

# A morphological study on the dioecious endemic *Erodium somanum* H. Peşmen (Geraniaceae), critically endangered in Turkey

Dilek Oskay\*

Celal Bayar University, Faculty of Science and Arts, Department of Biology, Manisa, Turkey

**Abstract** – Morphological features of the endemic *Erodium somanum* are investigated based on the specimens collected from natural populations from Soma in Manisa. Almost all morphological characteristics are expanded and some morphological characteristics are firstly determined in this study. *E. somanum* is a dioecious species and in this study drawings of male and female individuals are given for the first time. An umbel is 3–5 flowered in female plants and 6–11 flowered in male plants, pedicels accrescent to 20–25 mm in fruit. Flower morphology was identified in detail and drawings are given for the first time. Stigma color ranges from yellow to red in populations. The fruit is long-beaked 4.8–8 cm, stout and adpressed pilose, glandular below. Mericarp morphology investigated for fruit characters has a special diagnostic value for systematic studies. The mericarp micromorphology and seed micromorphology were determined for the first time. Mericarp size 9–12 mm, mericarps have two apical shallow pits (foveoles) without furrow beneath. Mericarp surface ornamentation is foveate with crowded bristles of dissimilar size, some longer and others shorter. Mericarp pit is crowded with eglandular hairs and some sparse, long-stalked glands which are also at the start of the awn. Seed size is 4.5–6×1.5–2 mm, seed type is narrowly ovate, seed surface is ruminant.

**Keywords:** dioecious plant, endangered endemic plant, *Erodium somanum*, flower morphology, micromorphology.

## Introduction

Geraniaceae have five genera characterized by their flower features, *Erodium*, *Geranium*, *Monsonia*, *Sarcocaulon*, *Pelargonium* (Takhtajan 1997). A sixth genus, *California*, has been segregated from *Erodium* primarily because of the absence of staminodes (Aldasoro et al. 2002). The genus *Erodium* is distributed across all continents. A major center of diversity is in the Mediterranean region (63 species), whereas in other regions only a few native species have been observed; North America (1), South America (1), Australia (5), and Asia (4) (Fiz et al. 2006). The first revision of *Erodium* species in Turkey and the East Aegean Islands was made by Davis who recognized 27 taxa (Davis 1967). Since then, five new species have been described (Davis et al. 1988, Güner et al. 2000, Yıldırım and Doğru-Koca 2004) and the total has now reached 32 taxa. Sixteen of these *Erodium* taxa are endemic in Turkey.

*Erodium somanum* H. Peşmen is an endemic species known from Soma in Manisa, west of Turkey (Davis et al. 1988). It was reported that *E. somanum*, in terms of general appearance is similar to *Erodium sibthorpiatum* Boiss. sub-

sp. *sibthorpiatum* and *Erodium absinthoides* Willd. subsp. *absinthoides*. But *E. somanum* is clearly different from *E. sibthorpiatum* subsp. *sibthorpiatum* in that it has less canescent leaves, lilac petals and a shorter (3.5–4.5 cm) beak to the fruit; also *E. somanum* is clearly different from *E. absinthoides* subsp. *absinthoides* in that it has lax rosettes, white petals and a longer (2–2.8 mm) sepal mucro (Davis et al. 1988). Then, it was seen that a new combination had been made as *Erodium sibthorpiatum* Boiss. var. *somanum* (Peşmen) El-Oqlah (El-Oqlah 1989). Moreover, it was seen that a new name *Erodium chrysanthum* subsp. *somanum* had been given but the new name of the author was not provided (Fiz et al. 2006). As shown there are contradictions in the nomenclature of this species. To overcome confusion in this regard, it seems that a detailed study about the species mentioned is needed. In this study, *E. somanum* was used because of the first name given to the type specimen. This species was first classified into the Endangered (En) category based on IUCN criteria (Ekim et al. 2000) and later classified as Critically Endangered (CR) according to data obtained from population studies and based on IUCN criteria (Oskay and Altan 2015).

\* Corresponding author, e-mail: dilek.oskay@cbu.edu.tr

*E. somanum* naturally grows in rocky habitats, above 800 m, after the tree line. Total distribution area of populations is approximately 5 km<sup>2</sup>, in the surroundings of the east-west extension of Güllük Mountains in Soma. Distribution soils are slightly alkaline, without salt and a generally limey structure, adequately ferrous but poor in phosphorus. Climate type is semi-arid upper Mediterranean where the winters in particular are cool (Oskay and Altan 2015).

Studies on its morphology are limited. Pollen features and chromosome numbers of *E. somanum* have been investigated (Oskay et al. 2011). The present study is aimed at expanding morphological descriptions of this endemic species, including its detailed floral features. Mericarp surface is a very important diagnostic character for *Erodium* species; mericarp and seed surface have been investigated and scanning electron microscopy (SEM) photos are given first time in this study.

## Material and methods

*E. somanum* was collected from natural populations during a project supported by Scientific Research Projects from Celal Bayar University. The specimens are dried according to standard herbarium techniques and stored at Celal Bayar University Science and Education Faculty.

The taxonomical description of the plants was made according to *E. somanum* in "Flora of Turkey Vol. 10" by Davis et al. (1988). For the morphological studies, dried samples were used. Specific characters were measured at least twenty times. Photographs and drawings with general views of the male and female individuals, flower parts and fruit have been added to the study because it is a dioecious species. All measurements with fruit and seed were made at least thirty times. Fruit and seed were also directly placed on prepared stubs and covered with gold for micromorphological features by SEM. Photographs are taken with a Jeol JSM 6060. For fruit terminology the following literature was consulted (Davis 1967, Fiz et al. 2006). Seed terminology from the following literature was consulted (Stearn 1996).

## Results

### Morphology of vegetative parts

*E. somanum* is a dioecious perennial plant (Fig. 1, On-line Suppl. Fig. 1, On-line Suppl. Fig. 2). Plant populations consist of female and male individuals. Plants are very wide hard cushions up to 60 cm diameter. Rootstock is vertical, woody and black colored. Basal leaves are bipinnatisect, oblong elliptic, 6–16×15–37 mm with 4–20 mm petiole. Leaves are 3–5 segments, linear, acute, adpressed eglandular pubescent with stipules. Stems are erect, 1.3–19.5 cm (excluding peduncules) and simple or scarcely branched, covered with folded mixed villi, bearing 2–4 peduncules. Peduncules are 12–70 mm eglandular hirsute and have stipitate glands. The umbel inflorescences have 3–5 flowers in female plants and 6–11 flowers in male plants. Umbels are



Fig. 1. General appearance of *Erodium somanum* in nature.

multibracteate and bracts are pale grey. Pedicels are very slender, 8–20 mm (accrescent to 20–25 mm in fruit) and glandular pubescent.

### Morphology of reproductive parts

There are two types of flowers in *E. somanum*. Female plants have only female flowers while male plants have only male flowers. The flowers are medium size, actinomorphic corolla and borne in bracteate umbels. *E. somanum* have pentamerous flowers consisting of five sepals, five petals, five antipetalous nectaries and five staminodes. Five fertile stamens and five staminodes enclose the vestigial gynoecium in male flowers while five vestigial stamens and five staminodes enclose a gynoecium with five carpels in female flowers (On-line Suppl. Fig. 3). Petals are pale sulphur yellow in colour, broadly obovate, 3–8×6.5–12 mm, pilose towards base. Petal veins are usually darker than the rest of the petal (Fig. 2). Sepals appearance is transparent, sepal veins are usually green and darker than the rest of the sepal (Fig. 2). Sepal shape is oblong-elliptic, 2–5×4–8 mm (accrescent to 4–8×10–14 mm in fruit), obtuse with 0.5–1.5 mm mucro (On-line Suppl. Fig. 4). Dorsal part of sepal is covered with dense stipitate glands and eglandular villose. The sepals are not deciduous after fruit formation. The syn-

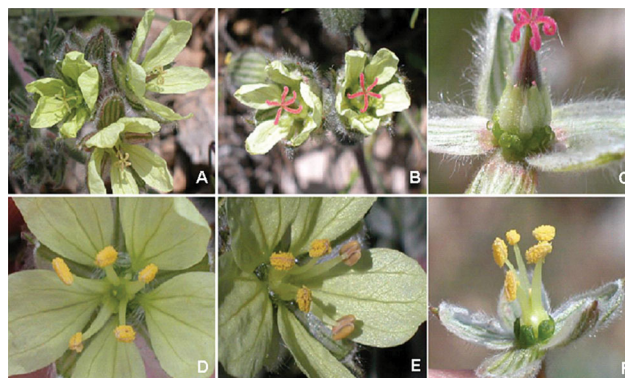


Fig. 2. Reproductive parts of *Erodium somanum*: (A, B) Female flowers; (C) Nectaria and pistil in female flowers; (D, E) Male flowers; (F) Nectaria and stamens in male flowers.

carpous ovary has five carpels, with each chamber having a single ovule with basal placentation. The long style is terminated by five furcated stigmas. Stigma color ranges from yellow to red in populations. The stamens are antisepalous, extrorse and versatile. Anthers are two-celled and opened longitudinally.

Fruit type is a schizocarp and it is divided into five mericarps (Fig. 3, On-line Suppl. Fig. 4). Fruit is long-beaked with beak 4.8–8 cm long, stout and adpressed pilose, glandular below. The outer part of the style separates into five long awns that usually remain attached to the mericarps. Awns are spirally twisted below and rarely deciduous. Mericarp is sized 9–12 mm and is light brown with whitish bristles (Fig. 3). Mericarps have two apical shallow pits (foveoles) without a furrow beneath. Mericarp awn is not plumose. Mericarp surface ornamentation is foveate with crowded bristles of dissimilar size, some longer and others shorter (Fig. 4). Mericarp pit is crowded with eglandular hairs and some sparse, long-stalked glands which are also at the start of the awn (Fig. 4).

Seed is glabrous, light brown-dark green brown (Fig. 5A). Seed is 4.5–6 mm long and 1.5–2 mm wide, seed shape is oblanceolate, almost terete, dorsal section of the seed is plain, ventral section of the seed is slightly swollen. Apex of the seed is rounded. Hilum not recessed and is clearly evident. Hilum is linear and sub basal, in other words extending upwards from the base of the seed. When



Fig. 3. Fruit (A) and mericarp (B) of *Erodium somanum*.

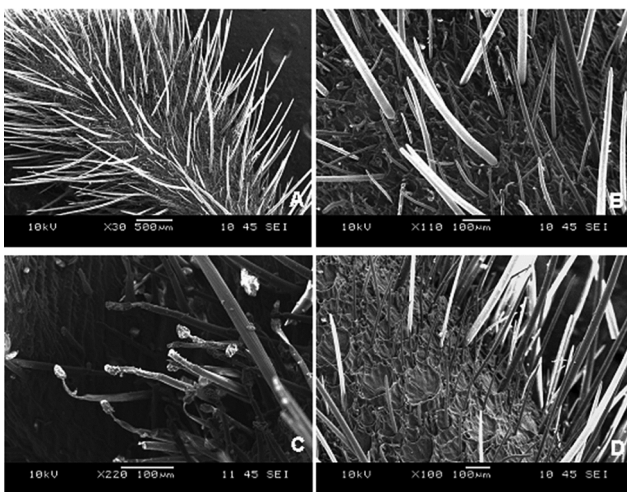


Fig. 4. Scanning electron microscopy photographs of *Erodium somanum* mericarps: (A) mericarp surface; (B) long and short bristles; (C) glandular hairs; (D) foveate surface ornamentation.

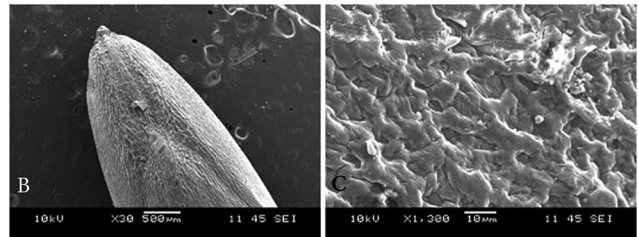


Fig. 5. Seeds of *Erodium somanum*: (A) General view; (B, C) Scanning electron microscopy photographs of seed surface at different magnification.

SEM photographs of seed surface are examined, it is determined to be ruminated (Figs. 5B, C) according to the following literature (Stearn 1996).

## Discussion

*E. somanum*, a critically endangered endemic species in Turkey, was investigated morphologically in the present study in order to contribute to the description and to elucidate some morphological details. The taxonomical description was carried out according to *E. somanum* in “Flora of Turkey” by Davis et al. (1988). Almost all morphological characteristics are expanded and some morphological characteristics, such as mericarp micromorphology, seed micromorphology and flower morphology are determined for the first time. Mericarp morphology investigated for fruit characters has a particular diagnostic value for systematic studies.

Some differences were found in the morphological characteristic from the description of the taxon in “Flora of Turkey” by Davis et al. (1988). These differences are shown in Table 1. The differences in this study occur because of the goal behind the assessment, the number of samples investigated, the greater time devoted to the task and spent on the related field work. In addition, climatic conditions vary from year to year and may affect the adaptation of plants.

This plant is an example of dioecious species, so female and male flowers morphology were identified in detail and drawings are given for the first time. Some differences were found (Tab. 1) in the flower characters from the description of the taxon (Davis et al. 1988). Some characteristics are new findings: there are five fertile stamens and five staminodes that enclose the vestigial gynoeceum in male flowers and five vestigial stamens and five staminodes that enclose a gynoeceum with five carpels in female flowers; the petal veins are usually darker than the rest of the petal; sepals are transparent; sepal veins are usually green and darker than the rest of the sepal; dorsal part of sepals covered with dense stipitate glands and are eglandular villous; the sepals

**Tab. 1.** Comparison of plant characters of *Erodium somanum*.

Plant characters	Unit	“Flora of Turkey” (Davis et al. 1988)	In this study
Hard cushions	cm	up to 40 diameter	up to 60 diameter
Basal leaves	mm	10–15 × 25–30	6–16 × 15–37
Petiole	mm	15–20	4–20
Stems	cm	7–18	1.3–19.5
Peduncules	mm	15–45	12–70
Pedicels	mm	10–15	8–20
Sepals	mm	2–2.5 × 6–6.5	2–5 × 4–8
Sepals in fruit	mm	4–5 × 10–12	4–8 × 10–14
Sepal mucro	mm	0.5–1	0.5–1.5
Petals	mm	6.5 × 6.5–7	3–8 × 6.5–12
Fruit	cm	5–5.5	4.8–8
Mericaip	mm	8	9–12
Mericaips	–	not foveolate	with 2 shallow apical pits (foveoles)

are not deciduous after the fruit formation; stigma color ranges from yellow to red in populations.

The phylogenetic relationships and evolution in *Erodium* have been described according to gene sequences by Fiz et al. (2006). This work is very important in the sense that 74 *Erodium* taxa have been collected from all over the world. The morphological characters used in the phylogenetic analyses of authors are noteworthy because about half of these characters are mericaip features. We have benefited from this work and from the “Flora of Turkey” when evaluating the characters of the mericaip. It was reported that mericaips were hispid, not foveolate, in the “Flora of Turkey” (Davis et al. 1988). In contrast, the results of this study show that mericaips are hispid but there are two quite shallow apical pits (foveoles) and these pits are densely hispid (Tab. 1).

Approximately 32 *Erodium* taxa are distributed in Turkey; however the micromorphology of most species has not been investigated. Micromorphological investigations on the mericaip of some annual taxa of *Erodium* were conducted by Oskay and Eş (2015) who ascertained the meri-

carp micromorphology of *E. hoefftianum* C.A. Meyer, *E. botrys* (Cav.) Bertol, *E. malacoides* (L.) L’Hérit, *E. moschatum* (L.) L’Hérit, *E. cicutarium* (L.) L’Hérit, sub sp. *cicutarium*, *E. ciconium* (L.) L’Hérit taxa. Authors investigated several fruit characters of *Erodium* species, such as fruit type, length of fruit, length of mericaip, form of mericaip apex (presenting pits, ridges or furrows), and glandulose structures (glands, glandular hairs and papilles) and found significant differences between species. In a study by Coşkunçelebi et al. (2012) *E. hendrikii*, a closely related taxon to *E. malacoides*, was compared with respect to characters of basal leaves, stem indumentum, trichome type on mericaip surface, petal colour, sepal length, beak of fruit and mericaip. And so these two closely related taxa were separated thanks to the new findings.

There is no detailed information about seed microsculpturing in *Erodium* species. Seed macro and micro morphological characters of 19 taxa belonging to the family Geraniaceae were investigated by Ather et al. (2012). They found data that could be useful in providing additional information for taxonomic delimitation at various levels. Also they stated that the morphological and phylogenetic relationship of the taxa within the family Geraniaceae correlates well with seed morphological data. The findings of seed characteristics in this study are compared with the findings of seed characteristics by Ather et al. (2012), and it is seen that *E. somanum* has its own distinct characters.

In conclusion, in this study we aimed to introduce morphological details of the endemic *E. somanum*, a perennial dioecious plant species. The morphological features of the investigated taxon were quite similar to those reported by Davis et al. (1988) in “Flora of Turkey”. However, morphological findings concerning the reproductive parts of *E. somanum* are, with some exceptions, presented for the first time.

## Acknowledgements

I would like to thank Scientific Research Projects from Celal Bayar University (Project Number: FEF-2007-12) for the financial support. I also would like to thank Dr. Cem Azeri for illustrations.

## References

- Aldasoro, J. J., Navarro, C., Vargas, P., Sa’Ez, L. L., Aedo, C., 2002: *California*, A new genus of Geraniaceae endemic to the Southwest of North America. *Anales del Jardín Botánico de Madrid* 59, 209–216.
- Ather, A., Abid, R., Qaiser, M., 2012: The seed atlas of Pakistan-VII. Geraniaceae. *Pakistan Journal of Botany* 44, 1059–1064.
- Coşkunçelebi, K., Terzioğlu, S., Karaköse, M., Güzel, M. E., 2012: Contributions to the description and molecular properties of *Erodium hendrikii* Alpınar (Geraniaceae), endemic to Turkey. *Turkish Journal of Botany* 36, 455–461.
- Davis, P. H., 1967: *Erodium* L’Hérit. In: Davis P. H., (ed.), *Flora of Turkey and the East Aegean Islands*, Vol. 2, 475–487. Edinburgh University Press, Edinburgh, UK.
- Davis, P. H., Mill, R. R., Tan, K., 1988: *Erodium* L’Hérit. In: Davis, P. H., Mill, R. R., Tan, K., (eds.), *Flora of Turkey and the East Aegean Islands*, Vol. 10 (Suppl. I), 105–106. Edinburgh University Press, Edinburgh, UK.
- Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N., 2000: Red data book of Turkish plants, Pteridophyta and Spermatophyta, Ankara (in Turkish).
- El-Oqlah, A. A., 1989: A revision of the genus *Erodium* L’Hérit in the Middle East. *Feddes Repertorium* 100, 3–4.
- Fiz, O., Vargas, P., Alarcon, M. L., Aldasoro, J. J., 2006: Phylogenetic relationships and evolution in *Erodium* (Geraniaceae) based on trnL-trnF sequences. *Systematic Botany* 31, 739–763.
- Güner, A., Özhatay, N., Ekim, T., Başer, K. H. C., 2000: *Erodium* L’Hérit. In: Güner, A., Özhatay, N., Ekim, T., Başer, K. H.

- C., (eds.), Flora of Turkey and East Egean Islands, Vol 11 (Suppl. II), 74–75. Edinburgh University Press, Edinburgh, UK.
- Oskay, D., Altan, Y., Kesercioğlu, T., 2011: Investigation of pollen features and chromosome numbers of *Erodium somanum*, Biological Diversity and Conservation 4, 175–179.
- Oskay, D., Altan, Y., 2015: An investigation on habitat and population properties of local endemic *Erodium somanum*. Ekoloji 24, 32–39.
- Oskay, D., Eş, Ö., 2015: Micromorphological investigations on mericarp of some annual taxa of *Erodium*. C.B.U. Journal of Science 11, 59–68.
- Takhtajan, A., 1997: Diversity and classification of flowering plants. Columbia University Press, New York, USA.
- Stearn, W.T., 1996: Botanical Latin, 4th edition. Publisher David & Charles.
- Yıldırım, Ş., Doğru-Koca, A., 2004: A new species from Turkey, *Erodium aytacii* Yıldırım & A. Doğru-Koca (Geraniaceae). The Herb Journal of Systematic Botany 11, 1–6.