

Stream ecosystems in mountain grassland (West Carpathians)*

7. *Ciliata*

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Abstract — The effect of agricultural wastes from areas of intense and traditional pastoral economy on the composition and numbers of *Ciliata* communities (*Ciliata*, *Protozoa*) on a stony bottom (in the lotic zone) and on a slimy bottom (in the lenitic zone) of the mountain streams Biała Woda and Kamionka in the Western Carpathians was analysed. It was found that the current runoff of pollution to the streams did not bring about any significant changes in *Ciliata* communities. The differentiation of these communities depended rather upon the variability of the stream bottom.

Key words: stream ecosystems, influence of pastoral economy, the West Carpathians, *Ciliata*, *Protozoa*.

1. Introduction

The economic activity of man usually brings about changes in the natural biocenoses of the environment in which it is carried out. In the case of an aquatic environments this usually leads to a deterioration in the quality of the water.

The composition and numbers of communities of *Ciliata* were investigated in two streams of the upper Grajcarek catchment basin, where agricultural wastes were introduced by the ground runoff from areas where the traditional pastoral system was practised and from those of intensive pasturing.

* The investigations were carried out within Project 10.2.

2. Area and method of investigation

The material was collected at 2-monthly intervals from May 1976 to April 1978, except for some short periods in winter when the streams were covered with ice. Three stations were established, two of them in the Biała Woda stream (an area practising the traditional pasture system) and a third one in the Kamionka stream (an area following the intensive pasture system, with mineral fertilization applied to mountain pastures). In the year 1976, at the same time intervals, samples were also taken from a small spring in the middle of a mountain pasture and giving rise to the Kamionka stream. A detailed description of the investigated area is given by K o w n a c k i (1982).

Two types of sample were collected: in the lotic zone of the stream algal aggregations on submerged stones were scraped off from an area about 1 cm² of fine sediment was taken with a teaspoon from small depressions between the stones. On the day after collection the samples were examined *in vivo* under the microscope. Identification was carried out according to the K a h l key (1935). The abundance of the different protozoan species was estimated according to the following scale:

- 1) sporadic, i.e., under 2 specimens in 1 ml of sediment;
- 2) scarce, i.e., 2—10 specimens in 1 ml of sediment;
- 3) numerous, i.e., from 11—12 specimens in 1 ml of sediment;
- 4) very numerous, i.e., from 21—50 specimens in 1 ml of sediment;
- 5) mass occurrence, i.e., more than 50 specimens in 1 ml of sediment.

The calculation were made in a 0.05 ml drop of water, the protozoan of all groups being totalled.

3. Results

The following groups of organisms were found in the investigated samples: *Rhizopoda*, *Ciliata*, *Rotatoria*, *Heliozoa*, *Gastrotricha*, and *Nematodes*.

In the ciliate group 48 species were identified. Among them were the free-swimming species of the *Holotricha* and *Spirotricha* groups and species creeping on the substratum belonging to the *Hypotricha* group. The qualitative composition of *Ciliata* and their occurrence in the individual years of the investigation at the stations in the two streams are given in Table I. During the entire period of the investigation the microfauna of *Ciliata* was poorly differentiated and their numbers were few. Out of 48 identified species only a small numbers appeared in all or almost all the years of investigation. These were: *Aspidisca costata*, *A. lynceus*, *Chilodonella uncinata*, *Cinetochilum margaritaceum*, *Cyclidium citrullus*, *Frontonia acuminata*, *Glaucoma scintillans*, *Litonotus*

Table I. List of Ciliata found in the investigated streams

Species	Saprobity	Station		
		B 1	B 2	K 2
<i>Aspidisca costata</i> Dujardin	α	+	+	+
- <i>herbiocla</i> Kahl	0	+		+
- <i>lynceus</i> Ehrb.	α		+	+
- <i>sulcata</i> Kahl	β		+	+
<i>Aspidisca</i> sp.			+	+
<i>Chilodonella cucullulus</i> O.F.M.	α		+	+
- <i>labiata</i> Stokes	β			+
- <i>turgidula</i> Penard	β	+		
- <i>uncinata</i> Ehrb.	α		+	+
<i>Chilodonella</i> sp.		+		+
<i>Chilodontopsis vorax</i> Stokes	β		+	
<i>Chlamydomon cyclops</i> Entz	β			+
<i>Cinetochilum margaritaceum</i> Perty	β - ρ	+	+	+
<i>Cyclidium citrullus</i> Cohn	α			+
- <i>oblongum</i> Kahl	α - β			+
<i>Didinium</i> sp.		+		
<i>Dileptus cygnus</i> Clap. et L.	β		+	
<i>Dileptus</i> sp.				+
<i>Euplotes affinis</i> Dujardin	β		+	+
- <i>patella</i> (O.F.M.) Ehrb.	β			+
<i>Frontonia acuminata</i> Ehrb.	β -0		+	+
<i>Frontonia</i> sp.				+
<i>Glaucocystis scintillans</i> Ehrb.	ρ - β		+	+
<i>Halteria grandinella</i> O.F.M.	β	+	+	+
<i>Hemiophrys</i> sp.				+
<i>Lembdion lucens</i> Maskell	β		+	+
<i>Litonotus cygnus</i> O.F.M.	β			+
- <i>fasciola</i> Ehrb.	α		+	+
<i>Isoxyphyllum helus</i> Stokes	β	+		
<i>Isoxyphyllum</i> sp.				+
<i>Mesodinium</i> sp.				+
<i>Metopus</i> sp. O.F.M.	ρ			+
<i>Muscula elegans</i> Ehrb.	0	+		
- <i>parva</i> Kahl	0			
<i>Oxytricha</i> sp.				+
<i>Paramecium aurelia</i> Ehrb.	β			+
- <i>caudatum</i> Ehrb.	α		+	
<i>Pleuronema crassum</i> Dujardin	ρ		+	+
<i>Pleuronema</i> sp.				+
<i>Prorodon teres</i> Ehrb.	α			+
<i>Prorodon</i> sp.			+	+
<i>Strebilidium gyrans</i> Stokes	0			+
<i>Tracheloptyllum</i> sp.			+	+
<i>Uroleptus lacteus</i> Kahl	β			+
<i>Uroleptus</i> sp.			+	+
<i>Urostyia</i> sp.			+	+
<i>Verticella convallaria</i> Linne	α			+
<i>Verticella</i> sp.				+
<i>Holotricha</i> non det.			+	+
<i>Hypotricha</i> non det.			+	+

fasciola, *Oxytricha* sp., und *Uroleptus lacteus*. The slight qualitative differentiation of the investigated fauna was above all shown by the fact that in samples from summer or autumn (i.e., periods when the greatest abundance of species is usually noted) the number of ciliate species did not exceed ten. In the winter period samples without any protozoan species were fairly frequent. Apart from the continuity of occurrence of the ciliate species mentioned above, no constant or periodical predominance of any species at the two types of station was observed.

In the identified ciliate community there occurred species consuming very varied food. Some species fed on algae only (chiefly of the diatom group and filamentous blue-green algae), other species fed on bacteria or mixed food. The group feeding on mixed food was usually characterized by the largest number of species, contrary to that feeding exclusively on algae. The appearance of algae-consuming species was distinctly seasonal and correlated with an increased abundance of algae

in the substratum. This group included the following species: *Nassula parva*, *Nassula* sp., *Strobilidium gyrans*, *Uroleptus lacteus*, *Prorodon teres*, *Frontonia acuminata*, and *Lembadion lucens*. The numbers of the ciliates were low (usually the 2nd degree of the scale). The species which fed on bacteria or on mixed food were distinctly more numerous. A seasonal increase in number was noted in the species *Aspidisca costata*, *A. lynceus*, *Cinetochilum margaritaceum*, *Cyclidium citrullus*, *Litonotus cygnus*, and *Lembadion lucens*.

The type of food and its abundance constitute the most important factors of the environment, limiting the occurrence of *Ciliata*. This also explains the difference between the settlement of algal aggregations on stones in the lotic zone and in the mud from marginal water. The number of macrofauna was greater in the mud, owing to deposits of organic matter which favoured the development of bacteria.

The ciliate microfauna was very similar in all the investigated streams, especially with regard to its qualitative composition, while the number of species varied throughout the entire period of the investigation. In spring, the numbers of protozoan increased during May and June, in summer during August, and in autumn during October or sometimes even at the beginning of November. In winter, when the streams were not completely icebound, no protozoan were found in algal aggregations on stones while in the mud of marginal water

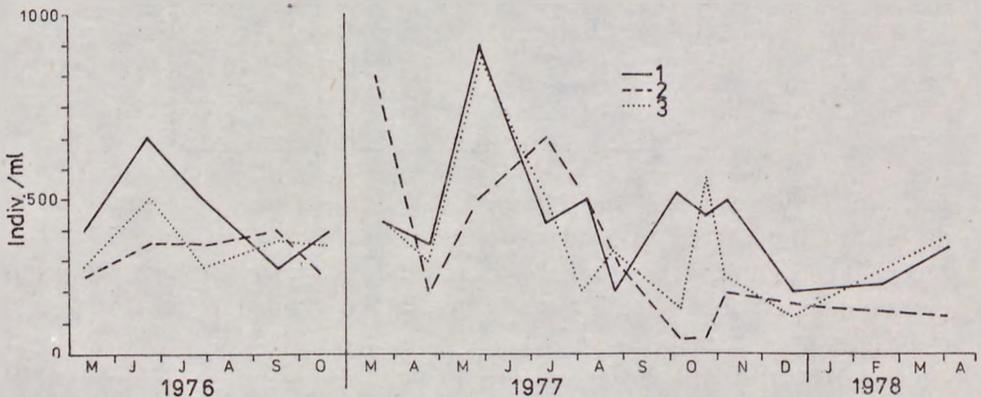


Fig. 1. The number of *Protozoa* in the muddy bottom of the lenitic zone of the Biala Woda and Kamionka streams in the years 1976—1977; 1 — station No 2 in the Kamionka stream; 2 — station No 1 in the Biala Woda stream; 3 — station No 2 in the Biala Woda stream

microfauna was present. The differences between these two habitats were particularly pronounced in the Kamionka stream, where the numbers of protozoan were always greater in the samples from marginal water than in those from algal aggregations on stones (fig. 1). In warm

seasons of the year the number of ciliate species in marginal water was almost doubled. In general, the microfauna of the Kamionka stream was richer than that of the Biała Woda stream.

The saprobiological characteristics of the ciliate community showed that the mass development of most species occurred in β - or α -mesosaprobic zones. The sporadically occurring species *Glaucoma scintillans*, *Metopus* sp., or *Paramecium caudatum* find the most favourable conditions in a polysaprobic environment. Also the typically oligosaprobic species such as *Frontonia acuminata*, *Nassula elegans*, or *Strobilidium gyrans* occurred in small numbers. The species *Aspidisca costata*, *Chilodonella uncinata*, *Cinetochilum margaritaceum*, and *Cyclidium citrullus* appeared in small numbers but were characterized by constancy of occurrence, i.e., they were noted during the entire period of the investigation. Their mass occurrence is associated with medium polluted waters while a mass development of *Glaucoma scintillans* occurs in a polysaprobic environment. In the ciliate communities of the investigated streams no mass occurrence of any species was observed, this indicating that in both streams the degree of water purity is so far satisfactory. The calculated saprobic index found within the range 1.0—1.4 showed that the water of the streams Biała Woda and Kamionka were pure and of oligotrophic character. It was only in the spring of the Kamionka stream that the distinct increase in pollution was unquestionably due to its use as a watering-place for sheep during the summer months.

4. Discussion and conclusions

Ciliata constitute an important link in the food chain of aquatic biocenoses, playing the role of destruenters. As was shown by Faure-Frémiet (1950, 1957), the most important groups are micro- and macrophagous organisms, i.e., bacteria-consumers and predatory forms. Many authors stressed the occurrence of distinct correlations between increasing numbers of *Ciliata* and, simultaneously, of bacteria in the environment (Straškrabová, Legner 1968, Bick 1973, Taylor 1978). Moreover, as was suggested by Bick (1966), the appearance of *Ciliata* was connected with the quality of the decaying organic matter, or, more precisely, with the type of bacteria decomposing it. In the investigated streams an increase in the number of *Ciliata* were noted in the spring-summer period and in autumn, this being correlated with the seasonal growth in the water of bacteria, especially of heterotrophic and ammonifying ones, observed by Starzecka and Trela (1982). This seems to suggest that in the same period the quantity of bacteria in the bottom also increased. On the basis of numerous investigations,

Rodina (1958) stated that the numbers of the bacterial flora of the bottom are usually 10—100-times greater than those in the water. As was observed in the present study, the ciliate microfauna in the Kamionka stream was slightly more numerous than in the Biała Woda stream, especially in the mud from marginal water. Starzecka and Trela (1982) also found the greatest numbers of ammonifying bacteria in the Kamionka stream in the region of intense sheep grazing.

The seasonal appearance (especially in spring and autumn) of *Ciliata* consuming only algae, chiefly diatoms and blue-green algae, was most frequently correlated with a simultaneous growth of algae in the substratum. As Kawecką reported (1982), a pronounced increase in the number of blue-green algae was noted in spring and that of diatoms in spring, autumn, and winter. The absence of *Ciliata* in the last period can be explained by their sensitivity to low water temperatures.

The above-discussed dependences support the opinion that the type of food and its abundance are the most important factors limiting the occurrence of *Ciliata* in the environment, though many others play a certain role, e.g., the type of bottom (Moore 1939).

Ciliata are usually regarded as cosmopolitan organisms, forming similar communities in the same habitats. The obtained results point to a marked similarity of the ciliate fauna to the microfauna of pure head water sectors of the Stirone Torrente flowing out of a spring at a similar altitude above sea level in Italy (Madoni, Ghetti 1981).

The conducted investigation of protozoans (chiefly the ciliate group) showed a satisfactory degree of water purity in the Biała Woda and Kamionka streams (the oligotrophic zone). This being in agreement with the evaluation carried out by Starzecka and Trela (1982) on the basis of a bacteriological study. These authors classified the waters of the two streams as relatively pure or even very pure with a tendency to periodical increase in pollution in areas with intensive systems of economy. Currently, the ground runoff of agricultural wastes does not effect significant changes in communities of *Ciliata*.

5. Polish summary

Ekosystemy połokowe na terenach pastwisk górskich (Karpaty Zachodnie)

7. Orzęski

Analizowano wpływ ścieków rolniczych pochodzących z terenów o intensywnej i tradycyjnej gospodarce pasterskiej na jakość zespołów orzęsków (*Ciliata*, *Protozoa*), zasiedlających kamieniste dno w strefie lotycznej i lenitycznej potoków górskich. Terenem badań były dwa potoki: Biała Woda i Kamionka, w zlewni górnego Grajcarka,

w rejonie wsi Jaworki (Karpaty Zachodnie). W obu potokach przez cały badany okres (1976—1978) rozwijała się mało różnorodna gatunkowo (48 gatunków) i mało liczebna fauna orzęsków. Stosunkowo dużą stałością występowania odznaczały się następujące gatunki: *Aspidisca costata*, *A. lynceus*, *Chilodonella uncinata*, *Cinetochilum margaritaceum*, *Cyclidium citrullus*, *Frontonia acuminata*, *Glaucoma scintillans*, *Litonotus fasciola*, *Oxytricha* sp. oraz *Uroleptus lacteus* (tabela I).

Wzrost liczebności orzęsków miał miejsce na wiosnę, zwykle w maju i czerwcu, latem w sierpniu oraz jesienią w październiku i na początku listopada (ryc. 1). Większą liczebność mikrofauny notowano z reguły w mule miejsc przybrzeżnych strefy lenitycznej.

Sezonowe pojawianie się orzęsków odżywiających się wyłącznie glonami korelowało ze wzrostem liczebności glonów w podłożu. Natomiast wzrost liczebności orzęsków korzystających z pokarmu bakteryjnego następował w okresie wiosenno-jesiennym, tj. w czasie notowania zwiększonych ilości bakterii heterotroficznych i amonifikacyjnych.

Ustalono, że aktualne wpływy zanieczyszczeń do potoków nie powodują zauważalnych zmian w zespołach orzęsków. Oba potoki stanowią wody czyste (oligotroficzne) z tendencją okresowego nieznacznego wzrostu zanieczyszczenia w rejonie gospodarki intensywnej.

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