Phylogenetic relationships of the bacchine flower flies (Diptera: Syrphidae) based on molecular characters, with a description of a new species of *Melanostoma* (Schiner, 1860)

Ximo Mengual  
Zoologisches Forschungsmuseum Alexander Koenig,  
Adenauerallee 160, 53113 Bonn, Germany  
x.mengual@leibniz-zfmk.de

Abstract

The phylogenetic relationships among the genera of the tribe Bacchini *sensu lato* (i.e., Syrphinae with simple, unsegmented aedeagus) were inferred using molecular evidence. The mitochondrial protein-coding gene cytochrome c oxidase subunit I (COI) and the nuclear ribosomal 28S and 18S rRNA genes for 54 bacchine taxa were analyzed using Bayesian inference and Maximum Likelihood. Among the analyzed taxa there is a new species of *Melanostoma* (Schiner) from Cameroon, *Melanostoma janeceki* Mengual, sp. nov., which is described in full. This new species has a complete metasternum without excavation, a characteristic that is not present in other species of *Melanostoma*, usually with an excavated metasternum, but it is the diagnostic character of the genus *Afrostoma* Skevington, Thompson & Vockeroth. Based on the phylogenetic placement of *Melanostoma janeceki* Mengual, sp. nov. the taxonomic status of *Afrostoma* as a genus is discussed and a new generic classification of Bacchini stat. rev. and Melanostomini stat. rev. is presented in the light of the inferred phylogeny. Results did not recover Bacchini *sensu lato* monophyletic, but into two groups as follows: *Melanostoma* and related genera, and *Baccha, Platycheirus* and related genera. *Pseudoplatychirus* van Doesburg is considered junior synonym of *Platycheirus* Le Peletier & Audinet-Serville, and *Afrostoma* Skevington, Thompson & Vockeroth as junior synonym of *Melanostoma*. *Pyrophaena* Schiner and *Eocheilosia* Hull comb. nov. are ranked as valid genera, and consequently, the genus *Platycheirus* is divided into four subgenera: *Platycheirus* (Carposcalis) (Enderlein), *Platycheirus* (Pachysphyria) (Enderlein), *Platycheirus* (Platycheirus), and *Platycheirus* (Tuberculanostoma) (Fluke) comb. nov.

Keywords

*A frostoma* – bacchine – Bacchini – melanostomine – Melanostomini – new synonym
Introduction

Commonly known as flower flies or hoverflies, syrphids (Diptera: Syrphidae) are distributed worldwide, absent only in remote oceanic islands and Antarctica (Thompson & Rotheray, 1998). While adults feed on pollen and nectar, larvae have a large array of natural histories (Ureña & Hanson, 2010; Rotheray & Gilbert, 2011; Pérez-Lachaud et al., 2014; Fleischmann et al., 2016). Syrphid species have been used as bioindicators (Sommaggio, 1999; Tscharntke et al., 2005; Ricarte et al., 2011; Sommaggio & Burgio, 2014), and they contribute to very important ecosystem services, such as pollination, biological control of pests or decomposition of organic matter (Lardé, 1989; Schmidt et al., 2004; Bergh & Short, 2008; Bugg et al., 2008; Ssymank & Kearns, 2009; Morales & Wolff, 2010; Martínez-Falcón et al., 2012; Nelson et al., 2012; Inouye et al., 2015).

The family is currently divided into four subfamilies, namely Microdontinae, Eristalinae, Pipizinae, and Syrphinae (Mengual et al., 2015), although some authors prefer to consider the microodontines as a different family (Thompson, 1969; Speight, 1987, 2018). Phylogenetically, Pipizinae and Syrphinae form a clade (Ståhls et al., 2003; Hippa & Ståhls, 2005; Mengual et al., 2015; Young et al., 2016a) whose members have primarily predatory larvae (Rotheray, 1993; Rojo et al., 2003; Downes et al., 2017). However, some Syrphinae species have become phytophagous secondarily (Nishida et al., 2002; Weng & Rotheray, 2008; Reemer & Rotheray, 2009; Zuijen & Nishida, 2011; Dumbardon-Martal, 2016). Vockeroth (1969) divided the subfamily Syrphinae into six tribes, namely Bacchini, Melanostomini, Paragini, Toxomerini, Chrysotoxini and Syrphini. Later, Vockeroth (1992) rearranged his tribal system with the currently accepted four tribes: Bacchini, Paragini, Toxomerini, and Syrphini. This current tribal classification of Syrphinae needs a revision based on recent molecular studies, where Bacchini and Syrphini were never resolved as monophyletic (Mengual et al., 2008a, 2012, 2015; Mengual & Thompson, 2011; Mengual, 2015; Young et al., 2016a; Pauli et al., 2018).

Classically, Bacchini is defined as Syrphinae taxa with the aedeagus of the male genitalia rather simple, undivided (Vockeroth, 1969, 1992), and face and scutellum entirely black. The coloration of the face and scutellum is no longer a defining characteristic for Bacchini as there are Bacchini species with pale parts of the face (Vockeroth, 1990; Thompson, 1999) and Syrphini species with face and scutellum entirely black (Vockeroth, 1969, 1990; Huo, 2014). The tribe Bacchini *sensu lato*, hereafter the members of Syrphinae with a simple aedeagus, has undergone several modifications in its definition, mostly due to the concept of the genus *Baccha* Fabricius, 1805, which ended up to an extremely diverse tribe (Vockeroth, 1969). Bigot (1883) was the first to use a name to refer a suprageneric group, Bacchidae. Since Williston (1885) separated them into Melanostominae and Bacchini, in almost every case where the author distinguished between Melanostomini (also wrongly written as Melanostomatini; see Sabrosky, 1999) and Bacchini, the latter included several genera and species of Syrphini placed under *Baccha* (Williston, 1885; Hull, 1949; Wirth et al., 1965; Vockeroth, 1969; Shatalkin, 1975). Thompson et al. (1976) made a major rearrangement redefining the genus *Ocyptamus* Macquart, 1834 and placing it within Syrphini, which helped in the current definition of Bacchini, but the current concept of Bacchini *sensu lato* is based mostly on Vockeroth (1992) and Thompson (1999).

Although the members of Bacchini were accepted without major controversy, generic definitions have been unclear and the systematic status of some supraspecific taxa was unstable (Thompson & Rotheray, 1998; Mengual...
et al., 2008a; Láska et al., 2013; Young et al., 2016a). Young et al. (2016b) gave a precise background on how the genera *Platycheirus* Le Peletier & Audinet-Serville, 1828 and *Melanostoma* Schiner, 1860 have been defined historically. Nowadays the genus *Melanostoma* only includes species with an excavated metasternum (Andersson, 1970), and the metasternum with an anterior excavation is established as the diagnostic character to separate this genus from the other bacchines (Andersson, 1970; Barkalov, 2009). The latest member to be part of Bacchini *sensu lato* was described by Thompson & Skevington (2014), the monotypic genus *Afrostoma* Skevington, Thompson & Vockeroth, 2014. Besides the description of their new genus, Thompson & Skevington (2014) also provided an excellent outline of the tribe Bacchini *sensu lato* since its origin and gave a synopsis for each genus. Thompson & Skevington (2014) used DNA barcodes (Hebert et al., 2003a, b) to place their new genus *Afrostoma* in a phylogenetic context and stated some diagnostic characteristics, i.e., lack of male secondary characters in legs (as in *Melanostoma*, but usually present in many *Platycheirus* species), metasternum without basolateral excavation (as in *Platycheirus*, but the diagnostic character for *Melanostoma*), antennal pits confluent, and male genitalia without synapomorphies of *Platycheirus*. At first glance, *Afrostoma* looks like a *Melanostoma* without metasternal excavation and male genitalia of *Melanostoma* species (Fluke, 1957) are overall very similar to those of *Afrostoma*. Male genitalia characters are rather distinct between *Afrostoma* and *Platycheirus*, the two genera close to *Melanostoma* with metasternum not excavated: i.e., *Platycheirus* has surstyli with a long, slightly curved lateral lobe, and a short, stout basomedial lobe (sustyli elongate and simple in *Afrostoma*, with a small tubercle instead of a basomedial lobe); *Platycheirus* has postgonites usually slender with a hook-like process (postgonites massive, solid, irregular in shape in *Afrostoma*), and the distiphallus in *Platycheirus* is slightly expanded at apex (distiphallus notched in *Afrostoma*) (Fluke, 1957; Thompson & Skevington, 2014; Young et al., 2016b).

Recent phylogenetic studies have resolved the tribe Bacchini *sensu lato* into two or three different clades, grouping genera related to *Melanostoma* in one clade, and genera related to *Platycheirus* in another (Mengual, 2015; Mengual et al., 2015; Young et al., 2016a), and sometimes, resolving the genus *Baccha* in its own evolutionary lineage (Rotheray & Gilbert, 1999; Ståhls et al., 2003; Mengual et al., 2008a). Only the phylogeny by Hippa & Ståhls (2005) based on morphological characters have inferred all these groups into a single clade. The proposed classification of Shatalkin (1975), with Melanostomini divided into Platycheirina and Melanostomina (see Thompson, 1972), reflects most of the present phylogenetic relationships among Bacchini. In this study, Shatalkin (1975) placed *Baccha* under Bacchini together with *Ocyptamus* (currently in Syrphini) and *Allobaccha* Curran, 1928 (currently also in Syrphini), and his Melanostomini was equivalent to the current Bacchini with the exclusion of *Baccha*.

The present author gathered molecular data during some years to study more closely the phylogenetic relationships among Bacchini *sensu lato*. To perform the analysis we used three molecular markers: almost the entire mitochondrial protein-coding gene cytochrome c oxidase subunit I (COI), the D2–D3 region of the nuclear ribosomal 28S rRNA gene, and a small fragment of the nuclear ribosomal 18S rRNA gene. The aims of this study are twofold: (i) to infer the phylogenetic relationships of the tribe Bacchini *sensu lato* based on molecular characters and the largest taxon sampling up-to-date; and (ii) to describe a new species of *Melanostoma* from...
Cameroon without metasternal excavation. Consequently, a new generic classification of Bacchini stat. rev. and Melanostomini stat. rev. is presented and some taxonomic actions are carried out: _Pseudoplatychirus_ van Doesburg, 1955 is considered junior synonym of _Platycheirus_ and _Afrostoma_ as junior synonym of _Melanostoma_. _Pyrophaena_ Schiner, 1860 and _Eocheilosia_ Hull, 1949 comb. nov. are ranked as valid genera, and consequently, the genus _Platycheirus_ is divided into four subgenera: _Platycheirus_ (Carposcalis) (Enderlein, 1938), _Platycheirus_ (Pachysphyria) (Enderlein, 1938), _Platycheirus_ (Platycheirus), and _Platycheirus_ (Tuberculanostoma) (Fluke, 1943) comb. nov.

**Material and methods**

**Taxonomy**
The new species of _Melanostoma_ was collected during the field work done by Vlašáňková et al. (2017) in the Mendong Buo area (6.592699°N, 10.189999°E; 2100–2200 m above sea level), ca. 5 km south-east of Big Babanki, in the Bamenda Highlands, North-West Province, Cameroon. This new species to science is refereed as _Melanostoma_ sp. in Vlašáňková et al. (2017). In the present study, the division between Bacchini sensu stricto and Melanostomini stated by Thompson & Skevington (2014) will be followed to discuss the results.

New species is described in full with terminology following Thompson (1999) and Cumming & Wood (2017). In the description of type labels, the contents of each label is enclosed within double quotation (“”), italics denote handwriting, and the individual lines of data are separated by a double forward slash ( // ). At the end of each record, between square brackets ([ ] ) and separated by a comma, the number of specimens and sex, the holding institution, and the unique identifier or number are given. The abbreviations used for collections follow the standard of the Systema Dipterorum (Thompson, 2013), and their equivalents are given below:

- **BMNH**: The Natural History Museum, London, UK.
- **NBC**: Naturalis Biodiversity Center, Leiden, The Netherlands.
- **MNHN**: Muséum National d’Histoire Naturelle, Paris, France.
- **ZFMK**: Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany.

All measurements are in millimeters and were taken using a reticle in a Leica M165 C microscope. Photographs were composed using the software Zerene Stacker 1.04 (Richland, Washington, 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 (version 5.6). Body length was measured from the anterior oral margin to the posterior end of the abdomen, in lateral view. Wing length was measured from the wing tip to the basicosta.

**Taxon sampling for molecular analyses**
The selection of taxa for this study was based on Thompson & Skevington (2014) (see fig. 1). Members of all genera and subgenera of Bacchini and Melanostomini were included in the analysis, with the exception of _Afroxanthandrus_ Kassebeer, 2000 and _Xanthandrus_ (Androsyrphus) Thompson, 1981 because there were no available specimens for the present molecular study. A total of 90 taxa were used in the analyses, including 54 bacchine and melanostomine taxa. Table 1 lists the species included in the analysis, the collection data and the GenBank accession numbers. Some new species to science, which will be described in following publications, were included as well and they are indicated in fig. 2 as ‘sp.n.’ plus the lab code in brackets.
Outgroups and the Syrphini taxa included in this work were selected based on previous phylogenetic works and current knowledge. Microdon mutabilis (Linnaeus, 1758) was constrained as outgroup as all previous phylogenies resolved Microdontinae as the sister...
| Taxa                              | Locality information                                                                 | Lab code     | Accession No. COI | Accession No. 28S | Accession No. 18S |
|-----------------------------------|---------------------------------------------------------------------------------------|--------------|-------------------|-------------------|-------------------|
| OUTGROUP                          |                                                                                       |              |                   |                   |                   |
| Microdon mutabilis (Linnaeus, 1758) | UK: England, Cumbria, Whiborrow, IV.2004. Leg.: S.M. Hewitt. Det.: M. Reemer.          | MZH_Y149     | EU431494          | EU431463          | EU431537          |
| Eristalinae                       |                                                                                       |              |                   |                   |                   |
| Neoascia tenur (Harris, 1780)     | THE NETHERLANDS: De Wiechen, Afoort co., 199–521, 31.VII.2007. Leg.: M.P. van Zuijen. Det.: M.P. van Zuijen. | MZH_XP220    | EU431489          | EU431458          | EU431526          |
| Eumerus ovatus Loew, 1848         | FRANCE: Dep. Bas-Rhin, Selestat, Forêt de l'Ill, 184 m., 23.VI.2005. Leg.: M.P. van Zuijen & J. van Steenis. | MZH_Y463     | EU431483          | EU431452          | EU431518          |
| Pipizinae                         |                                                                                       |              |                   |                   |                   |
| Clausenia hispanica (Strobl, 1909)| GREECE: Samos island, IV.2011. Leg.: A. Vujić. Det.: A. Vujić.                       | MZH_Y1452    | HF542942          | HF542912          | KM224476          |
| Cryptopipiza notabilis (Violovitsh, 1985) | SWEDEN: Smålånd, Skärvete, Skirö, 23.VI.2010. Leg.: N. Johansson. Det.: G. Ståhls. | MZH_Y1330    | KM224456          | KM542914          | KM224473          |
| Heringia heringi (Zetterstedt, 1843) | GREECE: Lesvos, nr. Agiassos, 08.V.2007. Leg.: A. Vujić. Det.: A. Vujić.              | MZH_Y984     | HF542944          | HF542915          | KM224477          |
| Neocnemodon intensica (Curran, 1921) | CANADA: Quebec, Gatineau Co., Masham Twp., hilltop nr Duncan Lake, 21.VII.2001. Leg.: J. & A. Skevington. | MZH_Y1012    | HF542948          | HF542919          | KM224479          |
| Pipiza quadrimaculata (Panzer, 1804) | FINLAND: Ka, Joutseno, Riikanmaa, KKJ-Y 3591:6777, 05.VII.2007. Leg.: M.P. van Zuijen & W. & J. van Steenis. Det.: G. Ståhls. | MZH_XP218    | EU431506          | EU431474          | EU431562          |
| Pipizella certa Violovitsh, 1981  | SWEDEN: Ds Skållerud, Ryrs naturreservat, RN 652.492–9 130725–9. Leg.: Nils Ryholm. Det.: G. Ståhls. | MZH_XP119    | KM224518          | KM224501          | KM224475          |
| Trichopsomyia lasiotibialis Fluke, 1937 | PERU: Madre de Dios, rio Tambopata, Sachavacayoc centre, 12°51′S 69°22′W, 4.IX.2009. Leg.: J. T. Smit. | MZH_Y1121    | HF546068          | HF546074          | KM224484          |
| Triglyphus fulvicornis Bigot, 1884 | AUSTRALIA: Tasmani, Lake St. Clair NP, Shadow Lake circuit, AMG 55 429–5337, 850 m., 22.I.2006. Leg.: W. van Steenis. | MZH_XP113    | EU431508          | EU431476          | EU431564          |
| Syrphinae                         |                                                                                       |              |                   |                   |                   |
| Allograpta obliqua (Say, 1823)    | USA: Utah, Garfield Co., Alvoy Wash, 7 km S Escalante, 37°42.5′N 11°37.8′W, 1900 m., 29.VI.2002. Leg.: M.E. Irwin & F. Parker. Det.: F.C. Thompson. | MZH_XP38     | EF127310          | EF127389          | EU241833          |
Argentinomyia catabomba (Williston, 1891)  
COLOMBIA: Dpto Valle del Cauca, Cali, Cerro San Antonio, 2200 m., 03°29.137′N 76°33.596′W, 24.II.2006. Leg.: X. Mengual. Det.: X. Mengual.

Argentinomyia longicornis (Walker, 1836)  
COLOMBIA: Dpto Valle del Cauca, Cali, Cerro San Antonio, 2175 m., 15.II.2006. Leg.: X. Mengual. Det.: X. Mengual.

Argentinomyia luculenta (Fluke, 1945)  
PERU: Cuzco, Est. Biol. Wayqecha, Trocha Oso near 2nd landslide, Malaise trap 6, WP 532, 13°1.1°S 71°35.075′W, 2806 m., 8–11.XII.2011. Leg.: Norrbom, Steck, Sutton & Nolazco. Det.: X. Mengual.

Argentinomyia neotropica (Curran, 1937)  
ARGENTINA: Jujuy Prov., 36 km S Jujuy, Arroyo Las Lanzas, Malaise trap in wooded, damp wash, 24°27.25′S 65°17.83′W, 1278 m., 27.X–14.XI.2003. Leg.: M.E. Irwin, F.D. Parker. Det.: X. Mengual.

Argentinomyia sp.  
ECUADOR: Zamora-Chinchipe Prov., Cantón Zamora, Sector San Francisco, Páramo, 2600 m., 26.VII–11.VIII.2012, Malaise, 3°59.488′S 79°7.655′W. Leg.: X. Mengual. Det.: X. Mengual.

Argentinomyia sp. nov.1  
COSTA RICA: Páramo, Cerro de la Muerte, 14.I.2005. Leg.: F.C. Thompson. Det.: X. Mengual.

Argentinomyia sp. nov.2  
COSTA RICA: PN Tapantí, Estación La Esperanza, 2800 m, 13.I.2005. Det.: F.C. Thompson.

Baccha elongata (Fabricius, 1775)  
FINLAND: Ta, Vesijako, Malaise Trap. 2004. Leg.: J. Jakovlev. Det.: G. Ståhls.

Baccha maculata Walker, 1852  
MALAYSIA: Sabah (Borneo), Penampang Distt., Crocker Range, Ulu Kalanggan, Dipterocarp tree, 5°51.383′N 116°18.484′E, 1350 m., 20.X.2011. Leg.: M. Hauser & S. Gaimari. Det.: X. Mengual.

Chrysotoxum intermedium Meigen, 1822  
SPAIN: Alicante, Ibi, E.B. Torretes, 18.V.2007. Leg.: X. Mengual. Det.: X. Mengual.

Dasysyrphus albostriatus (Fallén, 1817)  
THE NETHERLANDS: Leiden, Meijendel dune area, 5.IX.2005. Leg.: excursion participants. Det.: G. Ståhls.

Didea intermedia Loew, 1854  
FINLAND: Espoo, VII.2001. Leg.: G. Ståhls.
| Taxa                          | Locality information                                                                 | Lab code | Accession No. COI | Accession No. 28S | Accession No. 18S |
|-------------------------------|---------------------------------------------------------------------------------------|----------|------------------|------------------|------------------|
| Eocheilosia aff. harrisi      | NEW ZEALAND: Waikato, N of Taupo, paintball camp, 576 m., 38°31.283′S 176°2.35′E,   | ZFMK-AHE | ZFMK_AHE266       |                   |                  |
|                               | 38°31.283′S 176°2.35′E, 14–16.XII.2017, Malaise trap, Beech forest.                  |          |                  |                  |                  |
| Platycheirus (Eocheilosia)     | CHILE: Region IV, Limari Prov., Furduto-Aguas Amarillas, 7 km N Los Vilos, 31°50.96′S 71°29.60′W, 28.XII.2003-8.XII.2004 |          |                  |                  |                  |
| Eosipogonester compadri        | SPAIN: Alicante, PN, Manjil-Pego-Obila, Muntanya Vereda, 19.07.2007                   |          |                  |                  |                  |
| Episperus balteatus           | RUSSIA: Komyr-Tolomé, Turoshhatsky-kordon obsho, 38°59′.30′, 2000-3.                  | MZH XP 53 | EU431346          |                  |                  |
| Eriozona syrphoides           | SPAIN: Alicante, P.N. Marjal Pego-Oliva, Muntanya Vereda, 19.07.2007                  |          |                  |                  |                  |
| Eupeodes corollae             | SOUTH AFRICA: Kwazulu Natal N.P., trail to The Crack, 1600 m., 09.XII.2012, 28°41.072′S 28°56.245′E |          |                  |                  |                  |
| Fazia centropogonis           | COSTA RICA: PN Tapanti, Estación La Esperanza, 2600 m., 13.01.2005                     |          |                  |                  |                  |
| Ischiodon aegyptius           | PANAMA: Fortuna Reserve, 1200 m., 8°41.76′N 82°13.2′W, 23.VIII.2012                  |          |                  |                  |                  |
| Leucopodella bigoti           | ECUADOR: Zamora-Chinchipe Prov., Canton Zamora, Podocarpus sp., 2000, 3°58.3′S 79°4.864′W |          |                  |                  |                  |
| Leucopodella gracilis         | COSTA RICA: PN Tapanti, 1600 m., 12.X.2005                                          |          |                  |                  |                  |
| Leucopodella sp. (gracilis complex) | COSTA RICA: PN Tapanti, 1600 m., 12.X.2005                                          |          |                  |                  |                  |
| Leucopodella sp. nov.1         | ECUADOR: Zamora-Chinchipe Prov., Canton Zamora, Podocarpus sp., 2000, 3°58.3′S 79°4.864′W |          |                  |                  |                  |

Table 1: Taxa used in the molecular analyses, including GenBank accession numbers. GenBank accession (cont.)
Leucopodella sp. nov.2
VENEZUELA: Lara, El Cercado, 10°07′N 69°14′W, 530 m., 1.I.2015. Leg.: E. Arcaya. Det.: X. Mengual.

Leucopodella sp. nov.3
COLOMBIA: Dpto Caldas, Manizales, Corrg. Las Palomas, Reserva Natural Río Blanco. 18.II.2006, 2200–2500 m., 5°04′N 75°26.2′W. Leg.: C. Gutierrez. Det.: X. Mengual.

Leucopodella sp. nov.4
COLOMBIA: Dpto Valle del Cauca, Cali, Cerro San Antonio, 2200 m., 15.II.2006. Leg.: C. Gutiérrez. Det.: X. Mengual.

Leucopodella sp. nov.5
PERU: Cuzco, Est. Biol. Wayqecha, Trocha Oso ner 2nd landslide, Malaise trap 6, WP 532, 13°11.07′S 71°35.075′W, 2806 m., 8–11.XII.2011. Leg.: Norrbom, Steck, Sutton & Nolazco. Det.: X. Mengual.

Leucozona (Leucozona) lucorum (Linnaeus, 1758)
ITALY: South Tirol, Val Venosta, VII.2001. Leg.: G. Ståhls. Det.: G. Ståhls.

Megasyrphus erraticus (Linnaeus, 1758)
FINLAND: Ab, Karislojo, Karkalinniemi, V.2004. Leg.: G. Ståhls. Det.: G. Ståhls.

Melangyna (Melangyna) lasiophthalma (Zetterstedt, 1843)
FINLAND: N, Mäntsälän Mustametsä, 10.V.2003. Leg.: G. Ståhls. Det.: G. Ståhls.

Melanostoma annulipes (Macquart, 1842)
MADAGASCAR: Fianarantsoa Prov., road from Valbio to Ranomafana, 25.XI.2004. Leg.: X. Mengual. Det.: X. Mengual.

Melanostoma diffusum Hull, 1941
MADAGASCAR: Fianarantsoa Prov., Ranomafana N.P., Sakarao region, 26.XI.2004. Leg.: X. Mengual. Det.: X. Mengual.

Melanostoma janeceki Mengual, sp. nov.
CAMEROON: North-West Prov., Bamenda Highlands, 5km SE Big Babanki, Mendong Buo area, 6°5.434′N 10°18.15′E, 2100–2200 m., XI.2012. Leg.: S. Janeček. Det.: X. Mengual.

Melanostoma janeceki Mengual, sp. nov.
CAMEROON: North-West Prov., Bamenda Highlands, 5km SE Big Babanki, Mendong Buo area, 6°5.434′N 10°18.15′E, 2100–2200 m., XI.2012. Leg.: S. Janeček. Det.: X. Mengual.

Melanostoma janeceki Mengual, sp. nov.
CAMEROON: North-West Prov., Bamenda Highlands, 5km SE Big Babanki, Mendong Buo area, 6°5.434′N 10°18.15′E, 2100–2200 m., XI.2012. Leg.: S. Janeček. Det.: X. Mengual.
| Taxa                                      | Locality information                                                                 | Lab code    | Accession No. COI | Accession No. 28S | Accession No. 18S |
|-------------------------------------------|--------------------------------------------------------------------------------------|-------------|------------------|------------------|------------------|
| *Melanostoma mellinum* (Linnaeus, 1758)   | GERMANY: 2015. Det.: X. Mengual.                                                     | ZFMK_D140  | MK751096         | MK751067         | MK751100         |
| *Melanostoma scalare* (Fabricius, 1794)   | FINLAND: Ok, Kuhmo, Lentuankoski, 15.VIII.2006. Leg G. Stähls. Det.: G. Stähls.     | MZH_Y441   | EU431500         | EU431468         | EU431549         |
| *Melanostoma polynesiotes* Mengual & Ramage, 2018 | FRENCH POLYNESIA: Tahiti, Tahiti iiti – sentier vers le Mt Atara, 20.IX.2012 (fauchage), 17°47.375′S 149°14.899′W, 825 m. Leg.: T. Ramage. Det.: X. Mengual. | ZFMK_D269  | MF446515         | MF446466         | MF446421         |
| *Melanostoma quadripunctatum* (Skevington & Thompson, 2014) [previously Afrostoma quadripunctatum] | KENYA: Western Prov., Kakamega Forest, 00°14.13′N 34°51.87′E, 30.VIII–5.IX.2000, Malaise trap. Leg.: R. Copeland. Det.: F.C. Thompson. (USNM ENT 00036401) | SYCNC010–13 | KF919067         |                   |                   |
| *Melanostoma sylvarum* Hull, 1941         | MADAGASCAR: Fianarantsoa Prov., Ranomafana N.P., Talatakely region, Valbio Center. 18.XI.2004. Leg.: X. Mengual. Det.: X. Mengual. | MZH_XP54   | MK751037         | MK751068         |                   |
| *Melanostoma univittatum* (Wiedemann, 1824) | INDONESIA: Northern Sulawesi, Tamarares, Langowan [Lagoon]. 1°08′N 124°50′E, 1°30′–1°50′E, 13–20.VIII.2004. Leg.: M. Meray, M.F. & C. Dien. Det.: X. Mengual. | MZH_XP47   | EF127314         | EF127393         | MK751101         |
| *Meligranna guttata* (Fallén, 1817)       | FINLAND: Ab, Nietoinen, Perkko, 6733:222, 21.VII.2004. Leg.: A. Haarto. Det.: G. Stähls. | MZH_Y478   | EF501960         | EF501968         | KM270800         |
| *Meliscaeva cinctella* (Zetterstedt, 1843) | CZECH REPUBLIC: Bohemia, PLA Jizerske mountains, Korenov, 12.VI.2005. Leg.: L. Mazánek. Det.: L. Mazánek. | MZH_S557   | EU241743         | EU241791         | EU241845         |
| *Ocyptamus funebris* Macquart, 1834       | COSTA RICA: San José, Heredia, INBioparque, 15–21.I.2005, Malaise trap. Det.: F.C. Thompson. | MZH_S487   | EF127364         | EF127443         | EU409242         |
| *Orphnabaccha calda* (Walker, 1852)       | ECUADOR: Zamora-Chinchepe Prov., Cantón Zamora, Carretera Viejía, Point 1, 1500 m., 7.VIII.2012, 3°57′33′S 79°1′633′W. Leg.: X. Mengual. Det.: X. Mengual. | ZFMK_D038  | MK751038         | MK751069         | MK751102         |
| *Paragus (Pandasyophthalmus) haemorrhous* Meigen, 1822 | SPAIN: Alicante, 2000. Leg.: A. Vujić. Det.: A. Vujić. | MZH_S48    | AY174470         | AY476866         | EU409259         |
Parasyrphus macularis (Zetterstedt, 1843)  
GERMANY: Nordrhein-Westfalen, NP Eifel, 50°30.484′N 6°15.034′E, Gut Heistert, Perlenbachtal Aue, Kalterherberg, 533 m., 17.V.2012. Leg. A. Symank. Det. A. Symank.

Pelloloma nigrifacies Vockeroth, 1973  
SOUTH AFRICA: Woodcliffe, Naude’s Nek, Maclear, Eastern Cape, 2500 m., 30°43.9′S 28°8.216′E, 09.II.2016. Leg.: A. Vujić. Det.: A. Symank.

Platycheirus (Carposcalis) chalconotus (Philippi, 1865)  
COLOMBIA: Dpto Caldas, Villamaría, via al Nevado del Ruiz, Sector El 8, 3500 m., 19.II.2006. Leg.: C. Gutierrez. Det.: X. Mengual.

Platycheirus (Carposcalis) spinipes Vockeroth, 1990  
COLOMBIA: Dpto Caldas, Villamaría, via La Esperanza km 8, 2530 m., 19.II.2006. Leg.: C. Gutierrez. Det.: X. Mengual.

Platycheirus (Pachysphyria) coerulescens (Williston, 1887)  
USA: NE, Sioux Co., Harrison 6 mi. NNE, Gilbert Baker SWMA, 18.IV.2004. Leg.: J. & W. van Steenis. Det. W. van Steenis.

Platycheirus (Platycheirus) albimanus (Fabricius, 1781)  
SWEDEN: 2000. Leg.: J. van Steenis. Det.: J. van Steenis.

Platycheirus (Platycheirus) nielseni Vockeroth, 1990  
SWEDEN: 2000. Leg.: J. van Steenis. Det.: J. van Steenis.

Platycheirus (Platycheirus) antennatum (Fluke, 1943) [previously Tuberculanostoma antennatum (Fluke, 1943)]  
COLOMBIA: Dpto Caldas, Villamaría, via al Nevado del Ruiz, Sector El 8, 3500 m., 19.II.2006. Leg.: F.C. Thompson. Det.: X. Mengual.

Platycheirus (Tuberculanostoma) sp. nov.1 [previously Tuberculanostoma sp. nov.1]  
PERU: Cuzco, Acjanaco, WP 540, 13°11.954′S 71°37.074′W, 3519 m., 9.XII.2011. Leg.: Norrbom, Steck, Sutton & Nolazco. Det.: X. Mengual.
| Taxa                                      | Locality information                                                                 | Lab code  | Accession No. COI | Accession No. 28S | Accession No. 18S |
|------------------------------------------|---------------------------------------------------------------------------------------|-----------|-------------------|-------------------|-------------------|
| Pyrophaena granditarsa (Forster, 1771)   | THE NETHERLANDS: Leiden, Kortenhof fen area, 5.IX. 2005. Leg.: J. van Steenis. Det.: G. Ståhls. | MZH_S563  | EF127321          | EF127400          | EU431551          |
| Pyrophaena rosam (Fabricius, 1787)       | GERMANY: Nordrhein-Westfalen, Nationalpark Eifel, Winterberg 05–19.VIII.2012, Malaise, 405 m, 50°36.441’N 6°24.651’E. Leg.: J. Esser. Det.: X. Mengual. (ZFMK-TIS-2861) | ZFMK_D203 | MK751045          | MK751076          | MK751109          |
| Rohdendorfia alpina Sack, 1938           | ITALY: Stelvio Pass. Leg.: G. Ståhls. Det.: G. Ståhls. | MZH_G344  | EF127338          | EF127420          | EU431552          |
| Rohdendorfia bella Mengual, 2019         | INDIA: Jammu and Kashmir State, Ladakh, near Tso Moriri (lake), 32°54’N 78°1’8’E, 5333 m, 25–28.VIII.2010. Leg.: I. Abela-Hofbauerová. Det.: X. Mengual. | ZFMK_D268 | MH282897          | MH282902          | MH282904          |
| Salpingogaster nigra Schiner, 1868        | COLOMBIA: Dpto Meta, PNN Sumapax, Cabaña Las Miras, 710 m, 3°48’N 73°52’W, 29.V–19.VI.2004. Leg.: H. Vargas. Det.: X. Mengual. | MZH_XP77  | EU241748          | EU241796          | EU241853          |
| Scaeva pyrastr (Linnaeus, 1758)           | SPAIN: Alicante, 1999. Det.: S. Rojo. | MZH_S57   | EF127329          | EF127410          | EU431553          |
| Sphazigaster ambulans (Fabricius, 1978)   | AUSTRIA: Inst. Leg.: J. van Steenis. Det.: J. van Steenis. | MZH_S158  | EF127350          | EF127431          | KM270811          |
| Sphaerophoria scripta (Linnaeus, 1758)    | SPAIN: Alicante, Aspe, Partida Tolomó, 07.II.2006. Leg.: P. Hurtado. Det.: X. Mengual. | MZH_XP142 | EU241752          | EU241800          | EU241860          |
| Syrphocheilus claviventris (Strobl, 1910) | ITALY: South Tirol, Stelvio Pass, 28.VII.1999. Leg.: G. Ståhls. Det.: G. Ståhls. | MZH_G327  | EF127334          | EF127415          | KM270812          |
| Syrphus vitripennis Meigen, 1822          | GREECE: Lesbos island, IV.2001. Leg.: S. Rojo & C. Perez. Det.: S. Rojo. | MZH_S53   | AY212797          | AY261728          | EU431554          |
| Talahuia fervida (Fluke, 1945)            | COLOMBIA: Dpto Bocayá, SFF Iguaque, Lagunillas, 5°25’N 73°27’W, 3380 m., 28.VI–19.VII.2001. Leg.: P. Reina. Det.: X. Mengual. | MZH_XP56  | MK751046          | MK751077          | MK751110          |
| Toxomerus marginatus (Say, 1823)          | USA: New York, Geneva, VII.1999. Leg.: M. Schmaedick. Det.: F.C. Thompson. | MZH_S64   | AY261705          | AY261752          | EU431555          |
| Xanhdhans (Xanhdhans) agrolas (Walker, 1849) | AUSTRALIA: Tasmania, Mt Field NP, Lake Belcher Track, AMG 55 468–5273, 110 m, 21.I.2006. Leg.: W. van Steenis. Det.: X. Mengual. | MZH_XP110 | MK751050          | MK751081          | MK751114          |
| Xanhdhans (Xanhdhans) bucephalus (Wiedemann, 1830) | ECUADOR: Zamora-Chinchipe Prov., Cantón Zamora, Carretera Vieja, Point 2, 4°1.613’S 79°0.564’W, 27.VII.2012, 1230 m. Leg.: X. Mengual. Det.: X. Mengual. | ZFMK_D073 | MK751051          | MK751082          | MK751115          |
| Species                                      | Location Details                                                                 | GenBank Accession Numbers   |
|----------------------------------------------|----------------------------------------------------------------------------------|-----------------------------|
| **Xanthandrus (Xanthandrus) talamaui**        | CHINA: Sichuan Prov., Ya’an, Baoxing, Dengchigou, christian church of priest Armand David, 30°22.534’N 102°49.733’E, 1600–1800 m., 13.VI.2014, sweeping. Leg.: J. Hájek, J. Růžička, M. Tkoč. Det.: X. Mengual. | ZFMK_D241 MK751052 MK751083 MK751116 |
| **Xanthandrus (Xanthandrus) comatus**         | GREECE: Lesbos island, IV.2001. Leg.: S. Rojo & C. Pérez. Det.: G. Ståhls.        | MZH_S121 EF127340 EF127422 EU431556 |
| **Xanthandrus (Xanthandrus) plaumanni**       | COLOMBIA: Dpto Valle del Cauca, Cali, Cerro San Antonio, 2200 m., 03°29.137’N 76°33.596’W, 24.II.2006. Leg.: X. Mengual. Det.: X. Mengual. | MZH_XP98 KM270876 KM270844 KM270813 |
| **Xanthogramma pedissequum**                  | GREECE: Lesbos island, IV.2001. Leg.: S. Rojo & C. Pérez. Det.: S. Rojo.          | MZH_S120 EF127339 EF127421 EU431557 |
| **Xanthandrus (Xanthandrus) ruficorne**       | AUSTRALIA: Tasmania, Mt. Field np, Lake Belcher Track, AMG 55 468–5273, 1100 m., 21.I.2006. Leg.: M.P. van Zuijen & W. van Steenis. Det.: W. van Steenis. | MZH_XP122 MK751053 MK751084 MK751117 |
Figure 2  Maximum-likelihood tree based on the combined dataset (COI, 28S, and 18S) using Garli v.2.1.17 and the structural alignment for 28S and 18S. Bootstrap support values (above) and Bayesian posterior probabilities (below) are depicted at the nodes (only >50 or >0.5, respectively). BS = Bootstrap support values; PP = Bayesian posterior probabilities.
group of (Eristalinae + (Pipizinae + Syrphinae)); the same argument is valid for the inclusion of all genera of Pipizini plus *Eumerus ovatus* Loew, 1848 and *Neoascia tenur* (Harris, 1780). Members of Bacchini and Melanostomini were resolved as sister taxa of the other tribes of Syrphinae in previous works. Thus, in order to have a general view of the subfamily Syrphinae and to avoid any bias in the results due to taxon sampling, several Syrphini genera were also included in the analysis (see table 1).

**DNA extraction and sequencing**

A large fragment of the mitochondrial cytochrome c oxidase subunit I (COI) gene, a fragment of the nuclear 18S rRNA gene (variable region V4), and the D2–D3 region of the nuclear 28S rRNA gene were used to performed the analyses. One to three legs, the entire abdomen or the entire specimen, either dry pinned or ethanol preserved, were typically used for DNA extraction. Extractions were carried out using the NucleoSpin Tissue DNA Extraction kit (Machery-Nagel, Düren, Germany) following manufacturer's instructions; samples were resuspended in 100 μl ultra-pure water. Remnants of specimens were preserved and labelled as DNA voucher specimens and deposited at the Zoological Museum of the Finnish Museum of Natural History [MZH] and at the Zoological Museum Alexander Koenig [ZFMK], as listed in table 1.

DNA primers and PCR amplification protocols for mitochondrial COI, and nuclear 28S and 18S rRNA genes were the same as described in Mengual et al. (2008b, 2015) and Rozo-Lopez & Mengual (2015). Amplified DNA was electrophoresed on 1.5% agarose gels for visual inspection of amplified products. PCR products were enzymatically treated with ExoSap-IT (USB, Cleveland, oh, USA) or were cleaned using the commercially available QIAquick PCR Purification Kit (QIagen®). Bidirectional sequencing reactions were carried out by Macrogen® Inc. Chromatograms were edited for base-calling errors and assembled using Geneious 7.1.3 (Biomatters® Ltd).

**Sequence alignment**

The alignment of the protein-coding COI gene was done manually and it was not necessary to include gaps in this alignment. A total of 1,128 nucleotide characters were obtained for the COI data matrix. The 18S and 28S rRNA genes were aligned using the secondary structure of these genes, as explained by Kjer (1995) and implemented in Mengual et al. (2012, 2015) and Mengual (2015). The aligned small fragment of 18S used in this analysis had a total sequence length of 370 bp including gaps (ranging from 350 bp to 356 bp without gaps), and the D2–3 region of 28S a total of 658 bp including gaps (ranging from 562 bp to 589 bp without gaps). The final dataset had 2,156 bp.

**Barcoding analysis**

Thompson & Skevington (2014) used DNA barcodes of the Bacchini sensu lato genera to place *Afrostoma* into phylogenetic context. Although the utility of a fragment of a single gene for phylogenetic inference is questionable (see Doyle, 1992; Nichols, 2001; Hebert & Gregory, 2005, among others), the present author followed the analytical methodology used by Thompson & Skevington (2014), explained in Skevington & Thompson (2012), in order to incorporate the new species of *Melanostoma* without metasternal excavation to the same data matrix and to be able to compare the results of the barcoding analysis with the phylogenetic analysis based on three molecular markers. DNA sequences for the 5′ end of the COI gene for the species analyzed by Thompson & Skevington (2014) were downloaded from GenBank and three sequences from the new *Melanostoma* species from Cameroon were added to the matrix (658 bp of the 5′ end).
Bayesian inference using the Markov Chain Monte Carlo algorithm as implemented in MrBayes 3.2.6 (Huelsenbeck & Ronquist, 2001; Ronquist & Huelsenbeck, 2003) was performed using a parallelized version of the software. Data were not divided into partitions following Thompson & Skevington (2014). The best model of evolution for the data was determined using jModelTest 2.1.5 (Darriba et al., 2012) under the Akaike Information Criterion (AIC). The model chosen was GTR+I+G. Four chains (three hot, one cold) were run simultaneously for 500,000 generations, which were sufficient to bring the convergence (average standard deviation) to a value <0.009 (Ronquist et al., 2005). Trees were sampled every 100 generations, the temperature was set to 0.2 and the number of runs to 6. The initial 1,250 trees (25%) were discarded as burn-in and Bayesian posterior probabilities (PP) were calculated using a 50% majority-rule consensus tree inferred from the data (fig. 1).

**Phylogenetic analyses**

The Maximum Likelihood analysis and the Bayesian inference were performed two times each, one without the COI barcode sequence of *Afrostoma quadripunctatum* Skevington & Thompson, 2014, and a second time with the inclusion of this short sequence (647 bp) to evaluate the phylogenetic position of this species even with only a partial sequence of one of the three sequenced genes. For the analytical runs the data set was divided in five partitions: first codon position of COI, second codon position of COI, third codon position of COI, 28S gene and 18S gene. The best evolutionary model that fit the data was chosen each partition using jModelTest 2.1.5 (Darriba et al., 2012) under the Akaike Information Criterion (AIC), as recommended by Posada and Buckley (2004). The model chosen for position 1 of COI was GTR+I+G, TIM1+I+G for position 2 and TIM3+I+G for position 3. The model GTR+I+G was selected for 28S and the preferred model for 18S was TVM+I+G. The inclusion of the COI sequence of *Afrostoma quadripunctatum* did not change the model selection.

Data was analyzed under the recommended models using Garli v.2.1.17 (Zwickl, 2006, 2011) under Maximum Likelihood (ML) criterion. The author conducted 24 independent runs using scorethresholdforterm = 0.05 and signifi canttopochange = 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. 2). Bootstrap support values (BS) were estimated from 500 replicates using the same independent models in Garli.

Bayesian inference (BI) using the Markov Chain Monte Carlo algorithm as implemented in MrBayes 3.2.6 (Huelsenbeck & Ronquist, 2001; Ronquist & Huelsenbeck, 2003) was performed using a parallelized version of the software. Data were divided into the above five partitions and a separate GTR+I+G model for each partition was specified in the analysis where each partition has its own set of parameters. Priors were applied with default values. Six runs, with four chains each (one “cold” chain and three heated chains; temp = 0.2), were performed simultaneously for 20,000,000 generations, which were sufficient to bring the convergence (average standard deviation) to a value <0.007 (Ronquist et al., 2005), sampling trees every 2,500 generations. The program Tracer 1.7.1 (Rambaut et al., 2018) was used to check convergence and acceptable mixing. The initial 2,000 trees (25%) were discarded as burn-in and Bayesian posterior probabilities (PP) were calculated using a 50% majority-rule consensus tree inferred from the data (fig. 2).

Maximum Likelihood analysis and Bayesian inference were performed on the CIPRES
Science Gateway (Miller et al., 2010). All trees were drawn with the aid of FigTree v.1.4.4 (Rambaut, 2018), Adobe Illustrator® and Adobe Photoshop® CS5.

Results

Barcoding analysis
The Bayesian phylogram (fig. 1) based only on the DNA barcode region (the 5’ end of the COI gene) compares favorably with the cladogram from Thompson & Skevington (2014, figure 2). The same groupings and the same inferred relationships were found in the present analysis with a minor nomenclatural change: Platycheirus concinnus (Snow, 1895) appears as Platycheirus pictipes (Bigot, 1884) following the synonymy proposed by Young et al. (2016b). The novelty in the present study is the placement of the new species without metasternal excavation, Melanostoma janeceki sp. nov., as sister-group of Afrostoma quadripunctatum [= Melanostoma quadripunctatum] comb. nov. in fig. 1 with the highest Bayesian posterior probability. Note that Afrostoma quadripunctatum appears as Afrostoma vockerothi in the figure 2 of Thompson & Skevington (2014), and hereafter this species is referred as Afrostoma quadripunctatum or as Melanostoma quadripunctatum comb. nov. The group (Melanostoma janeceki sp. nov. + Afrostoma quadripunctatum) has a PP of 1, and the barcode similarity based on uncorrected pairwise distance between Melanostoma janeceki sp. nov. and Afrostoma quadripunctatum is 96.136% with the D226 and D228 specimens (25 nucleotide differences) and 96.059% with the D227 specimen (26 nucleotide differences).

The DNA barcodes for the three specimens of Melanostoma janeceki sp. nov. were almost identical. The only difference among the sequences of Melanostoma janeceki sp. nov. was an ambiguous call in one base (W for specimen D227 and A for specimens D226 and D228).

Phylogenetic analyses
No topological differences were found when Afrostoma quadripunctatum [= Melanostoma quadripunctatum comb. nov. in fig. 2] was excluded from the analysis, and the same relationships among taxa were recovered with both dataset, with or without the DNA barcode sequence of Afrostoma quadripunctatum. The ML and BI analyses resulted in highly similar tree topologies and are summarized together. The ML tree including the Afrostoma barcode with the best likelihood score (−288.46.913085) is presented in fig. 2 with the PP from the Bayesian analysis and the BS values from the ML analysis.

Although the taxonomic sampling effort was done to include all the diversity of the Bacchini sensu lato, it is worth to mention the other syrphine genera and pipizines were resolved in agreement with previous studies (Mengual et al., 2008a, 2012, 2015; Mengual, 2015; Young et al., 2016a; Mengual et al., 2018), with members of Pipizinae resolved as sister-group of Syrphinae. The subfamily Syrphinae was resolved monophyletic with genera grouped into three major clades. The first major clade comprises all the Syrphini genera, including the representatives of Toxomerini and Paragini. The second major clade comprises the genera Leucopodella Hull, 1949, Pelloloma Vockeroth, 1973, Talahua Fluke, 1945, Xanthandrus Verrall, 1901, Argentinomyia Lynch Arribalzaga, 1891, Afrostoma and Melanostoma. In this clade, Leucopodella species were placed as sister-group of two smaller clades: (Pelloloma + (Talahua + Xanthandrus)) and (Argentinomyia + Melanostoma), including Afrostoma. It is important to point out that the two studied species without metasternal excavation, i.e., Melanostoma janeceki sp. nov. and Afrostoma quadripunctatum, were resolved as sister taxa and embedded among
the species of the genus *Melanostoma*, which all have an excavation in the metasternum.

The third major clade as resolved in the present study has the representatives of the Bacchini, with *Baccha*, *Platycheirus* and all the other genera related to *Platycheirus*, i.e., *Tuberculanostoma*, *Pyrophaena*, *Syrphocheliosia* Stackelberg, 1964, *Spazigaster* Rondani, 1843, and *Rohdendorfia* Smirnov, 1924. Within this clade, *Baccha* was resolved as the sister-group of the other genera, *Tuberculanostoma* was placed embedded in the *Platycheirus* radiation, and (*Pyrophaena* + (*Rohdendorfia* + (*Syrphocheliosia* + *Spazigaster*))) were resolved as a clade sister to *Platycheirus*, including *Tuberculanostoma*.

**Melanostoma janeceki** Mengual, sp. nov.

*Melanostoma* sp. in Vlašánková et al. (2017). Figs. 3, 5C–E.

**Differential diagnosis.** Black, straight face with small, round facial tubercle; black thorax and abdomen black with terga 3–5 with two lateral, small yellow maculae on anterior margin (fig. 3). This species of *Melanostoma* with a complete metasternum (fig. 5C, D) is only known from Cameroon, and it is very similar to *Melanostoma quadripunctatum* (Skevington & Thompson, 2014) **comb. nov.**, known from Kenya and Uganda (fig. 5A, B). They differ by the COI gene sequence, sterna coloration in females (entirely yellow in *M. janeceki* sp. nov.; entirely black with two lateral yellow maculae on anterior margin of terga 2–5 in *M. quadripunctatum*; fig. 5E, F) and by the leg coloration: *M. janeceki* sp. nov. has pro- and mesofemora yellow in both sexes, and metafemora black except yellow on basal 1/4–1/3 in males or metafemora entirely yellow in females (fig. 3); and *M. quadripunctatum* males and females have all femora black with the very apex pale (fig. 5A).

Type locality. Cameroon: Northwest Province, Bamenda Highlands, ca. 5 km southeast of Big Babanki, Mendong Buu area, 6.592699°N, 10.189999°E, 2100–2200 m.

**Description**

Male: **Head:** Face straight with distinct facial tubercle, entirely black, pale pilose, sparsely grey pruinose except tubercle shiny; lunule black, shiny; frontal triangle black, sparsely grey pruinose, brownish pilose; eye contiguity long, longer than vertical triangle; ocellar triangle dark pilose; antenna brown, basoflagellomere darker apically; arista pilose, with pile shorter than the arista width at base; ociput black, silver grey pruinose, white pilose on ventral 1/2, brownish pilose on dorsal 1/2.

**Thorax:** Black except postalar callus slightly paler, brownish black; scutum shiny black, sparsely brownish pruinose, with short and long yellow pile with some darker pile; postpronotum white/grey pruinose, bare; scutellum black, yellow pilose with some darker pile intermixed, subscutellar fringe long, yellow. Pleuron black, pale pilose, sparsely pale pruinose; calypter yellow, yellow pilose; plumula yellow; halter pedicel and capitulum yellow; posterior spiracular fringes yellow; metasternum complete, bare. Scutum and pleuron with a golden iridescence. **Wing:** brownish, entirely microtrichose; alula broader than costal cell. **Legs:** pro- and mesofemora brown; pro- and mesotrochanter yellow; pro- and mesofemora yellow; posterior spiracular yellow; protarsal somere yellow basally; apical three mesotarsomeres black, basal two mesotarsomeres yellow; metacoxa black and metatrochanter yellow; metafemur black with basal 1/4–1/3 yellow and femoral-tibial joints yellow; metafemur black with basal 1/4–1/3 yellow; metatarsi black.

**Abdomen:** Parallel-sided, without lateral margin, entirely black except for the two lateral,
Figure 3  
*Melanostoma janeceki* Mengual, sp. nov. A, male holotype (ZFMK-DIP-00015940), lateral view; B, female paratype (ZFMK-DIP-00015958), lateral view; C, male holotype, habitus; D, female paratype (ZFMK-DIP-00015958), habitus; E, male holotype, frontal view; F, female paratype (ZFMK-DIP-00015958), frontal view; G, male holotype, labels; H, female paratype (ZFMK-DIP-00015958), labels.
Figure 4  A–B: *Melanostoma* sp. from Cameroon (ZFMK-DIP-00015959) with complete metasternum. A, lateral view; B, habitus. C–H: *Platycheirus solitarius* (van Doesburg, 1955) *comb. nov.* C, female holotype, lateral view; D, female holotype, habitus; E, female holotype, frontal view; F, female holotype, labels; G, female paratype, lateral view; H, female paratype, head, lateral view.
small yellow maculae on anterior margin of terga 3–4; tergum 5 has also two lateral, small yellow maculae but less evident. Terga dull black pruinose, with long yellow pile laterally and short black pile medially; sterna black except sterna 3–4 with a yellow fascia on posterior margin and sternum 5 with two lateral yellow maculae. Male genitalia: very similar to male genitalia of *M. quadripunctatum* (Thompson & Skevington, 2014, figure 3).

**Female:** Similar to male except for normal sexual dimorphism and as follows: frons black with two lateral silver pruinose maculae on eye margin; pro- and mesopleg yellow except apical tarsomeres; metafemur yellow; terga 2–5 black with two lateral yellow maculae.
(those on tergum 2 elongated along lateral margin); sterna yellow.

**Variation:** No variation has been observed in the studied specimens, although some variability in the extension of the abdominal maculae and in the coloration of the legs at some extent might be possible.

**Length** (N = 3): Body, 9.17 mm (8.3–10.2 mm); wing, 7.9 mm (7.2–8.6 mm).

**Geographical distribution.** Species known from Cameroon.

**Etymology.** The new species is named after its collector, Dr. Štěpán Janeček. Species epithet to be treated as a noun in the genitive case.

**Biology.** See Vlašánková et al. (2017, as Melanostoma sp.) for its relationship with *Impatiens burtonii* var. *burtonii* Hook. f. (Balsaminaceae).

**Material examined:** Type material. **Holotype,** male, pinned with genitalia in microvial, deposited in the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Bonn, Germany, and labelled: “CAMEROON: North-West Prov., // Bamenda Highlands, 5km SE Big // Babanki, Mendong Buo area, // 6.592699°N, 10.189999°E // 2100–2200 m., XI.2012. // Leg.: S. Janeček.” “DNA voucher specimen // ZFMK, Lab code // D226 // Bonn, Germany” “HOLOTYPE // Melanostoma // janeceki // Det. X. Mengual 2017” [red] “ZFMK DIP 00015940” [barcode]. **Paratypes:** 10♂, same data as holotype, DNA voucher ZFMK-D227 [ZFMK; ZFMK-DIP-00015941]; 1♀, same data as holotype, DNA voucher ZFMK-D228 [ZFMK; ZFMK-DIP-00015942]; 10♂, CAMEROON: North-West Prov., Mezan Division, Bafut-Ngemma Forest Reserve (35 km from Bamenda), in the way to the Lake (env. Chemin du Lac), 1500 m., 12.x.1970, L. Matile [ZFMK; ZFMK-DIP-00015955]; 1♂, CAMEROON: North-West Prov., Mezan Division, Bafut-Ngemma, env. Maison Forest, 2000 m., 10.x.1970, L. Matile [MNHN; ZFMK-DIP-00015954]; 1♀, CAMEROON: North-West Prov., Mezan Division, Bafut-Ngemma, Vallée de la Haute Ngemma, 2100 m., 27.x.1975, Mission Cameroon C.N.R.S. RCP 318 [MNHN; ZFMK-DIP-00015956]; 1♀, CAMEROON: North-West Prov., Mezan Division, Bafut-Ngemma, Vallée de la Haute Ngemma, galerie, marigot avait lac, 1800–1900 m., 30.x.1975, Mission Cameroon C.N.R.S. RCP 318 [MNHN; ZFMK-DIP-00015957]; 1♀, CAMEROON: North-West Prov., Mezan Division, Bafut-Ngemma, Vallée de la Haute Ngemma, prés Maison forestière, marigot, 2000 m., 25.x.1975, Mission Cameroon C.N.R.S. RCP 318 [ZFMK; ZFMK-DIP-00015957].

**Material of Melanostoma quadripunctatum** (Skevington & Thompson, 2014) comb. nov. **KENYA:** Kakamega Forest, 1585 m. [=5200 ft.], 18.xii.1970, E.E. Stubbs [4♂ 2♀, BMNH; 2♂ 1♀, ZFMK; ZFMK-DIP-00019927; ...00015944, ...00015945, ...00015946, ...00015950, ...00015951, ...00015943, ...00015946, ...00015952; ...]; 1♀, ...19.xii.1970, ... [1♀, BMNH; ZFMK-DIP-00015953]; ...; 20.xii.1970, ...[2♂, BMNH;ZFMK-DIP-00015948, ...00015949].

**Remarks.** Prior to this study, female specimens of *M. quadripunctatum* were unknown. They are very similar to females of *M. janeceki* sp. nov., but they can be distinguished by sternal and leg coloration as indicated in the diagnosis (fig. 5F).

**Discussion**

**Inferred generic relationships**

**Pelloloma, Talahua, Tuberculanostoma** and **Eocheilosia** have been included in a multi-gene phylogenetic analysis for the first time (see fig. 2). In its original description, Vockeroth...
(1973) placed the genus *Pelloloma* within the Syrphini, but already mentioned the possibility that it could be placed among the Melanostomini. Kassebeer (2000a) explained using morphological characters the reason to move *Pelloloma* to Melanostomini. Present results (fig. 2) support the placement of this genus in the Melanostomini.

Fluke (1945) described a new *Melanostoma* subgenus, *Melanostoma* (*Talahua*), for the species *Melanostoma fervidum* Fluke, 1945, which is characterized by large male genitalia. Hull (1949) followed Fluke (1945) and considered *Talahua* as a *Melanostoma* subgenus, but Thompson et al. (1976) elevated *Talahua* to full generic status as it has a complete metasternum, not reduced as defined for *Melanostoma*. More recently, Thompson (1999) placed a second species in the genus *Talahua*, *Melanostoma palliatum* Fluke, 1975, which has normal-sized male genitalia. Hereafter, the size of the male genitalia was not diagnostic for *Talahua*, but only the character of metacoxa with a pile tuft postero-medially as stated in the identification key by Thompson (1999). Our analysis resolved *Talahua* and *Xanthandrus* as sister taxa and *Argentinomyia* as sister taxon of *Melanostoma* (fig. 2), supporting the decision of Thompson et al. (1976).

When Fluke (1943) described his new genus *Tuberculanostoma* from Ecuador, he stated the similarity with *Carposcalis* Enderlein, 1938 (at the time most *Carposcalis* species were treated as *Melanostoma*) based on the presence of curved bristles on the profemur. This similarity was also pointed out by Hull (1949). Fluke (1943) also mentioned some diagnostic characters, such as face produced forward into a snout and a prominent facial tubercle, and the preferential habitat in high elevations. Years later, van Doesburg (1955) described *Tuberculanostoma solitarium* van Doesburg, 1955 from the Karakorum Mountains (a mountain range spanning the borders of Pakistan, India, and China) (see fig. 4C–H). This species has a produced face and a clear facial tubercle, but there are many differences from the Neotropical *Tuberculanostoma* as stated by Thompson & Skevington (2014). Results from Young et al. (2016b) using the 5′ end of the COI gene resolved *Tuberculanostoma* embedded in *Platycheirus*, somehow related with the stegnus subgroup, referred as subgenus *Platycheirus* (*Carposcalis*) by other authors (see Vockeroth, 1990; Thompson & Skevington, 2014; Young et al., 2016b). Previously, Vockeroth (1990) suggested the possibility to include *Tuberculanostoma* in *Platycheirus* as an alternative placement. Present results (fig. 2) support the suggestion of Vockeroth (1990) and corroborate the results of Young et al. (2016b). Based on the current evidences, the genus *Platycheirus* comprises four subgenera: *Platycheirus* (*Carposcalis*), *Platycheirus* (*Pachysphyria*), *Platycheirus* (*Platycheirus*), and *Platycheirus* (*Tuberculanostoma*) comb. nov. Nevertheless, as stated by Young et al. (2016b), there is the possibility that other monophyletic species groups within the genus *Platycheirus* could be recognized as distinct in the future. The present results differ from the proposed subgeneric classification of Thompson & Skevington (2014) as *Pyrophaena* and *Eocheilosia* are supported as valid genera and *Pseudoplatycheirus* is recognized as a junior synonym of *Platycheirus* (new synonym). *Platycheirus* (*Pachysphyria*) is equivalent to the *Platycheirus ambiguus* species group sensu Vockeroth (1990), Nielsen (2004, 2014) and Young et al. (2016b). Based on molecular characters (Mengual et al., 2008; this study) and the morphological characters of the original descriptions, the *Pseudoplatycheirus* species are *Platycheirus* species with elongated antennae, dichoptic males, widened protarsi, protemur with long, strong, curly setae and projected face. Broadened protarsi, projected face and modified setae on the protemur are characteristics also found in
other species groups within *Platycheirus*. All known specimens of *Pseudoplatycthirus* were collected at high elevations (van Doesburg, 1955; Zimina, 1958; Barkalov, 2007).

The present author has studied the holotype and paratype females of *Tuberculanosoma solitarium* deposited at NBC (fig. 4C–H) together with several Neotropical *Tuberculanosoma* species, and a few morphological differences are clear: frons broader than eye width in frontal view (much narrower than eye width in frontal view for the Neotropical species), frons and vertex with very long, erected pile (much shorter in Neotropical species), dorsal occiput without long, black bristles (dorsal occiput with 15–20 long, black bristles in Neotropical species), face with a patch of long pile on parafacia (Neotropical species without such pile patch), deep anterolateral tentorial pit in the inner side of the basoflagellomere (absence of tentorial pits in Neotropical species), procoxa medially broadened laterally (procoxa without modifications in Neotropical species), scutellum without bristles (scutellum with 1, usually 2 pairs of long, black bristles on posterior margin in Neotropical species), femora with dense, long pile postero-ventrally (femora with scattered pile in Neotropical species), wing marginal fringe short (wing marginal fringe longer in Neotropical species). The author of the present paper finds some morphological similarity between *Tuberculanosoma solitarium* and the species of *Pseudoplatycthirus* such as projected face, somehow reduced eyes, and enlarged gena and ventral occiput. The two known species of *Pseudoplatycthirus* resemble extremely morphologically modified species of the *Platycheirus manicatus* species group (see Nielsen & Barkalov, 2017). In the *P. manicatus* species group both sexes have the face slightly to strongly protruding below as in *Pseudoplatycthirus*, and males of the *P. manicatus* species group are characterized by the two basal broadened tarsomeres of the proleg, a character also present in the *Pseudoplatycthirus* males. Unfortunately, only females of *Tuberculanosoma solitarium* are known and this sex does not have the mentioned broadened tarsomeres of the proleg. Either related to *Platycheirus* species with produced face or not, the species *Platycheirus solitarius* (van Doesburg, 1955) comb. nov. does not belong to *Platycheirus* (*Tuberculanosoma*) based on the morphological differences, and the shared morphological characters (produced face) might possibly be the result of adaptation to extreme conditions, in this case, very high elevations in the Andes and in the Karakorum Mountains. Perhaps, the only two known females of *Platycheirus solitarius* (collected conspecifically with the type series of *Pseudoplatycthirus peteri* van Doesburg, 1955) belong to the same *Platycheirus* species group as the two species described as *Pseudoplatycthirus*.

Hull (1949) described *Eocheilosia* as a subgenus of *Cheilosia* Meigen, 1822 (Eristalinae, Rhingiini) for the species *Cheilosia ronana* Miller, 1921. Thompson (1972) placed his new species *Platycheirus milleri* Thompson, 1972 [now known as *Eocheilosia huttoni* (Thompson in Thompson & Vockeroth, 1989)] in *Platycheirus*, although he pointed out that this taxon may deserve generic recognition. Thompson & Vockeroth (1989) and Thompson & Skevington (2014) considered *Eocheilosia* as subgenus of *Platycheirus*, and Thompson (2008) stated that *Eocheilosia* is used for those species of *Platycheirus* with unmodified male prolegs present in New Zealand. Present study (fig. 2) resolved *Eocheilosia* within a clade of genera previously placed under *Platycheirus* (Thompson & Rotheray, 1998), including *Rohdendorfia*, *Syrphochromeiosia*, *Spazigaster*, and *Pyrophaena*. Previous DNA barcoding analyses (Thompson & Skevington, 2014; Young et al., 2016b; van Steenis et al., 2019) based on the 5′ end of the COI gene also resolved *Eocheilosia*
notata (Bigot, 1884) [as Platycheirus (Pseudo-platycheirus) notatus in Young et al. (2016b, figure 6)] within this clade. Hence, molecular evidence supports the full generic status for Eocheilosia comb. nov.  

Although there were no specimens available for the present study, the generic status of Afroxanthandrus is worth to comment. Kassebeer (2000b) described Afroxanthandrus as a new genus including Xanthandrus congoensis Curran, 1938 and his new species, Afroxanthandrus longipilus Kassebeer, 2000. Whittington (2003) listed the genus in his assessment of the Afrotropical syrphid fauna, but Mengual et al. (2008a) overlooked this taxon and did not include it in their classification. Later, Thompson & Skevington (2014) considered it as a subgenus of Xanthandrus, but did not officially propose it. Recently, Thompson (2019) considered Afroxanthandrus a junior synonym of Xanthandrus. The genus Xanthandrus sensu Thompson & Skevington (2014) is found in all biogeographic regions (Borges & Pamplona, 2002), with the typical subgenus present in the Neotropical, Nearctic, Palaearctic, Oriental and Australasian Regions, Afroxanthandrus found in the Afrotropical Region, and the subgenus Androsyrphus known only from Jamaica. The main differences between Afroxanthandrus and Xanthandrus are: head of the female swollen medially (flat in Xanthandrus), scutum entirely pruinose and granulate (shiny without granulation in Xanthandrus), femora slightly thickened (not so in Xanthandrus), and male genitalia. Xanthandrus species have one-lobe, digitiform or pointed surstyli and small postgonites squarish or triangular in shape (see Dušek & Láska, 1967; Borges & Pamplona, 2003). On the other hand, Afroxanthandrus congoensis has small surstyli laterally displaced and enlarged postgonites rectangular in shape, with a quite distinct aedeagus (Kassebeer, 2000b). Based on male genitalia characters, the present author tentatively considers Afroxanthandrus as a valid genus (table 2). The other taxon not available for molecular work in the present study is also placed in Xanthandrus. Thompson (1981) erected a new subgenus, Xanthandrus (Androsyrphus), for a species with swollen metafemora and with ventral spines on meso- and metafemora from Jamaica. He agreed that some dipterists might give full generic rank to Androsyrphus, but he hesitated to do so in the Bacchini sensu lato based on a leg character as legs are very variable in this group. Further analysis of this taxon combining morphology and molecular markers might change Thompson’s (1981) decision.  

**New generic diagnosis for Melanostoma**  
Generic concepts within Bacchini sensu lato have generally been difficult to define (Young et al., 2016b). Nowadays, there are published identification keys to sort out all the bacchine and melanostomine genera using morphological characters (Vockeroth & Thompson, 1987; Thompson & Rotheray, 1998; Thompson, 1999; Thompson et al., 2010; Láska et al., 2013; Thompson & Skevington, 2014). The importance of the metasternum shape during the history of syrphidology has been significant. The confusion between Platycheirus and Melanostoma was frequent until Anderson (1970) found the differences in the shape of the metasternum. Since then, a largely reduced, spearhead-shaped metasternum is a diagnostic character for the genus Melanostoma and Platycheirus species have an entire metasternum. Although the molecular data were limited, the lack of the basolateral excavation in the metasternum was a diagnostic character for Thompson & Skevington (2014) to erect a new genus, Afrostoma. Based on their own arguments, Afrostoma flies look very like Melanostoma species, endemic of the Afrotropical Region where the only other melanostomine is Melanostoma, with very similar
Table 2 New synthesis of generic and subgeneric names of Bacchini stat. rev. and Melanostomini stat. rev. (Syrphidae: Syrphinae)

| Tribe | Genus | Subgenus | Author, year | Type species |
|-------|-------|----------|--------------|--------------|
| Melanostomini | Afroxanthandrus | Kassebeer, 2000 | Afroxanthandrus congoensis (Curran, 1938) |
| Melanostomini | Argentinomyia | Lynch Arribalzaga, 1891 | Argentinomyia testaceipes Lynch |
| Melanostomini | Leucopodella | Hull, 1949 | Leucopodella lanei (Curran, 1936) = Leucopodella bigoti (Austen, 1893) |
| Melanostomini | Melanostoma | Schiner, 1860 | Melanostoma mellinum (Linnaeus, 1758) |
| Melanostomini | Pelloloma | Vockeroth, 1973 | Pelloloma nigripalpis Vockeroth, 1973 |
| Melanostomini | Talahua | Fluke, 1945 | Talahua fervida (Fluke, 1945) |
| Melanostomini | Xanthandrus | Thompson, 1981 | Xanthandrus (Androsyrphus) setifemoratus Thompson, 1981 |
| Melanostomini | Xanthandrus | Verrall, 1901 | Xanthandrus (Xanthandrus) comtus (Harris, 1780) |
| Bacchini | Baccha | Fabricius, 1805 | Baccha elongata (Fabricius, 1775) |
| Bacchini | Eocheilosia | Enderlein, 1937 | Eocheilosia ronana (Miller, 1921) |
| Bacchini | Platycheirus | Enderlein, 1937 | Platycheirus (Carposcalis) stegeanus (Say, 1829) |
| Bacchini | Platycheirus | Enderlein, 1937 | Platycheirus (Pachysphyria) dexter (Harris, 1780) |
| Bacchini | Platycheirus | Lepeletier & Serville, 1828 | Platycheirus (Platycheirus) scutatus (Meigen, 1822) |
| Bacchini | Platycheirus | Fluke, 1943 | Platycheirus (Tuberculanostoma) antennatus (Fluke, 1943) |
| Bacchini | Pyrophaena | Schiner, 1860 | Pyrophaena rosaria (Fabricius, 1787) |
| Bacchini | Rohdendorfia | Smirnov, 1924 | Rohdendorfia dimorpha Smirnov, 1924 |
| Bacchini | Spazigaster | Rondani, 1843 | Spazigaster apennini Rondani, 1843 = Spazigaster ambulans (Fabricius, 1798) |
| Bacchini | Syrphocheilosia | Stackelberg, 1964 | Syrphocheilosia aterrima Stackelberg, 1964 = Syrphocheilosia claviventris (Strobl, 1910) |

* Pseudoplatychirus van Doesburg, 1955 is a junior synonym of Platycheirus Le Peletier & Audinet-Serville, 1828 and Afrostoma Skevington, Thompson & Vockeroth, 2014 is a junior synonym of Melanostoma Schiner, 1860.

male genitalia, and without male external secondary characters as all other Melanostoma species, but with an entire metasternum.

Two morphological characters were diagnostic to separate Melanostoma and Platycheirus species (Andersson, 1970; Barkalov, 2009; Haarto & Ståhls, 2014): the shape of the metasternum and the morphology of male genitalia, especially the shape of surstyli and postgonites. Most Platycheirus males have modified protarsi, protibiae and/or with distinctive bristles or pile tufts on profemora, but they are so variable that cannot be used as diagnostic characters to define generic groups (Vockeroth, 1990; Young et al., 2016b). In a series of papers devoted to Bacchini sensu lato, Fluke (1937, 1943, 1945, 1957) studied in deep this group of genera and was the first author to study the male genitalia of these taxa (Fluke, 1957). When male genitalia...
are compared, there are no evident differences between *Melanostoma* and *Afrostoma*. However, differences between these two taxa and *Platycheirus* are clear (see Fluke, 1957; Shatalkin, 1975; Vockeroth, 1990, 1992; Haarto & Ståhls, 2014; Thompson & Skevington, 2014; Young et al., 2016b). *Platycheirus* species have: bifid or bilobed surstyli with a long, slightly curved lateral lobe, and a short, stout basomedial lobe; and postgonites usually slender and recurved, sickle-shaped. On the other hand, *Melanostoma* species and *Afrostoma* have: simple, one-lobed, elongate surstyli with a small basomedial tubercle; and postgonites massive, irregular or squarish in shape. Thus, male genitalia characters do not distinguish between *Afrostoma* and *Melanostoma*.

The present COI cladogram (fig. 1) places the specimens of *Melanostoma janeceki* sp. nov. as sister group of *Afrostoma quadripunctatum*, and its topology is identical to the cladogram by Thompson & Skevington (2014), except for the inclusion of the new *Melanostoma* species described here. *Melanostoma janeceki* sp. nov. has an entire metasternum like *Afrostoma quadripunctatum* and the COI analysis corroborates their close relationship. But results from the multigene analysis presented here do not support the generic concept of *Afrostoma*, as *Afrostoma quadripunctatum* is embedded within the *Melanostoma* species (fig. 2), as sister group of *Melanostoma janeceki* sp. nov. Thus, the present author recognizes *Afrostoma* as a junior synonym of *Melanostoma*, which means that there is a group of *Melanostoma* species with the metasternum entire, not reduced.

Afrotropical species of *Melanostoma* are in urgent need of a taxonomic revision. There are a few published identification keys (Bezzi, 1915; Curran, 1938; Dirickx, 2001) and none of them include all the described species. The same revisionary work is needed for the Oriental *Melanostoma* species (Lambeck & van Brink, 1973), and probably also in the other biogeographical regions where this genus occurs. *Melanostoma* species have a limited number of structural characters enough variable to be used for distinguishing species, and some of them are chromatic (Dirickx, 2001). Male genitalia in this genus are remarkably homogeneous (Dirickx, 2001) and the intraspecific variability is high, plus there are several species described based only on one sex. Thus, it is very likely that the same taxon has been described two times under different names based on different sexes or very distinct specimens of the same species. Haarto & Ståhls (2014) showed that the DNA barcode, the 5' end of the COI gene, does not help to sort out species in *Melanostoma* alone and the sequencing of another molecular marker, i.e., the ITS2 as in Haarto & Ståhls (2014), is needed to characterize different species. In short, the taxonomy of Afrotropical *Melanostoma* has been never globally attempted, and most of the species where described before Andersson (1970) pointed out the shape of the metasternum as diagnostic for this genus. During this work, the author studied many *Melanostoma* specimens from different collections trying to understand the variability of this character, and found other morphologically distinct *Melanostoma* species with a complete metasternum (see fig. 4A, B). Consequently, there is a group of *Melanostoma* species in the Afrotropical Region without basolateral excavation in the metasternum as in *Platycheirus*, and the group has more members besides *Melanostoma quadripunctatum* comb. nov. and *Melanostoma janeceki* sp. nov. Nevertheless, the largely reduced, spearhead-shaped metasternum as defined by Andersson (1970) is still a valid diagnostic character for the genus *Melanostoma* outside the Afrotropical Region.

**Bacchines and melanostomines**

Williston (1885) was the first author to recognize and name the two groups with simple...
unsegmented aedeagus as Bacchinae (including only Baccha) and Melanostominae (with Pyrophaena, Platycheirus and Melanostoma). Later, Williston (1887) reorganized his classification giving Melanostomini a tribe level and synonymizing Ocyptamus under Baccha. This classification was adopted by later authors (see Hull, 1949; Vockeroth, 1969) with small modifications until Vockeroth (1992), who lumped all the genera with simple, unsegmented aedeagus in Bacchini sensu lato. Before the step taken by Vockeroth (1992), Dušek & Láska (1967) grouped Xanthandrus with Melanostoma, and Platycheirus with Rhdendorfia, Spazigaster, and Pachysphyria, leaving the genus Baccha alone in their tribe Bacchini. Thompson (1972) also divided Melanostomini into two groups of genera based on male genitalia characters and the presence or absence of modified protibiae in males: the Melanostoma group and the Platycheirus group. In a similar line of thought, Shatalkin (1975) suggested two tribes, i.e., Melanostomini (subdivided into Melanostomina and Platycheirina) and Bacchini including Baccha, but also other Syrphini genera like Allobaccha and Ocyptamus; a group defined as “an artificial aggregation” by Vockeroth (1969). Later, Kassebeer (2000b) proposed a morphological synapomorphy for the melanostomine genera previously suggested by Fluke (1943), and considered Melanostomini monophyletic.

Male genitalia characters have been used to group these taxa. Thompson (1972) divided Melanostomini into the Melanostoma group (simple legs in males, with triangular or quadrate postgonites and elongate, usually not forked, surstyli) and the Platycheirus group (modified protibiae in males, sickle-shaped postgonites and forked surstyli). Later, Shatalkin (1975) used the same argument for his subtribes Melanostomina and Platycheirina within Melanostomini. Based on published literature (Fluke, 1957; Dušek & Láska, 1967; Thompson, 1972; Vockeroth, 1973, 1990, 1992; Shatalkin, 1975; Ōhara, 1980; Claussen, 1987; Dirickx, 2001; Borges & Pampiôna, 2003; Barkalov, 2007; Barkalov & Nielsen, 2010; Haarto & Ståhls, 2014; Thompson & Skevington, 2014; Young et al., 2016b) sickle-shaped postgonites and forked or bilobed surstyli are present in all Platycheirus subgenera, although some Carposcalis species do not have sickle-shaped postgonites, but triangular postgonites like a scalene triangle with a broad base, or their surstyli are not evidently bilobed. The species Platycheirus (Tuberculanostoma) antennatum (Fluke, 1943) is also an exception. The two species described as Pseudoplatychirus also have bilobed surstyli and sickle-shaped postgonites, but smaller, more compressed.

Eocheilosia has globular surstyli and sickle-shaped postgonites, and Syrphocheilosia claviventris (Strobi, 1910) has one-lobed surstyli and elongate, one-lobed postgonites. Spazigaster ambulans (Fabricius, 1798) has sickle-shaped postgonites but one-lobed surstyli, while Rhdendorfia species have one-lobed, sickle-shaped surstyli curved ventrally, and bilobed postgonites with dorsal lobe hook-shaped (Mengual & Barkalov, 2019). Pyrophaena rosa-rum (Fabricius, 1787) has sickle-shaped postgonites but broad, elongate, one-lobed surstyli. Pyrophaena granditarsa (Forster, 1771) also has elongate, not bilobed surstyli with a small basomedial tubercle, but solid, triangular postgonites. Pyrophaena rufigaster (Vockeroth, 1990) has one-lobed surstyli and postgonites with three dorsal hook-shaped protuberances, very similar to Platycheirus (Platycheirus) coracinus Vockeroth, 1990, a member of the Platycheirus pictipes species group sensu Young et al. (2016b). Final placement of these species is unclear and is beyond the scope of this study.

Regarding the genus Baccha, B. elongata (Fabricius, 1775) have massive postgonites with two processes pointed postero-ventrally and elongate surstyli with a small basomedial
tubercle, which could be interpreted as bilobed surstyli.

*Argentinomyia*, *Leucopodella*, *Pelloloma*, *Melanostoma*, and *Xanthandrus* species have one-lobed, elongate surstyli and postgonites massive (solid), irregular, elongate, triangular or squarish in shape. Some *Argentinomyia* species present surstyli very variable in shape, but nothing like a bilobed surstylus. *Talahua fervida*, however, has strongly modified male genitalia with elongate postgonites and surstyli three to four times longer than wide.

Cytotaxonomy, although scarce, can be used as an alternative data source for these groupings. On this topic, *Leucopodella* has five chromosome pairs and *Argentinomyia* species have four or five chromosome pairs (Boyes & van Brink, 1964; Boyes et al., 1971, 1973). *Melanostoma*, *Xanthandrus*, *Platycheirus sensu stricto* and *Platycheirus* (*Carposcalis*) has four chromosome pairs, but different in structure (Boyes & van Brink, 1964; Boyes et al., 1971). On the other hand, *Baccha* species have three (*B. elongata* and *B. obscuripennis* Meigen, 1822) or four (*Baccha maculata* Walker, 1852) pairs of chromosomes. Boyes et al. (1971) pointed out that the karyotypes of *Carposcalis* and *Platycheirus* are very similar, but quite different from *Melanostoma* and *Xanthandrus*, and they suggested two distinct groups although all have $2n = 8$. Some exceptions occur, e.g., *Xanthandrus bucephalus* (Wiedemann, 1830) with $2n = 10$, as Bacchini sensu lato has high karyological variation.

Based on previous studies and the results presented here, the current concept of Bacchini sensu lato is not monophyletic. Syrphinae genera with simple, unsegmented aedeagus are divided into two groups as follows: *Melanostoma* and related genera, and *Baccha*, plus *Platycheirus* and related genera. Although Shatalkin (1975) stated that the male genitalia of *Baccha* is reminiscent to genitalia of *Melanostoma* and *Leucopodella*, the genus *Baccha* has been resolved as sister group of *Platycheirus* and related genera based on the latest molecular analyses (Mengual, 2015; Mengual et al., 2015; Young et al., 2016a; this study). See table 2 for a list of genera and subgenera of Bacchini stat. rev. and Melanostomini stat. rev. and a new generic classification based on the present results.

**Acknowledgements**

I am very grateful to Štěpán Janeček and Anna Vlašánková for letting me study the material they collected in Cameroon and for a very fruitful collaboration. I thank Nigel Wyatt (BMNH), Ben Brugge and Pasquale Ciliberti (NBC), and Christophe Daugeron and Emmanuel Delfosse (MNHN) for letting me study material in their care. I am very indebted to all colleagues and collectors that made specimens available for so many years; without them this study would not have been possible. This research received support from the SYNTHESIS Project (http://www.synthesys.info/, grant FR-TAF-5931), which is financed by European Community Research Infrastructure Action under the FP7 “Capacities” Program.

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