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Macrofungi of *Aceri-Tilietum* and *Tilio-Carpinetum* in the "Dolina Rzeki Brdy" nature reserve in the Bory Tucholskie (NW Poland)

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Mycocoenological studies on macrofungi in the *Tilio-Carpinetum* and *Aceri-Tilietum* plant associations were carried out in 4 permanent plots (1000 m^2 each) in the southern part of the "Dolina Rzeki Brdy" nature reserve. In 1994-1995, the total number of 279 species, mostly *Basidiomycotina*, were recorded. Mycological investigations of *Aceri-Tilietum* were conducted for the first time. The share of biological groups: terricolous, litter-inhabiting and lignicolous fungi as well as the diagnostic role of macromycetes in the investigated phytocoenoses, are analysed in the paper.

Key words: macromycetes, mycocoenological studies, *Tilio-Carpinetum*, *Aceri-Tilietum*, Bory Tucholskie

INTRODUCTION

The Bory Tucholskie (Tuchola Forests) are some of the biggest forest areas in Poland. Mycological studies (Ławrynowicz 1993; Ławrynowicz, Dziedziński, Szkodzik and Szostek 1995; Ławrynowicz 1997; Komorowska 2002), and lichenological investigations (Lipnicki 2002) have recently been carried out in the area. Ławrynowicz and Szkodzik (1998) examined fungi in the *Leucobryo-Pinetum* and *Calluno-Genistetum* plant associations in "Kręgi Kamienne", a nature and archaeological reserve in Odry village.

Two oak-linden-hornbeam associations are examined in this study: *Aceri-Tilietum typicum* Faber 1936, not investigated mycologically so far, and *Tilio-Carpinetum stachyetosum* Traczyk 1962, confined to small areas within the Bory Tucholskie. The associations are most fully represented in the "Dolina Rzeki Brdy" reserve (Fig. 1), where permanent plots were established.

In the area studied, the river Brda flows through a ravine intersecting a hill range of an end moraine up to 25 m. The inclination of the valley walls reaches 50°. Nume-

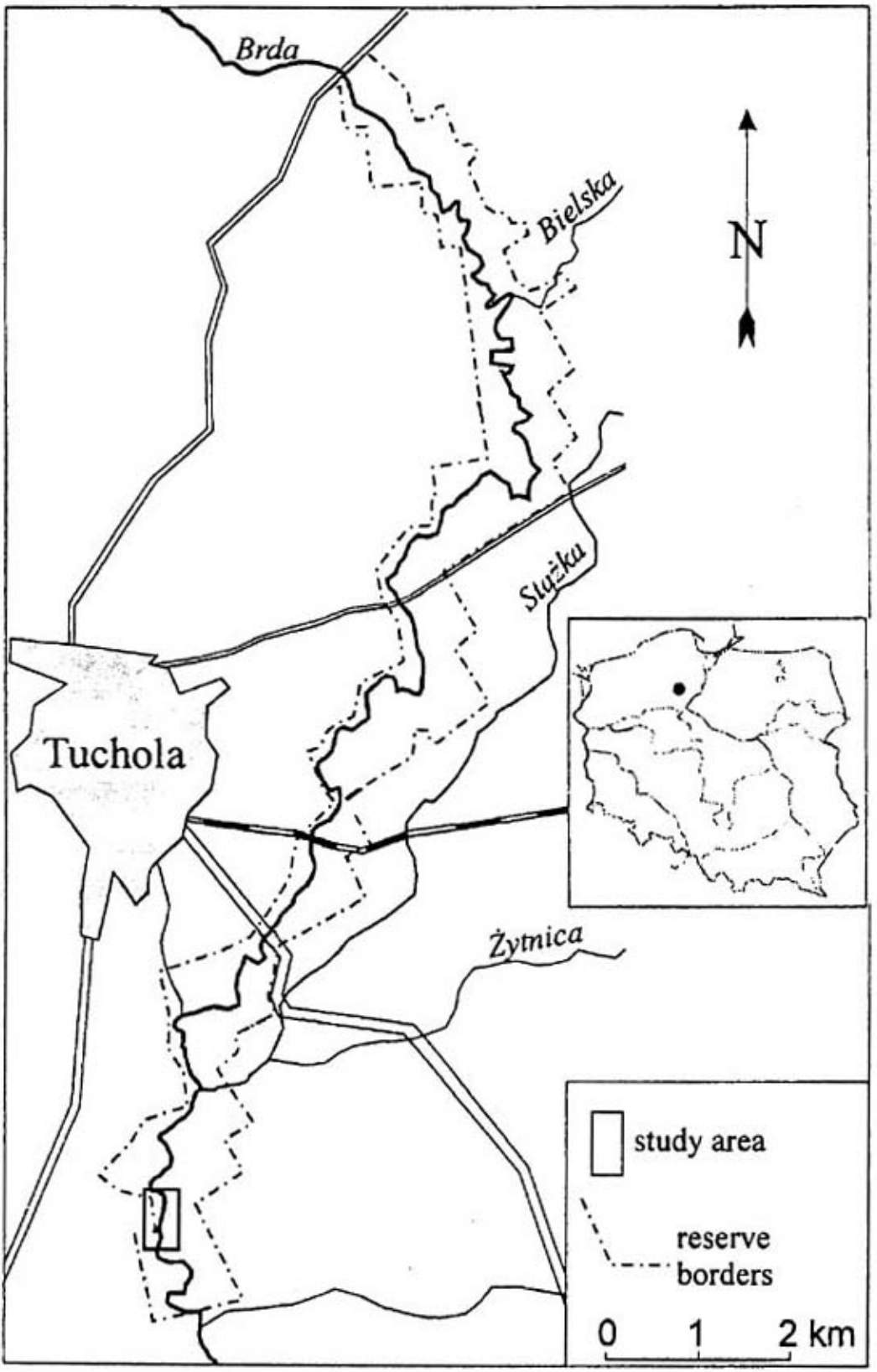

Fig. 1. Nature reserve „Dolina Rzeki Brdy"

rous slides and cliffs result from lateral erosion caused by the water course. In the Świt forest district, where the mycological studies were conducted, the river bed is covered with boulders from an eroded end moraine, and forms a ridge, called Piekło, a protected nature monument.

Haplic cambisols, as well as some luvic cambisols, prevail in the examined part of the reserve. They were formed from strong loamy sands, medium deep, deposited on light clay, relatively strongly sandy. Alluvial soils were formed in the areas directly adjacent to the river and periodically flooded (Iwicki 1976; Zuba 1978).

The climate of the Bory Tucholskie is transitional. It is greatly varied due to the interaction between continental air masses from Eastern Europe and the oceanic air from Western Europe, dominated by the polar-maritime air. According to Mikołajski and Wodziczko (1929), the Bory Tucholskie are situated in the area of annual precipitation of 500 – 600 mm, including approximately 100 – 140 mm in winter. The data from the Meteorological Station in Chojnice, some 30 km from the study area, important for mycological observations, are presented in Tables 1 and 2.

Table 1

Mean monthly air temperatures at the meteorological station at Chojnice

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean annual temperature
1994	0.9	-3.9	2.4	8.2	11.0	14.3	20.9	18.0	13.1	6.3	3.7	1.5	8.0
1995	-1.8	2.5	2.1	6.8	11.5	15.3	18.9	18.1	12.5	10.1	0.6	-5.1	7.6
1996	-5.4	-5.8	-1.5	7.6	11.7	15.0	14.7	17.4	9.9	8.6	4.1	-5.3	5.9
1997	-4.2	1.5	2.8	4.4	10.8	15.6	17.2	19.5	13.0	6.5	1.8	0.1	7.4

Table 2

Monthly totals precipitations at the meteorological station at Chojnice

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total annual precipitation
1994	88.3	16.1	102.6	21.7	47.1	30.9	12.0	36.5	70.3	41.0	41.3	79.6	587.4
1995	43.1	37.5	51.4	46.5	49.1	77.9	26.0	61.5	88.0	16.0	22.2	17.3	536.5
1996	4.7	28.5	2.9	9.9	108.9	83.9	105.5	79.3	44.9	40.5	30.4	14.6	554.0
1997	3.8	49.5	34.5	37.9	84.4	65.0	81.1	38.6	57.2	73.9	22.9	33.1	581.9

The climate in the "Dolina Rzeki Brdy" reserve is affected by local conditions. High banks, exposed westwards, are subject to stronger heating, while the evaporation of the river water increases air humidity, which has a beneficial effect on fruiting of fungi.

MATERIAL AND METHODS

Mycological studies in the "Dolina Rzeki Brdy" reserve were carried out in 1994 – 1995. Their basis was formed by phytosociological classification (W. and J. M. Matuszkiewicz 1996) and description of plant associations in the area (Boinski

2002). The studies were focused in 4 plots, 1000 m^2 each. One of them (I) was established in *Aceri-Tilietum typicum*; the other three (II, III and IV), on the other hand, were set up in *Tilio-Carpinetum stachyetosum*. Altogether 14 observations were conducted in each plot on the following days:

1994: 19 May; 8 July; 31 Aug.; 5 Sept.; 14 Sept.; 23 Sept.; 22 Oct.;

1995: 3 March; 22 June; 17 July; 21 Aug.; 16 Sept.; 3 Oct.; 7 Nov.

As a result of hypogeous investigations which followed mycocoenological observations, five species were added to the list of fungi in the reserve. The data gathered during mycosociological observations are given in Tables 3 and 4. Table 5 presents the species collected outside the plots, as well as hypogeous fungi collected after the studies in the plots had been completed.

The number of fruit-bodies was recorded each time upon their collection. It is given in tables 3 and 4 in a simplified form using a 3-degree scale according to Jahn, Nespiak and Tüxen (1967): r, n, a. The digit in the superscript next to the letter in the tables shows the number of observations during which a species was recorded.

To ensure as accurate a description of the occurrence of macromycetes in the plant associations in the reserve as possible, all the fungi found were divided into three groups: terricolous, litter-inhabiting and lignicolous fungi.

The itinerary method was used to cover the extensive variety of macrofungi that occur in the reserve. Diverse features of the habitat in the area were taken into account, from places periodically flooded to those elevated the most, as well as from typical patches associations, adjacent to permanent plots, to those drastically affected by the usage of roads and paths on tourist routes.

The determined species of fungi were catalogued, and dried fruit-bodies were deposited in the Herbarium Universitatis Lodziensis (LOD).

MYCOSOCIOLOGICAL ANALYSIS

Aceri-Tilietum typicum, where study plot I was established (Table 3), is a particularly important plant association in the "Dolina Rzeki Brdy" reserve. Its patches occur on the steep slopes of the Brda valley in the Świt forest unit. It grows on fertile soils where the layer of humus is well aerated. The tree stand comprises *Tilia cordata*, *Acer platanoides*, *Carpinus betulus*, *Quercus robur*, *Acer pseudoplatanus*, *Ulmus laevis* and *Fraxinus excelsior*. The shrub layer is well developed, with the greatest share of *Corylus avellana*, *Euonymus verrucosa*, as well as tree undergrowth. The field layer is rich in many species. *Hepatica nobilis*, *Anemone ranunculoides*, *Pulmonaria obscura*, *Lathyrus vernus*, *Ficaria verna* form colourful aspects.

Plot I is situated on the slope of the Brda valley, exposed westwards. The tree stand is formed chiefly by *Pinus sylvestris*, introduced artificially, as well as *Tilia cordata*, *Acer platanoides* and *Carpinus betulus*. *Corylus avellana* and the undergrowth of deciduous trees prevail in the shrub layer. Mainly eutrophic species, such as *Asarum europaeum*, *Hepatica nobilis*, *Stellaria holostea* and *Asperula odorata*, form the field layer, the coverage of which is approximately 40%. Lying branches can be found in the field layer. Cambisols, as well as luvic cambisols on light loamy sands, medium deep, deposited on light clay, prevail in this plot. The pH of the humus layer is 6.5.

Table 3
Macromycetes in *Aceri-Tilietum typicum* plant association (plot I)

Terricolous species			
Hygrophoropsis aurantiaca (Wulf.: Fr.) R. Mre.	n^3	*Lactarius mitissimus* Fr.	n^1
Tricholoma terreum (Schff.: Fr.) Kumm.	n^3	*Lactarius deliciosus* Fr.	r^3
Laccaria amethystina (Bolt. ex Hooker) Murr.	n^2	*Humaria hemisphaerica* (Wigg.: Fr.) Fuckel	r^2
Chroogomphus rutilus (Schff.: Fr.) O. K. Miller	n^2	*Laccaria laccata* (Scop.: Fr.) Bk. et Br.	r^1
Mycena pura (Pers.: Fr.) Kumm.	n^2	*Hygrophorus eburneus* (Bull.: Fr.) Fr.	r^1
Russula densifolia Gill.	n^1	*Inocybe patouillardi* Bres.	r^1
Lactarius rufus (Scop.) Fr.	n^1	*Suillus variegatus* (Swartz: Fr.) O. Kuntze	r^1
Tricholoma sulphureum (Bull.: Fr.) Kumm.	n^1	*Mycena hematopoda* (Pers.: Fr.) Kumm.	r^1
Boletus edulis Bull.: Fr.	n^1	*Russula lepida* Fr.	r^1
Russula ochroleuca (Pers.) Fr.	n^1	*Boletus luridus* Schff.: Fr.	r^1
Russula delica Fr.	n^1	*Dermocybe cinnamomea* (L.: Fr.) Wünsche	r^1
Hebeloma crustuliniforme (Bull.: Fr.) Quel.	n^1	*Hebeloma sinapizans* (Paulet: Fr.) Gill.	r^1
Suillus granulatus (L.: Fr.) O. Kuntze	n^1	*Lactarius torminosus* (Schff.: Fr.) S. F. Gray	r^1
Amanita pantherina (DC: Fr.) Krbh.	n^1		
Litter-inhabiting species			
Auriscalpium vulgare S. F. Gray	n^4	*Stereum hirsutum* (Willd.: Fr.) S. F. Gray	r^1
Mycena sanguinolenta (A. & S.: Fr.) Kumm.	n^3	*Mycena acicula* (Schff.: Fr.) Kumm.	r^1
Mycena galopoda (Pers.: Fr.) Kumm.	n^2	*Mycena debilis* (Fr.) Quél.	r^1
Mycena zephirus (Fr.: Fr.) Kumm.	n^1	*Rickenella fibula* (Bull.: Fr.) Raith.	r^1
Mycena erubescens V. Hohnel	n^1	*Mycena epipterygia* (Scop.: Fr.) S. F. Gray	r^1
Strobilurus stephanocystis (Hora) Sing.	r^1		
Lignicolous species			
Armillariella mellea (Fl. Dan.: Fr.) Karst.	n^2	*Meruliopsis corium* (Fr.) Ginns	r^1
Pluteus atricapillus (Secr.) Sing.	n^1	*Paxillus panuoides* Fr.	r^1
Schizopora paradoxa (Schrad.: Fr.) Donk	n^1	*Daedalea quercina* (L.: Fr.)	r^1
Flammulina velutipes (Curt.: Fr.) Sing.	r^2	*Pluteus romellii* (Britz.) Sacc.	r^1
Calocera cornea (Batsch: Fr.) Fr.	r^1	*Gymnopilus penetrans* (Fr.: Fr.) Murr.	r^1
Oudemansiella platyphylla (Pers.: Fr.) Mos.	r^1	*Hypholoma fasciculare* (Huds.: Fr.) Kumm.	r^1

The occurrence of fungi turned out to be the smallest in this plot. Altogether 50 species were collected (Table 3), including 27 terricolous species, 11 litter-inhabiting species and 12 species that produce fruit-bodies on wood, chiefly on stumps. A greatly inclined slope on which the plot is located does not encourage litter deposition. As a result of substrate deficit, few litter-inhabiting fungi occur in it. Conditions for the development of fungi inhabiting rotting stumps were relatively good. The majority of species, including 20 terricolous, 8 litter-inhabiting and 10 lignicolous species, were collected only once, and only 7 species, 3 terricolous and 4 litter-inhabiting ones, were recorded more than twice.

Tilio-Carpinetum stachyetosum association (Table 4) dominates in the "Dolina Rzeki Brdy" in terms of the area. It develops on fertile, moist habitats whose layer of humus is fairly thick. The tree stand consists of two layers, and its age structure is diversified. *Carpinus betulus*, *Quercus petraea*, *Tilia cordata* and the planted *Pinus*

sylvestris prevail in it. *Euonymus verrucosa*, *Cornus sanguinea*, *Lonicera xylosteum*, as well as *Corylus avellana* and tree undergrowth, occur in the shrub layer. The field layer is rich in species and forms colourful phenological aspects. Three plots, II, III and IV, were established in the *Tilio-Carpinetum* association.

Similarly to the *Aceri-Tilietum* association, the pine has a considerable share in the tree stand. Planted in the area, it brings about soil leaching and, consequently, an increase in substrate acidity. Thus, deciduous and coniferous litter can be found in the area, which also affects fungi, as species typical of both oak-linden-hornbeam forests and coniferous forests, associated with the pine, occur there.

Plot II is situated in a flat area, with a slight inclination only. The sucker tree stand is formed by *Tilia cordata*, *Carpinus betulus*, *Betula pendula*. Pines as old as 160 years are also present. Few individuals of *Larix decidua* occur in the immediate vicinity of the plot. The field layer is relatively poor, and its coverage reaches 20%. Suckers and seedlings of *Acer platanoides*, *Tilia cordata*, *Carpinus betulus*, as well as *Oxalis acetosella*, *Maianthemum bifolium*, *Polygonatum odoratum* and *Viola* sp. form the field layer. The pH of luvic cambisols in the humus layer equals 5.5.

Plot III is situated near a bend in the Brda river. *Carpinus betulus*, *Tilia cordata*, *Betula pendula*, as well as few individuals of *Pinus sylvestris*, up to 27 m tall and 160-year-old, form the tree stand. The trees are fairly solitary, and there is no shrub layer. The field layer is quite poor: *Polygonatum odoratum* and *Maianthemum bifolium* occurred most frequently in it. The soil, whose pH in the humus layer was 5.5, is covered with litter and lying branches. The moss layer did not occur. The soil is exposed in some places, and has been rooted by wild boars to a great extent.

The land in **plot IV** is slightly inclined towards the Brda river (westwards). Trees are slender, especially *Pinus sylvestris*, *Betula pendula* and *Carpinus betulus* ca. 50-year-old, and 19, 22 and 16 m tall, respectively. One 90-year-old pine occurs in the plot. *Carpinus betulus*, *Corylus avellana*, *Tilia cordata*, *Frangula alnus* prevail in the shrub layer and cover ca. 70%. The field layer is poor, with some 5% coverage. Eutrophic species, such as *Stellaria holostea*, *Asarum europaeum*, *Anemone nemorosa*, *Galium odoratum*, prevail. The forest floor is covered with deciduous and coniferous litter, as well as fallen branches in some places. The plot is rooted, and the soil is exposed; the pH of the humus layer equals 6.0.

Table 4

Macromycetes in *Tilio-Carpinetum stachyetosum* (plots: II, III and IV)

Species	No. of plots		
	I	II	III
Terricolous species			
Russula ochroleuca (Pers.) Fr.	n^4	n^2	n^2
Hygrophoropsis aurantiaca (Wulf.: Fr.) R. Mre.	n^3	n^2	n^3
Laccaria laccata (Scop.: Fr.) Bk. et Br.	n^1	n^1	n^2
Laccaria amethystina (Bolt. ex Hooker) Murr.	n^1	n^2	n^3
Mycena pura (Pers.: Fr.) Kumm.	n^1	n^2	n^1
Lactarius rufus (Scop.) Fr.	n^1	r^1	r^1
Tricholoma sulphureum (Bull.: Fr.) Kumm.	r^1	r^1	n^1
Xerocomus chrysenteron (Bull. ex St. Amans) Quel.	n^5	a^1	n^4

Tab. 4 cont.

Paxillus involutus (Batsch) Fr.	n^4	n^3	n^2
Collybia peronata (Bolt.: Fr.) Sing.	n^3	n^4	n^3
Collybia asema (Fr.) Quel.	n^3	n^2	n^1
Cystoderma carcharias (Pers.) K. et M.	n^2	n^1	n^2
Amanita citrina (Schff.) S. F. Gray	n^1	n^2	n^2
Lycoperdon perlatum Pers.: Pers.	r^2	n^2	n^1
Bovista pussila (Batsch): Pers.	r^2	r^1	r^1
Xerocomus subtomentosus (L.: Fr.) Quél.	r^1	r^1	r^1
Lactarius necator (Bull.: Fr.) Karst.	n^1	n^1	
Lycoperdon lividum Pers.	r^2	n^1	
Stropharia aeruginosa (Curt.: Fr.) Quel.	r^2	r^2	
Mycena hematopoda (Pers.: Fr.) Kumm.	r^1		r^1
Clitocybe clavipes (Pers.: Fr.) Kumm.	n^2		n^1
Collybia butyracea (Bull.: Fr.) Quél.	r^4		r^1
Hygrophorus hypothejus (Fr.: Fr.) Fr.	r^1		n^1
Lactarius quietus Fr.	r^1		r^2
Inocybe geophylla (Sow.: Fr.) Kumm.	r^1		r^1
Lactarius ichoratus Batsch.: Fr.	r^1		r^1
Russula aeruginea Lindbl.	r^1		r^1
Tricholoma terreum (Schff.: Fr.) Kumm.		n^2	n^3
Russula delica Fr.		n^2	n^2
Hebeloma crustuliniforme (Bull.: Fr.) Quel.		n^2	n^2
Suillus granulatus (L.: Fr.) O. Kuntze		n^1	n^3
Amanita pantherina (DC: Fr.) Krbh.		n^1	n^1
Humaria hemisphaerica (Wigg.: Fr.) Fuckel		r^1	r^1
Lepiota cristata (A. et S.: Fr.) Kumm.		n^2	n^2
Lepista nuda (Bull.: Fr.) Cke.		n^1	n^1
Lycoperdon molle Pers.: Pers.		n^1	n^1
Russula chamaeleontina (Fr.) Fr. ss. Romagn.		n^1	r^1
Xerocomus badius (Fr.) Kühn. ex Gilb.		r^3	r^2
Leccinum griseum (Quel.) Sing.		r^3	r^1
Amanita muscaria (L.: Fr.) Hooker	n^3		
Lepista nebularis (Fr.) Harmaja	r^1		
Cantharellus tubaeformis Fr.	r^1		
Mycena galericulata (Scop.: Fr.) S. F. Gray	r^1		
Lepista inversa (Scop.: Fr.) Pat.	r^1		
Otidea onotica (Pers.) Fuckel	r^1		
Tarzetta cupularis (L.: Fr.) Lambotte ss. Dennis	r^1		
Clitocybe gibba (Pers.: Fr.) Kumm.		n^1	
Agaricus arvensis Schff.: Fr.		n^1	
Russula nigricans (Bull.) Fr.		n^1	
Amanita rubescens (Pers.: Fr.) Gray		r^3	
Macrolepiota rhacodes (Vitt.) Sing.		r^3	
Leucocoprinus badhamii (Bk. et Br.)		r^3	
Cantharellus cibarius Fr.		r^1	

Tab. 4 cont.

Lycoperdon nigrescens (Pers.: Pers.) Lloyd		r^1	
Russula decolorans Fr.		r^1	
Russula livescens (Batsch) Quél. ss. Bres.		r^1	
Agrocybe praecox (Pers.: Fr.) Fay.		r^1	
Chroogomphus rutilus (Schff.: Fr.) O. K. Miller			n^3
Russula densifolia Gill.			n^1
Lactarius mitissimus Fr.			n^1
Hygrophorus eburneus (Bull.: Fr.) Fr.			r^2
Inocybe patouillardi Bres.			r^2
Suillus variegatus (Swartz: Fr.) O. Kuntze			r^1
Collybia maculata (A. et. S.: Fr.) Quel.			n^2
Phallus impudicus L.: Pers.			n^2
Elaphomyces muricatus Fr.			n^1
Amanita phalloides (Fr.) Link			r^3
Macrolepiota procera (Scop.: Fr.) Sing.			r^2
Russula olivascens (Pers.: Schff.) ss. Bres.			r^2
Agaricus macrocarpus (Moell.) Moell.			r^4
Laccaria proxima (Boud.) Pat.			r^4
Macrolepiota mastoidea (Fr.) Sing.			r^1
Cortinarius incisus Pers.: Fr.			r^1
Scleroderma citrinum Pers.			r^1
Suillus luteus (L.: Fr.) S. F. Gray			r^1
Tricholoma tigrinum (Schff.) Quél.			r^1
Litter-inhabiting species			
Mycena sanguinolenta (A. et S.: Fr.) Kumm.	n^5	n^2	n^4
Auriscalpium vulgare S. F. Gray	n^3	n^1	n^1
Stereum hirsutum (Willd.: Fr.) S. F. Gray	n^2	n^2	n^5
Mycena zephirus (Fr.: Fr.) Kumm.	n^2	n^2	n^2
Mycena galopoda (Pers.: Fr.) Kumm.	n^2	n^1	n^1
Thelephora terrestris Pers.: Fr.	n^4	r^1	n^3
Crepidotus variabilis (Pers.: Fr.) Kumm.	n^3	n^4	r^1
Mycena acicula (Schff.: Fr.) Kumm.	r^1	r^1	
Marasmius rotula (Scop.: Fr.) Fr.	r^1	r^2	
Mycena erubescens V. Hohnel	n^1		r^2
Strobilurus stephanocystis (Hora) Sing.		r^1	r^1
Crucibulum laeve (Huds. ex Relh.) Kambly		n^1	n^1
Marasmius androsaceus (L.: Fr.) Fr.		n^1	r^1
Mycena debilis (Fr.) Quél.	r^2		
Hymenoscyphus epiphyllus (Pers.: Fr.) Rehm apud Kaufmann	n^2		
Onnia triqueter (Fr.) Imaz.	r^2		
Hymenoscyphus fructigenus (Bull. ex Mérat) S.F. Gray	r^1		
Mycena adonis (Bull.: Fr.) S.F. Gray	r^1		
Tubaria furfuracea (Pers.: Fr.) Gill.	r^1		
Mycena vitilis (Fr.) Quél.		r^1	
Rickenella fibula (Bull.: Fr.) Raith.			r^2

Tab. 4 cont.

Marasmius scorodonius (Fr.) Fr.			n^1
Marasmiellus ramealis (Bull.: Fr.) Sing.			r^1
Mycena aetites (Fr.) Quél.			r^1
Lignicolous species			
Armillariella mellea (Fl. Dan.: Fr.) Karst.	n^5	n^2	r^1
Pluteus atricapillus (Secr.) Sing.	n^2	r^4	n^3
Kuehneromyces mutabilis (Schff. : Fr.) Sing. et Smith	n^3	r^1	n^2
Fomes fomentarius (L.: Fr.) Fr.	n^1	n^1	n^6
Xylaria hypoxylon (L.) Grev.	r^3	r^5	r^3
Dacrymyces stillatus Nees: Fr.	r^2	r^5	r^2
Exidia plana (Wigg.) Donk	r^2	r^3	r^4
Fomitopsis pinicola (Sw.: Fr.) P. Karst.	r^2	r^3	r^3
Calocera viscosa (Pers.: Fr.) Fr.	r^2	r^2	r^3
Bjerkandera adusta (Willd.: Fr.) P. Karst.	r^1	r^2	r^2
Exidia truncata Fr.	r^1	r^1	r^4
Pholiota flammans (Fr.) Kumm.	r^2	r^1	
Lentinus lepideus (Fr.: Fr.) Fr.	r^1	r^1	
Gymnopilus penetrans (Fr.: Fr.) Murr.	r^2		r^2
Hypholoma fasciculare (Huds.: Fr.) Kumm.	r^1		r^3
Lycoperdon pyriforme Schff.: Pers.	n^2		n^2
Piptoporus betulinus (Fr.) Karst.	r^3		r^3
Heterobasidion annosum (Fr.) Bref.	r^2		r^1
Tremella mesenterica Retz. ex Hook.	r^1		r^2
Calocera cornea (Batsch: Fr.) Fr.		r^3	r^1
Oudemansiella platyphylla (Pers.: Fr.) Mos.	r^2		
Meruliopsis corium (Fr.) Ginns	r^1		
Paxillus panuoides Fr.	r^1		
Laetiporus sulphureus (Bull.: Fr.) Murr.	r^2		
Sphaerobolus stellatus (Tode) Pers.	r^2		
Trametes versicolor (L.: Fr.) Pilát	r^1		
Pseudoclitocybe cyathiformis (Bull.: Fr.) Sing.	r^1		
Chondrostereum purpureum (Pers.: Fr.) Pouzar	r^1		
Xylaria longipes Nitschke		r^7	
Schizopora paradoxa (Schrad.: Fr.) Donk		n^3	
Hypoxylon serpens (Pers.: Fr.) Fr.		r^1	
Trametes gibbosa (Pers.: Fr.) Fr.		r^1	
Crepidotus mollis (Schff.: Fr.) Kumm.		r^1	
Hapalopilus rutilans (Pers.: Fr.) P. Karst.		r^1	
Postia caesia (Schrad.: Fr.) P. Karst.			r^3
Pluteus phlebophorus (Dittm.: Fr.) Kumm.			r^1
Polyporus brumalis (Pers.) Fr.			r^1
Coprinus micaceus (Bull.: Fr.) Fr.			r^1
Datronia mollis (Sommerf. : Fr.) Donk			r^1
Nectria cinnabarina (Tode.: Fr.) Fr.			r^1
Pholiota aurivella (Batsch: Fr.) Kumm.			r^1

As many as 77 species (Table 4) were collected in **plot II**. The number of terricolous species (34) and lignicolous species (27) is similar. A high number of species inhabiting stumps and logs is conditioned by the great amount of this type of substrate in plot 2. Weakened trees are attacked by parasites: *Armillaria mellea* develops on some of them, while fruit-bodies of *Laetiporus sulphureus* occurred twice on one of the oak trees. Only 16 species (8 terricolous, 4 litter-inhabiting and 4 lignicolous) were found in this plot more than twice, while 37 (20 terricolous, 6 litter-inhabiting and 11 lignicolous) only once.

Seventy five species were recorded in **plot III**. As the amount of lying wood was smaller in comparison with plot II, the number of species inhabiting logs and stumps decreased, and only 20 species were recorded. Thirteen species occurred in the litter and on small twigs. Terricolous fungi were quite numerous, and as many as 42 species were collected. Species that may occur on weakened trees usually do not infect them, preferring stumps and logs. 39 species were collected once (22 terricolous, 8 litter-inhabiting, 9 lignicolous), and 17 species (8 terricolous, 1 litter-inhabiting, 8 lignicolous) were observed more than twice throughout the two years of observations.

Fruit-bodies of 95 species were collected in **plot IV**. The number of terricolous species (55) is twice as high as that of species recorded on wood (25), and three times as high as that of litter-inhabiting species (15). Hypogeous fruit-bodies of *Elaphomyces muricatus* were found in this plot. Two species, *Pholiota aurivella* and *Piptoporus betulinus*, were noticed on live birches. 21 species (8 terricolous, 3 litter-inhabiting and 10 lignicolous) were recorded more than twice, while 49 species (31 terricolous, 9 litter-inhabiting and 9 lignicolous) occurred only once throughout the study.

As many as 113 species were added to the list of species as a result of the observations conducted **outside the plots** (Table 5).

Table 5
The list of the fungi collected outside the plots

Agaricus semotus Fr.	*Tricholomopsis rutilans* (Schff.: Fr.) Sing.
Agaricus silvaticus Schff.	*Xylaria polymorpha* (Pers.) Grev.
Amanita fulva (Schff. :) Pers.	*Hydnum rufescens* Fr.
Amanita gemmata (Fr.) Gill.	*Lycoperdon umbrinum* Pers.: Pers.
Amanita virosa (Fr.) Bert.	*Macrocystidia cucumis* (Pers.: Fr.) Heim
Antrodiella hoehnelii (Bres. ex Höhn.) Niemelä	*Macrolepiota excoriata* (Schff.: Fr.)
Ascocoryne cylichnium (Tul.) Korf	*Mycena pura* f. *rosea* Schum.
Bisporella citrina (Batsch) Korf et Carpent.	*Otidea bufonia* ssp. *cochleata* (L. ex St. Amans) Fuckel
Bolbitius vitellinus (Pers.) Fr.	*Gleophyllum sepiarium* (Wulf.: Fr.) P. Karst.
Bovista aestivalis (Bonord.) Demoulin	*Mycena lineata* (Fr.) Quel. ss. Lange
Calvatia excipuliformis (Schff.: Pers.) Perdeck	*Oudemansiella longipes* (Bull.ex St. Amans) Mos.
Clavicorona pyxidata (Pers.: Fr.) Doty	*Psilocybe montana* (Pers.: Fr.) Kumm.
Clavulina cinerea (Fr.) Schroeter	*Inocybe griseolilacina* Lge.
Collybia confluens (Pers.: Fr.) Kumm.	*Mycena strobilina* (Pers.: Fr.) Kumm.
Collybia cookei (Bres.) J. D. Arnold	*Mycena corticola* (Pers.: Fr.) S. F. Gray
Coprinus disseminatus (Pers.: Fr.) S. F. Gray	*Rozites caperata* (Pers.: Fr.) Karst.

Tab. 5 cont.

Coprinus hiascens (Bull.: Fr.) Fr.	*Mycena viscosa* (Secr.) R. Mre.
Coprinus impatiens (Fr.) Quél.	*Pholiota alnicola* (Fr.) Sing.
Coprinus silvaticus Peck	*Russula albonigra* Krbh.
Cortinarius amoenolens R. Hry.	*Russula flava* Romell in Lindblad
Cortinarius sanguineus (Wulf.) Fr.	*Russula emetica* Fr.
Craterellus cornucopioides (L.): Pers.	*Russula foetens* (Pers.: Fr.) Fr.
Cyathus striatus (Huds.) : Pers.	*Russula heterophylla* (Fr.) Fr.
Cystoderma amianthinum (Scop.: Fr.) Fay.	*Lactarius decipiens* Quél.
Elaphomyces asperulus Vitt.	*Panellus mitis* (Pers.: Fr.) Sing.
Entoloma sericeum (Bull. ex Merat) Quél.	*Scleroderma verrucosum* (Bull.) : Pers.
Ganoderma applanatum (Pers. ex Wallr.) Pat.	*Tricholoma lascivum* (Fr.) Gill.
Geastrum rufescens Pers.: Pers.	*Hypholoma subviride* (Berk. et Curt.) Dennis
Genea hispidula (Berk. et Br.) Tul.	*Lactarius pyrogalus* Bull.: Fr.
Gomphidius glutinosus (Schff.) Fr.	*Tricholoma ustale* (Fr.: Fr.) Kumm.
Helvella crispa Fr.	*Tylopilus felleus* (Bull.: Fr.) P. Karst.
Hydnum repandum L.: Fr.	*Laccaria bicolor* (R. Mre.) Orton
Hymenochaete rubiginosa (Dicks.: Fr.) Lev.	*Postia fragilis* (Fr.) Jülich
Hymenogaster tener Berk. et Br.	*Bulgaria inquinans* Fr.
Inonotus radiatus (Sow.: Fr.) P. Karst.	*Lactarius vietus* Fr.
Lactarius chrysorrheus Fr.	*Leotia lubrica* Pers.
Lactarius uvidus Fr.	*Thelephora palmata* (Scop.): Fr.
Lepiota aspera (Pers.: Fr.) Quél.	*Lepiota ventriosospora* Reid
Lepiota clypeolaria (Bull.: Fr.) Kumm.	*Coriolellus flavescens* (Bres.) Bond. et Sing.
Merulius tremellosus Fr.	*Hypoxylon fragiforme* (Pers.: Fr.) Kickx
Mycena polygramma (Bull.: Fr.) S. F. Gray	*Psathyrella candolleana* (Fr.) Mre.
Peniophora incarnata (Pers.: Fr.) P. Karst.	*Armillaria ostoyae* Romagn.
Peziza micropus Pers.	*Postia lactea* (Fr.) P. Karst.
Phaeolus schweinitzii (Fr.) Pat.	*Galerina marginata* (Fr.) Kühn.
Phellinus nigricans (Fr.) P. Karst.	*Resupinatus trichotis* (Pers.) Sing.
Pholiota lenta (Pers.: Fr.) Sing.	*Skeletocutis nivea* (Jungh.) Keller
Pluteus salicinus (Pers.: Fr.) Kumm.	*Hypoxylon fuscum* (Pers.: Fr.) Fr.
Polyporus ciliatus (Fr.) : Fr.	*Steccherinum fimbriatum* (Pers.: Fr.) J. Erikss.
Polyporus squamosus (Huds.): Fr.	*Steccherinum ochraceum* (Pers. in Gmelin: Fr.) S. F. Gray
Pseudohydnum gelatinosum (Scop.: Fr.) P. Karst.	*Leptopodia atra* (König : Fr.) Boud.
Rhizopogon luteolus Fr. apud Fr. et Noidh.	*Hypoxylon multiforme* (Fr.) Fr.
Russula turci Bres.	*Junghuhnia nitida* (Fr.) Ryv.
Russula cyanoxantha Schff.: Fr.	*Inocybe dulcamara* (A. et S.: Pers.) Kumm.
Schizophyllum commune Fr.: Fr.	*Stereum sanguinolentum* (A. et S.: Fr.) Fr.
Scutellinia scutellata (L. ex St. Amans) Lambotte	*Eutypella alnifraga* Sacc.
Sparassis crispa (Wulf.): Fr.	*Lactarius camphoratus* (Bull.: Fr.) Fr.
Trametes hirsuta (Wulf.: Fr.) Pilát	*Cystoderma cinnabarinum* (A. et S.) Fay.
Trichaptum abietinum (Fr.) Ryv.	*Tremella encephala* Pers.
Tricholoma saponaceum (Fr.) Kumm.	

The quantitative ratio of terricolous, litter-inhabiting and lignicolous fungi equalled almost 5:1:4. A fairly numerous group of lignicolous fungi shows that sufficient amounts of suitable substrate in which mycelia can develop and produce fruit-bodies can be found in the area.

Fruit-bodies of interesting species were found outside the observation plots, including hypogeous species: *Elaphomyces asperulus*, *Genea hispidula*, *Hymenogaster tener*, *Rhizopogon luteolus*, *Geastrum rufescens*, *Clavicorona pyxidata*, *Peziza micropus*, as well as a protected species, *Sparassis crispa*.

The two-year observations conducted in the reserve including the area outside the plots, provided more complete data on the occurrence of the total number of 279 fungi. Even though they did not supported studies on the differentiation between *Tilio-Carpinetum* and *Aceri-Tilietum*, they made it possible to recognize additional terricolous and lignicolous species, in particular, from river habitats and tourist routes.

Two protected species, *Phallus impudicus* and *Sparassis crispa*, as well as 27 species inscribed in the Red list of threatened macromycetes in Poland (Wojewoda and Ławrynowicz 1992) in the following categories: E - endangered; V - vulnerable; R - rare; I - indeterminate, were found in the „Dolina Rzeki Brdy" reserve in 1994 – 1996. The threatened macromycetes are: *Geastrum rufescens* (E), *Mycena adonis* (R), *Amanita virosa* (V), *Phaeolus schweinitzii* (R), *Boletus edulis* (V), *Phellinus nigricans* (R), *Lactarius deliciosus* (V), *Sparassis crispa* (R), *Leptopodia atra* (V), *Cantharellus cibarius* (I), *Onnia triqueter* (V), *Cortinarius incisus* (I), *Oudemansiella longipes* (V), *Datronia mollis* (I), *Bulgaria inquinans* (R), *Macrolepiota procera* (I), *Coprinus hiascens* (R), *Macrolepiota rhacodes* (I), *Cystoderma cinnabarinum* (R), *Psilocybe montana* (I), *Gomphidius glutinosus* (R), *Russula alutacea* (I), *Inocybe griseolilacina* (R), *Russula livescens* (I), *Junghuhnia nitida* (R), *Steccherinum fimbriatum* (I), *Lactarius chrysorrheus* (R).

CONCLUSIONS

- 279 fungal species, including 5 species of hypogeous fungi, were identified in the material collected.
- 27 species on the red list of threatened fungi in Poland (Wojewoda and Ławrynowicz 1992) were recorded, as well as 2 species of fungi protected: *Sparassis crispa* and *Phallus impudicus*.
- 166 fungal species served as the basis of the mycosociological analysis.
- Several species considered to be typical of the oak-linden-hornbeam stand are found in the area studied: *Amanita phalloides*, *Phallus impudicus*, *Russula cyanoxantha*, *Clitocybe gibba*, *Mycena pura*, *Collybia confluens*.
- The share of the pine in the tree stand in deciduous forests significantly influences the species composition of fungi. Species associated with the pine occur among dominant species and species present in all plots, including terricolous, litter-inhabiting and lignicolous fungi (Tables 3–5).
- Despite the oak-linden-hornbeam type of the habitat, a considerable share of species typical of coniferous forests was noted as a result of the presence of the pine in the tree stand: *Amanita gemmata*, *Clitocybe clavipes*, *Lactarius rufus*, *Tylopilus fel-*

leus, Suillus variegatus, Auriscalpium vulgare, Strobilurus stephanocystis, Pseudohydnum gelatinosum.

- No conspicuous diagnostic role of fungi in the coenological differentiation between *Aceri-Tilietum* and *Tilio-Carpinetum* was established in the analysis of the species composition in those plant associations.

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REFERENCES

Boinski M. 2002. Szata leśna Tucholskiego Parku Krajobrazowego. (In:) M. Ławrynowicz, B. Rózga (eds) Tucholski Park Krajobrazowy 1985 – 2000, stan poznania. Wyd. UŁ, Łódź: 230-331.

Iwicki S. 1976. Zagospodarowanie turystyczne rejonu Tucholi. Instytut Turystyki, Warszawa: 1-157.

Jahn H., Nespiak A., Tüxen R. 1967. Pilzsoziologische Untersuchungen in Buchenwäldern (*Carici-Fagetum*, *Melico-Fagetum* und *Luzulo-Fagetum*) des Wesergebirges. Mitt. Flor.-soz. Arbeitgem. N. F. Heft 11/12: 159-197.

Komorowska H. 2000. Materiały do poznania macromycetes Borów Tucholskich i terenów przyległych. (In:) M. Lisiewska, M. Ławrynowicz (eds) Monitoring grzybów. PTB, Poznań-Łódź: 81-98.

Lipnicki L. 2002. Porosty rezerwatu "Dolina Rzeki Brdy" w Tucholskim Parku Krajobrazowym. In: M. Ławrynowicz, B. Rózga (eds) Tucholski Park Krajobrazowy, stan poznania. Wyd. UŁ, Łódź: 380-396.

Ławrynowicz M. 1993. Grzyby Borów Tucholskich – badania i wstępne wyniki. In: M. Rejewski, A. Nienartowicz, M. Boinski (eds) Bory Tucholskie – Walory przyrodnicze – Problemy ochrony – Przyszłość. Toruń: 94-103.

Ławrynowicz M. 1997. Bory Tucholskie jako środowisko występowania grzybów. In: W. Fałtynowicz, M. Latałowa, J. Szmeja (eds) Dynamika i ochrona roślinności Pomorza. Gdańsk-Poznań: 183-192.

Ławrynowicz M., Dziedziński T., Szkodzik J., Szostek B. 1995. Różnorodność mikologiczna Borów Tucholskich. In: Szata roślinna Polski w obliczu przemian. Materiały konferencji i sympozjów 50 Zjazdu PTB. Kraków: 241.

Ławrynowicz M., Szkodzik J. 1998. Macromycetes of the Kręgi Kamienne nature-archaeological reserve in the Bory Tucholskie (NW Poland). Acta Mycol. 33 (2): 327-340.

Matuszkiewicz W., Matuszkiewicz J.M. 1996. Przegląd fitosocjologiczny zbiorowisk leśnych Polski. Phytocoenosis 8 (n.S.) Seminarium Geobotanicum 3. Warszawa – Białowieża.

Mikołajski J., Wodziczko A. 1929. Zarys fizjograficzny Pomorza. Instytut Bałtycki, Toruń: 1-87.

Wojewoda W., Ławrynowicz M. 1992. Red list of threatened macrofungi in Poland. (In:) K. Zarzycki, W. Wojewoda, Z. Heinrich (eds) List of threatened plants in Poland. 2. ed. Inst. Bot. im. W. Szafera PAN, Kraków: 27-56.

Zuba S. 1978. Rezerwat przyrody "Piekło" – projekt. Zarząd Główny Stow. Inż. i Techn. Leśnictwa i Drzewnictwa. Zespół Rzeczoznawców (msc.).

Macromycetes *Aceri-Tilietum* i *Tilio-Carpinetum* w rezerwacie "Dolina Rzeki Brdy" w Borach Tucholskich (NW Polska)

Streszczenie

Rezerwat "Dolina Rzeki Brdy" należy do rzadko spotykanych w Borach Tucholskich obszarów pokrytych lasami liściastymi. Szczególnie interesujące botanicznie i mikologicznie są zespoły grądów: *Tilio-Carpinetum*, z uwagi na usytuowanie w strefie przejściowej z *Galio-Carpinetum* oraz *Aceri-Tilietum*, grądu zboczowego dotychczas nie badanego mikologicznie.

Dwuletnie obserwacje na 4 stałych powierzchniach, 1000 m^2 każda, powtarzane 14-krotnie na powierzchniach i uzupełnione zbiorami poza powierzchniami pozwoliły na wyróżnienie 279 gatunków grzybów makroskopowych. Grzyby zebrane na powierzchniach w liczbie 166 gatunków były podstawą analizy mikosocjologicznej.

Usytuowanie zespołu *Aceri-Tilietum* na zboczu oraz udział sosny w drzewostanie miały duży wpływ na owocowanie grzybów. Nachylenie zbocza doliny Brdy sprawia, że szczątki roślin, w tym głównie ściółka, drobne gałęzie, szyszki itp. łatwo zsuwają się w dół ograniczając możliwości rozwoju typowych dla nich grzybów, zaś powszechny udział sosny wraz z towarzyszącymi jej grzybami mikoryzowymi zaciera różnice mikologiczne między zespołami roślinnymi.

Swoisty klimat kształtujący się w warunkach parowania wody oraz osłony od wiatru, jaką stanowią wysokie brzegi Brdy sprzyja występowaniu grzybów i sprawia, że rezerwat stanowi refugium dla 27 gatunków zagrożonych grzybów w tym dwóch: *Sparassis crispa* i *Phallus impudicus* gatunków objętych ścisłą ochroną prawną w Polsce.