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A new species of *Eryngium* (Apiaceae) from Turkey: *Eryngium babadaghensis*

Gülay ECEVİT GENÇ[1,*], Emine AKALIN URUŞAK[1], Arno WÖRZ[2]

[1]Department of Pharmaceutical Botany, Faculty of Pharmacy, İstanbul University, Beyazıt, 34452 İstanbul - TURKEY

[2]Staatliches Museum für Naturkunde, Rosenstein 1, D-70191 Stuttgart - GERMANY

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Abstract: *Eryngium babadaghensis* G.Ecevit-Genç, E.Akalın & A.Wörz sp. nova (Apiaceae, Saniculoideae) is described as a new species from the Babadağ (Fethiye-Muğla) in south-west Turkey. The new species is closely related to *E. kotschyi* Boiss., which is endemic to Turkey. A Latin diagnosis; taxonomic descriptions; photos of the holotype, fruit, and transverse sections of the basal leaves, peduncles, and fruits; and scanning electron microscope (SEM) images of the calyx and surface of the scales on the mericarp of the new species are presented. The geographical distribution of the new species and *E. kotschyi* are mapped. Diagnostic characters of *E. babadaghensis* and *E. kotschyi* are presented with photos and in a table.

Key words: *Eryngium,* Saniculoideae, Apiaceae, new species, Turkey

Türkiye'den *Eryngium'un* (Apiaceae) yeni bir türü: *Eryngium babadaghensis*

Özet: *Eryngium babadaghensis* G.Ecevit-Genç, E.Akalın & A.Wörz sp. nova (Apiaceae, Saniculoideae), Türkiye'nin güneybatısında yer alan Babadağ'dan (Fethiye-Muğla) yeni bir tür olarak tanımlandı. Yeni tür Türkiye için endemik olan *E. kotschyi* Boiss. türü ile yakın akrabadır. Yeni türün Latince tanımı, taksonomik betimlemesi, holotipin, meyvenin, taban yaprakların, pedunkul ve meyve enine kesitlerinin, kaliks ve merikarp üzerindeki pulların (SEM) fotoğrafları verilmiştir. Yeni türün ve *E. kotschyi* türünün dağılımı haritalanmıştır. *E. babadaghensis* ve *E. kotschyi* türlerinin ayırt edici karakterleri tablo şeklinde ve fotoğraflarla verilmiştir.

Anahtar sözcükler: *Eryngium*, Saniculoideae, Apiaceae, yeni tür, Türkiye

* E-mail: gulece@istanbul.edu.tr

Introduction

The genus *Eryngium* L. (Apiaceae, Saniculoideae) comprises about 250 species that grow in Eurasia, northern Africa, northern and southern America, and Australia. About 60 of the 250 *Eryngium* species occur in western Eurasia and northern Africa. It is the most species-rich genus of the *Apiaceae* (Pimenov & Leonov, 1993). *Eryngium* grows in the temperate regions of every continent. Species richness is, however, unequally spread between and within the eastern and western hemispheres. In each hemisphere, 2 centres of diversity are recognised: central-western Mexico and central-eastern South America (South Brazil, north-east Argentina, and Uruguay) and the western Mediterranean and south-western Asia (Turmel, 1948, 1949). A new subgeneric classification of the genus was presented by Wörz (2005). It comprises 5 subgenera: *Eryngium*, *Semiaquatica*, *Monocotyloideae*, *Fruticosa*, *and Foetida*; 3 of these grow exclusively in the New World and Australia, 1 predominantly in northern and southern America, and a few species in the Mediterranean. *Eryngium* Subgen. *Eryngium* is restricted to western Eurasia and northern Africa.

In Turkey *Eryngium* is represented by 24 species, 46% of which are endemic (Davis, 1972; Davis et al., 1988; Duman, 2000; Wörz & Duman, 2004; Özhatay & Kültür, 2006).

Materials and methods

Previous studies on Turkish *Eryngium* species were wholly based on morphological characters. In the PhD study on the species from western and southern Turkey that was carried out by Ecevit-Genç, additional information was collected concerning the anatomy of mericarps and peduncles. These new data were found to be important for delimiting the species. During 2 years of botanical study, specimens of *Eryngium* were collected; we recognised the specimens from Babadağ (Fethiye-Muğla) to be new to science, belonging in Subg. *Eryngium*, Sect. *Campestria* H. Wolff. It is closely related to *Eryngium kotschyi.* These collections were compared with specimens of related species from the herbaria AEF, ANK, E, GAZI, HUB, ISTE, ISTF, ISTO, K, and with records in the literature (Boissier, 1872; Wolff, 1913; Hayek, 1927; Chater, 1968; Mouterde, 1970; Zohary, 1972; Meikle, 1977; Pimenov & Tamamschan, 1987).

In addition, scanning electron microscopy (SEM) was used to examine the surface of the scales on the mericarp surface, and light microscopy was used to examine the anatomy of peduncle and fruit transverse section of the new *Eryngium* species and *E. kotschyi*. We analysed 10 samples for anatomical studies and 5 samples for mericarp surface and calyx.

The distribution of *Eryngium kotschyi* was prepared according to the *Flora of Turkey and the East Aegean Islands* and field surveys.

Species description

Eryngium babadaghensis G.Ecevit-Genç, E.Akalın & A.Wörz, sp. nova (Figures 1-5). Subgen. *Eryngium*, Sect. *Campestria* H.Wolff

Type: Turkey C2 Muğla: Fethiye, Babadağ, Eşekbayıltan, 1610 m, stony slopes, serpentine, clearing in *Juniperus excelsa* communities, 08.vii.2008, G.Ecevit-Genç & İ.Genç (ISTE 86121) (holotype ISTE, isotype STU).

Diagnosis: Ab Eryngio kotschyi foliis basalis segmentis linearibus, segmentis terminalibus longior quam lateralis; petiolis 9-22 cm longis (non 5-15 cm); foliis caulinis segmentis usque ad 1 mm latis; stylis 7-9 mm longis (non 9-10 mm); fructibus ovatis-oblongis vel oblongis (non ovatis); pedunculis costa prominenta, fasciculis vascularis 17-20 (non 14-17); canalibus secretoriis 37-39 (non 26-29) differt.

Description

Glabrous perennial with a fibrous collar. Flowering stems erect, up to 75 cm tall, the upper part bright blue and the underside glaucous. Basal leaves persistent, numerous, petiolate, coriaceous; lamina obovate, narrowly cuneate at the base, 9-24 × 10-14 cm, palmately veined, 3-4 palmatisect with (3-)5-7 linear segments, segments pungent, parallel veined, 2-3 mm broad, the terminal segment longer than the lateral segments, petiole 9-22 cm, sheathed, often spiny near apex; middle cauline leaves similar, coriaceous, 2- to 4-palmatisect with (3-)5-7 elongate segments, 8-21 × 13-19 cm, segments linear, 0.5-1 mm wide at the apex, terminal segment 6-11 mm long, petioles up to 4 cm long, sheathed, often spiny near the apex; upper cauline leaves similar but with a shortly sheathed, spiny-margined petiole; prophyllae trifid, 60-80 × 7-12 mm, acute, spiny margined. Synflorescence paniculate, stout; capitula 7-23, hemispherical, 8-25

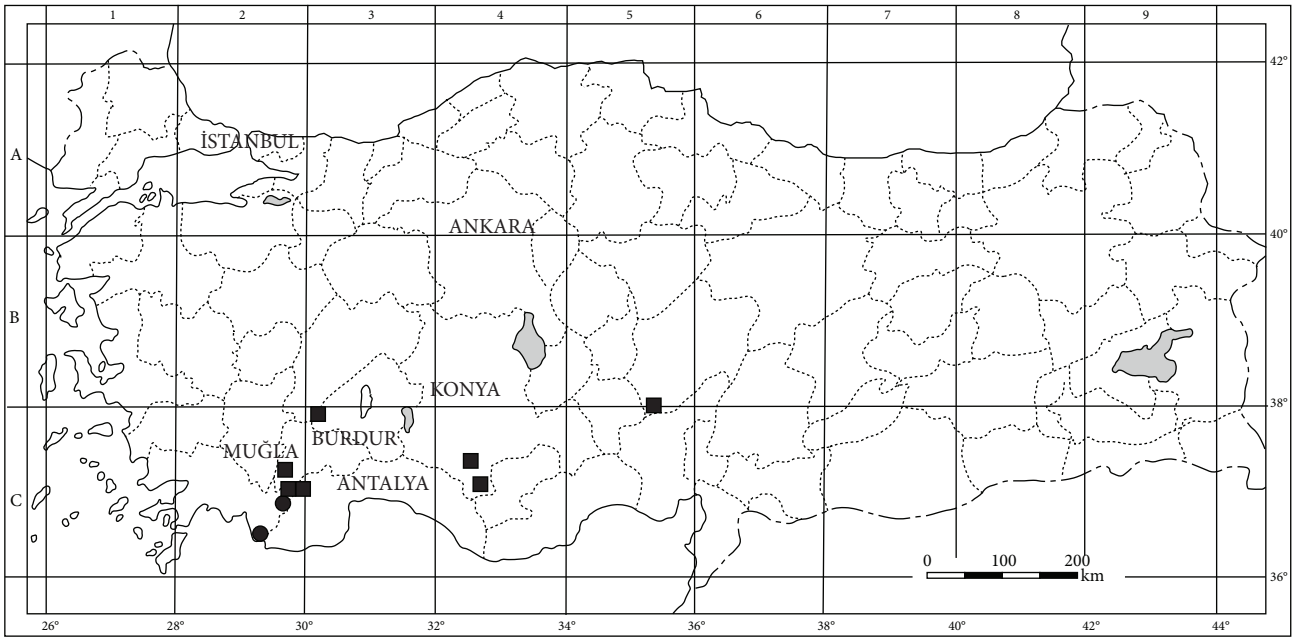

Figure 1. Distribution map of *Eryngium babadaghensis* (●) and *E. kotschyi* (■) in Turkey.

mm in diameter; involucral leaves 6-10 per capitulum, subulate, 20-70 × 2-6 mm, unequal, 2-4 × as long as capitulum, linear lanceolate with a broadened midrib and 1-2 pairs of spines; bracts all entire or the outermost tricuspidate, linear, pungent, 9-18 mm; sepals 3.3-3.8 mm, ovate, with a thickened midrib, acuminate, sometimes mucronate, broadly scarious margined, the calyx epidermal surface tuberculate-striate; petals 3.5-4.0 mm, white to lilac with a long inflexed lobe; style 7-9 mm long; fruits oblong or ovate-oblong, 9-10 mm long (including sepals), 3.0-3.8 mm broad, flattened, with long-acuminate to subulate appendages at the margins and the apices, shorter ones on the back; mericarps usually obovate-depressed, 5 rib with oil ducts present, associated with some bundles; mesocarp unlignified; endocarp partially lignified; vallecular and commissural vittae present; endocarp consists of 1 layer of parenchymatous cells; carpophore absent; druze crystals dispersed in the endocarp and mesocarp (Figure 2); the mesocarp surface of *E. babadaghensis* is aculeate under SEM (Figure 4).

Fl. 7-8, Fr. 8-10.

Chromosome number: 2n = 56, 112 (mixoploid).

Anatomical characters

Transverse sections were cut through the upper part of the peduncle. The peduncle is triangular or rounded and ribbed in section. The single layer of epidermal cells is covered with a crenate cuticle. The collenchyma tissue is located below the epidermis. It is irregular, 10- to 12-layered in the ribs, and 8- to 9-layered in the hollows. The parenchymatous tissue is located below the collenchyma tissue. Secretory canals are numerous (37-39) and embedded in the parenchymatous tissue. Some parenchymatous and collenchymatous cells contain numerous crystals. Vascular bundles are numerous (17-20) and arranged in a ring. Phloem and xylem are partly separated from each other by sclerenchyma tissue. The phloem is embedded in sclerenchyma tissue and parenchyma tissue. The xylem is embedded in the sclerenchyma tissue. The pith consists of large orbicular or polyhedral parenchymatous cells. The secretory canals are few in number (3-4) and embedded in parenchymatous tissue. Some parenchymatous cells contain a few crystals (Figure 3).

Paratypes: C2 Muğla: Fethiye, Babadağ, Eşekbayıltan site, 1463 m, stony slope, serpentine, clearing in *Juniperus excelsa* communities. 08.09.2008 (ISTE 86122); Fethiye, Eren Mountain, Girdev (Eren) plateau, 1700 m, 29.10.2009 (ISTE 87041).

Conservation status

Eryngium babadaghensis is endemic to south-west Anatolia. It is an eastern Mediterranean

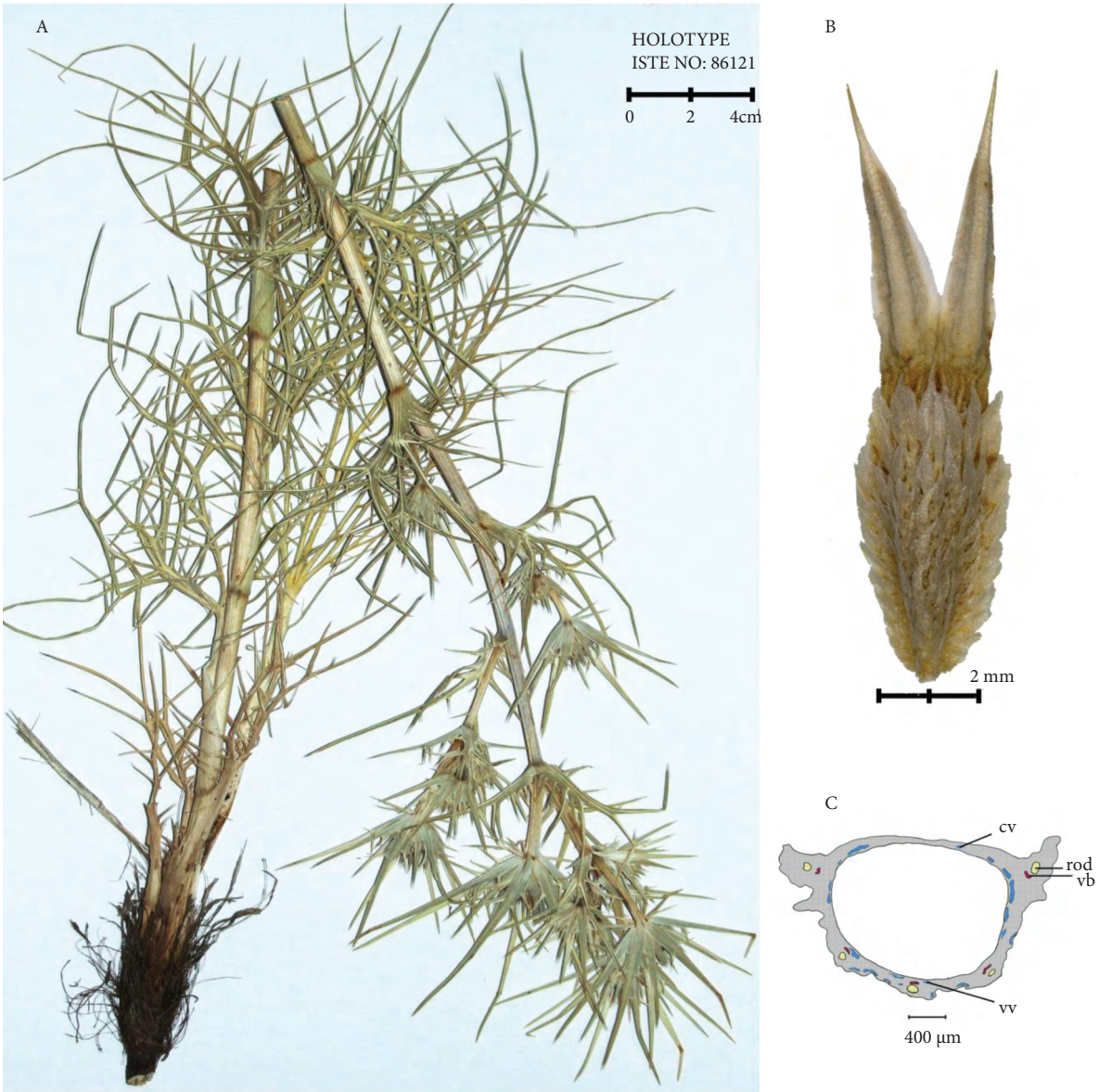

Figure 2. *Eryngium babdaghensis:* A- holotype, B- fruit, C- transverse section of mericarp, rod- rib oil duct, vb- vascular bundles, cv- commissural vitta, vv- vallecular vitta.

floristic element. The new species is recorded from only 2 localities near Fethiye (Muğla) in an area of occupancy estimated to be less than 500 km^2; the population size is estimated to be below 250 mature individuals. Therefore, it should be classified as endangered EN (criteria B2a, D1) (IUCN, 2001).

Ecology

Eryngium babadaghensis grows at an altitude of 1400-1700 m on the slope of a serpentine hill under the relatively open canopy of *Juniperus excelsa M.*Bieb. and *Cedrus libani* A.Rich. with *Teucrium scordium* L., *Satureja spinosa* L., *Capsella bursa-pastoris* (L.) Medik., *Stellaria media* (L.) Vill., *Silene italica* (L.) Pers., *Buxus sempervirens* L., and *Asyneuma linifolium* (Boiss. & Heldr.) Bornm. It is endemic to south-west Turkey (Figure 1).

Etymology

The mountain, Babadağ, is in south-west Turkey. The name of this mountain is given to the species described.

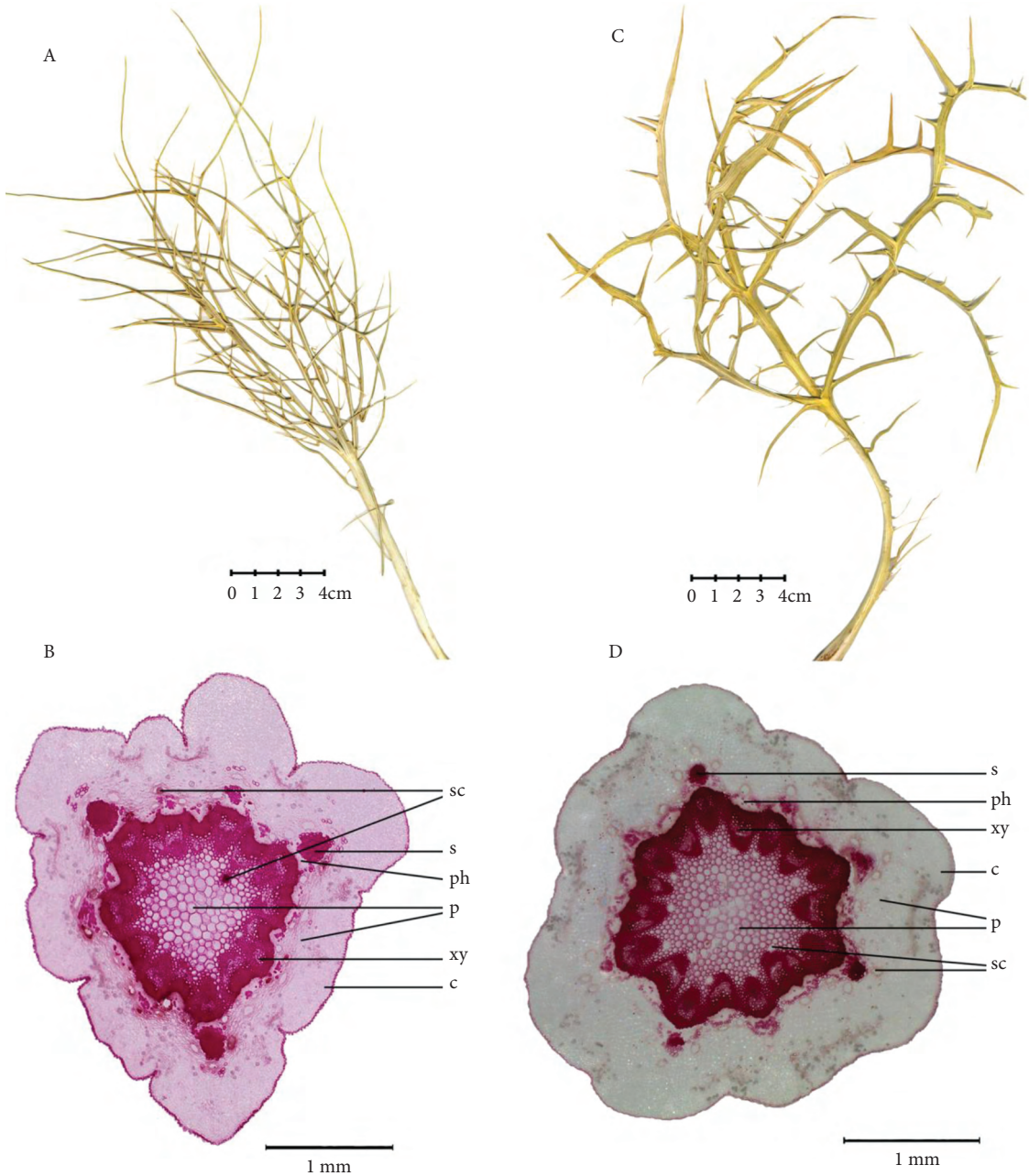

Figure 3. *Eryngium babadaghensis*: A- basal leaf, B- transverse section of peduncle. *E. kotschyi*: C- basal leaf, D- transverse section of peduncle. c- collenchymas, p- parenchyma, ph- phloem, s- sclerenchyma, sc- secretory canals, xy- xylem.

Discussion

The new species is morphologically similar to the endemic *Eryngium kotschyi* (Syn: *E. digitifolium* Stapf & Wettst. type specimens are examined). Comparative characters are summarised in the Table.

Differs from *E. kotschyi* by its linear basal leaf segments with the terminal segment longer than the lateral, by the longer petioles (9-22 cm versus 5-15 cm), the linear cauline leaf segments up to 1 mm broad, the styles 7-9 mm (versus 9-10 mm), the ovate-oblong to oblong fruits (versus ovate), and the peduncles with prominent ribs; the 17-20 vascular bundles (versus 14-17); and 37-39 secretory canals (versus 26-29).

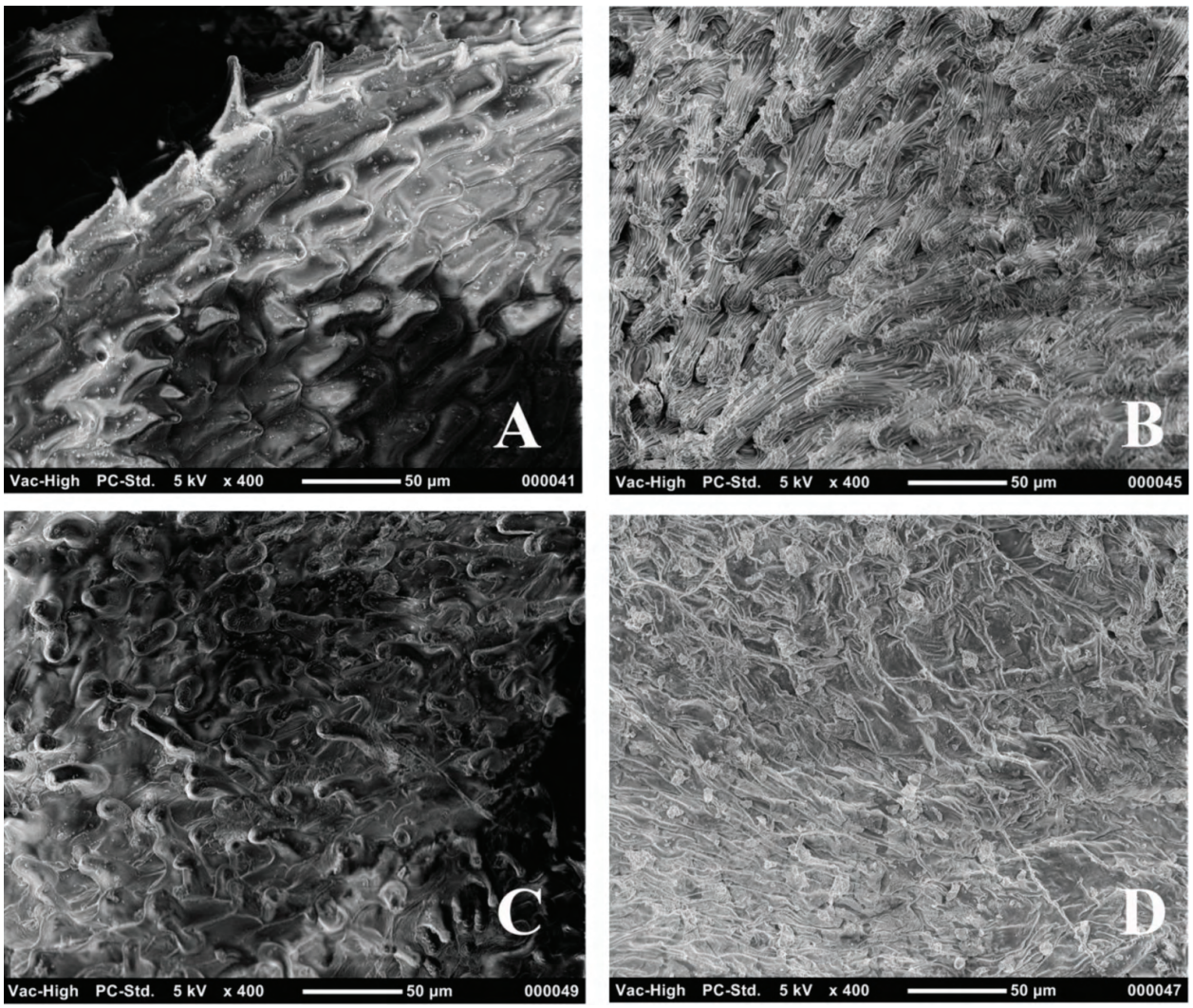

Figure 4. SEM photos of *Eryngium babadaghensis* and *E. kotschyi*. *E. babadaghensis*: A- mericarp surface, B- calyx epidermal surfaces. *E. kotschyi*: C- mericarp surface, D- calyx epidermal surfaces.

The somatic chromosome number of *E. babadaghensis* was 2n = 56, 112 (mixoploid) and not 2n = 16 as in *E. kotschyi*. In addition, the chromosome number of *E. kotschyi* was reported for the first time in this study (Figure 5).

The micromorphological characters show evidence of interesting specific variations that are significant for identification. The calyx epidermal surface of *E. babadaghensis* is tuberculate-striate, not ruminate, and the mericarp surface of *E. babadaghensis* is aculeate/tuberculate-smooth, not tuberculate-granulate (Figure 4).

The peduncle anatomy of the new species is relatively similar to *Eryngium kotschyi*, but differs from it according to the characters given (Table).

The close relationship between *Eryngium babadaghensis* and *E. kotschyi* and their sympatric distribution indicate a relatively recent separation of these 2 species. It is probably an evolution based exclusively on habitat differences. Serpentine habitats are characterised by their lack of nutrients and their high content of heavy metals, especially nickel, which may occur in concentrations toxic to many plants. Physiological adaptations to these habitats include either tolerance or accumulation and storing of these toxic metal ions. Hyperaccumulation of nickel is frequently observed in many Turkish species of the Brassicaceae (Reeves et al., 1983;

Table. Diagnostic characters of *Eryngium babadaghensis* and *E. kotschyi*.

Characters	*E. babadaghensis*	*E. kotschyi*
Flowering stems tall/colour	up to 75 cm tall/upper part is mauve, underside is glaucous	up to 110 cm tall/upper part is dark purple, underside is green
Basal leaves	numerous, lamina obovate, narrowly cuneate at the base, 9-24 × 10-14 cm, 3-4 palmatisect, segments linear, 2-3 mm broad, the terminal segments longer than the lateral	a few, lamina orbicular, broadly cuneate at the base, 6-20 × 6-27 cm, 2–4 palmatisect, segments linear-lanceolate, c. 7 mm broad, all segments are ± equal in length
Petioles	9-22 cm long	5-15 cm long
Cauline leaves	8-21 × 13-19 cm, segments linear, 0.5-1 mm wide at the apex, ultimate segment 6-11 cm long	3-12 × 12-18 cm, segments lanceolate, 1-2.2 mm wide at the apex, ultimate segment up to 5 (-6) cm long
Involucral leaves	6-10 per capitulum, entire or tricuspidate, linear-lanceolate 20-70 × 4-8 mm, 2-4 × as long as capitulum	6-15 per capitulum, entire or tricuspidate, lanceolate, 15-45 × 2-5 (-6) mm, 1-3 × as long as capitulum
Bracts	entire or the outermost tricuspidate, 9-18 mm long	entire, 7-13 mm long
Sepals	ovate, 3.3-3.8 mm long, acute or mucronate at the apex	ovate-lanceolate, 3.6-4.2 mm long, acuminate at the apex
Style	7-9 mm long	9-10 mm long
Fruit	oblong or ovate-oblong, 9-10 mm long, 3-3.8 mm broad	ovate, 6.8-9 mm long, 3.5-4.5 mm broad
Peduncle anatomy shape	triangular or rounded, ribs are prominent	rounded, ribs are not prominent
Collenchyma tissue in cortex	10-12 layered in the ribs and 8-9 layered in the hollows	8-10 layered in the ribs and 5-6 layered in the hollows
Secretory canals in cortex	37-39	26-29
Vascular bundles	17-20	14-17
Secretory canals in pith	3-4	6-8
Calyx epidermal surface	tuberculate-striate	ruminate
The surface of the scales on mericarp	aculeate/tuberculate-smooth	tuberculate-granulate
Chromosome number	2n = 56, 112	2n = 16

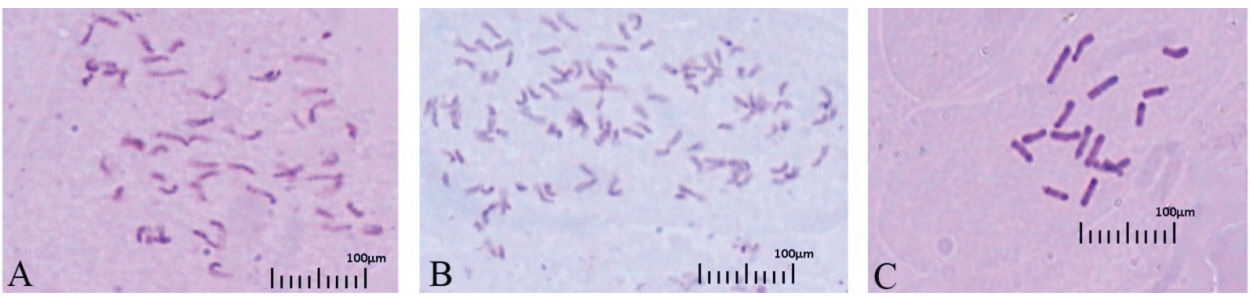

Figure 5. A chromosome metaphase plate of *Eryngium babadaghensis*: A: 2n = 56, B: 2n = 112. *E. kotschyi*: C: 2n = 16.

Reeves, 1988; Reeves et al., 2009) and *Centaurea* (Reeves & Adıgüzel, 2004). The vast majority of the species of *Eryngium* prefer calcareous soil. Apart from *E. babadaghensis*, 2 other species—*E. trisectum* A.Wörz & H.Duman and *E. thorifolium* Boiss.—grow exclusively in serpentine habitats. *E. thorifolium* is closely related to *E. pseudothorifolium* Contandr. & Quezel, and *E. trisectum* is closely related to *E. palmito* Boiss. & Heldr. Both *E. thorifolium* and *E. pseudothorifolium* occur in Fethiye (Muğla), not far from *E. babadaghensis* and *E. kotschyi*. Hence, the colonisation of serpentine habitats evolved at least 3 times within *Eryngium*.

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