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Palynological Studies in the Genus *Silene* L. (Caryophyllaceae) from Jordan

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ABSTRACT. Pollen morphology of 12 species of the genus *Silene* belonging to 8 sections were investigated by using Light Microscope SEM and TEM. Three groups of exine type of the pollen grains were shown, punctate, punctate-undulate and semi-reticulate. TEM micrographs show that operculate, non-annulate pore are made of the same layers as the exine *i.e.* tectum, columellae and foot layer. This emphasizes the retention of the Caryophyllaceae in the Centrospermae.

Pollen morphological characters are of great value at specific or generic levels in plant taxonomy. Palynologists make use of the number, form and location of apertures, and the sculpturing on the surface of the exine as well as the general shape and size of the pollen grains. In addition to light microscope (LM), Scanning (SEM) and Transmission (TEM) electron microscopy studies are of great assistance in examining clearly the exine and intine structures (Erdtman and Dunbar 1966). Pollen and spore characters are receiving increased recognition for their value in determining taxonomic dispositions and phylogentic relationships at the species, generic and familial levels (Erdtman 1952).

Nowicke (1975) studied the pollen of the families of the Centrospermae and concluded that there was a close and natural association with the presence of spinulose or tubuliferous and punctate ektexines in the Caryophyllaceae and other related families.

Ghazanfar (1984) studied the pollen morphology of some species of *Silene* of the sections *Siphonomorpha* and *Auriculatae*. She showed only punctate tubuliferous/spinulose ektexine and punctate, reticulate or semi-reticulate tubuliferous/spinulose ektexine.

In the present investigation 12 species of *Silence* (Caryophyllaceae) of the 8 sections in Jordan have been studied.

Materials and Methods

All pollen grains listed in Table 1, were obtained from fresh flowers collected directly during field trips and from dried specimens kept in the following Herbaria, (Department of Biological Sciences, Jordan Natural History Museum, Yarmouk University and the Herbarium of plant systematics, Department of Freie Universitat-Berlin, West Germany).

Samples of pollen grains were analyzed with a Scanning and Transmission electron and Light microscopes.

1. Erdtman's improved acetolysis method (1960) was used to acetolyse the mature pollen grains and their characters were studied as listed in Table 1. Measurements and observations by light microscope were for an average of 10-15 grains for each species.
2. For Scanning electron microscopy mature anthers were selected from dry specimens, then pressed or squeezed. The pollen grains were fixed on a clean stub with double-sided sellotape. Then stubs were transferred into the rotatory coating apparatus and coated under vacuum with gold and the mounted specimens examined in a Zeiss Scanning electron microscope at a voltage of 20-25 kv. Photographs were taken at different magnifications.
3. Transmission electron microscopy was used for the study of two species of *Silene*, grains being fixed in glutaraldehyde, in phosphate buffer (pH 7.4) and then post fixed in 0.2% Osmium tetroxide dissolved in phosphate buffer. Epon-Araldite resin was used for embedding (Glauert 1974). The sections were cut with an Ultratome-E and thin sections contrast-stained with uranyl acetate and lead citrate. (A Zeiss microscope EMLOCR, of the Biology Department, Yarmouk University, was used for examination).

Results

The morphological characteristics of the pollen grains of *Silene* species were calculated (Table 1). The diameter of pollen grains studied ranged from 36-60 μm. The number of pores ranged from 21-50. The distance between any two pores ranged from 2.5-10 μm. The diameter of pores ranged from 3-6 μm.

Examination of the ektexine surface of all species under the SEM gave very

Table 1. Pollen morphology of some species of *Silene* in Jordan.

Sections and species	Diameter of pollen (μm)	Number of pores	Pore Cover	Distance between (2) pores (μm)	Diameter of pores (μm)	Sculpture of Ektexine
Sect. Inflatae						
Silene vulgaris (Moench) Gracke	42-48	24-33	Present	7-10	5-6	Punctate
Sect. Rigidulae						
Silene reinwardtii Roth.	51-57	22-31	Absent	4-5	4-5	Punctate-undulate
Sect. Atocion						
Silene aegyptiaca (L.) L.f.	39-42	25-32	Present	5-6	5-6	Punctate
Sect. Lasiocalycinae						
Silene crassipes Fenzl et Pugill	36-42	20-27	Present	5-8	3-4	Punctate
Sect. Dichotomae						
Silene trinervis Banks et Sol.	42-45	21-29	Absent	4-4.5	4-4.5	Punctate-undulate
Sect. Scorpioideae						
Silene villosa Forssk.	45-51	28-37	Present	4-6	4-6	Semi-reticulate
Silene palaestina Boiss.	42-45	31-40	Present	3-4	3.5-4.5	Semi-reticulate
Silene vivianii Steud.	45-51	27-35	Absent	4-4.5	4-4.5	Punctate-undulate
Silene arabica Boiss.	54-60	36-42	Present	3.5-4.5	3.5-4.5	Punctate
Sect. Dipterospermae						
Silene colorata Poir.	48-54	32-40	Present	2.5-3.5	3-5	Semi-reticulate
Sect. Conoimorpha						
Silene coniflora Ness ex Otth.	39-42	41-50	Present	3.6-4	3-4	Punctate
Silene coniodea L.	45-51	37-44	Present	3-4.5	3-4.5	Punctate

good diagnostic characters. These exine surfaces showed three types of sculpturing: punctate, punctate-undulate, and semi-reticulate (pls. A,B,C,D,E and F).

TEM micrographs of cross sections of pollen (*S. aegyptiaca* section *Atocion* and *S. damacena* section *Seropioideae*) (pls. G & H) showed an exine has more or less a distinguishable wall, with regular voids (operculum) which are covered by a thick layer of a surface coating material, while in the other *Silene* species the voids are filled with a dark material and spinulose protuberances. The endexine (MEDINE, Saad 1986) is in a fragmented state, while the intine form a clear continuous electron transparent layer.

Discussion

The pollen grains of 12 species of *Silene* studied were pantoporate, spheroid in shape and with the pores operculate and non-annulate, easily seen and distinctly delimited (pls. A,B,C,D,E and F).

The shape of the pores in all species is isodiametric and rounded. The number and the diameter of pores, and the distance between them, varied considerably. The highest pore number (41-50) is found in *S. coniflora*, the lowest (20-27) in *S. crassipes*. The largest pore diameter 5-6 μm is found in *S. vulgaris* and *S. aegyptiaca*. The largest distance between pores 5-10 μm was found in *S. vulgaris* and *S. crassipes* (Table 1).

Three different exine sculpturing patterns were shown by SEM. A punctate exine was found in 6 species, punctate-undulate was present in 3 species and semi-reticulate sculpturing was present in 3 species. It was possible to differentiate or separate them according to the fine details of various kinds of verucation and perforations (*e.g.* size, shape and distance between them). The presence of a semi-reticulate exine seems likely to have been derived from the punctate condition and is regarded to be phylogentically more advanced than the others (Ghazanfar 1984).

TEM micrographs of non-acetolysed grains of *S. aegyptiaca* and *S. damascena* (pls. G & H), have more or less the same layers of exine (*e.g.* tectum, columellae and foot layer), while the plants are morphologically different (Zohary 1966). On the other hand the endexine layer is fragmented, well developed and is clear under the pores, which indicates it of being more advanced from a phylogentical point of view (Saad 1972; Saad and El-Ghazaly 1986).

It seems that the number and diameter of pores in Jordanian *Silene* (Table 1) are influenced by the prevailing environmental conditions under which the particular species survive. The smallest number and diameter of pores seem

associated with a dry habitat, while the mesophytic species which are adapted to less sever environmental conditions, possess higher number and larger diameters than those of xerophytic species (Clarke and Jones 1977).

The same may be true of the presence or absence of the operculum (solid lid covering the pore) in the grains. The species without an operculum are found in dry places (Basset and Crompton 1967; Saad 1986).

Finally, the present investigation concerns the morphology of pollen of some species of *Silene* in Jordan and also to emphasize the systematic study of these species. Our data supports the views of (Ghazanfar 1984; Nowicke 1975), about the exine's reticulation and the retention of the Caryophyllaceae in the Centrospermae.

Acknowledgements

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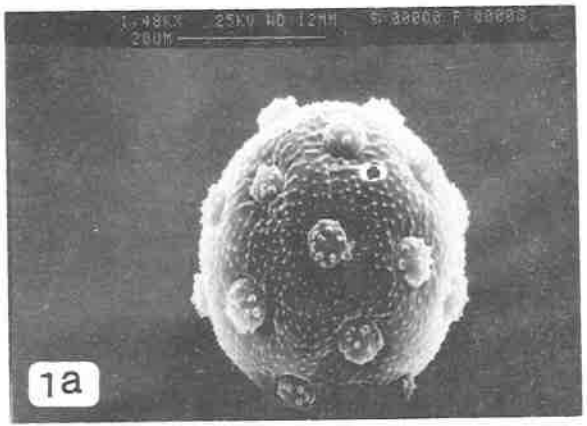
Plate A: (SEM) Scanning electron micrographs of pollen grains of *Silene*.



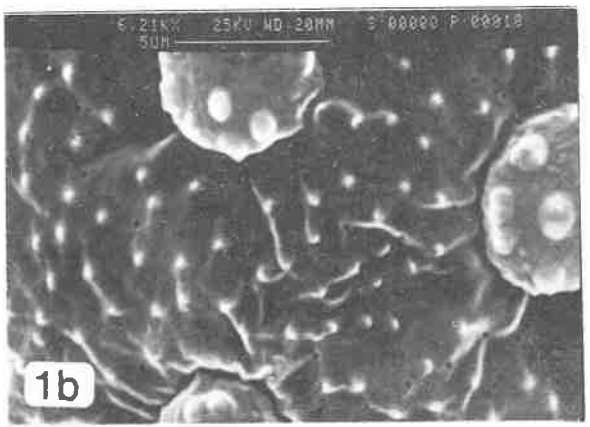
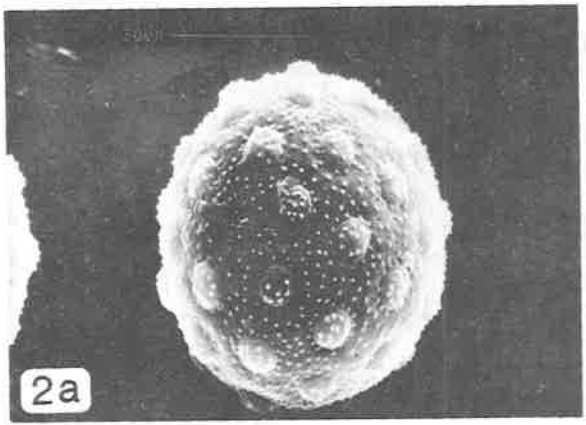


Fig. 1. (a&b) *Silene aegyptiaca.*



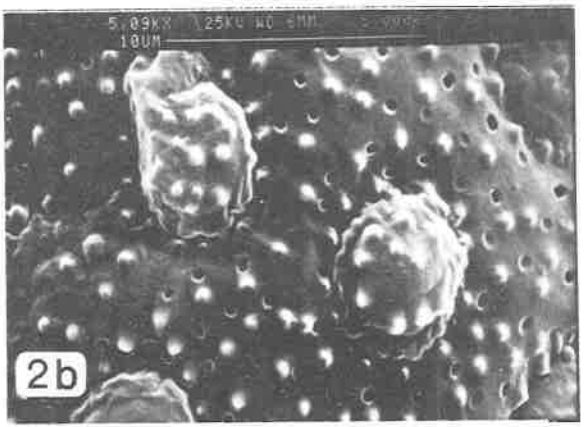
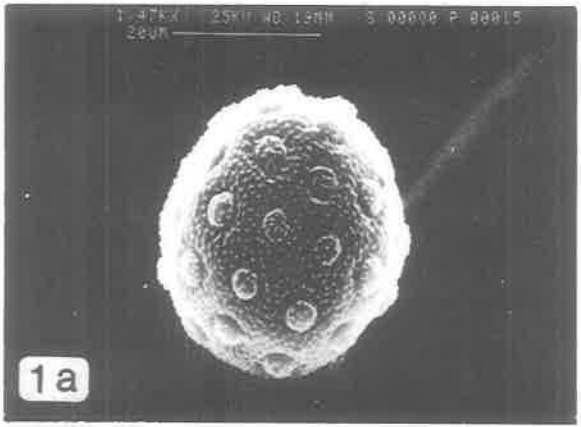
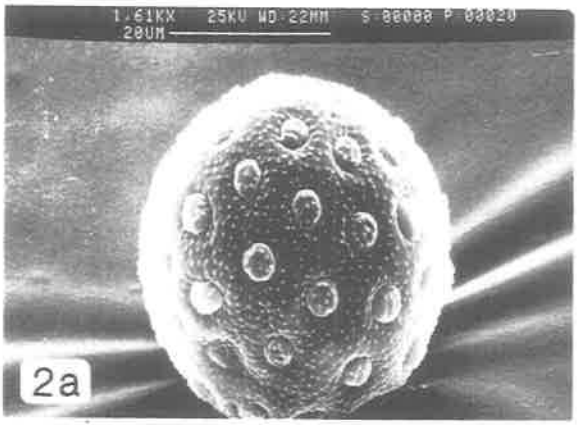
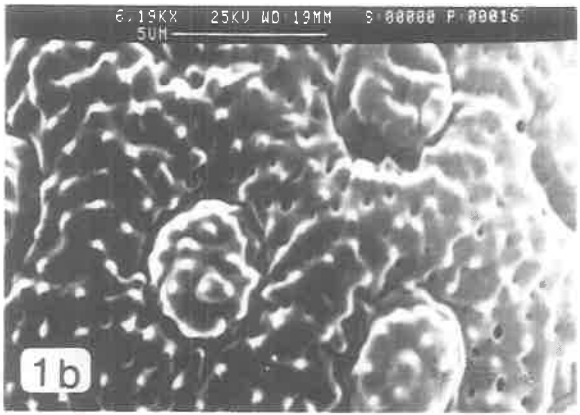


Fig. 2. (a&b) *Silene colorata.*

Plate B: (SEM) Scanning electron micrographs of pollen grains of *Silene*.







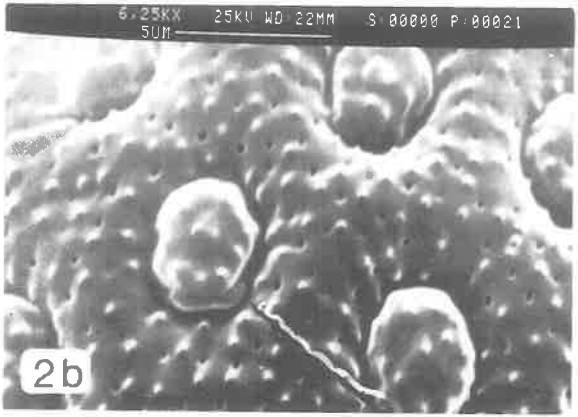
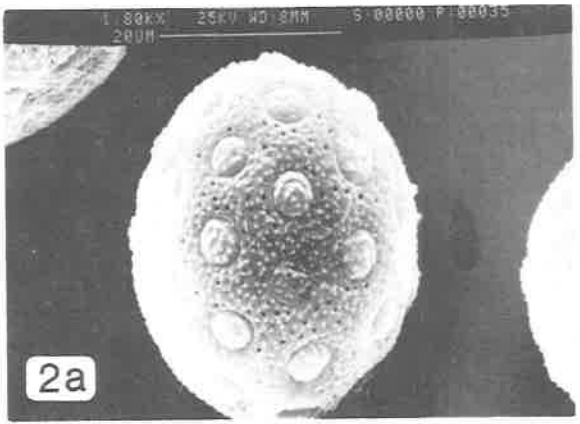
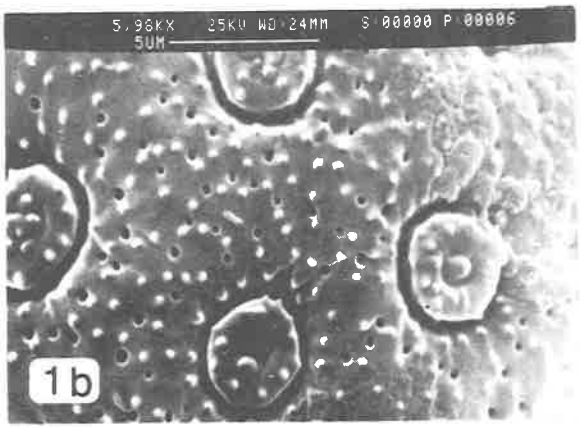


Fig. 1. (a&b) *Silene arabica.*

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

Plate C: (SEM) Scanning electron micrographs of pollen grains of *Silene*.





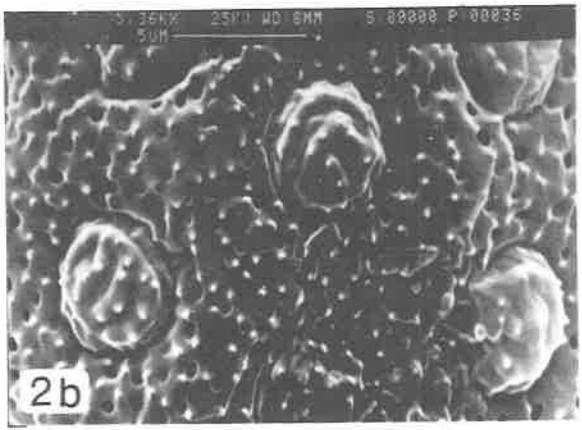
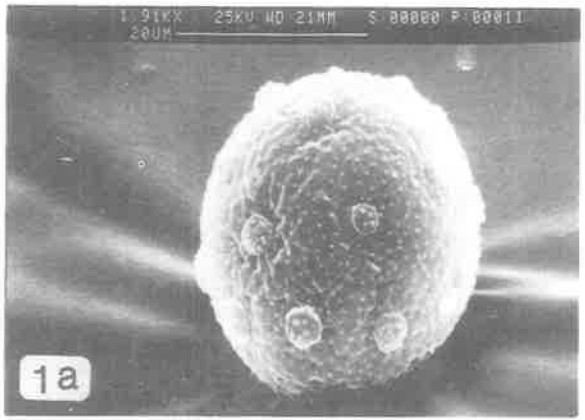


Fig. 1. (a&b) *Silene conoidea.*

Fig. 2. (a&b) *Silene paleastina.*

Plate D: (SEM) Scanning electron micrographs of pollen grains of *Silene*.



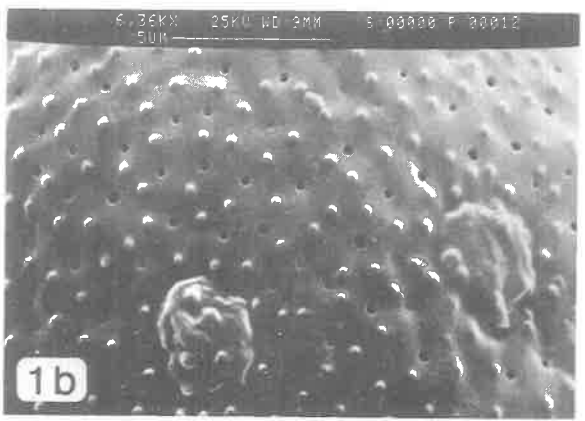
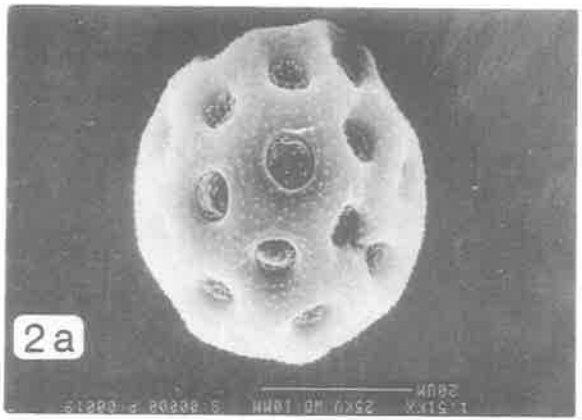


Fig. 1. (a&b) *Silene crassipes*.



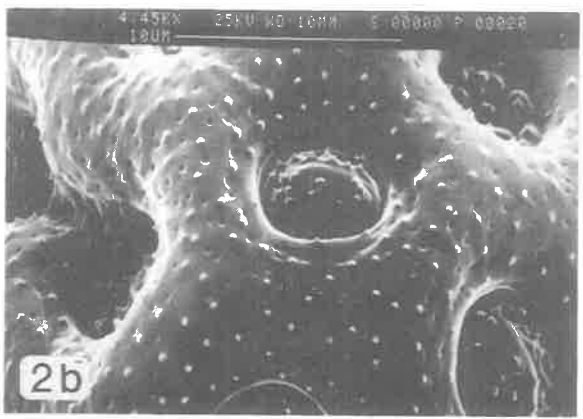
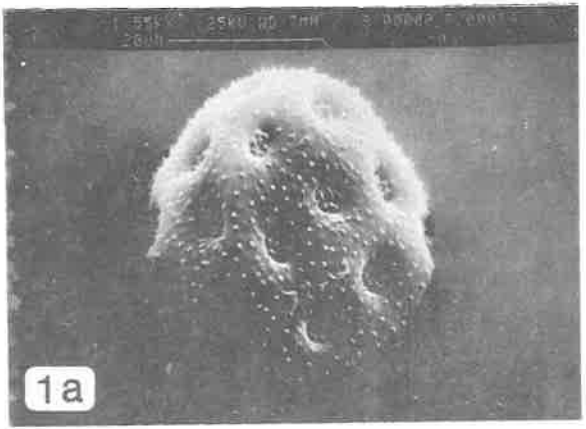


Fig. 2. (a&b) *Silene reinwardtii*.

Plate E: (SEM) Scanning electron micrographs of pollen grains of *Silene*.



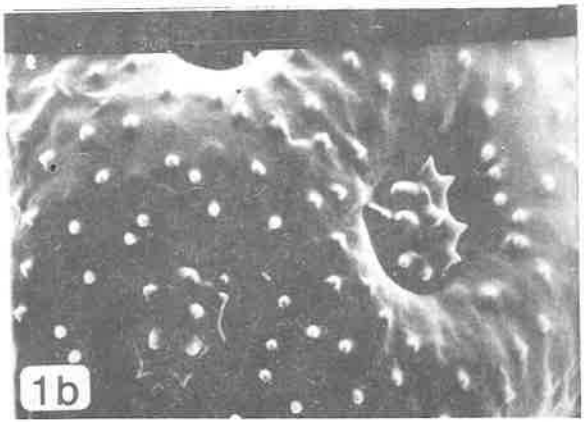


Fig. 1. (a&b) *Silene trinervis.*

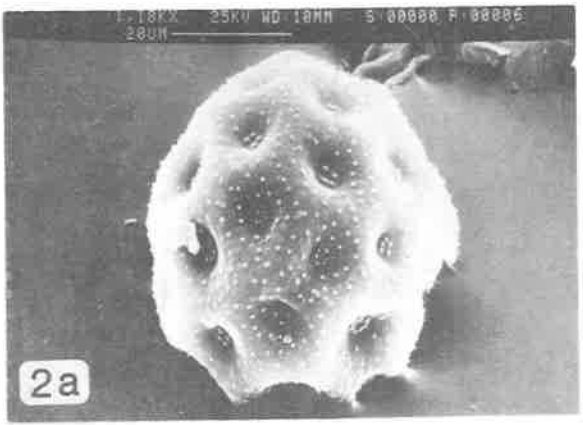
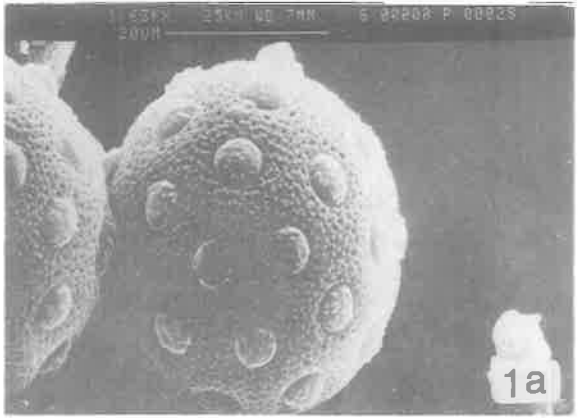
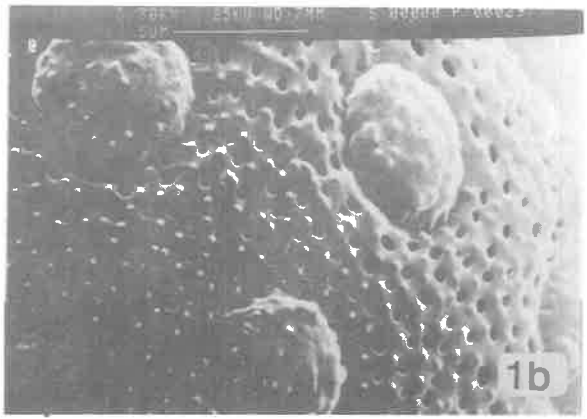


Fig. 2. (a&b) *Silene vivianii.*

Plate F: (SEM) Scanning electron micrographs of pollen grains of *Silene*.





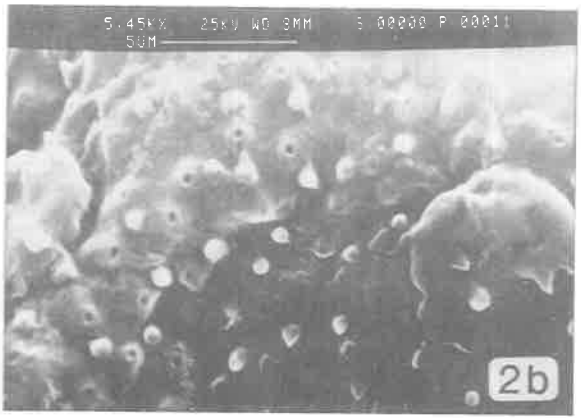


Fig. 1. (a&b) *Silene villosa.*

Fig. 2. (a&b) *Silene vulgaris.*

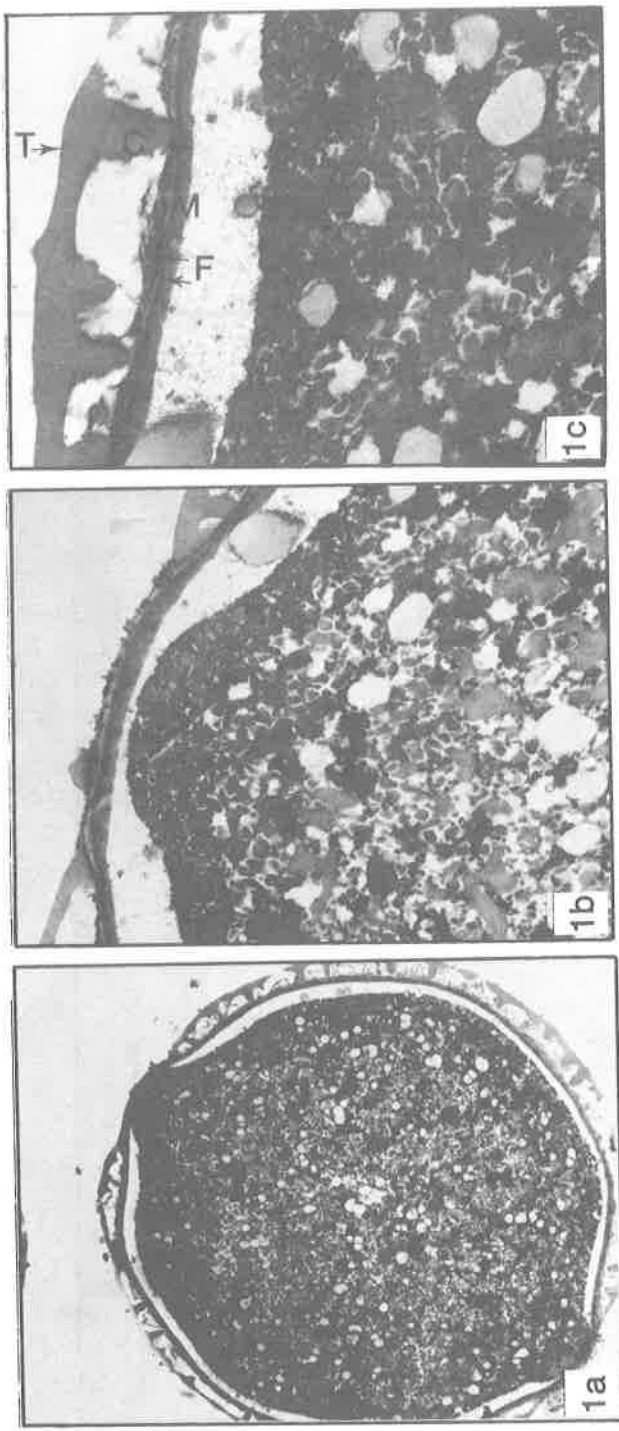


Plate G: Fig. 1, (a,b&c) (TEM) Transmission electron micrographs (X3240, X12000, X20000) of pollen grain of *Silene aegyptiaca*, sections through non-acetolysed pollen grain. Notice the tectum (T), columella (C), foot layer (F) and the medine (M).

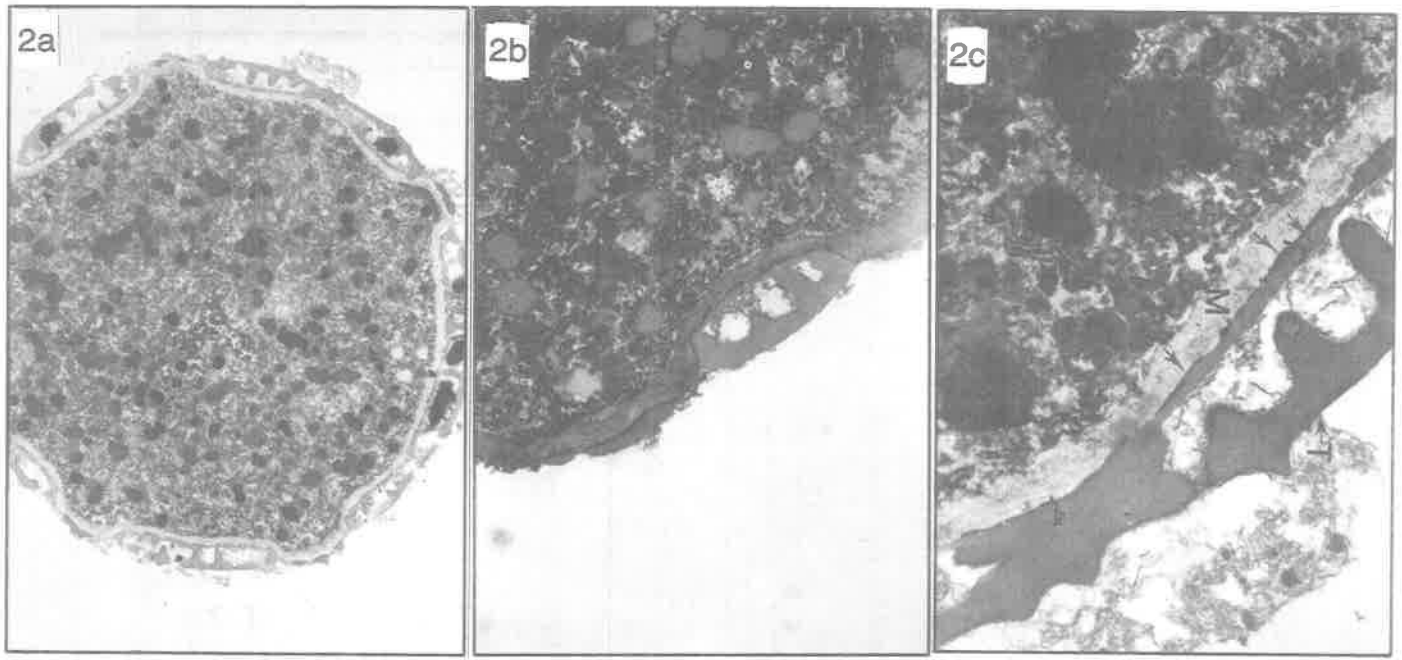


Plate H: Fig. 1, (a,b&c) (TEM) Transmission electron micrographs (X3240, X12000, X20000) of pollen grain of *Silene damascena*, sections through non-acetolysed pollen grain. Showing the tectum (T), columella (C), foot layer (F) and the medine (M).

دراسة المظهر الخارجي والتشريحي لاثنى عشر نوعا من حبوب اللقاح لنباتات جنس السايلين (عائلة الكاريوفيليسي) في الأردن

فوزي محمد كريم و أحمد العقله

متحف التاريخ الطبيعي - جامعة اليرموك - اربد - الأردن

أظهرت الدراسة التي تمت بواسطة المجهر الالكتروني الماسح والناقل والمجهر الاعتيادي، لأنواع مختلفة من حبوب اللقاح لنباتات جنس السايلين اختلافاً واضحاً في هذه الأنواع من حيث الشكل والسطح الخارجي كما اكدتها الدراسة التشريحية لهذه الانواع من حبوب اللقاح وعلاقة ذلك بالبيئة والمناخ ومدى إنتشار هذه النباتات في الأردن.

الصفات المورفولوجيه لحبوب أو غبار اللقاح في جنس السايلين لها ميزات مختلفه يمكن بواسطتها دمج أو فصل بعض الأنواع عن بعضها أو العكس صحيح. فمختلف الدراسات التصنيفيه الحديثه للنباتات تعتمد على شكل، حجم، زخارف السطح الخارجي، أو عدد ونوع طبقات الغلاف الخارجي بواسطة المقاطع التشريحيه لحبوب اللقاح وتتم هذه الدراسة عادة بواسطة المجهر الضوئي الاعتيادي والمجهر الالكتروني الماسح والناقل. فقد اظهرت الدراسات السابقه التي قام بها كل من نويك ١٩٧٥ لدراسة عائلة الكاريوفيليسي ومدى علاقتهابالعوائل المقاربه لها بواسطة الطرق المذكوره اعلاه، وكذلك غضنفر ١٩٨٤ دراستها لأنواع السايلين في امريكا واوروبا بواسطة نفس الطرق السابقه. وقد جاءت دراستنا لأنواع السايلين في الأردن مطابقه تماما كما تم دراسته سابقاً.

طريقة العمل:

١ - بالتعاون مع جامعة برلين الحره/ المانيا الغربيه تمت دراسة اثنا عشر نوعا من جنس السايلين التابع لعائلة الكاريوفيليسي في الأردن وقد اخذت العينات

من الحقل مباشرة أو من معشب متحف التاريخ الطبيعي الأردني، ومعشب كلية العلوم قسم علوم الحياه، وكذلك من معشب قسم النبات/ جامعة برلين الحره.

٢ ـ تمت دراسة الأنواع المذكورة في الجدول رقم (١) لحبوب اللقاح بواسطة المجهر الضوئي الاعتيادي والمجهر الالكتروني الماسح والناقل.

نتيجة البحث والمناقشه:

ان نتيجة دراسة هذه الأنواع من حبوب اللقاح مذكوره في جدول رقم (١) من البحث فقد اظهرت الدراسة فروقاً واضحة في الحجم وعدد الثقوب الموجوده في كل حبة من هذه الحبوب حسب كل نوع وبيئته. ولوحظ ان السطح الخارجي لجدار حبة اللقاح اظهر زخرفته تباين مابين نوع ونوع آخر حيث اظهرت الدراسة ثلاثة أنواع من الزخارف يقع تحت كل منها مجموعة من أنواع جنس السايلين وتبين لنا أن ثقوب الانبات لحبوب اللقاح قد تكون مغطاة في بعض الانواع بأغطية قد تكون منبعجة خارج جدار اللقاح وهي ذات زخارف وزوائد مختلفة عن زخارف حبة اللقاح نفسها وفي بعض الأنواع الأخرى تكون هذه الاغطيه قابعة تحت مستوى الجدار الخارجي لحبة اللقاح وتكون ذات لون داكن وزوائد شوكيه وزخارف قد تنسجم مع الزخارف العامه للحبة كلها. كذلك اظهرت دارسة الشكل الخارجي وعدد الثقوب الموجودة في حبة اللقاح العلاقة بعضها ببعض ومدى تأثر هذه الانواع بالحرارة والرطوبة والبيئه وتأثير ذلك على إنتشار تلك الانواع في البيئات المختلفة للأردن.