A new *Eumerus* hoverfly (Diptera: Syrphidae) from Namibia and South Africa, with notes on similar species

ANTONIO RICARTE[1*], MARTIN HAUSER[2], SCOTT KINNEE[2] & Mª ÁNGELES MARCOS-GARCÍA[1]

[1]*Centro Iberoamericano de la Biodiversidad (CIBIO), University of Alicante, 03690 San Vicente del Raspeig, Alicante, Spain. E-mails: ricarte24@gmail.com, marcos@ua.es*

[2]*California Department of Food and Agriculture, Plant Pest Diagnostics, 3294 Meadowview Road, Sacramento, CA 95832-1448, USA. E-mails: phycus@gmail.com, scott.kinnee@cdfa.ca.gov*

[*]*Corresponding author*

Running title: New *Eumerus* from Namibia and South Africa

Abstract

Within the pollinator family Syrphidae, *Eumerus* Meigen, 1822 is a diverse genus with over 70 species recorded in the Afrotropical Region. A new species is described here from Namibia and South Africa. Adults are small to medium size flies, with spur-like expansions in the metatarsomeres 2 and 3. DNA sequences of the Cytochrome *c* oxidase subunit I (COI) gene were obtained from Namibian specimens. This is only the second *Eumerus* species documented from Namibia, where it was recorded from The National Botanic Garden, Windhoek. The new species is compared with similar species such as *Eumerus vestitus* Bezzi, 1912, for which a lectotype is designated. In addition, a new and preliminary morphological concept of the *Eumerus obliquus* group is proposed and a key to its African species is provided.

Key words. Adult morphology, male genitalia, identification key, COI bar code, *Eumerus lyneborgi* sp. nov., *Eumerus vestitus*, lectotype, Afrotropical Region.

INTRODUCTION

Amongst genera of the pollinator family Syrphidae (Larson *et al.* 2001; Rotheray & Gilbert 2011) *Eumerus* is widespread in the Old World, and is the most species rich in the Mediterranean, Central Asia and South Africa. In the Afrotropics, the genus is present from Mauritania to South Africa and on islands in the Atlantic and Indian oceans. Although Leif Lyneborg's unpublished manuscript key to the Afrotropical species of *Eumerus* includes 127 species, only 68 are actually described and/or documented from this region (Smith & Vockeroth *in* Crosskey 1980; Kassebeer 2000; Barkemeyer 2002; Marcos-García *et al.* 2013; Lyneborg *et al.* 2015; Smit *et al.* 2017). Amongst these 68 species, *Eumerus varipennis* Curran, 1938 is the only species recorded from Namibia (Lyneborg *et al.* 2015), although nine other species were recognised to occur in this country by Leif Lyneborg before he passed away (unpublished key). This low species diversity (one species) is clearly a consequence of low collecting activity and even more a lack of publishing. Namibia borders with Angola, Botswana and South Africa, countries with a very uneven knowledge of their *Eumerus* diversity; Angola has one species recorded, Botswana two, and in contrast South Africa 39. Early stages of *Eumerus* are known only for a few of the 250+ species described worldwide. Both saprophagous and phytophagous larvae are known within the genus in association with a wide range of plants and situations (Ricarte *et al.* 2017; Souba-Dols *et al.* 2020). The strong bias in our knowledge of the larval biology of *Eumerus* limits our understanding of the diversification processes and phylogeny of this speciose genus.

During a visit to The National Botanic Garden of Namibia, Windhoek in November 2018, adults of the genus *Eumerus* were collected. The general aim of

this paper is to contribute to knowledge of *Eumerus* diversity in the Afrotropical Region by describing a new species.

MATERIALS AND METHODS

Adults of *Eumerus* were collected in The National Botanic Garden of Namibia, Windhoek in late November 2018. With an extension of 12 hectares of mainly unmodified landscape (Fig. 1A), this garden focuses on Namibian flora and brings together a collection of 254 plant species (National Botanical Research Institute 2020). *Eumerus* adults were spotted flying around Kobas plants (*Cyphostemma* sp) (Vitaceae) (Fig. 1B), which are native to Namibia but introduced in the garden area. Other conspecific adult specimens were found in other collections (see collection acronyms below). All specimens available were added to the new species type series. The new species was compared with morphologically similar *Eumerus* species. For examined material, information of different specimens is separated by a semicolon (;), while information from different labels on the same pin is separated by a bar ('/') in type series lists. Any information on the label format or data printing is detailed in brackets.

INSERT FIG. 1 HERE

DNA sequences of the Cytochrome *c* oxidase subunit I (COI) gene of Namibian adult specimens were generated and analysed by Scott Kinnee. From legs of two adults, gDNA was extracted using a modified non-destructive insect protocol for the DNeasy Blood and Tissue Kit (Qiagen, Valencia, CA). Samples were placed in individual 1.5 mL microcentrifuge tubes with 20 µL Proteinase K solution and 180 µL ATL buffer and incubated for 24 h in a 55 °C water bath. 200 µL manufacturer's AL buffer was added to each tube and sample mixed briefly and incubated at 70 °C for ten min. To each tube 200 µL of 100% EtOH was added and mixed briefly. The mixture was pipetted into DNeasy Spin Columns and standard kit protocol was followed for ethanol washes and elution in 50 µL AE buffer. Extracted DNA was accessioned into the California State Collection of

Arthropods Frozen Tissue Collection (CSCA FTC) and stored in 100% EtOH at -80 °C. A unique identification number was generated by the CSCA database for all DNA vouchers and DNA templates. Primers TY-J-1460 (TACAATTTATCGCCTAAACTTCAGCC) and C1-N-2191 (GGATCACCTGATATAGCATTCCC) (Simon *et al.* 1994) were used for amplification of the standard COI barcode region of the mitochondrial DNA. Polymerase Chain Reaction (PCR) was carried out in a PTC-200 Thermal Cycler (MJ-Research: Bio-Rad, Hercules, CA) with the following conditions: 94 °C for 3 min, 32 cycles of 20 s at 94 °C, 20 s at 50 °C, 30 s at 72 °C, followed by a final extension of 5 min at 72 °C. PCR was performed with the following parameters for each reaction: 5 U Platinum Taq (Invitrogen, Carlsbad, CA), 5 μL of manufacturer's 10X buffer (20 mM Tris –HCl pH 8.4 and 500 mM KCl), 2.5 mM $MgCl_2$, 10 mM dNTP's (Sigma-Aldrich, St. Louis, MO), 0.1 μM each primer, 3 μL of DNA template and ddH_2O to 50 μL. Amplicons were purified using QIAquick PCR & Gel Clean-up Kit (Qiagen) and eluted in 30 μL of manufacturer's EB buffer. Sequencing reactions utilizing the same forward and reverse primers were performed using the Applied Biosystems Big Dye Terminator V3.0 sequencing chemistry on an ABI 3730 DNA capillary sequencer. Electropherograms for the COI gene were edited and aligned with Sequencher version 4.6 (Gene Codes Corporation, Ann Arbor, MI). The GenBank accession numbers are in square brackets in the specimen examined list, all of them start with the letters MN.

When run through Lyneborg's manuscript key to the Afrotropical species of *Eumerus*, the species keyed out to the unpublished name ''Eumerus thompsoni''. We could compare the specimen Lyneborg intended to use as the holotype (deposited in the USNM) for his species with ours and confirmed that they were conspecific. To avoid confusion with additional material Lyneborg labelled as paratypes (in his unpublished key he indicated that there is additional material, but never listed it), we decided to use a different name for this taxon.

The male genitalia were dissected following Ricarte *et al.* (2012). To obtain the length/width ratio of the basoflagellomere, width was measured at its

maximum and length was measured from the most distal point of the pedicel to the basoflagellomere apex. Adult length (L) was measured from the antennal insertions to the tip of the abdomen, while wing length (WL) was measured from the tegula to the apex. Adult images were created as stacks of photos taken with a camera (Leica DFC 450) attached to a binocular microscope (Leica M205 C) and mounted in Leica Application Suite X (LAS X) ®, v. 3.0.4.16529 and, for male genitalia, with a Visionary Digital ™ system at the California Department for Agriculture, Sacramento (USA). The equipment with LAS X was used for measuring lengths. The terminology used in adult descriptions followed Thompson (1999).

Collection acronyms as detailed below are indicated in square brackets ([]) after each specimen or list of specimens deposited in a same institution.

BMSA = National Museum, Bloemfontein, South Africa.

CEUA = Colección Entomológica de la Universidad de Alicante, CIBIO Institute, Alicante, Spain

CNC = Canadian National Collection, Ottawa, Ontario, Canada

CSCA = California State Collection of Arthropods, Sacramento, CA, USA

MCSNG = Museo Civico di Storia Naturale “Giacomo Doria”, Genova, Italy

NMSA = KwaZulu-Natal Museum, Pietermaritzburg, South Africa

RMCA = Royal Museum for Central Africa, Tervuren, Belgium

UQIC = University of Queensland Insect Collection, Queensland, Australia

USNM = National Museum of Natural History, Smithsonian Institution, Washington DC, USA

ZMB = Museum für Naturkunde Berlin, Germany

RESULTS

***Eumerus lyneborgi* Ricarte & Hauser, sp. nov.**

Figs 2–8

Material examined. **Holotype**: 1m#, Namibia, Windhoek, Jardín Botánico ('Botanical Garden'), 27.xi.2018, en ('hovering around') *Cyphostemma* sp (Vitaceae), leg. E. Galante [CEUA] [MN717173]. **Paratypes**: 2f#, Namibia, Windhoek, Jardín Botánico ('Botanical Garden'), 27.xi.2018, en ('hovering around') *Cyphostemma* sp (Vitaceae), leg. E. Galante [CEUA] [MN717174]; 1m#, Willowmore, Capland, Dr. Brauns (printed label) / A L Melander Collection 1961 (printed white & green label) / HOLOTYPE m# 'Eumerus thompsoni' Lyneborg det. 2006 (printed orange label) / USNMENT 01477958 (printed label with barcode) / PARATYPE *Eumerus lyneborgi* (printed yellow label) [USNM]; 1m#, S AFRICA: OFS x 5, SW of Paul Roux, 28 18'S: 27 27'E, 1700m, Date 11.iii.1991, Londt & Whittington, Rocky hill & farmland (printed label) / NMSA-DIP 55489/PARATYPE m# 'Eumerus thompsoni' Lyneborg det. 2006 (printed yellow label) [NMSA]; 2m#, NAMIBIA, Windhoek, National botanical Gardens, -22.5725, 17.0945, 29.XI.2018, A.D. Young [CSCA, CNC] [MN717168]; 1m#, S Africa Eastern Cape, Graaff-Reinet 760m, Urquhart Caravan Park, 32º14'16"S 24º31'42"E, 26-28.x.2004, J&A Londt, Succulent rocky slopes / DNA-RMCA, K. Jordaens 2014 114D07 / NMSA-DIP 65122 [NMSA]; 1m#, RSA: Free State, Brandfort, Florisbad Res. Stat. 28º46.039'S 26º0.4234'E, 17-20.ix.2012, A.H. Kirk-Spriggs / *Eumerus* sp. det. Kurt Jordaens & M. De Meyer / DNA 110E01 K. Jordaens RMCA 2014 / BMSA(D) 36795 / Malaise traps, *Acacia* savanna / Entomology Dept. National Museum P.O. Box 266 Bloemfontein 9300 South Africa (printed in blue label) [BMSA].

The holotype lacks the left mesoleg and metaleg (used for DNA analysis) and has its genitalia stored in a plastic microvial. One of the two CEUA paratypes lack the left proleg, left metaleg, and right mesoleg (all used for DNA analysis), and it is partly covered in fungus hyphae. The specimen from RSA (110E01) was sequenced by Kurt Jordaens (RMCA; currently unpublished) who shared the COI sequence with us. The sequence is identical with ours.

Diagnosis. Small to medium size species (7.5–9 mm, n = 3); eye pilose (Fig. 2); in male, frontal triangle 1.7× longer than eye contiguity; basoflagellomere convex dorsally, straight ventrally (Fig. 2), 1.4–1.5× longer than wide (n = 2); metafemur swollen; metatarsomeres 2 and 3 with a long spur-like expansion posteriorly, less conspicuous in metatarsomere 3 of female (Fig. 3); tergum IV orange posteriorly (orange part sometimes obscured by pollinosity); terga II–IV each with a pollinose fascia posteriorly and a pair of diagonal markings sometimes narrowly connected with the posterior pollinosity (terga II and IV), and approaching each other on the tergum anterior margin (Figs 4, 6A); sterna-IV posterior margin with two roundish expansions leaving a concave region centrally; male genitalia (Fig. 7) with different sets of various-sizes black spinae on the inner side of the surstylus (Figs 8A, B).

INSERT FIG. 2 HERE

INSERT FIG. 3 HERE

Description—*Male* (holotype). L = 8.5 mm, WL = 5.4 mm. *Head* (Figs 2, 4). Eye pilose except for posterior margin and near eye contiguity; eye pile white except for some dark brown pile intermixed dorsally; facets near eye contiguity larger than those in the posterior part of eye; eye contiguity 8-facets or 0.25 mm long; vertical triangle black, pollinose and with long erect black pile intermixed with some light red posteriorly; ocellar triangle isosceles, pollinosity absent from the areas surrounding the ocelli; occiput black, with denser pollinosity on eye margin; occiput pile light red, turning to white from the middle of the occiput to the gena; frontal triangle 1.7× longer than eye contiguity; frontal triangle (including lunules) and face white pollinose, with long white pile; gena black, with white pollinosity; antenna white pollinose, but more sparsely than that of frontal triangle and then the background colour of antenna visible; scape and pedicel black, but pedicel turning to brown at its apex; pedicel black pilose dorsally, white pilose ventrally; basoflagellomere black, except for baso-ventral brown area; basoflagellomere convex dorsally, straight ventrally, and pointing apically; basal third of antennal arista brown, the reminder black; basoflagellomere 1.4× longer than wide. *Thorax* (Figs 3, 4). Scutum, scutellum,

and pleuron black, postpronotum slightly orange; scutum white pollinose laterally and anteriorly, with a medial and two thinner pollinose white vittae at each side of the medial vitta, the lateral vittae crossed by a thin line of pollinosity from the transverse suture to the inner lateral vitta; posterior margin of scutum and scutellum with metallic greenish reflections; scutum black pilose, with pale pile intermixed on anterior and posterior margins, notopleuron, and postalar callus; posterior anepisternum, anepimeron and dorsal part of katepisternum with long white to light-brown pile and densely greyish-white pollinose; scutellum densely greyish-white pollinose on its anterior and posterior margins; scutellum mainly light-brown pilose, with some long black pile intermixed posteriorly; longest scutellum pile over 0.4 mm long; legs black, except for the red to reddish black apices of femora, basis of tibiae, posterior side of metatibia, and protarsomeres 3–4, and meso- and metatarsomeres 5 dorsally; posterior sides of pro- and mesofemora densely greyish-white pollinose and mainly with white to light-yellow pile; metafemur conspicuously swollen (2.8× longer than wide at its maximum width), dorsally greyish-white pollinose, with long white pile dorsally and ventrally; preapical antero-ventral flange of metafemur provided with 11 spinae, postero-ventral flange with nine spinae; apical two thirds of metatibia swollen; metatibia red to reddish black on the posterior side, along its entire length; metabasotarsomere simple, somewhat flattened; metatarsomeres 2 and 3 each, with a long spur-like expansion posteriorly; wing extensively microtrichose, alula bare anteriorly; calypter light yellow, with long light-yellow pile marginally; halter light yellow. *Abdomen* (Fig. 4). Terga II–III black, with posterior margins narrowly and inconspicuously red; tergum IV black, with a semicircular orange area posteriorly; terga I-IV covered in sparse pollinosity, which is denser on the posterior margins of terga II–IV and the lateral margins of terga III and IV; terga II–IV each with a pair of diagonal vittae of dense white (greyish on tergum IV) pollinosity with their outer ends connecting with the lateral and posterior pollinose areas and their inner ends approaching each other at the midpoint of each tergum anterior margin (tergum III with diagonal markings slightly separated from the posterior and lateral pollinose areas); dense markings of pollinosity on

terga coarsely punctuated; terga II–IV with light red pile, except for the black-pilose areas with sparser pollinosity; sterna brown, blackish centrally, with long light-brown pile; sterna-IV posterior margin with two roundish expansions leaving a concave region centrally (Fig. 5). *Genitalia* (Figs 7, 8). Very distinctive, with different sets of various-sizes black spinae on the inner side of the surstylus (Figs 8A, B); anterior lobe of surstylus forming an arm with processes bearing setulae (Figs 7, 8A); hypandrium with a branched process basally (Figs 7, 8D).

INSERT FIG. 4 HERE

INSERT FIG. 5 HERE

Female (Figs 2B, 3B, 6). Same as the male except for the following characters: frons greyish-white pollinose, more sparsely near lunules, besides of the clearer areas surrounding the ocelli; frons, on the area anterior to ocellar triangle, with reddish white pile; lunules red; metafemur with 10–14 spinae on the anterior preapical antero-ventral flange; expansion of metatarsomere 3 less developed than in male; tergum II–III entirely black (Fig. 6); posterior margin of tergum IV inconspicuously red; sternum IV simple in its posterior margin, somewhat excavated centrally.

INSERT FIG. 6 HERE

Etymology. This species is named after Leif Lyneborg who contributed greatly to knowledge of Afrotropical *Eumerus*, and left behind an important manuscript key to the Afrotropical species of *Eumerus* including the one here described. The specific epithet '*lyneborgi*' should be treated as a noun in the genitive case

Distribution. Namibia, South Africa.

INSERT FIG. 7 HERE

INSERT FIG. 8 HERE

Remarks on *Eumerus lyneborgi* sp. nov. and similar species

Eumerus lyneborgi **sp. nov.** is similar to *E. vestitus* Bezzi, 1912 in body size and constitution, predominantly pollinose frons, with punctured pollinosity (females),

swollen metafemur, with two ventral rows of short black spinae, one antero-apically and other postero-apical, lateral margins of terga III and IV pollinose, and tergum IV widely pollinose posteriorly. Bezzi (1912) described *E. vestitus* based on males and females from 'Guinea Portoguese' (nowadays, Guinea-Bissau), supposedly the male and three females the authors of the present paper found in the MCSNG collection. These specimens are all labelled as 'syntypus' and a female has an additional label of 'Typus'. Bezzi (1912) did not mention a holotype or type specimen for his new species in the description. Thus, according to articles 73.1.1 and 73.1.2 of the International Commission on Zoological Nomenclature (1999), this 'Typus' is not a valid holotype and therefore all specimens are syntypes. In addition, no subsequent type designation for *E. vestitus* is known to the authors of the present paper. In the past, curators sometimes labelled arbitrarily as 'Typus' the best looking specimen within the type series (M.A. Alonso-Zarazaga *in lit.*), and this is likely to be the case for this 'Typus' specimen. Thus, lectotype designation is possible for this nominal species in order to stabilise this species concept, especially because it is a mixed type series and the newly described species in this paper is similar to *E. vestitus*. Thus, we here designate the male specimen as lectotype (Fig. 9). All other specimens (females) become automatically paralectotypes (Figs 10, 11).

INSERT FIG. 9 HERE

All specimens of the type series, except for one are recognised to be conspecific. The outlier specimen (female paralectotype) has (1) denser and longer eye pilosity (eye with very short and scattered pile in the other two females) (Fig. 10C, D), (2) slight but obvious pollinosity surrounding posterior ocelli (this same area is shiny or nearly so in the other two females), (3) individual dots of frontal pollinosity very small (larger in the other females) (Fig. 10A, C), (4) basoflagellomere tapering dorsally for the apical two thirds (for the apical half or less, in the other two females) (Fig. 10C, D), (5) metatibia bumped ventrally (less bumped, tending to straight, in the other two females), (6) apex of metatibia without short black spinae (apex of metatibia with two short black spinae in the other two females) (Fig. 11). This outlier female is similar to the female of *E.*

obliquus (Fabricius 1805) (widespread in Africa) and *E. figurans* Walker, 1859 (not recorded from Africa). However, it differs from that of *E. obliquus* in the pollinose vertex (broadly shiny in *E. obliquus*), wide pollinose posterior margin of scutellum (much narrower to almost absent in *E. obliquus*), narrow diagonal vittae of terga III and IV (wider in *E. obliquus*), and shiny posterior margin of tergum IV (extensively pollinose in *E. obliquus*); and differs from the female of *E. figurans* in the pollinose vertex and occiput (vertex and occiput shiny in *E. figurans*), the densely and homogeneously pollinose frons (frons with a medial line of sparser pollinosity in *E. figurans*), and the short spinae of the anteroapical row of metafemur (longer spinae in *E. figurans*). The outlier specimen did not key out with Lyneborg's manuscript key to the Afrotropical species of *Eumerus*, and might represent an undescribed sister species of *E. vestitus*. However, we decided not to describe it as a separate taxon due to the absence of other specimens, including males with conspecific morphology.

INSERT FIG. 10 HERE

Additional examined material of other Eumerus *species*. Type series of the nominal species, *Eumerus vestitus* Bezzi, 1912. **Lectotype**: 1m#, GUINEA PORTOGUESE, *Rio Cassine*, ~~XII.1899~~-IV.1900. L. Fea (part of the date crossed out as indicated) / SYNTYPUS m# *Eumerus vestitus* Bezzi, 1912 (on pink label). **Paralectotypes**: 1f#, GUINEA PORTOGUESE, *Rio Cassine*, ~~XII.1899~~-IV.1900. L. Fea (part of the date crossed out as indicated) / vestitus Bezzi / TYPUS (printed in red) / *Eumerus vestitus* n. sp. (handwritten on a pink label; 'n. sp.' is an interpretation of the actual label lettering) / SYNTYPUS f# *Eumerus vestitus* Bezzi, 1912 (on pink label) / Museo Civico di Genova; 2f#, GUINEA PORTOGUESE, *Rio Cassine*, ~~XII.1899~~-IV.1900. L. Fea (part of the date crossed out as indicated) / SYNTYPUS f# *Eumerus vestitus* Bezzi, 1912 (on pink label) / Museo Civico di Genova [MCSNG]. The male syntype lacks the antennae and the right prolegs, and the head is pasted to thorax in its original position. The female syntype labelled as 'typus' lacks the left basoflagellomere, while another female lacks the left metatarsus. There were specimens from Egypt, donated by Becker to Bezzi and found by this latter author that they were erroneously identified as *E.*

obliquus, mentioned in the original description, which we could not locate. Additional material of *Eumerus vestitus*: 2m#, 1f#, Egypt, Cairo, Gizera, 24.ix.1992, leg. M. Hauser [CSCA]; 1m#, Egypt, Luxor, Westbank of Nile river 25.694N 32,628E, 1.iv.2018 leg Schmid-Egger [CSCA]; 1m#, Tunisia, Monastir, 15km S Sousse, 28.vi.1994, leg. M. Hauser (first record of *E. vestitus* from Tunisia) [CSCA].

INSERT FIG. 11 HERE

Eumerus obliquus: AFRICA. 1f#, 'Cap. B. Spei.' [South Africa, Cape of Good Hope], Coll. H. Loew, *obliquus F* (hand written); 1m#, Africa, Coll. H. Loew [ZMB]; 1f# [published in Marcos-García *et al.* (2013)], Île de la Réunion (France), Les Avirons, 24.vi.2010, Leg.: N. Estela Ribera, Det. as *E. obliquus* by A. Ricarte & M.A. Marcos-García in 2010 (CEUA00105083) [CEUA] ; 1m#, 2f#, Mozambique, Sofala Prov. Gorongosa Park, small lake, 18°56'39"S 34°26'35"E, 300m, ex Malaise, 19-30.iv.2015 leg. M. Hauser & A. Rung [CSCA]; 1m#, Zambia Southern Prov., Livingston, 17.842 S 15.857 E, 960m, 1.v.2016, leg M. Hauser & CJ Borkent [CSCA]; 1m#, Zambia, Northern Prov. 8.8 km WSW Kakumbi, S Luangwa NP, 22-26.iv.2016, 525m, 13.115 S 31.726 E, Malaise trap, leg. M. Hauser, CJ Borkent & DM Ndalamei [CSCA]; 1m#, Mali 30 km N Bamako, 20.vii.1991, leg. M. Schwarz [CSCA]; 1m#, Ghana, Northern Region, Mole National Park, 165m, 09°15'33"N 01°51'43"W, Malaise trap, 28-30.iv.2014 leg. S. Gaimari & M. Hauser [CSCA]; 1m#, Tunisia, Monastir, 15km S Sousse, 28.vi. 1994, leg. M. Hauser [CSCA]. AUSTRALIA. 1f# with puparium, Palmwoods, nr Nambour, Qld, C. Hayward, emerged 17.v.1986, ex rotting guava infested with larvae of *Dacus tryoni* (UQIC Reg #94996) [CSCA]. EUROPE. 1f#, Spain (mainland), Alicante, San Juan, 01.iv.2020, Leg. M.A. Marcos; 1f# [published in Ricarte *et al.* (2008)], Spain, Balearic Islands, Mallorca, Ses Salines, P/29.x.2005, Leg.: M.A. Marcos-García (#6844), Det. as *E. obliquus* by A. Ricarte in 2006 (CEUA00084841). *Eumerus obliquus* is widespread all over Africa, also found in the Canary and various Mediterranean islands, as well as in mainland Europe: Spain (first records in the present paper), southern France and

Italy (Speight 2020). This species is also introduced in Australia and South America (Garcete-Barrett *et al.* 2020).

A female of *Eumerus punctifrons* Loew, 1857 with the following data: Tunis, 62285 [ZMB].

Photos of the holotype of *Eumerus figurans* Walker, 1859 at the Natural History Museum, London, available at https://www.nhm.ac.uk/.

Key to the African species of the *Eumerus obliquus* group

The *Eumerus obliquus* group as defined in the discussion includes *E. incilis* Smit *in* Smit *et al.* (2017), *E. lyneborgi* **sp. nov.**, *E. obliquus*, *E. unicolor* Loew, 1858 [= *E. wainwrighti* (Curran, 1938)] and *E. vestitus*.

1. Face below antennae polished black, without pollinosity; scutum shiny, without a pattern of pollinose markings or only with a faint vestigial pattern; tarsomeres 4 and 5 of all legs black, contrasting conspicuously with the reddish brown tarsomeres 1−3; male eyes separated by a distance equalling the width of the anterior ocellus … ***E. unicolor***

- Face below antennae always pollinose; scutum with a conspicuous pattern of pollinose markings, more reduced but still conspicuous in *E. incilis* [see figure 39 and 40 in Smit *et al.* (2017)]; tarsi of all legs either uniform in colour or with a dark gradient towards the apex; male eyes holoptic … 2

2. Metatarsomere 2 with a conspicuous apical extension (Fig. 3A, B); male metabasotarsomere unmodified … ***E. lyneborgi* sp. nov.**

- Metatarsomere 2 without apical extensions; male metabasotarsomere strongly modified in most species, simple in *E. punctifrons* … 3

3 Metatibia with 2−3 short black apical spinae (Fig. 11A); posterior half of tergum IV extensively pollinose … 4

- Metatibia without apical spinae (Fig. 11B); tergum IV shiny between the two diagonal pollinose vittae and the posterior margin of tergum … 5

4 Eye with short sparse pile; metabasotarsomere brown (Fig. 9B) and, in male, with a small basal tooth in the sulcus [see figure 30 in Smit *et al.* (2017)] … ***E. vestitus***

- Eye usually bare; metabasotarsomere black and, in male, without teeth in the dorsal sulcus [see figure 27 in Smit *et al.* (2017)] … ***E. incilis***

5 Vertex with black pile and extensive areas free of pollinosity or sparsely pollinose [see figure 4A in Garcete-Barrett *et al.* (2020)]; male metabasotarsomere laterally compressed, with a dorsal ridge [see figure 4E in Garcete-Barrett *et al.* (2020)] … ***E. obliquus***

- Vertex without black pile, covered in dense pollinosity except for a narrow area surrounding each ocellus [see figure 57 in Smit *et al.* (2017)]; male metabasotarsomere without ridge … ***E. punctifrons***

DISCUSSION

The new species here described represents the second documented finding of a *Eumerus* hoverfly in Namibia, after *E. varipennis* (Lyneborg *et al.* 2015). *Eumerus lyneborgi* **sp. nov.** has some characters which places it in relationship with *E. vestitus* (see Results), as well as *E. incilis*, *E. unicolor*, *E. punctifrons* and *E. obliquus.* All these species are robust and of similar body size; with eyes meeting for a certain linear distance in males; extensively and densely pollinose frons (female), thorax and abdomen, pollinosity conspicuously punctured in many body regions (e.g. female frons); the punctuation on the body is always very deep and clear, but not necessarily dense; hind margin of scutellum pollinose for a variable extension; swollen metafemur; short tarsomeres, often modified in metalegs (either with extensions like in *E. lyneborgi* **sp. nov.** or with ridges like in *E. vestitus*). However, these species can be readily separated from the new species by the male genitalia morphology (*E. incilis*: see Smit *et al.* 2017), shape of the metabasitarsomere (*E. obliquus*), or eye pilosity (very short and sparse in *E.*

vestitus). Smit *et al.* (2017) defined the *E. obliquus* group rather narrow and included only species with a dorsal ridge on the metabasitarsomere in males, although in his key, *E. punctifrons* is in close proximity to his *E. obliquus* group. We define the *E. obliquus* group wider and include all the above mentioned species (see key provided under results). It is very likely that this group will include more species, but this would be beyond the scope of this paper and a study should also include molecular data of other species. The male genitalia of *E. lyneborgi* **sp. nov.** are also distinctive, with many black spinae arranged in different ways on the inner side of the surstylus (Figs 8A, B).

Species of the Asian *Eumerus figurans* group can also, especially in females, resemble members of the *E. obliquus* group. They can be distinguished by the rim of the scutellum, which is always black in the *E. obliquus* group (but dusted with white pubescence), while in the *E. figurans* group the chitin at the rim of the scutellum is distinctly yellow coloured. The *E. figurans* group includes *Eumerus figurans*, with several undescribed closely related species, as well as *Eumerus rufoscutellatus* Brunetti, 1913 and *Eumerus pulcherrimus* Brunetti, 1915. In Africa *Eumerus feae* Bezzi, 1912 also has a yellow rim at the scutellum and there are multiple undescribed species in Africa similar to *E. feae*. The relationships between these species and species groups need to be more thoroughly investigated.

According to the examined specimens and morphological notes in Lyneborg's unpublished key, the new species appears to be variable in the following characters: body length (7–9 mm); eye contiguity length (0.15–0.25 mm); density of eye pile; colour of scutellum pile (from all pale yellowish to some black pile intermixed with the pale yellowish pile); length of long scutellum setae (from 0.3 to 0.4 mm or more); colour of pro- and mesofemora (from black with very narrow yellow-brown apex, to dark brown with a widely yellow-brown apex); tarsomeres colour (from black to brownish black, tarsomere 5 sometimes somewhat yellow brown); number of spiny setae on the preapical anteroventral flange of metafemur (11–13); length of anteroventral carina of metatibia (up to half of the tibia length); shape and size of pollinose fasciae in terga 3 and 4 (from

narrowly united at the tergum midline to well separated, sometimes not reaching the tomentose lateral vittae of terga).

As the National Botanic Garden of Namibia (Windhoek) area is mainly unmodified highland savannah (National Botanical Research Institute 2020) (Fig. 1A), we suggest this might be one of the preferred adult habitats of *E. lyneborgi* **sp. nov.**. Other paratypes were collected in *Acacia* savannahs and succulent rocky slopes in the Republic of South Africa, coinciding essentially with the type of environment and vegetation found in the botanical garden in Windhoek. The termophilous nature of the *Eumerus* hoverflies is also confirmed with the findings of this new species, since the collected specimens were flying in a slope without shadow at a day time of high insolation (3:30 to 4:30 pm, local time). The finding of this new species addresses the need to further survey the hoverfly diversity of this world region, and search breeding sites to understand the requirements of this poorly known insect community of Africa.

ACKNOWLEDGEMENTS

We thank very much Eduardo Galante and Andrew Young for collecting the adults found in The National Botanic Garden of Namibia, Windhoek. We also thank Torsten Dikow for loaning us further specimens of the new species deposited at the USNM and Maria Tavano (MCSNG) for loaning the *E. vestitus* syntypes. Thanks to Michael Ohl and Jenny Pohl for arranging the loan of *E. obliquus* specimens of Loew's Collection. We are grateful to M.A. Alonso-Zarazaga for his nomenclatural advice. Many thanks to John Smit, Kurt Jordaens and Snežana Radenković for discussions and their insight into this group, as well as sharing their unpublished COI barcode with us. In addition, J. Smit and K. Jordaens are thanked for their useful reviews of the present paper. Thanks to Eduardo Galante and José Manuel Miquel to facilitate photos to illustrate this paper. Antonio Ricarte's position (Ref. UATAL05) at the University of Alicante is funded by the 'Vicerrectorado de Investigación y Transferencia de Conocimiento'. This

study belongs to Project PGC2018-095851-A-C65 of the Spanish Ministry of Science, Innovation and Universities.

No conflict of interests exist.

REFERENCES

Barkemeyer, W. (2002) Zur Syrphidenfauna der Kapverdischen Inseln (Diptera: Syrphidae). *Mitteilungen des Internationalen Entomologischen Vereins e.v. Frankfurt am Main*, 27, 9–28.

Bezzi, M. (1912) Ditteri raccolti da Leonardo Fea durante il suo viaggio nell' Africa occidentale. Parte 1ª: Syrphidae. *Annali del Museo civico di storia naturale di Genova*, 45, 400–453.

Brunetti E. (1913) New and interesting Diptera from the eastern Himalayas. *Records of the Indian Museum*, 9, 255–277.

Brunetti, E. (1915) Notes on Oriental Syrphidae: with descriptions of new species. Part II. *Records of the Indian Museum*, 11, 201–256.

Curran, C.H. (1938) Records and descriptions of African Syrphidae.—I (Diptera). *American Museum Novitates*, 1009, 1–15.

Fabricius, J.C. (1805) *Systema antliatorum secundum ordines, genera, species adiectis synonymis, locis, observationibus, descriptionibus*. Reichard, Brunsvigae, 373 pp.

Garcete-Barrett, B.R., Morales, M.N., Hauser, M., Smit, J.T., González, L., Ramírez De López, M.B., Arias, O., Adorno, M., Sormanti, G. & Mereles, A. (2020) New geographical records and key to the species of *Eumerus* Meigen, 1823 (Diptera, Syrphidae) introduced into the Americas and Hawaii. *Revista Brazileira de Entomologia*, 64(1), 1–6.

International Commission on Zoological Nomenclature (1999) *International Code of Zoological Nomenclature, 4th edition*. The International Trust for Zoological Nomenclature, London, UK.

Kassebeer, C.F. (2000) Die Schwebfliegen (Diptera, Syrphidae) von La Réunion, mit Anmerkungen zur Fauna der Madagassis. *Dipteron*, 3(1), 43–66.

Larson, B.M.H., Kevan, P.G. & Inouye, D.W. (2001) Flies and flowers: taxonomic diversity of anthophiles and pollinators. Canadian Entomologist, 133, 439–465.

Loew H. (1857) Nachricht über syrische Dipteren. *Verhandlungen des zoologisch-botanischen Vereins in Wien*, 7, 79–86.

Lyneborg, L., Pape, T. & Thompson, F.C. (2015) New Afrotropical eumerine flower fly synonyms (Diptera: Syrphidae). *Entomologist's Monthly Magazine*, 151, 117–124.

Marcos-García, M.A., Ricarte, A. & Estela, N. (2013) An updated hoverfly checklist (Diptera: Syrphidae) of the Mascarene Island of Réunion, France. *Journal of the Entomological Research Society*, 15, 59–68.

Meigen, J. W. (1822) *Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten*. Dritter Theil. Schulz-Wundermann, Hamm. x + 416 pp.

National Botanical Research Institute (2020) The National Botanic Garden. Available from http://www.nbri.org.na/sections/botanic-garden (accessed 15 April 2020)

Ricarte, A., Marcos-García, M.A. & Rotheray, G.E. (2008) The early stages and life histories of three *Eumerus* and two *Merodon* species (Diptera: syrphidae) from the Mediterranean region. *Entomologica Fennica*, 19, 129–141.

Ricarte, A., Nedeljković, Z., Rotheray, G.E., Lyszkowski, R.M., Hancock, E.G., Watt, K., Hewitt, S.M., Horsfield, D. & Wilkinson, G. (2012) Syrphidae (Diptera) from the Greek island of Lesvos, with description of two new species. *Zootaxa*, 3175, 1–23.

Ricarte, A., Souba-Dols, G.J., Hauser, M. & Marcos-García, M.A. (2017) A review of the early stages and host plants of the genera *Eumerus* and *Merodon* (Diptera: Syrphidae), with new data on four species. *PLoS ONE*, 12(12), e0189852. https://doi.org/10.1371/journal.pone.0189852

Rotheray, G.E. & Gilbert, F.S. (2011) *The Natural History of Hoverflies*. Forrest Text, Cardigan, UK, 334 pp.

Simon, C., Frati, F., Beckenbach, A., Crespi, B., Liu, H. & Flook, P. (1994) Evolution, weighting and phylogenetic utility of mitochondrial gene-sequences and a compilation of conserved polymerase chain-reaction primers. *Annals of the Entomological Society of America*, 87, 651–701.

Smit, J.T., van Harten, A. & Ketelaar, R. (2017) Order Diptera, family Syrphidae. The hoverflies of the Arabian Peninsula. *In*: van Harten, A. (Ed), Arthropod fauna of the UAE, 6. Department of the President's Affairs, Abu Dhabi, UAE. pp. 572–612.

Smith, K.G.V. & Vockeroth, J.R. (1980) Family Syrphidae. *In*: Crosskey, R.W. (Ed), *Catalogue of the Diptera of the Afrotropical Region*. British Museum, London, pp. 488–510.

Speight, M.C.D. (2020) Species accounts of European Syrphidae, 2020. Syrph the Net, the database of European Syrphidae (Diptera). *Syrph the Net publications, Dublin*, 104: 1–314.

Souba-Dols, G.J., Ricarte A., Hauser, M., Speight, M. & Marcos-García, M.A. (2020) What do *Eumerus* larvae feed on? New immature stages of three species (Diptera: Syrphidae) breeding in different plants. *Organisms Diversity & Evolution*, 20, 267–284.

Thompson, F.C. (1999) A key to the genera of the flower flies of the Neotropical Region including the descriptions of genera and species and a glossary of taxonomic terms. *Contributions on Entomology, International*, 3, 319–378.

Walker, F. (1859) Catalogue of the dipterous insects collected at Makessar in Celebes, by Mr. A. R. Wallace, with descriptions of new species. *Journal of the proceedings of the Linnean Society*, 3–4, 90–172.

Figure captions

FIGURE 1. Habitat of *Eumerus lyneborgi* **sp. nov.** at The National Botanic Garden of Namibia, Windhoek. A: unmodified highland savannah landscape (Photo: José Manuel Miquel); B: Kaoko Kobas, *Cyphostemma uter* (Vitaceae), where *E. lyneborgi* **sp. nov.** adults were spotted flying (Photo: Eduardo Galante).

FIGURE 2. *Eumerus lyneborgi* **sp. nov.**, head, semi-lateral view. A: male, holotype; B: female, paratype (Namibia). Scale bar = 0.5 mm.

FIGURE 3. *Eumerus lyneborgi* **sp. nov.**, metatarsus. A: male, holotype, scale bar = 0.25mm; B: female, paratype (Namibia), scale bar = 0.5 mm. Legend: e, spur-like expansion.

FIGURE 4. *Eumerus lyneborgi* **sp. nov.**, male, holotype, overall appearance. A: dorsal view; B: lateral view. Scale bar = 1 mm.

FIGURE 5. *Eumerus lyneborgi* **sp. nov.**, male, holotype, sternum IV. Scale bar = 0.75 mm.

FIGURE 6. *Eumerus lyneborgi* **sp. nov.**, female, paratype (Namibia), overall appearance. A: dorsal view; B: lateral view. Scale bar = 2 mm.

FIGURE 7. *Eumerus lyneborgi* **sp. nov.**, male, paratype (unpublished paratype of 'E. thompsoni', Namibia), genitalia. Legend: a, anterior lobe of surstylus; b, basal process of hypandrium; c, cercus; h, hypandrium; p, spina of the inner side of surstylus; s, surstylus.

FIGURE 8. *Eumerus lyneborgi* **sp. nov.**, male, paratype (Namibia), genitalia. A: epandrium, dorsal view; B: epandrium, lateral view; C: hypandrium, dorsal view; D: hypandrium, lateral view. Scale bar = 0.5 mm.

FIGURE 9. *Eumerus vestitus*, male, lectotype, body, overall appearance. A: dorsal view with original labels; B: lateral view. Scale bar = 1 mm.

FIGURE 10. *Eumerus vestitus*, females, paralectotypes, frons (A, B), antennae and eyes (C, D). A, C: specimen with typical *E. vestitus* morphology; B, D: outlier specimen (non-conspecific?). Scale bar = 0.5 mm.

FIGURE 11. *Eumerus vestitus*, females, paralectotypes, metatibiae. A: specimen with typical *E. vestitus* morphology; B: outlier specimen (non-conspecific?). Scale bar = 0.25 mm.