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A PALYNOLOGICAL INVESTIGATION ON SILENE L. (CARYOPHYLLACEAE) SPECIES DISTRIBUTED IN NORTH CYPRUS AND WEST ANATOLIA

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Abstract: In this study, the palynology of Silene sipylea LO. Schwarz, S.fabaria (L.) Sibth.& Sm., S.tenuiflora Guss., S.lydia Boiss. distributed in West Anatolia (B1, C1, C2) as well as S.discolor Sibth.& Sm. and S.colorata Poir. var.colorata distributed in North Cyprus was investigated. Pollens taken from the mature flowers of the species were according to the method of Erdtman [1]; and then pollen diameter, pore diameter, distance between two pores and exine values were measured; the number of pores determined; and micrographs taken by light microscopy included in the study. In addition, significant palynological characters of the species were presented in the table form. The systematic position of the species with respect to palynological data was discussed. Unlike other species, S.tenuiflora pollens are reticulate, whereas those of the other Silene species that have been examined are spheroidal, tectate, microechinate and microperforate. The largest pollens are found in S.sipylea, while S.lydia had the greatest number of pores.

Key Words: *Silene L., Pollen, West Anatolia, North Cyprus*.

KUZEY KIBRIS VE BATI ANADOLU'DA YAYILIŞ GÖSTEREN SILENE L. (CARYOPHYLLACEAE)TÜRLERİ ÜZERİNDE PALİNOLOJİK BİR ARAŞTIRMA

Özet: Batı Anadolu (B1, C1, C2)'da yayılış gösteren Silene sipylea LO. Schwarz, S.fabaria (L.) Sibth.& Sm., S.tenuiflora Guss., S.lydia Boiss. ile Kuzey Kıbrıs'ta yayılış gösteren S.discolor Sibth.& Sm. ve S.colorata Poir. var.colorata türleri palinolojik bakımdan incelenmiştir. Tür örneklerinin olgun çiçeklerinden alınan polenleri Erdtman [1] yöntemine göre preparat haline getirilerek polenlerin çapı, porların çapı, porlar arası uzaklık ve ekzin değerleri ölçülmüş, por sayıları bulunmuş, ışık mikroskobunda çekilen mikrofotoğrafları çalışmaya eklenmiştir. Ayrıca türlere ait önemli palinolojik karakterler tablolar halinde gösterilmiştir. Palinolojik veriler açısından türlerin sistematikdeki yerleri tartışılmıştır. S.tenuiflora'nın polenleri diğer türlerden farklı olarak, ağsı (retikulat) iken, diğer incelenen Silene türlerinin polenleri sferoidal, tektat, mikroekinat ve mikroperforattır. En büyük polenler Silene sipylea'da türünde, en fazla por ise S.lydia'da tespit edilmiştir.

Anahtar Sözcükler : *Silene L., Polen, Batı Anadolu, Kuzey Kıbrıs*.

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1. INTRODUCTION

In this study, the palynology of *Silene sipylea* (endemic to Turkey), *S.fabaria*, *S.tenuiflora*, *S.lydia*, *S.discolor* and *S.colorata* var.*colorata* distributed in West Anatolia as well as in North Cyprus, was investigated. The objectives of the study were to establish the pollen characteristics of the species (pollen type, pollen structure, ornamentation, pollen diameter, pore diameter, distance between two pores, exine thickness, number of pores) and also discuss their systematic positions.

Silene is represented with about 170 taxa in the Flora of Turkey and almost 20 taxa in the Flora of North Cyprus. [2, 3, 4, 5, 6]. Except for some floristic investigations, significant studies on the plants of North Cyprus include Stephonson's [7] morphological study on 7 endemic succulent species (*Crassulaceae*).

Significant taxonomical and palynological studies on *Silene* species include Melzheimer's [8] revision of the *Silene* taxa distributed in the Balkans. In this study, a comparative examination of the seed, calyx and petal characters as well as pollen characteristics was made. In her palynological study, Ghazanfar [9] determined the pollen characteristics of *Silene* belonging of the section *Siphonomorpha* Otth. Prentice [10, 11, 12, 13] investigated the taxonomy of the *Silene* species in the section *Elisanthe* (Fenzl) Fenzl.

Greuter [14] worked on the classification of the *Silene* species avaliable in Greece. In this study, the systematic characters of the sections were reviewed and the phylogenetic relationship of the genus among species examined. Desfeux & Lejeune [15] made a phylogenetic analysis of the 22 of the European-Mediterranian *Silene*. In a series of palynological studies he conducted on some *Silene* and *Dianthus* L. species, Yıldız [16, 17, 18, 19] determined the pollen characters of the species and discussed their taxonomical positions. In these studies, light and scanning electron microscopy (SEM) was used, the pollen characters were termed tectate, periporate, spheroidal, spinulose and microperforate. In a palynogical study they conducted Skvarla & Nowicke [20] established the pollen morphology of some species including *Silene* and *Dianthus*. In this study pollen characteristics of *Silene noctiflora* L. were described as pantoporate and reticulate.

It can be seen that there are no detailed taxonomical and palynological studies exclusively on the *Silene* species of North Cyprus. The objectives of the present study are to determine the palynological characteristics tof *Silene* species growing West Anatolia and North Cyprus, to provide support to North Cypriot *Silene* species, on which a limited number of studies have been made so far; and to pave the way for some biosystematic studies to be conducted in future.

2.MATERIALS AND METHODS

Specimens belonging to the *Silene* species to be examined were collected from West Anatolia (B1, C1, C2) and North Cyprus between the years 2001 and 2003 (Figure 1, Table 1).

Before the plants were collected, some information was gathered from various floristic works covering the investigation area and immediate surroundings [2, 3, 4, 5, 21] and two herbariums [Ege University Faculty of Sciences Herbarium(EGE), North Cyprus Herbarium].

An average of 6-7 specimens belonging to each species were collected from each locality. Some of the specimens were put into 70% alcohol to be used in morphological studies. Determination of the plant specimens was made using works entitled "Flora of Turkey and East Eagean Islands" [2], "Flora of Cyprus" [5] along with "An Illustrated Flora of North Cyprus" [4]. In addition, the plants that

were identified were checked in Ege University Faculty of Science Herbarium (EGE) and North Cyprus Herbarium.

For the palynological study, pollens were extracted from both the mature flowers placed into envelopes in the field and the specimens that were made into herbarium specimens. The pollens were prepared according to method of Erdtman [1] and left to dry in centrifuge tubes. Pollens taken from the bottom of the centrifuge tube with the help of glycerine-jelly pieces mounted onto the tip of dissection needles were made into preparations. After about a month, all pollen preparations were examined one by one. Pollen micrographs were taken under an Olympus trinocular research microscope using a camera, and then added to the study (Figs. 2, 3, 4). Measurements of different parts of the pollen such as pollen diameter, pore diameter, distance between two pores and exine thickness were taken using an immersion object-lens (x100) and a scale ocular (x10). These measurements were repeated on about 30 pollens for each species. Arithmetic means and standard deviations were also calculated seperately. Assesment of the palynological findings obtained was made according to Kremp [21], Erdtman [22], Faegri & Iverson [23], Nilsson et al. [24], Nilsson [25] and Moore et al. [26].

The plants were given numbers starting with the letter 'K', as an abbreviation for K.YILDIZ.

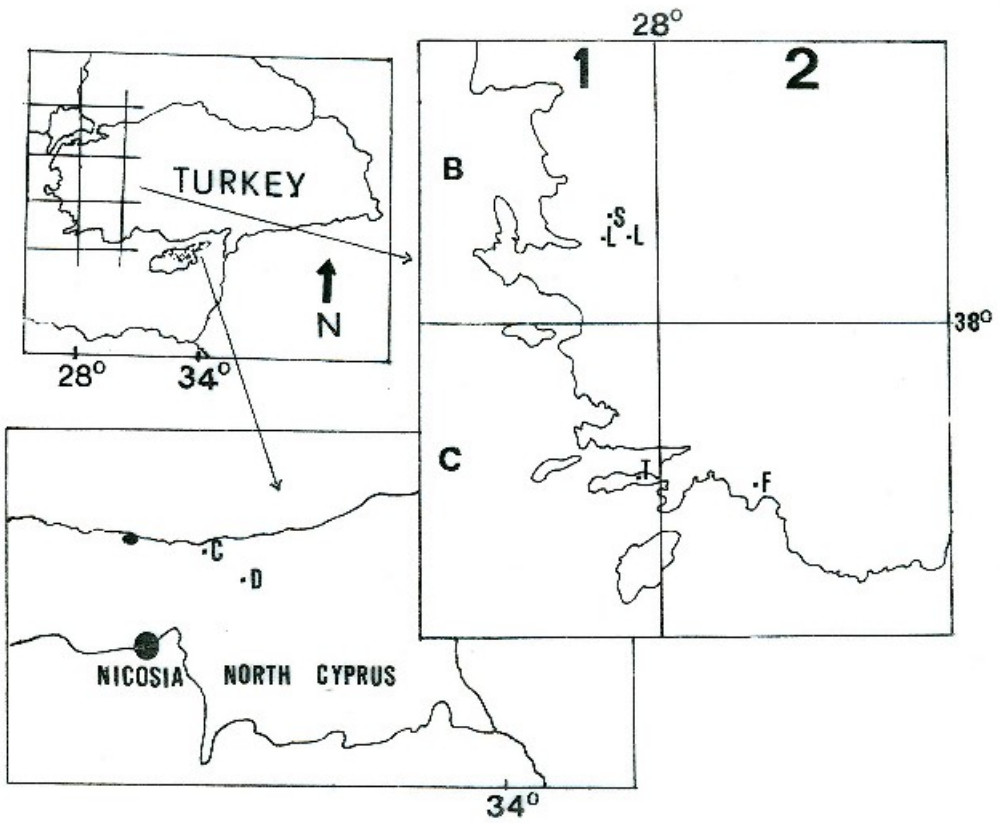

Figure 1. Map of the investigation area (**.**S: *Silene sipylea,* **.** F: *S.fabaria,* **.** T: *S.tenuiflora* **.**L: *S.lydia,* **.** D: *S.discolor,* **.** C: *S.colorata* var.*colorata*)

Table 1. Source of *Silene* species pollens. (B, C: Squares of Flora of Turkey).

SPECIES	LOCALITY, DATE, NUMBER
Silene sipylea (West Anatolia) Endemic to Turkey	B1 Manisa, Sipil mountain, near road, slopes, 800-900 m, 05.06.2002, K060.
S.fabaria (West Anatolia)	C2 Muğla, between Sultaniye-Kaunas, 200-300m, 08.05.2003, K063.
S.tenuiflora (West Anatolia)	C1 Muğla, 40 km from Marmaris to Datça, rocky places, hill, 300-400m, 20.07.2003, K070.
S.lydia (West Anatolia)	1.B1 Manisa, Sipil mountain, near road, slopes, rocky places, 500-600m, 14.05.2003, K067. 2. B1 Manisa, Sipil mountain, near lake, 900-1000m, 14.05.2003, K066.
S.discolor (North Cyprus)	Lefkoşa (Nicosia), Alevkaya (Halevga), in forest and near road, 750-800m, 20.06.2003, K058.
S.colorata var. *colorata* (North Cyprus)	Girne (Kyrenia), Hz. Ömer shore, sea level, 20.06.2003, K069.

3. RESULTS

3.1. Pollen Characteristics

3.1.1 Silene sipylea (K060, West Anatolia) (Figure 2a, b):

Pollen grains; periporate, spheroidal, tectate, there is a fine area in pore and exine area, pore sometimes prominent. Pores usually with 10-16 granules, sometimes with 4-5 granules. Ornamentation microechinate, microperforate.

3.1.2. S.fabaria (K063, West Anatolia) (Figure 2c, d):

Pollen grains; periporate, spheroidal, tectate, there is a fine area in pore and exine area Some pores 8-12 granules, some pores have no granules, Ornamentation microechinate, microperforate.

3.1.3. S. tenuiflora (K070, West Anatolia) (Figure 3a, b):

Pollen grains; periporate, spheroidal, semitectate, there is no a fine area in pore and exine area, or a little. Pores with 8-15 granules. Some pores with no granules. Ornamentation microechinate, reticulate.

3.1.4. S. lydia (K067, West Anatolia) (Figure 3c, d):

Pollen grains; periporate, spheroidal, tectate, there is no a fine area in pore and exine area, or a little. Pore sometimes prominent. Pores with 3-5 granules, there are circles out of pore and in middle pore. Ornamentation microechinate, microperforate.

3.1.5. S.discolor (K058, North Cyprus) (Figure 4a, b):

Pollen grains; periporate, spheroidal, tectate, there is a rather fine area in pore and exine area, por bölgelerinde ekzinde çok incelme var. Pores with 7-12 granules, Ornamentation microechinate, microperforate.

3.1.6. S.colorata var.colorata (K069, North Cyprus) (Figure 4c, d):

Pollen grains; periporate, spheroidal, tectate, there is no a fine area in pore and exine area, Pores with 5-8 granules. Ornamentation microechinate, microperforate.

Tablo 2. Morphological data of *Silene* species pollens
(M: Means=Average diameter of pollen, S: Standard deviation, Figs. 2, 3, 4).

	Diameter of Pollen (µm)			**Diameter of Pore (µm)**		
Species	**Min. - Max.**	**M**	**S(±)**	**Min. - Max.**	**M**	**S(±)**
Silene sipylea	46.20-49.35	47.51	0.91	5.25-9.45	7.04	1.28
S. fabaria	30.45-34.65	32.99	1.20	4.20-6.30	5.40	0.56
S.tenuiflora	31.50-37.80	34.26	1.94	5.25-7.35	6.41	0.60
S.lydia	37.80-42.00	39.13	1.29	4.20-5.25	4.51	0.49
S.discolor	36.75-45.15	41.19	2.24	4.20-6.30	5.00	0.83
S.colorata var.*colorata*	42.00-48.30	45.48	1.97	5.25-8.40	6.65	0.93

Table 2. (continued**)**

	Distance between two pores (µm)			**Exine thickness (µm)**			**Number of pores**
Species	**Min. x Max.**	**M**	**S(±)**	**Min. x Max.**	**M**	**S(±)**	
S.sipylea	6.30-9.45	7.53	0.88	3.15-4.20	3.36	0.47	17-19
S.fabaria	4.20-6.30	4.85	0.71	2.10-4.20	3.21	0.67	22-25
S.tenuiflora	3.15-5.25	4.44	0.63	2.10-4.20	3.71	0.67	14-18
S.lydia	4.20-6.30	4.81	0.61	2.10-4.20	3.39	0.55	37-42
S.discolor	4.20-6.30	4.94	0.68	3.15-4.20	3.38	0.40	21-32
S.colorata var.*colorata*	3.15-5.25	4.20	0.54	3.15-4.20	3.47	0.50	32-39

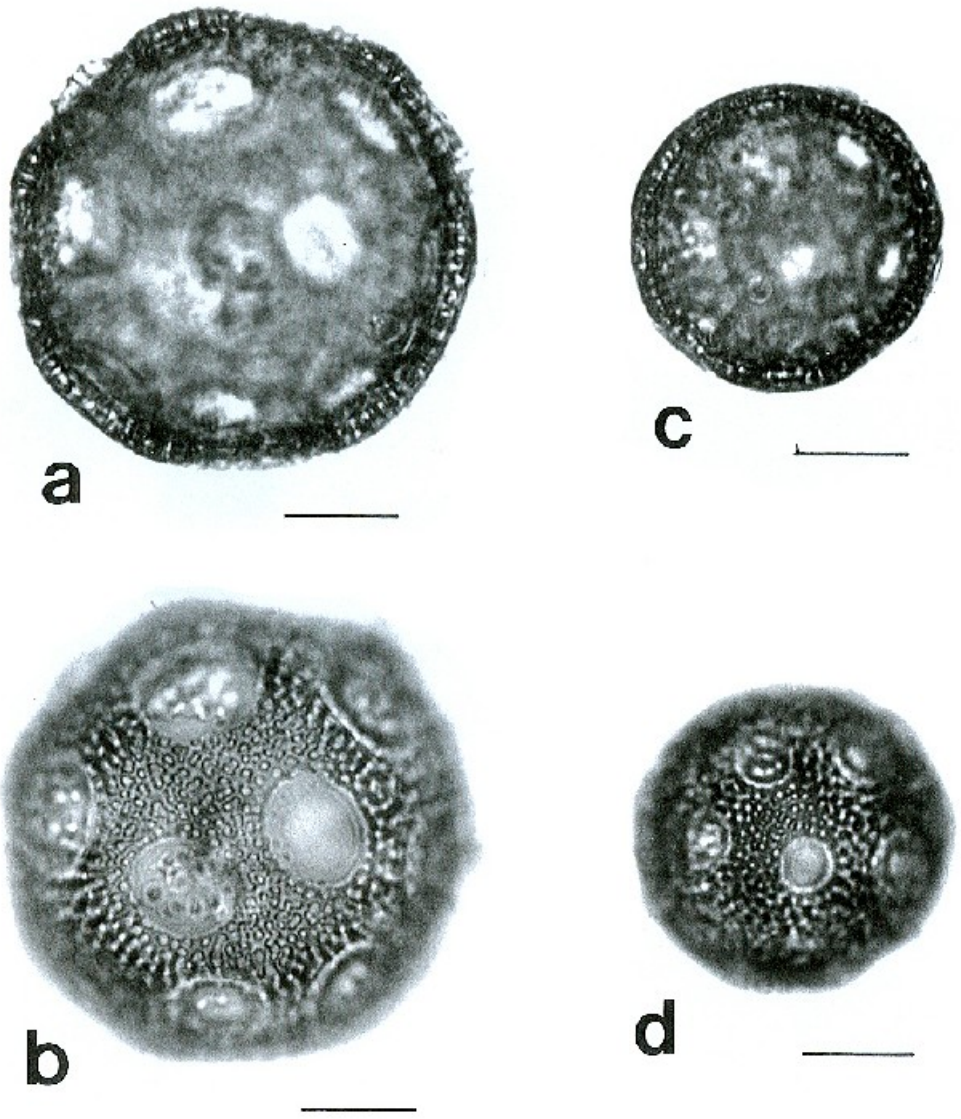

Figure 2. Light micrographs of *Silene sipylea* (K060) (a, b) and *S.fabaria* (K063) (c,d) polen. a,c. Optical section, b.d. Omamentation. (The scale equals 10 µm).

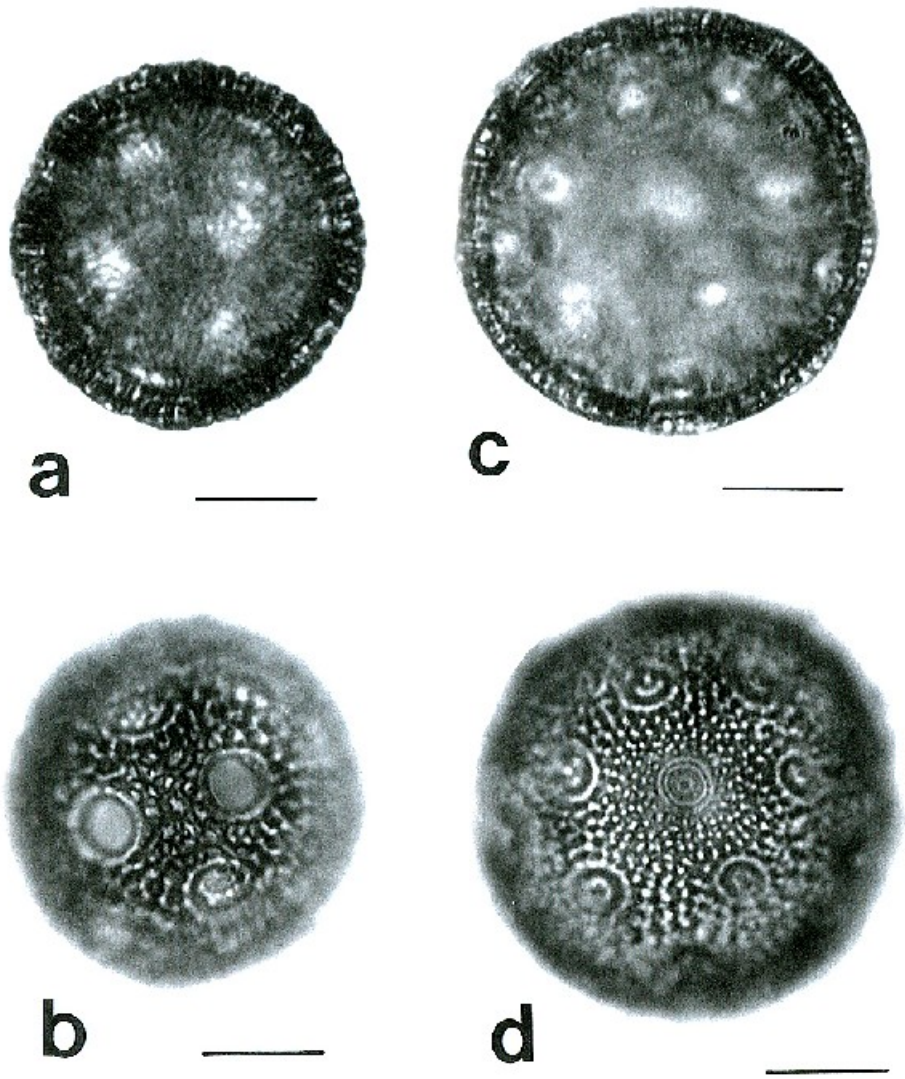

Figure 3. Light micrographs of *Silene tenuiflora*: (K070) (a, b) and *S.lydia* (K067) (c, d) pollen. a, c. Optical section, b.d. Ornamentation. (The scale equals 10 µm).

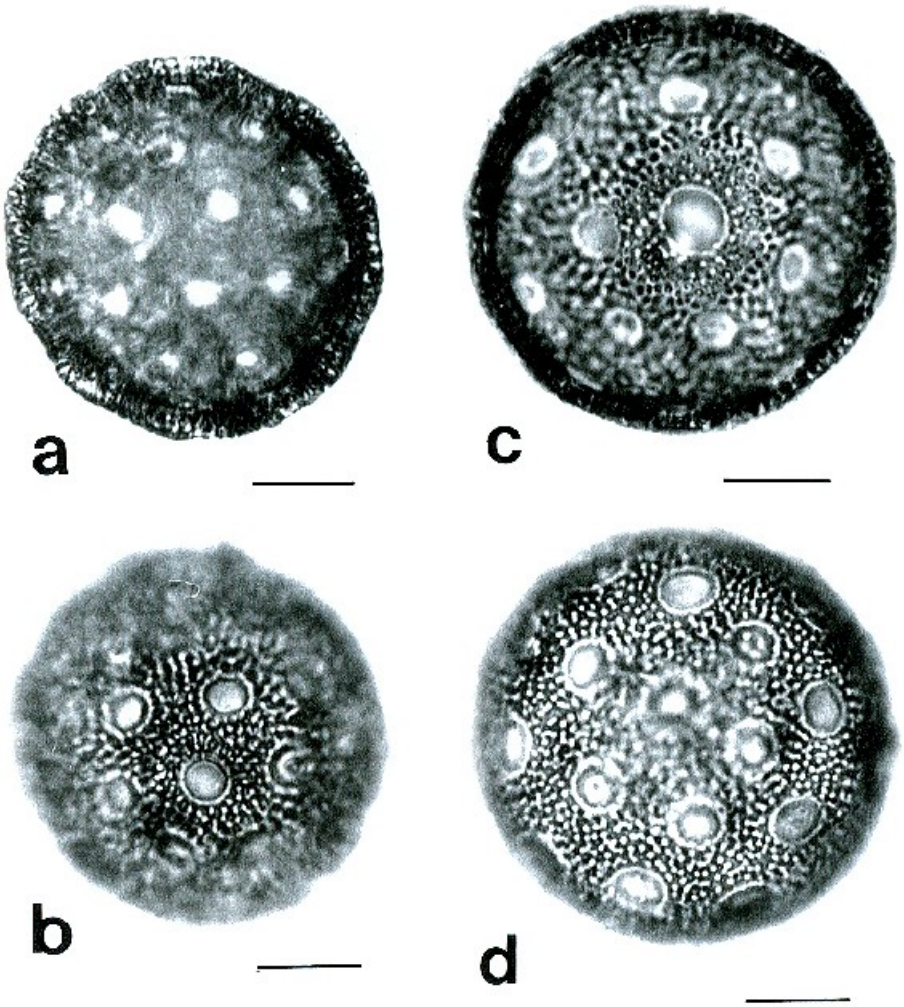

Figure 4. Light micrographs of *Silene discolor*: (K058) (a, b) and *S.colorata* var.*colorata*: (K069) (c, d) pollen. a, c. Optical section, b.d.Ornamentation.(The scale equals 10 µm).

4. DISCUSSION

A comparative investigation was conducted on the palynology of 6 species (*S.sipylea*, *S.fabaria*, *S.tenuiflora*, *S.lydia* from West Anatolia and *S.discolor* and *S.colorata* var.*colorata* from North Cyprus), which is represented with nearly to 170 taxa in the Flora of Turkey and almost 20 taxa in the Flora of North Cyprus [2, 3, 4, 5, 6]. In this study, important characters of *Silene* species (pollen structure, ornamentation, pollen diameter, pore diameter, distance between two pores and exine thickness) were compared.

As regards the pollen measurements, the species examined were found to be of medium size and had large pollen values. The largest pollen diameter was measured in *S.sipylea* (46.20-49.35, 47.51±0.91 µm); the smallest pollen diameter in *S.fabaria* (30.45-34.65, 32.99± 1.20 µm); the largest pore diameter in *S.sipylea* (5.25-9.45; 7.04±1.28 µm); and the smallest pore diameter in *S.discolor* (4.20-6.30; 4.51±0.49 µm). The greatest number of pores was found in *S.lydia* (37-42); the smallest in *S.tenuiflora* (14-18). It was also seen that the distance between pores was greater in *S.sipylea* (6.30-9.45; 7.53±0.88 µm) as compared to the other species

(Table 2, Figs. 2-4). Large distance between two pores caused *S.sipylea*, which had the largest pollen diameter, to have fewer pores than all the other species in study except for *S.tenuiflora*.

In a palynological study they carried out on some *Silene* and *Dianthus* species, [20] termed the pollens of *Silene noctiflora* pantoporate, reticulate, which exibited similarities with the characteristics we obtained (*S.tenuiflora*; Figs. 3a, b, periporate, reticulate).

In the studies carried out on the *Silene* species distributed in our area of investigation and surroundings [9, 16, 17, 18, 19], the pollens were generally termed tectate, spheroidal, periporate, microechinate (spinulose), reticulate and microperforate. The *Silene* pollens in our study were also found to have similar characters (Table 2).

It is well known that the aperture characteristics and exine structures of pollens are the main characters used in determining the evolutionary patterns among genera, families and even larger taxa [27, 28, 29, 30]. Presence of projections on the surface of the tectum is an indication of an advanced character [29]. An exine with an imperforate is considered a primitive character [27, 28]. Ornamentation types of pollens are valid morphological characters in taxonomy. Moreover, those with a small number of pores are considered primitive while those with a large number of pores are regarded as advanced [31, 32]. Taxa are arranged in an evolutionary order in the Flora of Turkey [2] and the Flora of North Cyprus [5]. An examination of the species we worked on will not help us make justifiable comments on the evolutionary process of the species as far as the pollen surfaces are concerned; however, it will demonstrate that species with a greater number of pores, such as *S.colorata* var.*colorata* (32-39) and *S.lydia* (37-42) are more advanced as compared to other species (Table 2, Figs. 3c, d; 4c, d). In a view of palynological data obtained, there are no discrepancies in the evolutionary arrangement of the examined species in the Flora of Turkey [2] and the Flora of North Cyprus [5].

In a palynological study conducted on species *S.behen* L. (section *Behenantha* Otth) [33], pollens were termed tectate, microechinate-spinulose and irregular microperforate and the number of pores was given as 14-20; *S.tenuiflora*, however, was termed semitectate, reticulate with 14-18 pores (Table 2), showing that *S.tenuiflora* has not gone through a process of evolution as regards the number of pores, but it is far more advanced than *S.behen* as the surface of its pollens is more ornamented and reticulate. Consequently, it can be stated that there no discrepancies in the evolutionary arrangement of these species in the Flora of Turkey [2].

In some palynological studies conducted [18, 19], the pollens of *S.sipylea* and those of *S.bupleroides* L., from the same section (section *Sclerocalycina* Boiss.), were expressed as microechinate, the number of pores as 16-22 [18], and the pollens of *S.chlorifolia* Sm. as microechinate, the number of pores 20-26. The pollens of *S.sipylea*, however, were termed microechinate, with 17-19 pores, which shows that it is more primitive than *S.chlorifolia*. Classification of the species is accurate according to palynological observations. The pollens of *S.fabaria* and those of *S.vulgaris* (Moench) Garcke *vulgaris*, from the same section (section *Inflatae* Boiss.), *are* microechinate, the number of pores 15-31 [19]; and the pollens of *Silene cserei* Baumg subsp.*aeoniopsis* (Bornm.) Chowdh. are microechinate, the number of pores 18-24 [19]. The pollens of *S.fabaria* are microechinate and the number of pores 22-25, but it is quite difficult to make any evolutionary comments on the systematic position of the species as far as their pollen characters are concerned. The pollens of *S.lydia* and those of *S.conica* L., from the same section (section *Conomorpha* Otth), are reticulate and the number of pores 32-40; the pollens of *S.conoidea* L. are reticulate, and the number of pores 30-34 [19]. The pollen of *S.lydia*

are microechinate, microperforate with 37-42 pores (Table 2, Figure 3c, d) and it is more primitive than *S.conica* ve *S.conoidea*. Consequently, its place the Flora of Turkey [2] needs to reexamined.

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