Contribution to the knowledge of two *Compositae* species in the Bulgarian flora

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Abstract. New data about the distribution and population size, as well as a discussion of the alien and invasive status are provided for two *Compositae* species in the Bulgarian flora: *Dittrichia viscosa* and *Silphium perfoliatum*. The former is a Mediterranean species that was first recorded in Bulgaria in 1931 and never seen again until recently. Due to this, it was evaluated as an endangered species in the first edition of the *Bulgarian Red Data Book* and included in the list of the legally protected species. In the period 2019–2021, new localities were recorded in three floristic regions: Znepole region, Valley of River Struma and Rhodopi Mts (*Eastern*). All recently found localities are restricted to road verges and, apparently, reflect a recent human assisted colonization of the species. Judging from the literature and observations in the field, *D. viscosa* should be considered a naturalized, potentially invasive alien species in the Bulgarian flora. *Silphium perfoliatum* is native to North America. In Bulgaria, it was first reported in 2010 from the Northeast Bulgaria floristic region as a casual species. A new locality was recorded in 2021 in the Forebalkan (*Eastern*) floristic region. Based on the field observations in the new locality, *S. perfoliatum* should be considered a naturalized, non-invasive alien species in the Bulgarian flora. The text is illustrated with photographs from the new localities of both species.

Key words: alien species, *Asteraceae*, *Dittrichia viscosa*, invasive potential, new records, *Silphium perfoliatum*

Introduction

Surveys in different parts of Bulgaria, with special attention to alien species, often result in gathering of new chorological data or recording of new species for the Bulgarian flora. The aim of the present article is to report new data about the distribution and population size of two *Compositae* species, *Dittrichia viscosa* (L.) Greuter and *Silphium perfoliatum* L., and to discuss their alien status and invasive potential in the Bulgarian flora.

Material and methods

Herbarium specimens and live plants were collected from a few localities in Bulgaria. Herbarium specimens were deposited in the Herbarium of the Institute of Biodiversity and Ecosystem Research (SOM) at the Bulgarian Academy of Sciences (IBER-BAS). Live plants have been cultivated in the vegetation house of IBER-BAS for further observations. Morphological characters have been studied in the collected Bulgarian material and compared with relevant taxonomic literature (e.g., Ball 1976; Tutin 1976; Clevinger 2006; Kuzmanov 2012). Data about the habitats and populations were collected in the field. Taxonomy of all other species mentioned in the text follows Delipavlov & Cheshmedzhiev (2011). Assessment of the native and invasive status of the species is based on field observations and relevant literature (Wacquant 1990; Hassan & al. 2016; Molnár & al. 2019; Cumplido-Marin & al. 2020; Gudžinskas & Taura 2020; Sladonija & al. 2021). Understanding of the relevant terms follows the ter-

minology and concepts suggested by Richardson & al. (2000).

Results and discussion

Dittrichia viscosa (L.) Greuter [syn. *Inula viscosa* (L.) Aiton] (Figs. 1, 2)

Morphological description of the taxon is provided in *Flora of the R Bulgaria* (Kuzmanov 2012). The species is distinctive with the following characters: plants are perennial, strongly aromatic, with characteristic smell; leaves alternate; well developed flowering specimens are relatively large (0.7–1.0 m tall), strongly branched and woody at base; capitula numerous on each stem; outer florets ligulate, *ca.* 10-12 mm long, clearly longer than the involucral bracts; achenes cylindrical, abruptly contracted at apex, pappus hairs in one row, connate near base and forming a brownish cap (Ball 1976; Kuzmanov 2012).

Flowering from late August to November, fruiting from September to December. In South Bulgaria, after the first strong and long frosts (usually in December) the plants look dry, with withered leaves in winter (in warmer regions the plants may be evergreen all year round, see Parolin & al. 2014). Nevertheless, when strong frosts are lacking, fruiting capitula continue to develop and seeds may still ripen in December – January (Figs. 3, 4).

***Distribution and habitats in Bulgaria*: Znepole region:** at road verge along the motorway Kulata – Sofia, W of Topolnitsa village, *ca.* 690 m, 42.35196°N, 23.09800°E, 20.10.2019, with flowers, *V. Vladimirov* obs.; **Valley of River Struma (*Northern*):** at road verge along Struma Highway from Kulata village to Sofia city, N-NW of Mursalevo village, *ca.* 374 m, 42.13013°N, 23.03443°E, 20.10.2019, a single flowering specimen, coll. *V. Vladimirov*; along Struma Motorway from Kulata to Sofia, at road verge NW of Blagoevgrad town, *ca.* 320 m, 42.06610°N, 23.03970°E, 11.01.2020, one large (*ca.* 1 m tall) and about 10 small fruiting specimens, as well as a dozen of vegetative young specimens, all with withered leaves, *V. Vladimirov* obs.; along Struma Motorway from Kulata to Sofia, at road verge N-NW of Mursalevo village, *ca.* 340 m, 42.13012°N, 23.03445°E, 11.01.2020, one large fruiting specimen with already withered leaves, *V. Vladimirov* obs.; **Valley of River Struma (*Southern*):** In arenosis et saxosis non procul vicum Topolnica, distr. Petrič, 20.09.1931, leg. *N. Stojanoff* (SOA 11417; SOM 77300); at road verge of Struma Highway from Sofia to Kulata village, *ca.* 0.8 km before the fork to General Todorov village, *ca.* 170 m, 41.46318°N, 23.31656°E, 26.11.2020, a single fruiting specimen with *ca.* 40 stems, *V. Vladimirov* obs.; **Rhodopi Mts (*Eastern*):** at road verge along the road from Asenovgrad to Kardzhali town near Gabrovo village, Chernoochene Municipality, *ca.* 624 m, 41.79757°N, 25.26912°E, 23.10.2019, coll. *V. Vladimirov* (SOM) (Fig. 5).

In the locality near Gabrovo village in the Eastern Rhodopi Mts, a single flowering specimen was observed at the road verge. Associated species were: *Cichorium intybus*, *Cynodon dactylon*, *Dichanthium ischaemum*, *Eragrostis minor*, *Melilotus* sp., *Plantago lanceolata*, *Setaria viridis*, and *Trifolium repens*.

In the past, the species was collected only once, in 1931, in a locality very close to the Bulgarian-Greek border (SOA 11417; SOM 77300; Stojanov & Stefanov 1933). Now, it is very difficult to assess whether that occurrence resulted as a natural spread from the localities in North Greece, or it was human-assisted introduction. Rarity of the species in the Bulgarian flora was the reason to assign to the taxon an Endangered status and include it in the *Red Data Book* (Ganchev 1984, as *Inula viscosa*). In fact, Stojanov & Stefanov (1933: 999) stated that the species occurs 'in damp sands and gravel in the ditch near Topolnitsa village, next to the road to Petrich town', which suggests that the introduction of the species might have been human assisted. For the preparation of the *Red List of Bulgarian Vascular Plants* (Petrova & Vladimirov 2009) several field trips have been organized to the area of Topolnitsa village and along the road to Petrich. However, all searches were unsuccessful and *D. viscosa* was not found. Therefore, the species was evaluated as Data Deficient (Vladimirov 2009). *Dittrichia viscosa* is legally protected in Bulgaria under the national Biological Diversity Act (2002, 2007).

The construction of Struma Motorway from Sofia city to Kulata village in the past decade has created unvegetated habitats, which are very suitable for establishment and spread of plant species that are good colonizers. The colonizing capacity of *D. viscosa* has been mentioned in a number of publications (e.g., Wacquant 1990; Hassan & al. 2016). Indeed, the species shows excellent colonizing abilities since it has appeared and rapidly spread only a few years after the

Fig. 1. *Inula viscosa* on the verge of Struma Motorway, 20.10.2019 (photo V. Vladimirov).

Fig. 3. *Inula viscosa* on the verge of Struma Motorway, 11.01.2020 (photo V. Vladimirov)

Fig. 2. *Inula viscosa*: flower heads (photo V. Vladimirov)

Fig. 4. Seeds of *Inula viscosa*, 11.01.2020 (photo V. Vladimirov)

Fig. 5. *Inula viscosa*, along the road Asenovgrad – Kardzhaly near Gabrovo village (photo V. Vladimirov)

construction of the road verges. Dolna Dikanya – Dupnitsa lot of the motorway was constructed in the period 2011–2013 and was open for use in 2013, and Dupnitsa – Blagoevgrad lot was constructed in 2013–2015 and open in 2015. Thus, only 2–3 years after the suitable habitats became available, the first flowering specimens of *D. viscosa* have already appeared. Apparently, this is related to the transport and intensively used road network. It is very likely that the intensive traffic of motorcars and trucks on the motorway facilitates the spread of the species along the road verges. The locality in Eastern Rhodopi Mts is also associated with roads and transport. So far, no plants of *D. viscosa* have been recorded off the road verges. Thus, all recently found localities of the taxon are part of its alien range and it should be considered a naturalized alien species in the Bulgarian flora.

So far, *D. viscosa* has been recorded in Bulgaria in the habitat J4.2 Road networks (sensu EUNIS 2021). In its native range, the species is common in human-disturbed areas as a ruderal, and sometimes as a weed in crops. Expansion of the species in such habitats and its ability to colonize new habitats was recorded already in 1970s and 1980s (Wacquant 1990). In the past decades, *D. viscosa* has also expanded to coastal habitats, including salt marshes, i.e., it tolerates high salinity (Hassan & al. 2016). Due to use of deicing chemicals, road verges represent a special type of habitat that is suitable for invasion and further spread of halophyte and salt-tolerant plant species. Similar pattern has been observed with the congeneric *Dittrichia graveolens*, also a native Mediterranean species, common in coastal habitats, which invades and rapidly spreads along the road verges in South and Central Europe, far outside its native range (Šajna & al. 2017).

Distribution worldwide: Native to the Mediterranean – South Europe (from Portugal and Spain in the west, to Turkey in the east), Middle East (Israel, Jordan, Lebanon, Syria) and North Africa (from Morocco in the west, to Egypt to the east) (Greuter 2006+; Parolin & al. 2013; Sladonja & al. 2021). Introduced to Australia, North America (Sladonja & al. 2021), South America (Chile – Novoa 2017), and to some European countries: naturalized in Belgium and Great Britain, and casual in Germany (Greuter 2006+). However, Preston (2006) maintains that in North America the species 'does not appear to have become naturalized at any site'.

***Invasive potential*:** Expansion of *D. viscosa* to new habitats in its native range has been discussed in a number of articles, e.g., Wacquant (1990) and Hassan & al. (2016). Recently, 'unusual spread of *D. viscosa* has been recorded in coastal Croatia' (Sladonija & al. 2021). Also, the species has demonstrated invasive behaviour in Australia (CRC Australian Weed Management 2003). These facts suggest that *D. viscosa* is an excellent colonizer, capable of rapid invasion of new habitats and new geographical areas. The recently recorded localities of the species in Bulgaria are all a result of human assisted spread and, thus, are part of the alien distribution range of the species. Although so far the species has been restricted only to road verges, the availability of other suitable habitats in close proximity, especially in the Valley of River Struma floristic region, e.g., gravelly river banks, urban and peri-urban areas with disturbed ground, makes the invasion of these places very likely and probably only a matter of time. Climate change, especially warming, undeniably will facilitate the spread and establishment of the species in Bulgaria further to the north of its former distribution limit in North Greece. Considering this and the observed rapid colonization of suitable sites, the species presumably is potentially invasive and should be monitored closely and controlled duly, when necessary. Consequently, *Dittrichia viscosa* should be delisted from Annex 3 (Protected species) of the national Biological Diversity Act.

Silphium perfoliatum L. (Figs. 6, 7)

A concise morphological description of the species in Bulgaria is provided in the *Flora of R Bulgaria* (Kuzmanov 2012). Mention deserves the fact that the plants may reach up to 3.0 m in height in favourable conditions, with involucres *ca.* 3 cm in diameter. The most distinctive characters of this taxon from all other *Compositae* species in Bulgaria are the large size of the plants (usually above 1 m), square stems (clearly 4-angled) and opposite upper leaves, abruptly contracted into a winged petiole and connate at the base so as to form a cup round the stem (perfoliate leaves).

***Distribution and habitats in Bulgaria*: Northeast Bulgaria:** Near Obraztsov Chiflik, Ruse district (Vladimirov & Petrova 2010); **Forebalkan (*Eastern*):** In openings in a mixed deciduous forest on the banks of river Ovcharka, between Zhaltesh village and Gabrovo town, *ca.* 450 m, 42.85773°N, 25.37029°E, 31.08.2021, coll. *V. Vladimirov* (SOM) (Fig. 8).

Fig. 7. *Silphium perfoliatum*: flower head (photo V. Vladimirov).

Fig. 6. *Silphium perfoliatum*: 4-angled stem and leaves (photo V. Vladimirov).

Fig. 8. *Silphium perfoliatum*, on the banks of Ovcharka River between Zhaltesh village and Gabrovo town, 31.08.2021 (photo V. Vladimirov).

Silphium perfoliatum was first recorded in the Bulgarian flora as a casual in September 2010 (Vladimirov & Petrova 2010). It seems that in the newly found locality along river Ovcharka, the species has been present for more than 10–15 years and is naturalized. At least 500–600 stems have been observed in several adjacent stands, covering a total area of *ca.* 400 m2. The population occupied mostly the right bank of the river. Most plants were flowering. The tallest specimens reached slightly above 3.0 m in height. *Silphium perfolatum* was the dominant taxon, with 40–50% (to 90% in some stands) projective cover, and the highest herbaceous species in the community. Associated herbaceous plants were: *Angelica sylvestris*, *Carex* spp.,

Cirsium creticum, *Dactylis glomerara*, *Epilobium hirsutum*, *Equisetum* sp., *Eupatorium cannabinum*, *Galeopsis speciosa*, *Lycopus europaeus*, *Lythrum salicaria*, *Pteridium aquilinum*, *Rubus caesius*, *Rubus* sp., *Sonchus arvensis*, and *Urtica dioica*. Sparse trees were also present, e.g., *Carpinus betulus*, *Prunus cerassifera* and *Salix fragilis*.

The exact pathway of introduction of the species to both known localities is unknown. Kuzmanov (2012) maintains that in Bulgaria, the species is used as an ornamental plant and in some parts of the country trials for its cultivation as a fodder plant are taking place. Most likely, in the locality along river Ovcharka, viable parts (e.g., rhizome fragments) of the species have been accidentally thrown away with garden waste from the settlements nearby. The vigorous vegetative propagation and the large size give an advantage to the species and it successfully outcompetes the native herbaceous and some shrub species. Most likely, the local spread of the species is achieved mostly by vegetative means, by short-distance movement of rhizome fragments, e.g., by running water after a heavy rain.

So far, the species has been recorded in Bulgaria in the following types of habitats: J4.2 Road networks and G1.2 Mixed riparian floodplain and gallery woodland (sensu EUNIS 2021). In its native range, *S. perfoliatum* grows in wet prairies, open forests and along rivers (Barkley 1986 cited by Gudžinskas & Taura 2020), whereas in the non-native range, the species grows on riverbanks and in damp meadows (Tutin 1976), and at roadsides (Molnár & al. 2019).

***Distribution worldwide*:** Native to eastern North America (Clevinger 2006). In Europe, it is naturalized in a number of countries such as France, Germany, Italy, Switzerland, Ukraine, while in other countries it is a casual or with an unknown alien status (Greuter 2006+). So far, the species has not been reported from any of the Balkan countries (cf. Greuter 2006+).

Invasive potential: Judging from literature and observations in the field, it can be inferred that *S. perfoliatum* may naturalize and form locally extensive stands, especially along small rivers. However, at least in the Bulgarian localities, it does not show invasive behaviour. Therefore, at present, it should be considered a naturalized, non-invasive species. This is congruent with the observations from elsewhere in Europe (e.g., Molnár & al. 2019; Cumplido-Marin & al. 2020; Gudžinskas & Taura 2020).

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