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The most recent alien species of the ruderal flora in the abandoned villages of the Kampinos National Park (Central Poland)

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Abstract: Field research on the ruderal flora of 15 abandoned villages in the Kampinos National Park revealed that among ca. 550 vascular plant species identified 11% represent the newest flora settlers – the epoecophytes. The number of epoecophytes in particular villages varied from 16 to 31. Only 5 species were present in all the villages: *Amaranthus retroflexus, Conyza canadensis, Galinsoga parviflora, Robinia pseudoacacia,* and *Syringa vulgaris.* Distribution of epoecophytes in particular villages was generally low. Only *Conyza canadensis*, *Robinia pseudoacacia* and *Syringa vulgaris* were common. The observed phenomenon results from the ongoing intensive depopulation process in the majority of the villages followed by decreased anthropopressure. The desynanthropization of the flora seems to have little impact on penetration by invasive species such as *Echinocystis lobata* and *Impatiens glandulifera.*

Among the rare and endangered species of synanthropic flora of the Kampinos National Park two epoecophytes were found: *Anthemis ruthenica* and *Camelina microcarpa*.

Keywords: epoecophytes, Kampinos National Park, Poland, ruderal flora, villages

Introduction

Epoecophytes is a group of plants distinguished in the flora of Poland in the geographical and historical classification by KORNAŚ (1981). Plants from this

group are closely associated with human activity and are therefore considered to be synanthropic. Among alien species (anthropophytes) that arrived in Poland after the 15th century, epoecophytes are characterised by permanent settlement in synanthropic habitats, and frequently by great expansiveness (SUDNIK-WÓJCIKOWSKA, KOŹNIEWSKA 1988). For this reason many of them have been classified as invasive species in Poland (INSTITUTE OF NATURE CONSERVATION PAS 2009). Epoecophytes, although they form a group of the most recent alien species, have become a permanent element of vegetation and landscape in almost all the sites which they reached.

The Kampinos National Park, like other regions in Poland, not only those under protection, is not free from alien species (BOMANOWSKA 2006, 2009, FERCHMIN 1979, KIRPLUK 1996, 1998, 2003). The encroachment and spreading of epoecophytes in Kampinos Forest was facilitated by the early development of settlement, then forest management (deliberate introduction of certain alien species, particularly trees and shrubs), and currently tourism and the development of residential areas on the periphery of the national park. The buyout of buildings and agricultural land has been carried out in Kampinos National Park since the middle of 1970s. Villages have become depopulated, and habitats where only recently human everyday pressure ceased are now transformed. Regardless of these facts, the problem of invasive species in this area remains unresolved. It has been assumed that the acquisition of land in KNP through buyout will allow for more effective implementation of nature conservation aims in the park and naturalization of the environment. The restoration of typical forest habitats is expected as a result of this process. The elimination of dispersed settlement will reduce the number of public roads, thus limiting access to natural highly valuable areas in order to enable their protection. In addition, it will eliminate the negative effects of construction and settlement on the natural environment (KAMPINOSKI PARK NARODOWY. The Official WebSite).

The aim of our study was to analyze the adaptation of epoecophytes to the conditions of renaturalized flora in depopulated villages. The analysis covered the list of epoecophyte species, their population size, frequency, and the effect of reduced anthropogenic pressure and increasing isolation of villages in the Kampinos region on epoecophytes.

Material and methods

Floristic studies were carried out in 1992–1995 and 2004–2007, in ruderal habitats in 15 selected villages of Kampinos National Park. Villages where the depopulation process was advanced were chosen for the study. Most villages are located in the centre of the national park. They are surrounded by extensive forests and meadows, and access to them is difficult. Villages are located a long distance from major transport networks and roads, and are rarely visited by tourists (MARKOWSKI 2009a). In recent years, after ongoing land buyouts, the number of people in the villages was reduced, or villages became completely abandoned. In the depopulated areas the management of the national park

carries out intensive activities that involve the demolition of buildings, land ploughing and afforestation (MARKOWSKI 2009b).

Karolinów, Ławy and Nowe Budy are completely depopulated villages today. One homestead has remained in each of the villages of Bieliny and Grabina, and a few remained in Cisowe and Granica. A slightly higher number of homesteads still remain in Rybitwa and Zamość. No significant changes were observed in Nowa Dąbrowa, Janówek and Koszówka, while in Józefów, Kiścinne and Buda single new buildings next to the old ones have been constructed (KIRPLUK 2009).

The study was carried out in all ruderal habitats, including roadsides, land near houses and fences, yards of abandoned homesteads or sites after the demolition of buildings, ruins, heaps of rubble, rubbish heaps and strips of farming lands adjoining them.

Floristic analysis included floristical surveys for each village, considering the frequency of species, etc. The 'site' was defined as the occurrence of species in the village, regardless of the size of the studied area. Epoecophytes were identified based on studies by Sudnik-Wójcikowska (1987), Rutkowski (1998) and own observations. *Tanacetum parthenium* (L.) Sch. Bip. was not classified as an epoecophyte because this species was clearly planted and did not spread outside the former home garden. However, it has the status of an "invasive species" in Poland (INSTITUTE OF NATURE CONSERVATION PAS 2009).

Four synanthropic species: *Hesperis matronalis, Impatiens gladulifera, Lupinus polyphyllus* and *Syringa vulgaris* were reclassified with respect to previous studies (KIRPLUK 1996, 1998) from ergasiophygophytes to epoecophytes. This decision was made based on changes observed in 2004–2007, when the species clearly spread and occurred in new localities, and also because they are considered invasive in Poland (INSTITUTE OF NATURE CONSERVATION PAS 2009).

Botanical nomenclature followed the "Flowering Plants and Pteridophytes of Poland. A Checklist" (MIREK et al. 2002).

The frequency of epoecophytes in the studied villages was established based on agreed scales:

a) constancy of epoecophytes in all villages:
   I = 1–3 sites – species very rare for ruderal flora,
   II = 4–6 sites – species rare for ruderal flora,
   III = 7–9 sites – species popular for ruderal flora,
   IV = 10–12 sites – species very popular for ruderal flora,
   V = 13–15 sites – species common for ruderal flora.
b) distribution of epoecophytes in individual villages (estimate):
   1 – species rare in a village; single specimens, covering less than 5% of the site area,
   2 – species popular in a village, covering 5-50% of the site area,
   3 – species common in a village, covering over 50% of the site area.

The participation of rare and endangered epoecophyte species in the flora of 15 selected villages was evaluated based on the list of "Rare, endangered and protected plant species of synanthropic flora of Kampinos National Park"

(KIRPLUK, BOMANOWSKA 2008). We also evaluated the participation of invasive epoecophyte species in the flora of abandoned villages in the Kampinos region. We used data from the internet platform "Alien species in Poland" (INSTITUTE OF NATURE CONSERVATION PAS 2009) and data from the Regulation of the Minister of the Environment of 9 September 2011 on the list of plants and animals of alien species which, when introduced to the natural environment, pose a threat to native biodiversity or natural habitats (Dz.U. of 2011 No. 210, item 1260).

Results and Discussion

The results presented below concern the presence of epoecophytes only in 15 selected villages of Kampinos Forest. This is associated with the limited number of penetrated habitats. As initially assumed only ruderal habitats were investigated, merely including the contact zone with segetal habitats. The results of the present study probably do not consider the total number of epoecophytes, which may be found in the entire area of the Kampinos National Park, particularly the numerous villages located there (ruderal habitats) as well as in abandoned fields.

The analysis of the ruderal habitats of the 15 depopulated villages of the Kampinos National Park revealed the presence of 62 epoecophytes (Tab. 1). This corresponds to about 11% of the total number of species (about 550) found in the villages of the Kampinos region. The number of epoecophytes in individual villages ranged from 16 to 31. Only 5 species were present in all the villages: *Amaranthus retroflexus, Conyza canadensis, Galinsoga parviflora, Robinia pseudoacacia* and *Syringa vulgaris*. In the majority of sites we found *Acer negundo, Acer pseudoplatanus, Aesculus hippocastanum, Cannabis sativa var. spontanea, Chamomilla suaveolens, Chenopodium strictum, Erigeron annuus, Galinsoga ciliata, Lupinus polyphyllus, Mentha rotundifolia, Oxalis fontana, Rosa rugosa, Rudbeckia laciniata, Solidago gigantea* and *Symphoricarpos albus.* Only one site per village was found for *Amaranthus chlorostachys, Anthemis ruthenica, Atriplex longipes, Atriplex oblongifolia, Atriplex prostrata, Bryonia alba, Camelina microcarpa, Lepidium virginicum, Lolium multiflorum, Oenothera albipercurva, Oenothera ammophila, Spiraea chamaedryfolia* and *Xanthium albinum.*

Considering the number of sites with epoecophytes in the flora of 15 villages of the Kampinos region, most of the species are very rare (I) (Fig. 1). The number of rare species found in the flora of all villages is considerably lower (II). Very popular (IV) and popular species (III) have the lowest share. Common species (V) were also found in a very low number.

Only three out of the above-listed species (*Conyza canadensis*, *Robinia pseudoacacia* and *Syringa vulgaris*) were found to be common and very popular in all the villages. *Galinsoga parviflora* was found less frequently (in 9 villages). The frequency of most species in the studied sites was low (Tab.1).

The participation of epoecophytes is correlated with the size of the human settlement (KORNAŚ 1977). The villages of the Kampinos region covered by this study are medium-sized and their populations continue to decrease. This also

Tab. 1. Degree of distribution of epoecophytes in 15 abandoned villages of Kampinos National Park.

village	Bieliny 1992-1995	Bieliny 2004-2007	Buda 1992-1995	Buda 2004-2007	Cisowe 1992-1995	Cisowe 2004-2007	Grabina 1992-1995	Grabina 2004-2007	Granica 1992-1995	Granica 2004-2007	Janówek 1992-1995	Janówek 2004-2007	Józefów 1992-1995	Józefów 2004-2007	Karolinów 1992-1995	Karolinów 2004-2007	Kiścinne 1992-1995	Kiścinne 2004-2007	Koszówka 1992-1995	Koszówka 2004-2007	Ławy 1992-1995	Ławy 2004-2007	Nowa Dąbrowa 1992-1995	Nowa Dąbrowa 2004-2007	Nowe Budy 1992-1995	Nowe Budy 2004-2007	Rybitew 1992-1995	Rybitew 2004-2007	Zamość 1992-1995	Zamość 2004-2007	N	IS (PL)
Species																																
Acer negundo L.			1	1	1				1		1		1		1		1		1		1				1						**10**	**Y**
Acer pseudoplatanus L.	1		1	1		**1**			1								1								1		3				**8**	
Acorus calamus L.							1																		1						**2**	**Y**
Aesculus hippocastanum L.			1	2	1		1		1		1		1		1		1		1		1		1		2		1		1		**14**	
Amaranthus chlorostachys Willd.	1																														**1**	
Amaranthus retroflexus L.	1		1	2	1		1		2		1		1		1		2		1		1		2		1		1		1		**15**	**Y**
Anthemis ruthenica M. Bieb.									1																						**1**	
Anthoxanthum aristatum Boiss.				2					1												1								1		**4**	**Y**
Atriplex longipes Drejer																							1								**1**	
Atriplex oblongifolia Waldst. & Kit.									1																						**1**	
Atriplex prostrata Boucher ex DC.																													1		**1**	
Bidens frondosa L.				1										**1**									1		1		1				**5**	**Y**
Bryonia alba L.	1																														**1**	**Y**
Camelina microcarpa Andrz.																					1										**1**	
Cannabis sativa L. var. *spontanea* Vavilov	1		1	1	1		1		2				1		1		1		1		1		1				1				**12**	
Chamomilla suaveolens (Pursh) Rydb.	2		2	1			1		1		1		1				1		2		1		2		1		1		1		**13**	**Y**
Chenopodium strictum Roth	1		1	1			1		1		2		1		1		1		1		1		1		1				1		**13**	
Conyza canadensis (L.) Cronquist	3		3	3	2		2		3		2		2		1		3		2		3		3		3		3		2		**15**	**Y**
Datura stramonium L.	1			1			1																1		1		1		1		**7**	**Y**
Echinocystis lobata (F. Michx.) Torr. & A.Gray											1			**1**					1				1					**1**	1		**6**	**Y**
Elsholtzia ciliata (Thunb.) Hyl.														**1**											1		1		1		**4**	**Y**
Erigeron annuus (L.) Pers.				**1**			1		1		1									**1**	1				2		1				**8**	

Tab.1. – cont.

village	Bieliny 1992-1995	Bieliny 2004-2007	Buda 1992-1995	Buda 2004-2007	Cisowe 1992-1995	Cisowe 2004-2007	Grabina 1992-1995	Grabina 2004-2007	Granica 1992-1995	Granica 2004-2007	Janówek 1992-1995	Janówek 2004-2007	Józefów 1992-1995	Józefów 2004-2007	Karolinów 1992-1995	Karolinów 2004-2007	Kiścinne 1992-1995	Kiścinne 2004-2007	Koszówka 1992-1995	Koszówka 2004-2007	Ławy 1992-1995	Ławy 2004-2007	Nowa Dąbrowa 1992-1995	Nowa Dąbrowa 2004-2007	Nowe Budy 1992-1995	Nowe Budy 2004-2007	Rybitew 1992-1995	Rybitew 2004-2007	Zamość 1992-1995	Zamość 2004-2007	N	IS (PL)
Galinsoga ciliata (Raf.) S.F.Blake	1	1			1		1		1		1		1					**1**	1		1		1		1		1			**12**	**Y**
Galinsoga parviflora Cav.	2	2		2	1		1		2		1		1		2		2		2		2		2		1		2		1	**15**	**Y**
Helianthus tuberosus L.	1	1					1																				1			**4**	**Y**
Hesperis matronalis L.			**1**				1								1						1									**4**	**Y**
Impatiens glandulifera Royle			**1**																								1			**2**	**Y**
Impatiens parviflora DC.					**1**								1							**1**										**3**	**Y**
Juncus tenuis Willd.		1							1							**1**				**1**							1			**5**	**Y**
Lepidium densiflorum Schrad.		1							1																				**1**	**3**	
Lepidium virginicum L.								1																						**1**	
Leymus arenarius (L.) Hochst.		1							1		1																			**3**	
Lolium multiflorum Lam.																							1							**1**	**Y**
Lupinus polyphyllus Lindl.	1	1		1					1		1		1		1						1				1		1			**9**	**Y**
Lycium barbatum L.		1		1				1									1													**4**	**Y**
Melilotus officinalis (L.) Pall.															1									**1**			1			**3**	
Mentha rotundifolia (L.) Huds.	1	1		1		1		1		1		1		1									1		1		1		1	**12**	
Oenothera albipercurva Renner ex Hudziok											1																			**1**	**Y**
Oenothera ammophila Focke																											1			**1**	**Y**
Oenothera biennis L.				1																	1						1			**3**	
Oenothera parviflora L.									1												1									**2**	
Oenothera rubricaulis Kleb.													1												1					**2**	
Oxalis fontana Bunge	1			1		1		1		1		1							1		1				1		1			**10**	
Parthenocissus inserta (A.Kern.) Fritsch				1					1						1						1				1					**5**	
Quercus rubra L.									1						1						1				1			2		**5**	**Y**

Tab.1. – cont.

village	Bieliny 1992-1995	Bieliny 2004-2007	Buda 1992-1995	Buda 2004-2007	Cisowe 1992-1995	Cisowe 2004-2007	Grabina 1992-1995	Grabina 2004-2007	Granica 1992-1995	Granica 2004-2007	Janówek 1992-1995	Janówek 2004-2007	Józefów 1992-1995	Józefów 2004-2007	Karolinów 1992-1995	Karolinów 2004-2007	Kiścinne 1992-1995	Kiścinne 2004-2007	Koszówka 1992-1995	Koszówka 2004-2007	Ławy 1992-1995	Ławy 2004-2007	Nowa Dąbrowa 1992-1995	Nowa Dąbrowa 2004-2007	Nowe Budy 1992-1995	Nowe Budy 2004-2007	Rybitew 1992-1995	Rybitew 2004-2007	Zamość 1992-1995	Zamość 2004-2007	N	IS (PL)
Reynoutria japonica Houtt.									1						1																**2**	**Y**
Rhus typhina L.			1																										1	1	**3**	**Y**
Robinia pseudoacacia L.	2		2		3		2		3		2		2		1		1		2		2		1		1		2		3		**15**	**Y**
Rosa rugosa Thunb.	1						1		1				1										1		1		1		1		**8**	**Y**
Rudbeckia laciniata L.	1		1		1		1		1		1						1		1		1		1		1		1		1		**13**	**Y**
Sambucus racemosa L.	1				1																				1						**3**	
Sarothamnus scoparius (L.) Wimm. ex W.D.J.Koch																	1		1							**1**					**3**	
Senecio vernalis Waldst. & Kit.	1										1																				**2**	**Y**
Sisymbrium loeselii L.				**1**					1		1		1				1														**5**	**Y**
Solidago canadensis L.	1								1				1			**1**									1						**5**	**Y**
Solidago gigantea Aiton	2		1		1		1		2		1		1				1		1		1		1		1		3		2		**14**	**Y**
Spiraea chamaedryfolia L.									1																						**1**	
Symphoricarpos albus (L.) S.F.Blake	1				1		1		1				1		1		1		1				1		2		1		1		**12**	**Y**
Syringa vulgaris L.	3		2		3		2		3		2		1		2		2		2		2		3		2		2		2		**15**	**Y**
Tragopogon dubius Scop.									1							**1**						**1**	1						1		**5**	
Veronica persica Poir.													1						1						1						**3**	**Y**
Xanthium albinum (Widder) H.Scholz																													1		**1**	**Y**
total number of species in partcular village	**24**		**26**		**25**		**16**		**31**		**26**		**26**		**19**		**18**		21		**23**		**21**		**29**		**29**		**22**			

Explanations: N – total number of record, 1– rare species, 2 – frequent species, 3 – common species; IS (PL) – invasive species in Poland according to “Alien Species in Poland” (http://www.iop.krakow.pl/ias/Baza.aspx): Y – yes;
In bold – the new occurences in 2004-2007

results in less intensive management of this area. The villages of the Kampinos region with their ruderal habitats (similar to local fields or meadows) in most of the cases have never been under intensive use. This is because of the poor quality, sandy and marshy soils, as well as the large distance from major transport routes. Since the 1970s, when the Kampinos National Park began the buyout of land and these areas rapidly become depopulated, the isolation of abandoned local villages has increased, mainly because of the dramatic decline in population. The penetration of these areas, both by local people and tourists, is also decreasing.

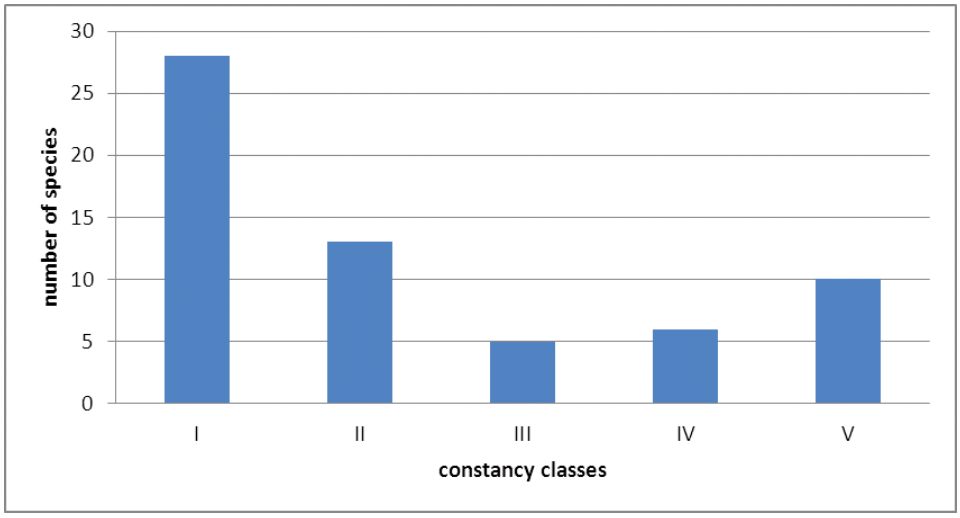

Fig.1. Proportion of epoecophytes in the distinguished constancy classes

Generally, the number of epoecophytes in individual villages is comparable. However, the lowest number of epoecophytes (Tab. 1) was found in three villages: Grabina (16 taxa), Kiścinne (18) and Karolinów (19). Grabina and Karolinów are located peripherally, and are totally (Karolinów) or almost totally depopulated (Grabina). The case of Kiścinne is different because it is located near one of the major roads running across the Park. Kiścinne is one of the smallest studied villages and this fact seems to be decisive here. The highest number of epoecophytes (Tab. 1) was found in Granica (31 taxa), which may support the hypothesis on the correlation between the number of epoecophytes and isolation of the site. In this case the isolation is dramatically reduced because of the continuous penetration of this area by tourists (visiting the nearby educational centre and open-air museum, the Museum of Kampinos Forest, war cemetery, educational path, children's playground and car park) and because of its location on the periphery of Kampinos National Park. Of all the studied sites the village of Granica is the most exposed in terms of tourism-related factors. Despite the high depopulation rate it is an open area for the encroachment of

new invaders which may quickly establish themselves in habitats that were previously transformed by humans. The increasing number of ways to access the site, and not the status of the site, seems to be most decisive for the population of epoecophytes.

Among very rare epoecophytes found in the abandoned villages of the Kampinos area special attention should be paid to two species: *Anthemis ruthenica* and *Camelina microcarpa.* They are included in the list of "Rare, endangered and protected plant species of synanthropic flora of Kampinos National Park" (KIRPLUK, BOMANOWSKA 2008). *Anthemis ruthenica* was found only in Janówek, and *Camelina microcarpa* in Ławy, in 1992-1995. However, during further study years (2004-2007) these species were no longer found.

According to art. 120 clause 1 of the act of 16 April 2004 on nature conservation (Dz. U. of 2009 No. 151, item 1220), "it is forbidden to introduce and import alien plant species to the natural environment".

In the abandoned villages of the Kampinos region three taxa out of 16 plant species listed in the Regulation of the Minister of the Environment of 9 September 2011 on the list of plants and animals of alien species which when introduced to the natural environment pose a threat to native biodiversity or natural habitats (Dz.U. of 2011 No. 210, item 1260) were found. These are: *Echinocystis lobata, Impatiens glandulifera* and *Reynoutria japonica.* The highest number of sites was recorded for *Echinocystis lobata*, which was found in 6 villages. *Impatiens glandulifera* and *Reynoutria japonica* were found in 2 sites each. In all the studied sites these species were rare. However, *Reynoutria japonica* occupied a slightly larger area in Karolinów, but it did not exceed 5% of the site (see "Materials and Methods"). Most sites of these species were recorded as early as in 1992-1995 (Tab. 1). In 2004-2007 two new sites were found for *Echinocystis lobata* and one site for *Impatiens glandulifera* (Tab.1). This shows that the Park area is gradually becoming invaded by these species, posing a threat to native flora. This problem requires firm action from the Kampinos National Park services.

The total participation of invasive epoecophyte species in the flora of abandoned villages in the Kampinos region is considerably high. As many as 37 of the found taxa are regarded as invasive species (INSTITUTE OF NATURE CONSERVATION PAS 2009) (Tab.1). In the abandoned villages of Kampinos National Park they pose a considerable threat, which was proven in this study. The emergence of new sites is being observed, as is the penetration of new species to the villages where they had not been recorded previously (Tab.1, in bold). Interestingly, the highest number of new localities (3-4) was recorded both in the villages where depopulation ceased (Buda, Józefów, Koszówka) and in Karolinów, a completely abandoned village, the most isolated, and located in the heart of the Kampinos National Park, far from tourist routes and public roads. The present findings demonstrate that for invasive plant species increased isolation of sites and desynanthropization of flora (KIRPLUK 2011) have little impact. Probably these factors only slow down the rate of colonization of new areas. This problem would require relevant multi-year studies considering the

biology of the species. However, as we are dealing with the national park, the situation requires firm action by the managerial services. This was suggested much earlier by FERCHMIN (1979) with reference to invasive tree species.

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