Murmansk Marine Biological Institute KSC RAS

Mass components of plankton in the Barents Sea zone of seasonal ice

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INTRODUCTION

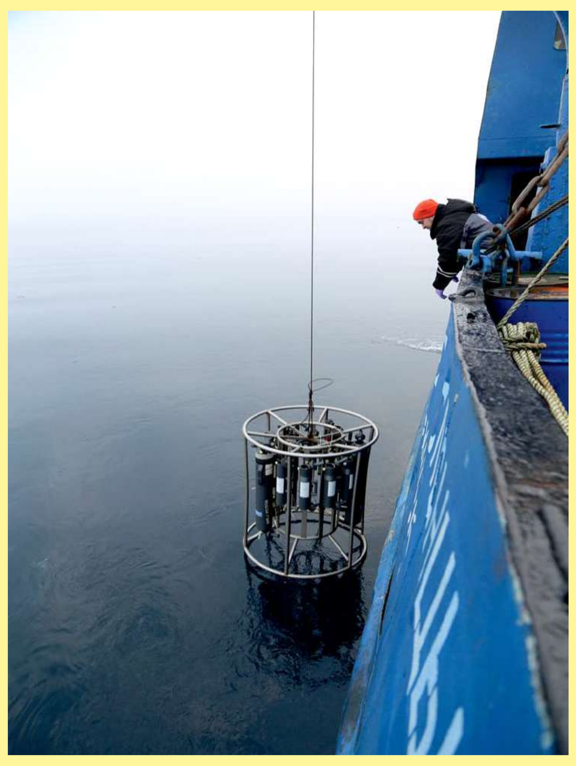
Bacterioplankton is a typical component of planktonic communities in marine ecosystems. According to Whitman et al. (1998), bacterioplankton processes 40 to 80 % of all organic carbon produced by phytoplankton. Viral lysis that according to Wommack & Colwell (2000) regulates the structure of microbial communities and has a significant influence on the formation of energy and carbon fluxes in trophic networks plays an important part in the functioning of pelagic ecosystems. Data on virioplankton and bacterioplankton living in arctic marine waters covered by seasonal ice are scarce and insufficient.

The purpose of our work was to study the quantitative characteristics of the most abundant components of the Barents Sea plankton, as well as environmental factors that determine the features of their distribution in the ice-edge zone in April, one of the iciest months of the year.

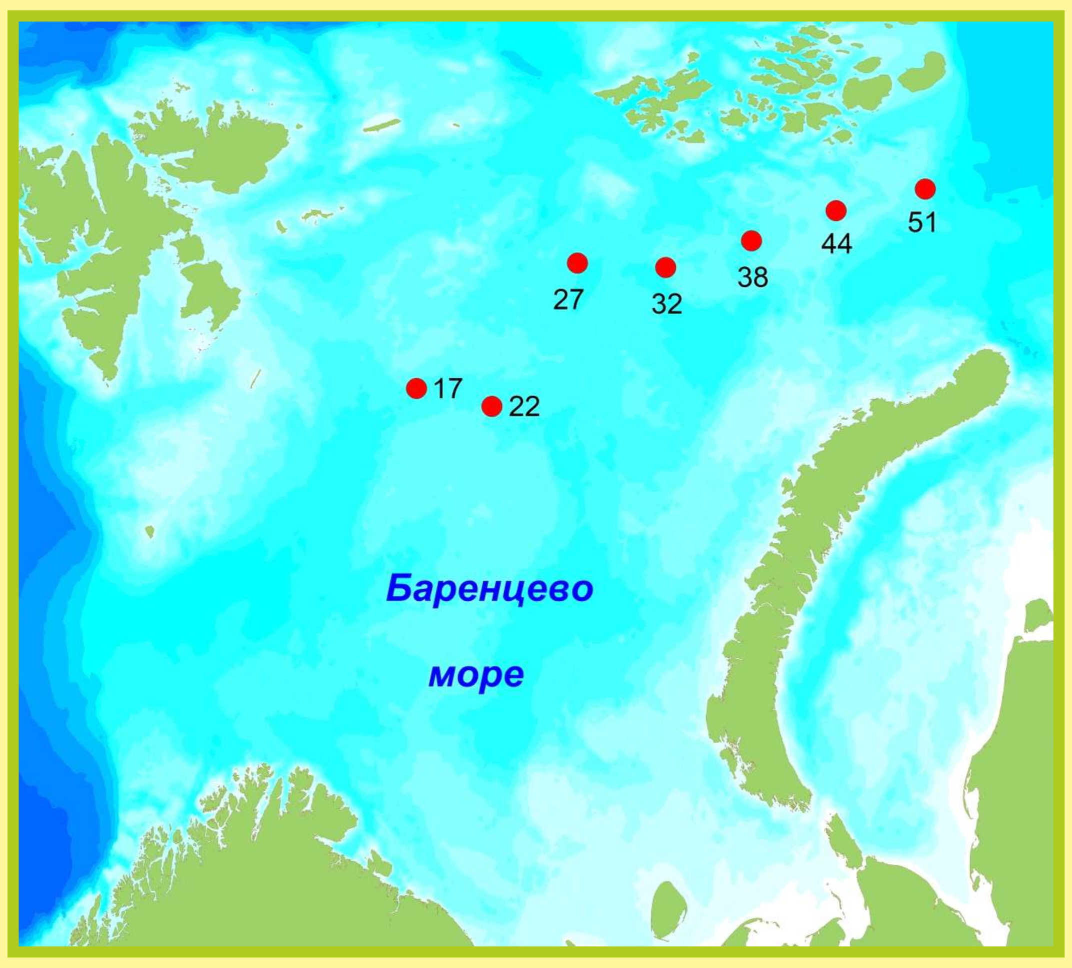




Types of sea ice in the study area

Sampling of seawater using water sampling bottles attached to a rosette deployed off the side of r/v "Dalnie Zelentsy"

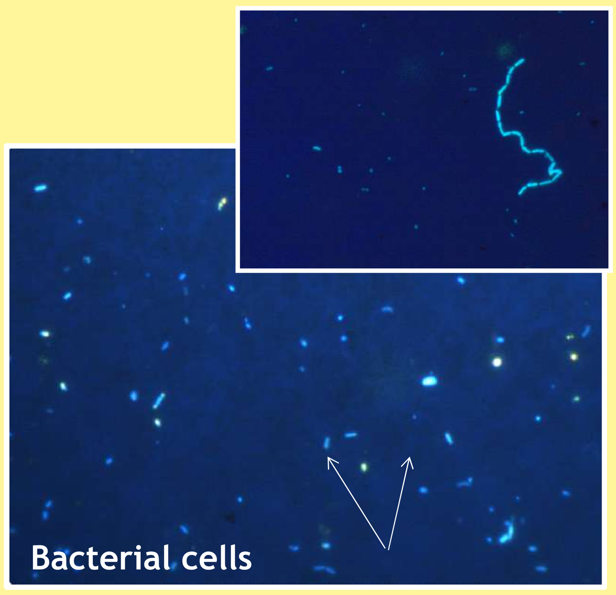


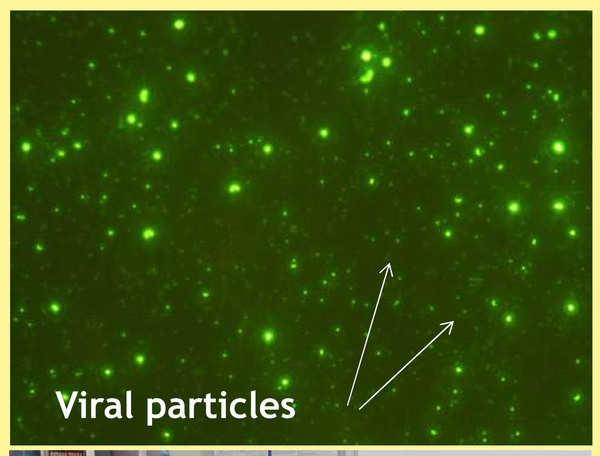
Map of sampling stations in the Barents Sea

MATERIALS AND METHODS

Studies were carried out from r/v "Dalnie Zelentsy" in the northern Barents Sea (76–79° N, 34–64° E) in April 13–25, 2016. To measure depths and thermohaline parameters of seawater, a SEACAT SBE 19 plus profiler was deployed. Water samples were collected from 7 standard levels by Niskin plastic water samplers attached to a Hydrobies MWS12 rosette. To study bacterioplankton and virioplankton, we used the standard method of epifluorescence microscopy. Abundance and size of bacterioplankton cells were determined using the DAPI fluorochrome (Porter & Feig 1980) and filters designed at the Russian Joint Institute for Nuclear Research (Dubna) with a pore diameter of 0.2 µm. Abundance of viruses was determined using the SYBR Green I fluorochrome and Wathman Anodisc filters with a pore diameter of 0.02 µm (Noble & Fuhrman 1998). Bacterial biomass in carbon units was calculated according to Norland (1993). The chlorophyll concentration was determined spectrophotometrically using Vladipor filters with a pore size of 0.45 µm (Water ... 2001).

Specimens were analyzed at 1000x magnification





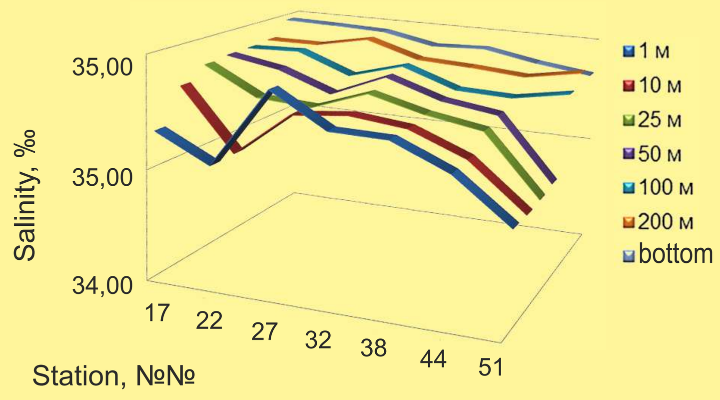
Researcher M.P. Venger identifying cells and particles of bacterioplankton and virioplankton using an Olympus BX51 fluorescent microscope with an image analysis workstation

RESULTS

1. In 2016, the ice extent in the Barents Sea was 33 % below normal (Ledovaya... 2016). During the studies low air temperatures (-0.81 to -8.65°C) did not contribute to active development of ice melting and freshening of seawater as was evidenced by an increased salinity of the upper water layer (34.45–34.89 ‰).

Distribution of water temperature and salinity at sampling stations

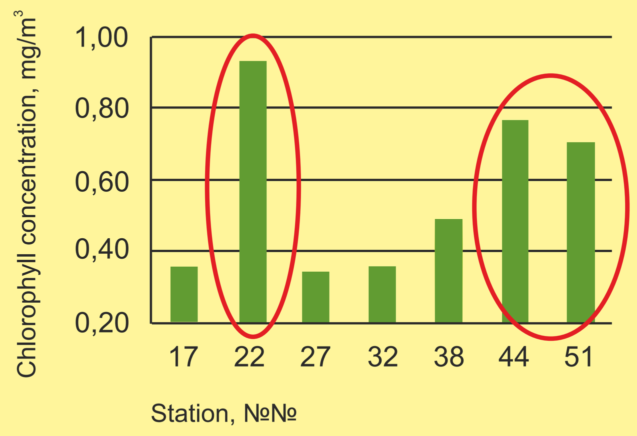
Depth, m	17	22	27	32	38	44	51
1	0,86	-1,20	1,60	-1,48	-1,83	-1,81	-1,68
10	1,49	-1,17	-1,26	-1,15	-1,84	-1,83	-1,67
25	1,76	0,39	-1,24	-0,83	-1,81	-1,82	-1,61
50	1,79	1,34	-1,21	-0,64	-1,76	-1,81	-1,49
100	1,80	1,84	-0,79	-0,58	-1,68	-1,78	1,54
200	1,88	1,69	0,51	-0,67	-0,66	-1,01	1,58
seabed	2,13	1,93	0,36	-0,25	-0,05	-0,62	0,56



Distribution of water salinity at sampling stations

2. The content of the main photosynthetic pigment (0.23–0.93 mg/m³) in the photosynthetic layer (0–50 m) did not exceed the limits established for oligotrophic waters (0.01–1.00 mg/m³), but its average concentration (0.49 ± 0.03 mg/m³) was 3.7 times higher than that in the waters along the Kola Meridian Transect during the polar night (Vodopyanova & Makarevich 2016). Locally increased chlorophyll values (0.70 to 0.93 mg/m³) in surface waters at stations 22, 44, and 51 were observed together with a decreased transparency of seawater, a consequence of active storm events during the observation period, which may cause the penetration of both suspended matter and representatives of the ice flora from sea ice into sub-ice seawater.

Sation	Depth, m	Transparency, Secchi disk, m
17	247	20
22	252	12
27	281	12
32	300	26
38	300	—
44	260	18
51	300	11

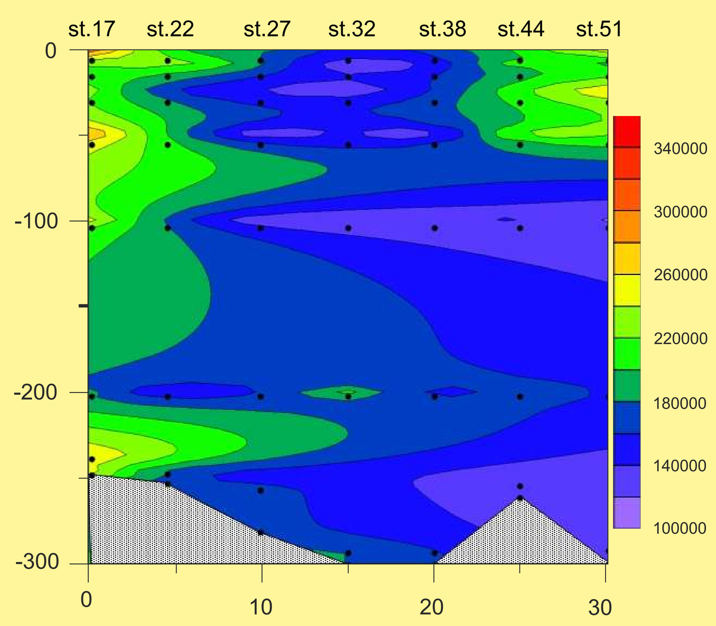


Distribution of chlorophyll in surface waters

3. Against the background of the prelaunch state of plankton communities, the total abundance and biomass of bacterioplankton varied from 0.12 to 0.32 (on average 0.20 ± 0.01) × 106 cells/ml and from 1.63 to 4.57 (2.62 ± 0.41) mg C/m3, respectively. The indicators were relatively evenly distributed vertically; their values in surface and bottom waters did not differ significantly.

Study area	Season	Sampling depth	Bacterioplankton, mln cells/ml		Source
			Range	Average	
Central and North-Eastern Barents Sea	spring	0–50 m	0.17–0.32	0.22–0.02	Our data
		100 m–seabed	0.12–0.26	0.18–0.02	
White Sea (coastal waters)	spring	0–10 m	0.07–0.12	–	Sazhin et al. 2009
Kara Sea (along the Northern Sea Route)	spring	Surface waters	0.07–0.35	–	Sazhin et al. 2017
Beaufort Sea (Franklin Bay)	spring	Surface waters	–	0.35–0.11	Sala et al. 2008
Central and North-Western Barents Sea	summer	0–200 m	0.59–1.40	–	Howard-Jones et al. 2002
Central Arctic Ocean	autumn	55–235 m	0.04–0.47	–	Steward et al. 2007
Beaufort Sea (Franklin Bay)	winter	Surface waters	–	0.26–0.06	Sala et al. 2008

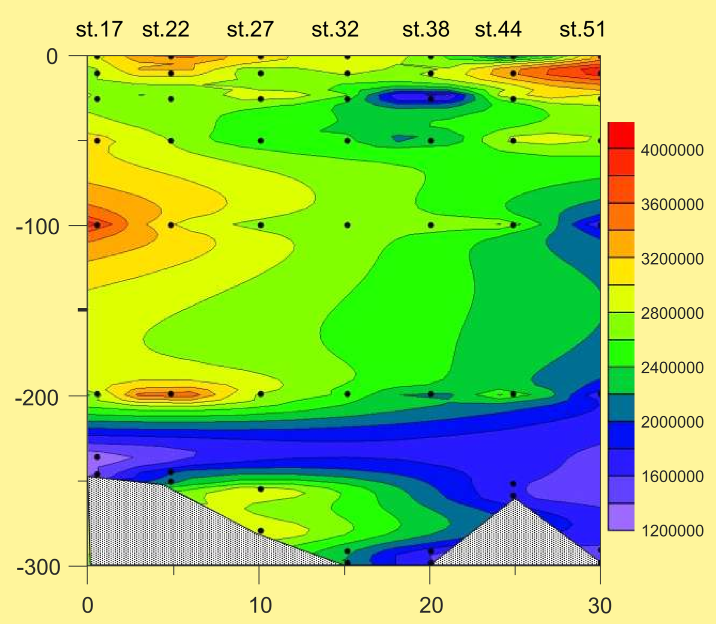
Distribution of bacterioplankton



4. The abundance of virioplankton in the study area varied from 1 to 4 million particles per ml with an average value of 2.5 ± million particles/ml. Except for the significant difference between the abundance of viruses in surface waters and near the seabed, no specific patterns in their distribution were observed.

Region of the Arctic	Season	Sampling depth	Viruses, mln particles/ml		Source
			Range	Average	
Central and North-Eastern Barents Sea	spring	0–50 m	0.9–4.0	2.9–0.2	Our data
		100 m –seabed	1.2–3.9	2.3–0.3	
Kara Sea (along the Northern Sea Route)	spring	Surface waters	1.1–8.5	4.0–0.9	Sazhin et al. 2017
Central and North-Western Barents Sea	summer	Surface waters	1.9–22.0	–	Howard-Jones et al. 2002
		Subsurface waters	4.2–14.0	–	
Arctic Ocean (off the Coast of Greenland)	summer	Surface waters	1.4–5.6	–	Middelboe et al. 2002
Central Arctic Ocean	autumn	55–235 m	0.7–11.0	–	Steward et al. 2007
Beaufort Sea (Franklin Bay)	autumn	0–60 m	–	5.9–2.5	Payet & Suttle 2007
	winter	0–60 м	–	5.3–2.8	

Distribution of virioplankton



CONCLUSIONS

Observations in the Barents Sea ice edge zone in April 2016 were carried out during the period preceding the sub-ice bloom;

The quantitative indicators of bacterioplankton, as well as the concentration of the main photosynthetic pigment during this period were consistent with characteristics of marine waters of the oligotrophic category;

The abundance and biomass of bacterioplankton were below the values recorded in the Barents Sea in summer in the zone of drifting ice;

In our studies, the abundance of virus particles in the ice edge zone was everywhere greater than the abundance of their potential hosts, bacteria, and was lower than in other Arctic marine areas covered by ice;

Analysis of the data obtained during the observation period suggests that viruses (their lytic infection) did not have a significant effect on the development of bacterial communities;

Relatively uniform distribution and insignificant limits of the range of abundance of virioplankton and bacterioplankton were evidence of the presence of a dynamic equilibrium between the factors influencing the production and elimination of both virus particles and bacterial cells in the environment.

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