

Supplementary Figures and Tables

Seasonality in spatial turnover of bacterioplankton along an ecological gradient in the East China Sea: biogeographic patterns, processes and drivers

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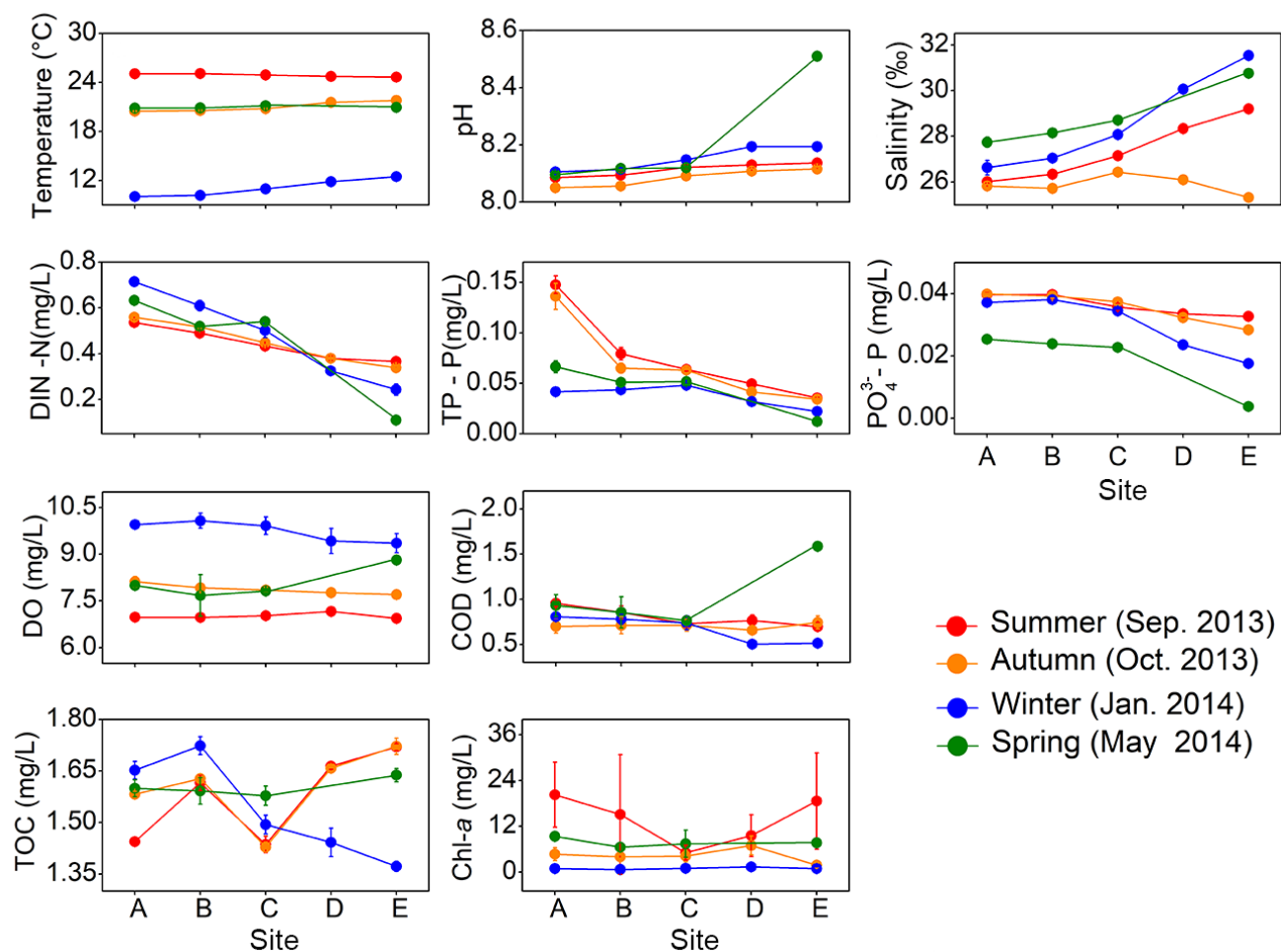


Figure S1. Spatiotemporal dynamics of water environmental parameters across five sites over seasons. Data represent mean \pm standard deviation (n = 5). DIN: dissolved inorganic nitrogen; TP: total phosphorus; COD: chemical oxygen demand; DO: dissolved oxygen; TOC: total organic carbon; Chl-*a*: chlorophyll-*a*. Site D was not sampled in spring.

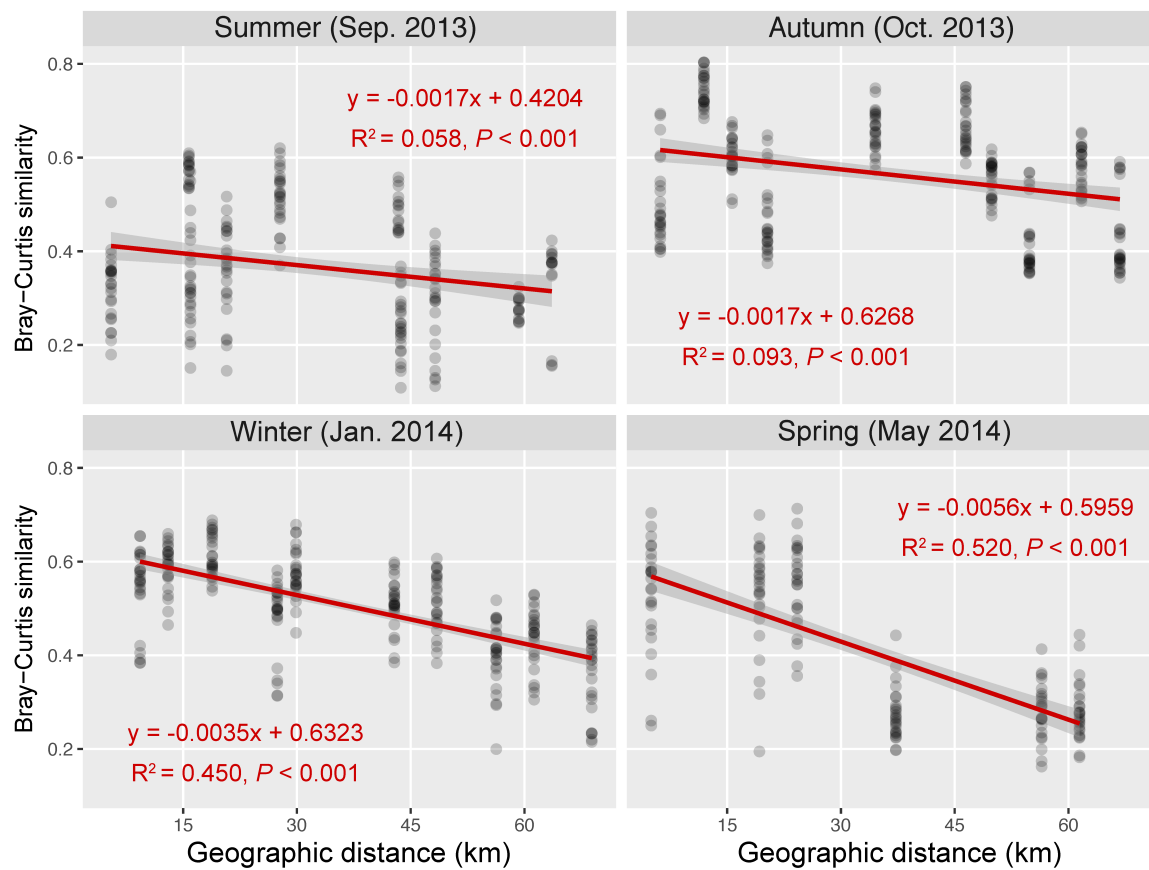


Figure S3. Significant correlations between Bray-Curtis similarity and geographic distance showing the distance-decay pattern in the similarity between bacterial communities. Solid lines present linear fit.

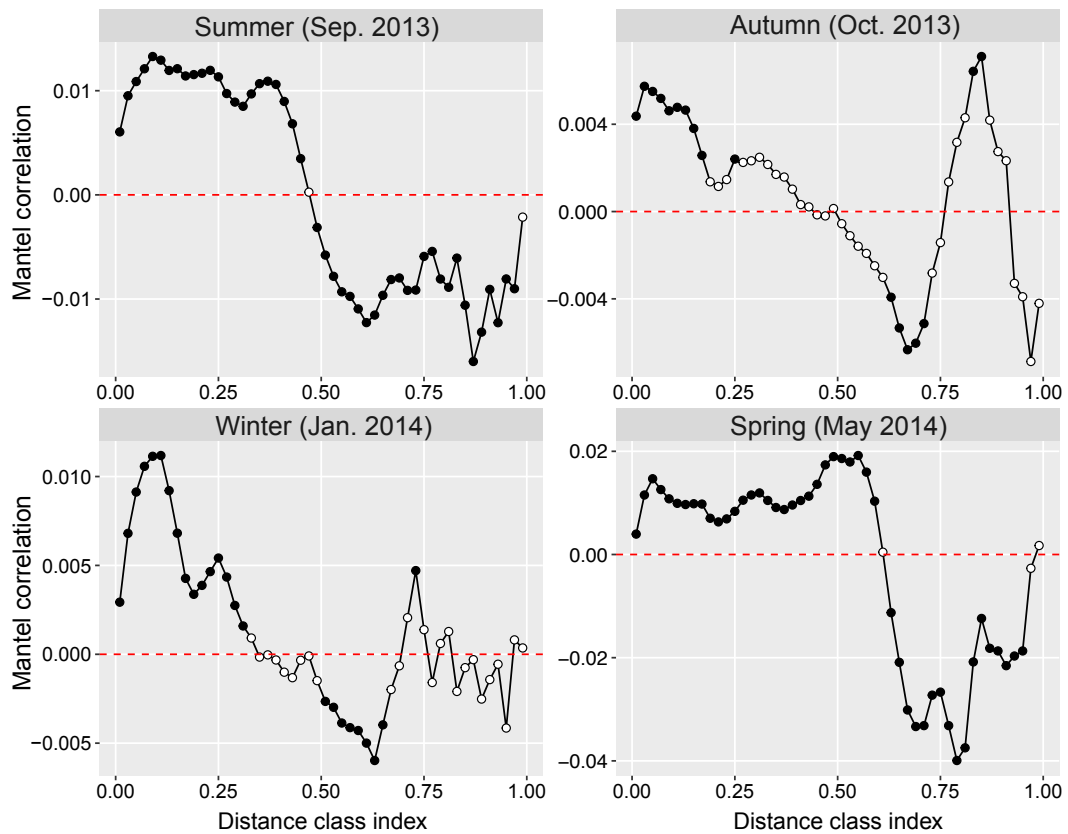


Figure S4. Mantel correlograms testing phylogenetic signal in ecological niches of bacterial OTUs across between-OTU phylogenetic distance classes in four seasons. Solid and open symbols present significant ($P < 0.05$ after Holm correction, 999 permutations) and nonsignificant Pearson correlations of between-OTU niche differences with between-OTU phylogenetic distances, respectively, across phylogenetic distance classes.

Table S1. Two-way crossed analysis of similarity (ANOSIM) of bacterial community composition based on Bray-Curtis dissimilarity across seasons and sampling sites (999 permutations).

Factor	R	P
<i>Season</i>		
Global ANOSIM	0.978	0.001
Summer vs. Autumn	0.908	0.001
Summer vs. Winter	0.944	0.001
Summer vs. Spring	0.995	0.001
Autumn vs. Winter	1.000	0.001
Summer vs. Spring	1.000	0.001
Winter vs. Spring	1.000	0.001
<i>Site</i>		
Global ANOSIM	0.627	0.001
Site A vs. Site B	0.441	0.001
Site A vs. Site C	0.447	0.001
Site A vs. Site D	0.785	0.001
Site A vs. Site E	0.830	0.001
Site B vs. Site C	0.567	0.001
Site B vs. Site D	0.964	0.001
Site B vs. Site E	0.996	0.001
Site C vs. Site D	0.479	0.001
Site C vs. Site E	0.781	0.001
Site D vs. Site E	0.317	0.002

Table S2. One-way analysis of similarity (ANOSIM) of bacteria community composition based on Bray-Curtis dissimilarity between sites in each season (999 permutations).

	Summer (Sep. 2013)			Autumn (Oct. 2013)			Winter (Jan. 2014)			Spring (May 2014)		
	R	P	P_{adj}	R	P	P_{adj}	R	P	P_{adj}	R	P	P_{adj}
A vs. B	0.588	0.016	0.023	0.424	0.008	0.009	0.548	0.008	0.011	0.202	0.087	0.131
A vs. C	0.548	0.008	0.020	0.520	0.008	0.009	0.660	0.008	0.011	0.050	0.341	0.341
A vs. D	0.680	0.008	0.020	0.760	0.008	0.009	0.916	0.008	0.011	—	—	—
A vs. E	0.508	0.018	0.023	0.740	0.008	0.009	0.968	0.008	0.011	0.992	0.008	0.016
B vs. C	0.876	0.008	0.020	0.884	0.008	0.009	0.380	0.048	0.053	0.128	0.159	0.191
B vs. D	1.000	0.008	0.020	1.000	0.008	0.009	0.892	0.008	0.011	—	—	—
B vs. E	1.000	0.018	0.023	1.000	0.008	0.009	1.000	0.008	0.011	0.984	0.008	0.016
C vs. D	0.442	0.024	0.027	0.508	0.008	0.009	0.488	0.016	0.020	—	—	—
C vs. E	0.703	0.018	0.023	0.532	0.008	0.009	0.876	0.008	0.011	0.988	0.008	0.016
D vs. E	0.395	0.071	0.071	0.360	0.008	0.009	0.224	0.103	0.103	—	—	—

P_{adj} : P value adjusted by FDR. P_{adj} values in bold indicate significant difference between sites ($P_{\text{adj}} < 0.05$).

Table S3. Distance-based multivariate linear model (DistLM) of compositional variation of bacterial community (based on Bray-Curtis dissimilarity) against environmental variables with 999 permutations. Marginal tests: each variable was analyzed individually (ignoring other variables); Sequential tests: forward selection of variables, where the proportion of variation explained by each variable added to the model was conditional on the variables previously included in the model.

Season	Marginal tests				Conditional tests				
	Variable	pseudo-F	<i>P</i>	Prop (%)	Variable	pseudo-F	<i>P</i>	Prop. (%)	Cumulative Prop. (%)
All	Temp.	22.59	0.001	19.89	Temp.	22.59	0.001	19.89	19.89
	DO	20.68	0.001	8.290	PO ₄ ³⁻	16.23	0.001	12.24	32.13
	PO ₄ ³⁻	12.59	0.001	10.39	DIN	15.47	0.001	10.05	42.18
	Salinity	10.54	0.001	18.52	pH	12.33	0.001	7.110	49.28
	COD	9.167	0.001	9.150	Salinity	13.98	0.001	7.020	56.31
	pH	8.223	0.001	1.950	DTL	5.120	0.001	2.460	58.76
	Chl- <i>a</i>	7.711	0.001	5.480	Chl- <i>a</i>	3.685	0.001	1.710	60.48
	TP	6.563	0.001	6.730	TP	3.471	0.001	1.570	62.04
	DTL	5.301	0.001	12.15	TOC	1.903	0.013	0.850	62.89
	DIN	5.280	0.001	7.810	DO	1.332	0.168	0.590	63.49
	TOC	1.805	0.057	5.500	COD	1.105	0.277	0.490	63.98
Summer Sep. 2013	PO ₄ ³⁻	7.945	0.001	27.45	PO ₄ ³⁻	7.945	0.001	27.45	27.45
	Temp.	7.632	0.001	26.65	TP	3.486	0.001	10.77	38.22
	Salinity	7.106	0.001	25.28	DTL	2.408	0.006	6.950	45.17
	DIN	7.092	0.001	25.24	DIN	2.389	0.013	6.420	51.59
	DTL	7.083	0.001	25.22	pH	2.135	0.023	5.400	56.99
	pH	6.877	0.001	24.67	TOC	1.687	0.078	4.100	61.09
	TP	4.580	0.001	17.91	Temp.	1.108	0.325	2.660	63.75
	COD	4.561	0.003	17.84	DO	1.064	0.374	2.580	66.33
	TOC	2.293	0.038	9.840	Chl- <i>a</i>	0.852	0.522	2.070	68.40
	Chl- <i>a</i>	2.062	0.063	8.940	COD	0.643	0.761	1.610	70.01
	DO	1.866	0.067	8.160	Salinity	0.583	0.791	1.510	71.52
Autumn Oct. 2013	DIN	10.16	0.001	30.64	DIN	10.16	0.001	30.64	30.64
	pH	9.357	0.001	28.92	TP	3.837	0.001	10.30	40.94
	TP	9.031	0.001	28.19	DO	2.849	0.002	7.060	48.00
	DTL	8.899	0.001	27.90	Salinity	2.173	0.004	5.100	53.10
	Temp.	8.605	0.001	27.23	TOC	1.169	0.245	2.720	55.82
	DO	8.339	0.001	26.61	COD	1.020	0.400	2.370	58.19
	PO ₄ ³⁻	7.699	0.001	25.08	DTL	0.994	0.469	2.320	60.51
	TOC	1.674	0.134	6.790	PO ₄ ³⁻	0.950	0.478	2.210	62.72
	Salinity	0.932	0.455	3.900	pH	0.822	0.620	1.940	64.66
	COD	0.655	0.739	2.770	Temp.	0.717	0.740	1.720	66.38
	Chl- <i>a</i>	0.584	0.844	2.480	Chl- <i>a</i>	0.665	0.825	1.640	68.02
Winter Jan. 2014	DIN	11.12	0.001	32.58	DIN	11.12	0.001	32.58	32.58
	DTL	10.98	0.001	32.31	TP	3.057	0.001	8.230	40.81
	pH	10.86	0.001	32.06	DTL	2.025	0.023	4.970	45.78
	Temp.	10.77	0.001	31.90	Salinity	1.710	0.043	4.040	49.82
	Salinity	10.64	0.001	31.64	pH	1.367	0.136	3.620	53.44
	PO ₄ ³⁻	9.703	0.001	29.67	COD	1.292	0.181	3.370	56.81
	TOC	8.420	0.001	26.80	PO ₄ ³⁻	1.172	0.254	3.030	59.84
	COD	8.138	0.001	26.13	DO	1.095	0.342	2.570	62.41
	TP	6.787	0.001	22.79	TOC	1.026	0.404	2.410	64.82
	DO	4.831	0.002	17.36	Chl- <i>a</i>	0.859	0.618	2.030	66.85
	Chl- <i>a</i>	1.853	0.061	7.450	Temp.	0.767	0.714	1.850	68.70
Spring May 2014	pH	13.95	0.001	43.67	pH	13.95	0.001	43.67	43.67
	PO ₄ ³⁻	13.41	0.001	42.69	Chl- <i>a</i>	2.954	0.006	8.340	52.01

	DIN	12.96	0.001	41.85	DTL	1.914	0.053	4.920	56.93
	Salinity	11.75	0.001	39.49	PO ₄ ³⁻	1.677	0.087	4.550	61.48
	COD	11.67	0.001	39.34	DIN	1.666	0.096	3.940	65.42
	TP	11.48	0.001	38.94	COD	1.541	0.142	3.820	69.24
	DTL	11.29	0.001	38.55	Temp.	1.322	0.227	3.030	72.27
	DO	7.423	0.001	29.20	TP	1.058	0.355	2.490	74.76
	TOC	3.841	0.005	17.58	DO	0.967	0.500	2.230	76.99
	Chl- <i>a</i>	1.564	0.165	8.000	Salinity	0.689	0.703	1.640	78.63
	Temp.	0.689	0.618	3.690	TOC	0.452	0.889	1.140	79.77

DTL, distance to land; DIN, dissolved inorganic nitrogen; TP, total phosphorus; Temp., water temperature; COD, chemical oxygen demand; DO, dissolved oxygen; TOC, total organic carbon. Chl-*a*, chlorophyll-*a*. *P* values in bold indicate significant correlations ($P < 0.05$).

Table S4. Spearman's correlation coefficients between geo-environmental factors.

Season	Variables	DTL	Temp.	pH	Salinity	DO	COD	TOC	DIN	TP	PO ₄ ³⁻
Summer (Sep. 2013)	Temp.	-0.904***									
	pH	0.877***	-0.851***								
	Salinity	0.979***	-0.885***	0.867***							
	DO	0.302	-0.417*	0.292*	0.341						
	COD	-0.777***	0.693***	-0.822***	-0.765***	-0.134					
	TOC	0.693***	-0.599**	0.469*	0.685***	0.255	-0.332				
	DIN	-0.971***	0.913***	-0.828***	-0.958***	-0.380	0.759***	-0.699***			
	TP	-0.979***	0.874***	-0.873***	-0.968***	-0.283	0.805***	-0.668***	0.958***		
	PO ₄ ³⁻	-0.882***	0.867***	-0.842***	-0.878***	-0.270	0.762***	-0.510*	0.872***	0.902***	
	Chl- <i>a</i>	-0.130	0.187	-0.245	-0.152	-0.254	0.259	0.136	0.184	0.121	0.141
Autumn (Oct. 2013)	Temp.	0.976***									
	pH	0.937***	0.923***								
	Salinity	-0.196	-0.194	-0.110							
	DO	-0.841***	-0.805***	-0.785***	0.119						
	COD	0.081	0.016	-0.039	-0.208	-0.031					
	TOC	0.687***	0.670***	0.583**	-0.671***	-0.515**	0.027				
	DIN	-0.981***	-0.964***	-0.922***	0.199	0.889***	-0.004	-0.663***			
	TP	-0.942***	-0.913***	-0.861***	0.320	0.763***	0.067	-0.746***	0.931***		
	PO ₄ ³⁻	-0.934***	-0.902***	-0.888***	0.165	0.732***	-0.040	-0.671***	0.888***	0.863***	
	Chl- <i>a</i>	-0.345	-0.339	-0.203	0.508	0.191	-0.474*	-0.365	0.323	0.293	0.294
Winter (Jan. 2014)	Temp.	0.984***									
	pH	0.931***	0.919***								
	Salinity	0.969***	0.948***	0.928***							
	DO	-0.639**	-0.613**	-0.607**	-0.630**						
	COD	-0.837***	-0.811***	-0.820***	-0.831***	0.647***					
	TOC	-0.868***	-0.864***	-0.843***	-0.900***	0.657***	0.731***				
	DIN	-0.981***	-0.967***	-0.931***	-0.969***	0.671***	0.840***	0.868***			
	TP	-0.600**	-0.597**	-0.557**	-0.589**	0.645***	0.648***	0.620***	0.602**		
	PO ₄ ³⁻	-0.907***	-0.897***	-0.877***	-0.894***	0.657***	0.845***	0.943***	0.907***	0.654***	
	Chl- <i>a</i>	0.258	0.245	0.341	0.237	-0.335	-0.337	-0.363	-0.254	-0.187	-0.369
Spring (May 2014)	Temp.	0.733***									
	pH	0.898***	0.558*								
	Salinity	0.964***	0.710***	0.841***							
	DO	0.272	-0.231	0.312	0.227						
	COD	0.365	-0.151	0.336	0.417	0.628**					
	TOC	0.359	-0.117	0.398	0.410	0.431	0.573**				
	DIN	-0.776***	-0.271	-0.792***	-0.748***	-0.399	-0.484*	-0.468*			
	TP	-0.877***	-0.503*	-0.900***	-0.847***	-0.263	-0.423	-0.500*	0.879***		
	PO ₄ ³⁻	-0.941***	-0.734***	-0.867***	-0.917***	-0.242	-0.336	-0.362	0.711***	0.836***	
	Chl- <i>a</i>	-0.319	-0.287	-0.491*	-0.274	0.293	0.270	0.134	0.408	0.521*	0.375

DTL, distance to land; DIN, dissolved inorganic nitrogen; TP, total phosphorus; Temp., water temperature; COD, chemical oxygen demand; DO, dissolved oxygen; TOC, total organic carbon. Chl-*a*, chlorophyll-*a*. Bold values indicate significant correlations (* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$).