



Diversity and systematics of the Ibero-Balearic *Eumerus* (Diptera: Syrphidae): Providing tools for species identification

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Abstract. The syrphid genus *Eumerus* Meigen, 1822 is one of the most speciose in the world. In the Ibero-Balearic area (including Andorra and the Spanish side of the Pyrenees), recent taxonomic studies have increased the knowledge of *Eumerus* in Europe. A high taxonomic diversity together with a complex morphology make species identification difficult in this genus. The lack of updated and comprehensive tools to assist in the identification of species prompted the production of a dichotomous key to all Ibero-Balearic species of *Eumerus* and generation of DNA barcodes for ten species. In summary, a total of 37 species of *Eumerus* and nine species groups are reported in this geographical region. *Eumerus caballeroi* Gil Collado, 1929 is proposed as junior synonym of *Eumerus nudus* Loew, 1848 and the taxonomic status of *Eumerus pauper* Becker, 1921 is discussed. The first sequences of the 5' region of the Cytochrome c oxidase subunit I gene (COI-5') of *Eumerus subornatus* Claußen, 1989 and *Eumerus truncatus* Rondani, 1868 were obtained and their systematic positions corroborated.

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INTRODUCTION

The genus *Eumerus* Meigen, 1822 is amongst the most diverse syrphid genera, with 316 described species worldwide (Evenhuis & Pape, 2024). It belongs to the tribe Merodontini, within the subfamily Eristalinae, together with the following genera: *Amphoterus* Bezzi, 1915, *Azpeytia* Walker, 1865, *Lyneborgimyia* Doczkal & Pape, 2009, *Megatrigen* Johnson, 1868, *Merodon* Meigen, 1803, *Platynochaetus* Wiedemann, 1830 and the fossil *Liomyodia* Evenhuis, 1994 (Thompson & Rotheray, 1998; Doczkal & Pape, 2009; Doczkal et al., 2016; Midgley et al., 2023; Moran, 2023). In addition, *Eumerus* is the most widespread genus within Merodontini, as it occurs in the Afrotropical, Australasian, Oriental and Palaearctic Regions (Grković et al., 2015; van Steenis et al., 2017) and has also been introduced into the Nearctic and Neotropics (Marinoni & Morales, 2007; Speight et al., 2013; Garcete-Barrett et al., 2020; Torreta et al., 2021, 2023).

Regarding its habitat preferences, *Eumerus* can be found in forest and scrubland areas, grasslands, wetlands and close to aquatic environments, such as lakes and rivers

(Speight, 2024), but it is more associated with arid and semiarid areas (Mutin, 2019). Larvae of *Eumerus*, as for other Merodontini, are phytophagous (feeding on live plant tissues) or saprophagous (feeding on decaying organic materials). Some species, such as *Eumerus strigatus* (Fallén, 1817), are regarded as pests of plants of agricultural or horticultural importance (Ricarte et al., 2017). Nevertheless, the scarce number of species for which their immature stages are known addresses the serious need to further investigate the natural history of *Eumerus* (e.g. Orengo-Green et al., 2024).

For *Eumerus*, the first systematic approach based on mitochondrial DNA was that of Chroni et al. (2017), who recognized seven groups of species. Currently, this number is eleven (Grković et al., 2021; Malidžan et al., 2022). In the Ibero-Balearic area (see Material and methods for geographic delimitation) there are currently nine groups, which henceforth will be referred to by the following specific epithets: *barbarus* group, *basalis* group, *clavatus* group, *obliquus* group, *olivaceus* group, *ornatus* group, *pulchellus* group, *strigatus* group and *tricolor* group (Chroni et al.,

2017; van Steenis et al., 2017; Smit et al., 2017; Grković et al., 2017, 2019a, b; Ricarte et al., 2018; Aguado-Aranda et al., 2022, 2023; Aracil et al., 2023; Barkalov & Mutin, 2024).

The alpha diversity of syrphids on the Ibero-Balearic area is very high with 420+ species recorded (Ricarte & Marcos-García, 2017; Ricarte et al., 2022). Gil Collado (1930), who published the first monograph on the hoverflies of Spain, highlighted the presence of 14 species of *Eumerus* in this area. Moreover, this author published the first identification key for the Iberian *Eumerus*. Subsequently, studies resulted in the increase in the number of species (e.g. Ricarte et al., 2018). Although the knowledge of the genus *Eumerus* in the Ibero-Balearic area has increased recently, there are no current identification keys that include all the species in this region. On the other hand, the taxonomic status or systematic position of certain species such as *Eumerus caballeroi* Gil Collado, 1929 and *Eumerus truncatus* Rondani, 1868 still needs clarification. The only key to the Palaearctic species of *Eumerus* is that of Stackelberg (1961). This could result in the overlooking of valid species (e.g. Aguado-Aranda et al., 2022). Despite the fact that new regional keys were published in the last decade (e.g. Speight et al., 2021), the lack of an updated global key could result in the overlooking species, especially if new species are discovered.

The aims of the present work are (1) to assess the systematic position and the taxonomic status of the Ibero-Balearic species of *Eumerus* based on morphological and molecular evidence and (2) to provide a comprehensive identification key to all these taxa in order to facilitate future studies on this genus.

MATERIAL AND METHODS

Study area

The Ibero-Balearic area is located in the western Mediterranean basin sensu van Steenis et al. (2017). It covers more than 600,000 km² and includes mainland Portugal, Spain (plus Andorra and Gibraltar) and the Balearic archipelago. There are two biogeographical regions on the Iberian Peninsula: the Eurosiberian (restricted to the northernmost areas and including rainy and mountainous landscapes) and the Mediterranean (where there is large variety of habitats) (Rivas-Martínez et al., 2014).

Material examined

A total of 3,579 adult specimens of 23 species of *Eumerus* were studied. New material was collected (by hand net or Malaise trap) or, exceptionally, reared at different localities in 29 Spanish provinces. Material deposited in the following entomological collections was also examined: California State Collection of Arthropods (CSCA, Sacramento, USA); Colección Entomológica de la Universidad de Alicante (CEUA-CIBIO, Alicante, Spain); Museo Nacional de Ciencias Naturales (MNCN, Madrid, Spain); University of Cádiz (Andalucía, Spain); Museum für Naturkunde der Humboldt Universität (ZMHU, Berlin, Germany); private collections of André P.W. van Eck (Tilburg, The Netherlands), Jeroen van Steenis (Amersfoort, The Netherlands), Luis Óscar Aguado Martín (Valladolid, Spain), Martin Hauser (California, USA) and Miguel Carles Tolrá (Barcelona, Spain). The specimens examined belonging to the *tricolor* and *barbarus* groups can be consulted in the supplementary material of Aguado-Aranda et al. (2023)

and Aguado-Aranda et al. (2024a), respectively. Similarly, the examined material of *Eumerus colladoi* was previously published in Aguado-Aranda et al. (2022). Online supplementary material (Supplements S1–S4) is listed at the end of this paper.

All the specimens examined were databased in an Excel table. A unique bar code label was assigned to the new material added to the CEUA-CIBIO collection. The information on the specimens examined is detailed in a supplementary excel file (Supplement S1) except that for the type material of *Eumerus nudus*, which is indicated in the main text. The format for the type series of *E. nudus* follows Aguado-Aranda et al. (2024a). Distribution maps were generated using all known Ibero-Balearic records of all species of *Eumerus* reported from this region (Andréu, 1926; Gil-Collado, 1930; Marcos-García, 1983, 1985a, b, 1986, 1990a, b; Pérez-Bañón, 1995; Marcos-García & Louis, 2001; Mengual, 2005; Carles-Tolrá & Aguirre-Segura, 2007; Ricarte, 2008; Ricarte et al., 2008, 2013, 2017, 2020, 2021; Ricarte et al., in press; van Eck, 2011, 2016; Lorenzo et al., 2020; van Eck et al., 2020; Aguado-Aranda et al., 2022; van Eck & Carles-Tolrá, 2023). Maps were produced using the software QGIS v3.22.16 (QGIS Association, 2024). For distribution maps of the species in the *barbarus* and *tricolor* groups, see Supplement S2. Conservation status of all Ibero-Balearic species of *Eumerus* was obtained from the European Red List of Hoverflies (Vujić et al., 2022).

Morphological study

Material was identified using the keys in Grković et al. (2019b) and Speight et al. (2021). Photographs of specimens were taken using a Leica DFC 450 camera attached to a Leica M205 C binocular microscope. Male genitalia were dissected and prepared following Ricarte et al. (2012) and stored in glycerine in plastic micro vials (pinned with the specimen). Hand drawings of male genitalia were done by the first author from printed photographs. Morphological terminology followed Thompson (1999) for adults, except for the term “hair/s” (replacement for “pilis/pile”), the terms “fore”, “mid” and “hind” (replacement for “pro”, “meso” and “meta”), and the term “notopleural sulcus”, which follows Doczkal & Pape (2009). Terminology for male genitalia follows Doczkal (1996). For illustrations and tables cited from the literature “fig.” and “table” (lower case) are used, while “Fig.” and “Table” (upper case) are used for those which are original to this work.

Molecular study

DNA was extracted from 1–2 legs of one male of *Eumerus alpinus*, two specimens (1♂ and 1♀) of *Eumerus amoenus*, three (1♂ and 2♀) of *Eumerus argyropus*, one male of *Eumerus consimilis*, three specimens (2♂ and 1♀) of *Eumerus etnensis*, two (1♂ and 1♀) of *Eumerus flavitarsis*, one female of *Eumerus funeralis*, two specimens (1♂ and 1♀) of *Eumerus hungaricus*, two (1♂ and 1♀) of *E. nudus*, one male of *Eumerus obliquus*, two specimens (1♂ and 1♀) of *Eumerus ornatus*, two (1♂ and 1♀) of *Eumerus pulchellus*, one male of *Eumerus pusillus*, two specimens (1♂ and 1♀) of *Eumerus ruficornis*, two (1♂ and 1♀) of *Eumerus sogdianus*, two (1♂ and 1♀) of *Eumerus subornatus* and three (2♂ and 1♀) of *Eumerus truncatus*. The NZY Tissue gDNA Isolation kit, following the manufacturer’s protocol for animal tissues, was used for all species but *E. consimilis*, *E. etnensis*, *E. funeralis*, *E. hungaricus* and *E. sogdianus*. DNA of these specimens was extracted using the QIAGEN DNeasy Blood and Tissue kit in the research laboratory of Jeffrey H. Skevington by the first author. Laboratory protocols for the PCR amplification, PCR products visualization, purification and sequencing reactions of the 5′ (COI-5′) end region of the Cytochrome *c* oxidase subunit I gene, and the COI-5′ fragments “A”, “B” and “C” for “older”

specimens (collection date previous to the year 2000), followed Aguado-Aranda et al. (2023).

The editing of the sequences was done using the software Sequencher v5.4.6 (Gene Codes Corporation, Ann Arbor, MI, USA). Additionally, all *Eumerus* COI-5' sequences available at the public repository of GenBank were downloaded (listed in Supplement S3). Alignment was performed manually using the software AliView v1.25 (Larsson, 2014). The final matrix had a length of 602 bp. Molecular analyses were conducted in MEGA7 (Kumar et al., 2016), with 1000 replications, using the Maximum Likelihood Composite model for Neighbor-Joining (NJ) and the General Time Reversible model (GTR), with gamma distribution (+G) and the invariant sites (+I), for Maximum Likelihood (ML) proposed by the corrected Akaike information criterion (AICc). A sequence of *Platynochaetus setosus* (Fabricius, 1794) was used to root the tree.

RESULTS

General results

In total, 595 new specimens were recorded between 1906 and 2024 of the following species in the Ibero-Balearic

area: 21 specimens (16♂ and 5♀) of *E. alpinus*, 62 (30♂ and 32♀) of *E. amoenus*, 31 (3♂ and 28♀) of *E. argyropus*, nine (3♂ and 6♀) of *E. colladoi*, one female of *E. consimilis*, four (3♂ and 1♀) of *E. etnensis*, six (3♂ and 3♀) of *E. hungaricus*, 21 (10♂ and 11♀) of *Eumerus larvatus*, 33 (18♂ and 15♀) of *E. nudus*, 10 (5♂ and 5♀) of *E. obliquus*, 8 (6♂ and 2♀) of *E. ornatus*, 202 (89♂ and 113♀) of *E. pulchellus*, 87 (48♂ and 39♀) of *E. pusillus*, 19 (14♂ and 5♀) of *E. sogdianus*, 3 (1♂ and 2♀) of *E. strigatus*, 65 (22♂ and 43♀) of *E. subornatus* and 13 (11♂ and 2♀) of *E. truncatus*.

The results confirm the occurrence of 37 *Eumerus* species and nine species groups in the Ibero-Balearic area (Table 1; Fig. 1). The first known DNA barcodes were generated for *E. subornatus* and *E. truncatus*. In addition, COI-5' sequences were obtained for Ibero-Balearic specimens of the following species: *E. alpinus*, *E. amoenus*, *E. argyropus*, *E. obliquus*, *E. ornatus*, *E. pulchellus*, *E. pusillus* and *E. sogdianus*.

Table 1. Ibero-Balearic species of *Eumerus* arranged in the species groups cited in the literature. Legend for the IUCN Categories: Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Vulnerable (VU), Endangered (EN), Critically Endangered (CR). ¹*bactrianus* subgroup, ²*binominatus* subgroup.

Group	Species	IUCN Category
<i>barbarus</i>	<i>E. barbarus</i> (Coquebert, 1804)	LC
	<i>E. gibbosus</i> van Steenis, Hauser & van Zuijlen, 2017	EN
	<i>E. sulcitibius</i> Rondani, 1868	LC
<i>basalis</i>	<i>E. pusillus</i> Loew, 1848	LC
<i>clavatus</i>	<i>E. clavatus</i> Becker, 1923	LC
<i>obliquus</i>	<i>E. obliquus</i> (Fabricius, 1805)	LC
<i>olivaceus</i>	<i>E. alpinus</i> Rondani, 1857	LC
	<i>E. nudus</i> Loew, 1848	LC
<i>ornatus</i>	<i>E. argyropus</i> Loew, 1848	LC
	<i>E. flavitarsis</i> Zetterstedt, 1843	LC
	<i>E. ornatus</i> Meigen, 1822	LC
	<i>E. subornatus</i> Claußen, 1989	EN
<i>pulchellus</i>	<i>E. emarginatus</i> Loew, 1848	NE
	<i>E. pulchellus</i> Loew, 1848	LC
<i>strigatus</i>	<i>E. amoenus</i> Loew, 1848	LC
	<i>E. consimilis</i> Šimić & Vujčić, 1996	LC
	<i>E. funeralis</i> Meigen, 1822	LC
	<i>E. pauper</i> Becker, 1921 ¹	DD
	<i>E. sogdianus</i> Stackelberg, 1952	LC
	<i>E. strigatus</i> (Fallén, 1817)	LC
<i>tricolor</i>	<i>E. truncatus</i> Rondani, 1868	EN
	<i>E. ancylostylus</i> Aguado-Aranda & Ricarte in Aguado-Aranda et al., 2023	NE
	<i>E. azabense</i> Ricarte & Marcos-García in Ricarte et al., 2018	CR
	<i>E. bayardi</i> Séguy, 1961	NE
	<i>E. grillator</i> Smit in Grković et al., 2019a ²	VU
	<i>E. grandis</i> Meigen, 1822	LC
	<i>E. hispanicus</i> van der Goot, 1966	VU
	<i>E. larvatus</i> Aracil, Grković & Pérez-Bañón in Aracil et al., 2023	NE
	<i>E. petrarum</i> Aguado-Aranda, Nedeljković & Ricarte in Aguado-Aranda et al., 2023	NE
	<i>E. ovatus</i> Loew, 1848	EN
	<i>E. tarsalis</i> Loew, 1848	EN
	<i>E. sabulonum</i> (Fallén, 1817)	LC
	<i>E. tricolor</i> (Fabricius, 1798)	LC
Individual species	<i>E. colladoi</i> Ricarte & Aguado-Aranda in Aguado-Aranda et al., 2022	NE
	<i>E. etnensis</i> van der Goot, 1964	VU
	<i>E. hungaricus</i> Szilády, 1940	EN
	<i>E. ruficornis</i> Meigen, 1822	EN

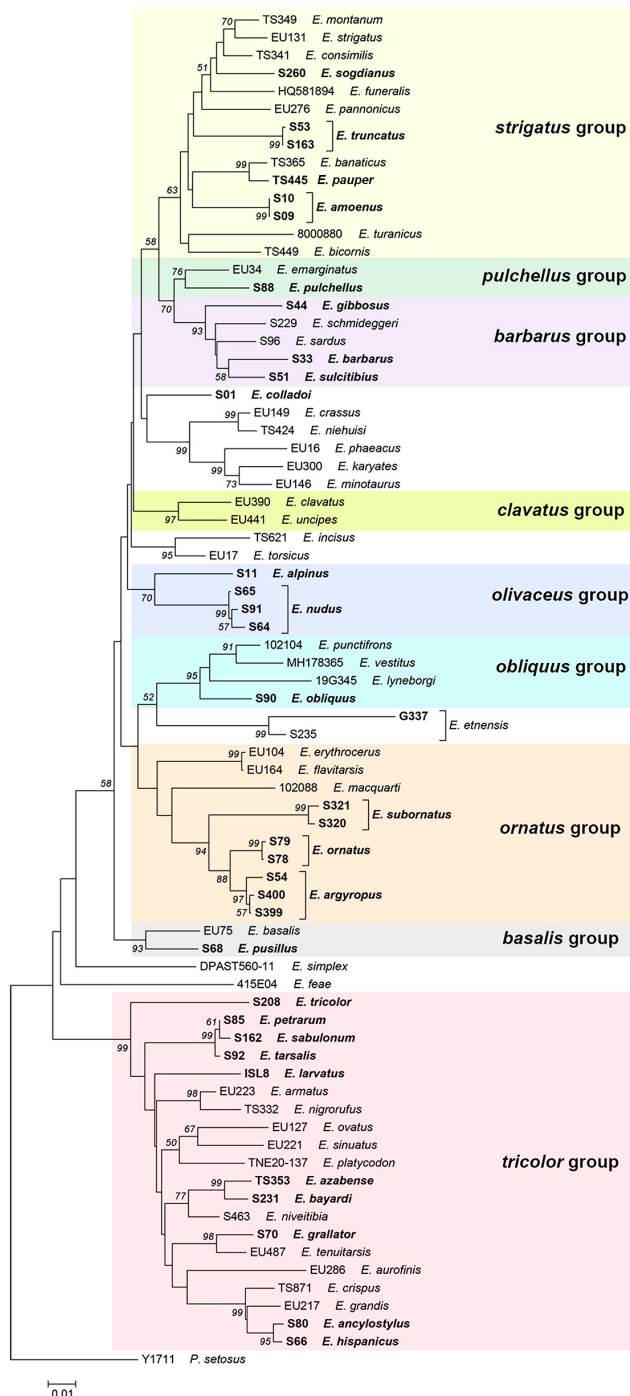


Fig. 1. Neighbor-Joining tree of all *Eumerus* based on COI-5'. Barcodes generated from Ibero-Balearic specimens are highlighted in bold. Bootstrap values >50 are shown near nodes. Branch lengths are measured in terms of the number of substitutions.

The Ibero-Balearic species of *Eumerus*

The known synonyms and distribution in Spanish provinces and Portuguese districts of each Ibero-Balearic *Eumerus* species as well as their global distributions are indicated below [for specific details of their worldwide range, see Reverté et al. (2023) and Speight (2024)]. Records for Andorra and Gibraltar are also indicated. For the acronyms of the Spanish provinces see Supplement S4.

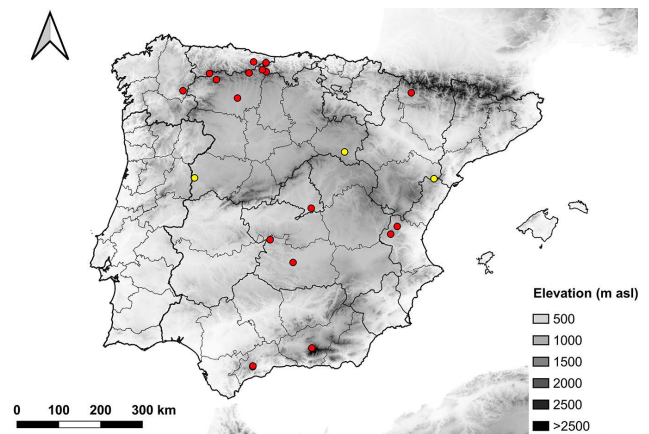


Fig. 2. Map showing the Ibero-Balearic distribution of *E. alpinus*. Confirmed records – red circles; literature records – yellow circles.

Eumerus alpinus Rondani, 1857

Ibero-Balearic distribution. New records: Spain (GR, LE, LU, M, MA). Published records: Spain (CO, CR, HU, O, SA, SO, TE, V) (Fig. 2).

Worldwide distribution. A European and Mediterranean species, occurring from the Iberian Peninsula to the Balkans.

Eumerus amoenus Loew, 1848

Eumerus liops Bezzi & Stein, 1907

Eumerus terminalis Santos Abreu, 1924

Ibero-Balearic distribution. New records: Spain (J, LU, TO). Published records: Andorra, Gibraltar, Spain (A, AL, AV, B, C, CC, CR, GR, IB (ib, ma, me), M, MA, SA, SS) (Fig. 3).

Worldwide distribution. A Palearctic species occurring from the westernmost parts of Europe to Asia (e.g. Mongolia, Tajikistan).

Eumerus ancylostylus Aguado-Aranda & Ricarte in Aguado-Aranda et al., 2023

Ibero-Balearic distribution. Published records: Spain (GI, LE).

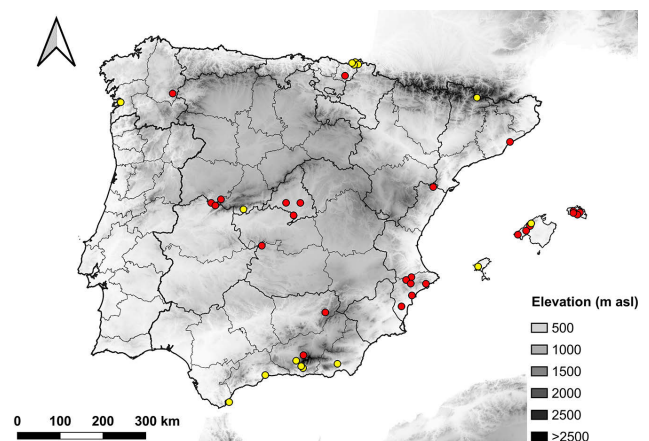


Fig. 3. Map showing Ibero-Balearic distribution of *E. amoenus*. Confirmed records – red circles; literature records – yellow circles.

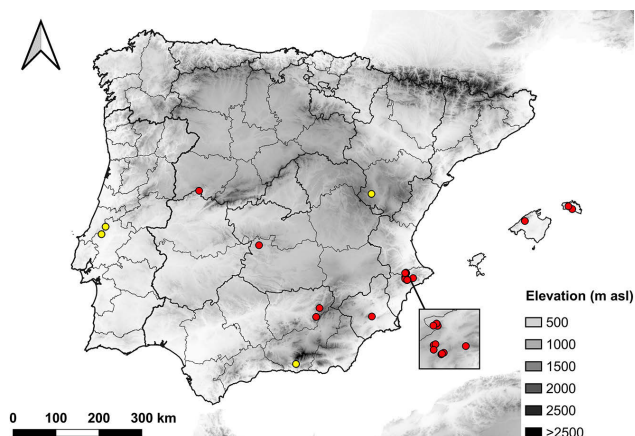


Fig. 4. Map showing Ibero-Balearic distribution of *E. argyropus*. Confirmed records – red circles, literature records – yellow circles.

Worldwide distribution. South-western Europe (France and Spain).

***Eumerus argyropus* Loew, 1848**

Eumerus exilipes Rondani, 1850

Eumerus bernhardi Lindner, 1969

Ibero-Balearic distribution. New records: Spain (CR, J, SA, V). Published records: Portugal (Leiria, Santarém), Spain (A, GR, IB (ma, me), TE) (Fig. 4).

Worldwide distribution. A Mediterranean species occurring from the south of the Iberian Peninsula to Turkey.

***Eumerus azabense* Ricarte & Marcos-García in Ricarte et al., 2018**

Ibero-Balearic distribution. Published records: Portugal (Beja), Spain (SA).

Worldwide distribution. Endemic to the Ibero-Balearic area.

***Eumerus barbarus* (Coquebert, 1804)**

Eumerus australis Meigen, 1838

Eumerus iris Loew, 1848

Eumerus truquii Rondani, 1857

Eumerus fucatus Rondani, 1868

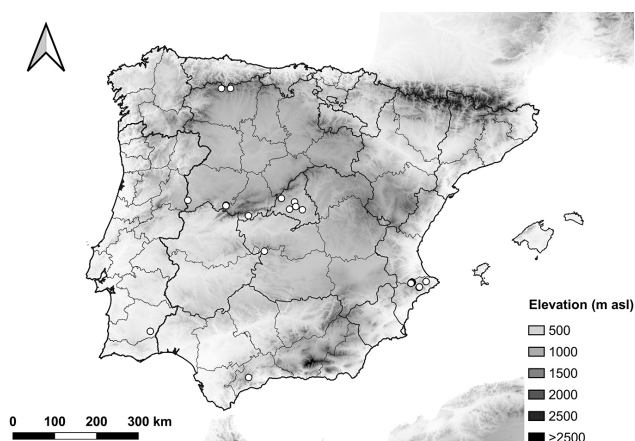


Fig. 5. Map showing Ibero-Balearic distribution of *E. colladoi*. Confirmed records – white circles.

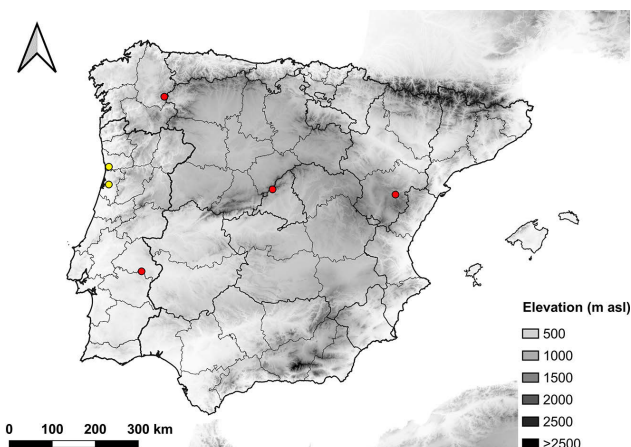


Fig. 6. Map showing Ibero-Balearic distribution of *E. consimilis*. Confirmed records – red circles, literature records – yellow circles.

Ibero-Balearic distribution. Published records: Gibraltar, Spain (A, AL, CC, CR, CU, IB (ib, ma, me), M, SA, SE, V, ZA).

Worldwide distribution. A species occurring in south-western (France, Portugal and Spain) and central Europe, but also in the North of Africa (from Morocco to Egypt).

***Eumerus bayardi* Séguy, 1961**

Ibero-Balearic distribution. Published records: Portugal (Leiria), Spain (AL).

Worldwide distribution. Western Europe (France, Portugal and Spain).

***Eumerus clavatus* Becker, 1921**

Ibero-Balearic distribution. Published records: Spain (Z).

Worldwide distribution. A Mediterranean species occurring from western Europe to Ukraine, but also present in North Africa.

***Eumerus colladoi* Ricarte & Aguado-Aranda in Aguado-Aranda et al., 2022**

Ibero-Balearic distribution. New records: Spain (AL, AV). Published records: Portugal (Beja), Spain (A, CR, LE, M, MA, MU, SA, V) (Fig. 5).

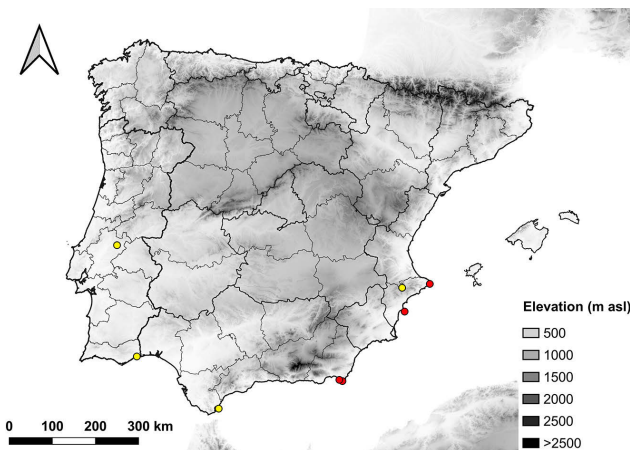


Fig. 7. Map showing Ibero-Balearic distribution of *E. etnensis*. Confirmed records – red circles, literature records – yellow circles.

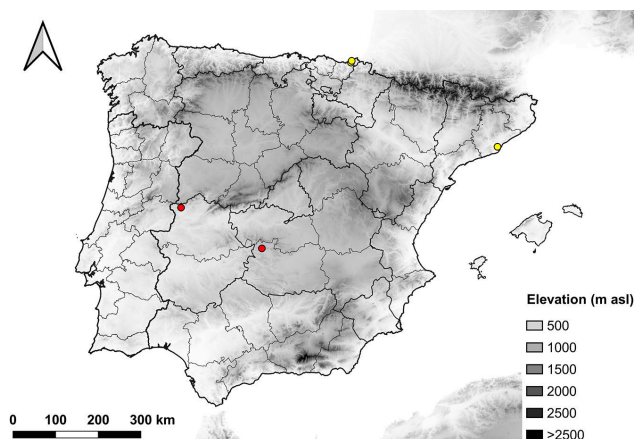


Fig. 8. Map showing Ibero-Balearic distribution of *E. flavitarsis*. Confirmed records – red circles, literature records – yellow circles.

Worldwide distribution. Western Europe (France, Portugal and Spain).

***Eumerus consimilis* Šimić & Vujić, 1996**

Ibero-Balearic distribution. New records: Spain (M). Published records: Portugal (Aveiro, Oporto), Spain (LU, Z) (Fig. 6).

Worldwide distribution. A Palearctic species occurring from the westernmost parts of Europe (e.g. France, Spain) to the Balkans and Georgia.

***Eumerus emarginatus* Loew, 1848**

Eumerus cavitibius Rondani, 1850

Ibero-Balearic distribution. Published records: Spain (IB (ma)).

Worldwide distribution. A Mediterranean species present in central (Italy) and eastern Europe (Greece and Aegean islands).

***Eumerus etnensis* van der Goot, 1964**

Ibero-Balearic distribution. Published records: Gibraltar, Portugal (Faro, Santarém), Spain (A, AL) (Fig. 7).

Worldwide distribution. A Palearctic species occurring in western (e.g. France, Spain) central Europe (e.g. Italy, Malta), but also in the North of Africa (Algeria).

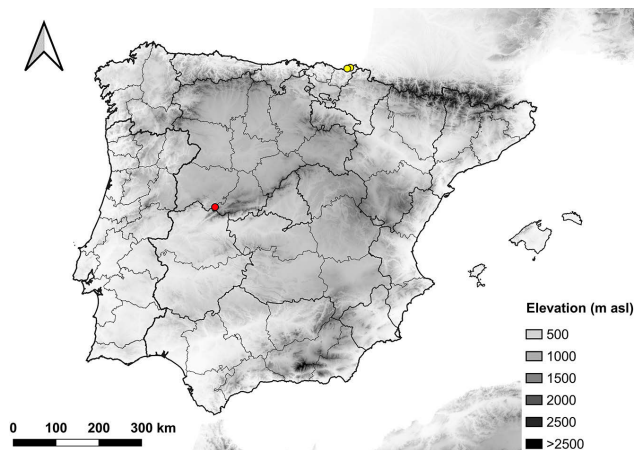


Fig. 9. Map showing Ibero-Balearic distribution of *E. funeralis*. Confirmed records – red circles, literature records – yellow circles.

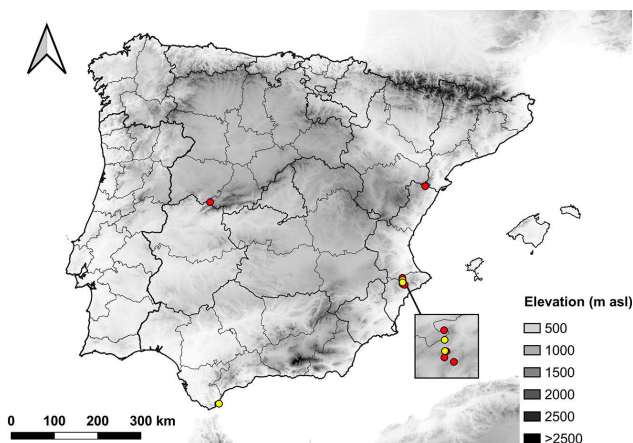


Fig. 10. Map showing Ibero-Balearic distribution of *E. hungaricus*. Confirmed records – red circles, literature records – yellow circles.

***Eumerus flavitarsis* Zetterstedt, 1843**

Eumerus elegans Schiner & Egger, 1853

Eumerus silesiacus Becker, 1921

Ibero-Balearic distribution. Published records: Spain (B, CC, CR, SS) (Fig. 8).

Worldwide distribution. A Palearctic species that extends from southwestern Europe to Russia and the Pacific coast of Asia.

***Eumerus funeralis* Meigen, 1822**

Eumerus tuberculatus Rondani, 1857

Eumerus victorianus Paramonov, 1957

Ibero-Balearic distribution. Published records: Spain (SA, SS) (Fig. 9).

Worldwide distribution. A cosmopolitan species, occurring in the Palearctic Region but also introduced in the Australasian, Nearctic and Neotropical Regions.

***Eumerus gibbosus* van Steenis, Hauser & van Zuijlen, 2017**

Ibero-Balearic distribution. Published records: Portugal (Beja, Santarém), Spain (A, AB, AL, V).

Worldwide distribution. Endemic to the Ibero-Balearic area (mainland Portugal and Spain).

***Eumerus grillator* Smit in Grković et al., 2019a**

Ibero-Balearic distribution. Published records: Spain (A, AL, BU, CR, GR, M, SO, V).

Worldwide distribution. Endemic to mainland Spain.

***Eumerus grandis* Meigen, 1822**

Eumerus annulatus (Panzer, 1798)

Ibero-Balearic distribution. Published records: Spain (GI).

Worldwide distribution. A Palearctic species occurring from southwestern Europe to Georgia and Armenia.

***Eumerus hispanicus* van der Goot, 1966**

Ibero-Balearic distribution. Published records: Spain (A, SG, TE, V).

Worldwide distribution. Endemic to Spain.

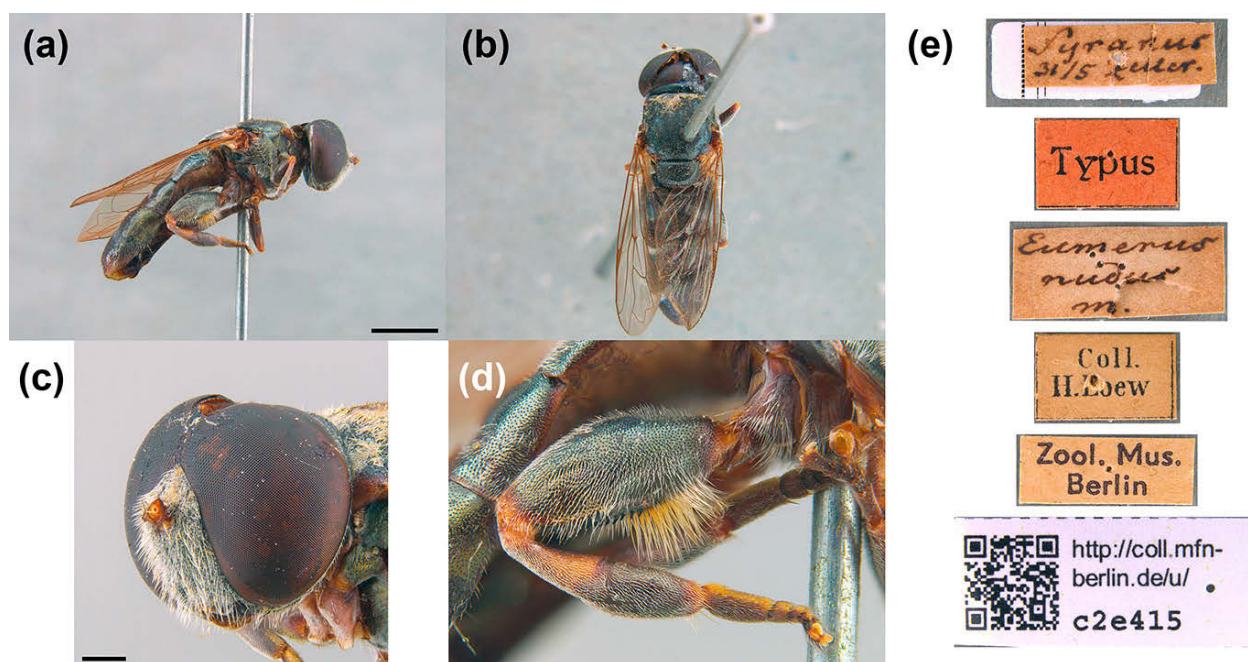


Fig. 11. *Eumerus nudus*, holotype, habitus: (a) lateral view; (b) dorsal view. Head: (c) lateral view. Right leg: (d) lateral view. (e) Labels. Scale bars (mm) = (a, b) 2, (c, d) 0.5.

Eumerus hungaricus Szilády, 1940

Eumerus elaverensis Séguy, 1961

Ibero-Balearic distribution. New records: Spain (CS). Published records: Gibraltar, Spain (A, SA, V) (Fig. 10).

Worldwide distribution. A Palearctic species that extends from western Europe (France and Spain) to Turkey, but also present in the North of Africa.

Eumerus larvatus Aracil, Grković & Pérez-Bañón in Aracil et al., 2023

Ibero-Balearic distribution. Published records: Spain (A, AL).

Worldwide distribution. Endemic to Spain.

Eumerus nudus Loew, 1848

(Figs 11–13)

Eumerus ruficauda Bigot, 1884

Eumerus caballeroi Gil Collado, 1929, syn. n.

Examined material. Holotype (♂) – Syrakus, 31/5, Zeller // Typus // *Eumerus nudus* m. // Coll. H. Loew // Zool. Mus. Berlin {original labels} (ZMHU).

Genitalia. Epandrium with a simple posterior surstylar lobe, with a triangular-like expansion antero-medially and straight posteriorly (Fig. 12B). Cercus with long black hairs (Fig. 12B, D). Anterior surstylar lobe square-shaped, with three protruding lobes (in lateral view) (Fig. 12B). Interior accessory lobe rectangular shaped and covered with short hairs (Fig. 12B). Hypandrium simple (Fig. 12A).

Ibero-Balearic distribution. New records: Spain (GR). Published records: Gibraltar, Spain (A, AL, CR, M, O, SS, TE, V).

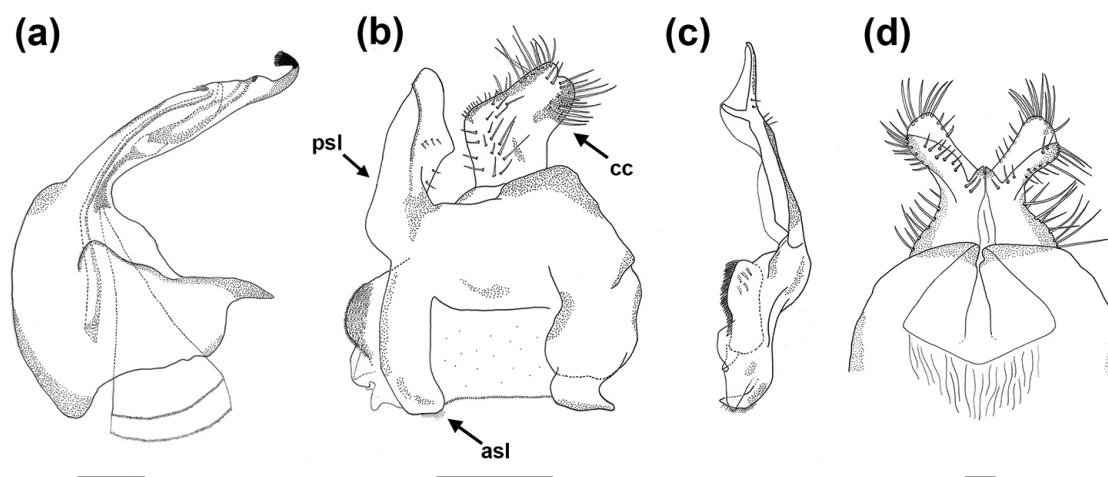


Fig. 12. *Eumerus nudus*, male genitalia, hypandrium: (a) lateral view. Epandrium: (b) lateral view; (c) ventral view; (d) dorsal view. Legend: asl – anterior surstylar lobe; cc – cercus; psl – posterior surstylar lobe. Scale bars (μm) = (a, c) 250, (b) 500, (d) 100.

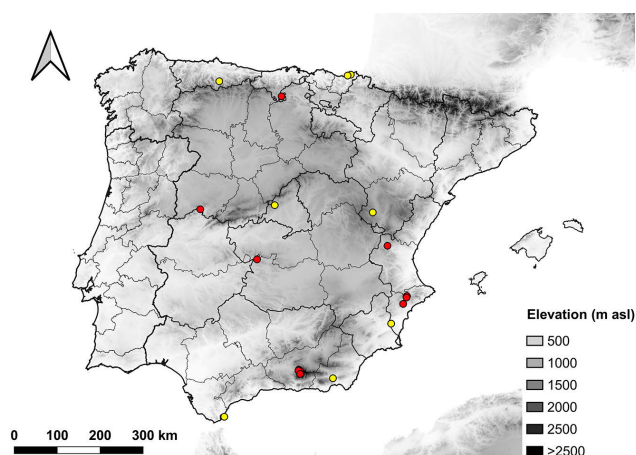


Fig. 13. Map showing the Ibero-Balearic distribution of *E. nudus*. Confirmed records – red circles, literature records – yellow circles.

Worldwide distribution. A species mainly occurring in the Mediterranean Basin, extending from Spain to Turkey and the North of Africa (Algeria, Morocco and Tunisia).

Taxonomic notes. This species resembles *E. caballeroi*, which was described by Gil Collado (1929) based on a single female collected in the locality of ‘Laguna Guedira’ (Morocco). The holotype of *E. caballeroi* is deposited in the MNCN. It was not possible to examine the holotype because it has been on loan since 2001 (Mercedes París, pers. comm.), but we could examine a female identified as *E. caballeroi* by Juan Gil Collado kept at the same institution (see Supplement S1). Based on the morphology, there are no substantial differences between the female of *E. caballeroi* identified by Gil Collado and the females of *E. nudus* from the Ibero-Balearic area. *Eumerus nudus* has a Mediterranean distribution, being also present in North Africa (Speight, 2024). In addition, Malidžan et al. (2022) confirm the presence of this species in Morocco and present a barcode sequence for one male specimen. Based on all this evidence, it is proposed that *E. caballeroi* is a junior synonym of *E. nudus*.

***Eumerus obliquus* (Fabricius, 1805)**

Eumerus lugens Wiedemann, 1830

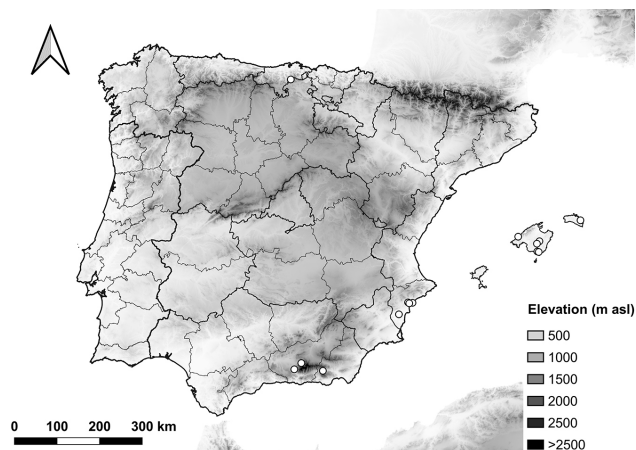


Fig. 14. Map showing Ibero-Balearic distribution of *E. obliquus*. Confirmed records – white circles.

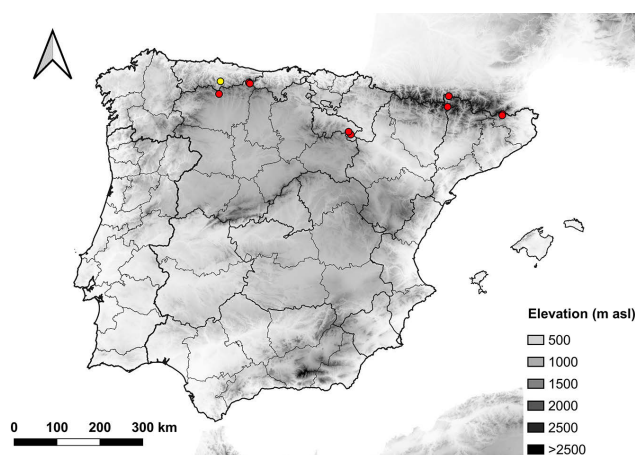


Fig. 15. Map showing Ibero-Balearic distribution of *E. ornatus*. Confirmed records – red circles, literature records – yellow circles.

Eumerus cilitarsis Loew, 1848

Eumerus crassitarsis Costa, 1885

Ibero-Balearic distribution. New records: Spain (AL, GR, S). Published records: Spain (A, IB (me)) (Fig. 14).

Worldwide distribution. An almost cosmopolitan species, occurring in the Afrotropical and Palearctic Regions and has been introduced into other parts of the world (i.e. Australasian, Nearctic and Neotropical Regions).

***Eumerus ornatus* Meigen, 1822**

Eumerus fumipennis Curtis, 1839

Eumerus leucopyga Becker, 1921

Ibero-Balearic distribution. New records: Spain (HU, L, LO). Published records: Spain (GI, LE, LU) (Fig. 15).

Worldwide distribution. A Palearctic species occurring from the north of the Iberian Peninsula to the European parts of Russia.

***Eumerus ovatus* Loew, 1848**

Eumerus bicolor (Rondani, 1857)

Ibero-Balearic distribution. Published records: Andorra, Spain (GI).

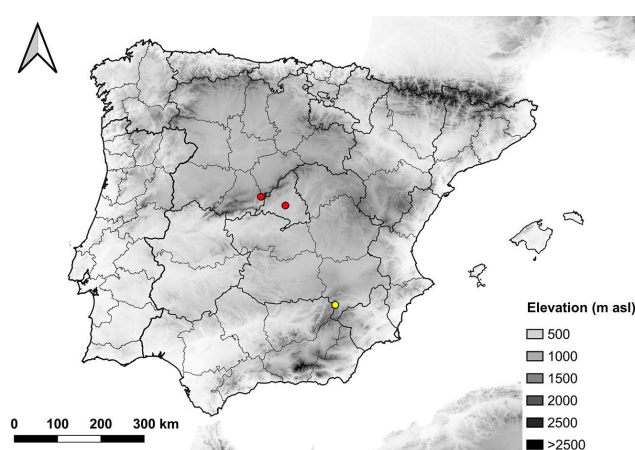
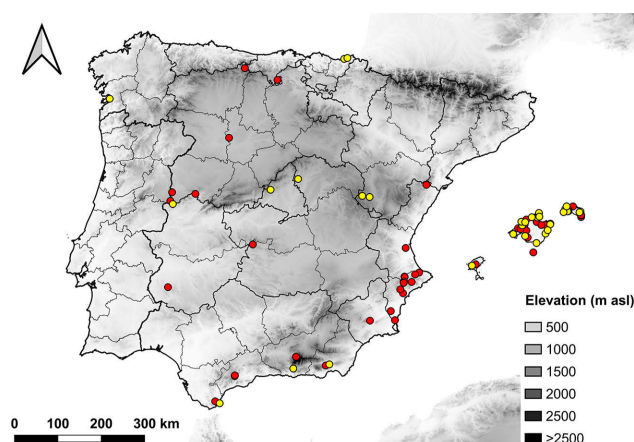


Fig. 16. Map showing Ibero-Balearic distribution of *E. pauper*. Confirmed records – red circles, literature records – yellow circles.



Balearic Islands

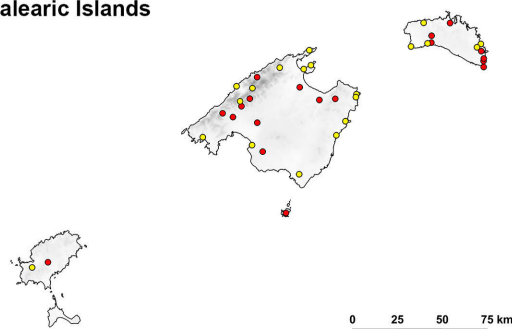


Fig. 17. Map showing Ibero-Balearic distribution of *E. pulchellus*. Confirmed records – red circles, literature records – yellow circles.

Worldwide distribution. A European species occurring from the north of the Iberian Peninsula to the mountain ranges in the Caucasus.

Eumerus pauper Becker, 1921

Ibero-Balearic distribution. New records: Spain (AV, M). Published records: Spain (AB) (Fig. 16).

Worldwide distribution. Endemic to Spain.

Taxonomic notes. The type series of *Eumerus bifurcatus* van Steenis & Hauser in Grković et al., 2019b consists of five specimens (4♂ and 1♀) collected in ‘Albacete, Sierra de Alcaraz, Puerto de las Crucetillas’ (Spain) (Grković et

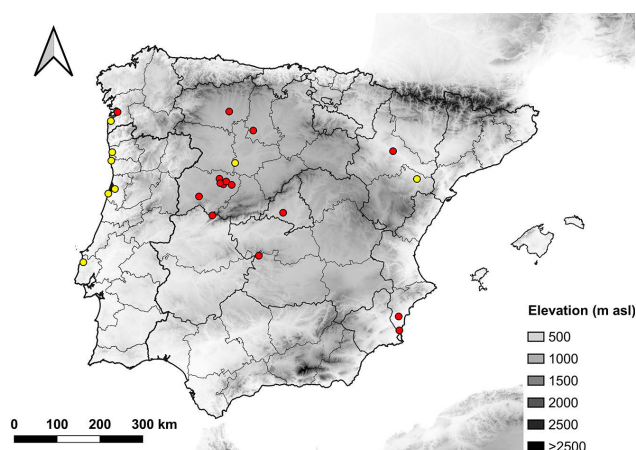


Fig. 19. Map showing Ibero-Balearic distribution of *E. sogdianus*. Confirmed records – red circles, literature records – yellow circles.

al., 2019b). In the course of this study, six specimens of *E. bifurcatus* (four males and two females) deposited in the MNCN were examined (see Supplement S1). This material was previously identified, and labelled, as *E. pauper* by Gil Collado (1930) who indicated that the males appeared to be similar morphologically (besides sexual dimorphism) to the female of *E. pauper*. The description of *E. pauper* was based on a single female from Spain (without further details on type locality). Based on the original descriptions, no significant differences were found between the females of *E. bifurcatus* and *E. pauper*. The holotype of *E. pauper* is preserved in the collection of the ZMHU, but it had been on loan for years at the time of the current study (Jenny Pohl, in litt.). In addition, Grković et al. (2019b) did not mention *E. pauper* in their revision of the *Eumerus bactrianus* Stackelberg, 1952 species subgroup. The morphological evidence indicates that the use of the name “*E. pauper*” to replace “*E. bifurcatus*” is acceptable until the type is examined as there are no grounds to think that *E. bifurcatus* differs from *E. pauper*. On the other hand, *E. pauper* is also reported from Greece (van de Weyer & Dils, 1999) and the lower banks of the Volga River (Stackelberg, 1961). These records should be viewed with caution as the

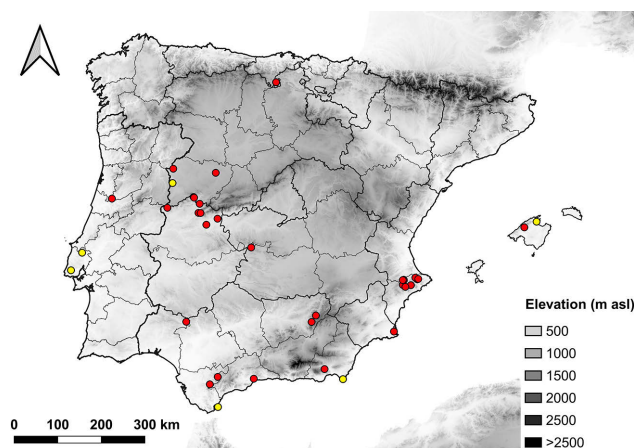


Fig. 18. Map showing Ibero-Balearic distribution of *E. pusillus*. Confirmed records – red circles, literature records – yellow circles.

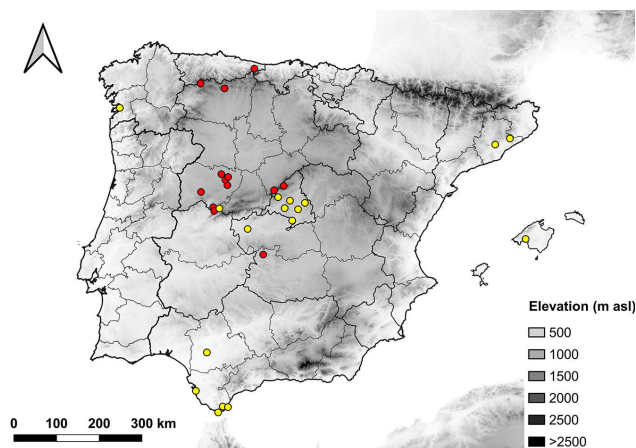


Fig. 20. Map showing Ibero-Balearic distribution of *E. strigatus*. Confirmed records – red circles, literature records – yellow circles.

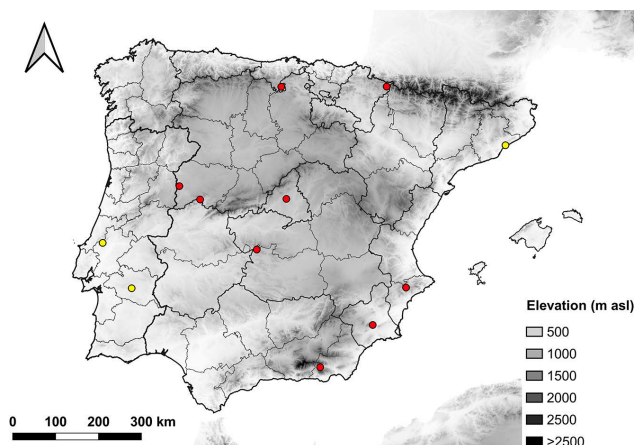


Fig. 21. Map showing Ibero-Balearic distribution of *E. subornatus*. Confirmed records – red circles, literature records – yellow circles.

similarity of *E. pauper* to other species in the subgroup may have resulted in misidentification.

***Eumerus petrarum* Aguado-Aranda, Nedeljković & Ricarte in Aguado-Aranda et al., 2023**

Ibero-Balearic distribution. Published records: Spain (GR).

Worldwide distribution. Endemic to Spain.

***Eumerus pulchellus* Loew, 1848**

Eumerus delicatae Rondani, 1850

Ibero-Balearic distribution. New records: Spain (BA, GR, LE, MA, S, VA). Published records: Gibraltar, Spain (A, AL, C, CA, CR, GU, IB (ib, ma, me), M, MU, SA, SG, SS, TE) (Fig. 17).

Worldwide distribution. A Mediterranean species, present along the Basin, from the Iberian Peninsula to Turkey.

***Eumerus pusillus* Loew, 1848**

Ibero-Balearic distribution. New records: Portugal (Aveiro), Spain (CA, H, J, MA, MU, S, V). Published records: Gibraltar, Portugal (Lisbon), Spain (A, AL, CC, CR, IB (ma), SA) (Fig. 18).

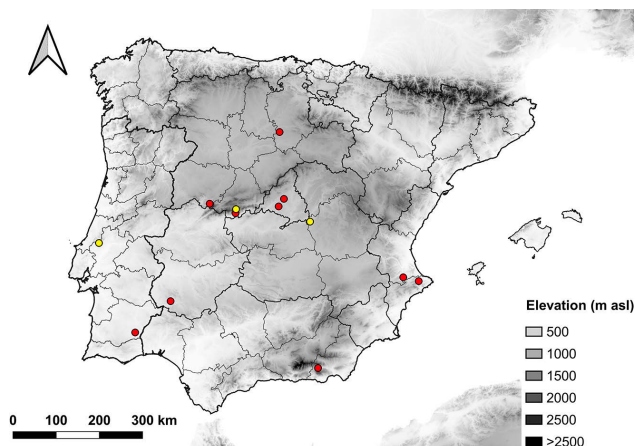


Fig. 22. Map showing Ibero-Balearic distribution of *E. truncatus*. Confirmed records – red circles, literature records – yellow circles.

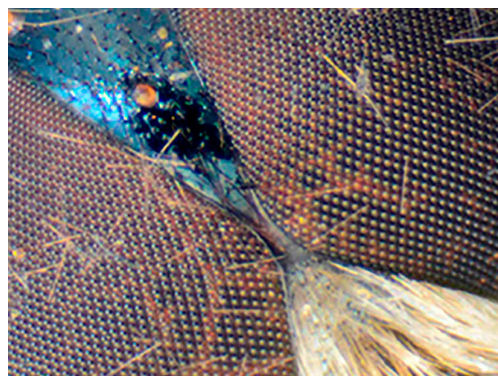


Fig. 23. *Eumerus ovatus*, male, eye contiguity. Source (CC-BY): Grković et al. (2021).

Worldwide distribution. This species occurs along the Mediterranean Basin, from the Iberian Peninsula to Greece and Turkey.

***Eumerus ruficornis* Meigen, 1822**

Eumerus ruficornis Macquart, 1829

Eumerus barbiventris Rondani, 1850

Ibero-Balearic distribution. Published records: Spain (M).

Worldwide distribution. A Palaearctic species occurring from northern Europe (e.g. Sweden) to the north of Africa.

Taxonomic notes. The only known record of this species in the area studied is that reported by Gil Collado (1930) based on an unknown number of specimens collected at ‘Chinchón’ (Madrid). After examining the material of *Eumerus* preserved in the MNCN, no specimens labelled or



Fig. 24. *Eumerus subornatus*, male, thorax, lateral view (arrow indicates the notopleural sulcus).

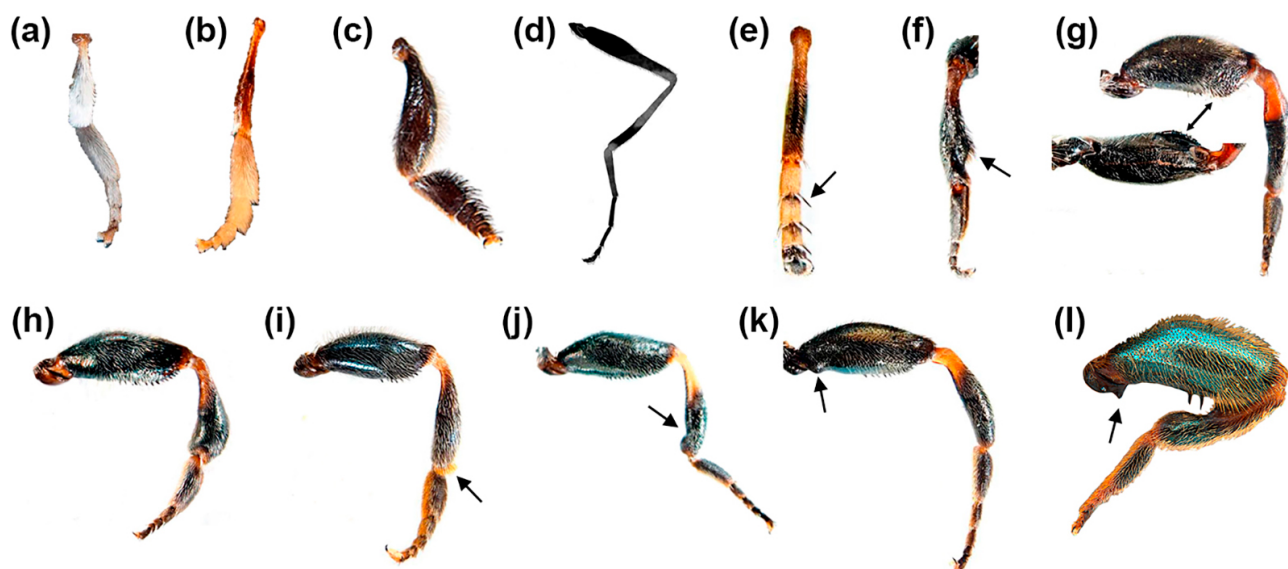


Fig. 25. Leg segments, male: (a) *E. argyropus*, hind tibia and tarsus, dorsal view; (b) *E. flavitarsis*, hind tibia and tarsus, dorsal view; (c) *E. obliquus*, hind basotarsomere, antero-lateral view; (d) *E. grallator*, hind leg, antero-lateral view; (e) *E. tarsalis*, fore leg, dorsal view (arrow indicates the long black seta); (f) *E. hungaricus*, hind tibia, dorsal view (arrow indicates the brush of hairs); (g) *E. alpinus*, hind femur, apico-ventral lamina (double-headed arrow indicated the position of the lamina); (h) *E. clavatus*, hind tibia, antero-lateral view; (i) *E. etnensis*, hind tibia, antero-lateral view (arrow indicates the distal brush of hairs); (j) *E. pusillus*, hind leg, antero-lateral view (arrow indicates the concavity); (k) *E. funeralis*, hind leg, antero-lateral view (arrow indicates the basal protuberance); (l) *E. sulcitibius*, hind leg, antero-lateral view (arrow indicates the projection). Sources: (a–c, e–k) Speight et al. (2021) (with permission), (d) Grković et al. (2019a) (CC-BY).

identified as “*E. ruficornis*” were found. Larvae of this species appear to feed on *Scorzonera humilis* L. (Speight, 2024). This plant is a European endemic distributed in central and western Europe. On the Iberian Peninsula, it is mainly present in the Eurosiberian region [see fig. 5 of Díaz de la Guardia & Blanca (1986)]. However, Johansson (2011) highlights that intensive farming has depleted the populations of *S. humilis* in Europe. Thus, the presence of this species in the Ibero-Balearic area needs to be confirmed.



Fig. 26. *Eumerus flavitarsis*, male, habitus, dorsal view (arrow indicates the maculae on tergum II). Scale bar = 2.5 mm.

***Eumerus sabulonum* (Fallén, 1817)**

Eumerus selene Meigen, 1822

Eumerus rubriventris Macquart, 1829

Eumerus litoralis Curtis, 1839

Ibero-Balearic distribution. Published records: Portugal (Faro, Leiria, Santarém, Viseu), Spain (AV, BI, CC, CR, GR, LE, M, NA, PO, SA, SG, ZA).

Worldwide distribution. A Palearctic species occurring from the south of Fennoscandia to the north of Africa and European parts of Russia.

***Eumerus sogdianus* Stackelberg, 1952**

Ibero-Balearic distribution. New records: Spain (A, C, LE, M, P, SA, Z). Published records: Portugal (Aveiro, Braga, Lisbon, Oporto), Spain (CC, CR, PO, TE, VA) (Fig. 19).

Worldwide distribution. A Palearctic species occurring from south-western Europe to the European parts of Russia, central Asia and China.

***Eumerus strigatus* (Fallén, 1817)**

Eumerus grandicornis Meigen, 1822

Eumerus lunulatus Meigen, 1822

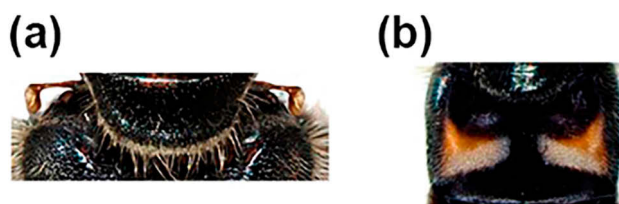


Fig. 27. Dorsal view: (a) *E. obliquus*, male, scutellum; (b) *E. subornatus*, female, tergum II. Source (with permission): Speight et al. (2021).

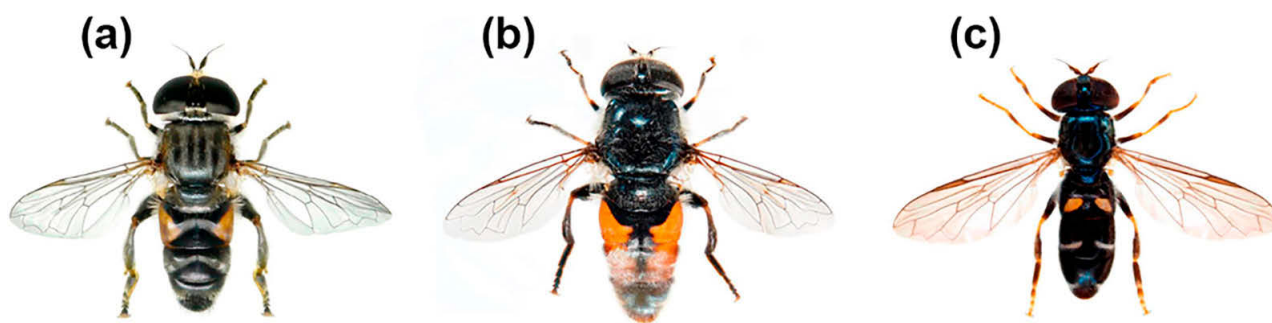


Fig. 28. Habitus, dorsal view: (a) *E. etnensis*, male; (b) *E. ovatus*, male; (c) *E. flavitarsis*, female. Source (with permission): Speight et al. (2021).

Eumerus planifrons Meigen, 1822

Eumerus aeneus Macquart, 1829

Eumerus melanopus Rondani, 1857

Eumerus lunulatus var. *rufitarsis* Strobl, 1906

Eumerus griseofasciatus (Matsumura, 1916)

Ibero-Balearic distribution. New records: Spain (O). Published records: Gibraltar, Spain (A, B, BI, C, CA, CR, HU, IB (ma), LE, M, MU, SA, SE) (Fig. 20).

Worldwide distribution. A Palearctic species, occurring from Fennoscandia to the south of the Iberian Peninsula, Turkey and Russia. It has been introduced into the Australasian, Nearctic and Neotropical Regions.

***Eumerus subornatus* Claußen, 1989**

Ibero-Balearic distribution. New records: Spain (A, AL, M, MU, NA, S). Published records: Portugal (Évora, Santarém), Spain (B, CR, SA) (Fig. 21).

Worldwide distribution. France, Morocco, Portugal and Spain.

***Eumerus sulcibius* Rondani, 1868**

Ibero-Balearic distribution. Published records: Portugal (Guarda, Leiria, Santarém), Spain (A, AB, AV, CU, LE, M, S, SA, TE, V).

Worldwide distribution. From southwestern Europe (France, Portugal and Spain) to Georgia, including several Mediterranean islands (e.g. Crete).

***Eumerus tarsalis* Loew, 1848**

Ibero-Balearic distribution. Published records: Spain (B, GR, M).

Worldwide distribution. From south and central Europe to Russia and Mongolia, but also occurring in the north of Africa.

***Eumerus tricolor* (Fabricius, 1798)**

Eumerus varius Meigen, 1822

Ibero-Balearic distribution. Published records: Spain (A, BU, C, LE, M, S, V).

Worldwide distribution. From southwestern Europe to the European parts of Russia, but also from Siberia to the Pacific coast of Asia.

***Eumerus truncatus* Rondani, 1868**

Ibero-Balearic distribution. New records: Spain (A, AL, BA, BU, CU, SA, V). Published records: Portugal (Beja, Santarém), Spain (AV, M) (Fig. 22).

Worldwide distribution. France, Greece, Italy, Portugal, Spain and the north of Africa.

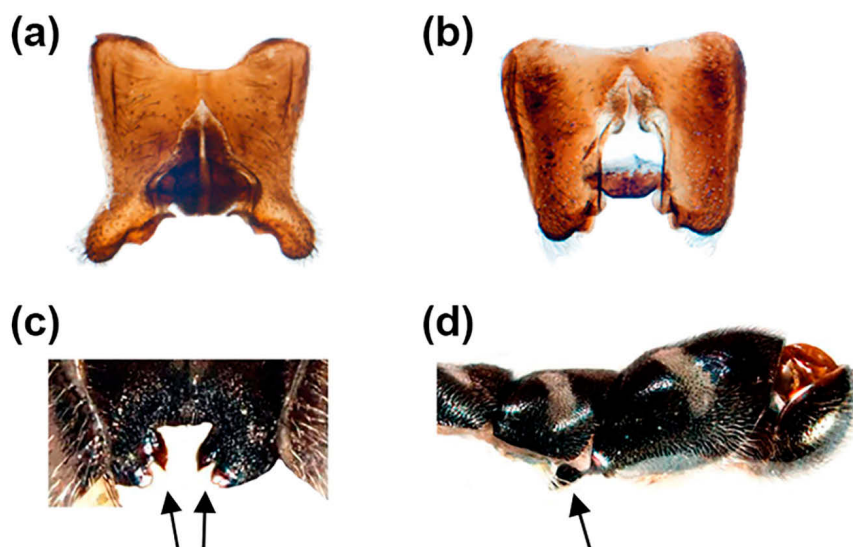


Fig. 29. Sternum IV, male, ventral view: (a) *E. barbarus*; (b) *E. gibbosus*; (c) *E. ruficornis*, posterior margin (arrows indicate the incisions). Abdomen, male, lateral view: (d) *E. clavatus* (arrow indicates the projection). Sources: (a, b) van Steenis et al. (2017) (CC-BY), (c, d) Speight et al. (2021) (with permission).

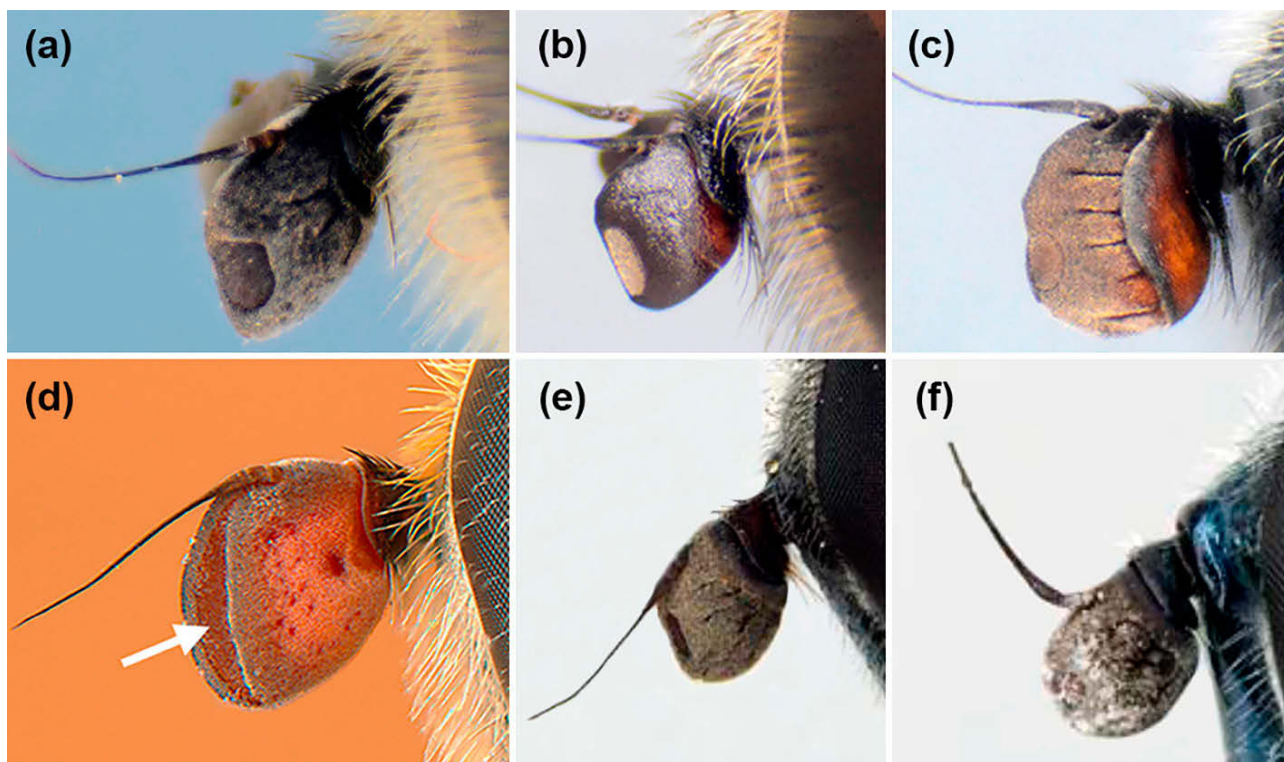


Fig. 30. Basoflagellomere, lateral view: (a) *E. ovatus*, male; (b) *E. larvatus*, male; (c) *E. larvatus*, female; (d) *E. truncatus*, female (arrow indicates the half-moon area); (e) *E. sabulonum*, female; (f) *E. petrarum*, female. Sources (CC-BY): (a) Grković et al. (2021), (b, c) Aracil et al. (2023), (e, f) Aguado-Aranda et al. (2023).

Key to the Ibero-Balearic species of *Eumerus*

The present dichotomous key is based on the keys of van Steenis et al. (2017), Grković et al. (2019b), Speight et al. (2021) and Aguado-Aranda et al. (2023). In this key, species reported from the Ibero-Balearic area are included. However, the low interspecific variability in females of *E. consimilis*, *E. sogdianus* and *E. strigatus* makes their identification difficult, and consequently they are not included in the key (females of *E. sogdianus* appear to have a rectangular basoflagellomere, whereas females of *E. strigatus* and *E. consimilis* appear to have an oval basoflagellomere). For more information, see table 1 of Grković et al. (2017). Similarly, the female of *E. emarginatus* is also not included, as its morphological similarity to related species makes it difficult to distinguish.

- 1 Eyes holoptic or slightly dichoptic (i.e. separated by a distance equivalent to the width of the frontal ocellus) (Fig. 23) 2
- Eyes clearly dichoptic (i.e. separated by a distance greater than the width of the frontal ocellus) 38

Males

- 2 With notopleural sulcus (Fig. 24) 3
- Without notopleural sulcus 6
- 3 Hind tibia with dense silvery-white pilosity all over its dorsal surface, obscuring the colour of the integument (Fig. 25a) *E. argyropus*
- Hind tibia with more scattered silvery-white pilosity on its dorsal surface, not obscuring the colour of the integument.. 4

- 4 Tergum II with triangular maculae that are longer (length-wise) than those on terga III–IV (Fig. 26). Hind basotarsomere dorso-ventrally flattened and extended laterally (Fig. 25b) *E. flavitarsis*
- Tergum II with oblique maculae, similar in length to those on terga III–IV. Hind basotarsomere circular in cross section... 5
- 5 Eye contiguity 2× longer than the medial length of frontal triangle *E. ornatus*
- Eye contiguity as long as the medial length of frontal triangle or shorter *E. subornatus*
- 6 Hind femur with apico-ventral lamina (as in Fig. 25g) 7
- Hind femur without lamina 10
- 7 Scutellum white pollinose all over its posterior margin (Fig. 27a). Dorsal side of hind basotarsomere with a ridge (Fig. 25c) *E. obliquus*
- Scutellum without pollinosity all over its posterior margin. Hind basotarsomere without ridge 8
- 8 Tergum II with two triangular orange maculae laterally (Fig. 28a). Apex of hind tibia with a characteristic brush of orange hairs (Fig. 25i) *E. etnensis*
- Tergum II black, without orange maculae. Apex of hind tibia without a brush of hairs 9
- 9 Eye bare. Central plate of scutellum with hairs shorter than a third of the length of the hairs on the vertical triangle. Ventral side of hind femur with hairs as long as half the maximum width of the femur or longer (Fig. 11d) *E. nudus*
- Eye pilose. Central plate of scutellum with hairs as long as a third of the length of the hairs on the vertical triangle or longer. Ventral side of hind femur with hairs shorter than half the maximum width of the femur *E. alpinus*
- 10 Apical half of hind tibia swollen (Fig. 25h). Sternum III with a triangular forwardly-directed extension (Fig. 29d) *E. clavatus*

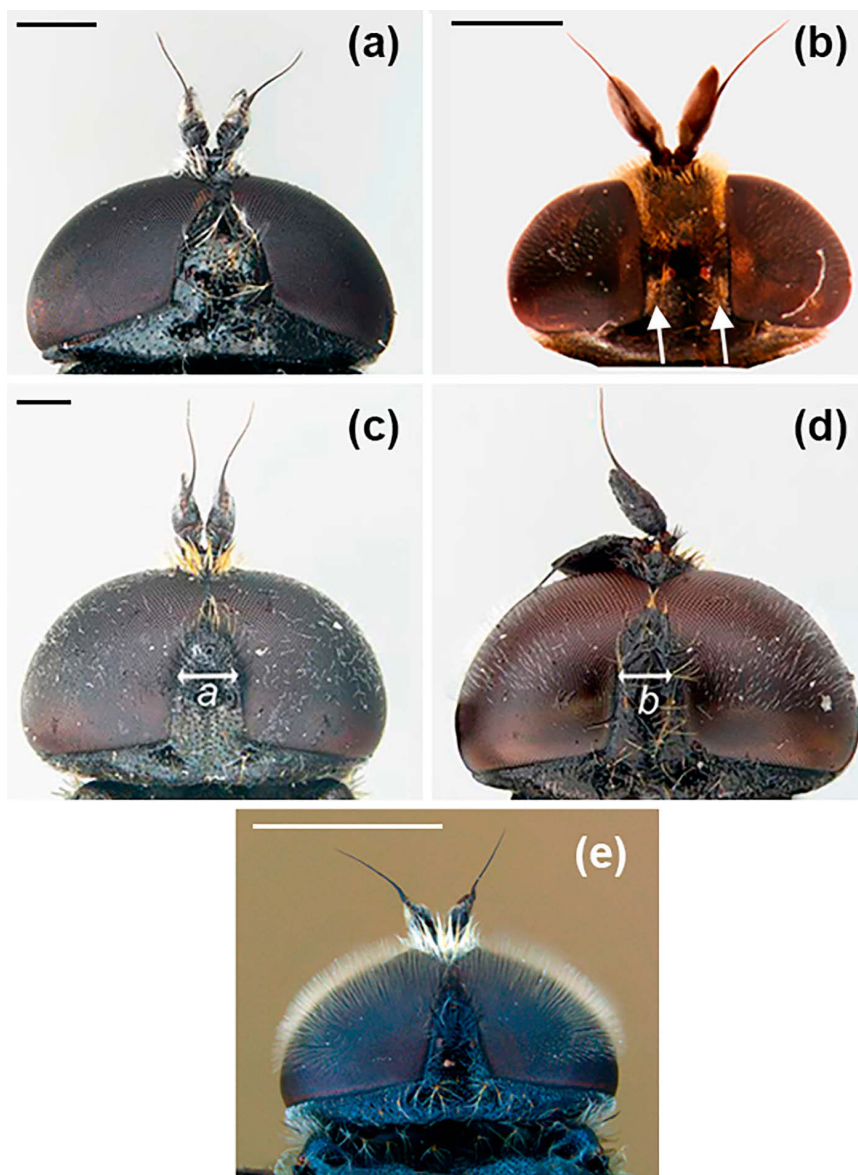


Fig. 31. Head, dorsal view: (a) *E. petrarum*, male; (b) *E. sulcitibius*, female (arrows indicate the pollinose spots); (c) *E. ancylostylus*, male; (d) *E. grandis*, male; (e) *E. azabense*, male. Vertical triangle width (mm): $a = 0.58$, $b = 0.43$. Scale bars (mm) = (a, c–d) 0.5, (b) 1, (e) 2. Sources: (a, c–d) Aguado-Aranda et al. (2023) (CC-BY), (b) van Steenis et al. (2017) (CC-BY), (e) Ricarte et al. (2018) (with permission).

- Hind tibia uniform in width. Sternum III without modifications 11
- 11 Basoflagellomere with an ellipsoidal area apically (as in Fig. 30a). Abdominal integument usually bicoloured (i.e. black and red to orange) 12
- Basoflagellomere without ellipsoidal area. Abdominal integument black 23
- 12 Hind femur, tibia and tarsus very slender, conspicuously longer in proportion to their width (Fig. 25d) *E. grallator*
- Hind femur, tibia and tarsus of typical proportions 13
- 13 Eye bare 14
- Eye conspicuously pilose 16
- 14 Tarsomeres 2–4 of fore leg each with a long black seta postero-apically (Fig. 25e) *E. tarsalis*
- Tarsomeres 2–4 of fore leg without such setae 15
- 15 Vertical triangle wide (>0.44 mm) (Fig. 31a). Interior accessory lobe of the surstylus triangular in lateral view (Fig. 32f) *E. petrarum*
- Vertical triangle narrow (<0.44 mm). Interior accessory lobe of the surstylus square-shaped in lateral view (Fig. 32g) *E. sabulorum*
- 16 Hairs on scutum short, less than 1/3 of the length of the hairs on the vertical triangle (Fig. 33b) *E. tricolor*
- Hairs on scutum long, more than 1/3 of the length of the hairs on the vertical triangle (Fig. 33a) 17
- 17 Ventral side of hind femur with white hairs on the basal half and black hairs on the apical half (Fig. 34a) *E. bayardi*
- All hairs on the ventral side of the hind femur of the same colour 18
- 18 Basoflagellomere square-shaped (Fig. 30b). Hairs on ventral side of hind femur as long as the maximum width of the femur (Fig. 34b) *E. larvatus*
- Basoflagellomere rectangular or oval. Hairs on ventral side of hind femur shorter than maximum width of femur 19
- 19 Terga II–IV mainly red *E. hispanicus*
- Terga II–IV mainly black, but with lateral red maculae at least on tergum II 20

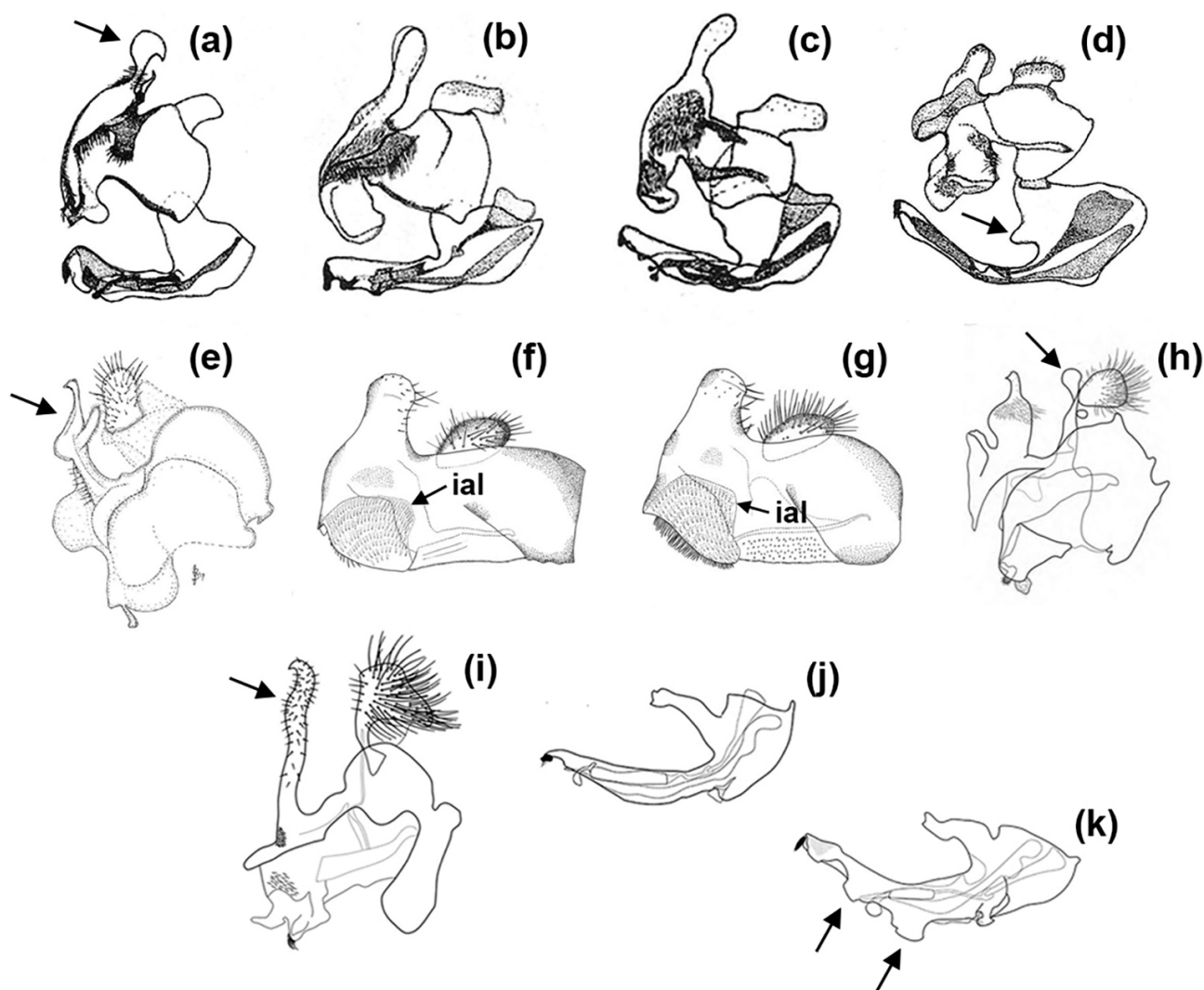


Fig. 32. Male genitalia, lateral view: (a) *E. strigatus* (arrow indicates the surstylus); (b) *E. consimilis*; (c) *E. sogdianus*; (d) *E. amoenus* (arrow indicates the projection). Epandrium, lateral view: (e) *E. pauper* (arrow indicates the surstylus); (f) *E. petrarum*; (g) *E. sabulorum*; (h) *E. truncatus* (arrow indicates the appendage); (i) *E. barbarus* (arrow indicates the surstylus). Hypandrium, lateral view: (j) *E. barbarus*; (k) *E. gibbosus* (arrows indicate the expansions). Legend: ial – interior accessory lobe. Sources: (a–d) Vujić & Šimić (1999) (with permission), (e) Grković et al. (2019b) (CC-BY), (f, g) Aguado-Aranda et al. (2023) (CC-BY), (h–k) van Steenis et al. (2017) (CC-BY).

- | | | |
|----|--|------------------------|
| 20 | Terga III–IV densely covered with silvery-white hairs (Fig. 28b)..... | <i>E. ovatus</i> |
| – | Terga III–IV not covered with silvery-white hairs | 21 |
| 21 | Eye with hairs as long as or longer than half of the length of the hairs on the vertical triangle (Fig. 31e)..... | <i>E. azabense</i> |
| – | Eye with hairs shorter than half the length of the hairs on the vertical triangle | 22 |
| 22 | Basoflagellomere as wide as long or wider than long (ratio length:width = 1:1–1.1). Vertical triangle wide (>0.5 mm) (Fig. 31c). Genitalia with posterior surstylar lobe rounded anteriorly (Fig. 35a)..... | <i>E. ancylostylus</i> |
| – | Basoflagellomere longer than wide (ratio length:width = 1:0.8–0.9) Vertical triangle narrow (<0.5 mm) (Fig. 31d). Genitalia with posterior surstylar lobe straight anteriorly (Fig. 35b)..... | <i>E. grandis</i> |
| 23 | Hind trochanter with a rounded to triangular extension (as in Fig. 25l). Genitalia with posterior surstylar lobe hook-shaped apically (as in Fig. 32i)..... | 24 |
| – | Hind trochanter without extensions. Genitalia with posterior surstylar lobe not hook-shaped | 26 |
| 24 | Ventral side of hind femur with two rows of apical black spinulae, and 2–3 medial spinulae 2× longer than the apical ones (Fig. 25l) | <i>E. sulcitibius</i> |
| – | All spinulae on the ventral side of hind femur similar in length | 25 |
| 25 | Sternum IV with an elongate rounded lobe at each of its posterior corners (Fig. 29a). Hypandrium without bulges or expansions on its outer side (opposite to the side next to the epandrium) (Fig. 32j)..... | <i>E. barbarus</i> |
| – | Sternum IV without posterior lobes, but with rounded posterior corners (Fig. 29b). Hypandrium with two square expansions on its outer side (Fig. 32k)..... | <i>E. gibbosus</i> |
| 26 | Hind tibia with an apico-ventral concavity (Fig. 25j) | <i>E. pusillus</i> |
| – | Hind tibia without a concavity | 27 |
| 27 | Terga III–IV with remarkably long hairs laterally (as in Fig. 36b)..... | 28 |
| – | Terga III–IV without such hairs laterally | 29 |
| 28 | Hind tibia (in dorsal view) with a tuft of (mostly) black hairs laterally (Fig. 25f)..... | <i>E. hungaricus</i> |

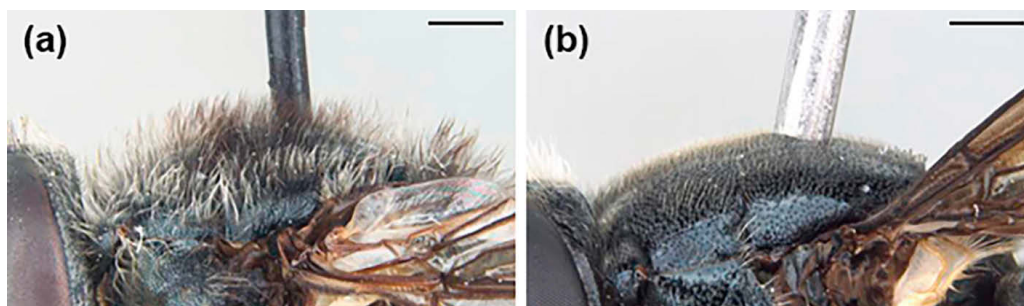


Fig. 33. Mesonotum, lateral view: (a) *E. azabense*; (b) *E. tricolor*. Scale bars (mm) = (a) 0.75, (b) 0.5. Source (CC-BY): Aguado-Aranda et al. (2023).

- Hind tibia (in dorsal view) without a characteristic tuft of hairs laterally *E. pulchellus*
- 29 Vertical triangle with only black hairs. Posterior margin of sternum IV, medially, with a pair of valve-like spiny structures (Fig. 37g) *E. colladoi*
- Vertical triangle only with light yellow hairs or with black and yellow hairs intermixed. Sternum IV without valve-like spiny structures 30
- 30 Sternum IV with posterior margin either with a deep triangular indentation and two lateral inwardly-directed lobes or with a shallow concavity with lateral lobes of variable size (Fig. 37b, d, e) 31
- Sternum IV with posterior margin triangularly indented, without lateral lobes or with ill-defined lobes (Fig. 37a, c, f) 34
- 31 Sternum IV with an inner incision on its lateral lobes (Fig. 29c) *E. ruficornis*
- Sternum IV without incisions on its lateral lobes 32
- 32 Tergum IV without pollinose maculae, or maculae very reduced and inconspicuous. Genitalia with posterior surstylar lobe bifurcated (Fig. 32e) *E. pauper*
- Tergum IV with conspicuous pollinose maculae. Genitalia with posterior surstylar lobe simple (not bifurcated) 33
- 33 Sternum IV with a posterior indentation as deep as the length between the deepest point of the indentation and the anterior margin of sternum IV (including lateral lobes) (Fig. 37b). Posterior surstylar lobe, basally, narrower than its apex (Fig. 32b) *E. consimilis*
- Sternum IV with a posterior indentation of much shorter depth than the length between its anterior end and the anterior margin of the sternum (Fig. 37d, e). Posterior surstylar lobe, basally, wider than its apex (Fig. 32c) *E. sogdianus*
- 34 Hind femur with a baso-ventral bulge (Fig. 25k) *E. funeralis*
- Hind femur without a bulge 35
- 35 Genitalia with hypandrium bearing a basal projection on its inner side (Fig. 32d) *E. amoenus*
- Genitalia with a hypandrium without projections 36
- 36 Genitalia with a spoon-like appendage between cerci (Fig. 32h) *E. truncatus*
- Genitalia without appendages between cerci 37
- 37 Basal half of hind femur, ventrally, with hairs shorter or as long as spinae on femur. Apical third of hind tibia concave ventrally. Posterior surstylar lobe triangular and slightly inclined away from cercus (see fig. 7 of Claßen & Standfuss, 2017) *E. emarginatus*
- Basal half of hind femur, ventrally, with hairs conspicuously longer than the spinae on femur. Apical third of hind tibia straight ventrally. Posterior surstylar lobe curved apically and slightly inclined towards cercus (Fig. 32a) *E. strigatus*

Females

- 38 With notopleural sulcus (Fig. 24) 39
- Without notopleural sulcus 42
- 39 Tergum II with two triangular reddish-orange areas entirely covering the grey pollinose maculae (Fig. 28c) *E. flavitarsis*
- Tergum II with two triangular reddish-orange maculae not entirely covering the grey pollinose maculae (as in Fig. 27b), or sometimes absent 40
- 40 Ventral side of hind femur with hairs at least 2× longer than the apical spina *E. ornatus*
- Ventral side of hind femur with hairs just slightly longer than the apical spina 41
- 41 Hind tibia with dense silvery-white pilosity all over its dorsal surface, obscuring the colour of the integument (more visible under artificial white light). Tergum II without yellow marks or with extremely reduced yellow marks *E. argyropus*
- Hind tibia with more scattered silvery-white pilosity on its dorsal surface, not obscuring the colour of the integument. Tergum II usually with conspicuous yellow marks (Fig. 27b) *E. subornatus*
- 42 Basoflagellomere with an ellipsoidal area apically. Abdomen usually with red parts 43

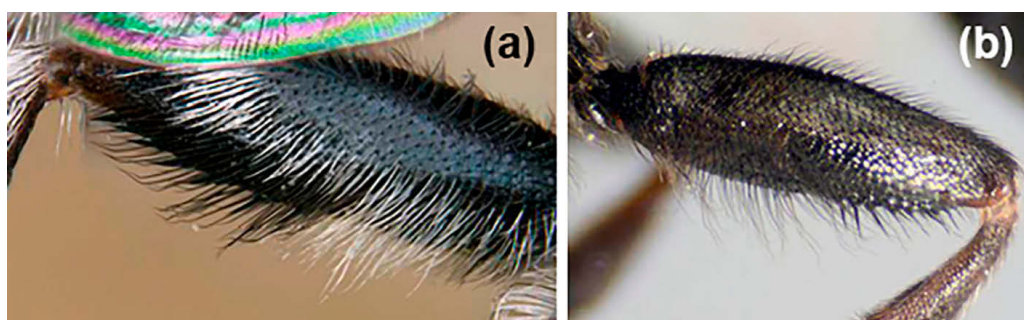


Fig. 34. Hind femur, antero-lateral view, male: (a) *E. bayardi*; (b) *E. larvatus*. Sources (CC-BY): (a) Aguado-Aranda et al. (2023), (b) Aracil et al. (2023).

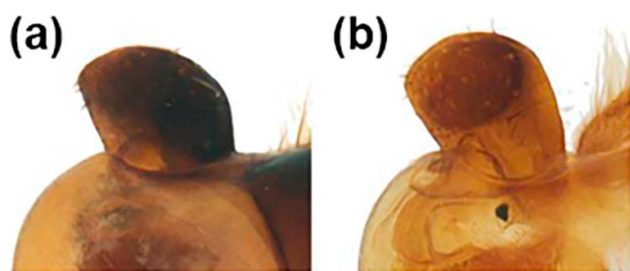


Fig. 35. Male genitalia, posterior surstylar lobe, lateral view: (a) *E. ancyllostylus*; (b) *E. grandis*. Source (CC-BY): Aguado-Aranda et al. (2023).

- Basoflagellomere without an ellipsoid area. Abdomen black 51
- 43 Hind femur, tibia and tarsus very slender, conspicuously longer in proportion to their width (as in Fig. 25d) *E. grallator*
- Hind femur, tibia and tarsus of typical proportions 44
- 44 Eye bare 45
- Eye with conspicuous pilosity 47
- 45 Tarsomeres 2–4 of fore leg each with a long black seta postero-apically (as in Fig. 25e) *E. tarsalis*
- Tarsomeres 2–4 of fore leg without long black setae 46
- 46 Vertex conspicuously elevated with respect to eye margin (in lateral view). Basoflagellomere usually tapering towards the apex (Fig. 30f) *E. petrarum*
- Vertex not elevated, at the same or very similar level to the margin of the eye (in lateral view). Basoflagellomere usually axe-shaped and extending towards the apex (Fig. 30e) *E. sabulonum*
- 47 Hind femur with ventral hairs on its basal half clearly shorter than its spinae *E. tricolor*
- Hind femur with ventral hairs on its basal half longer than its spinae 48
- 48 Basoflagellomere square-shaped (Fig. 30c) *E. larvatus*
- Basoflagellomere rounded to oval 49
- 49 Basoflagellomere yellow basally *E. grandis*
- Basoflagellomere unicolourous 50
- 50 Hairs on vertex and scutellum of similar length.. *E. azabense*
- Hairs on scutellum half the length of those on vertex *E. hispanicus*
- 51 Hind femur with an antero-dorsal keel bearing a row of spinae (as in Fig. 25g) 52
- Hind femur without an antero-dorsal keel 55

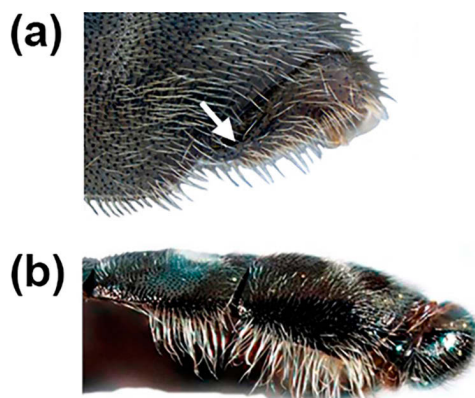


Fig. 36. Abdomen, lateral view: (a) *E. funeralis*, female, tergum V (arrow indicates the ridge); (b) *E. pulchellus*, male, terga III–IV. Sources: (a) Garcete-Barrett et al. (2020) (CC-BY), (b) Speight et al. (2021) (with permission).

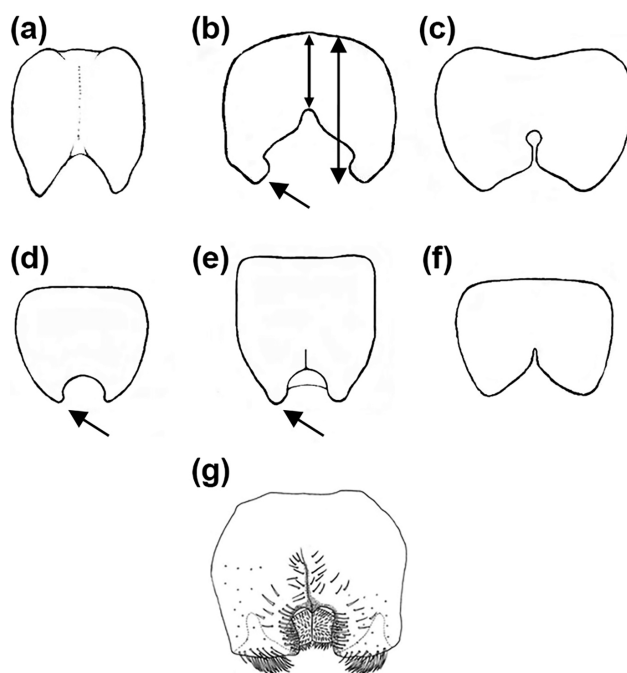


Fig. 37. Sternum IV, male, ventral view: (a) *E. amoenus*; (b) *E. consimilis*; (c) *E. funeralis*; (d, e) *E. sogdianus*; (f) *E. strigatus*; (g) *E. colladoi*. Single-headed arrows indicate lateral lobes. Double-headed arrows indicate mid-line length and maximum length of the sternum. Sources: (a–f) Speight et al. (2021) (with permission), (g) Aguado-Aranda et al. (2022) (CC-BY).

- 52 Terga II–IV each with a pair of pollinose maculae connecting medially or almost so (as in Fig. 28a) 53
- Terga II–IV each with a pair of maculae clearly separated medially 54
- 53 Eye conspicuously pilose. Scutellum thickly white-pollinose on its posterior margin (as in Fig. 27a). Tergum II black *E. obliquus*
- Eye bare. Scutellum with shiny posterior margin. Tergum II with two lateral triangular orange maculae (as in Fig. 28a) ... *E. etnensis*
- 54 Eye pilose. Hairs on scutum at least a third of the length of the hairs on the vertex (Fig. 38a) *E. alpinus*
- Eye bare. Hairs on scutum less than a third of the length of the hairs on the vertex (Fig. 38b) *E. nudus*



Fig. 38. Mesonotum, female, lateral view: (a) *E. alpinus*; (b) *E. nudus*. Scale bar = 1 mm.

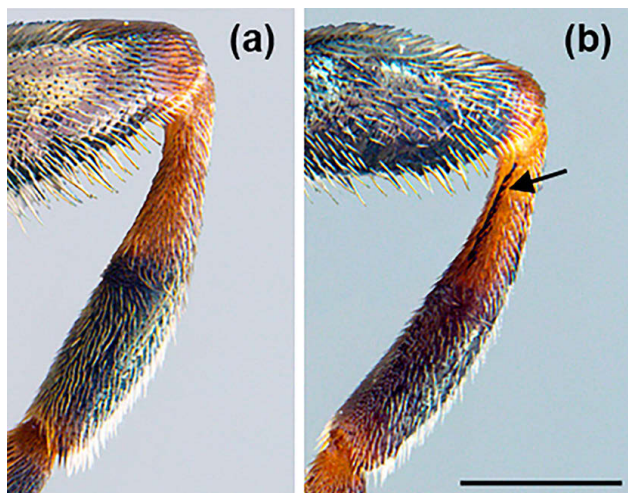


Fig. 39. Hind tibia, ventral view: (a) *E. colladoi*; (b) *E. amoenus* (arrow indicates the row of hairs). Scale bar = 500 μ m. Source (CC-BY): Aguado-Aranda et al. (2022).

- 55 Basoflagellomere with a dorso-ventrally orientated sulcus.....*E. clavatus*
 – Basoflagellomere lacks a sulcus 56
 56 Tergum IV without pollinose maculae.....*E. pauper*
 – Tergum IV with a pair of white-pollinose maculae 57
 57 Vertex only with black hairs. Ventral side of hind tibia without short adpressed spinae on its basal third, only with hairs (Fig. 39a)*E. colladoi*
 – Vertex with light yellow hairs or both yellow and black hairs intermixed. Ventral side of hind tibia with a row of short adpressed spinae on its basal third (as in Fig. 39b) 58
 58 Hind tibia with an apico-ventral concavity (as in Fig. 25j)
*E. pusillus*
 – Hind tibia lacks a concavity..... 59
 59 Tergum V with a lateral ridge-like fold (Fig. 36a).....
*E. funeralis*
 – Tergum V flattened, without folds 60
 60 Basoflagellomere with a half-moon flattened area apically (more visible under artificial white light) (Fig. 30d)
*E. truncatus*
 – Basoflagellomere lacks a characteristic apex 61
 61 Basoflagellomere tapering towards apex.....*E. hungaricus*
 – Basoflagellomere not tapering towards apex..... 62
 62 Vertex lacks white pollinose spots behind posterior ocelli.....
*E. ruficornis*
 – Vertex with white pollinose spots behind posterior ocelli (as in Fig. 31b) 63
 63 Hind femur 3 $\times$ longer than wide at its maximum width..... 64

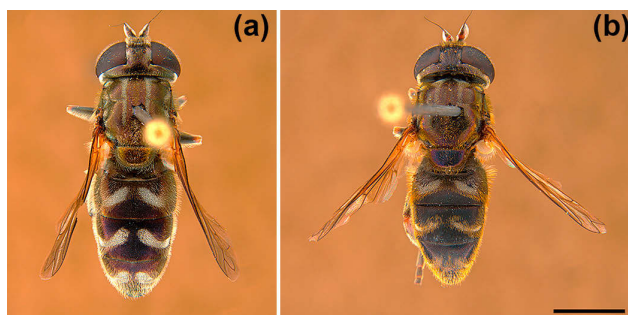


Fig. 40. Abdomen, female, dorsal view: (a) *E. barbarus*; (b) *E. gibbosus*. Scale bar = 2.5 mm.

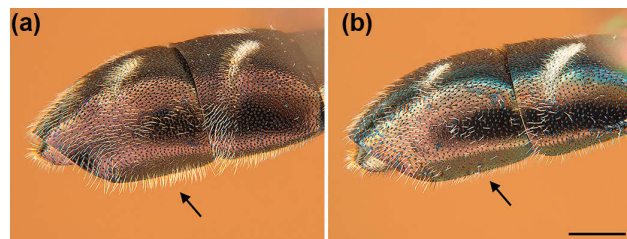


Fig. 41. Abdomen, female, lateral view: (a) *E. pulchellus*; (b) *E. amoenus*. Scale bar = 500 μ m.

- Hind femur more than 3 $\times$ longer than wide at its maximum width 66
 64 Hind femur with 1–2 black spinae on its ventral side 2 $\times$ longer than the apical spinae (as in Fig. 25l)*E. sulcitibius*
 – All spinae on the ventral side of hind femur similar in length 65
 65 Terga III–IV with wide pollinose maculae (2 $\times$ the width of one of the stripes of pollinosity on the scutum) (Fig. 40a).....
*E. barbarus*
 – Terga III–IV with narrow pollinose maculae (equal to or less than the width of one of the stripes of pollinosity on the scutum) (Fig. 40b).....*E. gibbosus*
 66 Ventral side of hind femur with long hairs (at least 2 $\times$ longer than spinae). Lateral margins of terga III–IV with hairs usually as long as the width of their own pollinose maculae at their midpoints (Fig. 41a)*E. pulchellus*
 – Ventral side of hind femur with short hairs, just slightly longer than the spinae. Lateral margins of terga III–IV with hairs usually clearly shorter than the width of their own pollinose maculae at their midpoints (Fig. 41b).....*E. amoenus*

DISCUSSION

Diversity, distribution and conservation

This study revealed at least 37 species of *Eumerus* in the Ibero-Balearic area: Andorra (2 spp.), Gibraltar (8 spp.), Portugal (13 spp.) and Spain (37 spp.). All species known from mainland Portugal are also known from Spain. Eight species are reported on the Balearic Islands: Ibiza (3 spp.), Mallorca (7 spp.) and Menorca (5 spp.) (Ricarte et al., in press). The species richness of the Ibero-Balearic area is similar to that found in other areas in the Mediterranean Basin such as France (plus Corsica) with 37 species (Speight, 2024) and the Balkan Peninsula with 45 species (Grković, 2018; Malidžan et al., 2022). In total, seven species are endemic to the area studied: *Eumerus azabense*, *E. gibbosus*, *E. grallator*, *E. hispanicus*, *E. larvatus*, *E. pauper* and *E. petrarum*. The recent records of *E. colladoi* and *E. ancylostylus* from southern France have refuted the endemic status of these species in the Ibero-Balearic area (Aguado-Aranda et al., 2024b; Speight & Lebard, 2024).

The knowledge of the diversity of *Eumerus* is very uneven, especially between the Spanish provinces. There are only eight Spanish provinces with 10+ species of *Eumerus* whilst in the rest of the provinces the species richness ranges from 0 to 8. On the other hand, records based on singletons must be viewed with caution, especially if it is difficult to identify the species involved. For example, *E. emarginatus* is reported from Mallorca based on a single female (Riddiford & Ebejer, 2006). Likewise, the

Table 2. Biogeographical distribution in Europe of the Ibero-Balearic *Eumerus* according to Speight et al. (2020).

Species	Alpine	Atlantic	Continental	Macaronesian	Mediterranean	Northern	Pannonian	Total
<i>E. alpinus</i>		•	•		•			3
<i>E. amoenus</i>	•	•	•	•	•			5
<i>E. ancylostylus</i>	•	•	•		•			4
<i>E. argyropus</i>			•		•			2
<i>E. azabense</i>					•			1
<i>E. barbarus</i>					•			1
<i>E. bayardi</i>					•			1
<i>E. clavatus</i>			•		•		•	3
<i>E. colladoi</i>		•			•			2
<i>E. consimilis</i>		•	•		•			3
<i>E. emarginatus</i>					•			1
<i>E. etnensis</i>				•	•			2
<i>E. flavitarsis</i>	•	•	•		•	•	•	6
<i>E. funeralis</i>	•	•	•		•	•	•	6
<i>E. gibbosus</i>					•			1
<i>E. grillator</i>					•			1
<i>E. grandis</i>	•		•		•	•	•	5
<i>E. hispanicus</i>					•			1
<i>E. hungaricus</i>			•		•		•	3
<i>E. nudus</i>					•			1
<i>E. obliquus</i>				•	•			2
<i>E. ornatus</i>	•	•	•		•	•	•	6
<i>E. ovatus</i>			•		•		•	3
<i>E. pauper</i>					•			1
<i>E. petrarum</i>					•			1
<i>E. pulchellus</i>		•		•	•			3
<i>E. pusillus</i>					•			1
<i>E. ruficornis</i>		•	•		•	•	•	5
<i>E. sabulonum</i>	•	•	•		•	•	•	6
<i>E. sogdianus</i>		•	•		•		•	5
<i>E. strigatus</i>	•	•	•		•	•	•	6
<i>E. subornatus</i>					•			1
<i>E. sulcitibius</i>					•			1
<i>E. tarsalis</i>	•	•	•		•		•	5
<i>E. tricolor</i>	•	•	•		•		•	5
<i>E. truncatus</i>					•			1
Total	10	15	18	4	37	7	13	

only known record of *E. grandis* is also a single female collected in the Pyrenees in Girona (Grković et al., 2021). Thus, most of the Spanish provinces are insufficiently studied and further sampling is required to confirm the species records, to complete the species inventory and to get a better view of their distributions. On the other hand, all Ibero-Balearic *Eumerus* are principally Mediterranean and 13 of them are present only in that region (Table 2). Five species have the widest biogeographical ranges within Europe (Table 2): *Eumerus flavitarsis*, *E. funeralis*, *E. ornatus*, *E. sabulonum* and *E. strigatus*. However, as noted above, the knowledge of distribution of the species is far from complete, as new records have extended their biogeographical ranges. Knowledge of distributions is crucial for the conservation of species, especially for red-listed species. The conservation status of 67 European species of *Eumerus* has been evaluated based on IUCN criteria (Vujić et al., 2022), of which 12 are Ibero-Balearic and are categorized as threatened (two as Critically Endangered, seven as Endangered and three as Vulnerable) (see Table 1). Therefore, conservation is needed to prevent endangered species from disappearing from the Ibero-Balearic area.

Systematics of species and species groups

The analysis of the barcodes supports the systematic position of *E. subornatus* and *E. truncatus* as representatives of the *ornatus* and *strigatus* groups, respectively (Fig. 1). The phylogenetic relationships of *E. colladoi*, *E. etnensis*, *E. hungaricus* and *E. ruficornis*, however, still need to be resolved. Concerning *E. etnensis*, the resulting tree appears to reflect a close relationship with the *obliquus* group. This group includes species with stocky, punctuated and extensively white pollinose body; a hind margin of scutellum with a stripe of white pollinosity, a thickened hind femur and hind tarsomeres usually with some modification (Ricarte et al., 2020). The specimens of *E. etnensis* examined comply with the diagnosis of the species group except for the band of pollinosity on the posterior margin of the scutellum (which is absent in *E. etnensis*) and the absence of modifications of the hind tarsomeres. Based on these results, it is plausible that *E. etnensis* is a member of the *obliquus* group, which may consist of two subgroups. Nevertheless, the observed morphological differences and the low support (<50) obtained for this relationship reveal the need for further data to confirm that *E. etnensis* is a member of the *obliquus* group.

Identification tools

In this study an updated key to the Ibero-Balearic species of *Eumerus* is provided that can be used to identify species of economic importance or endemic species in future systematic and faunistic surveys. Furthermore, the first known COI-5' sequences of Ibero-Balearic specimens of ten *Eumerus* species were obtained for a wider geographical representation of the species' molecular data in the gene databases. DNA barcodes are a useful tool for species delimitation and testing morphological species concepts (e.g. Ståhls et al., 2009). As a result of this study, the first known molecular data for *E. subornatus* and *E. truncatus* was recorded, which provides reference sequences of these species that can be used in future comparative studies. Barcodes also allow identification when morphological data are not conclusive and can be a useful tool for identifying larvae (e.g. Andrić et al., 2014). Concerning *Eumerus*, this is particularly relevant for females as traditional characters usually overlap between taxa, especially within the same species group (e.g. Grković et al., 2019b). For instance, the COI-5' sequences clearly separated females of *E. argyropus* and *E. subornatus* (Fig. 1). In summary, the present work provides both morphological and molecular tools for species delimitation in *Eumerus* and will facilitate new research focused on the diversity, taxonomy and systematics of this genus in the Ibero-Balearic area.

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Online supplementary files:

- S1 (<http://www.eje.cz/2025/003/S01.xlsx>). Details of material examined.
- S2 (<http://www.eje.cz/2025/003/S02.pdf>). Distribution maps of *barbarus* and *tricolor* species groups.
- S3 (<http://www.eje.cz/2025/003/S03.xlsx>). List of DNA sequences.
- S4 (<http://www.eje.cz/2025/003/S04.pdf>). Acronyms of Spanish provinces.