

Morphological and Palynological Investigation on *Silene gigantea* L. var. *gigantea* and *Silene behen* L. (*Caryophyllaceae*) Distributed in Western Anatolia and Northern Cyprus

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Abstract: A comparative investigation was carried out on the morphology and palynology of *Silene gigantea* L. var. *gigantea* and *Silene behen* L. species of the family Caryophyllaceae distributed in Western Anatolia and Northern Cyprus. An examination conducted on *S. gigantea* var. *gigantea* revealed that the calyx length in Western Anatolian specimens was shorter than that of those from Northern Cyprus, that the basal petal blades of the Western Anatolian specimens did not have any ligula while those from Northern Cyprus did, and that the petal blades belonging to the specimens from Northern Cyprus demonstrated less clefting as compared to those from Western Anatolia. Therefore, *S. gigantea*, growing in Western Anatolia and Northern Cyprus, could be separated into 2 subspecies. In addition, *S. behen* also could be separated into 2 subspecies. It was also observed that the seeds taken from all specimens of both species were reniform, with the tubercles on the seed surfaces of the *S. behen* species having a longer conical structure as compared to those of *S. gigantea* var. *gigantea*. Pollen grains of both species are spheroidal, tectate and spinulose-microperforate. It was also determined that *S. gigantea* var. *gigantea* specimens collected from Northern Cyprus had greater pore diameters, whereas *S. behen* specimens from Western Anatolia had greater distances between the pores.

Key Words: *Silene* L., Morphology, Pollen, Western Anatolia, Northern Cyprus

Batı Anadolu ve Kuzey Kıbrıs'ta Yayılış Gösteren *Silene gigantea* L. var. *gigantea* ve *Silene behen* L. (*Caryophyllaceae*) Türleri Üzerinde Morfolojik ve Palinolojik Bir Araştırma

Özet: Araştırmada, Caryophyllaceae familyasının Batı Anadolu ve Kuzey Kıbrıs'ta yayılış gösteren *Silene gigantea* L. var. *gigantea* ve *Silene behen* L. türleri morfolojik ve palinolojik bakımdan karşılaştırmalı olarak incelenmiştir. Yapılan incelemede *S. gigantea* var. *gigantea*'nın Batı Anadolu örneklerindeki kaliks boyu Kuzey Kıbrıs örneklerinden daha kısa olduğu, Batı Anadolu örneklerinin petal aya tabanlarında dilcik bulunmazken Kuzey Kıbrıs örneklerinde mevcut olduğu, *S. behen*'in Kuzey Kıbrıs örneklerine ait petal ayasının Batı Anadolu örneklerine göre daha az yarıma gösterdiği tespit edilmiştir. Bu nedenle, Batı Anadolu ve Kuzey Kıbrıs'ta yetişen *S. gigantea* iki alt türe ayrılabilir. Ayrıca, *S. behen* de iki alt türe ayrılabilir. Bunun yanında, her iki türün de tüm örneklerden alınan tohumları reniform olup, *S. behen* türünün tohumlarının tohum yüzeylerindeki çıkıntılarının (tüberkül) *S. gigantea* var. *gigantea*'ye göre daha uzun konik yapıda olduğu görülmüştür. Her iki türün polenleri sferoidal, tektat, mikroekinat ve mikroperforatır. *S. gigantea* var. *gigantea*'nın Kuzey Kıbrıs örneklerinde por çapının, *S. behen*'in Batı Anadolu örneklerinin porlar arası uzaklıklarının daha fazla oldukları tespit edilmiştir.

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

Introduction

Specimens of *Silene gigantea* var. *gigantea* and *S. behen* of the genus *Silene* L., distributed in Western Anatolia and Northern Cyprus, collected from different geographical regions and localities (Figure 1, Table 1), were examined in the present study in an effort to observe their morphological (Tables 2 & 3, Figures 1-7) and palynological similarities and differences (Table 4, Figures 8 & 9). The objective of the study was to

determine the kind of morphological (flower, seed) and palynological (pollen type, pollen structure, ornamentation, pollen diameter, pore diameter, distance between 2 pores, exine thickness, number of pores) differences between the 2 species stemming from their distributions in 2 different geographical regions.

Silene is represented by about 170 taxa in the Flora of Turkey and by about 20 taxa in the Flora of Northern Cyprus. *Silene* is a genus of the family *Caryophyllaceae*,

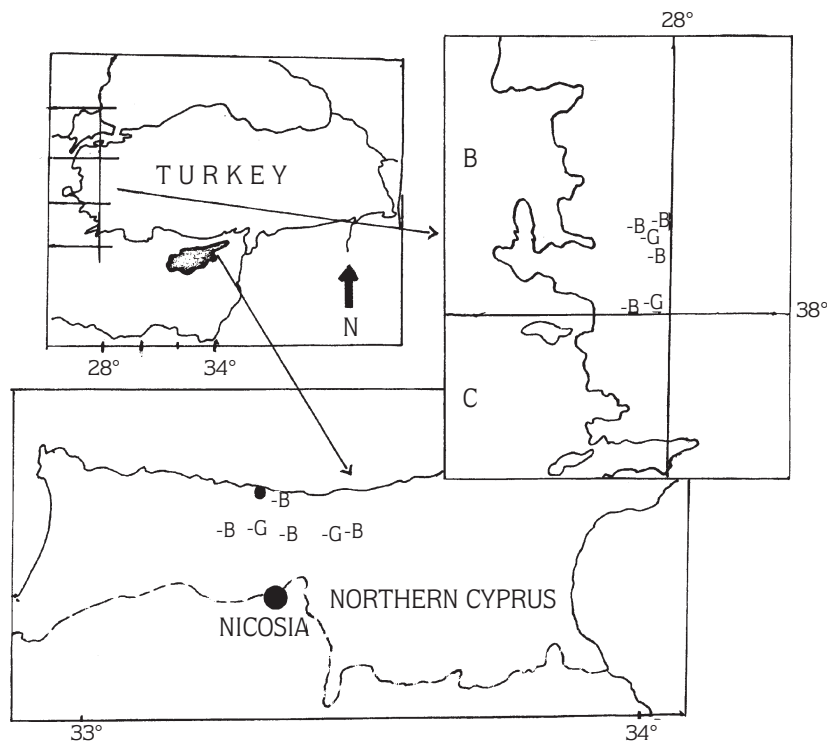


Figure 1. Map of the investigation area (• G: *Silene gigantea* var. *gigantea*, • B: *Silene behen*).

Table 1. Data for the collection of *Silene gigantea* var. *gigantea* and *S. behen*.

SPECIES	LOCALITY, DATE, NUMBER
<i>Silene gigantea</i> var. <i>gigantea</i> (K064, Western Anatolia)	1. B1 İzmir, Tire, slopes, 250-300 m, 10.05.2003, K064.
	2. B1 İzmir, Kemalpaşa, slopes, under forest, near road, 500-600 m, 30.06.2003, K072.
<i>S. gigantea</i> var. <i>gigantea</i> (K057, Northern Cyprus)	1. Girne (Kyrenia), St. Hilarion castle, slopes, banks, limestone rocks, scrub, 25.04.2001, 700 m, K057.
	2. Lefkoşa (Nicosia), Alevkayası (Halevga), banks, rocky places, scrub, 600 m, 20.06.2003, K071.
<i>S. behen</i> (K059, Western Anatolia)	1. B1 İzmir, Tire, slopes, scrub, 250-300 m, 15.05.2002, K059.
	2. B1 Manisa, Sipil mountain, 200 m, 05.05.2001, K054.
	3. B1 Manisa, Sipil mountain, slopes 400 m, 04.05.2003, K062.
	4. B1 Manisa, Sipil mountain, valley, 200 m, 14.05.2003, K065.
<i>S. behen</i> (K053, Northern Cyprus)	1. Girne (Kyrenia), near Kayalar village, rocky places, 300 m, 22.04.2001, K051.
	2. Lefkoşa (Nicosia), Buffavento castle, rocky places, 800-900 m, 23.04.2001, K052.
	3. Girne (Kyrenia), 5 km from Alevkayası (Halevga) to Girne (Kyrenia), Northern, Kyrenia rocks, rocky places and scrub, 600 m, 23.04.2001, K053.
	4. Girne (Kyrenia), St. Hilarion castle, rocky places, slopes, 700 m, 08.06.2002, K061.
	5. Girne (Kyrenia), Alevkayası (Halevga), near road, 800 m, 20.06.2003, K068.

Table 2. Morphological characteristics of *Silene gigantea* var. *gigantea* and *S. behen* (Figures 2-5) .

Species	<i>Silene gigantea</i> var. <i>gigantea</i> (K064, Western Anatolia)	<i>Silene gigantea</i> var. <i>gigantea</i> (K057, Northern Cyprus)	<i>S. behen</i> (K059, Western Anatolia)	<i>S. behen</i> (K053, Northern Cyprus)
Height of Plant, (cm)	60-100	30-100	10-90	10-30 (40)
Basal leaves	Pubescent, Spathulate	Glacous, sometimes densely pubescent, spathulate	Obovate, spathulate, Oblanceolate	Obovate, spathulate, Oblanceolate
Cauline leaves (cm)	Obovate, spathulate	Narrower obovate-spathulate	(-5) 8 –20 Wide Lanceolate Narrowly elliptical Oblanceolate	4-10 x 0.6-2.5 Obovate
Inflorescence	Paniculate	Paniculate	Dichasium, Upper monochasium	Spreading Dichasium
Size of Calyx (mm, nerves-veins)	6-7 x 3 10-nerved	10 x 3 10-nerved	11-14 10 anastomosing veins	10-15 10 anastomosing veins
Surface of Calyx	Glandular	Smaller Glandular	Glabrous	Glabrous
Size of petal (mm)	15-16 x 0.5-1	12-15 x 0.5-0.7	12-15 x 2-3	10-13 x 2-3
Petal limb	Bifid, no scales	Deeply bifid 2 scales	Bifid, no scales	Little bifid, no scales
Anthophore (mm)	2 - 4.5	4 – 5	2 - 2.5	c. 1
Size of Fruit (Capsule) (mm)	9-11 x 5-6	8-10 x 6-7	7-9 x 6-7	8-9 x 7-8
Shape of Capsule	Broadly ovoid, teeth slightly reflexed	Broadly ovoid	Ovoid	Wide ovoid, subglobose
Habitat	Slopes 500 – 600 m	Limestone rocks, 600 – 900 m	Slopes, rocky places, fields 0 - 1400 m	Slopes, fields 0 – 1150 m
Flowering period (in months)	May-July	May-July	April-May	February-May
Distribution	Balkans, Aegean and Mediterranean	Balkans, Aegean and Mediterranean	Mediterranean	Mediterranean

having the greatest number of species both in the Turkish and Northern Cypriot floras (Davis, 1967; 1988; Meikle, 1977; Viney, 1994; Güner et al., 2001).

Apart from certain floristic studies on the plants of Northern Cyprus (Meikle, 1977, 1985; Viney, 1994, 1996), other significant studies include Stephenson's study (1993) on 7 endemic succulent species from the family *Crassulaceae* distributed on the island of Cyprus.

There are many taxonomical, morphological and palynological studies on the *Silene* species in our investigation area and its environs. Melzheimer (1977) conducted a biosystematic revision of the *Silene* taxa distributed in the Balkans. The study includes a comparative examination of the seed, calyx, petal and pollen characteristics. In a palynological study they carried out on 11 *Centrospermae* families, which also included *Silene* and

Table 3. Seed morphology of *S. gigantea* var. *gigantea* and *S. behen* species [except *S. gigantea* var. *gigantea* (Northern Cyprus) specimen] (Figures 6 & 7).

Species	<i>Silene gigantea</i> var. <i>gigantea</i> (K064, Western Anatolia)	<i>S. behen</i> (K059, Western Anatolia)	<i>S. behen</i> (K053, Northern Cyprus)
Seed			
Type	Reniform	Reniform	Reniform
Length-width (mm)	1.5 x 1.2	1.6 x 1.3	1.5 x 1.2
Length-width ratio	1.25	1.23	1.25
Shape of Tubercle	Conical	Long conical, tips dark	Long conical, tips dark
Surface type	Flat and concave	Concavo-convex	Concavo-convex, flat
Granulation	Coarse	Fine	Fine
Testa cell max. x min. (mm)	2.14-3.09 x 0.47-0.71	1.6-2.4 x 0.6-1.2	2.2-2.6 x 0.6-1.2
Number of suture points per plate	9-16	20-30	19-26
Suture outline	Sinuuous	Serrate	Serrate
Hylar zone type	Recessed	Little recessed	Little recessed

Table 4. Palynological data of *Silene gigantea* var. *gigantea* and *S. behen* (M: Means = Average diameter of pollen, S: Standard deviation, Figures 8 & 9).

Species	Diameter of Pollen (µm)			Diameter of Pore (µm)			Distance between 2 pores (µm)			Exine thickness (µm)			Number of pores
	Min.- Max.	M	S(±)	Min.- Max.	M	S(±)	Min.- Max.	M	S(±)	Min.- Max.	M	S(±)	
<i>Silene gigantea</i> var. <i>gigantea</i> (K064, Western Anatolia)	39.90-50.40	44.45	2.47	4.73-9.45	6.20	1.05	6.30-12.60	9.25	1.35	3.15-4.73	4.02	0.53	13-19
<i>S. gigantea</i> var. <i>gigantea</i> (K057, Northern Cyprus)	42.00-48.30	45.56	1.86	3.68-10.50	7.09	1.38	6.30-13.65	9.20	2.20	3.15-4.20	3.41	0.42	12-1 ⁷
<i>S. behen</i> (K059, Western Anatolia)	40.95-47.25	44.39	2.09	5.25-7.35	6.30	0.82	6.30-11.55	8.93	1.52	3.15-3.15	3.15	0.00	13-16
<i>S. behen</i> (K053, Northern Cyprus)	40.95-46.20	43.16	1.44	5.25-8.40	6.73	0.88	4.73-9.45	6.97	1.19	2.63-4.20	3.33	0.47	15-21

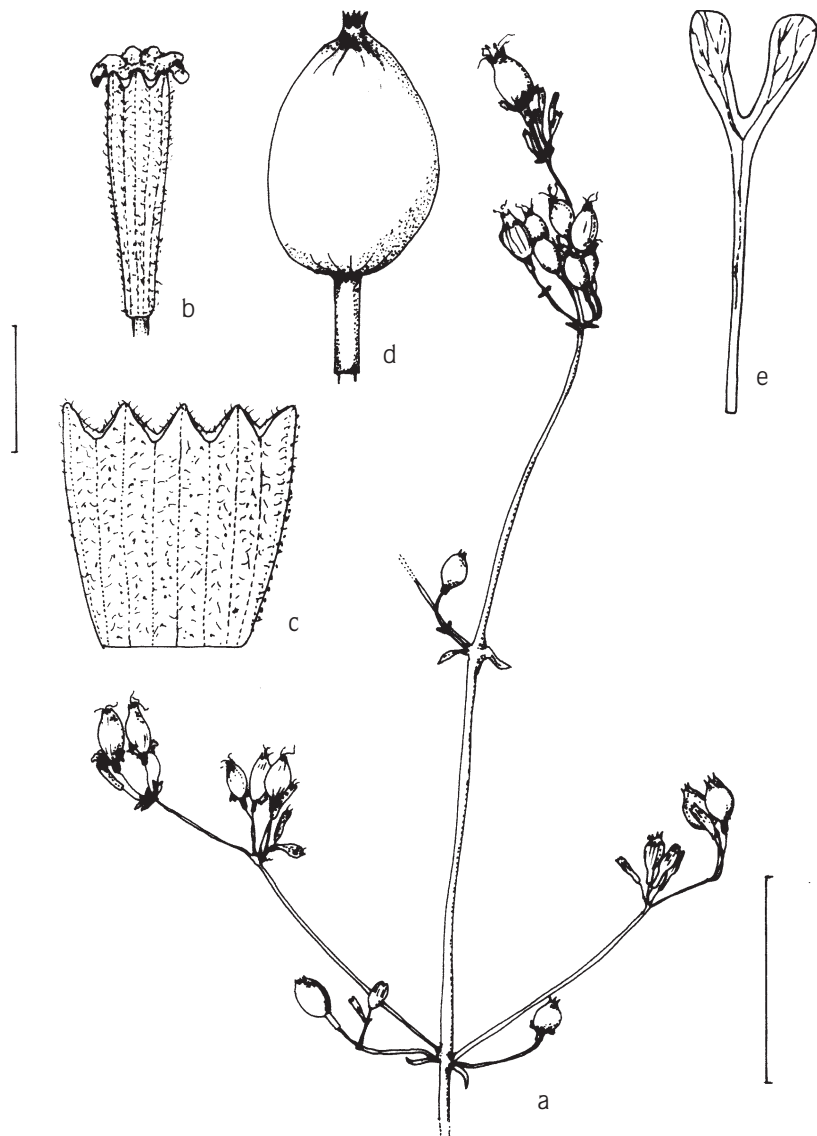


Figure 2. *Silene gigantea* var. *gigantea* (Western Anatolia, K064): a. General view (—: 5 cm), b. Calyx (Flower), c. Calyx (Opened flower), d. Petal, e. Fruit (Capsule), (b, c, d, e: —: 0.5 mm).

Dianthus species from the family *Caryophyllaceae*, Skvarla and Nowicke (1976) determined by SEM the pollen morphology of certain species. In the above-cited study, the pollen characteristics of *Silene noctiflora* L. were described as pantoporate and reticulate. In a study where he discussed the taxonomical position of *Silene thebana* Orph. ex Boiss., which is distributed in Greece, Melzheimer (1987) made use of seed morphology as the most distinguishing criterion. In a palynological study he conducted, Ghazanfar (1984) determined the pollen characteristics of *S. gigantea* of the section *Siphonomorpha*

from the island of Samos and the species *S. italica* (L.) Pers. and *S. viridiflora* L. Prentice (1978, 1979, 1980) carried out taxonomical, karyological and palynological investigations on *Silene* species of the section *Elisanthe*. Authier (1992) made a series of morphological investigations on *S. remotiflora* Vis., which is distributed in North-west Greece. In Authier's study, the systematic characteristics of the sections were reviewed, and the phylogenetic relationships of the genus among the species examined. Desfeux and Lejeune (1996) made a phylogenetic analysis of 22 of the European-Mediterranean

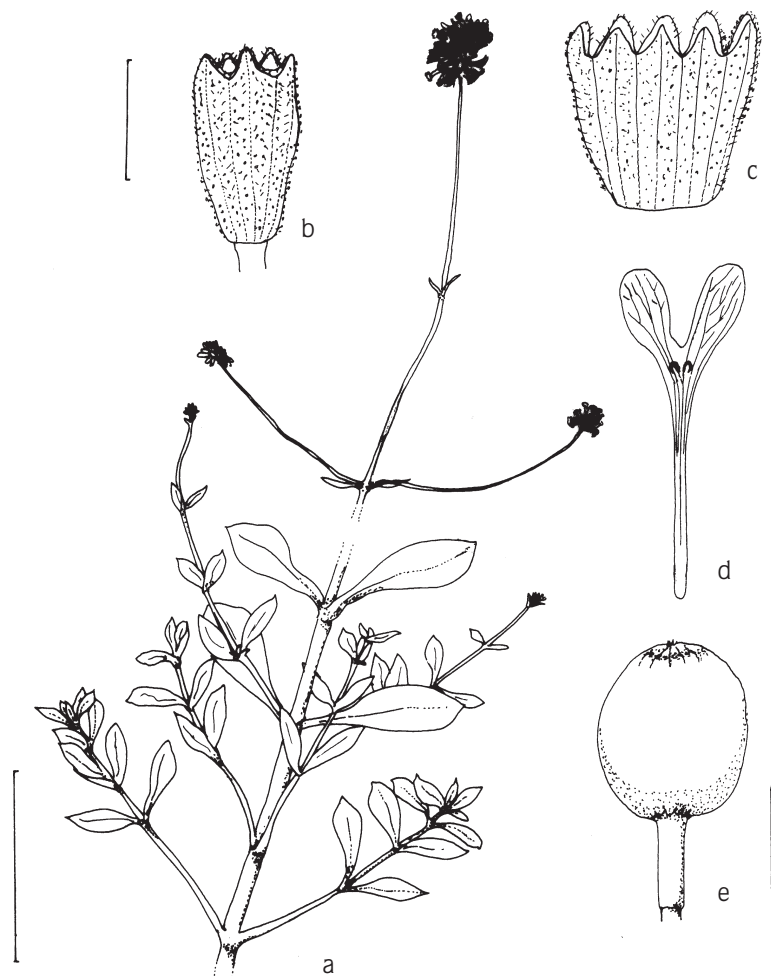


Figure 3. *Silene gigantea* var. *gigantea* (Northern Cyprus, K057): a. General view (—: 5 cm), b. Calyx (Flower), c. Calyx (Opened flower), d. Petal, e. Fruit (Capsule), (b, c, d, e: —: 0.5 mm).

Silene species. *Lychnis-Melandrium* genera, known to have close similarities with *Silene*, were discussed. Yıldız and Çırpıcı (1992) investigated the morphology of 8 *Silene* species distributed in Tokat province and its environs. Yıldız and Çırpıcı (1998) also determined the seed morphology of 19 *Silene* species distributed in Turkey, 3 of which were endemic, using stereo and scanning electron microscopy (SEM). Yıldız (2002) also worked on the seed morphology of 17 *Caryophyllaceae* species distributed in Northern Turkey including *Dianthus* and *Silene* species. In a number of palynological studies he conducted on certain *Dianthus* and *Silene* species, Yıldız (1996a, 1996b, 2001a, 2001b) determined the pollen characters of the species and discussed their taxonomical

positions. In these studies, light microscopy and SEM were used and the pollen characters were termed tectate, polyantoporate, spheroidal and spinulose-microperforate. It can be seen that there are no detailed morphological or palynological studies exclusively on the *Silene* species of Northern Cyprus. The objectives of the present study include determining morphological and palynological characteristics that could originate from the geographical differences between the individuals of the same species that grow in Western Anatolia and Northern Cyprus, providing support to Northern Cypriot *Silene* species, on which a limited number of studies have been performed so far, and thus paving the way for future biosystematic studies.

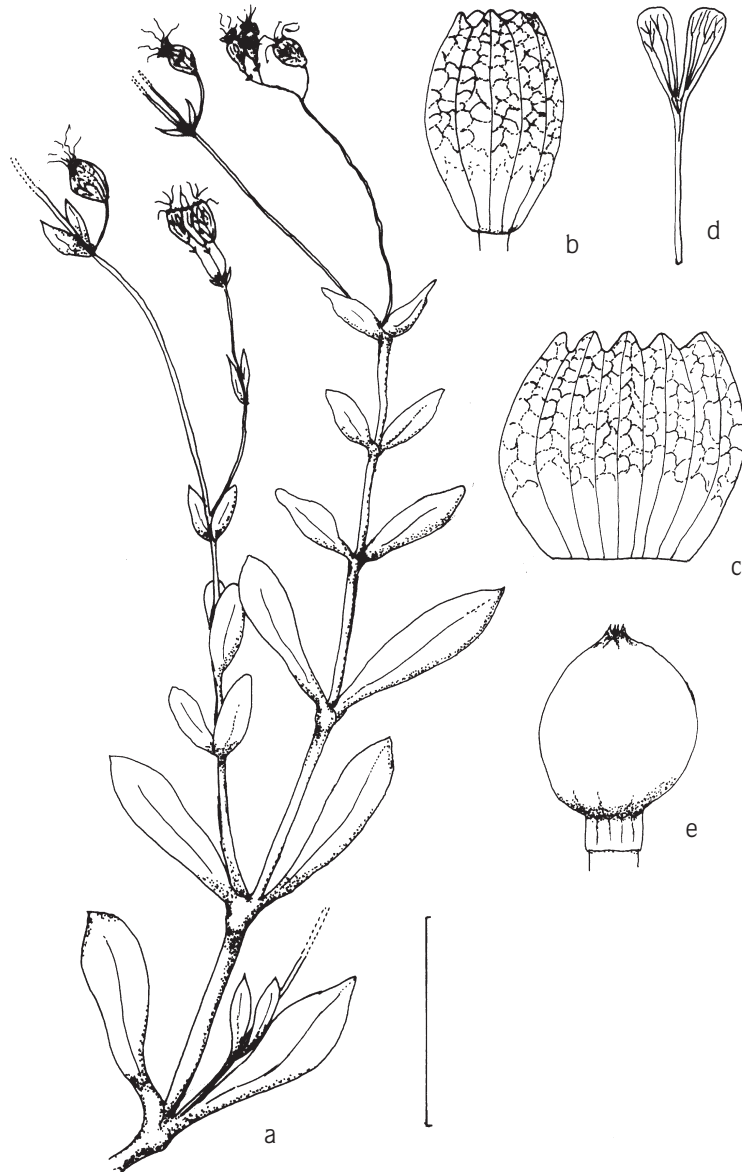


Figure 4. *Silene behen* (Western Anatolia, K059): a. General view (—: 5 cm), b. Calyx (Flower), c. Calyx (Opened flower), d. Petal, e. Fruit (Capsule), (b, c, d, e: —: 0.5 mm).

S. gigantea var. *gigantea* is divided into 2 varieties (var. *gigantea* and var. *incana*) in the Flora of Turkey (Davis, 1967). However, it has no known variety in the Flora of Cyprus (Meikle, 1977). According to the key to diagnostics in the Flora of Turkey, it was understood that both Western Anatolian and Northern Cypriot specimens were *S. gigantea*; thus, specimens from both regions were termed *S. gigantea* var. *gigantea*.

Materials and Methods

Prior to the field studies, information was gathered from various floristic works covering the investigation area and immediate surroundings (Davis, 1967, 1988; Meikle, 1977; Viney, 1994; Güner et al., 2001) and 2 herbaria (Ege University Faculty of Sciences Herbarium [EGE], Northern Cyprus Herbarium).

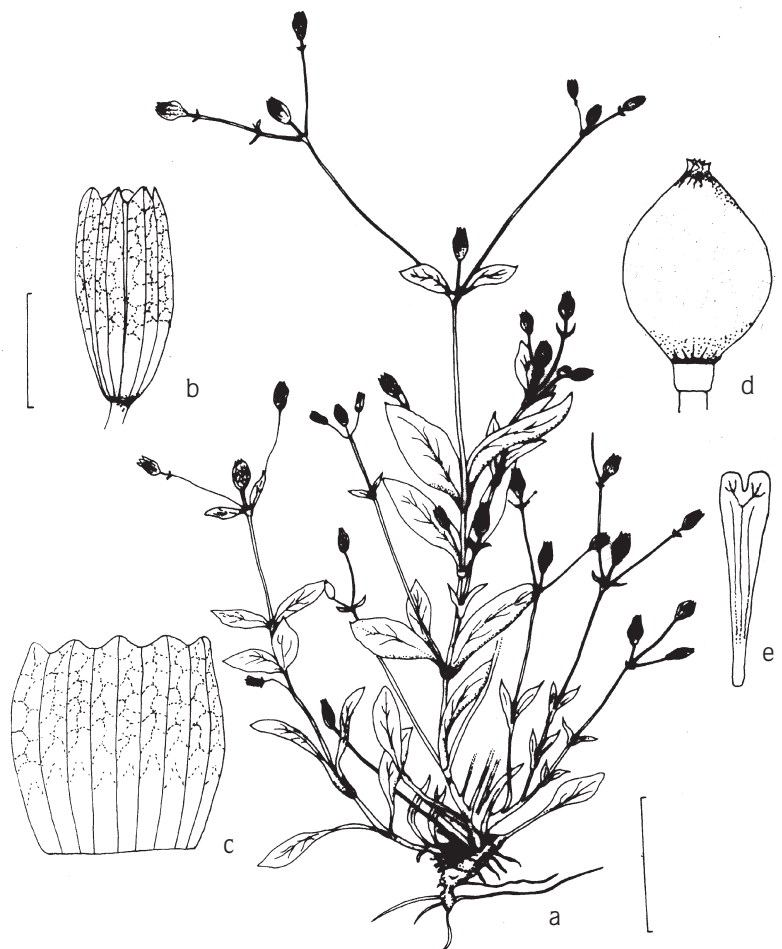


Figure 5. *Silene behen* (Northern Cyprus, K053): a. General view (—: 5 cm), b. Calyx (Flower), c. Calyx (Opened flower), d. Petal, e. Fruit (Capsule), (b, c, d, e: —: 0.5 mm).

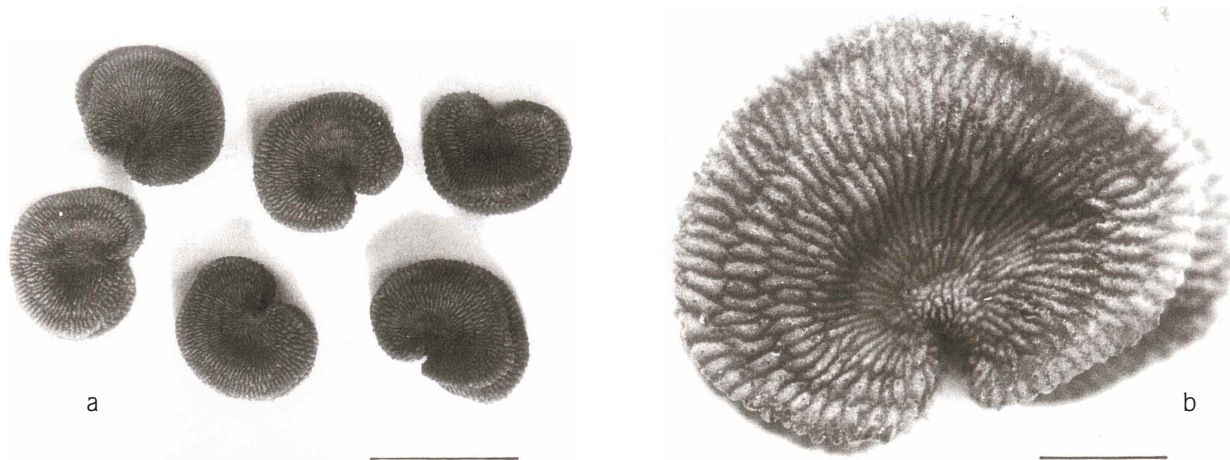


Figure 6. Light micrographs of *Silene gigantea* var. *gigantea* seed (Northern Cyprus, K057): a. General view (—: 2 mm), b. Seed surface (—: 0.5 mm).

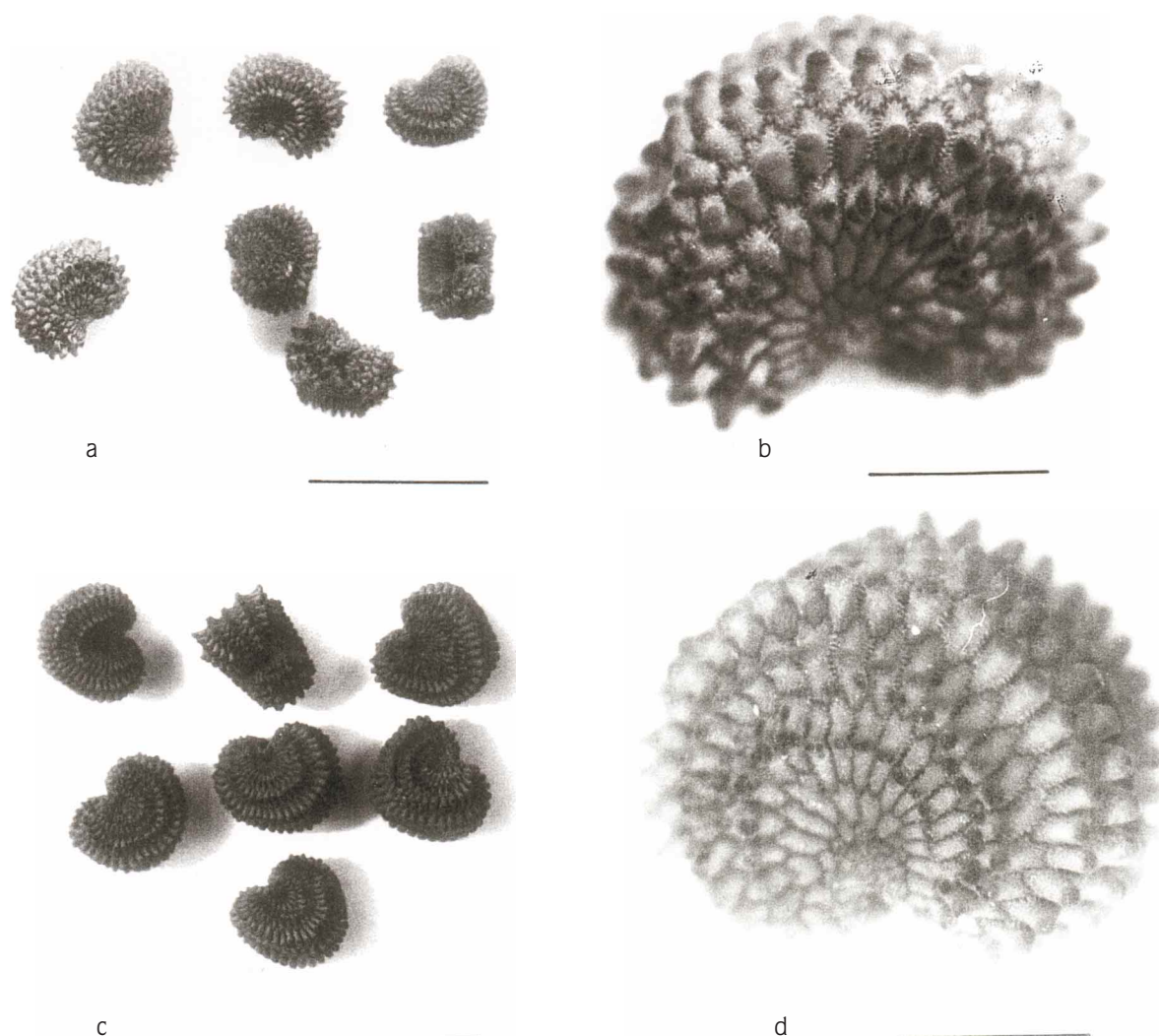


Figure 7. Light micrographs of *Silene behen* seed (a, b: Western Anatolia, K059, (c, d: Northern Cyprus, K053): a, c. General view, b, d. Seed surface. (a, c; —: 2 mm), (b, d; —: 0.5 mm).

The specimens of the species collected from the investigation area between 2001 and 2003 included 12 *S. gigantea* var. *gigantea* specimens from 4 different localities in Western Anatolia (B1) and Northern Cyprus, 20 *S. behen* specimens from 4 different localities in Western Anatolia and 30 from 6 different localities in Northern Cyprus (Figure 1, Table 1). Some of the specimens were put into 70% alcohol to be used in morphological studies. The plant specimens collected from the investigation area were determined using works entitled "Flora of Turkey and East Aegean Islands" (Davis, 1967), "Flora of Cyprus" (Meikle, 1977) and "An

Illustrated Flora of Northern Cyprus" (Viney, 1994). Moreover, the plants that were identified were then checked in the Ege University Faculty of Science Herbarium (EGE) and Northern Cyprus Herbarium.

Owing to their significance in the determination of *Silene* species collected from Western Anatolia and Northern Cyprus, diagnostics such as plant height, arrangement of the basal and cauline leaves, inflorescence, sepal, petal and fruit (capsula) were presented in the form of a table (Table 2) in the morphological study. Furthermore, drawings of 4 plants belonging to 2 species showing the general view and

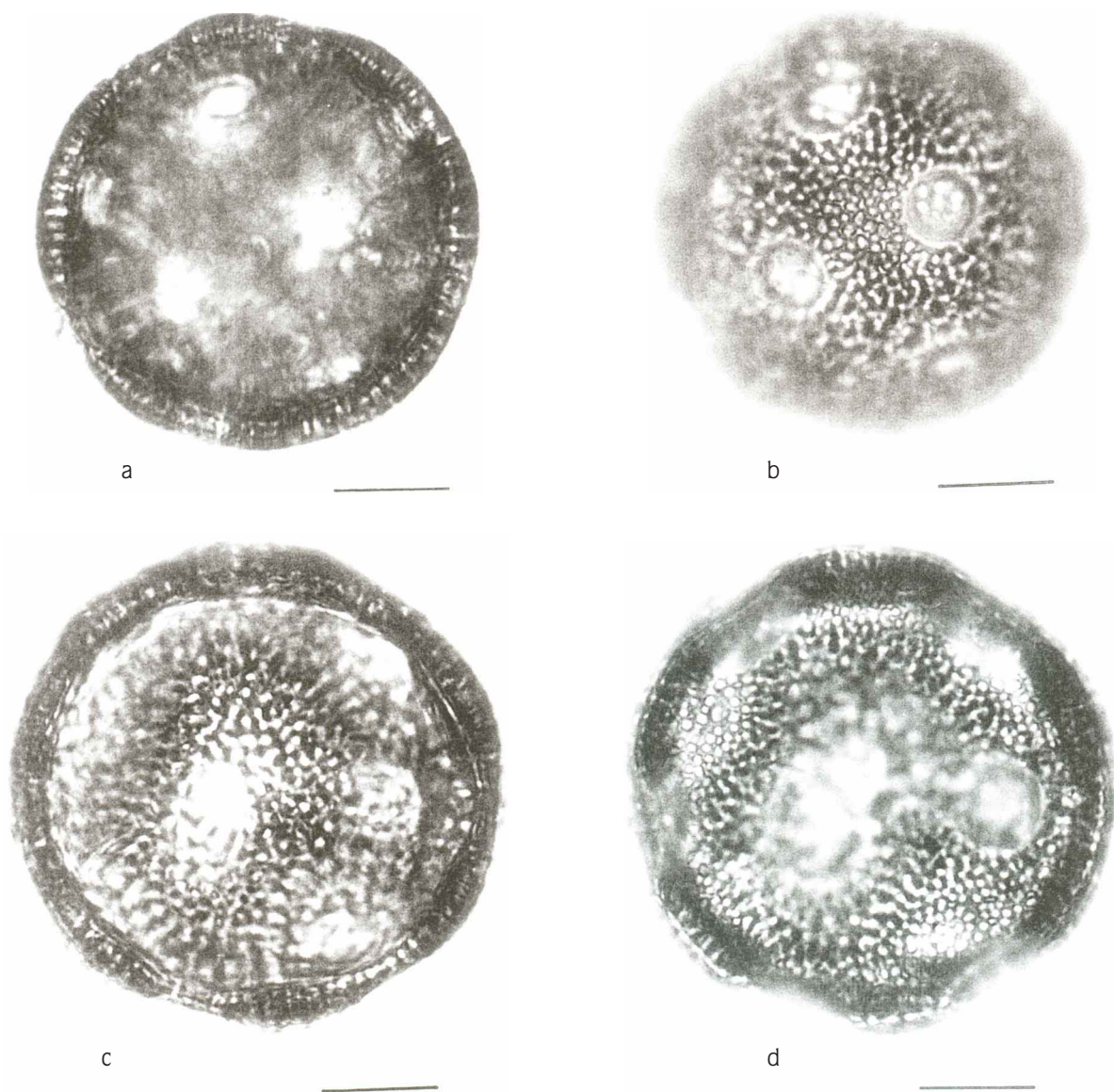


Figure 8. Light micrographs of *Silene gigantea* var. *gigantea* pollen (— : 10 μ m), (a, b; Western Anatolia, K064): a. Optical section, b. Ornamentation, (c, d; Northern Cyprus, K057), c. Optical section, d. Ornamentation.

parts such as the calyx (sepals), petal and fruit were included in the study (Figures 2-5). The specimens collected were deposited in Celal Bayar University Department of Biology for future reference. The plants were given numbers starting with the letter 'K' as an abbreviation for K.YILDIZ.

Micrographs of the seeds were obtained using an Olympus WM trinocular stereo dissection microscope (Figures 6 & 7). A NFK x 3.3 LD 125 lens was used

during the examination. At least 20 seeds from each species (except for the *S. gigantea* var. *gigantea* specimen from Northern Cyprus) were examined to specify the micromorphological character of the seeds. The morphological characters of the seeds were determined according to Prentice (1978) and Stearn (1996).

For the palynological study, on the other hand, pollen was extracted from both the flowers, placed into envelopes in the field and the specimens deposited as

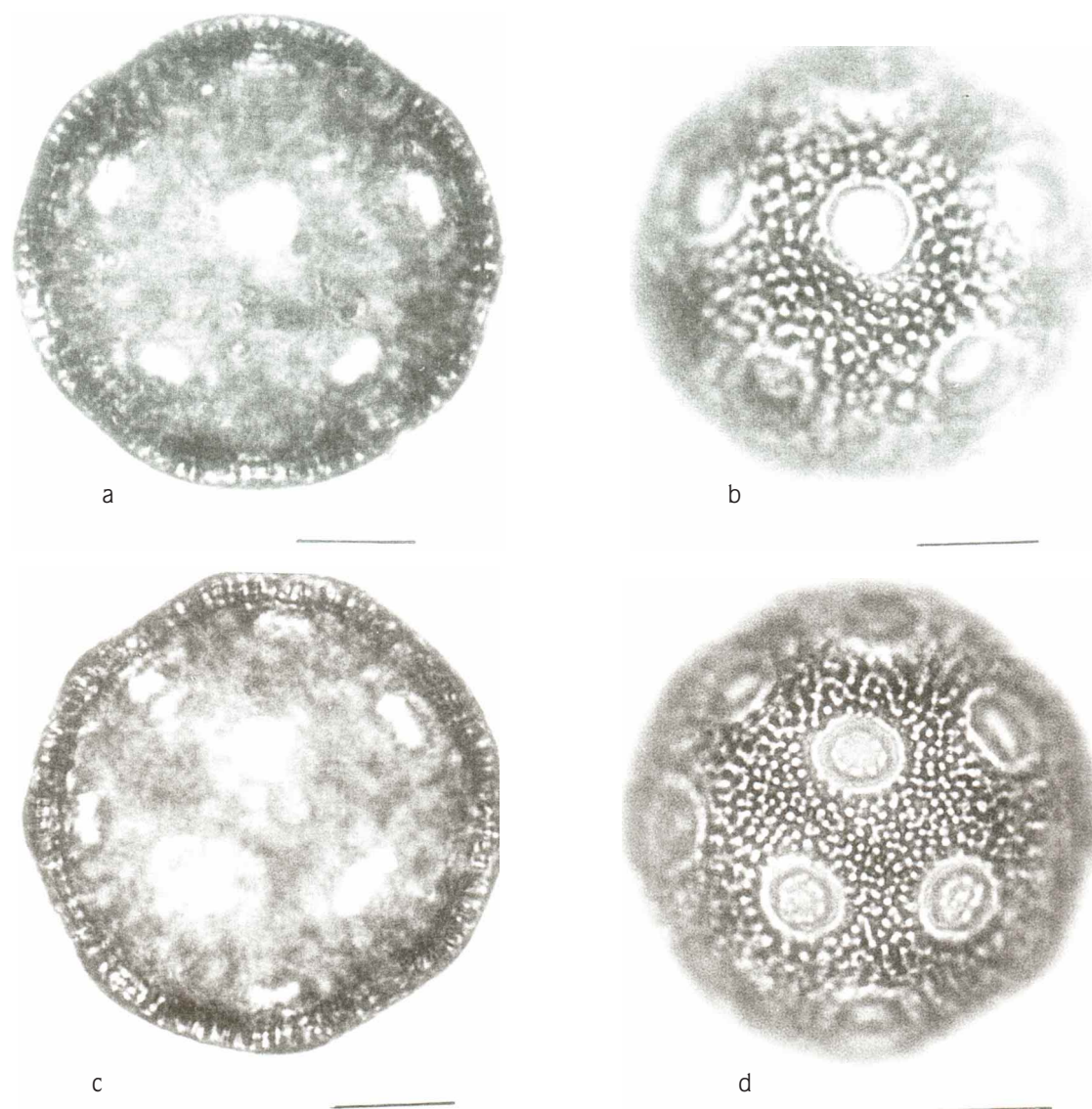


Figure 9. Light micrographs of *Silene behen* pollen (— :10 μ m), (a, b; Western Anatolia, K059): a. Optical section, b. Ornamentation; (c, d; Northern Cyprus, K053), c. Optical section, d. Ornamentation.

herbarium specimens. The pollen was prepared according to the method described by Erdtman (1960) and left to dry in centrifuge tubes. Pollen taken from the bottom of the centrifuge tube with the help of glycerine-jelly pieces mounted onto the tip of dissection needles was 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 (Figures 8 & 9). Measurements of different parts of the pollen such as

pollen diameter, pore diameter, distance between 2 pores and exine thickness were taken using an immersion object-lens (x100) and a scale ocular (x10). Measurements were repeated on about 30 pollen grains for each species. Arithmetic means and standard deviations were also calculated separately. The assessment of the palynological findings obtained was made to Kremp (1968), Erdtman (1969), Faegri and Iversen (1975) and Moore et al. (1997).

Results

Morphological Characteristics

Silene gigantea var. *gigantea* (Western Anatolia) (Figure 2):

60-100 cm, basal leaves pubescent, spathulate, cauline leaves obovate, spathulate, inflorescence paniculate, calyx 6-7 x 3 mm, glandular, petal 15-16 x 0.5-1 mm, bifid, no scales, 10-nerved, anthophore 2-4.5 mm, capsule 9-11 x 5-6 mm, broadly ovoid, teeth slightly reflexed.

S. gigantea var. *gigantea* (Northern Cyprus) (Figure 3):

30-100 cm, basal leaves glaucous, sometimes densely pubescent, spathulate, cauline leaves narrower obovate-spathulate, inflorescence paniculate, calyx 10 x 3 mm, 10-nerved, smaller glandular, petal 12-15 x 0.5-0.7 mm, deeply bifid, 2 scales, anthophore 4-5 mm, capsule 8-10 x 6-7 mm, broadly ovoid.

S. behen (Western Anatolia) (Figure 4):

10-90 cm, basal leaves obovate, spathulate, oblanceolate, cauline leaves (-5) 8-20 mm, wide lanceolate, narrowly elliptical oblanceolate, dichasium, inflorescence upper monochasium, calyx 11-14 mm, 10 anastomosing veins, glabrous, petal 12-15 x 2-3 mm, bifid, no scales, anthophore 2-2.5 mm, capsule 7-9 x 6-7 mm, ovoid.

S. behen (Northern Cyprus) (Figure 5) :

10-30 (40) cm, basal leaves obovate, spathulate, oblanceolate cauline leaves 4-10 x 0.6-2.5 mm, obovate, inflorescence spreading dichasium, calyx 10-15 mm, 10 anastomosing veins, glabrous, petal 10-13 x 2-3 mm, little bifid, no scales, anthophore c. 1, capsule 8-9 x 7-8 mm, wide ovoid, subglobose.

Seed Characteristics:

Silene gigantea var. *gigantea* (Western Anatolia) (Figure 6):

Reniform, length-width 1.5 x 1.2 mm, length-width ratio 1.25, shape of tubercle conical, surface type flat and concave, granulation coarse, testa cell max. x min. 2.14-3.09 x 0.47-0.71 mm, number of suture point per plate 9-16, suture outline sinuous, hylar zone type recessed.

S. behen (Western Anatolia) (Figure 7):

Reniform, length-width 1.6 x 1.3 mm, length-width

ratio 1.23, shape of tubercle long conical, tips dark, surface type concavo-convex, granulation fine, testa cell max. x min. 1.6-2.4 x 0.6-1.2 mm, number of suture point per plate 19-26, suture outline serrate, hylar zone type little recessed.

S. behen (Northern Cyprus) (Figure 7):

Reniform, length-width 1.5 x 1.2 mm, length-width ratio 1.25, shape of tubercle long conical, tips dark surface type concavo-convex, flat granulation fine, testa cell max. x min. 2.2-2.6 x 0.6-1.2 mm, number of suture point per plate 20-30, suture outline serrate, hylar zone type little recessed.

Pollen Characteristics:

Silene gigantea var. *gigantea* (K064, Western Anatolia) (Figures 8a, b):

Pollen grains; polyantoporate, spheroidal, tectate-perforate, operculum with 4-10 granules, sometimes no granules. Ornamentation, spinulose-microperforate. Spinules coarse and irregular.

S. gigantea var. *gigantea* (K057, Northern Cyprus) (Figures 8c, d):

Pollen grains; polyantoporate, spheroidal, tectate-perforate. Operculum with 5-8 granules, sometimes no granules. Ornamentation, spinulose-microperforate, spinules coarse and irregular.

S. behen (K059, Western Anatolia) (Figures 9a, 9b):

Pollen grains; polyantoporate, spheroidal, tectate-perforate. Operculum with no granules. Ornamentation, spinulose-microperforate, spinules irregular.

S. behen (K053, Northern Cyprus) (Figures 9c, 9d):

Pollen grains; polyantoporate, spheroidal, tectate-perforate, there is a fine area in pore. Ornamentation, spinulose-microperforate, spinules irregular, Operculum with 5-12 prominent granules.

Discussion

In the study, the most important morphological and palynological characters of *Silene* specimens from different localities were compared. These are led by characteristics such as leaves of the plants on the base and cauline, calyx, petal, fruit, seed and pollen diameter, pore diameter, pollen structure and ornamentation (Tables 2-4, Figures 1-9).

As regards the areas of their distribution, it was observed that *S. gigantea* var. *gigantea* grew in rocky, stony, bushy areas at altitudes of 250-900 m, while *S. behen* mainly occurred on slopes at altitudes ranging between sea level and 1400 m. Elevations where *S. gigantea* var. *gigantea* and *S. behen* specimens were collected were compatible with those mentioned in various floristic studies (Davis, 1967, 1988; Meikle, 1977; Viney, 1994). *S. gigantea* var. *gigantea* is a perennial, but *S. behen* is an annual grassy plant. As for the inflorescence, *S. gigantea* var. *gigantea* is mostly panicle and *S. behen* is dichasium, but sometimes monochasium. The most distinctive vein in the calyx is observed in *S. behen*. The calyx of *S. gigantea* var. *gigantea* has glandular hair and is shorter. An anthophore is present in the specimens of both species that were examined. The forms of capsules display similarities in all the specimens of the 2 species. Although the seed characteristics of the species examined resemble one another, the tubercles on the seed surface of the *S. behen* specimens have a longer conical shape (Table 2, Figures 2-7).

An examination conducted on *S. gigantea* var. *gigantea* specimens from Western Anatolia and Northern Cyprus revealed that their plant heights, basal and cauline leaves, inflorescence, calyx pubescence, anthophore and capsule characteristics displayed certain similarities. However, it was determined that the calyx size was 6-7 x 3 mm in Western Anatolian specimens, whereas it was 10 x 3 mm in those from Northern Cyprus. It was also found that the specimens from Turkey did not have any ligula on the basal petal blades, while the Northern Cypriot specimens had 2 small ligula (Table 2, Figures 2 & 3).

While *S. behen* specimens from Western Anatolia and Northern Cyprus showed similarities regarding their basal leaves, inflorescence, vein structure of the calyx and glabrous of the calyx surface, petal length and the condition of the ligule, it was found that the height of plant and anthophore of the *S. behen* specimens from Northern Cyprus [10-30 (-40) cm; about 1 mm] was shorter than those from Western Anatolia (10-90 cm, 2-2.5 mm). Moreover, the petal blade is deeply cleft in the Western Anatolian specimens, whereas it is less cleft in the Northern Cypriot specimens (Table 2, Figures 4 & 5).

S. gigantea var. *gigantea* belongs to the section *Siphonomorpha*, which also includes *S. italica* and *S. viridiflora*. Yıldız and Çirpıcı (1998) studied the seed

morphology of these species, which are distributed in Turkey, using stereo and scanning electron microscopy. In this study, *S. italica* was termed reniform; 1.0-1.6 x 0.7-1 mm; seed surface flat or concave; surface granulation distinctive with medium or coarse; tubercles distinctively long and conical; hilum generally recessed. *S. viridiflora*, on the other hand, was determined as oval or reniform; 0.8-1.1 x 0.6-0.8 mm; surface flat or concave, surface granulation distinctive with medium or coarse; tubercles generally long and conical, often obtuse and generally pitted; hilum recessed, flat or prominent in some specimens. There are no distinctive differences between the seed characteristics of these 2 species and those of *S. gigantea* var. *gigantea* (Table 3, Figure 6).

In the palynological study, pollen measurements revealed that the pore diameters of the *S. gigantea* var. *gigantea* specimens from Northern Cyprus were larger than those from Western Anatolia, that the distance between the pores of the Western Anatolian pollen was wider than that of the Northern Cypriot pollen, and that the number of pores was somewhat similar in *S. gigantea* var. *gigantea*, while *S. behen* specimens from Northern Cyprus had less pollen. As for the ornamentation, it was observed that the operculum of the pollens of the *S. behen* specimens from Western Anatolia was without granules, whereas the operculum of those in Northern Cyprus had 5-12 granules (Table 4, Figures 8 & 9).

In a palynological study on 11 *Centrospermae* families, which also include *Silene* and *Dianthus* species, Skvarla and Nowicke (1976) termed the pollen of *Silene noctiflora* pantoporate and reticulate. In their study, the pollen types of *S. gigantea* var. *gigantea* and *S. behen* were polypantoporate, spinulose or microperforate according to different terminologies (Table 4, Figures 8 & 9), which exhibited similarities with the present study.

In palynological study, Ghazanfar (1984) reported the pollen diameter as 40-48 µm, the pore diameter as 5.5-9 µm, the distance between 9 pores as 9-12 µm, and the number of pores as 19-23 for the pollen of *S. gigantea* the pollen diameter as 35-45 µm, the pore diameter as 5-7 µm, the distance between 2 pores as 5-10 µm, and the number of pores as 20-26 for the pollen of *S. italica*; and the pollen diameter as 36-45 µm, the pore diameter as 5-7.5 µm, the distance between 2 pores as 6.9-9 µm, and the number of pores as 29-34 for the pollen of *S. viridiflora*. On the other hand, in a palynological study, Yıldız (1996a) determined the mean pollen diameter as

49.90 ± 1.80 µm, and the pore diameter as 7.04 ± 1.26 µm, the distance between 2 pores as 7.68 ± 0.46 µm, the number of pores as 20-28, and the number of operculum granules as 12-20 for the pollens of *S. italica*; and the pollen diameter as 40.21 ± 2.91 µm, the pore diameter as 7.17 ± 0.96 µm, the distance between 2 pores as 6.60 ± 2.48 µm, the number of pores as 25-32, and the number of operculum granules as 10-15, for the pollen of *S. viridiflora*. The species studied belong to the section *Siphonomorpha*, which also includes *S. gigantea* var. *gigantea*. In all the specimens of *S. gigantea* var. *gigantea* from Western Anatolia and Northern Cyprus, the pollen diameter is 39.90-50.40 µm, the pore diameter 3.68-10.50 µm, the distance between 2 pores 6.30-13.65 µm, the exine thickness 3.15-4.73 µm, and the number of pores 11-17 (Table 4, Figure 8). The measurements obtained for the *S. gigantea* pollen examined, except for the number of pores (Table 4), were similar to one another.

Pollen characters were established in other palynological studies on some *Silene* and *Dianthus* species, in which the taxonomical positions of the species were discussed (Yıldız, 1996b, 2001a, 2001b). The pollen characters observed in these studies were termed tectate, polyaperturate, spheroidal and spinulose-microperforate. *Silene* pollen can be seen to have similar characteristics in the present study too (Table 4). A

species having an imperforate exine (Walker, 1974a, 1974b) and few pores (Van Campo, 1966) is considered primitive. It can be seen that the number of pores in *S. gigantea* var. *gigantea* is lower than those of *S. italica* and *S. viridiflora*. In view of such an evaluation, *S. gigantea* var. *gigantea* can be regarded as a more primitive species compared to *S. italica* and *S. viridiflora*. Therefore, its place in the Floras of Turkey and Northern Cyprus needs further discussion.

Our examinations revealed that plant parts belonging to individuals of the same species growing in different localities change from time to time. In addition to these differences, it was determined that although *S. gigantea* var. *gigantea* belonged to the same variety, the specimens from Northern Cyprus had 2 small ligula in the petal basal blade while the Western Anatolian specimens did not have any, and that the pore diameter of the same species from Northern Cyprus was wider. For this reason, we think that *S. gigantea* growing in Western Anatolia and Northern Cyprus could be separated into 2 subspecies. The petal blade of the *S. behen* specimens from Northern Cyprus was less cleft compared to that of the Western Anatolian specimens; and the distance between 2 pores was greater in the Western Anatolian specimens. For this reason, *S. behen* also could be separated into 2 subspecies.

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