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Research article

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The genus *Afrosyrphus* Curran (Diptera, Syrphidae), with a description of a new species

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Abstract. The flower fly genus *Afrosyrphus* Curran, 1927 (Diptera, Syrphidae) is revised and a new species, *Afrosyrphus schmuttereri* sp. nov., from Kenya and Uganda is described. Diagnoses, illustrations, DNA barcodes and known distributional data are provided for the two species of this genus, as well as an identification key. A critical review of the published literature is also provided.

Keywords. Flower flies, hover flies, DNA barcoding, identification key, Afrotropical Region.

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Introduction

Curran (1927) described a new genus of flower flies (Diptera Linnaeus, 1758: Syrphidae Latreille, 1802) based on a single male collected a few years earlier in the Democratic Republic of the Congo (DRC). This new genus and new species was named *Afrosyrphus varipes* Curran, 1927. The type specimen was collected in Kisangani in 1915 by Lang and Chapin, members of The American Museum of Natural

History Expedition (1909–1919). Later on, in a series of articles dedicated to African Syrphidae (Curran 1938a, 1938b, 1939a, 1939b), another two males and a female of *A. varipes* from the same country, but collected by Bequaert between 1913 and 1915, were studied by Curran (1938b). For many years (until Schmutterer 1974) these were the only known specimens of this very peculiar, stingless bee-mimicking fly, with elongated antennae, rather pilose body, and metaleg with dense dorsal and ventral fringes of long pile.

At the time of the original description, Curran (1927) could not relate his new genus and species to other known genera and suggested some morphological relationship with *Syrphus* Fabricius, 1775 (e.g., ventral calypter with long, erect pile) and with *Chrysotoxum* Meigen, 1803 (e.g., elongated antennae). Years later, Curran (1938b) mentioned the resemblance between this taxon and some species of *Leucozona* (*Ischyrosyrphus*) Bigot, 1882. Hull (1949) gave a short diagnosis for *Afrosyrphus*, and years later Vockeroth (1969) redescribed the genus and described the male genitalia for the first time. Based on characters of the male genitalia, Vockeroth (1969) suggested a close generic affinity with *Epistrophe* Walker, 1852.

Interestingly, while studying predatory syrphid larvae in Kenya, Schmutterer (1974) found abundant larvae of *Afrosyrphus* feeding on different species of aphids (Hemiptera Linnaeus, 1758: Sternorrhyncha Amyot & Serville, 1843: Aphidoidea Geoffroy, 1762), which were reared into adults, identified at the time as *A. varipes*. These were the first specimens of *Afrosyrphus* reared from larvae, but also the first records from Kenya and the first time that the genus had been collected since 1915. In the *Afrotropical Catalogue*, Smith & Vockeroth (1980) listed *A. varipes* from DRC, Kenya, Angola and South Africa, but no source for the two latter country citations was given (see also Dirickx 1998). More recently, Ssymank (2012) collected four specimens of *A. varipes*, a male and three females, in Cameroon (Province Adamaoua, Dept Vina).

The aim of this study is to describe a new species of *Afrosyrphus*, to document the first records of *Afrosyrphus* from Uganda and to provide an identification key for this genus, as well as DNA barcodes (Hebert *et al*. 2003a, 2003b) for the two known species of *Afrosyrphus*. We also review the existing literature, and after the study of collection material we re-evaluate the identity of some historical records of *Afrosyrphus*.

Material and methods

Collecting sites

Between January 15th, 2017 and February 7th, 2017, the authors of the present study carried out field work in the Taita Hills (Kenya) with the aim of collecting Diptera, with special focus on flower flies (Syrphidae). We stayed at the Taita Research Station of the University of Helsinki in Wundanyi (Toivonen *et al*. 2012), from which we made one- or two-day trips to different areas in the vicinity, including Wesu and Vuria Peaks, Mwatate area, Iyale (Fig. 1A), Chawia and Ngangao Forests.

A similar team of syrphidologists, including most of the authors of the present study, visited Uganda from December 1st to December 18th, 2018. This time, the coordinators of the expedition were Kurt Jordaens (Royal Museum for Central Africa, Tervuren, Belgium) and James Peter Egonyu (Makerere University, Kampala, Uganda). During our stay we visited several protected areas, i.e., Ruwenzori National Park, Kibale Forest National Park, Bwindi Impenetrable National Park (Fig. 1B) and Mabamba Swamps.

In both countries, hand nets and Malaise traps were used to collect flower flies. Nevertheless, no specimens of *Afrosyrphus* were found among the material collected using Malaise traps.

During our study, specimens of *Afrosyrphus* originally collected and reared by Schmutterer (1974) were found among the material loaned to Pavel Láska in the Department of Zoology, Palacký University (Olomouc, Czech Republic). Láska and coauthors used this material to describe the puparia of some

Betasyrphus Matsumura, 1917 (Mazánek *et al*. 1999) and the puparium of *Afrosyrphus* (Láska *et al*. 2000). This material was available for our study thanks to Libor Mazánek.

Terminology, measurements and photography

The new species is described in full, with terminology following Thompson (1999) and Cumming & Wood (2017). The abbreviations used for collections follow the standard in *Systema Dipterorum* (Thompson 2019), and their equivalents are given below:

AMNH = American Museum of Natural History, New York, USA
ASPC = Axel Ssymank personal collection, Wachtberg, Germany
CNC = Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Canada
ICIPE = International Centre of Insect Physiology and Ecology, Nairobi, Kenya
MZH = Finnish Museum of Natural History Luomus, Helsinki, Finland
NBC = Naturalis Biodiversity Centre, Leiden, the Netherlands
NMK = National Museum of Kenya, Nairobi, Kenya
RMCA = Royal Museum for Central Africa, Tervuren, Belgium
USNM = National Museum of Natural History, Washington DC, USA
ZFMK = Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany

We follow the principles of FAIR & Open Science publishing to cite the studied material as recommended by this journal. At the end of each record the holding institution is indicated.

All measurements are in millimetres and were taken using a reticule in a Leica® M165C microscope. Body length was measured from the anterior oral margin to the posterior end of the abdomen, in lateral

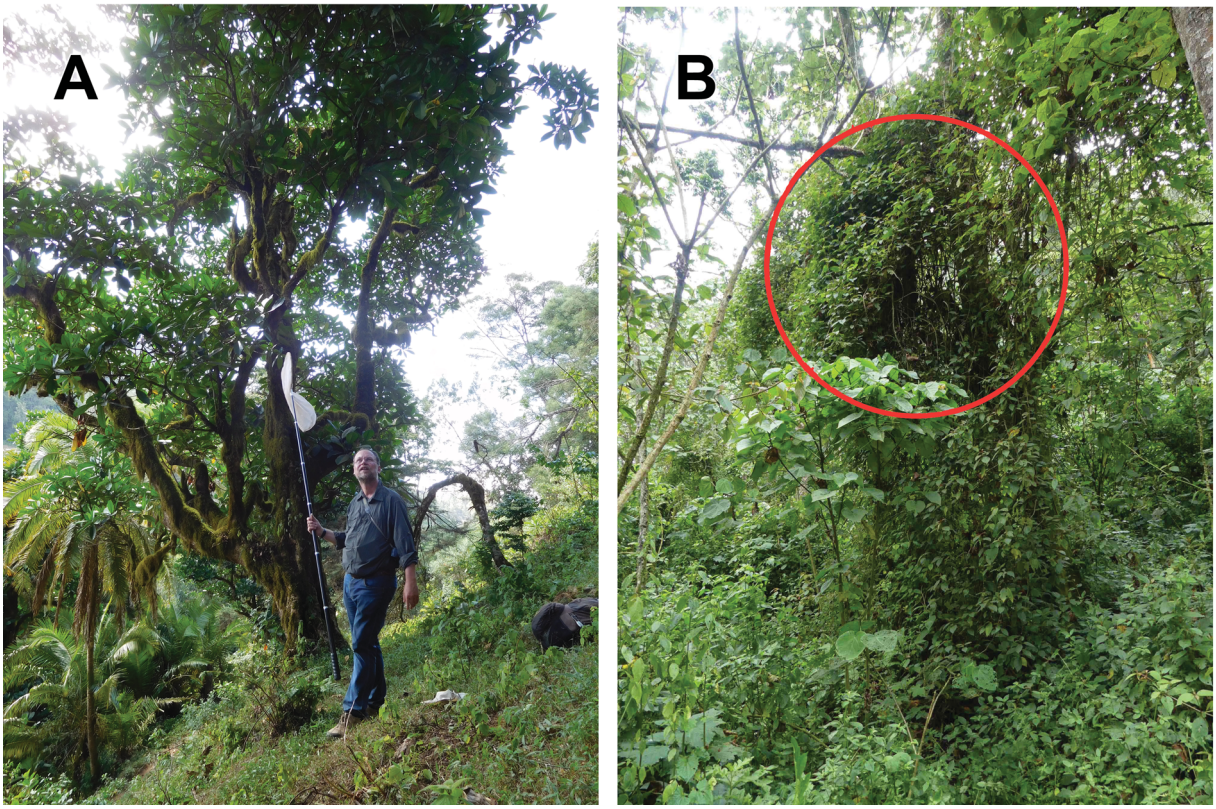

Fig. 1. Localities where *Afrosyrphus schmuttereri* sp. nov. was collected. **A**. Sampling point in the trail to Iyale (Taita Hills, Kenya). **B**. Sampling point in the Ruhija Section of the Bwindi Impenetrable National Park (Uganda). Red circle indicates exactly where the flower flies were hovering.

view. Wing length was measured from the wing tip to the basicosta. Photographs were composed using Zerene Stacker® ver. 1.04 software (Richland, WA, USA), based on images of pinned specimens taken with a Canon EOS 7D® mounted on a P-51 Cam-Lift (Dun Inc., VA, USA) and with the help of Adobe Lightroom® ver. 5.6. Simple-Mappr (Shorthouse 2010) was used to create Fig. 2.

Adult identification

Existing available keys were used to identify the collected specimens. Curran (1927), Hull (1949) and Vockeroth (1969) were used to determine the genus; then, the specimens from Taita Hills were checked by direct comparison against material from several collections, including the holotype of *A. varipes*, and against the original description of *A. varipes*.

Molecular studies

One or two legs of several specimens were used for DNA extraction. Extractions were carried out using the DNeasy Blood and Tissue Kit (Qiagen Inc., Santa Clara, CA, USA) following the manufacturer's protocol. Entire specimens or remnants of specimens were preserved and labelled as DNA voucher specimens for the purpose of morphological studies and deposited in the above-mentioned collections, as listed in the 'Material examined' sections.

The mtDNA barcode of the 5′ region of the cytochrome *c* oxidase subunit I gene (COI) was amplified using forward primer LCO1-1490 (5′-GCTCAACAAATCATAAAGATATTGG-3′; Folmer *et al*. 1994) and reverse primer COI-Dipt-2183R, also known as COI-780R (5′-CCAAAAAATCARAATARRTGYTG-3′; Gibson *et al*. 2011). PCR amplification protocols were the same as described in Rozo-Lopez & Mengual (2015). All new sequences were submitted to GenBank via BOLD (www.boldsystems.org). GenBank accession numbers are listed for each sequenced specimen in the text.

We ran a distance-based Neighbor-Joining analysis using the Jukes-Cantor Model as implemented in Geneious ver. 7.1.3, where we included several DNA barcode sequences for species of the genera *Epistrophe* and *Epistrophella* Dušek & Láska, 1967 in order to visualize the distance between the two species of *Afrosyrphus*. We also ran a maximum likelihood (ML) analysis using Garli ver. 2.01 (Zwickl 2006, 2011) and the GTR+I+G model (Fig. 6). Forty-eight independent runs were conducted using scorethreshforterm = 0.05 and significanttopochange = 0.0001 settings and the automated stopping criterion, terminating the search when the ln score remained constant for 50 000 consecutive generations. The tree with the highest likelihood was retained and is presented here (Fig. 6). Bootstrap support values (BS) were estimated from 1000 replicates using the same model in Garli. Analytical runs were performed on the CIPRES Science Gateway (Miller *et al.* 2010). All trees were drawn with the aid of FigTree ver. 1.3.1 (Rambaut 2009).

Results

Taxonomy

Phylum Arthropoda Latreille, 1829
Class Insecta Linnaeus, 1758
Order Diptera Linnaeus, 1758
Family Syrphidae Latreille, 1802
Subfamily Syrphinae Newman, 1834

Afrosyrphus Curran, 1927

Type species

Afrosyrphus varipes Curran, 1927, by monotypy.

Differential diagnosis (adapted from Vockeroth 1969)

Moderately robust, rather pilose species with extremely long, slender antennae, obscure abdominal markings and densely pilose hind legs. Face almost straight in profile, with low tubercle, densely pale pruinose laterally, with a shining, broad, dark median facial vitta. Eye apparently bare (with extremely short and scattered pile), holoptic in male. Antenna porrect or nearly so, with postpedicel longer than scape and pedicel together; arista bare, subbasal. Mesonotum dull, heavily pruinose; pleura dull, pruinose. Thoracic pile pale, unusually long but not obscuring ground colour. Subscutellar fringe very long and dense. Dorsal and ventral katepisternal pile patches narrowly joined posteriorly, clearly separated anteriorly. Metasternum bare. Hind coxa and hind trochanter with a pile tuft at median angle. Wing membrane with extensive bare areas on rather more than basal half, microtrichia on rest of membrane very fine but moderately dense. Ventral calypter with many fine, erect pale pile on posterior part of dorsal surface. Apical half of hind femur and hind tibia of both sexes with dense dorsal and ventral fringes of long, mostly dark pile. Abdomen unmargined, narrowly oval, long pilose.

Distribution

Afrotropical Region (see Fig. 2).

Systematic remarks

Vockeroth (1969) suggested a close relationship with *Epistrophe* based on adult morphology and male genitalia. Láska *et al*. (2000) described the puparium of *Afrosyrphus* based on the material from Kenya collected by Schmutterer and argued that *Afrosyrphus* is more closely related to *Epistrophella* based on the puparium morphology. Our unpublished target enrichment Syrphinae phylogeny supports both of these hypotheses, with *Epistrophella* sister to *Afrosyrphus* + *Epistrophe*.

Afrosyrphus schmuttereri sp. nov.
urn:lsid:zoobank.org:act:974F2588-579F-44AA-940C-F2FB9390B195
Figs 1–2, 3B, 3D, 4B–C, 5B, 5F–H, 6

Afrosyrphus varipes – Schmutterer 1972a: 447; 1972b: 279; 1974:44. — Láska *et al.* 2000: 79.

Differential diagnosis

This species can be distinguished from *A. varipes* as stated in the identification key. Overall a more robust species with slightly broader abdomen, darker pilosity in calypter, scutum and abdominal segments, and male frontal triangle with black pruinosity along eye margin that looks entirely shiny (Fig. 3B–C). Male

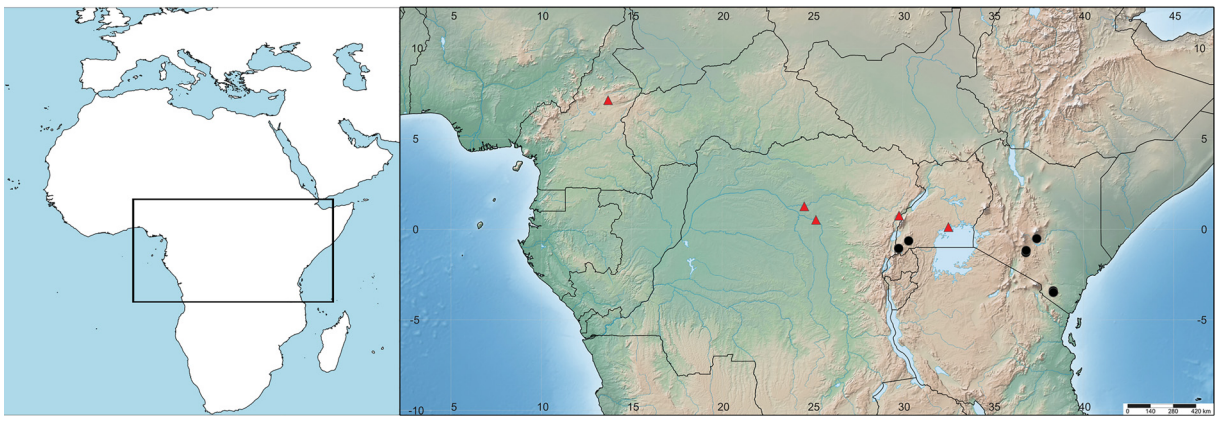

Fig. 2. Known distribution of *Afrosyrphus varipes* Curran, 1927 (red triangles) and *Afrosyrphus schmuttereri* sp. nov. (black circles).

genitalia as in Fig. 5F–H. Females are also darker than in *A. varipes*. In females, tergite 2 has a posterior dark fascia (tergite 2 entirely orange in *A. varipes*; Fig. 4A–B), the femora are darker than the tibiae (femora only slightly darker than tibiae in *A. varipes*) and the face is dark in background colour (orange in *A. varipes*). Both sexes have similar hind legs. The hind first tarsomere (= metabasitarsomere) appears orange and shining, as it has no long, black pile (Fig. 5B).

Etymology

This new species is named after its first collector, Prof. Heinrich Schmutterer, in his honour, for his dedicated work on entomology in Kenya. This species epithet is to be treated as a noun in the genitive case.

Material examined

Holotype

KENYA • ♂; Nairobi Province, Nairobi City, Chimoro; 01°16.502′ S, 36°48.452′ E; 1686 m a.s.l. [approx. altitude]; 3 Oct. 1970; H. Schmutterer leg.; specimen identifier: ZFMK-DIP-00067253; ZFMK.

Paratypes

KENYA • 1 ♀; same collection data as for holotype; specimen identifier: ZFMK-DIP-00067254; ZFMK • 1 ♂; Taita-Taveta Co., Taita Hills, Mwatate area; 3.48444° S, 38.33251° E; 1011 m a.s.l.; 24 Aug.–7 Sep. 2011; R. Copeland leg.; Malaise trap below Bura Bluff, riverine forest; specimen identifier: ICIPE 9542; ICIPE • 3 ♂♂; Taita Taveta Co., Taita Hills, trail to Iyale; 3.40094° S, 38.33206° E; 1867 m a.s.l.; 27 Jan. 2017; A. Ssymank leg.; ASPC • 2 ♂♂; same collection data as for preceding; G. Ståhls leg.; specimen identifiers: https://id.luomus.fi/GJ.1956, https://id.luomus.fi/GJ.1957; GenBank: MN662559, MN662545; MZH • 6 ♂♂; same collection data as for preceding; 28 Jan. 2017; X. Mengual leg.; specimen identifiers: ZFMK-DIP-00019820, 00019826, 00019828 to 00019829, 00019831, 00015961; ZFMK • 2 ♂♂; same collection data as for preceding; specimen identifers: ZFMK-DIP-19822 to 19823; NMK • 5 ♂♂; same collection data as for preceding; M. Reemer leg.; NBC • 1 ♂; same collection data as for preceding; NMK • 11 ♂♂; same collection data as for preceding; J.H. Skevington leg.; specimen identifiers: CNC657049 to 657051, CNC653515 to 653522; CNC • 2 ♂♂; same collection data as for preceding; specimen identifiers: CNC653523 to 653524; NHK • 1 ♂; same collection data as for preceding; specimen identifier: CNC653525; USNM • 3 ♂♂; same collection data as for preceding; 1 Feb. 2017; X. Mengual leg.; specimen identifiers: ZFMK-DIP-00019825, 00019827, 00015960; ZFMK • 1 ♂; same collection data as for preceding; specimen identifier: ZFMK-DIP-00015967; alternative specimen identifier: CNC1565136; GenBank: MN662563; ZFMK • 1 ♀; Eastern Province, Njuki-ini Forest, near forest station; 0.51660° S, 37.41843° E; 1455 m a.s.l.; 14–28 Aug. 2007; R. Copeland leg.; Malaise trap, inside indigenous forest; specimen identifier: USNM ENT 01518184; USNM.

UGANDA • 1 ♀; Western Region, Ankole District; 30 Dec. 1975; M. Paulus leg.; specimen identifier: CNC DIPTERA 102961; GenBank: MN662536; CNC • 6 ♂♂; Western Region, Kabale District, Bwindi Impenetrable National Park, Ruhija Section; 1.06114° S, 29.77811° E; 2314 m a.s.l.; 14 Dec. 2018; M. Reemer leg.; NBC • 1 ♂; same collection data as for preceding; CNC • 1 ♂; same collection data as for preceding; MZH • 1 ♂; same collection data as for preceding; RMCA • 1 ♂; same collection data as for preceding; specimen identifier: ZFMK-DIP-00061259; GenBank: MN662534; ZFMK.

Description

Male

Head (Figs 3D, 4C). Face with distinct, low facial tubercle and with 3–4 grooves, black medially and yellow laterally, yellow pilose with seldom black pile on dorsal half and a shiny, bare median vitta, with dense pale pruinosity covering yellow lateral areas; gena yellow, with a small black macula at eye

margin, yellow pilose with pale pruinosity dorsally; lunule black, with violet iridescence; frons black, with long black pile, shiny medially, with black pruinosity along eye margin (following pale pruinosity of face) and dorsally at eye angle; vertical triangle black, black pruinose, black pilose; antennal base inflated, protruded; antennal pits clearly separated; antenna elongated, black pilose, scape partly brown, pedicel and postpedicel black; postpedicel longer than scape and pedicel together; arista black, bare; eye almost bare, with a few scattered pile; occiput pale pruinose.

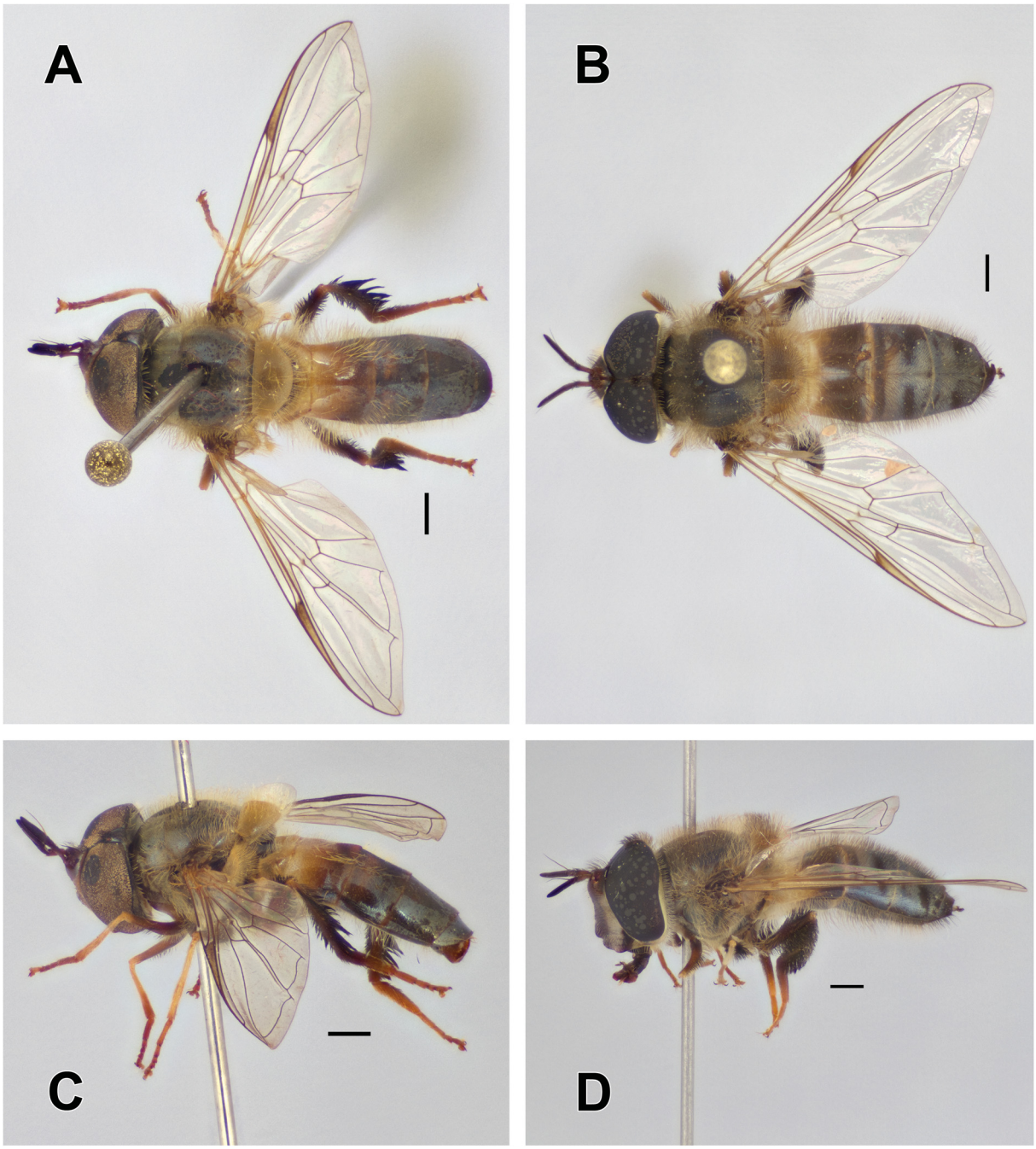

Fig. 3. A. *Afrosyrphus varipes* Curran, 1927, ♂ (ZFMK-DIP-00015968), dorsal view. **B**. *Afrosyrphus schmuttereri* sp. nov., paratype, ♂ (ZFMK-DIP-00019829), dorsal view. **C**. *Afrosyrphus varipes*, ♂ (ZFMK-DIP-00015968), lateral view. **D**. *Afrosyrphus schmuttereri* sp. nov., paratype, ♂ (ZFMK-DIP-00019829), lateral view. Scale bars: 1 mm.

Thorax (Fig. 4B–C). Scutum black, densely pale pruinose, with long yellow and brown pile; postpronotum paler, bare, densely pale pruinose; postalar callus yellow; scutellum yellow, pale pruinose, mostly dark pilose with some pale pile on anterior and posterior margins, subscutellar fringe with long, yellow pile. Pleuron black except katatergum yellow, densely pale pruinose, yellow pilose; metaepisternum bare; metasternum bare; postmetacoxal bridge incomplete; calypter yellow, mostly yellow pilose, ventral calypter with brown fringe and fine erect pile on posterior part of dorsal surface; plumule long, pale; halter pedicel and capitulum yellow; posterior spiracular fringes yellow.

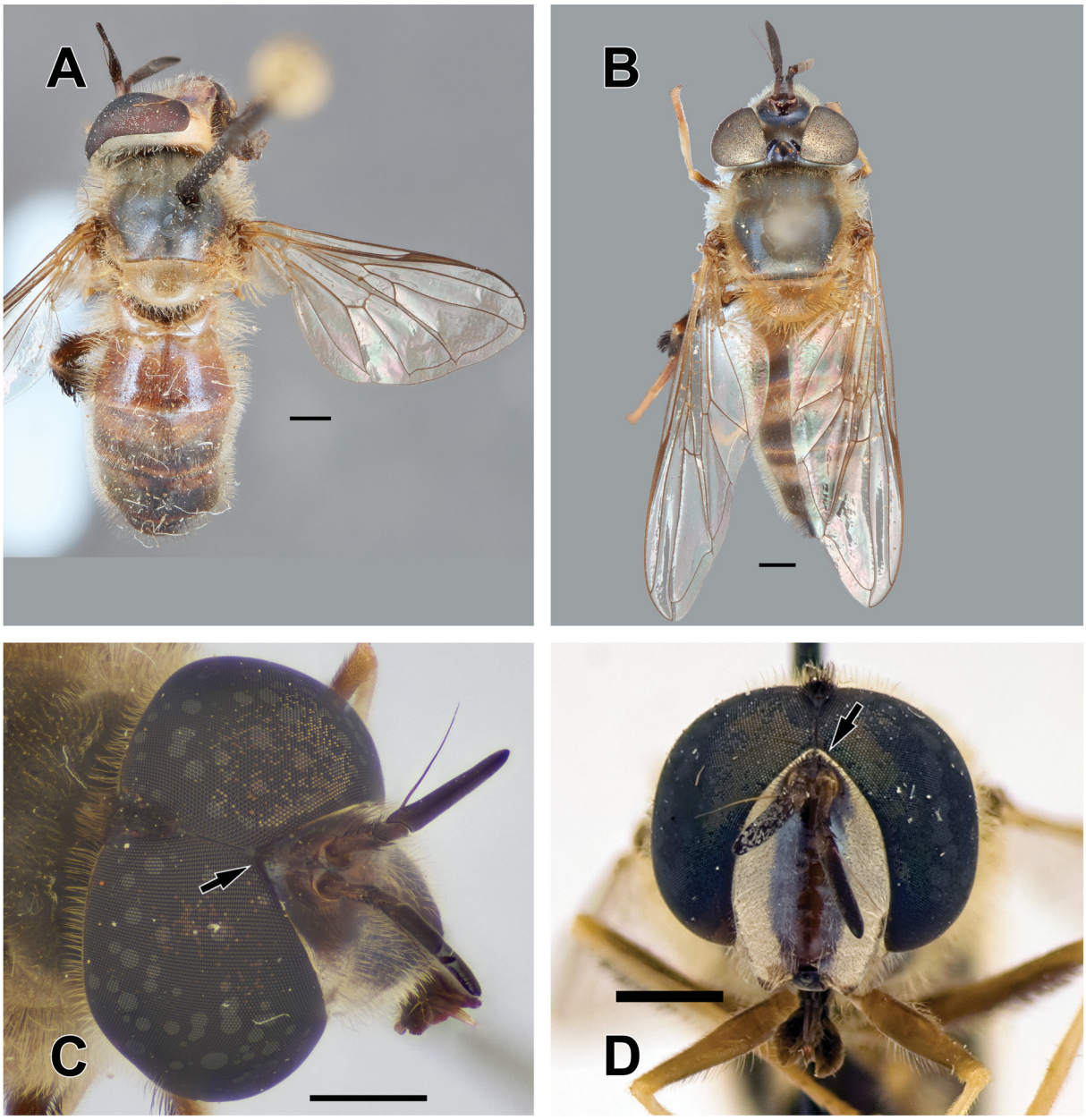

Fig. 4. A. *Afrosyrphus varipes* Curran, 1927, ♀ (CNC DIPTERA 102962), dorsal view. **B**. *Afrosyrphus schmuttereri* sp. nov., paratype, ♀ (CNC DIPTERA 102961), dorsal view. **C**. *Afrosyrphus schmuttereri* sp. nov., paratype, ♂ (ZFMK-DIP-00019829), dorsal view of head. **D**. *Afrosyrphus varipes*, ♂ (USNM ENT 00114576), frontal view of head. Arrows on C and D indicate the frontal triangle. Scale bars: 1 mm.

Wing. Hyaline, stigma yellow except dark brown basally; membrane bare basally, cells c, br and bm entirely bare, apical cells microtrichose but bare very basally; alula microtrichose.

Legs. Coxae and trochanters black, mostly yellow pilose; fore and mid femur yellow at base very narrowly and on apical half, darker basally; fore femur with long pile posteriorly, black apically and yellow basally; mid femur similar, but also with long pile anteriorly; fore and mid tibia yellow, yellow pilose; fore and mid tarsomeres yellow; hind coxa and hind trochanter with tuft of black pile medially; hind femur and hind tibia brown; hind femur with dense dorsal and ventral fringes of long pile, yellow on basal half and black on apical half; hind tibia with dense dorsal and ventral fringes of long black pile; hind tarsomeres pale.

Abdomen (Fig. 4B–C). Unmargined, narrowly oval, long pilose. Tergite 1 yellow, densely pale pruinose, yellow pilose; tergite 2 yellow on basal half and posterior margin, black on posterior half, with posterior margin yellow, pale pilose anteriorly and laterally, dark pilose medially on posterior half, densely pale pruinose; tergite 3 yellow on basal half, black on posterior half and on lateral margins, yellow pilose laterally and dark pilose medially, with some pale pile on anterior margin, densely pale pruinose, with two fasciate areas on posterior half less pruinose; tergite 4 black with a yellow fascia on posterior margin, with two medial yellow maculae on anterior half, yellow pilose laterally and dark pilose medially, densely pale pruinose, with two fasciate areas on posterior half less pruinose, smaller than on tergite 3; tergite 5 black, pruinose, black pilose. Sternite 1 yellow, with long yellow pile; sternites 2 and 3 yellow anteriorly and black posteriorly, with long yellow and black pile; sternite 4 black, long black pilose.

Male genitalia. As in Fig. 5F–H.

Female

Similar to male except normal sexual dimorphism and as specified in diagnosis.

Variation

Based on studied material, colouration of pile on scutum and scutellum may vary slightly in amount of dark pile, ranging from little to many.

Length (N = 4): body 12.7 mm (12.5–12.8 mm); wing 10.9 mm (10.8–11.0 mm).

Genetics

A total of five specimens was successfully sequenced; three 5′-COI sequences with a length of 658 bp (https://id.luomus.fi/GJ.1957, Genbank: MN662545; https://id.luomus.fi/GJ.1956, Genbank: MN662559; ZFMK-DIP-00061259; Genbank: MN662534), one 627 bp long (ZFMK-DIP-00015967, Genbank: MN662563) and one sequence that was 307 bp long (CNC DIPTERA 102961, Genbank: MN662536). The obtained DNA barcodes have an uncorrected pairwise distance of 0.08–1.52% among the specimens of this new species and differ by 5.54–6.54% from the two COI sequences obtained for *A. varipes*.

Biology

Schmutterer used larvae of *Afrosyrphus* to study their biological response as predators of common aphid species in East Africa (Schmutterer 1972b) or as prey for East African ants (Schmutterer 1972a). Schmutterer (1974) reared larvae of *Afrosyrphus* feeding on several hosts on six species of plants belonging to five different families from Kenya (preys and host plants are summarized in Table 1). He wrote that larvae of *Afrosyrphus* "of older stages of development stand out in comparison to those of many other aphidophagous Syrphidae of East Africa by their relatively broad, strongly flattened body. The greenish yellow of the last larval stage turns brownish 2–3 days before pupation. The drop-shaped, brown pupa has at its rear end a relatively long extension formed from a pair of stigmatic tubes."

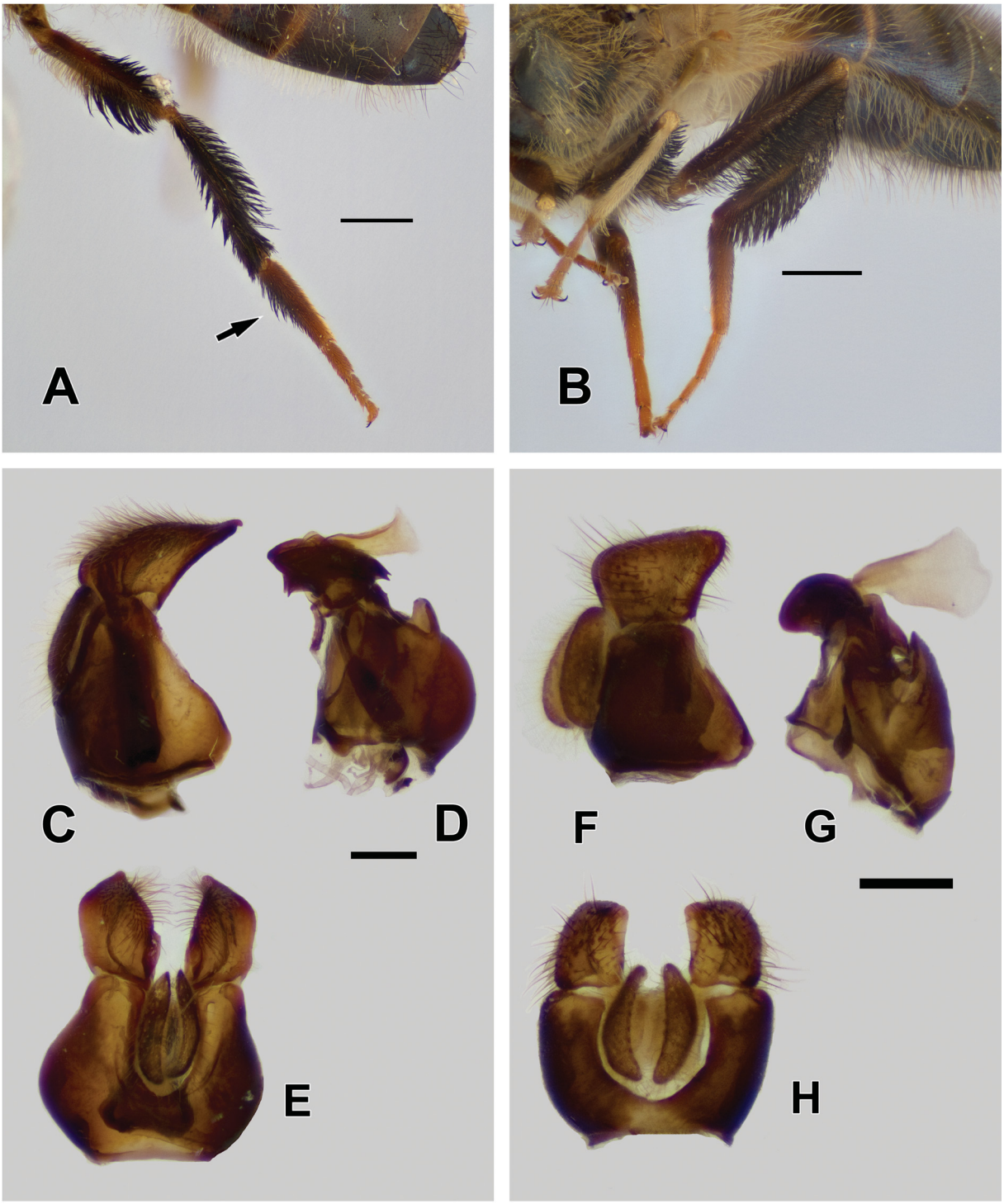

Fig. 5. A. *Afrosyrphus varipes* Curran, 1927, ♀ (ZFMK-DIP-00015969), hind leg. Arrow indicates the long black pile on the hind first tarsomere (= metabasitarsomere). **B**. *Afrosyrphus schmuttereri* sp. nov., paratype, ♂ (ZFMK-DIP-00019829), hind leg. **C–E**. *Afrosyrphus varipes*, ♂ (ZFMK-DIP-00015968), genitalia. **C**. Epandrium and surstyli, lateral view. **D**. Hypandrium, postgonites and aedeagus, lateral view. **E**. Epandrium, cerci and surstyli, dorsal view. **F–H**. *Afrosyrphus schmuttereri* sp. nov., paratype, ♂ (ZFMK-DIP-00019829), genitalia. **F**. Epandrium and surstyli, lateral view. **G**. Hypandrium, postgonites and aedeagus, lateral view. **H**. Epandrium, cerci and surstyli, dorsal view. Scale bars: A–B = 1 mm; C–H = 0.25 mm.

Table 1. Reported prey, host plants and localities for *Afrosyrphus schmuttereri* sp. nov. in Kenya (adapted from Schmutterer 1974). Hemipteran names follow Favret (2019) and plant names follow The Plant List (2013).

Prey (Aphidoidea)	Host plant	Locality and dates
Brachycaudus aegyptiacus (Hall, 1926)	*Rumex abyssinicus* Jacq. (Polygonaceae)	Nairobi Co., Chiromo: 11 Sep. 1970, 3 Oct. 1970, 16 Nov. 1970
Brevicoryne brassicae (Linnaeus, 1758)	*Brassica oleracea* L. (Brassicaceae)	Taita-Taveta Co., Taita Hills: 16 Nov. 1970; Nairobi Co., Chiromo: 5 Sep. 1970
Uroleucon compositae (Theobald, 1915)	*Baccharoides lasiopus* (O.Hoffm.) H.Rob. (Asteraceae)	Kiambu Co., Upper Kiambu: 30 Jan. 1970; Nairobi Co., Chiromo: 14 Jul. 1970, 28 Aug. 1970, 3 Oct. 1970, 22 Oct. 1970, 14 Dec. 1970, 22 Jan. 1971
Hyperomyzus lactucae (Linnaeus, 1758)	*Sonchus oleraceus* (L.) L. (Asteraceae)	Nairobi Co., Chiromo: 24 Oct. 1970
Macrosiphum rosae (Linnaeus, 1758)	*Rosa* sp. (Rosaceae)	Nairobi Co., Convent Drive: 7 Oct. 1970, 3 Nov. 1970
Myzus persicae (Sulzer, 1776)	*Solanum seaforthianum* Andrews (Solanaceae)	Nairobi Co., Chiromo: 18 Jan. 1971

Schmutterer (1974) also stated that "in laboratory experiments, mature larvae ready to pupate are quiescent under certain conditions and can survive several weeks without damage". He noted that at constant temperature, low humidity causes the quiescence, and guessed that *Afrosyrphus* spans longer periods of drought as a quiescent larva under field conditions. This could be the reason why adults almost disappear in the highlands of Kenya during dry seasons (Schmutterer 1974).

Ssymank (2012) collected four adult specimens of *A. varipes* between 10:00 and 12:00 at full sun on a hilltop with a single flowering tree, *Phyllanthus discoideus* (Baill.) Müll.Arg. (Euphorbiaceae). However, specimens of the new species from Taita Hills were collected between 10:00 and 11:00, hovering high between large trees in the shade. These specimens were all males and clearly using the opening between the trees on the slope as a landmark while waiting for females to appear. This landmark mating strategy is common in syrphids and similar to hilltopping, but the flies may use any type of landmark from a trail to a forest opening, rocks or a particular tree (Skevington 2008). The trees in the shade were close to the forest margin of a primary lower montane cloud forest (Fig. 1A), in a small valley invaded by the South American invasive angel's trumpet of the family Solanaceae, *Brugmansia suaveolens* (Humb. & Bonpl. ex Willd.) Bercht. & J.Presl. Schmutterer (1974) reported larvae of *Afrosyrphus* feeding on the aphid *Myzus persicae* (Sulzer, 1776) from the closely related invasive *Solanum seaforthianum* Andrews; thus, *B. suaveolens* might be the host plant of the aphids for the *Afrosyrphus* larvae in the Taita Hills area.

Regarding the specimens collected from Bwindi Impenetrable National Park (Uganda), they were collected between 10:00 and 11:00, hovering in a sunspot in dense, moist forest over the top of a small tree approximately 3 m high, at heights of between 3 and 6 m (Fig. 1B). Once the area fell into shade, no more specimens could be found.

The type locality is in Nairobi City, probably the urban park and Nairobi riverside in or near Chiromo. According to the host plants in Table 1 reported by Schmutterer (1974), the vegetation and habitat is ruderal, with tall herb vegetation on deep soils probably adjacent to the Nairobi River. The larvae obviously use different aphid species on a variety of plant families, including aphids living on up to 4 m tall herbs like the spinach rhubarb (*Rumex abyssinicus* Jacq.) and the invasive Brazilian nightshade (*Solanum seaforthianum*). Some humidity may play an important role in supporting good aphid populations and the larval development of *Afrosyrphus*. We assume, based on our own records, that the

primary habitat is forest margins or canopy gaps in lower montane cloud forest, where tall lush herb vegetation naturally grows, and that the type locality represents the secondary habitat type of the species.

Distribution

Species known from Uganda and Kenya (Fig. 2).

Remarks

The material collected and reared by Schmutterer (1972a, 1972b, 1974) was originally identified as *Afrosyrphus varipes*, but our study of this material revealed that it belongs to *A. schmuttereri* sp. nov. The puparium description by Láska *et al*. (2000) was based on material reared by Schmutterer (1974); thus, Láska *et al*. (2000) described the puparium of *A. schmuttereri* sp. nov. Moreover, Láska *et al*. (2000) stated that the immature stages the authors used to describe the puparium of *Afrosyrphus* were collected on 30 Oct. 1970 by Prof. Schmutterer from colonies of the aphid *Brachycaudus aegyptiacus* (Hall, 1926) in Nairobi. After study of all the published works by Schmutterer (1972a, 1972b, 1974), we think that Láska *et al*. (2000) were referring to the material from Chiromo (Nairobi) collected on 3 Oct. 1970, as no other immature specimens were collected in October 1970 in Nairobi on *B. aegyptiacus*. Reared adults from those immatures collected on 3 Oct. 1970 belong to the type series of *A. schmuttereri* sp. nov., i.e., the holotype male (ZFMK-DIP-00067253) and a paratype female (ZFMK-DIP-00067254).

Afrosyrphus varipes Curran, 1927
Figs 1–2, 3A, C, 4A, D, 5A, C–E, 6

Afrosyrphus varipes Curran, 1927: 50 (type locality: Kisangani [=Stanleyville], Democratic Republic of the Congo; holotype, ♂, AMNH, by monotypy).

Differential diagnosis

This species can be distinguished from *A. schmuttereri* sp. nov. as stated in the identification key. Overall a smaller species with slightly narrower abdomen, paler pilosity on calypter fringe, scutum and abdominal segments, and male frontal triangle with pale pruinosity along eye margin (Fig. 4D). Male genitalia as in Fig. 5C–E, with ventrally pointed surstyli and postgonites with a large triangular posterodorsal process (see also Vockeroth 1969: fig. 29). Females are also lighter than in *A. schmuttereri* sp. nov. Tergite 2 is entirely orange in *A. varipes* (with posterior black fascia in A. *schmuttereri* sp. nov.), the femora are only slightly darker than the tibiae (femora darker than tibiae in A. *schmuttereri* sp. nov.), and the face is pale in background colour (black in *A. schmuttereri* sp. nov.). Both sexes have similar hind legs. The hind first tarsomere (= metabasitarsomere) appears dark and bristly due to the presence of long, black pile (Fig. 5A).

Material examined

Holotype

DEMOCRATIC REPUBLIC OF THE CONGO • ♂; Tshopo Province, Kisangani [= Stanleyville]; 1° N, 25.1667° E; ca 460 m a.s.l.; Mar. 1915; Lang and Chapin leg.; based on image at http://research.amnh.org/iz/types_db/details.php?specimen_id=2410; AMNH.

Other material

CAMEROON • 1 ♂, 2 ♀♀; Adamaoua Province, Ngaoundéré, Ranch de Ngaoundaba; 7.12944° N, 13.69556° E; 1265 m a.s.l.; 12 May 2006; A. Ssymank leg.; specimen identifiers: ZFMK-DIP-00015968 to 00015970; ASPC • 1 ♀; same collection data as for preceding; specimen identifier: ZFMK-DIP-00015971; GenBank: MN662551; ZFMK.

DEMOCRATIC REPUBLIC OF THE CONGO • 1 ♂; Tshopo Province, Yambuya; 1.263669° N, 24.552813° E; ca 400 m a.s.l.; 24 Nov. 1913; J. Bequaert leg.; specimen identifier: USNM ENT

00114576; USNM • 1 ♂; North Kivu Province, P.N. Albert, Lesse (near Tungudu); 0.75° N, 29.8° E; 760 m a.s.l.; 21 Jul. 1914; J. Bequaert leg.; specimen identifier: RMCA ENT 000034062; RMCA.

UGANDA • 1 ♀; Central Region, Entebbe, Kisubi Forest; 0.11928° N, 32.52831° E; ca 1160 m a.s.l.; 24 Apr. 1976; M. Paulus leg.; specimen identifier: CNC DIPTERA 102962; GenBank: MN662560; CNC.

Genetics

A total of two specimens was successfully sequenced, one sequence with a length of 627 bp (ZFMK-DIP-0001597, Genbank: MN662551) and another one 307 bp long (CNC DIPTERA 102962, Genbank: MN662560). The obtained COI sequences have an uncorrected pairwise distance of 0.33% and differ by 5.54–6.54% from the COI sequences obtained for *A. schmuttereri* sp. nov.

Distribution

This species has previously been recorded from Cameroon (Ssymank 2012), DRC (Curran 1927, 1938b), Angola and South Africa (Smith & Vockeroth 1980) (see also Dirickx 1998). No specimens from the latter two countries were studied by the present authors, as Smith & Vockeroth (1980) did not provide any information about the records. Here, we present the first records from Uganda. The material from Kenya collected and studied by Schmutterer (1974) was originally identified as *A. varipes*, but it belongs to *A. schmuttereri* sp. nov. Consequently, the presence of *A. varipes* in Kenya needs confirmation, as well as its presence in Angola and South Africa.

MtDNA COI barcodes

The topology of the tree with the highest likelihood (Fig. 6) compared favourably with the Neighbor-Joining tree (not shown). A total of seven specimens were successfully sequenced. The obtained COI sequences have an uncorrected pairwise distance of 0.08–1.52% among the specimens of *A. schmuttereri* sp. nov., 0.33% between the two specimens of *A. varipes* and 5.54–6.54% between the two species of *Afrosyrphus*.

Key to species of **Afrosyrphus** *Curran, 1927*

1. Females: eyes separated above antennae (dichoptic) (Fig. 4B) 3
– Males: eyes joined above antennae (holoptic) (Figs 3B, 4C–D) 2

2. Hind first tarsomere without long, black pile (Fig. 5B). Abdominal tergites 2–4 dark pilose medially and pale pilose laterally, except tergites 2 and 3 pale pilose on anterior margin; tergite 5 dull, pruinose (Fig. 3B, D). Scutellum mostly dark pilose, with some pale pile on anterior and posterior margins (Fig. 3B, D). Ventral calypter fringe with dark pile. Frontal triangle shiny medially, with black pruinosity along eye margin and dorsally (appearing entirely shiny, black; Fig. 4C). Genitalia as in Fig. 5F–H (Kenya, Uganda) .....***A. schmuttereri*** sp. nov.
– Hind first tarsomere with long, black pile on basal ⅓ (Fig. 5A). Abdominal tergites 2–4 entirely pale pilose; tergite 5 shiny (Fig. 3A, C). Scutellum mostly pale pilose, with seldom dark pile (Fig. 3A, C). Ventral calypter fringe with pale pile. Frontal triangle shiny medially, with pale pruinosity along eye margin (Fig. 4D). Genitalia as in Fig. 5C–E (Cameroon, DRC, Uganda, Angola?, South Africa?) .....***A. varipes*** Curran, 1927

3. Hind first tarsomere without long, black pile (Fig. 5B). Tergite 2 with black fascia on posterior margin (Fig. 4B). Face dark in background colour (Kenya, Uganda) .....***A. schmuttereri*** sp. nov.
– Hind first tarsomere with long, black pile on basal ⅓ (Fig. 5A). Tergite 2 entirely orange (Fig. 4A). Face paler, orange in background colour (Cameroon, DRC, Uganda, Angola?, South Africa?) .....***A. varipes*** Curran, 1927

Discussion

The African hover fly fauna remains one of the most poorly collected and studied continental faunas in the world. Finding a new species in a previously monotypic genus is a significant discovery that helps us better understand the morphological boundaries of the lineage. The description of a new species here also reassigns known ecological and larval information previously attributed to *A. varipes*. Further study on *A. varipes* is now warranted, as we can only assume that the larvae perform similar functions. Recent increased interest in the African fauna will undoubtedly turn up many other important new discoveries.

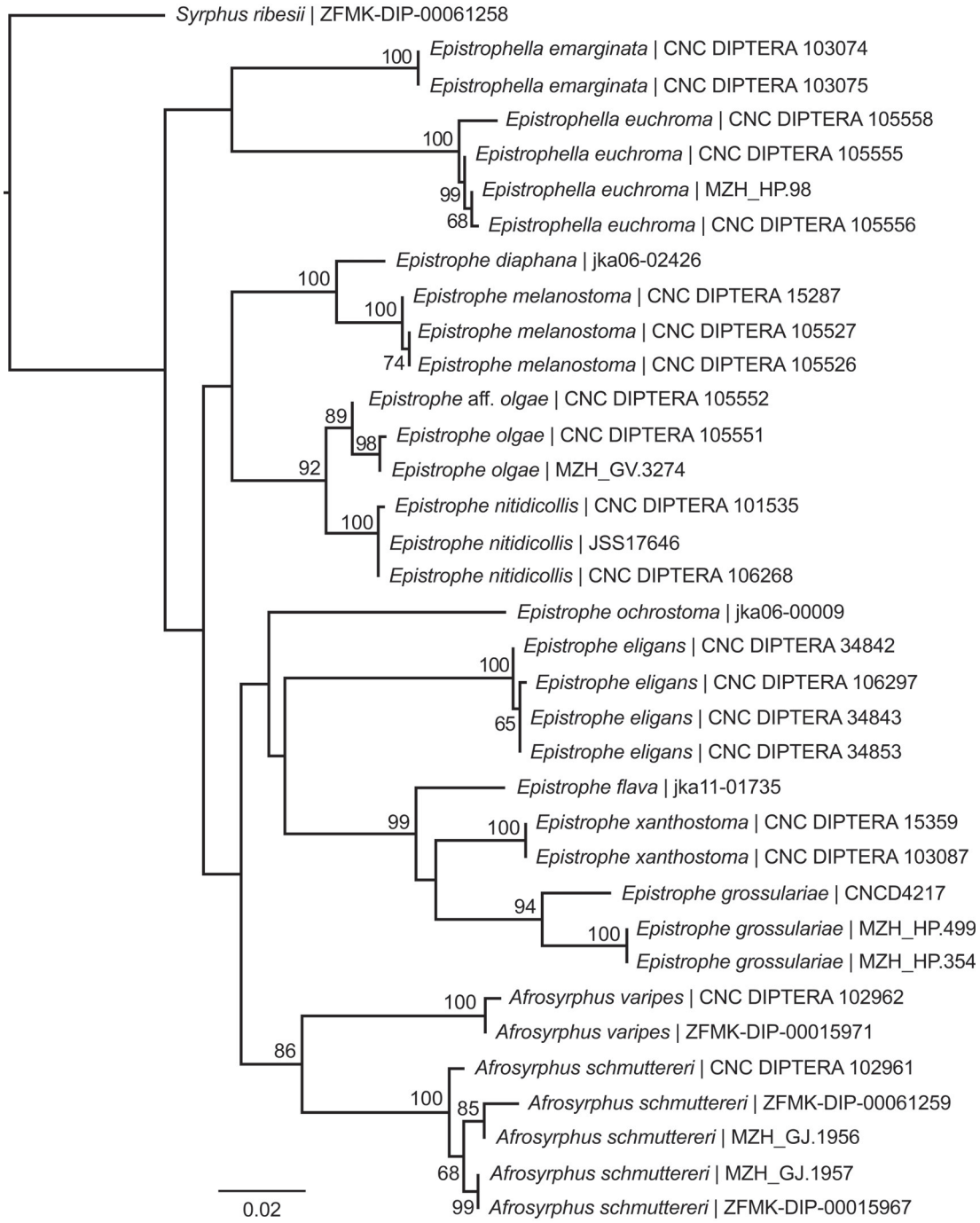

Fig. 6. Maximum-likelihood tree (ln L = -2626.879678) based on COI barcodes, using Garli ver. 2.01. Bootstrap support values are depicted at the nodes (only > 50).

From the currently known geographical distribution and altitudinal range (from ca 1011 to 2314 m a.s.l.) we can assume that *Afrosyrphus schmuttereri* sp. nov. is essentially an Eastern arc Afromontane species (in the Afromontane-Afroalpine Biotic Zone; Happold & Lock 2013), which may potentially occur in and around all lower and higher cloud forest relics, and possibly even southwards up to the Drakensberg in South Africa, although we do not have data. *Afrosyrphus varipes*, on the other hand, seems to be linked to the Rainforest Biotic Zone in the western and central part of the African continent, with a much lower known altitudinal range (from 400 to 1265 m a.s.l.).

A serious threat to the primary habitat of *Afrosyphus schmuttereri* sp. nov. is the rapid loss of natural primary cloud forests in the region (Rogers *et al*. 2008; Wagura 2014) due to overuse of water, as well as spreading corn fields and settlements into the cloud forest areas. We believe that the spraying of pesticides may be an important threat as well, as some of the reported host plants are cultivated as edible plants or for medical use (*Rumex abyssinicus* Jacq. and also *Baccharoides lasiopus* (O.Hoffm.) H.Rob.; see Useful Tropical Plants Database 2019). Consequently, as important pollinators and flower visitors, hover flies should be protected as far as possible by the use of selective pesticides when chemical control measures are applied against homopterous insects. Nevertheless, some agricultural use and anthropogenic changes can promote secondary urban or riverine vegetation, which is obviously suitable for *Afrosyrphus* larvae. The loss of larger areas of the natural cloud forests will inevitably also change the water balance and reduce the available secondary habitats, as brooks and small rivers will dry out and no longer have lush herbaceous vegetation.

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