EKOLOGIA POLSKA (Ekol. pol.)	25	1	45–57	1977

Eligiusz PIECZYŃSKI

Department of Hydrobiology, Institute of Ecology, Polish Academy of Sciences,
Dziekanów Leśny near Warsaw

NUMBERS AND BIOMASS OF THE LITTORAL FAUNA IN MIKOŁAJSKIE LAKE AND IN OTHER MASURIAN LAKES*

ABSTRACT: In shallow littoral habitats the numbers and biomass of the benthos are high, much higher than the numbers and biomass of the macroperiphytonic fauna (inhabiting the underwater parts of emergent macrophytes). The seasonal dynamics of numbers of the benthos and macroperiphytonic fauna is different, which may indicate that these two faunal groupings are to some extent specific. Differences can also be seen between habitats and two consecutive study years.

Contents

1. AIM OF THE WORK, AREA AND METHODS

The aim of the study was to assess the numbers and biomass of invertebrate fauna in various littoral habitats, and to describe the seasonal changes in numbers and dominance structure of this fauna. In the analysis two basic components of the littoral fauna were used: the benthos, and the invertebrates inhabiting the underwater parts of the emergent macrophytes (primarily the reed).

The most important object of study was the Mikołajskie Lake (Table I), in which three littoral habitats were analysed:

*Praca wykonana w ramach problemu węzłowego nr 09.1.7 („Procesy decydujące o czystości powierzchniowych wód śródlądowych").

Table I. Characteristics of Mikołajskie Lake and other Masurian lakes studied

Lake	Trophic type and mixis	Area (ha)	Mean depth (m)	Maximum depth (m)	Area of littoral in per cent of total lake area
Mikołajskie	eutrophy, holomixis	460	11.0	27.8	19
Bełdany	eutrophy, holomixis	941	10.0	46.0	*
Flosek	dystrophy, holomixis	4	3.0	8.0	9**
Śniardwy	eutrophy, polymixis	10,970	5.9	23.4	34.5
Tałtowisko	mesotrophy, holomixis	327	14.0	39.5	29
Tałty-Ryńskie	eutrophy, holomixis	1,831	13.6	50.8	7***

*No data.
**Poorly developed littoral.
***Approximate data.

Site I: A littoral without emergent macrophytes, with a high degree of exposure to waves, 0.4–0.5 m deep, its bottom being soft sandy and with thin layer of mud.

Site II: A littoral overgrown by bulrush (*Schoenoplectus lacustris* (L.) Palla), with a low degree of exposure to waves, about 0.5 m deep, and with a fairly soft, muddy and sandy bottom.

Site III: A littoral overgrown by reed (*Phragmites communis* Trin.), with a medium degree of exposure to waves, about 0.5 m deep, its bottom being hard sandy and stony and with thin layer of mud.

On the above sites studies were carried out from June 1971 to October 1972, during which period samples were collected at one month's intervals. During the persistence of the ice cover on the lake (January-March 1972) only benthos samples were collected, and only at site I.

Besides, the following 5 other Masurian lakes (Table I) were investigated once during the summer seasons:

Lake Bełdany (9 August 1972): A reed-overgrown littoral with a low degree of exposure to waves, 0.4–0.5 m deep, and with a soft, sandy bottom.

Lake Flosek (16 July 1971): A littoral without emergent macrophytes, slight waves, depth 0.3–0.4 m, a fairly hard bottom with a large amount of accumulated tree leaves and branches.

Lake Śniardwy (9 August 1972): A reed-overgrown littoral, a low degree of exposure to waves, about 0.4 m deep, with a very hard, sandy and stony bottom.

Lake Tałtowisko (18 August 1972): A reed-overgrown littoral, a medium degree of exposure to waves, about 0.4 m deep, with a very hard, sandy and stony bottom covered by thin layer of mud.

Lake Tałty-Ryńskie (11 August 1972): A littoral overgrown by reed, with a medium degree of exposure to waves, about 0.4 m deep, and with a soft, muddy and sandy bottom.

The benthos samples collected by using a tubular bottom-sampler of the Lastočkin-Ulomskij type, 10 cm^2 in catching area, were rinsed on a sieve of a mesh size of 0.4 × 0.4 mm. The samples were fixed in 4% formalin solution. Each time a series of 10 benthos samples was collected at each of the study sites.

The samples of the fauna living on the underwater parts of the emergent macrophytes (hereafter called the macroperiphytonic fauna, in accordance with the terminological suggestion

of Wolnomiejski and Dunajska 1966) were collected as follows: Over a reed (or bulrush) plant a plexiglass tube (7 cm in diameter) was put from above, the plant was then cut at the bottom with a secateur, the lower opening of the tube was covered with a net (made of bolting-cloth) and the tube with the plant in it was taken out of the water. The plant was placed in a tray, the periphyton was scraped off it by means of a scalpel, and the sample thus collected was preserved in 4% formalin solution. The plant, from which the periphyton had been scraped, was measured (length and diameter; its comparison to a cylinder made it possible to calculate the surface area colonized by macroperiphytonic fauna, and its subsequent estimation per m^2 of plant surface area). The putting of the tube over the plant prior to the taking of the plant out of the water was to prevent the mobile forms from escaping. Each time 10 (bulrush), or 20 (reed) – from 10 this year's plants (young), and 10 last year's (old) – macroperiphytonic fauna samples were collected at each of the sites studied. Because no significant differences in numbers and biomass were found between the macroperiphytonic fauna living on the young and that living on the old reed plants (the mean values for the whole material collected in the Mikołajskie Lake were almost identical), the division into these two categories was abandoned. The result differs from the earlier studies carried out in this lake by Opaliński (1971) who found, in a littoral analysed during the period July-September, over twice as high numbers of the fauna living on the old as of that on the young reed plants.

During the collecting of samples the density of the plants was estimated (10 measurements in squares of 0.25 m^2), which made it possible, later on, to estimate the numbers and biomass of the macroperiphytonic fauna per m^2 of littoral area.

In the laboratory, the samples of both the benthos and the fauna inhabiting the macrophytes were subjected to a gross examination, during which invertebrates of a minimum body size of about 2 mm were separated. The taxonomic identity of these invertebrates was established, and they were counted and weighed (on a torsion balance with an accuracy to the nearest 0.25 mg, after a previous drying on filter paper until no wet marks were left). The analysis did not include the molluscs, because the sampler used for benthos sample collecting made it impossible to numerically assess this animal group. The data on the biomass of the fauna was only used for comparing the various littoral habitats. This data was omitted in the analysis of the seasonal changes, because it had been found not to add anything new in relation to the description of numbers (because of the random occurrence of large-weight forms, the regularities concerning the biomass of the fauna were less clear than the regularities relating to numbers).

The total number of samples collected was as follows: in Mikołajskie Lake 450 benthos samples and 340 samples of macroperiphytonic fauna, and in the remaining lakes 50 and 80 samples, respectively.

2. RESULTS

2.1. Composition of littoral fauna

In the material collected from the Mikołajskie Lake and the other lakes studied the following invertebrate groups were found:

Benthos. *Turbellaria*, *Mermithidae*, *Oligochaeta*, *Hirudinea*, *Mollusca*, *Isopoda*, *Odonata*, *Ephemeroptera*, *Sialidae*, *Heteroptera*, *Coleoptera*, *Trichoptera*, *Heleidae*, *Chironomidae*, *Chaoboridae*, *Diptera* varia, *Hydracarina*. A total of 17 groups.

Macroperiphytonic fauna. *Hydrozoa*, *Oligochaeta*, *Hirudinea*, *Mollusca*, *Isopoda*, *Odonata*, *Coleoptera*, *Trichoptera*, *Heleidae*, *Chironomidae*, *Chaoboridae*. A total of 11 groups. All the groups, except *Hydrozoa*, were also represented in the benthos.

As has been mentioned, in the further analysis the *Mollusca* were omitted.

2.2. Numbers and biomass of littoral fauna in different habitats

Benthos. In the Mikołajskie Lake a characteristic regularity was observed, both in respect of the numbers and biomass of the benthos, namely – the lowest numerical values at site I (a littoral without emergent macrophytes) and the highest at site III (a littoral overgrown by reed) (Table II). In respect of numbers the ratio of the sites III/I was 3.2, and in respect of biomass – 5.1. The numbers and biomass of benthos, recorded for site II (a littoral overgrown by bulrush) were only slightly lower than those recorded for site III. On the above data it may be concluded that the emergent macrophytes provide favourable conditions for the growth of benthos (rich food supplies, isolation from waves, etc.).

Table II. Numbers and biomass of the benthos in various littoral habitats of Mikołajskie Lake and of other lakes studied
I–III – sites; in brackets – range of numbers or biomass

Lake	Littoral overgrown by:	Numbers per m^2 of littoral area	Biomass (g) per m^2 of littoral area
Mikołajskie I	without macrophytes	4,800 (800–17,400)	6.56 (1.75–15.32)
Mikołajskie II	bulrush	14,600 (4,100–29,200)	23.71 (10.20–45.87)
Mikołajskie III	reed	15,300 (9,100–27,100)	33.62 (15.47–85.22)
Bełdany	reed	9,900	20.67
Flosek	without macrophytes	7,300	22.60
Śniardwy	reed	9,900	30.65
Tałtowisko	reed	11,300	20.77
Tałty-Ryńskie	reed	9,200	14.52

The values of numbers and biomass of the littoral benthos of the other Masurian lakes studied were within the range of the mean values recorded for the Mikołajskie Lake (Table II), and the regularity observed in this lake was confirmed: in a habitat not overgrown by emergent macrophytes (Lake Flosek) the smallest numbers of benthos were found.

Data relating to the biomass of the benthos in the deeper zones of the Mikołajskie Lake indicate that littoral habitats overgrown by emergent macrophytes have a considerably richer benthos. Namely, Kajak and Dusoge (1975b) reported the following average annual values for the benthos biomass (after subtracting the value of the molluscs occurring at smaller depths): 4 m – 21.5 g/m^2, 8 m – 8.0, 12 m – 5.6, 16 m – 7.8, 24 m – 3.2. Thus it is only the benthos at the depth of 4 m that attains a value similar to that found for site II (bulrush) in the

littoral. At a littoral site devoid of emergent macrophytes (site I) the benthos biomass does not exceed the values recorded for the depths 8–16 m. This is yet another example to confirm the favourable effect of emergent macrophytes on the growth of the benthos.

As in the Mikołajskie Lake, regularities relating to the value of the benthos biomass at various depths can also be found in Lake Tałtowisko. For this lake Kajak and Dusoge (1975a) reported the following mean annual values of the benthos biomass (after subtracting the molluscs): 4 m – 36.0 g/m^2, 8 m – 9.0, 12 m – 8.7, 16 m – 6.2, 24 m – 6.9, 36 m – 0.1. So only at the depth of 4 m was the benthos biomass higher than in a reed-overgrown littoral; at greater depths – definitely lower.

For Lake Śniardwy – zone of a depth 6–10 m – the same authors (Kajak and Dusoge 1976) recorded a mean biomass of the benthos (without molluscs) equal to 5.1 g/m^2. It was thus 6 times as large in the reed-overgrown littoral.

The numbers and biomass values of the benthos found in the Mikołajskie Lake, especially in littoral habitats overgrown by emergent macrophytes, were high. For comparison, it should be added here that for Lake Jeziorak Mały, which is strongly eutrophic, Wolnomiejski (1965) recorded the following average numbers of littoral benthos (for the period May-November): at the depth of 0–0.5 m – 2,540 individuals/m^2, at the depth of 1 m – 2,960 individuals/m^2. For Lake Glubokoe, which is a mesotrophic lake, Ščerbakov (1967) in turn recorded the following average numerical values of the benthos (for the period May-October): in a littoral overgrown by the horse-tail (*Equisetum heleocharis* Ehrb.) – numbers 1,720 individuals/m^2, biomass 9.66 g/m^2; in a reed-overgrown littoral – numbers 4,290 individuals/m^2, biomass 11.57 g/m^2. Borodič (1974) found at various sites in a littoral zone without macrophytes at the depth of 1 m in the Kujbyšev dam reservoir average annual values of benthos biomass of the range 0.03–5.78 g/m^2. For the dam reservoir Učinskoe Sokolova (1963) recorded the following average numerical values of the benthos (for the period June-September): in a habitat overgrown by the cat's-tail (*Typha latifolia* L.) – numbers 7,950 individuals/m^2, and biomass 39.59 g/m^2; in a reed-overgrown habitat – numbers 3,880 individuals/m^2, biomass 4.37 g/m^2. Thus in most cases the values are considerably lower than those found for the Mikołajskie Lake (and the other Masurian lakes studied). (Examples of habitats have been given in which the molluscs either played an insignificant role, or could be subtracted from the total numbers and biomass of the littoral benthos.)

Macroperiphytonic fauna. It has been found that in the Mikołajskie Lake the fauna living on the reed is much richer than the fauna living on the bulrush (Table III). Calculated per m^2 of plant surface area, the numbers were 5.2 times as large, the biomass 4.7 times. Calculated per m^2 of littoral area, the differences were lesser (because of the higher density of the bulrush), yet still clear: numbers 2.5 times, the biomass 2.3 times as large on the reed. In the other lakes studied the macroperiphytonic fauna on the reed attained numerical values of the range found for the Mikołajskie Lake, although the variation of numbers and biomass was considerable: from very low (lakes Śniardwy and Bełdany) to very high (Lake Tałtowisko).

It is difficult to compare the results with the data in the literature, because the individual authors use different study methods, include different taxonomic groups in the fauna living on the macrophytes (e.g., they include in it the cladocerans and copepods), and particularly because they do not use the method of calculating the fauna per unit area of the plant surface, and only by this approach is a full comparability possible.

In Lake Glubokoe Ščerbakov (1967) observed, according to data given per m^2 of littoral area, 3 times as rich (in respect of numbers and biomass) a fauna on *Equisetum* as on

Table III. Numbers and biomass of the macroperiphytonic fauna in various littoral habitats of Mikołajskie Lake and of other lakes studied
II–III – sites; in brackets – range of numbers or biomass

Lake		Macrophyte	Density of macrophytes per m^2 of littoral area	Surface area of macrophytes (m^2) per m^2 of littoral area	Numbers per:		Biomass (g) per:	
					m^2 of macrophyte surface area	m^2 of littoral area	m^2 of macrophyte surface area	m^2 of littoral area
Mikołajskie	II	bulrush	110 (60–146)	1.48 (0.85–2.06)	410 (40–960)	610 (0.01–1.200)	0.15 (0.01–0.57)	0.22 (0.01–0.53)
	III	reed	65 (40–102)	0.73 (0.41–1.16)	2,140 (160–3,770)	1,560 (70–4,070)	0.70 (0.21–1.44)	0.51 (0.09–1.06)
Bełdany		reed	64	0.50	810	400	0.19	0.09
Śniardwy		reed	64	0.64	340	220	0.23	0.15
Tałtowisko		reed	83	1.04	3.440	3.580	1.84	1.91
Tałty-Ryńskie		reed	36	0.54	1.460	790	0.60	0.32

Phragmites, but the differences were connected with the size of the substrate surface (3 times as large in the case of *Equisetum*). In the Učinskoe dam reservoir Sokolova (1963) found, also according to data given per m^2 of littoral area, that the fauna living on *Phragmites* was poorer (in respect of numbers and biomass) than the fauna living on *Typha* and *Schoenoplectus*. It is difficult to establish to what extent this reflected differences in the size of the substrate (plants).

In the light of the data reported by the above authors, the numbers and the biomass of the macroperiphytonic fauna presented in this paper can be considered low.

The ratio benthos/macroperiphytonic fauna. Evaluated for the Masurian lakes studied during the present research, as also from the comparable data reported by other authors (in either case, on the per m^2 of littoral area basis), this ratio has revealed the following regularities (Table IV):

Table IV. The ratio benthos/macroperiphytonic fauna (data per m^2 of littoral area) in the littoral of various bodies of water

Lake (dam reservoir)	Macrophyte	Numbers	Biomass (g)
Mikołajskie	*Schoenoplectus*	14,600/610 = 23.93	23.71/0.22 = 107.77
	Phragmites	15,300/1,560 = 9.81	33.62/0.51 = 65.92
Bełdany	*Phragmites*	9,900/400 = 24.75	20.67/0.09 = 229.67
Śniardwy	*Phragmites*	9,900/220 = 45.00	30.65/0.15 = 204.33
Tałtowisko	*Phragmites*	11,300/3,580 = 3.16	20.77/1.91 = 10.87
Tałty-Ryńskie	*Phragmites*	9,200/790 = 11.65	14.52/0.32 = 45.37
Glubokoe*	*Phragmites*	4,290/9,000 = 0.48	11.57/1.01 = 11.45
	Equisetum	1,720/30,300 = 0.06	9.66/3.75 = 2.58
Učinskoe dam reservoir**	*Phragmites*	3,880/1,100 = 3.53	4.37/3.25 = 1.34
	Typha	7,950/3,680 = 2.16	39.59/21.31 = 1.86

*Acc. to Ščerbakov (1967), slightly altered.
**Acc. to Sokolova (1963), slightly altered.

In the Mikołajskie Lake and in other Masurian lakes, the benthos in respect of the numbers clearly dominated over the macroperiphytonic fauna. The value of the ratio benthos/macroperiphytonic fauna ranged from 3.16 (Lake Tałtowisko – reed) and 9.81 (Mikołajskie

Table V. Size distribution (in per cent) of *Chironomidae* and *Oligochaeta* in the benthos and macroperiphytonic fauna of the littoral of Mikołajskie Lake
II–III – sites

Groupings of fauna		*Chironomidae*					*Oligochaeta*				
		size classes (mm)									
		1–3	4–6	7–9	10–12	>12	< 6	6–10	11–15	16–20	> 20
Benthos	II	17.8	62.9	16.3	2.8	0.2	46.7	33.9	13.2	3.9	2.3
	III	16.3	46.8	23.1	11.5	2.3	41.0	37.2	15.7	4.9	1.2
Macroperiphytonic fauna	II	61.4	35.0	3.6	–	–	91.6	8.4	–	–	–
	III	70.5	27.8	1.3	0.3	0.1	100.0	–	–	–	–

Lake – reed) to 45.00 (Lake Śniardwy – reed). In respect of the biomass this ratio was in each case higher and ranged from 10.87 (Lake Tałtowisko – reed) to 229.67 (Lake Bełdany – reed).

The greater differences in biomass than in numbers between the benthos and the macroperiphytonic fauna result from the fact that in the benthos there are organisms of a larger body-size and thereby heavier. An illustration of this is provided by the size distribution of *Chironomidae* and *Oligochaeta* in the benthos and in the macroperiphytonic fauna of the Mikołajskie Lake littoral habitats under study (Table V).

According to the data reported by other authors the above-discussed regularity (numerical dominance of benthos over macroperiphytonic fauna) is partly confirmed by the situation in the dam reservoir Učinskoe (Table IV). With the values of the ratio benthos/macroperiphytonic fauna being generally lower, the benthos predominates. However, its predominance is greater in respect of numbers than in respect of the biomass. In Lake Glubokoe (Table IV) the dominance of benthos over the macroperiphytonic fauna applies to the biomass only. In respect of the numbers, the macroperiphytonic fauna predominates.

According to the data contained in the present paper it may be stated that in shallow littoral habitats the benthos clearly dominates in respect of numbers, and – especially – in respect of biomass over the macroperiphytonic fauna living on the underwater parts of the emergent macrophytes.

Data from the literature indicates that as regards the macroperiphytonic fauna living on submerged macrophytes the reverse is observed, that is to say, it usually dominates over the benthos, both in respect of the numbers and biomass. This no doubt is associated with the high – much higher than in the case of emergent macrophytes – surface area of these plants. For example, Soszka (1975), who studied the invertebrate fauna living on 4 submerged macrophyte species (*Potamogeton lucens* L., *P. perfoliatus* L., *Myriophyllum spicatum* L. and *Elodea canadensis* Rich.) in the Mikołajskie Lake, found that its numbers were in general (in 16 out of 18 cases studied) clearly higher than the numbers of the benthos, the maximum differences being 10, 40, and even 50-fold.

2.3. Seasonal changes in the numbers and dominance structure of the littoral fauna

Benthos. In 1971, the maximum of numbers of the benthos at site I (without emergent macrophytes) in the Mikołajskie Lake occurred during the period June-July, after which period a fall in numbers was observed down to a very low level, this level persisting through the autumn, winter and spring. In 1972, a slightly marked maximum of numbers occurred in July. The level of dominance (understood as the percentage attained by the first dominant species) – very high, on an average 68%, the range 39–98%. In the dominance structure the most important role was played by *Chironomidae*, which were found to dominate (or co-dominate) in 11 out of the 17 cases analysed, their dominance being of a permanent nature, e.g., in 1971 – during the period June-September, in 1972 – during the period July-October. *Oligochaeta* played a secondary role, being dominant in 7 of the cases analysed. The role of the remaining groups of the fauna was small (Fig. 1).

At site II (bulrush) in 1971, two distinct maxima of benthos numbers could be seen: a very high maximum in June, and a fairly high one in November. In 1972, there occurred only one very high maximum of numbers in August. The level of dominance – high, on an average 51%, the range 32–69%. The most important role in the dominance was played by *Oligochaeta*,

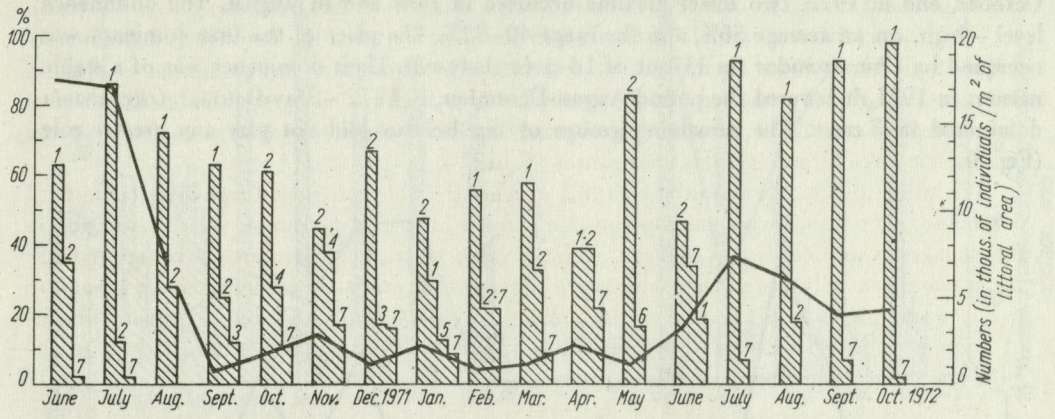

Fig. 1. Seasonal changes in numbers (line) and dominance structure (columns) of the benthos in Mikołajskie Lake littoral (site I – without emergent macrophytes)

1 – Chironomidae, 2 – Oligochaeta, 3 – Hirudinea, 4 – Ephemeroptera, 5 – Coleoptera, 6 – Chaoborus sp., 7 – others; groups whose contribution was < 10% have not been presented

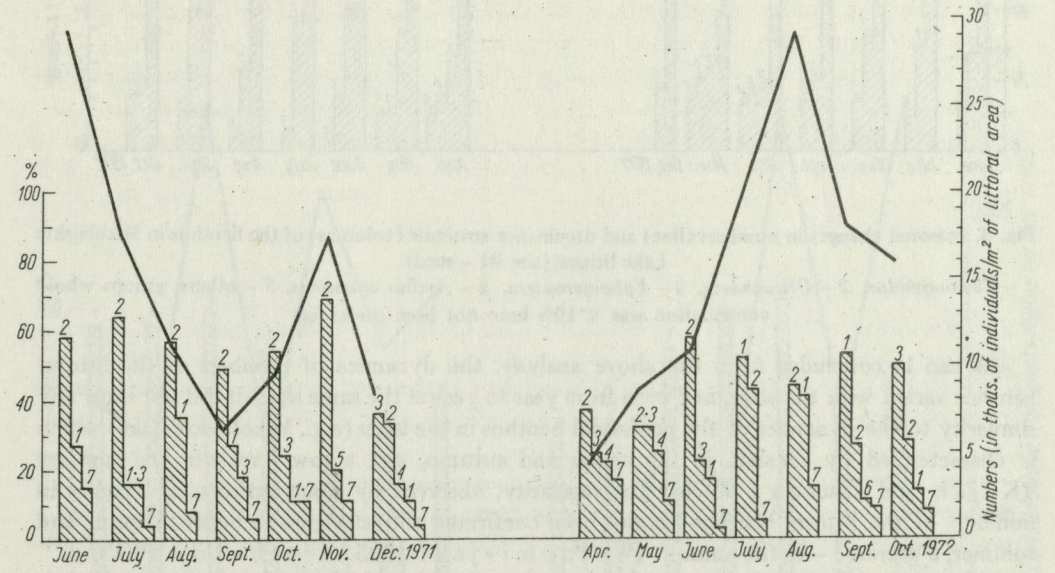

Fig. 2. Seasonal changes in numbers (line) and dominance structure (columns) of the benthos in Mikołajskie Lake littoral (site II – bulrush)

1 – Chironomidae, 2 – Oligochaeta, 3 – Ephemeroptera, 4 – Hirudinea, 5 – Asellus aquaticus L., *6 – Hydracarina*, 7 – others; groups whose contribution was < 10% have not been presented

which dominated (or co-dominated) in 10 out of 14 cases analysed. Their dominance was found to be very stable in 1971 (the period June-November). Besides them the place of the first dominant was occupied by: *Chironomidae* (2 cases) and *Ephemeroptera* (3 cases) (Fig. 2).

At site III (reed) in 1971, a very high maximum of numbers of the benthos was recorded for October, and in 1972, two lower maxima occurred in June and in August. The dominance level – high, on an average 56%, and the range 40–82%. The place of the first dominant was occupied by *Chironomidae* (in 11 out of 14 cases analysed). Their dominance was of a stable nature: in 1971, it covered the period August-December, in 1972 – May-October. *Oligochaeta* dominated in 3 cases. The remaining groups of the benthos did not play any greater role (Fig. 3).

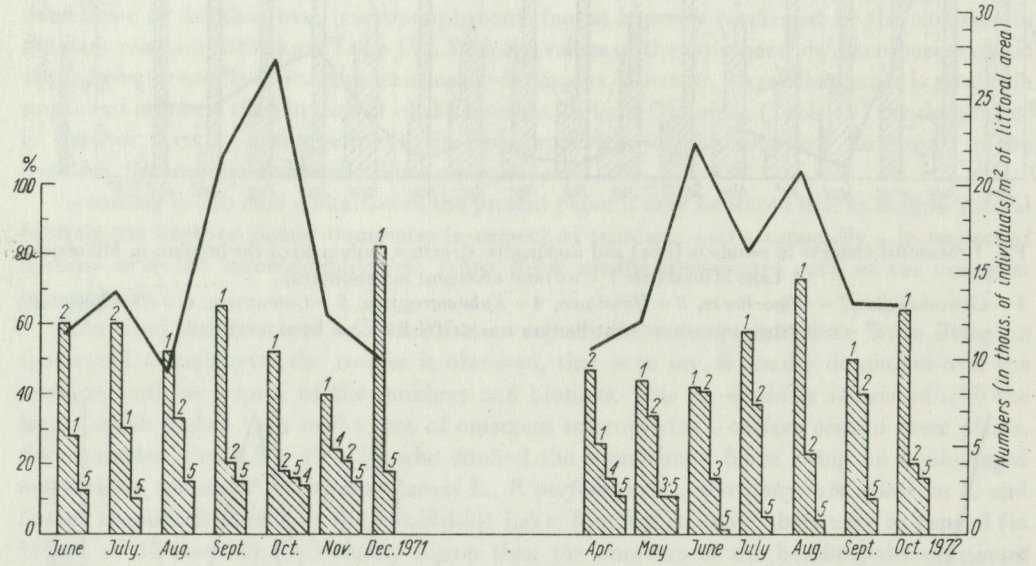

Fig. 3. Seasonal changes in numbers (line) and dominance structure (columns) of the benthos in Mikołajskie Lake littoral (site III – reed)

1 – Chironomidae, 2 – Oligochaeta, 3 – Ephemeroptera, 4 – Asellus aquaticus, 5 – others; groups whose contribution was < 10% have not been presented

As can be concluded from the above analysis, the dynamics of numbers of the littoral benthos varied with the sites, and even from year to year at the same sites. It did not show any similarity to the dynamics of the profundal benthos in the lakes (e.g., Mikołajskie Lake) which is characterized by maxima in the spring and autumn, and a low level – in the summer (Kajak and Dusoge 1976). The regularity, observed by some authors, of changes in numbers of the littoral benthos has not been confirmed either: a growth between spring and summer, a decrease – in the autumn (Wolnomiejski 1965, Ščerbakov 1967).

Macroperiphytonic fauna. At site II (bulrush) in 1971, with a generally low level of the numbers of the macroperiphytonic fauna, a not quite well marked maximum of numbers was observed during the period October-November. In 1972, with a generally much higher level of numbers of the macroperiphytonic fauna, the maxima of numbers occurred in June and in September. The level of dominance – very high, on an average 73%, the range 51–99%. The place of the first dominant was occupied mainly by *Chironomidae* (in 10 out of 12 cases analysed), their dominance being stable (in 1971 – during the period June-November). Besides, the place of the first dominant was occupied by *Oligochaeta* (in 2 cases). The role of the remaining groups of the fauna was insignificant (Fig. 4).

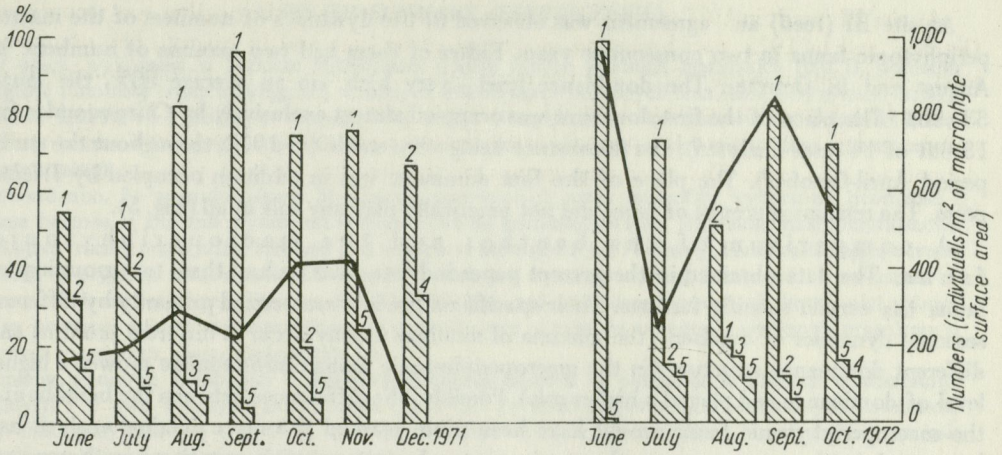

Fig. 4. Seasonal changes in numbers (line) and dominance structure (columns) of the macroperiphytonic fauna in Mikołajskie Lake littoral (site II – bulrush)

1 – Chironomidae, 2 – Oligochaeta, 3 – Heleidae, 4 – Trichoptera, 5 – others; groups whose contribution was < 10% have not been presented

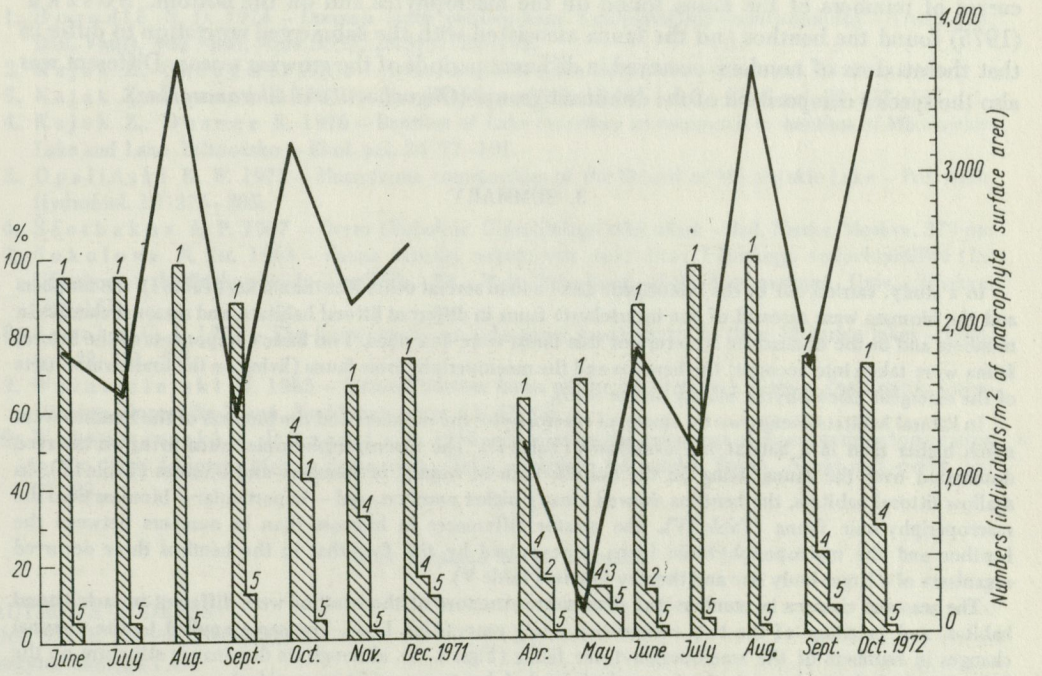

Fig. 5. Seasonal changes in numbers (line) and dominance structure (columns) of the macroperiphytonic fauna in Mikołajskie Lake littoral (site III – reed)

1 – Chironomidae, 2 – Oligochaeta, 3 – Heleidae, 4 – Trichoptera, 5 – others; groups whose contribution was < 10% have not been presented

At site III (reed) an agreement was observed of the dynamics of numbers of the macroperiphytonic fauna in two consecutive years. Either of them had two maxima of numbers: in August and in October. The dominance level – very high, on an average 80%, the range 53–98%. The place of the first dominant was occupied almost exclusively by *Chironomidae* (in 13 out of 14 cases analysed), the dominance being very stable (in 1972, throughout the study period April-October). The place of the first dominant was in addition occupied by *Trichoptera*. The remaining groups of fauna did not practically play any role at all (Fig. 5).

A comparison of the benthos and the macroperiphytonic fauna. The data obtained in the present paper indicate that each of these two groupings of fauna has certain specific features. Their specific nature is characterized primarily by different seasonal dynamics of numbers (the maxima of numbers usually occur in different months) and different dominance structure (in the macroperiphytonic fauna *Chironomidae* showed a higher level of dominance and played a higher role). Possibly, the differences between the benthos and the macroperiphytonic fauna would have been more marked if a more detailed analysis had been used (with an accuracy to the species, not only to taxonomic groups, as in the present study).

The specific nature of the benthos and the macroperiphytonic fauna is supported also by other authors. Wolnomiejski and Dunajska (1966) expressed the view that the specific nature and differentiation of the macroperiphytonic fauna, and the specific course of the seasonal changes indicate its specific features as an independent ecological unit. Sokolova (1963) has found that in principle there is no agreement in the course of the curves of numbers of the fauna found on the macrophytes and on the bottom. Soszka (1975) found the benthos and the fauna associated with the submerged vegetation to differ in that the maxima of numbers occurred in different periods of the growing season. Different was also the species composition of the dominant groups (*Oligochaeta* and *Chironomidae*).

3. SUMMARY

In a study, carried out in the Mikołajskie Lake and in several other Masurian lakes (Table I), the numbers and the biomass were assessed of the invertebrate fauna in different littoral habitats, and seasonal changes in numbers and in the dominance structure of this fauna were described. Two basic components of the littoral fauna were taken into account: the benthos and the macroperiphytonic fauna (living on the underwater parts of the emergent macrophytes, mainly on the reed).

In littoral habitats overgrown by emergent macrophytes the numbers and the biomass of the benthos were much higher than in a habitat not overgrown (Table II). The macroperiphytonic fauna living on the reed dominated over the fauna living on the bulrush both in respect of numbers and biomass (Table III). In shallow littoral habitats, the benthos showed clearly higher numbers, and – in particular – biomass than the macroperiphytonic fauna (Table IV). The greater differences in biomass than in numbers between the benthos and the macroperiphytonic fauna were caused by the fact that in the benthos there occurred organisms of a larger body size and thereby heavier (Table V).

The seasonal changes in numbers and dominance structure of the benthos were different in each littoral habitat, and in either of the two consecutive study years (Figs. 1–3). The same applied to the seasonal changes in numbers of the macroperiphytonic fauna (Figs. 4–5), although its dominance structure on the bulrush and on the reed was similar (a very high level of dominance of *Chironomidae*).

The data obtained in the present study indicate that each of the two groupings of the littoral fauna studied: the benthos and the macroperiphytonic fauna, has certain specific features expressed primarily by different seasonal dynamics of numbers (maxima of numbers as a rule occurring in different months), and by differences in the dominance structure (a higher level of dominance and a more important role of *Chironomidae* in the macroperiphytonic fauna).

4. POLISH SUMMARY (STRESZCZENIE)

W pracy, wykonanej w Jeziorze Mikołajskim i kilku innych jeziorach mazurskich (tab. I), oceniano liczebność i biomasę fauny bezkręgowej w różnych środowiskach litoralnych oraz charakteryzowano zmiany sezonowe liczebności i struktury dominacji tej fauny. Uwzględniano dwa podstawowe składniki fauny litoralnej: bentos i faunę makroperyfitonową (zasiedlającą podwodne części makrofitów wynurzonych, głównie trzcinę).

Stwierdzono, że w środowiskach litoralnych, porośniętych przez makrofity wynurzone, liczebność i biomasa bentosu są znacznie wyższe niż w środowisku nie porośniętym (tab. II). Fauna makroperyfitonowa zasiedlająca trzciny przewyższa, zarówno pod względem liczebności, jak i biomasy, faunę zasiedlającą oczeret (tab. III). W płytkich środowiskach litoralnych bentos ma wyraźnie wyższą liczebność i – zwłaszcza – biomasę niż fauna makroperyfitonowa (tab. IV). Większe pod względem biomasy niż liczebności różnice między bentosem i fauną makroperyfitonową spowodowane są tym, że w bentosie występują organizmy o większych rozmiarach, a więc cięższe (tab. V).

Zmiany sezonowe liczebności i struktury dominacji bentosu są odmienne w różnych środowiskach litoralnych i w dwu kolejnych latach badań (fig. 1–3). To samo dotyczy zmian sezonowych liczebności fauny makroperyfitonowej (fig. 4–5), choć jej struktura dominacji jest zbliżona na oczerecie i trzcinie (bardzo wysoki poziom dominacji *Chironomidae*).

Dane uzyskane w niniejszej pracy przemawiają za pewną odrębnością dwu badanych zespołów fauny litoralnej: bentosu i fauny makroperyfitonowej. Polega ona przede wszystkim na odmiennej sezonowej dynamice liczebności (szczyty liczebności przypadają z reguły w innych miesiącach) oraz na różnicach w strukturze dominacji (wyższy poziom dominacji i większa rola *Chironomidae* w faunie makroperyfitonowej).

5. REFERENCES

1. Borodič N. D. 1974 – Donnaja fauna osušnoj zony Kujbyševskogo vodochranilišča – Trudy Inst. Biol. Vnutr. Vod Akad. Nauk SSSR, 28(31):125–142.
2. Kajak Z., Dusoge K. 1975a – Macrobenthos of Lake Tałtowisko – Ekol. pol. 23: 295–316.
3. Kajak Z., Dusoge K. 1975b – Macrobenthos of Mikołajskie Lake – Ekol. pol. 23: 437–457.
4. Kajak Z., Dusoge K. 1976 – Benthos of Lake Śniardwy as compared to benthos of Mikołajskie Lake and Lake Tałtowisko – Ekol. pol. 24: 77–101.
5. Opaliński K. W. 1971 – Macrofauna communities of the littoral of Mikołajskie Lake – Pol. Arch. Hydrobiol. 18: 275–285.
6. Ščerbakov A. P. 1967 – Ozero Glubokoe. Gidrobiologičeskij očerk – Izd. Nauka, Moskva, 379 pp.
7. Sokolova N. Ju. 1963 – Fauna zaroslej nekotorych makrofitov Učinskogo vodochranilišča (In: Učinskoe i Možajskoe vodochranilišča, Ed. N. Ju. Sokolova) – Izd. Moskovskogo Univ., Moskva, 108–153.
8. Soszka G. J. 1975 – The invertebrates on submerged macrophytes in three Masurian lakes – Ekol. pol. 23: 371–391.
9. Wolnomiejski N. 1965 – Littoral bottom fauna of the lake Jeziorak Mały – Zesz. nauk. Uniw. Mikołaja Kopernika Toruń, Nauki mat.-przyr. 13: 47–63.
10. Wolnomiejski N., Dunajska B. 1966 – Studies on the groupings of macroperiphytonic fauna in the Lake Jeziorak Mały – Zesz. nauk. Uniw. Mikołaja Kopernika Toruń, Nauki mat.-przyr. 16: 77–88.

Paper prepared by H. Dominas

AUTHOR'S ADDRESS:
Doc. dr hab. Eligiusz Pieczyński
Instytut Ekologii PAN
Dziekanów Leśny k. Warszawy
05–150 Łomianki
Poland.