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SPATIAL STRUCTURE OF PHYTOCENE IN THE BALTIC SEA IN MAY 1992

Semyonova S.N., Krasovski I.V., Zezera A.S., Feldman V.N.
tlantic Scientific Research Institute of Marine Fisheies and Oceanography (AtlantNIRO), 5.Dm.Donskoy Str, Kaliningrad, Russia

ABSTRACT

The paper presents the results of research on phytoplankton, carried out in the Southern part of the Baltic Sea in May 1992. The state of algae development is relatively high. The major part of plankton is represented by Flagellatae and Peridineae. Toxical species Goniaulax catenata (Lev) Kof. dominated among Peridineae. Irregular distribution of vegetative plankton over the area seems to be caused by various successional state of phytocene. The highest qualitative indices of development were observed within inshore zone. Maximum vegetation was observed in the Gdansk deep, which creates a good gorage base for fish aggregations.

INTRODUCTION

At present both fresh-water reservoirs and some seas, such as the Baltic Sea, are heavily polluted by nonpurified sewage, oil and oil products, as well as by other harmful substances (Yurkovski, 1975). Thus detailed research of the Baltic Sea ecosystem becomes of greater importance.

Researches of phytoplankton constitute a component of complex investigations, carried out by AtlantNIRO to control seasonal variability of algae development in the Southern Baltic Sea, which has been poorely studied.

In the paper the species composition and development of vegetable plankton is presented in the Baltic Sea in May 1992.

MATERIALS AND METHODS

Phytoplankton was sampled during 19 cruise of SRTMK-8083 "Monocrystal" at 25 stations of the standard investigation area in the Southern Baltic Sea from 16 to 23 May 1992. Samples were collected with bottles from the depth of 0, 5, 10, 25, 50, 75 and 100 m, and condensed by means of reverse filtration method through the nuclear filters, made by OIYI (Dubna), with pore diameter of 1 μ km (Semyonova, 1985; Sorokin, 1975). Material was fixed in 40% formaline, neutralized by KOH. Alga were identified and counted on table in a drop of 0.05cm^3 in volume at one or two replicates, depending on cell density in sample, by means of light microscope at magnification of 10 x 20, 10 x 40, 10 x 90. A unite of count was chosen as following: in blue-green algae - a number of colonies and trichomes, in genera Scenedesmus, Pediastrum, Coelastrum - a number of cenobions, in other - a number of cells. Biomass is estimated by means of species comparison with a certain geometric form. Various development parameters were calculated by means of the EC-1033 computer according to the programme, elaborated by us. In the paper the data from the depth of 5 m and layer of 0-25 m were used.

RESULTS AND DISCUSSION

We revealed 90 species and intraspecific taxons of algae, belonging to 6 systematic sections and composed group of Flagellatae (Table 1). Peridineae are the most deverse group (29 species), followed by Protococcineae (22 species and subspecies) and Bacillariophyton (19 species and subspecies). Blue-green algae (Cyanophyton consist of less than 10 species and intraspecific taxons. Other groups are represented by small number of species (1-3 species).

The majority of algae vegetates everywhere. Only small proportion of species was apparently associated to certain sea areas. Thus Peridineae Goniaulax catenata (Lev.) Kof. vegitated mainly off Baltijsk, while Sceletonema costatum (Grev.) Cl. (centric diatoms) concentrated mostly off Liyepaya and near the Gulf of Riga mouth. Peridineae species Gymnodinium acidotum Nyg. and Peridinium wisconsinense Eddy were observed only of Baltijsk.

Two peaks are usually observed in the seasonal dymanics of phytoplankton development: spring and fall (Nikolayev, 1985). The spring peak is observed in March-April and is caused by intense vegetation of diatoms with Sceletonema costatum (Grev.) Cl. dominated.

In May during a survey we found phytocene at stage similar to that for late fall. The total vegetable plankton abundance in the layer of 0-25 m varied within a wide range from 17.0 to 1663.9 mln. cells m^{-3} (Table 2). Phytoplankton horizontal distribution was as following: major development occured in shallow coastal areas. The absolute abundance indices there varied from 56.0 tp 1124.7 mln. cells m^{-3}. Comparison of phytoplankton abundance in certain sea areas (Fig. 1) shows high development indices northwestward of Baltijsk (up to 1663.9 mln cells m^{-3}). Dense aggregations (up to 1124.7 mln cells m^{-3}) were observed off Liyepaya. In deep sea algae vegetation was less pronounced. We observed no mass diatoms development to the surveys start (Fig. 1). Vegetation of the early-spring diatoms Sceletonema costatum (Grev.) Cl. occured in restricted areas northward of Liyepaya (over 140.0 mln. cells m^{-3}). The distribution of total vegetable plankton cells revealed is strongly related to the

intensity of Peridineae development (Fig.1). Algae abundance varied considerably from 13.0 to 899.9 mln. cells m^{-3}. Average amount exceeded 100 mln. cells m^{-3} Goniaulax catenata (Lev.) Kof. dominated (Fig. 1). Average cell abundance over the area amounted to 95.2 mln. cells m^{-3} (Table 2). The most intense development of Goniaulax catenata (Lev.) Kof. (over 800.0 mln cells m^{-3}) was observed in the southern part of the investigation area. Nortward of Liyepaya the algae abundance amounted to over 50.0 mln cells m^{-3}. Besides Peridineae considerable proportion of the total abundance is constituted by Flagellatae (Fig. 1). The latter abundance varied from 0.4 to 703.9 mln. cells m^{-3} averaging to 78.8 mln. cells m^{-3} over the area. Flagellatae mainly concentrated in the southern part of the investigation area (up to 703.9 mln. cells m^{-3}). Concentrations over 40.0 mln. cells m^{-3} were observed off Liyepaya and at the mouth of the Riga Bay. In the central sea area the vegation of Flagellatae was extremely weak. Abundance of the latter varied from 0.4 to 5.0 mln. cells m^{-3}.

Average biomass of total phytoplankton in the area amounted to 870.4 mg m^{-3} (Table 3). Distribution of the total phytoplankton biomass (Fig. 2) generally followed the distribution of total algae abundance. The observed mass of vegetable plankton was high and varied from 103.9 to 6801.1 mg m^{-3}. The main concentration was observed off Baltijsk. Besides, a patch of similar high biomass (over 1500.0 mg m^{-3}) was found off Liyepaya. The biomass decreased northwards along the coast (from 790.1 mg.m^{-3} of Ventspils to 570.7 mg m^{-3} near the mouth of Riga Bay. In the central sea area the lower biomass as compared to the coastal zone was observed due to the weak algae development. The lowest biomass (below 100.0 mg m^{-3}) and abundance were found off Klaipeda. Peridineae caused the main contribution into the total biomass and total abundance of vegetable plankton (Table 3). The distribution of those algae group almost entirely followed the spatial distribution of the total phytoplankton biomass (Fig. 2). The major biomass proportion was represented by one species of Goniaulacaceae family, that of Goniaulax catenata (Lev.) Kof. (Table 3). The highest biomass of Goniaulax catenata (Lev.) Kof. occured in the southern sea area off Baltijsk (Fig. 2). A patch of biomass amounted to 736.9 mg m^{-3} was

found off Ventspils, and a patch of biomass 558.7 mg m^{-3} appeared near Liyepaya. Off Klaipeda Goniaulax catenata absolute biomass was the lowest one as compared to other sea areas.
The contribution of Flagellatae into the total biomass was insignificant due to low cells volume. (Fig. 2). Biomass of Flagellatae varied from 0.1 to 173.9 mg m^{-3} over the sea area. The major concentration of Flagellatae occured in coastal area with maximum indices off Baltijsk.

Sea surfece temperature varied from 6° to 9.2°C in May 1992. Higher temperatures were recorded in brackish areas off Baltijsk, Liyepaya and at the Gulf of Riga mouth . The thermocline was mainly poorely developed. Hight temperature gradient was observed in the layer of 3-5 m. A vertical distribution of vegetable plankton is characterized by mosaicness, related to sea temperature conditions. A trophogenic layers distributed to the depth of 25 m, while peak quantitative indices of algae development (average 422.5 mln. cells m^{-3} and 1597.1 mg m^{-3}) occured at 5 m level. Cell number and biomass decreased sharply below 50 m.

The distribution of total phytoplankton abundance and biomass at 5 m level followed the same trend of vegetable plankton, as that in the layer of 0-25 m. At the depth of 5 m, similar to the layer of 0-25 m, two areas appeared, that of intense and poor algae vegetation. The rich area located near the coast. Phytoplankton abundance varied there from 98.4 to 3270.6 mln. cells m^{-3}. Maximum concentration was observed northwestwards off Baltijsk (Fig. 3). A patch of high phytoplankton content (over 1600.0 mln. cells m^{-3}) was found off Liyepaya. Contours, outlined areas of high cells content, almost coinsided to the boundaries of high algae biomass area (Fig. 4). The maximum biomass of vegetable plankton over the sea area amounted to 1032.7 mg m^{-3} and was recorded off Baltijsk. Areas with biomass indices over 2.0 g m^{-3} occured off Liyepaya and Ventspils. Relatively low phytoplankton amount was observed in the open sea (up to 88.0 mln. cells m^{-3} and 616.3 mg m^{-3}).

Peridineae, Flagellatae and Diatoms dominated quantitatively at the level of 5 m and in the layer of 0-25 m. In a shallow zone off Baltijsk an intense vegetation of Protococcineae, such as

Oocystis submarina Lag., Ankistrodesmus pseudonerabis var. spiralis Korsch. and Kirchneriella irregularis (Sm.) K. was also observed. Peridineae dominated over entire area in cell number and biomass, and formed the major proportion of plankton. Flagellatae were the second important component, however only in abundance due to small cells volume. Diatoms were of some importance only in a coastal zone off Liyepaya and at the Gulf of Riga mouth (Fig. 3,4).

Distribution of Peridineae abundance and biomass essentially coinsided to that of total phytoplankton . Rich in Peridineae area was located along the coast (Fig. 3,4). Peak abundance (over1300.0 mln. cells m^{-3}) and biomass (about 10.0 g m^{-3}) were observed off Baltijsk. High algae concentration was found off Liyepaya (232.1 mln.cells m^{-3} and 1.7 g m^{-3}) and Ventspils (287.1 mln. cells m^{-3} and 2.1 g m^{-3}). Quantitative indices of Peridineae development is almost entirely determined by Goniaulax catenata (Lev.)Kof. vegetation intensity (Fig. 3.4).

Flagellatae developed mainly in a coastal zone: Total cell amount over the sea area varied from 2.4 to 1788.6 mln. cells m^{-3}. Peak abundance was observed off Baltijsk (Fig. 3). Flagellatae concentration about 100.0 mln. cells m^{-3} was found at the Gulf of Riga mouth, off Klaipeda and Liyepaya. The similar trend was observed in those algae biomass distribution (Fig. 4). The highest indices (up to 281.2 mg m^{-3}) was found off Baltijsk. Biomass over 10.0 mg m^{-3} was observed at the Gulf of Riga, off Liyepaya and Klaipeda.

CONCLUSION

Phytoplankton abundance and biomass, observed in the Baltic Sea in May, exceeded those of the Atlantic productive areas (Vinogradova et al., 1979; Semyonova, 1976; Semyonova, Fedulov, 1987, 1990).

Peridineae dominated both by species number and cells abundance.

As our observations showed, surveys in May 1992 coinsided to the late spring "blooming" of Peridineae Goniaulax catenata (Lev.) Kof. and Flagellata mass vegetation. It was confirmed by a high development level and quantitative indices over the sea area.

The data available (Gorjunova, Demina, 1974) showed, that Goniaulax catenata (Lev.) Kof. is a toxical species. Toxins produced by the algae, are suluble in water.

During events of "red" tides, i.e. "blooming" of Goniaulax catenata (Lev.) Kof., the latter may cause sudden mass fish mortality and occurence of toxical molluscs.

The highest vegetative plankton abundance and biomass were observed in the coastal zone. The central sea area was characterized by poor plankton.

Maximum vegetation was observed in the Gdansk depression, which creates a good gorage base for commercial fish aggregations.

Comparison of phytoplankton quantitative indices distribution at the level of 5 m and in the layer of 0-25 m also showed peak abundance and biomass in the coastal areas.

During surveys Diatoms development seemed to reach the fading stage followed the spring peak. Only in the northern part of the investigation area off Liyepaya and near the Gulf of Riga mouth, the areas of high early-spring diatoms Sceletonema costatum (Grev.) Cl. vegetation was observed.

Heterogenous distribution of phytoplankton abundance and biomass in the area is caused by various successional state of phytocene. Algae seasonal vegetation is started from shallow southern areas.

Water pollution with industrial sewages has a strong impact on algae development. Thus in the area off Baltijsk the vegetation of Peridineae species (Gymnodinium acidotum Nyg.) was revealed, which indicated the organical pollution of water. In the area off Klaipeda phytoplankton was poorely developed from the surface to the bottom. That event deserves a more detailed investigation as the water is heavily polluted with oil products there.

Sea water state requires continuous monitoring, since toxical algae and species-indicators of organical pollution have appeared.

REFERENCES

Goryunova, S.B. and N.S.Demina. 1974. Algae-producers of toxical substances. Nauka. M.,p.44-52. (In Russian).

Nikolayev, I.I. 1985. Biological seasons of the Baltic Sea. Trudy VNIRO (Latv.Dep.) vol.2, p.115-140. (In Russian).

Semyonova, S.N. 1976. Phytocene succession in relation to the upwelling intensity off the North-West Africa. Oceanological conditions of fishery grounds in the Atlantic Ocean. Trudy AtlantNIRO, N 67, p. 87-92. (In Russian).

Semyonova, S.N. 1985. Phytoplankton succession in the East sector of the subantarctic and antarctic Atlantic Ocean. Complex researches of bioproduction in the Southern Ocean. Trud VNIRO. M. vol.1, p. 158-173. (In Russian).

Semyonova, S.N. and P.P.Fedulov. 1987. Phytocene seasonal variability off the South Georgia. Ecological researches in the Atlantic and South-East Pacific Oceans. Trudy AtlantNIRO, Kaliningrad, p. 30-36. (In Russian).

Semyonova, S.N. and P.P.Fedulov. 1990. Seasonal phytoplankton successions in various modifications of the Antarctic water masses off Buve Island. Antarctic krill (biological, technological and economic aspects).Trudy AtlantNIRO, Kaliningrad, p. 129-146. (In Russian).

Sorokin, Yu.I. 1975. Heterotrophic microplankton as a component of sea ecosystems. Journal of general biology. Vol. 36, N 5, p. 716-730. (In Russian).

Vinogradova, L.A., N.N.Zhygalova, S.N.Semyonova and V.A.Sushin. 1979. Spatial structure of phytoplankton assembles in the North Sea in May 1974. Functional characteristics of plankton assembles in the North Sea. Trudy AtlantNIRO, Kaliningrad, N 78, p. 3-23. (In Russian).

Yurkovski,A.K.1975. Some considerations on state and trends in chemical and biological syatems of the Baltic Sea. Riga. Znaniye , p. 60-65. (In Russian).

Table 1

Species composition of phytoplankton in the Baltic Sea in May 1992

NN	Taxon	I survey
1.	Chrysophyta	3
	Pyrrophyta	
2.	Cryptomonadineae	2
	Peridineae	29
3.	Euglenophyta	1
4.	Flagellata	2
	Chlorophyta	
5.	Volvocineae	1
	Protococcineae	22
	Ulothrichineae	1
6.	Bacillariophyta	19
7.	Cyanophyta	10
	Total	90

Table 2

Average abundance (mln. cells m^{-3}) of phytoplankton in the Southern Baltic Sea (layer - 0-25 m) in May 1992

Chryso-phyta	Pyrrophyta			Eugleno-phyta	Pla-gella-ta	Chlorophyta				Xanth-ophy-ta	Bacil-lario-phyta	Cyano-phyta	Total
	Crypto-monadi-neae	Peridi-neae	Goniau-lax ca-tenata			Volvo-ci-neae	Proto-coccii neae	Conju-gatae	Ulo-thri-chi-neae				
7.0	0.3	109.5	95.2	1.4	78.8	0.2	4.2	-	0.1	-	49.0	1.6	252.1

Table 3

Average biomass (mg m^{-3}) of phytoplankton in the Southern Baltic Sea (layer 0-25 m) in May 1992

Chryso-phyta	Pyrrophyta			Eugle-nophy-ta	Flagel-latae	Chlorophyta				Xanth-ophy-ta	Bacil-lario-phyta	Cyano-phyta	Total
	Crypto-monadi-neae	Peridi-neae	Gonia-ulax cate-nata			Volvo-cine-ae	Proto-cocci-neae	Conju-gatae	Uloth-richi-neae				
1.1	0.1	778.8	688.1	0.7	12.4	0.1	2.6	-	0.3	-	66.9	7.4	870.4

LEGENDS

Figure 1. Abundance distribution (mln. cells m^{-3}) of the total phytoplankton and main groups in the layer of 0-25 m of the Southern Baltic Sea in May 1992.
A - the total phytoplankton
B - Peridineae
C - Goniaulax catenata
D - Flagellatae
E - Bacillariophyta

Figure 2. Biomass distribution (mg m^{-3}) of the total phytoplankton and main groups in the layer of 0-25 m in the Southern Baltic Sea in May 1992.
A - the total phytoplankton
B - Peridineae
C - Goniaulax catenata
D - Flagellatae
E - Bacillariaphyta

Figure 3. Abundance distribution (mln. cells m^{-3}) of the total phytoplankton and main groups at 5-m level in the Southern Baltic Sea in May 1992.
A - the total phytoplankton
B - Peridineae
C - Goniaulax catenata
D - Flagellatae
E - Bacillariophyta

Figure 4. Biomass distribution (mg m^{-3}) of the total phytoplankton and main groups at 5-m level in the Southern Baltic Sea in May 1992.
A - the total phytoplankton
B - Peridineae
C - Goniaulax catenata
D - Flagellatae
E - Bacillariophyta

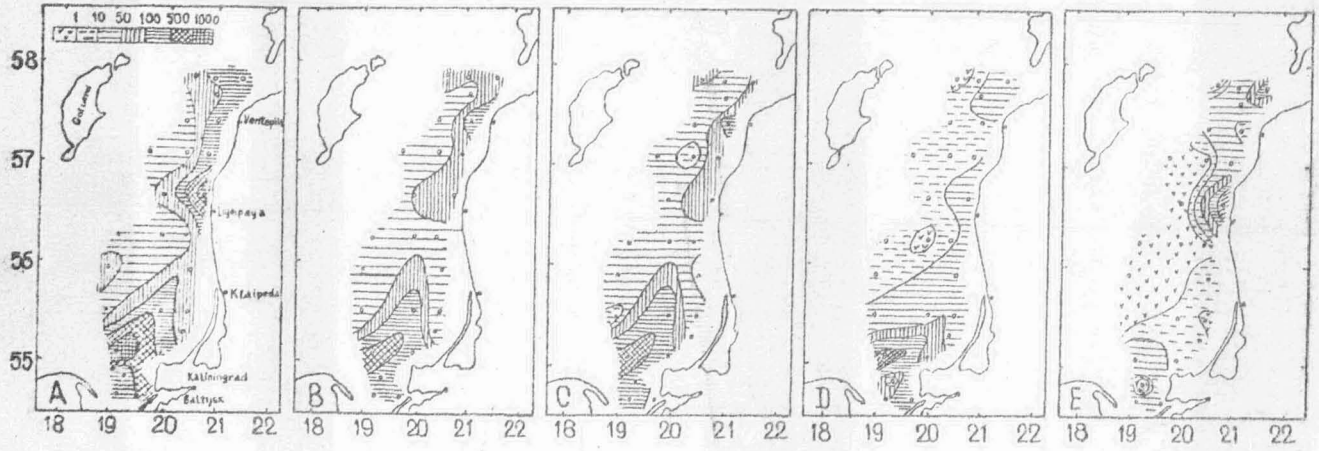
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Fig. 1

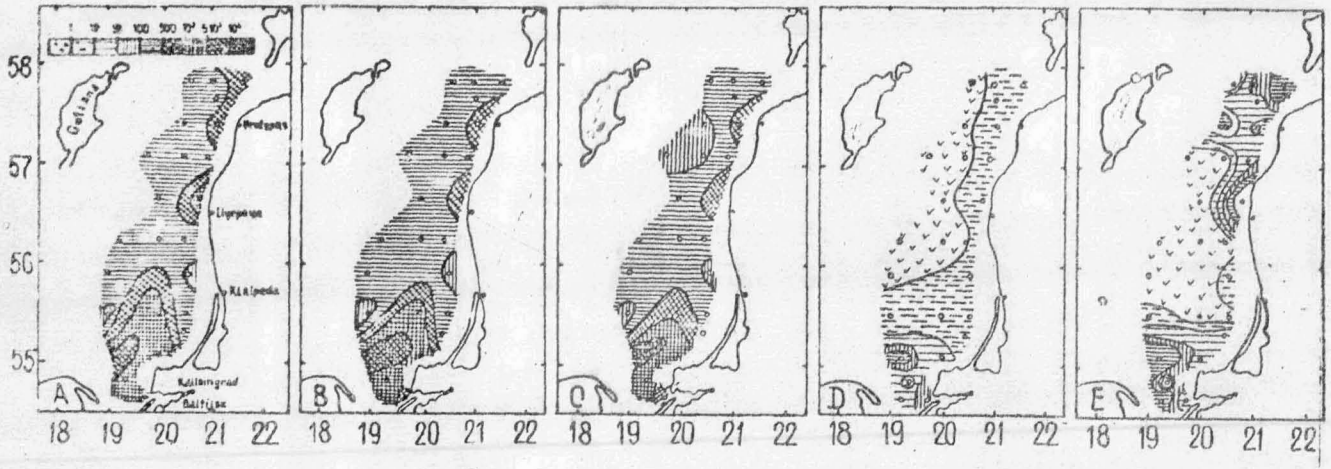
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Fig. 2

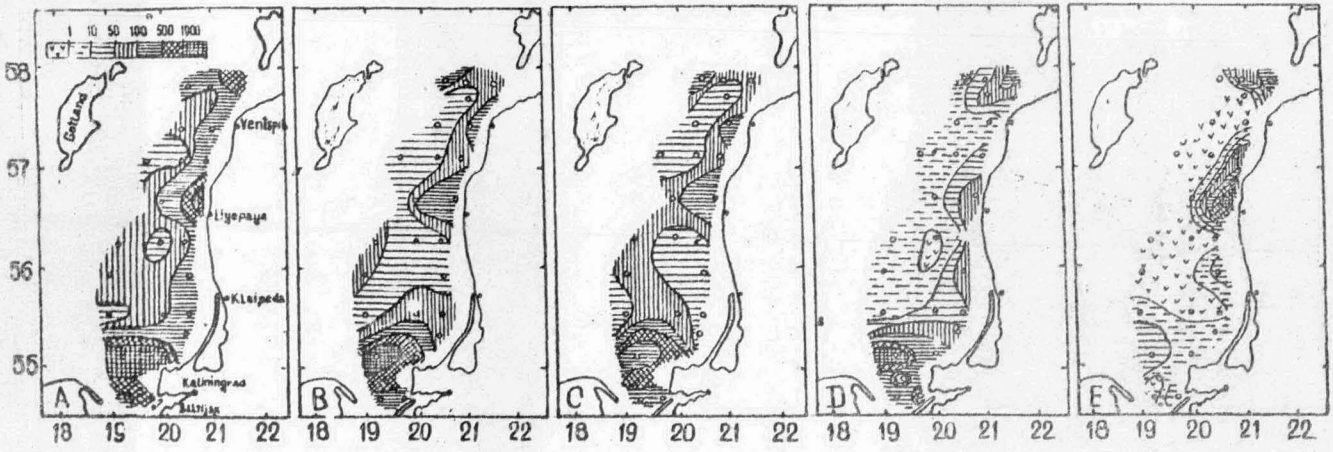
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Fig. 3

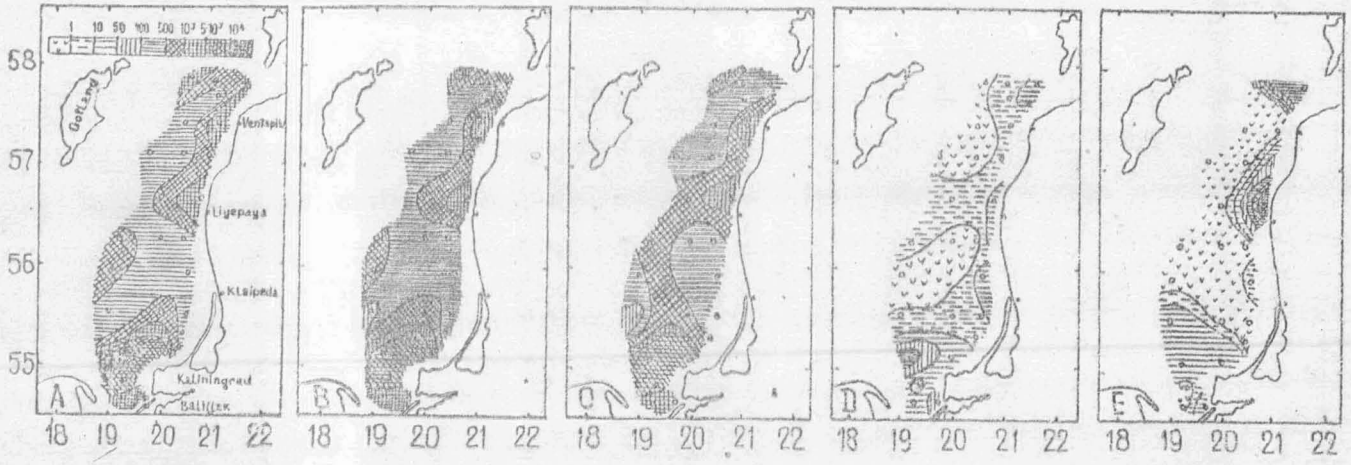
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Fig. 4