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The Effects of the *Reynoutria Japonica* Species on the Biodiversity in the Natural Park of Maramureş Mountains

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Abstract. *Reynoutria japonica* (Knotweed japanese) was introduced in Romania as an ornamental plant in parks and botanic gardens or private gardens from where the plant has escaped being declared spontaneous, and later invasive. In the year 2000 was registered in more than 137 localities all around the country (Sîrbu and Oprea, 2011). The species has evolved along Vişeu River becoming a problem that affected everyone. *Reynoutria japonica* takes important surfaces along Vişeu River which initially have been cultivated by the ones inhabitants affecting biodiversity. The observations have been made inside the Natural Park of Maramureş Mountains. Soil samples were taken from plains, but also from the interior of several viable *Reynoutria japonica* populations and the observations and the analyses were made inside the environment department from the University of the Agricultural Sciences and Veterinary Medicine Cluj-Napoca. As a result of the observations we can confirm that the majority of the land plots worked by the inhabitants are surrounded by this invasive plant. The preliminary results have shown that the micro fauna is weaker in comparison to the unpopulated plains. Samples taken in the study showed that the number of mites change depending on rainfall. After an arid grassland livestock mites are smaller than soils covered with herds of *R. japonica*.

Keywords: biodiversity, invasive plants, ecological impact, edaphic fauna

INTRODUCTION

Reynoutria japonica Houtt. (*Polygonum cuspidatum* Sieb. Et Zucc.; Fallopia japonica Ronse Decr.) is a native species from Eastern Asia (Japonia, Ins. Sachalin, Korea, China, Vietnam) (Alberternst et Böhmer, 2006; Winttenberg, 2005; Mandák *et al*., 2004) and it was introduced in Europe to be used as an ornamental plant (Pysek, 2006). Gradually, the *R. japonica* (Knotweed japanese) became known in the entire Europe as an adventive plant. It is very plastic from an ecological and geographical point of view is common in Norway and Finland (Barney *et al*., 2006 quoted by Sîrbu and Oprea, 2011) and Greece.

The *R. japonica* was introduced in Romania as an ornamental plant in gardens and parks and later got out of control. A long time this plant was known as a culture plant (Sirbu and Oprea, 2011). The plant was cultivated in botanic gardens here, in our country, but it escaped in the ecosystems of the cultivars (Săvulescu, 1952). It was mentioned for the first time in 1940 by Pauca, quoted by Oprea (2005) in Rabagani locality (Bihor county), and it was later spotted in Cluj-Napoca by Topa (1947). In 1959 Alexandru Borza mentioned the existence of a species in several localities in Transylvania. In Moldavia it was reminded as a culture plant a bit later, in 1968, and a year later it was declared subspontaneous in Bistricioara (Mititelu *et al*., 1968; Zanoschi, 1971). Even if at the middle of last century it was mentioned in only two localities as being a wild species in our country, in 2000 their number reached 47, and in 2011 the number of localities reached 136. Even so, current data indicate the fact that the *R. japonica* is quite prevalent in Transylvania, Maramures, Crisana and Moldavia. It is not so common in Banat, Oltenia and Muntenia and is completely inexistent in Dobrogea (Sîrbu and Oprea, 2011).

The *Reynoutria* has a big impact on infested ecosystems and sometimes it affects in irreversible way the genetic diversity of the area. The lack of balance inside the ecosystems caused the invasive plants that have managed to get in. Without a certain unbalance, invasive species could not stand a chance in passing through and affecting that ecosystem (D'antonio *et al*., 1999; Maxwell *et al*., 2003).

The capacity of the *Reynoutria* of creating dominant populations limits the quantity of energy that reaches the ecosystem and changes it (Kowarik, 1996). Once introduced in an ecosystem the *Reynoutria* has the capacity of replacing completely the vegetal indigenous communities found on big areas through shading (Oprea and Sîrbu, 2006; Sîrbu and Oprea, 2008). The species of the *Reynoutria* also have the capacity of maintaining certain equilibrium in the ecosystem through the modification of resources leaving the native species little chance to compete with them (Pauchard, 2002). The dense communities made by these species blind the soil reducing the access of the light with less than 90% (Bamev *et al*., 2006).

When the aerial stalk of plants die, usually during autumn and winter, the naked soil is being gently washed by the waters that lead to the increase of erosion especially on riverbanks (Wittenberg, 2005; Shaw and Seiger, 2002).

The species determine the alteration of the draining regime and the quality of the waters of the river. It also leads to the deterioration of the physical properties of the soil (Barney *et al*., 2006).

The Japanese knotweed has a negative impact on fauna; mainly on insects when native plant species from which insects take their food are replaced with populations of R. japonica (Schwabe and Kratochwil, 1991).

This paper aims at highlighting the negative impact that *R. japonica* had on the invaded ecosystem. It also follows the development of plants in different areas and their impact on comparative edaphic fauna and grassland affected by the invasion of *R. japonica*.

MATERIALS AND METHODS

Description of the area.

The research is concentrated mainly on the area of Maramures Mountains Natural Park which 2005 has been declared a protected area, included in the V category of the World Conservation Union. Was declared natural park because of the landscape of the mountain area, covered in forests and alpine meadows, diverse flora and fauna, typical for the Carpathian Mountains, stabile ecosystems (forests, meadows, lakes, swamps, reeds and underground waters), the existence of habitats on large unfragmented areas and the conservation of the traditional way of life.

Maramures Mountains Natural Park is located north of Maramures county, across settlements Borsa, Mosei, Viseu de Sus, Viseu de Jos, Leordina, Ruscova, Repedea, Poienile de sub Munte, Petrova and Bistra including Maramures Mountains Massif to the Romanian state border with Ukraine. Between 47 ° 35' parallels and 47 ° 58' north latitude and between 24 ° 8' meridians and 25 ° 2' west longitude. It has an area of 1500 km2 being the largest Natural Park in Romania.

The relief is up to 1900 m fragmented by deep valleys where gorges and depression were formed; areas suitable for human settlements development. The most important rivers are Frumuşeaua, Ruscova, Vaser and Ţîşla, tributaries of Viseu River on which have developed the most important cities in the area, Borsa and Viseu de Sus (Dumitrascu *et al*., 2012).

Description of the *R. japonica specie*

R. japonica is a geophytes vigorous plant, with a highly developed root system, that can reach 5 to 6 m (sometimes-even 15 -20 m) in length and penetrates the soil up to 2-3 m in depth (Fuchs, 1957; Barney *et al*., 2006). The rhizomes can spread up to 2.5 m in a single vegetation period (Hagemann, 1995 quoted by Sîrbu and Oprea, 2011) and can penetrate a layer of asphalt of up to 8 cm in thickness (Hagemann, 1995 quoted by Sîrbu and Oprea, 2011).

It has a great ecological plasticity and can be found on different types of soil (sandy land, swamps, ruderal land, cliffs and river deposits). With a pH between 3,5 and 7,4, organic matter with a percent of 2 to 25 and a great variety of nutrients (Palmer, 1994 cited by Barney *et al*., 2006; Barney *et al*., 2006; Alberternst and Böhmer, 2006 quoted by Sîrbu and Oprea, 2011). The plant is usually installed in open spaces unshaded but according to some authors she has the ability to grow in half shaded places such as trails, forest edge (Alberternst, 1995).

Methods

Observations and measurements were performed in September 2012 when *Reynoutria japonica* plants have reached full maturity, and most plants had inflorescences. The plants present on a square meter in each sample unit (3 different points of sampling) were counted. The mass of green plants and the average height of the plants was measured. The average pH of the soil in the three main areas of study was established using equipment from the UASVM Cluj-Napoca.

Extraction of microarthropodes of the soil

The study of the micro-arthropods began with a soil sample with a depth of 10 cm, with a metallic cup. Six soil samples were taken, 3 from the meadow and 3 from the Reynoutria infested area. The sampling was performed twice, first after a long period of drought and the second after a rainy period.

For the extraction, the Berlese-Tullgren method was used. This method uses an installation that is made of a funnel in which the soil sample is placed, a heat source placed over the soil sample and the funnel communicate with a receptacle in which we have conservation liquid. Once the system is turned on, te soil will gradually heat up, from the surface down, which will determine the arthropods to retreat in the depth, towards the receptacle (Sandor *et al*., 2012).

RESULTS AND DISCUSSIONS

In the town of Viseu de Sus *R. japonica* is highly spread, especially on the side of Viseu river and its tributaries. The soil in this area is sandy on the surface but in depth the granulometry increases. The roots of *R. japonica* do not penetrate the soil in the depth, 90% percent of them are spread in the first 25 cm of soil.

Tab. 1

pH values in different areas

Soil sampling area	Meadow	*R. japonica* infested area
Area A (*Zăvoi*)	5,9	6,6
Area B (*La Dig*)	5,5	6,2
Area C (*La Bucur*)	5,6	6,4

The pH of the soil does not vary much, the differences between the *R. japonica* infested areas and the meadows probably occur because of the annual burnig of the *R. japonica* area. It can be observed that the lowest value was registered in zone B, where the meadow was abandoned and had vegetation typical for acid soils (Tab. 1).

Results regarding *Reynoutria japonica species*

According to climate condition, 2012 was a dry year, recording an annual rainfall of 552 liters/m^2. The average precipitate in the last ten years was of 809.26 liters/m^2. For this reason a large number of plants per m^2 in the study were dried. However, in July there were no dry plant populations of Japanese knotweed.

Tab. 2

Average Japanese knotweed plants in each area

Soil sampling area	Nr. sample	Nr. pl/ m^2		
		dried	green	total
Area A	1	18	10	28
	2	16	13	29
	3	20	11	31
Area B	4	22	10	32
	5	25	6	31
	6	19	8	27
Area C	7	13	14	27
	8	11	15	26
	9	15	14	29

In Tab. 2, we can observe that most of the *Renoutria japonica* species plants was recorded in the area B called The Dig, with an average in the population of 30 plants per m^2. Also most dry plants were recorded in this area with an average of 22 plants/m^2. Last area under study (C) contains most green plants/m^2 from all areas. Differences between the samples obtained from the three areas studied are not significant. After comparing the areas between them we obtained $t = -0.377$, $p > 0.05$, $t = 1.603$, $p > 0.05$, $t = 1.511$, $p > 0.05$ (Tab. 2).

Tab. 3

Height and weight of *R. japonica* plants

Soil sampling area	Nr. sample	Average height of green plants / m^2 (cm)	Average height of green plant area (cm)	mass of green plant /m^2 (g)	Average of green plants / m^2 on area (g)
Area A	1	260,2	268,4	2632	2726
	2	276,3		2843	
	3	268,8		2702	
Area B	4	224,4	253,4	1956	2090
	5	270,5		1821	
	6	262,2		2494	
Area C	7	291,3	301,4	3895	4326
	8	312,7		4654	
	9	300,1		4430	

In Tab. 3 are shown the average height and weight of green plant species per area. The most vigorous and tall plants were recorded in the last area under study with an average of plant height of 301.4 cm. Also in this area is the average the weight of green plants/m2 plants is 4326 grams. The average height of the plants in the study area C is significantly higher than in area A ($t = 4.244$, $p < 0.05$) and area B ($t = 3.164$, $p < 0.05$).

In study area B the average weight of green plants is smallest with a value of 2090 g/m2. This value is significantly distinct from the A ($t = 2.958$, $p < 0.05$) and B ($t = -7.33415$, $p < 0.05$). All the population of Japanese knotweed recorded an average plant height of 253.4 cm, the lowest average of the three areas.

Results on edaphic fauna

Many micro arthropods feed on bacteria, fungi and nematodes playing an important role in regulating edaphic livestock micro flora and micro fauna. At the same time, they represent an important source of food for other edaphic organisms and is an important link between micro flora and macro fauna (Sandor *et al*., 2011).

Tab. 4

The number of mites per m^2 in two times

Soil sampling area	11.05.2013 (after drought)		16.06.2013 (after rain)	
	Mites ind./m^2 meadow	Mites ind./m^2 Reynoutria	Mites ind./m^2 meadow	Mites ind./m^2 Reynoutria
Area A	2547	5095	1019	2038
	3057	13248	1019	17834
	2038	10191	1019	5095
Area B	2038	1528	2547	1019
	1528	1528	6114	4585
	1528	6624	5095	9171
Area C	2038	9681	9171	11210
	5605	5095	2038	14777
	3057	3057	12229	9681

The results obtained after a drought period (11.05.2013) indicate smallest flocks of mites than flocks of meadow in soils invaded by *R. japonica* ($t = -2.539$, $p < .05$). The samples studied differ after a period during which there have been rainfall (16.06.2013) but these differences are not significant ($t = -1.676$, $p > 0.05$) (Tab. 4). In both cases the numbers of mites increased in both grassland soils and in soils covered with knotweed after a rainy period but these increases are not statistically significant ($t = -1.323$, $p > 0.05$, $t = -0.919$, $p > 0.05$).

Tab. 5

The number of collembolans per m^2 in two times

Soil sampling area	11.05.2013 (after drought)		16.06.2013 (after rain)	
	Collembolans ind./ m^2 meadow	Collembolans ind./m^2 Reynoutria	Collembolans ind./m^2 meadow	Collembolans ind./ m^2 Reynoutria
Area A	1019	2038	1019	5095
	1019	17834	3566	2547
	1019	5095	10700	4585
Area B	2038	1528	1019	1528
	1324	1528	4076	1019
	3057	2547	6114	2038
Area C	1019	5605	16305	10700
	6624	5095	14267	2547
	5605	1019	5095	5095

Collembolans livestock are lower than in grassland soils covered with Japanese knotweed after a prolonged period of drought (11.05.2013) but the differences are not significant ($t = -1.152$, $p > 0.05$). After a rainy period (16.06.2013) flocks from grasslands increased from those in soils covered with knotweed (Tab. 5), but the increase is not significant t = 1.423, $p > 0.05$.

Collembolans sample taken after a rainy period (16.06.2013) is significantly higher than the sample taken after drought (11.05.2013) in meadow t = 2.196, $p < 0.05$

CONCLUSION

Due to the drought of early 2012 many Japanese knotweed plants were dried but nevertheless green plants covered the ground completely standing out the C area plants are significantly more robust than the other two areas.

Edaphic fauna is influenced by climatic condition. Number of grassland collembolans increased significantly after a rainy period, while the number of mites is significantly lower than grassland areas covered by Japanese knotweed after a period of drought.

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