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Description of the previously unknown male of *Systropha* (*Austrosystropha*) *macronasuta* (Hymenoptera: Halictidae: Rophitinae) from Kenya

Silas Bossert[1] & Sébastien Patiny[2]

Abstract. We describe and illustrate for the first time the previously unknown male of *Systropha* (*Austrosystropha*) *macronasuta* Strand. We provide a species diagnosis and modified couplets of the recent identification key to allow for easy identification of this sex. Based on the first record of *S. macronasuta* from the African mainland, we discuss the distribution of the species.

INTRODUCTION

The genus *Systropha* Illiger consists of a small but conspicuous group of Old-World halictid bees in the subfamily Rophitinae, a monophyletic group (Patiny *et al*., 2008). After *Dufourea* Lepeletier, it is the second most species-rich rophitine genus with a total of 29 species, seven of which have been described in the last two decades (Baker, 1996; de Silva & Packer, 2016; Patiny, 2004; Patiny *et al*., 2013; Patiny & Michez, 2007). The most recent reviews of the genus were conducted by Ebmer (1994) and Baker (1996). Subsequent studies by Patiny & Michez (2006, 2007) and Patiny *et al*. (2013) improved our understanding of the phylogeny and biology of the genus by implementing an illustrated subgeneric classification, cladistic analyses, and synoptic keys including all taxa described at that time.

Systropha has a wide distribution in the Old World, ranging from South Africa to northern Europe, and reaching western China in its eastward range (Ascher & Pickering, 2016; Baker, 1996). They are most abundant in the xeric areas of the Mediterranean Region (Michener, 1979). Despite this great distributional range, *Systropha* are generally rare bees, but they appear to be locally common when their respective host

[1] Department of Entomology, Cornell University, Ithaca, New York 14853, USA (sb2346@cornell.edu).
[2] Université de Mons, Pentagone 3D08, 6, avenue du Champ de Mars, 7000 Mons, Belgium (patiny.s@gmail.com).
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plants are present (Gonzalez *et al*., 2014). The host plants are species of *Convolvulus* L., *Ipomoea* L., and *Merremia* Dennst. ex Endl., all members of the cosmopolitan family Convolvulaceae (Baker, 1996; Ebmer, 1994; Patiny & Michez, 2007).

Notably, the males of *Systropha* have distinct morphological characters. They display highly modified apical antennal flagellomeres, usually forming spiral-like curls (Figs. 1–4), giving the genus its common name, spiral-horned bees. This conspicuous modification of the antennae has already been mentioned in the first description of species in the genus (Scopoli, 1770: as *Eucera curvicornis* Scopoli), and constitutes a unique modification among all bees. In four species, *Systropha androsthenes* Baker, *S. punjabensis* Batra & Michener, *S. glabriventris* Friese, and *S. sirikitae* de Silva & Packer, the number of antennal flagellomeres is surprisingly reduced, with *S. glabriventris* having just nine distinct segments. Other morphological adaptations of *Systropha* males include highly modified sternal structures, which perform specific functions during courtship and territorial competition (Fraberger & Ayasse, 2007). In most species, these sterna bear striking projections such as spines, tubercles, and/or carinae, which are often species specific and commonly used for identification (*e.g*., Amiet *et al*., 1999; Patiny & Michez, 2006; Warncke, 1977). Interestingly, males of *S. planidens* Pérez and *S. curvicornis* (Scopoli) were observed to use their elongated eighth sternum (*c.f*., Fig. 8) as a ramming device during territorial fights (Fraberger & Ayasse, 2007).

Strand (1911) described *S. macronasuta* based on a single female without mention of a type locality. According to the type label, the specimen is from Zanzibar (Ebmer, 1994), where it was assumed to be endemic (Patiny *et al*., 2013). Here we present the first discovery of the species from the African mainland and provide the description of the male.

MATERIAL AND METHODS

Specimens were collected during a field expedition to Kenya in October 2012. The collection locality is near Marigat in Baringo County, in the Kenyan part of the Great Rift Valley (0°27′22″N, 35°52′49″E). Specimens were hand collected on shrubs of *Ipomoea* sp. (Morning Glory), very likely *Ipomoea spathulata* Hallier f. (Figs. 13–14). The specimens were examined and photographed using a Zeiss Semi SV6 microscope and a 105 Color Axiocam.

A male specimen is retained in the collection of the Museum für Naturkunde Berlin (former ZMHB), where the female holotype of *S. macronasuta* is kept. An additional male and a female are in the private collection of S. Patiny, Ham-sur-Heure. Six male and 13 female specimens are deposited in the Cornell University Insect Collection (CUIC; http://cuic.entomology.cornell.edu/).

Additional specimens of *S. macronasuta* that have not been examined in the framework of this study are located in the collection of the USDA Bee Biology and Systematics Laboratory (1♀, Kenya: Great Rift Valley, Marigat, 11.6 km WbyS; Kimalel; Marigat-Kabarnet road, 12 October, 2012, leg. T. Griswold, on *Ipomoea* sp; 1♀, Kenya: Great Rift Valley, Marigat, 15.8 km W; Kabarnet, Patakwanini, 12 October, 2012, leg. W. Tiren, D. Martin, on *Ipomoea* sp.), and in the collection of Laurence Packer at York University, Canada (6♀♀, 5♂♂, Kenya: Great Rift Valley, Nakuru-Sigor Road, 0.045435N, 35.9331E, 09 September, 2011, leg. Packer, Mutiso, Martins; 1♀, Kenya: Great Rift Valley, Kerio Valley, Kabarnet-Iten Rd, 0.486N 35.709E, 12 October, 2012, leg. Packer).

For the description and the modified keys, a number of abbreviations were used: tergum (T), sternum (S), and flagellomere (F).

SYSTEMATICS

Genus *Systropha* Illiger, 1806
Systropha (*Austrosystropha*) *macronasuta* Strand, 1911
(Figs. 1–12)

Material examined: 6♂♂, 13♀♀, Kenya: Great Rift Valley, Marigat, 0°27′22″N, 35°52′49″E, 1300 m, 12 October, 2012, leg. B.N. Danforth, T. Griswold, L. Packer, D. Martins, C. Njoki, M. Nzisa Mutiso, W. Tiren (CUIC).

Diagnosis: ♂: The specimens match the subgeneric morphology of *Austrosystropha* (Patiny & Michez, 2006): F7 and following flagellomeres well-differentiated and forming part of the spiral, femur 1 dorsoventrally and laterally enlarged, femur 2 enlarged but less prominent than femur 1, coxa 3 elongate, T7 laterally toothed.

Systropha macronasuta is the largest species of *Austrosystropha* (12.0–15.5 mm) known to date. The first six terga lack teeth, S1 is unmodified, and S2–S4 bear blade-like projections. S6 has two small apicolateral teeth, and the apex of S8 is enlarged with a well-developed ventral groove (Figs. 8–9). S6 bears a protruding bilobed projection (Fig. 9). The inner hind tibial spurs show two ventral rows of teeth but these are less prominent than in the female. The proboscis is conspicuously elongate and up to 5.6 mm in length.

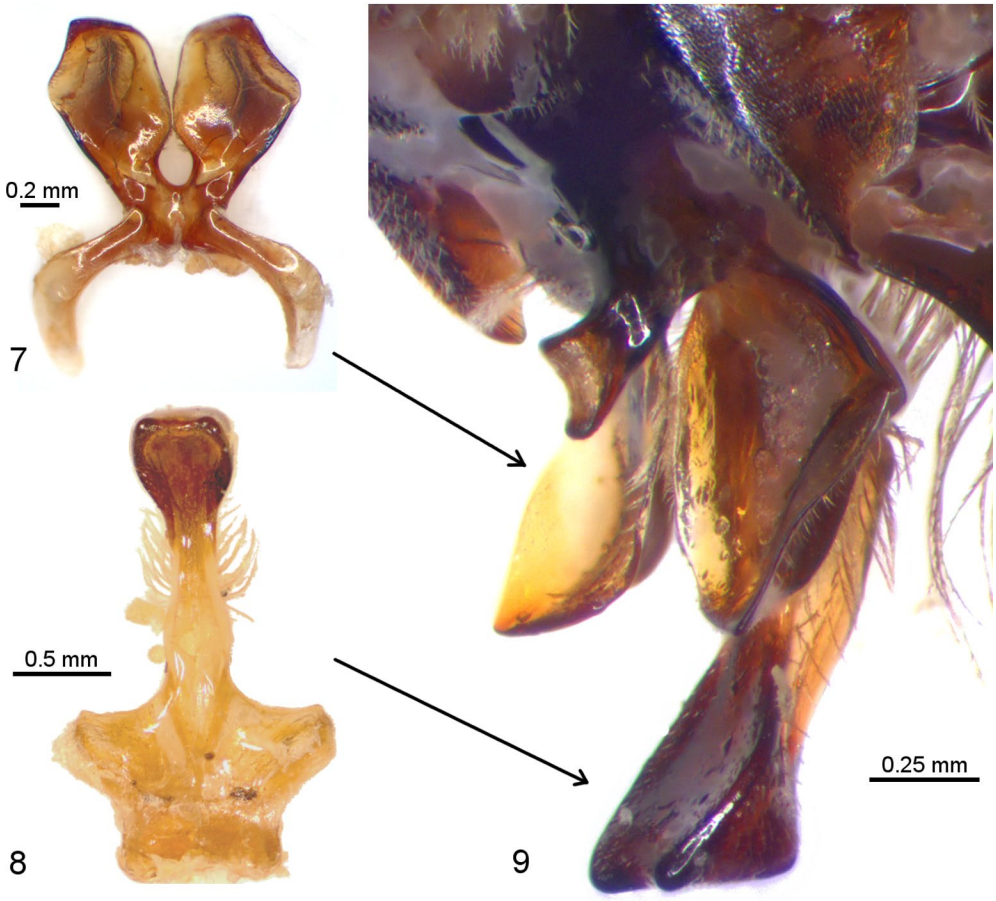
♀: As all females of the subgenus, the female of *S. macronasuta* possess two conspicuous and well-developed rows of ventral teeth on the inner hind tibial spurs of tibia 3. The overall body size is large (11.5–13.0 mm in length). The integument is dark brown, with creamy white setae on the thorax, the first tergum, and the anterior parts of T2. The pilosity of the following terga is increasingly brownish, and the setae on T5 and T6 are entirely brown. The second submarginal cell has a pentagonal shape.

Description: ♂: Head (Fig. 4) slightly shorter than broad (length: 2.25–2.63 mm; width: 2.36–2.83 mm). Integument darkish brown to black with creamy white setae. Setae highly branched, most densely plumose around antennal sockets, sparse and thin around ocelli and denser along posterior part of vertex. Setae which originate from genal area noticeably long and plumose (Fig. 2). Clypeus distinctly protruding, clearly shorter than broad (length: 0.39–0.46 mm; width: 0.94–1.08 mm), entirely shagreened with sparse, shallow but coarse punctation. Clypeal distal margin without projections but setae extending below margin. Mandible dark, bearded, 1.11–1.22 mm long, bidentate with preapical tooth shorter than apical tooth. Proboscis long, comparable with morphology of female mouthparts drawn in Ebmer (1994). Genal area slightly broader than compound eye (Fig. 2), with coarse punctation and shiny interspaces. Malar distance linear. Supraclypeal area shagreened, upper half with punctation. Supra-antennal area without punctation but with coarse structuring and dull surface. Antennal foramen located in lower third of face, in close proximity to epistomal sulcus. Scape enlarged, cone-shaped in frontal view. F1 conspicuously long and slender (length: 0.96–1.01 mm; width: 0.20–0.21), longer than two following segments combined. Apical flagellomeres (F7–F11) strongly recurved, forming apical hook. F11 short. Dorsal surfaces of F1–F6 dark brown, F7–F11 light to reddish brown. Ventral surfaces of F3–F11 lighter colored. Diameter of lateral ocellus 0.18–0.19 mm, median ocellus 0.25–0.26 mm. Ocular-ocellar line 0.44–0.45 mm in length.

Mesosoma: Integument predominantly black, darkish brown along ventral parts of mesepisternum. Pilosity creamy white, most dense on scutellum and on metepisternum behind base of hind wing, less dense on mesoscutum and metanotum. Sparse

Figures 1–6. The male of *Systropha* (*Austrosystropha*) *macronasuta* Strand. **1.** Habitus. **2.** Head, lateral view. **3.** Habitus, dorsal view. **4.** Head, frontal view. **5.** Habitus, lateral view. **6.** Metasomal terga, dorsal view.

but erect setae on mesepisternum. Propodeal triangle completely hairless. Intertegular distance 2.57–2.87 mm. Mesoscutum with punctation, generally dense but with greater distances between punctures around median and parapsidal lines. Interspaces up to three times puncture diameter. Integument between punctation shiny, slightly shagreened. Distal part of mesepisternum with shallow and scattered punctation, interspaces usually more than three times puncture diameter, mostly shiny. Basal



Figures 7–9. Details of male metasomal sterna 6–8 of *Systropha* (*Austrosystropha*) *macronasuta* Strand. **7.** Sternum 7. **8.** Sternum 8. **9.** Metasomal sterna in natural position, lateral view.

area of propodeum without punctation but slightly shagreened and less shiny than posterior surface. Posterior surface of propodeum almost completely impunctate and distinctly shiny. Tegula brown, slightly darker anteriorly. Wings not strongly pigmented, yellowish-brown with brown venation. Three submarginal cells, stigma yellow-brown. First recurrent vein intersecting at second submarginal cell. Basal vein strongly arcuate.

Metasoma: Surfaces of T1–T7 with fine reticulate sculpture on tergal discs and marginal zones, most prominent on T1–T5. Surfaces of T1–T4 evenly and acutely punctured, interspaces sometimes greater than 3 times diameter. Punctation on T5–T7 slightly more dense but less acute. Marginal zones of T1–T5 notably less densely punctured, with sparse and very shallow punctures. Only T7 with distinct lateral spines and a blunt median process, comparable with *S. krigei* Brauns (Brauns, 1926: his fig. 2a). T1 with erect white setae, all other terga except T7 with sparse, more or less appressed, setae and without tergal bands. Coloration of setae mostly whitish, becoming darker on T6 and T7. Setae on T7 mostly yellowish-brown, erect. Sternal structures without bands of setae, but with a patch of sparse, erect and branched setae on S1. Following sterna more or less hairless, except for small sparse lateral patches.

Figures 10–12. Genital capsule of *Systropha* (*Austrosystropha*) *macronasuta* Strand. **10.** Dorsal view. **11.** Oblique dorsal view. **12.** Ventral view.

S1 unmodified. S2–S4 with distinct, paired blade-like ventral projecting lobes, those on S3 most prominent. S5 unmodified. S6 with two lateral spines and a conspicuous median posterior process (Fig. 9). S7 and S8 highly modified (Figs. 7–9); S8 elongate, with enlarged, bilobed apex visible in unprepared specimens. Genital capsule morphology illustrated in figures 10–12.

Modified Couplets of the Species Identification Key of *Systropha* by Patiny *et al*. (2013)

2. T6–T7 lacking lateral teeth; S2–S3 with compressed tubercles, forming an apical lamella; S6 with two teeth (a medio-proximal and a medio-terminal ventral tooth) [Morocco] ..... *S*. (*Systropha*) *pici* Pérez
—. T6 and/or T7 with strong lateral teeth; S2–S3 with differently shaped tubercles or blade-like projections; S6 lacking teeth as described above but may have a ventral projection and small apicolateral teeth 3

6. T1–T5 lacking teeth 6a
—. T1–T5 with small lateral spines or blades 7
6a. Small species (ca. 8–9 mm); vertex and/or mesoscutum at least partly covered with reddish setae; S6 distally without protruding projection [South Africa] ..... *S*. (*Austrosystropha*) *krigei* Brauns
—. Large species (ca. 12–15 mm); all setae of vertex and mesosoma whitish, without red; S6 distally with protruding projection (Fig. 9) [Eastern Africa (Zanzibar, Kenya)] ..... *S*. (*Austrosystropha*) *macronasuta* Strand

DISCUSSION

The subgenus *Austrosystropha* is characterized by a number of shared characters and formed a monophyletic group in cladistic analyses of morphological characters (Patiny & Michez, 2006, 2007). Based on the description and the diagnosis herein, the male of *S. macronasuta* is clearly a member of the subgenus. *Austrosystropha* is endemic to Africa with all species having a sub-Saharan distribution, yet there seem to be at

Figures 13–14. Photographs of the host plant, *Ipomoea* sp. (likely *Ipomoea spathulata* Hallier f.) in Kenya (photographs by B. Danforth). **13.** Inflorescence detail. **14.** Habitus.

least two different groups. An East African group differs from a Sahelo-Sudanian group mainly by the presence of a greater pilosity, an enlarged apex of the male S8, and unmodified mid-femora (Patiny *et al*., 2013). *Systropha macronasuta* belongs to the East African group based on the pilosity and the shape of the S8, which is in line

with the collection locality of the examined specimens. However, the mid-femora are slightly inflated, possessing an intermediate character state between the two groups. Overall, *S. macronasuta* can be safely associated with the East African group, thereby rendering the shape of the mid-femora as a less reliable character to delineate these groups. Patiny *et al.* (2013) further indicated a closer relationship of *S. aethiopica* Friese and *S. macronasuta* based on the high degree of morphological resemblance in the females. By comparing the newly described male, a number of distinct structural divergences can be observed. These differences are best characterized by the shape of S6 and S8, the absence/presence of lateral teeth on T7, and the shape of the genital capsule. However, the overall similarity of the males of *S. aethiopica* and *S. macronasuta* underpins the close relationship of these taxa.

Systropha macronasuta was hypothesized to be an island endemic of Zanzibar (Patiny *et al.*, 2013), as there are no records from the African mainland. Based on the new findings from Kenya, it is clear that *S. macronasuta* also occurs on the African mainland and likely has a wider distribution in Eastern Africa. Nonetheless, the currently available records do not clarify if the species recently colonized the mainland or if it is currently spreading. It appears more likely that the species has been overlooked in the past because of a lack of historical records and museum specimens from the mainland.

Systropha species are well-known for their narrow pollen preferences for *Convolvulus* and other genera of Convolvulaceae; *i.e.*, *Merremia* and *Ipomoea* (Baker, 1996; Ebmer, 1994; Gonzalez *et al.*, 2014; Patiny & Michez, 2007). These host plant preferences seem to be loosely related to the subgeneric classification; *Systropha s.str.* is associated with *Convolvulus*, while *Austrosystropha* is associated with *Ipomoea* (Patiny & Michez, 2006, 2007). This can be explained by the biogeographic distribution of the respective host plants, as the oligolectic bees presumably exploit the locally abundant species of morning glory. The findings presented in this study are in line with the observations that *Austrosystropha* tends to collect pollen from *Ipomoea*, since both sexes were collected on a species of the genus.

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