

A new natural hybrid of *Convolvulus* (Convolvulaceae) from central Anatolia, Turkey

Candan Aykurt* & Hüseyin Sümbül

Department of Biology, Faculty of Science, University of Akdeniz, Antalya, Turkey (*corresponding author's e-mail: candanqwe@yahoo.com)

Received 22 Apr. 2010, revised version received 7 July 2010, accepted 2 Aug. 2010

Aykurt, C. & Sümbül, H. 2011: A new natural hybrid of *Convolvulus* (Convolvulaceae) from central Anatolia, Turkey. — *Ann. Bot. Fennici* 48: 428–434.

Convolvulus × *turcicus* C. Aykurt & Sümbül, a new natural hybrid between *C. holosericeus* subsp. *holosericeus* and *C. compactus* from central Anatolia, Turkey, is described and illustrated. The morphological characteristics of *C. × turcicus* are compared with those of its parents. The pollen characteristics of *C. × turcicus* and its parents were examined by means of light microscopy and SEM.

Introduction

The family Convolvulaceae (bindweed family) consists of 58 genera and approximately 2000 species, with the genus *Convolvulus* comprising some 250 species worldwide (Staples & Yang 1998). The family is nearly cosmopolitan in distribution, but its members are primarily tropical plants, with many genera endemic to tropical zones of individual continents (Austin 1998). The Turkish *Convolvulus* species were revised by Parris (1978) in the *Flora of Turkey and East Aegean Islands*. According to that treatment, there were 32 species and 3 imperfectly known species that were reported, and one more species was described at a later time (Davis *et al.* 1988).

To date, very few hybrids in *Convolvulus* were reported (e.g. Carine *et al.* 2007) whereas in *Calystegia* (Convolvulaceae) hybrids were frequently encountered (i.e. Brown *et al.* 2009). No hybrids among the *Convolvulus* species were recorded in Turkey. Furthermore, in species-rich herbaria in Turkey such as ANK, GAZI, HUB, ISTE, ISTF and VAN uncommon specimens that

could be considered hybrids were not encountered. However, during the field trips, some individual samples collected from the provinces of Eskişehir and Kütahya, show intermediacy in terms of some morphological characters between *C. holosericeus* subsp. *holosericeus* and *C. compactus*.

In the present study, these individuals collected due to being considered hybrids, were evaluated morphologically and palynologically in detail. In terms of some morphological characters, the putative hybrids have some characters intermediate between *C. holosericeus* subsp. *holosericeus* and *C. compactus*, mainly in the habit, outer sepal shape and indumentum, ovary indumentum and stigma length; indeed in some cases, they exhibit ranges that exceed those of the parents (e.g. filament length). The term ‘harmomegathy’ was introduced by Wodehouse (1935) to describe alterations in the pollen form, which are now known to accompany the changes in the degree of hydration of the grains. The main function of harmomegathy is to protect the male gametophyte against desiccation during

pollen exposure. Bots and Mariani (2005) studied pollen viability in the field. They dehydrated mature pollen grains taken from opened anthers and observed that the grains were metabolically inactive, which critically decreased the reproductive efficiency of the hybrid forms. As a result of the palynological studies, we opine that one of the criteria that can be used in establishing the hybrid status of taxa is the percentage of dry pollen grains.

Material and methods

During the project “Taxonomical Studies on genus *Convolvulus* L. (Convolvulaceae) in Turkey” between the years 2007 and 2009, a great number of specimens of this taxon were collected and morphologically examined. From squares B2 and B3 (Davis’ grid system), approximately 60 specimens of *C. holosericeus* subsp. *holosericeus* from 24 different localities, and approximately 60 specimens of *C. compactus* from 26 different localities were sampled. Approximately 35 specimens of *C. × turcicus* were sampled from four different localities in square B3. During the morphological studies of the sampled specimens, the characters of the taxa such as the habit, the stem, the leaves (cauline and basal leaves), the corolla, the filament, the anther, the ovary, the style, the stigma, the capsule (if present) and the seed (if present) were considered and evaluated. In addition, the specimens of the genus *Convolvulus* from the herbaria such as GAZI, HUB, ANK, ISTE, ISTF and VAN, were studied. The specimens that were collected during the field trips within the scope of this study are deposited in the herbarium of AKDU (Herbarium of the Biology Department of Akdeniz University).

The hybrid individuals were collected from Eskişehir (localities: Seyitgazi; between the Kırka and the Yarbasan villages; and the Sarayören village) and Kütahya (locality: Kütahya–Eskişehir road) where *C. holosericeus* subsp. *holosericeus* and *C. compactus* occur in close proximity (Fig. 1). In Eskişehir, more than ten intermediate specimens were observed in an area where both *C. holosericeus* subsp. *holosericeus* and *C. compactus* are common. The collected hybrids

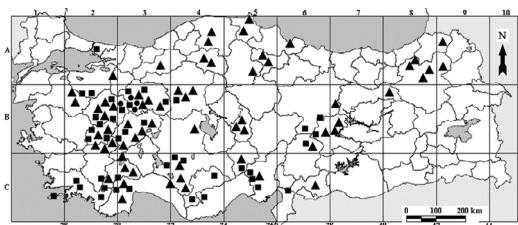


Fig. 1. Distribution of *Convolvulus × turcicus* (●), *C. holosericeus* subsp. *holosericeus* (▲) and *C. compactus* (■) in Turkey.

were initially examined using Post and Dinsmore (1932), Karamanoğlu (1964), Stace (1972), Sa’ad (1967), Parris (1978), Rechinger (1979), Meikle (1985), and Davis *et al.* (1988).

The pollen morphology of *C. × turcicus* and its parents was examined by means of light microscopy (LM) and SEM. For the LM analysis, the pollen grains were first treated with 96% alcohol to remove the oily substances, and then they were embedded in glycerin jelly stained with basic fuchsin (Wodehouse 1935). In the LM studies, the following parameters were measured from 50 pollen grains per species: the polar axis (*P*), the equatorial axis (*E*), and the exine and the intine thickness. To examine the exine sculpture in detail, scanning electron microscopy (SEM) was also used. For the SEM study, the pollen was first treated with 70% alcohol and then dried before mounting on the stubs with gold. The photomicrographs were taken with a Zeiss LEO-1430 Electron Microscope. In this study, the terminology of Punt *et al.* (1994) was used.

Results and discussion

For the genus *Convolvulus*, the sepal characters are one of the distinctive characters used in identifying the species. In *C. × turcicus*, the sepals are quite different from the parent taxa in terms of the shape and the indumentum. Furthermore, the filaments are longer than those of the parent taxa. The shapes of the cauline leaves generally are similar in all three taxa and the length and the width of the leaves are in between the parent taxa in the hybrid forms. A more detailed comparison of the hybrid with its parents is given in Table 1.

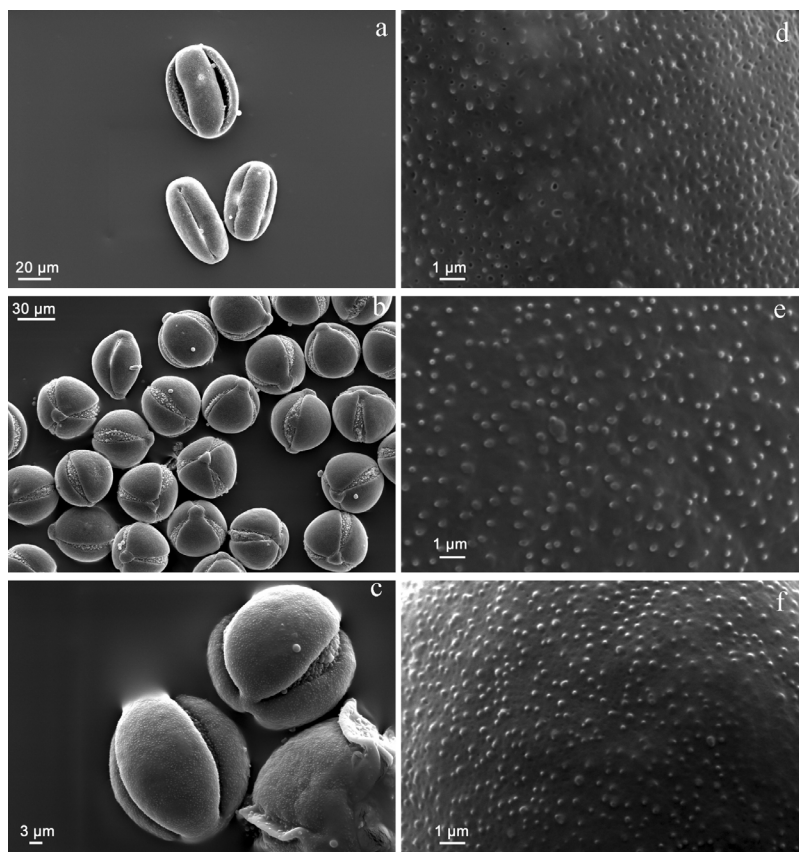


Fig. 2. SEM photographs of the pollen grains of *Convolvulus* × *turcicus* and its parents. — **a** and **d**: *C.* × *turcicus*. — **b** and **e**: *C. holosericeus* subsp. *holosericeus* (*C.* Aykurt 2174, AKDU). — **c** and **f**: *C. compactus* (*C.* Aykurt 2173, AKDU).

Concerning the variation of *C. compactus* in Turkey, we can say that especially the shape and the length of the leaves are variable. It is possible to come across this species especially in central Anatolia, Turkey, between the altitudes of 250 and 2135 meters. The leaves of *C. compactus* are often thicker than those of the hybrid individuals and *C. holosericeus* subsp. *holosericeus*, and are densely sericeous and spatulate. Carine *et al.* (2007) analyzed the variation in the leaf length and width of the hybrid individuals and the parental taxa. They also examined molecularly and morphologically the hybridization amongst the *Convolvulus* species endemic to the Canary Islands. Accordingly, the putative hybrids were strictly intermediate in terms of the mean leaf width, although there was some overlap with the parental taxa in terms of the mean leaf length.

We studied the pollen grains of *C.* × *turcicus* from an isotype. According to SEM (Fig. 2) and LM (Fig. 3), dry pollen grains of *C.* × *turcicus*

are subprolate, medium or large, the polar axis ranges between 44.07 and 59.45 μm , and the equatorial axis between 31.77 and 45.1 μm ; the aperture is tricolpate, the exine thickness range between 2.05 and 4.1 μm , the intine thickness ranges between 1.02 and 2.05 μm , the ornamentation is microechinate-perforate; with the perforations approximately being circular, dense, distinct and irregularly distributed. The pollen grains of *C. holosericeus* subsp. *holosericeus* and *C. compactus* are tricolpate, large and spheroidal; the equatorial outline is circular, and the ornamentation is microechinate-perforate; with the perforations approximately being circular, dense, distinct and irregularly distributed (specimens *C.* Aykurt 2174 and *C.* Aykurt 2173).

Under normal conditions, the pollen grains in *Convolvulus* often have a spheroidal or nearly-spheroidal shape. But in many species, some pollen grains have changed their shape and size as a result of dehydration. In our study, we found

Fig. 3. LM photographs of the pollen grains of *Convolvulus* × *turcicus* and its parents. — **a:** *C.* × *turcicus*. — **b:** *C. holosericeus* subsp. *holosericeus* (*C. Aykurt* 2174, AKDU). — **c:** *C. compactus* (*C. Aykurt* 2173, AKDU). Scale bars = 30 µm.

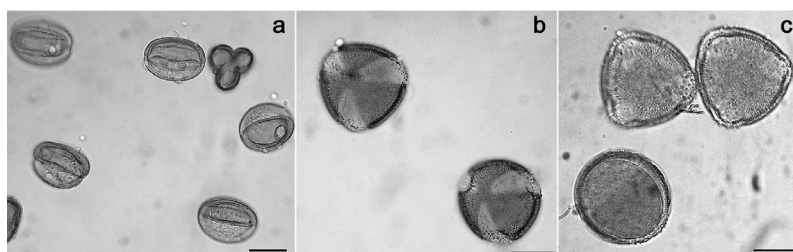


Table 1. Comparison of some diagnostic morphological and palynological characters of *C.* × *turcicus* with its parents.

	<i>C. holosericeus</i> subsp. <i>holosericeus</i>	<i>C.</i> × <i>turcicus</i>	<i>C. compactus</i>
Morphological characters			
Habit	usually lax cushion forming, woody-based, perennials	lax cushion forming, woody-based, perennials	dense, moss-like cushion forming shrublet
Stem length	10–50 cm	2–10(–15) cm	0.5–10 cm
Cauline leaves	linear-lanceolate, linear-oblong, 10–45 × 2–5 mm	linear-ob lanceolate to linear-spathulate, 10–35 × 1.5–5 mm	linear-lanceolate to spatulate, 6–45 × 1.5–5 mm
Flowers	axillary and terminal, solitary or 2–4 flowered cymes	axillary and terminal, solitary or 2–5 flowered cymes	axillary and terminal, solitary or 2–5 flowered cymes
Pedice l	1–15 mm	0.5–4 mm	very short (0.5 mm) or sessile
Peduncle	10–40 mm	3–10 mm	wanting or up to 10 mm
Bracteoles	linear, 1.5–5 × 0.2–1 mm, shorter than pedicel	linear, linear-ensiform, 4.5–14 × 0.5–1.5 mm, longer than pedicel	linear-lanceolate, 6–12 × 1–2 mm, longer than pedicel
Outer sepals	broadly obovate-suborbicular, pouched at base, 6.5–10 × 5.5–8 mm, acuminate, short adpressed-sericeous or subglabrous	broadly obovate-elliptic, 10.5–12 × 5–6 mm, long acuminate, densely and long adpressed-sericeous	Oblong-lanceolate to broadly obovate, 6–17 × 3–6 mm, long acuminate-caudate, densely, spreading villose
Corolla	dirty white, cream, pale yellow, rarely pale pink, 20–30 mm long	cream, pale yellow, 18–25 mm long	white, pale pink, pink rarely pale yellow, 18–25 mm long
Filament	6–10 mm	8.5–11.5 mm	4.5–6 mm
Ovary	sparsely and short adpressed-sericeous	densely sericeous	densely villose
Stigma	3–3.5 mm long, 1/2 or 1/3 about style	5.5–6 mm long, 1/2 about style	5.5–6 mm long, longer than style
Palynological characters			
Polar axis (<i>P</i> , µm)	59.45–(64.65)–69.7	44.07–(52.18)–59.45	51.25–(55.05)–57.91
Equatorial axis (<i>E</i> , µm)	62.52–(65.63)–71.75	31.77–(39.84)–45.1	52.27–(55.93)–59.45
<i>P/E</i>	0.98	1.31	0.98
Shape	spheroidal	subprolate	spheroidal
Aperture	tricolpate	tricolpate	tricolpate
Ornamentation	microechinate-perforate	microechinate-perforate	microechinate-perforate
Exine (µm)	1.02–2.05	2.05–4.1	1.54–2.05
Intine (µm)	1.02–1.54	1.02–2.05	1.02–1.54

that more than 92% of the pollen grains in the hybrid individuals were dehydrated. This rate, in the parental taxa, ranged between 4% and 8% (6%–8% in *C. holosericeus* subsp. *holosericeus* and 4%–5% in *C. compactus*). The dehydrated pollen grains of *C. × turcicus* are subprolate and their exines are rather thick. We may conclude that this is one of the criteria which can be used to establish the hybrid status of the taxa and it negatively affects the reproduction efficiency of the hybrid individuals.

We attempted to find fruiting material during field trips made at different times (June, July, August and September) in 2008 and 2009 to the areas where these individuals grew. However, they did not bear fruit, and their sepals were dried and their ovaries did not swell.

Convolvulus × turcicus C. Aykurt & Sümbül (*Convolvulus holosericeus* Bieb. subsp. *holosericeus* × *Convolvulus compactus* Boiss.), *nothosp. nova* (Figs. 1–4).

Basis lineae, frequenter laxe pulvinata, adpressa-sericea perennis. Caulis procumbens vel ascendens, 2–10(–15) cm altus, bene-ramosus e basi. Folia lineare-oblancheolata ad lineare-sphatulata, 4.5–35 × 1.5–5 mm, acuta, sessilia, versus basin attenuata, adpressa-sericea, reticulata-pinnata nervosa. Folia basalia similia foliis caulinis, saepe lineare-sphatulata, obtusa ad acuta, semi-amplexicaulia et margine scarioso basi; folia anteriora persistentia basi. Inflorescentia axillaris vel terminalis, cyma cum 2–5 floribus vel solitaria; pedicellus 0.5–4 mm; pedunculus 3–10 mm. Bracheteae similes floribus caulinis, lineare-oblancheolatae ad oblancheolatas 8–22 × 1.5–3 mm. Brachetolae lineare-ensiformatae, 4.5–14 × 0.5–1.5 mm, longiores quam pedicellis. Sepala exteriora late obovate-elliptica, 10.5–12 × 5–6 mm, longe acuminata, lato superiore saepe purpureo, longe adpressa-sericea. Sepala media obovata, 9.5–11 × 4–4.5 mm, longe acuminata, longe adpressa-sericea, disparia cum dimidio dextro et sinistro, uno dimidio membranaceo ad marginem; parte membranacea glabra vel glabrata. Sepala interiora obovata, 8.5–9 × 3–4 mm, longe acuminata ad caudata, longe adpressa-sericea, utrinque

membranacea versus marginem; parte membranacea glabra vel glabrata. Corolla cremea vel dilute lutea, 18–25 mm longa, alligatura pilosa supra partem exteriorem, pilosa in parte terminale; corollae tubus glabriusculus. Stamina inaequilonga, 9–12 mm; fila intagra ad marginem; antherae oblongae apice retuso. Ovarium ovatum-globosum, 1.5–2 × 1.5–2 mm, dense sericeum, circumdatum glabro disco basi; stylus 10–11 mm longus, dense sericeus; stigmata filiforma, 5.5–6 mm, paene dimidia styli. Florescentia inter Maium et Iulium.

HOLOTYPE: Turkey. C. Anatolia, B3 Eskişehir, Seyitgazi, 2 km from Seyitgazi to the Cevizli road, steppe, 1117 m, 7.VI.2008 C. Aykurt 2172 & N. Kemaloğlu (AKDU).

Woody-based, often lax cushion forming, adpressed-sericeous perennials. Stem procumbent or ascending, 2–10(–15) cm, much branched from base. Leaves linear-oblancheolate to linear-sphatulata, 4.5–35 × 1.5–5 mm, acute, sessile, attenuate at base, adpressed-sericeous, conspicuous reticulato-pinnatus nerved. Basal leaves resembling cauline leaves, often linear-sphatulata to oblancheolate-sphatulata, obtuse to acute, semi-amplexicaule and scariosus margin at base; dead leaves persistent at base. Inflorescence axillary and terminal, solitary or 2–5 flowered cymes; pedicel 0.5–4 mm; peduncle 3–10 mm. Bracts similar to cauline leaves, linear-oblancheolate to oblancheolate, 8–22 × 1.5–3 mm. Bracteoles linear-ensiform, 4.5–14 × 0.5–1.5 mm, longer than pedicels. Outer sepals broadly obovoid-elliptic, 10.5–12 × 5–6 mm, long acuminate, upper side often purplish, long adpressed-sericeous. Middle sepal obovoid, 9.5–11 × 4–4.5 mm, long acuminate, long adpressed-sericeous, with right and left half unequal, one half membranous towards margin; membranous part glabrous or glabrescent. Inner sepals obovoid, 8.5–9 × 3–4 mm, long acuminate to caudate, long adpressed-sericeous, with both half membranous towards margin; membranous part glabrous or glabrescent. Corolla cream or pale yellow, 18–25 mm long, with hairy bands on outside; petals pubescent at apex. Stamens unequal, 9–12 mm long; filaments entire at margin; anthers oblong with retuse apex, 2 mm long. Ovary ovoid-subglobose, 1.5–2 × 1.5–2 mm, densely sericeous, surrounded by a glabrous disc at base;

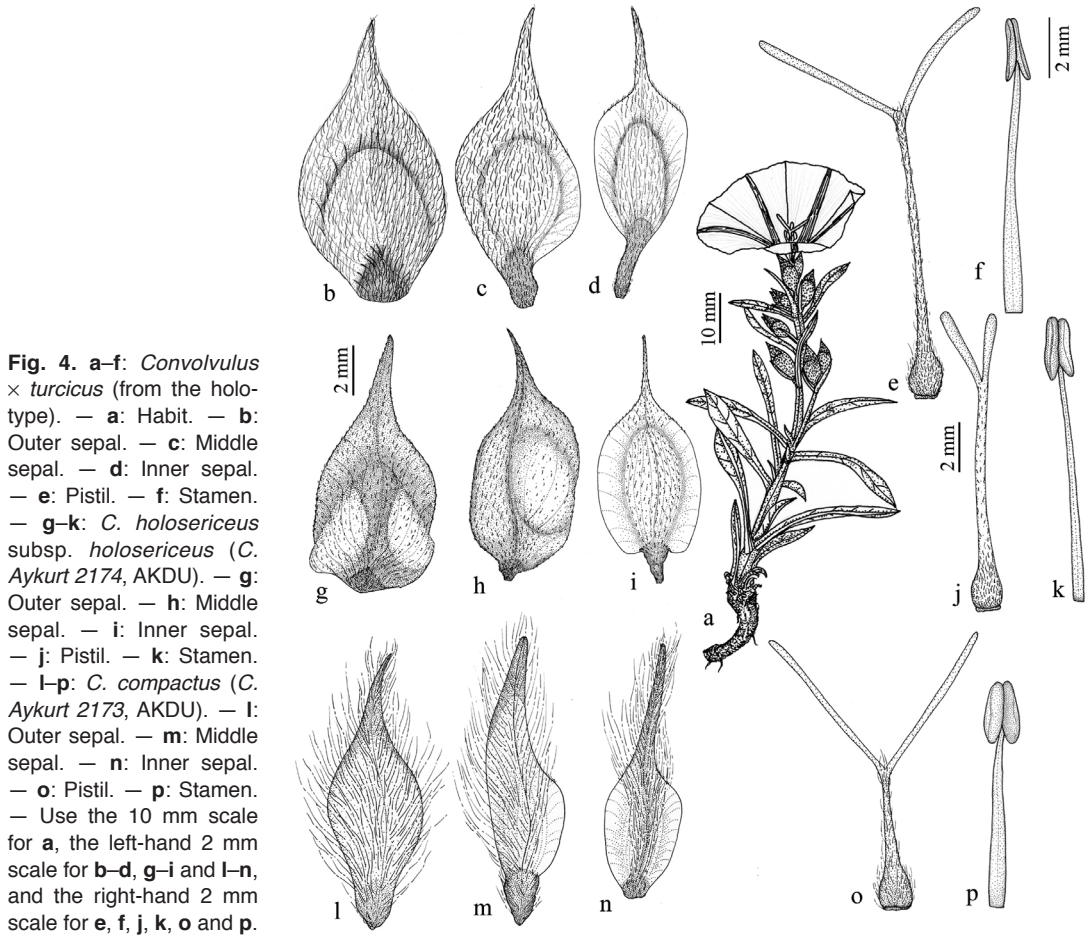


Fig. 4. a–f: *Convolvulus* × *turcicus* (from the holotype). — a: Habit. — b: Outer sepal. — c: Middle sepal. — d: Inner sepal. — e: Pistil. — f: Stamen. — g–k: *C. holosericeus* subsp. *holosericeus* (*C. Aykurt 2174*, AKDU). — g: Outer sepal. — h: Middle sepal. — i: Inner sepal. — j: Pistil. — k: Stamen. — l–p: *C. compactus* (*C. Aykurt 2173*, AKDU). — l: Outer sepal. — m: Middle sepal. — n: Inner sepal. — o: Pistil. — p: Stamen. — Use the 10 mm scale for a, the left-hand 2 mm scale for b–d, g–i and l–n, and the right-hand 2 mm scale for e, f, j, k, o and p.

style 10–11 mm, densely sericeous; stigmas filiform, 5.5–6 mm, half about style. Flowering time May–July.

Key to *Convolvulus* × *turcicus* and its parental taxa

1. Outer sepals pouched at base *C. holosericeus*
1. Outer sepals not pouched at base 2
2. Sepals densely scattered villous; filament 4.5–6 mm; stigma longer than style *C. compactus*
2. Sepals adpressed sericeous; filament 8.5–11.5 mm; stigma half about style *C. × turcicus*

Convolvulus × *turcicus* is distributed in central Anatolia (B3 square; Fig. 1) and is endemic to Turkey, being an Irano-Turanian taxon. It grows on the limestone slopes and on the steppes in the Seyitgazi, Kırka, Sarayören (Eskişehir) and Kütahya province. Its altitudinal range is

930–1120 m. Within this area, it is associated with plants such as *Astragalus vulneraria*, *A. wiedemannianus*, *Convolvulus compactus*, *C. holosericeus* subsp. *holosericeus*, *Centaurea thirkei*, and *Globularia trichosantha*.

Convolvulus compactus and *C. holosericeus* subsp. *holosericeus* that have a wide distribution area especially in southern and central Anatolia, have a common distribution in the same habitat and the same geographical areas in the B2, B3, B6, C2, C3, C4 and the C5 squares (Fig. 1).

In Turkey, *C. holosericeus* subsp. *holosericeus* and *C. holosericeus* subsp. *macrocalycinus* are distributed in a wide area and the latter is endemic to Turkey. *Convolvulus holosericeus* subsp. *holosericeus* is mainly distributed across inner and southern Anatolia and it is also present in the Balkan Peninsula, the Crimea and the Caucasian region. Similarly, *C. compactus* is mainly

distributed across the inner and the southern regions of Turkey and in the Balkan Peninsula.

COLLECTED AND EXAMINED SPECIMENS from B2 and B3 squares of Turkey (all in AKDU): — *C.* × *turcius*: *C.* Anatolia, B3 Kütahya, 7.5–8 km from Kütahya to Eskişehir, limestone slopes, 930 m, 6.VI.2008 *C. Aykurt 2140*. B3 Eskişehir, Seyitgazi, 2 km to Kurka, 1 km of Yarbasan village road, 39.27268N, 30.55319E, steppe, 1079 m, 15.VI.2009 *C. Aykurt 2706*. B3 Eskişehir, Seyitgazi, 1.5 km from path way entrance of 2 km from Seyitgazi to Cevizli road, 36.42525N, 30.70214E, steppe, 1117 m, 15.VI.2009 *C. Aykurt 2711*. B3 Eskişehir, Seyitgazi, entrance of Sarayören village, limestone slopes, 1075 m, 15.VI.2009 *C. Aykurt 2713*. — *C. holosericeus* subsp. *holosericeus*: B1/B2: Balıkesir, *C. Aykurt 1975*, *C. Aykurt 1985*. Denizli, Çivril, *C. Aykurt 2111*, *C. Aykurt 2108i*. Kütahya, Çavdarhisar, *C. Aykurt 2135*, *C. Aykurt 2137*; Gediz, *C. Aykurt 2127*; NW of Derbent, *C. Aykurt 1991*; 18 km from Kütahya to Eskişehir, *C. Aykurt 2155*. Uşak, Bölme environs, *C. Aykurt 2690*, *Aykurt 2123*. Ulubey, *C. Aykurt 2116*, *C. Aykurt 2120*, *C. Aykurt 2692*. B2/3: Burdur, Keçiborlu, *C. Aykurt 2683*. B3: Afyon, Bolvadin, *C. Aykurt 2189*; Çay, *C. Aykurt 2197*; Emirdağ, *C. Aykurt 2181*. Eskişehir, Çifteler, *C. Aykurt 2179*; Eskişehir–Ankara road, *C. Aykurt 2718*; Mahmudiye, *C. Aykurt 2720*; Seyitgazi, *C. Aykurt 2709*, *C. Aykurt 2174*; Sivrihisar, *C. Aykurt 2726*. Kütahya, Altıntaş village, *C. Aykurt 2538*. — *C. compactus*: B2: Balıkesir, Harmançık, *C. Aykurt 1986*, *C. Aykurt 1990*. Kütahya, S of Hamidiye, *C. Aykurt 1998*. Denizli, Çivril, *C. Aykurt 2107*, *C. Aykurt 2112*, *C. Aykurt 2686*. Uşak, Ulubey, *C. Aykurt 2117*, *C. Aykurt 2118*, *N. Kemaloğlu*. Kütahya, Çavdarhisar, *C. Aykurt 2133*; from Çavdarhisar to Kütahya, *C. Aykurt 2136*; Kütahya–Eskişehir road, 6.VI.2008, *C. Aykurt 2139*. Uşak, Bölme, *C. Aykurt 2689*; Ulubey, *C. Aykurt 2691*. B3: Eskişehir, from Kütahya to Eskişehir, *C. Aykurt 2159*; Eskişehir–Seyitgazi road, *C. Aykurt 2167*; Seyitgazi, *C. Aykurt 2173*, *C. Aykurt 2708*, *C. Aykurt 2712*; Çifteler, *C. Aykurt 2178*; Eskişehir–Ankara road, *C. Aykurt 271*, *C. Aykurt 2723*, *C. Aykurt 2728*. Afyon, Bolvadin, *C. Aykurt 2192*; Şuhut, 7.VI.2008, *C. Aykurt 2198*; Dinar, *C. Aykurt 2203*; Sandıklı, *C. Aykurt 2700*.

Acknowledgements

We thank Dr. R. Tekoğlu (Akdeniz University) for checking the Latin diagnosis. The new hybrid was collected during the “Taxonomical Studies on genus *Convolvulus* L. (Convolvulaceae) in Turkey” project is funded by Akdeniz University Scientific Research Projects Unit (project number 2007.03.0121.006). We are indebted to the Akdeniz University Scientific Research Projects Unit for the financial support.

References

- Austin, D. F. 1998: Parallel and convergent evolution in the Convolvulaceae. — In: Mathews, P. & Sivadasan, M. (eds.), *Biodiversity and taxonomy of tropical flowering plants*: 201–234. Mentor Books, Calicut.
- Bots, M. & Mariani, C. 2005: *Pollen viability in the field*. — Radboud Universiteit, Nijmegen.
- Brown, J. M., Brummitt, R. K., Spencer, M. & Carine, M. A. 2009: Disentangling the bindweeds: hybridization and taxonomic diversity in British *Calystegia* (Convolvulaceae). — *Botanical Journal of the Linnean Society* 160: 388–401.
- Carine M. A., Robba, L., Little, R., Russell, S. & Santos Guerra, A. 2007: Molecular and morphological evidence for hybridization between endemic Canary Island *Convolvulus*. — *Botanical Journal of the Linnean Society* 154: 187–204.
- Davis, P. H., Mill R. R. & Tan, K. 1988: *Convolvulus* L. — In: Davis, P. H., Mill R. R. & Tan, K. (eds.), *Flora of Turkey and the East Aegean Islands* (Suppl. I), vol. 10: 182. Edinburgh University Press, Edinburgh.
- Karamanoğlu, K. 1964: The species of *Convolvulus* L. in Turkey. — *De la Faculte des Sciences de l'Universite D'Ankara* 13: 225–251.
- Meikle, R. D. 1985: *Convolvulus* L. — In: Meikle, R. D. (ed.) *Flora of Cyprus*, vol. 2: 1163–1179. The Bentham-Moxon Trust, Royal Botanic Garden, Kew.
- Parris, B. S. 1978: *Convolvulus* L. — In: Davis, P. H. (ed.), *Flora of Turkey and the East Aegean Islands* 6: 198–221. Edinburgh University Press, Edinburgh.
- Post, G. E. & Dinsmore, J. E. (eds.) 1932: *Flora of Syria, Palestine and Sinai*, 2nd ed. — American Press, Beirut.
- Punt, W., Blackmore, S., Nilsson, S. & Thomas, A. 1994: *Glossary of pollen and spore terminology*. — LPP Foundations, Utrecht.
- Rechinger, K. H. 1979: *Convolvulus* L. — In: Rechinger, K. H. (ed.), *Flora des Iranischen Hochlandes und der Umrahmenden Gebirge*, vol. 3: 2–22. Akad. Druck- & Verlagsanstalt, Graz.
- Sa'ad, F. 1967: *Convolvulus species of the Canary Isles, the Mediterranean region and the Near and Middle East*. — Bronder-Offset, Rotterdam.
- Stace, C. A. 1972: *Convolvulus* L. — In: Tutin, G. T., Heywood, V. H., Burges, N. A., Moore, D. M., Valentine, D. H., Walters, S. M. & Webb, D. A. (eds.), *Flora Europea*, vol. 3: 79–82. Cambridge University Press, London.
- Staples, G. W. & Yang, S. Z. 1998: Convolvulaceae. — In: Editorial Committee of the Flora of Taiwan (eds.), *Flora of Taiwan*, 2nd ed., 4: 341–384. Department of Botany, National Taiwan University, Taipei.
- Wodehouse, R. P. 1935: *Pollen grains*. — McGraw-Hill, New York, London.