

Impact of particulate organic matter composition and degradation state on the vertical structure of particle-associated and planktonic lacustrine bacteria

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Supplement. Table S1 provides the DNA extraction yields per filter and water depth. Table S2 provides an overview on measured basic chemical and physical parameters and amino sugars of Lake Brienz (LB) and Lake Zug (LZ) sampled in spring and fall 2009. Table S3 gives concentrations of amino acids. Table S4 gives detailed results of variation partitioning of bacterial community composition data with environmental variables. Fig. S1 depicts degradation indices measured along the lake water columns, Fig. S2 shows redundancy analysis (RDA) triplots including anoxic water samples of LZ, and Fig. S3 shows partial RDA triplots of oxic water samples with depth as a conditional variable.

Table S1. DNA extraction yield (ng l^{-1}) from lake water filtered through a 5.0 μm and a 0.2 μm filter connected in series. Lake Brienz (LB) was sampled in May and September 2009 and Lake Zug (LZ) in March and October 2009

Water depth (m)	LB May		LB Sep		Water depth (m)	LZ Mar		LZ Oct	
	5 μm	0.2 μm	5 μm	0.2 μm		5 μm	0.2 μm	5 μm	0.2 μm
5	179	278	178	2816	5	1130	2099	365	1131
10	110	380	281	1501	10	1612	1746	536	1851
20	53.2	598	132	824	15	1163	1350	467	1487
30	54.9	201	79.6	1002	25	716	1951	46.2	1021
40	45.9	91.8	70.4	346	60	447	1348	78.4	906
70	8.96	35.8	20.2	218	80	150	788	16.1	1026
100	11.7	38.5	21.8	343	100	203	926	45.4	935
150	8.95	9.49	20.2	508	130	117	663	42.7	724
200	10.1	55.1	17.9	216	170	203	522	105	956
240	18.5	51.6	29.1	660	190	179	1491	842	1148

Table S2. Basic chemical and physical parameters and concentrations of particulate amino sugars of Lake Brienz (LB) sampled in May and September 2009 and Lake Zug (LZ) sampled in March and October 2009. TOC: total organic carbon; TN: total nitrogen; TP: total phosphorus; T: temperature; GlcN: glucosamine; ManN: mannosamine; GalN: galactosamine; MurA: muramic acid

Sampling	Depth (m)	TOC ^a (mg l ⁻¹)	TN ^a (mg l ⁻¹)	NO ₃ ⁻ (mg l ⁻¹)	TP (µg l ⁻¹)	SO ₄ ²⁻ (mg l ⁻¹)	Cl ⁻ (mg l ⁻¹)	Na ⁺ (mg l ⁻¹)	Ca ²⁺ (mg l ⁻¹)	Mg ²⁺ (mg l ⁻¹)	Alkalinity (mmol l ⁻¹)	O ₂ ^a (mg l ⁻¹)	pH	T ^a (°C)	GlcN ^b (nmol l ⁻¹)	ManN ^b (nmol l ⁻¹)	GalN ^b (nmol l ⁻¹)	MurA ^b (nmol l ⁻¹)
LB May	5	0.62	0.40	0.41	7.13	11.0	0.89	0.76	29.3	3.65	1.55	11.6	7.88	10.58	8.42	1.01	2.55	2.88
	10	0.74	0.47	0.40	8.22	11.3	0.83	0.77	28.0	3.98	1.56	12.0	8.21	8.44	13.9	1.90	2.49	2.26
	20	0.85	0.42	0.40	7.33	11.0	0.86	0.66	27.3	3.68	1.54	11.4	8.19	7.58	4.61	0.61	1.21	0.99
	30	0.65	0.38	0.41	7.01	11.1	0.86	0.86	30.8	3.93	1.52	11.3	8.14	6.91	3.85	0.20	1.15	0.92
	40	0.78	0.40	0.41	5.88	11.0	0.83	0.69	29.6	3.80	1.52	11.6	8.09	6.23	2.57	0.09	0.65	0.49
	70	0.56	0.40	0.39	5.21	10.9	0.85	1.08	27.0	3.58	1.50	12.2	8.09	5.37	1.15	0.07	0.33	0.10
	100	0.52	0.39	0.40	5.14	11.0	0.80	0.87	27.0	3.61	1.50	12.1	8.12	5.31	0.70	0.11	0.27	0.19
	150	0.57	0.42	0.40	5.06	11.0	0.79	0.59	27.4	3.89	1.50	11.8	8.09	5.29	0.77	0.06	0.31	0.08
	200	0.59	0.37	0.40	4.63	11.0	0.96	0.71	26.9	3.59	1.52	10.9	8.04	5.29	0.69	0.07	0.27	0.06
	240	0.54	0.41	0.40	5.96	11.1	0.82	0.73	27.2	3.70	1.52	11.2	7.84	5.30	1.18	0.14	0.46	0.39
LB Sep	5	0.55	0.34	0.27	19.9	8.76	0.53	0.27	23.2	1.89	1.24	10.4	8.01	14.12	3.68	0.65	1.53	0.91
	10	0.77	0.34	0.29	33.8	9.35	0.50	0.28	24.0	2.09	1.28	10.5	7.95	11.35	2.83	0.70	0.72	0.85
	20	0.74	0.36	0.31	54.2	9.58	0.59	0.29	24.1	2.17	1.36	10.7	7.92	10.28	3.95	0.53	2.19	0.48
	30	0.57	0.39	0.34	39.4	9.67	0.58	0.43	28.1	2.28	1.41	10.5	7.91	8.95	0.77	0.53	0.28	0.63
	40	0.61	0.42	0.39	63.6	10.3	0.69	0.35	28.5	2.49	1.51	10.9	7.87	6.15	0.98	0.12	0.32	0.36
	70	0.52	0.45	0.39	27.5	10.4	0.91	0.53	26.2	2.47	1.53	11.2	7.84	5.86	0.65	0.06	0.24	0.14
	100	0.53	0.44	0.40	26.8	10.0	0.74	0.55	26.0	2.73	1.53	10.9	7.86	5.76	0.87	0.06	0.31	0.25
	150	0.49	0.41	0.39	23.8	10.6	0.75	0.47	28.6	2.97	1.53	11.0	7.85	5.62	0.68	0.09	0.24	0.37
	200	0.55	0.43	0.40	21.8	10.5	0.78	0.58	25.5	2.71	1.54	11.2	7.84	5.62	1.10	0.16	0.45	1.03
	240	0.51	0.43	0.40	45.1	10.6	0.78	0.47	27.6	2.80	1.55	10.9	7.83	5.62	1.89	0.19	0.38	0.72
LZ Mar	5	2.14	0.55	0.30	77.1	6.52	6.32	4.26	39.0	7.22	2.58	10.3	8.43	4.99	70.6	2.38	10.8	4.21
	10	2.37	0.55	0.29	75.3	6.47	6.51	4.12	39.0	6.55	2.62	10.3	8.38	4.95	19.1	0.85	7.88	1.21
	15	2.16	0.52	0.31	81.7	6.48	6.52	4.15	38.8	6.75	2.61	10.3	8.46	4.87	12.3	0.90	5.46	0.62
	25	2.09	0.53	0.32	78.2	6.52	5.47	4.15	39.0	6.96	2.61	10.2	8.44	4.63	14.2	1.04	3.49	0.91
	60	2.04	0.54	0.35	82.1	6.54	6.46	4.01	38.9	6.74	2.60	8.86	8.34	4.33	8.53	0.26	3.12	0.93
	80	2.06	0.59	0.38	93.7	6.54	6.57	4.16	39.4	6.70	2.64	7.03	8.11	4.35	11.0	0.96	5.38	0.61
	100	1.89	0.58	0.41	126	6.53	6.49	4.14	40.5	7.27	2.69	4.24	8.06	4.48	12.0	0.18	3.63	0.99
	130	2.00	0.56	0.36	159	6.45	6.36	4.06	41.3	7.54	2.74	1.46	7.39	4.51	10.2	0.80	4.37	0.73
	170	1.86	0.49	0.32	184	6.37	6.19	3.97	41.4	6.88	2.77	0.75	7.93	4.47	10.7	0.93	3.88	1.27
	190	1.97	0.49	0.31	194	6.43	6.07	3.95	41.8	7.00	2.78	0.80	7.94	4.48	12.7	0.88	4.54	3.41
LZ Oct	5	2.43	0.23	0.02	25.0	5.33	6.29	4.40	27.2	7.66	2.25	10.0	8.14	13.26	21.6	2.47	2.77	3.31
	10	2.54	0.25	0.02	42.2	5.15	6.36	4.19	30.4	7.49	2.27	9.97	8.11	13.24	35.6	2.64	9.33	5.38
	15	2.37	0.26	0.06	39.1	5.41	6.44	4.02	31.8	7.52	2.32	6.53	7.45	8.65	8.02	0.14	2.79	2.09
	25	1.99	0.51	0.43	86.7	5.16	5.93	3.89	30.2	7.14	2.56	7.68	7.42	6.01	6.58	0.21	2.49	0.27
	60	1.89	0.50	0.43	95.2	5.70	6.64	4.02	28.6	7.75	2.59	7.37	7.40	4.61	2.96	0.19	1.38	0.74
	80	1.88	0.50	0.44	115	5.61	6.49	4.22	37.0	8.02	2.61	6.21	7.36	4.52	3.90	0.10	1.75	0.35
	100	1.89	0.50	0.46	158	5.62	6.26	3.94	38.9	7.30	2.69	3.47	7.29	4.50	2.78	0.08	1.17	0.30
	130	1.95	0.44	0.36	172	5.54	6.38	4.11	39.1	7.79	2.71	0.93	7.23	4.51	5.89	0.06	2.42	0.61
	170	1.94	0.29	0.15	167	5.52	6.32	4.07	36.9	7.45	2.71	0.96	7.21	4.51	6.26	0.46	2.09	0.44
	190	1.94	0.27	0.03	230	5.32	6.21	4.44	40.8	8.08	2.76	0.58	7.16	4.53	10.3	0.24	3.64	0.38

^aPublished by Köllner et al. (2012); ^bPublished by Carstens et al. (2012)

Table S3. Concentrations of particulate amino acids of Lake Brienz (LB) sampled May and September 2009 and Lake Zug (LZ) sampled in March and October 2009. All amino acids concentrations are given in units of nmol l⁻¹. For abbreviations of individual amino acids, see www.ncbi.nlm.nih.gov/Class/MLACourse/Modules/MolBioReview/iupac_aa_abbreviations.html

Sampling	Depth (m)	Ala	Gly	Thr	Ser	Val	Leu	Ile	Pro	Asp	Met	Glu	Phe	Tyr	Lys
LB May	5	112	91.0	39.0	42.4	41.4	63.9	31.6	38.8	67.5	5.38	90.1	24.5	15.7	44.3
	10	65.2	50.8	26.2	20.4	24.1	56.6	23.6	30.6	49.5	7.84	61.9	21.5	14.8	22.8
	20	49.2	45.0	19.5	19.1	18.6	34.6	15.2	20.7	32.4	2.89	41.0	12.6	7.59	12.0
	30	29.2	28.1	13.1	11.8	12.5	19.8	8.42	10.5	22.3	2.37	24.0	7.90	4.23	2.96
	40	19.0	19.9	11.1	8.74	11.9	16.3	7.43	9.39	17.6	2.24	21.0	6.17	4.40	9.29
	70	11.4	9.8	5.62	5.45	4.60	8.23	4.45	2.80	7.78	1.08	9.91	3.44	2.54	0.11
	100	6.26	6.56	3.03	3.04	2.88	6.08	2.90	4.46	6.62	0.58	9.37	2.71	1.32	3.60
	150	5.80	7.08	3.95	2.82	4.01	5.68	2.31	2.27	5.50	0.79	7.33	2.45	1.37	bd
	200	4.82	5.51	4.00	3.11	3.63	6.31	2.75	4.10	6.59	0.97	8.16	2.91	1.52	3.11
240	8.17	8.46	5.36	4.74	4.58	8.64	4.51	5.13	9.13	1.11	12.3	3.90	1.62	3.34	
LB Sep	5	38.3	22.8	13.1	19.1	17.0	33.8	15.1	18.3	39.8	3.16	65.3	17.4	5.98	17.7
	10	bd	bd	6.72	1.03	12.3	21.2	7.42	14.5	25.7	2.41	32.0	17.9	4.23	bd
	20	5.38	18.9	13.5	6.48	17.4	17.0	9.14	12.7	26.2	2.81	32.2	8.23	3.39	8.36
	30	1.01	1.06	2.87	1.63	5.09	6.32	3.11	4.83	9.9	1.37	12.7	4.04	1.29	2.52
	40	13.0	8.35	3.80	5.12	5.67	8.57	4.66	9.65	19.8	2.49	37.5	8.70	2.44	13.8
	70	9.09	3.57	1.25	1.62	1.61	4.63	1.87	8.56	6.17	0.52	10.0	3.71	0.75	bd
	100	3.26	5.05	2.46	1.92	3.49	5.99	2.66	3.82	9.9	1.38	13.7	3.88	1.70	2.01
	150	bd	0.35	1.66	0.83	2.64	5.33	2.18	5.36	5.77	1.17	6.65	3.18	0.62	bd
	200	1.56	3.80	4.06	2.83	4.93	6.64	3.68	5.73	11.9	1.24	14.8	5.02	2.29	bd
240	bd	1.00	7.91	0.68	9.48	6.37	2.43	5.46	18.1	2.43	17.9	5.59	2.14	4.43	
LZ Mar	5	113	139	56.6	73.7	50.3	199	80.1	131	149	34.4	251	100	27.3	164
	10	58.3	94.2	49.0	57.5	41.4	165	71.9	57.0	157	26.6	216	91.7	20.9	20.9
	15	124	149	64.9	59.1	73.7	133	55.0	145	157	70.7	192	63.3	43.3	111
	25	113	90.0	34.6	39.9	33.8	64.4	30.2	41.6	58.8	5.75	82.6	21.6	15.1	43.2
	60	9.08	15.3	7.86	7.16	6.29	25.7	9.91	17.7	23.7	2.30	43.3	17.7	0.94	34.3
	80	23.1	23.9	11.9	9.67	12.7	23.4	8.61	13.9	22.4	1.54	26.2	9.40	1.51	10.1
	100	36.5	41.6	22.3	17.2	22.6	34.9	16.7	26.0	42.6	bd	51.2	12.7	9.93	bd
	130	24.0	28.8	12.9	16.3	10.1	30.6	14.8	18.6	33.2	0.54	42.2	11.5	0.22	31.7
	170	33.9	35.6	17.2	17.5	14.7	31.2	14.9	19.2	30.6	0.79	35.4	13.6	3.25	12.1
190	58.2	48.5	16.1	23.0	14.6	37.8	16.5	26.4	28.8	1.68	38.9	16.2	7.77	36.5	
LZ Oct	5	287	239	113	183	97.4	309	147	197	393	53.3	473	134	96.0	183
	10	249	203	80.7	184	58.2	263	147	165	287	43.8	344	118	80.1	176
	15	98.5	80.2	33.6	83.8	25.5	117	66.1	72.2	93.9	13.8	127	55.1	34.9	106
	25	36.7	34.7	11.9	20.3	11.6	27.4	14.2	18.3	29.3	2.74	36.0	10.5	5.78	9.08
	60	16.5	14.5	6.86	9.70	5.36	14.4	8.19	9.25	14.0	1.28	17.8	5.47	1.44	9.06
	80	25.0	16.5	7.36	11.4	7.50	13.3	7.77	9.91	12.2	1.45	13.7	4.24	1.00	2.23
	100	3.65	10.8	7.16	3.50	8.56	12.5	4.67	10.4	19.1	1.36	25.2	7.65	1.07	7.02
	130	13.6	27.9	15.1	11.9	29.6	27.9	12.0	19.5	43.3	1.07	52.5	14.9	0.57	26.7
	170	38.9	33.7	15.3	24.3	13.2	35.7	22.2	23.8	36.5	3.30	46.1	17.3	9.65	21.7
190	62.7	55.9	29.8	41.8	29.1	71.1	40.8	47.0	71.1	7.75	90.7	33.3	17.2	45.9	

Table S4. Results for variation partitioning with the environmental variables, which were selected by forward selection in the redundancy analyses (RDAs) with oxic water samples (see Fig. 4 in the main manuscript). The contribution (%) of each environmental variable to the adjusted r^2 (r^2_{adj}) and its significance are given (** $p < 0.01$). For the RDA with the particle-associated bacterial communities (BCs), the r^2_{adj} is 0.67 and for the RDA with the free-living bacterial communities the r^2_{adj} is 0.68. T: temperature; TOC: total organic carbon; TP: total phosphorus

Variable	Particle-associated BCs	Free-living BCs
Cl	5.89**	3.13**
NO ₃ ⁻	5.01**	3.08**
SO ₄ ²⁻	3.66**	4.10**
O ₂	3.94**	2.26**
T	8.51**	9.28**
C:N	6.13**	9.05**
TOC	1.37	2.26**
Alkalinity	3.47**	1.95**
TP	3.95**	2.44**
pH	3.45**	-

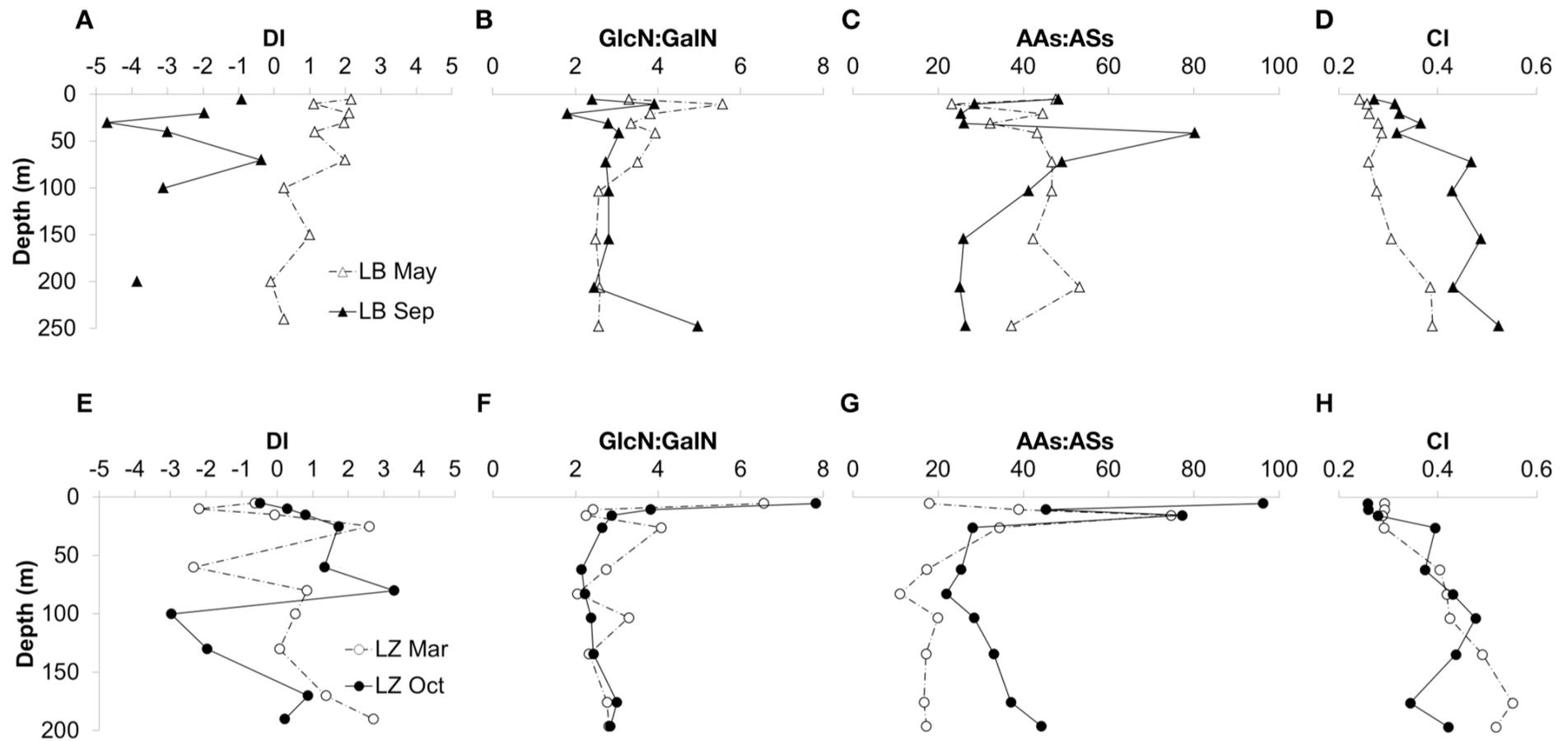


Fig. S1. Degradation indices (DI) based on (A,E) the abundance of particulate amino acids; (B,F) ratios between particulate glucosamine and particulate galactosamine (GlcN:GalN); (C,G) ratios between total particulate amino acids and total particulate amino sugars (AAs:ASs); and (D,H) the chlorin index (CI) for the water columns of Lake Brienz (LB) sampled in May and September 2009 and of Lake Zug (LZ) sampled in March and October 2009

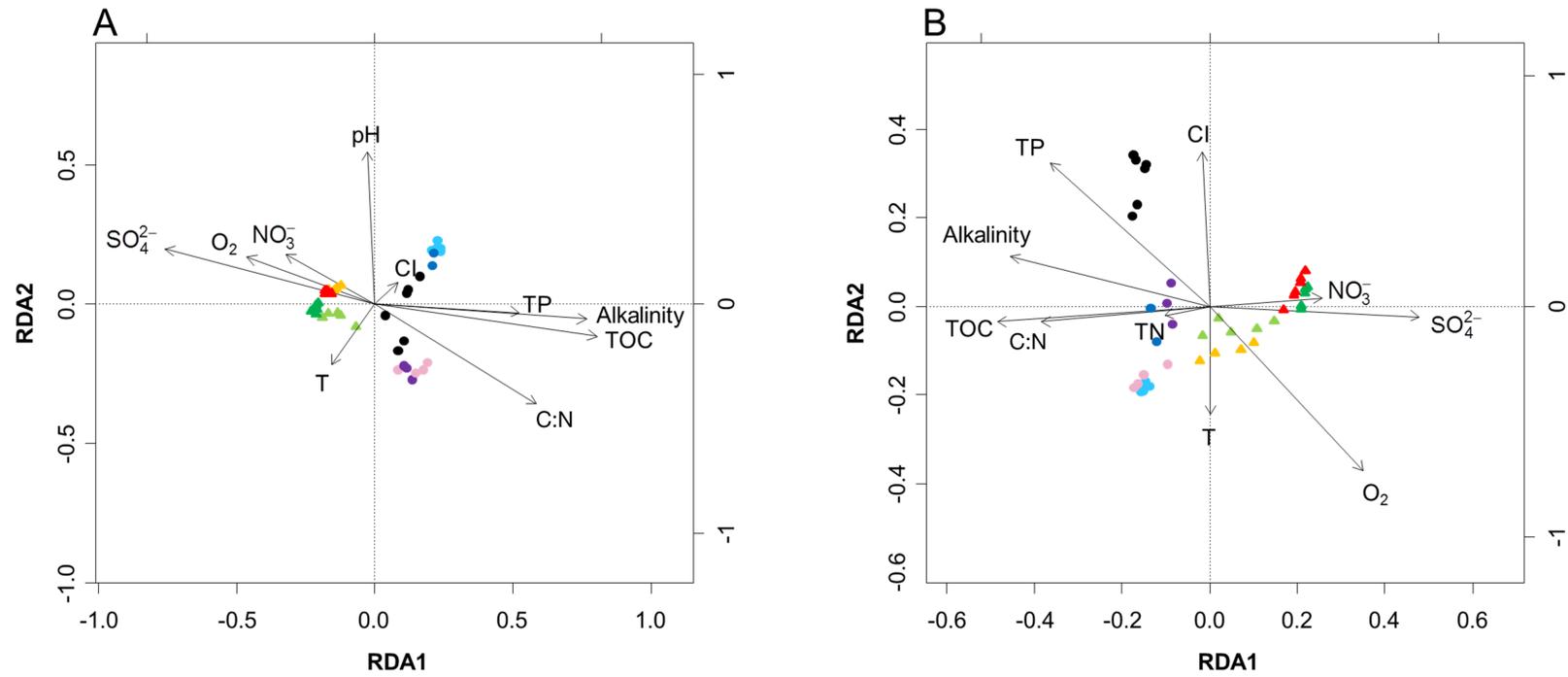


Fig. S2. Redundancy analysis (RDA) triplots of Hellinger-transformed ARISA data of (A) particle-associated and (B) free-living bacterial communities (BCs) and constraining environmental variables. The first 2 canonical axes explain 30.6 and 39.2% of the total variance of the particle-associated and the free-living BC data, respectively. Water samples from Lake Brienz are symbolized by triangles and Lake Zug by circles. Color coding is identical to Fig. 2 in the main manuscript. CI: chlorin index; T: temperature; TOC: total organic carbon; TN: total nitrogen; TP: total phosphorus

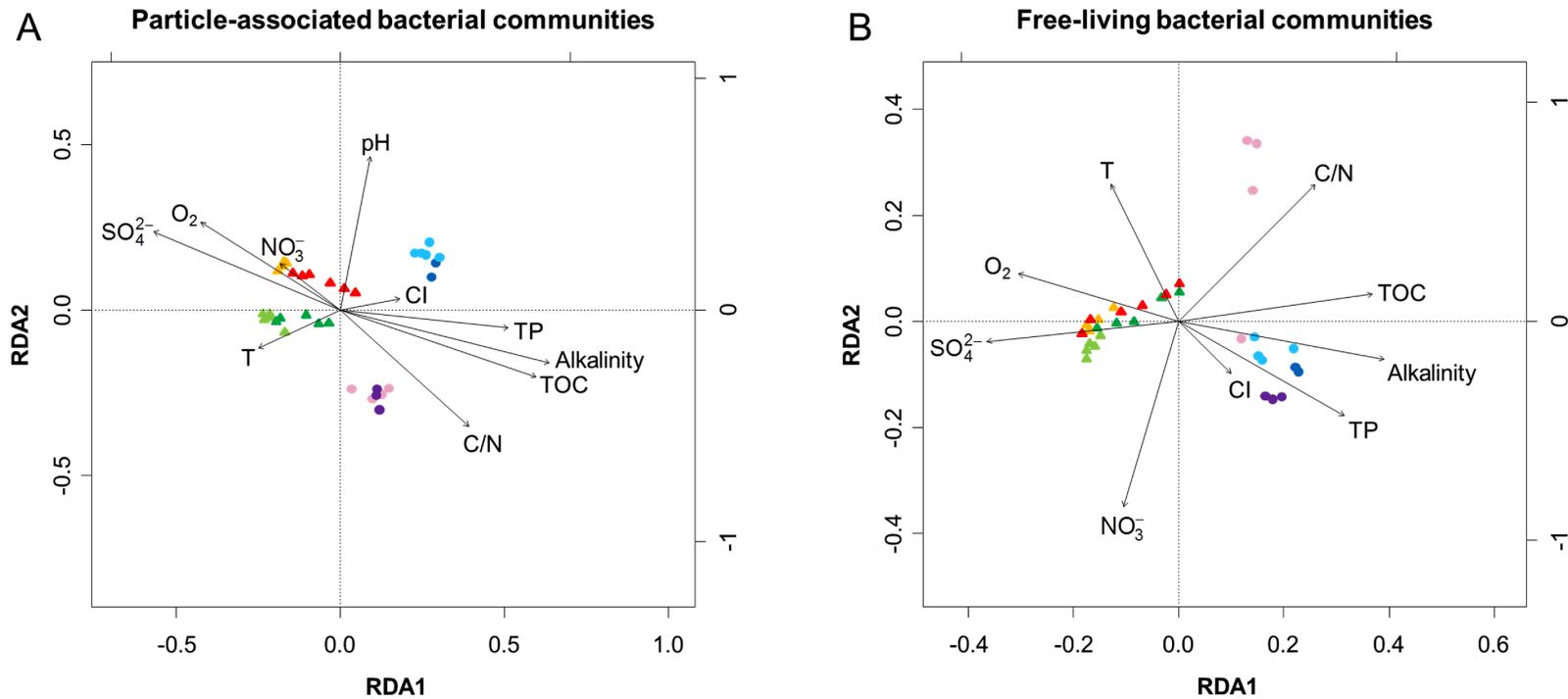


Fig. S3. Partial redundancy analysis (RDA) triplots of Hellinger-transformed ARISA data of (A) particle-associated and (B) free-living bacterial communities from oxic waters, with depth as a conditional variable. Color coding is identical to Fig. 2 in the main manuscript. CI: chlorin index; T: temperature; TOC: total organic carbon; TP: total phosphorus

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