

Supplementary Material

**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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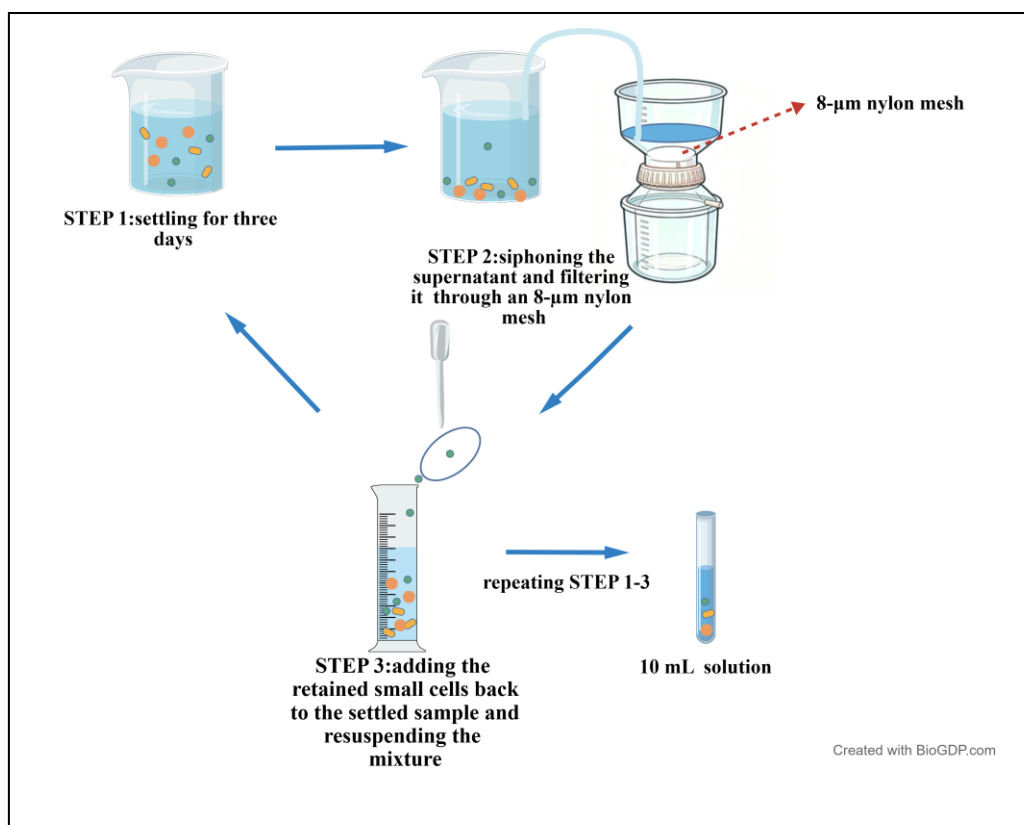


Fig.S1. Flow diagram of the diatom concentration procedure. The process involves four main steps: (1) settling the sample for three days; (2) siphoning the supernatant and filtering it through an 8- μ m nylon mesh; (3) adding the retained small cells back to the settled sample and resuspending the mixture;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

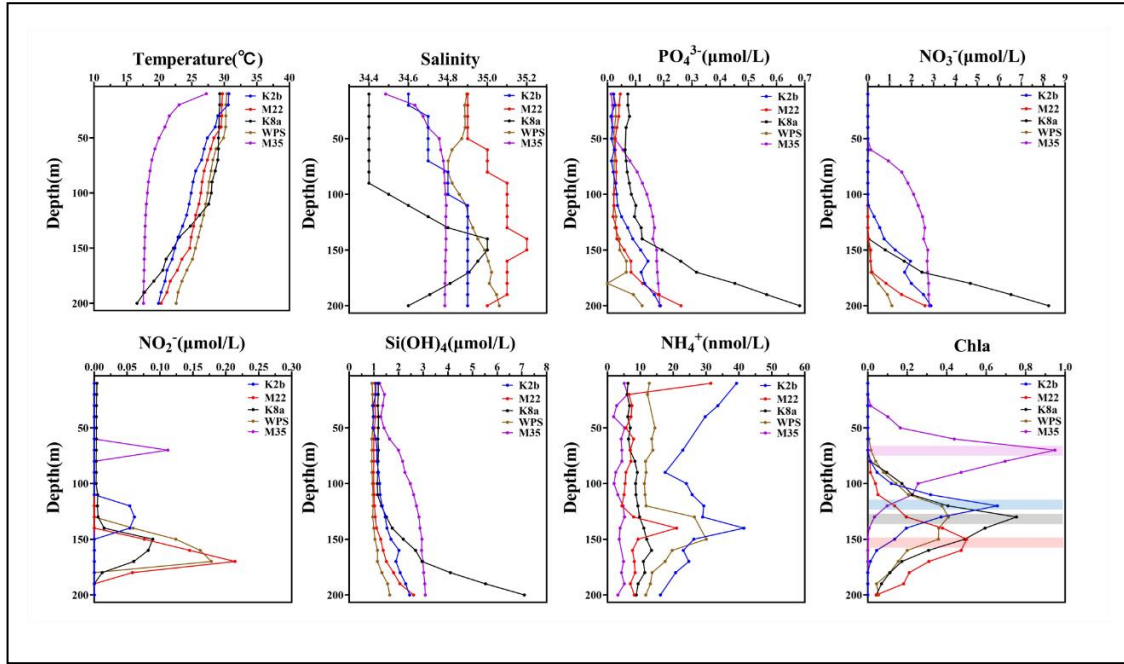


Fig. S2 Vertical profiles of temperature, salinity, nutrients, and chlorophyll-a within the 0-200 m layer during summer season. In the Chla graph, the strip-shaped color blocks represent the approximate positions of the DCM layer at different stations. The depths of the DCM at stations K8b and WPS almost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

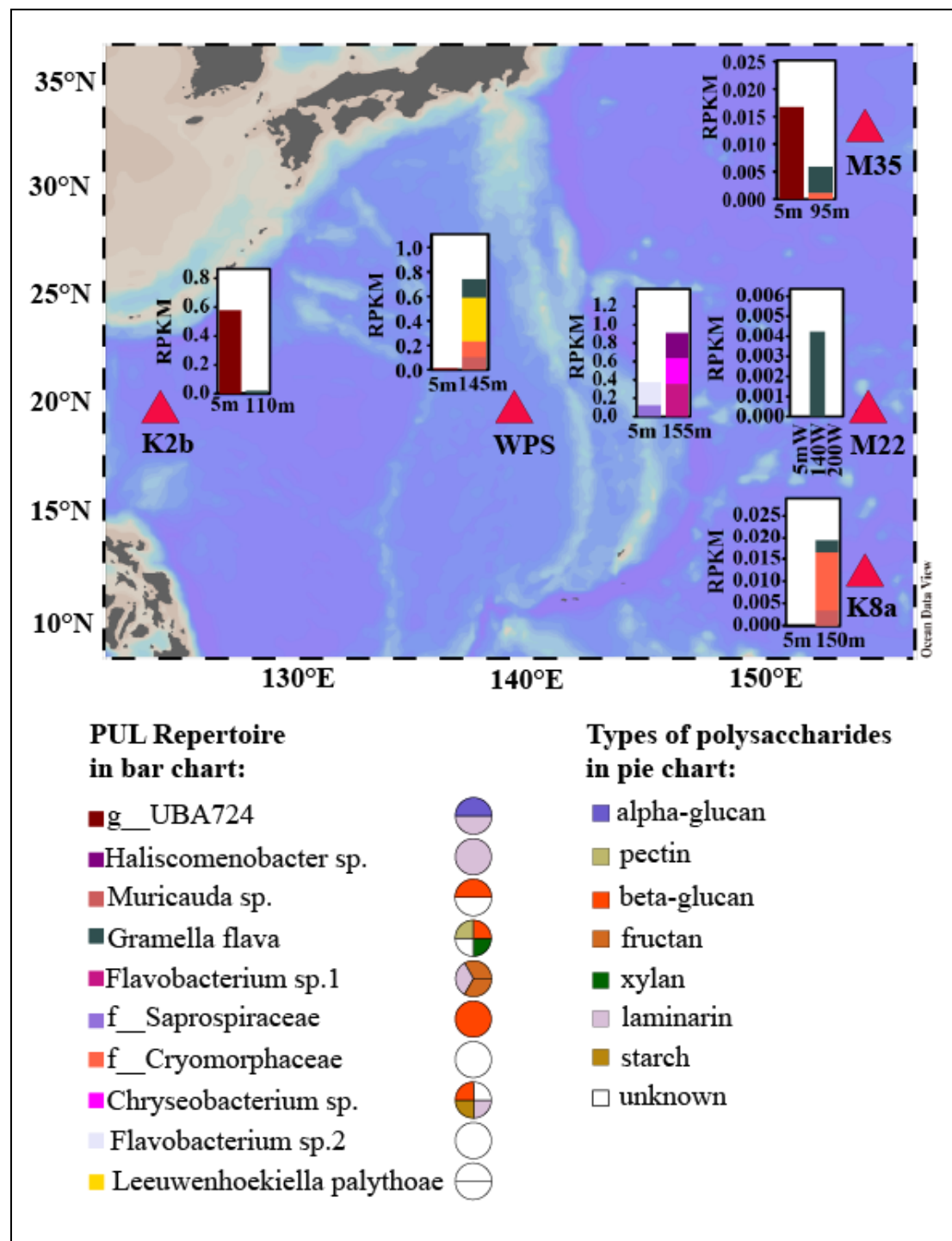


Fig. S3 Abundance pattern of Bacteroidetes MAGs with PUL annotations. In all bar charts, MAG abundance is represented by RPKM. The pie chart partitions reflect the quantity of PULs possessed by the bacteria, with colors corresponding to the types of polysaccharides that may be degraded. MAGs, metagenome-assembled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

38

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

39 Note: “-” indicates unavailable samples.

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

43

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
<i>Thalassiothrix</i>	140.2(K2b)	Measurement and calculation
<i>Thalassiothrix</i>	157.3(M22)	Measurement and calculation
<i>Thalassiosira</i>	373.3(K2b)	Measurement and calculation
<i>Thalassiosira</i>	170.0(M22)	Measurement and calculation
<i>Thalassiosira</i>	502.4(K8a)	Measurement and calculation
<i>Thalassiosira pacifica</i>	373.3(K2b)	Measurement and calculation
<i>Thalassiosira pacifica</i>	170.0(M22)	Measurement and calculation
<i>Thalassiosira pacifica</i>	502.4(K8a)	Measurement and calculation
<i>Thalassionema</i>	89.5(K2b)	Measurement and calculation
<i>Thalassionema</i>	72.9(M22)	Measurement and calculation
<i>Thalassionema nitzschioides</i>	91.1(K2b)	Measurement and calculation
<i>Thalassionema nitzschioides</i>	104.3(M22)	Measurement and calculation
<i>Thalassionema frauenfeldii</i>	89.5(K2b)	Measurement and calculation
<i>Thalassionema frauenfeldii</i>	72.9(M22)	Measurement and calculation
<i>Synedra</i>	2176.6	Measurement and calculation
<i>Rhizosolenia</i>	2842.9	Measurement and calculation
<i>Rhizosolenia styliformis</i>	2842.9	Measurement and calculation
<i>Rhizosolenia imbricata</i>	2842.9	Measurement and calculation
<i>Rhizosolenia hyalina</i>	2842.9	Measurement and calculation
<i>Rhizosolenia clevei</i>	2842.9	Measurement and calculation
<i>Pseudo-nitzschia pungens</i>	86.9	Harrison et al., 2015
<i>Protoraphis</i>	19.1	Measurement and calculation
<i>Pleurosigma</i>	195.5(K2b)	Measurement and calculation
<i>Planktoniella</i>	8351.2	Chitari et al., 2017
<i>Planktoniella formosa</i>	8351.2	Chitari et al., 2018
<i>Pinnularia</i>	590	Rath et al., 2023
<i>Nitzschia</i>	36.6(K2b)	Measurement and calculation
<i>Nitzschia</i>	18.8(M22)	Measurement and calculation
<i>Nitzschia</i>	1.65(K8a)	Measurement and calculation
<i>Nitzschia lorenziana</i>	36.6(K2b)	Measurement and calculation
<i>Nitzschia lorenziana</i>	18.8(M22)	Measurement and calculation
<i>Nitzschia lorenziana</i>	1.65(K8a)	Measurement and calculation
<i>Nitzschia longissima</i>	36.6(K2b)	Measurement and calculation
<i>Nitzschia longissima</i>	18.8(M22)	Measurement and calculation
<i>Nitzschia longissima</i>	1.65(K8a)	Measurement and calculation
<i>Navicula</i>	95.2(K2b)	Measurement and calculation
<i>Navicula</i>	24.1(M22)	Measurement and calculation
<i>Mastogloia rostrata</i>	1195.3(K2b)	Measurement and calculation
<i>Mastogloia rostrata</i>	1035.9(M22)	Measurement and calculation
<i>Leptocylindrus danicus</i>	1150.3(K2b)	Measurement and calculation

<i>Leptocylindrus danicus</i>	3609.4(K8a)	Measurement and calculation
<i>Hemiaulus</i>	601.2(K2b)	Measurement and calculation
<i>Hemiaulus</i>	2035.4(M22)	Measurement and calculation
<i>Hemiaulus hauckii</i>	601.2(K2b)	Measurement and calculation
<i>Hemiaulus hauckii</i>	2035.4(M22)	Measurement and calculation
<i>Haslea</i>	51.2(K2b)	Measurement and calculation
<i>Haslea</i>	74.3(M22)	Measurement and calculation
<i>Guinardia striata</i>	1290	Harrison et al., 2015
<i>Guinardia flaccida</i>	4870	Harrison et al., 2015
<i>Eunotogramma</i>	44.49	Measurement and calculation
<i>Eucampia</i>	441	Harrison et al., 2015
<i>Eucampia zodiacus</i>	441	Harrison et al., 2015
<i>Eucampia cornuta</i>	441	Harrison et al., 2015
<i>Ditylum brightwellii</i>	3645.8(M22)	Measurement and calculation
<i>Coscinodiscus</i>	633.4(K2b)	Measurement and calculation
<i>Chaetoceros</i>	37.4(K2b)	Measurement and calculation
<i>Chaetoceros</i>	54.1(M22)	Measurement and calculation
<i>Chaetoceros pelagicus</i>	176.3	Harrison et al., 2015
<i>Cerataulina pelagica</i>	452	Harrison et al., 2015
<i>Bellerochea horologicalis</i>	1140	Harrison et al., 2015
<i>Bacteriastrum</i>	111.3(K2b)	Measurement and calculation
<i>Bacteriastrum</i>	314.7(M22)	Measurement and calculation
<i>Asteromphalus</i>	525.6(K2b)	Measurement and calculation
<i>Asteromphalus Arachne</i>	1218.4(K2b)	Measurement and calculation
<i>Asterolampra</i>	355.0(K2b)	Measurement and calculation
<i>Asterolampra</i>	314.3(M22)	Measurement and calculation
<i>Asterolampra vanheurckii</i>	314.3(M22)	Measurement and calculation
<i>Asterionella</i>	46.2	Harrison et al., 2015
<i>Ampora</i>	1.9(K2b)	Measurement and calculation
<i>Ampora</i>	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 $\pm$ SD)					
Stations	Water (ng C L ⁻¹)			Trap (μ g C m ⁻² L ⁻¹)	
	Depth	Summer	Winter	depth	Summer
K2b	5m	85.24 $\pm$ 3.47		50m	313.03 $\pm$ 4.13
	DCM	43.42 $\pm$ 9.06		100m	12.98 $\pm$ 0.40
	200m	14.95 $\pm$ 0.65		200m	77.71 $\pm$ 1.03
K8a	5m	8.15 $\pm$ 0.37	44.22 $\pm$ 1.20	50m	0.11 $\pm$ 0.01
	DCM	13.30 $\pm$ 0.76	8.20 $\pm$ 1.41	100m	0.32 $\pm$ 0.005
	200m	6.59 $\pm$ 0.43	5.71 $\pm$ 0.57	200m	1.87 $\pm$ 0.07
M22	5m	34.69 $\pm$ 0.47	69.55 $\pm$ 1.00	50m	8.28 $\pm$ 0.66
	DCM	83.24 $\pm$ 0.71	23.70 $\pm$ 5.63	100m	2.79 $\pm$ 0.44
	200m	11.28 $\pm$ 4.03	25.79 $\pm$ 0.11	200m	0.77 $\pm$ 0.22
WPS	5m	1.34 $\pm$ 0.28			
	DCM	1.76 $\pm$ 0.95			
	200m	4.64 $\pm$ 0.87			
M35	5m	22.15 $\pm$ 4.40			
	DCM	491.36 $\pm$ 25.40			
	200m	4.36 $\pm$ 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 $\mu\text{g C m}^{-2}$ d^{-1})	100m (12.98 $\mu\text{g C m}^{-2}$ d^{-1})	200m (77.71 $\mu\text{g C m}^{-2}$ d^{-1})
<i>Rhizosolenia</i>	67%	33%	95%	76%	67%	66%
<i>Mastogloia rostrata</i>	21%	0	0	22%	28%	20%
<i>Thalassiosira</i>	0	30%	0	0	0	0
<i>Nitzschia</i>	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 $\mu\text{g C m}^{-2}$ d^{-1})	100m (0.32 $\mu\text{g C m}^{-2}$ d^{-1})	200m (1.87 $\mu\text{g C m}^{-2}$ d^{-1})
<i>Thalassiosira</i>	62%	57%	76%	0	79%	32%
<i>Hemiaulus</i>	33%	0	0	0	0	0
<i>Navicula</i>	0	20%	16%	17%	5%	14%
<i>Thalassiothrix</i>	0	16%	0	0	0	0
<i>Mastogloia rostrata</i>	0	0	0	82%	0	5%
<i>Rhizosolenia</i>	0	0	0	0	0	19%
<i>Asteromphalus arachne</i>	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 $\mu\text{g C m}^{-2}$ d^{-1})	100m (2.79 $\mu\text{g C m}^{-2}$ d^{-1})	200m (0.77 $\mu\text{g C m}^{-2}$ d^{-1})
<i>Rhizosolenia</i>	74%	0	50%	0	17%	0
<i>Hemiaulus</i>	18%	0	0	58%	12%	45%
<i>Ditylum</i>	0	75%	0	0	0	0
<i>Planktoniella formosa</i>	0	20%	0	0	0	0
<i>Nitzschia</i>	0	0	27%	4%	12%	22%
<i>Mastogloia rostrata</i>	6%	0	0	34%	32%	0
<i>Pinnularia</i>	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

59 **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

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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
<i>Rhizosolenia</i>	83227	3567	18004
<i>Nitzschia</i>	49257	6964	17325
<i>Mastogloia rostrata</i>	57749	3057	12909
<i>Bellerochea horologicalis</i>	0	0	5775
<i>Thalassionema nitzschioides</i>	0	1189	3397
	M22 50m	M22 100m	M22 200m
<i>Nitzschia</i>	15966	17495	8832
<i>Thalassionema nitzschioides</i>	340	1868	849
<i>Navicula</i>	7304	1359	679
<i>Thalassiosira</i>	0	0	170
<i>Pinnularia</i>	170	510	170
	K8a 50m	K8a 100m	K8a 200m
<i>Nitzschia s</i>	679	510	3907
<i>Navicula</i>	170	170	2378
<i>Thalassiosira</i>	0	510	849
<i>Mastogloia rostrata</i>	340	0	340
<i>Thalassionema</i>	0	0	340

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64 **Table S8 The contribution of diatom carbon production to total phytoplankton carbon**
65 **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

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

Station	Depth	Carbon content of diatoms ($\mu\text{g C m}^{-2}\text{d}^{-1}$)	Carbon content of total phytoplankton ($\text{mg C m}^{-2} \text{d}^{-1}$)	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

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