

DISTRIBUTION AND THE ROLE OF *MYTILUS EDULIS* (LINNÉ) IN THE COASTAL ZONE OF THE POMERANIAN BAY

ZBIGNIEW PIESIK¹, BRYGIDA WAWRZYNIAK-WYDROWSKA²

¹*Department of Biology and Protection of the Sea,
Pedagogical University of Słupsk,
ul. Arciszewskiego 22, 76-200 Słupsk, Poland*

²*Department of Biological Oceanography, University of Szczecin,
ul. Łukasińskiego 43, 71-065 Szczecin, Poland*

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Abstract

Distribution of *Mytilus edulis* in the 4-nautical mile-wide coastal zone of the Pomeranian Bay was studied in 1992 and 1993. The study revealed uneven settling of the bottom by *Mytilus edulis* with densities ranging from 0 to 17 488 ind./m². The frequency (F) of the blue mussel occurrence was about 60%. The average density of *Mytilus* (1 578 ind./m²) and the (wet weight) biomass (264.8 g/m²) suggest that it is the dominant form of macrozoobenthos and plays a major role in the process of biofiltration, biosedimentation and bioaccumulation of nutrients. The growing biomass of *M. edulis* in the bay caused by the process of eutrophication serves as a convenient food resource for benthophagous fishes, mainly for the flounder, viviparous eelpout and roach (Krzykawski and Zatachowski 1983, Witek 1995).

INTRODUCTION

Growing process of eutrophication and pollution of the Baltic Sea connected with the increase of the biomass of seston, mostly phytoplankton, has a defined impact on the development of the fauna of the filtrators group finding

abundant food resource in the Baltic (Head 1974 et al.). Pelagic larvae (trochofora, veliger) and the sedentary forms of *Mytilus edulis* find convenient trophic conditions in the Pomeranian Bay. Their food resource is considerably supplemented with seston being carried to the bay through the straits from the adjacent Szczecin Lagoon and the Kamień Lagoon. Extensively growing phytoplankton of the Szczecin Lagoon had been, in considerable degree, utilised by the zebra mussel *Dreissena polymorpha* (cf. Wiktor 1969). In the 1980's a drastic reduction in the population of *D. polymorpha* was reported from the Szczecin Lagoon (Piesik 1992). Mass-scale growing planktonic algae are in substantial amounts carried out from the lagoon through the straits to the Pomeranian Bay enriching the food resource for the blue mussel and the other filtrators.

It is possible to assume that the growth of phytoplankton, linked to the process of eutrophication, has been a factor causing the increase in the density and the biomass of *M. edulis*. This assumption seems to be reasonable in view of the fact that the sedentary forms of the blue mussels are under lower pressure from the predators, than is for instance *Macoma baltica* (Piesik unpubl.). The growth of *M. edulis* in the Pomeranian Bay, from the ecological point of view, can be considered a positive phenomenon. The blue mussel, in the course of its life activities, contributes to the elimination of excessively developing phytoplankton. It also contributes to the utilisation of seston which ends up as agglutinates and faeces sedimented on the bottom. Finally it accumulates in its biomass substantial amounts of mineral salts, in this number also nutrients, slowing down the development of planktonic algae.

The aim of the present study was to estimate in further details the distribution, quantities, and the biomass of *Mytilus edulis* in the most exposed to antropogenic factors — the coastal zone of the Pomeranian Bay. Such data can serve in the future for comparative analysis of the blue mussel development against a background of the action of various factors, in this number eutrophication and pollution of the Pomeranian Bay.

MATERIAL AND METHODS

In 1992 and 1993 the occurrence of *Mytilus edulis* was studied in a 4-nautical mile-wide coastal zone of the Pomeranian Bay, between Świnoujście and Mrzeżyno. The mussels were acquired using a 625 cm² Van Veen grab, from 69 sampling sites. Each sample was composed of two loads of the grab. Location of the sampling sites was determined from a radar bearing along 8 transects perpendicular to the coastal line at the following distances from the shore: 0.25, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, and 4.0 nautical miles (Fig. 1). In 1992 the material was collected from the following transects: No. 1 (off

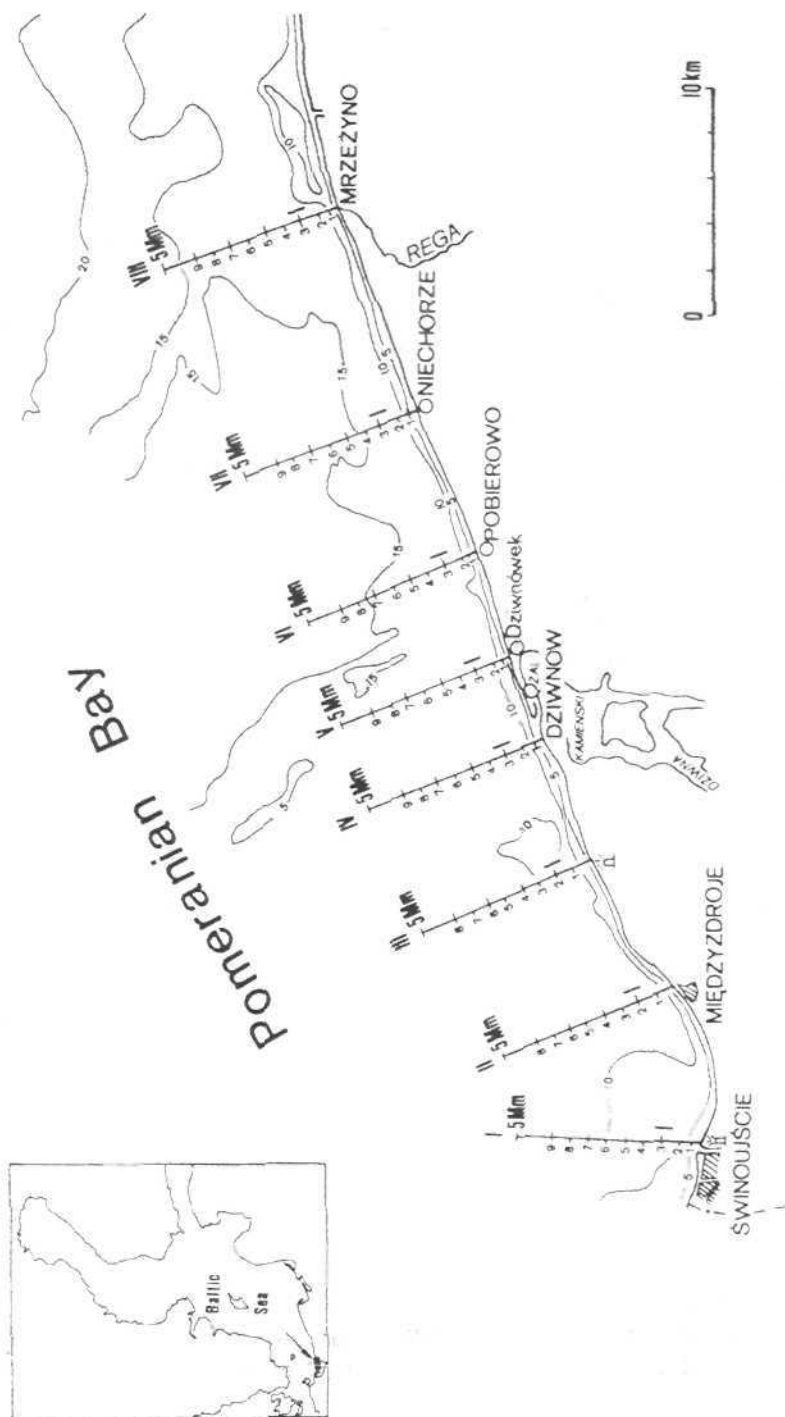


Fig. 1. Location of sampling stations and transects in Pomeranian Bay

Swinoujście) — July, No. 2 (off Międzyzdroje) — August, No. 3 (off Kikut lighthouse) — September, No. 4 (off Dziwnów) — October. In 1993 the remaining transects were sampled: No. 5 (off Dziwnówek) — October, No. 6 (off Pobierowo) — August, No. 7 (off Niechorze) — May, and No. 8 (off Mrzeżyno) — July.

The material acquired was rinsed on a 1-mm mesh size benthos sieve and subsequently preserved in 4% formaldehyde solution. In the laboratory the material was sorted to determine the density of the mussels for 1 m² of the bottom. Wet weight of the mussel (including water in the mantle cavity) following its drying with paper tissue was determined on an analytic balance to the nearest 0.001 g and referred to 1 m² of the bottom. Shell size of 3926 individuals of the blue mussel was measured to the nearest 0.5 mm using a slide calliper.

RESULTS

The distribution of the *Mytilus edulis* in the 4-mile coastal zone of the Pomeranian Bay was irregular (Tab. 1, Fig. 1) and it was constant on the transects No. 2 and 3. On the remaining transects, with the exclusion of the transect No. 8, blue mussels were patchily distributed. On the transect No. 8, off the Rega River estuary, as far as 4 nautical miles offshore no *M. edulis* was found (Tab. 1). Patchy distribution pattern of the blue mussel (over 1000 ind./m²) has been found on 32% of the sites, while the area of the bottom

Table 1
Abundance (ind.: m⁻²) and frequency (F %) of the *Mytilus edulis* in the studied area of Pomeranian Bay

Nm	Swinoujście I	Międzyzdroje II	Latarnia Kikut II	Dziwnów IV	Dziwnówek V	Pobierowo VI	Niechorze VII	Mrzeżyno VIII
0,25	0	-	-	-	0	0	6896	0
0,5	0	3480	5024	17488	1280	0	720	0
1,0	32	432	112	3776	608	1688	2832	0
1,5	144	4576	4272	0	152	8	584	0
2,0	48	1008	2240	0	0	3440	32	0
2,5	352	5216	6944	0	16	296	0	0
3,0	0	1360	2544	768	0	0	0	0
3,5	32	4832	9872	784	40	0	0	0
4,0	3072	7200	4480	32	0	0	0	0
average	408	3513	4436	2856	232	603	1229	0
F	55%	100%	100%	62%	55%	44%	55%	0%

without *M. edulis* can be estimated for 42%. The biomass (wet weight) exceeding 1000 g/m² was recorded on 4.3% of the sites only. The frequency (F) of the blue mussel occurrence in the studied area equalled 57.7%. The most favourable conditions for *M. edulis* occurred in the coastal section between Międzyzdroje and Dziwnów (transects Nos. 2–4) what can be judged

Table 2
Biomass of the *Mytilus edulis* (in $g_{ww} \cdot m^{-2}$) in the studied area of Pomeranian Bay

Nm	Swinoujście I	Międzyzdroje II	Latarnia Kikut II	Dziwnów IV	Dziwnówek V	Pobierowo VI	Niechorze VII	Mrzeżyńo VIII
0,25	0	-	-	-	0	0	780,3	0
0,5	0	228,8	827,2	6129,2	387,1	0	71,7	0
1,0	5,2	20,8	6,4	312	185,9	683,2	173	0
1,5	3,9	777,6	617,6	0	9,6	0,2	84,3	0
2,0	8,4	224,4	206,4	0	0	1043,5	0,3	0
2,5	42,9	692,8	833,6	0	0,9	19,9	0	0
3,0	0	56	196,8	384	0	0	0	0
3,5	2,7	379,2	1097,6	500	46	0	0	0
4,0	312,96	384	528	6,7	0	0	0	0
average	41,79	345,4	539,2	916,5	69,9	194,1	123,3	0

by its high densities and the considerable biomass (Tab. 1 and 2). The highest average biomass of *M. edulis* in the bay was recorded at the depth range of 5–9.9 m ($573 g/m^2$ of wet weight). At the depth range of 10–14.9 m the average biomass was lower and it equalled $228.8 g/m^2$ (of wet weight). At the depth range of 15–20 m the biomass declined down to $82.6 g/m^2$ (of wet weight). The analysis of the length distribution of *M. edulis* in the Pomeranian Bay revealed that only sporadically its shell reached 38 mm. The average shell length of the blue mussel in the studied area showed only narrow seasonal differences namely: May — 9.8 mm, July — 7.9 mm, August — 10 mm, September — 9.7 mm, and October — 11.5 mm. The population was usually dominated by overwintered individuals of 1+ age group. Considerable part of the population constituted the individuals of the age groups: 0 and 2+. The oldest *M. edulis* presently recorded reached 6 years of age. Essential part of the population of this bivalve species consisted individuals from 3 to 11 mm of length. The most often encountered type of percentage length distribution is presented on Fig. 2a. On the other hand Fig. 2b shows the percentage length distribution of the mussels collected off Pobierowo with clear decrement of the length classes between 7 and 16 mm, which has been attributed to the feeding activity of the flounder.

The blue mussel studied, formed cylindrical and spherical multigenerational aggregations — the shape facilitating their relocation under influence of almost constantly flowing demersal currents (W–E). Considerable inclination of the bottom especially between the shore and 10-m isobath helps such aggregation to roll. Type of substrate occurring in the Pomeranian Bay (fine- and medium grained sand, sporadically occurring gravel sand) does not seem to be a decisive factor in *M. Edulis* (Piesik, Wydrowska unpubl.) occurrence. More important is the bottom configuration (pits, ditches which collect moving aggregations) and the trophic conditions, which are more favourable in the areas of estuaries, and the straits due to carried-in seston.

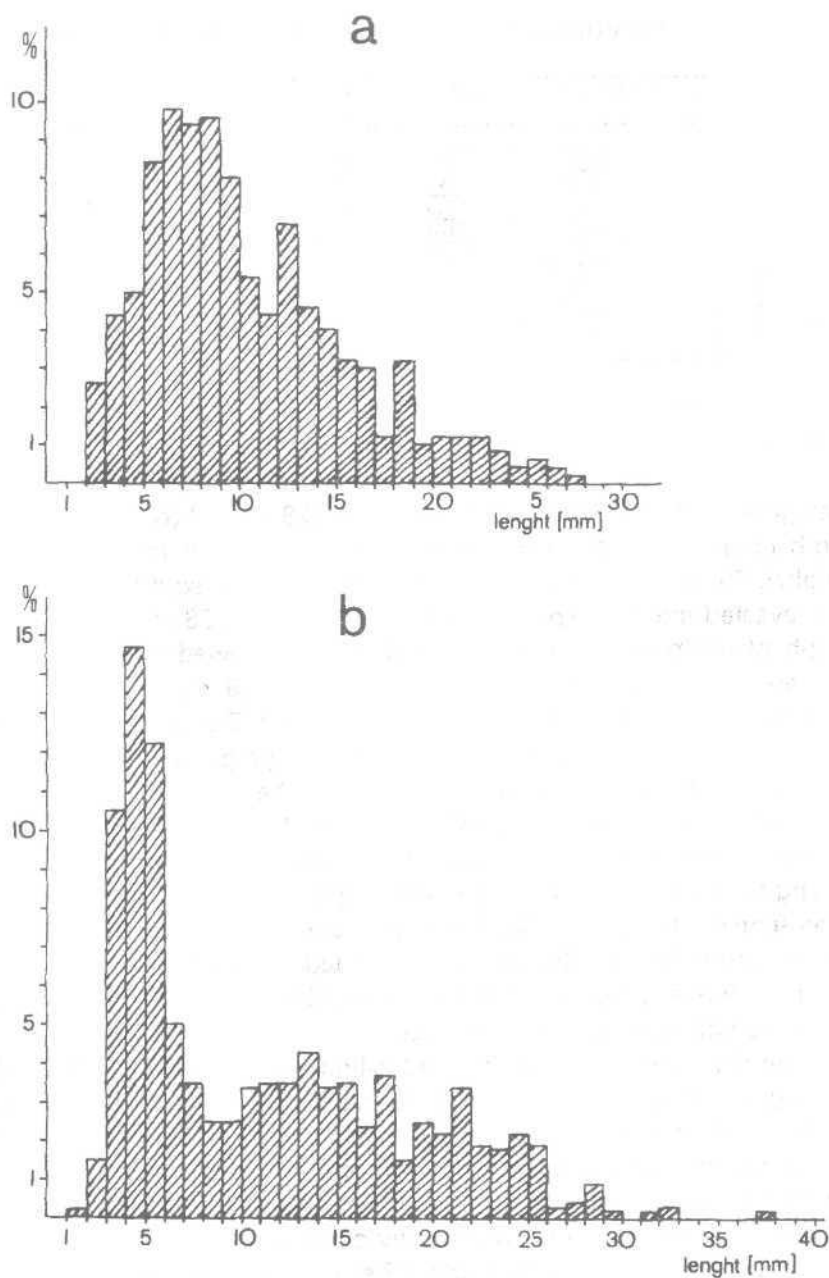


Fig. 2. Percentage distribution of the length shell of *Mytilus edulis*
 a) out of profile VI (Pobierowo)
 b) out of profile VII (Niechorze)

DISCUSSION

M. edulis in the Polish coastal zone has been studied as a part of more extensive surveys of macrozoobenthos of the Southern Baltic (Powilleit et al. 1995, Hera and Wiktor 1985, Warzocha 1995, Wenne and Wiktor 1982, Żmudziński 1982, and others). Directly adjacent to the shore, 4-mile coastal zone of the Pomeranian Bay has been studied at very few sampling sites which makes difficult to compare the data of different authors and to determine the changes of *M. edulis* quantities and the biomass attributed to the growing eutrophication and self-purification of this water body. It can be concluded from the data estimated by Żmudziński (1967) for the period of the 1950's and 1970's that the combined biomass of all bivalves in the 4-mile coastal area off Świnoujście exceeded 100 g/m² (of wet weight), while the average in the stretch Międzyzdroje–Dziwnów ranged between 10 and 100 g/m² of wet weight. The biomass in the area between Dziwnówek and Mrzeżyno reached 1–10 g/m² of wet weight. According to our own data (Tab. 2) it can be assumed that in the 1990's the biomass of *M. edulis* in the Pomeranian Bay has grown substantially, exceeding the biomass of all other bivalve species of the preceding time-period with the exception of the Świnoujście area. The presently revealed biomass of *M. edulis* substantially exceeds also the biomass of the whole zoobenthos in the coastal area of the Pomeranian Bay estimated by Ostrowski (1977) and Warzocha (1985). Personal information acquired from the fishermen seem to confirm such assumption. The fishermen complained, that in the recent times, they had to remove large amounts of the blue mussel from their nets, which made their work difficult. In the previous times such phenomenon had not been observed on such extensive scale. It is possible that the eutrophication of the coastal waters of the Pomeranian Bay and linked to it phytoplankton development, contribute to the blue mussel growth in this area.

The area studied, between the mouths of the Świna and Dziwna Straits (transects Nos. 1–4) was fourfold more abundant in the respect of the biomass of *M. edulis*, than the area between the mouth the Dziwna Strait and the Rega River (transects Nos. 5–8). Similarly the quantities of the blue mussel between the Świna and Dziwna was 5 time higher. Less extensive growth of *M. edulis* in the eastern part of the Bay is confirmed also by the data on the occurrence frequency: Świna–Dziwna $F = 82\%$, Dziwna–Rega $F = 39\%$. The present authors see higher abundance of *M. edulis* in the western part of the studied area as a result of the richer food resources there, supplemented by the seston carried through the Świna Strait from eutrophicated Szczecin Lagoon, known for its phytoplankton blooms (Piesik 1992) and development of the other forms of seston. Abundant occurrence of *M. edulis* in the Pomeranian Bay was confirmed by Żmudziński (1982) and

Powilleit et al. (1995). From the data of Herra and Wiktor (1985) and Wenne and Wiktor (1982) concerning the blue mussel in the Bay of Gdańsk it is evident that the biomass of *M. edulis* in the Pomeranian Bay is higher (Tab. 3). This may be explained by the higher degree of pollution and

Table 3

Comparison of biomass of the *Mytilus edulis* in Gulf of Gdańsk and Pomeranian Bay at 3–20 m. b.s.l.

depth	biomass g_{ww}/m^2				range	autors
	3-5m	5,1-10m	10,1-20m	mean		
Zalew Pucki	29,8	-	-	29,8	0-90,4	Wenne, Wiktor 1982
Zatoka Gdańska	10,1	60,1	66,6	45,6	0-135,1	Wenne, Wiktor 1982
Zatoka Gdańska	0,3	62	4,8	24,5	0-186,2	Herra, Wiktor 1985
Zatoka Pomorska	0	573,3	186,2	264,8	0-6129,2	autors

negative results of eutrophication of the Bay of Gdańsk supplied with waters of the Vistula River. The above-mentioned authors observed a drop in the overall biomass of *M. edulis* in the shallow part of the Bay of Gdańsk from 120.4 g/m^2 (of wet weight) in the 1960's down to 45.3 g/m^2 (of wet weight) in the 1970's. The average quantities and the biomass of *Mytilus* in the Pomeranian Bay (1575 ind./ m^2 ; 264.8 g/m^2 of wet weight) exceeds the average quantity and biomass of the blue mussel presented by Warzocha (1995) from the whole shallow area of the Polish coastal waters (199 ind./ m^2 ; 32.4 $g_{ww} \cdot m^{-2}$ respectively). In view of the above it seems reasonable to conclude that out of the entire Polish coastal zone, *Mytilus edulis* finds the most convenient conditions for its development in the Pomeranian Bay.

CONCLUSIONS

1. *Mytilus edulis* is a dominant species in the respect of biomass in the macrobenthos of the shallow area of the Pomeranian Bay reaching average value of biomass 264.8 g/m^2 of wet weight (0–6129.2 g/m^2).
2. Average density of *M. edulis* in the Bay was 1575 ind./ m^2 (0–17488 ind./ m^2).
3. Frequency of occurrence (F) of the blue mussel in the Bay ranged from 0 to 100% (59.4% in average).
4. The most intensive growth of the blue mussel in the area studied was recorded between Międzyzdroje and Dziwnów, where the highest values of biomass, density and frequency of occurrence were observed.
5. The blue mussel plays positive role in the eutrophicated waters of the Pomeranian Bay eliminating seston, accumulating it (partly) in the bottom deposits in the process of biosedimentation. Because of its high biomass it

accumulates in its body a considerable amount of mineral salts in this number also nutrients.

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