forests

MDPI

Supplementary Materials

Similarity and Differences Among Soil Fungal Assemblages in Managed Forests and Formerly Managed Forest Reserves

Marta Brygida Kujawska [1], Maria Rudawska [1]*, Robin Wilgan [1] and Tomasz Leski [1]

Table S1. The contribution of the main trees species with a specified age (y) in the managed forests (M) and forest reserves (R) at three study sites (P –Przytok, K - Kalisz, L – Łochów).

		Tree contribution at study sites (%)				
Management type	**Stands**	***Pinus sylvestris***	***Picea abies***	***Quercus robur***	***Betula pendula***	***Abies alba***
Managed forests	PM	65 (100y)	33 (70y)	0	0	0
	KM	85 (80–110y)	0	0	0	8 (35–70y)
	LM	88 (55–110y)	4 (55–110y)	8 (55–110y)	3 (55–110y)	0
Reserve forests	PR	40 (70–150y)	46 (110y)	5 (70–145y)	0	0
	KR	52 (35–190y)	0	0	7 (55–95y)	40 (35–190y)
	LR	91 (105y)	4 (50–105y)	3 (50–105y)	0	0

Table S2. The share of the detected phyla in the managed forests (M) and forest reserves (R) based on the number of the identified operational taxonomic units (OTUs) and the number of sequence reads.

Phylum	**No of OTUs**			**No of Reads**		
	Total	**M**	**R**	**Total**	**M**	**R**
Ascomycota	292	270	276	996370	620148	376222
Basidiomycota	233	203	210	1312442	712706	599736
Mucoromycota	21	17	21	48492	32519	15973
Mortierellomycota	18	17	16	206910	120389	86521
Rozellomycota	11	11	11	29029	14830	14199
Chytridiomycota	5	5	5	3945	1460	2485
Glomeromycota	4	4	3	1095	772	323
Basidiobolomycota	2	2	2	2793	1606	1187
Kickxellomycota	2	2	2	439	382	57
Olpidiomycota	2	2	2	1610	747	863
Zoopagomycota	2	2	2	2106	992	1114
Blastocladiomycota	1	1	1	65	29	36
Calcarisporiellomycota	1	1	1	87	32	55
Entomophthoromycota	1	1	1	100	21	79
Entorrhizomycota	1	1	0	40	40	0
Monoblepharomycota	1	1	0	102	102	0
Sporidiobolales	1	1	0	56	56	0
UN Fungi	1	1	1	14108	9070	5038

Table S3. The most frequent soil fungal OTUs from all trophic groups found in the managed forests (M) and forest reserves (R); *(only fungal OTUs with total frequency 21-24 plots are included).*

		Frequency (No of plots)		
Trophic group	**Fungal OTU**	**Total**	**M**	**R**
Ectomycorrhizal fungi	UN Boletaceae	23	11	12
	Imleria badia	23	11	12
	Cenococcum geophilum	22	11	11
	Amanita fulva	22	12	10
	Xerocomellus pruinatus	22	12	10
	Piloderma sphaerosporum	21	12	9
Saprotrophic fungi	UN *Umbelopsis*	24	12	12
	UN *Mortierella*	24	12	12
	UN Hyaloscyphaceae	24	12	12
	UN Archaeorhizomyces	24	12	12
	Trichoderma nothescens	24	12	12
	Penicillium thomii	24	12	12
	Penicillium daleae	24	12	12
	Mortierella parvispora	24	12	12
	Mortierella macrocystis	24	12	12
	Mortierella gemmifera	24	12	12
	Geomyces auratus	24	12	12
	Penicillium atrofulvum	24	12	12
	UN *Cladophialophora*	24	12	12
	Mortierella alliacea	24	12	12
	UN *Trechispora*	23	12	11
	UN Ophiocordycipitaceae	23	11	12
	UN Clavicipitaceae	23	11	12
	Penicillium arianeae	22	11	11
	Penicillium adametzii	21	10	11
	Clitocybe subditopoda	21	10	11
Pathotrophic fungi	*Verticillium leptobactrum*	24	12	12
	Pochonia bulbillosa	24	12	12
	UN *Syncephalis*	24	12	12
	Stegonsporium protopyriforme	24	12	12
	Schizangiella serpentis	23	11	12
Other symbiotrophic fungi	*Phialocephala fortinii*	24	12	12
	UN *Oidiodendron*	24	12	12
	Oidiodendron pilicola	24	12	12
	Oidiodendron echinulatum	24	12	12
	Oidiodendron rhodogenum	24	12	12
	Oidiodendron maius	23	11	12
	Xanthoparmelia chlorochroa	23	11	12
	Oidiodendron tenuissimum	22	10	12
	Oidiodendron chlamydosporicum	21	10	11
Other fungi	UN Rozellomycota 8	24	12	12
	UN Helotiales	24	12	12
	UN Fungi	24	12	12
	UN Chaetothyriales	24	12	12
	UN Basidiomycota 3	24	12	12
	UN Basidiomycota 2	24	12	12
	UN Basidiomycota 4	24	12	12
	UN Rozellomycota 3	23	11	12
	UN Rozellomycota 4	23	11	12
	UN Leucosporidiales	23	12	11

UN Ascomycota 1	23	11	12
Solicoccozyma terricola	23	12	11
UN Rozellomycota 6	23	11	12
UN Ascomycota 4	23	11	12
UN Ascomycota 3	22	11	11
UN Capnodiales	21	10	11
UN Rozellomycota 9	21	10	11
UN Agaricales	21	9	12
Saitozyma podzolica	24	12	12
UN Venturiaceae	24	12	12
UN Dermateaceae	22	12	10
UN Tremellales	21	10	11
Chaetomium homopilatum	21	10	11
UN *Meliniomyces*	24	12	12
Meliniomyces variabilis	24	12	12

Table S4. Frequency of the soil fungal OTUs from different trophic groups found in the managed forests only.

Trophic group	Fungal OTU	Frequency (No of plots)
Ectomycorrhizal fungi	*Amanita masasiensis*	3
	Hygrophorus hypothejus	2
	Amanita xylinivolva	2
	Lactarius helvus	2
	Russula amethystina	1
	Melanogaster ambiguus	1
Saprotrophic fungi	UN *Hyaloscypha*	4
	Apiotrichum wieringae	4
	Hygrocybe griseobrunnea	3
	Xylodon rimosissimus	3
	UN *Articulospora*	3
	Schwanniomyces polymorphus	3
	Mortierella beljakovae	3
	UN *Xylaria*	2
	Penicillium turcosoconidiatum	2
	Entoloma juncinum	2
	Clitocybe phyllophila	2
	UN Preussia	2
	Postia rennyi	2
	Phlebiella christiansenii	2
	UN *Psathyrella*	1
	UN *Idriella*	1
	Mycena silvae-nigrae	1
	Mortierella lignicola	1
	Microcera rubra	1
	Hypochnicium subrigescens	1
	Cystofilobasidium capitatum	1
	Chlorosplenium chlora	1
	Umbelopsis changbaiensis	1
Pathotrophic fungi	*Volutella consors*	3
	Sphaeropsis visci	2
	Exobasidium kishianum	1
	Entorrhiza aschersoniana	1
	Cordyceps brongniartii	1

	Clonostachys candelabrum	1
Other symbiotrophic fungi	*Bulbothrix asiatica*	3
	Sistotrema oblongisporum	3
	Diversispora spurca	2
Other fungi	UN *Tulasnella*	4
	UN Sanchytriaceae	3
	Slooffia tsugae	1
	Rhodotorula toruloides	1
	Goffeauzyma aciditolerans	1
	Flagellospora fusarioides	1
	UN Pleosporaceae	1
	UN Cuniculitremaceae	1

Table S5. Frequency of the soil fungal OTUs from different trophic groups found in forest reserves only.

Trophic group	Fungal OTU	Frequency (No of plots)
Ectomycorrhizal fungi	*Xerocomellus cisalpinus*	3
	UN *Pseudotomentella*	2
	Russula emetica	2
	Cortinarius miwok	2
	UN *Wilcoxina*	1
	UN *Piloderma*	1
	UN *Inocybe*	1
	Tomentella botryoides	1
	Strobilomyces echinocephalus	1
	Russula caerulea	1
	Russula badia	1
	Russula anatina	1
	Russula aeruginea	1
	Lactarius camphoratus	1
	Cortinarius parvannulatus	1
	Cortinarius flexipes	1
Saprotrophic fungi	*Absidia repens*	5
	Utharomyces epallocaulus	4
	UN *Alatospora*	3
	Auxarthron californiense	3
	Trichoderma longipilis	3
	Trechispora stellulata	3
	Thielavia appendiculata	3
	Talaromyces veerkampii	3
	Hyphodontia pallidula	3
	UN Scolecobasidium	2
	Termitomyces clypeatus	2
	Tausonia pullulans	2
	Penicillium gracilentum	2
	Penicillium alexiae	2
	Lepiota fuscovinacea	2
	Hygrocybe noninquinans	2
	Arachnopeziza obtusipila	2

	Absidia fusca	2
	Xylodon borealis	2
	Mucor racemosus	2
	Cryptodiscus cladoniicola	2
	Mortierella hyalina	1
	Gymnoascus reessii	1
	Conocybe sulcatipes	1
	Ceramothyrium carniolicum	1
	Basidiodendron caesiocinereum	1
Pathotrophic fungi	UN *Dothiorella*	3
	Phyllosticta rhapiolepidis	2
	Phacidiella eucalypti	1
	Laetisaria lichenicola	1
Other symbiotrophic fungi	*Gibbosporina nitida*	1
Other fungi	*Krasilnikovozyma tahquamenonensis*	6
	Hymenopellis radicata	4
	UN Lyophyllaceae	2
	Sporothrix sp	2
	Marasmius guyanensis	2
	UN Pyronemataceae	2
	UN Clavariaceae	2
	UN Onygenales	1
	Arcopilus cupreus	1
	UN *Trichophaea*	1

Table S6. List of the 80 fungal OTUs with a relative abundance ≥ 0.5% at ≥ 3 plots, identified in managed forests and forest reserves (means and standard deviation (SD) for 12 plots).

Trophic group	**Phyllum**	**Order**	**Species**	**Relative abundance (%)**			
				Managed forests		**Forest reserves**	
				Mean	**SD**	**Mean**	**SD**
Ectomycorrhizal fungi	Ascomycota	Eurotiales	*Elaphomyces granulatus*	3.80	3.89	1.89	3.27
			Elaphomyces muricatus	3.38	4.34	2.30	2.98
		Helotiales	*Acephala macrosclerotiorum*	0.08	0.10	0.38	0.37
		Myrthidiales	*Cenococcum geophilum*	0.47	0.48	1.29	1.97
			UN *Cenococcum*	0.43	0.30	1.21	1.38
	Basidiomycota	Agaricales	*Amanita fulva*	3.88	5.38	6.02	9.07
			Amanita porphyria	0.30	0.34	0.95	1.74
			Amanita rubescens	1.47	1.72	1.07	1.87
			Cortinarius aurantiobasis	0.30	0.49	0.27	0.48
			Cortinarius humboldtensis	0.14	0.21	1.54	3.05
		Atheliales	***Tylospora fibrillosa****	0.12	0.14	4.09	5.63
			Piloderma olivaceum*	1.84	3.43	1.06	1.96
			Piloderma sphaerosporum	5.19	7.62	9.70	10.27
			UN *Tylospora*	0.50	0.55	0.09	0.19
		Boletales	*Imleria badia*	4.24	4.42	2.68	2.30
			Scleroderma citrinum	3.01	2.06	0.61	1.06
			UN Boletaceae	3.89	3.85	3.05	3.16
		Russulales	*Lactarius quietus*	2.13	3.58	5.43	7.98
			Lactarius rufus	4.07	4.72	0.38	0.71

			Lactarius tabidus*	0.44	0.50	0.74	0.89
			Russula decolorans	7.42	10.14	<0.01	<0.01
			Russula ochroleuca	5.63	12.58	5.65	4.69
		Thelephorales	***Pseudotomentella tristis****	0.42	0.52	0.07	-
			UN Thelephoraceae	1.74	4.87	0.65	1.34
Saprotrophic fungi	Ascomycota	Archaeorhizo-mycetales	*Archaeorhizomyces borealis*	0.48	0.58	0.11	0.08
			UN Archaeorhizomyces	4.28	3.98	3.16	1.78
		Eurotiales	*Aspergillus inflatus*	0.92	1.29	1.71	1.80
			Penicillium adametzii	1.80	2.24	0.84	1.07
			Penicillium arianeae	0.48	0.48	0.36	0.43
			Penicillium atrofulvum	0.35	0.47	0.35	0.45
			Penicillium catalonicum	0.40	0.81	1.33	1.36
			Penicillium daleae	0.71	0.78	0.66	0.73
			Penicillium thomii	0.85	0.65	0.67	0.57
			UN *Penicillium*	0.42	0.57	0.72	0.67
		Helotiales	**UN Hyaloscyphaceae***	1.80	1.09	1.19	1.65
		Hypocreales	*Trichoderma fomiticola*	0.82	0.70	0.69	0.48
			Trichoderma nothescens	0.54	0.41	0.42	0.35
			Trichoderma oblongisporum	0.17	0.31	0.60	1.08
		Pezizales	*Byssonectria fusispora*	0.78	1.74	0.99	2.68
		Thelebolales	*Geomyces auratus*	0.30	0.43	0.69	0.91
	Basidiomycota	Trechisporales	UN *Trechispora*	0.17	0.19	1.02	1.26
	Mortierellomycota	Mortierellales	*Mortierella angusta*	0.80	0.59	0.91	1.33
			Mortierella gemmifera	0.58	1.09	0.31	0.25
			Mortierella macrocystis	1.50	1.24	1.33	0.94
			Mortierella parvispora	0.23	0.23	0.76	1.31
			UN *Mortierella*	4.55	2.55	5.36	4.36
	Mucoromycota	Mucorales	*Absidia caatinguensis*	0.20	0.19	0.39	0.38
		Umbelopsidales	**UN *Umbelopsis****	1.37	0.84	0.60	0.69
Pathotrophic fungi	Ascomycota	Glomerellales	*Verticillium leptobactrum*	0.93	0.84	0.89	0.61
		Hypocreales	*Pochonia bulbillosa*	0.37	0.27	0.32	0.29
			UN *Tolypocladium*	0.55	0.91	0.13	0.13
Other symbiotic fungi	Ascomycota	Helotiales	***Pezoloma ericae****	0.48	0.72	0.14	0.10
			UN *Oidiodendron*	0.39	0.35	0.45	0.25
			Oidiodendron pilicola	0.98	1.50	0.77	0.63
			Oidiodendron echinulatum	2.14	1.89	1.73	1.32
			Oidiodendron chlamydosporicum	0.68	0.90	0.28	0.28
			Oidiodendron rhodogenum	0.39	1.01	1.31	2.33
Other fungi	Ascomycota	Chaetosphaeriales	*Chloridium paucisporum*	0.47	0.81	0.58	1.25
		Chaetothyriales	**UN Chaetothyriales***	1.71	1.06	0.95	0.80
		Helotiales	UN Helotiales	3.50	3.31	2.29	1.42
			Meliniomyces bicolor	0.65	0.64	0.19	0.25
			Meliniomyces variabilis	0.37	0.19	0.33	0.32
			Meliniomyces vraolstadiae	0.38	0.36	0.32	0.37
			UN *Meliniomyces*	1.00	0.54	0.93	0.71
		Hypocreales	UN *Fusarium*	0.39	0.56	0.09	0.16
		Sordariales	UN Sordariales	0.35	0.83	1.33	2.62
		-	UN Ascomycota 1	0.93	1.56	0.74	0.96
		-	UN Ascomycota 2	0.33	0.72	0.64	1.37
	Basidiomycota	Atheliales	UN Atheliaceae	3.15	3.74	1.61	2.77
		Cantharellales	UN Cantharellales	1.19	1.31	0.42	0.87
			UN *Sistotrema*	0.96	2.10	2.67	3.22

	Filobasidiales	*Solicoccozyma terricola*	0.64	0.61	0.58	0.42
	Leucosporidiales	**UN Leucosporidiales***	0.55	0.50	0.28	0.50
	Sebacinales	UN Sebacinales	0.36	0.55	0.34	0.59
	Tremellales	*Saitozyma podzolica*	0.47	0.55	0.58	0.75
	-	UN Basidiomycota 3	0.89	0.93	0.73	0.53
	-	UN Rozellomycota 3	0.33	0.31	0.31	0.31
Rozellomycota	-	UN Rozellomycota 4	0.17	0.27	0.48	0.86
	-	UN Rozellomycota 8	0.75	1.29	0.40	0.38
-	-	UN Fungi	0.64	0.56	0.49	0.22

* **statistically significant** differences between managed forests and forest reserves (Kruskal-Wallis test; $p<0.05$).