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PENETRATION AND NATURALISATION OF INVASIVE ALIEN PLANT SPECIES (NEOPHYTES) IN WOODLANDS OF THE SILESIAN UPLAND (SOUTHERN POLAND)

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Abstract: During the period 1998-2001 phytosociological studies and mapping of the selected 20 neophytes in the woodlands of the Silesian Upland were carried out. For this purpose 52 randomly chosen fragments of forest complexes were investigated. A tentative list of neophytes and ergasiophygophytes occurring in the woodlands of the study area amounts to 40 species. The most frequent amongst the studied species are: *Quercus rubra*, *Padus serotina*, *Impatiens parviflora*. The examined plants mainly occur along roads and paths; about 16% of all localities were noted under the forest canopy. The widest contribution to forest communities is made by *Impatiens parviflora*. The most invaded forest communities are: disturbed patches of deciduous forests, resembling *Querco roboris-Pinetum*, and degraded patches of *Tilio-Carpinetum* and *Luzulo pilosae-Fagetum*. Apart from holoagriophytes non-woodland species can be found such as *Galinsoga ciliata*, *G. parviflora*, *Erigeron annuus*, *Conyza canadensis*, *Oxalis fontana*. The penetration and naturalisation of alien plant species is encouraged by forest fragmentation and the introduction of alien woody plants species.

Key words: neophytes, kenophytes, invasive alien plants, woodlands, disturbance of forest communities, Silesian Upland.

INTRODUCTION

One of the greatest contemporary threats to native vegetation, in addition to habitat disturbance, is alien plant invasion. In research on plant invasions focus is kept on mechanisms of penetration of alien plant species and susceptibility of plant communities to invasions (Tilman 1997; Faliński 1998; Davis et al. 2000; Fargione et al. 2003; Pyšek et al. 2004). The type of habitat, where a particular alien plant species appears, plays a crucial role in the further spreading of an invader. The more frequently an alien plant species is noted in natural habitats the more competitive it is and the higher threat it will cause to native elements of flora. In Poland and in other countries invasive alien plant species are being listed. In our country invasive alien species mainly include kenophytes sensu Kornaś (1990) = neophytes, i.e. species introduced after 1500. A list of agriophytes (neophytes penetrating natural habitats) for Poland was first compiled by Kornaś (1968) and later by Zając with collaborators (1998), Tokarska-Guzik (2003) and for Upper Silesia by Sendek (1974). In the present study an alien species is defined as a taxon in a given area, whose presence is due to human involvement, regardless of whether or not these activities are intentional and unintentional (Pyšek et al. 2004). The spreading of these species in a new territory is considered an invasion, when introduced plants overcome barriers to dispersal within the new region and can cope with the abiotic environment and biota in the general area (see Richardson et al. 2000; Pyšek et al. 2004; Chmura and Sierka 2004 for review). It is very often stressed that some

alien plant species that are not classified as "invasive", yet may become invasive in the future (Kowarik 1995; Pyšek 2001; Pyšek et al. 2004). The aim of this study was to establish a tentative list of neophytes occurring in forests and to analyse their participation in various types of habitats in the woodland areas of the Silesian Upland situated in southern Poland.

STUDY AREA

The study area lies in southern Poland, mainly on the territory of Silesian province. The north-western fragment of the upland is situated in the Opole province and the south-eastern part is located in the Małopolska province. The Silesian Upland covers ca 3 990 km^2 . The natural environment of this area has been transformed by man for several hundred years. This process has intensified in the last two centuries due to increasing urbanisation and industrialisation. Rich mineral resources, especially coal, contributed to the development of the mining and metallurgical industry, towns and a dense network of roads and railways. On the territory of the Silesian Upland natural forests had dominated in landscape until the end of the 18th century. As the result of forest management and logging for agriculture and urbanisation purposes, the total cover and number of large forest complexes have decreased while the number of isolated, small forests increased. Contemporary woodlands, only to very small extent, are remnants of the former Silesian Primeval Forest; they are primarily planted pine forests (Sendek 1974). In this area Cabała (1990) distinguished 17 plant associations and 26 units of lower rank – subassociations. The most frequent and occupying large areas are: *Leucobryo-Pinetum*, *Molinio-Pinetum*, *Calamagrostio villosae-Pinetum*, *Querco roboris-Pinetum* and *Calamagrostio-Quercetum petraeae*.

METHODS

The objects of the studies conducted during 1998-2001 were plant species of alien origin, neophytes (kenophytes) according to the classification by Kornaś (1990), occurring in the woodland areas of the Silesian Upland. Their list was made on the basis of literature data (Kornaś 1968; Hereźniak 1992; Zając et al. 1998; Celiński et al. 1991; Nowak 1999; Urbisz 1996, 2001), herbarium materials (KTU) and own field data. Based on the literature, 20 permanently established neophytes, meeting the criteria requirements of invasive species, were chosen for detailed studies. Fifty two fragments of large forest complexes were investigated. Each of these encompassed at least ten forest sections. In them, the following types of habitats were distinguished on the basis of their natural, semi-natural or anthropogenic character and shape:

1. Forest habitats: natural and semi-natural dense patches of forest vegetation, at least 50 m away from paths and margins.

2. Non-forest habitats of anthropogenic origin:

a) semi-natural and ruderal habitats of a linear character (forest edges, fringes of drainage and fire-control ditches, clear-cut areas)

b) semi-natural and ruderal habitats of irregular shape (forest meadows, woodland glades, felling sites, ruderal sites (dumping sites), vicinity of feeding racks, forest crops)

c) habitats associated with transport routes (forest paths, edges of roads and railways). Tree stands in each forest section were classified into one of the following age classes: 0-20 yrs, 21-40 yrs, 41-80 yrs, over 80 yrs.

The presence of each species within a given forest section was noted in each habitat type and was regarded as a single record. This record was treated as the stand of a particular species. In case of woody plants the occurrence of the following phases of the life-cycle were noted: seedling, juvenile individual, sapling, mature individual including blooming and fruiting individuals. This was done in order to examine whether a given species completes its life-cycle and can therefore be considered as established. Forest communities were identified using the commonly applied Braun-Blanquet method (Braun-Blanquet 1964). Phytosociological studies were conducted in those sites where the examined neophytes were found, in patches easy to identify in terms of syntaxonomical affiliation. The monocultures of cultivated anthropophytes and pine plantings were excluded. A total of 267 relevés were used for the purposes of these investigations. The syntaxonomic nomenclature was adopted after Matuszkiewicz (2001) and plant names follow Mirek et al. (2002).

RESULTS

In the woodland areas of the Silesian Upland 40 alien plant species were observed. Most of the recorded species (24) have the status of agriophytes in Polish flora (Zając et al. 1998). A less numerous group (11) comprises epecophytes, i.e. plants occurring in ruderal or segetal plant communities. The last group is composed of ergasiophygophytes (5), i.e. cultivated plants, escaping from cultivation, not permanently established in the flora of Poland (Table 1). In the woodland areas of the Silesian Upland a total of 1,853 floristic records of neophytes was collected (Fig. 1). The most frequent is *Quercus rubra* (400 stands), next is *Padus serotina* (377 stands). Among forbs *Impatiens parviflora* predominates. The group of rather common species (over 100 stands) includes: *Juncus tenuis*, *Lupinus polyphyllus*, *Solidago gigantea*. The rarest are *Reynoutria sachalinensis* and *Acer negundo* (Fig. 1). Neophytes mainly occur in habitats associated with transport routes: mostly at forest paths, along forest roads, less frequently in the vicinity of roads and railways (Fig. 2). The examined species were also frequently found in forest patches. The quite numerous floristic records come from forest margins.

Table 1. A tentative list of neophytes and ergasiophygophytes occurring in the woodlands of the Silesian Upland. Source: Chmura 2002; Urbisz 1996; Urbisz 2000; Nowak 1997; Sendek 1974; Celiński et al. 1991

Origin (geographical region)	Arrival in Poland (first record)	Status in the flora
Species of American origin		
**Acer negundo* L.	XVIII 1808 (HEREŹNIAK 1992)	a
Amelanchier spicata (Lam.) K. Koch	XIX (ZAJĄC et al. 1998)	a
Bidens frondosa L.	2\2 XX (ZAJĄC et al. 1998)	a
**Conyza canadensis* (L.) Cronquist	1\2 XVIII (ZAJĄC et al. 1998)	e
**Epilobium adenocaulon* Hausskn.	XIX\XX ((ZAJĄC et al. 1998)	a
**Erechtites hieracifolia* (L.) Raf. ex DC.	1902 (SCHUBE 1903)	e
**Erigeron annuus* (L.) Pers.	2\2 XVIII (ZAJĄC et al. 1998)	e
Fraxinus pennsylvanica Marschall	1817 (HEREŹNIAK 1992)	a
**Galinsoga ciliata* (Raf.) S.F. Blake	1\2 XX (ZAJĄC et al. 1998)	e
**Galinsoga parviflora* Cav	1807 (PODBIELKOWSKI 1995)	e
**Juncus tenuis* Willd	1896 (PODBIELKOWSKI 1995)	e
**Lupinus polyphyllus* Lindl.	XIX (SOWA, WARCHOLIŃSKA 1992)	a
Lysimachia punctata L.	XIX (ZAJĄC et al. 1998)	a
**Padus serotina* (Ehrh.) Borkh.	1813 (HEREŹNIAK 1992)	a
Pinus banksiana Lamb.	1822 (HEREŹNIAK 1992)	e
Pinus nigra J.F. Arnold	? SENETA, DOLATOWSKI (1997)	er
Pinus rigida Mill.	1817 (HEREŹNIAK 1992)	er
Pinus strobus L.	1798 (HEREŹNIAK 1992)	e
Philadelphus pubescens Loisel	1820 (HEREŹNIAK 1992)	er
Physocarpus opulifolius (L.) Maim	1806 (HEREŹNIAK 1992)	er
Pseudotsuga menziesii (Mirb.) Franco	1833 (HEREŹNIAK 1992)	e
**Quercus rubra* L.	1806 (HEREŹNIAK 1992)	a
**Robinia pseudoacacia* L.	ca. 1600 (SZYMANOWSKI 1960)	a
Rudbekia laciniata L.	XIX\XX (ZAJĄC et al. 1998)	a
**Solidago canadensis* L.	1836 (WEBER 1998)	a
** Solidago gigantea* Aiton	1853 (WEBER 1998)	a
Solidago graminifolia (L.) Elliott	XIX (ZAJĄC et al. 1998)	a
Species of Asiatic origin		
**Impatiens glandulifera* Royle	1900 (SCHUBE 1903)	a
**Impatiens parviflora* DC	2\2 XIX (ZAJĄC et al. 1998)	a
Larix kaempferi (Lamb.) Carriere	SENETA, DOLATOWSKI (1997)	er
**Reynoutria japonica* Houtt.	XIX (ZAJĄC et al. 1998)	a
**Reynoutria sachalinensis* (F. Schmidt) Nakai	XIX (ZAJĄC et al. 1998)	a
Rosa rugosa Thumb.	XIX (ZAJĄC et al. 1998)	a
Veronica filiformis Sm.	1\2 XX (ZAJĄC et al. 1998)	a
Species of American-Asiatic origin		
**Oxalis fontana* Bunge	1881 (HANTZ 1979)	a
Species of Southern European origin		
**Aesculus hippocastanum* L.	1576 (SZYMANOWSKI 1960)	a
Digitalis purpurea L.	XVIII-XIX (HANTZ 1993)	a
Mahonia aquilefolium (Pursch) Nutt	? - SENETA, DOLATOWSKI (1997)	e
Species of European-Asiatic origin		
Lonicera tatarica L..	XVIII (ZAJĄC et al. 1998)	e
Rumex confertus Willd.	1\2 XX (ZAJĄC et al. 1998)	a

Explanations: a – agriophyte (neophyte occurring in natural and semi-natural habitats), e – epecophyte (neophyte of ruderal and segetal habitats), er – ergasiophygophyte (cultivated plant occasionally escaping) ? – no available data, * species chosen for detailed investigations

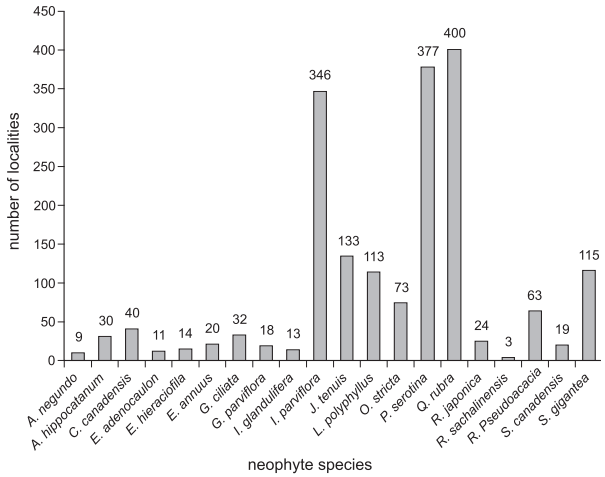

Fig. 1. Number of stands of examined neophytes in the woodland areas of the Silesian Upland.

Smaller number of floristic records concern clearings, the vicinity of drainage and fire-control ditches. The smallest number of neophyte stands was observed at felling sites, dumping sites, forest meadows and close to feeding racks (Fig. 2). Table 2 summarises contributions of particular neophytes to habitats in woodland areas. Within forest patches *Impatiens parviflora* has the biggest frequency and contribution to the total records in this type of habitat (30% of the total number of stands in forest phytocoenoses). Also *Padus serotina* and *Quercus rubra* contribute significantly, respectively: 24% and 22%. These two tree species together occupy 75% of all records in forest patches. Small balsam *I. parviflora* is especially worthy of attention, since it spreads spontaneously in contradistinction to the two former species. The three mentioned species also make large contributions to remaining groups of habitats including those associated with transport routes (from 16% to 22%; Table 2). The remaining frequent species (each about 5%) are: *Juncus tenuis*, occurring almost only at forest paths, *Solidago gigantea* and *Oxalis fontana*. Within other linear-shaped habitats (clear-cut areas, forest edges, ditches, etc.) the following species make quite large contributions: *Solidago gigantea*, *Lupinus polyphyllus*, *Reynoutria japonica*, *Robinia pseudoacacia*. To sum up, they constitute 26% of the total localities in this set of habitats. Amongst clear-cut areas, felling sites and rubbish dumps frequent species are: *Solidago gigantea*, *Robinia pseudoacacia*, *Lupinus polyphyllus*, *Conyza canadensis*, *Erechtites hieracifolia* – 40% of stands in this group. Amongst 20 neophytes 17 species were observed inside the forest, in natural and semi-natural habitats. The most frequent species in forest habitats is *Impatiens parviflora*, which spreads in 41-80 yrs old tree stand (Fig. 3). The plant occurs more rarely in elder tree stands (more than 80 yrs), and quite frequently in young tree stands (21-40 yrs). However, it was observed once in the youngest tree stands under 20 yrs. *Padus serotina* was the most frequently noted in tree stands aged 41-80 yrs, also its individuals were observed in the interval of 21-40 yrs and in tree stands aged more than 80 yrs. Two localities were recorded in the youngest tree stands. Red oak *Quercus rubra* was observed frequently in the age classes of 21-40 and 41-80 yrs (Fig. 3). It occurs most rarely in the oldest tree stands. The species was not noted in the youngest tree stands. The remaining species occur too rarely in woodland habitats to make any comparisons. The examined species occur most frequently in two types of plant associations: mixed coniferous forest *Querco roboris-Pinetum* and suboceanic coniferous forest *Leucobryo-Pinetum* (Fig. 4). In these two plant communities about 40% of all stands of neophytes in forest patches were recorded. The large group of plant communities, in which neophytes are found, comprises plant associations of *Querco-Fagetea*: oak-hornbeam forest *Tilio-Carpinetum* and acidophilous beech wood *Luzulo pilosae-Fagetum*. Taking into consideration that many patches of *Querco roboris-Pinetum* may be degenerative forms of deciduous forests, especially in the Silesian Upland (Cabała 1990), one can say that neophytes penetrate mainly deciduous woodlands. The plant communities of alliance *Fagion* (lack of characteristic species facilitating detailed diagnosis) contribute quite significantly (Fig. 4). Of the remaining semi-natural and disturbed coniferous and mixed forests associations, most neophytes were recorded in woodlands with the dominance of *Pinus sylvestris*. These are pine plantings within an oak-hornbeam forest habitat, some of these were distinguished as the anthropogenic community *Pinus sylvestris-Impatiens parviflora*. Other forest patches correspond to the *Dicrano-Pinion* alliance. Amongst the remaining coniferous forest associations, a tendency toward decrease in the number of neophyte records with the growth of habitat humidity was observed. Therefore, in the *Molinio-Pinetum* and *Calamagrostio villosae-Pinetum* associations there are fewer stations of neophytes

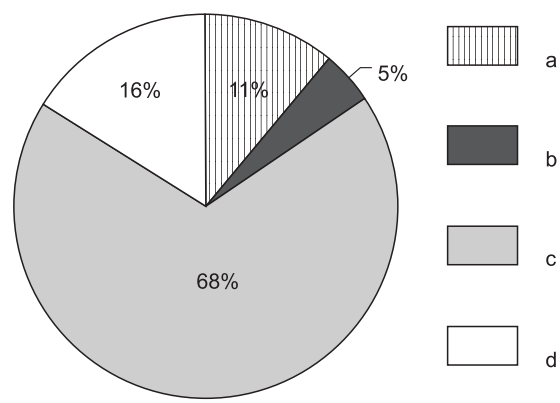

Fig. 2. Share of particular habitats in the whole data set from total number of neophyte stands. a – forest margins, ditches, b – clear cut areas, ruderal habitats, c – vicinity of roads and paths, d – forest habitats

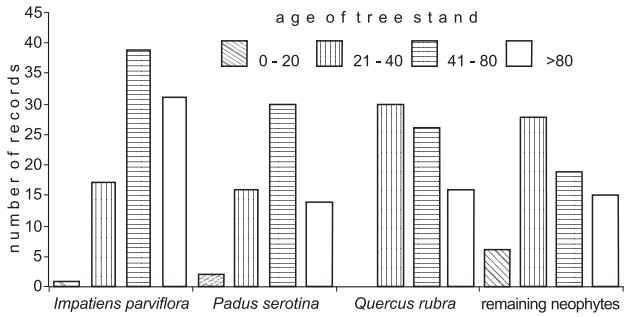

Fig. 3. Number of stands of selected neophytes in different ages of the tree stand.

than in *Calamagrostio-Quercetum* (Fig. 4). Other species, as *Erechtites hieracifolia*, *Epilobium adenocaulon* and *Reynoutria sachalinensis* were noted only in strongly transformed habitats with a ruderal character, outside of forest dense patches (Table 3). In *Vaccinio uliginosi-Pinetum* no neophytes were recorded.

The most widespread is *Impatiens parviflora* which appears in ten forest associations and three plant communities. One type of species-poor community of man-made origin with the contribution and domination of Scots pine (at least 60% of cover-abundance) was described as *Pinus sylvestris-Impatiens parviflora*. In plant associations of mesic deciduous forests of *Querco-Fagetea* class the species is the most frequent. In oak-hornbeam forest *Impatiens parviflora* has a high constancy and scores the biggest coverage at fourth degree in the scale of Braun-Blanquet. The species has smaller coverage in the variant with *Carex brizoides*. *Impatiens parviflora* has the same frequency in beech-wood *Luzulo pilosae-Fagetum*, however its coverage does not exceed 25%. This neophyte is also frequent in rare patches of *Ficario-Ulmetum minoris* but its cover-abundance is smaller. Amongst syntaxa from the *Vaccinio-Piceetea* class, *Impatiens parviflora* is quite frequent in the mixed coniferous forest *Querco roboris-Pinetum*. In other coniferous assemblages such as *Molinio-Pinetum* and *Calamagrostio villosae-Pinetum* it is rarer. In *Calamagrostio arundinaceae-Quercetum* of *Quercetea robori-petraea* class, grouping acidophilous forest communities *Impatiens parviflora* has medium constancy and its maximum cover amounts to 50%. In riparian alder forests *Fraxino-Alnetum* and anthropogenic communities with the domination of *Pinus sylvestris* it occurs rarely and less abundantly (Table 3). Other frequent species are *Padus serotina* and *Quercus rubra*. They occur in the same plant associations and communities, differing from each other in coverage and constancy. Black cherry *P. serotina* was more frequently noted in coniferous forest *Leucobryo-Pinetum* than red oak. Both species reproduce in this

Table 2. Number of neophyte stands in particular habitats. For each number of stands of the species the percentage of the contribution to the total number of stands recorded in the habitat was shown

Species	**Forest margins**		**Felling sites, ruderal habitats and cultivation sites**		**Surroundings of roads and paths**		**Forest patches**	
	No.	%	No.	%	No.	%	No.	%
Acer negundo	2	0.98	0	0	3	0.23	4	1.34
Aesculus hippocastanum	5	2.45	0	0	16	1.26	9	3.01
Conyza canadensis	7	3.43	7	8.3	24	1.89	2	0.67
Epilobium adenocaulon	0	0	2	2.38	9	0.71	0	0
Erechtites hieracifolia	0	0	5	5.95	9	0.71	0	0
Erigeron annuus	2	0.98	3	3.57	13	1.03	2	0.67
Galinsoga ciliata	3	1.47	0	0	28	2.21	1	0.33
Galinsoga parviflora	1	0.49	1	1.9	15	1.18	1	0.33
Impatiens glandulifera	5	1.96	1	1.9	6	0.47	1	0.33
Impatiens parviflora	35	17.15	17	20.2	204	16.1	90	30.1
Juncus tenuis	1	0.49	1	1.9	129	10.2	2	0.67
Lupinus polyphyllus	19	9.31	5	5.95	75	5.93	14	4.7
Oxalis fontana	8	3.92	1	1.9	60	4.74	4	1.34
Padus serotina	34	16.7	10	11.9	266	21.03	67	22.4
Quercus rubra	36	17.64	11	13.1	279	22.05	74	24.74
Reynoutria japonica	9	4.41	1	1.9	11	0.86	3	1
Reynoutria sachalinensis	3	1.47	0	0	0	0	0	0
Robinia pseudoacacia	10	4.9	6	7.14	39	3.08	8	2.67
Solidago canadensis	2	0.98	2	2.38	13	1.03	2	0.67
Solidago gigantea	23	11.27	11	13.1	66	5.22	15	5.01
Total	205	100%	84	100%	1265	100%	299	100%

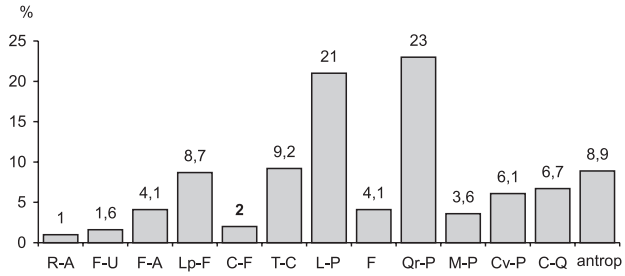

Fig. 4. Percentage of examined neophytes in forest communities. R-A – *Ribo nigri-Alnetum*, F-U – *Ficario-Ulmetum*, Lp-F – *Luzulo pilosae-Fagetum*, C-F – *Carici-Fagetum*, T-C – *Tilio-Carpinetum*, L-P – *Leucobryo-Pinetum*, F- *Fagion*, Qr-P – *Querco roboris-Pinetum*, M-P – *Molinio-Pinetum*, Cv-P – *Calamagrostio villosae-Pinetum*, C-Q – *Calamagrostio-Quercetum*, antrop – anthropogenic community with *P. sylvestris*).

association. Their seedlings were encountered in herb layer. Black cherry is more frequent species in such plant associations as: *Querco roboris-Pinetum*, *Luzulo pilosae-Fagetum*, *Ficario-Ulmetum minoris* or in a community with *Pinus sylvestris*. However, *Q. rubra* was more frequently observed in *Calamagrostio-Quercetum*. Red oak seedlings were present in each community except for *Molinio-Pinetum* and *Carici-Fagetum*. *Solidago gigantea* occurs in many communities, but is a rare species. Only in *Calamagrostio-Quercetum* the species is quite frequent. Some species occur in forest patches sporadically, having single or a few records in a given forest community. These are: *Acer negundo*, *Aesculus hippocastanum*, *Galinsoga ciliat*a, *G. parviflora*, *Impatiens glandulifera*, *Juncus tenuis*, *Reynoutria japonica*. Lupin *Lupinus polyphyllus* has a low frequency in particular plant communities, its cover is rather high only in *Fraxino-Alnetum* (Table 3). It was reported from patches of *Querco roboris-Pinetum* and *Leucobryo-Pinetum*, too. Also in degenerated patches of *Leucobryo-Pinetum* single individuals of *Robinia pseudoacacia* were recorded in the shrub and tree layer. In phytocoenoses of *Querco roboris-Pinetum* as well as in a community with *Pinus sylvestris* seedlings of the species were observed in the ground layer, too.

DISCUSSION

Of the 20 species selected for more detailed study in this work, 11 have obtained the status of invasive species in Polish flora (Tokarska-Guzik 2003). These are: *Robinia pseudoacacia*, *Impatiens parviflora*, *Solidago gigantea*, *Lupinus polyphyllus*, *Acer negundo*, *Solidago canadensis*, *Reynoutria japonica*, *Padus serotina*, *Impatiens glandulifera*, *Quercus rubra*, *Reynoutria sachalinensis*. Other species in this study, i.e. *Erigeron annuus*, *Juncus tenuis*, *Aesculus hippocastanum*, *Epilobium adenocaulon*, are included in a subset of naturalised plants, most frequent in natural habitats. The species mentioned above usually invade forest and riparian habitats in Poland. The

Table 3. Phytocoenotic spectrum of the examined species. Constancy and Braun-Blanquet values are included in the table. For explanations see fig. 4

Name of plant association	***L-P***	***M-P***	***Qr-P***	***Cv-P***	***C-Q***	***T-C***	***Lp-F***	***C-F***	***F***	***F-U***	***F-A***	***R-A***
Number of relevés in the table	67	9	49	27	16	37	24	5	10	5	13	5
A. negundo	.	.	.	.	.	I^{1}	.	.	.	.	.	.
A. hippocastanum	.	.	.	.	.	.	.	.	I^{1}	.	.	.
C. canadensis	.	.	.	.	.	.	.	.	.	.	.	.
E. annuus	.	.	.	.	.	.	.	.	I^{2}	.	.	.
G. ciliata	.	.	.	.	I^{+}	.	.	.	.	.	.	.
G. parviflora	.	.	.	.	.	I^{+}	.	.	.	.	.	.
I. glandulifera	.	.	.	I^{+}	.	I^{1}	.	.	.	.	.	.
I. parviflora	I^{+-2}	II^{+-1}	III^{+-4}	I^{+-1}	II^{1-3}	III^{+-4}	III^{+-2}	.	III^{1-5}	III^{+-2}	II^{+-2}	I^{1}
J. tenuis	.	.	.	.	I^{+}	.	.	.	.	.		I^{+}
L. polyphyllus	I^{+-2}	.	I^{+}	.	.	.	.	.	.		I^{2-3}	.
O. fontana	.	.	.	.	I^{+}	I^{+}	I^{+}	.		.		.
P. serotina	IV^{+-4}	III^{+-2}	IV^{+-4}	I^{+-2}	II^{+-3}	I^{+-3}	III^{+-2}	.	.	.	II^{1-2}	.
Q. rubra	III^{+-4}	I^{1}	III^{+-3}	II^{+-2}	IV^{+-4}	I^{1-3}	I^{1-2}	.	.	.	I^{+}	.
R. japonica	I^{1}	.	.	.	.	.	.	I^{2}	.	.	.	.
R. pseudoacacia	I^{1-3}	.	I^{+-2}	.	.	.	.	.	.	.	.	.
S. canadensis	.	.	.	.	.	.	.	.	.	.	.	.
S. gigantea	I^{+}	.	I^{1}	.	II^{+-2}	I^{+}	.	I^{1}	I^{+}	.	I^{2}	.

remaining species as *Conyza canadensis*, *Galinsoga ciliata*, *G. parviflora*, *Oxalis fontana*, *Erechtites hieracifolia* are found more frequently in ruderal and segetal habitats. Other authors (Fabiszewski and Kwiatkowski 2001) additionally included expansive native and alien species, introduced before 1500 – archaeophytes to the concept of the invasive plant. However, in their lists, species kenophytes (neophytes) predominated. Of the neophytes occurring in the woodlands of Poland the *Impatiens parviflora* is the most abundant species. There is a rich collection of literature about its occurrence in forest communities, including: Kujawa-Pawlaczyk (1991) and literature citied there; Obidziński and Symonides (2000); Chmura and Orczewska 2004; Chmura and Urbisz (in press). Studies show that the species appears frequently also in forest patches, under tree canopy as in open habitats with an extensive availability of light, e.g. forest paths or forest margins. This is the species of S-R life strategy (Grime 1985), i.e. it easily colonises both little and highly disturbed, environments. Moreover, the species has a wide tolerance to light conditions (Whitelam and Johnson 1982). The remaining species represent mainly strategy C, i.e. they are competitors including trees: *Acer negundo*, *Aesculus hippocastanum*, *Robinia pseudoacacia*, *Padus serotina*, *Quercus rubra*. The abundant and frequent occurrence of the latter two species is caused by their cultivation in the past. Another cause is the fact that these are forest species in their native range of North America, therefore they find similar biotopic conditions in European woodland habitats. The results of studies conducted in other regions of Poland showed that not only spontaneous spreading but intentional introduction of alien woody plants influenced their further spread (Adamowski et al. 1998). R, CR and SR strategists are not capable enough to persist in forests, because this habitat is saturated with plant species. The species of these strategies are most frequently annual plants, penetrating into dense patches of communities using "safe microsites of germination" and temporarily available sources of nutrients and water (Davis et al. 2000; Obidziński and Symonides 2000). Analysing the study results, one can say that there are three groups of habitats where neophytes are concentrated. These are: forest habitats; open habitats (vicinity of transport routes, glades, clear-cut areas, ditches) and ruderal habitats (dumping sites, some felling sites, vicinity of feeding rakes, buildings, and some roads). The two latter habitats arose and persist owing to human activities. Open habitats, deprived of tree canopy, but not without vegetation, are migration routes of non-woodland plants into the forest complex. Fragmentation and thinning of forests favours penetration and naturalisation of species photophilous and resistant to disturbances (Peterken and Game 1984; Brothers and Spingarn 1992; Medwecka-Kornaś 1994). Also the formation of island-like scattered clear-cut areas and other ruderal habitats in forest complexes encourages alien plant invasion, as do dense net of footpaths and roads (Solińska-Górnicka and Symonides 1995). A selection of species for forest regeneration in felling sites indirectly determines the invasibility of forest communities. The considerable contribution of larch, fir, Scots pine to deciduous woodlands and especially a rise of homogeny, congeneric tree stands lead to the impoverishment of the herb layer and, as a consequence, decrease in competition conditions (Medwecka-Kornaś 1994).

Some efforts should be taken to protect native biodiversity from competitive invasive alien plant species especially the most frequent ones. In the case of *Impatiens parviflora* the best method of its control seems to be by the biological agent *Puccinia komarovii* – a rust fungus, very specific parasite which causes considerable mortality in neophyte populations (Bacigálová et al. 1998). Other control methods like individuals removal provide ambiguous results. Adamowski and Keczyński (1998) described a successful attempt to stop the invasion of *Impatiens parviflora* in the Białowieża National Park but Csontos (1986) in his removal experiment, obtained quite high level of survival (14%) owing to the seed bank in soil. Other species like *Padus serotina* and *Quercus rubra* also constitute a threat to forest vegetation, e.g. *Padus serotina* inhabits the regeneration of native forest trees as *Fagus sylvatica*, *Quercus* sp., *Betula* sp. and *Pinus sylvestris* (Starfinger 1997). A set of various treatments is recommended to control those species. These include: chemical treatment, complete uprooting of trees and shrubs, planting shade trees, e.g. *Fagus sylvatica* on sites following the removal of specimens (Oosterbaan and Olsthoorn 2004).

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