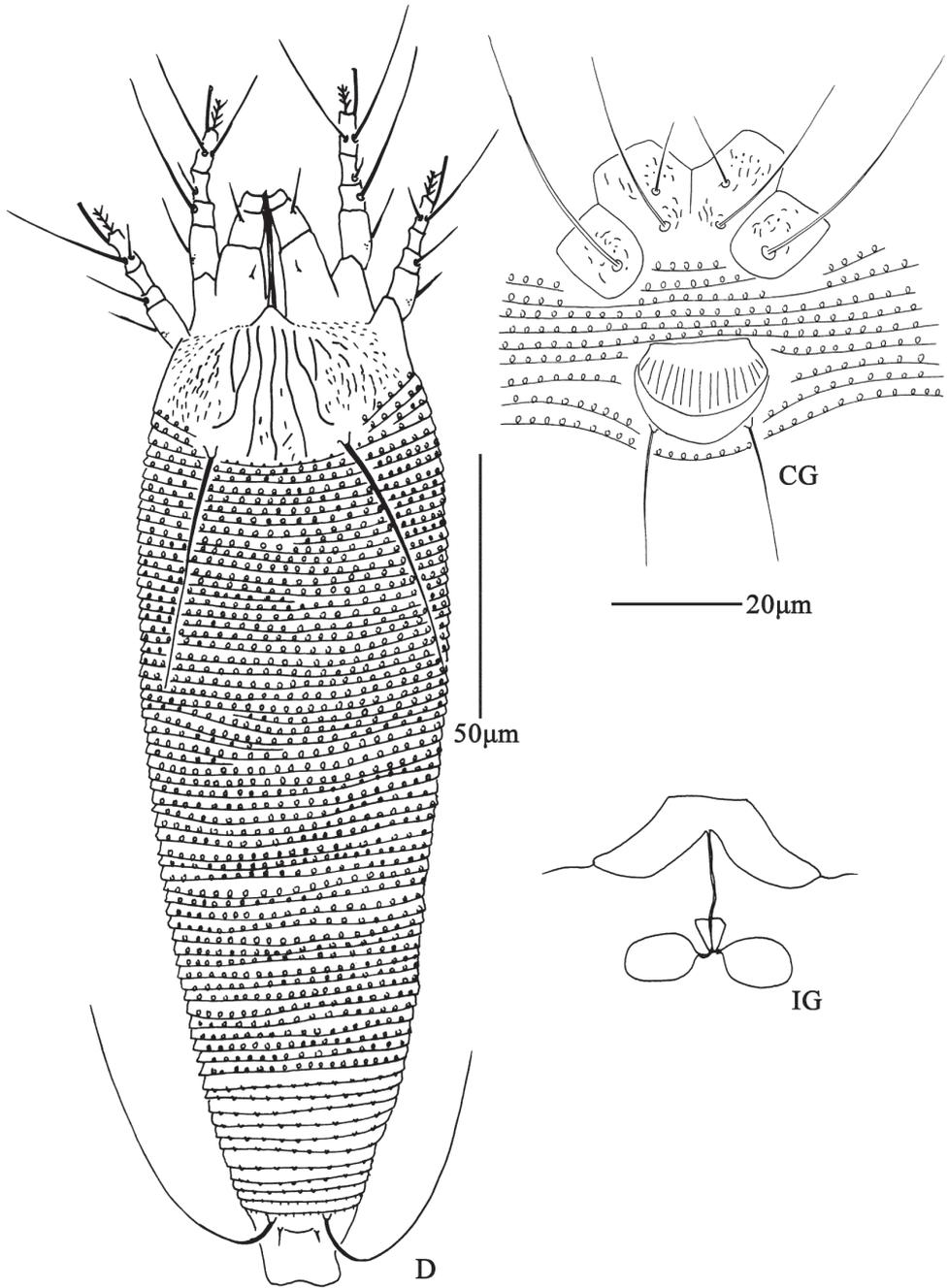
### *Aceria pulicaris* sp. n.

urn:lsid:zoobank.org:act:1C9F694D-397D-4919-A594-462CAB23BFE7

[http://species-id.net/wiki/Aceria\\_pulicaris](http://species-id.net/wiki/Aceria_pulicaris)

Figures 6–8

**Description.** Female (n = 10, dorsal view): Body vermiform, 203 (203–223), 58 (55–58) wide; light yellow. **Gnathosoma** 25 (25–26), projecting obliquely downwards, pedipalp coxal seta (*ep*) 3 (2–3), dorsal pedipalp genual seta (*d*) 5 (5–7), cheliceral stylets 18 (18–23). **Prodorsal shield** 31 (31–35), 35 (35–36) wide, median, admedian and submedian lines complete and parallel, between median and admedian lines with some short lines, prodorsal shield with many short lines at lateral; anterior shield lobe acuminate. Scapular tubercles near rear shield margin, 22 (22–24) apart, scapular setae (*sc*)



**Figure 6.** *Aceria pulicaris* sp. n. **D** dorsal view of female **CG** coxae and female genitalia **IG** female internal genitalia.

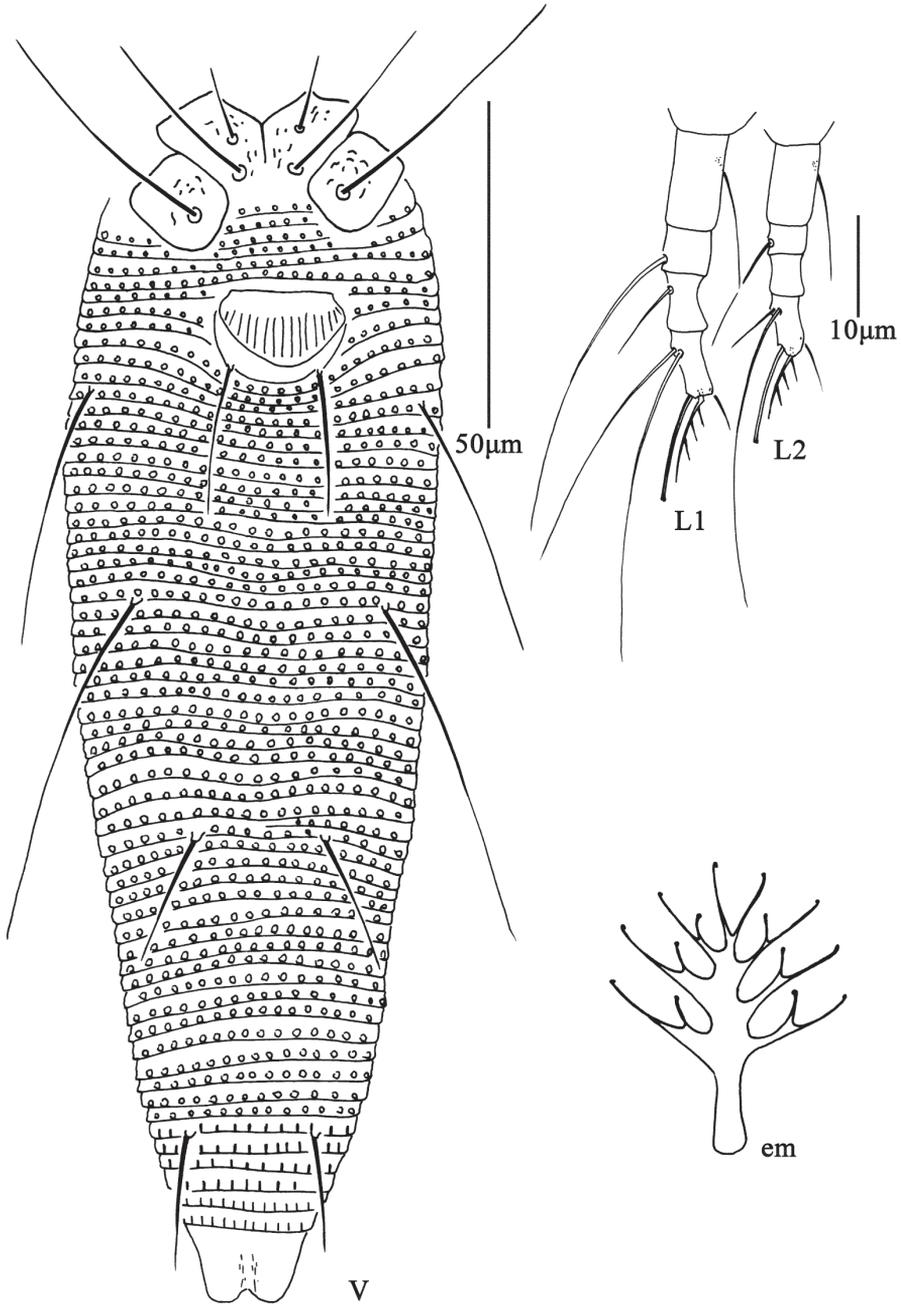
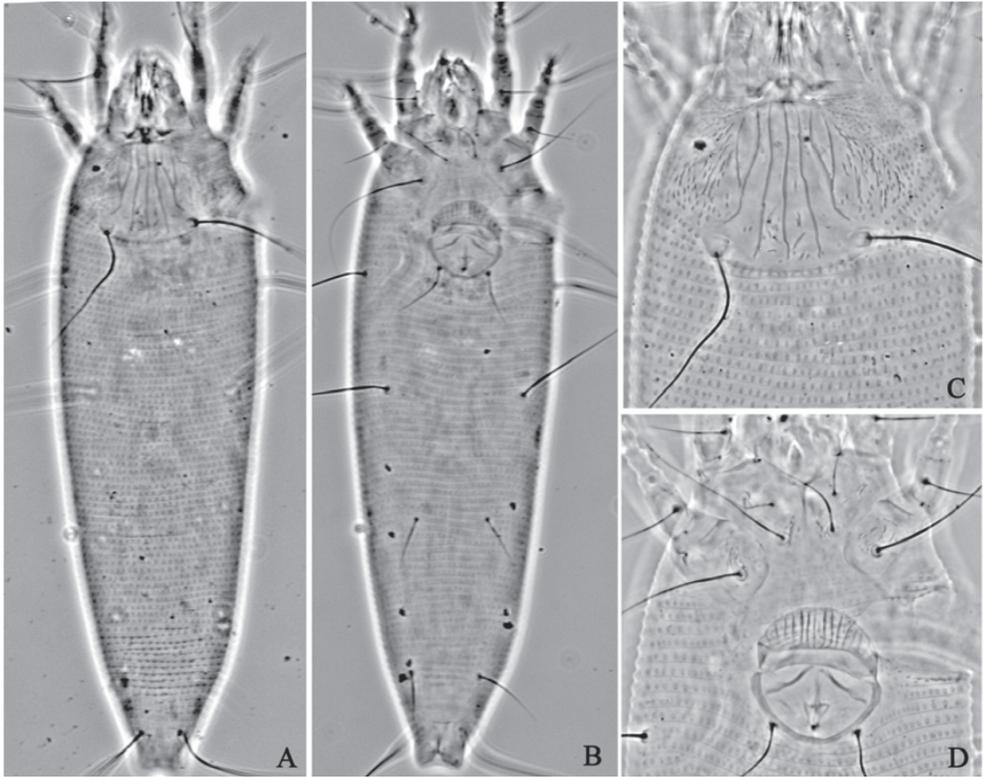


Figure 7. *Aceria pulicaris* sp. n. **V** ventral view of female **em** empodium **L1** leg I **L2** leg II.



**Figure 8.** *Aceria pulicaris* sp. n. **A** dorsal view of female **B** ventral view of female **C** prodorsal shield **D** coxae and female genitalia.

43 (43–44), projecting posteriorly. **Coxigenital region** with 6 (6–7) microtuberclated annuli. Coxisternal plates with short lines and granules, anterolateral setae on coxisternum I (*lb*) 11 (8–11), 10 (10–11) apart, proximal setae on coxisternum I (*la*) 29 (27–29), 7 (7–8) apart, proximal setae on coxisternum II (*2a*) 45 (45–48), 21 (21–22) apart, tubercles *lb* and *la* apart 5 (5–6), tubercles *la* and *2a* 7 (7–8) apart. Prosternal apodeme 6 (6–7). **Legs** with usual series of setae. Leg I 38 (38–41), femur 10 (10–11), basiventral femoral seta (*bv*) 14 (14–15); genu 5 (5–6), antaxial genual seta (*l''*) 32 (32–33); tibia 5 (5–6), paraxial tibial seta (*l'*) 8 (7–8), located at 1/3 from dorsal base; tarsus 8 (7–8), seta *ft'* 24 (24–25), seta *ft''* 30 (28–30), seta *u'* 5 (5–6); tarsal empodium (*em*) 6 (6–7), simple, 4-rayed, tarsal solenidion ( $\omega$ ) 10 (10–11), slightly knobbed. Leg II 33 (33–35), femur 8 (8–9), basiventral femoral seta (*bv*) 12 (12–13); genu 3 (3–4), antaxial genual seta (*l''*) 12 (12–13); tibia 4 (4–5); tarsus 7 (7–8), seta *ft'* 6 (6–7), seta *ft''* 30 (30–31), seta *u'* 5 (5–6); tarsal empodium (*em*) 6 (6–7), simple, 4-rayed, tarsal solenidion ( $\omega$ ) 10 (10–11), slightly knobbed. **Opisthosoma:** opisthosoma dorsally with 66 (66–69) annuli, with round microtubercles on rear annular margins, ventrally with 64 (64–68) annuli, with round microtubercles on rear annular margins. Setae *c*2

40 (40–43) on ventral annulus 10 (10–11), 55 (55–56) apart; setae *d* 58 (58–62) on ventral annulus 24 (24–25), 38 (38–40) apart; setae *e* 21 (21–23) on ventral annulus 40 (40–41), 20 (20–23) apart; setae *f* 22 (22–23) on 6th ventral annulus from rear, 18 (18–20) apart. Setae *h1* 3 (3–4), *h2* 63 (63–66). **Female genitalia** 15 (15–16), 20 (20–21) wide, coverflap with 16 longitudinal ridges, setae *3a* 21 (21–22), 13 (13–15) apart.

**Male:** Unknown.

**Type material.** Holotype, female (slide number IRAN207, marked Holotype), from *Pulicaria gnaphalodes* (Vent.) Boiss. (Asteraceae), Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 21-VIII-2010, coll. Samira Sinaie, deposited as slide mounted specimens in the Arthropod/Mite Collection of the Department of Entomology, NJAU, Jiangsu Province, China. Paratypes, 2 females (slide number IRAN207), with the same data as holotype; 7 females (slide number 207), from *Pulicaria gnaphalodes* (Vent.) Boiss. (Asteraceae), Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 21-VIII-2010, coll. Samira Sinaie, deposited as slides in the Department of Plant Protection, FUM, Iran.

**Relation to host.** Vagrant.

**Etymology.** The specific designation *pulicaris* is from the generic name of host plant, *Pulicaria*.

**Differential diagnosis.** This species is similar to *Aceria lactucae* (Canestrini, 1893), but can be differentiated from the latter by female genital coverflap with 16 ridges (female genital coverflap with 12 ridges in *Aceria lactucae*), empodium 4-rayed (empodium 5-rayed in *Aceria lactucae*), between median and admedian lines with short lines on prodorsal shield (between median and admedian lines smooth in *Aceria lactucae*).

### *Aceria tosichella* Keifer, 1969

[http://species-id.net/wiki/Aceria\\_tosichella](http://species-id.net/wiki/Aceria_tosichella)

Figure 9

*Aceria tosichella* Keifer, 1969: 1–2, pl.1.

*Aceria tritici* Shevtchenko, 1970; Shevtchenko et al. 1970: 224–235, figures 2–4.

*Aceria tosichella*; Amrine & Stasny 1994: 92.

*Aceria tosichella*; Hong & Zhang 1996: 28.

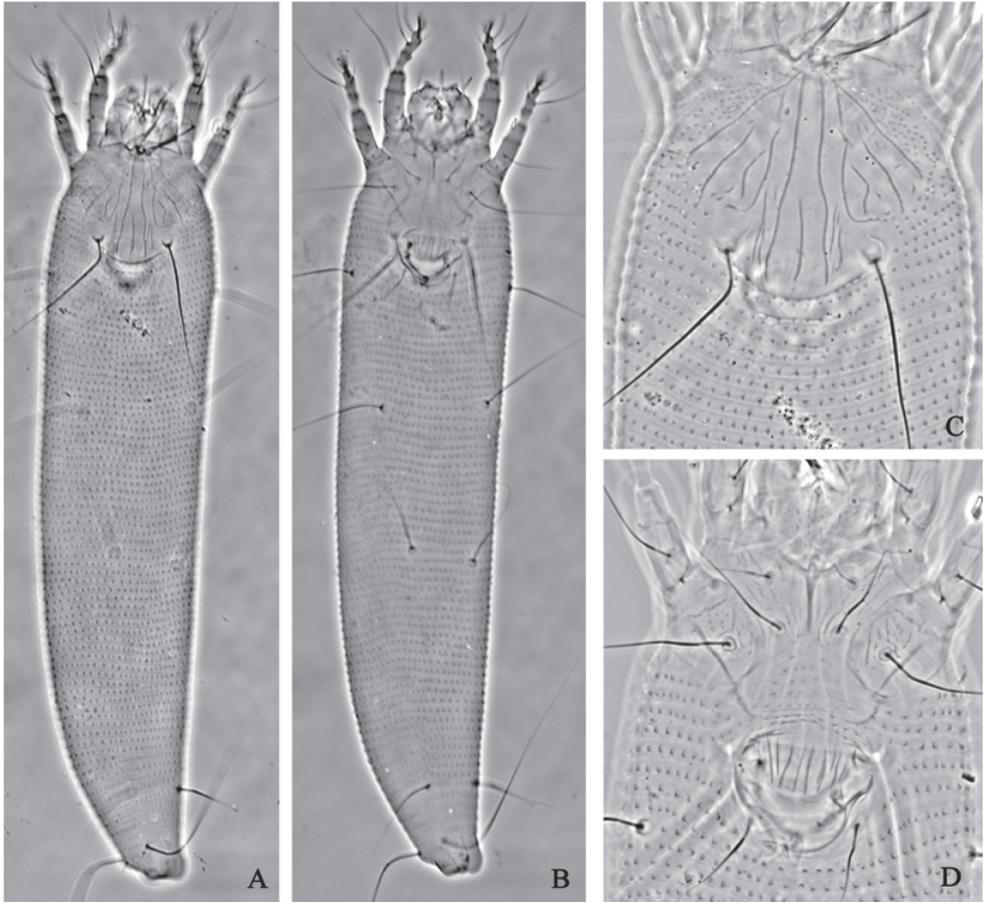
*Aceria tosichella*; Baker et al. 1996: 318, figure 573.

*Aceria tosichella*; Skoracka 2005: 64–66.

*Aceria tosichella*; Hong et al. 2006: 231.

*Aceria tosichella*; Song et al. 2008: 14.

*Aceria tosichella*; Ripka 2008: 154.



**Figure 9.** *Aceria tosichella* Keifer, 1969 **A** dorsal view of female **B** ventral view of female **C** prodorsal shield **D** coxae and female genitalia.

*Aceria tosichella*; Xue et al. 2009: 466.

*Aceria tosichella*; Pereira et al. 2009: 539–542.

**Material examined.** 3 females (slide number IRAN209), from *Setaria viridis* (L.) Beauv. (Poaceae), Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 21-VIII-2010, coll. Hussein Sadeghi, deposited as slide mounted specimens in the Arthropod/Mite Collection of the Department of Entomology, NJAU, Jiangsu Province, China; 11 females (slide number 209), from *Setaria viridis* (L.) Beauv. (Poaceae), Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 21-VIII-2010, coll. Samira Sinaie, deposited in the Department of Plant Protection, FUM, Iran.

**Host.** *Avena sativa* L., *Hordeum vulgare* L., *Pennisetum* sp. Rich, *Secale cereale* L., *Setaria viridis* (L.) Beauv., *Sorghum* sp. Moench, *Triticum aestivum* L., *Zea mays* L. (Poaceae).

**Relation to host.** Vagrant, often causing leaf curl, virus transmission.

**Distribution.** Asia; Australia; Brazil; Canada; Europe; Iran; Italy; Mexico; Poland; Russia; Serbia; USA.

### Tribe Eriophyini Nalepa, 1898

#### Genus *Eriophyes* von Siebold, 1851

#### *Eriophyes rotundae* Mohanasundaram, 1983

[http://species-id.net/wiki/Eriophyes\\_rotundae](http://species-id.net/wiki/Eriophyes_rotundae)

Figure 10

*Eriophyes rotundae* Mohanasundaram 1983: 263–265, figure 1.

*Eriophyes rotundae*; Amrine & Stasny 1994: 208.

**Material examined.** 3 females (slide number IRAN218), from *Cyperus rotundus* L. (Cyperaceae), Torogh, Mashhad, Razavi Khorasan Province, Iran, 36.2333°N, 59.6000°E, 22-X-2010, elevation 920m, coll. Samira Sinaie, deposited as slide mounted specimens in the Arthropod/Mite Collection of the Department of Entomology, NJAU, Jiangsu Province, China; 16 females (slide number 218), from *Cyperus rotundus* L. (Cyperaceae), Torogh, Mashhad, Razavi Khorasan Province, Iran, 36.2333°N, 59.6000°E, 22-X-2010, elevation 920m, coll. Samira Sinaie, deposited in the Department of Plant Protection, FUM, Iran.

**Host.** *Cyperus rotundus* L. (Cyperaceae).

**Relation to host.** Vagrant.

**Distribution.** India, Iran.

### Subfamily Phyllocoptinae Nalepa, 1892

#### Tribe Anthocoptini Amrine & Stasny, 1994

#### Genus *Aculops* Keifer, 1966

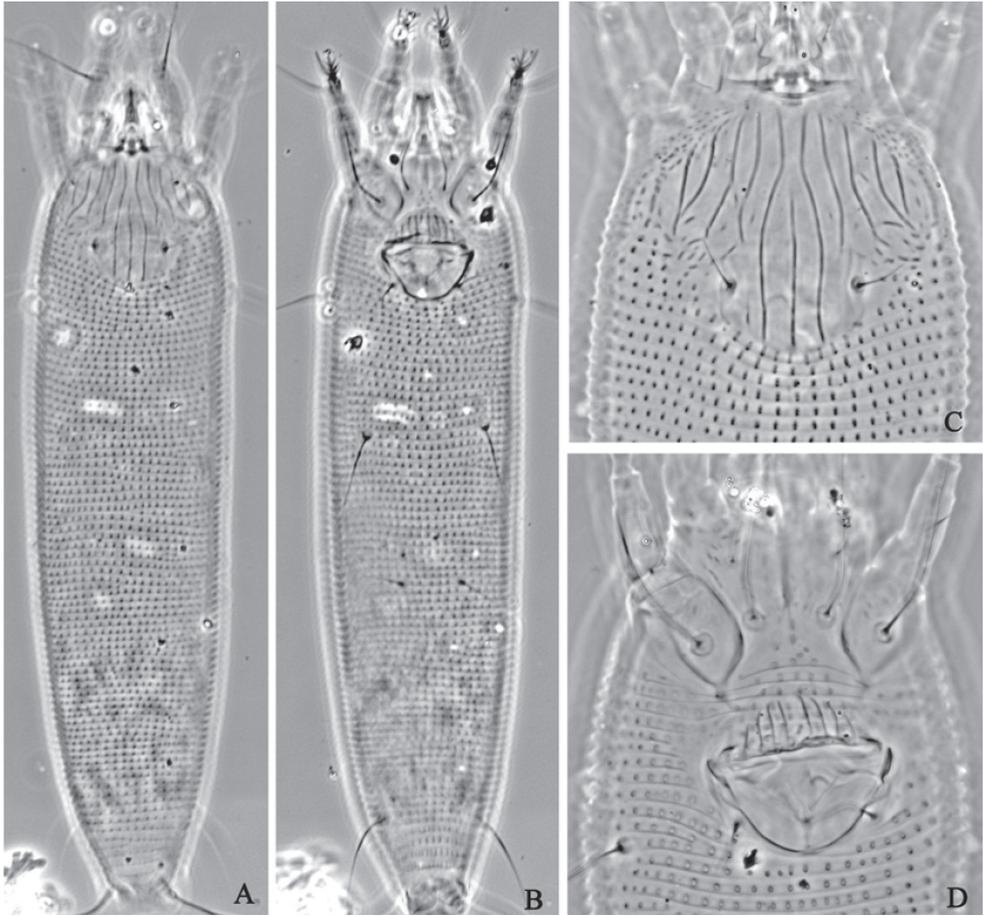
#### *Aculops maroccensis* Keifer, 1972, rec. n.

[http://species-id.net/wiki/Aculops\\_maroccensis](http://species-id.net/wiki/Aculops_maroccensis)

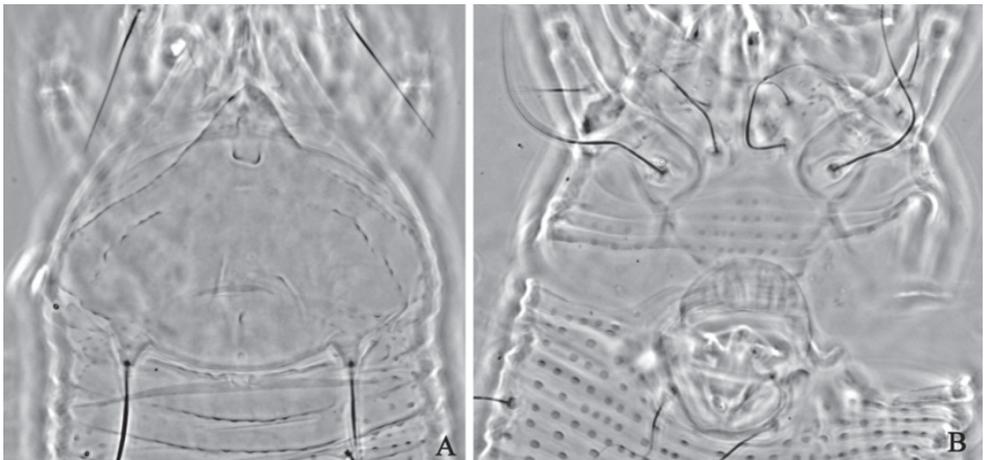
Figure 11

*Aculops maroccensis* Keifer 1972: 3, pl. 2.

*Aculops maroccensis*; Amrine & Stasny 1994: 108.



**Figure 10.** *Eriophyes rotundae* Mohanasundaram, 1983 **A** dorsal view of female **B** ventral view of female **C** prodorsal shield **D** coxae and female genitalia.



**Figure 11.** *Aculops maroccensis* Keifer, 1972, rec. n. **A** prodorsal shield **B** coxae and female genitalia.

**Material examined.** 3 females (slide number IRAN205), from *Mentha piperita* L. (Lamiaceae), Golmakan, Mashhad, Razavi Khorasan Province, Iran, 36.4833°N, 59.1500°E, elevation 945m, 13-VIII-2010, coll. Samira Sinaie, deposited as slide mounted specimens in the Arthropod/Mite Collection of the Department of Entomology, NJAU, Jiangsu Province, China; 15 females (slide number 205), from *Mentha piperita* L. (Lamiaceae), Golmakan, Mashhad, Razavi Khorasan Province, Iran, 36.4833°N, 59.1500°E, elevation 945m, 13-VIII-2010, coll. Samira Sinaie, deposited in the Department of Plant Protection, FUM, Iran.

**Host.** *Mentha piperita* L. (Lamiaceae).

**Relation to host.** Vagrant.

**Distribution.** Morocco, Iran.

### Genus *Aculus* Keifer, 1959

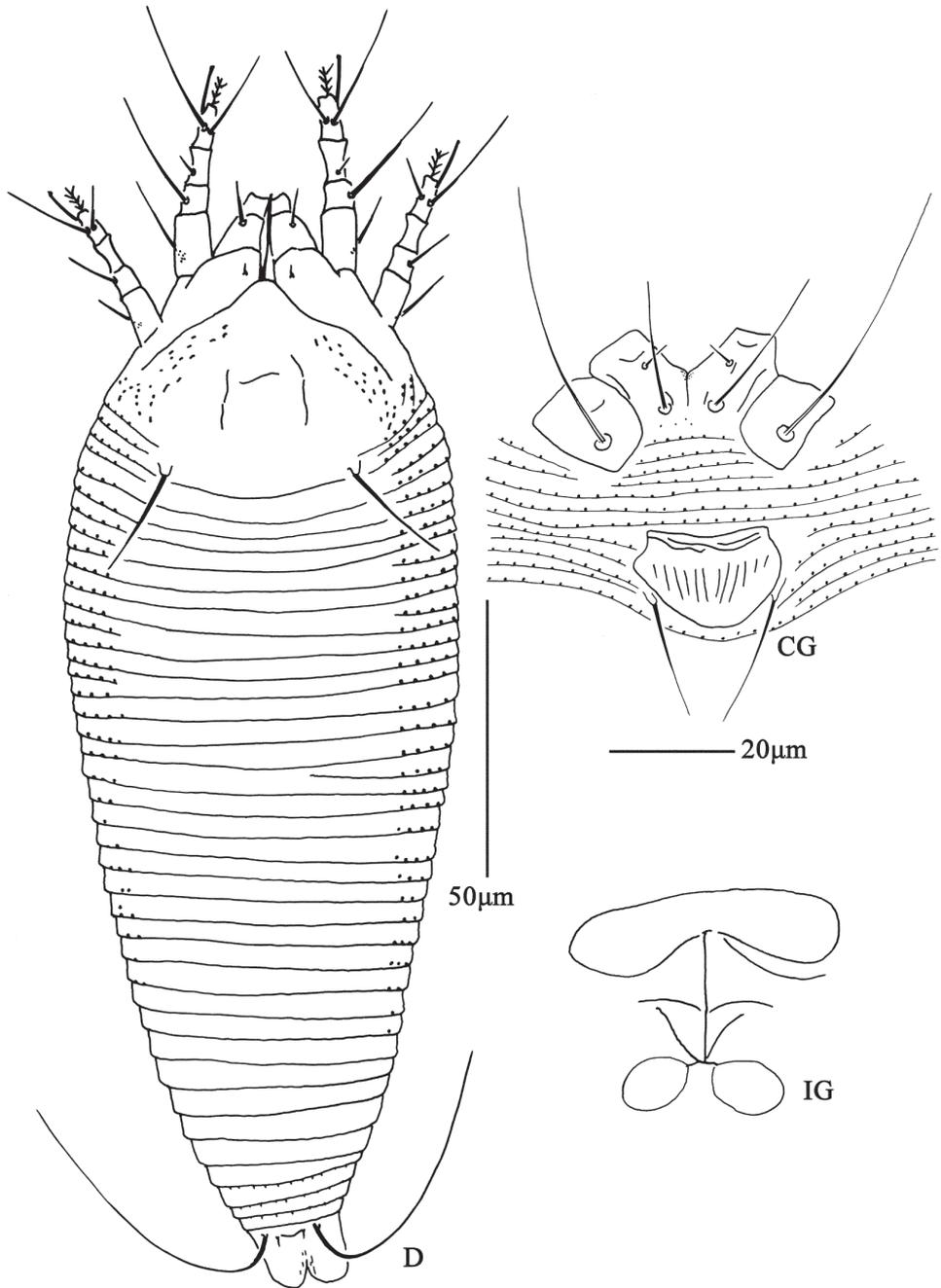
#### *Aculus medicager* sp. n.

urn:lsid:zoobank.org:act:D46F68D0-77E6-4419-94EB-3BB509384865

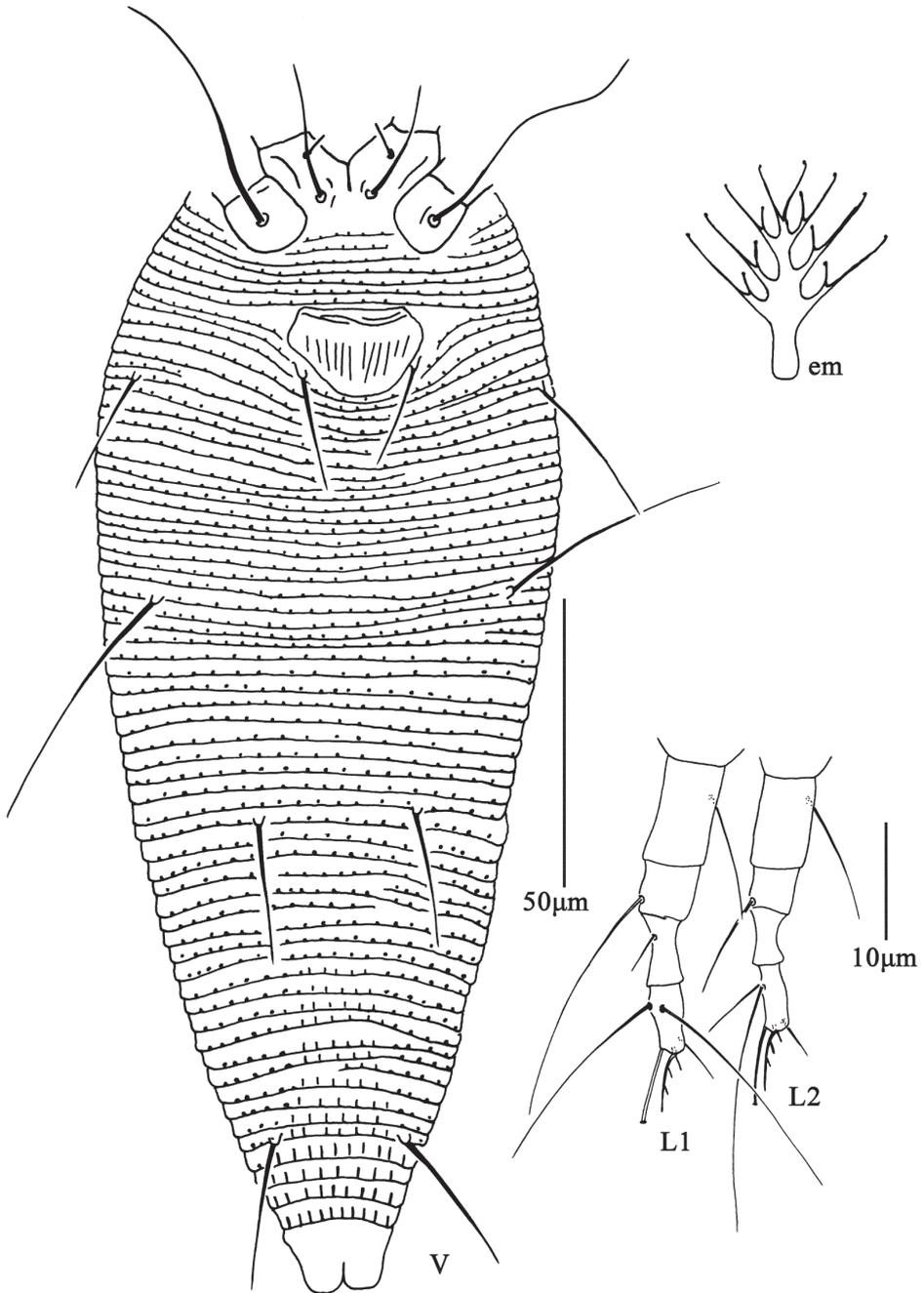
[http://species-id.net/wiki/Aculus\\_medicager](http://species-id.net/wiki/Aculus_medicager)

Figures 12–14

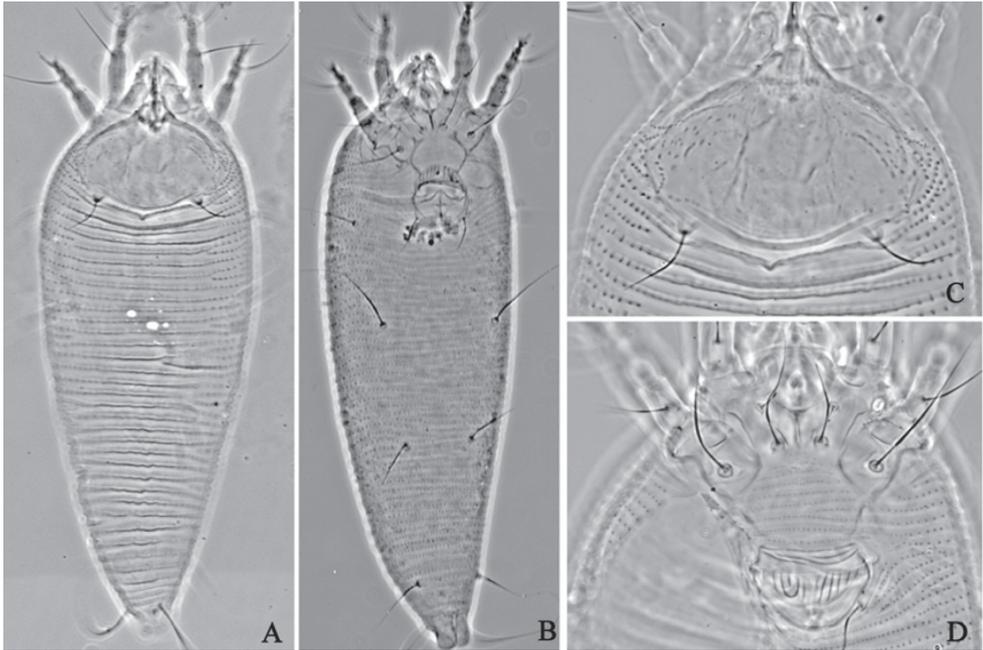
**Description.** Female (n = 14, dorsal view): Body fusiform, 218 (218–233), 72 (69–72) wide; light yellow. **Gnathosoma** 24 (24–25), projecting obliquely downwards, pedipalp coxal seta (*ep*) 3 (2–3), dorsal pedipalp genual seta (*d*) 7 (6–7), cheliceral stylets 22 (22–23). **Prodorsal shield** 42 (42–43), 52 (50–52) wide, median and admedian lines absent, submedian lines incomplete, prodorsal shield with many granules at lateral; anterior shield lobe broad. Scapular tubercles near rear shield margin, 37 (37–40) apart, scapular setae (*sc*) 17 (17–18), projecting posteriorly. **Coxigenital region** with 7 (6–7) microtuberclated annuli. Coxisternal plates with few short lines, anterolateral setae on coxisternum I (*lb*) 4 (4–7), 14 (13–14) apart, proximal setae on coxisternum I (*la*) 23 (23–28), 7 (7–8) apart, proximal setae on coxisternum II (*2a*) 47 (45–47), 27 (25–27) apart, tubercles *lb* and *la* apart 6 (5–6), tubercles *la* and *2a* 11 (10–11) apart. Prosternal apodeme 6 (6–7). **Legs** with usual series of setae. Leg I 37 (37–40), femur 9 (9–10), basiventral femoral seta (*bv*) 14 (14–15); genu 5 (5–6), antaxial genual seta (*l*<sup>n</sup>) 24 (24–25); tibia 8 (7–8), paraxial tibial seta (*l*) 4 (4–5), located at 1/3 from dorsal base; tarsus 7 (7–8), seta *ft*<sup>2</sup> 22 (22–23), seta *ft*<sup>3</sup> 27 (27–30), seta *u*<sup>5</sup> 5 (5–6); tarsal empodium (*em*) 7 (6–7), simple, 4-rayed, tarsal solenidion ( $\omega$ ) 8 (8–9), slightly knobbed. Leg II 34 (34–37), femur 9 (8–9), basiventral femoral seta (*bv*) 13 (12–13); genu 4 (3–4), antaxial genual seta (*l*<sup>n</sup>) 10 (10–11); tibia 6 (5–6); tarsus 7 (7–8), seta *ft*<sup>1</sup> 7 (6–7), seta *ft*<sup>2</sup> 28 (28–30), seta *u*<sup>6</sup> 6 (5–6); tarsal empodium (*em*) 7 (6–7), simple, 4-rayed, tarsal solenidion ( $\omega$ ) 8 (8–10), slightly knobbed. **Opisthosoma:** opisthosoma dorsally with 35 (35–38) annuli, with round microtubercles at lateral, ventrally with 64 (64–68) annuli, with round microtubercles on rear annular margins. Setae *c*2 23 (23–24) on ventral annulus 12 (12–13), 77 (75–77) apart; setae *d* 45 (45–48) on



**Figure 12.** *Aculus medicager* sp. n. **D** dorsal view of female **CG** coxae and female genitalia **IG** female internal genitalia.



**Figure 13.** *Aculus medicager* sp. n. **V** ventral view of female **em** empodium **L1** leg I **L2** leg II.



**Figure 14.** *Aculus medicager* sp. n. **A** dorsal view of female **B** ventral view of female **C** prodorsal shield **D** coxae and female genitalia.

ventral annulus 25 (24–25), 56 (56–58) apart; setae *e* 23 (20–23) on ventral annulus 39 (39–40), 25 (25–26) apart; setae *f* 25 (24–25) on 5th ventral annulus from rear, 21 (21–22) apart. Setae *h1* 3 (3–4), *h2* 53 (53–65). **Female genitalia** 14 (14–15), 23 (22–23) wide, coverflap with three short lines at base and 12 longitudinal ridges, setae *3a* 17 (17–18), 17 (17–18) apart.

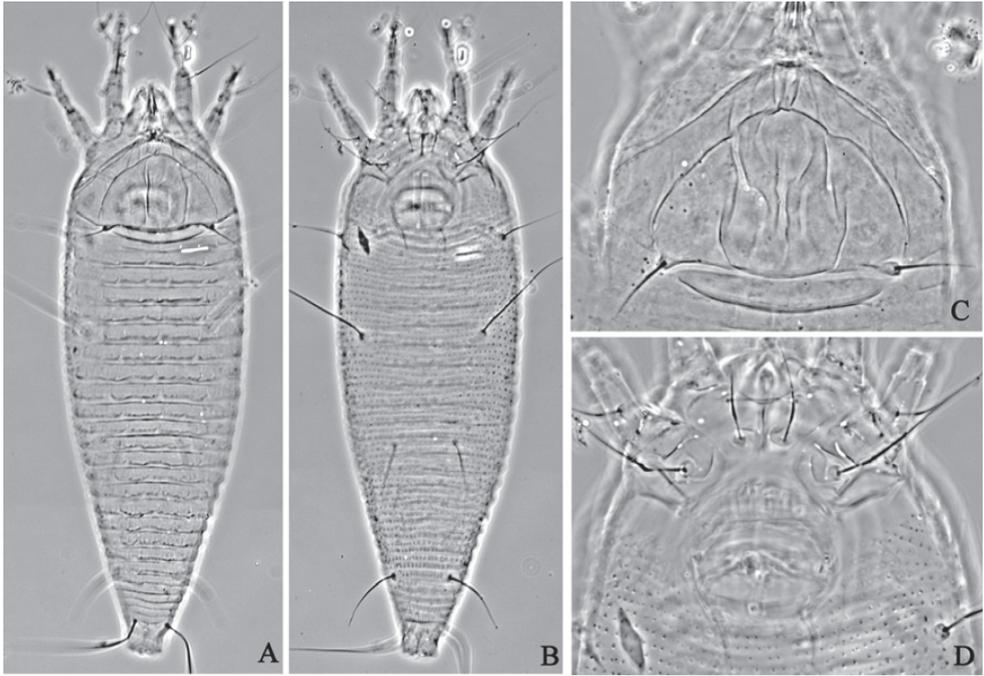
**Male:** Unknown.

**Type material.** Holotype, female (slide number IRAN204, marked Holotype), from *Medicago sativa* L. (Leguminosae), Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 10-VIII-2010, coll. Samira Sinaie, deposited as slide mounted specimens in the Arthropod/Mite Collection of the Department of Entomology, NJAU, Jiangsu Province, China. Paratypes, 2 females (slide number IRAN204), with the same data as holotype; 11 females (slide number 204), from *Medicago sativa* (Leguminosae), Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 10-VIII-2010, coll. Samira Sinaie, deposited in the Department of Plant Protection, FUM, Iran.

**Relation to host.** Vagrant.

**Etymology.** The specific designation *medicager* is from the generic name of host plant, *Medicago*.

**Differential diagnosis.** This species is similar to *Aculus alfalfae* (Roivainen, 1950), (from *Medicago sativa*), but can be differentiated from the latter by prodorsal shield



**Figure 15.** *Tetra lycopersici* Xue & Hong, 2005, rec. n. **A** dorsal view of female **B** ventral view of female **C** prodorsal shield **D** coxae and female genitalia.

with submedian lines and granules (prodorsal shield smooth in *Aculus alfalfae*), dorsal annuli with granules at lateral (dorsal annuli smooth in *Aculus alfalfae*), empodium 4-rayed (empodium 6-rayed in *Aculus alfalfae*).

**Remarks.** Alfalfa (*Medicago sativa* L.) is native to Asia Minor. The wild types in the Caucasus and in the mountainous regions of Afghanistan, Iran and adjacent regions. Now, alfalfa is widely cultivated throughout the world as fodder plant for cattle. The new species were described from the local/native plant from Iran.

### Genus *Tetra* Keifer, 1944

#### *Tetra lycopersici* Xue & Hong, 2005, rec. n.

[http://species-id.net/wiki/Tetra\\_lycopersici](http://species-id.net/wiki/Tetra_lycopersici)

Figure 15

*Tetra lycopersici* Xue & Hong 2005: 46–47, figure 5.

**Material examined.** 3 females (slide number IRAN203), from *Solanum nigrum* L. (Solanaceae), Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 30-VII-2010, coll. Samira Sinaie, deposited as slide mounted specimens in the Arthropod/Mite Collection of the Department of

Entomology, NJAU, Jiangsu Province, China; 5 females and 1 male (slide number 203), from *Solanum nigrum* L. (Solanaceae), Ferdowsi University campus, Mashhad, Razavi Khorasan Province, Iran, 36.3000°N, 59.5167°E, elevation 915m, 30-VII-2010, coll. Samira Sinaie, deposited as slides in the Department of Plant Protection, FUM, Iran.

**Host.** *Solanum lycopersicum* L. var. *lycopersicon*, *Solanum nigrum* L. (Solanaceae).

**Relation to host.** Vagrant.

**Distribution.** China, Iran.

## Acknowledgements

This work was partly supported by Ferdowsi University of Mashhad, Iran, the National Natural Science Foundation of China (No. 31172132) and Specialized Research Fund for the Doctoral Program of Higher Education (SRFDP) from the Ministry of Education of China (No. 20100097110012). We thank Xiao Han of NJAU for early review of the manuscript.

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# The genus *Anthia* Weber in the Republic of South Africa, Identification, distribution, biogeography, and behavior (Coleoptera, Carabidae)

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## Abstract

A key is presented for the identification of the four species of *Anthia* Weber (Coleoptera: Carabidae) recorded from the Republic of South Africa: *Anthia cinctipennis* Lequien, *Anthia circumscripta* Klug, *Anthia maxillosa* (Fabricius), and *Anthia thoracica* (Thunberg). For each of these species, illustrations are provided of adult beetles of both sexes as well as illustrations of male reproductive structures, morphological redescriptions, discussions of morphological variation, annual activity histograms, and maps of occurrence localities in the Republic of South Africa. Maps of occurrence localities for these species are compared against ecoregional and vegetation maps of southern Africa; each species of *Anthia* shows a different pattern of occupancy across the suite of ecoregions and vegetation types in the Republic of South Africa. Information about predatory and foraging behaviors, Müllerian mimicry, and small-scale vegetation community associations is presented for *A. thoracica* based on field and laboratory studies in Kruger National Park, South Africa.

## Keywords

*Anthia*, Carabidae, taxonomy, identification, savanna, South Africa, *Apristis promontorii* Péringuey

## Introduction

Beetles in the genus *Anthia* Weber are some of the largest and most conspicuous representatives of the family Carabidae in sub-Saharan Africa (Scholtz and Holm 1985; Picker, Griffiths, and Weaving 2002). Adults of *Anthia* species (Figure 1) and those of the closely related genus *Termophilum* Basilewsky (Figure 2) are boldly patterned in black and white or yellow stripes and/or spots. These beetles are armed with potent chemical defenses and are able to spray highly concentrated acidic secretions over a distance of a meter or more, often directed at the head and eyes of an attacker (Scott et al. 1975; Huey and Pianka 1977). Sympatric species of *Anthia* and *Termophilum* often have similar color patterns, a fact that has been interpreted as a possible example of Müllerian mimicry (Marshall and Poulton 1902; Huey and Pianka 1977). The genus *Anthia* and its relatives offer remarkable opportunities for studies of chemical ecology, as well as aposematic color patterns and the evolution of mimetic coloration.

Unfortunately, studies of the ecology, evolution, and behavior of these beetles have long been hampered by the lack of reliable, illustrated identification materials for species of *Anthia* and related genera. The two older revisions by Péringuey (1896) and Obst (1901), and the catalogue of species by Csiki (1929) often conflict in the placement of individual taxa, and these historic works generally lack good habitus images or line drawings that could be used by non-specialists to identify species in this group. Fortunately, recent revisionary work by Schmidt (2001, 2002) and Schmidt and Gruschwitz (2002) has helped to clear up many longstanding nomenclatural issues in this group and provide a firm foundation for the development of reliable identification materials.

The present treatment was written to provide identification materials for species of *Anthia* (*sensu* Basilewsky 1950) from the present-day Republic of South Africa (RSA). This paper forms part of a series of studies on southern African Carabidae and Cicindelidae, with a particular focus on taxa associated with the Kruger National Park in the Republic of South Africa. Previous contributions in this series include Mawdsley and Sithole (2008, 2009), Mawdsley (2009, 2011), and Mawdsley et al. (2011). The goal of this series of publications is to provide high-quality identification materials for groups of ground beetles and tiger beetles which are of potential interest to conservation biologists, environmental scientists, and park and natural area managers.

Unlike many parts of sub-Saharan Africa, the Republic of South Africa has been well sampled for *Anthia* and related genera and there is a wealth of museum material available for study. Even with this wealth of material, there has been considerable confusion in the literature regarding the identification and appropriate names to assign to these species. At the level of generic names, many authors follow Péringuey (1896), Obst (1901), and Csiki (1929) in applying the genus name *Anthia* to a larger group of approximately 66 species from sub-Saharan Africa, southern Asia, and India. In this paper, we follow Basilewsky (1950), Schmidt (2001, 2002), Schmidt and Gruschwitz (2002), and Lorenz (2005a, 2005b) in restricting the use of the genus name *Anthia*



**Figure 1.** Adult female of *Anthia thoracica* (Thunberg), photographed in the N'waswitshaka Research Camp, Skukuza, Kruger National Park, Republic of South Africa.



**Figure 2.** Adult male of *Termophilum homoplatum* (Lequien), photographed in the N'waswitshaka Research Camp, Skukuza, Kruger National Park, Republic of South Africa.

Weber to the group of approximately fourteen species exhibiting sexual dimorphism in the structure of the pronotum and/or mandibles.

There has also been considerable confusion regarding the number of species of *Anthia* in southern Africa. Csiki (1929) represents the most conservative estimate, recognizing just two species, *A. maxillosa* (which he called *A. fabricii*) and *A. thoracica*. Péringuey (1896) recognized an additional five species for a total of seven. In this paper, we recognize four species that can be readily separated on the basis of attributes of pronotal and elytral vestiture and surface sculpture, as well as by the structure of the male genitalia. Our conclusions parallel those of Schmidt (2001, 2002) and Schmidt and Gruschwitz (2002) as well as the late Pierre Basilewsky, who studied this genus for many years. According to Basilewsky's identification labels on museum specimens that we examined, Basilewsky recognized the same four species from South Africa that we recognize here.

## Materials and methods

We examined specimens of species of *Anthia*, *Termophilum*, and allied genera in the collections of the following museums: Field Museum of Natural History, Chicago, Illinois (FMNH); Kruger National Park Museum (Scientific Services), Skukuza, South Africa (KNPC); South African National Collection of Insects, Pretoria, South Africa (SANC); National Museum of Natural History, Smithsonian Institution, Washington, D.C. (NMNH); Transvaal Museum, Pretoria, South Africa (TMSA).

Field observations on adults of *A. thoracica* and other Anthiini were conducted during month-long visits by the senior author to the Kruger National Park in 2007, 2008, 2009, and 2010. Systematic field surveys for Anthiini and other diurnally active Carabidae were conducted in areas where adults of Anthiini had been collected historically in the park, or where adult beetles had been observed recently by park staff. Our surveys focused primarily on the Skukuza Ranger District in the central portion of the park, with field trips north to Satara, Letaba, Olifants, and Shingwedzi and south to Pretoriuskop. In surveying these areas we employed a variety of techniques, including driving surveys, walking surveys, and pitfall trapping (Mawdsley et al. 2011). Driving surveys were quickly identified as the most productive of these survey techniques for large Anthiini and consequently were widely applied throughout the southern area of Kruger National Park. In this survey approach, a party of four searchers drove slowly in a car along secondary sand or gravel roads and stopped whenever large carabid beetles were observed running on or across the road, or in vegetation along the side of the road. When a beetle was observed, the car was stopped and one or more persons left the vehicle in order to capture the beetle. In walking surveys, a group of four searchers walked slowly along segments of sand and gravel roads, looking for Carabidae running among dead leaves, vegetation, or on bare ground. We also deployed pitfall traps of different diameters in areas where Anthiini were observed, although we found through experience that our small-diameter traps

were less productive at capturing large-bodied Carabidae and were frequently raided by baboons, mongoose, and other predatory vertebrates. We conducted field surveys under all weather conditions, from sunny days with no cloud cover, to sunny days with afternoon thunder showers, to overcast, rainy days. Ambient air temperatures during surveys varied from 18C to 35C.

The driving technique proved to be a particularly productive method for collecting Anthiini, as well as other large Carabidae such as species of *Tefflus* Leach (Mawdsley et al. 2011). In addition to adults of *A. thoracica*, this method resulted in capture of adults of *Termophilum burchelli* (Hope), *T. homoplatum* (Lequien), *T. massilicatum* (Guérin), and *Cypholoba graphipteroides* (Guérin). The driving technique has the advantage of being able to cover a large geographic area within a relatively limited amount of time. The disadvantage to this technique is that many smaller-bodied species of Carabidae and Cicindelidae are overlooked, particularly those that are cryptically colored. However, we found that these taxa (particularly Carabidae of the genus *Graphipterus* Latreille and Cicindelidae of the genera *Dromica* Dejean and *Lophyra* Motschulsky) were easily detected during walking surveys.

For studies of beetle biology in captivity, individual adult beetles were captured by hand and placed singly into large 4-liter plastic holding containers containing a shallow layer of sand and gravel in the bottom. Each container was provided with a small ball of cotton soaked in water, to provide a water source for the adult beetles. To examine prey preferences, we provided each captive beetle with a variety of potential food items, primarily insects and other arthropods which were collected at lights at night in the Skukuza research camp. We recorded acceptance/rejection of each potential food item and the associated order and family of each prey item offered to the beetles.

Voucher specimens of beetles collected in Kruger National Park are deposited in the KNPC, NMNH, and TMSA collections.

Attributes of the abdominal ventral sterna are referred to using the numbering system generally accepted in Carabid studies, i.e., the sternum divided medially by the hind coxae is sternum II (the first being hidden) and the last visible is sternum VII (Liu et al. 2011).

### **Genus *Anthia* Weber, 1801**

<http://species-id.net/wiki/Anthia>

*Anthia* Weber (1801:17).

Type Species: *Carabus sexguttatus* Fabricius (1775:236); subsequent designation by Latreille (1810:426).

*Pachymorpha* Hope (1838:51); synonymized by Basilewsky (1950:80).

*Thoracolobus* Gistel (1857:50); synonymized by Csiki (1929:377).

**Diagnosis.** Body large and massive, adults of South African species always 40 mm or greater in length; body black or dark brown, usually with yellow or white setae and

pubescence. Prothorax cordiform, distinctly expanded laterally and usually with large lateral flanges. Mandibles and prothorax sexually dimorphic: mandibles elongate in males, shorter in females; base of pronotum with two posterior flanges or flattened extensions in males, tumescent without extensions in females. Elytra smooth with rows of minute punctures or feebly striatiopunctate, never markedly striatiopunctate in South African species (although other species in the genus do have striatiopunctate elytra).

**Recognition from sympatric genera.** Specimens of southern African species of *Anthia* may be readily distinguished from those of allied genera by the presence of broad lateral flanges on the pronotum and the sexual dimorphism in the structure of the mandibles and pronotal base. Most other South African Anthiini also have the elytra markedly striatiopunctate, at least in part. The only sympatric genus with which species of *Anthia* might be confused is *Termophilum* Basilewsky, that contains several large species that are similar in overall appearance and markings with those of the genus *Anthia*. However, species of *Termophilum* have a much simpler pronotal structure that lacks the large lateral flanges and secondary sexual characteristics present in *Anthia* species. Species of *Termophilum* also lack the sexual dimorphism in the mandibles that is seen in species of *Anthia*.

**Notes on Taxonomy.** Basilewsky (1950) was the first to point out that the generic names *Anthia* Weber and *Pachymorpha* Hope have the same type species, *Carabus sexguttatus* Fabricius. The name *Anthia* clearly has priority over *Pachymorpha*. Basilewsky (1950) noted that a replacement name for *Pachymorpha* was not necessary, as the species formerly classified in that genus fit readily within his restricted concept of the genus *Anthia*, a generic concept which we follow here. *Thoracolobus* was proposed by Gistel (1857) for the two species *A. maxillosa* (F.) and *A. thoracica* (Thunberg) and is clearly synonymous with *Anthia* Weber as treated here.

### Key to South African species of *Anthia* Weber 1801

- 1 Elytra with a distinct band of white setae along lateral margins ..... 2
- Elytra lacking distinct band of white setae along lateral margins .....  
..... *A. maxillosa* (Fabricius)
- 2 Pronotum with lateral patches of white, yellow, or brown setae; aedeagus stout, thick ..... 3
- Pronotum lacking lateral patches of white, yellow, or brown setae; aedeagus narrow, elongate.....*A. cinctipennis* Lequien
- 3 Lateral flanges of pronotum with large patches of dense yellow or brown reclinate seta forming two large round or ovate “spots;” aedeagus stout and thick along entire length (Figure 28).....*A. thoracica* (Thunberg)
- Lateral flanges of pronotum with more-or-less distinct patches of suberect white setae; aedeagus thinner towards base (Figure 31) *A. circumscripta* Klug

***Anthia thoracica* (Thunberg, 1784)**

[http://species-id.net/wiki/Anthia\\_thoracica](http://species-id.net/wiki/Anthia_thoracica)

Figures 1, 3–11, 28, 32, 36

*Carabus thoracicus* Thunberg (1784:69).

*Carabus fimbriatus* Thunberg (1784:70); synonymized by Dejean (1825:340).

*Anthia portentosa* Dohrn (1882:246); synonymized by Obst (1901:285).

*Anthia thoracica* var. *stigmodera* Péringuey (1896:375); synonymized by Csiki (1929:379).

*Anthia dohrni* Rousseau (1905:8); synonymized by Csiki (1929:379).

**Type Locality.** “Capite bonae spei” (= Cape of Good Hope).

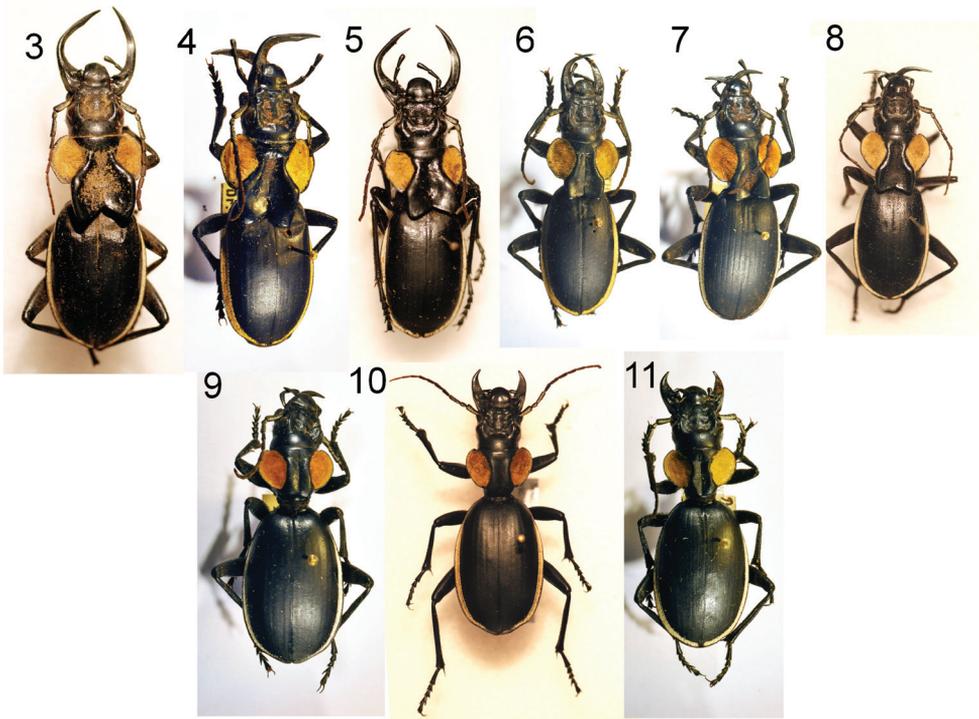
**Type Depository.** *Carabus thoracicus* and *Carabus fimbriatus*, Uppsala University, Museum of Evolution, Zoology Section; *Anthia portentosa*, formerly in the Museum für Naturkunde Stettin, and apparently lost in World War II; *Anthia thoracica* var. *stigmodera*, South African Museum, Iziko Museums of Cape Town.

**Diagnosis.** Easily separated from sympatric species of *Anthia* by the large round or ovate patches of yellow or brown setae on the lateral flanges of the pronotum. *Anthia thoracica* is the most widespread species of *Anthia* in South Africa and although adults are usually encountered singly, the species can be locally abundant.

**Description.** Body size massive, length of male (exclusive of mandibles) 46.8–52.8 mm, length of female 40.5–50.3 mm. Integument black.

Head elongate, prognathous. Mandibles elongate and sickle-shaped in male, short and stout in female. Male mandibles asymmetrical, with left mandible more markedly recurved than right. Length of right mandible in male 9.9–14.7 mm. Palpi elongate, slender, terminal segment securiform. Antennae elongate, antennomeres 1–3 and the base of 4 with small white reclinate setae dorsally; antennomeres 5–11 with brown pubescence. Eyes small, moderately convex. Frons markedly impressed, with fine scattered round punctures and an irregular median tubercle. Vertex smooth, with small scattered round punctures.

Pronotum cordiform, with broad lateral flanges, distinctly broader than head in both sexes. Two well-defined round or oval patches of short reclinate yellow setae present, one patch on each of the lateral flanges of the pronotum. Pronotum in male with large longitudinal median impression and with two large basal flanges projecting over base of elytra, lateral margins of flanges markedly elevated, apical margins oblique. Pronotum in female markedly impressed medially, lacking basal flanges but with two large, broad tubercles at base. Pronotal surface rugosely punctate medially, smooth with scattered small round punctures otherwise. Scutellum triangular, small and nearly obsolete. Elytra ovate, moderately convex. Elytral surface smooth, with 8 linear striate interneurals (feebly impressed or nearly obsolete in South African specimens) and scattered small round punctures. Elytral disc with short, scattered brown setae. Lateral



**Figures 3–11.** Six adult males (**3–8**) and three adult females (**9–11**) of *A. thoracica* (Thunberg), showing variation in male mandible length, in the size of the pronotal flanges in males, and in body size in both sexes. **3** male, Willowmore, Eastern Cape Province, RSA, NMNH **4** male, Lichtenburg, North West Province, RSA, TMSA **5** male, Queenstown, Eastern Cape Province, RSA, NMNH **6** male, Thabina, Gauteng Province, RSA, TMSA **7** male, Bushbuckridge, Mpumalanga Province, RSA, TMSA **8** male, Lichtenburg, North West Province, RSA, NMNH **9** female, Farm Alfa, Mpumalanga Province, RSA, TMSA **10** female, vic. Hazyview, Mpumalanga Province, RSA, NMNH **11** female, Bothaville, Free State Province, RSA, TMSA.

margins of elytra with a well-defined band of short white reclinate setae. Femora large, massive, with large round punctures. Tibiae elongate, slender, with lateral carinae, protibiae with antennal cleaner notch and a single stout subtending seta, meso- and meta-tibiae thickened at end, with dense reclinate brown setae towards apices and an apical setal fringe, tibial spurs 1-2-2. Tarsi stout, densely setose, protarsi in male broadly expanded, with comb-like setae ventrally.

Abdomen convex, shining, with numerous small round punctures and transverse wrinkles, especially towards lateral margin of ventrites. Apex of sternum VII feebly emarginate in male and broadly rounded in female. Male aedeagus stout, thick (Figure 28).

**Variation.** Males exhibit considerable variation in the size and length of mandibles and in the size of the basal flange on the pronotum (Figures 3-8). Females also exhibit some variability in overall body size (Figures 9-11).

**Adult activity patterns.** Unimodal, with greatest activity from October to March (Figure 36).

**Material Examined.** 164 pinned adult specimens from the following localities: Republic of South Africa: Eastern Cape Province: Algoa Bay, Despatch, Grahamstown, Port Elizabeth, Port St. Johns, Queenstown, Willowmore. Free State Province: Bothaville, Hendrik Verwoerd Dam, Krugersdrift Dam, Vanwyksfontein Farm, Winburg. Gauteng Province: Boksburg, Cullinan, Florida, Heidelberg, Johannesburg, Pienaars River, Pretoria, Thabina, Valhalla, Zoutpan Pta. KwaZulu-Natal Province: Hluhluwe, Ndumu, Pongola River, “E. Zululand,” “Zululand.” Limpopo Province: Groblersdal, Leydsdorp, Messina, Mogaladi, Mokeetse, Pietersberg, 20-26 miles NE of Pietersberg, Pumbe Sands, Shilouvane, Shingwedzi, Warm Baths, Zebediela, Zoutpansberg. Mpumalanga Province: Barberton, Bushbuckridge, Farm Alfa, Elands River/Middelburg, Groot draai on the Olifants River, Hazyview, vic. Hazyview, Malelane, Nelspruit, Numbi Gate, N’waswitshaka Research Camp, Skukuza, Stolsnek, Waterval pass, Waterval river pass. Northern Cape Province: De Aar, Kimberley. North West Province: Hartebeespoort Dam, Lichtenburg, Mafeking, Rustenburg, 14 miles E Ventersdorp. Western Cape Province: Cape of Good Hope, Cape Town, Dendron. [Additional material was examined from Botswana, Mozambique, Namibia, Tanzania, and Zimbabwe.]

**Notes on Taxonomy.** *Carabus thoracicus* and *C. fimbriatus* are the names given by Thunberg in the same paper to male and female specimens of the present species, a fact which was first noted by Dejean (1825). The name *Carabus thoracicus* has page priority and was selected by Dejean (1825) as the valid name for the species. Dohrn (1882) described a form of this species with slender elytra from South Africa under the name *A. portentosa*. Because the name *A. portentosa* was already occupied, Rousseau (1905) in the Genera Insectorum proposed the replacement name *A. dohrni*. However, no replacement name is needed, as individuals with slender elytra occur throughout the range of the species and thus *A. portentosa* Dohrn should simply be treated as a synonym of *A. thoracica*. The name *A. thoracica* var. *stigmolera* was a manuscript name of Chaudoir’s which Péringuey published in 1896; it refers to a form of this species in which the elytral interneurs are more markedly impressed.

***Anthia maxillosa* (Fabricius, 1781)**

[http://species-id.net/wiki/Anthia\\_maxillosa](http://species-id.net/wiki/Anthia_maxillosa)

Figures 12–17, 29, 33, 37

*Carabus maxillosus* Fabricius (1781:298).

*Anthia atra* Chaudoir (1843:717); synonymized by Péringuey (1896:372).

*Anthia fabricii* Crotch (1871:3) (unnecessary replacement name).

**Type Locality.** “Cap. bon. sp.” (= Cape of Good Hope).

**Type Depository.** *Carabus maxillosus*, Zoological Museum of the University of Copenhagen; *Anthia atra*, Muséum National d’Histoire Naturelle, Paris.

**Diagnosis.** Easily separated from sympatric species of *Anthia* by the lack of patterned setae on the pronotum and elytra. Scattered white setae may be present along



**Figures 12–17.** Four adult males (**7–15**) and two adult females (**16–17**) of *A. maxillosa* (Fabricius), showing variation in male mandible length, in the size of the pronotal flanges in males, and in body size in both sexes. **12** male, Reichsfontein Gate, Richtersveld National Park, Northern Cape Province, RSA, TMSA **13** male, Free State Province, RSA, NMNH **14** male, Namaqualand, Waterval Farm, Northern Cape Province, RSA, TMSA **15** male, Calvinia, Northern Cape Province, RSA, TMSA **16** female, Willowmore, Eastern Cape Province, RSA, TMSA **17** female, Grootmist, North West Province, RSA, NMNH.

the elytral margins in unrubbed specimens, but these do not form the distinct bands that are found in the other South African *Anthia* species.

**Description.** Body size massive, length of male 42.0–45.0 mm (exclusive of mandibles), length of female 40.5–45.8 mm. Integument black.

Head elongate, prognathous. Mandibles sexually dimorphic and as described for *A. thoracica* except that the left mandible of the male is more markedly recurved. Length of right mandible in male 9.3–12.6 mm. Palpi as in *A. thoracica* except terminal maxillary palpomere more markedly securiform. Antennae as described for *A. thoracica*, including vestiture. Eyes, frons, and vertex as described for *A. thoracica*.

Pronotum cordiform, lateral flanges present but not as broadly expanded as in *A. thoracica*, pronotum still broader than head in both sexes. Form of pronotal base is sexually dimorphic as in *A. thoracica*, with the apical margins of the flanges in male oblique or slightly curved. Pronotum lacking dorsal setae, surface smooth and shining, with scattered small round punctures. Scutellum as in *A. thoracica*. Elytra ovate,

markedly convex. Elytral surface sculpture as in *A. thoracica*; vestiture in unrubbed specimens composed of scattered brown setae dorsally and a few scattered white setae laterally, never forming well-defined bands. Apex of elytra rounded in females, slightly more pointed in males. Femora and tibiae as in *A. thoracica* except with scattered stout black setae. Tarsi as described for *A. thoracica* including sexual dimorphism.

Abdomen as in *A. thoracica* except abdominal sterna not as markedly wrinkled laterally. Abdominal sternum VII broadly emarginate at apex in male, broadly rounded at apex in female. Male aedeagus elongate, slender (Figure 29).

**Variation.** Males exhibit considerable variation in the size and length of mandibles and in the size of the basal flange on the pronotum (Figures 7-15). Females also exhibit some variability in overall body size (Figures 16-17).

**Adult activity patterns.** Unimodal, with greatest activity August-October (Figure 37).

**Material Examined.** 235 pinned adult specimens from the following localities: Republic of South Africa: Eastern Cape Province: 20 miles S Aberdeen, Aberdeen-Beaufort West, Despatch, Grahamstown, Willowmore. Free State Province: Bothaville, no locality specified. Limpopo Province: Grootdraai, Zoutpansberg. Mpumalanga Province: Barberton, Lydenburg. Northern Cape Province: Calvinia, 30 km W Calvinia, De Aar, Duineveld near Stampriet, Kenhardt, Marydale, Nieuwoudtville, Nosob Camp in Kalahari Park, Pofadder, Strydenburg, Van Rhyn's Pass, Victoria West. Namaqualand region [in Northern Cape]: Braakrivier Mouth, Dikdoorn Farm, Gembokvlakte Farm, Harslagkop, Hoekbaai, Katdoringvlei, Klein Kogel Fontein, Kotzesrus, Nababiep, Oograbies, 36 miles E Port Nolloth, Port Nolloth, Quaggasfontein, Rietport Farm, Rooddam Farm, 9 miles S Springbok, 18 km S Springbok, 50 km E Springbok, Springbok-Mesklip, Stallberg Valley, Stinkfontein, 3 km NW Titiesbagi, Vogelklip, Waterval Farm, Wildpaarde Hoek. Richtersveld region [in Northern Cape]: Brakfontein, Buffelsriver valley, Helskloof, Holgat Mouth, 10 W Kuboos, Manganese Mine, Reichsfontein Gate in Richtersveld National Park. North West Province: Grootmist, Haartebeespoort Dam. Western Cape Province: Cape Town, Cedarberg, Koeke-naap, Kookfontein, Longkloof, Matiesfontein, Skulpbaai, Touws River, Vanwyksfontein, Zwartskraal farm. [Additional material was examined from Botswana, Namibia, and Zimbabwe.]

**Notes on Taxonomy.** There has been considerable confusion in the literature and in collections regarding the identity of this species. Most of the confusion is the result of various authors mistakenly associating the name *Carabus maxillosus* Fabricius (1781:298) with the name *Manticora maxillosa* Fabricius (1781:320). These two names were proposed in separate genera and the identities of the taxa to which these names refer are quite clear from the original descriptions. *Carabus maxillosus* is said to have glabrous elytra and two projecting "lamellae" on the base of the thorax; the term "lamellae" accurately describes the modified basal flanges of the pronotum in males of this species, a feature which places this taxon into the modern carabid genus *Anthia*. In contrast, *Manticora maxillosa* is said to have mandibles with a basal tooth and elytra with serrate lateral margins and small tubercles on the

disc, features which are not found in *Anthia* but which are commonly encountered in the modern-day sympatric cicindelid genus *Manticora* F. These two names appear in other, subsequent works by Fabricius but there is always a clear distinction between *Carabus maxillosus* with its basal pronotal flanges (Fabricius 1787:194; Fabricius 1801:220, as *Anthia maxillosa* following Weber 1801:17) and *Manticora maxillosa* with its scabrous elytra (Fabricius 1787:220; Fabricius 1801:167). Crotch (1871) erroneously considered *Carabus maxillosus* to be a junior homonym of *Manticora maxillosa*, and proposed the replacement name *A. fabricii* for the anthiine species. This replacement name was subsequently adopted by Csiki (1929) in the Coleopterorum Catalogus and consequently is widely used in collections. It is, however, entirely unnecessary, as the two names refer to different taxa and were originally proposed in different genera.

Csiki (1929) listed 18 taxa described from southern and eastern Africa as synonyms of *A. maxillosa* (which he called *A. fabricii*). These names all need to be carefully reviewed in order to determine whether they represent valid species.

### ***Anthia cinctipennis* Lequien, 1832**

[http://species-id.net/wiki/Anthia\\_cinctipennis](http://species-id.net/wiki/Anthia_cinctipennis)

Figures 18–22, 30, 34, 38

*Anthia cinctipennis* Lequien (1832:unpaginated).

*Anthia hottentota* Olliff (1889:368–369), synonymized by Csiki (1929:378).

*Anthia limbipennis* Chaudoir (1861:567), synonymized by Csiki (1929:378).

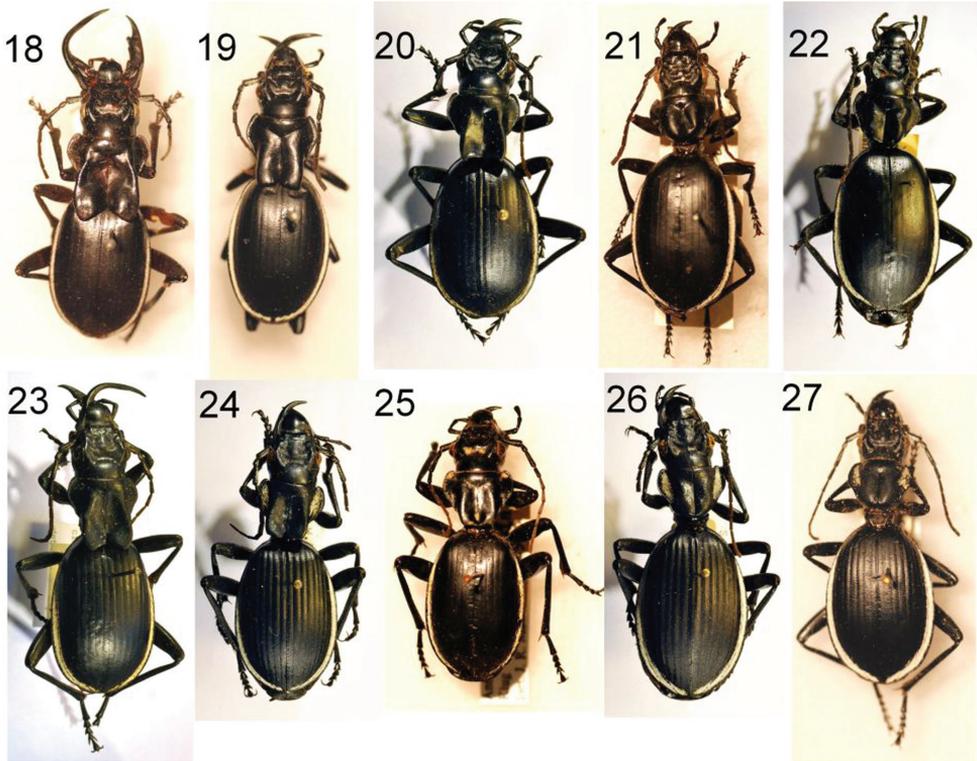
*Anthia pachyoma* Chaudoir (1883:26), synonymized by Csiki (1929:378)

**Type Locality.** “Cap de Bonne-Espérance” (= Cape of Good Hope).

**Type Depository.** *Anthia cinctipennis*, *Anthia limbipennis*, and *Anthia pachyoma*, Muséum National d’Histoire Naturelle, Paris; *Anthia hottentota*, Hope Department of Entomology, University Museum, Oxford University.

**Diagnosis.** Easily separated from *A. thoracica* by the lack of large round or ovate setal patches on the pronotum, and easily separated from *A. maxillosa* by the presence of a band of white setae along the lateral margins of the elytra. Less easily separated from *A. circumscripta*, although unrubbed specimens of the latter species always have scattered white setae on the lateral flanges of the pronotum. Male genitalia of *A. circumscripta* and *A. cinctipennis* are also diagnostic, with the aedeagus slender in *A. cinctipennis* and stouter and more robust in *A. circumscripta* (Figures 30, 21). Judging by the number of museum specimens examined, *A. cinctipennis* is also much more frequently encountered in RSA than *A. circumscripta*, which is known from relatively few specimens from RSA.

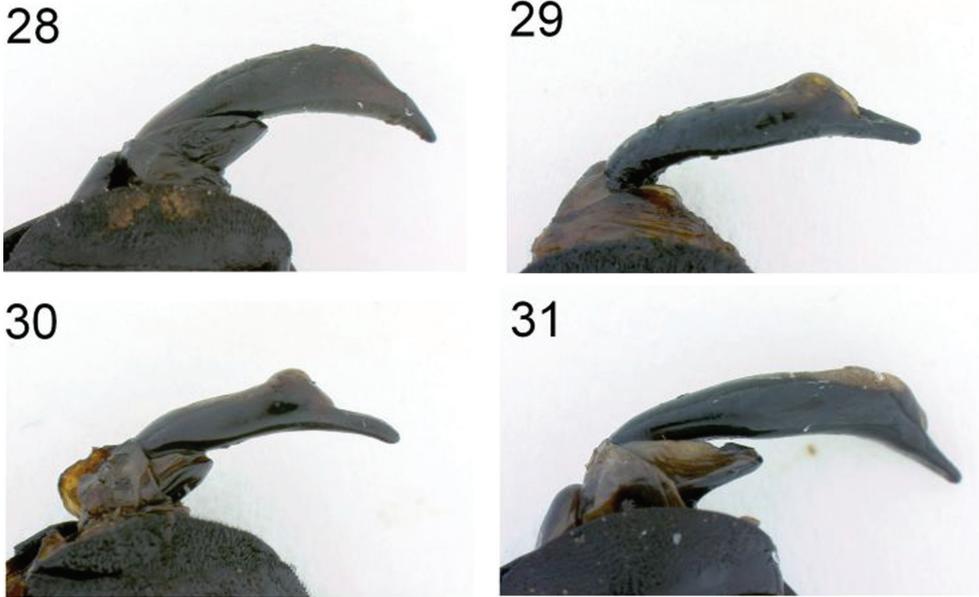
**Description.** Body size massive, length of male 41.3–43.8 mm (exclusive of mandibles), length of female 43.5–48.8 mm. Integument black.



**Figures 18–27.** Three adult males (**18–20**) and two adult females (**21–22**) of *A. cinctipennis* Lequien, showing variation in male mandible length, in the size of the pronotal flanges in males, and in body size in both sexes. **18** male, Cullinan, Gauteng Province, RSA, NMNH **19** male, Cradock, Eastern Cape Province, RSA, NMNH **20** male, Nauwkluft, Namibia, TMSA **21** female, Grahamstown, Eastern Cape Province, RSA, NMNH **22** female, Langjan Nature Reserve, Limpopo Province, RSA, TMSA. Three adult male (**23–25**) and two adult females (**26–27**) of *A. circumscripta* Klug, showing variation in male mandible length, in the size of the pronotal flanges in males, and in body size in both sexes. **23** male, Rehoboth, Namibia, TMSA **24**, male, Namib Desert, Namibia, TMSA **25** male, Zimbabwe, NMNH **26** Namib Desert, Namibia, TMSA **27** Ganab, Namibia, NMNH.

Head elongate, prognathous. Mandibles sexually dimorphic and as described for *A. maxillosa* except that right mandible of the male has a broad tooth along inner margin. Length of right mandible in male 8.9–10.7 mm. Palpi as in *A. maxillosa*. Antennae as described for *A. thoracica*, including vestiture. Eyes, frons, and vertex as described for *A. thoracica*.

Pronotum as in *A. maxillosa*, no dorsal setae present. Basal flange of pronotum well-developed in males; apex of this flange oblique or slightly curved. Pronotal surface markedly shining, with scattered small round punctures. Scutellum as in *A. thoracica*. Elytra broad, ovate and somewhat more flattened than in other sympatric *Anthia* species. Elytral sculpture and vestiture as in *A. thoracica*. Femora, tibiae, and tarsi as in *A.*



**Figures 28–31.** Dorsal view of abdominal apex, with aedeagus extended **28** *A. thoracica* (Thunberg) **29** *A. maxillosa* (Fabricius) **30** *A. cinctipennis* Lequien **31** *A. circumscripta* Klug.

*maxillosa*. Mesotibiae distinctly broadened at apex in both sexes, with a patch of short reddish setae on expanded portion.

Abdomen as in *A. maxillosa*. Abdominal sternum VII rounded but with a small shallow notch at tip in male, broadly rounded in female. Male aedeagus elongate, slender (Figure 30).

**Variation.** Males exhibit considerable variation in the size and length of mandibles and in the size of the basal flange on the pronotum (Figures 18–20). Females also exhibit some variability in overall body size (Figure 21–22).

**Adult activity patterns** Bimodal (Figure 38), with an activity peak from September–January in central and northeastern RSA (Free State, Gauteng, Limpopo, and Mpumalanga Provinces) and another, smaller activity peak in July in the Kalahari Gemsbok Park and other areas in Northern Cape Province.

**Material Examined.** 131 pinned adult specimens from the following localities: Republic of South Africa: Eastern Cape Province: Cradock, Graaff Reinet, Grahamstown, 14 miles E Middelburg. Free State Province: Bothaville, Reddersburg, Smithfield. Gauteng Province: Bronkhorstspuit, Cullinan, Johannesburg, Pretoria, Rhenosterpoort, Valhalla, Zoutpan Pta. KwaZulu-Natal Province: Elandskraal, “E. Zululand.” Limpopo Province: Dzombo Plots, Gravelotte, Grootdraai, Langjan Nature Reserve, Louis Trichardt, Messina, Nyandu Sandveld, Nylsvley, Penge, 20–26 km NE of Pietersburg, Pietersburg, Shilouvane, Warm Baths, Woodbush, Zoutpansberg. Mpumalanga Province: Barberton, Loskop, Lydenburg, Pilgrim’s Rest, Satara, Skukuza, Waterval, Waterval Pass. Northern Cape Province: Kimberley, Marydale, Richmond, 47 miles N

of van Rhynsdorp, Kalahari Gemsbok Park: Farm Mara, 25 km S of Mata Mata, Mata Mata, Twee Rivieren. [Additional material was examined from Botswana, Mozambique, Tanzania, and Zimbabwe.]

***Anthia circumscripta* Klug, 1853**

[http://species-id.net/wiki/Anthia\\_circumscripta](http://species-id.net/wiki/Anthia_circumscripta)

Figures 23–27, 31, 35, 39

*Anthia circumscripta* Klug (1853:245).

**Type Locality.** “Tette” (= Tete, Mozambique).

**Type Depository.** *Anthia circumscripta*, Museum für Naturkunde, Humboldt-Universität, Berlin.

**Diagnosis.** Unrubbed specimens have scattered areas of white setae on the lateral flanges of the pronotum, which is a diagnostic feature for this species. Rubbed specimens resemble *A. cincipennis* but males can be separated by the structure of the male genitalia which are slender in *A. cincipennis* and stouter and more robust in *A. circumscripta* (Figures 30, 31). This species is known from relatively few specimens from RSA; however, it is represented in museum collections by large series from Botswana and Namibia, where it is evidently more frequently collected.

**Description.** Body size massive, length of male 41.3–48.0 mm (exclusive of mandibles), length of female 42.6–50.4 mm.

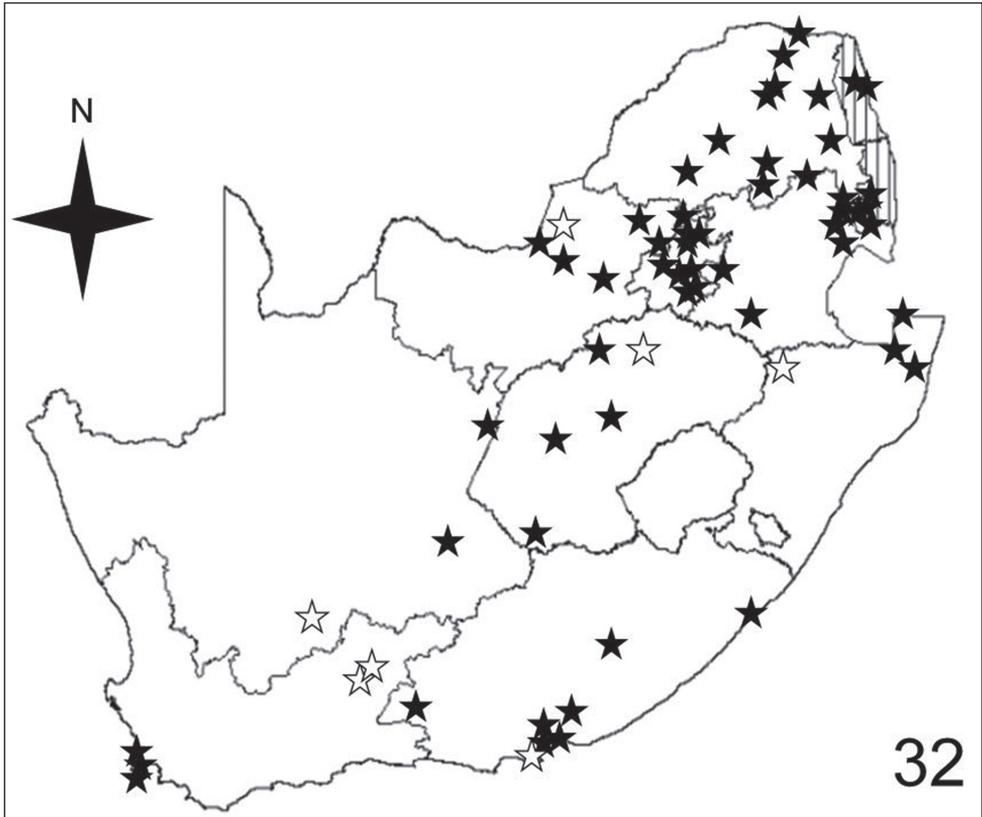
Head elongate, prognathous. Mandibles larger in males than in females. Length of right mandible in male 7.4–8.6 mm. Palpi as in *A. maxillosa*. Antennae, eyes, frons, and vertex as in *A. thoracica*.

Pronotum cordiform, shape as in *A. cincipennis* except that the basal flanges in male are often much smaller; apical margin of flanges transverse, with distinct emargination at apex of both flanges. Lateral flanges of pronotum with a more-or-less distinct patch of scattered short white reclinate setae. Pronotal surface sculpture smooth and shining, markedly punctate with large round punctures. Scutellum as in *A. thoracica*. Elytra elliptical-oval, convex medially. Vestiture as in *A. thoracica*. Each elytron with 8 distinct longitudinal striate interneurs, which may be feebly to somewhat markedly impressed; each interneur with a row of small round punctures, remainder of surface with scattered small round punctures. Legs as in *A. maxillosa*, mesotibiae modified in both sexes as described for *A. cincipennis*.

Abdomen as in *A. thoracica*. Male aedeagus stout, robust (Figure 31).

**Variation.** Males exhibit considerable variation in the size and length of mandibles and in the size of the basal flange on the pronotum (Figures 23–25). Females also exhibit some variability in overall body size (Figures 26–27).

**Adult activity patterns.** Distinctly bimodal (Figure 39), with populations from the Namib and Kalahari deserts having a July activity peak while populations from eastern Botswana, Zimbabwe and the few RSA records have an activity peak in No-



**Figure 32.** Distribution map showing collecting localities of museum specimens of *A. thoracica* (Thunberg) in the Republic of South Africa. Dark stars indicate specimens that we personally examined; white stars indicate literature records.

vember–March. Figure 39 shows records from throughout southern Africa, since only a very few specimens from RSA were available for study.

**Material Examined.** 2 pinned adult specimens from the following localities: Republic of South Africa: Free State Province: Golden Gate. KwaZulu-Natal Province: Maritzburg. [Additional material was examined from Botswana, Kenya, Namibia, Tanzania, Zambia, and Zimbabwe].

### **Taxonomic note on *Apristus promontorii* Péringuey**

Obst (1901) erroneously included an “*A. promontorii* Péringuey (1898)” in his list of species of the genus *Anthia*, with a comment that he had not actually examined the original description of the species. Had Obst consulted Péringuey’s original description (Péringuey 1898:329), it would have been readily apparent that the species in question was described in the genus *Apristus* Chaudoir (Coleoptera: Carabidae: Lebiini) rather

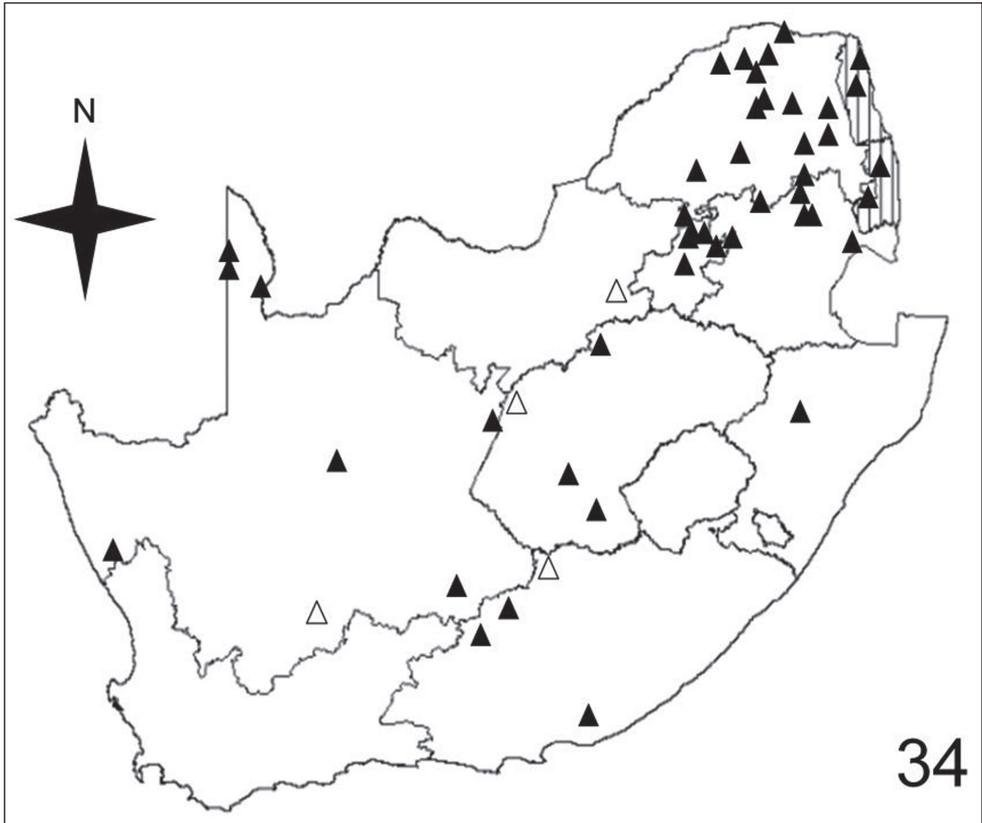


**Figure 33.** Distribution map showing collecting localities of museum specimens of *A. maxillosa* (Fabricius) in the Republic of South Africa. Dark circles indicate specimens that we personally examined; white circles indicate literature records.

than *Anthia* Weber. Furthermore the species could not possibly belong to the tribe Anthiini, as its maximum dimensions were given as 3.5 mm in length and 1.5 mm in width, measurements that are far smaller than those of any known species of Anthiini. Following Obst, Csiki (1929:381) listed *A. promontorii* Péringuey as a species *incertae sedis* under the genus *Anthia* in the Coleopterorum Catalogus. This placement has been followed by other authors and cataloguers, although clearly incorrect. The name *Anthia promontorii* should be treated as a synonym of *Apristus promontorii*.

### Comparative distribution of *Anthia* species in the Republic of South Africa

Figures 32–35 illustrate the distribution of species of *Anthia* in the Republic of South Africa based on museum specimen records, literature records, and our own recent collections. The individual species show markedly different patterns of distribution. *Anthia thoracica* has been most frequently collected in the northern and eastern portions of the country (Figure 32), particularly in Gauteng, Limpopo, and Mpumalanga

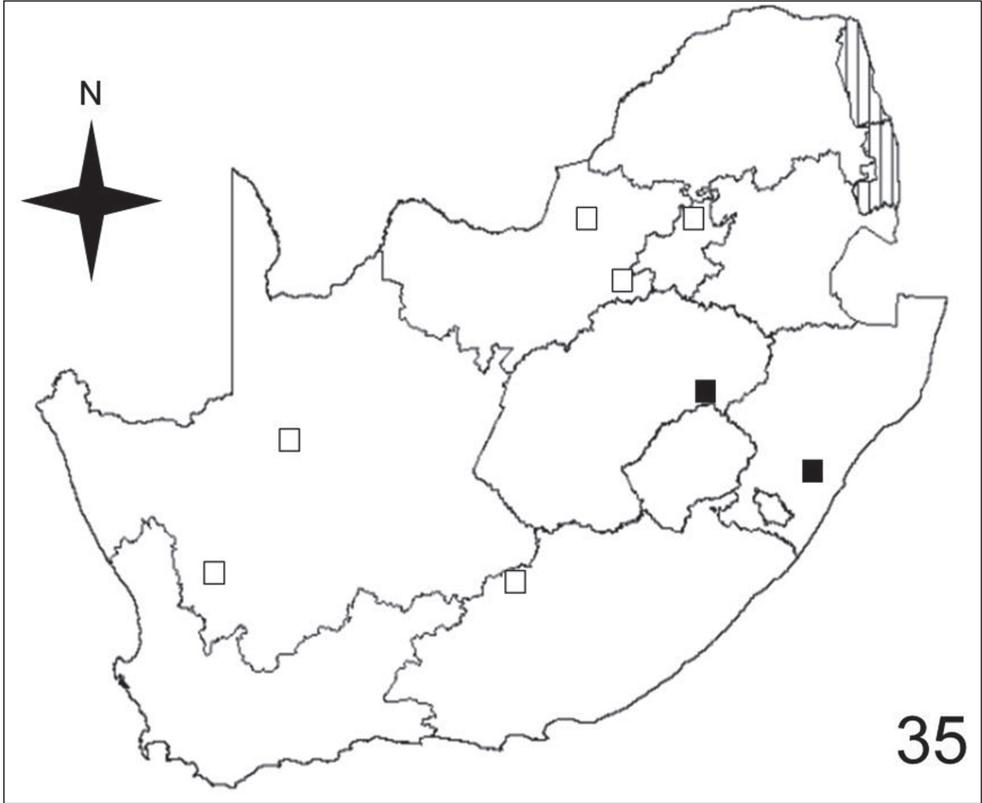


**Figure 34.** Distribution map showing collecting localities of museum specimens of *A. cinctipennis* Lequien in the Republic of South Africa. Dark triangles indicate specimens that we personally examined; white triangles indicate literature records.

Provinces. *Anthia maxillosa* has been most frequently collected in the west (Figure 33), particularly the Western Cape and Northern Cape Provinces. *Anthia cinctipennis* has a distribution pattern somewhat similar to that of *A. thoracica* (Figure 34), with a high concentration of records in Gauteng, Limpopo, and Mpumalanga Provinces, while *A. circumscripta* appears to be rare everywhere in the Republic of South Africa (Figure 35), with very few literature or specimen records. As noted above, *A. circumscripta* has been collected in much greater numbers in Botswana and Namibia, and forms a characteristic part of the *Anthia* fauna in both the Kalahari and Namib deserts.

#### **Association of *Anthia* species with terrestrial ecoregions and veld types in the Republic of South Africa**

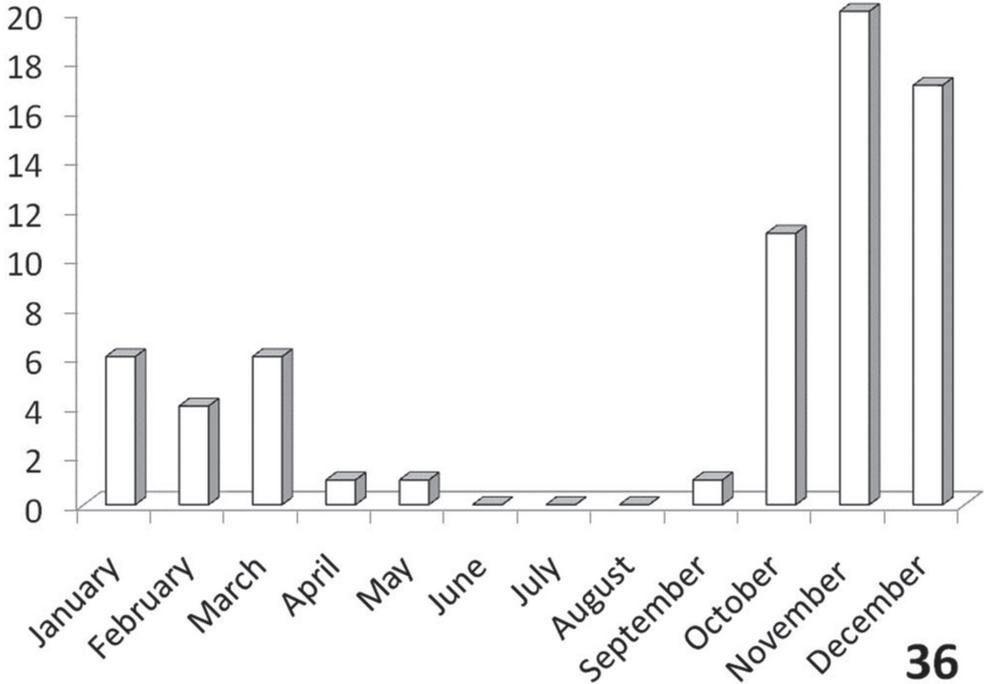
Schmidt (2001, 2002) and Schmidt and Gruschwitz (2002) were the first to note that species of Anthiini appear to be closely associated with particular vegetation communi-



**Figure 35.** Distribution map showing collecting localities of museum specimens of *A. circumscripta* Klug in the Republic of South Africa. Dark squares indicate specimens that we personally examined; white squares indicate literature records.

ties in southern Africa. We extend this analysis here using a new map and classification of terrestrial ecoregions that have been developed for continental Africa and Madagascar by Burgess et al. (2004). Comparisons between the map presented by Burgess et al. (2004) and the species distribution maps presented in this paper (Figures 32-35) clearly show the associations between the distributions of individual species of *Anthia* and the terrestrial ecoregions recognized by Burgess et al. (2004) in southern Africa. To examine the association of *Anthia* species with vegetation communities, we also compared our *Anthia* distribution maps against an older but nonetheless widely-used vegetation map which shows the distribution of various veld types in South Africa (Acocks 1988). For this comparison, we used Acocks' Map 2, which is intended to show actual (as opposed to historic or potential future) vegetation communities in the Republic of South Africa.

Adults of species of *Anthia* are widely distributed throughout the Republic of South Africa (Figures 32-35) and have been collected in twelve of the seventeen terrestrial ecoregions recognized by Burgess et al. (2004). The five ecoregions with no records of *Anthia* species are: Kalahari *Acacia* Woodlands; KwaZulu-Cape Coastal Forest Mosaic;

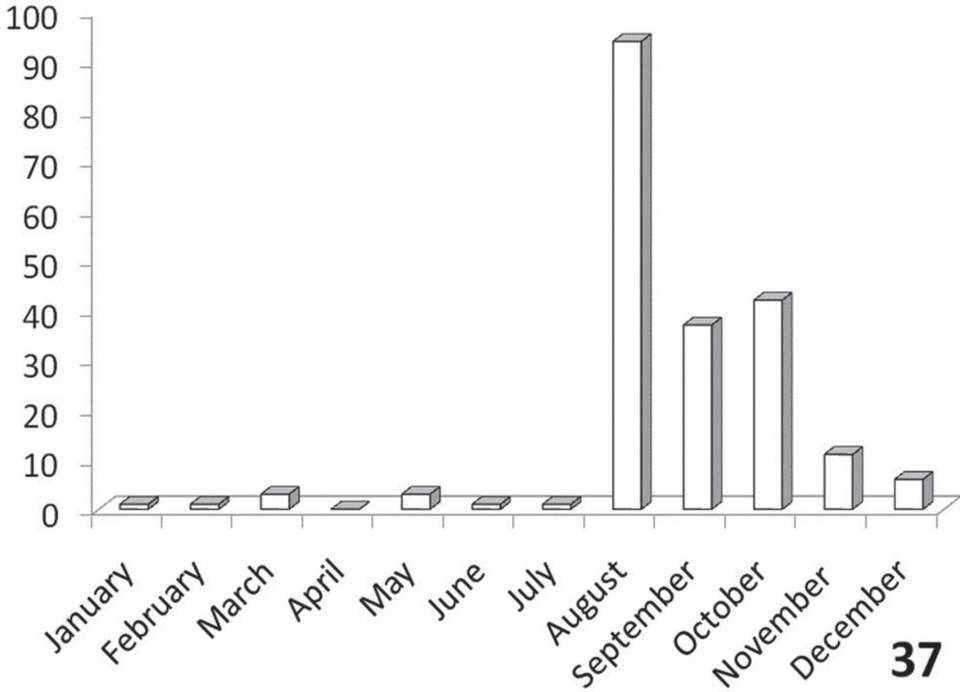


**Figure 36.** Activity patterns of adults of *A. thoracica* (Thunberg) in South Africa, based on museum specimen records and summed by month across all years. The vertical axis indicates numbers of specimens.

Knysna-Amatole Montane Forests; Montane Fynbos and Renosterveld; and Southern African Mangroves. In some cases (e.g. Southern African Mangroves) this absence of records may represent a true absence of *Anthia* beetles from the ecoregion, while in other cases (e.g. Kalahari *Acacia* Woodlands) the absence of records is likely due to the relatively small amount of this particular ecoregion that occurs in the Republic of South Africa and the absence of surveys for *Anthia* species in those particular small habitat patches.

Adults of *A. thoracica* have been collected in eight of the seventeen terrestrial ecoregions recognized by Burgess et al. (2004) in the Republic of South Africa: Highveld grasslands (36.1% of collecting sites); Zambezi and Mopane Woodlands (19.7% of collecting sites); Southern Africa bushveld (13.1% of collecting sites); Nama Karoo (11.5% of collecting sites); Albany Thickets (8.2% of collecting sites); Maputaland Coastal Forest Mosaic (4.9% of collecting sites); Lowland Fynbos and Renosterveld (4.9% of collecting sites); and Drakensburg Alti-Montane Grasslands and Woodlands (1.6% of collecting sites).

Adults of *A. maxillosa* have been collected in eight of the seventeen terrestrial ecoregions recognized by Burgess et al. (2004) in the Republic of South Africa: Succulent Karoo (48.3% of collecting sites); Nama Karoo (25.9% of collecting sites); Lowland Fynbos and Renosterveld (6.9% of collecting sites); Kalahari Xeric Savanna (5.2% of collecting sites); Highveld Grasslands (5.2% of collecting sites); Albany Thickets



**37**

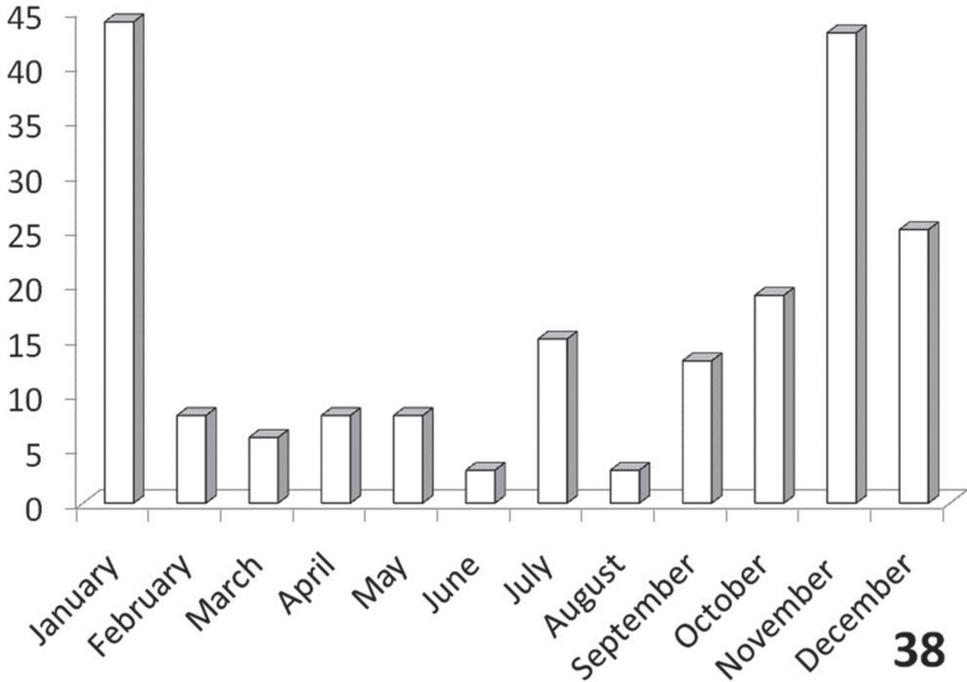
**Figure 37.** Activity patterns of adults of *A. maxillosa* (Fabricius) in South Africa, based on museum specimen records and summed by month across all years. The vertical axis indicates numbers of specimens.

(3.4% of collecting sites); Southern Africa Bushveld (3.4% of collecting sites); and Drakensburg Montane Grasslands, Woodlands, and Forests (1.7% of collecting sites).

Adults of *A. cinctipennis* have been collected in eight of the seventeen terrestrial ecoregions recognized by Burgess et al. (2004) in the Republic of South Africa: Highveld grasslands (36.2% of collecting sites); Southern Africa Bushveld (25.5% of collecting sites); Nama Karoo (14.9% of collecting sites); Zambezian and Mopane Woodlands (10.6% of collecting sites); Kalahari Xeric Savanna (6.4% of collecting sites); Succulent Karoo (2.1% of collecting sites); Maputaland-Pondoland Bushland and Thickets (2.1% of collecting sites); and Drakensburg Montane Grasslands, Woodlands, and Forests (2.1% of collecting sites).

Adults of *A. circumscripta* have been collected in three of the seventeen terrestrial ecoregions recognized by Burgess et al. (2004) in the Republic of South Africa: Nama Karoo (37.5% of collecting sites); Highveld Grasslands (37.5% of collecting sites); and Drakensburg Montane Grasslands, Woodlands, and Forests (25% of collecting sites). In adjacent countries (Namibia, Botswana, Zimbabwe), this species has also been collected in the Namib Desert, Kalahari Xeric Savanna, and Southern Africa Bushveld ecosystems.

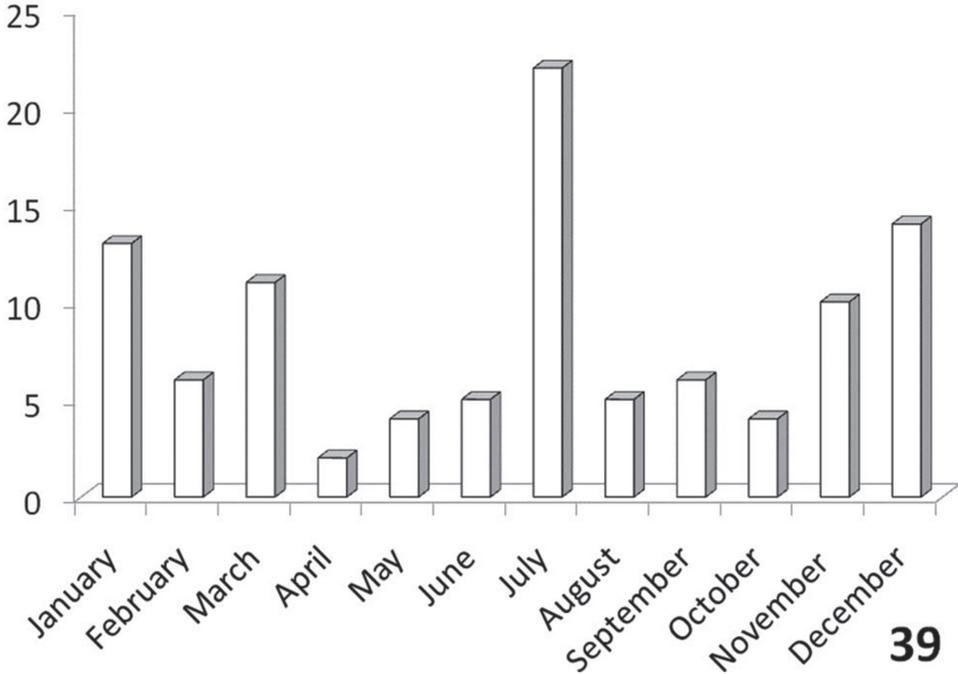
To compare these findings across the four *Anthia* species and the seventeen terrestrial ecoregions in the Republic of South Africa, we used the Spearman rank correlation coefficient (Lowry 2011). We use the Spearman rank correlation coefficient rather



**Figure 38.** Activity patterns of adults of *A. cinctipennis* Lequien in South Africa, based on museum specimen records and summed by month across all years. The vertical axis indicates numbers of specimens.

than standard regression because we do not know whether the numbers of collecting sites are distributed normally across the set of ecoregions (Lowry 2011). The Spearman rank correlation coefficient tests the significance of correlation between two lists of values. A test statistic close to 1 or -1 indicates that the relative rankings expressed in the two lists of values are markedly correlated. To obtain lists of values for each of the four species of *Anthia*, we calculated the percentage of the total number of collecting sites in each of the seventeen terrestrial ecoregions listed by Burgess et al. (2004) for the Republic of South Africa (Table 1). Next, the Spearman rank correlation coefficient was calculated for each of the possible comparisons of the lists of values in each of the species columns in Table 1, using an online calculator developed by Wessa (2011). These coefficients are reported in Table 2. Inspection of Table 2 shows clearly that for all four species, the relative percentages of collecting sites in each ecoregion are not significantly similar at the 95% level (test statistic between .95 and 1.0 or between -.95 and -1.0). From these findings, it can be inferred that these four species appear to be distributed across the set of southern African ecoregions in statistically dissimilar ways. These results make intuitive sense, given the obvious visual differences in the species distribution maps for these taxa (Figures 32-35).

Adults of *Anthia* species are likewise broadly distributed across the various veld types or large-scale vegetation communities recognized by Acocks (1988) in southern Africa, with collection records of species of *Anthia* from eight of the ten veld types re-



**Figure 39.** Activity patterns of adults of *A. circumscripta* Klug in South Africa, based on museum specimen records and summed by month across all years. The vertical axis indicates numbers of specimens.

corded for the Republic of South Africa. The two veld types with no records of *Anthia* species are Scrubby mixed Grassveld and Forest and Scrubforest. It is possible that the lack of records of *Anthia* species from these two veld types is due simply to lack of sampling activities in these two communities, both of which are relatively restricted in geographic extent (Acocks 1988).

Adults of *A. thoracica* have been collected in six of the ten veld types: Bushveld (51.6% of collecting sites); Karoo (11.3% of collecting sites); Sweet Grassveld (9.7% of collecting sites); Mixed Grassveld (9.7% of collecting sites); Sour Grassveld (9.7% of collecting sites); and Fynbos (8.1% of collecting sites).

Adults of *A. maxillosa* have been collected in seven of the ten veld types: Karoo (63.1% of collecting sites); Desert (14.3% of collecting sites); Bushveld (10.7% of collecting sites); Fynbos (7.1% of collecting sites); Succulent Karoo (2.4% of collecting sites); Sweet Grassveld (1.2% of collecting sites); and Sour Grassveld (1.2% of collecting sites).

Adults of *A. cinctipennis* have been collected in six of the ten veld types: Bushveld (45.8% of collecting sites); Sour Grassveld (29.2% of collecting sites); Karoo (18.8% of collecting sites); Desert (2.1% of collecting sites); Sweet Grassveld (2.1% of collecting sites); Mixed Grassveld (2.1% of collecting sites).

Adults of *A. circumscripta* have been collected in just three of the ten veld types: Sour Grassveld (50%); Karoo (37.5%); and Bushveld (12.5%).

**Table 1.** Percentage of collecting sites for each of four species of *Anthia* in each of the seventeen terrestrial ecoregions in the Republic of South Africa.

Terrestrial Ecoregion	% collecting localities for <i>A. thoracica</i>	% collecting localities for <i>A. maxillosa</i>	% collecting localities for <i>A. cinctipennis</i>	% collecting localities for <i>A. circumscripta</i>
Maputaland Coastal Forest Mosaic	4.9	0.0	0.0	0.0
KwaZulu–Cape Coastal Forest Mosaic	0.0	0.0	0.0	0.0
Knysna-Amatole Montane Forests	0.0	0.0	0.0	0.0
Zambeian and Mopane Woodlands	19.7	0.0	10.6	0.0
Southern Africa Bushveld	13.1	3.4	25.5	0.0
Kalahari Acacia Woodlands	0.0	0.0	0.0	0.0
Highveld Grasslands	36.1	5.2	36.2	37.5
Drakensburg Montane Grasslands, Woodlands, and Forests	0.0	1.7	2.1	25.0
Drakensburg Alti-Montane Grasslands and Woodlands	1.6	0.0	0.0	0.0
Maputaland-Pondoland Bushland and Thickets	0.0	0.0	2.1	0.0
Lowland Fynbos and Renosterveld	4.9	6.9	0.0	0.0
Montane Fynbos and Renosterveld	0.0	0.0	0.0	0.0
Albany Thickets	8.2	3.4	0.0	0.0
Kalahari Xeric Savanna	0.0	5.2	14.9	0.0
Nama Karoo	11.5	25.9	6.4	37.5
Succulent Karoo	0.0	48.3	2.1	0.0
Southern African Mangroves	0.0	0.0	0.0	0.0

**Table 2.** Spearman rank correlation coefficients from pairwise comparisons of the columns of values for each species in Table 1.

	<i>A. thoracica</i>	<i>A. maxillosa</i>	<i>A. cinctipennis</i>
<i>A. maxillosa</i>	0.319655		
<i>A. cinctipennis</i>	0.441241	0.50938	
<i>A. circumscripta</i>	0.347861	0.444142	0.492868

We again applied the Spearman rank correlation coefficient (Lowry 2011) to examine the relative abundance of collecting sites of the four species of *Anthia* across the ten veld types. Table 3 shows the percentage of collecting sites for each species in each of the veld types. Table 4 shows the Spearman rank correlation coefficient for each pairwise comparison of columns in Table 3, calculated using the web calculator developed by Wessa (2011). Here again the pairwise comparisons between columns are not significantly similar at the 95% level. This findings suggests that the four species of *Anthia* are distributed across the veld type of South Africa in statistically dissimilar ways.

**Table 3.** Percentage of collecting sites for each of four species of *Anthia* in each of the ten veld types in the Republic of South Africa.

Veld Type	% collecting localities for <i>A. thoracica</i>	% collecting localities for <i>A. maxillosa</i>	% collecting localities for <i>A. cinctipennis</i>	% collecting localities for <i>A. circumscripta</i>
Desert	0.0	14.3	2.1	0.0
Succulent Karoo	0.0	2.4	0.0	0.0
Karoo	11.3	63.1	18.8	37.5
Bushveld	51.6	10.7	45.8	12.5
Scrubby mixed Grassveld	0.0	0.0	0.0	0.0
Sweet Grassveld	9.7	1.2	2.1	0.0
Mixed Grassveld	9.7	0.0	2.1	0.0
Sour Grassveld	9.7	1.2	29.2	50.0
Forest and Scrubforest	0.0	0.0	0.0	0.0
Fynbos	8.1	7.1	0.0	0.0

**Table 4.** Spearman rank correlation coefficients from pairwise comparisons of the columns of values for each species in Table 3.

	<i>A. thoracica</i>	<i>A. maxillosa</i>	<i>A. cinctipennis</i>
<i>A. maxillosa</i>	0.347412		
<i>A. cinctipennis</i>	0.831126	0.431049	
<i>A. circumscripta</i>	0.693726	0.401331	0.802852

### Seasonality of *Anthia* species in the Republic of South Africa

The histograms in Figures 36-39 summarize dates of collection of museum specimens of *Anthia* species across all years. These charts suggest that individual species of the genus *Anthia* exhibit marked seasonality in the timing of adult emergence and in the timing of adult activity patterns, as noted previously by Schmidt (2001) and Schmidt and Gruschwitz (2002). In general, emergence and activity patterns in adults of *Anthia* appear to be coordinated with the onset of seasonal rains (Schmidt 2001; Schmidt and Gruschwitz 2002). As shown in Figure 36, adults of *A. thoracica* were most frequently collected between October and March, corresponding to the seasonal monsoonal rains in the eastern portion of the country (du Toit et al. 2003), where *A. thoracica* has been most frequently collected (Figure 32). In contrast, most collections of *A. maxillosa* have occurred between August and October (Figure 37), corresponding to the period of winter rains in the Northern and Western Cape provinces (Mares 2002) where this species has been most frequently collected (Figure 33). *Anthia cinctipennis* and *A. circumscripta* exhibit similar bimodal activity patterns in the Republic of South Africa (Figures 38 and 39), with populations in the eastern portion of the country active during the summer monsoon rains (September-January and November-March, respectively; Figures 38 and 39), while Kalahari Desert populations of both species are active during July.

## Investigations of possible allometry in secondary sexual characteristics of males of *Anthia* species

Males of species of *Anthia* in the Republic of South Africa often have enlarged and elongated mandibles as well as distinctive flanges on the base of the pronotum (Figures 3–8, 12–15, 18–20, 23–25). Both mandibles and flanges come in large, small, and intermediate sizes, and in general, larger-bodied males appear to have larger mandibles and pronotal flanges than smaller males. We were interested in determining whether mandible and pronotal flange size of these beetles scale isometrically (mandible and flange size increases at the same rate as body size) or allometrically (mandible and flange size increase at a rate disproportionately greater than body size). We measured three variables, right mandible length, pronotal length (from apex to base of flange), and elytral width (a surrogate measure of body size, measured at the widest point with the elytra fully closed in a natural position) for all male specimens of these four *Anthia* species in the NMNH collection. For *A. thoracica*, we observed only a very weak correlation between elytral width and mandible length ( $R^2 = 0.61$ ) and between elytral width and pronotal length ( $R^2 = 0.63$ ) using standard linear regression. Both  $R^2$  values improved with the use of a polynomial ( $x^2$ ) function in the regression, to 0.67 and 0.75, respectively. The improved fit with the polynomial function and the generally low  $R^2$  values from the standard linear regression suggests that both mandible size and pronotal flange size scale non-linearly with respect to body size in this species. In the other three species, mandible length and pronotal length were very poorly correlated with elytral width ( $R^2$  values ranging from 0.04 to 0.27), suggesting that mandible and pronotal flange size is not correlated with elytral width.

## South African Anthiini as vectors for *Cyaneolytta* larvae (Coleoptera: Meloidae)

Many large-bodied Carabidae in southern Africa have been documented as serving as vectors for the phoretic larvae of species in the blister beetle genus *Cyaneolytta* Péringuey (Bologna et al. 1990; Di Iulio et al. 2003). In the Republic of South Africa, larvae of these beetles have been collected in association with adults of all four species of *Anthia* as well as several sympatric species of *Termophilum* (Di Iulio et al. 2003). The nature of these phoretic associations remains unclear (Di Iulio et al. 2003) although a number of possible explanations have been advanced by Bologna et al. (1990).

## Observations on the biology and behavior of *Anthia thoracica* (Thunberg) in the Kruger National Park

*Anthia thoracica* is one of two species in the genus *Anthia* recorded from Kruger National Park, a large and well-known conservation area which is located in eastern Limpopo and Mpumalanga Provinces, South Africa (du Toit et al. 2003). Recent fieldwork

in the southern portion of this park by the senior author has provided us with opportunities to examine certain aspects of the biology of *A. thoracica* under both field and laboratory conditions. Protocols for field surveys for *A. thoracica* and other Anthiini, as well as methods for laboratory maintenance of captive Anthiini, are described above under the Materials and Methods section.

Occurrences within Kruger National Park: Specimens of *A. thoracica* have been collected at the following localities within Kruger National Park: Malelane, Numbi Gate, Pumbe Sands, Shingwedzi, Skukuza, and Stolsnek. In addition, the senior author and associates have recently encountered this species on sand and gravel roads in the vicinity of the Pretoriuskop and Skukuza rest camps, and in the N'waswitshaka Research Camp at Skukuza.

Associated ecological communities: Gertenbach (1983) characterized a series of 35 "landscapes" in Kruger National Park which are defined on the basis of plant communities, climate, geology, soils, vegetation, and vertebrate species composition. Adults of *A. thoracica* have been collected in the following five landscapes within the Park: Lowveld sourveld bushveld of Pretoriuskop (Gertenbach Landscape 1; Pretoriuskop; Figure 40). Malelane mountain bushveld (Gertenbach Landscape 2; Malelane, Numbi Gate, Stolsnek). Thickets of the Sabie and Crocodile Rivers (Gertenbach Landscape 4; N'waswitshaka Research Camp, Skukuza; Figure 41). *Combretum* spp./*Colophospermum mopane* (Bentham) Leonard (Fabaceae) rugged veld (Gertenbach Landscape 22; Shingwedzi). Pumbe sandveld (Gertenbach Landscape 30; Pumbe Sands). Common geomorphological features in these landscapes include eroding granite, gneiss, or basalt koppies and hills. Extensive sand deposits, sometimes as deep as 6 meters, are also found in many of these landscapes. The silver cluster-leaf tree (*Terminalia sericea* Burchell, Combretaceae; Figure 40) is a major component of the vegetation in several of these landscapes (although less common in the vicinity of Skukuza; Gertenbach 1983).

Co-occurrence with allied species: We collected adults of *A. thoracica* in association with adults of *Termophilum burchelli* (Hope), *T. homoplatum* (Lequien), *T. massilicatum* (Guérin), and *Cypholoba graphipteroides* (Guérin) (all Carabidae: Anthiini). Adults of *T. homoplatum* and *T. massilicatum* were found primarily in the open savanna areas extending northward area from Skukuza to Satara (Figure 42), while adults of *T. burchelli* and *C. graphipteroides* were found in denser thickets and woodlands from Pretoriuskop in the south along the banks of the Sabie River to Skukuza (Figures 40–41). The related species *A. cinctipennis* Lequien has also been collected in Kruger National Park, with records from Skukuza, Satara, and the Nyandu Sandveld (Figure 42).

Activity period: Specimen records from South Africa (Figure 36) indicate that collections of *A. thoracica* have occurred between September and May, with a peak in November–December. Emergence of adults of *A. thoracica* appears to be triggered by the onset of seasonal rains (Schmidt 2001), which in Kruger National Park typically occurs in November or December (du Toit et al. 2003). Adult beetles are usually encountered singly, walking rapidly on sand or gravel roads or in open areas of the veld. Our field observations of this species in the Park were conducted during the early rainy



**Figure 40.** *Terminalia sericea* Burchell woodland near Pretoriuskop, Kruger National Park, habitat for *A. thoracica* (Thunberg) and *Termophilum burchelli* (Hope).

season in November and December, corresponding to the time of peak collections of *Anthia* species and other Anthiini as indicated by museum specimen labels. No adults of *A. thoracica* were observed during a visit to the Park during the late dry season in September, 2006.

**Weather and climate:** Adult activity patterns of *A. thoracica* appear to be markedly influenced by weather and climatic conditions (Schmidt 2001). As mentioned above, adult emergence is clearly associated with the onset of seasonal rains (Schmidt 2001). In the Kruger National Park, adults can be found diurnally walking on sand and gravel roads and in open areas of the veld immediately following a rainfall event. After a series of days without rain, adult activity patterns change and the foraging adults are only encountered crepuscularly and nocturnally. On subsequent overcast or rainy days, however, adults again become active diurnally. Similar activity patterns with respect to weather and climatic conditions have been noted in populations of the carabid *Tefflus meyerlei delagorguei* in Kruger National Park (Mawdsley et al. 2011).

**Defensive behaviors:** Adults of *A. thoracica* spray copious amounts of highly concentrated formic acid from their pygidial glands when disturbed (Scott et al. 1975; Schmidt 2001). As noted by Huey and Pianka (1977), the spray is often directed towards the head and eyes of the person disturbing the beetle. If picked up by a human, the beetle often directs the spray towards the hands of the person disturbing it. There



**Figure 41.** *Acacia nigrescens* Oliver – *Combretum apiculatum* Sonder woodland near Skukuza, Kruger National Park, habitat for *A. thoracica* (Thunberg), *Termophilum homoplatum* (Lequien), and *Cypholoba graphipteroides* (Guérin).

appears to be a limited supply of acid available to the beetle; the adults of *A. thoracica* and *Termophilum* species which we kept in captivity did not spray again after the initial capture. It has been suggested to the authors that the formic acid may be acquired and concentrated by the beetle as a by-product from consuming ants (Hymenoptera: Formicidae). However, other species of Carabidae have the ability to synthesize formic acid in their pygidial glands and to spray this acid as a defensive compound (e.g. Rossini et al. 1997).

Mimicry: *Anthia thoracica* and the sympatric species *T. homoplatum* (Lequien) share similar color patterns which include large round or ovate eyespots, a black, shining dorsal integument, and a narrow white linear band along the outer margin of the elytra (Figures 1, 2). In *A. thoracica*, the eyespots are on the pronotum while in *T. homoplatum* the eyespots are on the base of the elytra. Both species occur in similar habitats at the same times of year and exhibit similar fast walking behaviors. Both species are chemically defended, with the capacity to spray similar combinations of highly concentrated formic acid and other acidic compounds from the pygidial glands (Scott, Hepburn, and Crewe 1975). Marshall and Poulton (1902) suggested that the similarity in coloration between these two species may be an example of mimicry. Since both species share a similar noxious defensive behavior, any mimetic interactions



**Figure 42.** Open grassland savanna near Satara, Kruger National Park, habitat for *Anthia cinctipennis* Lequien, *Termophilum homoplatum* (Lequien), and *Termophilum massilicatum* (Guérin).

would likely be an example of Müllerian mimicry (Wickler 1968). Wickler (1968) emphasizes the importance of identifying potential agents of selection which could be responsible for driving the evolution of mimetic resemblances between species. In Kruger National Park, potential predators which forage for terrestrial arthropods in the areas where Anthiine beetles are encountered and which might serve as agents of selection for mimetic interactions between *Anthia* and *Termophilum* species include chacma baboon (*Papio ursinus* (Kerr)), vervet monkey (*Chlorocebus pygerythrus* Cuvier), banded mongoose (*Mungos mungo* Gmelin), black-backed jackal (*Canis mesomelas* (Schreber)), southern ground hornbill (*Bucorvus leadbeateri* (Vigors)), and the secretary bird (*Sagittarius serpentarius* (Miller)). We observed foraging adults of all of these vertebrate species in the areas that we surveyed for Anthiine beetles, with chacma baboon, vervet monkey, and banded mongoose present in significant numbers ( $n > 10$  individuals) at many sites. The abundance of these potential predators suggests that there may be considerable selection pressures on large carabid beetles that are driving the evolution of chemical defenses, aposematic coloration, and Müllerian mimicry complexes. On balance, the hypothesis of mimicry between these two beetle species seems reasonable.

Prey species: Adults of *A. thoracica* in captivity showed few preferences regarding prey items and consumed a wide range of prey species, including representatives of the following orders and families: Coleoptera: Carabidae, Cerambycidae, Curculionidae,

Scarabaeidae, Tenebrionidae. Hemiptera: Cicadidae, Cydnidae. Hymenoptera: Formicidae. Isoptera: Termitidae. Lepidoptera: Arctiidae, Geometridae, Noctuidae, Saturniidae. Orthoptera: Acrididae. These insects were captured at lights at night in the N'waswitshaka Research Camp and fed to the live *A. thoracica*.

Foraging behavior: Adults of *A. thoracica* exhibit a rapid walking behavior which appears to serve multiple functions: foraging for food, detection of mates, and dispersal of adults. In captivity, this behavior was often noticed in adults of *A. thoracica* which had not been fed for several hours.

Prey detection: Adults of *A. thoracica* were observed to move and vibrate their antennae in the presence of potential prey items, suggesting that chemical cues may form an important part in the detection and recognition of prey items.

Predatory behaviors: Adults of *A. thoracica* seized prey using their mandibles and rapidly crushed prey items with the mandibular bases, using the labial and maxillary palpi to hold and manipulate the prey item. Liquid contents of prey and soft tissues were consumed whole while heavily sclerotized parts and appendages (legs, wings) were discarded.

Drinking: Captive adults of *A. thoracica* were observed drinking from wet cotton balls which we provided in their containers; in drinking, the adult beetle stands perpendicular to the water source, the ventral surface of the head is pressed against the wet cotton and water is then taken directly into the buccal cavity.

Antennal cleaning: Adults of both sexes of *A. thoracica* have an antennal cleaning notch along the inner margin of the protibiae. Adults were observed drawing the antennae through this notch after feeding, after handling by humans, and after being introduced into a new captive holding chamber.

## **Concluding Remarks**

We hope that the identification materials presented in this paper will be of assistance to entomologists, field biologists, national park managers, and others who want to identify specimens of *Anthia* species in the Republic of South Africa. We also hope that this paper helps to spark additional interest in these large and spectacular members of the South African insect fauna. Species of the genus *Anthia* and related genera are large, common, and conspicuous members of savanna and woodland ecosystems throughout southern and eastern Africa. Our understanding of the natural history of this group is limited at present and further investigations of the life history, immature stages, and biology of these beetles are clearly needed. The genus *Anthia* and its relatives provide excellent opportunities for studying the evolution of chemical defenses, aposematic coloration, and Müllerian mimicry. *Anthia* and its relatives also have attributes which suggest they may be excellent candidates for inclusion in monitoring programs that track ecosystem condition or ecological integrity in southern Africa. Adult activity patterns of *Anthia* species closely track a variety of environmental and climatological variables (Schmidt 2001), and the presence of adult beetles could be taken as indicative

of the presence of certain favorable climatic conditions (Schmidt 2001). Adults (and presumably larvae) of *Anthia* species and relatives are voracious predators (Schmidt 2001) and thus the presence of the adult beetles is indicative of a suitable arthropod prey base for both larval and adult development. Our results and those of Schmidt and Gruschwitz (2002) suggest that individual species of *Anthia* show close associations with particular ecoregions or vegetation communities, and thus species of these beetles could potentially also serve as indicators of community condition. The survey protocols for adults of *Anthia* and related genera are relatively straightforward (see Methods above) and can be easily replicated using small teams of surveyors. Identification of species in the genus *Anthia* and related genera is based largely on external surface sculpture and setal patterns (Schmidt 2002), which could be mastered by non-specialists. By making these basic identification materials widely accessible, we hope to stimulate further interest in these fascinating members of the southern African carabid fauna.

## Acknowledgements

We dedicate this paper to the late P. Basilewsky in recognition of his numerous significant contributions to the taxonomy of African Carabidae. For assistance with fieldwork, we thank F. Venter, V. Ndlovu, J. Baloyi, O. Sithole, A. Manganyi, P. Khoza, and T. Khoza of South African National Parks. For additional field assistance we thank R. D. Mawdsley, as well as J. du G. Harrison and his family. For assistance with visits to museum collections, we thank A. Newton and M. Thayer (FMNH), G. Zambatis (KNPC), R. Staals and B. Grobbelaar (SANC), and J. du G. Harrison and Ruth Müller (TMSA).

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# Taxonomic notes on *Lasioglossum* (*Lasioglossum*) *subopacum* (Smith) and *L. (L.) okinawa* Ebmer et Maeta (Hymenoptera, Halictidae) from Asia

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## Abstract

*Lasioglossum* (*Lasioglossum*) *subopacum* (Smith) is recorded from the Korean Peninsula for the first time. *Lasioglossum* (*L. (L.) okinawa* Ebmer et Maeta from Japan is ranked to a subspecies of *L. (L.) subopacum* judging from the characteristics of the male. The male of *L. (L.) subopacum okinawa* is described for the first time. Some bionomical notes of both subspecies are presented.

## Keywords

Hymenoptera, Halictidae, *Lasioglossum*, Asia, taxonomy

## Introduction

The halictine bee subgenus *Lasioglossum* s. str. Curtis, 1833 (Halictidae: Halictinae) is morphologically characterized by the second submarginal crossvein of female fore wing as strong as the first, and the female inner hind tibial spur serrate or pectinate with five or more teeth. This subgenus is mainly known from the Holarctic Region with 111 species recorded in the Palearctic Region. Two of them, *Lasioglossum* (*Lasioglossum*) *subopacum* (Smith, 1853) and *L. (L.) okinawa* Ebmer et Maeta, 1999 are known to occur in Asia: the former from eastern to southeastern Asia (Pesenko 2006), and the latter only from the Ryukyu Islands, southwestern Japan (Ebmer and Maeta 1999). The latter taxon was originally described based on only female specimens. In the course of my study of Asian halictid bee fauna, I have been examined extensive series of specimens collected particularly from eastern Asia. Through careful examination, I have found *L.*

*subopacum* from the Korean Peninsula (South Korea) for the first time, as well as the previously undescribed males of *L. okinawa*. In addition, I found that the male of *L. okinawa* cannot be clearly separated from *L. subopacum*, so I concluded that *L. okinawa* should be properly treated a geographical race, a subspecies of *L. subopacum*. In the present paper, I report the new taxonomic notes of *L. subopacum* including the male description of *L. subopacum okinawa* and some bionomical notes of both subspecies.

## Material and methods

This study is based on the specimens deposited in the following institutions, which are referred to in the text by the following abbreviations: ELKU, Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka, Japan; EBSU, Prof. Emeritus Yasuo Maeta's collection, deposited in the Division of Environmental Biology, Faculty of Life and Environmental Science, Shimane University, Matsue, Japan; BPBM, Maa's collection borrowed from the Bernice P. Bishop Museum, Honolulu, Hawaii, USA; MNHAH, the late Dr. Shoichi F. Sakagami's collection, deposited in the Museum of Nature and Human Activities, Hyogo, Sanda, Japan; and without acronym, my private collection, now deposited in the ELKU.

Terminology and style used in the description follow McGinley (1986), Murao and Tadauchi (2007). Abbreviations used in the text are as follows: Fn, nth antennal flagellomere; IS, interspaces between punctures; PP, punctures; Sn, nth metasomal sternum; Tn, nth metasomal tergum. The scientific names of flowering plants visited by bees are cited from Yonekura and Kajita (2003–).

Comparative material examined. *Lasioglossum (Lasioglossum) occidens* (Smith, 1873): 1♂, Rifu-cho, Miyagi Pref., Honshu, Japan, 14. VIII. 1979 (K. Goukon, MNHAH, illustrated in Fig. 12); 1♂, Kusasenri, Choyo-son, Aso-gun, Kumamoto Pref., Kyushu, Japan, 11. IX. 2004 (T. Sugimoto, illustrated in Fig. 16); 1♂, Mt. Ten-zan, Kyuragi-machi, Saga Pref., Kyushu, Japan, 13. VIII. 2004 (T. Sugimoto, illustrated in Fig. 17). *Lasioglossum (L.) sakishima* Ebmer et Maeta, 1999: 1♂, Yonehara, Iriomote-jima, Okinawa Pref., Ryukyus, Japan, 18. VI. 1972 (O. Tadauchi, ELKU, illustrated in Figs 13, 18); 1♂, Ohtomi, Iriomote-jima, Okinawa Pref., Ryukyus, Japan, 23. V. 2003 (T. Mita, illustrated in Fig. 19).

## Taxonomy

### *Lasioglossum (Lasioglossum) subopacum subopacum* (Smith, 1853)

[http://species-id.net/wiki/Lasioglossum\\_subopacum\\_subopacum](http://species-id.net/wiki/Lasioglossum_subopacum_subopacum)

Figs 11, 20, 22

*Halictus subopacus* Smith, 1853, Cat. Hym. Brit. Mus., 1: 63 [Syntype: Natural History Museum, London, United Kingdom; ♀, Foo-cho-foo (now Fuzhou, Fujian

- Prov.), north China]; Smith, 1873, Trans. ent. Soc. London, 1873: 200 [in list]; Dalla Torre, 1896, Cat. Hym., 10: 85; Cockerell, 1909, Ann. Mag. nat. Hist., (8)4: 316 [♀, in key]; Cockerell, 1919, Ann. Mag. nat. Hist., (9)3: 123; Wu, 1941, Cat. Ins. Sin., 6: 273; Hirashima, 1957, Sci. Bull. Fac. Agr. Kyushu Univ., 16(1): 20.
- Halictus chinae* Strand, 1910, Berl. ent. Zeitschr., 54: 182 [Syntypes: Museum für Naturkunde an der Humboldt Universität zu Berlin, Germany; 2♀, Tsingtau (now Qingdao, Shandong Prov.), China]; Strand, 1915, Ent. Mitt., 4: 63 [in list]; Blüthgen, 1926, Deutsch. ent. Zeitschr., 1925: 396 [Synonymy]; Wu, 1941, Cat. Ins. Sin., 6: 272.
- Halictus horishensis* Cockerell, 1911, Ann. Mag. nat. Hist., (8)8: 662 [Holotype: U. S. National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; ♂, Horisha, Taiwan]; Ebmer, 1980, Linzer biol. Beitr., 11(1): 501 [Synonymy].
- Halictus perangulatus* Cockerell, 1911, Ann. Mag. nat. Hist., (8)8: 663 [in key], 666 [Syntype: Museum für Naturkunde an der Humboldt Universität zu Berlin, Germany, 7♀, Taiwan]; Blüthgen, 1922, Deutsch. ent. Zeitschr., 1922: 63 [Synonymy].
- Halictus baguionis* Crawford, 1918, Proc. ent. Soc. Washington, 19: 170 [Holotype: U. S. National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; ♀, Luzon, Bagua, Philippines]; Blüthgen, 1926, Deutsch. ent. Zeitschr., 1925: 416 [Synonymy].
- Lasioglossum* (*Sericohalictus*) *subopacum*: Pesenko, 1986, Trudy Zool. Inst. Akad. Nauk SSSR, 159: 137 [in key].
- Lasioglossum* (*Leuchalictus*) *subopacum*: Pesenko, 2006, Zoosyst. Ross., 15(1): 159.
- Lasioglossum* (*Lasioglossum*) *subopacum*: Ebmer, 1980, Linzer biol. Beitr., 11(1): 500, 501; Sakagami & Tadauchi, 1995, Esakia, 35: 183, Fig. 16; Ebmer, 1998, Linzer biol. Beitr., 30(1): 410; Ebmer & Maeta, 1999, Linzer biol. Beitr., 31(1): 230, Figs 7–9.

**Diagnosis.** This species is divided into two subspecies, one of which is newly relegated to a subspecies of *Lasioglossum subopacum* as treated below. The nominotypical subspecies is separated from the ssp. *okinawa* by only the female characteristic that propodeum, and T1 basally with dense and thick yellowish tomentose as in Figs 20, 22. In male, both subspecies cannot clearly separate. This subspecies is separated from the other Korean *Lasioglossum* s. str. species in having the combination of following characters: the mesoscutum reflexed upward in both sexes and densely transversely rows on medio-anterior margin in female; the female propodeum and T1 with dense yellowish tomentose; the shape of hair tufts on male S6 and the gonostylus as in Fig. 11; and the male genitalia without ventral retrorse.

**Distribution.** China (north and southeastern areas), Taiwan, Vietnam, Philippines, and Korean Peninsula (south).

**Flight record.** Female: March to December. Male: May to October.

**Flower record.** In Korea, this species visited the following six species of flowering plants. Apiaceae: *Angelica miqueliana*. Asteraceae: *Aster yomena*; *Sonchus arvensis*. Brassicaceae: *Brassica* sp. Caprifoliaceae: *Lonicera* sp. Rosaceae: *Crataegus* sp.

**Specimens examined.** [SOUTH KOREA] 2♀ 1♂, Cheju Is., 17. X. 2005 (O. Tadauchi and R. Murao), 22. X. 2005 (O. Tadauchi); 1♀, Myeong-do-am, 400–600m,

Cheju city, Cheju Is., 15. IX. 1998 (O. Tadauchi, ELKU); 2♀, Pijarim Forests, Pukcheju-gun, Cheju Is., 24. IV. 1997 (O. Tadauchi and J. C. Paik, ELKU); 1♂, Pijarim, Pukcheju-gun, Cheju Is., 15. IX. 1998 (J. C. Paik, ELKU); 1♂, Kwanumsa, 500m, Cheju city, Cheju Is., 14. IX. 1998 (O. Tadauchi, ELKU); 8♀, KwangNung, Pocheon-shi, Gyeonggi-do, 19. V. 1992 (O. Tadauchi, ELKU).

[CHINA] Hunan Prov.: 1♀, Yuanling, 7. V. 1939 (T. C. Maa, BPBM); 1♀ Changteh, Yangshan, 11. X. 1938 (T. C. Maa, BPBM). Fujian Prov.: 1♀, Changting city, 3. VI. 1940 (T. C. Maa, BPBM); 12♀, Chungan, Bohea Hill, 11. VIII. 1939 (T. C. Maa, BPBM), 25. IX. 1939 (T. C. Maa, BPBM), 30. IX. 1939 (T. C. Maa, BPBM), 7. X. 1939 (T. C. Maa, BPBM), 24. IV. 1940 (T. C. Maa, BPBM), 6. V. 1940 (T. C. Maa, BPBM), 11. VIII. 1943 (T. C. Maa, BPBM); 1♀, Kienyang, Nwangkeng, 30. VII. 1943 (T. C. Maa, BPBM); 1♀, Kienyang, Liutun, 6. VII. 1942 (T. C. Maa, BPBM); 3♀ and 1♂, Shaowu city, 26. V. 1943 (T. C. Maa, BPBM), 11. IX. 1943 (T. C. Maa, BPBM), 8. XII. 1941 (T. C. Maa, BPBM), 23. XII. 1941 (T. C. Maa, BPBM, illustrated in Figs 20, 22); 1♀, Shaowu, 9. VII. 1942 (T. C. Maa, BPBM); 2♀, Shaowu, Shuipeichieh, 7. VII. 1941 (T. C. Maa, BPBM), 20. VII. 1941 (T. C. Maa, BPBM); 7♀, Shaowu, ShuiPeiKai, 16. III. 1942 (T. C. Maa, BPBM), 26. III. 1942 (T. C. Maa, BPBM), 13. V. 1943 (T. C. Maa, BPBM), 1. VI. 1943 (T. C. Maa, BPBM), V. 1945 (T. C. Maa, BPBM), 1♀, Shaowu, Tachuland, 25. IV. 1943 (T. C. Maa, BPBM); 2♀, Yungan, 19. X. 1940 (T. C. Maa, BPBM), 22. IV. 1941 (T. C. Maa, BPBM).

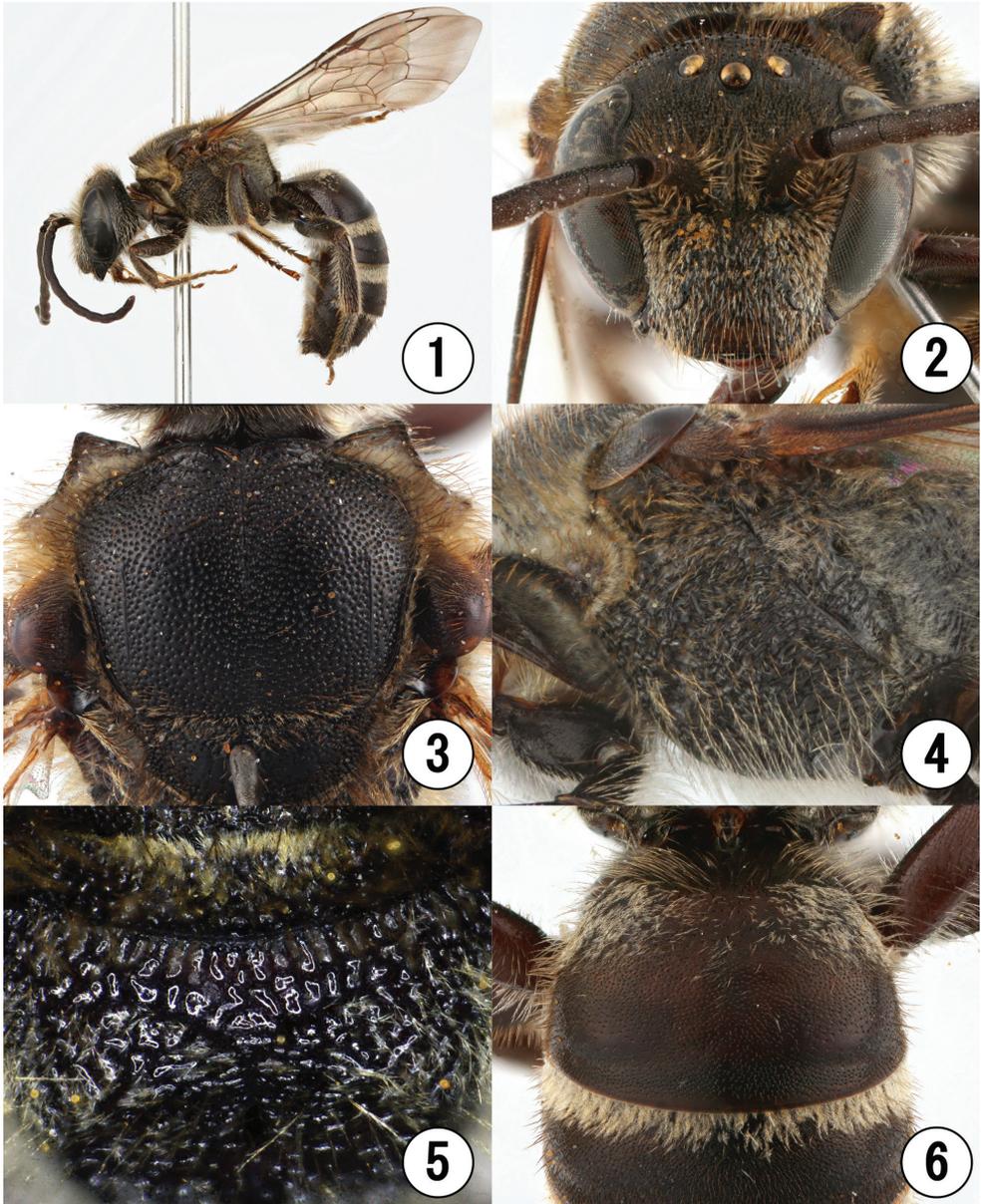
***Lasioglossum (Lasioglossum) subopacum okinawa* Ebmer & Maeta, 1999, stat. n.**

[http://species-id.net/wiki/Lasioglossum\\_subopacum\\_okinawa](http://species-id.net/wiki/Lasioglossum_subopacum_okinawa)

Figs 1–10, 14, 15, 21, 23

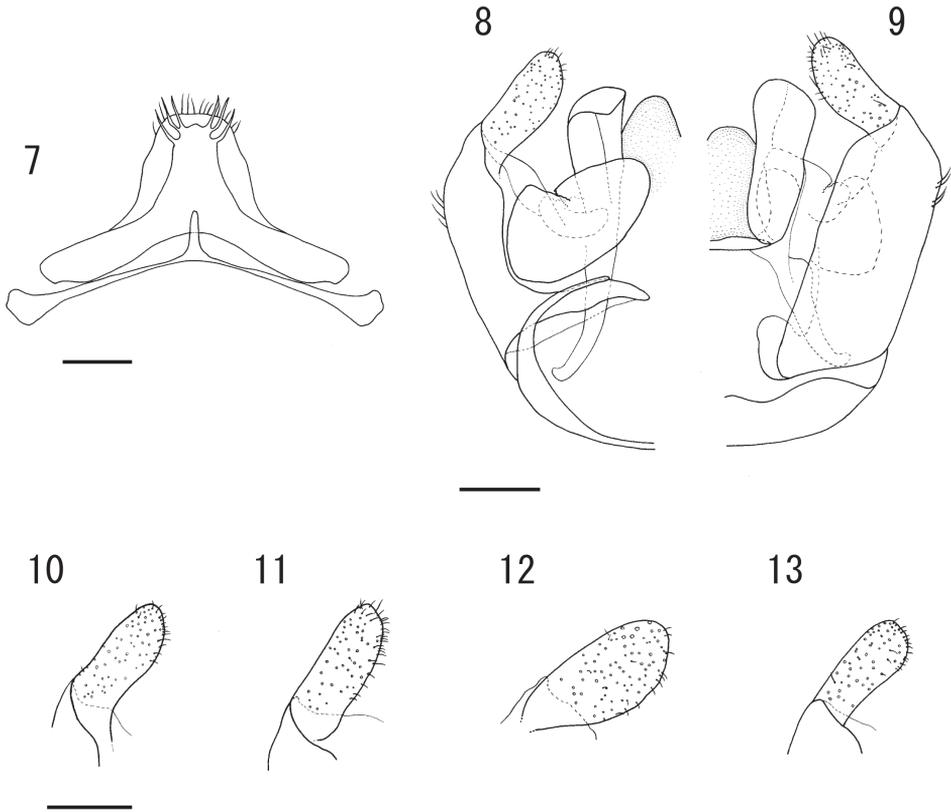
*Lasioglossum (Lasioglossum) okinawa* Ebmer et Maeta, 1999, Linzer biol. Beitr., 31: 230–233 [Holotype: EBSU; ♀, Okinawa-jima, Okinawa Pref., Japan]; Ikudome, 1999, Ident. Guide Aculeata Nansei Is., Jap.: 746.

**Diagnosis.** This subspecies is separated from the ssp. *subopacum* by the female propodeum and T1 basally with sparse and thin whitish tomentose as in Figs 21, 23. In Japan, it is closely similar to *Lasioglossum (Lasioglossum) occidens* (Smith, 1873) and *L. (L.) sakishima* Ebmer et Maeta, 1999. However, it is separated from the former by the mesoscutum reflexed upward in both sexes and densely transversely rows on medio-anterior margin in female, the T1 basally with whitish tomentose tufts in both sexes (Figs 6, 23), the shape of hair tufts on male S6 (Fig. 15), and the gonostylus narrowly rounded apically as in Fig 10; from the latter by the basal elevation of male labrum broadly rounded (Fig. 14), the sculpture on female mesoscutum as stated above, the shape of both hair tufts on male S6 and gonostylus. In contrast, in *L. occidens*, mesoscutum flat in both sexes and densely coarsely punctate on medio-anterior margin in female, T1 without tomentose hair tufts in both sexes as in Fig. 16, hair tufts on



**Figures 1–6.** Male of *Lasioglossum* (*Lasioglossum*) *subopacum okinawa* Ebmer et Maeta **1** lateral habitus **2** head in frontal view **3** mesoscutum **4** mesosoma in lateral view **5** propodeal dorsum **6** first metasomal tergum.

male S6 as in Fig. 17, and gonostylus broadly rounded as in Fig. 12; in *L. sakishima*, basal elevation of male labrum small and rounded as in Fig. 18, female mesoscutum reticulate–punctate on anterior margin, shape of hair tufts on male S6 as in Fig. 19, and gonostylus truncate apically as in Fig. 13.

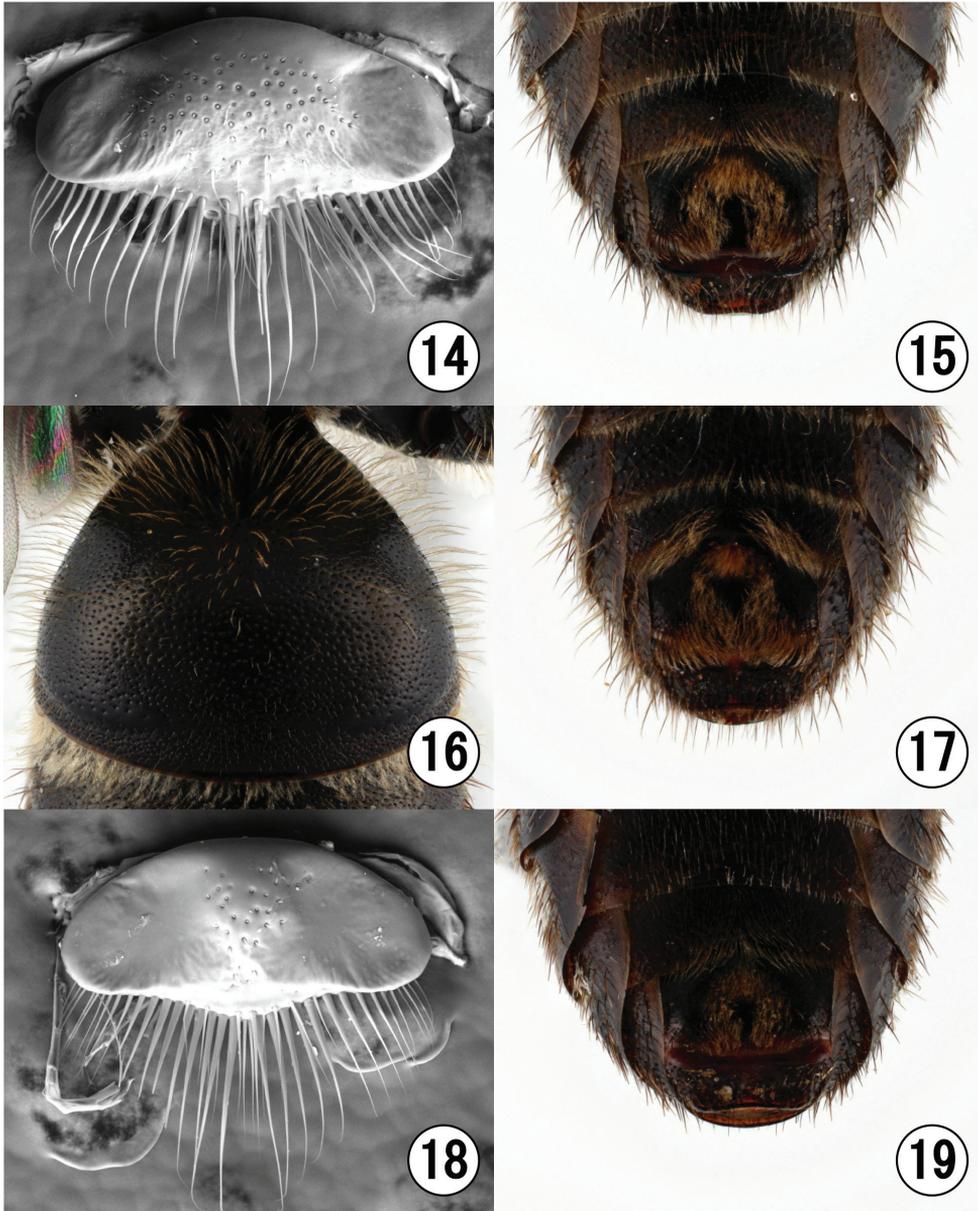


**Figures 7–13.** 7–10 Male of *Lasiglossum (Lasiglossum) subopacum okinawa* Emer et Maeta **7** seventh and eighth metasomal sterna **8** genitalia in ventral view **9** genitalia in dorsal view **10–13** gonostylus of genitalia in ventral view **11** Male of *L. (L.) subopacum subopacum* (Smith) **12** Male of *L. (L.) occidens* (Smith) **13** Male of *L. (L.) sakishima* Ebmer et Maeta Scale bars: 0.2mm.

**Description of male (new to science).** Body length 7.0–8.7mm, wing length 6.0–7.1mm (n=5).

**Color.** Body black except on the following parts: mandible apical half reddish brown; tegula blackish brown translucent; tibial spur yellow; posterior margin of metasomal terga narrowly brown translucent. Wings nearly transparent; veins and pterostigma blackish brown.

**Pilosity.** Mostly whitish; pale brown on mesosoma dorsally; mesoscutellum and metanotum mixed with blackish brown hairs. Head with sparse short fine branched hairs, and mixed with moderately dense tomentose on lower paraocular area. Hairs on mesosoma finely branched except on the following parts: dorsal, lateral surface, and around lateral lobe of pronotum with dense tomentose. T1 (Fig. 6) basally with a pair of tomentose tufts, however sometimes disappear. Disc on T2–5 with moderately dense short and simple hairs. Basal hair bands on metasomal terga present on T2–4 or T2–3. Apical fimbriae on metasomal terga absent. Acarinarium absent. S6 with well-formed, distinctive hair tufts as in Fig. 15.



**Figures 14–19.** 14–15 Male of *Lasioglossum* (*Lasioglossum*) *subopacum okinawa* Ebmer et Maeta. 16–17 Male of *L. (L.) occidens* (Smith) 18–19 Male of *L. (L.) sakishima* Ebmer et Maeta 14, 18 labrum 16 first metasomal tergum 15, 17, 19 distal parts of metasomal sternum.

Structure. Head nearly as long as wide; head length/width ratio 1.0–1.01 (n= 5). Vertex flat medially. Distance between lateral ocelli nearly as long as that between lateral ocellus and compound eye. Frons and paracocular area with reticulate–punctate, dimly shiny. Supraclypeal area slightly convex in lateral view, dimly shiny, with reticulate–punc-

tate; IS with distinct tessellation. Clypeus 1.5× distance between lower rim of antennal socket and upper margin of clypeus; nearly flat, with moderately dense PP; IS nearly smooth. Basal area of labrum 2× as wide as long; basal elevation weakly developed, broadly rounded; distal process absent; labral fimbriae acutely pointed at apex. Mandible edentate. Hypostomal carina moderately developed; its anterior angle obtuse. Postgena slightly depressed, with distinct lineoration. Scape length 0.5–0.6mm (n= 5), F2 2.2× F1.

Pronotal dorsolateral angle acute, moderately projecting; pronotal lateral ridge incomplete, interrupted by oblique lateral sulcus; lower portion of lateral ridge inconspicuous, narrowly rounded. Mesoscutum (Fig. 3) with oily–dull luster, dense PP excluding anteriorly, IS smooth; its anterior margin weakly reflexed upwards, with reticulate–punctate. Mesoscutellum marginally and longitudinally with dense PP. Metanotum and mesepisternum coarsely rugulose. Propodeum coarsely rugulose; propodeal dorsum (Fig. 5) 0.7× mesoscutellum, and nearly as long as metanotum; shield marginally with lateral carina that not reaching to apical margin on dorsal surface. Basitibial plate of hind leg carinate marginally. Inner hind tibial spur without distinct teeth.

Metasomal terga with oily–dull luster. T1 with weak lineolation over entire surface, medially and apically with dense PP. T2–3 with dense PP over entire surface; IS weakly lineolate over entire surface. T4–5 similar to IS of T2–3. S7–8 (Fig. 7): S7 with short and slender median process; S8 without median process. Male genitalia as in Figs 8–10. Gonobase ventral arm ring–shaped, and not connected to each other at apical ends: bottom nearly flat. Gonocoxite smooth. Gonostylus simple and flat, butter knife–like apically. Ventral retrorse lobe absent.

**Variation.** Male clypeus black over the entire surface, or with a small yellow spot on lower margin.

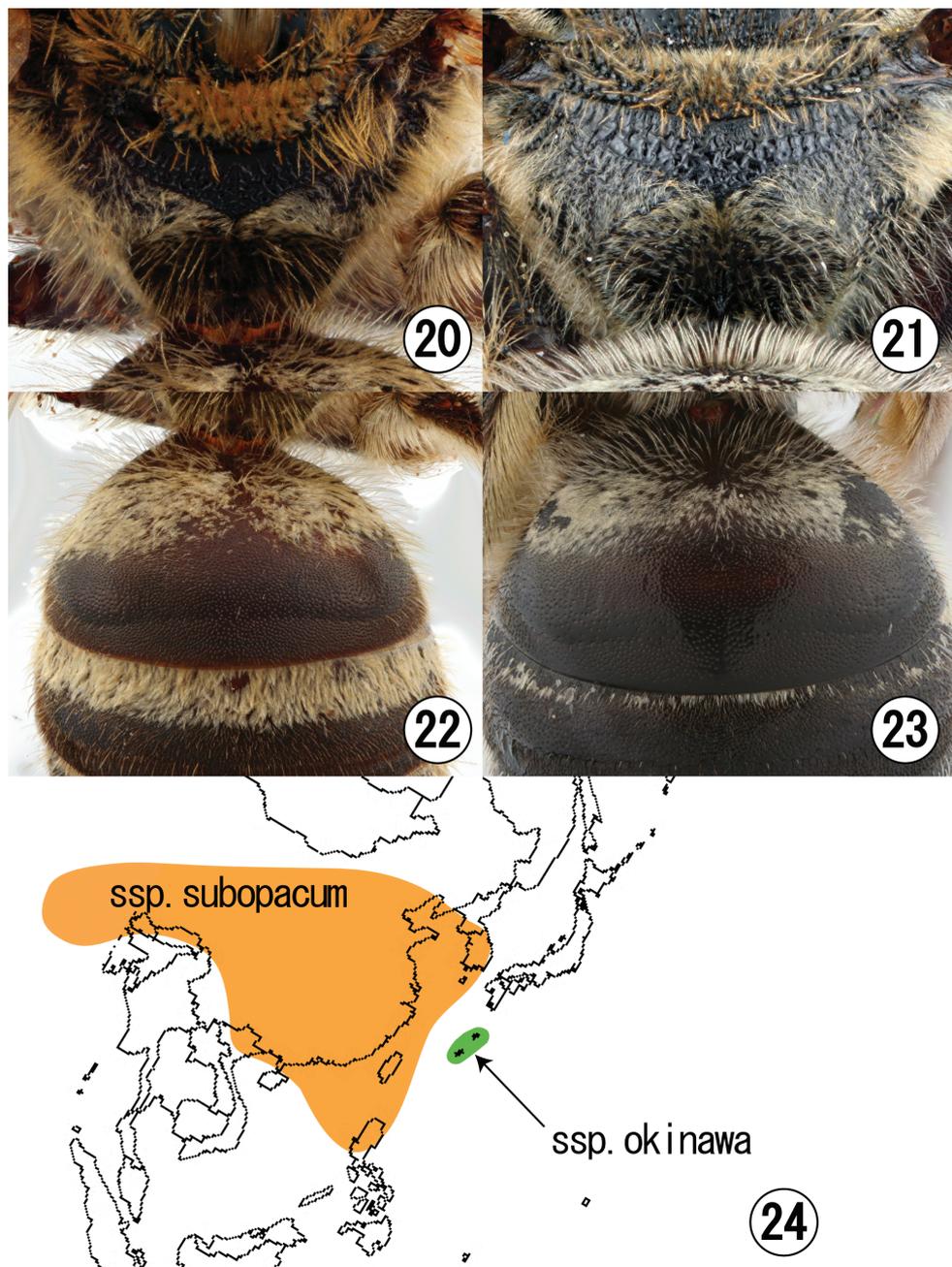
**Distribution.** Japan (central Ryukyus: Amami–ôshima, Okinawa–jima, Kume–jima).

**Flight record.** Female: April to November. Male: May to October.

**Flower record.** This species visited the following six species of flowering plants. Apiaceae: *Foeniculum vulgare*. Asteraceae: *Bidens pilosa* var. *radiata*; *Solidago altissima*. Euphorbiaceae: *Mallotus japonicus*. Polygonaceae: *Fallopia japonica* var. *japonica*; *Persicaria longisetata*.

**Collecting site.** So far as the author’s survey in both Amami–ôshima and Okinawa–jima, this species was mainly collected from around subtropical forest at mountain areas, but in Kume–jima from open land such as cultivated area.

**Specimens examined.** Holotype: ♀, Mt. Yonaha–dake, Okinawa–jima, Okinawa Pref., Japan, 7. VII. 1998 (Y. Maeta, EBSU). [JAPAN] [Ryukyus] Kagoshima Pref.: 1♀16♂, Mt. Yuwan–dake, Uken–son, Amami–ôshima, 14. X. 2004 (R. Murao, 1♂ illustrated in Fig. 1, 1♂ in Fig. 4, 1♂ in Figs 7–10, 1♂ in Fig. 15); 1♂, Mt. Yuwan–dake, alt.500m, Amami–ôshima, 17. VII. 1963 (C. M. Yoshimoto, ELKU); 2♂, Mt. Yuwan–dake, 24. VII. 1963 (Y. Hirashima, ELKU), 29. VII. 1963 (Y. Hirashima, ELKU); 8♀2♂, Shinmura, Amami–ôshima, 23. VII. 1954 (S. Ueda, ELKU; S. Miyamoto and Y. Hirashima, ELKU), 29. VII. 1954 (S. Ueda, ELKU); 1♀, Yuwan, Amami–ôshima, 31. VII. 1963 (Y. Hirashima, ELKU); 3♀, Santarou–toge, Sumi-



**Figures 20–24.** 20, 22 Female of *Lasioglossum* (*Lasioglossum*) *subopacum subopacum* (Smith) 21, 23 Female of *L. (L.) subopacum okinawa* Ebmer et Maeta 20, 21 hairs on propodeum 22, 23 hairs on first metasomal tergum 24 Distribution of both ssp. *subopacum* and ssp. *okinawa*.

you–son, Amami–ôshima, 15. X. 2004 (R. Murao, 1♀ illustrated in Figs 21, 23); 1♀, Yakkachi, Sumiyou–son, Amami–ôshima, 19. VII. 1933 (T. Esaki and K. Yasumatsu, ELKU). Okinawa Pref.: 3♀ (paratypes), same data as the holotype; 1♀1♂, 60–180m, Izumi, Motobu, Okinawa–jima, 22. V. 1982 (S. Ikudome, ELKU, 1♂ illustrated in Figs 2, 3, 5, 6); 1♂, Mt. Yonaha–dake, Kunigami–son, Okinawa–jima, 14. VI. 2002 (Y. Maeta, EBSU); 14♀, Hedo, Okinawa–jima, 5. IV. 1979 (K. Ohara, ELKU); 1♀, Nago, Okinawa–jima, 7. IV. 1979 (K. Ohara, ELKU); 1♀, Mt. Katsuu–dake, Nago–shi, Okinawa–jima, 3. XI. 2004 (R. Murao); 6♀3♂, Gima, Kume–jima, 27. V. 2003 (R. Murao); 3♀3♂, Zenda, Kume–jima, 27. V. 2003 (R. Murao, 1♂ illustrated in Figs 4, 14); 1♀, Nakadomari, Kume–jima, 26. V. 2003 (R. Murao).

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