

Morphological and Anatomical Studies of Seed Coat in *Silene* Species (Caryophyllaceae) from Jordan

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ABSTRACT. On the basis of a study of 22 of 30 species representing 12 sections of *Silene* in Jordan, we find that the seed coats exhibit considerable anatomical diversity, particularly the exotesta and mesotesta. Equivocal relationships are demonstrated for species with essentially identical seed features and seed coat sculpturing. Outer layers of the seed appear to be more open to adaptive modifications than inner ones.

The genus *Silene* (Caryophyllaceae) has traditionally been considered to consist more or less of about 35 species in Jordan, Palestine and Syria. As long ago as the Flora Orientalis (Boissier 1967) as well as the monographic works of Rohrbach (1968) and Williams (1896) recommended to botanists in search of the relationships within the genus *Silene*. The floras of Halacsy (1900) and Hayek (1924) mainly contain remarks on the shape, size of petals and corona, as well as other floral characters. Description of seed coat structure in *Silene* species is only summarized in floras at the end of generic descriptions and in Melzheimer (1987). This type of statement is to give first information for taxonomic or diagnostic purposes. It has been found satisfactory to examine the seed at high magnifications with the scanning electron microscope (SEM), as well as the seed coat anatomy, by light microscope, in order to obtain sufficient characters on seed coat layers or surface sculpturing.

Materials and Methods

1. Seed of 22 different species of 12 sections of *Silene* were collected on field trips and from Herbarium specimens (Department of Biological Sciences,

Yarmouk University and the Jordan Natural History Museum Herbarium, Yarmouk University. (Table 1).

2. Median longitudinal microtome sections (10-14 μm) of seed coats were studied by paraffin method (Berlyn and Miksche 1976).

3. Scanning electron micrographs (SEM) of many seeds of *Silene* species were examined using "Cambridges S 100" Scanning Electron Microscope provided by the Department of Systematic Botany, Freie Universität, Berlin, West Germany.

Results

The data described in Table 1 indicate a range of variation in colour of mature seeds from brown through grey to black. Shape ranges from reniform to ear-shaped or ovate to rounded. The seed coats ranged in thickness from 6-14 μm to 36-47 μm . The number of cell layers within seed coats range from 1-2, 2, 2-3 to 2-4.

In median longitudinal sections of mature seeds, the mature embryo is mostly enclosed by many rows of endospermal cells (Plate B, Fig. 2c) whose accumulated product is mainly starch (staining deeply blue in safranin-fast green stain). The whole is surrounded by a seed coat which mostly covered by a thin film of colourless mucilage layer and other resistant layers (Plates A-J), consisting of thick-walled, lignified, collapsed or sclerenchyma cells.

Finally, from previous data (Table 1) very good taxonomic evidence has emerged to recognize and differentiate the species of *Silene* as well as the studies of the seed coat surface under the scanning electron microscope. Various types of sculpturing can be detected from smooth in *S. succulenta* to granulate - tuberculate or papilla - like in *S. fuscata* (Plate D, Fig. 2, and Plate G, Fig. 2).

Discussion

The seed characters listed in Tables are helpful for recognition of some related species of *Silene*.

The seeds examined were in general reniform to ear-shaped or ovate-rounded and brown to black in colour, with the hard external surface varying from rough to smooth also indicating a display of (2-4) rows or cells at grooved back of the seed and (3-5) rows of tubercles at the convex face of the seed.

In median longitudinal sections of mature seed coats of species of *Silene*, (Table 1) composed of the tegment and testa (developed inner and outer integuments), exhibit considerable diversity in anatomy, particularly in features of the mesotesta and exotesta. Most of these species shearing variable features of 1. seed coat thickness, 2. seed coat number of layers, 3. presence or absence (collapsed) of mesotesta cells and 4. irregular swollen of exotesta cells. (Plate A).

Additional significant characters related to seed coat sculpturing are revealed by scanning electron microscopy and indicate that 1. *Silene apetala*, *S. colorata*, *S. colorata* spp. *oliveriana* and *S. vivianii* are more or less similar in their ear-shaped seeds and closely related in their sculpturing of seed coat (testa cells) (Pl. B & Pl. C). 2. *S. palaestina*, *S. succulenta*, *S. villosa*, and *S. villosa* var. *villosa* have the same type of smooth reticulation (Pl. D & Pl. E). 3. *S. aegyptiaca*, *S. conoidea* and *S. crassipes*, have more or less the same type of ovate-rounded shape of seeds and sculpturing of the seed coat (testa cell) (Pl. F). 4. *S. damascena*, *S. fuscata*, *S. gallica* and *S. linearis* they have nearly reniform shaped seeds and the same type of reticulation and striation of seed coat (testa cells) (Pl. G, & Pl. H). Finally, *S. longipetala*, *S. trinervis*, *S. arabica*, *S. coniflora* and *S. vulgaris*, have different seed shapes but they have more or less the same tuberculate-colliculate seed coat sculpturing pattern, (Pl. I & Pl. J).

In addition to the flora features seed characters of *Silene* species were used to separate the taxa from each other. Melzheimer (1987) used the characters of seed testa cells which were investigated under SEM to segregate the taxa. In this study we agree with Melzheimer's point of view but we add that these characters are not valid in delimiting the genus into different sections because some of the species from two different sections show the same seed character. These various types of seed surface sculpturing mentioned above are presumed to be due to hybridization or an ecological factor.

Acknowledgements

We wish to express our gratitude to Professor Dr. W. Frey, Freie Universität, Berlin, West Germany, for putting the material and the facilities of the scanning electron microscope at our disposal.

Table 1. Comparison of anatomical and morphological features of the seed coat of *Silene* species from Jordan

Section and species	Seed coat thickness μm	Seed coat No. cell layers	Mesotesta cells	Exotesta cells	Seed colour	Seed shape and sculpturing
Sect. Lasiostemones <i>Silene longipetala</i> Vent.	31-40	2-3	Present, collapsed	Irregularly swollen or collapsed	Brown	Reinform-tuberculate, flat to furrowed on back.
Sect. Inflatae <i>Silene vulgaris</i> (Moench) Garcke	36-47	3-4	Present, collapsed	Flattened or collapsed	Brown	Orbicular-reinform, finely tuberculate, flat to furrowed on back.
Sect. suffruticosae <i>Silene succulenta</i> Forssk.	—	—	—	—	Brown	Rounded smooth with nearly flat on back.
Sect. Rigidulae <i>Silene reinwardtii</i> Roth	25-33	2-4	Present, 2-3 rows	Irregularly swollen or collapsed	Deep brown	—
<i>Silene linearis</i> Decne	31-41	1-2	Present, collapsed	Papilla-like to flattened	Deep brown	Reinform finely wrinkled, nearly flat back.
Sect. Actocion <i>Silene aegyptiaca</i> (L.) L.f.	22-45	2	Absent	Undulate, dome-shaped	Light brown	Rounded, finely tuberculate with concave faces and nearly plane back.
<i>Silene fuscata</i> Link. ex Brot.	—	—	—	—	Light brown	Reinform deeply concave faces, wrinkled-tuberculate not furrowed back.
<i>Silene rubella</i> L.	8-19	2	Absent	Radially enlarged, papilla-like	Brown	—
Sect. Behenantha <i>Silene behen</i> L.	9-17	2-3	Absent	Undulate dome-shaped	Brown	—
Sect. Lasiocalycinae <i>Silene crassipes</i> Fenzl et Pulgill.	—	—	—	—	Brown	Rounded, wrinkled with deeply concave faces at center.
Sect. Dichotomae <i>Silene trinervis</i> Banks et Sol.	29-37	3-4	Present, 1-2 rows	Radially enlarged, papilla-like	Deep brown	Reinform, tuberculate with slightly concave faces and grooved back.

Table 1. (Contd.)

Section and species	Seed coat thickness μm	Seed coat No. cell layers	Mesotesta cells	Exotesta cells	Seed colour	Seed shape and sculpturing
Sect. Scorpioideae						
<i>Silene villosa</i> Forssk.	11-23	2	Absent	Radially enlarged, papilla-like	Deep brown	Reinform, smooth with faces, concave, and straight rows of wrinkles, not grooved back.
<i>Silene damascena</i> Boiss et Gaill.	8-19	2-3	Absent	Radially enlarged, papilla-like	Deep brown	Reinform, finely wrinkled deeply grooved on back.
<i>Silene palaestina</i> Boiss.	20-33	2	Absent	Swollen, papilla-like	Deep brown	Reinform, smooth wrinkled, slightly grooved on back.
<i>Silene vivianii</i> Steud.	19-31	2	Absent	Radially enlarged, papilla-like	Brown	Ear-shaped with undulate margins, rugose, deeply grooved back.
<i>Silene arabica</i> Boiss.	—	—	—	—	Brown	Reinform with widely deeply concave faces, finely straight and grooved back.
Sect. Silene						
<i>Silene gallica</i> L.	—	—	—	—	Black	Reinform, tuberculate, faces deeply concave and plane back.
Sect. Dipterospermae						
<i>Silene colorata</i> Poir.	8-22	2	Absent	Irregularly swollen or collapsed	Light brown	Ear-shaped with undulate wings acutely tuberculate on faces and deeply grooved.
<i>Silene colorata</i> Poir. subsp. <i>oliveriana</i> (Otth.) Rohrb	—	—	—	—	Light brown	Ear-shaped with undulate wings tuberculate on faces and deeply grooved.
<i>Silene apetala</i> Willd.	6-14	2	Absent	Radially enlarged, papilla-like	Deep brown	Ear-shaped with undulate margins, tuberculate.
Sect. Conoimorpha						
<i>Silene coniflora</i> Nees ex. Otth.	18-32	2-3	Present, collapsed	Irregularly swollen to flattened	Brown	Reinform, tuberculate-wrinkles, slightly concave and shallow grooved.
<i>Silene conoidea</i> L.	12-29	2-3	Present, collapsed	Irregularly swollen to flattened	Black	Rounded to ovate slightly tuberculate, nearly flat on back.

Table 2. Seed characters and type with related *Silene* species

Seed-shape, coat-structure Exotesta-sculpturing	Species
1. Rounded, smooth with nearly thick on back	<i>S. palaestina</i> , <i>S. succulenta</i> , <i>S. villosa</i> , <i>S. villosa</i> , var. <i>villosa</i> .
2. Ear-shaped with undulate wings, tuberculate	<i>S. apetala</i> , <i>S. colorata</i> , <i>S. colorata</i> var. <i>oliveriana</i> , <i>S. vivianii</i> .
3. Rounded to ovate exotesta. Swollen to flattened, or tuberculate, exotesta dome like.	<i>S. aegyptiaca</i> , <i>S. conidea</i> , <i>S. crassipes</i> .
4. Reniform, smooth, wrinkled exotesta, papilla like.	<i>S. damasciana</i> , <i>S. fuscata</i> , <i>S. gallica</i> , <i>S. linearis</i> .
5. Reniform tuberculate, wrinkled slightly concave, exotesta, papilla like or swollen to flattened.	<i>S. arabica</i> , <i>S. coniflora</i> , <i>S. longipetala</i> , <i>S. trinervis</i> , <i>S. vulgaris</i> .

Plate A. Cross sections of seed coats of *Silene*.

(extg: exotegmen; entg: endotegmen; exts: exotesta; ms: mesotesta).

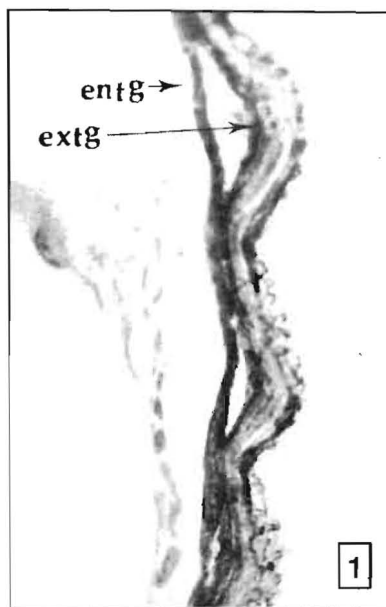
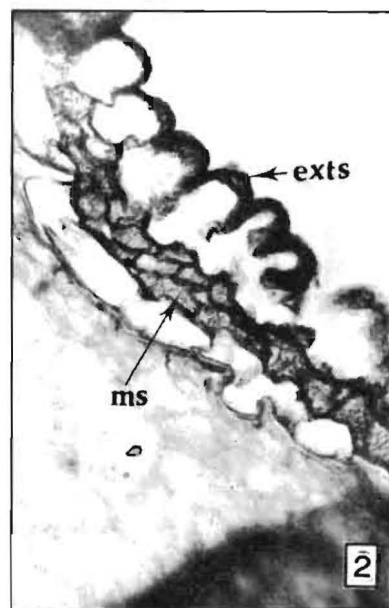
**Fig. 1.** *Silene behen*, ($\times 360$).**Fig. 2.** *Silene reinwardii*, ($\times 360$).**Fig. 3 & 4.** *Silene rubella*, ($\times 360$, $\times 240$).

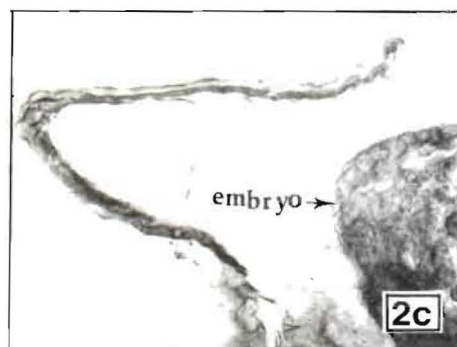
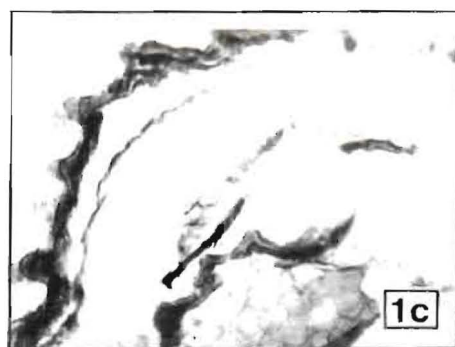
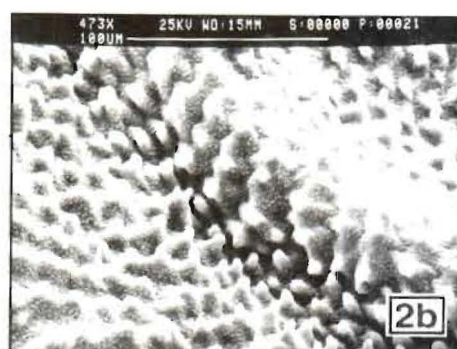
Plate B. Cross sections of seeds of *Silene*.**Fig. 1.** (a,b,c) *Silene apetala***Fig. 2.** (a,b,c) *Silene colorata*

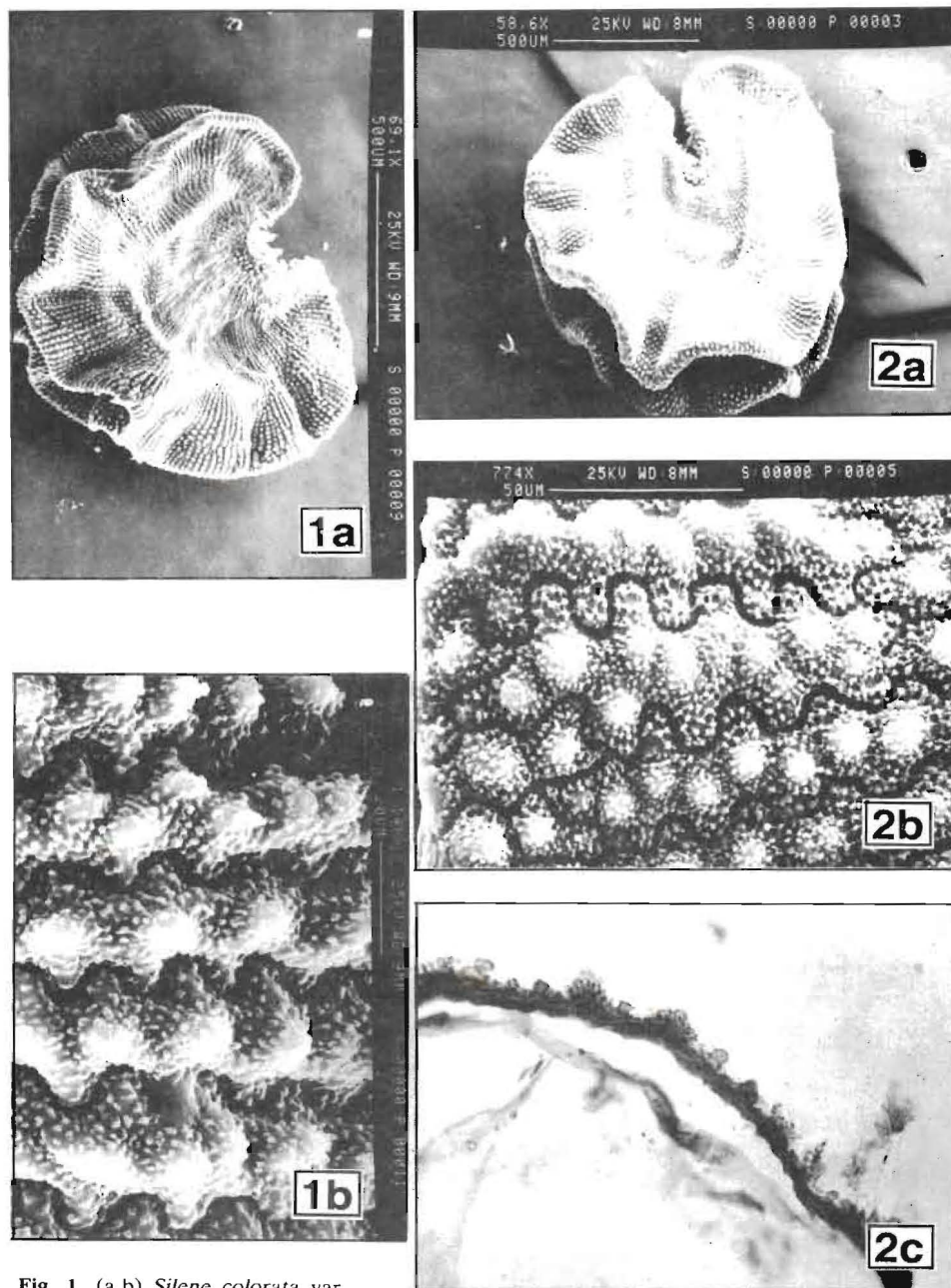
Plate C. Cross sections of seeds of *Silene*.Fig. 1. (a,b) *Silene colorata* var.
*oliveriana*Fig. 2. (a,b,c) *Silene vivianii*

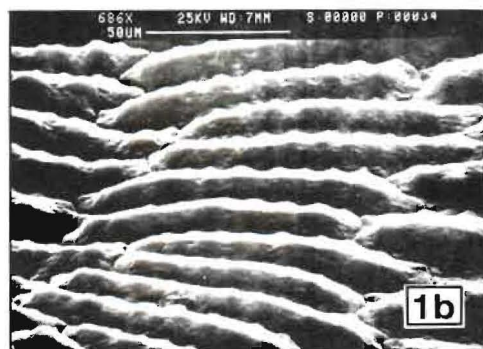
Plate D. Cross sections of seeds of *Silene*.**Fig. 1.** (a,b,c) *Silene palaestina***Fig. 2.** (a,b) *Silene succulenta*

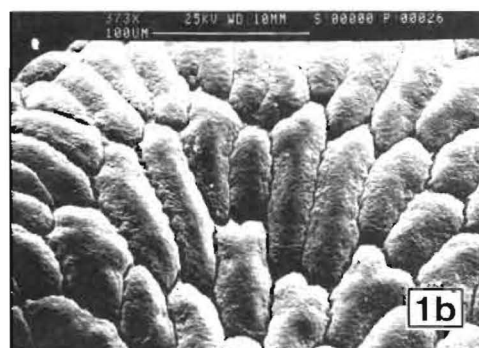
Plate E. Cross sections of seeds of *Silene*.Fig. 1. (a,b,c) *Silene villosa*Fig. 2. (a,b) *Silene villosa* var. *villosa*

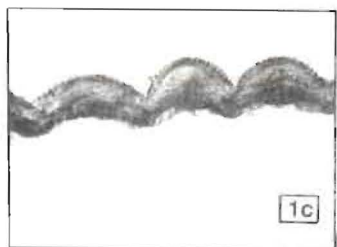
Plate F. Cross sections of seeds of *Silene*.Fig. 1. (a,b,c) *Silene aegyptiaca*Fig. 2. (a,b,c) *Silene conoidea*Fig. 3. (a,b) *Silene crassipes*

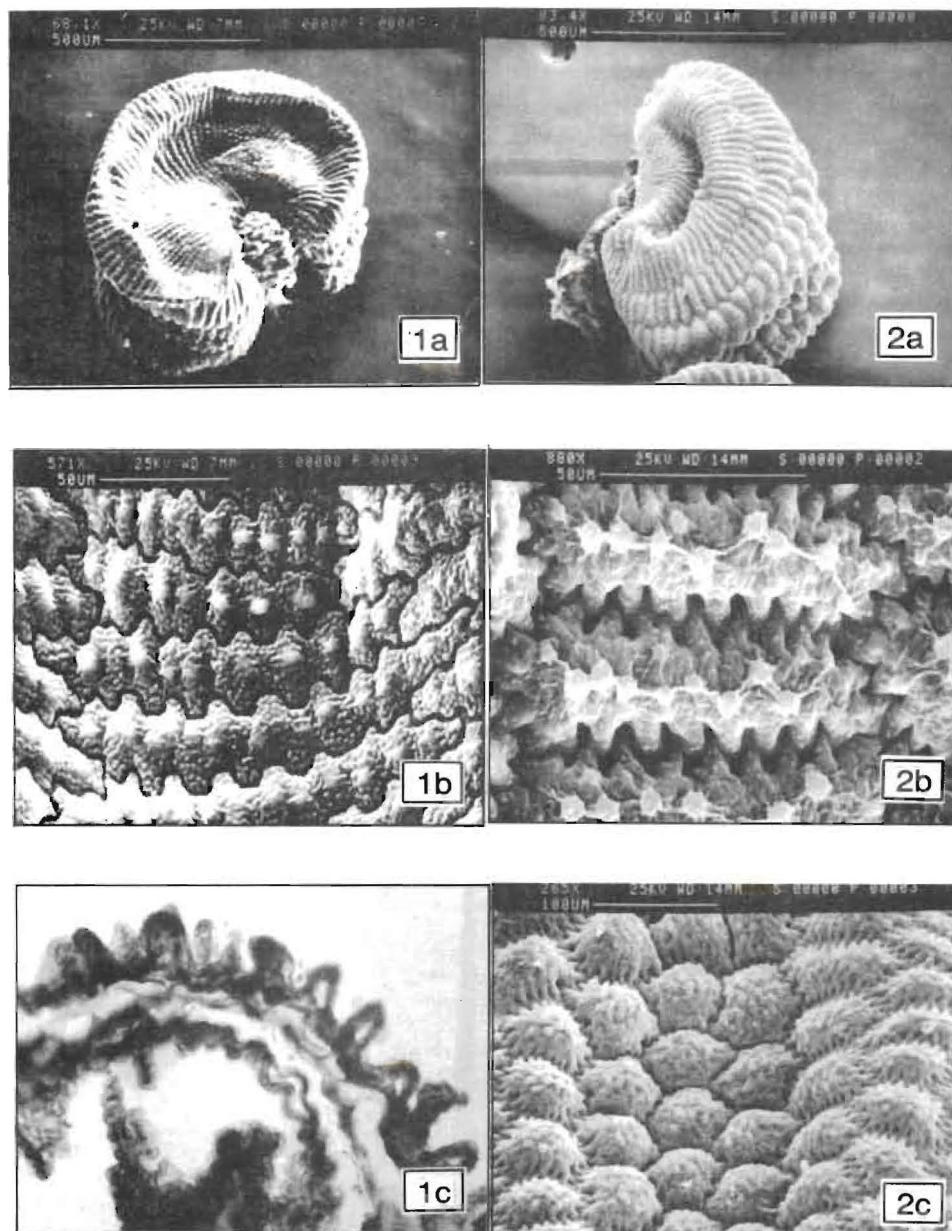
Plate G. Longitudinal sections of seeds of *Silene*.**Fig. 1.** (a,b,c) *Silene damascena***Fig. 2.** (a,b,c) *Silene fuscata*

Plate H. Cross sections of seeds of *Silene*.



Fig. 1. (a) *Silene gallica*

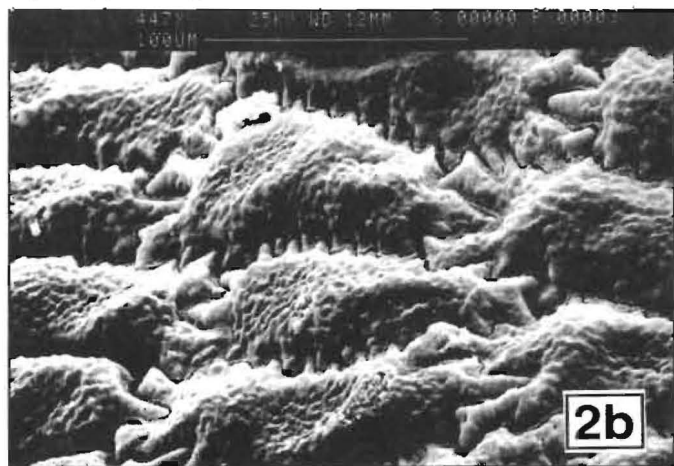


Fig. 2. (a,b,c) *Silene linearis*

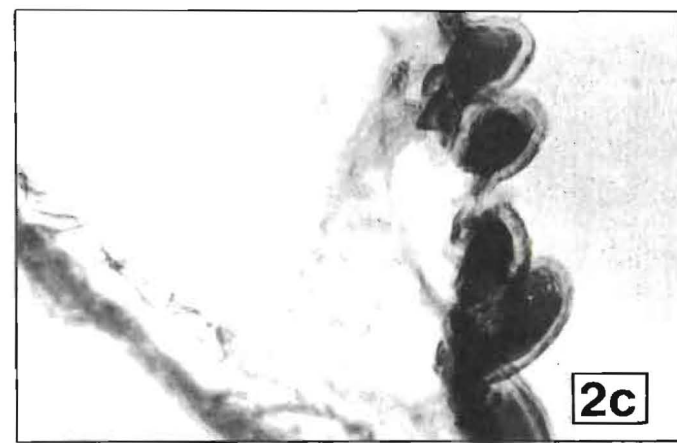


Plate I. Cross sections of seeds of *Silene*.



1a



1b

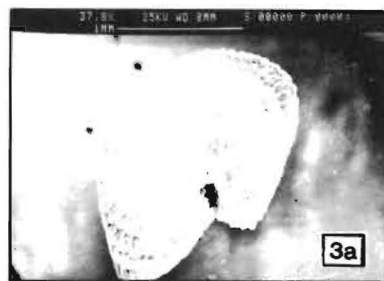


2a



2b

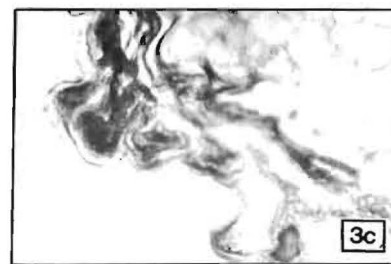
Fig. 2. (a,b) *Silene coniflora*



3a

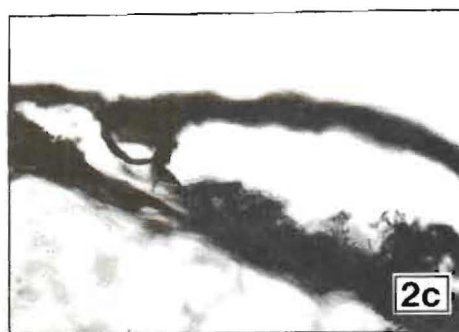
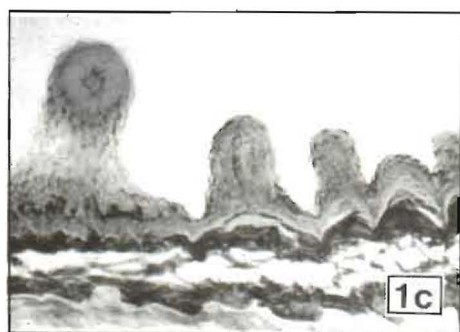
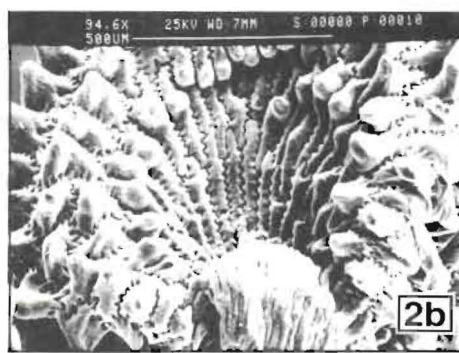
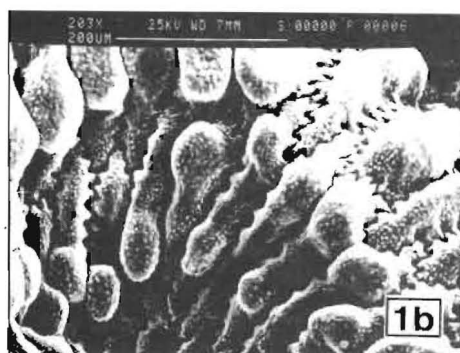
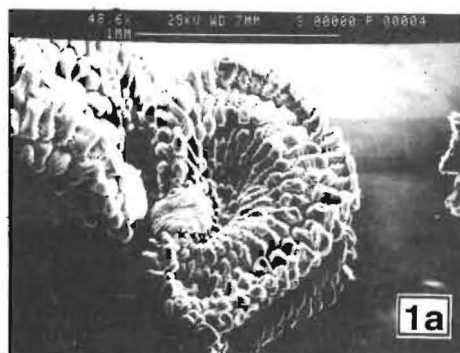


3b



3c

Fig. 3. (a,b,c) *Silene longipetala*

Plate J. Longitudinal sections of seeds of *Silene*.**Fig. 1.** (a,b,c) *Silene trinervis***Fig. 2.** (a,b,c) *Silene vulgaris*

References

- Berlyn, G.P. and Miksche, J.P.** (1976) *Botanical microtechnique and cytochemistry*, The Iowa State University Press, U.S.A.
- Boissier, E.** (1867) *Flora Orientalis*. 1. Genevae: Basileae & Lugduni, 576 p.
- Esau, K.** (1977) *Anatomy of Seed Plants*, John Wiley, New York, 767 p.
- Halácsy, E.von.** (1900) *Silene*, in: *Conspectus Florae Graecae*. 1: 153-196. Lipsiae.
- Hall, J.L.** (1978) *Electron microscopy and cytochemistry of plant cells*, Elsevier/North-Holland Biomedical Press.
- Hayek, A.von.** (1924) *Silene*, in: *Id. Prodrum Florae Peninsulae Balcanicae* 1: 255-285, *Reprt. Spec. Nov. Regni. Veg. Bcih.* 30(1): 255-285.
- Melzheimer, V.** (1987) On the taxonomic position of *Silene thebana* (Caryophyllaceae) *Pl. Syst. Evol.* 155: 251-256.
- Metcalf, C.R. and Chalk, L.** (1972) *Anatomy of the Dicotyledons*, Vol. I & II, Oxford University Press.
- Rohrbach, P.** (1868) *Monographie der Gattung Silene*. Leipzig, 210 p.
- Williams, Fr. N.** (1896) A revision of the genus *Silene*. *Linn. J. Bot.* 32: 1-196.
- Zohary, M.** (1966) *Flora Palaestina I*, Jerusalem, 364 p.

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دراسة المظهر الخارجي والتشريحي لاثنين وعشرين نوعاً من بذور نباتات جنس السايلين (عائلة الكاريوفيليسي) في الأردن

أحمد العقلة و فوزي محمد كريم

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أظهرت الدراسة التي تمت بواسطة المجهر الالكتروني الماسح لأنواع مختلفة من بذور نباتات جنس السايلين اختلافاً واضحاً في هذه الأنواع من حيث الشكل والسطح الخارجي للبذور كما أكدتها الدراسة التشريحية لهذه الأنواع من البذور.

ان جنس السايلين يقع ضمن العائلة النباتية كاريوفيليسي ويحتوي على حوالي (٣٠) نوعاً في الاردن والدول العربية المجاورة كما ورد في كتب الباحثين أمثال بواسيه في كتابه فلورا أورينتاليس سنة ١٩٦٧ . وكذلك العالم روباج ١٨٦٨ ووليم سنة ١٨٩٦ وهاليس سنة ١٩٠٠ وهيكل سنة ١٩٢٤ حيث كانت جميع دراساتهم لهذا الجنس تعتمد - بصورة خاصة على شكل وحجم أوراق التوزيع للزهرة مع إشارة بسيطة عابرة للبذور. ان هذا النوع من الدراسة ليس كافياً في الوقت الحاضر بعدم أن تم استخدام المجهر الالكتروني الماسح ، اضافة إلى عمل المقاطع بطريقة الشمع في البذرة . بينت الدراسة أنواع الطبقات الخلية المحيطة بها . وبذلك تمت اضافة معلومات جديدة عن أنواع هذا الجنس مدرجة في الجدول رقم (١) .

طريقة العمل

- ١ - بالتعاون مع جامعة برلين الحرة / ألمانيا الغربية تم انتقاء اثنين وعشرين (٢٢) نوعاً من بذور جنس السايلين من معشب متحف التاريخ الطبيعي الأردني ومعشب كلية العلوم قسم الحياة.

- ٢ - عمل شرائح مقاطع عرضية وطولية لهذه البذور بواسطة طريقة الشمع لدراسة طبقات الغلاف المحيط بجيني البذرة.
- ٣ - استعمال المجهر الالكتروني الماسح لدراسة السطح الخارجي للبذرة.

نتيجة البحث والمناقشة

يُلاحظ من الجدول رقم (١) والمتضمن الصفات التصنيفية للأنواع المدروسة، فقد أظهرت دراسة المظهر الخارجي للبذور لجنس السايدين بأنه يتغير ما بين اللون البني الرمادي إلى الأسود كما تبين لنا من خلال هذه الدراسة بأن الشكل العام للبذرة يتدرج من شكل الكلية إلى الشكل المستدير البيضوي مروراً بشكل الأذن. أظهرت الدراسة أيضاً بأن عدد صفوف الخلايا على الطرف الخارجي للبذرة (صفة تصنيفية جيدة وتختلف من نوع لآخر) في الأنواع المدروسة ما بين ١ - ٤ صفوف.

وكنتييجة لدراسة تشريح البذرة تحت المجهر الضوئي أظهرت بأن الجنين محاطاً كلياً بطبقات من خلايا للاندوسيرم، وتعتبر هذه الصفات صفة تشخيصية للأنواع. ان استخدام المجهر الماسح الالكتروني أظهر صفات جديدة وجيدة تضاف إلى الصفات التشخيصية الأخرى من أجل تثبيت وفرز الأنواع عن بعضها البعض. اعتماداً على الصفات كلها مجتمعة وعلى ضوء النتائج التي يتم التوصل إليها أثبتت الدراسة ثلاثة نماذج من الخلايا للغلاف الخارجي.