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Pollen Morphology of *Origanum* L. (Labiatae) Taxons in Türkiye

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Abstract: The research work was conducted to investigate the pollen morphology of twenty-two taxa of *Origanum* L., which had been described in accordance with their external-morphological characteristics and comparatively examined through the light and scanning electron microscopes (SEM). Each taxons had also been described palynologically. According to palynological data the pollens of *Origanum* L. showed reticulate and suprareticulate ornamentation. Chilocalyx section, that showed reticulate ornamentation, contained the taxons of *O. bilgeri* P. H. Davis, *O. minutiflorum* O. Schwarz and P. H. Davis and *O. micranthum* Vogel. *O. husnucan-baserii* Duman and Aytaç was one of the taxons in *Brevifilamentum* section and this taxon also exhibited reticulate ornamentation, Suprareticulate ornamentation had been found in other taxons.

Key words: Labiatae (Lamiaceae), *Origanum* L., pollen, pollen morphology, scanning electron microscope

Introduction

The genus *Origanum* L. is a member of Labiatae family which has forty-one different species in the world, whereas in Turkey there are eight sections that include twenty-six taxa (*O. calcaratum* juss. and *O. symes* A. Carlstrom are excluded) (Heywood, 1985; Cronquist, 1982; Davis, 1982; Davis, 1982; Davis *et al.*, 1988; Duman *et al.*, 1995). The endemism is 57%.

There are limited number of studies in pollen morphology of *Origanum* L. Husain and Heywood (1982) have studied the pollen morphology of *Origanum* L. species. Varghese and Verma (1968) shortly mention about the light microscopic features of *Origanum vulgare* L. pollen grains. In this study, thirty different kinds of *Origanum* L., six of which grow in Turkey, are examined and their similar species are separated according to their pollen characteristic.

This study aims at contributing to the systematic problems of *Origanum* L. species, which are widely used in medicinal and aromatic plants.

Materials and Methods

The pollens used in this study were obtained from the herbarium species as well as living species. Twenty-two taxa were examined in the years of 1997-1999; the number of herbarium collection used in this study and the locality of each species are given in Table 1. At least 30 pollen species from each taxon are scrutinized on light microscope. The pollen slides were made with the techniques of Erdtman (1960, 1969) and SEM. On the light microscope, pollen grains of each taxons per P, E, Clg and Clt were measured until the gausse curve is reached. The average, variations and the standard deviations of these measurements were calculated separately. SEM jeol JX A

-840, which was used throughout this study, belongs to Gebze Tübitak Marmara Research Center. The photographs of pollen samples, which revealed the detailed surface ornamentations on their general appearance, were developed by the dimension ranging from 2200 and 11000. On these microphotographs, the supratectal structure, lumen and perforation diameter and the thickness of muri on the reticulation were measured. On the 2 μ^2 area of the microphotographs, the lumen number on the mezocolpium area, the perforation numbers and diameters were calculated separately for the pollen grains of each species. The terminology of Erdtman (1960, 1969), Faegri and Iverson (1975) and Walker and Doyle (1975) was followed.

Results and Discussion

The pollen grains of *Origanum* were 4-6-8 colpate, subprolate, prolate sferoid, oblate sferoid, suboblate (Table 1). The colpi were elongated, narrowing at the poles. The colpus membrane was covered by small granules or big granules (Fig.1-10). The ectexine was thicker than the endexine. Tectum was subtectate. The ornamentation was reticulate or suprareticulate, the lumina different in shape and size in *Origanum* (Table 3-4, Fig. 1-10). In polar view they were circular or circular-elliptically. Based on polen size, shape in equatorial view and ornamentation, pollen type could be recognized:

Pollen type I: Pollar diameter less than 30 μm , ornamentation suprareticulate, rarely reticulate. Pollen grains suboblate (*O. acutidens* (Hand-Mazz.) Ietswaart, *O. minutiflorum* Schwarz and P.H. Davis, *O. majorana* L. (Antalya), *O. onites* L. and *O. vulgare* L. ssp. *gracile* (C. Koch.) Ietswaart), P/E = 0.82-0.88, dimensions

Table 1: List of *Origanum* L. collections used in this study

Taxa	Locations	Collector
<i>O. boissieri</i> Ietswaart	C5, IÇEL Gülek- Maden road, şimşir area, Ağaçkesme. River-bed, rock hollows. 1600m 22.7.1995	K.H.C. Baser. ESSE. 11596
<i>O. saccatum</i> P. H. Davis	C4, ANTALYA, Alanya, Hadim-Alanya road 53. km 1250-1300m 9.8.1994	H. Duman ESSE. 11219
<i>O. solymicum</i> P. H. Davis	C3, ANTALYA, Kemer, surroundings of Kuzdere village	G. Tumen ESSE. 10110
<i>O. hypericifolium</i>	C2, BURDUR, Gölhisar, Kiemen area, on surroundings of Evciler village 24.8.1993	G. Tumen ESSE. 10205
O. Schwarz and P. H. Davis		
<i>O. sipyleum</i> L.	B1, MANISA, Sipil mountain 20.8.1993	G. Tumen ESSE. 8086
<i>O. sipyleum</i>	B1, BALIKESIR, surroundings of Küpeler village 130m 20.9.1990	G.Tumen ESSE. 8777
<i>O. sipyleum</i>	A4, ANKARA, Kizilcahamam	G. Tumen ESSE. 8055
<i>O. sipyleum</i>	A4, ANKARA, Beypazarı 23.8.1993	G. Tumen ESSE. 8056
<i>O. sipyleum</i>	C3, ISPARTA, Sütçüler plateau	G. Tumen ESSE. 8068
<i>O. rotundifolium</i> Boiss.	A9, ARTVIN, Ardanuç, Ekşinar village, sand hills	G. Tumen ESSE. 10305
<i>O. acutidens</i> (Hand-Mazz.) Ietswaart	B7, TUNCELI, surroundings of Ovacık, slopes 15.8.1994	G. Tumen ESSE. 10746
<i>O. haussknechtii</i> Boiss.	B7, MALATYA, Arapkir, 17km on the south of Kemalîye 1000m 10.10.1995	K. Taş, G. Tumen, H: Duman ESSE. 12026
<i>O. bargyli</i> Mouterde	C6, ADANA, Osmaniye, between Yarpuz and Ağulu 1190m 20.7.1995	K.H.C. Baser, H. Duman A. Altıntaş ESSE 11543
<i>O. leptocladum</i> Boiss.	C4,C5 IÇEL, Silifke, Yassıkaya area 17.7.1994	F. Çalış, G. Tumen ESSE. 10944
<i>O. hüsnücan-baserii</i> and Aytaç	C4, ANTALYA, Alanya Gökbel road, Bucak-çökele plateau 1275m 17.7.1995	K.H.C. Baser, H. Duman A. Duman Altıntaş ESSE 11507
<i>O. bilgeri</i> P. H. Davis	C4, ANTALYA, On the rocks between Alanya Yerköprü plateau and Türbelenos plateau	H. Duman ESSE 10696
<i>O. micranthum</i> Vogel	C5, IÇEL, Tarsus, Gülek boğazı, near castle ruins 15.7.1994	G. Tumen ESSE. 10716
<i>O. minutiflorum</i>	C3, ANTALYA, Saklıkent 30.5.1990	G. Tumen ESSE. 8775
Schwarz and P. H. Davis		
<i>O. majorana</i> L.	B1, BALIKESIR, The garden of Akçay Fener Holiday Resort 7.7.1991	G. Tumen ESSE. 9322
<i>O. majorana</i>	C4, ANTALYA, Alanya, Konaklı village 7.7.1994	K.H.C. Baser. A. Kaya ESSE. 9605
<i>O. onites</i> L.	B1, BALIKESIR, Kazdağı, on the way to Kapıkule 17.7.1991	G. Tumen ESSE. 9568
<i>O. syriacum</i> L. var. <i>bevanii</i> (Holmes) Ietswaart	C6, KAHRAMANMARAŞ, Büyüksir village 20.7.1991	G. Tumen ESSE. 9212
<i>O. vulgare</i> L. ssp. <i>gracile</i> (C. Koch) Ietswaart	A7, GİRESUN, Trabzon road, Armalit mountain 23.7.1992	G. Tumen ESSE. 9568
<i>O. vulgare</i> L. ssp. <i>hirtum</i> (Link) Ietswaart	A1, ÇANAKKALE, Biga 15.7.1993	G. Tumen ESSE. 10076
<i>O. vulgare</i> L. ssp. <i>viride</i> (Boiss) Hayek	A2, BURSA, Inegöl road, on the 19km of Inegöl-Pazaryeri road.	K.H.C. Baser. ESSE 7768
<i>O. vulgare</i> L. ssp. <i>vulgare</i>	A5, SINOP, Çangal mountain, The hilly areas around Alabalık lake.	G. Tumen ESSE. 9652
<i>O. laevigatum</i> Boiss.	C6, HATAY, Belen, Halilbey plateau, Atik Plateau 15.8.1994	G. Tumen ESSE. 10715

PxE= 22.87-28.49 X 29.16-32.76 µm (Table 2). Pollen grains oblate sferoid (*O. bilgeri* P.H. Davis, *O. majorana* L. (Balikesir), *O. syriacum* L. var. *bevani* (Holmes) Ietswaart and *O. vulgare* L. ssp. *hirtum* (Link) Ietswaart), P/E= 0.88-1.00, dimensions PxE= 23.73-29.35 X 26.44-33.07 µm (Table 2). Reticulate ornamentation shown by *O. bilgeri* P.H. Davis and *O. minutiflorum* Schwarz and P.H. Davis (Fig. 6, 7)

Pollen type II: Pollar diameter less than 40 µm, ornamentation suprareticulate, rarely reticulate. Pollen grains oblate-sferoid (*O. saccatum* P.H. Davis, *O. sipyleum* L. (Ankara-Kizilcahamam, Isparta), *O. rotundifolium* Boiss., *O. leptocladum* Boiss. and *O. laevigatum* Boiss.), P/E = 0.88-1.00, dimensions PxE = 32.99-39.15 X 32.07-41.02 µm (Table 2). Pollen grains prolate sferoid (*O. hypericifolium* O. schwarz and P.H. Davis, *O. sipyleum* L. (Manisa, Balikesir and Ankara-Beypazarı) and *O. bargyli* Mouterde) P/E = 1.00-1.14, dimensions PxE = 31.72-37.91 X 32.07-33.97, subprolate (*O.*

micranthum Vogel, *O. vulgare* L. ssp. *viride* (Boiss.) Hayek and *O. vulgare* L. ssp. *vulgare*), P/E = 1.14-1.33, dimensions PxE = 32.17-39.29 X 27.33-33.44 µm (Table 2). Reticulate ornamentation shown only by *O. micranthum* Vogel (Fig. 6)

Pollen type III: Pollar diameter less than 45 µm, ornamentation suprareticulate and rarely reticulate. Pollen grains subprolate (*O. boissieri* Ietswaart, *O. solymicum* P.H. Davis and *O. haussknechtii* Boiss.), P/E= 1.14-1.33, dimensions PxE = 40.73-46.02 X 35.18-38.00, Prolate (*O. hüsnücan-baserii* Duman and Aytaç), P/E = 2-1.14, dimensions PxE = 40.99 X 31.98 (Table 2). Reticulate ornamentation shown only by *O. hüsnücan-baserii* Duman and Aytaç (Fig. 6).

The results of these investigation show that pollen morphology of the Türkiye representatives of *Origanum* L. is comparatively homogenous. Nevertheless, based on pollen size, shape in polar view and ornamentation, three pollen types can be distinguished (Table 2).

The maximum P value was observed in *O. solymicum* P. H. Davis with values 46.02 μm and maximum E values in *O. rotundifolium* Boiss. with values in 41.2 μm (Table 2). The minimum P values was observed in *O. vulgare* L. ssp. *gracile* (C. Koch) Ietswaart with values in 22.87 μm . The minimum E values was observed in *O. vulgare* L. ssp. *viride* (Boiss.) Hayek. with values in 27.33 μm . The highest value of P/E was found in *O. hüsnücan-baserii* Duman and Aytaç (Table 2) and the minimum P/E value in *O. vulgare* L. ssp. *gracile* (C. Koch) Ietswaart (Table 2). Besides in the taxa subprolate, oblate sferoid, prolate sferoid, suboblate, prolate grains were found. There is little variation in the size of pollen grains (Table 2). In Hussain and Heywood's (1982) study, the polar and equatorial axis confirm approximately the same numerical values of this investigation.

The ectexin in apocolpial areas of *O. hypericifolium* O. Schwarz and P. H. Davis, *O. sipyleum* L., *O. rotundifolium* Boiss., *O. leptocladum* Boiss. and *O. micranthum* Vogel was thicker than the area in mesocolpium. In Hussain and

Heywood's (1982) study confirm this results except for *O. micranthum* Vogel. Some pollen grains demonstrate differences in the aperture system of which *O. majorana* L., *O. onites* L. (4-6-8) , *O. syriacum* L. var. *bevanii* (Holmes) Ietswaart, *O. solymicum* P.H. Davis, *O. hüsnücan-baserii* Duman and Aytaç (6-8) and *O. sipyleum* L. (Balikesir) *O. vulgare* L. ssp. *hirtum* (Link) Ietswaart. (4-6) have been shown aperture number variations (Table 2). These taxons have heteromorphic characteristics in terms of the number of their aperture (Aytug, 1967; Inceoglu, 1973).

The pollen grains of *Origanum* L. taxons show similar features under light microscope; however when SEM is used, the number of lumen in 2 μ^2 per section, the number of perforation in each lumen and the muri thickening show different features (Table 3 and 4).

In this study, number of lumen per 2 μ^2 averaged between 3 and 8, whereas the perforation number had an average ranging from 5 to 33. Pollen grains showed supracolpate ornamentation (Fig.1, 2, 3, 4, 5, 7 C and 8, 9, 10 D). The

Table 2: Morphological observations of the pollens of *Origanum* L.

Taxa	Shape	P/E	Polar axis (μm) P	Equatorial axis (μm) E	Clt (μm)	Clg (μm)	Exine (μg)	Colpus No.
			Mean \pm SD	Mean \pm SD				
Sect. Amaracus								
<i>O. boissieri</i>	Subprolate	1.19	45.56 \pm 2.47	38 \pm 3.75	4.39	42.37	2.22	6
<i>O. saccatum</i>	Oblate sferoid	0.97	38.08 \pm 2.53	38.9 \pm 2.97	3.51	38	1.56	6
<i>O. solymicum</i>	Subprolate	1.25	46.02 \pm 3.99	36.66 \pm 4	3.97	42.04	1.55	6-8
Sect. Anatolicon								
<i>O. hypericifolium</i>	Prolate sferoid	1.03	35.74 \pm 2.94	32.68 \pm 2.82	3.42	32.15	1.56	6
<i>O. sipyleum</i> (Manisa)	Prolate sferoid	1.02	32.99 \pm 2.2	32.07 \pm 2.4	3.19	31	1.56	6
<i>O. sipyleum</i> (Balikesir)	Prolate sferoid	1.13	37.91 \pm 2.84	33.54 \pm 3.6	3.26	30.05	1.56	4-6
<i>O. sipyleum</i> (Ankara, Kizilcahamam)	Oblate sferoid	0.90	31.72 \pm 1.17	33.54 \pm 2	3.19	30.13	1.56	6
<i>O. sipyleum</i> (Ankara, Bey pazari)	Prolate sferoid	1.1	36.6 \pm 2.42	32.77 \pm 2.46	3.21	28.86	1.56	6
<i>O. sipyleum</i> (Isparta)	Oblate sferoid	0.94	32.86 \pm 2.15	32.07 \pm 2.24	2.00	27.74	1.56	6
Sect. Brevifilamentum								
<i>O. rotundifolium</i>	Oblate sferoid	0.94	39.15 \pm 2.5	41.2 \pm 2.19	3.96	35.59	2.34	6
<i>O. acutidens</i>	Suboblate	0.83	24.25 \pm 1.81	29.16 \pm 2.57	3.90	31.51	2.34	6
<i>O. haussknechtii</i>	Subprolate	1.15	40.73 \pm 3.6	35.18 \pm 3.3	3.51	35.1	1.56	6
<i>O. bargyli</i>	Prolate sferoid	1.07	36.53 \pm 2.86	33.97 \pm 2.8	3.72	31.45	1.56	6
<i>O. leptocladum</i>	Oblate sferoid	0.95	38.91 \pm 2.79	40.76 \pm 2.52	3.37	36.52	1.56	6
<i>O. hüsnücan-baserii</i>	Prolate	1.28	40.99 \pm 2.93	31.98 \pm 2.84	5.77	37.69	2.34	6-8
Sect. Chilocalyx								
<i>O. bilgeri</i>	Oblate sferoid	0.91	27.63 \pm 1.63	29.64 \pm 1.33	2.07	22.70	1.56	6
<i>O. micranthum</i>	Subprolate	1.2	35.48 \pm 2.18	28.93 \pm 2.51	3.37	31.71	1.56	6
<i>O. minutiflorum</i>	Suboblate	0.87	25.84 \pm 1.23	29.48 \pm 1.18	3.51	22.54	1.56	
Sect. Majorana								
<i>O. majorana</i> (Balikesir)	Oblate sferoid	1.00	27.53 \pm 0.79	27.37 \pm 0.79	3.37	23.74	1.56	4-6-8
<i>O. majorana</i> (Antalya)	Suboblate	0.82	25.47 \pm 1.36	30.98 \pm 0.91	3.57	26.91	1.56	4-6-8
<i>O. onites</i>	Suboblate	0.86	28.49 \pm 1.64	32.76 \pm 1.15	2.01	24.69	1.56	4-6-8
<i>O. syriacum</i> var. <i>bevanii</i>	Oblate sferoid	0.88	29.35 \pm 1.85	33.07 \pm 1.28	2.83	27.11	1.56	6-8
Sect. Origanum								
<i>O. vulgare</i> ssp. <i>gracile</i>	Suboblate	0.76	22.87 \pm 1.30	29.82 \pm 1.53	2.54	21.84	1.56	6
<i>O. vulgare</i> ssp. <i>hirtum</i>	Oblate sferoid	0.89	23.73 \pm 1.13	26.44 \pm 1.47	3.43	21.11	1.56	4-6
<i>O. vulgare</i> ssp. <i>viride</i>	Subprolate	1.17	32.17 \pm 3.16	27.33 \pm 2.57	3.12	31.66	1.56	6
<i>O. vulgare</i> ssp. <i>vulgare</i>	Subprolate	1.17	39.29 \pm 3.16	33.44 \pm 2.14	3.24	31.98	1.56	6
Sect. Prolaticorolla								
<i>O. laevigatum</i>	Oblate sferoida	0.99	36.68 \pm 1.32	36.90 \pm 1.37	3.06	30.52	1.56	6

Key: P/E: the rate length of the polar axis to the equatorial diameter
clt: colpus width

Mean \pm S.D: mean standart deviation
clg: colpus length

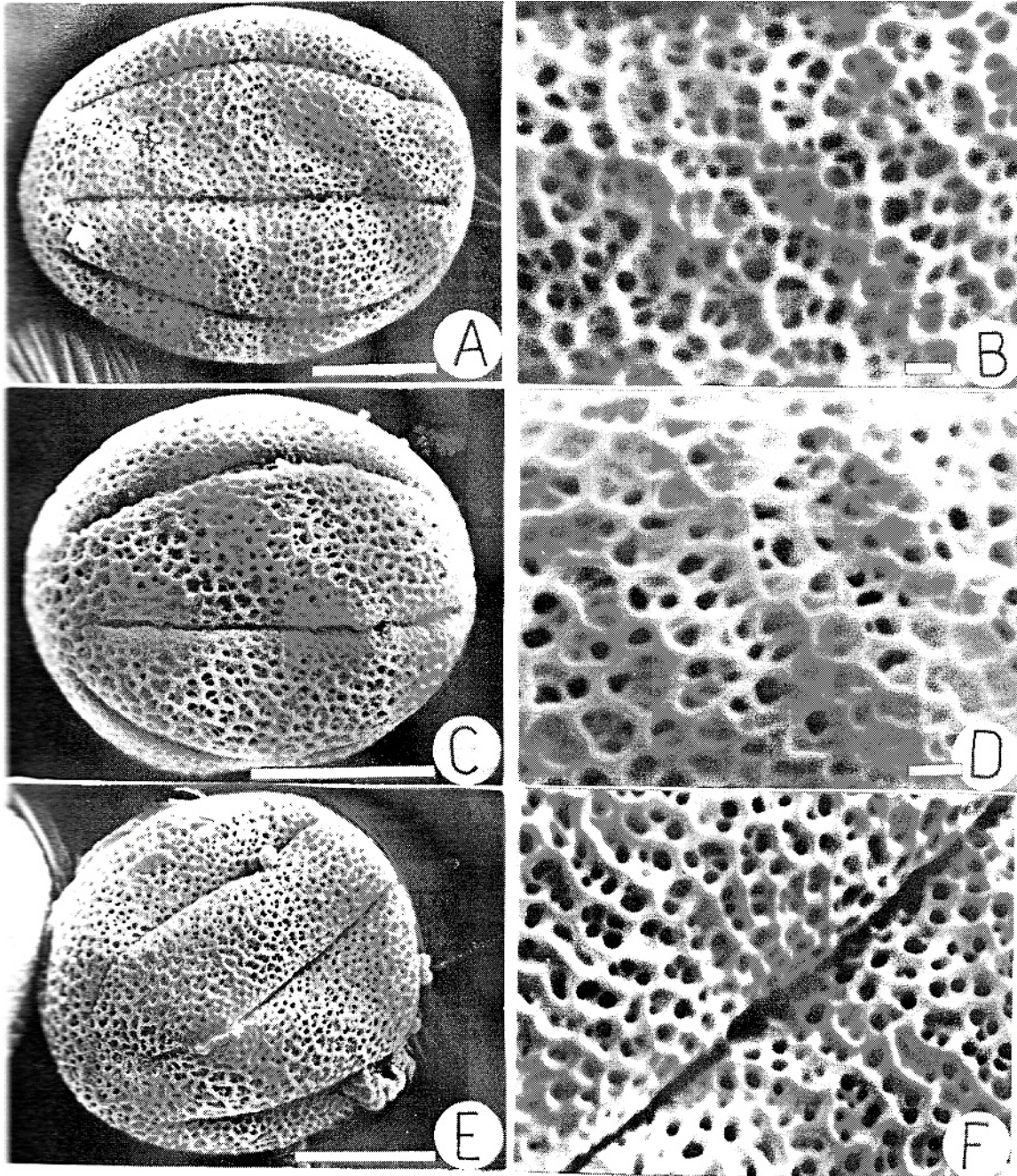


Fig. 1: SEM micrograms of (A, C, E) view of whole pollen grain in equatorial view, (B, D, F) magnified view showing sculpturing of the tectum. A. *O. boissieri* x2200. B. *O. boissieri* x8500. C. *O. saccatum* x3000. D. *O. saccatum* x9000. E. *O. solymicum* x2500. F. *O. solymicum* x8500. Scale bars: A-C-E 10 μ m, B-D-F 1 μ m

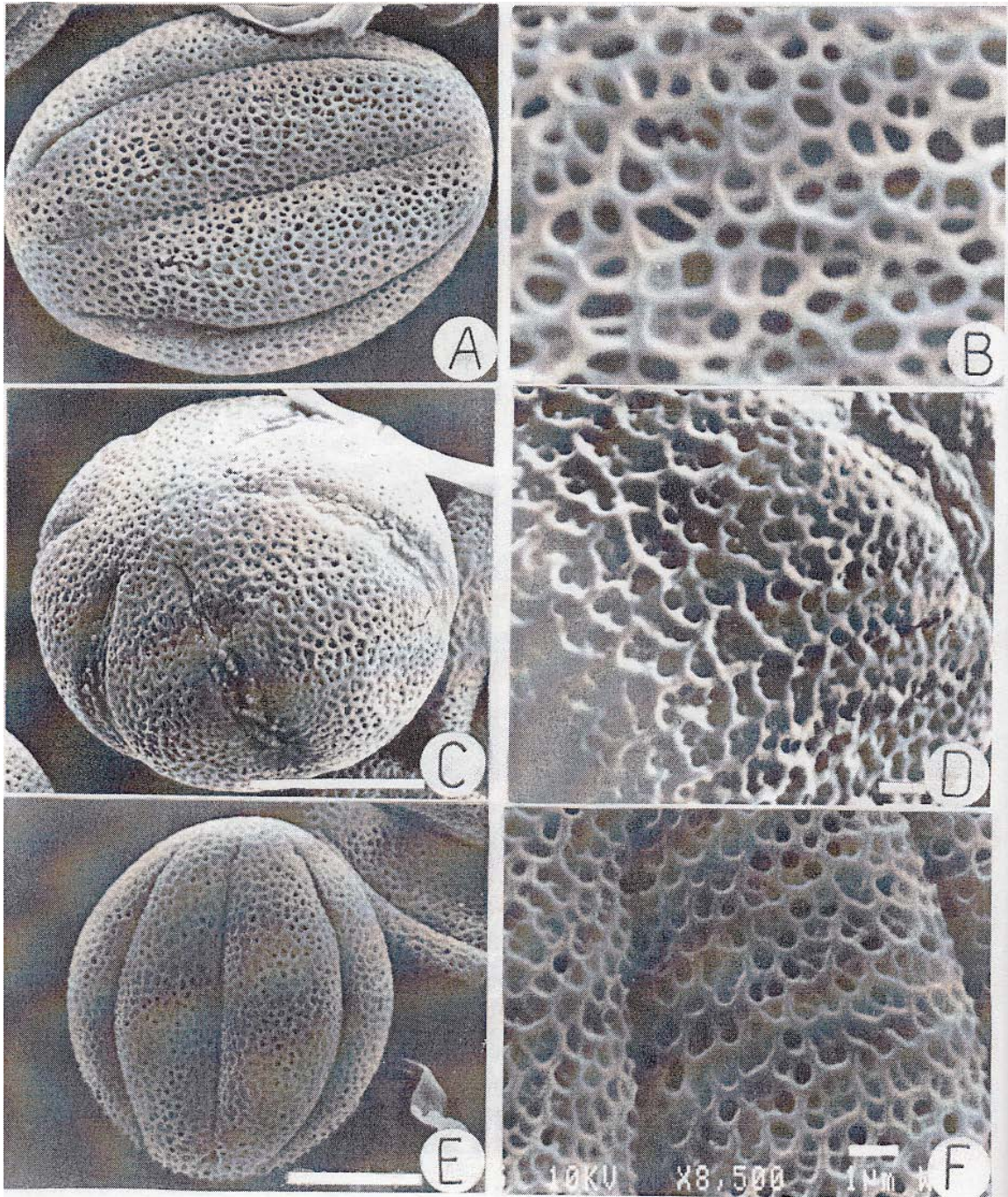


Fig. 2: SEM micrograms of (A, E) view of whole pollen grain in equatorial view, (C) whole pollen grain showing the polar region, (B, D, F) magnified view showing sculpturing of the tectum. A. *O. hypericifolium* x2700. B. *O. hypericifolium* x11000. C. *O. sipyleum* (Manisa) x3000. D. *O. sipyleum* (Manisa) x8000. E. *O. sipyleum* (Balikesir) x2500. F. *O. sipyleum* (Balikesir) x8500. Scale bars: A-C-E 10 μ m, B-D-F 1 μ m.

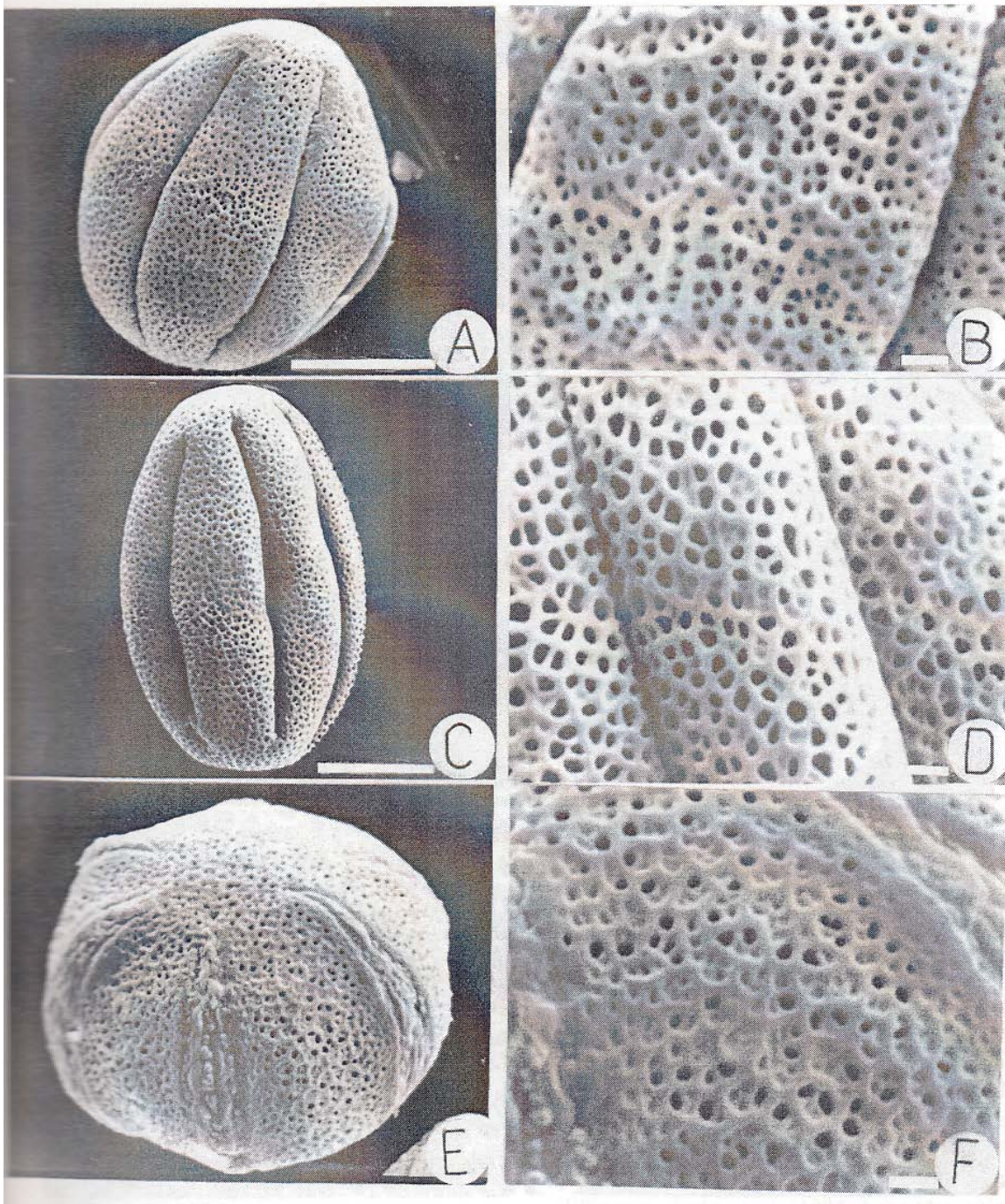


Fig. 3: SEM micrograms of (A, C) view of whole pollen grain in equatorial view, (E) whole pollen grain showing the polar region, (B, D, F) magnified view showing sculpturing of the tectum. A. *O. sipyleum* (Ankara-Kizilcahamam) x2700. *O. sipyleum* (Ankara-Kizilcahamam) x9000. C. *O. sipyleum* (Ankara-Beypazari) x2200. D. *O. sipyleum* (Ankara-Beypazari) x8000. E. *O. sipyleum* (Isparta-Sütçüler) x3300. F. *O. sipyleum* (Isparta-Sütçüler) x9000. Scale bars: A-C-E 10 μ m, B-D-F 1 μ m.

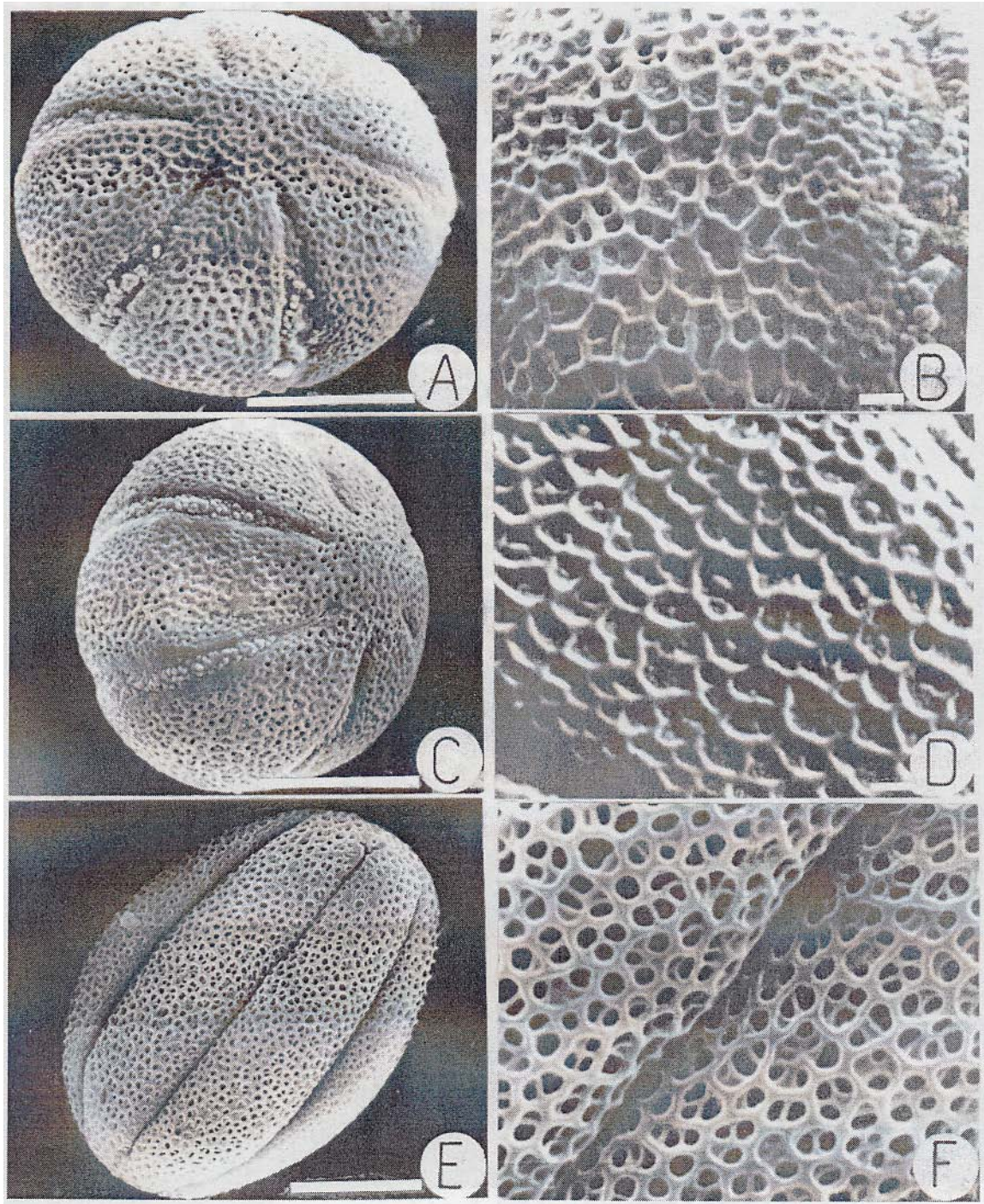


Fig. 4: SEM micrograms of (A, C) view of whole pollen grain showing the polar region, (E) whole pollen grain in equatorial view, (B, D, F) magnified view showing sculpturing of the tectum. A. *O. acutidens* x3000. B. *O. acutidens* x8000. C. *O. haussknechtii* x2700. D. *O. haussknechtii* x7500. E. *O. bargyli* x2300. F. *O. bargyli* x8000. Scale bars: A-C-E 10 μm , B-D-F 1 μm .

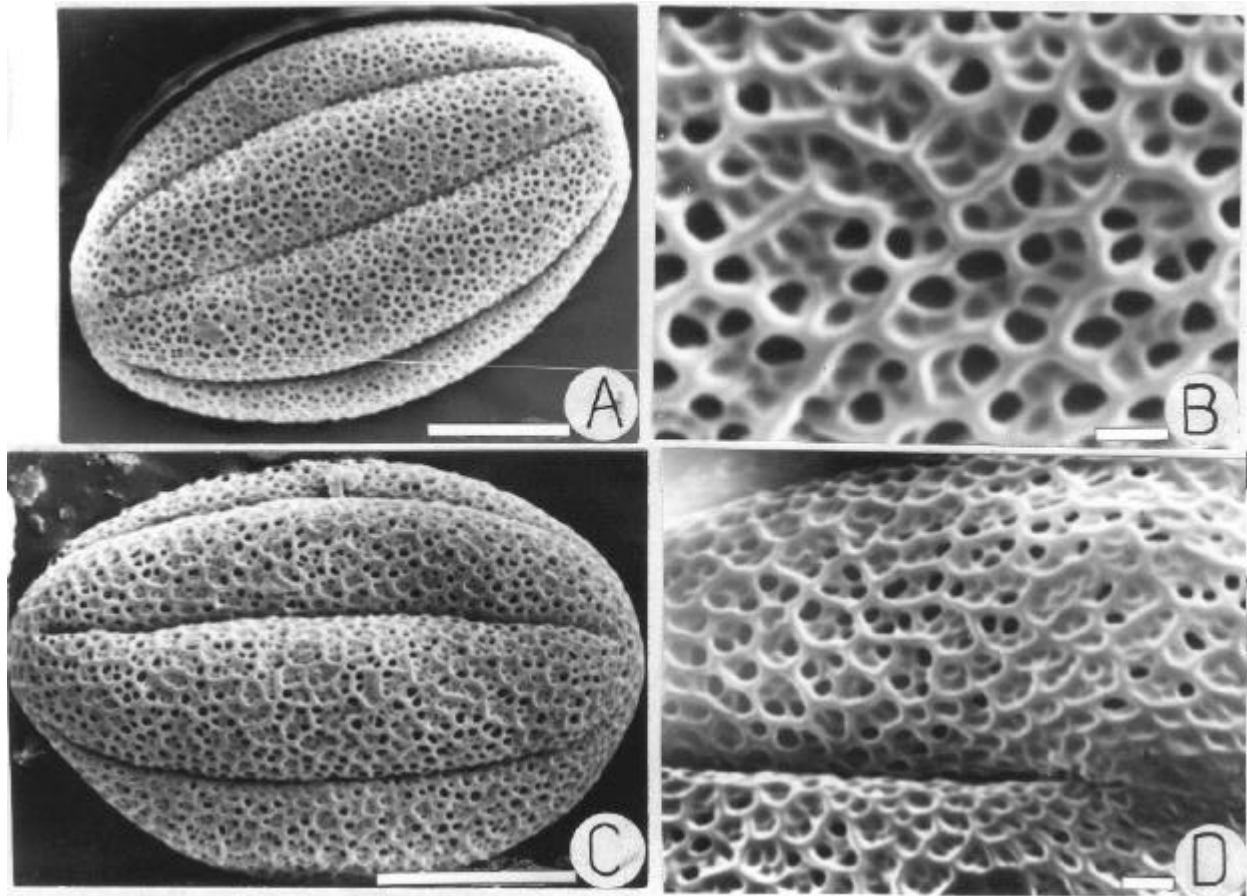


Fig. 5: SEM micrograms of (A, C) view of whole pollen grain in equatorial view, (B, D) magnified view showing sculpturing of the tectum. A. *O. rotundifolium* x2200. B. *O. rotundifolium* x11000. C. *O. leptocladum* x3000. D. *O. leptocladum* x9000. Scale bars: A-C-E 10 μ m, B-D-F 1 μ m.

perforations differed in size and shape and have had an irregular structure (Table 3, Fig.1, 2, 3, 4, 5, 7 C-D, 8, 9, 10). According to Hussain and Heywood (1982), perforation number per was lumina found between 1 and 7 and ornamentation in this species was only reticulate. However, in this investigation, all species in chilocalyx section and *O. husnucan-baserii* Duman and Aytacı in breviflamentum section showed reticulate ornamentation (Table 4, Fig. 6, 7 A, B).

Ietswaart (1980,1982) has collected similar species according to their external morphological characteristics (Amaracus, anatolicon, breviflamentum, chilocalyx, majorana, origanum, prolaticorolla). The species in the

sections have been found differences in essential oil chemistry (Baser *et al.*, 1991; 1992; 1993; 1994; 1996; 1998; Sezik *et al.*, 1993; Tumen and Baser, 1993; Tumen *et al.*, 1994; 1995a,b). The samples collected from different localities studied in Anatolicon and majorana sections (Table 1). In this study, little variations have been observed for pollen grains of the samples (Table 3). However, their palynological features exhibit no significant difference. Irene *et al.* (1994) have also noted that these species demonstrate no difference as far as palynological term are concerned, but different geographically, ecologically, macromorphologically, phytochemically and caryologically.

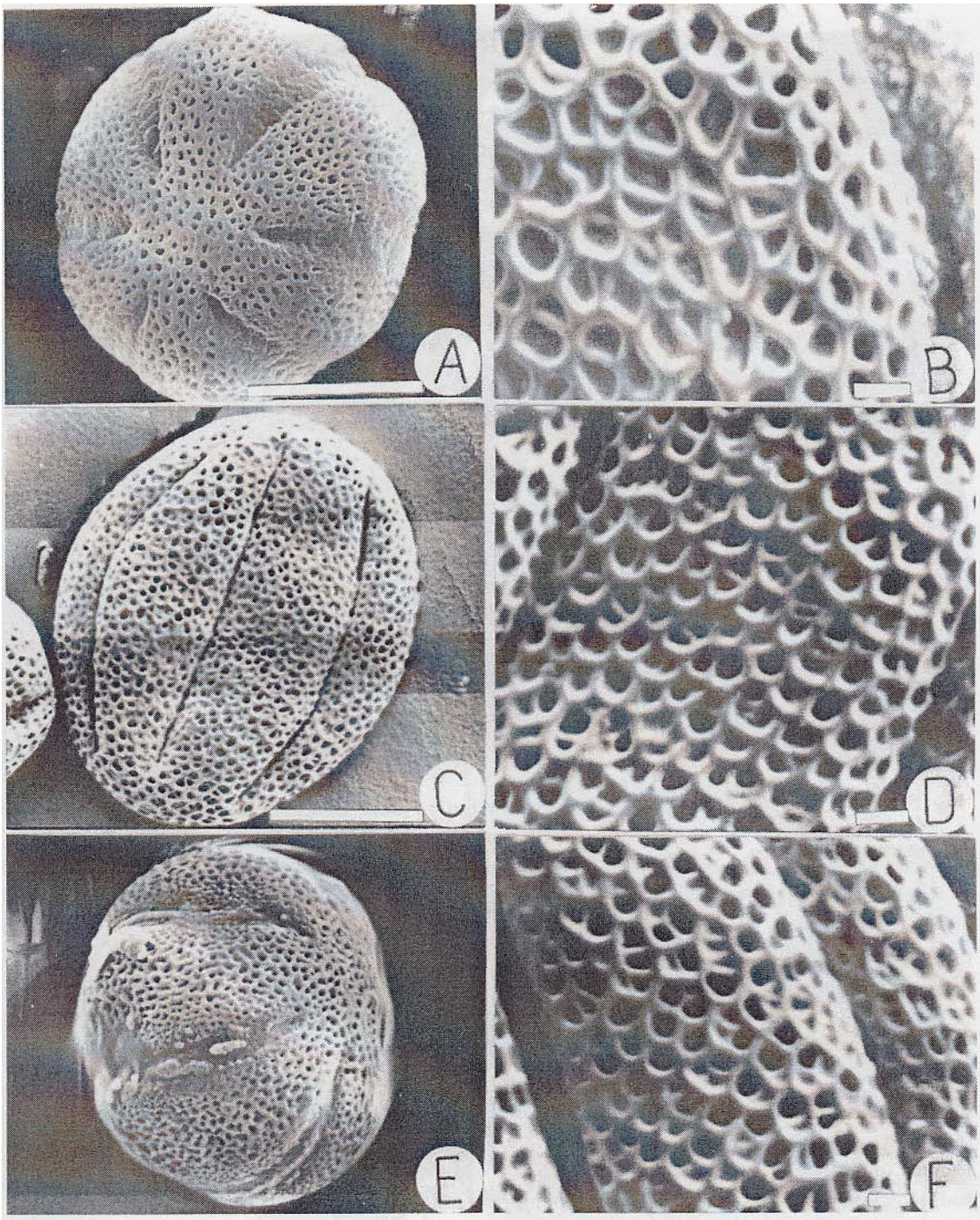


Fig. 6: SEM micrograms of (A, E) view of whole pollen grain showing the polar region, (C) whole pollen grain in equatorial view, (B, D, F) magnified view showing sculpturing of the tectum. A. *O. hüsnücan-baserii* x3000. B. *O. hüsnücan-baserii* x9000. C. *O. bilgeri* x2500. D. *O. bilgeri* x8000. E. *O. micranthum* x3300. F. *O. micranthum* x7000. Scale bars: A-C-E 10 μ m, B-D-F 1 μ m.

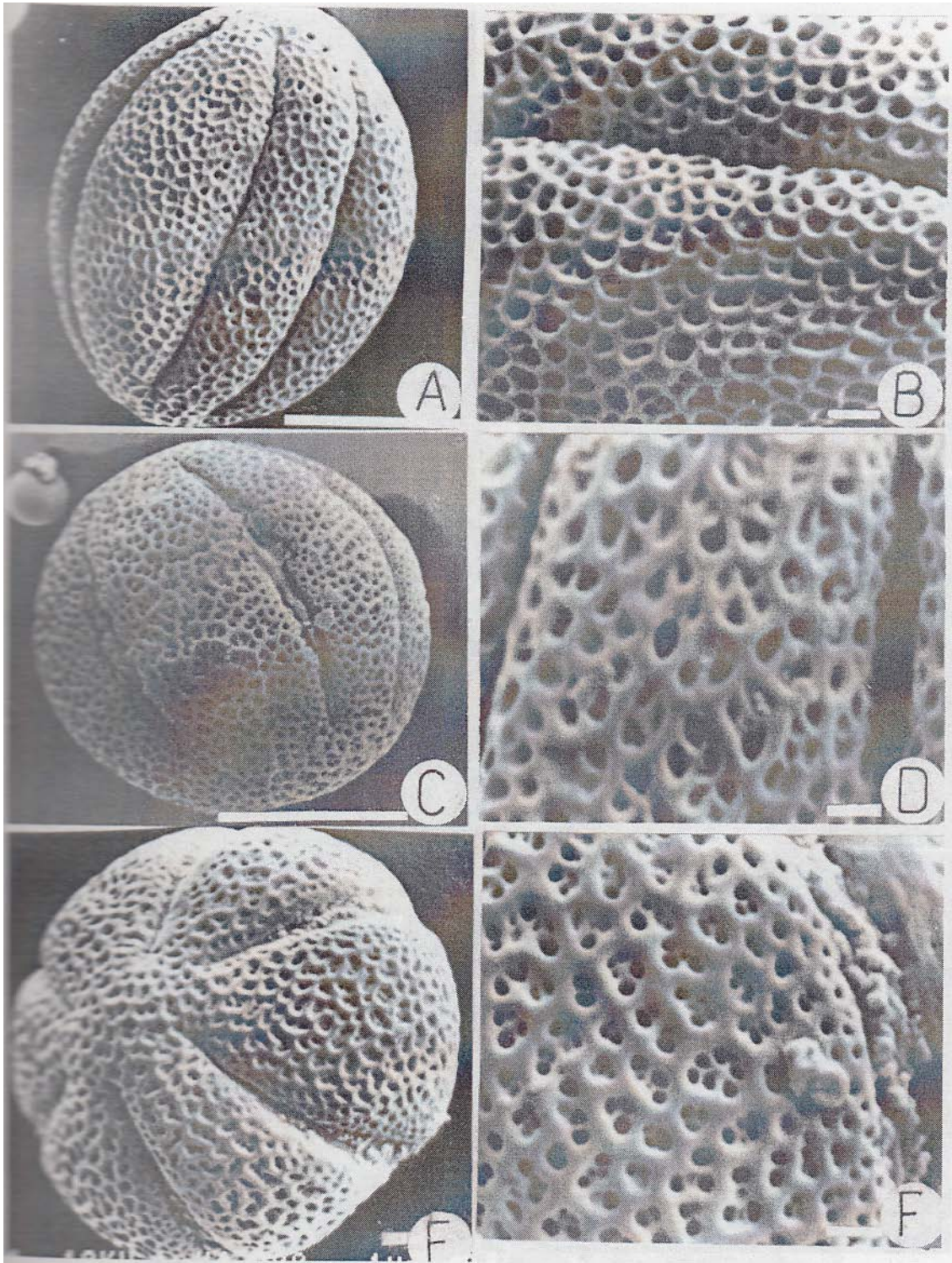


Fig. 7: SEM micrograms of (A, C) view of whole pollen grain in equatorial view, (E) whole pollen grain showing the polar region, (B, D, F) magnified view showing sculpturing of the tectum. A. *O. minutiflorum* x3300. B. *O. minutiflorum* x8500. C. *O. majorana* (Balikesir) x3300. D. *O. majorana* (Balikesir) x10000. E. *O. majorana* (Antalya) x4000. F. *O. majorana* (Antalya) x8500. Scale bars: A-C 10 μ m, E-B-D-F 1 μ m.

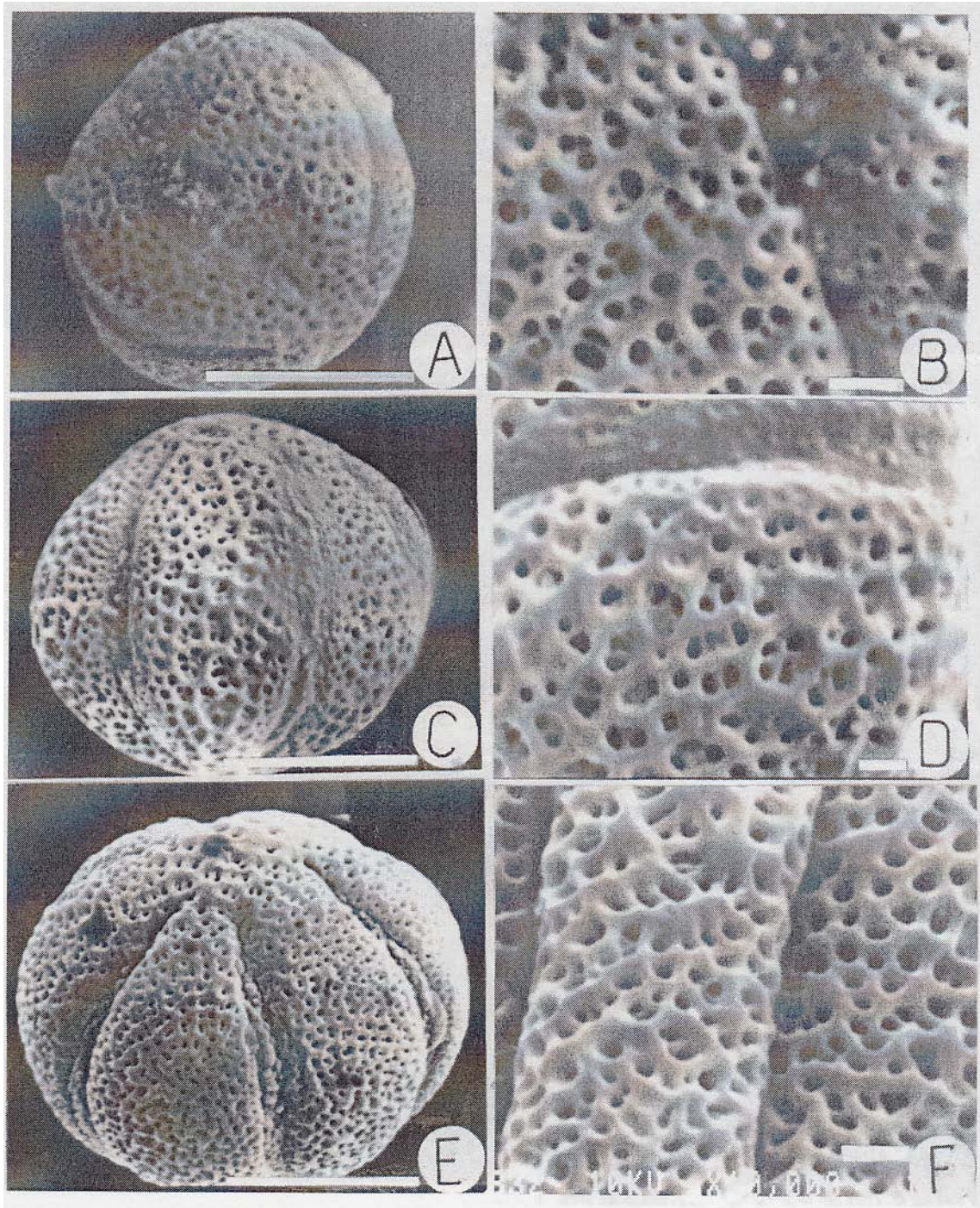


Fig. 8: SEM micrograms of (A, C) view of whole pollen grain in equatorial view, (E) whole pollen grain showing the polar region, (B, D, F) magnified view showing sculpturing of the tectum. A. *O. onites* x3500. B. *O. onites* x11000. C. *O. syriacum* var. *bevani* x3500. D. *O. syriacum* var. *bevani* x8000. E. *O. vulgare* ssp. *gracile* x3500. F. *O. vulgare* ssp. *gracile* x10000. Scale bars: A-C-E 10 μ m, B-D-F 1 μ m.

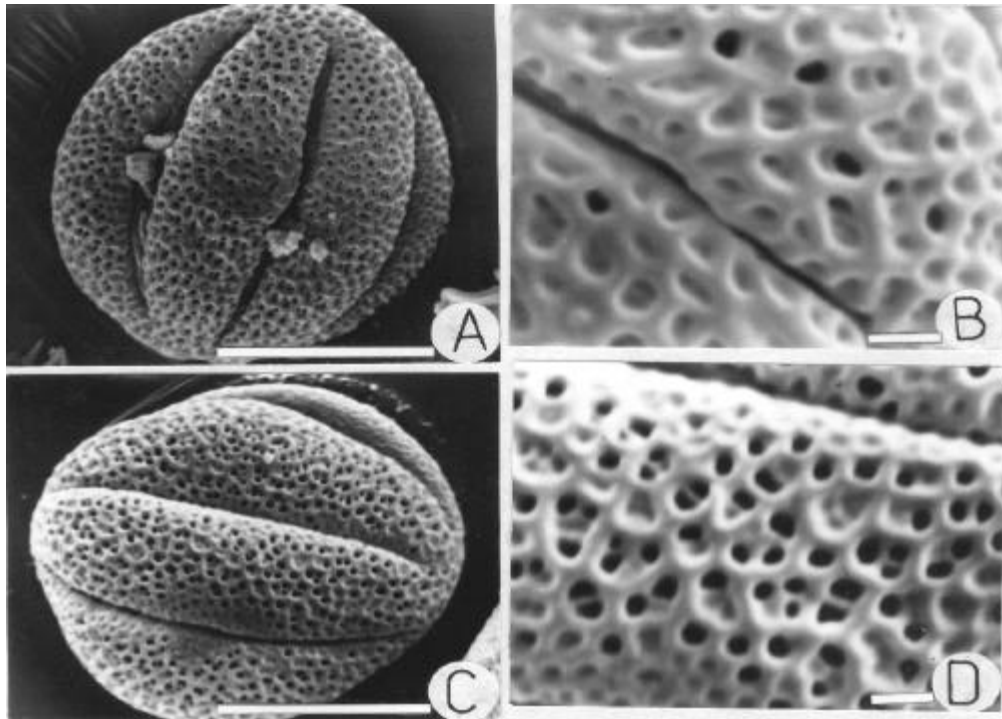


Fig. 9: SEM micrograms of (A, C) view of whole pollen grain in equatorial view, (B, D) magnified view showing sculpturing of the tectum. A. *O. vulgaris* ssp. *hirtum* x3500. B. *O. vulgaris* ssp. *hirtum* x13000. C. *O. vulgaris* ssp. *viride* x3700. D. *O. vulgaris* ssp. *viride* x11000. Scale bars: A-C-E 10 μ m, B-D-F 1 μ m.

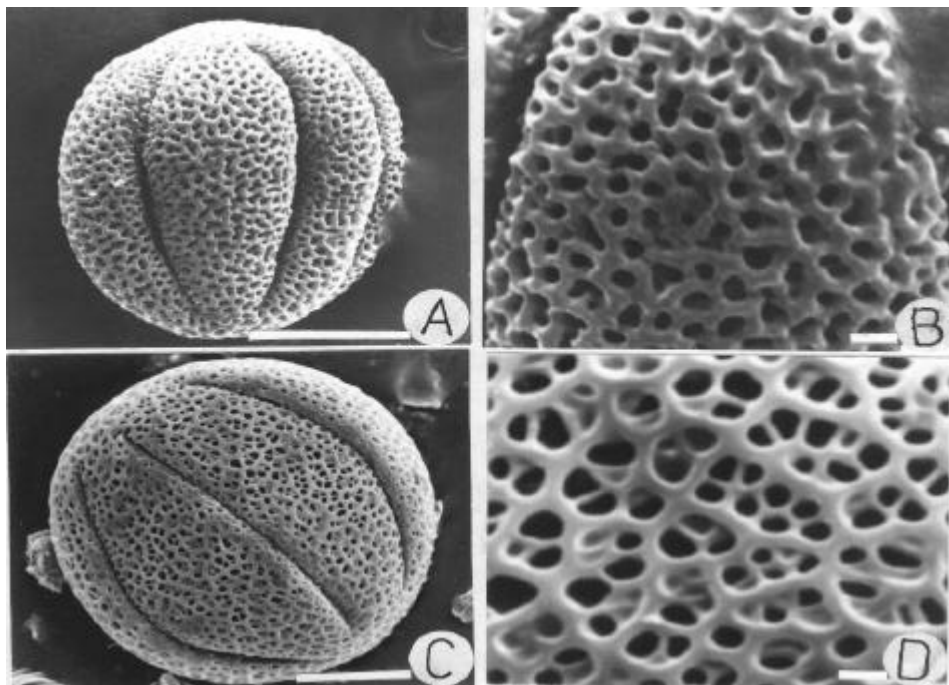


Fig. 10: SEM micrograms of (A, C) view of whole pollen grain in equatorial view, (B, D) magnified view showing sculpturing of the tectum. A. *O. vulgaris* ssp. *vulgare* x3000. B. *O. vulgaris* ssp. *vulgare* x9000. C. *O. laevigatum* x2000. D. *O. laevigatum* x8500. Scale bars: A-C-E 10 μ m, B-D-F 1 μ m.

Table 3: The palynological features of the pollens that have supracretate ornamentation on SEM microphotographs

Taxa	No. of lumen	No. of perforation	Perforation diameter (µm)			In lumen perforation diameter	Muri thickness (µm)		
			Min	Max	Mean		Min	Max	Mean
<i>O. sipyleum</i> (Ankara,Kizilcahamam)	3	33	0.13	0.39	0.24	1-7	0.20	0.40	0.29
<i>O. sipyleum</i> (Manisa,Sipil mountain)	4	20	0.13	0.38	0.25	1-5	0.13	0.38	0.28
<i>O. sipyleum</i> (Isparta, Sütçüler)	4	22	0.12	0.35	0.27	1-6	0.24	0.35	0.27
<i>O. vulgare</i> ssp. <i>gracile</i>	-	18	0.10	0.42	0.27	-	0.11	0.53	0.28
<i>O. onites</i>	4-5	11	0.20	0.50	0.27	1-6	0.20	0.50	0.33
<i>O. majonara</i> (Antalya)	4.5 -5	13	0.18	0.37	0.31	1-6	0.31	0.63	0.40
<i>O. vulgare</i> ssp. <i>hirtum</i>	-	10	0.14	0.57	0.32	-	-	-	-
<i>O. sipyleum</i> (Balikesir)	3.5	14	0.20	0.46	0.33	1-8	0.20	0.33	0.25
<i>O. majonara</i> (Balikesir)	2.5 - 3	7	0.11	0.66	0.33	1-6	0.22	0.56	0.35
<i>O. solymicum</i>	3	10	0.16	0.58	0.33	1-5	0.33	0.50	0.36
<i>O. vulgare</i> ssp. <i>viride</i>	2-2.5	12	0.22	0.55	0.34	1-6	0.28	0.56	0.36
<i>O. leptocladum</i>	2-2.5	16	0.24	0.56	0.35	1-8 (10)	0.17	0.33	0.30
<i>O. sipyleum</i> (Ankara,Beypazari)	4	21	0.19	0.50	0.36	1-5	0.19	0.38	0.28
<i>O. syriacum</i> var. <i>bevanii</i>	2	5-6	0.22	0.60	0.36	1-6	0.31	0.92	0.49
<i>O. saccatum</i>	4	11	0.18	0.56	0.36	1-8	0.25	0.38	0.30
<i>O. boissieri</i>	1-1.5	10-11	0.15	0.67	0.40	2-15	0.31	0.50	0.35
<i>O. bargyli</i>	2	12	0.24	0.80	0.46	1-5	0.21	0.50	0.28
<i>O. acutidens</i>	3-4	9	0.26	0.84	0.48	2-5	0.13	0.21	0.19
<i>O. rotundifolium</i>	1	10	0.36	0.63	0.51	3-15	0.32	0.42	0.36
<i>O. hypericifolium</i>	1.5	12	0.30	1.00	0.53	1-5	0.20	0.50	0.30
<i>O. haussknechtii</i>	-	9	0.24	1.28	0.60	-	-	-	-
<i>O. laevigatum</i>	1-1.5	6	0.46	1.35	0.79	1-8	0.38	0.92	0.52
<i>O. vulgare</i> ssp. <i>vulgare</i>	8	-	-	-	-	-	0.24	0.47	0.34

The species are put in order in terms of their average perforation diameter in their palynological features

Table 4: Palynological features of the pollen species having reticulate ornamentation on SEM microphotographs

Taxa	Number of lumen	Lumen diameter (µm)			Muri diameter		
		Min	Max	Mean	Min	Max	Mean
<i>O. minutiflorum</i>	13	0.18	0.62	0.42	0.13	0.25	0.18
<i>O. bilgeri</i>	11-12	0.37	0.67	0.43	0.19	0.38	0.27
<i>O. micranthum</i>	10	0.23	0.75	0.49	0.15	0.38	0.28
<i>O. husnucan-baserii</i>	4	0.25	1.37	0.60	0.19	0.50	0.37

As a conclusion, the pollen grains of the species from section chilocalyx and only in *O. husnucan-baserii* Duman and Ayaç of brevifilamentum section show distinct ornamentation (Reticulate) from the others

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