Changes in composition and distribution of benthic algae on the Polish coast of the Baltic Sea (1986–1991)

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Phytobenthos
Southern Baltic
Changes in composition

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Abstract

The composition and frequency of phytobenthic organisms along the Polish Baltic coast was analysed. During 5 years of observations, Chlorophyta were found to be dominant, and the brown alga *Pilayella litoralis* was expanding rapidly in highly eutrophic areas. Absent at the start of observations, *Fucus vesiculosus* appeared in some areas in 1990.

1. Introduction

Our knowledge of the vegetation on the Polish coast of the Baltic Sea is generally insufficient and only a few aspects have been worked out satisfactorily. The phytoplankton is one of them, as a result of many years' research at the Marine Fisheries Institute in Gdynia. In addition, the University of Gdańsk has recently contributed to this task, although its work has been confined to the Gulf of Gdańsk. Finally, the Gdańsk Branch of the Environmental Protection Institute has been monitoring the Polish economic zone of the Baltic.

Our knowledge of the phytobenthos is much poorer. Much of the little work that has been done was incidental to studies of agar-agar stocks.

However, interest in the phytobenthos has increased in recent years, especially in Puck Bay, which is an important model basin in investigations of biocenotic changes resulting from pollution build-up.

What has so far been published on the southern Baltic phytobenthos deals mainly with the Gulf of Gdańsk, and with Puck Bay in particular (Bursa, Wojtusiak and Wojtusiak, Kornas, after: Pliński, 1972). As in the littoral around all seas, the phytobenthos of this region includes species of the three algae classes–green (Chlorophyceae), brown (Phaeophyta) and red (Rhodophyta) – as well as seed plants (Spermatophyta). Owing to the low salinity in the Gulf of Gdańsk, the number of algae species is low compared to oceanic coasts. During the last twenty years the community composition of the Puck Bay phytobenthos has undergone changes, the most notable of which is the considerable expansion of Ectocarpaceae species (Pliński and Florczyk, 1984; Pliński, 1990), which have also spread rapidly into other coastal areas of the Baltic. At the same time, some other species have become extinct, notably the red alga *Furcellaria fastigiata,* species of the Ceramium genus, and the brown alga *Fucus vesiculosus.* The differences in the range of occurrence and biomass are significant, but in comparison with the situation in the late 1960s they are enormous. Important features of the degradation of phytobenthos communities in the Gulf of Gdańsk are the loss of almost 40% of species within the present century and the limitation of their occurrence to depths no greater than 6 m; at the beginning of the century bottom flora was frequently found at depths of 25 m and more. These changes are due to the water transparency having been reduced by ever greater amounts of suspended matter, limiting the access of light, and to bottom sludge preventing algae from growing on a solid substrate, the latter being a crucial biotic element in their development. As similar changes have been noted in many areas of the Baltic, the cenotic situation of the phytobenthos had to be established along other stretches of the Polish coast besides the Gulf of Gdańsk. That is why in 1986 a pilot study of the presence of macroalgae was started in a narrow littoral strip from the beach to a depth of 0.5 m.

2. Material and methods

The material was collected every summer from 1986 at the end of July and beginning of August. Sampling sites were added every year in order to obtain the best possible picture of the floristic situation. In 1991, samples from 42 stations on the open sea coast of the southern Baltic (from Hel to Świnoujście) and in the Gulf of Gdańsk (between Puck Bay and the eastern Polish border) were analysed (Fig. 1). The macroalgae were collected from

wooden piles, from stones in the littoral; floating algae were sampled from the water, and thalli washed up on the beach were picked up there.

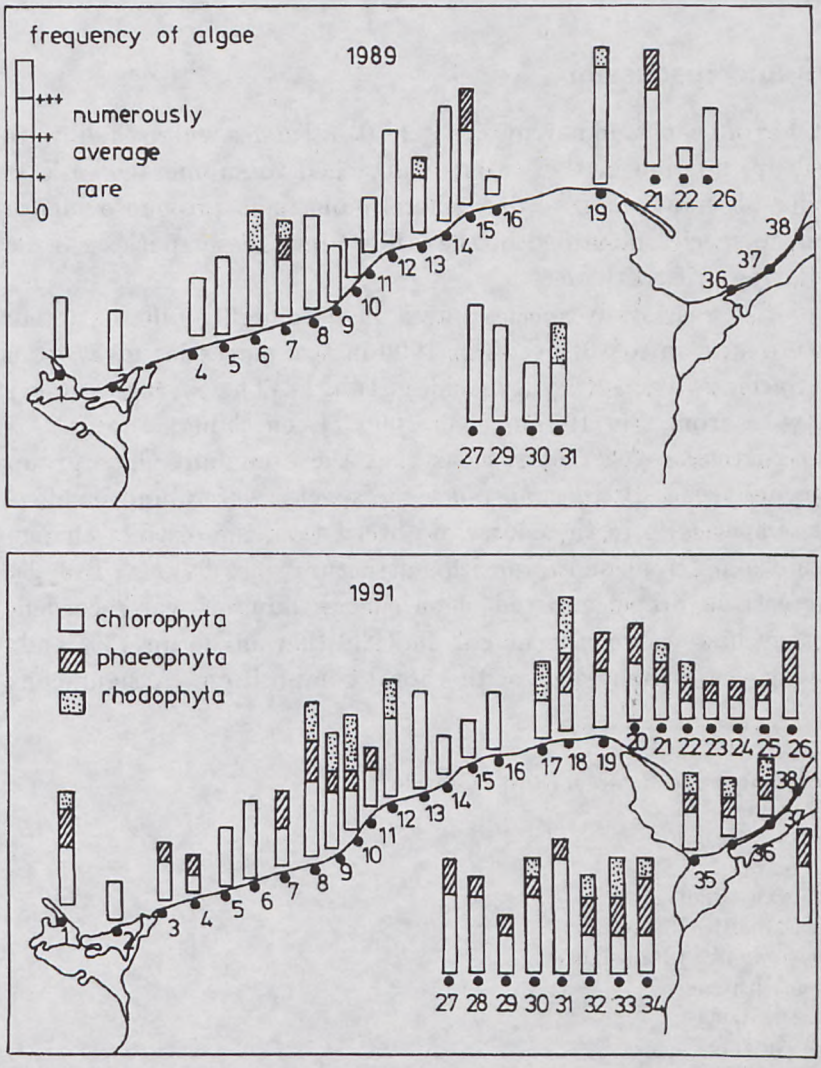

Fig. 1. Occurrence of Chlorophyta, Phaeophyta and Rhodophyta at selected stations in two years (number of station refers to the place name in Table 1)

The collected algae were put into 0.5 l plastic bottles. Immediately after collection, the material was preserved in formalin. During the sampling, a site description for every station was compiled; special attention was paid to the density of the coastal vegetation cover, the identification of the substrate and the extent to which this was covered by vegetation.

The biological material collected was analysed qualitatively in the laboratory. After initial thallus segregation, the species were identified in accordance with the available keys (Lakowitz, 1929; Starmach, 1972, 1977; Pliński, 1988).

3. Results and discussion

The stretches of beach and narrow coastal littoral zones where thalli were found washed up, floating in the water or attached to submerged objects was kept under observation. The data thereby obtained provide evidence only of the algae species identified in the study area; these species can be regarded as having drifted there.

During the five year study species numbers were highly differentiated: from a complete lack up to 10 species in 1990 in two places far away from one another (Sarbinowo and Kąty Rybackie) (Tab. 1). The average number was rather low — from 2 in 1987 to 4 in 1990. Even though the data is incomplete in particular years, it is clear that the dominant algae group were the Chlorophyceae. Brown and red algae species were found incidentally (see list of species)[1]. In the course of observation, the distinct change taking place in the macroalgae composition structure was obvious (Tab. 2): a gradual increase in brown and red algae species number was recorded. Before 1987 they had scarcely occurred. In 1989 they made up 13% and in the following years about 40% of the floral composition. A significant

[1] List of species
Chlorophyta: *Enteromorpha clathrata* (Roth) Greville
E. compressa Greville
E. intestinalis (L.) Link
E. linza (L.) J. Agardh
E. paradoxa (Dillwyn) Bliding
E. ramulosa (J. E. Smith) Hooker
Cladophora aegagropila (L.) Rabenhorst
C. albida (Hudson) Kützing
C. glomerata (L.) Kützing
C. rupestris (L.) Kützing
C. sericea (Hudson) Kützing
Phaeophyta: *Ectocarpus siliculosus* Dyllwyn
Pilayella litoralis (Lyngbye) Kjellman
Sphacelaria cirrosa (Roth) C. A. Agardh
Fucus vesiculosus L.
Rhodophyta: *Polysiphonia violacea* (Roth) Greville
Ceramium circinatum (Kützing) J. G. Agardh
C. diaphanum (Lightfood) Roth
C. rubrum (Hudson) C. A. Agardh
Rhodomela confervoides (Hudson) Silva

Table 1. Numbers of recorded species of algae in each year (in parentheses the respective numbers of green, brown and red species)

	Number of stations and name of place	Character of bottom	1986	1987	1989	1990	1991
1.	Świnoujście	sand	5(500)	5(500)	2(200)	5(410)	6(321)
2.	Międzyzdroje	sand	5(500)	2(200)	4(400)	3(300)	2(200)
3.	Dziwnów	sand	7(700)	4(400)	X	3(300)	3(210)
4.	Rewal	sand-stone	3(300)	5(500)	2(200)	3(300)	2(110)
5.	Mrzeżyno	sand-stone	2(200)	2(200)	2(200)	2(200)	3(300)
6.	Kołobrzeg	sand-stone	3(300)	3(300)	4(301)	5(401)	3(300)
7.	Ustronie Morskie	sand-gravel	9(810)	5(500)	7(502)	6(321)	3(120)
8.	Sarbinowo	sand	X	X	2(200)	10(532)	6(411)
9.	Mielno	sand	4(400)	2(200)	5(500)	6(312)	5(311)
10.	Łazy	sand	X	2(200)	3(300)	6(402)	3(111)
11.	Dąbki	sand	2(200)	X	3(300)	5(311)	5(320)
12.	Darłówek Wschód	sand	3(300)	4(400)	3(300)	4(301)	4(301)
13.	Jarosławiec	sand	2(200)	2(200)	4(301)	5(320)	3(300)
14.	Ustka	sand	3(300)	3(300)	4(400)	3(300)	2(200)
15.	Rowy	sand	4(310)	1(100)	4(220)	5(410)	2(200)
16.	Łeba	sand	X	3(300)	2(200)	4(220)	2(200)
17.	Lubiatowo	sand	X	X	X	X	5(302)
18.	Dębki	sand	X	0(000)	X	4(130)	5(212)
19.	Rozewie	stone	X	X	3(201)	3(120)	3(210)
20.	Chałupy (*)	sand	X	X	X	3(120)	3(210)
21.	Hel (*)	sand	X	X	4(310)	2(101)	5(221)
22.	Hel (**)	sand	X	X	2(200)	2(200)	5(311)
23.	Jurata (**)	sand	X	X	X	2(110)	3(120)
24.	Kuźnica (**)	sand	X	X	X	1(100)	2(110)
25.	Chałupy (**)	sand	X	X	X	1(100)	4(220)
26.	Władysławowo	sand	X	X	1(100)	1(100)	2(110)
27.	Gnieżdżewo	stone	X	X	3(300)	4(310)	3(210)
28.	Rzucewo	sand-gravel	X	X	X	4(310)	5(410)
29.	Osłonino	sand-gravel	X	X	5(500)	7(511)	3(210)
30.	Rewa	sand-gravel	X	X	4(301)	4(211)	5(311)
31.	Gdynia	sand-stone	X	X	3(201)	7(511)	5(212)
32.	Sopot	sand	X	X	X	3(021)	5(212)
33.	Jelitkowo	sand	X	X	X	4(301)	6(213)
34.	Brzeźno	sand	X	X	X	X	4(211)
35.	Stegna	sand	X	1(100)	X	3(021)	5(311)
36.	Kąty Rybackie	sand	X	2(200)	1(100)	10(631)	5(311)
37.	Krynica Morska	sand	X	0(000)	2(200)	5(320)	4(211)
38.	Piaski	sand	X	X	1(100)	6(231)	5(230)

* open sea
** Puck Bay

Table 2. Combined percentage of green, brown and red species for all stations in particular years

Algae	1986	1987	1989	1990	1991
green	96	100	87	63	59
brown	4	-	4	25	25
red	-	-	9	12	16

increase was noted in macroalgae abundance from 1989 to 1991 (Fig. 1).

Analysing the occurrence of particular species reveals that they are confined to particular areas (Tab. 1). This would support some earlier findings as to the occurrence of two green algae genera: Enteromorpha and Cladophora (Pliński and Florczyk, 1984), which in turn would point to the presence of specific Chlorophyceae populations in the southern Baltic. This hypothesis requires further detailed study. A similar phenomenon was found in the case of one of the brown algae species – *Pilayella litoralis*. This species occurs at high densities in two clearly isolated areas: the Gulf of Gdańsk and the Gulf of Pomerania. Elsewhere along the coast it occurs sporadically (Tab. 3).

In the last two years *Fucus vesiculosus* has been present. In some areas it occurs in quite large numbers (Sarbinowo – Ustronie Morskie, Dębki – Rozewie, Chałupy (on the open sea side) – Piaski). In addition, the occurrence of red algae has become typical of some areas. Large numbers were found on the central Polish coast (Darłowo – Sarbinowo), near Dębki and Lubiatowo, in the Gulf of Gdańsk except in Puck Bay, and at the western end of the beach at Świnoujście. The most common of the red algae were the Ceramium species.

Table 3. Occurrence of some algae species at each station in 1990 and 1991

Stations	*Enteromorpha*				*Cladophora*				*Pilayella*	
	compresa		*intestinalis*		*rupestris*		*sericea*		*litoralis*	
	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
1. Świnoujście	+++	+	+++	+	++	-	++	-	+	++
2. Międzyzdroje	+++	+	+++	-	++	+	-	+	-	-
3. Dziwnów	+++	+	+++	-	++	-	++	+	-	+
4. Rewal	++	+	++	-	+++	-	-	-	-	+
5. Mrzeżyno	+++	+	+++	-	++	+	-	+	-	-
6. Kołobrzeg	+	+	+	-	++	+	++	+	-	-
7. Ustronie Morskie	-	-	-	++	+++	-	++	-	-	+
8. Sarbinowo	++	++	++	++	+++	++	+++	+	+	-
9. Mielno	-	-	-	+	++	++	++	+	-	-

Table 3. (continued)

Stations	*Enteromorpha*				*Cladophora*				*Pilayella*	
	compresa		*intestinalis*		*rupestris*		*sericea*		*litoralis*	
	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
10. Łazy	+	-	+	-	++	++	++	-	-	-
11. Dąbki	++	-	++	+	++	+	-	+	-	+
12. Darłówek Wschód	+++	+	+++	++	++	-	-	-	-	-
13. Jarosławiec	+	++	+	-	++	+++	++	+	-	-
14. Ustka	-	+	-	++	+++	-	++	-	-	-
15. Rowy	+	+	+	-	+	+	-	-	-	-
16. Łeba	-	-	-	-	++	+	–	+++	++	-
17. Lubiatowo	nd	+	nd	-	nd	+	nd	+	nd	-
18. Dębki	+	-	+	++	-	+++	-	-	++	-
19. Rozewie	-	-	-	++	-	-	-	-	+	-
20. Chałupy (*)	-	-	-	+	-	-	-	++	+	-
21. Hel (*)	-	-	-	+	-	-	-	+	+	+
22. Hel (**)	-	-	-	+	+	-	-	+	-	+
23. Jurata (**)	+	-	-	+	-	-	-	-	-	++
24. Kuźnica (**)	+++	-	-	-	-	-	-	-	-	+
25. Chałupy (**)	+++	-	-	++	-	+	-	-	-	++
26. Władysławowo	-	-	+++	++	-	-	-	-	-	++
27. Gnieżdżewo	-	-	++	++	++	++	-	-	+++	+ +
28. Rzucewo	-	+	++	++	+++	++	-	-	+++	+
29. Osłonino	-	+	+	++	++	-	-	-	+++	+
30. Rewa	+++	+++	+	++	+	+	-	-	++	+
31. Gdynia	+++	+++	+	+	+	+++	-	++	+	+
32. Sopot	-	-	-	-	-	-	-	+	+	++
33. Jelitkowo	++	-	++	+	-	-	+	+	nd	++
34. Brzeźno	nd	+	nd	-	nd	-	nd	+	-	+++
35. Stegna	-	+	-	+	-	+	-	-	++	-
36. Kąty Rybackie	-	-	-	++	+	-	-	-	++	+
37. Krynica Morska	-	-	-	++	+	-	-	-	++	+
38. Piaski	-	-	++	++	+	-	-	+	++	+

frequency: no algae, + rare, ++ average, +++ numerous, nd — no data

* open sea

** Puck Bay

4. Conclusion

Comparison of observations shows that the phytobenthos of the Polish Baltic coast is little differentiated with respect to species. This means that this phytocoenosis is still seriously endangered all along the coast. However, new phenomena are revealing changes in the development dynamics of this ecological formation: this applies in particular to the increase in *Fucus vesiculosus*. This may be a new tendency in the development of this species because the increase in occurrence of *F. vesiculosus* thalli, slight in 1990,

was much greater in 1991. Attention been drawn to a similar phenomenon by scientists in other Baltic Sea areas (personal information).

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