ARCTIC BIODIVERSITY CONGRESS

Trondheim, NORWAY, December 2-4, 2014

Changes in sea ice ecosystem in the Arctic Ocean observed during a life-time of research at ice stations and ships

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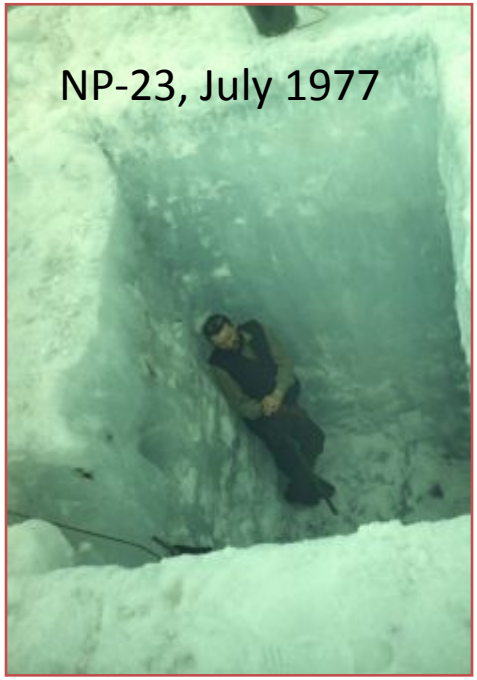
MULTI-YEAR ICE versus SEASONAL ICE



The pre-melting period:
Multi-year ice>80%
Seasonal ice<10%
Domination up to middle of 90th

The melting period:
Multi-year ice<10%
Seasonal ice>80%
Domination since late 90th-recent

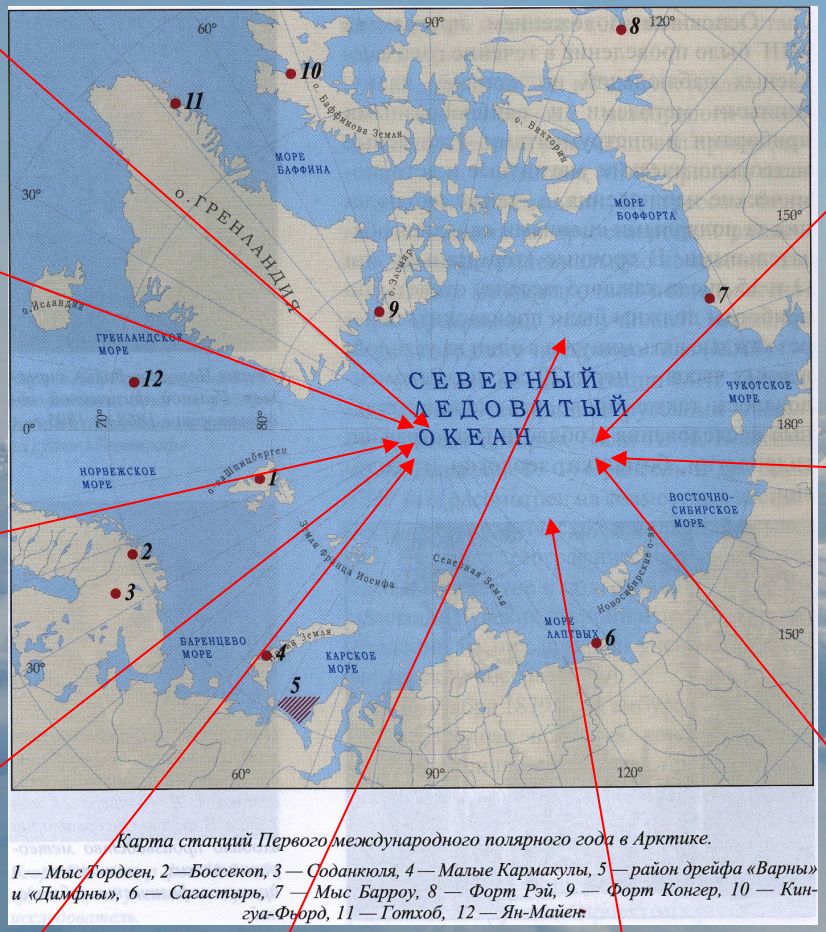
Biology-oriented research in the Central Arctic Ocean since “Fram” up to 70th

Platform, Year	*Observations*	*Publications*
“Fram” 1893-1896	Phyto-zooplankton, *sea ice biota*	Nansen,1902; Sars, 1900; Gran, 1904
“Nautilus”, 1931	Zooplankton	Hardy et al., 1936
“Sadko”, 1935-1938	Zooplankton	Gorbunov, 1946, Yashnov, 1940
NP-1, 1937-1938	Phyto-zooplankton, *sea ice biota*	Shirshov, 1938,1944;Bogorov, 1938; Usachev, 1938-1961
“Sedov”, 1937-1938	Zooplankton	Gorbunov, 1946; Bogorov 1946a
I-169, 1941	Zooplankton	Bogorov 1946a
NP-2-5	Zooplankton	Brodsky, 1964; Virketis, 1957; Gur’yanova, 1957
T-3, 1952-1955	Phyto-zooplankton, *sea ice biota*	Mohr, 1959; Barnard, 1959
T-3, 1957	Primary production, sea ice	Appolonio, 1959
“Alpha”, 1957-1958	Primary production, zooplankton	English, 1959, 1961; Johnson, 1963
T-3, 1958	Zooplankton	Grainger, 1965
“Seadragon”, 1960	Zooplankton	Grice, 1962
“Arlis-1”, 1960-1961	Primary production, sea ice	Appolonio, 1961
“Arlis-2”, 1961-1962	Phyto-zooplankton	Hopkins, 1968; Kawamura, 1967; Minoda, 1967,
T-3, 1963-1970	Zooplankton, *sea ice biota*	Harding, 1966; Hunkins, 1965; Hughes, 1968 et al., Horner, 1976
NP-14-19, 1965-1970	Zooplankton	Pavshtiks, 1970, 1980 et al.

Arctic Basin Sea Ice Biota publications before middle of 70th

- Nansen, F. 1906. *Protozoa on the ice floes of the North Polar sea,* Sci. Results Norw. North Polar Exp., 5, 16: 1-22
- Usachev, P.I. 1949. *The microflora of polar ice*, Acad. Nauk USSR, Trudy Inst. Oceanol., 3: 216-259
- Barnard, J.L. 1959*. Epipelagic and under-ice amphipoda of the Central Arctic basin*, Geoph. Res. Papers, N 63, Sci. Studies at Fletcher's ice Island T-3, 1952-1955, 1: 115-129
- Horner, R.A. 1976. *Sea ice organisms*, Oceanogr. and Mar. Biol. Annu. Rev. 14, Aberdeen, pp. 167-182
- Нужно найти цитирование М. Дунбара обо мне в жур Арктик

1975-2011



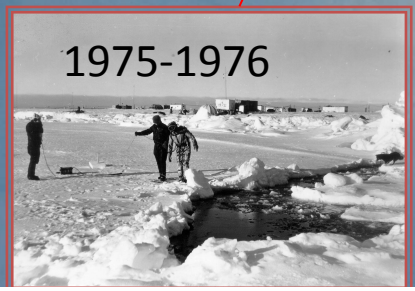
Карта станций Первого международного полярного года в Арктике.

1 — Мыс Гордсен, 2 —Боссекоп, 3 — Соданкюля, 4 — Малые Кармакулы, 5 — район дрейфа «Варны» и «Димфны», 6 — Сагастырь, 7 — Мыс Барроу, 8 — Форт Рэй, 9 — Форт Конгер, 10 — Кингуа-Фьорд, 11 — Готхоб, 12 — Ян-Майен.

SHEBA 1997-1998

Arctic-2000

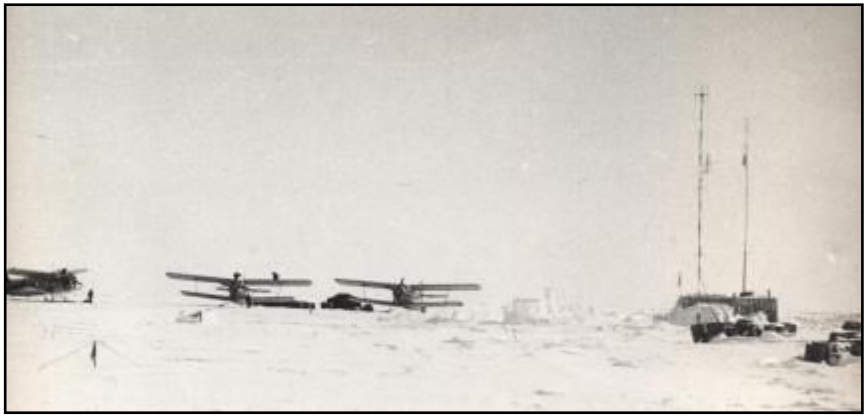
APL/ICEX-2003



Drifting ice station “North Pole-22”
Logistic, Operation, Research
1974-1982

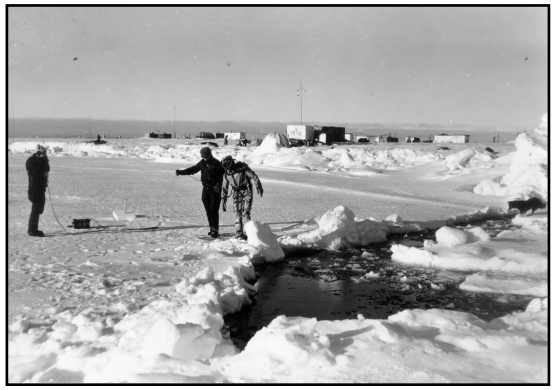








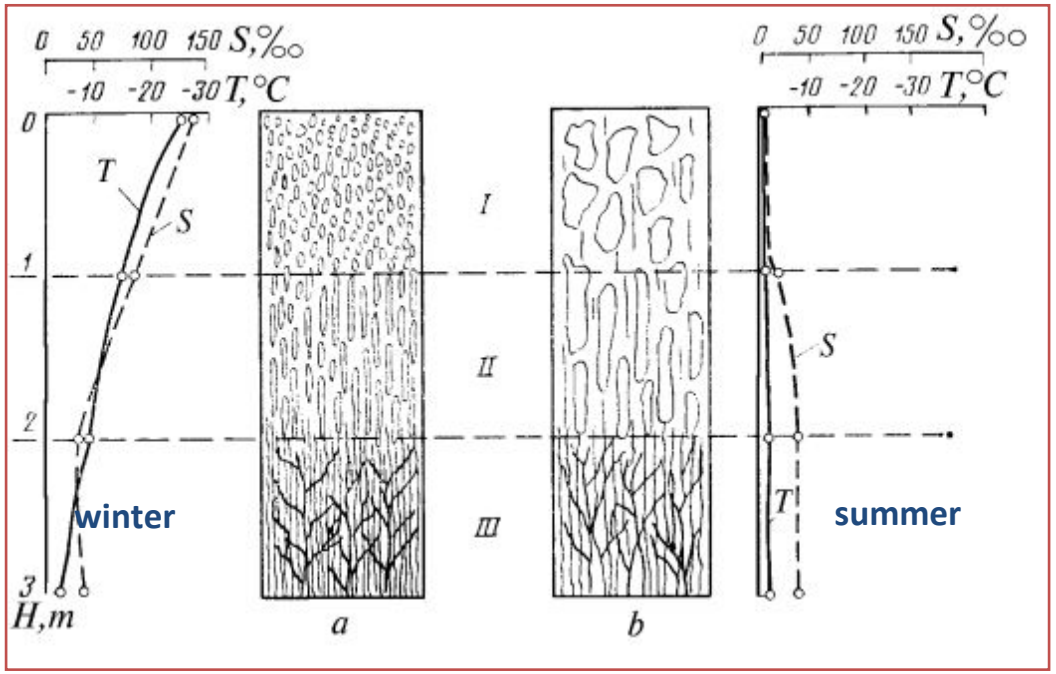

Under ice diving for science



Ice core samplings

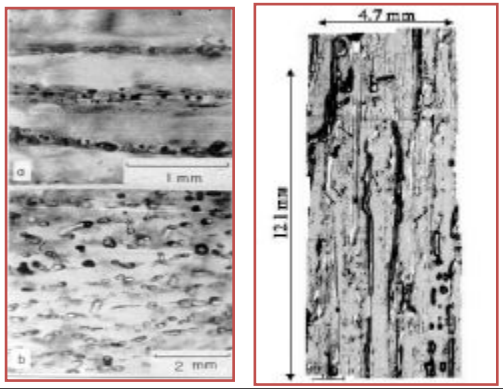
Physical ice structure

The scheme reflects the winter (a) and summer (b) physical structure of ice according to the temperature in these seasons.

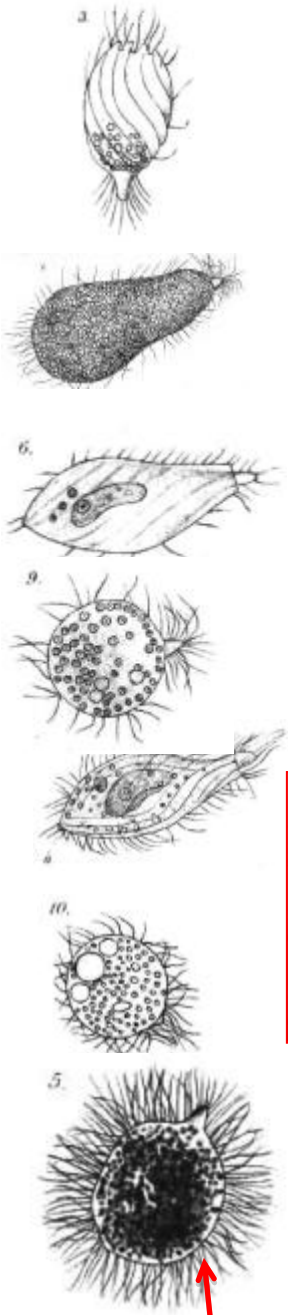


In winter the lower layer is dominated by formations in the form of thin long membranes and brine channels, the middle – by capillaries and partially brine pockets, the upper - mainly by brine cells.

In the summer, when it starts warming up of ice interior the bulk melting intensively covers the upper layers and less noticeable the bottom, where the temperature close to the temperature of the water under the ice.



Vertical section of first-year ice: brine tubes, brine pockets, vapor bubbles, inclusions
From: Light et., 2001, J. Geophys. Res.

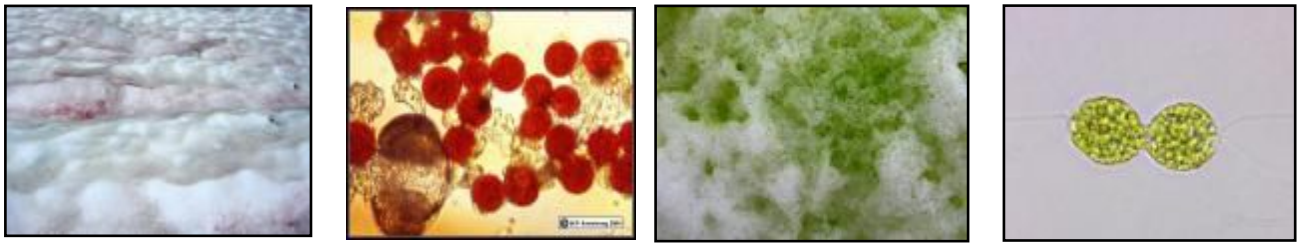


From: *Nansen, 1906*

SEA ICE BIOTA

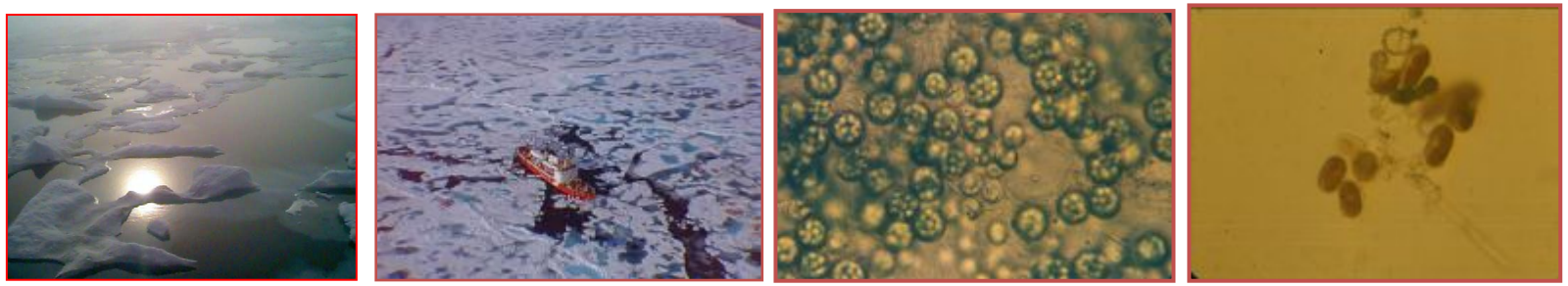
UPPER SEA-ICE SURFACE

Snow algae



Author ???

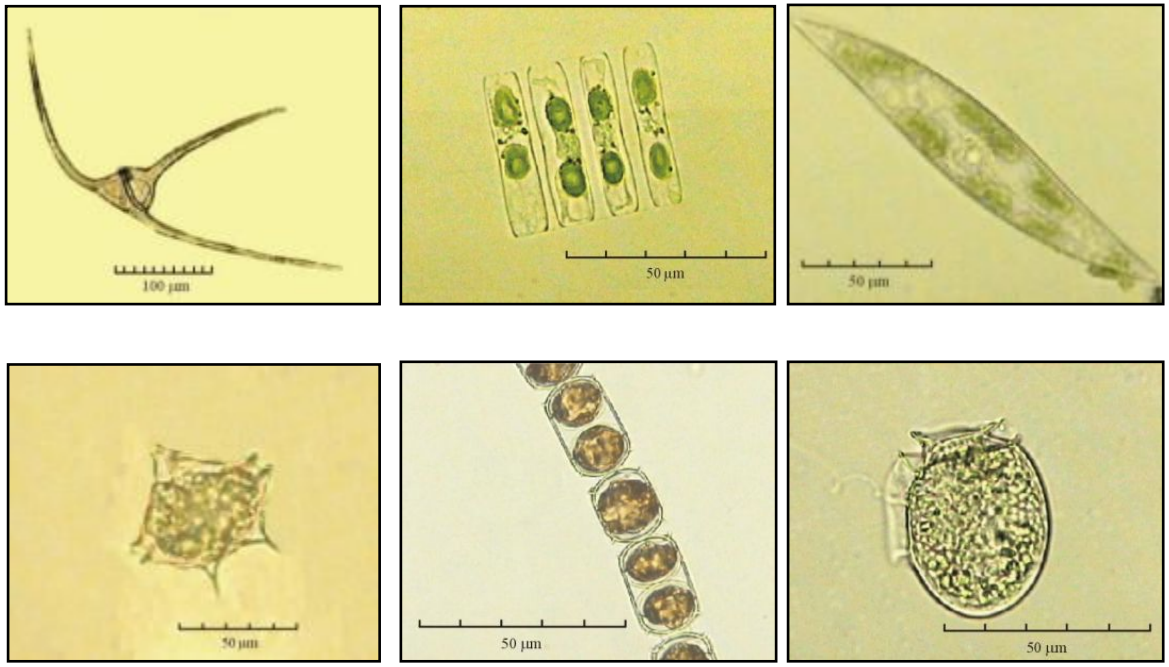
Micro biota of fresh water puddles



Total list of algal species is 26 and 20 of protozoa.
Dominants in snow *Chlamydomonas nivalis*
Dominants in puddles *Ancylonema nordenskioldii*

SEA ICE BIOTA

SEA ICE INTERIOR



Courtesy: Institute of Polar Ecology
Kiel University, Germany

Cryoflora includes 171 algae species (Bacillariphyta -148, Chlorophyta – 20, Silicoflagellatae – 2, Dynophyta – 1, Cyanophyta – 1).

Cryofauna includes Nematoda, Turbellaria, Acarina, Protozoa, Apherusa glacialis (juv.) and Tisbe furcata (juv.)

SEA ICE BIOTA
SEA ICE/WATER INTERFACE

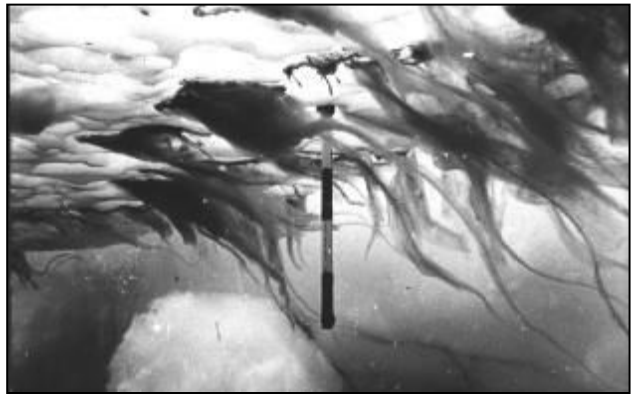
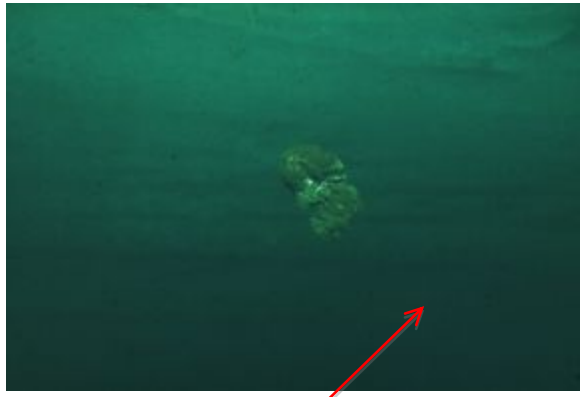
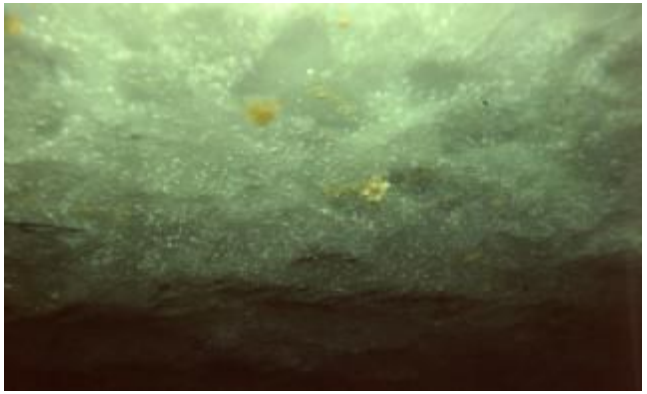


Photo V. Grichenko



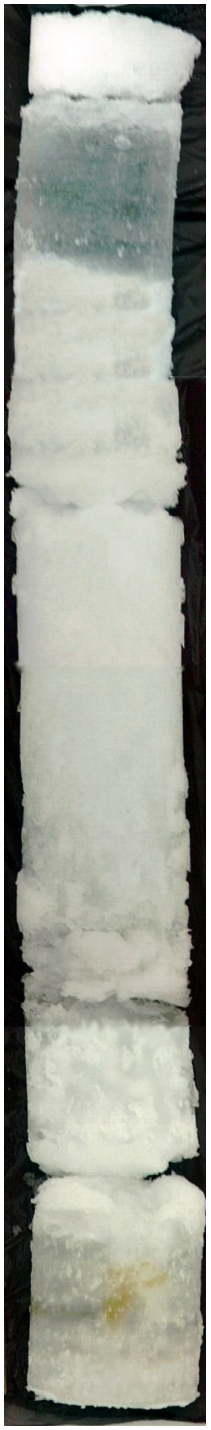


Bottom sea ice surface colonized by cryopelagic algae forming mass aggregations of benthic- and plankto-benthic types. Species dominant: *Melosira arctica* and *Chaetoceros karianus*.

Total list of under ice-associated cryopelagic fauna consists of 48 species with domination by amphipods

Photos: B.Bluhm (UAF)and P.Leopold (NPI)

Ecological ice structure



Freshwater community
in the upper ice sections
and melting sea-ice surface

Two plant communities are related to this structure: the first consisting of diatoms lives in the lower layer, the second consisting mainly of green algae is attributed to the upper layer. Both communities live under different environmental conditions: the upper plant community is exposed to the maximum gradient of temperature and salinity:-20°C to -30°C and more 100‰ in winter and about O°C and 1‰ in summer, respectively. The lower community on the contrary lives under more or less stable conditions of the available temperature and salinity corresponding to those in sea water. This is accompanied by different tolerance of algae towards salinity, fresh water algae developing in the upper layer, marine algae – in the lower layer.

Seawater community
in the bottom ice sections
and water-ice interface

POC and DOC in multi-year, seasonal ice and under ice sea water during winter and summer period.

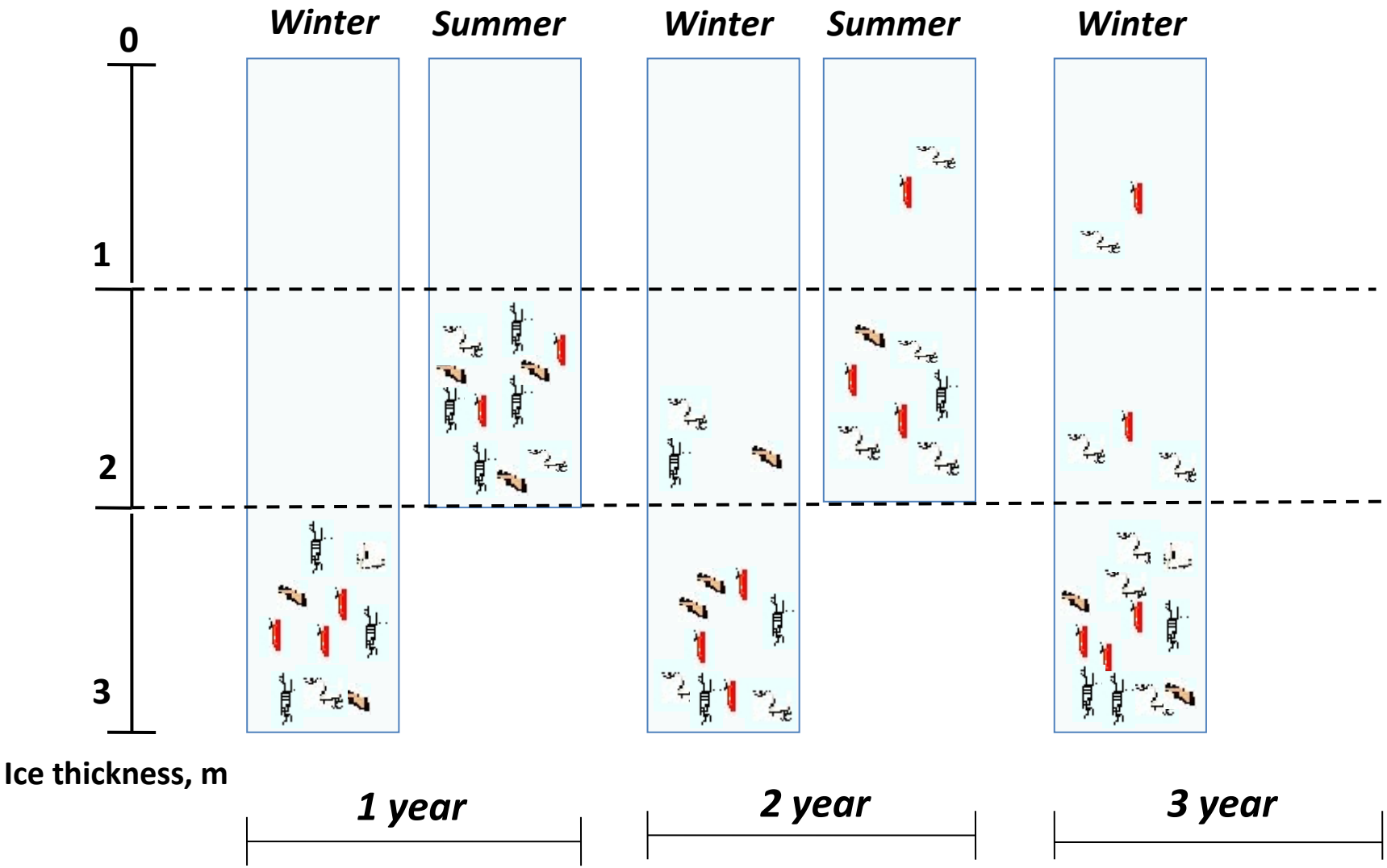
(Observations at NP-23,1977-1978, and NP-22,1980-1981)

Object	Season	POC, ug/l	DOC, mg/l
Multi-year ice	winter	226 (n=37)	4,4 (n=45)
	summer	427 (n=37)	5,5, (n=36)
Seasonal ice	winter	92 (n=42)	3,3 (n=47)
Sea water, O m	winter	29 (n=10)	3,5 (n=7)
	summer	78 (n=16)	3,1 (n=16)

Conclusion:

Organic production produced by the MYI sea ice flora is the main trophic base for all ice-associated biological communities

Stability of the vertical structure of the MY ice



Stability of MY in geographical scale of the Arctic Ocean

Figure 3-29. Surface currents in the Arctic region. Square boxes indicate that the denser inflowing (Atlantic and Pacific) waters are submerging under the Polar Surface Water. The continuation of these flows can be seen in Figure 3-27.

1. The zone of Beaufort Gyre; 2. The zone of Transpolar drift; 3. The transitional zone;
4. The zone of one-year ice production; 5. The zone of outflow of the multi-year ice

Conclusions
for pre-melting period

1. On the *steady-stable c*limatic level, *the multi-year ice* is the main stable component of the sea-ice cover in the Arctic Ocean which dominates between other age groups in respect to area and volume;
2. Species composition, structure and function of the sea ice biota are steady-stable in time and space in geographical scale of the AO.

The main reason for stability:

- existence of a thin stratified surface layer protecting the contact of the sea ice with warm Atlantic water;
- mechanism regulating the average equilibrium sea ice thickness;
- peculiarities of the large-scale ice circulation maintaining the equilibrium sea-ice budget

И. А. МЕЛЬНИКОВ

ЭКОСИСТЕМА АРКТИЧЕСКОГО МОРСКОГО ЛЬДА

THE ARCTIC SEA ICE ECOSYSTEM

I.A. MELNIKOV

1997

Gordon and Breach Science Publishers

NP-22, 23; SHEBA; ARCTIC-2000, APL/ICEX expeditions in the Canadian Arctic Basin

(the same region, 20-years difference in observations, good chance for comparison of data)

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NP-22,23
1995-1981

SHEBA
1997-1998

Арктика-2000

APL/ICEX
2003

SEA ICE INTERIOR: FLORA

NP-22, 23 1977-1981	TAXA	**SHEBA Arctic 2000, APL/ICEX 1997-2003**
79	*Bacillariophyta*	18
1	*Dinophyta*	5
0	*Chrysophyta*	1
0	*Silicoflagellatae*	1
5	*Chlorophyta*	1
Total: 85	**Total species number: 101**	Total: 26
	Similarities between species: 8%	

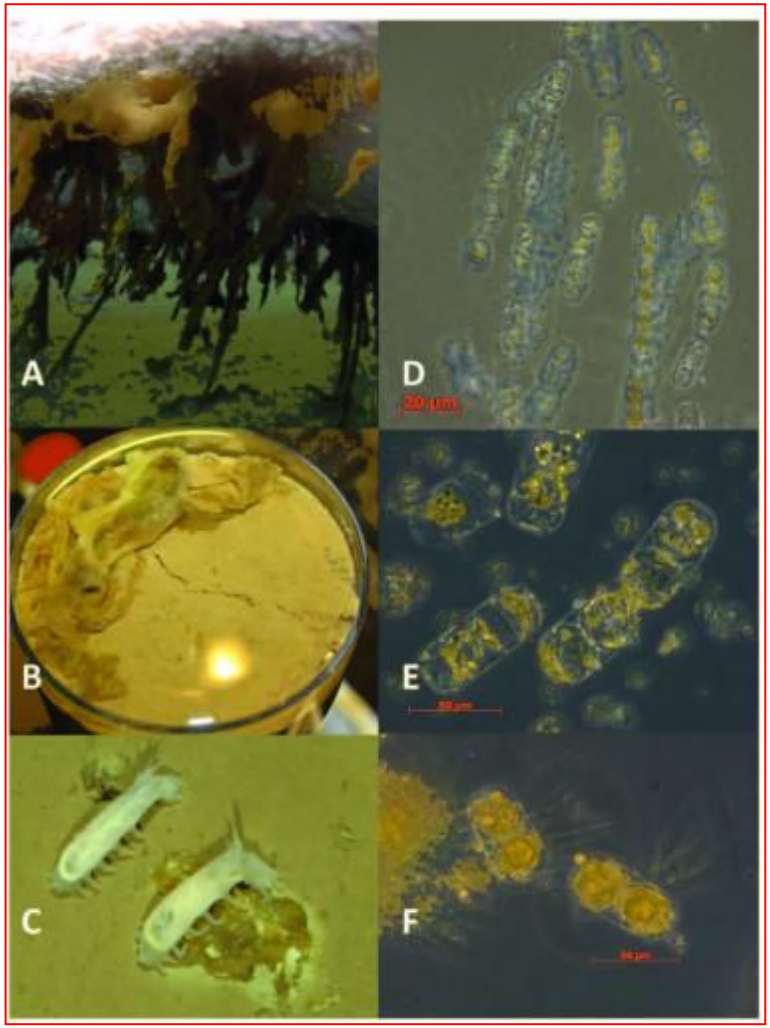
SEA ICE INTERIOR:
FAUNA

NP-22, 23 1977-1981	TAXA	**SHEBA Arctic 2000, APL/ICEX 1997-2003**
3	Protozoa	0
1	Foraminifera	1
1	Acarina	0
2	Nematoda	0
1	Terbellaria	0
1	Harpacticoida	0
1	Amphipoda	0
Total: 10	**Total species number: 10**	Total: 1
	Similarities between species: 10%	

Melosira arctica under ice and ….on the depth 4400 m in the Central Arctic Ocean

78N and 166W, SHEBA, July 1998

August 2000, 82N и 172E

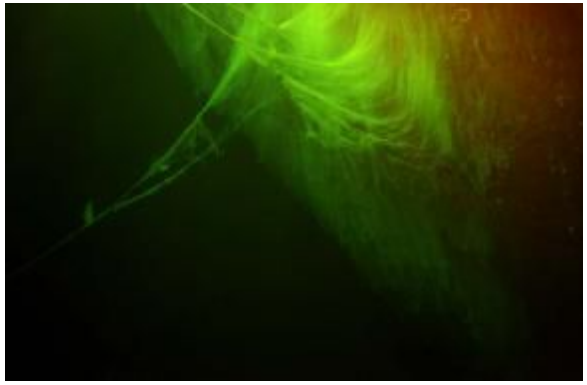


82-89N и 30-130E, «Polar Stern-2012»

Boetius et al., 2013

Brackish-water algae development at the bottom of ice-breaker “Des Grosillier” during SHEBA time in the Arctic Basin

17 September 1998

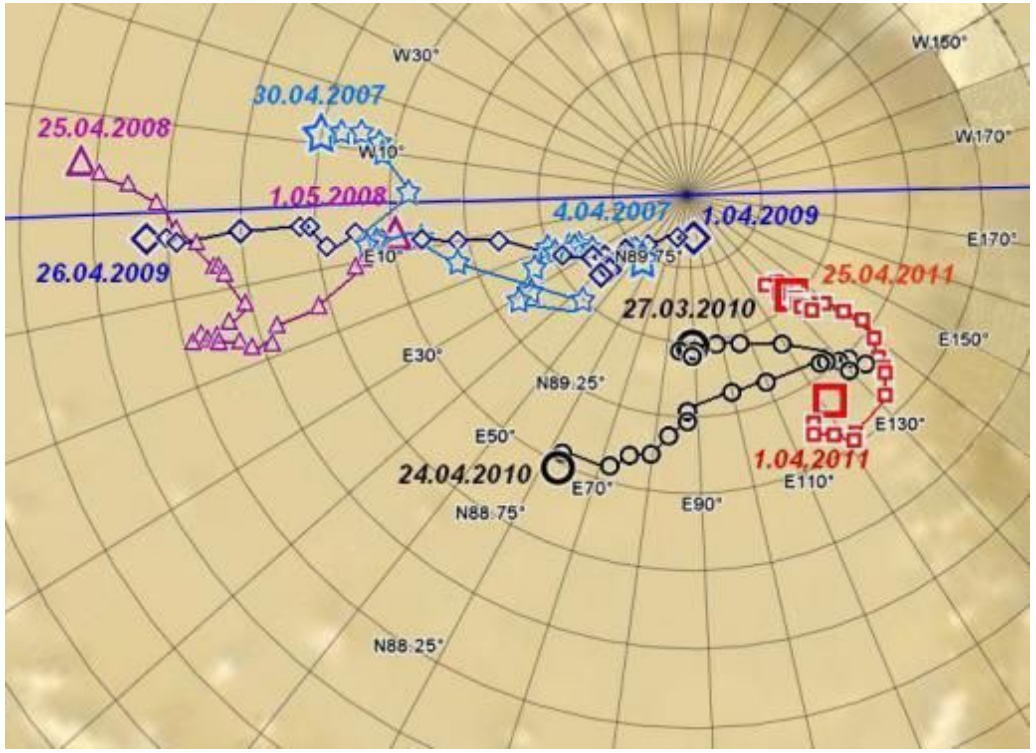


Aggregations of *U.implexa* on bottom of ice-breaker

Pan-Arctic Ice Camp Expeditions

PAICEX
2007-2011

www.paicex.ocean.ru



PAICEX-2007, April 4-27

N

W

E

S

Ice camps:

1. *"I.Papanin"*
2. *"E.Fedorov"*
3. *"P.Shirshlov"*
4. *"E.Krenke"*

Mobil team «F. Nansen»

SEA ICE INTERIOR: FLORA (PAICEX 2007-2011)

TAXA	2007	2008	2009	2010	2011
Centrophyceae	14	15	8	9	10
Pennatophyceae	38	13	17	10	14
Silicoflagellatae	1	1	1	1	1
Chrysophyceae	3	6	-	-	1
Dinophyta	7	11	5	3	1
Bcero	63	46	31	23	27
Sorensen's similarity index	0,41				
		0,22			
			0,24		
				0, 23	
	0,17				

- Species and cells numbers of diatoms are remarkable decreased but, in contrary, *Dinophyta* cists are increased
- Sorensen's similarity index is very low (0,17)
- Only two diatoms - *Fragilariopsis cylindrus* and *Nitzschia frigida*, one *Silicoflagellatae* - *Dictyocha speculum*, and cist - *Dinoflagellatae sp*. were common observed in all collected ice samples

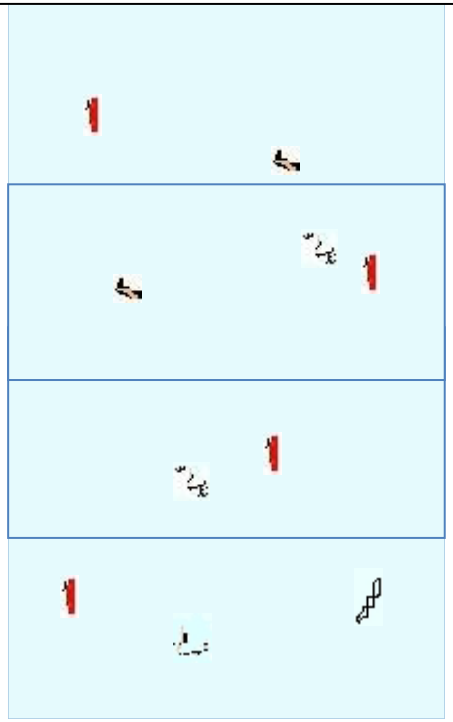
CRYOPELAGIC FAUNA

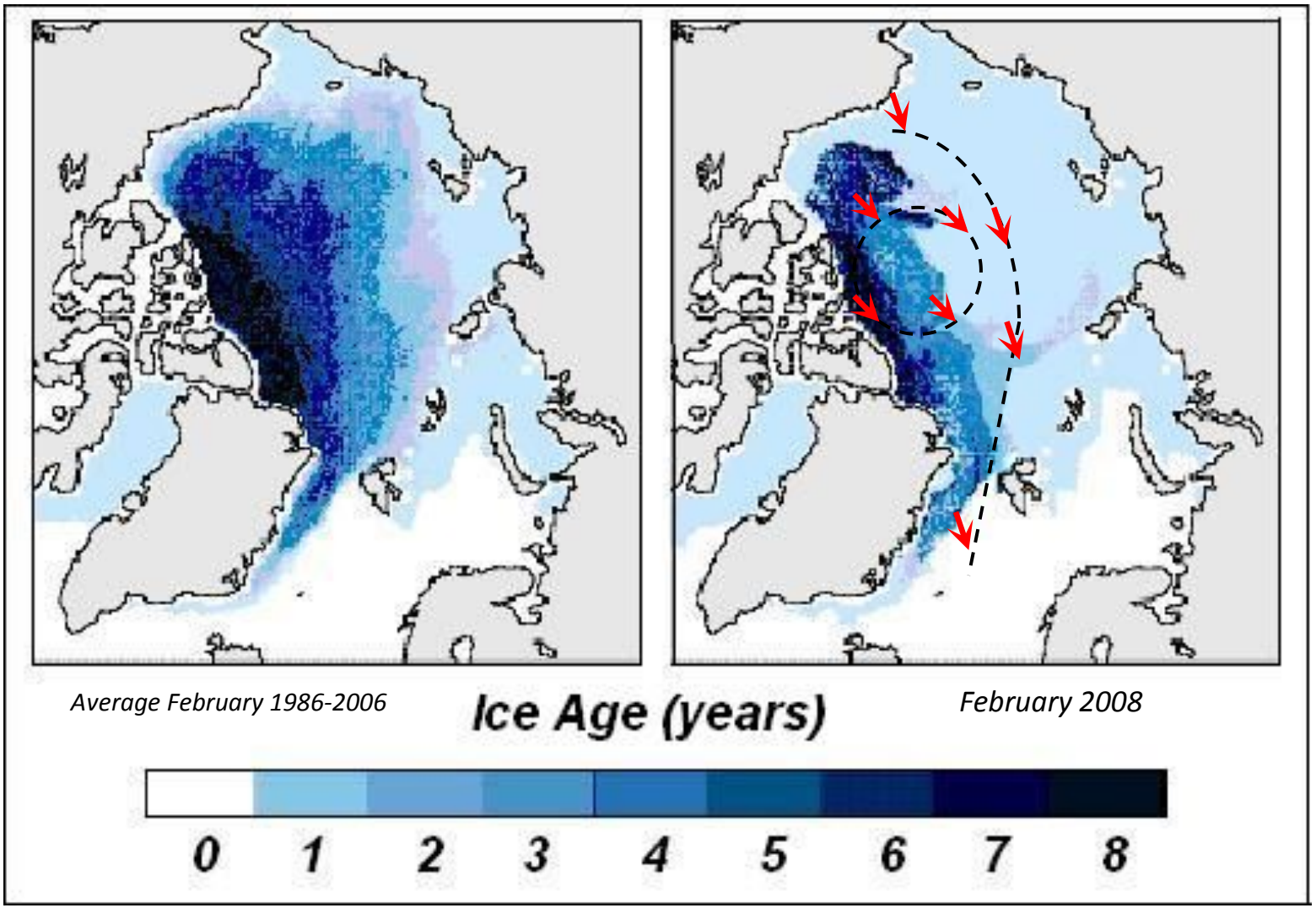
Из постоянных обитателей фауны подо
льдом только два вида амфипод
Apherusa glacialis и *Gammarus wilkitzki* в
стречались в течение всего периода
наблюдений, остальные виды –
из планктона и самый массовый
Oithona similis

NP-22, 23 1977-1980	Group	**PAICEX 2007-2011**
1	Foraminifera	0
1	Radiolaria	0
2	Pteropoda	0
1	Polychaeta	0
18	Copepoda	11
1	Ostracoda	1
1	Mysidaceae	0
2	Isopoda	0
14	Amphipoda	2
1	Chaetognatha	1
1	Appendicularia	1
1	Decapoda	0
TOTAL: 48		**TOTAL: 16**

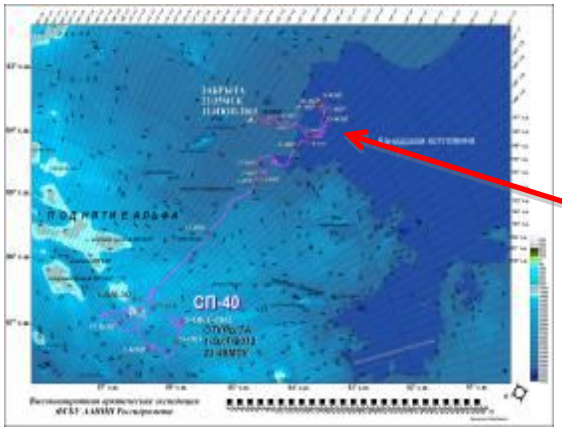
Seasonal ice formation

Sea level



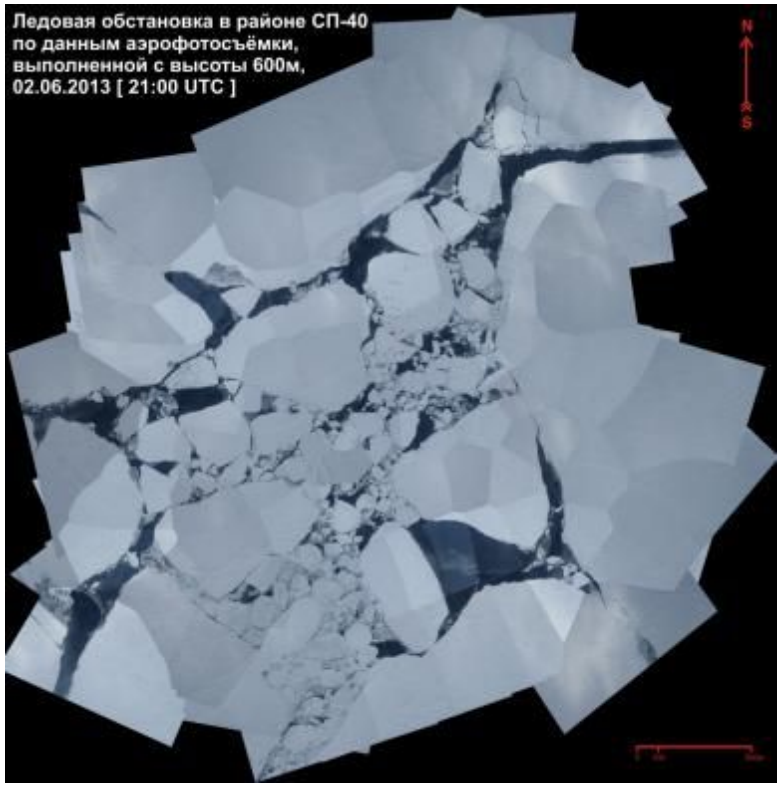


MY ice about 6%, seasonal ice more 90% of the AO sea ice extent.
(*Source: http://nsidc.org/data/seaice_index/n_plot.html).*

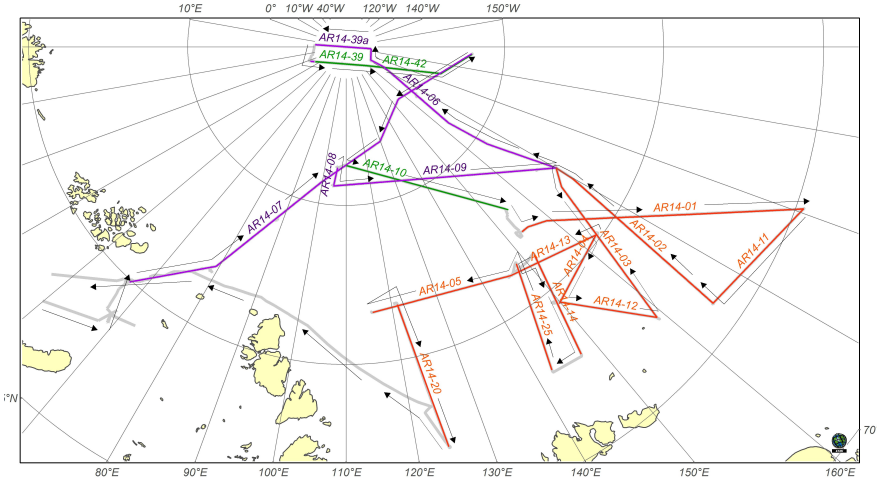


Ice conditions around drifting ice station NP-40, June 02, 2013, when station was nearby the Alfa ridge in Canada Basin

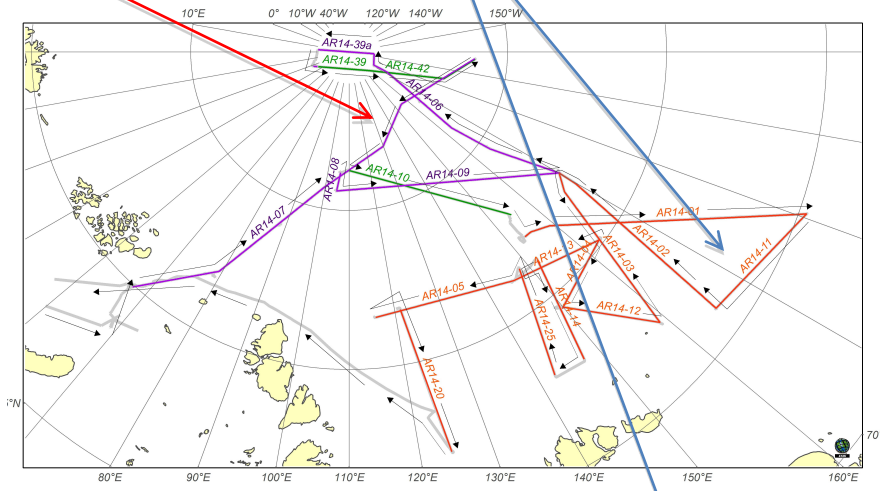
Photo made from elevation of 600 m

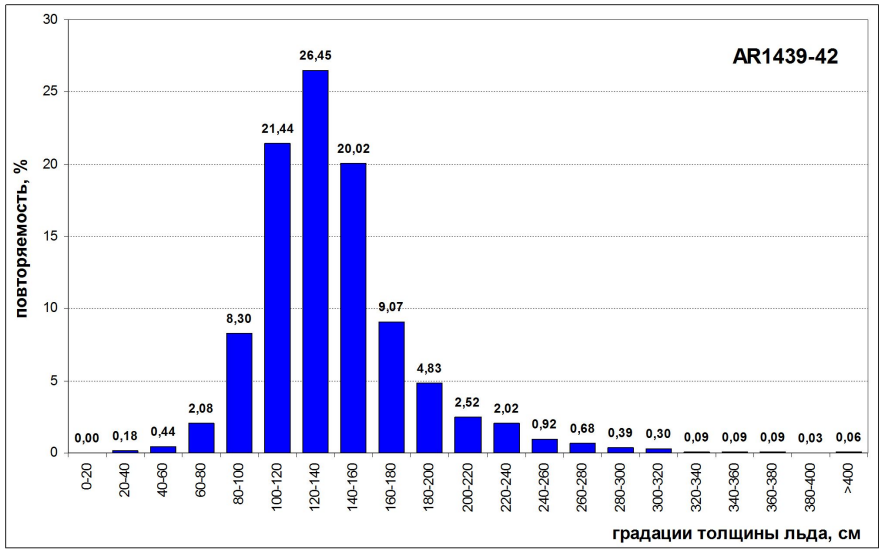


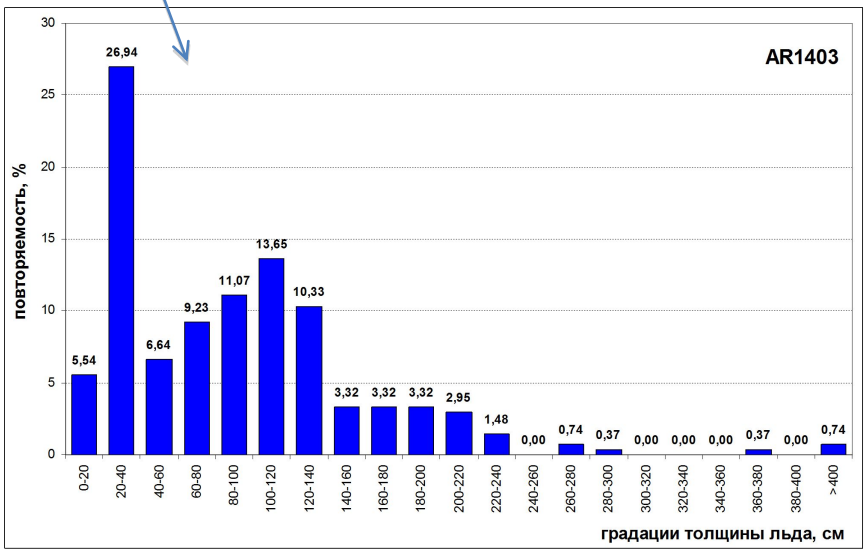
Russian “Ak. Fedorov” expedition in the Arctic Ocean
August-September 2014



Thickness distribution of uniformed sea ice in North (A) and North-East (B) profiles in August-September 2014



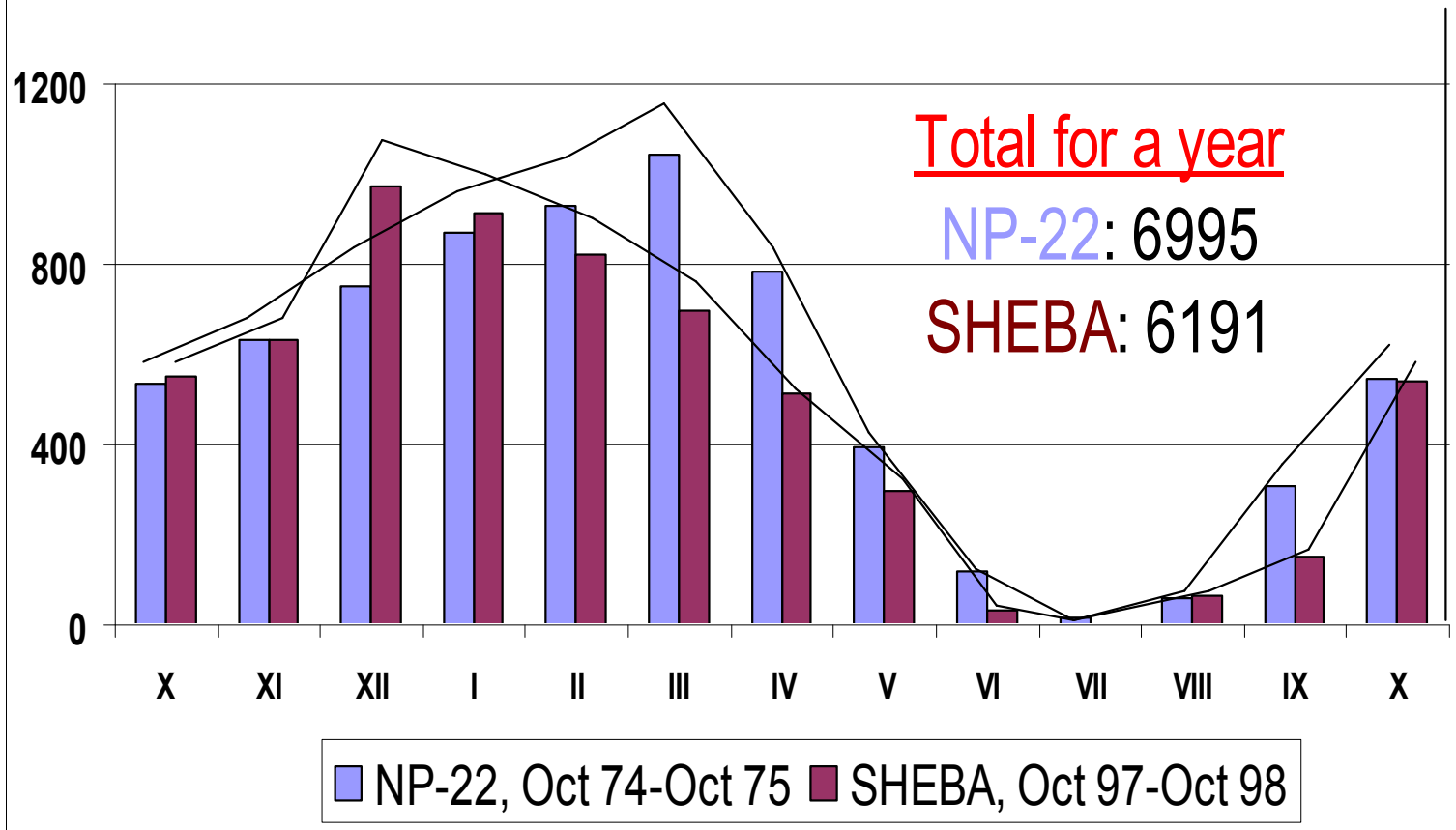




SUMMARY

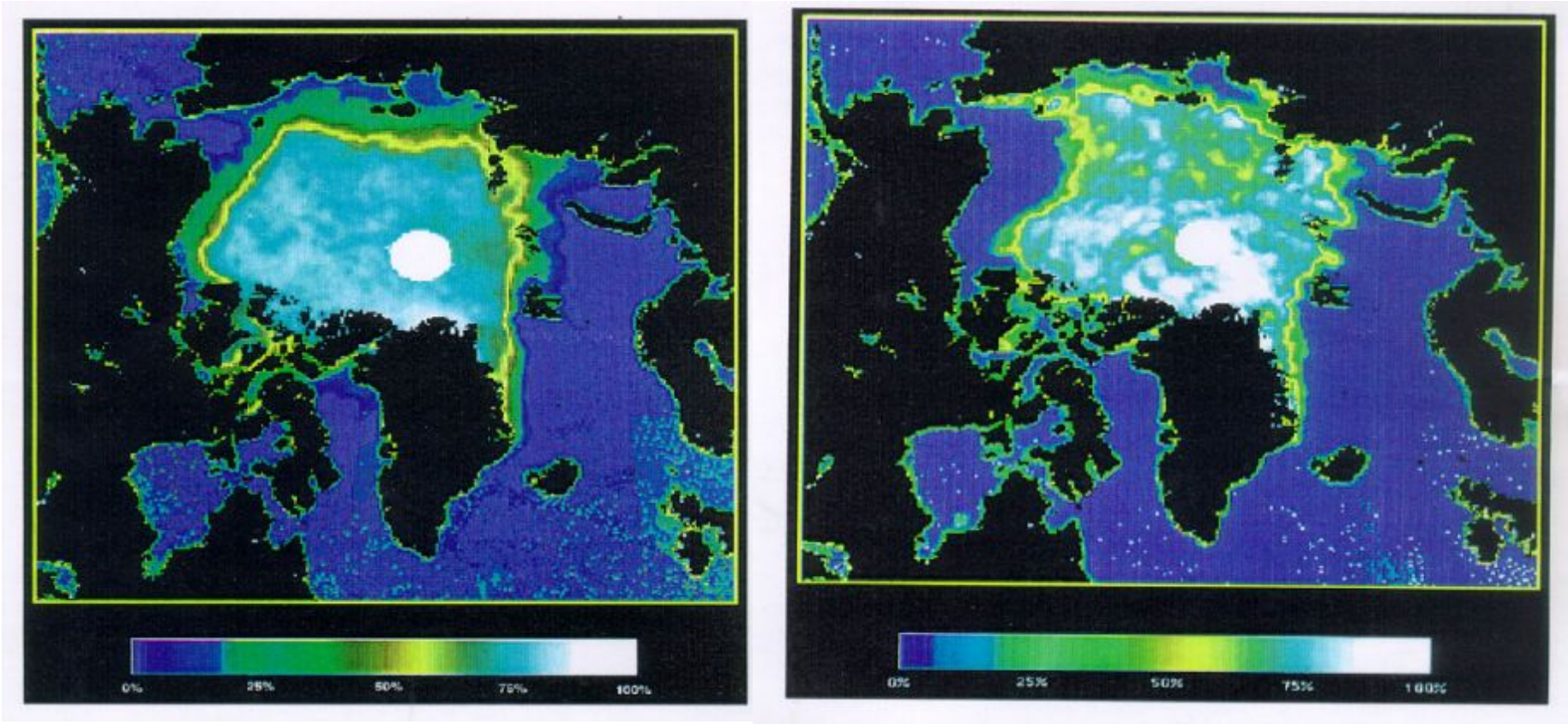
In recent Arctic sea-ice cover, two ecological systems co-exist: multi-year and seasonal sea ice ecosystems of which the composition and function are different. Due to remarkable decreasing of the first, and simultaneous increasing of the second, it should expect the restoration in biodiversity and primary productivity of the Arctic Ocean. If this trend will remain, the biological peculiarities of the Arctic Ocean will be similar to ones of the Southern Ocean.

SUM OF COLD DAY TEMPERATURE



Ten-Year Mean for September, 30

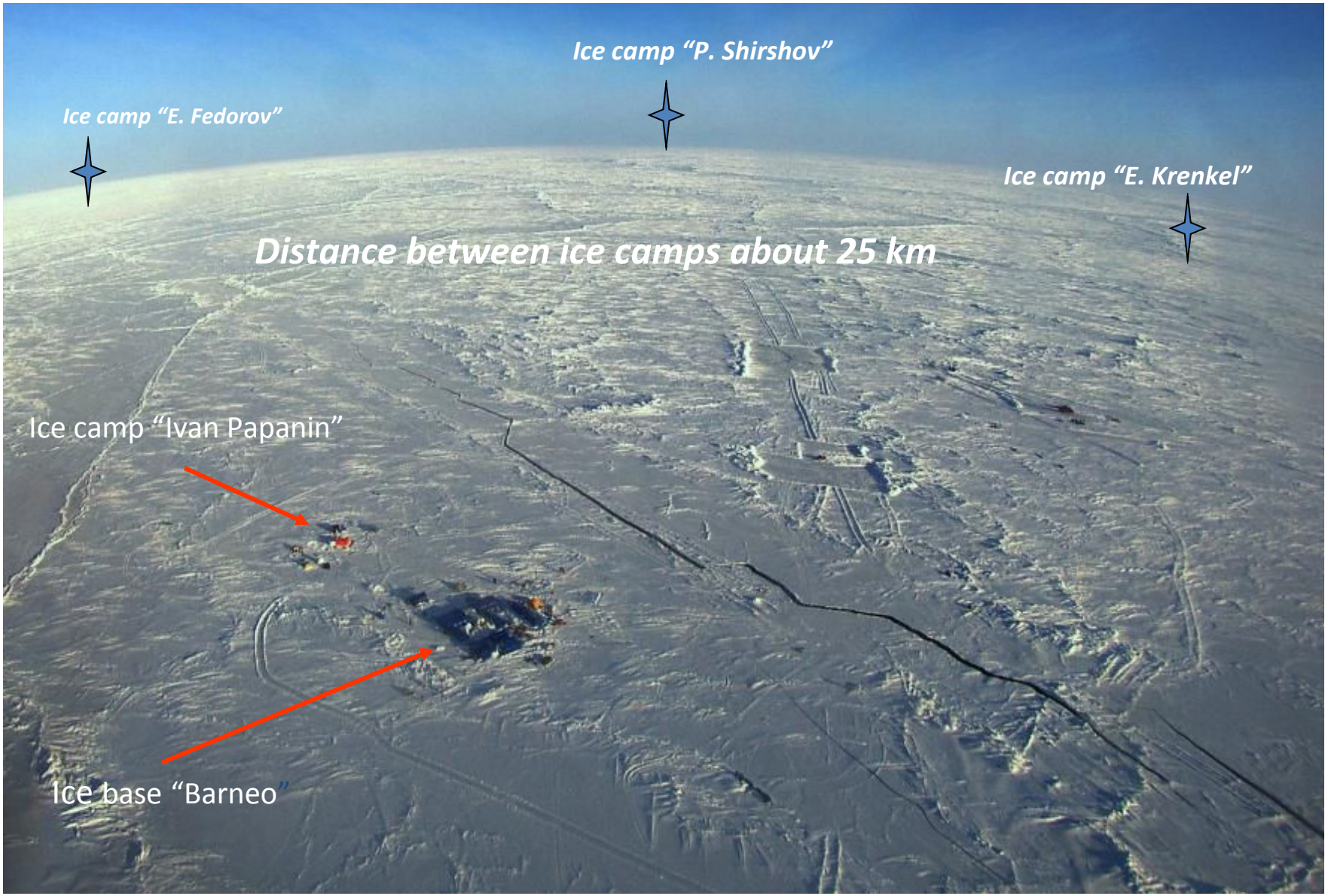
September 30, 1998



Courtesy of W. Chapmen (NASA)

Question: Are the observed changes in sea ice biota composition due to the local change in environmental conditions or these changes wide-spread to the whole AO?

PAICEX-2007


Ice camp “P. Shirshov”
Ice camp “E. Fedorov”
Ice camp “E. Krenkel”
Distance between ice camps about 25 km
Ice camp “Ivan Papanin”
Ice base “Barneo”

Methodology

Field sampling strategy:

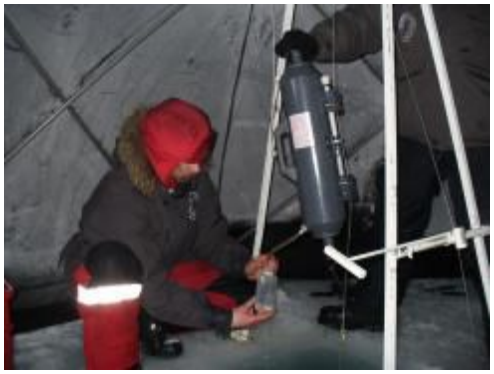
- *Long-term **micro-scale observations** on a small area of the sea ice cover during the winter and/or the summer;*
- *The **meso- and macro scale survey** reveled uniformity in the distribution of the sea ice characteristics within the geographical boundaries of the AO.*

Observations:

- *Upper ice surface;*
- *Sea ice itself;*
- *Water-ice interface.*

Methodological requirements:

- *Using same ice core or water sample for all kind of analyses*



SCUBA under ice sampling




Goal:

(1) Sampling of cryofauna associated with under ice surface of ice

(2) Water sampling from ice-water interface.

Preliminary results:

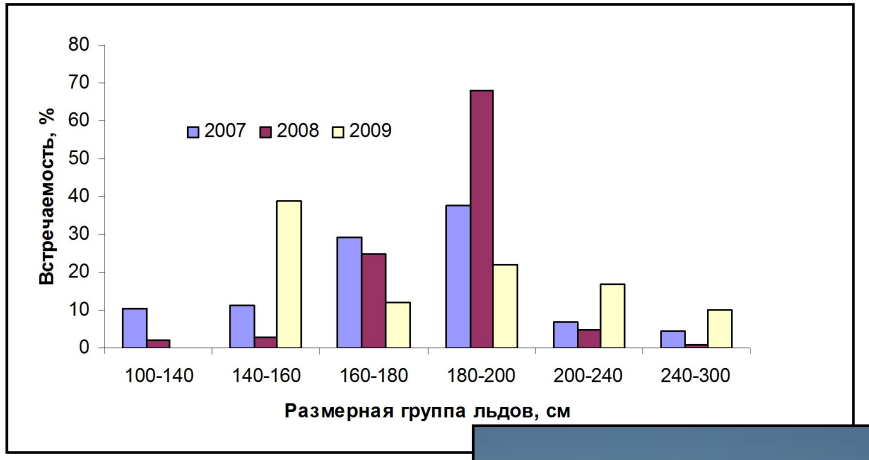
(1) Fauna consists of mainly young stage amphipod *Apherusa glacialis* (150 inds), and *C.glacilis, Acartia sp*., and *O.similis*.

(2) Salinity of water – 16‰.

(3) (Fo) – 0.62, that is an order of magnitude higher than at 5 m depth!

Ice thickness
PAICEX 2007-2011

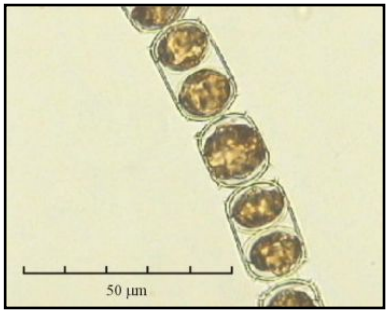
Year	Number of Measurements	Average thickness, cm
2007	137	178 ± 26.6
2008	213	182 ± 15.5
2009	39	183 ± 36.2
2010	23	162 ± 32.5
2011	19	151 ± 21.3

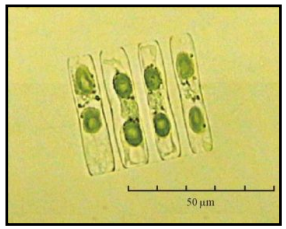


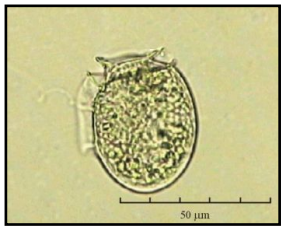
- Выявлено доминирование сезонных льдов
- Встречаемость многолетнего льда составляет около 10%
- Отмечено возрастание торосистости

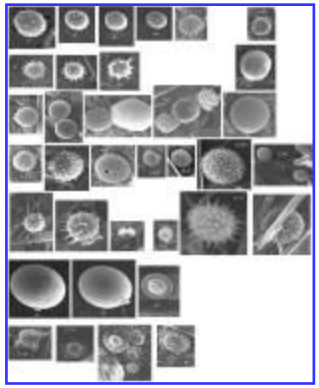
ICE ALGAE SPECIES ABUNDANCE

(PAICEX 2007-2010)









GROUP	07	08	09	10
Centrophyceae:	14	15	8	9
Pennatophyceae:	38	13	17	10
Silicoflagellatae	1	1	1	1
Chrysophyceae	3	6	-	-
Dinophyta	7	11	5	3
Total	63	46	31	23
Sorensen's similarity index	0.41			
		0.22		
			0.24	
	0.18			

• Число видов и количество клеток диатомовых водорослей заметно уменьшилось, но возросло количество цист динофлагеллят

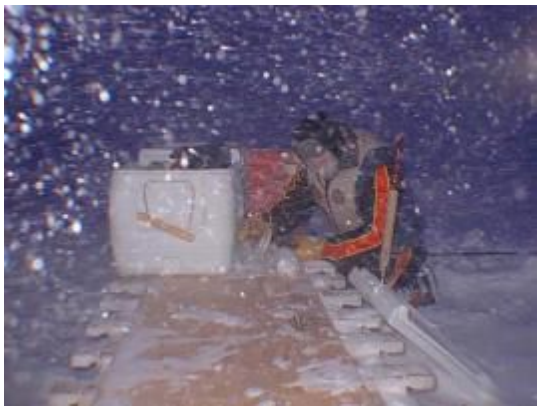
• Индекс сходства между сообществами очень низкий

• Только два диатомовых вида *Fragilariopsis cylindrus* и *Nitzschia frigida*, силикофлагеллята *Dictyocha speculum*, и цисты *Dinoflagellatae sp*. были общими для всех собранных проб

SUMMARY

In recent Arctic sea-ice cover, two ecological systems co-exist: multi-year and seasonal ice ecosystems of which the composition and function are different. Due to remarkable decreasing of the first, and simultaneous increasing of the second, it should expect the restoration in biodiversity and primary productivity of the Arctic Ocean. If this trend will remain, the biological peculiarities of the AO will be similar to ones of the Southern Ocean.

Story of one sea ice sampling, SHEBA, Jan 05, 1998



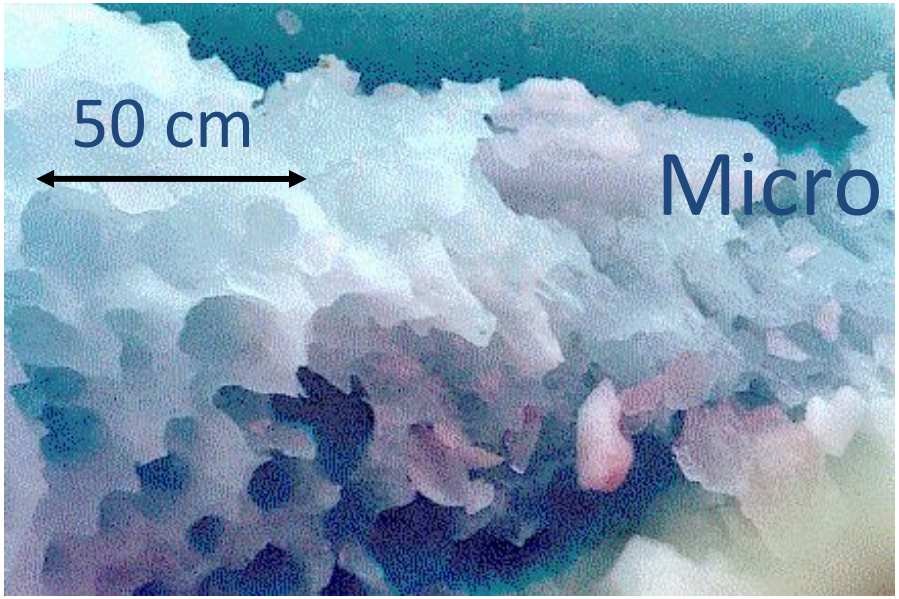
3 hours of ice coring and processing

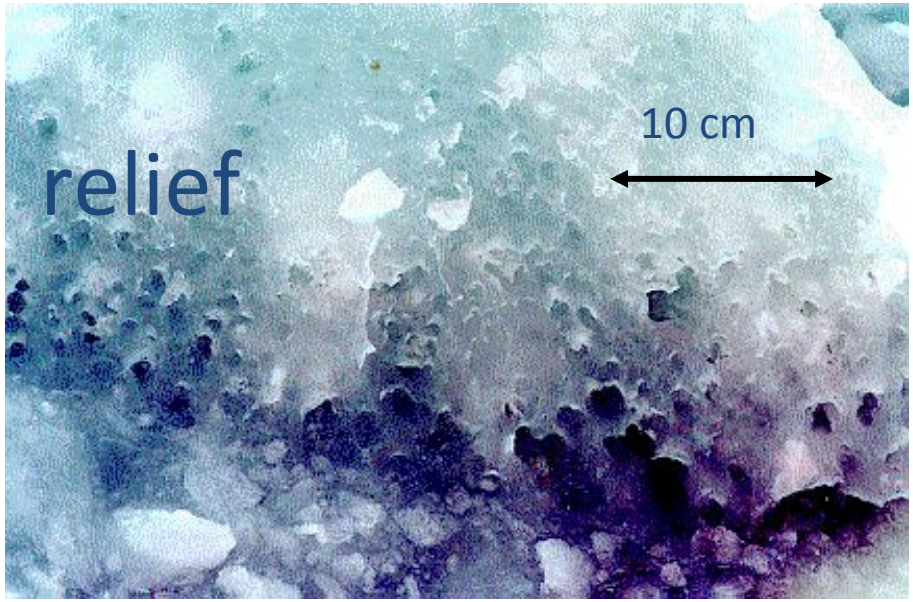
Before ice sampling

After 4 hours of work on ice

Coming back with…nothing

Bottom sea-ice topography

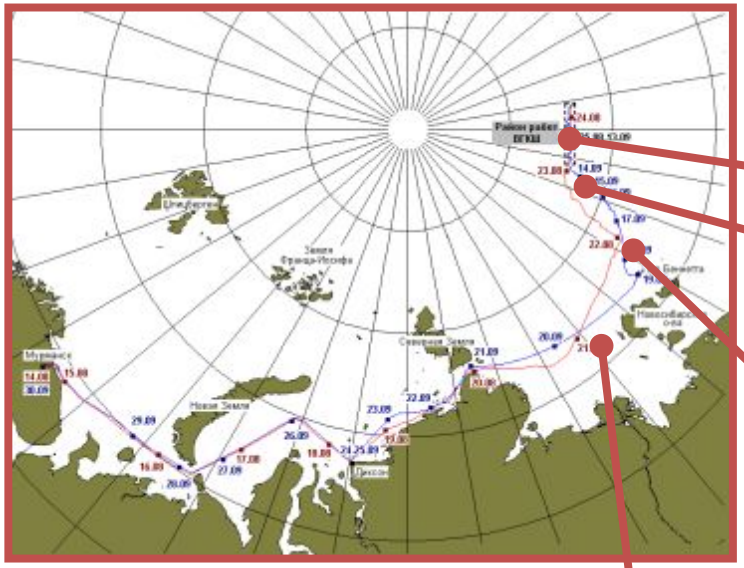


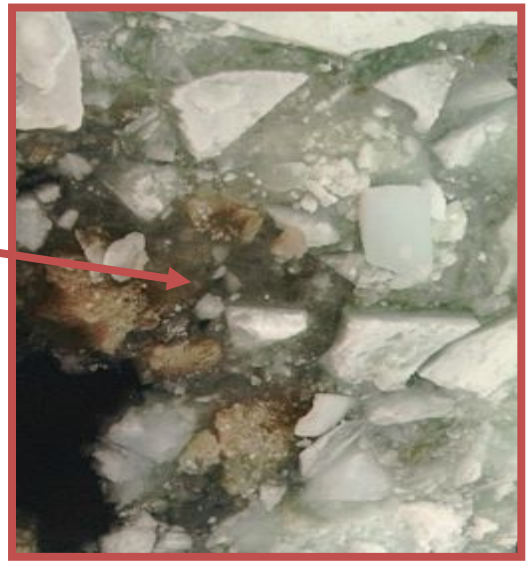


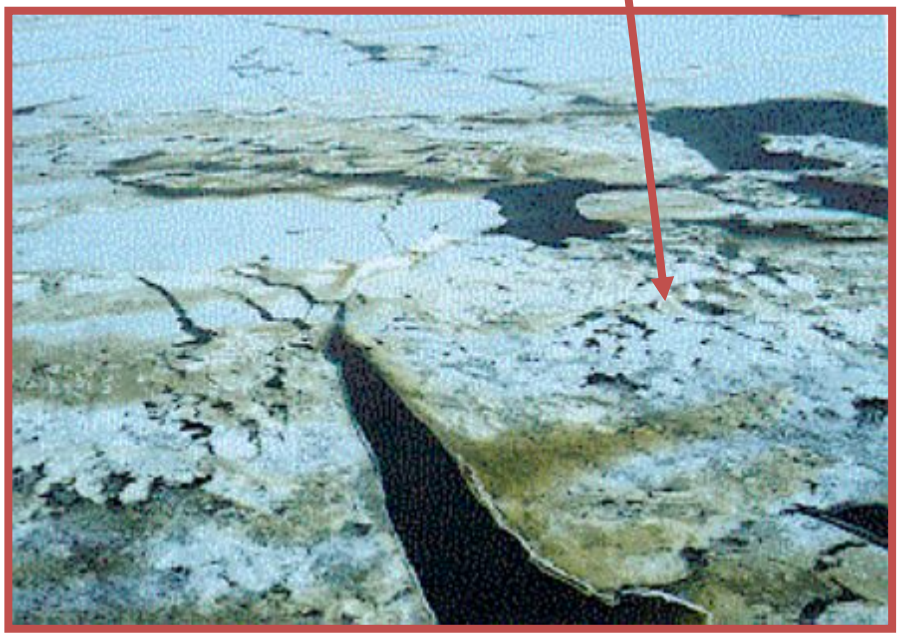
Sediment-laden sea ice in the Arctic Ocean

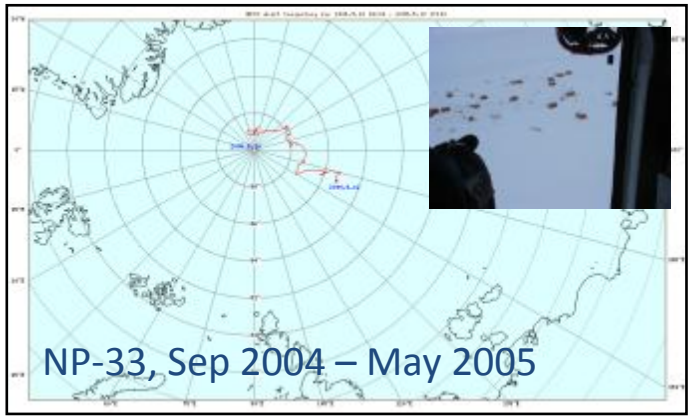
Russian “Arctic-2000” expedition, “Ak.Fedorov”

August-September 2000







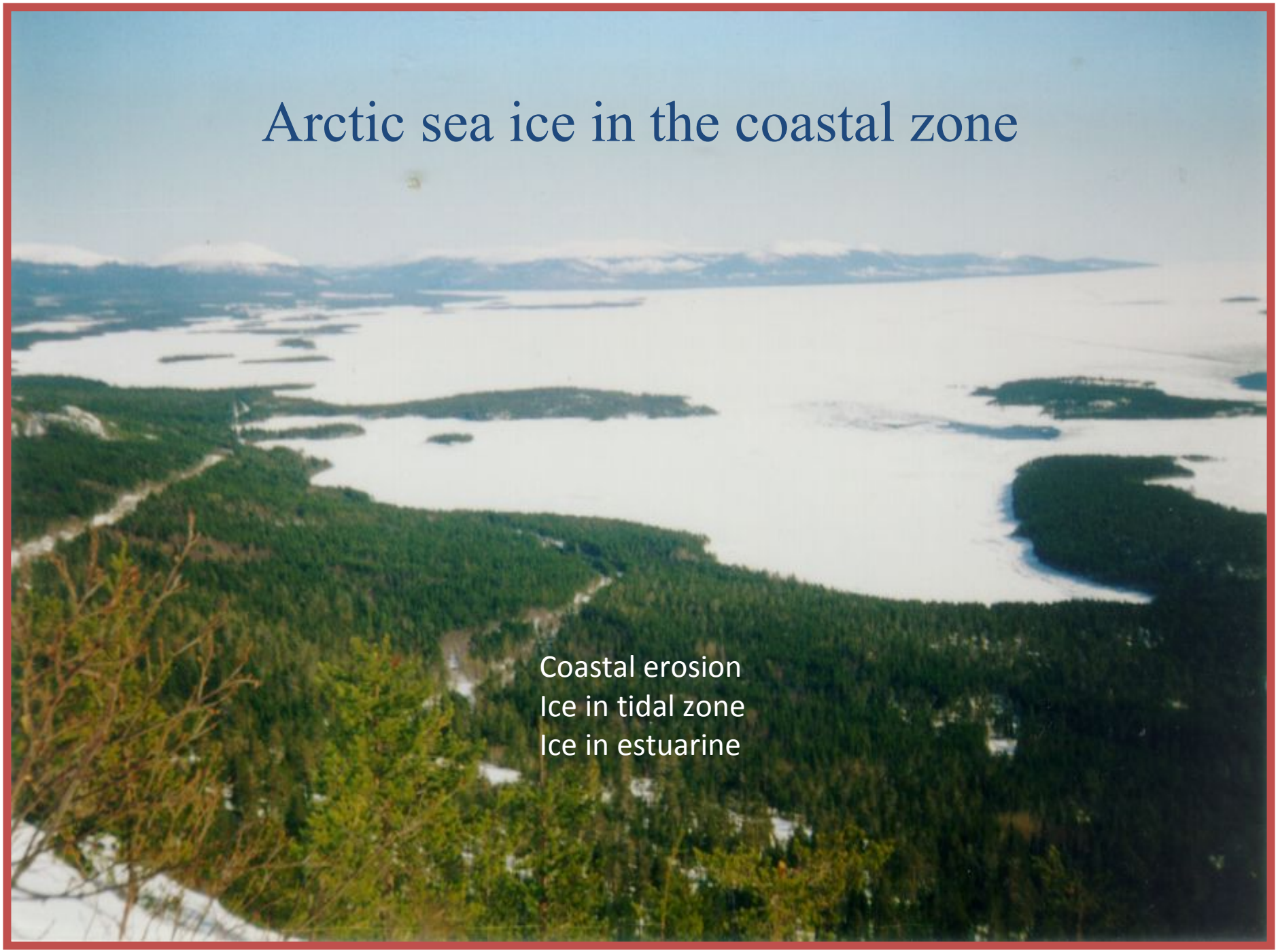


Pseudo-sea-ice-biota: Chukchi Sea benthos on ice in the Central Arctic Ocean

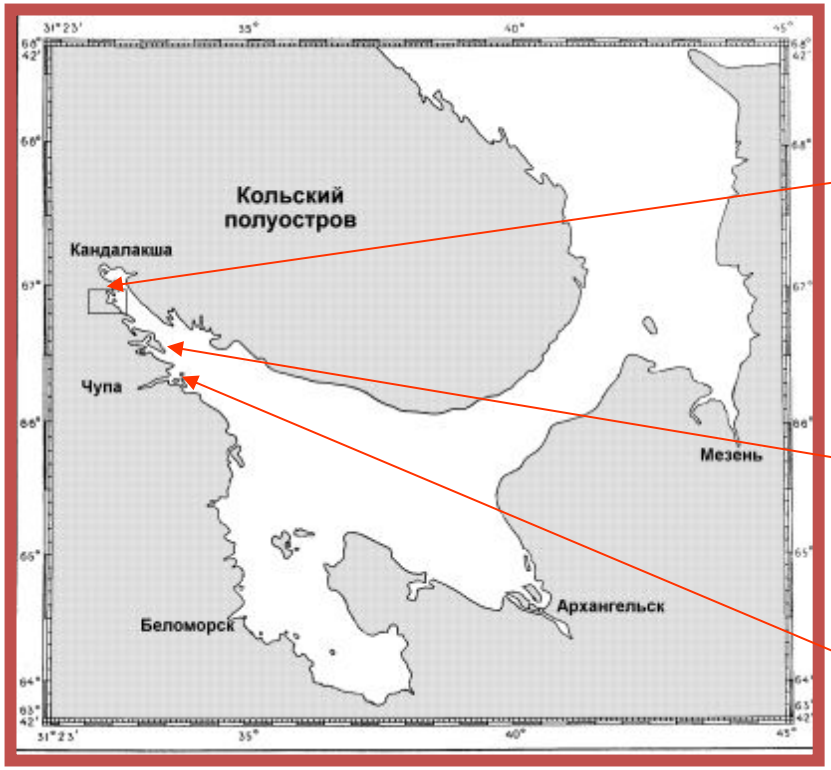
At Russian ice station “North Pole-33”, July 17, 2005 (87°47N and 168W) were collected benthic invertebrates on ice surface: Sponges Demospongia; Abietinaria; Alcyonaria*; Mesidothea sibirica*; Bivalvia: *Astarte borealis and Muskulus sp*.; Gastropoda: *Naticidae sp*; Sea star: *Lophaster furcifer*; Bryozoa: *Flustra foliacea* and *Gemellaria loricata*

Melnikov. Zezina, 2012

Arctic sea ice in the coastal zone



STUDY AREA: three sites in
Kandalaksha Bay of the White Sea



Coastal sea ice zone in Kandalaksha bay of the White Sea

Accumulative coast

Abrasive coast

Two types of coast: (1) long, wide and flatable beach (accumulative coast), and (2) rocky, sharp and narrow shore (abrasive coast)

Example of accumulative coast

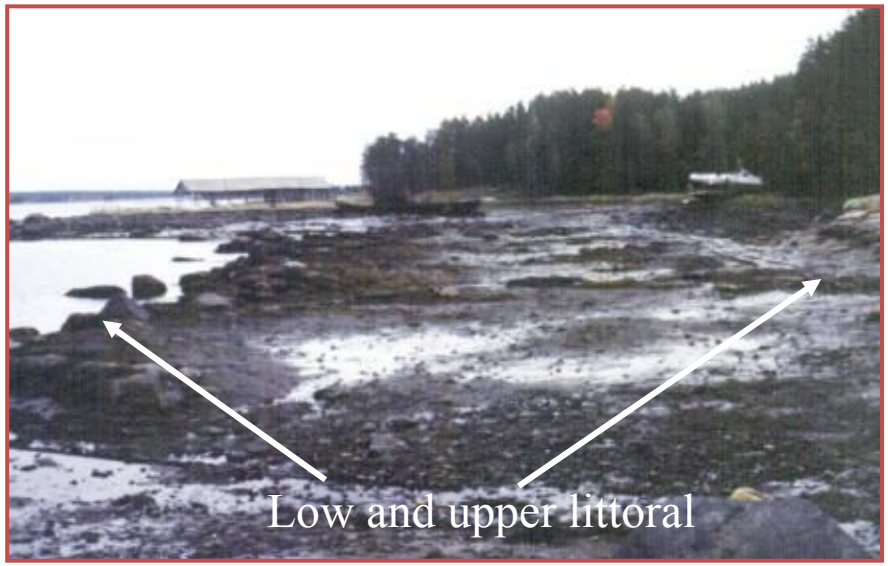
Kandalaksha Bay, region of the MBS MSU, 1999

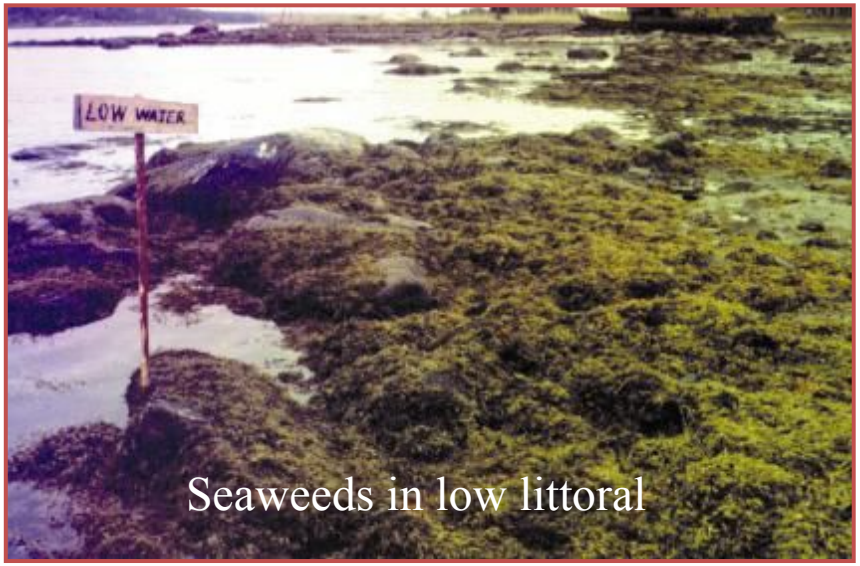
High tide

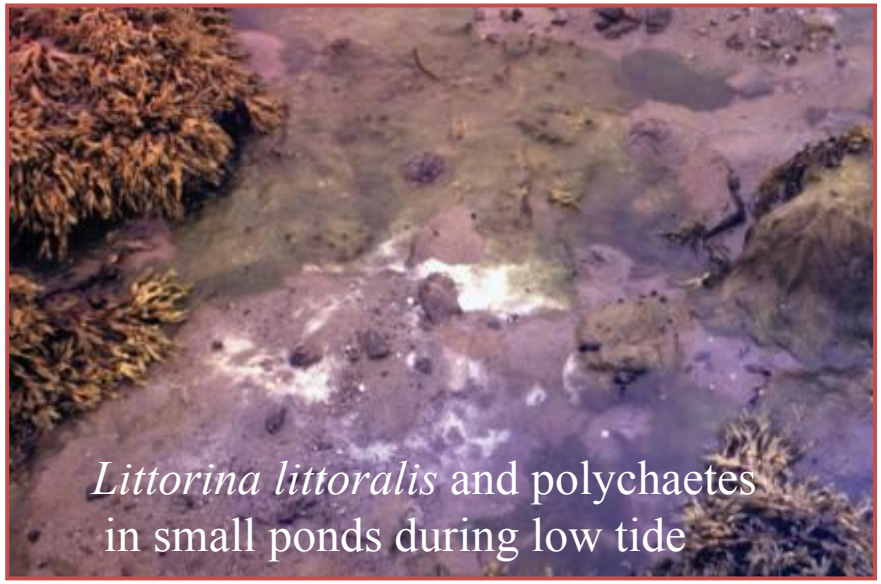
Low tide

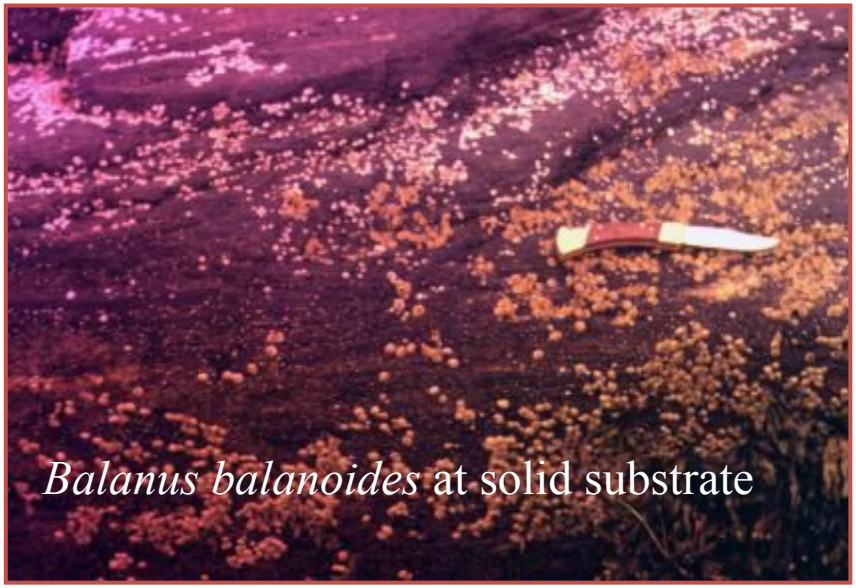
LITTORAL ZONE IN SUMMER

Kandalaksha Bay, region of the MBS MSU, September 1999









LITTORAL ZONE IN WINTER

Kandalaksha Bay, region of the MBS MSU, April 1999

Fast ice and hummocks

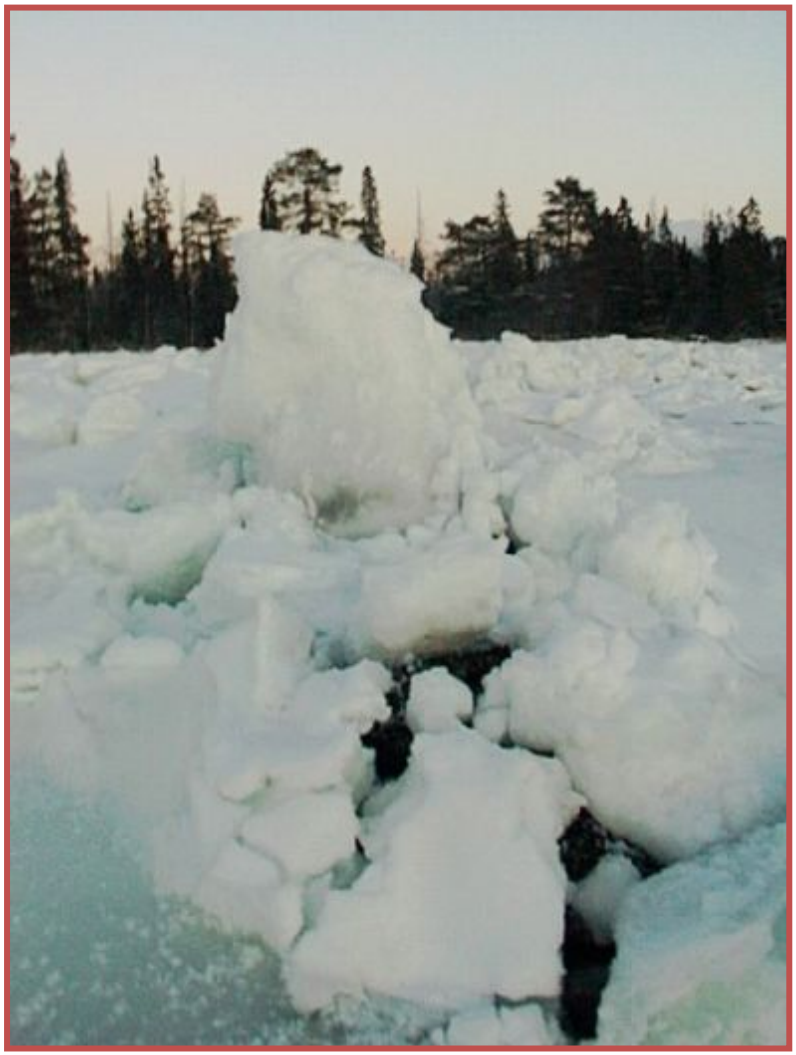
Ridged ice

Ice edge and polynya

Anchored ice on "dried" littoral during low tide

"Ice balls" in fast and shore ice interaction zone, Kandalaksha Bay, White Sea, March 2002

Accumulative coast



Ice formation on the level coast

Melting coastal ice in low tide

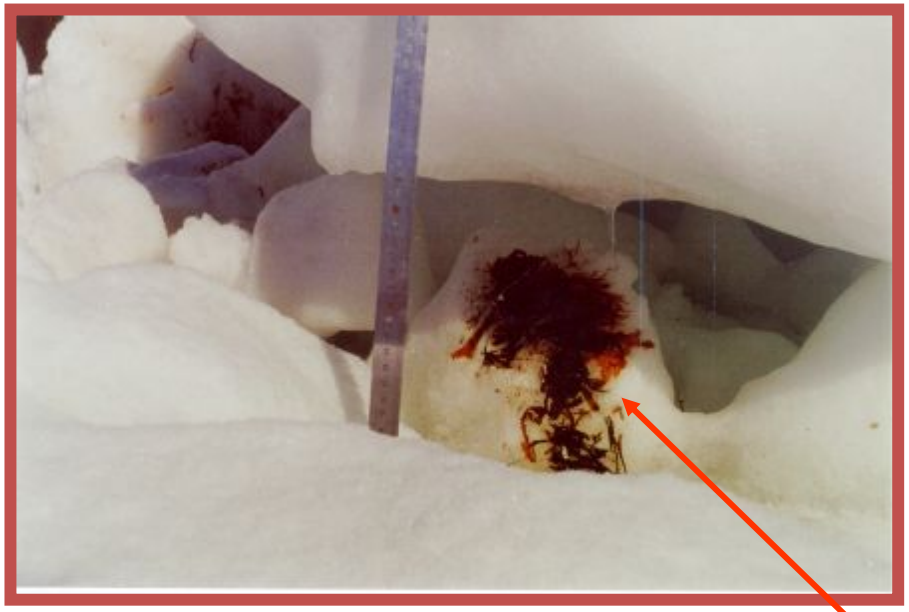
SEA ICE-BOTTOM INTERACTIONS

Kandalaksha Bay, region of the MBS MSU, April 1999

During the low and high tides the ice "bulldozing" the floor, large and small stones in direction to upper shoreline and accumulate sediments and stones.

SEA ICE IMPACT ON BENTHIC POPULATIONS

Kandalaksha Bay, region of the MBS MSU, April 1999



We found that after the winter season about 90% of *seaweeds* and up to 70% of *balanoides* number are destroyed by ice annually

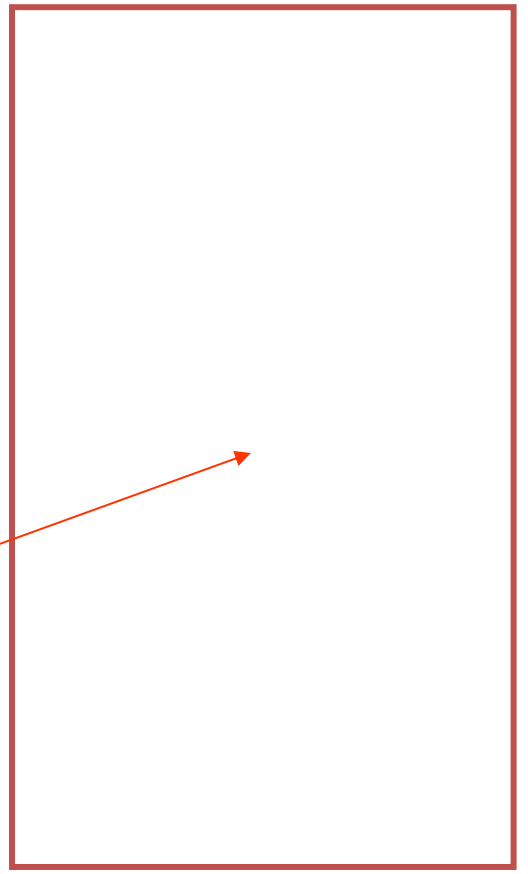
EROSION IN COASTAL SEA ICE ZONE

Kandalaksha Bay, region of the MBS MSU, September 1999

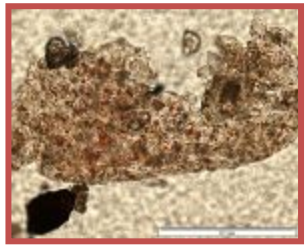
EROSION IN COASTAL SEA ICE ZONE

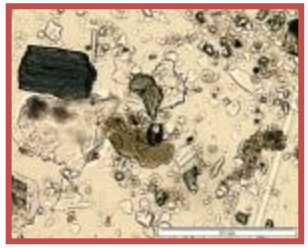
Chupa Inlet, winter 2003-2004

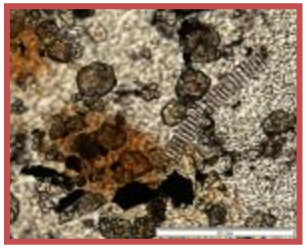
Terrestrial materials in the coastal sea ice

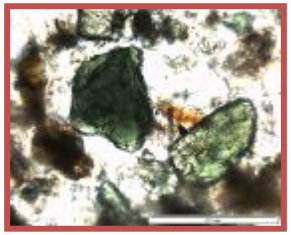


Sediment-laden particles









SEA ICE BIOLOGICAL PROCESSES in LITTORAL ZONE

Kandalaksha Bay, region of the MBS MSU, January 1997

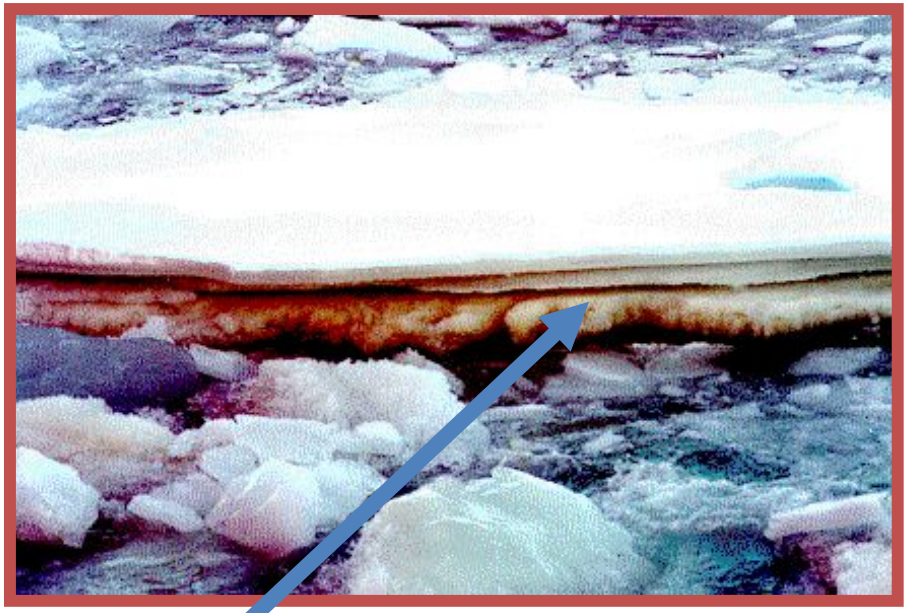
Stages:

1. Overflow of sea water on upper-ice surface during the high tide
2. Phytoplankton bloom in pond; freezing of water in pond; next overflow
3. Multi-layers formation

Chl_a: *3000-5000 ug/l in ice and <1-2 ug/l in under-ice sea water*

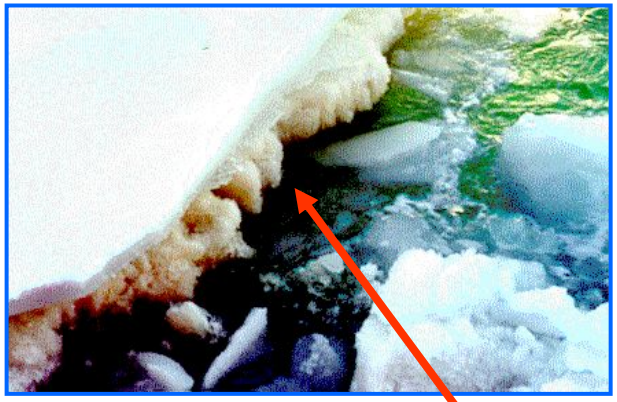
Infiltration ice in the Arctic Ocean

"Russian Arctic-2000" Expedition, September 2000, 82N 170W

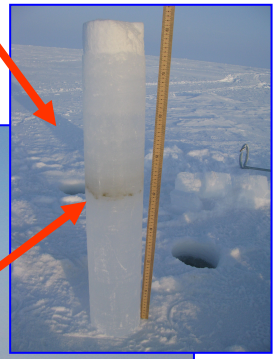


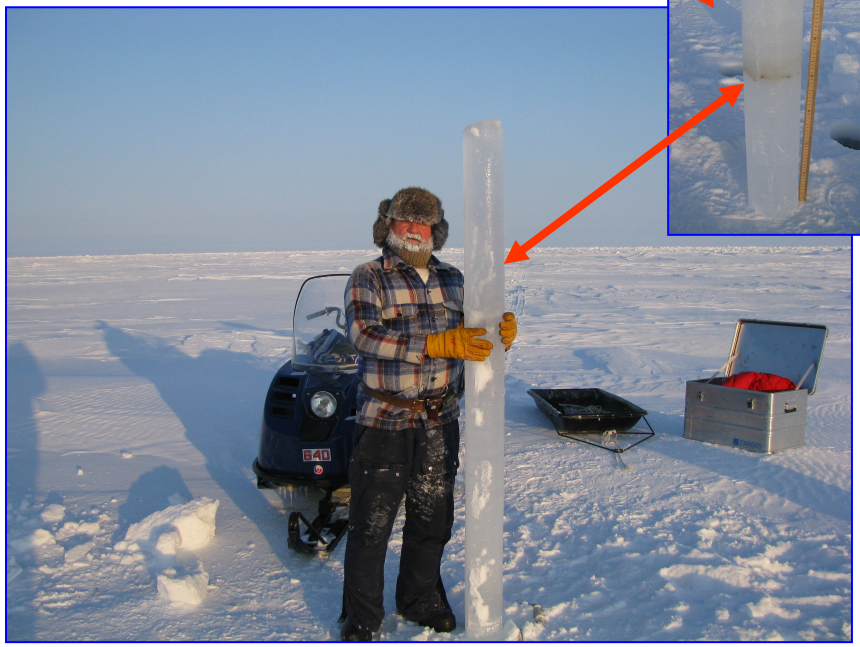
Snow-ice algae community

Infiltration ice in the AO



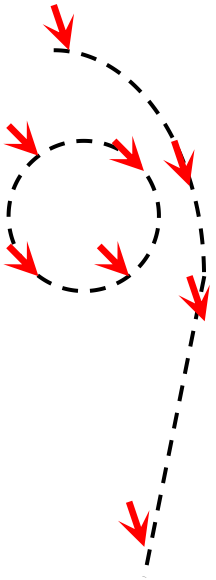
September 18, 2000
82N 170W
“Arctic -2000” expedition
Icebreaker «Ak. Fedorov»





April 05, 2009
PAICEX-2009

ISW, Feb 1992



Average February 1986-2006

February 2008

Площадь льда в феврале 2008 (справа) по сравнению за этот месяц за период 1985-2000 (слева). Многолетние льды занимают площадь около 6%, а сезонные льды более 90% площади океана. (*Источник: http://nsidc.org/data/seaice_index/n_plot.html).*

ECOSYSTEM

E. ODUM ' s conception, the ecological system implies " … any unity, including all organisms in a given area, interacts with a physical environment in a such way that an energy flux creates a clearly-determined trophical structure, species diversity, and matter flux within the system" (Odum, 1971).

By another words, such exchange by energy between biotic and abiotic parts within the system when the functional stability is established even for a while.

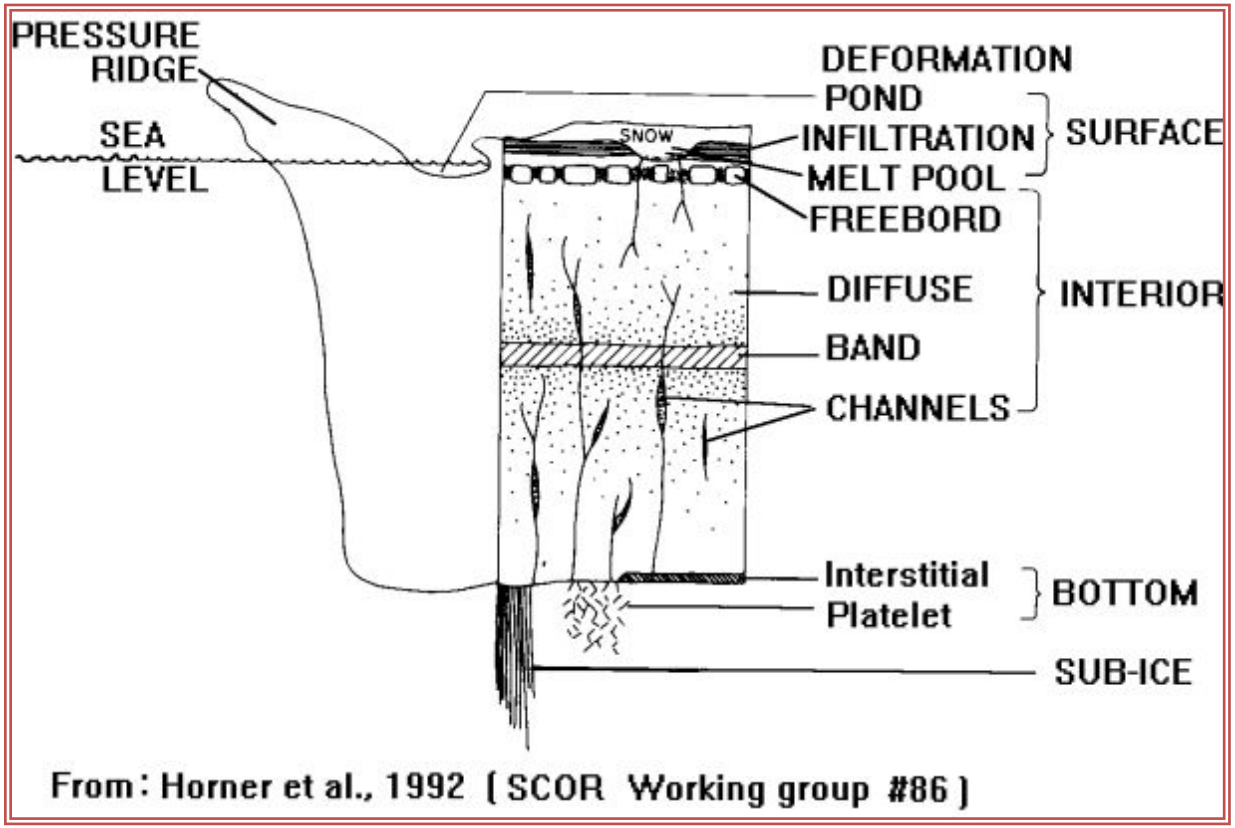
ECOSYSTEM = BIOTOP + BIOTA

Chaos in terminology!

Previously used terms in sea ice ecology

- ***Ice plankton, cryoplankton.*** Organisms peculiar to sea ice that developed and form communities in and around ice in summer (Zubov, 1945);
- ***Brown ice, colored ice.*** Defined by color and algal content (Fukushima, 1961, 1965);
- ***Plankton ice***. Formed when seawater freezes (Matsuda, 1961; Meguro, 1962; Meguro et al., 1966);
- ***Epontic***. Attached and non-attached species especially adapted for life in sea ice (Bunt & Wood, 1963);
- ***Cryophyton.*** Algae living in snow and ice fields (Round, 1981);
- ***Cryobiont***. Refers to organisms inhabiting snow and ice (Kol, 1942; Bursa, 1963);
- ***Sympagic.*** Refers to organisms living with sea ice (Whitaker, 1977; Carey, 1985);
- ***SIMCO.*** Sea Ice Microbial COmmunities; includes viruses, bacteria, diatoms etc. (Sullivan & Palmisano, 1981);
- ***Interfacial.*** Free-floating algae at the ice-water interface (Tremblay et al., 1989) etc.

Sea ice terms adopted by WMO (World Meteorological Organization) in 1968 (Kingstown) were used as a base to develop terms for sea ice biota communities and their occurrence in Polar regions



1. Horner et al., 1992. *Ecology of the sea ice biota*. 1. *Habitat, terminology, and methodology*. Polar Biol. 12: 417-427.

2. Legendre et al.,1992. *Ecology of the sea ice boita*. 2 *Global significance*. Polar Biol. 12: 429-444.

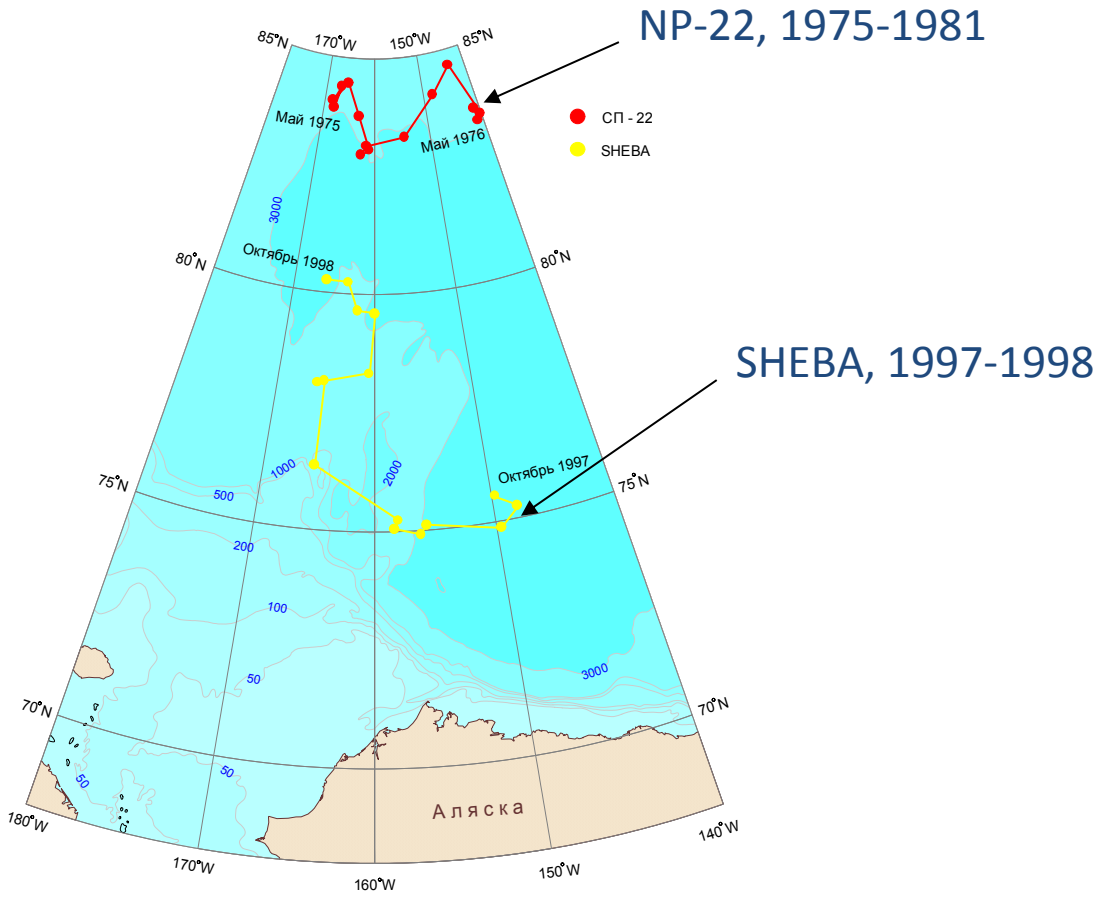
US experiment: Surface HEat Budget in the Arctic ocean

SHEBA Ice Camp

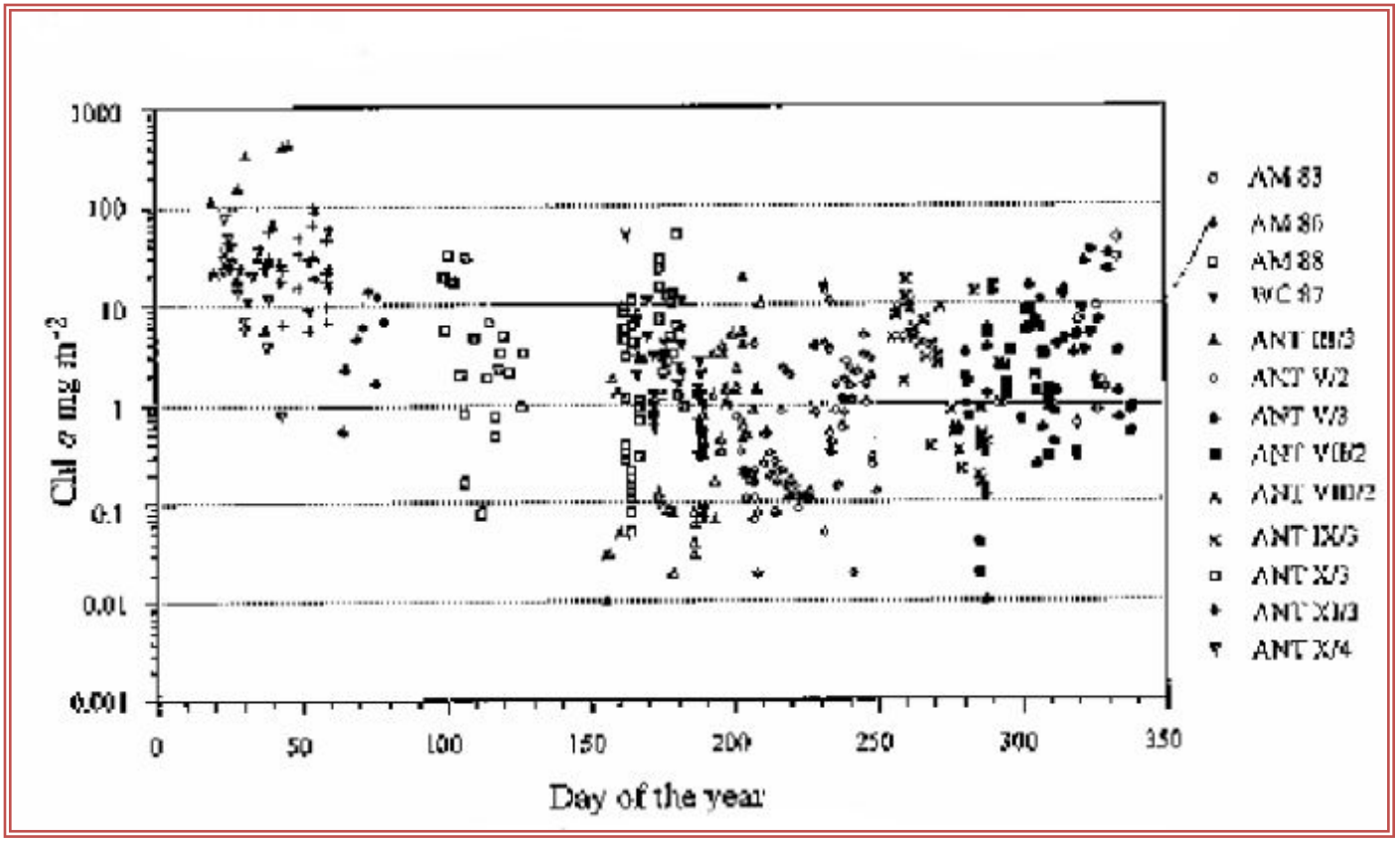
September 1997-October 1998

NP-22 and SHEBA drift in the Canadian Basin

(same region, 20-years difference, chance for comparison of data)

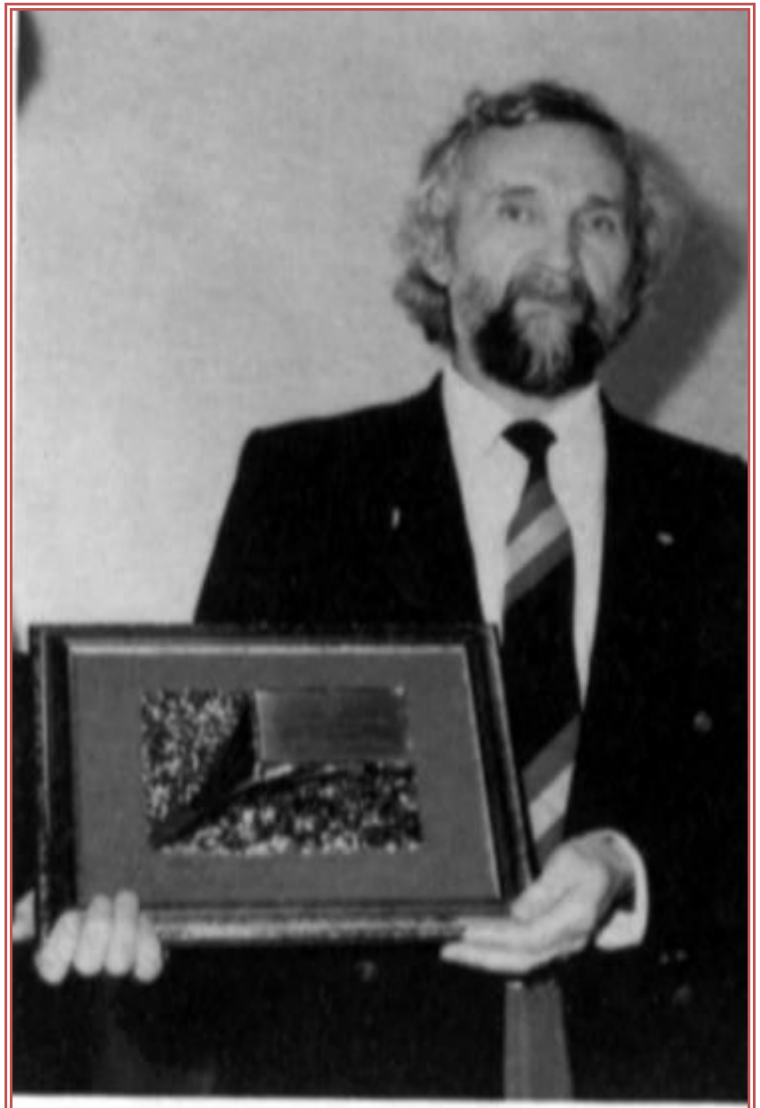


Chlorophyll *a* in Antarctic sea ice



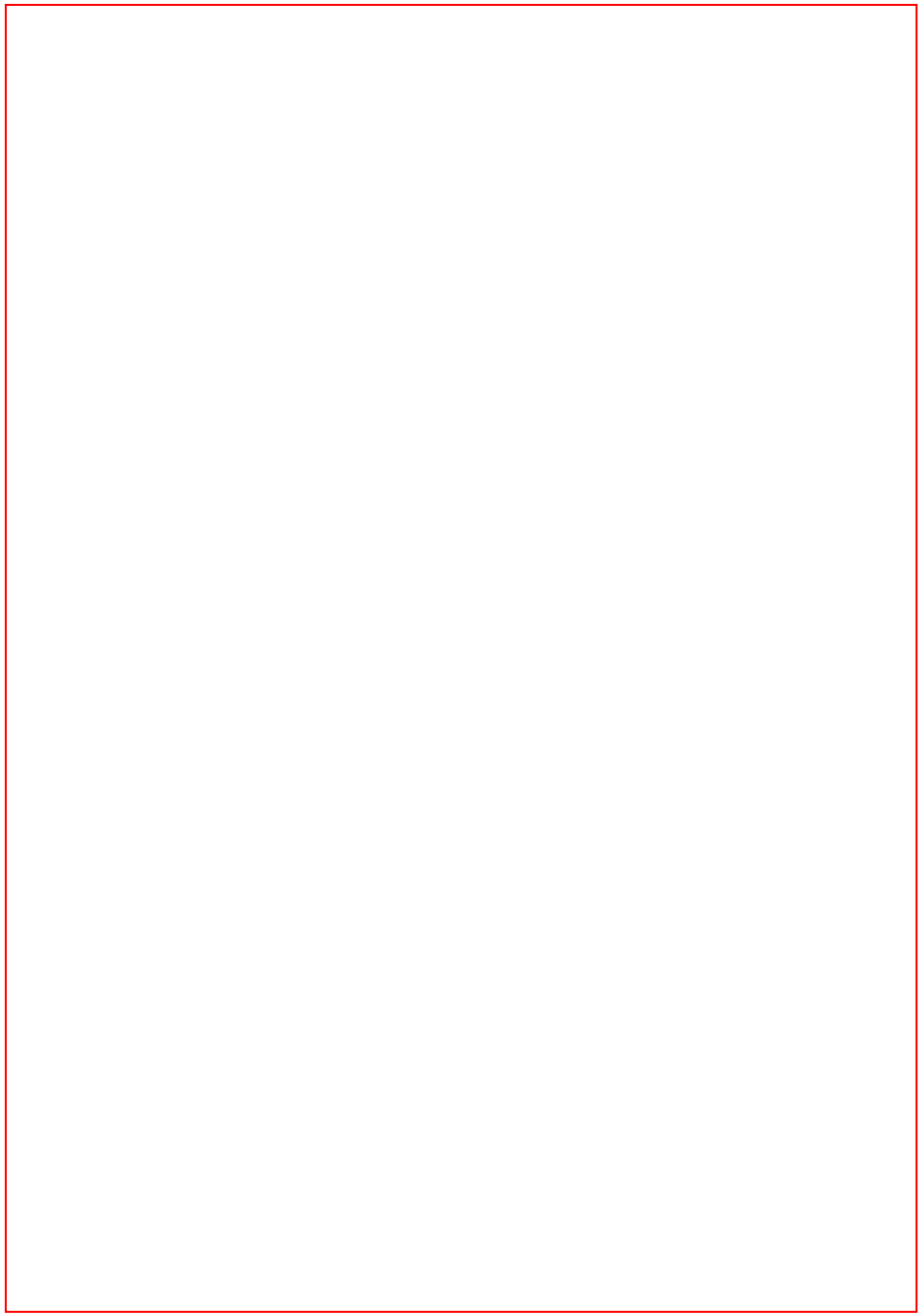
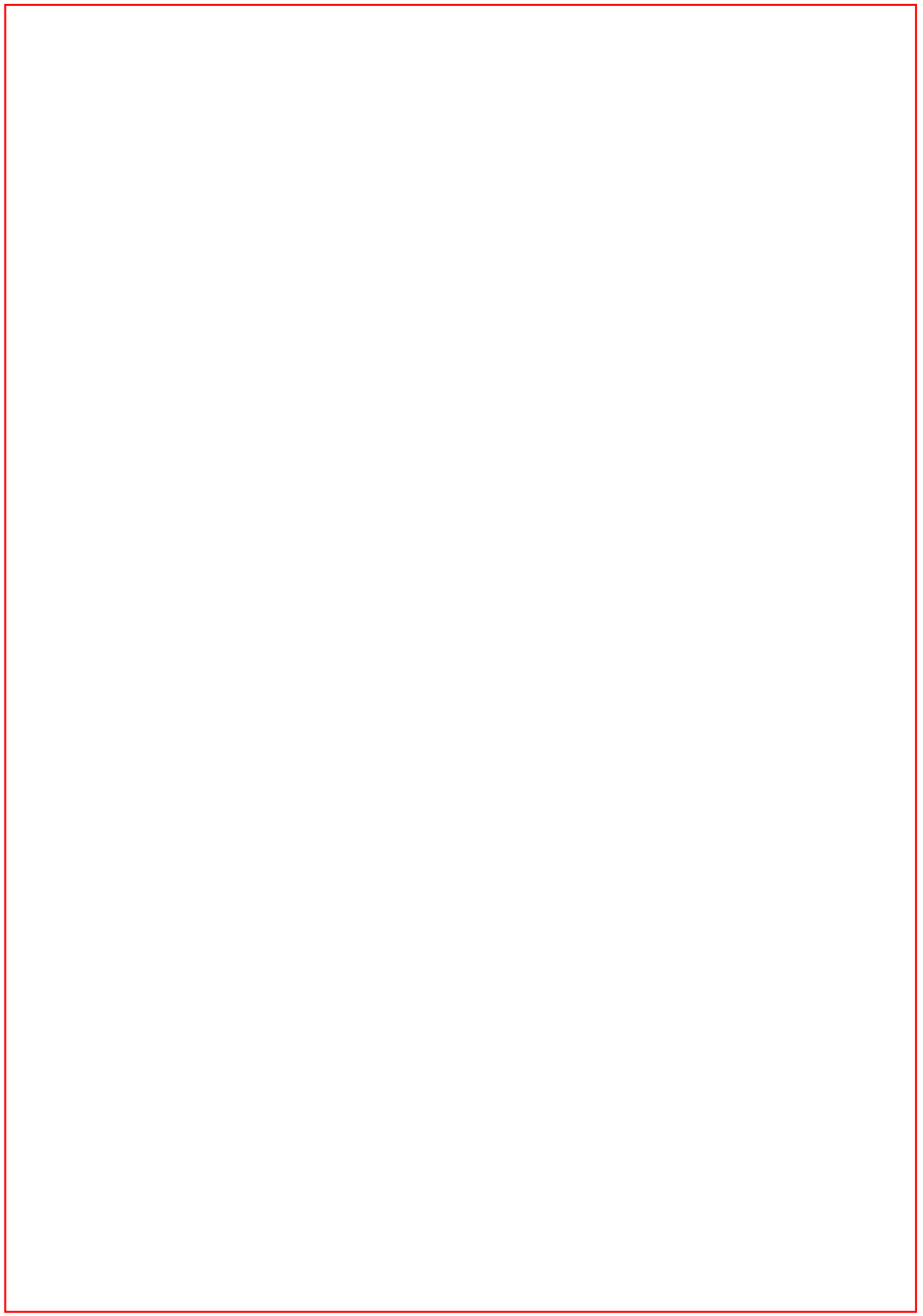
Areal Chl *a* concentrations determined from 448 sea ice cores collected during 13 US and German cruises. *From: Dieckmann et al.,1998.*

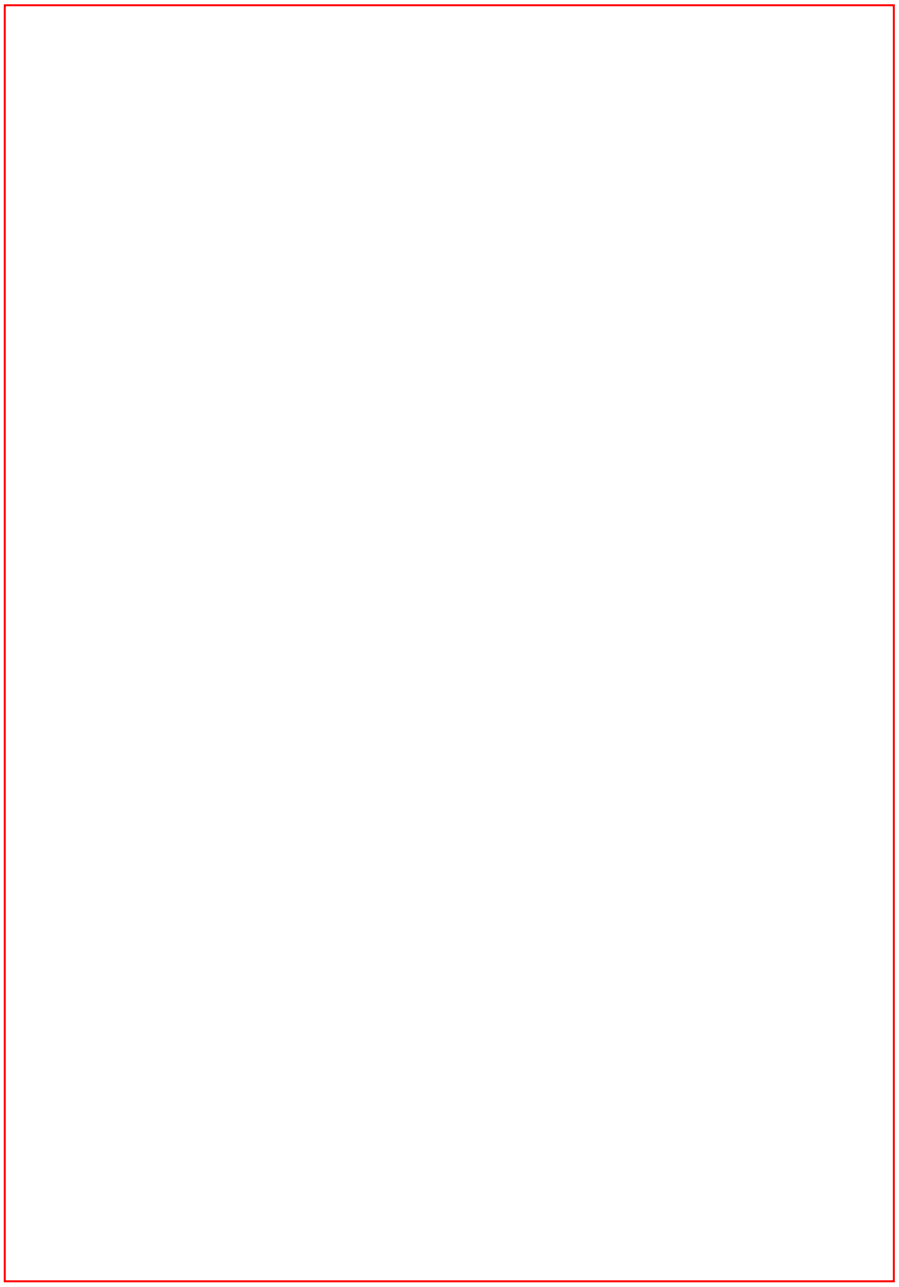
1994 CMAS Grand Prix Award

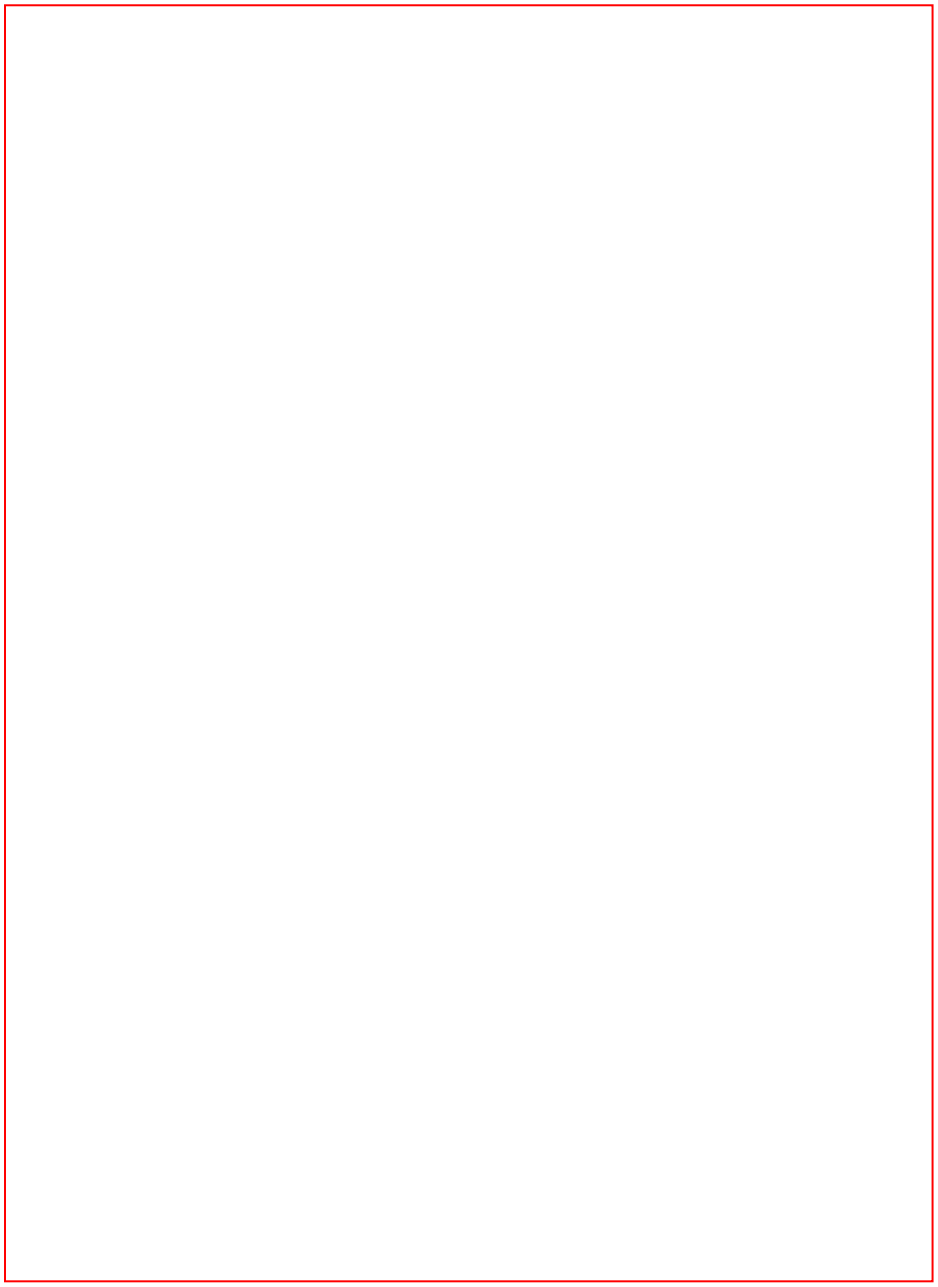


(Photo: courtesy of the CMAS).

"I am one of those who're very grateful to the KGB. In 1972 they refused to issue me with a visa to leave the USSR. The only ocean I didn't need a visa to get to was the Arctic Ocean".





GRC 1997

GRC 1999

GRC 2001

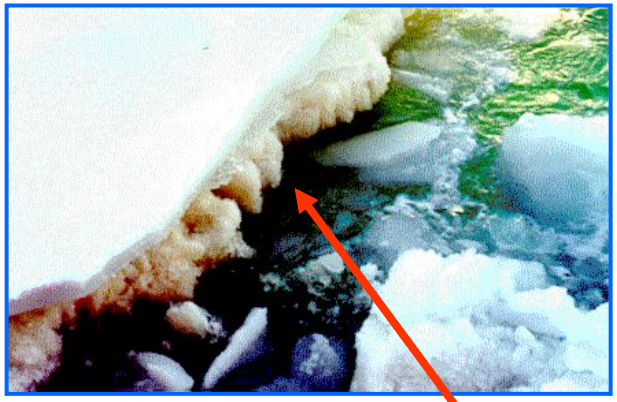
GRC 2001

Polar Marine Sciences

"A model, at best, contains everything we know“ - *Barbara* said

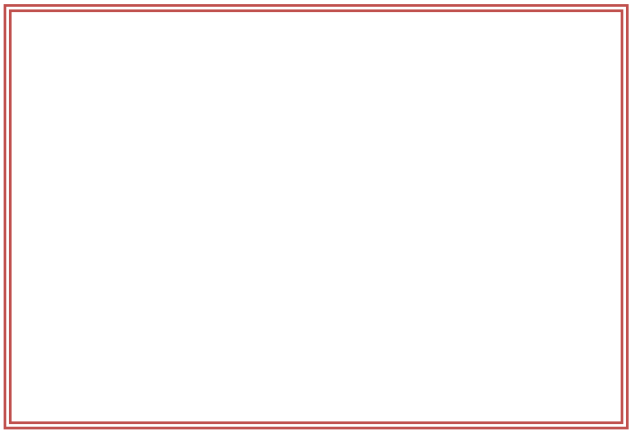
“Do you really believe that there are enough data for parameterization the sea ice biological model?” – *Igor* asked.

Инфильтрационный лед в СЛО: развитие диатомовых водорослей



Сентябрь 18, 2000
Канадский бассейн, 82N 170W
Экспедиция “Арктика -2000”
на нэс «Ак.Федоров»

Апрель 05, 2009, ПАЛЭКС-2009



Зап. часть моря Уэдделла
Антарктика, февраль 1992

Interstitial fauna

NP-22, 23 1977-1980	Group	PAICEX 2007-2011
3	Protozoa	0
1	Foraminifera	0
1	Acarina	0
2	Nematoda	0
1	Turbellaria	0
1	Harpacticoida	0
1	Amphipoda	0

Интерстициальная фауна, связанная с обитанием внутри льда в настоящее в ремя не обнаружена