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DEVELOPMENT AND STRUCTURE OF THE GOCZAŁKOWICE RESERVOIR ECOSYSTEM XIII. PLANT-DWELLING FAUNA

ABSTRACT: Development dynamics and numbers of invertebrate fauna were examined on particular plant species occurring in great concentrations, i.e., on *Batrachium aquatile* (L.) Dum., *Myriophyllum spicatum* L., *Polygonum amphibium* L., *Potamogeton lucens* L., *P. crispus* L., *Glyceria maxima* Holm. and *Elodea canadensis* Rich. Chironomidae dominated distinctly on all plants with the exception of *Elodea canadensis*. Seasonal dynamics of invertebrate fauna numbers varied. This fauna compared with benthic fauna of Goczałkowice reservoir showed that these are two different communities.

KEY WORDS: Reservoir, ecosystem, invertebrates, plant-dwelling fauna, seasonal cycles.

1. INTRODUCTION

Complex hydrobiological studies on Goczałkowice reservoir required to examine the fauna on higher aquatic vegetation as an important link in production of organic matter in the reservoir. This paper is a part of general investigations conducted between 1964 and 1967, the results of which are partly published (K u f l i k o w s k i 1974).

This fauna, called plant-dwelling, phytophilous, vegetation fauna or zoophytos, is a significant fish food, apart from plankton and benthos. It is the least analysed problem in hydrobiology. Attempts to explain the role of this fauna as a whole are rare in literature and usually based on scanty material.

This fauna has been most comprehensively examined in reservoirs in USSR (F o m e n k o 1964, G a e v s k a j a 1966, Z i m b a l e v s k a j a 1967, 1969, 1971, 1973, 1981). And in Poland – the Masurian lakes (B o w n i k 1970,

Pieczyńska 1972, Pieczyński 1973, 1977, Kowalczewski 1975, Soszka 1975a, 1975b, Urban 1975, Prejs 1977).

The fauna numbers have been estimated here, showing seasonal changes in numbers and dominance structure of fauna. Macrophytes are arranged according to fauna numbers per 1 litre of fresh plant weight.

2. METHODS

During the research period 180 ha of the reservoir (6% of its surface) were overgrown by macrophytes. *Potamogeton lucens, P. crispus, Myriophyllum spicatum* and *Polygonum amphibium* dominated and among emergent plants – *Glyceria maxima*. Detailed characteristics of macrophytes investigated between 1964 and 1967 are given in paper by Kuflikowski (1968).

Material for investigations was collected between 1964 and 1967 in monthly intervals during vegetation (between June and September). In October the majority of macrophyte species were decomposed; 1965 was not taken into account because of lower water level in the reservoir causing the death of macrophytes (Kuflikowski 1968). Samples were collected from plants occurring abundantly in bigger monospecific concentrations such as *Batrachium aquatile, Myriophyllum spicatum, Polygonum amphibium, Potamogeton lucens, P. crispus, Glyceria maxima* and *Elodea canadensis* (taken into consideration only in 1966 and 1967).

Here the volumetric method has been used as it is the easiest to compare, regardless of the size and density of plants per surface unit. In the place of the highest concentration of plants they were sampled by a quick movement into the vessel. After rinsing and separating the fauna the volume of plants was measured in a scaled cylinder. The material divided from plants was fixed in formalin.

This paper is based on dominant species. Full species composition of plant-dwelling fauna is given by Kuflikowski (1974) and in the list of species (Krzyżanek and Krzyżanek 1986).

3. RESULTS

3.1. COMPOSITION AND FAUNA NUMBERS ON PARTICULAR PLANT SPECIES

In material collected from 7 macrophyte species the following groups of invertebrates occurred: Nematoda, Oligochaeta, Hirudinea, Cladocera, Ostracoda, Hydracarina, Amphipoda, Ephemeroptera, Trichoptera, Megaloptera, Chironomidae, Lepidoptera, Coleoptera and Gastropoda.

Six more numerous groups were analysed in greater detail, namely Oligochaeta, Hirudinea, Ephemeroptera, Trichoptera, Chironomidae and Gastropoda. Dominant communities of invertebrates were observed on particular plant species.

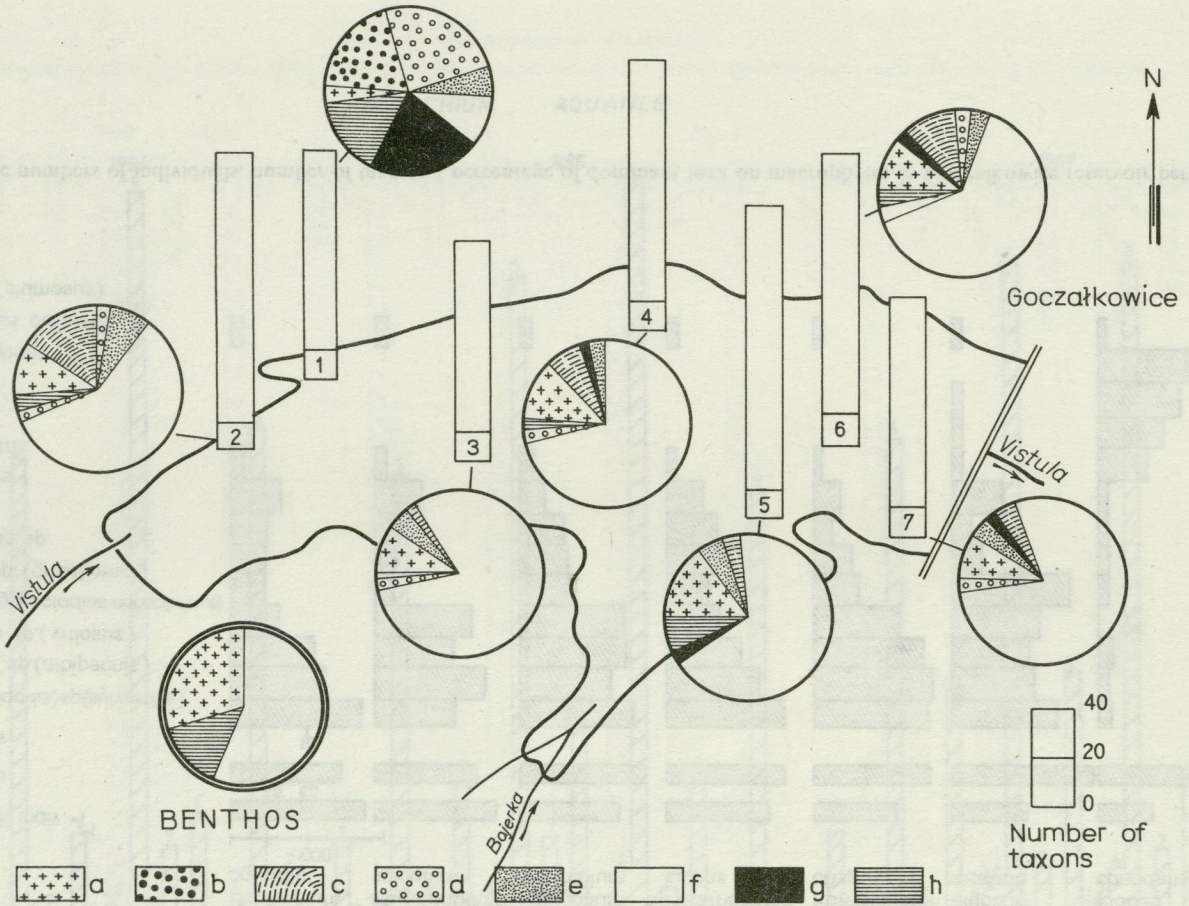

Fig. 1. Percentage of particular groups of invertebrates on macrophytes and in benthos
1 – *Elodea canadensis*, 2 – *Polygonum amphibium*, 3 – *Myriophyllum spicatum*, 4 – *Potamogeton crispus*, 5 – *Glyceria maxima*, 6 – *Potamogeton lucens*, 7 – *Batrachium aquatile*, a – Oligochacta, b – Hirudinea, c – Cladocera, d – Ephemeroptera, e – Trichoptera, f – Chironomidae, g – Gastropoda, h – other groups

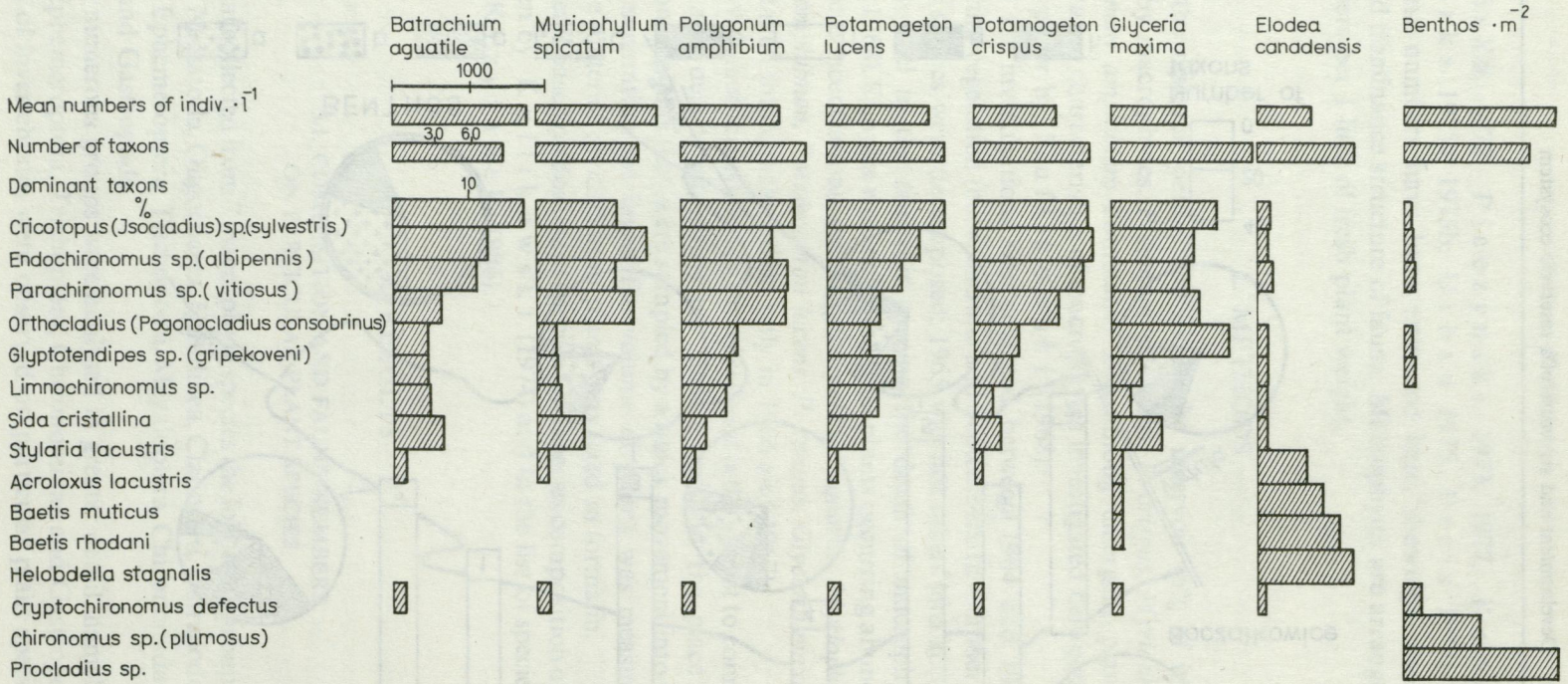

Fig. 2. Average numbers of individuals, number of taxa and percentage of dominant taxa on macrophytes in Goczałkowice reservoir between 1964 and 1967

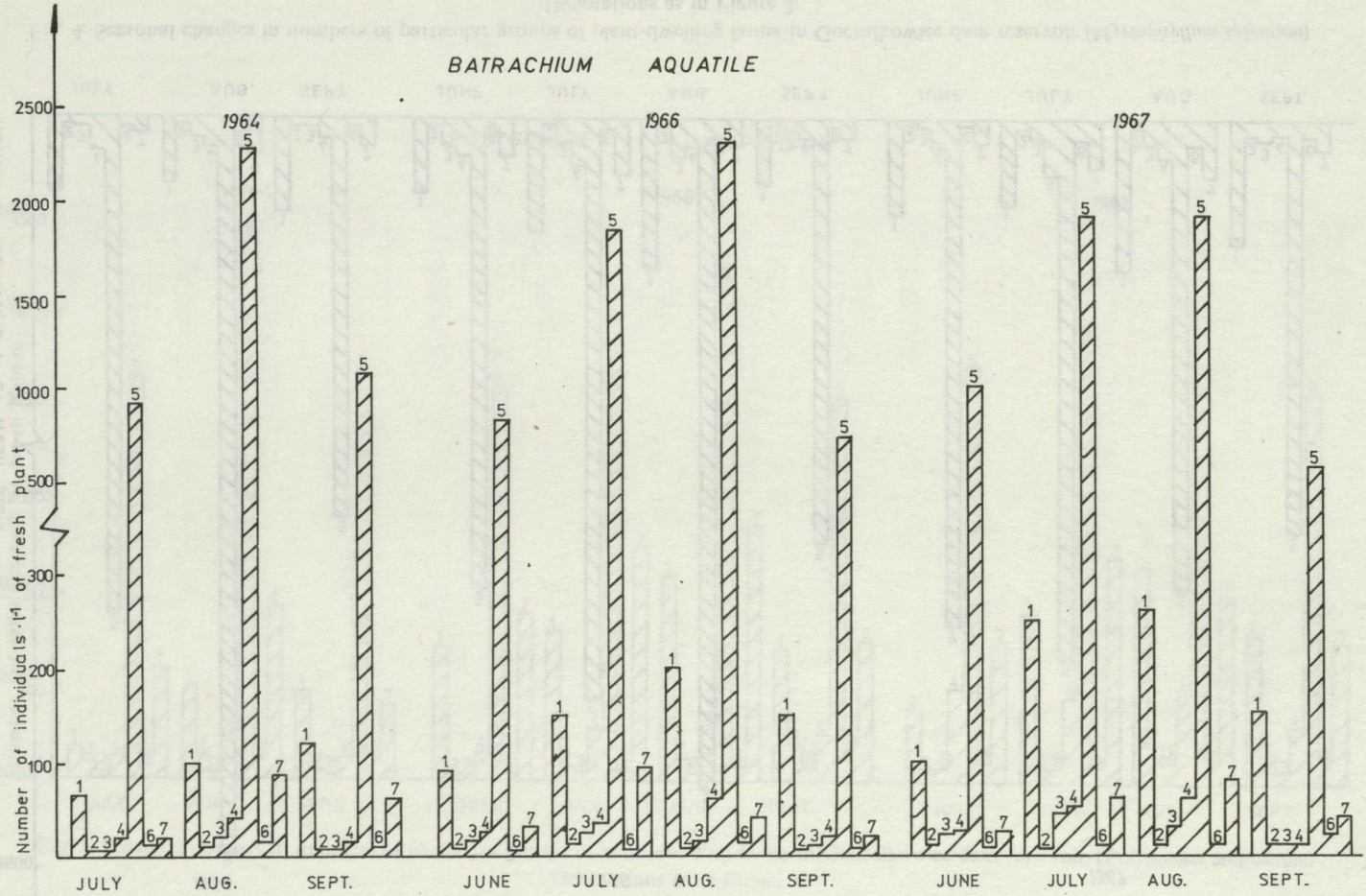

Fig. 3. Seasonal changes in numbers of particular groups of plant-dwelling fauna in Goczałkowice dam reservoir (*Batrachium aquatile*)
1 – *Oligochaeta*, 2 – Hirudinea, 3 – Ephemeroptera, 4 – Trichoptera, 5 – Chironomidae, 6 – Gastropoda, 7 – other groups

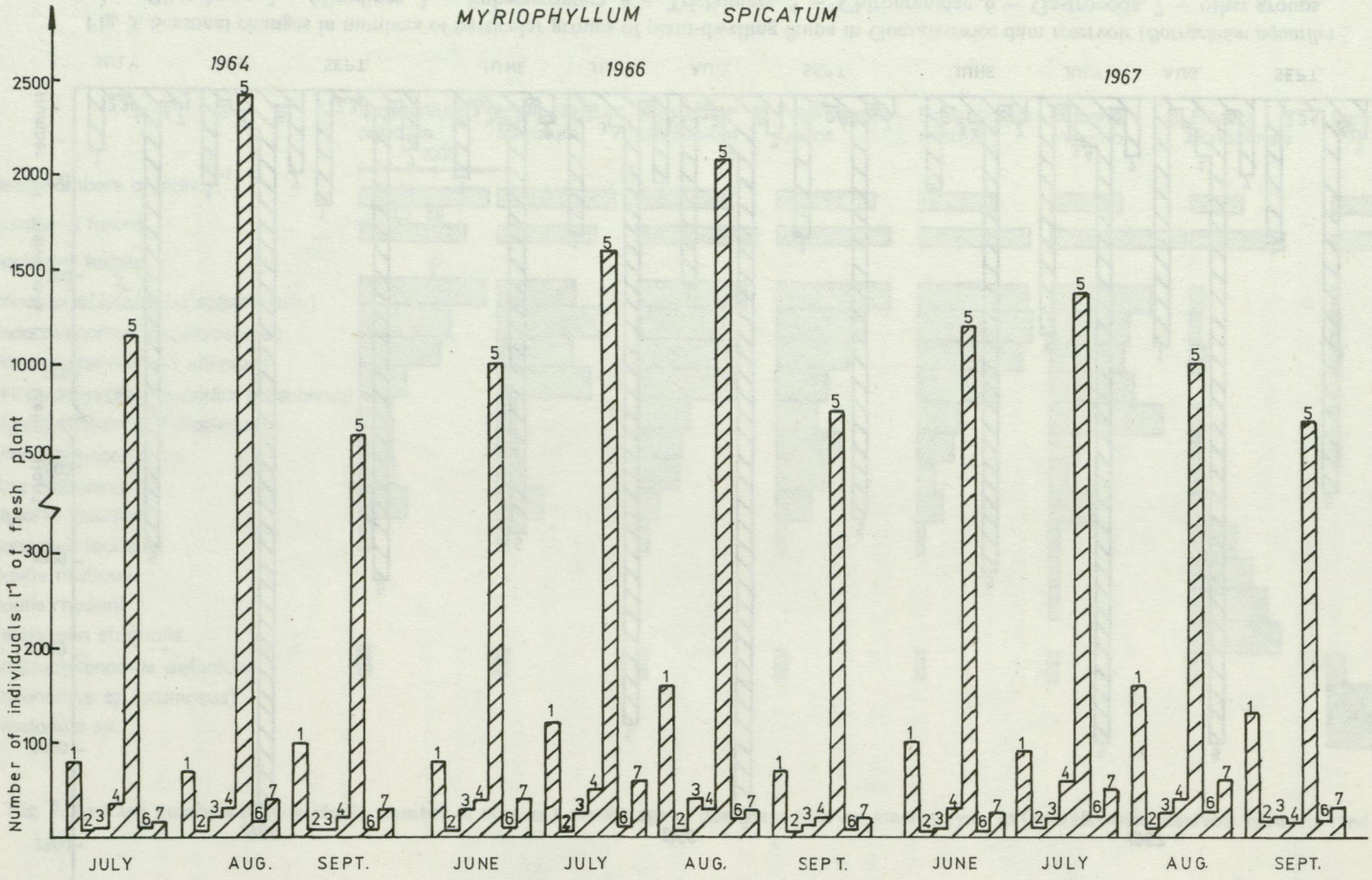

Fig. 4. Seasonal changes in numbers of particular groups of plant-dwelling fauna in Goczałkowice dam reservoir (*Myriophyllum spicatum*)
Denotations as in Figure 3

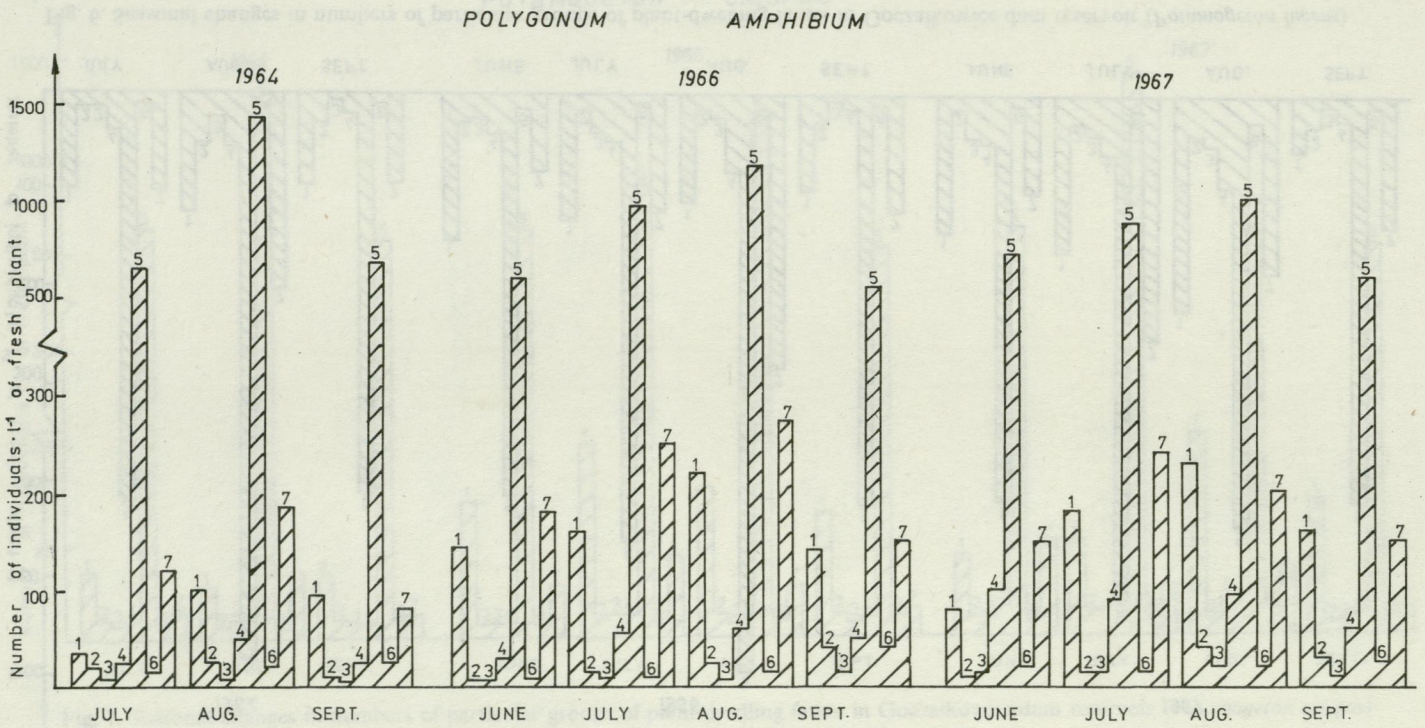

Fig. 5. Seasonal changes in numbers of particular groups of plant-dwelling fauna in Goczałkowice dam reservoir (*Polygonum amphibium*)
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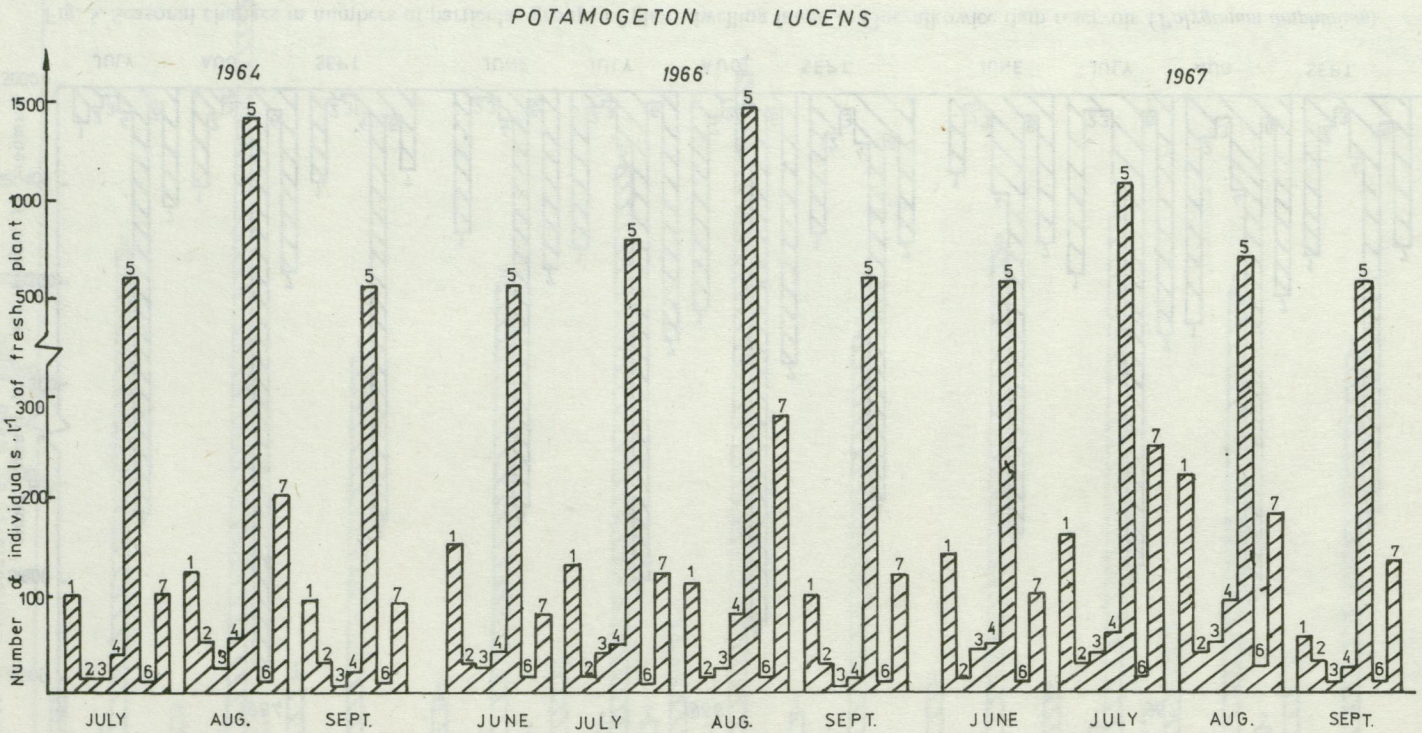

Fig. 6. Seasonal changes in numbers of particular groups of plant-dwelling fauna in Goczałkowice dam reservoir (*Potamogeton lucens*)
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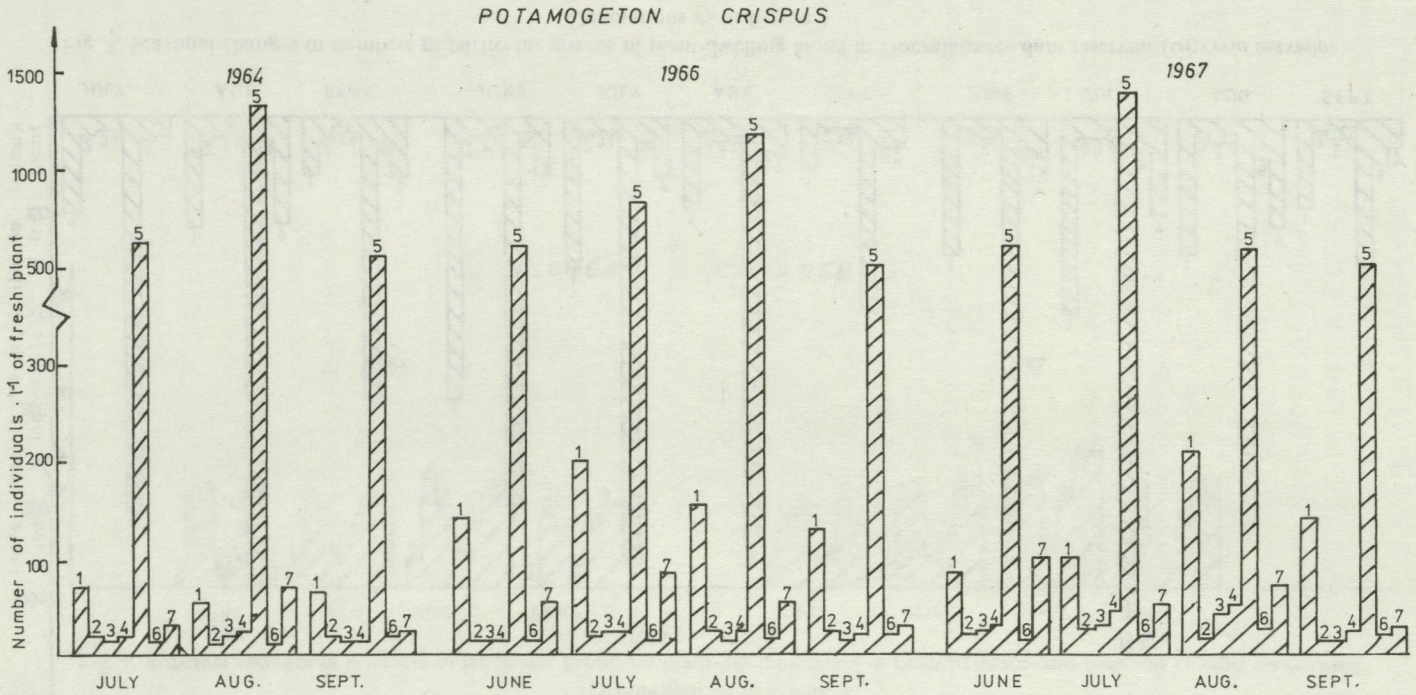

Fig. 7. Seasonal changes in numbers of particular groups of plant-dwelling fauna in Goczałkowice dam reservoir (*Potamogeton crispus*)
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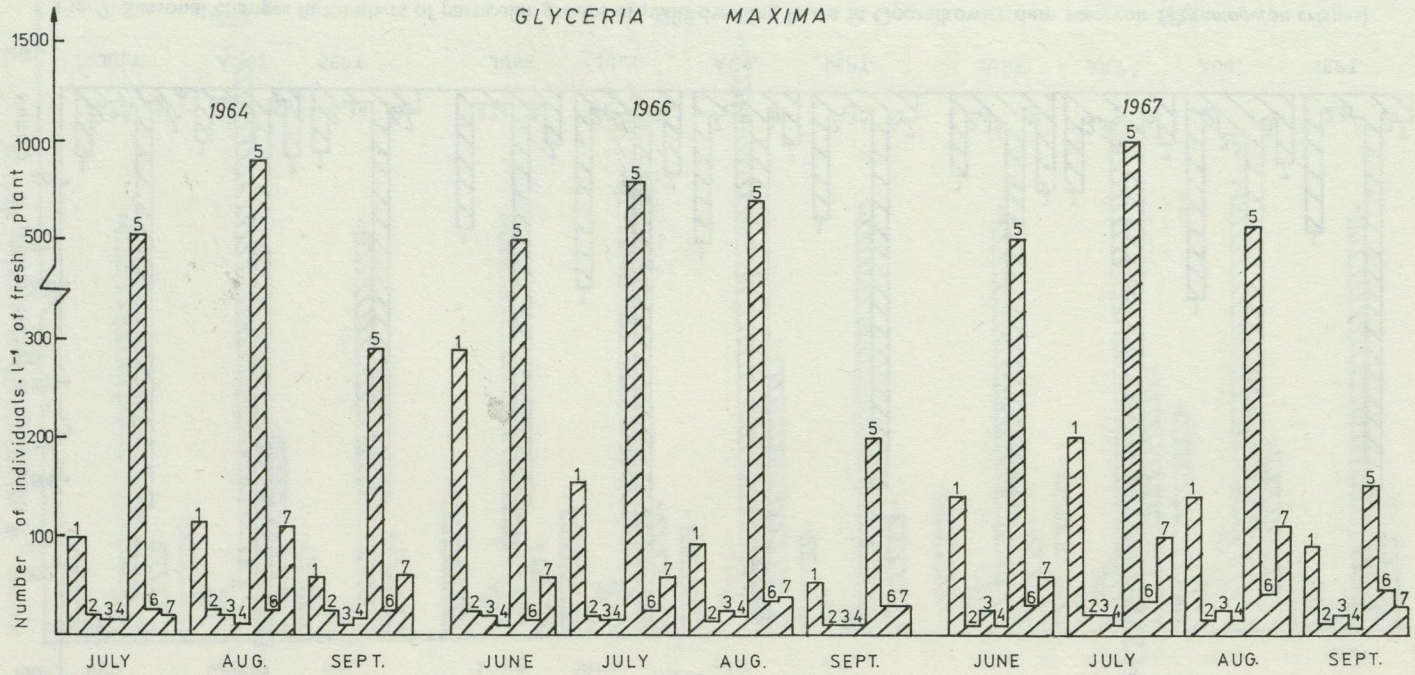

Fig. 8. Seasonal changes in numbers of particular groups of plant-dwelling fauna in Goczałkowice dam reservoir (*Glyceria maxima*)
Denotations as in Figure 3

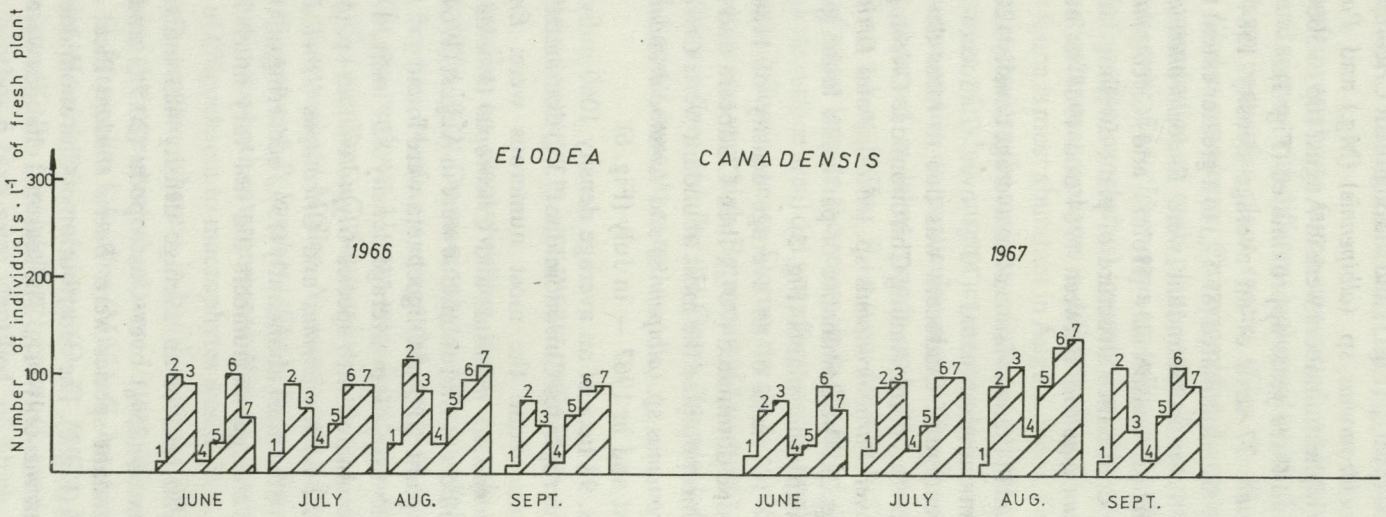

Fig. 9. Seasonal changes in numbers of particular groups of plant-dwelling fauna in Goczałkowice dam reservoir (*Elodea canadensis*)
Denotations as in Figure 3

Batrachium aquatile. 84 taxa of an average density 1692 indiv.·l^{-1} were found. Chironomidae dominated (81.5%) (Fig. 1) and among them *Cricotopus* (*Isocladius*) sp. (*sylvestris*) (Fabr.), *Endochironomus* sp. (*albipennis*) (Mg.) and *Parachironomus* sp. (*vitiosus*) G. (Fig. 2). The highest numbers were in August (up to 3000 indiv.·l^{-1}). The dominance structure in all three years approximated (Fig. 3).

Myriophyllum spicatum. 77 taxa of an average density 1584 indiv.·l^{-1} were identified. Chironomidae also dominated (81.5%) to a greater extent than Oligochaeta. Among Chironomidae the most abundant were *Endochironomus* sp. (*albipennis*), *Orthocladius* (*Pogonocladius*) *consobrinus* (Holm.) and *Cricotopus* (*Isocladius*) sp. (*sylvestris*).(Fig. 2). The dominance structure of plant-dwelling fauna of this group approximated *Batrachium aquatile*. Between 1964 and 1967 its numbers decreased slightly (Fig. 4).

Polygonum amphibium. 111 taxa of fauna of an average density 1266 indiv.·l^{-1} were distinguished. Chironomidae dominated (70%) over Cladocera and Oligochaeta (Fig. 1). This high percentage of Cladocera was due to mass development of *Sida cristallina* (O. F. Müll.) on this plant. Among Chironomidae *Cricotopus* (*Isocladius*) sp. (*sylvestris*) dominated over *Parachironomus* sp. (*vitiosus*) and *Orthocladius* (*Pogonocladius*) *consobrinus* (Fig. 2). The dominance of particular fauna groups was slightly different as compared with other plants (Fig. 5).

Potamogeton lucens. 107 taxa of an average density of 1180 indiv.·l^{-1} were determined. Chironomidae dominated (70%), then Cladocera and Oligochaeta, 10% each (Fig. 1). Among Chironomidae the most abundant were: *Cricotopus* (*Isocladius*) sp. (*sylvestris*), *Endochironomus* sp. (*albipennis*) and *Limnochironomus* sp. The highest numbers were in August and in 1967 – in July (Fig. 6).

Potamogeton crispus. 98 taxa of an average density 1060 indiv.·l^{-1} were found. Similarly as on other macrophytes Chironomidae (73%) dominated over Oligochaeta (Fig. 1). Among Chironomidae the most numerous were: *Endochironomus* sp. (*albipennis*), *Parachironomus* sp. (*vitiosus*) and *Cricotopus* (*Isocladius*) sp. (*sylvestris*) (Fig. 2). The highest numbers of Chironomidae were in August (1964, 1966) and in July (1967) (Fig. 7). On this plant 10% of Oligochaeta were found.

Glyceria maxima. 115 taxa of an average density 824 indiv.·l^{-1} were identified. Chironomidae (69%) dominated with species *Glyptotendipes* sp. (*gripekoveni*) (Kieff.) *Orthocladius* (*Pogonocladius*) *consobrinus* and *Cricotopus* (*Isocladius*) sp. (*sylvestris*) (Fig. 2). Oligochaeta were the most abundantly (15%) occurring on this plant among all macrophytes. Seasonal changes in numbers did not vary much in particular years (Fig. 8).

Elodea canadensis. 80 taxa of an average density 483 indiv.·l^{-1} were found. Ephemeroptera dominated (25%) over Gastropoda (20.5%) and Hirudinea (19%) (Fig. 1). The most abundant species were: *Baetis rhodani* Pict., *B. muticus* L. and *Helobdella stagnalis* (L.) (Fig. 2). The contribution of Chironomidae to the entire fauna community on this plant was only 11%. The seasonal changes were also small (Fig. 9).

3.2. SEASONAL CHANGES IN NUMBERS OF PLANT-DWELLING FAUNA

Communities of invertebrate fauna connected with macrophytes have a great variety of groups and species with different biological cycles. Thus the numbers of fauna vary in time and on particular plant species (Figs. 3–9). Although on all plants examined, except *Elodea canadensis*, Chironomidae dominate to a great extent, the arrangement of communities on each plant varies. Four taxa dominate: *Cricotopus* (*Isocladius*) sp. (*sylvestris*), *Endochironomus* sp. (*albipennis*), *Parachironomus* sp. (*vitiosus*) and *Orthocladius* (*Pogonocladius*) *consobrinus*, but their percentage in each community on particular macrophytes is different (Fig. 2).

Generally, this fauna is most abundant in August, but not in all years (Figs. 4, 6–8). Quantitative changes concern the majority of groups, but first of all the Chironomidae. Periodical emergences of adult insects cause changes in species dominance and arrangement in communities on particular plants. Similar seasonal changes in this fauna have been observed in lakes, ponds and dam reservoirs (Zimbalevskaja 1967, Soszka 1975a, Pieczyński 1977).

The lowering of water level in the reservoir in 1965 and drying of its considerable part (25% of the whole surface area) did not affect negatively the development of plant-dwelling fauna in the following years. During the studies (1964–1967) the per cent of repeatability of species was very high. Between 1964 and 1967 only 4 taxa disappeared: Chironomidae (*Microtendipes pedullus* (de Geer), *Psectrocladius obvius* (Walk), *Ablabesmyia monilis* (L.) and *Limnophyes* sp.).

3.3. COMPARISON OF PLANT-DWELLING FAUNA AND BENTHOS

Parallelly to studies on plant-dwelling fauna benthic fauna was investigated (Krzyżanek 1970, 1973). On macrophytes 132 taxa of plant-dwelling fauna were found, whereas in benthos 94 of an average density 2015 indiv. $\cdot$ m^{-2} of bottom.

Oligochaeta. On macrophytes 11 taxa were found (*Limnodrilus* sp., *Chaetogaster diaphanus* (Gruit.), *C. langi* Bret., *C. diastrophus* (Gruit.), *C. limnaei* Baer, *Ophidonais serpentina* (Müll.), *Nais barbata* Müller, *N. pseudoobtusa* Pig., *Stylaria lacustris* (L.), *Pristina aequiseta* Bourne and *P. longiseta* (Ehr.)). In benthos there were 7 taxa. Only two taxa were common for both environments: *Nais pseudoobtusa* and *Limnodrilus* sp. The contribution of Oligochaeta to macrophytes was from 3.5% of *Elodea canadensis* to 15.5% of *Glyceria maxima*, whereas in benthos about 30% (Fig. 1).

Hirudinea. Among the vegetation there were 10 taxa (*Glossiphonia complanata* (L.), *G. heteroclita* (L.), *G. heteroclita* f. *hyalina* (Müll.), *G. heteroclita* f. *papillosa* (Braun), *Helobdella stagnalis*, *Hemiclepsis marginata* (O. F. Müll.), *Piscicola geometra* (L.), *Cystobranchus fasciatus* (Koll.), *Erpobdella octoculata* (L.) and *Batracobdella verrucata* (F. Müll.)). In the benthos 6 taxa were identified, of which 5 were common. Their percentage on macrophytes was from 0.6% on *Batrachium aquatile* to 19% on *Elodea canadensis* and 1% in benthos.

Ephemeroptera. In the plant-dwelling fauna 9 taxa were found (*Siphlonurus aestivalis* Etn., *Baetis rhodani, B. muticus, Centroptilum luteolum* (Müll.), *Cloeon dipterum* L., *Ephemerella ignita* Poda, *Caenis horaria* (L.), *C. luctuosa* Burm. and *C. macrura* Steph.). In benthos there were only *Caenis moesta* Bgtss. and *C.* sp. Ephemeroptera occurred from 0.5% on *Polygonum amphibium* to 25% on *Elodea canadensis*; they were only 1% of all animals in benthos.

Trichoptera. Macrophytes were colonized by 12 taxa (*Orthotrichia* sp., *Agraylea multipunctata* Curt., *Polycentropus flavomaculatus* Pict., *Cyrnus flavidus* Mc. L., *Ecnomus tenellus* Ramb., *Phryganea bipunctata* Retz., *Atripsodes aterrimus* Steph., *Mystacides azurea* L., *M. longicornis* L., *Triaenodes bicolor* Curt., *Oecetis ochracea* Curt. and *O. furva* Ramb). In benthos there were 11 taxa, but only four were common for both environments: *Polycentropus flavomaculatus, Cyrnus flavidus, Mystacides azurea, Oecetis ochracea.* Trichoptera did not contribute much to the entire fauna community, from 1% on *Glyceria maxima* to 5.5% on *Polygonum amphibium*, and about 1.5% in benthos.

Chironomidae. On vegetation 22 taxa were found (*Tanytarsus* sp. (*mancus*) (Walk), *Parachironomus* sp. (*vitiosus*), *P.* sp., *Cryptochironomus defectus* K., *Glyptotendipes* sp. (*gripekoveni*), *Limnochironomus* sp., *Polypedilum* sp. (*convictum*) (Walk), *P.* sp. (*nubeculosum*) (Mg.), *Endochironomus* sp. (*albipennis*), *E.* sp. (*impar*) (Walk), *Sergentia* sp. (*coracina*) (Zett.), *Microtendipes* sp. (*pedullus*) (de Geer), *Psectrocladius* sp. (*psilopterus*) K., *P. obvius, Cricotopus* (*Isocladius*) sp. *sylvestris, Cricotopus* sp. (*algarum*) (K.), *Synorthocladius semivirens* Edv., *Orthocladius* (*Pogonocladius*) sp. (*consobrinus*), *Limnophyes* sp., *Corynoneura* sp. (*celeripes*) Winn., *Tanypus* sp. (*vilipennis*) (Kieff.) and *Ablabesmyia* sp. (*monilis*)).

In the community of benthic fauna 42 taxa were identified, but a considerable number occurred either individually or in small numbers. Two taxa distinctly dominated here: *Chironomus* sp. (*plumosus*) L. and *Procladius* sp., which were not found on macrophytes. Only 13 taxa were common for both environments.

Gastropoda. On plants 13 taxa were found (*Valvata naticina* Mke., *Aplexa hypnorum* L., *Physa fontinalis* L., *Lymnaea stagnalis* L., *L. peregra* (O. F. Müll.), *L. corvus* (Gmel.), *L. turricula* (Held.) *L. truncatula* (O. F. Müll.), *Anisus vortex* L., *Armiger crista* f. *nautileus* L., *A. crista* f. *spinulosus* Cles., *Planorbarius corneus* L. and *Acroloxus lacustris* L.). In the benthos there were 14 taxa, but only 4 were connected with macrophytes and the bottom (*Valvata naticina, Planorbarius corneus, Anisus vortex* and *Lymnaea stagnalis*).

The comparison of plant-dwelling and benthic fauna in the reservoir showed the same dominant groups of invertebrates (Chironomidae and Oligochaeta) but different taxonomic composition. On all plants, except *Elodea canadensis*, dominated: *Cricotopus* (*Isocladius*) sp. (*sylvestris*), *Endochironomus* sp. (*albipennis*), *Parachironomus* sp. (*vitiosus*) and *Orthocladius* (*Pogonocladius*) *consobrinus*, which in benthos occurred either sporadically or not at all. In benthos, however, dominated *Procladius* sp. and *Chironomus* sp. (*plumosus*), not occurring on plants (Fig. 2). Only *Cryptochironomus defectus* occurred rather evenly in benthos and on plants.

Also the fluctuations of numbers of both communities varied. In the community of plant-dwelling fauna there were no distinct differences in numbers of fauna on all plant species in particular months, whereas the numbers of benthic fauna decreased rapidly after the emergence of Chironomidae, which occurs two or three times a year.

The investigations show that plant-dwelling and benthic fauna are different communities. This is also true for taxa occurring both in benthos and on plants. Quantitative differences were considerable, taxa occurring abundantly on macrophytes were found individually in benthos and vice versa.

4. DISCUSSION

The analysis of plant-dwelling fauna on dominant plants of Goczałkowice dam reservoir shows that Chironomidae dominate distinctly over Oligochaeta, with the exception of *Elodea canadensis* (Ephemeroptera, Hirudinea, Gastropoda) (Fig. 1). The dominance of Chironomidae on macrophytes in different reservoirs has been confirmed by other scientists (Gaevskaja 1966, Soszka 1975a, Pieczyński 1977, Zimbalevskaja 1981).

The arrangement of plant-dwelling fauna is more alike on macrophytes having a similar morphology (*Batrachium aquatile* and *Myriophyllum spicatum, Polygonum amphibium* and *Potamogeton lucens*). Fauna on *Glyceria maxima* is more distinct in character, and quite different is the arrangement of communities of invertebrates on *Elodea canadensis* (Figs. 1, 2).

Communities of invertebrates connected with macrophytes have a variety of groups of different ecological and etiological conditions. Greatly specialized and mining species are closely connected not only with plants but with their particular species (Popova 1953, Šilova 1976). Periphytic species may change from plant substrates to other such as submerged trees and experimental substrates (Soszka 1975b).

Dominant taxa of plant-dwelling fauna have been compared with those of benthic fauna in the reservoir examined (Fig. 2). On macrophytes 13 taxa were found, in benthos – 8, whereas only 6 were common. Still the quantitative differences among taxa on macrophytes and in benthos were considerable. Taxa occurring abundantly on macrophytes occurred sporadically in benthos and those more abundant in benthos were found singly on macrophytes. These studies show that there is a basic difference between the plant-dwelling and benthic fauna of Goczałkowice dam reservoir and that they can be considered as two different communities.

5. SUMMARY

This is an attempt to present communities of invertebrate fauna on particular macrophytes (*Batrachium aquatile, Myriophyllum spicatum, Polygonum amphibium, Potamogeton lucens, P. crispus, Glyceria maxima* and *Elodea canadensis*) being of greater significance in overgrowing Goczałkowice reservoir.

Taxa of Chironomidae dominated on the majority of macrophytes examined. Only on *Elodea canadensis* dominated: Ephemeroptera, Hirudinea and Gastropoda (Fig. 1). The highest fauna density was on *Batrachium aquatile* (1692 indiv.·l^{-1}) and *Myriophyllum spicatum* (1584 indiv.·l^{-1}), and the smallest on *Glyceria maxima* (824 indiv.·l^{-1}) and *Elodea canadensis* (483 indiv.·l^{-1}).

The numbers and seasonal changes of groups of plant-dwelling fauna were analysed (Figs. 3–9). This fauna was compared with benthos and Chironomidae were found to dominate distinctly over other groups in both environments. According to these investigations plant-dwelling and benthic faunas are two different communities.

6. POLISH SUMMARY

Praca stanowi próbę ujęcia zespołów fauny bezkręgowej na poszczególnych makrofitach (*Batrachium aquatile, Myriophyllum spicatum, Polygonum amphibium, Potamogeton lucens, P. crispus, Glyceria maxima* i *Elodea canadensis*), mających większe znaczenie w procesie zarastania zbiornika zaporowego w Goczałkowicach.

Na zdecydowanej większości badanych makrofitów dominowały taksony *Chironomidae*. Jedynie na *Elodea canadensis* dominowały *Ephemeroptera, Hirudinea* i *Gastropoda* (rys. 1). Największe zagęszczenie fauny było na *Batrachium aquatile* (1692 osobn.·l^{-1}) i *Myriophyllum spicatum* (1584 osobn.·l^{-1}), a najmniejsze na *Glyceria maxima* (824 osobn.·l^{-1}) i *Elodea canadensis* (483 osobn.·l^{-1}).

W badaniach tych przedstawiono analizę liczebności i zmian sezonowych ugrupowań fauny naroślinnej (rys. 3–9). Porównano tę faunę z bentosem i stwierdzono wyraźną dominację *Chironomidae* nad pozostałymi grupami w obu środowiskach. Jednakże skład gatunkowy, jak i dynamika liczebności są zupełnie odmienne. Badania te wskazują, że fauna naroślinna i fauna denna są to 2 odmienne zespoły.

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