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Biocenoza potoku wysokogórskiego pozostającego pod wpływem turystyki. 4. Fauna denna Rybiego Potoku (Tatry Wysokie)*

Biocenosis of a high mountain stream under the influence of tourism. 4. The bottom fauna of the stream Rybi Potok (the High Tatra Mts)

Wpłynęło 8 lipca 1976 r.

A b s t r a c t — The stream Rybi Potok, which crosses the strict nature reserve on the territory of the Tatra National Park takes in the domestic sewage from the shelter at Lake Morskie Oko, whose annual turnover is over one million tourists. The influence of sewage causes the development of characteristic zoocenoses permitting the distinction of certain zones: a septic zone — 1 m from the sewage discharge, with larvae of the genus *Psychoda* dominating; a zone of strong pollution — 3 to 10 m below the sewage outlet, where *Ostracoda, Oligochaeta, Nematoda, Chironomidae (Prodiamesa olivacea, Paratanytarsus* sp., *Chironomus* gr. *thummi)* prevail; a zone of self-purification — 30—500 m below the sewage discharge where a vigorous increase in the total amount of fauna takes place, with *Chironomidae (Orthocladiinae* juv., *Thienemanniella* sp., *Micro-cricotopus* sp.) dominating; a of pure montane stream zone — where develops the typical community of the Tatra streams of the montane forest zone with the mayflies *Baetis alpinus, Chironomidae (Orthocladius (Euorthocladius) rivicola, O. (Euorthocladius) saxosus)* dominating.

The present work is a part of complex investigations carried out in montain territories by the Laboratory of Water Biology of the Polish Academy of Sciences. One of the aims of these investigations was to determine the influence of tourist traffic on the biocenosis of a typical Tatra stream.

* Praca wykonana w ramach problemu węzłowego PAN-21.

The investigations were carried out on the territory of the Tatra National Park where, in spite of special nature protection regulations, the number of tourists increases rapidly from year to year. The areas around the shelters, where the tourist traffic concentrates, are specially exposed to danger. Most of the shelters, particularly the old ones, were not adapted to such mass tourist traffic and are at present the main source of environment pollution. An example is the old shelter at Lake Morskie Oko which is visited every year by more than a million people (according to the manager of the shelter, Czesław Łapiński) (fig. 3), and whose sewage is discharged in a not fully purified state into the Rybi Potok.

In the years 1971—1975 the following aspects were studied: physiography and character of the substratum of the catchment area of the Rybi Potok (Pasternak 1971), the hydrochemical character of the stream (Bombówna 1977), the physiological groups of bacteria (Starzecka 1977), and communities of attached algae (Kawecka 1977). Simultaneously ichthyobiological and ichthyopathological investigations (Łysak, Markiewicz — unpublished materials) were carried out. The bottom fauna was also investigated, the results being presented below. *Oligochaeta* were identified by Dr. E. Dumnicka, *Ostracoda* by Assoc. Prof. T. Sywula, *Hydracarina* by Dr. E. Biesiadka, *Collembola* by Assoc. Prof. A. Szeptycki. Identification of *Ephemeroptera* and *Plecoptera* was checked and completed by Assoc. Prof. R. Sowa, and of *Trichoptera* by Dr. B. Szczęsny.

Faunistic investigations had been carried out in the Rybi Potok for a long time. The mayflies were investigated by Kamler (1960) who reported from this territory 4 species, the stoneflies by Kamler (1964) Wojtas (1964) — 28 species, the caddis flies by Riedel (1961—1962), Szczęsny (1966) — 5 species, *Chironomidae* by Kownacki (1971) — 35 taxonomic units, and *Oligochaeta* by Dumnicka (1976) — 14 species. Zawolski (1964) gives in the list of *Simuliidae* of the Tatras from the Rybi Potok 1 species but most probably 4 other species which he mentions as common all over the Tatras were also found in that stream. The whole bottom fauna was investigated in the years 1962/63 in the Rybi Potok at Wanta (Kownacka, Kownacki 1965). The aim of the above-mentioned papers was to present the special composition of the fauna or to show some ecological relations. No investigations, however, were carried out on the zoocenosis of the Rybi Potok.

It should be stressed that there are few Polish publications concerning the influence of sewage on the zoocenoses of montane streams. Only Szczęsny (1974) investigated the influence of the municipal sewage of Krynica on the bottom fauna of the montane stream Kryniczanka and Zięba (1968) investigated the effect of the municipal and industrial pollution of Krosno on the zoocenoses of the River Wisłoka. Works of sanitary aspect carried out on the Rivers Soła (Musiał, Turoboyski, Chobot, Łabuz 1950) or Raba (Musiał, Chobot, Pudo 1962) give only sparse information on the aquatic animals of these rivers.

Description of the territory and investigation method

The Rybi Potok rises from Lake Morskie Oko at an altitude of 1393 m and flows initially across a wide terrace. At a distance of about 220 m below the lake it spreads considerably, forming the so-called Rybie Stawki, which are about 3 m deep. The gradient in this sector is 6 to 10‰,

Ryc. 1. Mapa Rybiego Potoku z zaznaczeniem stanowisk
Fig. 1. Map of the stream Rybi Potok showing localization of sampling stations

the banks being overgrown with clumps of dwarf pine and grass. Further on the stream bed narrows, its gradient increasing rapidly, and the stream rushes down, breaking its waters against huge boulders forming numerous cascades in a deep valley covered with dense spruce forest. At an altitude of 1085 m, after a 4 km course, it falls into the Białka (tributary of the River Dunajec, the catchment area of the Baltic Sea), whose mean gradient is 77‰. Six stations (fig. 1) were established in the Rybi Potok. Station 2 A was added separately since in some of the samples collected below the sewage discharge (to 1 m) the existence of a particular zoocenosis differing greatly from the zoocenosis of station 2 (3 to 10 m from the sewage discharge) was found. Samples were collected on the following dates: 26—27.V, 15.VII, 2.IX, 22.X, and 1—2.XII. 1971, and 24—25.I, 27—28.III, 3.VI. 1972, in an attempt to cover the periods of most intensive tourist traffic.

At each station and on all dates several samples were collected by means of a hand net covered with 0.3 mm mesh bolting cloth. In the laboratory all the zoological specimens over 0.5 mm in size were picked out from the samples and subsequently identified and counted for a volume of 2 dcm^3 of the substratum. In order to distinguish the communities of the bottom fauna the index of dominance (Kownacki 1971) was used.

Review of the bottom fauna in the Rybi Potok

As a result of the investigations carried out in the years 1971—1972, 136 taxonomic units of aquatic fauna were found to be living in the Rybi Potok (Table I). By taking into consideration earlier faunistic elaborations this number is increased to 160 units, although it is not complete. Larval stages of a number of groups, especially flies (*Diptera*), encountered in the stream have been little elaborated, while *Nematoda* and *Tardigrada* have not been elaborated at all. *Cladocera* and *Copepoda* are the subject of a separate elaboration (Dr. K. Smagowicz).

The main component of the bottom fauna in the Rybi Potok are *Chironomidae*, which constitute 53 to 80 per cent of the total fauna (fig. 2) and are represented by the largest number of taxonomic units. Only in the vicinity of the sewage outlet (station 2 A, 2) is their share in the zoocenosis lower (4—25 per cent). At station 2 A larvae of *Diptera* of the genus *Psychoda* (76.5 per cent) dominate, whereas at station 2 *Crustacea* prevail (51.6 per cent), mainly *Ostracoda* and *Copepoda*. Of the other groups *Oligochaeta* and *Nematoda* are fairly numerous in the vicinity of sewage (stations 2 A, 2, 3, 4), while *Ephemeroptera* dominate at the unpolluted stations (1, 5, 6). *Turbelaria*, *Plecoptera*, and *Diptera* — *Empididae* and *Simuliidae* — may sometimes occur more numerously but their share in the whole bottom fauna does not exceed 5 per cent. Single specimens of *Hydrozoa*, *Mollusca*, *Hydracarina*, *Collembola*, *Trichoptera*, and *Tipulidae* also occur, playing, however, no great role in the whole fauna of the Rybi Potok.

Tabela I. Średnia roczna ilość fauny dennej zasiedlającej 2 dcm^3 dna kamienistego na poszczególnych stanowiskach w Rybim Potoku
(x - obecne w próbach)

Table I. Annual mean numb r of bottom fauna settling 2 dcm^3 of stony bottom at the particular stations in the Rybi Potok stream
(x - present in the samples)

Takson - Taxon	Stanowiska - Stations						
	1	2a	2	3	4	5	6
Hydra sp.	5,4	-	-	-	28,0	9,3	-
Planaria alpina	4,8	-	-	10,8	312,0	5,4	8,8
Chaetogaster diastrophus	-	-	-	x	x	-	-
- diaphanus	-	-	-	x	x	x	-
Nais elinguis	x	-	-	-	x	-	-
- bretscheri	-	-	-	x	x	-	-
- communis	x	-	x	x	x	x	x
- variabilis	x	-	x	x	x	x	x
- pardalis	-	-	-	x	x	-	-
- pseudobtusa	x	-	-	x	-	-	-
- alpina	x	-	-	-	x	-	-
Lumbriculidae	0,1	x	x	2,4	1,1	-	-
Oligochaeta	9,1	30,0*	452,3	442,8	625,0	9,7	8,1
Nematoda (non det.)	8,8	57,0	583,3	463,7	177,9	7,6	0,3
Tardigrada (non det.)	0,1	-	-	60,0	-	17,1	0,1
Ancylus fluviatilis	-	-	-	-	34,0	21,0	0,1
Pisidium sp.	-	-	x	3,2	-	-	-
Sperchon brevirostris	x			x	x	x	x
- glandulosus	-			-	-	x	-
Atractides gibberipalpis	x			-	-	-	x
- nodipalpis	x			x	-	x	-
Hygrobates foreli	x			x	x	x	-
Feltria rubra	-			-	-	x	-
- zschokkei	x			-	-	-	x
Hydracarina	17,5	3,3	5,1	2,7	28,8	11,8	3,4
Ostracoda **	30,7	0,6	1374,4	163,0	11,4	0,5	0,4
Copepoda	29,1	-	816,5	49,6	126,2	7,4	-
Cladocera	16,7	-	249,5	7,5	35,0	9,5	-
Collembola ***	0,4	-	0,2	0,7	0,2	9,7	0,7
Baetis alpinus	0,5	-	-	-	11,0	9,7	264,6
- muticus	13,8	-	x	0,2	25,0	85,0	3,3
- rhodani	8,3	-	-	2,6	41,0	31,7	0,9
- vernus	4,0	-	-	20,0	9,6	0,1	-
- sp. (juv.)	31,0	-	6,1	61,3	146,6	125,0	-
Epeorus sylvicola	-	-	-	-	-	-	2,2
Ecdyonurus venosus	0,1	-	-	-	0,2	-	0,6
Rhithrogena iridina	0,1	-	-	-	-	-	0,6
- hybrida	-	-	-	-	-	-	0,8
- sp. (juv.)	0,1	-	-	-	-	-	0,3
Habroleptoides modesta	1,3	-	-	-	-	0,1	-
Ephemeroptera	59,2	-	6,1	84,1	233,4	251,6	273,3
Brachyptera sp.	-	-	-	-	-	-	2,2
Protonemura sp. ****	6,4	-	5,0	19,1	29,8	30,3	17,3
Amphinemura sp. ****	1,3	-	0,1	23,9	13,1	16,8	0,1
Nemoura babiogorensis	-	-	17,5	29,6	1,4	0,1	-
- sp. (juv.)	2,9	-	-	-	0,1	0,1	-
Leuctra sp. ****	-	-	-	-	-	0,1	11,8
Diura bicaudata	-	-	-	-	-	0,1	-
Isoperla buresi	0,1	-	-	0,3	0,3	-	5,7
- sudetica	16,3	-	-	13,3	7,5	18,3	2,2
- sp. (juv.)	-	-	-	3,7	0,1	0,1	1,1
Perla grandis	-	-	-	-	-	-	1,0
Dinocras cephalotes	0,1	-	-	-	-	-	-
Plecoptera (juv.)	31,3	-	0,2	387,5	6,3	152,0	11,0
Plecoptera	58,4	-	22,8	477,4	58,6	217,9	52,4

cont. tab. I

Takson - Taxon	Stanowiska - Stations						
	1	2a	2	3	4	5	6
Rhyacophila philopotamoides	-	-	-	-	-	-	0,3
- obliterata	-	-	-	1,2	1,4	-	-
- fasciata	-	-	-	-	0,6	-	-
- nubila	0,2	-	-	-	-	-	-
- vulgaris	-	-	-	0,5	0,4	-	0,3
- tristis	2,6	-	-	0,5	6,5	6,6	9,8
- sp. (juv.)	2,0	-	x	5,5	0,6	0,7	2,6
Philopotamus ludificatus	-	-	-	0,5	0,3	0,1	-
Polycentropus flavomaculatus	2,7	-	x	6,5	2,5	4,0	0,1
Apatania fimbriata	0,1	-	-	3,0	4,7	3,6	-
Drusus discolor	-	-	-	-	-	-	4,9
- sp.	0,1	-	-	-	-	-	1,1
Ecclisopteryx madida	-	-	-	-	-	-	0,1
Stenophylax sp.	-	-	-	-	0,1	1,7	0,1
Limnephilidae (juv.)	0,2	-	-	-	0,2	0,6	-
Sericostomatidae	0,2	-	-	-	0,1	-	-
Psilopteryx psorosa carpatica (♀)	x	-	-	-	-	-	-
Plectrocnemia conspersa	-	-	-	1,0	-	-	-
Synafophora intermedia	-	-	-	-	-	-	0,3
Trichoptera (juv.)	0,6	-	-	-	-	-	0,7
Trichoptera	8,7	-	x	18,7	17,4	17,3	20,3
Macropelopia nebulosa	-	-	9,2	-	0,1	-	-
Thienemannimyia - Grupa (l.)	15,9	-	65,0	171,0	102,0	24,0	0,3
Conchapelopia pallidula (p.)	-	-	0,1	0,5	-	-	-
Thienemannimyia carnea (p.)	-	-	1,0	-	-	-	-
Nilotanypus dubius	0,1	-	0,2	-	-	-	0,8
Tanypodinae (juv.)	47,7	-	x	199,6	306,0	75,0	0,2
Pseudodiamesa branickii	-	-	-	1,0	-	0,1	0,1
Diamesa gr. cinerella (l.)	1,4	-	70,2	48,3	14,3	46,0	6,8
- thienemanni (p.)	0,1	-	-	0,3	0,6	-	-
- hamaticornis (p.)	0,1	-	-	-	-	-	-
- starmachi (l.,p.)	-	-	29,9	4,6	0,6	-	-
- gr. latitarsis	-	-	-	-	-	-	1,5
- incallida (♂)	-	-	-	-	-	-	x
- bohemani (♂)	-	-	-	-	-	-	x
- sp. (juv.)	4,2	-	90,5	310,0	63,4	229,0	115,5
Heptagyia sp.	-	-	-	0,1	-	-	0,1
Potthastia longimana	3,8	-	-	66,2	43,6	1,1	-
Prodiamesa olivacea (l,p,♂)	0,4	1,0	73,8	0,1	-	-	-
Brillia modesta	-	-	-	-	-	-	0,2
- longifurca	-	-	3,5	-	-	-	-
Eukiefferiella gr. bavarica (l)	11,6	-	-	60,7	428,0	39,0	13,6
- bavarica (p)	0,1	-	-	-	1,1	-	-
- cfr calvescens (p)	-	-	-	-	0,1	-	0,1
- devonica (l.,p.)	-	-	-	23,0	205,1	10,1	1,7
- minor (l.,p.)	27,2	-	2,5	61,7	96,9	21,0	10,6
- clypeata (l.,p.)	-	-	-	-	0,1	-	4,3
- gr. brevicalcar	0,3	-	-	1,0	2,5	-	3,4
- tirolensis (♂)	-	-	-	-	-	-	x
- claripennis (l.,p.)	-	-	-	14,2	7,6	-	19,2
- coerulescens (♂)	-	-	-	-	-	-	x
- sp. (juv.)	0,1	-	2,5	1,5	-	0,5	27,7
Cardiocladius sp.	0,2	-	-	-	-	-	13,4
Synorthocladius semivirens	76,8	3,3	30,1	153,5	115,5	14,5	2,6
Parorthocladius nudipennis	1,2	-	-	5,5	16,3	9,4	16,8
Orthocladius (Euorthocladius) frygidus (l,p)	5,0	-	1,4	0,2	6,2	8,6	10,3
- (E.) rivicola (l,p)	5,6	-	5,3	6,0	3,7	2,6	50,0
- (E.) rivulorum	-	-	-	-	-	-	0,3
- (E.) saxosus	-	-	-	-	0,1	-	39,9
- gr. rhacobius (rhacobius ?) (p)	0,1	-	-	5,0	0,6	0,4	0,1
- gr. rhacobius (saxicola ?) (p)	-	-	3,2	-	-	-	-
Cricotopus + Orthocladius (l)	13,9	-	57,4	157,7	78,6	51,4	30,8
Cricotopus gr. tremulus (p)	0,1	-	-	7,7	1,7	-	-
Acricotopus lucens	-	-	0,5	-	-	-	0,1
Eudactylocladius sp. (p)	0,1	-	1,7	-	-	-	-

cont. tab. I

Takson - Taxon	Stanowiska - Stations						
	1	2a	2	3	4	5	6
Rheocricotopus sp. (l)	3,9	-	13,9	70,2	22,5	6,8	0,1
- effusus (p,♂)	0,2	-	-	11,5	0,1	-	x
- fuscipes (♂)	-	-	-	-	-	-	x
Microcricotopus sp. (l)	15,4	-	-	285,8	1670,0	109,0	0,6
- parvulus (p)	-	-	-	-	0.1	-	-
Heterotrissocladius marcidus	-	-	-	1,0	6,0	-	-
Chaetocladius sp. (l)	0,5	-	6,4	23,2	-	-	-
- gr. tibialis (p)	-	-	-	2,7	-	-	-
- perennis (p)	-	-	2,0	0,7	0,5	-	-
Limnophyes sp.	0,1	-	0,2	1,4	-	-	-
Metriocnemus sp.	0,1	-	7,9	6,0	-	-	-
Parametriocnemus stylatus	-	-	-	-	-	-	0,3
Krenosmittia boreoalpina (p)	-	-	-	-	-	-	0,1
Rheosmittia sp (p)	-	-	-	-	0,1	-	-
Psectrocladius gr. psilopterus	0,1	-	12,0	4,2	-	-	-
Corynoneura sp. (l,p)	28,7	-	33,4	54,0	69,7	83,5	4,2
- lobata (♂)	-	-	-	-	-	-	x
Thienemanniella sp. (l,p)	9,1	-	2,4	589,7	210,3	183,1	4,0
Orthocladiinae (juv.)	344,8	6,6	233,0	5190,9	1266,7	992,0	169,6
Chironomus gr. thummi (l,p)	-	-	14,5	-	-	-	-
Polypedilum gr. convictum (l,p)	0,5	-	187,0	29,2	0,1	-	0,1
- sp.	-	-	10,4	87,0	96,4	9,2	-
Endochironomus gr. dispar	-	-	1,2	-	-	-	-
Microtendipes chloris	-	-	x	-	-	-	-
Limnochironomus nervosus	-	-	0,5	-	-	-	-
Pentapedilum exsectum	-	-	1,2	0,2	-	-	-
Chironomini (juv.)	21,0	-	-	-	-	-	-
Micropsectra sp. (l,p)	200,6	-	23,8	197,3	136,2	16,6	0,3
Paratanytarsus sp. (l,p)	1,2	6,6	156,5	93,0	20,6	3,5	-
Rheotanytarsus sp.	3,4	-	x	1,5	-	-	-
Tanytarsini (juv.)	-	-	21,0	14,5	10,1	18,6	2,4
Chironomidae	825,6	17,5	1175,3	7953.5	5004,1	1955,0	552,1
Pericoma sp.	-	-	-	-	-	-	0,9
Psychoda sp. (cfr alterna)	-	212,3	24,0	-	-	-	-
- sp. (cfr severini)	-	27,0	-	1,0	-	-	0,2
- sp.	0,1	108,0	6,2	1,5	-	-	0,1
Simuliidae *****	3,3	-	-	2,7	1,2	23,0	83,7
Blephariceridae	-	-	-	-	-	1,1	15,1
Empididae	64,1	6,6	7,7	203,0	253,5	29,7	14,8
Tipulidae	0,2	-	1,1	-	-	5,7	0,3
Diptera inne - Other Diptera	67,7	353,9	39,0	208,2	254,7	59,5	115,1
Coleoptera	0,1	-	0,2	-	-	-	-

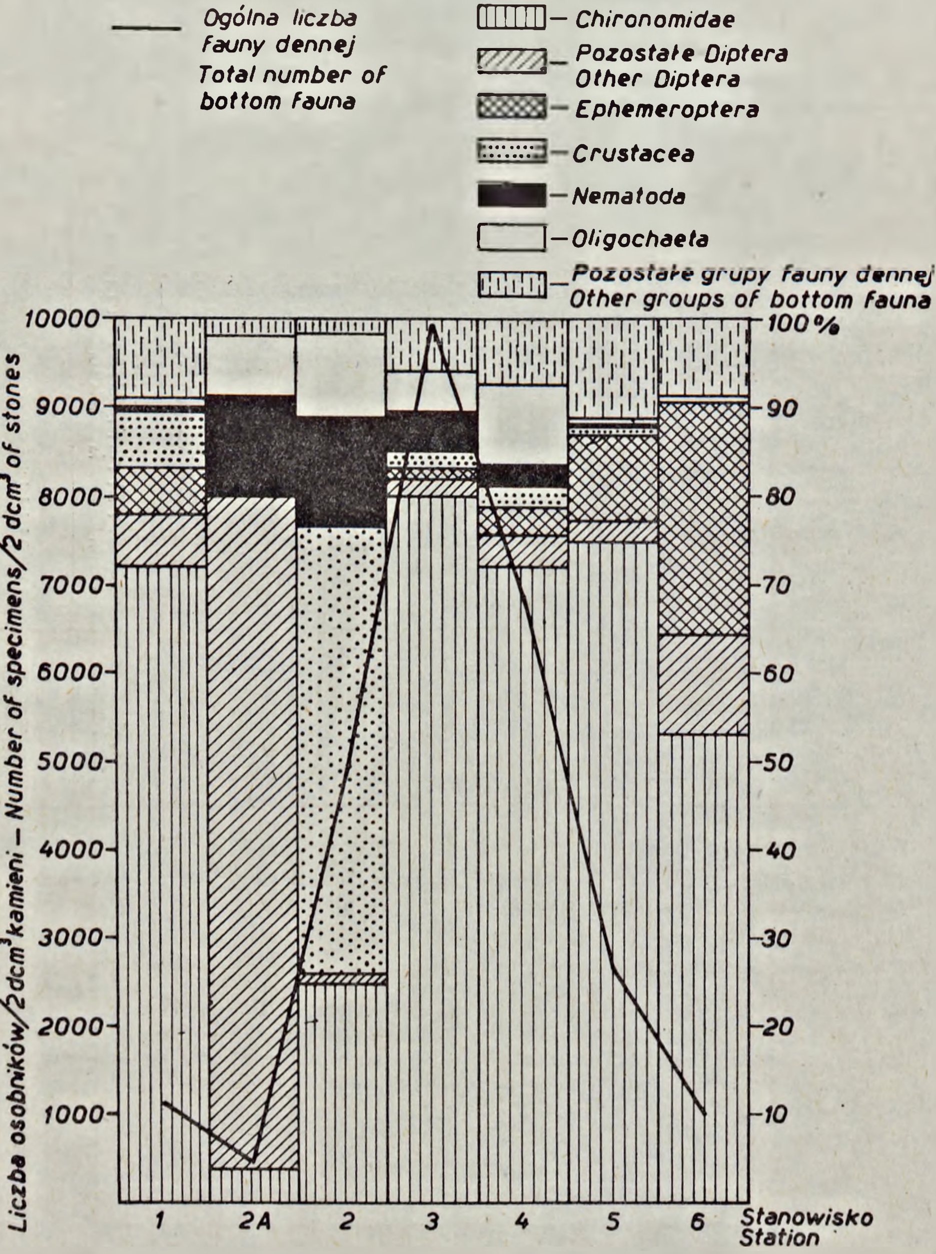
*- Chaetogaster sp. (okazy zniszczone - destroyed specimen)

**- Candona candida (Müll.), C. sarsi Hartw., Cypria ophthalmica (Jur.), Cyclocypris serena (Koch.), st. 1, 2; Potamocypris pallida Alm. st. 1 (det. Sywula).

***- Agrenia bidenticulata (Tullb.), Hydroisotoma schafferi (Kr.) st. 6 (det. Szeptycki).

****- Protonemura auberti Illies, P. brevistyla Ris, P. montana Kimm., P. nimborum Ris - w całym potoku - in the whole stream, P. intricata Ris, P. lateralis (Pict.) st. 6; Amphinemura standfussi Ris - w całym potoku - in the whole stream, A. sulcicollis (Stephens) st.6; Leuctra armata Kempny, L. handlirschi Kempny, L. inermis Kempny, L. nigra Kempny, L. prima Kempny, L. rosinae Kempny, L. teriolensis Kempny - w całym potoku - in the whole stream, L. pseudosignifera Aubert st. 1, L. autumnalis Aubert st. 6 (Wojtas 1964).

*****- Odagmia monticola Fried, Prosimulium sp. st. 6.



Ryc. 2. Ogólna ilość fauny dennej na tle procentowego składu fauny w Rybim Potoku
Fig. 2. Total number of the bottom fauna as against the percentage of faunistic communities in the Rybi Potok

Influence of sewage on the distribution of zoocenoses in the Rybi Potok

Several zoocenoses can be distinguished in the Rybi Potok on the basis of the dominating taxonomic units of the bottom fauna (fig. 3). Along the whole course of the stream, except for the sector under the direct influence of sewage (stations 2 A, 2) young stages of *Orthocladiinae* (individuals under 2 mm) dominate. Apart from these at the outflow from Lake Morskie Oko (station 1) above the sewage outlet into the Rybi Potok, larvae and pupae of *Chironomidae* of the genus *Micropsectra* and the species *Synorthocladius semivirens* are most numerous. Besides, *Tanypodinae* (*Thienemannimyia* group), *Empididae*, stoneflies of the genera *Amphinemura* and *Isoperla* are also frequent. Among the mayflies *Baetis muticus, B. rhodani, B, vernus* are most numerous, while *B. alpinus* and species of the genus *Rhithrogena* are found as single specimens. Caddis flies are represented by several species of which *Rhyacophila tristis* and *Polycentropus flavomaculatus* are, however, always dominants. *Oligochaeta* occur also in small numbers. Among them *Nais alpina* is the most frequent. The number of individuals is not high, the annual mean being 1182 individuals/2 dcm^3 substratum.

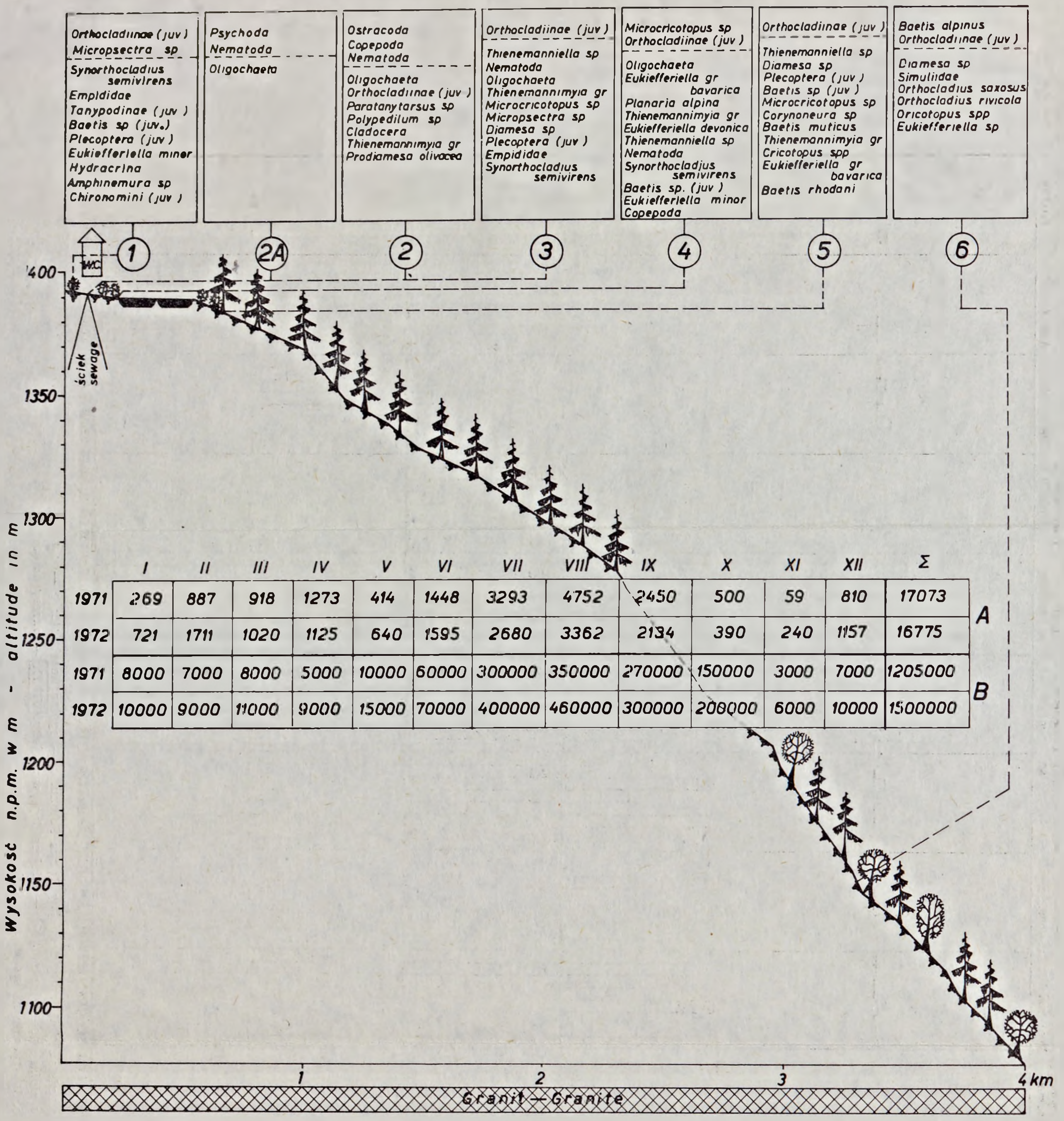
About 100 m below Lake Morskie Oko where sewage is discharged to the stream from the shelter the faunistic composition changes rapidly. At a distance within 1 m from the sewage pipe (station 2 A) two species of the genus *Psychoda*, and also *Nematoda* and *Oligocheta* dominate in the community. *Chironomidae* occur here as single specimens their presence probably being only a random one since the specimens caught were in most cases damaged. There are no mayflies, stoneflies, or caddis flies. The number of taxonomic units and the annual mean number of individuals are very low (458/2 dcm^3 substratum). However, already 3 to 10 m from the sewage pipe (station 2) an increase in the number of individuals (4772/2 dcm^3 substratum) and taxonomic units takes place, the first dominant being *Ostracoda — Candona candida*. *Nematoda* and *Oligochaeta* (*Nais communis*) are also very numerous. Here, too, *Copepoda* and *Cladocera* carried down from the lake are to be found. In the taxocenosis *Chironomidae* larvae of the genera *Polypedilum, Paratanytarsus, Tanypodinae* (*Conchapelopia pallidula, Thienemannimya carnea*), and *Prodiamesa olivacea* dominate. Only at this station were larvae and pupae of *Chironomus* gr. *thummi* found, this being a form typical of the polysaprobic zone. Apart from these, attention should be drawn to less numerous but also characteristic forms, especially of the subfamily *Chironomini: Microtendipes* gr. *chloris, Endochironomus dispar,* and

Limnochironomus nervosus which occurred at this station but nowhere else. In spring *Diamesinae* — *Diamesa thienemanni* and *D. starmachi* — which so far had not been associated with sewage, developed in masses here. Single young specimens of the genus *Baetis* are most probably carried down with the water from higher up the stream and do not pass through the whole life cycle here. Stoneflies are represented here by individual species of which only *Nemoura babiogorensis* develops in great numbers. Caddis flies are absent, only empty cases which had been carried down being found. The triclads *Planaria alpina*, were also absent. *Psychodidae* which in the neighbourhood of the sewage pipe were the main dominant are adominants here.

About 30 m below the sewage pipe (station 3) a further change of zoocenosis takes place. Again young stages of *Orthocladiinae* accompanied by larvae of the genus *Thienemanniella* are most numerous, an important role still being played by *Nematoda* and *Oligochaeta* (*Nais bretscheri*), similarly as at the preceding station. This demonstrates a still fairly strong influence of sewage. Many species found only as single specimens at other stations developed here numerously, e.g. *Potthastia longimana*, species of the genera *Chaetocladius*, and *Psectrocladius*. Single specimens of mayflies of the genus *Baetis* (*B. muticus*, *B. rhodani*, *B. vernus*) again occur, neither *Baetis alpinus* nor representants of the genus *Rhithrogena*, however, being found. Among the stoneflies *Nemoura babiogorensis* continues to be the most numerous, though larvae of genera *Amphinemura*, *Protonemura*, *Isoperla* occur too. Caddis flies are represented mainly by *Polycentropus flavomacultatus* larvae. Larvae of the flies *Empididae* are also numerous, whereas *Ostracoda*, similarly as *Copepoda* and *Cladocera*, which dominates at the preceding station, are here found in small numbers only. Larvae of *Psychoda* occur here also as single specimens. It was this station that the most numerous fauna (9982 individuals/2 dcm^3 substratum) was noted.

At stration 4, above the Rybie Stawki 100—120 m below the sewage outlet *Chironomidae* of the genus *Microcricotopus* (most probably *M. parvulus*) are the first dominant, the second being young stages of *Orthocladiinae*. *Oligochaeta* are still an important subdominant, whereas *Nematoda* loses its importance in the community. The fact that the substratum is richly covered with moss conditions the development of numerous species of the genus *Eukiefferiella* (*E.* gr. *bavarica*, *E. devonica*, *E. minor*). *Baetis alpinus* larvae occur as single specimens, *B. rhodani* and *B. muticus* being more numerous. Mayflies of the genus *Rhithrogena* are still absent. The total number of fauna is still very high (annual mean 6947 individuals/2 dcm^3 substratum).

At station 5, below the Rybie Stawki, 500 to 550 m from the sewage outlet, the same species dominate in the community as at station 3, i.e. young stages of *Orthocladiinae* and larvae of the genus *Thienemanniel-*

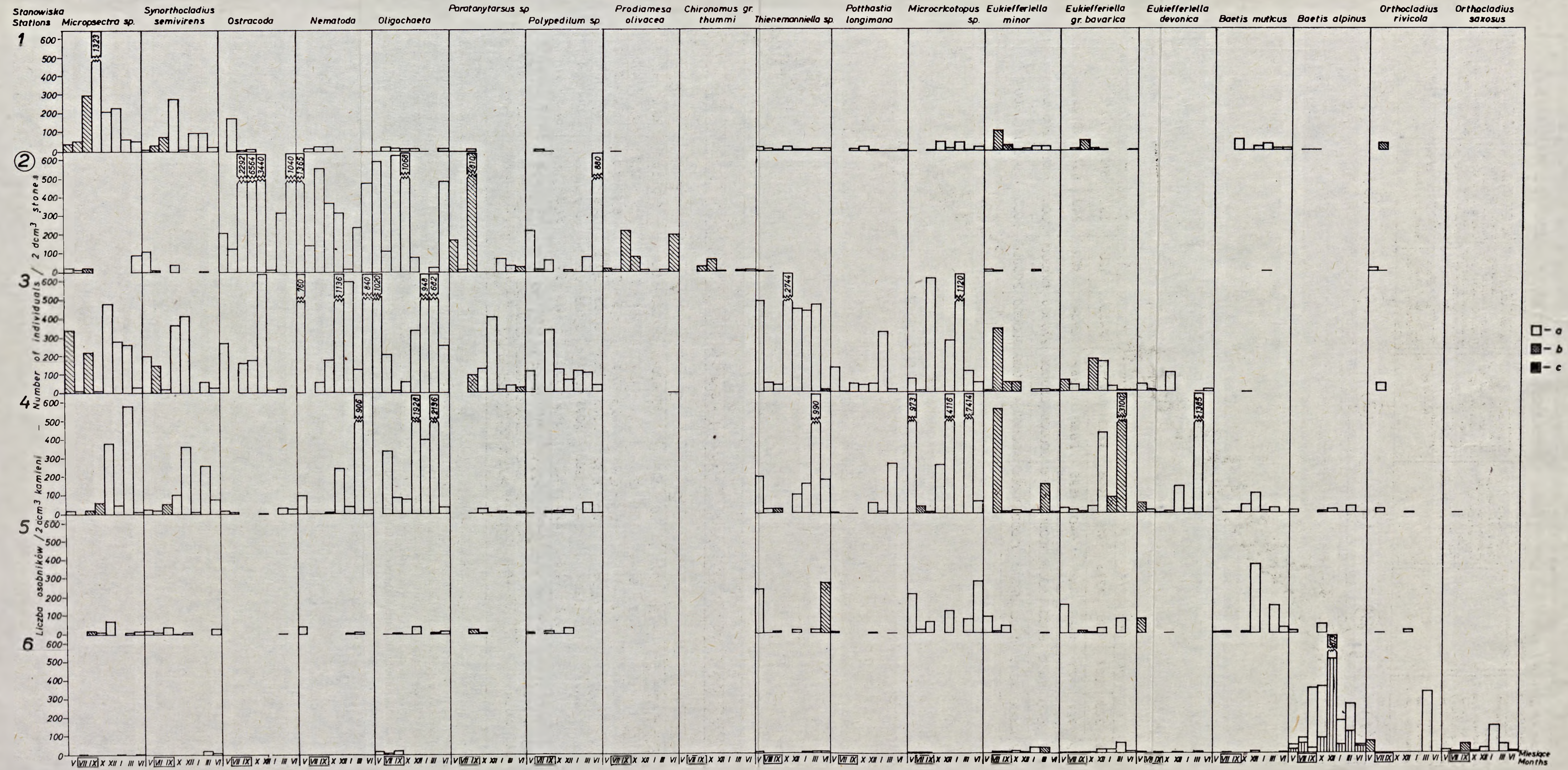


	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Σ	
1971	269	887	918	1273	414	1448	3293	4752	2450	500	59	810	17073	A
1972	721	1711	1020	1125	640	1595	2680	3362	2134	390	240	1157	16775	
1971	8000	7000	8000	5000	10000	60000	300000	350000	270000	150000	3000	7000	1205000	B
1972	10000	9000	11000	9000	15000	70000	400000	460000	300000	200000	6000	10000	1500000	

Stanowisko - Station	1	2	3	4	5	6
Odległość od ścieku (m) Distance from sewage	- (30 - 70)	0 - 10	15 - 30	100 - 120	500 - 550	3200 - 3250
Temperatura Temperature °C	1,2 - 12,4	1,2 - 12,6	1,2 - 12,4	1,1 - 11,9	1,1 - 12,7	1,2 - 10,9
pH	6,4 - 7	6,4 - 6,9	6,5 - 7,1	6,5 - 7,1	6,4 - 7,8	6,4 - 7
$N-NH_4$ mg/l	0 - 0,106	0,016 - 1,192	0,008 - 0,356	0,008 - 0,176	0,008 - 0,136	0 - 0,106
PO_4 mg/l	0 - 0,054	0,010 - 0,268	0,005 - 0,111	0,006 - 0,082	0 - 0,090	0 - 0,100
O_2 %	67,2 - 114,5	69,2 - 90,1	66,2 - 95,6	64,3 - 94	69,2 - 95,1	67,5 - 91,8
Pokrywa roślinna Plant cover	Mech Moss 25 - 50% Calothrix gipsophila	Mech Moss >25% Phormidium favosum Leptomitus lacteus >25%	Mech Moss 50 - 75% Phormidium favosum Leptomitus lacteus 25-50%	Mech Moss 50 - 75% Chlorophyta Leptomitus lacteus (skąpo - sparse)	Mech Moss >25% Oedogonium sp Hydrurus foetidus	Mech (skąpo) Moss (sparse) Hydrurus foetidus Homoeothrix janthina

Ryc. 3. Zespoły fauny dennej w Rybim Potoku na poszczególnych stanowiskach na tle czynników środowiska i natężenia ruchu turystycznego (zespoły scharakteryzowano na podstawie dominantów i subdominantów). Ilość turystów nocujących (A) i zatrzymujących się chwilowo (B) w schronisku Morskie Oko w latach 1971—1972 (dane kierownika schroniska mgr Czesława Łapińskiego)

Fig. 3. Bottom fauna communities in the Rybi Potok at particular stations against the background of environmental factors and tourist traffic intensity (communities were characterized on the basis of dominants and subdominants). The number of overnight tourists (A) and those visting briefly (B) at the shelter at Lake Morskie oko in the years 1971—1972 (data from the manager of the shelter Mr. C. Łapiński



Ryc. 4. Sezonowe zmiany liczebności ważniejszych przedstawicieli fauny dennej w Rybim Potoku. a — ogólna liczebność; b — okresy pojawu poczwarek u *Chironidae*; c — osobniki *Baetis alpinus* poniżej 2 mm. ② — miejsce dopływu ścieku. VII IX — okresy natężenia ruchu turystycznego. W styczniu na stanowisku 5 nie pobrano prób

Fig. 4. Seasonal changes in the number of more important representants of the bottom fauna in the Rybi Potok. a — total number; b — periods of occurrence of *Chironomidae pupae*; c — individuals of *Baetis alpinus* under 2 mm. ② — sewage outlet. VII IX period of increased tourist traffic. In January at station 5 no samples were taken.

la, whereas *Nematoda* and *Oligochaeta*, occurring only sporadically, have no importance. Among the mayflies *Baetis muticus* and *B. rhodani* are the most numerous, while larvae of *Diamesinae* are also an important element at this station. The total number of specimens is already relatively low (annual mean 2801 individuals/2 dcm^3 substratum).

An entirely different zoocenosis develops at station 6, 3300 m below the sewage discharge in the vicinity of the forest lodge at Wanta. The mayflies *Baetis alpinus* dominate in the zoocenosis. Among other mayflies, larvae of *B. muticus* and *B. rhodani* are here very rare, whereas larvae of the genera *Rhithrogena* (*R. iridina*, *R. hybrida*), and *Epeorus sylvicola* begin to occur. Of the *Chironomidae*, apart from the young stages of *Orthocladiinae*, larvae of *Orthocladius rivicola*, and *O. saxosus* occur numerously. An important component of the community are *Simuliidae*. *Oligochaeta* and *Nematoda* are found as single specimens.

When analysing the distribution of zoocenoses along the course of the Rybi Potok the influence of sewage on the bottom fauna communities is clearly seen. Several zones can be distinguished, each showing a different degree of this influence.

Just below the sewage outlet larvae of flies of the genus *Psychoda* are the main representant, these organisms being typical of the septic zone (Hynes 1962). The constant inflow of organic matter covering the substratum together with poorly oxidized water flowing from the sewage pipe, create exceptionally unfavourable developmental conditions for the stream fauna. This zone in a Tatra stream is extremely short, not exceeding even 1 m in length.

However, even 3 to 10 m below the sewage autlet the situation changes. Oxygen deficiency never occurs (fig. 3); on the contrary, a great amount of organic matter covering the stones with a thick layer an a slow current cause the development of a quite different zoocenosis. There occur crustaceans (*Ostracoda* and *Copepoda*), which can develop in masses where a slow current and a large amount of organic matter create favourable living conditions for them. Larvae of *Chironomidae* of the subfamilies *Chironomini* and *Tanytarsini* (*Paratanytarsus*), and the species *Prodiamesa olivacea* also find suitable amounts of nutrition in the sediments, rich in organic matter. Here occur larvae of *Chironomus* f.l. *thummi*, typical indicator forms of the polysaprobic zone (Sladeček 1973). At the same time there appear, even in large numbers, species of the genus *Diamesa* (*D. thienemanni*, *D. starmachi*), which have hitherto been reported as typical of the winter-spring zoocenosis of clean submontane rivers, their occurrence not having been associated with sewage. Apart from this, a number of organisms typical of clean waters are also found, which get there by chance and can survive in this zone for a long period of time. This zone should be defined as highly polluted; the term "polysaprobic" cannot be used for it, since the fauna and habitat conditions differ from those in a typical polysaprobic zone (S l a d e č e k 1973).

The next zone develops in the stream in a sector 30 to 150 m below the sewage discharge. The sewage acts here mainly by way of eutrophication, this causing a vigorous increase in the amount of fauna. The qualitative composition of the zoocenosis, however, is constant, with the same organisms dominating, the difference lying in the value of the index of dominance and the position occupied in the community. For example, *Oligochaeta* and *Nematoda* are more numerous nearer the sewage outelt, their share in the community subsequently decreasing. In places where the stream bottom is covered with moss over a large area, forms living in moss play an important role (genus *Eukiefferiella*).

Below the Rybie Stawki, which act as natural settling tanks, the stream becomes purified to a considerable degree. The total quantity of fauna decreases, whereas the community composition remains similar to that observed above these pond. Though *Oligochaeta* and *Nematoda* are found sporadically, a number of dominants and subdominants from the preceding zone still occur.

A different zoocenosis was observed at station 6, where the stream is already purified. The bottom fauna community developing here differs greatly from the one previously described, being, however, similar to that developing in other Tatra streams at the same altitude (K o w n a c k a 1971, K a w e c k a, K o w n a c k a, K o w n a c k i 1971).

It follows from the above observations that the influence of domestic sewage on the zoocenosis in a well-oxidated montane stream is slightly different from that shown in the schemes for polluted rivers (B a r t s c h, O n g r a m 1959, S l a d e č e k 1973). The zone where typical sewage organisms (*Psychoda*) develop is extremely short, not exceeding 1 m. There is no zone in which *Oligochaeta* of the family *Tubificidae* would occur (*Tubificidae* do not occur in the Rybi Potok and *Oligochaeta* are represented by *Naididae*). *Chironomus* gr. *thummi*, a leading form in the polysaprobic zone, occurs at station 2 but is only one of the adominants. In the stream below the sewage outlet a number of organisms characteristic for clean waters are also found. The bottom fauna communities in a polluted montane stream thus cannot be referred to the K o l k w i t z - M a r s s o n (1909) saprob system and its later modifications (S l a d e - č e k 1973). S a d o v s k i (1940) drew attention to this fact and introduced his own system, distinguishing two parallel classes of indicator organisms according to the degree of water oxidation; one class, characteristic of lowland rivers and lakes, corresponds with the Kolkwitz--Marsson's system, and the other is characteristic of montane rivers, ground waters, and springs.

The observed differences in the bottom fauna composition between stations 5 and 6 cannot be explained only by the change in sewage concentration. It should be supposed that if it were not for the pollution we would have two natural zoocenoses determining two zones in the Rybi Potok. The first would cover the outflow from Lake Morskie Oko and the sector of the stream flowing across the terrace below the moraine (stations 1 to 5). This conclusion would be corroborated by the fact that the majority of the subdominants at station 1 are also subdominants at stations 3, 4, and 5 (fig. 3). Among the mayflies, *Baetis muticus*, *B. rhodani*, and *B. vernus*, and not *B. alpinus* and species of the genus *Rhithrogena*, prevail here. These species are characteristic rather of streams and submontane rivers. The gradient of 6 to 10‰ in this sector is also the same as that of the streams flowing at the foot of the Tatra Mts, whereas the gradient at station 6, where a zoocenosis typical of montane forest streams develops, is 113‰, similarly as in other Tatra streams. These observations would affirm the importance of the gradient in the distribution of aquatic organisms in streams ("the gradient principle" — Huet 1954, Starmach 1956).

Influence of sewage on the development of bottom forms of the fauna dominating in the Rybi Potok

In the investigated stream some groups of organisms can be distinguished in dependence on their reaction to the influence of sewage (fig. 4). In this division dominants, subdominants, and more important adominants were considered. Some of them are discussed in detail below. In this discussion species were taken into account, but not those higher taxonomic units which could not be closely identified (e.g. *Nematoda*) or those which were the subject of a separate elaboration (e.g. *Oligochaeta* — Dumnicka 1976, *Copepoda* and *Cladocera* — Smagowicz).

Organism of the polluted zone

Organisms living in the highly polluted zone. Species and animal groups occurring exclusively or in great masses at stations 2 and 3 and found as single specimens at others are included in this group.

Candona (*Candona*) *candida* (Müller) — throughout the year this species constitutes over 90 per cent of the total taxocene of *Ostracoda* at station 2. It developed in masses from September till December. In other months it is less numerous, a quantitative increase being observed only in June (fig. 4). It is a ubiquitous and widespread species. In our climatic zone it occurs only in autumn, winter and spring (S y w u l a 1974). So far its relation to sewage has not been determined. Its mass appearance in the Rybi Potok is most probably associated on the one hand with the increase in organic matter accumulated after the period of increased tourist traffic, and on the other with the decrease in water temperature in the stream. At other stations this species is of less importance.

Prodiamesa olivacea (M e i g.) — at station 2 larvae of this species occur more numerously from September till October and in June. In those periods pupae (fig. 4) were observed to appear. At stations 1 and 3 single specimens were found. S z c z ę s n y (1974) report it from the upper sector of the Kryniczanka stream in a muddy habitat. It was also found in a limnocrenous spring near Cracow (K o w n a c k i, unpublished materials) and in the Prądnik stream it was very numerous along the whole course in muddy habitats and being a dominant in the source (D r a t n a l 1976). This species was also numerous in the sewage polluted Mettma stream (Black Forest) where it inhabited integuments of bacteria *Sphaerotilus notens*, which, us laboratory investigations showed, constituted its foot (J a n k o v i č 1974). L e h m a n n (1971) considers this species to be eurythermic and eurytopic. It seems, however, that it requires a muddy habitat with a great amount of organic matter, a slow current, and low water temperature. It can thus develop below a sewage outlet if the above conditions are satisfied. It cannot, however, be regarded as an indicator species of the β-α mezosaprobic zone (S l a d e č e k 1973), even though it can also develop there in masses (T h i e n e m a n n 1954).

Chironomus gr. *thummi* — We did not succeed in identifying precisely the larvae and pupae of this form. They were found exclusively at station 2 from September till October. At another time single larvae (fig. 4) only were caught. The appearance of that species at that time may be associated with the increase in organic matter caused by mass touristic traffic in the summer season. It is a form characteristic of a highly polluted (H y n e s 1962) or polysaprobic zone (S l a d e č e k 1973).

Polypedilum sp. — occurred at station 2 in large numbers in May and June, i.e. in a period of lower sewage concentration. However, at station 3, at which a gradual mineralization of sewage already takes place, it occurred from September till March. It may be supposed that larvae of this genus prefer an environment in which sewage is already slightly purified.

Paratanytarsus sp. — it was not possible to define the larvae and pupae as to species. Numerous larvae were found at stations 2 and 3, pupae occurring from May till June and then in September (fig. 4). No distinct correlation could be observed between the intensification of tourist traffic and their development, most probably this being dependent on the biology of the species.

Organisms developing in the zone of high eutrophication of the stream water by sewage. Species which developed in masses at stations 3 and 4, and sometimes 5, while occurring only sporadically at others, were included in this group.

Thienemaniella sp. — the absence of adult forms made precise identification impossible. Larvae of this species occurred abundantly at station 3 from autumn till spring. During the period of increased tourist traffic — from July till September — a decrease in their number was noted. At station 4 the development of larvae takes place also in the winter months, their total number, however, being smaller. On the other hand, below the Rybie Stawki (station 5) an increase in number took place in May and June, pupae occurring at the same time. At stations 1 and 6 only single specimens were found (fig. 4). The genus appeared in other Tatra streams at the same altitude in great numbers in June (Kownacki 1971). In a small stream near Schlitz (Hessen, GFR) species of this genus were also a form dominating among the aquatic vegetation (moss, algae) overgrowing the stones (Ringe 1974). A mass occurrence of *Thienemanniella* larvae at stations below the sewage outlet is, without any doubt, connected with an exceptionally strong development of the vegetation cover there. The decrease in number during the summer period at stations 3 and 4, however, may be caused by two factors: either the concentration of sewage is at that time too high for these larvae or a mass emergences take place (though no pupae were found).

Potthastia longimana (Kieff.) — larvae of this species were caught throughout the year at stations 3 and 4, their maximum number, however, being reached in the winter. At stations 1 and 5 single specimens only were found. They were absent below the sewage outlet (station 2) and in a typical, unpolluted Tatra stream (station 6, fig. 4). Hitherto this species had been found as single specimens in the Tatra streams below an altitude of 850 m (Kownacki 1971, Ertlowa 1964). The appearance of this species in the Rybi Potok is obviously connected with the increase in water trophy caused by sewage.

Microcricotopus sp. — this is most probably *M. parvulus* (Kieff.) since its pupae were found at station 4. Young larval stages developed in masses at station 3 and especially station 4 in winter, whereas older larval stages and pupae were found in the summer months. At stations 1 and 5 they were less frequent, while they were completely absent at station 2 below the sewage outlet and were caught only as single individuals at station 6 (fig. 4). In the Tatra streams larvae of this genus have been found only in small numbers (Kownacki 1971). Lehmann (1971) characterized *M. parvulus* (Kieff.) as a rheophile-rheobiont, inhabiting stones and the vegetation overgrowing them. It is possible that the rapid increase in the number of this species in the Rybi Potok at station 4 is connected with the development of the vegetation cover.

Organisms showing tolerance for sewage

Species developing at stations 1 to 5 which do not avoid places of high pollution, though their development might be weaker, have been included in this group. Their development here is most probably conditioned by factors other than sewage.

Micropsectra sp. — this is most probably *M.* gr. *atrofasciata*. Larvae and pupae occurred at stations 1 to 5 fairly numerously, at station 6 only single specimens being caught. At station 1 larvae of this genus occur throughout the year. Their maximum number in October was caused by a mass development of young forms. From May till September pupae were found. Such a development curve is characteristic of species of this genus, a similar situation being reported from the Olszowy stream, a montane tributary of the River Raba (Kawecka, Kownacki 1974). At the station below the sewage outlet, on the other hand, deflections occur in the course of the curve. At station 2, below the sewage outlet, larvae and pupae are found only during the summer season but at stations 3 and 4 throughout the year, great differences in number, however, being observed in particular months. Changes in number are certainly caused by a change in the sewage concentration.

Synorthocladius semivirens (Kieff.) — at station 1 the development curve of this species is very similar to that of the species of the preceding genus. Maximum number occur in October, pupae being reported from July till September. At station 2 a considerable decrease in the number of larvae is observed. A consecutive increase is observed at stations 3 and 4 but at station 3 the development curve is very uneven, at station 4 becoming similar to that from station 1. At station 5 their number again decreases, at station 6 only single specimens being found (fig. 4). This species is characteristic of submontane streams and rivers, in the Tatra streams above an altitude of 1000 m usually being found sporadically (Kownacki 1971). Lehman (1971) considers it to be characteristic of the potamone. The development of this species in the Rybi Potok seems to be caused, on the one hand, by increased trophy in the stream and on the other by a decrease in the gradient. Although it avoids high sewage concentration (it was absent in September at station 2 and small numbers were reported from station 3), it reacts indifferently to a low one.

Baetis muticus L. — this species develops at station 1 and occurs again at stations 4 and 5. Below the sewage outlet (stations 2 and 3) only single specimens are found, these being brought there by chance. In streams it usually develops below an altitude of 1100 m (Kownacka 1971, Sowa 1975 a) and rather in small numbers (Müller-Liebenau 1969).

Organisms of the pure zone

To this group belong organisms which do not occur in the polluted zone or in the zone of strong water eutrophication by sewage.

Baetis alpinus Pictet — at station 6 young larvae of this species occur in great numbers from late autumn until spring, their maximum taking place in December. In successive months the participation of older larvae increases, whereas their number decreases. From May till July the emergence of adult forms takes place. A similar development course for the species is given by Sowa (1975 b).

STRESZCZENIE

Rybi Potok wypływający z Morskiego Oka na wysokości 1393 m n.p.m. przepływa przez rezerwat ścisły na terenie Tatrzańskiego Parku Narodowego i wpływa do Białki na wysokości 1085 m n.p.m., po przepłynięciu 4 km. W górnym biegu przyjmuje niecałkowicie oczyszczone ścieki schroniska turystycznego przy Morskim Oku. Ścieki powodują rozwój charakterystycznych zoocenoz pozwalających na wydzielenie kilku stref.

1. Strefa septyczna — w odległości do 1 m od ujścia ścieków. Prócz larw muchowek z rodzaju *Psychoda*, małej ilości *Oligochaeta* i *Nematoda* praktycznie brak fauny.

2. Strefa silnego zanieczyszczenia — 3—10 m poniżej ujścia ścieków. Rozwija się zespół, w którym dominują *Ostracoda*, *Oligochaeta*, *Nematoda*, *Chironomidae* (*Prodiamesa olivacea*, *Tanytarsini* — *Paratanytarsus* i *Chironomini* z przewodnią dla ścieków formą *Chironomus* gr. *thummi*), brak natomiast jętek, widelnic, chruścików.

3. Strefa samooczyszczania — rozciąga się na odcinku 30—500 m poniżej zrzutu ścieków. Na tym odcinku zmineralizowane ścieki oddziałują troficznie na faunę. W zespole występują gatunki charakterystyczne dla czystych potoków i rzek podgórskich (*Diamesa thienemanni*, *D. starmachi*, *Synorthocladius semivirens*, *Potthastia logimana*, *Baetis rhodani*, *B. muticus*), dla odcinków zanieczyszczonych (*Nematoda*), formy spotykane w czystych potokach tatrzańskich tu rozwijające się masowo (*Microcricotopus* sp., *Thienemanniella* sp.) i wreszcie gatunki związane z pokrywą roślinną porastającą kamienie (fauna mcholubna — rodzaj *Eukiefferiella*). Jakościowy skład zespołu na stanowiskach w tej strefie nie wykazuje większych różnic. Natomiast w górnej partii tej strefy powyżej Rybich Stawków odgrywających rolę naturalnych osadników obserwujemy gwałtowny wzrost ogólnej ilości fauny i większy udział form ściekolubnych. Poniżej stawków ilość fauny znacznie się zmniejsza, a gatunki ściekowe nie odgrywają już takiej roli w zoocenozie.

4. Strefa czystego potoku reglowego. Rozwijający się tu zespół jest bardzo podobny do tego, jaki spotyka się w innych potokach na tej wysokości. Dominuje *Baetis*

alpinus, młodociane larwy z rodzaju *Diamesa*, *Orthocladius (Euorthocladius) rivicola*, *O. (Euorthocladius) saxicola*. Ogólna ilość fauny jest już bardzo niska. Powyższą zoocenozę zaobserwowano na stanowisku 6, 3200 m poniżej ścieku. Można jednak przypuszczać na podstawie analogii do innych potoków tatrzańskich, że zoocenoza ta rozwija się już 1000 m poniżej Morskiego Oka.

Gdyby nie było zanieczyszczeń, to prawdopodobnie można by wyróżnić w Rybim Potoku dwie strefy:

a. Wypływ z Morskiego Oka i potok płynący przez taras o spadku jednostkowym 6—10‰, gdzie rozwijają się zoocenozy charakterystyczne dla potoków podgórskich (*Synorthocladius semivirens*, *Baetis rhodani*, *B. muticus*).

b. Strefa typowego tatrzańskiego potoku reglowego o spadku około 80‰, gdzie dominuje *Baetis alpinus*.

W potoku możemy rozróżnić kilka grup organizmów w zależności od ich reakcji na działanie ścieków:

1. Organizmy strefy zanieczyszczonej — zaliczono tu gatunki i formy żyjące w strefie silnego zanieczyszczenia (*Candona (Candona) candida*, *Prodiamesa olivacea*, *Chironomus* gr. *thummi*, *Polypedilum* sp., *Paratanytarsus* sp.) oraz w strefie zeutrofizowania wody potoku przez ścieki (*Thienemanniella* sp., *Potthastia longimana*, *Microcricotopus* sp.).

2. Organizmy wykazujące tolerancję na działanie ścieków (*Micropsectra* sp., *Synorthocladius semivirens*).

3. Organizmy wód czystych unikające ścieki (*Baetis alpinus*).

Reasumując, należy stwierdzić, że długość strefy, gdzie ścieki działają toksycznie w Rybim Potoku, jest bardzo krótka, około 1 m. Natomiast dłuższy jest odcinek potoku, w którym rozwój naturalnych zoocenoz został zakłócony, a wzrost troficzności wody powoduje rozwój form nietypowych dla potoku tatrzańskiego. Pamiętając, że Rybi Potok płynie przez rezerwat ścisły na terenie Tatrzańskiego Parku Narodowego, należy dążyć do stworzenia takiego systemu ochronnego, który pomimo nieuniknionego rozwoju turystyki, będzie całkowicie likwidował ścieki schroniska.

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