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Diatom community assemblages and microbial degradation resistance modulate local heterogeneity in diatom contribution to carbon export in the western North Pacific Subtropical Gyre

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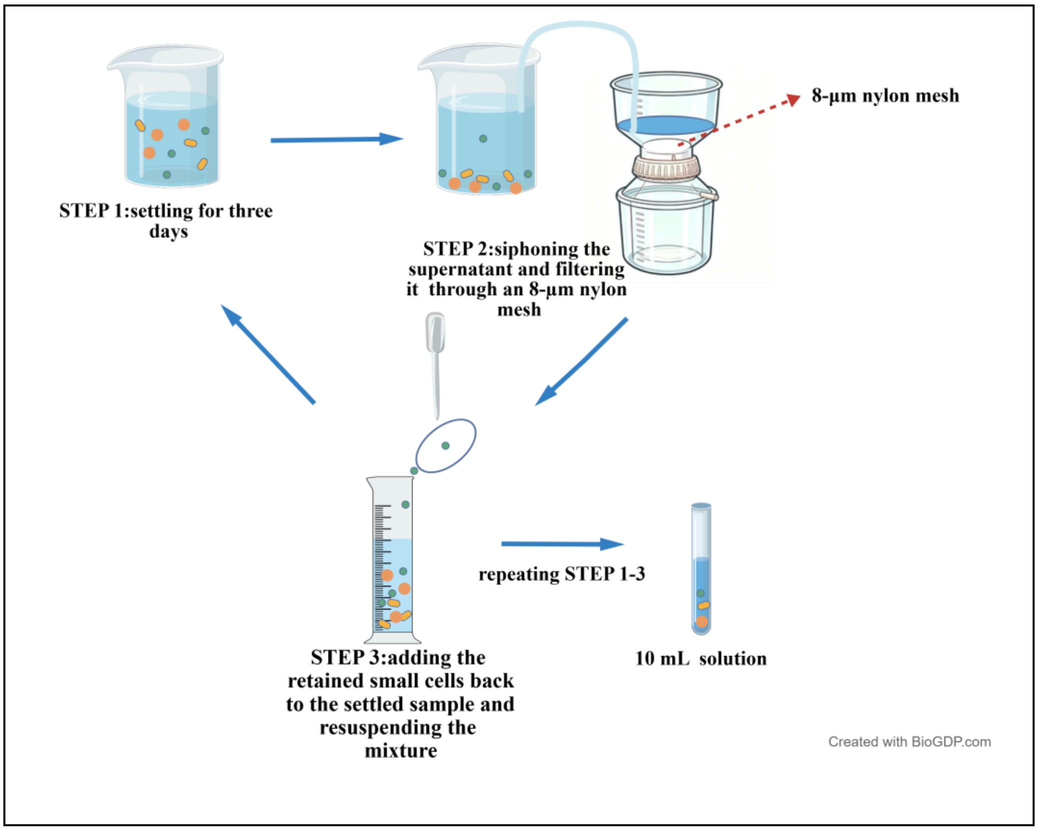


Fig.S1. Flow diagram of the diatom concentration procedure. The process involves four main steps: (1) settling the sample for three days; (2) siphoning the supernatant and filtering it through an 8-μm nylon mesh; (3) adding the retained small cells back to the settled sample and resuspending the mixture; and (4) repeating steps 1–3 until a final volume of 10 mL is obtained.

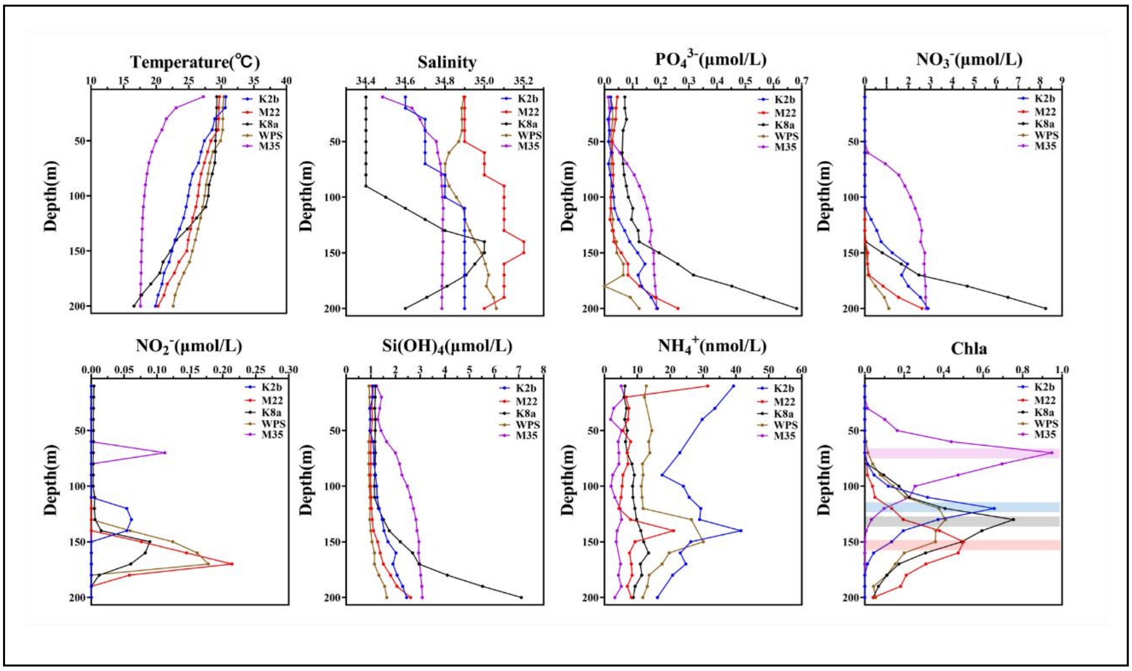
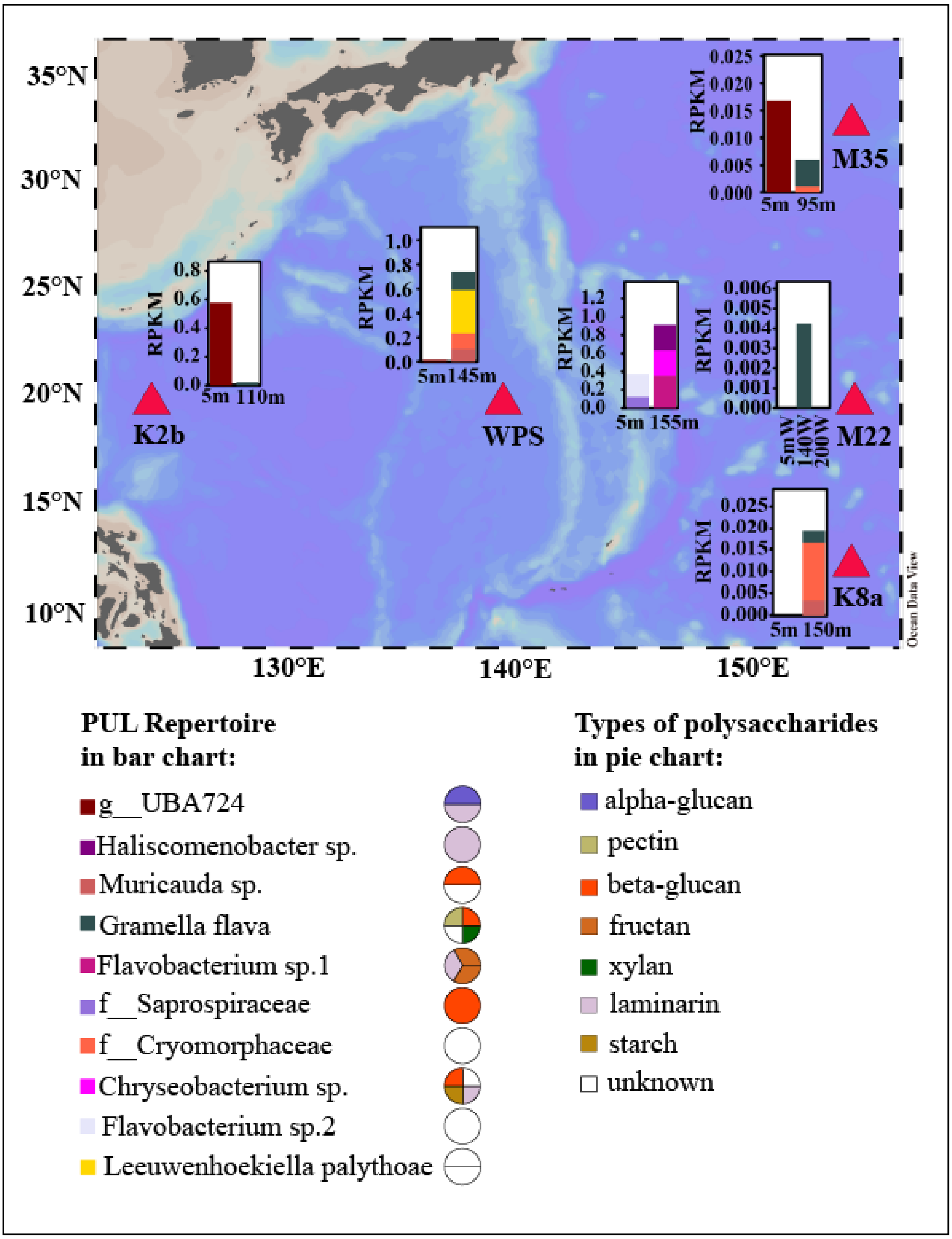


Fig. S2 Vertical profiles of temperature, salinity, nutrients, and chlorophyll-a within the 0-200 m layer during summer season. In the Chla graph, the strip-shaped color blocks represent the approximate positions of the DCM layer at different stations. The depths of the DCM at stations K8b and WPS almost coincide.



36 **Fig. S3 Abundance pattern of Bacteroidetes MAGs with PUL annotations.** In all bar charts, MAG abundance is represented by RPKM. The pie chart partitions reflect the quantity of PULs possessed by the bacteria, with colors corresponding to the types of polysaccharides that may be degraded. MAGs, metagenome-assembled genomes. PUL, polysaccharide utilization loci. Schlitzer, Reiner, Ocean Data View, odv.awi.de, 2025.

Table S1 Overview of sampled stations, collected methods, and sample details

Sample type	Station	The depth of sampling (m)			Sampling methods
Water samples (summer)	K2b	5	DCM (110)	200	CTD
	WPS	5	DCM (145)	200	
	M22	5	DCM (155)	200	
	K8a	5	DCM (150)	200	
	M35	5	DCM (95)	200	
Water samples (winter)	M22	5	DCM (135)	200	CTD
	K8a	5	DCM (146)	200	
Sediment trap samples (summer)	K2b	50	100	200	Sediment trap
	M22	50	100	200	
	K8a	50	100	200	
Environmental DNA samples(summer)	K2b	5	DCM (110)	-	In-situ large-volume filter pumps
	WPS	5	DCM (145)	-	
	M22	5	DCM (155)	-	
	K8a	5	DCM (150)	-	
	M35	5	DCM (95)	-	
Environmental DNA samples(winter)	M22	5	DCM (135)	200	In-situ large-volume filter pumps

Note: “-” indicates unavailable samples.

The depth of sampling refers to the collection of samples from three distinct depths: 5 m, the depth of the deep chlorophyll maximum (DCM), 200 m. For sediment trap samples, the three distinct depths are 50m, 100m, and 200m, respectively.

Table S2 Estimation of average carbon biomass values for diatom genera and species

Genus or species	Carbon content (pg C $cell^{-1}$)	The source of the data
Thalassiothrix	140.2(K2b)	Measurement and calculation
Thalassiothrix	157.3(M22)	Measurement and calculation
Thalassiosira	373.3(K2b)	Measurement and calculation
Thalassiosira	170.0(M22)	Measurement and calculation
Thalassiosira	502.4(K8a)	Measurement and calculation
Thalassiosira pacifica	373.3(K2b)	Measurement and calculation
Thalassiosira pacifica	170.0(M22)	Measurement and calculation
Thalassiosira pacifica	502.4(K8a)	Measurement and calculation
Thalassionema	89.5(K2b)	Measurement and calculation
Thalassionema	72.9(M22)	Measurement and calculation
Thalassionema nitzschioides	91.1(K2b)	Measurement and calculation
Thalassionema nitzschioides	104.3(M22)	Measurement and calculation
Thalassionema frauenfeldii	89.5(K2b)	Measurement and calculation
Thalassionema frauenfeldii	72.9(M22)	Measurement and calculation
Synedra	2176.6	Measurement and calculation
Rhizosolenia	2842.9	Measurement and calculation
Rhizosolenia styliformis	2842.9	Measurement and calculation
Rhizosolenia imbricata	2842.9	Measurement and calculation
Rhizosolenia hyalina	2842.9	Measurement and calculation
Rhizosolenia clevei	2842.9	Measurement and calculation
Pseudo-nitzschia pungens	86.9	Harrison et al., 2015
Protoraphis	19.1	Measurement and calculation
Pleurosigma	195.5(K2b)	Measurement and calculation
Planktoniella	8351.2	Chitari et al., 2017
Planktoniella formosa	8351.2	Chitari et al., 2018
Pinnularia	590	Rath et al., 2023
Nitzschia	36.6(K2b)	Measurement and calculation
Nitzschia	18.8(M22)	Measurement and calculation
Nitzschia	1.65(K8a)	Measurement and calculation
Nitzschia lorenziana	36.6(K2b)	Measurement and calculation
Nitzschia lorenziana	18.8(M22)	Measurement and calculation
Nitzschia lorenziana	1.65(K8a)	Measurement and calculation
Nitzschia longissima	36.6(K2b)	Measurement and calculation
Nitzschia longissima	18.8(M22)	Measurement and calculation
Nitzschia longissima	1.65(K8a)	Measurement and calculation
Navicula	95.2(K2b)	Measurement and calculation
Navicula	24.1(M22)	Measurement and calculation
Mastogloia rostrata	1195.3(K2b)	Measurement and calculation
Mastogloia rostrata	1035.9(M22)	Measurement and calculation
Leptocylindrus danicus	1150.3(K2b)	Measurement and calculation

Leptocylindrus danicus	3609.4(K8a)	Measurement and calculation
Hemiaulus	601.2(K2b)	Measurement and calculation
Hemiaulus	2035.4(M22)	Measurement and calculation
Hemiaulus hauckii	601.2(K2b)	Measurement and calculation
Hemiaulus hauckii	2035.4(M22)	Measurement and calculation
Haslea	51.2(K2b)	Measurement and calculation
Haslea	74.3(M22)	Measurement and calculation
Guinardia striata	1290	Harrison et al., 2015
Guinardia flaccida	4870	Harrison et al., 2015
Eunotogramma	44.49	Measurement and calculation
Eucampia	441	Harrison et al., 2015
Eucampia zodiacus	441	Harrison et al., 2015
Eucampia cornuta	441	Harrison et al., 2015
Ditylum brightwelii	3645.8(M22)	Measurement and calculation
Coscinodiscus	633.4(K2b)	Measurement and calculation
Chaetoceros	37.4(K2b)	Measurement and calculation
Chaetoceros	54.1(M22)	Measurement and calculation
Chaetoceros pelagicus	176.3	Harrison et al., 2015
Cerataulina pelagica	452	Harrison et al., 2015
Bellerochea horologicalis	1140	Harrison et al., 2015
Bacteriastrum	111.3(K2b)	Measurement and calculation
Bacteriastrum	314.7(M22)	Measurement and calculation
Asteromphalus	525.6(K2b)	Measurement and calculation
Asteromphalus Arachne	1218.4(K2b)	Measurement and calculation
Asterolampra	355.0(K2b)	Measurement and calculation
Asterolampra	314.3(M22)	Measurement and calculation
Asterolampra vanheurckii	314.3(M22)	Measurement and calculation
Asterionella	46.2	Harrison et al., 2015
Ampora	1.9(K2b)	Measurement and calculation
Ampora	10.3(M22)	Measurement and calculation

Note：Differences in carbon biomass resulting from station - specific variations in the average cell size of the same genus is indicated by annotating biomass values with their corresponding station sources.

Table S3 Estimated carbon biomass for investigated stations

Estimated carbon biomass (Mean ± SD)					
Stations	Water (ng C L^{-1})			Trap (μg C m^{-2} L^{-1})	
	Depth	Summer	Winter	depth	Summer
K2b	5m	85.24±3.47		50m	313.03±4.13
	DCM	43.42±9.06		100m	12.98±0.40
	200m	14.95±0.65		200m	77.71±1.03
K8a	5m	8.15±0.37	44.22±1.20	50m	0.11±0.01
	DCM	13.30±0.76	8.20±1.41	100m	0.32±0.005
	200m	6.59±0.43	5.71±0.57	200m	1.87±0.07
M22	5m	34.69±0.47	69.55±1.00	50m	8.28±0.66
	DCM	83.24±0.71	23.70±5.63	100m	2.79±0.44
	200m	11.28±4.03	25.79±0.11	200m	0.77±0.22
WPS	5m	1.34±0.28			
	DCM	1.76±0.95			
	200m	4.64±0.87			
M35	5m	22.15±4.40			
	DCM	491.36±25.40			
	200m	4.36±1.29			

Table S4 Proportion of dominant species based on carbon biomass across sampling stations and corresponding depth layers

Stations / Species	Water			Trap		
K2b	5m（85.24 ng C/L）	DCM（43.42 ng C/L）	200m（14.95 ng C/L）	50m（313.03 μg C m^{-2} d^{-1}）	100m（12.98 μg C m^{-2} d^{-1}）	200m（77.71 μg C m^{-2} d^{-1}）
Rhizosolenia	67%	33%	95%	76%	67%	66%
Mastogloia rostrata	21%	0	0	22%	28%	20%
Thalassiosira	0	30%	0	0	0	0
Nitzschia	0	14%	5%	0	2%	1%
K8a	5m（8.15 ng C/L）	DCM（13.3 ng C/L）	200m（6.59 ng C/L）	50m（0.11 μg C m^{-2} d^{-1}）	100m（0.32 μg C m^{-2} d^{-1}）	200m（1.87 μg C m^{-2} d^{-1}）
Thalassiosira	62%	57%	76%	0	79%	32%
Hemiaulus	33%	0	0	0	0	0
Navicula	0	20%	16%	17%	5%	14%
Thalassiothrix	0	16%	0	0	0	0
Mastogloia rostrata	0	0	0	82%	0	5%
Rhizosolenia	0	0	0	0	0	19%
Asteromphalus arachne	0	0	0	0	0	20%
M22	5m（34.69 ng C/L）	DCM（83.24 ng C/L）	200m（11.28 ng C/L）	50m（8.28 μg C m^{-2} d^{-1}）	100m（2.79 μg C m^{-2} d^{-1}）	200m（0.77 μg C m^{-2} d^{-1}）
Rhizosolenia	74%	0	50%	0	17%	0
Hemiaulus	18%	0	0	58%	12%	45%
Ditylum	0	75%	0	0	0	0
Planktoniella formosa	0	20%	0	0	0	0
Nitzschia	0	0	27%	4%	12%	22%
Mastogloia rostrata	6%	0	0	34%	32%	0
Pinnularia	0	0	11%	1%	11%	13%

Table S5 Alpha diversity index of the diatom community based on carbon biomass in summer

Sample sites	Richness	Pielou	Simpson
K2b_5m	6	0.79	0.73
K2b_DCM	9	0.77	0.77
K2b_200m	2	0.64	0.27
WPS_5m	2	0.92	0.44
WPS_DCM	2	0.91	0.44
WPS_200m	4	0.61	0.42
M22_5m	11	0.51	0.61
M22_DCM	10	0.33	0.40
M22_200m	9	0.34	0.40
K8a_5m	5	0.52	0.51
K8a_DCM	5	0.53	0.51
K8a_200m	6	0.71	0.68
M35_5m	6	0.78	0.68
M35_DCM	19	0.80	0.87
M35_200m	4	0.53	0.41

Table S6 Alpha diversity index of the diatom community based on carbon biomass in winter

Sample sites	Richness	Pielou	Simpson
M22_5m	7	0.55	0.42
M22_DCM	7	0.67	0.60
M22_200m	4	0.58	0.52
K8a_5m	10	0.70	0.72
K8a_DCM	6	0.92	0.79
K8a_200m	6	0.75	0.68

Table S7 Dominant species, based on cell abundance, contributing to export Flux

Dominant species of each station	Flux of intact cells (cells m^{-2} d^{-1})		
	K2b 50m	K2b 100m	K2b 200m
Rhizosolenia	83227	3567	18004
Nitzschia	49257	6964	17325
Mastogloia rostrata	57749	3057	12909
Bellerochea horologicalis	0	0	5775
Thalassionema nitzschioides	0	1189	3397
	M22 50m	M22 100m	M22 200m
Nitzschia	15966	17495	8832
Thalassionema nitzschioides	340	1868	849
Navicula	7304	1359	679
Thalassiosira	0	0	170
Pinnularia	170	510	170
	K8a 50m	K8a 100m	K8a 200m
Nitzschia s	679	510	3907
Navicula	170	170	2378
Thalassiosira	0	510	849
Mastogloia rostrata	340	0	340
Thalassionema	0	0	340

Table S8 The contribution of diatom carbon production to total phytoplankton carbon production in the water column

Station	Depth	Carbon content of diatoms (ng C L^{-1})	Carbon content of total phytoplankton (mg C L^{-1})	The percentage of diatom carbon in total phytoplankton carbon (%)
K2b	5	85.24	4.24	2.1
K2b	DCM	43.42	3.14	1.4
K2b	200	14.95	3.54	0.4
M22	5	34.69	2.38	1.5
M22	DCM	83.24	3.14	2.7
M22	200	11.28	1.59	0.7
K8a	5	8.15	1.13	0.7
K8a	DCM	13.30	3.10	0.4
K8a	200	6.59	0.92	0.7

Table S9 The contribution of diatom carbon export to total phytoplankton carbon export

Station	Depth	Carbon content of diatoms (μg C $m^{-2}d^{-1}$)	Carbon content of total phytoplankton (mg C m^{-2} d^{-1})	The percentage of diatom carbon in total phytoplankton carbon (%)
K2b	50	313.03	0.97	32.2
K2b	100	12.98	0.05	26.0
K2b	200	77.71	0.30	25.9
M22	50	8.28	0.28	3.0
M22	100	2.61	0.11	2.4
M22	200	0.77	0.10	0.8
K8a	50	0.11	0.66	0.02
K8a	100	0.32	0.09	0.4
K8a	200	1.87	0.18	1.0