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ARTICLE

Two species of the hoverfly genus *Eumerus* Meigen (Diptera: Syrphidae) new record for Pakistan

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Abstract. An updated checklist of the genus *Eumerus* Meigen, 1822 is presented from Pakistan along with two new country records, *i.e., Eumerus vestitus* Bezzi, 1912 and *Eumerus sogdianus* Stackelberg, 1952. *Eumerus sogdianus* is native to Central and Southern Europe, but recorded from east to Central and Southern Asia, and *Eumerus vestitus* is native to the Afrotropical region, but recently also recorded from India. Both species are collected from northern areas of Pakistan – the extreme edge of the western Himalayas, where a significant diversity of hoverflies has been reported in recent studies. A brief diagnosis, identification key, and a taxonomic remark on known Pakistani *Eumerus* species are presented. A distribution map and detailed photographs of the newly recorded species are also presented.

Keywords. Gilgit-Baltistan; Invasive species; Onion bulb fly; Oriental region; Distribution.

INTRODUCTION

Syrphidae (Diptera) is one of the most speciose families in Diptera, with approximately 6,200 described species worldwide (Miranda *et al.,* 2013). They are important pollinators, biocontrol agents, decomposers, and bioindicators (Sommaggio, 1999; Speight & Castella, 2001; Marín-Armijos *et al.,* 2017). The hoverfly fauna of Pakistan has been recently updated (Shehzad *et al.,* 2017). Although the taxonomic revision of adult hoverflies in Pakistan is still in the preliminary stage of development, there has been some work published with material from the Southern and Western parts of the country. Many regional revisions with new species or records for Pakistan have been published from the northern areas in the last five years (see detailed references in Hassan *et al.,* 2021). The knowledge of larval taxonomy, its associated host plants, natural enemies, and the list of pest species of economic crops in the country has not yet been thoroughly updated. However, the following potential aphidophagous hoverfly species, *Episyrphus balteatus* (De Geer, 1776), *E. viridaureus* (Wiedemann, 1824), *Ischiodon scutellaris* (Fabricius, 1805), and *Scaeva pyrastri* (Linnaeus, 1758) have been utilized successfully in Pakistan against soft sucking pests of commercial crops (Hamid, 1984; Irshad, 2001, 2014; Jamali *et al.,* 2018; Faheem *et al.,* 2019), whereas the biology of phytophagous hoverflies is rarely documented.

The phytophagous hoverfly genus *Eumerus* currently includes over 300 valid species (Evenhuis & Pape, 2019; Grković *et al.,* 2019; Mutin, 2019), from which four are already reported from Pakistan, *Eumerus aurifrons* (Wiedemann, 1824), *E. nepalensis* Brunetti, 1908, *E. pulverulentus* Brunetti, 1923, and *E. sexvittatus* Brunetti, 1915 (Shehzad *et al.,* 2017). The adults of these hoverflies usually prefer to fly at ground level in grasslands and at the borders of woods and bushes often near the larval food plants. The adults are usually quick fliers and, associated

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to their low flying habit, makes them difficult to spot (van Veen, 2010). The majority of *Eumerus* species prefer living in arid and semi-arid regions of the world (Grković *et al.,* 2019; Mutin, 2019). The larvae are particularly associated with commercialized plants, make mines in bulbs, and are considered a pest for commercial bulb plantations. They feed on various decaying parts of plants, including roots, fruits, bulbs, and stems of different plant families, such as Liliaceae, Amerillaceae, and Orobanchaceae, which sometimes can cause serious damage to ornamental and crop plants (van Veen, 2010; Gilasian *et al.,* 2020).

Since 2017, when an updated catalogue of Pakistani Syrphidae was published by Shehzad *et al.* (2017), many new country records have been published in the last five years (Hassan *et al.,* 2021). The present study provides new information and updates the existing knowledge of *Eumerus* species from Pakistan.

MATERIAL AND METHODS

The adult specimens of *Eumerus sogdianus* were collected from onion (*Allium cepa* Linnaeus) and coriander (*Coriandrum sativum* Linnaeus) from Kresmathang, Skardu (Gilgit-Baltistan) and *Eumerus vestitus* were found hovering around the trunk of the Kachnar tree (*Bauhinia variegata* Linnaeus) at Pir Mehr Ali Shah Arid Agricultural University (PMAS-AAUR) Rawalpindi, and Kachnar Park, Islamabad, Pakistan. The adult specimens were collected by aerial sweeping on sunny days and are deposited in the National Insect Museum (NIM), National Agriculture Research Center (NARC), Islamabad, Pakistan. For studying the genitalia, the abdomen of male individuals was removed and macerated in saturated KOH solution at 120°C for 5-7 minutes, and then washed with acetic acid and water before dissecting the genitalia. The genitalia were transferred to glycerin for further dissection and examination. The specimens were identified using the following literature: van Veen (2010), Anooj *et al.* (2020), and Speight *et al.* (2021). Images for the dorsal habitus were taken using Nikon D850 digital camera with a Nikon MICRO NIKKOR 105 mm lens, while the male sternum IV and the genitalia photographs were taken with a D850 digital camera using a Nikon SMZ18 microscope. Terminology of adult morphology follows Cumming & Wood (2017). The distribution map was prepared by using the present collection and previously reported data from neighboring countries (Burgio & Sommaggio, 2002; Khaghaninia *et al.,* 2010; van Eck, 2011; Ghorpadé, 2015; Grković *et al.,* 2015; Samin *et al.,* 2016; El-Hawagry *et al.,* 2017; Smith *et al.,* 2017; Mutin & Barkalov, 2018; Anooj *et al.,* 2020; Dawah *et al.,* 2020; Speight *et al.,* 2021; Torretta *et al.,* 2021; Heimburg *et al.,* 2022).

Taxonomy

Genus *Eumerus* Meigen, 1822

Eumerus Meigen, 1822 Meigen, 1822: 202.

Type species: *Syrphus tricolor* Fabricius, 1798: 562 (Curtis design., 1839: 749).

Diagnosis: Medium sized species with dark colored body, covered with short silver hairs in some species. Head with eyes densely haired or bare, face without tubercle, male eyes holoptic or narrowly dichoptic. Hind femur swollen, with rows of strong and sharp spines posteroventrally. Wings with crossvein r-m at or beyond middle of cell dm, cell r_1 open, vein M_1 strongly angulate medially. Abdomen black with silvery or brownish yellow spots on tergites II-IV or with red abdominal tergites.

Key to species of *Eumerus* from Pakistan

1. Eyes densely covered with short hairs; antennae orange 2
— Eyes bare or sparsely covered with microscopic hairs on lower half; antennae dark brown 3
2. Body length 5.0-6.5 mm; male hind distitarsus white and dorsoventrally flattened (Garcete-Barrett *et al.,* 2020, figs. 2G), whereas distitarsus pale yellow with only the basitarsus flattened in females ..... ***Eumerus aurifrons* (Wiedemann)**
— Body length 5.0-8.0 mm; males unknown; hind distitarsus pale yellow and normal, not swollen ..... ***Eumerus nepalensis* Brunetti**
3. Antennae elongated, pedicel ⅔ the length of the postpedicel (Brunetti, 1923, plate VI, fig. 6) ..... ***Eumerus pulverulentus* Brunetti**
— Antennae short, pedicel ⅓ the length of the postpedicel 4
4. Scutellum with posterior margin pale yellow (Fig. 4A); male with hind basitarsus swollen on apical ¾ (Fig. 6F) ..... ***Eumerus vestitus* Bezzi**
— Scutellum wholly black; males hind tarsus normal, without modification as above 5
5. Body length 8.0 mm; males unknown; thorax dull black, covered with short yellowish-brown hairs, scutum without median longitudinal vittae ..... ***Eumerus sexvittatus* Brunetti**
— Body length 5.5-7.0 mm; thorax shiny black, covered with short white hairs, scutum with two longitudinal narrow vittae of white microtrichia (Fig. 1A) ..... ***Eumerus sogdianus* Stackelberg**

Eumerus aurifrons (Wiedemann, 1824)

Pipiza aurifrons Wiedemann, 1824: 52.

Type locality: 'W. Indies' (Lectotype ZMUC00024836: http://daim.snm.ku.dk/digitized-type-collection-details?catno=zmuc00024836).

Material examined: Pakistan. Punjab: Islamabad Capital Territory, Kachnar Park, 4♂, 14.x.2017; Trail 5, 1♂, 1♀, 14.x.2017; 1♀, 12.iv.2018, leg. M.A. Hassan (NIM).

Remarks: *Eumerus aurifrons* is remarkably similar to *E. nepalensis,* both possessing orange antennae, and densely haired eyes (see detailed diagnosis and comparative note under *E. nepalensis*). At present, these two species can only be differentiated based on the presence of hind basitarsus flattened in females of *Eumerus aurifrons,* whereas hind basitarsus is normal, not flattened in females of *E. nepalensis.*

Distribution: Pakistan (Khyber Pakhtunkhwa: Peshawar; Punjab: Murree), – Australia, China (Taiwan), Ghana, America (Hawaii), India (Bihar, Chandigarh, Jammu Kashmir, Karnataka, Maharashtra, Punjab, Tamil Nadu, West Bengal), Indonesia, Madagascar, Nigeria, Paraguay, Philippines, Sri Lanka, Tanzania (Bigot, 1892; Paramonov, 1957; Smith & Vockeroth, 1980; Ôhara & Kusigemati, 1985; Ghorpadé & Shehzad, 2013; Ghorpadé, 2015, 2019; Mitra *et al.,* 2015; Thompson & Vockeroth, 2016; Shehzad *et al.,* 2017; Garcete-Barrett *et al.,* 2020; Steenis *et al.,* 2021).

***Eumerus nepalensis* Brunetti, 1908**

Eumerus nepalensis Brunetti, 1908: 76.

Type locality: Nepal (Chonebal).

Remarks: *Eumerus nepalensis* was originally described based on a single female from Nepal. The type specimen is deposited in the collection of the Zoological Survey of India, Calcutta (Ghorpadé, 2015). This species is only known in Nepal, India, Afghanistan and Pakistan. Unfortunately, the male is still unknown. Morphologically, this species is very similar to *Eumerus aurifrons* but can be distinguished by the relatively larger body size (5.0-8.0 mm) and the female with hind basitarsus is normal, not flattened. The images of the type specimen were not available for the present study for morphological comparison with *E. aurifrons.* We hope to confirm the validity of this species in future studies either based on type images or to find new material from the type locality. However, recently, Garcete-Barrett *et al.* (2020) provided detailed photographs and diagnostic characters of both males and females of *Eumerus aurifrons,* in which the di-

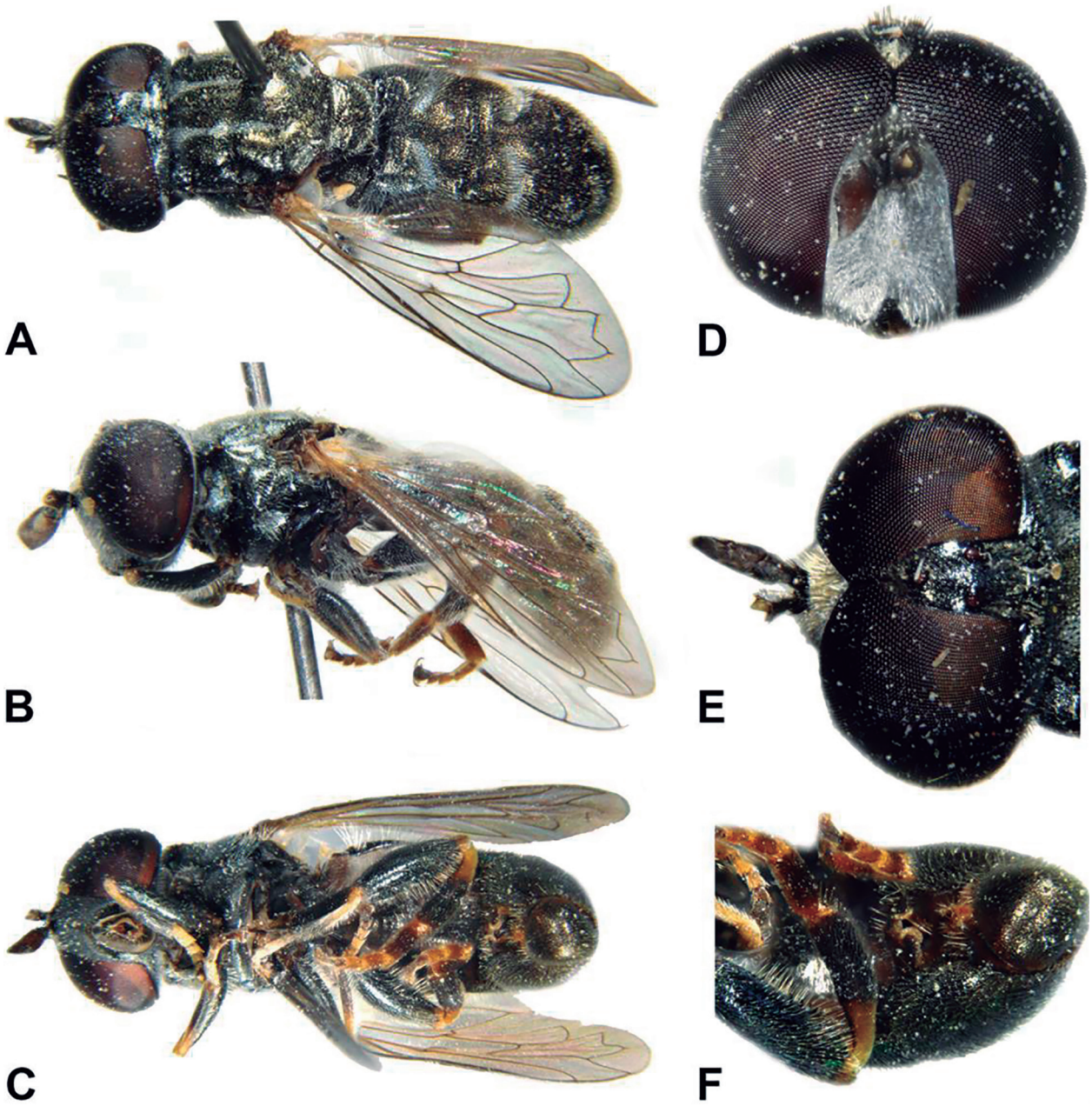

Figure 1. *Eumerus sogdianus* Stackelberg, male: (A) Dorsal habitus, (B) Lateral habitus, (C) Ventral habitus, (D) Head, frontal view, (E) Head, dorsal view, (F) Close view of male genital segments, ventral view.

agnosis of females is quite similar to the original description of *Eumerus nepalensis,* where eyes have whitish hairs and its scutellum has a distinct rim which is narrowly serrated in ventral view.

Distribution: Pakistan (Punjab: Murree), – India (Himachal Pradesh, Jammu Kashmir), Afghanistan, Nepal (Brunetti, 1908, 1915, 1923; Mitra *et al.,* 2015; Shehzad *et al.,* 2017; Ghorpadé, 2014, 2015, 2019).

***Eumerus pulverulentus* Brunetti, 1923**

Eumerus pulverulentus Brunetti, 1923: 258.

Type locality: India (Bihar District: Pusa).

Remarks: Brunetti described this species based on both males and females from India. The type specimens are deposited in the Natural History Museum, London. He remarked that this species is quite distinct among its congeners due to the scutellum with a yellow margin, elongated antennae, and the markings on abdominal tergite IV. During our present study, we found that *E. vestitus* is similar to *Eumerus pulverulentus* in the yellow margined scutellum, but *E. vestitus* can be easily distinguished by the shape of sternite IV of the male, the distinct row of short spines on apical ⅓ of hind femora, and the enlarged hind basitarsus.

Distribution: Pakistan (Khyber Pakhtunkhwa: Peshawar), – India (Bihar, Jammu Kashmir, Rajasthan) (Mitra *et al.,* 2015; Shehzad *et al.,* 2017).

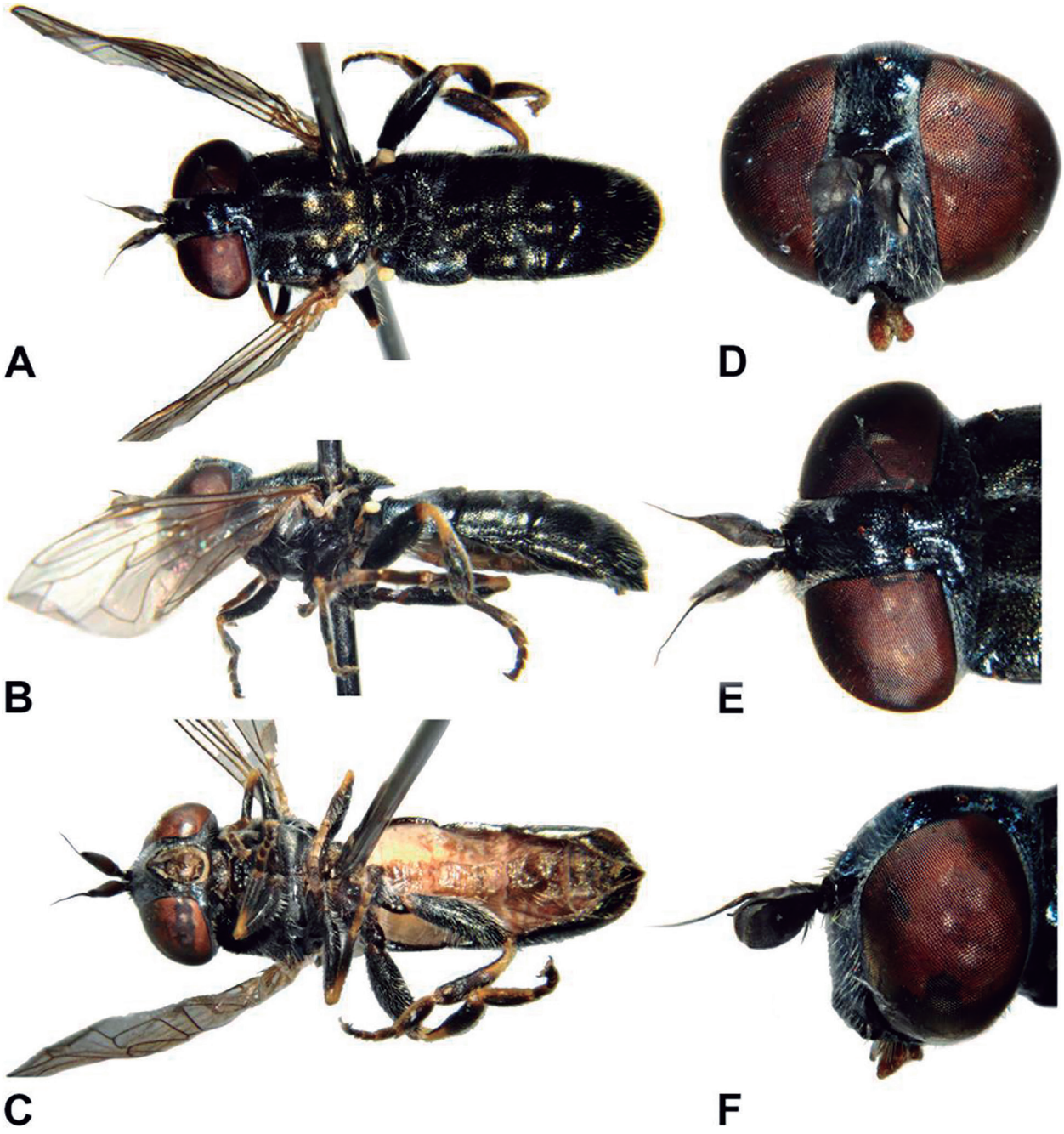

Figure 2. *Eumerus sogdianus* Stackelberg, female. (A) Dorsal habitus, (B) Lateral habitus, (C) Ventral habitus, (D) Head, frontal view, (E) Head, dorsal view, (F) Head, lateral view.

Eumerus sexvittatus Brunetti, 1915

Eumerus sexvittatus Brunetti, 1915: 245.

Type locality: India (Kumaon District: Bhowali, Western Himalayas).

Remarks: *Eumerus sexvittatus* was described by Brunetti from a single female specimen from India. The type specimen is deposited in the collection of the Zoological Survey of India, Calcutta. The major diagnostic characters used in the original description are based largely on body coloration, the presence or absence of hairs on the eyes, and body size. However, the male sternite IV and genitalia are probably necessary for comparison with known congeners in India and Pakistan. The male is still unknown.

Distribution: Pakistan (Punjab: Khanewal), – India (Uttarakhand) (Brunetti, 1915; Ghorpadé, 2015, 2019; Shehzad *et al.,* 2017).

Eumerus sogdianus Stackelberg, 1952 (Figs. 1-3, 7)

Eumerus sogdianus Stackelberg, 1952: 390.

Type locality: Tajikistan (Dushanbe).

Eumerus arat Violovitsh, 1981: 93.

Type locality: Russia (Tuva). After Mutin & Barkalov 2018: 17.

Diagnosis: *Eumerus sogdianus* can be distinguished by the shape of male genitalia (Figs. 3D-F) and the lobular projection of sternite IV in males (Fig. 3C).

Material examined: Pakistan. Gilgit-Baltistan: Skardu, Kresmathang Olding, 4♂, 24.vii.2015; 1♂, 2♀, 22.x.2016; 1♂, 14.x.2017, leg. M.A. Hassan (NIM).

Distribution: Pakistan (Gilgit-Baltistan: Skardu), **new country record,** – Australia, Austria, China, Germany, Iran (Gilan Province), Italy, Kazakhstan, Mongolia, New Zealand, North America, Portugal, Russia, Switzerland, Tajikistan (Dushanbe), Transcaucasus (Georgia, Armenia and Azerbaijan), Uzbekistan, (Bagachanova, 1990; Burgio & Sommaggio, 2002; Samin *et al.,* 2016; Barkalov & Mutin, 2019; Mutin & Barkalov, 2018; Khaghaninia *et al.,* 2010; van Veen, 2010; van Eck, 2011; Speight *et al.,* 2021; Torretta *et al.,* 2021; Heimburg *et al.,* 2022).

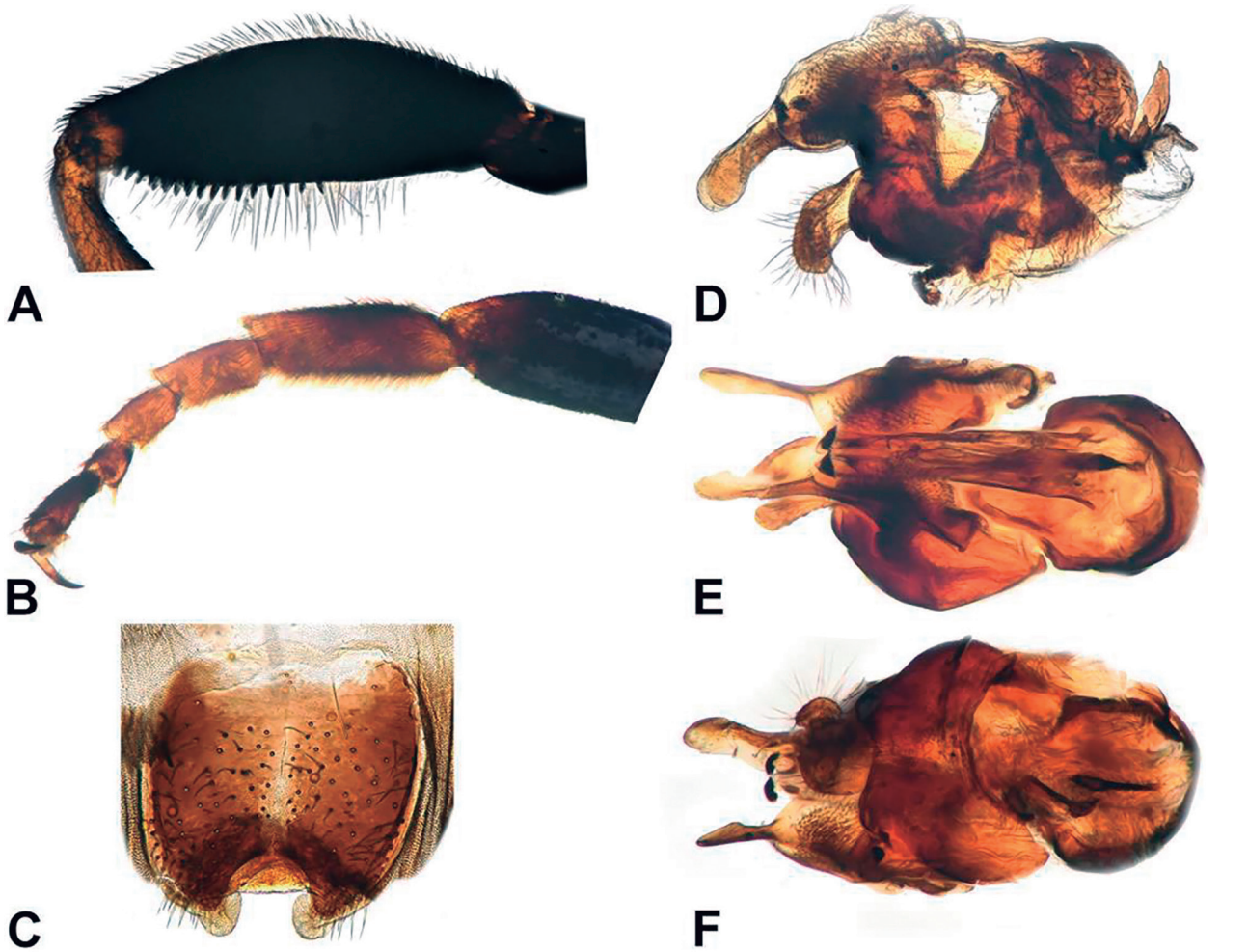

Figure 3. *Eumerus sogdianus* Stackelberg, male. (A) Hind femora, posterior view, (B) Hind tarsus, posterior view, (C) Sternite IV, ventral view, (D) Male genitalia, lateral view, (E) Male genitalia, ventral view, (F) Male genitalia, dorsal view.

Eumerus vestitus Bezzi, 1912 (Figs. 4-6, 7)

Eumerus vestitus Bezzi, 1912: 443.

Type locality: Guinea-Bissau (West Africa).

Diagnosis: *Eumerus vestitus* can be easily characterized by the following characters: eyes holoptic in males (Fig. 4D), dichoptic in females (Fig. 5D), sparsely covered with short yellowish hairs; vertex with yellowish hairs, ocellar triangle dark brown (Fig. 5E); face densely covered with white hairs; scutellum dark brown, hind margin with distinctly long yellowish hairs (Fig. 5A); male with swollen hind basitarsus bearing long bristle-like black hairs dorsolaterally (Fig. 6F); abdominal tergites II-IV with an oblique greyish stripe; sternite IV in male with U-shaped depression medially, with ventrally thick spatulated microtrichia (Figs. 6A-B).

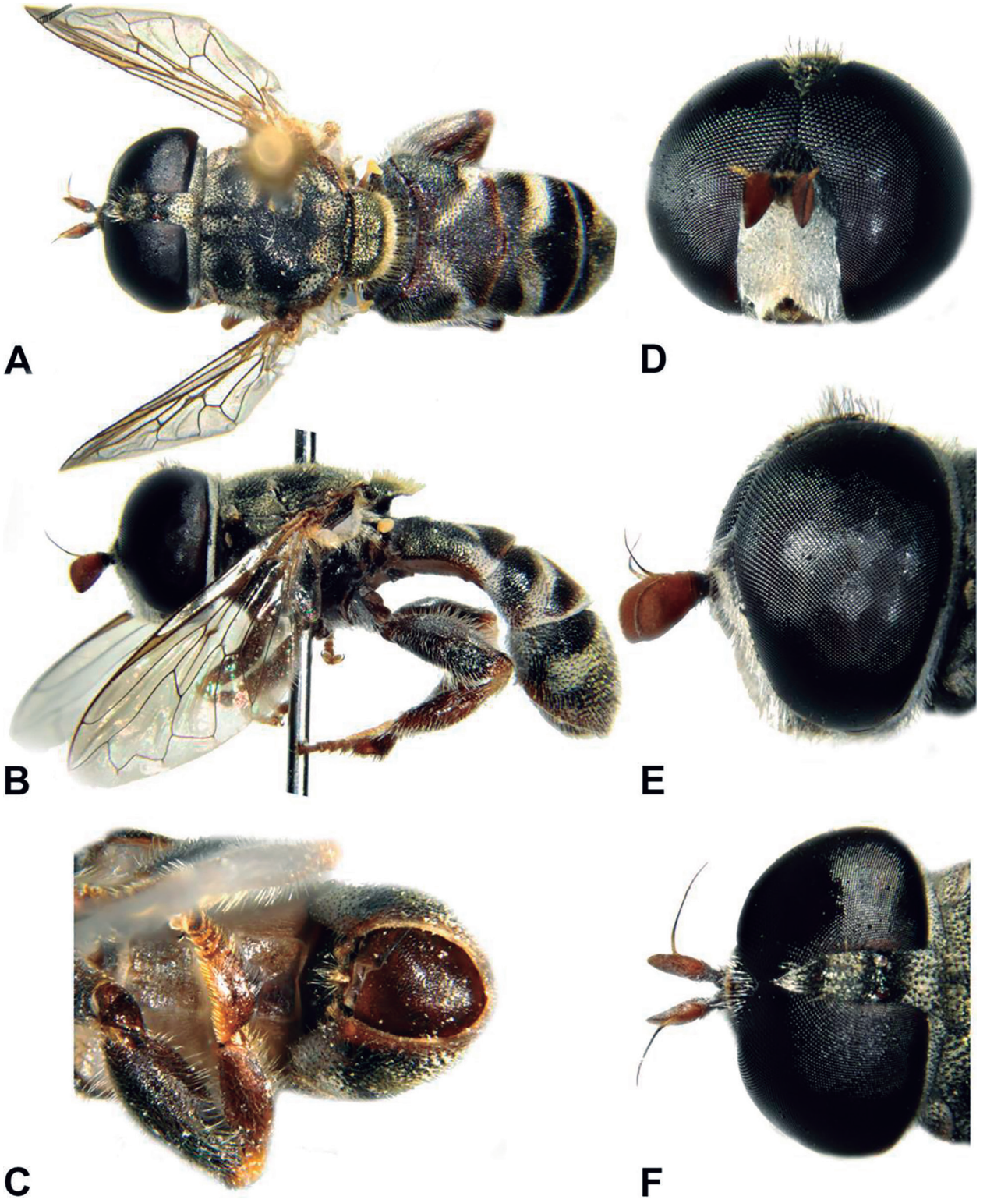

Figure 4. *Eumerus vestitus* Bezzi, male. (A) Dorsal habitus, (B) Lateral habitus, (C) Ventral habitus, (D) Head, frontal view, (E) Head, lateral view, (F) Head, dorsal view.

Material examined: Pakistan. Punjab province, Arid Agriculture University, Rawalpindi, 1♂, 2♀, 22.x.2016; 1♂, 15.vii.2017; 1♂, 14.x.2017, leg. M.A. Hassan (NIM).

Distribution: Pakistan (Punjab: Rawalpindi), **new country record,** – Arabian Peninsula, Egypt (Ezbet El Nakhl), Greece (Santorini Island), Guinea-Bissau, India (New Delhi), Saudi Arabia, Syria, UAE, Yemen (Bezzi, 1912; Efflatoun, 1922; Curran, 1938; Grković *et al.,* 2015; Smith *et al.,* 2017; El-Hawagry *et al.,* 2017; Dawah *et al.,* 2020; Anooj *et al.,* 2020).

DISCUSSION

The taxonomic status and host plants of all known *Eumerus* species in Pakistan are updated. The larvae of *Eumerus* are associated with a wide range of host plants

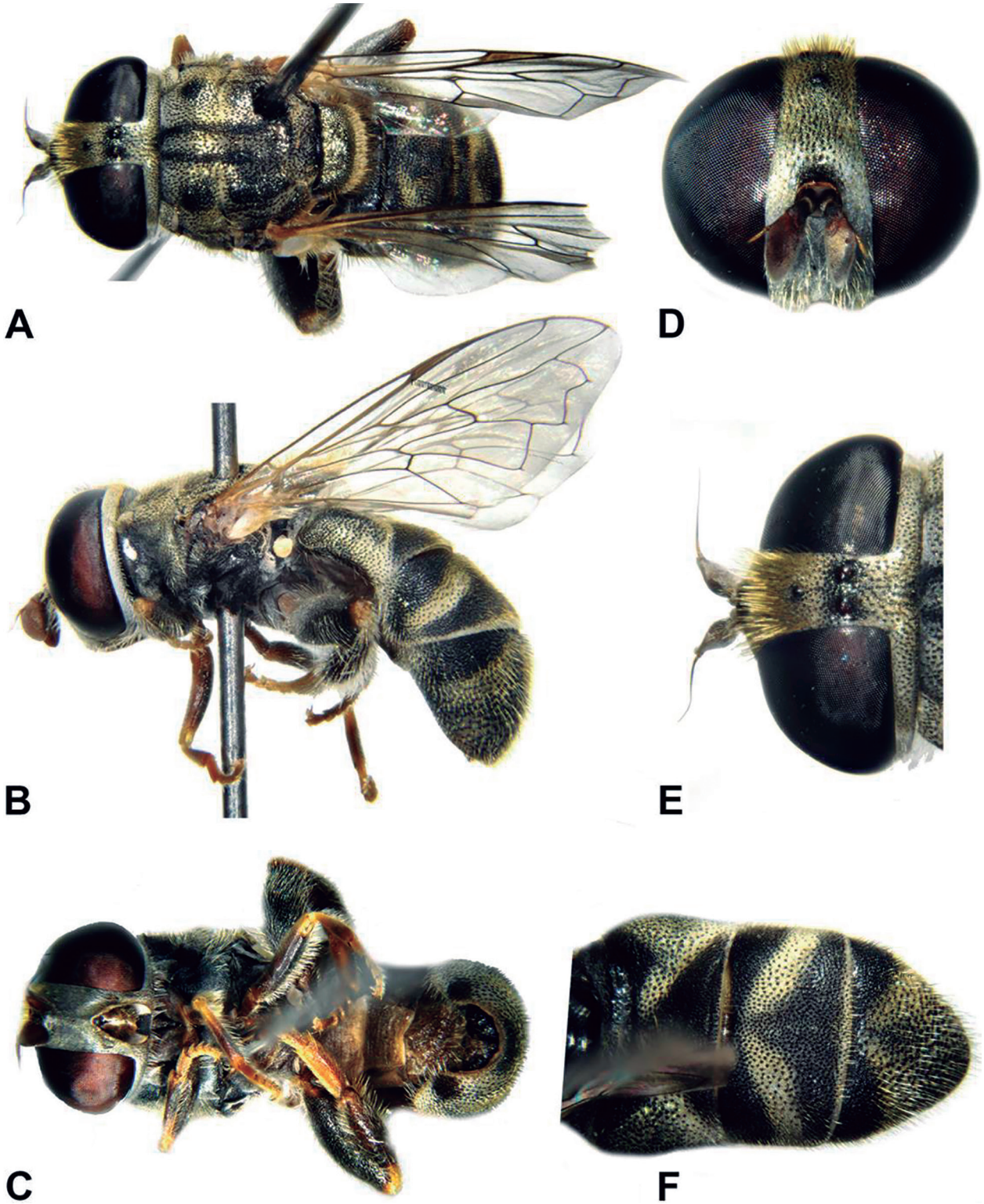

Figure 5. *Eumerus vestitus* Bezzi, female. (A) Dorsal habitus, (B) Lateral habitus, (C) Ventral habitus, (D) Head, frontal view, (E) Head, dorsal view, (F) Abdomen, dorsal view.

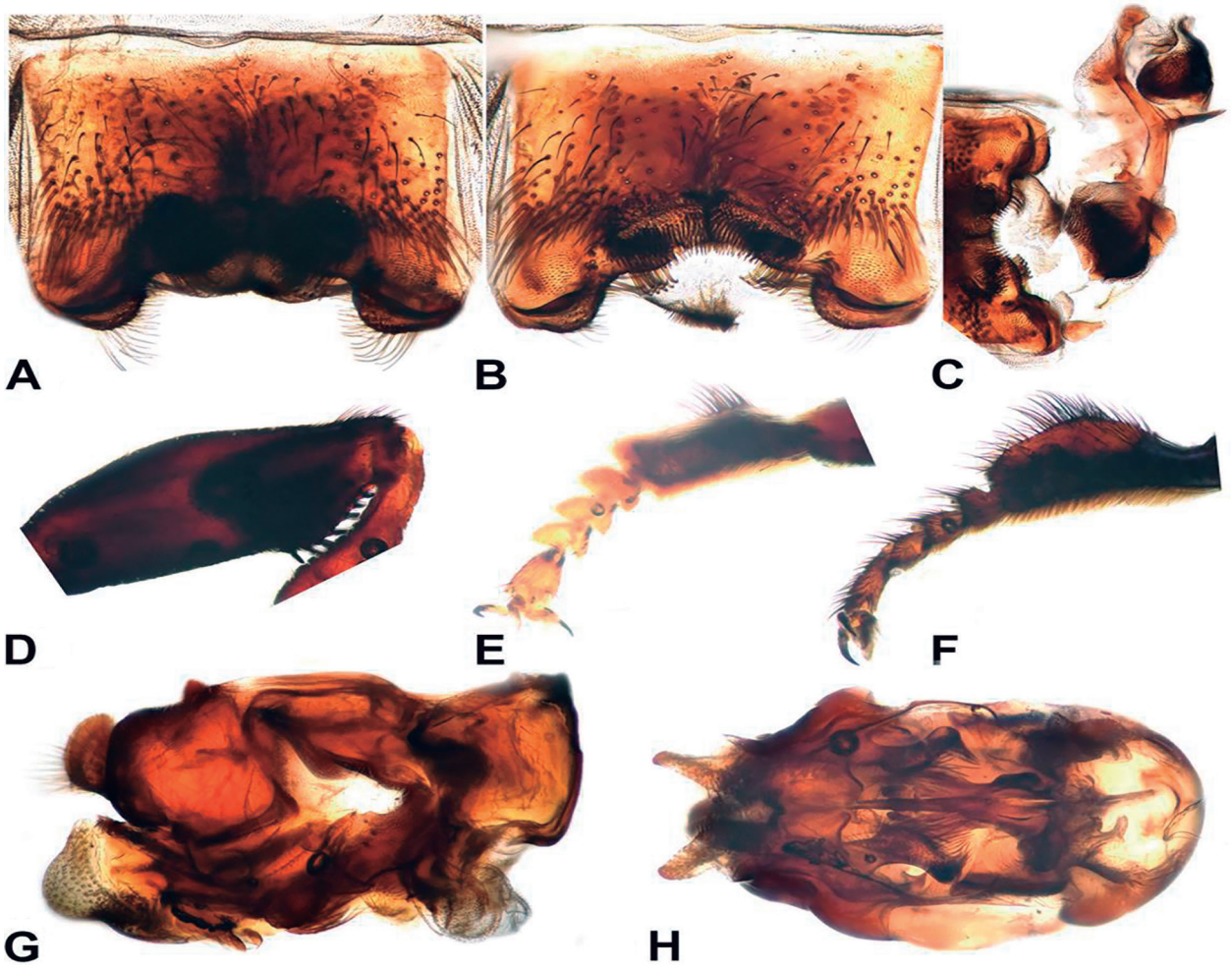

Figure 6. *Eumerus vestitus* Bezzi, male. (A) Sternite IV, dorsal view, (B) Sternite IV, ventral view, (C) Sternite IV, close view ventral thick spatulated microtrichia, (D) Hind femora, posterior view, (E) Hind tarsus, lateral view, (F) Hind tarsus, posterior view, (G) Male genitalia, lateral view, (H) Male genitalia, ventral view.

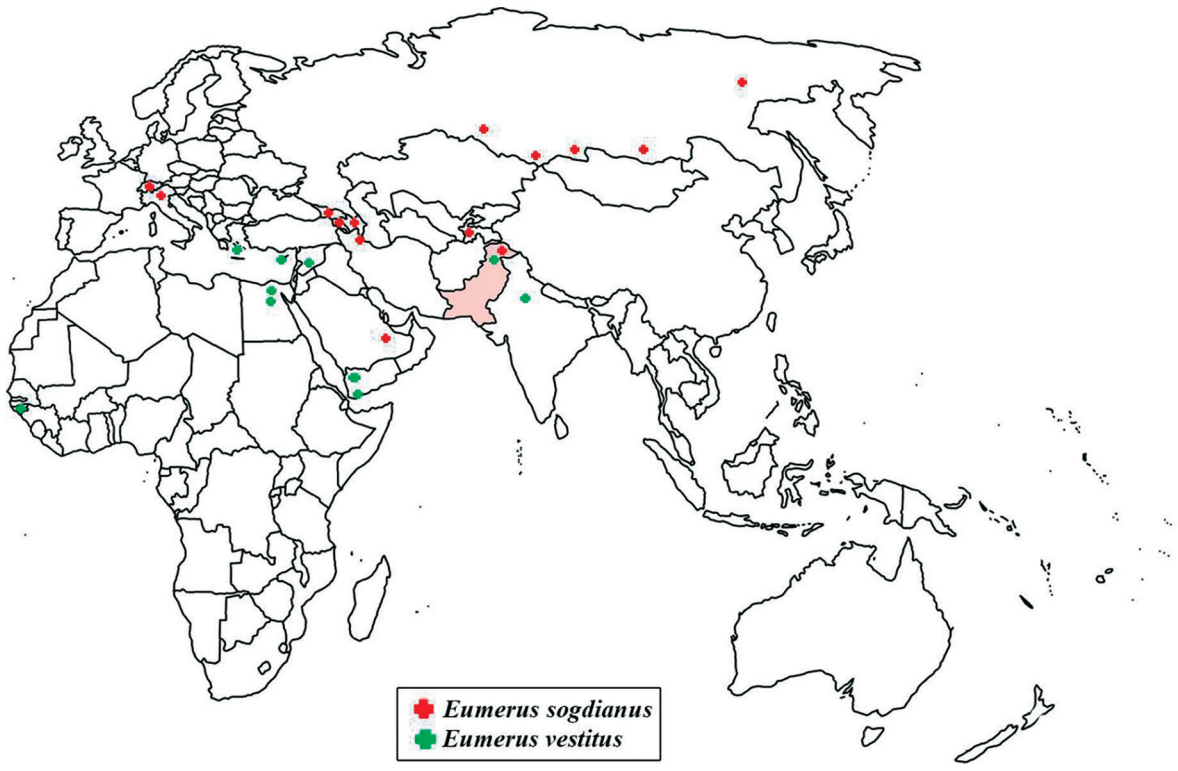

Figure 7. Map showing the geographic distribution of *Eumerus sogdianus* Stackelberg and *Eumerus vestitus* Bezzi in Pakistan and its neighboring countries.

and are saprophagous and phytophagous in nature (Souba-Dols *et al.,* 2020). No information is available on the larval identification and description of these species in Pakistan. The newly recorded taxa are particularly associated with the lower parts of Kachnar trees, onion, and coriander flowers in the Palaearctic parts of the country, particularly from the northern and northeastern regions. However, the previously recorded species are associated with forest trees, agricultural crops, and ornamental plants, which are briefly summarized herein. Alam *et al.* (1969) found the larvae of *Eumerus aurifrons* under the bark of *Albizia lebbeck* (Fabaceae) at Peshawar. Beeson (1953) reported that the larvae of *Eumerus aurifrons* lived in fermenting sap of *Albizia lebbeck* (Fabaceae) and other forest trees. *Eumerus sogdianus* has reportedly been reared from species of Amaryllidaceae, Apiaceae, and Solanaceae (Speight *et al.,* 2021). Brunetti (1923) described *Eumerus pulverulentus* from India, from the stem of *Euphorbia* sp. *Eumerus sogdianus* is presently collected from the onion and coriander fields of Gilgit-Baltistan and *Eumerus vestitus* is found hovering around the base of the Kachnar tree in Rawalpindi and Islamabad, Punjab, Pakistan.

AUTHORS' CONTRIBUTIONS: MAH: Conceptualization; **AS:** Supervision; **MAH: AS: UD: ZM:** Writing – review & editing; **MQ: NF:** Writing – original draft; **MAH: ZM:** Methodology. All authors actively participated in the discussion of the results; they reviewed and approved the final version of the paper.

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