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Polygala turcica* (Polygalaceae), a new species from E Turkey, and a new identification key to Turkish *Polygala

Abstract

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Polygala turcica Dönmez & Uğurlu (Polygalaceae) is described and illustrated as a new species from Kars province in E Turkey. It is similar to *P. peshmenii* Eren & al., but is clearly isolated from the other species of *Polygala* sect. *Polygala* with respect to habit and morphological characters. Morphology, including that of pollen, is discussed with respect to taxonomic value. The conservation status of the new species is assessed. A new identification key is provided for all *Polygala* species known from Turkey.

Additional key words: SW Asia, endemic, pollen morphology

Introduction

The genus *Polygala* L. (Polygalaceae) comprises c. 325 species (Eriksen & Persson 2007; Mabberley 2008), most of them distributed in tropical regions. The *Polygala* species naturally growing in Eurasia range from annuals to perennials, some of them having a woody underground stock. Turkey is one of the important diversity centres for *Polygala*, with 16 native species as well as the rarely cultivated *P. myrtifolia* L. (Cullen 1965; Peşmen 1980; Davis & al. 1988; Eren & al. 2008).

During a field trip in the Aras valley, very unusual specimens of a caespitose *Polygala* were collected by the first author. All of the native *Polygala* species in Turkey are herbaceous, with above soil-level ascending or creeping stems. However, the unusual plants in the Aras valley form caespitose cushions with erect to stiffly spreading branches similar to spiny *Astragalus* species

and *Onobrychis ornata* (Willd.) Desv. (Fabaceae). They are here described as a new species: *P. turcica* Dönmez & Uğurlu.

The *Polygala* account for the Flora of Turkey by Cullen (1965) recognized 12 species and included an identification key. Since then, *P. inexpectata* Peşmen & Erik (Peşmen 1980) and *P. peshmenii* Eren & al. (Eren & al. 2008) have been described, and *P. venulosa* Sm. and *P. hohenackeriana* Fisch. & C. A. Mey. were added to the Turkish Flora by Baytop (1971) and Peşmen (1980), respectively. The recent checklist (Akyıldırım 2012) did not include any taxonomic or nomenclatural novelties with respect to *Polygala*. In the present study, a new identification key for all 17 Turkish species is provided. This key has been prepared not merely by inserting the species published after the Cullen's (1965) account, but by adding or altering distinguishing characters so as to more accurately identify the species.

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Material and methods

After the first collection of the new species, the locality was visited three times in the following years to observe the population size, collect more material with mature fruit and take photographs. In addition to morphological studies, the specimens have been studied with respect to seed and pollen morphology. For pollen morphology, pollen grains of *Polygala turcica* have been investigated by light microscopy (LM) and scanning electron microscopy (SEM). For LM study, pollen slides were prepared according to the method by Wodehouse (1935). The following parameters were examined and measured: pollen type, polarity, symmetry and shape; pollen size, i.e. polar axis and equatorial axis; exine sculpturing; and number of apertures. Pollen size represents the mean of about 30 pollen grains. For scanning SEM study, seeds and pollen of *P. peshmenii* and *P. turcica* were first treated with 70% alcohol, then air-dried before being mounted on stubs subsequently coated with gold-palladium mixture. The photomicrographs were taken with a Zeiss EVO 50 EP electron microscope. The palynological terminology mainly follows Punt & al. (2007) and Hesse & al. (2009).

Results

Taxonomic treatment

***Polygala turcica* Dönmez & Uğurlu, sp. nov.** (*Polygala* L. sect. *Polygala* subsect. *Polygala*). – Fig. 1; 2A, B; 3A, B. Holotype: Turkey, A9 Kars, Kağızman-Karakurt road, 5 km from Kuloğlu village to Karakurt, 40°03'80"N, 42°51'69"E, 1314 m, stony slopes along Aras river, 14 May 2009, Dönmez 15242 (HUB; isotypes: HUB, W).

Diagnosis — *Polygala turcica* is similar to *P. peshmenii* Eren & al., but it differs from that species by having a caespitose habit, semi-imbricate basal leaves, longer stem leaves, larger inner sepals, longer corolla, sessile and smaller anthers, larger fruit, larger fruit wing, truncate fruit apex and larger seeds. See also Table 1.

Description — *Subshrubs*, dwarf, caespitose, 20–40 cm tall. *Stems* with many simple branches arising from base, rigid, distinctly striate, together with leaves puberulous throughout. *Leaves* alternate, dimorphic; *basal leaves* scale-like at base of stems with axillary bud, semi-clasping, semi-imbricate, ovate, carinate, 5–6 × 3–4 mm,

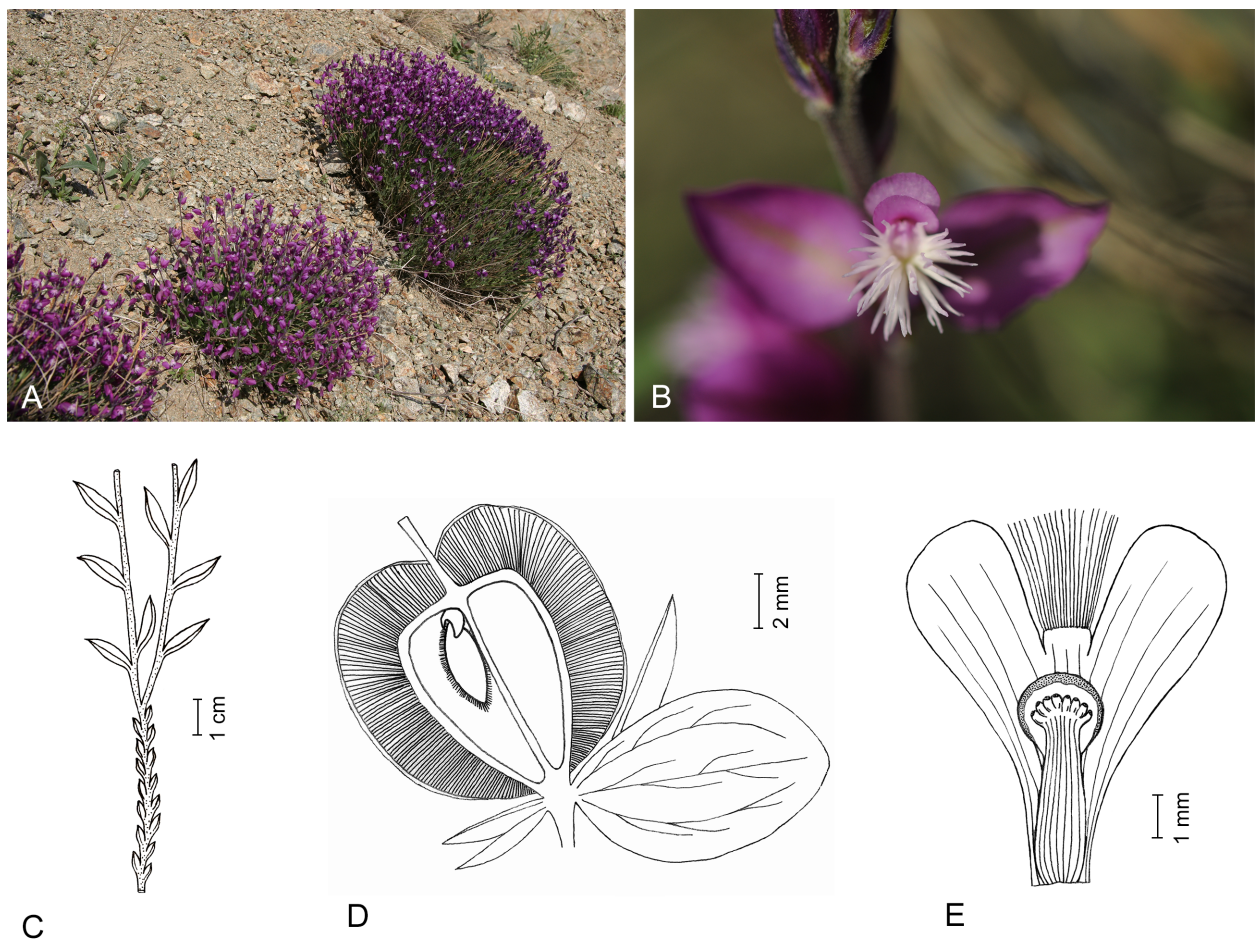


Fig. 1. *Polygala turcica* – A: habitat and habit; B: flower; C: leaf dimorphism; D: sepals and fruit; E: petal, stamens and coma. – A, B: type locality, 14 May 2009, photographed by A. Dönmez; C, D: from Dönmez 19166; E: from Dönmez 15242; C–E: drawn by D. Sancar.

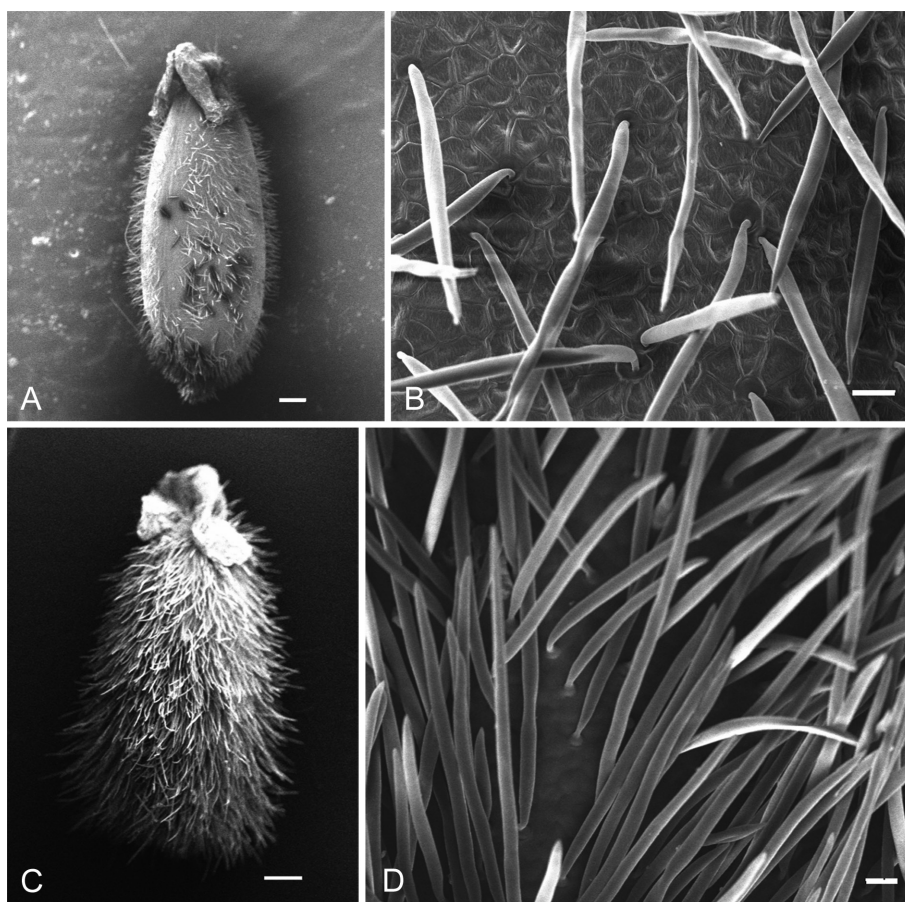


Fig. 2. SEM photographs of seeds – A, B: *Polygala turcica* (from Dönmez 19166); A: general view; B: details of surface. – C, D: *P. peshmenii* (from Eren 78/03 & Şirin); C: general view; D: details of surface. – Scale bars: A, C = 300 μ m; B, D = 20 μ m.

leathery, apex acute; *stem leaves* leaf-like, freely dispersed, lanceolate, 11–15(–19) \times 2–3 mm, margin entire. *Inflorescence* terminal, racemose; *raceme* 40–60 \times 10–12 mm, lax, with 6 to 8 flowers; *bracts* deciduous with distinct scar, leaf-like, carinate, 5–6 \times 0.8–1.2 mm, margin scariosus; *bracteoles* in 1 pair, caducous, violet-blue, lanceolate, carinate, 2–3 \times 0.4–0.6 mm, glabrous, margin scariosus, apex acute. *Pedicel* 2.6–2.9 mm long, puberulous. *Flowers* bright to dark violet, 10–12 mm long, glabrous. *Sepals* 5, persistent; *outer sepals* hairy at base; *lower 2 outer sepals* slightly unequal, lanceolate, 3.5–4 \times 1.8–2.2 mm, apex acute; *upper outer sepal* ovate, scarcely gibbous, 6–8 \times 3.5–4.5 mm, apex acute; *inner sepals (wings)* petaloid, elliptic, 9–11 \times 5–7 mm, shorter than mature fruits (incl. wings), glabrous, veins not anastomosing, apex obtuse. *Corolla* 8–9 mm long, slightly shorter than inner sepals; *upper 2 petals* 2.8–3.2 \times 1.3–1.5 mm, apex truncate; *lower petal (keel)* 3–3.5 mm long, with 2 crests and apex fringed. *Stamens* 8, concealed by 2 concave crests; *filaments* fused almost throughout their length with a tuft of hairs at apex; *filament* sheath glabrous, adnate to middle of corolla; *anthers* sessile, 0.2–0.3 mm long, opening by a pore at apex. *Ovary* obovate, 1–1.5 \times 0.4–0.6 mm; *style* c. 2 mm long; *stigma* trilobed, capitate. *Capsule* sessile, ovate, 7.5–8.5

\times 5–5.5 mm (excluding wings), bilocular, symmetrically 2-winged, apex truncate; *wings* 1.5–2 mm wide; *style* c. 1.5 mm long. *Seeds* 3.4–3.6 \times 1.4–1.6 mm, broadly oblong, densely covered with subpatent trichomes 0.2–0.3 mm long; *appendage (strophiole)* 3-lobed, 0.6–0.7 \times 0.2–0.3 mm.

Pollen morphology — Pollen grains (Fig. 3A, B) are stephanocolporate, isopolar, radially symmetric, oblate-spheroidal, and circular in polar view. Polar axis ranges from 30–36 μ m, while equatorial axis ranges from 30–37 μ m. Exine sculpturing is psilate on mesocolpium and apocolpium. Number of apertures varies between 9 and 10.

Phenology — Flowering in May and fruiting in July.

Distribution and ecology — An Irano-Turanian element currently known only from the type locality in the Aras

valley in Kars province, E Turkey. Growing on stony slopes and dry steppes at altitudes of 1310–1320 m.

Conservation status — According to IUCN (2012) criteria, this new species should be assigned to the category Critically Endangered: CR B1ab(iii,v)+2ab(iii,v). The area of occupancy is estimated to be less than 1 km² and the species is known only from a single location. Moreover, the location is close to a main road, and is thereby at risk of various activities causing damage to, or destruction of, the plants and their habitat.

Etymology — *Polygala turcica* is named for its country of occurrence.

Additional specimens examined — ***Polygala turcica***: TURKEY: A9 KARS: Kağızman-Karakurt road, 5 km from Kuloğlu village to Karakurt, 40°03'80"N, 42°51'69"E, 1314 m, stony slopes along Aras River, 4 Aug 2009, Dönmez 15992 & Uğurlu (HUB); *ibid.*, 5 May 2013, Dönmez 18488 (HUB); *ibid.*, 12 Aug 2014, Dönmez 19166 (B). — ***Polygala peshmenii***: TURKEY: C3 ANTALYA: between Antalya and Feslikan Yayla, ascent to Feslikan Yayla above Çakırlar, main road, c. 4 km below Geyikbayırı, 36°31'33"N, 30°18'14"E, 370 m, vertical limestone rocks

in open *Pinus brutia* Ten. forest, 12 May 2003, Eren 78/03 & Şirin (isotype: HUB).

Discussion

Polygala turcica is outstanding among the species of the genus with respect to its caespitose life form. Nearly all of the *Polygala* species in Turkey have soft herbaceous aerial stem parts and creeping, ascending or erect branches. While all of the *Polygala* species (except *P. peshmenii*) grow on deep soils, *P. turcica* grows on stony slopes.

Different forms in basal and upper leaves are a common phenomenon of Eurasian *Polygala* species. However, leaf differentiation between the basal and upper parts is most pronounced in *P. turcica*, best referred to as distinct leaf dimorphism according to the concept of Raven & al. (2006). The basal leaves are thick-textured and fleshy, small in size, semi-clasping the stem and semi-imbricate. The stem leaves clearly differ by their leaf-like texture, larger size (4–5 × as large as the basal leaves), lanceolate shape and by being sessile and freely arranged on the stem (Fig. 1C).

The flowers of *Polygala turcica* are larger than those of *P. peshmenii* at first sight. The inner sepals of the new species are larger than those of *P. peshmenii*. The white comas on top of the petals are very distinct and equal in size to the petal parts under the stereo microscope (Fig. 1E), while a three-dimensional view of the coma and other petal parts displays misleading proportions (Fig. 1B).

Symmetry of the fruit wings is an important character for distinguishing *Polygala* species, and it is used in several identification keys in published *Polygala* accounts. However, close examination of a specimen at immature fruiting stages reveals that the wings have various degrees of symmetry during development from ovary to mature fruit. A specimen of *P. vulgaris* L. may show fruits with symmetric and asymmetric wings, depending on the stage of development. While the lower fruits (mature ones) have nearly symmetric wings, the upper (immature ones) have distinctly asymmetric wings. This phenomenon will require further research

with respect to ontogeny and fruit maturation. In the case of *P. turcica*, the wings do not exhibit different symmetry at various stages of development, and the mature fruit has a distinct shape by having larger dimensions compared with *P. peshmenii* and symmetric wings. Moreover, similar to the fruit, seed size is also larger than in *P. peshmenii*. The fruit apex of *P. turcica* is truncate and the loculi are symmetric, whereas the apex of the fruit in *P. peshmenii* is asymmetric and emarginate (see Table 1).

Polygala rausiana U. Raabe & al. (Raabe & al. 2009) is also another species superficially similar to *P. turcica*. However, there are many differences in details between them. The new species differs from *P. rausiana* by its very distinct basal leaves, absence of petiole and longer stem leaves, sessile anthers, truncate fruit apex and narrower fruit wing.

In *Polygala*, gibbosity of the upper sepal depends on maturity. While the sepals lack a distinct gibbous shape in flower, they become gibbous in the mature stage. Hence, we suppose that this character is not very helpful

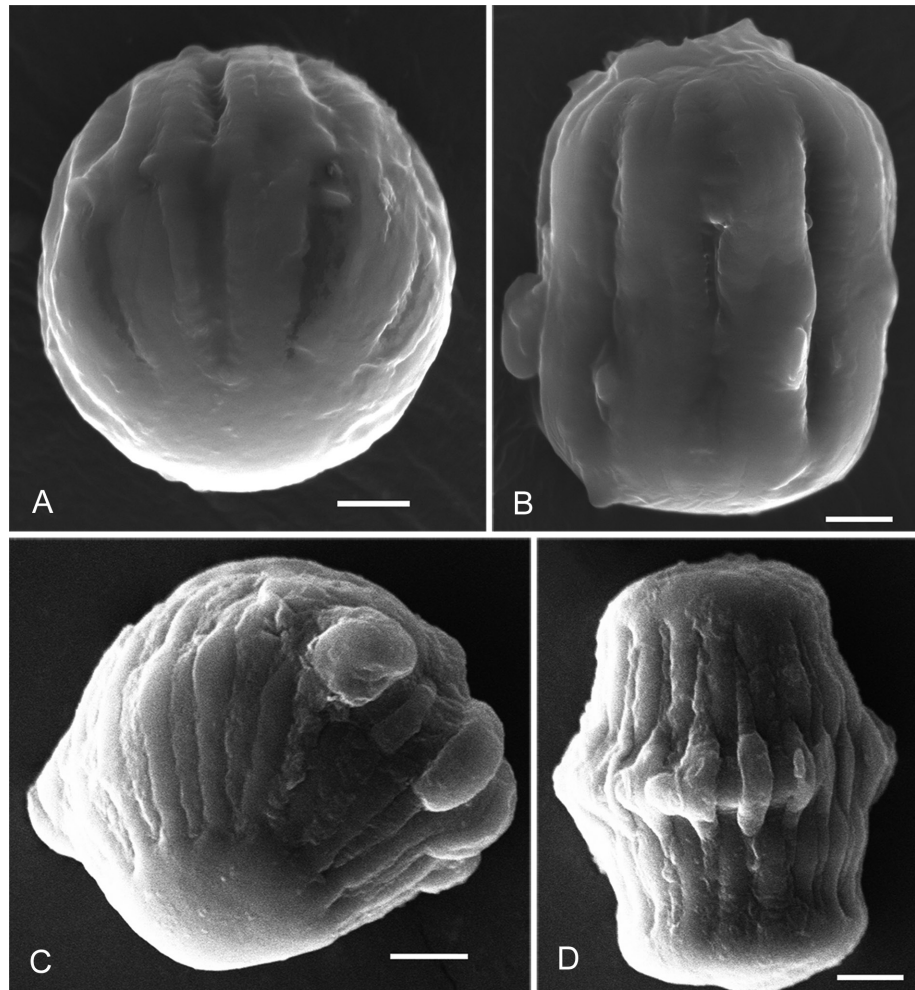


Fig. 3. SEM photographs of pollen – A, B: *P. turcica* (from Dönmez 15242); C, D: *P. peshmenii* (from Eren 78/03 & Şirin). – A, C: oblique equatorial view showing apertures and psilate apocolpium; B, D: equatorial view showing apertures and psilate mesocolpia. – Scale bars: A–D = 5 µm.

Table 1. Comparison of *Polygala turcica* with *P. peshmenii* and *P. rausiana*.

Character	<i>Polygala turcica</i>	<i>Polygala peshmenii</i>	<i>Polygala rausiana</i>
Habit	caespitose	multi-branched, erect	suffrutescent, erect-ascending
Basal leaves	semi-clasping, semi-imbricate	spreading, not imbricate	spreading, not imbricate
Stem leaves length/width ratio	6–7	c. 3	2.5–3
Stem leaves width [mm]	2–3	5–6	2–5
Inner sepals size [mm]	9–11 × 5–7	7–9 × 3–6	8–10 × 3.5–4
Corolla length [mm]	8–9	5–7	c. 8
Anther length [mm]	0.2–0.3	0.6–0.7	unknown
Anther base	sessile	stipitate	stipitate
Capsule size excluding wing [mm]	7.5–8.5 × 5–5.5	5–6 × 3–3.5	6.5–8(–10) × 4–4.8(–8)
Capsule wings	symmetric	asymmetric	± asymmetric
Capsule wings width [mm]	1.5–2	0.5–0.6	1.5–2.5
Capsule apex	truncate	emarginate	obcordate
Seed size [mm]	3.4–3.6 × 1.4–1.6	3–3.5 × 1.3–1.4	3.5–4 × c. 1.2
Pollen aperture number	9 or 10	>10	unknown

for distinguishing species based on single collections in the flowering or fruiting stage.

The SEM images of the seeds highlight that *Polygala turcica* differs from *P. peshmenii* by having larger size, less dense trichomes (Fig. 2A, C) and a more distinct reticulate sculpturing on the seed surface: the sculpturing in *P. turcica* consists of conspicuous polygonal cells (Fig. 2B), compared to the slightly reticulate and inconspicuous cells of *P. peshmenii* (Fig. 2D).

Pollen morphology of *Polygala* species of NW Europe was examined by Furness & Stafford (1995), and that of Thai species was examined by Krachai & al. (2009). The pollen grains of *P. turcica*, some NW European species (e.g. *P. alpestris* Rchb. and *P. comosa* Schkuhr) and some Thai species (e.g. *P. chinensis* and *P. longifolia*) are all similar in polarity, symmetry and exine sculpturing. The species examined in the present study are also similar, with the exception of aperture numbers: *P. turcica* has 9 or 10 apertures (Fig. 3A, B), whereas *P. peshmenii* has a higher number (Fig. 3C, D).

Identification key for the genus *Polygala* in Turkey

1. Shrubs with single stem, 100–250 cm tall; wings 15–20 mm long (cultivated) *P. myrtifolia* L.
- Herbs, if semishrubs then multibranched, less than 45 cm tall; wings usually less than 15 mm long ... **2**
2. Annuals; filaments united for only c. ½ their length. *P. monspeliaca* L.
- Perennials (± annual in *P. hohenackeriana*); filaments united to apex or nearly so **3**
3. Upper sepal gibbous; axillary racemes usually present as well as terminal racemes **4**
- Upper sepal not gibbous; axillary racemes absent ... **6**
4. Capsule unequally winged; anthers stipitate *P. pruinosa* Boiss.
- Capsule equally winged; anthers sessile **5**
5. At least lower leaves acute; nerves of inner sepals not anastomosing *P. stocksiana* Boiss.

- Lower leaves obtuse; nerves of inner sepals anastomosing *P. supina* Schreb.
- 6. Corolla shorter than or as long as inner sepals, but not exerted **7**
- Corolla clearly longer than inner sepals, clearly exerted **14**
- 7. Young raceme not comose; bracts much shorter than pedicels **8**
- Young racemes comose; bracts equalling or exceeding pedicels **11**
- 8. Chasmophytic semishrubs; inflorescence not comose *P. peshmenii* Eren & al.
- Herbs; inflorescence comose **9**
- 9. Inner sepals 4–5 mm long, narrower than capsule, veins not anastomosing *P. alpestris* Rchb.
- Inner sepals 6–8 mm long, broader than capsule, veins anastomosing **10**
- 10. Plants herbaceous, ascending to erect; leaves nearly glabrous *P. vulgaris* L.
- Plants caespitose; leaves puberulous throughout ... *P. turcica* Dönmez & Uğurlu
- 11. Capsule 9 mm or longer; plant with a stout woody stock *P. papilionacea* Boiss.
- Capsule less than 7 mm long; plant with a slender stock **12**
- 12. Plants 7 cm or more tall *P. comosa* Schkuhr
- Plants less than 5(–7) cm tall **13**
- 13. Plants green or greyish; flowers bluish, lilac or green on veins ... *P. hohenackeriana* Fisch. & C. A. Mey.
- Plants densely canescent; flowers violet-purple ... *P. inexpectata* Peşmen & Erik
- 14. Capsule sessile; inner sepals narrower than capsule *P. venulosa* Sm.
- Capsule stipitate; inner sepals broader than capsule **15**
- 15. Capsule abruptly contracted into a stipe, which is longer than capsule; inner sepals 12–17 mm long . . . *P. major* Jacq.
- Capsule gradually tapered into a stipe, which is shorter than capsule; inner sepals 10–12 mm long ... **16**

16. Plants prostrate at base, stems ascending; inner sepals almost equalling corolla *P. transcaucasica* Tamamsch.
 – Plants ascending-erect; inner sepals much shorter than corolla *P. anatolica* Boiss. & Heldr.

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