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POLLEN MORPHOLOGY OF THE THREE GENERA OF SUBFAMILY PAPILIONOIDEAE IN EGYPT (*MELILOTUS*, *TRIFOLIUM* AND *TRIGONELLA*)

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The pollen morphology of 28 species belonging to three genera (*Melilotus*, *Trifolium* and *Trigonella*) of subfamily Papilionoideae in Egypt was studied. The size, shape, exine ornamentation and structure of the aperture allowed the recognition of three pollen types, viz. *Trifolium* type (subtypes 1 and 2), *Trigonella* type and *Melilotus* type (subtypes 1 and 2). This result will help establishing the taxonomic position of the species within their genera. A key to the generic types and subtypes is given.

Key words: Leguminosae, light microscopy (LM), pollen grains, scanning electron microscopy (SEM), tribe Trifolieae

INTRODUCTION

The Trifolieae is one of 22 tribes of the subfamily Papilionoideae in the Leguminosae. The tribe Trifolieae as outlined by Heyn (1981) has been interpreted to include *Medicago*, *Trigonella*, *Melilotus*, *Factorovskya*, *Trifolium*, *Ononis* and *Parochetus*. However, she argued that the last two genera are sufficiently distinct that their inclusion in the Trifolieae is doubtful. The recent floristical accounts tend to accept the tribe without *Ononis* (Davis 1970, Zohary 1972, Townsend 1974).

Ferguson and Skvarla (1983) reported that pollen grains of Papilionoideae have wide range of transitional forms of granular interstitia. They have divided the pollen of Papilionoideae into three types: (1) with large, widely spaced irregular granules; (2) with densely packed groups of columellas and granules; and (3) with a mass of more or less disorganised granules. Gautam *et al.* (1991) described the cohesion of pollen grain through exinal connection in *Melilotus indica*. Ming-jou and Tseng-Chieng (1999) studied the pollen morphology and seed of *Trigonella hamosa* by SEM in the framework of taxonomic description that represents as a new record to the flora of Taiwan. Gillett *et al*. (1973) described the pollen grains of 45 American *Trifolium* species with aid of light and scanning electron microscope and provided a key of their identification. Furthermore three common pollen types have been observed in *Trifolium*

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and the three other genera (*Medicago*, *Trigonella* and *Melilotus*) of the tribe Trifolieae. Erdtman *et al.* (1963) produced a key to the pollen of 11 Scandinavian clovers (*Trifolium* sp.) based on the size and the shape of the grains and proved that some species of section Lotoideae in genus *Trifolium* have fairly large pollen grains, also one species (*Trifolium alexandrinum*) of section *Trifolium* has large pollen grains. Kamel (1992) studied the macro- and micromorphology of genus *Trifolium* in Egypt. The revision revealed the presence of 18 species. A comparative study on the Egyptian species of genus *Trigonell*a showed the presence of 10 species belonging to five sections (Hassan 1992). El-Bous (1995) studied the taxonomic and chemical characters of genus *Melilotu*s in Egypt, five Egyptian species were recorded in the study. Gazar *et al.* (2002) studied the morphology of the whole plant and the seed storage proteins of the genera *Melilotus*, *Trifolium* and *Trigonella*. In this work the cladistic analysis of the genera *Melilotus*, *Trifolium* and *Trigonella* revealed that *Trifolium* species were clustered in one clade and another clade for the species of genus *Trigonella*. In *Melilotus* all species are strongly related to each other except for *Melilotus albus* that evolved early and has its special taxonomic characters and position in this genus. This study aims to complete the overview on the taxonomy of the genera of Trifolieae using the morphological characters of the pollen grains in order to establish the taxonomic position of the species and the genera using all available characters.

MATERIAL AND METHODS

Pollen material were obtained from the anthers of living plants from the field (fixed in F. A. A.), collected by the authors or from herbarium specimens kept in Cairo University Herbarium (CAI), Suez Canal University Herbarium (SUEZ) and Herbarium of Royal Botanic Gardens, Kew (K). The list of the species is given in Table 1.

Pollen grains were prepared for study using the acetolysis method of Erdtman (1960). Light microscope (LM) slides were examined using Olympus microscope with a ×100 magnification objective and a ×10 magnification eyepiece. For each taxon 15 grains were measured for polar and equatorial length, colpus length. For scanning electron microscopy (SEM), the dehydrated grains were mounted on clean stubs using double-side sellotape and silver bast. These stubs were sputter-coated with gold in a Polar on E 5000 and examined using JEOL-JSM-SEM at 15 kV in the unit of electron microscopy at Assiut University. The descriptive terminology used is based on Erdtman (1969), Faegri and Iversen (1989), Moore *et al.* (1991).

Table 1
List of specimens examined for pollen morphology

Taxa	Localities
Trifolium	
T. fragiferum L.	Alexandria, Faculty of Agriculture farm, 28.8.1976, El Hadidi s.n. (CAI). – Alexandria in incultis advis Nougzap et Sidi Gaber prope Ramlah, 1880. Letourneux 242 (K).
T. resupinatum L.	Wadi Um Rakham between Mersa Matruh and Agiba, 21.3.1975. V. Tackholm, El-Hadidi et al. s.n. (CAI). – Ismailia, the road of Suez Canal Univ. 21.2.1999, M. Gazar (SUEZ).
T. tomentosum L.	Mersa Matruh, 8.3.1990, W. Kamel s.n. (SUEZ). – 26 km after El-Arish, 1.5.2000, Gazar and Kamel (SUEZ).
T. glanduliferum Boiss	Rafah, Bir el Malih, at coast, 22.3.1928, G. Tackholm s.n. (CAI). – Sinai, El-Arish, 29.3.1989, Gamal El-Din 347 (SUEZ).
T. campestre Schreb.	Wadi El-Habs, between Mersa Matruh and Agiba, 21.3.1975, V. Tackholm and El-Hadidi. – Waste ground road near Dahshur, 14.4.1922, Simpson 1035 (K).
T. philistaeum Zohary	Bir Lahfen S of El-Arish, 21.3.1928, G. Tackholm s.n. (CAI). – Sinai, Rahah, near the station, 22.3.1928, G. Tackholm s.n. (CAI).
T. argutum Sol.	Sinai, El-Arish, 2.5.1952, G. Tackholm s.n. (CAI).
T. repens L.	Alexandria, 17.11.1944, Gilbert 144 (K). – Egypt, Giza Saft El-Lebban, 9.4.1927, Simpson 4829 (K).
T. nigrescens Viv.	Sallum, Sidi Barrani. 29.3.1963, Abdel Megid and Shalaby 180 (CAI).
T. alexandrinum L.	Sinai, El-Rabba at the entrance of wadi Arbaein, 25.4.1995, M. Gazar et al. (SEUZ). – Dakhla Oasis, Esab El-Mauhab, 16.3.1967, El-Hadidi, Kosinova and Chrtek s.n. (CAI).
T. lappaceum L.	Sinai, El-Arish, wadi bed, 1.5.1998, M.Gazar et al. (SUEZ).
T. incarnatum L.	Giza, in the botanical garden of Faculty of Science, Cairo Univ. 24.5.1953, Imam s.n. (CAI).
T. dasyurum C. Presl	Saniet Hagg Ayyad, wadi El-Habs, between Mersa Matruh and Agiba, 23.3.1974, V. Tackholm, El-Hadidi et al. s.n. (CAI). – Burg El-Arab, 5.4.1956, El Batanouny s.n. (CAI).
T. angustifolium L.	Sinai Peninsula , 1984, Abdallah et al. (CAI). – Rahah, 27.3.1974, Tackholm et al. (CAI).
T. dichroanthum Boiss.	Sinai , El-Arish, 1.5.1925, G. Tackholm s.n. (CAI).
T. purpureum Lois.	Wadi Umm Rakham between Mersa Matruh and Agiba, 21.3.1975, V. Tackholm, El-Hadidi et al. s.n. (CAI). – El-Arish, Rafah, 2.4.1987, Gibal 672 (CAI).
Trigonella	
T. arabica Delile	Wadi El-Arish, 3.2.1959, Bolous, s.n. (CAI). – El-Arish, near the Faculty of Education, 3.5.1999, Gazar and Kamel.
T. occulata Ser.	Giza: west of Abu-Rouash village, 2.4.1923, Simpson 2162 (CAI).
T. stellata Forssk.	Between Mersa Matruh and Agiba, 23.3.1974, V. Tackholm, El Hadidi et al. s.n. (CAI). – El-Arish, Gebel El-Halal, 25.4.1996, M.Gazar et al. (SUEZ).

Table 1 (continued)

Taxa	Localities
T. laciniata L.	El-Minya, El-Minya University, near Faculty of Science in fields, gardens, clay soil, 28.3.1990, Shabatai 2783 (CAIM).
T. maritima Poir.	Matrouh, wadi Habes, 10 km from Matrouh, sandy soil. 8.3.1990, M. Gazar and Hassan (SUEZ). – Sallum, Sidi Barrani, 11.4.1930, Abbas 89 (CAIM).
T. glabra Thumb.	Egypt, Ismailia, near the faculty of Medicine, Suez Canal University, 14.4.2000, M. Gazar. – El-Lahum, along the road to medium pyramids, 26.3.1981, Boulos s.n. (CAI).
T. cylindracea Desv.	Bir-El Mehleha on the coast 23.2.1928, G. Tackholm 1366. – El-Shallaq 10 km before Rafah, 1.3.1989, Hassan (SUEZ).
Melilotus	
M. albus Medik	Faculty of Agriculture, Cairo University. 14.6.1999, M. Gazar (SUEZ). – Western Mediterranean region, Ras El-Hekma, spring 1955, El-Hadidi (CAI).
M. sulcatus Desf.	Wadi Habes, between Mersa Matruh and Agiba, 21.3.1975, V. Tackholm, El-Hadidi et al. s.n. (CAI). – Ismailia, Suez Canal University near Faculty of Agriculture 28.3.2000, M. Gazar (SUEZ).
M. segetalis Bort.	Ismailia, Bot. Garden of Suez Canal University, 21.2.2000, M. Gazar (SUEZ). – Wadi El-Natrum, Rest House road, 18.3.1989, El-Bous (CAI).
M. indicus (L.) All.	Western Desert, El-Gedidia village, weeds in fields 14.5.1978, Abd El Ghani s.n. (CAI). – El-Faiyum, Shakshouk, 20.3.1990, El-Bous 105 (SUEZ).
M. messinensis L	Al-Arish district: El Dahia around Faculty of Education as weed 2.3.1989. El-Bous 106 (SUEZ). – Ismailia, Abu Suweir, 11.3.2001, Gazar and Kamel.

RESULTS

The morphology of pollen grains, the structure of the aperture, the shape and the size of the grain and the ornamentation of exine, allow the recognition of three pollen types, viz. *Trifolium* type (subtypes 1 and 2), *Trigonella* type and *Melilotus* type (subtypes 1 and 2). The palynologial data of pollen characters among the studied taxa is summarised in Table 2.

Key of pollen types of the investigated taxa

1a Equatorial axis 21.4–38.2 µm 2

1b Equatorial axis 12–20 µm 4

2a Exine ornamentation regulate, scabrate or reticulate or reticulate with short rod-like remnants 3

2b Exine ornamentation microreticulate all over grain *Trigonella* type

3a Lumina less than 2 μm irregularly, absent at poles or also at mesocolpium *Trifolium* subtype 1

3b Lumina 3–4 μm, regularly distributed *Trifolium* subtype 2

4a Polar axis 25 μm or less, circular in polar view *Melilotus* subtype 1

4b Polar axis more than 27 μm, semicircular or lobbed in polar view *Melilotus* subtype 2

Trifolium type

Trifolium *subtype 1*

Grains circular to truncate-triangular in polar view, rectangular-obtuse to rhombic-obtuse in equatorial view, trizonocolporate, 27.82–38.52 × 21.4–29.9 μm. Ornamentation is regulate-scabrate or Muri and Lumina (less than 2 μm)

Table 2
Mean measurements of the studied *Trifolium* pollen grains in microns: Polar axis (P), Equatorial diameter (E), Colpus length (Cl), shape at Polar view (amb), semi-triangular (ST), semicircular (SC), Prolate (Pro), sub-prolate (SubPro), Preprolate (PrePro), Circulate (C), Spheroidal (S)

Species	P	E	P/E	Cl/P	Amb	Shape category
T. fragiferum L.	27.8–32.0	21.4–27.8	1.2–1.3	0.80	ST	Pro to SubPro
T. resupinatum L.	29.3–32.0	25.6–32.0	1.1–1.2	0.85	SC	SubPro
T. tomentosum L.	22.4–33.5	20.0–33.5	1–1.1	0.60	C	S
T. glanduliferum Boiss.	25.4–32.2	21.8–25.7	1.1–1.2	0.80	C	SubPro
T. campestre Schreb.	27.8–34.2	25.7–29.9	1.2–1.3	0.75	C	Pro to SubPro
T. philistaeum Zohary	27.8–32.1	22.0–23.5	1.2–1.3	0.80	ST	Pro to SubPro
T. argutum Sol.	29.9–34.2	23.5–25.7	1.2–1.3	0.85	ST	Pro to SubPro
T. nigrescens Viv.	31.1–33.8	22.7–23.7	1.2–1.3	0.70	C	SubPro
T. repens L.	32.1–38.5	21.4–23.5	1.5–1.6	0.90	ST	Pro
T. alexandrinum L.	39.0–42.1	24.0–26.7	1.6–1.7	0.80	SC	Pro
T. lappaceum L.	42.8–47.8	27.8–29.7	1.5–1.6	0.80	ST	Pro
T. incarnatum L.	40.6–47.0	27.8–32.1	1.4	0.90	SC	Pro
T. dasyurum C. Presl	29.9–34.2	23.5–25.8	1.2–1.3	0.85	SC	Pro to SubPro
T. angustifolium L.	32.0–40.6	25.6–32	1.3–1.4	0.70	SC	Pro
T. dichroanthum Boiss.	43.0–49.2	34.2–38.5	1.2	0.90	C	SubPro
T. purpureum Lois.	47.0–49.0	32.0–34.2	1.4	0.90	ST	Pro

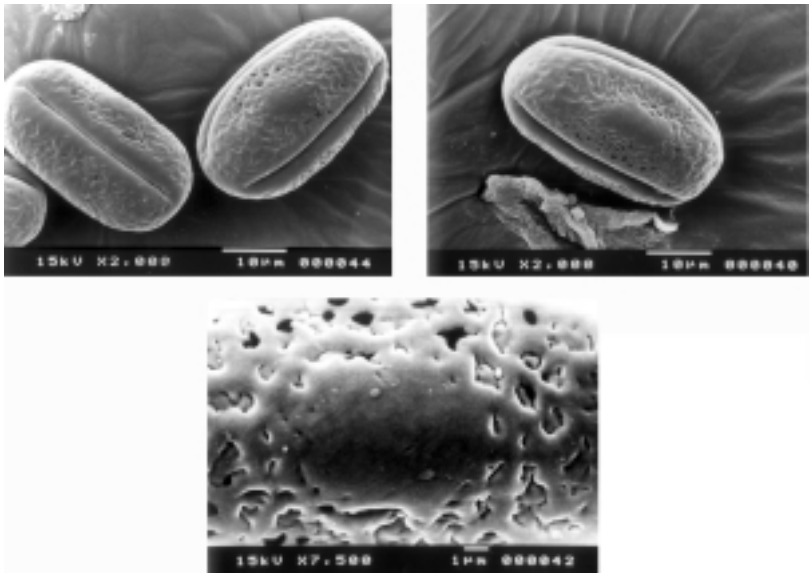

Fig. 1A–C. Trifolium fragiferum. – A–B (top, left and right) = Equatorial view showing colpi length nearly as long as polar axis with straight edges and rounded apices, apocolpium area (at poles) perforated. – C (buttom) = Detail of mesocolpium area with regulate tectum and smooth in the middle

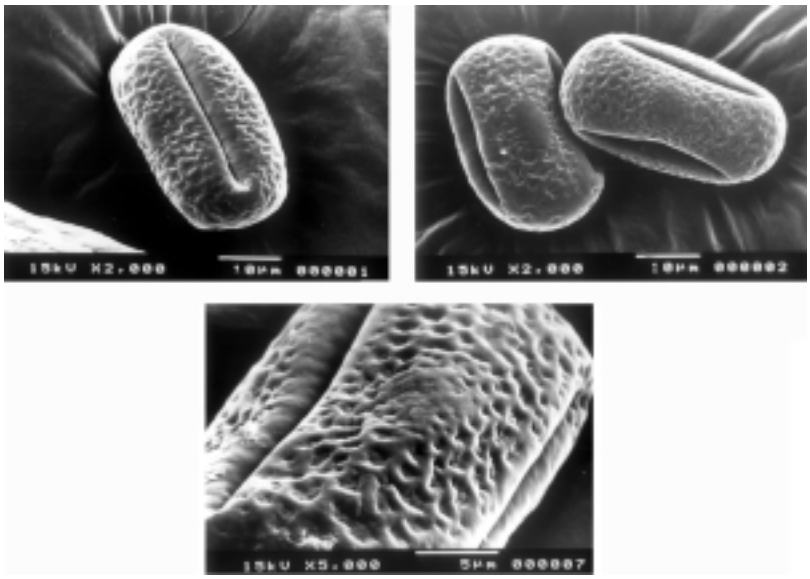

Fig. 2A–C. Trifolium resupinatum. – A–B (top, left and right) = Equatorial view showing colpi ± long with straight acute end. – C (buttom) = Detail of tectum with irregularly rectangular lumina

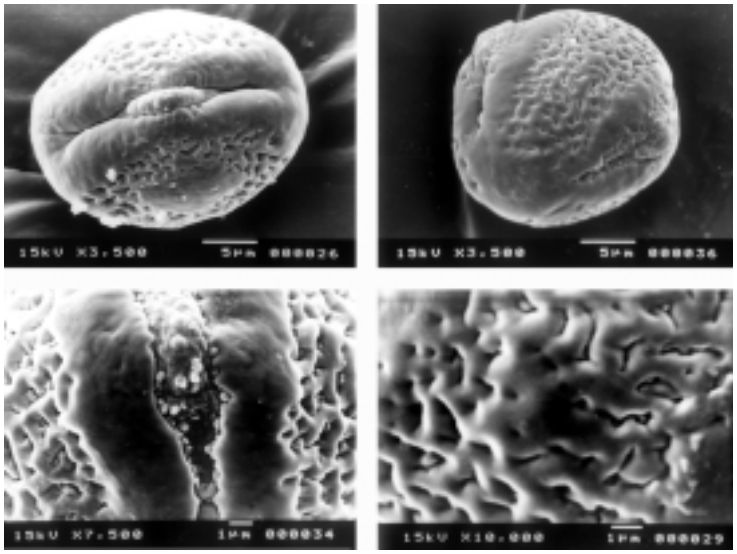

Fig. 3A–D. Pollen grains of *Trifolium tomentosum*. – A–B (top, left and right) = Equatorial view showing mesocolpial pouches and elongate endoaperture, colpi short, wide in the middle with rounded obtuse end. – C (buttom, left) = Detail of densely granular colpus membrane and well-differentiated colpus margins. – D (buttom right) = Mesocolpium area regulate with microperforate striae; colpi length 19.6 µm with rounded obtuse end

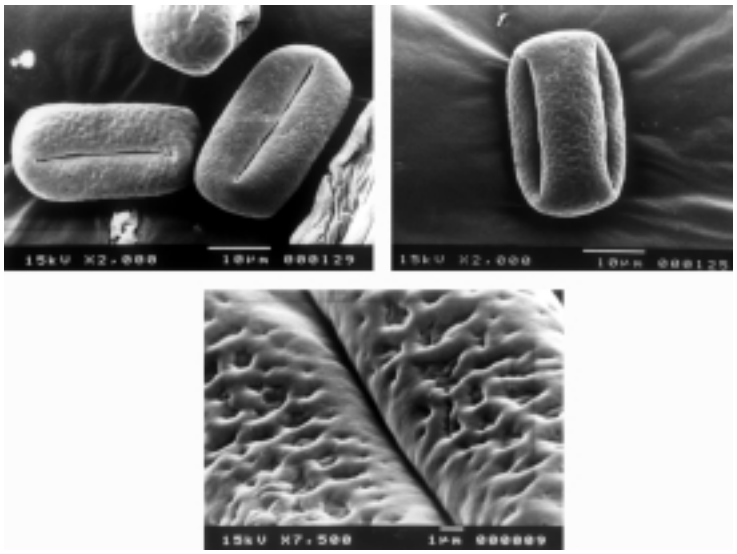

Fig. 4A–C. Trifolium campestre. – A–B (top, left and right) = Equatorial view (quadrangular convex in shape) showing colpi edges straight with acute apex. – C (buttom) = Detail of even mesocolpium area with slightly perforate or smooth membrane

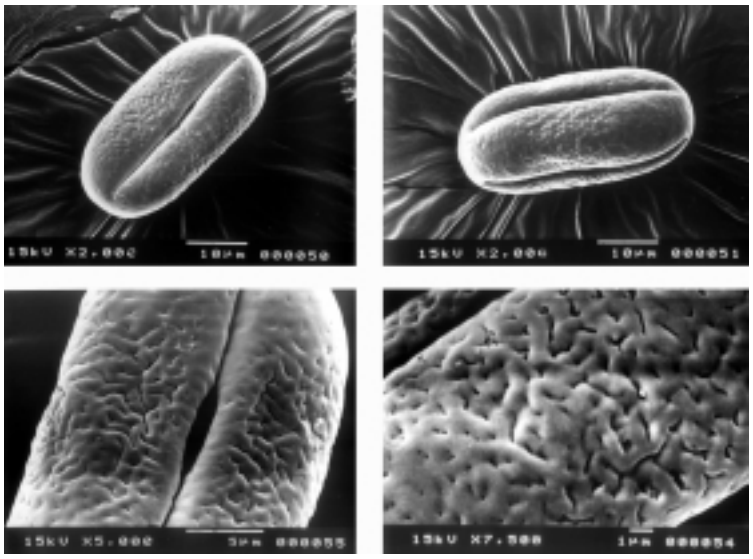

Fig. 5A–D. Trifolium repens. – A–B (top, left and right) = The pollen of equatorial view (quadrangular obtuse) showing regulate tectum at mesocolpium and pitted perforate area at poles, colpi length (30 µm) tapering end rounded inside. – C (buttom, left) = Detail of mesocolpus without obvious pouches and elliptic pori. – D (buttom, right) = Detail of apocolpium showing pitted perforate area

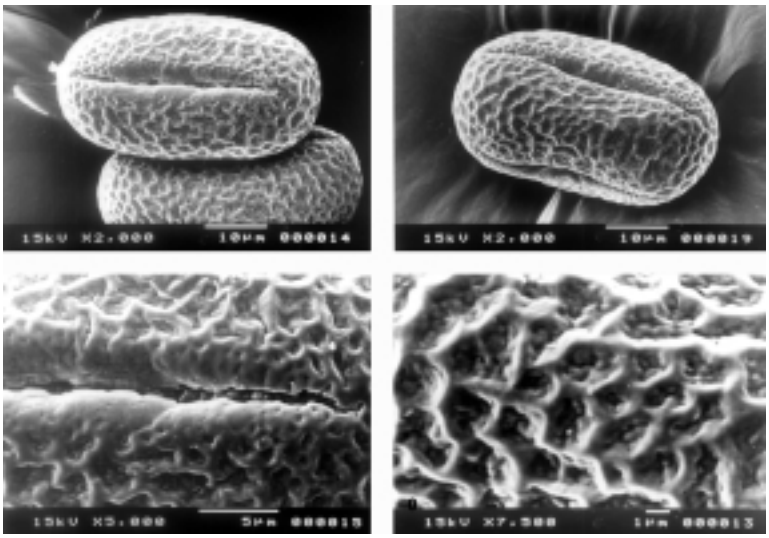

Fig. 6A–D. Pollen grains of *Trifolium alexandrinum.* – A–B (top, left and right) = Equatorial view showing quadrangular obtuse, endopori are not distinct. – C (buttom, left) = Colpus membrane microperforate. – D (buttom, right) = Detail of lumina showing regularly distributed of reticulate ornamentation with short, rod-like remnants

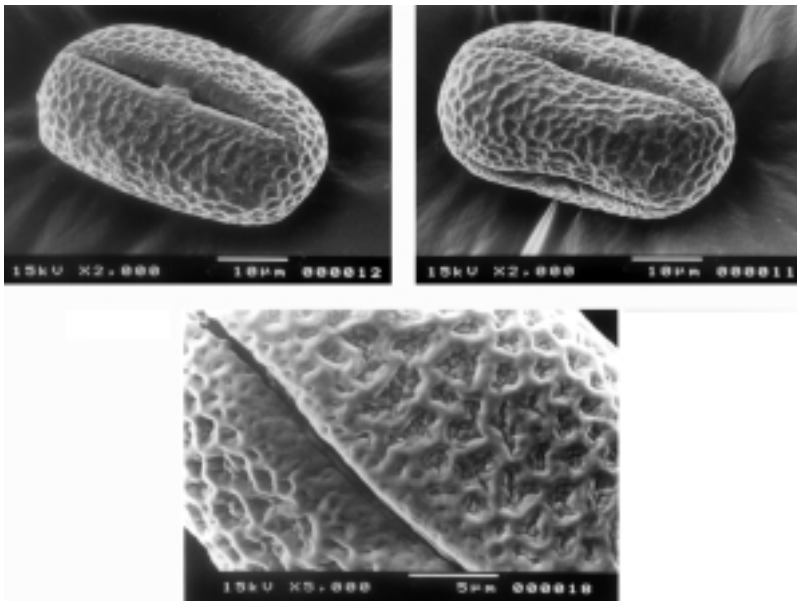

Fig. 7A–C. Pollen grains of *Trifolium purpureum.* – A–B (top, left and right) = Equatorial view. – C (buttom) = Detail of colpus membrane showing microperforate colpus margin and mesocolpium area

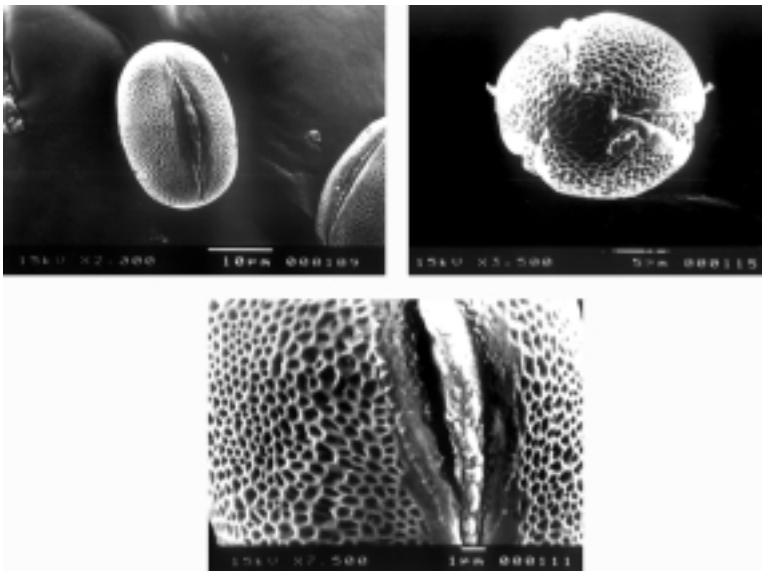

Fig. 8A–C. Trigonella arabica. – A (top, left) = Equatorial view prolate shape with broad colpus (elliptic pore) and pointed at poles. – B (top, right) = Polar view. – C (buttom) = Detail of mesocolpium area and opercula colpi

reduced to few or sparse at pole area. Columella thicker and more prominent at poles. Colpus long, wide, distinctly sunken margin, with straight edges and apices acute; costae colpi thin. This type characteristic to *Trifolium fragiferum* (Fig. 1A–C), *T. resupinatum* (Fig. 2A–C), *T. campestre* (Fig. 4A–C), *T. repens* (Fig.

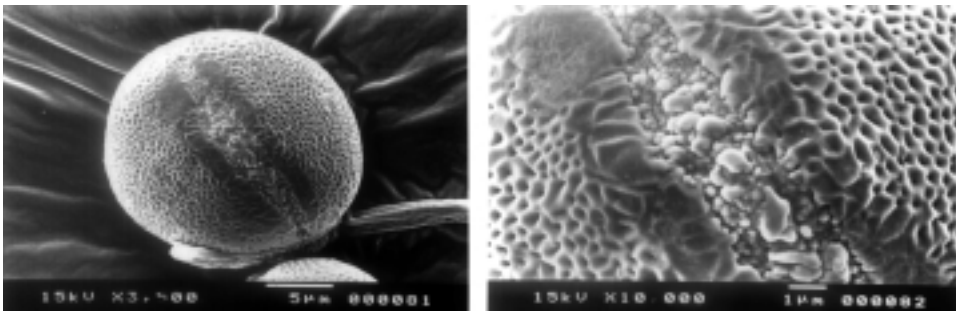

Fig. 9A–B. Trigonella stellata. – A (left) = Equatorial view showing subprolate. – B (right) = H shape colpus membrane with thick costa colpi

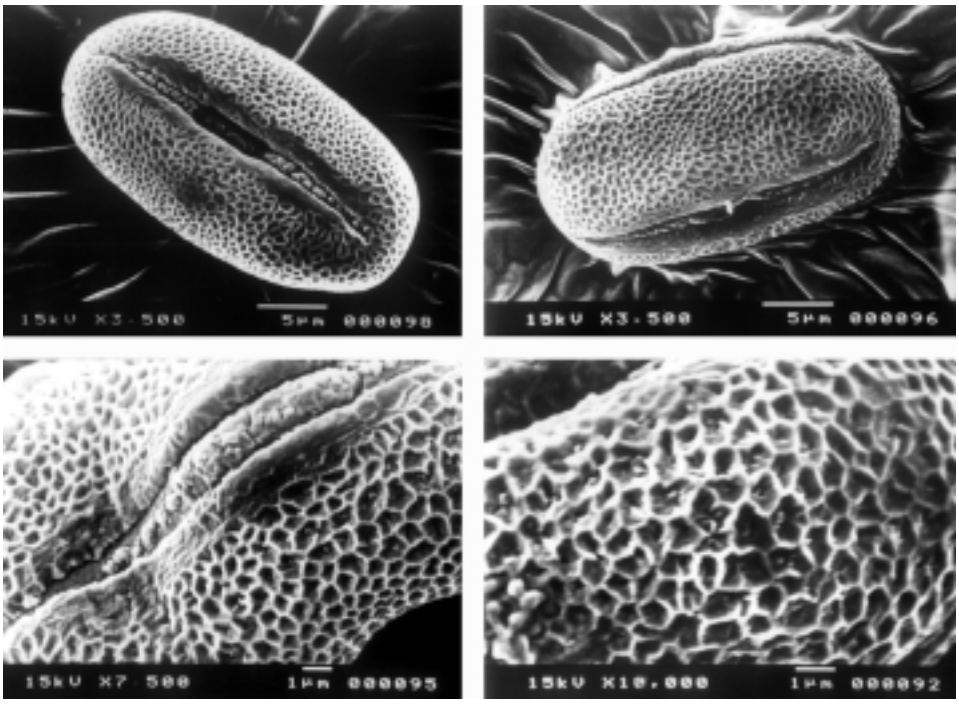

Fig. 10A–D. Trigonella maritima. – A–B (top, left and right) = Equatorial view showing preprolate shape. – C (buttom, left) = The pollen showing mesocolpial pouches and elongate endoaperture. – D (buttom, right) = Detail of mesocolpial tectum

5A–D), *T. glanduliferum*, *T. philistaeum* and *T. nigrescens*. Within this type, ornamentation is lacking. In mesocolpium area, pori often indicated merely by the presence of rupture or constriction to colpus, costae colpi thick, with undulated margin as in *Trifolium tomentosum* (Fig. 3A–D).

Trifolium *subtype 2*

Grains semicircular to circular or semitriangular in polar view, rectangular-obtuse in equatorial view, trigonocolpate, 30–49 × 24–38.5 µm, prolate or subprolate. Ornamentation is reticulate with short rod-like remnants. Columella thick, regularly distributed. Lumina 3–4 µm in diameter, pori well distinct, circular. Colpi margin regularly straight with obtuse end, costae colpi thin perforated at margin. This type characteristic to *Trifolium alexandrinum* (Fig. 6A–D), *T. purpureum* (Fig. 7A–C), *T. lappaceum*, *T. incarnatum*, *T. dasyurum*, *T. angustifolium*, *T. dichroanthum* and *T. argutum*.

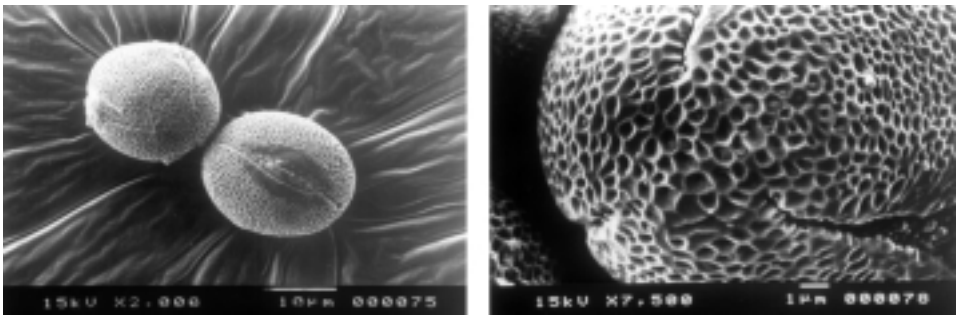

Fig. 11A–B. Trigonella glabra. – A (left) = Equatorial view showing subprolate shape. – B (right) = Apocolpium area showing semiangular pollen

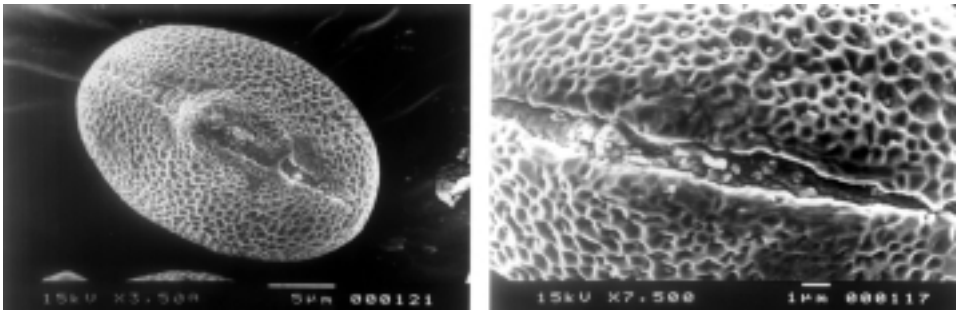

Fig. 12A–B. Trigonella cylindracea. – A (left) = Equatorial view showing prolate shape with slightly mesocolpium pouches. – B (right) = mesocolpium area showing very thin costa colpi

Trigonella type

Grains porate or subporate in equatorial view, angular in polar view; trizonocolporate, 22.6–31.1 × 15.8–18.7 (20.8) µm. Ornamentation microreticulate all over the surface, without sculpturing element. Lumina are less angular, while Muri have a penta or rounded surface. Colpi narrow and slit-like, never sunken endopori well-defined, elliptical represented by a bridge or rupture underlain by an H-shaped endoaperture, costae colpi present; colpus membrane thick, and undulated. This pollen type is characteristic to all *Trigonella* species in Egypt: *T. arabica* (Fig. 8A–C), *T. stellata* (Fig. 9A–B), *T. maritima* (Fig. 10A–D), *T. glabra* (Fig. 11A–B), *T. cylindracea* (Fig. 12A–B), *T. occulata* and *T. laciniata*.

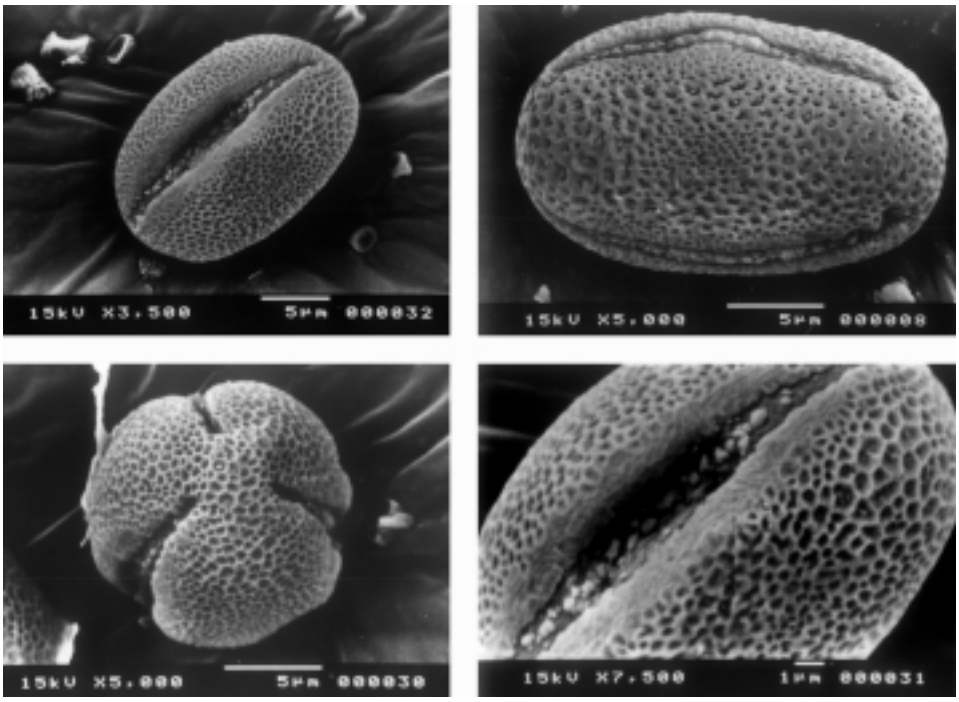

Fig. 13A–D. Melilotus sulcatus. – A–B (top, left and right) = Equatorial view showing mesocolpial pouches and round endoaperture. – C (buttom, left) = Polar view showing angular pollen apocolpium area. – D (buttom, right) = Detail of densely granular colpus membrane, slightly mesocolpial pouches and psilate tectum

Melilotus type

Melilotus *subtype 1*

Grains semicircular or lobbed in polar view, elongated elliptical in equatorial view, 25.6–31.1 × 13–19.1 µm. Ornamentation foveolate-fasulate with deep rounded pits. Lumina 2–4 µm in diameter, diameter larger than separating Muri. The endopori obscure, cover by fine granules and colpus margin is microperforated, colpi in length to the axis with in rolled edges and obtuse apices. This pollen type is characteristic to *Melilotus sulcatus* (Fig. 13A–D), *M. segetalis* (Fig. 14A–D), *M. messinensis* (Fig. 15A–D) and *M. indicus* (Fig. 16A–D).

Melilotus *subtype 2*

Grains circular to slightly triangular or trilobate in polar view, prolate to elliptic in equatorial view, 22–25 × 16–17 µm. The grain is wrinkled in meso-

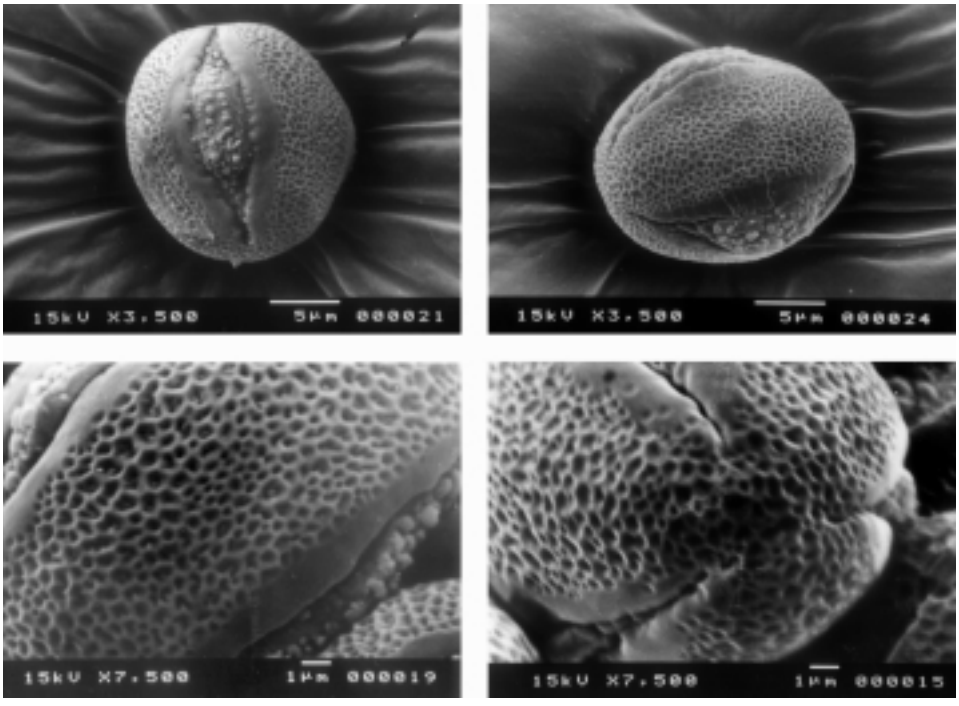

Fig. 14A–D. Melilotus segetalis. – A–B (top, left and right) = Equatorial view showing granular colpus membrane, operculum-like structure and undifferentiated colpus margins. – C (buttom, left) = Mesocolpium area showing faveolate fasulate and smooth colpus edge. – D (buttom, right) = Polar view showing apocolpium area

colpium area given the appearance of reticulate venation and also scrobiculate but not at apocolpium areas which are superreticulate-perforate. Colpus relatively narrow, as long as polar axis. This pollen type is characteristic to *Melilotus albus* (Fig. 17A–D).

DISCUSSION

The pollen grains of the investigated species belonging to the three genera (*Melilotus*, *Trifolium* and *Trigonella*) are typically radially symmetrical, trizonocolpate. The shape varied from prolate or subprolate or preprolate except in *Trifolium tomentosum* where it is spherical (P/E 1–1.1 µm). Generally, the grains ranged between 18.8 and 49.2 µm in length. In *Trifolium* species the equatorial axis ranged between 21.4 and 38.5 µm, among the species of the other two genera, it is characterised by an equatorial axis which is not exceeding 20 µm. Exine ornamentation is microreticulate in *Trigonella*, regulate-

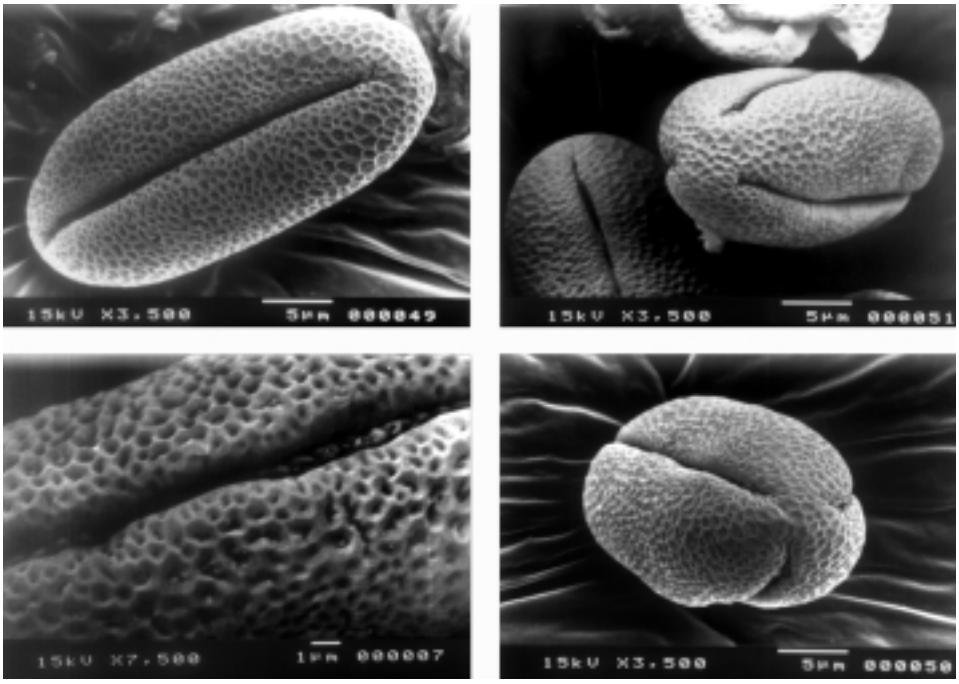

Fig. 15A–D. Melilotus messinensis. – A–B (top, left and right) = Equatorial view showing preprolate shape and narrow colpus with pointed end. – C (buttom, left) = Detail of aperture with microperforate colpus membrane. – D (buttom, right) = Polar view showing semiangular pollen

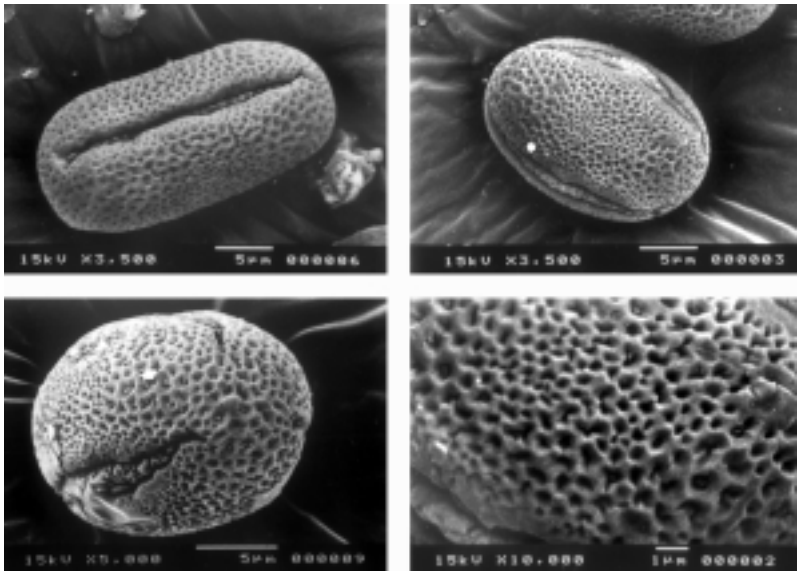

Fig. 16A–D. Melilotus indicus. – A–B (top, left and right) = Equatorial view. – C (buttom, left) = Polar view showing densely granular colpus membrane. – D (buttom, right) = Detail of mesocolpium area with faveolate ornamentation and also microperforate in the middle

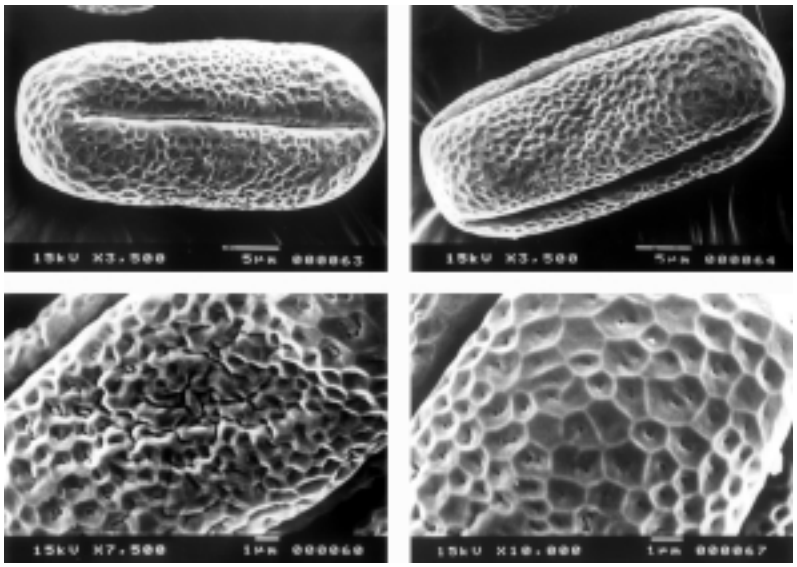

Fig. 17A–D. Melilotus albus. – A–B (top, left and right) = Equatorial view showing preprolate shape and narrow colpus with straight acute end. – C (buttom, left) = Detail of wrinkled in mesocolpium area. – D (buttom, left) = Polar area showing superreticulate-perforate ornamentation

scabrate in *Trifolium* subtype 1, reticulate with short rod-like remnants in *Trifolium* subtype 2, and falvate-fasulate with deep rounded pits in *Melilotus* subtype 1 or reticulate venation and also scrobiculate in *Melilotus* subtype 2. The pollen morphology of *Trifolium* is discussed in some general studies (e.g. Gillett *et al*. 1973, Ferguson and Skvarla 1981, Zohary and Heller 1984, Moore *et al.* 1991). Zohary and Heller (1984) described the pollen morphology of 45 species in section Lotoidea which are characterised by prolate pollen grains of smaller size (29–31 µm). In the present study, *Trifolium repens* and *T. nigrescens* of section Lotoidea have subprolate to prolate pollen grains of larger size (31–38.5 µm) in polar view. Earlier studies on *Trifolium* (e.g. Moore *et al.* 1991, Zohary and Heller, 1984) reported pollen grains with only reticulate exine. The present study recognises two *Trifolium* pollen subtypes: subtype 1, having regulate scabrate with lumina usually reduced to few and smooth a long colpus edges, sparsely perforate at polar area. Eight species belonging to subtype 1 (*T. fragiferum*, *T. tomentosum*, *T. resupinatum*, *T. glanduliferum*, *T. campestre*, *T. repens*, *T. philistaeum* and *T. nigrescens*). The second subtype is characterised by reticulate ornamentation with rod-like remnants all over the surface of the grains. Eight species belong to subtype 2 (*T. incarnatum*, *T. lappaceum*, *T. angustifolium*, *T. purpureum*, *T. dichroanthum*, *T. dasyurum*, *T. argutum* and *T. alexandrinum*). This may justify the treatment of the species of the two subtypes as distinct taxonomic groups. Erdtman *et al*. (1963) and Zohary and Heller (1984) investigated the pollen grains of two cultivated species of section *Trifolium* (*T. alexandrinum* and *T. pratense*). Both species are characterised by large pollen grain of 39–42.1 µm in length and 24–26.7 µm in diameter. The present study agrees with earlier finds concerning *T. alexandrinum* cultivated in Egypt. Moore *et al.* (1991) described one pollen type to genus *Melilotus* and *Ononis* which are characterised by reticulum disappears at poles, or restricted to a few widely spaced Lumina only, grain larger than 27 µm. Here, genus *Melilotus* has been observed with two subtypes: subtype 1, faveolate fasulate with deep rounded pits all over grain (*M. indicus*, *M. sulcatus*, *M. segetalis* and *M. messinensis*) and the size of grains ranged from 26.6 to 31.1 µm in length and from 13 to 19.1 µm in diameter. The shape category of all species, except in *M. indicus* (preprolate shape), was prolate or subprolate (13–16). *Melilotus albus* has another subtype (subtype 2): wrinkled in mesocolpium area given the appearance of venation and also scrobiculate but in apocolpi area having superreticulate-perforate and also the size of grains were 22–25.68 µm in length and 16–17 µm in diameter.

Pollen grains of *Trigonella* have middle size grains (18–32.1 µm) in length and (12.8–16.5 µm) in diameter with microreticulate tectum. El-Gazaly (1993) showed the same type of ornamentation of *Trigonella hamosa* and *T. stellata* with different size. *Trigonella arabica* was described by Gillett *et al*. (1973) observed reticulate faveolate over part of the surface, areolate-reticulate at polar

ends and along the furrow. In the present study although the pollen grain morphology of *Trigonella* tends to be of rather uniform type a few trends are evident within the species. Such as: (a) change in shape from subprolate to prolate; (b) increase in pollen size (Table 2).

*

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