Establishment of *Reynoutrietum japonicae* association in Bulgaria: composition and distribution

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Abstract. This study explores plant communities dominated by the invasive species *Fallopia ×bohemica* (Bohemian Knotweed) in Bulgaria. Using field data from 91 locations, an analysis identified the association *Reynoutrietum japonicae* within the alliance *Aegopodion podagrariae*. That association is recorded for the first time in Bulgaria. The vegetation is characteristically dominated by the Bohemian Knotweed species, which forms dense stands with low species richness. It mainly occurs in disturbed areas, such as riverbanks, roadsides and abandoned spots. This study contributes to understanding the distribution and composition of plant communities dominated by that invasive species. The negative impact of Bohemian Knotweed on the native flora and vegetation is also highlighted, with an emphasis on the need in control measures.

Key words: invasive alien species, plant communities, *Reynoutria japonica*, ruderal habitats, species richness, vegetation analysis, weed control

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Introduction

Introduced through increased global trade and travel, invasive alien species (IAS) pose presently a major threat to native biodiversity worldwide by disrupting the ecosystems in numerous ways by affecting their physical, chemical, and biological aspects (Rai 2015; Lone & al. 2019). They spread easily due

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to abundant seeds, habitat fragmentation, water dispersal, competitiveness, allelopathy, and adaptability (Chen & al. 2017; Roiloa & al. 2020). Some are even cultivated for food or for aesthetic purposes, which aids unintentionally their spread. Invasive plants flourish in disturbed habitats, where with their widespread presence and stable populations they outcompete the native species and transform the environment (Stefanowicz & al. 2017, 2021; Zavialova & al. 2021). Natural habitats like mires, bogs and mountain woodlands have fewer alien plants, as compared to the disturbed areas and especially the farmlands, where habitat fragmentation occurs (Chytrý & al. 2005; Pyšek & al. 2005; Küzmič & Šilc 2017; Wagner & al. 2017). In some places, IAS are found to evolve and thrive much better in the invaded areas than in their native habitats (Maurel & al. 2013; Pal & al. 2020). These aggressive invaders have a powerful negative impact on the native species and ecosystems by causing extinction, pollination network disruptions, and even threatening human health, along with inflicting economic damage (Nijs & al. 2009; Petrova & al. 2013; Trichkova & al. 2017). The European Union aims at safeguarding Europe's biodiversity by minimizing the harm caused by intentional or accidental introduction and spread of the invasive alien species by issuing Regulation (EU) No 1143/2014. That regulation is mandatory for all member states, and they are required to implement concerted actions so as to limit expansion of the invasive alien species.

Reynoutria japonica, notorious for affecting gravely both biodiversity and human wellbeing, ranks among the world's most destructive IAS (Lowe & al. 2000). Japanese Knotweed is included in the Global Database of the European and Mediterranean Plant Protection Organization (EPPO 2024) focused on providing complete pest-specific information. The species is listed in the *Worst invasive alien species threatening biodiversity in Europe* under the SEBI2010 initiative for a standardized system for monitoring biodiversity across Europe (EEA 2007). Introduced as an ornamental plant for its attractive looks, *R. japonica* has escaped the decorative gardens and has embarked on a relentless invasion of the natural ecosystems (Zavialova & al. 2021; Vladimirov & Petrova 2023). Its aggressive spread disrupts native vegetation by posing a significant threat to native biodiversity. Bohemian Knotweed (*Fallopia ×bohemica*) is a hybrid between Japanese Knotweed (*F. japonica*) and Giant Knotweed (*F. sachalinensis*) (Petrova & al. 2013; Kus Veenvliet & al. 2019) and the hybrid has been mentioned as more invasive than its parent species (Láníková 2009).

So far, plant communities dominated by *Reynoutria ×bohemica* have been mentioned in the vicinity of Kokalyane village, Sofia District, Bulgaria. They are related to the *Alnion incanae* Pawłowski & al. 1928 and *Senecionion fluviatilis* Tüxen ex Moor 1958 alliances (Glogov 2021). Still, there exists a significant knowledge gap regarding that vegetation type in Bulgaria (Tzonev & al. 2009; Apostolova 2023).

This paper aims to explore the floristic composition, syntaxonomy and distribution patterns of *Fallopia ×bohemica*-dominated plant communities in Bulgaria.

Material and methods

Study area

The study was conducted in four areas of Bulgaria (Fig. 1). The first one is located in the Forebalkan (Lovech and Gabrovo Districts), the second in Mt Western Sredna Gora (Sofia District), the third area comprises Sofia Valley (the capital city of Sofia and Sofia District), and the fourth covers Breznik and Radomir Valley (Sofia and Pernik Districts). Only three vegetation plots have been included in the Natura 2000 network from three sites of community interest (SCIs): Skalsko (BG0000263), river Rositsa (BG0000609) and Bulgarka (BG0000399).

Three main geomorphological units can be recognized in the considered areas: 1) The Forebalkan (including Strazhata Hill, Devetashko Plateau and Mt Lovchanska), with alternating low mountain ridges and depressions, 2) A Transitional Zone including Mt Sredna Gora and the depression structures of Sofia, Radomir, Kostenets and Dolna Banya, Radomir and Breznik, Zlatitsa and Pirdop (Stefanov 2002). Karst is the most common bedrock type in the Strazhata

Hill and Devetashko Plateau. Silicate substrates are widespread in Mt Sredna Gora, Mt Lovchanska and the valleys of Sofia, Radomir, Kostenets and Dolna Banya, Radomir and Breznik, Zlatitsa and Pirdop.

The climate in the studied areas is temperate to continental, with characteristically warm summers and cold winters. The precipitation maximum occurs in May and June and the minimum occurs in January and February (Velev 2002).

The soils in the Strazhata Hill and Devetashko Plateau are mosaics of luvisol and rendzic leptosols, comprising more than 40% of carbonates (Ninov 2002). In Mt Western Sredna Gora and the depressions, the soils are dystric cambisols and umbric leptosols (Ninov 2002).

Data sampling and analysis

Within the 2017–2023 field seasons, 91 relevés were set on the territory of Bulgaria, following the Braun-Blanquet approach (Braun-Blanquet 1965, Westhoff & van der Maarel 1973). The size of plots was 16 m^2, as recommended for grassland communities (Chytrý & Otýpková 2003).

Altitude, slope inclination and location were measured by Garmin eTrex Vista, and the exposition was determined by compass. Soil depth was graded at three degrees: (1) shallow (<10 cm depth), (2) moderately deep (10–20 cm) and (3) deep (>20 cm).

All relevé data were stored in the Balkan Vegetation Database (Vassilev & al. 2016, 2020; BVD). Numerical classification was performed by PC-ORD (McCune & Mefford 1999) and JUICE 7.0 (Tichý 2002) software packages. Sørensen (Bray-Curtis) index was used for distance measurement and similarity was calculated by Ward's clustering method. The species values were square-root-transformed and three cut levels (0, 5, 25) were used. The diagnostic species were determined by calculating the Phi-coefficient (Chytrý & al. 2002). All clusters were standardized to equal size (Chytrý & al. 2006). Only the statistically significant Phi-coefficient values evaluated by Fisher's exact test ($P<0.05$) were considered. The threshold value for a species to be considered as diagnostic was set up at Phi-coefficient ≥ 0.3. Species with Phi-coefficient ≥ 0.5 were considered highly diagnostic. The species constancy was presented in percentage in a synoptic table. Relevant literature sources were also considered so as to explain the diagnostic role of the species. Species with cover above 50% at least in 5% of the relevés in any cluster were considered dominant, whereas constant species were those having at least 50% presence in a cluster.

Nomenclature of the vascular plants followed Delipavlov & Cheshmedzhiev (2003) and was subsequently standardized according to the Euro+Med PlantBase.

Results and discussion

Association *Reynoutrietum japonicae* Görs & Müller in Görs 1975 is a newly established plant association in the country, dominated by the hybrid species *Fallopia* ×*bohemica* (Chrtek & Chrtková) J.P. Bailey (syn.: *Reynoutria* ×*bohemica*). According to Láníková (2009), such vegetation could be dominated by *R. japonica*, *R. sachalinensis* and their hybrid *R.* ×*bohemica*. The latter is morphologically similar to *R. japonica* and *R. sachalinensis* but the two species have not been recorded so far as wild in the Bulgarian flora (Petrova & al. 2013).

As a result of the cluster analysis, the authors have found two variants of natural fluctuation within the core association (var. *typicum*). These are var. *Urtica dioica* and var. *Clematis vitalba*. Both variants retain the main dominant and diagnostic species but slightly differ in the species composition (Table 1). Variant *Urtica dioica* is found on nitrophilous substrates, which entail distribution of nitrophilous species, such as *Sambucus ebulus* and *Galium aparine*. The cover of nitrophilous and ruderal species is positively correlated with *Robinia pseudoacacia* (Dzwonko & Loster 1997), a species present also in var. *Urtica dioica*. On the other hand, var. *Clematis vitalba* is found close to forest edges and shrublands, or occupies logging sites. That is why, the species composition is characterized by the presence of species such as *Rubus cae-*

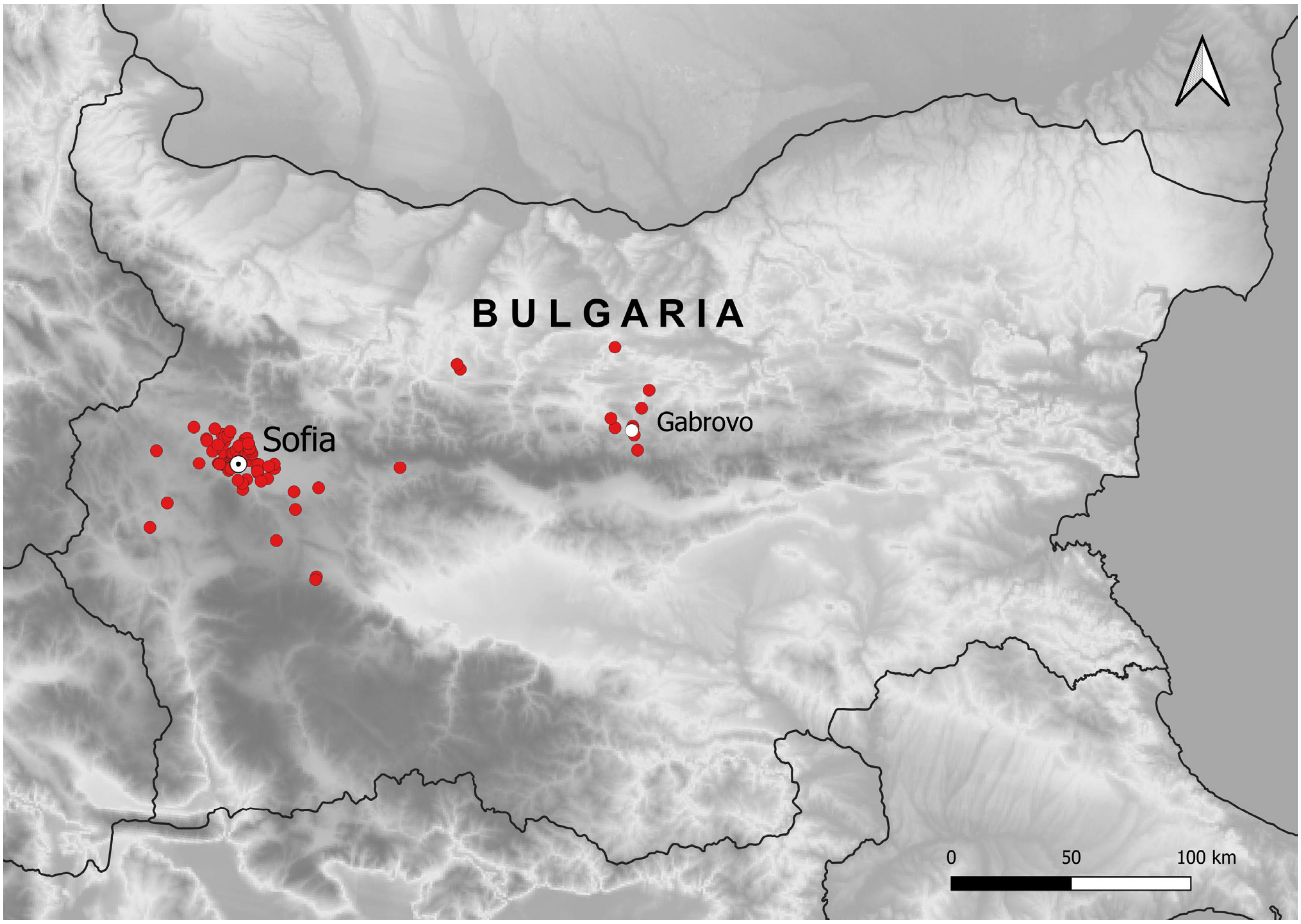

Fig. 1. Distribution of the *Reynoutrietum japonicae* association in Bulgaria.

sius and *Ailanthus altissima*. Variant *typicum* features the most common plant communities within the association and lacks differential species distinguishing it from others. According to Láníková (2009), in the Czech Republic, that vegetation exhibits three variants, distinguished by the dominant species: var. *Reynoutria japonica*, var. *Reynoutria sachalinensis* and var. *Reynoutria ×bohemica*.

Association *Reynoutrietum japonicae* is related to the alliance *Aegopodion podagrariae*, of the *Circaeo lutetianae-Stachyetalia sylvaticae* order and *Epilobietea angustifolii* class (syntax. syn. *Galio-Urticetea* Passarge ex Kopecký 1969). The latter unites the Eurasian temperate and boreal forest fringes and clearings of tall-herb seminatural perennial vegetation (Mucina & al. 2016). These communities thrive in mesic to wet, nutrient-rich areas, and can be found in both natural and anthropogenically disturbed habitats (Láníková & al. 2009).

Syntaxonomic scheme:

Cl. *Epilobietea angustifolii* Tüxen & Preising ex von Rochow 1951

Ord. *Circaeo lutetianae-Stachyetalia sylvaticae* Passarge 1967

All. *Aegopodion podagrariae* Tüxen 1967

Ass. *Reynoutrietum japonicae* Görs & Müller in Görs 1975

Var. *typicum*
Var. *Urtica dioica*
Var. *Clematis vitalba*

The plant communities dominated by that hybrid taxon are found primarily in the human-altered environments, such as riverbanks, canals, roadsides, parks, abandoned orchards, railways, and dumps.

Fig. 2. Association *Reynoutrietum japonicae.*

That vegetation is adaptable and tolerates flat or slightly sloping terrains (up to 10°), with varying light conditions. The soils are moderately deep and formed on different types of bedrock. The studied localities of the *Reynoutrietum japonicae* association in Bulgaria are shown in Fig. 1.

Fallopia ×bohemica has been used in parks as an ornamental plant in the past, but very quickly it has gone wild and spread widely. It forms very dense stands and can displace the native species from the natural flora. That species grows up to 3 m high, forming dense and monodominant phytocoenoses (Fig. 2). Its total vegetation cover ranges between 95% and 100%. The species richness found by the authors was extremely low, ranging between one and nine species, with an average of 2.9 species per sample plot. The total number of observed species was 53. In the study of Tabašević & al. (2021), the *Reynoutrietum japonicae* ass. has been found in ruderal habitats of Serbia. The study has documented an average of 14.19 species per sample plot, with a total of 92 species identified across 21 plots.

Knotweed is also found to disrupt the native tree communities by significantly reducing light and potentially interfering with root fungi, which hinders the survival and growth of the tree seedlings (Urgenson 2012). Single specimens of *Artemisia vulgaris*, *Elymus repens*, *Ballota nigra*, *Arrhenatherum elatius*, *Dactylis glomerata*, *Sambucus ebulus,* and *Stellaria media* are mostly found as accompanying species. Participation of other IAS, such as *Robinia pseudoacacia* and *Ailanthus altissima,* in the association is also registered in Bulgaria (Table 1). Likewise, *R. japonica* has a common association with other IAS, such as *Solidago canadensis*, *Impatiens parviflora*, *I. glandulifera*, and *Erigeron annuus* (Shevchyk & al. 2022).

Table 1. Synoptic table of *Reynoutrietum japonicae* association.

№ of relevés in table		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
№ of relevés in BVD	Layer	16820	16898	21824	22473	26981	28394	28395	28429	28456	28465	28466	28468	28472	28477	28479	28497	28499	28501	28502	28507	28540	28614	28617	28464	28609	27947	28498	21806	28409	28494	28425	28438	21963	28446	28613	28398	28509	28516	28616	24185	28452	21916
Diagnostic species for ass. *Reynoutrietum japonicae*																																											
Fallopia ×bohemica	h	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
variant *Urtuca dioica* (V1)																																											
Urtica dioica	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	r	r	r	r	.	.
Sambucus ebulus	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Galium aparine	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Robinia pseudoacacia	sh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
variant *Clematis vitalba* (V2)																																											
Clematis vitalba	sh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus caesius	sh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.
Ailanthus altissima	sh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diagnostic species for all. *Aegopodion podagrariae*, ord. *Circeo lutetianae-Stachyetalia sylvaticae* & cl. *Epilobietea angustifolii*																																											
Calystegia sepium	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Humulus lupulus	sh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ballota nigra	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.
Torilis japonica	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Geum urbanum	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex divulsa	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chelidonium majus	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.
Diagnostic species for cl. *Papaveretea rhoeadis*																																											
Convolvulus arvensis	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.
Brassica napus	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Veronica triloba	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cirsium arvense	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sinapis arvensis	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diagnostic species for cl. *Sisymbrietea*																																											
Amaranthus hybridus	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lactuca serriola	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cynodon dactylon	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.
Bromus sterilis	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elymus repens	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r
Artemisia vulgaris	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.
Cirsium vulgare	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diagnostic species for cl. *Molinio-Arrhenatheretea*																																											
Dactylis glomerata	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.
Arrhenatherum elatius	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex crispus	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Rumex conglomeratus	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lolium perenne	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla reptans	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Verbena officinalis	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex hirta	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Holcus lanatus	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diagnostic species for cl. *Alno glutinosae-Populetea albae*																																											
Hedera helix	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Circaea lutetiana	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex remota	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salix alba	sh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Salix fragilis	sh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.
Fraxinus excelsior	juv	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Other species																																											
Poa angustifolia	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	r	.
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Typha latifolia	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunus cerasifera	sh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Echinochloa crus-galli	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fraxinus pennsylvanica	juv	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.
Acer negundo	sh	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Brachypodium sylvaticum	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Poa trivialis subsp. *sylvicola*	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phragmites australis	h	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Table 1. Continuation

43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91			
22324	22471	22234	28476	28611	27002	21776	21815	26988	21869	28620	28504	28612	28619	28410	21804	21875	22271	24260	21950	22078	21884	21938	28427	28426	28428	28621	16851	22123	22497	24504	26896	23805	21964	28445	28434	28461	28447	28467	28565	28448	28487	28449	28615	24424	28439	28618	28610	28400	PF	PF (V1)	PF (V2)
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	100	100	100
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h, herb layer; **sh**, shrub layer; **juv**, juvenile; **PF**, Percentage Frequency.

Sample plots information: *locality, sampling date, altitude, total cover, aspect, slope, GPS – coordinates*:

1. Elin Pelin Municipality, near Novi Han village, 06.07.2017, 585 m, 100%, 42.60537, 23.60724; **2**. Elin Pelin Municipality, Lozenska Mt, near Gabra village, 28.07.2017, 827 m, 100%, 42.53924, 23.61804; **3**. Kostinbrod Municipality, between Kosntinbrod town and Voluyak village, 16.05.2018, 530 m, 100%, 42.79908, 23.24039; **4**. Bozhurishte Municipality, near Bozhurishte town, 18.06.2017, 549 m, 100%, 42.76011, 23.22033; **5**. Sofia Municipality, near Dolni Bogrov village, 07.06.2020, 529 m, 100%, 42.706862, 23.50107; **6**. Radomir Municipality, Radomir town, 25.08.2021, 682 m, 100%, 42.54244, 22.96637; **7**. Sofia Municipality, Lyulin 1 neighborhood, 24.08.2021, 562 m, 100%, 42.73004, 23.2472; **8**. Sofia Municipality, near Busmantsi village, 27.06.2022, 542 m, 100%, 42.67622, 23.41732; **9**. Gabrovo Municipality, Gabrovo town, near Yantra River, 23.07.2022, 412 m, 100%,42.85787, 25.33275; **10**. Sofia Municipality, near Lomsko Shose Metro Station, bank of Kakach River, 28.07.2022. 528 m, 180, 3°, 100%, 42.74136, 23.28825; **11**. Sofia Municipality, Krasna Polyana 3, bank of Vladayska River, 29.07.2022, 578 m, 100%, 42.6829, 23.2734; **12**. Sofia Municipality, near Bistritsa village, 30.07.2022, 848 m, 100%, 42.60662, 23.34711; **13**. Zlatitsa Municipality, Zlatitsa town, 02.08.2022. 673 m, 100%, 42.71077, 24.14223; **14**. Sofia Municipality, between Iliyantsi neighborhood and Severen Park, along Kakach River, 05.08.2022, 522 m, 100%, 42.75247, 23.30256; **15**. Sofia Municipality, between Trebich neighborhood and Kubratovo village, 05.08.2022, 515 m, 315, 5°, 100%, 42.77553, 23.33775; **16**. Sofia Municipality, near Benkovski neighborhood, bank of Suhodolska River, 13.08.2022, 518 m, 360, 8°, 100%, 42.73681, 23.3512; **17**. Sofia Municipality, near Benkovski neighborhood, channel, 13.08.2022, 518 m, 100%, 42.73836, 23.35641; **18**. Sofia Municipality, near Benkovski neighborhood, along Perlovska River, 13.08.2022, 514 m, 90, 5°, 100%, 42.74201, 23.36902; **19**. Sofia Municipality, between Benkovski neighborhood and Chepintsi village, 13.08.2022, 516 m, 100%, 42.74236, 23.38622; **20**. Sofia Municipality, between Benkovski neighborhood and Kubratovo village, sewage treatment, 13.08.2022, 514 m, 100%, 42.75687, 23.37074; **21**. Radomir Municipality, between Debeli Lag and Izvor villages, 14.09.2022, 649 m, 100%, 42.44829, 22.88499; **22**. Dryanovo Municipality, between Gostilitsa and Kalomen villages, bank of Yantra River, 04.07.2022, 236 m, 100%, 43.02661, 25.40421; **23**. Gabrovo Municipality, Gabrovo town, bank of Yantra River in the central part, 12.08.2022, 384 m, 100%, 42.87731, 25.31865; **24**. Sofia Municipality, near Obelya neighborhood, along Kakach River, 28.07.2022, 533 m, 180 , 1°, 100%, 42.74148, 23.28209; **25**. Sofia Municipality, Suhodol neighborhood, 05.21.2022, 626 m, 180, 10°, 100%, 42.69732, 23.22112; **26**. Samokov Municipality, near Zlokuchene village, 09.06.2021, 839 m, 100%, 42.42029, 23.52815; **27**. Sofia Municipality, between Benkovski and Orlandovtsi neighborhoods, along Suhodolska River, 13.08.2022, 518 m, 270, 5°, total over 100%, 42.72999, 23.35458; **28**. Sofia, near Voluyak village, 16.05.2018, 523 m, 100%, 42.78381, 23.24226; **29**. Sofia Municipality, between Krasna Polyana and Suhodol neighborhoods, 30.10.2021, 626 m, 100%, 42.69543, 23.25436; **30**. Sofia Municipality, near Mirovyane village, 11.08.2022, 517 m, 100%, 42.76961, 23.31536; **31**. Sofia Municipality, near Sofia airport, 26.06.2022, 514 m, 90, 1°, 100%, 42.68801, 23.41655; **32**. Sofia Municipality, Nadezhda neighborhood, near Kaufland, 08.07.2022, 541 m, 100%, 42.72912, 23.2859; **33**. Sofia ,Municipality, near Suhodol village, 20.05.2018, 617 m, 100%, 42.70619, 23.23098; **34**. Sofia Municipality, Ovcha Kupel neighborhood, 19.07.2022, 569 m, 100%, 42.6885, 23.26283; **35**. Dryanovo Municipality, near Slaveykovo village, 02.07.2022, 260 m, 100%, 42.95848, 25.36742; **36**. Sofia Municipality, near Bozhurishte town, along Gurmazovska River, 07.08.2021, 549 m, 100%, 42.77036, 23.20959; **37**. Sofia Municipality, between Benkovski neighborhood and Kubratovo village, bank of Iskar River, 13.08.2022, 515 m, 45, 10°, 100%, 42.76251, 23.37359; **38**. Sofia Municipality, near Kubratovo village, 15.08.2022, 513 m, 100%, 42.78055, 23.36518; **39**. Gabrovo Municipality, Gabrovo town, 12.08.2022, 394 m, 100%, 42.88162, 25.32467; **40**. Dolna Banya Municipality, between Dolna Banya town and villa are Dolna Banya, 25.08.2019, 756, 100%, 42.29062, 23.73697; **41**. Gabrovo Municipality, Gabrovo town, near Museum of humor and satire, bank of Yantra River, 22.07.2022, 385 m, 90, 5°, 100%, 42.87801, 25.31899; **42**. Sofia, near Novi Iskar town, 02.06.2018, 521 m, 100%, 42.80027, 23.35812; **43**. Sofia Municipality, near Kazichane village, 29.06.2018, 551 m, 100%, 42.65051, 23.47056; **44**. Bozhurishte Municipality, near Prolesha village, near graves, 16.06.2017, 595 m, 100%, 42.78301, 23.15259; **45**. Bozhurishte Municipality, near Prolesha village, 01.07.2017, 595 m, 100%, 42.79046, 23.14978; **46**. Sofia municipality, near Iliyantsi neighborhood, along Kakach River, 05.08.2022, 518 m, 315, 2°, 100%, 42.75432, 23.3064; **47**. Sofia Municipality, Malinova Dolina neighborhood, 31.10.2022, 666 m. 100%, 42.62977, 23.34391; **48**. Sofia Municipality, near Voluyak village, 11.06.2020, 548 m, 100%, 42.74699, 23.23946; **49**. Sofia , Lyulin, 10.05.2018, 578 m, 100%, 42.70774, 23.25793; **50**. Kostinbrod Municipality, near Kostinbrod town, 16.05.2018, 536 m, 100%, 42.8105, 23.22669; **51**. Sofia Municipality, near Levski G neighborhood, 08.06.2020, 523 m, 100%, 42.71425, 23.37382; **52**. Sofia , Novi Iskar town, 30.05.2018, 516 m, 100%, 42.79527, 23.3476; **53**. Suhindol Municipality, near Krasno Gradishte village, close to Rositsa River, 20.06.2023, 119 m, 100%, 43.18577, 25.22505; **54**. Sofia Municipality, between Benkovski neighborhood and Chepintsi village, 13.08.2022, 514 m, 100%, 42.75051, 23.38167; **55**. Sofia Municipality, Vitosha neighborhood, near Acibadem hospital, 31.20.2022, 670 m, 270, 8°, 100%, 42.63965, 23.31883; **56**. Ugarchin Municipality, Ugarchin town, bank of Kamenitsa River, 10.09.2023, 261 m, 134, 8°, 100%, 43.10535,24.41551; **57**. Sofia Municipality, near Suhodolska River to Orion, 20.05.2022, 553 m, 100%, 42.71587, 23.27894; **58**. Sofia, Vardar Metro Station, 13.05.2018, 561 m, 100%, 42.70436, 23.28554; **59**. Sofia Municipality, between Novi Iskar town and Kubratovo village, 30.05.2018, 511 m, 100%, 42.78296, 23.34844 **60**. Bozhurishte Municipality, between Slivnitsa town and Hrabarsko village, 12.07.2017, 577 m, 100%, 42.83227, 23.083; **61**. Breznik Municipality, near Breznik town, 19.09.2019, 735, 95%, 42.73757, 22.89873; **62**. Sofia Municipality, between Zhiten village and Novi Iskar town, 18.05.2018, 553 m, 100%, 42.82229, 23.26753; **63**. Sofia Municipality, near Suhodol village, 28.07.2018, 635 m, 100%, 42.69929, 23.21978; **64**. Sofia Municipality, between Kubratovo and Svetovrachene villages, 30.05.2018, 218 m, 100%, 42.77809, 23.36786; **65**. Sofia Municipality, near Zhiten village, 18.05.2918, 532 m, 100%, 42.80729, 23.25807; **66**. Sofia Municipality, Vrazhdebna neighborhood, near Sofia airport and Iskar River, 26.06.2022, 526 m, 90, 5°, 100%, 42.70325, 23.42337; **67**. Sofia Municipality, Vrazhdebna neighborhood, near Sofia airport, 26.06.2022, 527 m, 100%, 42.70392, 23.41292; **68**. Sofia Municipality, near Busmantsi village, 27.06.2022, 544 m, 100%, 42.67106, 23.42016; **69**. Sofia Municipality, near Dolni Bogrov village, Blatata, 30.06.2022, 539 m, 135, 2°, 100%, 42.69691, 23.47409; **70**. Elin Pelin Municipality, near Ognyanovo village, 26.07.2017, 587 m, 100%, 42.62344, 23.7308; **71**. Sofia Municipality, near Bankya town, 20.08.2018, 728 m, 100%, 42.69709, 23.11773; **72**. Bozhurishte Municipality, near Gurmazovo village, 21.06.2017, 580 m, 100%, 42.74569, 23.18332; **73**. Dolna Banya Municipality, near villa area Dolna Banya, 22.08.2019, 864m, 100%, 42.27866, 23.73359; **74**. Sofia Municipality, between Dolni Bogrov village and bank of Lesnovska River, 23.05.2020, 531 m, 360, 10°, 100%, 42.68897, 23.50375; **75**. Gabrovo Municipality, near Nikolchovtsi village, 28.06.2019, 383 m, 100%, 42.8836, 25.23403; **76**. Sofia Municipality, near Suhodol village, 20.05.2018, 641 m, 100%, 42.70034, 23.21498; **77**. Sofia Municipality, Krasna Polyana neighborhood, near Vladaiyska River, 18.07.2022, 569 m, 100%, 42.68991, 23.28689; **78**. Sofia Municipality, parking of Vranya Park, 02.07.2022, 560 m, 100%, 42.63975, 23.43854; **79**. Sofia Municipality, near Vrabnitsa-1 neighborhood, 28.07.2022, 648 m, 100%, 42.73605, 23.28422; **80**. Sofia Municipality, Ovcha Kupel neighborhood, near Kaufland, 19.07.2022, 589 m, 90, 2°, 100%, 42.68318, 23.26841; **81**. Sofia Municipality, Lagera neighborhood, 29.07.2022, 583 m, 100%, 42.68188, 23.28082; **82**. Kostinbrod Municipality, Kostinbrod town, bank of Slivnishka River, 21.09.2022, 540 m, 360, 8°, 100%, 42.82984, 23.18991; **83**. Sofia Municipality, near Slavia Stadium, 19.07,2022, 592 m, 100%, 42.67449, 23.26933; **84**. Sofia Municipality, near Sever Railway Station, Voenna Rampa neighborhood, 11.08.2022, 532, 100%, 42.72637, 23.31536; **85**. Gabrovo Municipality, near Etara, bank of the near river, 22.07.2022, 542 m, 360, 3°, 100%, 42.80148, 25.35116; **86**. Gabrovo Municipality, between Novakovtsi and Vranilovtsi villages, 20.07.2022, 278 m, 100%, 42.91854, 25.21218; **87**. Gabrovo Municipality, Gabrovo town, 18.07.2019, 375 m, 100%, 42.89054, 25.3245; **88**. Sofia Municipality, between Krasna Polyana and Suhodol neighborhoods, 09.07.2022, 616 m, 100%, 42.69573, 23.23785; **89**. Ugarchin Municipality, near Ugarchin town, 08.09.2023, 275 m, 100%, 43.08728, 24.43277; **90**. Sofia Municipality, Mladost neighborhood, Vartopo Park, 30.20.2022, 603 m, 100%, 42.6436, 23.36497; **91**. Sofia Municipality, the entrance of Zapaden Park to Mega Mall, 28.08.2021, 566 m, 100%, 42.7104, 23.27287.

Although they are non-woody plants (herbaceous), *Reynoutria* spp. in their maximum stage of development have a "shrub-like habit" and form extremely dense phytocoenoses. After formation of a dense plant community, when the aboveground plant parts die, a thick layer of debris is formed on the soil surface. The extensive above-ground biomass combined with a thick layer of debris, which is hard to decompose, hinders the other plants' growth and thus greatly affects the ruderal communities (Woch & al. 2021; Zavialova & al. 2021). Also, knotweeds release allelochemicals that inhibit the germination and growth of other plants (Kato-Noguchi 2021). Invasive alien plants disrupt the native ecosystems, leading to a decline in abundance and diversity of the native plant species (Vilà & al. 2011). The use of that species for ornamental purposes along rivers, streams and canals needs to be banned. Monthly mowing during the growing season would exhaust the plant rhizomes but would not lead to the species removal. Eradication of those plants should be carried out by suitable machinery, followed by careful collection of all root debris. Treatment with herbicides is recommended, followed by covering of the entire plant stand with solid and dark materials for approx. one year (Petrova & al. 2013).

While traditional mechanical and chemical methods for controlling invasive plants may be problematic, biological and ecological control offer a promising alternative by harnessing the power of the native species or environmental manipulation, so as to weaken the invasive plants and potentially restore the invaded ecosystems (Chen & al. 2017). The studies of Shaw & al. (2009) and Grevstad & al. (2013) have shown that psyllids (*Aphalara itadori*) feed and reproduce only on the Japanese Knotweed (and a few very close relatives), with a minimal risk to other plants, which makes them promising candidates for controlling that weed without harming the other vegetation.

Public opinion about the introduced species could pose a profound obstacle, since the way in which the people see the invasive species does not always agree with the scientific evidence and thus does not always reflect the true ecological threat (Simberloff & al. 2013). Management of the invasive species requires a holistic approach, where knowledge of biological invasion is vital for the design of control programs to minimize ecological damage. Future research should bridge the gap between science and real-world applications by exploring some new monitoring tools and biocontrol methods (Hulme 2006; Bartz & Kowarik 2019; Roiloa & al. 2020; Rai & Singh 2020).

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