

Epilobium adenocaulon and *Oenothera glazioviana* (*Onagraceae*): new alien species for the Bulgarian flora

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Abstract. *Epilobium adenocaulon* and *Oenothera glazioviana*, two alien species new for the Bulgarian flora, have been recorded in West Bulgaria. Both species are presently among the widest-spread alien species in Europe and have been reported already for the majority of the neighbouring countries. The diagnostic characters of the taxa and their sites in Bulgaria are described and some notes about their habitats and ecology are presented. The invasion status of the taxa in Europe is also discussed.

Key words: alien species, *Epilobium adenocaulon*, invasive status, *Oenothera glazioviana*

Introduction

Rivers, together with other transport routes such as roads and railways, are common pathways for the spread of alien plants (Planty-Tabacchi & al. 1996; Richardson & al. 2007). River banks and river gravel bars, as frequently disturbed habitats, offer many opportunities for the establishment of the early colonizers, such as many alien species. Still, the potential of gravel bars as habitats for alien species in Bulgaria has not been explored. Here we report two new alien species, *Epilobium adenocaulon* and *Oenothera glazioviana*, found first on gravel bars in West Bulgaria. In addition, we report another locality of *E. adenocaulon* from the centre of Sofia. Both species are native to North America and are common aliens in other European countries, but have not been reported so far from Bulgaria (Assyov & Petrova 2012; Petrova & al. 2012, 2013).

Material and methods

Herbarium specimens were deposited in the Herbarium (SOM) of the Institute of Biodiversity and Ecosys-

tem Research, Bulgarian Academy of Sciences, Sofia. Morphological characters are described on the basis of materials collected and compared with the relevant literature sources. Data about populations and habitats in Bulgaria are based on visual observations and information about the species ecology, and habitat preferences are matched with literature data and the authors' personal observations. Terminology of species invasion status follows Richardson & al. (2000).

Results

Epilobium adenocaulon Hausskn. in Österr. Bot. Z. 29 (1879) 119 (Fig. 1).

Epilobium adenocaulon belongs to *E. sect. Synstigma* (Hausskn.) Raimann (Smejkal 1997), which is represented in the Bulgarian flora by eight native species (Assyov & Petrova 2012).

According to *Flora Nordica* (Snogerup 2010), two separate species have been distinguished, *E. adenocaulon* and *E. ciliatum* Raf., which are otherwise commonly given as synonyms (e.g. Raven 1980a). Both

species are native to North America and alien to Europe. Most reports of their European occurrences do not distinguish between them, therefore, they should be regarded as occurrences of *E. adenocaulon* s.l. The main difference between these species is their branching: *E. ciliatum* is branching from the base, while *E. adenocaulon* only above. *Epilobium adenocaulon* has turions always present in autumn and usually purplish-pink flowers, while in *E. ciliatum* turions are frequently absent and flowers are white or whitish-pink (Snogerup 2010).



Fig. 1. Herbarium specimen of *E. adenocaulon* collected in the Cherna Mesta valley (deposited in SOM).

Morphology: Perennial herb, overwintering by leaf rosettes. Stems simple or branched, 20–140 cm, glabrous or with few scattered simple trichomes below, with glandular and simple eglandular hairs above and especially in the inflorescence. Leaves 3–10 × 1–3 cm, shortly petiolate (2–5 mm), lanceolate to narrowly ovate, with rounded to cordate base, glandular-hairy on the margin (Fig. 2). Flower buds erect. Sepals 4, petals 4, 3–6 mm, deeply notched, purplish-pink. Stigma club-shaped (Fig. 3). Fruit a narrow, hairy, 4-chambered capsule, up to 10 cm long. Seeds 1 mm, spindle-shaped, with a pellucid appendage and longitudinal irregularly serrated white stripes on the testa (Fig. 4) (cf. Raven 1980a; Smejkal 1997; Kubát & al. 2002; Snogerup 2010).

The shape of testa is the main morphological character for correct determination of the species. Therefore, if seeds are not available, *E. adenocaulon* could be misidentified, especially with *E. roseum* Schreb., a similar native species common across Bulgaria (Assyov &



Fig. 2. Detail of leaf of *E. adenocaulon* of a plant collected in the Czech Republic (photo D. Michalčová).



Fig. 3. Detail of flower of *E. adenocaulon* with the club-shaped stigma; plant collected in the Czech Republic (photo V. Kalníková).



Fig. 4. Detail of *E. adenocaulon* seed; plant collected in the Czech Republic (photo D.B. Dittrichová).

Petrova 2012). The seeds of the latter species are rounded at the ends, without pellucide appendage, and the testa is with rounded papillae, but unlike in *E. adenocaulon* not in distinct rows (Fig. 5). Other differences between these species are in the leaf shape and flower buds. *Epilobium roseum* has ovate leaves with rounded base, longer petiole (5–20 mm) and nodding flower buds (Smejkal 1997; Strgulc Krajšek & Jogan 2004). In Bulgaria, *E. adenocaulon* can be also misidentified with other native species, *E. tetragonum* L. or *E. obscurum* Schreb. (Assyov & Petrova 2012). The two species have very short petiole



Fig. 5. Detail of *E. roseum* seed; plant collected in the Czech Republic (photo D.B. Dittrichová).

(0–4 mm), the stem base of *E. obscurum* has leafy stolons and its flower buds are nodding. *Epilobium obscurum* has glandular trichomes on the hypanthium, while *E. tetragonum* has only simple eglandular ones (Smejkal 1997).

Species of *Epilobium* L. can easily hybridize. Hybrids of the alien *E. adenocaulon* with most of the other native European taxa from *E. sect. Epilobium* have been described, for instance, by Smejkal (1982, 1997) and Krahulec (1999).

Distribution range: The native range of *E. adenocaulon* is North America, extending from Alaska and North Canada to Mexico. Its secondary range includes South America (Chile, Argentina, the Falkland Islands), Europe, East Asia (Japan, Korea, East Siberia), Hawaii, Australia, Tasmania, and New Zealand (Smejkal 1997). It is widespread across most of Europe (29 countries), and in 21 European countries it has been naturalized (Lambdon & al. 2008). In South Europe, *E. adenocaulon* has been reported only from Italy (Celesti-Grapow & al. 2009) and Spain (Alonso 2012), and in the Balkan Peninsula and adjacent countries – from Slovenia, Croatia (Strgulc Krajšek & Jogan 2004) and Romania (Holub & Vicol 1971).

Habitat preferences: *Epilobium adenocaulon* grows in similar environments both in its primary and secondary distribution ranges, mainly in semi-natural and anthropogenic habitats such as wet meadows, river banks, forest clearings, and disturbed ruderal places along roads and railways.

Invasiveness: Due to its wide ecological amplitude and ability to produce a large amount of seeds distributed by the wind, *E. adenocaulon* spreads and gets established very fast (Smejkal 1982; Strgulc Krajšek & Jogan 2004). In other European countries, where it has been established for a long time, although present in plant communities, it never becomes their dominant (Mlíkovský & Stýblo 2006). However, in some Balkan countries, such as Slovenia and Croatia, it has been considered invasive due to its fast spreading (Strgulc Krajšek & Jogan 2004; Boršić & al. 2008). It is included in the list of 'Worst invasive alien species threatening biodiversity in Europe' (Larsson & al. 2007).

Distribution in Bulgaria: *Epilobium adenocaulon* was found in small populations (few individuals) in three floristic regions of West Bulgaria:

1. Sofia region: 1 km S of the central railway station, Ivan Stambolov St., Zhenski Pazar, 10.09.2014; as weed in flower pots and containers in a flower shop next to the St. Kiril i Metodiy Church, 541 m a.s.l., 42°42'13"N, 23°19'16"E, J. Danihelka obs.

2. Znepole region: Mt Milevska Planina, river Treklyanska valley, near Treklyano village, Kyustendil district, side river bar, partly shaded by river bank vegetation,

coarse gravel substrate, vegetation with dominance of *Alnus glutinosa* in the shrub layer and *Calamagrostis pseudophragmites*, *Epilobium hirsutum* L., *Melilotus albus* Medik., and *Mentha longifolia* in the herb layer, 741 m a.s.l., 42°33'14.1"N, 22°36'00.4"E, 15.08.2013, V. Kalníková & S. Palpurina obs.

3. Rila Mts: two localities in the Cherna Mesta river valley, above Cherna Mesta village, Blagoevgrad district, 18.08.2013: **A).** Mid-channel river bar, sunny habitat, mainly stony and sandy substrate, open vegetation with dominance of *Salix purpurea* L. and *S. euxina* I.V. Belyaeva [*S. fragilis* auct. bulg.] in the shrub layer, and *Agrostis stolonifera* L., *Artemisia vulgaris* L., *Rumex alpinus* L., and *Saponaria officinalis* L. in the herb layer, 1036 m a.s.l., 42°03'35.7"N, 23°43'38.4"E, coll. V. Kalníková & S. Palpurina, rev. J. Danihelka (SOM 169840) (Fig. 1). **B).** Mid-channel river bar, partly shaded by river bank vegetation, mainly gravelly and stony substrate, vegetation with dominance of *Alnus incana* (L.) Moench in the shrub layer and *Calamagrostis pseudophragmites* (Haller f.) Koeler, *Mentha longifolia* (L.) Huds., *Rumex alpinus*, and *Tussilago farfara* L. in the herb layer (Fig. 6), 999 m a.s.l., 42°03'30.3"N, 23°43'39.8"E, V. Kalníková & S. Palpurina obs.



Fig. 6. Locality of *E. adenocaulon* on a gravel bar with *Calamagrostis pseudophragmites* in the Cherna Mesta River (photo V. Kalníková).

Oenothera glazioviana Micheli in Martius, Fl. Bras. 13(2) (1877) 178 [syn. *O. erythrosepala* (Borbás) Borbás]

Oenothera glazioviana belongs to *O.* subgen. *Oenothera* (Raven 1980b), represented in Bulgaria by three alien species: *O. biennis* L., *O. parviflora* L. and *O. stricta* Link (Assyov & Petrova 2012).

Morphology: Herbaceous biennial. Stem erect, simple or branched, 30–180 cm high, hairy, red-spotted at the base of the long hairs. Leaves broadly lanceolate, with crinkled margins. Inflorescence many-flowered. Sepals red-striped or entirely red, at least on the later flowers. Hypanthial tube 30–50 mm long. Petals yellow, broadly obcordate, 30–50 × 32–58 mm. The most important diagnostic character is the long style, 20–60 mm, with the stigma overtopping the anthers. Fruit a capsule, lanceolate, 20–35 mm long, densely glandular, with long stiff hairs having red bulbous bases.

Oenothera glazioviana can be easily distinguished from the other Bulgarian *Oenothera* species. First of



Fig. 7. Habitat of *O. glazioviana* at the Rilska Reka river (photo V. Kalníková).

all, unlike *O. glazioviana*, no other species of the genus recorded so far in Bulgaria has red bristles on the stem or the inflorescence, and all of them have shorter petals: *O. biennis* – 15–30 mm, *O. parviflora* – 6–12 mm, and *O. stricta* – 15–35 mm. Furthermore, *O. parviflora* has sepal tips in the bud separated from the very base, and the petals of *O. stricta* have often a red spot at their base (Jehlík 1997; Rostański & Karlsson 2010).

Oenothera glazioviana can hybridize with other species of the genus (Raven 1980b; Jehlík 1997; Rakaj & Rostański 2009).

Distribution range: *Oenothera glazioviana* is native to North America. It was introduced as a popular ornamental plant in South America, Europe and part of East Asia, where it is currently widespread. The species is reported also from Japan, Malaysia, the Azores and the Canary Islands. In mid-19th century, it was introduced



Fig. 8. Herbarium specimen of *O. glazioviana* collected in the Rilska Reka valley (deposited in SOM).

to Great Britain. Presently, it is widespread and common across most of Europe (Jehlík 1997; Raven 1980b). On the Balkan Peninsula it is reported from Greece (Arianoutsou & al. 2010), Romania (Sîrbu & Oprea 2010), Albania and Montenegro (Rakaj & Rostański 2009), and Serbia (Zlatković & al. 1998).

Habitat preferences: *Oenothera glazioviana* is common in semi-natural and anthropogenic habitats. It prefers open sunny habitats, with sandy or gravelly, frequently disturbed soils. It can be found in industrial areas, at road edges, along railways or other ruderal places, on sandy coasts, along river banks, etc. (Jehlík 1997; Mihulka & Pyšek 2001; Rakaj & Rostański 2009).

Invasiveness: Among the alien species of the genus in Europe, *O. glazioviana* was classified second after *O. biennis* as the worst potential invader, with high probability of a future spread in Europe (Mihulka & al. 2006). The spread of *O. glazioviana* is favoured mainly by its use as an ornamental plant, high fecundity and high seed production, and the ability to survive disturbance as it can grow and produce seeds from just few remaining intact basal axillary buds (Mihulka & al. 2003, 2006; Martínková & al. 2006). According to the national alien species lists (see 'Distribution range' above for references), *O. glazioviana* has spread across most of the Balkan Peninsula. This contradicts the suggestion of Mihulka & Pyšek (2001) that the climate of the Balkan Peninsula, with its high maximum mean month temperatures and insufficient rainfall, is not suitable for invasion of this species. Across the Balkan Peninsula, *O. glazioviana* has been described as invasive only for Romania (Sîrbu & Oprea 2010). In Serbia it is not considered invasive and not even potentially invasive (Lazarević & al. 2012). Its invasive status in the other Balkan countries is unknown.

Distribution in Bulgaria: *Oenothera glazioviana* was recorded in one locality, where it was represented by few individuals.

Valley of River Struma (Northern): foothills of Rila Mts, River Rilska valley, near Stob village, Kyustendil district, side river bar, sunny habitat, mainly stony and sandy substrate, herb vegetation with dominance of *Agrostis stolonifera*, *Artemisia vulgaris*, *Calamagrostis pseudophragmites*, *Lythrum salicaria* L., *Melilotus albus*, and *Tussilago farfara* (Fig. 7), 446 m a.s.l., 42°05'23.4"N, 23°06'03.3"E, 16.08.2013, coll. V. Kalníková & S. Palpurina, rev. J. Danihelka (SOM 169839) (Fig. 8).

Concluding remarks

Epilobium adenocaulon and *Oenothera glazioviana* were reported as new alien species for Bulgaria, with few localities and small populations. Nevertheless, their invasive status in other European and Balkan countries indicates their potential as invasive species also for the Bulgarian territory. Both species are pioneer light-demanding plants and river bars fit well to their habitat preferences, along with other frequently disturbed habitats, such as railways, roadsides, industrial places, and in the case of *O. glazioviana*, also sandy places. On the basis of their habitat preferences and the fact that they are already widespread in the neighbouring Balkan countries, we assume that these species have been present in the Bulgarian flora for a long time but were overlooked.

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