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Scilla vardaria (Asparagaceae subfamily Scilloideae): a threatened new species of *Scilla* L. from Northeast Turkey with a floral corona

Hasan YILDIRIM[1*], Yusuf GEMİCİ[1] & Paul WILKIN[2]

[1]*Ege University, Faculty of Science, Department of Biology, 35100, Bornova-Izmir, Turkey.*
E-mail: hasanyldrm@gmail.com
[2] *Royal Botanic Gardens, Kew, Richmond TW9 3AB, UK*

Abstract

Scilla vardaria Yıldırım & Gemici (Asparagaceae) is described as a new species. Diagnostic morphological characters, a full description and detailed illustrations are provided on the basis of the type specimen and observations of wild populations. The new species is characterized by the conical floral corona structure formed by fusion of its filaments, with anthers arising almost at the floral corona apex. Its seeds are borne in pyriform capsules and are oblong, straw to pale yellow with a cucullate, pale creamy yellow elaiosome which is adherent to the testa and the bulb is brown-pink. It is easily distinguished from all other *Scilla* species on the basis of these morphological characters.

Key words: Hyacinthaceae, taxonomy, Rize, Turkey, conservation status

Introduction

The genus *Scilla* Linnaeus (1753: 338) contains 91 species distributed in Europe, Africa and Western Asia (Govaerts 2013). Both its generic and specific-level taxonomic limits have been the subject of considerable debate by systematists (e.g. Speta 1998a,1998b, Stedje 1998, Pfosser & Speta 1999). In contrast with many previous treatments, *Scilla* L. s.l. was divided into many small genera by Speta (1998a), although this classification has not been widely taken up (see e.g. Govaerts 2013). According to Speta (1998b) only the *Scilla bifolia* Linnaeus (1753: 339) [the generitype of *Scilla* L.] group, which included *Chionodoxa* Boissier (1844: 61), formed the genus *Scilla* s.s. We have been studying taxa of *Scilla* and *Puschkinia* Adams (1805: 164) from Turkey based on morphological, molecular, ecological and reproductive system data since 2004 (see Gemici & Yıldırım 2010).

Our studies so far suggest support for Speta's conclusion that species placed in *Chionodoxa* by, for example, Mordak (1984) are most closely related to *S. bifolia* and its allies among the taxa that comprise *Scilla* s.l. However, among the scilloid taxa occurring in Turkey, *Puschkinia* is separable from *Scilla* s.l. (including *Chionodoxa*) based on differences in its floral corona and seed morphology. The species that were formerly placed in *Chionodoxa* have a distinct perigon tube and filaments that are well-developed, flattened and form a central cone at the top of perigon tube. These two characters were used to distinguish *Scilla* from *Chionodoxa* prior to the work of Speta (1971, 1976, 1998b) that placed *Chionodoxa* among the synonyms of *Scilla*, based on molecular (Pfosser & Speta, 1999) and cytotaxonomical studies, seed morphology and the ability to form hybrids with *S. bifolia* L. s.l. Thus in this study we regard *Chionodoxa* as a synonym of genus *Scilla* s.l. and this underlies our generic placement of the new species.

Mordak (1984) recognized 14 species of *Scilla* in her treatment in Flora of Turkey, with three species of *Chionodoxa* and a monotypic *Puschkinia*. Since then, *Scilla seisumsiana* Ruksans & Zetterlund in Ruksans (2007: 373) with a second species of *Puschkinia* (Rix & Mathew 2007). The World Checklist of Asparagaceae

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(Govaerts 2013) includes 16 *Scilla* species in Turkey, with *Scilla autumnalis* Linnaeus (1753: 339) as *Prospero autumnale* (Linnaeus) Speta (1982: 4), *Scilla persica* Haussknecht (1896: 44) as *Zagrosia persica* (Haussknecht) Speta (1998a: 124), *Scilla winogradowii* Sosnowsky (1914: 3) as synonym of *Scilla monanthos* Koch (1849: 251) and all taxa of *Chionodoxa* as synonyms of *Scilla*, in contrast to Mordak (1984). During fieldwork carried out within the scope of a research project on *Scilla* and its allies in Turkey (Gemici &Yıldırım 2010) between 2007 and 2010 by the first and second authors the majority of species belonging to *Scilla* s.l. and *Puschkinia* were collected from various localities in Turkey. During these studies material of an unknown scilloid geophyte was collected at the Kaçkar Mountain range in Rize province (NE Turkey). The Kaçkar Mountain range is located in the East Black Sea region, and placed in the Colchian sector of the Euxinian province of the Euro-Siberian phytogeographical region. The highest peak of the Kaçkar Mountain range is 3932 m high. Most of the area consists of Tertiary granite, granodiorite, quartz diorite, syenite and monzonite (Tandoğan 1971, Güner 1983, Güner et al. 1987). The plant from the Kaçkar Mountain range was compared with related taxa occurring in Turkish and European herbaria and against the relevant taxonomic literature (Boissier 1881, Komorov 1935, Grossheim 1940, Galushko 1978, Davis 1984, Davis *et al*. 1988, Güner *et al.* 2000, Takhtajan 2001, Özhatay & Kültür 2006, Özhatay *et al*. 2009, 2011). Initial examination of the new plant, suggested that it resembled both *Scilla* and *Puschkinia*, although it shows morphological differences from all existing taxa. Thus it is a hitherto unknown taxon and should be considered as a new *Scilla* species given both its morphology (detailed below), its close relationship with *S. bifolia* and its allies demonstrated by plastid marker-based phylogenetic systematic studies that are being prepared for publication. *S. bifolia* is the type species of *Scilla*, so it would be unadvisable to describe the new plant in any other genus.

Materials and methods

Specimens of *Scilla* s.l. were studied in the following herbaria: AIBU, ANK, EGE, G, GAZI, HUB, ISTE, K, KATO, KNYA and VANF. Features of gross morphology of *Scilla vardaria* and allied taxa were examined under a binocular stereoscopic microscope. Samples of seed and pollen, coated with gold, were examined with a scanning electron microscopy (SEM). Photographs of the living material were taken with a digital camera.

Results

The morphological differences between the new species and all other taxa of *Scilla* s.l. and *Puschkinia* are summarized in Table 1.

Description

Scilla vardaria Yıldırım and Gemici *sp. nov.* (Figs. 1–4)

Planta bulbosa, perennis, glabra. Bulbi tunica exteriore membranacea, fusca pallide purpurea; squama interiore succulenta, purpurea. Folia plerumque 2, canaliculata, apices cucullata. Racemus laxus. Bracteae minutae, membranaceae, interdum absentes. Pedicelli erecti usque suberecti interdum curvi. Perigonium aeque caeruleum; segmenta late campanulata usque stellata, subaequalia, patentia, connata 1/4–1/5 basi; tubum subcampanulatum usque globosum; faucem habens coronam conoideam. Stamina apice coronae inserta; filamenta fere absentia; antherae subsessiles, e corona leviter exertae, dorsifixae, introrsae, flavae. Ovarium subglobosum vel obovoideum, 3-loculatum, ovulis paucis omnibus loculatis; stylus strictus; stigma parvum, truncatum. Capsula pyriformis, 3-lobata. Semina flava, pauca omnibus loculata; testa reticulata, ovoidea usque ellipsoidea; elaiosoma flava, cucullata, adhaerens ad testam, leviter tuberculata.

Type:—TURKEY. Province A8 Rize: Çamlıhemşin, Kaçkar mountain, 1,520 m., openings in *Picea orientalis* forests, 28 April 2010, *H. Yıldırım 1675* (holotype EGE!, isotypes K!, EGE!, HUB! and Herb. Yıldırımlı!).

Bulbs 21–30 × 10–18 mm, ovoid to subglobose; outer tunic membranaceous, very thin textured, pale brown, sometimes pink-hued; inner scales fleshy, pink-hued. Leaves usually 2, rarely 3, 11–19 × 0.8–1.7 cm, dark green to yellow-green, linear, canaliculate, cucullate at apex. Stem solitary, 4–9 cm long, erect, stout. Inflorescence a simple, lax (1) 2–9 flowered raceme, axis erect, brown to light green, sometimes tinged bronze, 3–7 cm long, . Bracts 1–2(5) mm long, lanceolate to ovate, sometimes linear, membranaceous, white to purple-hued, sometimes absent. Pedicels 1–6 cm long, erect to suberect, sometimes curved downwards, slender. Perigon uniformly pale violet-blue, broadly campanulate to stellate with lobes 10–15 × 4–5 mm, subequal, oblong-lanceolate, united in lower 1/4– 1/5; tube (below perianth insertion point) 1.5–3 × 2–3 mm, subcampanulate to infundibular, originating from both floral corona and perianth, white at base. Floral corona (above perianth insertion point) 2.5–3.5 × 3–3.5 mm, conical, pale blue to white, sometimes pale blue at apex only, apex margin very minutely irregularly toothed or entire, formed by the fusion of the filaments. Anthers inserted at the floral corona apex; light to pale yellowish, 2–4 × 1–1.5 mm, dorsifixed, introrse; filaments reduced. Ovary 2–3 × 2–3 mm, dark blue, subglobose or obovoid, 3-1ocular, ovules 4–5 per locule; style 1–1.5 mm long; stigma small, truncate. Capsule 4–6 × 6–8 mm, pyriform, 3-lobed, pale greenish. Seeds 1.5–2 mm broad, 4–12 in each capsule, ovoid to ellipsoid, with an elaiosome; testa pale yellow, reticulate; elaiosome pale cream yellow, cucullate, adherent to testa, slightly tuberculate.

TABLE 1. Morphological differences among *Scilla vardaria*, *Scilla* s.s. and *Puschkinia*.

	Characters	*Scilla vardaria*	*Scilla* s. str. (including *Chionodoxa)*	*Puschkinia* sp. pl.
Perigon	**colour**	uniformly rich blue	uniformly blue to blue-white	blue-white, pale to yellow-green
	tube	present	present or absent	present
Stamens	**filaments fused in a floral corona**	yes	no	yes
	floral corona lobes	absent	not applicable	with 6-conspicuous prolonged lobes
	free portion of the filament	null	conspicuous	null or very short
Seed	**elaiosome**	present	present or absent	absent
	testa	reticulate	not reticulate or very rarely reticulate (according to unpublished data), smooth or papillate	alveolate
Capsule	**shape**	pyriform, clearly 3 lobed	subglobose,elliptical or rarely pyriform	subglobose
Bulb	**tunics**	pale brown to pink-hued	dark violet or, brown to black	brown
	scales	pink-hued	white, rarely pink	white

Etymology:—This species is named after Prof. Dr. Yusuf Vardar (1921–2009), who was an expert in plant physiology and the founder of the Dean of Ege University Science Faculty (1961–1969) and the Botany department. He also was the Rector of Ege University from 1971 to 1974.

Distribution:—*S. vardaria* is endemic to the Kaçkar Mountain range in the province of Rize in northeastern Anatolia (Fig. 6). This area belongs to the Euro-Siberian floristic region.

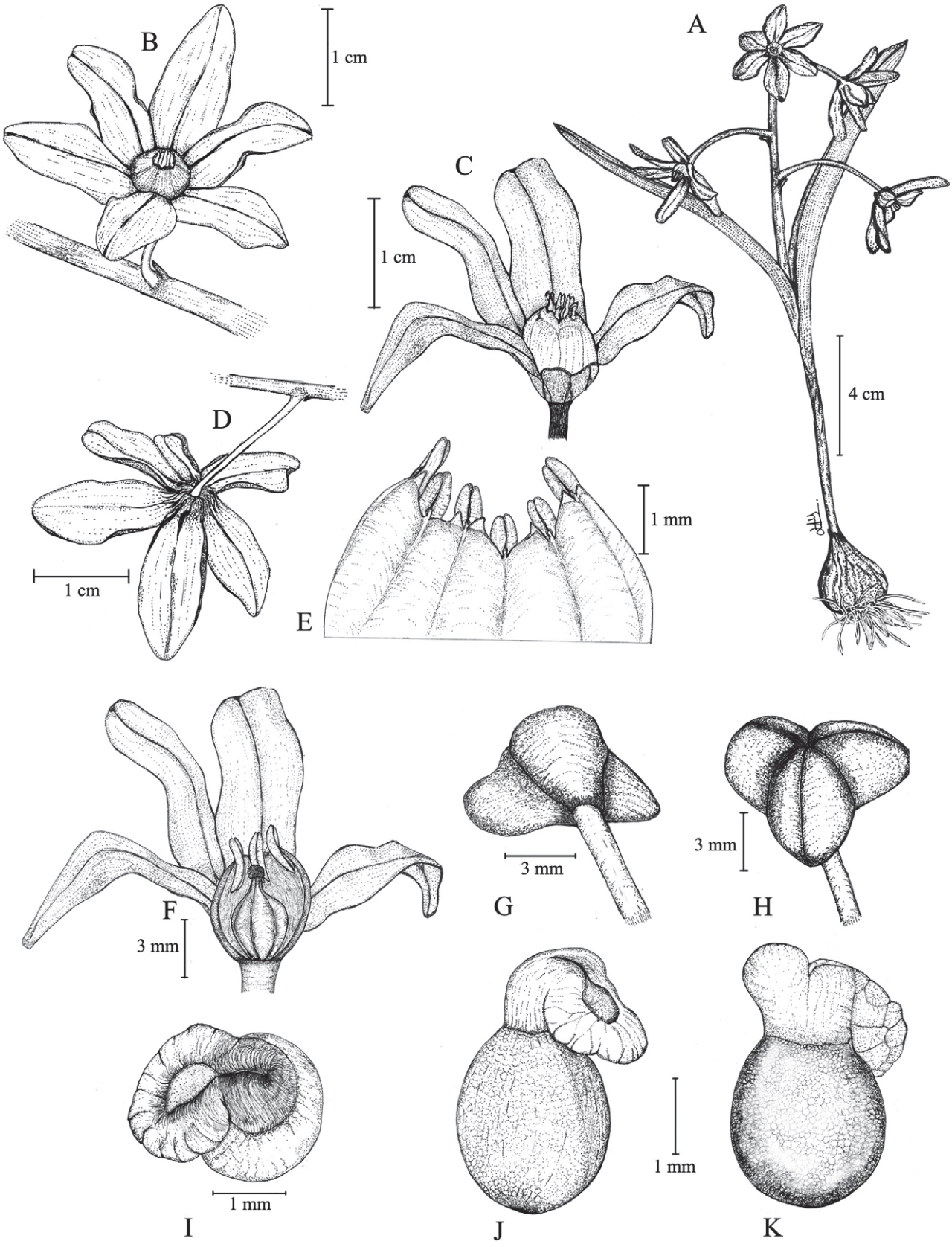

FIGURE 1. A–I. *Scilla vardaria* (from holotype). **A**. Habit; **B–C.** Frontal view of flower with floral corona structure. **D.** Dorsal view of flower with perigon tube. **E.** Floral corona structures **F.** Front view of flower with floral corona and pistil. **G–H.** Fruits. **I–K.** seeds with elaiosomes.

FIGURE 2. *Scilla vardaria* (from type locality). **A.** Habit. **B.** Frontal view of flower. **C.** Dorsal view of flowers.

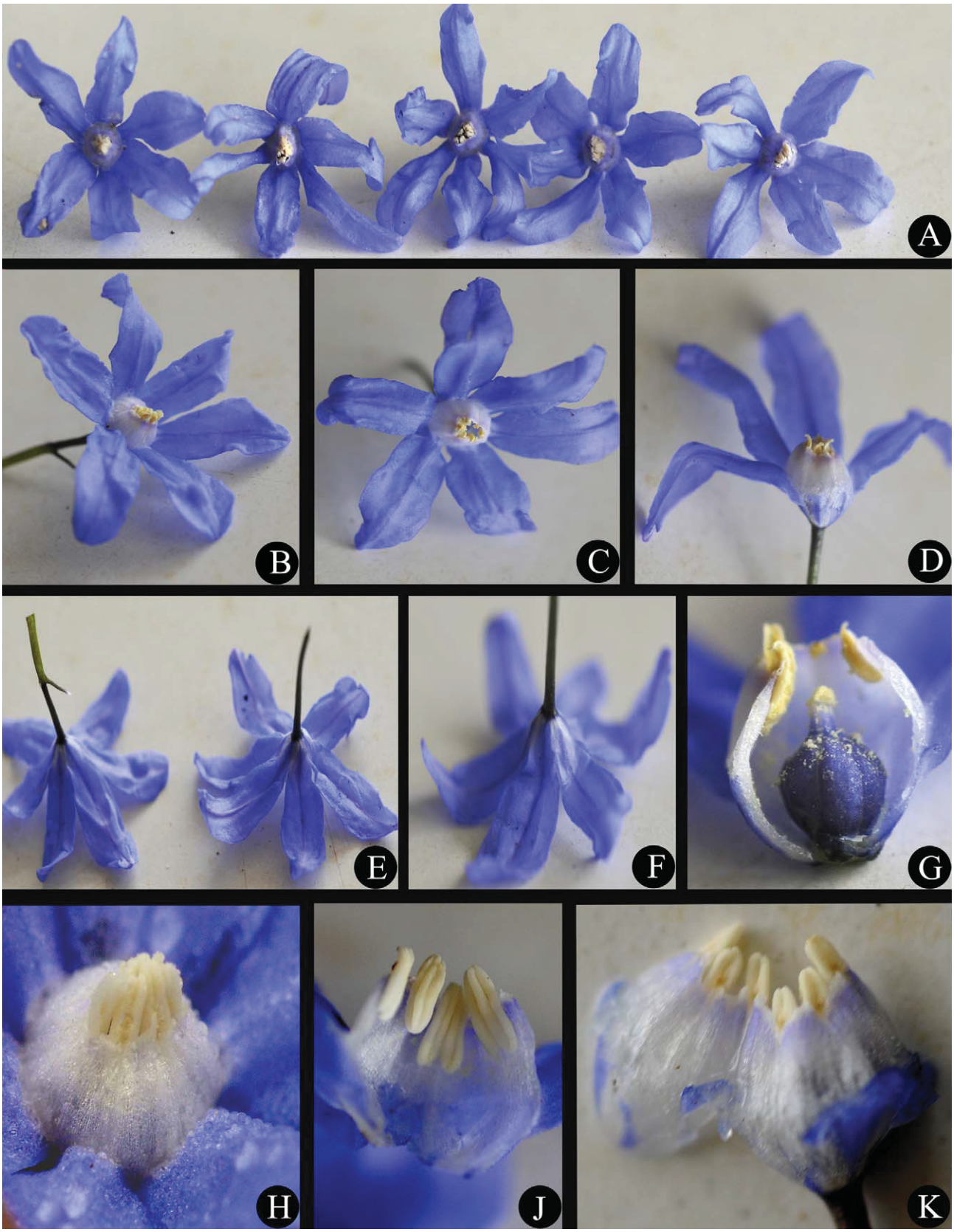

FIGURE 3. *Scilla vardaria*: A–K. Details of flowers.

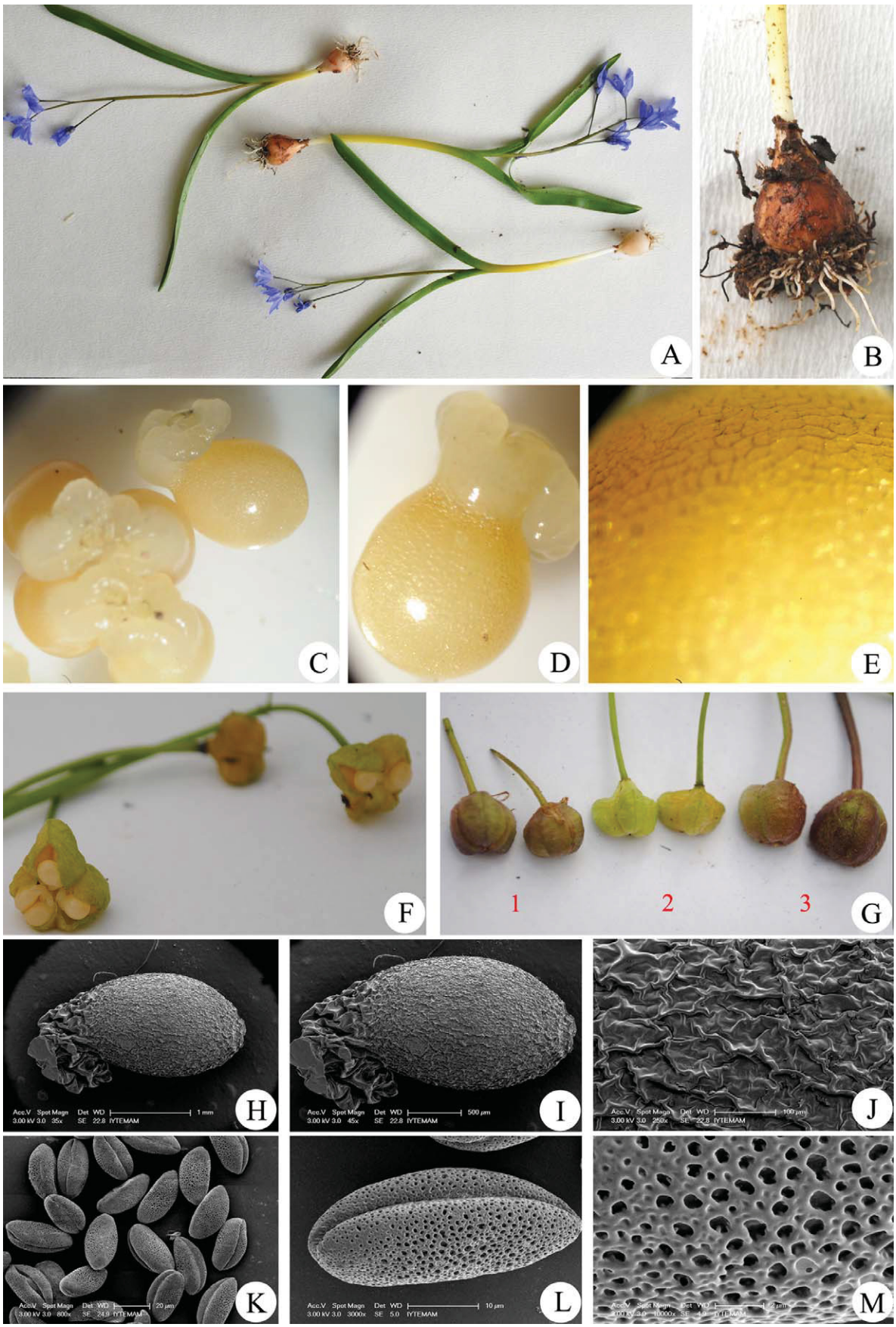

FIGURE 4. A–F. *Scilla vardaria* (A. Habit. **B.** Bulb. **C–D.** Seeds. **E.** Seed surface. **F.** Mature fruits with seeds). **G.** Fruits of. **1.** *Scilla luciliae* (syn: *Chionodoxa luciliae*). **2.** *Scilla vardaria*. **3.** *Scilla bifolia*. **H–M.** SEM photographs of seeds and pollen grains of *Scilla vardaria* (**H–J.** Seed and seed surface. **K–M.** Pollen grains).

Ecology:—*S. vardaria* occurs on mountain steppes and meadows in the subalpine zone, as well as in the clearings of *Picea orientalis* dominated forests or *Picea orientalis* and *Fagus orientalis* mixed forests, at altitudes ranging from 1200 to 1980 m a.s.l. Flowering and subsequently fruiting plants can be observed from April to June. It grows on soils rich in humus resulting from the accumulation of dead plants on granite soils. Soil properties are indicated in Table 2, the data of which are presented through the system of Altınbaş (2000) and Lindsay & Norvell (1978).

TABLE 2. Soil properties at the type locality of *Scilla vardaria*.

Water saturation (%)	Conductivity dS m^{-1}	pH	CaCO3 (%)	Organic content (%)	N (%)
72	0.275	4.88	0.4	5.7	0.36

Macro-elements (ppm)				Micro- elements (ppm)				
P	K	Ca	Mg	Na	Fe	Mn	Zn	Cu
2.03	367	700.00	90.75	50.60	33.29	9.55	1.91	0.06

Conservation status:—*S. vardaria* is hitherto known only from an area of less than 10 km^2 at the type locality. Following the IUCN criteria (IUCN 2001), the plant is categorized as 'Critically Endangered' (CR): B2ab(ii). The area where it occurs is well known for its touristic activities, and therefore unregulated development could represent the primary potential threat.

Scilla vardaria and the morphology of *Scilla* and *Puschkinia*

Some species of *Scilla* (formerly placed under *Chionodoxa*), such as *S. forbesii* (Baker 1870: 436) Speta (1976: 31) do not possess a floral corona but the filaments are well-developed, flattened and form a central cone at the top of perigon tube (Fig. 5). All such taxa have a distinct perigon tube. This highlights the potential for flower evolution in *Scilla* s.l. Although *S. vardaria* shows superficial morphological similarities to both *Scilla* and *Puschkinia* taxa on initial examination, it is easily distinguished using the floral corona structure and seeds characters. As described above, plastid marker-based phylogenetic studies that are being prepared for publication (H. Yıldırım and collaborators) show a close relationship with *S. bifolia* and its allies, with the new species forming a clade with certain morphologically distinct units provisionally referred to *S. bifolia*, that is sister *to S. bifolia* s.s. taxa such as *S. forbesii* that were formerly recognized under *Chionodoxa*. Both clades have moderate to strong bootstrap support. *S. bifolia* is the generitype of *Scilla*. Thus, *S. vardaria* must be described as a species of *Scilla* even though it extends the morphological limits of the genus through, for example, its floral corona structure and the reticulate seed testa. The presence of a floral corona and reticulate testa are novel morphological characters for *Scilla* s.l. as described to date. However, some *Scilla* specimens (from the *S. bifolia* group) that have a reticulate testa were collected from NE and E Anatolia by us during the fieldwork described above.

Puschkinia comprises 2 species [*P. scilloides* Adams (1805:164) and *P. peshmenii* Rix & Mathew (2007: 56)] and is distributed from Daghestan and Bestau in the northern Caucasus and eastern Turkey to Lebanon and northwestern Iran (Rix & Mathew 2007). The presence of a floral corona has been regarded by many authors to be a morphological character unique of *Puschkinia*. Although *S. vardaria* has a floral corona structure that resembles the floral corona found in *Puschkinia*, the floral corona of *Puschkinia* is tubular and distinctly 6-lobed (Fig. 5), as opposed to the conical and entire (or rarely minutely lobed) corona of *S. vardaria*. In addition, the anthers of *Puschkinia* are inserted at the middle of its floral corona and not at its apex as in *S. vardaria*. *S. vardaria* also differs from *Puschkinia* in other floral and seed morphological characters (see Table 1); a blue-white to yellow-green perigon (not rich-blue); and seeds without elaiosome (not with distinct elaiosome). The perigon and its mid-vein are concolour (not darker) and seeds are only reticulate veined (not alveolate with sarcotesta).

FIGURE 5. A–C. *Scilla bifolia* (**A.** Habit, **B**. Flower, **C**, Stamens and pistil); **D–F**. *Chionodoxa sardensis* (synonym of *Scilla sardensis*) (D. Habit, E. Flower with a cone form stamen position, F. Stamen and pistil); G–J. *Scilla vardaria* (G. Habit, H. Flower and floral corona, J. Floral corona, stamen and pistil), K–M. *Puschkinia scilloides* (K. Habit, L. Flower and floral corona with corona lobes, M. Floral corona, stamen and pistil).

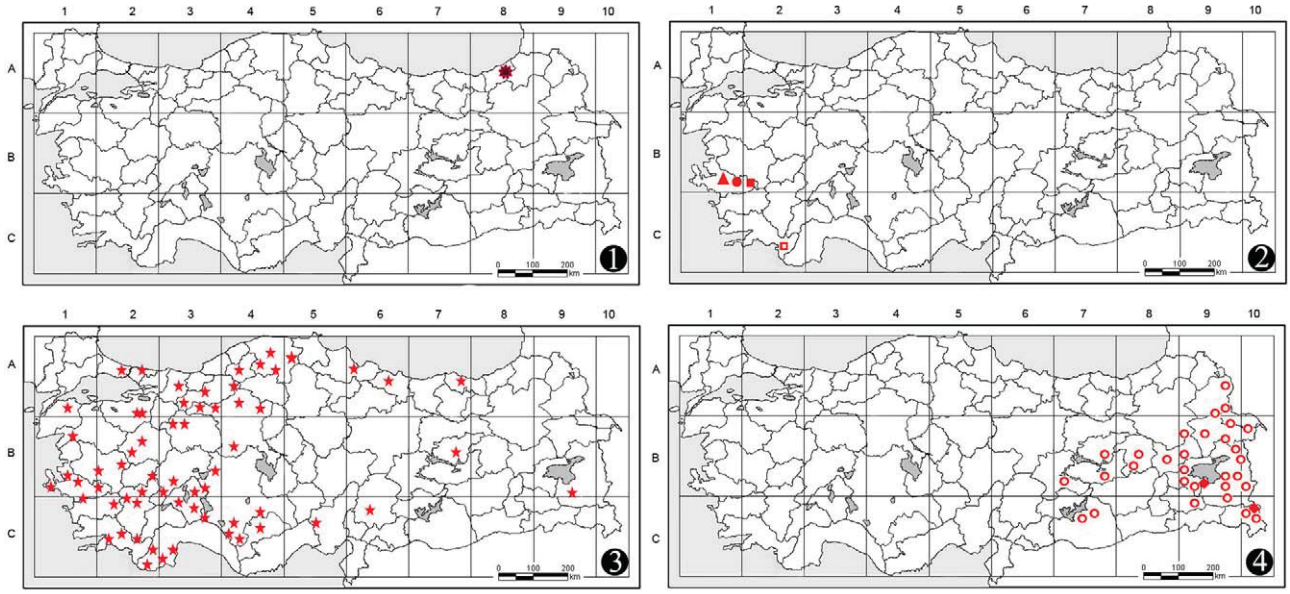

FIGURE 6. Distribution of 1. *Scilla vardaria*; 2. *Scilla luciliae* (syn: *Chionodoxa luciliae*), *Scilla siehei* (syn: *Chionodoxa siehei*), *Scilla sardensis* (syn: *Chionodoxa sardensis*), *Scilla forbesii* (syn: *Chionodoxa forbesii*); 3. *Scilla bifolia;* 4. *Puschkinia scilloides*, *Puschkinia peshmenii* in Turkey.

Diagnostic key for *Scilla* L. and *Puschkinia* Adams in Turkey as currently circumscribed

1. Testa distinctly alveolate, sarcotesta present. Floral corona present, with distinct 6 dentate lobes; anthers inserted at middle or base of corona..... ***Puschkinia***
- Testa reticulate, smooth or papillate, sarcotesta absent. Floral corona lacking or if present entire (rarely minutely lobed) and anthers inserted at corona apex or with flattened filaments forming a cone..... ***Scilla*** sensu lato

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