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Research Note

Taxonomy and Threatened Categories of Three *Achillea* L. (Asteraceae-Anthemideae) Species Previously Cited in the Data Deficient (DD) Category

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Abstract: This study presents the taxonomy and threatened categories of 3 *Achillea* L. (Asteraceae-Anthemideae) species: *A. membranacea* (Labill.) DC., *A. brachyphylla* Boiss. & Hausskn., and *A. boissieri* Hausskn. ex Boiss. These species belong to sect. *Babounya* (DC.) O.Hoffm. and were previously placed in the data deficient (DD) category in the *Red Data Book of Turkish Plants.* Descriptions, localities, distribution map, and images of the species are given. Threatened categories of the species were determined as *A. membranacea* in VU, and *A. brachyphylla* and *A. boissieri* in EN.

Key Words: *Achillea,* Compositae, IUCN, taxonomy

Daha Önce Yetersiz Veri (DD) Kategorisinde Bulunan Üç *Achillea* L. (Asteraceae-Anthemideae) Türünün Tehlike Kategorileri ve Taksonomisi

Özet: Bu çalışma üç *Achillea* L. (Asteraceae-Anthemideae) türünün; *A. membranacea* (Labill.) DC., *A. brachyphylla* Boiss. & Hausskn. ve *A. boissieri* Hausskn. ex Boiss. taksonomisini ve tehlike kategorilerini içermektedir. Bu türler *Babounya* (DC.) O.Hoffm. seksiyonuna aittir ve daha önce *Türkiye Bitkileri Kırmızı Kitabı*'nda Yetersiz Veri (DD) kategorisinde yer almıştır. Türlerin betimleri, lokaliteleri, yayılış haritası ve resimleri verilmiştir. Türlerin tehlike kategorileri; *A. membranacea* için VU, *A. brachyphylla* ve *A. boissieri* için ise EN olarak belirlenmiştir.

Anahtar Sözcükler: *Achillea,* Compositae, IUCN, taksonomi

Introduction

Achillea L., an unarmed, perennial, and allogamous genus of Asteraceae, includes about 110-140 species, which are centred in SE Europe and SW Asia, with extensions through Eurasia to North America. The species of the genus have remarkable ecological adaptability (Ehrendorfer & Guo, 2006).

On the basis of recent multi-disciplinary (including DNA-analysis) studies the genera *Otanthus* Hoffmanns. & Link and *Leucocyclus* Boiss. were transferred to *Achillea*, which is the core genus of the subtribe *Achilleinae* Bremer & Humphries, by Ehrendorfer and Guo (2005). Additionally, a new section was designated as *Achillea* sect. *Otanthus* (Hoffmanns. & Link) Ehrend. & Y.-P.Guo by the same authors. *Otanthus maritimus* (L.) Hoffmanns. & Link was transferred to *Achillea*, and was placed under a new separate section designated as *Otanthus* and combined as *Achillea maritima* (L.) Ehrend. & Y.-P.Guo by Ehrendorfer and Y.-P. Guo. After the new combination, this section includes only 1 species, *Achillea maritima*.

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Morphological examination of *Leucocyclus* performed during the present study showed that this genus has too many similarities with *Achillea,* particularly members of section *Arthrolepis* Boiss., with its leaf shape, numerous ligules, and large capitula with single head, except for white disc florets, which are rarely seen within the genus *Achillea*.

Traditional sections of *Achillea,* sect. *Arthrolepis*, and *Santolinoideae* DC. were joined together within sect. *Babounya* (DC.) O.Hoffm by Ehrendorfer & Guo, and the genus *Leucocyclus* was arranged under sect. *Babounya* as *Achillea formosa* (Boiss.) Sch.Bip. (Ehrendorfer & Guo, 2005).

Following the transfer of *Otanthus* and *Leucocyclus* to *Achillea,* the genus *Achillea* is now represented by 46 species (52 taxa) belonging to 5 sections in Turkey, and 22 (29 taxa) of them are endemic to Anatolia (Huber-Morath, 1975; Duman, 2000; Danihelka, 2001; Ehrendorfer & Guo, 2005; Arabacı & Yıldız, 2006a).

According to IUCN rules, threatened categories of 26 *Achillea* species (28 taxa) and *Leucocyclus formosus* Boiss. (with 2 taxa) were given as CR-2, EN-2, VU-4, LR(cd)-6, LR(nt)-5, LR(lc)-8, and DD-3 in the *Red Data Book of Turkish Plants*, as proposed by Turkish botanists on the basis of IUCN Red List Categories and Criteria Version 2.3, as well as on assessment of the conservation status and distribution data for Turkish endemic and non-endemic species (IUCN, 1994; Ekim et al., 2000).

Based on the results of the present study, the threatened categories of the 3 *Achillea* species, namely *A. membranacea* (Labill.) DC, *A. brachyphylla* Boiss. & Hausskn., and *A. boissieri* Hausskn. ex Boiss., were proposed to belong to sect. *Babounya*. These species were placed in the data deficient (DD) categories of the publications mentioned above due to inadequate data for determining their threat categories (Ekim et al., 2000). Furthermore, taxonomical remarks on the species are given.

Materials and Methods

A comprehensive revision of Turkish *Achillea* was undertaken by the authors in 2001. During field studies, flowering and fruiting specimens of *A. membranacea*, *A. brachyphylla*, and *A. boissieri* were collected and photographed between 2002 and 2006.

The specimens were identified using the related literature (Post, 1933; Rechinger, 1964; Huber-Morath, 1975; Duman, 2000). In addition, the specimens found in the herbarium of Harran University were examined. Photographs of some specimens were obtained from herbaria of the Botanical Museum (LD), Genève (G), and Wien (W). Localities of previously collected specimens were established from the related literature (Boissier, 1875; Guo et al., 2004; Ehrendorfer & Guo, 2005; Arabacı & Yıldız, 2006a, 2006b).

Threatened categories of the taxa were established according to IUCN v.3.1 (IUCN, 2001). Guidelines from the IUCN Red List Categories and Criteria were also used (IUCN, 2003). Distribution was estimated from maps based on survey data. The abbreviations of the authors of plant names were confirmed with Brummitt and Powell (1992). The specimens collected by the authors were deposited in the herbarium of İnönü University (INU), Malatya, Turkey.

Results and Discussion

Achillea membranacea (Labill.) DC., Prodr. 6:32 (1838).

Type: in Libano, *Labillardiére*.

Syn: *Anthemis membranacea* Labill., Icon. Pl. Syr. 3:14, t.9 (1809).

Achillea imbricata DC., Prodr. 6:32 (1838).

Arthrolepis membranacea (Labill.) Boiss., Diagn. Ser. 1(11):15 (1849) (Figure 1-2).

Perennial herb with thick, woody rootstocks; primary root strongly developed. Stems numerous, 25-50 cm, shortly lignified at basal part, erect, angular, simple or with few branches; laxly leaved, usually with short, densely foliated sterile shoots at the base, pannose. Leaves homomorphic, linear, (1.5-) 2-6 × 0.3-0.6 cm, sessile, pinnatisect, densely adpressed-woolly; primary leaf segments imbricate or somewhat distant, up to 4 × 3 mm, 3-partite or 3-lobate, lobes cuneate or oblong, 1.5-4 × 0.5-1 mm, margins spiniform dentate with 1 distinctly elongated main tooth with cartilaginous tips. Peduncles 3-12 cm long. Capitula 1-5, 15-17 × 18-20 mm; involucres broadly hemispherical to depressed, 7-10 × 9-15 mm, glabrous or sparingly hairy; phyllaries 3-4-seriate, pale green, outer circular-ovate, 4 × 3 mm, obtuse, with pellucid margins up to 1 mm, inner oblong,

Figure 1. *Achillea membranacea*. a) Habit and habitat; b) Leaves; c) Capitulae.

8 × 3.5 mm, obtuse, with 1-2 mm pellucid margins; receptacle paleaceous; palea lanceolate, 6-7 × 2-2.5 mm, acute, scarious, glabrous. Ray florets 10-15(-16), yellow, 9-15 × 3-12 mm, limb semi-elliptic and 3-lobate, 6-12 × 3-4 mm, female, fertile; style 3.5 × 0.1-0.2 mm, style arms brownish, 0.5 mm; disc florets c. 50-70, yellow, 4.5-5 × 1 mm; style 4 × 0.2 mm, style arms brownish, 1 mm; stamens 5, anthers 2 × 0.3 mm, pale yellow, obtuse at the apex and base, filament 2.5 × 0.2 mm; ovary 2 × 0.7-0.9 mm long; achenes obovate, 2.5-3 × 1.5-1.75 mm, brownish, compressed dorsally, lineate, ribbed; pappus absent.

Distribution: Turkey: C7 Şanlıurfa: Birecjik (Birecik), Djebel Taken, *Sintenis* 1888:521, photo!). from Bir (Birecik) to Tscharmelik (Çermelik), *Haussknecht*. Birecik, around *Hermit Ibis* breeding Area, limestone, 300 m, 06.vi.2002, *B. Yıldız & T. Arabacı* 1385! Op. cit., 24.v.2003, *T. Arabacı* 1514! **Syria:** No. ul-Haşş *Post*; Aleppo, *Post;* Syrian desert Hamâh to Palm. *Boissier*; Hauran (the district N. of Dar'â and S of Kiswah) 3 km S of Damascus district, *Post*. **Palestine:** Palestine Moab (the district S of the Jabbok), *Post*. **Iraq:** 3 km SE Rutbah (R. 9865). 45 km resp. 206 km E Rutbah (R. 9958, 12843).

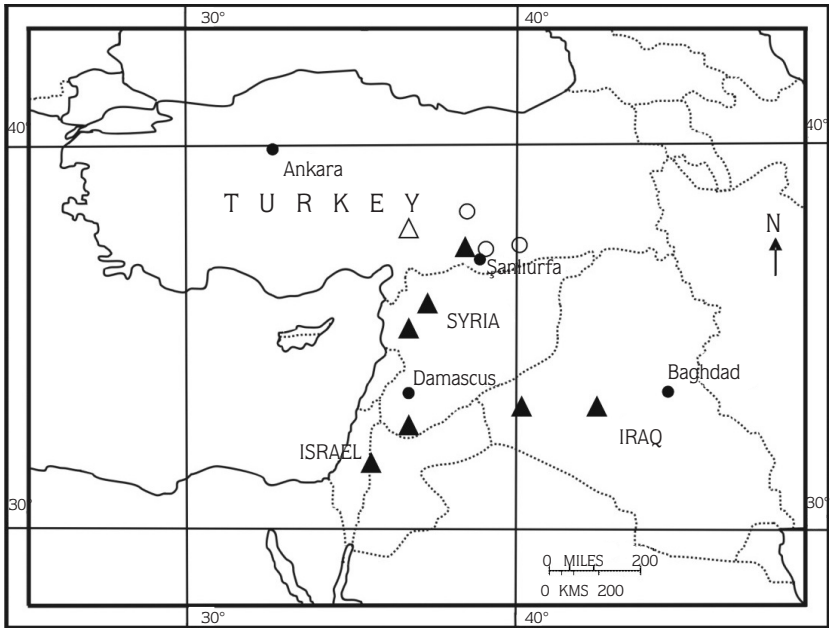

Figure 2. Worldwide distribution of *Achillea membranacea* (▲), *Achillea brachyphylla* (❍), and *Achillea boissieri* (Δ).

Ecology and Habitat Preference: Flowering in May and June, fruiting in June and July. Growing between 300 and 500 m, on limestone hills and steppes exposed to sun and drought.

Conservation Status: *A. membranacea* is known from 7 different localities given in the floras of Turkey, Iraq, Syria, and Palestine. The species only grows around the Birecik district in Turkey. During field studies conducted in this area we observed that the growing area of the species is not more than 10 km^2.

The main threats to this species are overgrazing, erosion, and clear land in the area. Surviving individuals were located only on steep slopes that herbivorous animals cannot reach; however, according to the floras mentioned above, this species is known from 3 localities in Syria, 2 in Iraq, and 1 in Palestine. When evaluated, the threat category of this species at the national level may be critically endangered (criterion B1b) due to the fact that the number of individuals is very small and continually declining; but, it is classified as vulnerable (criterion B1ab (iii)) on the basis of its global distribution (Table).

Table. Threatened categories of the species.

Species Name	*A. membranacea*	*A. brachyphylla*	*A. boissieri*
Category	VU	EN	EN
B Criteria	1ab (iii)	2ab (iii)	1+2ab (iii)
C Criteria		1	1
Area of occupancy (km^2)		400	20
Extent of occurrence (km^2)		4000	200
Locations	7	4	4
Individuals		1250	800
Endemic	-	+	+

Discussion: *A. membranacea* is related to *A. oligocephala* Boiss. & Balansa, but differs by its larger involucres (7-10 × 9-15 mm, not 4-6 × 4.5-8 mm), inner phyllaries with broad pellucid margins (1-2 mm, not 0.5-1 mm), and long ligules (9-15 × 3-12 mm, not 4.5-8 × 2-4.5 mm).

Achillea brachyphylla Boiss. & Hausskn. In Boiss., Fl. Or. 3:273 (1875).

Syntype: Turkey: C7 Urfa: in petros. calc. inter Surug (Suruç) et Orfam (Urfa), 360 m, 6.v.1865, *Haussknecht* (W, photo!); Mesopotamia, Gebel Taktak (Tektek Da.), 3.v.1867, *Haussknecht* (G, photo!, W) (Figure 2-3).

Perennial herb with thick, woody rootstocks, primary root strongly developed, caespitose. Stems numerous, (7-)10-20(-23) cm, shortly lignified at the basal part, erect, angular, unbranched, laxly leaved, with shortened densely foliated sterile shoots at the base, canescent. Leaves homomorphic, linear, 0.5-1.5 × 0.1-0.25 cm, sessile, pinnatisect, ± densely-woolly; primary leaf segments imbricate, 1-1.5 × 1.5 mm, 3-partite or 3-lobate, lobes homomorphic, obovate, 1-1.5 × 0.5-1 mm, margins denticulate. Peduncles (1-)2-4(-6) cm long. Capitula 1(3), 7-10 × 10-20 mm; involucres broadly hemispherical to depressed, 6-8 × 7-10(-14) mm; phyllaries 3-seriate, outer ovate-lanceolate, 2.5-3.5 × 1-1.5 mm, acute, with pellucid margins up to 1 mm, tomentose, inner oblong, 4.5-5.5 × 1.5-2 mm, obtuse, with 1 mm pellucid margins, puberulent; receptacle paleaceous; palea oblong, 5-6 × 2-2.5 mm, obtuse, scarious margined, glabrous or pilose. Ray florets 10-15, yellow, becoming ochroleucous at maturity, 7 × 4-5.5 mm, limb rectangular and 3-lobate, 3.5-5 × 4-5.5 mm, female, fertile; style 3 × 0.1-0.2 mm, style arms brownish, 0.4-0.5 mm; disc florets c. 40-60, yellow, 4-5 × 1 mm; style 4 × 0.2 mm, style arms brownish, 1 mm; stamens 5, anthers 2 × 0.3 mm, pale yellow, obtuse at the apex and base, filament 2.5 × 0.2 mm; ovary 2 × 0.7 mm long; achenes obovate, 2-3 × 1-1.3 mm, whitish, compressed dorsally, scrobiculate, ribbed; pappus absent.

Distribution: Turkey: C7 Şanlıurfa: Nimrud Dagh (Nemrut Da. nr Kahta), *Sintenis* 1888:815. Tektek Mountains Rüstem Stream, 600 m, 29.iv.2001, *Ö.F.Kaya sn*! 44 km from Şanlıurfa to Viranşehir, Tektek Mountains, Çoban Boğazı Pass, calcareous slopes, 07.vi.2002, *B. Yıldız* 15136! & *T. Arabacı*; Op. cit., 24.v.2003, *T. Arabacı* 1512! Op. cit., 23.iv.2004, *T. Arabacı* 1633! 12 km from Şanlıurfa to Birecik, *Pinus* L. forested area, 550 m, 22.iv.2004, *T. Arabacı* 1630!

Figure 3. *Achillea brachyphylla*. a) Habit and habitat; b) Capitulae.

Ecology and Habitat Preference: Flowering time of the species is April and May, fruiting is May and June. It grows on calcareous rocky slopes and steppes between altitudes of 300 and 600 m.

Conservation Status: *A. brachyphylla*, which is endemic to Şanlıurfa province, is an enigmatic and poorly known member of the genus. The main growing area of the species is the Tektek Mountains and a protected area for forestation at the east end of Şanlıurfa province. This species is faced with the same treat in the distribution area as that of *A. membranacea*. The main occupancy area of the species in the Tektek Mountains contains approximately 1000 mature individuals, which are localised on rocky slopes. According to observations carried out during field studies in the western part of Şanlıurfa province, we found only 1 locality in the protected area for plantation. The occupancy area in this locality is less than 10 km^2. Individuals of the species found in this area were estimated to total 250.

The record given from Nemrut Mountain by *Sintenis (Sintenis* 1888:815) is probably wrong. Nemrut Mountain and its vicinity were searched, as detailed, as a possible habitat by the authors, but no evidence of its existence in the area was found.

On the basis of these data, this species is at very high risk of extinction in the wild; therefore, it should be placed in the endangered category (criterion B2ab (iii); C1) (Table).

Discussion

Ligule colour is a useful criterion used to distinguish *Achillea* species. In the original description of *A. brachyphylla* given in the *Flora Orientalis* by Boissier, it was stated that ligules are ochroleucous (Boissier, 1875). In the later revision of the *Achillea* species growing in Turkey, prepared by Huber-Morath (1975) for the *Flora of Turkey*, the colour of ligules has been misleadingly reported as white. For this reason botanists have tried for several decades to find *Achillea* species with white ligules in south-east Anatolia, where all individuals are yellow. The real *A. brachyphylla* was named *A. membranacea* in some studies because of its yellow ligules. After the detailed field studies carried out in Şanlıurfa province by the first author, this problem was solved and its colour was established as yellow, becoming ochroleucous at the time of fruiting.

There is another problem we want to point out capitula numbers of the species. All specimens observed during the field studies and the examined herbarium specimens showed that this species is always single-capitulate, except Haussknecht's specimen collected from the Tektek Mountains and preserved in G.

A. brachyphylla is related to *A. membranacea* and *A. oligocephala*, but it differs from the former by its short stem (7-)10-20(-23) cm (not 25-50 cm) and leaves 0.5-1.5 × 0.1-0.25 cm (not ((1.5-)2-6 × 0.3-0.6 cm), tomentose involucre (not glabrous or sparingly hairy) with acute (not obtuse) ovate-lanceolate outer phyllaries (not circular-ovate) 2.5-3.5 × 1-1.5 mm (not 4 × 3 mm), inner phyllaries 4.5-5.5 × 1.5-2 mm (not 8 × 3.5 mm) with 1-mm pellucid margins (not 1-2-mm pellucid margins), and obtuse (not acute), oblong (not lanceolate) palea 5-6 × 2-2.5 mm (not 6-7 × 2-2.5 mm); the latter has a larger involucre 6-8 × 7-10(-14) mm (not 4-6 × 4.5-8 mm) and long ray florets 7 × 4-5.5 mm (not 4.5-8 × 2-4.5).

Achillea boissieri Hausskn. ex Boiss., Fl. Or. 3:272 (1875).

Type: Turkey: C6 Maraş: in rup. calc. inter Kawkirt et Allischen dagd (Aliser Da. between Maraş and Elbistan), in faucibus fl. Dschikan (Ceyhan), 900 m, 17.viii.1865, *Haussknecht* (holotype G, photo!; isotype W, photo!) (Figure 2).

Because *A. boissieri* was previously described, detailed taxonomy and images of this species are not given here (Arabacı & Yıldız, 2006b).

Distribution: Turkey: C6 Kahramanmaraş: 6 km from Ekinözü to Alişar village, serpentine, 1250 m, 23.vii.2004, *T. Arabacı* 1963 *& T. Dirmenci*! Op.cit. 24.viii.2004, *T. Arabacı* 1976! Ekinözü, Alişar village, serpentine, 1400 m, 23.vii.2004, *T. Arabacı* 1966 *& T. Dirmenci*! Berit Mountain, 10 km north of Süleymanlı, 1200-1300 m, 27.vii.2006, *T. Arabacı* 2190 *& T. Dirmenci*!

Conservation Status: *A. boissieri* is endemic to Kahramanmaraş province and found only on Berit Mountain. It was previously known only from the type locality. On this occasion this species was evaluated as belonging to the critically endangered category (criterion B1a). After comprehensive field studies we have recorded additional distribution for this species at Ceyhan Valley in Ekinözü district and south of Berit Mountain. As such, the

distribution of the species is expanded and the area of occupancy is estimated to be 20 km^2. The extent of its occurrence is estimated to be 200 km^2. Population size is estimated to be 800 mature individuals. In light of all these data, we propose to classify this species in the endangered category (criteria B1+2ab (iii); C1) (Table).

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