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BENTHOS OF THE SŁUPSK BANK AND THE GULF OF GDAŃSK (PRELIMINARY INFORMATION)

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Preliminary results of ongoing studies on benthos in the Słupsk Bank and in the Gulf of Gdańsk are discussed. Additionally, some results of studies on periphyton growing on certain artificial substrata deployed within a 1 km² square of the bottom close to Station 2 in the Słupsk Bank are given. The test site, 17 m deep, is delimited by the following coordinates: 54°56.55' N 16°50.67' E; 54°56.39' N 16°51.56' E; 54°55.88' N 16°51.28' E; 54°56.04' N 16°50.38' E.

INTRODUCTION

A study on gravel mining effects on benthos of the Słupsk Bank has been carried out by the author since 1987, samples being collected every year. A test site was marked with bouys and numerous markers to carry out sampling programmes aimed at collection of hydrological, geological, and biological data. Additionally, benthos of the Gulf of Gdańsk was sampled in 1981, the sampling being repeated in 1983.

MATERIALS AND METHODS

All the benthos samples were collected with a van Veen grab following Dybern et al. (1976). The samples were collected from 21 stations located in the Słupsk Bank (Fig. 1) and from 35 stations in the Gulf of Gdańsk (cf. Fig. 4 in Okołotowicz 1985).

Some additional substrata such as stones fouled with algae were collected by a team of divers.

Five large boulders, each weighing approximately 3–4 t, were raised from the bottom in May 1989 at a separate 19 m deep station (54°53.38' N 16°30.25' E; the test site). Benthos and fouling organisms were sampled from the boulders after these had been placed on the deck of the Polish salvage ship "Posejdon".

Fig. 1. Location of benthos stations in the Słupsk Bank — depths of stations (m) are given in brackets: 1(16), 2(17), 3(17), 4(15), 5(15), 6(20), 7(16), 8(20), 9(15), 10(15), 11(15), 12(16), 13(16), 14(14), 15(16), 16(15), 17(16), 18(17), 19(16), 20(17), 21(17), 22(14), 23(16)

At the test site, numerous markers were installed to carry out special hydrological and geological investigations. The markers were 3 m long metal tubes of 8 cm outer diameter. They were driven vertically into the sediment to a depth of 2 m. A total of 66 plexiglass plates (5 x 2 x 0.5 cm) serving to monitor the periphyton (= fouling organisms) in the area were placed at 11 marked sites. The plexiglass plates were deployed on 18 May 1988. They were placed in groups of 6 on each of the 11 shelves attached to the metal markers about 30 cm above the bottom. The plexiglass plates were set up in the following way: at a distance of 0.5 cm from the shorter side of the plate there is a pin-hole allowing to mount every plate on a vertical pin on the shelf connected to the marker. Six such pins were firmly fixed by sheet rubber gaskets used to stabilize them horizontally. Thus, every plate was in contact with the shelf at a distance of 1 cm, its upper, lower, and lateral surfaces of 20 cm² being free for periphyton to grow.

On 9 August 1988, divers collected one plate from each of the 8 markers visited, while on 22 October 1988, two plates from each of the 10 markers visited were collected. No new plates were placed on marker shelves at those two dates. After removal, the plates were immediately, i.e. under water, placed in a special container.

The periphyton was scraped from the plates with a scalpel and preserved in 4% formaldehyde. To study the periphyton in the entire water column, 4 sets of 3 oak bark stoppers strung on a line passed through an aperture in the middle of each stopper were anchored at each corner of the test site on 29 May 1988. Five microscopic slides were inserted into 5 corresponding incisions made in each stopper. The 3 stoppers strung on a line were exposed to fouling at the following depth levels: 30 cm above the bottom, 10 m above the bottom, and about 1 m below the water surface. To maintain each stopper with slides at its pre-set depth level, the whole construction was anchored with sinkers and a plastic float was attached at the top of the construction. Only one of the 4 sets of stoppers with slides was found to remain until 7 August 1988 when the slides were collected for inspection.

Taxa of the periphyton scraped from the plexiglass plates collected in August and October 1988 were identified. Additionally, the benthos collected in the Śtupsk Bank and in the Gulf of Gdańsk was identified as well.

RESULTS

Taxa of the periphyton scraped from the plexiglass plates are listed in Table 1, while taxa of the benthos of the Śtupsk Bank and some samples from the Gulf of Gdańsk are listed in Table 2.

The periphyton, growing on the plexiglass plates exposed from May until August 1988 was found to contain 28 taxa; among these there was the diatom *Nitzschia acicularis* which grew particularly abundantly on the slides exposed 7 m below the sea surface. The diatom was accompanied by numerous sessile peritrichous ciliates.

Table 1

Taxa identified in periphyton on plexiglass plates deployed in the Słupsk Bank

Taxon	Exposure period	
	18 May – 9 Aug. 88	18 May – 22 Oct. 88
<i>Zoothamnium commune</i> Kahl	+	+
<i>Laomedea geniculata</i> (L.)	+	+
Ciliata, Peritricha, Sessilina	+	+
<i>Acineta tuberosa</i> Ehr.	+	+
<i>Mytilus edulis</i> L.	+	+
<i>Gammarus salinus</i> Spooner	+	+
<i>Gammarus oceanicus</i> Segerstr.		+
<i>Balanus improvisus</i> Darwin		+
<i>Jaera albifrons</i> s.l.		+
Ostracoda		+
Calanoida		+
Cyclopoida		+
Harpacticoida	+	
Copepoda, eggs and nauplii	+	+
Rotatoria	+	+
Nematoda	+	+
Acarina		+
<i>Nitzschia acicularis</i> W. Sm.	+	
<i>Coscinodiscus granii</i> Gough	+	+
<i>Synedra tabulata</i> (C.A. Ag.) Kütz.	+	+
<i>Diatoma elongatum</i> (Lyngb.) Ag.	+	+
<i>Diploneis didyma</i> (Ehr.) Cl.	+	+
<i>Diploneis ovalis</i> (Hilse) Cl.	+	+
<i>Diploneis interrupta</i> (Kütz.) Cl.		+
var. Heeri (Pant) Hustedt, nova comb.		
<i>Melosira moniliformis</i> (Müll.) Ag.	+	+
<i>Licmophora gracilis</i> (Ehr.) Grun.	+	
<i>Rhoicosphenia curvata</i> (Kütz.) Grun.	+	+
<i>Nitzschia closterium</i> (Ehr.) W. Sm.	+	
<i>Cymbella prostrata</i> (Berkeley) Cl.	+	
<i>Fragilaria</i> sp.	+	+
<i>Chaetoceros</i> sp.		+
<i>Nodularia spumigena</i> Mert. f. <i>litorea</i> Thuret	+	+
<i>Phormidium fragile</i> (Menegh.) Gom.	+	
<i>Phormidium</i> sp.		
<i>Chroococcus limneticus</i> Lemm.	+	
<i>Oscillatoria</i> sp.	+	+
<i>Spongomorpha uncialis</i> (O.F. Müll.) Kütz.	+	+
<i>Eutreptia viridis</i> Perty		+
<i>Dionobryon</i> sp.		
Eugleninae		+

^x Found on a glass object exposed in water column about 7 m below the water surface

Table 2

Benthos of the Słupsk Bank and some data on benthos of the Gulf of Gdańsk (= G Gd)

Taxon	July 1987	May 1988	May, Aug. 1989	G Gd 81, 83	on stones
<i>Furcellaria lumbricalis</i> (Huds.) Lam.	+	+	+	—*	+
<i>Rhodomela confervoides</i> (Huds.) Silva	+	+	+	—*	+
<i>Phyllophora brodiaei</i> (Turner) J. G. Ag.	+	+	+	—*	+
<i>Delesseria sanguinea</i> (L.) Lam.			+	—*	+
<i>Ceramium tenuissimum</i> (Lyng.) J. G. Ag.	+	+	+	—*	+
<i>Sphacelaria artica</i> Harvey	+	+	+	—*	+
<i>Cladophora rupestris</i> (L.) Kütz.	+	+		—	+
<i>Enteromorpha prolifera</i> (O. F. Müll.) J. G. Ag.	+	+			+
<i>Spongomorpha uncialis</i> (O. F. Müll.) J. G. Ag.	+	+	+		+
<i>Zoothamnium commune</i> Kahl		+	+		
Ciliata, Peritricha, Sessilina	+	+	+		+
<i>Acineta tuberosa</i> Ehr.	+	+	+		+
<i>Laomedea geniculata</i> (L.)	+	+	+		+
<i>Cordylophora caspia</i> (Pallas)					+
<i>Electra crustulenta</i> V. <i>baltica</i> Borg	+	+	+	+	+
<i>Planaria torva</i> O. F. Müll.	+	+			+
Nematoda	+	+	+	+	+
Oligochaeta	+	+	+	+	+
<i>Nereis diversicolor</i> O. F. Müll.	+	+	+	+	+
<i>Pygospio elegans</i> Clapar.	+	+	+	+	+
<i>Antinoella sarsi</i> (Kinberg)	+	+	+	+	+
Polychaeta	+			+	
<i>Piscicola geometra</i> L.			+		+
Ostracoda		+			
Harpacticoida		+			
<i>Gammarus salinus</i> Spooner	+	+	+	+	+
<i>Gammarus oceanicus</i> Segerstr.	+	+	+	+	+
<i>Bathyporeia pilosa</i> Lindstr.	+	+	+	+	+
<i>Corophium volutator</i> Pallas		+	+	+	+
<i>Corophium crassicornе</i> Brucelius	+	+			

cd. table 2

Taxon	July 1987	May 1988	May, Aug. 1989	G Gd 81, 83	on stones
<i>Jaera albifrons</i> s. l.	+	+	+	+	+
<i>Idotea granulosa</i> Rathke		+	+		+
<i>Euridice pulchra</i> Leach	+	+			
<i>Diastylis rathkei</i> Kröyer	+	+	+	+	
<i>Balanus improvisus</i> Darwin	+	+	+	+	+
<i>Mysis mixta</i> Lill.	+	+		+	+
<i>Praunus inermis</i> Rathke	+	+			+
<i>Crangon crangon</i> (L.)	+	+		+	
Acarina	+		+		+
<i>Cricotopus vitripennis</i> Mg. larvae	+	+	+		+
<i>Mytilus edulis</i> L.	+	+	+	+	+
<i>Mya arenaria</i> (L.)	+	+	+	+	
<i>Cardium glaucum</i> Brug.	+	+	+	+	
<i>Macoma baltica</i> (L.)	+	+	+	+	
<i>Theodoxus fluviatilis</i> L.	+	+		+	+
Hydrobiidae	+	+		+	
<i>Clupea harengus membras</i> L. larva	+				+
<i>Myoxocephalus scorpius</i> L.					+
Pisces, ova			+		+
Number of taxa	39	41	33	22	37

* I. Florczyk, pers. comm.

A colony-forming ciliate protozoan, *Zoothamnium commune* which had developed mass quantities and formed almost a monoculture of a kind was observed on the slides exposed 30 cm above the bottom at the test site. The species played also a dominant role in the periphyton growing on the plates fixed to the marker shelves.

A total of 31 taxa were identified in the periphyton developed on the plexiglass plates exposed from May until October 1988. *Mytilus edulis* and a colony-forming hydroid *Laomedea geniculata*, the latter growing in an underwater meadow or a mat of a kind on the plates, were co-dominants in terms of abundance and biomass.

A total of 49 taxa were identified among the benthos of the Słupsk Bank (Table 2), at least 20 of them occurring also within the corresponding depth zone of the Gulf

of Gdańsk. However, 6 species of attached algae are at present missing in the Gulf of Gdańsk. The red alga *Delesseria sanguinea* has never been found in the Gulf.

It should be pointed out that 37 benthic taxa were found on stones in the Słupsk Bank, *Mytilus edulis* playing a dominant role in terms of abundance and biomass.

The 6 most important, with respect to biomass and abundance, zoobenthic species in the Słupsk Bank were: *Mytilus edulis*, *Gammarus salinus*, *Bathyporeia pilosa*, *Pygospio elegans*, *Nereis diversicolor*, and *Laomedea geniculata*.

DISCUSSION

Gravel mining activities in the Słupsk Bank prompted the Sea Fisheries Institute in Gdynia to conduct investigations on the benthos of the area; the first ecological evaluation of the zoobenthos was based on data collected in 1978 by Warzocha (1980) from 18 stations. The author mentioned found the presence of 23 taxa of which 2 crustacean species: *Calliopius laeviusculus* and *Palaemon adspersus* as well as the polychaete *Streptosyllis websterii* were not present in my samples which, on the other hand, contained 28 additional taxa.

It is worth mentioning, however, that studies on the benthos of the area had, until quite recently, disregarded benthic macroalgae; only the red alga *Delesseria sanguinea* was mentioned among the algae of the Słupsk Bank by Lakowitz (1929). *Phytobenthos*, particularly the red algae *Furcellaria lumbricalis*, *Rhodomela confervoides*, *Phyllophora brodiaei*, *Delesseria sanguinea*, and *Ceramium tenuissimum* are found attached to stones which are relatively abundant and scattered on the Słupsk Bank bottom.

Apart from an appropriate hard substrate and sufficient amounts of nutrients, the red algae in the area enjoy favourable light conditions due to the low depth (up to 20 m) and significant water transparency throughout the year. Even during periods of intensive phytoplankton growth, the water is transparent down to the bottom, which corresponds with a high Secchi depth reaching even up to 10 m. It is worth mentioning that the water transparency in the open Gulf of Gdańsk is about 3 times lower than that in the Słupsk Bank, for which reason no red algal species occur in the Gulf in contrast to the Słupsk Bank.

The Słupsk Bank water column is usually well oxygenated, at least up to full saturation, due to the intensive mixing. During storms, the near-bottom current velocity can reach 50 cm/s in the area. The high water dynamics, affecting even the bottom, induces mobility of the sand and gravel down to 30 cm depth in the sediment during the year. This is the reason of the abundance and biomass of zoobenthos in mobile sediments being rather low, the parameters being high for organisms overgrowing stones. Besides, these sediments contain very little detrital organic matter, which limits the occurrence of detritivorous organisms, *Macoma balthica* in particular, the

average abundance of which in the Słupsk Bank (26 ind./m²) is 25 times lower than that in the corresponding depth zone (10–20 m) of the Gulf of Gdańsk (650 ind./m²). *M. baltica* is a perfect biological indicator of eutrophication of the latter region.

The very low content of detrital organic matter in the Słupsk Bank sediments results also in a very low sediment content of different chemical pollutants, especially those which are absorbed by the particulate organic matter. This is the reason why the sand-containing effluent released by the suction hopper dredgers operated in the Słupsk Bank is considered to be almost neutral, from the chemical point of view, to biota.

The high water transparency of the Słupsk Bank results, among other things, from the luxuriant growth of many various suspension feeders, and especially *Mytilus edulis*. The bioactivity of the bivalve creates favourable conditions for the occurrence of red algae down to the maximum depth of the Bank, i.e. about 20 m. Forming a dense or compact layer on stones and boulders, the mussel creates the most characteristic community in the Słupsk Bank. In the case of boulders, the bivalve covers about 50% of their upper surface, the lateral surfaces being covered in almost 100%. The surfaces not covered by the mussel are usually more densely overgrown with red algae. The red algae are also found attached in large quantities to the mussel shells, larger and older shells being preferred. The maximum abundance of the mussel on a stony bottom can reach 22,000 ind./m². In the mussel community, *Gammarus salinus* with its abundance reaching 360 ind./m² is a subdominant from the quantitative point of view.

At the sandy bottom of the Słupsk Bank, the most numerous organism is the crustacean *Bathyporeia pilosa* with an average abundance amounting to 360 ind./m² and the maximum abundance of up to 1320 ind./m². The species is absent in the corresponding depth zone (10–20 m) of the Gulf of Gdańsk. Similar is the abundance of the polychaete *Pygospio elegans* reaching up to 4500 ind./m² (with an average of 970 ind./m²) in the Słupsk Bank, the abundance of the species being 140 times lower (7 ind./m²) in the corresponding depth zone of the Gulf of Gdańsk. The almost complete absence of snails of the family Hydrobiidae in the Słupsk Bank is also worth mentioning, while the snails reach, on the average, abundances of 150 ind./m² in the corresponding depth zone of the Gulf of Gdańsk.

With respect to the periphyton scraped from the plexiglass plates, it can be said that the mussels can reach densities of over 400 ind./20 cm², which corresponds to 20 ind./cm². That was the case in October 1988, the whole mussel assemblage being dominated by individuals 1-, 2-, and 3-mm long. The colony-forming hydroid *Laomedea geniculata* (about 150–200 colonies per cm²) and the crustacean *Gammarus salinus* (20 ind./20 cm²) accompanied the mussels in mass quantities.

As far as the Gulf of Gdańsk macrozoobenthos is concerned, its average biomass in the depth zone of 8–58 m increased within 1961–1981 by the factor of 2.8.

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