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Fauna denna potoku Sucha Woda (Tatry Wysokie) w cyklu rocznym

The bottom fauna of the stream Sucha Woda (High Tatra Mts) in the annual cycle

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Abstract — The bottom fauna in the stream Sucha Woda was chiefly represented by larvae of insects, especially of flies (dominant *Chironomidae*), mayflies, stone-flies, and caddis flies. The distribution of these groups showed a distinct „etagement", as well as quantitative and qualitative differences according to the height and the velocity of the current. Above 1550 m the fauna is poor both qualitatively and quantitatively (30—80 idividuals per 2 dcm³). The dominant forms are *Diamesa* gr. *latitarsis* (*Chironomidae*). One quantitative peak is observed here in September, brought about chiefly by *Diamesa* gr. *latitarsis* and by some stone-flies, and *Simuliidae*. At the altitude 1550—1000 m the number of species and individuals greatly increases in the stream. *Eukiefferiella minor* and *Parorthocladius nudipennis* (*Chironomidae*), as well as *Baetis alpinus* and *Rhitrogena loyolaea* (*Ephemeroptera*) predominate here. A thrice repeated increase in fauna was noted in winter (the greatest), in spring, and summer. Below 1000 m a number of species characteristic of rivers with a small gradient and a higher content of calcium appear in the stream. A large number of individuals are noted (510 per 2 dcm³). The dominant forms are *Orthocladius rivicola* and *O. thienemanni* (*Chironomidae*). The fauna increases three or four times in number. The smallest number of individuals is noted in winter and the greatest in summer.

The present work, forming part of collective investigations [including the physiography and character of the substratum (Pasternak 1971), the chemical composition of the water (Bombówna 1971), alga communities (Kawecka 1971) and taxocens of *Chironomidae* (Kownacki 1971) of the streams of Polish Tatra Mts] carried out by the Laboratory of Water Biology of the Polish Academy of Sciences under the direction of Prof. Karol Starmach, limed at determining the

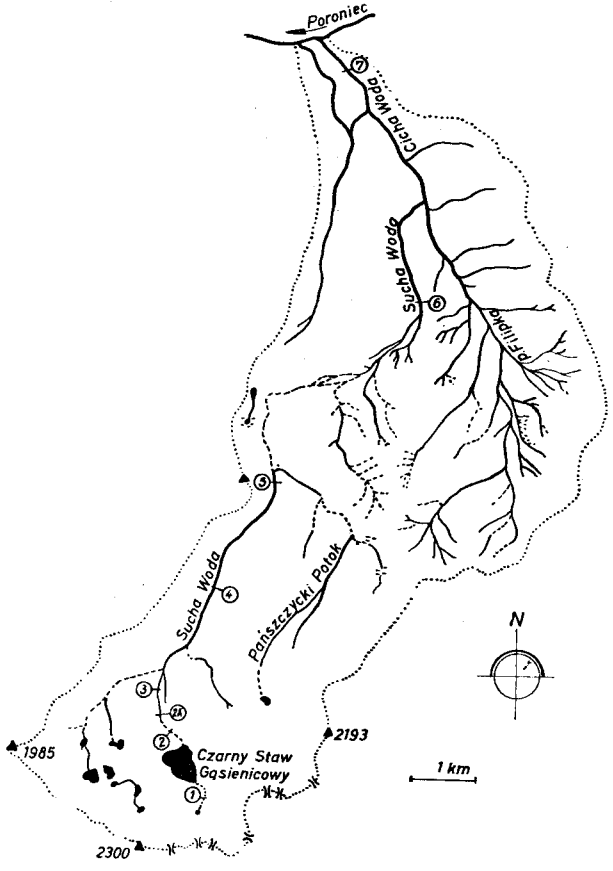
quantitative relationships in the zoocoenoses of streams in the High Tatra Mts, and especially at showing the quantitative and qualitative differences depending on the altitude and the seasons.

The stream Sucha Woda was chosen for these investigations, since it is the longest stream in the Polish part of the High Tatra Mts, flowing through all altitudinal floristic zones.

No systematic faunistic investigations have as yet been carried out in this stream, mention of its fauna being only made in some works dealing with particular groups of insects from the Tatra Mts (Steinberg 1935, Kamler 1960, Wojtas 1964, Zwolski 1964).

Mode of investigations

Samples in the stream Sucha Woda were collected at seven points (fig. 1) from May 1965 to May 1966 at approximately monthly intervals.



Ryc. 1. Mapa potoku Sucha Woda

Fig. 1. Map of the Sucha Woda stream

Towards the end of 1965 additional points were chosen (2 and 2A), at which from December 1965 to November 1966 samples were taken. At each of these stations 10 quantitative samples (5 in the winter months) were collected from a stony substratum with a sampler (having a net of 0.3 mm meshes). Moreover, qualitative samples were collected from moss and places of stagnant water (when the quantitative sample could not be collected).

To distinguish the zoocoenoses within each sampling-point the index of dominance (d) was calculated, i. e. the ratio of the mean number of individuals of the given species in the series of samples × 100 to the sum total of the mean numbers of individuals of all species in the series, multiplied by the frequency.

The frequency is the relation between the number of samples in which the given species occurred and the number of samples in the series. According to the index of dominance, whose value lies within the interval 0 to 100, three groups of organisms were distinguished: dominants of a value of the index of dominance 10 to 100, subdominants (index of dominance 1 to 9), and adominants from 0 to 0.9. According to the index of dominance, communities were distinguished at the particular stations, serving subsequently to mark out zones of the stream. Annual changes in the quantity of fauna were considered on the basis of changes in the number of individuals in 2 dcm^3 of stones.

It seems that if the problem of converting the amount of material to a unit is essential in the elaboration of one group of fauna, in the elaboration of the whole bottom fauna the mode of sampling and segregating the material is more important.

Some authors, when elaborating the bottom fauna quantitatively (Obr 1956, Winkler 1957, 1963, Pawłowski 1959), took into account only larger larval stages, this being evidenced by the list of species reported in these works. In such elaborations the share of the particular groups of animals in the bottom fauna does not correspond to their actual state.

The author's observations carried out so far, as well as the data reported by Sowa (1965), Dratnal, Szczęsny (1965), and Kownacka, Kownacki (1965), showed a qualitative and quantitative predominance of Diptera in the Carpathian rivers. On the other hand, in the bottom fauna of the Carpathian river Orava (Obr 1956) the percentage share of *Diptera* was very small. The author reports only forms of over 8 mm in size.

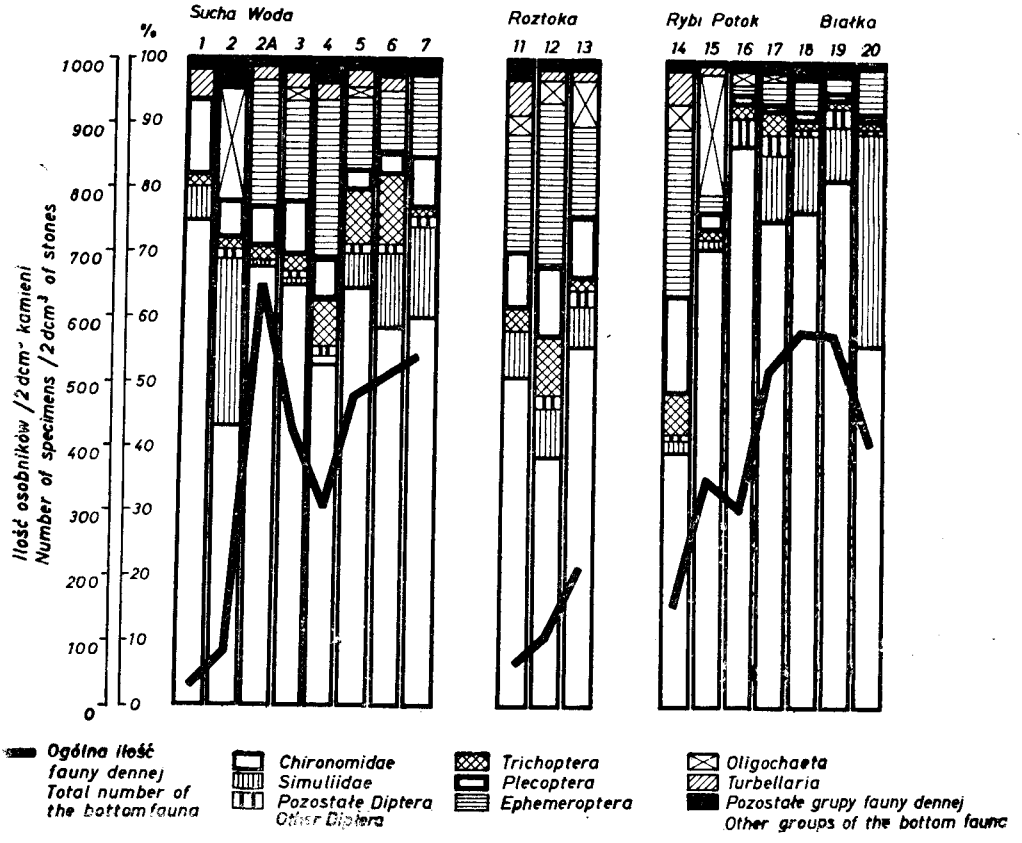
In quantitative elaborations concerning the fauna of flowing waters it would therefore be expedient to report the smallest size of the investigated individuals. The division into micro- and macrobenthos generally applied was complemented in the present work by the notion mesobenthos (Żadin 1965), by which animals 2 to 8 mm in size were determined. Organisms below 2 mm were regarded as microbenthos and those above 8 mm as

macrobenthos. The majority of *Diptera* (*Chironomidae, Simuliidae,* and *Empididae*) larvae, of mayflies and stone-flies, as well as the juvenile stages of these groups in the investigated stream belonged to the mesobenthos. Mesobenthos is the chief quantitative component of bottom fauna in the streams of the Tatra Mts.

In the present work animals belonging to the macro- and microbenthos were exclusively taken into account.

Results

The share of the particular systematic groups in the bottom fauna at the successive stations in the stream Sucha Woda in comparison with other streams of the High Tatra is presented in fig. 2. The bottom fauna of



Ryc. 2. Ogólna ilość fauny dennej na tle procentowego składu fauny w potoku Sucha Woda w porównaniu z innymi potokami Tatr Wysokich

Fig. 2. Total number of the bottom fauna on the background of percentage composition of the bottom fauna in the Sucha Woda stream in comparison with other streams of the High Tatra

the stream consisted chiefly of larvae of insects constituting on the average over 95 per cent of the total number of animals. The other groups were represented by *Turbellaria,* 0.3—3 per cent, *Oligochaeta,* about 1 per cent on the average (exceptionally 18 per cent), and *Hydracarina,* never exceding 1 per cent of the total number of animals. Single specimens of *Hirudinea* and *Mollusca* were found, but they played only an insignificant role in the whole of the bottom fauna. No representatives of crustaceans, especially of amphipods, were encountered though, e. g. in the Beskid stream Wielka Puszcza, they were among the chief representatives of the fauna (S o w a 1965). Only one specimen of *Niphargus* s p. was faund.

Diptera larvae of the family *Chironomidae* were among insects the most numerous group of the bottom fauna. They predominated in the stream both with regard to the number of species and the number of individuals (44—75 per cent of the total number of animals). The essential element of the fauna were *Simuliidae,* especially in the high-mountain and submontane part of the stream (in some cases they represented up to 20 per cent, and on the average 5—10 per cent of the whole fauna). At an altitude below 1550 m the essential component of fauna in the stream were mayflies (10—25 per cent), stone-flies (3—10 per cent), and caddis flies (1—12 per cent). The other groups of insects occurred in small numbers, their value being expressed in fractions of a one per cent.

The present work aimed at determining the quantitative ratios between the particular components of the zoocoenosis; hence all groups and all developmental stages were taken into account. However, their systematic elaboration presented great difficulties. The mode of preservation applied made it impossible to determine some groups, such as, e. g., *Hydracarina* or *Turbellaria.* Little is hitherto known about the larval stages of insects living in water and frequently they cannot be determined. For this reason the dominant groups of *Ephemeroptera, Plecoptera,* and *Trichoptera* were more fully elaborated. Adult forms were caught for this purpose, since in many cases the determination is possible only on such a basis. *Chironomidae* were elaborated separately (K o w n a c k i 1971), while in the present work only the dominant species were taken into account. On the basis of the materials from Sucha Woda 20 species of mayflies were determined 18 of them being reported from this stream for the first time, and two — *Baetis melanonyx* and *Rhithrogena* sp. (*hercynia*?) — are new for Poland. The list presented includes almost all mayflies hitherto found in the Tatra Mts, with the exception of lacustrine species reported by H r a b e (1942), Z e l i n k a (1952), and K a m l e r (1960).

In the stream Sucha Woda only 39 species of stone-flies were found, hence fewer than was reported by W o j t a s (1964) from this stream. The present author did not succeed in finding particularly those species which in W o j t a s' material occurred sporadically (usually a single specimen

at one station). The new species for this stream are *Diura bicaudata* and *Brachyptera starmachi,* and for the Tatra Mts *Leuctra moselyi.*

38 *Trichoptera* species were determined from the stream Sucha Woda, this representing about one fourth of all *Trichoptera* known from the whole Tatra Mts (129 species), and about one third of *Trichoptera* known from the Polish part of these mountains. *Trichoptera* from Sucha Woda had not previously been determined. It was only on the basis of the author's materials that Szczęsny (1967) described 3 new species.

Diptera in the stream Sucha Woda were chiefly represented by *Chironomidae,* among which 70 forms were determined (Kownacki 1971).

Communities of bottom fauna along the course of the stream

The quantitative and qualitative composition of communities of bottom fauna determined on the basis of the index of dominance varies at the particular stations along the course of the stream (Table I).

Chironomidae (*Diptera*) are the dominant group, but at different stations various species of them prevail. At stations 1 and 2 *Diamesa gr. latitarsis* larvae are dominants.

At station 1 the important dominants among flies are *Simuliidae* larvae and larvae of stone-flies (*Protonemura brevistyla*). The triclad (*Planaria alpina*) is also often encountered.

At station 2 the essential element of the fauna are *Simuliidae* larvae, whereas larvae of stone-flies of the genus *Protonemura* occur as single specimens. *Oligochaeta* play an important role here. Larvae of species of stone-flies, such as *Amphinemura standfussi* and *Planaria alpina,* are also often encountered. The other groups of animals at the two stations are chiefly represented by individuals in the first stages of development, occurring in small numbers and only in few samples (adominants B). Worthy of note is the almost entire lack of representatives of *Ephemeroptera* at these stations. It was only at station 2 that single larvae at the first developmental stages appeared in the autumn. Both the number of taxonomic units and that of individuals (30—80 per 2 dcm^3 of stones) is very small.

Station 2A, lying 50—100 m belowe station 2, differs essentially from those described above. Larvae of *Chironomidae (Eukiefferiella minor* and *Parorthocladius nudipennis*) and of mayflies (*Baetis alpinus*) predominate here. Mayflies *Rhithrogena tatrica* * and stoneflies of the genus *Protonemura* are subdominants. Important components of the zoocoenosis are the triclad *Planaria alpina,* larvae of the beetle *Elmis* sp., stone-flies *Capnia vidua, Isoperla sudetica* (small), and larvae of caddis flies of the genus *Rhyacophila,* especially *Rhyacophila tristis.* Many new species appear. The

* According to new nomenclature *Rithrogena tatrica* Zel. = *Rh. loyolasa* Nevás.

Tabela I. Zoocenozy na poszczególnych stanowiskach w Suchej Wodzie ułożone według wskaźnika dominacji

Table I. Zoocenoses at the particular stations in Sucha Woda arranged according to the indices of dominance

Wartość wskaźnika dominacji
Values of the indices of dominance

- dla dominantów 1 / for dominants 1
- dla dominantów 2 / for dominants 2
- dla subdominantów / for subdominants
- dla adominantów A / for adominants A

cyfry bez ramek — dla adominantów B
figures without frames — for adominants B

Stanowisko Station	I Strefa Zone I		II Strefa Zone II				III Strefa Zone III	
	1	2	2A	3	4	5	6	7
Chironomidae	57,4	55,9	69,8	65,8	53,87	62,08	56,9	60,4
Simuliidae	1,6	16,9	0,05	0,20	0,77	2,4	7,4	11,9
Baetis alpinus			16,8	8,7	10,7	6,88	2,3	2,5
Protonemura brevistyla	2,7	0,001	0,001	0,023	0,009	0,0008		
Oligochaeta	0,06	8,9	0,008	0,49	0,041	0,81	0,09	0,027
Rhithrogena tatrica			3,17	4,8	7,7	0,37	0,0003	0,002
Protonemura sp. (juv.)		0,003	2,1	1,1	0,6	0,45	0,17	0,46
Leuctra sp. (juv.)	0,14		0,006	1,4	1,5	0,29	0,92	2,0
Planaria alpina	0,86	0,38	0,69	1,1	2,1	1,1	1,2 ?	0,09 ?
Elmis sp.			0,34	1,26	0,002			
Limnephilidae (juv.)	0,19	0,20	0,045	0,24	2,6	3,4	0,7	0,023
Synafophora intermedia						0,012	3,72	0,019
Baetis sp (juv.)		0,008					1,27	2,05
Amphinemura standfussi		0,64						
Plecoptera (juv.)	0,002	0,57	0,41	0,14	0,048	0,09	0,04	0,11
Rhyacophila tristis			0,32	0,12	0,01	0,00004	0,0003	0,0005
Capnia vidua			0,28	0,13	0,09	0,06		0,0005
Rhyacophila sp. (juv.)	0,008	0,06	0,25	0,11	0,11	0,023	0,20	0,0005
Isoperla sudetica			0,21	0,20	0,04	0,006	0,00001	0,0005
Hydracarina	0,003	0,001	0,17	0,09	0,02	0,15	0,54	0,34
Leuctra rosinae	0,065		0,010	0,17	0,02	0,0004	0,0004	0,0005
Ameletus inopinatus			0,00002	0,01	0,31	0,007	0,0005	0,0004
Drusus discolor			0,06	0,04	0,12	0,001	0,002	0,0005
Rhithrogena hybrida					0,0002	0,0002	0,35	0,0003
Rhithrogena ferruginea carpathica						0,07	0,27	0,029
Glossosomatidae				0,0001		0,0008	0,16	0,010
Drusus sp.				0,007	0,07	0,059	0,16	0,0002
Ecclisopteryx madida						0,021	0,14	
Leuctra gr inermis			0,007	0,03	0,008	0,001	0,11	0,16
Baetis rhodani							0,025	0,69

number of taxonomic units is higher than at stations 1 and 2, but lower than at the other ones. The number of individuals increases, being the highest of all those noted in the stream (666 individuals per 2 dcm^3 of stones). This is due to the mass development of *Chinonomidae* and of juvenile stages of *Ephemeroptera*.

At station 3 the specific composition is similar to that at station 2A, though the value of the index for the dominant species decreases here. Among *Chironomidae Eukiefferiella minor* continues to prevail, but *Parorthocladius nudipennis* shows only a slightly lower value of the index. The other two dominant species: *Chironomidae Eukiefferiella bavarica* and larvae of *Cricotopus* g r. *algarum* have an index similar to the first two species. The first subdominant are larvae of mayflies (*Baetis alpinus* and *Rhithrogena tatrica*); *Planaria alpina, Leuctra* s p., and *Elmis* s p., which previously were adominants, are now among the subdominants. On the other hand, a smaller share of *Rhyacophila* larvae was noted in the community. Many new taxonomic units appear, but the number of individuals (442 per 2 dcm^3 of stones) is lower than at station 2A.

The chief dominant at station 4 are larvae of *Parorthocladius nudipennis* (*Chironomidae*), the next one mayflies (*Baetis alpinus, Rhithrogena tatrica*) being the first subdominant. Small larvae of *Limnephilidae, Planaria alpina,* and *Leuctra* s p. are important subdominants. The number of taxonomic units is similar to that noted at the neighbouring stations, but the number of individuals (309 per 2 dcm^3 of stones) is smaller.

At station 5 *Parorthocladius nudipennis* also predominates, having, however, a lower index than at station 4. The first subdominants are the midge *Orthocladius rivicola* and the mayfly *Baetis alpinus,* the other one being *Planaria alpina* and small *Limnephilidae* and *Simuliidae* larvae. The mayfly *Rhithrogena tatrica,* an important component of the previous stations, plays no essential role here. The number of taxonomic units is similar to that noted at stations 3 and 4, but the number of animals increases (482 per 2 dcm^3 of stones).

At stations 6 and 7 larvae of the midge *Orthocladius rivicola* and *Orthocladius thienemanni* are the dominant forms. The first subdominant (station 6) or the second dominant (station 7) are *Simuliidae* larvae. The mayfly *Baetis alpinus* continues to be one of the subdominants, while *Rhithrogena tatrica* was encountered only in winter as single specimens. The latter species was replaced at this station by others of the genus *Rhithrogena,* especially by *Rhithrogena ferruginea, R. carpathica, R. hybrida* (station 6), *Rhithrogena* s p. (*hercynia*), and *R. semicolorata* (station 7). The importance of larvae of these species is no longer the same as was that of *Rhithrogena tatrica* at the previous stations. At stations 6 and 7 there appear many new species of mayflies of the genus *Baetis* (*Baetis rhodani, B. sinaicus, B. fuscatus, Ecdyonurus* (*Ecdyonurus* s p., *E. torrentis, E. venosus*), *Epeorus assimilis, Habroleptoides modesta,* and *Ephemerella*

krieghoffi, and of stone-flies *Isoperla oxylepis* and *Chloroperla tripunctata,* whose index of dominance value is still low, though they acquire importance in the community. The other subdominant at station 6 are larvae of *Synafophora intermedia,* which only here develop in masses. It was also at this station that the only specimen of *Niphargus sp.* was caught. At station 7 the presence of the snail *Ancylus fluviatilis* was noted for the first time, as well as that of the leech, of single mayflies *Caenis rivulorum, Ephemerella ignita,* and *Habrophlebia lauta,* of caddis flies *Rhyacophila mocsaryi,* and of larvae of the genus *Hydropsyche.* The number of taxonomic units is similar at the two stations (slightly increasing at station 7), and so is the number of individuals (513 per 2 dcm^3 of stones at station 6 and 539 per 2 dcm^3 of stones at station 7).

Observations of the distribution of the three dominant groups of *Ephemeroptera, Plecoptera,* and *Trichoptera* of bottom fauna show a zoning in the occurrence of some species.

In the high-mountain part of the stream mayflies do not occur (juvenile stages of *Rhithrogena tatrica* and *Baetis alpinus* are sometimes encountered).

From the altitude of 1550 to 1200 m above sea-level the fauna of mayflies is represented by only three species: *Baetis alpinus, Rhithrogena tatrica,* and *Amelatus inopinatus.* In the lower section of the stream, flowing in the forest zone at an altitude of 1200—900 m, apart from the above-mentioned species, *Baetis melanonyx, Rhithrogena semicolorata, and R. hybrida* occur. Below 900 m above sea-level *Rhithrogena tatrica* are no longer encountered, while a number of new species appear. These are *Baetis sinaicus, B. scambus* and *B. fuscatus, B. moticus, B. rhodani, Epeorus assimilis, Ecdyonurus* sp., *E. torrentis, E. venosus, Rhithrogena* sp., *Habroleptoides modesta,* and *Ephemerella krieghoffi.* In the lower section of the stream Sucha Woda, called Cicha Woda, three further species appear: *Habrophlebia lauta, Ephemerella ignita,* and *Caenis rivulorum* (Table II).

When analysing the vertical distribution of stone-flies in the stream the observations of both Wojtas (1964) and the present author were taken into account (Table III).

Above the altitude of 1550 m species of a wide vertical range occur, these being *Leuctra rosinae* and *Amphinemura standfussi* encountered along the whole lenght of the stream, as well as *Protonemura auberti* and *P. brevistyla* absent only at station 7. In the forest zone at an altitude of 1500—1000 m the largest number of species was found. (Wojtas reports their greatest number from a height of 1200—900 m above sea-level). At station 7 they become less numerous, but at the same time a number of new species appear, such as *Amphinemura borealis, Leuctra albida,* and *L. fusca.*

In the highest sections of the stream *Trichoptera* were represented

Tabela II Rozmieszczenie jętek w potoku Sucha Woda
(na podstawie średnich rocznych ilości osobników zasiedlających 2 dcm^3 kamieni)

Table II. Distribution of mayflies in the stream Sucha Woda
(on the basis of mean annual numbers of individuals settled on 2 dcm^3 of stones)

mniej niż 1 osobnik/2 dcm^3 kamieni
less than 1 individual per 2 dcm^3 of stones

1 - 10 osobników/2 dcm^3 kamieni
1 - 10 individuals per 2 dcm^3 of stones

ponad 10 osobników/2 dcm^3 kamieni (cyfry oznaczają ilość osobników)
over 10 individuals per 2 dcm^3 of stones (the figures denote the number of individuals)

oba gatunki
both species

tylko B. alpinus
only B. alpinus

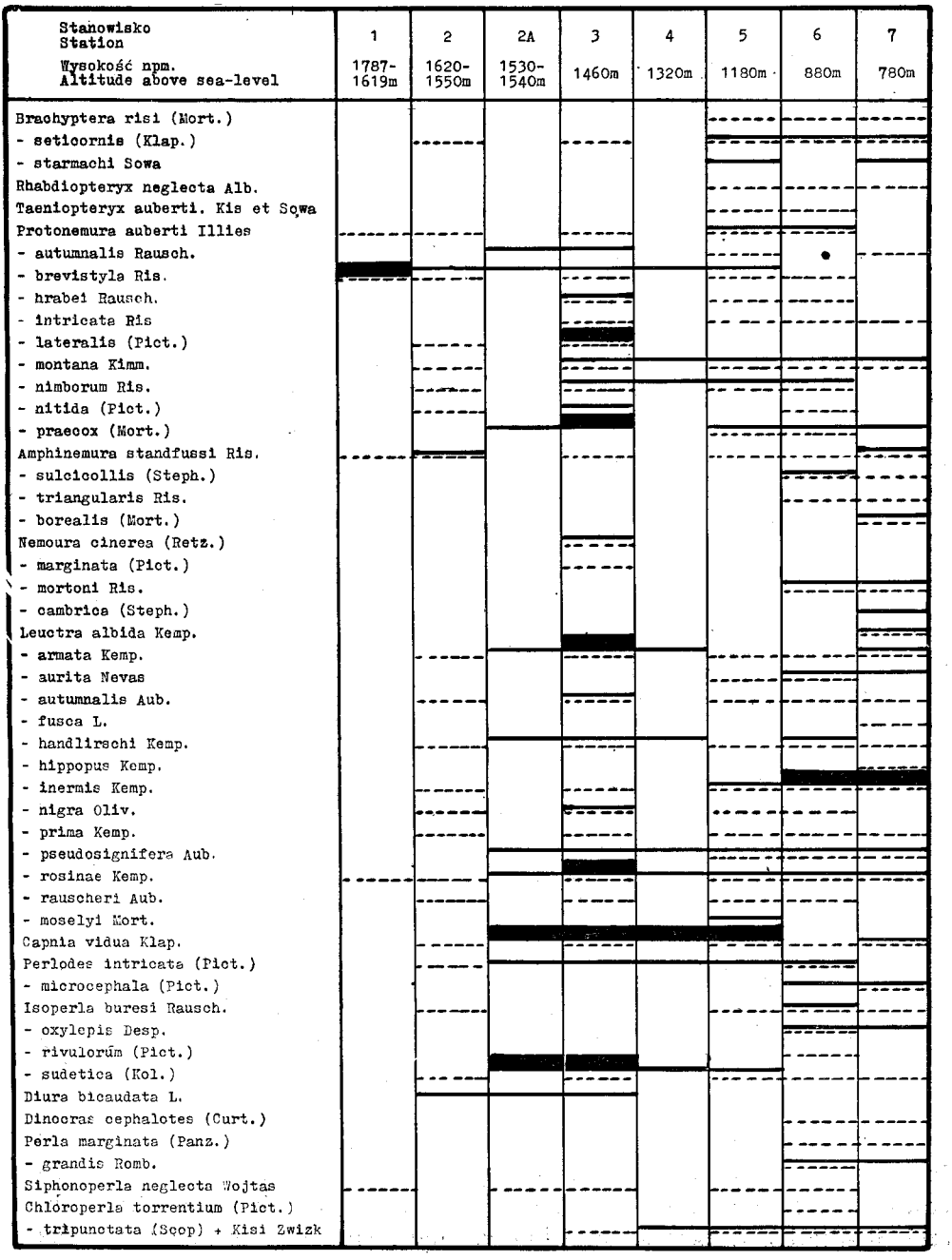
\+ 2 gatunki: Rhithrogena ferruginea i R. carpathica niemożliwe do odróżnienia w czasie prowadzenia badań
2 species: Rhithrogena ferruginea and R. carpathica are included here, not distinguishable in the course of investigations

Stanowisko Station	1	2	2A	3	4	5	6	7
Wysokość npm. Altitude above sea-level	1787-1619m	1620-1550m	1530-1540m	1460m	1320m	1180m	880m	780m
Ameletus inopinatus Etn.					2			
Baetis fuscatus L. + scambus Etn								
- alpinus Pict. + melanonyx Pict.			115	42	40	50	17	18
- muticus L.								
- rhodani Pict.								
- sinaicus Bog.								
Epeorus assimilis Etn.								
Ecdyonurus sp.								
torrentis Kim.								
- venosus F								
Rhithrogena sp. (hercynia Landa ?)								
semicolorata (Eust.)								
- hybrida Etn.								
- Spp. +								
- tatrica Zel			21	24	27			
Habrophlebia lauta Etn.								
Habroleptoides modesta Hag.								
Ephemerella ignita Popa								
- krieghoffi Ulm.								
Caenis rivulorum Etn.								

by larvae of *Rhyacophila* sp., *Stenohpylacini*, and *Limnephilidae* in the first developmental stages, as well as by single specimens of, e.g., *Drusus monticola* and of some *Rhyacophila*. In the middle part of the stream at a height of 1550—1200 m above sea-level the representatives of *Trichoptera* were chiefly larvae of *Rhyacophila*, especially of *R.* tristis, *R. glareosa*, and *R. vulgaris*, as well as *Silo pallipes* and *Drusus discolor*. *Lithax niger* larvae were found exclusively at an altitude of 1550 m in the proximity of out-flows from springs. Below the altitude of 1200 m the mentioned species occur no longer, or as only single specimens. Below this

Tabela III. Rozmieszczenie widelnic w potoku Sucha Woda na podstawie materiałów własnych ——— (średnia roczna ilość osobników zasiedlających 2 dom^3 kamieni) i Wojtasa (1964)– – – – Znaki oznaczające ilość osobników/2 dom^3 kamieni jak w tabeli II

Table III. Distribution of stone-flies in the stream Sucha Woda on the basis of the materials of the author ——— (mean annual number of individuals settled on 2 dom^3 of stones) and Wojtas (1964)– – – –. The signs denoting the number of individuals per 2 dom^3 of stones are the same as in Table II



altitude *Synafophora intermedia* and *Ecclisopteryx madida* occur (their peak of development was observed at station 6). In the lowest part of the stream below 800 m *Rhyacophila mocsaryi* and larvae of the genus *Hydropsyche* appeared (Table IV).

The observed changes of zoocoenoses of the particular stations are related with the changes of the environment. There appears a distinct relationship between the altitude and the specific composition and the number of taxonomic units. With increasing altitude the number of species diminishes in the zoocoenoses. In the highest parts of the streams widely distributed forms and high-mountain species are chiefly encountered. Together with the altitude many factors change, such as the climatic conditions, the water temperature, the geological structure of the substratum (P a s t e r n a k 1971), and the chemical composition of the water (B o m b ó w n a 1971). These factors influence the formation of a plant cover in which most of the organisms find an alimentary base. The essential factors influencing the development of fauna are springs and the freezing up of the stream in some sections. At station 2A, where the largest number of individuals were noted, the water of several strong springs flows into the stream, owing to which the latter does not freeze up and even no ice cover forms on it. The temperature of the water, stable throughout the year, favours the development of *Homoeothrix* and of thick moss cushions. The vegetation brings about favourable conditions for the development especially of *Chironomidae* and younger larval stages of other groups. The freezing up of the stream, observed at stations 1 and 2, stops the development of the autumn community. The community is set up every year from the beginning. The mentioned factors are of the greatest importance to the development of the zoocoenoses at the stations lying in the upper and middle course of the stream. Other factors, such as, e.g. the geological structure of the substratum or the slope of the stream play a much less important part here. On the other hand, their influence on the formation of zoocoenoses becomes visible in the submontane part of the stream (stations 6 and 7). The number of species increases. New species of mayflies, caddis flies, and stone-flies appear, characteristic of submontane rivers and streams with a small gradient and higher calcium content.

On the basis of fauna communities arranged according to the diminishing index of dominance (Table I), of the number of taxonomic units, and the number of individuals settled on 2 dcm^3 of stones at a station in the course of the year, four zones can be distinguished in the stream Sucha Woda.

The first zone is found at an altitude of over 1500 m. Streams rising in the Zmarzły Staw under the Zawrat and in the Czarny Staw Gąsienicowy belong here. The fauna of these streams is poor both quantitatively and qualitatively. Larvae of *Diptera*, and especially of *Chironomidae*

Tabela IV. Rozmieszczenie chruścików w potoku Sucha Woda (na podstawie średnich rocznych ilości osobników zasiedlających 2 dcm^3 kamieni).

Table IV. Distribution of caddis flies in the stream Sucha Woda (on the basis of the mean annual numbers of individuals settled on 2 dcm^3 of stones)

Stanowisko Station Wysokość npm. Altitude above sea-level	1 1787-1619m	2 1620-1550m	2A 1530-1540m	3 1460m	4 1320m	5 1180m	6 880m	7 780m
Rhyacophila glareosa McL.								
- fasciata Hag.								
- moosaryi Klap.								
- nubila Zett.								
- obliterata McL.								
- philopotamoides McL.								
- polonica McL.								
- tristis Pict.								
- vulgaris Pict.								
Rhyacophila sp.								
Glossosoma conformis Nebois.								
Synafophora intermedia Klap.							33.4	
Agapetus fuscipes Curt.								
Philopotamus ludificatus McL.								
Hydropsyche instabilis Curt.								
Tinodes rostocki McL.								
Brachycentrus subnubilus Curt.								
Micrasema minimum McL.								
Drusus annulatus Steph.								
- biguttatus Pict.								
- discolor Ramb.								
- monticola McL.								
Ecclisopteryx madida McL.								
Potamophylax nigricornis Pict.								
Acrophylax vernalis Dz.								
- zerberus Brau.								
Halesus rubricollis Pict.								
Melampophylax nepos McL.								
Stenophylax sp.								
Limnophilus sp.								
Allogamus auricollis Pict.								
- starmachi Szcz.								
- uncatus Brau.								
Pseudopsilopteryx zimmeri McL.								
Annitella thuringica Ulm.								
Lithax niger Fbr.								
Silo pallipes Fbr.								
Sericostoma flavicorne Schmid.								
Notidobia ciliaris L.								

predominate, and among them *Diamesa* gr. *latitarsis*. No mayflies occur. *Trichoptera* and *Plecoptera* are mostly represented by larvae in the first developmental stages. The stream in this zone flows only seasonally.

The second zone lies in the proximity of the outflow of strong springs. It is characterised by a considerable quantitative richness. The number of taxonomic units is larger than in the first zone, but smaller than in the third one. The pattern of dominance is similar to that of the third zone. The first dominant here is *Eukiefferiella minor*, the subdominants being *Parorthocladius nudipennis*, *Baetis alpinus*, and *Rhithrogena tatrica*. The stream does not freeze up at all, since the water flowing out of the lake joins that of several vauclusian springs. In winter this is the beginning of the stream. The temperature shows insignificant variations in the course of the year (4—7°C). The stones are overgrown throughout the year with a thick layer of mosses and algae (*Hydrurus* and *Homoeothrix*).

The third zone is in the forest area. It is characterized by a greater qualitative richness, the number of individuals, however, being smaller than in the fourth zone. *Chironomidae* (*Parorthocladius nudipennis*) larvae predominate here. Mayflies have the same pattern as in the second zone. *Baetis alpinus* and *Rhithrogena tatrica* continue to develop in masses. The stream does not freeze up completely during the whole winter, but some of its sections are covered with a thick layer of ice and snow under which the water flows. The annual variations of the water temperature amount to 0.5—10 °C. The stones in the stream are covered in winter with a layer of *Hydrurus* and *Homoeothrix* algae and in summer with a thin layer of diatoms. Moss in this section covers large stones only.

The fourth zone is the stream at the foot of the Tatra Mts (below the altitude of 900 m) with a considerable qualitative and quantitative richness of fauna. The dominant species are the midges *Orthocladius rivicola* and *O. thienemanni* and *Simuliidae* larvae, while the share of mayflies decreases. The stream has a small gradient; the annual variations of temperature amount to 0.3—15 °C. The diurnal variations of temperature are generally insignificant, ranging from 3.5 °C in the summer to 1.5 °C in the spring and autumn. The stream usually flows throughout the year, but in the lower section of the zone an ice cover sometimes forms on the stones. Stations 6 and 7 are assigned to this zone.

The boundaries between the discriminated zones are not distinctly marked, one zone passing into the other. Over long sections of the stream mixed communities are encountered, where species from two neighbouring zones predominate (stations 3 and 5). The boundary between the area of springs and the montane stream is poorly marked, common elements occurring in them. Perhaps the distinguished spring zone could be included as a subzone in the zone of the montane stream.

Seasonal changes of bottom fauna in the particular zones

The course of the curve of seasonal changes at the particular stations depends on the altitude above sea-level and the zone in which the investigated station lies.

Above 1500 m in the high-mountain zone few animals occur, the curve illustrating the changes in the amount of fauna being monoapical. Four periods of development of the fauna can be distinguished in this zone. In the first initial period from May to mid June or July single small *Simuliidae* and *Plecoptera* larvae of the genus *Protonemura* (station 1) and *Amphinemura* (station 2) are observed in the stream. After this period an increase in the number of individuals is noted in the stream and there develops a community peculiar to this zone, chiefly composed of *Chironomidae* (*Diamesa* gr. *latitarsis*), *Plecoptera* (*Protonemura brevistyla,* and *Amphinemura standfussi*) larvae. The number of *Simuliidae* decreases in the community. This period lasts till September, when a maximum in the number of these forms is noted. Pupae and large larvae before flight appear in September. The flights of the adult one bring about in October a decrease in number. In September and October the triclads *Planaria alpina* play an important part in the community. There appear in this period small larvae of species characteristic of the lower lying stations, e. g., *Eukiefferiella* sp., or single *Ephemeroptera* larvae. According to the altitude and the distance from the outflow from the lake, the period of development of the autumn community can be longer or shorter, this having a bearing on its abundance. The community perishes at the time when some parts of the stream dry up or freeze up in the winter. The fourth period (from November to May) is the longest, when the whole stream is covered with a thick layer of snow. In the spring, after the melting of snow in the stream, single larvae in the first developmental stages appear again. The length of the periods of development of the fauna depends on the atmosperic conditions in the given year. In 1965 the pioneer community appeared at station 2 no earlier than June, whereas in 1966 it already developed in May and in June the species characteristic of this station (*Diamesa* gr. *latitarsis*) were dominant.

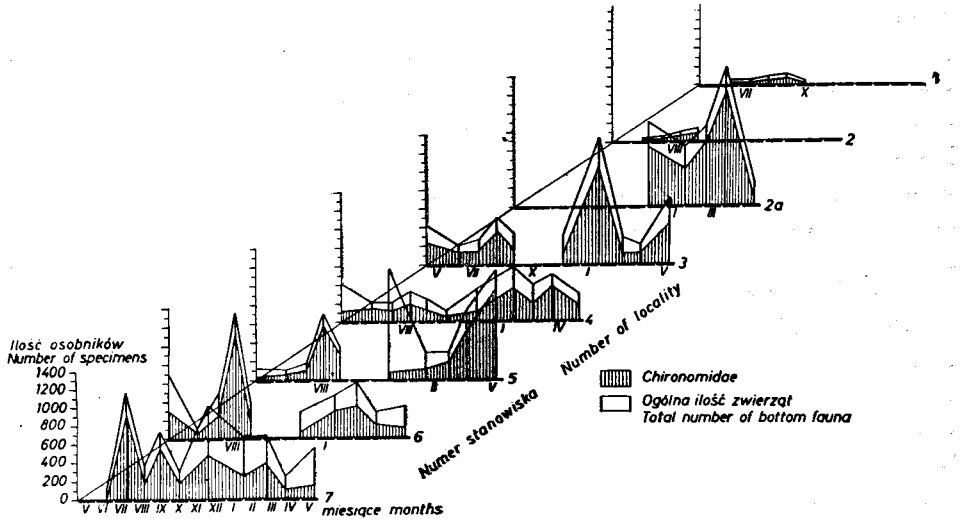
In the section of the stream flowing in the forest zone a thrice repeated increase in the number of bottom fauna takes place: in the spring (April and May), in the summer (occurring at all stations in August), and in the winter (from December to January). The largest numbers were observed in winter and the smallest in summer. The winter peak is brought about by a very large number of young *Ephemeroptera* (*Baetis alpinus*) and *Chironomidae* (*Parorthocladius nudipennis*) larvae. The size of individuals of these species increases during the winter, whereas their numbers decrease. This decrease, observed in April or May, is due to the flight of the winter population of *Parorthocladius nudipennis.* The spring peak is brought about, apart from *Baetis alpinus* and *Chironomidae,* by a large

number of species in the first developmental stages, whose development will take place in summer. The decrease in number in June is caused by many factors, such as the end of the flight of *Parorthocladius nudipennis*, the greater flow (higher water level) and consequently the washing down of many organisms, and the disappearance of the cover of *Hydrurus* and *Homoeothrix*, in which the dominant species developed. The increase in number in August is brought about in the upper parts of the zone by the summer population of *Parorthocladius nudipennis* and *Rhithrogena tatrica*, and in the lower part of the zone chiefly by *Parorthocladius nudipennis* and *Orthocladius rivicola*. A decrease in the number of *Baetis alpinus* was observed, this species flying out in this period. The flight of the majority of species dominant in the community brings about a decrease in the number of fauna in the autumn. New species appear. In October larvae of *Diamesa* gr. *latitarsis* develop numerously in this zone. Slightly different changes of the bottom fauna occur in winter at station 5. The lack of a spring maximum in May 1965 and the decrease in the number of fauna in February till March, is caused by ice, which at this station covers almost the whole stream, only a few places not being frozen up. The ice cover inhibits the development of algae with which the majority of dominant species, especially *Chironomidae* species, are related. Larvae of *Limnephilidae* develop under the ice; during the winter season and immediately after the melting of ice they are one of the chief dominants. The changes in the number of bottom fauna are brought about chiefly by *Chironomidae*, the course of the curve of changes of the total number of fauna being the reflection of changes of this group. It is only at station 5 that in May the number of bottom fauna is determined by larvae of *Limnephilidae*, the winter maximum in December being brought about by small larvae of the mayfly *Baetis alpinus* and small *Simuliidae* larvae.

The seasonal changes of fauna in the stream below 900 m show differences as the height decreases and the width of the stream grows larger.

In the upper part of the zone of the stream at the foot of the Tatra Mts a thrice repeated increase in number is observed, similarly as in the zone of the forest area of the stream. The increase in number in the spring is due to the development of *Chironomidae* (*Orthocladius rivicola*) and *Simuliidae*. On account of the high water level observed from May to mid June, a large quantity of fauna was washed down. Large numbers of *Orthocladius rivicola* and *O. thienemanni*, as well as of *Simuliidae* and *Baetis* sp., were noted in August. The decrease observed in September was caused by the flight of the dominant *Chironomidae*, whereas the other species continue to increase. The winter peak is due to the development of the caddis fly *Synafophora*, of *Chironomidae*, and of small *Leuctra* sp. larvae. The decrease in the number of species and their flight bring about a decrease in number in April. *Simuliidae appeared* in masses in May.

On the other hand, in the lower part of the zone of the stream at the foot of the Tatra Mts, four peaks of fauna development were observed. The first greatest in July, was chiefly due to larvae of *Chironomidae* (*Orthocladius rivicola* + *O. thienemanni*). In August, on account of the flight of these species, there occurs a decrease in number. The next, much smaller peak in September, is caused by the second generation of the same species. The winter peak lasts from December to March. Apart from *Chironomidae* (chiefly *Diamesa* sp.), it is caused by small larvae of *Simuliidae, Baetis* sp., and *Leuctra* sp. They gradually decrease in number, but increase in size. The appearance of dominant species of *Chironomidae* (*Orthocladius rivicola* + *O. thienemanni*), *Simuliidae,* and many others brings about an increase in number in May.



Ryc. 3. Roczne zmiany ogólnej ilości fauny dennej (z uwzględnieniem *Chironomidae*) w potoku Sucha Woda

Fig. 3. Annual changes of the total number of bottom fauna (taking into the consideration *Chironomidae*) in the Sucha Woda stream

The changes in the total amount of fauna at all stations depend on changes of *Chironomidae,* the other groups of fauna having less effect on the shaping of the total amount of fauna (fig. 3). *Turbellaria,* which in the high-mountain and forest zone are represented by a single species of *Planaria alpina,* usually have one peak of development in September, October, and another one in April, May. In the zone of submontane streams these peaks occur in July and from January to March.

Ephemeroptera. In the high-mountain zone single small larvae appear in the autumn, which are observed in the other seasons. Presumably, they develop from eggs deposited by mayflies flying out in summer in the lower parts of the stream. Changes in number in the forest zone result from

changes of the two dominant species, *Baetis alpinus* and *Rhithrogena tatrica*. The winter peak observed in December is due to small larvae of *Baetis alpinus* occurring in masses. Subsequently, their number decreases, the share of larvae of medium size increasing, while from June to September large individuals and single larvae before flight are noted. Flights of adults and the greater mortality of small larvae bring about a decrease in the number of *Baetis alpinus*. The smaller summer peak is due to the development of *Rhithrogena tatrica*. In the submontane zone the curves of development of *Ephemeroptera* differ from one another at the two stations. In the upper part of the zone an increase in number was twice observed: in the spring (in May) and in the summer (August, September). No distinct winter maximum was noted. Also in the lower part of the zone an increase in number was twice observed: one in the summer (August, September) and the other very marked in winter (January). A slight increase in number was observed early in May. These changes are chiefly brought about by *Baetis alpinus*, whose large numbers induce the winter peak in the lower part of the zone and the summer peak in the upper part, the share of small *Baetis* sp. larvae being also of some importance here. The appearance of a number of species in the summer and spring leads to an increase in the amount of fauna in this period. The minimum quantities at these stations are related with the flights of the dominant species.

Plecoptera are the next most important component of the fauna. The changes in the amount of the whole bottom fauna in the high-mountain zone coincide with the changes of one species (*Protonemura brevistyla*) developing here. The increase in number noted in June is related with the development of larvae of *Protonemura*, sp. Small larvae of *Leuctra* sp. were also encountered here throughout the year in small numbers having no bearing on the total amount. At station 2 the increase in number in August is brought about by *Amphinemura standfussi*. The decrease in the amount of fauna in September is due to the flight of this species. The other species occur in very small numbers. The stream Sucha Woda in the forest zone has a winter maximum from December to February. The number of *Plecoptera* slightly increase in it in May and none too markedly in summer. The changes in the number of *Plecoptera* are chiefly related with larvae of *Protonemura* sp. and *Leuctra* sp. in the younger stages of development. The winter peak is also due to these larvae and to the species *Capnia vidua* developing in winter. On the other hand, the flights of the majority of species and their larvae, whose flight begins in late spring, as e.g. *Leuctra rosinae* or *Perlodes intricata*, observed in summer, have an effect on the decrease in the total number of *Plecoptera*.

The changes in the number of *Plecoptera* at station 6 are similar to those in the forest zone (stations 2A, 3, 4, and 5), whereas at station 7 two distinct peaks of development can be observed: a small summer peak (in

September) and a very marked winter peak (from January to March). The winter maximum is chiefly due to the mass appearance of *Leuctra* sp. in the first developmental stages and of *Protonemura* sp. larvae. In summer, apart from small *Protonemura* larvae, small larvae of *Plecoptera* appear. In the course of this season and in early autumn the majority of flights of adult forms take place.

Trichoptera. On account of the small number of *Trichoptera* larvae encountered throughout the year in the high-mountain zone their quantitative changes could not be determined. The chief forms occurring here are small larvae of *Limnephilidae* and *Rhyacophila.* In the forest zone at stations 3 and 4 two peaks of development are observed: a winter peak (December — February) and a spring peak in May, brought about chiefly by *Limnephilidae* larvae in the first developmental stages and by larvae of *Drusus* and *Rhyacophila* sp. A slight increase in number is observed in summer. At station 5 there occurs an increase in number in July and August, chiefly related with the appearance of *Stenophylacini, Chaetopterygini,* and *Drusus* sp. larvae. The decrease in number in autumn and spring, and the considerable increase in February, April, and May, is chiefly brought about by *Limnephilidae* in the first stages of development. The increased number of *Trichoptera* observed in the submontane stream (station 6) is related with the development of *Synafophora intermedia* which is here the second dominant throughout the year (with the exception of the period of flight in June and July). Larvae of *Limnephilidae* and *Drusus* sp. also play an important part.

At station 7 not many *Trichoptera* larvae are encountered in the course of the year. A small peak is observed in September (chiefly juvenile stages of *Limnephilidae* and *Synafophora intermedia*), another one in February (*Glossosoma conformis* and *Synafophora intermedia*), and a third fairly high peak in May, related with the occurrence of *Stenophylacini* and *Chaetopterygini* larvae.

Zoocoenoses of the particular habitats of the stream

The substratum in the investigated stream is built almost exclusively of boulders and large stone, which are usually covered with algae or moss. Almost no other environment, such as sand or slime, is encountered, the gravels forming behind boulders or near the bank being usually mixed with stones. In the lower part of the stream near its bank a very thin layer of slime was encountered on stones, but could not be collected without them. Thus, only one stony enviroment was distinguished, being dealt with jointly with plants covering it, with gravel, and sand, and with slime found near the bank. Environments related with the current were distinguished.

Apart from *Chironomidae, Simuliidae* occur in masses in swift current,

single specimens being encountered in places with no current, where they were probably brought in by the water. *Blepharoceridae* were encountered exclusively in places with a very strong current. *Baetis alpinus* and large larvae of *Rhithrogena tatrica* prefer to settle in places with a swift current. Small larval stages of *Rhithrogena tatrica* are more often encountered in still waters or in places with a slow current. A number of species are related with these places, above all *Oligochaeta,* larvae of mayflies, *Amelatus inopinatus, Habroleptoides modesta, Caenis rivulorum, Habrophlebia lauta,* stone-flies: *Diura bicaudata* and *Capnia vidua, Diptera*: *Dicranota sp., Nilotanypus dubius, Microspectra* gr. *praecox, Corynoneura* gr. *minuta, Parametriocnemus borealpinus,* and *P. stylatus.*

A number of species occur about which it cannot be said for certain that they choose some particular habitat, since they are usually are encountered everywhere (*Synafophora intermedia, Planaria alpina*). Although on the basis of the number of individuals it appears that the given species chooses some particular kind of habitat, it would be difficult to find one occurring in only a single habitat. *Amelatus inopinatus,* a species characteristic of high-mountain lakes and still waters in the stream, is sporadically encountered in places with a very swift current, while *Simuliidae,* which are typical rheobionts were encountered in still waters. It seems that this is due to microhabitats forming around each stone. Fissures, crevices, and hollows in the stones are inhabited by numerous animals, such as larvae of *Hydracarina* or *Chironomidae,* whose structure shows no distinct adaptation to life in a current. On stones, cascades, and in very swift current numerous pupae of *Chironomidae* were observed in the crevices of stones. Larvae of mayflies of the genus *Rhithrogena* were usually encountered at the bottom of stones. It therefore seems that the flattening of these larvae can be explained not so much by their adaptation to life in a current, as by the possibility of moving in crevices between stones. This would be corroborated by larvae of *Ecdyonurus* with a flattened body, which are not usually encountered in places with a swift current. At the bottom of stones, on their sides, and in the crevices larvae of *Synafophora intermedia,* as well as larvae and pupae of *Rhyacophila,* were found. The upper surface of stones is usually less numerously inhabited, unless it is covered with a layer of algae in which *Chironomidae* develop in masses. On large, even stones only larvae of *Simuliidae and Blepharoceridae* and those of single representatives of other species are encountered. On even, shaly plates larvae of *Simuliidae, Blepharoceridae,* and *Cardiocladius* sp. (*Chironomidae*) are the only representatives of fauna. Observations showed that *Simuliidae* and *Blepharoceridae* readily inhabit stones of over 20 cm, rather avoiding the smaller ones of 5 to 10 cm. Caddis flies also prefer to inhabit large stones. This is probably due to the fact that larger stones are less subject to shifting in the substratum than the smaller ones. In places with slow or no current, as well as on the

surface of stones and between them, numerous larvae of caddis flies, such as *Stenophylacini, Chaetopterygini,* and *Drusinae,* or small *Limnephilidae* building cases were encountered. The covering of the stone by plants (moss, algae) changes the arrangement of microhabitats around it. Stones overgrown with algae are densely inhabited, especially by *Chironomidae* larvae. The flattened larvae of mayflies avoid algae, and those of the genus *Baetis* are sporadically encountered.

Moss is one of the richest environments in the stream Sucha Woda. It covers stones in this stream from the height of 1400 to 1500 m above sea-level (stations 2A, 3, and 4). Below 1400 m only single tufts were encountered. The moss is inhabited by a characteristic community of *Chironomidae* (K o w n a c k i 1971).

The other groups of animals form no distinct community characteristic of moss. It is only larvae of some *Diptera* (e.g. *Pericoma* sp.) which choose this habitat. The other groups are chiefly represented by juvenile larval stages and mayflies, mostly by small larvae of *Baetis alpinus.* Flattened mayflies of the genus *Rhithrogena* and *Ecdyonurus* avoid this habitat.

Large numbers of *Plecoptera* larvae represented by young larvae of *Protonemura* sp., *Leuctra* sp., and *Plecoptera* (the youngest stages undeterminable even as to genus) occurred in the moss. Also *Leuctra pseudosignifera, Protonemura nimborum, P. brevistyla,* and *P. nitida* were encountered in it in smaller numbers. K a m l e r (1964) reports that the environment of moss is the richest in *Plecoptera* larvae, whose numbers amount here to 2000 larvae per square metre; it is therefore 18 times richer than the environment of stones.

Trichoptera are represented in moss chiefly by the youngest larvae of *Limnephilidae* and *Drusus discolor* (particularly numerous in May), and by young larvae of *Rhyacophila* and *Rhyacophila tristis.* Also among caddis flies it would be difficult to distinguish a fauna characteristic of the moss environment. Moss is a hatchery of younger stages of development of caddis flies, this being corroborated by R i e d e l's (1962) investgations.

No rheophilous forms, such as *Simuliidae* or *Blepharoceridae,* were enccountered in the moss. Single specimens of *Simuliidae* occurred on the surface of moss cushions but never inside it.

Oligochaeta were fairly often observed, especially when a patch of moss could be collected together with the subsoil.

Hydracarina never represented a more important element of this environment in the stream Sucha Woda, which would not be in agreement with D o r i e r's (1938) observations for mosses of Alpine streams and of those P r u n e s c u - A r i o n and E l i a n (1966) for moss in the Carpathian streams.

Both the present author's and other author's (K a m l e r 1964) observations have shown that the moss environment is one of the richest in the stream. This is due to the favourable alimentary conditions, especially to

Chironomidae (Thienemann 1954), and to the more advantageous current conditions prevailing in moss (Gieysztor M. 1962).

STRESZCZENIE

W latach 1965 i 1966 przeprowadzono badania fauny dennej w potoku Sucha Woda (Tatry Wysokie). Próby fauny zbierano na ośmiu stanowiskach (ryc. 1) w odstępach mniej więcej miesięcznych.

W Suchej Wodzie faunę reprezentowały głównie larwy owadów, a zwłaszcza muchówki (*Chironomidae, Simuliidae* i *Blepharoceridae*), jętki, widelnice i chruściki, w mniejszym stopniu chrząszcze. Z pozostałych grup zwierząt spotykano wypławki, skąposzczety, wodopójki i pojedyncze okazy pijawek, ślimaków i skorupiaków (ryc. 2). Szczególną uwagę zwrócono na grupy dominujące: *Ephemeroptera* i *Plecoptera* i *Trichoptera*, które starano się oznaczyć dokładniej.

W badanym potoku znaleziono przedstawicieli 20 gatunków *Ephemeroptera*, 39 gatunków *Plecoptera* i 38 gatunków *Trichoptera*. Stwierdzono piętrowość w rozmieszczeniu dominujących grup fauny dennej. W najwyższych częściach potoku powyżej 1500 m przedstawicielami fauny były głównie *Chironomidae* (*Diamesa* gr. *latitarsis*) i kilka gatunków widelnic, chruścików i mustyków oraz wypławek *Planaria alpina*.

Na wysokości 1500—1400 m rozwijają się masowo niektóre *Chironomidae* (*Eukiefferiella minor, Parorthocladius nudipennis*) i *Ephemeroptera* (*Baetis alpinus* i *Rhithrogena tatrica*). Oprócz wymienionych gatunków dominujących rozwijają się licznie larwy z rodzaju *Rhyacophila* i *Litax niger* (*Trichoptera*) oraz liczne gatunki widelnic, zwłaszcza z rodzaju *Protonemura* i *Leuctra*. *Simuliidae* nie występują prawie zupełnie.

Na wysokości 1400—1100 m npm. zespół fauny dennej jest zasadniczo podobny do opisanego powyżej, ubywa tylko z zespołu pierwszy dominant poprzedniej strefy Eukiefferiella minor i zmniejsza się ogólna ilość osobników.

Poniżej 1100 m rozwija się zespół, w którym dominują nadal larwy *Chironomidae* (*Orthocladius rivicola* i *O. thienemanni*). Jętki *Rhithrogena tatrica* zostają zastąpione przez inne gatunki tego rodzaju, a *Baetis alpinus* jest tylko subdominantem. Pojawia się szereg nowych gatunków jętek widelnic i chruścików, a ogólna ilość osobników wzrasta. Zauważono zależność między zmianami składu zoocenozy a zmianami wysokości npm., temperatury wody, podłoża geologicznego i składu chemicznego wody. Zmiany zaobserwowane między stanowiskami na wysokości 1500 i 1540 m npm. są spowodowane z jednej strony wysychaniem potoku na stanowisku wyższym, a z drugiej strony — masowym rozwojem glonów i nieprzerwanym okresem wegetacji na niższym stanowisku. Przebieg krzywej obrazującej zmiany ilości osobników w kolejnych porach roku (ryc. 3) jest różny na różnych wysokościach. Na stanowiskach powyżej 1550 m zaobserwowano jednorazowy wzrost ilości fauny we wrześniu. W maju i czerwcu znajdowano pojedyncze osobniki głównie *Simuliidae* w pierwszych stadiach rozwojowych. Od lipca do września rozwija się zespół charakterystyczny dla tego stanowiska, złożony głównie z larw *Diamesa* gr. *latitarsis, Amphinemura standfussi* i *Protonemura brevistyla*. Po tym okresie następuje spadek liczebności, wylatują gatunki dominujące, a w zespole pojawiają się młode osobniki gatunków charakterystycznych dla niżej położonych stanowisk i wypławek *Planaria alpina*.

Na wysokości 1000—1550 m można wyróżnić trzy szczyty rozwoju fauny dennej. Największy szczyt zimowy powodują młode stadia jętki *Baetis alpinus* i z *Chironomidae* — *Parorthocladius nudipennis*. Mniejszy wiosenny wywołuje pojawienie się licznych młodych osobników należących do gatunków mających rozwój w lecie. Trzeci najmniejszy letni wywołują głównie *Chironomidae* — *Parorthocladius nudipennis*,

Orthocladius rivicola i jętka *Rhithrogena tratrica*. Zmniejszanie się ilości osobników powodują wyloty dorosłych, a w czerwcu spadek ilości może być spowodowany spłukaniem fauny przez wody powodziowe.

Na stanowiskach poniżej 1000 m obserwowano trzy lub czterokrotny wzrost ilości fauny dennej. Ilość osobników w lecie (sierpień) jest największa, a w zimie (grudzień do marca) najmniejsza. Zwiększenie się ilości fauny w lecie powodują larwy *Orthocladius rivicola* i *O. thienemanni, Simuliidae* i młode larwy *Baetis* sp. w zimie larwy chruścika *Synafophora intermedia* i *Chironomidae* na stanowisku 6, a *Chironomidea* (*Diamesa* sp.) i *Simuliidae* na stanowisku 7.

Zaobserwowano rozmieszczenie zoocenoz w obrębie siedlisk na stanowisku. Zanotowano wyraźne różnice między miejscami o silnym prądzie, gdzie wystąpiły głównie larwy *Baetis alpinus, Rhithrogena tatrica, Simuliidae, Blepharoceridae* oraz niektóre gatunki *Chironomidae*, a miejscami bez prądu, gdzie spotykano *Oligochaeta*, larwy jętek *Amelatus inopinatus, Habroleptoides modesta, Caenis rivulorum*, widelnic *Diura bicaudata, Capnia vidua* oraz niektóre muchówki. W mchu rozwijały się głównie młodociane stadia jętek, widelnic i chruścików oraz larwy *Chironomidae* z rodzaju *Eukiefferiella*.

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