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Abietetum albae plant association from “Murowaniec” nature reserve in Central Poland

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Abstract: The study presents the structure and floristic composition of mixed fir forest at the northern range limit of European silver fir (*Abies alba*) in Poland. Phytosociological data were collected in the forest reserve “Murowaniec”, which was established to protect mixed forest ecosystems with a large contribution of fir trees. Changes in floristic composition of these coniferous forests in the last 40 years were discussed. Protective measures are suggested in this paper, aiming at conservation of the forest ecosystems of the reserve.

Additional key words: *Abietetum albae*, „Murowaniec” nature reserve, protection strategy

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Introduction

The plant association *Abietetum albae* was first described from the Świętokrzyskie Mts. (Dziubałtowski 1928). Its typical forms have a limited range of distribution, including mainly the South Polish Uplands (Matuszkiewicz J. 2001). In other parts of Poland, phytocoenoses of this forest association are floristically poor. Such forms were found, for example, in the Kraków–Częstochowa Upland, Łódź–Wieluń Plateau and the Central Małopolska Uplands (Hereźniak 1993). Although this community was described very early, its delimitation has been the most frequent problem in later phytosociological works (Matuszkiewicz J. 2001). In particular, this applied to its forms from the borders of its range, as their floristic composition deviates from the type. Similar forest ecosystems are present also in the reserve “Murowaniec” in Central Poland. The first geobotanical data on forest communities in the reserve were presented by Olaczek (1965). He classified the mixed forest

stands with fir trees as *Pino-Quercetum abietetosum*, emphasizing that this is only a preliminary diagnosis. Recently, however, Hereźniak (2002) postulated that they should be classified as *Abietetum polonicum*. Currently, a rich geobotanical documentation of *Abietetum* is available from other parts of Poland (Matuszkiewicz J. 1977, 2001; Brzeg, Rutkowski 2004; Marciniuk, Wierzba 2004).

Study area

The reserve “Murowaniec” (41.6 ha) was established in 1963, to protect the multi-layered, nearly primeval forest with a large contribution of the European silver fir (*Abies alba*) at the northern limit of its range. The whole area of the reserve is owned by the State Treasury and is a part of the Radomsko Forest District. It lies in the Pajęczno Commune and District within the Łódź Province. According to the regional division by Kondracki (1998), it is located in the Nizina Południow Wielkopolska Lowland, in the

Szczerców Basin. In the geobotanical classification of Poland (Szafer 1977), the reserve is situated in the Euro-Siberian Region, Central European Lowland-Upland Province, Baltic Division, Central Upland Belt Subdivision, Northern Peripheral Plateau Land and Widawa District.

There are acid brown-earth and pseudogley soils in the reserve. In the classification of forest site types (Forest Management Plan... 1988–1997), the study area consists of fresh broad-leaved forest sites and a small proportion of fresh mixed forest sites.

In the reserve, floristic and phytosociological studies were conducted by Olaczek (1965), Klama et al. (1999), Urbański (2004) and Górski (2005).

Material and methods

Field research was conducted in 2004. Geobotanical documentation included all types of forest communities of the reserve (see Fig. 1), but this study presents only material concerning the floristic composition and differentiation of phytocoenoses of *Abietetum albae*. Relevés were made according to the classic Braun-Blanquet method (Pawłowski 1966, Dierschke 1994). Distribution of the documented phytocoenoses is shown in figure 1. The degree of cover by individual species was assessed on the modified scale of Barkman et al. (1964). The constancy values and cover coefficients were computed according to the procedure proposed by Pawłowski (1966). The differentiation of floristic composition of the distinguished types of phytocoenoses is presented in analytic and synthetic tables (Tables 1–2). The tables are based on data from a total of 21 relevés, either original or published by Olaczek (1965).

The classification and names of forest associations followed Matuszkiewicz W. (2001). Syntaxonomic diagnoses of species were based on works by Matuszkiewicz J. (1977, 2001) and Matuszkiewicz W. (2001).

The names of plant species followed Mirek et al. (2002) for vascular plants, Ochyra et al. (2003) for mosses, and Schumacker and Váňa (2000) for liverworts.

Results

Community structure

The mixed fir forest in the reserve “Murowaniec” is a multi-layered forest stand, whose tree layer is dominated by the European silver fir (*Abies alba*), with an admixture of the pedunculate oak (*Quercus robur*) and Scots pine (*Pinus sylvestris*). Sporadically (and with a low degree of cover), there is also a small admixture of hornbeam (*Carpinus betulus*), sessile oak (*Quercus petraea*), silver birch (*Betula pendula*), or – planted singly – European larch (*Larix decidua*). The

mean degree of cover by the tree layer is 60% and the maximum value is 80%. The shrub layer is formed mainly by the fir, pedunculate oak, and hazel (*Corylus avellana*), with an admixture of hornbeam, Norway spruce (*Picea abies*), silver birch, aspen (*Populus tremula*), and alder buckthorn (*Frangula alnus*). In some places, the shrub cover is very dense, limiting the development of lower layers of vegetation. The mean degree of cover by the shrub layer is 40% and the maximum value is 80% again. Within the herb layer, 48 species have been recorded. Its physiognomy is determined by *Oxalis acetosella*, *Rubus pedemontanus* and *Dryopteris carthusiana*. The degree of cover by this layer ranges from 5% to 80%. Bryophytes growing on the ground are important elements of the structure of this forest ecosystem. As in the case of the herb layer, the degree of cover by the moss layer depends on the density of the shrub layer. It reached up to 60% (mean 30%). Among bryophytes, the most common in the studied forest patches are *Eurhynchium angustirete* and *Plagiomnium affine*.

Floristic and phytosociological characterization of the association

The floristic composition of fir forest in the studied reserve includes species of the following ecological-syntaxonomic groups (see Table 1):

- differential species of fir and spruce forests (suballiance *Vaccinio-Abietenion*): mainly fir as a dominant component of the tree layer, and the herbaceous *Athyrium filix-femina* and *Fagus sylvatica*;
- differential species of mixed coniferous forests: *Galeobdolon luteum*, *Mycelis muralis* or *Carex digitata*;
- species of acidophilic coniferous forests (class *Vaccinio-Piceetea*); however, with low participation of *Pinus sylvestris*, *Lycopodium annotinum*, *Vaccinium myrtillus*;
- species of fertile deciduous forests (class *Querc-Fagetea*): hazel and hornbeam (mainly in the shrub layer), *Eurhynchium angustirete* and *Milium effusum*.

Beside the fir, a species characteristic of *Abietetum polonicum* is the moss *Thuidium tamariscinum*. In the reserve, it was found in four of nine the documented patches, although its degree of cover was low. Among the differential species distinguishing this association from other fir-spruce forest communities, the following were present in the reserve: *Rubus pedemontanus* – a constant and dominant component of the forest floor – as well as *Atrichum undulatum*.

A large group of species of fir forests in the reserve is composed of typical forest species, associated mainly with coniferous forests, acidophilic oak forests and beech forests. They are constant elements of the described phytocoenoses, and they usually accounted for a large proportion of the cover by the herb



Fig. 1. "Murowaniec" nature reserve – the current vegetation and survey map

Table 1. Phytocoenoses of *Abietetum albae* Dziubałtowski 1928 from “Murowaniec” nature reserve

Successive number	1	2	3	4	5	6	7	8	9	Con- stancy	Cover coeffi- cient	
Number of relevé in the field	18	17	9	8	16	12	13	15	14			
Forest division	37a	36g	36g	37d	37d	36g	37a	37d	37a			
Area of relevé [m ²]	200	200	400	400	200	400	200	200	200			
Cover of tree layer [%]	70	50	80	50	40	80	75	40	75			
Cover of shrub layer [%]	80	60	40	15	20	30	30	30	30			
Cover of herb layer [%]	5	10	10	80	80	70	70	60	70			
Cover of moss layer [%]	1	2	15	60	25	25	10	50	60			
	2	2	1	1	2	2	2	2	2			
Date	10	10	10	10	10	10	10	10	10			
	2004	2004	2004	2004	2004	2004	2004	2004	2004			
Number of species	21	28	20	22	19	26	25	22	24			
I. ChAss. <i>Abietetum polonicum</i>												
<i>Abies alba</i>	a	3.4	2.1	4.4	3.4	3.3	4.4	4.4	3.2	4.4	V	4639
	b	4.5	3.3	3.4	2.1	1.1	1.1	+	.	1.1	V	1894
	c	+	+	+	r	+	1.1	+	1.1	+	V	146
<i>Thuidium tamariscinum</i>		r	.	.	.	1.2	.	.	1.2	+	II	112
II. Differential species of <i>Abietetum</i>												
<i>Rubus pedemontanus</i>		r	r	+	3.4	3.3	3.4	4.4	3.4	4.4	V	3063
<i>Milium effusum</i> (Ch. III)		.	+	+	1.1	1.1	+	1.1	1.1	+	V	244
<i>Urtica dioica</i>		+	+	r	+	+	+	+	+	+	V	46
<i>Geranium robertianum</i>		.	.	+	.	+	+	.	.	.	II	17
<i>Atrichum undulatum</i> (Ch. III)		r	r	.	.	.	.	+	.	.	II	8
<i>Dryopteris dilatata</i> (Ch. IV)		.	.	.	.	r	.	.	.	.	I	1
<i>Gymnocarpium dryopteris</i>		.	.	.	.	.	.	.	.	+	I	6
III. ChCl. <i>Quercus-Fagetea</i>												
<i>Carpinus betulus</i>	a	.	.	1.1	.	.	.	.	.	.	I	56
	b	.	1.1	.	.	.	+	2.1	.	1.1	III	311
	c	.	r	.	.	.	+	.	.	.	II	7
<i>Fagus sylvatica</i>	b	.	.	.	.	.	.	1.1	.	1.1	II	111
<i>Ulmus glabra</i>	b	.	.	.	.	.	.	+	.	.	I	6
<i>Padus avium</i>	b	.	.	.	+	1.1	.	.	2.1	.	II	256
<i>Corylus avellana</i>	b	1.1	2.1	1.1	1.1	1.1	2.1	+	1.1	.	V	672
<i>Tilia cordata</i>	b	+	.	.	.	.	.	.	.	+	II	11
<i>Eurhynchium angustirete</i>		.	+	1.2	3.3	2b.4	1.2	.	2b.4	1.1	IV	1033
<i>Viola reichenbachiana</i>		+	+	+	.	.	.	.	.	.	II	17
<i>Galeobdolon luteum</i>		.	.	.	r	.	2.2	+	1.1	.	III	257
<i>Stachys sylvatica</i>		.	r	.	.	.	r	+	.	+	III	13
<i>Carex digitata</i>		.	r	.	.	.	+	r	.	.	II	8
<i>Pulmonaria obscura</i>		.	r	.	.	.	.	r	.	.	II	2
<i>Sanicula europaea</i>		.	r	.	.	.	.	.	.	.	I	1
<i>Aegopodium podagraria</i>		r	.	.	.	.	.	.	.	.	I	1
<i>Melica nutans</i>		.	.	.	.	.	+	.	.	.	I	6
<i>Hepatica nobilis</i>		.	.	.	.	.	r	.	.	.	I	1
<i>Galium odoratum</i>		.	.	.	.	.	.	+	.	.	I	6
<i>Circaea lutetiana</i>		.	.	.	.	.	.	+	.	.	I	6
<i>Dryopteris filix-mas</i>		.	.	.	.	.	.	.	+	.	I	6

Successive number	1	2	3	4	5	6	7	8	9		
VI. ChCl. <i>Vaccinio-Piceetea</i>											
<i>Pinus sylvestris</i>	a	.	.	.	.	1.1	.	.	.	I	56
<i>Vaccinium myrtillus</i>	.	r	.	.	.	.	.	.	.	I	1
<i>Picea abies</i>	b	.	.	.	.	.	.	r	.	I	1
<i>Lycopodium annotinum</i>	.	.	.	.	.	.	.	.	r	I	1
VII. Others											
<i>Oxalis acetosella</i>	1.1	1.1	1.1	4.4	3.4	3.4	2.1	2.2	3.3	V	2500
<i>Plagiomnium affine</i>	r	+	2a.2	3.3	2a.2	2.2	2a.1	2b.4	3.4	V	1590
<i>Dryopteris carthusiana</i>	r	r	+	1.1	2.1	r	.	+	+	V	270
<i>Luzula pilosa</i>	r	.	r	.	+	r	r	+	.	IV	16
<i>Maianthemum bifolium</i>	r	r	r	r	.	+	r	.	.	IV	11
<i>Pteridium aquilinum</i>	.	.	.	+	1.1	1.1	.	2.1	1.1	III	367
<i>Athyrium filix-femina</i>	+	.	.	+	1.1	.	.	r	r	III	69
<i>Rubus idaeus</i>	.	.	.	1.1	+	+	.	.	+	III	72
<i>Galeopsis pubescens</i>	.	.	.	+	+	.	.	.	r	II	12
<i>Moehringia trinervia</i>	r	r	r	.	.	.	.	.	.	II	3
<i>Geum urbanum</i>	r	r	.	.	.	.	+	.	.	II	8
<i>Viscum album</i> subsp. <i>abietis</i>	o	.	.	.	.	o	.	.	o	II	0
<i>Mycelis muralis</i>	.	r	+	r	.	.	.	.	.	II	8
<i>Sambucus nigra</i>	.	r	+	.	.	.	.	.	.	II	7
<i>Sorbus aucuparia</i>	.	.	r	.	.	r	.	.	.	II	2
<i>Hedera helix</i>	.	r	.	+	.	.	.	.	.	II	7
<i>Hieracium murorum</i>	r	.	.	.	.	.	.	.	.	I	1
<i>Deschampsia caespitosa</i>	.	.	r	.	.	.	.	.	.	I	1
<i>Ajuga reptans</i>	.	r	.	.	.	.	.	.	.	I	1
<i>Viola canina</i>	.	r	.	.	.	.	.	.	.	I	1
<i>Veronica officinalis</i>	.	.	.	.	.	.	.	r	.	I	1
<i>Quercus robur</i>	a	2.1	2.1	.	1.1	.	.	.	+	III	450
	b	.	.	.	.	.	.	r	.	I	1
	c	+	+	.	.	.	+	.	.	II	17
<i>Populus tremula</i>	a	.	1.1	.	.	.	.	.	.	I	56
	c	.	+	.	.	.	.	.	.	I	6
<i>Betula pendula</i>	a	.	.	.	.	.	.	+	.	I	6
<i>Larix decidua</i>	a	.	.	.	.	.	+	.	.	I	6
<i>Sorbus aucuparia</i>	b	.	1.1	.	.	.	+	1.1	+	III	122
<i>Frangula alnus</i>	b	.	.	.	.	.	.	.	1.1	I	56
<i>Polytrichastrum formosum</i>	.	.	.	.	.	+	.	.	1.3	II	61
<i>Dicranella heteromalla</i>	r	.	.	.	.	.	.	r	.	II	2
<i>Sciuro-hypnum oedipodium</i>	.	.	.	+	.	.	.	.	.	I	6
<i>Cornus sanguinea</i>	b	.	.	.	+	.	.	.	.	I	6
<i>Polytrichastrum longisetum</i>	.	.	.	+2	+	.	+	.	.	II	17
<i>Oxyrrhynchium speciosum</i>	.	.	.	.	.	.	+	.	.	I	6
<i>Chiloscyphus profundus</i> on soil	.	.	.	.	.	.	+	.	.	I	6
<i>Sambucus nigra</i>	b	.	.	.	.	.	.	.	+	I	6
<i>Quercus petraea</i>	c	.	.	r	.	.	.	.	.	I	1

Table 2. Floristic composition of phytocoenoses of *Abietetum albae* from reserve documented in the 60's and currently

Number of column		1	2			
Source of data		Olaczek (1965)	original			
Number of relevés		12	9			
Total number of species in the table		90	77			
I. D Vaccinio-Abietenion						
<i>Abies alba</i>	a	V	5208	V	4417	ChAss. <i>Abietetum</i>
	b	V	5417	V	1894	
	c	V	1021	V	146	
<i>Hieracium murorum</i>		IV	146	I	1	
<i>Athyrium filix-femina</i>		III	279	III	69	
<i>Fagus sylvatica</i>	b			II	111	
	c	I	4			
II. ChCl. Vaccinio-Piceetea						
<i>Picea abies</i>	b	III	142	I	1	
	c	II	17			
<i>Pinus sylvestris</i>	a	IV	338	I	56	
	b	II	54			
	c	III	63			
<i>Pleurozium schreberi</i>		V	1896			
<i>Trientalis europaea</i>		V	525			
<i>Vaccinium myrtillus</i>		V	3229	I	1	
<i>Lycopodium annotinum</i>		III	463	I	1	
III. Differential species of acidophilous mixed forests						
<i>Carex digitata</i>		IV	250	II	8	ChCl. <i>Quercus-Fagetea</i>
<i>Veronica officinalis</i>		V	304	I	1	
<i>Mycelis muralis</i>		IV	221	II	8	
<i>Galeobdolon luteum</i>		I	8	III	257	ChCl. <i>Quercus-Fagetea</i>
<i>Anemone nemorosa</i>		III	413	o		ChCl. <i>Quercus-Fagetea</i>
<i>Fragaria vesca</i>		IV	363			
IV. D Abietetum polonicum						
<i>Rubus hirtus et pedemontanus</i>		?		V	3063	
<i>Thuidium tamariscinum</i>		III	179	II	112	ChAss. <i>Abietetum</i> (reg.)
<i>Atrichum undulatum</i>		III	317	II	8	ChCl. <i>Quercus-Fagetea</i>
<i>Dryopteris dilatata</i>				I	1	
<i>Hieracium lachenalii</i>		III	58			
<i>Cruciata glabra</i>		I	8			
IVa. Differential species of moist form of <i>Abietetum</i> - <i>Abietetum circaeetosum</i>						
<i>Urtica dioica</i>				V	46	
<i>Geranium robertianum</i>				II	17	
<i>Gymnocarpium dryopteris</i>		I	42	I	6	
V. ChCl. <i>Quercus-Fagetea</i>						
<i>Corylus avellana</i>	b	V	658	V	672	
	c	IV	33			
<i>Carpinus betulus</i>	a	I	83	I	56	
	b	V	567	III	311	
	c	II	92	II	7	
<i>Eurhynchium angustirete</i>				IV	1033	
<i>Milium effusum</i>		II	50	V	244	
<i>Melica nutans</i>		II	333	I	6	
<i>Hepatica nobilis</i>		I	46	I	1	
<i>Sanicula europaea</i>		I	46	I	1	

Number of column		1		2	
<i>Pulmonaria obscura</i>		I	4	II	2
<i>Padus avium</i>	b			II	256
<i>Stachys sylvatica</i>				III	13
<i>Viola reichenbachiana</i>				II	17
<i>Dryopteris filix-mas</i>				I	6
<i>Galium odoratum</i>				I	6
<i>Aegopodium podagraria</i>				I	1
<i>Tilia cordata</i>	b	I	8	II	11
	c	I	4		
<i>Galium schultesii</i>		I	8		
VI. Others					
<i>Oxalis acetosella</i>		V	838	V	2500
<i>Luzula pilosa</i>		V	708	IV	16
<i>Maianthemum bifolium</i>		V	1125	IV	11
<i>Dryopteris carthusiana</i>		III	104	V	270
<i>Rubus idaeus</i>		IV	329	III	72
<i>Pteridium aquilinum</i>		V	550	III	367
<i>Hedera helix</i>		III	96	II	7
<i>Moehringia trinervia</i>		II	50	II	3
<i>Frangula alnus</i>	b	III	138	I	56
	c	IV	33		
<i>Sorbus aucuparia</i>	b	V	813	III	122
	c	V	125	II	2
<i>Quercus robur</i>	a	IV	546	III	450
	b	V	1279	I	1
	c	V	621	II	17
<i>Populus tremula</i>	a	I	42	I	56
	b	III	246		
	c	V	117	I	6
<i>Ajuga reptans</i>		III	100	I	1
<i>Betula pendula</i>	a	I	42	I	6
	b	V	450		
	c	V	79		
<i>Quercus petraea</i>	a	II	125		
	b	III	650		
	c	II	88	I	1
<i>Deschampsia caespitosa</i>		I	4	I	1
<i>Polytrichastrum formosum</i>		V	3129		
<i>Viola riviniana</i>		IV	467		
<i>Carex pilulifera</i>		IV	329		
<i>Calamagrostis arundinacea</i>		III	279		
<i>Convallaria majalis</i>		III	171		
<i>Lycopodium clavatum</i>		III	63		
<i>Hieracium sabaudum</i>		II	92		
<i>Galium boreale</i>		II	88		
<i>Veronica chamaedrys</i>		II	50		
<i>Astragalus glycyphyllos</i>		II	50		
<i>Melampyrum nemorosum</i>		II	50		
<i>Festuca ovina</i>		II	17		
<i>Plagiomnium affine</i>				V	1590
<i>Galeopsis pubescens</i>				II	12
<i>Dicranella heteromalla</i>				II	2

Shortened table

layer. This group includes *Oxalis acetosella*, *Luzula pilosa*, *Maianthemum bifolium*, *Pteridium aquilinum*, *Rubus idaeus*, and in some places also the stinging nettle (*Urtica dioica*).

In the study area, patches of *Abietetum* can be divided into two physiognomic forms (treated here as non-typological units):

- 1) a form with a dense shrub layer (up to 80%), dominated by fir saplings, so that the degree of cover by the herb layer is only about 10%, while by the moss layer ranges from 1 to 15% (see Table 1, relevés 1–3); such patches are very shaded and difficult to walk through;
- 2) a form with *Rubus pedemontanus*, which can be termed an “open” fir forest: the degree of cover by the shrub layer is much lower (15–30%); the herb layer is dominated by *R. pedemontanus*, with numerous herbaceous species; the moss layer has a high degree of cover and is dominated by *Plagiomnium affine* and *Eurhynchium angustirete* (see Table 1, relevés 4–9).

Assessment of the degree of naturalness of *Abietetum* phytocoenoses in the reserve

The mixed fir forest in the study area has many features of natural forest. It has the characteristic multi-layered horizontal structure and its tree layer is composed of trees varying in age. The naturally conditioned biodiversity of the ecosystem is enriched by mosses, liverworts, lichens, and fungi growing on rotting wood. The best-preserved phytocoenoses of *Abietetum* are found in the southern part of the reserve (plots 37d and 36g). Well-preserved patches are also present on plots 37a and the northern part of plot 36g.

The north-eastern part of the reserve (plots 36a–d and 36f) is a degenerated form of *Abietetum*. In this part of the reserve, the forest stand was planted (Olaczek 1965). Its physiognomy resembles the continental mixed coniferous forest, composed of pine, oak, and some fir trees (Hereźniak 2002). Nevertheless, the composition of its herb layer and the large numbers of fir saplings indicate that this patch should be assigned to *Abietetum*.

Discussion

The line-up presented in Table 2 shows that during the last 40 years there have been significant changes in floristic composition of mixed fir forest in the reserve. Current phytocoenoses are markedly poorer, compared to the data from the 60's. The number of acidophilous species and their participation in the plant cover decreased. Particularly low participation of *Vaccinium myrtillus* was noticed (see Table 2). *Pleurozium schreberi* was not found in our study. It is worth noting that this species, formerly abundant in patches of *Abietetum* (Olaczek 1965), has not been re-

ported in simultaneous bryological studies as well (Urbański 2004). On the other hand, *Eurhynchium angustirete* occurred with the same frequency and participation in moss layer.

Comparing the map of distribution of *Pino-Quercetum abietetosum* patches (see Olaczek 1965, Fig. 1) to current distribution of mixed fir forests in the reserve (Fig. 1 in this article), one can notice a decrease in the acreage of *Abietetum* phytocoenoses in the western part and their transformation into *Tilio-Carpinetum*. Succession changes of the forests recognized earlier as *Pino-Quercetum abietetosum* into *Tilio-Carpinetum* have been documented by Wozniwoda (2002).

The lack of spruce, which is present in phytocoenoses of *Abietetum* outside of the reserve (Matuszkiewicz J. 1977, 2001; Brzeg, Rutkowski 2004; Marciniuk, Wierzba 2004), results from the earlier forest management in the reserve. This is confirmed by forestry records about the presence of spruce trees in the tree layer from the interwar period. However, spruce restores in the “Murowaniec” reserve at present.

Suggested protective measures

The protection of forest ecosystems should consist in preserving the undisturbed course of natural processes of forest dynamics in all developmental phases of the forest stand (also at the phase of tree death). This means that the reserve should not be subject to any form of forest management. Dead trees, both standing and fallen ones, must continue to be left in the reserve. Foresters should not make any attempts to change the structure of the tree layer, particularly in the northeastern part of the reserve. Epiphytic mosses and liverworts are important elements of the vegetation of the reserve. Their protection is possible by means of preventing a local reduction of the humidity of the forest interior. It is advisable to create a buffer zone around the reserve, where forest management (especially decreasing the density of the tree and shrub layer) would be limited. Along the western edge of the reserve, the forest ecosystems border on arable fields, so they are exposed to the drying influence of winds from that direction; hence, a dense shrub layer should be allowed to develop there.

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