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Fauna Living on the Plants and Mining Fauna Associated with *Potamogeton lucens* L. in the Eutrophic Lake Głębokie

Fauna naroślinna i minująca, związana z *Potamogeton lucens* L., w eutroficznym Jeziorze Głębokim

Нарастительная и минирующая фауна, связанная с *Potamogeton lucens* L., в эвтрофном озере Глембоке

INTRODUCTION

In the literature concerning the macroinvertebrates inhabiting water plants there have been few studies on the mining fauna (1, 4, 8, 10, 11). Especially, there are little data connected with qualitative and quantitative relations between the fauna living on the surface of the plants and the fauna mining their tissues (2, 9, 10).

The aim of this study was to characterize the qualitative composition and density of the animals living on *Potamogeton lucens* and of those mining this plant and to determine a quantitative share of mining fauna in the whole fauna associated with pond-weeds. Attention was also paid to ecological significance of particular taxa occurring in both, mentioned above, zoocoenoses.

TERRAIN

Lake Głębokie, situated in the Łęczna-Włodawa lake district (eastern Poland), has a surface of 12 ha and a maximum depth 6 m. Fields, meadows and a transient peat-bog surround the lake. The lake bottom is covered with a thick layer of detritus. Emerged plants make a dense inshore belt composed mainly of *Phragmites communis* Trin. and *Typha*

latifolia L. Meadows of *Ceratophyllum demersum* L. and clusters of *Potamogeton lucens* L. cover the bottom at a depth of 0.5—2 m. Submerged plants grow till the depth of about 2.5 m.

Studies were conducted on 4 stations. Station I and II were situated in the littoral adjoing the fields, at depths of 0.5 and 2 m, respectively. Stations III and IV occurred on the opposite side of the lake, in littoral neighboring with the peat-bog, at depths of 0.5 and 2 m, respectively.

MATERIAL AND METHODS

Materials were collected between July and September, 1980 and between May and November, 1984, at one month intervals. Samples were taken with a new type of apparatus (7). One sample consisted of 5 pieces of stalks of about 5 cm long each, together with leaves fixed to them. They were taken from various parts of the shoots. Each time 5 samples were collected from each station.

Fauna living on plant surface was collected macroscopically, after putting material on white trays filled with water. Then the mining invertebrates were taken out using stereoscopic microscope. Only the organisms longer than 2 mm were taken into account.

Collected organisms were fixed in a 4% formalin solution. After taking out the invertebrates, plants were dried on blotting paper and weighed up to 0.5 mg.

Density of the mining invertebrates and of those living on plants was expressed per 100 g wet weight of the plants. For the ecological analysis the coefficient of ecological significance of species after K a s p r z a k and N i e d b a ł a (6) was calculated:

$$Q = \sqrt{C \cdot D}$$

where: C — constancy of occurrence, D — indicator of dominance.

On the basis of the computed value of the coefficient, the taxa found were divided into four classes: Q_4=over 20, Q_3=10.1—20, Q_2=5.1—10, Q_1=under 5.

RESULTS

29 taxa of various systematic rank were found to exist in the collected material. Among them 18 occurred exclusively on the surface of the pond-weeds, 4 exclusively in mines and 7 taxa were found in both fauna living on the surface of plants and mining fauna (Table 1).

Among common taxa to both zoocoenoses, only *Glyptotendipes* ex gr. *gripekoveni* K i e f f. occurred more abundantly in mines than on the surface of plants (Fig. 1). In Mikołajskie Lake in tissues of *Potamogeton lucens* only 20% of numbers of this taxa were found (10).

Taxa found exclusively on the surface of pond-weeds were typical representatives of periphytonic fauna (Table 1).

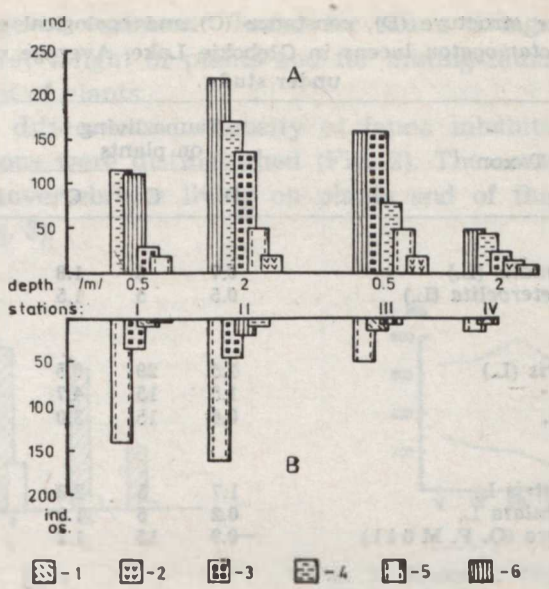

Fig. 1. Average density (number of specimens/100 g wet weight of plants) of common taxa of fauna living on plants — A and mining fauna — B inhabiting *Potamogeton lucens* in Głębokie Lake; 1 — *Limnochironomus* sp., 2 — *Cryptochironomus* ex gr. *pararostratus*, 3 — *Pentapedilum ceciliae*, 4 — *Tanytarsus* ex gr. *lauterborni*, 5 — *Glyptotendipes* ex gr. *gripekoveni*, 6 — *Endochironomus* ex gr. *tendens*

Among 4 taxa encountered exclusively in mines (Table 1), only *Endochironomus* ex gr. *signaticornis* K i e f f. is an obligatory miner (1, 3, 11, 13), however three remaining ones are found also on the surface of plants.

In the fauna occurring on the plants *Cricotopus* ex gr. *silvestris* F a b r., *Endochironomus* ex gr. *tendens* F a b r., *Tanytarsus* ex gr. *lauterborni* K i e f f. and *Pentapedilum ceciliae* T s h e r n reached very high values (Q_4) of the coefficient of ecological significance. Species of great significance belonging to class Q_3 were: *Glyptotendipes* ex gr. *gripekoveni*, *Psectrocladius* ex gr. *psilopterus* K i e f f., *Limnochironomus* sp. and *Cyrnus flavidus* M c L.

In the mining fauna only *Glyptotendipes* ex gr. *gripekoveni*, and *Pentapedilum ceciliae* had very great ecological significance (Q_4). The remaining taxa were characterized by low values of ecological significance coefficient (Table 1).

Average density of the whole fauna inhabiting *Potamogeton lucens* achieved 775 ind./100 g wet weight of plants, whereas in mines it was 149 ind./100 g wet weight of plants.

Tab. 1. Dominance structure (D), constance (C) and ecological significance (Q) of taxa inhabiting *Potamogeton lucens* in Głębokie Lake. Average values for stations under study

Taxon	Fauna living on plants			Mining fauna		
	D	C	Q	D	C	Q
Hirudinea:						
Helobdella stagnalis (L.)	0.7	5	1.8			
Glossiphonia heteroclita (L.)	0.5	5	1.5			
Naididae:						
Stylaria lacustris (L.)	1.5	29	6.5			
Nais Müll.	1.5	15	4.7			
Naididae n. det.	0.6	15	3.0			
Gastropoda:						
Acroloxus lacustris L.	1.7	5	2.9			
Bithynia tentaculata L.	0.2	5	1.2			
Lymnaea peregra (O. F. Müll.)	0.9	15	1.2			
Crustaceae:						
Asellus aquaticus L.	0.2	5	1.0			
Hydracarina	0.1	10	1.0			
Ephemeroptera	1.4	35	7.0			
Trichoptera:						
Cyrnus flavidus McL.	5.5	45	15.7			
Orthotrichia Eaton	0.2	5	1.0			
Lepidoptera:						
Acentropus niveus Oliv.	0.6	5	1.7	0.4	5	1.4
Chironomidae:						
Glyptotendipes ex gr. *gripekoveni* Kieff.	4.6	75	18.5	60.8	80	69.8
Pentapedilum ceciliae Tshern.	12.4	75	30.5	14.5	35	22.5
Limnochironomus Kieff.	2.6	40	10.2	3.8	20	8.6
Tanytarsus ex gr. *lauterborni* Kieff.	15.9	100	39.9	1.4	15	4.5
Cryptochironomus ex gr. *pararostratus* Harn.	2.3	40	9.6	1.9	5	3.1
Endochironomus ex gr. *tendens* (Fabr.)	20.3	95	43.9	19.0	5	3.1
Cricotopus ex gr. *silvestris* Fabr.	22.7	95	46.4			
Psectrocladius ex gr. *psilopterus* Kieff.	3.1	45	11.8			
Corynoneura celeripes Winn.	0.9	20	4.2			
Glyptotendipes polytomus Kieff.	0.8	15	3.4			
Alabesmyia monilis (L.)	0.2	5	1.0			
Endochironomus ex gr. *signaticornis* (Kieff.)				2.8	5	3.7
Cricotopus latidentatus Tshern.				1.1	10	3.3
Polypedilum ex gr. *convictum* (Walk.)				0.2	5	1.2
Dolichopodidae				6.6	5	5.7

Average range of variation * found for fauna living on plants was 812 ind./100 g wet weight of plants and for mining fauna was 209 ind./ /100 g wet weight of plants.

Considerable differences in density of fauna inhabiting pond-weeds among the stations were distinguished (Fig. 2). The seasonal variety of density of the invertebrates living on plants and of those mining was also notable (Fig. 3).

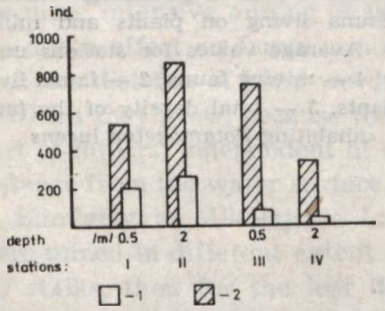

Fig. 2. Average density (number of specimens/100 g wet weight of plants) of fauna living on plants and mining fauna inhabiting *Potamogeton lucens* in Głębokie Lake; 1 — mining fauna, 2 — fauna living on plants

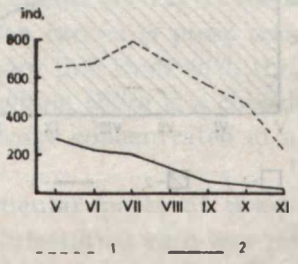

Fig. 3. Seasonal changes in density (number of specimens/100 g wet weight of plants) of the fauna living on the surface and mining fauna associated with *Potamogeton lucens* in Głębokie Lake. Average values for stations under study; 1 — fauna living on plants, 2 — mining fauna

Maximum density of fauna living on plants was stated in July (795 ind./100 g wet weight of plants), after that density decreased from month to month to reach the minimum in November (225 ind./100 g wet weight of plants).

Maximum density of the mining fauna was achieved in May (284 ind./ /100 g wet weight of plants), soon after beginning of the vegetation period. Then, a gradual decrease in density was observed and minimum was noticed in November (25 ind./100 g wet weight of plants).

In the Mikołajskie Lake a peak of density of invertebrates living on plants was observed in October, and of miners in August whereas the minimum for both groups was stated in July (10).

Together with the changes of density of the whole fauna inhabiting *Potamogeton lucens*, changes in quantitative relations between the fauna living on plants and mining fauna were noticed (Fig. 4). The largest percentage share of mining fauna in the total numbers of the whole

* The range of variation within the reach of series (R) has been adopted after Kasprzak (5): $R=x_n-x_1+1$, where x_n=the highest estimate, x_1=the lowest estimate.

fauna associated with pond-weeds was observed in May (30%), then the proportion of the mining fauna gradually decreased and the living organisms on the plants increased. In November a small increase in the percentage share of miners was observed again.

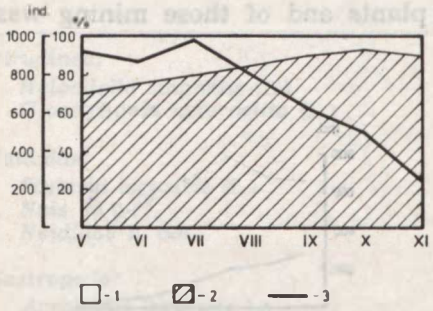

Fig. 4. Seasonal changes in density (number of specimens/100 g wet weight of plants) of the fauna inhabiting *Potamogeton lucens* and in percentage share of the fauna living on plants and mining fauna. Average values for stations under study; 1 — mining fauna, 2 — fauna living on plants, 3 — total density of the fauna inhabiting *Potamogeton lucens*

DISCUSSION

The mining fauna make a considerable part of the whole fauna inhabiting *Potamogeton lucens*, amounting to about 20% of numbers. The mining larvae of *Chironomidae* constituted only about 1% of the larvae inhabiting submerged plants in lakes Mikołajskie (10) and Vechten (2). On the other hand, G a j e w s k a (3), on the basis of data of various authors, stated that the mining fauna usually amounted to about one third of the density of the whole fauna which is associated with water plants.

Larvae of *Chironomidae* dominated both among invertebrates occurring on the plant surface and among miners. They stated average 86% of numbers of fauna living on plants and 94.5% of mining fauna.

The common taxa were prevailing among miners. They were also components of fauna living on plant surface. Some of them dominated at the same time in both zoocoenoses, but their quantitative share in mining fauna was different among the stations (Fig. 1).

Among the mining fauna only larvae of *Dolichopodidae*, *Acentropus niveus* O l i v. and *Endochironomus* ex gr. *signaticornis* are to be classified among groups of active miners (3). Other taxa belong to less active miners or forms without any mining activity (3). *Glyptotendipes* ex gr. *gripekoveni* and *Pentapedilum ceciliae* had the biggest ecological significance among the mining fauna. The remaining taxa — also belonging to typical miners — *Acentropus niveus*, *Endochironomus* ex gr. *signaticornis* and larvae of *Dolichopodidae* were characterized by small ecological significance.

Both the course of seasonal changes in density of the mining fauna with maximum in May and minimum in November and decrease of the percentage share in miners in the total numbers of the whole fauna associated with pond-weeds seem to deny views that older aquatic macrophytes are more intensively mined than young macrophytes (7).

No direct relations have been noticed between zonal distribution of pond-weeds (increasing depth) and intensity of mining (Fig. 2). However, the study conducted in Mikołajskie Lake showed that the greater depth the more intensive mining of the submerged plants (9, 11). It seems that the depth effect on fauna mining *Potamogeton lucens* is more connected with the distance of pond-weeds from the shore line than with the depth at which they grow, because their leaves, in which there is a considerable part of miners, independent of depths are always concentrated at a small distance from the water surface.

Similarly in Mikołajskie Lake (11), particular parts of pond-weeds were mined in different extent. The highest infestation rate was recorded for stalks, then for the leaf veins, the leaf blades showing the lowest infestation rate. At the same time there were above twice more miners in stalks than in leaves. Moreover, particular parts of plants were mined by specified systematic groups of invertebrates. In stalks, petioles and leaf veins only larvae and pupae of *Chironomidae* occurred, whereas in leaf blades larvae of *Lepidoptera* and *Dolichopodidae* were found exclusively.

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STRESZCZENIE

Celem przeprowadzonych w latach 1980 i 1984 badań nad fauną naroślinną i minującą było porównanie ich składu gatunkowego i zagęszczenia oraz określenie ilościowego udziału minerów w faunie zasiedlającej *Potamogeton lucens*.

W zebranym materiale stwierdzono 29 taksonów różnej rangi systematycznej, z czego 18 występowało wyłącznie na powierzchni roślin, 4 wyłącznie w minach, a 7 taksonów należało zarówno do fauny roślinnej, jak i minującej. W skład fauny minującej wchodziły z reguły pospolite gatunki, które w większości występowały także w faunie naroślinnej (tab. 1). Zarówno w faunie naroślinnej, jak i minującej dominowały larwy *Chironomidae*. Stanowiły one średnio 86% liczebności fauny naroślinnej i 94,5% fauny minującej.

Fauna minująca stanowiła znaczną, bo wynoszącą ok. 20% liczebności, część fauny zasiedlającej *Potamogeton lucens*. Jej udział ilościowy był różny na poszczególnych stanowiskach i zmieniał się w czasie (ryc. 2 i 4).

Stwierdzono różną intensywność minowania poszczególnych części morfologicznych roślin. Najintensywniej były minowane łodygi, następnie nerwy liści i blaszki liściowe, przy czym w łodygach występowało z reguły ponad dwukrotnie więcej minerów niż w liściach. Poszczególne części roślin minowane były przez określone grupy zwierząt. W łodygach i nerwach liści występowały tylko larwy *Chironomidae*, a w blaszkach liściowych tylko larwy *Lepidoptera* i *Dolichopodidae*.

Nie stwierdzono kierunkowej zależności między strefowym rozmieszczeniem roślin a intensywnością minowania (ryc. 2).

РЕЗЮМЕ

Целью проведенных в 1980 и 1984 гг. исследований было сравнение видового состава и плотности нарастительной и минирующей фауны, определение количественного участия минеров в фауне, заселяющей *Potamogeton lucens*.

В собранном материале определили 29 таксонов разного систематического ранга, 18 из них выступало исключительно на поверхности растений, 4 исключительно в минах, а 7 таксонов принадлежало как к минирующей фауне, так и к нарастительной. В состав минирующей фауны обычно входили обыкновенные виды, большая часть которых выступала и в нарастительной фауне (табл. 1). В обеих фаунах доминировали личинки *Chironomidae*. Они составляли в среднем 86% численности нарастительной фауны и 94,5% минирующей.

Минирующая фауна составляла значительную (около 20% численности) часть фауны, заселяющей *Potamogeton lucens*. Ее количественное участие на отдельных местообитаниях было разное и изменялось (рис. 2 и 4).

Наблюдали разную интенсивность минирования отдельных морфологических частей растений. Больше всего были минированы стебли, затем листовые нервы и пластинки, причем в стеблях было в 2 раза больше минеров, чем в листьях. Отдельные части растений минировали определенные группы животных. В стеблях и листовых нервах обитали только личинки *Chironomidae*, а в листовых пластинках — только личинки *Lepidoptera* и *Dolichopodidae*.

Не обнаружили зависимости между зональным распределением растений и интенсивностью минирования (рис. 2).