Elements of seasonal dynamics of macrobenthos on a shelf of northeast Sakhalin (sea of Okhotsk)

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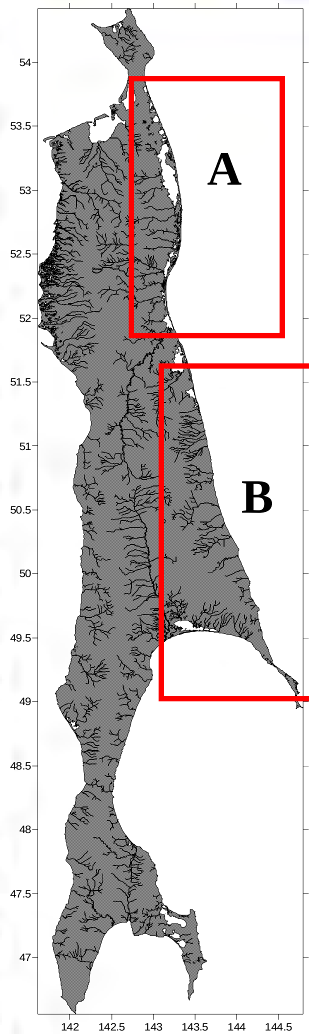
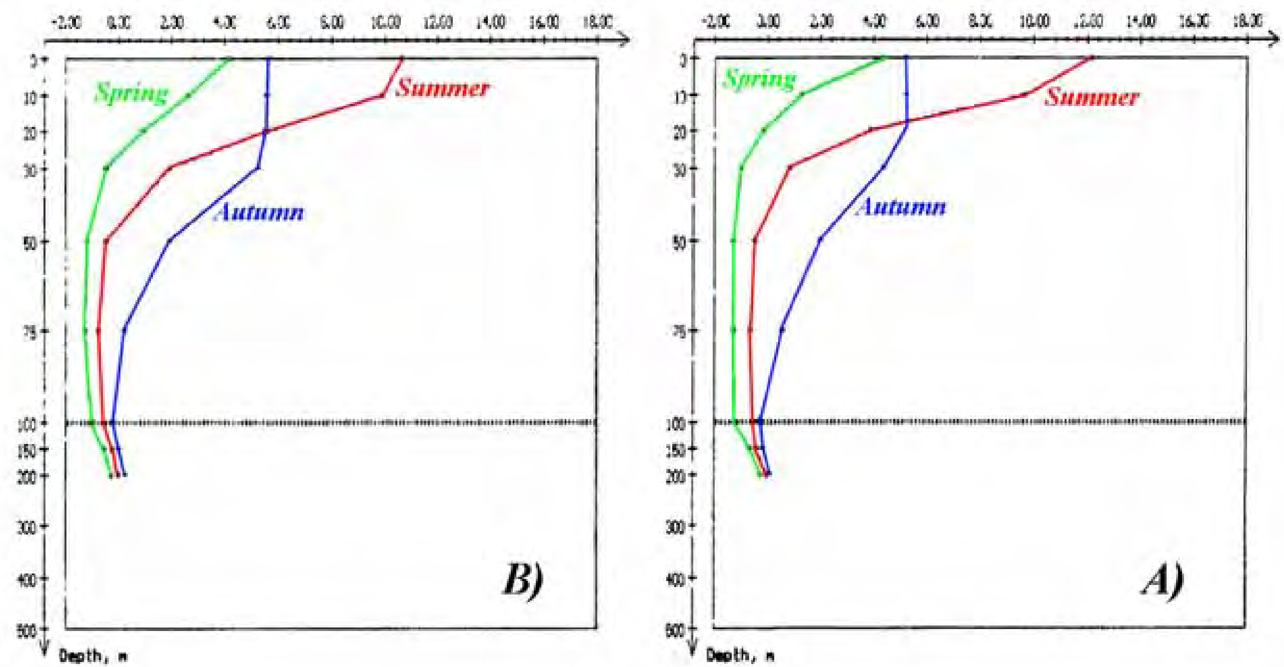
Preconditions

- Now the shelf of sea of Okhotsk at coast of northeast Sakhalin actively accustoms the oil and gas industry. Available descriptions of a benthos are based on single shootings. Ignorance of a natural variability can result as in errors in an estimation of the anthropogenous influence, and to errors in the description of global (climatic or others) changes of a benthos.

The factors defining the variability and the seasonal dynamics of a macrobenthos:

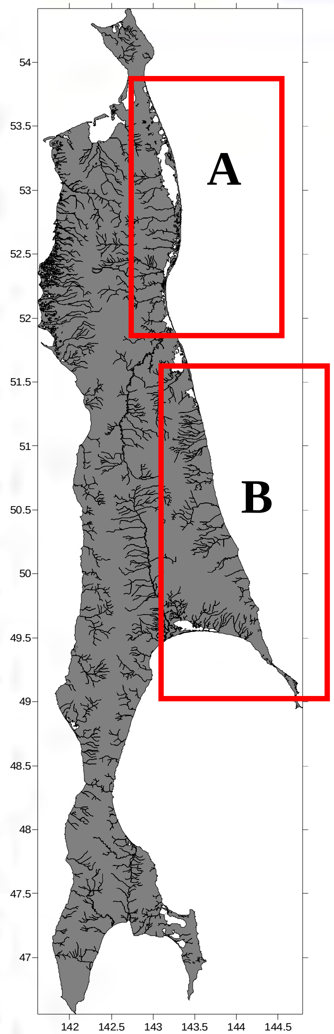


- The ice season lasts from November till June.
- Presence of a cold intermediate layer. The top border of this layer is stretched from depth of 20-30 m (spring, summer) to 50-75 m (autumn); bottom - from 200 to 300 m.

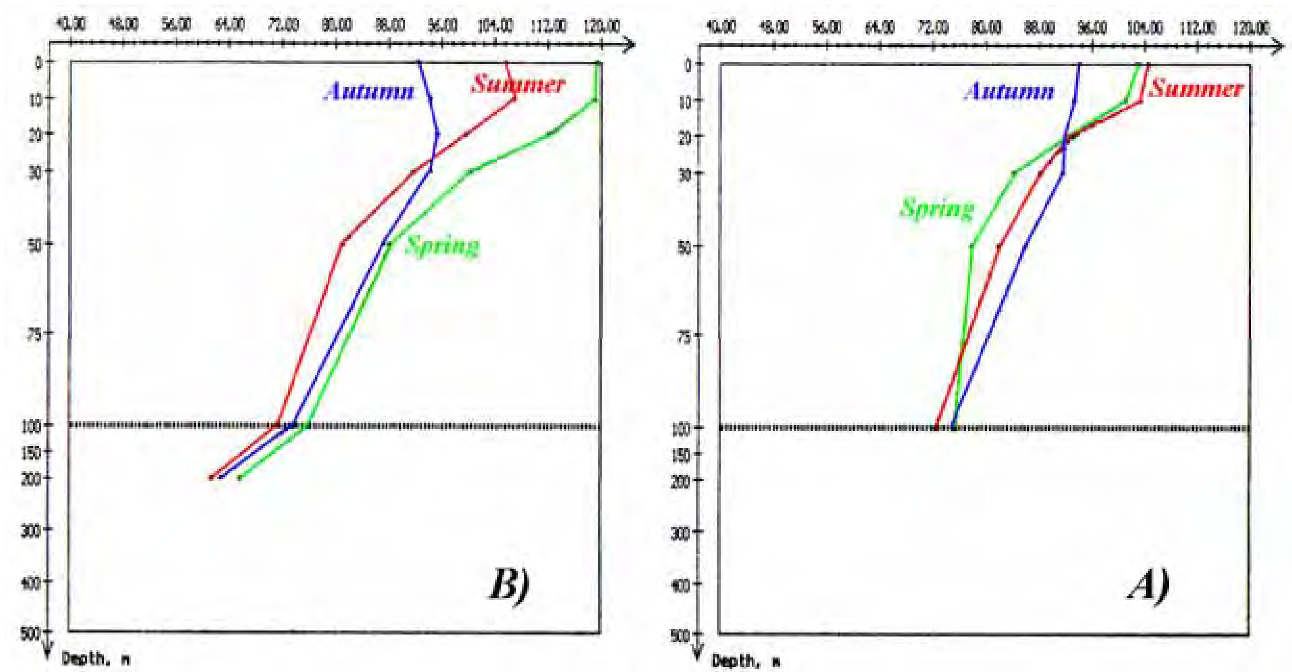


Seasonal variability of the temperature (°C) (from: Pishalnik, Bobkov, 2000)

The factors defining the variability and the seasonal dynamics of a macrobenthos:

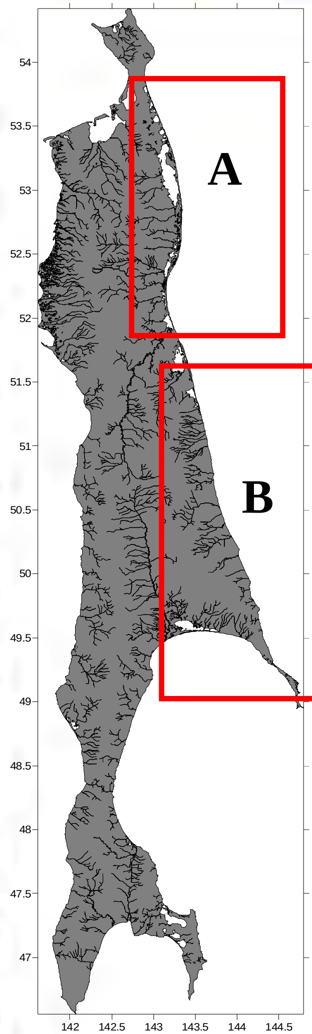


- **In vertical distribution of average values of oxygen the maximum presence on depth of 10-20 m, homogeneous distribution of oxygen to depth of 100 m in the autumn is observed.**

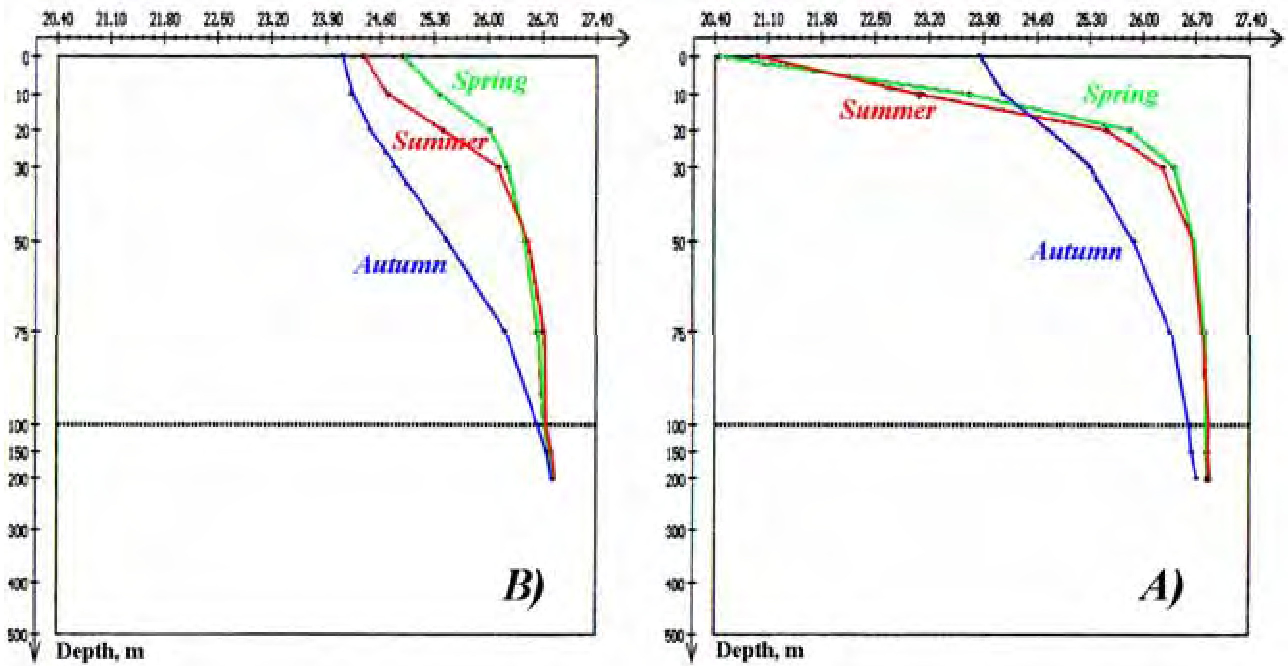


Seasonal variability of the dissolved oxygen (%) (from: Pishalnik, Bobkov, 2000)

The factors defining the variability and the seasonal dynamics of a macrobenthos:

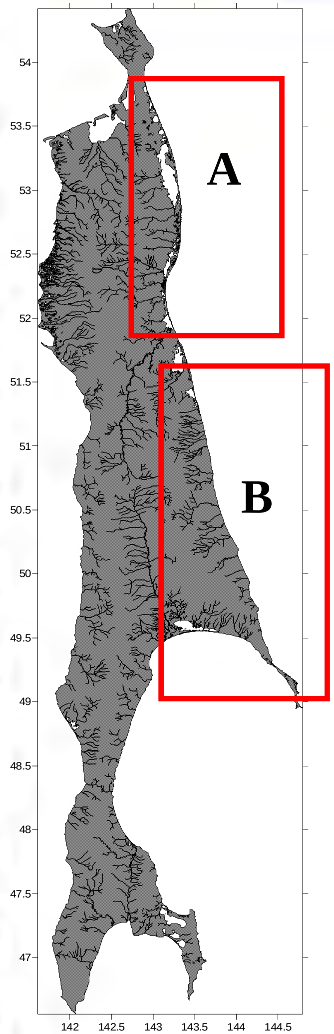


- **Biogenes:**
- **Concentration of phosphates in water is minimum in a zone of photosynthesis and decreases on continuation of the warm period;**

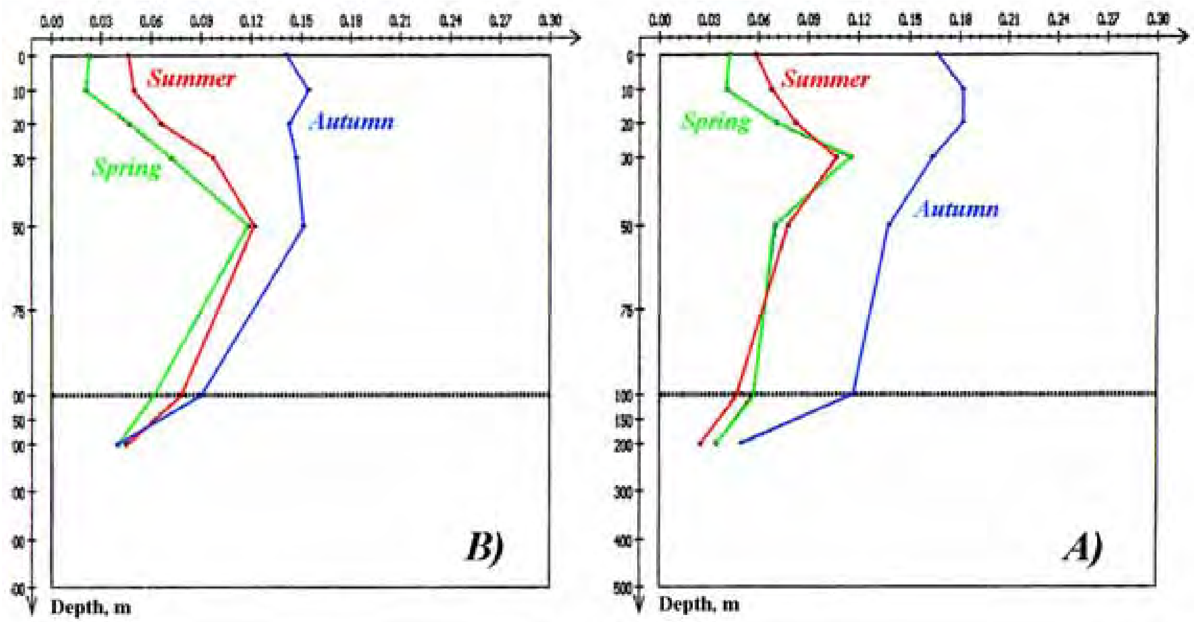


Seasonal variability of the phosphates (µM) (from: Pishalnik, Bobkov, 2000)

The factors defining the variability and the seasonal dynamics of a macrobenthos:

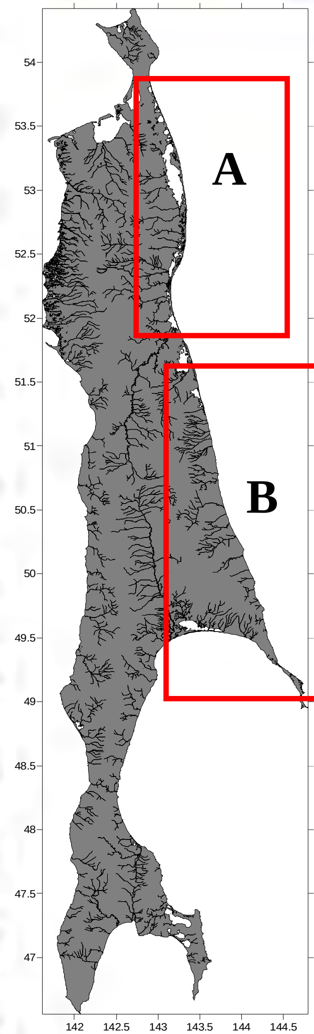


- **Biogenes:**
- **Concentration of nitrites on the contrary increases by the end of the warm period at decomposition of the accumulated organic substance of a phytoplankton, its maximum is necessary on a jump layer;**

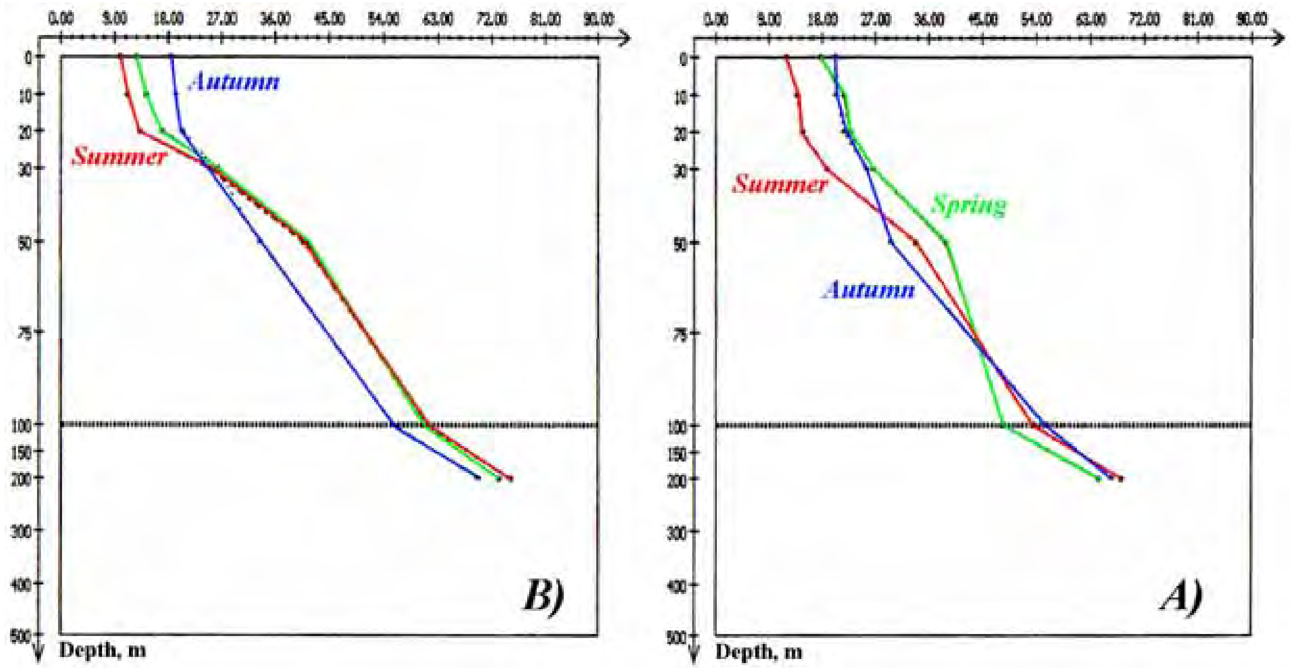


Seasonal variability of the nitrites (µM) (from: Pishalnik, Bobkov, 2000)

The factors defining the variability and the seasonal dynamics of a macrobenthos:



- **Biogenes:**
- **Concentration of silicates is minimum in a photosynthetic layer and decreases in the summer because of consumption by a phytoplankton.**



Seasonal variability of the silicates (µM) (from: Pishalnik, Bobkov, 2000)

The factors defining the variability and the seasonal dynamics of a macrobenthos:

- **The fodder factor (seasonal variability of a phytoplankton as basic supplier of fodder substance): the maximum of production of a phytoplankton is observed in the early spring and, to a lesser degree, in the autumn.**

- **All aforesaid should cause considerable seasonal variability of a benthos on a shelf.**

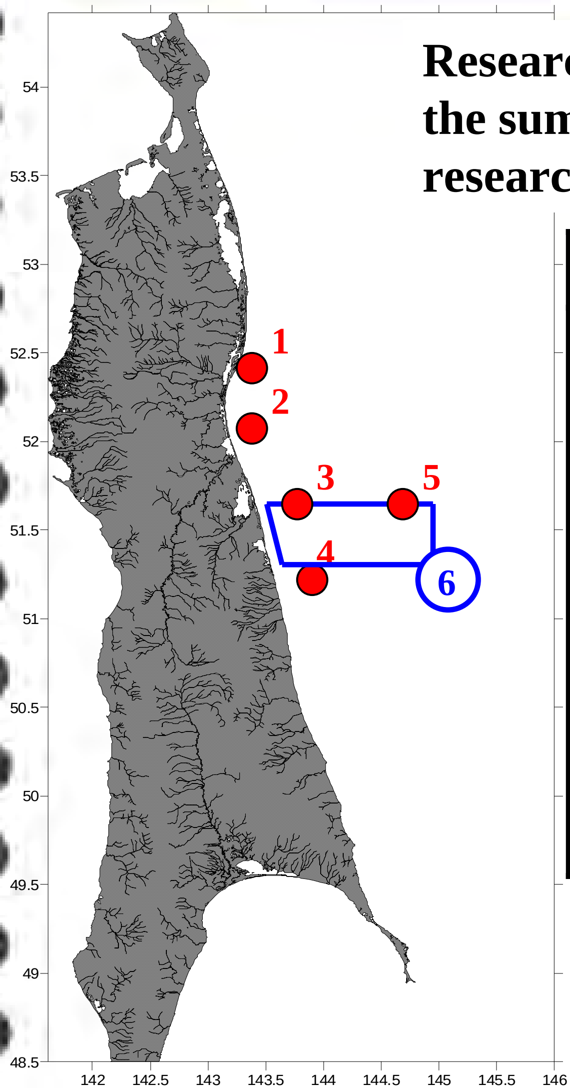
- **Proceeding from the considered schedules following vertical zones are allocated:**
- **Jump layer - to depth of 50 m;**
- **The top department of a shelf to depth of 100 m with the expressed seasonal variability of oceanographic indicators;**
- **The bottom department of a shelf with constant oceanographic conditions (is deeper 100 m).**

The factors defining the variability and the seasonal dynamics of a macrobenthos:

- **Terms of approach of seasons and their duration on a northeast shelf of Sakhalin (from: Pishalnik, Bobkov, 2000):**

Winter	Spring	Summer	Autumn
½ December January February March April ½ May	½ May June July	August ½ September	½ September October November ½ December

Material and methods



Researches were conduct on 6 ranges in 2008-2010 in the spring, in the summer and in the autumn. Sampling made from a board of a research vessel "Dmitry Peskov" by a Van-Veen sampler (0,2 м^2).

#	Depth, m	Soil	Year	Spring	Summer	Autumn
1	23-25	Small sands	2008	10/40*	–	10/40*
2	25-28	Cobble & pebble	2009	10/40*	10/40*	–
3	65-94	Sands	2009	12/48*	12/48*	12/48*
4	85-90	Silt sands	2010	12/36*	–	12/36*
5	210-220	Silt & pebble	2010	12/36*	–	12/36*
6	0-243	Large sands - silt	2010	13/39*	–	13/39*

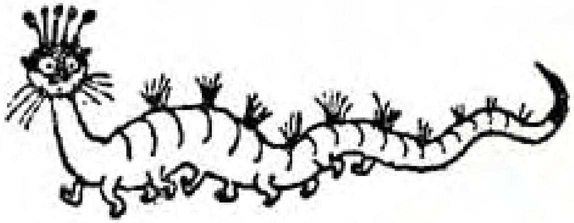
*** in numerator - number of stations, in a denominator - number of samples**

Results: Jump layer
(Range # 1: 23–25 m, small sands)

- On all indicators of abundance and structural characteristics similar laws are observed. On number of the met species and on density and on a biomass are marked the growth in the end of spring and decrease in the autumn.

	Jule 4	Jule 12	October 2	October 15
S	56	59	53	46
N, ind./m^2	90500±9869	113300±10656	1219±117	642±58
B, g/m^2	197±22	240±22	252±28	187±20
Dominant	*Echinarachnius parma + Diastylis bidentata*	***E. parma + Megangulus luteus + D. bidentata***	***E. parma + M. luteus***	***E. parma***
$B_{dominant}$, %	58.4	80.3	66.6	65.5
I (N), bit/species	0.05	0.06	1.82	2.03
I (B), bit/species	1.74	1.67	1.42	1.15
ABC, %	-1.72	0.61	12.54	15.65

Results: Jump layer (Range # 1: 23–25 m, small sands)



- **At transition from late spring by the autumn the index of a species variety on density and the ABC-indicator sharply increases. It testifies to growth of stability of bottom community. This phenomenon speaks by mass reproduction and presence of small forms during the warm period of year that is characteristic for the seasonal seas (Ozolinsh, 2002, Labay, Pecheneva, 2005).**

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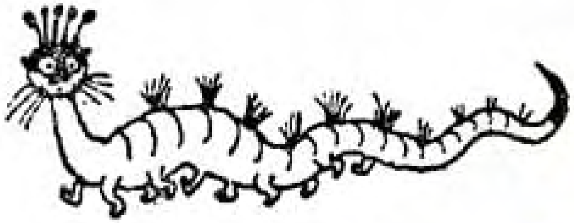
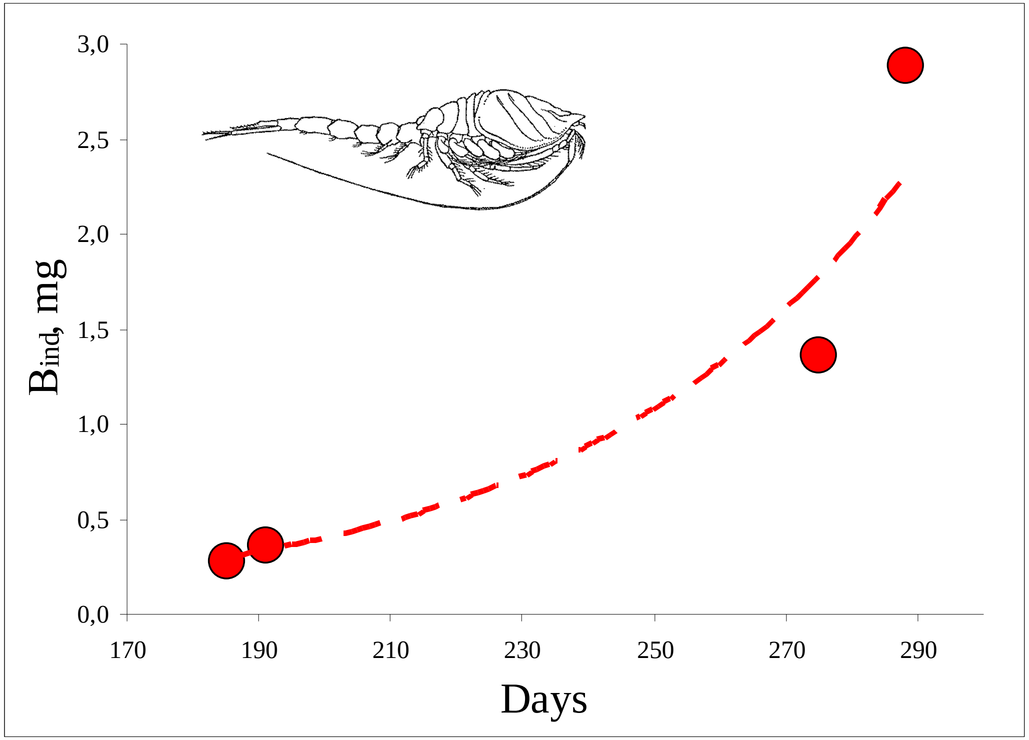


- **Most brightly seasonal variability is shown in dynamics of indicators of two key species of Crustacea: cumacea *Diastylis bidentata* and isopoda *Saduria entomon*. The first species steadily dominates in a bottom community in the end of spring, value of the second species increases in the autumn.**

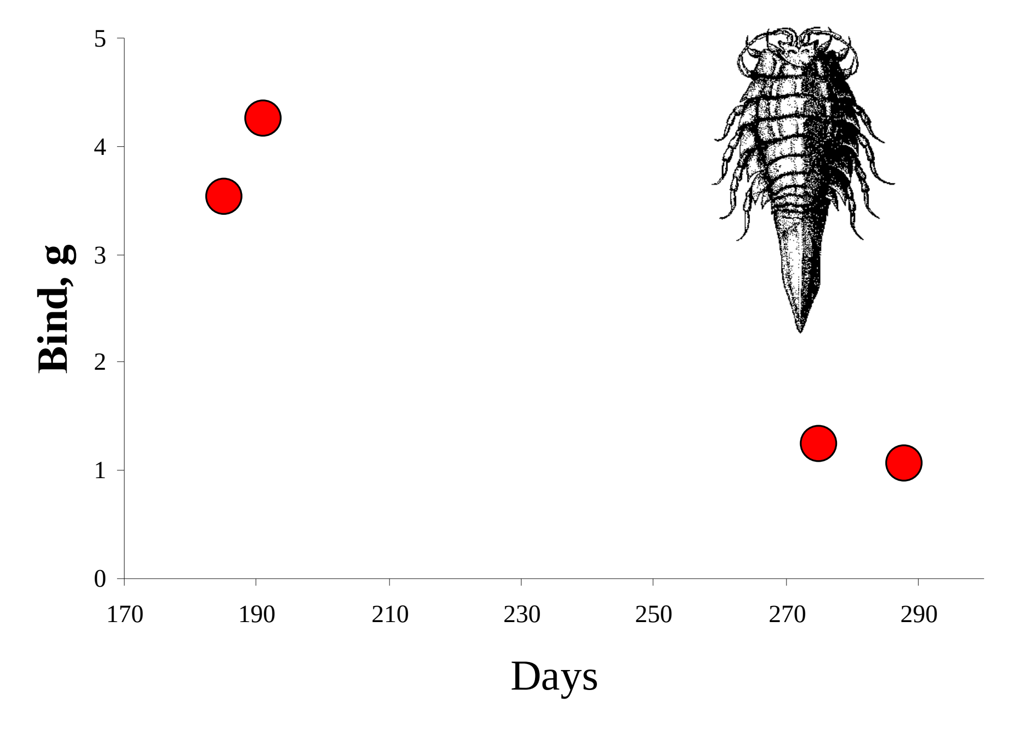
•Cumacea is reach the maximum indicators in the middle of July. To the middle of October their density biomass falls as a result of elimination (dying off of a young's and eating up by predators). Described changes were accompanied by exponential growth of an individual biomass (Fig.).



Results: Jump layer
(Range # 1: 23–25 m, small sands)

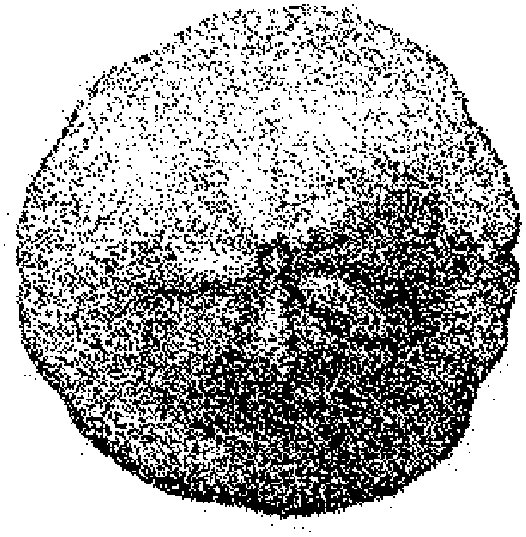
- **Anadrom migration is characterizes the isopod *Saduria entomon*. Females are migrate for reproduction to coast to fresh waters exits where there is a development and a feeding of young's. Adult individuals during this period occupy coastal shoal of a shelf. In the autumn numerous young's migrates from coast to a shelf (Garkalina, 1982).**

•Variability of indicators of abundance of *Saduria entomon* passes according to species biology. In July on range are noted not abundant adult individuals with a high individual biomass. In the autumn the species biomass sharply increases at the expense of density growth provided with young's migration. The given phenomenon is traced on falling of an individual biomass (Fig.).



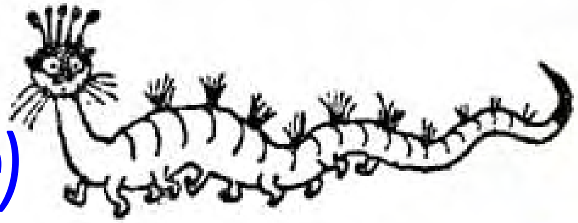
Results: Jump layer
(Range # 1: 23–25 m, small sands)

- **One more feature of dynamics of mass species consists in constant uniform growth of an average biomass of flat sea-urchin's (with 77 g/m^2 to 103 g/m^2). This phenomenon is accompanied by density growth at weak variability of an individual biomass. Such dynamics of indicators of an abundance it is possible only in the presence of constant migration of sea-urchin's from adjacent areas (possibly, from the big depths). Noted migration explains dynamics of structure of bottom community which during monitoring changes from polydominant in monodominant with prevalence of *Echinarachnius parma*.**



•Hence, changes of indicators of benthos abundance and structural indexes are caused by seasonal variability and defined by feature of biology of mass species.

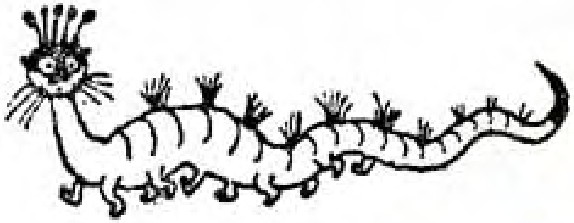
Results: Jump layer
(Range # 2: 25–28 m, cobble & pebble)

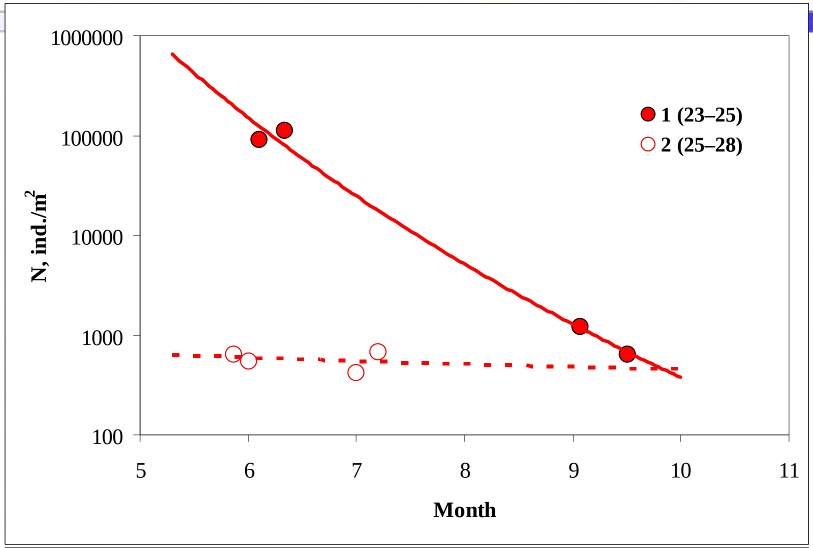


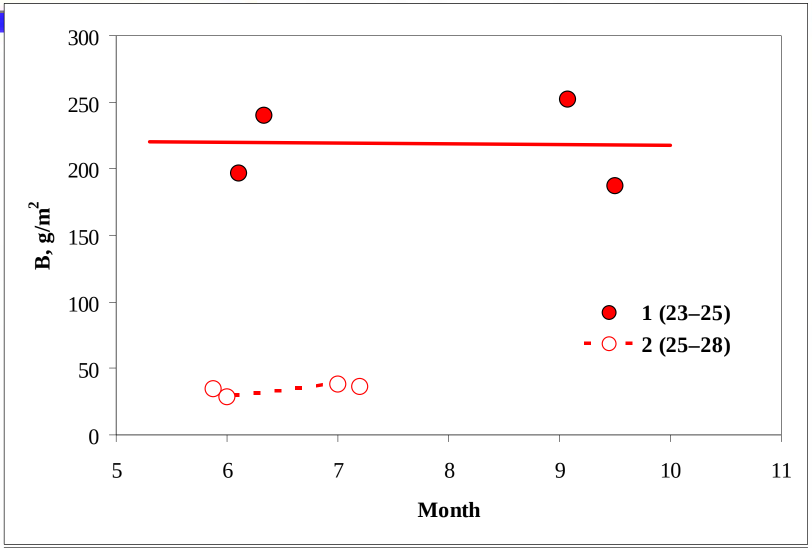
- **Decrease in the number of met species is marked from the middle of spring to the beginning of summer. Density and biomass of a benthos are characterized by decrease in the middle of the monitoring period.**

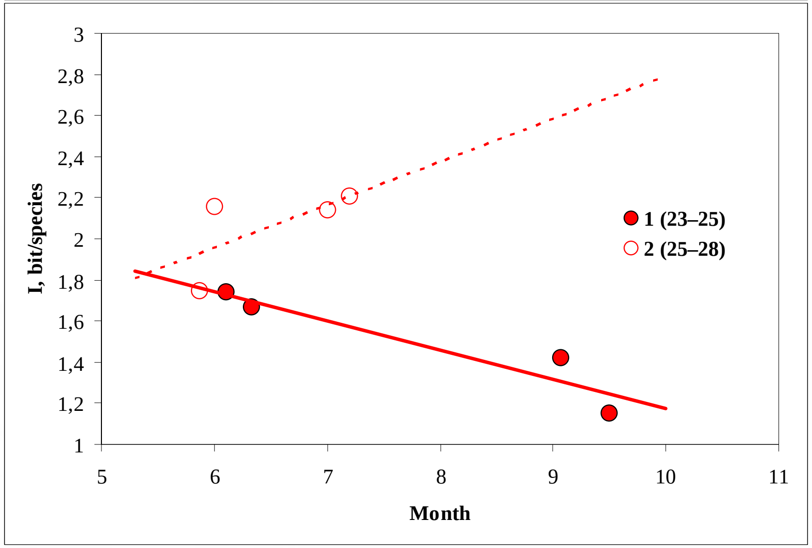
	June 26	July 1	August 1	August 7
S	49	52	44	46
N, ind./m^2	653±63	556±54	417±42	677±70
B, g/m^2	35±4.5	29±3.5	38±5.2	36±5.0
Dominant	*Megangulus luteus + Nephtys longosetosa*	–	–	*Nephtys longosetosa*
$B_{dominant}$, %	63.7	–	–	11.0
I (B), bit/species	1.75	2.16	2.14	2.21
ABC, %	8.9	9.4	9.5	5.2

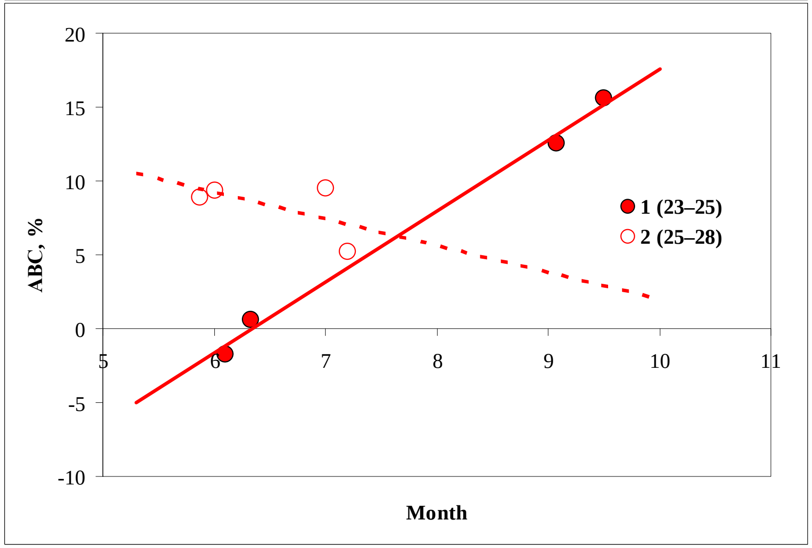
Results: Jump layer
The general laws



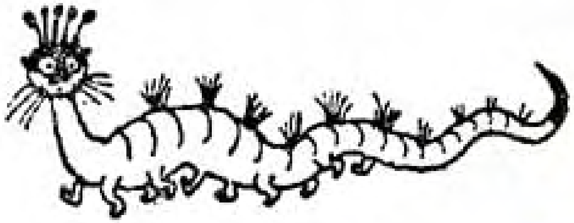








Results: top department
(Range # 6: 50–60 m, silt sands)



- A specific variety, a density and a biomass of a benthos are sharply increased from spring by the autumn. Density growth is provided by Crustacea, first of all – amphipoda, after summer reproduction. Biomass growth is caused by mollusks.

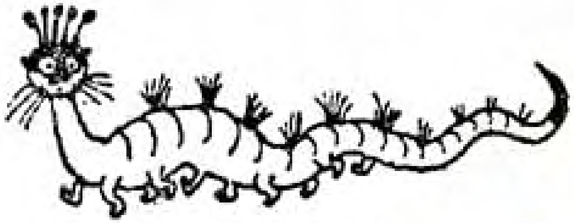
	July 3	November 1
S	**66**	**80**
N, ind./m^2	**2926±330**	**3548±373**
B, g/m^2	**107±11**	**182±21**
Dominant	Actiniaria, *Serripes groenlandicus*	*S. groenlandicus*, Actiniaria
B $_{dominant}$, %	**53.4**	**58.9**
I (B), bit/species	**2.19**	**2.03**
ABC, %	**17.4**	**16.9**

Results: top department
(Range # 3: 65–94 m, sands)

- **Growth of number of species (S) is observed from the spring period to autumn. The density of a benthos increases from spring by the summer when the mass reproduction of Cumacea is marked. The biomass on the contrary falls from June by October. It speaks that large organisms die off in the summer after reproduction, and young's and small species providing high density do not make good the loss of a biomass.**

	June 19	August 9	October 18
S	49	52	44
N, ind./m^2	374	3497	1667
$N_{\text{with out Cumacea}}$, ind./m^2	343	744	1536
B, g/m^2	720	392	364
$B_{\text{Echinoidea}}$, g/m^2	687	293	238
Dominant	*Echinarachnius parma*	***E. parma***	*E. parma*
B_{dominant}, %	95.4	74.8	65.5
I (B), bit/species	0.30	1.23	1.55
ABC, %	14.2	3.3	9.9

Results: *top department*
(Range # 4: 85-90 m, silt sands)

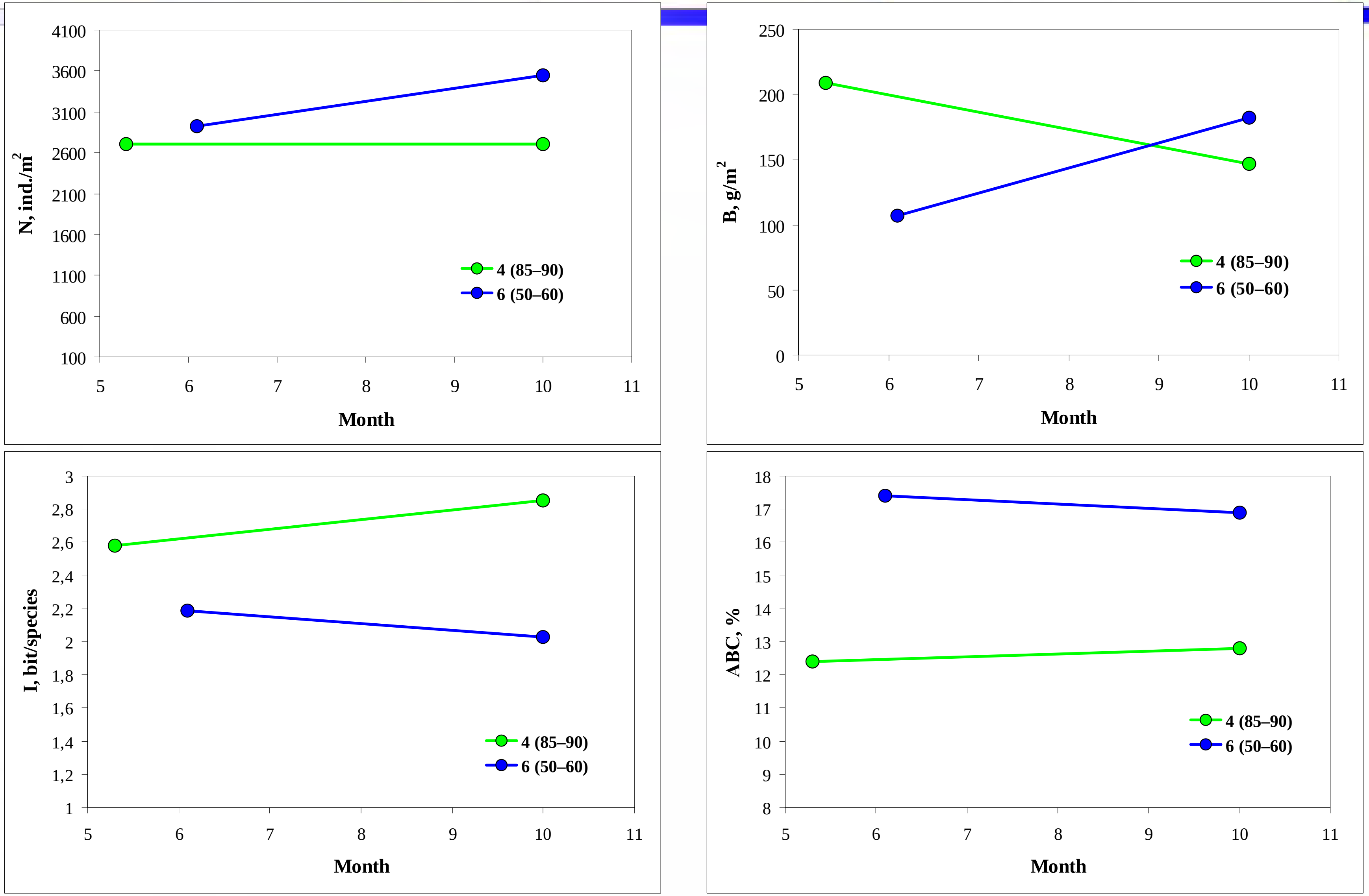


A specific variety and density of benthos did not change considerably from the beginning of spring to the autumn. The biomass has opposite decreased.

	June 9	October 31
S	173	180
N, ind./m^2	2706±238	2705±281
B, g/m^2	209±21	147±17
Dominant	*Echinarachnius parma*	–
$B_{dominant}$, %	27.1	–
I (B), bit/species	2.58	2.85
ABC, %	12.4	12.8

- **Biomass decrease is defined by decrease in a biomass of sea-urchin's first of all and accompanied by decrease in structure of community. Decrease in density and biomass of flat sea-urchin's is caused by their migration on shoal, as well as on ranges # 1 and 3. Hence the general laws in seasonal variability of a benthos at the upper departments of a shelf are observed.**

Results: top department
The general laws

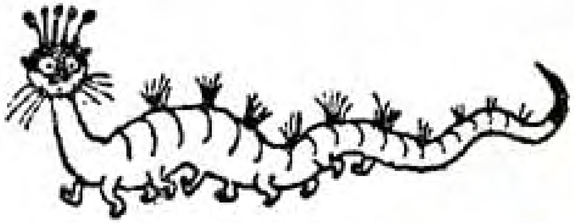


Results: bottom department
(Range # 6: 100-110 m, silt)

Seasonal processes again change an orientation on transitive horizon of 100-110 m. The maximum values of indicators of abundance and a variety are characterize the spring and considerably decrease by the autumn. Density falling is observed on all mass groups: Polychaeta and Crustacea (Cumacea, Amphipoda). Biomass decreasing also characterizes all significant groups: Polychaeta, Ophiuroidea, Holothurioidea and bivalve mollusks. The Sipuncula biomass has increased it is considerable (more than in 3 times!).

	July 3	November 1
S	119	92
N, ind./m^2	4397±466	1485±160
B, g/m^2	117±12	84±9
Dominant	*Ophiura sarsi, Chiridota pellucida,* Maldanidae	*O. sarsi, Ch. pellucida*
$B_{dominant}$, %	53.0	45.0
I (B), bit/species	2.59	2.21
ABC, %	22	24

Results: bottom department
(Range # 6: 150-160 m, silt)



Similar changes were marked on depth of 150–160 m: decrease in a specific variety, a density from spring by the autumn. Decrease in indicators is observed for key groups: Polychaeta, Sipuncula, Foraminifera, Holothurioidea and Bivalvia. Return dynamics distinguishes dominating on this depth Pogonophora - growth of a density and a biomass from the spring by the autumn..

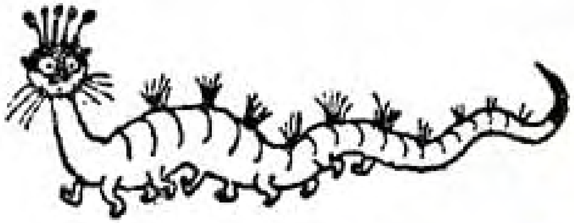
	July 3	November 1
S	125	117
N, ind./m^2	1250±136	1151±110
B, g/m^2	101±10	101±11
Dominant	Pogonophora, *Hyperammina subnodosa*	Pogonophora, *H. subnodosa*
$B_{dominant}$, %	36.8	48.3
I (B), bit/species	2.61	2.33
ABC, %	19.0	14.5

Results: bottom department
(Range # 5: 210-220 m, silt & pebble)

A specific variety and density of a benthos practically did not change from spring by the autumn, for a biomass the increase is noted. Growth of the general biomass is defined by Echinodermata biomass growth: Ophiuropidea and Crinoidea. It is accompanied by decrease in structure of bottom community because of an invariance of indicators of an abundance of other mass group - Pogonophora.

	June 9	**October 31**
S	**194**	**187**
N, ind./m^2	**1018±88**	**1001±85**
B, g/m^2	**78±8.1**	**97±10.4**
Dominant	Pogonophora, *Ophiura sarsi*	Pogonophora, *Ophiura sarsi*
B$_{dominant}$, %	**48.1**	**44.9**
I (B), bit/species	**2.46**	**2.27**
ABC, %	**11.5**	**10.2**

Results: bottom department
(Range # 6: 230-270 m, silt)

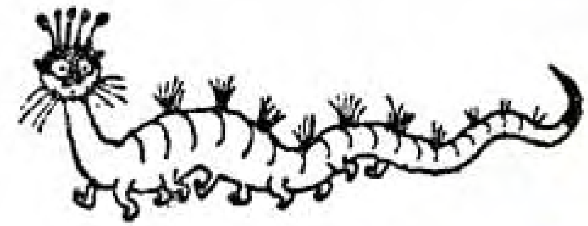


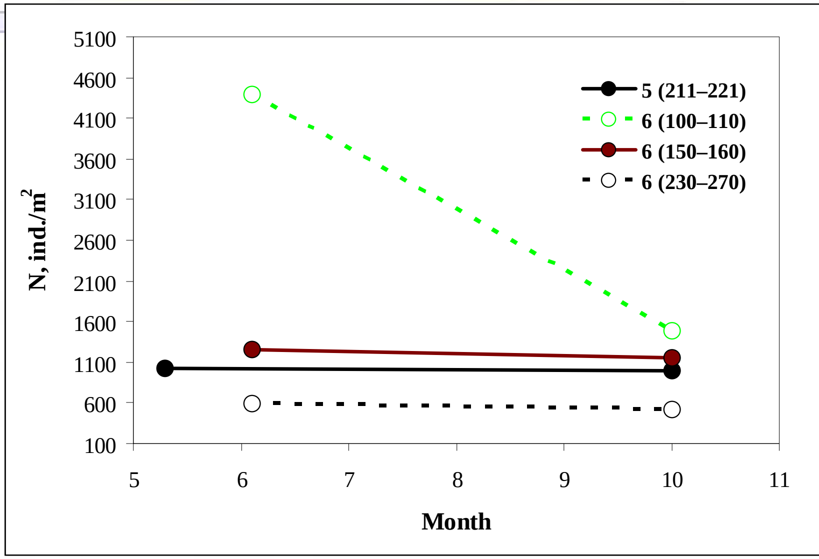
A specific variety and a density of a benthos decrease from spring by the autumn, and the biomass increases. Density decrease is marked on all groups defining this indicator: Polychaeta and Foraminifera. Biomass growth is defined by growth of a biomass of prevailing group - Pogonophora.

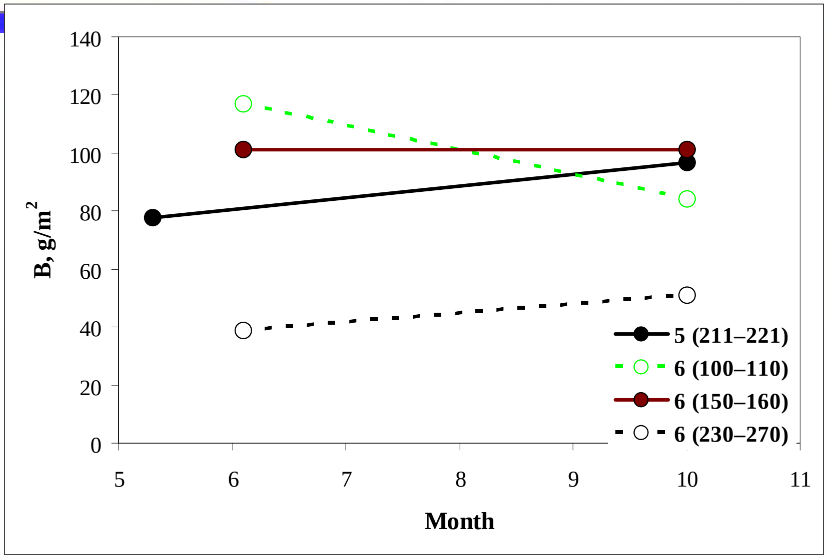
	July 3	November 1
S	121	106
N, ind./m^2	598±61	519±50
B, g/m^2	39±4	51±5
Dominant	Pogonophora	Pogonophora
$B_{dominant}$, %	48.5	50.2
I (B), bit/species	2.25	2.08
ABC, %	19.6	19.4

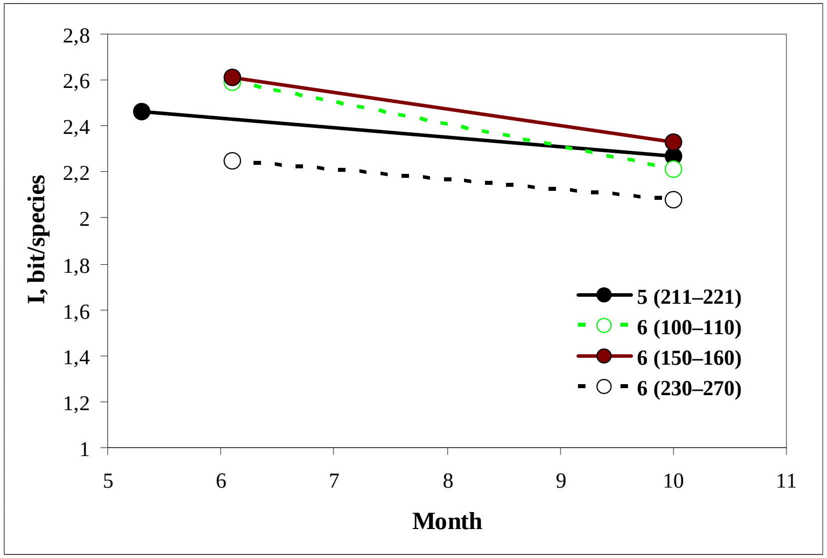
Results: bottom department

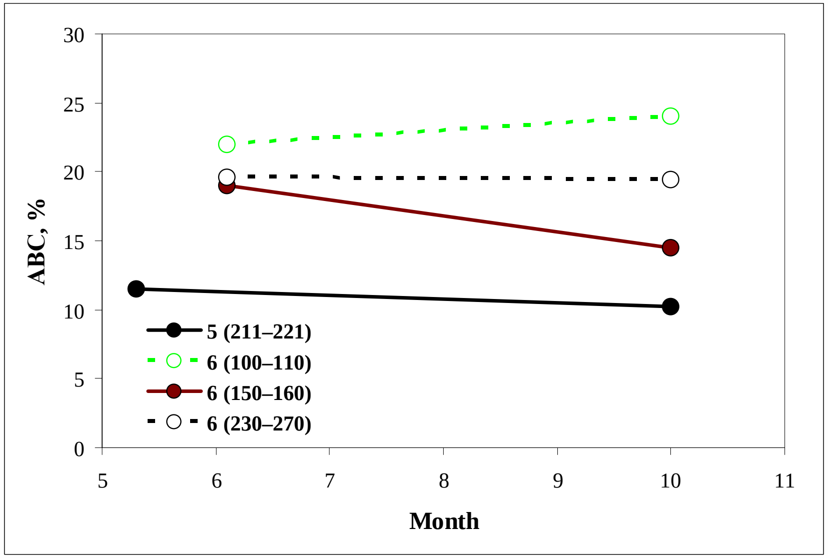
The general laws



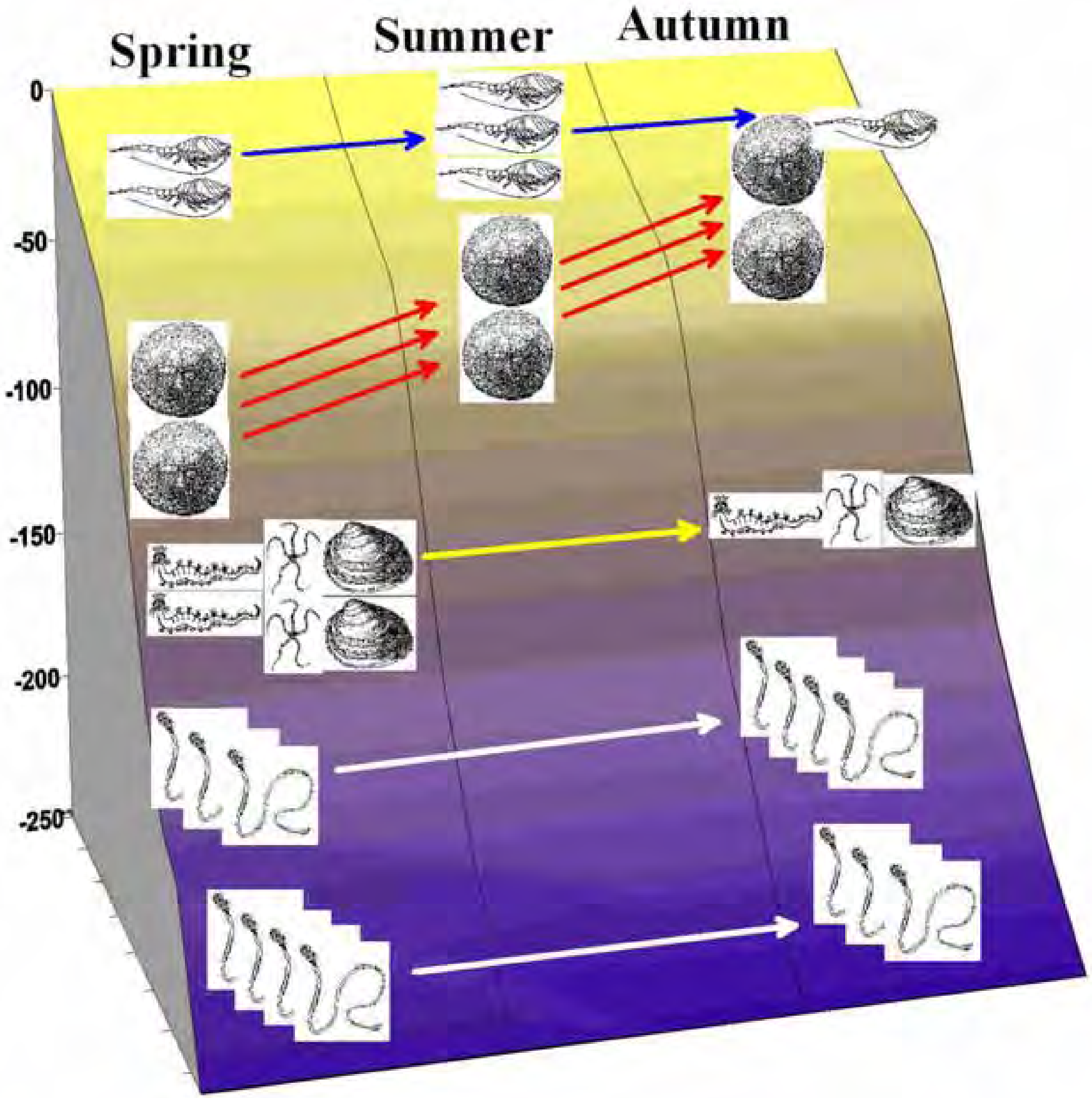








Conclusion



Thus, changes of a benthos in top departments of a shelf of northeast Sakhalin are caused by dying off of seniors generations, the periods of reproduction and vertical migrations of key species. In the bottom department of a shelf variability is smoothed and defined by a smooth gain or reduction of a biomass of the basic groups.