Supporting information for

Stochastic community assembly of abundant taxa maintains the relationship of soil biodiversity-multifunctionality under mercury stress

Running title: Abundant taxa drive diversity-functionality

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This supplementary file includes 5 figures and 4 tables: Figs. S1 to S5, and Tables S1 to S4

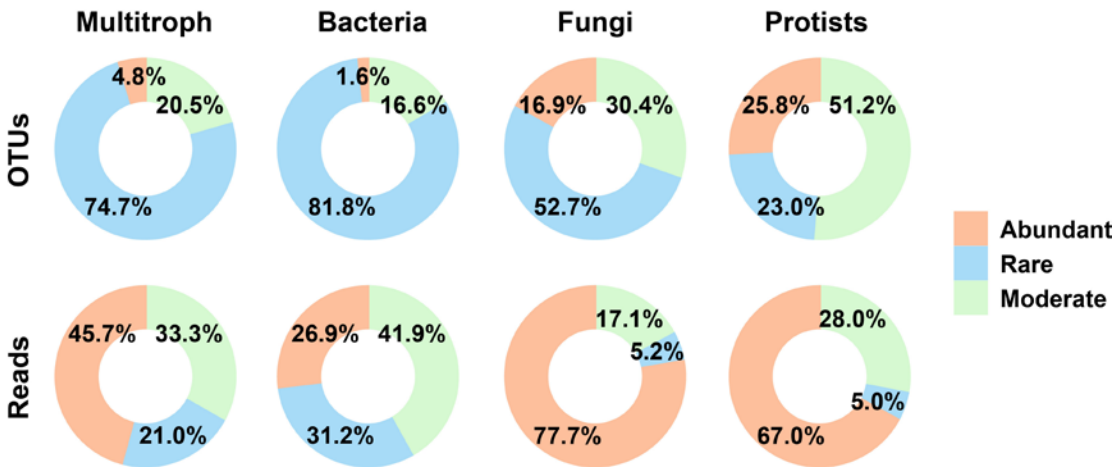

Fig. S1 The OTU and read proportions of abundant, rare, and moderate taxa of multitroph (i.e., all three soil organisms), bacteria, fungi, and protists.

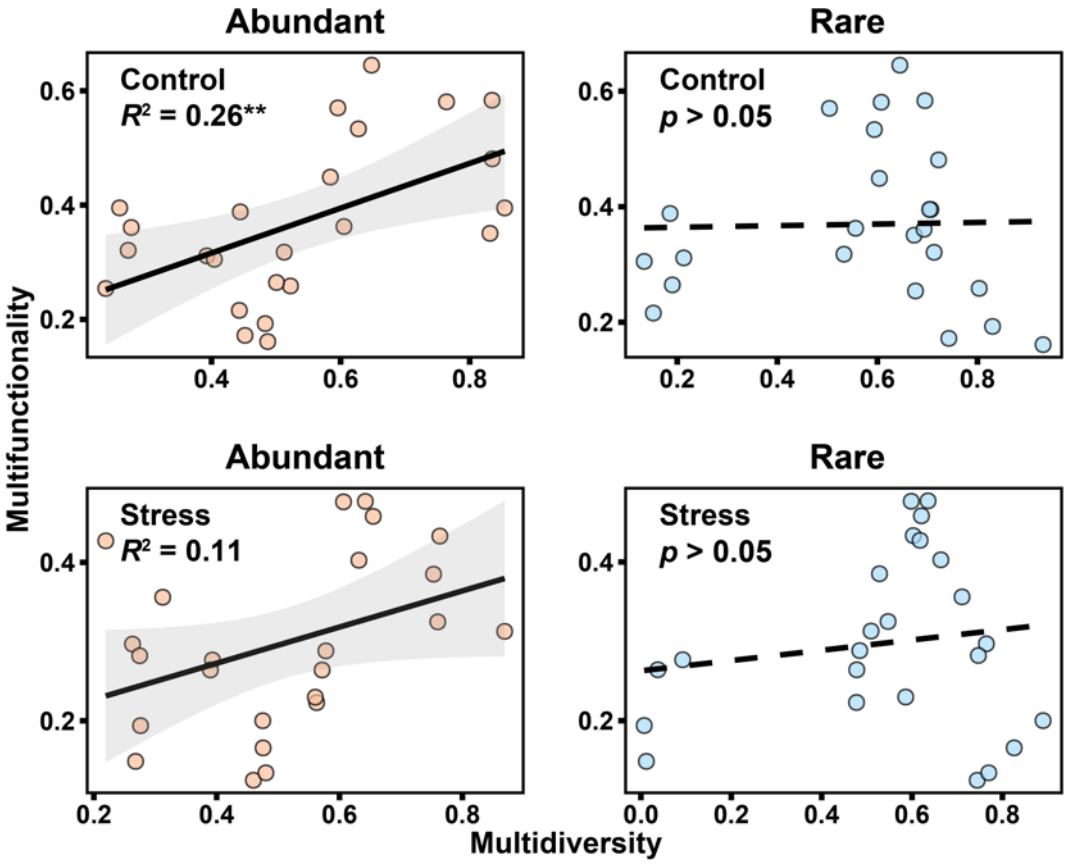

Fig. S2 Linear relationships between multifunctionality and soil abundant and rare taxa biodiversity in the control and Hg stress samples. Statistical analysis was performed using ordinary least-squares linear regressions; *p* values are indicated by asterisks: $^{**}p < 0.01$.

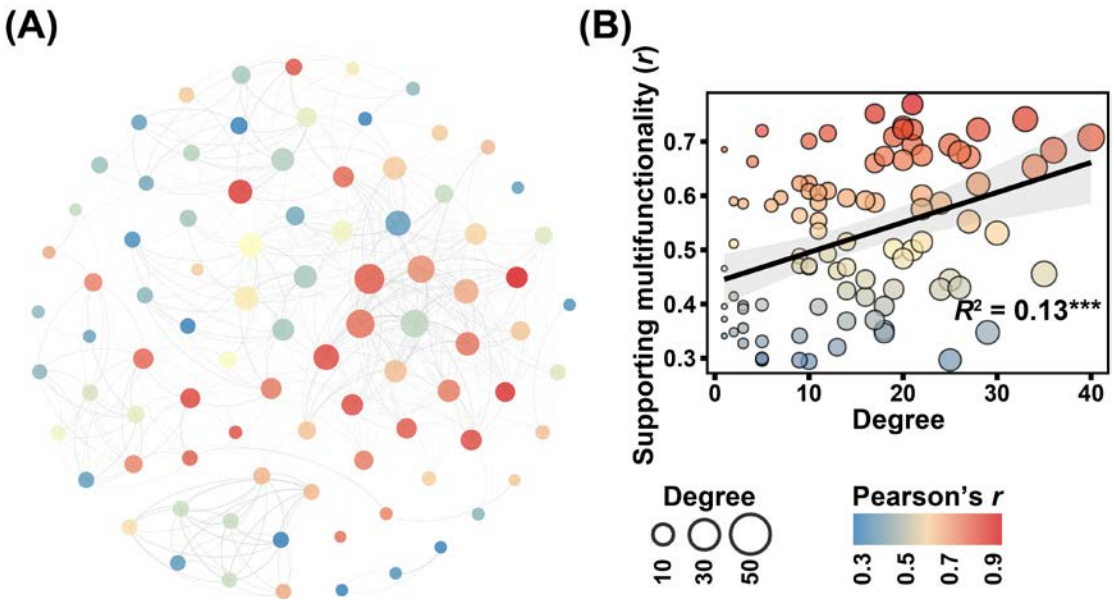

Fig. S3 Links between the associations among soil phylotypes and their support for multifunctionality. (A) Correlation network for abundant taxa. Only nodes with Pearson's correlation coefficients of > 0 were displayed to highlight their support for multifunctionality. (B) Linear relationships between the nodes' degree and their support for multifunctionality of abundant taxa. Significance levels are shown as follows: $^{***}p < 0.001$.

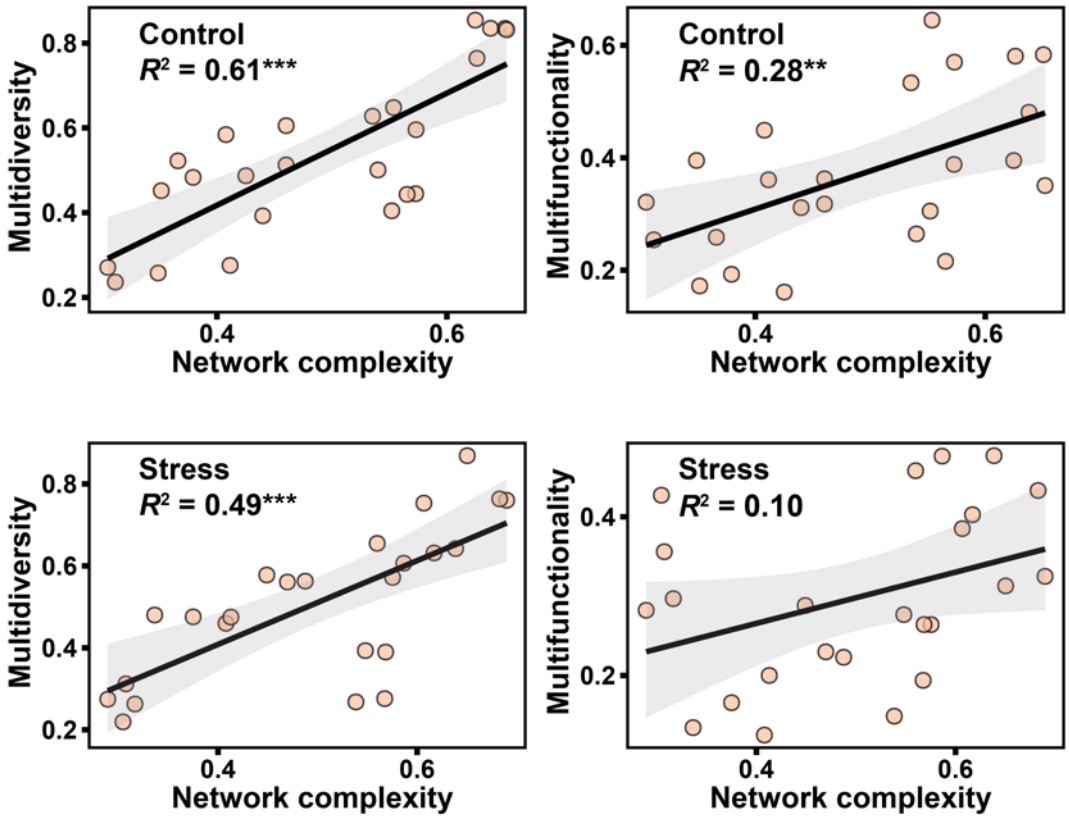

Fig. S4 Linear relationships between soil multitrophic network complexity versus multidiversity of soil abundant taxa and multifunctionality in the control and Hg stress samples. Statistical analysis was performed using ordinary least-squares linear regressions; *p* values are indicated by asterisks: $^{**}p < 0.01$, and $^{***}p < 0.001$.

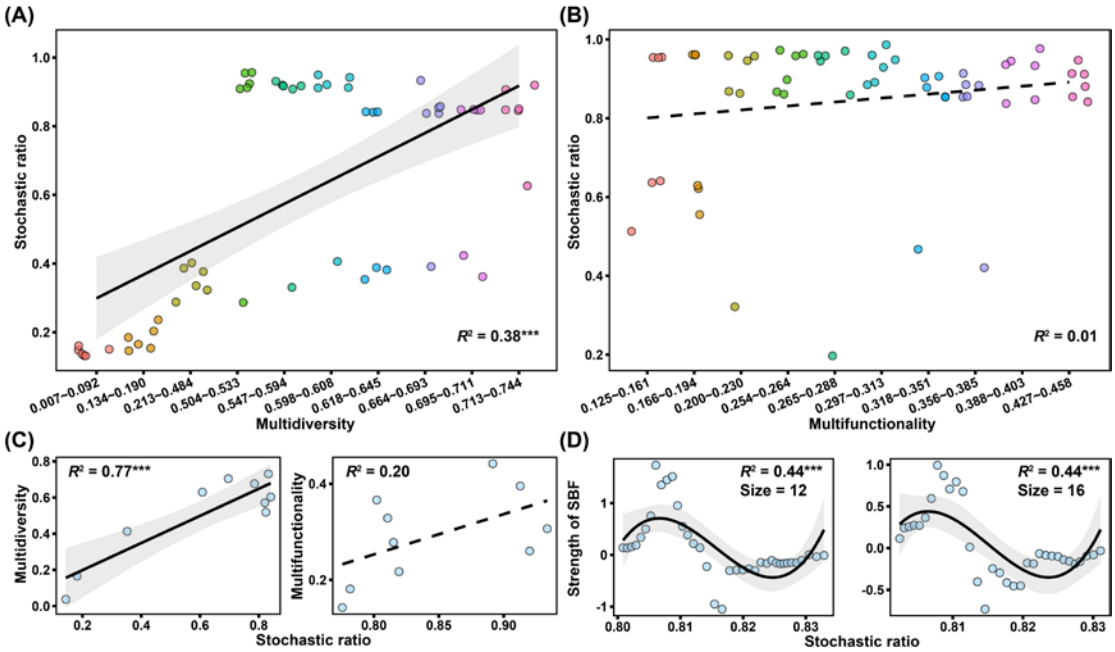

Fig. S5 Effects of community assembly processes on multidiversity of rare taxa and multifunctionality. (A and B) Patterns of stochasticity ratio, estimated via null models, across different categories of multidiversity and multifunctionality. (C) Relationships between stochasticity ratio versus multidiversity and multifunctionality. The relationships were estimated by ordinary least-squares linear regressions. (D) Effects of community assembly processes on the relationships between soil rare taxa biodiversity and multifunctionality. The variances of SBF strengths across stochasticity ratio gradients were based on moving window sizes of 12 and 16 samples. The relationships were estimated by ordinary least-squares linear regressions with third-order polynomial fits. Significance levels are shown as follows: $^{***}p < 0.001$.

Table S1 Detailed information of sampling locations, land uses, treatments and soil properties.

Sample ID	Sampling location	Logitude	Latitude	Land use	Treatment	SOC	pH
						g kg^{-1}	
P1T0-1	Maoming, Guangdong	110°50′E	21°34′N	Paddy	Control	32.55	6.41
P1T0-2	Maoming, Guangdong	110°50′E	21°34′N	Paddy	Control	37.26	6.26
P1T0-3	Maoming, Guangdong	110°50′E	21°34′N	Paddy	Control	33.67	5.97
P1T0-4	Maoming, Guangdong	110°50′E	21°34′N	Paddy	Control	34.34	6.29
P2T0-1	Yueyang, Hu'nan	112°25′E	29°32′N	Paddy	Control	18.87	7.33
P2T0-2	Yueyang, Hu'nan	112°25′E	29°32′N	Paddy	Control	16.18	7.83
P2T0-3	Yueyang, Hu'nan	112°25′E	29°32′N	Paddy	Control	22.46	7.49
P2T0-4	Yueyang, Hu'nan	112°25′E	29°32′N	Paddy	Control	20.22	7.42
P3T0-1	Wuchang, Heilongjiang	127°07′E	44°58′N	Paddy	Control	49.59	6.21
P3T0-2	Wuchang, Heilongjiang	127°07′E	44°58′N	Paddy	Control	51.61	4.77
P3T0-3	Wuchang, Heilongjiang	127°07′E	44°58′N	Paddy	Control	48.47	5.42
P3T0-4	Wuchang, Heilongjiang	127°07′E	44°58′N	Paddy	Control	48.92	6.47
U1T0-1	Maoming, Guangdong	110°50′E	21°34′N	Upland	Control	44.04	5.73
U1T0-2	Maoming, Guangdong	110°50′E	21°34′N	Upland	Control	37.94	5.11
U1T0-3	Maoming, Guangdong	110°50′E	21°34′N	Upland	Control	44.43	5.17
U1T0-4	Maoming, Guangdong	110°50′E	21°34′N	Upland	Control	47.19	4.99
U2T0-1	Yueyang, Hu'nan	112°25′E	29°32′N	Upland	Control	18.46	7.40
U2T0-2	Yueyang, Hu'nan	112°25′E	29°32′N	Upland	Control	18.07	7.50
U2T0-3	Yueyang, Hu'nan	112°25′E	29°32′N	Upland	Control	17.67	7.48
U2T0-4	Yueyang, Hu'nan	112°25′E	29°32′N	Upland	Control	12.95	7.45
U3T0-1	Wuchang, Heilongjiang	127°07′E	44°58′N	Upland	Control	33.22	5.42

U3T0-2	Wuchang, Heilongjiang	127°07′E	44°58′N	Upland	Control	41.68	4.72
U3T0-3	Wuchang, Heilongjiang	127°07′E	44°58′N	Upland	Control	35.38	4.53
U3T0-4	Wuchang, Heilongjiang	127°07′E	44°58′N	Upland	Control	38.92	4.62
P1T2-1	Maoming, Guangdong	110°50′E	21°34′N	Paddy	Stress	37.04	6.25
P1T2-2	Maoming, Guangdong	110°50′E	21°34′N	Paddy	Stress	36.59	7.31
P1T2-3	Maoming, Guangdong	110°50′E	21°34′N	Paddy	Stress	33.22	5.67
P1T2-4	Maoming, Guangdong	110°50′E	21°34′N	Paddy	Stress	33.67	6.29
P2T2-1	Yueyang, Hu'nan	112°25′E	29°32′N	Paddy	Stress	19.77	7.63
P2T2-2	Yueyang, Hu'nan	112°25′E	29°32′N	Paddy	Stress	21.11	7.77
P2T2-3	Yueyang, Hu'nan	112°25′E	29°32′N	Paddy	Stress	24.70	7.67
P2T2-4	Yueyang, Hu'nan	112°25′E	29°32′N	Paddy	Stress	21.79	7.57
P3T2-1	Wuchang, Heilongjiang	127°07′E	44°58′N	Paddy	Stress	53.63	6.06
P3T2-2	Wuchang, Heilongjiang	127°07′E	44°58′N	Paddy	Stress	49.37	6.19
P3T2-3	Wuchang, Heilongjiang	127°07′E	44°58′N	Paddy	Stress	50.94	6.23
P3T2-4	Wuchang, Heilongjiang	127°07′E	44°58′N	Paddy	Stress	57.22	6.24
U1T2-1	Maoming, Guangdong	110°50′E	21°34′N	Upland	Stress	45.02	4.81
U1T2-2	Maoming, Guangdong	110°50′E	21°34′N	Upland	Stress	42.66	4.71
U1T2-3	Maoming, Guangdong	110°50′E	21°34′N	Upland	Stress	35.19	5.05
U1T2-4	Maoming, Guangdong	110°50′E	21°34′N	Upland	Stress	44.83	4.74
U2T2-1	Yueyang, Hu'nan	112°25′E	29°32′N	Upland	Stress	17.28	7.55
U2T2-2	Yueyang, Hu'nan	112°25′E	29°32′N	Upland	Stress	18.46	7.62
U2T2-3	Yueyang, Hu'nan	112°25′E	29°32′N	Upland	Stress	18.07	7.63
U2T2-4	Yueyang, Hu'nan	112°25′E	29°32′N	Upland	Stress	16.69	7.60
U3T2-1	Wuchang, Heilongjiang	127°07′E	44°58′N	Upland	Stress	36.37	4.43

U3T2-2	Wuchang, Heilongjiang	127°07′E	44°58′N	Upland	Stress	38.92	4.36
U3T2-3	Wuchang, Heilongjiang	127°07′E	44°58′N	Upland	Stress	37.74	4.17
U3T2-4	Wuchang, Heilongjiang	127°07′E	44°58′N	Upland	Stress	38.14	4.36

Abbreviation: SOC, soil organic carbon.

Table S2 Biodiversity of soil multiple microorganisms including bacteria, fungi, and protists.

	Abundant taxa				Rara taxa			
Sample ID	**Multidiversity**	**Bacterial richness**	**Fungal richness**	**Protistan richness**	**Multidiversity**	**Bacterial richness**	**Fungal richness**	**Protistan richness**
P1T0-1	0.65	88	72	130	0.64	4032	291	105
P1T0-2	0.76	89	83	133	0.61	4074	244	112
P1T0-3	0.60	89	70	122	0.50	3980	221	83
P1T0-4	0.63	85	78	120	0.59	4159	244	104
P2T0-1	0.48	50	83	128	0.83	6044	231	158
P2T0-2	0.45	51	81	124	0.74	6067	217	128
P2T0-3	0.52	54	90	119	0.80	6000	253	137
P2T0-4	0.49	49	83	130	0.93	6095	296	166
P3T0-1	0.58	85	65	133	0.60	3803	188	146
P3T0-2	0.39	92	61	94	0.21	2912	75	64
P3T0-3	0.61	88	67	130	0.56	3681	179	134
P3T0-4	0.51	79	60	135	0.53	3712	178	124
U1T0-1	0.83	97	76	148	0.70	4117	316	111
U1T0-2	0.85	96	76	153	0.71	4059	325	113
U1T0-3	0.83	100	78	141	0.72	3960	351	109
U1T0-4	0.83	96	77	147	0.67	3802	329	104
U2T0-1	0.27	53	65	113	0.71	5356	213	137
U2T0-2	0.28	53	68	109	0.69	5250	210	133
U2T0-3	0.24	49	64	113	0.68	5263	213	124
U2T0-4	0.26	52	63	115	0.70	5308	206	138
U3T0-1	0.44	88	61	109	0.19	1656	104	72
U3T0-2	0.40	86	56	112	0.13	1356	117	52
U3T0-3	0.44	88	59	112	0.15	1325	110	64
U3T0-4	0.50	95	61	111	0.19	1409	121	72
P1T2-1	0.65	91	76	121	0.62	3935	304	91
P1T2-2	0.63	88	78	117	0.66	4078	322	96
P1T2-3	0.61	91	74	115	0.60	3791	301	87

P1T2-4	0.64	95	69	125	0.64	3976	300	98
P2T2-1	0.46	52	83	121	0.74	5697	260	117
P2T2-2	0.48	51	85	122	0.83	5845	278	138
P2T2-3	0.48	53	84	122	0.77	5853	227	140
P2T2-4	0.48	52	86	119	0.89	5871	272	167
P3T2-1	0.56	91	64	123	0.48	3587	166	110
P3T2-2	0.58	90	58	137	0.48	3494	171	113
P3T2-3	0.57	91	62	128	0.48	3484	174	109
P3T2-4	0.56	88	63	128	0.59	3656	177	148
U1T2-1	0.75	98	73	136	0.53	2883	242	112
U1T2-2	0.87	97	80	148	0.51	2725	241	109
U1T2-3	0.76	95	70	146	0.55	3042	269	102
U1T2-4	0.76	99	71	140	0.60	2993	294	114
U2T2-1	0.22	51	66	104	0.62	5011	208	109
U2T2-2	0.31	53	68	116	0.71	5276	223	133
U2T2-3	0.26	51	65	114	0.76	5309	230	151
U2T2-4	0.27	53	63	117	0.75	5297	220	149
U3T2-1	0.39	86	62	100	0.09	1048	101	51
U3T2-2	0.28	86	55	89	0.01	958	79	29
U3T2-3	0.27	90	51	89	0.01	1143	75	28
U3T2-4	0.39	91	59	98	0.04	998	88	36

Table S3 Multifunctionality and single soil function.

Sample ID	Multifunctionality	GLU	XYL	CBH	NAG	LAP	ACP
		nmol g^{-1} h^{-1}	nmol g^{-1} h^{-1}	nmol g^{-1} h^{-1}	nmol g^{-1} h^{-1}	nmol g^{-1} h^{-1}	nmol g^{-1} h^{-1}
P1T0-1	0.64	414.89	119.64	27.68	168.88	55.80	1663.57
P1T0-2	0.58	393.24	108.58	21.99	136.33	54.49	1631.73
P1T0-3	0.57	387.80	127.27	24.93	194.15	41.37	1244.93
P1T0-4	0.53	333.53	118.50	28.25	166.45	45.29	1153.32
P2T0-1	0.19	268.57	31.62	21.04	114.78	26.95	276.92
P2T0-2	0.17	277.62	31.40	30.36	105.31	15.18	204.10
P2T0-3	0.26	319.53	32.84	20.23	181.61	24.54	419.76
P2T0-4	0.16	279.11	35.49	22.05	133.90	11.25	176.58
P3T0-1	0.45	335.76	35.59	23.15	154.91	60.07	1255.63
P3T0-2	0.31	316.23	23.12	25.00	73.52	45.19	1015.96
P3T0-3	0.36	333.65	30.85	24.33	94.16	55.54	972.03
P3T0-4	0.32	330.39	28.27	20.13	107.53	40.47	1006.81
U1T0-1	0.58	237.32	66.39	57.45	336.74	34.10	1174.75
U1T0-2	0.40	257.26	50.83	21.70	161.59	27.39	1598.52
U1T0-3	0.48	242.62	61.78	41.84	266.97	20.92	1376.53
U1T0-4	0.35	233.29	59.66	14.20	120.63	43.41	1150.89
U2T0-1	0.32	589.85	63.06	48.56	88.51	4.84	247.45
U2T0-2	0.36	626.09	36.40	64.53	145.26	4.29	177.49
U2T0-3	0.25	538.60	39.55	42.66	99.01	3.09	199.78
U2T0-4	0.40	569.82	59.84	58.55	194.27	4.07	202.69
U3T0-1	0.39	400.79	20.73	61.15	144.39	5.72	1274.41
U3T0-2	0.31	339.98	24.13	50.83	105.41	1.72	1201.59
U3T0-3	0.22	266.81	17.66	21.72	117.55	3.38	1228.87
U3T0-4	0.26	353.68	21.88	28.54	119.11	2.70	1234.96
P1T2-1	0.46	330.76	82.48	14.64	128.26	46.53	1438.17
P1T2-2	0.40	299.11	82.49	11.91	103.08	54.92	1017.05

P1T2-3	0.48	333.21	82.83	19.25	167.43	41.40	1393.68
P1T2-4	0.48	387.45	82.16	20.09	132.92	47.62	1282.97
P2T2-1	0.12	236.46	13.55	18.21	102.42	25.29	157.91
P2T2-2	0.17	246.80	19.85	26.47	135.55	19.81	178.67
P2T2-3	0.13	225.52	9.42	24.71	132.99	18.65	168.68
P2T2-4	0.20	236.26	18.75	37.93	134.35	21.88	223.69
P3T2-1	0.22	341.38	27.33	22.62	115.31	11.48	758.91
P3T2-2	0.29	338.55	17.27	35.15	105.77	17.61	1099.04
P3T2-3	0.26	335.12	14.48	30.23	140.38	12.81	962.16
P3T2-4	0.23	350.47	23.37	34.59	120.49	4.04	730.28
U1T2-1	0.39	246.48	40.81	26.43	250.55	26.29	1080.53
U1T2-2	0.31	191.40	41.71	23.00	206.94	24.65	930.66
U1T2-3	0.32	257.66	45.75	22.29	171.36	27.77	950.29
U1T2-4	0.43	327.74	49.06	23.91	286.24	28.68	987.16
U2T2-1	0.43	754.06	44.40	77.67	81.26	12.41	191.12
U2T2-2	0.36	691.89	47.38	57.32	71.31	14.05	157.46
U2T2-3	0.30	675.43	31.04	45.29	113.36	4.04	163.48
U2T2-4	0.28	579.79	37.82	46.11	87.29	7.64	239.29
U3T2-1	0.28	365.42	27.06	34.42	132.50	0.00	1104.16
U3T2-2	0.19	247.24	24.04	22.99	101.42	0.00	1148.53
U3T2-3	0.15	236.51	10.86	18.60	100.16	0.00	1045.40
U3T2-4	0.26	332.98	24.17	36.69	155.28	0.00	933.24

Abbreviations: GLU, β-glucosidase; XYL, β-xylosidase; CBH, β-cellobiohydrolase; NAG, N-acetylglucosaminidase; LAP, leucine aminopeptidase; ACP, acid phosphatase.

Table S4 Network complexity and single topological feature.

Sample ID	Network complexity	Node number	Edge number	Average degree	Average path length	Network diameter	Graph density	Clustering coefficient	Modularity
P1T0-1	0.55	190	1018	10.72	3.36	11.48	0.06	0.54	0.58
P1T0-2	0.63	195	1075	11.03	3.27	9.84	0.06	0.55	0.59
P1T0-3	0.57	181	948	10.48	3.22	9.99	0.06	0.54	0.58
P1T0-4	0.54	176	920	10.45	3.32	11.49	0.06	0.55	0.58
P2T0-1	0.38	161	670	8.32	4.36	14.25	0.05	0.64	0.63
P2T0-2	0.35	150	637	8.49	4.68	14.25	0.06	0.62	0.61
P2T0-3	0.37	168	698	8.31	4.42	14.15	0.05	0.63	0.63
P2T0-4	0.43	159	699	8.79	4.46	14.25	0.06	0.65	0.64
P3T0-1	0.41	177	747	8.44	4.16	11.61	0.05	0.58	0.66
P3T0-2	0.44	179	757	8.46	4.12	10.89	0.05	0.59	0.67
P3T0-3	0.46	182	792	8.70	4.09	10.89	0.05	0.59	0.67
P3T0-4	0.46	174	749	8.61	4.04	10.17	0.05	0.58	0.67
U1T0-1	0.65	210	1226	11.68	3.32	10.64	0.06	0.55	0.57
U1T0-2	0.62	222	1271	11.45	3.41	10.66	0.05	0.54	0.58
U1T0-3	0.64	208	1220	11.73	3.46	10.73	0.06	0.55	0.57
U1T0-4	0.65	211	1243	11.78	3.33	10.64	0.06	0.54	0.57
U2T0-1	0.31	128	491	7.67	3.21	10.88	0.06	0.57	0.36
U2T0-2	0.41	130	502	7.72	2.80	8.99	0.06	0.58	0.42
U2T0-3	0.31	127	459	7.23	3.35	10.97	0.06	0.60	0.39
U2T0-4	0.35	129	490	7.60	3.01	9.94	0.06	0.58	0.39
U3T0-1	0.57	161	852	10.58	3.16	9.01	0.07	0.54	0.50
U3T0-2	0.55	165	875	10.61	3.31	9.18	0.06	0.54	0.49
U3T0-3	0.57	167	888	10.63	3.22	9.04	0.06	0.53	0.51
U3T0-4	0.54	177	918	10.37	3.28	9.02	0.06	0.53	0.50
P1T2-1	0.56	191	1008	10.55	3.30	10.64	0.06	0.54	0.58
P1T2-2	0.62	172	925	10.76	3.24	9.18	0.06	0.55	0.57
P1T2-3	0.59	184	1001	10.88	3.30	10.67	0.06	0.55	0.57

P1T2-4	0.64	187	1054	11.27	3.22	9.99	0.06	0.55	0.58
P2T2-1	0.41	160	644	8.05	4.24	12.56	0.05	0.64	0.64
P2T2-2	0.38	153	658	8.60	4.55	14.25	0.06	0.63	0.62
P2T2-3	0.34	158	656	8.30	4.80	14.25	0.05	0.63	0.61
P2T2-4	0.41	161	665	8.26	4.23	12.56	0.05	0.63	0.63
P3T2-1	0.49	181	811	8.96	4.01	10.14	0.05	0.59	0.65
P3T2-2	0.45	177	788	8.90	4.05	10.91	0.05	0.57	0.64
P3T2-3	0.58	182	834	9.16	3.40	8.38	0.05	0.59	0.63
P3T2-4	0.47	180	813	9.03	4.11	10.96	0.05	0.58	0.66
U1T2-1	0.61	217	1240	11.43	3.51	10.80	0.05	0.54	0.56
U1T2-2	0.65	220	1306	11.87	3.42	10.64	0.05	0.54	0.56
U1T2-3	0.69	211	1298	12.30	3.31	10.64	0.06	0.55	0.57
U1T2-4	0.68	215	1313	12.21	3.35	10.65	0.06	0.54	0.58
U2T2-1	0.30	122	465	7.62	3.88	11.64	0.06	0.60	0.40
U2T2-2	0.31	136	503	7.40	3.32	10.11	0.05	0.57	0.40
U2T2-3	0.32	128	480	7.50	3.28	10.11	0.06	0.58	0.37
U2T2-4	0.29	133	493	7.41	3.41	10.87	0.06	0.57	0.40
U3T2-1	0.55	165	855	10.36	3.22	9.07	0.06	0.54	0.49
U3T2-2	0.57	157	849	10.82	3.23	9.93	0.07	0.54	0.50
U3T2-3	0.54	160	845	10.56	3.27	10.05	0.07	0.54	0.49
U3T2-4	0.57	172	895	10.41	3.17	8.24	0.06	0.53	0.51