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Vegetation of forest islands in the agricultural landscape near Poznań (West-Central Poland)

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ABSTRACT: The studies were carried out in different types of forest islands in the agricultural landscape North-East of Poznań (West-Central Poland). In the investigated patches of forest islands 58 plant communities were identified. From 8 to 45 phytocenoses were found in each plot, depending on its habitat diversity, genesis, macrorelief, development, size and direct neighbourhood.

KEYWORDS: West-Central Poland, agricultural landscape, forest degeneration, forest islands.

Introduction

Studies in landscape ecology have a long history in Poland, particularly in the Wielkopolska region. Since the 1920's of the 20th century, ADAM WODZICZKO (1887-1948), a professor of the University at Poznań propagated the formation of landscape in agreement with human needs, but at the same time preserving all natural values. In Poland agricultural areas occupy about 60% of the total area and therefore have a significant influence on the quality of natural environment.

One of the landscape element is the plant cover, that has been strongly transformed as a result of anthropopressure. Industrial and agricultural areas, and even the majority of forests are dominated by secondary communities, which exist thanks to human activity. Facing the increasing environmental dangers, it becomes more and more important to recognize and to protect the biological resources, not only the natural but also the seminatural ones.

In the agricultural landscape, forest islands are the remnants or substitutes of forests. Many authors have described their biocenotic, climatic, economic and aesthetic importance. In Poland, this subject was discussed by CZARNECKI (1956), WILUSZ (1958), BURA & LIS (1978), ZAJĄCZKOWSKI (1982, 1988), KARG (1983), BUGAŁA (1986), WALIGÓRA (1986), RATYŃSKA (1986), DĄBROWSKA-PROT (1987), LOSTER & DZWONKO (1988), WOJTERSKA (1988), BAŁAZY et al. (1990), GÓRKA et al. (1991), LOSTER (1991), SZWED & RATYŃSKA (1991), RATYŃSKA & SZWED (1993a, c, d), etc.

The objective of our present work is to assess the geobotanical diversity of selected forest islands in an intensively utilized agricultural area, localized to the north-east of Poznań. Even small patches of forest provide space where seminatural and natural communities can be preserved. They are also environmental islands for forest plant species, both woody plants and herbs.

The nomenclarure used follows RUTKOWSKI et al. (1994) for vascular plants and MATUSZKIEWICZ (1981) and BRZEG (1989) for plant communities.

Study area

The investigated area is located about 15 km north-east of Poznań, at the border of the Landscape Park "Zielonka Forest". It is enclosed by a complex of forests of "Dziewicza Góra" (Virgin Mountain) and "Kobylnica", and of the Główna River. They are intensively agriculturally utilized areas which cover an area of about 1200 ha between the villages of Wierzenica, Wierzonka, Milno and Kicin (Fig.1).

According to KONDRACKI's (1978) physico-geographic division the studied area is situated in the Wielkopolska Lakeland, in region of the Brandenburg-Wielkopolska which is characterized by C. European oak-hornbeam forest (*Galio-Carpinetum*) (J. M. MATUSZKIEWICZ 1993). Most of the area are the hills of the terminal moraines and with the plain of the ground moraine (KONDRACKI 1978). The major climatic data are presented in Fig. 2.

The morphological diversity of the terrain is reflected in the plant cover. The discussed area is dominated by the potential habitats of species-poor oak-hornbeam forests - *Galio sylvatici-Carpinetum* (WOJTERSKI et al. 1982). Rather small areas are occupied by the potential habitats of oak-pine forests (*Querco roboris-Pinetum*). Only in the valley of the river, along its tributaries and in local small depressions there are carr habitats (*Circaeo-Alnetum* and *Ficario-Ulmetum campestris*) and the habitat of fertile alder forests (*Ribo nigri-Alnetum*).

The investigated area, although rather small, is characterized by a rich mosaic of forest islands and afforetations. They have been developed primarily in the form of woodlots. In small valleys running down to the valley of the Główna River, the widest patches of natural forest islands in this area can be found. The fields of the Plant Breeding Station at Wierzenica-Wierzonka are separated by marginal grassy belts where solitary trees and shrubs grow or, rarely, by 20-30-meter wide and several hundred meters long compact hedgerows (patches of *Pruno-Crataegetum*). Local and field roads are accompanied by one-row or two-row tree belts. Particularly noteworthy is the tree plantation on both sides of the road between the villages of Wierzonka and Milno which consists mostly of *Acer platanoides*, *A. pseudoplatanus* and *Quercus robur*.

Furthermore, in the discussed area several trees are recorded as nature monuments: magnificent white poplars (*Populus alba*), oaks (*Quercus robur*) (BANASZAK & RATYŃSKA 1992) and pear-trees (*Pyrus communis*).

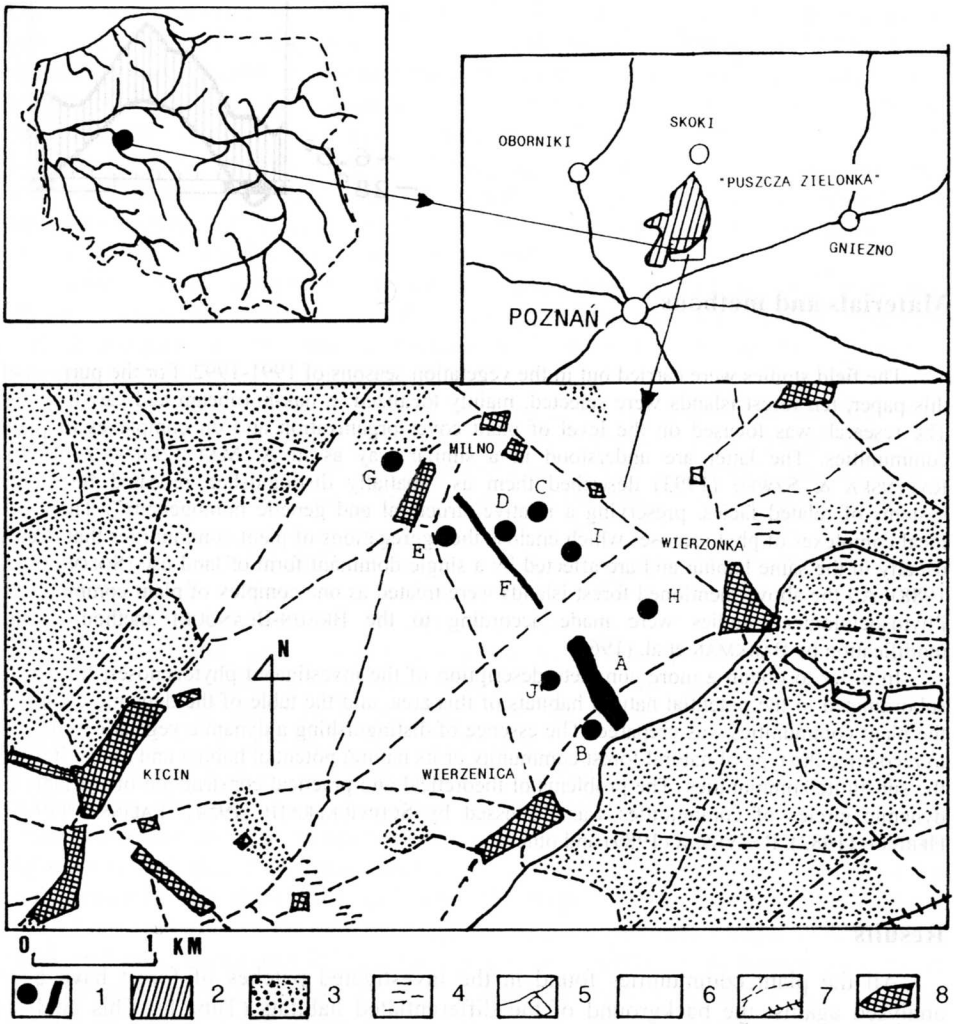

Fig. 1. Localization of the study area. Explanation: 1 - Localization of studied forest islands; 2 - area of the Landscape Park "Puszcza Zielonka"; 3 - forests; 4 - wetlands; 5 - waters; 6 - agricultural land; 7 - roads; 8 - buildings.

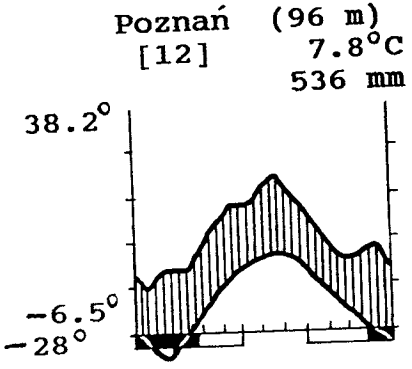

Fig. 2. Climatic diagram of Poznań which is situated close neighbourhood of the study area, after WALTER & LIETH (1967).

Materials and methods

The field studies were carried out in the vegetation seasons of 1991-1992. For the purpose of this paper, ten forest islands were selected, mainly localized in oak-hornbeam and carr habitats. The research was focused on the level of plant cover organization and on complexes of plant communities. The latter are understood in a similar way as in A. MATUSZKIEWICZ (1990); RATYŃSKA & SZWED (1993) described them as "spatially distinguished repeated functional systems of related facies, preserving a relative structural and genetic homogeneity". These are local complexes of phytocenoses which enclose the aggregations of plant communities that occurr usually in the same habitat and are affected by a single dominant form of land use (SOLON 1983, 1988). All the above-mentioned forest islands were treated as one complex of plant communities. Phytosociological studies were made according to the BRAUN-BLANQUET method in the modification by BARKMAN et al. (1964).

In order to obtain a more complete description of the investigated phytocenoses, they were subordinated to the potential natural habitats of this area, and the table of the dynamic circles of the plant communities was prepared. The essence of distinguishing a dynamic vegetation circle is to recognize the type of natural forest community or its natural potential habitat and assign it to all the substitute communities. The problems of theoretical and practical construction of the table of dynamic circles of communities was discussed by SCHWICKERATH (1954), FALIŃSKI (1966), HERBICH (1982), RATYŃSKA (1989) and others.

Results

All the plant communities found in the investigated patches of forest have been analysed against the background of the differentiated habitats (Tab. 1). This analysis indicates that phytocenoses associated with the moistest and poorest habitats are comparatively infrequent, i.e. those associated with alder carr (*Circaeo-Alnetum*) and alder-ash forest (*Fraxino-Ulmetum campestris*). The total number of phytocenoses found in the study area is 58. In the potential habitat of oak-hornbeam forest (*Galio- sylvatici-Carpinetum*) 37 communities were identified (Tab. 1). On the one hand, it is the result of the expansion of the above-mentioned habitats. On the other hand, it results from the intensification and differentiation of human influence.

In the investigated area, forest communities develop, or are preserved, primarily in the oak-hornbeam forest habitat. Only in the hardly accessible ravines perpendicular to the Główna River, fragments of carrs were found. It must be stressed that these phytocenoses are most natural. The composition and quantitative relations of groups of plant communities forming the investigated forest islands are presented in Tab. 2. The floristic composition of the stands is seminatural. However, due to the small area, the influence of the surrounding fields is often very strong. The uncontrolled felling of trees and the absence of cultivation treatments, create different forms of degeneration. These are: pinetization, i.e. the introduction of coniferous trees into deciduous habitats; geranietization revealed in a mass appearance of annuals and biennials from the *Lapsano-Geranion* alliance; and, to a lesser degree, cespitization (excessive sodding), and fruticetization which is a result of a strong development of the undergrowth. The above-mentioned forms of forest community degeneration were distinguished by OLACZEK (1972), and BRZEG & KROTOSKA (1984).

Among shrub communities, particulary noteworthy are patches with blackthorn (*Pruno-Crataegetum*) and elder (*Sambucetum nigri*). They dominate long low hedgerows (Tab. 2, complex F). These and other hedgerows, valleys, etc. play the role of ecological corridors in the landscape (FORMAN 1983, BAUDRY 1984, TABACCHI et al. 1990). Very interesting are also the already historic materials (Tab. 2, complex G) referring to the cemetery at Kliny (unfortunately, in the summer of 1992 that area was "put in order", i. e. some trees and all shrubs were cleared out and herbs were destroyed). The shrub layer here consisted of lilac (*Syringa vulgaris*) and elder (*Sambucus nigra*). In the spring, the cemetery, which is situated on a hill, appeared as a large flowerbed from a distance. Complex J, the so-called Żalik (BANASZAK & RATYŃSKA 1992), occupies the highest local elevation and is dominated by *Pinus sylvestris*. The shrub layer here is not well developed and the ground floor consists mainly of grasses.

The communities of herbaceous species of the investigated forest islands can be divided into three main groups: fringe, ruderal and field communities whose genesis is connected with the direct neighbourhood of arable fields. The first group is mainly represented by the community with *Urtica dioica*, patches of *Alliarietum officinalis*, *Alliario-Chaerophylletum* and *Galio-Veronicetum*. Ruderal associations whose presence, similarly as the presence of segetal communities, is the result of a strong anthropopressure, do not occupy any major area. Most common among them are the phytocenoses of *Balloto-Leonuretum* and *Leonuro-Arctietum*. It must be stressed that sometimes it is difficult to distinguish between nitrophilous fringe communities from the *Galio-Calystegietalia* order and ruderal phytocenoses from the *Onopordietalia* order. Many ruderal communities in the investigated area (patches with *Rumex obtusifolius*, with *Conium maculatum*, and *Leonuro-Arctietum*) have a distinct fringe character. Among the communities whose presence is closely connected with the neighbouring arable fields, patches with *Elymus repens* dominate with regard to the size of the area. In the majority of the analysed forest islands, also phytocenoses with *Stellaria media* were observed.

The total number of plant communities observed in the investigated patches of forest is 58. As for the number of phytocenoses, the forest growing in the largest ravine running to the Główna River is the most diverse one (Tab. 2, complex A). Including the

Tab. 1 Dynamic cirle of communities; number of communities in functional-ecological groups

potential habitat*	C-A	F-U	G-C	Q-C
real vegetation				
number of communities	16	29	37	11
Forest communities**				
Circaeo-Alnetum	2m	.	.	.
Ficario-Ulmetum campestris	.	4	.	.
Galio sylvatici-Carpinetum	.	.	4	.
Chelidonio-Robinietum	.	.	r	.
Populus tremula juv. com.	.	.	r	.
Pinus sylvestris com.	.	.	2m	2a
Querco roboris-Pinetum	.	.	.	3
Σ	**1**	**1**	**4**	**2**
Shrub communities				
Salicetum pentandro-cinereae	4	+	.	.
Sambucetum nigri	+	3	3	r
Pruno-Crataegetum	+	2a	3	+
Cuscuto-Humuletum lupuliformi	.	+	.	.
Convolvulo-Rubetum caesii	.	+	.	.
Rubus caesius com.	.	+	1	.
Rhamnus cathartica com.	.	.	r	.
Rosa sp. com.	.	.	r	.
Lycietum halimifolii	.	.	r	.
Syringa vulgaris com.	.	.	1	.
Σ	**3**	**6**	7	**2**
Wetland communities				
Phragmitetum communis	r	.	.	.
Cardamino-Beruletum erecti	+	.	.	.
Phalaridetum arundinaceae	+	.	.	.
Caricetum vulpinae	1	.	.	.
Caricetum gracilis	2m	.	.	.
Σ	**5**	-	-	-
Meadow & sward communities				
Rumici-Alopecuretum	r	.	.	.
Scirpetum silvatici	+	.	.	.
Poetum trivialis	2m	+	.	.
Potentilla reptans com.	.	r	.	.
Bromus inermis com.	.	+	.	.
Arrhenatheretum medioeuropaeum	.	+	2a	+
Festuca ovina sl. com.	.	.	1	2m
Σ	**3**	**4**	**2**	**2**

Tab. 1 - continued

Tall herb communities				
Eupatorietum cannabini	r	.	.	.
Alliario-Chaerophylletum	r	+	1	.
Alliarietum officinalis	+	2m	2m	.
Urtica dioica com.	2a	2b	3	.
Urtico-Aegopodietum	.	4	1	.
Galio-Veronicetum	.	1	2b	.
Anthriscetum silvestris	.	+	2m	.
Conium maculatum com.	.	r	r	.
Chelidonium majus com.	.	r	+	.
Impatiens parviflora com.	.	+	+	.
Chaerophylletum aromatici	.	r	.	.
Helianthetum tuberosi	.	+	.	.
Trifolio-Geranietea sl. com.	.	.	r	+
Galeopsis tetrahit com.	.	.	r	.
Lamium album com.	.	.	r	.
Σ	**4**	**11**	**12**	**1**
Clearcut communities				
Rubetum idaei	.	+	+	r
Calamagrostietum epigei	.	.	+	r
Epilobietum angustifolii	.	.	+	.
Σ	**-**	**1**	**3**	**2**
Ruderal communities				
Rubus obtusifolius com.	.	r	r	.
Tanaceto-Artemisietum	.	+	+	.
Leonuro-Arctietum	.	2m	1	.
Leonuro-Ballotetum	.	1	3	.
Saponaria officinalis com.	.	.	+	.
Convolvulo-Agropyretum	.	.	r	.
Σ	**-**	**4**	**6**	**-**
Field-accompanying communities				
Stelaria media com.	.	+	2m	.
Elymus repens com.	.	2b	4	3
Bromus tectorum com.	.	.	2m	1
Σ	**-**	**2**	**3**	**2**

* C-A - *Circaeo-Alnetum*; F-U - *Fraxino-Ulmetum campestris*; G-C - *Galio sylvatici-Carpinetum*; Q-P - *Querco roboris-Pinetum*

** abundance scale of BRAUN-BLANQUET modified by BARKMAN *et al.* (1964)

Tab. 2 The composition and quantitative relations of the plant communities creating the forest islands; number of communities in functional-ecological groups

Forest island mark	A	B	C	D	E	F	G	H	I	J
number in field	8	9	4	5	7	10	6	2	3	1
Potential habitat *	*C–A F-U G-C*	*F-U*	*C–A F-U G-C*	*F-U G-C*	*F-U*	*G-C*	*G-C*	*G-C*	*G-C Q-P*	*G-C*
Number of communities	45	17	19	9	8	18	12	11	9	13
Forest communities										
Circaeo-Alnetum	1	.	.	.	.	.	.	.	.	.
Ficario-Ulmetum	4	5	.	.	.	.	.	.	.	.
F-U. geranietyzation	.	.	2m	3	1	.	.	.	.	.
Galio-Carpinetum geranietyz.	2a	.	3	.	.	.	.	.	5	.
G-C. pinetyzation	2m	.	.	.	.	.	.	.	.	.
Querco roboris-Pinetum	+	.	.	.	.	.	.	.	.	.
Chelidonio-Robinietum	.	.	+	.	.	.	.	.	.	.
Populus tremula com.,juv.	.	.	.	.	.	+	.	.	.	.
Pinus sylvestris com.	.	.	.	.	.	.	.	.	.	5
Σ	**5**	**1**	**3**	**1**	**1**	**1**	**-**	**-**	**1**	**1**
Shrub communities										
Salicetum pentandro-cinereae	+	.	.	.	.	.	.	.	.	.
Rhamnus cathartica com.	+	.	.	.	.	.	.	.	.	.
Cuscuto-Humuletum lupuli	+	.	.	.	.	.	.	.	.	.
Convolvulo-Rubetum caesii	+	+	.	.	.	.	.	.	.	.
Sambucetum nigri	3	+	2m	3	3	2b	2b	.	.	.
Pruno-Crataegetum	2a	1	4	2a	2b	5	+	4	.	1
Rubus caesius com.	+	.	r	.	.	.	.	1	.	+
Rosa sp. com.	.	.	.	.	.	r	.	.	.	.
Syringa vulgaris com.	.	.	.	.	.	.	3	.	.	.
Lycietum halimifolii	.	.	.	.	.	.	r	.	.	.
Σ	7	**3**	**3**	**2**	**2**	**3**	**4**	**2**	**-**	**2**
Wetland communities										
Phragmitetum communis	r	.	.	.	.	.	.	.	.	.
Caricetum gracilis	+	.	.	.	.	.	.	.	.	.
Cardamino-Beruletum erecti	+	.	.	.	.	.	.	.	.	.
Caricetum vulpinae	+	.	+	.	.	.	.	.	.	.
Phalaridetum arundinaceae	.	.	1	.	.	.	.	.	.	.
Σ	**4**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Meadow & sward communities										
Scirpetum silvatici	r	.	.	.	.	.	.	.	.	.
Potentilla reptans com.	r	.	.	.	.	.	.	.	.	.
Bromus inermis com.	+	.	.	.	.	.	.	.	.	.
Poetum trivialis	1	.	1	.	+	.	.	.	.	.

Tab. 2 - continued

Forest island mark		A	B	C	D	E	F	G	H	I	J
Festuca ovina sl. com.		1	.	.	.	.	.	.	.	.	2m
Arrhenatheretum medioeuropaeum		2m	.	.	.	.	r	.	1	2a	1
aff. *Rumici-Alopecuretum*		.	.	r	.	.	.	.	.	.	.
	Σ	**6**	**-**	**2**	**-**	**1**	**1**	**-**	**1**	**1**	**2**
Tall herb communities											
Eupatorietum cannabini		r	.	.	.	.	.	.	.	.	.
Chaerophylletum aromatici		r	.	.	.	.	.	.	.	.	.
Chelidonium majus com.		r	+	.	.	.	.	.	.	.	.
Helianthetum tuberosi		r	+	.	.	.	.	.	.	.	.
Impatiens parviflora com.		+	+	.	.	.	.	.	.	.	.
Urtico-Aegopodietum		3	3	.	.	.	.	.	.	.	.
Anthriscetum sylvestris		r	+	.	.	.	2m	.	+	.	.
Alliario-Chaerophylletum		+	+	r	1	.	+	.	.	.	1
Alliarietum officinalis		1	.	2m	2m	.	2m	.	+	+	.
Urtica dioica com.		2m	2b	3	3	2b	3	2b	3	1	2m
Galio-Veronicetum		+	+	1	.	2m	2m	2b	+	2m	+
Trifolio-Geranietea sl. com.		+	.	.	.	.	+	.	.	.	+
Conium maculatum com.		r	.	.	.	.	r	.	.	.	.
Galeopsis tetrahit com.		.	.	r	.	.	.	.	.	.	.
	Σ	**13**	**8**	**5**	**3**	**2**	**7**	**2**	**4**	**3**	**4**
Clearcut communities											
Epilobietum angustifolii		+	.	.	.	.	.	.	.	.	.
Calamagrostetum epigei		+	.	.	.	.	r	.	.	.	r
Rubetum idaei		+	.	.	.	.	+	.	+	.	r
	Σ	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**1**	**-**	**2**
Ruderal communities											
Rumex obtusifolius com.		+	.	.	.	.	.	.	.	+	.
Tanaceto-Artemisietum		+	+	+	.	.	.	.	.	.	.
Leonuro-Arctietum		1	+	.	.	3	r	r	.	.	.
Leonuro-Ballotetum		1	2a	+	+	.	+	+	2b	2a	.
Convolvulo-Agropyretum		.	.	.	.	.	+	.	.	.	.
Saponaria officinalis com.		.	.	.	.	.	.	1	.	.	.
Lamium album com.		.	.	.	.	.	.	+	.	.	.
	Σ	**4**	**3**	**2**	**1**	**1**	**3**	**4**	**1**	**2**	**-**
Field-accompanying communities											
Bromus tectorum com.		2m	2a	.	.	.	.	.	.	.	2m
Elymus repens com.		3	2b	2b	3	.	4	2a	3	4	3
Stellaria media com.		+	.	+	+	+	.	+	2m	+	.
	Σ	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**2**

* C-A - *Circaeo-Alnetum*; F-U - *Fraxino-Ulmetum campestris*; G-C - *Galio sylvatici-Carpinetum*; Q-P - *Querco roboris-Pinetum*

degeneration forms, 45 plant communities were found there. The poorest in this respect are the small-area field refuges (only 8-9 phytocenons - complexes D,E, and I). There is a clear correlation between the size of the forest island and both its habitat diversity and the number of plant communities. An similar relationship between the number of forest species and the size of forest islands was noted by SCANLAN (1981), FORMAN & BAUDRY (1984), LOSTER & DZWONKO (1988), ZACHARIAS & BRANDES (1990), RATYŃSKA & SZWED (1993d), etc.

The largest participation of close-to-natural and seminatural communities was recorded in the ravines running to the Główna River (Tab. 2, complexes A and B). Among the studied forest islands, these are distinguished by the presence of well-preserved patches of *Ficario-Ulmetum campestris* (all the vegetation layers typical of forests are well developed, and consist mostly of typical elm carr species), and such phytocenons like *Urtico-Aegopodietum*, *Convolvulo-Rubetum caesii*, *Helianthetum tuberosi* and the community with *Chelidonium majus*, i.e. nitrophilous fringe communities. Both of the above-mentioned forest islands are remnants of former forests.

Field observations have shown that the composition and quantitative relationships among herbaceous plant communities accompanying field afforestations are influenced by the exposure of terrain. Along the borders with the southern and western exposure, mezoxerothermophilous phytocenoses occur, with the participation of such species like: *Euphorbia cyparissias*, *Poa pratensis* ssp. *angustifolia*, *Galium mollugo* var. *erectum*. One can also encounter patches of grass and of ruderal vegetation there. Along the borders with northern and eastern exposure, nitrophilous edge communities dominate.

The microhabitat of the small-area environmental islands does not allow for the development of forest inside the island. The layer structure is poorly developed and the area is quantitatively dominated by shrubs or herbs. Practically, in this case the whole island acts as a fringe community (compare with RANNEY et al. 1981).

Small-area forest islands become refuges of forest species in the agricultural landscape. During the investigation, the following species have been found (excluding trees and shrubs): three species of ferns, namely *Dryopteris spinulosa, D. filix-mas* and *Pteridium aquilinum*; numerous grasses such as *Poa nemoralis, Festuca gigantea, Brachypodium sylvaticum, Dactylis aschersoniana, Melica nutans;* and other herbs, i.e., *Scrophularia nodosa*.

The so-called "ecological areas" are also enclaves which provide refuges for species and communities of seminatural perennial vegetation. Intensive utilization of arable land consists in the maintenance of the cultivated phytocenons at an early stage of succession. The crops usually change every year or every second year. Perennial herbs and grasses can develop only along field margins, in forest islands and in hardly accessible places like slopes, ravines, local depressions, etc.

Conclusions

Forest islands in the agricultural landscape usually are very interesting from the point of science. Surrounded by monocultures, they are refuges for species and communities (both of plants and animals) connected with the close-to-natural landscape.

The number and composition of plant communities that are the components of forest islands are influenced by their size, habitat diversity, direct neighbourhood and exposure. The larger the enclave, and the more diverse and natural the habitat, the more numerous are the plant communities accompanying them.

Close-to-natural forest communities may only develop secondarily in larger patches of forest. Copses or small woods, where the ratio of the area of fringe to inside vegetation is high, are poor in natural and seminatural species and communities.

Regardless of the negligible area and the resulting disturbances in the floristic composition and structure of the forest communities building the field afforestation one may observe a retreat of seminatural herbaceous communities accompanied by a invasion of distinctly synanthropic communities. The latter develop as edge communities along the border between fields and fringe communities. Seminatural communities were most frequent along the borders between afforestations and meadows.

The formation of the landscape according to the requirements of the present ecological knowledge should aim at preserving or reconstructing the mosaic pattern of habitats. In areas where arable land dominates, patches of forests and post-glacial water bodies should be absolutely protected, and fragments of margins between fields should be left unutilized.

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