

Geranium biuncinatum (Geraniaceae): new record for the flora of Iran

Somayeh Esfandani-Bozchaloyi^{1*} and Farideh Attar²

Received: 15 June 2018 / Accepted: 18 September 2018 / Published online: 20 February 2019

Abstract. *Geranium biuncinatum* Kokwaro was collected during a fieldwork around (Khuzestan province, Shoshtar to Masjed Soleyman) in South West of Iran. It is added as a new record for the flora of Iran. Micromorphological features of mericarps and seeds are investigated by Scanning Electron Microscopy. Differences between *Geranium biuncinatum* and its relatives are discussed. Its diagnostic characters, geographical distribution map and detailed pictures are given.

Keywords: *Geranium*; Geraniaceae; Iran; New record; Flora.

Geranium biuncinatum (Geraniaceae): un nuevo registro para la flora de Irán

Resumen. *Geranium biuncinatum* Kokwaro fue recolectado durante la salida al campo en la provincia Juzestán (entre Shushtar y Masjed Soleyman) en el suroeste de Irán. Se incorpora como un nuevo registro para la flora de Irán. Se han estudiado con el microscopio electrónico de barrido los caracteres micromorfológicos del mericarpo y de las semillas. Se destacan las diferencias entre *G. biuncinatum* y las especies relacionadas. Se presentan las imágenes de los caracteres diagnósticos y los mapas de su distribución geográfica

Palabras clave: *Geranium*; Geraniaceae; Irán; Nuevo registro; Flora.

Introduction

The genus *Geranium* L. is a member of Geraniaceae family with about 325 species which are distributed through most parts of the world except lowland tropical regions (Aedo, 2017). Different number of species from 23 to 25 is recorded for the flora of Iran (Schönbeck-Temesy, 1970; Janighorban, 2005; Esfandani-Bozchaloyi *et al.*, 2017 a, b, c, d). Yeo (1984) classified the genus *Geranium* into three subgenera: subg. *Geranium*, subg. *Erodioidea* (Picard) Yeo and subg. *Robertium* (Picard) Rouy. The subgenus *Robertium* is recognized by the carpel projection method for fruit discharge. It has been divided into eight sections. One of these sections is *Geranium* sect. *Trilophia* Yeo, which consists of seven species: *Geranium biuncinatum* Kokwaro, *G. favosum* Hochst., *G. mascatense* Boiss., *G. ocellatum* Cambess., *G. trilophum* Boiss., *G. yemense* Deflers. and *G. brevipes* Hutch. & Dalziel. Two species of this section were previously recorded for Iran: *G. mascatense* and *G. trilophum* (Schönbeck-Temesy, 1970). Laundon (1961) and Kokwaro (1971) had completely studied the *Geranium* sect. *Trilophia* in the Northeast tropical Africa. Aedo *et al.* (2016) also studied this section in their recent revision and monograph. In the present paper we are adding *G. biuncinatum* for the Flora of Iran. With this new record the total number of *Geranium* species known from Iran rises to 23. This study provides the macro

and micro-morphological characters used for the species delimitation in *Geranium* sect. *Trilophia* from Iran.

Material and Methods

During field investigation in Khuzestan province, south west Iran, an interesting *Geranium* specimen was collected in May 1992 (Figure 1). This specimen was identified as *Geranium biuncinatum*. Different references were used for the correct identification of the species (Davis, 1967; Schönbeck-Temesy, 1970; Zohary, 1972; Janighorban, 2005; Aedo *et al.*, 2016). The positive identification of the specimen was done in the herbarium of Tehran University Herbarium (TUH) (Figure 2) by a digital stereomicroscope Dino-Lite Pro (AM413T Model). For detailed micromorphological study the scanning electron microscope (SEM, JSM-6380A, JEOL) was used. Dry seeds and pollen grains were directly mounted on metallic stub using double adhesive tape and coated with gold for a period of 6 minutes in sputtering chamber (BAL-TEC, SCDOOS) and observed under SEM. The terminology used is in accordance with previously published studies of Punt *et al.* (1994) and Hesse *et al.* (2009). Differences between this newly recorded species and its relatives are discussed. In addition, locality and the distribution map are given.

¹ Department of Plant Sciences, Faculty of Biological Sciences, Shahid Beheshti University, Tehran, Iran. E-mail: somayehesfand@yahoo.com, Corresponding author

² Central Herbarium of Tehran University, School of Biology, College of Science, Tehran University, Tehran, Iran. E-mail: farattar@yahoo.com, fatar@khhayam.ut.ac.ir

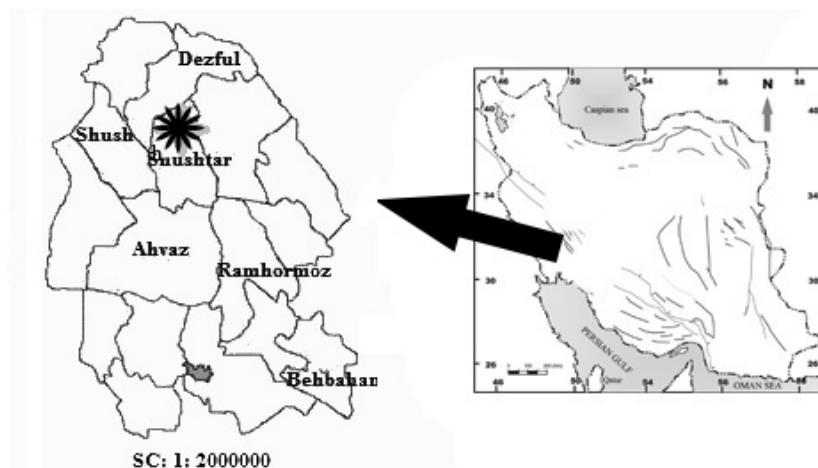


Figure 1. Distribution of *Geranium biuncinatum* in Iran.

Results

Geranium biuncinatum Kokwaro, Webbia 25(2): 639. 1971. TYPE: Somalia, Northern Region, Sugli Al Hills, 10°58'N, 48°53'E, 15 Nov 1929, C.L. Collenette 289 (K). Iran: Khuzestan, Shoshtar to Masjed Soleyman, 30 km to Masjed Soleyman, 21 Apr 1992, Dadjou, Attar, Mehdi & Moja (THU 12923) (Figure 2).

All the species of *Geranium* section *Trilopha* are annual herbs, erect or ascending, pubescent with short and long hairs in form of glandular and eglandular hairs (Figure 3G-I). Leaves are usually opposite. Most species have palmatifid leaves (with the divisions reaching about the middle), polygonal in outline and with five segments (Figure 3E). The five sepals form a quincuncial calyx. The two inner sepals are usually smaller and less pubescent than the others. The external surface of each sepal is smooth (Figure 3F). The petals are erect-patent, with entire apex and gradually tapering towards the base, that was, without a distinct claw. Petal color is usually purple with a dark basal spot (Figure 3D). The petals of all species are glabrous on both surfaces and ciliate on the basal margin with short eglandular hairs.

To provide better distinction between *Geranium biuncinatum*, *G. trilophum* and *G. mascatense* seed and fruit micromorphology were considered. Mericarps of *G. biuncinatum* have toothed wings continuing in a pair of recurved horns which is a typical feature in the genus (Figure 3A, J-L). Whereas mericarps of *G. trilophum* have two longitudinal toothed wings bent dorsally to form a trough-like structure with an evident ridge in the middle, protruding from the trough-like structure (Figure 3B, O-P). The main difference between *G. trilophum* and *G. biuncinatum* is the presence of horns on mericarps of *G. biuncinatum* (Figure 3A). Sepals continued the growth and cover the mericarp in the latter (Figure 3F). *Geranium mascatense* is recognized by its distinctive mericarps with strongly prominent ribs and consequently, deep furrows (Figure 3C, M-N). By studying seed and fruit ornamentations it was found that these features are of diagnostic importance in section *Trilopha*.

The pollen grains are sub-prolate with striate-rugulose tectum (Figure 4C, F, I). Pollen characters are as follows: polar length (P = 64-65 μm), equatorial diameter (E =

54-60 μm), colpi (50-56 μm), mesocolpium (43-47 μm), apocolpium (21-23 μm), exine (5.3-5.8 μm). The pollen grains are of the "Erodium-type" (Aedo *et al.*, 2016).

Distribution. *Geranium biuncinatum* is found in Eritrea, Oman, Saudi Arabia, Somalia, Sudan and Yemen (Aedo *et al.*, 2016), where it occurs on mountain slopes, from 200 to 2,300 m asl. The present location (Figure 1) is about 1,200 km far from the nearest location, according to Aedo *et al.* (2016).

Habitat. *Geranium biuncinatum* occurs on dry and stony soils at 150 m asl. It grows together with *G. trilophum*. Flowering time: May.

Discussion

Previous studies showed that morphometric studies are capable of species separation in the genus *Geranium* of Iran. (Esfandani-Bozchaloyi & Sheidai 2018; Esfandani-Bozchaloyi & Zaman 2018; Esfandani-Bozchaloyi *et al.* 2018a, b, c, d). Aedo *et al.* (2016) mentioned that there are two common features in all species of sect. *Trilopha*: a) "Erodium-type" pollen grains with striate exine ornamentation and b) fruit with twisted rostrum. Our findings are in concordance with these observations. The highest diversity of the group is located in Iran, the Arabian Peninsula and adjacent regions of northeast Africa (Aedo *et al.*, 2016). According to the latter authors there are some similarities between three species of this section. The identification key for species separation in *Geranium* sect. *Trilopha* provided by Aedo *et al.* (2016) distinguishes different species based on mericarp shape and petal color. Our observations are in concordance with Aedo *et al.* (2016).

Geranium trilophum is found in the Northern parts of the Persian Gulf; it was previously reported from Saudi Arabia by Alfarhan & Thomas (2001). The presence of *G. biuncinatum* besides two other species of Northern Africa is very interesting due to the penetration of tropical elements to Southern parts of Iran.

Acknowledgements

The authors wish to thank Saeed Javadi Anaghizi in Central laboratory of the Shahid Beheshti University for providing the facilities of scanning electron microscopy.

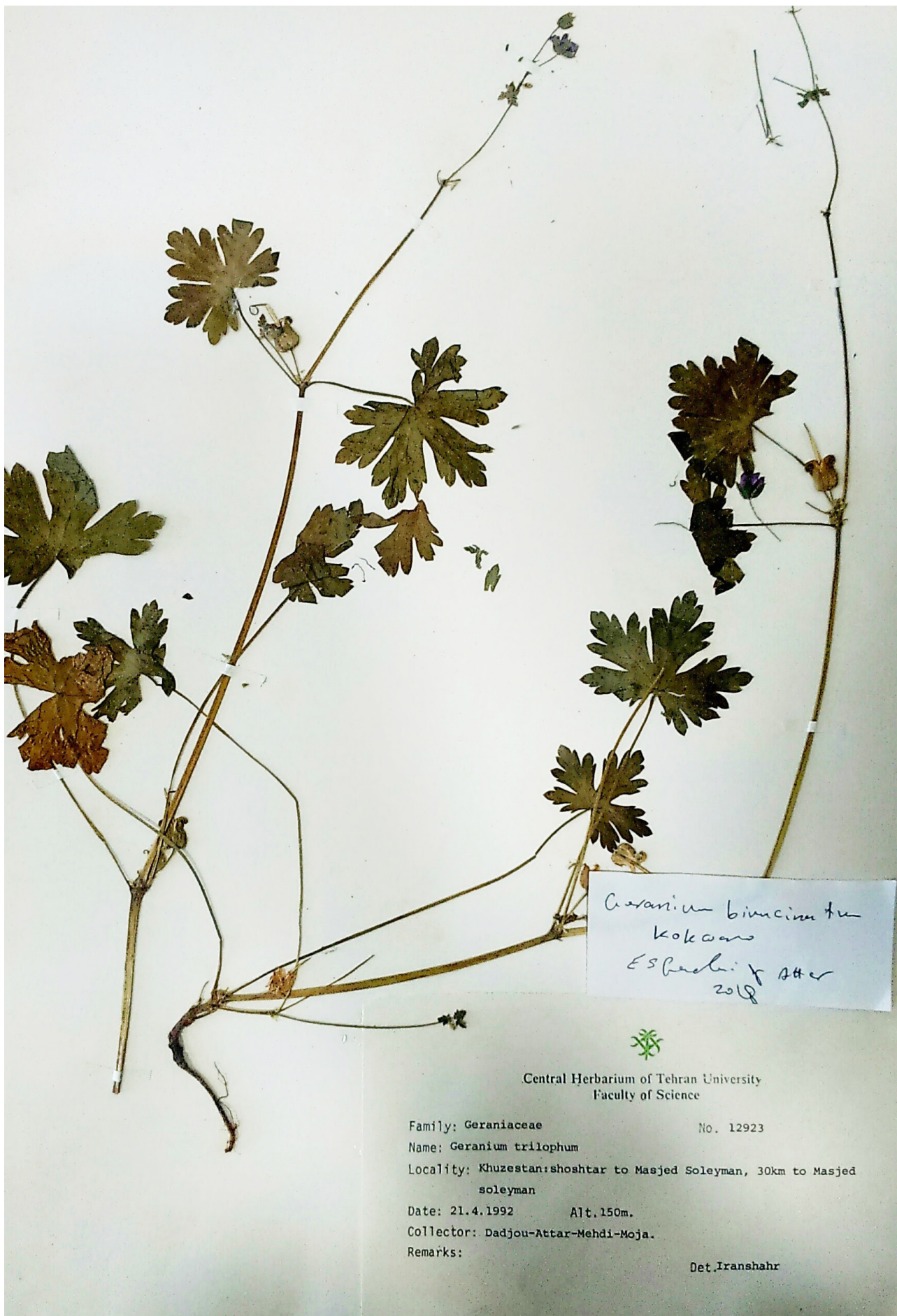


Figure 2. *Geranium biuncinatum* (TUH 12923).

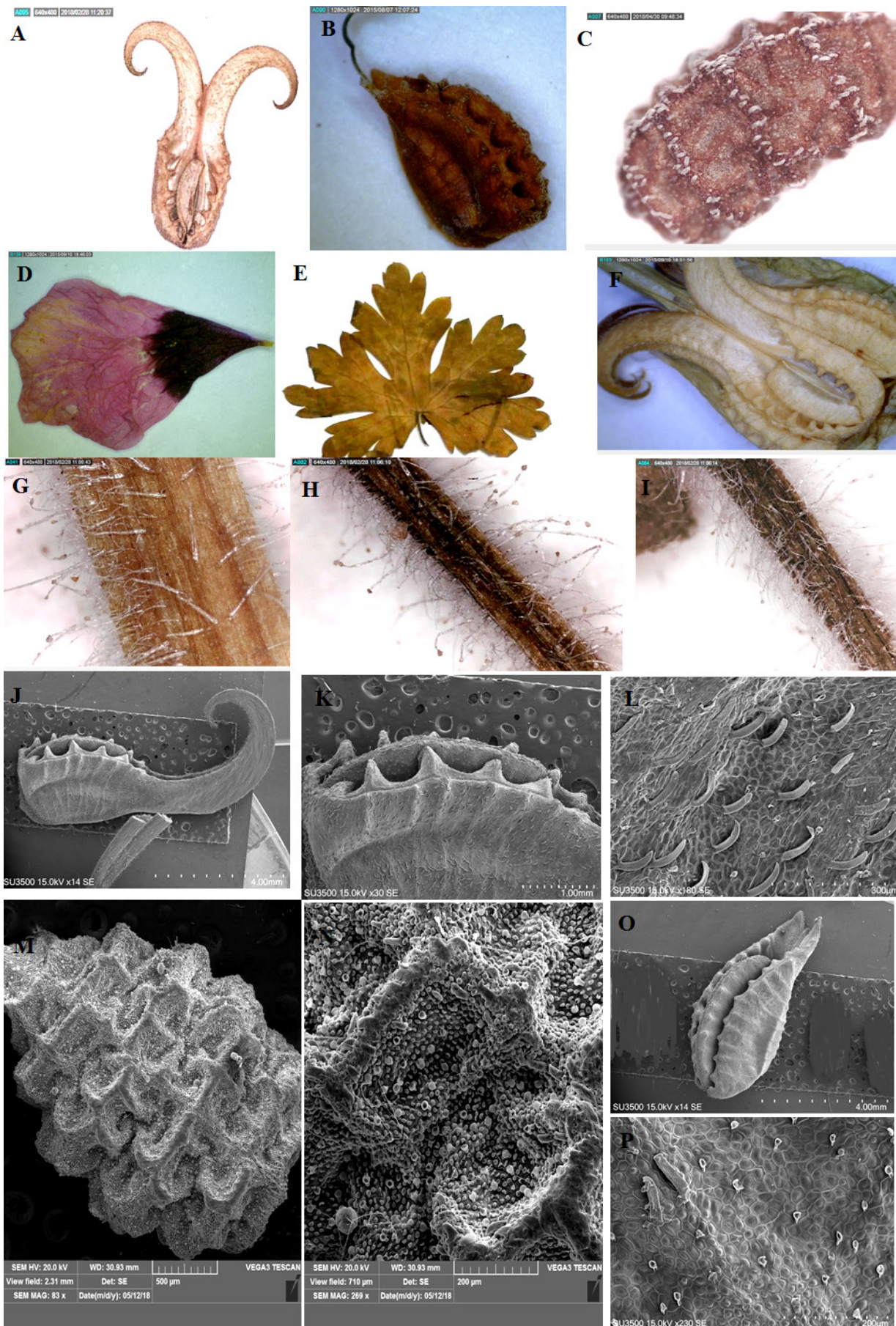


Figure 3. Detailed features of *Geranium biuncinatum* (A, D–L), *G. trilophum* (B, O, P) and *G. mascatens* (C, M, N). A–C, mericarp; D, petal; E, leaf shape; F, sepal; G, stem hair; H, peduncle hair; I, pedicle hair; J–P, SEM micrographs of the mericarp.

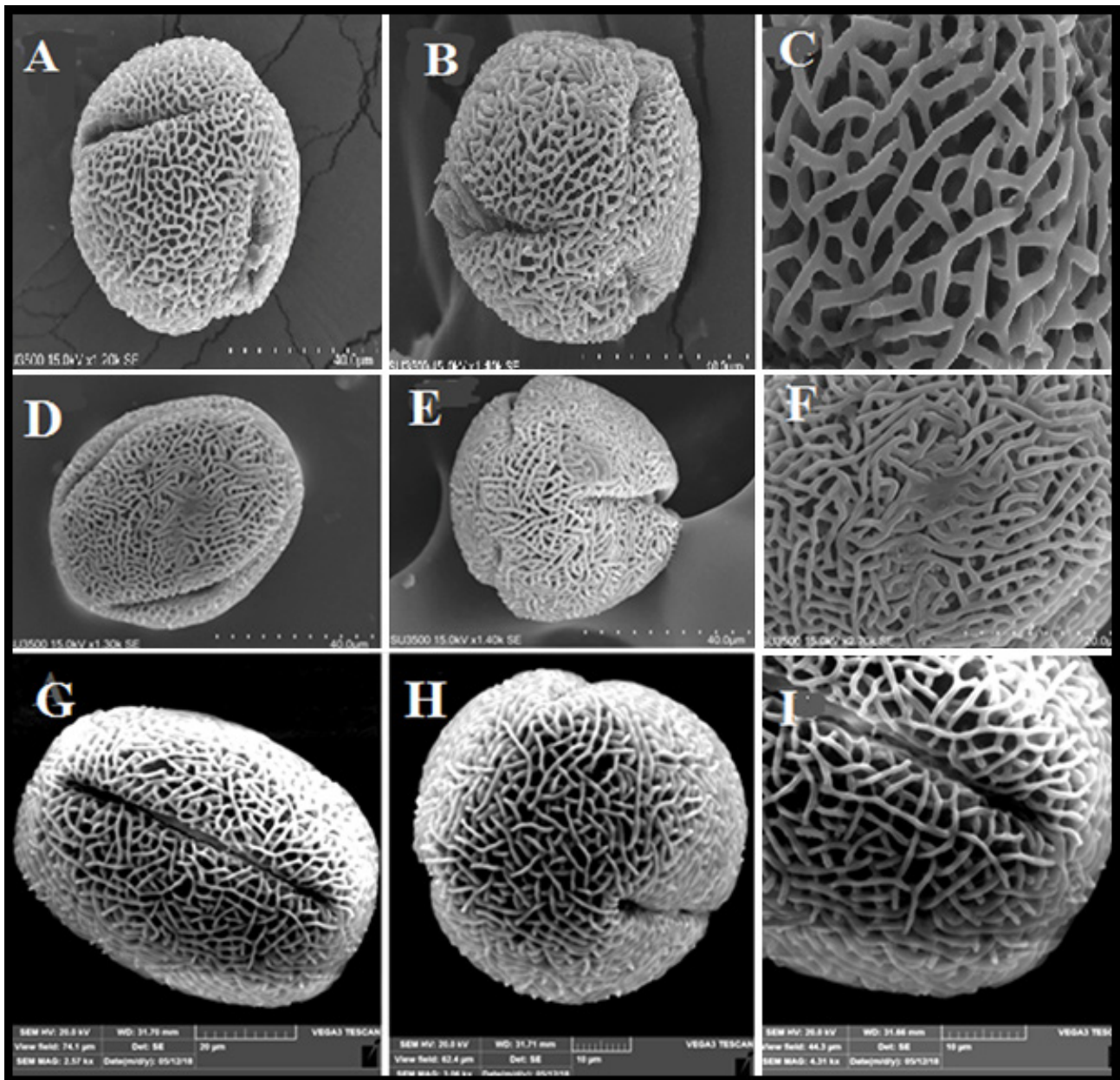


Figure 4. Pollen micrographs of *Geranium biuncinatum* (A-C), *G. trilophum* (D-F) and *G. mascatense* (G-I). A, D, G) Equatorial view. B, E, H) Polar view. C, F, I) Exine sculpture.

References

- Aedo, C. 2017. Taxonomic Revision of *Geranium* Sect. *Ruberta* and *Unguiculata* (Geraniaceae). *Ann. Missouri Bot. Gard.* 102: 409–465.
- Aedo, C., Barberá, P. & Buira, A. 2016. Taxonomic revision of *Geranium* sect. *Trilopha* (Geraniaceae). *Syst. Bot.* 41(2): 354–377.
- Alfarhan, A. & Thomas, J. 2001. Geraniaceae. In: Chaudhary, S.A. (Ed.). *Flora of the Kingdom of Saudi Arabia* vol. 2(1). Pp. 443–449. *Nat. Agric. Wat. Res. Cent.*, Riyadh.
- Davis, P.H. 1967. *Geranium* L. In: Davis, P.H., Cullen, J. & Coode J. E. (Eds.). *Flora of Turkey*, Vol 2. University Press, Pp. 451–474. Univ. Press, Edinburg.
- Esfandani-Bozchaloyi, S. & Sheidai, M. 2018. Molecular diversity and genetic relationships among *Geranium pusillum* and *G. pyrenaicum* with inter simple sequence repeat (ISSR) regions, *Caryologia* 71 (4): 1–14. <https://doi.org/10.1080/00087114.2018.1503500>
- Esfandani-Bozchaloyi, S. & Zaman, W. 2018. Taxonomic significance of macro and micro-morphology of *Geranium* L. species Using Scanning Electron Microscopy. *Micros Res Tech* 81 (12) :652–666. DOI: 10.1002/jemt.23159
- Esfandani-Bozchaloyi, S., Sheidai, M., Keshavarzi, M. & Noormohammadi, Z. 2017a. Genetic Diversity and Morphological Variability in *Geranium Purpureum* Vill. (Geraniaceae) Of Iran. *Genetika* 49: 543–557. <https://doi.org/10.2298/GENSR1702543B>

- Esfandani-Bozchaloyi, S., Sheidai, M., Keshavarzi, M. & Noormohammadi, Z. 2017b. Species Delimitation in *Geranium* Sect. *Batrachioidea*: Morphological and Molecular. *Act Bot Hung* 59(3-4): 319-334. doi: 10.1556/034.59.2017.3-4.3
- Esfandani-Bozchaloyi, S., Sheidai, M., Keshavarzi, M. & Noormohammadi, Z. 2017c. Genetic and morphological diversity in *Geranium dissectum* (Sec. *Dissecta*, Geraniaceae) populations. *Biologia* 72(10): 1121-1130. DOI: 10.1515/biolog-2017-0124
- Esfandani-Bozchaloyi, S., Sheidai, M., Keshavarzi, M. & Noormohammadi, Z. 2017d. Analysis of genetic diversity in *Geranium robertianum* by ISSR markers. *Phytologia Balcanica* 23(2): 157-166.
- Esfandani-Bozchaloyi, S., Sheidai, M. & Keshavarzi, M. 2018a. Macro- and micro-morphological study of fruits and seeds in the genus *Geranium* (Geraniaceae), *Phytotaxa*. 375(3):185-204. doi.org/10.11646/phytotaxa.375.3.8
- Esfandani-Bozchaloyi, S., Sheidai, M., Keshavarzi, M., & Noormohammadi, Z. 2018b. Species Relationship and Population Structure Analysis In *Geranium* Subg. *Robertium* (Picard) Rouy With the Use of ISSR Molecular Markers. *Act. Bot. Hung* 60(1-2): 47-65.
- Esfandani-Bozchaloyi, S., Sheidai, M., Keshavarzi, M. & Noormohammadi, Z. 2018c. Species Identification and Population Structure Analysis in *Geranium* Subg. *Geranium* (Geraniaceae). *Hacquetia* 17(2): 235-246. doi.org/10.1515/hacq-2018-0007
- Esfandani-Bozchaloyi, S., Sheidai, M., Keshavarzi, M. & Noormohammadi, Z. 2018c. Morphometric and ISSR-analysis of local populations of *Geranium molle* L. from the southern coast of the Caspian Sea. *Cytol. Genet.* 52(4): 309-321.
- Hesse, M., Halbritter, H., Zetter, R., Weber, M., Buchner, R., Frosch-Radivo, A. & Ulrich, S. 2009. *Pollen Terminology- An Illustrated Handbook*. Springer Wien, New York.
- Janighorban, M. 2005. Geraniaceae, *Flora of Iran* Vol. 62. 1st ed. Res. Inst. For. Rang. Publ., Tehran.
- Kokwaro, J.O. 1971. The family Geraniaceae in North-East tropical Africa. *Webbia*. 25: 623-669.
- Laundon, J.R. 1961. Notes on *Geranium* in Africa and Arabia. *Bol. Soc. Brot. ser.* 35: 59-73.
- Punt, W., Blackmore, S., Nilsson, S. & Thomas, L.F. 1994. *Glossary of pollen and spore terminology*. Utrecht.
- Schönbeck-Temesy, E. 1970. Geraniaceae. In: Rechinger, K.H. (Ed.). *Flora Iranica*, Vol 69, Akad. Druck, Graz, pp. 30-58.
- Yeo, P.F. 1984. Fruit-discharge-type in *Geranium* (Geraniaceae): its use in classification and its evolutionary implications. *Bot. J. Linn. Soc.* 89: 1-36.
- Zohary, M. 1972. *Flora Palaestina. Platanaceae to Umbelliferae*. The Israel Acad. Sci. Hum., Jerusalem.