



Systematics of the bee subgenus *Systropha* (*Austrosystropha*) (Hymenoptera: Halictidae): Description of a new species and proposal of a new sex association

SEBASTIEN PATINY¹, DAVID BALDOCK² & DENIS MICHEZ¹

¹Laboratoire de Zoologie, UMONS, Place du Parc 20, 7000 Mons, Belgium. E-mail: patiny.s@gmail.com, denis.michez@umons.ac.be

²Nightingales, Haslemere Road, Milford, Surrey GU8 5BN, England. E-mail: david@tiphia.eu

Abstract

Systropha is a small genus of bees belonging to Rophitinae (sister-group to all remaining Halictidae). Three subgenera are recognized in *Systropha*: *Austrosystropha* and *Systrophidia* that are sub-Saharan endemics, and *Systropha s.str.*, which occurs in Africa and Eurasia. As a result of the rarity of *Systropha* specimens in collections and the difficulty in associating males and females due to sexual dimorphism, there remain numerous undescribed or unassociated sexes in *S. (Austrosystropha)*. The present paper gives the descriptions of a new species *Systropha oti* **sp. n.** (from Kenya) and the previously undescribed female of *S. aethiopica*, both in the subgenus *Austrosystropha*. We further discuss the diagnostic features of the subgenus with regard to these new taxa and update the previous key to species.

Key words: Apoidea, Rophitinae, taxonomy, Africa, Convolvulaceae

Introduction

The bee family Halictidae contains 4326 valid nominal species (Ascher 2009) and represents more than 20% of the global diversity among bees (Michener 2007). This family is usually divided into four subfamilies: Halictinae, Nomiodinae, Nomiinae, and Rophitinae. Halictinae and Nomiinae are the most speciose subfamilies with 80% and 12% of the species; Nomiodinae, by contrast, contains only 2% of the species (Danforth *et al.* 2008). There are 257 recorded species of Rophitinae (6% of the Halictidae) classified into 13 genera and distributed Worldwide. The Rophitinae constitute the basal sister-clade to all remaining halictid lineages (Danforth *et al.* 2006, 2008; Patiny *et al.* 2008).

Rophitinae are distributed worldwide, except in Australia. There is a nearly complete separation between the New and Old World faunas of Rophitinae. Only the genus *Dufourea* occurs in both faunas. The genus *Systropha*, which is the focus of the present paper, comprises 27 species that are endemic to the Old World (Patiny 2004; Patiny & Michez 2006, 2007). This genus is very distinctive among Rophitinae, being characterized by some conspicuous traits: (i) the unique folding of the male antennae; (ii) the shape of the male sterna; (iii) the female's strict oligolecty on morning glory (Convolvulaceae: *Convolvulus* for temperate bees, *Ipomoea* and *Merremia* for tropical bees). Based on phylogenetic analyses, Patiny & Michez (2006, 2007) recognized the monophyly of three subgenera within the genus *Systropha*: *Systropha s.str.* (comprising 17 Eurasian species), *Systrophidia* (comprising only *Systropha glabriventris* Friese, 1922), and *S. (Austrosystropha)*. The latter subgenus currently contains nine described species distributed in the driest parts of sub-Saharan Africa, including the Indian Ocean islands (Patiny & Michez 2007). According to the diagnosis presented by Patiny & Michez (2006), the following features characterize *S. (Austrosystropha)*: (i) male forefemur usually enlarged dorso-ventrally and laterally; (ii) male T7 always laterally toothed; (iii) male T1–T5 with angular or spiny graduli in *S. aethiopica* and *S. arnoldi*; (iv) inner hind tibial spur of female curved and coarsely toothed in two ventral rows; (v) pilosity of female metasomal sterna densely developed, less downy, coarse in several species.

Some species, particularly in the subgenus *Austrosystropha*, are still poorly described, being only known from the holotype, and thus only one of the sexes has been described. Both sexes have been described in *S. krigel* and *S. nora*. The remaining seven species: *S. aethiopica*, *S. arnoldi*, *S. bispinosa*, *S. macronasuta*, *S. martiali*, *S. rhodesiensis*, and *S. ugandensis* are only known from males or females. Recent fieldwork in Kenya has led to the discovery of the female of *S. aethiopica* and one new species described here as *Systropha oti* **sp. n.** In addition to providing descriptions of *S. oti* **sp. n.** and the female *S. aethiopica*, the present paper also reassess the diagnosis of the subgenus. Finally, this paper lists the species in *S. (Austrosystropha)* and a key to the species is given.

Material and methods

Material. The type material of most *Systropha* species was reviewed by Patiny & Michez (2006). Type material is in the following museums: NHML (Natural History Museum, London, UK), SEMK (Snow Entomological Museum, Lawrence, Kansas, USA), Naturalis (Leiden, Netherlands) and ZMHB (Museum für Naturkunde, Berlin, Germany). Whereas the description of *S. oti* **sp. n.** is based on the holotype and a single paratype, ten individuals of *S. aethiopica*, both male and female, were collected by net on a pale pink-flowered species of *Ipomoea* (Convolvulaceae).

Abbreviations used for morphological parts

Morphological terminology is based on Michener (2007) and that for microsculpturing on Harris (1979). The following abbreviations are used in the text: A = antennal articles and flagellomeres (A1 being the scape, A2 the pedicel, and A3–A13 the flagellomeres); Bt = basitarsus (with a number designating the leg concerned proceeding from anterior to posterior); Cx = coxa (numbering as in Bt); F = femur (numbering as in Bt); PLb = labial palpus; PMx = maxillary palpus; S = metasomal sternum (numbering designating the segment proceeding from anterior to posterior); T = metasomal tergum (numbering as in S); Tb = tibia (numbering as in Bt).

The integument ultrastructure of *S. aethiopica* was studied using SEM (JEOL JSM-6100) associated to the software Semafore (JEOL, Sollentuna, Sweden) (fig 2). The pictures of habitus (*S. aethiopica*, *S. oti* **sp. n.**) were made using a Nikon D1 camera associated with binocular Olympus (figs 1–3).

Catalogue of the species included in the subgenus *Systropha* (*Austrosystropha*)

Generic identity: *Systropha* Illiger

Type species: *S. curvicornis* (Scopoli)

Complete synonymy is given in Patiny & Michez (2006).

Included species

01. *Systropha* (*Austrosystropha*) *aethiopica* Friese 1911

S. (Austrosystropha) aethiopica Friese 1911: 654, «Brit. Öst.Africa, Mulango»; holotype ♂ (examined); ZMHB

Material studied: 2 ♂ 1 ♀, Kenya, Tsavo East National Park, Galana River Lodge, D.W.Baldock, 04.ii.2010, on *Ipomea* sp. NHML; 1 ♂, Kenya, Turtle Bay, Watamu, D.W.Baldock, 29.i.2010, on *Ipomea* sp.; NHML.

Female (figs 1a–b, 2).

Diagnosis: Medium-sized (body length= 8 mm). Head, notum, pleura, S1–2 and T1–2 covered with short creamy-white hairs. Hind tibial spurs with coarse teeth along two longitudinal rows. Last terga, sterna, hind legs and ventral side of body with long, dark brownish hairs. Fore and midlegs with light hairs. T3 with dark and light hairs intermixed.

Description. Head: Clypeus coarsely punctate, except on apex. Labrum about as long as clypeus, impunctate but dull, entirely microsculptured like other parts of face cuticle. Mandibles black with blonde beards. Mouthparts remarkably long. Three basal segments of PMx flattened, about as long as three apical ones. PLb as long as glossa,

long and flattened; second segment of PLb longer than others, about as long as first and third together. Glossa slightly shorter than half body length. Cuticle of gena shiny, regularly punctate and covered with appressed creamy-white hairs. Frons and vertex dull, entirely microsculptured and with a few large punctures. Frons pilosity short and sparse, creamy white. Antenna entirely dark; scape densely punctate. First flagellomere twice as long as second. **Mesosoma:** Pronotum shiny, densely and finely punctate. Mesoscutum and metanotum dull, microsculptures partly hiding punctation. Propodeal area large and strongly depressed, densely and neatly microsculptured. Mesotibial spur about as long as Bt2. Tb3 inner spur coarsely toothed along both edges (fig 2a). Fore and mid legs with pale hairs. Hind legs with an abundant dark brownish pilosity. Wing venation black. Pleura and propodeum sides shinier than nota, more weakly microsculptured, regularly punctate. Mesosoma pilosity sparse, creamy-white, remarkably short on nota. **Metasoma:** Terga dull; punctures large and shallow. Apical margin of T1 abrupt, fringed with light hairs. Distal half of terga dull, like proximal part. T1–2 with an abundant creamy-white pilosity. T3–5 and anal fringe with dark brownish hairs. T3 displaying a mixture of clear and darker hairs. Sterna dull, lightly shiny, with an apical fringe of dark hairs (shorter in middle of segment), insertion of hairs causing a coarse relief of distal part of sterna.

Comments. The female of *S. aethiopica* has the Tb3 spur that is characteristic of *S. (Austrosystropha)*, with two longitudinal rows of coarse teeth (fig 2a). This character and others (see introduction and identification key) suggests the female of *S. aethiopica* to be morphologically close to another species of the subgenus *Austrosystropha*: *S. macronasuta*, which is an island endemic (Zanzibar) that shows some gross resemblance to *S. aethiopica*. Both species mainly differ in some superficial divergences in the pilosity and the considerably larger size of *S. macronasuta* (figs 2c–d). The island endemism of this latter species suggests that the observed allometry, but gross resemblance with *S. aethiopica*, could be a consequence of insularity (as observed in many organisms see for instance Polet, 2011; Lee & Lin, 2012).

The sex association proposed here is based on the following evidence: (i) their co-occurrence at the collecting site, (ii) foraging on the same host-plants; (iii) proximity in various characters such as patterns of the pilosity, (iv) coloration, (v) size and (vi) mouthpart morphology.

02. *Systropha (Austrosystropha) arnoldi* Friese 1922

S. (A.) arnoldi Friese 1922: 2, «Rhodesia, Bulawayo» (Zimbabwe); holotype ♂; ZMHB examined

03. *Systropha (Austrosystropha) bispinosa* Friese 1914

S. (A.) bispinosa Friese 1914 in Schulthess: 296, «Kamerun, Dchang» (Cameroon); holotype ♂ (labelled TYPE); ZMHB examined

04. *Systropha (Austrosystropha) krigei* Brauns 1926

S. (A.) krigei Brauns 1926: 192, «Südafrika, Transvaal, Pretoria» (South Africa); description of both sexes, syntypes ?lost

05. *Systropha (Austrosystropha) macronasuta* Strand 1911

S. (A.) macronasuta Strand 1911: 110, «Zanzibar» (Tanzania); holotype ♀; ZMHB examined

06. *Systropha (Austrosystropha) martiali* Patiny and Michez, 2007

S. (A.) martiali Patiny and Michez, 2007: 63–64, Sudan Rahad vill. 38 [interpreted coordinates: 14.4°N 33.53°E] pherom. trap 7.9.1983 J.H.Lourens; holotype ♂, ZMA examined

07. *Systropha (Austrosystropha) norae* Patiny 2004

S. (A.) norae Patiny 2004: 907, «Nigeria, Ile-Ife»; holotype ♂; description of the female in the same article; SEMK examined

08. *Systropha (Austrosystropha) oti* sp. n.

Material studied: Holotype and paratype: 2 ♂, Kenya, E. of Mwingi, 14.v.2007, leg. M.Halada, both type are deposited in Oberösterreichische Landesmuseen (Linz, Austria).

Male (figs 1e–f, 3).

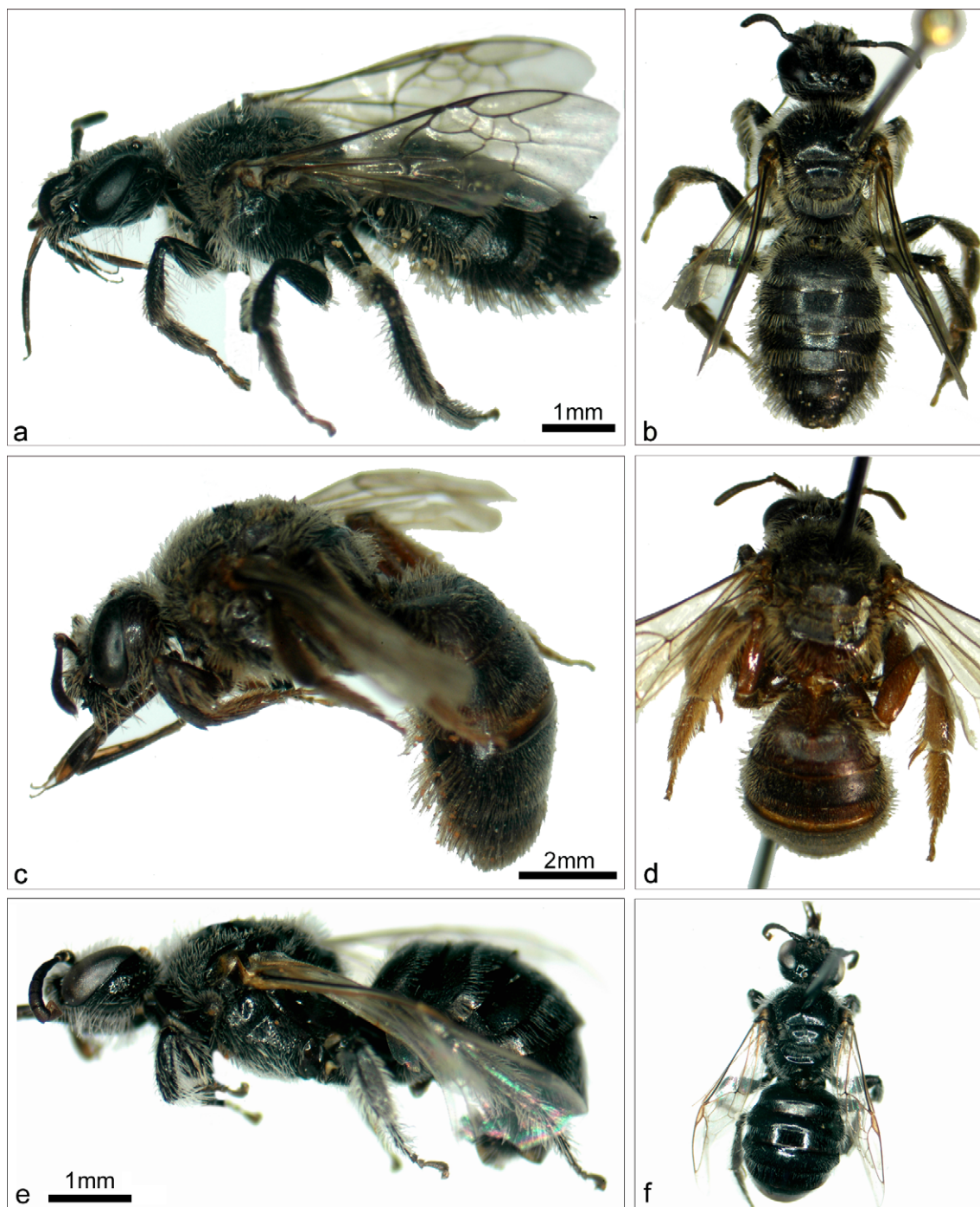


FIGURE 1. *Systropha* (*Austrosystropha*) spp. a, lateral habitus of *Systropha aethiopica* female. b, dorsal habitus of *S. aethiopica* female. c, lateral habitus of *S. macronasuta* female. d, dorsal habitus of *S. macronasuta* female. e, lateral habitus of *S. oti* **sp. n.** male. f, dorsal habitus of *S. oti* **sp. n.** male.

Diagnosis: Small species (Body length= *ca.* 6 mm); smaller than other species in subgenus. Body with sparse silver-white hairs. Five terminal flagellomeres shortened, flattened and in a spiral. S1 with a median blunt tooth. S2 with low convexities (close to those observed in *S. ugandensis*) ending in a terminal hook. T3–4 with lateral arms of graduli blade-shaped.

Description. Head: Clypeus as short as labrum; densely punctate / micro-punctate, lightly shiny. Mouth parts longer than face. PLb longer than galea and PMx. Second segment of PLb longer than basal and two apical segments. Galea shagreened. Face cuticle shiny, sparsely punctured; covered with sparse, semi-erect, silver-white hairs. Scape, pedicel and flagellum (first eight flagellomeres), densely micro-sculptured, dull. Five terminal flagellomeres of antenna, yellowish, flattened and strongly reduced; all five included in antennal terminal spiral.

Mesosoma: Cuticle of dorsal part of mesosoma lightly micro-punctate, more densely sculptured in proximal part of metapostnotum and in distal margin of the scutellum. Metapostnotum densely sculptured in its proximal part. Thorax and legs covered in short silver-white hairs, shorter on ventral side. Wings clear. Veins brownish yellow.

Metasoma: T1–2 with sparse white (very short) hairs. T3–4 with blade-shaped graduli. Distal part of T1–5 as long or longer than proximal half. T6 with lateral teeth. S1 with a thick median blunt tooth (fig 3c). S2 with low convexities ending in a short hook (fig 3c). S3 with very low convexities. S4 and following without conspicuous relief. S6 with a small subtrapezoidal appendage. S7 X-shaped, distal parts rounded, yellowish, about as long as apodemes. S8 narrow and straight. Genitalia with sharp penis valves (figs 3a–b). Gonostyli long and thin, about as long as 1/3 of gonocoxites (figs 3a–b). Gonocoxites with an inner row of hairs (figs 3a–b).

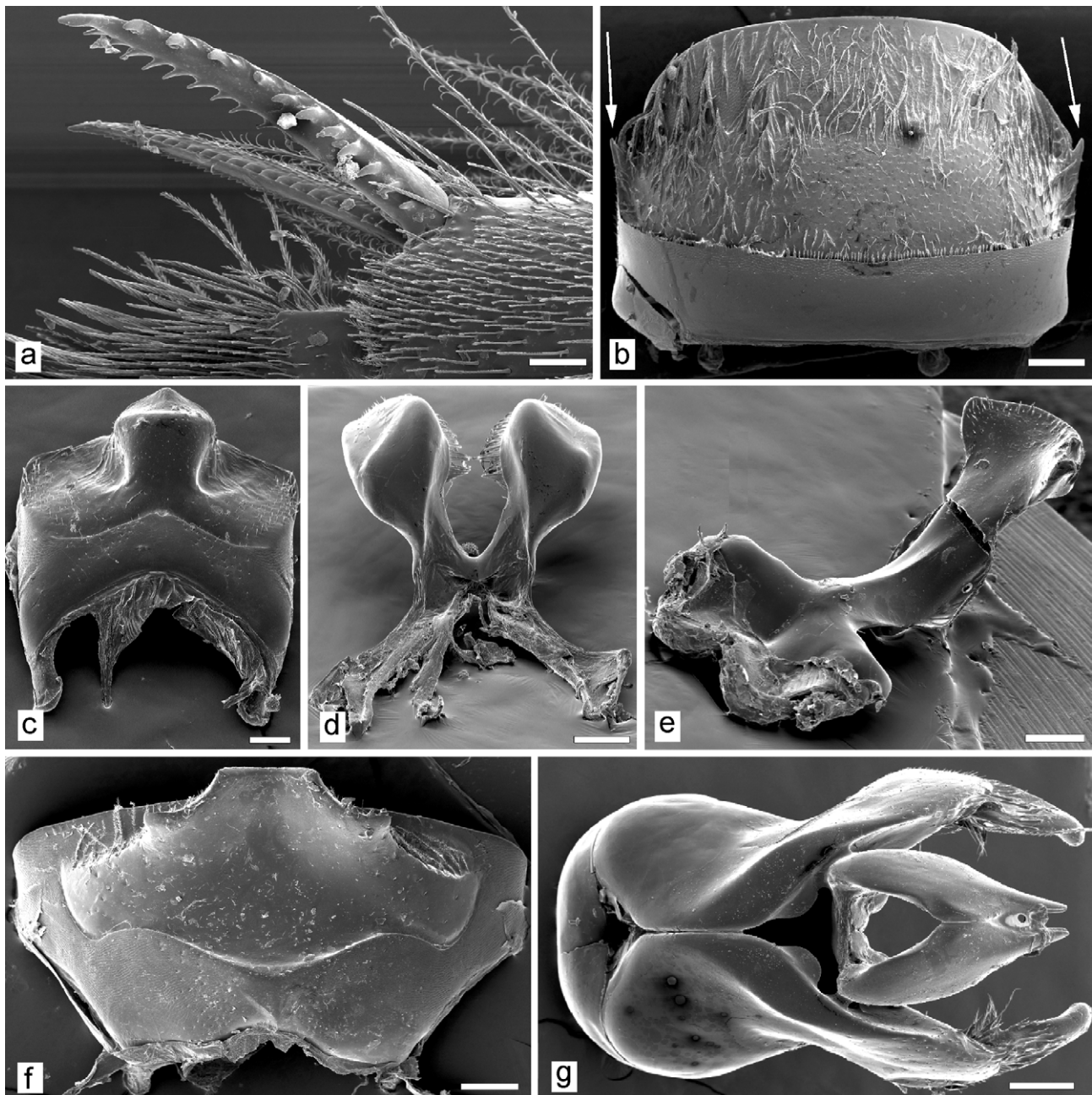


FIGURE 2. *Systropha aethiopica*. a, hind tibia spur of female (scale= 100µm). b, terga of male with lateral spines (scale= 300µm). c, sternum 6 of male (scale= 200µm). d, sternum 7 of male (scale= 200µm). e, sternum 8 of male (scale= 200µm). f, sternum 2 of male (scale= 300µm). g, genitalia of male (200µm).

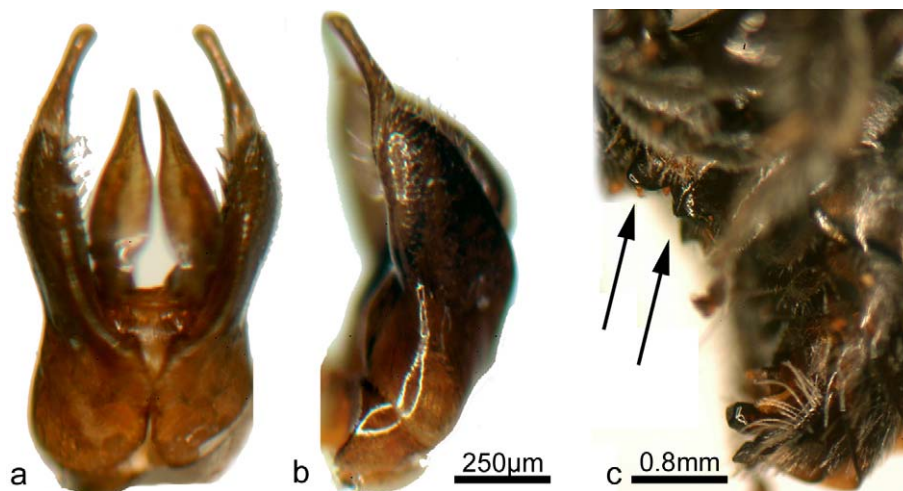


FIGURE 3. *Systropha oti* sp. n. male. a, genitalia in dorsal view. b, genitalia in lateral view. c, metasoma in lateral view, with arrows indicating sterna 1 and 2.

Female: Unknown.

Comments. The reduced size of *S. oti* sp. n. is noteworthy when compared to the average size of congeneric species. Whereas almost all taxa in the subgenus are medium sized species (above 8 mm in length), *S. oti* is considerably smaller (ca. 6 mm). The species also displays a very short pilosity restricted to only few body parts. Both the small size and the pilosity suggest a general adaptation to aridity. In males, S1 has a blunt process, which is autapomorphic in *S. (Austrosystropha)* and only shared with *S. hirsuta* at the genus level.

09. *Systropha (Austrosystropha) rhodesiensis* Friese 1922

S. (A.) rhodesiensis Friese 1922: 3, «Rhodesia, Bulawayo» (Zimbabwe); syntypes ♀ (labelled TYPE); ZMHB examined

10. *Systropha (Austrosystropha) ugandensis* Cockerell 1931

S. (A.) ugandensis Cockerell 1931: 400, «Uganda, Kampala»; holotype ♂; NHML examined

Key to the African species of *Systropha*

The following key is adapted from the one published in Patiny & Michez (2006). The present excerpt is designed for determination of only the African species of *Systropha*.

Females

- 1 Hind tibia inner spur untoothed. 2
- Tb3 inner spur with 2 ventral rows of strong teeth (subgenus *Austrosystropha*) 4
- 2 Large species (ca. 10 mm). Whole body integument brownish. Pilosity very short, blonde, sparse almost restricted to head and thoracic parts. Namibia *S. (Systrophidia) glabriventris* Friese
- Variably sized species. Whole body integument black. Pilosity grey to whitish-grey. Morocco . . . 3 (subgenus *Systropha* s.str.)
- 3 Large species (ca. 10 mm). Flagellum black. Pilosity of metasoma densely branched; hairs bicolor, dark brownish basally, paler apically (whitish-blonde on T1–3, darker from T4 apicad). *S. maroccana* Warncke
- Medium-sized species (<10 mm; often smaller). Ventral side of flagellum reddish brown. Pilosity of metasoma whitish-grey, long and abundant, covering almost all body parts. *S. pici* Pérez
- 4 Small species (ca. 8 mm). White pilosity on face, mesoscutum and first terga; reddish-orange on scutellum and metasoma apex (anal fringe and previous sclerites). Wings hyaline. South-Africa *S. krigei* Brauns
- Larger species. Pilosity different. Wing darker in some species. 5
- 5 Mesoscutum and scutellum covered with rather sparse and short greyish pilosity. Metasoma with thick black hairs on terga and sterna. Leg pilosity black. Medium-sized species (ca. 9 mm). Nigeria *S. norae* Patiny
- Pilosity variably dark, usually brownish on mesosoma, legs and metasoma. Metasoma without thicker hairs. Size ca. 8 mm, except one larger species (ca. 12 mm), the latter restricted to Zanzibar. Eastern Africa 6
- 6 Pilosity of mesoscutum golden blonde, erect. Terga with dark brownish hairs; paler on sterna. Second submarginal cell subtrapezoidal (narrower along its anterior side). Zimbabwe *S. rhodesiensis* Friese

- Pilosity of mesoscutum pale blonde, short and appressed. T1–2 with pale blonde hairs; darker on posterior terga and sterna. Second submarginal cell larger along its anterior side (quadrangular). Medium-sized to large species. Eastern Africa. Kenya, Tanzania and Zanzibar7
- 7 Small body size (ca. 8 mm). Mesoscutum pilosity pale blonde, rather sparse. T1–2 with short pale-blond hairs. Second submarginal cell more quadrangular. Continental Eastern Africa. *S. aethiopica* Friese
- Very large body size (ca. 12 mm). Mesoscutum pilosity greyish. Terga and sterna with dark brown hairs. Second submarginal cell pentagonal. Zanzibar *S. macronasuta* Strand

Males

- 1 Last flagellomeres extremely short (nearly fused) forming a hook at the tip of the flagellum. Namibia. *S. (Systrophidia) glabriventris* Friese.
- Last flagellomeres well separated (longer)2
- 2 T6–7 untoothed. S2–3 with compressed tubercles, forming an apical lamella. S6 double toothed (a medio-proximal and a medio-terminal ventral tooth). Morocco. *S. (Systropha) pici* Pérez
- T6 and/or T7 with strong lateral teeth. S2–3 with differently shaped tubercles. S6 untoothed.3
- 3 S1 with a median blunt tooth. S2 with low convexities ending in a short hook. *S. (Austrosystropha) oti* sp.n.
- S1 without tooth. S2 usually different with stronger appendages4
- 4 S2 with two small convexities. S3 with rounded elevations. S6 untoothed. Morocco *S. (Systropha) maroccana* Warncke
- S2–3 with larger processes; in numerous species one single and large foliate process. S6 with lateral teeth. Sub-Saharan Africa (subgenus *Austrosystropha* (*partim*))5.
- 5 A9–13 enlarged medially. S8 apex almond-shaped, enlarged6
- A9–13 not enlarged medially. S8 apex narrow with a longitudinal groove8
- 6 T1–5 untoothed. South-Africa. *S. krigei* Brauns
- T1–5 with small lateral spines or blades7
- 7 T2–4 with lateral small acute spines (fig 2b). Shape of sterna as in figs 2c–d) Kenya *S. aethiopica* Friese
- T2–4 with flattened blade-shaped spines. Shape of sterna different. Zimbabwe *S. arnoldi* Friese
- 8 Mesopleura with tubercles. Saharan Africa9
- Mesopleura spiny. Eastern Africa10
- 9 Mesopleura with well-individualized ventral tubercles. S2–3 with blade-like convexities. Large body size (ca. 10 mm). Nigeria *S. norae* Patiny
- Mesopleura ventrally spiny. S2–3 with more rounded convexities. Smaller body size (<10 mm). Eastern Africa. *S. martiali* Patiny
- 10 Medium body sized (ca. 9.5 mm). S8 apex subrectangular. Pilosity greyish blonde. S2–3 with low rounded ridge medially interrupted. Uganda. *S. ugandensis* Cockerell
- Larger body size (ca. 12 mm). S8 apex nearly as long as wide. Pilosity blonde. S2–3 with more angular convexities. Cameroon *S. bispinosa* Friese

Discussion

Species in the genus *Systropha* are characterized by a very strong sexual dimorphism. Males and females usually only share few characters (Patiny & Michez 2006). As a consequence, evidence of mating behavior (courtship, mating, etc.), foraging and other ecological data are the best clues for hypothesizing sex associations. In addition, insights such as day-phenology or gross resemblance in the pilosity pattern (development and color) can constitute complementary characters supporting a proposal of associating sexes. In the case of *S. aethiopica*, specimens were caught together at the same host-plants, seeming to constitute a kind of a *rendez-vous* flower (Alcock *et al.* 1978). Together with the above detailed morphological similarity of males and females, this supports the proposed sex association within *S. aethiopica*.

At a higher taxonomic level, two groups of species can be defined in *Systropha* (*Austrosystropha*) (Patiny & Michez 2006). The first includes the Sahelo-Sudanian and Sudanian species: *S. bispinosa*, *S. martiali*, *S. norae* and *S. ugandensis*. The second includes the species occurring in the eastern part of sub-Saharan Africa: *S. aethiopica*, *S. arnoldi*, *S. macronasuta*, *S. rhodesiensis* and *S. oti* sp. n. The Sahelo-Sudanian species show a nearly impubescent habitus, with inflation of the fore and mid femora and narrow and straight apex of S8 (Patiny & Michez 2006, 2007). In contrast, the species occurring in eastern Africa display a ubiquitous (sometimes dense) pilosity on the whole body, denser on the thorax, inflation is limited to F1. In the males and S8 always presents an elliptically enlarged apex. This dichotomy is pictured and supported by the phylogenetic reconstruction discussed by Patiny & Michez (2006). The Sahelo-Sudanian species form a distinct subclade within *S. (Austrosystropha)*, while, the East African species branch basally. The new species *S. oti* sp. n. shows all the characteristic features of the East African *S. (Austrosystropha)* and belongs obviously to this group of sub-Saharan species.

Another interest in the above description of the *S. aethiopica* female follows from the given opportunity to investigate further floral choices of *Systropha*. The cladogram and character mapping presented by Patiny & Michez (2007) showed undetermined floral choices for several species in the sub-Saharan *S. (Austrosystropha)*. The above data show that, like the other species of that subgenus, *S. aethiopica* forages on *Ipomoea*, which strengthens the suggested hypothesis of a subgenus specialization on Convolvulaceae.

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