

## *Cirsium sivasicum* sp. nov. and *C. peshmenianum* sp. nov. (Asteraceae) and their allies from Turkey

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Two new species of *Cirsium* Mill. from east Anatolia (Turkey): *C. sivasicum* Yıldız, Arabacı & Dirmenci and *C. peshmenianum* Yıldız, Dirmenci & Arabacı, are described and illustrated. Both new species belong to *C.* sect. *Epitrachys* DC. (Asteraceae: Cardueae) and are closely related to *C. rigidum* DC., *C. leuconeurum* Boiss. & Hausskn. and *C. karduchorum* Petr. The differences between the new species and their allies are discussed and a diagnostic key is provided. A detailed description of a previously poorly known species, *C. leuconeurum*, is also provided. The pollen grain morphology of the new species and their allies were investigated with light and scanning electron microscopes. Based on the shape of the spines and the surface ornamentation, the pollen grains of the species were divided into 3 types: *C. rigidum* and *C. sivasicum* (type I), *C. leuconeurum* and *C. peshmenianum* (type II), *C. karduchorum* (type III).

The genus *Cirsium* Mill. has approximately 250 species, distributed in Eurasia, North America and northern and eastern Africa, especially in wet waste grounds and steppes. It is one of the largest genera of the subfamily Carduoideae, tribe Cynareae/Cardueae (Asteraceae) (Boissier 1875, Charadze 1963, Davis and Parris 1975, Werner 1976, Petrak 1979, Kadereit and Jeffrey 2007).

According to recent studies, 61 species (75 taxa) are found in Turkey, of which 20 (25 taxa) are endemic. The species are classified in three sections: *C.* sect. *Epitrachys* DC. (43 species), sect. *Cirsium* (17 species) and sect. *Cephalonoplos* (Neck.) DC. (1 species) (Davis and Parris 1975, Davis et al. 1988, Güner et al. 2000, Daşkın et al. 2006, Yıldız and Dirmenci 2008, Yıldız et al. 2009a, 2009b). The pollen morphology has only been studied in one or two species (Erdtman 1945).

A still poorly known species, *C. leuconeurum*, was described in 1885 based on type specimens collected from Mount Berit (Kahramanmaraş) by Haussknecht. A second fragmentary material was collected from Mount Ahır (Kahramanmaraş) by G. Post. In recent years, the present authors have collected more material from the type locality and from Ahır (Kahramanmaraş) mountains. Some specimens have also been collected from Mount Engizek (Kahramanmaraş) by H. Duman. These specimens apparently belong to *C. leuconeurum*, but more or less different from the type and an emended description of the species based on the specimens mentioned above is presented below.

It is further concluded that specimens collected from Sivas province in Turkey belong to a previously undescribed

species with affinities to *C. rigidum* DC., and specimens collected from Van province represent another previously undescribed species with affinities to *C. leuconeurum* Boiss. & Hausskn. and *C. karduchorum* Petr. The differences between the new species and their allies are presented in detail in Table 1.

### Material and methods

The material on which this study is based were collected from east Anatolia (Artvin, Hakkari, Kahramanmaraş, Sivas and Van provinces) during revisionary studies of Turkish *Cirsium* species between Jun–Sep in the years 2006 to 2009 (Fig. 1). In addition, *Cirsium* specimens collected from Turkey and neighbouring countries by many botanists and deposited in the herbaria ANK, BM, E, EGE, G, GAZI, HUB, ISTE, ISTF, ISTO, K, W and WU have been revised. Pertinent reference works from the literature were used to identify the specimens (Boissier 1875, Somnier and Levier 1895, Petrak 1910, 1912, 1964, 1979, Charadze 1963, Davis and Parris 1975, Huber-Morath 1980, 1982, Sorger and Buchner 1983a, 1983b, Davis et al. 1988, Güner et al. 2000, Özhatay et al. 2009).

Pollen grains were prepared for light microscopy following the methods described by Wodehouse (1935). Samples were examined using light (LM) and scanning electron microscopes (SEM). The following parameters were measured: polar axis (P), equatorial diameter (E), exine thickness, length and thickness of the spines.

Table 1. Comparison of diagnostic characters used to distinguish new species of *Cirsium* and allied species.

Species	<i>C. rigidum</i>	<i>C. sivasicum</i>	<i>C. leuconeurum</i>	<i>C. peshmenianum</i>	<i>C. karduchorum</i>
Stem	multi-stemmed from base, ascending-erect, 40–80(–100) cm, with a few branches above	multi-stemmed from base, ascending-erect, 50–100 cm, much branched	few stemmed from base, ascending-erect, 40–80(–100) cm, much branched	few stemmed from base, erect, 100–150 cm, with a few branches above	few stemmed from base, erect, 75–150 cm, with a few branches above
Basal leaves	15–25 × 7–10 cm (excluding 8–10 cm petiole), glaucous	30–40 × 15–27 cm (excluding 10–15 cm petiole), green	15–30 × 10–15 cm (excluding ca 5 cm petiole), green	30–40 × 16–20 cm (excluding 10–15 cm petiole), green	30–40 × 15–20 cm (excluding 15–20 cm petiole), glaucous
Median leaves	7–12 × 5–7 cm, pinnatifid; lobes often rounded; apical spine to 15 mm	30–35 × 14–18 cm, pinnatisect; lobes acute at apex; apical spine 3–10 mm	7–30 × 3–10 cm, pinnatifid; lobes acute at apex; apical spine 5–15 mm	10–30 × 4–18 cm, pinnatisect to 2/3; lobes acute at apex; apical spine 8–18 mm	20–40 × 10–20 cm, pinnatifid; lobes acute at apex; apical spine 4–14 mm
Leaves indumentum	glabrous to sparsely arachnoid above, glabrous beneath	sparsely arachnoid above, glabrous beneath	glabrous to sparsely arachnoid on both surfaces	glabrous to sparsely arachnoid above, glabrous beneath	glabrous to sparsely arachnoid above, glabrous beneath
Involucral leaves	shorter than involucre	as long as or shorter than involucre	shorter or longer than involucre	shorter than involucre	much shorter than involucre
Involucre	20–30 × 20–30 mm	20–30 × 30–40 mm	20–30 × 20–30 mm	15–25 × 15–25 mm	25–30 × 20–40 mm
Phyllaries	8–10-seriate	7–9-seriate	7–11-seriate	7–11-seriate	11–14-seriate
Median phyllaries	12–17 mm, with erecto-patent (2–)3–5 mm apical spine	10–15 mm, with erecto-patent 1–3 mm apical spine	10–21 mm, with erecto-patent 2–6(–8) mm apical spine	10–13 mm, with erecto-patent 1–3 mm apical spine	17–24 mm, with reflexed or recurved 5–10 mm apical spine
Corolla length (mm)	25–30	27–35	21–30	23–30(–35)	25–35
Pappus length (mm)	18–26	22–27	15–25	13–20	18–22
Achene length (mm)	5.0–5.5	7.5–8.5	6.0–8.5	5–7	6.0–7.5

In addition, the quotients P/E were calculated (Table 2). Twenty measurements per population were taken for P and E and 10 for the other parameters. Measurements and LM micrographs were taken with an Olympus BX 51 microscope. All of the measurements were done using CARNOY 2.0 (Schols et al. 2002). For scanning electron microscopy (SEM), pollen grains were placed directly on the stubs, coated with gold and examined using an XL-30 ESEM-FEG/PHILIPS scanning electron microscope (Fig. 2–5). The pollen terminology generally follows Faegri and Iversen (1975) and Punt et al. (2007).

***Cirsium sivasicum* Yıldız, Arabacı & Dirmenci sp. nov. (Fig. 6B, 7B, 8D–F, 9B, 10B) ( *C. sect. Epitrachys* DC.)**

*Cirsio rigido* DC. affinis, a quo foliis basalibus 30–40 × 15–27 cm (petiolo excepto) (non 15–25 × 7–10 cm), lobis foliorum acutis ad acuminatos (non rotundis), foliis mediis viridibus (non glaucis), involucri phyllis mediis oblongis, spina apicali 1–3 mm (non lanceolatis, spina apicali 3–5 mm) imprimis differt.

**Type:** Turkey. B6 Sivas: Zara, 3–4 km south of Bolucan, 1400 m a.s.l., eroded slopes, 18 Jul 2007, Yıldız 16487 (holotype: ISTE, isotypes: G, GAZI, HUB, INU).

Perennial, multi-stemmed from base. Stem 50–100 cm tall, ascending-erect, stout, much branched, unwinged but longitudinally striate, glabrous. Basal leaves 30–40 × 15–27 cm (excluding the 10–15 cm long petiole), green, oblong in outline, pinnatisect, spinose-strigose above with adpressed 0.5–1.5 mm long setae, ca 2 per 2 mm square, otherwise sparsely arachnoid; lower surface glabrescent; lateral lobes 4–5-paired, unequally bifid, 7–13 × 1–3 cm, oblong, acute to acuminate, with a moderately stout apical spine, 2–7 × 0.3–0.7 mm, margins spinulose, veins prominent on lower surface. Stem leaves diminishing from base to inflorescence, the median 30–35 × 14–18 cm, oblong to obovate in outline, pinnatisect, ca 3–5-lobed, spinose-strigose above with 0.5–1.5 mm long setae, ca 2 per 2 mm square, otherwise sparsely arachnoid; lower surface glabrescent; lateral and terminal lobes oblong, acute, with apical spine 3–10 × 0.5–1.0 mm, margins spinulose-ciliate; upper cauline leaves to 20 × 12 cm, large auriculate, completely clasping the stem; involucre 20–30 × 30–40 mm, globose to ovoid; phyllaries adpressed, glabrous, yellowish, 7–9-seriate, the outer 7–10 × 3–5 mm, ovate to oblong, including a week ± straight 1–2 × 0.2 mm apical spine; the median 10–15 × 2.5–4.0 mm, oblong, including an erecto-patent 1–3 × 0.2 mm apical spine; the inner 20–27 × 2.5–3.0 mm, linear-lanceolate, including a week erecto-patent 3–4 × 0.2 mm apical spine. Corolla purple, 27–35 mm long, lobed to 1/3–1/2, lobes ca 15 mm long. Style 15–18 mm long, exerted, shortly bilobed; filaments 4–5 mm long, densely white hairy, anthers 8–12 mm long, acuminate. Achenes 7.5–8.5 × 3.0–3.2 mm, obovate-oblong, brownish, asymmetric, compressed, with a ca 0.5 mm long umbo, apex ring yellow,

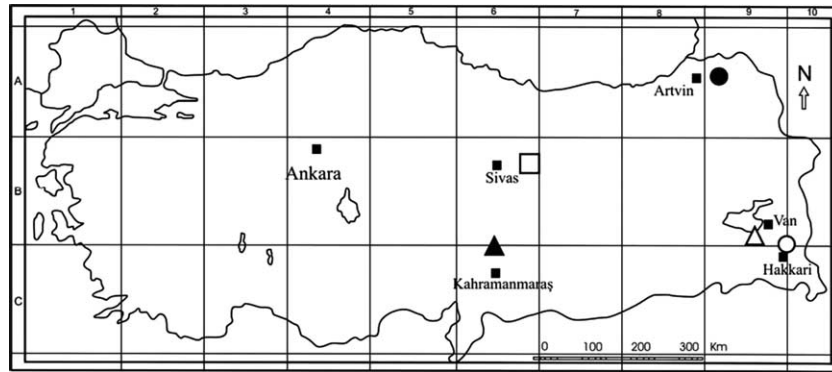


Figure 1. Distribution of *Cirsium rigidum* (●), *C. sivasicum* (□), *C. leuconeurum* (▲), *C. peshmenianum* (△) and *C. karduchorum* (○) in Turkey.

Table 2. Length of pollen polar axis and equatorial axis of the new species and their allies (all measurements in  $\mu\text{m}$ ).

Taxa	Polar axis		Equatorial axis	
<i>C. rigidum</i>	(59.95)	64.54 (68.41)	(45.15)	50.90 (60.67)
<i>C. sivasicum</i>	(45.95)	58.90 (66.82)	(43.02)	48.36 (53.33)
<i>C. leuconeurum</i>	(44.29)	50.55 (55.80)	(36.34)	39.66 (42.03)
<i>C. peshmenianum</i>	(50.05)	57.09 (63.80)	(40.83)	47.14 (51.51)
<i>C. karduchorum</i>	(42.91)	46.53 (49.17)	(40.66)	45.01 (48.69)

narrow. Pappus 22–27 mm long plumose, stramineous. Flowering and fruiting in Jul–Sep.

#### Habitat and ecology

*Cirsium sivasicum* grows in open places in *Quercus cerris* L. scrub between 1300 and 1500 m a.s.l. together with *Eryngium campestre* L., *Astragalus* spp., *Thymus sipyleus* Boiss., *Onobrychis* sp., *Acantholimon ulicinum* Boiss., *Salvia microstegia* Boiss. & Balansa, *Rosa* sp., *Centaurea* sp., *Helichrysum plicatum* DC. and *Origanum acutidens* (Hand.-Mazz.) Ietsw.

#### Distribution and conservation status

*Cirsium sivasicum* is endemic to Sivas province, east Anatolia and is an Irano–Turanian element. It is known from a few neighbouring areas between 1300 and 1500 m a.s.l., where its distribution area is less than 100 km<sup>2</sup> and the total number of individuals is approximately 500–1000 (B2abii). Therefore, it should be regarded as ‘Endangered’ (EN) (IUCN 2001).

#### Etymology

The species epithet is derived from the name of the province (Sivas) where the type was collected.

#### Additional specimens examined (paratypes)

Turkey. B6 Sivas: between Divriği and Zara, 28 km northwest of Divriği, 1350 m a.s.l., 13 Jul 1981, Nydegger 16965 (E, G, W); between Sincan and Divriği, 8 km east of Sincan, 1380 m a.s.l., 14 Jul 1982, Nydegger 17144 (G); between Divriği and Sincan, 1350 m a.s.l., 22 Jul 2009,

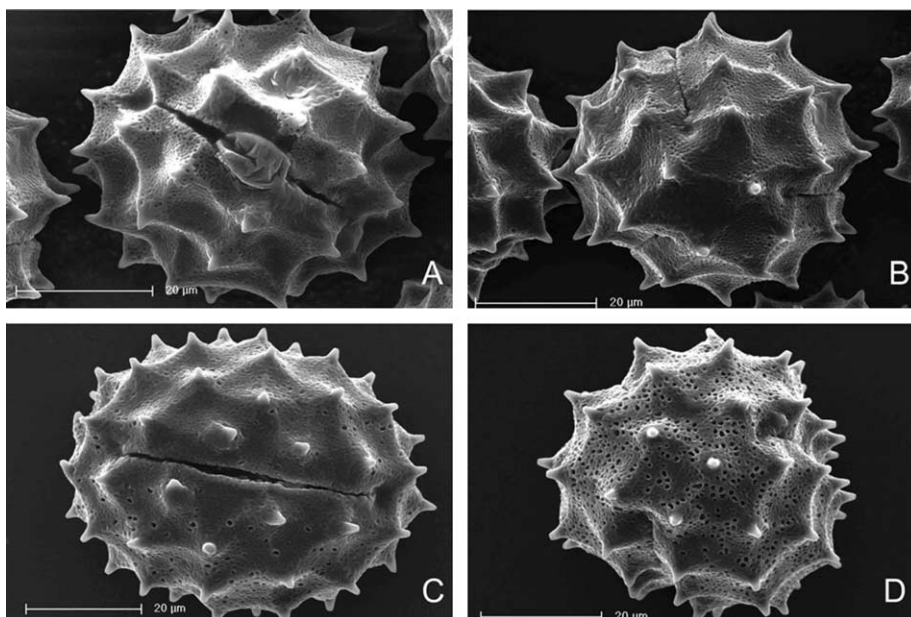


Figure 2. Pollen micrograph of *Cirsium sivasicum* (A)–(B) and *C. rigidum* (C)–(D). (A), (C) equatorial view, (B), (D) polar view.

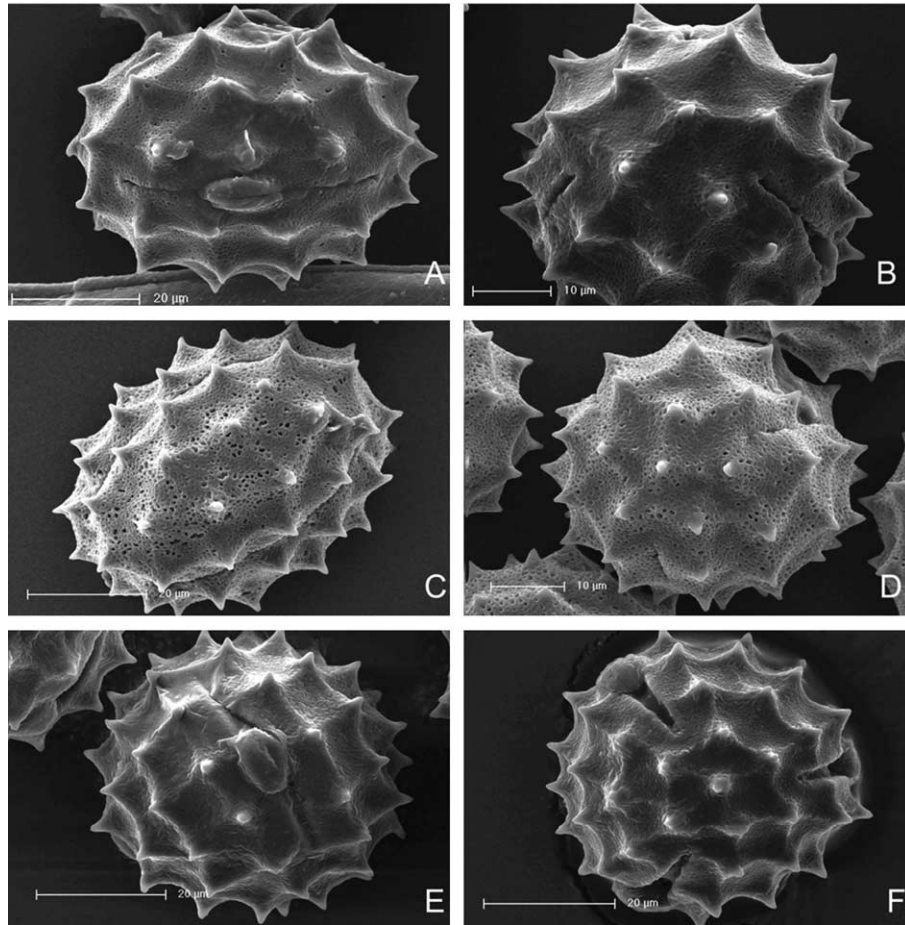


Figure 3. Pollen micrographs of *Cirsium peshmenianum* (A)–(B), *C. leuconeuro* (C)–(D), *C. karduchorum* (E)–(F). (A), (C), (E) equatorial view, (B), (D), (F) polar view.

39°29'900"N, 37°56'300"E, Yıldız 17066 and Tekin; between Zara and Bolucan, Karabel pass, 1500 m a.s.l., 22 Jul 2009, Yıldız 17056 and Tekin.

***Cirsium peshmenianum* Yıldız, Dirmenci & Arabacı sp. nov. (Fig. 6D, 7D, 8J–L, 9D, 10C) (C. sect. *Epitrachys* DC.)**

*Cirsio leuconeuro* Boiss. & Hausskn. et *C. karduchorio* Petr. affinis; a *C. leuconeuro foliis basalibus majoribus* 30–40 × 16–20 cm (non 15–30 × 10–15 cm), petiolis 10–15 cm longis (non circa 5 cm), involucri phyllis spina apicali 1–3 mm (non 2–6 mm) differt. A *C. karduchorio foliis basalibus ad 3/4* (non 1/4) dissectis, involucri minoribus 15–25 × 15–25 mm (non 25–30 × 20–40 mm), involucri phyllis spina apicali 1–3 mm (non 5–10 mm) differt.

**Type:** Turkey. B9 Van: between Çatak and Bahçesaray, north of Yukarınarlı village, between Yukarınarlı village and Karapet pass, south slopes, 2200–2400 m a.s.l., conglomerate, 38°08'680"N, 42°02'000"E, 18 Aug 2008, Yıldız 16958, Dirmenci and Fırat (holotype: ISTE, isotypes: E, INU, W).

Perennial, single or a few stemmed from base. Stem 100–150 cm tall, erect, few branched above, unwinged, glabrous. Basal leaves 30–40 × 16–20 cm (excluding the 10–15 cm

long petiole), oblong in outline, green, pinnatisect to 3/4, spinose-strigose above with 0.5–1.1 mm long, adpressed setae, ca 2 per 2 mm square, otherwise sparsely arachnoid; lower surface glabrous; lateral lobes in 5–6 pairs, 8–10 × 5–6 cm, unequally tripartite, triangular, acute, with a stout, 7–17 mm long apical spine, spinulose along margins. Median cauline leaves 10–30 × 4–18 cm, oblong in outline, sessile, auriculate, auricles clasping the stem, pinnatisect to 2/3, 5–6-lobed, spinose-strigose above with 0.5–1.0 mm long, adpressed setae, ca 2 per 2 mm square, otherwise glabrous to sparsely arachnoid; lower surface glabrescent; lateral and terminal lobes 3.5–5.0 × 2.0–2.5 cm, triangular-ovate, acute, unequally tripartite, with thickened veins much raised on lower surface, terminating in a stout, 8–18 mm long apical spine, spinulose-ciliate along margins; upper cauline leaves 7–15 × 3–7 cm, oblong to ovate, shortly auriculate. Uppermost (involucre) leaves 2–3 cm long, shorter than involucre, sessile. Capitula erect, 1–4 on each branch, 20–30(–35) × 15–25 mm, sessile or pedunculate to 2 cm; involucre 15–25 × 15–25 mm, ovoid to subglobose; phyllaries adpressed, glabrous, yellowish, 7–11-seriate, the outer 5–7 × 2–3 mm, ovate, including a moderately stout, straight, 1.0–1.5 × 0.2–0.3 mm long apical spine; the median 10–13 × 2–3 mm, oblong, including an erecto-patent 1–3 × 0.2–0.3 mm apical spine; the inner 20–23 × 2.0–2.5 mm, lanceolate, including an erecto-patent 3–4 ×

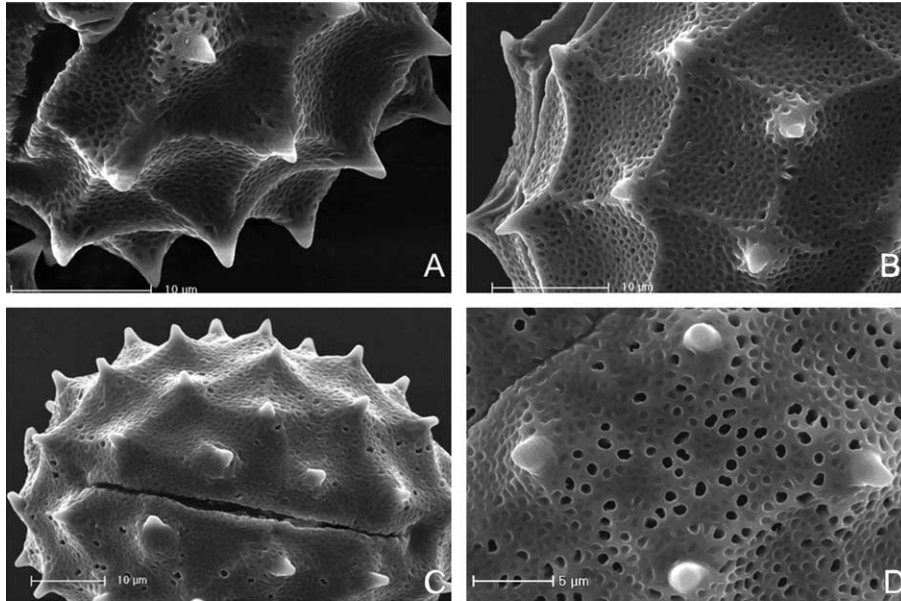


Figure 4. Pollen micrograph of *C. sivasicum* (A)–(B) and *C. rigidum* (C)–(D). (A), (C) detail of spines, (B), (D) exine structure.

0.2 mm apical spine. Corolla purple, 23–30 (–35) mm long, lobed to 1/4–1/3. Style 13–17 mm long, exerted, shortly bi-lobed; filaments 3–5 mm long, densely hairy;

anthers 8–10 mm long, acuminate. Achenes 5–7 × 2–3 mm, ovate-oblong, dark brown, strongly asymmetric, slightly compressed, with a ca 0.5 mm long umbo, apex ring yellow,

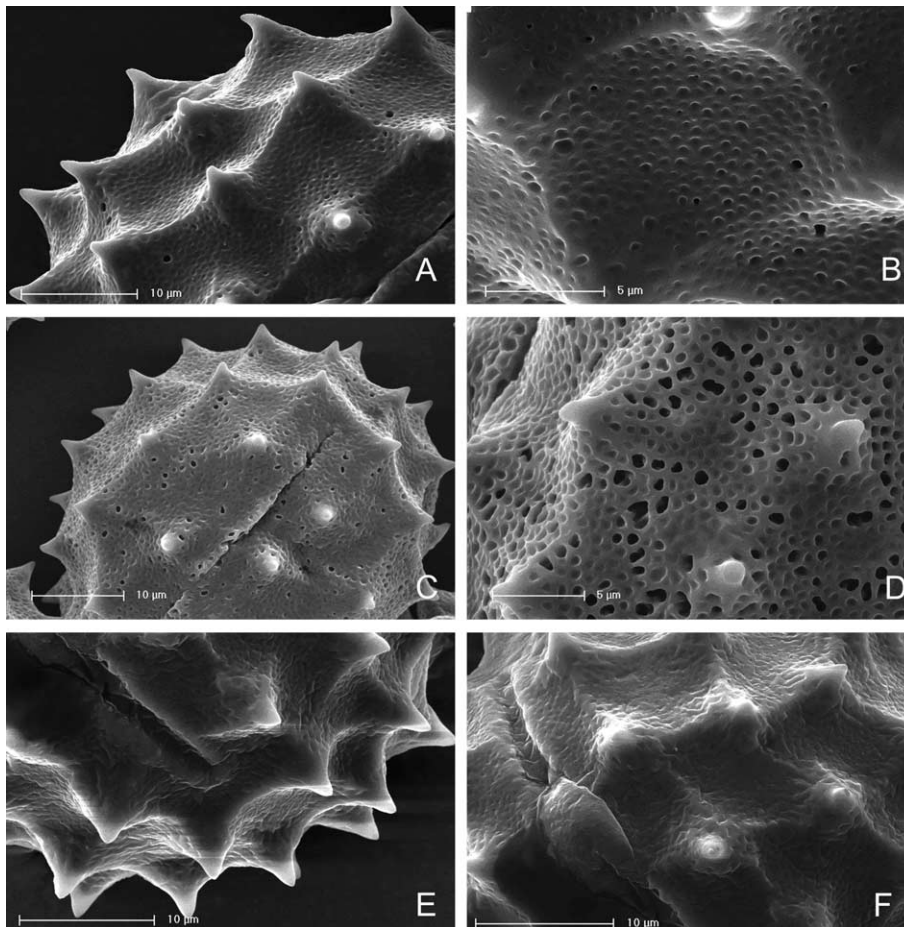


Figure 5. Pollen micrograph of *Cirsium peshmenianum* (A)–(B), *C. leuconeurum* (C)–(D), *C. karduchorum* (E)–(F). (A), (C), (E) detail of spines, (B), (D), (F) exine structure.

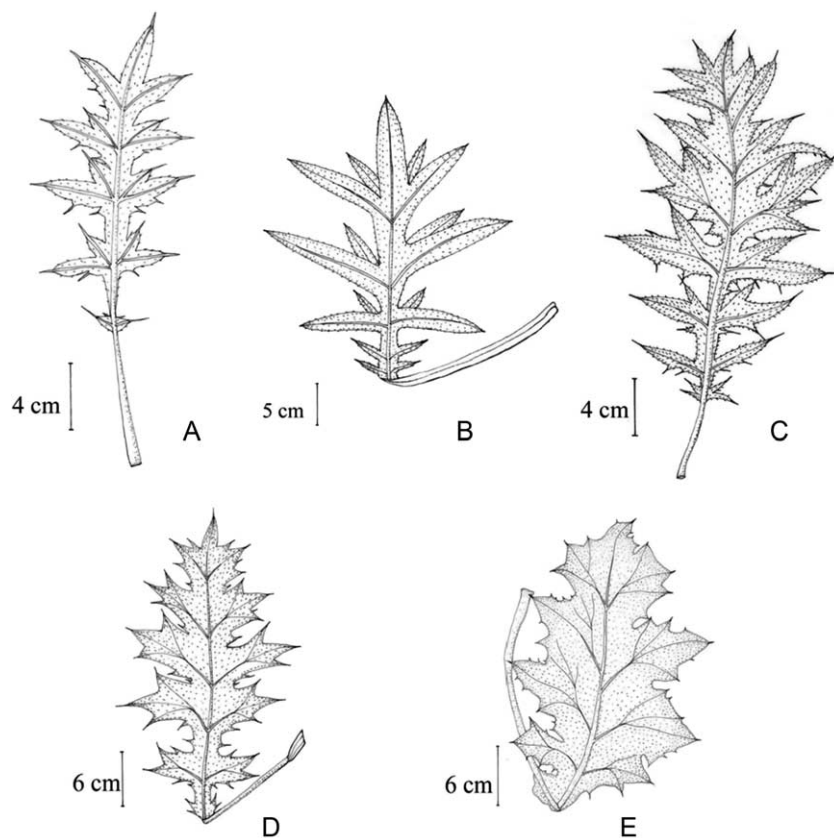


Figure 6. Basal leaves of (A) *Cirsium rigidum* (from Dirmenci 3621), (B) *C. sivasicum* (from Yıldız 16487), (C) *C. leuconeurum* (from Dirmenci 3675), (D) *C. peshmenianum* (from Yıldız 16958), (E) *C. karduchorum* (from Yıldız 16932).

narrow. Pappus (13–)15–20 mm long plumose, dirty white. Flowering and fruiting in Aug–Sep.

#### **Habitat and ecology**

*Cirsium peshmenianum* grows on conglomerate between 2200 and 2400 m a.s.l. The area was floristically poor at the time of collection.

#### **Distribution and conservation status**

*Cirsium peshmenianum* is endemic to Van province and is an Irano–Turanian element. It is only known from the type locality where its distribution area is apparently less than 10 km<sup>2</sup> and the total number of known individuals is ca 500 (B2abii). It should therefore be regarded as ‘Critically Endangered’ (CR) (IUCN 2001).

#### **Etymology**

The species was named after the late Associate Prof. Dr Hasan Peşmen, a well-known plant taxonomist in Turkey.

***Cirsium leuconeurum* Boiss. & Hausskn. in Boiss. (1875, p. 534) (Fig. 6C, 7C, 8G–I, 9C, 10D). (*C. sect. Epitrachys* DC.)**

**Type:** Turkey. C6 Maraş; ad rivulos in monte Berytdagh Cataoniae, 1830 m a.s.l., Haussknecht (G)!

Perennial, few stemmed from the base. Stem 40–80 (–100) cm tall, ascending to erect, stout, much branched above, unwinged, glabrous. Basal leaves 15–30 × 10–15 cm (excluding the ca 5 cm long petiole), narrowly ovate to oblong in outline, green, pinnatifid, sparsely spinose-strigose above with 0.5–1.3 mm long, patent to adpressed setae, ca 2 per 2 mm square, glabrous to sparsely arachnoid on both surfaces; lateral lobes 4–7-paired, unequally 2–3 partite, ovate to triangular-lanceolate, acute, 1–9 × 0.5–2.0 cm, with a 7–16 mm long, stout apical spine, spinulose along margins. Median cauline leaves 7–30 × 3–10 cm, narrowly ovate to oblong, with large auricles clasping the stem, pinnatifid, sparsely spinose-strigose above with patent to adpressed, 0.3–1.6 mm long seta, 2–4 per 2 mm square, glabrous to arachnoid on both surfaces; lateral lobes 3–5-paired, unequally bifid, triangular, 3–6 × 1.5–3.0 cm, acute, lateral and terminal lobes and teeth with thickened veins much raised on the lower surface, terminating in stout, 5–15 mm long apical spine, spinulose along margins; upper cauline leaves 4–10 × 2–5 cm, oblong to ovate, shortly auriculate. Uppermost (involucral) leaves 3–5, (2–)4–8 cm long, shorter or longer than involucre. Capitula erect, 3–14 on each branch, rarely solitary, cylindric to subglobose, 30–40 × 20–30 mm, with 1–8 cm long peduncle. Involucre 20–30 × 20–30 mm; phyllaries in 7–11 rows, glabrous to sparsely arachnoid; outer phyllaries 8–15 mm long, ovate to oblong, including an erecto-patent to ± recurved 2–7 mm long apical spine; median phyllaries 10–21 mm, oblong-lanceolate, including an erecto-patent

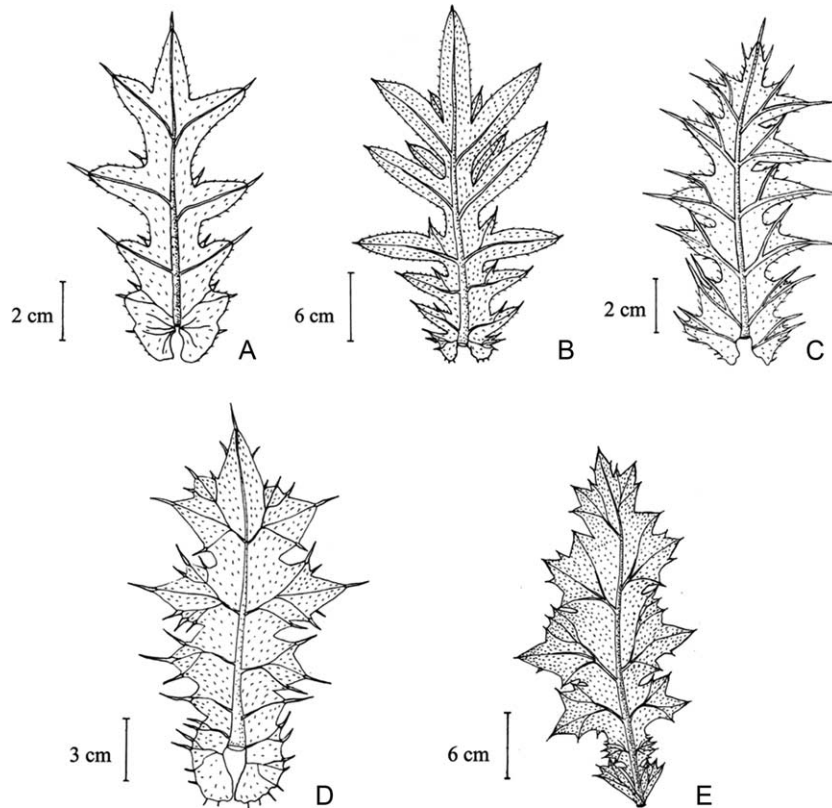


Figure 7. Median cauline leaves of (A) *Cirsium rigidum* (from Dirmenci 3621), (B) *C. sivasicum* (from Yıldız 16487), (C) *C. leuconeurum* (from Dirmenci 3675), (D) *C. peshmenianum* (from Yıldız 16958), (E) *C. karduchorum* (from Yıldız 16932).

2–6(–8) mm long apical spine; inner phyllaries 15–25 mm long, linear-lanceolate, including an erecto-patent 3–6 mm long apical spine. Corolla purple, 21–30 mm long, lobed to 1/5–1/6; lobes 5–8 mm long. Style 13–18 mm long, exserted, shortly bilobed; filaments 2–3 mm long, densely hairy; anthers 13–18 mm long, acute. Achenes 6.0–8.5 × 2–3 mm, oblong, asymmetric, slightly compressed, with ca 0.5 mm long umbo, apex ring yellow, narrow. Pappus 15–25 mm, long plumose, dirty white. Flowering and fruiting in Jul–Sep.

#### Habitat and ecology

*Cirsium leuconeurum* grows on calcareous slopes, rocky slopes and dried stream sides between 1830 and 2500 m a.s.l. together with *Astragalus* spp., *Cirsium lappaceum* Fisch. subsp. *anatolicum* Petr., *Cousinia foliosa* Boiss. & Balansa, *Gundelia tournefortii* L., *Juniperus* sp. and *Nepeta glomerata* Montbret & Aucher.

#### Distribution in Turkey

South Anatolia (Anti-Taurus) B6 Kahramanmaraş: Çardak, Kandil Mount, 24 Jul 1952, Davis 20232, Dods and Çetink (BM, E, K)! Engizek Mountain, south of Elibüyük Hill, 2500 m a.s.l., 25 Aug 1986, H. Duman 2315 (E, GAZI)! Gökşun, Kınıkköz village, Berit Mountain, Çavdar Gediği, calcareous west slopes, 2000–2100 m a.s.l., 3 Sep 2006, 38°01'000"N, 36°49'000"E, Yıldız 16435 and Dirmenci! Ahır Mountain, rocky slopes, 2290 m a.s.l., 20 Jul 2008,

Dirmenci 3675, Arabacı and Akçiçek! Elbistan, Sarıgüzel, Berit Mountain, south slopes, 2260 m a.s.l., 22 Aug 2008, 37°59'400"N, 36°55'500"E, Yıldız 16985, Dirmenci and Arabacı! C6 Gaziantep: Akher (Ahir) Da., G. Post.

#### Conservation status

*Cirsium leuconeurum* is endemic to Kahramanmaraş province and is an east Mediterranean element. This species was previously placed in 'Lower Risk – Conservation Dependent' (LR (cd)) category in the Türkiye Bitkileri Kırmızı Kitabı (red data book of Turkish plants) (Ekim et al. 2000). However, according to our observations, it is only present in a few localities where its area of occupancy is apparently less than 2000 km<sup>2</sup> (B2abii). Accordingly, it should be regarded as 'Vulnerable' (VU) according to the IUCN criteria (2001).

#### Key to the new species and their allies

The key given below include ten species including the new species. These species are characterized by lower leaf surfaces glabrous or very sparsely arachnoid on veins only, but with sparse, less than 5 per 2 mm square, setae on the upper surface (close with 5 or more per 2 mm square in *C. cassium* only). All other Turkish species belonging to *C.* sect. *Epitrachys* have lower leaf surfaces arachnoid to tomentose and 5 or more setae per 2 mm square on the upper leaf surfaces (Fig. 9).

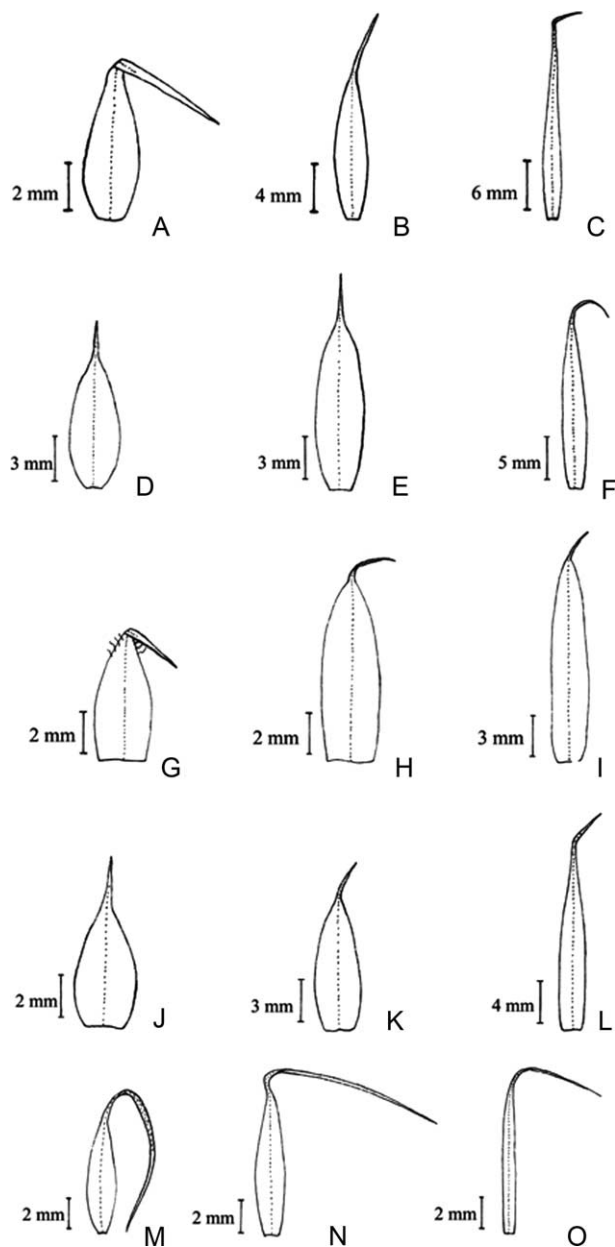


Figure 8. *Cirsium rigidum* (from Dirmenci 3621): (A) outer phyllary, (B) median phyllary, (C) inner phyllary. *Cirsium sivasicum* (from Yıldız 16487): (D) outer phyllary, (E) median phyllary, (F) inner phyllary. *Cirsium leuconeurum* (from Dirmenci 3675): (G) outer phyllary, (H) median phyllary, (I) inner phyllary. *Cirsium peshmenianum* (from Yıldız 16958): (J) outer phyllary, (K) median phyllary, (L) inner phyllary. *Cirsium karduchorum* (from Yıldız 16932): (M) outer phyllary, (N) median phyllary, (O) inner phyllary.

1. Involucre sessile in dense corymbs..... *C. congestum*  
– Involucre in racemes or racemose panicles..... 2
2. Involucral leaves clearly longer than the involucre .... 3  
– Involucral leaves shorter, equal or shortly exceeding the involucre..... 5
3. Upper leaf surface densely setose with 5 or more seta per 2 mm square..... *C. cassium*

- Upper leaf surface with less than 5 seta per 2 mm square (rarely completely absent in *C. pseudobracteosum*)..... 4
4. Median cauline leaves glaucous, 5–11-paired; pappus 10–12 mm long; corolla pinkish purple.....  
..... *C. pseudobracteosum*  
– Median cauline leaves green, 4–6-paired; pappus 14–16 mm long, corolla whitish pink to pink ..... *C. bracteosum*
5. Involucre 10–15 × 10–15 mm; corolla 15–17 mm long; pappus 11–15 mm long..... *C. aduncum* subsp.  
..... *bashkalense*  
– Involucre 15–40 mm; corolla >20 mm long; pappus >15 mm long ..... 6
6. Involucral leaves clearly shorter than involucre; median phyllaries with a conspicuously recurved, 5–10 mm long apical spine..... *C. karduchorum*  
– Involucral leaves shorter or longer than involucre; median phyllaries with an erect or erecto-patent, 1–6 mm long apical spine ..... 7
7. Leaves glaucous, lobes rounded at apex (except for the apical spine)..... *C. rigidum*  
– Leaves yellowish-green to green, lobes acute to acuminate at apex, rarely rounded..... 8
8. Stems single or a few from base, erect, 100–150 cm tall; involucre 15–25 × 15–25 mm ... *C. peshmenianum*  
– With few to many stemmes from base, ascending to erect, 50–100 cm tall; involucre 20–40 × 20–40 mm ..... 9
9. Lobes of basal leaves oblong; capitula 1–2 on each branch; median phyllaries oblong, with erect, 1–3 mm long apical spine..... *C. sivasicum*  
– Lobes of basal leaves ovate to triangular-lanceolate; capitula 3–14 on each branch; median phyllaries lanceolate, with an erecto-patent, 2–6 mm long apical spine ..... *C. leuconorum*

### Pollen morphology of the new species and their allies

*Cirsium rigidum* Pollen grains tricolporate, 68% of pollen subprolate, amb circular (Fig. 11). Exine 1.82  $\mu\text{m}$  thick, thinner at the poles, ornamentation echinate, tectum complete structured, microreticulate with suprategal spinules, reticules irregular and large. Spinules conic, blunt ended, 1 per 100  $\mu\text{m}^2$ , 2.2  $\mu\text{m}$  long, base diameter 2.3  $\mu\text{m}$ , intine 1.2  $\mu\text{m}$  thicker. Colpi margins distinct with pointed ends. 42.25  $\mu\text{m}$  long, Distances between colpi ends 23.9  $\mu\text{m}$  (Table 3).

*Cirsium sivasicum*: Pollen grains tricolporate, 65% of pollen subprolate, amb circular (Fig. 11). Exine 2.14  $\mu\text{m}$  thick, thinner at the poles, ornamentation echinate, tectum complete structured, microreticulate with suprategal spinules, reticules regular and small. Spinules conic and pointed, 1–2 per 100  $\mu\text{m}^2$ , 2.8  $\mu\text{m}$  long, base diameter 3.3  $\mu\text{m}$ , intine 1.21  $\mu\text{m}$  thicker. Colpi margins distinct with pointed ends, 33.7  $\mu\text{m}$  long. Distances between colpi ends 33.7  $\mu\text{m}$  (Table 3).

*Cirsium leuconeurum*: Pollen grains tricolporate, 55% of pollen subprolate, amb circular (Fig. 11). Exine 1.77  $\mu\text{m}$  thick, thinner at the poles, ornamentation echinate. Tectum complete structured, perforate-microreticulate with suprategal spines. Spines conic and pointed, 1–3 per



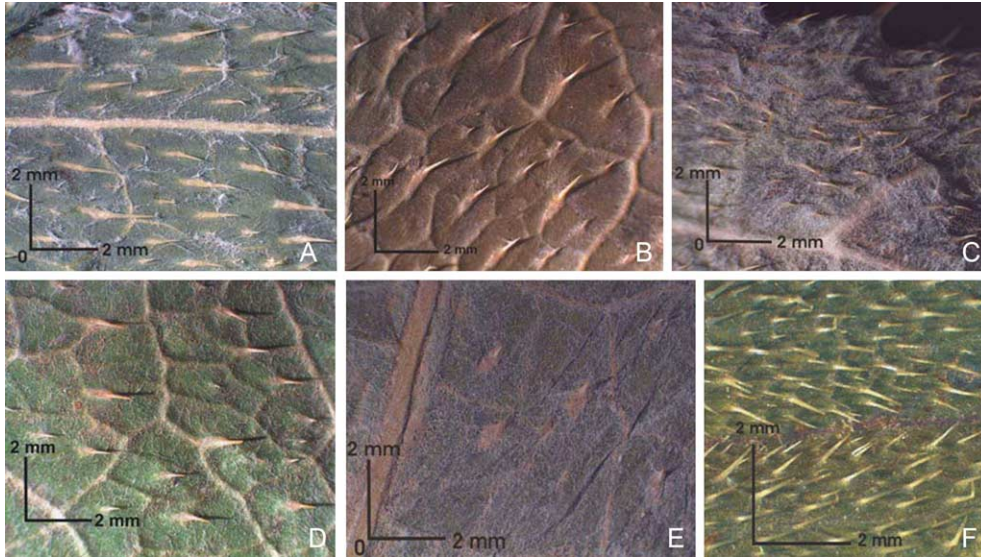


Figure 9. Upper leaf surface of (A) *Cirsium rigidum*, (B) *C. sivasicum*, (C) *C. leuconeurum*, (D) *C. peshmenianum*, (E) *C. karduchorum*, (F) *C. cassium*.

100  $\mu\text{m}^2$ , 3.3  $\mu\text{m}$  long, base diameter 2.6  $\mu\text{m}$ , intine 0.81  $\mu\text{m}$  thicker, colpi margins distinct with pointed ends, 36.0  $\mu\text{m}$  long (Table 3).

*Cirsium peshmenianum*: Pollen grains tricolporate, 55% of pollen subprolate, amb circular (Fig. 11). Exine 1.68  $\mu\text{m}$  thick, thinner at the poles, ornamentation echinate. Tectum complete structured, perforate-microreticulate with suprategal spines, reticules on tectum surface irregular and large. Spines conic and curved, 1–2 per 100  $\mu\text{m}^2$ , 4.1  $\mu\text{m}$  long, base diameter 5.2  $\mu\text{m}$ , intine 1.34  $\mu\text{m}$  thicker, colpi margins distinct with pointed ends, 32.8  $\mu\text{m}$  long (Table 3).

*Cirsium karduchorum*: Pollen grains tricolporate, 75% of pollen prolate spheroidal, amb circular (Fig. 11).

Exine 1.65  $\mu\text{m}$  thick, thinner at the poles, ornamentation echinate. Tectum complete structured, rugulate with suprategal spines. Spines conic and pointed, 2–3 per 100  $\mu\text{m}^2$ , 3.2  $\mu\text{m}$  long, base diameter 4.3  $\mu\text{m}$ , intine 1.77  $\mu\text{m}$ . Colpi margins distinct with pointed ends, 29.7  $\mu\text{m}$  long (Table 3).

## Discussion

*Cirsium sivasicum* is an isolated species but it has some similarities with *C. rigidum* with respect to facies, habitus, corolla and pappus sizes. It differs from *C. rigidum* by its

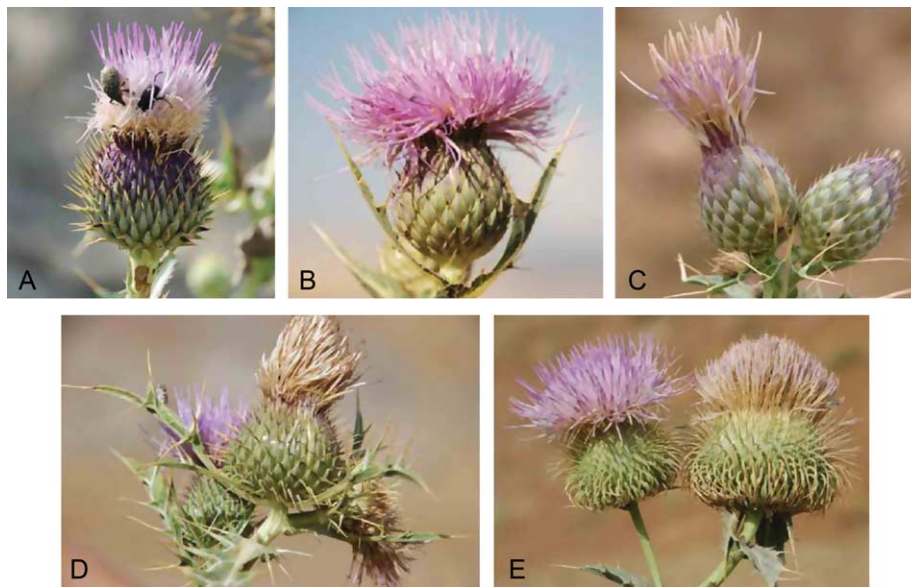


Figure 10. Capitula of (A) *Cirsium rigidum*, (B) *C. sivasicum*, (C) *C. peshmenianum*, (D) *C. leuconeurum*, (E) *C. karduchorum*.

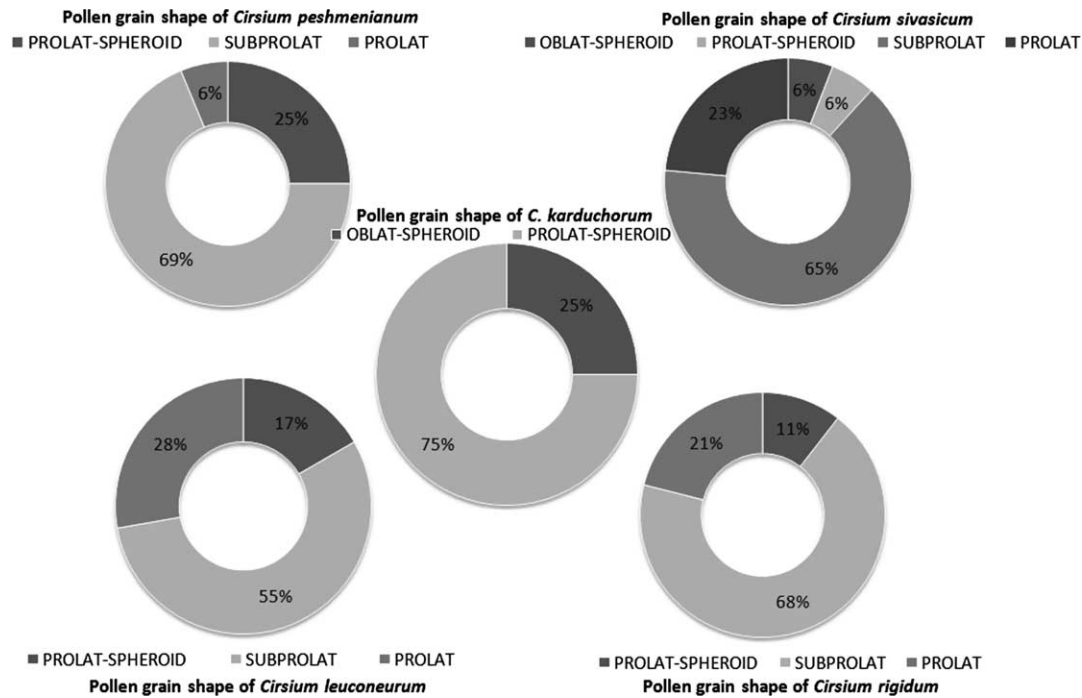


Figure 11. Pollen grain shape in the new species and their allies.

larger basal leaves, 30–40 × 15–27 cm excluding the 10–15 cm long petiole, (not 15–25 × 7–10 cm excluding the 8–10 cm long petiole), greenish (non glaucous), median phyllaries oblong with a 1–3 mm long apical spine (not lanceolate with (2–)3–5 mm long apical spine).

*Cirsium peshmenianum* is similar to *C. leuconeurum* and *C. karduchorum* with respect to habitus, the short involucral leaves, corolla and pappus sizes, but it is easily distinguished from *C. leuconeurum* by its larger basal leaves 30–40 × 16–20 cm (not 15–30 × 10–15 cm) with 10–15 cm long petiole (not ca 5 cm), the median phyllaries with a 1–3 mm long apical spine (not 2–6(–8) mm). It differs from *C. karduchorum* by its basal leaves pinnatisect to 3/4 (not pinnatifid to 1/4), involucre 15–25 × 15–25 mm (not 25–30 × 20–40 mm), median phyllaries 10–13 mm long with an erecto-patent 1–3 mm apical spine (not 17–24 mm with a reflexed or recurved, 5–10 mm long apical spine) (Fig. 6–10). Additional morphological differences between the two new species and their relatives are given in Table 1.

As stated Davis and Parris in ‘Flora of Turkey’ (1975, p. 393), the specimens collected by Davis from the north face of Berit Mount differ from the type mainly in terms of longer median phyllaries (19–21 mm) with longer apical spines (6–8 mm). Our studies showed that the specimens collected from the north side of Mount Berit by Davis (D. 20232) and the present authors (Yıldız 16435, 16985) so indeed differ from the type, but in our opinion these differences falls within the variation of the species.

According to ‘Flora Iranica’, *C. leuconeurum* is a synonym of *C. strigosum* (M. Bieb.) M. Bieb. (Petrauk 1979). The present authors have carried out detailed studies on the specimens preserved in BM, E, G, K and W. Our

conclusion is that *C. leuconeurum* should be kept as a species separate from *C. strigosum*. *Cirsium leuconeurum* differs from *C. strigosum* by having 3–14 capitula on each branch, median phyllaries oblong-lanceolate with an up to 8 mm long apical spine. *C. strigosum* has 1–3 capitula on each branch, median phyllaries broadly ovate to ovate-lanceolate with a 3–5 mm long apical spine. In addition, these two species are geographically isolated.

The pollen of the new species and their allies may be divided into 3 types, based on the shape of spines/spinules and the surface ornamentation: ‘type I’ with echinate ornamentation, tectum complete structured, microreticulate with supracteal spinules, includes *C. rigidum* and *C. sivasicum*, which are distinguished from each other by the reticulate shape on the tectal area and tips of the spines; ‘type II’ with echinate ornamentation, tectum complete structured, perforate-microreticulate with supracteal spines, includes *C. leuconeurum* and *C. peshmenianum*, which are distinguished from each other by the perforation/reticulate shape on the tectal area and tips of the spines; ‘type III’ with echinate ornamentation, tectum complete structured, rugulate with supracteal spines, belongs to *C. karduchorum* (Fig. 2–5, Table 3). In conclusion, both morphological and palynological data corroborates our classification of these five *Cirsium* species.

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Table 3. Pollen morphological characters of the new species and their allies.

Type	Taxa	Type	Ornamentation			Spine/spinule characters				
			Tectum surface	Reticule shape	reticule per 1 $\mu^2$	Tip	Base	Ornamentation (at base)	number per 100 $\mu^2$	Connection between two spines
I	<i>C. rigidum</i>	echinate	microreticulate	irregular and large	1–3	blunt-ended	narrow	microreticulate	1	somewhat prominent
I	<i>C. sivasicum</i>	echinate	microreticulate	regular and small	3–4	pointed	wide	microreticulate	1–2	somewhat prominent
II	<i>C. leuconeurum</i>	echinate	perforate/microreticulate	irregular and large	1–2	pointed	narrow	microreticulate	1–3	prominent
II	<i>C. peshmenianum</i>	echinate	perforate/microreticulate	regular and large	3–5	curve	extremely wide	microreticulate	1–2	prominent
III	<i>C. karduchorum</i>	echinate	rugulate/psilate	–	–	pointed	extremely wide	rugulate	2–3	prominent

W and the curators of these herbaria, whose gave us permission to examine the specimens. Also, thanks to the curators of herbaria ANK, EGE, G, GAZI, HUB, ISTE, ISTF, ISTO, WU and to Mehmet FIRAT and Mehmet TEKIN for help during to field studies.

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## Appendix 1. Additional specimens examined

*Cirsium rigidum* (type) Georgia ad fluv. Aragum circa Mzehet, Iberiae, Steven (holotype: G, E); Batum, Voronov s.n. (W); Transcaucasia pre et dist. Tiflis, in jugo Saguramo, in decliv. Siccis. 19 Jul 1922, Grossheim s.n. (K, W). Turkey. A9 Artvin: Ardanuç, 450 m a.s.l., Hub.-Mor. 15948; Ardanuç, 600 m a.s.l., eroded shady slopes, 26 Jun 1957, Davis 30062 and Hedge (E, K, BM); around Ardanuç, eroded slopes, 600 m a.s.l., 18 Aug 2006, Yıldız 16345 and Dirmenci; ibid 27 Jun 2008, Dirmenci

3621 and Akçiçek; ibid 6 Aug 2008, 41°07'600''N, 42°04'100''E, Yıldız 16867.

*Cirsium karduchorum* (type) Iraq. Erbil: Mons Hergurd ad confines Persiae, ca 36°40'N, 044°50'E in vaile supra pagum Nowanda, ca 2000–2600 m a.s.l., 10–14 Aug 1957, Rechinger 11330 (W); Algirdh Dagħ, 2900 m a.s.l., 24 Aug 1948, Gillett 12333 (E); Kani Sawaran Range, nr. Alana, 1900 m a.s.l., 31 Aug 1957, Ali al-Rawi and Serhang, 24672 (E). Turkey. C9 Hakkari: between Hakkari and Berçelan Plateau, 2400–2500 m a.s.l., 5 Sep 2007, Dirmenci 3579 and Fırat; ibid 2130 m a.s.l., 16 Aug 2008, 37°360'000''N, 043°44'500''E, Yıldız 16932, Dirmenci and Fırat; C9/10 Hakkari: Karadağ, above Hakkari, rocky slopes, 13 Aug 1954, Davis 24326 and Polunin (BM, E, K, W).

*Cirsium strigosum* (type) Iran. Dik Dash, 28 Aug 1929, Gilliat-Smith 2645 (E photo); Saharas and Ametz, shade slopes, 3000–3300 m a.s.l., Jul 1935, N. Lindsay 563 (BM); Kazvin: Montens Elsburs centr. Prope Gacesar, 2500 m a.s.l., Sabeti 1429 (W); Khorasan, Bardu forest, 20 Aug 1940, Koelz 16781 (type of *C. strigosum* M. Bieb. var. *khorasanicum* Boiss.) (W).