Supplementary information

Ecological responses of core phytoplankton by latitudinal differences in the Arctic Ocean in late summer revealed by 18S rDNA metabarcoding

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Running title: Phytoplankton dynamics in summer Arctic Ocean



Figure S1. Nonmetric multidimensional scaling (nMDS) plots by the Bray–Curtis dissimilarity method using environmental factors.

Table S1. Sampling information in the Arctic Ocean from late summer seasons during 2015-2019. A total of 70 investigation sites during the ARA06B, 07B, 09B, and 10B cruises using the South Korean ice breaker research vessel Araon.

		Depth of	Dauth	Depth Sampling date (m) (Local)	Sampling Time (Local)	Location	
Cruise No.	Site Name	SCM layer (m)	(m)			Latitude (N)	Longitude (W)
	06B-10SCM	30	39	03-Aug-15	17:00	70.50000	168.6667
	06B-10S 06B-14SCM	0 42	200	04.4 15	22.50	74 707 (7	167.0010
	06B-14S	0	200	04-Aug-15	22:50	/4./9/6/	167.9012
	06B-19SCM	0	145	07-Aug-15	07:30	75.00000	173.5963
	06B-23SCM	45	1125	09-Aug-15	12:00	77.99633	173.2252
ARA06B	06B-26SCM	45	2710	10-Aug-15	22:50	80 77500	172 8972
	06B-26S 06B-03SCM	0 9	2710	10-740g-15	22.50	00.77500	172.0772
	06B-03S	0	48	02-Aug-15	13:30	67.33317	168.8342
	06B-31SCM 06B-31S	<u>60</u> 0	263	16-Aug-18	07:40	77.47250	164.1175
	06B-39SCM	55	269	20-Aug-15	07:15	75.70883	166.8723
	07B-01SCM	10	44	05-Aug-16	20.25	65 17333	168 6910
	07B-01S 07B-10SCM	0 35		05 Hug 10	20.25	05.17555	100.0910
	07B-10S	0	39	07-Aug-16	16:50	70.50000	168.6665
	07B-12SCM 07B-12S	35 0	55	08-Aug-16	05:40	72.35983	168.6665
	07B-14SCM	45	223	09-Aug-16	07:50	74.79850	167.8097
	07B-19SCM	30	277	11-Aug-16	23:00	76.00850	173 5427
	07B-19S 07B-02SCM	0	211	11-740g-10	25.00	70.00050	175.5427
	07B-02S	0	43	06-Aug-16	07:10	66.62967	168.6872
ARA07B	07B-20SCM 07B-20S	27 0	1223	12-Aug-16	11:10	77.01967	176.6978
	07B-21SCM	32	1693	12-Aug-16	22:00	78.01117	177.3488
	07B-21S 07B-22SCM	32	1769	13-Aug-16	11:00	78 53700	176 9310
	07B-22S 07B-29SCM	0 62	1705	15 Mag 10	11.00	10.55700	170.9510
	07B-29S	0	275	18-Aug-16	18:30	77.43317	164.1163
	07B-03SCM 07B-03S	25 0	50	06-Aug-16	15:50	67.67000	168.9600
	07B-30SCM 07B-30S	56	987	19-Aug-16	03:00	76.57217	165.3352
	07B-31SCM	47	278	19-Aug-16	13.10	75 71083	166 8147
	07B-31S 09B-11SCM	0 34	2/0	19 14 10	15.10		100.0147
	09B-11S	0	761	10-Aug-18	13:55	77.01250	173.6297
	09B-12SCM 09B-12S	0	256	11-Aug-18	01:22	75.99350	173.5820
	09B-14SCM	8	47	12-Aug-18	01:20	73.97933	169.9702
	09B-145	17	336	14-Aug-18	08:50	75 15600	175 9643
ARA09B	09B-18S 09B-02SCM	0 34			00.20		
	09B-02S	0	125	06-Aug-18	19:10	73.57717	168.2857
	09B-23SCM 09B-23S	0	1780	20-Aug-18	00:30	78.94750	164.6412
	09B-05SCM	50	2122	07-Aug-18	20:10	75.50167	161.1272
	09B-08SCM	38	2076	09-Aug-18	06:25	76.00100	175 5598
	09B-08S 10B-01SCM	0 12	2070	07 Hug 10	00.25	70.00100	115.5590
	10B-01S	0	37	05-Aug-19	15:45	62.99983	168.1500
AD 4 10D	10B-11SCM 10B-11S	<u> </u>	39	08-Aug-19	04:01	70.49983	168.6663
ARA10B	10B-14SCM	27	176	09-Aug-19	02:31	73.88867	168.2000
	10B-19SCM	50	3452	15-Aug-19	12.00	79,48550	160,9928
	10B-19S	0					

	10B-23SCM	38	285	18-Aug-19	16:38	75.69117	166.6380
	10B-23S	0					
	10B-04SCM	10	51	06-Aug-19	19:55	67.66983	168.9598
	10B-04S	0					

Table S2. Experimental information for amplification of V4-V5 regions in 18s rDNA in the Arctic Ocean from late summer seasons during 2015-2019.

Target region	G () .	Primer		PCR reaction		D	
	Step	Forward	Reverse	mixtures (25-µL)	PCK condition	Reference	
18s rDNA (V4-V5 region)	First PCR	Ilumina preadapter ±Sequencing primer sequence± TAReuk454F WD1 (5'- CCAGCASC YGCGGTAA TTGG-3')	Ilumina preadapter ±Sequencing primer sequence±TA ReukREV3 (5'-ACTTTC GTTCTTGA TYRA-3')	200 μ mol L ⁻¹ each dNTP, 1.5 mmol L ⁻¹ MgCl ₂ , 0.3 μ mol L ⁻¹ each primer, 2.5 U Taq DNA polymerase (TaKaRa, EX Taq, Kyoto, Japan), and DNA template (20 ng μ L ⁻¹)	initial denaturation step at 95°C for 3 min, followed by 35 cycles of denaturation at 95°C for 10 s, annealing at 52°C for 45 s, and extension at 72°C for 1 min, and a final extension step of 72°C for 5 min.		
	Second PCR	Ilumina preadapter ±Sequencing primer sequence± TAReuk454F WD1 (5'- CCAGCASC YGCGGTAA TTGG-3')	Ilumina preadapter ±Sequencing primer sequence±TA ReukREV3 (5'-ACTTTC GTTCTTGA TYRA-3')	200 μmol L ⁻¹ each dNTP, 1.5 mmol L ⁻¹ MgCl ₂ , 0.3 μmol L ⁻¹ each primer, 2.5 U Taq DNA polymerase (TaKaRa, EX Taq, Kyoto, Japan), DNA template (600 ng), and Nextera XT index Kit (Illumina, CA, USA)	initial denaturation step at 95°C for 3 min, followed by 12 cycles of denaturation at 95°C for 10 s, annealing at 52°C for 45 s, and extension at 72°C for 1 min, and a final extension step of 72°C for 5 min.	(Stoeck et al., 2010;Jung et al., 2018)	
	Pooling	Triplicate read PCR purificatio	ction products (sai n Kit (No. 28104, io-analyzer 2100 (me amount) were pooled and p Qiagen Inc.). Their DNA cond Agilent Technologies, Palo A	purified using a Qiaquick centration was measured in		

Table S3. Summary of V4-V5 regions in 18s rDNA metabarcoding analysis and alpha diversity indices in the Arctic Ocean from late summer seasons during 2015-2019. Two groups and 06B-10SCM were determined based on the nMDS result (Fig. 3b).

Group	Total Bases	Read Count (97%)	Good's Coverage	
Lower latitudes (<74°N)	54,922,936±27,943,905	67,879±32,595	0.999±0.000	
Higher latitudes (>74°N)	47,776,496±22,837,165	53,603±25,916	0.999±0.010	
06B-10SCM	18,601,090	25,285	0.999	

Table S4. Classification Information of common phytoplankton operational taxonomic units (OTUs) in theArctic Ocean from late summer seasons during 2015-2019.

OTU	Phylum	Class	Order	Family	Identified species	% Identity	Access. No.	
#118			Thalassiophysales	Catenulaceae	Amphora sp.1	95.6	MK656308	
#135		Bacillario-	Naviculales	Naviculaceae	Seminavis obtusiuscula	98.4	MN382133	
#061		phyceae	5	Bacillariaceae	Nitzschia biundulata	98.8	MK330221	
#028			Bacillariales		Fragilariopsis kerguelensis	98.8	LR812489	
#020					Chaetoceros sp.	97.4	MH843674	
#003				Chaetocerotaceae	Chaetoceros gelidus	99.7	KT88447	
#089			Chaetocerotales		Chaetoceros contortus	99.7	MG972222	
#015	Bacillarionhyta	Mediophyceae		Leptocylindraceae	Leptocylindrus danicus	95	MZ546209	
#033	Daemanophyta		Thalassiosirales	Thalassiosiraceae	Thalassiosira sp.	99.5	MH011738	
#037			Cymatosirales	Cymatosiraceae	Brockmanniella brockmannii	100	KY979974	
#075			Anaulales	Anaulaceae	Eunotogramma lunatum	91.1	MN917237	
#053		Coscinodisco- phyceae	Melosirales	Melosiraceae	Melosira arctica var. krembsii	99.1	MZ546210	
#018		-	-	-	Uncultured diatom1	99.5	KC488521	
#045		-	-	-	Uncultured diatom4	100	HQ222548	
#007		-	-	-	Uncultured diatom3	98.2	LC191057	
#078		-	-	-	Uncultured diatom2	99.4	JQ782066	
#006		Chlorophyceae	Chlamydomonadales	Chlamydomonadaceae	Carteria sp.	99.5	JN934685	
#008]		Chromulinales	Chromulinaceae	Uncultured Ochromonas sp.	99.5	MG674914	
#025		Mamiello-	Mamiellales	Bathycoccaceae	Bathycoccus prasinos	99.8	XR002608757	
#001	Chlorophyta	phyceae		Mamiellaceae	Micromonas pusilla	99.5	KT860843	
#077	Chlorophyta	Pyramimonado-	Pyramimonad	Pyramimonad	Pyramimonas australis	99.4	KY980350	
#105		phyceae	ales	aceae	Pyramimonas sp.	99.1	MG661056	
#023		Synuro- phyceae	Ochromonadales	-	Uncultured Ochromonadales sp.	99.7	JF698963	
#533		Ulvophyceae	Trentepohliales	Trentepohliaceae	Trentepohlia sp.	99.1	KX586935	
#046			Gonyaulacales	Gonyaulacaceae	Alexandrium tamarense	99.7	KX229684	
#074				Pyrophacaceae	Fragilidium duplocampanaeforme	97.7	KY624502	
#014	Dinophyta	Dinophyta Dinophyceae Peridiniales Suessiales	Gymnodiniales	Kareniaceae	Karlodinium veneficum	99.8	KY979983	
#085				Gymnodiniaceae	Gyrodinium sp.	100	MZ687483	
#005			Peridiniales	Heterocapsaceae	Heterocapsa rotundata	99.8	KY980394	
#016			G., 1	Suessiaceae	Protodinium simplex	99.7	KY980085	
#094			Suessiales		Pelagodinium sp.	93	MN121036	
#062		1		Thoracosphaer ales	Thoracosphaer aceae	Adenoides eludens	98.8	KY980212

#040		-	-	-	Uncultured dinoflagellate1	100	AY295439
#043		-	-	-	Uncultured dinoflagellate3	99.7	KC488514
#050		-	-	-	Uncultured dinoflagellate2	98.9	KC911774
#067		-	Syndiniales	-	Uncultured syndiniales	99.7	EU793007
#107			Cryptomonad ales	Baffinellaceae	Baffinella frigidus	99.4	MK828433
#705				Cryptomonad aceae	Uncultured Cryptomonadaceae	98.4	FJ431409
#069	~ .	Стурю-рнусеае	Pyrenomonad		Teleaulax gracilis	99.4	JQ966995
#084	Cryptophyta		ales	Geminigeraceae	Teleaulax amphioxeia	100	MK956825
#086		T 1	T 1 1	-	Telonema antarcticum	99.4	KY980049
#093		Telonemea	Telonemida	-	Uncultured Telonemida	100	HM561271
#181	Euglenida	Euglenoidea	Euglenales	Euglenaceae	Trachelomonas granulata	96.6	MK894270
#100			Parmales	Triparmaceae	Triparma retinervis	100	MK650067
#070		Bolido-phyceae	Parmales	Triparmaceae	Bolidomonas pacifica	99.7	KY980029
#019	-	Delaga sharesa	Pelagomonad ales	Pelagomonad aceae	Aureococcus anophagefferens	99.8	KY980028
#042		Pelago-phyceae	Sarcinochrysid ales	Sarcinochrysid acea	Chrysophaeum taylorii	95.4	MK088057
#029	Heterokonta		Dictyochales	Dictyochaceae	Dictyocha sp.	100	MZ687569
#051	Thereforentia		F1 11 1	-	Florenciella parvula	99.7	MZ611727
#072		Dictyocho- phyceae	Florenciellales	-	Pseudochattonella sp.	99.7	MZ687706
#058			Dadinallalas	-	Pedinellales sp.	99.4	JF794054
#106			Pedinellales	-	Helicopedinella sp.	95.8	KT861167
#041		-	-	-	Ochrophyta sp.	100	MZ687610
#026	Haptophyta		nesio- Phaeocystales	Phaeocystaceae	Phaeocystis pouchetii	100	KR091066
#017		Prymnesio- phyceae		Thacocystaccae	Phaeocystis cordata	96.6	JX660992
#379		F,	-	-	Haptophyta environmental	100	KR338601
#054	D'	Picomonadea	Picomonadida	Picomonadidae	Picomonas sp.	100	MZ687537
#099	Picozoa	-	-	-	Uncultured picobiliphyte	99.6	HQ222460

Supplementary Reference

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