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Pollen and seed morphology of *Velezia* L. (Caryophyllaceae) genus in Turkey

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Abstract: In this study, pollen and seed morphology of *Velezia* L. (Caryophyllaceae) species in Turkey were investigated by light and scanning electron microscopy. The genus is represented by 5 species in Turkey: *V. tunicoides* P.H.Davis, *V. hispida* Boiss., *V. quadridentata* Sibth. & Sm., *V. pseudorigida* Hub.-Mor. and *V. rigida* L. Endemism ratio of the genus is 60%, which shows that Turkey is the gene center for this genus. The pollen grains of *Velezia* species are radially symmetrical and isopolar, oblate-spheroidal, operculate, and polypantoporate, pores with conical spinules on operculum. Pollen ornamentation, pore numbers, exine thickness, pore diameter, operculum ornamentation, and spinule sizes are varying characters between *Velezia* species. Seeds of *Velezia* species are bright black when mature; the embryo is straight, the cylindrical seeds are dorsiventrally compressed usually with incurved and thickened margins; the hilum being situated in the centre of the concave surface. Number of seeds in capsule, seed length and width, presence of tubercle, suture shape and the number of suture points per plate are important characters in differentiating *Velezia* species.

Key words: Caryophyllaceae, morphology, pollen, seed, *Velezia*

Türkiye *Velezia* L. (Caryophyllaceae) cinsi polen ve tohum morfolojisi

Özet: Bu çalışmada Türkiye *Velezia* L. (Caryophyllaceae) cinsi polen ve tohum yapıları, ışık ve taramalı elektron mikroskopları kullanılarak incelenmiştir. Cins ülkemizde 5 tür ile temsil edilmektedir: *V. tunicoides* P. H. Davis (endemik), *V. hispida* Boiss., *V. quadridentata* Sibth. & Sm., *V. pseudorigida* Hub.-Mor. ve *V. rigida* L. Cinsin endemizm oranı % 60'dır ve bu oran cinsin gen merkezinin Türkiye olduğunu göstermektedir. *Velezia* türlerinin polenleri radyal simetrili ve isopolardır, şekilleri oblat-sferoidal olan polenler, operkulumlu ve polipantoporattır; porlar operkulumda konik spinüllüdür. Polen ornamentasyonu, por sayıları, ekzin ve intin kalınlığı, por çapı, operkulum ornamentasyonu ve spinül boyutları *Velezia* türleri arasında farklılık gösteren karakterlerdir. *Velezia* türlerinin tohumları olgunlukta parlak siyahtır; embriyo dik ve silindirik tohumlar genellikle kıvrılmış ve kalınlaşmış kenarlı ve dorsoventral olarak basıktır; hilum konkav yüzeyin ortasında yer alır. Kapsüldeki tohum sayısı, tohum boy ve eni, tüberkül varlığı, sütur başına gözlenen diş sayısı, *Velezia* türlerini ayırmada önemli karakterlerdir.

Anahtar sözcükler: Caryophyllaceae, morfoloji, polen, tohum, *Velezia*

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Introduction

The Caryophyllaceae is a large, cosmopolite family of 86 genera and about 2200 species of herbs and small shrubs (Bittrich, 1993; Heywood, 1998), of which 32 the genera, including over 470 species, occur as native species in Turkey (Coode, 1967; Davis et al., 1988; Güner et al., 2000; Menemen & Hamzaoğlu, 2000; Vural & Dönmez, 2002; Duran & Menemen, 2003; Aytaç & Duman, 2004; Deniz & Düşen, 2004; Ataşlar & Ocak, 2005; Özhatay & Kültür, 2006; Mutlu, 2006; Vural et al., 2006; Bağcı et al., 2007; Ecevit-Genç et al., 2007; Aksoy et al., 2008; Bağcı, 2008; Tugay & Ertuğrul, 2008; Vural, 2008; Kandemir et al., 2009; Hamzaoğlu et al., 2010).

Despite the size of the family, its wide range of habitats, and global ubiquity, systematics of the Caryophyllaceae still relies on overall similarities of morphological characters used for recognizing taxa. Even though meticulous morphological studies have been conducted to establish reasonably well-diagnosed taxa (Bittrich, 1993), Caryophyllaceae systematics and classification have been searched in detail under a lot of palynological frameworks designed by different scientists (Erdtman, 1960; Erdtman et al., 1961; Barkoudah, 1962; Chanda, 1962; Heslop-Harrison, 1963; Vishnu-Mittre & Gupta, 1964; Kuprianova, 1967; Erdtman, 1969; McNeill & Bassert, 1974; Walker, 1974a; Walker, 1974b; Fægri et al., 1989; Nowicke, 1975; Skvarla & Nowicke, 1976; Iwarsson, 1977; Candau, 1978; Takhtajan, 1980; Muller, 1981; Romanova, 1982; Ghazanfar, 1984; Prentice et al., 1984; Prentice, 1987; Al-Eisawi, 1989; Taia, 1994; Punt & Hoen, 1995; Yıldız, 2001; Jordan & Macphail, 2003; Perween & Qaiser, 2003; Perveen & Qaiser, 2006; Kaplan, 2008; Sahreen et al., 2008; Yıldız et al., 2009).

Caryophyllaceae was divided into 3 subfamilies; Paronychioideae, Alsinoideae, and Silenoideae (Pax & Hoffmann, 1934; Davis & Cullen, 1965; Coode, 1967; Hutchinson, 1973; Rendle, 1975). This arrangement of the family was changed by Bittrich (1993) as Alsinoideae, Caryophylloideae, and Paronychioideae.

Caryophyllaceae pollen grains are suboblate-subprolate (if 3-colpate), and spherical or ± rounded polyhedral (if porate or pantocolpate); their diameters range from 24 to 65 mm in pantocolpate or pantoporate pollen grains and from 12.5 × 8 mm to 28 × 23 mm in tricolpate or triporate grains. The exine is tectate; and the tectum is mostly punctitegillate or occasionally anulopunctate, or rarely reticulate (Melzheimer, 1975; Iwarsson, 1977), and finely spinulose (Bittrich, 1993).

The genus *Velezia* L. belongs to the family Caryophyllaceae, subfamily Caryophylloideae (Bittrich, 1993). The genus represented by 5 species in Turkey: *V. hispida* Boiss. (endemic), *V. quadridentata* Sibth. & Sm., *V. rigida* L., *V. pseudorigida* Hub.-Mor. (endemic), and *V. tunicoides* P.H. Davis (endemic) (Coode, 1967). Endemism ratio of the genus is 60% and it is a good clue showing that Turkey is the gene centre for this genus.

There are a lot of studies about pollen grains of genera related to *Velezia* according to Bittrich's (1993) classification: *Gypsophila* L. (Nowicke, 1975; Taia, 1994; Yıldız, 2001; Perveen & Qaiser, 2006; Ataşlar et al., 2009), *Saponaria* L. (Nowicke, 1975; Arkan & İnceoğlu, 1992; Yıldız, 2001; Ataşlar, 2004; Perveen & Qaiser, 2006; Çinbilgel et al., 2007), *Bolanthus* (Ser.) Reichb. (Pınar & Oybak, 1997), *Ankyropetalum* Fenzl (Barkoudah, 1962), *Dianthus* L. (Nowicke, 1975; Skvarla & Nowicke, 1976; Taia, 1994; Yıldız, 2001; Perveen & Qaiser, 2006; Sahreen et al., 2008; Vural 2008; Yıldız et al., 2009), *Petrorhagia* (Ser.) Link (Yıldız, 2001; Perveen & Qaiser, 2006), and *Silene* L. (Nowicke, 1975; Skvarla & Nowicke, 1976; Ghazanfar, 1984; Prentice et al., 1984; Prentice, 1987; Taia, 1994; Yıldız, 1996; Yıldız, 2001; Yıldız, 2005; Perveen & Qaiser, 2006; Yıldız, 2006; Yıldız & Minareci, 2008; Yıldız et al., 2009). Except for 2 studies on pollen morphology of *Velezia rigida* (Yıldız, 2001; Perveen & Qaiser, 2006), there are no published data about pollen morphology of other *Velezia* species.

There are some investigations carried out on seed morphology of different Caryophyllaceae genera (Barkoudah, 1962; Ball & Heywood, 1964; Prentice et al., 1986; Volponi, 1986; Bittrich, 1993; Yıldız & Çırpıcı, 1998; Yıldız 2002). Yıldız (2002) studied the seed morphology of *Velezia rigida* collected from Turkey with SEM. However, there are no data about seed morphology of other *Velezia* species.

This study presents the pollen and seed morphology of all Turkish *Velezia* species investigated in detail by light and scanning electron microscopy.

Materials and methods

Pollen and seed materials were collected from wild populations. Localities of the specimens are given below. The specimens are deposited in Eskişehir Osmangazi University Herbarium (OUFE).

Pollen slides were prepared using the technique of Wodehouse (1959). LM studies were performed using a Leitz-Wetzlar microscope. Measurements were based on 20 pollen grains per specimen. Twenty seeds from each plant were measured for length and width under a stereomicroscope. For SEM studies, pollen grains and seeds were coated with gold in a sputter-coater. Morphological observations were carried out in a Jeol 5600 electron microscope in the Electron Microscopy Laboratory of Eskişehir Osmangazi University.

The pollen morphology terminology adopted by Fægri and Iversen (1975), Fægri et al. (1989) and Brochmann (1992) was used. Shape classification follows Erdtman (1969), based on P/E ratio in Table 1. The seed terminology adopted by Murley (1951), Koul & Ranina (2000) and Pınar et al. (2009) was followed.

Specimens examined

V. tunicoides; **C3 Antalya:** Entrance of Göynük holiday villages, dry stream bed, 2 m, 12.07.2007, N36°38′84′′ E30°32′96′′, *İEP* 111 (OUFE); *V. hispida*; **B3 Afyon:** İscehisar, 2 km to Karakaya village, north hillsides, 1161 m, 24.06.2005, N38°53′19′′ E30°48′47′′, *İEP* 79 (OUFE); **C3 Isparta:** Gölcük Lake National Park, ca. 1200 m, 23.07.2006, N37°43′60′′, E30°30′′, *İEP* 109 (OUFE); *V. quadridentata*; **B1 İzmir:** Emiralem to Menemen, 6 m, 21.05.2005, N38°27′48′′ E27°12′18′′, *İEP* 70 (OUFE); *V. pseudorigida*; **C2 Muğla:** Muğla to Yılanlı Forest Management Planning Department, crossroads of power-plant, southeast, stony-calcerous hillside, 1250-1260 m, 21.07.2006, N37°13′32′′ E26°27′33′′, *İEP* 103 (OUFE); *V. rigida*; **B2 Kütahya:** Çavdarhisar crossroads to Emet, 300-1140 m, 06.07.2003, *İEP* 4 (OUFE).

Results

In the Flora of Turkey (Coode, 1967), the genus *Velezia* is represented by 6 species, namely *V. hispida*, *V. quadridentata*, *V. fasciculata*, *V. rigida*, *V. pseudorigida*, and *V. tunicoides*. Based on the specimens collected from the localities of *V. fasciculata* given in Flora of Turkey (Coode, 1967) and the specimens obtained from HUJ (Hebrew University Jerusalem Herbarium), which were identified as *V. fasciculata*, the authors decided that these specimens are not *V. fasciculata*, all are *V. rigida*. So the number of species of genus *Velezia* in Turkey declined to 5.

Pollen morphology

Size, symmetry, and shape

The pollen grains of *Velezia* are radially symmetrical and isopolar. Shape is oblate-spheroidal with the polar axes of 27.92-39.64 µm and the equatorial axes of 28.21-39.80 µm (Table 1, Figures 1-2). Polar size of pollen grains is 27.92 ± 1.23 µm for *V. tunicoides*, 39.64 ± 1.21 µm for *V. hispida*, 33.80 ± 0 µm for *V. quadridentata*, 33.56 ± 1.53 µm for *V. pseudorigida,* and 34.04 ± 1.34 µm for *V. rigida*. Equatorial size of pollen grains is 28.21 ± 1.39 µm for *V. tunicoides*, 39.80 ± 1.21 µm for *V. hispida*, 33.80 ± 2.13 µm for *V. quadridentata*, 33.56 ± 1.34 µm for *V. pseudorigida,* and 34.04 ± 1.03 µm for *V. rigida.*

Apertures

The pollen grains are operculate and polypantoporate. Pores 4.24-5.49 µm in diameter and circular. Operculum 2.61-3.28 µm wide; 0.73-1.18 µm high with 6-10 conical spinules on operculum. But operculum of *V.tunicoides* has shown psilate-rugulate ornamentation (Table 1, Figures 1-2). Pore numbers of species are 11 for *V. tunicoides*, 12 for *V. quadridentata,* and 14 for *V. hispida*, *V. pseudorigida,* and *V. rigida*.

Exine

The exine is subtectate and 1.25-2.72 µm in thickness. The ectexine is thicker than endexine. Intine thickness ranges between 0.34-0.61 µm. Ornamentation scabrate-microperforate (*V. tunicoides* and *V. hispida*) or scabrate-foveolate (*V. quadridentata*, *V. pseudorigida,* and *V. rigida*). Tectal spinules conical, 0.22-0.54 µm high and 0.21-0.43 µm wide.

Table 1. Pollen morphology of *Velezia* species (values in μm).

	V. tunicoides	*V. hispida*	*V. quadridentata*	*V. pseudorigida*	*V. rigida*
Polar axes	27.92 ± 1.23	39.64 ± 1.21	33.80 ± 0	33.56 ± 1.53	34.04 ± 1.34
Equatorial axes	28.21 ± 1.39	39.80 ± 1.21	33.80 ± 2.13	33.56 ± 1.34	34.04 ± 1.03
Pollen dimension (P/E)	0.989	0.995	0.997	0.988	0.997
Pollen shape	OS	OS	OS	OS	OS
Pollen aperture type	Pp	Pp	Pp	Pp	Pp
Pollen ornamentation	SM	SM	FG	FG	FG
Operculum ornamentation	PR	S	G	G	S
Exine structure	SM	SM	SF	SF	SF
Exine thickness	2.72	1.34	1.61	1.25	1.34
Intine thickness	0.61	0.46	0.58	0.46	0.34
Pores diameter	4.24	5.49	5.33	4.96	4.45

Abbreviations: **FG:** Foveolate-granulate, **G:** Granulate, **OS:** Oblate-spheroidal, **Pp:** Polypantoporate, **PR:** Psilate-rugulate, **S:** Scabrate, **SF:** Scabrate-foveolate, **SM:** Scabrate-microperforate.

Seed morphology

Homogeneity in seed size and shape was found among *Velezia* species (Table 2). The largest seeds occur in *V. hispida* (1.88 ± 0.08 mm in length and 0.79 ±. 0.07 mm in width). The smallest seeds are found in *V. tunicoides* (1.57 ± 0.14 mm in length and 0.45 ± 0.10 mm in width). The seed shape is cylindrical-oblong in all of *Velezia* species. The colour of seeds is black when mature. Shape of suture is sinous or smoothly sinous for *V. tunicoides*; irregularly digitate for *V. hispida*, *V. pseudorigida,* and *V. rigida*; regularly digitate for *V. quadridentata*. The bright black seeds are dorsiventrally compressed usually with incurved and thickened margins, the hilum being situated in the centre of the concave surface and the embryo is straight (Figure 3).

Discussion

Caryophyllaceae is a stenopalynous family (Perveen & Qaiser, 2006). Basically, 3 pollen types were observed in the family; tri-colpate with spinulose and tubuliferous/punctate ektexine, pantoporate with spinulose and tubuliferous/punctate ektexine and pantoporate with reticulate ektexine (Nowicke, 1975).

Pollen grains of *Velezia* species are oblate-spheroidal, operculate, polypantoporate with scabrate-microperforate or scabrate-foveolate ornamentation. Pollen ornamentation, pore numbers, exine thickness, pore diameter, operculum ornamentation, and spinule sizes are important characteristics for determining the pollen grains of these species. In addition, some seed morphological characters like the number of seeds in capsule, seed length and width, tubercle presence, suture shape and the number of suture points per plate are also helpful properties for differentiating *Velezia* species. Some properties of *Velezia* seeds were procured after our investigations (Table 2). There are no previous data about the numbers of the seeds in the capsules. Numbers of the seeds in the capsules are different within the species: 4 for *V. tunicoides*, 6 for *V. hispida*, 13 for *V. quadridentata*, 5-7 for *V. pseudorigida,* and 6-10 for *V. rigida*.

According to Nowicke (1975), pollen grains of *Gypsophila acutifolia* Fisch. are pantoporate, spinulose, and tubuliferous/punctate ektexine. Taia (1994) determined that the pollen grains of *G. viscosa* Murray are pantoporate, tegillate exine and granulate or bacculate tectum and *G. capillaris* Forssk. are

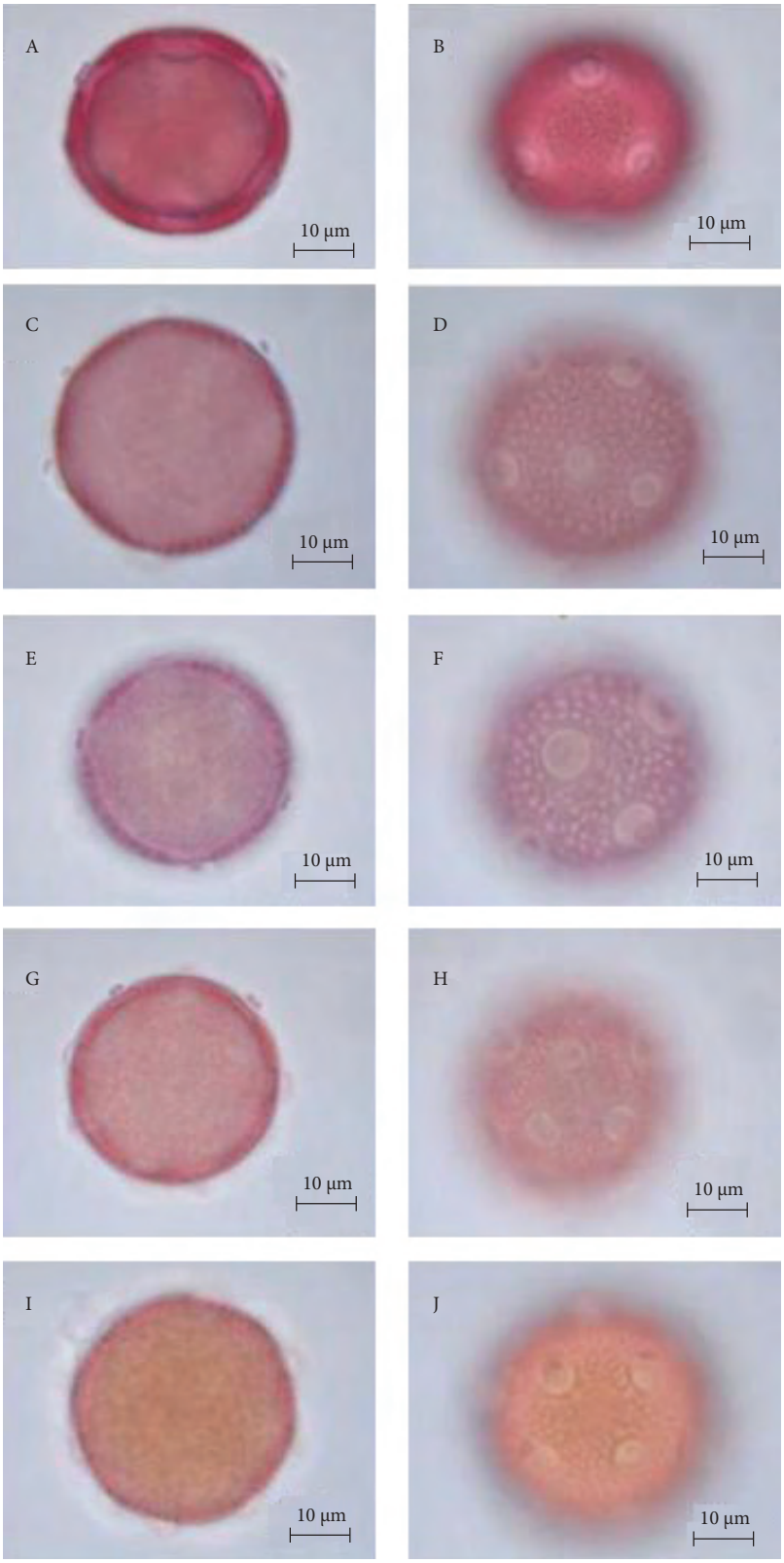

Figure 1. LM photos of pollen grains of *Velezia* species: A-B: *V. tunicoides*, C-D: *V. hispida*, E-F: *V. quadridentata*, G-H: *V. pseudorigida*, I-J: *V. rigida*.

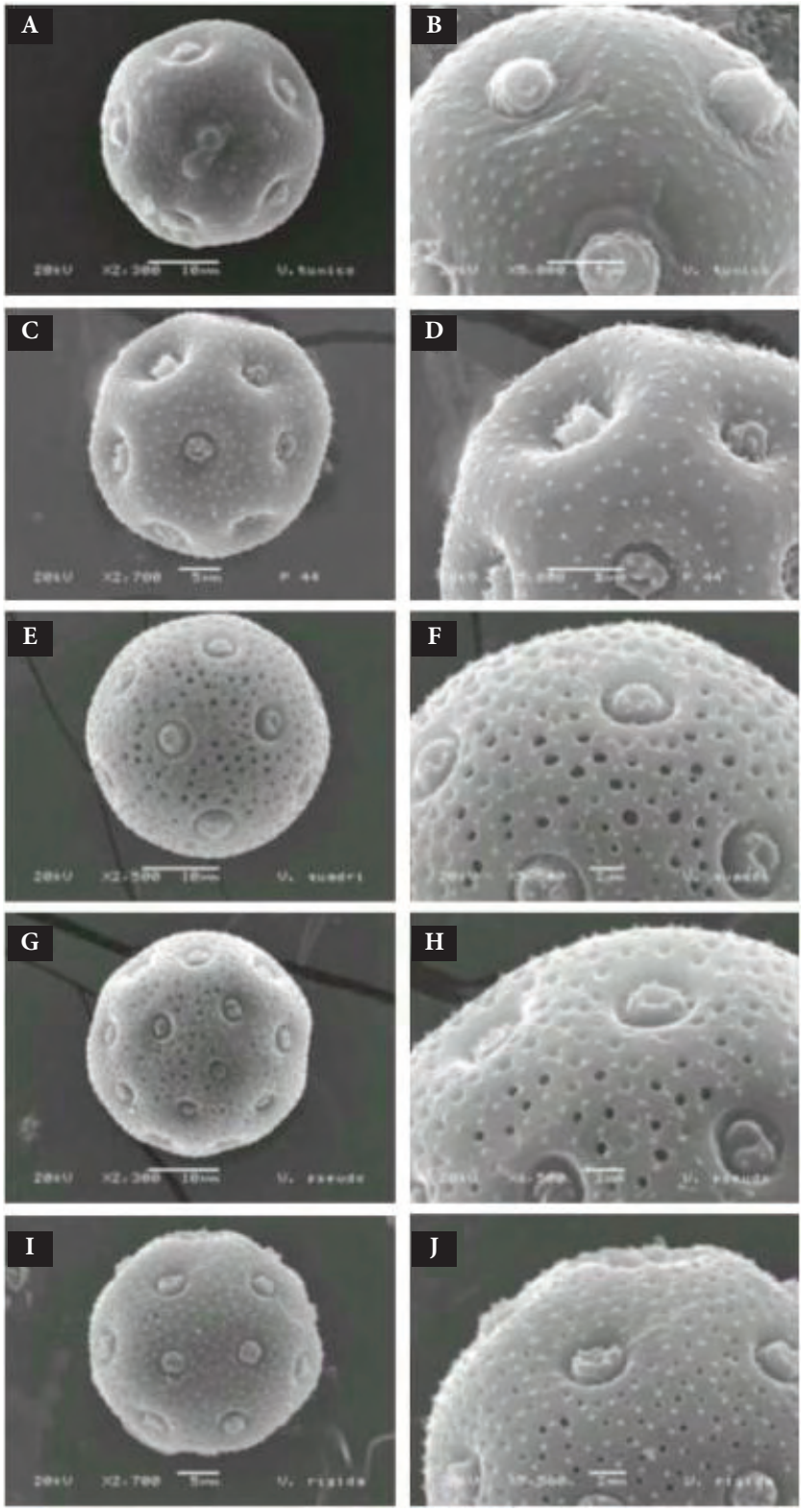

Figure 2. SEM photos of pollen grains of *Velezia* sepecies: *V. tunicoides* A-B, *V. hispida* C-D, *V. quadridentata* E-F, *V. pseudorigida* G-H and *V. rigida* I-J.

Table 2. Seed morphology of *Velezia* species (values in mm).

	V. tunicoides	*V. hispida*	*V. quadridentata*	*V. pseudorigida*	*V. rigida*
Seed length	1.57 ± 0.14	1.88 ± 0.08	1.63 ± 0.15	1.65 ± 0.18	1,73 ± 0,20
Seed width	0.45 ± 0.10	0.79 ± 0.07	0.69 ± 0.15	0.51 ± 0.04	0.45 ± 0.08
Number of seeds in capsule	4	6	13	5-7	6-10
Colour of mature seed	Bright black	Bright black	Bright black	Bright black	Bright black
Seed type	Cylindrical-oblong	Cylindrical-oblong	Cylindrical-oblong	Cylindrical-oblong	Cylindrical-oblong
Seed face type	Round	Round	Round	Round	Round
Surface granulation	Coarse	Coarse	Coarse	Coarse	Coarse
Shape of dorsal surfaces	Smooth	Smooth	Smooth	Smooth	Smooth
Shape of ventral surfaces	Concave	Concave	Concave	Concave	Concave
Seed tubercle presence	Present (ventral)	Present (dorsal and ventral)	Present (ventral)	Present (dorsal and ventral)	Present (dorsal and ventral
Shape of suture	Sinuous or smoothly sinuous	Irregularly digitate	Regularly digitate	Irregularly digitate	Irregularly digitate
Number of suture points per plate	7-11	13-17	13-19	17-20	13-17

trizonocolpate, semitectate exine, and bacculate or reticulate tectum. Pollen grains of *G. elegans* M.Bieb. and *G. venusta* Fenzl from Turkey were determined as angulate, with 9-14 pores, and microperforate tectum (Yıldız, 2001). A study based on 12 taxa of Turkish *Gypsophila* species were investigated by light, scanning electron, and transmission electron microscopes. *Gypsophila* pollens were found to be polyporate and spheroidal. Exine structure was tectate, operculum exists in the form of scattered pieces in *G. curvifolia* Fenzl while it exists as a whole in other taxa (Ataşlar et al., 2009).

Arkan and İnceoğlu (1992) suggested that Turkish *Saponaria* pollen grains were mostly like *Drypis* L. pollen grains morphologically. In another study, pollen grains of *Saponaria* were determined as polypantoporate (11-12 pores) and ornamentation spinulate-microperporate and spheroidal pollen grains of *S. kotschyi* Boiss. were determined as polypantoporate and with 12 pores by Ataşlar (2004). Another study performed on *S. pamphylica* Boiss. & Heldr. in Turkey also reported polypantoporate pollens with 11-12 pores (Çinbilgel et al., 2007).

Yıldız (2001), reported the pollen grains of *S. glutinosa* M.Bieb., *S. orientalis* L., and *S. prostrata* Willd. spp. *prostrata* (endemic) has 11-20 porate, tectum microperforate, reticulate. This pollen type was also observed on 10 *Dianthus* and 3 *Petrorhagia* and *Velezia rigida*. This type was denominated as Dianthus type and described with perforations rather sparse; columellae irregular, thinning towards the base; tectum mictoperforate, reticulate; grains with 11-20 (generally 11-16) pores; grain size ranges from 20.68 ± 2.42 µm to 45.35 ± 3.57 µm. Measured properties of *Velezia rigida* are pollen diameter (34.25 ± 1.30 µm), pore diameter (5.25 - 0.39 µm), exine thickness (2.48 - 0.54 µm), and the number of pores (13-16) recorded by Yıldız in this study. According to our results polar axes is 27.92-39.64 µm and the equatorial axes is 28.21-39.80 µm, pore diameter is 4.45 µm, and the number of pores are 14 for *Velezia rigida*. Our results are in line with Yıldız's results.

A previous study explored the pollen flora of Pakistan Caryophyllaceae species (Perveen & Qaiser, 2006). According to this study, *Velezia rigida* was taken apart in the Stellaria media type with *Acanthophyllum* sp., *Arenaria* sp., *Cerastium* sp., *Dianthus* sp., *Gypsophila* sp., *Holosteum umbellatum* L., *Lepyrodiclis* sp., *Lychnis coronaris* (L.) Desr., *Minuartia* sp., *Myosoton aquaticum* (L.) Moench, *Petrorhagia alpina* (Habl.) Ball & Heywood, *Pseudostellaria heterantha* (Maxim.) Pax, *Sagina saginoides* (L.) Karst., *Saponaria subrosularis* Rech. F., *Silene* sp., *Stellaria* sp., and *Vaccaria hispanica* (Miller) Rauchert. Pollen diameter is 32.5 µm, pore diameter is 3.75 µm, operculum is spinulose, exine thickness is

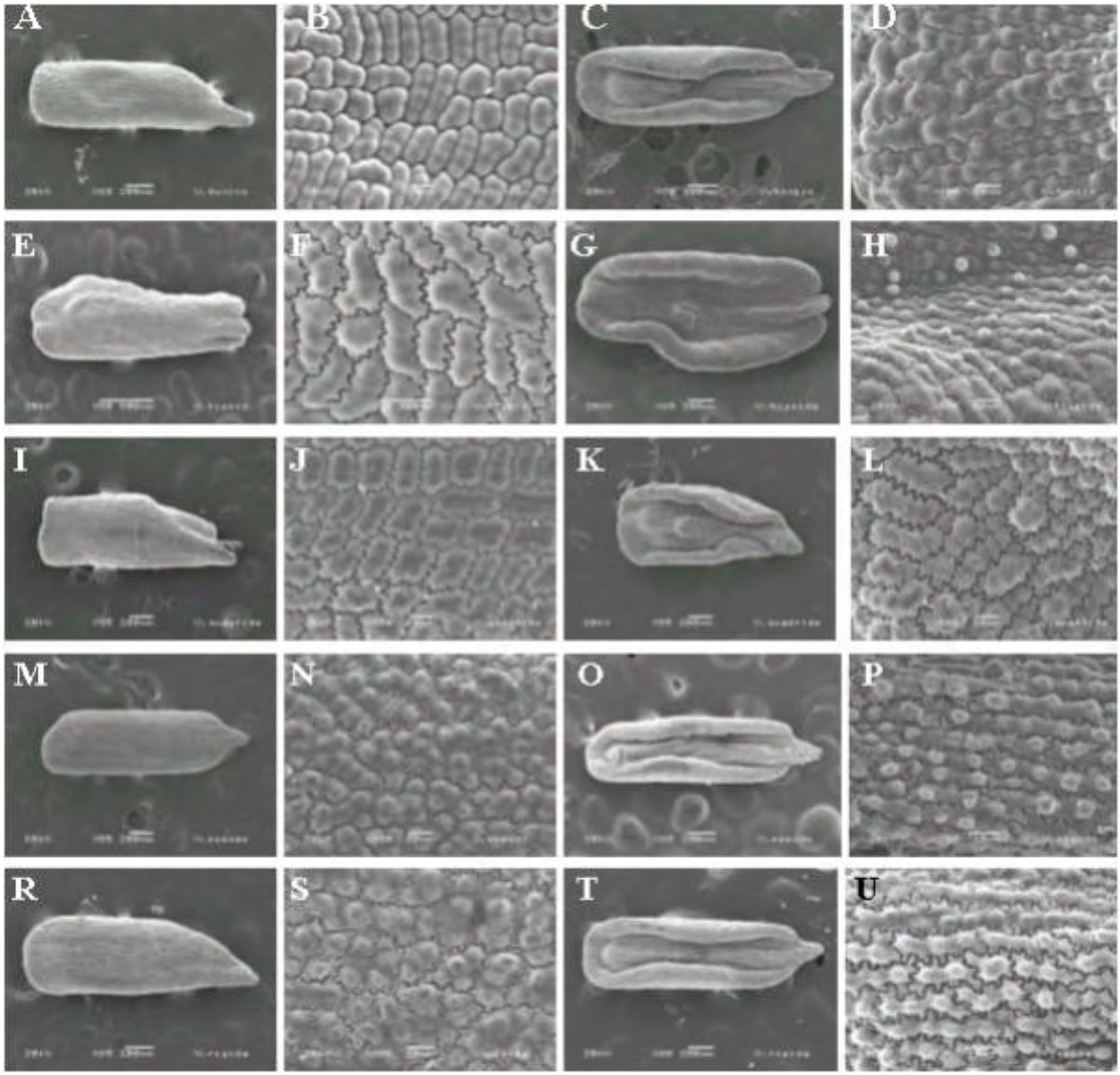

Figure 3. SEM photos of seeds of *Velezia* species: A-D: *V. tunicoides*, E-H: *V. hispida*, I-L: *V. quadridentata*, M-P: *V. pseudorigida*, R-U: *V. rigida*. A, E, I, M, R: dorsal, B, F, J, N, S: dorsal ornamentation, C, G, K, O, T: ventral, D, H, L, P, U: ventral ornamentation.

2.0 µm, and tectum is punctate-spinulose of *V. rigida*. This study is in agreement with our contention.

Except these 2 studies that investigated pollen morphology of *Velezia rigida* (Yıldız, 2001; Perveen & Qaiser, 2006), there are no reported data about pollen morphology of other *Velezia* species.

Some *Bolanthus* species from Turkey were palynologically investigated by Pınar & Oybak (1997). Pollen grains of these species were polypantoporate and with 14-24 pores.

Nowicke (1975), and Skvarla and Nowicke (1976) defined the pollen grains of a hybrite carnation (*Dianthus barbatus* L. x *superbus* L.) as pantoporate, spinulose, and tubuliferous-punctate ektexine. Taia (1994) reported that *D. cyri* Fisch. and Mey., and *D. strictus* Banks and Sol. has pantoporate and 8-aperturate pollen grains. Sahreen et al. (2008) investigated pollen morphology of 8 *Dianthus* species grown in Pakistan. Polypantoporate pollen grains have less

than 12 pores. Other study carried out a new species of *Dianthus* from Turkey and it is pollen grains were also polypantoporate and number of pores was 8-14 (Vural, 2008).

Nowicke (1975), and Skvarla and Nowicke (1976) described the pollen grains of *Silene noctifolia* L. as pantoporate with finely reticulate ektexine.

Ghazanfar (1984) carried out a study on pollen morphology of all species of genus *Silene*, sections *Siphonomorpha* Otth. and *Auriculatae* (Boiss.) Schischk. comparatively. According to this study, the pore number of the species *Siphonomorpha* is, on the whole, lower than that of the species in *Auriculatae*. Though most of the species in *Siphonomorpha* have 20 to 26 pores. *S. prilipkoana* Schischk. and *S. goniocaula* Boiss. spp. *behboudiana* have 18 to 20 pores, but they remain amongst the few in *Auriculatae* with a low pore number. The pores in all species are protruding and their delimitation distinct. The sculpture of the ektexine of the species studied in section *Siphonomorpha* is punctuate; the puncti are distinct and scattered. The tectum is spinulose or tubiliferous. Section *Auriculatae* shows 3 different ektexine patterns. A punctate, spinulose/tubiliferous; a reticulate, spinulose/tubuliferous ektexine and a semireticulate, spinulose/tubuliferous ektexine. The presence of semi-reticulate and reticulate ektexines in the *Auriculatae* and their total absence in the *Siphonomorpha* suggest a relationship between such ektexines and phylogenetically advanced taxa (Ghazanfar, 1984).

Taia (1994) studied 21 *Silene* species from Egypt and recorded that all pollen grains were pantoporate pollens with different pore numbers (18, 20, 22, 23, 25, 26).

Yıldız (1996, 2001, 2005, 2006) irradiated different *Silene* species in Turkey in several studies. Most of *Silene* taxa have polypantoporate and spheroidal pollens with different ornamentations. But exceptions were also assigned for different species of *Silene* (2005).

Imperforate exine (Walker, 1974a; 1974b) and fewer number of pores (Van Campo, 1966) are generally accepted as primitive. Based on all these studies mentioned above, it is clear that 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. The genus *Velezia* belongs to Caryophylloideae subfamily, which has unique pollen types and localized in a narrow distribution.

As seen in these studies, species related to *Velezia* (Bittrich, 1993) belong to a small genus with unique pollen type and localized in a narrow distribution, such as *Bolanthus* or widespread genera with a mix pollen type, such as *Gypsophila*, *Dianthus,* and *Silene*.

There are some investigations carried out on different Caryophyllaceae genera seed morphology (Barkoudah, 1962; Ball & Heywood, 1964; Prentice, 1986; Volponi, 1986; Bittrich, 1993; Yıldız & Çırpıcı, 1998; Yıldız 2002). The seed type is generally reniform in the family of Caryophyllaceae. However, the *Dianthus*, *Petrorhagia,* and *Velezia* genera belonging to this family have different and scarcely seen cylindrical seed type that is not likely to be seen in the family (Ball & Heywood, 1964). Yıldız (2002) performed a study on seed morphology of *Velezia rigida* collected from Turkey with SEM and described the pollen grains of this species as cylindrical, rounded surface, seed back is concave or flat rounded convex, not tuberculate.

The taxonomy of *Velezia* was restricted to only morphological analyses made by Coode (1967). However, due to the characteristics of morphology, some new aspects are needed for the diagnoses of some plant samples. Correct identification of the species and an accurate diagnosis is very important for not only floristic studies but also for purpose of SEM techniques and rational use of micromorphology of pollen and seeds of *Velezia,* which is a small genus but appears to be same morphologically.

It is clear that with this study pollen ornamentation, pore numbers, exine and intine thickness, pore diameter, operculum ornamentation of pollen grains and seed number in capsule, seed length and width, tubercle presence, suture shape and number of suture points per plate are helpful characters in determining *Velezia* species.

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