PNAS
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Supplementary Information for

A trait-based understanding of wood decomposition by fungi

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www.pnas.org/cgi/doi/10.1073/pnas.1909166117

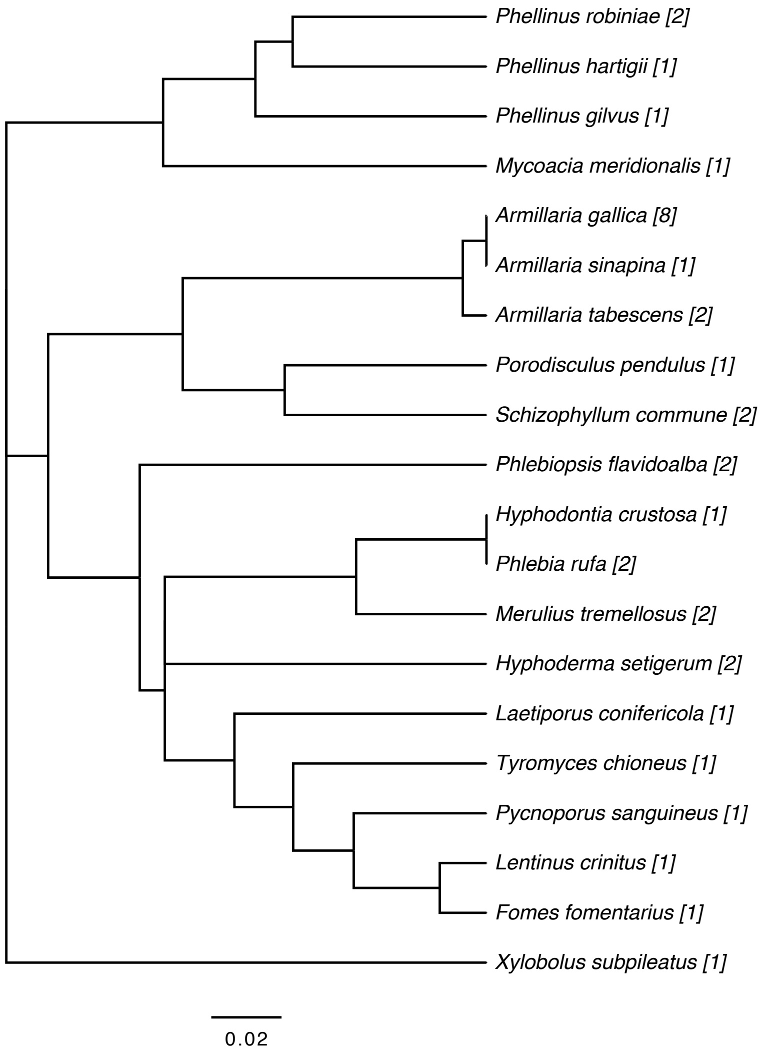

Fig. S1. Phylogeny of the 20 fungal species used in this study, with the number of unique isolates per species indicated in brackets. The phylogenetic tree was inferred based on large subunit region (LSU) sequences for each fungus (full details of the phylogenetic analysis in 1, 2).

Table S1. All traits analyzed in this study, with variable numbers as presented in Fig. 3. The trait data have previously been described in (1), with the exception of decomposition rate.

Nr	Variable	Description
V1	Decomposition rate	Mass loss over 122 days (% dry weight), geometric mean across 10,16, and 22 °C
V2	Temperature niche minimum	Lower bound of thermal niche width (°C)
V3	Temperature niche maximum	Upper bound of thermal niche width (°C)
V4	Optimal temperature	Temperature at maximum extension rate (°C)
V5	Temperature niche width	Temperature range supporting at least half the maximum extension rate (°C)
V6	Moisture niche minimum	Lower bound of moisture niche width (MPa)
V7	Moisture niche maximum	Upper bound of moisture niche width (MPa)
V8	Optimal moisture	Moisture at maximum extension rate (MPa)
V9	Moisture niche width	Moisture range supporting at least half the maximum extension rate (MPa)
V10	Competitive ranking	Position in overall competitive hierarchy (Elo ranking system)
V11	Offensive ability	Avg extension rate when displacing a competitor / monoculture extension rate
V12	Defensive ability	Avg extension rate when fungus is overgrown / monoculture extension rate
V13	Extension rate	Linear extension rate (mm day^{-1})
V14	Hyphal density	Dry mass ($\mu g\ cm^{-2}$) at 1 cm from the edge of the growing front
V15	Beta-glucosidase	Enzyme activity per unit biomass over 7 days
V16	Cellulase	Enzyme activity per unit biomass over 7 days
V17	Acid phosphatase	Enzyme activity per unit biomass over 7 days
V18	Chitinase	Enzyme activity per unit biomass over 7 days
V19	Leucine aminopeptidase	Enzyme activity per unit biomass over 7 days
V20	Peroxidase II (substrate TMB)	Enzyme activity per unit biomass over 7 days
V21	Phenol oxidase II (substrate ABTS)	Enzyme activity per unit biomass over 7 days
V22	Peroxidase I (substrate H_2O_2)	Enzyme activity per unit biomass over 7 days
V23	Phenol oxidase I (substrate l-DOPA)	Enzyme activity per unit biomass over 7 days

Table S2. Phylogenetic least squares regression (3, 4) for the relationship between decomposition rate and (i) extension rate, (ii) acid phosphatase activity, and (iii) the dominance-tolerance trade-off for moisture. Analyses are analogous to those in the main text (Figs. 1C, 1D, and 4A, respectively), with the exception that the effect of extension rate was analyzed for the average decomposition rate across all temperatures, because the phylogenetic analysis did not allow for repeated measures per isolate. All models were fit using the gls function in R with corPagel correlation structure (5, 6). Pagel's λ (7) indicates the degree of phylogenetic signal in the relationship and was estimated simultaneously with the regression coefficients (4). We determined whether the phylogenetic signal was statistically significant by testing the models against a model where λ was fixed at zero (phylogenetic independence), using likelihood ratio tests (LRT).

	Pagel's λ		LRT for λ = 0			Main effect			
Model	λ	95% CI	LR	df	*P*	slope	*F*	df	*P*
log(decomposition rate*) ~ log(extension rate)	0.44	[-0.02, 0.90]	3.33	3	0.07	0.19	2.47	1,32	0.13
log(decomposition rate† + 1) ~ log(acid phosphatase activity + 1)	0.28	[-0.36, 0.93]	0.86	3	0.35	-0.21	4.64	1,32	0.04
log(decomposition rate*) ~ moisture trade-off	0.46	[0.03, 0.90]	4.18	3	0.04	0.46	2.58	1,32	0.12

*Geometric mean decomposition rate across 10, 16 and 22 °C.

†Decomposition rate at 22 °C, the temperature enzyme activity was measured at.

Table S3. Decomposition rate measured for each isolate under standardized laboratory conditions at 10, 16 and 22 °C (N = 6 replicates per temperature).

Isolate	Decomposition rate (% dry mass loss over 122 days) ± SD			
	10 °C	16 °C	22 °C	geometric mean
Armillaria gallica FP102531 C6D	4.07 ± 1.61	10.21 ± 2.76	17.12 ± 1.87	8.93
Armillaria gallica EL8 A6F	3.20 ± 1.17	1.89 ± 1.26	15.42 ± 5.10	4.54
Armillaria gallica FP102534 A5A	2.94 ± 1.12	6.09 ± 3.16	11.00 ± 1.36	5.81
Armillaria gallica FP102535 A5D	3.78 ± 0.87	7.23 ± 3.51	12.30 ± 2.72	6.95
Armillaria gallica FP102542 A5B	2.35 ± 1.28	5.90 ± 4.90	9.20 ± 3.53	5.03
Armillaria gallica HHB12551 C6C	2.03 ± 1.07	0.11 ± 0.16	39.51 ± 17.94	2.04
Armillaria gallica OC1 A6E	2.29 ± 0.51	1.92 ± 2.20	9.26 ± 2.08	3.44
Armillaria gallica SH1 A4A	2.18 ± 0.47	0.34 ± 0.40	10.78 ± 2.99	2.00
Armillaria sinapina PR9	1.72 ± 0.83	6.76 ± 1.47	8.28 ± 1.12	4.58
Armillaria tabescens FP102622 A3C	3.56 ± 0.75	0.14 ± 0.22	13.28 ± 7.89	1.89
Armillaria tabescens TJV93 261 A1E	2.83 ± 0.59	3.67 ± 1.37	12.75 ± 2.78	5.10
Fomes fomentarius TJV93 7 A3E	10.41 ± 1.81	21.26 ± 11.9	47.24 ± 28.68	21.87
Hyphodontia crustosa HHB13392 B7B	4.29 ± 1.01	13.38 ± 5.67	13.62 ± 5.92	9.21
Hyphoderma setigerum HHB12156 B3H	5.64 ± 1.49	6.28 ± 0.85	12.45 ± 3.01	7.61
Hyphoderma setigerum FP150263 B2C	2.67 ± 1.02	5.63 ± 0.61	18.82 ± 9.96	6.57
Laetiporus conifericola HHB15411 C8B	2.29 ± 0.19	20.28 ± 9.79	7.60 ± 7.49	7.07
Lentinus crinitus PR2058 C1B	3.47 ± 0.99	9.30 ± 2.28	16.01 ± 7.58	8.02
Mycoacia meridionalis FP150352 C4E	2.16 ± 1.01	5.67 ± 1.35	7.96 ± 1.21	4.60
Merulius tremullosus FP102301 C3E	22.78 ± 2.58	32.27 ± 9.91	53.5 ± 4.78	34.01
Merulius tremellosus FP150849 C3F	13.52 ± 1.51	15.95 ± 1.79	43.91 ± 11.72	21.15
Phlebiopsis flavidoalba FP102185 B12D	11.18 ± 2.91	18.52 ± 14.63	27.94 ± 9.43	17.95
Phlebiopsis flavidoalba FP150451 A8G	6.40 ± 1.17	8.89 ± 1.82	25.93 ± 17.2	11.38
Phellinus gilvus HHB11977 C4H	5.15 ± 2.24	19.47 ± 7.45	42.09 ± 18.84	16.16
Phellinus hartigii DMR94 44 A10E	2.30 ± 0.27	12.86 ± 4.80	17.39 ± 12.86	8.01
Porodisculus pendulus HHB13576 B12C	2.61 ± 0.58	2.43 ± 0.55	4.36 ± 0.51	3.02
Phellinus robiniae FP135708 A10G	3.68 ± 0.49	4.52 ± 0.96	8.28 ± 4.79	5.17
Phellinus robiniae AZ15 A10H Banik/Mark	2.22 ± 0.90	6.12 ± 1.99	26.29 ± 2.09	7.10
Phlebia acerina MR4280 B9G *	11.88 ± 2.99	24.59 ± 8.28	16.18 ± 8.47	16.78
Phlebia acerina DR60 A8A *	5.97 ± 2.14	21.10 ± 1.89	73.39 ± 10.22	20.98
Pycnoporus sanguineus PR SC 95 A11C	4.44 ± 0.59	18.30 ± 9.26	37.43 ± 13.34	14.49
Schizophyllum commune TJV93 5 A10A	3.92 ± 1.24	2.02 ± 2.07	12.69 ± 3.52	4.65
Schizophyllum commune PR1117	2.55 ± 1.11	3.32 ± 1.19	6.87 ± 0.61	3.88
Tyromyces chioneus HHB11933 B10F	5.35 ± 1.46	16.74 ± 3.65	29.06 ± 9.35	13.75
Xylobolus subpileatus FP102567 A11A	2.17 ± 1.61	7.45 ± 4.17	8.55 ± 6.37	5.17

* The accepted name of these isolates is *Phlebia rufa* and is used in Fig. S1. The name of the original cultures as stored in our collections (*Phlebia acerina*) is maintained here for reference.

Table S4. Hyphal extension rate measured for each isolate under standardized laboratory conditions at 10, 16 and 22 °C (N = 5 replicates per temperature).

Isolate	Extension rate (mm day^{-1}) ± SD		
	10 °C	16 °C	22 °C
Armillaria gallica FP102531 C6D (south) *	0.30 ± 0.05	0.36 ± 0.05	0.34 ± 0.06
Armillaria gallica EL8 A6F (north) *	0.18 ± 0.06	0.26 ± 0.05	0.38 ± 0.15
Armillaria gallica FP102534 A5A (south) *	0.26 ± 0.05	0.24 ± 0.05	0.32 ± 0.06
Armillaria gallica FP102535 A5D (south) *	0.16 ± 0.05	0.30 ± 0.05	0.24 ± 0.06
Armillaria gallica FP102542 A5B (south) *	0.20 ± 0.05	0.24 ± 0.05	0.40 ± 0.06
Armillaria gallica HHB12551 C6C (north) *	0.14 ± 0.06	0.32 ± 0.05	0.48 ± 0.15
Armillaria gallica OC1 A6E (north) *	0.20 ± 0.06	0.26 ± 0.05	0.36 ± 0.15
Armillaria gallica SH1 A4A (north) *	0.06 ± 0.06	0.18 ± 0.05	0.66 ± 0.15
Armillaria sinapina PR9	0.33 ± 0.04	0.60 ± 0.05	0.84 ± 0.07
Armillaria tabescens FP102622 A3C	0.35 ± 0.03	0.60 ± 0.04	0.93 ± 0.16
Armillaria tabescens TJV93 261 A1E	0.32 ± 0.03	0.68 ± 0.13	1.56 ± 0.06
Fomes fomentarius TJV93 7 A3E	0.36 ± 0.08	1.28 ± 0.22	4.62 ± 0.24
Hyphodontia crustosa HHB13392 B7B	1.20 ± 0.03	0.99 ± 0.07	1.77 ± 0.20
Hyphoderma setigerum HHB12156 B3H	1.39 ± 0.06	3.70 ± 0 †	6.46 ± 0.17
Hyphoderma setigerum FP150263 B2C	0.44 ± 0.03	1.90 ± 0.06	4.68 ± 0.22
Laetiporus conifericola HHB15411 C8B	1.08 ± 0.78	3.31 ± 0.13	6.00 ± 0.30
Lentinus crinitus PR2058 C1B	1.64 ± 0	3.06 ± 0.09	6.17 ± 0.12
Mycoacia meridionalis FP150352 C4E	0.36 ± 0.01	1.10 ± 0.01	1.60 ± 0
Merulius tremullosus FP102301 C3E	3.30 ± 0.10	5.85 ± 2.31	8.67 ± 0.56
Merulius tremellosus FP150849 C3F	3.40 ± 0	6.50 ± 2.24	8.33 ± 0.39
Phlebiopsis flavidoalba FP102185 B12D	2.28 ± 0.08	5.70 ± 0.20	8.41 ± 0.74
Phlebiopsis flavidoalba FP150451 A8G	3.04 ± 0.05	7.40 ± 0	10.57 ± 0.15
Phellinus gilvus HHB11977 C4H	1.40 ± 0.05	1.53 ± 0.18	3.70 ± 0
Phellinus hartigii DMR94 44 A10E	0.49 ± 0.12	1.26 ± 0.07	0.94 ± 0.10
Porodisculus pendulus HHB13576 B12C	0.95 ± 0.25	1.25 ± 0.20	2.90 ± 0.74
Phellinus robiniae FP135708 A10G	0.40 ± 0.02	1.52 ± 0.03	3.32 ± 0.11
Phellinus robiniae AZ15 A10H Banik/Mark	0.39 ± 0.02	1.24 ± 0.01	2.84 ± 0.07
Phlebia acerina MR4280 B9G	3.70 ± 0	7.40 ± 0	8.27 ± 0.09
Phlebia acerina DR60 A8A	3.70 ± 0	7.40 ± 0	8.23 ± 0.30
Pycnoporus sanguineus PR SC 95 A11C	0.81 ± 0.03	3.21 ± 0.07	7.26 ± 0.17
Schizophyllum commune TJV93 5 A10A	1.88 ± 0.25	3.32 ± 0.08	7.40 ± 0
Schizophyllum commune PR1117	1.06 ± 0.04	1.64 ± 0	4.60 ± 0.41
Tyromyces chioneus HHB11933 B10F	1.92 ± 0.13	3.37 ± 0.10	5.67 ± 0.12
Xylobolus subpileatus FP102567 A11A	0.74 ± 0.10	1.00 ± 0.09	1.04 ± 0.09

* SDs for *Armillaria gallica* are reported at the species level, for pooled isolates from northern and southern locations (5 isolates each). Previous work (2) had shown very little variation across the large number of isolates from this species.

† Hyphal extension was measured to the closest mm after 2 weeks; true variance exceeds zero but was not detected.

Table S5. Wood mass loss (8–10) and community-weighted hyphal extension rate (this study) for 74 logs in the field decomposition experiment, located at 3 sites. Extension rate is the average hyphal extension rate measured under standardized laboratory conditions of 14 fungi isolated from the top or bottom of each log ("neither" indicates that top and bottom were indistinguishable due to the advanced state of decay of the log). If both sides of the log were sampled, we averaged the community-weighted extension rate of the top and bottom. Half the logs deployed in 2011 (3 years decay time) were enclosed in a polypropylene insect mesh (1 mm^2). Table continued on next two pages.

Woody plant species	Site	Years decayed	Mesh	Sampling side (top / bottom)	Extension rate (mm day^{-1})	Mass loss (%)
Celtis occidentalis	2	3	absent	both	13.19	37.4
Celtis occidentalis	2	3	present	both	1.10	29.8
Celtis occidentalis	6	3	absent	both	0.92	33.0
Celtis occidentalis	6	3	present	both	9.90	45.7
Celtis occidentalis	7	3	absent	bottom	13.54	49.0
Celtis occidentalis	7	3	present	both	15.41	67.4
Fraxinus americana	2	3	absent	bottom	4.64	12.6
Fraxinus americana	2	3	present	both	5.46	14.3
Fraxinus americana	6	3	absent	both	5.90	13.6
Fraxinus americana	6	3	present	bottom	1.03	11.4
Fraxinus americana	7	3	absent	both	13.60	26.0
Fraxinus americana	7	3	present	bottom	10.11	29.6
Juglans nigra	2	3	absent	both	2.33	19.9
Juglans nigra	2	3	present	both	7.90	27.2
Juglans nigra	6	3	absent	bottom	15.96	26.2
Juglans nigra	6	3	present	bottom	7.72	20.2
Juglans nigra	7	3	absent	bottom	16.48	36.6
Juglans nigra	7	3	present	both	15.60	31.5
Juniperus virginiana	2	3	present	bottom	6.83	4.1*
Lonicera maackii	2	3	absent	both	10.84	25.2
Lonicera maackii	2	3	present	top	3.31	21.1
Lonicera maackii	6	3	absent	bottom	15.36	23.2
Lonicera maackii	6	3	present	both	2.49	15.2
Lonicera maackii	7	3	absent	both	15.66	28.2
Lonicera maackii	7	3	present	both	3.29	18.2
Pinus echinata	2	3	absent	bottom	1.26	27.7
Quercus alba	2	3	absent	both	12.08	46.9
Quercus alba	2	3	present	both	6.20	27.3
Quercus alba	6	3	absent	both	13.30	46.2

Woody plant species	Site	Years decayed	Mesh	Sampling side (top / bottom)	Extension rate (mm day^{-1})	Mass loss (%)
Quercus alba	6	3	present	both	10.88	44.5
Quercus alba	7	3	absent	both	16.40	59.2
Quercus alba	7	3	present	both	6.95	29.0
Quercus velutina	2	3	absent	both	1.98	25.3
Quercus velutina	2	3	present	both	8.21	32.4
Quercus velutina	6	3	absent	both	2.05	27.9
Quercus velutina	6	3	present	bottom	8.79	37.0
Quercus velutina	7	3	absent	bottom	15.86	53.2
Quercus velutina	7	3	present	both	9.06	45.2
Acer rubrum	2	5	absent	bottom	16.03	80.2
Aesculus glabra	2	5	absent	both	15.57	81.9
Aesculus glabra	6	5	absent	both	14.38	81.5
Aesculus glabra	7	5	absent	both	6.65	80.1
Amelanchier arborea	2	5	absent	top	0.22	57.3
Amelanchier arborea	6	5	absent	top	7.13	81.5
Amelanchier arborea	7	5	absent	neither	7.82	97.5
Asimina triloba	2	5	absent	both	4.69	46.1
Asimina triloba	6	5	absent	bottom	15.86	67.6
Asimina triloba	7	5	absent	top	2.66	79.0
Carya tomentosa	6	5	absent	both	14.33	56.9
Carya tomentosa	7	5	absent	bottom	15.41	68.8
Celtis occidentalis	2	5	absent	top	1.45	60.4
Celtis occidentalis	6	5	absent	both	1.08	69.9
Cornus florida	2	5	absent	top	3.38	47.8
Cornus florida	6	5	absent	top	0.26	54.5
Cornus florida	7	5	absent	bottom	1.34	68.5
Diospyros virginiana	2	5	absent	top	1.94	67.0
Diospyros virginiana	6	5	absent	top	15.09	84.7
Diospyros virginiana	7	5	absent	top	15.19	84.6
Gleditsia triacanthos	2	5	absent	both	7.49	58.8
Gleditsia triacanthos	6	5	absent	both	0.09	62.1
Juniperus virginiana	2	5	absent	bottom	0.02	37.9
Juniperus virginiana	6	5	absent	bottom	0.64	27.6
Juniperus virginiana	7	5	absent	bottom	6.29	32.1
Pinus strobus	6	5	absent	both	5.33	50.7
Platanus occidentalis	2	5	absent	both	3.18	69.1
Platanus occidentalis	6	5	absent	bottom	0.43	81.8
Platanus occidentalis	7	5	absent	both	2.26	62.8
Quercus velutina	2	5	absent	top	0.06	54.5
Quercus velutina	6	5	absent	bottom	0.48	67.4
Quercus velutina	7	5	absent	bottom	1.90	63.2

Woody plant species	Site	Years decayed	Mesh	Sampling side (top / bottom)	Extension rate (mm day^{-1})	Mass loss (%)
Ulmus rubra	2	5	absent	bottom	0.34	54.3
Ulmus rubra	6	5	absent	both	0.26	44.5
Ulmus rubra	7	5	absent	both	2.69	74.2
Vitis vulpina	6	5	absent	both	1.82	66.3

* Sample excluded from statistical analysis as an outlier (very low mass loss, further than 1.5 times the interquartile range from the mean mass loss after 3 years).

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