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Reseda malatyana (Resedaceae), a new chasmophytic species from eastern Anatolia, Turkey

Hasan YILDIRIM*, Serdar Gökhan ŞENOL
Department of Biology, Faculty of Science, Ege University, Bornova, İzmir, Turkey

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Abstract: *Reseda malatyana* Yıldırım & Şenol (Resedaceae) is illustrated and described as a new species to science, endemic to eastern Anatolia, Turkey. *Reseda malatyana* is related to *Reseda armena* Boiss. It differs from *Reseda armena* by the following characters: densely smaller, unbranched at the upper part, papillate-hispidulous stems; dark green, thicker, and densely papillate-hispidulous leaves; bigger petals; smaller pedicels; relatively smaller with sinus seeds; oblate-spheroidal, tricolporate, and rugulate pollen grains. *R. malatyana* is a perennial species that colonizes on marlstone rocky cliffs, known from a single locality in Levent Canyon, located in Malatya Province. It is an obligated chasmophytic species. In addition, the conservation status, distribution map, and notes on the biogeography and ecology of the new species are given. Moreover, the morphological description of *Reseda armena*, a poorly known and insufficiently characterized species due to its rarity and very limited material present in herbaria, is amplified and expanded based on the present material obtained from field studies and several herbaria.

Key words: *Reseda*, *Phyteuma*, chasmophyte, ecology, conservation, taxonomy

1. Introduction

The family Resedaceae is represented by 6 genera and about 85 species, distributed in arid regions of the Mediterranean basin, central Asia to southeastern Asia, India, Africa, the southwestern United States, and Mexico (Willis, 1973; Mabberley, 1987; Kubitzki, 2003).

The genus *Reseda* L. is the largest genera of Resedaceae, with almost 65 species, extending from the Mediterranean region to the Canary and Cape Verde Islands, the Sahara and eastern Africa, and northwestern India (Abdallah and De Wit, 1978; Martín-Bravo et al., 2007). According to Abdallah and De Wit (1978), the *Reseda* species are distributed in dry semiarid vegetation, from the lowland to high mountains. With the exception of 4 *Reseda* species (*R. alba* L., *R. lutea* L., *R. luteola* L., and *R. phyteuma* L.), which are worldwide weeds, almost all of the *Reseda* species are narrowly distributed in the Mediterranean basin (Martín-Bravo et al., 2007).

According to Martín-Bravo et al. (2007) and Martín-Bravo and Jiménez-Mejías (2009, 2013), *Reseda* sect. *Phyteuma* Lange is represented by 14 species distributed in Europe, southwestern Asia, and North Africa, with a main diversity center in the Mediterranean basin. Most of the species are narrow endemics (12 species) from the western (especially the Iberian Peninsula and northwestern Africa) or eastern (especially Turkey and Middle Eastern coasts) Mediterranean region. The section is a monophyletic group in the genus *Reseda* based on nrITS and plastid *trnL-F* sequences. Martín-Bravo and Jiménez-Mejías (2009, 2013) reported that *Reseda* sect. *Phyteuma* has some taxonomic problems, particularly with species circumscription or delimitation, which are mainly due to limited morphologic characters and hybridization.

Martín-Bravo and Jiménez-Mejías (2013) revised *Reseda* sect. *Phyteuma* based on herbarium materials. They indicated that some species in *Reseda* sect. *Phyteuma* have a similar morphology at first glance, which causes their incorrect identification (mainly *R. orientalis*, *R. odorata* L., and *R. balansae* Müll.Arg.).

Pollen morphology is of great taxonomic significance among the taxa of family Resedaceae, and it has been investigated in many studies (Arbo, 1974; Rao, 1974; Mitra and Mitra, 1976; Moore and Webb, 1978; La-Serna Ramos, 1996; Perveen and Qaiser, 2001).

The genus *Reseda* is represented by 16 species (a total of 20 taxa) in Turkey, 8 taxa of which are endemic to Turkey (Coode, 1965; Davis, 1988; Özhatay, 2000; Kanoğlu, 2012; Martín-Bravo and Jiménez-Mejías, 2013).

Malatya is one of the floristically rich provinces in Turkey (Yıldız et al., 2003). Recently, many new species

* Correspondence: hasanyldrm@gmail.com

have been described from Malatya (Yıldırım et al., 2010; Mutlu and Karakuş, 2012; Tan et al., 2012; Koç and Aksoy, 2013; Yıldırım and Erol, 2013; Yıldırım and Şenol, 2013).

In June 2010, during fieldwork in Levent Canyon in Malatya, eastern Anatolia, we collected an interesting specimen of *Reseda* on marlstone rocky cliffs. As a result of our detailed macro- and micromorphological studies, we concluded that the collected *Reseda* specimens differ from all other *Reseda* species in morphological characters and specific habitat. It was considered as a new species that shows some morphological similarities with *R. armena*, belonging to *Reseda* sect. *Phyteuma*.

2. Materials and methods

The material of the new species was compared with herbaria specimens of *Reseda* in ANK, BAS, EGE, G, GAZI, HUB, and K. In addition, relevant literature (Coode, 1965; Abdallah and De Wit, 1978; Davis, 1988; Kanoğlu, 2012; Martín-Bravo and Jiménez-Mejías, 2013) was examined. The gross morphology of *R. malatyana* and *R. armena* was examined by stereobinocular microscope. A total of 35 *R. malatyana* specimens (usually without collecting the whole plant, but rather only some parts of them) and almost 30 *R. armena* specimens were used. Approximately 50 pollen grains and 30 mature seeds were measured using a light microscope. For scanning electron microscopy (SEM), the selected seed and pollen grains were placed on aluminum stubs using double-sided adhesive tape, sputter-coated with gold using a K550 Emitech sputter coater, and then examined using FEI Quanta 250 field emission gun SEM. Photographs of the living material were taken with a Nikon D300 digital camera.

3. Results

***Reseda malatyana* Yıldırım & Şenol sp. nov.** (Figures 1 and 2).

Type: Turkey, B7 Malatya: Akçadağ district, Levent Canyon, on marlstone rocky cliffs 1320 m, 18.05.2011, *H.Yıldırım* 1803 (holotype: EGE, isotypes: EGE, ANK, GAZI).

Diagnosis: *Reseda malatyana* is related to *R. armena*, but it differs from *R. armena* by perennial habit (not annual or perennial); stems 5–15(–20) cm, unbranched at upper part, densely papillate-hispidulous, densely leafy (not 20–35 cm, densely branched, glabrous or ±scabrous, less leafy); leaves dark green, densely or sparsely papillate-hispidulous (not bright green or sometimes glaucous, glabrous, or ±scabrous); pedicels 1–3 mm in flower, 3–5 mm in fruit, densely papillate (not 3–11 mm in flower, 6–15 mm in fruit, scabrous); chasmophytic (not growing on soil); pollen tricolporate, rugulate (not tricolpate, microreticulate).

Description: Dwarf, perennial herb with several stems at base. Stem 5–15(–20) cm, erect to erect-ascending, unbranched at upper part, densely papillate-hispidulous. Leaves entire, petiolate, densely or sparsely papillate-hispidulous, alternate, obovate-oblanceolate to slightly elliptic or rarely lanceolate, dark green, acute to obtuse at apex, sometimes mucronate, 5–16 × 25–90 mm with petiole, texture relatively thick. Inflorescence racemose, dense, 2–8 cm in flower, up to 11 cm long in fruit. Pedicels densely papillate, 1–3 mm in flower, 3–5 mm in fruit. Bract linear-lanceolate to linear, 3–4 mm long, densely papillate-hispidulous. Sepal dialysepalous, densely papillate, lobes 5–6, linear-lanceolate to oblong-spathulate, 0.7–0.9 × 2–3 mm in flower not or slightly accrescent in fruit, obtuse, persistent. Corolla dialypetalous, heteromorphic, light pale yellow, deciduous; superior petals 2, 3–4 mm, limb trisect, with 2 palmatisect lateral lobes, each with 4–5 linear or linear-spathulate laciniae, central lobe linear-spathulate; lateral petals 2, 3–3.5 mm, with 1 palmatisect lateral lobe, with 4–5 linear or linear-spathulate laciniae, central lobe linear-spathulate; anterior petals 2, 1.5–2 mm, reduced to central lobe. Stamens 18–20, longer than petals; filaments 2–2.5 mm long, filiform, deciduous; anthers oblong, 0.8–1 mm long. Ovary with 3 carpels. Capsules 6–8 × 8–11 mm, pendulous when ripe, obovoid-oblong to globose, slightly papillate-hispidulous on ridges; capsule teeth 1.5–2 mm, densely papillate on margin. Seeds 1.5–2 mm long, reniform, with a sinus, undulate-rugose, straw-colored or light-yellowish to brownish-yellow when ripe. Pollen grains oblate-spheroidal, 3-colporate; polar axis P (19–)21.45 ± 0.4(–23) µm, and equatorial diameter E (19.5–)22.63 ± 0.48(–24) µm. P/E ratio: 0.94. Colpi (16.4–) 18.42 ± 0.44(–19.2) µm, tectum rugulate. Flowering in May to June, fruiting in June to July.

Etymology: The species epithet is derived from Malatya Province, where the new species was first discovered.

Distribution, habitat, and ecology: *Reseda malatyana* is a local endemic restricted to Levent Canyon in Malatya, eastern Anatolia (Figure 3). This area has a continental semiarid climate with hot, dry summers and cold, snowy winters. *R. malatyana* is an element belonging to the Irano-Turanian floristic region. The dominant vegetation of area is steppic vegetation. The new species grows only on eastward-oriented marlstone rocky cliffs in Levent Canyon, between 1225 and 1350 m (Figure 4). It is an obligate chasmophytic species. Species growing in the near vicinity include *Alkanna malatyana* Şenol & Yıldırım*, *Asplenium haussknechtii* God. & Reut., *Campanula alisan-kilincii* Yıldırım & Şenol*, *Chaenorhinum semispeluncarum* Yıldırım, Kit Tan, Şenol & Pirhan*, *Euphorbia herniariifolia* Willd. var. *glaberrima* Hal., *Galium scopulorum* Schönb.-Tem.*, *Micromeria cristata* (Hampe) Briseb. subsp. *orientalis* P.H.Davis*, *Minuartia juniperina* (L.) Maire &

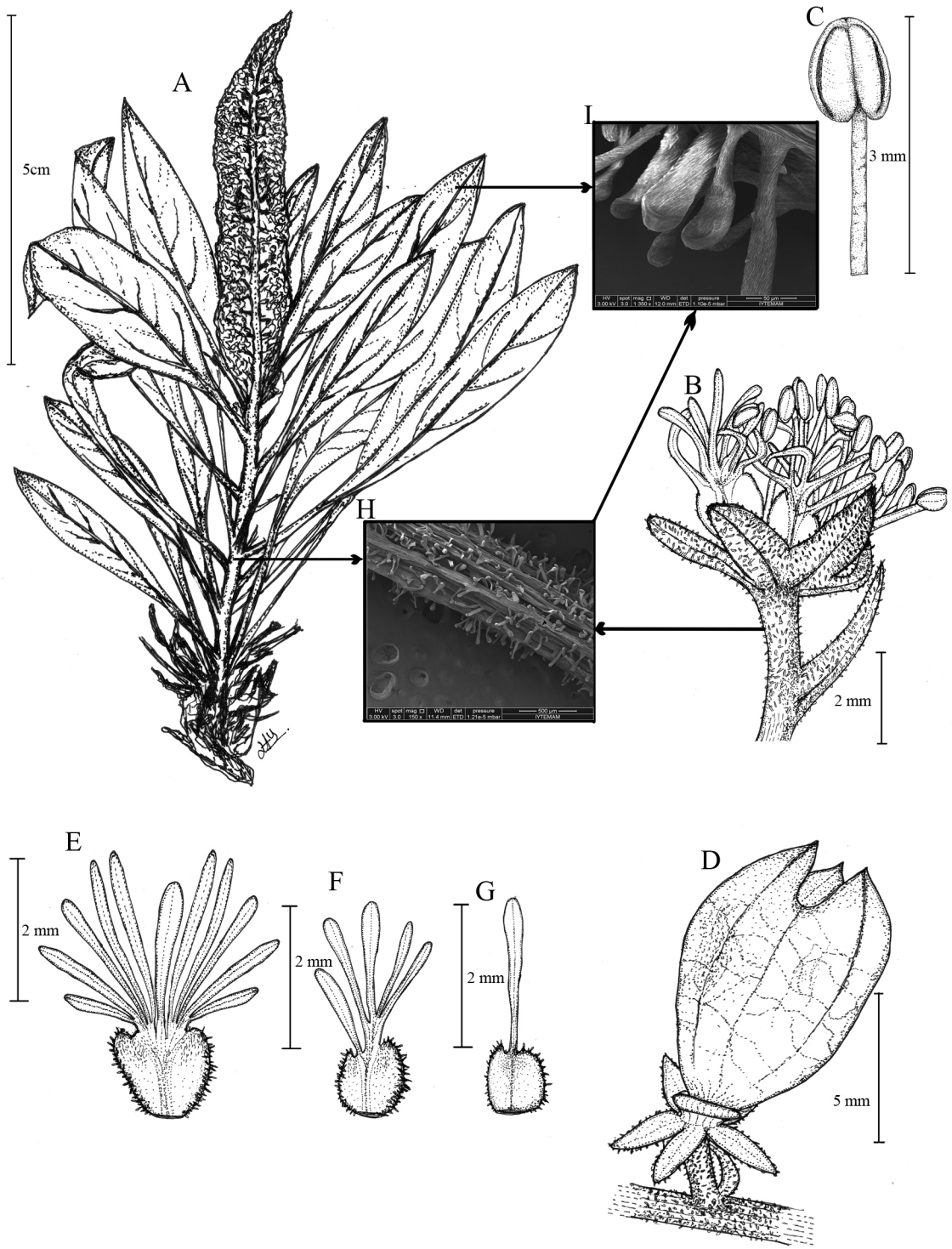

Figure 1. *Reseda malatyana*: A- habit; B- flower; C- stamen; D- capsule; E- superior petal; F- lateral petal; G- anterior petal; H, I- indumentum (papillae).

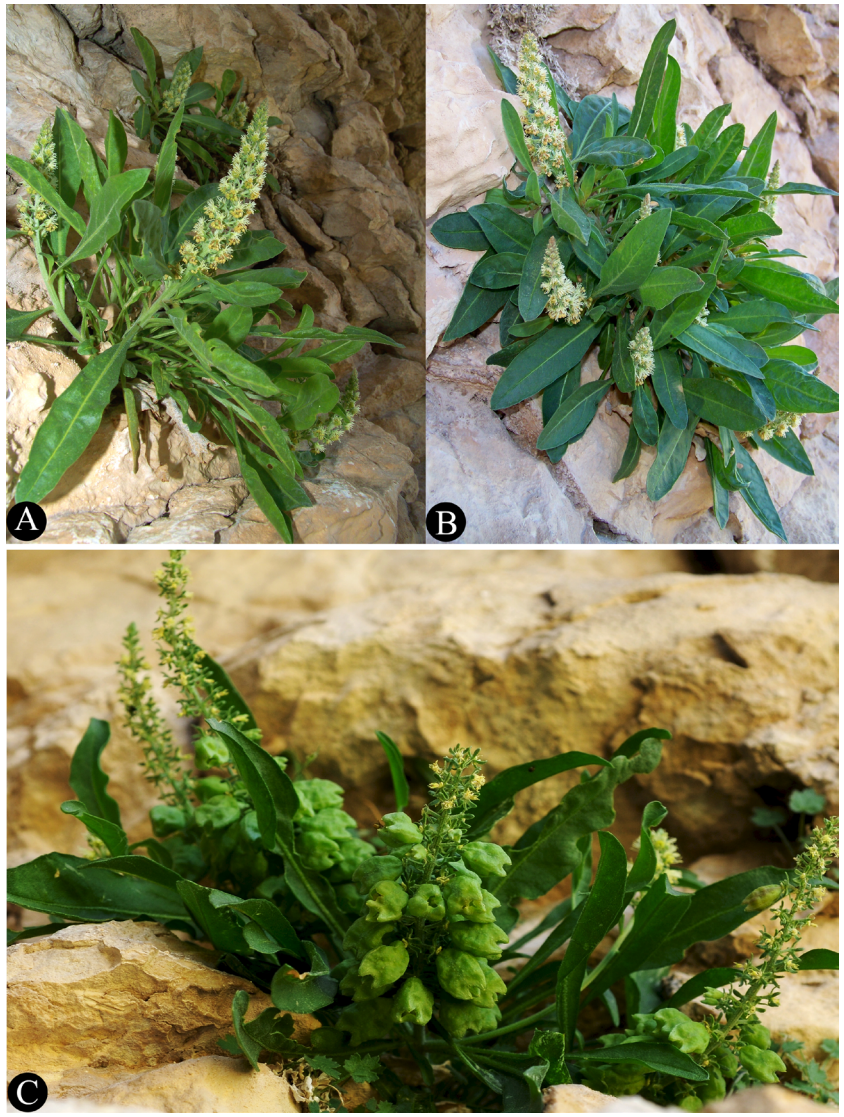

Figure 2. *Reseda malatyana*: A, B- habit in flowers; C- habit in fruiting.

Figure 3. Habitat and population of *Reseda malatyana*.

Petitm, *Onosma molle* DC., *Parietaria judaica* L., *Pimpinella paucidentata* Matthews, *Rosularia sempervivum* (M.Bieb.) Berger subsp. *libanotica* (Labill.) Eggli, *Scrophularia rimarum* Bornm., *Silene brevicaulis* Boiss.*, and *Stachys cataonica* Bhattacharjee & Hub.-Mor.* (taxa denoted by an asterisk are endemic to Turkey).

Suggested conservational status: The population area of *Reseda malatyana* was calculated as 0.108 km^2 and about 380 individuals were observed in total. Following the criteria laid out by the International Union for Conservation of Nature (IUCN Standards and Petitions Working Group, 2013), the plant is categorized as 'Vulnerable' (VU) D1, on account of its number of individuals.

Description of poorly known species *Reseda armena* Boiss.: *Reseda armena* (Figure 5) belongs to *Reseda* sect. *Phyteuma* and is a poorly known and insufficiently characterized species due to its rarity and very limited material present in herbaria. Morphological properties of *R. armena* are amplified and expanded in this paper based on our field studies, type specimens of *R. armena* var. *armena* and *R. armena* var. *scabridula*, and herbaria materials in ANK, BAS, EGE, GAZI, HUB, and K. Annual or perennial herb with several stems at base. Stem 20–35 cm, each stem densely branched, glabrous (var. *armena*) or slightly scabrous (var. *scabridula*). Leaves entire, petiolate, glabrous or ±slightly scabrous (var. *scabridula*), alternate, oblanceolate to elliptic, bright green or sometimes glaucous, obtuse to acute at apex, 3–20 × 15–85 mm with petiole; texture relatively thin. Inflorescence racemose, lax, 7–13 cm in flower, 9–22 cm long fruit. Pedicels scabrous, 3–11 mm in flower, 6–15 mm in fruit. Bract linear-lanceolate to narrowly elliptical, 2–4 mm long, slightly scabrous to glabrous. Sepal dialysepalous, densely papillate, lobes 5–6, linear-lanceolate to oblong-spathulate, 0.4–0.8 × 2.5–4 mm in flower not or slightly accrescent in fruit, obtuse, persistent. Corolla dialypetalous, heteromorphic, whitish yellow, deciduous; superior petals 2, 2–3 mm, limb trisect, with 2 palmatisect lateral lobes, each with 5–6 linear or linear-spathulate laciniae, central lobe linear-spathulate; lateral petals 2, with 1 lateral lobe palmatisect, 1.5–2.5 mm, central lobe linear-spathulate; anterior petals 2, 1–2.5 mm, reduced to central lobe. Stamens 20–23, longer or as long as petals; filaments 1.5–3 mm long, filiform, deciduous; anthers oblong, 0.6–0.8 mm long. Ovary with 3 carpels. Capsules 3–9 × 5–15 mm, pendulous when ripe, obovoid-oblong to subglobose, glabrous; capsule teeth 1–2 mm. Seeds 2.5–3.5 mm long, reniform, without sinus, undulate-rugose, dark brown to straw-colored when ripe. Pollen grains oblate-spheroidal (subprolate in dry pollen), 3-colpate; Polar axis P (18.2–)21.1 ± 0.32(–22.4) µm, and equatorial diameter E (19–)20.24 ± 0.34(–22.5) µm. P/E ratio: 1.04. Colpi (16.8–)18.25 ± 0.58(–19.5) µm, tectum microreticulate. Flowering in May to June, fruiting in June to August.

4. Discussion

Reseda malatyana belongs to *Reseda* sect. *Phyteuma* based on its morphological features. It shows some affinity to *R. armena*, which is placed in the same section (Figure 4), and can be easily distinguished from *R. armena* by several distinctive features. *R. malatyana* is characterized by its perennial habit, 5–15(–20) cm, unbranched (at upper part), densely leafy and densely papillate-hispidulous stems; densely or sparsely papillate-hispidulous, dark green and thick textured leaves; densely papillate-hispidulous, 1–3 mm in flowering time and 3–5 mm in fruiting time

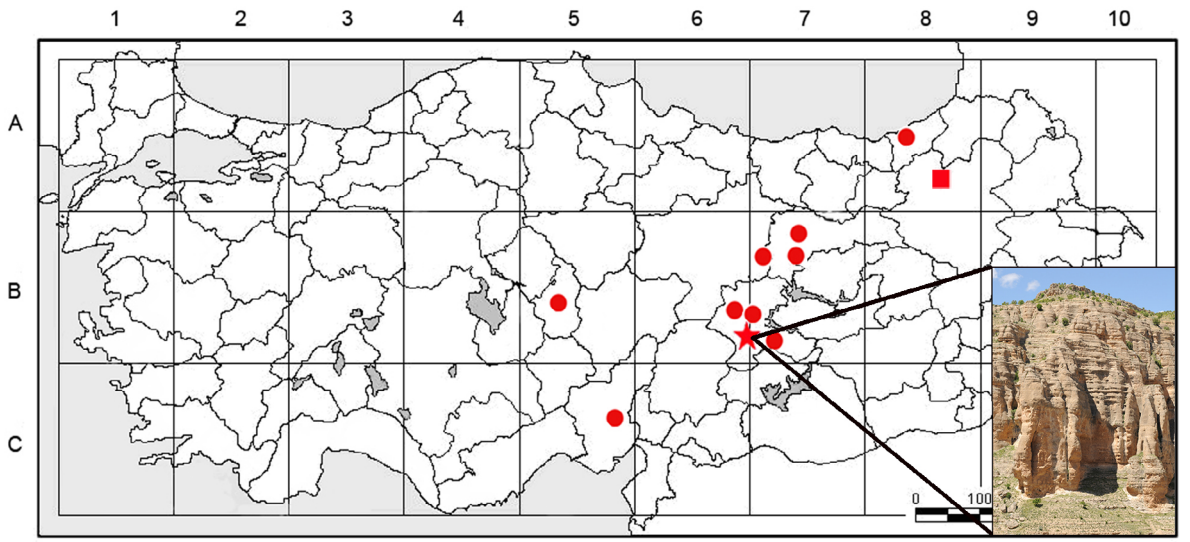

Figure 4. Distribution map of *Reseda malatyana* (★), *Reseda armena* var. *armena* (●), and *Reseda armena* var. *scabridula* (■).

pedicels; and 1.5–2 mm with a small sinus seeds. Details of the differences between *R. malatyana* and *R. armena* are listed in Table 1.

Although the fresh pollen grains of *R. malatyana* and *R. armena* are nearly the same shape, the pollen grain shape in *R. armena* var. *armena* changes after drying. The pollen grain shape in *R. malatyana* does not change after drying (Figure 5). Details of the differences between *R. malatyana* and *R. armena* pollen features are listed in Table 2.

The seeds of both species have rugulate surface ornamentation, but contrary to *Reseda armena*, the seeds of *R. malatyana* have a sinus and the seeds of *R. malatyana* are smaller than the seeds of *R. armena* (Figure 6). In addition, *R. armena* has dark brown to straw-colored seeds but *R. malatyana* has straw-colored or light yellowish to brownish-yellow seeds.

Reseda species grow in many different habitats, such as scree, sandy areas, roadsides, fields, stony areas, or hillsides, whereas *R. malatyana* grows on marlstone bare rocks as an obligate chasmophytic species. It was not seen in other habitats (on soils, scree, etc.). Although some *Reseda* species occupy a range of habitats that can include bare rock crevices, such as *R. attenuata* Ball, *R. glauca* L., *R. orientalis* (Müll.Arg.) Boiss., and *R. phyteuma* L., none of them are obligate chasmophytic species. As a result, the obligate chasmophyte habitat may have been an isolated and restricted population from other species. Although *R. armena* was given as a perennial in the *Flora of Turkey* by Coode (1965), we collected several specimens of *R. armena* within the annual form in Malatya Province. Moreover, Boissier (1843) emphasized that the lifespan of *R. armena* is annual.

Levent Canyon mostly consists of marlstone, a sedimentary rock formed by chalk with clay, and big rocky cliffs. Some saxicolous plants (*Alkanna malatyana*, *Campanula alisan-kilincii*, *Galium scopulorum*, and *Pimpinella paucidentata*) grow on the big marlstone rocky cliffs in Levent Canyon. These plants are likely relict endemic plants. Most likely, *R. malatyana* is a relict endemic species, too. In our opinion, *R. malatyana* and *R. armena* may have had a common ancestor. In this context, the obligate chasmophyte habitat of *R. malatyana* and the differentiations in the pollen morphology of *R. malatyana* and *R. armena* could have provided ecological and reproductive isolation in their populations in ancient times.

4.1. Additional specimens examined (paratypes): Turkey, B7 Malatya: Akçadağ district, Levent Canyon, on marlstone rocky cliffs, 1225 m, 30.06.2010, *H.Yıldırım* 1742; ibid., 26.06.2011, *H.Yıldırım* 2119 (EGE); ibid., 26.06.2011, *H.Yıldırım* 2120 (EGE); ibid., 10.09.2011, *H.Yıldırım* 2224 (EGE).

4.2. Additional specimens examined (similar taxa): *Reseda armena* var. *armena*: Turkey: Armenia, *Aucher* 2616 (G-lectotype); Armenia, *Aucher* 2676 (G-paratype); A8 Artvin: Çoruh Vadisi, Yusufeli, Köprügören Köyü, yol kenarı yamaçlar, 840 m, 29.07.1991, *A.Güner* 9896, *T.Ekim*, *M.Koyuncu*, *H.Karaca* (GAZI); B5 Nevşehir: Ortahisar, Volkanik tüf, yamaç, bahçe kenarı, 1200 m, 20.05.1989, *M.Vural*, *Ü.Kol*, *N.Adıgüzel* 4776 (GAZI); B7 Erzincan:

Table 1. Morphological differences between *Reseda malatyana* and *R. armena*.

Characters	*Reseda malatyana*	*Reseda armena*
Habit	Dwarf perennial	Annual or perennial
Stem	5–15(–20) cm, unbranched upper, densely papillate-hispidulous	20–35 cm, densely branched upper, glabrous or slightly scabrous (in var. *scabridula*)
Leaves	Dark green, densely or sparsely papillate-hispidulous	Bright green or sometimes glaucous, glabrous or ±slightly scabrous (in var. *scabridula*)
Inflorescence	Dense, 2–8 cm in flower, up to 11 cm long in fruit	Lax, 7–13 cm in flower, 9–22 cm long in fruit
Pedicel	Densely papillate, 1–3 mm in flower, 3–5 mm in fruit	Scabrous, 3–11 mm in flower, 6–15 mm in fruit
Petal	Superior petals 3–4 mm; lateral petals 3–3.5 mm; anterior petals 1.5–2 mm	Superior petals 2–3 mm; lateral petals 1.5–2 mm; anterior petals 1–2.5 mm
Seed	1.5–2 mm, sinus present, straw-colored or light yellowish to brownish-yellow	2.5–3.5 mm, sinus absent, dark brown to straw-colored
Pollen	Oblate-spheroidal, tricolporate, tectum rugulate	Prolate-spheroidal, tricolpate, tectum microreticulate
Habitat	On marlstone rocky cliffs	Usually on serpentine soil or other metamorphic soil, never on bare rocks

Figure 5. A- Habitat of *Reseda armena* var. *armena*, B- capsules of *R. armena* var. *armena*.

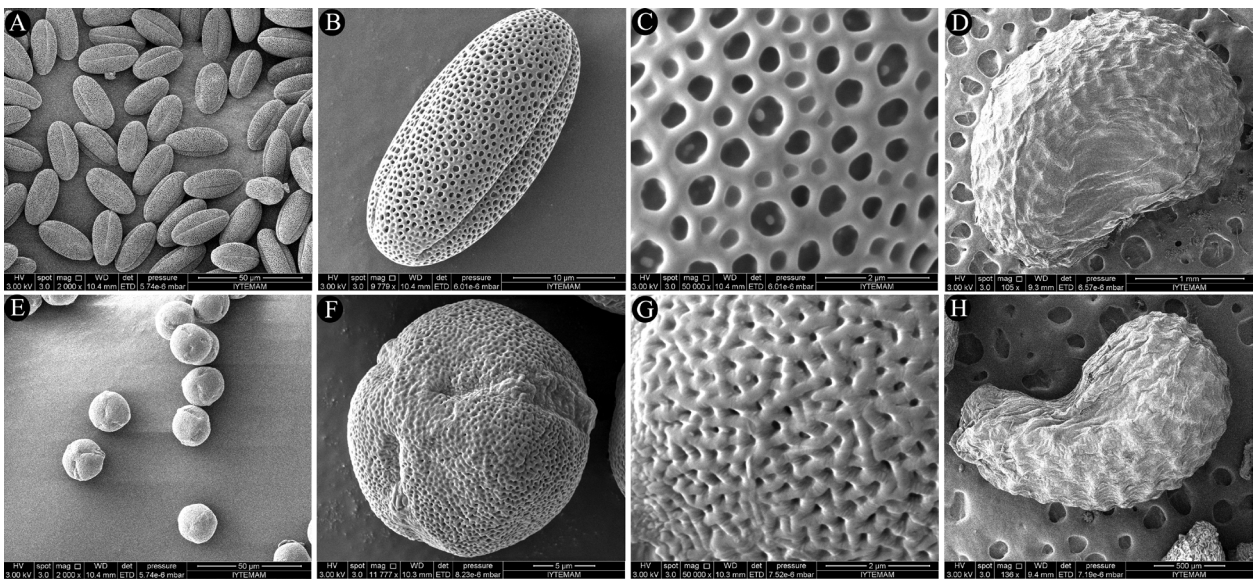

Figure 6. SEM photographs of pollen grain and pollen surface of: A, B, and C- *Reseda armena* var. *armena*; E, F, and G- *Reseda malatyana*. SEM photographs of the seeds: D- *Reseda armena* var. *armena*, H- *Reseda malatyana.*

Table 2. Pollen measure and features of *Reseda malatyana* and *R. armena.* Values are mean ± standard deviation.

	Polar axis (µm)	Equatorial axis (µm)	Colpi (µm)	Shape	Type of aperture	Exine surface ornamentation types
Reseda malatyana	P (19–) 21.45 ± 0.4(–23)	E (19. 5–) 22.63 ± 0.48(–24)	(16.4–) 18.42 ± 0.4(–19.2)	Oblate-spheroidal (same in dry pollen)	Colporate	Rugulate
Reseda armena var. *armena*	(18.2–) 21.1 ± 0.32(–22.4)	(19–) 20.24 ± 0.34(–22.5)	(16.8–) 18.25 ± 0.5(–19.5)	Prolate-spheroidal (subprolate in dry pollen)	Colpate	Microreticulate

Erzincan-Refahiye arası, Volkanik taşlı tepeler, 1400 m, 26.08.1957, *Hedge* & *Davis* 32675 (ANK); Ilıç, Hasanova-Kuruçay arası, Bozyayla Köyü yolu, tebeşirli düz yamaçlar, 1015 m, 23.07.2008, *A.Güner* 15098 (GAZI); Sakaltutan Çeşmesi 17.07.1962, *A.Pamukçuoğlu s.n.* (EGE 12055); B6 Malatya: Darande, Ağılbaşı-Ozan Köyü yolu, Serpantin alan, 905 m, 27.05.2011 *H.Yıldırım* 1928 (EGE); ibid., 26.06.2011, *H.Yıldırım* 2084 (EGE); B7 Malatya: Yazıhan-Hekimhan yolu üzeri, Kuruçay girişi, silisli toprak üzeri, 18.06.2013, *H.Yıldırım* 2691 (EGE). C5 Adana, Pozantı, Armutoğlu-Kızıldağ, serpantin çakıllı yamaçlar, 1355 m, 22.06.2007, *M.Vural* 10016, *H.Duman* (GAZI).

Reseda armena var. *scabridula*: Turkey, A8 Erzurum: Kalkgeroil, ViI. Erzurum, Am untem Ende des Tortum Göl, 1100 m, 16.07.1958, *Huber & Simon* (BAS-holotype).

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