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Revision of the *bactrianus* subgroup of the genus *Eumerus* Meigen (Diptera: Syrphidae) in Europe, inferred from morphological and molecular data with descriptions of three new species

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Abstract. With more than 300 described species, the genus *Eumerus* is one of the largest genera of hoverflies (Diptera: Syrphidae). In this paper, we define the *Eumerus bactrianus* subgroup and revise the subgroup in Europe for the first time, providing an illustrated key for its European species. We describe three new species: *E. banaticus* Nedeljković, Grković & Vujić n.sp. from Serbia and Romania; *E. bicornis* Grković, Vujić & Hayat n.sp. from Greece and Turkey; and *E. bifurcatus* van Steenis & Hauser n.sp. from Spain. Species of this subgroup exhibit a distinctive apomorphic morphological feature, i.e. the bifurcated posterior surstylus. We discuss the distributions of seven Palaearctic species of this subgroup: *E. bactrianus* Stackelberg, 1952, *E. pannonicus* Ricarte, Vujić & Radenković, 2016, *E. turanicola* Stackelberg, 1952, *E. turanicus* Stackelberg, 1952, and three species described here. Molecular species delimitation, which strongly supports our morphological results, is based on maximum parsimony analysis of mitochondrial COI sequences.

Key words. Syrphidae, *Eumerus bactrianus* subgroup, molecular taxonomy, disjunct distribution.

1. Introduction

Syrphidae (hover flies) is a large dipteran family whose members have evolved to mimic different species of Hymenoptera, including wasps, bumblebees and bees. The genus *Eumerus* is widely distributed in the Palaearctic, Afrotropical, Oriental, and Australian regions, with more than 250 described species (Pape & Thompson 2015). Members of this genus are recognizable by the recurrent M_1 vein, as well as their usually blackish or blackish-red appearance with light pollinose markings on the abdominal tergites. Over 170 species inhabit the Palaearctic Region, with the greatest diversity occurring in the Turano-Mediterranean region. The Afrotropical region holds more than 70 species of *Eumerus* with most of them not described yet, but with valuable existing data thanks to

L. Lyneborg, who unfortunately passed away before he was able to publish his work (Pape 2007). A few species have been introduced into the Nearctic, including *E. funeralis* Meigen, 1822, *E. strigatus* (Fallén, 1817) and *E. narcissi* Smith, 1928, with this latter even having been described from California and redescribed by Speight et al. (2013). Three *Eumerus* species have been introduced into the Neotropics: *E. strigatus* (Gerding et al. 1999), *E. funeralis* (Thompson 1976) and *E. obliquus* (Fabricius, 1805) (Marinoni & Morales 2007). Adult *Eumerus* are usually inconspicuous, blackish flies that are most often observed hovering just above vegetation. They are best known as pests, since their larval stages are associated with a variety of commercially grown plants (Collin 1920; Martin 1934; Pérez-Banón & Marcos-García 1998; Ricarte et al. 2008, 2017). The host plants for several *Eumerus* species are known (Ricarte et al. 2017); for example, *Narcissus*, *Allium*, *Hyacinthus*, *Pastinaca*, *Iris*, and *Solanum tuberosum* for *E. strigatus* and *E. funeralis* Meigen, 1822 (Hodson 1927), and *Allium* for *E. amoenus* Loew, 1848 (Assem & Nasr 1967; Farag & Doss 1981). The plant hosts for larvae of the *bactrianus* subgroup of *Eumerus*, the subject of the present paper, remain unknown, but it is possible that they develop under similar circumstances.

The most comprehensive taxonomic study of the Palearctic species of *Eumerus* is that of Stackelberg (1961), in which more than 80 species were considered and for which an illustrated key was generated. In Europe, the genus has more recently been intensively explored by Doczkal (1996), Vujić & Šimić (1999), Speight et al. (2013), and van Steenis et al. (2017). The present study is part of a comprehensive investigation of the genus *Eumerus* on the Balkan Peninsula (Grković et al. 2015, 2017; Chroni et al. 2017). Here, we deal with an unexplored subgroup of the *strigatus* group (Grković et al. 2017), which consists of species related to *E. bactrianus* Stackelberg, 1952 that are distinguishable from other species of the *strigatus* group by the bifurcated posterior surstylus (Figs. 6–7).

Markov et al. (2016) first described species of this subgroup in Europe as being related to the Central Asian species *E. bactrianus*. At that time, relationships among related species and their taxonomies were poorly understood. What was clear was that *E. pannonicus* Ricarte, Vujić & Radenković, 2016 (Fig. 2E,F) belongs to the same taxonomic unit as *E. bactrianus* and its related species (described by Stackelberg 1952), since they share the unique apomorphic character of a bifurcated posterior surstylus. Grković et al. (2017) investigated mitochondrial DNA sequences (mtDNA, cytochrome *c* oxidase subunit I) of *E. pannonicus*, which was the only available representative of the subgroup, and revealed its position to be in the *strigatus* species group.

Discovering undescribed representatives of the *bactrianus* subgroup in Europe has led to the need for a revision of this subgroup. Thus, here, we focused on the diversity of this subgroup in Europe, since data on its Asian species (*E. bactrianus*, *E. turanicola* Stackelberg, 1952 and *E. turanicus* Stackelberg, 1952) already exist thanks to Stackelberg (1952, 1961). All three of these Asian species are described from the Gissar mountain range in Tajikistan (Stackelberg 1952) in Central Asia (Fig. 10). *Eumerus bactrianus* has also been listed in the fauna of Israel (Kaplan 1974), but this record is questionable (specimens were unavailable for study).

In order to explore the *bactrianus* subgroup in Europe, we assessed morphological and molecular characters for species delimitation, an approach that has proved efficient in recent studies of different syrphid genera (Vujić et al. 2012, 2013; Nedeljković et al. 2013, 2015; Grković et al. 2015, 2017). In this paper, we define and describe the *bactrianus* subgroup and provide differential diagnoses for all European species. We describe the adult males and females of three new species, supported by molecular data, and redescribe the type species of the subgroup. Further, we compare European species to Asian representatives, focusing on the diagnostic morphological characters given by Stackelberg (1961).

2. Material and methods

Material. For our redescription of *E. bactrianus*, from which the name of the *bactrianus* subgroup is derived, we studied male and female paratypes from Tajikistan, deposited in the Zoological Institute in St. Petersburg, Russia (ZIN) (holotype unavailable). We also studied type specimens of *E. pannonicus*, collected in 2014 near Mokrin, Vojvodina (Serbia) (Markov et al. 2016). Specimens of *E. banaticus* n.sp. and *E. bicornis* n.sp. from Greece and Turkey were collected using hand nets by researchers from the Laboratory for Biodiversity Research and Conservation of the University of Novi Sad between 2012 and 2017. Specimens from Turkey were collected as part of a project by The Scientific and Technological Research Council of Turkey (TÜBİTAK) during 2014, 2015 and 2016. Specimens of *E. bifurcatus* n.sp. were collected by Jeroen van Steenis and Menno P. van Zuijen in 2003.

Morphological study. Male terminalia of dry or softened specimens were dissected by means of entomological pins and forceps. Terminalia were boiled in 10 % KOH, rinsed in glacial acetic acid and alcohol, and stored in glycerine in microvials attached to the respective specimen. Figures and drawings of *E. banaticus* n.sp., *E. bicornis* n.sp. and *E. pannonicus* were created using photographs of characters taken with a Leica DFC 320 (Wetzlar, Germany) camera attached to a Leica MZ16 binocular stereomicroscope and then processed in Adobe Photoshop CS3 v10.0 (Adobe Systems, San Jose, CA, USA). Body parts were drawn from dry specimens.

Terminalia of *E. bactrianus* and *E. bifurcatus* n.sp. were drawn with the aid of a drawing tube attached to a Wild M10 microscope. Photographs of these species were taken with a Canon EOS D6 camera and a micro-

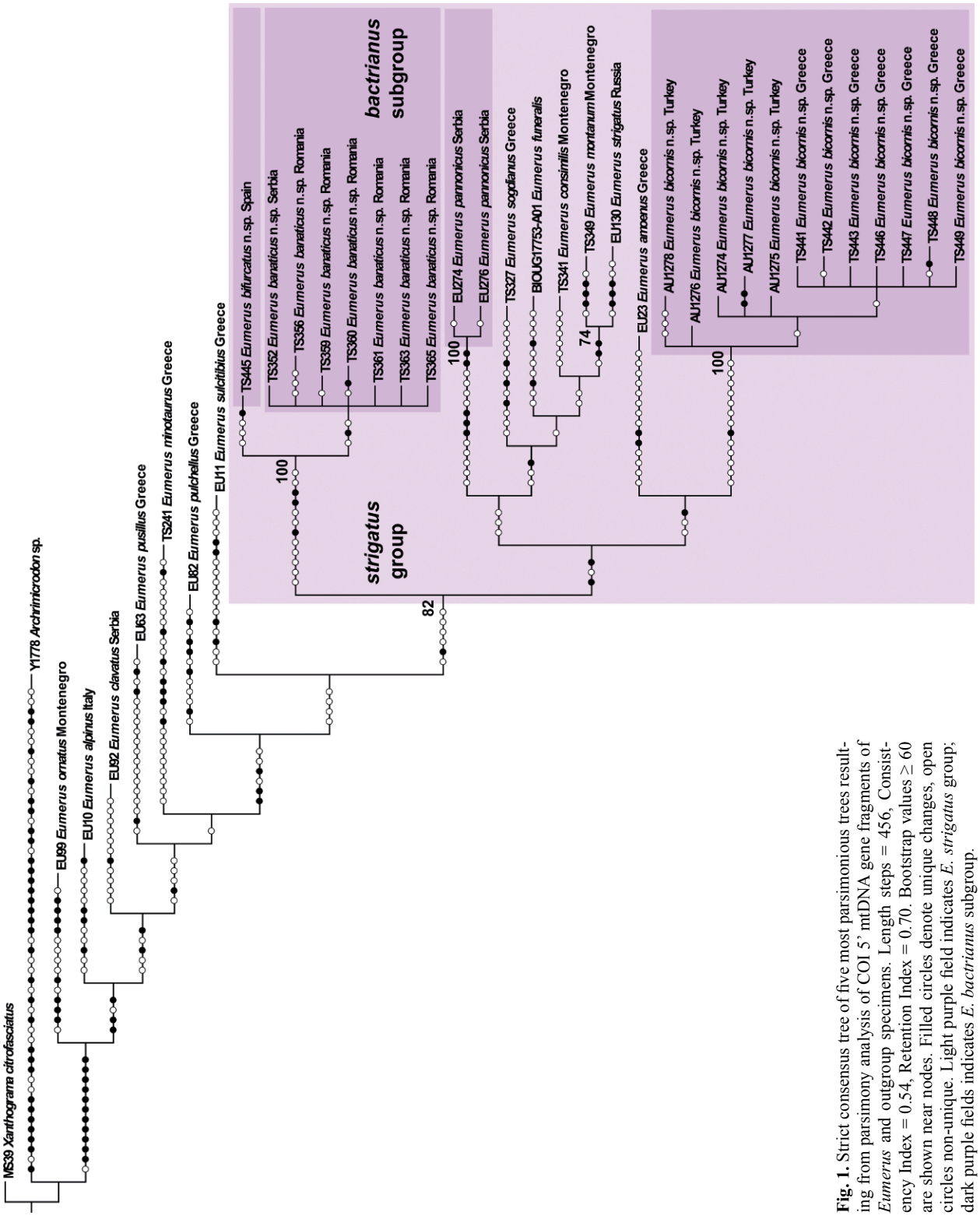


Fig. 1. Strict consensus tree of five most parsimonious trees resulting from parsimony analysis of COI 5' mtDNA gene fragments of *Eumerus* and outgroup specimens. Length steps = 456, Consistency Index = 0.54, Retention Index = 0.70. Bootstrap values ≥ 60 are shown near nodes. Filled circles denote unique changes, open circles non-unique. Light purple field indicates *E. strigatus* group; dark purple fields indicates *E. bactrianus* subgroup.

objective lens attached to a Wild M10 microscope. All photographs were stacked using the CombineZ (Hadley 2010) stacking software and edited with the Adobe Photoshop CS3 V 10.0 software (Adobe Systems, San Jose, CA, USA).

Terminology referring to wing cells follows Cumming & Wood (2017). Thompson (1999) and McAlpine (1981) are followed concerning the remaining non-genital body parts. Terminology referring to male genitalia follows Doczkal (1996) and Hurkmans (1993).

Molecular analysis. ***Laboratory procedures***: Specimens used for molecular analyses are listed in Supplementary Table S1. Each specimen was labelled as a DNA

voucher specimen and deposited in the insect collections of FSUNS and EMIT. DNA extractions were carried out from two or three legs of the specimens using a slightly modified SDS Extraction Protocol (Chen et al. 2010). The 5' region of the mitochondrial protein-coding gene cytochrome *c* oxidase subunit I (COI) was amplified with the forward primer LCO-1490 (5'-GGTCAACAAATCATAAAGATATTGG-3') and reverse primer HCO-2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3') (Folmer et al. 1994). PCR reactions were carried out in 25 µl reaction volumes and the reaction mix consisted of 1 × Taq buffer (ThermoScientific, Lithuania), 2 mM $MgCl_2$, 0.1 mM of each nucleotide, 1.25 U Taq polymerase, 5 pmol of each primer, and approximately 50 ng DNA. Amplification was performed under the following conditions: initial denaturation for 3 min at 94°C; 30 s denaturation at 94°C, 45 s annealing at 50°C, 1 min extension at 72°C (29 cycles); and a final extension for 8 min at 72°C. The PCR products were purified by Exonuclease I and Shrimp Alkaline Phosphatase enzymes (ThermoScientific, Lithuania) and then sequenced using the forward primer on an ABI3730x1 Genetic Analyzer system (Applied Biosystems) at the Finnish Institute for Molecular Medicine (FIMM), Helsinki, Finland (http://www.fimm.fi).

Analysis of DNA sequences: Alignment of the COI sequences was performed using the Clustal W algorithm (Thompson et al. 1994), as implemented in BioEdit version 7.2.5. (Hall 1999). We used *Archimicrodon* sp. (GenBank accession no. KU365483) and *Xanthogramma citrofasciatum* De Geer, 1776 (GenBank accession no. KU365484) as outgroups. Additional representatives of the major *Eumerus* species groups were included in our analysis. Sequences were clustered using parsimony analysis implemented in NONA (Goloboff 1999), spawned with the aid of Winclada (Nixon 2002), using the heuristic search algorithm with 1000 random addition replicates (mult*1000), holding 100 trees per round (hold/100), maxtrees set to 100 000 and applying TBR branch swapping. Nodal support for the tree was assessed using non-parametric bootstrapping with 1000 replicates using Winclada.

Abbreviations. Used in ***descriptions***: **il** – interior accessory lobe of posterior surstylus, **ps** – posterior surstylus, **s** – sternite, **t** – tergite. Used in ***figures***: **as** – anterior surstylus, **bh** – basal projection of hypandrium, **db** – dorsal bulge of dorsal flexure of hypandrium, **il** – interior accessory lobe of posterior surstylus, **lh** – lateral outgrowth of hypandrium, **lp** – lateral prolongation of bifurcated posterior surstylus, **mp** – main prolongation of bifurcated posterior surstylus, **pa** – pile on anterior surstylus, **ps** – posterior surstylus, **vm** – ventral margin of posterior surstylus.

Depositories. Studied specimens have been deposited in the following collections: California State Collection of Arthropods, Plant Pest Diagnostic Branch, Department of Food & Agriculture, Sacramento, USA (**CSCA**); Entomological Museum of Isparta, Turkey (**EMIT**); Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, Serbia (**FSUNS**); Natural Biodiversity Centre, Leiden, The Netherlands (**NBC**); Private collection of Jeroen van Steenis, Amersfoort, The Netherlands (**PJSA**); Russian Academy of Science, Zoological Institute, St. Petersburg, Russia (**ZIN**).

Distribution map. The map was created in DIVA-GIS Version 5.2.0. (Hijmans et al. 2005) and enhanced with the Adobe Photoshop CS3 V 10.0 software (Adobe Systems, San Jose, CA, USA).

3. Results

3.1. Molecular analysis

The generated COI gene fragments comprised a total of 631 characters for 37 specimens (35 *Eumerus* specimens + 2 outgroup specimens), including 124 parsimony-informative characters in the total matrix. The resulting strict consensus tree generated from five most parsimonious trees by Maximum Parsimony is shown in Fig. 1, revealing the *strigatus* group as being monophyletic. Within this group, specimens of the *bactrianus* subgroup are clearly resolved into three different clades *E. pannonicus*; *E. bicornis* n.sp.; and *E. bifurcatus* n.sp. + *E. banaticus* n.sp. (bootstrap values = 100). Although *E. bifurcatus* n.sp. is associated with *E. banaticus* n.sp., this sample formed a separate branch within that clade.

3.2. Taxonomy

3.2.1. *Eumerus strigatus* group

The *strigatus* group comprises relatively small and inconspicuous blackish flies, typically with a bronze sheen, and with an elongated abdomen lacking red or yellow markings on the tergites. The basoflagellomere is usually rectangular and reddish to dark-brown or black. The eye contiguity is more than seven ommatidia long. The legs are largely black and simple and without distinct apomorphic structures. The hind femur is moderately swollen, and the leg connections, tips of the femora and the basal thirds of tibiae are bright yellow. The shape of abdominal sternite 4 in males is an important differentiating character among species. The main diagnostic character used to distinguish species from this group is the shape of the posterior surstylus (Grković et al. 2017). Females of different species of the genus are not easy to distinguish. This difficulty is compounded by the fact that several species are sympatric and can be found in the same habitat.

European species belonging to the *strigatus* group are as follows: *E. amoenus*; *E. consimilis* Šimić & Vujić,

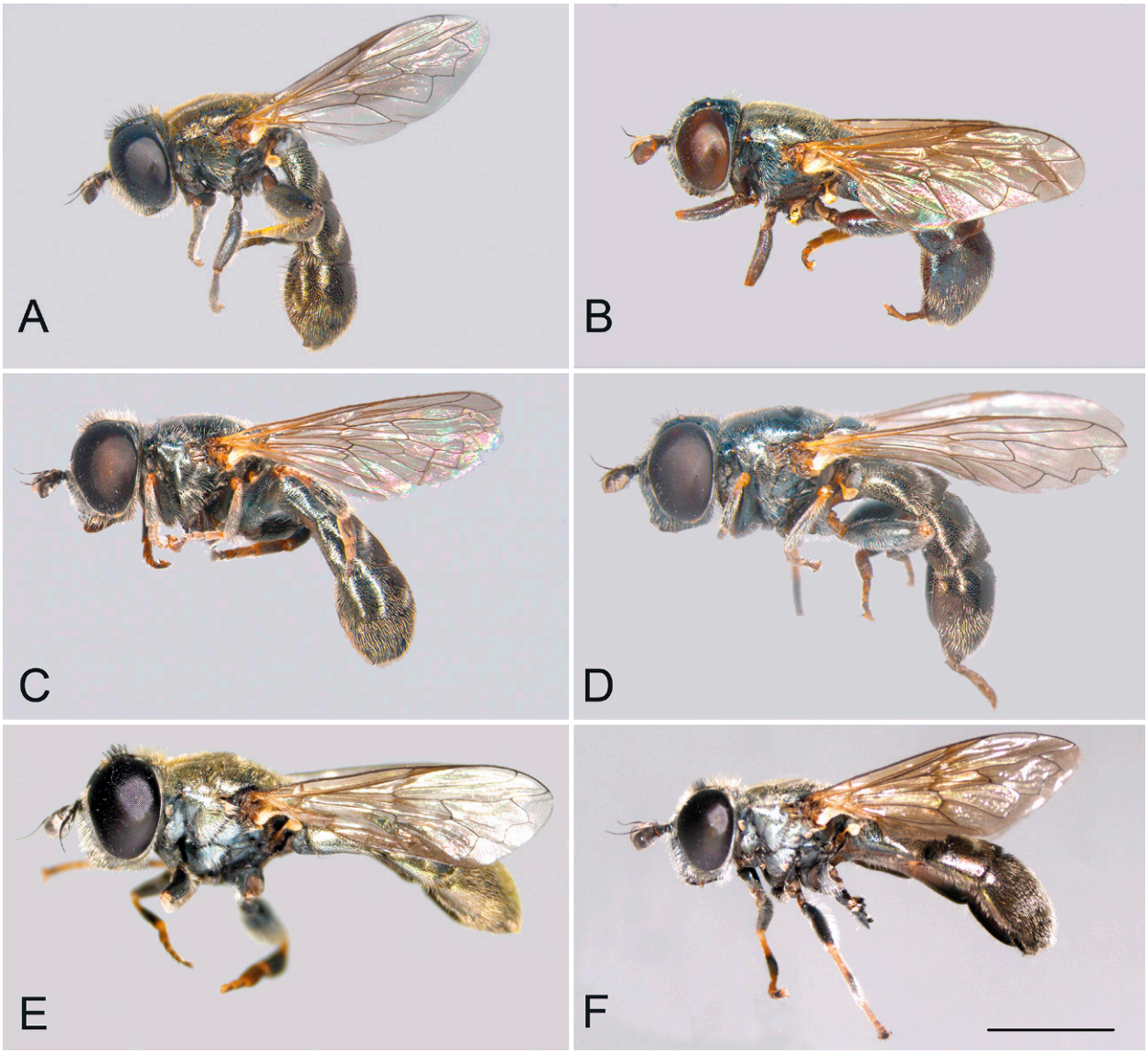


Fig. 2. Adult specimens of *Eumerus*, lateral view. **A**: *E. banaticus* n.sp., male. **B**: *E. banaticus* n.sp., female. **C**: *E. bicornis* n.sp., male. **D**: *E. bicornis* n.sp., female. **E**: *E. panonnicus* Ricarte, Vujić & Radenković, 2016, male. **F**: *E. panonnicus*, female. Scale: 2 mm.

1996; *E. funeralis*; *E. montanum* Grković, Vujić & Radenković, 2017; *E. narcissi*; *E. strigatus*; *E. sogdianus* Stackelberg, 1952; and a group of species related to *E. bactrianus* (i.e., *E. pannonicus* and the three species described in the present paper).

3.2.2. *Eumerus bactrianus* subgroup

Differential diagnosis. Members of this subgroup are very similar to other species of the *strigatus* group. Eyes in the male are holoptic with a long eye contiguity. White pilose and white pollinose face and frons. Basoflagellomere dark-brown to black, usually slightly elongated (Figs. 4A–E, 9A–D). Mesoscutum with long narrow pollinose vittae nearly reaching scutellum (Fig. 3A). The most distinctive characters of the subgroup, differentiating it from other species of the *strigatus* group, are the shape of sternite 4 in males (Fig. 5F–I), which in the *E. bactrianus* subgroup is more complex, and the bifurcated surstylus (Figs. 6A,B,E,F,I,J, 7A,B,E,F). The interior accessory lobe of the posterior surstylus is covered with long dense pile. Females of the *bactrianus* subgroup are extremely similar to females of other species of the *strigatus* group. Generally, they have a somewhat smaller basoflagellomere, and the distance between the posterior ocellus and eye margin is slightly longer than for females of other *strigatus* species (except for females of *E. amoenus*). Other differences vary depending on the species being compared.

Notes. Stackelberg (1952) described three species based on the specific structure of the male epandrium with bifurcated posterior surstylus: *E. bactrianus*, *E. turanicus* and *E. turanicola*. We compared European species with type specimens of *E. bactrianus* and with the available literature (Stackelberg 1952, 1961) to find distinctive characters for species of this subgroup. We examined figures of the male terminalia, sternites and antennae [see

Stackelberg 1952: pp. 395, fig. 32 (*E. turanicus*); pp. 397, fig. 33 (*E. turanicola*)]. The most distinctive characters in adult males of these three species are: shape of the branches of the posterior surstylus, shape of the basoflagellomere, and shape of abdominal sternite 4. *Eumerus turanicus* can easily be distinguished from the other two species by the characteristic thorn-like outgrowth anteriorly on the cercus, the very dense pilosity dorsally on the main branch of the posterior surstylus, the oval-shaped basoflagellomere, and the unique stair-notched shape of sternite 4. *Eumerus turanicola* possesses a triangular basoflagellomere and the posterior surstylus is incompletely divided with a ventral triangular extension.

3.2.3. Redescription of *Eumerus bactrianus* Stackelberg, 1952

Redescription. ***Male***. Length of body 8.4 mm, of wing 5.6 mm. ***Head***: eyes holoptic, eye contiguity 7–8 ommatidia long; ommatidia near eye margin slightly larger than those in posterior part; ventral eye margins slightly divergent; eyes with white moderately long and dense pile, but bare along posterior eye margin; face pilosity very dense, light-yellow; face covered with silvery-white pollinosity; pile on frons light-yellow, black on ocellar triangle and light-yellow on posterior part of vertex; ocelli arranged in almost equilateral triangle, ratio of distance between anterior and posterior ocellus *to* distance between posterior ocelli 1 : 0.8; frons with triangular white pollinose macula anteriorly at eye contiguity, with two white pollinose maculae along eye margin posterolaterally to posterior ocelli; occiput anteriorly along eye margin densely white pollinose up to dorsal 3/4, dorsal-most part non-pollinose, shiny black instead; antenna brownish with scattered silvery pollinosity; basoflagellomere trapezoid, dark-brown laterally and orange-brown medially; arista black and thickened basally; scape and pedicel dark-brown to black; pile on pedicel white, ventral pile 3–4 × longer than dorsal pile (Fig. 4B). ***Thorax***: shiny black with golden sheen; scutum medio-laterally with two dense white pollinose vittae covering 2/3 of scutal length, moderately punctuated, covered in short yellow to golden-yellow pilosity; pleura on dorsal half with golden sheen and yellow to golden-yellow pile, bronze sheen on ventral half with white to light-yellow pile; posterior anepimeron with some pile anteriorly; postalar region with row of strong black setulae; scutellum with rather broad rim. ***Legs***: black; bases of femora and basal 1/4–1/3 of tibiae yellowish; all tarsi yellow ventrally, tarsomeres 1–4 entirely orange-yellow; hind coxa with long white pile; hind femur moderately swollen, white pilose, ventral pile 2–3 × longer than dorsal pile (Fig. 5A); posteroventral pile 3/5 as long as femoral width, about 1.5 × longer than anteroventral pile; hind femur apically with row of 8 spines on anterior ridge and row of 15 spines on posterior ridge; tarsomere 1 of midleg with strong black setae ventrally; tarsomere 1 twice as long as tarsomere 2 of hind tarsus. ***Wings***: hyaline, microtrichose except for basal parts of cells cua and bm; halter light-brown. ***Abdomen***: oval, parallel-sided, shiny black with bronze sheen, weakly punctuated, medially with black and short pile, laterally with longer and light-yellow to golden-yellow pile, t4 predominantly with golden-yellow pile; t2–4 lateromedially with two slightly lunulate and oblique maculae of white pollinosity, those on t4 straighter; sternites brown, white pilose; s3 nearly square, about 1.1 × longer than broad; s4 rectangular, posterolateral narrowly-rounded corners with long pile and posteromedially with deep incision. ***Terminalia*** (Fig. 7A–D): genital capsule white pilose; ps bifurcated with main prolongation hooked (Fig. 7A,B: mp) and oval laterally (Fig. 7A,B: lp); ventral margin of ps greatly protruded (Fig. 7A: vm); anterior surstylus elongated (Fig. 7A,B: as); il triangular (Fig. 7B: il). — ***Female***. Similar to male, except for normal sexual dimorphism. Length of body 7.6 mm, of wing 5.4 mm. ***Head***: face more parallel-sided, eye margins not divergent ventrally; frons along eye margin grey-white pollinose from anterior end of

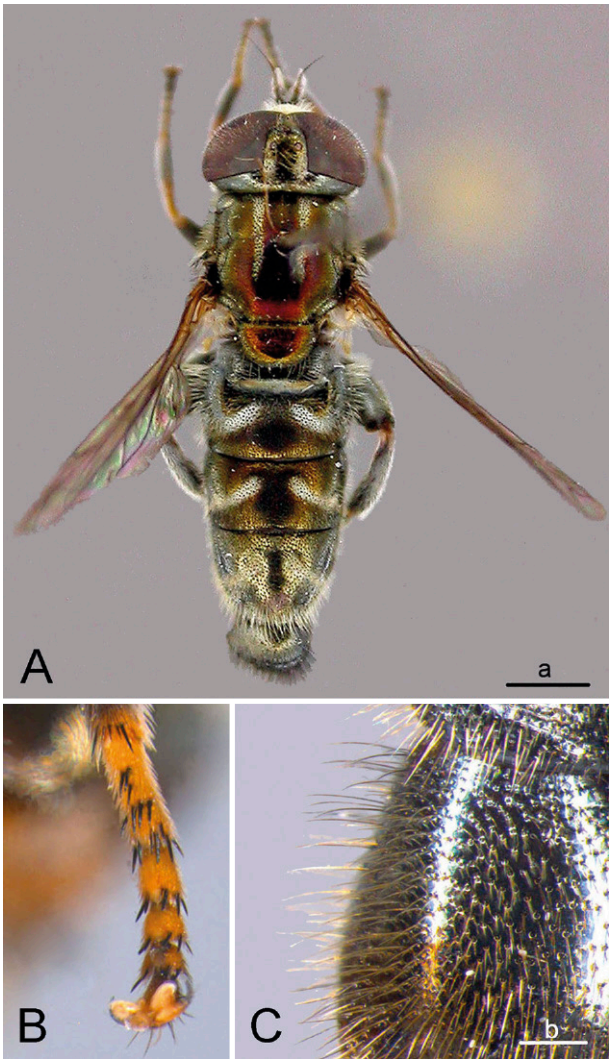


Fig. 3. A: *Eumerus bifurcatus* n.sp., adult specimen, dorsal view. **B**: *E. bicornis* n.sp., male mid tarsus, ventral view. **C**: *E. banaticus* n.sp., lateral margin of abdominal T4 in male. Scale: a: 1 mm, b: 0.2 mm.

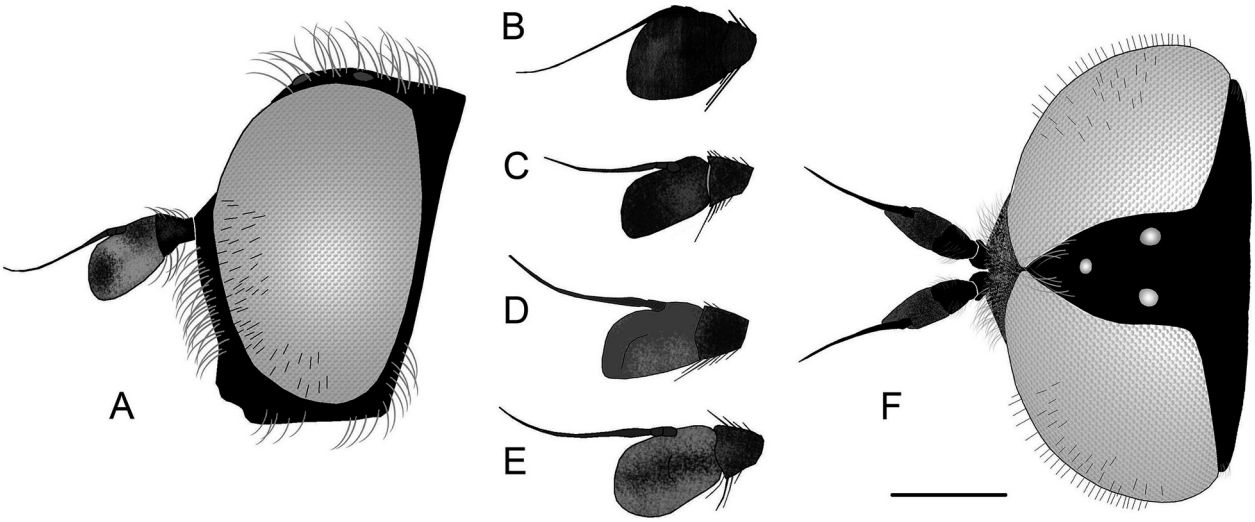


Fig. 4. A: Head, male, lateral view, and male antenna, outer side, of *Eumerus bicornis* n.sp. **B**–**E**: Antenna, male, lateral view of *E. bactrianus* Stackelberg, 1952 (**B**), *E. banaticus* n.sp. (**C**), *E. bifurcatus* n.sp. (**D**), *E. panonnicus* Ricarte, Vujić & Radenković, 2016 (**E**). **F**: Head, male, dorsal view of *E. bicornis* n.sp. Scale: 0.5 mm.

frons to just anterior of posterior ocellus, anterior of ocellar triangle with scattered grey pollinosity; ocelli nearly equilateral, ratio 1 : 0.92. ***Thorax***: posterior anepimeron bare. ***Legs***: hind femur white pilose, ventral pile 1.5–2 × longer than dorsal pile (Fig. 9F); posteroventral pile 3/5 as long as femoral width, about 1.5 × longer than anteroventral pile; hind femur apically with row of five setae on anterior ridge and row of 10 setae on posterior ridge. ***Abdomen***: white pollinose maculae on t3 and t4 more lunulate; s3 rectangular, about 1.5 × longer than wide; s4 square, 1.1 × longer than wide.

Differential diagnosis and remarks. Distinguishing characters are as follows: basoflagellomere fan-like with pointed ventral margin (Fig. 4B), approximately as long as wide as in males of most species of the *E. strigatus* group (whereas the basoflagellomere is slightly elongated in other species of the *E. bactrianus* subgroup) (Fig. 4A,C,D); tarsomeres 1–4 orange-yellow; hind femur with posteroventral pilose fringe along entire length of femur, pile rather long, about 3/5 as long as width of femur (Fig. 5A); t4 medially with long rectangular white pollinose and obliquely-placed maculae; anterior surstylus elongated (Fig. 7A: as); ventral margin of posterior surstylus greatly protruded (Fig. 7A: vm), similar to that of *E. bifurcatus* but these two species can clearly be separated by the shape of the dorsal part of the posterior surstylus and the shape of the interior accessory lobe of the posterior surstylus (Fig. 7B,F: il).

Material examined. ***Type material***: Paratypes. TAJIKISTAN: 1♂, 1♀ ‘у. Кондара 1100 m | д. ВарзобаТадж. | Гуссаковский [Kopdara 1100 m | d. VarzobaTadž. | Gussakovskii] 15.v.[19]39’, ‘Paratypus *Eumerus* | *bactrianus* | Stackelberg 1952’ [red label], 1♂ (ZIN); 1♀, ‘Щабмик. Побеи | Лобма рбц Гариа | субаиья 2–2500 m | Гуссаковский 4.VIII.[1]946’, ‘Paratypus | *Eumerus* | *bactrianus* | Stackelberg 1952’ (ZIN).

3.2.4. European species of *Eumerus bactrianus* subgroup

Eumerus banaticus Nedeljković, Grković & Vujić n.sp.

Description. Length of body 7–8 mm, of wing 4.5–5 mm. ***Male*** (Figs. 2A, 3C, 4C, 5B,F, 6A–D). ***Head***: eyes holoptic, eye contiguity 6–7 ommatidia long; ommatidia near eye margin slightly larger than those in posterior part; ventral eye margins slightly divergent; eye conspicuously pilose, with bare areas near eye contiguity being larger than those at posterior part of eye; vertical triangle black with black pile; vertical triangle with white pollinose maculae near posterior and anterior corners; area posterior to ocellar triangle with long, erect, intermixed yellow and black pile; ocelli arranged in almost equilateral triangle, ratio of distance between anterior and posterior ocellus *to* distance between posterior ocelli 1 : 0.94 (in holotype; varies to 1 : 0.8); occiput with narrow grey pollinosity on eye margin; frontal triangle white pollinose with long yellow pile in anterior part, with tuft of long black pile laterally; face white pollinose with long silvery-yellow pile; antenna black with sparse silvery pollinosity; basoflagellomere about twice as long as wide, bar-shaped (Fig. 4C), slightly widened towards apex; arista bare and black; pedicel elongated, dark-brown but lighter at base. ***Thorax***: scutum with conspicuous bronze reflections and orange-yellow pile, longer in posterior part of scutum (a few black pile can be present); scutum with two white pollinose vittae extending for anterior 4/5 of scutal length; postalar region with row of strong black setulae; scutellum with rather broad rim. ***Legs***: all femora extensively black; fore tarsus and mid tarsus completely black; all tibiae extensively black; hind femur moderately swollen with row of short, black spines ventrally on apical 3/4 of femur length and long yellow

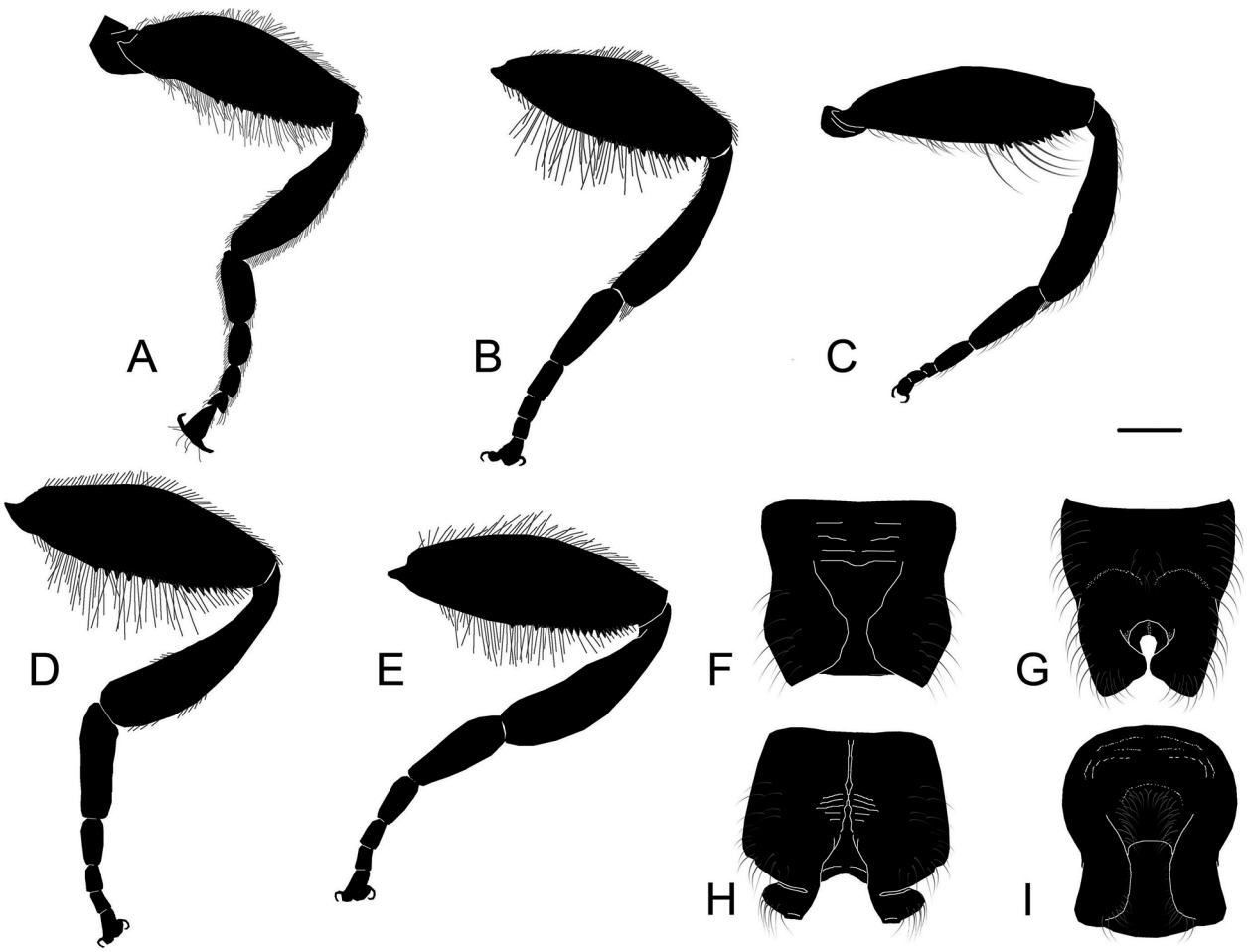


Fig. 5. Male hindleg of *Eumerus*.**A**: *E. bactrianus* Stackelberg, 1952, **B**: *E. banaticus* n.sp., **C**: *E. bicornis* n.sp., **D**: *E. bifurcatus* n.sp., and **E**: *E. panonnicus* Ricarte, Vujić & Radenković, 2016. Abdominal 4th sternite in male of **F**: *E. banaticus* n.sp., **G**: *E. bicornis* n.sp., **H**: *E. bifurcatus* n.sp., and **I**: *E. panonnicus* Ricarte, Vujić & Radenković, 2016. Scale: 0.2 mm.

pile ventrally (Fig. 5B); hind tarsomere 1 about same length as hind tarsomeres 2–4 combined. ***Wings***: hyaline, microtrichose except for basal parts of cells cua and bm; halter white. ***Abdomen***: oval, parallel-sided, shiny black with bronze sheen, weakly punctuated; t1–3 with blue reflections; t4 with bronze reflections; t2 and t3 with black pile medially and white pile laterally; t4 with dense posteriorly-adpressed, orange-yellow pile; t2 and t3 with two oblique bar-shaped white-pollinose fasciae not reaching lateral margins of tergites; lateral margins of t4 with longer pile; pollinose maculae curved, absent from t4; sternites brownish with bronze reflections; s2 and s3 shiny in medial part but pollinose in lateral parts; medial parts of s2 and s3 with long, erect, yellowish-white pile; s4 divided into two parts, separated by membrane and bearing yellow pile at and near margins (Fig. 5F). ***Terminalia*** (Fig. 6A–D): ps bifurcated with hooked main prolongation and oval lateral prolongation (Fig. 6A,B: mp, lp); cerci almost rectangular, oblique in lateral corners; hypandrium with two ventral triangular protuberances (Fig. 6C,D: bh). — ***Female*** (Figs. 2B, 8A, 9C,G). Similar to male, except for normal sexual dimorphism. ***Head***: ocelli nearly equilateral, ratio 1 : 0.96; frons shiny black with thin pollinose markings at eye margin and two small triangular pollinose maculae posterior to ocellar triangle; frons with yellowish-white pile. ***Thorax***: scutum with additional medial, narrow white pollinose vitta. ***Abdomen***: s4 rectangular, longer than wide.

Variability. This species can exhibit variable colouring of the legs, ranging from completely black with only hind tarsomere 1 yellow ventrally (specimen from Serbia) to the tibiae and femora basally yellow and the tarsi entirely yellow (specimens from Romania).

Differential diagnosis and remarks. This species differs from others in the subgroup on the basis of the following combination of characters: costal pile black; tarsi of mid and hind legs extensively black; t4 without pollinose maculae and with lateral margins covered by longer pile (Fig. 3C), whereas in other species of the subgroup the pile on t4 are approximately the same length across the entire surface; hypandrium with two triangular and very prominent thorn-like tubercles ventrally (Fig. 6C,D: bh), similar to *E. bifurcatus* but in this species the tubercles are oval (Fig. 7G,H: bh); ventral margin of posterior surstylus is slightly protruded (Fig. 6A).

Derivatio nominis. The name *banaticus* is derived from Banat, the geographical region in the east of the Pannonian Plain where the type specimens were collected.

Material examined. ***Type material***: Holotype ♂, SERBIA: Mokrin, Pašnjaci velike droplje, 71 m, 7.vi.2016, 45°55′30″N 20°17′52.8″E, T. Tot leg. (FSUNS) – Paratypes. ROMANIA: 3♂, 1♀, Banat, Satchinez-Timis, 15.viii–7.ix.2012, 45°57′32.4″N 21°3′10.8″E, Râdak leg. (FSUNS).

Eumerus bicornis Grković, Vujić & Hayat n.sp.

Description. Length of body 7–8 mm, of wing 5–6 mm. ***Male*** (Figs. 2C, 3B, 4A,F, 5C,G, 6E–H). ***Head***: eyes holoptic, eye contiguity 6–8 ommatidia long; ommatidia near eye contiguity larger than those in posterior part of eye; ventral eye margins slightly divergent; pile on eye moderately long and dense, posterior margin of eye bare; face pilosity yellowish to white, face covered with silvery-white pollinosity; pile on vertex white, but mixed with black near anterior ocellus; ocelli arranged in almost equilateral triangle (Fig. 4F), posterior ocelli larger than anterior ocellus, ratio of distance between anterior and posterior ocellus *to* distance between posterior ocelli 1 : 0.85; antenna dark brown with shiny silvery pollinosity, basoflagellomere rectangular, slightly elongated; arista black, basally thickened; pile on pedicel white, ventral pile up to 4 × longer than dorsal pile (Fig. 4A). ***Thorax***: shiny black with golden sheen; scutum mediolaterally with two dense white pollinose vittae covering 2/3 of scutal length, moderately punctuated, covered in short, white pilosity; postalar region with row of strong black setulae; scutellum with rather broad rim. ***Legs***: black; base of femora and basal 1/4 of tibiae yellowish; proximal three tarsomeres of midleg yellow; all tarsi yellow ventrally and between segments; hind coxa with long white pile; hind femur moderately swollen, with ventral pile slightly longer than dorsal ones, with a few distinctly longer white setae posteroventrally as long as depth of femur (Fig. 5C); hind femur apically with row of 3–4 spines on anterior ridge and row of 8–12 spines on posterior ridge; tarsomere 1 of midleg with very strong distinctive black setulae ventrally (Fig. 3B); legs covered with white to yellowish pilosity, golden-yellow pile on tarsi ventrally. ***Wings***: hyaline, microtrichose except for basal parts of cells cua and bm; halter light-brown. ***Abdomen***: oval, parallel-sided, black, softly punctuated, shiny; tergites medially with black pilosity, but white laterally; three pairs of white lunulate and obliquely-located pollinose maculae on t2–4, not reaching lateral margin, maculae on t4 reduced to two small dots or short lines, narrower than maculae on t2–3; sternites light-brown, as is membrane, moderately wide, covered in sparse pilosity; s3 approximately as long as wide; s4 slightly elongate with deep medial incision (Fig. 5G). ***Terminalia*** (Fig. 6E–H): genital capsule white pilose; ps bifurcated apically (Fig. 6E,F), cercus elongate with separate tooth anteriorly (Fig. 6E); both sides of hypandrium with bulge dorsal to dorsal flexure (Fig. 6G,H: db). — ***Female*** (Figs. 2D, 8B, 9A,E,H). Similar to male, except for normal sexual dimorphism. ***Head***: frons slightly wrinkled, grey-white pollinosity along eye margin from anterior end of frons to just anterior to posterior ocellus; ocelli nearly equilateral, ratio 1 : 0.91. ***Abdomen***: pollinose maculae on t4 much more pronounced than in males (Fig. 8B).

Differential diagnosis and remarks. Differentiated from other species of the *bactrianus* subgroup by: tarsomeres 1–3 of midlegs yellow and by very strong and distinctive black setulae on basitarsus ventrally (Fig. 3B); conspicuous fringe of long white setae-like pile posteroventrally on apical part of hind femur in both male and female (Figs. 5C, 9H); costal pile distinctively yellow; anterior surstylus covered in long pile (Fig. 6F); cercus with distinctive apomorphic tooth anteriorly (Fig. 6E); both dorsal prolongations of posterior surstylus are rounded and finger-like (Fig. 6E,F), whereas in other species of the subgroup the main body of the posterior surstylus is hooked and the lateral prolongation is oval.

Derivatio nominis. The name is derived from the divided posterior surstylus, giving the appearance of two horns (*bicornis*, lat.).

Material examined. ***Type material***: Holotype ♂, TURKEY: Isparta, Merkez, Kirazlıdere Mevkii, 1260 m, 9.vii.2015, 37°44′34.2″N 30°31′23″E, A. Vujić et al. leg. (FSUNS). – Paratypes TURKEY: 6♂, 2♀, Isparta, Merkez, Kirazlıdere Mevkii, 2.ix.2014, 1196 m, 37°44′32.85″N 30°31′26.78″E, leg. R. Hayat et al. (EMIT, FSUNS, PJSA); 1♂, 1♀, Merkez, Gölcük Tabiat Parkı, 25.vi.2015, 1400 m, 37°44′07″N 30°29′48.0″E, leg. R. Hayat et al. (EMIT); 26♂, 4♀, Merkez, Kirazlıdere Mevkii, 9.vii.2015, 1260 m, 37°44′34.2″N 30°31′23″E, leg. A. Vujić et al. (EMIT, FSUNS); 1♂, Merkez, Kirazlıdere Mevkii, 9.vii.2015, 1250 m, 37°44′34.2″N 30°31′23″E, leg. A. Vujić et al. (EMIT); 2♂, Merkez, Kirazlıdere Mevkii, 11.vii.2015, 1300 m, 37°44′20.7″N 30°30′55″E, leg. R. Hayat (EMIT); 1♂ Merkez, Kirazlıdere Mevkii, 8.ix.2015, 1310 m, 37°44′20.7″N 30°30′55″E, leg. R. Hayat et al. (EMIT); 13♂, 2♀, Merkez, Kirazlıdere Mevkii, 19.vi.2016, 1196 m, 37°44′32.85″N 30°26.8″E, leg. R. Hayat et al. (EMIT, FSUNS, PJSA); 30♂, Merkez, Kirazlıdere Mevkii, 19.vi.2016, 1220 m, 37°44′34.2″N 30°31′23″E, leg. R. Hayat et al. (EMIT, FSUNS); GREECE: 7♂, 3♀, Peloponnese, Chelmos-Kalavryta Ski Centre, 6–8.vi.2017, 1704 m, 38°00′24.35″N 22°11′41.37″E, leg. A. Vujić et al. (FSUNS).

Eumerus bifurcatus van Steenis & Hauser n.sp.

Description. ***Male*** (Figs. 3A, 4D, 5D,H, 7E–H). Length of body 7.7–8.2 mm, of wing 5.2–5.6 mm. ***Head***: eyes holoptic, eye contiguity 7–9 ommatidia long; ommatidia near eye margin slightly larger than posterior part; ventral eye margins slightly divergent; eyes with white moderately long (half as long as facial pile) and dense pile (distance between pile equivalent to 2–4 ommatidia), posterior eye margin bare; white facial pilosity very dense, face covered with silvery-white pollinosity; pile on frons white, but black on ocellar triangle and white pilose on posterior part of vertex; ocelli arranged in almost equilateral triangle, ratio of distance between anterior and posterior ocellus *to* distance between posterior ocelli 1 : 0.91; frons with small triangular white pollinose macula anteriorly at eye contiguity, with two small white pollinose maculae along eye margin posterolaterally to posterior ocelli; occiput densely white pollinose anteriorly along eye margin up to dorsal 2/3, but dorsal-most part non-pollinose and shiny black; antenna dark-brown to black with scattered silvery pollinosity; basoflagellomere rectangular, slightly elongated (Fig. 4D); arista black, basally thickened; pile on pedicel white, ventrally

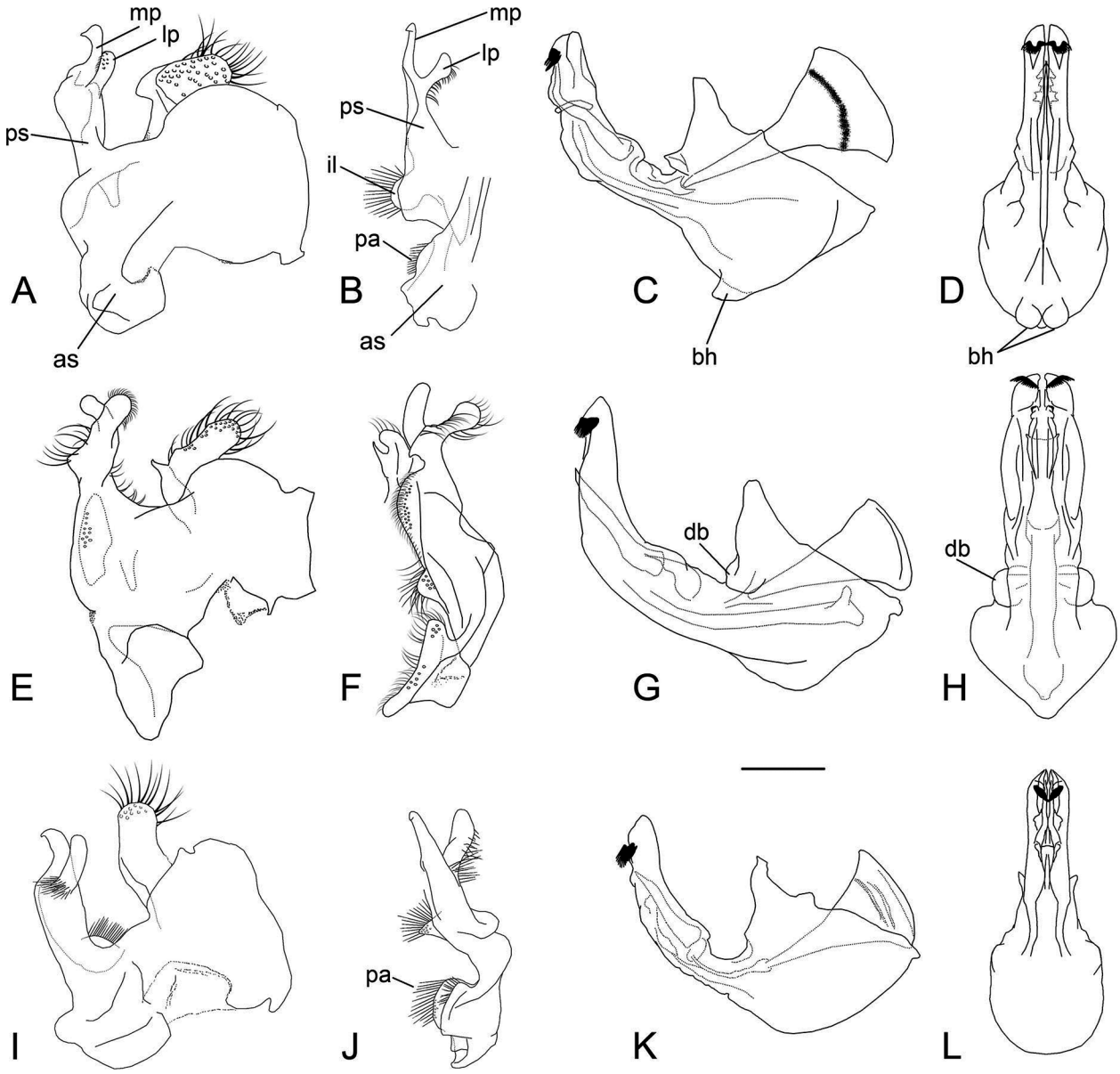


Fig. 6. Male genitalia of *Eumerus*. **A**–**D**: *E. banaticus* n.sp., epandrium lateral view (**A**) and ventral view (**B**), hypandrium lateral view (**C**) and ventral view (**D**). **E**–**H**: *E. bicornis* n.sp., epandrium lateral view (**E**) and ventral view (**F**), hypandrium lateral view (**G**) and ventral view (**H**). **I**–**L**: *E. panonnicus* Ricarte, Vujić & Radenković, 2016, epandrium lateral view (**I**) and ventral view (**J**), hypandrium lateral view (**K**) and ventral view (**L**). Scale: 0.2 mm. — ***Abbreviations***: as – anterior surstylus, bh – basal projection of hypandrium, db – dorsal bulge of dorsal flexure of hypandrium, il – interior accessory lobe of posterior surstylus, lp – lateral prolongation of bifurcated surstylus, mp – main prolongation of bifurcated surstylus, pa – pile on anterior lobe of surstylus, ps – posterior surstylus, vm – ventral margin of posterior surstylus.

3–4 × longer than dorsal pile. ***Thorax***: shiny black with bronze sheen; scutum mediolaterally with two dense white pollinose vittae covering 2/3–3/4 of scutal length; moderately punctuated; covered in short white pilosity; posterior anepimeron bare; postalar region with row of strong black setulae; scutellum with rather broad rim. ***Legs***: black, basal 1/5–1/4 of femora brown-yellow to yellow; mid-tarsus with tarsomeres 1–4 orange-brown to dark-brown; hind coxa with long white pile; hind femur moderately swollen and white pilose, ventral pile 3–5 × longer than dorsal pile (Fig. 5D); posteroventral pile 3/4–4/5 as long as femoral width, about 1.5 × longer than anteroventral pile; hind femur apically with row of 5–8 setae on anterior ridge and row of 14–17 setae on posterior ridge; mid-tarsomere 1 with strong black setulae ventrally; hind tarsomere 1 2.3–2.5 × longer than tarsomere 2. ***Wing***: hyaline, microtrichose except for basal parts of cells cua, bm and r, sometimes only cell bm bare basally; halter light-brown. ***Abdomen***: oval, parallel-sided, shiny black with bronze sheen; weakly punctuated; medially with short black pile, laterally with longer and white pile, t4 predominantly white pilose; t2–4 lateromedially with two rectangular and oblique maculae of white pollinosity, those on t4 very short; sternites brown, white pilose; s2 about 1.5 × longer than broad; s3 about 1.3 × longer than broad; s4 about 1.3 × longer than pos-

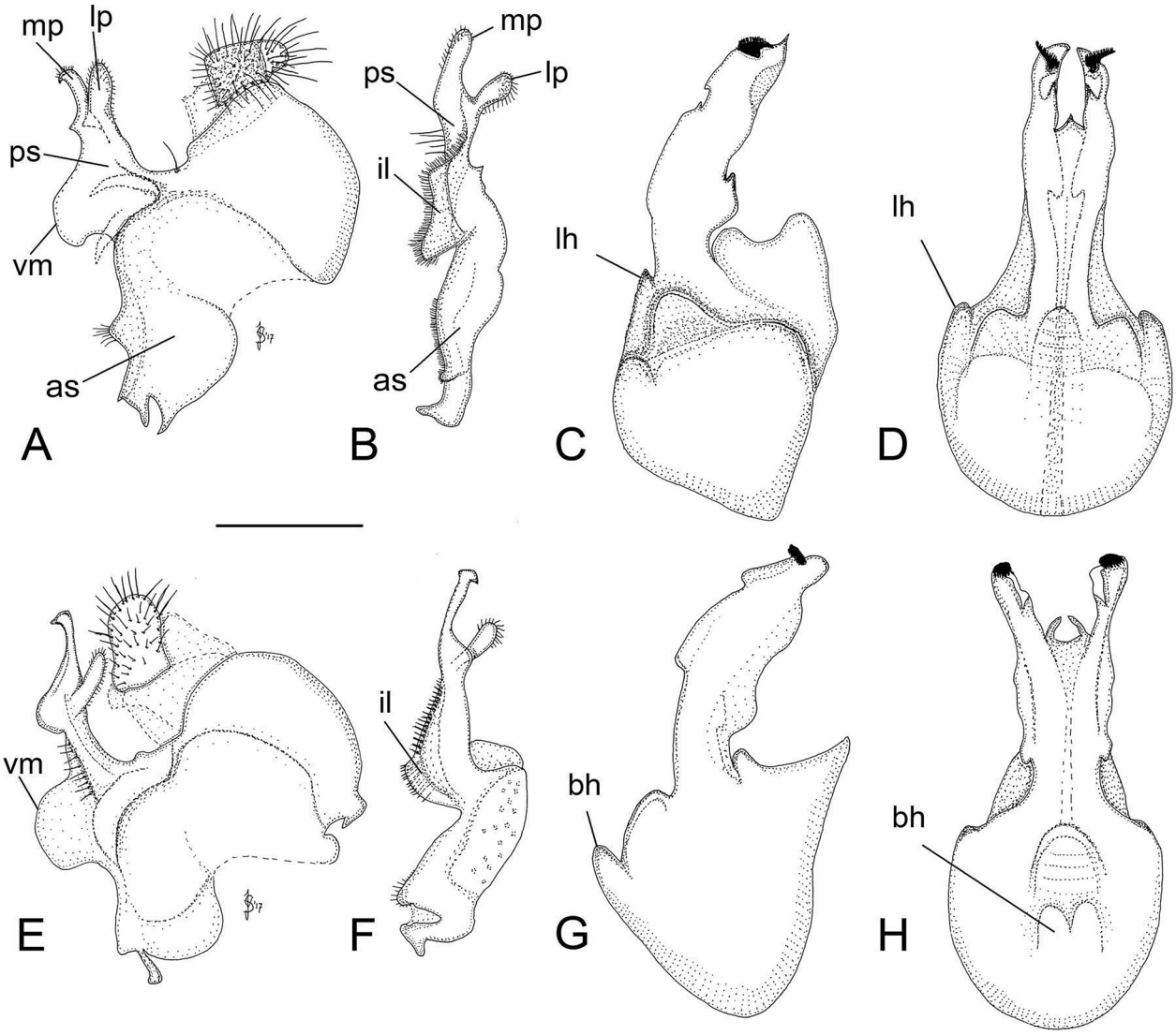


Fig. 7. Male genitalia of *Eumerus*. **A**–**D**: *E. bactrianus* Stackelberg, 1952, epandrium lateral view (**A**) and ventral view (**B**), hypandrium lateral view (**C**) and ventral view (**D**). **E**–**H**: *E. bifurcatus* n.sp., epandrium lateral view (**E**) and ventral view (**F**), hypandrium lateral view (**G**) and ventral view (**H**). Scale: 0.5 mm. — ***Abbreviations***: as – anterior surstylus, bh – basal projection of hypandrium, il – interior accessory lobe of posterior surstylus, lh – lateral outgrowth of hypandrium, lp – lateral prolongation of bifurcated surstylus, mp – main prolongation of bifurcated surstylus, ps – posterior surstylus, vm – ventral margin of posterior surstylus.

terolateral broadly-rounded corners with long pile, posteromedially with deep incision (Fig. 5H). ***Terminalia*** (Fig. 7E–H): genital capsule white pilose; ps bifurcated, main prolongation hooked, lateral one oval (Fig. 7E,F); ventral margin of ps expanded (Fig. 7E: vm); anterior surstylus elongated, il trapezoid (Fig. 7F). Hypandrium with two triangular oval projections ventrally (Fig. 7G,H: bh). — ***Female*** (Fig. 9I). Similar to male, except for normal sexual dimorphism. Length of body 7.3 mm, of wing 5.2 mm. ***Head***: face more parallel-sided, ventral eye margins not divergent; eye margin grey-white pollinose from anterior end of frons to just anterior to posterior ocellus; ocelli nearly equilateral, ratio 1 : 0.93. ***Legs***: hind femur white pilose, ventral pile 2–3 × longer than dorsal pile; posteroventral pile 7/10 as long as femoral width, about 1.5 × longer than anteroventral pile; hind femur apically with row of five setae on anterior ridge and row of 12 setae on posterior ridge. ***Abdomen***: white pollinose maculae on t3 clearly narrower than on t2; t4 without white pollinose maculae; s3 rectangular, twice as long as wide; s4 1.8 × longer than wide.

Differential diagnosis and remarks. The combination of characters distinguishing this species from others in the *bactrianus* subgroup are: tarsomeres 1–4 of midlegs orange-brown to dark-brown; hind femur with posteroventral fringe of long pile (3/4–4/5 as long as width of femur) along entire length of femur (Fig. 5D); t4 medially with short rectangular obliquely-located and white pollinose maculae; ventral part of posterior surstylus greatly protruded (Fig. 7E: vm), but it differs from that of *E. bactrianus* by the shape of the dorsal part of the posterior surstylus (Fig. 7E,F: mp, lp) and the shape of the interior accessory lobe of the ps (Fig. 7F: il); hypandrium with two triangular projections ventrally, but they are oval (Fig. 7G,H: bh) as opposed to thorn-like in *E. banaticus* (Fig. 6C,D: bh).

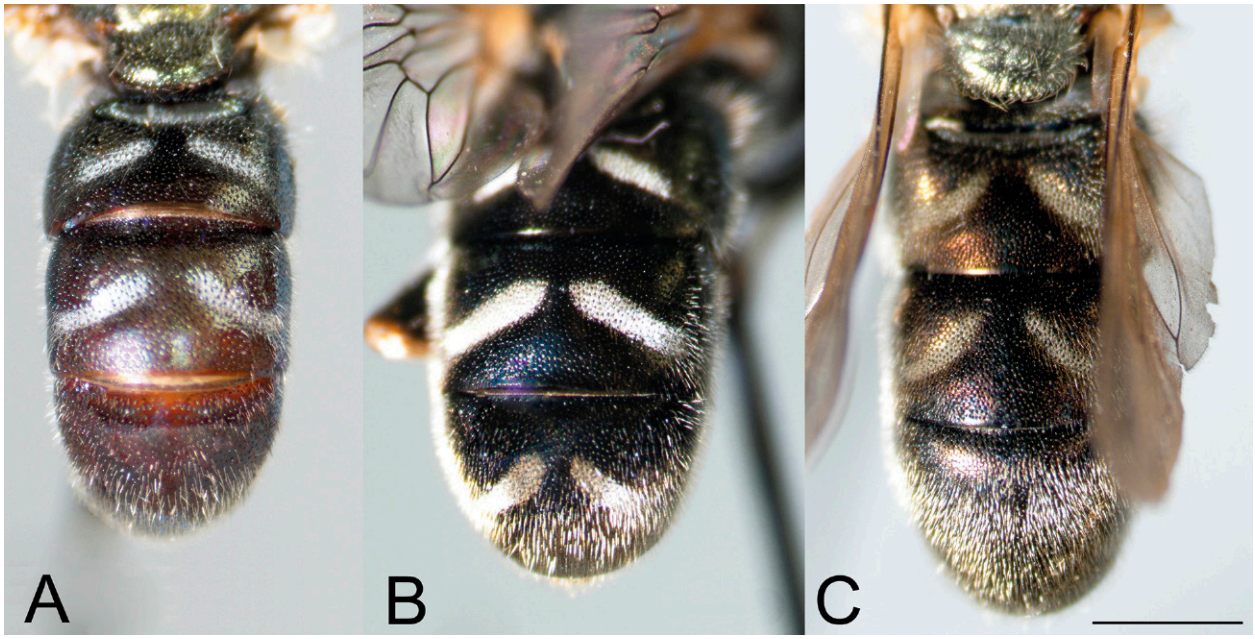


Fig. 8. Abdominal tergites of adult female *Eumerus* specimens, dorsal view. **A**: *E. banaticus* n.sp. **B**: *E. bicornis* n.sp. **C**: *E. panonnicus* Ricarte, Vujić & Radenković, 2016. Scale: 1 mm.

This species was collected together with *E. sulcitibius* Rondani, 1868 and *E. gibbosus* van Steenis, Hauser & van Zuijen, 2017 in the Sierra de Alcaraz, Spain (van Steenis et al. 2017), which is a low mountainous area with open pine-dominated forest (*Pinus halepensis* and *P. nigra*) with an undergrowth of Mediterranean maquis and diverse yellow- and white-flowering Apiaceae.

Derivatio nominis. The character that places this species within the *E. bactrianus* subgroup is the bifurcated surstylus, prompting the species name, which we have re-latinized to bifurcatus.

Material examined. ***Type material***: Holotype, ♂, 'SPAIN | Albaceta | J. van Steenis & | M.P. van Zuijen leg.', 'Sierra de Alcaraz, 1000–1200 m | Puerto de las Crucetillas, C 415 | km 184–186 steep slope, open pine | forest near *Populus* plantation | 38°32′N 2°23′W, on *Thapsia vilosa* | 22.vi.2003' (NBC). – Paratypes 2♂, 1♀ SPAIN: with same data as holotype except '1200 m / Puerto de las Crucetillas, C 415 / km 186 slope near | *Populus* plantation and small | stream 38°32′N 2°24′W | on *Thapsia vilosa* 21.VI.2003', (CSCA, PJSA); 1♂ with same data as holotype except '1400 m, 38°31′N 2°26′W | 21-VI-2003' (PJSA).

Eumerus pannonicus Ricarte, Vujić & Radenković, 2016

Differential diagnosis and remarks. In contrast to the other species of the *bactrianus* subgroup, the dorsal pile of the pedicel are long, almost as long as the ventral pile or of the same length; basoflagellomere widened towards the apex with distal part oval, unlike other species of the *bactrianus* subgroup in which the distal part of the basoflagellomeres are rather pointed ventrally; costal pile intermixed yellow and black; dense yellow to gold pile on t4, giving the abdomen a shiny gold appearance; anterior surstylus with very long pile (Fig. 6J, pa), whereas in other species of the subgroup the pile ranges from short (as in *E. banaticus*, Fig. 6B) to long (as in *E. bicornis*, Fig. 6F).

Material examined. ***Type material***: Paratypes SERBIA: 1♂, 1♀ Mokrin, Pašnjaci velike droplje, 75 m, 11.vi.2014, 45°54′22.14″N 20°18′6.48″E, A. Ricarte et al. leg. (FSUNS).

3.3. Identification key for European species of the *Eumerus bactrianus* subgroup

Males

1 Anterior surstylus covered with very long pile (Fig. 6J: pa); ventral pile of pedicel long, almost as long as dorsal pile or of the same length (Fig. 4E); distal part of basoflagellomere oval (Fig. 4E) [Serbia] ..... ***E. pannonicus***

1' Anterior surstylus covered with short or moderately long pile; ventral pile of pedicel 3–4 × longer than dorsal pile; distal part of basoflagellomere pointed ventrally (Fig. 4A–D) **2**

2 Pollinose maculae on t4 absent; lateral margin of t4 with moderately long yellow pile, usually mixed with a few black pile (Fig. 3C); base of hypandrium with two thorn-like projections (Fig. 6C,D: bh) [Romania, Serbia] ..... ***E. banaticus* n.sp.**

2' Pollinose maculae on t4 present, even if only as dots; margin of t4 with uniformly long pile; without thorn-like projections on the base of the hypandrium and, if projections are present, they are more oval (Fig. 7G: bh) **3**

3 Hind femur with ventral pile slightly longer than dorsal pile, but with a few distinctive long (as long as the depth of the femur) white setae posteroventrally

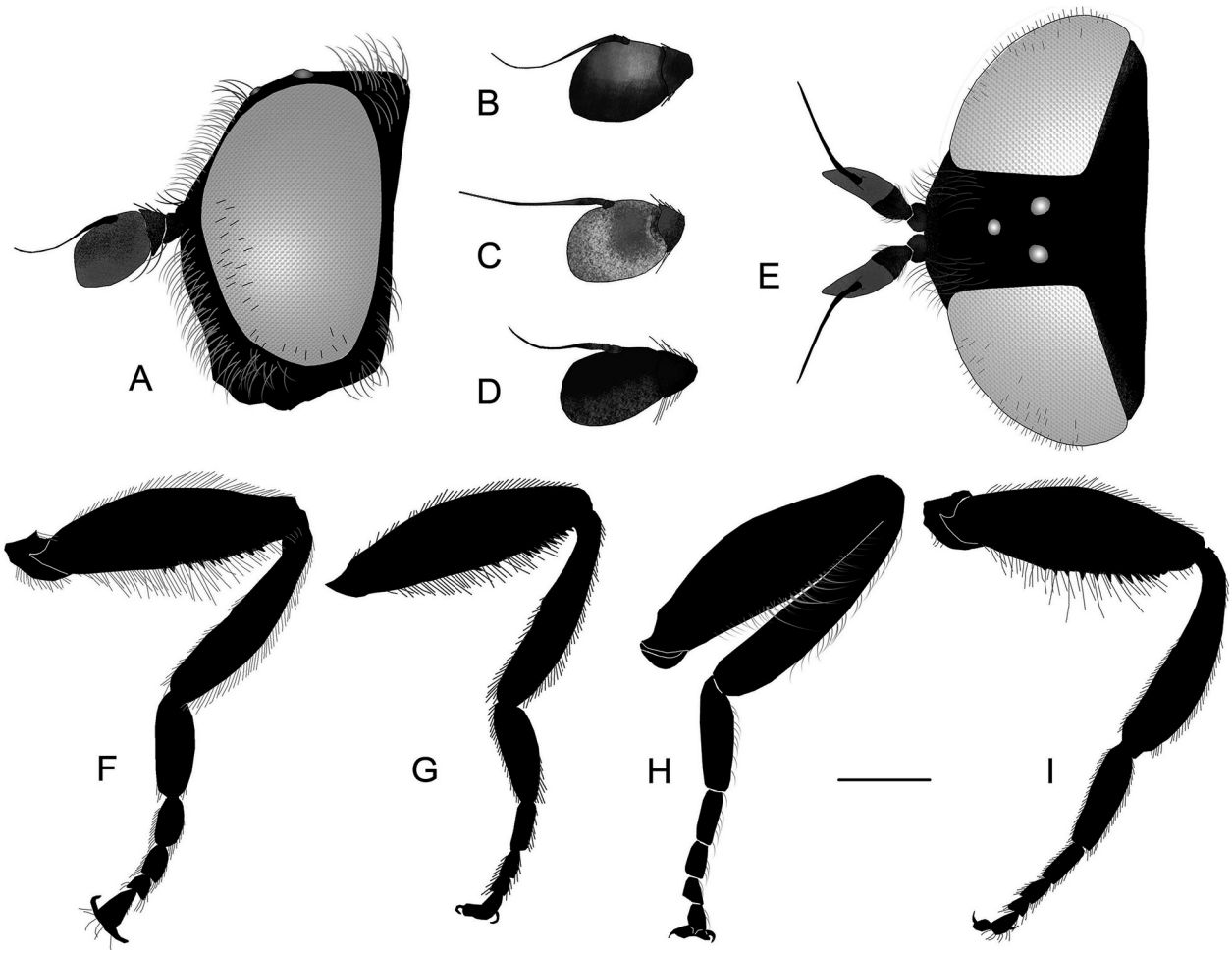


Fig. 9. A: Head, female, lateral view, and female antenna, outer side, of *Eumerus bicornis* n.sp. **B**–**D**: Antenna, female, lateral view of *E. bactrianus* Stackelberg, 1952 (**B**), *E. banaticus* n.sp. (**C**), *E. bifurcatus* n.sp. (**D**). **E**: Head, female, dorsal view of *E. bicornis* n.sp. **F**–**I**: Female hindleg of *E. bactrianus* n.sp. (**F**), *E. banaticus* n.sp. (**G**), *E. bicornis* n.sp. (**H**), and *E. bifurcatus* n.sp. (**I**). Scale: 0.5 mm.

(Fig. 5C); tarsomeres 1–3 of midleg yellow (Fig. 3B); both dorsal prolongations of posterior surstylus rounded (Fig. 6E,F: mp, lp) [Greece, Turkey] ..... ***E. bicornis* n.sp.**

3' Ventral pile of hind femur uniform in length (Fig. 5D); tarsomere of midleg orange-brown to brown; main dorsal prolongation of posterior surstylus hooked and lateral prolongation oval (Fig. 7E,F: mp, lp) [Spain] ..... ***E. bifurcatus* n.sp.**

Females

1 Dorsal pile on pedicel black, as long as yellow ventral pile (Fig. 9D); pile on katatergite yellow to brown; maculae on tergites positioned slightly obliquely, approximately at an angle < 45º. (Tergites with golden sheen, t4 covered in golden pilosity (Fig. 8C). Pollinose maculae on t4 obscured.) [Serbia] ..... ***E. pannonicus***

1' Dorsal pile on pedicel much shorter than ventral pile (Fig. 9A–C); pile on katatergite white to yellow; pollinose maculae on tergites positioned more horizontally **2**

2 Pollinose maculae on t4 present. (Hind femur posteroventrally with some longer and conspicuously posteriorly-directed pile. Tarsomeres 1–3 of midleg yellow, other tarsomeres 4 and 5 brown.) [Greece, Turkey] ..... ***E. bicornis* n.sp.**

2' Pollinose maculae on t4 absent **3**

3 Ventral pile of hind femur shorter than half depth of hind femur (Fig. 9G); s4 square-shaped. [Romania, Serbia] ..... ***E. banaticus* n.sp.**

3' Ventral pile of hind femur longer than half depth of hind femur (Fig. 9I); s4 longer than wide. [Spain] ..... ***E. bifurcatus* n.sp.**

4. Discussion

Our results provide morphological and genetic evidence for the existence of three new species of the hoverfly genus *Eumerus*. Together with related species from Central Asia that were described by Stackelberg (1952), we classify these three new species in the *bactrianus* subgroup, which we describe and define.

During a pollinator survey in almost undisturbed habitats in Vojvodina (Pannonian Plain), Markov et al.



Fig. 10. Distribution of species of the *Eumerus bactrianus* subgroup in Europe and Central Asia based on Stackelberg (1952) and the current study.

(2016) found a new species of hoverfly and named it *E. pannonicus*. That event represented the first time that a species from the *bactrianus* subgroup had been found in Europe. Chroni et al. (2017) investigated COI-3' mtDNA sequences to infer species delimitation within the genus *Eumerus* and postulated the presence of two major clades, i.e., the *tricolor* group and a second one comprising all other species. The *E. strigatus* group was included within this second clade, along with *E. amoenus* and *E. consimilis* that were clearly separated from each other. Based on COI barcodes and morphological characters, Grković et al. (2017) confirmed species assignments within the *E. strigatus* group, but highlighted the need for further study of species related to *E. bactrianus*. Here, we define the *bactrianus* subgroup and describe three new species belonging to it. Thus, we increase to four the number of described European species in this subgroup. These species are related to the Central Asian species described by Stackelberg (1952), but can all be distinguished from these latter by the shape of the posterior surstylus as well as the shape of the male abdominal sternite 4. However, based on the shape of the epandrium, which we consider to be an apomorphic character, species from the *bactrianus* subgroup share the same ancestor that we assume had a large ancestral range extending from the Iberian Peninsula to the Middle East and Caucasus (Fig. 10).

In accordance with the studies of Chroni et al. (2017) and Grković et al. (2017), our molecular analysis distinguished the *strigatus* group from other *Eumerus* species and revealed this group to be monophyletic. Within the *strigatus* group, specimens of the *bactrianus* subgroup are clearly differentiated into different clades. Our delineation of morphological species according to mtDNA sequences was recovered with high bootstrap values, adding support to their species status. The COI sequence-based approach has proven effective as a molecular identification system and for assisting morphological identification to clarify species boundaries, describe new species, and to quantify species diversity in the family Syrphidae (e.g. Ståhls et al. 2009; Skevington & Thompson 2012; Suk & Han 2013; Thompson & Skevington 2014; Jordaens et al. 2015; Šašić et al. 2016; Ačanski et al. 2016), as well as within the genus *Eumerus* that is a focus of our study (Grković et al. 2015, 2017; Chroni et al. 2017). Furthermore, the COI barcodes generated here reveal affinities among the analysed species. Within the *strigatus* group, *E. amoenus* (the species with most distinct morphology, Grković et al. 2017) is clustered with *E. bicornis* n.sp., *Eumerus bifurcatus* n.sp. and *E. banaticus* n.sp. form a single cluster, and *E. pannonicus* is associated with the other members of the *strigatus* group. Based on their obvious morphological similarities to other species of the *bactrianus* subgroup, we previously hypothesized that all these species represented a single genetic subgroup within the *strigatus* group (Grković et al. 2017). COI barcoding in that study did not unequivocally support that assumption, though it was very successful in delimiting species of the *bactrianus* subgroup according to their morphological distinctiveness. While COI barcoding has successfully been used to reveal phylogeographic patterns among the closely-related species of the genus *Merodon* Meigen, 1803 (Ståhls et al. 2016), additional molecular markers and/or longer mitochondrial sequences may be necessary to infer phylogenetic relationships within *Eumerus* (Chroni et al. 2017). In the present study, species delimitation based on COI barcodes corresponded to morphological differentiation, but did not provide good phylogenetic resolution at the analysed taxonomic level; i.e., did not support the monophyly of the *E. bactrianus* subgroup. Therefore, future research to include additional gene regions should better clarify the systematic position of the *E. bactrianus* subgroup within the *E. strigatus* group.

Almost all described species of the *bactrianus* subgroup are associated with biodiversity hotspots in Europe and Central Asia, namely those of the Mediterranean, Irano-Anatolian and Central Asian mountains. Two exceptions are from the Pannonian Plain, i.e., *E. banaticus* n.sp. and *E. pannonicus*. In contrast to other species of the *strigatus* group, species of the *bactrianus* subgroup are mostly allopatric, which is common for highland hoverfly species (Vujić et al. 2013). European species of the *bactrianus* subgroup are regionally-restricted or are limited to small areas. Both *E. pannonicus* and *E. banaticus* n.sp. are lowland species of the northern Serbian and eastern Romanian parts of the Pannonian Plain, respectively, inhabiting altitudes lower than 100 m a.s.l. *Eumerus bicornis* sp.n. inhabits high mountains in eastern Turkey and Chelmos Mountain of the Peloponnese, with an altitudinal range from 1200 to 1700 m a.s.l. *Eumerus bifurcatus* sp.n. is recorded from the Iberian peninsula, where it inhabits altitudes between 1000 and 1200 m a.s.l. along the Baetic mountain chain. *Eumerus bifurcatus* sp.n. is the most westerly distributed of the group, giving it a Turano-Mediterranean distribution pattern (see Taglianti et al. 1999). Various studies have discussed this distribution pattern in animal species (Ribera & Blasco-Zumeta 1998; Sanmartín 2003; Ferchaud et al. 2012; García-Vázquez et al. 2016), as well as whether it originates from dispersal or vicariant events (Voelker 1999; Sanmartín 2003). Many examples have been found of insect species and species groups exhibiting disjunct distributions between western and eastern Mediterranean regions and even extending to the Asiatic steppes. Ribera & Blasco-Zumeta (1998) listed sixty-two species of insects in nine orders with disjunct distributions or that belong to species groups with disjunct distributions between the steppe areas in the central Monegros region (NE Spain) and the steppes of the Eastern Mediterranean or Central Asian regions, including 13 steppe-based dipteran species and 11 species from vicariant groups. Avgin (2006) reported a few ground beetle species from Başkonuş Mountain National Park (Kahramanmaraş, Turkey) with Turano-Mediterranean distributions. Oosterbroek & Arntzen (1992) studied different groups of Mediterranean terrestrial animals and linked the origin of younger lineages to formation of a continuous landmass that separated the Tethys and Paratethys seas in the Late Oligocene – Early Miocene. This landmass connected Western Europe to the area today roughly corresponding to the Balkans and Turkey, resulting in diversification of many Mediterranean groups. Sanmartín (2003) used a dispersal-vicariance analysis (DIVA) to assess the relative roles played by dispersal and vicariance in shaping the disjunct Mediterranean distribution patterns of the beetle subfamily Pachydeminae Reitter, 1902. The main conclusion of that study was that nearly 38% of the speciation events resulted from dispersal to a new area followed by allopatric speciation. Sanmartín (2003) considered North Africa and the Gibraltar Strait, which was closed during the Messinian salinity crisis, to be an alternative dispersal route by which lineages could have achieved circum-Mediterranean distributions. García-Vázquez et al. (2016) reconstructed the evolutionary and biogeographical history of pan-Mediterranean species of the beetle genus *Deronectes* Sharp, 1882 (Dytiscidae), which revealed that its diversification was shaped by geological and climatic changes around the Mediterranean since the Miocene. One species of a hoverfly genus related to *Eumerus*, *Merodon ottomanus* Hurkmans, 1993, is found in the high mountains of Valencia and Alicante provinces, but it was described from Turkey, and thus is distributed only in the extreme western and eastern parts of the Mediterranean basin (Marcos García et al. 2007; Vujić et al. 2011), i.e., a distribution pattern also observed in the *bactrianus* subgroup that is a focus of this study. Thus, there are many examples of disjunct east-west Mediterranean distributions among insects. At the end, we highlight the importance of conservation of these relict species in fragile habitats under constantly increasing anthropogenic pressure.

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Electronic Supplement File

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File 1: grkovic&al-syrphidaeeumerusbactr-asp2019-electronic-supplement-1.doc — **Table S1.** List of specimens used for molecular analysis with their GenBank accession numbers (newly-generated sequences in this study are in boldface; other sequences were retrieved from GenBank). — DOI: 10.26049/ASP77-1-2019-02/1