Research Article

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First Record of an Invasive Alien Plant Species of EU Concern in Bulgaria: *Heracleum sosnowskyi* Manden. (Apiaceae)

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Abstract: *Heracleum sosnowskyi* (Apiaceae) was recorded for the first time in Bulgaria in 2017. Initially, it was seen on photographs in the social media (Facebook), and then, localised in a residential area in Sofia City. A brief morphological description of the species is provided, mostly based on the material from the Bulgarian locality. The population comprises about 150-200 individuals, including many flowering and fruiting ones. The pathways of introduction and the invasive potential of the species are discussed. *Heracleum sosnowskyi* is included in the List of Invasive Alien Species of European Union (EU) concern under the Regulation (EU) 1143/2014 of the European Parliament and of the Council, which appeals that the EU Member States undertake measures for eradication of such aliens. Appropriate control measures for the species are proposed based on literature survey and the observed state and size of the Bulgarian locality.

Key words: Bulgarian flora, *Heracleum pubescens*, Sosnowsky's hogweed, Giant hogweeds, non-native species

Introduction

Invasive alien species are recognised as one of the most significant causes of native biodiversity loss. Many of them may also have negative effect on the economy of a particular country or region and/or may threaten human health (Genovesi & Shine 2004, Keller et al. 2011). Therefore, these species have been of particular interest to researchers during the past two decades. In Bulgaria, the special attention to suitable habitats, such as railway tracks, roadsides, urban environment, margins of agricultural fields, riparian habitats, etc., resulted in the discovery of many alien vascular plants new to the country. Only for the past two years, at least six plant species have been newly reported for the alien flora of Bulgaria (Vladimirov & Delcheva 2016, Petrova & Barzov 2017, Petrova & Gerasimova 2017, Petrova et al. 2017, Vladimirov et al. 2016, 2017).

Social media, such as Twitter or Facebook, may play an important role in the early detection of alien species, since people share readily photographs of living objects, which somehow attract their attention. For example, earlier this year photos of a spectacular species of *Heracleum* L. were shared among Facebook-friends within the Bulgarian plants group, and luckily, the pictures were spotted by the second author of this article. The author of the photographs appointed the approximate location of the plants, and consequently, we were able to recognise the locality from the photographs and to record an alien plant species which appeared to be one of the invasive alien species of European Union (EU) concern.

We report for the first time the occurrence of an invasive alien species of EU concern from the genus *Heracleum* in Bulgaria and analyse its pathways of introduction, invasive potential and the possible measures for control.

Materials and Methods

The plant material was collected in Sofia City where is the only so far known locality of the species in

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Bulgaria. The morphological characters were noted from the Bulgarian material and compared with the data from the relevant literature (Brummit 1968, Nielsen et al. 2005, EPPO 2009). The collected herbarium material was deposited in the herbarium of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences (SOM). The data about the population and habitat in Bulgaria are based on personal observations. The analysis of the invasive potential of the species is based on the available literature about its biology, ecology and invasion success (Nielsen et al. 2005, EPPO 2009, Kabuce & Priede 2010), as well as on the personal observations in the recorded Bulgarian locality.

Results and Discussion

Heracleum sosnowskyi Manden. was recorded for the first time as an alien species to the Bulgarian flora.

Heracleum sosnowskyi Manden., Zametki Sist. Geogr. Rast. 12: 17, 1944 (Figs. 1, 2).

Herbaceous biennial to short-lived perennial, usually monocarpic. Stems 1.5-2.0(3.0) m, erect, branched in the upper part, ridged and sparsely hairy, with conspicuous purple blotches. Leaves 60-120 cm, divided to a varying extent, usually two times ternate, acute, pubescent beneath. Compound umbels usually 2-6, slightly convex, 30-60 cm in diameter, the terminal is the largest, with 50-120 finely hirsute rays. Petals 9-10 mm long, white, the other distinctly radiate. Fruit a pair of winged mericarps; each mericarp is elliptic in outline, (6)9-11 × (3)5-6 mm, one-seeded, densely hairy when unripe; wings of ripe mericarps with minute spines on small swellings; vittae strongly swollen, 0.6-1.0 mm wide, reaching ¾ of the length of the fruit (Fig. 3).

In Bulgaria the species is flowering in June-July and fruiting in July-August. Flowers are insect-pollinated, visited by many species, including bees (Fig. 4). Mericarps are dispersed by wind, watercourses, and by attaching to animal fur or human shoes and clothes, as well as to tyres of vehicles (Nielsen et al 2005, EPPO 2009).

The genus *Heracleum* L. is represented by four native species in the Bulgarian flora: *H. angustisectum* (Stoj. & Acht.) Peev, *H. sibiricum* L., *H. ternatum* Velen., and *H. verticillatum* Pančić (Peev 1982). *Heracleum sosnowskyi* is easily distinguished from all of them by its bigger leaves (usually more than 60 cm long), bigger compound umbels (ca. 30-60 cm in diameter in *H. sosnowskyi* and up to 20-30 cm in the native species), and higher number of rays of the compound umbels (ca. 50-120 in *H. sosnowskyi* and up to 35-50 in the native species).

Fig. 1. *Heracleum sosnowskyi* – whole plant (Photo: V. Vladimirov)

Taxonomy

The taxonomic status of *H. sosnowskyi* has not been resolved yet. Some authors consider it a subspecies or synonym of other species, e.g. *H. mantegazzianum* Sommier & Levier, and *H. pubescens* (Hoffm.) M. Bieb. (Kabuce & Priede 2010, Hand 2011). We prefer to retain its specific status as proposed by Mandenova (1944) and as accepted in the List of the Invasive Alien Species of EU concern (EU 2016), EASIN database (http://alien.jrc.ec.europa.eu/SpeciesMapper) and other sources (Jahodová et al. 2007, Kabuce & Priede 2010).

Distribution in Bulgaria

Sofia floristic region: Sofia City, grasslands among the blocks of flats in Lyulin-1 residential district, ca. 560 m a. s. l., N 42.727026°, E 23.254605°, 28.06.2017, in flower, V. Vladimirov & B. Assyov obs. (photos); loc. ibid., 13.07.2017, in flowers and unripe fruits, leg. V. Vladimirov (SOM); loc. ibid. 15.07.2017, B. Assyov & A. Petrova obs.

The population comprises about 150-200 individuals that are clustered into 3 groups: one large group, covering about 50-60 m^2, and two smaller groups of about 10-15 m^2 each. The plants of *H. sosnowskyi* are rather dense, ca. 100-150 cm tall and

Fig. 2. A dense group of *Heracleum sosnowskyi* individuals in Sofia City (Photo: V. Vladimirov)

Fig. 3. Mericarps of *Heracleum sosnowskyi* at the locality in Bulgaria (Photo: V. Vladimirov)

Fig. 4. *Heracleum sosnowskyi* is a melliferous plant and attracts bees (Photo: V. Vladimirov)

overtop the native grassland vegetation dominated by *Arrhenatherum elatius* (L.) J. Presl & C. Presl, *Dactylis glomerata* L., *Elymus caninus* (L.) L., *E. repens* (L.) Gould, *Hordeum murinum* L., and *Poa pratensis* L.

Distribution worldwide

The species is native to the Caucasus and Trans-Caucasia (Armenia, Azerbaijan, Georgia, Russia, and Asiatic Turkey). Introduced to a number of countries in Europe and Asia (Belarus, Estonia, Germany, Hungary, Latvia, Lithuania, Poland, Central and Northern Russia, and Ukraine) (EPPO 2009, Hand 2011). In most of these countries the species became established and invasive.

Habitat preferences

In its native range, *H. sosnowskyi* inhabits meadows, river valleys, forest margins and flood-plains of water bodies. In the invaded range, the species occurs mostly in man-made and semi-natural habitats, roadsides, disturbed habitats, agricultural fields, abandoned agricultural land, parks, and pastures (Kabuce & Priede 2010). In Bulgaria, the species was recorded in a man-made habitat – relatively large grasslands created some 40-50 years ago between the buildings of the residential area and maintained by yearly mowing. Most of the occurring native species in the locality are typical for the mesophytic meadows around Sofia City.

Pathways of introduction and invasive potential

Heracleum sosnowskyi was introduced as an agricultural crop in Europe, e.g. in North-East Russia, Latvia, Estonia, Lithuania, Belarus, Ukraine, and former German Democratic Republic, to provide silage fodder for livestock (Nielsen et al. 2005). It was also transported to some botanical gardens as an ornamental plant (Kabuce & Priede 2010).

In Bulgaria, despite the interviews with the local residents, we were unable to detect the exact year and pathway of introduction of the species to the area. There are two main options: **1.** The species was unintentionally introduced by seeds attached to a suitable vector, e.g. vehicle or human shoes/clothes, and this involves very long distance dispersal from another European or Asiatic country where the species is present. **2.** The species was intentionally introduced as an ornamental plant and cultivated in the grassland between the blocks of flats. None of the two pathways can be proved at this stage but the first one seems to be more likely. Bearing in mind the current population size, with already three separate groups of well-established and flowering plants, the species must have been present in this locality for at least 10 years.

The species has enormous reproductive potential. The number of fruits in the terminal

compound umbels in the recorded population in Bulgaria ranged from 2,100 to 4,500. Taking into account that each stem usually bears 3-5 lateral compound umbels, although smaller than the terminal one, the number of seeds per plant may exceed 20,000. There are literature data for up to 100,000 seeds per plant (Nielsen et al. 2005). The seeds have dormancy and require cold stratification for optimal germination (Nielsen et al. 2005, Moravková et al. 2007, EPPO 2009). Seed bank is rapidly depleted for one (Moravková et al. 2007) or two years (Nielsen et al. 2005).

Heracleum sosnowskyi has negative effect on the native flora and vegetation since it outcompetes the Bulgarian native grassland species and forms tall and very dense stands which eventually become monodominant, replacing the native vegetation. Moreover, the plants contain furanocoumarins that are activated in sunlight. In contact with human skin and under ultraviolet radiation, these chemicals cause burning of the skin, and thus, the species represents a serious health hazard for humans (Kabuce & Priede 2010).

However, the species has some benefits, e.g. it is a good melliferous plant (Fig. 4) and can be used as ornamental or for extraction of essential oils (Tkachenko 2015).

EU legislation and national obligations

On 01.01.2015 the Regulation (EU) No. 1143/2014 of the European Parliament and of the Council of 22 October 2014 (EU 2014) came into force. The core of this Regulation is the List of Invasive Alien Species of Union concern, which is regularly updated. The first Union list entered into force on 03.08.2016 and it comprises 14 species of vascular plants, including *Heracleum sosnowskyi* (EU 2016). Each Member State is obliged to notify the European Commission, in writing, about the detection of an invasive alien species of Union concern (Article 16 of the Regulation 1143/2014). After the early detection and within three months after notifying the Commission, the Member States are obliged to apply eradication measures and inform the Commission and the other Member States on these measures (Article 17 of the Regulation 1143/2014).

Recommended measures for control

The grasslands between the buildings in the residential area are mowed every year by the local municipality and the grass is used for composting. This year the vegetation was mowed in mid-July, and the plants of *H. sosnowskyi* were cut at the stage of unripe fruits (the municipality was not informed yet about the presence of the species). However, some imperfections were noticed in respect to control of the invasive species, e.g. we found at least three flowering stems with unripe fruits that were cut but not collected and left in the grasslands. We gathered the umbels with the unripe seeds and noticed that they were able to ripen within 2-3 weeks. Timing of cutting was a bit too late for the effective control of the species since it allowed some unripe seeds to fall down and ripen later. Also, we observed that cutting of the aboveground parts once a year at the stage of late flowering/unripe fruits stimulated re-growth from off-root buds and the individuals survived and managed to recover. Thus, from monocarpic the plants become short-lived perennials which can flower again in another vegetative season.

Taking into account the national obligation of Bulgaria under the Regulation (EU) 1143/2014 as well as the current state and management of the population of *H. sosnowskyi* in Bulgaria, we recommend the following eradication measures: **1.** Regular mowing (every year, 2-3 times per growing season) of all plants in the population; the first mowing should be done before the beginning of July (at the stage of full flowering at the latest; seed set must not be allowed) and all cut stems and inflorescences must be collected carefully and used for composting; **2.** Monitoring of the effectiveness of the control measures until all plants are eradicated, seed bank is depleted and there is no any seedling emerging for at least three consequent years; **3.** Raising of public awareness in the residential area about the necessity of the control measures.

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