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Seed Diversity among Certain Species of Caryophyllaceae in Egypt

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Abstract: In the present study, data are used to re-asses the relationships between certain weed species of the family Caryophyllaceae in Egypt. Seed diversity of fourteen species belonging to five genera of the family Caryophyllaceae in Egypt were studied using light and scanning electron microscopy. These genera are *Dianthus*, *Vaccaria*, *Silene*, *Stellaria* and *Spergula*. Macromorphological criteria concerned with vegetative and reproductive organs were investigated. NTSYS-pc program was used for analyzing the data of seed and macromorphological characters. The taxonomic relationships between the studied taxa were discussed as well as SEM micrographs of seeds are provided.

Key words: Seed diversity, morphology, taxonomy, Caryophyllaceae, Egypt

INTRODUCTION

The family Caryophyllaceae comprises about 87 genera with 2300 species^[1]. The species are generally herbs with swollen nodes, rarely subshrubs. Leaves are simple, opposite decussate and exstipulate, only stipulate in tribe Sperguleae. Flowers are actinomorphic and mostly bisexual. Epicalyx is formed in *Dianthus* species (4-5 bracteoles). Calyx is 5-sepaled; sepals are connate into a tube in subfamily Silenoideae and of free sepals in subfamily Alsinoideae. Corolla is of five distinct petals, frequently clawed in Lychnideae. Stamens are in one or two whorls, either 5 or 10, rarely 3. Gynoecium is composed of a single compound pistil, 2-5 carpels with an equal number of styles. Ovary is superior, 1-loculed with numerous free central ovules or 3-5-loculed with axial placentation. Fruit is a capsule or achene enclosed in a persistent calyx with single seed to many. Seeds are brown to black, winged or not. The hilum presents on the face in tribe Diantheae and laterally in tribe Lychnideae. Embryo is straight in tribe Diantheae and is peripheral or spiral in the tribe Lychnideae.

The weed flora of Egypt comprises about 470 species distributed in farmlands, wastelands, roadsides and canal-banks^[2]. These weeds represent about 22.5% of the total number of the flora of Egypt^[3]. Eight weed species of *Silene*, two species of *Stellaria*, two species of *Vaccaria* and a species of *Dianthus*, *Spergula* are reported.

The morphological characters are important tools for taxonomic purposes, they have been successfully applied for the identification and classification of the taxa belonging to the family Caryophyllaceae in Egypt^[4-9].

In the present study data are used to re-asses the relationship between certain weed species of the family caryophyllaceae in Egypt.

MATERIALS AND METHODS

The morphological study is based on intensive fieldwork collected in the spring of 2004 and the available material in the herbaria of CAI and Assiut University Herbarium (ASTUH, proposed abbreviation). Seed materials were taken from fresh samples fixed in FAA (Formalin Acetic Acid) or from herbarium specimens. Table 1 lists the specimens used in SEM study.

Samples were observed with Light Microscopy (LM). SEM observations were made on seeds coated with a thin layer of gold/palladium and examined with a JEOL J-SM-T 200 SEM operated at accelerating voltage of 15 kV of Assiut University, Assiut, Egypt.

The data of morphological characters and seed criteria were numerically analyzed using NTSYS-pc program^[10] for creating the data matrix. The presence of each character was scored with (1) and the absence was scored with (0). The similarity of pattern was measured according to the Jaccard's coefficient $S_j = (a)/(a+b+c)$ where, (a) is the number of characters present in both species, (b) is the number of characters found in one species only and © is the number of characters that found only in the other studied species^[11]. The matrix of Jaccard's coefficient was used to illustrating the phenogram of similarities between the studied taxa. Two

Table 1: Investigated specimens for SEM studies

Species	Collections
<i>Dianthus cryi</i> Fisch. and C.C. Mey.	Faiyum, 5.5.1967, El Hadidi s.n. (CAI)
<i>Vaccaria hispanica</i> (Miller) Rauschert	Nile Delta, 5.4.1972, Ibrahim <i>et al.</i> s.n. (CAI)
<i>Vaccaria oxydonta</i> Boiss.	Balana, 12.1.1964, Boulos s.n. (CAI)
<i>Silene villosa</i> Forssk.	El-Arish, 20.3.1928, G. Täckholm s.n. (CAI)
<i>Silene rubella</i> L.	Rosetta, 25.3.1979, Hoseny and Sharnfo s.n. (CAI)
<i>Silene behen</i> L.	Ismailia, 11.12.1982, Alaa Amer 3357 (CAI)
<i>Silene gallica</i> L.	Ismailia, 20.3.1982, Alaa Amer 1694 (CAI)
<i>Silene apetala</i> Willd.	Wadi Habs, 21.3.1975, El Hadii s.n. (CAI)
<i>Silene nocturna</i> L.	Wadi Fairan, Sinai, 10.5.1956, El Hadidi s.n. (CAI)
<i>Silene vivianii</i> Steud.	Amria, Alexandria, 8.4.2003, Zareh and Faried 109 (ASTUH)
<i>Silene colorata</i> Poirlet	Burg el Arab, 4.4.1948, Shabetai z 7100 (CAI)
<i>Stellaria media</i> (L.) Vill.	Dakhla Oasis, 13.2.1968, Gun Romée s.n. (CAI)
<i>Stellaria pallida</i> (Dumort.) Murb.	Assiut, 29.3.2003, Zareh and Faried 101 (ASTUH)
<i>Spergula fallax</i> (Lowe) E.H.L. Krause	Wadi Habs, 23.3.1974, V. Täckholm <i>et al.</i> s.n. (CAI)

phenograms were constructed, the first was based on the data of seed criteria and the second was based on combined characters of seed and macromorphological criteria.

RESULTS

Forty morphological characters concerned with seed shape, elevation, color, size, hilum, surface, peripheral ridges, cell pattern, anticlinal wall boundaries and embryo were studied. These characters used in computer analysis were indicated in Table 2. The seed structure and sculpture patterns are shown in Fig. 3 and 4. The numerical analysis of the seed characters was illustrated by the dendrogram shown in Fig. 1.

Four seed types were distinguished based on seed structure and elevation:

Silene type: This type is characteristic to *Silene* species. Seeds are generally ± reniform with lateral excavate hilum and peripheral or spiral embryo. The lateral surface is grooved on both sides. Some seed criteria are characteristic to confined species, e.g. the peripheral ridges are flat in *S. nocturna* and *S. rubella* (Fig. 3d) while in *S. villosa*, *S. behen* (Fig. 3g) and *S. gallica* (Fig. 3e) the seeds are characterized by tuberculate surface. Nevertheless, the seeds of *S. vivianii*, *S. apetala* and *S. colorata* (Fig. 3f) are characterized by conspicuous winged seeds. Lateral surfaces are generally smooth or granulate, rarely colliculate-granulate or tuberculate-granulate. Both lateral and peripheral face are usually similar in pattern and anticlinal wall boundaries being linear to broadly oblong, sinuate to wavy. In *S. nocturna* and *S. rubella* the anticlinal walls of lateral face are differ than peripheral ones.

Stellaria-Vaccaria type: Seeds are globose, not grooved with straight embryo and the hilum on the face. In *Stellaria* species the seeds are tuberculate and

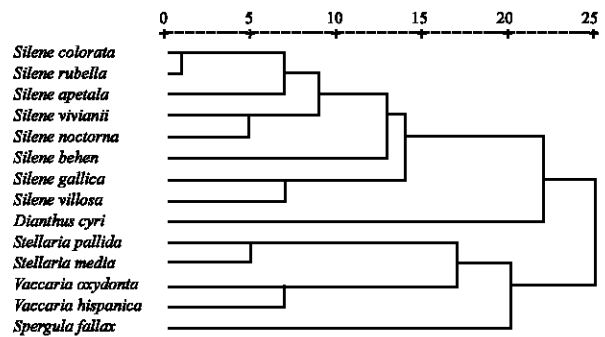


Fig. 1: Dendrogram illustrating the relationships among the fourteen studied species based on seed diversity

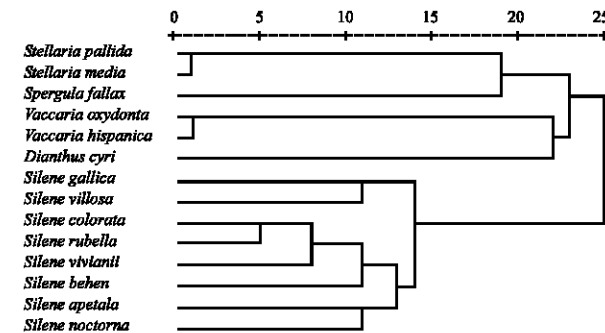


Fig. 2: Dendrogram illustrating the relationships among the fourteen studied species based on the variation in combined data of seed criteria and macromorphological characters

compressed laterally (Fig. 3i) while in *Vaccaria* they are smooth and concave (Fig. 3b and c). The cells are isodiametric, wavy to sinuate (Fig. 4c, k and l), in *Vaccaria hispanica*, they are rectangular and straight (Fig. 4b).

Spergula type: Seeds are compressed laterally, shield shape with broad hyaline entire wing (Fig. 3h). The hilum is on the face and the embryo is straight. The seeds are

Table 2: Seed criteria of the studied taxa

Seed character		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Shape	Elliptic	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Globose	0	1	1	0	0	0	0	0	0	0	0	1	1	0
	Ear-shape	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Rounded-reniform	0	0	0	1	1	1	1	1	1	0	1	0	0	0
	Shield-shape	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Laterally compressed	0	0	0	1	1	1	1	1	1	1	1	1	1	1
Elevation	Concave	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Grooved	0	0	0	0	1	0	0	0	1	0	0	0	0	0
	Flattened	1	0	0	0	0	1	1	1	0	1	1	0	1	1
	Rounded	0	1	1	0	0	0	0	0	0	0	0	1	0	0
Color	Reddish-brown	1	0	0	1	1	1	1	1	1	1	1	1	0	0
	Pale brown	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Black	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Size	0.4-0.9 mm in diameter	1	1	1	0	0	1	0	0	0	0	1	1	1	1
	1.3-2.0 mm in diameter	0	0	0	1	1	0	1	1	1	1	0	0	0	0
Hilum	On the face	1	1	1	0	0	0	0	0	0	0	0	1	1	1
	Lateral	0	0	0	1	1	1	1	1	1	1	1	0	0	0
	Flat	1	0	0	0	0	1	0	0	0	0	0	0	0	0
	Excavate	0	1	1	1	1	0	1	1	1	1	1	1	1	1
Peripheral ridges	Absent or not distinct	0	1	1	0	0	0	0	0	0	0	0	0	0	1
	Winged	1	0	0	0	0	0	0	0	0	1	1	0	0	1
	Flat	1	0	0	0	1	0	1	0	1	1	1	0	0	0
Lateral surface	Tuberculate	0	0	0	1	0	1	0	1	0	0	0	1	1	0
	Colliculate-granulate	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Tuberculate	0	0	0	0	0	0	0	0	0	0	0	1	1	1
	Granulate	1	0	0	1	0	0	1	0	0	0	1	0	0	0
	Smooth	0	1	1	0	1	1	0	1	0	0	0	0	0	0
Cell pattern	Tuberculate-granulate	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	Lomentum	0	0	0	0	0	1	0	0	1	1	0	1	0	0
	Isodiametric	0	0	1	0	0	0	0	0	0	0	0	1	1	0
	Rectangular	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Linear	1	0	0	1	1	1	1	1	1	1	1	0	0	1
	Broadly oblong	1	0	0	1	0	0	0	1	0	0	0	0	0	0
Anticlinal wall boundaries	Parallely arranged	0	0	0	0	1	1	1	0	1	1	1	0	0	1
	Randomly arranged	1	1	1	1	0	0	0	1	0	0	0	1	1	0
	Sinuate	1	0	0	0	1	1	1	1	0	1	1	1	1	0
	Wavy	0	1	0	1	0	0	0	0	1	0	0	0	0	1
	Straight	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Embryo	Straight	1	1	1	0	0	0	0	0	0	0	0	1	1	1
	Peripheral or spiral	0	0	0	1	1	1	1	1	1	1	1	0	0	0

(1) *Dianthus cyri*, (2) *Vaccaria hispanica*, (3) *Vaccaria oxydonta*, (4) *Silene villosa*, (5) *Silene nocturna*, (6) *Silene behen*, (7) *Silene rubella*, (8) *Silene gallica*, (9) *Silene vivianii*, (10) *Silene apetala*, (11) *Silene colorata*, (12) *Stellaria media*, (13) *Stellaria pallida* and (14) *Spergula fallax*

Table 3: Macromorphological criteria of the studied taxa

Macromorphological character		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Habit	Erect	1	1	1	0	1	0	0	1	0	1	1	0	0	1
	Ascending or decumbent	0	0	0	0	0	0	0	1	0	0	0	1	1	1
	Procumbent	0	0	0	1	0	1	1	0	1	0	0	0	0	0
Stem	Branched from base	1	0	0	1	1	1	1	1	1	1	1	1	1	1
	Branched above	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	Glabrous	1	1	1	0	0	1	1	0	0	0	0	0	0	1
	Partly hairy	0	0	0	0	0	0	0	1	0	0	0	1	1	0
	Appressed-pubescent	0	0	0	0	0	0	0	0	1	1	1	0	0	0
Leave	Papillose-viscid	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Puberulent	0	0	0	0	1	0	1	0	1	0	0	0	0	0
	Stipulate	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Exstipulate	1	1	1	1	1	1	1	1	1	1	1	1	1	0
	Linear	1	0	0	0	0	0	0	0	1	1	0	0	0	1
	Lanceolate	0	1	1	0	0	0	0	1	0	1	0	0	0	0
	Spathulate	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Spathulate to oblong	0	0	0	0	1	0	1	0	0	0	0	0	1	0
	Ovate	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Ovate-rhombic	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	Obovate	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Obovate-spathulate	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
Scabridulous	Scabridulous	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Obtuse	0	0	0	1	0	0	1	0	0	0	1	0	0	1
	Acute	1	1	1	0	1	1	0	1	1	1	1	1	1	0
	Scarious margined	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3: Continue

Macromorphological character	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Inflorescence														
Solitary	1	0	0	1	0	0	0	0	0	0	0	0	0	0
Dichasial cyme	0	1	1	1	0	1	1	0	0	0	0	0	0	0
Monochasial cyme	0	0	0	0	1	0	0	1	1	1	1	1	1	0
Bracteoles (Epicalyx)														
Absent	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Present	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Calyx (bracts)														
Leathery	0	0	0	1	0	1	1	1	1	1	1	1	0	0
Equal in length	1	1	1	1	0	1	1	1	1	1	1	1	1	1
Unequal in length	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Calyx of free sepals	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Calyx united in a tube	1	1	1	1	1	1	1	1	1	1	1	0	0	0
Lanceolate	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Spathulate	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Oblong-lanceolate	0	0	0	0	0	0	0	0	0	1	0	1	1	1
Oblong	0	0	0	0	1	1	1	0	1	0	1	0	0	0
Ovate	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Winged	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Tuberculate	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Nerves striate	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5-nerved	0	1	1	0	0	0	0	0	0	0	0	1	1	1
10-nerved	0	0	0	1	1	1	1	1	1	1	1	0	0	0
Nerves not winged	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Veins reddish	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Anatomizing	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Scarios tipped	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Scarios margined	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Narrowly scarios margined	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Teeth absent	1	0	1	0	0	0	0	0	0	0	0	1	1	1
Teeth lanceolate	0	0	1	0	1	0	0	0	0	1	0	0	0	0
Teeth triangular	0	1	0	0	1	0	0	0	0	1	0	0	0	0
Teeth ovate	0	0	0	1	0	1	0	1	0	0	0	0	0	0
Teeth oblong	0	0	0	0	0	0	1	0	1	0	1	0	0	0
Teeth obtuse	0	0	0	1	0	0	1	1	1	0	1	0	0	0
Teeth acute	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Petals														
Petals absent	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Differentiated into claw and limb	0	0	0	1	1	1	1	1	1	1	1	0	0	0
Not differentiated	1	1	1	0	0	0	0	0	0	0	0	1	1	1
Dentate	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Oblong	1	0	0	0	0	0	0	0	1	1	1	1	1	0
Lanceolate	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Obovate	0	0	0	1	1	1	1	1	0	0	0	0	0	0
Pink	1	1	1	1	0	1	1	1	0	0	1	0	0	0
White	0	0	0	0	1	0	0	1	1	0	0	1	1	1
Limb 2-parted	0	0	0	1	1	1	1	1	1	1	1	1	1	0
Lobes obovate	0	0	0	1	0	0	1	0	0	0	1	1	1	0
Lobes ovate-oblong	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Lobes linear	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Lobes cuneate	0	0	0	0	1	0	1	0	0	0	0	0	0	0
Lobes denticulate	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Stamens														
10	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1-2 or 5	0	0	0	0	0	0	0	0	0	0	0	1	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Ovary														
One-ovuled	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Many-ovuled	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Styles														
2	1	1	1	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	1	1	1	1	1	1	1	1	1	1	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Capsule														
4-valved dehiscent	1	1	1	0	0	0	0	0	0	0	0	0	0	0
5-valved dehiscent	0	0	0	0	0	0	0	0	0	0	0	0	0	1
6-valved dehiscent	0	0	0	0	0	0	0	0	0	0	0	1	1	0
3-5-valved dehiscent	0	0	0	1	1	1	1	1	1	1	1	0	0	0
Ovoid	1	0	0	0	0	1	1	0	1	0	1	1	1	1
Globose	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Oblong-ovoid	0	1	1	0	0	0	0	1	0	0	0	0	0	0
Oblong	0	0	0	1	1	0	0	0	0	0	0	0	0	0

(1) *Dianthus cyri*, (2) *Vaccaria hispanica*, (3) *Vaccaria oxydonta*, (4) *Silene villosa*, (5) *Silene nocturna*, (6) *Silene behen*, (7) *Silene rubella*, (8) *Silene gallica*, (9) *Silene vivianii*, (10) *Silene apetala*, (11) *Silene colorata*, (12) *Stellaria media*, (13) *Stellaria pallid* and (14) *Spergula fallax*

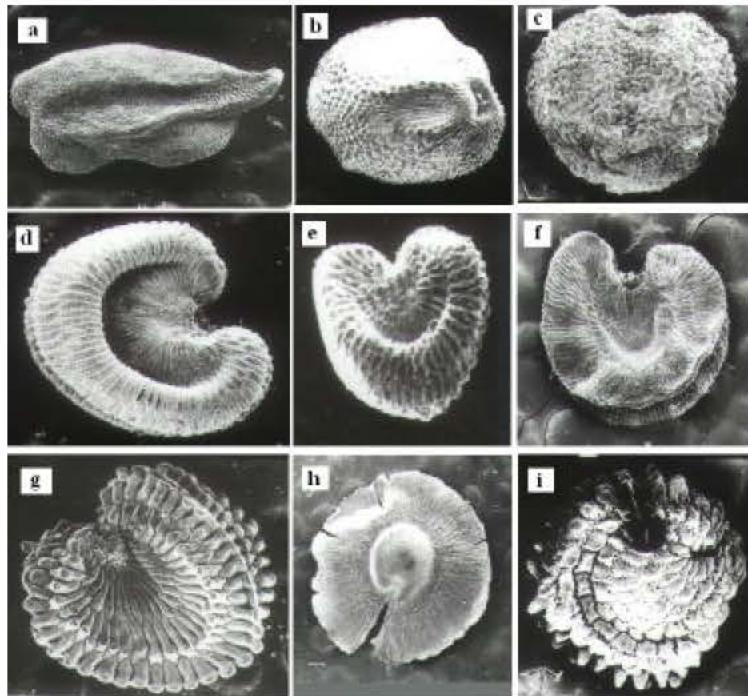


Fig. 3: SEM micrographs of seed shape:-(a) *Dianthus cydi*, (b) *Vaccaria hispanica*, (c) *Vaccaria oxydonta*, (d) *Silene rubella*, (e) *Silene gallica*, (f) *Silene colorata*, (g) *Silene behen*, (h) *Spergula fallax* and (i) *Stellaria pallida*

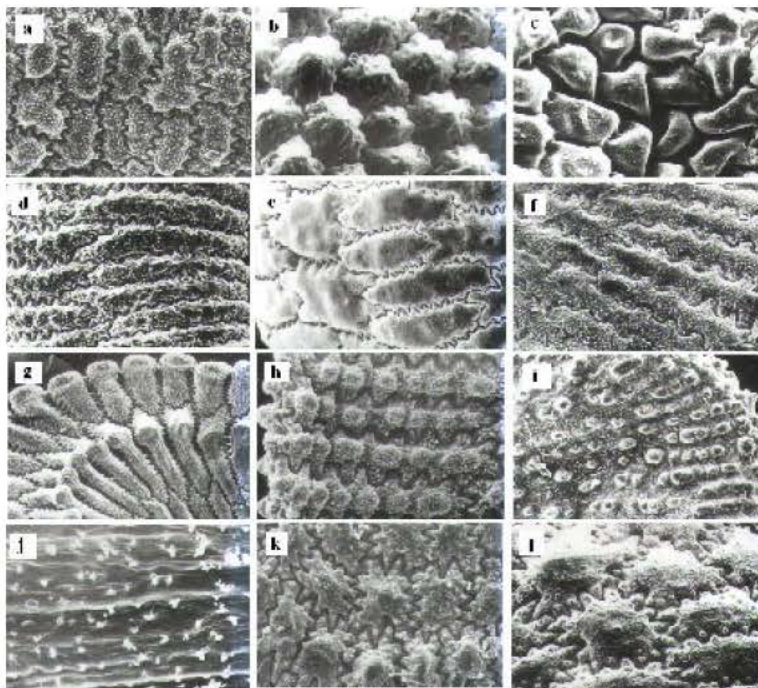


Fig. 3: SEM micrographs of seed coat surface:-(a) *Dianthus cydi*, (b) *Vaccaria hispanica*, (c) *Vaccaria oxydonta*, (d) *Silene rubella*, (e) *Silene gallica*, (f) *Silene colorata*, (g) *Silene behen*, (h) *Silene opetala*, (i) *Silene vivianii*, (j) *Spergula fallax*, (k) *Stellaria pallida* and (l) *Stellaria pallida*

tuberculate with linear cell pattern and wavy anticlinal wall boundaries (Fig. 4j).

Dianthus type: Seeds are elliptic, flattened with straight embryo and the hilum is on the face. The seeds are granulate with linear cell pattern and sinuate anticlinal wall boundaries (Fig. 4a).

Eighty-eight macromorphological characters concerned with vegetative organs (habit, stem, leaves) and reproductive organs (inflorescence, bracteoles, calyx, petals, stamens, ovary, styles, stigma and capsule) were indicated in Table 3. The numerical analysis of macromorphological data and seed characters as a combined data was illustrated by the phenogram shown in Fig. 2.

DISCUSSION

The analysis of certain morphological characters of seeds was applied for the systematic studies of the studied weed taxa, these characters were proved useful in the distinction and differentiation between these taxa.

The large number of stable seed characters observed by light and SEM indicating that the studied seeds are very diverse. This can provide good criteria for the classification of the species. Some criteria are characteristic and constant for some species, this allow the unequivocal identification of their character such as shield-shape seeds with broad hyaline wing for *Spergula fallax*; reniform seeds with laterally grooved surface and peripheral or spiral embryo for *Silene* species; isodiametric or rectangular cell surface for *Vaccaria* and *Stellaria* species.

The cluster analysis of the applied 128 character (Fig. 2) divided the studied species into two major groups. Of these, the genus *Silene* is delimited as a separate aggregate. This aggregate agrees with Pax and Hoffmann's regard^[12] in which they treated the *Silene* species as separate tribe namely Silenoideae.

Three morphologically homogenous groups are recognized in *Silene* aggregate. The first homogenous group is divided into *Silene gallica* and *S. villosa* with less degree of similarity being 52%, this result agrees with Chowdhuri^[13] who separated them in two sections based on morphological characters and Zareh^[14] into two groups based on pollen characters, the earlier possesses spinulose, tubuliferous/punctuate ectexine and the later possesses finely reticulate ectexine. Similarly, the second homogenous group is divided into *S. nocturna* and *S. apetala* with degree of similarity 52%, this also agrees with the regards of Chowdhuri^[13] and Zareh^[14] who

separated them in two different groups, the earlier possesses spinulose, tubuliferous/punctuate ectexine and the later possesses reticulate ectexine. On the other hand, the third homogenous group divided into *Silene colorata* and *S. rubella* with degree of similarity is 64%, the two species are also similar in their pollen grains being 30-35 porate and with spinulose, tubuliferous/punctuate ectexine^[14].

The dendrogram based on seed diversity showed that the relationship between the two closed taxa of *Stellaria* is 80%; this result seems to be adequate with the regards seeing them as two different species^[1,15]. On the other hand, the analysis based on the combined data showed that the degree of similarity between them is 92%; this result is very reliable as a taxonomic character and confirmed the regard seeing them as two closed subspecies (*Stellaria media* (L.) Vill. ssp. *media* and *Stellaria media* (L.) Vill. ssp. *pallida* (Dumort.) Asch and Graebn).

Similarly, the relationship between the two studied *Vaccaria* based on combined data is 92% and this confirmed to regard them as two subspecies namely *Vaccaria hispanica* (Mill.) Rauschert ssp. *hispanica* and *Vaccaria hispanica* (Mill.) Rauschert ssp. *oxyodonata* (Boiss.) Greuter and Burdet.

Dianthus cyri showed some affinity to *Silene* species (based on seed analysis only); *Dianthus* can easily distinguish morphologically from *Silene* species by its calyx that have 4 or more bracteoles at base (epicalyx). The analysis that based on combined data showed that the degree of similarity between them is very low (13%) and *Dianthus* is more similar to *Vaccaria*; this result agrees with the separation of *Dianthus* and *Silene* in two different tribes (Diantheae and Silenoideae), also the grouping of *Dianthus* and *Vaccaria* in tribe Diantheae^[12].

Stellaria and *Spergula* are regarded by Pax and Hoffmann^[12] as a third tribe known as Alsinoideae, the two genera are delimited in a cluster, two branches are united in a homogenous group and represent the two *Stellaria* species, the third branch represent *Spergula*, this result confirmed the regard them in one tribe.

The previous results showed that the numerical analysis of macromorphological data and seed characters as a combined data is more significant than the corresponding trees based on the analysis of seed characters alone.

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