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Title: Effects of local forest continuity on the diversity of fungi on standing dead pines

1   **EFFECTS OF LOCAL FOREST CONTINUITY ON THE DIVERSITY OF FUNGI ON STANDING**

2   **DEAD PINES**

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5   **APPENDIX B. Responses of individual species**

6   In the main text of this article we report the results of the community analyses. Here we report analyses on

7   the responses of single species analyses using the same explanatory variables. We also briefly report the

8   methods of the single species analyses and shortly discuss the results.

9   **METHODS**

10   Responses of single species were analyzed with a Mixed Effects Logistic Regression (n = 52). The aim was

11   to study which environmental variables explain occurrences of each species the best. Species that occurred

12   on ≥ 10 study trunks were included into the analysis (n = 14). A Mixed Effects Logistic Regression with a

13   binomial distribution and a log-linear link function was conducted separately for each species. Explanatory

14   variables were the same as in the GLMM (see the main text). Site and trunk identities were included into the

15   model as hierarchically structured random effects by nesting trunks within sites. The model selection was

16   conducted as in the GLMM. The analysis was performed in R (version 3.3.2; R Core Team, 2016) using

17   function "glmer" from the package "lme4" (Bates et al., 2016).

18   **RESULTS**

19   Studied variables explained the presence of four species altogether. For the rest, the final models did not

20   include any statistically significant variables. Occurrences of *Actidium hysterioides* were negatively affected

21   by years from death (Table B.1). The final model also included dead wood diversity that had a marginally

22   significant negative effect on the species (Table B.1). Occurrences of *Chaenothecopsis pusiola* were best

23   explained by a negative effect of dead wood diversity, a negative effect of age at death, and a positive effect

24   of years from death (Table B.1). These were all variables included in the final model. Canopy openness

25   appeared to have a positive effect on the occurrences of *Glonium nitidum* (Table B.1). Number of stumps

26   and years from death were the other variables included in the final model (Table B.1). The negative effect of

27　years from death was marginally significant (Table B.1). Occurrences of *Micarea elachista* were best

28　explained by a negative effect of dead wood diversity (Table B.1). Another variable included in the final

29　model was the number of stumps that had a marginally significant positive effect on the species as well

30　(Table B.1).

31　　　Species final models of which included marginally significant effects of certain variables were

32　*Micarea prasina* (a positive effect of years from death), *Mycocalicium subtile "thin"* (a negative effect of

33　management intensity), Pyrenomycete sp. 4 (a negative effect of dead wood diversity, and a positive effect

34　of canopy openness), and *Trichaptum fuscoviolaceum* (a negative effect of years from death) (Table B.1).

35 **Table B.1.** Results from the Mixed Effects Logistic Regression for individual species (n = 52 for each). Cells
36 show estimates (B), standard errors (SE), z values, and statistical significances (P). Dead wood (DW)
37 diversity was calculated with Shannon's diversity index. The units used for variables are in brackets.
38 Abbreviations: YFD = years from death, AAD = age at death, stumps = management intensity, canopy =
39 canopy openness.

Species		B	SE	z value	P
Actidium hysterioides	(Intercept)	-1.72	0.76	-2.27	0.023
	DW diversity	-1.09	0.62	-1.75	0.081
	YFD (y)	-1.42	0.69	-2.07	0.039
Chaenothecopsis pusiola	(Intercept)	-0.75	0.35	-2.16	0.031
	DW diversity	-0.76	0.37	-2.05	0.041
	AAD (y)	-0.81	0.41	-1.97	0.049
	YFD (y)	0.97	0.41	2.38	0.017
Glonium nitidum	(Intercept)	0.18	0.61	0.30	0.763
	Stumps (pc ha^{-1})	1.00	0.67	1.48	0.138
	YFD (y)	-1.04	0.55	-1.90	0.058
	Canopy (%)	1.75	0.78	2.25	0.025
Micarea contexta	(Intercept)	-1.73	0.69	-2.51	0.012
	YFD (y)	0.55	0.44	1.25	0.213
Micarea elachista	(Intercept)	-3.19	0.92	-3.46	< 0.001
	DW diversity	-2.58	0.92	-2.81	0.005
	Stumps (pc ha^{-1})	0.84	0.47	1.80	0.072
Micarea melaena	(Intercept)	0.81	0.46	1.77	0.076
	AAD (y)	-0.43	0.43	-1.01	0.315
Micarea misella	(Intercept)	-0.59	0.41	-1.44	0.149
	YFD (y)	0.12	0.34	0.35	0.728
Micarea prasina	(Interept)	-1.20	0.71	-1.69	0.091
	YFD (y)	0.74	0.44	1.68	0.093
Mycocalicium subtile "big"	(Intercept)	-0.86	0.32	-2.74	0.006
	AAD (y)	-0.51	0.36	-1.44	0.150
Mycocalicium subtile "thin"	(Intercept)	-2.34	1.15	-2.03	0.043
	Stumps (pc ha^{-1})	-1.70	0.99	-1.72	0.085
Pyrenomycete sp. 1	(Intercept)	-1.31	0.34	-3.82	< 0.001
	Canopy (%)	0.33	0.39	0.85	0.398
Pyrenomycete sp. 2	(Intercept)	-2.46	2.55	-0.96	0.335
	DW diversity	-1.15	1.28	-0.90	0.370
	AAD (y)	-1.25	1.33	-0.94	0.346
	YFD (y)	-1.04	1.21	-0.86	0.388
Pyrenomycete sp. 4	(Intercept)	-0.65	0.44	-1.49	0.136
	DW diversity	-0.82	0.43	-1.94	0.053
	Canopy (%)	0.99	0.51	1.93	0.053
Trichaptum fuscoviolaceum	(Intercept)	-1.71	0.61	-2.83	0.005
	YFD (y)	-0.84	0.49	-1.70	0.089

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DISCUSSION

Occurrences of *Chaenothecopsis pusiola* showed a positive association with time since tree death, and for *Micarea prasina* the positive effect was nearly statistically significant. The species occurred more likely on trunks that had died longer time ago. The positive effect of time since tree death on *C. pusiola* might be explained by its suggested parasitic relationship with lichens and non-symbiotic algal colonies (Tuovila, 2013). Also, more suitable habitats form with time, as the species prefers decorticated wood (Lõhmus and Lõhmus, 2001). *M. prasina* is a crustose lichen especially common in old-growth forests (Stenroos et al., 2015). Presumably, this slow-growing species (Stenroos et al., 2011) benefits from long periods since tree death like lichens in general.

Years from death had a negative effect on pyrenomycetes *Actidium hysterioides* and *Glonium nitidum* and polypore *Trichaptum fuscoviolaceum,* yet the effect was not statistically significant for the latter two. All these species might be early successional species. Many pyrenomycetes latent in the wood are abundant in initial decay stages (Heilmann-Clausen, 2001; Hendry et al., 2002). Additionally, increasing moisture content with proceeding decomposition (Sollins et al., 1987) might hinder these species adapted to dry conditions (Boddy et al., 1989, 1985). *T. fuscoviolaceum* is a pioneer species that is often among the initial decomposers (Niemelä et al., 1995; Renvall, 1995). The species loses in competitive ability or due to depleting resources when late-stage specialists colonize the community (Rayner and Boddy, 1988; Stokland et al., 2012).

C. pusiola responded negatively to the increasing trunk age at death. The species seems to occur frequently on decorticated, decayed surfaces on the base of the boles (Hanna Tuovila, personal communication). Such microhabitat patches might be more common in younger trunks due to the differences in decay succession. Old standing kelo trees, for example, rarely offer such microhabitats. Therefore, the species might prefer trunks that have died at younger age.

Dead wood diversity had a negative effect on *C. pusiola, Micarea elachista*, *A. hysterioides* and Pyrenomycete sp. 4, although the effect was not statistically significant for the latter two. *C. pusiola* also occurs in managed forests as long as suitable substrates are available (Hanna Tuovila, personal communication), and therefore the species might not be dependent on old-growth forests *per se*. The

68 negative effect on *M. elachista* might indicate that the species is not dead wood dependent as such since it

69 can also grow on old living trees (Coppins, 1983; Czarnota, 2007). Like many pyrenomycetes, also *A.*

70 *hysterioides* and Pyrenomycete sp. 4 might be associated with early stages of decomposition (Heilmann-

71 Clausen, 2001; Hendry et al., 2002). The emergence of more specialized species with increasing dead wood

72 diversity might have an adverse effect on these species.

73 Pyrenomycetes *G. nitidum Ellis* and Pyrenomycete sp. 4 showed a positive response to canopy

74 openness, yet the effect was not statistically significant for the latter. Pyrenomycetes in general are

75 characterized by high resistance to water stress (Boddy et al., 1989, 1985). Consequently, the competitive

76 superiority of these species in dry circumstances might explain the result.

77 Altogether, negative responses to local continuity were predominant among individual species. Such

78 responses could be expected from generalists that lose to late-stage specialists in competitiveness (Marvier et

79 al., 2004). Kruys et al. (1999) hypothesized that species dependent on dead wood continuity require habitats

80 that are scarce within a landscape. Presumably, these species are specialists and rare. In our study, such

81 species did not probably have enough occurrences to be included in the analyses. Some of these species

82 might be *e.g.* veteran tree specialists that inhabit the oldest trunks for which the age parameters were not

83 successfully quantified. Therefore, more research on rare and specialized species is required to clarify their

84 relationship with local continuity.

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