| ACTA HYDROBIOL. | 7 | 4 | 317—328 | KRAKÓW 1965 |
|---|---|---|---|---|

ELŻBIETA KWIATKOWSKA-GRABACKA

# Mikrofauna dna stawów rybnych w Gołyszu — Microfauna of the bottom of fish ponds in Gołysz

Mémoire présenté le 11 janvier 1965 dans la séance de la Commission Biologique de l'Académie Polonaise des Sciences, Cracovie

The present work is connected with joint investigations on the influence of fertilization upon communities of organisms in carp ponds. These investigations were organised in the Laboratory of Water Biology of the Polish Academy of Sciences by Professor Karol Starmach. The aim of this work was the study of *Ciliata* microfauna on the bottom of fertilized ponds.

I wish to express my sincere thanks to Professor K. Starmach for entrusting this problem to me and for his valuable indications during its realisation.

## Characteristics of the investigated terrain and description of the method employed

The material was collected from April till September 1962 inclusive, from four rearing ponds at the Gołysz Fishery Farm (Cieszyn district). The layers of slime and primary soils of this farm are silt-clay formations and the majority of its ponds have fairly thick layers of slime. The differences in the mechanical composition of slime in particular ponds are exceedingly small. The mineral composition of the bottom is as follows: the soil material contains an average amount of slime substances, the slime strata have an abundant or average amount of organic substances, a small amount of carbonates, an average amount of $P_2O_5$ and $K_2O$ and acid reaction (Pasternak, 1959).

The external appearance of the ponds is as follows (Table I): Wyszni II — a pond slightly overgrown. The vegetation above the surface of the water covered the banks of the pond and a small shallow place in its south-western part.

Wyszni III — the pond is divided by three old partly damaged dykes on which shrubs grow. The last sector of the pond forms a large and shallow place, densely overgrown.

Wyszni V — the pond is divided by an old dyke into two parts, of which the larger one in exploitation is deep and slightly overgrown, while the smaller part, on the southern side, is very shallow and densely overgrown.

Table I

Detailed data concerning investigated ponds

| Name of pond | Area | | Mean depth of pond in cm | Depth of stands | | Fertilizers used in kg per the whole pond | | | Fish stock |
|---|---|---|---|---|---|---|---|---|---|
| | impounded | flooded | | A | B | | P | N | |
| Wyszni II | 8.3 | 8.3 | 110 | 115-160 | 40-60 | acid phosphate ammonia ammoniates | 234 | 775 | $K_1$ 2000/ha foeded 120 kg N/ha |
| Wyszni III | 6.9 | 6.7 | 110 | 120-160 | 40-65 | acid phosphate ammonia | 265 | 630 | $K_1$ 2000/ha feeded 120 kg N/ha 40 $P_2O_5$/ha |
| Wyszni V | 5.7 | 5.5 | 120 | 150-170 | 25-50 | acid phosphate ammonium sulphate | 250 | 672 | $K_1$ 2000/ha 120 kg N/ha 40 kg $P_2O_5$/ha |
| Wyszni VI | 6.2 | 6.0 | 70 | 90-120 | 20-50 | unfertilized | - | - | $K_1$ 2000/ha unfeeded |

Wyszni VI — in the southern part of the pond there is a large area densely overgrown in its upper part mostly with carex and in the lower one with manna which is sparsely disseminated in the remaining part of the pond.

Two permanent stands were determined in each pond for collecting samples: point A, situated in the the deep (usually over 1 m) part of the pond, not overgrown and deprived of vegetation at a distance of several metres from the outlet box and point B in the shallow (usually under 50 cm) and overgrown part.

The Starmach's slime sucker was used for collecting material. Samples were collected every two weeks. Qualitative and quantitative analysis (evaluation) was carried out on live material. For estimation the Grospietsch (1958) 6 degree scale was used.

Samples of slime from both stands differed decisively in appearance. Samples from the deep stands contained fine slime of a greyish-brown colour. The slime from shallow stands was brownish-black with a considerable amount of vegetal remains and its upper thin layer acquired during the summer period a greenish-yellow colouring owing to a profuse development of algae. The lower stratum, however, was characterised by a distinctly putrescent odour.

## Characteristics of the Ciliata fauna from particular ponds

During the initial period the character of the microbenthos was very similar in all the ponds. The generally poor samples collected in the first weeks after the flooding of the ponds were characterised by a numerical prevalence of microflora in relation to the microfauna. At that time the *Ciliata* were not numerous. Their numbers increased rapidly from the month of May onwards. Individual species reached their greatest quantities in different months.

Wyszni II — *Navicula* sp. appeared in the middle of May in masses at stand A, while there were still very few *Ciliata*. At stand B, however, *Vorticella* sp. appeared in great numbers. The distinctiveness of stand B then became evident, for here the amount and number of *Ciliata* species increased much more rapidly than at stand A. In the beginning of June *Cyclidium citrullus* (assembling near agglomerations of bacteria), *Paramecium caudatum* and *Spirostomum minus* appeared in great numbers at stand B. From July onwards a mass development of algae was observed, in which green algae and flagellates prevailed, their presence causing a distinctly green colouring of the upper stratum of slime in the sample and giving a yellowish-green colour to the water. The samples had a distinctly putrid odour and the colour of the slime was brownish--black. In July *Coleps hirtus* and *Coleps amphacanthus* appeared in masses and *Cyclidium citrullus*, *Halteria grandinella*, and *Lacrymaria elegans* were numerous. The first specimens of saprophelic *Ciliata*, characteristic for rotting slime, were already present. Their number increased towards the end of July. As for algae, species of the genus *Scenedesmus* achieved a mass development. In the first half of August fish began to die in masses in this pond. The water became turbid and acquired a distinctly green colouring. At both stands a considerable number of algae appeared, mostly green algae and flagellates, among which *Trachelomonas* sp. dominated. Agglomerations of thread-like blue--green algae were fairly numerous. The number of saprophelic *Ciliata* of the genus *Metopus* distinctly increased, among which *Metopus spiralis* was the most frequent. They also appeared at stand A. The *Ciliata* which feed on algae were abundantly filled with food. *Amoeba* sp. appeared in numbers and their endoplasm was also abundantly filled with food. Large numbers of shells of crustaceans, mostly of the *Bosmina* and *Cyclops* genera, were observed especially at stand A. In connection with the dying of fish, the pond was limed, besides other processes, and the water rapidly recovered its transparency. A distinct decrease in the number of *Ciliata* took place at the end of August. Saprophelic *Ciliata* disappeared almost completely, while algae with a distinct prevalence of green algae of the *Scenedesmus* genus at stand A and flagellates of the *Phacus* genus at stand B continued to appear in considerable numbers. At the beginning of September the number of *Ciliata* did not alter to any great degree. Several saprophelic species appeared again. Only *Coleps hirtus* and *Cyclidium libellus* were numerous. The number of *Ciliata* decreased distinctly at the end of September.

Pond Wyszni III — in the middle of May the ciliate *Nassula* sp. appeared abundantly at stand A and in mass numbers at stand B. Towards the end of June a mass appearance of *Cinetochilum margaritaceum* and of *Stylonychia mytilus* took place at stand B. No losses in fish rearing were noted in this pond. At the end of July and in August several saprophelic species were noted at stand B, but this was not especially important for the association of *Ciliata* fauna as the specimens appeared only sporadically. In the summer months the thin upper stratum of slime at stand B also acquired a greenish colouring from the algae developing in masses with a predominance of green algae. *Cyclidium citrullus* and *Vorticella* sp. appeared in considerable numbers at stand A in the middle of August. *Vorticella* sp. was present at that time in great masses at stand B. At both stands the number of species was at its maximum *Coleps hirtus* occurring the most numerously. In September the number of *Ciliata* distinctly decreased.

Wyszni V — towards the middle of May the number of *Ciliata* was three times greater at stand B than at stand A. Saprophelic *Ciliata* already then appeared sporadically at stand B, while *Coleps hirtus* and *Coleps incurvus* were very numerous. At stand A green algae. with a mass development of *Closterium* and diatoms prevailed decidedly. The period from July to August, inclusive, was distinguished by the most abundant numerical development of *Ciliata* with a distinct dominance of the number of species at stand B. Particular species attained successively the peak of their development. At the beginning of July *Coleps incurvus* and *Cyclidium libellus* were numerous at stand B. Towards the end of July, *Coleps hirtus* and *Cyclidium citrullus* were very numerous, and *Chilodonella uncinata* and *Cinetochilum margaritaceum* fairly numerous. In August this last species appeared in masses beside very numerous *Aspidisca costata, Coleps incurvus, Cyclidium libellus,* and *Loxodes striatus.* In September the amount of *Ciliata* diminished considerably. Only a mass appearance of *Vorticella* sp., a great number of *Coleps hirtus* and numerous *Coleps amphacanthus* and *Cyclidium libellus* were observed at stand B.

Wyszni VI — *Aspidisca sulcata* and *Halteria grandinella* were numerous at the end of April at stand A. Saprophelic species appeared already at the beginning of June and continued to be present during the whole season though always in exceedingly small quantities. Towards the end of June *Flagellata* were very numerous at stand B, as for *Ciliata,* there was a mass appearance of *Loxodes striatus* and *Spirostomum minus.* The most abundant development of *Ciliata* at stand *B* was noted in August. At stand A, however, the number of *Ciliata* was very small. At stand B there was a mass appearance of *Cyclidium citrullus,* while *Coleps amphacanthus, Coleps hirtus,* and *Loxodes striatus* were numerous. The greatest amount of algae was observed at stand B, where many *Ciliata* feeding on them were also present. In September the quantity of *Ciliata* diminished. Very numerous *Aspidisca costata* and *Cinetochilum margaritaceum* and numerous *Stylonychia mytilus* were also present at that time at stand B.

## Discussion of results

In the sediment accumulating on the bottom of the pond metabolic processes constantly take place. Detritus of vegetal origin (remnants of dying plants and animals), mineral particles and very fine grains of sand are the components of slime. The organic matter contained in the sand is the main source of food for organisms living there.

When analysing the *Ciliata* fauna of the investigated ponds, a distinct difference between its qualitative and quantitative composition at the two stands was noted in the first place, to the advantage of the shallow stand. This difference was evident in all the ponds at the beginning of the season, becoming more and more apparent in the process of time. The phenomenon was chiefly conditioned by the fact that the amount of organic substance on the bottom of the pond is different in different parts and alters during the season of vegetation. The highest content of organic substance was observed in the shallowest parts of the pond and inversely. This is caused in the shallowest part of the pond by the presence of an abundant rooted vegetation which, on dying, considerably enriches the bottom with this component (W r ó b e l, 1960).

In decomposition processes the principal role falls to the bacteria. A greater content of organic matter in the slime of shallow and overgrown parts of a pond makes possible the abundant formation of bacterial flora on which the majority of *Ciliata* feed. Besides, a better insolation of the bottom in these places favoured a profuse development of algae in the upper stratum of slime which, on the one hand, enriched the bottom with organic matter and, on the other, made possible the development of the *Ciliata* feeding on algae. These last were always more numerous at shallow stands than at deep ones.

The quantity of *Ciliata* showed changes during the season. In the first weeks after the pond had been flooded the number of these organisms was not very great. In general, the number of species and their quantity gradually increased until the month of July. But the rate was not the same at the two stands, the increase being more rapid at shallow ones. In the majority of ponds *Ciliata* appeared most abundantly from the end of July until August, inclusive. A slow decrease in quantity began in September. Individual species, however, attained their independent maximum development in different months. This is undoubtedly connected with the course of the processes of accumulation and decomposition of organic matter. After the flooding of ponds organic substances already existing on the bottom are subject to decomposition. A new enrichment of the bottom with organic matter as a result of the preponderance of accumulative processes over the processes of decomposition begins only in July (W r ó b e l 1960). B o m b ó w n a (1957) also observed maximum amounts of sediment towards the end of summer and at the beginnning of autumn.

The total number of *Ciliata* in a given pond can be divided into three groups: species found exclusively at stand B form a decided majority, species found at stand A constitute a very small part, and the remainder is formed of species found at both stands. The relation is similar in nearly all the ponds (fig. 1). However, this distribution of species on

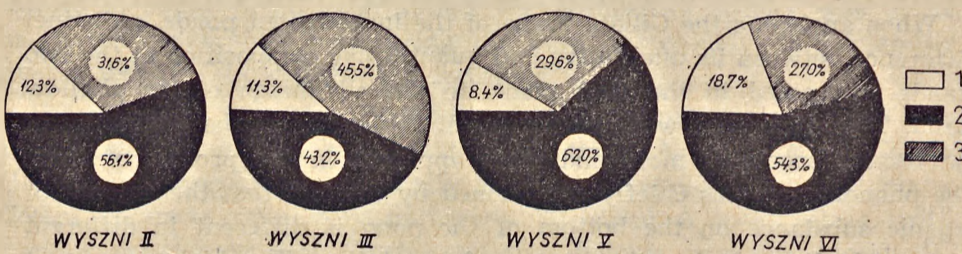


Fig. 1. Distribution number of *Ciliata* species at individual stands. 1 — species found exclusively at stand A in ponds, 2 — species found exclusively at stand B in ponds, 3 — species found in both stands in ponds

the bottom of the pond does not signify that territorial ranges of appearance of particular species exist, only that there are on the bottom of ponds two somewhat different associations of conditions for the development of *Ciliata*. It must be stressed that the quantity of species appearing at one type of stand in all ponds is very small.

Among the *Ciliata* from the investigated ponds species feeding on bacteria distinctly prevailed. The bacterial flora of the bottom, in the opinion of R o d i n a (1958), quoted after W r ó b e l (1960), is 10 to 100 times more abundant than the bacterial flora of water, while the fertilizing of ponds in itself has a favourable influence on the quantity of microorganisms and on the increase of their activity. The influence of fertilization on the protozoan fauna is therefore probably intermediary through the intensifying of the rate of bacterial processes in the slime of the bottom, thus accelerating the circulation of matter in the pond and contributing to a higher output of the pond.

The *Ciliata* of the control pond demonstrated a slightly lower quantitative development with a more regular course than in fertilized ponds. Stand B, when compared with analogical stands in fertilized ponds, showed a very slight difference. The greatest number of *Ciliata* appeared there in the month of August. The saprophelic group was not numerous and represented only by specimens appearing sporadically. It must be remembered, however, that this pond receives water from a fertilized pond (Wyszni VII) and has, moreover, transparent water which makes possible an additional enrichment of the bottom in organic matter by means of the photosynthesis of lower plants, especially at a stand that is shallow and occupies a farly large surface area.

Saprophelic *Ciliata*, differentiated by L a u t e r b o r n (1915) and W e t z e l (1928), are species characteristic for rotting slime producing sulphurated hydrogen. Species belonging to this group were present in all ponds, mostly at stand B, most frequently during the summer period. They always formed a minority in the total number of *Ciliata* species at this stand. In these places the slime, lying under a thin green layer of algae, was of a brownish-black colour and had a distinctly putrescent odour. The number of saprophelic species increased in the ponds when fish were dying. At that time the *Ciliata* were observed in the pond Wyszni II also at stand. A, which might indicate a considerable pollution of the bottom and an extension of the anaerobic milieu. Saprophelic *Ciliata* were always found in the deeper parts of the slime. However, these *Ciliata* characteristic for decaying slime are a positive indication of an alteration in the oxygen conditions and of the appearance of putrescent processes on the bottom of the pond — these processes were accompanied by the dying fish in the pond Wyszni II. The *Ciliata* can therefore be an important indication of changes in the circulation of matter at the bottom of the ponds, especially where processes of reduction begin to prevail over those of oxydation.

## Notes on some species

A list of determined species and their appearance in particular ponds is presented in the tables (Tables II—V). During the investigation of material, measurements of the length of *Ciliata* specimens were carried out. Measurements of length which differ from the dimensions presented in K a h l's key (1935) are listed below.

For *Aspidisca costata* E h r b g. — 20 μ, *Dileptus monilatus* S t o k e s — the range of dimensions amounted from 400 to 720 μ, for *Epalxis striata* K a h l — 40 μ, *Lembadion lucens* M a s k e l l — 60 μ, *Loxophyllum helus* S t o k e s — this species demonstrated a great variability of size within the range 80—200 μ, *Metopus laminarius* K a h l fo. *minor* K a h l — 80 μ, *Metopus spiralis* S m i t h also showed a great variability from 60 to 140 μ, in *Pleuronema crassum* D u j a r d i n — 55 μ, *Spirostomum filum* (E h r b g.) P e n a r d — a great variability of size within the range of 340—800 μ, in *Spirostomum minus* Roux there is also a great variability of size within the range of 600—1020 μ.

Table II

The development of Ciliata in a deep (A) stand and a shallow one (B) in the WYSZNI II pond

| | No. | Species | Date of collecting samples | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 27 IV | | 9 V | | 18 V | | 4 VI | | 3 VII | | 31 VII | | 14 VIII | | 28 VIII | | 11 IX | | 26 IX | |
| | | | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| | | | stands | | | | | | | | | | | | | | | | | | | |
| A | 1. | Aspidisca sulcata Kahl | | | | | | | 0 | | | | | | | | 0 | | | | | |
| A | 2. | Aspidisca sp. | | | 0 | | | | | | | | | | | | | | | | | |
| A | 3. | Coleps hirtus var. minor Kahl | | | | | | | | | | | | | 0 | | 0 | | | | | |
| A | 4. | Mesodinium acarus Stein | | | 0 | | | | | | | | | | | | | | | | | |
| A | 5. | Spathidium sp. | | | | | | | | | | | | | 1 | | | | | | | |
| A | 6. | Stentor roeseli Ehrbg. | | | | | | | | | | | | | 0 | | | | | | | |
| A | 7. | Uroleptus sp. | | | | | | | 0 | | | | | | | | | | | | | |
| A + B | 8. | Aspidisca costata Dujardin | 0 | | 1 | | | 0 | | | | 0 | | | | | 2 | 0 | | 1 | | |
| A + B | 9. | Aspidisca lynceus Ehrbg. | | | 0 | | | 0 | | | | | | | | | | 0 | | | | |
| A + B | 10. | Cinetochilum margaritaceum Perty | | | | | | | | | | 0 | | | | | 0 | 0 | | | | |
| A + B | 11. | Coleps hirtus Nitzsch | | | | | | 1 | | 1 | | 4 | | 3 | 3 | | 1 | 3 | | 2 | 0 | |
| A + B | 12. | Halteria grandinella O.F.Müller | | | | | | 0 | | | | 2 | | | 1 | | | 1 | | | | 0 |
| A + B | 13. | Lacrymaria elegans Engelmann | | | | | | | | | | | | 2 | 0 | | | | | | | |
| A + B | 14. | Lionotus sp. | | | 0 | | | | | | | 0 | | | | | 0 | 0 | | | 0 | |
| A + B | 15. | Oxytricha sp. | | | 0 | | | 0 | 0 | 0 | | 0 | | | | | | 0 | | | | 2 |
| A + B | 16. | Paramecium caudatum Ehrbg. | | | | | | | | 2 | | | | | 0 | | | | | | | 1 |
| A + B | 17. | Prorodon sp. | | | | | 0 | | | 0 | | | | 2 | | 2 | 2 | | | 1 | | 1 |
| A + B | 18. | Stentor coeruleus Ehrbg. | 0 | | | | | | | | | | | | 0 | | | 1 | | 0 | | |
| A + B | 19. | Uroticha sp. | | | | | | | | | | 1 | | | | | 0 | | | | | |
| A + B | 20. | Vorticella sp. | | | 0 | | | 3 | | | | 0 | | | | | 0 | 2 | | 1 | 0 | 0 |
| A + B | * 21. | Epalxis sp. | | | | | | | | | | 0 | | 0 | 1 | 2 | | 0 | | 0 | | |
| A + B | * 22. | Metopus es O.F.Müller | | | | | | | | 0 | | | | 1 | 0 | | | 0 | | 0 | | |
| A + B | * 23. | Metopus undulans Stokes | | | | | | | | | | | | | 1 | 0 | | | | | | |
| A + B | * 24. | Metopus sp. | | | | | | | | | | | | | 0 | 0 | | | | 0 | | |
| A + B | * 25. | Plagiopyla ovata Kahl | | | | | | | | | | | | | 0 | 1 | | | | 0 | | |
| B | * 26. | Caenomorpha lauterborni Kahl | | | | | | | | | | | | | | 0 | | | | | | |
| B | * 27. | Caenomorpha medusula Perty | | | | | | | | | | | | | | 1 | | | | | | |
| B | * 28. | Epalxis exquia Penard | | | | | | | | | | | | 0 | | | | | | | | |
| B | * 29. | Epalxis striata Kahl | | | | | | | | | | | | | | | | | | 0 | | |
| B | * 30. | Ludio parvulus Penard | | | | | | | | | | | | | | 1 | | | | 1 | | |
| B | * 31. | Metopus bacillatus Lavander | | | | | | | | 0 | | | | | | | | | | | | |
| B | * 32. | Metopus caducus Kahl | | | | | | | | | | | | | | 0 | | | | | | |
| B | * 33. | Metopus extensus Kahl | | | | | | | | | | 0 | | | | | | | | | | |
| B | * 34. | Metopus es var. rectus Kahl | | | | | | | | | | 0 | | | | | | | | | | |
| B | * 35. | Metopus fuscus Kahl | | | | | | | | | | | | | | 0 | | | | | | |
| B | * 36. | Metopus laminarius f.minor Kahl | | | | | | | | | | | | 2 | | 0 | | | | | | |
| B | * 37. | Metopus minimus Kahl | | | | | | | | | | | | 0 | | | | | | | | |
| B | * 38. | Metopus nassutus Da Cunha | | | | | | | | | | | | 0 | | | | | | | | |
| B | * 39. | Metopus pulcher Kahl | | | | | | | | | | | | | | 0 | | | | | | |
| B | * 40. | Metopus spinosus Kahl | | | | | | | | | | | | | | | | | | 0 | | |
| B | * 41. | Metopus spiralis Smith | | | | | | | | | | | | | | 2 | | | | 0 | | |
| B | * 42. | Metopus striatus McMurrich | | | | | | | | | | | | | | 0 | | | | | | |
| B | 43. | Aspidisca herbicola Kahl | | | | | | | | 1 | | | | | | 0 | | | | | | |
| B | 44. | Chilodonella uncinata Ehrbg. | | | | | | | | 0 | | | | | | | | | | | | |
| B | 45. | Coleps amphacanthus Ehrbg. | | | | | | | | | | 3 | | 0 | | | | 2 | | 1 | | |
| B | 46. | Coleps hirtus var.lacustris Fauré-Fr. | | | | | | | | | | 0 | | | | | | | | | | |
| B | 47. | Cyclidium citrullus Cohn | | | | | | 0 | | 2 | | 2 | | 0 | | 0 | | | | | | |
| B | 48. | Cyclidium libellus Kahl | | | | | | | | | | 0 | | | | 0 | | | | 2 | | |
| B | 49. | Cyclidium sp. | | | | | | | | 0 | | | | | | | | | | | | |
| B | 50. | Lacrymaria pupula O.F.Müller | | | | | | | | 0 | | | | 2 | | 1 | | 0 | | | | |
| B | 51. | Lembadion magnum Stokes | | | | | | | | 0 | | | | | | | | | | | | |
| B | 52. | Loxophyllum sp. | | | | | | | | | | | | | | | | | | 0 | | |
| B | 53. | Phascolodon vorticella Stein | | | | | | | | 0 | | | | | | | | | | | | |
| B | 54. | Spirostomum minus Roux | | | | | | | | 2 | | 0 | | | | 0 | | 2 | | 0 | | |
| B | 55. | Stentor sp. | | | | | | | | 0 | | | | | | 0 | | | | | | |
| B | 56. | Strobilidium gyrans Stokes | | | | | | 0 | | | | 1 | | | | | | | | | | |
| B | 57. | Vorticella similis Stokes | | | | | | 0 | | | | | | | | | | | | | | |

The six-grade scale given by Grospietsch 1958

0 – very rare   1 indiv. under the cover glass
1 – rare   1-2 indiv. under the cover glass
2 – sporadic   2-10 indiv. under the cover glass
3 – mean   10-20 indiv. under the cover glass
4 – frequent   20-30 indiv. under the cover glass
5 – mass   above 30 indiv. under the cover glass

In horizontal lines the distribution of species is given as in fig. 1.
Saprophelic Ciliata are marked with an asterisk.

Table III

The development of Ciliata in a deep (A) stand and a shallow one (B) in the WYSZNI III pond

| | No. | Species | Date of collecting samples | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 27 IV | | 9 V | | 18 V | | 4 VI | | 22 VI | | 3 VII | | 31 VII | | 14 VIII | | 28 VIII | | 11 IX | | 26 IX | |
| | | | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| | | | stands | | | | | | | | | | | | | | | | | | | | | |
| A | 1. | Aspidisca turrita Ehrbg. | | | | | | | | | | | | | | | | | | | | | 0 | |
| A | 2. | Dileptus anser O.F.Müller | | | 0 | | | | | | | | | | | | | | | | | | | |
| A | 3. | Dileptus monilatus Stokes | | | | | | | | | | | | | | | 0 | | | | | | | |
| A | • 4. | Metopus es var. pinguis Kahl | | | | | | | | | | | | | 0 | | | | | | | | | |
| A | • 5. | Metopus nasutus Da Cunha | | | | | | | | | | | | | 0 | | | | | | | | | |
| A + B | 6. | Aspidisca costata Dujardin | 1 | | 0 | | | 0 | 1 | | | | | 1 | | | | | 0 | 1 | | | 1 | |
| A + B | 7. | Aspidisca lynceus Ehrbg. | | | 1 | | | 0 | | | | 0 | | | 1 | | | | | 1 | | | | |
| A + B | 8. | Chilodonella uncinata Ehrbg. | | | 1 | | | 2 | | 0 | | | | | | | | | | | | | | |
| A + B | 9. | Chilodonalla sp. | | | | | | | | | | | | | | | | | | | 0 | 1 | | |
| A + B | 10. | Cinetochilum margaritaceum Perty | | | | | | | | | | 5 | | | | | | | | 1 | | 1 | 1 | |
| A + B | 11. | Coleps amphacanthus Ehrbg. | | | | | | | | | | | | | | | | 0 | 2 | | | | | |
| A + B | 12. | Coleps hirtus Nitzsch | | | | | | | | 1 | | | | | 1 | | | | 2 | 3 | | | | |
| A + B | 13. | Cyclidium citrullus Cohn | | | | | | | | | | | | 1 | 0 | | 2 | | | 0 | | | | |
| A + B | 14. | Euplotes sp. | 1 | | | | | | | | | | 0 | | | | | | | | | 0 | | |
| A + B | 15. | Halteria grandinella O.F.Müller | | | | | | | | | | | | | 0 | | | | 0 | 0 | | | | 0 |
| A + B | 16. | Lembadion lucens Maskell | | | 0 | | | | | | | | | | | | | | | 0 | | | | |
| A + B | 17. | Lionotus sp. | | | 0 | | | | 0 | | | 0 | | 0 | | | | | 0 | | 0 | | | |
| A + B | 18. | Loxophyllum hellus Stokes | | | | | | | | | | | 0 | | | | | | 0 | 0 | | | | |
| A + B | 19. | Mesodinium acarus Stein | | | | | | 1 | 1 | | | | | 1 | | | | | | | | | | |
| A + B | 20. | Nassula sp. | | | | | 3 | 4 | | | | | | | | | | | | | | | | |
| A + B | 21. | Oxytricha sp. | 0 | | 0 | | 0 | | | | | 2 | | | | | | | | 1 | | 0 | | |
| A + B | 22. | Paramecium caudatum Ehrbg. | | | | | | | | | | | 0 | | | | | | 0 | 0 | | 3 | | 1 |
| A + B | 23. | Prorodon sp. | | | | | | 1 | | | | | | | | | | | 1 | 1 | 0 | 0 | | |
| A + B | 24. | Spirostomum minus Roux | | | | | | | | | | | | 0 | | | 0 | 0 | | 0 | | 1 | | 1 |
| A + B | 25. | Vorticella sp. | | | | | | | | | | 0 | | 1 | | | 2 | 4 | 1 | 1 | | | | |
| B | • 26. | Caenomorpha medusula Perty | | | | | | | | | | | | | | | | 1 | | | | | | |
| B | • 27. | Epalxis sp. | | | | | | | | | | | | | | | | | | | | 0 | | |
| B | • 28. | Ludio parvulus Penard | | | | | | | | | | | | | | | | 0 | | 0 | | | | |
| B | • 29. | Metopus contractus Penard | | | | | | | | | | | | | | | | | | 0 | | | | |
| B | • 30. | Saprodinium dentatum Lauterborn | | | | | | | | | | | | | | | | | | 0 | | | | |
| B | 31. | Aspidisca herbicola Kahl | | | | | | 0 | | | | | | | | | | | | | | | | |
| B | 32. | Cyclidium sp. | | | | | | | | 0 | | | | 0 | | | | | | | | | | |
| B | 33. | Cyclotrichium sp. | | | | | | | | | | 0 | | | | | | | | | | | | |
| B | 34. | Didinium sp. | | | | | | 0 | | | | | | | | | | | | | | | | |
| B | 35. | Euplotes patella Müller-Ehrbg. | | | | | | | | | | | | 0 | | | | | | 0 | | | | |
| B | 36. | Lionotus fasciola Ehrbg.-Wrzesniowski | | | | | | | | | | | | | | | | | | 0 | | | | |
| B | 37. | Loxodes striatus | | | | | | | | | | | | | | | | | | | | | | 0 |
| B | 38. | Paruroleptus musculus var.simplex Kahl | | | | | | | | | | 0 | | | | | | | | | | | | |
| B | 39. | Spirostomum filum (Ehrbg.) Penard | | | | | | | | | | | | | | | | | | 0 | | | | 1 |
| B | 40. | Stentor coeruleus Ehrbg. | | | | | | | | | | | | 1 | | | | | | 2 | | 0 | | |
| B | 41. | Stentor roeseli Ehrbg. | | | | | | | | | | | | | | | | | | | | 0 | | |
| B | 42. | Stylonychia mytilus Ehrbg. | | | | | | | | | | 4 | | | | | | | | | | | | |
| B | 43. | Stylonychia sp. | | | | | | | | | | | | | | | | | | | | | | 0 |
| B | 44. | Urostyla sp. | | | | | | | | | | | 0 | | | | | | | | | | | 0 |

Table IV

The development of Ciliata in a deep (A) stand and a shallow one (B) in the WYSZNI V pond

| | No. | Species | Date of collecting samples | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 27 IV | | 9 V | | 18 V | | 22 VI | | 3 VII | | 31 VII | | 14 VIII | | 28 VIII | | 11 IX | | 26 IX | |
| | | | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| | | | stands | | | | | | | | | | | | | | | | | | | |
| | 1. | Aspidisca herbicola Kahl | | | | | | | 0 | | | | | | | | 0 | | | | | |
| | 2. | Aspidisca lynceus Ehrbg. | 0 | | 1 | | | | | | | | | | | | | | | | | |
| A | 3. | Chilodonella cucullulus O.F.Müller | | | 0 | | | | | | | | | | | | 0 | | | | | |
| | 4. | Chilodonella sp. | | | | | | | | | | | | | 0 | | 0 | | | | | |
| | 5. | Uroleptus dispar Stokes | | | | | | | | | | | | | | | 0 | | | | | |
| | 6. | Uroleptus rattulus Stein | | | | | | | | | 0 | | | | | | | | | | | |
| | 7. | Aspidisca costata Dujardin | 0 | | 0 | | 1 | | 2 | | 0 | 1 | | | 0 | | 2 | | 2 | | 0 | 1 |
| | 8. | Aspidisca sulcata Kahl | | | 0 | | 1 | 0 | | | | 0 | | | | | | | | | | |
| | 9. | Chilodonella uncinata Ehrbg. | | | 0 | | 1 | | 1 | | | | | 2 | | | 1 | | | | | |
| | 10. | Cinetochilum margaritaceum Perty | | | | | | | | | | | | 2 | 2 | 4 | | | | | | |
| | 11. | Coleps amphacanthus Ehrbg. | | | | | | 0 | 0 | 0 | | 0 | | 0 | | 3 | 0 | 1 | | 2 | 0 | |
| | 12. | Coleps hirtus Nitzsch | | | | | 0 | 3 | 0 | | | | | 3 | 1 | | 1 | 1 | | 3 | 2 | |
| | 13. | Coleps incurvus Ehrbg. | | | | | | 3 | | 0 | | 2 | | 0 | | | | 2 | | | 1 | |
| | 14. | Cyclidium citrullus Cohn | | | | | | | | | | | | 3 | 0 | | | 0 | | 2 | | |
| A | 15. | Halteria grandinella O.F.Müller | | | | | 0 | 1 | | 0 | 0 | | | 0 | | | | | | | | |
| + | 16. | Lacrymaria pupula O.F.Müller | 0 | | | | | 0 | | 0 | | 0 | | | | 0 | | 0 | | | | |
| | 17. | Lacrymaria sp. | | | 0 | | | | | | | | | | | | | | | 0 | | |
| B | 18. | Lionotus fasciola Ehrbg.-Wrześniowski | | | | | | 0 | | | | | | | | | 0 | | | | | |
| | 19. | Lionotus sp. | | | | | | | | | | | | 0 | | 0 | 0 | 0 | | | | |
| | 20. | Mesodinium sp. | | | | | | | | | | | 0 | | | | | | | 0 | | |
| | 21. | Prorodon sp. | 1 | | | | | 0 | 0 | | | | | | | 0 | | | | | | |
| | 22. | Spirostomum minus Roux | | | | | | 0 | | | | | | | | 1 | | 1 | | 0 | 0 | 0 |
| | 23. | Stentor coeruleus Ehrbg. | | | | | 0 | 1 | 2 | | | | | | | | 1 | | | | | |
| | 24. | Stentor sp. | | | | | 0 | | | | | | | | | 0 | 0 | | | | | |
| | 25. | Uroleptus sp. | | | | | | | | | 0 | | | | 1 | | 0 | 0 | | | 0 | 0 |
| | 26. | Urotricha sp. | | | | | | 0 | | | | | | | 0 | | | | | | | |
| | 27. | Vorticella sp. | | | | | | 0 | | 0 | | 1 | 0 | 1 | | | | | | 4 | | |
| | • 28. | Caenomorpha lauterborni Kahl | | | | | | | | 0 | | | | | | | | | | 0 | | 0 |
| | • 29. | Caenomorpha medusula Perty | | | | | | | | | | 0 | | 0 | | | | 0 | | | | |
| | • 30. | Caenomorpha medusula var. trinucleata Kahl | | | | | | | | | | 0 | | | | | | | | | | |
| | • 31. | Epalxis sp. | | | | | | | | | | | | 1 | | 0 | | | | 1 | | |
| | • 32. | Ludio parvulus Penard | | | | | | | | | | | | 0 | | | | | | 0 | | |
| | • 33. | Metopus es O.F.Müller | | | | | | 0 | | 0 | | | | 0 | | | | | | 0 | | |
| | • 34. | Metopus es var. rectus Kahl | | | | | | | | | | 0 | | | | | | | | | | |
| | • 35. | Metopus intercredens Kahl | | | | | | | | | | | | | | 0 | | | | | | |
| | • 36. | Metopus minimus Kahl | | | | | | | | | | 0 | | | | | | | | | | |
| | • 37. | Metopus nasutus Da Cunha | | | | | | | | | | | | | | 0 | | | | | | |
| | • 38. | Metopus pullus Kahl | | | | | | | | 0 | | | | | | | | | | | | |
| | • 39. | Metopus spinosus Kahl | | | | | | | | | | | | 0 | | 0 | | | | | | |
| | • 40. | Metopus spiralis Smith | | | | | | | | | | 1 | | | | 0 | | | | 0 | | |
| | • 41. | Metopus undulans Stokes | | | | | | | | 0 | | | | | | | | | | | | |
| | • 42. | Metopus sp. | | | | | | 0 | | 0 | | | | | | 0 | | 0 | | | | |
| | • 43. | Plagiopyla nasuta Stein | | | | | | | | | | | | 0 | | 0 | | | | | | |
| | • 44. | Plagiopyla ovata Kahl | | | | | | | | | | | | 0 | | | | 0 | | | | |
| | • 45. | Plagiopyla sp. | | | | | | 1 | | | | | | | | | | | | | | |
| | 46. | Aspidisca sp. | | | | | | | | 0 | | | | | | | | | | | | |
| | 47. | Balonema biceps Penard | | | | | | | | 0 | | | | | | | | | | | | |
| | 48. | Campanella umbellaria Linné | | | | | | | | 0 | | | | | | | | | | | | |
| | 49. | Coleps hirtus var. lacustris Fauré-Fr. | | | | | | | | | | | | | | | | | | 1 | | |
| B | 50. | Coleps hirtus var. minor Kahl | | | | | | | | | | | | 0 | | 0 | | | | | | |
| | 51. | Cyclidium libellus Kahl | | | | | | | | | | 2 | | 0 | | | | 2 | | | | |
| | 52. | Cyclidium sp. | | | | | | | | | | | | 0 | | | | | | | | |
| | 53. | Dileptus cygnus Clap. et L. | | | | | | 0 | | | | | | | | | | | | | | |
| | 54. | Euplotes patella f. typicus Kahl | | | | | | 0 | | | | | | | | | | | | | | |
| | 55. | Frontonia leucas Ehrbg. | | | | | | 0 | | | | | | | | | | 0 | | | | |
| | 56. | Glaucoma sp. | | | | | | | | | | | | | | 0 | | | | | | |
| | 57. | Holophrya simplex Schewiakoff | | | | | | 0 | | | | | | | | | | | | | | |
| | 58. | Holophrya sp. | | | | | | | | | | 0 | | | | | | | | 0 | | |
| | 59. | Lacrymaria elegans Engelmann | | | | | | | | 1 | | | | | | | | | | | | |
| | 60. | Lembadion lucens Maskell | | | | | | 0 | | | | | | | | | | | | | | |
| | 61. | Loxodes striatus Engelmann | | | | | | | | | | 0 | | 1 | | 2 | | 0 | | | | |
| | 62. | Oxytricha sp. | | | | | | 0 | | | | 0 | | | | | | | | 0 | | |
| | 63. | Paramecium caudatum Ehrbg. | | | | | | | | | | | | | | | | | | | | 0 |
| | 64. | Phascolodon vorticella Stein | | | | | | 0 | | | | | | | | | | | | | | |
| | 65. | Saprophilus muscorum Kahl | | | | | | | | | | | | 0 | | | | | | | | |
| | 66. | Spathidium sp. | | | | | | | | | | 0 | | | | | | 0 | | | | |
| | 67. | Spirostomum intermedium Kahl | | | | | | | | | | | | | | | | 0 | | | | |
| | 68. | Stentor roeseli Ehrbg. | | | | | | 1 | | | | | | | | | | | | | | |
| | 69. | Stylonychia muscorum Kahl | | | | | | | | | | | | 1 | | | | | | | | |
| | 70. | Trachelophyllum pusillum Perty Clap. et L. | | | | | | | | | | | | 0 | | | | | | | | |
| | 71. | Urocentrum turbo O.F.Müller | | | | | | | | | | | | 1 | | | | | | | | |

Table V

The development of Ciliata in a deep (A) stand and a shallow one (B) in the WYSZNI VI pond

| | No. | Species | Date of collecting samples | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 27 IV | | 9 V | | 18 V | | 4 VI | | 22 VI | | 3 VII | | 31 VII | | 14 VIII | | 28 VIII | | 11 IX | | 26 IX | |
| | | | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B | A | B |
| | | | stands | | | | | | | | | | | | | | | | | | | | | |
| | 1. | Aspidisca herbicola Kahl | | | 0 | | | | | | | | | | | | | | | | | | | |
| | 2. | Aspidisca lynceus Ehrbg. | | | 1 | | | | 0 | | | | | | | | | | | | | | | |
| | 3. | Aspidisca sulcata Kahl | 3 | | | | 0 | | | | | | | | | | | | | | | | | |
| | 4. | Coleps hirtus var. minor Kahl | | | 0 | | | | | | | | | | | | | | | | | | | |
| | 5. | Dileptus monilatus Stokes | | | | | | | | | | | | | | | 1 | | | | | | | |
| A | 6. | Lembadion lucens Maskell | | | 0 | | | | | | | | | | | | | | | | | | | |
| | 7. | Pleuronema crassum Dujardin | | | 0 | | | | | | | | | | | | | | | | | | | |
| | 8. | Saprophilus sp. | | | | | | | | | | | | | 2 | | | | | | | | | |
| | 9. | Strobilidium gyrans Stokes | 4 | | | | | | | | | | | | | | | | | | | | | |
| | 10. | Urotricha agilis Stokes | | | 0 | | | | | | | | 0 | | | | 0 | | | | | | | |
| | 11. | Vorticella similis Stokes | | | 0 | | | | | | | | | | | | | | | | | | | |
| | 12. | Aspidisca costata Dujardin | 1 | | 0 | | | | | | 0 | | 0 | | 1 | | 0 | | | 0 | | 3 | | |
| | 13. | Aspidisca sp. | | | | | | 0 | 0 | | 0 | | | | | | | | | | | | | |
| | 14. | Cinetochilum margaritaceum Perty | | | | | | | | | | | 0 | | | | | | | | | 0 | | 3 |
| | 15. | Cyclidium sp. | 0 | | | | | | | | | 1 | | | | | | | | | | | | |
| | 16. | Halteria grandinella O.F.Müller | | | | | | 2 | | 0 | | 0 | 0 | 0 | | 1 | | 1 | | 0 | | 0 | | |
| | 17. | Holophrya sp. | 0 | | | | | | | 1 | | | | | | | | 0 | | | | | | |
| A | 18. | Lionotus sp. | | | | | | | | | | | 0 | | 0 | | | | | 0 | | 0 | 0 | |
| | 19. | Mesodinium acarus Stein | | | 1 | | | | 0 | 1 | | | | | | | | | | | | | | |
| + | 20. | Mesodinium sp. | | | | | | | 0 | | | | | | 0 | 0 | | | | | | | | |
| B | 21. | Oxytricha sp. | | | | | | 0 | 1 | 0 | | | | | 1 | | | | | | | | | 0 |
| | 22. | Pleuronema coronatum Kent | | | | | | | 0 | 0 | | | | | | | | | | | | | | |
| | 23. | Prorodon sp. | 0 | | 0 | | | | 0 | 0 | | | | | | | | | 1 | 2 | | | | |
| | 24. | Stylonychia mytilus Ehrbg. | | | 0 | | | | | | | | | | | | | | | | | 0 | | 2 |
| | 25. | Stylonychia sp. | | | | | | | | | | | | | | | | 0 | | | | | 0 | |
| | 26. | Uroleptus sp. | | | | | | | | | | | 0 | | | | 0 | | | | | | | 0 |
| | 27. | Vorticella sp. | | | | | 0 | | | | | 1 | | 0 | | | | | | | | | | |
| | • 28. | Caenomorpha medusula Perty | | | | | | | | 0 | | | | | | | | 0 | | | | | | |
| | • 29. | Epalxis sp. | | | | | | | | | | | | | | | | 0 | | | | 0 | | |
| | • 30. | Metopus es O.F.Müller | | | | | | | | 0 | | 0 | | | | | | | | | | | | |
| | • 31. | Metopus es var. rectus Kahl | | | | | | | | | | | | 0 | | | | | | | | | | |
| | • 32. | Metopus spinosus Kahl | | | | | | | | | | | | | | | | 0 | | 0 | | | | |
| | • 33. | Metopus spiralis Smith | | | | | | | | | | | | | | | | 0 | | | | | | |
| | • 34. | Metopus striatus McMurrich | | | | | | | | | | | | | | | | 0 | | | | | | |
| | • 35. | Metopus sp. | | | | | | | | | | | | 0 | | | | | | | | | | |
| | • 36. | Plagiopyla ovata Kahl | | | | | | | | | | | | | | 1 | | | | | | | | |
| | • 37. | Saprodinium dentatum Lauterborn | | | | | | | | | | | | | | | | | | | | 1 | | |
| | 38. | Coleps amphacanthus Ehrbg. | | | | | | | | | | | | 0 | | | | 2 | | 0 | | 0 | | |
| | 39. | Coleps hirtus Nitzsch | | | | | | | | 0 | | 2 | | 0 | | 2 | | 0 | | 1 | | 0 | | |
| | 40. | Coleps incurvus Ehrbg. | | | | | | | | 0 | | 1 | | 2 | | | | 1 | | 0 | | 0 | | |
| | 41. | Cyclidium citrullus Cohn | | | | | | | | | | | | 0 | | | | 4 | | | | 2 | | |
| | 42. | Cyclidium libellus Kahl | | | | | | | | | | | | | | | | | | 0 | | | | |
| | 43. | Euplotes patella f.latus Kahl | | | | | | | | 0 | | | | | | | | | | | | | | |
| B | 44. | Euplotes patella f.typicus Kahl | | | | | | | | 0 | | | | | | | | | | | | | | |
| | 45. | Euplotes sp. | | | | | | | | | | | | | | | | | | | | 0 | | |
| | 46. | Frontonia leucas Ehrbg. | | | | | | | | | | | | | | 0 | | 1 | | | | | | |
| | 47. | Lacrymaria olor O.F.Müller | | | | | | | | | | | | | | | | 0 | | | | | | |
| | 48. | Loxodes magnus Stokes | | | | | | | | | | | | | | | | 1 | | | | | | |
| | 49. | Loxodes rostrum O.F.Müller | | | | | | | | | | | | | | 0 | | | | | | | | |
| | 50. | Loxodes striatus Engelmann | | | | | | | | | | 4 | | | | | | 2 | | 0 | | 0 | | |
| | 51. | Loxophyllum helus Stokes | | | | | | | | | | | | | | | | | | | | 0 | | |
| | 52. | Paruroleptus lacteus Kahl | | | | | | | | | | | | | | | | 0 | | | | | | |
| | 53. | Prorodon teres Ehrbg. | | | | | | | | 0 | | 0 | | | | | | | | 0 | | | | |
| | 54. | Spirostomum filum (Ehrbg.) Penard | | | | | | | | | | | | 0 | | | | 0 | | | | 0 | | |
| | 55. | Spirostomum intermedium Kahl | | | | | | | | | | 2 | | | | 1 | | 0 | | | | | | |
| | 56. | Spirostomum minus Roux | | | | | | | | | | 5 | | 3 | | 1 | | 1 | | | | | | 0 |
| | 57. | Urocentrum turbo O.F.Müller | | | | | | | | | | 0 | | | | | | | | | | | | |
| | 58. | Uroleptus dispar Stokes | | | | | | | | | | | | | | | | 0 | | 0 | | | | |
| | 59. | Uroleptus limnetis Stokes | | | | | | | | 0 | | | | | | | | | | 0 | | | | |

## STRESZCZENIE

Badano rozwój orzęsków w mule dennym nawożonych stawów rybnych. Materiał zbierano z czterech stawów odrostowych Gospodarstwa Doświadczalnego PAN w Gołyszu, przez cały sezon wegetacyjny w roku 1962. W każdym stawie wyznaczono dwa stanowiska zbioru prób: w głębokiej części stawu w pobliżu odpływu oraz w płytkiej części stawu, gęsto zarośniętej roślinnością wynurzoną.

W badanym materiale znaleziono 113 gatunków orzęsków. Stwierdzono wyraźną różnicę w ilości orzęsków na obu stanowiskach na korzyść stanowiska płytkiego. Zjawisko to wiąże się niewątpliwie z większą zawartością materii organicznej w mule płytkich i zarosłych części stawów. Ogólną liczbę gatunków orzęsków danego stawu można podzielić na trzy grupy: zdecydowana większość to gatunki znajdywane wyłącznie na stanowisku płytkim, bardzo niewielka część to gatunki znajdywane wyłącznie na stanowisku głębokim, ostatnia grupa to gatunki występujące na obu stanowiskach.

Liczebność orzęsków wykazywała zmiany w ciągu sezonu. W pierwszych tygodniach po zalaniu stawów ilości tych organizmów były niewielkie. W większości stawów występowały one najobficiej od końca lipca do sierpnia włącznie. Powolny spadek zaczynał się we wrześniu. Niezależnie od tego poszczególne gatunki osiągały w różnych miesiącach maksymalne rozwoje.

Wśród orzęsków badanych stawów przeważały gatunki odżywiające się bakteriami. Nawożenie stawów wpływa korzystnie na liczebność drobnoustrojów i wzmożenie ich działalności. Wpływ nawożenia na faunę pierwotniakową jest więc przypuszczalnie pośredni poprzez wzmożenie tempa procesów bakteryjnych w mule dennym, co z kolei przyśpiesza obrót materii w stawie.

W miesiącach letnich znajdywano gatunki saprpelowe, które w stawach nawożonych występowały w większych ilościach niż w kontrolnym. Pojawiły się one głównie na stanowiskach płytkich, a w okresie śnięcia ryb w jednym ze stawów, gdy był on silniej zanieczyszczony, pewne gatunki znaleziono również na stanowisku głębokim. Gatunki te mogą być wskazówką zmiany warunków tlenowych i pojawienia się procesów gnilnych na dnie stawu.

Orzęski stawu kontrolnego wykazały nieco słabszy rozwój ilościowy zwłaszcza na stanowisku głębokim. Stanowisko płytkie różniło się niewiele od analogicznych stanowisk w stawach nawożonych.

## REFERENCES


Bombówna M., 1957. Tworzenie się osadów dennych w stawach rybnych. Biuletyn Zakł. Biol. Stawów, 4, 112—126.

Grospietsch T., 1958. Beträge zur Rhizopodenfauna Deutschlands. Hydrobiologia, 10, 305—322.

Kahl A., 1935. Wimpertiere oder *Ciliata*, in Dahl: Die Tierwelt Deutschlands. Jena, G. Fischer.

Lauterborn R., 1915. Die sapropelische Lebewelt. Verh. Nat. Med. Ver. Heidelberg (NF) 13, 395—481.

Pasternak K., 1959. Gleby gospodarstw stawowych dorzecza Górnej Wisły. Acta Hydrobiol., 1, 3—4, 221—283.

Wetzel A., 1918. Der Faulschlamm und seine Ciliaten-Leitformen. Z. Morph. Ökol. d. Tiere, 13, 179—328.

Wróbel S., 1960. Współzależność między dnem i wodą w stawach. Acta Hydrobiol., 2, 2, 69—124.



Adres autorki — Author's address

Mgr Elżbieta Kwiatkowska-Grabacka

Zakład Biologii Wód, Polska Akademia Nauk, Kraków, ul. Sławkowska 17.