forests

Supplementary materials

Diversity and communities of fungal endophytes from four *Pinus* species in Korea

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Keywords: host specificity; fungal endophyte; fungal diversity; pine trees

Table S1. Characteristics and conditions of 18 sampling sites in Korea.

pine species	Geographic Locations	Latitude (°)	Longitude (°)	Altitude (m)	Tree Age (years)	Precipitation (mm) 2016	Temperature (°C) 2016	pH	Organic Matter (g/kg)	Available Phosphate (mg/kg)	Ka	Ca	Mg	Electrical Condictivity	Available Silicic acid (mg/kg)
											(cmol+/kg)				
Pinus rigida	Ansung (1R)	37.0744580	127.1119200	70	45	284	25.5	5.9	20.8	252.4	0.7	4.2	1.7	0.4	123.2
	Seosan (2R)	36.8906971	126.4491716	60	45	295.6	25.2	6.1	22.3	336.6	1.1	6.6	2.4	1.1	75.9
	Jungeup (3R)	35.5521138	127.0191565	240	45	205.1	27.1	5.3	30.4	892.7	1.0	5.8	1.9	0.2	7.9
	Yungyang(4R)	36.6061179	129.0885334	250	43	323.9	23	6.1	21.4	251.2	0.8	7.4	2.8	0.1	96.2
Pinus densiflora	Jungeup (1D)	35.5565492	126.9866204	310	50	205.1	27.1	5.3	30.4	892.7	1.0	5.8	1.9	0.2	7.9
	Jejudo (2D)	33.3737599	126.4716048	1030	40	98.6	27.4	5.3	50.6	591.7	1.2	4.6	1.8	1.7	0.0
	Hoengseong (3D)	37.5098629	128.1603840	540	45	360.1	25.7	5.7	30.2	547.2	0.8	3.7	1.1	0.8	48.9
	Bonghoa (4D)	37.0054026	128.9415950	700	35	416.5	25.9	6.1	27.0	571.7	0.9	5.5	1.5	0.4	11.2
	Yangpung (5D)	37.6118298	127.4436801	300	50	385	25.4	6.0	24.4	299.6	0.5	5.1	1.1	0.6	248.8
Pinus thunbergii	Pohang (1T)	36.1205372	129.4117678	1010	40	113.2	25.9	5.6	22.1	153.3	0.5	6.9	2.5	0.5	116.3
	Jejudo (2T)	33.4729632	126.5005679	30	45	98.6	27.4	5.3	55.7	464.0	11.7	5.5	2.0	38.7	0.1
	Seosan (3T)	36.8766539	126.3867902	40	50	295.6	25.2	6.1	22.3	336.6	1.1	6.6	2.4	1.1	75.9
	Gangneung (4T)	37.9165560	128.8103605	10	35	424.2	24.1	5.6	25.3	667.1	0.6	3.3	1.2	0.3	49.6
	Yeosu (5T)	34.7087622	127.7600016	30	45	157.8	25.3	6.1	31.9	526.2	0.8	6.4	1.6	0.8	81.0
Pinus koraiensis	Hongchun (1K)	37.8073347	127.9294259	470	30	429.4	25.3	5.8	21.7	217.9	0.4	4.2	1.1	0.4	138.4
	Jecheon (2K)	37.1883303	127.9838292	320	30	419.7	24.1	5.8	25.5	320.5	0.7	5.6	1.8	0.2	70.8
	Chuncheon (3K)	37.9058734	127.9312447	250	35	617.1	25.2	6.2	30.2	302.6	0.6	4.1	1.6	0.6	30.1
	Pocheon (4K)	37.9654135	127.1123213	120	50	366.3	25.1	5.7	21.3	237.3	0.9	3.9	0.9	0.4	72.4

http://www.kma.go.kr; http://www.rda.go.kr.

Table S2. The closest relatives of fungal endophytes isolated from pine trees based on the sequence analyses of the nuclear ribosomal internal transcribed spacer region (rDNA ITS) and nuclear large subunit ribosomal DNA (LSU rDNA).

Isolates no.	Description	Registered Accession no.	Homology	Phylum	DNA Region
1	*Cladosporium* sp.	MK883615	99%	Ascomycota	ITS
2	*Cladosporium cladosporioides*	MK883616	99%	Ascomycota	ITS
3	*Alternaria* sp.	MK883617	100%	Ascomycota	ITS
4	*Cladosporium* sp.	MK883618	100%	Ascomycota	ITS
5	*Leptodontidium orchidicola*	MK883619	99%	Ascomycota	ITS
6	*Cladosporium tenuissimum*	MK883620	100%	Ascomycota	ITS
7	*Aspergillus fumigatus*	MK883621	100%	Ascomycota	ITS
8	*Talaromyces amestolkiae*	MK883622	100%	Ascomycota	ITS
9	*Penicillium miczynskii*	MK883623	100%	Ascomycota	ITS
10	*Penicillium minioluteum*	MK883624	99%	Ascomycota	ITS
11	*Penicillium* sp.	MK907923	100%	Ascomycota	LSU
12	*Penicillium* sp.	MK907924	90%	Ascomycota	LSU
13	*Fusarium graminearum*	MK883625	100%	Ascomycota	ITS
14	*Galactomyces candidum*	MK907925	100%	Ascomycota	LSU
15	*Penicillium bialowiezense*	MK883626	99%	Ascomycota	ITS
16	*Fusarium graminearum*	MK883627	100%	Ascomycota	ITS
17	*Penicillium chrysogenum*	MK907926	100%	Ascomycota	LSU
18	*Talaromyces* sp.	MK883628	99%	Ascomycota	ITS
19	*Penicillium* sp.	MK883629	91%	Ascomycota	ITS
20	*Penicillium glabrum*	MK852289	99%	Ascomycota	LSU
21	*Penicillium steckii*	MK907927	99%	Ascomycota	LSU
22	*Penicillium sumatrense*	MK883630	99%	Ascomycota	ITS
23	*Talaromyces* sp.	MK883631	97%	Ascomycota	ITS
24	*Fusarium graminearum*	MK883632	99%	Ascomycota	ITS
25	*Fusarium graminearum*	MK883633	100%	Ascomycota	ITS
26	*Penicillium sumatrense*	MK883634	99%	Ascomycota	ITS
27	*Penicillium brevicompactum*	MK883635	99%	Ascomycota	ITS
28	*Penicillium oxalicum*	MK883636	100%	Ascomycota	ITS
29	*Penicillium expansum*	MK883637	99%	Ascomycota	ITS
30	*Penicillium citreosulfuratum*	MK883638	99%	Ascomycota	ITS
31	*Penicillium canescens*	MK883639	100%	Ascomycota	ITS
32	*Fusarium graminearum*	MK883640	100%	Ascomycota	ITS
33	*Fusarium graminearum*	MK883641	99%	Ascomycota	ITS
34	*Penicillium sumatrense*	MK907928	100%	Ascomycota	LSU
35	*Penicillium chrysogenum*	MK883642	100%	Ascomycota	ITS
36	*Fusarium graminearum*	MK883643	95%	Ascomycota	ITS
37	*Penicillium chrysogenum*	MK883644	99%	Ascomycota	ITS
38	*Penicillium samsonianum*	MK907929	99%	Ascomycota	LSU
39	*Fusarium graminearum*	MK883645	100%	Ascomycota	ITS
40	*Fusarium oxysporum*	MK883646	100%	Ascomycota	ITS
41	*Microdiplodia* sp	MK883647	99%	Ascomycota	ITS
42	*Lophodermium conigenum*	MK883648	99%	Ascomycota	ITS
43	*Umbelopsis isabellina*	MK907930	99%	Mucoromycota	LSU
44	*Umbelopsis dimorpha*	MK883649	99%	Mucoromycota	ITS
45	*Umbelopsis isabellina*	MK883650	99%	Mucoromycota	ITS
46	*Sarocladium implicatum*	MK883651	99%	Ascomycota	ITS
47	*Albophoma yamanashiensis*	MK907931	100%	Ascomycota	LSU
48	*Irpex lacteus*	MK883652	99%	Basidiomycota	ITS
49	*Pestalotiopsis microspora*	MK883653	99%	Ascomycota	ITS
50	*Fusarium solani*	MK918631	100%	Ascomycota	ITS
51	*Umbelopsis isabellina*	MK883654	99%	Mucoromycota	ITS
52	*Peniophora* sp.	MK907932	100%	Basidiomycota	LSU
53	*Gongronella guangdongensis*	MK907933	100%	Mucoromycota	LSU
54	*Phomopsis* sp.	MK883655	100%	Ascomycota	ITS

55	*Antrodia sinuosa*	MK883656	100%	Basidiomycota	ITS
56	*Lophodermium conigenum*	MK883657	100%	Ascomycota	ITS
57	*Umbelopsis dimorpha*	MK883658	100%	Mucoromycota	ITS
58	*Phlebiopsis pilatii*	MK883659	100%	Basidiomycota	ITS
59	*Irpex lacteus*	MK883660	99%	Basidiomycota	ITS
60	*Lophodermium conigenum*	MK883661	100%	Ascomycota	ITS
61	*Leotiomycetes* sp.	MK883662	100%	Ascomycota	ITS
62	*Septoria* sp.	MK883663	100%	Ascomycota	ITS
63	*Diaporthe phaseolorum*	MK883664	100%	Ascomycota	ITS
64	*Leotiomycetes* sp.	MK883665	100%	Ascomycota	ITS
65	*Fusarium incarnatum*	MK883666	100%	Ascomycota	ITS
66	*Sarocladium implicatum*	MK883667	100%	Ascomycota	ITS
67	*Pestalotiopsis mangiferae*	MK883668	97%	Ascomycota	ITS
68	*Xylaria* sp.	MK883669	99%	Ascomycota	ITS
69	*Fusarium graminearum*	MK883670	99%	Ascomycota	ITS
70	*Pezicula rhizophila*	MK883671	99%	Ascomycota	ITS
71	*Cenangium ferruginosum*	MK907934	98%	Ascomycota	LSU
72	*Pezicula ericae*	MK883672	100%	Ascomycota	ITS
73	*Lophodermium conigenum*	MK883673	100%	Ascomycota	ITS
74	*Nectria mariannaeae*	MK883674	99%	Ascomycota	ITS
75	*Lachnum* sp.	MK883675	98%	Ascomycota	ITS
76	*Fusarium graminearum*	MK883676	99%	Ascomycota	ITS
77	*Eurotium rubrum*	MK907935	100%	Ascomycota	LSU
78	*Rhizodermea veluwensis*	MK883677	100%	Ascomycota	ITS
79	*Cryptosporiopsis* sp.	MK883678	99%	Ascomycota	ITS
80	*Mucor circinelloides*	MK883679	99%	Mucoromycota	ITS
81	*Fusarium graminearum*	MK883680	97%	Ascomycota	ITS
82	*Limonomyces roseipellis*	MK918632	100%	Basidiomycota	ITS
83	*Sydowia polyspora*	MK883681	100%	Ascomycota	ITS
84	*Penicillium chalabudae*	MK907936	100%	Ascomycota	LSU
85	*Sphaeropsis sapinea*	MK883682	100%	Ascomycota	ITS
86	*Rhytismataceae* sp.	MK883683	99%	Ascomycota	ITS
87	*Superstratomyces atroviridis*	MK918633	97%	Ascomycota	ITS
88	*Thanatephorus cucumeris*	MK883684	99%	Basidiomycota	ITS
89	*Fusarium solani*	MK918634	99%	Ascomycota	ITS
90	*Fusarium graminearum*	MK883685	99%	Ascomycota	ITS
91	*Penicillium spinulosum*	MK883686	99%	Ascomycota	ITS
92	*Penicillium ochrochloron*	MK907937	99%	Ascomycota	LSU
93	*Penicillium daleae*	MK907938	97%	Ascomycota	LSU
94	*Chaetomium aureum*	MK883687	99%	Ascomycota	ITS
95	*Cadophora finlandica*	MK883688	98%	Ascomycota	ITS
96	*Hypocreaceae* sp.	MK883689	99%	Ascomycota	ITS
97	*Sarocladium implicatum*	MK883690	100%	Ascomycota	ITS
98	*Isaria* sp.	MK883691	98%	Ascomycota	ITS
99	*Acremonium roseolum*	MK883692	98%	Ascomycota	ITS
100	*Geomyces vinaceus*	MK883693	99%	Ascomycota	ITS
101	*Lachnellula subtilissima*	MK883694	98%	Ascomycota	ITS
102	*Xylaria* sp.	MK883695	99%	Ascomycota	ITS
103	*Lophodermium conigenum*	MK883696	98%	Ascomycota	ITS
104	*Lophodermium conigenum*	MK907939	98%	Ascomycota	LSU
105	*Lophodermium conigenum*	MK883697	98%	Ascomycota	ITS
106	*Aspergillus oryzae*	MK883698	100%	Ascomycota	ITS
107	*Rachicladosporium cboliae*	MK907940	99%	Ascomycota	LSU
108	*Oidiodendron* sp.	MK883699	100%	Ascomycota	ITS
109	*Myriangium* sp.	MK883700	99%	Ascomycota	ITS
110	*Lophiostoma* sp.	MK883701	96%	Ascomycota	ITS
111	*Bionectria ochroleuca*	MK907941	98%	Ascomycota	LSU
112	*Phlebia tremellosa*	MK842052	100%	Basidiomycota	ITS

113	*Pezicula melanigena*	MK842053	100%	Ascomycota	ITS
114	*Trichoderma virescentiflavum*	MK842054	100%	Ascomycota	ITS
115	*Sphaeropsis sapinea*	MK842055	99%	Ascomycota	ITS
116	*Lophodermium pinastri*	MK842056	100%	Ascomycota	ITS
117	*Fusarium graminearum*	MK852290	100%	Ascomycota	LSU
118	*Septoria pini-thunbergii*	MK842057	100%	Ascomycota	ITS
119	*Nigrospora* sp.	MK842058	94%	Ascomycota	ITS
120	*Fusarium graminearum*	MK852291	99%	Ascomycota	LSU
121	*Fusarium incarnatum*	MK842059	99%	Ascomycota	ITS
122	*Coprinellus xanthothrix*	MK907942	99%	Basidiomycota	LSU
123	*Psathyrella* sp.	MK842060	100%	Basidiomycota	ITS
124	*Pholiota multicingulata*	MK842061	99%	Basidiomycota	ITS
125	*Chaetomium nigricolor*	MK842062	99%	Ascomycota	ITS
126	*Trichoderma* sp.	MK842063	99%	Ascomycota	ITS
127	*Arthrinium sacchari*	MK842064	100%	Ascomycota	ITS
128	*Lophodermium conigenum*	MK842065	99%	Ascomycota	ITS
129	*Paraconiothyrium brasiliense*	MK842066	99%	Ascomycota	ITS
130	*Pezicula ericae*	MK842067	99%	Ascomycota	ITS
131	*Penicillium expansum*	MK852292	99%	Ascomycota	LSU
132	*Pezicula ericae*	MK842068	100%	Ascomycota	ITS
133	*Paraconiothyrium brasiliense*	MK842069	100%	Ascomycota	ITS
134	*Chaetomium grande*	MK842070	97%	Ascomycota	ITS
135	*Mollisia* sp.	MK842071	99%	Ascomycota	ITS
136	*Zalerion varium*	MK842072	99%	Ascomycota	ITS
137	*Coniochaeta* sp.	MK842073	100%	Ascomycota	ITS
138	*Sclerostagonospora* sp.	MK842074	99%	Ascomycota	ITS
139	*Ulocladium consortiale*	MK907943	100%	Ascomycota	LSU
140	*Pezicula neosporulosa*	MK842075	100%	Ascomycota	ITS
141	*Togninia* sp.	MK842076	99%	Ascomycota	ITS
142	*Fusarium solani*	MK842077	99%	Ascomycota	ITS
143	*Aspergillus parvulus*	MK842078	100%	Ascomycota	ITS
144	*Penicillium raistrickii*	MK842079	99%	Ascomycota	ITS
145	*Aspergillus fumigatus*	MK842080	99%	Ascomycota	ITS
146	*Epicoccum nigrum*	MK842081	100%	Ascomycota	ITS
147	*Rhizodermea veluwensis*	MK852293	99%	Ascomycota	LSU
148	*Geomyces vinaceus*	MK842082	100%	Ascomycota	ITS
149	*Cylindrocarpon* sp.	MK842083	100%	Ascomycota	ITS
150	*Geomyces vinaceus*	MK842084	99%	Ascomycota	ITS
151	*Caliciopsis pinea*	MK842085	100%	Ascomycota	ITS
152	*Caliciopsis pinea*	MK907944	99%	Ascomycota	LSU
153	*Sarocladium subulatum*	MK842086	100%	Ascomycota	ITS
154	*Penicillium* sp.	MK842087	100%	Ascomycota	ITS
155	*Oidiodendron* sp.	MK852294	99%	Ascomycota	LSU
156	*Venturia hystrioides*	MK842088	100%	Ascomycota	ITS
157	*Penicillium janthinellum*	MK907945	99%	Ascomycota	LSU
158	*Peyronellaea glomerata*	MK907946	99%	Ascomycota	LSU
159	*Oidiodendron* sp.	MK907947	99%	Ascomycota	LSU
160	*Xylariomycetidae* sp.	MK842089	100%	Ascomycota	ITS
161	*Paecilomyces* sp.	MK842090	100%	Ascomycota	ITS
162	*Leptostroma* sp.	MK842091	98%	Ascomycota	ITS
163	*Phaeomoniella pinifoliorum*	MK842092	100%	Ascomycota	ITS
164	*Penicillium* sp.	MK842093	99%	Ascomycota	ITS
165	*Fusarium tricinctum*	MK842094	100%	Ascomycota	ITS
166	*Nectria rigidiuscula*	MK842095	99%	Ascomycota	ITS
167	*Periconia* sp.	MK842096	100%	Ascomycota	ITS
168	*Nigrospora sphaerica*	MK842097	93%	Ascomycota	ITS
169	*Aspergillus westerdijkiae*	MK842098	100%	Ascomycota	ITS
170	*Aspergillus terreus*	MK907948	99%	Ascomycota	LSU

171	*Penicillium expansum*	MK907949	99%	Ascomycota	LSU
172	*Cylindrocarpon* sp.	MK842099	100%	Ascomycota	ITS
173	*Penicillium ochrochloron*	MK907950	100%	Ascomycota	LSU
174	*Leotiomycetes* sp.	MK842100	99%	Ascomycota	ITS
175	*Lophodermium conigenum*	MK842101	96%	Ascomycota	ITS
176	*Eurotiomycetes sp.*	MK842102	99%	Ascomycota	ITS
177	*Caliciopsis orientalis*	MK852295	99%	Ascomycota	LSU
178	*Eurotiomycetes* sp.	MK907951	99%	Ascomycota	LSU
179	*Caliciopsis orientalis*	MK842103	99%	Ascomycota	ITS
180	*Lophodermium conigenum*	MK842104	99%	Ascomycota	ITS
181	*Schizophyllum commune*	MK842105	100%	Basidiomycota	ITS
182	*Preussia funiculata*	MK842106	99%	Ascomycota	ITS
183	*Eurotiomycetes* sp.	MK842107	99%	Ascomycota	ITS
184	*Penicillium janthinellum*	MK852296	99%	Ascomycota	LSU
185	*Acremonium cavaraeanum*	MK842108	97%	Ascomycota	ITS
186	*Cenangium ferruginosum*	MK852297	99%	Ascomycota	LSU
187	*Pseudogymnoascus* sp.	MK907952	99%	Ascomycota	LSU
188	*Penicillium* sp.	MK842109	99%	Ascomycota	ITS
189	*Pseudogymnoascus roseus*	MK842110	94%	Ascomycota	ITS
190	*Lophodermium conigenum*	MK907953	99%	Ascomycota	LSU
191	*Alternaria tenuissima*	MK852298	99%	Ascomycota	LSU
192	*Peniophora incarnata*	MK842111	99%	Basidiomycota	ITS
193	*Lophodermium conigenum*	MK852299	99%	Ascomycota	LSU
194	*Plenodomus collinsoniae*	MK842112	100%	Ascomycota	ITS
195	*Pseudocercospora* sp.	MK842113	100%	Ascomycota	ITS
196	*Albifimbria viridis*	MK842114	100%	Ascomycota	ITS
197	*Sclerostagonospora* sp.	MK842115	99%	Ascomycota	ITS
198	*Sclerostagonospora opuntiae*	MK842116	98%	Ascomycota	ITS
199	*Rhytismataceae* sp.	MK852300	99%	Ascomycota	LSU
200	*Rhytismataceae* sp.	MK907954	99%	Ascomycota	ITS
201	*Rhytismataceae* sp.	MK842117	98%	Ascomycota	LSU
202	*Dothideomycetes* sp.	MK842118	99%	Ascomycota	ITS
203	*Lachnum* sp.	MK842119	99%	Ascomycota	ITS
204	*Rhytismataceae* sp.	MK907955	99%	Ascomycota	LSU
205	*Rhytismataceae* sp.	MK907956	99%	Ascomycota	LSU
206	*Penicillium ochrochloron*	MK852301	99%	Ascomycota	LSU
207	*Lophodermium conigenum*	MK907957	100%	Ascomycota	LSU
208	*Lophodermium nitens*	MK842120	100%	Ascomycota	ITS
209	*Lophodermium nitenssequence*	MK842121	99%	Ascomycota	ITS
210	*Rhytismataceae* sp.	MK852302	100%	Ascomycota	LSU
211	*Rhytismataceae* sp.	MK907958	100%	Ascomycota	LSU
212	*Lophiostoma* sp.	MK848663	100%	Ascomycota	ITS
213	*Leotiomycetes* sp.	MK848664	95%	Ascomycota	ITS
214	*Rhytismataceae* sp.	MK848665	99%	Ascomycota	ITS
215	*Talaromyces pinophilus*	MK848666	99%	Ascomycota	ITS
216	*Rhytismataceae* sp.	MK848667	99%	Ascomycota	ITS
217	*Rhytismataceae* sp.	MK848668	100%	Ascomycota	ITS
218	*Ceratobasidium* sp.	MK848669	96%	Basidiomycota	ITS
219	*Lophodermium piceae*	MK907959	99%	Ascomycota	LSU
220	*Beltrania* sp.	MK848670	100%	Ascomycota	ITS
221	*Leotiomycetes* sp.	MK907960	100%	Ascomycota	LSU
222	*Rhytismataceae* sp.	MK848671	99%	Ascomycota	ITS
223	*Rhytismataceae* sp.	MK848672	99%	Ascomycota	ITS
224	*Rhytismataceae* sp.	MK907961	100%	Ascomycota	LSU
225	*Trichocomaceae* sp.	MK852303	100%	Ascomycota	LSU
226	*Nectria cucurbitula*	MK907962	100%	Ascomycota	LSU
227	*Eurotium* sp.	MK848673	99%	Ascomycota	ITS
228	*Eurotiales sp.*	MK852304	100%	Ascomycota	LSU

229	*Sclerostagonospora* sp.	MK848674	99%	Ascomycota	ITS
230	*Penicillium chloroleucon*	MK848675	99%	Ascomycota	ITS
231	*Acremonium* sp.	MK848676	99%	Ascomycota	ITS
232	*Mycoleptodiscus terrestris*	MK848677	100%	Ascomycota	ITS
233	*Teichospora melanommoides*	MK848678	100%	Ascomycota	ITS
234	*Alternaria* sp.	MK848679	100%	Ascomycota	ITS

Table S3. Result of the permutational multivariate analysis of variance (PERMANOVA) between different environmental factors found in all sampling sites.

Source	Degree of Freedom	Sum of Squares	Mean Squares	*F*-value	R^2	Pr (>*F*)
Altitude	1	0.7520	0.75198	1.76060	0.03401	0.023*
Tree age	1	0.2772	0.27725	0.63499	0.01254	0.931
Precipitation	1	0.6063	0.60630	1.39030	0.02705	0.101
Temperature	1	0.3341	0.33409	0.76717	0.01511	0.804
pH	1	0.3312	0.33122	0.76049	0.01498	0.796
Organic matter	1	0.3674	0.36741	0.84499	0.01662	0.711
Silicic acid	1	0.4538	0.45383	1.04790	0.02053	0.410
K	1	0.4595	0.45954	1.06140	0.02079	0.344
Ca	1	0.7361	0.73613	1.72220	0.03330	0.016*
Mg	1	0.7060	0.70595	1.64930	0.03193	0.023*

* significant p-value, $P < 0.05$
** highly significant p-value, $P < 0.001$

Table S4. Summary of 144OTUs isolated from three tissues.

Putative Taxonomic Assignment[a]	Phyla[b]	Plant Tissues
Acremonium cavaraeanum	A	Needle
Acremonium roseolum	A	Needle
Acremonium sp.	A	Needle
Schizophyllum commune	B	Stem
Albifimbria viridis	A	Needle, Root
Albophoma yamanashiensis	A	Needle, Stem, Root
Alternaria sp.	A	Needle, Stem, Root
Alternaria tenuissima	A	Stem
Antrodia sinuosa	B	Needle, Stem, Root
Arthrinium sacchari	A	Needle, Stem
Mollisia sp.	A	Needle, Root
Aspergillus fumigatus	A	Needle, Stem, Root
Aspergillus oryzae	A	Needle
Aspergillus parvulus	A	Needle, Root
Aspergillus terreus	A	Needle
Aspergillus westerdijkiae	A	Needle, Root
Beltrania sp.	A	Needle, Stem
Bionectria ochroleuca	A	Stem, Root
Cadophora finlandica	A	Root
Caliciopsis orientalis	A	Needle
Caliciopsis pinea	A	Needle, Root
Cenangium ferruginosum	A	Needle, Root
Ceratobasidium sp.	B	Needle
Chaetomium aureum	A	Root
Chaetomium grande	A	Needle, Stem, Root
Chaetomium nigricolor	A	Root
Cladosporium cladosporioides	A	Needle, Stem, Root
Cladosporium sp.	A	Needle, Stem, Root
Cladosporium tenuissimum	A	Needle, Root
Coniochaeta sp.	A	Needle, Stem, Root
Coprinellus xanthothrix	B	Stem, Root

Cylindrocarpon sp.	A	Root
Diaporthe phaseolorum	A	Needle, Stem, Root
Epicoccum nigrum	A	Stem
Rhizodermea veluwensis	A	Root
Eurotiales sp.	A	Root
Eurotiomycetes sp.	A	Needle, Stem, Root
Eurotium rubrum	A	Needle
Eurotium sp.	A	Stem
Phaeomoniella pinifoliorum	A	Needle, Root
Fusarium graminearum	A	Needle, Stem, Root
Fusarium incarnatum	A	Needle, Stem, Root
Fusarium oxysporum	A	Stem, Root
Fusarium solani	A	Needle, Stem, Root
Fusarium tricinctum	A	Needle, Stem
Galactomyces candidum	A	Needle, Stem, Root
Geomyces vinaceus	A	Needle, Root
Gongronella guangdongensis	M	Stem, Root
Hypocreaceae sp.	A	Needle, Root
Irpex lacteus	B	Needle, Stem, Root
Lachnellula subtilissima	A	Needle, Stem, Root
Leotiomycetes sp.	A	Needle, Root
Leptodontidium orchidicola	A	Needle, Stem, Root
Leptostroma sp.	A	Needle
Limonomyces roseipellis	B	Needle, Root
Lophiostoma sp.	A	Needle, Stem, Root
Lophodermium conigenum	A	Needle, Stem, Root
Lophodermium nitens	A	Needle
Lophodermium nitenssequence	A	Needle
Lophodermium piceae	A	Needle, Stem
Lophodermium pinastri	A	Needle, Stem, Root
Microdiplodia sp.	A	Needle, Stem, Root
Mucor circinelloides	M	Stem, Root
Mycoleptodiscus terrestris	A	Root
Myriangium sp.	A	Needle, Stem, Root
Nectria cucurbitula	A	Needle
Nectria mariannaeae	A	Needle, Root
Nectria rigidiuscula	A	Stem, Root
Nigrospora sp.	A	Stem
Nigrospora sphaerica	A	Needle
Oidiodendron sp.	A	Needle, Root
Paecilomyces sp.	A	Needle, Root
Paraconiothyrium brasiliense	A	Needle, Stem, Root
Penicillium bialowiezense	A	Needle, Stem, Root
Penicillium brevicompactum	A	Needle, Stem, Root
Penicillium canescens	A	Stem, Root
Penicillium chalabudae	A	Root
Penicillium chloroleucon	A	Stem
Penicillium chrysogenum	A	Needle, Stem, Root
Penicillium citreosulfuratum	A	Stem, Root
Penicillium daleae	A	Stem, Root
Penicillium expansum	A	Needle, Stem, Root
Penicillium glabrum	A	Stem
Penicillium janthinellum	A	Root
Penicillium miczynskii	A	Stem, Root
Penicillium minioluteum	A	Needle, Stem, Root
Penicillium ochrochloron	A	Stem, Root
Penicillium oxalicum	A	Needle, Root
Penicillium raistrickii	A	Stem, Root
Penicillium samsonianum	A	Needle, Stem, Root

Penicillium sp.	A	Needle, Stem, Root
Penicillium spinulosum	A	Stem, Root
Penicillium steckii	A	Needle, Stem
Penicillium sumatrense	A	Needle, Stem, Root
Peniophora incarnata	B	Root
Peniophora sp.	B	Needle, Root
Periconia sp.	A	Root
Pestalotiopsis mangiferae	A	Needle, Stem, Root
Pestalotiopsis microspora	A	Stem, Root
Peyronellaea glomerata	A	Stem
Pezicula ericae	A	Needle, Root
Pezicula melanigena	A	Needle, Root
Pezicula neosporulosa	A	Needle, Root
Pezicula rhizophila	A	Root
Phlebia tremellosa	B	Needle
Phlebiopsis pilatii	B	Needle, Stem, Root
Pholiota multicingulata	B	Root
Phomopsis sp.	A	Needle, Stem
Plenodomus collinsoniae	A	Needle, Stem, Root
Preussia funiculata	A	Needle, Root
Psathyrella sp.	B	Root
Pseudocercospora sp.	A	Needle
Pseudogymnoascus roseus	A	Root
Pseudogymnoascus sp.	A	Needle, Stem, Root
Rachicladosporium cboliae	A	Needle, Stem, Root
Rhytismataceae sp.	A	Needle, Root
Sarocladium implicatum	A	Needle, Stem, Root
Sarocladium subulatum	A	Stem
Sclerostagonospora opuntiae	A	Root
Sclerostagonospora sp.	A	Needle, Root
Septoria sp.	A	Needle, Stem, Root
Sphaeropsis sapinea	A	Needle, Stem, Root
Superstratomyces atroviridis	A	Needle, Stem
Sydowia polyspora	A	Needle, Stem
Talaromyces amestolkiae	A	Needle
Talaromyces pinophilus	A	Needle
Talaromyces sp.	A	Stem, Root
Teichospora melanommoides	A	Needle
Thanatephorus cucumeris	B	Needle, Stem, Root
Togninia sp.	A	Stem
Trichocomaceae sp.	A	Needle
Trichoderma sp.	A	Needle, Stem, Root
Trichoderma virescentiflavum	A	Needle, Stem, Root
Ulocladium consortiale	A	Stem
Umbelopsis dimorpha	M	Needle, Stem, Root
Umbelopsis isabellina	M	Needle, Stem, Root
Cryptosporiopsis sp	A	Needle, Stem, Root
Dothideomycetes	A	Root
Isaria sp.	A	Needle
Lachnum sp.	A	Needle, Root
Venturia hystrioides	A	Stem
Xylaria sp	A	Needle, Stem, Root
Xylariomycetidae sp.	A	Needle
Zalerion varium	A	Needle, Stem, Root

[a]Phyla: A = Ascomycota; B = Basidiomycota; M = Mucoromycota.

[b]Putative taxonomic assignment of each OTU.

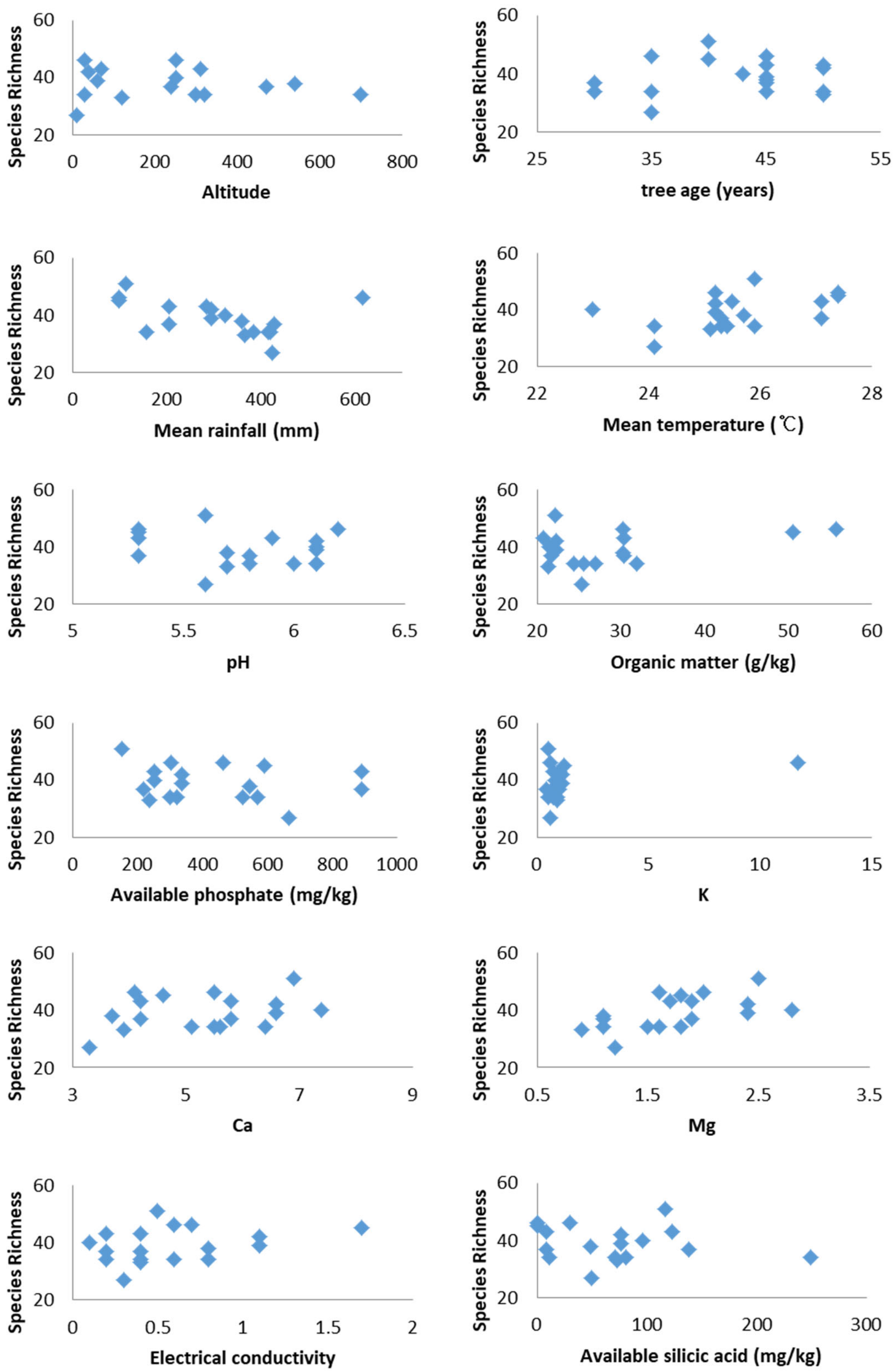

Figure S1. Scatter plots showing relationships between species richness and the factors of sampling sites.

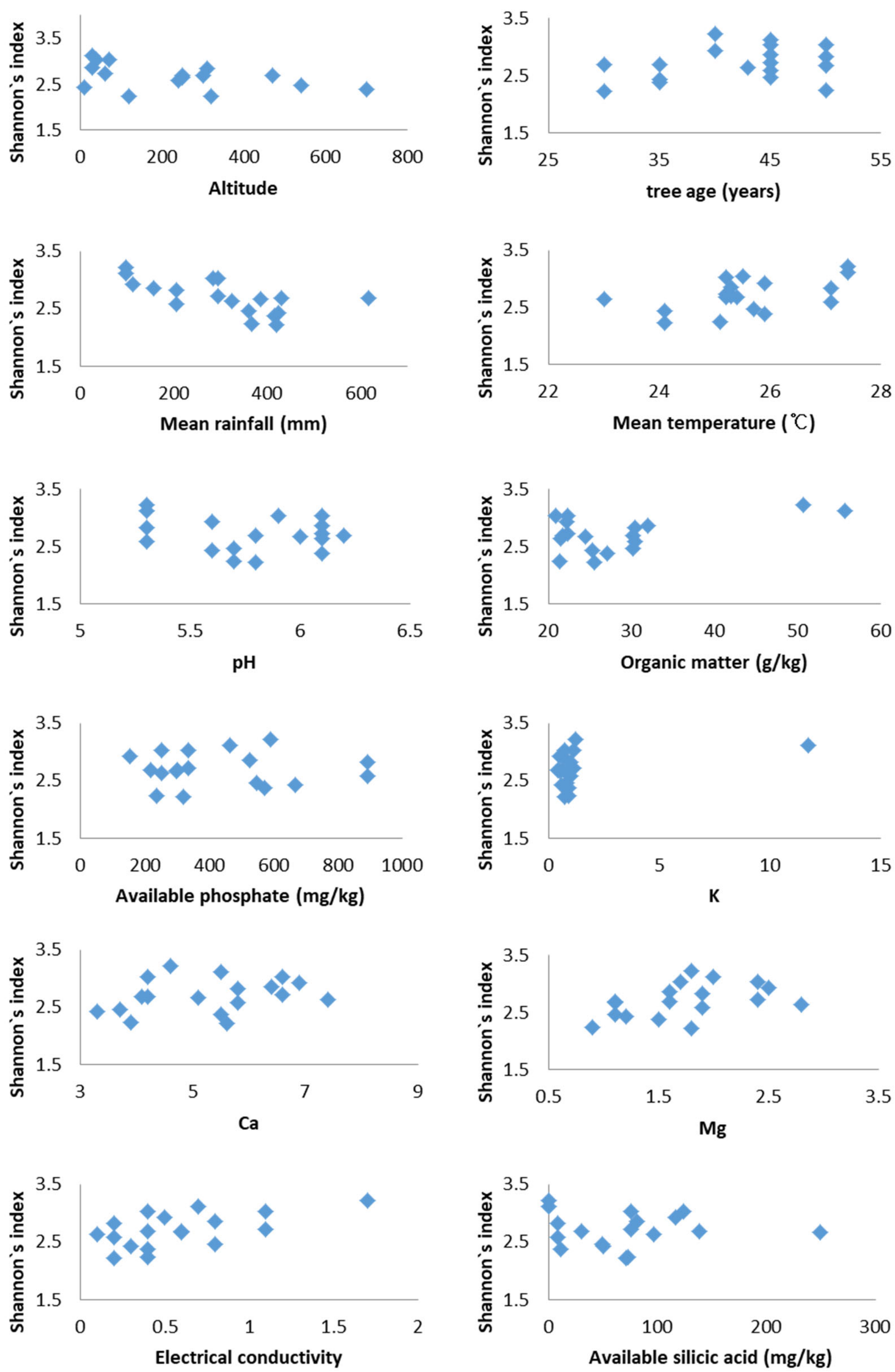

Figure S2. Scatter plots showing relationships between Shannon's index and the factors of sampling sites.

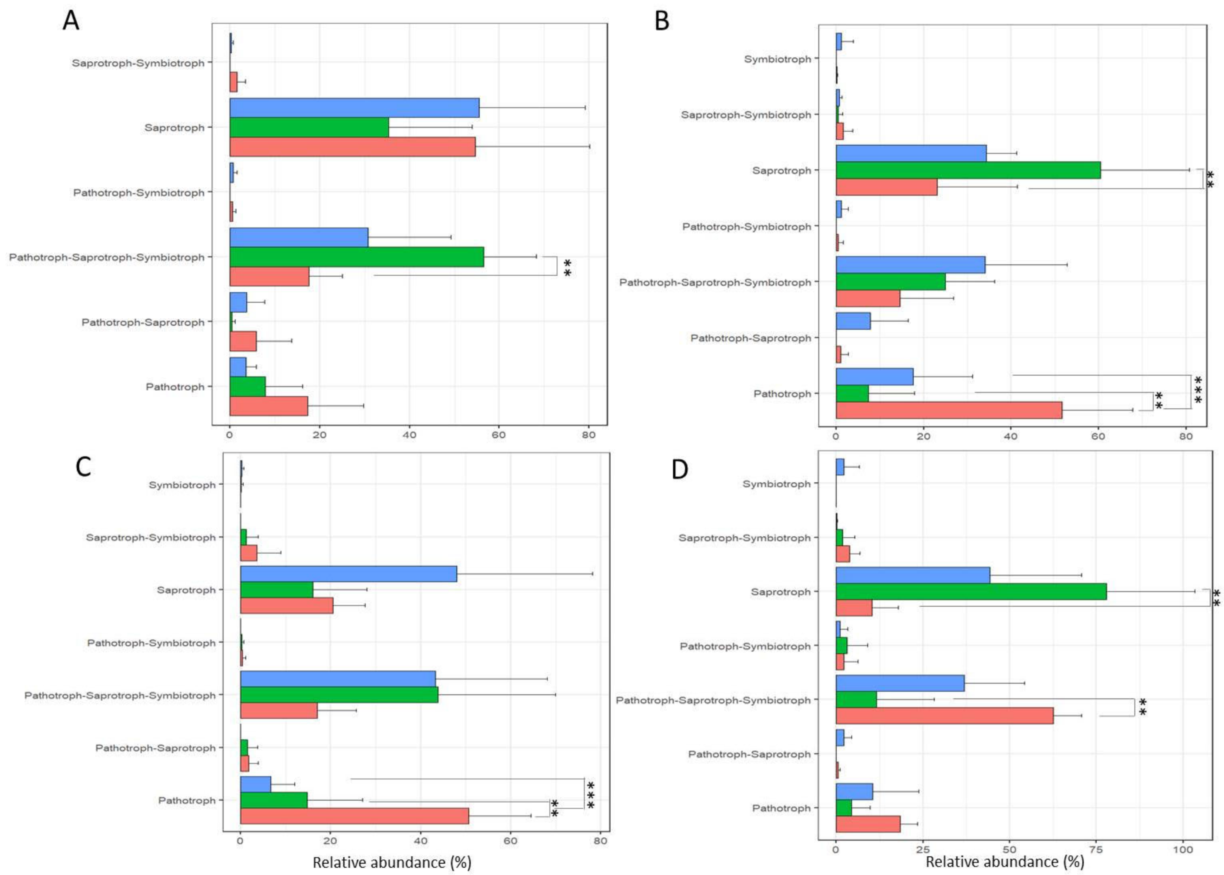

Figure S3. Relative abundance of Trophic mode in *Pinus* species (A) *P. rigida,* (B) *P. densiflora,* (C) *P. thunbergii,* and (D) *P. koraiensis.* Blue, green and pink bars mean root, stem, and needle, respectively. The data were analysed by employing the analysis of variance and Tukey's test ($P < 0.05$) using R version 3.6. Significance codes : 0 ***, 0.001 **, 0.01 *.

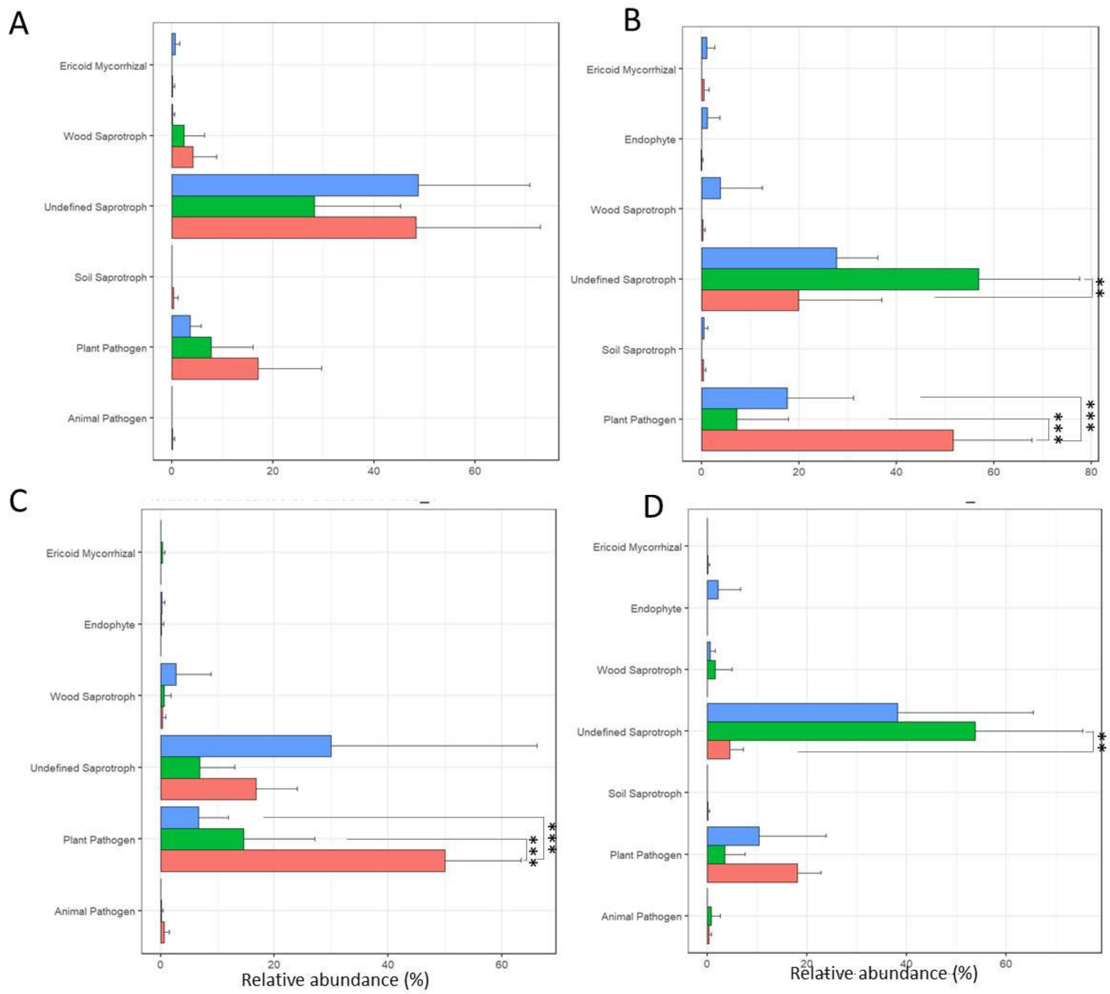

Figure S4. Relative abundance of Fungal Guild in *Pinus* species (A) *P. rigida,* (B) *P. densiflora,* (C) *P. thunbergii,* and (D) *P. koraiensis.* Blue, green and pink bars mean root, stem, and needle respectively. The data were analysed by employing the analysis of variance and Tukey's test ($P < 0.05$) using R v3.6. Significance codes: 0 ***, 0.001 **, 0.01 *.