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EXPERIMENTALLY INCREASED FISH STOCK  
IN THE POND TYPE LAKE WARNIAK  
X. NUMBERS AND DISTRIBUTION OF ZOOMICROBENTHOS\*

(Ekol. Pol. 21: 575-581). The numbers of zoomicrobenthos in the 3 years with an increased fish stock was smaller than in the period before the experiment. During the 4 years of studies relatively small changes of the qualitative composition were observed. In comparison with other Masurian lakes the percentage of the *Ostracoda* and juvenile *Chironomidae* forms was greater, and the zoomicrobenthos was found in deeper layers of sediment.

I. INTRODUCTION, AREA AND METHOD

The aim of this paper is to characterize zoomicrobenthos (numbers, qualitative composition, vertical distribution) in pond type lake Warniak. The studies have been a part of joint investigations on the effect of increased fish stock (introduction of carp and bream - Zawisza and Ciepiewski 1973) on the lake biocenosis.

Lake Warniak is a eutrophic water body of a pond type, 38.4 ha of surface, 3.7 m max. depth, 1.5 m mean depth, and the bottom covered with a thick

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\*Praca wykonana w ramach problemu węzłowego Nr 09.1.7.

sediment layer of gyttja type. Aquatic vegetation, mostly the submerged one, covers the greater part of the lake (Bernatowicz 1969).

In 1967 carp and bream were introduced. In 1968 and 1969 the introduction of carp was repeated. Each year in spring the lake was divided by nets and fish were introduced into the bordered parts. As all introduced fish were not caught their stock increased in the following years.

In each fenced part of the lake 2 sites were chosen, on which zoomicrobenthos was sampled. The sites were in the not overgrown part of the lake and were about 1.5 m deep.

The samples were taken in summer: three times in 1966, 1967 and 1969, and four times in 1968. From each site a series of 5–10 samples were taken with a tube sampler of a surface 10 cm<sup>2</sup> constructed by Kajak, Kacprzak and Polkowski (1965). Some samples 16 cm high, were divided into horizontal layers: I – from sediment surface to the depth of 2.0 cm, II – 2.0–8.0 cm, III – the deepest 8.0–16.0 cm.

Then the samples were elaborated according to the method used in the studies of zoomicrobenthos in other Masurian lakes (Stańczykowska 1966), i.e., fixed in 4% formalin, rinsed on a sieve of mesh diameter 45  $\mu$  and sorted under 100 enlargement.

## II. THE NUMBERS OF ZOOMICROBENTHOS

During the studies conducted in lake Warniak no visible differences were observed in the numbers of zoomicrobenthos on different sites and in different parts of the lake. In 1966 (the year preceding the increased fish stock), in 1967 and 1968, and in spring 1969 the numbers were similar. Some differences were observed in different parts of the lake only in summer and autumn 1969.

The seasonal changes in number had also a similar course in different lake parts in particular years. Therefore in the further analysis the data from different lake parts are treated jointly.

No visible regularities of the number dynamics of zoomicrobenthos were observed in the season. The maxima and minima of occurrence in different years were recorded at different times. Perhaps, this lack of regularity is due to the relatively rare sampling.

Mean zoomicrobenthos numbers calculated from the entire material in particular years show a decreasing tendency (Tab. I). They are higher in the years preceding the introduction of fish than in the following years.

Numbers of zoomicrobenthos (in thousands of individuals per 1 m<sup>2</sup> of bottom surface) in lake Warniak in successive years of studies

Tab. I

	1965*	1966	1967	1968	1969
Average	45	51	33	17	27
Range	32-80	43-78	22-53	15-22	6-42

\* Acc. to Stańczykowska and Przytocka-Jusiak (1968).

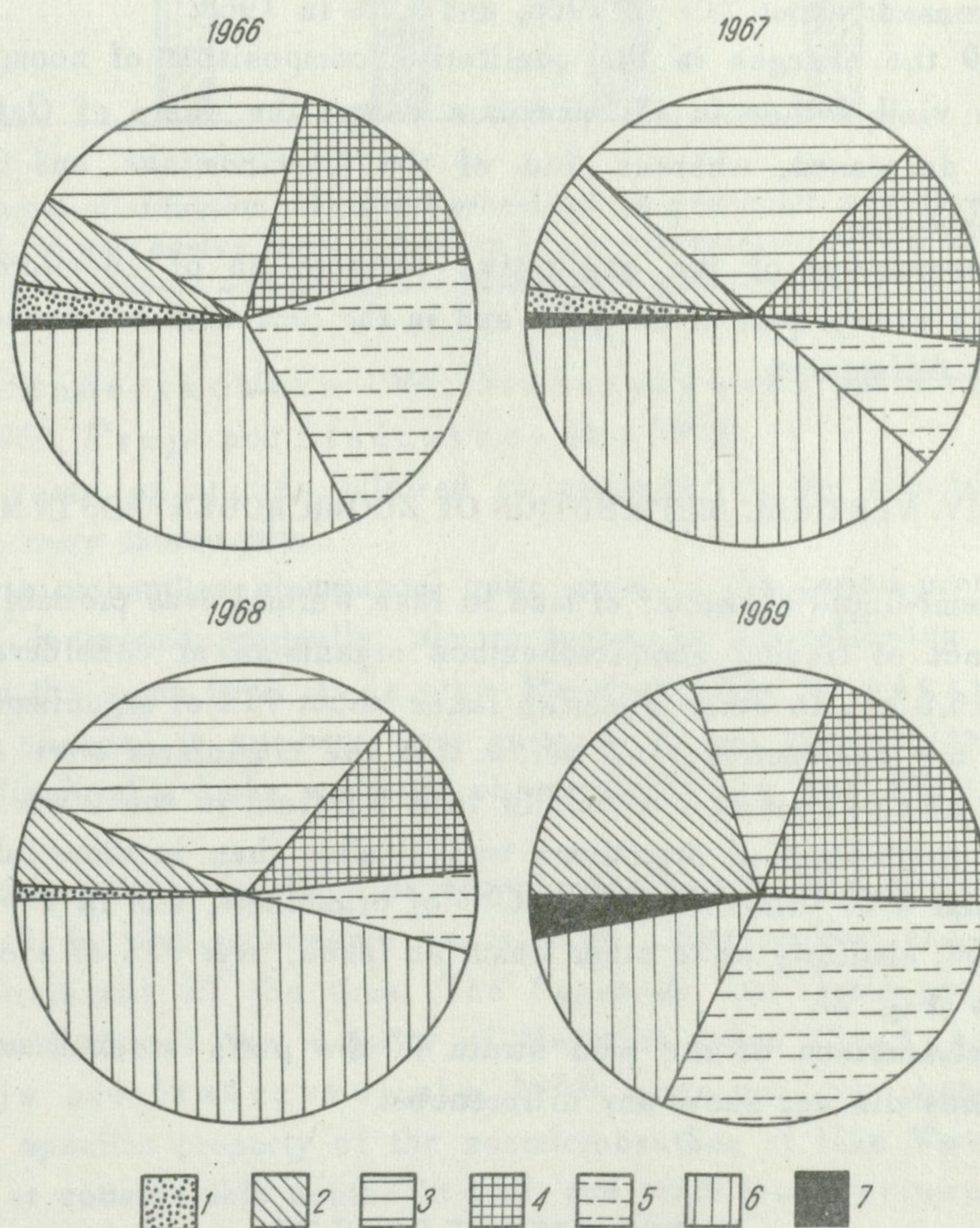


Fig. 1. Qualitative composition of zoomicrobenthos (in %) in lake Warniak in successive years of studies

1 - Nematoda, 2 - Oligochaeta, 3 - Cladocera, 4 - Copepoda, 5 - Chironomidae, 6 - Ostracoda, 7 - others

### III. QUALITATIVE COMPOSITION OF ZOOMICROBENTHOS

Six groups of fauna were observed mainly in the zoomicrobenthos of lake Warniak — *Nematoda*, *Oligochaeta*, *Cladocera*, *Copepoda*, *Ostracoda* and *Chironomidae* (Fig. 1). Among them the *Ostracoda* dominated, and then the *Cladocera*, *Copepoda* and *Chironomidae*. The *Nematoda* were hardly few per cent, and the *Oligochaeta* 6–17%.

The qualitative composition during the first three years of studies (1966–1968) did not change much. The share of *Ostracoda* increased gradually: 33% in 1966 and 46% in 1968. Simultaneously the share of *Chironomidae* decreased: about 21% in 1966, and 5.7% in 1968.

In 1969 the changes in the qualitative composition of zoomicrobenthos were more visible than in the previous years: the share of *Ostracoda* and *Cladocera* decreased, whereas that of the *Chironomidae* and *Oligochaeta* increased visibly.

The comparison of the qualitative composition of zoomicrobenthos on sites in the control part of the lake and in the part with increased fish stock showed no differences.

### IV. VERTICAL DISTRIBUTION OF ZOOMICROBENTHOS IN MUD

The semi-liquid character of mud in lake Warniak was probably the reason for the fact of finding zoomicrobenthos organisms at considerable depths, such as 16.0 cm. In other Masurian lakes about 91% of organisms were found in the 4 top centimetres, and below that the organisms were sporadically found (Stańczykowska 1966). In lake Warniak, in the 2 cm surface mud layer the percentage of organisms was smaller than in other lakes. And so, in 1966 and 1967 there was about 60% of organisms, and in 1968 about 80%, but in 1969, similarly as in other Masurian lakes, over 90% of zoomicrobenthic organisms (Fig. 2).

The comparison of the mud strata in the parts stocked with fish and control ones did not show any differences.

### V. DISCUSSION OF RESULTS

The zoomicrobenthos of lake Warniak, as shown in the studies preceding the experiment, differs considerably from the zoomicrobenthos of other parallelly examined Masurian lakes (Stańczykowska 1967). It occurs very abundantly and the percentage of *Ostracoda* and juvenile *Chironomidae* forms is higher than in other examined lakes, where the *Nematoda* and *Copepoda* visibly

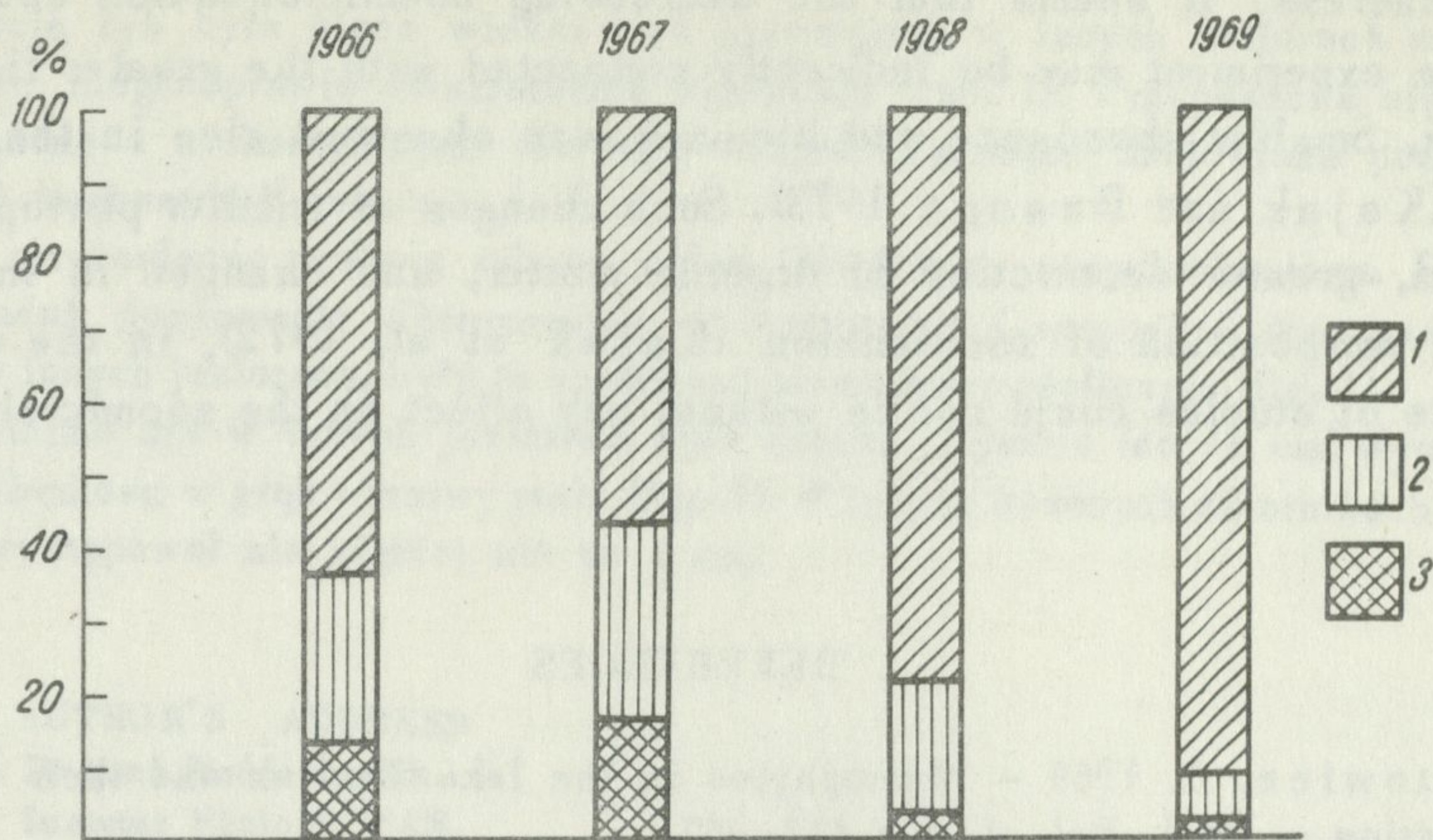


Fig. 2. Vertical distribution of zoomicrobenthos in particular mud layers in lake Warniak, in successive years of studies (of. in percentage per 1 cm<sup>3</sup> of mud)

Layers: 1 - 0-2.0 cm, 2 - 2.0-8.0 cm, 3 - 8.0-16.0 cm

dominated (Stańczykowska 1967, Stańczykowska and Przytocka-Jusiak 1968, Prejs and Stańczykowska 1972).

The 4 years of studies allowed to characterize the zoomicrobenthos of this lake more thoroughly.

The zoomicrobenthos abundance, quite great in the period preceding the experiment, decreased gradually, almost twice, in the following years and remained on the same level as in other Masurian lakes (Stańczykowska 1967). The changes in numbers were quite mild, and such violent changes as in the Mikołajskie Lake were not observed (Prejs and Stańczykowska 1972).

The qualitative composition of zoomicrobenthos in lake Warniak did not change much in the successive years. The *Chironomidae* and *Ostracoda* markedly dominated all the time. The *Copepoda* and *Ostracoda*, although the most numerous in the majority of Masurian lakes (Stańczykowska 1967, Prejs and Stańczykowska 1972), were not very abundant here.

Another specific property of the zoomicrobenthos of lake Warniak is its occurrence at considerable depths in mud, and much lesser occurrence in the surface layer. Only in the last year of the investigations the zoomicrobenthos was more abundantly observed in the top mud layers.

The studies on the zoomicrobenthos in lake Warniak did not show any direct effect of fish on this benthic community. No differences were observed in particular years between the stocked with fish and control parts of the lake.

Nevertheless, it seems that the decreasing zoomicrobenthos abundance during the experiment may be indirectly connected with the greater fish concentration. Smaller abundance and biomass was observed also in the macrobenthos (Kajak and Dusoge 1973). Such changes as smaller phytoplankton production, greater destruction of organic matter, and changes in the numbers and composition of zooplankton (Kajak et al. 1972), in the successive years of studies could not be without any effect on the zoomicrobenthos.

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#### EKSPERYMENTALNE ZWIĘKSZENIE OBSADY RYB W STAWOWYM JEZIORZE WARNIAK

##### Streszczenie

W ciągu 4 kolejnych lat (1966–1969) prowadzono w jeziorze Warniak badania liczebności, składu jakościowego i rozmieszczenia pionowego w mule zwierząt mikro-bentosowych. Stwierdzono, że liczebność tego zespołu w okresie poprzedzającym

introdukcję ryb była nieco większa od przeciętnej w innych jeziorach mazurskich, następnie uległa prawie dwukrotnemu obniżeniu (tab. I). Przypuszcza się, że było to związane z niekorzystnymi dla tego zespołu zmianami środowiska pod wpływem rosnącej koncentracji ryb.

Nie stwierdzono wpływu ryb na skład jakościowy zoomikrobentosu. Przez cały czas badań dominowały *Chironomidae* i *Ostracoda*; *Copepoda* i *Nematoda*, bardzo liczne w innych jeziorach, były tu spotykane stosunkowo nielicznie (fig. 1).

Odmienne niż w innych jeziorach było bardzo głębokie (do 16 cm) występowanie zoomikrobentosu w głąb warstwy mułu (fig. 2). W innych badanych zbiornikach zoomikrobentos występował nie głębiej niż do 4 cm.

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