

BARBARA KAWECKA, MARTA KOWNACKA, ANDRZEJ KOWNACKI

## Ogólna charakterystyka biocenoz w potokach Polskich Tatr Wysokich

### General characteristics of the biocoenosis in the streams of the Polish High Tatras

Mémoire présenté le 1 mars 1971 dans la séance de la Commission Biologique  
de l'Académie Polonaise des Sciences, Cracovie

Abstract — On the basis of algae and bottom-fauna communities in the streams of the High Tatra Mts the following zones were distinguished: 1. the zone of high-mountain streams (at an altitude of 1550—2100 m), with community composed of the algae *Cyanophyceae* (*Chamaesiphon polonicus*) and of larvae of *Chironomidae* (*Diamesa steinboeckii*, *D. gr. latitarsis*); 2. the zone of the montane streams (at an altitude of 1000—1550 m) of which the algae *Hydrurus foetidus*, *Homoeothrix janthina*, the diatom *Diatoma hiemale*, the mayflies *Baetis alpinus*, *Rhitrogena loyolaeae*, and *Chironomidae* *Parorthocladius nudipennis* on limestone substratum or *Orthocladius rivicola* on granite substratum are typical. 3. the zone of the sub-montane streams and rivers (at an altitude of 500—1000 m) in which the diatoms *Diatoma vulgare* var. *Ehrenbergii*, *D. vulgare* var. *capitulatum*, *Cymbella affinis*, *Synedra ulna*, green alga *Ulothrix zonata* dominate, and in zoocoenosis *Orthocladius rivicola*, *O. thienemanni*, and *Simuliidae*.

On the initiative of Prof. Karol Starmach, the Laboratory of Water Biology of the Polish Academy of Sciences has been engaged since 1962 in the complex study of the biocoenosis in the streams of the High Tatra. So far the nature of the drainage basin ground has been described (Pasternak 1968, 1971) and also description of the chemical composition of water (Bom bówna 1968, 1971, the algae (Kawicka 1965, 1971), the bottom fauna of these streams (Kownacka, Kownacki 1965, 1968; Kownacka 1971; Kownacki 1971), and the fishes of the largest of the streams under study, the Białka, have been given (Solewski 1965). Documentation to be found in the researches of Kawicka (1971), Kownacka (1971), Kownacki (1971) and in unpublished materials of authors.

On the basis of the researches mentioned above and especially on that of the characteristic algae and bottom fauna communities in the streams of the High Tatra Mts three distinct zones can be distinguished\* (fig. 1).

#### The zone of the high — mountain streams

This was distinguished in the highest parts of the streams running in the zone of the mountain pastures and dwarf mountain pines at an altitude of. c. 1550—2100 above sea level. These streams, which are 0.5—2 m wide, run steeply down the rocks or between the granite boulders. Their gradient amounts to from 600 to 200‰.

They carry water intermittently. In winter, which at this altitude lasts for seven months, they are frozen and covered with snow. They originate from patches of snow and from small periodic springs flowing out of the debris and the lakes of the Tatra Mountains. Their water is cold (0.5—8,5°C) and only near the outflows of the lakes does it can exceed 10°C in summer-time. The pH of the water ranges from 6.2 to 6.8. Calcium content is low (2.5—3.7 mg Ca/l).

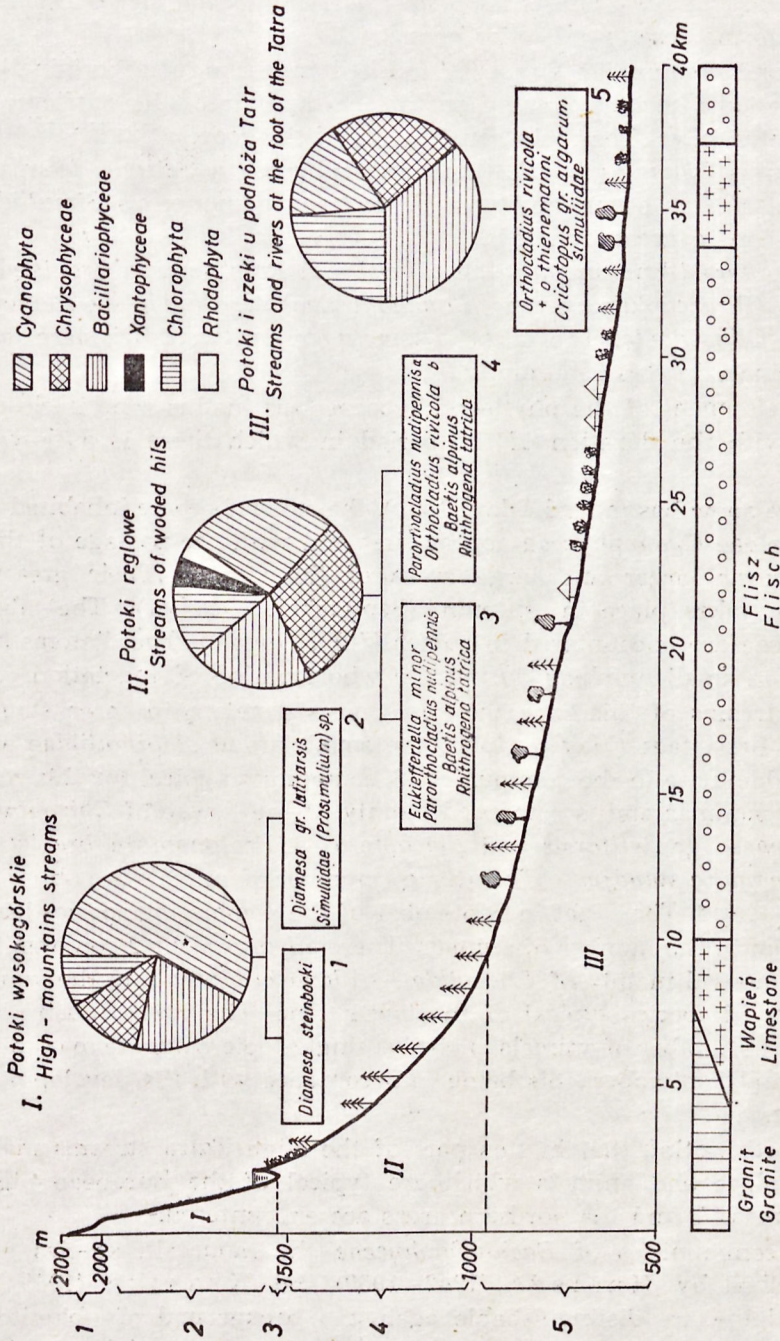
The phytocoenosis, composed mainly of lichens and the various genera of the algae *Cyanophyceae* formed dark patches on the stones. *Chamaesiphon polonicus* dominated among them and was locally accompanied by other species such as: *Ammatoidea Normannii*, *Scopulonema polonicum*, *Calothrix Braunii*, *Coelodesmium Wrangelii*, *Schizothrix lacustris*, *Phormidium uncinatum*, and *P. innundatum*. Of the filiform *Chlorophyceae*, *Chlorhormidium rivulare* and *Ch. flaccidium* grew here. Diatoms and desmids were found in the fine slime. The abundant sods of moss were inhabited by the various species of the diatoms which, however, were not very numerous. The cells of *Cymbella ventricosa*, *Diatoma hiemale*, *D. hiemale* var. *mesodon*, *Navicula rotaeana*, and species of the genus *Achmanthes*, *Gomphonema longiceps* var. *montanum* occurred most frequently.

In the streams of the high-mountain zone a typical zoocoenosis composed of the larvae of *Chironomidae* (*Diptera*) develops, mainly of the genera *Diamesa*, which are represented by some species only. Here are encountered, *Tricladida Planaria alpina*, a few *Plecoptera*, and caddis-flies. There are no mayflies (sometimes in the lower parts of this zone young specimens occur, but they do not undergo complete metamorphosis).

The number of species and specimens is small.

On the basis of the species dominating in this zone it is possible to distinguish two bottom fauna communities. The first one, in a stream running out of a patch of snow at an altitude of c. 2000 m above sea level,

\* The zones of the ranges of the stream biocoenosis described below do not agree precisely with the generally accepted physiographic units and layers in the High Tatras and on the whole they have a slightly higher vertical range.



Ryc. 1. Strefowe rozmieszczenie fito-zoocenozy w potokach Polskich Tatr Wysokich. I strefa — potoki wysokogórskie; II strefa — potoki reglowe; III strefa — potoki i rzeki u podnóża Tatr; 1, 2, 3, 4, 5 — podstrefy.

Fig. 1. Zonal distribution of the phyto- and zoocenosis in the streams of the Polish High Tatras. Zone I — the high-mountains streams; Zone II — the sub-montane streams; Zone III — streams and rivers at the foot of the Tatra; 1, 2, 3, 4, 5 — sub-zones

is composed exclusively of larvae *Diptera: Chironomidae* of the genus *Diamesa* and single specimens of *Empididae* and *Simuliidae*. *Diamesa steinboeckii* is the dominant species here.

The second community was distinguished in the streams originating from the periodic springs flowing out of the debris and the outflows of the High Tatra lakes. The main constituents of the zoocoenosis are larvae from the genus *Diamesa*. Apart from these, other *Orthocladinae* from the genus *Chaetocladius* occur, and also *Eukiefferiella*, numerous *Simuliidae* (which develop in great quantities particularly near the outflows of the lakes), *Plecoptera* (*Amphinemura standfussi* and *Protonemura brevistyla*), caddis flies (*Rhyacophila* sp. and *Limnephilidae*), *Tricladida* — *Planaria alpina*, and *Oligochaeta*. The larvae *Diamesa* gr. *latitarsis* (*Diamesa laticauda*) dominate in this community.

The development of the phyto- and zoocoenosis in this zone is closely connected with the duration of the period in which there is a flow of water.

After the snow has melted (May, June), the stones become inhabited by algae. The algae *Cyanophyceae* appear first and with the passage of time gradually cover larger and larger areas of the stones. Their greatest development takes place in autumn (September, October). The algae *Chlorophyceae* are encountered in summer (July, August). The diatoms are maintained in small numbers during the whole period of vegetation.

In the streams of this zone the zoocoenosis develops in three stages. During the first stage (May to July), the small larvae of *Simuliidae* and *Plecoptera* dominate in the community. A community typical for this zone develops in summer and is composed mainly of the larvae of *Chironomidae* — *Diamesa* gr. *latitarsis* and *Plecoptera* — *Protonemura brevistyla* and *Amphinemura standfussi*. The greatest number of animals are observed during this period. The flight in September of the dominating species leads to a reduction in the number of animals. There appears a third community, which is composed mainly of *Tricladida* — *Planaria alpina* and the young larval stages of species typical of the lower zone. The curve illustrating the changes in number of animals is always single-tropic with one maximum in August and September, this being in accordance with the development of the algae.

It is worth noting that in this part of the High Tatra streams many species of algae and animals which are typical of the European high-mountain massifs and the northern areas are encountered.

In the communities of *Bacillariophyceae* the mountain species and those described by Hustedt (1942, 1959) and Krasske (1949) as northern Alpine are distinguishable against a background of ubiquitous species. Those which occur here permanently deserve special attention. Among them are: *Melosira distans* var. *alpigena*, *Eunotia bigibba*, *E. bigibba* var. *pumila*, *Neidium affine* var. *longiceps*, *Cymbella hebridica*.

The zoocoenoses in the Tatra streams described above are similar to the high-mountain zoocoenosis of the Alps and Lapland. *Diamesa steinbocki*, for example, is the only representative of the bottom fauna of the glacier outflows and the outflows of the perpetual snows of the Alps and Lapland (Thienemann 1954). *Diamesa latitarsis* and *D. laticauda* live in the high-mountain streams of the Alps (Serra-Tosio 1967).

#### The zone of mountain streams (montane zone)

This zone was distinguished in the streams at an altitude of 1000—1550 m above sea level in the area of the spruce zone. These streams flow throughout the year and their gradient is from 20—100‰, average 80—66‰. The width of the river-bed amounts to from 2 to 6 m, the bed is covered with pebbles, and in some places gravel and sand are found. The current is mixed. The substratum is composed either of granites (Rybi Potok, Potok Roztoka) or limestones (part of the Sucha Woda). The temperature of the water ranges during the year from 0.5 to 4°C in winter and from 6.8 to 12.5°C in summer. The pH of the water in the streams with granite is 6.4—6.9 and the calcium content about 4 mg Ca/l. In the streams with limestone substratum the pH is 6.8—7.5 (8.3), and the calcium content 7.2—14.3 mg Ca/l. In this zone great environmental differences are found which are caused by the different geologic structure, the disappearance of the water in the rock debris and by the confluents of numerous springs and small forest streams.

*Hydrurus foetidus* and *Homoeothrix janthina* accompanied by great numbers of the diatoms dominate in the communities of algae forming tremellose brownish-yellow coating on the stones. *Phormidium uncinatum* and *Chamaesiphon polonicus* are found quite frequently. Other *Cyanophyceae* algae live here also, such as: *Chamaesiphon carpaticus*, *Ch. fuscus*, *Tolypothrix distorta* f. *penicillata*, *Calothrix fusca* etc.; of *Chlorophyceae* *Prasiola fluviatilis*, *Chlorohormidium flaccidum* and *Ch. rivulare*, *Ulothrix zonata* are to be found, numerous species of desmids, and the red algae *Lemanea fluviatilis* and *Chantransia pygmaea*.

In the group of the diatoms the most numerous were: *Diatoma hiemale*, *D. hiemale* var. *mesodon*, *Cymbella ventricosa*, *Ceratoneis arcus*, *Achnanthes microcephala*, *A. minutissima*, *Cocconeis placentula* var. *euglypta*, *Gomphonema intricatum* var. *pumilum*, and *Fragilaria capucina* var. *lanceolata*. Among these the species *Diatoma hiemale* and its variety *mesodon* were regarded as typical because they reached the highest rate of spatiality and considerable stability in this section (Kawicka 1971).

The zoocoenoses developing in the streams of this zone are composed of a great number of species and specimens. Numerous midges from the subfamily of *Orthocladinae*, the mayflies, *Plecoptera*, and the caddis flies

live here. The mayflies *Baetis alpinus* and *Rhithrogena tatrlica*\* are the indicatory forms of this zone. The larvae *Chironomidae*, which are more numerous than the mayflies show a greater dependence upon the substratum. The larvae *Parorthocladius nudipennis* are the first dominant in the streams with a limestone substratum and the larvae *Orthocladius rivicola* in those with a granite substratum.

In the montane streams two communities differing in the number of specimens and the system of domination can be distinguished. In the proximity of strong springs at an altitude of c. 1550 m above sea level, where the fluctuations of temperature during the year are small (4—8°C), the stones are covered with a thick layer of moss and algae (mainly *Hydrurus foetidus*, *Homoeothrix janthina*, and *Bacillariophyceae*). The group of animals is dominated by *Eukiefferiella minor* (the first dominant) and *Parorthocladius nudipennis* (the second dominant). The numerous larvae of mayflies (*Baetis alpinus*, *Rhithrogena tatrlica*), of *Plecoptera* (*Caphnia vidua*), of caddis flies (*Rhyacophyla tristis*), and beetles from the genus *Elmis* are also found here.

A community similar to that described above develops in the montane streams at an altitude of 1000—1500 m above sea level. It differs from the former in the smaller number of specimens and in the order of domination. The larvae *Parorthocladius nudipennis* or *Orthocladius rivicola* are the first dominants here. The mayflies *Baetis alpinus* and *Rhithrogena tatrlica* are important elements (the second dominant, the first sub-dominant).

In the montane zone of the streams the period of vegetation lasts throughout the year. At the end of May and in June the communities of plants and animals diminish because of the increased flow of water. A restoration of the communities of algae takes place during summer (July, August). Many species appear for the first time. Green alga *Ulothrix zonata* develops in great numbers. The spring diminution in the zoocoenosis is followed by an increase in the number of animals during the summer, which is caused mainly by the summer population of the larvae *Chironomidae* — *Parorthocladius nudipennis* and the mayflies *Rhithrogena tatrlica*. Many species appear whose development occurs in summer but they are not as numerous as the dominant species. In September and October together with a very reduced water level, the number of *Hydrurus foetidus* diminishes considerably, but *Homoeothrix janthina* continues to develop. The diatom are found in masses and a stronger development of *Chamaesiphon polonicus* and *Phormidium* follows. In this period a decrease in number of insects larvae is observed which is caused by the flight of the majority of species of the summer community. The midge *Diamesa latitarsis* and *Tricladida* — *Planaria alpina* dominate in the zoocoenosis.

\* According to new nomenclature *Rhithrogena tatrlica* Zel. = *Rh. loyolaea* Navás.

The period from November to May is characterized by a mass development of *Hydrurus foetidus* and *Homoeothrix janthina* and of the diatoms of which *Diatoma hiemale* and its *mesodon* variety reach the greatest numbers. At the same time an increase in the number of fauna takes place in the zoocenosis and it reaches its greatest number during the period between February and March. This is caused mainly by the winter populations of the larvae of *Chironomidae* (*Parorthocladius nudipennis*) and the young larvae of the mayflies (*Baetis alpinus*).

In the annual development of the biocenosis of this zone there can be observed, in contrast to the preceding zone, a several changes in number which follow in succession. The winter maximum, which can be defined as the quantitative maximum, is caused by the development of mainly one or two species of algae (*Hydrurus foetidus* and *Homoeothrix janthina*) and, as far as animals are concerned, by *Parorthocladius nudipennis* and *Baetis alpinus*. The numerical increase in August is also visible qualitative increase. Here a considerably variety of species are observed, but they do not reach great numbers.

#### The zone of the streams and rivers flowing at the foot of the Tatras

Here belong the streams and rivers flowing at an altitude below 1000 m above sea level. Their gradient does not exceed 20% and is usually not less than 10‰. The width of the bed is from 10 to 20 m. The bottom is covered with pebbles and near the banks gravelly — sandy shoals are found over wide areas. The lotic zone is clearly separated from the lenitic zone. These streams flow over a Flysh or limestone substratum. The alkaline reaction of the water is 7.4—8.5 pH throughout the year. The calcium content considerably increases. The temperature of the water in summer fluctuates from 10 to 17°C, while in winter it falls even to 0.3°C.

In this zone mainly the diatoms develop, reaching the greatest variety of species and large numbers. They are concentrated on the stones near the banks, forming dark brown delicate filaments and in the current of the stream they form yellow jellies. They also appear in great numbers in the mud and between the filaments of *Chlorophyceae*. In the group of *Bacillariophyceae* the following species dominate: *Diatoma vulgare* var. *Ehrenbergii*, *D. vulgare* var. *capitulatum*, *Cymbella ventricosa*, *C. affinis*, *Achnanthes pyrenaica*, *Synedra amphicephala*, *S. ulna*, *Ceratoneis arcus*, and *Gomphonema intricatum* var. *pumilum*. The following species and varieties were recognized as typical of this zone: *Diatoma vulgare* var. *Ehrenbergii*, *D. vulgare* var. *capitulatum*, *Cymbella affinis*, and *Synedra ulna*, because nowhere also did they develop so abundantly. Among *Chlorophyceae* *Ulothrix zonata* played a significant part. *Hydrurus foetidus* developed abundantly from autumn till spring.

The zoocoenoses which develop in this zone are characterized by a considerable qualitative and quantitative variety. The larvae of *Chironomidae* (*Orthocladius rivicola* and *O. thienemanni*) and the larvae of *Simuliidae* dominate here. The importance of the mayflies is not so considerable in this zone as in the preceding one. Many new varieties of *Chironomidae* appear (*Potthastia gaedei*, *Synorthocladius semivirens*, *Eukiefferiella clypeata* and the larvae *Tanytarsini*, *Chironomini*), of mayflies (*Baetis sinaicus*, *B. rhodani*, *Epeorus assimilis*, *Habroleptoides modesta*, *Ephemerella krieghoffi*, *Caenis rivulorum*); of Plecoptera (*Isoperla oxylepsis*, *Chloroperla tripunctata*, *Leuctra fusca*, *L. albida*); of caddis flies (*Synphophora intermedia*, *Rhyacophila mocsaryi*, larvae from the genus *Hydropsyche*). Only at this altitude were single specimens of the snails *Ancylus fluviatilis*, *Radix* sp., and leeches found.

On the basis of differences in the system of dominating species three sub-zones can be distinguished in this zone:

a) sub-montane stream — upper section 850—1000 m above sea level.

Here there are large boulders and numerous falls: gradient 20‰. *Orthocladius rivicola* is the dominant species and *O. thienemanni* appears only as individual specimens. An important element are the larvae of *Chironomidae* (*Eukiefferiella minor* and *E. bavarica*) and the larvae of caddis flies. *Baetis alpinus*, *B. melanonyx* dominates among the mayflies.

b) sub-montane stream — lower section, 700—850 m above sea level.

The bottom of the stream is covered with pebbles, gradient 10—20‰. *Orthocladius rivicola* and *O. thienemanni*, which are the dominant species, occur in more or less similar numbers. The larvae of *Cricotopus* gr. *algarum* are the first subdominants. Apart from them the larvae of *Orthocladius rivulorum* and *Eukiefferiella cyanea* also occur in this zone.

c) sub-montane rivers, 500—700 m above sea level.

The bottom is covered exclusively with the pebbles, gradient 10‰.

*Orthocladius thienemanni* is the dominant species. *O. rivicola* is not numerous. Apart from the larvae of *Cricotopus* gr. *algarum*, which are the first subdominants in this zone, the occurrence of the larvae of *Chironomidae* *Synorthocladius semivirens*, of the mayflies *Baetis rhodani*, and of caddis flies of the genus *Hydropsyche* is typical.

In the zone of sub-montane streams and rivers the vegetation continues throughout the year. The spring floods (April, May, June) lead to rapid devastation of the phyto- and zoocoenosis but their communities regenerate quickly. In summer (July, August) they are well developed and at that time the greatest variety of species is observed. The green alga *Ulothrix zonata* develops abundantly. In July the quantitative maximum of the fauna is observed, this being caused mainly by the larvae of *Chironomidae* (*Orthocladius rivicola* and *O. Thienemanni*). The flight of these species in August causes a fall in number. In September a fresh increase in number caused by the development of the second generations of the above-



-mentioned species is observed. From September till October the water blooms of diatoms are observed, mainly of *Diatoma vulgare* var. *Ehrenbergii*, and *D. vulgare* var. *capitulatum* and a considerable development of *Cymbella affinis*, and *Synedra ulna*. Also *Chaetophora elegans* reaches its highest peak of development.

The diatoms continue to develop during late autumn and in winter. From December till March the composition of the zoocoenosis undergoes a visible changes. The species which dominated in summer (*Orthocladus rivicola* and *O. thienemanni*) occur as individual specimens. A community composed of the larvae of *Chironomidae* (*Diamesa* gr. *insignipens*, *D. starmachi*, *D. thienemanni*), of the small larvae of *Simuliidae*, *Ephemeroptera* (of the genus *Baelis*) and of *Plecoptera* (of the genus *Leutra*), develops in those places which are not frozen.

In this zone the quantitative and qualitative maximum of fauna development occurs in summer.

It must be stressed that the borders between the zones are indistinct except in the case of transition between the high-mountain and the montane zones. One zone runs smoothly into another. The differences in the system of domination between stations situated at the opposite borders of the zone may be greater than those between stations lying in two different zones but near the border. Along large sectors of the streams a mixed community is found, which is characterized by a greater number of dominating species with a low index of domination.

The borders of the zones are not constant and may shift during the year. In winter they move downstream and in summer upstream. Different streams may have the same zones at different altitudes, depending on the climatic conditions. Certain sub-zones of the stream may not appear or may be replaced by others.

The division of the streams described above cannot be formulated in the generally used fishing classification of the rivers (Fric 1872, Nowicki 1882, Thienemann 1954, Huet 1954, Starmach 1956). All the streams of the high-mountain zone and the upper sections of the montane zone have a gradient considerably over 80‰, which according to Starmach (1956), is the top limit for trout. The typical system suggested by Illies, Botosaneanu (1963): spring — springstream — stream of zone III — stream of zone IV — mountain river, is replaced in the Tatras by the following structure: outflow from beneath the snows and small periodic debris streams or outflow from high-mountain lakes — source area — mountain stream in the sub-montane zone — stream and river at the foot of the Tatras. In the system suggested by Illies, Botosaneanu (1963) the change of zones takes place with the confluence of two equivalent streams or rivers. In the Tatra streams the change of zones takes place with the change of altitude, regardless of the affluents which may be regarded as equivalent. A diagram of division of streams similar

to that of the Tatras was given by Botosaneanu (1959) for the high-mountain massif of Retezat.

## STRESZCZENIE

Na podstawie zbiorowisk roślinnych i zwierzęcych w potokach Tatr Wysokich wyróżniono 3 strefy.

I. Strefa potoków wysokogórskich, wysokość 2100—1550 m n.p.m., spadek 600—200 ‰, temperatura wody 0,5—8,5 (10) °C. Podłoże granitowe, odczyn wód 6,2—6,8 pH, zawartość wapnia 2,5—3,7 mg Ca/l. Okres wegetacyjny trwa od maja do listopada.

Zbiorowiska roślinne złożone są głównie z sinic, z których dominuje *Chamaesiphon polonicus*. Ilość gatunków i osobników zwierząt reprezentowana przez larwy *Chironomidae* (Diptera) z rodzaju *Diamesa* jest bardzo mała. W potokach tej strefy wyróżniono dwa zespoły: 1) charakterystyczny dla potoków wypływających spod płatów śniegu (wys. ok. 2000 m n.p.m.), z gatunkiem dominującym *Diamesa steinbocki*, 2) charakterystyczny dla potoków wypływających ze źródeł rumowiskowych oraz jezior wysokogórskich, w którym dominują larwy *Diamesa* gr. *latitarsis* (*D. latitarsis*).

II. Strefa potoków górskich (reglowych), wysokość 1000—1550 m n.p.m. spadek (średnio) 80—60 ‰, temperatura wody 0,5—4 °C w zimie i 6,8—12,5 °C w lecie. Odczyn wody na podłożu granitowym 6,4—6,9 pH, zawartość wapnia 4 mg Ca/l, na podłożu wapiennym odczyn wód 6,8—7,5 (8,3) pH, zawartość wapnia 7,2—7,8 (14,3) mg Ca/l. Wegetacja trwa cały rok. Fito- i zoocenozy złożone są tu z dużej ilości osobników i gatunków.

W zbiorowiskach glonów dominuje *Hydrurus foetidus* i *Homoeothrix janthina*. Towarzyszą im licznie okrzemki, z których *Diatoma hiemale* z odmianą *mesodon* charakteryzuje tę partię potoku. Licznie rozwijają się zielonice, sinice, a także krasnorosty. Ze zwierząt żyją tu głównie ochotki z podrodziny *Orthocladinae*, jętki, widelnice, chruściki. Formą wskaźnikową tej strefy jest jętka *Baetis alpinus* i *Rhithrogena tatica*. Wyróżnić tu można 2 zespoły z gatunkami dominującymi: 1) wysokość 1550 m (źródła) — *Eukiefferiella minor* (pierwszy dominant) i *Parorthocladus nudipennis* (drugi dominant), 2) wysokość 1000—1500 m n.p.m. larwy *Parorthocladus nudipennis* lub *Orthocladus rivicola* (pierwszy dominant).

W cyklu rocznym zachodzą silne wahania liczebności fito- i zoocenozy. Maksimum jakościowe (lipiec—sierpień) spowodowane jest wzrostem różnorodności gatunków. Najliczniejsze są wtedy zielonice, larwy *Chironomidae* — *Parorthocladus nudipennis* i jętka *Rhithrogena tatica*. Maksimum ilościowe (listopad—maj) spowodowane jest rozwojem kilku gatunków, z glonów *Hydrurus foetidus* i *Homoeothrix janthina*, ze zwierząt *Parorthocladus nudipennis* i *Baetis alpinus*.

III. Strefa potoków i rzek płynących u podnóża Tatr, wysokość 500—1000 m n.p.m., spadek poniżej 20 ‰, temperatura wody od 0,3 °C w zimie do 17 °C w lecie. Podłoże jest fliszowe, odczyn wody zasadowy 7,4—8,5 pH, zawartość wapnia 23—33 mg Ca/l. Wegetacja trwa cały rok. Fito- i zoocenozy charakteryzują się bogactwem jakościowym i ilościowym.

Dominują tu okrzemki, z których charakterystyczna dla tej strefy jest *Diatoma vulgare* var. *Ehrenbergii* wraz z *D. vulgare* var. *capitulatum*, *Cymbella affinis*, *Synedra ulna*. Spotyka się liczne zielonice, z których *Ulothrix zonata* odgrywa główną rolę w zbiorowiskach. W zoocenozach dominują larwy *Chironomidae* (*Orthocladus rivicola* i *O. thienemanni*) oraz larwy *Simuliidae*.

Można tu wyróżnić 3 podstrefy: 1) potok podgórski — górny odcinek wysokości 850—1000 m n.p.m., z przewagą larw *Orthocladius rivicola*, 2) potok podgórski — dolny odcinek wys. 760—850 m n.p.m., gdzie w jednakowej ilości występuje *Orthocladius rivicola* i *O. thienemanni*, 3) rzeki podgórskie wys. 500—700 m n.p.m., gdzie dominuje *Orthocladius thienemanni*.

W rocznym rozwoju fito- i zoocenozy tej strefy obserwujemy szereg następujących po sobie zmian liczebności. W okresie letnim (lipiec, sierpień, wrzesień) następuje maksymalny rozwój ilościowy i jakościowy zoocenozy (dwa pokolenie *Orthocladius rivicola* i *O. thienemanni*), a kamienie porośnięte są głównie przez zielenice. We wrześniu i październiku pojawiają się masowo okrzemki (zakwity *Diatoma vulgare* var. *Ehrenbergi*, *D. vulgare* var. *capitulatum*). Zimą rozwija się zespół złożony z larw *Chironomidae* (*Diamesa*), *Simuliidae*, *Ephemeroptera*, *Plecoptera*. Wśród glonów nadal dominują okrzemki i pojawia się *Hydrurus foetidus*.

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Adres autorów — Author's addresses

dr Barbara Kawecka

dr Marta Kownacka

dr Andrzej Kownacki

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