

Savvichev Alexander

RUSALCA 2014, Synthesis and Publications February, 20-22, 2014, Honolulu, HI, USA



 "Total Number of Bacteria, Bacterial Production, and Carbon Isotopic Composition of Suspended Organic Matter in the Water Column of the Chukchi Sea (based on three RUSALCA Expeditions)"



Presentations should focus on the information that other synthesis groups would like to know to help them in their work (i.e., confirmation of prior conclusions, new findings and understanding, etc.; no need to present goals, station locations, methods, *raw data, etc.)*

Kathleen (February 10, 19:45)



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- There are **three sets of data** characterizing the abundance and activity of microorganisms in the water column investigated by us sea basin:
- **1.** The total number of bacteria (microscopy of fixed samples)
- 2. Quantitative characterization of the real activity of the microorganisms in the water column (¹⁴C uptace) Production of Bacteria
- 3. Carbon Isotopic Composition of Suspended Organic Matter $(\delta^{13}C, \infty)$ in surface and near bottom water samples
- The data were obtained on cruises in 2004, 2009 and 2012 using the same methods

The total number of bacterioplankton is most a general characteristic of an abundance of microorganisms in water column of the seas and oceans

2004

The Number of Bacteria in the Surface of Water Column Chukchi Sea varied from 70 x 10^3 cell per ml (in Herald canyon) to 280 x 10^3 cell per ml (near Chukotka Peninsula).

Average 170×10^3 cell per ml.



The Number of Bacteria in the Water Column of Bering Strait varied from 550 x 10^3 cell per ml (near Chukotka) to 1500 x 10³ cell per ml (near Alaska); of Chukchi Sea – from **88 x 10³ cell** per ml (north) to **380 x 10³ cell** per ml (Herald Canyon); in East Siberian Sea from 76 x 10^3 to 160 x 10³ (Longa Strait) Average **210 x 10³ cell per** ⁶⁷ ml



2012

The Number of Bacteria in the Surface of Water Column of Chukchi Sea varied from 70-100 $x 10^3$ cell per ml (North of Herald Canyon and Chukchi Sea) to 490 x 10^3 cell per ml (near Chukotka); average 240 x 10³ cell per ml The water area of the Chukchi Sea in terms of Bacteria Number is clearly divided into two parts: the northern and southern. The Number of Bacteria in these parts differ by 3 times.

Thus, the average total number of bacterioplankton in late summer for a three-year study ranged from $170 \text{ to } 240 \text{ x } 10^3 \text{ cells}$



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It is possible to organize this slide to compare the data on the number of bacteria in other seas of the Arctic (this is possible instead of numbers to represent bars)



Белое море

^{-5000-4000-3000-2500-2000-1500-1000 -500 -200 -100 -50 -25 -10 0 50 100 200 300 400 500 600 700 800 1000 (}Meters)



2004

Production of Bacteria, surface waters, $\mu g \ C \ ml^{-1} \ day^{-1}$

In the southern part of the Chukchi Sea and the Bering Strait bacterial production had similar values $(0,35 - 0,78 \ \mu g \ C \ ml^{-1} \ day^{-1})$. In contrast, in the northern part of the sea in the waters of the canyon Herald bacterial production values were extremely low $(0,08 - 0,14 \ \mu g \ C \ ml^{-1} \ day^{-1})$. The maximum production of bacteria is found out in Bering strait near to coast of Alaska, and in a southern part of Chukchi Sea. Production of bacteria in East Siberian Sea twice more low, than in Chukchi Sea.

Chukchi and East Siberian Sea 0.10 – 0.75 (Average 0.38)





Carbon Isotopic Composition of Suspended Organic Matter (δ^{13} C, ‰) in surface and near bottom water samples **2004**





St.	δ ¹³ C, ‰	δ ¹³ C, ‰	Δ, ‰
	surface	near	
	layer	bottom	
		layer	
cs-8	-21,47	-20,23	1,24
cs-4	-22,93	-20,79	2,14
cs-16	-22,73	-20,61	2,12
cs-17	-23,7	-20,69	3,01
cen-5	-21,73	-20,62	1,11
cen-3	-21,89	-22,01	-0,12
cen-1	-23,1	-22,34	0,76
hc-49	-24,05	-22,63	1,42
hc-55	-22,21	-21,24	0,97
cl-9a	-24,08	-21,84	2,24
ls-3	-25,31	-22,55	2,76
ss-5	-24,51	-22,58	1,93
ss-4	-24,11	-24,7	-0,59
wn-3	-24,05	-22,81	1,24
wn-2	-23,97	-23,07	0,9
wn-1	-25,07	-24,35	0,72
gd-7	-21,63	-18,19	3,44
ie-1	-24,26	-26,81	-2,55
hc-60	-20,77	-20,3	0,47

Carbon Isotopic Composition of Suspended Organic Matter ($\delta^{13}C$, ‰) in surface and near bottom water samples **2012**



St.	δ ¹³ C, ‰	δ ¹³ C, ‰	Δ, ‰
2012	surface	near bottom	
	layer	layer	
CS-4	-23,66	-22,03	1,63
CS-17	-21,98	-21,67	0,31
CL-5a	-19,33	-20,39	-1,06
CEN-4	-23,06	-22,03	1,03
CEN-1A	-22,83	-22,24	0,59
HC-2	-23,26	-21,77	1,49
HC-26	-24,22	-23,74	0,48
HC-70	-23,53	-21,97	1,56
G-12	-24,65	-22,09	2,56
CL3R	-24,62	-24,18	0,44
CL-8	-21,13	-20,97	0,16
CS-8R	-25,73	-20,86	4,87
CS-10	-25,66	-20,97	4,69

The data that we would like to use in the synthesis article (2004, 2009 and 2012)

2004 carbon uptake rates in the Chukchi Sea



→From the first Rusalca cruise in 2004, we got an average carbon uptake rate about 36.8 mg C m-2 h-1 in the Chukchi Sea!



→ In 2009 last year (Sept), the average rate was a much lower value than others. This might be due to a seasonal variation since phytoplankton normally have a lower productivity in September in the Chukchi Sea. But, from satellite images (SeaWifs), Chlorophyll-a conc and estimated PP in the Chukchi Sea in 2009 was significantly lower than other years (next slides).



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A. Savvichev, I. Rusanov and K. Crane, 2004

 "Microbial processes of methane production and oxidation in the water and sediments of the Chukchi Sea (based on three RUSALCA Expeditions)" **2004** In the water column of the Bering Strait and southern Chukchi Sea, the **contents of methane** varied from **0.14 to 0.43 µl/l**. The methane content in the surface layer of the water column was minimal and corresponded to CH_4 partial pressure in the atmosphere above. The greatest amount of methane was detected in bottom water of St. 24 and 25 (on the transect from the Chukotka Peninsula and Cape Lisburne in Alaska).



Methane concentration in water column of Chukchi Sea, nM 1⁻¹

(a - southern part of the area, b - canyon Herald).



Individual Profiles of the Methanoxidation Rates in Water Column of Chukchi Sea, nM CH₄ l⁻¹ day⁻¹



In the surface water of the Chukchi Sea, the contents of methane varied from 5.1 to 15.3 *nM* average 9.2). In the surface water of the East Siberian Sea, the contents of methane varied from **5.08 to** 10.87 *nM*, average 8.1 *nM*).



In the nearbottom water of the Chukchi Sea, the contents of methane varied from 5.1 to 66.3 nM average 21.3).



The values of methane in surface sediments of Chukchi and East Siberian Sea vary from (from 234 nM to 603 nM CH₄/dm³)



2004 Bottom sediment samples from grabs and cores were analyzed north of the Bering Strait. The data show that the values of methane in Western Chukchi Seafloor vary from 5.5-to 420- μ l CH₄/dm³, varying by location and depth. Sediments from the southern stations of the Chukchi Sea were characterized by rather low methane content (up to 40 μ l CH₄/dm³)





Activity of microbial processes (methane generation-MG, methane oxidation-MO and sulfate reduction-SR) in the bottom sediments of the Chukchi Sea (2004)

In the surface water of the Chukchi Sea, the contents of methane varied from 5.1 to 15.3 *nM* average 9.2). In the surface water of the East Siberian Sea, the contents of methane varied from **5.08 to** 10.87 *nM*, average 8.1 *nM*).



In the nearbottom water of the Chukchi Sea, the contents of methane varied from 5.1 to 66.3 nM average 21.3).



In the surface water of the Chukchi Sea (2012), the **contents of methane** was varied from **2.0 to 12.9 nM**

(average 5.6).

During the three years of research it was the lowest average content of methane in surface water



In the near-bottom water of the Chukchi Sea, the **contents of methane** varied from 6.7 to 26.5 nM (average 15.5).

The methane content in the bottom water layer for the three years of research compared to the surface methane content was more stable



		[CH ₄],	MG
St. 2012		µM dm ⁻³	nM dm ⁻³ day ⁻¹
CS-4 grab	0-2	0,39	<1,0
CS-17	0-5	1,12	5,5
CL-6	0-5	0,50	<1,0
G-1	0-5	40,65	56
HC-2 core	20-25	1,52	3,5
	50-55	2,05	18
	120-125	9,38	54
HC-3	0-5	0,29	<1,0
	45-50	0,58	11
	95-100	1,65	23
HC-26	0-2	0,67	<1,0
box	45-50	1,70	18
G-5	0-5	0,40	<1,0
box	40-45	2,19	21
HC-4	105-110	2,05	12
core	150-155	1,65	18
	245-250	3,13	35
HC-70	0-5	1,55	10
G-12	0-2	0,57	<1,0
CL-3R	0-5	2,53	12
box	40-45	2,01	21
HC-10	15-30	11,65	42
H ₂ S	115-130	83,93	240
CL-2	0-2	0,38	<1,0

2012

Methane concentration $\left[CH_{4}\right]$ and Activity

of microbial methane generation-MG in the bottom sediments of the Chukchi Sea