

## Communication

# First records of *Rudbeckia hirta* and *Oenothera glazioviana* in the flora of Kosovo

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### Abstract

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Two new alien species, *Rudbeckia hirta* and *Oenothera glazioviana*, were recorded for the first time in southeastern Kosovo along the banks of the Lepenci River. The localities, habitat types and population sizes of these species were studied. Twenty individuals of *Rudbeckia hirta* were found in a 50 m<sup>2</sup> area, indicating its early naturalisation. *Oenothera glazioviana*, *Oenothera glazioviana*, known for its high invasiveness, was recorded close to *Rudbeckia hirta* habitat. These findings suggest that the river acted as a pathway for the introduction of these alien species. Considering the invasive nature of *Oenothera glazioviana*, it threatens native biodiversity. This study highlights the importance of proactive monitoring and management strategies to reduce the impact of invasive species and protect natural habitats in Kosovo.

**Keywords:** alien flora, Balkans, floristics, habitat disturbance, plant naturalisation.

## INTRODUCTION

The flora of Kosovo is one of the richest in the Balkans. Despite the small area of the country, it contains about 3000 vascular plant species (Stevanović, 1999, Stevanović et al., 2007; Millaku et al., 2013). Of these, about 19% of species and subspecies are considered endemic (Rexhepi, 1982; Krasniqi, 1998; Stevanović et al., 2003; Tomović et al., 2014; Berisha et al., 2020), while 9.9% are considered endangered (Millaku et al., 2013). It is well known that among many other threats, alien plant taxa pose a significant threat to natural ecosystems, plant communities (Gaertner et al., 2009; Vilà et al., 2011) and overall human well-being (Richardson et al., 2000).

It is widely recognised that rivers, along with transport routes such as roads and railways, are common pathways for spreading alien plants (Hulme et

al., 2008). Riverbanks and gravel bars, which are often permanently disturbed habitats, provide ample opportunity to establish early colonisers, including many alien species (Hulme, 2009). However, the potential of gravel bars and riverbanks as habitats for alien species remains mainly unexplored in Kosovo (Kadriaj et al., 2023).

The genus *Rudbeckia* L. (Asteraceae) in Europe is represented by six naturalised or casual alien species: *Rudbeckia bicolor* Nutt., *Rudbeckia drummondii* Paxton, *Rudbeckia fulgida* Aiton, *Rudbeckia hirta* L., *Rudbeckia laciniata* L. and *Rudbeckia triloba* L. (Greuter, 2006; Jędrzejczak et al., 2022). This genus contains 31 species (Cox & Urbatsch, 1994; IPNI, 2023), all native to North America (Harkess & Lyons, 1994). While *Rudbeckia* species are widely cultivated for their ornamental properties (Akasaka et al., 2015), they have also been used as fodder, silage

and nectar sources. *Rudbeckia hirta* L. (Asteraceae), an annual or biennial herb, is well known in horticulture and has historical significance as American Indians used it to treat inflammatory conditions, colds, earaches, wounds, and snakebites (Barker, 2004).

The genus *Oenothera* L. (Onagraceae) consists of about 200 species (Mabberley, 1997; Mihulka & Pyšek, 2001) and is thought to have originated in Central America. Representatives of this genus are native to Central, North and South America, with many species now being naturalised worldwide (Dietrich et al., 1997; Rostański et al., 2004). To date, about 70 species of the genus have been reported in Europe, of which 29 species are known to be cultivated in Europe (Rostański & Ramst, 2001; Rostański et al., 2004, Rostański, 1982, 1985, 1991; Cullen et al., 2011). Most species of the genus occur in both primary and secondary open habitats, including roadsides, riverbanks and dunes (Dietrich et al., 1997). Most *Oenothera* species are biennial and have specific light requirements for seed germination (Salisbury, 1974).

Here, we present information on the records of two new alien species in the flora of Kosovo, *Rudbeckia hirta* L. and *Oenothera glazioviana* Micheli,

discovered on the banks of the Lepenci River in southeastern Kosovo. Although both species are native to North America, they are widespread aliens in various European countries, but their occurrence in Kosovo has not yet been reported (Krasniqi et al., 2011; Kadriaj et al., 2023).

## MATERIALS AND METHODS

This study included fieldwork carried out in the village of Firajë, located at the foot of Mt. Luboten, Sharri Mts. in 2023. In addition to the field surveys, the distribution data were supplemented by reviewing and revising herbarium specimens and relevant literature. The distribution of the species in the Republic of Kosovo was mapped using a 10 × 10 km grid. In addition, detailed notes on the habitat type and associated plant species were recorded. These newly documented floristic records include findings that were not previously recorded in the available literature sources of Kosovo. The specimens collected during the study were archived in the Herbarium of the Faculty of Mathematics and Natural Sciences of the University of Prishtina. The nomenclature of plant species is used according to the *Euro+Med Plantbase* (Euro+Med, 2006).



Fig. 1. *Rudbeckia hirta* growing in occasionally flooded areas along the Lepenci River. Photographs by F. Millaku.

## RESULTS AND DISCUSSION

*Rudbeckia hirta* L. (Asteraceae) is an annual, sometimes biennial or perennial plant, 30–100 cm tall (Fig. 1). It belongs to the Heliantheae tribe (Greuter, 2006). The species is cultivated for ornamental purposes and has naturalised in abandoned areas such as wastelands, but also in forests and along riverbanks, especially in Central Europe (Tutin et al., 1976), where it was introduced in the second half of the 19th century (Bělohávková, 2004). Although this species is known to occur in West and Central Europe (Tutin et al., 1976; Nāburga & Evarts-Bunders, 2019) and in several countries of southeastern Europe, such as Slovenia (Trpin & Vreš, 1995; Martinčič, 1999), Croatia (Nikolić, 2020), Bosnia and Herzegovina (Obradović & Budak, 1982) and Serbia (Stojanović & Jovanović, 2018), there is no corresponding update for its current distribution in the *Euro+Med Plantbase* (Euro+Med, 2006).

During our field expeditions, we recorded the species in the vicinity of the Lepenci River in flooded areas as well as in wet meadows that have been degraded and negatively affected by human activities. At this site, more than 20 individuals of flowering *Rudbeckia hirta* were recorded, accompanied by *Artemisia vulgaris* L., *Sanguisorba officinalis* L., *Stachys palustris* L., *Dipsa-*

*cus laciniatus* L. (see below for a complete list of accompanying plant taxa). The plant individuals of *Rudbeckia hirta* were all concentrated in an area of 50 m<sup>2</sup> and formed a clear stand. This group of plant species in the area confirms that human activities have affected and disturbed the entire habitat. Based on the species composition and habitat condition, we have classified it according to EUNIS as (V39) mesic perennial anthropogenic herbaceous vegetation (Chytrý et al., 2020).

**Examined specimen:** *Rudbeckia hirta* L. Surroundings of the Lepenci River, flooded or occasionally flooded areas and wet meadows. Firajë, foot of Mt. Luboten, Sharri Mts. (Fig. 2), 708 m a.s.l., limestone. Leg. et det. F. Millaku, 25 June 2023.

*Oenothera glazioviana* Micheli (= *Oenothera erythrosepala* Borbás) belongs to the *Oenothera* subgen. *Oenothera* (Raven, 1980), which is represented by 96 species in Europe (Raab-Straube, 2018). It is a biennial herbaceous plant with an erect stem, 30–180 cm tall, which may be simple or branched. The stem is hairy and red, spotted at the base of the long hairs, making it easy to recognise in the field. The species is native to North America and can easily hybridise with other species of the genus (Rakaj & Rostański, 2009; Kalníková & Palpurina, 2015). *Oenothera glazioviana* has been introduced to Great Britain as a popular ornamental plant and has subsequently spread and become established throughout most of Europe (Jehlík, 1997; Raven, 1980). On the Balkan peninsula, it has been reported from Albania and Montenegro (Rakaj & Rostański, 2009; Stešević & Petrović, 2010), Romania (Sîrbu & Oprea, 2010), Greece (Arianoutsou et al., 2010), Bosnia and Herzegovina (Maslo, 2023) and Serbia (Zlatković et al., 1998).

*Oenothera glazioviana* is commonly found in both semi-natural and human-influenced environments. It thrives in open, sunny habitats that are often disturbed by sandy or gravelly soils (Mihulka & Pyšek, 2001). Consequently, this species was recorded in the same habitat type as *Rudbeckia hirta*, only a few metres away (Fig. 3). Nevertheless, *Oenothera glazioviana* shows significant differences in invasiveness compared to *Rudbeckia hirta*. Among other alien species of the genus *Oenothera* occurring in Europe, *Oenothera glazioviana* was ranked in the top three most worrying invaders, with a high probability of expanding its range (Mihulka et al., 2006). The ability of *Oenothera glazioviana* to spread is facilitated

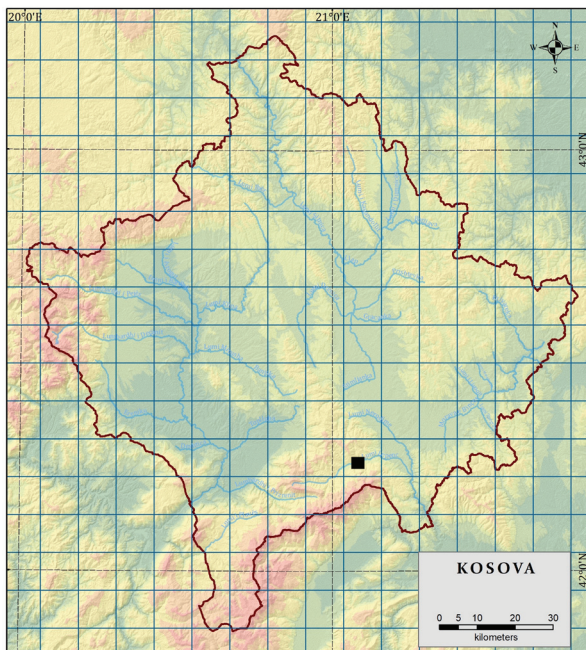


Fig. 2. Location of *Rudbeckia hirta* and *Oenothera glazioviana* in Kosovo. Both species were recorded in the same locality (Firajë, at the foot of Mt. Luboten, Sharri Mts.).





Fig. 3. *Oenothera glazioviana* growing in an occasionally flooded area along the Lepenci River. Photographs by F. Millaku.

by several factors, including its popularity as an ornamental plant, high seed production, and resilience to disturbance, as it can regenerate and produce seeds from even a few intact basal axillary buds (Mihulka et al., 2003, 2006; Martinková et al., 2006).

**Examined specimen:** *Oenothera glazioviana* Micheli. Surroundings of the Lepenci River, in flooded or occasionally flooded areas and wet meadows. Firajë, at the foot of Mt. Luboten, Sharri Mts. (Fig. 2), 695 m a.s.l., limestone. Leg. et det. F. Millaku, 25 June 2023.

Accompanying plant taxa recorded at the sites of the two species, *Rudbeckia hirta* and *Oenothera glazioviana*, were *Achillea millefolium* aggr., *Agrostis stolonifera* L., *Ajuga genevensis* L., *Alcea setosa* (Boiss.) Alef., *Alopecurus pratensis* L., *Anthoxanthum odoratum* L., *Arctium lappa* L., *Artemisia vulgaris* L., *Bellis perennis* L., *Bromus racemosus* L., *Cichorium intybus* L., *Cirsium arvense* (L.) Scop., *Convolvulus arvensis* L., *Dipsacus laciniatus* L., *Elytrigia repens* (L.) Nevski, *Erigeron annuus* (L.) Desf., *Filipendula vulgaris* Moench, *Galium verum* L., *Lactuca serriola* L.,

*Lathyrus pratensis* L., *Lathyrus tuberosus* L., *Leucanthemum vulgare* aggr., *Lotus corniculatus* L., *Malva thuringiaca* (L.) Vis., *Medicago lupulina* L., *Melilotus albus* Medik., *Plantago lanceolata* L., *Plantago major* L., *Poa pratensis* L., *Potentilla reptans* L., *Prunella vulgaris* L., *Ranunculus polyanthemus* L., *Ranunculus repens* L., *Rubus caesius* L., *Rumex crispus* L., *Salvia pratensis* L., *Sanguisorba officinalis* L., *Schedonorus pratensis* (Huds.) P. Beauv., *Stachys palustris* L., *Tanacetum vulgare* L., *Taraxacum* F. H. Wigg. sect. *Taraxacum*, *Trifolium patens* Schreb., *Trifolium pratense* L., *Trifolium repens* L., *Urtica dioica* L.

Based on the information collected in this study, the classification of *Rudbeckia hirta* as an alien species that escaped from cultivation, and using the assessment criteria for alien species (Tyler et al., 2015), we suggest that *Rudbeckia hirta* is currently in the early stages of naturalisation in Kosovo. Considering the known invasiveness of *Oenothera glazioviana* in Europe and noting that within the Balkans, it is classified as invasive in Romania (Sîrbu & Oprea, 2010), we conclude that the species has the potential to become invasive in Kosovo.

The study, identification, and reporting of alien and invasive plants in Kosovo is still a relatively new and understudied topic. Krasniqi et al. (2011) have reported for the first time on the status of three alien plant species for Kosovo: *Amorpha fruticosa* L., *Reynoutria japonica* Houtt., and *Helianthus tuberosus* L. In 2016, a national report (Maxhuni & Ibrahim 2016) provided tabular data on six alien plant species, including three additional species, *Ambrosia artemisiifolia* L., *Datura stramonium* L. and *Robinia pseudoacacia* L., but no precise supporting data was reported. A more detailed study was performed by (Kadriaj et al., 2023) in eastern Kosovo, where data on the distribution and status of 20 alien plant species were provided. Two new species reported here were added to the cumulative curve of reported alien species, which shows a clear growth trend (Fig. 4).

The expected increase in the prevalence of invasive and alien plant species in the Balkans, including Kosovo, is primarily attributed to climatic changes (Pyšek & Richardson, 2010), among other contributing factors such as land-use changes, habitat fragmentation, and increased globalisation facilitating species introductions (Pyšek et al., 2020). This phenomenon poses a significant threat to the biological diversity of the region and the long-term sustainability of its natural ecosystems (Šilc et al., 2012; Panjković et al., 2021). Invasive alien species can outcompete native flora (Oduor et al., 2016), alter ecosystem dynamics, degrade habitat quality, and compromise ecosystem services (Eviner et al., 2012; Vaz et al., 2017) that are crucial for human well-being. Mitigating the spread of invasive species requires comprehensive monitoring, early detection, rapid response strategies, and proactive management efforts (Meyerson & Mooney, 2007). In addition, increasing public awareness, fostering

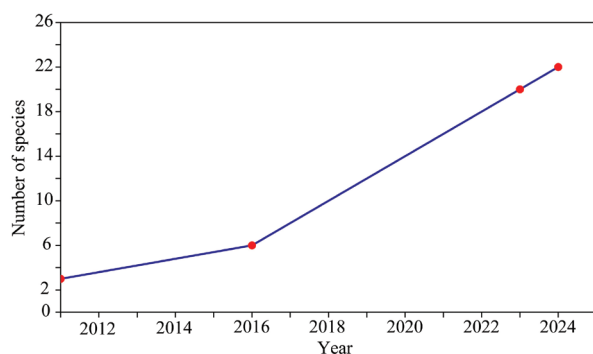


Fig. 4. Cumulative curve of the recorded alien plant taxa in Kosovo from 2011 to 2024.

transboundary collaboration, and implementing stringent biosecurity measures are integral components of effective invasive species management strategies for the region. Failure to address this challenge may exacerbate ecological imbalances, reduce ecosystem resilience, and impede conservation efforts to safeguard the region's rich biodiversity and ecological integrity.

The identification of *Rudbeckia hirta* and *Oenothera glazioviana* as new alien species in Kosovo highlights the significant role of rivers as pathways for the introduction and establishment of alien plants. These findings emphasise the need for proactive monitoring and management strategies to mitigate the impact of alien species on native biodiversity. While *Rudbeckia hirta* appears to be in an early stage of naturalisation, *Oenothera glazioviana* poses a significant risk due to its high invasion potential. The presence of these species, their habitat preferences and their established distribution in neighbouring countries suggest that they may have been overlooked in previous surveys. Addressing the challenges posed by alien species is critical to maintaining the ecological integrity and long-term sustainability of natural habitats in Kosovo.

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**Author contribution.** FM conducted field surveys, observed plants in the field, and conceived the idea for the study. BK assisted with the analysis, provided help with herbarium material, wrote and edited specific sections of the manuscript. NB assisted in fieldwork, collected data, performed the analysis, and wrote both the initial and final versions of the manuscript. All authors read and approved the final manuscript.

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