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SICYOS ANGULATUS AND *ECHINOCYSTIS LOBATA*, TWO INVASIVE VASCULAR PLANTS ON THE DANUBE VALLEY, BETWEEN THE BAZIAS AND MACESU DE SUS (ROMANIA)

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Abstract: Biological invasion of alien plants is considered to be one of the most serious threats to biodiversity in alluvial vegetation. The effects of two invasive alien plants, *Sicyos angulatus* L. and *Echinocystis lobata* (Michx.) Torr. et A. Gray (Cucurbitaceae) on the flora and community structure of the alluvial vegetation were investigated at 12 sites at streams in the Danube Valley. *Sicyos angulatus* has invaded the alluvial vegetation of this area and causes problems because the degree of aggression on other species is very high. It suppresses native vegetation such as trees, shrubs and tall grasses on bank slope and higher floodplains. *Echinocystis lobata* is an annual vine that can climb up to 6 (12) m and has become more widespread in the Danube Valley. *E. lobata* colonises mainly riparian habitats, floodplains, gallery forests, swamps and disturbed swamps, wetlands and woodland margins, and it is a very aggressive species of the vegetation in this area. In order to control the introduction and expansion of alien plants, limitation of artificial disturbances and appropriate alien plant management are needed in riparian areas.
Key words: Danube Valley, invasive plants, *Sicyos angulatus*, *Echinocystis lobata*, habitat

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Introduction

Globalization increases trade, travel and transport and leads to an unprecedented homogenization of the world's biota by the introduction and subsequent establishment of organisms beyond their natural ranges. Some of these alien species become invasive and pose threats to the environment and human economy and health (Elton 1958, Kornaś 1990, Vila et al. 2000, Pimental 2002, European Commission 2004, Hulme et al. 2009).

Invasive species have greatly weakened ecosystems worldwide, as they are associated with diseases that spread among crops and forests (Krebs 2009). Exotic species compete with native species and threaten ecosystem stability.

The studies on alien species are of particular interest today to protect natural habitats and reduce or eliminate ecological and economic damage.

Invasive species are one of the most serious threats to biodiversity. This paper shows the negative effects of two invasive vascular species plants, *Sicyos angulatus* L. and *Echinocystis lobata* (Michx.) Torr. et A. Gray (Cucurbitaceae) on the physiognomy and floristic composition of phytocoenoses within the Danube Valley vegetation, between the towns of Baziaş and Măceşu de Sus, region of Romania. Thus, the studies were carried out in the Danube Valley in 12 localities: Baziaş, Ostrovul Moldova Veche,

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Corinini, Berzeasca, Sviniţa, Dubova, Mraconia, Eşelniţa, Orşova, Drobeta-Turnu Severin, Simian and Măceşu de Sus.

Sicyos angulatus is a very dangerous weed, introduced in Europe as a decorative species in the 19th century, but it started to escape from cultivated plots and spread spontaneously by seeds. In Europe, it is recognized as an invasive alien plant, while in America it became one of the five most noxious weeds that cannot be controlled with 'standard' weed control programmes (Stešević & Jovović 2005). *S. angulatus* can grow in a wide range of habitats such as coastal areas, lowland shrub lands or rainforests up to 2000 meters in elevation. There is a vast area of adaptation of *S. angulatus* throughout the world, so it is urgent to find some way to slow or even stop its invasion effectively (Zhao et al. 2019).

This species can be found in many European countries: Serbia, Montenegro, Bosnia, Herzegovina, Austria, Czech Republic, Italy, Romania, Russia, Sweden, Norway, France, United Kingdom, Spain, Germany and Turkey. The species is mentioned for first time in Romania by Baumgarten in 1816 (in Sîrbu & Oprea 2011) and Heuffel (1858), in Transylvania and Banat, respectively.

This species is also considered a weed in agricultural and horticultural crops around the world. It is a species that spreads very easily by means of water, air, with the help of animals and anthropogenic. Morphologically, the fruit has characteristics that allow it to attach because of its thorns to animal fur, footwear and clothing, as well as to agricultural machinery, thus favouring the spread. It also has strong, branched tendrils (vines). At the same time axillary buds show a special importance because they have the ability to form a new plant, thus being able to form a type of dense stem network that can stretch over large areas and reach up to 6 (8) m in height, suffocating all nearby vegetation.

It clings to the crop plants and causes them to be shaded, and the weight of its stems leads to the collapse of cultivated plants and to the difficulty of collecting crops (Stešević & Jovović 2005).

Echinocystis lobata (Wild cucumber) is native to central North America from the east coast to the Rocky Mountains where it is associated with a broad range of riparian habitats, including stream, river and lake side areas (Foster & Duke 1990). It was introduced to Europe in the late 19th century as an ornamental and medicinal plant.

In Europa, *E. lobata* is an invasive alien species, recorded in Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Latvia, Poland, Romania, Slovakia, Slovenia, Norway, Ukraine and the European part of Russia, including in regions of the Southern Urals in Urali Mts. (DAISIE 2014 and regional/ national data bases, Abramova 2012). The species is absent from the UK and Ireland. It is found in the floristic composition of wetlands, colonises mainly riparian habitats, floodplains, gallery forests, the banks of the river and lake, the bushes, and also the roadsides.

In Romania, the species was first reported from Transylvania, by Moesz, in 1904, near Darste (Braşov County) (Sîrbu & Oprea 2011).

E. lobata is an annual herbaceous plant with thorny fruits. Due to the fact that it is a plant with ornamental and medicinal importance, this species has escaped from the crops becoming invasive in many areas of Europe and our country.

E. lobata is an invasive species with high capacity for adaptability and high ecological plasticity (Klotz 2009). It can produce a very large number of seeds, spreads

easily and is very stable to adverse environmental factors (Klotz 2009). These considerations make this species have a negative impact on native vegetation and is difficult to combat.

Material and methods

The study area is located in the southern part of Romania, in the Danube Valley, and occupies an area found in the southern counties of Caraş-Severin, Mehedinţi and Dolj. So, the following studies carried out in the Danube Valley in the 12 localities presented above were aimed at the monitoring of the two invasive species: *Sicyos angulatus* and *Echinocystis lobata* noting the frequency of species, the Raunkiaer method; vitality, according to the Braun-Blanquet scale; the size of the populations; population density (individuals/ u.s.); the rate of population growth or/ and decrease; spatial distribution; the floristic structure of phytocoenoses in which the populations of species are found; abundance-dominance (AD) of species in sample surfaces, according to Braun-Blanquet scale; phenological state; reproductive capacity (no seeds or other propagations/ individual); assessment of the degree of acclimatisation, invasiveness and aggressiveness; preferences for ecological factors; types of Natura 2000 habitats invaded by these species. In each study locality, a minimum of two typical river vegetation sample areas of at least 1000 m^2 were chosen where the species appeared: *Echinocystis lobata* and *Sicyos angulatus.*

Results and discussion

The invasive vascular plants have penetrated and overwhelmed many native species in almost all river fields in Romania in recent years.

Sicyos angulatus has invaded the vegetation in this area and has a very high anthropogenic impact on the physiognomy and floristic composition within phytocoenoses, since the degree of invasiveness and aggressiveness of this species is very high. *S. angulatus* is one of the most notorious invasive lianas. Suppresses native vegetation, having a negative impact on trees, shrubs, as well as grassy species on the water's edge and vegetation in floodplains.

This species has high population densities, so it had to be removed from the invasion habitats and was chosen as it has a rapid and dense growth and is associated with shading and suffocation of vegetation. The species was found in all 12 localities in the Danube Valley. Studies have been done in all existing habitats in these areas. The species has been found in the following types of natural habitats: 91E0* - Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*), CLAS. PAL.: 44.3, 44.2 şi 44.13; 92A0 - *Salix alba* and *Populus alba* galleries, CLAS. PAL.: 44.141, 44.162 şi 44.6; 91F0 - Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia* along the great rivers (*Ulmenion minoris*), CLAS. PAL.: 44.4; 91I0* - Euro-Siberian steppic woods with *Quercus* spp.; 6430 - Hydrophilous tall-herb fringe communities of plains and of the montane to alpine levels, CLAS. PAL.: 37.7 and 37.8.; and 6440 - Alluvial meadows of river valleys of the *Cnidion dubii*, CLAS. PAL.: 37.23 (Gafta & Mountford – coord. 2008). In the island of Moldova Veche and at Măceşu de Sus the species is abundantly found and causes great damage in forest phytocenoses by suffocating vegetation. Thus, in the area of the island of Moldova Veche species has a large

dominant abundance in the following locations: 44.68932-21.64259; 44.68824-21.64219; 44.68819-21.63719; 44.68720-21.62295, 44.68736-21.62180.

The species frequently invades, together with *Amorpha fruticosa* and *Ailanthus altissima* phytocoenoses from the following plant communities: *Salicetum albae* Issler 1924, *Stellario nemorum-Alnetum glutinosae* (Kästner 1938) Lohmeyer 1957, *Salici-Populetum* Meijer-Drees 1936 (Table 1).

In this area the species grows intensely. In the studied territory the species was also found in relative places with high humidity, besides households, besides fences, bridges, road edges in the localities of Corinini, Berzeasca, Sviniţa, Dubova, Mraconia, Eşelniţa, Orşova (Fig. 1).

Table 1. The structure of the relevées for *Salici-Populetum* Meijer-Drees 1936

No.of relevée	1	2	3	4	5	K
Coverage (%) (tree layer)	70	70	70	70	60	
Coverage (%) (herbaceous layer)	60	60	50	60	60	
Surface (m^2)	1000	1000	1000	1000	1000	
Char. Ass.						
Salix alba	2	2	1	1	1-2	V
Populus alba	3-4	3-4	4	4	3-4	V
Salicion triandrae						
Salix triandra	-	+	+	-	-	II
Calystegia sepium	+	+-1	+	-	-	III
Aegopodium podagraria	+-1	1	1-2	1	1	V
Agrostis stolonifera	1	+-1	1	2	2	III
Urtica dioica	1	1	1	2	2	V
Poa trivialis	-	1	1	+-1	+-1	IV
Rubus caesius	+	+	+	+	+	V
Salicetalia et Salicetea purpurea						
Populus nigra	-	-	+	+	+	III
Salix fragilis	+	+	-	+	+	IV
Salix purpurea	-	+	+	+	-	III
Ranunculus repens	+	1-2	+-1	1	1	IV
Stachys palustris	+	-	-	-	+	II
Cornus sanguinea	+	+	+	+	+	V
Poa palustris	-	+-1	+-1	-	-	II
Lysimachia nummularia	1	1-2	+-1	1-2	1	V
Glechoma hederacea	+-1	+	-	+	-	III
Solanum dulcamara	+	-	-	-	+	II
Phragmitetalia						
Lycopus europaeus	+	+	-	+	-	III
Lythrum salicaria	+	-	+	-	-	II
Variae Syntaxa						
Rubus caesius	+	-	+	+	+	IV
Sicyos angulatus	2-3	3	3	2-3	3	V
Phytolacca americana	+	+	1	1	1	V
Ailanthus altissima	+	+-1	1	+	+-1	V
Ambrosia artemisiifolia	-	-	+	-	+	II
Echinocystis lobata	1	+-1	1	-	-	III

Oenothera glazioviana	+	-	-	+	-	II
Amorpha fruticosa	1-2	1	1	2	+	V
Conyza canadensis	+	+	+	+	+	V
Erigelon annuus subsp. *annuus*	+	+	+	+	+	V
Aster lanceolatus	+-1	1	1	1	1	V
Mentha longifolia	-	+	+	+	+	IV
Ranunculus ficaria	+-1	1	1	1	1	V
Conium maculatum	+	+	+	+	+	V
Polygonum hydropiper	+	-	+	-	+	III
Equisetum arvense	+	+	+	+	+	V

Place and data of relevées: 1-5, Măceşu de Sus, 20.09.2020

The species has an intense development, forming very numerous populations, spread over large areas also in the Măceşu de Sus: 43.80192-23.65363; 43.80152-23.65373; 43.80129-23.65386; 43.80121-23.65390; 43.80123-23.65391; 43.80082-23.65409; 43.80027-23.65429. The species is found in the floristic composition of the following plant communities: *Salicetum albae* Issler 1924, *Stellario nemorum-Alnetum glutinosae* (Kästner 1938) Lohmeyer 1957, *Salici-Populetum* Meijer-Drees 1936, *Salicetum fragilis* Passarge 1957, *Quercetum roboris pedunculiflorae* Simon 1960 (syn.: *Fraxino angustifoliae-Quercetum pedunculiflorae* Chifu et al. (1998) 2004), *Quercetum pedunculiflorae* Borza 1937, *Scirpetum sylvatici* Ralski 1931 em. Schwich 1944, *Agrostio-Festucetum pratensis* Soó 1949; *Agrostietum stoloniferae* (Ujvárosi 1941) Burduja et al. 1956. Thus, the largest populations with high abundence-dominance were found in phytocoenoses of *Salici-Populetum* Meijer-Drees 1936 in the area of Măceşu de Sus. Here the species forms dense populations that reach very high heights including native vegetation on very large areas. In the area of Măceşu de Sus we recorded an area of three hectares in which it is found as a dense network species *Sicyos angulatus* this having a very large negative impact on the natural habitat 92A0. Also, the species has compounded the saplings from the forest nursery in the area and is very difficult to combat mainly because of the thorny fruits and highly developed tendrils. In this area *Sicyos angulatus* develops alongside other invasive plants: *Amorpha fruticosa, Ailanthus altissima, Abutilon theophrasti, Conyza canadensis, Ambrosia artemisiifolia, Erigelon annuus* subsp. *annuus, Oenothera glazioviana, Phytolacca americana* and *Aster lanceolatus* (Fig. 1, 2).

Fig. 1. Sicyos angulatus in the Danube Valley, on the edge of the 92A0 Natura 2000 (M. Niculescu)

Fig. 2. Sicyos angulatus at Măceşu de Sus (M. Niculescu)

In view of the negative effects, it has on biodiversity, it is necessary to carry out a plan to monitor and combat in the Danube Valley, for this invasive species that mainly causes damage in forestry.

Echinocystis lobata is an annual, climbing species with branched rudders that can climb up to 6 (12) m and has become widespread in the phytocoenoses within the vegetation of the Danube Valley. *E. lobata* mainly colonizes riparian habitats, vegetation found in flood plains, grassland forests, swamps and disturbed marshes, wetlands and forest edges being a very aggressive species on the vegetation of this area. Thus, for this species, each study site consisted of a typical stretch of river vegetation of at least 1000 m^2 where *Echinocystis lobata* appeared.

Studies carried out the species was found in the following natural habitats: 91E0* – Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*), CLAS. PAL.: 44.3, 44.2 şi 44.13; 92A0 – *Salix alba* and *Populus alba* galleries, CLAS. PAL.: 44.141, 44.162 and 44.6; 91I0* – Euro-Siberian steppic woods with *Quercus* spp.; 91F0 – Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia* along the great rivers (*Ulmenion minoris*), CLAS. PAL.: 44.4. and 3270 - Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p. vegetation; CLAS. PAL.: 24.52. (Gafta & Mountford – coord. 2008).

Vegetation has been characterized by the following species: *Alnus glutinosa, Anthriscus sylvestris, Bromus inermis, Calystegia sepium, Fraxinus excelsior, Galium aparine, Glyceria maxima, Humulus lupulus, Phragmites australis, Poa palustris, Sambucus nigra, Symphytum officinale* and *Urtica dioica.*

This species was found in the floristic composition of the following plant communities: *Helianthetum tuberosi* (Moor 1958) Oberd. 1967, *Salicetum albae* Issler 1939, *Stellario nemorum-Alnetum glutinosae* (Kästner 1938) Lohmeyer 1957, *Salici-Populetum* Meijer-Drees 1936, *Salicetum fragilis* Passarge 1957, *Quercetum pedunculiflorae* Borza 193, *Quercetum roboris pedunculiflorae* Simon 1960 (syn.: *Fraxino angustifoliae-Quercetum pedunculiflorae* Chifu et al. (1998) 2004). In invaded habitats, this species damages the native vegetation over which it develops abundantly, causing the plants to shade and dry out. The species, also develops on water channels in the area: Măceşu de Sus-Cîrna: 43.80496-23.64946; 43.90255-23.65159; 43.80992-23.64738; 43.81945-23.65110; 43.82154-23.66406; 43.83184-23.67055. It develops well in the following plant communities: *Polygono lapathifolii-Bidentetum* Klika 1935;

Echinochloo-Polygonetum lapathifolii Soó et Csűrös 1974; and *Phalaridetum arundinaceae* (Horvatič 1931) Libbert 1931 and *Glycerietum maximae* Hueck 1931.

The species is located in the Danube Valley locations in relative sites: besides fences, garbage storage sites, around the sheep stalls in the area, through abandoned and poorly maintained gardens.

To date, the intentional action attributed to the fight against *E. lobata* has not been widely taken. Indirectly, the plant can be removed during treatments for the control of other invasive species, for example, weeds (*Fallopia* spp.) on the edges of the water. Given the nature of these habitats, actions attributed to the protection of valuable natural areas should be based on the extraction, cutting or dining of wild cucumber plants (Dajdok & Kącki 2009). The possibility of applying chemical means must be adapted to local conditions and provisions (in many countries the use of chemicals is prohibited, such as herbicides in the vicinity of the waters).

Conclusions

In order to control the introduction and expansion of invasive plants, as well as the anthropogenic impact of these species on biodiversity, a number of measures for the protection and proper management of invasive plants in riparian areas need to be defined and implemented. In agricultural, horticultural and forestry systems invasive plants can cause economic losses of up to 60%. In order to minimise such losses, substantial time and effort must be invested in eradicating invasive populations and preventing their spread (Pichancourt et al. 2012). Management is most effective when the invasion is detected early and comprehensive control measures are implemented quickly, any effect is thus limited. Therefore, early identification of the areas in which efforts should be concentrated (e.g., prevention, elimination, and monitoring) is essential for cost-effective management. Both species strongly affect biodiversity within natural habitats. *Sicyos angulatus* is very common in riverside areas and open spaces, suppressing the growth of native vegetation and being difficult to eradicate especially when stretching over large areas. The most problematic characteristic of *Sicyos angulatus* is its rapid growing long vines.

Echynocystis lobata spreads easily because it has rapid growth, has a high reproductive potential, and has propagation that can remain viable for more time, is a species spread very easily by humans. This species is especially in the invasion in wetlands, dense networks eliminating other herbaceous plants. In forest habitats through abundant development can greatly reduce the amount of light, thus suppressing the development of other species of the shrub and grassy star. Considering these, it is very important that these two species are to be monitored permanently and the best methods of control to be found, without affecting the biodiversity and phytocoenoses in which they develop.

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