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Verbascum ergin-hamzaoglui (Scrophulariaceae), a new species from South Anatolia, Turkey

Faik Ahmet KARAVELİOĞULLARI[1,*], Sezgin ÇELİK[2], Birol BAŞER[3], Ahter YAVRU[1]

[1]Gazi University, Arts and Science Faculty, Department of Biology, Teknikokullar, 06500 Ankara - TURKEY

[2]Kırıkkale University, Science and Literature Faculty, Department of Biology, Kırıkkale - TURKEY

[3]Bitlis Eren University, Arts and Science Faculty, Department of Biology, Bitlis - TURKEY

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Abstract: *Verbascum ergin-hamzaoglui* Karavel. *sp. nova* (Sect. *Bothrosperma* Murb.), is described for the first time to the scientific community from South Anatolia in Turkey. The diagnostic morphological characters of these new species and other closely related species (*V. diversifolium* Hochst. and *V. cymigerum* Hub.-Mor.) are discussed. In addition, distribution maps of *V. ergin-hamzaoglui* and its related species are provided. The pollen morphologies of 3 taxa belonging to *Verbascum* L. from the family Scrophulariaceae from Turkey were investigated using a light microscope (LM) and scanning electron microscope (SEM). This family's pollens show similarities to the eurypalynous family. The pollens of these taxa are generally of radial and isopolar symmetries. Pollen shape changes from subprolate to spheroidal. The shape of the aperture is tricolporate, sculpture is tectate, and ornamentation is reticulate. The seeds of this group are brown and are of oblong shape in *V. diversifolium* and *V. cymigerum,* while the shape is ovate in *V. ergin-hamzaoglui*.

Key words: *Verbascum,* pollen morphology, seed surface, SEM, Turkey

Verbascum ergin-hamzaoglui (Scrophulariaceae), Türkiye'nin Güney Anadolu bölgesinden yeni bir tür

Özet: *Verbascum ergin-hamzaoglui* Karavel. *sp. nova* (Sect. *Bothrosperma* Murb.), Güney Anadolu'dan bilim dünyası için ilk defa tanımlanmaktadır. Bu yeni türün ve yakın akrabaları olan diğer türlerin (*V. diversifolium* Hochst. ve *V. cymigerum* Hub.-Mor.) ayırtedici morfolojik karakterleri tartışılmıştır. Ayrıca *Verbascum ergin-hamzaoglui* ve yakın türlerin dağılım haritası verilmiştir. Türkiye`den Scrophulariaceae familyasından *Verbascum* L. cinsine ait 3 taksonun polen morfolojisi ve tohum yüzeyi ışık mikroskobu ve taramalı elekron mikroskobu (SEM) ile incelenmiştir. Bu familyanın polenleri tek tip apertur yapısı göstermektedir. Bu taksonların polenleri genellikle radyal ve izpolar simetrilidir. Polenlerin şekilleri subrolattan spheroidala değişir. Apertur şekli trikolporat, skulupturı tektat ve ornamentasyonu retikulattır. Bu gruptaki tohum rengi kahverengi, tohum şekli *V. ergin-hamzaoglui* türünde ovat, *V. diversifolium* ve *V. cymigerum* türlerinde oblongtur.

Anahtar sözcükler: *Verbascum,* polen morfoloji, tohum yüzeyi, SEM, Türkiye

* E-mail: faikak@gazi.edu.tr

Introduction

The genus *Verbascum* L. (Scrophulariaceae) comprises some 360 species around the world (Heywood, 1993). In Turkey, with an additional 129 hybrids, the genus is represented by 243 species, which are divided into 13 partly artificial groups. The endemism ratio of the genus is very high, with 193 endemic species (80%) (Huber-Morath, 1978; Davis et al., 1988; Vural & Aydoğdu, 1993; Karavelioğulları et al., 2004, 2006, 2008a, 2009a, 2009b; Sutorý, 2001, 2004; Özhatay, 2006; Kaynak et al., 2006; Parolly & Tan, 2007; Parolly & Eren, 2008; Yilmaz & Dane, 2008; Bani et al., 2010).

The genus *Verbascum* have been divided into 2 sections, namely sect. *Aulacospermae* Murb. and sect. *Bothrospermae* Murb. One of the most important differences between these 2 sections is that of the seed morphology of their members. In sect. *Aulacospermae,* the seeds are longitudinal corrugated, while in sect. *Bothrospermae* the seeds are transversal corrugated alveolate. All Turkish species of *Verbascum* belong to sect. *Bothrosperma* Murb. (Murberck, 1925, 1933; Huber-Morath, 1971).

The first revision of Turkey's *Verbascum* was made by Huber-Morath for the *Flora of Turkey* (Huber-Morath, 1978). Later, 8 species and 6 hybrids were described (Vural & Aydoğdu, 1993; Karavelioğulları et al., 2004, 2006, 2008a, 2009a; Sutorý, 2001, 2004; Özhatay, 2006; Kaynak et al., 2006; Parolly & Tan, 2007; Parolly & Eren, 2008; Dane & Yılmaz, 2009), and 3 new species were recorded (Dane & Yılmaz, 2005; Yilmaz & Dane, 2008; Karavelioğulları, 2009b).

The pollen morphology of the family Scrophulariaceae has been examined by a number of researchers including Erdtman (1952), Moore and Webb (1978), Inceoglu (1982), Vargehese (1986), Argue (1986), Karim and El-Oqlah (1989), Minki and Eshbaugh (1989), Karavelioğulları et al. (2005), Juan et al. (1997, 1999, 2000), and Vujicic et al. (1993).

Materials and methods

In 2004, a taxonomic revision of *Verbascum* group A was completed by the first author for Turkey (Karavelioğulları et al., 2008b). Then, during field research studies in Niğde province in 2006, an unusual population of *Verbascum* was determined. At first glance, it seemed to be close to *V. diversifolium* Hochst. and *V. cymigerum* Hub.-Mor. The specimens were cross-checked with the keys provided by Huber-Morath (1978, 1981) and the *Verbascum* accounts given in various relevant literature sources such as Ferguson (1972), Fedchenko (1955), Feinbrun-Dothan (1978a, 1978b), Meikle (1985), Boulos (2009), and Ekim (2000). The specimens of this new species were also cross-checked with material kept at GAZI, ANK, and TUB (Holmgren et al., 1990). The abbreviations of the authors of plant names were checked from Brummitt and Powell (1992). Also, the threat category assessment of the new species was performed according to IUCN criteria (IUCN, 2001).

Both pollen grains and seed samples were taken from specimens housed at GAZI. The pollen grain specimens were prepared according to the Erdtman method (Erdtman, 1960). Polar axis, equatorial diameter, A/B ratio, exine (Ex), colpi long axis (Clg), colpi short axis (Clt), and Ornamentation (Or) were measured. The terminology used was in accordance with Erdtman (1952), Kremp (1965), Faegri and Iversen (1964), and Walker and Doyle (1976). The pollen grains of each taxon were measured until a Gauss curve occurred for A, B, A/B, exine, and intine, and the averages of the measurements were calculated using SPSS 8.0. Pollen grain measurements were performed using a Prior light microscope (Karim and EL-Oqlah, 1989) and under 100× magnification, utilising an immersion objective. For scanning electron microscope (SEM) investigations, the pollen grains were put on stubs and sputter-coated with gold plate. The SEM examination was carried out on a JEOL JSM-6060 (Pınar et al., 2009a)

The lengths and widths of 10 seeds of each taxon were measured with a Euromex micrometer using the stereomicroscope and the average values of these measurements were calculated. The dry seeds were coated by a Polaron SC 502 gold coater and investigated by SEM with a JEOL JSM-6060 (Juan et al., 1997, 1999, 2000; Vujicic et al., 1993; Pınar et al., 2009b).

Taxonomy

Verbascum ergin-hamzaoglui Karavel. **sp. nova**

(Sect. *Bothrosperma* Murb.) (Figures 1-2).

Diagnosis: Affinis V. cymigero sed pilis stellatis et glandulosis (non floccoso-tomentosis); foliis basalibus lanceolatis ad oblongis, integris (non late ovatiss, bicrenatis); calycibis lobatis, acutis (non mucronatis); capsulis ovatis ad oblongis (non late ovatis) differt.

Type: Turkey. C5 Niğde: Ulukışla-Maden village, 25. km, Sakapınarderesi, 1500-1700 m, 02.07.2006, calcareous stony slopes, *F.A.Karavelioğulları* 3567, *M.U.Özbek* & *B.Bani* (holotype: GAZI, isotypes: ANK, HUB, ISTE).

Usually biennial or perennial, 30-70 cm tall, densely stellate and stalked glandular. Stem robust, terete, branched. Basal leaves 6-18 × 1.5-3 cm (include petiole), mostly congested at base, lanceolate to oblong, entire, acute. Cauline leaves 2-4 × 1-3 cm, lanceolate to oblong, entire, acute. Inflorescence loose, simple or branched, numerous clusters of 1-8 flowers (accessory flowers 1) pedunculate, rarely sessile. Bracts 3-5, 5-10 × 3-6 mm, lanceolate to ovate, entire, acute to acuminate. Stalk of dichasium 5-15 mm, pedicels 5-20 mm. Bracteoles 3-5, 2-3 × 1-2 mm, linear-lanceolate, entire, acute. Calyx 5-10 mm, divided almost to base, lanceolate, acute. Corolla 10-20 mm diam., yellow, tube 2 mm, lobes unequal, orbicular, without pellucid-punctate, stellate tomentose outside. Stamens 5, 4-7 mm, all anthers reniform, filaments 5-6 mm with purple-

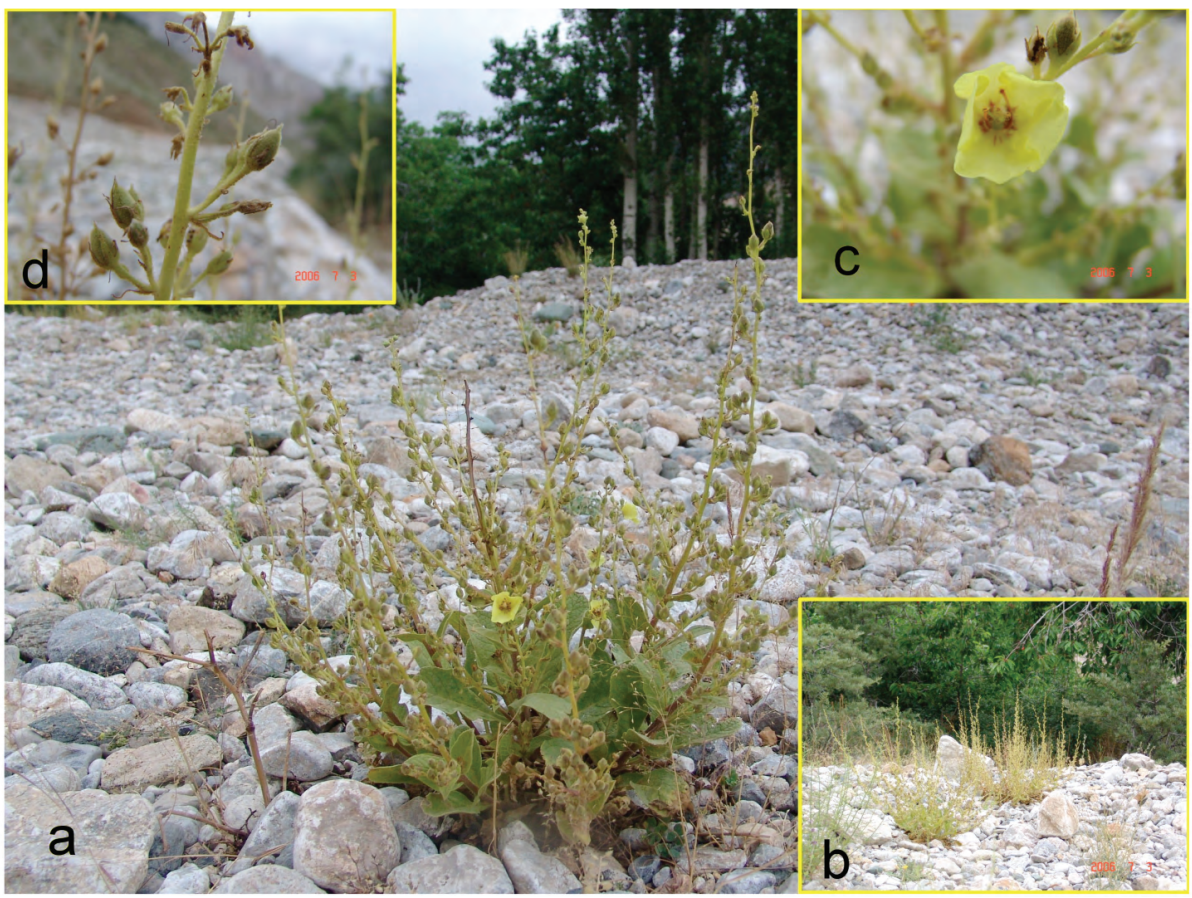

Figure 1. Verbascum ergin-hamzaoglui Karavel. a- habitus, b- population, c- flower, d- fruit.

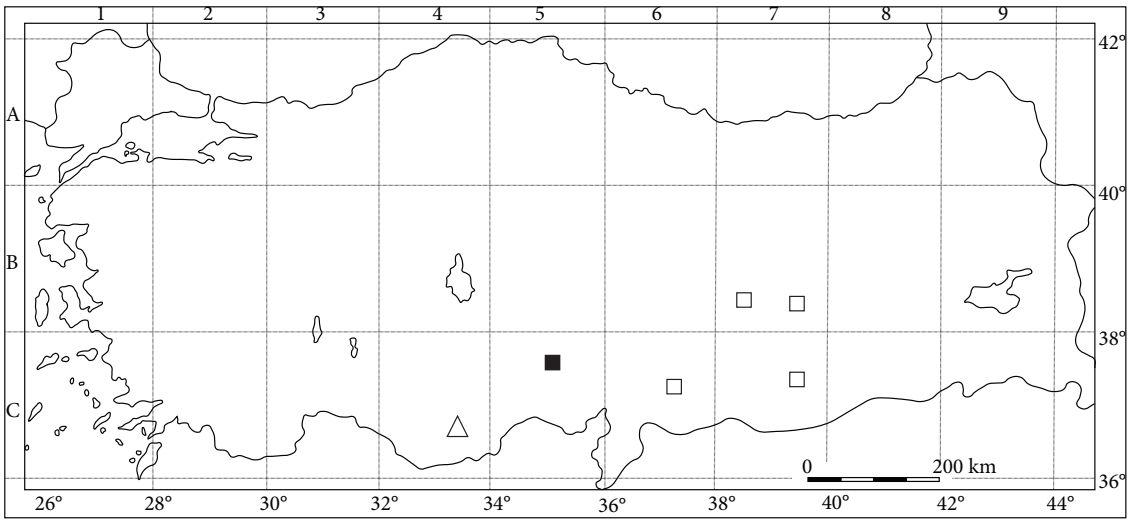

Figure 2. Distribution map of *Verbascum ergin-hamzaoglui* (■), *V. cymigerum* (Δ), *V. diversifolium* (□) in Turkey.

violet woolly, 2 anterior glabrous near apex. Ovary globose. Stylus 5-7 mm, filiform. Stigma 2-3 × 0.5 mm, spathulate. Capsule 2-6 × 1-5 mm, ovate to oblong, densely stellate hairs.

Fl. 6-7, Fr. 7-8. calcareous stony slopes, 1500-1700 m.

Examined representative specimens: *Verbascum diversifolium*: Turkey. C6 Gaziantep: prope Nizip, 1842/43 *J.A.Lorent* (Type TUB, photo!); Nizip-Birecik, 6 km, 1700 m, 17.08.2006, *F.A.Karavelioğulları* 3572 et al.; B7 Elazığ: Kale-Elazığ, 18 km, 1140 m, 12.07.2001, *F.A.Karavelioğulları* 3116 et al. (GAZI); Malatya: Malatya to Harput, 21.06.1906, *G.B.Post* s.n. (ANK); C7 Urfa: Siverek, *Kotschy* 1843: 67 (Type of *V. mesopotamicum*) (ANK). – *V. cymigerum*: C4 Içel: 14 km N of Gilindire, Yeniyürük, 470 m, *Hub.-Mor*. 9530 (ANK).

Etymology

This new species is named in honour of the eminent botanist Prof. Dr. Ergin Hamzaoğlu.

Red list assessment

The extent of occurrence was approximately 20 km^2. This new species is distributed in a single location. *V. ergin-hamzaoglui* grows on calcareous stony slopes. Its habitat continues to decline due to agricultural activities and other local uses (criteria B1ab (iii) under CR). The threat category of *V. ergin-hamzaoglui* is suggested as CR [B1ab (iii)].

Results and discussion

Verbascum ergin-hamzaoglui belongs to group G in the *Flora of Turkey* (Huber-Morath, 1978; Davis et al., 1988). The number of species in group G has now reached 14 after the inclusion of *Verbascum ergin-hamzaoglui*.

Verbascum ergin-hamzaoglui is also close to *V. cymigerum* but differs from it in having stellate and stalked glandular indumentum (not with densely white floccos-tomentose, numerous stalked glandular); lanceolate, lanceolate to oblong or entire basal leaves (not broadly ovate, coarsely bicrenate); inflorescence with clusters of 1-8 flowers (not with clusters 3-25 flowers); lanceolate, acute calyx lobes (not lanceolate to oblong-spathulate, acute or mucronate); ovate to oblong capsules (not broadly ovate) (Table 1).

Verbascum ergin-hamzaoglui is allied to *V. diversifolium* but differs from it in having long stalked glandular indumentum (not with eglandular hairs), and basal leaves entire (not crenate-dentate); inflorescence with clusters of 1-8 flowers (not with clusters of 1-4 flowers); lanceolate, acute calyx lobes (not triangular-lanceolate acutish); filaments with purple-violet woolly (not filament with whitish-yellow woolly); and ovate to oblong capsules (not broadly ovate to subglobose) (Table 1).

Table 1. Diagnostic characters of *Verbascum ergin-hamzaoglui* with the related *V. cymigerum* and *V. diversifolium*.

Characters	*V. ergin-hamzaoglui*	*V. cymigerum**	*V. diversifolium*
Hair situation	densely stellate and stalked glandular	with densely white floccose-tomentose, numerous stalked glandular	with adpressed hard stellate hairs and eglandular
Basal leaves	lanceolate, lanceolate to oblong, entire	broadly ovate, coarsely bicrenate	lanceolate to linear- lanceolate, crenate-dentate
Inflorescence	with clusters of 1-8 flowers	with clusters 3-25 flowers	with clusters 1-4 flowers
Calyx	lanceolate, acute lobes	lanceolate to oblong-spathulate, acute or mucronate lobes	triangular-anceolate, acutish lobes
Filament	with purple-violet woolly	with purple-violet woolly	with whitish-yellow woolly
Capsule	ovate to oblong	broadly ovate	broadly ovate to subglobose

* Huber-Morath (1978).

The polar axis of the pollen grains of *V. diversifolium* was measured to be 21.53 µm. However, *V. ergin-hamzaoglui* has the largest pollen grain axis with a diameter of 21.76 µm. The equatorial diameter of the pollen grains of *V. diversifolium* is 17.38 µm, while in *V. ergin-hamzaoglui*, the diameter is 19.20 µm. The pollen grain colpi long axis of *V. diversifolium* is 17.41 µm, whereas in *V. ergin-hamzaoglui* it is 17.66 µm. The colpi short axis of the grain of *V. diversifolium* is 2.38 µm, while in *V. ergin-hamzaoglui* it is 3.12 µm. The exine of the pollen grains of *V. diversifolium* was calculated to be 0.95 µm. However, in *V. ergin-hamzaoglui* the exine of the pollen grains is 1.45 µm. The reticula become smaller towards to the edge of the colpi. The reticula are heterobrachate. In *V. diversifolium* the number of perforations per 1 µm² is 1-4, the size of the lumina of the pollen grains is between 0.24 and 0.86 µm, and the average thickness of the muri is 0.17-0.25 µm. However, in *V. ergin-hamzaoglui* the number of perforations per 1 µm² is 1-2, the size of the lumina of the grains is from 0.31 µm to 1.37 µm, and the average thickness of the muri is 0.28-0.42 µm (Figure 3, Table 2).

The polar axis of the pollen grains of *V. cymigerum* was measured to be 26.46 µm. However, *V. ergin-hamzaoglui* has the largest pollen grain axis, with a diameter of 21.76 µm. The equatorial diameter of the pollen grains of *V. cymigerum* is 18.40 µm, while in *V. ergin-hamzaoglui* the diameter is 19.20 µm. The pollen grain colpi long axis of *V. cymigerum* is 19.42 µm, whereas in *V. ergin-hamzaoglui* it is 17.66 µm. The colpi short axis of the grain of *V. cymigerum* is 3.34 µm, while in *V. ergin-hamzaoglui* it is 3.12 µm. The exine of the pollen grains of *V. cymigerum*is is 1.44 µm. However, in *V. ergin-hamzaoglui* the exine of the pollen grains is 1.45 µm. The reticula become smaller towards to the edge of the colpi. The reticula are heterobrachate. In *V. cymigerum* the number of perforations per 1 µm² is 1-3, the size of the lumina of the pollen grains is approximately between 0.53 µm and 2.05 µm, and the average thickness of the muri is 0.16 µm to 0.42 µm. However, in *V. ergin-hamzaoglui* the number of perforations per 1 µm² is 1-2, the size of the lumina of the grains is approximately from 0.31 µm to 1.37 µm, and the average thickness of the muri is 0.28-0.42 µm (Figure 3, Table 2).

The seeds of this group are brown and oblong in *V. diversifolium*, while they are ovate in *V. ergin-hamzaoglui*. The seed surface is reticulate in *V. diversifolium* and *V. ergin-hamzaoglui,* but in the other taxa it is aveolate-reticulate. The average seed size of *V. diversifolium* is 0.9 × 0.7 mm and in *V. ergin-hamzaoglui* it is 1.15 × 0.5 mm (Figure 4).

The seeds of this group are brown and oblong in *V. cymigerum*, while they are ovate in *V. ergin-hamzaoglui*. The seed surface is reticulate in *V.*

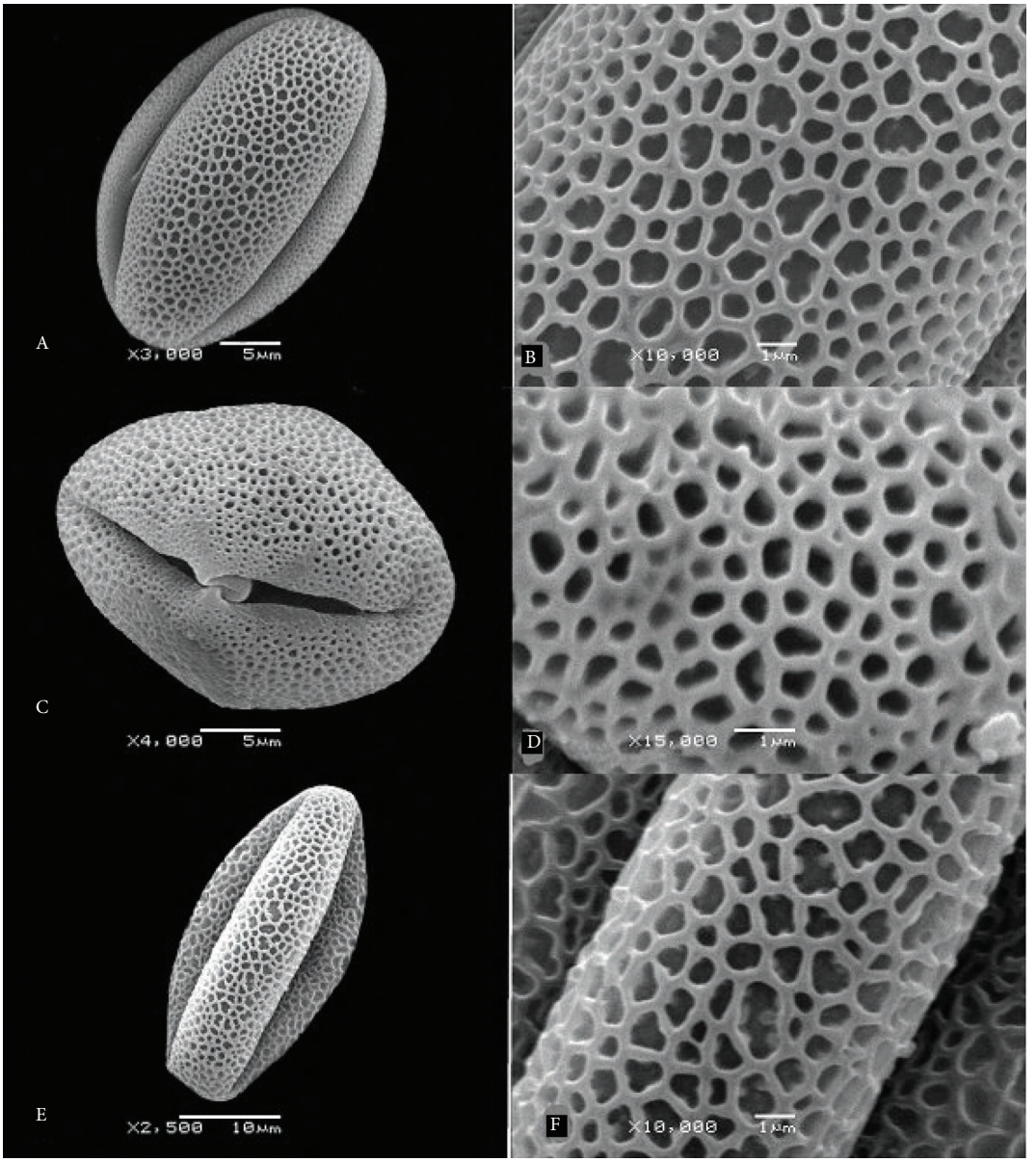

Figure 3. SEM photos of the pollen grain of *V. ergin-hamzaoglui, V. diversifolium*, and *V. cymigerum. V. ergin-hamzaoglui*: A- equatorial view, B- detail of pollen grain (*FAK* 3567). *V. diversifolium*: C- equatorial view, D- detail of pollen grain (*FAK* 3572). *V. cymigerum*: E-polar view, F- detail of pollen grain (*Hub.-Mor*. 9530).

Table 2. The morphological characteristics of the pollen grains of *V. ergin-hamzaoglui, V. diversifolium*, and *V. cymigerum*.

Taxa	P	E	P/E ratio	Clg	Clt	Ex	L	t
V. ergin-hamzaoglui	21.76 ± 1.47	19.20 ± 1.49	1.13	17.41 ± 1.20	3.12 ± 0.30	1.45 ± 0.21	19.55 ± 0.91	4.06 ± 0.54
V. diversifolium	21.53 ± 1.70	17.38 ± 1.38	1.24	17.66 ± 1.55	2.38 ± 0.37	0.95 ± 0.17	19.42 ± 1.17	3.29 ± 0.35
V. cymigerum	26.46 ± 1.49	18.40 ± 1.77	1.44	19.42 ± 1.61	3.34 ± 0.22	1.44 ± 0.19	16.96 ± 0.89	3.81 ± 0.41

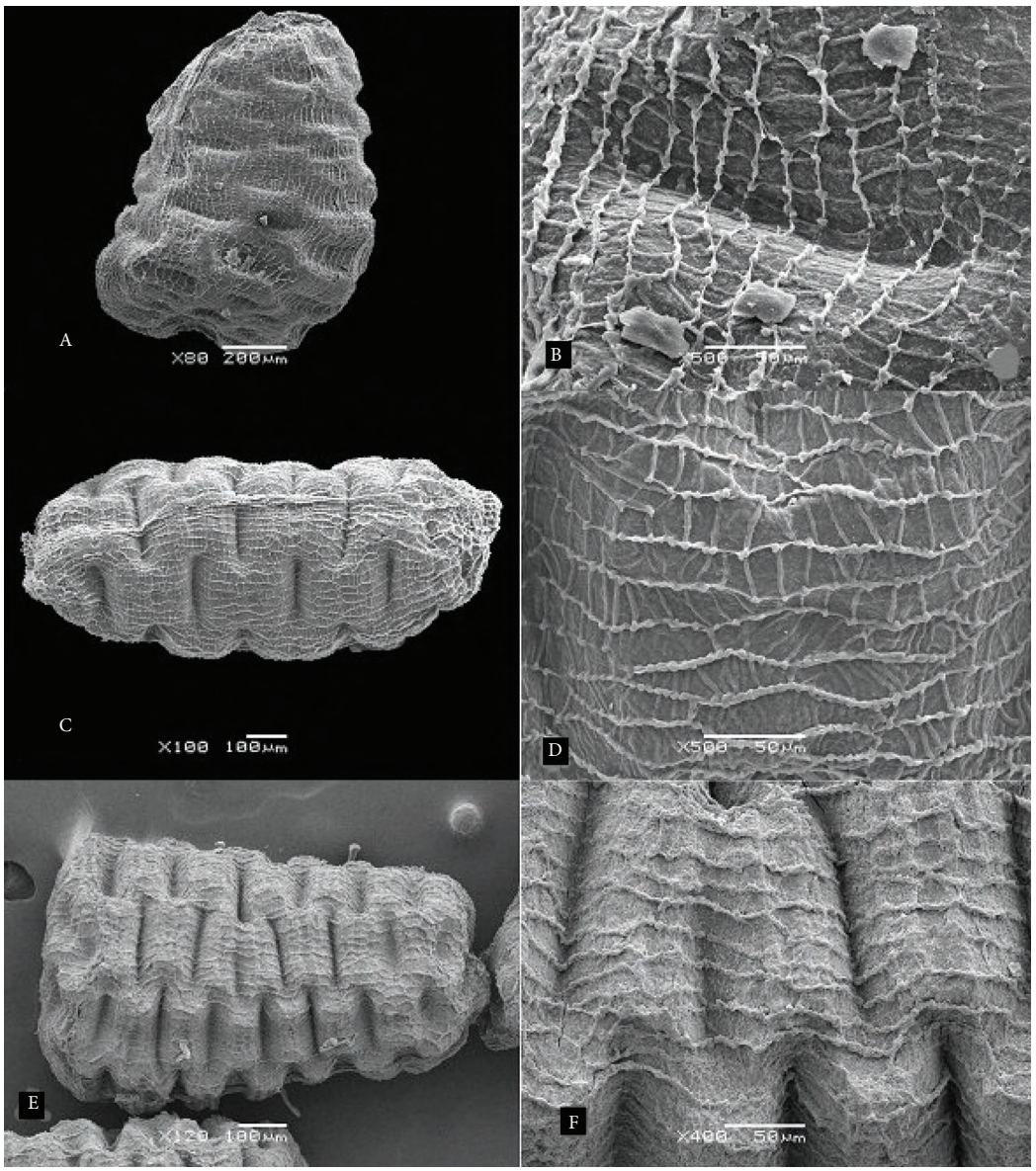

Figure 4. SEM photos of the seed coat of *V. ergin-hamzaoglui, V. diversifolium,* and *V. cymigerum*. *V. ergin-hamzaoglui*: A- general shape, B- seed coat surface (*FAK* 3567). *V. diversifolium*: C- general shape, D- seed coat surface (*FAK* 3572). *V. cymigerum*: E-general shape, F- seed coat surface (*Hub.-Mor*. 9530).

cymigerum and *V. ergin-hamzaoglui,* but in the other taxa it is aveolate-reticulate. The average seed size of *V. cymigerum* is 0.7 × 0.4 mm and in *V. ergin-hamzaoglui* it is 1.15 × 0.5 mm (Figure 4).

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