

Two new *Achillea* L. (Asteraceae) species from Turkey

Zeki AYTAÇ*, Hayri DUMAN, Murat EKİCİ

Department of Biology, Faculty of Science, Gazi University, Teknikokullar, Ankara, Turkey

Received: 15.04.2015 • Accepted/Published Online: 09.09.2015 • Final Version: 07.06.2016

Abstract: Two new *Achillea* species, *Achillea adenii* Aytaç & M.Ekici and *Achillea baltai* H.Duman & Aytaç sp. nov. of sect. *Santolinoidea* DC. (Asteraceae), are described and illustrated as new species. *A. adenii* grows at Babadağ in Muğla Province (southwestern Anatolia), while *A. baltai* grows at Aladağlar in Niğde Province. Diagnostic morphological characters, which are useful in discriminating the two new species from their close relatives, *A. sintenisii* Hub.-Mor., *A. sipikorensis* Hausskn. & Bornm., and *A. armenorum* Boiss. & Hausskn., are presented. Some notes on the ecology, pollen and seed morphology, conservation status, and distributions of the new species and a key to related species are also given.

Key words: Anatolia, Compositae, new species, *Santolinoidea*

1. Introduction

Compositae (Asteraceae) has about 23,000 species, 1620 genera, 30 tribes, and 5 subfamilies throughout the world (Kubitzki, 2007). *Achillea* is included in the *Anthemideae* Cass. tribe and is represented by about 115 taxa in the world. According to the latest studies, *Achillea* has 6 sections and 58 taxa, and 53% (31) of these are endemic to Turkey (Arabacı, 2012). All sections, except for sect. *Arthrolepis* Boiss. and sect. *Santolinoidea* DC., have more than 10 capitula on their inflorescence (Huber-Morath, 1975, 1986). Although the members of this genus are usually distributed in inner, eastern, and southeastern Anatolia, *A. cretica* L., *A. nobilis* L. subsp. *densissima* (O.Schwarz ex Bässler) Hub.-Mor., and *A. grandifolia* Friv. grow in the southwestern parts of Anatolia.

Unusual specimens belonging to *Achillea* were collected from Babadağ during a project supported by the Ministry of the Environment and Forestry in southern Anatolia (C2, Fethiye district, Muğla Province) and during a floristic expedition in the Aladağlar Mountains (Niğde Province).

All samples were compared with many other *Achillea* specimens collected from different localities and deposited in various herbaria in Turkey such as ANK, GAZI, HUB, and KYN (see Appendix on the journal's website). Furthermore, all the relevant literature was checked (Huber-Morath, 1975 and 1986; Richardson, 1976; Valant-Vetschera, 1996 and 2000; Duman, 2000; Arabacı and Yıldız, 2006a and 2006b). After close examination of the specimens, we concluded that they belonged to hitherto

undescribed species of sect. *Santolinoidea* and were closely related to *A. sintenisii* Hub.-Mor., *A. sipikorensis* Hausskn. & Bornm., *A. milliana* H.Duman, and *A. armenorum* Boiss. & Hausskn.

2. Materials and methods

The morphological data used in the description of the new species were directly obtained from the authors' collections from Muğla and Niğde and by using a binocular stereoscopic microscope when necessary.

The pollen and seed morphologies of these species were examined by scanning electron microscopy (SEM) at GAZI. The pollen was treated with 70% alcohol and then dried before mounting on stubs with gold for the SEM study. The SEM photomicrographs were taken with a JEOL JSM 6060 SEM at Gazi University. Names of the plants were checked using the IPNI database (2012) and terminologies for pollen morphology were used in accordance with Punt et al. (2007). The author names of plants were checked using Brummit and Powell (1992).

3. Results

Achillea adenii Aytaç & M.Ekici sp. nov. (Figure 1)

Type: Turkey, C2 Muğla, Fethiye, Babadağ, calcareous rocks, 1600–1650 m, 23.07.2011, *Aytaç* 10429 & *M. Ekici* (holotype: GAZI; isotypes: ANK, HUB, and Yıldırım).

Paratype: Turkey, C2 Muğla, Fethiye, Babadağ, calcareous rocks, 1500–1600 m, 14.06.1993, *Koyuncu* 10427 & *H. Duman* (AEF).

* Correspondence: zaytac@gazi.edu.tr

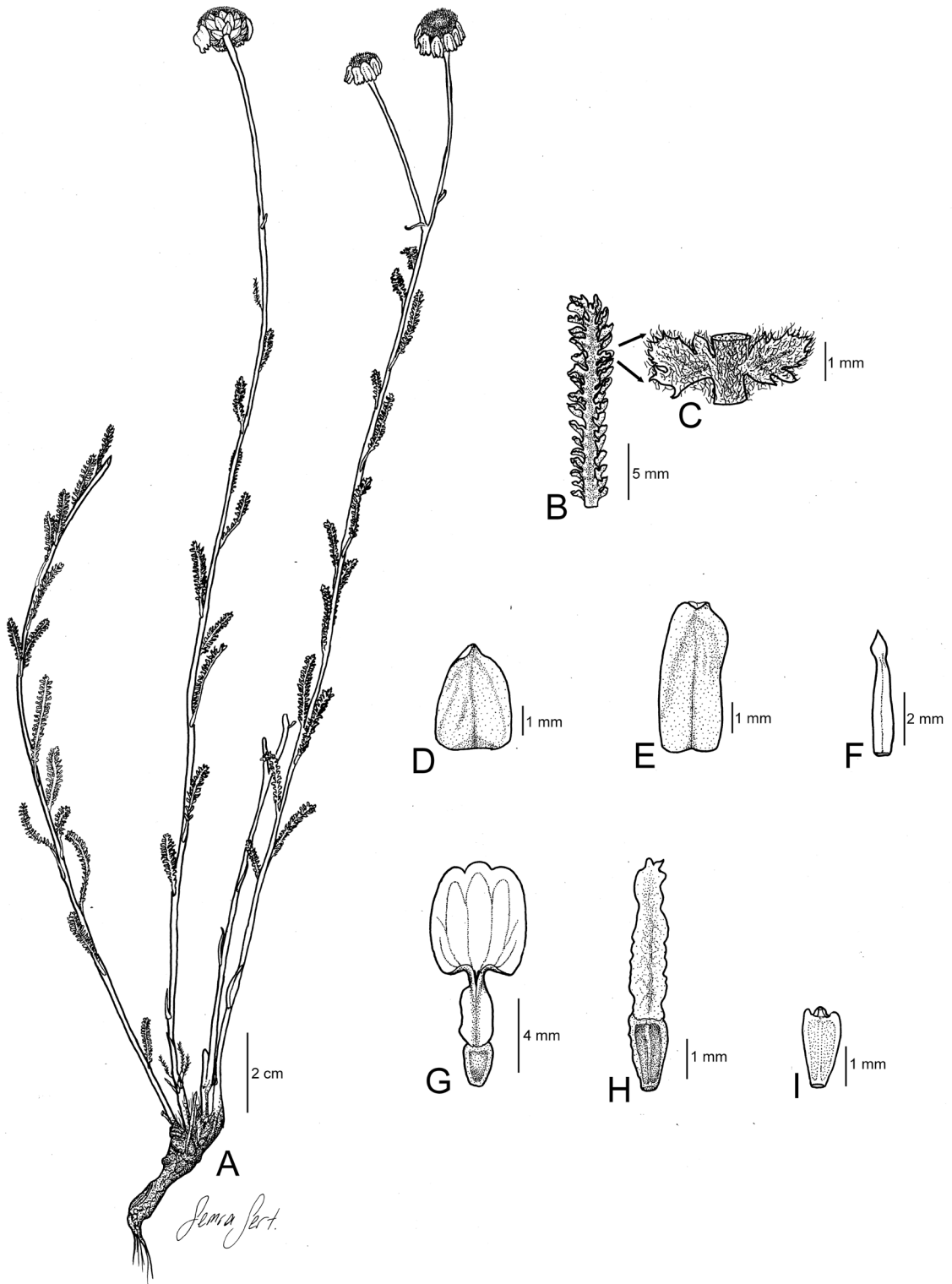


Figure 1. *Achillea adenii*. A- Habitus, B- stem leaf, C- cross-section of leaves, D- outer phyllaries, E- inner phyllaries, F- palea, G- ray flowers, H- tubular flowers, I- achene (Aytaç 9779 et al.).

Diagnosis: *Achillea adenii* is related to *A. sintenisii* but it differs by its longer stem (30–40 cm, not 10–25 cm); stem leaf segments always simple and ovate-lanceolate (not undivided or 3-lobed and orbicular); peduncle 5–7 cm (not 3–5 cm), single capitulum (not 1–4); only outer phyllaries pinnose on middle veins, others glabrous (not tomentose to glabrescent), phyllaries with scarios margins (not scarios); ligules 10–12 mm (not 3–5.5 mm). It is similar to *A. sipikorensis* with its always solitary capitulum, but the ligules are 6–8 and 10–12 mm long (not 8–10(–15) and 6–8 mm long).

Description: Perennial herb with woody rootstocks. Stems procumbent, numerous, 30–40 cm long, with short sterile shoots, unbranched, terete, obtusely four-angled, adpressed to subadpressed tomentose. Leaves homomorphic, wooly-tomentose, linear, median cauline ones 7–16 × 1–2 mm, pinnatisect, with ovate lanceolate, 1–3-denticulate, apiculate segments 0.5–1 mm, undivided. Peduncles 5–7 cm. Capitula 1(–2) per stem, globose to hemispherical and depressed, 10–12 × 8–10 mm, broadly

rounded at base. Phyllaries in 3–4 series, outer ones 10–12 mm, ovate-oblong, median ones oblong-orbicular, inner ones lanceolate, all phyllaries scarios-margined, outer ones pinnose on middle vein. Receptacle paleaceous; palea 5–6 mm, linear-lanceolate, membranaceous. Ligules 6–8, white, 10–12 mm long, with three lobes; tube 3–4 mm, lobes 7–8 mm, oblanceolate; anthers yellow, slightly exerted from tube. Disc flowers cream, 50–70, 3.5–4 mm, slightly exerted from involucre; style brownish, 1–2 mm, stigma two-partite as long as style. Cypselae oblong, 2–3 mm, compressed dorsally. Pappus absent.

Fl & fr. 5–6, steppe, calcareous slopes, 1500–1650 m.

Pollen structure: Pollen grains of *A. adenii* are oblate-spheroidal, tricolporate. $P = (17.28) 19.66 \pm 1.21$, $E = (19.2) 21.8 \pm 1.18 (23.28)$. Ornamentation is echinate to perforate (Figures 2A and 2B).

Achene structure: Cypselae oblong, 2–3 mm, compressed dorsally. Ornamentation is reticulate (Figures 3A and 3B).

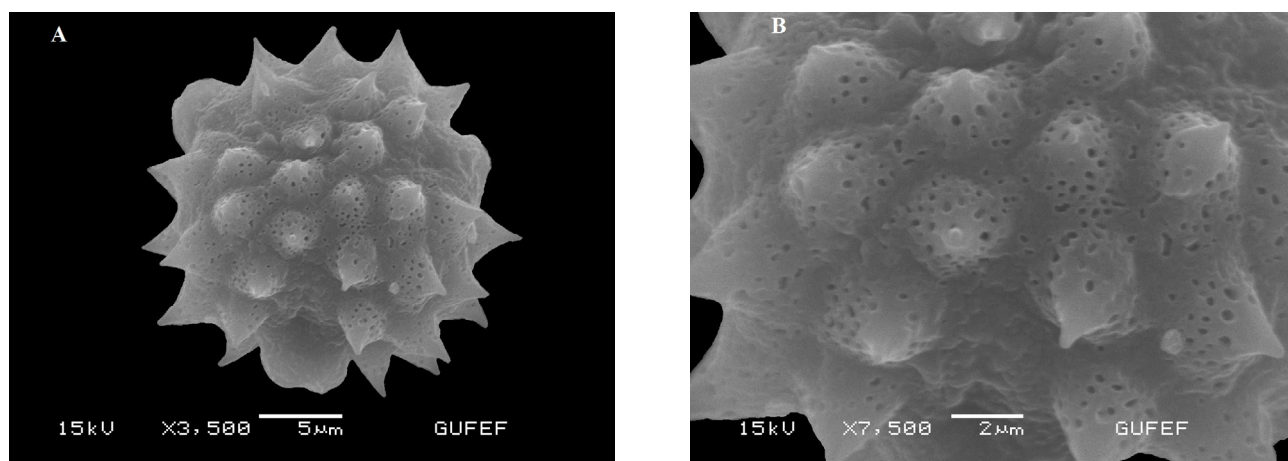


Figure 2. Pollen micrographs of *A. adenii*. A- Equatorial view, B- ornamentation (Aytaç 10429 & M. Ekici).

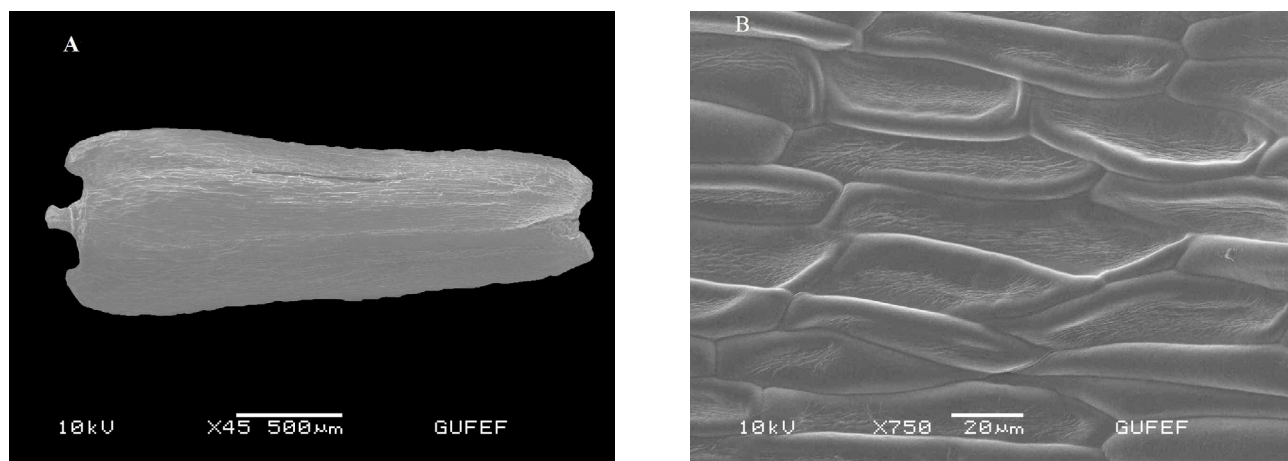


Figure 3. Achene micrographs of *A. adenii*. A- General appearance, B- ornamentation of seed coat surface (Aytaç 10429 & M. Ekici).

Etymology: This species is named in honor of the granddaughter of the first author.

Conservational status: The specimens were collected in C2 Muğla (Fethiye) Province, where the species seems to be rare in its habitat. It is known from two different localities. The range of this local endemic species is restricted to a single location (IUCN Criteria B1a). Populations are pure, with an area of occupancy smaller than 10 km², and according to field observations, it is estimated that the total number of individuals of this endemic species does not exceed 70–80 in its single locality (criteria B2a). Therefore, we suggest that *Achillea adenii* should be evaluated as Critically Endangered (CR) according to the IUCN (2011).

***Achillea baltai* H.Duman & Aytaç sp. nov.** (Figure 4)

Type: Turkey, C6 Niğde: Pozantı Dağı, Sivri tepe, 2050–2100 m, 08.06.2013, calcareous rocks, *Duman* 10321 & *T. Balta*, holotype: GAZI; isotypes: ANK, HUB, Yıldırımli.

Diagnosis: *Achillea baltai* is related to *A. armenorum* but differs by its narrower leaves (7–15 × 1–1.5 mm, not 5–20 × 1.5–4); longer peduncle 10–20 (not 5–10(–20) mm); phyllaries 3(–4) (not 4); ray flowers white (not reddish-purple between lamina and tube); disc flowers completely white (not tube reddish-purple, lobes white). Ligule 6–8 and 5–6 mm long (not 8–10 and 1.5–2.5 mm long).

Description: Perennial herb with woody rootstocks. Stems procumbent, numerous, 15–20 cm long, with short sterile shoots, unbranched, terete, longitudinally striped, densely wooly-tomentose. Leaves densely wooly-tomentose, oblong-linear, 7–15 × 1–1.5 mm, pinnatifid, segments imbricate, minute, undivided, ovate-triangular, acuminate to denticulate; median cauline and upper leaves 3–10 × 1–2 mm, pinnatisect, segments densely imbricate, to 3-lobed, with orbicular, 1-denticulate lobes 0.3–5 mm. Peduncles 1–2 cm. Capitula 3–9, corymbose, 2–3 cm broad, involucre hemispherical to globose, 5–8 × 4–8 mm.

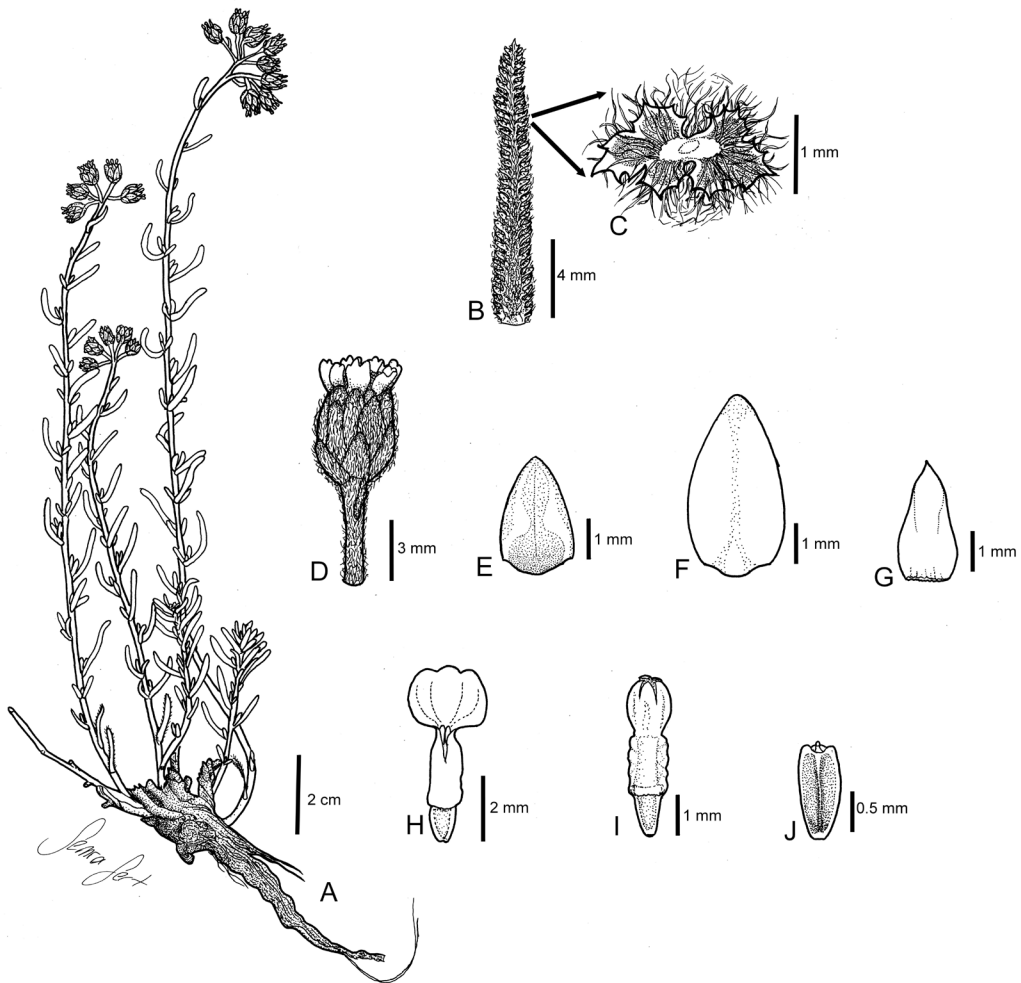


Figure 4. *Achillea baltai*. A- Habitus, B- stem leaf, C- cross-section of leaves, D- capitulum, E- outer phyllaries, F- inner phyllaries, G- palea, H- ray flowers, I- tubular flowers, J- achene (*Duman* 10321).

Phyllaries in 3(–4) series, outer ones 2.5–3 × 1–2 mm ovate-lanceolate, median ones oblong-lanceolate, (2–)3 × 1–1.5 mm, inner ones as long as median, ±linear, all phyllaries with scarious brownish margins, white and hairy. Receptacle paleaceous, palea 2.5–3 mm, linear-lanceolate, densely long white and hairy. Ligules 6–8, white, reddish-purple base of limb and tube, 5–6 mm, with 3 lobes; tube 2–3 mm, lobes 2–3 mm; anthers yellowish, exerted from tube. Disc flowers reddish-purple above, 15–20, 2.5–3 mm, exerted from involucre; style brownish, 1–2 mm, stigma 2-partite, as long as style. Cypselae oblong, 1.5–2 (immature) mm, compressed dorsally. Pappus absent.

Fl & fr. 5–6, steppe, calcareous slopes, 2050–2100 m.

Pollen structure: Pollen grains of *A. baltai* are oblate-spheroidal, tricolporate. $P = (16.32) 19.49 \pm 1.35$, $E = (19.2) 21.73 \pm 1.18 (24.00)$. Ornamentation is echinate to perforate (Figures 5A and 5B).

Etymology: This species is named in honor of Tolga Balta, who was one of the collectors and supporters of this field trip.

Conservational status: The specimens were collected at C6 Niğde, Pozantı Dağı (Niğde Province), where the species seems to be very local. It is known from the type collections. The range of this local endemic species is restricted to a single location (IUCN Criteria B1a). Populations are pure, with an area of occupancy smaller than 10 km², and according to field observations, it is estimated that the total number of individuals of this endemic species does not exceed 70–80 in its single locality (Criteria B2a). Therefore, we suggest that *A. baltai* should be evaluated as Critically Endangered (CR) according to the IUCN (2011).

Distribution: *A. adenii* is currently known only from the type locality in southern Anatolia, an E. Medit. element, endemic. *A. baltai* is known only from the type locality in central Anatolia, an Irano-Turanian element, endemic (Figure 6).

4. Discussion

While many members of the genus *Achillea* have more than one capitula on their stems, some members of sect. *Artholepis* and sect. *Santolinoidea* have 1–4 capitula on their stems. Only *A. sipikorensis* has one capitulum, while *A. sintenisii*, *A. monocephala* Boiss. & Balansa, *A. brachyphylla* Boiss. & Hausskn., *A. membranacea* (Labill.) DC., *A. oligocephala* DC., *A. gypsicola* Hub.-Mor., *A. sivasica* Çelik & Akpulat, *A. ketenoglui* Duman, *A. armenorum* Boiss. & Hausskn., *A. milliana* H.Duman, and *A. hamzaoglui* Arabacı & Budak have 1–10 and sometimes more than 10. All species mentioned above grow within the Irano-Turanian phytogeographic region.

A. adenii is an E. Mediterranean element and is close to *A. sipikorensis* by having one capitulum. It is also close to *A. sintenisii* by having a number of capitula and ray flowers. While *A. sipikorensis* and *A. sintenisii* grow in serpentine or gypsum soil and on calcareous substrates or gypsum, respectively, in the eastern parts of Anatolia, *A. adenii* grows in calcareous soil in the southwestern parts of Anatolia. This new species is different from its related species in its geographic distribution and ecological properties. The comparison of *A. adenii*, *A. sipikorensis*, and *A. sintenisii* is given in Table 1.

Achillea baltai is very close to *A. armenorum*, but all other *Achillea* species that grow in Turkey have white, cream, or yellow ligules and disc flowers, while only *A. armenorum* has reddish-purple disc flowers. Moreover, the leaves of *A. baltai* are narrower and are distinctly imbricate. It is also closely related to *A. milliana* H.Duman, but disc flowers are 15–20 (not 40–50) and capitula more than 5.

Achillea baltai grows on calcareous rocks and in high steppe regions in the Irano-Turanian region. The comparison of *A. armenorum* and *A. milliana* is given in Table 2.

The pollen grains of these two species are oblate-spheroidal, like other *Achillea* species. According to

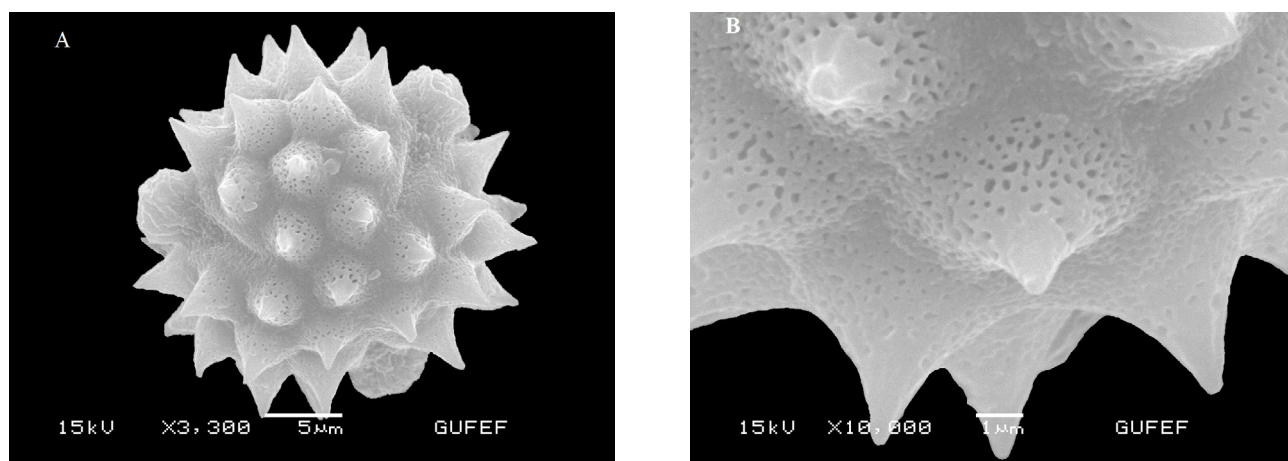


Figure 5. Pollen micrographs of *A. baltai*. A- Equatorial view, B, ornamentation (Duman 10321 & T. Balta).

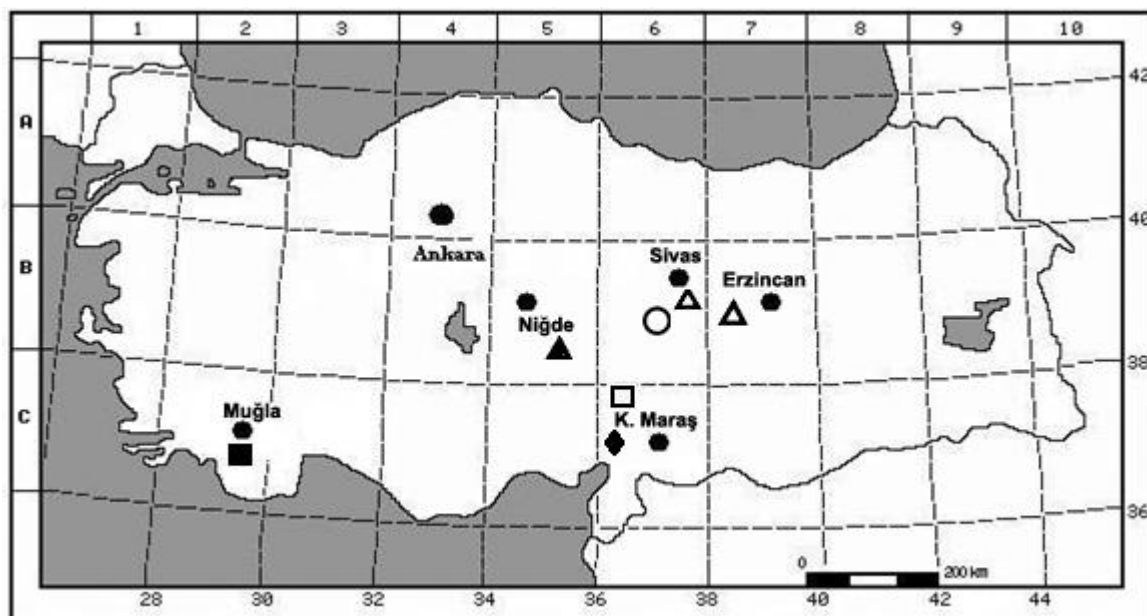


Figure 6. Distribution of *Achillea* species: *A. adenii* ■, *A. baltai* ▲, *A. sintenisii* ○, *A. armenorum* □, *A. sipikorensis* △, *A. milliana* ◆, city centers ●.

Table 1. Comparison of *Achillea adenii* with 2 morphologically related *Achillea* species.

Characters	<i>A. adenii</i>	<i>A. sipikorensis</i>	<i>A. sintenisii</i>
Stem	30–40 cm	10–20 cm	10–25 cm
Peduncle	5–7 cm	(1.5–)3–8 cm	(1–)3–5 cm
Capitula	Always solitary, 10–12 × 8–10 mm	Always solitary, 6–10 × 7–20 mm	1–4, 4–5 × (5–)6–10 mm
Ray flowers	6–8, 10–12 mm	8–10(–15), 6–8 mm	6–8, 3.5–5 mm
Outer phyllaries	Scarious margins, glabrous	Scarious brownish margins, puberulent to glabrescent	Scarious brownish margins, tomentose to glabrescent
Cypselae	Oblong, 2–3 mm	Linear-oblongate, 2.5–3 mm	Oblong, 2 mm
Habitat	Calcareous slopes	Gypsum and serpentine	Calcareous rocks and gypsum hills

Table 2. Comparison of morphological characters between *Achillea baltai* and *A. armenorum*.

Characters	<i>A. baltai</i>	<i>A. armenorum</i>	<i>A. milliana</i>
Leaves	7–15 × 1–1.5 mm, strongly imbricate	5–20 × 1.5–4 mm, ±imbricate	5–10 × 1–1.5 mm, densely imbricate
Peduncle	10–20 mm	5–10(–20) mm	5–20 mm
Ligules	6–8, 5–6 mm, white	8–10, 1.5–2.5 mm, white	6–8, 4–4.5 mm, white
Disc flowers	White to cream, 2.5–3 mm long	Reddish-purple, 3–4 mm long	White, 2–2.5 mm long
Palea	Linear-lanceolate densely long pilose, whitish above	Lanceolate, with spreading pilose, brownish above	Lanceolate, with spreading pilose, brownish above
Cypselae	(Immature) oblong	Linear-oblongate	Linear-oblongate

previous studies (Akyalçın et al., 2011; Akyalçın et al., 2014), the pollen ornamentations are echinate in light microscopy and echinate-microperforate and echinate-rugulate microperforate in SEM. In conclusion, the species examined showed substantial variation in pollen characteristics at both the interspecific and intraspecific levels.

Key to *A. adenii*, *A. sipikorensis*, *A. sintenisii*, *A. armenorum*, *A. milliana*, and *A. baltai*

- 1- Capitula solitary (-2)
- 2- Ligules 8–10(-15); capitula 6–10 – 7–20 mm.....*A. sipikorensis*
- 2- Ligules 6–8; capitula 10–12 × 8–10 mm.....*A. adenii*
- 1- Capitula more than one
- 3- Leaves linear; ligules 6–8; disc and ligules completely white

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- 4- Capitula (1–)2–5(-6); disc flowers 40–60
- 5- Peduncles (1–)3–5 cm; palea glabrous.....*A. sintenisii*
- 5- Peduncles 0.5–2 cm; palea pilose.....*A. milliana*
- 4- Capitula 5–10; disc flowers 15–20.....*A. baltai*
- 3- Leaves linear-oblong; ligules 8–10; tube of disc flowers and between limb and tube of ligules reddish to reddish-purple.....*A. armenorum*

Acknowledgments

We want to thank Semra Sert for the illustration and Ahter Vişne for comments on pollen and achene structure. *A. adenii* was collected from Fethiye district during the “Determination of Biodiversity Project for the Fethiye County, Muğla Province and Special Environmental Protection Area”. *A. baltai* was collected during one of the field trips supported by Tolga Balta, who is the general director of ENCON (Environmental Consultancy Co.).

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Appendix.

Specimens examined: *Achillea sipikorensis*: B6 Kayseri: Kırklar geçidi, 2000–2250 m, 28.06.2009, *Aytaç* 8602 GAZI; Sivas, Gürün 3 km E Ulaş, 06.06.1990, 1360 m, *Nydegger* 45652 GAZI; Sivas: Gürün, Akpınar, 15.06.1992, 1650 m, *Nydegger* 4628 GAZI. Sivas around airport, Çebiler köyü, 1310 m, step, 19.07.2008, *Güner* et al. 14910, GAZI; B7 Sivas: Yıldızeli, Çırçır village, 1300 m, steppe, 30.07.1996, *Dönmez* 5337 HUB; Kangal, Hanyeri Bridge, 1577 m, steppe, 31.06.2011, *Özüdoğru* 3160, HUB. *A. sintenisii*: A6 Sivas: Cebiler köyü, 1310 m, jipsli step, 19.07.2008, *Güner* 14790 et al. GAZI; ibid. Tepeönü köyü, 1350 m, 08.07.2008 *Aytaç* 9012 et al. GAZI; Kangal, Mescitli-Kavak, 1660–1670 m, kireçli yamaçlar, 11.07.2007, *Aytaç* 9096 et al. GAZI; Hafik, Topçu Yeniköy, 1375 m, 01.06.2003, *Aytaç* 8488, GAZI; Hafik, Tavşanlı köyü, Tepeli mevki, jipsli topraklar, 27.07.1991, *Hamzaoğlu* 3914 & *Aydoğdu*, capitula (1–2) usually 3, GAZI; Kayseri-Sivas 11 km, Kayadibi, 1340 m, 13.07.1992, *Nydegger* 46258, GAZI.

Achillea armenorum: B6 Kahramanmaraş, Göksun, Çardak, Ericek village, Berit Dağı, Arpaçukuru yaylası, 2600 m, kayalıklar, 24.07.1992, *Aytaç* 5516 & *Duman*, GAZI, type locality; ibid. 25.07.1992, *Aytaç* 5532 & *Duman* GAZI.

Achillea milliana: C6 Adana, Düziçi, Düldül dağ, 2200 m, limestone rocks, 21.VII.1995, *H. Duman* 5894 & *K.H.C. Baser* & *A. Altıntaş* (holo. GAZI).