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Invasion of *Sicyos angulatus* in Riparian Habitats in the Jiu and Danube Area (Romania)

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Abstract: *Sicyos angulatus* (Cucurbitaceae) is an invasive species because of its rapid growth rate, intensive dispersal and ability to adapt to a wide range of environments. It has become an invasive species in the Ostroveni area, an area at the confluence of the Jiu River and the Danube River in the Oltenia region of Romania. This species spreads, climbs and takes over everything in its path. It can also outcompete native plants very quickly as it is a prolific breeder. The aim of this study was to demonstrate the invasive potential of *S. angulatus* in the forests of the Jiu and Danube confluence area by calculating several indicator values. The results showed that the number of plants varies depending on factors such as location, water availability and shade. They also showed that *S. angulatus* is a plant that occupies its niche in the ecosystem and has a negative impact on the local flora. Population control should therefore start with early detection, so that control and eradication are less costly.

Keywords: density; disturbance; invasive plant; plant community; riparian habitats

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1. Introduction

Invasive plants are species that can disrupt the stability of an ecosystem by reducing its biodiversity. They can produce many offspring and occupy large areas, causing considerable damage to natural habitats, especially riverbanks, forest edges and other open areas [1]. Invasive plant species grow and spread rapidly, outcompeting native species [2]. It is estimated that there are already more than 12,000 alien species in Europe, of which around 10–15% are invasive. They invade all types of habitats, both terrestrial and aquatic [3].

Anastasiu and Negrean [4] identified 435 alien species in the Romanian flora, while Sârbu and Oprea [5] mentioned that 671 alien plant species have been inventoried in the country. The criteria for invasive status are both the ability to spread and the negative impact on the composition of the flora and phytocoenoses.

Sicyos angulatus is native to eastern North America. In Europe (especially in the central, southern and eastern regions) it is an intensively spreading alien species [6]. It was introduced into Europe in the 19th century for ornamental purposes [7]. Outside of Europe, it is alien to the Caribbean and East Asia [8]. In Romania, *S. angulatus* was first discovered at the beginning of the 19th century in Transylvania [9]. At present, this species is included in the quarantine legislation list of vascular plants and is already considered a naturalised species [10]. It is invasive in the Maramureş, Crisana, Transylvania and Banat regions, and less frequently in the Muntenia, Moldova and Dobrogea regions [4]. This species occurs throughout the Danube valley in forest habitats [10].

Sicyos angulatus is an annual species of the Cucurbitaceae family with rapidly growing long stems [11]. It can crawl or climb, displacing native vegetation and disturbing fragile ecosystems [12]. It can thrive in a wide range of environments, from sunny grasslands to shady forests [13]. In addition, with its ability to flower from summer to autumn, produce many seeds and spread rapidly, it has all the characteristics of a true invader. Seeds germinate throughout the growing season and seedlings grow rapidly, extending up to

30 cm in a day under favourable humidity and temperature conditions [1]. The dispersal of thorny fruits in flowing water can facilitate rapid local spread of *S. angulatus* [14]. Seeds can germinate and grow in areas with temperatures ranging from 5 °C to 40 °C and can survive in wet to semi-arid soils. It can tolerate moderately saline soils [1].

Sicyos angulatus saw explosive growth in the Danube basin after the natural floods of 2005. It affected many habitats, especially those of willow and poplar trees. The forestry staff had problems with the massive invasion of this species, especially with the poplar saplings, which were sometimes suppressed due to the large number of individuals and large biomass. Since there are only a few references regarding the presence of invasive species in the Oltenia region, southwest Romania, and a few examples indicating their negative impact, the aim of this research was to determine their invasive potential in the forests of the Jiu and Danube confluence region. We tried to determine the abundance and density of *S. angulatus* in the study area and to reveal the influence of ecological factors on the invasion of this species. We also aimed to evaluate the invasiveness and its dependence on ecological conditions such as drought, and to reveal the relationship between the density of *S. angulatus* individuals and the structure of plant communities.

2. Materials and Methods

2.1. Study Area

Ostroveni is in the southeastern part of Dolj County, Oltenia Region, Romania (43°48′22″ N 23°53′39″ E) and covers an area of 5465 ha. The study area is located at the confluence of the Jiu River with the Danube River (Figures 1–3). From a conservation point of view, the study area is an integral part of two protected areas.

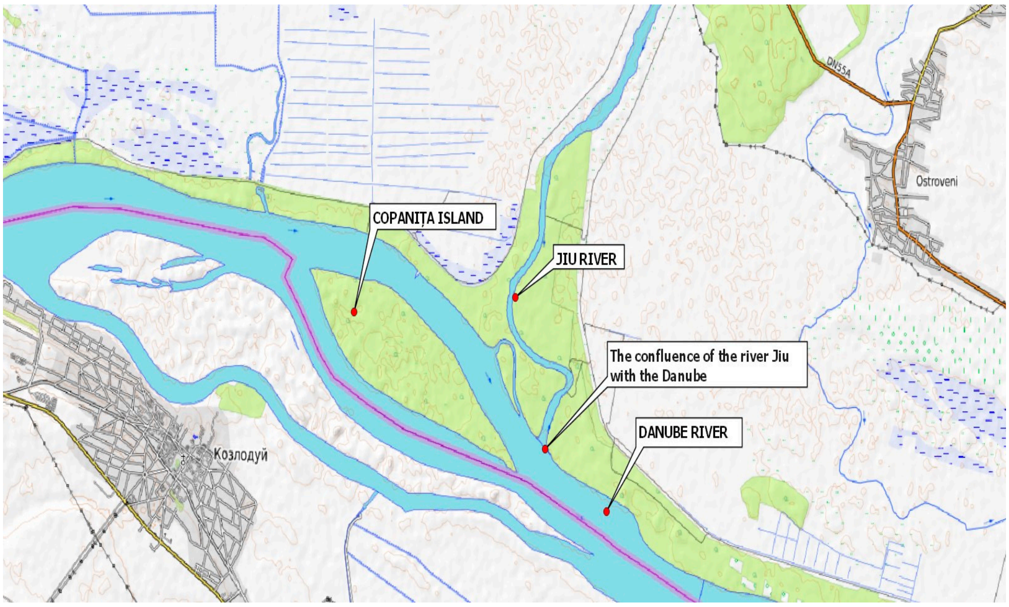

Figure 1. Map of the study area.

Ostroveni is a plain that includes the valley of the river Danube, and where the altitude varies from 30 m to 350 m above sea level. The study area is located on the terraces close to the Danube. The area is represented by a tabular plain covered with sand dunes, descending in steps towards the Danube and laterally towards Jiu and Olt. The study area is located on the second terrace of the Danube. The sandy material of the dunes along the Danube represents the most recent deposits of the Quaternary Period, laid down in strips under the action of the Àustru (hot wind). During the warm periods of the year, the area receives little rainfall and is characterised by high temperatures, which means that the vegetation is poorly developed and unable to restore the sandy soil [15].

Figure 2. The confluence of the Jiu and Danube Rivers.

Figure 3. Forest habitats on the island of Copanița.

Groundwater levels vary with the seasons and the amount of precipitation, with the highest levels present in the spring and the lowest in the autumn [15]. In the plain east of the Jiu River, the depth of the groundwater is between 5 and 13 m.

The climate of the region is continental with a slight Mediterranean influence. According to the Köppen classification system, the study area belongs to the Cfax zone, with an average annual temperature of 11.2 °C [16]. Since July and August are very hot in this area and the sandy soils heat up very easily, the temperature on the surface of the sands very often exceeds 60 °C [16]. Winters are generally mild. Summers are characterised by heat, dryness and drought, autumns are sometimes wet, and springs are early due to the advection of warm Mediterranean air. There is sometimes a sudden transition to winter from autumn, and a secondary maximum in annual rainfall may also occur during this period [16]. Most of the precipitation falls in the period between May and June, and a severe drought occurs in the period between July and September [16]. The aridity index (Thornthwaite method) is variable, sometimes exceeding 50% in the study area. The natural conditions of the region are determined by the climate and extreme meteorological phenomena. For example, in the summer of 2000, 46 of the 92 summer days had temperatures above 33 °C [16].

The anthropogenic impact on the environment in the study area is strong. The area is particularly affected by the significant deforestation of former forest areas. The entire study area belongs to the Natura 2000 site, located in the floodplain of the Danube, where relief is provided by a succession of sand dunes (mostly fixed by plantations) and valleys in which puddles have formed. The dunes stretch along the Danube from the village of Ostroveni. These formations run parallel to the Danube and have a thin cover of sandy soil on the surface, which allows for the growth of 3–4 m high bushes of *Hippophae rhamnoides* and *Salix alba*.

2.2. Field Studies and Data Analysis

The study area covered 10,000 m^2. A total of 25 sample plots of 400 m^2 each, representing the Ass. *Salicetum albae* Issler 1924 (*Salicetum albae fragilis* 1926 em. Soó 1957), in which populations of *Sicyos angulatus* appeared were studied. The plant communities were studied using the Braun-Blanquet cover scale (in percent) approach [17]. For the classification of the plant communities, publications by Coldea and Pînzaru [18], Coldea [19], Sanda [20], Mucina [21,22] and Rodwell [23] were consulted. The analysed plant communities form the 92A0 *Salix alba* and *Populus alba* galleries habitat type (according to the Palearctic Classification it corresponds to 44.141, 44.162 and 44.6 habitat types).

The summary table of the described plant communities contains the number of relevé, altitude (m a.s.l.), exposure, slope inclination, tree layer cover (%), herb layer cover (%) and the study area (m^2). The species were arranged in the phytosociological table according to coenotaxonomic criteria. We noted the constancy of species (K) to express the presence of species individuals in the sample plots and analysed the degree of their fidelity to the plant community.

To determine the density of the *Sicyos angulatus* population, the number of plants (individuals per 1 m^2) was counted and then converted to the number of plants per hectare. The results were recorded according to the following five-point scale: 1 (1–20 plants), 2 (21–50 plants), 3 (51–100 plants), 4 (101–500 plants), 5 (more than 501 plants).

The following indicators were calculated: abundance (A), constancy (C), dominance (D) and ecological importance index (W). A dendrogram of the similarity of the study plots was delineated according to the values of these indices.

Abundance (A) is the number of individuals of the study species occurring in a study plot. This value was expressed as an absolute number and was used to calculate other indices. According to the abundance value, the species occurring in each area were characterised as rare, quite rare, abundant and very abundant.

Constancy (C) of a species in the study plot. This is a structural indicator that shows the proportion of a given species in defining the structure of the community. Higher values of this index reflect adaptation to the conditions offered by the habitat. The constancy is estimated using the relationship

$$C = npA/Np.$$

where

C—constancy of the analysed species;

npA—number of sample plots where the species was found;

Np—total number of sample plots analysed.

Depending on the value of this index, the species were classified as follows: C1 accidental, present between 1–25% of the sample plots; C2 accessory, present between 25.1–50%; C3 constant, present between 50.1–75%; and C4 euconstant, present between 75.1–100% of the sample plots.

Dominance (D) shows the relationship between the population of the species studied and the sum of the individuals of the other species with which it is associated, expressing relative abundance. Dominance is considered an indicator of productivity because it shows the percentage of each species' contribution to the biomass production in the biocenosis. It is calculated according to the following formula [24]:

$$D = (nA \times 100)/N,$$

where

D—dominance of the analysed species;

nA—the total number of individuals of the analysed species found in the sample plot examined;

N—the total number of individuals of all species present in the sample plot.

Depending on the value of this indicator, the species were assigned to the following classes: D1 subrecessive (less than 1.1%); D2 recessive (between 1.1–2%); D3 subdominant (between 2.1–5%); D4 dominant (between 5.1–10%); and D5 eudominant (more than 10%).

The index of ecological importance (W) represents the ratio between the indices C and D and better illustrates the position of the study species in the biocenosis. It is calculated using the following formula:

$$W = (C \times D)/100.$$

Depending on the value of this index, species were assigned to the following classes: W1 with values below 0.1% (accidental species); W2 with values between 0.1–1% (accessory species); W3 with values between 1.1–5%; W4 with values between 5.1–10% (species characteristic of the given phytocoenosis); and W5 with values above 10%.

The results were processed using analysis of variance (ANOVA). The significance of the differences was estimated with the least significant distance multiple comparison test at the $p \leq 0.05$ level.

3. Results

3.1. Phytosociological Assessment of Sicyos angulatus in Plant Communities

The plant communities containing *Salix alba*, belonging to the ass. *Salicetum albae* Issler 1924, formerly called *Salicetum albae-fragilis* Issler 1926 em Soó 1957, are detailed below (Table A1). These communities arise frequently in Oltenia on the banks of streams and rivers, usually forming strips on one or both banks of these watercourses. They occur from the plain to the hilly areas. Such phytocoenoses were analysed near Ostroveni, on the banks of the Danube and the Jiu, at the confluence of the Jiu and the Danube, as well as on the banks of the Danube on the island of Copanița (Figure 3).

In the tree layer, besides *Salix alba*, the other woody species *Salix fragilis*, *Populus nigra*, *P. alba* and *P. canadensis* occurred. The most frequent herbaceous species were *Mentha longifolia*, *Agrostis stolonifera*, *Glechoma hederacea*, *Ranunculus ficaria*, *Urtica dioica* and *Equisetum arvense*. The invasive species *Sicyos angulatus*, *Ecballium elaterium*, *Amorpaha fruticosa*, *Symphyotrichum lanceolatum*, *Oxalis stricta* and *Bidens frondosa* were also recorded in these plant communities.

The current ecological and climatic conditions, as well as the geographical location of the habitats, favour the establishment of invasive species in these phytocoenoses. Some invasive species were in very high abundance and dominance in the studied plant communities. Although 2022 and especially 2023 were very dry years, *Sicyos angulatus* was very abundant (Figures 4 and 5), and in most populations a high density of individuals was recorded in the studied phytocoenoses (Table 1).

Figure 4. *Salicetum albae* Issler 1924 plant communities invaded by *Sicyos angulatus*.

Figure 5. Massive invasion of *Sicyos angulatus* in the *Salicetum albae* Issler 1924 community on the island of Copanița.

Table 1. Analysis of the studied characteristics of communities containing *Sicyos angulatus*. Different lower case superscript letters in the columns indicate significant differences between the localities.

No.	Localities	Abundance (Plants per ha)	Dominance (%)		Constancy (%)		W (Index of Ecological Significance, %)		Density (Plants per m^2)
1.	Ostroveni (Danube shore), shadow, close to water edge	1450 ^{a}	32.11 ^{a}	D_5	95.7 ^{a}	C_4	30.73 ^{a}	W_5	51.7 ^{a}
2.	Ostroveni (Danube shore), forest clearings, drier places	653 ^{bc}	7.8 ^{bc}	D_4	62.11 ^{bc}	C_3	4.84 ^{d}	W_3	30.27 ^{b}
3.	Jiu shore, Confluence Jiu-Danube, shadow, close to water edge	1304 ^{a}	24.36 ^{a}	D_5	80.7 ^{a}	C_4	19.66 ^{b}	W_5	46.36 ^{a}
4.	Jiu shore, Confluence Jiu-Danube, forest clearings, drier places	738 ^{b}	6.5 ^{c}	D_4	47.11 ^{cd}	C_2	3.06 ^{d}	W_3	24.25 ^{bc}
5.	Copănița island (Danube shore), shadow, close to water edge	1278 ^{a}	15.47 ^{b}	D_5	80.23 ^{ab}	C_4	12.41 ^{c}	W_5	33.12 ^{b}
6.	Copănița island (Danube shore), forest clearings, drier places	431 ^{c}	5.7 ^{c}	D_4	40.4 ^{d}	C_2	2.30 ^{d}	W_3	14.7 ^{c}
7.	Least significant difference (5%)	187.11	8.22		18.25		5.47		10.29

3.2. The Role of *Sicyos angulatus* in Communities

The most abundant populations of *Sicyos angulatus* were identified in Ostroveni (Danube bank) in the shaded habitats, close to the water's edge in the *Salix alba* stand (Table 1, Figure 6). The density of individuals in these communities was 1450 plants per ha. In the area along the Jiu River, at the confluence of the Jiu and Danube rivers, also in the shade and close to the water's edge, the density was very high with 1304 individuals per ha. Almost the same density was found in the area on the bank of the Danube on the island of Copănița (1278 plants per ha). The comparison of the density of *S. angulatus* in the sampling plots close to the water with those in the areas of forest clearing, both on the banks of the Danube and the Jiu River, showed a significant decrease (1450 plants per ha compared to 653 plants per ha in Ostroveni). The lower availability of water is therefore a factor that controls the spread of this species.

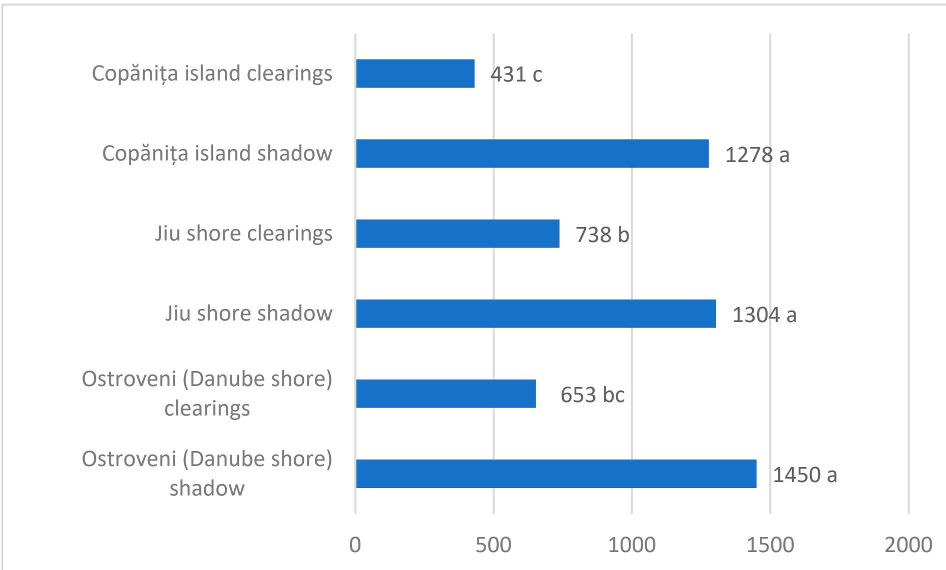

Figure 6. Abundance of *Sicyos angulatus* individuals (plants per ha) in the study areas. LSD 5% = 187.11.

The dominance analysis showed that the values of *S. angulatus* recorded at the water's edge were significantly higher than those recorded in areas with clearings. Therefore, the higher water availability makes this species dominant along the riparian zones (Table 1).

Sicyos angulatus and *Salix alba* were the most constant species in the plant communities studied. This proves that they have adapted to the conditions of the study area. Furthermore, the analysis of constancy showed similar regularities to those of dominance. Near the edges of the watercourses, *Sicyos angulatus* was the euconstant species (Table 1).

The values of the index of ecological significance suggest that *S. angulatus* is a well-adapted species which occurs in the analysed riparian plant communities (Table 1).

The calculated values of *S. angulatus* density showed significant differences. The highest values were recorded in Ostroveni (on the banks of the Danube), in shaded habitats close to the banks of the Jiu River and at the confluence of the Jiu and Danube rivers (Table 1).

The analysis of the similarity of the plant community composition between the study areas, based on the Bray-Curtis dissimilarity index, revealed two very different groups. The first group includes the three study areas close to the water and the second group includes the three areas further away from the water. Between these two groups the similarity is minimal (the dissimilarity index value was 0.841), while within these groups the index values were close to zero, especially within the group including the study areas with excess humidity (Figure 7).

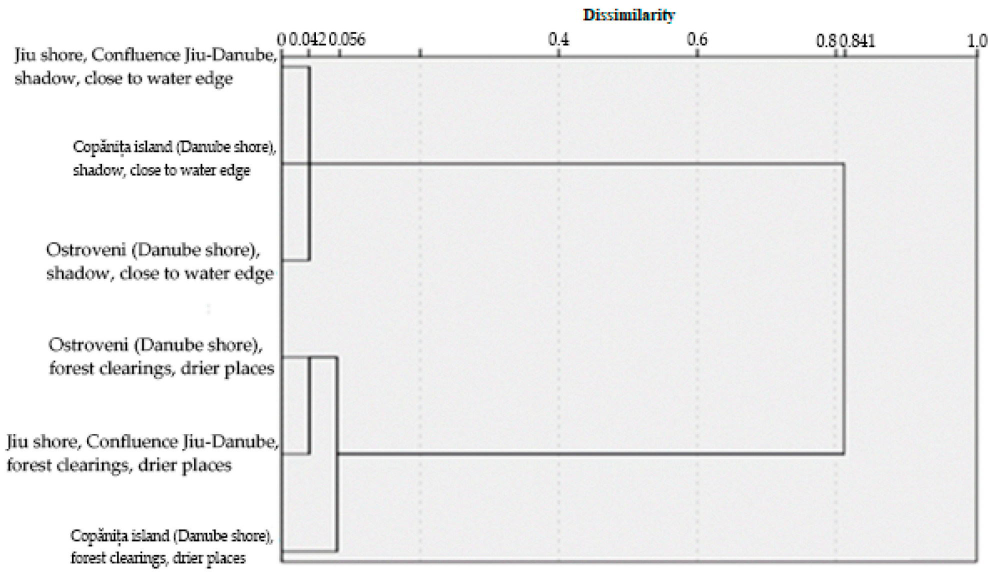

Figure 7. Hierarchical clustering of the study areas according to the values of the analysed ecological indices using the Bray-Curtis dissimilarity index and UPGMA linkage.

4. Discussion

The main cause of the spread of *Sicyos angulatus* in the study area is not known, but the spread is most likely related to transport on the Danube and Jiu rivers, tourism or even certain practices by the local population who are unaware of the invasiveness of this species. The floods of 2005 in the Danube valley played a significant role in increasing the number of invasive species in this area, and at the same time the climatic conditions combined with anthropogenic factors led to the spread and invasion of *S. angulatus*.

The staff of the Sadova forestry district tried to control *S. angulatus* manually in the poplar nurseries in the Danube valley. However, mechanical control is hardly applicable in nurseries, while the results of chemical control were negligible. The results of manual control were also unsatisfactory because very coarse plants are difficult to control manually due to the health risks to workers (Figure 8).

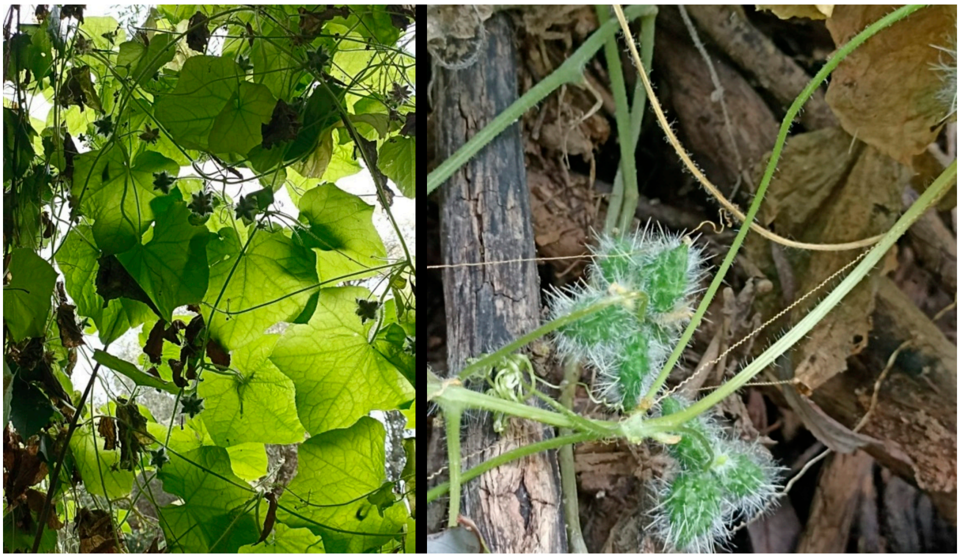

Figure 8. Abundant fruiting of *Sicyos angulatus* in the plant communities in the Jiu and Danube confluence area.

Sicyos angulatus can reach a height of 6-8 m. It is a climbing plant and can completely cover an area of its habitat and, as it spreads, outcompetes all plant species under the cover of its stems and leaves [25]. Field observations showed that the studied area can be considered an invasion hotspot, where *S. angulatus* exhibits large and dense populations. In Ostroveni it has caused a reduction in the native species and can be considered a threat to native habitats. *Sicyos angulatus* is a serious threat to riparian ecosystems [26]. The results of this study are consistent with those of Önen [27] who also mentioned that *S. angulatus* is a highly invasive vine that has become naturalised in the humid Black Sea region of Turkey. According to a study carried out in Japan, the invasion of *S. angulatus* in crop fields leads to an 80% reduction in yield at a population of 15–20 individuals per 10 m^2 and a 90–98% reduction at a population of 28–50 individuals per 10 m^2 [28].

In the southwestern part of Romania, the invasive *S. angulatus* has a wide distribution in forest habitats. It grows very well in *Salix* forests or in *Salix* with *Populus* groves on the banks of the Danube and Jiu rivers. Droughts in recent years have not affected the development and spread of this species. *Echinocystis lobata* (Michx.) Torr. & A. Gray is a similar species that grows in riparian tall herb, shrub and woodland habitats and has a similar negative impact on native biodiversity and plant communities [29,30]. Another invasive plant that outcompetes native species and causes major damage to ecosystems is *Reynoutria japonica* Houtt [31].

The density of *S. angulatus* individuals was lower in relatively dry habitats, but the invasiveness remains quite high, in some places negatively affecting the structure of native plant communities. Humidity and shade in riparian habitats are more favourable for the growth and reproduction of this species than in forest clearings and other drier habitats. According to field studies by Mikeladze and Bolkvadze [32], *S. angulatus* has quite large populations in moist and wet soils in western Georgia.

The temperate continental climate of the studied area, where summers are hot (average monthly temperature between 20 °C and 30 °C) and winters are only occasionally harsh (average temperature between −1 °C and −4 °C), has favoured the adaptation and reproduction of the species. Although the annual thermal amplitudes are high and the precipitation varies between 500 mm and 800 mm, falling mainly in spring and summer, these conditions also favour the growth of *S. angulatus*. *Sicyos angulatus*, which is native to North America, has adapted very well to the area studied because the climatic conditions of the native range are like those of the invaded region.

The climatic changes of the last decades, the geographical position at the confluence of two large water basins, the Danube and the Jiu, combined with anthropogenic factors such as trade, tourism and agricultural practices, have contributed to the invasiveness of *S. angulatus*. This has led to an explosion in the number of individuals and their range within the phytocoenoses studied. Therefore, *S. angulatus* has a negative impact on the biodiversity of the studied habitats, especially on the ass. *Salix alba* Issler 1924. *Sicyos angulatus* has a negative impact on the structure and species composition of the plant communities and at the same time on the conservation status of the Natura 2000 habitats. The massive development of this species also influences the dynamics of the *Populus alba* galleries. Six types of natural terrestrial and freshwater habitats of conservation interest have been identified in southern Oltenia, in the Danube and Jiu floodplains [33].

The large number of *S. angulatus* individuals within the populations, the high degree of invasiveness, the very high spreading capacity and the invasive energy has a negative influence on the flora and vegetation. In the Jiu and Danube confluence area, an integral part of two protected natural areas in the southwestern part of Romania, *S. angulatus* has invaded forest plantations, especially forest nurseries, affecting the development of poplar saplings. The high abundance and dominance of *S. angulatus* led to the overgrowth of *Populus alba* seedlings in the nurseries in the immediate vicinity of the study sites.

The conservation of biodiversity in this area must be carried out in close coordination with the measures for the integrated control of this species, using chemical or mechanical methods that do not affect the favourable conservation status of the habitats and forest species of economic interest.

Further research is needed to determine the extent of *S angulatus* invasion in the wetlands of Ostroveni and to define specific control measures in forest ecosystems. Successful conservation of an area can be achieved if invasive plant species are managed in a way that allows the proper development of native plants and thus the stability of the whole habitat and ecosystem. The results of this study on the density, abundance and dominance of *S. angulatus* should be used by foresters to define measures to control the species and restore the favourable conservation status of the plant communities and, implicitly, of the natural habitats at the confluence of the Danube and the Jiu rivers.

The successful implementation of management policies requires a comprehensive scientific knowledge of each new invasive or potentially invasive species.

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Appendix A

Table A1. Phytosociological relevés of the ass. *Salicetum albae* Issler 1924 communities containing *Sicyos angulatus*. Abbreviations: K—constancy class.

No. of Relevé	**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**	**K**
Canopy closure	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Coverage of herb layer (%)	60	60	60	60	70	50	60	50	30	30	40	60	40	40	30	40	30	20	50	50	40	50	20	30	50	
Area (m^2)	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	400	
Char. ass.																										
Salix alba	4	4	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	5	5	5	5	5	5	5	V
Salix fragilis	–	+	1	+	+	+	+	+	1	1	1	1	2	1	1	+	+	–	+	+	–	+	–	+	–	IV
Populus nigra	–	+	–	–	+	–	–	–	–	+	–	+	–	–	+	–	–	–	–	+	+	–	–	–	–	II
Populus alba	–	+	–	+	+	–	–	–	+	+	–	+	–	+	+	–	–	–	+	+	+	–	–	–	+	III
Populus × canadensis	–	+	–	+	+	–	–	–	+	+	–	+	–	+	+	–	–	–	+	+	+	+	–	–	+	III
Salicion triandrae																										
Agrostis stolonifera	–	+	+	+	–	–	+	+	+	–	–	+	+	+	–	–	+	+	+	–	–	–	+	+	+	III
Urtica dioica	+	–	+	–	+	+	–	+	–	+	+	–	+	–	+	+	–	+	–	+	+	+	–	+	–	III
Salicion albae																										
Rubus caesius	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	V
Humulus lupulus	+	–	+	–	+	+	–	+	–	+	+	–	+	–	+	+	–	+	–	+	+	+	–	+	–	III
Salicetalia et Salicetea purpurea																										
Salix purpurea	–	+	+	+	–	–	+	+	+	–	–	+	+	+	–	–	+	+	+	–	–	–	+	+	+	III
Rorippa sylvestris	+	–	+	–	+	+	–	+	–	+	+	–	+	–	+	+	–	+	–	+	+	+	–	–	–	III
Stachys palustris	+	–	–	–	+	+	–	+	–	+	+	–	–	–	+	+	–	+	–	+	+	+	–	+	–	III
Phragmitetalia																										
Lycopus europaeus	+	+	–	+	–	+	+	–	+	–	+	+	–	+	–	+	+	–	+	–	–	+	+	–	+	III
Lythrum salicaria	+	–	+	–	–	+	–	+	–	–	+	–	+	–	–	+	–	+	–	–	–	+	–	+	–	II
Querco-Fagetea																										
Carex remota	+	–	+	+	–	–	+	+	+	–	+	–	+	+	–	–	+	+	+	–	–	–	+	+	+	III
Fraxinus angustifolia	–	+	–	+	–	–	–	–	–	–	+	+	–	–	–	–	–	–	+	+	–	–	–	+	+	II
Solanum dulcamara	+	–	–	–	+	+	–	–	–	+	+	–	–	–	+	+	–	–	–	+	+	+	–	–	–	40
Stellaria nemorum	+	–	+	+	–	–	+	+	+	–	+	–	+	+	–	–	+	+	+	–	–	–	+	+	+	III
Vitis vinifera	+	–	+	+	–	–	+	+	+	–	+	–	+	+	–	–	+	+	+	–	–	–	+	+	+	III
Ranunculus ficaria	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	V
Accompanying species																										
Mentha longifolia	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	V
Conium maculatum	+	–	+	–	–	+	–	+	–	–	+	–	+	–	–	+	–	+	–	–	–	+	–	+	–	II
Polygonum hydropiper	+	–	+	–	+	+	–	+	–	+	+	–	+	–	+	+	–	+	–	+	+	+	–	+	–	II
Equisetum arvense	+	–	–	+	+	–	+	+	–	+	+	–	+	+	+	+	–	–	+	+	–	–	+	+	+	III
Agropyron repens	–	–	+	+	+	–	–	+	–	+	–	–	+	–	+	–	–	+	+	–	+	–	–	+	+	III

Table A1. *Cont.*

No. of Relevé	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	K
Sicyos angulatus	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**+**	**+**	**1**	**1**	**+**	**1**	**1**	**1**	**2**	V
Amorpha fruticosa	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	–	2	2	2	2	+	+	+	V
Ecballium elaterium	+	–	–	+	1	1	–	–	+	+	+	1	1	+	+	1	–	1	–	+	+	+	–	–	+	IV
Oxalis stricta	–	–	–	+	+	–	–	–	–	+	–	–	–	–	+	–	–	+	–	+	+	–	–	+	+	II
Bidens frondosa	–	–	+	+	+	1	1	+	+	+	–	–	+	+	+	–	–	+	+	+	+	1	–	+	+	IV
Symphyotrichum lanceolatum	–	1	+	1	1	–	–	2	+	+	1	1	1	1	1	1	1	+	1	1	1	–	–	1	2	IV

Place and data of the relevées: 1–10; Jiu-Danube Confluence, the bank of the Danube, 12 June 2022; 7 August 2023; 11–15, Jiu-Danube Confluence, the bank of the Jiu, 10 June 2022; 12 August 2023; 16–25, Copanița Island—the bank of the Danube, 27 June 2022; 14 August 2023.

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