



New insights on the distribution and floral choices of *Systropha* Illiger, 1806 in Africa (Hymenoptera, Apoidea), with description of a new species from Sudan

SÉBASTIEN PATINY¹ & DENIS MICHEZ²

¹Faculté universitaire des Sciences agronomiques de Gembloux, Entomologie fonctionnelle et évolutive, Passage des Déportés, 2, B-5030 Gembloux, Belgium. E-mail: patiny.s@fsagx.ac.be

²Université de Mons Hainaut, Laboratoire de Zoologie, Pentagone, Av. du Champs de Mars, 6, B-7000 Mons, Belgium
E-mail: denis.michez@umh.ac.be

Abstract

In the present paper, we describe a new species, *Systropha martiali* **sp.nov.** from central Sudan and we present additional records for two other species: *Systropha norae* Patiny and *Systropha ugandensis* Cockerell. The phylogenetic topology previously inferred for the genus is revised including the new species. A phylogenetic tree is presented with the known floral choices and distribution mapped upon it. This highlights a geographical component to the pattern of floral choice in *Systropha*.

Key words: Rophitinae, *Systropha*, Sahelo-Sudanian, biogeography, endemism

Introduction

The Rophitinae (Halictidae) include 13 genera and roughly 200+ species distributed worldwide except in Australia (Michener 2000). Five genera are found in the Old-World: *Dufourea* Lepeletier, *Morawitzia* Friese, *Morawitzella* Popov, *Rophites* Spinola and *Systropha* Illiger. Reviewing the latter, Patiny and Michez (2006) recorded 26 species subdivided into three subgenera: *Systropha* s.str., *Austrosystropha* Patiny and Michez and *Systrophidia* Cockerell. Each of these occurs in only one part of the African continent. *Systropha* s.str. is Palaearctic and restricted, in Africa, to the north Saharan belt (including Mediterranean and north Saharan steppe ecosystems). *Systrophidia* is endemic to southern Africa: Namibia, South-Africa and Zimbabwe. *Austrosystropha* is limited to sub-Saharan Africa. Within this latter subgenus, only three species (among the eight described), *S. bispinosa*, *S. norae* and *S. ugandensis* are recorded in the area between the Equator and the Sahara.

In the present paper, we describe one new species of *Austrosystropha*, *S. martiali* **sp. nov.**, and we report additional data for *S. norae* and *S. ugandensis*. In addition, we present an updated phylogenetic topology for *Systropha* (with a main focus on *Austrosystropha*). The mapping of floral choices and global distribution onto the tree, supports a discussion of the geographical patterning of species floral choices. The geographical patterns are compared to those of *Meliturgula* Friese (Andrenidae) and *Uromonia* Michener (Meganomiidae).

Material and methods

Illustration and mapping of biogeographical data

The microphotographs of both *S. martiali* sp.nov. and *S. norae* were made using a Nikon D70 mounted onto an Olympus microscope (Fig. 1).

The distribution maps were produced based on the records available in BDFGM (*Banque de données fauniques Gembloux-Mons*, Belgium) (Figs. 2–3). Distribution files were produced using DFF 2.0 (Barbier *et al.* 2005) and mapped with CFF 2.0 (Barbier & Rasmont 2000). The maps are based on Gall projection. The WGS84 datum was used as a default reference.



FIGURE 1. Males. a, face of *S. martiali*, b, face of *S. norae*, c, dorsal habitus of *S. martiali*; d, dorsal habitus of *S. norae*; e, S2 tubercle in *S. martiali*, arrow point on of the typical pike; f, S2 tubercles in *S. norae*, arrow points on of the typical plate.

Abbreviations used for morphological parts

Morphological terminology is based upon Michener (2000) and that for microsculpture is based upon Harris (1979). The following abbreviations are used in the text:

- A antennal segment (with a number designating the segment position, A1 is the scape);
- Bt basitarsus (with a number designating the leg concerned proceeding from anterior to posterior);
- Cx coxa (with a number designating the leg concerned proceeding from anterior to posterior);
- F femur (with a number designating the leg concerned proceeding from anterior to posterior);
- PLb labial palpus;
- PMx maxillary palpus;
- S metasomal sternum (with a number designating the segment proceeding from anterior to posterior);

T metasomal tergum (with a number designating the segment proceeding from anterior to posterior);
Tb tibia (with a number designating the segment proceeding from anterior to posterior).

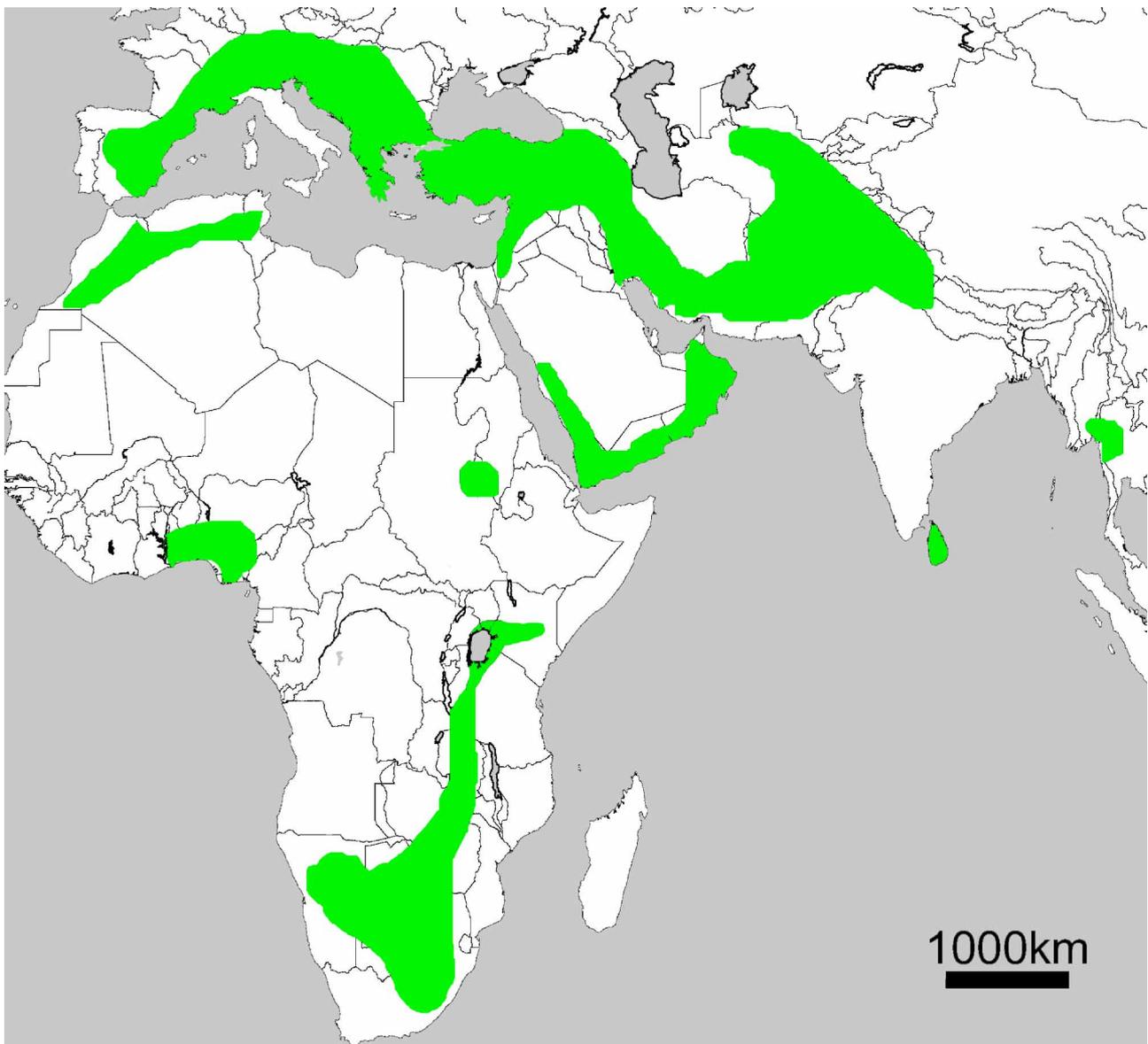


FIGURE 2. Global distribution of the genus *Systropha*.

Phylogenetic analysis

The phylogenetic position of the new species was inferred based on a dataset adapted from Patiny and Michez (2006). The data set included 33 characters coded for 11 species (see appendix). *Rophites* Spinola and *Morawitzia* Friese were chosen as outgroups according to the results of previous studies (Danforth *et al.*, 2006; Patiny & Michez, 2006).

A heuristic tree search (1000 replicates) was performed using PAUP 4.0b10 (Swofford 2002). Characters were considered unordered. A starting tree was obtained via stepwise addition. Addition sequence was random. We used TBR (tree-bisection-reconnection) for branch swapping and the ACCTRAN character-state optimization. A total of 10 cycles of successive approximations character weighting was necessary before tree statistics stabilised. Bootstrap values were computed with characters unweighted and weighted.

The displayed cladogram corresponds to the topology obtained with the characters weighted (Fig. 4). The mapping of floral choices and distributions along branches was realized using MacClade 4.0 (Maddison & Maddison 2000).

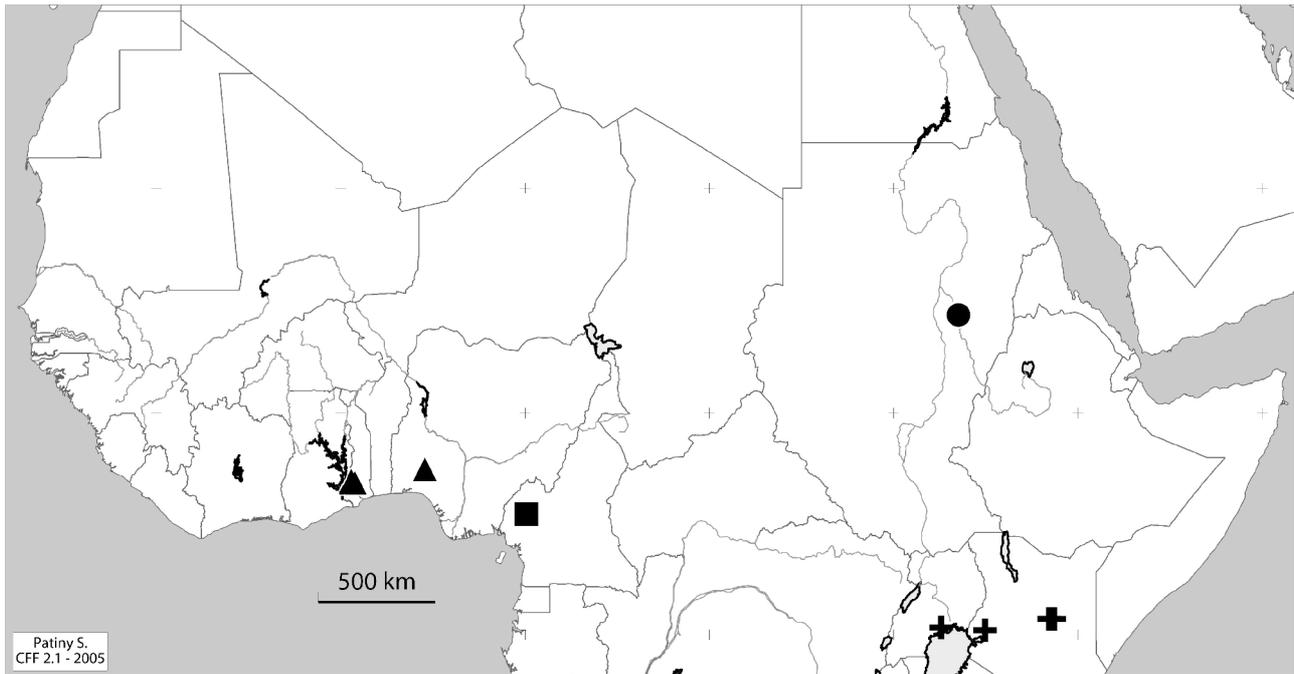


FIGURE 3. Known collecting localities of *Systropha* in Sub-Saharan Africa north of the Equator. *S. bispinosa* (square); *S. martiali* **sp. nov.** (circle); *S. norae* (triangles); *S. ugandensis*, crosses.

Results

Checklist of the Austrosystropha updated from Patiny and Michez, 2006

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

Systropha (*Austrosystropha*) *aethiopica* Friese 1911: 654, "Brit. Öst. Africa, Mulango"; holotype ♂ (labelled TYPE); Zoölogische Museum Humboldt universität Berlin (Germany) (hereafter ZMHB)

02 *Systropha* (*Austrosystropha*) *arnoldi* Friese 1922

Systropha (*Austrosystropha*) *arnoldi* Friese 1922: 2, "Rhodesia, Bulawayo" (Zimbabwe); holotype ♂ (labelled TYPE); ZMHB

03 *Systropha* (*Austrosystropha*) *bispinosa* Friese 1914

Systropha (*Austrosystropha*) *bispinosa* Friese 1914 in Schulthess: 296, "Kamerun, Dchang" (Cameroon); holotype ♂ (labelled TYPE); ZMHB

04 *Systropha* (*Austrosystropha*) *krigei* Brauns 1926

Systropha (*Austrosystropha*) *krigei* Brauns 1926: 192, "Südafrika, Transvaal, Pretoria" (South-Africa); syntypes ?lost

05 *Systropha* (*Austrosystropha*) *macronasuta* Strand 1911

Systropha (*Austrosystropha*) *macronasuta* Strand 1911: 110, "Zanzibar" (Tanzania); holotype ♀; ZMHB

06 *Systropha* *martiali* **sp. nov.**

07 *Systropha* (*Austrosystropha*) *norae* Patiny 2004

Systropha (*Austrosystropha*) *norae* Patiny 2004: 907, "Nigeria, Ile-Ife"; holotype ♂; Snow Entomological Museum, Lawrence Kansas (U.S.A.)

08 *Systropha* (*Austrosystropha*) *rhodesiensis* Friese 1922

Systropha (*Austrosystropha*) *rhodesiensis* Friese 1922: 3, "Rhodesia, Bulawayo" (Zimbabwe); syntypes ♀ (labelled TYPE); ZMHB

09 *Systropha* (*Austrosystropha*) *ugandensis* Cockerell 1931

Systropha (*Austrosystropha*) *ugandensis* Cockerell 1931: 400, "Uganda, Kampala"; holotype ♂; National History Museum, London (U.K.)

Description of *Systropha martiali* sp. nov.

Diagnosis. Female unknown. Male. Medium sized (L. ca. 10 mm). Antennae with 13 well-differentiated segments. Face with dense hair crests. Overall vestiture creamy-white. Mesonotum and scutellum with few fine and sparse punctures; cuticle shiny. F1 inflated; the ventral part somewhat compressed. T with fine punctures and sculptures, shiny. Graduli laterally flattened on T3-5. T2 with one single median crest.

Description. Female: unknown. Male (Figs. 1a,c,e). **Head.** Clypeus finely sculptured, dull, with some large and deep punctures; margin with a shallow median depression. Labrum about half as long as clypeus, smooth. Mandibles dark with reddish apex; ventral side with a dense vestiture forming a kind of beard together with the genae vestiture. Mouthparts not exposed. Genae smooth; punctation sparse, denser along eyes outer margins. Frons and vertex smoother than the ventral part of the face. Scapes and flagella densely sculptured, mat. A3-A13 reddish. Face covered in creamy-white hairs, which form dense and long crests rising from the face at the level of the antennal sockets. Lower back side of the head displaying a well differentiated beard-like vestiture. **Mesosoma.** Pronotum smooth. Mesonotum and scutellum finely punctured, sparsely in the median part of sclerites. Propodeum and propodeal area finely sculptured, dull. Propodeal area lightly depressed. Mesopleurae more densely punctured than nota. No tubercle on the ventral part of the mesopleurae. Cuticle of pronotum, mesepisterna, sides of propodeum and proximal part of legs somewhat red-brown. F1-F2 inflated. F1 enlarged ventrally, this part lightly compressed. Tb2 spur thick and finely toothed. Wings surface hyaline; veins brownish. Mesosoma vestiture creamy-white, short, denser on hind margin of pronotum, dorsal lobes, mesonotum, mesopleurae, scutellum, postscutellum, dorsal part of propodeum and terminal part of legs (Tb and Bt). **Metasoma.** Terga cuticle dark, lightly reddish on T(1)2-T5 margins. Anterior parts of T1-T3 displaying bluish reflections like in the Palearctic *S. planidens*. Punctation of terga fine and sparse, cuticle mostly shiny. Graduli of T3-T5 somewhat expanded and flattened, however not spiny. T7 with two strong lateral teeth. S1 deeply and narrowly indented. S2 with large irregular median crest forming two consecutive pikes, the distal being lower (Fig. 1e). Lateral part of S2 with very low transversal crests. S8 apex slightly enlarged. Metasoma vestiture very short, fine and sparse, creamy white on T1-T3, dark brownish on following segments. **Genitalia.** Due to the extreme desiccation of the specimen, we were unsuccessful observing genitalia and hidden sclerites.

Etymology: the specific epithet *martiali* is derived from *Martial* in honour of the first author's son.

Material studied: *Locus typicus:* Sudan Rahad vill. 38 [interpreted coordinates: 14.4°N 33.53°E] pherom. trap 7.9.1983 J.H.Lourens; *Type depository:* Zoölogisch Museum Amsterdam; 1 ♂ Holotype.

Comparative diagnosis of species in *Systropha* (*Austrosystropha*)

In the key proposed in Patiny and Michez (2006), *S. martiali* should be defined in couplet 10 of the key to males and identified based on the unique nature of the S2 tubercle.

Table 1 presents a comparative diagnosis of *S. aethiopica* (female unknown), *S. norae* (type species of the subgenus *Austrosystropha*) and *S. martiali* **sp.nov.** (female unknown) based on male diagnostic characters reported for *Austrosystropha*.

TABLE 1. Comparative diagnosis of *S. aethiopica*, *S. norae* and *S. martiali* **sp.nov.** In *S. martiali* (holotype), the S3-6 are hidden due to the post-mortem curling of metasoma. *The lengths given in first row were measured from vertex to T1 margin (avoiding interpreting the length of the curled part of abdomen).

	<i>S. aethiopica</i>	<i>S. norae</i>	<i>S. martiali</i>
Length*	6.2 mm	6.6 mm	5 mm
A9-13	Thick, ventrally enlarged	The three last segments strongly flattened	The three last segments strongly flattened
Hairs in facial crests	Lesser barbed hairs	Lesser barbed hairs (Fig. 1b)	Strongly barbed hairs (Fig. 1a)
Mesopleurae tubercles	No tubercle	Strong tubercles on mesopleurae ventral surface	No tubercle
F1	Inflated	Inflated	Inflated, ventrally compressed
Tb2 spur	Thick apically hooked	Thick	Short, thick; apex briefly hooked
T2-3 graduli	Spiny	Prominent and rounded	Flattened, blade-shaped
S1 indentation	Shallow emargination	No notable emargination	Deep and narrow indentation (Fig. 1c)
S2 differentiation	Large blade-like expansion of the S2 apex	Low tubercles on each side of the sternum apex (Fig. 1f)	Longitudinal crest process with a median and an apical pikes (Fig. 1e)
S3-6 differentiation	Median expansion on S3; Low tubercles on S4	Stronger tubercles on S3; Lower tubercles on S4	Not observed
S8 apex	Almond-shaped	Narrow with a ventral groove	Narrow with a ventral groove

Detail of the locality data

The *S. bispinosa* locus typicus is in Dschang (Cameroon) in the Adamaoua mountains.

S. martiali was collected in Wad Medani region, between Blue and White Nile valleys, ca. 100km south-southeast of Khartoum (Sudan) (Fig. 3).

All the records of *S. norae* reported so far are associated with moderate elevations, i.e. mountains to the east of Ibadan (Nigeria) (locus typicus: Ile Ife) and Togo mountains (Togo: Agou; Kloto).

Mapped data: 1973, 1♀, Ile-Ife (Nigeria, NI); 1973, 1♂, Ile-Ife (NI); 1980xi22, 1♂, Baumann, Agou (Togo, TO); 2004xii, 1♀, Kloto (TO); 2005xii, 1♀, Kloto (TO)

New data are reported for *S. ugandensis* in Kenya (Kakamega forest).

Mapped data: 1♂, Kampala (Uganda); 2003vi13, 1M, Mapera (Kenya, KE); 2003vi26, 1♂, Mapera (KE); 2003viii01, 1♀, Kaimosi (KE); 2003v01, 1♀, Kaimosi (KE); 2002x04, 1♂, Buyangu (KE).

Phylogenetic analysis

The trees, independent of the application of weighting method, are strongly congruent with the previously published topology. *Systropha* sensu stricto (*S. androstheneis*, *S. curvicornis*, *S. maroccana* and *S. planidens*) constitute a monophyletic group strongly supported by high bootstrap values (100 with weighting, 95 without). However, the relationships between the species within *Systropha* s.str. are poorly supported and appear

unresolved in the strict consensus based on the analysis of the unweighted characters.. *Austrosystropha* + *Systrophidia* constitute a second group also supported by high bootstrap scores: 74 (unweighted), 90 (weighted). The subgenus *Austrosystropha*, Patiny and Michez (2006) is also monophyletic and includes *S. martiali* **sp. nov.** Its monophyly is supported by bootstrap values of 92 (weighted) (75 when characters are unweighted).

There is strong congruence between floral choice and geographic distribution when these attributes are mapped onto the tree. *Systropha* as a whole are obviously oligolectic on Convolvulaceae: *Convolvulus*, *Ipomoea* and *Merremia*. *Austrosystropha*, for which records are available for only some species, and *Systrophidia* are respectively linked to *Ipomoea* and *Merremia* while the West-Palaeartic subgenus *Systropha* is oligolectic on *Convolvulus*. Patiny and Michez (2006) emphasized that the widest distributed species, *S. curvicornis*, (throughout most of the Palaeartic) is seemingly also the only polylectic species.

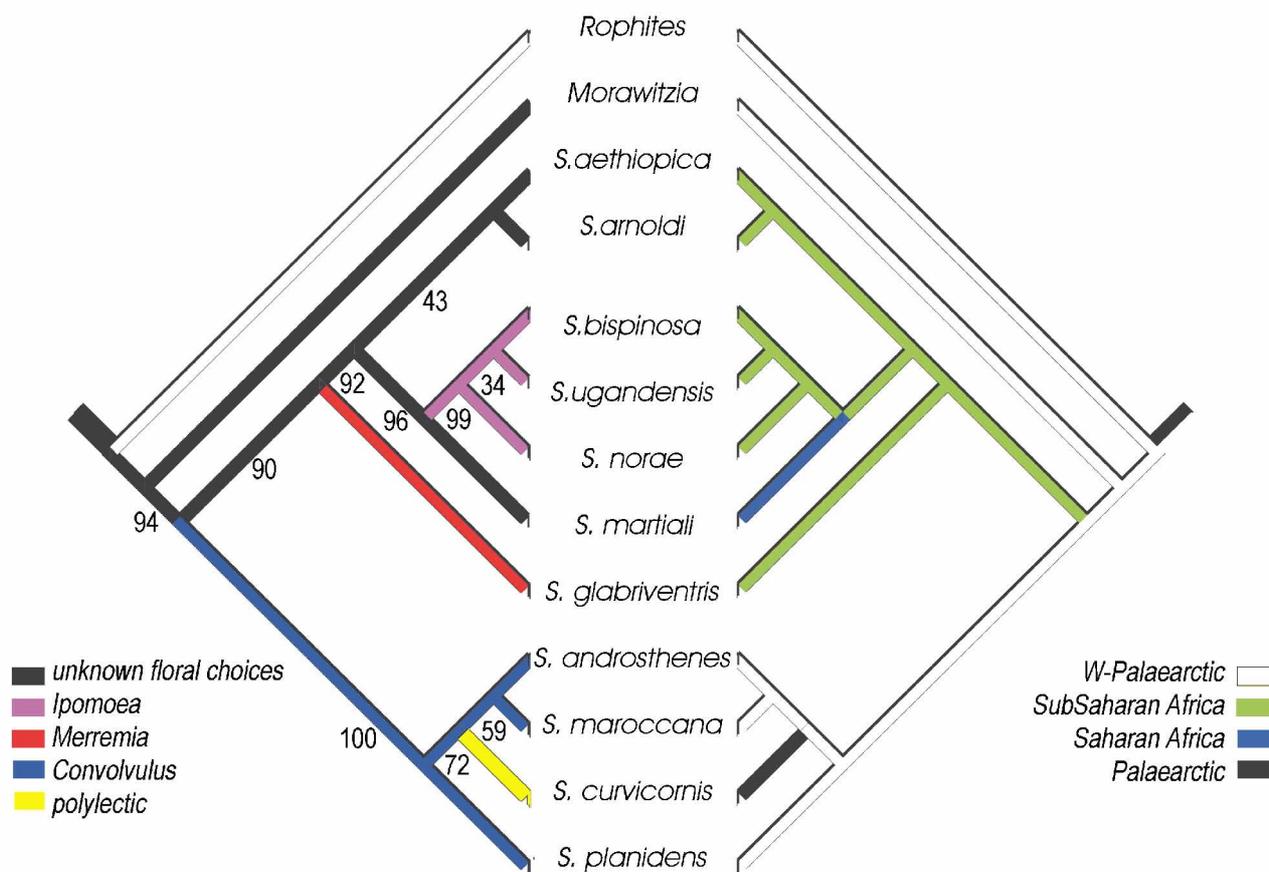


FIGURE 4. 50% majority rule consensus of the six trees obtained after ten cycles of successive weighting. Left tree displays the mapping of floral choices onto branches. Right tree displays the global distribution of species mapped onto branches. Numbers under branches on left tree correspond to the bootstrap scores after characters weighting. Trees parameters are L=58, CI=0.69, RI=0.81 when characters are unweighted; L=30, 96, CI=0.88, RI=0.94, with weighting applied.

Discussion

In a recent revision (Patiny and Michez, 2006), *Systropha* was subdivided into three subgenera. This study supports the monophyly of each of these subgenera with high bootstrap values (Fig. 4). Diagnostic characters for these groups are found in the structure of the flagellum apex, facial vestiture, femur, tapered graduli and morphology of the sterna. Based on the available topologies (Fig. 4; Patiny & Michez 2006), species groups

can be identified within the described subgenera. In *Austrosystropha*, *S. bispinosa*, *S. norae* and *S. ugandensis* form one monophyletic clade supported by high bootstrap scores. *Systropha aethiopica* + *S. arnoldi* display weaker support. *S. martiali* is sister to the *norae*-group. The position of *S. martiali* is supported by various structures such as the apomorphic S8 morphology (ventral groove) shared by *S. bispinosa* and *S. norae* and the plesiomorphic blade-like enlargement of the graduli evident in *S. aethiopica* and *S. arnoldi*. Among the described *Austrosystropha*, the structure of the S2 tubercles is unique in *S. martiali*.

Like the scattered Sahelian (southern Sahara) data reported for *Borgatomelissa* Patiny, *Meliturgula* Friese (Panurginae) and *Uromonia* Michener (Melittidae) (e.g.) the data for *S. martiali*, *S. norae* and *S. ugandensis* (Fig. 3) coincide with the geographical elements formerly hypothesised as favouring bee species richness (i.e.) coasts, mountains, river valleys (Patiny 2004; Patiny & Michez 2007).

Mapping of floral choices and distributions onto the tree topology reveals several interesting trends in *Systropha*. It is apparent from the available literature that the genus obviously specializes upon Convolvulaceae. However, each subgenus displays a clear preference for one specific taxon within this plant family. The species in *Systropha* s.str. are associated with *Convolvulus*, while *Austrosystropha* display preferences for *Ipomoea*, despite the partial presence of *Convolvulus* within their range. Because it includes only a single species, generalisation of ecological preferences is not possible for *Systrophidia*. However, it must be emphasized that all of the floral choice data reported point out a link between that species and *Merremia*. There is consequently a biogeographical patterning of the floral choices in *Systropha*. The West-Palaearctic species are linked to *Convolvulus*, the African to *Ipomoea* and the Namibian endemic to *Merremia*.

Acknowledgements

The authors are indebted to Dr W. Hogenes, Dr G. Schulten (ZMA, Amsterdam) and M. A. Pauly (FuSaGx, Gembloux). They also thank Mrs S. Cardinal (CU, Ithaca) for having kindly reviewed the English language. Thanks also to anonymous reviewers for their kind proof reading. S. Patiny is a FNRS postdoctoral researcher.

References

- Barbier, Y. & Rasmont, P. (2000) *Carto Fauna-Flora 2.0. Guide d'utilisation*, Université de Mons-Hainaut, Mons, 59 pp.
- Barbier, Y., Rasmont, P., Dufrière, M. & Sibert, J.M. (2005) *Data Fauna-Flora, Guide d'utilisation*, Université de Mons-Hainaut, Mons, 107 pp.
- Danforth, B. N., Sipes, S., Fang, J. & Brady, S.G. (2006) The history of early bee diversification based on five genes plus morphology. *Proceedings of the National Academy of Sciences USA*, 103(41): 15118–15123.
- Harris, R.A. (1979) A Glossary of surface sculpturing. *Occasional Papers in Entomology*, 28, 1–31.
- Maddison, D. & Maddison, W. (2000) MacClade 4.0 Analysis of Phylogeny and Characters Evolution. *Sinauer and Associates*.
- Michener, C.D. (2000) *The bees of the world*. The Johns Hopkins University Press, Baltimore, 913 pp.
- Patiny, S. (2004) Analysis of the Panurginae distribution in West-Africa and report of new data for *Meliturgula scriptifrons* (Walker, 1871) in Mali (Hymenoptera, Apoidea, Andrenidae). *Linzer biologische Beiträge*, 36(2): 901–906.
- Patiny, S. & Michez, D. (2006) Phylogenetic analysis of the *Systropha* Illiger, 1806 (Hymenoptera: Halictidae) and description of a new subgenus. *Annales de la Société entomologique de France*, 42(1): 27–44.
- Patiny, S. & Michez, D. (2007) Biogeography of bees (Hymenoptera, Apoidea) in Sahara and the Arabian deserts. *Insects Systematic and Evolution*, Accepted.
- Swofford, D. L. (2002) PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.

Appendix

<i>Rophites</i>	0000000000	0000000000	0000001000	000
<i>Morawitzia</i>	0000000000	0000000000	0000001000	000
<i>S_aethiopica</i>	1010001011	1010000010	2012010201	100
<i>S_androsthene</i> s	0011100111	0000011100	0002101011	000
<i>S_arnoldi</i>	101??01010	1010000010	1012120201	100
<i>S_bispinosa</i>	1110001011	1001100011	0011120100	001
<i>S_martiali</i>	1110??1010	1000000010	101301???0	001
<i>S_curvicornis</i>	0010100101	0000011100	0002120011	000
<i>S_glabriventris</i>	0012010000	1110001010	0110000001	100
<i>S_maroccana</i>	0010100100	0100011100	0102101011	010
<i>S_norae</i>	1110001011	1001100012	0011120100	001
<i>S_planidens</i>	0010100000	0000011100	0002120011	000
<i>S_ugandensis</i>	1?10?01011	1001100011	0011120100	001

01. Males' facial pilosity.
0, undifferentiated; 1, forming typical crests behind scapes
02. A3 length
0, A3 short; 1, A3 relatively elongated
03. Shape of the males' antennae apex
0, antennae apex straight; 1, antennae apex spiral
04. Males' flagellomere number
0, flagellum with 13 well-differentiated segments; 1, less than 13 segments, the apical very short; 2, less than 13 segments; the apical forming a typical hook
05. PMx relative size
0, PMx shorter than PLb; 1, PMx longer than PLb
06. Mouthparts length
0, mouthparts shorter than half of the body length; 1, mouthparts as long as, or longer than, half of the body length
07. Ocellar area convexity
0, ocellar area flat; 1, ocellar area notably convex
08. Size of the first submarginal cell
0, first submarginal cell short and straight; 1, first submarginal cell longer than the radial vein and slightly curved
09. Shape of the second submarginal cell (using the Rs/Rs+M ratio as estimator)
0, second submarginal nearly as wide anteriorly as posteriorly; 1, second submarginal narrowed; 2, second submarginal cell unusually narrowed
10. Position of the 1m-cu vein junction on Rs+M of 2nd submarginal cell
0, distal; 1, median
11. Size of the males' F1
0, F1 dorso-ventrally enlarged; 1, F1 dorso-ventrally and laterally enlarged, appearing inflated
12. Size of the males' F2
0, F2 not enlarged; 1, F2 dorso-ventrally enlarged
13. Males' F2 carina
0, not carinate; 1, carinate
14. Size of the males' Tb2
0, tibia proximal half not enlarged; 1, tibia proximal part nearly as large as the distal part
15. Size of the males' Cx3 apex
0, Cx3 apex not enlarged; 1, Cx3 flattened, distally enlarged
16. Hind tarsus median segments length
0, segments 3&4 of the Hind tarsus short; 1, segments long
17. Males' Bt3 length
0, Bt3 less than 0,6 time as long as Tb3; 1, Bt3 longer
18. Males' Tb3 inner spur
0, ventral edge of the Tb3 inner spur finely toothed along 2 ranks; 1, spur seemingly smooth
19. Propodeal area depression
0, propodeal area not depressed, propodeum regularly convex; 1, propodeal area depressed

20. Structure of tubercles on the males' mesopleurae ventral part
0, mesopleurae flat; 1, mesopleurae with short spiny tubercles; 2, tubercles larger (*S. norae*)
21. Lateral differentiation of the males' terga graduli
0, graduli undifferentiated laterally; 1, graduli forming lateral spines on first terga
22. Males' T6
0, T6 untoothed; 1, T6 toothed laterally
23. Males T7
0, T7 untoothed; 1, T7 toothed laterally
24. Differentiation of processes on the males' S2
0, S2 without process; 1, S2 margin notably convex; 2, S2 margin well differentiated in process(es)
25. Males' S2 with paired processes
0, S2 processes unpaired; 1, S2 processes paired
26. Differentiation of processes on the males' S3
0, S3 without process; 1, S3 margin notably convex; 2, S3 margin with well differentiated process
27. Males' S6 with a longitudinal carina
0, carina absent; 1, carina low; 2, carina well convex; 3 carina with well individualized proximal and distal teeth
28. Males' S6 with a terminal angular bud
0, S6 apex undifferentiated; 1, S6 with one apical median tooth; 2, S6 with 2 successive teeth along its longitudinal axis
29. Males' S7 terminal processes tapered
0, S7 terminal processes large; 1, S7 terminal processes apex tapered
30. Males' S8 apex size
0, S8 apex not enlarged; 1, S8 strongly enlarged and flattened
31. Males' S8 shape
0, S8 apex other; S8 apex with a typical elliptic almond-like shape
32. Males' S8 apex bearing small terminal process(es)
0, S8 without terminal process; 1, S8 apex toothed
33. Males' S8 apex with a ventral groove
0, no differentiated groove on the males' S8 apex; 1, S8 apex with a longitudinal ventral groove