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A PALYNOLOGICAL INVESTIGATION OF ENDEMIC TAXA FROM NORTHERN CYPRUS

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Abstract

Palynology of 19 endemic plant taxa belonging to 9 families distributed in North Cyprus was investigated by both light (LM) and scanning electron microscopy (SEM). The pollen grains were measured and their aperture characteristics and surface ornamentation determined. The systematic positions of the taxa as well as the genera they belonged to were investigated according to the data obtained. The largest pollen grains were found in *Salvia veneris* Hedge and the smallest ones in *Onosma caespitosum* Kotschy. The pollen type was generally termed trizonocolpate, pollen shapes spheroidal, prolate, subspheroidal, perprolate, supraprolate, pollen structure tectate and semitectate, and ornamentation scabrate, striate, microechinate, microperforate, reticulate, microreticulate, bireticulate, psilate and rugulate.

Introduction

Palynology of 19 endemic taxa viz., *Delphinium caseyi* B.L.Burtt (*Ranunculaceae*), *Brassica hilarionis* Post (*Brassicaeae*), *Arabis cypria* Holmboe (*Brassicaeae*), *Dianthus cyprius* A.K. Jackson et Turrill (*Caryophyllaceae*), *Silene fraudatrix* Meikle (*Caryophyllaceae*), *Hedysarum cyprium* Boiss. (*Fabaceae*), *Rossularia cypria* (Holmboe) Meikle, *Rosularia pallidiflora* (Holmboe) Meikle, *Sedum lampusae* (Kotschy) Boiss., (Crassulaceae), *Pimpinella cypria* Boiss., (*Apiaceae*), *Ferulago cypria* H.Wolf (*Apiaceae*), *Limonium albidum* (Guss.) Pignatti subsp. *cyprium* Meikle (*Plumbaginaceae*), *Onosma caespitosum* Kotschy (*Boraginaceae*), *Origanum syriacum* L. var. *bevanii* (Holmes) Letswaart (*Lamiaceae*), *Salvia veneris* Hedge (*Lamiaceae*), *Sideritis cypria* Post (*Lamiaceae*), *Phlomis cypria* Post var. *cypria* (*Lamiaceae*), *Scutellaria sibthorpii* (Benth) Hal. (*Lamiaceae*), *Teucrium cyprium* Boiss. subsp. *kyreniae* P.H.Davis. (*Lamiaceae*), belonging to 9 families distributed in North Cyprus were investigated. Pollen characteristics related to each taxon were determined. Pollen measurement values such as pollen diameter, pore diameter, exine thickness and number of pores/colpi, pollen type, structure and ornamentation of each taxon were also established in the study.

Apart from some floristic studies (Meikle, 1977, 1985; Viney, 1994, 1996) on the plants of North Cyprus, there are very few biological studies (Snogerop *et al.*, 1990; Stephenson, 1993) and these are far from being sufficient. For this reason, the present study is quite important as it investigates the pollen morphology of almost all endemic taxa of North Cyprus, a subject on which hardly any studies have been conducted to date. Presenting the endemics of North Cyprus to the world of science in detail is also important.

Skvarla & Nowicke (1976) conducted a palynological study on 11 *Centrospermae* families. In this study, pollen morphology of the species *Silene* and *Dianthus* from the family *Caryophyllaceae* was also determined. Greuter (1995) worked on the subspecies and sectional classification of the *Silene* species (119 species-39 sections) distributed in Greece. In a palynological study carried out on several *Dianthus* and *Silene* species, Yıldız (1996a, 1996b, 2001a, 2001b) established their pollen characters. Out of 12 *Centrospermae (Caryophyllales)* families, including the families *Caryophyllaceae* and *Plumbaginaceae*, Nowicke & Skvarla (1977) discussed the taxonomical positions of the families and species. Saez *et al*., (1998) examined the morphology of *Limonium vigoi* (L.) Sáez, Curcó & Rosselló *(Plumbaginaceae)*, a new tetraploid species distributed in Northwest of the Iberian Peninsula. Karyological, morphological and palynological differences between *Limonium girardionum* (Guss.) Fourr., and *L. grosii* (L.) Llorens were established in this study. Perveen *et al*., (1995) examined the pollen morphology of 49 species belonging to 20 genera of the family *Boraginaceae* that are distributed in Pakistan using the scanning electron microscopy (SEM) and described 11 different pollen types. In a palynological investigation on 30 *Boraginaceae* taxa distributed in Brazil, Scheel *et al*., (1996) specified 9 different pollen types according to aperture and surface ornamentations and based their classifications on these pollen types. Ashta *et al*., (1990) investigated the pollen morphology of *Salvia leucantha* collected from Northern Himalayas using the scanning electron and light microscopy. Although, most of the pollen had 6 colpi, others with 4, 5, 7, 8, 9, 10, 11 colpi were also encountered. Trudel & Morton (1992) determined the pollen morphology of 118 *Labiatae* species distributed in North America under SEM. Abu-Asab & Cantino (1994) conducted palynological examinations on several species belonging to the Tribe *Ajugeae* of the family *Labiatae*, which also included the genera *Teucrium* L., and *Scutellaria* L. Based on their palynological differences, a phylogenetic investigation was carried out between the two genera, general pollen characters of the genera *Teucrium* and *Scutellaria* established. La Serna Ramos *et al*., (1994) examined 26 of the 30 *Sideritis* L. species belonging to the subgenus *Marrubiastrum* (Moench.) Mend., using light and scanning electron microscopy. Oybak Dönmez *et al*., (1999) worked on the pollen ornamentation of 32 *Teucrium* species of Turkey under SEM. Torke (2000) conducted a taxonomical study on 8 *Salvia* L. species belonging to the section *Ecmania* distributed in high bushes on the Canary Islands and investigated the morphology, phenology, pollination biology, habitat and distribution of the species mentioned above.

No detailed palynological study is available on the endemics of North Cyprus. However, there are several palynological studies on species belonging to the genera which include endemics distributed in regions located around North Cyprus. With this study, pollen characteristics of all North Cyprus endemics have been presented to the world of science for the first time. The study will also help determine certain pollen morphology differences among plants distributed in Turkey, Syria, Lebanon, Palestine, Israel, Egypt and on neighboring islands. Furthermore, the data obtained in the present study will lay the foundation for future scientific studies to be conducted on the genera to which the taxa examined in this study belonged or other related taxa, as well as shedding some light on their systematics. The main objective of this study is to lay the basis for future bio-systematic (palynological) studies of the endemics of North Cyprus on which very few studies have been conducted so far.

Materials and Methods

Flowers bearing mature pollen were taken from both plant specimens placed into envelopes in the field and those deposited in the herbarium (Table 1, Fig. 1). The pollen grains taken from these flowers were prepared according to the Erdtman (1960) method and then left to dry in centrifuge tubes. About a month after this procedure, all pollen preparations were examined separately. Different pollen parts such as polar diameter (P), equatorial diameter (E), exine thickness, colpus length (Clg) or pore width and colpus width (Clt) were measured by means of light microscopy. About 50 pollens were used for obtaining their measurement values. For SEM, pollens were directly mounted on stubs using double-sided adhesive tape. Samples were coated with gold/palladium in POLARON SC 7620 ion-sputter and then observed by standard techniques using a LEO 440 scanning electron microscope. Photomicrographs of LM and SEM (Figs. 2-85) of the pollen showing the obtical section, ornamentation, equatorial view and colpus and general view were taken. Terminology of the data obtained was made according to Punt *et al*., (1994) and Moore *et al*., (1997). Data is presented in Table 2.

Results

Pollen characteristics of all North Cyprus endemics are presented to the world of science for the very first time. We believe that determination of the pollen characteristics of the taxa dealt with in the present study has laid the foundation for similar studies to be conducted in future.

The pollen type was generally termed trizonocolpate, pollen shapes spheroidal, prolate, subspheroidal, perprolate, supraprolate, pollen structure tectate and semitectate, and ornamentation scabrate, striate, microechinate, microperforate, reticulate, microreticulate, bireticulate, psilate and rugulate. The smallest pollen grains were measured in *Onosma caespitosum* (Table 2, Figs. 22, 68-70) and the largest ones in *Salvia veneris* (Table 2, Figs 25, 26, 73, 74).

Pollen characteristics:

1. *Delphinium caseyi* (Figs. 2, 3, 35-37)

Pollen grains; trizonocolpate, prolate, tectate. Ornamentation microperforate, scabrate.

2. *Brassica hilarionis* (Figs. 4, 5, 38-40)

Pollen grains; trizonocolpate, spheroidal-subspheroidal, semitectate. Ornamentation reticulate.

3. *Arabis cypria* (Figs. 6, 41-43)

Pollen grains; trizonocolpate, prolate, semitectate. Ornamentation reticulate.

4. *Dianthus cyprius* (Figs. 7, 8, 44-46)

Pollen grains; polypantoporate (12-15), spheroidal, tectate, Operculum with 6-11 granules. Ornamentation microechinate-microperforate, spinules irregular.

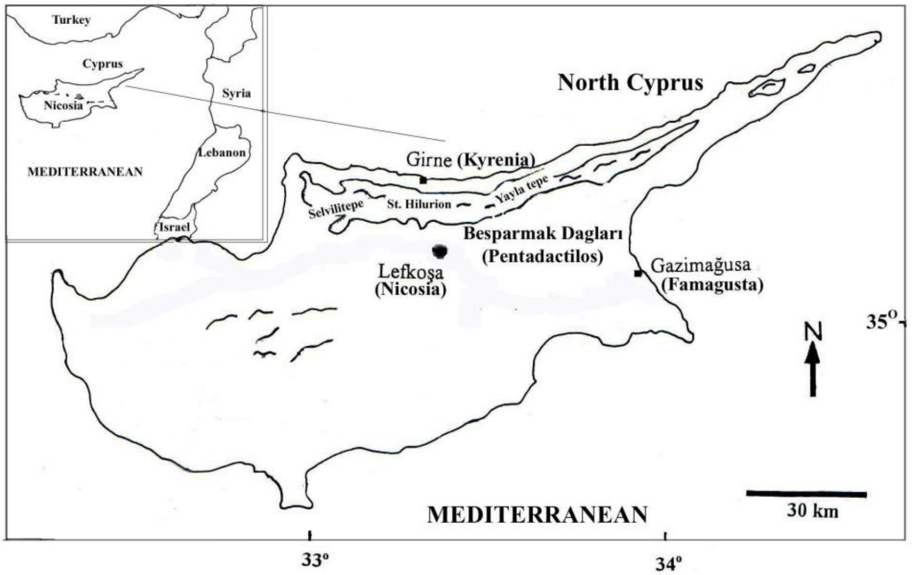


Fig. 1. Location of research area.

5. *Silene fraudatrix* (Figs. 9, 10, 47-49)

Pollen grains; polypantoporate (26-33), spheroidal, tectate. Operculum with 18-26 granules. Ornamentation microechinate-microperforate, spinules irregular.

6. *Hedysarum cyprium* (Figs. 11, 12, 50-52)

Pollen grains; trizonocolpate, prolate, semitectate. Ornamentation microreticulate.

7. *Rosularia cypria* (Figs. 13, 53, 54)

Pollen grains; trizonocolpate, perprolate, tectate. Ornamentation psilate.

8. *Rosularia pallidiflora* (Figs. 14, 55-57)

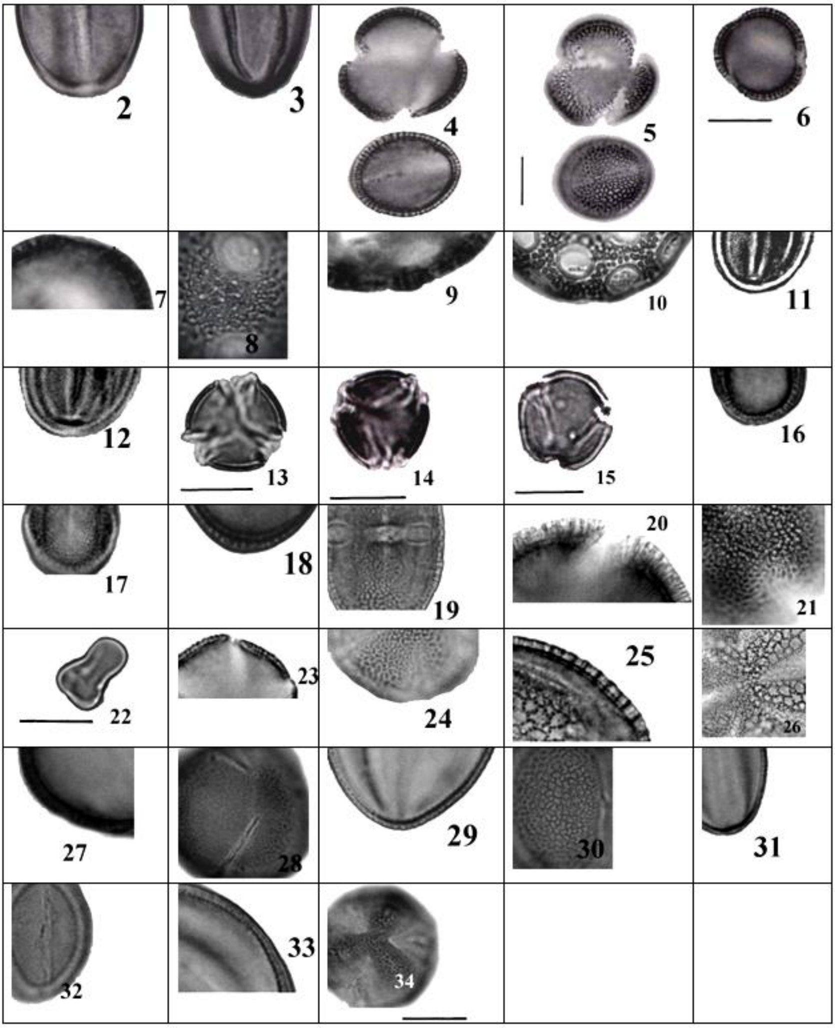
Pollen grains; trizonocolpate, perprolate, tectate. Ornamentation psilate.

9. *Sedum lampusae* (Figs. 15, 58-60)

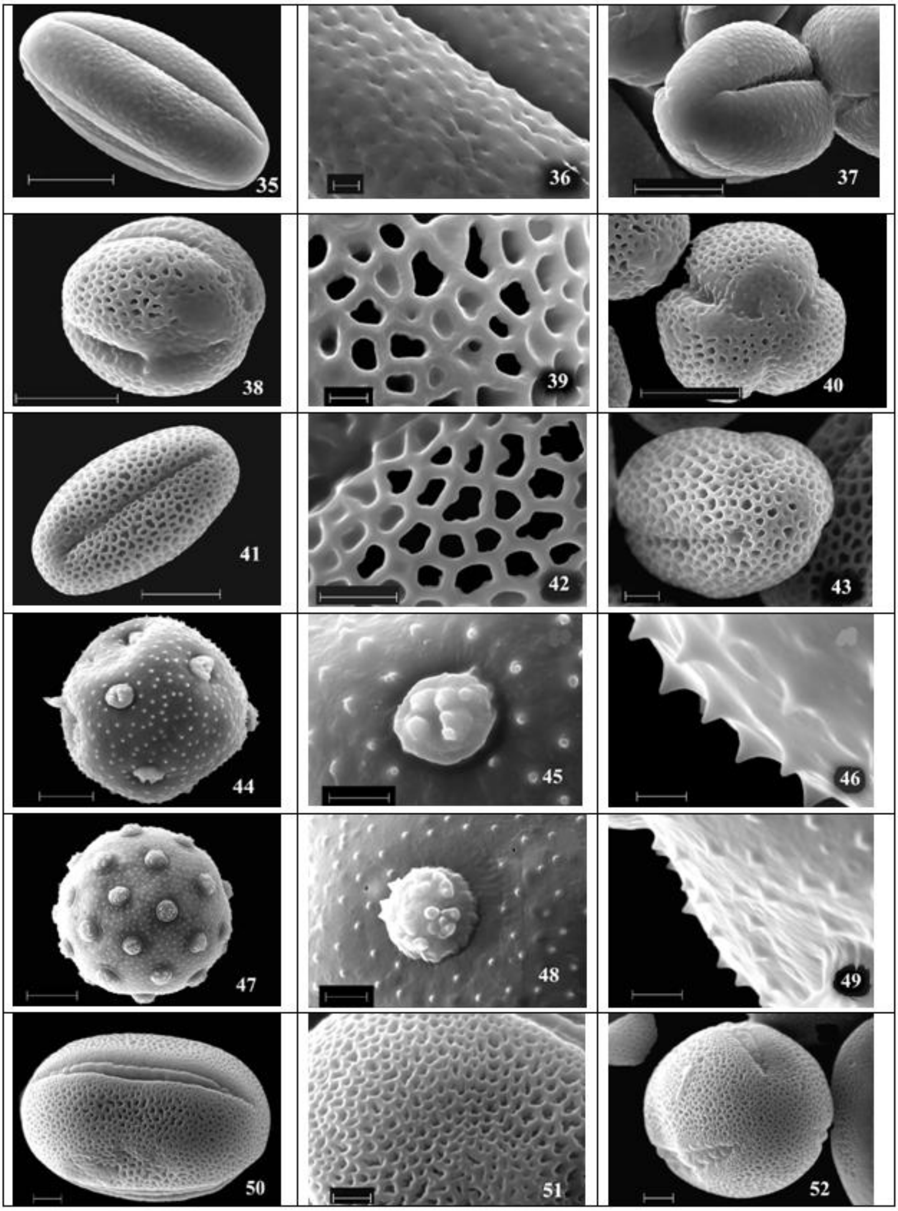
Pollen grains; trizonocolpate, perprolate, tectate. Ornamentation striate.

10. *Pimpinella cypria* (Figs. 16, 17, 61, 62)

Pollen grains; tricolporate, prolate, tectate. Ornamentation rugulate.

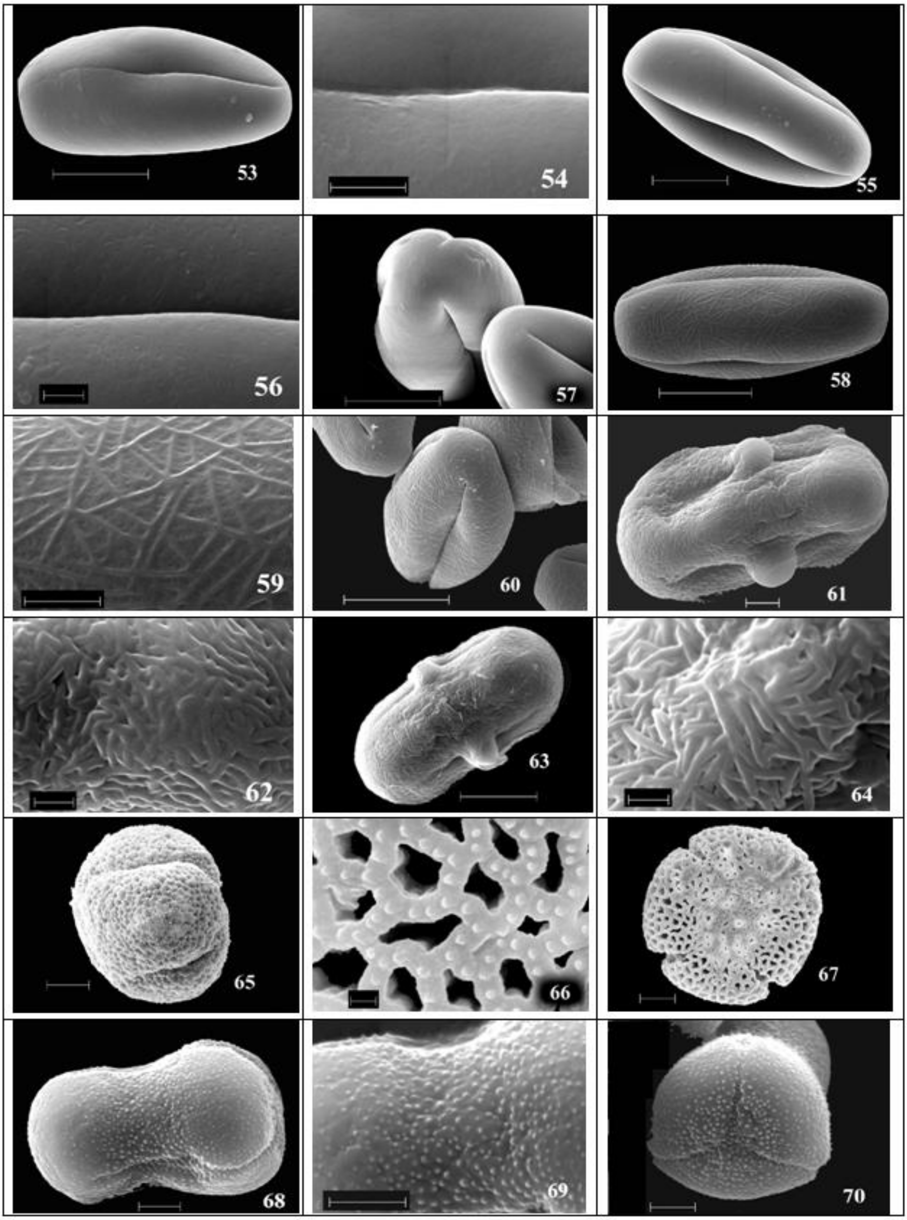


Figs. 2-34. Light Photomicrographs.
Figs. 2-3. *Delphinium caseyi*. 2. Obtical section. 3. Ornamentation and colpus. Figs. 4-5. *Brassica hilarionis.* 4. Polar and equatorial view, obtical section. 5. Polar and equatorial view, ornamentation (▬:10 µm). Fig. 6. *Arabis cypria*. Obtical section (▬:10 µm). Figs. 7-8. *Dianthus cypria*. 7. Obtical section. 8. Ornamentation and pore. Figs. 9-10. *Silene fraudatrix*. 9. Obtical section. 10. Ornamentation and pore. Figs. 11-12. *Hedysarum cyprium*. 11. Obtical section. 12. Ornamentation. Fig. 13. *Rosularia cypria*. Obtical section (▬:10 µm). Fig. 14. *Rosularia pallidiflora.* Obtical section (▬:10 µm). Fig. 15. *Sedum lampusae*. Obtical section (▬:10 µm). Figs. 16-17. *Pimpinella cypria*. 16. Obtical section. 17. Ornamentation. Figs. 18-19. *Ferulago cypria*. 18. Obtical section. 19. Ornamentation. Figs. 20-21. *Limonium albidum* subsp. *cyprium*. 20. Obtical section. 21. Ornamentation. Fig. 22. *Onosma caespitosum*. General view (▬:10 µm). Figs. 23-24. *Origanum syriacum* var. *bevanii*. 23. Obtical section. 24. Ornamentation. Figs. 25-26. *Salvia veneris*. 25. Obtical section. 26. Ornamentation. Figs. 27-28. *Sideritis cypria*. 27. Obtical section. 28. Ornamentation. Figs. 29-30. *Phlomis cypria* var. *cypria*. 29. Obtical section. 30. Ornamentation. Figs. 31-32. *Scutellaria sibthorpii*. 31. Obtical section. 32. Ornamentation. Figs. 33-34. *Teucrium cyprium* subsp. *kyreniae*. 33. Obtical section. 34. Ornamentation (▬:10 µm).

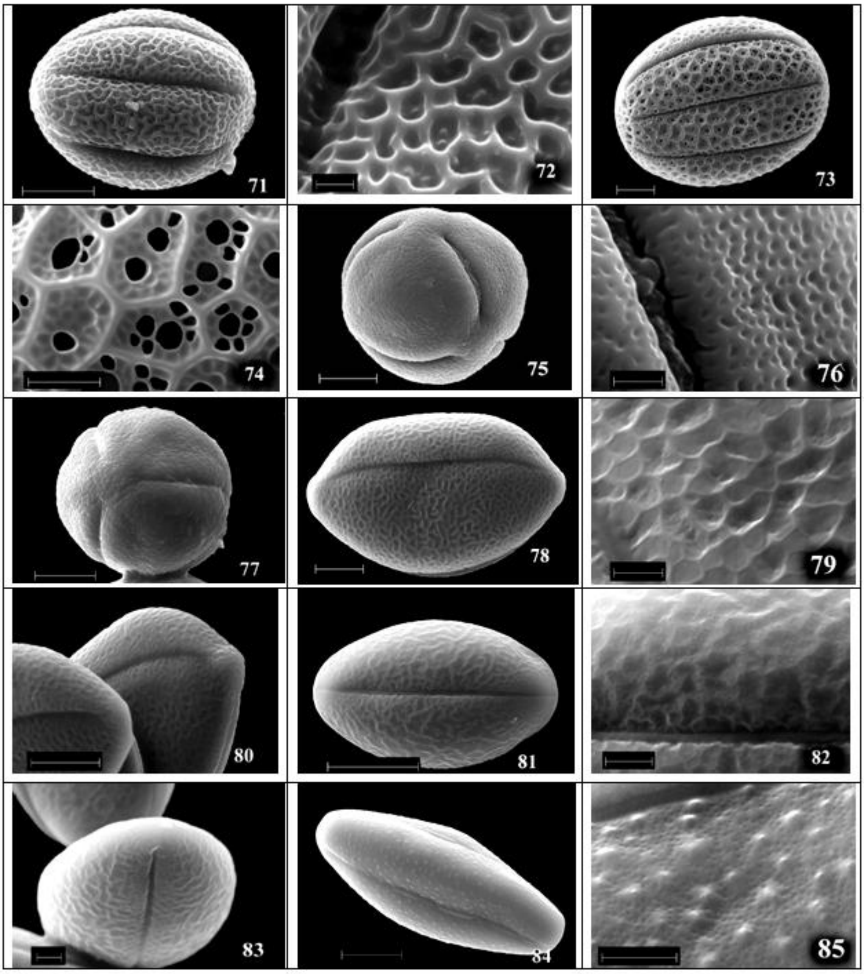


Figs. 35-85. SEM Photomicrographs.

Figs. 35-37. *Delphinium caseyi*. 35. Equatorial view (▬:10 µm). 36. Ornamentation and colpus (▬:1 µm). 37. Polar view and colpus (▬:10 µm). Figs. 38-40. *Brassica hilarionis*. 38. Equatorial view (▬:10 µm). 39. Ornamentation (▬:1 µm). 40. Polar view and colpus (▬:10 µm). Figs. 41-43. *Arabis cypria*. 41. Equatorial view (▬:10 µm). 42. Ornamentation (▬: 2 µm). 43. Polar view (▬: 3 µm). Figs. 44-46. *Dianthus cypria*. 44. General view (▬:10 µm). 45. Ornamentation and pore (▬:3 µm). 46. Microechinae (▬:1 µm). Figs. 47-49. *Silene fraudatrix*. 47. General view (▬:10 µm). 48. Ornamentation and pore (▬:2 µm). 49. Microechinae (▬:1 µm). Figs. 50-52. *Hedysarum cyprium*. 50. Equatorial view (▬:2 µm). 51. Ornamentation (▬:1 µm). 52. Polar view (▬:2 µm).



Figs. 53-54. *Rosularia cypria*. 53. Equatorial view (▬:10 µm). 54. Ornamentation and colpus (▬:2 µm). Figs. 55-57. *Rosularia pallidiflora*. 55. Equatorial view (▬:10 µm). 56. Ornamentation and colpus (▬:1 µm). 57. Polar view (▬:10 µm). Figs. 58-60. *Sedum lampusae*. 58. Equatorial view (▬:10 µm). 59. Ornamentation (▬:2 µm). 60. Polar view and colpus (▬:10 µm). Figs. 61-62. *Pimpinella cypria*. 61. Equatorial view (▬:3 µm). 62. Ornamentation (▬:1 µm). Figs. 63-64. *Ferulago cypria*. 63. Equatorial view (▬:10 µm). 64. Ornamentation (▬:1 µm). Figs. 65-67. *Limonium albidum* subsp. *cyprium*. 65. Equatorial view (▬:10 µm). 66. Ornamentation (▬:1 µm). 67. Polar view (▬:10 µm). Figs. 68-70. *Onosma caespitosum*. 68. Equatorial view (▬:2 µm). 69. Ornamentation (▬:2 µm). 70. Polar view and colpus (▬:2 µm).



Figs. 71-72. *Origanum syriacum* var. *bevanii*. 71. Equatorial view (▬:10 µm). 72. Ornamentation and colpus (▬:1 µm). Figs. 73-74. *Salvia veneris*. 73. Equatorial view (▬:10 µm). 74. Ornamentation (▬:3 µm). Figs. 75-77. *Sideritis cypria*. 75. Equatorial view (▬:10 µm). 76. Ornamentation and colpus (▬:2 µm). 77. Polar view (▬:10 µm). Figs. 78-80. *Phlomis cypria* var. *cypria*. 78. Equatorial view (▬:10 µm). 79. Ornamentation (▬:2 µm). 80. Polar view (▬:10 µm). Figs. 81-83. *Scutellaria sibthorpii*. 81. Equatorial view (▬:10 µm). 82. Ornamentation and colpus (▬:2 µm). 83. Polar view (▬:2 µm). Figs. 84-85. *Teucrium cyprium* subsp. *kyreniae*. 84. Equatorial view (▬:10 µm). 85. Ornamentation (▬:2 µm).

11. *Ferulago cypria* (Figs. 18, 19, 63, 64)

Pollen grains; tricolporate, prolate, tectate. Ornamentation rugulate.

12. *Limonium albidum* subsp. *cyprium* (Figs. 20, 21, 65-67)

Pollen grains; trizonocolpate-tetrazonacolpate, oblate, semitectate. Ornamentation reticulate-microechinate.

13. *Onosma caespitosum* (Figs. 22, 68-70)

Pollen grains; prolate, tectate, heteropolar, trichotomocolpate, Ornamentation scabrate.

14. *Origanum syriacum* var. *bevanii* (Figs. 23, 24, 71, 72)

Pollen grains hexazonocolpate, subraprolate-subspheroidal, semitectate. Ornamentation bireticulate.

15. *Salvia veneris* (Figs. 25, 26, 73, 74)

Pollen grains; hexazonocolpate, subraprolate-subspheroidal, semitectate. Ornamentation bireticulate.

16. *Sideritis cypria* (Figs. 27, 28, 75-77)

Pollen grains; trizonocolpate or tetrazonacolpate, subraprolate, subspheroidal, spheroidal, semitectate. Ornamentation suprareticulate.

17. *Phlomis cypria* var. *cypria* (Figs. 29, 30, 78-80)

Pollen grains; trizonocolpate, prolate, semitectate. Ornamentation reticulate.

18. *Scutellaria sibthorpii* (Figs. 31, 32, 81, 82)

Pollen grains; trizonocolpate, prolate, semitectate. Ornamentation microreticulate.

19. *Teucrium cyprium* subsp. *kyreniae* (Figs. 33, 34, 84, 85)

Pollen grains; tricolpate, perprolate, tectate, reticulate. Ornamentation scabrate-microreticulate.

Discussion

The ornamentation type of the pollen grains is a valid morphological character in taxonomy. Presence of spinules on the exine surface is an advanced character (Takhtajan, 1980). Pollen grains whose exine surface is smooth or slightly ornamented and with fewer numbers of pores/colpi termed primitive, while those with extremely ornamented and having a great number of pores/colpi are considered advanced (Van Campo, 1966; Cronquist, 1997). According to the specification we have used palynological terminology, an examination of the sequence of the taxa as well as the genera belonging to the same family within the Flora of Turkey, Cyprus and North Cyprus which showed that the ornamentation of *Dianthus cyprius* from the family *Caryophyllaceae* was more primitive than that of *Silene fraudatrix* with respect to their evolutionary progress as the former genus contained fewer pores than the latter (Figs. 7-10, 44-49). Therefore, the taxonomical position of the genera *Dianthus* and *Silene* within the Flora of Cyprus (Meikle, 1977), the Flora of North Cyprus (Viney, 1994) and the Flora of Turkey (Davis 1967) was consistent with the palynological data we obtained in this study.

According to a series of palynological observations we made on 6 taxa belonging to 6 different genera of the family *Labiatae*, the pollen type of *Origanum syriacum* var. *bevanii* and *Salvia veneris* was hexazonocolpate (with 6 colpi) with a bireticulate ornamentation (Figs. 23-26, 71-74), whereas the pollen type of the other *Labiatae* taxa were trizonocolpate and tetrazonocolpate with reticulate, microreticulate and scabrate ornamentations (Figs. 23-34, 71-85) showed that *Origanum* and *Salvia* taxa were more advanced as compared to *Sideritis cypria*, *Phlomis cypria* var. *cypria*, *Scutellaria sibthorpii*, *Teucrium cyprium* subsp. *kyreniae*. A striking fact is that the evolutionary order of the genera *Sideritis*, *Phlomis*, *Scutellaria* and *Teucrium* was correct in the Flora of Turkey (Davis, 1982) as compared to the genera *Origanum* and *Salvia*, but the position of these genera in the Flora of Cyprus and North Cyprus (Meikle, 1985; Viney, 1994) was just the opposite of that in the Flora of Turkey. Therefore, we believe that the systematic order in the Flora of Cyprus and North Cyprus should be reexamined.

Both species belonging to two different genera (*Brassica hilarionis* and *Arabis cypria*) of the family *Cruciferae* examined in this study had a reticulate ornamentation, the pollen of *Arabis cypria* bigger than those of *Brassica hilarionis* (Figs. 6-8, 41-46). Two species viz., *Rosularia cypria* and *Rosularia pallidiflora*, belonging to the genus *Rosularia* of the family *Crassulaceae* are distributed in the Flora of Cyprus. Both of these species are endemic to North Cyprus (Meikle, 1977). Palynological resemblances among *Rosularia* species are also true for another member of the same family, *Sedum lampusae.* All these species have *Sedum*-type pollen. However, it was observed that *Sedum* pollen were smaller as compared to *Rosularia* pollens (Figs. 13, 14, 53-57). It was also found that the pollen grains of *Ferulago,* belonging to the family *Umbelliferae,* were larger than those of *Pimpinella cypria* (Figs. 16, 17, 61, 62). As far as other pollen characters are concerned, no significant taxonomical difference has been encountered, either. Consequently, according to palynological data it has been difficult for the author(s) of the present study to provide any comments as regards the systematic classification of the genera *Brassica* and *Arabis*; *Rosularia* and *Sedum;* and *Ferulago* and *Pimpinella* within the Flora of Turkey, Cyprus and North Cyprus.

In a study conducted on 11 *Centrospermae* families, which also included *Silene* and *Dianthus* species from the family *Caryophyllaceae,* pollen morphology of some species were determined (Skvarla & Nowicke, 1976). In the study, the pollen type of *Dianthus barbatus* L., and *D. superbus* L., were given as pantoporate, echinate and tubulipher punctate, and that of *Silene noctiflora* L., as pantoporate and smooth reticulate. In our study, on the other hand, the pollen type of *Dianthus cyprius* and *Silene fraudatrix*, according to Punt *et al*., (1994), was polypantoporate, microechinate and microperforate, which displayed very similar characteristics to the above-mentioned study.

In a systematic revision, which involved the *Silene* taxa distributed in the Balkans, Melzheimer (1977) conducted a comparative examination on seed, fruit, calyx, corolla, chromosome and pollen characteristics of the *Silene* species. Palynological findings obtained in this study showed resemblances with the pollen characteristic of *Silene fraudatrix* (Figs. 9, 10, 47-49). The fact that pollen grains were polypantoporate and microechinate was fully consistent with the data obtained in our study.

In a palynological investigation conducted on a number of species distributed in Turkey (Yıldız, 1996a; 1996b; 2001a; 2001b), pollen characters related to *Dianthus* species were established as periporate, microperforate, reticulate; those related to *Silene* species as tectate, semitectate, periporate, spinulate, spinulate-microperforate and reticulate. Our examinations revealed that the *Dianthus cyprius* and *Silene fraudatrix* pollens were tectate, polypantoporate, microechinate and microperforate (Figs. 7-10, 44-49). The pollen characters obtained were generally compatible with those determined in previous studies except for pollen sizes, the numbers of pori and several ornamentation characteristics.

A series of observations made by Stephenson (1993) showed that pollen characteristics of both *Rosularia cypria* (Figs. 13, 53, 54) and *Rosularia pallidiflora* (Figs. 14, 55-57), which were stated as hybrids of one another and which constituted the subject of our palynological examinations, had similar characters (trizonocolpate, perprolate, psilate) and values; so the systematic positions of both species called for further investigation.

Nowicke & Skvarla (1977) investigated the pollen morphology of 12 families belonging to the order *Centrospermae* (*Caryophyllales*) under SEM and TEM as well as using light microscopy. The authors worked on a total of 134 species, 20 from the family *Plumbagineceae* and 2 from the family *Caryophyllaceae*. In this study, which dealt with the taxonomical positions of the families and species in question under the light of palynological data obtained, it was established that *Limonium* Mill., species (*L. viciosoi* Pau., *L. vulgare* Miller) had a tricolpate, reticulate, *Armeria* pollen type. Erdtman (1969) also determined that *Armeria maritime* Willd., (*Plumbagineceae*) pollen were tricolpate and densely reticulate. While describing *Limonium vulgare* and *Limonium humina* pollen in the pollen classification key, Moore *et al*., (1997) stated that they could be distinguished from *Armeria*-type pollen in that they had microechinates. In the present study, *Limonium albidum* subsp. *cyprium* was found to have a trizonocolpate or tetrazonocolpate, oblate, reticulate, microechinate pollen type (Figs. 20, 21, 65-67), which was in agreement with the study conducted by Moore *et al*., (1997). Previous studies have showed that pollen characters displayed by the genus *Limonium* are also seen in *Armeria*, *Limonium vulgarae* and *Limonium humila*.

The number of colpi in the pollen of *Limonium apthrodite* Artelari & Georgiou and *L. cythereum* Artelari & Georgiou, described by Artelari & Georgiou (1999) as two new species distributed on the island of Kithira (Greece), was reported as 3-4 as in *Limonium albidum* subsp. *cyprium*. It was also understood that the number of colpi in *Limonium* Mill., showed variations within the species.

In a palynological investigation they conducted on 30 *Boraginaceae* taxa, Scheel *et al*., (1996) specified 9 different pollen types according to aperture characteristics and surface ornamentations and provided a systematic interpretation on the species according to pollen types. *Onosma caespitosum* (Figs. 22, 68-70) pollen grains examined in the present study were found to have the greatest resemblance to those belonging to the taxa having the 9th pollen type. The pollen type in 12 taxa belonging to the genera *Heliotropium* and *Tournefortia*, which have heterocolpate-psilate type pollen, was reported to be ranging from prolate to subprolate. Furthermore, in a palynological study conducted on 49 species belonging to 20 genera of the family *Boraginaceae* that are distributed in Pakistan, Perveen *et al*., (1995) described the surface ornamentation as being generally psilate-subpsilate. The pollen type of *Onosma caespitosum*, whose pollen morphology we are trying to determine in this study, is prolate, while the surface ornamentation is scabrate.

Ashta *et al*., (1990) investigated the pollen variability of *Salvia leucantha* L., (in Northern Himalayas) under scanning electron and light microscopy. Most of the pollen grains had 6 colpi; however, several grains with 4, 5, 7, 8, 9, 10, 11 colpi were also observed. Although the pollen shape varied from oblate to suboblate, oblate-spheroidal, prolatespheroidal-subprolate and the pollen size ranged between 15-40 µm, exine ornamentation was reticulate and displayed few variations. The pollen of *Salvia forskahlei* L., is with 6 colpi, suboblate, subprolate and have granular ornamentation, while that of *Origanum vulgare* L., is with 6 colpi, suboblate, spheroidal and regular reticulate (Aytuğ, 1971). Based on the fact that they have 6 colpi and are regular reticulate, the pollen grains belonging to the genera *Origanum* and *Salvia* have been described as *Mentha* L.-type pollen grains by Moore *et al*., (1997). Trudel & Morton (1992) examined the pollen morphology 118 *Labiatae* (North America) species including *Salvia* and *Teucrium* using scanning electron microscopy and specified the pollen as spheroidal and tricolpate or hexacolpate with marked perforate or with or without subratectate reticulum. Of the pollen grains on which we have conducted a palynological study, *Origanum syriacum* var. *bevanii* grains are with 6 colpi and bireticulate; P: 29.76 ± 2.28µm, E: 23.35 ± 2.11µm (Table 2, Figs. 23, 24, 71, 72), whereas *Salvia veneris* grains are with 6 colpi, supraprolate, subspheroidal, and bireticulate; P: 56.83 ± 3.27 µm, E: 45.70 ± 4.01µm (Table 2, Figs. 25, 26, 73, 74). A comparison with other studies conducted on the same subject revealed that *Origanum syriacum* var. *bevanii* and *Salvia veneris* pollen grains exhibited resemblances with one another as regards the pollen shape, pollen type, aperture and exine ornamentation and had *Mentha*-type pollen grains.

Abu-Asab & Cantino (1994) conducted palynological examinations on several species of the tribe *Ajugeae* belonging to the families *Labiatae* and *Verbanaceae*. In this study, which also covered several species of the genera *Teucrium* and *Scutellaria*, different pollen types were determined for the tribe *Ajugeae*. Differences between the families as well as the genera were compared in terms of pollen morphology. Data belonging to 38 *Teucrium* species showed that pollen grains varied from oblate spheriodal to euprolate, aperture situation was colpate, ornamentation supratectate verrucate or often suprareticulate and the pollen type operculate. Evolutionary order of the *Teucrium* species as regards their palynological characteristics is from echinate or verriculate pollen to supratectate reticulum (Abu-Asab & Cantino, 1994). Because *Teucrium* exine ornamentations display great variations and are of stenopalinous type, it is very hard to determine their revolutionary order. Furthermore, *Scutellaria* species resemble *Teucrium* species in that they too are superculate and their ornamentations do not exhibit much difference.

La Serna Ramos *et al*., (1994) conducted a palynological investigation on 26 of the 30 *Sideritis* species belonging to the subspecies *marrubiastrum* using the scanning electron and light microscopy. Pollen characters of *Sideritis* were given as isopolar, radiosymmetric with 4, often 3 or 5, regular symmetries from suboblate to subprolate, generally prolate-spheriodal and oblate spheriodal, subprolate, rarely suboblate, ovoid, with 4, sometimes with 3 or 5, lobes; the apertures as tetrazonacolpate, in indented aperture form, with 3-5 elongated narrow colpi in most plants; the exine as reticulate and with short columellae. The genus *Sideritis* is eurypalynous, whereas *marrubiastrum*, one of its subgenera, is stenopalynous. Furthermore, the difference between their geographical distributions has led to variations in pollen grains as well as their morphology. It has been understood that it is rather difficult to determine the taxonomical borders in not only the species of the genus but also *Sideritis* species with respect to palynology. *Sideritis cypria* (Table 2, Figs. 27, 28, 75-77), which is trizonocolpate and tetrazonacolpate and four straight edges and is of a spheriodal and microreticulate character, displays a different pollen type as compared to *Labiatae* species.

Oybak Dönmez *et al*., (1999) studied the pollen ornamentation of 32 *Teucrium* species distributed in Turkey using the scanning electron microscopy. Exine ornamentations observed in the study was verrucate (in the sections *Teucrium*, *Scordium* Boiss., *Chamaedrys* Benth., *Pollium* Benth., *Stachybotrys* Benth., and *Scorodonia* Benth.) and reticulate (in the section *Isotriodon*). Of the species we studied, *Scutellaria sibthorpii* displayed a prolate pollen character with 3 colpi and with a scabrate-microreticulate ornamentation (Figs. 31, 32, 81-83), while the pollen character of *Teucrium cyprium* subsp. *kyrenia* was found to be perprolate with 3 colpi and with a suprareticulate ornamentation (Table 2, Figs. 33, 34, 84, 85). The taxa we studied displayed characters resembling those dealt with in other studies and their pollen type, aperture position and ornamentation characteristics showed that they possessed *Scutellaria*- type (Moore *et al*., 1997) pollen grains.

It is known that there are a great number of studies on the genera that include the taxa we have dealt with; however, hardly any palynological study is available related to the endemics of North Cyprus. We believe that the present study will lay the foundation for future studies to be conducted on the pollen flora of Cyprus.

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