

## Seed Exomorphic Characters of Different *Erodium* Plant Species in Libya (SEM Study)

Ghalia El Rabiai and Fatma Al Tira

Department of Botany, Faculty of Science, Benghazi University, Libya

**Abstract:** Seed Exomorphic characters of 10 taxa of *Erodium* species (Geraniaceae) in Libya were investigated by LM and SEM. The seed exomorphic characters which diagnostic at the species level are seed shape, dimensions, epidermal cell patterns as seen by SEM, anticlinal cell boundaries and periclinal cell wall. Different characteristics were appeared in the results and this can be used in classification of the species. In addition, to evaluate the genus description and its level in Libyan flora.

**Key words:** *Erodium* • Seed coat sculpture • Geraniaceae • Libya

### INTRODUCTION

The family Geraniaceae comprises 5 genera and 650 species [1]. The genus *Erodium* L'Hérit. includes more than 60 species worldwide [2]. More than 65% of these species are widespread throughout the Mediterranean region [3] which defined as the center of biodiversity of the genus [4].

In the last decade, several authors focused on and studied this genus from different points of view [5-9] investigated the seed morphology of 14 Egyptian species of the genus *Erodium* and different parameters like seed size, shape and surface pattern were found significant for specific delimitation.

Geraniaceae seeds characterized by size of 0.8-3.8 x 0.6-2.2 mm, oblanceolate, oblong, sub globose, apex truncate, retuse or rounded, ridge present, brown, light brown, orange brown, reddish brown or blackish brown,

undulate, foveate, rugosely foveate, foveately striate, rugosely striate, scalariform, areolate, areolate along with undulate, reticulate, reticulate foveate, reticulate with in reticulation foveate or appressedly reticulate, glabrous or sparsely pubescent [10]. Similarly, seed morphology is also found to be significant for infrageneric, specific or infraspecific delimitation.

The present work aims to study the different characters of seeds with special references to seed coat sculpture of 10 native species of *Erodium* in Libya. It is hoped that the results of the study will prove the significance in taxonomy of Geraniaceae in Libya.

### MATERIALS AND METHODS

Dry seeds of *Erodium* plant were collected from different locations of Libya. They were cleaned and examined by light microscope to show the different

Table 1: List of the studied taxa of the Libyan *Erodium* species and their localities

No	Taxa	Locality
1	<i>Erodium arborescens</i> (Desf.)WILD.	Garyounis area Al Makilly and Altamimy.
2	<i>E. cionium</i> (L.) L'HERIT	Garyounis area.
3	<i>E. cicutarium</i> (L.) L'HERIT	Toucara, Wadi Darna , and Almabny
4	<i>E. gruinum</i> (L.) L'HERIT	Garyounis area, Al Makhilly and Altamimy
5	<i>E. hirtum</i> (forsk.)Willd	Garyounis, Wadi Darna and Altamimy.
6	<i>E. laciniatum</i> subsp. <i>laceantum</i> (cav)willd	Benghazi University, Misrata, wadi Ahnioa, Mezda and Altamimy.
7	<i>E. laciniatum</i> subsp. <i>pulveratum</i> (cav)willd	Garyounis area, Garian and Misrata.
8	<i>E. malacoides</i> (L.) L'HERIT	Garyounis, Albamba and Alftaih.
9	<i>E. moschatum</i> (L.) L.Herit	Benghazi university, Misrata, Wadi Ahnioa, mezda and Altamimy.
10	<i>E. neuradifolium</i> Delile	Garyounis, Almabny, Altamimy, Alabiar and Toucara

exomorphic parameters like shape, dimensions, color and surface. Five to ten seeds of each taxon were taken to cover the range of variations. For SEM investigation, the seeds were dried and fixed to specimen stubs with an adhesive and placed on the revolving discs of Joel fine coat ion sputter (Joel, JFC 1100). Each seed was uniformly coated with 20-30 nm thick of gold. These specimens stubs were then fixed to the specimen holder of Scanning Electron Microscope (Joel JSM 1200) maintained at accelerating potential voltage of 15 Kv. and photomicrographs were taken at different magnifications.

The SEM investigation of seeds was carried out in central lab. at Faculty of Science, Ain Shams University, Cairo, Egypt. The described terminology used in this study for seed surface sculpture was described on the basis of [11, 12].

## RESULTS AND DISCUSSION

The results showed that the genus *Erodium* which collected from different locations of Libya has different characteristics which can be used as taxonomical parameters to differ between the species of *Erodium*. These characteristics are summarized in table (2). In the following, we described various aspects of seed structure and description that we found in the study:

***Erodium arborescens* (Desf.) Willd:** Seeds narrow ovoid to obclavate, with triangular apex, 3.8x1.14 mm, brown. Epidermal cells isodiametric or in different forms, 4-polygonal arranged in longitudinal rows parallel to the longitudinal axis of the seed; anticlinal boundaries raised, straight, thick, smooth with extra longitudinal anticlinal boundaries; periclinal cell walls concave and smooth (Fig. 1, A&B).

***E. ciconium* (L.) L'HERIT:** Seeds obclavate to cylindrical with truncate apex, 6x2 mm, brown. Epidermal cells differ in shape, 4- polygonal, anticlinal boundaries raised, straight, thick, smooth, with clearly defined extra longitudinal and transverse anticlinal cell boundaries; periclinal cell walls concave, smooth or with fine folds. (Fig.1, C&D).

***E. cicutarium* (L.) L'HERIT:** Seeds narrow ovoid to obclavate with round apex, 3 x 1 mm, brown. Epidermal cells isodiametric, 4-, 5-, 6-polygonal; anticlinal boundaries raised, straight or undulate, with fine folds; periclinal cell walls concave with fine folds. Fig.1, E&F).

***E. gruinum* (L.) L'HERIT:** Seeds cylindrical with truncate apex, 5.5x2 mm, brown. Epidermal cells differ in shape, polygonal; anticlinal boundaries raised, straight, thick, smooth, with clearly defined extra longitudinal and transverse cell boundaries; periclinal cell walls concave and reticulate (Fig.1, G&H).

***E. hirtum* (Forsk.) Willd:** Seeds narrow ovoid to obclavate, with truncate apex, 0.7x2.7 mm, reddish brown. Epidermal cells isodiametric or in different forms, 4-polygonal arranged in longitudinal rows parallel to the longitudinal axis of the seed; anticlinal boundaries raised, straight, thick, smooth with fine folds; periclinal cell walls concave with fine folds and papillate ( Fig. 1, I &J).

***E. lacinatum* subsp. *lacenatum* (CAV.) Willd:** Seeds narrow ovoid to obclavate, with round apex, 3x0.9 mm; dark brown. Epidermal cells isodiametric rarely elongated in one direction, 3, 4-polygonal; anticlinal boundaries raised, straight, thick, with fine folds or smooth; periclinal cell walls concave, smooth or with fine folds (Plate II, Fig.2, K&L).

***E. lacinatum* subsp. *pulverulentum* (CAV.) Willd:** Seeds narrow ovoid to obclavate with truncate apex, 2.5x 0.7 mm; dark brown. Epidermal cells isodiametric or elongated in one direction, 4, 5, 6-polygonal; anticlinal boundaries raised, straight, thick and smooth; periclinal cell walls concave and smooth (Fig.2, M&N).

***E. malacoides* (L.) L'HERIT:** Seeds narrow ovoid to obclavate, with round apex, 2.3x0.8 mm, brown. Epidermal cells isodiametric or elongated in one direction, 4-6 polygonal; anticlinal boundaries raised, straight, thick, smooth or with weak fine folds; periclinal cell walls flat and smooth (Fig.2, O&P).

***E. moschatum* (L.) L'HERIT:** Seeds narrow to obclavate with round apex, 3 x 0.9 mm, brown. Epidermal cells isodiametric, 4-, 5-, 6-polygonal; anticlinal boundaries raised, undulate with fine folds; periclinal cell walls concave with fine folds (Fig. 2, Q&R).

***E. neuradifolium* Delile:** Seeds obclavate to ovoid with round apex, 3x1 mm, brown. Epidermal cells isodiametric or elongated in one direction, 4, 5, 6-gonal, arranged in longitudinal rows parallel to the longitudinal axis of the seed; anticlinal boundaries raised, straight, thick, with fine folds; periclinal cell walls flat with fine folds (Fig. 2, S&T).

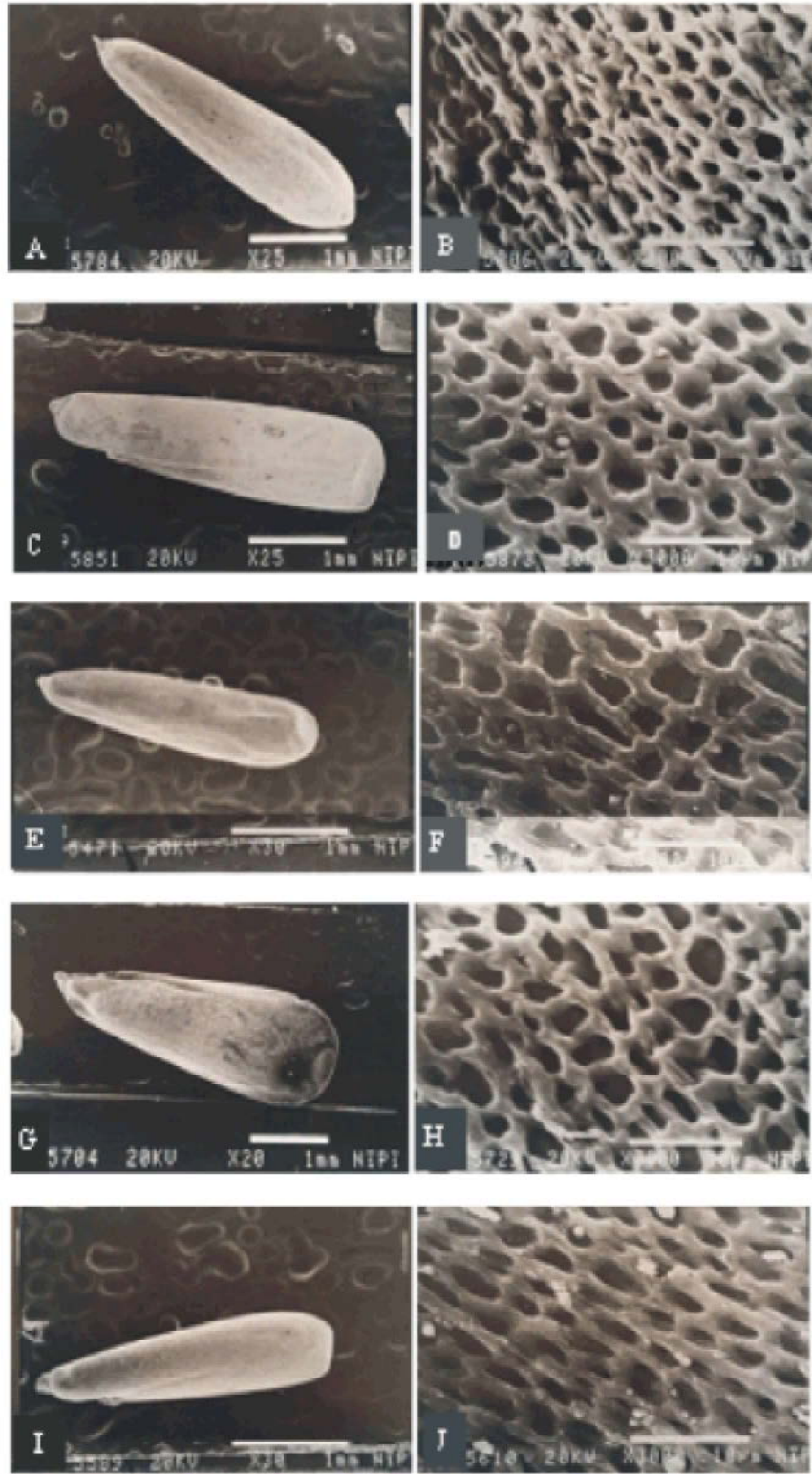


Fig. 1: Scanning electron micrographs. *Erodium arborescens*: A- Whole seed; B- Seed surface. *E. cionium*: C-Whole Seed; D-Seed surface *E. cicutarium*: E-Whole seed; F-Seed surface. *E. gruinum*: G-Whole seed; H-Seed surface. *E. hirtum*: I-Whole seed; J-Seed surface

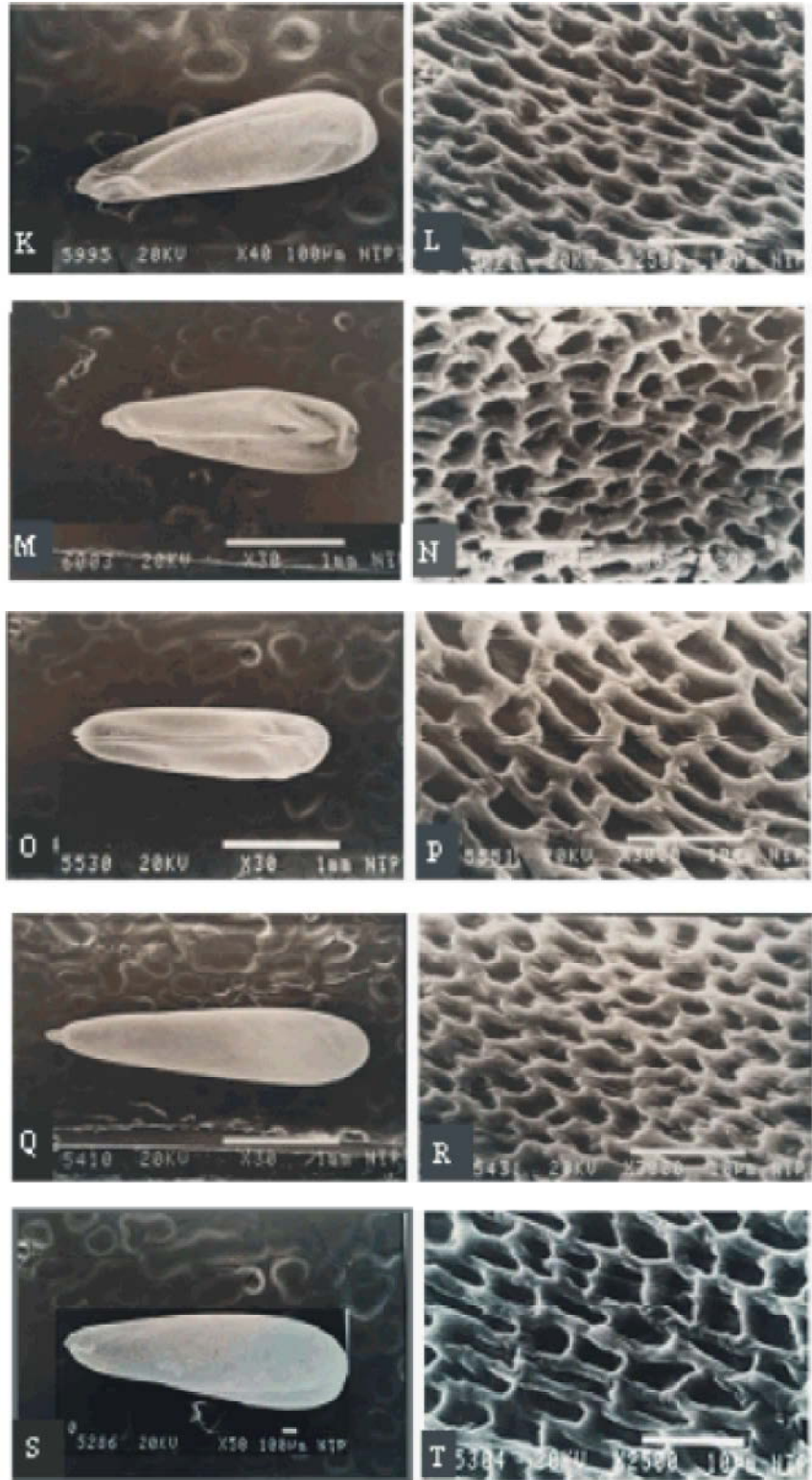


Fig. 2: Scanning electron micrographs. *E. laciniatum* subsp. *laceantum*: K-Whole seed; L-Seed surface. *E. laciniatum* subsp. *pulveratum*: M- Whole seed; N-Seed surface. *E.malacoides*: O-Whole seed; P- Seed surface. *E.moscatum*: Q-Whole seed; R-Seed surface *E. neuradifolium*: S-Whole seed; T- Seed surface

Table 2: List of studied taxa and some important features of their seeds

No.	Species	Seed size (mm)	Colour	Shape	Apex
1	<i>Erodium arborescens</i> (Desf.)WILD.	3.8x1.14	Brown	Narrow ovoid to obclavate	Acute
2	<i>E. ciconium</i> (L.) L'HERIT	6 x 2	Brown	Obclavate to cylindrical	Truncate
3	<i>E. cicutarium</i> (L.) L'Herit	3 x 1	Brown	Narrow ovoid	Round
4	<i>E. gruinum</i> (L.) L'HERIT	2x5.5	Brown		Truncate
5	<i>E. hirtum</i> (forsk.)Willd	2.7x 0.7	Reddish brown	Ovoid to obclavate	Truncate
6	<i>E. laciniatum</i> subsp. <i>laceantum</i> (cav)willd	x0.93	Dark brown	Ovoid to obclavate	Round
7	<i>E. laciniatum</i> subsp. <i>pulveratum</i> (cav)willd	x 0.7 2.5	Dark brown	Ovoid to obclavate	Truncate
8	<i>E. malacoides</i> (L.) L'HERIT	2.3x0.8	Brown	Ovoid to obclavate	Round
9	<i>E. moschatum</i> (L.) L.Herit	3 x 0.9	Brown	Obclavate	Round
10	<i>E. neuradifolium</i> Delile	3 x 1	Brown	Obclavate	Round

From the results, the seed color of all the investigated species falls within brown and as such conveys less taxonomic significance. While the seed shape of all the studied taxa are ranging from narrow ovoid to obclavate with a cute, truncate and round apex.

The study revealed that the seed size is ranging from 3.3x 0.7 mm in *Erodium* (the smallest) to 6 x 2 mm as in *E. ciconium* (the largest). Epidermal cell patterns are usually 5-, 6-polygonal but sometimes they were 4-polygonal as appeared in *E. malacoides*.

Epidermal cells are isodimetric in most of the investigated taxa but they are elongated in one direction as in *E. neuradifolium*. In *E. arborescens*, *E. gruinum* and *E. ciconium* epidermal cells are variable in shape. These cells are randomly arranged in the examined taxa with exception of *E. neuradifolium* and *E. arborescens* which they appeared parallel to the longitudinal axis of the seeds.

In the investigated taxa, the anticlinal cell boundaries are well developed. These are raised and straight in the most investigated taxa and the sculptures of the boundaries are smooth as in the vast majority of the investigated taxa or folded with fine folds as in *Erodium neuradifolium*.

In *Erodium ciconium* and *E. gruinum* there are clearly and defined extra longitudinal and transverse anticlinal cell boundaries, while in *Erodium arborescens* longitudinal anticlinal cell boundaries are only present.

Periclinal cell walls are fiat as appeared in *Erodium chium*, *E. malacoides* and *E. neuradifolium* or concave as in the remaining of the investigated taxa. Periclinal cell walls are smooth in most of the studied taxa, while they are folded with fine folds as in *Erodium neuradifolium*.

The seed morphological features provide the strength to the sub sectional delimitation of the section *Erodium* viz., Absinthioidea and Malacoidea. The subsection Absinthioidea including *E. ciconium* with apically truncate seeds while, Malacoidea including *E. cicutarium*, *E. laciniatum* and *E. malacoides* are

characterized due to the presences of apically rounded seeds and these species could also be separated with each other by having different seed coloration and surface patterns. From the results and according to the differences between *Erodium* plant seeds in Libya, these characters which appeared in the results can be used in classification of the species related to *Erodium*. In addition, to evaluate the genus description and its level in Libyan flora.

## REFERENCES

- Mabberley, D.J., 2008. Mabberley's Plant Book. A portabledictionary of plants, their classification and uses. Cambridge: Cambridge University Press.
- Alarcon, M.L., J.J. Aldasoro, C. Aedo and C. Navarro, 2003. A new species of *Erodium* L'Hér. (Geraniaceae) endemic to Australia. Botanical Journal of the Linnean Society, 141: 243-250.
- Radulović, N., M. Dekić, Z. Stojanović-Radić and R. Palić, 2009. Volatile constituents of *Erodium cicutarium* (L.) L'Hérit. (Geraniaceae). Central European Journal of Biology, 4: 404-410.
- Sharawy, S.M. and A. Badr, 2008. Systematic revision of *Erodium* species in Egypt as reflected by variation in morphological characters and seed protein electrophoretic profiles. International Journal of Botany, 4: 225-230.
- Guittonneau, G., 1972. Contribution aletude biosystematique de gene *Erodium* L' HERT dans Ic.
- Dahlgren, G., 1980. Cytological and morphological investigation of the genus *Erodium* L' HERT, in Aegean. Bot. Not., pp: 491-514.
- El Hadidy, N.M., A.A. Fayed and S.N. El Naggar, 1984. Systematic revision of *Erodium* (Geraniaceae) in Egypt Pl. Syst.
- El Naggar, S.M., 1991. Numerical taxonomy of the genus *Erodium* L' HERT in Egypt Feddes Repert, 102(7-8): 535-540.

9. El-Naggar, S.M., 1992. Seed morphology and taxonomy of the Egyptian species of *Erodium L'HERIT.* (Geraniaceae). Feddes Repertorium, 103: 345-350.
10. Ather, A., A. Rubina and M. Qaiser, 2012. The Seed Atlas Of Pakistan -VII. Geraniaceae. Pak. J. Bot., 44(3): 1059-1064.
11. Barthlott, W., 1981. Epidermal and seed surface applicability and some evolutionary aspects. Nord. J. Bot., I, pp: 345-355.
12. Barthlott, W., 1984. Micro-structural features of seed surface. In Current Concepts in Plant Taxonomy.