



Taraxacum pudicum, a new apomictic microspecies of *T.* section *Erythrosperma* (Asteraceae) from Central Europe

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Abstract

A new species of apomictic lesser dandelions, *Taraxacum pudicum* Vašut & Majeský is described. This species is a triploid diplosporous apomict, it belongs to the *T. scanicum* group and grows in the SE part of Central Europe, with the highest frequency found in southern Bohemia and Moravia. Species characteristics, notes on ecology and chorology are given. The relationship to other taxa and the controversy surrounding the description of apomictic species are discussed in this paper.

Key words: chromosome number, Compositae, geographical distribution, new species, taxonomy

Introduction

Taraxacum Wiggers (1780: 56) is a large genus found in the temperate zones of both hemispheres (Handel-Mazzetti 1907, Sterk 1987). It is comprised of approximately 60 sections worldwide (Kirschner & Štěpánek 1997, 2004, 2008, Uhlemann *et al.* 2004) and is known for having complex taxonomy due to a combination of different reproduction strategies, reticular evolution, and polyploidy (Kirschner *et al.* 2015). Whereas all diploids (and just a few exceptional tetraploids) reproduce either by allogamy or rarely by autogamy (e. g., Kirschner *et al.* 1994), all polyploids reproduce by obligate diplosporous apomixis. Since its discovery (Raunkiaer 1903), there has been an enormous number of described apomictic (micro)species to date. Because of the plethora of described taxa and because some authors described new species from a single locality or even a single herbarium specimen, the description of apomictic lineages as new microspecies were generally not accepted and controversial. However, recent biosystematic approaches have brought science back to the taxonomy of apomicts. Considering each morphological deviation, a new species is a *dead end*. Although genetic stability over large geographic areas due to obligate apomixis (e. g., Majeský *et al.* 2012) supports the concept of microspecies, there is still high potential for hybridisation and the formation of novel (singular) apomicts. Therefore, further biological characteristics, such as distribution, morphological stability in offspring, confirmed reproductive mode or genetic characteristics are required for considering an apomictic lineage of dandelions as a new species. Unfortunately, the vast majority of European *Taraxacum* species were described during the 1970s, and it will take considerable effort to purge the *Taraxacum* species list of vague taxa. So far, in Europe, such revisions have been performed only for some species, including *Taraxacum officinale* agg., *T.* sect. *Palustria* (Lindberg 1908: 17) Dahlstedt (1921: 37) and *T.* sect. *Alpeustria* van Soest (1966: 459) (Kirschner & Štěpánek 1998, Lundevall & Øllgaard 1999, Štěpánek *et al.* 2011).

In this paper, we present description of a new species of *Taraxacum* sect. *Erythrosperma* (Lindberg 1908: 45) Dahlstedt (1921: 36). The first author (RJV) recognised this morphotype over 15 year ago. Subsequently, we have studied its distribution, morphological stability, genetic diversity, ploidy and modes of reproduction. Following the modern approach of describing apomictic dandelions (e. g., Uhlemann 2007, Uhlemann *et al.* 2007, Trávníček *et al.* 2008, de Mera & Orellana 2008, 2009, 2012, Øllgaard & Räsänen 2008, Štěpánek *et al.* 2011, Marciniuk *et al.* 2012, etc.), we are convinced that this distinct morphotype deserves classification as a species. Therefore, we make valid publication of its name here.

Material and methods

The present study follows previous studies in *Taraxacum*. The protocols for field sampling and flow-cytometry were described by Doležel *et al.* (1989), and chromosome spread preparations were described by Vašut (2003). Flow-cytometric seed screening (Matzk *et al.* 2000) was used to test for reproductive mode. Microsatellites and AFLPs (Amplified Fragment Length Polymorphism) were used to test genetic diversity (Vašut *et al.* 2004, Majeský *et al.* 2012, 2015). Plants were cultivated by both authors for a period of more than 10 years (with gaps since 1998) to confirm morphological homogeneity among the populations as well as among the offspring. The terminology for describing morphological characteristics of dandelions uses special terms. In this paper, the morphological terminology follows the terms used by Dudman & Richards (1997) and Vašut (2003). Localities from which plants were used for the analyses are marked with appropriate initials: flow-cytometric analyses [FCM], flow-cytometric seed screen [FCSS], chromosome number counting [CN], plants included in the genetic diversity study [GD] and plants cultivated in a garden/greenhouse [cult.].

Taxonomy

Taraxacum pudicum Vašut & Majeský, **sp. nov.** (Figs. 1–2)

—*Taraxacum* aff. *slovacum* Klášť. in Vašut *et al.* (2004: 647).

Description:—Plants delicate with rich leaf-rosettes. Leaves pale (greyish)-green, without spots, usually 4–5× longer than wide, approximately 3–10(–15) cm long and 0.5–2.0 cm wide. The leaf blade is narrowly oblanceolate to elliptic, usually broadest in the middle or upper $\frac{1}{3}$, having 3(–4) pairs of lateral lobes. Lateral lobes of the inner leaves narrow and falcate, with a distal margin denticulate and convex and a proximal margin usually concave and entire. Lateral lobes of the outer leaves usually triangular or broadly falcate with entire margins, which are convex on the distal margin and concave on the proximal margin. Terminal lobes of the outer leaves distinctly triangular and acute and usually undulate on the distal margin; the proximal margin often has a pair of distinct teeth close to the central vein. Terminal lobes of the inner leaves tripartite, shortly lingulate, and sometimes denticulate on the distal margins, with an extended narrow acute tip. Interlobia large with a scarce narrow tooth. The petiole unwinged, green to pale purple and lanate at the base. Scapes short, usually shorter than or as long as the leaves, green at flowering and purplish at ripening, slightly lanate. Capitulum convex, 2.5 cm in diameter, (pale) yellow, outer strips grey-brown with pinkish fade. Inner bracts greyish-green and corniculate. Outer bracts usually 10–12, lanceolate to narrowly ovate, usually 5–7 mm long, 1.5–2.0 mm broad and greyish green, with a white hyaline margin narrow but distinct (0.1–0.2 mm broad), erect or only slightly recurved and corniculate. Stigmas yellow-green, dark-green when dried, with pollen present (irregularly sized). Achenes brown-purple, almost brown when dried, distinctly chestnut-red when not fully ripe, distinctly narrow, only sparsely spinulose, 3.6–4.0 mm long and 0.5–0.8(–0.9) mm broad, with a pyramid narrowly conical to cylindrical, (0.6–)0.8–1.0 mm long, a rostrum 5.0–6.0 mm long, and the pappus white.

Type:—CZECH REPUBLIC. South-western Moravia, district of Znojmo, along paths and roads in woods on sands between the villages of Kravsko and Bojanovice, approximately 2 km north of the centre of the village Kravsko, 370 m a. s. l., 48°56'30"N, 15°59'12"E, 1 May 2000, *R. J. Vašut* T-201.4 (holotype OL [herbarium specimen #24511], Fig. 1; isotypes OL [herbarium specimens #24512–21517], Fig. 2). [FCM, FCSS, CN, GD, cult.].

Etymology:—*pudicum* = chaste, modest, pure, virtuous. The name reflects short stems and a usually pale green appearance and an overall delicate habit of the plants. The plants, especially in cultivation, have flower heads “hidden” in pale green leaves.

Karyology:— $2n = 3x = 24$ (counted from the holotype locality); $2n \sim 3x$, distinguished by flow-cytometry (Vašut *et al.* 2004).

Mode of reproduction:—This species is apomictic. The mode of reproduction was tested in a single population (Kravsko-Bojanovice) and it was confirmed to be diplosporous apomixis by FCSS. Additionally, seeds of plants from five different populations were confirmed to also be obligate apomicts. These are marked in the list of known localities by [FCSS].



HOLOTYPUS

Taraxacum pudicum Vašut et Majeský,
species nova

FLORA MORAVICA

***Taraxacum pseudocristatum* nom. provis.**

Taraxacum sect. *Erythrosperma* (LINDB. fil.) DAHLST.

loc. Ph. r. 68 – Moravské podhůří Vysočiny, distr. Znojmo;
Kravsko – Bojanovice: in graminosis siccis in viis
silvestribus inter pagos, 2 km a septentrionali versus centri
pagi Kravsko; ca. 370 m s. m. 7061d.

die 1. V. 2000.
No. herb. T-201.4

leg. RADIM J. VAŠUT

FIGURE 1. Holotype of *Taraxacum pudicum*. Bar = 5 cm.



FIGURE 2. Isotypes of *Taraxacum pudicum*. Plants with well-developed inner leaves are shown.

Similar species:—The newly described species *Taraxacum pudicum* is quite distinct in its morphology. When it is well developed, it usually cannot be confused with any other described species in Central Europe. However, an undescribed morphotype sharing some characteristics with *T. pudicum* occurs rarely in the region. This unnamed morphotype has a more toothed leaf blade, broadened appendices on lateral lobes—similar to those of *T. danubium* Richards (1970: 108)—and broader (up to 0.5 mm) white hyaline margins on outer bracts. The general appearance of a delicate habit, the pale green colour of the whole plant, patent to adpressed outer bracts and narrow achenes in that unnamed plant suggests its putative relationship to *T. pudicum*, which was also confirmed by genetic analyses (Majeský *et al.* 2015).

Plants from extremely dry habitats and growing on rocky slopes are usually very small and have very narrow lobes. The terminal lobe is sometimes denticulate in such plants, which might lead to misidentifications as e.g. *T. cristatum* Kirschner *et al.* in Vašut *et al.* (2005: 204). However, this species differs in several distinct characteristics that are not influenced by ecological conditions. In particular, the achenes of *T. cristatum* have a broader shape and a slightly more spinulose upper part of the achene, and are brown in colour. The outer bracts of *T. cristatum* are spread distinctly and disorderly (to recurved), and it does not have the visually distinct hyaline margin of *T. pudicum*.

Taraxacum discretum Øllgaard (1986: 21) is another species found in NW Europe and is superficially similar to *T. pudicum*. However, based on field observations by the first author (Schiermonnikoog, the Netherlands), on the original descriptions (Øllgaard 1986) and on Hans Øllgaard's observations (H. Øllgaard, 2001 in litt.), it clearly differs from *T. pudicum* in having narrow leaves, recurved outer bracts that are dark greyish-green and a longer achene-cone that can be up to 1.2 mm in length.

Taraxacum slovacum Klášterský (1938: 8) is a species described from a single herbarium specimen of juvenile plants of *T. sect. Erythrosperma*. Juvenile plants of *T. pudicum* somewhat resemble plants of the holotype specimen of *T. slovacum*. The first author visited the type locality of *T. slovacum* and searched intensively for any morphotype that would resemble juvenile plants from the holotype specimen. No *T. pudicum* plants were found in the type locality (Zádiel, Slovakian Karst, SE Slovakia) or in the larger region, but diploid sexual plants having similar morphology to the holotype plant were found frequently. Based on these field observations, *T. slovacum* is very likely just a remarkable morphotype within the range of variability of the sexual species *T. erythrospermum* and is not related to *T. pudicum*. The first author published genetic data (Vašut *et al.* 2004) for *T. pudicum* under the name “*T. aff. slovacum* Klášť.” because data on *T. slovacum* from the field were not available at that time.

Ecology:—*Taraxacum pudicum* occurs mostly in semi-ruderal dry habitats, especially in sandy soils (mostly paths in open locust-woods of the *Balloto nigrae-Robinion*). However, it also grows in similar semi-ruderal habitats in pine woods, xerothermic grasslands (*Festucion vallesiacae*, *Koelerio-Phleion phleoidis*) and occasionally in ruderal places, such as abandoned mining areas and road verges.

Distribution:—*Taraxacum pudicum* is a Central European species. It occurs in the southern part of the Czech Republic (both Bohemia and Moravia), Lower Austria and Slovakia. The species is rather rare and has scattered occurrence within the distribution area. A higher concentration of localities was observed in the region between Brno and Znojmo city in Moravia (at the foothills of the Bohemian Massif).

Additional specimens examined:—CZECH REPUBLIC. Bohemia: Obory (Příbram): along the field path near the locality Hromádky (441.6 m), 2–2.5 km W (R. Hlaváček 31.5.1995 herb. R. Hlaváček, #C-7633). —Chrást u Kovářova, margin of forest on right bank of the Orlická přehrada dam, opposite the Orlík castle. 365 m a. s. l. (M. Soukup, V. Chán & V. Žila 2003 herb. Žila) [*very typical plants!*]. —Písek, xerothermic slopes near village Dědice, ca. 380–420 m a. s. l. (J. Moravec 1959 PR). [*T. cf. pudicum*]. —Stříbro, in valle Úterecký p. infra casam Šipín 1950 M. Deyl PR). —Nasavrky, Na Strádově (Železné hory), ca. 400 m a. s. l. (R. Hendrych 1942 PR) [*T. cf. pudicum*].

—CZECH REPUBLIC. Moravia: Budišov village, paths in pine forest on Kněžský kopec hill, 1.5 km towards E from the centre of village, 490 m a. s. l., 49°16'22"N 16°02'02"E (R. J. Vašut & L. Majeský 2008 OL) [FC, GD, cult.]. —Havraníky: heathland 1.2 km towards W from the village (P. Bureš et V. Grulich 1991 BRNU). —Ketekovice: castle ruins Levnov, 3.0 km towards SW from the centre of village, 330 m a. s. l. (R. J. Vašut 1999 OL). —Kravsko: road verges and paths, 1.5 km towards N from the centre of the village, 350 m n. m (R. J. Vašut 2000 OL). —Střížov near Jihlava, dry xerothermic slopes in S outskirts of the village the village, 475–530 m a.s.l. (J. Růžička s.d. MJ) [*T. cf. pudicum*]. —Kuřimská Nová Ves: xerothermic slopes on N outskirts of the village, 0.5 km towards NW from the centre of village, 480 m a. s. l. (R. J. Vašut 2000 OL). —Malhostovice: Malhostovická Pecka hill, 1.0 km towards SSW from the centre of village, 330 m a. s. l., 49°19'33"N 16°29'42"E (R. J. Vašut 1999 OL). [FC, FCSS, GD, cult.]. —Olbramkostel: castle ruins Šimperk, 3.0 km towards WNW from the centre of the village, 390 m a. s. l. (R. J. Vašut 2000 OL). —Pocoucov: xerothermic hill near the road to the Trnava village, 1.5 km towards NE from the centre of village, 460 m a. s. l. (R. J. Vašut 2000 OL). —Synalov —Kopaniny: pathways on S slope of the hill Sýkoř (702 m), 1.0

km towards S from its summit, 620 m a. s. l. (R. J. Vašut 1999 OL). [FC, GD, cult.]. —Tišnov —Květnice hill (470 m): pathway and S rocky slopes, 0.8 km towards SW from its summit, 380 m a. s. l. (R. Vašut 1999 OL). [FC, GD, cult.]. —Trnava u Třebíče, dry pasture, ca. 0.8 km towards NNW from the church in village, 460 m a. s. l., N49°15'33,9" E015°55'32,1" (L. Ekrt 2012 Ekrt herb.) [*T. cf. pudicum*].

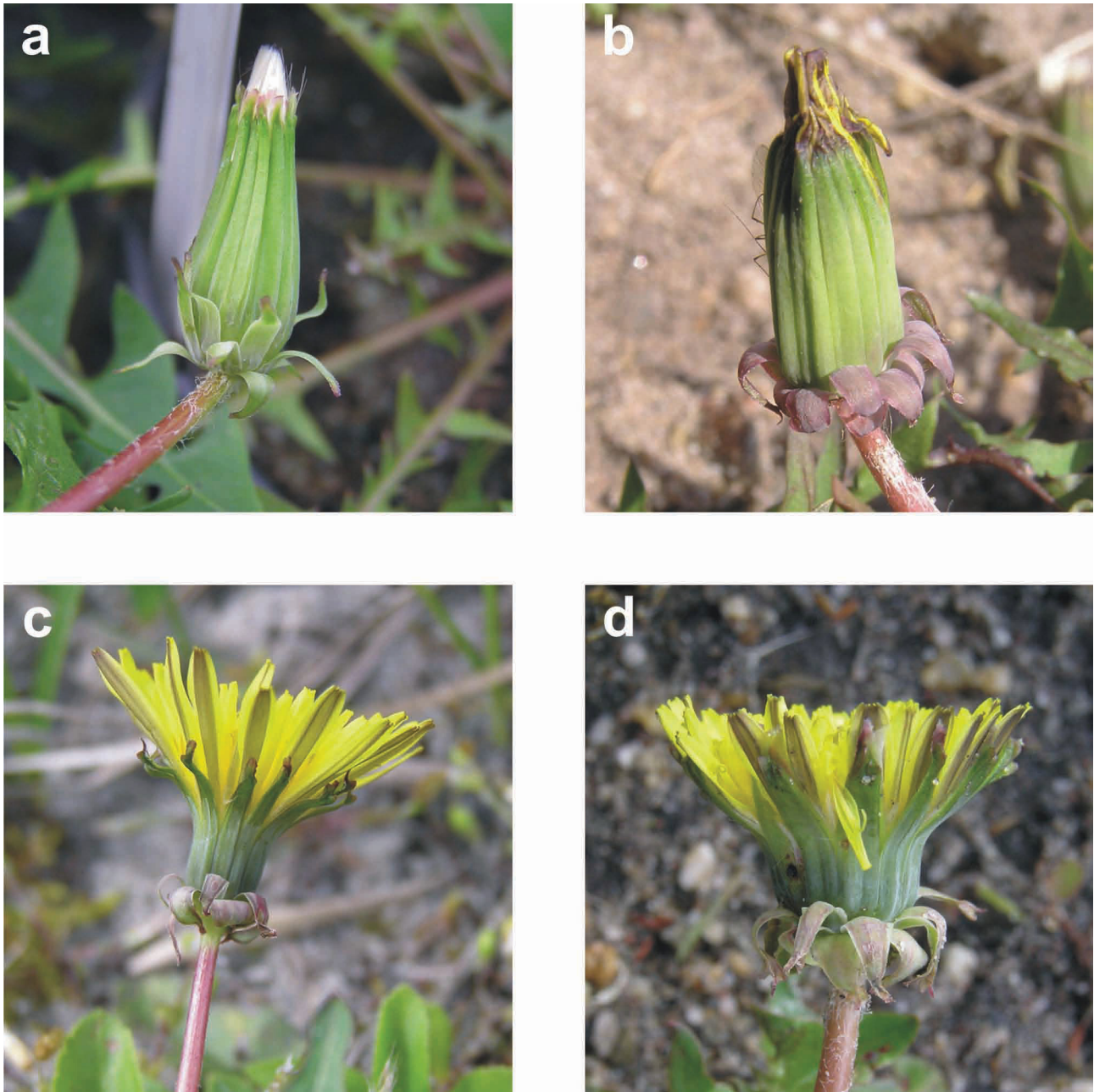


FIGURE 3. Capitulum of *Taraxacum pudicum* and allied species. A, *T. pudicum* (Czechia, Kravsko-Bojanovice, type locality); B, *T. cristatum* (Czechia, Bzenec); C, *T. discretum* (the Netherlands, Schiermonnikoog); D, yet unnamed morphotype of *T. scanicum* agg. (Czechia, Bzenec).

—AUSTRIA. Lower Austria: Baden, paths along castle ruins Rauhenstein, ca. 300 m a. s. l., 48°00'48"N 16°12'18"E (R. J. Vašut & E. Majeský 2009 OL) [*T. cf. pudicum*].

—SLOVAKIA. Košická Belá, Sivec hill (781 m a. s. l.), rocks at top of the hill (M. Dudáš 2015 herb. M. Dudáš) [*T. cf. pudicum*]. —Ladmovce, Kašvár hill, along pathways (M. Dudáš 2015 herb. M. Dudáš).

—POLAND. occurrence of species is yet unknown, however, some plants extreme in their morphology (grown either in shadow or in high grass) that resemble *T. pudicum* in several characters (outer bracts, achenes, the design of leaf-blade morphology) were collected in the vicinity of Żuchłów in Lower Silesia (Województwo dolnośląskie). This occurrence has to be confirmed by observing well developed plants.

Discussion:—The newly described species, *T. pudicum*, belongs to *T. sect. Erythrosperma*, which is comprised of (at least) one sexual diploid species, *T. erythrospermum* Andrz., and about 150 apomictic microspecies. Within this section, it belongs to the *T. scanicum* group that consists of 16 previously described species (Doll 1973, Øllgaard 1986, Schmid 2002, Vašut 2003, Vašut *et al.* 2005, Marciniuk *et al.* 2009). Widely distributed species of this group, i. e., *T. prunicolor*, *T. cristatum* and *T. scanicum* s. str., can hybridise with *T. erythrospermum*, resulting in local (couple of localities) or singular hybrid populations (Majeský *et al.* 2015). Although we did not detect hybridisation between *T. pudicum* and *T. erythrospermum*, we found morphotypes similar to *T. pudicum* that differed genetically. Thus, hybridisation between these species seems to be highly probable at sites where these species meet. This has to be taken into consideration when identifying *T. pudicum* from localities with the co-occurrence of *T. erythrospermum*.

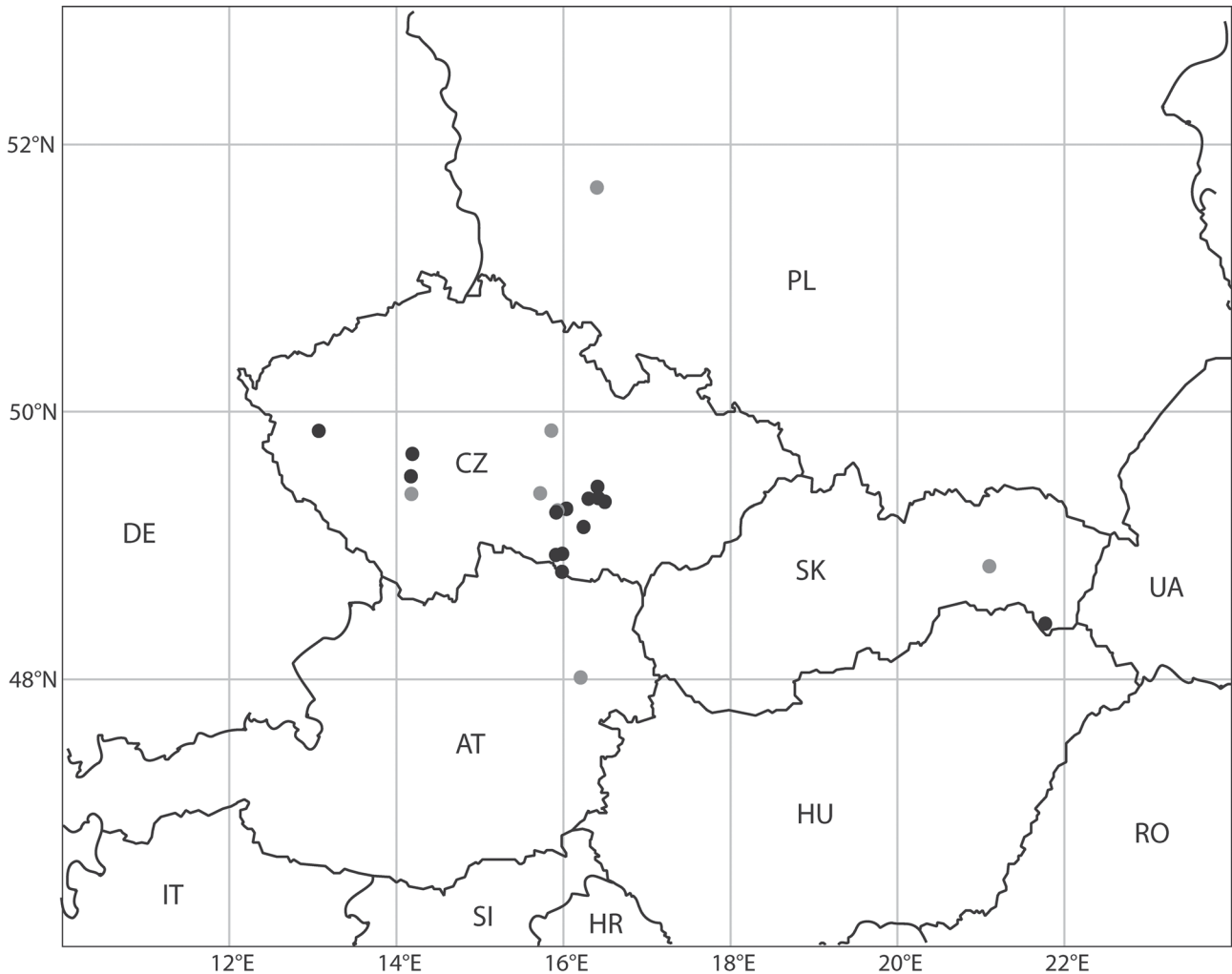


FIGURE 4. Distribution of *Taraxacum pudicum* in Central Europe. Black dots represent the well-documented occurrence of *T. pudicum* in the region; grey dots represents the samples likely belonging to *T. pudicum* [*T. cf. pudicum*].

The facts that *i*) the distribution area of *T. pudicum* highly overlaps with the NW limit of the distribution of *T. erythrospermum* in Central Europe, *ii*) the species has a significant plasticity depending on the biotope, and *iii*) a “sibling morphotype” occurs on sands of Pannonia, led the first author to question whether it is a stabilised species or just a hybrid of *T. erythrospermum* and some member of the *T. scanicum* group (e. g., *T. cristatum*). The genetic analyses of the microsatellites and AFLPs performed by the second author confirmed that individuals from different biotopes and different parts of its area are genetic clones and that if it is a hybrid then it is a hybrid of an older evolutionary history that spread over the SE part of Central Europe (see also Majeský *et al.* 2015). *Taraxacum pudicum* is one of 22 unnamed morphotypes mentioned by Vašut (2003) from the region of Moravia. In addition to this species, (Májeský *et al.* 2015) also studied genetic diversity of another three additional unnamed types (and four species) of the *T. scanicum* group out of these 22 unnamed types to find the origin of these local taxa. *Taraxacum pudicum* and other species of the *T. scanicum* group turned out to be genetically uniform, although putatively hybridising with sexual species. On the contrary, the remaining two unnamed morphotypes appeared to be morphologically as well as

genetically variable and considered to be the result of ongoing hybridisation between a group of apomictic species and the sexual *T. erythrospermum* (Majeský *et al.* 2015). We are convinced that such hybrids—although having apomictic reproduction—do not deserve the rank of species and should be named by the name of the group, i. e., either as *T. scanicum* agg. or *T. sect. Erythrosperma* only.

TABLE 1. Main differences between *T. cristatum*, *T. discretum*, and *T. pudicum*.

characters	<i>T. cristatum</i>	<i>T. discretum</i>	<i>T. pudicum</i>
outer bracts, position	irregularly spreading	recurved	erect
outer bracts, hyaline margin	absent	distinct	narrow, but distinct
colour of outer bracts	pale green, might become purplish when growing in dry places	dark green	pale greyish green, always green
achene colour	brown	red-brown	brown-purple
achene cone	0.7–0.9 (–1.0) mm	1.0 mm	0.7 mm
terminal lobe	longer than broad	longer than broad	as long as broad

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