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ANCIENT WOODLANDS' AND SYNANTHROPIC PLANTS AS INDICATORS OF MAINTENANCE OF THE FOREST COMMUNITIES IN THE NATURE RESERVES OF THE OŚWIĘCIM BASIN

Abstract: The landscape of the Oświęcim Basin, naturally dominated by forest communities, has been strongly transformed due to the long-term activities of man. Across time and space, it has been stamped by pond management and agriculture to the highest degree. Despite such a strong transformation of the natural environment fragments of forests which reflect the peculiarities of forest vegetation of the macroregion still occur. These are the Żaki and the Przeciszów nature reserves. The goal of the phytosociological studies done within their borders was the assessment of the *Tilio-Carpinetum* phytocoenoses which dominate in the reserves, regarding their: maintenance, naturalness, anthropological changes and compliance to anthropopressure, as well as natural values. Therefore, analyses related to the share of: character species, ancient woodland indicators and synanthropes were performed for purposes of the study. It has been proposed that transformations of the forest communities be assessed using the new formula of floristic naturalness coefficient (W_{NF}), based on the share of ancient woodland and synanthropic species.

Key words: *Tilio-Carpinetum,* reserves, ancient woodlands, coefficient of floristic naturalness

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1. INTRODUCTION

The natural environment of the Oświęcim Basin has been strongly transformed as a result of the long-term activities of man. Anthropopressure increased due to the development of colonization activities and associated with it – agriculture. As has been assessed, larger aggregations of inhabitants colonized river valleys – especially the Vistula River valley – in the second half of the 13th century, and the end of that century was characterized by intensive creation of villages and towns within the area being discussed (KOŹBIAŁ 2000). The main role in the transformation of the environment was played by breeding-pond management. This activity started at the turn of the 12th and 13th century, but the highest development took place in the 16th and partly the 17th century. As has been supposed, by then the managed ponds covered 25-35% of the area of the Upper Vistula Valley – the middle part of the larger unit (the Oświęcim Basin) which ranges along the Vistula River from Skoczów to the SW to Zator to the NE (WŁODEK 1957). After periods of flourishing and regression, the area of the ponds has significantly decreased and today it is not so large. However, across time, it has influenced the transformations of the natural environment because it gradually limited the area covered by forests. Actually, forests only grow in an area of approximately 8% of the Upper Vistula Valley (LEDWOŃ *et al.* 2004). The rest of the area is taken up by agricultural fields, buildings and industrial infrastructure. However, a cartographic analysis indicates that existing forests cover the same areas (locations) to a significant degree as they did before. This is clearly shown in one of the oldest cartographic works about the Oświęcim-Zator Dutchy – „DVCATVS OSWIECZIMIENSIS ET ZATORIENSIS DESCRIPTIO". It reflects the 16th century hydrographic network and forests of the described area precisely (Fig. 1). This raises an interesting question: to what degree have these forests maintained their natural – or similar to natural – character and, on the other hand, how deeply have they been transformed due to strong long-term anthropopressure.

2. MATERIALS AND METHODS

Studies have been done in the remnants of the natural landscape of the Oświęcim Basin – specifically in the middle part called the Upper Vistula Valley (KONDRACKI 2001). These remnants are protected in nature reserves: the Żaki and the Przeciszów, which are examples of more interesting forest refuges within the discussed mesoregion. They are located in the Oświęcim commune, in the villages of Żaki and Przeciszów, on the right river bank of the Vistula River. Both places directly neighbour with the navigation channel called the Nawiga, which was built in the Seventies of the 20th century (Fig. 2). The investment caused the area of the Żaki reserve to decrease more than 25%, despite the fact that it had the status of a reserve (established in 1959). The Przeciszów reserve received its legal status only in 1996. Both reserves are of a small or medium size (the first consists of 11.84 ha and the second – 85.13 ha). Independent of their legal protection that feature increases their susceptibility to anthropogenic influences. These forest islands are surrounded by areas used for agriculture or fish-breeding ponds. The sub-continental oak-hornbeam-linden forest – the *Tilio-Carpinetum* association – is a dominant community in both reserves (WILCZEK 1998).

Phytosociological relevés (35) were made within the reserves, following the BRAUN-BLANQUET (1964) method. They were then compiled into a phytosociological table (FUKAREK 1967, SCAMONI 1967). In both reserves data is completed from two periods: in the Przeciszów from May (11 relevés) and July 2008 (8 relevés), for the Żaki from May (11 relevés) and August 2009 (5 relevés). Relevés from particular reserves are in separate columns, so they can be treated independently. Owing to that fact, the comparison of phytocoenoses at areas with such different histories was possible. In the analysis of relevés (made in two groups) the following aspects were taken into consideration: the share of diagnostic species, the share of ancient woodland indicators (DZWONKO, LOSTER 2001; DZWONKO 2007), the share of synanthropes (ZAJĄC *et al.* 1975; ZAJĄC *et al.* 1998; TOKARSKA-GUZIK 2005) together with the collective share of these groups – „G" category (PAWŁOWSKI 1977). An original coefficient of floristic naturalness (W_{NF}) was published in this paper for the first time and used for the assessment the the degree of phytocoenoses maintenance in relation to forest communities of the Żaki and

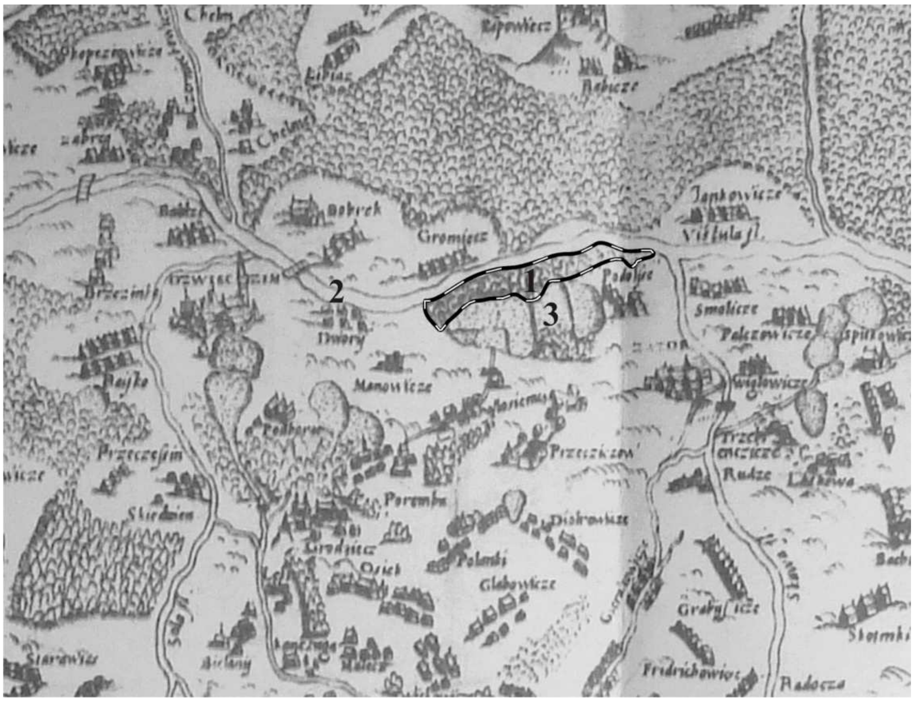

Fig. 1. Fragment of the Upper Vistula River Valley in the 16th century (after Krassowski *et al.* 1977). 1 – forest complex including future reserves; 2 – the Vistula River; 3 – breeding ponds

the Przeciszów nature reserves. The coefficient (W_{NF}) is the quotient of the roots from the sum of cover coefficients: the ancient woodland species and synanthropic species. However, the BRAUN-BLANQUET'S (1964) quantitative-cover scale should be transformed following the proposal by COETZEE and WERGER (DZWONKO 2007). The transformation of the scale makes it possible to promote species occurring in phytocoenoses numerously („r" to „5" amounts like 1:50), while at the same time, species present at low numbers will have a direct influence on the final result (this is important e.g. to synanthropic species at early stages of habitat colonisation).

$$W_{NF} = \begin{cases} \sqrt{\dfrac{\overline{P}_{las}}{\overline{P}_{syn}}} & \\ \sqrt{\overline{P}_{las}} & dla \quad \overline{P}_{las} > 0,\ \overline{P}_{syn} > 0 \\ \sqrt{\dfrac{1}{\overline{P}_{syn}}} & \end{cases} \qquad \begin{matrix} \overline{P}_{las} > 0,\ \overline{P}_{syn} > 0 \\ \overline{P}_{las} > 0,\ \overline{P}_{syn} = 0 \\ \overline{P}_{las} = 0,\ \overline{P}_{syn} > 0 \end{matrix} \qquad \overline{P} = \sum_{i=1}^{i=N} P_i / N$$

$$G\ (w\%) = \frac{g}{t}\ 100$$

W$_{NF}$ – coefficient of the floristic naturalness

$\overline{P}_{las}$ – mean cover of ancient woodland species within the given area

$\overline{P}_{syn}$ – mean cover of synanthropic species within the given area

$\overline{P}$ – mean cover of the group of species within the given area

P_i – sum of cover coefficients of the group of species in the relevé

N – number of relevés made within the study area

G – collective share of the group (in %)

g – sum of occurrences in the table of species from the given group

t – sum of occurrences of all species in the table, in total

The goal of the phytosociological studies in the reserves mentioned was the assessment of forest phytocoenoses in relation to the maintenance of their floristic composition. It should be stressed that the difference in the time of the conservation between the Żaki and the Przeciszów reserves amounts to 30 years.

The names of vascular plants follow MIREK *et al.* (2002), mosses – follow OCHYRA *et al.* (2003), and syntaxonomic units – MATUSZKIEWICZ (2002).

3. RESULTS

Results of the studies have been compiled in a phytosociological table (Tab. 1). A significant naturalness of the phytocoenoses studied is indicated there. First, in patches of oak-hornbeam-linden wood in both reserves character taxa that are quite numerous for the upper syntaxonomic units (alliance, order and class) are present, despite a complete lack of character taxa for the *Tilio-Carpinetum* association.

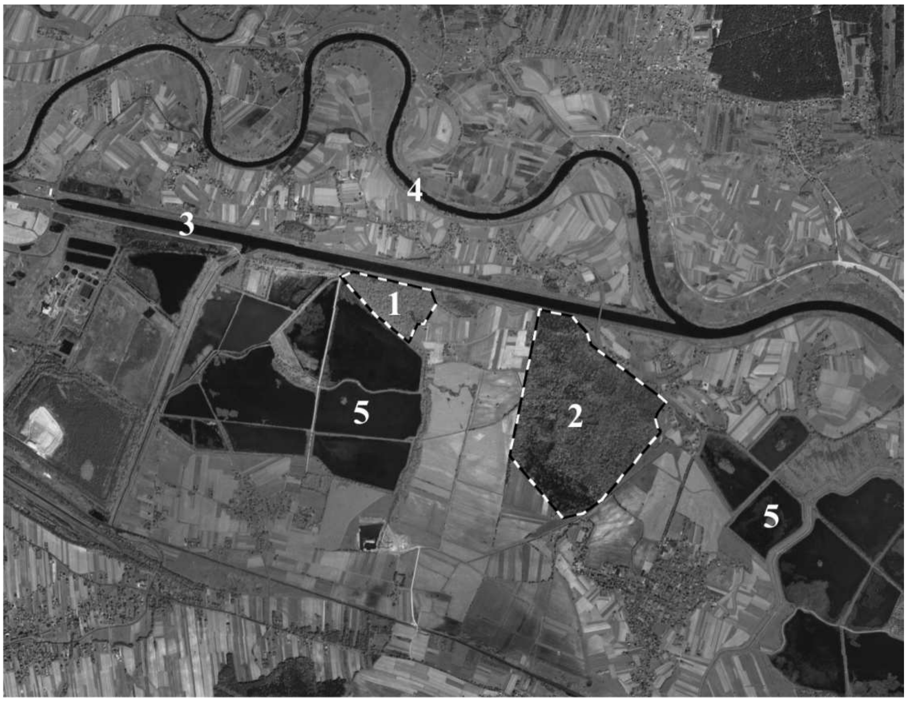

Fig. 2. Location of the nature reserves studied (source – Google Maps, changed). 1 – the Żaki reserve; 2 – the Przeciszów reserve; 3 – the Nawiga channel; 4 – the Vistula River; 5 – breeding ponds. Borders of the reserves are marked with white-black line

Secondly, good maintenance of the complexes analysed is proved by the significant share among vascular plants of the ancient woodland indicatory species (DZWONKO, LOSTER 2001; DZWONKO 2007). The collective share of that group (G) for the Żaki reserve amounts to 50.78%, and for the Przeciszów reserve – 47.31%. The limited abilities for spread and colonization of new areas in the case of ancient woodland indicators confirms the long-lasting presence of the woodlands in these areas. Therefore, the hypothesis based on an analysis of historical maps and stating that forests actually cover a small acreage within a strongly transformed Oświęcim Basin, but persist in their contemporary localities for hundreds of years, is true. Also the occurrence of anthropophytes (species diversity and quantity) indicates that vegetation cover is transformed to a low degree. The collective share of that group (G), represented exclusively in the material collected in the Przeciszów reserve amounts only 1.08%. A low degree of synanthropisation is also

Table 1. Phytosociological differentiation of vegetation in the Przeciszów and the Żaki nature reserves

Successive No.		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	33	34	35	Constancy
Date		03 V	07 VII	03 V	03 V	03 V	03 V	03 V	03 V	03 V	03 V	07 VII	03 V	03 V	07 VII	07 VII	07 VII	07 VII	07 VII	07 VII	08 V	08 V	08 V	08 V	08 V	16 VIII	16 VIII	16 VIII	16 VIII	16 VIII	16 VIII	16 VIII	16 VIII	16 VIII	16 VIII	16 VIII	
Density of tree layer a [%]		95	90	90	90	85	80	95	80	85	90	90	90	65	90	90	80	90	100	100	100	90	95	85	75	90	90	80	70	90	90	90	80	70	100	90	
Density of shrub layer b [%]		20	--	--	5	5	5	--	5	10	--	20	5	60	zn	--	70	10	30	10	zn	15	5	5	20	30	30	20	30	zn	10	20	70	30	10	40	
Cover of herb layer c [%]		100	90	90	85	95	95	80	85	80	85	50	70	60	50	90	30	70	90	100	90	95	75	80	95	80	100	90	90	70	70	80	50	100	90	70	
Cover of moss layer d [%]		--	5	--	5	30	20	--	--	zn	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	zn	--	--	--	--	--	--	--	--	--	--	
Area of relevé [m²]		150	100	150	100	150	150	150	100	100	100	100	150	100	100	100	100	100	100	100	120	120	150	120	120	200	200	200	200	200	200	200	200	200	200	200	
No. of species in the relevé		18	19	27	22	28	30	21	23	20	18	16	18	15	12	14	13	21	21	16	14	15	22	19	20	23	12	13	17	12	14	14	16	10	19	18	
No. of ancient woodland species		7	11	16	12	13	14	13	12	12	10	5	6	5	3	4	5	11	10	7	10	9	13	11	14	9	5	5	6	6	8	6	6	6	8	9	
No. of synanthropic species		0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Location of relevé		Przeciszów nature reserve																			Żaki nature reserve																
Ch. *Carpinion betuli*																																					
Tilia cordata	a	2.1	·	·	1.1	3.4	2.3	·	3.4	2.2	2.2	·	·	2.3	1.2	·	2.2	1.1	3.3	3.3	4.4	5.5	3.3	4.5	3.4	5.5	3.3	4.4	·	3.3	3.3	4.4	3.3	4.4	5.5	3.3	
Tilia cordata	b	+	·	·	·	1.1	·	·	1.1	·	·	·	·	·	·	·	·	·	·	·	+	2.2	·	1.1	1.2	2.2	2.3	2.3	2.3	·	+.2	1.2	1.2	2.3	1.2	2.2	V
Tilia cordata	c	·	·	·	+	+	+	·	r	·	·	·	·	·	·	·	·	·	·	·	+.2	·	+	·	·	·	·	·	·	·	·	·	+	·	·	+	
Carpinus betulus	a	4.4	3.3	4.4	3.4	2.2	2.1	4.5	·	3.3	2.2	4.4	3.4	·	3.3	4.4	2.2	3.3	2.2	2.2	4.5	·	3.3	·	·	·	·	·	·	4.4	2.3	·	1.2	·	1.2	2.2	
Carpinus betulus	b	·	·	·	1.1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1.1	·	·	·	·	·	2.2	·	+.2	1.2	+.2	1.2	·	1.2	IV
Carpinus betulus	c	·	·	r	·	·	·	·	·	1.1	1.1	+	2.3	r	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	
Stellaria holostea		·	·	·	·	·	·	·	·	**3.3**	**2.3**	**1.2**	**1.1**	·	·	·	·	·	·	·	·	·	·	·	·	**3.3**	**3.3**	**3.3**	·	·	·	·	·	·	·	·	**I**
Ch. ***Fagetalia + Querco-Fagetea***																																					
Acer platanoides	a	·	·	1.1	1.2	1.1	2.2	2.2	·	·	3.3	·	·	·	2.2	2.2	·	·	2.2	2.2	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	III
Acer platanoides	b/c	2.2	·	1.1	2.2	1.2	1.2	+	1.1	·	1.1	+	+	+	·	+	+	·	3.3	3.3	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	
Fraxinus excelsior	a	2.3	3.3	2.3	2.2	3.4	3.4	·	3.4	·	·	·	1.1	1.1	·	·	·	·	2.2	2.2	·	·	·	·	·	·	·	·	4.4	·	·	·	·	·	·	·	II
Padus avium	b	2.3	·	·	·	·	·	·	·	2.3	·	·	3.3	4.4	·	·	4.4	·	1.2	·	·	1.2	·	+.2	·	2.3	·	·	·	·	·	2.3	4.4	1.2	1.2	1.2	III
Padus avium	c	+.2	·	·	·	·	·	·	·	1.3	·	·	2.2	2.2	·	·	·	·	·	·	·	·	+	1.3	·	·	·	·	·	·	·	·	·	·	·	·	
Milium effusum		**+.2**	**1.2**	·	**1.2**	**1.2**	**2.2**	**+**	**1.2**	**+**	**+**	**2.3**	**+**	·	**2.3**	·	**1.2**	**3.3**	**2.2**	**+.2**	**+.2**	**+.2**	**+.2**	**+**	**2.2**	**3.3**	**2.3**	**2.3**	**3.3**	**4.4**	**4.4**	**3.3**	**3.3**	**3.3**	**4.4**	**3.3**	**V**
Aegopodium podagraria		**+**	**2.3**	**2.3**	**2.2**	**1.3**	**+.2**	**2.2**	**2.2**	**1.2**	·	·	·	·	·	**3.3**	·	**+**	**3.3**	**+**	**+**	**+**	**1.2**	**1.2**	·	**1.1**	**+**	**1.3**	·	**1.2**	**1.2**	·	**+**	**3.3**	**2.3**	·	**IV**
Polygonatum multiflorum		**+**	**1.3**	**+**	**2.3**	**1.3**	**1.2**	**1.1**	·	**+.2**	**+.2**	**1.2**	**1.2**	**+.2**	·	·	**+**	**+**	·	·	**+.2**	**+.2**	**1.2**	**1.2**	**2.2**	**1.1**	·	·	·	·	**+**	**+**	**+**	·	·	**+**	**IV**
Pulmonaria obscura		·	**2.3**	**1.2**	**2.2**	**2.2**	**2.3**	**1.2**	**2.2**	**+.2**	**1.2**	·	·	·	·	**1.2**	·	**1.2**	**+.2**	**3.3**	·	·	**1.2**	**+.2**	**+**	**+.2**	·	·	**+.2**	·	·	**+.2**	·	**+.2**	**+.2**	**+**	**IV**
Galeobdolon luteum		·	·	**+.2**	**1.2**	**2.2**	**1.2**	**1.3**	**1.2**	**2.2**	**1.1**	·	·	·	·	**3.3**	**2.2**	**1.2**	**1.2**	·	**1.1**	**2.2**	**2.3**	**1.2**	**3.4**	**+**	·	·	**+**	**1.1**	·	·	·	·	·	**1.1**	**III**
Mercurialis perennis		·	**3.3**	**1.2**	**2.3**	**+**	**1.3**	**+**	**2.2**	·	·	·	·	·	**2.3**	·	·	·	**+.3**	**3.3**	**+.2**	·	**1.2**	**1.2**	**2.3**	·	·	·	·	·	**+.2**	·	**+**	**+.3**	**+.2**	**1.1**	**III**
Impatiens noli-tangere		·	·	·	·	·	·	·	**3.4**	**+.2**	·	·	**+**	·	·	·	**1.2**	**1.2**	**1.2**	**2.3**	·	·	·	·	**+**	·	**+.2**	**+.2**	**+**	·	**+**	**1.1**	**+**	**1.1**	**1.1**	**1.1**	**III**
Anemone nemorosa		**3.3**	·	**1.2**	**3.3**	**2.3**	**2.3**	**4.5**	**+**	**2.3**	**3.4**	·	**2.3**	**3.3**	·	·	·	·	·	·	**2.3**	**2.3**	**4.4**	**3.4**	**3.3**	·	·	·	·	·	·	·	·	·	·	·	**III**
Ficaria verna		·	·	**+.2**	**1.2**	**4.5**	**5.5**	**3.3**	**2.3**	**2.2**	**2.3**	·	·	·	·	·	·	·	·	·	**2.3**	**1.2**	**2.2**	**2.3**	**2.3**	·	·	·	·	·	·	·	·	·	·	·	**II**
Allium ursinum		**5.5**	**3.3**	**5.5**	**4.4**	**1.2**	**+.2**	**+**	·	·	·	·	·	·	·	·	·	·	·	·	**5.5**	**5.5**	**1.2**	**1.2**	**+**	·	·	·	·	·	·	·	·	·	·	·	**II**
Sporadic species:		*Acer pseudoplatanus* 1a(1.1),6(r),8(r),11,13a(2.2),13(r),14; *Anemone ranunculoides* 6(1.2); *Atrichum undulatum* 4d(1.2),6d(1.2),12d,25d; *Carex sylvatica* 24; *Circaea lutetiana* 2,3(1.2),18(1.2),19,28; *Dryopteris filix-mas* 3,5,8,18,34; *Epipactis latifolia* 19; *Euonymus verrucosa* 26; *Eurhynchium* sp.2d; *Festuca gigantea* 35; *Gagea lutea* 7; *Galium odoratum* 7,10(3.3),14(2.3); *Hedera helix* 29(1.1),34; *Isopyrum thalictroides* 24(1.2); *Melica nutans* 10,11,15; *Paris quadrifolia* 22(1.2),29,30; *Plagiomnium undulatum* 2d(1.2),5d(2.3),6d(2.2); *Poa nemoralis* 17; *Primula elatior* 2; *Rubus hirtus* 5,10(r),19,27,35; *Stachys sylvatica* 28; *Stellaria nemorum* 5(1.3); *Ulmus scabra* 7a(3.3),8a(2.2),14b; *Veronica montana* 3; *Viola reichenbachiana* 4(r),9,25.																																			
Accompanying species																																					
Quercus robur	a	2.2	·	2.2	2.2	·	·	1.1	·	2.2	2.3	3.3	2.3	3.3	2.2	·	3.3	3.3	1.1	·	·	·	2.2	2.1	2.1	·	3.3	2.3	·	·	2.3	2.2	3.3	·	1.1	2.2	IV
Quercus robur	c	r	·	r	·	+.2	·	·	·	+	·	+	+	2.1	·	·	+	+	·	·	·	·	+	+	+	+	·	+	·	+	+	+	+	·	·	+	
Sambucus nigra	b	·	·	·	·	1.1	2.2	·	1.1	·	1.1	2.2	·	·	·	·	·	2.2	3.3	2.2	·	+	·	+	2.2	2.3	2.3	2.3	1.2	+.2	2.3	+.2	1.2	·	·	+.2	V
Sambucus nigra	c	+	·	+.2	1.2	+	2.2	+	1.1	+	r	·	r	·	·	+	+	·	·	+	+	·	1.2	1.2	1.2	·	·	·	·	+	·	·	·	·	+	+	
Euonymus europaea	b/c	·	·	·	·	·	+	·	·	·	·	·	·	·	+	+	·	+	·	·	·	+	·	·	·	+	·	·	+.2	·	·	·	·	·	+	+	II
Carex brizoides	c	+	+.2	·	·	1.2	1.2	+.2	1.2	2.2	·	+	3.4	3.3	+.2	+.2	+	1.2	1.2	+.2	·	·	+.2	2.3	+.2	·	2.3	3.3	+.2	+.2	·	4.4	1.3	·	1.3	+.3	IV
Oxalis acetosella		**2.3**	·	**+.2**	·	**+.2**	**1.2**	·	**1.3**	**2.2**	·	·	·	**+**	·	·	**2.3**	·	·	·	**1.2**	**+.2**	**2.3**	**1.3**	**2.2**	·	·	**+.2**	·	**+.2**	**+.2**	**+.2**	·	·	·	**+.2**	**III**
Anthriscus nitida		**+.2**	·	**+**	**+.2**	**2.2**	**+**	**1.1**	·	·	·	·	·	·	·	·	·	·	·	·	·	·	**+**	**+**	**+.2**	**+**	**+**	·	·	·	**+**	**+**	**+.2**	**+.2**	**2.3**	**2.3**	**III**
Galium aparine		1.2	·	1.2	+	+	+.2	1.2	1.2	1.2	+.2	·	+.2	·	·	r	·	·	·	·	1.2	2.2	+	1.2	1.2	·	·	·	2.3	·	·	·	·	·	·	·	III
Glechoma hederacea		+	+.2	+.2	·	2.3	·	·	·	1.2	·	·	·	·	·	·	·	+.2	+.2	·	·	·	1.2	2.2	2.2	+	·	+	·	·	2.3	+	+	1.1	+	·	III
Sporadic species:		*Abies alba* 3a,12a(1.1),15a(1.1); *Ajuga reptans* 2,4,6,8,9.17; *Alliaria officinalis* 15,17; *Alliaria petiolata* 4,6,7,25,28,35; *Alnus glutinosa* 12a(1.1),18a(1.1); *Athyrium filix-femina* 3(1.2),13,17,18(1.2),19; *Betula pendula* 19a(1.1); *Brachythecium rutabulum* 4d(1.2),5d(1.2); *Cardamine pratensis* 6,8; *Ceratodon purpurescens* 25d; *Chaerophyllum temulum* 2,11(1.2),15,18(1.2); *Chelidonium majus* 12; *Crataegus monogyna* 23b,32,34,35b(2.2); *Convallaria majalis* 10,17(2.3); *Deschampsia caespitosa* 26; *Dryopteris carhtusiana* 2,8,12,18(1.2); *Dryopteris dilatata* 13; *Euonymus europaea* 6,14,15,17,25,28,34; *Fissidens taxifolius* 2d; *Frangula alnus* 5b (1.1); *Galeopsis pubescens* 21,27,30,32,34; *Galeopsis speciosa* 26,27,29,31,32; *Geranium palustre* 25,28; *Geum urbanum* 2,6,11,25; *Impatiens parviflora* 16(1.3); *Juncus* sp. 13; *Lamium maculatum* 3; *Larix europaea* 8a(r),10a(1.1); *Maianthemum bifolium* 3,7(1.2); *Mycelis muralis* 17; *Picea abies* 28a(1.1);*Plagiomnium cuspidatum* 5d(1.2),6d(1.2),25; *Plagiomnium rostratum* 25d; *Ribes rubrum* 3,5,6; *Rubus caesius* 25; *Rubus idaeus* 13; *Symphytum tuberosum* 3,20(1.2),21,22(1.2),24(1.2); *Urtica dioica* 8(1.2),17,28(2.3); *Valeriana sambucifolia* 3.																																			

evidenced by the value of the floristic naturalness coefficient (W_{NF}) – in the Żaki reserve it achieves a value of 10.12 and in the Przeciszów – 9.56.

The areas studied are the forest islands among rural areas. Both are of different acreages and have a different protection history. The protection has however meant that they have been excluded from management and this has decreased threats of vegetation cover caused by anthropopressure. In particular, it reveals certain changes in habitat conditions. Unfortunately, changes occurring (e.g. at hydrological systems) have not retreated. In spite of this, the vegetation in both reserves still remains significantly natural and it is anthropogenically transformed only to a low degree. Between the Żaki and the Przeciszów nature reserves there are no distinct varieties. Anthropogenic transformations are insignificant and do not reveal the entire area of the areas studied, only fragments (e.g. *Pinus strobus* plantation in the Żaki reserve). Therefore, it can be expected that the oak-hornbeam-linden phytocoenoses will also maintain their naturalness in the future.

4. DISCUSSION

Nature reserves play an important role in the Polish system of nature protection. Together with national parks and Nature 2000 they maintain the most valuable fragments of the natural environment. They play a significant role in the protection of forest communities, especially within areas significantly transformed by man, where the area of patches maintained is small, and therefore the other mentioned forms of protection cannot be applied. Despite their important functions many nature reserves in Poland cannot fulfill their tasks in an appropriate way and therefore, the degree of maintenance of the plant cover there is not good.

The original coefficient of floristic naturalness (W_{NF}) was used for the assessment of the degree of maintenance in relation to forest communities. It also seems to be useful for the comparison of forest vegetation transformations, even without detailed floristic field studies. Because of the presented method, it is possible to plan for the future e.g. using materials compiled at assessments of nature (valorisations) or management plans for protected forest areas – as it was before. On the one hand, these are valuable as a historic data, because they are often the only source of knowledge about the vegetation at that time and they allow for conclusions regarding its transformations to be made. On the other hand, the validity and accuracy of some elaborations of that type is doubtful (HOLEKSA *et al.* 2008). Nevertheless, an instrument using two quite easily recognised groups of plants: ancient woodland species and synanthropic species seems to be very practical.

The degree of flora and vegetation transformations depends on many factors. The date of the establishment of the protection form is important, as well as conservation activities (not always appropriately selected). Many unfavourable transformations made by man before the establishment of the reserves have a long-lasting effect on their plant cover. For instance: changes in the water regime and the introduction of alien species (*Pinus strobus*) influenced the plant cover of the Żaki reserve in the direct vicinity of these places (WILCZEK *et al.* 2008). Moreover, the acreage and the shape of protected area play a crucial role in the maintenance of forest communities. BABCZYŃSKA-SENDEK *et al.* (1993) proved the distinct influence of reserves' acreage to the threat of their flora by the synanthropisation process. In the case of the areas they have studied an area of 10 ha provided the minimum resistance of ecosystems to some types of unfavourable changes. This problem was also studied and recognized by HOLEKSA (1993, 1997). He stressed the crucial role of acreage for effective maintenance of a forest during the entire natural life cycle, from regeneration, through development, and old age, and on to the natural death. As an area, which guarantees the functioning of these processes that shape the dynamics and structure of mixed fir-spruce-beech forests in the West Carpathians' lower belt, he suggests 42 to 100 plus ha (for the central zone to have the appropriate protection). The shape is closely connected with the dimensions of protected areas. A long border increases the probability of unfavourable influences from neighbouring areas. The more the shape of the reserve differs from a circle, the higher the relation of the periphery to acreage and the „edge effect" is more distinctive (PULLIN 2004). However, small nature reserves and those with an excessively developed borderline are supported by transition zones, which surround them and create an additional barrier against the influence of external factors.

The way areas adjacent to nature reserves are used is another factor which influences the naturalness of their plant cover. Studies of ADAMOWSKI *et al.* (1998)

indicate that the number of alien to forest species correlates with the degree of habitat degradation and plant community transformation. The deposit of rubbish at forest edges, herb layer trampling or grazing – strongly influence the process of the penetration and dispersion of alien taxa in forest complexes. Also phytocoenoses of protected areas neighbouring settlements and transportation routes are characterized by a significant degree of degeneration (GORCZYCA 2008). Transportation routes (represented by: asphalt routes and cart-roads, paths or river valleys) make the appearance of anthropophytes quite easy. The important role of transportation routes in the synanthropisation process of forest phytocoenoses was stressed by PAWLACZYK (1993). Among other factors causing forest transformations he also mentioned: the use and cultivation of forest (especially cuttings), the conscious introduction and unconscious bringing of alien species (that became a fact in the Żaki reserve), trampling and grazing and – what seems to be particularly important regarding this study – the fragmentation of forest complexes and the creation of long borderlines between forests and land used for agriculture or non-forest areas used in other ways. Plant communities (representing the *Rhamno-Prunetea* class and the *Trifolio-Geranietea sanguinei* class) on the edges of forests play a particular role in the synanthropisation process of forest phytocoenoses – as PAWLACZYK (1993) notes after BALCERKIEWICZ, KASPROWICZ (1989). They can speed up the synanthropisation process (as a „starting points" for invasive neophytes) or stop it (making the appearance and colonization of neophytes more difficult). SIERKA and CHMURA (2007) studied problems related to invasive and expansive species in the forest reserves of the Silesian-Cracow Upland. Among the factors which increase the frequency of the occurrence of invasive and expansive species in forest communities they noted: location of protected areas in the vicinity of settlements, intensive penetration by tourists and local people, fragmentation of phytocoenoses and habitat diversity. These elements influenced both: the encroachment and colonization of forest reserves by these taxa.

5. CONCLUSIONS

- The share of ancient woodland indicators and synanthropic species in phytocoenoses allows for the coefficient of floristic naturalness to be counted, which makes the assessment of anthropogenic transformations of forest vegetation possible.
- Strong and long-lasting anthropopressure has not caused significant changes in the species composition and vertical structure of the phytocoenoses studied.
- Shrubs surrounding the forest edge of the reserves studied influence the microclimatic conditions in the forest communities in a positive way and can form a natural barrier against the penetration and expansion of synanthropic species. The synanthropisation process of forest communities is probably also limited by neighbouring agricultural lands.

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