The chlorophyll a contents in the surface waters of the Gulf of Gdańsk

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Abstract

Distribution of chlorophyll a in the surface waters of the Gulf of Gdańsk was investigated in the years 1986–87. In the Gulf, the highest chlorophyll a concentrations are in April or May when the spring phytoplankton bloom takes place and are usually relatively high until November. The Vistula has a decisive influence on the spatial distribution of chlorophyll in the surface waters of the Gulf of Gdańsk. The concentration of pigments diminishes with the distance from the estuary; the decrease is more rapid towards the west. This influence of the Vistula is particularly noticeable to the Hel-Gdańsk line, as in farther parts of the Gulf concentrations of chlorophyll are usually relatively low and do not vary greatly. The lowest concentration of pigments is always observed in the inner part of Puck Bay.

1. Introduction

In studies of marine ecosystems, particularly in regions subjected to the effects of various types of pollution from the land, knowledge of the content of chlorophyll pigments in the surface waters during the vegetative season provides the information on processes taking place in the euphotic zone. The chlorophyll a content can be determined relatively quickly and easily, and the data obtained enable one to trace the changes in phytoplankton biomass in a water basin studied.

Studies on the concentration of chlorophyll pigments in the waters of the Gulf of Gdańsk commenced in the 70s (Renk et al., 1973; Malewicz et al., 1974; Latala, 1982) and were continued in the following years.
Conducting long-term observations enables one to define accurately a tendency in changes of the concentration of chlorophyll pigments in the basins studied, despite the fact that it is a factor which undergoes relatively large seasonal fluctuations. For this reason, the information presented here may be of some help in monitoring and prognostic studies connected with the protection of the natural environment in the Gulf of Gdańsk.

2. Material and methods

Material for study was collected from March to December 1986, and from February to December 1987, from 24 permanent stations located in the Gulf of Gdańsk (Fig. 1). Samples were collected to plastic containers from surface water layers and subjected to analysis in the laboratory on the same day.

![Distribution of stations in the Gulf of Gdańsk including the profiles for which the seasonal changes in chlorophyll a are presented in consecutive figures (Figs. 2-5)](image)

0.5 to 1 litre of water was filtered through a GF-83 Whatman fibre-glass filter. The filters were frozen down and stored at a temperature of \(-10^\circ\mathrm{C}\) for future analyses. Chlorophyll \(a\) concentration was measured
spectrophotometrically. Pigments were extracted in 12 ml 90% acetone according to Strickland and Parsons' method (1968) and analysis was carried out using a VSU-2G spectrophotometer and 1 cm cuvettes. The chlorophyll concentration was calculated using formulae of SCOR-UNESCO 17 working group (1966) as described elsewhere (Latała, 1982, 1985).

Basing on the results obtained, interpolations of the distribution of chlorophyll \(a\) in the surface waters of the Gulf were computed using a SURFER, Golden Software Inc. computer program.

3. Results and discussion

The maximum concentration of chlorophyll \(a\) noticed in the Gulf of Gdańsk in 1986 was 131 mg m\(^{-3}\), whereas in 1987 the values measured were distinctly lower and the maximum concentration of chlorophyll \(a\) reached 65 mg m\(^{-3}\). The maximum concentrations of chlorophyll, occurring during the phytoplankton blooming, were observed at all stations in April or May, which, to give an example, is illustrated for stations located on the Świbno profile (Figs. 2 and 3). The spring blooming of diatoms in the Gulf of Gdańsk takes place during this period each year (Piński et al., 1985). In both years studied, higher concentrations of chlorophyll \(a\) occurred during the vegetative season starting from March or April and lasting until November.

Low concentrations of chlorophyll \(a\) (several mg per 1 m\(^3\) of water) were observed at the winter–spring turn (February–March, Figs. 2 to 5) and in December, when the climatic conditions greatly restrict the development of phytoplankton. The spatial differentiation of pigment concentration is then insignificant (Fig. 6) and independent of the influence of the Vistula.

The concentrations of chlorophyll \(a\) measured in the waters of the Gulf of Gdańsk during the whole vegetative season are high and come within the range given as characteristic for highly eutrophicated waters (Likens, 1975) and of high productivity (Woźniak and Ostrowska, 1990).

The average chlorophyll \(a\) content of the Gulf of Gdańsk surface waters in 1986 (Fig. 8) was twice as high as in the following year (Fig. 9). The average for 1987 was very similar to that obtained from earlier studies conducted in 1981 (Fig. 10) (Latała, 1985). This may indicate that the high chlorophyll \(a\) contents determined in 1986 were not typical. Such long- and short-term fluctuations of chlorophyll pigment concentrations in the Baltic were often reported (Renk et al., 1983; Lorenz et al., 1991; Renk et al., 1991).
Fig. 2. Chlorophyll a contents on the profile Świbno in 1986

Fig. 3. Chlorophyll a contents on the profile Świbno in 1987
Fig. 4. Chlorophyll a contents on the profile Sopot in 1986

Fig. 5. Chlorophyll a contents on the profile EAST–WEST in 1987, at stations located at a depth of 10 m
Fig. 6. Chlorophyll $a$ contents (mg m$^{-3}$) in the surface waters of the Gulf of Gdańsk in February 1987

Fig. 7. Chlorophyll $a$ contents (mg m$^{-3}$) in the surface waters of the Gulf of Gdańsk in April 1986
Fig. 8. Mean contents of chlorophyll $a$ (mg m$^{-3}$) in the surface waters of the Gulf of Gdańsk in 1986

Fig. 9. Mean contents of chlorophyll $a$ (mg m$^{-3}$) in the surface waters of the Gulf of Gdańsk in 1987
Fig. 10. Mean contents of chlorophyll $a$ (mg m$^{-3}$) in the surface waters of the Gulf of Gdańsk in 1981 (Latala, 1985)

The spatial distribution of chlorophyll $a$ in the surface waters of the Gulf of Gdańsk over months is basically similar. The decisive influence of the Vistula on the distribution of chlorophyll in the Gulf of Gdańsk and, what follows, also on the phytoplankton biomass, is illustrated. This phenomenon has already been described in earlier papers (Renk et al., 1976; Latala, 1985). The Oder exerts similar influence on the distribution of pigments in the Gulf of Pomerania (Renk et al., 1991). The highest concentration of pigments has always been found on the Świnbo profile, close to the main estuary of the Vistula into the Gulf of Gdańsk. This is illustrated for April 1986 in Fig. 7, for the average values in both years studied in Figs. 8–9, and for stations located at a depth of 10 m on the East-West profile in 1987 in Fig. 5. The concentration of chlorophyll pigments diminishes with the increasing distance from the estuary. The influence of the Vistula is greater eastwards than westwards. A distinct influence of the Vistula on the distribution of chlorophyll pigments westwards usually can be observed up to the Hel–Gdańsk line. In the more westerly regions of the Gulf, the chlorophyll concentrations are relatively low and poorly differentiated (Figs. 7–9). Thus, the greater a distance from the shore in the central and eastern part of the Gulf of Gdańsk, the lower the chlorophyll concentration (e.g. on the Świnbo profile, Figs. 2 and 3).
This has not been noticed in the western part of the Gulf (e.g. the Sopot profile, Fig. 4).

The lowest concentration of chlorophyll a is always observed in inner Puck Bay. This part of the area is well separated from the Gulf of Gdańsk by the Rybitwia Sandbank. Similarly low chlorophyll pigment contents for this region have also been reported in earlier papers (Latała, 1982).

References


SCOR-unesco, 1966, Determination of photosynthetic pigments in sea-water, Monographs on oceanographic methodology, 1, 1–69.

