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Supporting Information for

Unraveling Phytoplankton Community Dynamics in the Northern Chukchi Sea under Sea-Ice -Covered and Sea-Ice-Free Conditions

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Introduction

The supporting information includes supplementary text for the methods section the provides further detail regarding the identification and quantification of phytoplankton using the Imaging FlowCytobot (IFCB) and Accuri C6 flow cytometer and text for the results and discussion section the provides further detail regarding size class groupings of nanophytoplankton and picophytoplankton. The supporting information also includes tables that are referenced within the main text. These tables include the abbreviations for the phytoplankton taxonomic and environmental parameter data, summary statistics associated with the Canonical Correspondence Analysis and summary data for each environmental parameter.

Text S1

A detailed discussion of IFCB data analysis and processing is described in Laney and Sosik (2014) and Selz et al. (2017). Briefly, microphytoplankton abundances (particles above 8 μm) were estimated using the IFCB. Digital micrographs collected by the IFCB were classified manually and by supervised machine learning. Picophytoplankton from 2-14 um were analyzed using the Accuri C6 flow cytometer. The size range of nanophytoplankton falls between 2-20um, which overlaps with the size thresholds of both the Accuri and IFCB. Therefore, the data from both instruments were merged so that smaller nanophytoplankton (2-10 μm) were estimated using data from the Accuri C6 and larger nanophytoplankton (10-20 μm) were estimated using data from the IFCB.

Text S2.

It is important to note that grouping by size class does have some limitations. Because nano- and picophytoplankton combine different taxa into generic size classes, we cannot determine what taxonomic differences may have occurred between sea-ice-cover and sea-ice-free conditions. The size relationship works well between size and the same phytoplankton type. However, this relationship falls apart when different phytoplankton types are combined in the same size class (e.g., here, picoeukaryotes and cyanobacteria are categorized as picophytoplankton), as these taxa have different traits, such as nutrient requirements and function within the environment. Size class based solely on cell size, tells us little about phytoplankton taxonomy, but they can still play an important role in establishing a relationship between phytoplankton size, carbon fixation (Huete-Ortega et al., 2012) and sinking velocities (Bach et al., 2012). Although nano- and picophytoplankton are present throughout the study site, the actual species composition within these classes may be changing. Therefore, we must be cautious when interpreting size class data such as these.

Abbreviation	Taxon	Functional Type or Size Class	Abbreviation	Taxon	Functional Type or Size Class
Bact	*Bacteriosira*	Diatom	**Nav**	*Navicula*	Diatom
Chaet	*Chaetoceros*	Diatom	**Odon**	*Odontella*	Diatom
Cosc	*Coscinodiscus*	Diatom	**Phaeo**	*Phaeocystis*	Haptophyte
Cylin	*Cylindrotheca*	Diatom	**PhaeoD**	*Phaeocystis with* Diatoms	Diatoms attached to colonies
Deto	*Detonula*	Diatom	**Pico**	Autotrophic Picoplankton	Pico-eukaryotes and cyanobacteria
Dict	*Dictyocha*	Silicoflagellate	**Pleuro**	*Pleurosigma*	Diatom
Dinob	*Dinobryon*	Golden alga	**Polar**	*Polarella*	Dinoflagellate
Ephe	*Ephemera*	Diatom	**Pseud**	*Pseudonitzschia*	Diatom
Euc	*Eucampia*	Diatom	**Pyram**	*Pyramimonas*	Green alga
Frag	*Fragilariopsis*	Diatom	**Rhizo**	*Rhizoselenia*	Diatom
Lepto	*Leptocylindrus*	Diatom	**Thaln**	*Thalassionema*	Diatom
Melo	*Melosira*	Diatom	**Thals**	*Thalassiosira*	Diatom
Nano	Nanophytoplankton	Nano-eukaryotes	**Uncdino**	Unclassified Dinoflagellates	Dinoflagellates
Nitz	*Nitzschia frigida*	Diatom	**UncPen**	Unclassified Pennates	Diatom

Table S1. Abbreviations for the phytoplankton taxonomy classifications and associated functional type or size class category.

Abbreviation	Description
Density	Sigma-theta, potential density
Depth	Depth
DIN	Total Dissolved Inorganic Nitrogen (NO_3 + NO_2 + NH_4)
ICE presence	Ice index
Light	Photosynthetically available radiation
P	Phosphate
Salinity	Salinity
Si	Silicate
Temp	Temperature

Table S2. Environmental variables and associated abbreviations included in CCA and PCA.

	Axis				*Total Inertia*
	1	2	3	4	
Eigenvalues	0.192	0.045	0.022	0.009	
Species-environmental Correlation	0.793	0.508	0.627	0.472	0.857
Cumulative % variance of species data	22.4	27.3	29.8	30.6	
Cumulative % variance of species-environmental relationship	70.6	86.1	94.2	96.4	
Sum of all Canonical Eigenvalues					0.2612 F=19.1 P=0.002

Table S3a. Summary statistics, significance and explained variation, determined from CCA.

Environmental variable	% variation explained	Cumulative contribution %	Adjusted P value
Si	15.9	50.1	0.018
Temp	5.3	16.6	0.018
Depth	2.4	7.7	0.018
Salinity	2.5	7.8	0.018
ICE presence	1.8	5.6	0.018
Density	1.3	4.1	0.018

Table S3b. Significance and explained variation for the Interactive stepwise CCA.

Parameter	Mean and range of variation	Mean and range of variation-PGA	Mean and range of variation-PGB	Mean and range of variation-PGC
Depths sampled (m)	32.3 (1.4–202.2)	38.5 (1.9–151.6)	33.4 (2.0–108.7)	29.3 (1.4–202.2)
Fraction of surface PAR	0.246 (undet.–28.820)	0.101 (undet–1.39)	0.094 (undet.–1.28)	0.381(undet–5.918)
Chl a (mg/m^3)	3.336 (0.002–32.840)	8.093 (0.037–32.840)	7.332 (0.204 –28.95)	0.462 (0.002–7.090)
DIN (mmol/m^3)	6.50 (undet. –89.08)	12.00 (undet–21.88)	12.18 (undet.–63.12)	3.102 (undet–72.77)
PO_4 (mmol/m^3)	1.09 (0.01–3.86)	1.61 (0.49– 2.50)	1.58 (0.54 –2.93)	0.750 (0.01–2.52)
SiO_3 (mmol/m^3)	16.22 (0.43–59.2)	36.92 (2.71–59.2)	25.45 (0.92 –57.81)	6.30 (0.43–42.69)
Temperature (°C)	-0.171 (-1.778 –7.264)	-1.620 (-1.778–-0.143	-1.260 (-1.764 –3.544)	0.906 (-1.675–7.264)
Salinity (PSU)	31.301 (24.642 – 34.556)	32.314 (29.834–34.442)	32.276 (29.784 – 33.378)	30.532 (24.642 –34.556)
SigmaT (kg/m^3)	25.098 (19.765-27.747)	25.992 (23.997–27.663)	25.948 (23.928 – 26.860)	24.410 (19.765 –27.747)
Phytoplankton Carbon (μg/L)	35.912 (0.001–1002.251)	83.980 (1.210–161.780)	99.544 (4.012 –1002.251)	12.260 (0.002–46.280)

Table S4. Mean and range of variation for each of the measured environmental variables and carbon abundance for all samples as well as those collected in regions at which each of the phytoplankton groups: PGA, PGB and PGC, were observed. Mean carbon abundances for each phytoplankton group were computed based on the clustered sample scores and associated taxon scores across the CCA axes.