

## 120 years of investigations on zoobenthos in the southern Baltic

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**ABSTRACT:** The scheme of macrozoobenthos research development in the southern region of the Baltic Proper is presented here. In the course of a 120-year-long investigation cycle, four different, partly overlapping periods can be distinguished: qualitative investigations, quantitative distribution studies, biomass investigations, and regular monitoring of zoobenthos.

### INTRODUCTION

The southern Baltic macrobenthic investigations were initiated by a German scientist, Karl Möbius, in 1871. The first hundred years witnessed only irregular examinations in which the year and area were randomly chosen. As late as the 1970s, systematic observations of the Baltic macrozoobenthos were started, which were partly coordinated to meet the Helsinki Convention regulations.

Macrobenthos research can be divided into four partly overlapping periods according to benthos-sampling performance methods: qualitative and quantitative investigations, biomass investigations, and regular monitoring.

### QUALITATIVE INVESTIGATIONS

The first investigation of the southern Baltic macrobenthic invertebrate composition was carried out in 1871. During the expedition of a German research vessel "Pommern" in 1871, Karl Möbius collected bottom macroinvertebrates along some profiles across selected Baltic Sea areas (Fig. 1). In the southern Baltic, however, the profiles run off the deepest parts of particular deeps, going along their edges rather than across them. This included some shallows important for the fisheries. There Möbius took benthos samples from 55 stations (Table 1).

In 1880, Meyer and Möbius (1882) examined the species composition and distribution of macrozoobenthos in the western region of the Gulf of Gdańsk, known as Puck Bay (Fig. 1). It is a shallow area; the deepest station fixed at the edge of the Gdańsk Deep has a depth of 67 m. Some years later (in 1893), Brandt collected bottom invertebrates from the Baltic Sea which included some areas from the southern Baltic.

The next bottom macrofauna investigation in the open waters of the southern Baltic Sea was carried out by Reibisch (1902) who, in 1901, took samples from over 10 stations situated mainly on the shallower Baltic grounds important for the fishery (Fig. 2).

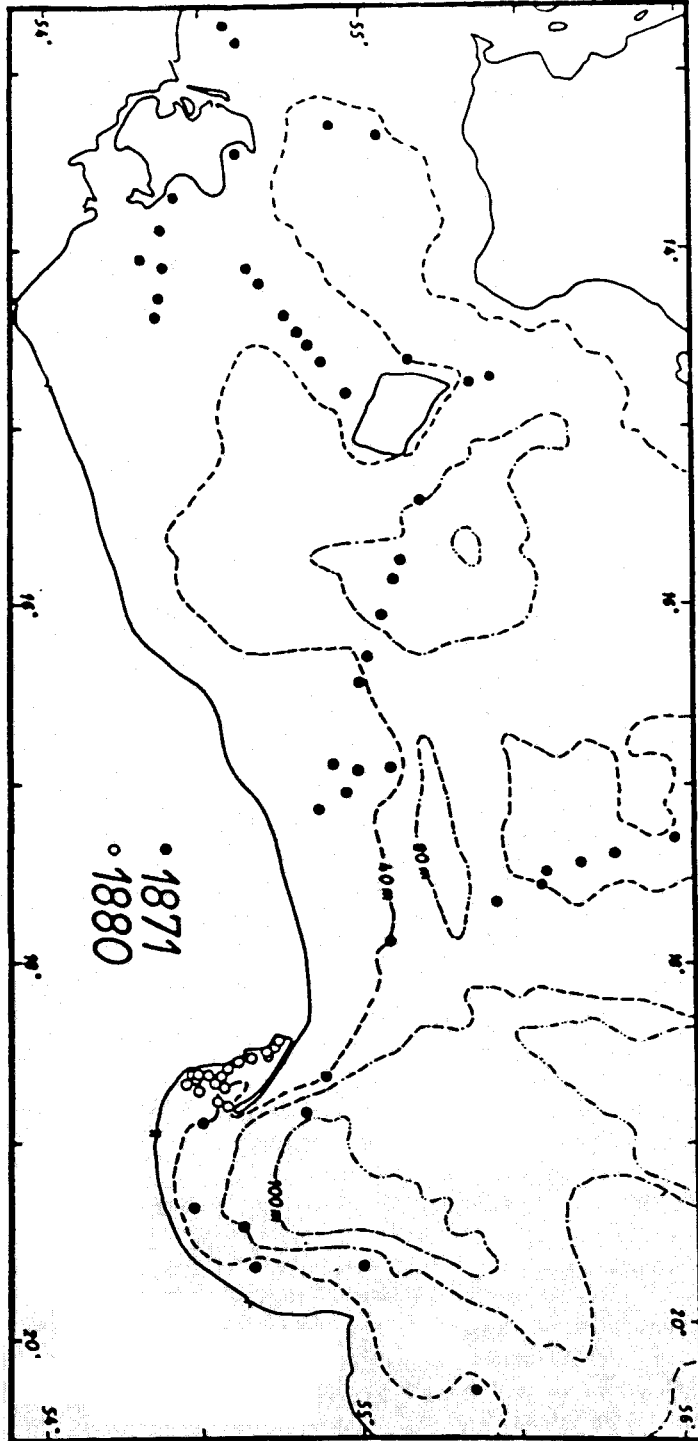


Fig. 1. Macrobenthos stations in the southern Baltic, investigated by Möbius (1873) and Meyer & Möbius (1882).

Table 1. Number of macrobenthic stations during the period of qualitative investigations in the southern Baltic. x – up to 5 stations, xx – up to 15 stations, xxx – up to 25 stations, xxxx – over 25 stations

Author	Years	Basins					Number of stations	
		Arcona	Bornholm	Słupsk	Gdańsk	Gotland	Below 40 m	Total
Möbius	1871	xx	xx	xx	xx	x	18	55
Meier, Möbius	1880				xxx		5	18
Reibisch	1901	x	x	x	x	x	5	14
Heinen*	1903–10	x	x				3	7
Skorikow*	1908	x	x			x	4	5
Demel	1924				xxxx		10	44
Demel	1932–35				xxxx		15	64
Seifert	1936–37		xxxx					36
Forsman	1953–54		xx				13	14
Jażdżewski	1961				xxxx			26
Total							73	283

\* The investigations refer only to worms, mainly Polychaetes

At the end of the 19th century and in the first decade of this century, three other qualitative investigations were carried out on the zoobenthos. These dealt with the geographical distribution of worms, mainly polychaetes, in the Baltic Sea, and they throw some light upon the interspecific relationships at that time. Michaelsen (1896), Skorikow (1910) and Heinen (1919) analysed the range of particular species in the Baltic Sea, including its southern region, or at least the southwestern strip.

In the 1920s and 1930s, relatively thorough fauna investigations were carried out on two sheltered coastal areas, especially the Greifswalder Bodden (Seifert, 1938), and Puck Bay (Demel, 1925, 1935), as far as along the southeastern region of the Baltic Sea (Lundbeck, 1929; Sklower, 1930). Somewhat later, very interesting fauna research was done off the Kalmarfjord and in the neighbouring parts of the Bornholm Basin (Forsman, 1956) as well as in Puck Bay (Jażdżewski, 1962, 1971).

As the evidence shows in the first research period – the qualitative one – the southern Baltic zoobenthos investigations were started by the Germans, who were followed by the Russians, the Poles, and finally the Swedish researchers.

At the time of the qualitative research, the bottom fauna samples were collected by means of bottom dredging devices of which no published description or diagram was included. Karl Möbius (1873, 1884) called the device "die Kurre". Until the beginning of this century, no exact geographical position had been stated; only some indirect location had been given according to the distances from lighthouses or other distinct onshore points.

#### QUANTITATIVE INVESTIGATIONS

These investigations of bottom macrofauna began in the first decade of this century by a Danish scientist Petersen (1914) – the inventor of the first bottom grab, later called

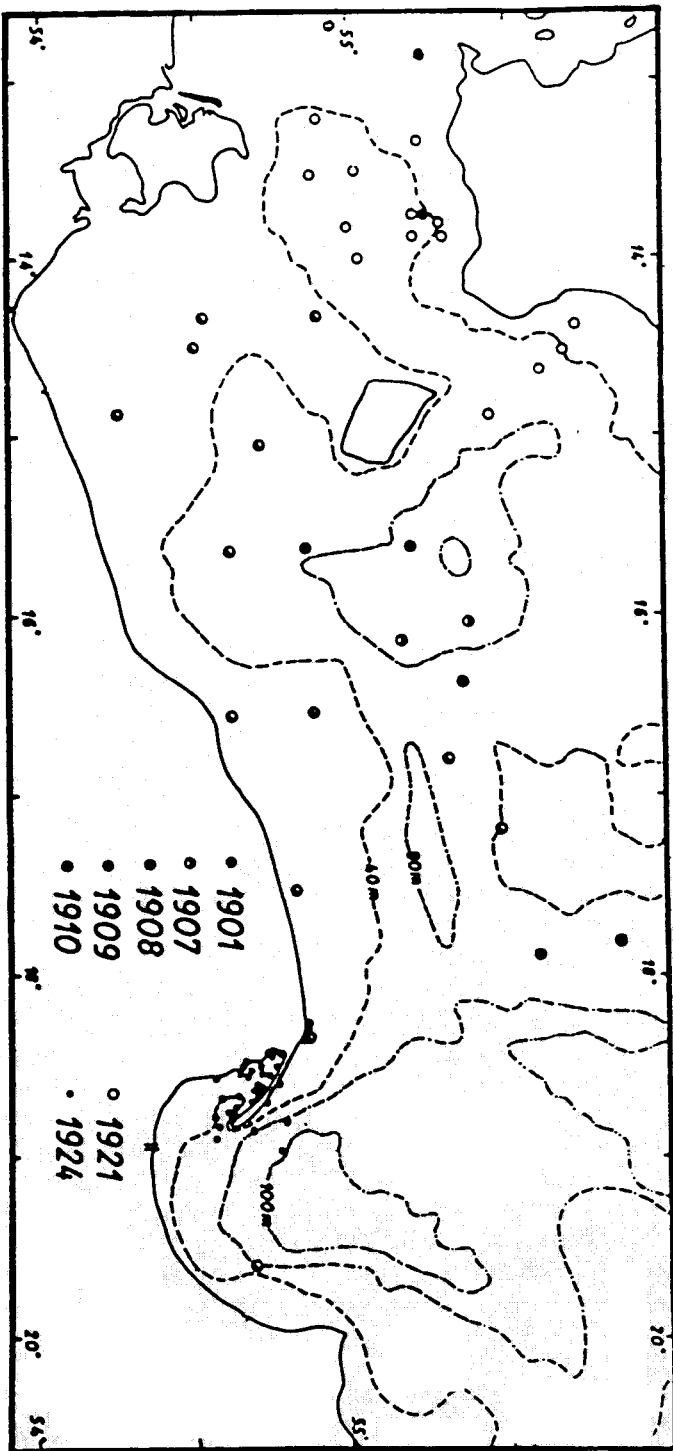


Fig. 2. Macrobenthos stations in the southern Baltic investigated by Reibisch (1902), Heinen (1919), Skorikow (1910), Thulin (1922), Demel (1925) and by Lundbeck (1929)

"Petersen's Bottom Grab". Petersen confined his research to Danish waters including only a tiny part of the Baltic Proper, i.e. the western edges of the Arcona Basin (Petersen & Jensen, 1911). The Swedish scientists, Thulin (1922) & Hesse (1924) conducted quantitative macrobenthic quantitative investigations which were extended to cover the whole of the Arcona Basin and northwest region of the Bornholm Basin (Fig. 2).

During the years 1932–1938 Mulicki (1938) examined the quantitative distribution of bottom macrofauna in the western part of the Gulf of Gdańsk (Fig. 3), having obtained samples from 72 stations (Table 2). Benthos samples were collected by means of a smaller bottom grab, known as the "Ekman Grab".

At the end of the 1930s and in the second half of the 1940s, a team of Polish biologists were the first to examine the Baltic Sea benthos using diving equipment, i.e. a diving helmet of their own construction. While diving several times in Puck Bay, they collected 40 samples per 0.25 m<sup>2</sup>, each time taking them directly from the bottom surface (Bursa et al., 1939; Bursa, 1948; Wojtusiak et al., 1950, 1951). During these investigations one could take into account not only soft bottoms (sandy and muddy) but also rocky and stony ones. The research results were presented in very picturesque illustrations, similar to those made by Petersen, the pioneer of the benthos quantitative investigations (Fig. 4).

It seems that, in the second research period of the Baltic Sea zoobenthos, various methods of benthos sampling were used. This period covered mainly the first decade, and the 1930s and 1940s of this century, significantly overlapping with the first and the third periods of the macrobenthic investigations.

### BIOMASS INVESTIGATIONS

The third period of southern Baltic zoobenthos research was started by a German scientist, Hagmeier (1926, 1930, 1987) and concentrated not only on species composition records but on the biomass and abundance of bottom macrofauna as well. In the years 1925, 1929 and 1931, Hagmeier collected samples of bottom macrofauna from about 200 stations in the southern Baltic Sea, reporting the total biomass of zoobenthos from each station (Rumohr, 1987). Unfortunately, Hagmeier was interested in a trendy problem at that time. The results of the zoobenthos species distribution often reported only the dominant species at particular stations, not always stating the abundance, let alone the biomass of individual species or of the total macrobenthos.

In 1948–1954, Demel & Mańkowski (1951), and Demel & Mulicki (1954, 1959) commenced a series of macrozoobenthic investigations in the southern Baltic Sea which was repeated every couple of years. The results gave a great number of samples collected from 272 stations located fairly evenly over all the area, 83% of them distributed at the depth of over 40 m (Table 3). This resulted in a number of maps showing the distribution of dominant species and general macrobenthos biomass.

Based on this material, Mulicki (1957, 1959, 1962) could establish the ecological demands of basic bottom invertebrate species. He analysed their occurrence related to temperature, salinity and oxygen in near bottom water and also to depth range and bottom type. The research was a classical one, rarely to be repeated.

In 1956 and 1957, Mulicki & Żmudziński (1969) returned to the problem of distribution and biomass of bottom macrofauna in the southern Baltic Sea, thus discovering vast benthos deserts in the Bornholm Deep and the Gdańsk Deep. Löwe (1963) analysed

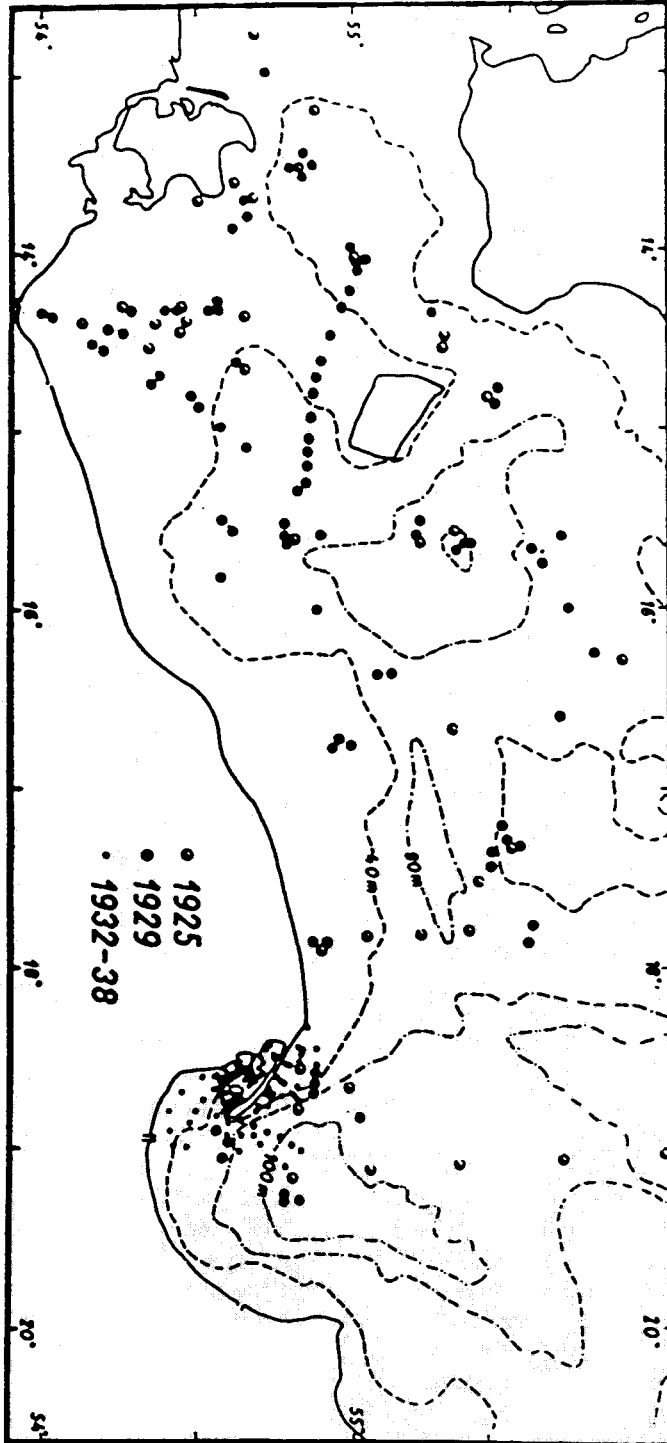


Fig. 3. Macrobenthos stations in the southern Baltic investigated by Hagmeier (1926, 1930) and Mulicki (1938)

Table 2. Number of macrobenthic stations during the period of quantitative investigations in the southern Baltic. For meaning of symbols see legend to Table 1

Author	Years	Basins				Number of stations		
		Arcona	Bornholm	Ślupsk	Gdańsk	Gotland	Below 40 m	Total
Petersen, Jensen	1911	x						2
Thulin	1921	xx	x				10	14
Mulicki	1935–38				xxxx		18	72
Bursa et al.	1938				xx			9
Bursa et al.	1939				xx			11
Wojtusiak et al.	1946				xx			10
Wojtusiak et al.	1948				xx			10
Total							28	128

bottom macrofauna stocks at about the same time in the Arcona and in part of the Bornholm Basins by drawing samples from 177 stations. This encompassed a high density of sampling points, as the area is not large (Table 3). In the 1960s and 1970s, interesting changes in the occurrence of zoobenthos in the Bornholm Deep were observed by Leppäkoski (1969, 1975), and in the whole southern Baltic by Żmudziński (1968, 1971, 1976).

In the 1960s, Żmudziński (1967, 1968, 1971, 1976, 1982) and Ostrowski & Żmudziński (1982) performed a huge job, investigating southern Baltic macrozoobenthos by taking samples from over 900 stations; 41 % of the samples were taken from a depth of over 40 m (Table 3). This research was continued in the seventies by a number of scientists including Andersin et al. (1977, 1978), Järvekülg (1979), Żmudziński & Osowiecki (1991), and others.

#### REGULAR MONITORING

Towards the end of the 1970s, systematic environmental monitoring was introduced, meeting the regulations of the Helsinki Convention. This meant the contribution of many, partly anonymous, scientists to southern Baltic macrobenthos investigations. Macrobenthos samples collected twice a year, as well as other macrobenthos material, enabled the issues of sections on benthos in "Assessment of the State of the Baltic Sea Environment" (HELCOM, 1987, 1990; Andersin et al., 1990; Żmudziński et al., 1987) and many other publications.

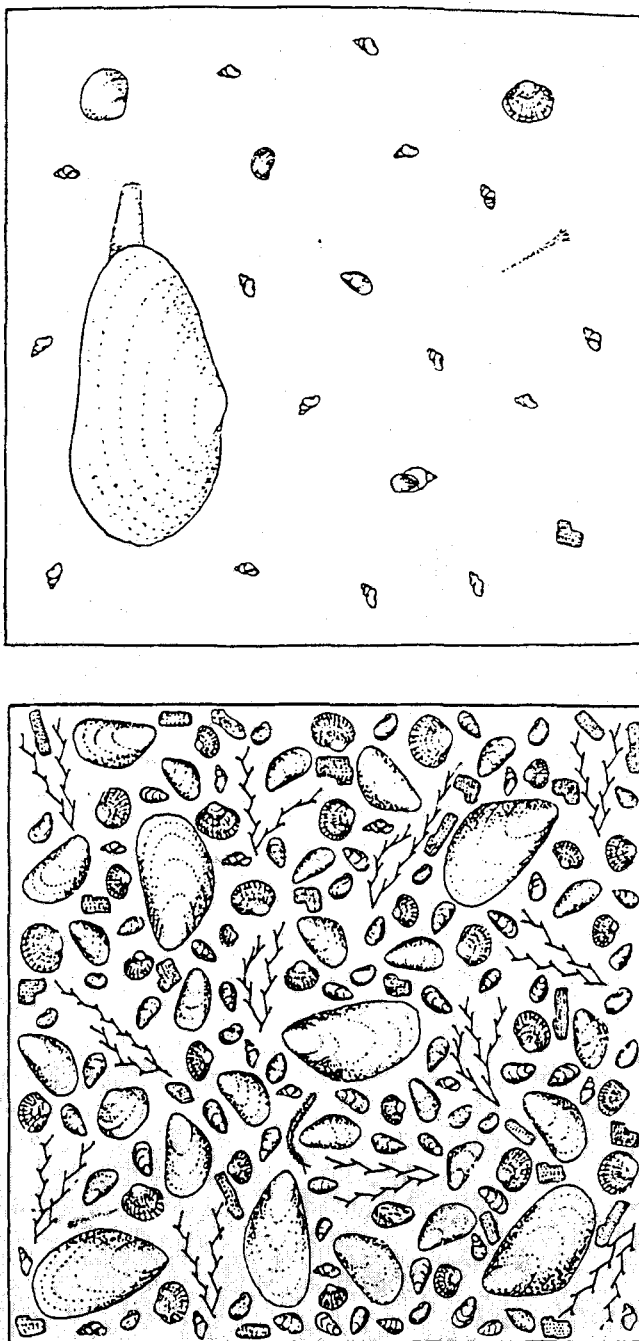


Fig. 4. Number of invertebrates (per 1 dm<sup>2</sup>) at selected stations of Puck Bay: *Hydrobia* community (on the left) and *Mytilus* community (on the right) (Bursa et al., 1939)



Table 3. Number of macrobenthic stations during the early period of biomass investigations in the southern Baltic. For meaning of symbols see legend to Table 1

Author	Years	Basins					Number of stations	
		Arcona	Bornholm	Ślupsk	Gdańsk	Gotland	Below 40 m	Total
Hagmeier	1925	xx	xx	xx	xx	x	22	39
Hagmeier	1929	xxx	xxxx	xx	xx	x	55	98
Hagmeier	1931	xx	xx	x	x	x	13	41
Demel, Mańkowski	1948–50	xx	xxxx	xxx	xxxx	x	77	102
Demel, Mulicki	1951–52	xx	xxxx	xxxx	xx	xx	85	102
Demel, Mulicki	1952–54	xx	xxx	xx	xxx	x	64	66
Mulicki, Żmudziński	1956–57	xxxx	xxxx	xxxx	xxxx	xxxx	162	191
Löwe	1955–58	xxxx	x				46	177
Żmudziński	1961	xx	xxx	xx	xx	x	41	63
Żmudziński	1962				xxxx		31	220
Tulkki	1963–64		xxx				22	24
Żmudziński	1963–66	xxx	xxxx	xxxx	xxxx		50	252
Żmudziński	1967–68	xxxx	xxxx	xxxx	xxxx	xxx	258	386
Total							913	1722

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