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Makrofauna bezkręgowych w stawach narybkowych w Gołyszu Część 1. Strefa roślinności przybrzeżnej

Macrofauna of invertebrates in the fry ponds at Gołysz Part 1. Littoral vegetation zone

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Abstract — The macrofauna of the littoral vegetation zone was examined in four summer fry ponds flooded for a short period (transfer ponds I and II) as well as in two ponds used also during the winter. Most differentiated with respect to taxonomy were *Chironomidae* and *Coleoptera*. Soon after flooding the individual categories of ponds, larvae of *Culicinae* and *Chironomidae* usually occurred very numerously but for a short time only. In the ponds flooded from August *Ephemeroptera*, *Chaoborinae*, and *Corixidae* were usually very numerous. Sometimes numerous predatory invertebrates (mainly *Coleoptera*) appeared among the littoral plants and in summer also frogs and tadpoles which, together with the fry, caused a decrease in nutritive animals. Nutrition reserves for the carp fry were in this zone of the ponds periodically considerable.

In carp ponds filled with water in various vegetation seasons a numerically rich fauna sometimes develops. Especially in the littoral zone with a bottom formerly overgrown with wild land vegetation favourable ecological conditions are found for the occurrence of various species of invertebrates. In order to increase the general fertility of transfer ponds their bottom is sometimes sown with cultivated plant mixtures (so-called green manuring).

The necessity of examining the vegetative fauna as an important aggregation of pond biocenoses was emphasized, among other authors, by Starmach (1954). A number of data concerning the littoral fauna from various ponds are found in the following publications: Wundsch (1919), Nordquist (1925), Wunder (1936), Movčan (1954) and also Handge (1962), Barthelmes (1964) and others. Such investigations have also been carried out with regard to the importance of the fauna of the brushwood as nutrition for fish. The complexity of these problems (considering the insufficient accuracy of the applied investigation methods) demands further observations of the littoral fauna.

The investigations described in this part of the present paper aimed at evaluating the composition and number of the littoral fauna during the summer season (transfer ponds I and II) as well as during the autumn-winter season (ponds flooded during the winter also). The basic results of investigations from the years 1959/60 and some comparative results from 1962 and 1965 are presented in this paper. The subject formed part of collective hydrobiological, ichthyological and chemical investigations of the Laboratory of Water Biology of the Polish Academy of Sciences carried out under the guidance of Prof. K. Starmach in the newly built fry ponds on the territory of the Experimental Farm of the Polish Academy of Sciences at Gołysz (district Cieszyn).

Territory of investigations and description of the environment

A complex of 12 experimental ponds, of which 6 were the subject of investigation, is supplied with water from the River Vistula by means of a ditch. Investigations were made in 2 ponds from each experimental breeding group, i.e. from the summer transfer ponds I — flooded from May till July (0.4—0.5 ha) and from the transfer ponds II — flooded from June till July or August (1.2—1.4 ha) and from the group of ponds flooded from August till April (1.6 ha). At an average, water level, the depth of the water was from 0.3 m near the inflow to 1.1 m near the outflow. A closer characteristic of the biotope in the transfer ponds I and II and the course of breeding intensification as well as a description of the macrophyte composition for the year 1959 were given by Krzeczkowska-Wołoszyn (1966).

Among the aquatic macrophytes there occurred most numerously: *Glyceria aquatica* L., *Polygonum* sp., *Juncus effusus* L.; with time the amount of mosses increased. In the littoral zone of the ponds, between the inner ditches passing parallel to the dyke and the waterline, land vegetation still remained for a fairly long time after the bottom was flooded; grass, sedges, and other macrophytes grew on the dyke and the neighbouring territories. Decomposing gradually, they became a trophic substrate for the development of bacteria, periphyton, and macrofauna. The presence of tough vegetation (*Glyceria aquatica*, *Juncus effusus*, less frequently *Typha* sp., at the outflows *Phragmites communis* and in shallower places sedges), apart from the soft vegetation, was a factor prolonging, to a certain extent, the development of the phytophilous vegetation since tough vegetation decomposes fairly slowly.

In the littoral zone, about 2 m in width, the bottom was compact and for the most part overgrown with land vegetation. This zone of the ponds differed, to a certain extent, from the central part whose bottom, before each flooding, was broken up with a cultivator and sown with mixtures of cultivated plants. Moreover, these two zones were separated by a deep ditch 1 m wide, usually less intensively overgrown.

In the first years of exploitation the ponds were fertilized with N + P + K and in the following years with organic manure as well. The general fertility of these ponds was at the beginning rather low, this fact being indicated by the small content of nutrient components in the waters of the transfer ponds I and II. A fairly high acidity of the pond bottom and not very favourable oxygen conditions (Krzeczkowska-Wołoszyn 1966) were recorded at that time. Hence, developmental conditions for the fauna of the examined ponds with carp fry did not seem favourable in the first investigation period.

Material and method

Samples of the fauna from the littoral zone were collected with a scraper fixed on a stick; the sharpened edge of the frame of this instrument was 18 cm long and the mesh diameter 0.5 mm. In order to get as full an evaluation as possible of the taxonomic composition of the macrofauna, a series of serpentine drags were made in the littoral brushwood. Quantitatively much smaller samples were collected separately by means of the same method. Usually 1 or 2 samples were taken from the shallow and deeper parts of the pond near the dyke. One sample consisted of the material from 2 drags of the scraper made close to each other on a length of 1 m. After separating the material from the remnants of plants the quantitative material was immediately segregated on a white dish with water, according to taxonomic groups. The obtained numerical data were subsequently referred to appropriate number classes. The applied method of evaluation characterizes only in a roughly comparative way the quantitative population of plants by the fauna and the season variations of its number.

In the summer months (1959/60), soon after filling the ponds with water, investigations were carried out every 3—7 days, a little later every 2 weeks, and in the autumn-winter season about once a month. In the years 1962 and 1965 samples were usually collected less frequently. In the material obtained from the littoral zone Dr. B. Skierska identified great numbers of *Culicinae* larvae of various age groups Dr. S. Mielewczyk verified the identification of the species *Corixidae* and Doc. J. Pawłowski — *Coleoptera.*

Fauna of the vegetation zone

General biological-ecological features of the aggregation

The inundated land vegetation of various species growing along the edges to a great extent decayed relatively early, undergoing subsequently a fairly quick decomposition. This fact created favourable trophic condition

for the phytophilous and associated fauna, especially in the first weeks after filling of the ponds.

Partial population of the examined ponds by invertebrates was observed from the day of flooding the bottom. The basis of new aggregations was the egg-laying of winged insects (*Diptera, Ephemeroptera* and others) and also the imigration of adult flying insects *(Coleoptera, Heteroptera)*. A part of this fauna certainly came there from the nursery ponds of the same complex filled with water earlier and from rearing ponds; besides, individual groups of fry ponds were already partly flooded before the catch and before letting out the water from the previously used reservoirs. Together with the inflowing water from the river a few specimens of some insects, *Hydracarina*, etc., also entered. On the parts of flooded plants protruding above the water level some land forms from the groups *Tardigrada, Araneidae, Lepidoptera* (caterpillars), *Aphidae*, and others still remained for a certain time.

Among the fauna collected by means of a scraper dragging, 3 not very clearly separated groups were distinguished with respect to the degree in which they were bound with the macrophytes. This division is connected with the developmental stages, the way of feeding, reproduction, mobility, persistence in holding to plants, etc. On these properties depended also the degree of catching in the samples faunistic specimens from various taxonomic and ecological groups.

To the first group belong organisms usually not very mobile, connected with plants in a more permanent way, e.g. by nutritive dependence, such as snails, leeches, larvae of some insects (some *Ephemeroptera, Odonata*, some *Heteroptera*, larvae of *Coleoptera*), and especially larvae of the species *Chironomidae* mining and building tubes on the plants. Some of these animals develop from eggs laid directly on plants or young larvae falling from the water (Alekseev 1955). In the scraper net mostly insects from this group were found.

In the second group representatives are found of the fauna loosely connected with the plants, which serve them mainly as a temporary resting or hiding place and sometimes also as a breeding ground for laid eggs and as a feeding place. They change place fairly easily and sometimes very frequently, being as a rule rather shy. To them belong: *Hydracarina, Corixidae*, and adult *Coleoptera*, changing their place either in an active way or carried passively by the water when more disturbed. This fauna was caught above all in large qualitative samples.

The third group consists of invertebrates floating freely among not very dense plant aggregations and belonging partly to the plankton (*Chaoborinae*, large *Crustacea*) or neuston *(Culicinae)*, the former being caught more frequently in large samples, collected by means of many times repeated drags.

Some of the macrofauna collected near the dykes, especially in densely overgrown shallower places, consisted of benthos forms. Benthos aggregations could also contain at the same time some phytophilous species.

The change from a vegetative to a benthos substrate was mainly caused by plants settling on the bottom as they were decomposing.

The formation of aggregations of the littoral fauna was certainly influenced to a great extent by carnivorous forms of invertebrates and vertebrates which periodically concentrated in this zone in great density.

Characteristic of the taxonomic composition

The littoral fauna consisted mainly of holometabolic insects such as *Diptera Coleoptera*, and, only partly, *Trichoptera*. Also some species of hemimetabolic *Hemiptera* and *Ephemeroptera* sometimes numerously populated this environment. Other insects (*Odonata*), as well as the monobiotope fauna of longer developmental cycles (*Oligochaeta*, *Mollusca*, *Hirudinea*) were represented as a rule in small numbers

In the littoral zone densely covered with land vegetation the common *Coleoptera* and *Chironomidae* were most differentiated with respect to species. In the basic material from the years 1959/60 about 120 taxons of the fauna, i.e. roughly as many as were determined by Wundsch (1919) in the ponds examined by him in Sachsenhausen. The composition of the collected invertebrates at Gołysz is shown in Tables I and II. In the years 1962 and 1965 the differentiation of species of this aggregation with a usually similar composition, was slightly smaller than in the initial period of investigation.

In the following survey, groups of macrofauna, dominating quantitatively or important because of feeding competition, predacity, etc. were considered.

Oligochaeta (Naididae, Enchytraeidae) similarly as *Nematodes*, were not numerous either in the summer transfer ponds I or in the winter ponds (about 1 per cent). Since some specimens, especially small ones, escape through the mesh of the net, the data concerning these two groups are not complete.

Mollusca, (especially *Gastropoda*) constituted in the transfer ponds I up to 8 per cent of the littoral fauna and in those flooded all through the winter even up to 30 per cent.

From the *Crustacea*, *Limnadia lenticularis* was very numerous and frequent in the transfer ponds I; in the ponds of group II it occurred less frequently. Near the dyke this species reached 14 per cent of the total population. Hajduk (1964) described it as a rare species in Poland. Usually in June *Triops cancriformis* occurred there also, appearing especially numerously in the years 1962, 1964, 1965 among thin growing vegetation and in parts free from macrophytes. These were mostly specimens differing greatly in size, and thus, specimens of various ages. Close to the bank this species was rarely found. *Triops cancriformis* is considered to be noxious and also as a food rival of fry (Hempel 1962, Barthelmes 1963).

Ephemeroptera were usually already represented from June (transfer ponds I) by *Cloeon dipterum*, a common species especially in ponds flooded over the winter (2—45 per cent of the littoral fauna). It was also mentioned by Barthelmes (1964) as an important component of transfer ponds in August and September. As is known, mayfly larvae are willingly consumed by the carp fry.

Among the *Heteroptera* four species of *Corixidae* from the genus *Sigara* dominated, reaching over 80 per cent of the total number of the littoral fauna (pond No 11). Larger specimens of *Heteroptera* were rarely encountered.

Coleoptera was also represented by more than 20 taxons, mainly in the form of larvae but also adult insects (up to 40 per cent of the macrofauna of this zone). In the transfer ponds I and II: *Berosus spinosus* (mainly adult forms), *Rhantus* sp. (*R. pulverosus*) usually dominated and in the ponds flooded at a later time *Ilybius ater* was found periodically. In the first investigation period other species were not numerous. In 1962 and 1965 *Coleoptera* presented a similar composition.

Carnivorous forms, especially larger species of beetles, can cause certain losses among the young fry and also in the fauna constituting nutrition elements in the ponds.

Among the *Culicinae* larvae of *Anopheles maculipennis*, regarded as most frequent in small overgrown reservoirs (Łukasik 1965), prevailed along with *Culex pipiens* and *Aedes dorsalis*, the former having in Polish climatic conditions usually 3 generations in one season, the latter being polycyclic (Skierska 1965). In 1959 larvae of mosquitoes reached periodically in the transfer ponds I 17—95 per cent and in transfer ponds II 45—57 per cent. In ponds inundated over the winter they formed 33—40 per cent. In the fauna floating among the plants, periodically fairly numerous were larvae and pupae of *Chaoborinae*.

Quantitatively an especially important component of the littoral fauna were larvae of *Chironomidae* (19—77 per cent) and sometimes c. 100 per cent as, e.g., in the pond No. 1 in 1959 found among the flooded plants. Apart from the phytophilous forms, *Chironomus* f.l. *thummi*, belonging rather to the benthos, was sometimes very numerous. Altogether 17 different forms of midges in the larval stage were determined.

Seasonal variation in the occurrence of fauna (estimation)

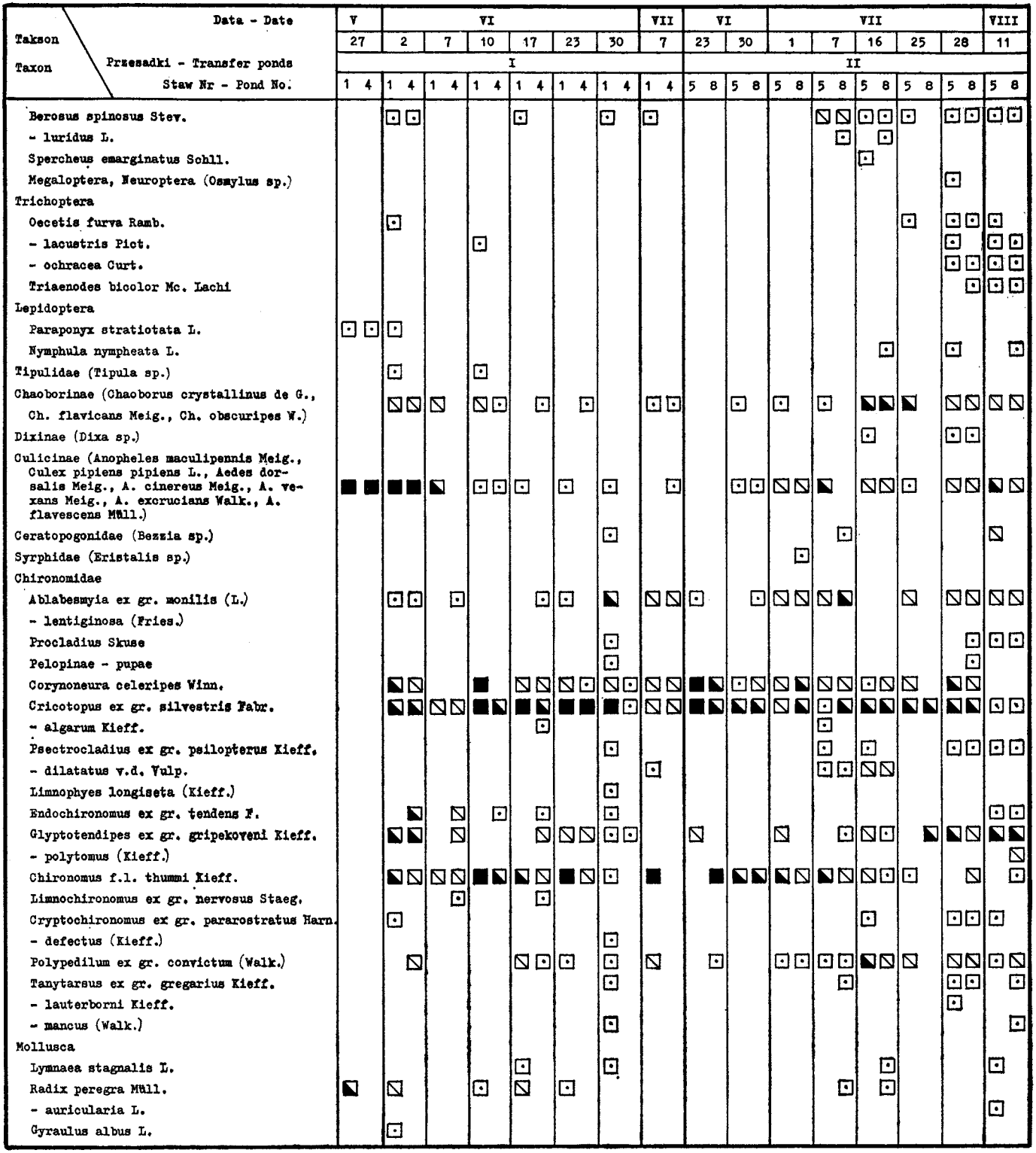
Already during flooding of the ponds young larvae of *Culicinae* began to appear. At the same time or a little later *Chironomidae* appeared, which after a period of two weeks occurred in great masses or very numerously though usually only for a short time (fig. 1). Such an intensive development of the *Diptera* larvae indicates favourable trophic conditions created after the flooding of plants. Fertilization might have also contributed to the improvement of

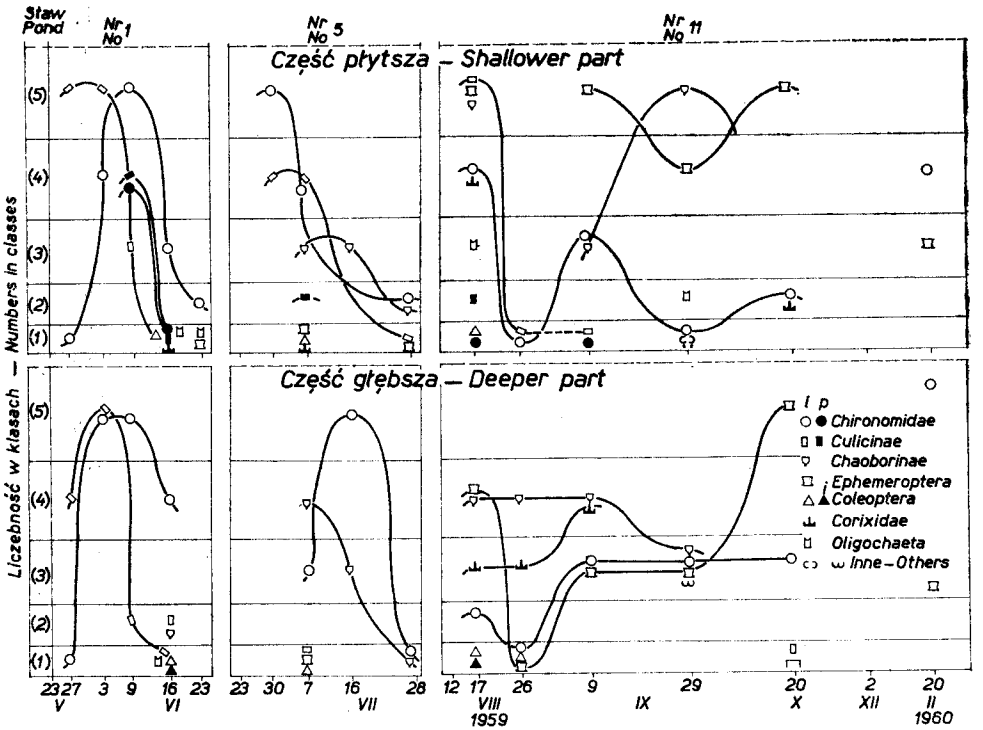
Tabela I. Skład i występowanie makrofauny przybrzeżnej w letnich stawach przesadkowych w roku 1959

Table I. Composition and occurrence of macrofauna of the littoral zones of summer transfer-ponds in 1959

⊡ - pojedynczy single ▨ - pospolity common ◪ - liczny numerous ■ - bardzo liczny very numerous

Takson / Taxon — Data - Date	V	VI							VII	VI		VII					VIII
	27	2	7	10	17	23	30	7	23	30	1	7	16	25	28	11
Przesadki - Transfer ponds	I										II					
Staw Nr - Pond No.	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	5 8	5 8	5 8	5 8	5 8	5 8	5 8	5 8
Oligochaeta (Stylaria lacustris l.)	⊡ ⊡	⊡		⊡ ⊡	▨ ⊡	⊡ ⊡			⊡			◪	⊡			
Araneae																
Argyroneta aquatica L.		⊡			⊡	⊡		⊡	⊡			⊡	⊡			
Hydracarina (Piona sp., Eylais sp., Limnesia sp.)		⊡				⊡	⊡ ⊡			■		⊡ ⊡	⊡ ⊡	⊡	⊡ ⊡	⊡ ⊡
Crustacea																
Limnadia lenticularis (L.)					⊡		⊡									
Triops cancriformis L.					⊡			⊡								
Ephemeroptera																
Cloëon dipterum L.		◪ ▨			⊡	⊡ ▨	◪ ▨	⊡	⊡	⊡ ⊡	⊡	▨ ▨	▨ ⊡	◪	◪ ◪	■ ◪
Caenis horaria L.															⊡ ⊡	⊡
- robusta Etn.						⊡										⊡
Odonata																
Lestes sponsa (Hansem.)				⊡	⊡ ⊡	⊡	⊡ ⊡	⊡								
Sympetrum sp. (S. meridionale Selys.)								⊡			⊡	⊡	⊡			
Enallagma cyathigerum (Charp.)		⊡			⊡											⊡
Coenagrion sp. (C. pulchellum Lind.)															⊡	⊡
Heteroptera, Corixidae																
(Sigara striata L., S. distincta Fieb., S. falleni Fieb., S. praeusta Fieb.)		▨ ▨				⊡ ⊡	▨	⊡ ▨	▨	▨ ▨	▨ ⊡	⊡ ⊡	⊡ ▨	◪	◪ ◪	◪ ◪
Gerris lacustris L.																⊡
Naucoris cimicoides L.																⊡
Nepa rubra L.												⊡				
Ranatra linearis L.					⊡			⊡				⊡				
Notonecta glauca L.															⊡	
Plea Leachi Mc. Gr. et K.													⊡			
Microvelia reticulata Burm.	⊡			⊡	⊡				⊡	⊡		⊡ ⊡				
Coleoptera																
Gyrinus natator L.													⊡		⊡	⊡
Haliplus ruficollis Deg.		⊡ ⊡										⊡				
- fulvus F.					⊡								⊡			
Hyphydrus ovatus L.				⊡												
Guignotus pusillus F.													⊡			
Hydroporus sp.		⊡		⊡				⊡				⊡ ⊡	⊡ ⊡			
Ilybius ater Deg.		⊡			⊡					⊡		⊡	⊡ ⊡			⊡
Ilybius sp.								⊡		⊡ ⊡						
Rhantus pulverosus Steph.					⊡			⊡	⊡	◪	⊡	⊡ ⊡	⊡			
Rhantus sp. (R. bistriatus Brgstr.)		⊡ ⊡		⊡	⊡		▨ ▨	▨ ⊡	⊡ ⊡	⊡	⊡	⊡ ⊡	⊡ ⊡		⊡ ⊡	⊡ ⊡
Graphoderus cinereus L.		⊡			⊡	⊡	⊡ ⊡	⊡				⊡ ⊡	⊡		⊡	
Acilius sulcatus L.													⊡			
Dytiscus marginalis L.					⊡		⊡ ⊡	⊡		⊡ ⊡		⊡ ⊡	⊡			
Helophorus sp.	⊡ ⊡							⊡	⊡	⊡		⊡ ⊡				
Hydrobius fuscipes L.								⊡		⊡	⊡	⊡	⊡			
Laccobius minutus L.	⊡	⊡ ⊡						⊡						⊡	⊡ ⊡	⊡
Helochares lividus Forst		⊡					⊡	⊡ ⊡				⊡ ⊡				
Enochrus testaceus F.		⊡							⊡ ⊡	⊡		⊡ ⊡	⊡ ⊡		⊡ ⊡	
Hydrophilus caraboides L.		⊡								⊡			⊡		⊡	


Data - Date
Takson
Taxon
Przesadki - Transfer ponds
Staw Nr - Pond No.
V 27
VI 2 7 10 17 23 30
VII 7
VI 23 30
VII 1 7 16 25 28
VIII 11
I
II
1 4 1 4 1 4 1 4 1 4 1 4 1 4 5 8 5 8 5 8 5 8 5 8 5 8 5 8 5 8
Berosus spinosus Stev.
- luridus L.
Spercheus emarginatus Schll.
Megaloptera, Neuroptera (Osmylus sp.)
Trichoptera
Oecetis furva Ramb.
- lacustris Pict.
- ochracea Curt.
Triaenodes bicolor Mc. Lachi
Lepidoptera
Paraponyx stratiotata L.
Nymphula nympheata L.
Tipulidae (Tipula sp.)
Chaoborinae (Chaoborus crystallinus de G.,
Ch. flavicans Meig., Ch. obscuripes W.)
Dixinae (Dixa sp.)
Culicinae (Anopheles maculipennis Meig.,
Culex pipiens pipiens L., Aedes dorsalis Meig., A. cinereus Meig., A. vexans Meig., A. excrucians Walk., A. flavescens Müll.)
Ceratopogonidae (Bezzia sp.)
Syrphidae (Eristalis sp.)
Chironomidae
Ablabesmyia ex gr. monilis (L.)
- lentiginosa (Fries.)
Procladius Skuse
Pelopinae - pupae
Corynoneura celeripes Winn.
Cricotopus ex gr. silvestris Fabr.
- algarum Kieff.
Psectrocladius ex gr. psilopterus Kieff.
- dilatatus v.d. Vulp.
Limnophyes longiseta (Kieff.)
Endochironomus ex gr. tendens F.
Glyptotendipes ex gr. gripekoveni Kieff.
- polytomus (Kieff.)
Chironomus f.l. thummi Kieff.
Limnochironomus ex gr. nervosus Staeg.
Cryptochironomus ex gr. pararostratus Harn.
- defectus (Kieff.)
Polypedilum ex gr. convictum (Walk.)
Tanytarsus ex gr. gregarius Kieff.
- lauterborni Kieff.
- mancus (Walk.)
Mollusca
Lymnaea stagnalis L.
Radix peregra Müll.
- auricularia L.
Gyraulus albus L.



Ryc. 1. Zmienność ilościowa makrofauny przybrzeżnej na przykładzie trzech różnych kategorii stawów według klas liczebności: (1) — 1—6, (2) — 7—16, (3) — 17—30, (4) — 31—50, (5) — 51—150 okazów na 1 próbę. 1 — larwy, p — poczwarki, i — imagines

Fig. 1. Quantitative variability of the littoral macrofauna on the example of 3 different pond categories according to number classes: (1) — 1—6, (2) — 7—16, (3) — 17—30, (4) — 31—50, (5) — 51—150 for one sample. 1 — larvae, p — pupae, i — imagines

the trophic situation, which influenced the increase in primary production subsequently made use of by *Diptera* larvae.

Relatively early and large losses in *Culicinae*, after the first generation had flown out, took place at a higher water level in comparison with the initial one. Thus, a greater depth of the water in the ponds was usually unfavourable for the development of new generations of mosquitoes. In such conditions a few specimens were found just at the bank line. In the transfer ponds I and II used in summer and flooded only for about six weeks, mosquitoes rarely disappeared entirely. It was only towards the end of the autumn (in ponds flooded till spring) that they ceased to appear.

The strong decrease in the amount of *Chironomidae*, after the first generation of insects had flown out, continued till the end of the time the ponds were under water, this being caused by withering and an early decay and decomposition of the soft parts of the leaves and stems. After these had dropped to the bottom the conditions for the development of the benthos species

improved. The decomposition process could be accelerated, especially in shallow and well warmed places. These processes were most probably associated with local losses of oxygen harmful for some species of the fauna.

At the banks of the ponds used only during summer the number of representatives of other faunistic groups, especially insects, increased gradually towards the end of the inundation period. In one case only (pond No 8—1959) were a great number of *Culicinae* larvae and also very numerous *Corixidae* found.

During the course of the seasonal quantitative changes of the fauna of the littoral zone of the transfer ponds I, differences indicating a certain dissimilarity or a different type of population of this zone by larvae of the two dominant groups were found. These differences concerned, e.g., the distribution and magnitude of occurrence of larvae maxima and their duration. The *Diptera* pupae also occurred in various periods and various amounts. In this group of ponds no great quantitative differences between the inflow and outflow parts) deeper, often overgrown with tough vegetation) were observed. Only in the pond No 4, the number of larvae at the outflow was considerably reduced.

Apart from the *Diptera* larvae and pupae, *Oligochaeta* and *Coleoptera*, usually in small numbers occurred already in the transfer ponds I, and later on also *Ephemeroptera* and *Heteroptera* (pond No 1). About 2 weeks after inundation, apart from *Diptera* larvae in various age groups, their more or less numerous pupae also occurred. At about that time mass swarming of mosquitoes sometimes took place.

In the transfer ponds II larvae of midges (in the pond No 8 small specimens being in the majority) occurred periodically in great numbers. In the inflow part of pond No 5 these larvae as well as *Culicinae* reached their highest numbers as early as about one week after inundation. The maximum number of *Chironomidae* in the outflow zone of the same pond was delayed in relation to shallower stations by about 2 weeks. In the other pond of this group, i.e. in No 8, the maximum numbers of these larvae were found at one intermediate date (7. 7. 1959). At that time *Culicinae* of the first generation had already completed their development, this being proved by their very numerous pupae found at the outlet. A new generation of mosquito larvae still developed there fairly numerously (4th class of number) till the middle (outflow) or end of July (inflow). It follows from the figure 1 that in the transfer ponds II, apart from the dominating groups, fairly numerous *Chaoborinae* occurred at the bank. Towards the end of July a distinct decrease in the number of these larvae was observed. From other faunistic groups only in the pond No 8 were numerous *Corixidae* found, especially in the last period at the inflow. At the outflow they were much less numerous. On the other hand, many larvae of *Ceratopogonidae* were found. According to the evaluation from the quantitative samples, there were few mayflies and *Coleoptera.*

It is striking that in the summer ponds flooded for a short time there was no a successive mass occurrence of insects before the catch of the fry.

Table II. Composition and occurrence of macrofauna of the littoral zones in longer flooded ponds in 1959/60

⊡ - pojedynczy single ⊠ - pospolity common ◪ - liczny numerous ■ - bardzo liczny very numerous

Takson / Taxon — Data - Date	VIII						IX				X		XII		I		III		IV			
	11		17		26		8		29		20		2		4		19		5		27	
Staw Nr - Pond No.	9	11	9	11	9	11	9	11	9	11	9	11	9	11	9	11	9	11	9	11	9	11
Nematodes																					⊡	
Oligochaeta (Stylaria lacustris, Naididae)							⊡		⊡								⊡	⊡				
Araneae (Argyroneta aquatica L.)			⊡				⊡		⊡													
Hydracarina (Piona sp., Limnochares sp.)							⊡		⊡		⊡	⊡										
Crustacea (Limnadia lenticularis)																						
Ephemeroptera																						
Cloëon dipterum			⊡		⊠		◪	◪	◪	◪	◪	■	◪	■	■	■	◪	⊠	■	■	■	■
Caenis horaria																					⊡	
Odonata (Coenagrion pulchellum Linden)									⊡										⊡		⊡	⊡
Heteroptera, Corixidae (Sigara praeusta, S. falleni, S. striata, S. distincta)	⊠	■	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	◪	■	◪	⊡	⊠	■	⊡	⊡		◪	◪
Gerris sp.																			⊡			
Ranatra linearis																					⊡	⊡
Notonecta glauca													⊡	⊡		⊡						
Coleoptera																						
Gyrinus natator							⊡		⊡		⊡						⊡		⊡			
Haliplus fulvus					⊡	⊡																
Guignotus pusillus			⊡				⊡						⊡									
Hydroporus sp.			⊡																			
Ilybius ater Deg.	⊠	⊡	⊡		⊡		⊡		⊡	⊡	⊡	⊡										
Ilybius sp.			⊡	⊡	⊡	⊡	⊡		⊡		⊡										⊡	
Rhantus pulverosus			⊡	⊡				⊡	⊡		⊡		⊡		⊡				⊡			
Rhantus sp. (R. bistriatus)	⊠		⊡	⊡		⊡																
Graphoderus cinereus																					⊡	
Colymbetes fuscus L.													⊡									
Hydaticus stagnalis F.					⊡																	
Dytiscus marginalis				⊡																	⊡	⊡
Helophorus sp. (H. aquaticus L.)													⊡									
Hydrobius fuscipes											⊡											
Laccobius sp. (L. minutus)			⊡																			
Enochrus testaceus	⊡		⊡		⊡																	
Helochares sp.			⊡																			
Berosus spinosus	⊡	⊡	⊡		⊡	⊡	⊡	⊡	⊡	⊡	⊡		⊡									
- luridus			⊡																			
Trichoptera																						
Cyrnus flavidus Mc L.																					⊡	
Oecetis furva																					⊡	⊡
Phryganea grandis L.									⊡		⊡		⊡	⊡								⊡
Lepidoptera (Nymphula nympheata)																			⊡			
Chaoborinae (Chaoborus crystallinus, Ch. obscuripes, Ch. flavicans)	⊡		⊠	⊡	◪	◪	◪	◪	⊠	⊡	◪	⊠	⊠		⊠	⊠	⊠		⊡	⊡	⊡	⊡
Culicinae (Anopheles maculipennis, Culex pipiens pipiens, Aedes dorsalis,)	■	⊠	◪	◪	⊠	⊠	⊠	⊠	⊠	⊡		⊡					⊡		⊡	⊡	⊡	⊡
Ceratopogonidae (Bezzia sp.)					⊡																	
Chironomidae																						
Ablabesmyia monillis			⊡	⊠	⊡	⊡	⊡	⊡		⊡									⊡		⊡	⊡
Procladius Skuse																	⊡				⊡	⊠
Corynoneura celeripes	⊡	⊡	⊠	◪	⊠	⊠	⊠	⊠	◪	◪	⊡	⊠	⊡	⊡					⊠	⊠		⊡
Cricotopus ex gr. silvestris	◪	⊠	◪	◪	■	■	◪	◪	⊠	⊠	⊡	⊠	⊠	⊡	⊠	⊠	⊡	■	■	■	◪	⊡
Psectrocladius ex gr. psilopterus									⊡		⊡	⊡	⊡					⊡				
- dilatatus														⊡								
Endochironomus ex gr. tendens					⊡				⊡	⊡	⊡	⊡										
Glyptotendipes ex gr. gripekoveni					◪	◪	⊠		⊠	⊠	⊠	⊠	◪	⊡			⊡		⊠	⊠	◪	⊠
- polytomus									⊡		⊡	⊡							⊡			
Chironomus f. l. thummi		⊡	⊠	⊡		⊡	⊡	⊡		⊡		⊡							⊡		⊡	⊡
- plumosus																						⊡
Microtendipes ex gr. chloris (Meig.)											⊡	⊡	⊡				⊡					
Polypedilum ex gr. convictum	⊡		⊡		◪	⊠	⊠	⊠		⊡		⊡			⊡		⊡		⊠		⊠	
Tanytarsus ex gr. gregarius					⊡																	
Mollusca																						
Lymnaea stagnalis																	⊡					
Radix peregra	⊡		⊡		⊡				⊡	⊡	⊡	⊡	⊡	⊡			⊡	⊡	⊡	⊡	⊡	
- auricularia							⊡		⊡		⊡		⊡								⊡	
Anisus vortex					⊡	⊡			⊡	⊠		⊡	⊡				⊡	⊡			⊡	
Gyraulus albus									⊡													

Conversely, in ponds flooded as late as August successive generations sometimes developed very numerously; some of this fauna flew out still before winter came and the remainder (mainly *Chironomidae*, *Ephemeroptera*, *Coleoptera* and *Corixidae*) was able to complete their development only in spring.

The course of the seasonal quantitative variability in more important groups of the littoral fauna during the autumn — winter period was even in little differentiated biotopes slightly different (ponds No 9 and No 11 -fig. 1, the deeper and the shallower part) but in general tendencies usually similar. This concerned above all the initial period of flooding in August. In these ponds, too, the first generation of the at that time numerous larvae of *Chironomidae*, *Culicinae*, and *Chaoborus* sp. completed their development after only 2—3 weeks of intensive occurrence. Apart from distinct losses in larvae this was also shown by the presence of pupae. At the same time, numerous imagines of *Diptera* were observed on the littoral helophyte aggregations and on the dykes. Already in this first period larvae of mayflies, especially in the inflow zone, occurred in both these ponds very numerously or even in masses (pond No 9). Apart from the larvae of *Chaoborus* (less frequently *Chironomidae*) these insects dominated still later during the winter, being as a rule present in great numbers. Among other insects, in the second part of August and less frequently at the beginning of September (pond No 11), *Corixidae* and sometimes also *Oligochaea* and *Coleoptera* (pond No 9) were relatively numerous. Except for the initial period *Chironomidae* were not as a rule numerous. A greater number of these larvae, mainly in the developmental stage III and IV, were found in February under the ice. Among them a fairly great share of young individuals was then observed. Thus, in the littoral zone of the ponds flooded for a long period a relatively numerous fauna occurred till the spring, this still being found in April during the catch of fry when the water was let out.

In 1962 and 1965 the macrofauna of the littoral zone was characterized by a similar group and, partly, species composition as in 1959. This concerned mainly the summer months when the majority of observations was made. Since in the two following years examinations were not so frequent as initially, their quantitative results were not fully comparable.

Summary

Investigations on the macrofauna in the overgrown parts of stagnant waters refer mostly to the population of determined species of aquatic plants by individual species or groups of invertebrates (Wunder 1936, Gurzęda 1959, Karassowska, Mikulski 1960, Rosine 1955, Hantge 1962, Matlak 1963, Kuflikowski 1970, Kořinkova 1971). The fauna loosely connected with the plants (especially more mobile and shy species), floating freely among these plants, are usually not caught by means of quantitative methods. And

yet this part of the fauna — collected by means of quantitative methods in a small percentage only or even entirely missed has, without doubt, a great influence on the quantitative relations in the whole aggregation, for they may have a considerable influence on the decrease in quantity of the nutritive littoral fauna. This was observed in aquarium conditions with a fairly great density of specimens collected from the same ponds at Gołysz.

The method applied in this work, i.e. fast dragging by means of a scraper, permits the collection of great amounts of materials and, at the same time, the determination of the qualitative composition of the littoral macrofauna. Moreover, this method permits a rough evaluation of quantitative relations, the participation of especially numerous faunistic groups, etc. Thus, at the same time the trophic conditions for the carp fry which often feed near the dyke in shallow places and overgrown parts were characterized.

In small, fairly shallow, transfer ponds flooded only in summer for a few weeks, developmental conditions for the fauna have some specific features. The chemical processes as well as the development of the organisms in them are accelerated as a result of the easy warming up of the bottom and the water. In this respect a slightly different type of environment was represented by slightly larger and deeper ponds flooded at a later time for about 8 months and periodically frozen.

In spite of some differences in conditions and period of populating the littoral zone by the macrofauna in the two groups of ponds, their qualitative composition was similar. This referred both to the first and later years when investigations were performed in the fry ponds at Gołysz. Thus, these data could indicate a certain regularity in the continuation of populating the three groups of ponds flooded successively. A more or less similar composition of groups and, partly, species of the fauna populating the vegetation zone of the ponds is given by Wundsch (1919), Willer (1924), Nordquist (1925), Movčan (1954), Barthelmes (1964), and for the littoral of lakes by Pieczyńska (1971).

Among the periodically dominating groups of the littoral macrofauna the *Chironomidae* were most differentiated with respect to species. Since the main peak of development of these larvae (and also of *Culicinae*) took place soon after flooding the ponds, this period should be regarded as a trophically specially favourable one. Numerous or sometimes even mass occurrences were, however, short-lasting. This was most probably caused by a relatively fast bacterial decomposition of the flooded land vegetation, leading to its gradual decay. Concomitantly with this decay a part of the fauna moved to the bottom, though this was not quantitatively checked because of methodical difficulties (compact bottom by the dykes, unlike its cultivated part within the ditches). The initially numerously developing populations of larvae could also cause a decrease of nutritive reserves for the next generations. Together with the course of decay of the macrophytes, the oxygen conditions for the invertebrates certainly deteriorated.

In the transfer ponds I and II the quantitative decrease in *Diptera* larvae lasted till the end of the season. A similar course of quantitative changes of the fauna was initially also represented by the later inundated ponds Nos 9 and 11. Apart from the periodically numerous larvae of *Chironomidae* and *Culicinae*, numerous larvae of the mayfly *Cloeon dipterum* were usually found in them beginning from August and in the pond No 11 also Chaoborus sp. and *Corixidae*. In the autumn-winter time the mayfly larvae and those of *Chaoborus* sp. dominated greatly in number over the *Chironomidae* and mosquito larvae. In the littoral zone insects not closely connected with plants gained dominance, whereas typical phytophilous forms did not find proper conditions for themselves (losses in land macrophytes in autumn).

In some cases population of the littoral vegetation zone by the fauna differed greatly even within the same pond. In the examined ponds it depended to a great extent on the local microenvironmental factor, different depths, dominance of soft or tough vegetation, abundance of nutrition etc. The nutritive competition, and predacity of invertebrates (mainly *Coleoptera*) and vertebrates (carp fry — Skaziński 1966, numerous frogs and tadpoles — Okoniewski, Okoniewska 1973, water fowl) could also be an important factor in the quantitative development of the littoral macrofauna.

With a periodically numerous occurrence, some groups of the littoral macrofauna (with the benthos and phytophilous fauna in the central part of the bottom under the cultivated plant mixture, and zooplankton) could constitute an important part of nutrition for reared fish. Especially in summer, the young fry concentrated and fed among the brushwood at the dykes. In the first period, i.e. soon after each of the three groups of the examined ponds were flooded, the larvae of *Chironomidae*, and at the same time or in later months the larvae of *Chaoborus* sp. floating in the water were without doubt of the greatest nutritive importance. Apart from the *Diptera* larvae, mayfly larvae *Cloeon dipterum* occurred fairly numerously, especially in the autumn and winter months. Hence the nutritive reserves for young carp were guaranteed till the spring of the following year.

STRESZCZENIE

Badania makrofauny przybrzeżnej przeprowadzono na terenie Zakładu Doświadczalnego PAN w Gołyszu — pow. Cieszyn w 6 nowych, karpiowych stawach narybkowych (2 letnie przesadki I i 2 przesadki II, 2 stawy zalane również przez zimę). Podstawowa część opracowania obejmuje lata 1959/60, a pewne dane uzupełniające pochodzą z lat 1962 i 1965. W pierwszym okresie, latem, zbierano próby co około 3—7 lub co 14 dni, a zimą zwykle 1 raz w miesiącu. Materiały z dwóch dalszych lat były zbierane nieco rzadziej. Zarówno duże próby jakościowe, jak i znacznie mniejsze ilościowe zbierano drapaczem przez szybkie koszenie wśród zalanych makrofitów; przy brzegach przeważała roślinność dziko rosnąca, a główną — centralną część stawów zajmowały mieszanki zasianych roślin uprawnych (tzw. zielone nawożenie).

W składzie fauny przybrzeżnej (razem ponad 120 taksonów) najbardziej zróżnicowane gatunkowo były *Coleoptera* i *Chironomidae* (tabele I i II). Wśród larw ochotkowatych przeważały formy

fitofilne (*Cricotopus* ex gr. *silvestris*, *Corynoneura* ex gr. *celeripes*, *Glyptotendipes* ex gr. *gripekoveni*, rzadziej *Endochironomus* ex gr. *tendens*). Okresowo obok nich pospolite były larwy uważane zwykle za bentosowe (*Chironomus* f.l. *thummi*, *Polypedilum* ex gr. *nubeculosum* i inne). W tym środowisku nie były one więc wyraźnie rozgraniczone. Chrząszcze wodne były reprezentowane głównie przez larwy i dorosłe okazy *Berosus spinosus*, a także larwy *Rhantus pulverosus*, okresowo *Ilybius ater* i szereg innych. Wśród *Culicinae* przeważały: *Anopheles maculipennis*, *Culex pipiens pipiens* i *Aedes dorsalis*. Pozostałe grupy fauny, a wśród nich także *Ephemeroptera* (głównie *Cloeon dipterum*) liczyły stosunkowo mało gatunków.

Latem występował liczny nieraz skorupiak *Triops cancriformis* (przesadki I), a obok niego i także później *Limnadia lenticularis*. Skład grupowy i gatunkowy fauny przybrzeżnej był podobny w różnych stawach i latach badań.

Wkrótce po zalaniu poszczególnych grup stawów przy brzegach pojawiały się nieraz licznie lub masowo larwy *Culicinae* i *Chironomidae* (ryc. 1). Okres ich intensywnego rozwoju trwał zwykle krótko, a wraz z wylotem pierwszej generacji ilości larw silnie spadały. W stawach zalanych tylko przez kilka tygodni letnich inne grupy fauny przybrzeżnej na ogół nie liczyły wiele okazów. Dopiero w stawach zalanych nieco później, oprócz licznych początkowo larw *Chironomidae* i *Culicinae*, już od sierpnia w dość dużych ilościach występowały *Ephemeroptera*, a w okresie jesienno-zimowym również *Chaoborus* sp. i *Corixidae*.

Pewne różnice w zasiedleniu partii przybrzeżnych przez makrofaunę zależały niewątpliwie od większej lub mniejszej głębokości, udziału tzw. miękkiej i twardej roślinności oraz związanych z tym warunków pokarmowych. Ponadto bezkręgowce luźniej związane z podłożem roślinnym ulegały łatwo przemieszczeniu przez silne falowanie. Do ubytków różnych komponentów fauny przy dość dużym jej zagęszczeniu blisko brzegów przyczyniały się niewątpliwie znacznie drapieżne bezkręgowce (głównie *Coleoptera*), a także kręgowce (hodowany narybek, ponadto żaby i kijanki). Różnorodna fauna przybrzeżna liczna okresowo w badanych stawach narybkowych mogła mieć jednak duże znaczenie jako pokarm dla hodowanego narybku karpia. Fauna ta, obok fauny wegetacyjnej i dennej w centralnej strefie stawów z mieszankami roślin uprawnych, stanowiła ilościowo bardzo ważną część biocenoz. Te dwa zgrupowania zwierząt pokarmowych opisano w II części opracowania.

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