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Results of quantitative investigation on the phytoplankton  
distribution in the southern Baltic for 1973

by

Z. Ringer  
Sea Fisheries Institute, Al. Zjednoczenia 1  
81 - 345 Gdynia, Poland



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Introduction

The pattern of quantitative distribution of the southern Baltic phytoplankton indicated the plant vegetation in 1973 to be more than twice as great as that in 1972. The highest number of plant cells per 1 cubic metre of the sea water was observed in the Gdańsk Deep area at 5 m depth. Beside of that, it was once more proved that the indicator species for the organic pollutions of sea water, i.o., Nitzschia palea entered the southern Baltic together with the polluted waters that came from the western region of this sea.

Material and method of investigation

The material destined for the study was taken from the following Baltic regions : the Arkona Sea, the Bornholm Deep and the Gdańsk Deep in all the four vegetation seasons,

winter season / January-February/,

spring season /April - May/,

summer season / June-July-August/, and

autumn season / October-November/.

On the whole 156 plankton samples were examined with respect to the quantitative occurrence of particular species in each of the above regions at 5, 10, 15, 20, 30, 40, 50 and 60 m depths. The samples were taken with a sampler and preserved by adding 4% formalin. The number of cells of a given species in each sample was determined using cylindric cells of 100 ml capacity in the reverse microscope of Utermohl's type. The cell coefficient K for the samples examined amounted to 8.400. The species composition of the phytoplankton in 1973 was studied in samples collected by vertical hauls with the Copenhagen net / gauze No 25 /, completed by those taken with the sampler. The results of qualitative determination of the phytoplankton composition are presented in Appendix 1.

Investigation results

Arkona Sea. From the detailed data for the Arkona Sea is evident that in the winter period the fairly abundant species was

Kirchneriella obesa / Chlorophyceae/. At 15 m depth as many as 168 million cells/m<sup>3</sup> of sea water were found in this region. The other plant species observed at the same time occurred in much lesser quantities and the range of their occurrence was confined to the depth of 15 m only,

In the spring season the following quantities of particular phytoplankton species were found in the area of the Arkona Sea:

Kirchneriella obesa, 475 million cells/m<sup>3</sup> at 15 m depth,

<u>Microcystis aeruginosa</u>	100	"	"	"	5	"
<u>Dinobryon balticum</u>	105	"	"	"	0,5	"
<u>Oocystis lacustris</u>	63	"	"	"	15	"
<u>Chaetoceros borealis</u>	96	"	"	"	10	"
<u>Chaetoceros holsaticus</u>	58	"	"	"	10	"

In the summer 1973 the most numerous species in the Arkona Sea were:

Microcystis aeruginosa 299 mill. cells/m<sup>3</sup> at 20 m depth,

<u>Anabaena spiroides</u>	117	"	"	"	10	"
<u>Anabaena flos-aeae</u>	172	"	"	"	15	"
<u>Kirchneriella obesa</u>	252	"	"	"	5	"
<u>Cyclotella meneghiniana</u>	193	"	"	"	20	"

In the same area the most abundant species in the autumn was Dictyosphaerium ehrenbergianum that occurred in the quantity of 445 million cells/m<sup>3</sup> at 5 m depth.

Bornholm Deep In the region of the Bornholm Deep tree species of phytoplankton were in the winter 1973 by far the most numerous as compared with the others. They were:

Kirchneriella obesa, with 252 mill. cells/m<sup>3</sup> at 15 m depth,

<u>Dictyosphaerium ehrenbergianum</u>	50	mill.	cells/m <sup>3</sup>	at 15 m	depth,
<u>Microcystis aeruginosa</u>	163	"	"	"	15 " "

In the same locality, but during the spring time beside of the species from group Chlorophyceae also the species of the group Bacillariophyceae were fairly abundant. From among the latter the most numerous were:

Kirchneriella obesa 978 mill. cells/m<sup>3</sup> at 5 m depth

<u>Chaetoceros borealis</u>	256	"	"	"	0,5	"
and <u>Skeletonema costatum</u>	119	"	"	"	20	"

The maximum number of cells that was found in this region in the summer belonged to the species Kirchneriella obesa, occurring in an extremely high number of 1,470 million cells/m<sup>3</sup> at 10 m depth. Such a number of plant cells was the largest ever noted. The next positions as regards the quantitative occurrence were occupied by:

<u>Microcystis aeruginosa</u>	508	mill. cells /m <sup>3</sup>	at 30 m depth,
<u>Anabaena sspiroides</u>	356	" "	" 0,5 "
<u>Cyclotella meneghiniana</u>	302	" "	" 20 "

The plant species found in the Bornholm Deep area in the autumn did not differ from those found there in the summer period, only their number per 1 cubic metre considerably lower:

<u>Kirchneriella obesa</u>	344	mill. cells/m <sup>3</sup>	at 30 m depth,
<u>Microcystis aeruginosa</u>	121	" "	" 10 "

Gdańsk Deep The third locality where quantitative investigation concerning the phytoplankton distribution were conducted, was the area of the Gdańsk Deep.

Here, the most numerous species in the winter was Kirchneriella obesa with 88 million cells per cubic metre at 10 m depth.

In the spring two groups of phytoplankton were dominating: Chlorophyceae and Bacillariophyceae.

Kirchneriella obesa reached at that time the record number of cells: 5166 million per cubic metre at 0,5 m depth. The second and third place belonged to Sceltonema costatum with 1709 million cells/m<sup>3</sup> at 0,5 m depth and Microcystis aeruginosa with 184 million cells/m<sup>3</sup> at 50 m depth. In the summer the dominating groups were Cyanophyceae and Chlorophyceae. The following species from these groups were most abundant:

<u>Microcystis aeruginosa</u>	521	million cells/m <sup>3</sup>	at 0,5 m depth
<u>Dictyosphaerium ehrenbergianum</u>	390	" "	" 0,5 "
<u>Anabaena sspiroides</u>	936	" "	" 10. "

Great quantities of two plankton species were found in this region in the autumn:

<u>Kirchneriella obesa</u>	340	million cells/m <sup>3</sup>	at 5 m depth and
<u>Coscinodiscus granii</u>	134	" "	" 10 "

#### General conclusions

Comparing the quantitative investigation results from 1972 and 1973 obtained for the southern Baltic on hydrographic backgrounds of respective years, temperature and salinity, the following facts may be taken into consideration:

In April 1972 an influx of the North Sea waters took place into

the Baltic. It brought about an increase in the salinity of the bottom water of the Arkona Sea up to 22<sup>o</sup>/oo, and slight decrease in the water temperature there. Among the phytoplankton of this locality some North Sea species appeared and gradually drifted southeastward together with the saline waters during the further part of the year.

Nearer to the Baltic entrance, i.e. in the western most part of the sea these species were observed in the late spring and summer, whereas farther to the east, for instance, in the Gdańsk Deep, the presence of some of them was noted as late as October.

There was no influx of saline waters from the North Sea into the Baltic during 1973. The temperature of the isohaline top water layer in winter months was in the Arkona Sea slightly higher than normal, and in the other south Baltic areas it did not show any deviation from the normal values during the whole year, excepting the autumn months when in the Bornholm Deep and Gdańsk Deep the temperature of the top water layer down to 40 m depth was found to be by about 1<sup>o</sup> lower than the normal one. The salinity during 1973 did not show any effects of the salt water influx that had taken place in 1972, i.e., it kept being normal all over the southern Baltic. Only local displacement of waters of the intermediate layer were observed to bring about either salinity increase /by about 1-2<sup>o</sup>/oo / in some Baltic regions, or a temperature increase, as it was observed, for example, in the Bornholm Deep Area. The water masses of the Baltic in 1973 showed greater stability as regards their hydrological characteristics in comparison with the year 1972 and the results of this fact found its expression in the qualitative composition of the phytoplankton as well as in the quantitative occurrence of particular species / number of cells per 1 cubic metre/.

As regards the qualitative composition of the phytoplankton it may be said that the year 1973 differed / by greater variety of species / from the year 1972 . In 1973 the groups of Cyanophyceae and Bacillariophyceae were represented by much more species in comparison with 1972, whereas the group of Chlorophyceae showed the same number of species in both the years.

The regions with the greatest variety of species composition differed in the two years. So, in 1972 the Bornholm Deep area presented the greater variety of phytoplankton species, whereas in 1973 the greater number of species was noted in the Gdańsk Deep area.

The highest number of plant cells per 1 cubic metre at a given depth in 1972 was found in the Bornholm Deep in August. At this time the species Cyclotella meneghiniana / Bacillariophyceae/ occurred at 10 m depth in the quantity of 1432 million cells /m<sup>3</sup> of water. In 1973,

the highest number of plant cells in 1 cubic metre of water occurred in the Gdańsk Deep.

In April 5166 million cells of the species Kirchneriella obesa were present in 1 cubic metre at 0,5 m depth.

The investigation results have indicated that the year 1973 decidedly exceeded the preceding year as regards the total phytoplankton biomass in 1 cubic metre of water. In extreme case example, the species Kirchneriella obesa in October 1973 in the Gdańsk Deep area at 5 m depth was found in 80 times greater quantity.

The obtained results make possible to determine the depths at which the phytoplankton was most abundant in 1972 and in 1973 in the three south Baltic deeps considered, so the depth range at which the phytoplankton was most numerous during both the years was found to be limited by 0,5 and 30 m depths.

In these two years the vertical distribution of the phytoplankton in the Gdańsk Deep area indicated that the depth of 5 m was the richest of all.

It may also be mentioned the quantitative occurrence in both the years, of the species regarded to be the indicator of organic pollution of sea waters, namely of Nitzschia palea / Bacillariophyceae /. This species appeared in the Arkona Sea and in the Bornholm Deep in August 1972, but in the Gdańsk Deep its presence was noted as late as in October that year. This fact may serve to draw a conclusion, that this species gets into the southern Baltic from the western part of this sea. In 1973 Nitzschia palea was found in the Arkona Sea and in the Bornholm Deep in July. In the latter locality at 10 m depth it occurred in considerable amount of 150 million cells/m<sup>3</sup>. The presence of Nitzschia palea, however, failed to be noted in the Gdańsk Deep till the end of the, thus it seems to prove the hypothesis that this species comes from the western part of the Baltic together with the water from there which are containing considerable amounts of organic pollutants.

## Appendix 1

### Species composition of south Baltic phytoplankton in 1973

#### Euglenineae

*Euglena viridis* Ehrenb.

#### Dinoflagellatae

*Ceratium fusus* /Ehr./

*Ceratium tripos* /O.F.M./ Nitzsch.

*Dinophysis acuminata* Clap. Lachm.

*Dinophysis acuta* Ehr.

*Dinophysis norvegica* Clap. Lachm.

*Dinophysis rotundata* Clap. Lachm.

*Dinophysis ovum* Schütt.

*Gonyaulax triacantha* Jörg.

*Gymnodinium rhomboides* Schütt.

*Gymnodinium* sp.

*Peridinium breve* Paul.

*Peridinium catenatum* Levander

*Peridinium depressum* Ball.

*Peridinium divergens* Ehr.

*Peridinium finlandicum* Paul.

*Peridinium pellucidum* /Bergh/ Schütt.

*Peridinium stenii* Jörg.

*Peridinium* sp.

#### Chrysophyceae

*Dinobryon balticum* /Schütt./ Lemm.

#### Silicoflagellatae

*Ebria tripartita* /Schum./ Lemm.

#### Cyanophyceae

*Anabaena flos-aquae* /Lyngb./ Breb.

*Anabaena spiroides* Klebh.

*Aphanizomenon flos aquae* /L./ Ralfs.

*Aphanothece microcopia* Næg.

*Chroococcus limneticus* Lemm.

*Gleocapsa minuta* /Kütz./ Holl.

*Lyngbya bipunctata* Lemm.

*Lyngbya limnetica* Lemm.

Lyngbya sp.

Merismopedia punctata Meyen

Merismopedia glauca /Ehrenb./ Nag.

Microcystis aeruginosa Kütz.

Nodularia spumigena Mert.

Oscillatoria sp.

Bacillariophyceae

Achnanthes taeniata Grun.

Antinocyclus ehrenbergii Ralfs.

Asterionella bleakelyei Smith.

Asterionella gracillima / Kantsch./

Chaetoceros affinis Laund.

Chaetoceros borealis Bail.

Chaetoceros brevis Schütt.

Chaetoceros curvisetus Cl.

Chaetoceros debilis Cl.

Chaetoceros decipiens Cl.

Chaetoceros didymus Ehr.

Chaetoceros gracilis Schütt.

Chaetoceros holsaticus Schütt.

Chaetoceros lacinosus Schütt.

Chaetoceros pseudocrinitus Ostf.

Chaetoceros similis Cl.

Chaetoceros wighami Bright.

Coscinodiscus granii Gough.

Coscinodiscus sp.

Cyclotella meneghiniana Kütz.

Cyclotella socialis Schütt.

Cyclotella stelligera Cl. Grun.

Cymbella prostrata /Berk./ Cl.

Diploneis interrupta /Kütz./ Cl.

Ditylimum brightwelli / West./ Grun.

Epithemia sorox Kütz.

Fragilaria crotonensis Kitt.

Gyrosigma acuminatum / Kütz./ Rabenh.

Melosira nummuloides /Dillw./ Ag.

Melosira undulata /ehr./ Kütz.  
Navicula placentula /Ehr./ Grun.  
Navicula sp.  
Nitzschia closterium /Ehr./ Smith.  
Nitzschia holsatica Hust.  
Nitzschia palea /Kütz./ Smith.  
Nitzschia seriata Cl.  
Rhizosolenia alataf. gracillima /Bright./ Cl.  
Rhizosolenia fragilissima Berg.  
Rhizosolenia setigera Bright.  
Rhoicosphaenia curvata /Kütz./ Grun.  
Sceletonema costatum /Grev./ Cl.  
Synedra ulna /Nitzsch./ Ehr.  
Synedra sp.  
Thalassionema nitzschioides Grun.  
Thalassiosira baltica /Grun./ Ost.  
Thalassiosira gravida Cl.  
Thalassiosira decipiens /Grun. Jörg.

#### Chlorophyceae

Ankistrodesmus falcatus / Corda/ Ralfs.  
Dictyosphaerium ehrenbergianum Naeg.  
Dictyosphaerium pulchellum Wood.  
Chlorella vulgaris Beyerinok  
Kirchneriella obesa /West./ Schm.  
Oocystis submarina Lagerh.  
Oocystis lacustris Chodat.  
Pediastrum boryanum Lemm.  
Pediastrum quadricauda /Turp./ Breb.  
Trochiscia brachiata / Möb./ Lemm.  
Trochiscia clevei Lemm.  
Trochiscia multispinosa Moeb./ Lemm.



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