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ORIGINAL PAPER

Communities of woody vegetation and wood destroying fungi in natural and semi-natural forests of Kyiv city, Ukraine

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Abstract

Selected forestry parameters were investigated in the system of trees and wood-destroying fungi in the natural forests of the Kyiv city on a gradient of recreational transformation. We investigated the vitality, age compositions, and health condition of woody plants (11 species), and species, systematic, trophic and spatial compositions of xylotrophic fungi (51 species, 224 findings of xylotrophs representing 34 genera, 20 families, 7 orders of divisions Basidiomycota; class Agaricomycetes). The results showed that communities of woody vegetation and xylotrophic fungi in forests depend on the degree of recreational transformation of the environment. Vitality, age compositions and health condition of trees altered species composition of xylotrophs.

Key words: consortium relation; natural forests; woody plants; xylotrophic fungi

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1. Introduction

Communities of woody vegetation and wood-destroying (xylotrophic) fungi of forest ecosystem play significant role in issue of evolutionary ecology. The actuality of the objects is stipulated by the core role of forests in biosphere stability, preservation of landscape and especially biotic variety (Mirkin & Naumova 1998). Xylotrophic fungi are decomposers, obligatory components of woody vegetation. Xylomycobiota shows the high sensitivity to environmental changes (Schmidt 2006). In other cases, they cause of root and stem rot, negatively affect the health condition of trees. Due to this, the study of communities of these organisms in phytocoenoses of natural origin is expedient. Problems of relationship between the communities of woody vegetation and wood-destroying fungi in urban conditions have long attracted the attention of scientists. The composition of xylotrophic fungi is a reflection of parameters of natural forest development and state, which evidences the unity of components at all hierarchic levels of their inter-links. In the phytocoenoses, which are not durable for anthropogenic or natural reasons, the resistance of biota species to negative influence is significantly diminished and in general, the attrition of the weakest plants and the reformation of species composition and ecosystem structures increases (Arefev 2010). Thus, the communities of woody vegetation and xylotrophic fungi is an important basis for correct indicating the state of forest ecosystems, has not been sufficiently studied so far. This concerns the necessity of complex analysis of evolutionally formed consortium relation between woody vegetation and xylotrophic fungi. The compositions of xylotrophic fungi and woody vegetation are reflection of parameters of artificial phytocoenoses' development and state (Blinkova & Ivanenko 2014, 2016). Due to the impact of urbanization on natural ecosystems, forests in Kyiv have undergone an intensive recreational transformation, which is manifested in breach of structural and functional integrity of phytocoenoses' organisation. This in turn essentially affects the functioning of communities of the dominant woody species and xylotrophic fungi in urban ecosystem. It is also notable that there is few data on communities of wood-destroying fungi and woody vegetation from the territory of natural and semi-natural forests of Kyiv. The aim of the study was to describe communities of woody vegetation and xylomyco-complex of natural and semi-natural forests in urban conditions depending on the degree of recreational transformation of the environment.

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2. Materials and methods

2.1. Study site

Communities of trees and xylotrophic fungi in the urban conditions of Kyiv were studied in natural and semi-natural forests belonging to the nature reserve fund of Ukraine (Table 1). The forests were selected for the analyses since human impact is maximised in these objects. Kyiv is located on the right and left banks of the Dnipro river at the border between the Forest-Steppe zone and the Polissya of Ukraine following the geo-botanical division of Ukraine. The area of the city is 835.6 km², of which 31.300 ha are natural and semi-natural forests. The average annual temperature over the period 2014–2015 was 8.6 °C. The vegetation season (> 5 °C) lasted 204 days and started on April 10. The climate is of a semi-continental type for the Forest-Steppe zone. The geomorphologic structure of Kyiv belongs to 3 geomorphologic zones: South Polissya, Dnipro, Azov-Dnipro (Bilyk 1977). Soddy-podzolic soils, gray forest soils and sod meadow soils are the main soil types in Kyiv (Gavrilyuk 1956). In the survey conducted 15 – 30 September 2015 we distinguished four localities of forests in Kyiv city (Table 1).

2.2. Description of methods

Within each studied forests, the mapping of dominant tree vegetation was carried out on experimental plots (EP1-EP4). The experimental plots that are representative of the forests were chosen by reconnaissance method of study. Each experimental plot was established according to detailed route-method of study (Dilis 1974; Vasilevich 1992; Mirkin 1998). The area of each experimental plot was 0.5 – 0.7 ha. Taking into account basic characteristics of recreational changes of elements of structural and functional organization of forests in Kyiv EP was divided according to the degree of the recreational transformation rate from minimal to maximal consequences. In general, the stages of recreational transformation were appraised according to Rysin (2003; Table 2).

2.2.1 Tree health conditions assessment and vitaly structure

The health condition of trees (category of state trees) was appraised in accordance with the Sanitary Forest Regulation in Ukraine (2016). In order to avoid the influence of the irregular intensity of sylvicultural practice upon the index of stand state, for each category of states the weighted average Kraft classes (WAKC; vitality composition of tree vegetation) was calculated as the sum of the number of trees of each Kraft class was multiplied by stand state index (I–V), divided by the total number trees in a certain category of state (Eytungen 1949). For each stand, forest mensuration parameters were estimated: age (A); average weighted diameter (D_{ave}), height (H_{ave}), fluctuations range (D_{min}–D_{max}; H_{min}–H_{max}) and standard deviation (S.D.), stand density (N), stand basal area as a sum of tree areas (G_n). Morpho-metric parameters were calculated by an optical altimeter Suunto PM-5 and callipers Waldmeister 100 alu. Mechanical damaged woody plants were the trees and bushes that have cut or sawn live branch, injure on the stem reaching cambium or prominent features of such damage independent of time such were inflicted.

Table 1. General characteristics of studied forests.

No. EP*	Name of tract	GPS coordinates	Year established	Affiliation to the nature reserve fund	Area [ha]	Dominant tree vegetation
1	Holosiivskyi lis	50°22′01′′N, 30°30′30′′E	2007	National Natural Park "Holosiivskyi"	1879.43	*Acer platanoides* L., *Carpinus betulus* L., *Quercus robur* L., *Tilia cordata* Mill., *Ulmus glabra* Huds.
2	Teremky	50°21′40′′N, 30°27′15′′E	2007	National Natural Park "Holosiivskyi"	93.8	*Carpinus betulus* L., *Prunus avium* L., *Quercus robur* L.
3	Lysa Hora	50°23′42′′N, 30°32′53′′E	1994	Historical and cultural monument-museum "Kyivska fortetsia"	137.1	*Acer campestre* L., *A. platanoides* L., *Carpinus betulus* L., *Fraxinus excelsior* L., *Quercus robur* L., *Tilia cordata* Mill.
4	Bila dibrova	50°54′68′′N, 30°67′22′′E	1978	Reserve of local importance "Bila dibrova"	3.0	*Acer platanoides* L., *Betula pendula* Roth, *Pinus sylvestris* L., *Prunus avium* L., *Quercus robur* L., *Sambucus nigra* L.

*The location of experimental plots.

Table 2. Stages of recreational digression establishment.

Digression stage	State of		
	Herbaceous cover and leaf-litter	Tree stratum and undergrowth	Soil surface
1	full species composition of herbaceous plant, projective cover is 90 – 100%, leaf-litter is not broken	trees are healthy, undergrowth is numerous and different ages	I stage of digression
2	appearance of ruderal, pratal herbaceous species, projective cover is 80 – 90%, leaf-litter begins to trample down	trees are weakened, undergrowth is numerous but not different ages	II stage of digression
3	share of ruderal, pratal herbaceous species is 5 – 10%, projective cover is 70 – 80%, leaf-litter is trample down	trees are weakened or heavily weakened, undergrowth is limited	III stage of digression
4	share of ruderal or pratal herbaceous species is 10 – 20%, projective cover is 50 – 70%, leaf-litter begins to deteriorate	trees are heavily weakened, low viability of undergrowth is located clumps	IV stage of digression
5	share of ruderal or pratal herbaceous species are dominating species, projective cover is 0 – 50% , leaf-litter is completely absent	trees are heavily weakened or wilting with significant mechanical damage, undergrowth is absent	V stage of digression

2.2.2 Soil surface layer and herbaceous cover assessment

The state of soil surface layer was showed according to the following categories: 1 – undisturbed soil; 2 – weakened mulch (single passes); 3 – footpath in mulch; 4 – footpath or road without mulch; 5 – footpath or road with washaways; 6 – deposition and washaways made by recreants descending on steep slopes. The stages of digression of soil surface layer were the following: I – under which the 3rd, 4th, 5th and 6th categories of disturbance cover up to 2% of the area of experimental plot; II – from 2% to 10% of area; III –10% – 25% of area; IV –26% – 40% of area; V – over 40% of the site area (Polyakov 2009). Clogging of solid waste of the soil surface was defined as the share clogging area of the total area of the experimental plot.

As for herbaceous cover taxa nomenclature was adopted according to Cherepanov (1995). The species composition and total projective cover of dominant herbaceous plants was determined.

2.2.3 Data collection and determination of fungi

According to Arefev (2010) the measuring unit is a host tree, on which carpophores of certain fungi species were detected. The collection of factual evidence was carried out during the period of visible growth and formation of carpophores of xylotrophic fungi in the vegetation period. Every detected species was photographed. Photographs were taken with Nikon Coolpix L830 digital camera. The species that were easily identified "in oculo nudo" and did not require additional micro-morphological studies were not included in exsiccates. The determination of fungi species was assessed with the methods of Clémençon (2009), Koukol et al. (2014). The scientific names of fungi and their macrosystems are according to MycoBank (Robert et al. 2005). Author´s names of species of fungi are according to Kirk & Ansell (1992).

2.2.4 Assessment of trophic and spatial compositions of fungi

Analysis of trophic composition of xylomycobiota was done by the distribution of wood destroying fungi by trees. We distinguished four trophic groups of xylotrophs: eurytrophes of II rank (consorts of coniferous and deciduous trees), eurytrophes of II rank on coniferous trees, eurytrophes of II rank on deciduous trees and stenotrophes (consorts of only one genus of woody plants). The dead substrate of the host tree of xylotrophic fungi was divided into deadwood, falling wood (branches and stems) and stump depending on the morpho-metric parameters. Analysis of spatial composition of xylomycobiota was effected by the distribution of wood destroying fungi by root, ground, boot, stem and photosynthesising myco-horizons (Blinkova & Ivanenko 2016).

2.2.5 Statistical analyses

Menhinik's Index was used for determining the xylomyco-biota species richness. Shannon's Index of diversity was used for the generalised assessment of wood-destroying fungi diversity. Pielou's Index was used for the generalized assessment of equitability of xylomycobiota (Schmidt 1980). The similarity of formed community "tree-xylomycobiota was studied using cluster analysis (Origin. 2015. Origin 8.6. OriginLab Corp., Northampton, MA) by the weighted average indicators of investigated species and fungi at each experimental plots. The standardized Euclidean distance was selected for the assessment of distance.

3. Results

Our assessment in the studied area showed that forests ranked by the effects of human impact and, accordingly, stages of recreational digression of territory: 1 – "Holosiivskyi lis", 2 – "Bila dibrova", 3 – "Lysa Hora„" 4 – "Teremky".

The mycological study detected altogether 51 species of macromycetes (224 findings of xylotrophic fungi), 34 genera, 20 families, 7 orders of division Basidiomycota (class Agaricomycetes) at all experimental plots (Appendix 1). In general, 451 individuals (11 species) of woody plants were studied.

3.1. Assessment results at the tract "Holosiivskyi lis"

The tract EP1 (0.7 ha) is an array of natural hornbeam oakery on gray forest loams. The first storey composed of *Quercus robur* L. and *Carpinus betulus* L. The second storey composed of *Tilia cordata* Mill., *Acer platanoides* L., *Ulmus glabra* Huds. The stand parameters of trees were followed (Table 3). The understorey was composed biogroups of *Corylus avellana* L., *Euonymus europaeus* L., *Euonymus verrucosa* Scop., and *Crataegus oxyacantha* L. The herbaceous vegetation was composed primarily of miscellaneous herbs. Projected cover of herbaceous storey was 93.5%. *Asperula odorata* L., *Brachypodium sylvaticum* L., *Carex sylvatica* L., *Lamium galeobdolon* Subsp., *Poa nemoralis* L., *Polygonatum odoratum* (Mill.) Druce, *Sanicula europaea* L., *Stellaria holostea* L. were dominated. Mechanically damaged trees were not registered. The total indicator of the state soil surface was I stage of digression. The overall stage of recreational transformation was I. At EP1 we detected 25 species (68, findings) of wood-destroying fungi presented 22 genera, 13 families, 7 orders on 5 species of trees. 70.6% findings of fungi were eurytrophes of II rank on deciduous trees and 22.1% – eurytrophes of I rank. Stenotrophes (7.3%, findings) was represented by only one species: *Fistulina hepatica* (Schaeff.) With. (Appendix 1). At EP1 the maximum number of wood-destroying fungi (44.1%, findings) were occurred in the ground myco-horizon, and 26.5% in the stem myco-horizon, 16.2% in the photosynthesising myco-horizon, 13.2% in the stumps myco-horizon (Appendix 2). 9 species of xylotrophic fungi were detected on *Quercus robur* L. Among them there were three parasite species, and their share in the phytocoenosis comprised only 10.0%: *Fistulina hepatica* (Schaeff.) With. (on tree of I Kraft class, II–III state categories; one deadwood; stumps, D_{ave} = 105.0 cm), *Inocutis dryophila* (Berk.) Fiasson et Niemelä (on tree of III Kraft class, IV state category) and *Phellinus robustus* (P. Karst.) Bourdot et Galzin (on trees of I Kraft class, III–IV state categories; one deadwood).

The analysis of the vitality of *Quercus robur* L. showed that 64.7% findings of wood-destroying fungi occurred mainly on trees of I Kraft class (64.0%, trees). The lowest number of fungi (5.9%, findings) occurred on trees of III Kraft class (12.0%, trees). The shares of trees of II and III Kraft classes were the same. WAKC of wilting trees (1.8) showed that the share of trees of I and II classes Kraft in this category gradually increased (Table 4). The analysis of the health conditions of *Quercus robur* L. revealed that the stands were heavily weakened (I = 1.68).

The proportion of healthy trees was below 24.0%. Others were weakened trees to varying degrees, including 5.5% recently dead stands. The greatest number of xylotrophs (29.4%, findings) occurred on 8.0% trees of IV state category. An equal distribution of xylotrophs (23.5%, findings) was detected on weakened (38.0%, trees) and heavily weakened trees (24.5%, trees). We also observed *Laetiporus sulphureus* (Bull.) Murrill on fallen wood (stems, D_{ave} = 67.5 cm) of *Quercus robur* L. 16 species of fungi were detected on *Carpinus betulus* L. The analysis of the vitality of *Carpinus betulus* L. showed that approximately one half of the wood-destroying fungi (47.1%, findings) occurred on trees of II Kraft class (26.2%, trees). An equal distribution of xylotrophs (17.6%, findings) was detected on IV and V Kraft classes (26.2% and 7.1%, trees). Only one species, *Vuilleminia comedens* (Nees) Maire (5.9%, findings), occurred on trees of III Kraft class (12.0%, trees). WAKC of heavily weakened individuals of *Carpinus betulus* L. (3.2 – 3.4) showed that drying of trees was natural process compared to the distribution of WAKC of *Quercus robur* L. The analysis of the health conditions of *Carpinus betulus* L. showed that the stands were healthy (I = 1.45) unlike *Quercus robur* L. The proportion of healthy trees was 38.1% and of the wilting ones was less 3.1%. An equal distribution of xylotrophs (29.4%, findings) was detected on weakened (16.7%, trees) and recently dead trees (16.7%, trees). On healthy trees of *Carpinus betulus* L. we registered carpophores of *Fomes fomentarius* (L.) Fr. (11.8%, findings). On fallen wood of *Carpinus betulus* L. (stems, logs, D_{ave} = 16.5 – 46.5 cm) we observed 12 species of wood-destroying fungi. *Bjerkandera adusta* (Willd.) P.Karst., *Pluteus cervinus* (Schaeff.) P.Kumm., *Schizopora paradoxa* (Schrad.) Donk, *Stereum subtomentosum* Pouzar, *Trichaptum biforme* (Fr.) Ryvarden preferred the broken area. *Auricularia auricula-judae* (Bull.) Quél., *Cerrena unicolor* (Bull.) Murrill, *Daedaleopsis tricolor* (Bull.) Bondartsev et Singer, *Fomes fomentarius* (L.) Fr., *Stereum hirsutum* (Willd.) Pers. and *Trametes gibbosa* (Pers.) Fr. developing on integral bark.

Table 3. Characteristic of dominant woody vegetation.

No. EP	Species	A, y.	N, pcs.	D_{ave}, cm	D_{min} – D_{max}; S.D.	H_{ave}, m	H_{min} –H_{max}; S.D.	P	G_n m^2ha^{-1}
1	*Q. robur*	80 – 100	162	88.4	72.1 – 122.1; 9.77	17.8	14.9 – 19.1;1.95		194.2
	C. betulus	60 – 80	194	29.7	24.5 – 39.7; 5.73	16.8	15.1 – 19.0;1.93		99.3
	T. cordata	60 – 80	69	33.2	22.5 – 37.4; 7.48	15.0	13.1 – 16.9;1.68		52.3
	A. platanoides	40 – 60	104	29.8	21.9 – 39.5; 6.13	14.1	13.0 – 15.84; 1.78	0.6 – 0.7	663.1
	U. glabra	60 – 80	75	32.5	24.7 – 45.3; 7.92	16.7	14.5 – 18.14 2.02		43.0
2	*Q. robur*	60 – 80	137	53.8	46.1 – 80.5; 9.98	19.3	17.2 – 21.5; 1.65	0.7 – 0.8	119.8
	P. sylvestris	60 – 80	148	36.8	26.5 – 40.1; 7.04	18.1	15.4 – 19.9; 1.86		101.5
	A. platanoides	20 – 40	58	16.3	12.5 – 19.1; 7.25	12.1	10.7 – 13.6; 1.14		29.7
3	*Q. robur*	60 – 80	97	56.7	44.1 – 69.5; 5.03	18.2	14.5 – 19.9; 2.14	0.8 – 0.9	98.4
	C. betulus	60 – 80	56	22.5	19.8 – 31.3; 4.98	17.0	14.5 – 18.4; 1.25		48.1
	A. platanoides	40 – 60	87	24.1	17.5 – 29.7; 6.48	14.9	12.8017.5; 2.35		64.1
	T. cordata	60 – 80	39	30.1	25.3 – 38.5; 8.26	14.8	12.8 – 18.0; 1.84		28.1
	F. excelsior	40 – 60	30	22.1	17.5 – 28.3; 5.74	15.1	13.9 – 16.8; 1.45		32.3
4	*Q. robur*	60 – 80	155	76.2	60.4 – 94.2; 8.12	19.1	16.4 – 24.3; 2.17	0.6 – 0.7	135.6
	A. platanoides	40 – 60	125	31.2	23.8 – 41.4; 8.55	15.3	13.7 – 18.0;1.95		78.5
	P. avium	40 – 60	44	34.8	25.1 – 40.1; 5.14	15.1	12.9 – 18.2; 2.27		25.3

Table 4. The health conditions of *Quercus robur* L. and the share of findings of wood destroying fungi.

EP	The health conditions*														
	I			II			III			IV			V		
	WAKC	%, trees	%, findings	WAKC	%, trees	%, findings	WAKC	%, trees	%, findings	WAKC	%, trees	%, findings	WAKC	%, trees	%, findings
1	1.5	24.0	6.0	2.1	38.0	23.5	3.0	24.5	23.5	1.8	8.0	29.4	4.0	5.5	17.6
2	2.0	21.4	23.9	2,5	39.3	42.8	2.3	10.7	11.1	3.0	21.4	11.1	4.5	7.2	11.1
3	1.3	13.9	14.3	1.3	36.1	14.3	2.2	38.8	42.8	3.3	5.6	28.6	4.0	5.6	0
4	1.4	37.9	11.2	1.4	25.8	18.5	2.7	16.7	18.5	2.4	16.7	33.3	2.7	2.9	18.5

Xylaria polymorpha (Pers.) Grev. developing in clasters on rotten wood of *Carpinus betulus* L.

Wood-destroying fungi recorded on *Tilia cordata* Mill. (*Fomes fomentarius* (L.) Fr., on stem of living tree of I Kraft class, V state category), *Acer platanoides* L. (*Dendrothele acerina* (Pers.) P.A. Lemke, on stem base of living tree of I–II Kraft classes, I–II state categories) and *Ulmus glabra* Huds. (*Dendrothele alliacea* (Quél.) P.A. Lemke, on stem base of living tree of I–II Kraft classes, I, III state categories) occurring only a few. On fallen wood (stems, D_{ave} = 19.5 cm) we registered *Schizopora flavipora* (Berk. et M.A. Curtis ex Cooke) Ryvarden and *Stereum subtomentosum* Pouzar. The plantings of *Tilia cordata* Mill., *Acer platanoides* L. and *Ulmus glabra* Huds. were healthy (I = 1.25; I = 1.34; I = 1.21).

3.2 Assessment results at the tract "Bila dibrova"

The tract EP2 has a low sandy hill, which are the remnants of upland terraces Dnipro and Desna. The first storey consisted of *Quercus robur* L. and *Pinus sylvestris* L.. The second storey composed of *Acer platanoides* L. (Table 3). The understorey was composed biogroups of *Corylus avellana* L., *Frangula alnus* Mill., *Sambucus nigra* L., *Sorbus aucuparia* L., *Cerasus avium* L., and *Rubus fruticous* L. The total projected cover of herbaceous storey was 80.0%. *Convallaria majalis* L., *Driopteris filix-mas* L., *Geranium sanguineum* L., *Stellaria nemorum* L., *Polygonatum multiflorum* (L.) All. were dominated. The mechanical damage of trees was not observed. The soil surface was in II stage of degradation. The overall stage of recreational transformation was II. In total, we detected we detected 29 species (72, findings) of wood destroying fungi from 23 genera, 15 families, and 6 orders on 6 species of trees. 61.1% findings of fungi were eurytrophes of II rank on deciduous trees and 36.1% – eurytrophes of I rank. Eurytrophes of II rank on coniferous trees (2.8%, findings) was represented by only one species *Heterobasidion annosum* (Fr.) Bref. (Appendix 1). At EP2 the 59.7% findings of wood destroying fungi were occurred in the ground myco-horizon (Appendix 2). On *Quercus robur* L. we detected 5 species of xylotrophic fungi. The analysis of health conditions of *Quercus robur* L. showed that the stands were weakened (I = 2.45). The proportion of healthy and the wilting trees was the same (21.4%). The share of recently dead stands were minimal at EP2 (7.2%). WAKC of healthy trees was 2.0 (Table 4). The maximum number of xylotrophs was recorded on *Quercus robur* L. trees of II state category (42.8%). The same number of xylotrophs (11.1%) was recorded on the trees of III and IV state categories. The analysis of vitality revealed that one third of findings (33.3%) were detected on trees in I Kraft development class (with 48.1% frequency at the plot). The smallest number of observations (3.8%) was recorded on trees in III Kraft development class. The proportion of xylotrophic fungi that developed in II, IV, V Kraft development classes ranged from 16.7% to 22.2%. Besides, the dead substrate of the three categories was also detected at the EP2 (Fig. 1). It should be noted that the biggest number of species and findings of xylotrophic fungi on dead substrate coincides with the falling wood of *Quercus robur* L. No wood destroying fungi were detected on trees of *Acer platanoides* L. (I = 1.35) and *Pinus sylvestris* L. (I = 2.42). Only developing of *Trametes ochracea* (Pers.) Gilb. et Ryvarden and *Trametes versicolor* (L.) Lloyd was detected on branches of *Acer platanoides* L. On stumps (D_{ave} = 50.6 cm) of *Pinus sylvestris* L. was detected 5 species of xylotrophic fungi. Wood-destroying fungi on understorey were found on the bark and saw cut of *Cerasus avium* L. (10 species; branches, D_{ave} = 7.8 cm; stems, D_{ave} = 17.9 cm) and on the bark of *Sambucus nigra* L. (2 species; branches, D_{ave} = 3.2 cm).

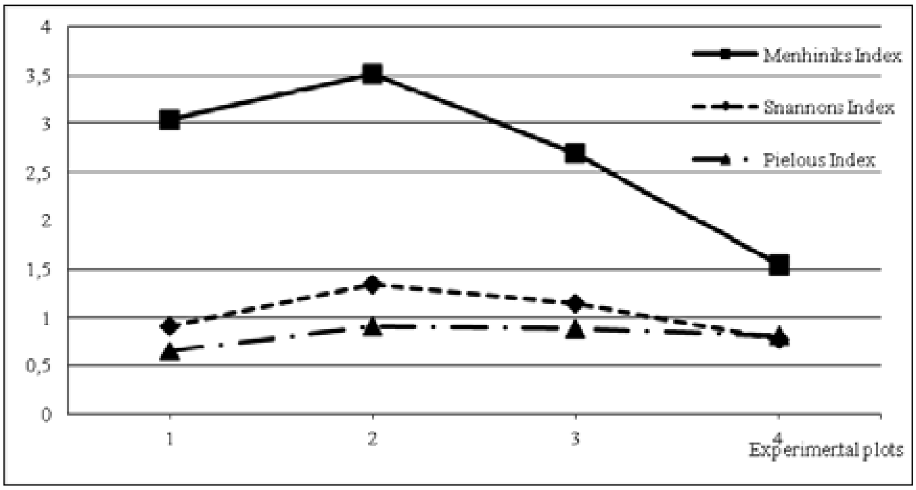

Fig. 1. Species richness of xylomyco-biota.

3.3. Assessment results at the tract Tract "Lysa Hora"

The tract EP3 is represented by hornbeam-oak forest, which was formed in place of cleared space of oak. The first storey consisted of *Quercus robur* L. and *Carpinus betulus* L. The second storey composed of *Acer platanoides* L., *Tilia cordata* Mill., and *Fraxinus excelsior* L. (Table 3). The undergrowth was poorly developed, sometimes represented by biogroups of *Sambucus nigra* L. and *Euonymus verrucosa* Scop. The herbaceous storey was represented by ruderal species. The projected cover of herbaceous storey was less than 35.0%. The total indicator of the state soil surface was III stage of digression. The total area of mechanical damage of trees was 0.32 m^2. The overall stage of recreational transformation was III. At EP3 we detected 19 species (50, findings) of wood destroying fungi from 13 genera, 10 families, and 5 orders on six species of trees. 74.0% findings of fungi were eurytrophes of II rank on deciduous trees and 16.0% – eurytrophes of I rank. Stenotrophes (10.0%, findings) was represented by *Fistulina hepatica* (Schaeff.) With. and *Peniophora rufomarginata* (Pers.) Bourdot et Galzin (Appendix 1). At EP3 the maximum number of wood destroying fungi (34.0%, findings) were occurred in the ground myco-horizon (Appendix 2). On *Quercus robur* L. we detected 5 species of xylotrophic fungi. The analysis of health conditions of *Quercus robur* L. showed that the stands were weakened (I = 2.41) too. The proportion of healthy trees was 13.4% (Table 4). The share of weakened (36.1%) and heavily weakened (38.8%) were almost equal. WAKC of wilting and recently dead trees of *Quercus robur* L. were 3.3 and 3.4 accordingly. 42.8% of findings of xylotrophic fungi was recorded on trees of II state category. The same number of xylotrophs (11.1%) was detected on the trees of I and II state categories (14.3%). The analysis of the vitality was quite predictable: 57.1% findings occurred mainly on 58.3% trees of I Kraft class. The analysis of the vitality of *Quercus robur* L. showed that the 64.7% findings of fungi occurred mainly on trees of I Kraft class (64.0%, trees). The lowest number of fungi (5.9%, findings) occurred on trees of III Kraft class (12.0%, trees). WAKC of wilting trees (1.8) showed that the share of trees in I, II Kraft classes gradually increased (Table 4).

On *Carpinus betulus* L. we detected 7 species of xylotrophic fungi. The same findings of xylotrophic fungi (30.0%) was detected on healthy trees (60.0%) and recently dead trees (4.0%). Value of WAKC of healthy individuals were not exceed 1.2 – 1.4. The developing of 5 species of xylotrophic fungi was detected on falling wood (branches, D_{ave} = 2.7 cm) of *Carpinus betulus* L. On stems (D_{ave} = 20.5 cm) of *Pinus sylvestris* L. was detected *Stereum hirsutum* (Willd.) Pers. One species of xylotrophic fungi were detected on individuals of second storey: *Acer platanoides* L. (*Dendrothele acerina* (Pers.) P.A. Lemke; 11 findings; I, III, V Kraft classes; I-III state categories), *Tilia cordata* L. (*Peniophora rufomarginata* (Pers.) Bourdot et Galzin; 1 finding; III Kraft class; II state category). The analysis of health conditions of *Acer platanoides* L. showed that the stands were healthy I = 1.37). The share of healthy trees was more than half (57.7%), wilting individuals were only 3.9%. *Tilia cordata* L. (I = 2.75) and *Fraxinus excelsior* L. (I = 1.65) had worse health condition compared to *Acer platanoides* L. Only *Peniophora cinerea* (Pers.) Cooke was recorded on deadwood of *Acer platanoides* L.

3.4. Assessment results at the tract "Teremky"

The tract EP4 was located in the Tract "Teremky„ on the outskirts of the city. The first storey consisted of one *Quercus robur* L. and the second storey composed of *Acer platanoides* L. and *Prunus avium* (L.) (Table 3). The projected cover of herbaceous storey was less than 35.0%. Ruderal and pratal species were dominated at EP4. The indicator species (only *Asarum europaeum* L., 0.5%) were recorded around butt of *Quercus robur* L. Mechanically damaged were registered only on stems of *Quercus robur* L. The total indicator of the state soil surface was IV stage of digression. The clogging of the soil's surface was about 7.5%. The overall stage of recreational transformation was IV.

At EP4 we detected 9 species (34, findings) of wood destroying fungi represented nine genera, seven families, four orders. 88.3% findings of fungi were eurytrophes of II rank on deciduous trees and 8.8% – eurytrophes of I rank. Stenotrophes (2.9%, findings) were represented by only one species: *Stereum gausapatum* (Fr.) (Appendix 1). The greatest number of the identified xylotrophic fungi (41.1%, findings) was founded in the photosynthesising myco-horizon and 35.3% – in the stem myco-horizon, while in the ground and the butt myco-horizons we detected the same number of wood destroying fungi (11.8%, findings) (Appendix 2). On *Quercus robur* L. we detected 6 species of xylotrophic fungi. We recorded only one biotrophic species – *Phellinus robustus* (P. Karst.) Bourdot et Galzin. Their frequency et EP4 was 11.0% (II, IV–V state category). The investigated stands of *Quercus robur* L. were weakened (I = 2.11). The proportion of healthy trees was 37.9% despite the high stage of recreational transformation. The maximum number of xylotrophs (33.3%, findings) was recorded on *Quercus robur* L. trees of IV state category, while their share in EP was only 16.7%. Share of fungi was equal on trees of II–III, V state categories – 18.5%. The analysis of the vitality of *Quercus robur* L. revealed that wood destroying fungi occurred mainly on *Quercus robur* L. trees of I Kraft class (48.0%, findings; 63,6%, trees); and the proportion of xylotrophic fungi in II and III Kraft classes was the same (26.0%, findings; 16.7%, trees). WAKC of wilting and recently dead stands were 2.4 and 2.6.

On living trees of *Acer platanoides* L. (I = 1.55) we detected only one species – *Dendrothele acerina* (Pers.) P. A. Lemke (80.0%, findings; 46.2%, trees of II state category). Analysis of the relationship between the findings of *Dendrothele acerina* (Pers.) P. A. Lemke on *Acer platanoides* L. and vitality of stands showed that 60.0% of the findings dedicated to the trees in I Kraft class (11.5%). Xylomycobiota was absent on individuals of *Acer platanoides* L. in III Kraft class (26.9%, trees). No wood destroying fungi were developed on trees in in IV Kraft class (7.8%, trees), V Kraft class (34.6%, trees) and *Prunus avium* (L.). The developing of 2 species (2, findings) of *Peniophora quercina* (Pers.) Cooke and *Vuilleminia comedens* (Nees) Maire) was detected on falling wood.

3.5. Species richness of wood destroying fungi

Analysis of species richness of wood destroying fungi of investigated forests in urban conditions on gradient of recreational transformation showed that the EP1 had species richest diversity. In general, species variety of xylotrophic macromycetes at experimental plots caused by existence of species with wide substrate preferendum. It is also associated with the development of stenotrophic fungi. Value of Menhinik's Index is increasing on gradient of recreational transformation. Interrelation between the degree of recreational transformation and value of Shannon's Index is not established. Assessment of equitability of xylomycobiota showed that value of Pielou's Index is decreasing on gradient of recreational transformation (Fig. 1). Distribution of xylomycobiota by categories of substrates showed that 31.3% of the findings were registered in *Quercus robur* L. (I–IV categories of state), 68.7% – in the dead substrates. Findings of xylomycobionts on *Carpinus betulus* L. were dominated in the dead substrates too (86.7%), the maximum number of findings of xylotrophic fungi on trees was at EP1. Findings of xylomycobionts on *Acer platanoides* L. were dominated in living trees (62.5%). Wood destroying fungi on *Pinus sylvestris* L. were registered only on old dead substrates. Distribution of xylomyco-biota by myco-horizons showed that the maximum number of findings were concentrated in the ground myco-horizon (38.4%), while the minimum – in the stem base myco-horizon (11.8%). The findings of xylotrophic fungi on root myco-horizon were unrecorded. Analysis of trophic composition of xylomycobiota at all EP showed that the greatest number of eurytrophes of II rank on deciduous species (88.3%) detected at EP4; eurytrophes of I rank (36.1%) – at EP2; eurytrophes of II rank on coniferous species (2.8%) – only at EP2. The average share of stenotrophes at the ecoprofile was 5.05%.

3.6. Peculiarities of studied consortium

It is clear accordingly, recreational transformation of EP that consortium relations of *Quercus robur* L. at EP1 and EP2 are more similar to each other (Fig. 2 a). In addition, consortium relations of EP3 and EP4 are more similar to each other. Analyses of formed consortium relations of *Acer platanoides* L. showed that consortium relations of EP2 and EP4 are more similar to each other too (Fig. 2 b). Such distribution confirmed our data on the absence of a direct relationship between the degree of recreational transformation of the territory and state of community of *Acer*-xylomycokomplex (Blinkova & Ivanenko 2016). Obtained results regarding the similarities of clusters, comparison of compositions of trees and fungi in the formed communities in the forests depending on the recreational transformation of environment in urban conditions require further researches. Analyse of dead substrate of the host tree of xylotrophic fungi showed that the biggest number of species were developed on deadwood (D_{ave} = 10.0 – 50.0 cm; 17 species) at EP2 (Fig. 3). Maximum number of species on stumps were recorded at EP2 too. Maximum number of species on branches and stems (D_{ave} = 5.0 – 10.0 cm) were recorded at EP1. It should be noted that the biggest number of findings of xylotrophic fungi on dead substrate coincides with the deadwood at EP1 (15 findings) and EP2 (13 findings)

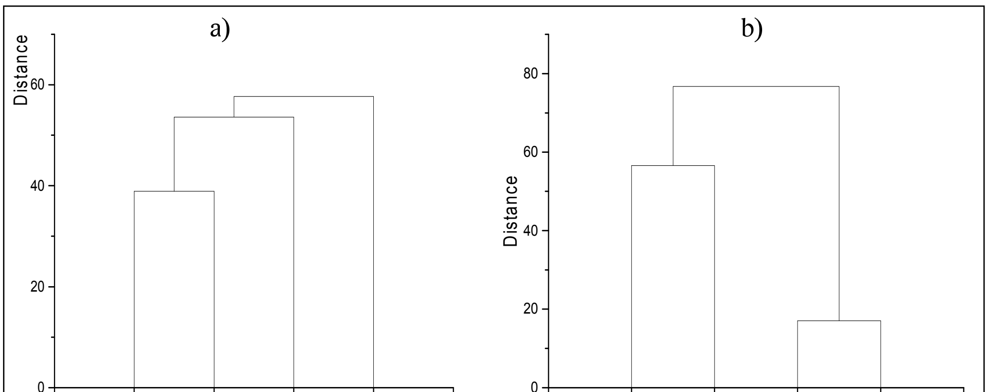

Fig. 2. Clustering dendrogram of ecological links of *Quercus robur* L. (a) and *Acer platanoides* L. (b) in natural and seminatural forests (EP1–EP4).

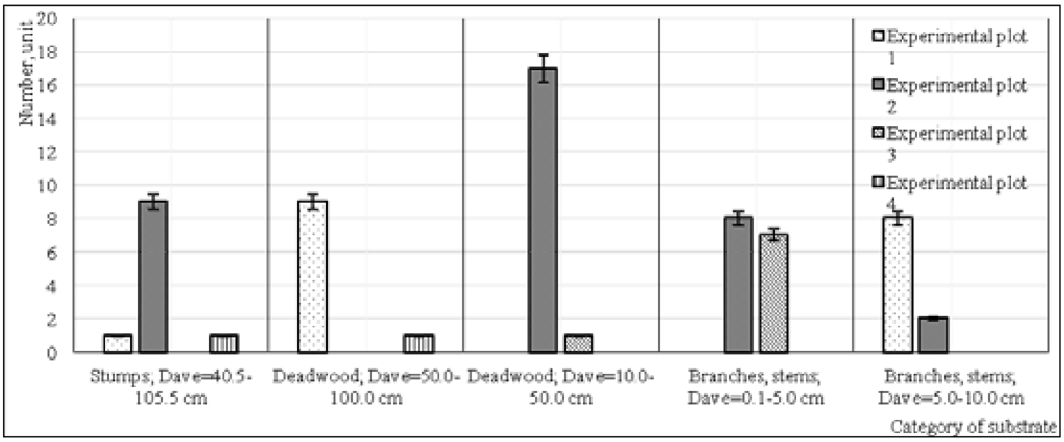

Fig. 3. Number of observed species of xylotrophic fungi on experimental plots in individual substrate categories.

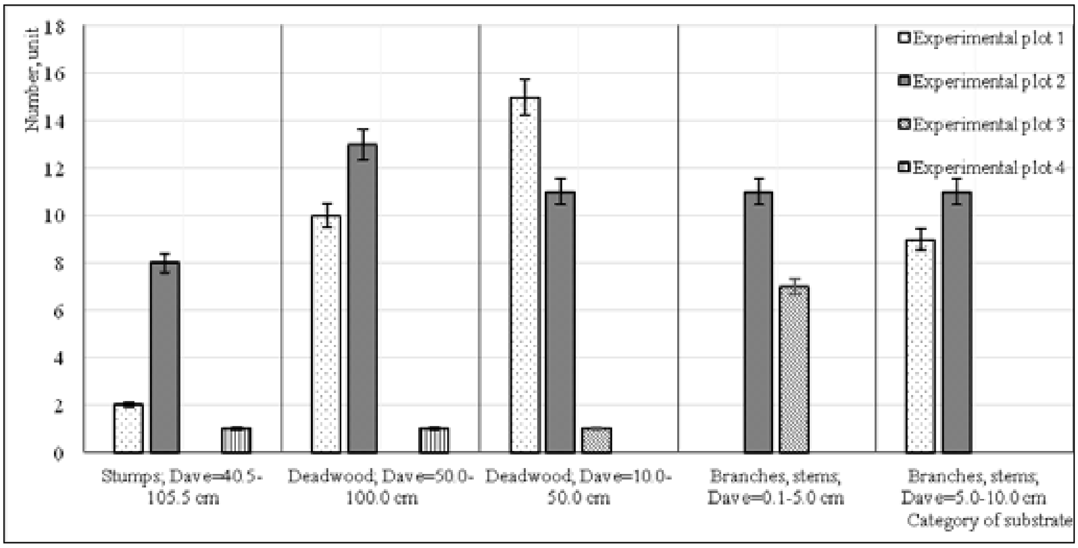

Fig. 4. Number of observed findings of xylotrophic fungi on experimental plots in individual substrate categories.

(Fig. 4). Minimum number of findings at the ecoprofile were assigned to stumps (only 1 – 8 findings). The close relationships between the distributions of fungi in various categories of dead substrate depending on recreational transformation of territory were not found.

4. Discussion

The diversity patterns of fungi along the geographical gradient appear to be influenced by management related factors (forest history, dead wood availability and continuity, habitat fragmentation). An increase in the abundance of dead wood in forests will benefit diversity (Odor et al. 2006). Previous publications shown that the some species are highly specialized in their resource use and suffer from loss of connectivity at three spatial scales (along the large-scale gradient, at the landscape scale and at the scale of a forest stand) (Norden et al. 2013). Conservation of fungi requires that substantial amounts of dead wood is left for natural decay in a variety of natural forest environments representing different tree species, so that heterogeneity in dead wood types is secured (Heilmann-Clausen et al. 2005).

Our distribution by myco-horizons on macro level evidences that xylomycobiota develops more in the ground myco-horizon. Depending on species composition of forests also the composition of xylotrophs is changing. It has been proved that the composition of xylotrophic fungi in studied recreational transformed forests are not balanced, as dispersal of xylotrophic fungi in them is limited by lesser quantity of available live and dead rooting substrate, by greater openness of canopy of the stand, by less protected properties of the herbaceous cover, digression of the soil surface layer.

The importance of different fractions of deadwood for species diversity of wood-inhabiting fungi was investigated in many studies. Category of substrate (living trees or deadwood) is essential for developing of xylotrophic fungi. The number of species varied in different deadwood and decay substrate. The different stages of decay and the different substrate of deadwood had significantly different species richness of xylotrophic fungi (Sefidi & Etemad 2015). The results of other studies indicated the morphometric parameters and category of dead wood describe the greatest variance of numbers of species. The differences in deadwood profiles among the habitat types can be considered the main source of variation. The high qualitative diversity of deadwood substrates in natural forests creates multiple ecological niches for individual fungal species to occupy. The natural forest structure and dynamics provide, in turn, variable microclimatic conditions to meet the demands of wood destroying fungi (Norden et al. 2004; Sefidi&Etemad 2015). Species number per tree increased significantly with increasing tree diameter, pointing out large trees to be most valuable for fungal diversity if single samples are compared. These are interpreted to reflect a combination of two factors: firstly, small diameter represent a larger surface area per volume and hence more space for fungal carpophors, than large diameter (Heilmann-Clausen & Christensen 2004). Fungal species richness in small-diameter deadwood was highest in recreational transformed forests (Juutilainen et al. 2016). Our results indicate that type of substrate (living trees or dead substrate) and morphometric parameters of deadwood substrate are very important factors affecting fungal community compositions. Moreover, this study showed that the biggest number of species and findings were recorded on deadwood compared to living trees. The highest value for richness and evenness indices calculated in large diameter dead wood.

Many scientists were focused on diversity and host preference of wood decaying fungi in urban areas. Compared of frequency and diversity of wood decaying fungi in natural forest of the town of Zvolen showed that the highest diversity and the highest incidence of wood decaying fungi were detected in area with minimum of the human impact on the forest (Sliacka 2013). Our results showed that state of communities of tree vegetation and xylotrophic fungi of natural and semi-natural forests in urban conditions depends on the degree of recreational transformation of the territory. The species richness of xylomycobiota at forests increases by the recreational transformation, which are evidences by the values of Menhinik's Index. Our data on changes in the condition of woody plants due to recreational transformation are correlated with the results of studies by other authors. The case study of Kyiv city has established that as increases the recreational transformation of natural and semi-natural forests, the interrelation of trophic, ecological and systematic compositions of xylotrophic fungi and vital, age compositions and health condition of woody vegetation is lost similar for our data to parks (Blinkova & Ivanenko 2016). The biggest number of findings of xylotrophs is detected on living trees of *Quercus robur* L. In general, health condition of dominating woody species in urban conditions is decreasing from the healthy to the heavily weakened. Our results show that under the categories of substrates of broad-leaved tree species, it has been established that 62.9% of findings of wood-destroying fungi is detected on living trees of I–IV state categories. Xylotrophs on coniferous species have been detected only on stumps of *Pinus sylvestris* L. Hence, inter-links between tree vegetation and xylotrophic fungi are significantly influenced by human activities.

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Appendix 1. Taxonomic and trophic compositions of wood destroying fungi at all experimental plots.

Order	Family	Species	Trophic groups*	No. EP
Agaricales	Fistulinaceae	*Fistulina hepatica* (Schaeff.) With.	S	1, 3
	Physalacriaceae	*Cylindrobasidium evolvens* (Fr.) Jülich	E2d	3
	Pluteaceae	*Pluteus cervinus* (Schaeff.) P.Kumm.	E1	1, 2
	Pterulaceae	*Radulomyces molaris* (Chaillet ex Fr.) Christ.	E2d	3
	Schizophyllaceae	*Schizophyllum commune* Fr.	E1	1
Auriculariales	Auriculariaceae	*Auricularia auricula-judae* (Bull.) Quél.	E1	1, 2
Corticiales	Corticiaceae	*Corticium roseum* Pers.	EI	3
		Dendrothele acerina (Pers.) P. A. Lemke	E2d	1, 3, 4
		D. alliacea (Quél.) P. A. Lemke	E2d	1
		Vuilleminia comedens (Nees) Maire	E2d	1, 2, 3, 4
Hymenochaetales	Hymenochaetaceae	*Hymenochaete rubiginosa* (Dicks.) Lév.	E2d	2
		Inocutis dryophila (Berk.) Fiasson et Niemelä	E2d	1
		Inonotus hispidus (Bull.) P. Karst.	E2d	3
		I. radiatus (Sowerby) P. Karst.	E2d	1
		Phellinus ferruginosus (Schad.) Pat.	E1	2, 3
		P. robustus (P. Karst.) Bourdot et Galzin	E2d	1, 2, 3, 4
		P. tuberculosus (Baumg.) Niemelä	E2d	2
	Schizoporaceae	*Schizopora flavipora* (Berk. et M.A. Curtis ex Cooke) Ryvarden	E1	1
		S. paradoxa (Schrad.) Donk	E1	1, 2, 3, 4
	Tubulicrinaceae	*Hyphodontia sambuci* (Pers.) J. Erikss.	E2d	2
Polyporales	Fomitopsidaceae	*Antrodia serialis* (Fr.) Donk	E1	2
		Laetiporus sulphureus (Bull.) Murrill	E1	1, 3
	Ganodermataceae	*Ganoderma lipsiense* (Batsch) G.F. Atk.	E1	2
		G. lucidum (Curtis) P. Karst.	E1	4
	Meruliaceae	*Bjerkandera adusta* (Willd.) P.Karst.	E1	1, 2
		Phlebia radiata Fr.	E2d	1, 2
		P. tremellosa (Schrad.) Nakasone et Burds.	E1	2, 4
	Phanerochaetaceae	*Irpex lacteus* (Fr.) Fr.	E2d	2
		Steccherinum fimbriatum (Pers.) J. Erikss.	E1	2
		S. ochraceum (Pers. ex J.F. Gmel.) Gray	E1	2
	Polyporaceae	*Cerrena unicolor* (Bull.) Murrill	E2d	1, 2, 3
		Daedaleopsis confragosa (Bolton) J. Schröt.	E2d	2
		D. confragosa var. *tricolor* (Bull.) Bondartsev et Singer	E2d	1, 4
		Fomes fomentarius (L.) Fr.	E2d	1, 2
		Lenzites betulina (L.) Fr.	E2d	2
		Polyporus alveolaris (DC.) Bondartsev et Singer	E2d	1, 2, 3
		P. squamosus (Huds.) Fr.	E2d	2
		P. tuberaster (Jacq. ex Pers.) Fr.	E2d	3
		Trametes gibbosa (Pers.) Fr.	E2d	1
		T. ochracea (Pers.) Gilb. Et Ryvarden	E1	2
		T.versicolor (L.) Lloyd	E1	2
		Trichaptum biforme (Fr.) Ryvarden	E2d	1
Russulales	Amylostereaceae	*Artomyces pyxidatus* (Pers.) Jülich	E2d	2
	Bondarzewiaceae	*Heterobasidion annosum* (Fr.) Bref.	E2c	2
	Peniophoraceae	*Peniophora cinerea* (Pers.) Cooke	E2d	3
		P. laeta (Fr.) Donk	E2d	3
		P. quercina (Pers.) Cooke	E2d	1, 2, 3, 4
		P. rufomarginata (Pers.) Bourdot et Galzin	S	3
	Stereaceae	*Stereum gausapatum* (Fr.) Fr.	S	4
		S. hirsutum (Willd.) Pers.	E2d	1, 2, 3
		S. subtomentosum Pouzar	E2d	1
Xylariales	Xylariaceae	*Xylaria polymorpha* (Pers.) Grev.	E2d	1

Note:* Eurytrophes of I rank (E1), eurytrophes of II rank on deciduous trees (E2d), eurytrophes of II rank on coniferous trees (E2c), stenotrophes (S).

Appendix 2. Distribution of xylotrophic fungi by myco-horizons at all experimental plots.

No.	Fungi-consorts	Trees-edificators of consortium	Myco-horizons*				
			1	2	3	4	5
1	*Antrodia serialis* (Fr.) Donk.	*Pinus sylvestris* L. (1)	—	—	1/2.7	—	—
2	*Artomyces pyxidatus* (Pers.) Jülich	*Pinus sylvestris* L. (1)	—	—	1/2.7	—	—
3	*Auricularia auricula-judae* (Bull.) Quél.	*Carpinus betulus* L. (1), *Sambucus nigra* L. (1)	—	1/1.1	—	1/2.0	—
4	*Bjerkandera adusta* (Willd.) P. Karst.	*Carpinus betulus* L. (4), *Quercus robur* L. (4)	—	6/6.5	1/2.7	1/2.0	—
5	*Cerrena unicolor* (Bull.) Murrill	*Carpinus betulus* L. (2), *Prunus avium* L. (1), *Quercus robur* L. (2)	—	4/4.3	—	1/2.0	—
6	*Corticium roseum* Pers.	*Carpinus betulus* L. (1)	—	1/1.1	—	—	—
7	*Cylindrobasidium evolvens* (Fr.) Jülich	*Carpinus betulus* L. (1)	—	1/1.1	—	—	—
8	*Daedaleopsis confragosa* (Bolton) J. Schröt.	*Prunus avium* L. (2)	—	2/2.2	—	—	—
9	*D. confragosa* var. *tricolor* (Bull.) Bondartsev et Singer	*Carpinus betulus* L. (1), *Prunus avium* (L.) L. (1)	—	2/2.2	—	—	—
10	*Dendrothele acerina* (Pers.) P. A. Lemke	*Acer platanoides* L. (21)	—	—	8/21.6	13/26.5	—
11	*D. alliacea* (Quél.) P. A. Lemke	*Ulmus glabra* Huds. (3)	—	—	—	3/6.1	—
12	*Fistulina hepatica* (Schaeff.) With.	*Quercus robur* L. (8)	—	—	8/21.6	—	—
13	*Fomes fomentarius* (L.) Fr.	*Carpinus betulus* L. (9), *Prunus avium* (L.) L. (1), *Quercus robur* L. (1), *Tilia cordata* Mill. (1)	—	5/5.4	3/8.1	2/4.1	2/4.4
14	*Ganoderma lipsiense* (Batsch) G.F. Atk.	*Quercus robur* L. (1), *Prunus avium* ~~(L.)~~ L. (1)	—	1/1.1	1/2.7	—	—
15	*G. lucidum* (Curtis) P. Karst.	*Quercus robur* L. (1)	—	—	1/2.7	—	—
16	*Heterobasidion annosum* (Fr.) Bref.	*Pinus sylvestris* L. (2)	—	—	2/5.4	—	—
17	*Hymenochaete rubiginosa* (Dicks.) Lév.	*Quercus robur* L. (7)	—	2/2.2	5/13.5	—	—
18	*Hyphodontia sambuci* (Pers.) J. Erikss.	*Sambucus nigra* L. (1)	—	—	1/2.7	—	—
19	*Inocutis dryophila* (Berk.) Fiasson et Niemelä	*Quercus robur* L. (1)	—	—	—	1/2.0	—
20	*Inonotus hispidus* (Bull.) P. Karst.	*Fraxinus excelsior* L. (1)	—	—	—	1/2.0	—
21	*I. radiatus* (Sowerby) P. Karst.	*Quercus robur* L. (1)	—	—	1/2.7	—	—
22	*Irpex lacteus* (Fr.) Fr.	*Prunus avium* L. (2), *Quercus robur* L. (2)	—	4/4.3	—	—	—
23	*Lenzites betulina* (L.) Fr.	*Betula pendula* Roth (1)	—	1/1.1	—	—	—
24	*Laetiporus sulphureus* (Bull.) Murrill	*Quercus robur* L. (5)	—	2/2.2	1/2.7	2/4.1	—
25	*Peniophora cinerea* (Pers.) Cooke	*Acer platanoides* L. (1)	—	—	—	—	1/2.2
26	*P. laeta* (Fr.) Donk	*Carpinus betulus* L. (2)	—	2/2.2	—	—	—
27	*P. quercina* (Pers.) Cooke	*Quercus robur* L. (11)	—	6/6.5	—	—	5/11.1
28	*P. rufomarginata* (Pers.) Bourdot et Galzin	*Tilia cordata* Mill. (2)	—	—	—	—	2/4.4
29	*Phellinus ferruginosus* (Schad.) Pat.	*Prunus avium* L. (1), *Quercus robur* L. (1)	—	1/1.1	—	—	1/2.2
30	*P. robustus* (P. Karst.) Bourdot et Galzin	*Quercus robur* L. (24)	—	1/1.1	—	14/28.6	9/20.0
31	*P. tuberculosus* (Baumg.) Niemelä	*Prunus avium* L. (1)	—	—	—	1/2.0	—
32	*Phlebia radiata* Fr.	*Carpinus betulus* L. (1), *Prunus avium* (L.) L. (1)	—	1/1.1	—	1/2.0	—
33	*P. tremellosa* (Schrad.) Nakasone et Burds.	*Prunus avium* L. (1), *Quercus robur* L. (1)	—	1/1.1	1/2.7	—	—
34	*Pluteus cervinus* (Schaeff.) P.Kumm.	*Carpinus betulus* L. (1), *Pinus sylvestris* L. (1), *Quercus robur* L. (2)	—	2/2.2	2/5.4	—	—
35	*Polyporus alveolaris* (DC.) Bondartsev et Singer	*Carpinus betulus* L. (3), *Prunus avium* (L.) L. (1), *Quercus robur* L. (1)	—	5/5.4	—	—	—
36	*P. squamosus* (Huds.) Fr.	*Prunus avium* L. (1)	—	1/1.1	—	—	—
37	*P. tuberaster* (Jacq. ex Pers.) Fr.	*Acer campestre* L. (1)	—	1/1.1	—	—	—
38	*Radulomyces molaris* (Chaillet ex Fr.) Christ.	*Carpinus betulus* L. (1), *Quercus robur* L. (2)	—	1/1.1	—	—	2/4.4
39	*Schizophyllum commune* Fr.	*Carpinus betulus* L. (2)	—	1/1.1	—	1/2.0	—
40	*Schizopora flavipora* (Berk. et M.A. Curtis ex Cooke) Ryvarden	*Tilia cordata* Mill. (1)	—	1/1.1	—	—	—
41	*S. paradoxa* (Schrad.) Donk	*Carpinus betulus* L. (4), *Quercus robur* L. (5)	—	4/4.3	—	1/2.0	4/8.9
42	*Steccherinum fimbriatum* (Pers.) J. Erikss.	*Pinus sylvestris* L. (1)	—	1/1.1	—	—	—
43	*S. ochraceum* (Pers. ex J.F. Gmel.) Gray	*Quercus robur* L. (1)	—	1/1.1	—	—	—
44	*Stereum gausapatum* (Fr.) Fr.	*Quercus robur* L. (1)	—	—	—	1/2.0	—
45	*S. hirsutum* (Willd.) Pers.	*Carpinus betulus* L. (8), *Quercus robur* L. (3)	—	7/7.5	—	4/8.2	—
46	*S. subtomentosum* Pouzar	*Carpinus betulus* L. (1), *Tilia cordata* Mill. (1), *Ulmus glabra* Huds. (1)	—	3/3.2	—	—	—
47	*Trametes gibbosa* (Pers.) Fr.	*Carpinus betulus* L. (2)	—	2/2.2	—	—	—
48	*T. ochracea* (Pers.) Gilb. Et Ryvarden	*Acer platanoides* L. (1), *Prunus avium* ~~(L.)~~ L. (1)	—	2/2.2	—	—	—
49	*T. versicolor* (L.) Lloyd	*Acer platanoides* L. (1), *Prunus avium* ~~(L.)~~ L. (4), *Quercus robur* L. (3)	—	7/7.5	—	1/2.0	—
50	*Trichaptum biforme* (Fr.) Ryvarden	*Carpinus betulus* L. (1)	—	1/1.1	—	—	—
51	*Vuilleminia comedens* (Nees) Maire	*Carpinus betulus* L. (5), *Quercus robur* L. (22)	—	8/8.6	—	—	19/42.2
52	*Xylaria polymorpha* (Pers.) Grev.	*Carpinus betulus* L. (1)	—	1/1.1	—	—	—
All together species /findings:		11/224	0/0	36/93	15/37	17/49	9/45
% of species /findings:			0/0	70.6/41.5	29.4/16.5	33.3/21.9	17.6/20.1

Note: * – pcs./%; 1 – root; 2 – ground; 3 – boot; 4 – stem; 5 – photosynthesizing myco-horizon; "–" – not detected.