A new species, *Gypsophila malyerii* (Caryophyllaceae) from Turkey

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Summary. *Gypsophila malyerii* Hamzaoglu & Koç, a new species of sect. *Capituliformes*, is described and illustrated from Turkey. Information on distribution, habitat and conservation status are given. The most similar species is *G. osmangaziensis*. The morphology and micromorphology of seed and pollen characters of the two closely related species are compared.

Key Words. micromorphology, pollen, seed, taxonomy.

Introduction

One of the largest families in the world, Caryophyllaceae contains about 100 genera and 3000 species (Hernández-Ledesma *et al.* 2015). It mostly occurs in the northern hemisphere and is less common in the southern hemisphere (Özhatay & Kültür 2006; Hernández-Ledesma *et al.* 2015; Koç *et al.* 2019). In recent years, molecular studies have been carried out on many genera of the Caryophyllaceae family (Fior & Karis 2007; Fu *et al.* 2008; Frajman *et al.* 2009; Rautenberg *et al.* 2010).

Increased molecular phylogenetic investigations of the family have resulted in new information about the family classification, including the creation of a new tribe, Eremogoneae Rabeler & W.L.Wagner (Bittrich 1993; Harbaugh *et al.* 2010). Molecular studies on *Petrorhagia*, *Velezia* and *Gypsophila* revealed the relationship among related taxa (Korkmaz & Doğan 2015; Poyraz *et al.* 2012; Hilooğlu *et al.* 2016). Molecular phylogenetic studies based on ITS and plastid trnQ-rps16 DNA in the largest genera (*Gypsophila* L., *Dianthus* L., *Arenaria* L., *Minuartia* L. and *Silene* L.) have resulted in revised treatments including new genera and synonymy (Dillenberger & Kadereit 2014; Madhani *et al.* 2018; Sadeghian *et al.* 2015).

The genus *Gypsophila* L. described by Linnaeus, comprises about 140 species, representing the fourth largest genus of the Caryophyllaceae Juss. (Mabberley 2018) and slightly more than 50% of these species occur in Turkey (Barkoudah *et al.* 1964). The main centre of diversity for *Gypsophila* is the temperate regions of Eurasia, Africa, Pacific Islands, with one species extending to Australia; introduced in North and South America (Madhani *et al.* 2018).

In Turkey, *Gypsophila* has 4 groups and 10 sections (Huber-Morath 1967; Davis *et al.* 1988; Ataşlar 2000). As a result of recent studies, new species have been added to the genus: *G. osmangaziensis* Ataşlar & Ocak, *G. munzurensis* Armağan, *G. turcica* Hamzaoglu, *G. yusufeliensis* Budak, *G. torulensis* Koç and *G. guvengorkii* Armağan, Özgökçe & A.Çelik. The total number of taxa has therefore increased to 63 in Turkey (Ataşlar & Ocak 2005; Hamzaoglu 2012; Budak 2012; Koç 2013; Armağan 2016; Armağan *et al.* 2017; Barkoudah 1962; Huber-Morath 1967; Davis *et al.* 1988; Ataşlar 2000; Özçelik & Özgökçe 2021).

The genus *Gypsophila* includes annuals, biennials and perennial herbs or semishrubs. It is related to *Bolanthus* (Ser.) Rchb., *Ankyropetalum* Fenzl and *Acanthophyllum* C.A.Mey. (Davis 1967; Davis *et al.* 1988). Previous studies have found that pollen and seed features provide taxonomically important micromorphological characters (Cronquist 1968; Amini *et al.* 2011). Ataşlar *et al.* (2009) reported that variation in pollen morphology of 12 *Gypsophila* species could be an indication of their genetic differences and therefore could be useful in differentiating taxa.

Materials and Methods

The first author collected some interesting *Gypsophila* specimens from the Beypazarı district (Ankara province, Inner Anatolia) in Turkey. A large number of specimens from different populations were later collected from the Beypazarı district. These specimens were compared with the relevant literature (Barkoudah 1962; Barkoudah *et al.* 1964; Davis *et al.* 1988; Huber-Morath 1967; Bojňanský & Fargašová

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Fig. 1. *Gypsophila malyerii*. A habit; B flower; C petal; D inflorescence; E capsule. PHOTOS: ERGIN HAMZAOĞLU.

Fig. 2. *Gypsophila malyerii*. A habit; B habitat general view. PHOTOS: ERGIN HAMZAOĞLU.

2007; Rechinger 1964, 1988; Shishkin 1970; Zohary 1966) and with the specimens kept in ANK, EGE, GAZI, ISTE, ISTO and KNYA (abbreviations follow Thiers 2021) and specimens from virtual herbaria at E and G were also examined. From each population, a minimum of five mature seeds of *G. malyerii* and *G. osmangaziensis* were placed onto stubs using double-sided adhesive tape and samples were coated with layer of gold in a Polaron SC7620 rotating and tilting vacuum coating apparatus for 60 s and scanned using a JEOL 5600 LV SEM (Scanning Electron Microscopy) by 20-kV accelerating voltage (Walker 1974a, 1974b). Minimum, maximum and mean values of the following pollen morphological characters were calculated: pollen ornamentation, pollen diameter, pore diameter, pollen shape, distance between two pores, operculum diameter, pore numbers, spinule numbers, punctum numbers. Measurements were made on 20 – 30 pollen grains and based on the ratio of polar axis to equatorial axis (P/E), the pollen shape class was identified by using Erdtman's system (Erdtman 1969). Pollen morphologies were determined by using the glossary of pollen and spore terminology of Punt *et al.* (2007).

Minimum, maximum and mean values of seed morphological characters were calculated as follows: length, width, colour, seed shape and surface type.

Morphological measurements were made using a ruler with 0.5 mm accuracy and an ocular micrometer. Seed morphology follows the terminology of Yildiz (2002) and Amini *et al.* (2011). Measurements of pollen and seed were made with the AlaMet 0.06 program. The average of the measured samples was calculated with Microsoft Office Excel. *Gypsophila malyerii* habit photographs were taken with an OLYMPUS C-5060 digital camera.

Taxonomic Treatment

***Gypsophila malyerii* Hamzaoglu & Koç sp. nov.** Type: Turkey. B4 Ankara: Beypazarı, between Harmanak-Uşakbükü, 36T0392454-4430814, 510 m, 22 Aug. 2020, marn areas, Hamzaoglu & Koç 7825 (holotype GAZI; isotypes ANK, GAZI).

<http://www.ipni.org/urn:lsid:ipni.org:names:77218375-1>

Perennial, with a woody rhizome, $\pm$ glaucous. *Stems* single, with a thick stock and ascending-erect, 45 – 80 cm, 6 – 8 mm diam., glabrous below, branches of inflorescence glandular-hairy above. *Basal leaves* oblanceolate, fleshy, lamina 50 – 80 mm long, 5 – 8 mm wide; *stem leaves* oblanceolate, 30 – 70 mm long, 3 – 6 mm wide. *Inflorescence* lax dichasial, 3 – 10 mm diam.,

Fig. 3. SEM micrographs of pollen grains. A1, A2 *Gypsophila malyerii*; B1, B2 *G. osmangaziensis*.

(8 –) 4 – 16 (– 20)-flowered; peduncles 4 – 42 mm. Bracts deltate, acuminate, scarious with a brownish midrib, entire to minutely undulate, glandular, 2 – 3 mm. Inner bracts deltoid to oblong acuminate. Alar pedicels 3 – 5 mm. Calyx campanulate-turbinate, cleft to $\frac{1}{2}$ into acuminate teeth with scarious margins, scabrid, 2.5 – 4 mm. Petals white, ovate, obtuse, 2.5 – 4 mm. Capsule globose, 2.5 – 4 mm long, as long as calyx. Seeds 2 in each capsule, tubercles obtuse, c. 2.5 × 4 mm. Figs 1, 2.

RECOGNITION. *Gypsophila malyerii* is related to *G. osmangaziensis* Ataşlar & Ocak. However, it differs from *G. osmangaziensis* in the bracts glandular hairy (not scabrid); alar pedicels 3 – 5 mm long (not 1 – 1.5 mm); calyx 2.5 – 4 mm long (not 2 – 2.5 mm); petals ovate, as long as calyx (not oblong-spathulate, 1.5 times as long as calyx). The seed and pollen morphology of the two species are also different.

DISTRIBUTION. This new species is known only from the type locality in Turkey (Map 1).

Table 1. Comparison of the diagnostic characters of *Gypsophila malyerii* and *G. osmangaziensis*.

Character	Species	
	<i>Gypsophila malyerii</i>	<i>Gypsophila osmangaziensis</i>
Stem length (cm)	45 – 80	100 – 180
Inflorescence	lax cluster	globose cluster
Bracts	glandular hairy	scabrid
Alar pedicel length (mm)	4 – 6	1 – 1.5
Calyx length (mm)	2.5 – 4	2 – 2.5
Petals	1.5 times as long as calyx, oblong-spatulate	as long as calyx, ovate

Table 2. Pollen morphological features of *Gypsophila malyerii* and the closely related species *G. osmangaziensis*.

Character		Species	
		<i>Gypsophila malyerii</i>	<i>Gypsophila osmangaziensis</i>
Polar axes (µm)	Max.	20.54	21.90
	Min.	23.59	25.63
	Mean ± SD	22.05 ± 1.02	23.21 ± 1.34
Equatorial axes (µm)	Max.	24.13	22.90
	Min.	25.50	27.22
	Mean ± SD	24.70 ± 0.48	25.06 ± 1.66
Pollen diam. (µm)	Max.	22.54	21.63
	Min.	24.59	25.73
	Mean ± SD	23.78 ± 0.89	23.32 ± 1.36
Distance between two pores (µm)	Max.	4.50	3.89
	Min.	5.90	6.13
	Mean ± SD	5.41 ± 0.37	5.00 ± 0.75
Pore diameter (µm)	Max.	2.54	2.31
	Min.	4.50	4.03
	Mean ± SD	3.88 ± 0.63	3.28 ± 0.65
Operculum diam. (µm)	Max.	1.36	1.18
	Min.	2.54	3.84
	Mean ± SD	1.97 ± 0.33	2.89 ± 0.66
Pollen ornamentation		microechinate- punctate-perforate	microechinate-punctate-perforate
Pollen shape		oblate-spheroidal	oblate-spheroidal
Number of pores		10 – 12	11 – 13
Number of spinules		8 – 6	10 – 12
Number of punctae		5 – 7	6 – 8

Min. minimum; **Max.** maximum; **SD** standard deviation.

SPECIMENS EXAMINED. TURKEY. *Gypsophila malyerii*: Turkey, B4 Ankara: Beypazarı, between Harmanak-Uşakbükü, 36T0392454-4430814, 510 m, 22 Aug. 2020, marn areas, *Hamzaoğlu & Koç* 7825 (holotype GAZI; isotypes ANK, GAZI). *Gypsophila osmangaziensis*: B3 Eskişehir: Tepebası, around Takmak village, 36S0273515-4399472, 925 m, 5 Sept. 2020, marn and gypsum areas, *Hamzaoğlu & Koç* 7836 (GAZI).

HABITAT. *Gypsophila malyerii* grows in marn areas. Species growing alongside it include: *Artemisia santonicum* L., *Genista sessilifolia* DC., *Inula aucheriana* DC., *Reaumuria alternifolia* (Labill.) Britten, *Salvia halophila* Hedge, *Hypericum turcicum* Özbek & Hamzaoglu, *Salvia halophila* Hedge, *Taraxacum*

farinosum Hausskn. & Bornm. ex Hand.-Mazz., *Gypsophila parva* Barkoudah, *Thymelaea passerina* (L.) Coss. & Germ., *Plantago maritima* L., *Euphorbia macroclada* Boiss., *Thymus leucostomus* Hausskn. & Velen.

CONSERVATION STATUS. *Gypsophila malyerii* is known only from one population in the locality of Beypazarı district (Ankara province). It grows in an area covering about 50 km². No threat has been observed for the species in the area; the number of individuals is quite high. Based on available data, it is proposed that the species should be evaluated as Least Concern (LC) (IUCN 2012).

PHENOLOGY. *Gypsophila malyerii* was observed flowering from July to August and fruiting in August.

Table 3. Seed morphological features of *Gypsophila malyerii* and the closely related species *G. osmangaziensis*.

Characters		Species	
		<i>Gypsophila malyerii</i>	<i>Gypsophila osmangaziensis</i>
Length (mm)	Min.	1.1	1.4
	Max.	1.3	1.5
	Mean ± SD	1.2 ± 0.07	1.4 ± 0.03
Width (mm)	Min.	0.8	1.1
	Max.	1	1.3
	Mean ± SD	0.9 ± 0.08	1.2 ± 0.05
Seed shape		orbicular-reniform	orbicular-reniform
Colour		dull black	dull black
Surface type		aculeate	verrucose
Margine		dentate	crenulate

Min. minimum; **Max.** maximum; **SD** standard deviation.

Fig. 4. SEM micrographs of seeds. A1, A2, A3 *Gypsophila malyerii*; B1, B2, B3 *G. osmangaziensis*.

ETYMOLOGY. The species epithet is in honour of the eminent botanist Prof. Dr Hulusi Malyer (Uludağ University, Bursa/Turkey), who sadly died of Covid-19.

NOTES. The pedicellate flowers, not in dense globose clusters, and the glandular hairy inflorescence, would place *Gypsophila malyerii* in group D in the *Flora of Turkey and Aegean Islands* (Huber-Morath 1967). However, no sectional separation was made in this study for a campanulate-turbinate calyx.

The genus *Gypsophila* grows mostly in steppes on calcareous hills, dry or rocky slopes, and sandy soils, sometimes weeds on farms, some species ruderals growing along roadsides (Madhani *et al.* 2018). Taxa of the genus *Gypsophila* have a wide distribution in Turkey, with about 63 taxa consisting of annual and perennial species (Huber-Morath 1967). The specimens collected from Beypazarı district (Ankara province) show similarity to *G. osmangaziensis* in having stems glabrous below and glandular hairy above, long leaves, long peduncles, bract shape, calyx shape, petal colour and capsule shape.

Map 1. Distribution map of *Gypsophila osmangaziensis* (●) and *Gypsophila malyerii* (▲) in Turkey.

However, they differ from this taxon in their lax dichasial inflorescence, glandular hairy bracts, 3 – 5 mm long pedicels, 2.5 – 4 mm long calyx and ovate petals as long as the calyx (Table 1).

Pollen and seed morphology

The pollen and seed morphology of *Gypsophila malyerii* and the closely related *G. osmangaziensis* were compared and some differences were determined with regard to these characteristics (Tables 2 & 3, Figs 3 & 4). Pollen size ranges from 20.54 – 25.63 µm in polar axes and 22.90 – 27.22 µm in equatorial axes. Cui *et al.* (2019) investigated the variation in pollen shape of 17 Chinese species of *Gypsophila*. They classified the *Gypsophila* species investigated into three groups, based on pollen ornamentation: microechinate, microechinate-punctate, and microechinate-punctate-perforate. Ataşlar *et al.* (2009) observed the pollen grains of 12 *Gypsophila* taxa studied from Turkey to be polyporate and spheroidal. In our study, the pollen shape for both *G. malyerii* and *G. osmangaziensis* was found to be similar: oblate-spheroidal, with microechinate-punctate-perforate ornamentation. The results of our pollen morphology studies are summarised in Table 2.

Ataşlar & Ocak (2005) reported that the seeds of *Gypsophila osmangaziensis* were dark-brown or dull black in colour and reniform in shape. Armağan *et al.* (2017) described the seeds of *G. guvengorkii* as brownish-black, reniform (1 – 1.2 × 1.2 – 1.4 mm) with obtuse tubercles. In our study, the seed shape was

found to be orbicular-reniform in both *G. malyerii* and *G. osmangaziensis* and the colour dull black (Table 3).

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