

Analysis of the composition and vertical distribution of the macroalgae in western part of the Gulf of Gdańsk in 1979 and 1980

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Macroalgae
Vertical distribution
Gulf of Gdańsk

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Abstract

The aim of this work was to collect recent data on the composition and distribution of macroalgae in the Gulf of Gdańsk with attention given to seasonal variations. Materials were collected upon 5 sampling profiles, situated in western part of the Gulf of Gdańsk, and on one sampling point at Jurata (shore line) (Fig. 1). Samples were collected at monthly intervals, during two vegetation seasons (1979 and 1980). In case of sampling points down to 1 m deep the materials were collected manually; in deeper areas a dredge was used. Upon the shore line samples for quantitative analyses were collected from randomly selected squares 1×1 m or 0.5×0.5 m, whereas materials for qualitative analyses were taken from large, undefined areas. In deeper places, in which the dredge was used, subsamples of 1 dm^3 were taken for quantitative analyses, and the degree of dredge filling with the material was estimated each time.

1. Introduction

Macroalgae of marine phytocenoses embrace red and brown seaweeds and some green algae. Their role in the coastal ecosystem structure consists of creating excellent conditions for the development of many animals, since they overgrow (together with the macrophytes) large parts of the bottom. Hence, a disturbance of the stability of plant communities may lead to irreversible changes in other elements of coastal biocenoses. Data on these communities in the Baltic Sea are rather scarce; as regards the Gulf of Gdańsk no continuous observations of plant communities were ever carried out. Most papers dealing with these problems are restricted to selected areas (Kornaś *et al.* 1960; Ciszewski *et al.* 1962; Przybyłek 1968; Ślesińska 1977; Pliński 1980) or describe the situation from many years back (Lakowitz 1907). Hence, it was decided to undertake studies on the composition and vertical distribution of macroalgae in the Gulf of Gdańsk, taking into account their seasonal occurrence.

2. Material and methods

Studies were carried out in the western part of the Gulf of Gdańsk. Materials were collected at monthly intervals, during two vegetation seasons: from May to November 1979, and from April to December 1980. 196 samples were analysed. Samples were collected upon 5 sampling profiles (Fig. 1), and from an additional station at Jurata. The latter station was only 1 m deep (sharp sloping of the bottom in this region made it impossible to collect samples from deeper water). The sampling profiles were as follows:

profile A – Region of Kuźnica, east of Cypel Rewski, sandy-muddy bottom, shoals of *Mytilus edulis* from the depth of 5 m,

profile B – section through the Puck Bay, along the line Władysławowo – Rewa, sandy, muddy or sandy-muddy bottom,

profile C – along the headline of Rewa, sandy bottom with gravel,

profile D – opposite of Kępa Redłowska, stony bottom,

profile E – region of Górki Zachodnie, sandy bottom.

Sampling points along these profiles were selected so that each point was 1 m deeper than the preceding one. Down to the depth of 1 m materials were collected manually; at deeper points – with a dredge. Each profile was sampled down to

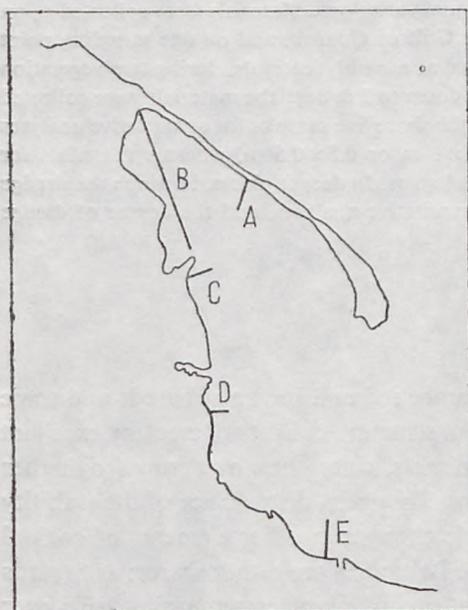


Fig. 1. Distribution of sampling profiles in the Gulf of Gdańsk

15 m depth. Upon the shore line samples for quantitative analyses were collected from randomly selected squares 1×1 m or 0.5×0.5 m, while qualitative analyses were made basing on materials collected from a large, undefined area. For the remaining

sampling points, quantitative analyses were made only if the dredge was at least 50% full with the material. In the latter case a 1 dm³ subsample was taken randomly, and the percentage of dredge filling was determined. Qualitative analyses were based on samples which contained as many representatives of the collected algae as possible. In each case the dredge was dragged along a 100 m line. Materials for qualitative analyses were preserved in 4% formalin solution, and then determined to species in the laboratory. Higher taxonomic units were used in the following cases:

1. for the representatives of *Spirogyra* and *Zygnema*, as determination to species in these genera requires continuous observations of their development and reproduction,

2. for the representatives of Ectocarpaceae, as sporangia were not present,

3. when only fragments of algae were collected.

All determinations were based on keys by Starmach (1972, 1977), Pankow (1971) and Lakowitz (1907). Materials for quantitative analyses were divided into taxa in the laboratory, dried upon a filter paper, weighed up to 0.01 g, and dried in 60°C for 24 h. in order to determine the dry weight. Percentages of particular taxa were calculated taking the dry weight of the subsample as 100%.

3. Results

3.1. Species composition

Qualitative analysis revealed that totally 35 taxa of the green, red and brown algae were present in the material (Table 1). The following species were most frequent: *Enteromorpha intestinalis*, *E. compressa*, *Ulothrix pseudoflacca*, all representatives of the Ectocarpaceae family, and *Ceramium diaphanum*. The most rare taxa were: *Enteromorpha linza* and *Ceramium gracillimum* (found twice), and *Monostroma* sp. *Chara baltica*, *Ulothrix implexa*, *Fucus vesiculosus*, *Ceramium tenuicorne* and *Zygnema* sp. (found only once).

It was also found that the green algae predominated over the remaining classes as regards the number of taxa (Table 2).

3.2. Distribution of benthic algae

As regards the region of studies, special attention should be given to the internal part of the Puck Bay, which was characterized by the most abundant species composition. Along profile B, which ran through the Puck Bay, 32 taxa were found, viz. as many as in all other profiles together with the station at Jurata. Distribution

of plants along this profile was characterized by a lack of zonation, as also occurrence of the red seaweeds already at the depth of 2 m. From among the 32 taxa, three were present only in this area. They were: *Fucus vesiculosus*, *Monostroma* sp. and

Table 1. List of the distinguished macroalgae taxa in the Gulf of Gdańsk in 1979 and 1980

Taxon	Year	
	1979	1980
<i>Enteromorpha intestinalis</i> Link	+	+
<i>E. compressa</i> Greville	+	+
<i>E. flexuosa</i> (Dillwyn) Bliding	+	+
<i>E. clathrata</i> (Roth.) Greville	+	+
<i>E. linza</i> (L.) J. Agardh	+	+
<i>E. ahneriana</i> Bliding	+	+
<i>E. prolifera</i> (O. F. Müller) J. Agardh	+	+
<i>E. ramulosa</i> (J. E. Smith) Hooker	+	+
<i>Cladophora fracta</i> Kütz.	+	+
<i>Cl. aegagropila</i> (L.) Rbh.	+	+
<i>Cl. glaucescens</i> (Griffiths) Harvey	+	+
<i>Cl. glomerata</i> (L.) Kütz.	+	+
<i>Cl. rupestris</i> (L.) Kütz.	+	+
<i>Cl. sericea</i> (Hudson) Kütz.	+	+
<i>Monostroma</i> sp.	+	-
<i>Chaetomorpha linum</i> (O. F. Müller) Kütz.	+	+
<i>Rhizoclonium riparium</i> (Roth.) Harvey	+	+
<i>Ulothrix pseudoflaccida</i> Wille	+	+
<i>U. subflaccida</i> Wille	+	+
<i>U. implexa</i> Kütz.	-	+
<i>Spirogyra</i> sp.	+	+
<i>Zygnema</i> sp.	+	-
<i>Chara baltica</i> Bruzelius	+	-
<i>Ectocarpus confervoides</i> (Roth.) Le Jolis	+	+
<i>E. siliculosus</i> Dillwyn	+	+
<i>Pilayella littoralis</i> (Lyngb.) Kjelm	+	+
<i>Fucus vesiculosus</i> (L.)	-	+
<i>Ceramium rubrum</i> (Huds.) C. A. Ag.	+	+
<i>C. gracillimum</i> Griff. Harvey	+	+
<i>C. strictum</i> Harvey	+	+
<i>C. diaphanum</i> (Lightf.) Roth.	+	+
<i>C. tenuicorne</i> (Kütz.) Waern.	+	-
<i>Furcellaria fastigiata</i> (L.) Lamour.	+	+
<i>Phyllophora brodiaei</i> (Turner) J. G. Ag.	+	+
<i>Polysiphonia nigrescens</i> (Smith) Grev.	-	+

+ present

- not present

Zygnema sp. As regards other profiles, number of taxa was much lower, ranging from 21 along the profile A to 8 along the profile E. Zonation in vertical distribution was most noticeable along the profile A. Apart from the mentioned three taxa found only in the region of profile B, there were a few species occurring at single points

Table 2. Relationship between number of taxa of green brown and red algae in the Gulf of Gdańsk in 1979 and 1980

Algae	Number of taxa collected during the whole studies	Number of taxa collected in the year		Percentage of taxa collected during the whole studies	
		1979	1980	1979	1980
Green	23	22	19	64	63
Brown	4	3	4	11	13
Red	8	8	6	25	23

Table 3. Vertical distribution of macroalgae in the Gulf of Gdańsk in 1979 and 1980

Taxon	Depth (m)				
	0-1	2-3	4-5	6-7	8-9
<i>Enteromorpha intestinalis</i>	+	+	+	-	-
<i>E. compressa</i>	+	+	+	-	-
<i>E. flexuosa</i>	+	+	+	+	-
<i>E. clathrata</i>	+	+	+	+	-
<i>E. linza</i>	+	-	-	-	-
<i>E. ahlneriana</i>	+	+	+	+	+
<i>E. prolifera</i>	+	-	-	-	-
<i>E. ramulosa</i>	+	-	-	-	-
<i>Monostroma</i> sp.	-	-	+	-	-
<i>Cladophora aegagropila</i>	+	+	+	+	+
<i>Cl. glaucescens</i>	+	+	+	-	-
<i>Cl. glomerata</i>	-	+	+	-	-
<i>Cl. fracta</i>	+	+	+	+	-
<i>Cl. rupestris</i>	+	+	+	-	-
<i>Cl. sericea</i>	+	+	+	+	-
<i>Chaetomorpha linum</i>	-	+	+	+	-
<i>Rhizoclonium riparium</i>	+	+	+	-	-
<i>Ulothrix pseudoflaccida</i>	+	+	+	+	+
<i>U. subflaccida</i>	+	+	+	+	-
<i>U. implexa</i>	+	-	-	-	-
<i>Spirogyra</i> sp.	+	+	+	+	-
<i>Zygnema</i> sp.	-	+	-	-	-
<i>Chara baltica</i>	+	-	-	-	-
<i>Ectocarpus confervoides</i>	+	+	+	+	+
<i>Ec. siliculosus</i>	+	+	+	+	+
<i>Pilayella littoralis</i>	+	+	+	+	+
<i>Fucus vesiculosus</i>	+	+	-	-	-
<i>Ceramium gracillimum</i>	-	-	+	-	-
<i>C. rubrum</i>	-	+	+	-	-
<i>C. strictum</i>	-	+	+	+	-
<i>C. diaphanum</i>	-	+	+	+	-
<i>C. tenuicorne</i>	-	+	-	-	-
<i>Furcellaria fastigiata</i>	-	+	+	+	+
<i>Phyllophora brodiaei</i>	-	+	+	+	+
<i>Polysiphonia nigrescens</i>	-	+	+	+	-

+ present

- not present

Fig. 2. Dry weight of macroalgae upon profile B in 1979 and 1980 at the depth of

Table 4. Number of macroalgae taxa upon successive depths in 1979 and 1980

Depth (m)	Green algae	Brown algae	Red algae
0 - 1	19	3	—
2 - 3	18	4	8
4 - 5	17	3	7
6 - 7	10	3	5
8 - 9	3	3	2

Table 5. Average numbers of taxa of the green, brown and red algae in successive months

Months	Green algae	Brown algae	Red algae	Total
May	12	2	3	17
June	15	3	4	22
July	14	3	3	20
August*	14	2	7	23
September	8	3	7	18
October	8	3	6	17
November	4	3	5	12
December*	1	2	6	9

* data from one year, unaveraged

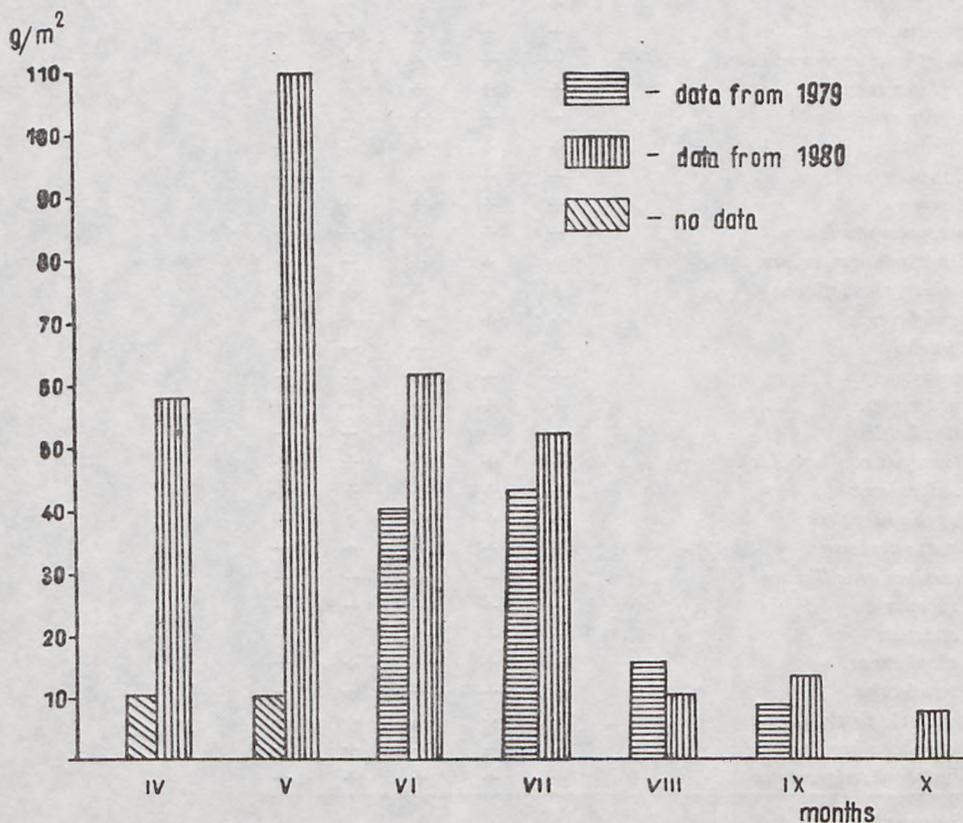


Fig. 2. Dry weight of macroalgae upon profile B in 1979 and 1980 at the depth of 1 m

only. These were: *Cladophora glomerata* (found only in profile C), *Ulothrix implexa* (found only in the region of profile D) and *Chara baltica* (found only on the station at Jurata).

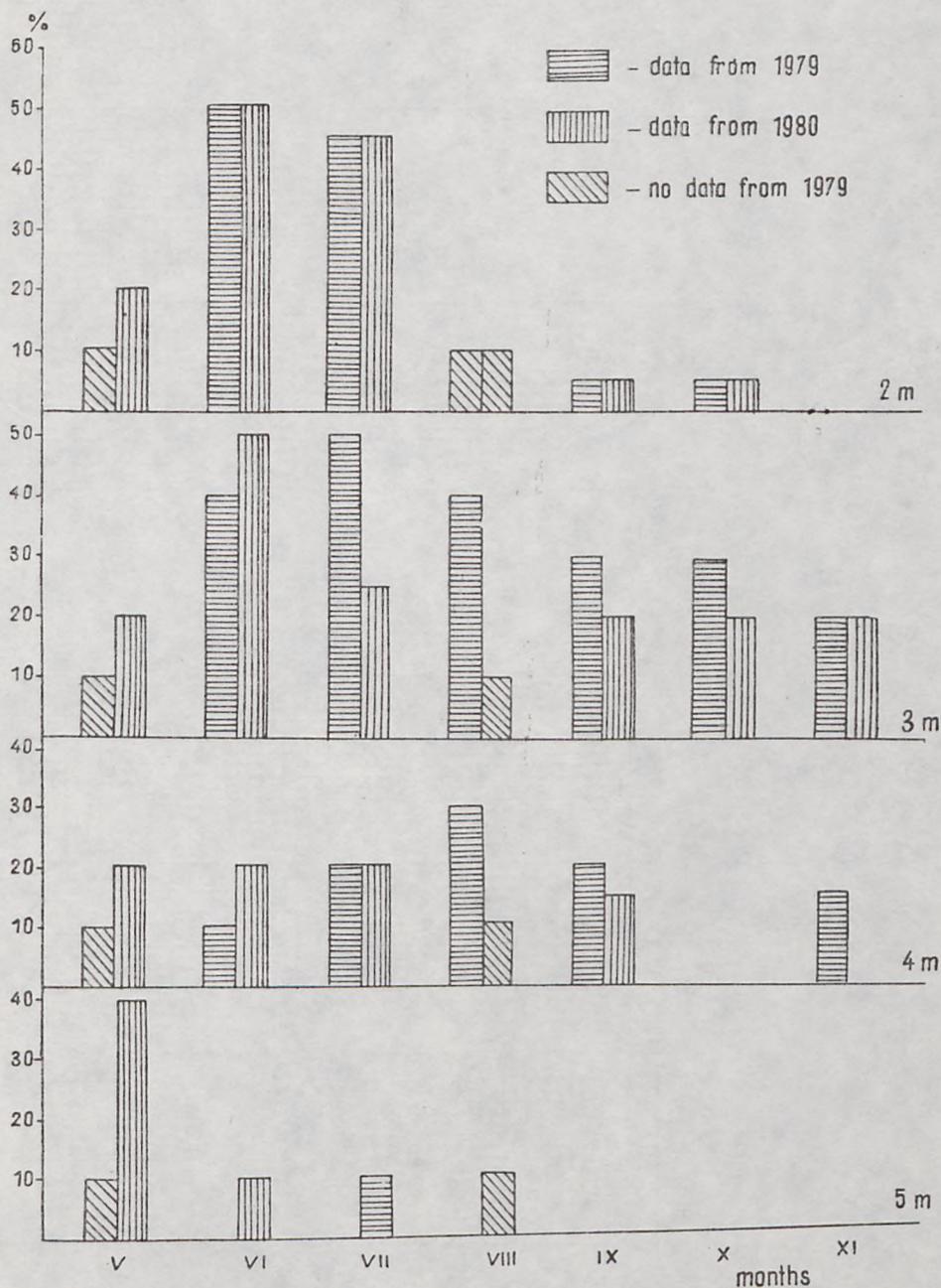
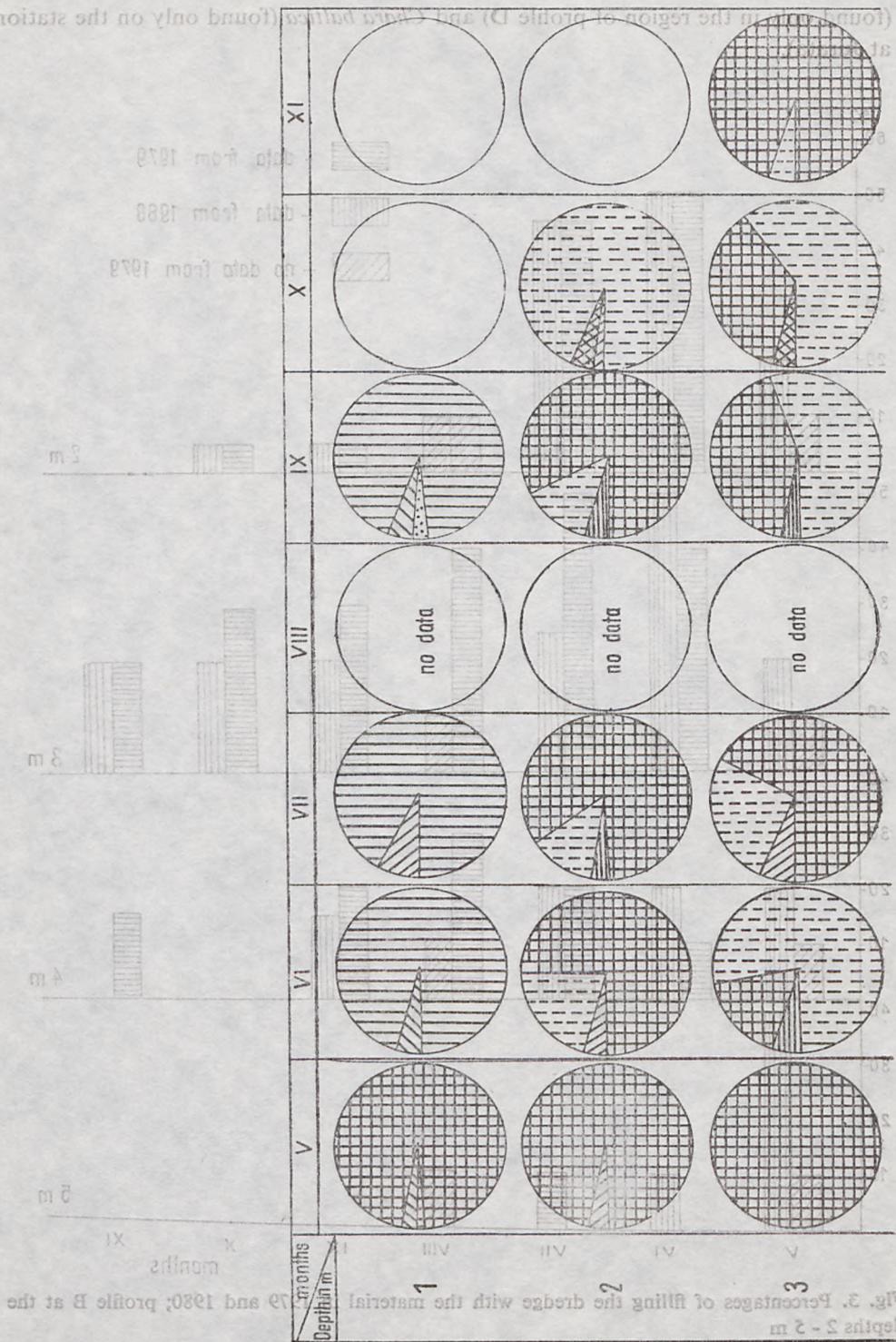


Fig. 3. Percentages of filling the dredge with the material in 1979 and 1980; profile B at the depths 2 - 5 m

only. These were: *Cladophora glomerata* (found only in profile C), *Ulothrix* sp. (found only in the region of profile D) and *Codium bursa* (found only on the station



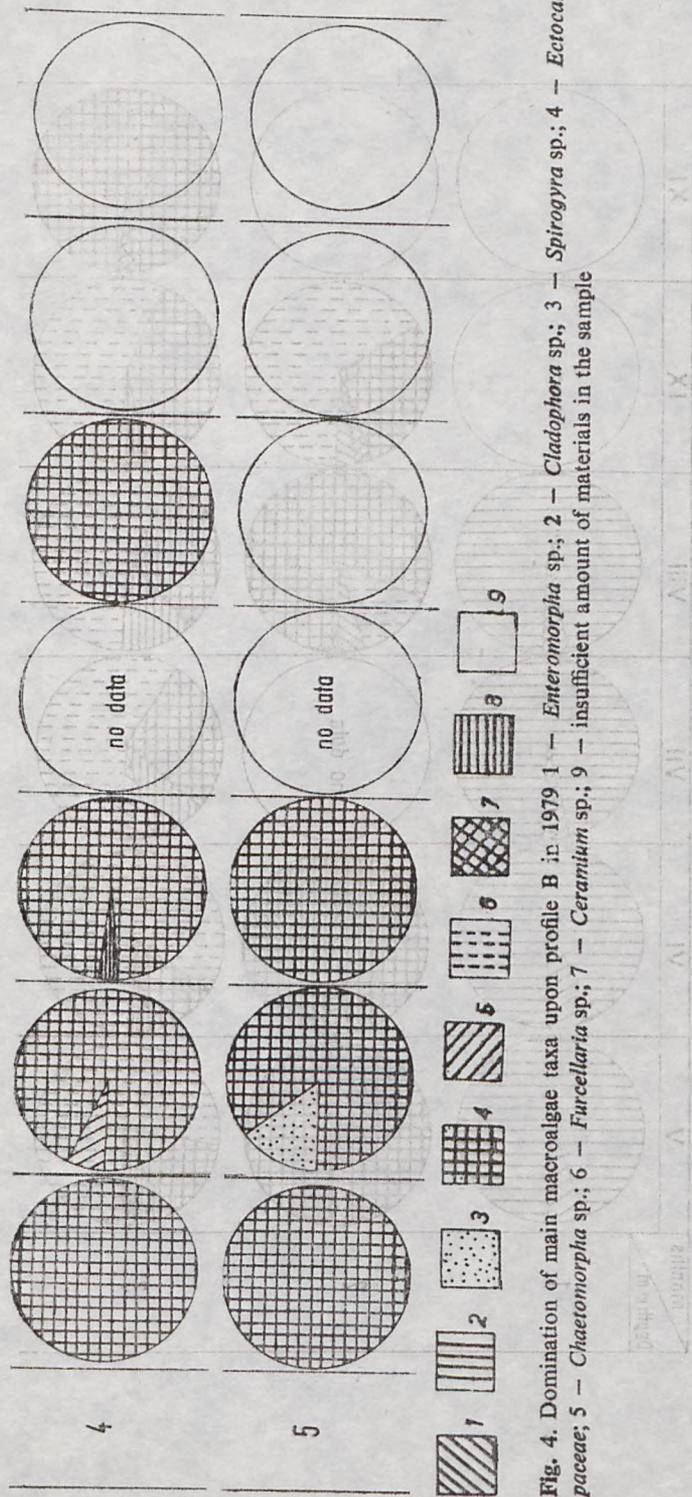
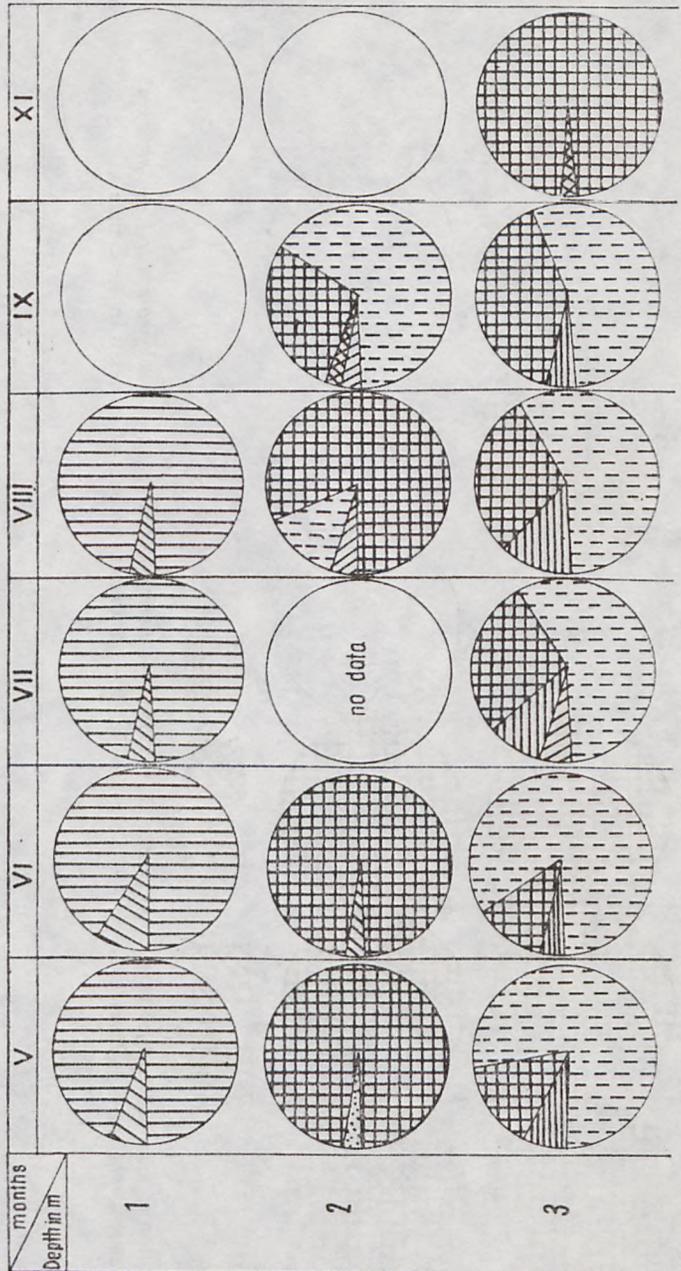


Fig. 4. Domination of main macroalgae taxa upon profile B in 1979 1 — *Enteromorpha* sp.; 2 — *Cladophora* sp.; 3 — *Spirogyra* sp.; 4 — *Ectocarpaceae*; 5 — *Chaetomorpha* sp.; 6 — *Furcellaria* sp.; 7 — *Ceramium* sp.; 9 — insufficient amount of materials in the sample



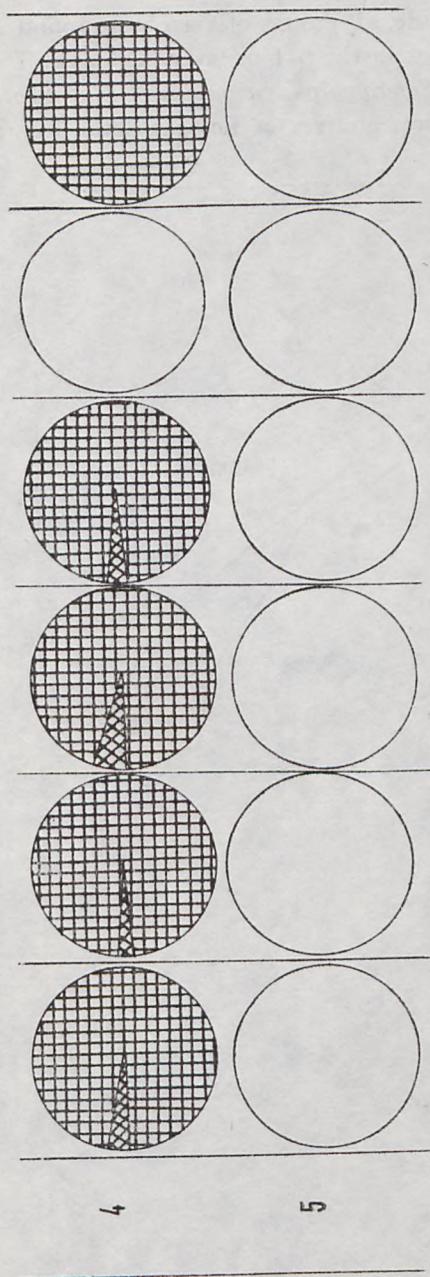


Fig. 5. Domination of main macroalgae taxa upon profile B in 1980 Explanations - see Figure 4

Macroalgae were found down to the depth of 9 m. The following species were found at this depth: brown seaweed *Pilayella littoralis* (profile C), and *Furcellaria fastigiata* and *Phyllophora brodiaei* (profile A). Vertical distribution of algae was characterized by weak or no zonation. As a rule, all groups of algae were found at all depths; only red seaweeds were not present in the 0–1 m layer (Table 3). The following species occurred at all depths: *Enteromorpha ahlneriana*, *Cladophora aegagropila*, *Ulothrix pseudoflacca*, and all representatives of Ectocarpaceae found

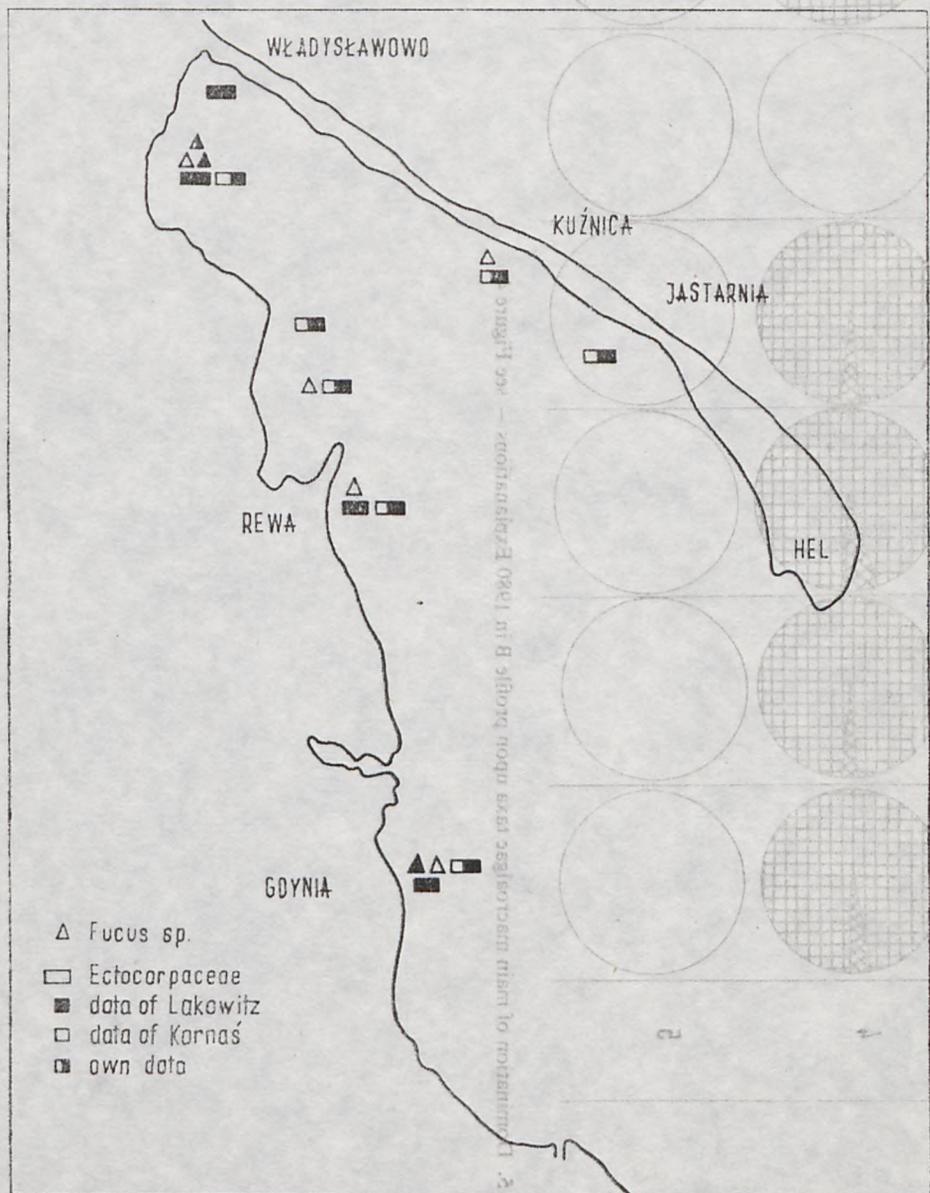


Fig. 6. Occurrence of selected brown seaweed genera according to various authors

in the Gulf of Gdańsk. Some species were present only at particular depths; these were: *Enteromorpha prolifera*, found at the depth 0–1 m only, *E. ranulosa* – 0–1 m, *Cladophora glomerata* – 2–5 m, *Chaetomorpha linum* – 2–7 m, *Fucus vesiculosus* – 2–3 m and *Ceramium rubrum* – 2–5 m.

Although there was no noticeable zonation, number of the taxa of green algae decreased along with increasing depth, and from the depth of 2 m the same was observed as regards the red seaweeds. On the other hand, number of taxa of the brown seaweeds did not change with depth (Table 4). As a result, at variable number of taxa of the green and red algae, percentage of brown seaweeds increased from about 14% in the 0–1 m layer to 37.5% in the 8–9 m layer.

3.3. Seasonal variability

Analysis of the composition and distribution of macroalgae in time should take into account seasonal variability, since this variability affects both the biomass and the qualitative structure.

Several species of the macroalgae were present throughout the whole vegetation season (from May to December) in both years. These were: one species of green algae – *Ulothrix pseudoflaccida*, one species of brown seaweeds – *Pilayella littoralis*, and three species of red seaweeds – *Ceramium diaphanum*, *Furcellaria fastigiata* and *Phyllophora brodiaei*. The remaining algae species occurred only in certain periods. In spring and summer green algae prevailed as regards number of taxa, whereas autumn was characterized by a slight domination of red seaweeds (Table 5).

Seasonal variability was also reflected in decreasing dry weight and percentage of the dredge filling with the material, beginning from May or June till December (Figs. 2, 3). Quantitative relations between main macroalgae also changed depending on the season (Figs. 4, 5).

4. Discussion and conclusions

Number of taxa of attached macroalgae found in the Gulf of Gdańsk during the present studies differed from numbers given by other authors for the same region in the past (Lakowitz 1907; Kornaś 1957). Lakowitz found 95 taxa (together with blue-green algae) in the Gulf of Gdańsk. Considering changes of the taxonomy, and the fact that his studies embraced larger area, it can be deduced that at Lakowitz's times about 85 taxa of algae occurred in the Gdańsk Bay, blue-green algae included. The latter were represented by 14 taxa. In 1979–1980 number of macroalgae taxa was lower by 26 species in relation to the data for 1907. This number does not take into account epiphytic species, such as *Elachista fucicola* (Reinke) Aresch., *Castagnea virescens* (Carm. Hooker) Thuret, Le Jolis jun., *Eudesme virescens* (Carm. Hooker) J. G. Ag., or *Laetsia difformis* (L) Aresch., which were mentioned by Lakowitz but were not considered in this work. Due to small number of the sampling profiles

and short duration of studies (two vegetation seasons) it is not possible to state what might be the real reason for the lack of the 26 mentioned species in 1979–1980 samples. It is possible that these species disappeared from the Gulf of Gdańsk, but they might have also become restricted to some regions only, with simultaneous decrease of the biomass.

Some differences were noted also as regards the distribution and number of macroalgae stations compared to earlier data (Lakowitz 1907; Kornaś, Medwecka-Kornaś 1973; Kornaś *et al.* 1960). Most significant differences were found for *Fucus* sp. (number of its stations decreased to one only) and *Ectocarpus* sp. (number of stations increased) (Fig. 6). In case of green and red algae these differences were less significant.

Another example of long-term changes in the composition and distribution of benthic algae consists of a decrease of the vertical range of occurrence. Lakowitz (1907) and Demel (1935) stated that 25 m were the maximal depth of algae occurrence in the Gulf of Gdańsk. According to Kornaś (1973) this depth was 18 m, while in 1979–1980 is decreased to 9 m only. It is probable that this decrease of maximal depth of macroalgae range resulted from decreasing transparency of water due to increasing pollution of the Gulf of Gdańsk.

Relating to the status in the sixties (Kornaś *et al.* 1960, Ciszewski *et al.* 1962) abundancy of *Fucus vesiculosus* and *Furcellaria fastigiata* in the south-west part of the Puck Bay decreased. On the other hand, abundancy of brown seaweeds of the Ectocarpaceae family increased. These facts suggest that changes taking place in the composition and distribution of attached macroalgae in the Gulf of Gdańsk are reflected by both: decreasing number of species and restricting range of vertical occurrence. At the same time, domination of some species considerably increased, this being especially noticeable in case of the Ectocarpaceae family. These phenomena suggest progressing eutrophication of the Gulf (Pliński 1979).

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