

**Rapid Communication****The first record of *Heracleum mantegazzianum* Sommier & Levier (Apiaceae) in Lithuania**Zigmantas Gudžinskas<sup>1,\*</sup> and Martynas Kazlauskas<sup>2</sup><sup>1</sup>Nature Research Centre, Institute of Botany, Žaliojų Ežerų Str. 49, LT-12200 Vilnius, Lithuania<sup>2</sup>Vilnius University, Šiauliai Academy, Institute of Regional Development, P. Višinskio Str. 25, LT-76352 Šiauliai, LithuaniaAuthor e-mails: [zigmantas.gudzinskas@gamtc.lt](mailto:zigmantas.gudzinskas@gamtc.lt) (ZG), [martynas.kazlauskas@sa.vu.lt](mailto:martynas.kazlauskas@sa.vu.lt) (MK)

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**OPEN ACCESS****Abstract**

New occurrences in Lithuania of *Heracleum mantegazzianum* Sommier & Levier, a species on the list of invasive alien species of European Union concern, are reported for the first time. *Heracleum mantegazzianum* was intentionally introduced in the 1990s and grown in a garden as an ornamental plant. After the abandonment of the homestead in ca. 1998, this plant gradually occupied open spaces and formed a dense stand around the place of cultivation and by mid-2000 it had begun to spread into the surrounding areas. The species was found at three sites in the vicinity of Bertaučiai village (Joniškis district, North Lithuania) in 2020. In 2020, the species occupied a total area of 0.35 ha, with different densities within the three sites. Considering the recent records of *H. mantegazzianum* in the vicinity of Bertaučiai village and the newly invaded areas, this species should be treated as already naturalized in Lithuania with a high potential for further spread and invasion into new areas. Therefore, immediate control and eradication measures should be implemented.

**Key words:** density of individuals, intentional introduction, invasive species, population size, spread

**Introduction**

Invasive alien species (hereafter IAS) have complex and long-term direct and indirect impacts on biodiversity, ecosystem functioning, economy, and human health (Tanner et al. 2013; Pyšek et al. 2020; Haubrock et al. 2021). The two large-growing *Heracleum* L. (Apiaceae) species *H. mantegazzianum* Sommier & Levier and *H. sosnowskyi* Mandenova are considered among the most dangerous invasive species in Europe and other regions of the world (Nielsen et al. 2005; Kabuce 2006; Jakubska-Busse et al. 2013; Stohlgren et al. 2013; EPPO 2020). Therefore, both species, as well as the related, but much rarer species *H. persicum* Fischer, have been listed as IAS of the European Union concern (Regulation (EU) No. 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species, hereafter, IAS Regulation; CIR 2016, 2017).

*Heracleum sosnowskyi* is the most frequent and highly invasive species in Eastern European countries but quite rare in Central Europe, whereas *H. mantegazzianum* is a widespread invasive plant species in most of the Western and Central European countries (Nielsen et al. 2005; Jahodová et al. 2007a, b; Vladimirov et al. 2019; EPPO 2020). Isolated populations of *H. mantegazzianum* have been recorded in Eastern Europe, e.g., in Latvia and Estonia (Kukk 1999, 2004; European Commission 2017) where it is well established, and therefore, an occurrence of this species had to be expected for Lithuania as well (Gudžinskas et al. 2018). Furthermore, *H. mantegazzianum* was occasionally grown in botanical gardens in the 1980s–1990s and existence of its populations in the wild had been highly probable. However, the occurrence of this species in Lithuania was not confirmed until 2020. In that year, while implementing the project “Investigations of the Status of Invasive and Alien Species in Lithuania”, we found the first occurrence of *H. mantegazzianum* in Lithuania and confirmed the identity of the species.

The most hazardous and widespread invasive species in Lithuania and neighboring regions is *Heracleum sosnowskyi*. It was introduced in the 1950s and cultivated as a possible source of fodder, and as a potential melliferous and ornamental plant (Gudžinskas 1998; Jurkonienė et al. 2016; Gudžinskas and Žalneravičius 2018). The restricted distribution of *H. mantegazzianum* in the Baltic region and all Eastern Europe suggests that this species had only occasionally been introduced there, to a much lesser extent than *H. sosnowskyi*, and mainly for ornamental purposes. In Estonia, for example, *H. mantegazzianum* has been locally cultivated as an ornamental plant since the 1870s and its distribution is still quite restricted (Kukk 1999, 2004). In Latvia (European Commission 2017), this species has been recorded only recently and its distribution in the country is insufficiently documented.

At the beginning of June 2020, we found a group of plants of the genus *Heracleum* before anthesis, the leaves of which by shape resembled *H. mantegazzianum*. As a result, we initiated further plant observations and confirmed our assumption that they indeed belong to *H. mantegazzianum*. Therefore, we continued the study with the aim of determining the means and pathway of its introduction, to estimate the status and size of its population, and to characterize the invaded habitats in Lithuania.

## Materials and methods

The sampling of plants for their identification and further studies on the distribution and size of the population were performed in July–August 2020. Aiming to reveal the distribution of *H. mantegazzianum*, we surveyed all potential habitats within a radius of ca. 2 km around the first locality and discovered two additional stands of this species. The sizes of the recorded stands were determined using online software provided from

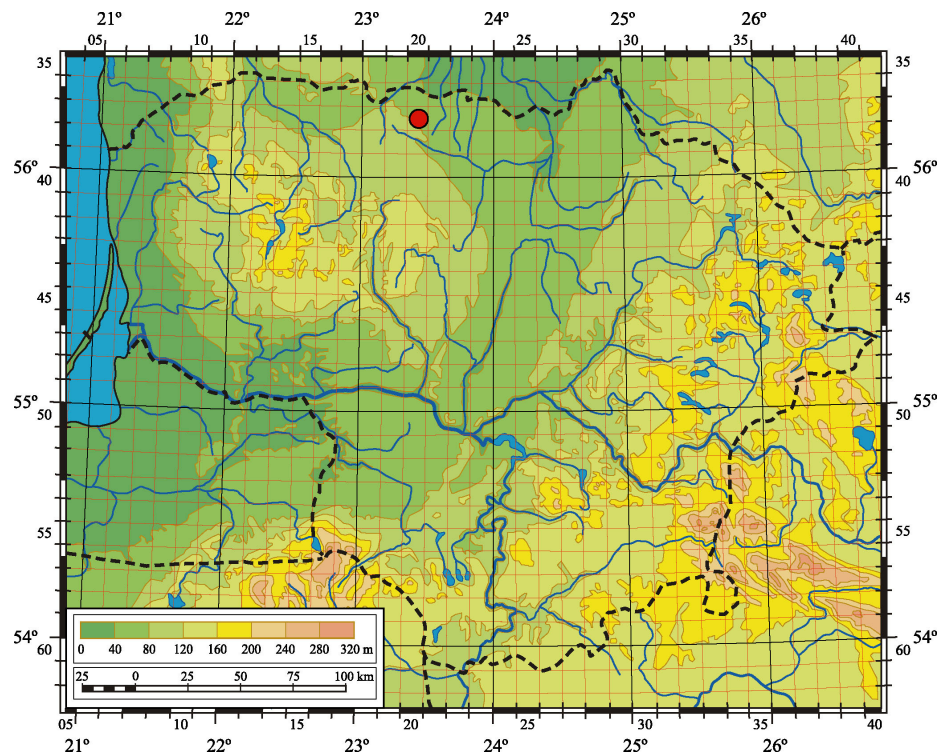
the Spatial Information Portal of Lithuania ([www.geoportal.lt](http://www.geoportal.lt)). Samples of *H. mantegazzianum* collected during this research were deposited at the Herbarium of the Institute of Botany of the Nature Research Centre, Vilnius (BILAS). A distribution map of *H. mantegazzianum* in Lithuania was compiled using a system of grid cells which were arranged according to geographical coordinates with sides of 6' of latitude and 10' of longitude.

The density of individuals in each of the three sites was estimated within five 1 m<sup>2</sup> plots, arranged in a transect with 5 m spaces and delimited by a wooden frame with all sides of 1 m. Individuals were assigned to maturity groups according to their morphological characters (Pergl et al. 2007; Gudžinskas and Žalneravičius 2018). Plants with developed stem and inflorescences were considered as reproductive individuals. Individuals with large compound leaves, which were at least half of the size or of the same size as leaves of reproductive plants, but without inflorescences, were treated as mature vegetative. Notably smaller individuals than the mature ones and having simple leaves with lobate margins or small compound leaves, which were still substantially different from the leaves characteristic for mature vegetative or reproductive plants, were designated as immature vegetative individuals (Gudžinskas and Žalneravičius 2018). Phytosociological relevés were recorded applying the Braun-Blanquet (1964) method. The cover of plants in an area was evaluated visually in percentage. Descriptive statistics includes the mean and standard deviation.

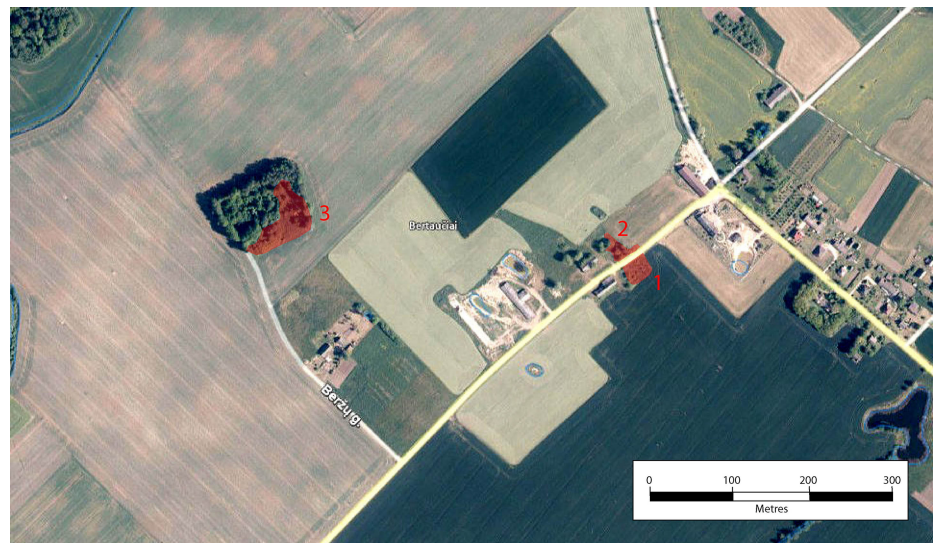
## Results

The first locality of *H. mantegazzianum* in Lithuania was noticed in the Joniškis district, ca. 8 km east of Skaistgiris, in the environs of Bertaučiai village (Figure 1), in abandoned mesic grassland (25 July 2020, 56.28326°N; 23.49916°E; BILAS). The first stand of *H. mantegazzianum* occupied ca. 720 m<sup>2</sup> area under an electric power line (Figure 2). The second quite sparse stand of this species occupying ca. 600 m<sup>2</sup>, was found on the opposite side of the road, along roadside, at the edges of a small anthropogenic woodland, in mesic anthropogenic grassland and on slopes of the gravel road embankment (Table 1). We surveyed the entire area within a radius of ca. 2 km around the recorded locality of *H. mantegazzianum* in search for other invaded sites and a dense stand of this species. Such a stand occupying ca. 2200 m<sup>2</sup> was found about 0.5 km west of the first recorded locality, on the parcel of an abandoned homestead. That population of *H. mantegazzianum* occupied open areas, the edges of a shrub stand, and single individuals were found under the tree canopy. Thus, in total, three stands of *H. mantegazzianum* occupied ca. 0.35 ha in the vicinity of Bertaučiai village in 2020.

Considering the size and current state of the *H. mantegazzianum* population in the abandoned homestead parcel, we presume it could be the



**Figure 1.** Location of the recorded population of *Heracleum mantegazzianum* in Lithuania (marked in red).



**Figure 2.** Sites of *Heracleum mantegazzianum* in the vicinity of Bertaučiai village (Joniškis district). Orthophotography used from the Spatial Information Portal of Lithuania ([www.geoportal.lt](http://www.geoportal.lt)).

**Table 1.** Geographical coordinates, occupied area, and coverage of *Heracleum mantegazzianum* at the study sites. The numbering of the sites corresponds to the numbering in Figure 2.

Site number	Latitude (°N)	Longitude (°E)	Stand size (m <sup>2</sup> )	Coverage of <i>H. mantegazzianum</i> (%)
1	56.28326	23.49916	720	60
2	56.28338	23.49837	600	25
3	56.28368	23.49137	2200	95

place of initial introduction in this area. Aiming to determine the history of the introduction of this species, local people were interviewed. According to this information, *H. mantegazzianum* had been growing there since the

**Table 2.** Mean density of *Heracleum mantegazzianum* individuals per square meter (mean  $\pm$  SD) by maturity group at the three study sites. Numbers in parentheses refer to the total number of individuals in that group at the study site.

Groups of individuals	Site number		
	1	2	3
Reproductive	(2)	(11)	5.0 $\pm$ 1.6
Mature vegetative	6.4 $\pm$ 4.0	(64)	8.2 $\pm$ 2.3
Immature vegetative	62.2 $\pm$ 36.0	17.4 $\pm$ 9.5	29.0 $\pm$ 6.5

1990s since the homestead was abandoned more than two decades ago. The former owners of the homestead brought *H. mantegazzianum* from Latvia and cultivated it as an ornamental plant. After the abandonment of the homestead around 1998, this plant gradually occupied open spaces and formed a dense stand in the parcel delimited from all sides by arable fields. The intense spread of *H. mantegazzianum* to the neighboring areas started in the second half of the year 2000. The stand along the road and under the electric power line started to form less than a decade ago and, despite several attempts of its eradication, the density of *H. mantegazzianum* individuals in the invaded plots is still increasing.

At the first site (Figure 2) under the electric power line, *H. mantegazzianum* occupied seldom managed grassland and covered ca. 60% of the area (Table 1). Other abundant species in the grassland were *Artemisia vulgaris* L., *Cirsium arvense* (L.) Scop., *Dactylis glomerata* L., *Elytrigia repens* (L.) Nevski, *Pastinaca sativa* L., and *Urtica dioica* L. (Supplementary material Table S1). At the second site (Figure 2), *H. mantegazzianum* covered ca. 25% of the area. A part of the stand of *Heracleum mantegazzianum* occupied edges of small sparse anthropogenic woodland composed of *Betula pendula* Roth, *Acer negundo* L., and *Salix caprea* L., extending to the neighboring grassland. The grassland there was dominated by *Artemisia vulgaris* L., *Calamagrostis epigejos* (L.) Roth, *Dactylis glomerata* L., *Festuca rubra* L., and *Pastinaca sativa* L. (Table S1). At the third site (Figure 2), which covered the parcel of the abandoned homestead, *H. mantegazzianum* formed a very dense stand and covered ca. 95% of the surface (Table 1). Only solitary individuals of *Artemisia vulgaris* L., *Cirsium arvense* (L.) Scop., *Dactylis glomerata* L., *Geum urbanum* L., and *Urtica dioica* L. were recorded in that plant community (Table S1).

We suppose that the first stand of *H. mantegazzianum* had established itself here quite recently, because only two reproductive individuals were found (Table 2). The number of mature vegetative individuals at the first study site ranged from 1 to 12 individuals, whereas the number of immature vegetative individuals ranged from 36 to 120 in sampling plots. In total, 11 reproductive individuals and 64 mature vegetative plants were counted at the second stand (Table 2). The density along the woodland was lower than in an open grassland and the number of immature vegetative plants ranged from 5 to 30 in individual sampling plots. At the third site, reproductive individuals of *H. mantegazzianum* were distributed quite

evenly throughout the stand and their number ranged from 3 to 7 in sampling plots. The number of mature vegetative individuals ranged from 6 to 12, whereas the number of immature vegetative individuals ranged from 21 to 38 plants per sampling plot.

## Discussion

Considering the wide distribution of *H. mantegazzianum* in Western and Central Europe (Nielsen et al. 2005; Jahodová et al. 2007; EPPO 2020) and its records in the neighboring Baltic countries, Estonia, and Latvia (Kukk 2004; European Commission 2017), an occurrence of this species had been expected for Lithuania as well (Gudžinskas et al. 2018). Although this species had been introduced there in the 1990s and had started spreading from the place of cultivation by the year 2000, the process remained unnoticed for more than a decade. This fact confirms the importance of continuous research into processes of introduction, escape, and naturalization of alien species (Gudžinskas and Taura 2020). Early detection and urgent eradication of species that are already invasive in neighboring regions is the best way to prevent large-scale invasions and avoid significant economic losses (Maxwell et al. 2009).

Considering the current size and state of the initial population of *H. mantegazzianum* in the parcel of the abandoned homestead and recently invaded areas, we conclude that this species is already naturalized in Lithuania.

The population of *H. mantegazzianum* in the vicinity of Bertaučiai village has spread only locally in more than two decades, in our opinion, because of the predominance of extensively cultivated land around the initial stand and quite small areas of abandoned or occasionally managed land. Many studies have confirmed that the abandonment of land is the most significant factor facilitating the spread and invasion of the tall species of *Heracleum* around the established stands (Gudžinskas et al. 2018). The establishment of *H. mantegazzianum* in annual crop fields is almost impossible and regular eradication in inhabited homestead areas have been the main limiting factors preventing its wider spread to new areas. Nevertheless, further search for newly infested localities of *H. mantegazzianum* not only in the vicinity of the village of Bertaučiai, but over a much larger radius should be performed because seeds of this species can easily be dispersed accidentally by humans, with agricultural machinery, and by wind in winter when a permanent cover of snow is formed (EPPO 2020). Particular attention should be paid to habitats along the banks of streams and drainage ditches within significant distances from currently known localities of *H. mantegazzianum*.

The three recorded sites invaded by *H. mantegazzianum* currently occupy quite a small area, but plants at one site form a very dense, nearly

pure stand. It should be noted that the density of reproductive, mature vegetative, and immature vegetative individuals of *H. mantegazzianum* in the stand of the abandoned homestead was significantly higher than the reported densities in several stands of *H. sosnowskyi* studied in Lithuania (Gudžinskas and Žalneravičius 2018). Furthermore, the density of *H. mantegazzianum* individuals in the studied stands was higher than that recorded in the Czech Republic (Pergl et al. 2007) and Germany (Nehrbass et al. 2006). A high density of individuals in stands could be an indicator of strong propagule pressure each year and favorable habitat conditions in moderately humid and fertile soil.

Many studies on *H. mantegazzianum* and *H. sosnowskyi* in their native ranges in Asia and in Europe confirmed that both are genetically closely related, but yet distinct species (Jahodová et al. 2007a, b). Some of the drawbacks of distinguishing these two species may arise because of common hybridization and the existence of introgressive populations (Jahodová et al. 2007b). Although some authors have highlighted issues related with the identification of tall *Heracleum* species in certain populations (Jakubská-Busse et al. 2013; Vladimirov et al. 2017, 2019), in most cases species can be recognized with a high level of confidence even in the field. The most reliable and easily noticeable feature is the shape of well-developed basal and lower cauline leaves of mature individuals. Lobes of *H. mantegazzianum* leaf segments, particularly of the terminal segment, are quite long, narrowly triangular, with sharply pointed apex (Figure 3A), whereas lobes of the terminal segments of *H. sosnowskyi* are quite short, widely triangular, with an abruptly pointed apex (Figure 3B). Morphological differences between *H. mantegazzianum* and *H. sosnowskyi* have been discussed in detail by Vladimirov et al. (2019).

Considering the particularly wide distribution and large areas invaded by *H. sosnowskyi* in Lithuania (Gudžinskas and Žalneravičius 2018; Gudžinskas et al. 2018) we suspect that there could be a slightly wider distribution of *H. mantegazzianum* in the country that has remained unrecognized. In some cases, their actual presence may have been misidentified as the widespread *H. sosnowskyi*. The two species may be confused by non-specialist surveyors due to external similarities or if specialist surveyors use distance methods to assess distribution and invaded areas (Sužiedelytė Visockienė et al. 2020). Particular attention should be paid to possible occurrences of the giant hogweed in Northern Lithuania as it may have been introduced as an ornamental plant from Latvia in other areas. According to reports by local inhabitants, the population of *H. mantegazzianum* in the vicinity of Bertaučiai village was also derived from plants obtained from Latvia.

Following provisions of the Regulation (EU) No 1143/2014 of the European Parliament and of the Council, immediate measures should be taken to eradicate invasive alien species of Union concern while the number of



**Figure 3.** Lower leaves of mature vegetative individuals of *Heracleum mantegazzianum* (A) and *H. sosnowskyi* (B). Photographs by Z. Gudžinskas.

individuals or populations is still limited. Rapid eradication measures are crucial to prevent the spread and further invasion. Currently, the eradication of the widespread invasive *H. sosnowskyi* is an ongoing process in Lithuania, and the eradication of the quite small population of *H. mantegazzianum*, occupying ca. 0.35 ha, should be considered a priority task. Although measures for *H. mantegazzianum* eradication are the same as for *H. sosnowskyi* (EPPO 2020), attention should be paid to the different longevity of their seeds in the soil seed bank. The viability of seeds of both species in soil decreases quickly, but few seeds of *H. mantegazzianum* may remain viable for more than seven years, whereas most of the seeds of *H. sosnowskyi* lose their viability after three years in the soil (Moravcová et al. 2007, 2018). Thus, after eradication of all living individuals of



*H. mantegazzianum*, the sites need to be repeatedly surveyed for a much longer time (up to 10 years) and, in the case of the emergence of new individuals from seeds, they must be eradicated immediately. Assessing the current population size of *H. mantegazzianum* in Lithuania, we suppose that complete eradication is still possible and could be implemented at relatively low cost.

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## Author’s contribution

ZG – research conceptualization; ZG – sample design and methodology; ZG, MK – investigation and data collection; ZG, MK – data analysis and interpretation, writing and editing.

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### Supplementary material

The following supplementary material is available for this article:

**Table S1.** Phytosociological relevés of plant communities with *Heracleum mantegazzianum* at three sites in the environs of Bertaučiai village (Joniškis district, Lithuania).

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