Biodiv. Res. Conserv. 1-2: 123-130, 2006

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Changes in plant species richness in some riparian plant communities as a result of their colonisation by taxa of *Reynoutria* (*Fallopia*)

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Abstract: This study deals with the current issue of the synanthropisation of plant cover which manifests itself, amongst other ways, in the spreading of species outside the limits of their natural distribution range. The aim of the studies undertaken for the present report was to estimate the type and scale of threat posed by alien plant species to native plant diversity. The studies were carried out using the example of *Reynoutria* (*Fallopia*) species (knotweeds), which are considered to be invasive in our country as well as in other regions of the world. This is an attempt to determine the impact of these plants on the composition and diversity of the natural components of the herb layer in floodplain forest. Investigations were performed on permanent study plots localised in patches of floodplain forest which have been preserved in the valleys of the Soła, Biała and Jasienica rivers. The results of the field studies have confirmed the hypothesis that *Reynoutria* species exert a negative influence on the native components of the floodplain forest herb layer. This impact is, however, different with regard to the various life forms and ecological habitat groups of the plants. The increase of surface coverd by knotweeds does not significantly influence the development of early spring geophytes which are able to complete their full life cycle.

Key words: invasive species, *Reynoutria*, *Fallopia*, riverside floodplain forests, ecological impact

1. Introduction

The aim of the investigation was to estimate the type and scope of threat posed by alien plant species to the native biological diversity, especially in view of the fact that these problems have hitherto been rarely addressed in Poland. The studies were carried out on the example of *Reynoutria* (*Fallopia*) species (knotweed) which are considered to be invasive plants in Poland (Fojcik & Tokarska-Guzik 2000; Tokarska-Guzik 2002, 2005; Tokarska-Guzik & Dajdok 2004) as well as in other regions of Europe and the world (e.g. Pyšek & Prach 1993; Brock *et al*. 1995; Sukopp & Starfinger 1995; Bailey *et al*. 1995; Bailey 1999).

Taxa from the genus *Reynoutria* are conspicuous rhizomatous perennials of large dimensions, spreading mainly through vegetative processes, which were introduced to Europe from Asia at the beginning of the 19th century as ornamental plants with numerous useful characteristics (Bailey & Conolly 2000). From sites of cultivation, these plants have spread both to ruderal habitats and to sites of natural character (river valleys, scrub margins and broadleaf forests). In Poland, as in other parts of Central Europe, two species occur at present: *Reynoutria* (*Fallopia*) *japonica* Houtt. [*Polygonum cuspidatum*; Japanese Knotweed], *Reynoutria* (*Fallopia*) *sachalinensis* (F. Schmidt) Nakai [*Polygonum sachalinense*; Giant Knotweed], as well as the hybrid between these two species described in the 1980s: *R.* ×*bohemica* Chrtek & Chrtková. *Reynoutria japonica* is fairly widespread over the whole national territory, especially in its southern part, while *R. sachalinensis* is scattered across the whole of Poland, locally rarer (Tokarska-Guzik 2001; Zając & Zając 2001). The exact distribution of the hybrid remains to be investigated in detail (Fojcik & Tokarska-Guzik 2000).

The present study is an attempt to determine the impact these plants have on the composition and diversity of natural components of the floodplain forest herb layer.

2. Material and methods

Field studies were carried out during the growing seasons of 2002-2004 in estuary segments of the Soła and Biała river valleys as well as in the middle section of the Jasienica river valley (Fig. 1).

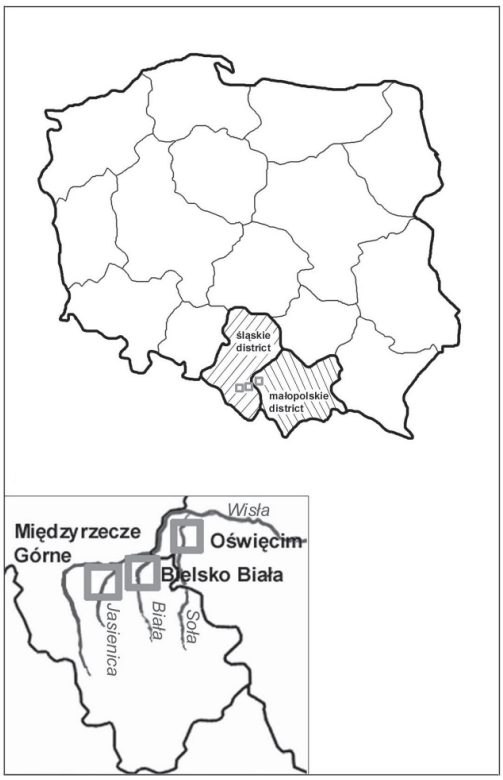

Fig. 1. Location of investigation plots

Investigations were performed on permanent study plots (20 m x 20 m) localised in patches of floodplain forest. The plots were selected to describe varying degree of surface coverage by knotweeds. The total number of plots investigated was 36 and in each of them 2 phytosociological relevès were taken in different growth seasons: one in spring and one in late summer. Additionally, within three study plots, measurements of longitudinal *Reynoutria* shoot growth rate were performed on 30 shoots selected at random. The studies were supplemented by a detailed inventory of the vascular flora occurring in the investigated sections of the river valleys.

3. Results and discussion

A total number of 451 vascular plant species were found to occur in the study area: 420 species in the section of the Soła river valley, 211 in the Biała river valley and 160 in the Jasienica stream valley. The vascular flora of the river valleys investigated is characterised by the highest proportion of hemicryptophytes which account for 50% species on the Soła, 51% on the Jasienica and 54.5% on the Biała, respectively. Geophytes and therophytes typically have also a relatively large share in the flora. Their high number is due to the special characteristics of riverside habitats. A higher proportion of therophytes relative to geophytes in the Biała and Jasienica river valleys is linked to the progressive habitat transformation. Native species dominate in the flora of the river valleys investigated, constituting 85% of the Jasienica, 79% of the Soła and 76% of the Biała, respectively. A characteristic feature of the flora and vegetation is the participation of taxa from the genus *Reynoutria*, which in the case of the Biała river have invaded the river banks on a massive scale. Ecological habitat groups are the indicator which varies most between the river valley segments analysed. On the Soła, species from fertile deciduous forests (*Querco-Fagetea*) and scrub communities, riverside forests and thickets (*Salicetea purpureae*) as well as meadow communities (*Molinio-Arrhenatheretea*) are dominant. On the Biała and Jasienica, ruderal and therophytic communities occur more frequently.

The composition and diversity of species in the herb layer of the floodplain forests selected for the study was dependent on the extent to which the investigated plot was covered by knotweed shoots. The largest number of vascular plant species was recorded from plots without any knotweeds (max. 28). In plots with increasing coverage of the invasive species (up to 40% and 41%-70%), a gradual reduction of the number of other species was noted. Sudden and extensive decreases in the number of herb layer species (minimum 3 species) and their coverage coefficients was seen in plots with a high proportion of knotweed (71%-100%) (Fig. 2; compare also Table 1 and 2). The number of species recorded on the study plots was different depending on the season of the vegetative period (in spring, this number was lower than in summer). In early spring, spring geophytes were recorded on the study plots (e.g. *Ficaria verna, Symphytum tuberosum, Anemone nemorosa, Dentaria glandulosa, Primula elatior*). Their development is not

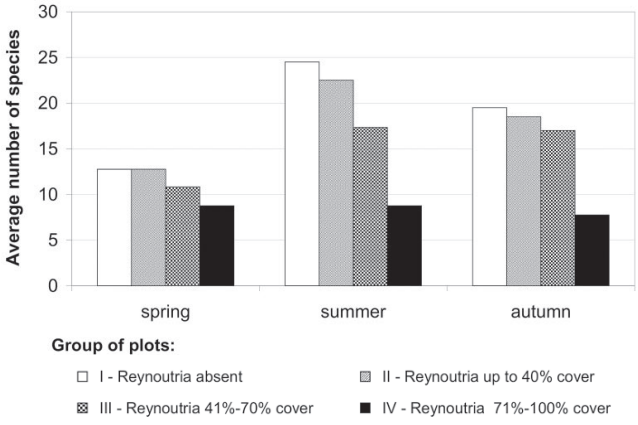

Fig. 2. Species richness in plots grouped by % cover of *Reynoutria* during different seasons of growth

Table 1. Changes in riparian plant communities herb layer composition and cover as a result of colonization by taxa of *Reynoutria* – spring aspect

No. of the relevès	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	Constancy
Date: 2004. April Day	13	13	19	19	14	16	16	16	13	13	13	13	13	16	16	16	13	13	14	19	16	16	16	19	19	16	16	16	
No. of plot	5S	6S	9S	10S	12S	1J	2J	3J	3S	4S	7S	8S	9S	4J	5J	6J	1/S	2/S	13/S	3B	7J	8J	9J	1B	2B	10J	11J	12J	
Cover of herb layer c in %	60	60	60	70	60	60	60	60	60	60	60	60	60	60	60	60	40	60	40	70	60	40	40	30	40	30	40	30	
Number of species in relevè	10	9	14	17	10	15	12	14	11	10	12	11	12	15	13	16	13	11	11	10	13	11	10	8	13	8	11	6	
Cover of *Reynoutria* in %	*Reynoutria* absent - Group I								up to 40% - Group II								41 to 70% - Group III							71 to 100% - Group IV					
Reynoutria japonica	.	.	.	.	.	.	.	.	r	.	r	.	+	.	.	.	.	.	r	2.2	.	.	.	+.2	2.2	.	.	.	II
Reynoutria xbohemica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.2	.	.	r	.	I
Reynoutria sachalinensis	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	r	.	r	.	.	+	+	r	II
Salicetea purpureae																													
Rubus caesius	.	.	+.2	+	+.2	+	+	+.2	.	r	.	+	1.2	1.2	+	+	r	r	r	r	r	r	r	+	+	+	+	.	V
Phragmitetea																													
Phalaris arundinacea	3.3	3.3	2.3	3.4	2.3	+.2	+	+.2	+	2.2	2.2	+	2.3	+	.	+	+	1.2	r	r	+	.	.	.	.	.	.	.	IV
Carex gracilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.3	.	.	.	.	.	.	.	.	.	.	I
Alno-Ulmion																													
Ficaria verna	2.3	2.3	1.2	+.2	2.3	1.2	+.2	2.3	+.2	2.2	+.2	+	+.2	+.2	+.2	+	r	2.3	+.2	5.5	2.3	+.2	1.2	+.2	+	+.2	+.2	+	V
Urtica dioica	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	+.2	1.2	+.2	+	+.2	+.2	+.2	+.2	1.2	+	+.2	+.2	+.2	+.2	+.2	+.2	+.2	+.2	1.2	+.2	V
Petasites hybridus	2.2	3.3	+.2	+	1.2	2.2	3.3	3.3	2.2	2.2	.	2.2	2.3	2.2	2.3	+.2	1.2	2.2	1.2	r	1.2	r	r	.	r	.	.	.	V
Galium aparine	+.2	.	+.2	+.2	+.2	+.2	+.2	+.2	+.2	+.2	.	1.2	+.2	+.2	+.2	+.2	1.2	.	+.2	.	+.2	r	.	+	.	+	+	.	IV
Lamium maculatum	+.2	+.2	+.2	+.2	+	+.2	+.2	+	+	+.2	.	1.2	.	+.2	.	1.2	1.2	1.2	+.2	r	+	.	+.2	.	.	.	.	.	IV
Glechoma hederacea	.	.	.	.	.	+	.	.	.	.	.	.	.	+.2	+	+	.	.	.	.	.	.	.	.	.	.	.	.	I
Gagea lutea	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	I
Chaerophyllum hirsutum	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Matteucia struthiopteris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	I
Padus avium	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Querco-Fagetea																													
Aegopodium podagraria	1.2	2.2	2.3	+.2	+	2.3	1.2	1.2	2.3	2.3	+	3.3	1.2	2.3	1.3	2.3	2.3	3.3	+.2	1.2	3.3	1.2	1.2	+.2	+.2	+.2	+.2	+.2	V
Symphytum tuberosum	r	+.2	+.2	r	+.2	+	+	+	+.2	1.2	r	+	.	1.2	+	+	1.2	+.2	+.2	+	+	+	+	1.2	+.2	1.2	+.2	1.2	V
Anemone nemorosa	.	.	.	.	.	+	+	1.2	.	.	.	.	.	.	+	+.2	.	.	.	.	+	+	r	.	.	.	r	.	II
Alliaria petiolata	.	.	+.2	+.2	.	.	.	.	r	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Primula elatior	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	+	.	+	.	.	.	.	+	I
Dentaria glandulosa	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Molinio-Arrhenatheretea																													
Anthriscus sylvestris	.	.	r	.	.	+.2	.	+.2	.	.	r	.	.	.	+.2	+	+	.	.	.	.	.	+	.	.	.	.	.	.	II
Caltha palustris	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	+	.	I
Poa trivialis	1.2	.	.	.	.	.	.	.	+.2	+.2	1.2	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	I
Symphytum officinale	.	.	.	.	.	.	.	.	.	.	r	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Artemisietea vulgaris																													
Rumex obtustifolius	+.2	r	.	r	.	+	.	+	.	.	r	.	.	.	+	.	.	r	.	.	.	.	.	.	r	.	.	.	II
Tussilago farfara	.	.	.	.	.	.	+	+.2	.	.	.	.	.	+	+.2	+	.	.	.	.	+	+	.	.	.	.	+	+	.	II
Impatiens glandulifera	.	.	1.2	1.2	.	.	.	.	.	.	.	.	1.2	.	.	.	+	.	+.2	.	.	.	.	.	+	.	.	.	II
Poa annua	.	.	+.2	+.2	.	+.2	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Cirsium arvense	.	r	.	.	r	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Tanacetum vulgare	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	I

Sporadic species: *Querco-Fagetea – Athyrium filix-femina* 20r; *Stachys sylvatica* 25(+); *Molinio-Arrhenatheretea – Filipendula ulmaria* 4r; *Heracleum sphondylium* 4r; *Sanguisorba officinalis* 4(+); *Taraxacum officinale* 25r; *Veronica chamaedrys* 25(+); *Artemisietea vulgaris – Cirsium vulgare* 4r; *Solidago canadensis* 25(+.2); *Solidago gigantea* 11(1.2)

significantly influenced by the growth of knotweed shoots during this period (Fig. 3). These species have enough time to go through their full life cycle. In the case of this group of plants, a decrease in the coverage coefficient can only be seen in plots with a massive occurrence of knotweeds (Table 1). In the summer season, *Aegopodium podagraria* and *Petasites hybridus*. Characteristic and differentiating species for the class *Salicetea purpureae* had their most abundant occurrence in plots without any knotweed and with small and medium coverage by knotweed plants (Fig. 4). Lack of light and saturation of the soil with rhizomes on plots

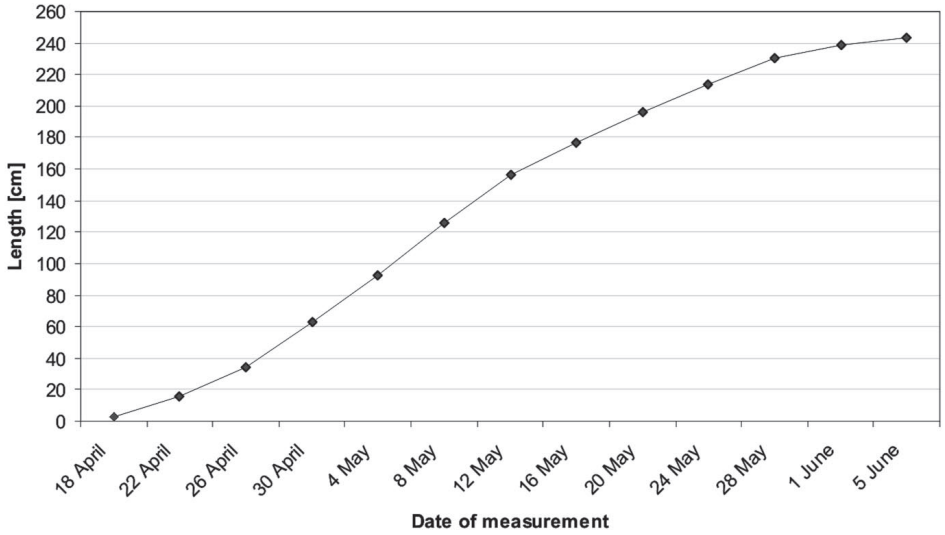

Fig. 3. The average rate of longitudinal growth of *Reynoutria* shoots measured on a sample of 30 shoots selected randomly

the rapid growth of shoots and especially the development of knotweed leaves leads to a conspicuous reduction in the vegetation of those species for which the peak of the life cycle falls in the summer period. The development of knotweed plants begins, depending on seasonal condition variations, in mid-April with the appearance of shoot tips which develop from subterraneous rhizomes. In the period between end of April and mid-May, rapid (very sudden) longitudinal growth of the shoots occurs (initially between 6 and 12 centimetres per 4 days; subsequently even as much as 40 cm per 4 days; Fig. 3) with simultaneous development of leaves. In the later period within the growth season, the rate of longitudinal shoot growth is significantly slower (during the first half of June, the shoots reach their maximal height); lateral shoots develop during this time.

On the study plots, the proportion of the most frequently recorded species has been compared with regard to the coefficient of coverage by *Reynoutria* shoots. The following species were included: *Ficaria verna*, *Symphytum tuberosum*, *Urtica dioica*, *Rubus caesius*, *Phalaris arundinacea*, *Calystegia sepium*,

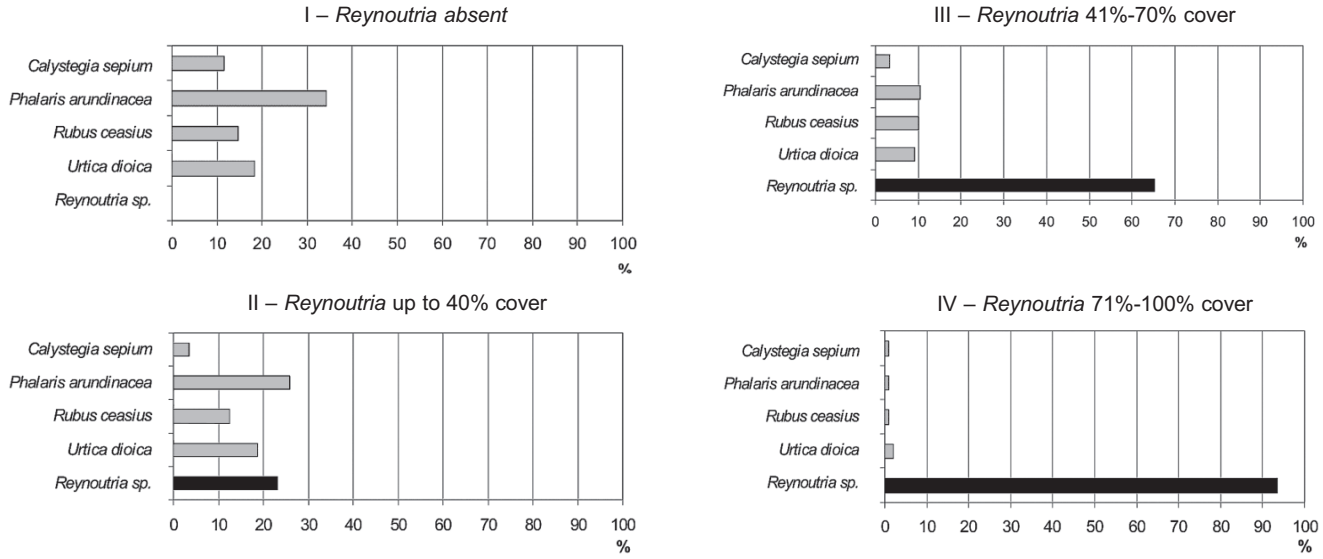

Fig. 4. Cover of species characteristic of the *Salicetea purpurea* community relative to cover of *Reynoutria*

from group IV (70-100% of *Reynoutria*) has effectively eliminated most characteristic species for this class. The only exceptions were *Urtica dioica* (a rhizome perennial) and *Calystegia sepium* (a creeper).

In the study plots without any knotweed or with low cover by knotweed plants, the presence of the characteristic species for most of the ecological habitat groups was confirmed. In these plots, a high proportion of species from thicket, scrub and forest facies was found. Their number drops conspicuously with an increase in the share of knotweed plants (group III plots). A high share of *Reynoutria* (70-100%) in group IV plots led to a reduction in most ecological habitat groups.

The gradual elimination of herb layer species is mainly caused by the expansion of knotweeds in the habitat investigated. Their sudden growth at the very beginning of the vegetative season with a simultaneous development of large leaves (their size in *R. sachalinensis* is 15-43 cm long and 10-27 cm broad; after Fojcik & Tokarska-Guzik 2000) causes strong shading of the soil and elimination of other species. Lack of light availability near the surface of the ground is additionally aggravated by the characteristics zigzag pattern of the leaf arrangement along the knotweed stem. Furthermore, knotweed rhizomes thrive in the soil to an extent which prevents many other species from taking root, germinating and going through the entire life cycle.

The similar results were published by Sukopp & Sukopp (1988), Schepker (1998) and Schlüpmann (2000), stated that one of the most serious problems is that *Reynoutria* modifies or expels the autochthonous vegetation by shadowing. Investigations conducted by Alberternst (1998) show that the number of plant species in vegetation transects with *Fallopia* were lower than in transects without the species.

The biological properties of representatives of genus *Reynoutria* cause these plants to have a definite reduction impact on the native components of plant communities (Tokarska-Guzik & Dajdok 2004; Tokarska-Guzik 2005). The enormous potential of these species for spreading by vegetative means, combined with their rapid growth and a capacity to adapt to diverse or even extreme habitat conditions, often invading and holding large areas, have resulted in this species earning the status of invasive plant and nuisance 'weed' (Tokarska-Guzik 2005).

The characteristics influencing the rate and success of alien plant invasions listed by Faliński (2004) include high fertility and reproductive potential of each individual, persistence of seeds (propagules); seeds equipped with devices which allow rapid long-distance transport; accelerated growth at the juvenile stage, early maturation to reproduction; resistance to extreme environmental conditions; dioecy, polygamy, self-pollination; ability to compete with other species (due to height, production of allelopathic substances etc.); phenotypical variability, ability to form mutants, polyploids, hybrids with related species. Taxa from the genus *Reynoutria* have many of the above-mentioned features. Above all, they belong to the group of plants with the most efficient mode of vegetative reproduction by rhizome segmentation (Alberternst *et al.* 1995; Child 1999; Fojcik & Tokarska-Guzik 2000). Potentially, a rhizome fragment which is only 1 cm in length and 0.7 g in weight may generate a new plant (Brock *et al.* 1995). Any transformations of the environment caused by natural factors (e.g. floods) as well as in particular by anthropogenic factors (earthworks, river regulation) favour the spreading of rhizomes (Pyšek & Prach 1993). Regulation of the Biała river and Jasienica stream as well as earthworks conducted in the Soła river valley have contributed to a major extent to the colonisation of large areas within the study zone by *Reynoutria* species. The growth rate of knotweed plants is especially high at the beginning of the vegetative season: 43.1 mm/day (Child 1999); 80 mm/day (Seiger 1997). Furthermore the soil which is thickly occupied by knotweed shoots (down to 7 m in depth) does not allow the germination of many species. According to the classification of life strategies (Grime 1979) knotweeds represent a C-type strategy, which decisively increases their invasive potential (Pyšek & Prach 1993). The following species are able to compete successfully with knotweeds even if the plants are present at high coverage coefficient: *Aegopodium podagraria*, *Urtica dioica* (rhizome perennials with similar mode of growth), balsams: *Impatiens parviflora* and *I. glandulifera* (alien annuals with an R-type life strategy and shallow root systems) as well as *Calystegia sepium* (a creeper).

4. Conclusions

The results of field studies have confirmed the hypothesis that representatives of genus *Reynoutria* exert a reducing influence on the native components of floodplain forest herb layer. This impact is, however, different with regard to various life forms and ecological habitat groups of plants. Increase of surface coverage by knotweeds does not significantly influence the development of early spring geophytes which are able to go through their entire life cycle. In the case of this group of plants, a decrease in coverage coefficient can only be seen in plots with massive occurrence of knotweeds.

Table 2. Changes in riparian plant communities herb layer composition and cover as a result of colonization by taxa of *Reynoutria* – late summer aspect

Number of the relevè		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	Constancy
Day		11	11	8	8	8	12	12	12	11	11	11	11	8	12	12	12	11	11	8	17	17	20	20	20	17	17	17	17	17	20	20	20	
Month		09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	
Year		03	03	03	03	03	04	04	04	03	03	03	03	03	04	04	04	03	03	03	03	03	04	04	04	03	03	03	03	03	04	04	04	
Locality and number of plot		5S	6S	9S	10S	12S	1J	2J	3J	3S	4S	7S	8S	9S	4J	5J	6J	1S	2S	13S	3B	7B	7J	8J	9J	1B	2B	4B	5B	6B	10J	11J	12J	
Cover of tree layer a1 in %		70	50	70	60	50	60	70	50	10	60	10	60	70	70	40	60	70	50	20	10	-	50	30	30	30	-	5	-	-	-	5	-	
Cover of tree layer a2 in %		-	-	-	-	-	-	-	-	30	-	40	5	-	-	-	-	-	-	20	30	-	-	-	-	10	5	5	-	-	-	-	-	
Cover of shrub layer b in %		5	5	20	5	5	5	20	5	50	30	10	30	10	10	50	30	30	5	20	10	-	5	20	10	10	5	5				5	5	
Cover of herb layer c1 in %		100	90	80	90	90	90	80	80	90	70	90	30	60	60	90	70	80	90	100	100	100	90	100	100	100	100	100	100	100	100	100	100	
Cover of herb layer c2 in %		-	-	-	-	-	-	-	-	80	80	90	80	90	90	80	80	90	100	90	30	40	100	90	30	10	10	-	-	-	-	-	-	
Cover of moss layer d in %		-	10	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Number of species in the relevè		20	15	15	19	22	21	18	20	15	18	20	18	16	17	20	18	22	16	13	14	20	18	17	14	9	8	11	5	3	7	11	6	
Cover of *Reynoutria* in %		*Reynoutria* absent - Group I								up to 40% - Group II								41 to 70% - Group III								71 to 100% - Group IV								
Reynoutria japonica		.	.	.	.	.	.	.	.	3.5	3.4	3.5	2.2	2.3	.	.	.	3.5	4.5	5.5	5.5	5.5	.	.	.	5.5	5.5	5.5	5.5	5.5	.	.	.	III
Reynoutria xbohemica	c_1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.4	.	2.3	2.3	2.4	2.3	2.3	.	I
Reynoutria sachalinensis	c_1	.	.	.	.	.	.	.	.	.	.	.	.	.	2.3	3.5	3.4	.	.	.	.	.	4.5	4.5	4.5	.	.	.	.	.	5.5	5.5	5.5	II
Salicetea purpureae																																		
Salix fragilis	a_1	4.4	2.2	4.4	3.3	3.3	2.2	3.3	2.2	.	3.3	.	3.3	3.3	2.2	.	2.2	3.3	3.3	.	+	.	2.2	.	+	2.2	.	.	.	.	.	.	.	IV
Salix fragilis	a_2	.	.	.	.	.	.	.	.	3.3	.	3.3	.	.	.	2.2	.	.	.	1.1	2.2	.	.	1.1	1.1	.	.	.	.	.	.	.	.	
Salix fragilis	b	.	+	1.2	+	2.2	.	1.2	+	3.3	2.2	.	1.1	.	.	2.2	1.1	1.1	1.1	.	.	.	1.1	.	.	.	.	.	.	.	.	.	.	
Salix alba	a_1	.	.	2.2	2.2	1.1	2.2	2.2	1.1	.	.	.	1.1	2.2	2.2	+	+	2.2	2.2	.	.	.	1.1	.	.	.	.	.	.	.	.	.	.	III
Salix alba	a_2	.	.	.	.	.	.	.	.	.	.	3.3	1.1	.	.	.	.	.	.	1.1	.	.	.	.	.	.	.	.	.	.	.	.	.	
Salix alba	b	.	.	.	.	+	.	.	+	.	.	.	.	+	+	.	.	1.1	.	.	.	.	.	1.1	.	.	.	+	.	.	.	+	.	
Salix alba	c	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Populus nigra	a_1	+	2.2	.	.	2.2	.	.	.	2.2	1.1	+	2.2	.	.	.	.	2.2	.	2.2	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Populus alba	a_1	+	2.2	.	.	2.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Salix purpurea	b	.	.	.	.	+	.	.	.	2.2	.	1.1	2.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Salix viminalis	b	.	.	.	.	.	.	.	.	.	.	2.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Rubus caesius		+	.	2.3	2.2	3.3	2.2	1.2	3.3	1.2	r	+	2.2	2.3	2.3	1.2	r	2.2	1.2	.	r	.	1.2	.	r	r	.	.	.	.	.	.	.	IV
Calystegia sepium		+.2	1.2	1.2	r	1.2	r	+	1.2	+.2	+.2	+.2	1.2	1.2	1.2	+.2	+.2	r	1.2	+.2	+	.	1.2	+.2	+	.	.	+	.	.	+	+	.	III
Phragmitetea																																		
Phalaris arundinacea		3.3	3.3	2.3	3.4	3.3	3.3	1.2	2.2	1.2	2.2	4.4	2.2	3.3	2.2	1.2	1.2	2.2	3.3	+	.	+.2	1.2	+	+	r	.	+	.	.	.	r	.	III
Phragmites australis		.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Carex gracilis		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Alno-Ulmion																																		
Alnus glutinosa	a_1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	II
Alnus glutinosa	a_2	.	.	.	.	+	+	+	1.1	.	.	.	.	1.1	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	
Alnus glutinosa	b	.	.	.	.	.	.	.	.	.	.	.	.	1.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Alnus incana	a_2	.	.	.	.	.	.	.	.	.	.	.	.	2.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Padus avium	b	+	.	.	.	.	r	.	.	2.2	.	.	1.1	.	.	2.2	.	2.2	.	1.2	.	.	.	1.2	.	.	.	.	.	.	.	.	.	.	II
Urtica dioica		3.3	2.2	3.3	2.2	1.2	2.2	3.3	1.2	3.2	3.3	1.2	3.3	2.2	2.2	3.2	3.3	2.2	3.3	2.2	+.2	+.2	3.3	2.2	+.2	1.2	+	+.2	r	.	r	+.2	r	V
Petasites hybridus		2.3	3.3	1.2	+	2.3	+	1.2	2.3	2.2	2.2	.	2.2	2.2	2.2	2.2	2.2	2.3	3.3	1.2	r	.	1.2	1.2	r	.	.	.	.	.	.	.	.	IV

Lamium maculatum		.	r	r	r	.	r	r	r	r	r	.	.	.	.	r	r	+.2	.	r	r	.	.	r	r	.	r	r	.	.	.	r	III
Humulus lupulus		1.2	.	.	.	.	r	.	.	1.2	1.2	r	r	.	.	+	1.2	.	.	.	1.2	.	.	.	.	.	+	.	+.2	+.2	.	.	.	II
Myosoton aquaticum		r	r	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	I
Circaea lutetiana		.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	r	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	I
Matteucia struthiopteris		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Querco-Fagetea																																	
Quercus robur	a_1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.1	.	.	.	+	.	.	.	.	.	.	.	I
Quercus robur	b	.	.	.	.	.	.	.	.	.	.	.	1.1	.	.	.	.	2.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Fraxinus excelsior	a_1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
Sambucus nigra	b	.	.	.	+	.	.	.	+	2.2	1.2	.	+	2.2	2.2	2.2	1.2	.	.	1.2	+	.	.	1.2	+	+	1.1	.	.	.	.	1.1	III
Sambucus nigra	c	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	
Cornus sanguinea	b	+	.	.	.	.	+	.	.	.	1.2	.	1.1	.	.	1.1	1.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Euonymus europaea	b	+	+	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Aegopodium podagraria		1.2	1.2	1.2	+	1.2	+	1.2	1.2	3.3	2.3	r	2.2	2.2	2.2	3.3	2.3	3.3	2.3	+.2	+	.	2.3	+.2	+	+	+.2	1.2	r	.	r	r	+.2	V
Athyrium filix-femina		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	r	.	.	.	.	.	.	I
Molinio-Arrhenatheretea																																	
Poa trivialis		+.2	.	r	r	1.2	r	r	1.2	.	+.2	1.2	.	+.2	+.2	.	.	r	1.2	.	.	.	1.2	.	.	.	.	.	.	.	.	.	III
Vicia cracca		.	.	.	.	+.2	.	+.2	.	.	.	+.2	.	r	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Symphytum officinale		1.2	1.2	.	.	.	.	.	.	r	.	r	.	.	.	.	.	.	1.2	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Anthriscus sylvestris		.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	r	r	.	.	.	.	.	.	.	.	I
Filipendula ulmaria		.	.	.	r	+.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Myosotis palustris		.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Artemisietea vulgaris																																	
Impatiens glandulifera		r	r	2.3	3.4	1.2	2.2	+.2	+.2	.	+.2	.	r	2.3	+.2	+	+	+	+	2.3	.	.	+	+	+	.	.	.	.	.	.	.	IV
Impatiens parviflora		.	.	.	.	.	2.2	1.2	1.2	.	.	.	.	.	1.2	+	+.2	.	.	.	.	.	+	+.2	+	.	r	.	.	.	r	r	r	III
Artemisia vulgaris		r	r	.	.	r	.	.	r	.	r	.	.	.	.	.	.	r	+.2	.	.	+.2	+.2	.	.	.	.	.	.	.	.	r	.	II
Cirsium arvense		+.2	.	.	.	+	.	.	+	.	.	1.2	.	.	.	.	.	.	.	.	r	.	r	.	r	.	.	.	.	.	.	.	.	II
Rumex obtustifolius		+.2	.	.	.	.	.	.	r	.	r	.	.	.	.	.	.	.	+	.	.	r	+	.	.	.	.	.	.	.	.	.	I
Solidago canadensis		.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	r	.	.	.	.	+	.	.	+	.	.	I
Aster novi-belgii		.	.	.	+.2	r	.	.	.	.	.	1.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Tanacetum vulgare		.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Melandrium album		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	I
Rudbeckia laciniata		.	r	.	.	.	.	.	.	.	+.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Accompying species																																	
Galeopsis speciosa		.	.	r	.	r	+	r	r	.	.	r	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Poa annua		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	r	r	r	.	.	.	.	.	.	.	.	I
Polygonum hydropiper		.	.	2.3	+.2	.	+.2	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Oxalis fontana		.	.	.	r	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	I
Capsella bursa-pastoris		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	r	.	.	.	.	.	.	.	.	I
Conyza canadensis		.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	I
Echinochloa crus-galli		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+.2	.	.	.	.	.	.	.	+.2	.	.	I
Galinsoga ciliata		.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	I
Plantago major		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	r	.	.	.	.	.	.	.	.	I

Sporadic species: *Querco-Fagetea – Equisetum sylvaticum* 3r; *Tilia platyphyllos* a_1 20(+); *Molinio-Arrhenatheretea – Equisetum palustre* 4r; *Daucus carota* 4r; *Lysimachia vulgaris* 5(+.2); *Lythrum salicaria* 11(+); *Artemisietea vulgaris – Echinocystis lobata* 5r; *Solidago gigantea* 11(+.2); *Fallopia dumetorum* 17(+.2); Accompying species – *Robinia pseudacacia* 16r; *Polygonum persicaria* 21(+.2); *Chenopodium album* 21(+.2); *Chenopodium polyspermum* 21(+.2); *Lycopersicon esculentum* 21(+.2); *Sonchus arvensis* 21r; *Cerastium arvense* 21r

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