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Taksoceny *Chironomidae* potoków polskich Tatr Wysokich

Taxocens * of *Chironomidae* in streams of the Polish High Tatra Mts

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A b s t r a c t — The main component of the bottom fauna in streams of the High Tatra Mts are insect larvae, especially *Chironomidae* (40—100% of the total number of animals). On the basis of the dominant species it is possible to distinguish five taxocens of *Chironomidae*, distributed in accordance with changes in altitude. It was possible to show differentiation of *Chironomidae* associations in individual habitats (stones, moss, algae) also within particular localities, as well as the dependence of the course of seasonal changes on altitude.

The aim of the work discussed was to investigate the bottom fauna of streams in the High Tatra Mts, with special attention to *Chironomidae*, to show dependences between the taxocen *Chironomidae* and certain habitat factors, and also an attempt at an ecological description of the streams. The work is part of collective studies conducted by the Institute of Hydrobiology of the Polish Academy of Sciences under the supervision of Prof. K a r o l S t a r m a c h, which are designed to work out the biocoenoses of the Tatra streams.

The first reports about the *Chironomidae* fauna of the Tatra Mts appeared in elaborations by N o w i c k i (1867, 1868, 1873) and B o b e k (1890). Unfortunately, changes in systematics from that time on do not permit indiscriminate acceptance of their classification. It was only the work of Z a v ř e l (1934, 1935, 1937, 1939), H r a b ě (1942), E r t l o w a (1964), K o w n a c k a, K o w n a c k i (1965a, 1965b, 1965c, 1967, 1968a)

* Taxocen after C h o d o r o w s k i (1960) „... this is a community of organisms related systematically, occurring in a specific habitat and showing a yearly recurrent structure of domination".

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which provided material for cognition of this family in the High Tatra Mts. On the basis of the Tatra material the species *Syndiamesa branicki* (Nowicki 1873a), *Trissocladius tatricus* (Zavřel, Pagast 1935), *Procladius tatrensis* (Gowin, Zavřel 1944), *Diamesa starmachi* (Kownacka, Kownacki 1970), as well as the larval stage of the sub-genus *Pseudokiefferiella* (Zavřel 1941) and the species *Nilotanypus dubius* Mg (Kownacki, Kownacka 1968b) were described for the first time.

In spite of quite numerous publications, the list of *Chironomidae* species known from streams in the High Tatras was rather short, compared with other mountains in Europe. Also, there were few ecological data concerning this group.

Area and methods

The stream Białka, together with the tributaries Rybi Potok, Roztoka, and Sucha Woda, drains the northern slopes of the Polish part of the High Tatra Mts. A detailed description of the substratum of the drainage area and chemism of the water of these streams may be found in papers by Pasternak (1971) and Bombówna (1971). A total of 20 sampling stations was marked on the streams mentioned above (fig. 1).

The material for quantitative investigations was collected from the stream Sucha Woda monthly in the period from May 1965 to May 1966 from 7 localities (in October 1965 samples were collected only from stations 1, 4, 7). In December 1965 the additional stations 2A was added and observations were carried out there up to November 1966. On the stream Białka and its tributaries the Rybi Potok and Roztoka samples were collected in the periods June 19th—27th, Aug. 7th—14th, Sept. 14th—20th in 1962 and May 14th—20th in 1963. From the stations 9 and 10 the material was collected in the months September and October 1967.

At each station the samples were taken from the stony bottom with a hand scraper covered with net (mesh 0.3 mm), the volume of the collected stones was measured, and the material obtained preserved in 4% formalin solution. The determined material was then converted to a volume of 2 dcm^3 stones. The basis of further computations was then the arithmetic mean of 10 samples (5 in winter) collected at one identical time at a station, or the arithmetic mean of all samples collected during the year from a whole station or a habitat at the station. From the moss and algae, as well as the hygropetric habitat, only qualitative samples were taken. In distinguishing the taxocens of *Chironomidae* the index of dominance used was:

$$d = \frac{\bar{Q} \cdot 100}{\Sigma \bar{Q}} \cdot f,$$

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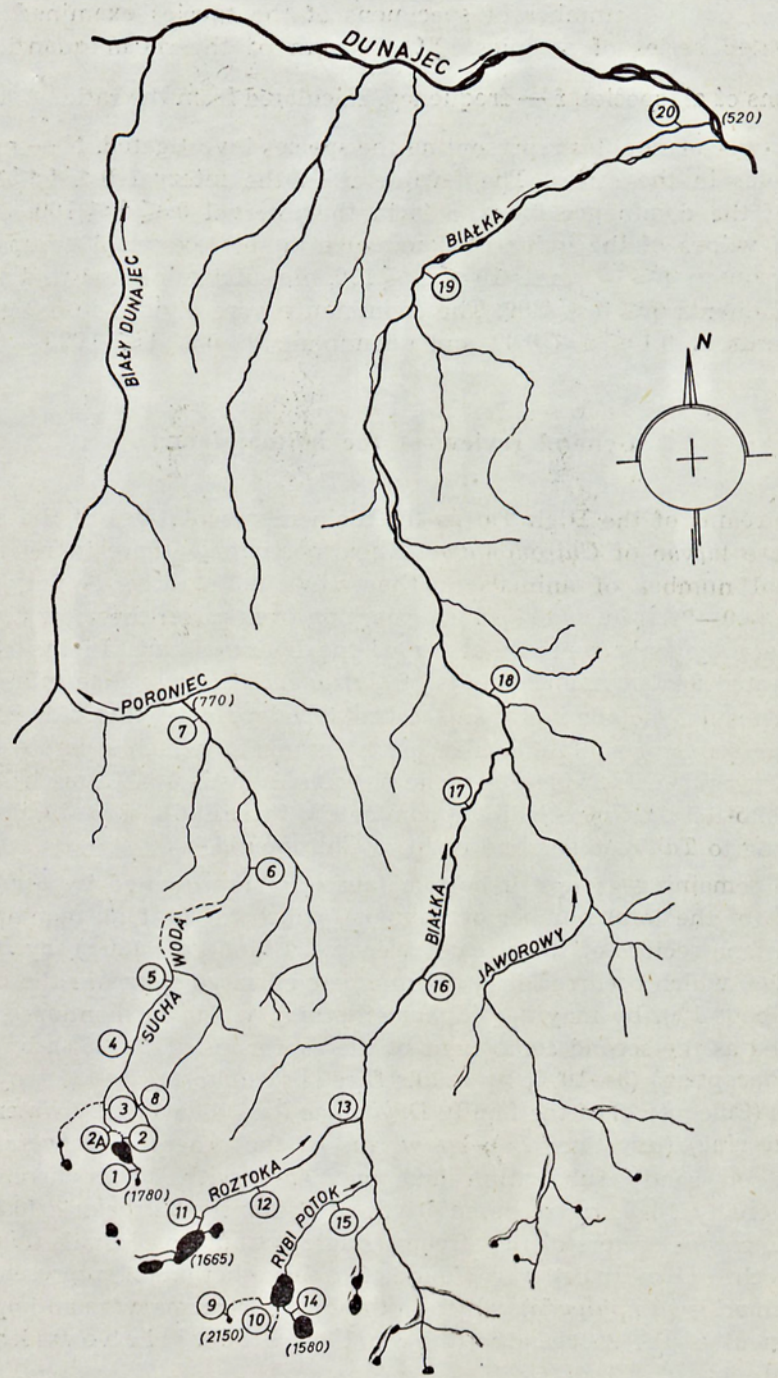

Ryc. 1. Lokalizacja stanowisk
Fig. 1. Localization of sampling stations

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where Q — mean number of specimens of the species examined in the investigated series of samples, ΣQ — sum of the mean quantities of specimens of all species, f — frequency, calculated from the ratio $\frac{n}{N}$, where: n — number of samples representing the species investigated, N — number of samples in the series. The f-value is in the interval $0 \leqslant f \leqslant 1$. The value of the dominance index d is in the interval $0 \leqslant d \leqslant 100$. On the basis of values of the index of dominance in the taxocen 3 groups were distinguished: the dominants $10 \leqslant d \leqslant 100$, the subdominants $1 \leqslant d \leqslant 9.99$, the adominants $0 \leqslant d \leqslant 0.99$. The adominants were divided into 2 groups: adominants A $0.1 \leqslant d \leqslant 0.99$ and adominants B $0 \leqslant d \leqslant 0.099$.

General review of the bottom fauna

In streams of the High Tatras the main representatives of the bottom fauna are larvae of *Chironomidae*. Their percentage share in relation to the total number of animals at the individual stations is very large, reaching 40—90%. In small springs emerging from under the snow *Chironomidae* are the only representatives of the bottom fauna. In the streams investigated 96 taxonomical units of *Chironomidae* were determined (this figure does not include larvae in the first developmental stages determined as to the genus or subfamily, nor species groups in which separate species were distinguished; Table I). In the streams investigated forms belonging to the sub-family *Orthocladiinae* dominated; three units were indicated as belonging to *Tanypodinae* and eight to *Chironomidae*.

The remaining groups of bottom fauna are represented by *Simuliidae* (5—10% of the total number of animals), which in the high montane and submontane sectors of the streams were very numerous (20%), by *Blepharoceridae*, which occurred in great numbers on large stones in the current zone (about 1%), by mayflies (*Ephemeroptera*), which in montane streams appeared as the second component of the zoocoenosis (10—25%), by stoneflies (*Plecoptera*) (3—10%), by caddis flies (*Trichoptera*) (1—12%), by cockchafers (*Coleoptera*) of the family *Dryopinae* (less than 1%), by water mites (*Hydracarina*) (less than 1%), by worms of the order *Oligochaeta* found mainly on sandy substratum and in places with slack current (1%, exceptionally 18%), by representatives of the order *Turbelaria* (0.3—3%). In submontane sectors of the streams single specimens of snails (*Mollusca*) and leeches (*Hirudinea*) were found. On the other hand, representatives of gammarids (*Amphipoda*), which in the Beskid streams were an important component of the zoocoenosis (Sowa 1965, Zaćwilichowska 1968) were absent.

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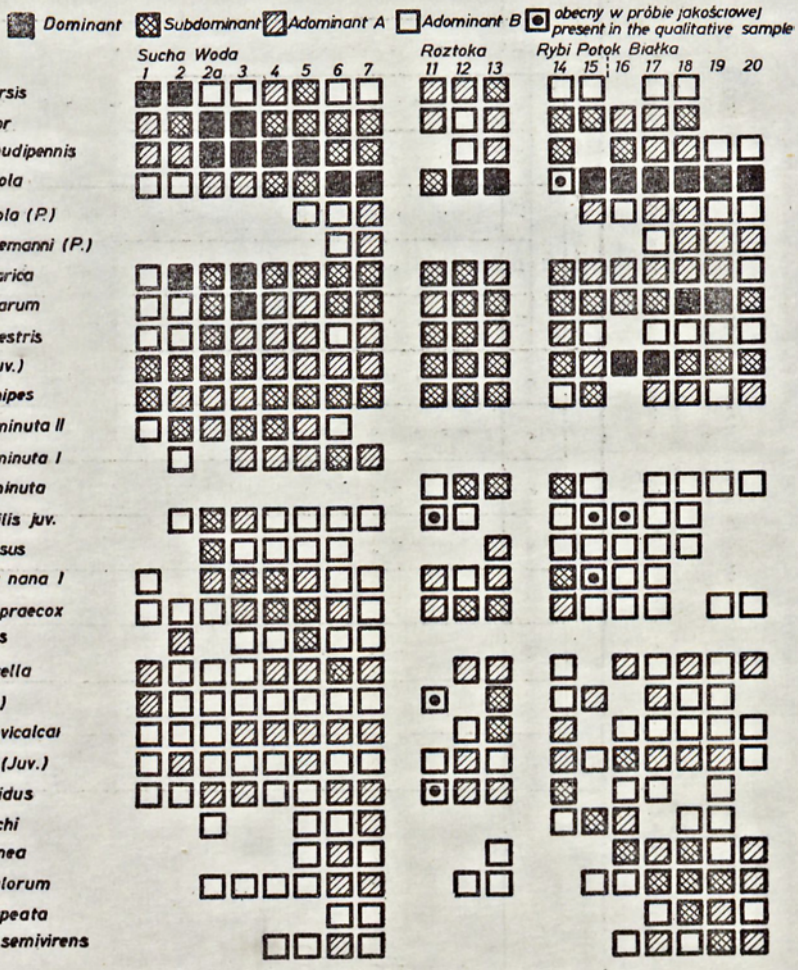
The vertical distribution of taxocens of *Chironomidae* in the Tatra streams

When observing *Chironomidae* larvae along the investigated streams one may note distinct differences not only in the species composition but also in the number of specimens, and on this basis it is possible to distinguish several taxocens (fig. 2).



Ryc. 2. Taksoceny *Chironomidae* na poszczególnych stanowiskach w badanych potokach

Fig. 2. *Chironomidae* taxocens at particular stations in the investigated streams

One taxocen was observed at the outflow of the lake Mnichowy Staw (2000 m above sea level; station 9), where not only the number of individuals, but also the number of species was very small. In this instance

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Tabela I. Średnia roczna ilość Chironomidae (w 2 dcm^3 kamieni) na poszczególnych stanowiskach w badanych potokach
(+ wartość od 0,1 - 0,9 osobników; - wartość 0,01 - 0,09 osobników; o obecny w próbie jakościowej; m młode larwy; p poczwarki; l larwy)

Table I. Annual average amount of Chironomidae (per 2 dcm^3 stones) at particular stations in the investigated streams
(+ value from 0.1-0.9 individuals; - value 0.01-0.09 individuals; o present in qualitative sample; m young larvae; l larvae; p pupae)

Gatunek / Species — Stanowiska / Stations	Sucha Woda								Białka i dopływy - Białka and tributaries									
									Roztoka			Rybi Potok		Białka				
	1	2	2A	3	4	5	6	7	11	12	13	14	15	16	17	18	19	20
Macropelopia sp.								+										
Thienemannimyia sp.						-	1	-							+	+	+	+
Nilotanypus dubius						-	7	1		+	1	-	o	+	1	+	+	+
Pelopinae (m)				+	-		+	-	o	o		+	+			-	+	+
Pseudodiamesa branickii	-	+	1	1	1	1	-	-	o	o	1	+	2	o	-			
Diamesa gr. insignipes	2	+	4	2	12	15	20	15	3	1	15	+	16		2	2	1	7
- starmachi					-	-	-	7				+		3		+	-	
- gr. cinerella	+	+	2	+	1	2	8	3		+	2	+	13	4	+	1	+	1
- gr. latitarsis (l.)	17	10	+	+	4	21	+	+	1	1	6	+	+		-	-		
- latitarsis (p)					-	-	-											
- laticauda (p)	-																	
- parva	-	-	-	+	-	-			o	o		-						
- gr. zernyi (p)				+	-	-		-										
Diamesa sp. (m)	+	+	+	-	+	4	-	+	o	o	14	+	2		1	+	-	
Potthastia longimanus								-							+	-	+	
- gaedei							3	+						o	-	+	5	
Heptagyia legeri					+	+	+	+	o	+	-	+	2	o	-	+	-	-
Heptagyia sp. B.							-								-	-	+	
Heptagyia sp. (m)					-	-	-	-		+	-	o	+		-	+	-	-
Prodiamesa olivacea													o		o			
Cardiocladius capucinus				+	-	-	1	1		o	+		-		1	+	1	2
Brillia longifurca								-			-		o		+		o	
- modesta			+	1	+	+	+	+	+	+	+		-				o	
Heterotrissocladius marcidus		+	+								o		-					
Eukiefferiella bavarica (l.)	-	12	26	39	5	9	16	22	3	4	2	4	+	2	3	5	2	+
- bavarica (p)		+		1	+	+	+	+										

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Eukiefferiella minor	+	4	178	46	4	17	23	17	2	-	2	9	15	3	3	8		
- lonongicalcar																	1	+
- lutethorax															-			
- similis juv		-	18	5	+	+	-	+	o	+	o	+	o	o	+	+	3	+
- brevicalcar	+	+	+	1	1	3	5	1		+	9	1	10	+	+	+	+	+
- alpestris	+	+	12	5	2	2	1	2	12	2	2	2	+		1	+	1	+
- clypeata							+	+							+	19	5	1
- cyanea		-				3	3	+			-			9	10	24	3	2
- gr. lobifera				+	+		+	-	+						+	3	4	
- gr coerulescens															-	1	6	6
- devonica (p)															-	-		
Eukiefferiella sp. (m)	+	+	2	+	+	6	1	1	+	+	1	2	+	7	2	3	3	1
Synorthocladius semivirens					-	1	1	1					+		1	1	10	5
Parorthocladius nudipennis	1	1	87	52	92	78	10	8		-	+	9		7	6	3	-	+
Orthocladius frigidus	-	+	3	2	+	1	7	2	o	1	3	4		1	+	1	1	
- rivicola + thienemanni	+	+	5	5	7	46	140	166	4	11	33	o	168	98	108	177	247	157
- rivicola (p)							2	2					4	+	+	2	1	+
- thienemanii (p)							-	+					-		-	1	2	3
- rivulorum			-	-	-	+	3	6		+	-		+	+	12	17	11	2
(saxosus ?)			14	1	+	+	+				1	-	+	+	+	+		
- gr rhyacobius (p)								+		-			+		+	+	-	-
Cricotopus gr. algarum	+	+	23	39	2	7	17	46	+	5	8	9	27	25	53	81	101	27
- bicinctus (p)								-								o	-	-
typ A.																	-	-
inaequalis	+		9	3	+	+	+				+	+						
saxicola (p)											+						-	
albiforceps (p)														o				
Psectrocladius gr. psilopterus		-										+						
Rheocricotopus fuscipes			2	3	3	2	2	1	+	+	+	+	+	+	1	+	-	-
- effusus								1										
Paracricotopus niger (p)																		-
Microcricotopus gr. parvulus				-				-	+	+			o	o	+	2	+	+
Chaetocladius gr. connectens							-											
Bryophenocladius sp.							-				+		o					
Limnophyes gr. pusilla				-													o	
- gr prolongatus										+		o	-					-
Limnophyes sp. (m)				-		-			o			o	o					
Metriocnemus atratulus				-														
- fuscipes																		
- gr hygropetricus				-	+		-											

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Gatunek Species / Stanowiska Stations	Sucha Woda								Białka i dopływy – Białka and tributaries									
									Roztoka			Rybi Potok		Białka				
	1	2	2A	3	4	5	6	7	11	12	13	14	15	16	17	18	19	20
Parametriocnemus boreoalpinus		+		1	+	26	+	-										
- stylatus				1	+	4	+	+			+	+	+	+	-			
Heleniella ornaticollis			+	1	+	-	+	+		+		+	o		1	+	+	-
Smittia aquatilis					-													
- zavreli											-							
Symbiocladius rhitrogenae							+											
Epoicocladius ephemerae																		o
Krenosmittia gr. boreoalpina (l.)				2	1	2		-	o	+	+	-	+	+	-	+	+	+
- borealpina (p)				-														
- camptophlebs (p)						-	-	-						-	-	-		
Rheosmittia languida							+	-			-			o	+	-	7	+
Parakiefferiella gr. batophila (l)			+	4	3	+	+	+		+	1					+		-
- batophila (p)																	-	
- gracilima (p)					-													
Pseudosmittia trilobata																		o
Pseudosmittia sp.													o					o
Thienemanniella gr. nana 1	-		15	21	7	7	+	-	+	+	2	3	o	+	-			
- gr. nana 2						-	+	2							+	1	+	+
Thienemanniella sp. (m)	-		+	+	+	+	-	-	o	o		+		o	o	+	-	+
Corynoneura gr. minuta 1		+		5	1	2	10	5										
- gr. minuta 2	-	2	4	18	6	2	3											
- gr. minuta									+	+	+	1			4	7	2	+
Corynoneura sp. (m)		+	+	+	+	1	+	+	o		+	o	-	o	+	-	+	+
Orthocladius sp. 1			1	+	-						-	-		-o	o			
Orthocladiinae (m)	3	2	44	19	2	6	8	6	7	6	11	12	7	110	169	84	53	8
Cryptochironomus larva psammophilus								-							+	-	+	-
Polypedillum gr. pedestre gr.								-									1	-
Polypedillum sp. (m)					-		-	-					+				+	+
Chironomini sp. (m)													+				1	+
Micropsectra gr. praecox	-	+	+	4	9	39	4	+	+	5	12	2	+	1	2	1	+	+
Tanytarsus gr. greganius					-											+	+	1
- gr. mancus																	6	+
- lobatifrons								-										
- gr. exiguus							-	+							-	-	2	+
- gr. lauterborni																	+	-
Tanytarsus sp. (m)																-	-	-
Tanytarsini (m)	-	+	1	+	1	+	1	+			-	1	o	o	-	+	2	-

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larvae of *Diamesa steinboecki* dominate. The accompanying species are *Diamesa latitarsis, D. parva,* and *D.* gr. *insignipes.*

Another taxocen develops in the stream flowing in the Mięguszowicki cirque (1900 m above sea level; station 10), the Żółty Potok (1500 m above sea level; station 8), and in the Sucha Woda stream (1550—1790 m above sea level; station 1 and 2). The dominant here is *Diamesa* gr. *latitarsis* (mainly *Diamesa laticauda*), subdominants are larvae of *Diamesa* gr. *insignipes* in higher sectors of the streams, and *Eukiefferiella minor* and *E. bavarica* in lower parts.

Both these taxocens represented mainly by a small number of larvae, mainly of the genus *Diamesa,* determine the high montane zone in the Tatra streams.

In the stream Sucha Woda (station 2A — 1550 m above sea level) and in the stream connecting the lake Czarny Staw with the lake Morskie Oko (1390—1500 m above sea level; station 14 at a place where rapid springs flow into the streams, there develops a taxocen characterized by a large number of specimens and a relatively large number of species. The dominant species is *Eukiefferiella minor,* the second dominant *Parorthocladius nudipennis.* Important components of the association are: *Eukiefferiella bavarica, E. lutethorax, E. alpestris, Crictotopus* gr. *algarum,* and juvenile larval stages of *Orthocladiinae.*

In streams of the montane forest zone, 1000—1500 m above sea level (stream Sucha Woda; stations 4 and 5), the dominant species is *Parorthocladius nudipennis.* Subdominants are larvae of *Diamesa* gr. *insignipes, Eukiefferiella bavarica, Thienemanniela* gr. *nana* I, and *Corynoeura* gr. *minuta* II, and in lower sectors *Orthocladius rivicola.* However, the stream Roztoka (stations 12 and 13) differs from that described above not only in the composition of the fauna but also in the number of specimens. Over the whole length of the stream the number of specimens is markedly lower than in other streams situated at the same altitude. Also the species compositions is different at these stations. *Orthocladius rivicola* is the dominant species, whereas *Parorthocladius nudipennis* appears here only as an adominant.

In montane streams and rivers at an altitude of 500—1000 m above sea level (stream Sucha Woda — stations 6 and 7; stream Białka — stations 16, 17, 18, 19, and 20) the number of specimens and taxonomic units rises. Also the taxocen *Chironomidae* changes. The dominant species are *Orthocladius rivicola* and *O. thienemanni,* while the share of *O. rivicola* is greater in the upper parts of this zone, at 700—800 m above sea level the two species occur in more or less equal quantities, whereas farther below, in montane streams a predominance of larvae of *Orthocladius thienemanni* was observed. Subdominants are larvae of *Cricotopus* gr. *algarum.* In this zone species appear which are not found or found only as single specimens

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at stations situated higher. Also a great many species which were leading forms in higher parts of the stream do not occur here.

When analysing the effect of habitat factors on the zonal distribution of taxocens of *Chironomidae,* the most distinct dependence was observed between the quantity and species composition of *Chironomidae* and altitude. Together with decreasing altitude the number of taxonomic units within the taxocen increases, and species occurring in the highest parts of the stream are usually absent in the lower parts and vice versa. Thus, besides the decrease in the number of species as the altitude increases one encounters the phenomenon of certain species being replaced by others.

Together with increased altitude also the climatic conditions (water temperature, ice cover, freeze-up and duration of the winter period) change, as well as chemical and geological conditions (changes in pH, Ca content in the water and structure of the substratum) and the gradient. Hence it is rather difficult to see in the change in altitude a single cause of faunistic changes.

During the year 1966 observations were carried out at two stations (2 and 2A) situated at the same altitude, removed from each other a maximum distance of 100 m, and having a similar chemical composition of the water. Nevertheless, the *Chironomidae* fauna in these two stations is quite different as to specimens and species composition. These changes are caused above all at one station by the inflow from a spring, favourable thermal conditions (especially in winter), and a thick cover of mosses and algae, and at the other station by freeze-up and drying out, the short vegetation period, and lack of well- developed plant cover. At the end of the vegetation period the composition of the taxocen *Chironomidae* at station 2 becomes similar to that observed at station 2A. It seems probable, therefore, that if it were not for the factors mentioned above the fauna at these two stations would not differ to such a marked extent. These factors, in particular the freeze-up and the break in continuity of the vegetation period, are the main elements effecting the development of the specific taxocen *Chironomidae* in the high mountain zone.

Changes in fish associations are explained by Huet (1954) on the basis of the gradient rule. Starmach (1956) employed this rule also in explaining changes in plant and animal (invertebrate) associations in rivers of the Carpathian Mts and the Małopolska Upland. Also in this paper may be seen a correlation between gradient and zoning. The mountain zone on the streams investigated begins at gradients of 600‰, and ends at a gradient of approximately 100‰. The spring- on sub-alpine zones include gradients of 100—80‰, and the zone of montane forest streams gradients of 50—70‰. Below the place where the gradient of the stream is less than 20‰ begins the zone of submontane streams and rivers. When considering the fauna composition in the individual localities numerous deviations from this rule are encountered. At station 14, which has the highest unitary

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gradient (321.6‰), a taxocen characteristic for the spring zone developed. However, it should be stressed that the number of specimens is characteristic for the high montane zone. Station 15 shows, in spite of a high unitary gradient (100‰), a species composition and number of specimens characteristic of sumbontane streams.

When analysing changes in the taxocens of *Chironomidae* and changes in their number at the particular stations, one may note a far-reaching dependence on the geological substratum and chemical composition, especially on changes in the pH and the Ca content in the water. The high montane zone has a crystalline substratum, the water an acid reaction and very small Ca content. In the montane zone the stream Sucha Woda flows over a calcareus substratum; its water shows an almost neutral reaction and increased calcium content; the pH is alkaline. The substratum is formed by sedimentary rock.

Further proof of the effect of the substratum on the fauna association may be found also in the separate character of the taxocen *Chironomidae* in the stream Roztoka, which flows exclusively over a crystalline substratum and shows a small Ca content in the water. The number of specimens is very small (similarly as in the high mountain zone). At the same time it should be remembered, that changes which took place in the composition and number of *Chironomidae* between stations 2 and 2A are not explained by changes in the chemical composition of the water, Ca content, and a different kind of geological substratum.

The importance of the chemical composition, especially lime salts, for the development and quantity of the bottom fauna has been stressed more than once by many authors. Dittmar (1955) reports the largest number of animals in streams of the Sauerland presenting a Ca content of 14—30 mg/l. Müller (1954) showed in streams with acid water (northern Sweden) greater settlement on an artificial bottom made of laid lime stones. This substratum was particularly frequented by phytophagous forms, since algae developed abundantly on the lime stones. Gessner (1955) stresses the importance of limestones for the development of algae in streams.

It would seem, therefore, that one of the basic causes of abundance of bottom fauna in streams is the covering of the substratum by algae and mosses. The irregular course of the curve showing changes in the total abundance of *Chironomidae* in the stream Sucha Woda together with the changing altitude is due to the development of algae and mosses at stations 2A and 3. The greater part of *Chironomidae* species in the stream investigated are phytophagous forms.

On the other hand, it was impossible to observe any dependence between changes in the taxocen *Chironomidae* and the changed water yield after the confluence of two main tributaries (Illies, Botosaneanu 1963). In the stream Roztoka fauntistic changes occur along the whole length of the stream, in spite of the fact that there are no tributaries which could be

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regarded as equal in importance to the main streams. In the stream Sucha Woda, on a sector between 1100—1500 m above sea level, changes in the distribution of *Chironomidae* larvae also occur, even though the Sucha Woda stream proper, which could be an equivalent tributary of the stream Czarny Potok, is dried out during the greater part of the year. Also no great differences in the structure of dominance and the number of specimens were observed between station 17, situated above the point of confluence of the stream Białka with its largest tributary, the Jaworzyna stream, and station 18 situated below this point of confluence, in spite of the distinct change in the character of the river. Markedly greater differences appear between stations 18 and 19. They are more than 10 km apart, but there is no tributary in this sector which could be considered equivalent to the stream Białka.

Also Berthelemy (1966) found, while investigating *Plecoptera* and *Coleoptera* of the Pyrenees, that the altitude above sea level is of greater importance in the area investigated that the volume of water yield. Vaillant, too, (1967) reports that in high mountains the water temperature in the stream is more important for the development of the bottom fauna (*Rhyacophila, Wiedemannia*) than the volume of water yield.

Such a large number of factors considered by different authors to be decisive for changes in the bottom fauna, as also the present author's own observations, permit the statement that the quantitative and qualitative changes in these fauna develop as a result of many factors, and it is difficult at the present time to declare that any one alone is responsible for these changes. Also Macan (1962) draws attention to the fact that it is impossible to consider one factor as responsible for all changes (this concerned the problem of the importance of the current). At best one might attempt to classify such factors in one area in some order of importance, which would not mean that this order would be valid in some other area. This method was attempted by Dittmar (1955), Albrecht (1953), and Vaillant (1967). Also different groups of aquatic organisms are dependent on different factors.

The differentiation of *Chironomidae* taxocens within habitats

Many authors employ as a basis of ecological considerations the type of substratum on which a given association develops. Its role is particularly stressed by the Scandinavian authors Berg (1948), Jonasson (1948), Thorup (1966), Ulfstrand (1967). Also the German investigators Thienemann (1936, 1941, 1954), Albrecht (1953), Dittmar (1955), and Illies, Botosaneanu (1963) give, besides a division into zones, a classification within particular zones according to the „mosaic of biotopes", i. e. habitats. Many Polish authors also distinguish faunistic

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associations on the basis of the type of substratum (Siemińska 1956, Starmach 1959, Sowa 1961, Smoleńska 1963).

In the streams investigated two types of hibitats were distinguished: stones, and mosses and the algae *Hydrurus foetidus*.

Stony habitat

The stony habitat was considered together with the algae cover on stones and sand found between stones and silt containing a substantial admixture of algae, which cover the stones in a thin layer in places without current. For this reason, five additional classes of current were distinguished within the stony habitat:

a) stones in rapid current (0.6—1 m/sec. *), in places where cascades develop and the water is white with air bubbles (depth 10—50 cm),

b) stones in even current (0.2—0.6 m/sec.), where the water surface is generally smooth and the depth great (more than 50 cm),

c) stones in current in a shallow place — in many places the bottom appears in the form of long stony shelves, over which a thin layer of water flows, generally not exceeding a depth of 10 cm,

d) stones in slow current (0.1—0.2 m/sec.), usually near the bank (depth 1—10 cm),

e) stones in places without current near the bank, behind large boulders, gravel banks with intermixed stones, stones covered by a thin layer of silt.

The *Chironomidae* taxocens living on stones in various current classes were investigated in the stream Sucha Woda, which includes all zones (stations 1 and 2 — high mountain zone, 3, 4 and 5 — montane zone (montane forest streams), 6 and 7 — zone of sub-montane streams).

As can be seen from Table II, the habitat of stones in various classes of current may be described on the basis of taxocens arranged according to the index of dominance, while it is difficult to find species inhabiting one class of current exclusively. For example, larvae of *Nilotanypus dubius*, which were the first dominant in a place without current at station 6, were found also among the taxocen of swift current but already as an adominant B.

It seems difficult to define any distinct limits between distinguished classes of current. Only the taxocen developing in places with rapid current differs significantly from those found in places without current. Shallow current, even current, and slow current present taxocens transitional between these two basic classes. It is worthy of note, however, that all current habitats are more similar to each other and usually present a certain common dominant species (with the highest dominance index in rapid

* Velocities of surface current are given at low water.

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current). On stones in places with slow current a species characteristic of places without current is usually the second dominant.

The lack of sharp limits and of species connected exclusively with one current habitat should be associated with microhabitats developing behind and around stones. Ambühl (1962) found in his investigations of the current around a stone that immediately next to the stone a thin „border zone" develops which is in fact without current. The importance of this layer to organisms was shown by Starmach (1959), Plescot (1962), Illies (1962). The width of this layer decreases together with the velocity of the current. Also behind stones there appears a zone of calm water (eaux calmes, Todtwasser). This zone exists also in places where the surface current is very swift and organisms characteristic of waters near the banks with slow current and of stagnant water without current may live here.

In the zone of „calm water" sand and various organic components accumulate. When samples were collected, even in those places with the swiftest current, pine needles, organic debris, and sand, which were washed out after disturbing the bottom structure fell together with stones into the net. Also all irregularities on the surface of stones favour the development of organisms not adapted to living in the current. In the fissures of stones from the cascades numerous larvae and pupae of *Chironomidae* are encountered. A sudden rise in the water level after rain of thaw may disturb this structure and then the border layer decreases and the zone of „calm water" vanishes; the organisms are washed out and carried down the stream.

There are, however, species which willingly choose certain habitats, even though they are found in other places. In rapid current such species are *Diamesa* gr. *latitarsis* and *Orthocladius rivicola,* in even and shallow current *Parorthocladius nudipennis,* and in places without current *Corynoneura gr. minuta* II, *C.* gr. *minuta* I, *Nilotanypus dubius, Micropsectra* gr. *praecox, Parametriocnemus borealpinus, P. stylatus. Rheocricotopus effusus, Syndiamesa branickii* and all remaining larvae of the sub-family *Tanypodinae, Chironomini,* and *Tanytarsini* are found. Also encountered are species which occur equally numerously on stones in all kinds of current — sometimes even in places where there is no current — e.g., *Eukiefferiella minor, E. bavarica.* Should a certain habitat have no decided dominant, such species may dominate.

It should also be stressed that the taxocens characteristic of various classes of current are quite dissimilar at different altitudes. The structure of dominance in rapid current in the high mountain sector of the stream differs from the structure found in a similar habitat in the sub-montane zone of streams and rivers (Table II). However, the species selecting a certain habitat show a greater vertical range in that habitat. For example, the species *Orthocladius rivicola,* characteristic of the zone of submontane

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Tabela II. Taxoceny Chironomidae w różnych siedliskach prądowych na poszczególnych stanowiskach w Suchej Wodzie
(uwzględniono wyłącznie dominanty i subdominanty)

Table II. Chironomidae taxocenosis in the different current habitats at particular stations in the Sucha Woda Stream
(including only dominants and subdominants)
[ ] dominant 1 + adominant A o adominant B

Stanowisko / Station	Silny prąd / Rapid current							Równy prąd / Smooth current							Płytki prądzik / Shallow current							Słaby prąd / Weak current							Bez prądu / Without current						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Diamesa gr. latitarsis	[26,16]	[18,32]	o	3,58	6,64	o	o	[59,41]	23,08		1,83	+		o	[18,53]			o	3,66	+		12,42	13,61	o	o	+	+	o		+	o	o	+	o		
Eukiefferiella bavarica	o	16,59	[17,50]	5,78	2,45	4,71	6,83		[25,62]	12,87	+	+	2,36	o			10,30	1,77	5,81	[20,77]	14,21		[17,48]	13,74	1,09	2,54	5,15	4,47	+	+	2,65	+	o	+	2,20
Parorthocladius nudipennis	+	+	2,43	[22,52]	6,94	2,16	+		2,56	[37,20]	[53,36]	[51,80]	3,36				9,77	[86,78]	[41,42]	2,81	+	4,37	+	[32,64]	[76,73]	[27,18]	3,99	2,56	1,83	2,55	6,95	[22,52]	[20,77]		o
Orthocladius rivicola	o	o	1,77	5,06	[19,54]	[54,31]	[56,15]			+	4,24	1,75	[39,83]	[34,29]					3,49	17,72	[65,67]			o	o	5,42	[17,03]	[46,23]			+	+	+	5,71	6,62
Cricotopus algarum	o	o	17,58	+	+	2,77	1,66			11,83	+	+	7,41	25,51			+	+	+	+	+			3,04	o	+	1,21	13,06			4,10		o	+	[38,28]
Eukiefferiella minor	o	3,47	10,47	2,75	5,36	3,55	3,12		2,56	9,71	4,35	5,53		1,76			[26,04]	+	17,91	1,45	3,71	1,46	+	14,46	+	1,14	1,31	4,16	2,75	5,73	2,26	+	+	4,20	8,45
Diamesa gr. insignipes	2,07	+	+	8,42	5,64	5,79	3,30	29,20		+	2,39	+	3,00	+	14,76				+	o	+	2,92	+		o	+	+	+	7,78		+	+	o	+	8,71
Orthocladinae (juv.)	o	1,09	3,90	+	+	+	+		5,12	2,23	+	1,66	3,48	+			4,70	+	+	3,06		[25,59]	2,86	6,05	+	+	o	1,86	[13,76]	1,27	+	+	o	o	+
Corynoneura gr. minuta 1		o	+	o	o	+	o			+	o		+	o						5,35	o		+	+	+	+	11,41	+			+	+	o	11,42	7,09
Corynoneura gr. minuta 2		+	+	+	o				2,56	o	1,65	o	o					+	o			+	1,06	1,53	+	+	1,07			[18,63]	10,66	3,43	+	1,27	
Rheocricotopus effusus			+	o	o	o	o			o	o	o	o	o					+	+	+			o	+	o		+			[18,91]	1,60		3,02	1,22
Nilotanypus dubius						o	o						+	+													+	o					o	[16,19]	+
Syndiamesa branickii		o	o	o	o	o						o												o	o	+		o	+	10,51	+	+	+		c
Thienemaniella gr. nana I			8,66	2,47	1,07	o		1,03		2,39	3,38	+	o					o	+	o	o			+	+	1,33	+				2,16	2,56	+	o	
Eukiefferiella alpestris	o	o	1,91	1,14	+	+	1,45			o			o				1,30	1,14			+	+		+		o		o	+	+	o			o	o	
Eukiefferiella similis juv.		o	1,55	o	o	o				+				o			1,05	+			o			+				o							o
Diamesa gr. cinerella	+	o	o	+	+	1,41	o				o	+	2,14	+					+		o	+	+	o	o	o	+	+	+		o	o	o	o	
Rheorthocladius frigidus	o	+	+	o	+	1,15	o			o	o	o	1,31	+										o		o	o	+			+	o		o	+
Orthocladius rivulorum				o	o	+	+			o			+	1,17													+	1,56					o		2,48
Brillia modesta			o	+	o	o	o			o	o		o				+	1,18						o	o	+		o			+	+	o	o	
Krenosmittia gr. boreo-alpina				o	o		o			o	o								9,41					o	o						+	+	+		o
Eukiefferiella brevicalcar	+	+	+	+	+	+	o			o	+	+	+	o					2,26	4,52	1,69		+	o		+	+	+		+	o	o	o		+
Micropsectra gr. praecox	o		+	+	+	o	o			+	+	+	o						1,04	1,67				+	+	8,49	2,72	+		1,81	2,80	7,71	9,85	5,44	+
Parametriocnemus boreo-alpinus		+		o	+	o	o			o		+	o							o			1,54	o	o	3,06	+			+	+	o	4,13	o	
Synorthocladius semivirens					o	o	o					o	o	o						+.	+					o	2,011	+				o	o	+	o
Parakiefferiella batophila				o						o	o	o	o								o			o		o	+	o			1,43	1,04	o	+	
Thienemannimyia sp.						o								o													o						1,22	o	

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streams in the montane zone, is a dominant or important subdominant on stones in places with rapid current. Similarly, the range occurrence of *Parorthocladius nudipennis* is markedly wider in the habitats of even and shallow current. A more limited range appears in associations of habitats without current. Only larvae of *Micropsectra* gr. *praecox* occur numerously at all altitudes (it is not known whether this is one species).

One of the basic factors having influencing the distribution of *Chironomidae* taxocens within a locality is the current, acting in certain instances directly, but mostly indirectly by way of changes in the substratum and eutrophyzing action (flowing waters are more abundant on oxygen and carry more organic matter). The velocity of the current influences the width of the layer of „border water" and the size of the area of „calm waters". The current also has an important mechanical function in the sorting of the substratum. In rapid current very large stones are deposited or smaller ones which are wedged in bettween the larger stones, so that they are immobile. In places with slower current smaller fractions of gravel and stones accumulate. During high water the bottom of a stream may be disturbed and washed out. It seems that these two factors — the current and the type of substratum — (this concerns the size of fractions and not the geological structure) are inseparably connected in mountain streams. Experimental investigations by Zimmerman (1962) show that the current velocity has a greater importance than the substratum. It seems, however, that in natural conditions these two factors act with similar force. The importance of current and substratum was streassed by Starmach (1959), Plescot (1962), Illies and Botosaneanu (1963), Berg (1948), and Joasson (1948).

Ulfstrand (1967), besides the two factors given above, stresses the effect of depth on the abundance of fauna and shows greater inhabitation of shallow waters. Ulfstrand's results are in accord with the findings of the present author. In the Tatra streams significantly larger numbers of animals were caught in rapid current in shallow places than in even current in deep places.

In discussing the fauna of stones, especially when elaborating groups of animals which are consumers of the Ist order, it is necessary to emphasize the close connection existing between their occurence and algae. Bare stones cannot be the substratum of the zoocoenoses which inhabit them. For the development of organisms, especially such as the majority of *Chironomidae*, first of all the development of algae is necessary. During the investigations it never occurred that there were no algae in places where larvae of insects lived. The quality and thickness of the alga cover are decisive factors in the distribution of *Chironomidae* taxocens. It may be assumed that within the locality the current, kind of substratum, and depth lead to the development of certain plant forms, which in turn are readily inhabited by definite zoocoenoses.

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The development of *Chironomidae* taxocens in habitats without current other than those in habitats situated in the current should be ascribed to the different conditions prevailing in such habitats. Apart from stones there are gravel banks and accumulations of fine plant silt. Here may develop forms which burrow into the substratum and detritusophagous forms (*Tanytarsini, Chironomini*). Here also different physical and chemical conditions may prevail. Kamler (1965) drew attention to the thermal micro-differentiation in places of stagnant water and in the current. Probably similar micro-differentiation may be shown for the chemism of these habitats. However, no impoverishment from the aspects of species variety and number of specimens of *Chironomidae* were shown in places without current, contrary to the findings of Kamler (1966) for *Ephemeroptera* and *Plecoptera* in the Tatra streams.

A greater impoverishment of fauna was found only in sandy places with stagnant water, where mainly *Oligochaeta* and *Tanytarsini* (*Micropsectra* gr. *praecox*) developed.

A different habitat is formed by parts of large stones protruding above the water surface though constantly splashed by the water. Here above all live larvae of the genus *Heptagyia*. Other larvae are found occasionally. A similar settlement of this habitat was shown by Thienemann (1954) in streams of the mountain Alps.

Chironomidae taxocens in mosses and the alga *Hydrurus foetidus*

In the Tatra streams the role of moss is quite important as a habitat of aquatic animals, especially in the upper sectors, where it covers a significant part of rock boulders and stones.

An important component of the moss fauna are *Chironomidae* appearing as a characteristic, fairly uniform taxocen (fig. 3), differing in the structure of dominance from taxocens of other habitats. They constitute 50—90% of the total number of specimens living in mosses.

In the taxocen of *Chironomidae* in mosses of the streams investigated *Eukiefferiella bavarica, E. minor,* and *E. lutethorax* dominate. These three species exchange their position in the structure of dominance and may have different index values, depending on the altitude at which they are found. In mosses of the streams discussed a certain role falls also to *Diamesa parva*, which at station 14 is the second dominant, while in the stream Roztoka it is a subdominant. Frequent among subdominants are *Micropsectra* gr. *praecox, Cricotopus* gr. *algarum, Thienemanniella* gr. *nana* I, *Diamesa* gr. *cinerella, and Orthocladius rivicola.* The remaining species occur sporadically.

A different structure of species is seen in the moss association in the stream Rybi Potok (station 15). In spite of the dominance of *Eukieferiella minor,* the typical structure of species in mosses is divided by species

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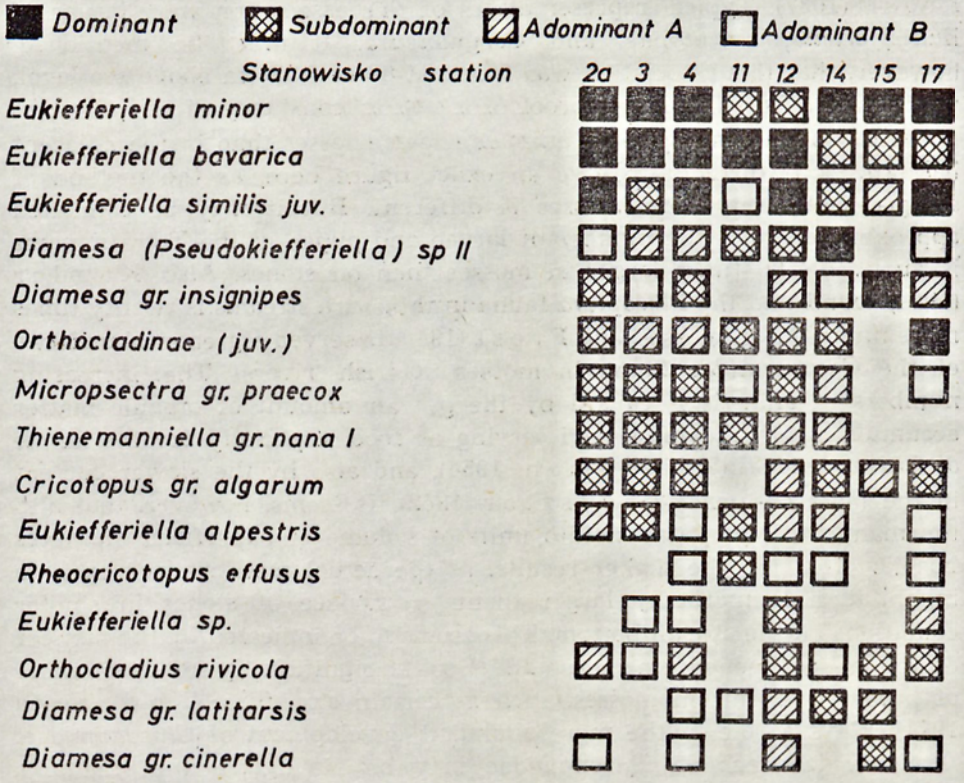
characteristic of the alga *Hydrurus*, which covers the substratum at this station nearly 100%, the moss also being overgrown by patches of this alga.

The moss association may be described exclusively on the basis of the structures of dominance, but there are no species connected exclusively with this habitat. Even species which dominate here occur also in other habitats.



Ryc. 3. Taksoceny *Chironomidae* w mchach badanych potoków
Fig. 3. *Chironomidae* taxocens in moses of the investigated streams

The taxocen discussed is characterized by its great constancy, even though the samples were collected from stations in various zones representing quite different associations on stony substratum. Species characteristic of a given zone are usually of no importance in the moss. For example, in the stream Sucha Woda, at 1180—1540 m above sea level, the dominant species is *Parorthocladius nudipennis*, which in moss is only adominant.

The moss fauna may in certain conditions model the composition of an association characteristic of a given zone. This is observed in the stream

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Sucha Woda at station 2A. As moss covers the substratum in this place 70—90%, it is impossible to collect only bare stones. Hence, at station a larger number of animals (in 2 cm^3 of stones) was collected and the composition of the association is a resultant of both the stone fauna and the moss fauna.

Thieneman (1954) found that larvae of the genus *Eukiefferiella* are characteristic of mosses in mountain stream. Similar taxocens of *Chironomidae* in a river in Ireland were reported by Humphries, Frost (1937). Typical representatives of this association were larvae of *Eukiefferiella, Cricotopus,* and *Corynoneura.* It must be mentioned, however, that this association was found at 60 and 230 m above sea level, which would be still further proof of the great constancy of this taxocen.

Nearly always many more animals live in mosses than in the adjacent habitats. It is difficult to give an exact figure here, as the method of sample collection from mosses is different. But it may be estimated approximately that the number of larvae and pupae in the Tatra streams is about 40—80 times larger in mosses than on stones. Also Kamler (1964) found that the *Plecoptera* fauna in the Tatra streams is twenty times more numerous in mosses, and Frost (1942) observed a greater abundance of the *Chironomidae* fauna in mosses in Irish rivers. The increasing numbers of animals is caused by the greater amount of organic matter accumulating in the moss, and serving as food, especially for the larvae of *Chironomidae* (Thieneman 1954), and also by the slower current in the moss cushions (Gieysztor 1962). It seems, however, that also the manner of computation into units of volume or superficial measures has its effect on the higher results, as the actual moss surface open to inhabitation is markedly larger than the surface of stones in similar conditions on the stream bottom. This seems to be indicated by the number of animal specimens from station 2A. Also the significantly smaller number of predatory forms in mosses, such as certain stoneflies (Kownacka 1971), plays a role in the more abundant development of *Chironomidae.*

Other taxocens of *Chironomidae* may be distinguished in the alga *Hydrurus foetidus.* This alga develops in the streams investigated below 1550 m above sea level in the period from autumn till spring. In summer this alga vanishes. It may flourish throughout the year only in the vicinity of springs. The alga appears in the form of a thin, low, formless jelly clinging to stones, or it forms several cm long jelly-like thalli of various length, sometimes reaching up to 0.5 m, as at station 20 (Kawecka 1971).

The taxocen developing within this alga is characterized by a small number of species, which however appear here in large numbers (the number of specimens is as great as in moss). The dominant species are larvae of *Orthocladius rivicola* and *Diamesa* gr. *insignipes.* Apart from these larvae of *Cricotopus gr. algarum* and *Diamesa* gr. *cinerella* are often

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found. The remaining species occur in small numbers. Larvae of the genus *Eukiefferiella,* which were dominants in the mosses, are here represented by singie specimens of *E. bavarica.* Also larvae of *Parorthocladius nudipennis* in qualitative samples of the alga *Hydrurus* occurred as single specimens, though this is contrary to observations on the basis of quantitative samples from stones. It is of interest that the larvae dominating in this association show a much higher vertical range than in other habitats. *Orthocladius rivicola* was at station 2A the second, but at station 3 the first dominant, in spite of being one of the adominants in quantitative samples from stones. The taxocen *Chironomidae* from station 15 develops under the influence of this alga.

It appears that in the skin of algae there exists a specific physical and chemical habitat (strong scent), leading to favourable living conditions only for certain species. On the jelly of the *Hydrurus* colony bacteria occur in abundance, especially near the end of the vegetation period of this alga. They are also accompanied by small algae, mainly *Diatomeae.* It is possible that the bacteria and algae overgrowing *Hydrurus* constitute the feeding matter of *Chironomidae* larvae characteristic of this taxocen.

Annual changes in numbers of *Chironomidae* in streams of the Polish High Tatra Mts

Seasonal changes in numbers and species composition of *Chironomidae* taxocens were observed in the stream Sucha Woda. For more accurate observation three stations (1, 4, and 7) were selected, which are characteristic of the zones distinguished in Tatra streams.

In the high mountain zone, the curve showing the change of dynamics of numbers of *Chironomidae* has one peak only (fig. 4). After the initial period there follows an increase and then a fall in the number of specimens. The period of favourable living conditions is very short, hence the species living here must pass through their whole development in a very short time. In this locality it is possible to distinguish four periods during the year. The first period, the „pioneer period" in which single larvae in the first developmental stages appear lasts more than one month. In the second period there develops the fairly numerous taxocen, characteristic of this locality, consisting of larvae and pupae of the genus *Diamesa,* mainly *D.* gr. *latitarsis* (dominant), but also *D.* gr. *insignipes, D.* gr. *cinerella,* and *Diamesa* sp. (subdominants), which emerge after less than two months. During the third period a fall in numbers occurs, and a subsequent taxocen begins to appear, consisting of *Orthocladiinae* larvae in the first developmental stages and young larvae of species characteristic of the lower — lying stations (*Parorthocladius nudipennis* and *Eukiefferiella minor*). This taxocen perishes at the moment of drying out or freezing up of the stream. Next

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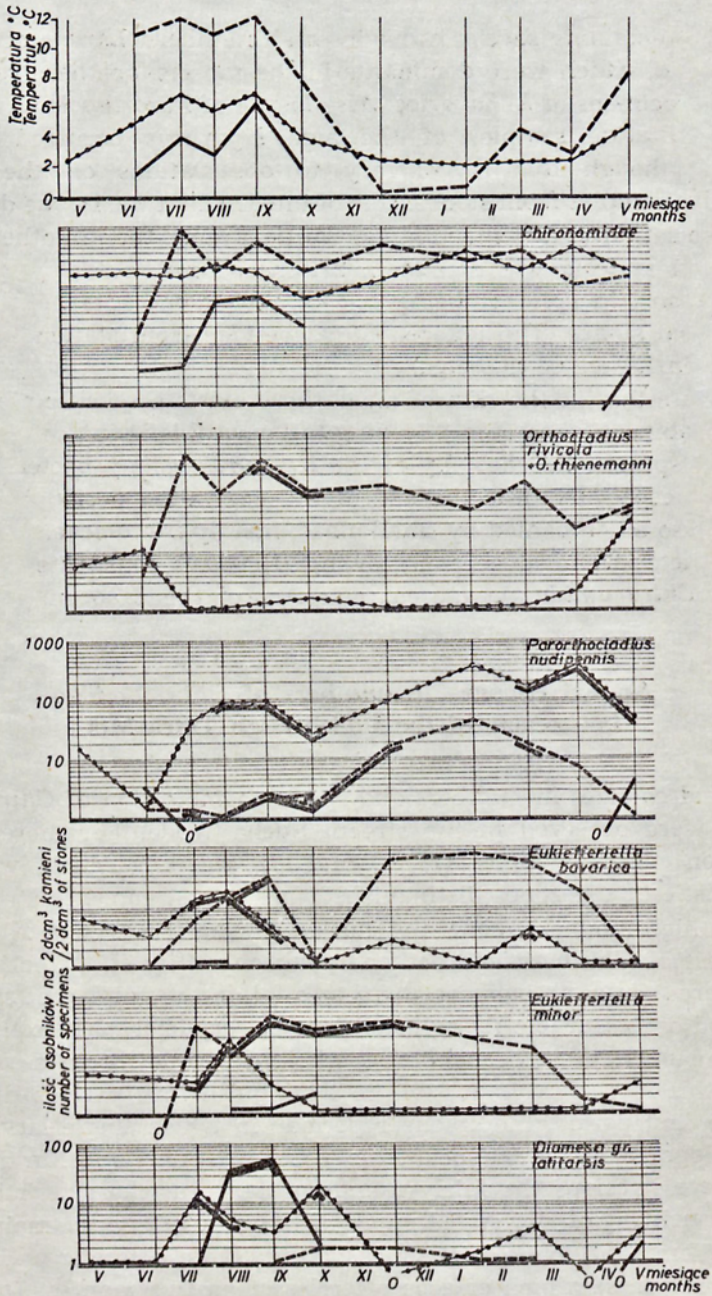

Ryc. 4. Sezonowe zmiany liczebności dominujących gatunków *Chironomidae* w potoku Sucha Woda na stanowiskach 1 ————, 4 ....., 7 —— ——, w zależności od temperatury (podwójna linia oznacza okres pojawu poczwarek)

Fig. 4. Seasonal changes of the dominant species of *Chironomidae* in the Sucha Woda stream at the station 1 ————, 4 ....., 7 —— ——, in the relation to temperature (Duble line denotes the period of the pupae appearance)

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comes the off season, which lasts the greater part of the year. The short duration of the vegetation period does not permit a more abundant development of algae (mainly *Cyanophyceae* develop). The feeding conditions are unfavourable in this locality, therefore the number of specimens is also small.

In streams of the montane zone the curve of changes in the total number of *Chironomidae* shows two peaks. There is one small maximum in summer and a second one, very large, in winter. Both are caused by the dominant species *P. nudipennis* (fig. 4), and the spring and autumm minima are caused by the emergence of adult forms. The winter maximum, caused exclusively by the dominant species, is much greater than the summer one. In winter the stones in this locality are overgrown by a thick layer of the algae *Homoeothrix varians* and *Hydrurus foetidus*. The mass development of algae greatly improves the feeding conditions favourable to this species, though on the other hand, the conditions prevailing in these thalli are unfavourable to the development of competing forms (e.g. *Eukiefferiella*). In summer the stones in this locality are covered by a thin layer of the diatoms only, the small number of which does not create favourable feeding conditions for any species.

In streams of the submontane zone the curve of seasonal changes during the year has many peaks (fig. 4). A double increase in the number of *Chironomidae* specimens can be observed in summer and autumn and two smaller maxima in winter. The changes in the summer and autumn period are caused by changes in the number of generations of dominant species of the genus *Orthocladius* (*O. rivicola* and *O. thienemanii*) and partly by larvae of *Cricotopus* gr. *algarum*. After a massive increase there follows flight and a fall in numbers; this is twice repeated. During this period the temperature in the locality is relatively high and usually exceeds 10°C., a fact which speeds up the development of these species. The stones are overgrown by a thin layer of the diatoms, in which larvae of the dominant species find favourable feeding conditions. In autumn there occurs a fall in temperature, and also the algae vanish. The third winter maximum is caused by the dominance of larvae of the genus *Diamesa* (*Diamesa starmachi* and *D.* gr. *insignipes*). This may be ascribed to the sudden change in physical conditions in the stream. All the water surface becomes covered by ice, and in places the stream freezes to the bottom. In such places the water appears on the surface ice of the and flows over it. The water cools markedly and significantly lower temperatures than in the higher lying localities are noted. The low temperature creates favourable conditions for the development of *Diamesa* larvae and at the same time inhibits the development of the remaining species. The warming of the water, beginning in March, causes a slow development of species of the genus *Eukiefferiella* (*E. bavarica*). The fourth maximum is connected with this period. (It is possible that the fall

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occuring between the two winter peaks was caused by changes in the localization of ice-free places.) The spring floods due to the melting of snow cause complete destruction of this taxocen.

STRESZCZENIE

W potokach Tatr Wysokich, Roztoce, Rybim Potoku, Białce i w Suchej Wodzie oraz w wysokogórskich potoczkach płynących w paśmie hal — *Chironomidae* były głównym składnikiem zoocenozy i stanowiły 40—90%, a w pewnych wypadkach nawet 100% ogólnej liczby zwierząt. Były również reprezentowane przez największą ilość jednostek taksonomicznych.

Analizując rozmieszczenie *Chironomidae* w badanych potokach, wyróżniono pięć zasadniczych taksocenów. Jeden spotykano wyłącznie w Dolinie za Mnichem w potoczku wypływającym spod płatu śniegu, gdzie dominuje *Diamesa steinboecki*, drugi w potokach pasma hal, gdzie rozwijają się larwy *Diamesa* gr. *latitarsis*. Trzeci taksocen scharakteryzowany przez larwy *Eukiefferiella minor* i *Parorthocladius nudipennis* wyróżniono w regionie źródeł i potoków w ich pobliżu. W pasmie regla rozwija się taksocen, w którym dominują larwy *Parorthocladius nudipennis*, natomiast taksocen wyróżniony w Roztoce na tej wysokości odbiega od tego schematu. Ostatni taksocen wyróżniono w potokach i rzekach podgórskich przepływających przez Rów Zakopiański i Podhale, gdzie dominują larwy *Ortocladius rivicola* i *O. thienemanni*.

Rozmieszczenie tych taksocenów jest zgodne ze zmianami wysokości. Najwyżej spotykano taksocen *Diamesa steinboecki* (2000 m n.p.m.), najniżej taksocen *Orthocladius rivicola* + *O. thienemanni* (poniżej 1000 m n.p.m.).

Udało się wykazać korelację pomiędzy spadkiem jednostkowym, budową geologiczną podłoża, chemizmem wody (zwłaszcza zmianami Ca w wodzie) a składem ilościowym i jakościowym *Chironomidae*. Jednak zmiany taksocenów, jakie zaobserwowano pomiędzy potokami płynącymi w pasmie hal a potokami w regionie źródeł, nie można wytłumaczyć tymi czynnikami. W tym wypadku decydującą rolę w ich zróżnicowaniu odgrywa wysychanie i wymarzanie potoku w zimie, słaby rozwój pokrywy roślinnej w potokach wysokogórskich, a w regionie źródliskowym silny rozwój glonów i mchów pokrywających kamienie, nieprzerwany okres wegetacyjny oraz korzystne warunki termiczne zwłaszcza w zimie. Wydaje się więc, że jednym z ważniejszych czynników wpływających na liczebność *Chironomidae* jest ilość i jakość rozwijającej się pokrywy roślinnej. Jednak w obecnej chwili, przy tak dużej ilości zmieniających się równocześnie czynników środowiska, trudno przypisać któremuś z nich decydującą rolę w zmianach zespołów fauny dennej.

Również w obrębie stanowisk udało się wykazać zróżnicowanie taksocenów *Chironomidae* w poszczególnych siedliskach. Wyróżniono taksocen *Chironomidae* zamieszkujący mchy, który wykazuje dużą stałość. Gatunkami dominującymi są *Eukiefferiella minor, E. bavarica, E. luthethorax*. W plecach glonu *Hydrurus* rozwijają się przede wszystkim larwy *Orthocladius rivicola, Diamesa* gr. *insignipes* i *D. thienemanni*. W obrębie siedliska kamienistego wyróżniono pięć dodatkowych klas prądowych. Wyraźne różnice zaobserwowano pomiędzy fauną *Chironomidae* z miejsc o silnym prądzie a miejscami bez prądu. Taksoceny *Chironomidae* zamieszkujące miejsca o równym prądzie i płytkim prądzie są zbliżone do taksocenów miejsc o szybkim prądzie, natomiast na kamieniach w miejscach o słabym prądzie żyją zarówno gatunki charakterystyczne dla szybkiego prądu, jak i miejsc bez prądu. Z szybkim prądem jest związanych szereg larw, takich jak *Diamesa* gr. *latitarsis, Orthocladius rivicola*, natomiast dla miejsc bez prądu są charakterystyczne *Nilotanypus dubius, Micropsectra gr. praecox, Syndiamesa branickii, Parametriocnemus borealpinus,*

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P. stylatus, *Corynoneura* gr. *minuta*. Jednakże gatunki żyjące np. w szybkim prądzie można spotkać w mniejszych ilościach w miejscach bez prądu i odwrotnie. Wykazano również, że taksoceny *Chironomidae* zamieszkujące te same siedliska zmieniają się wzdłuż biegu potoku, ale gatunki charakterystyczne dla jakiegoś siedliska w jego obrębie mają większy zasięg pionowy.

Również w zależności od wysokości krzywa obrazująca zmiany liczebności *Chironomidae* w ciągu roku ma zupełnie inny przebieg. W najwyższych partiach potoku krzywa jest jednowierzchołkowa. Po wstępnym okresie, w którym obserwujemy małe larwule i wylinki poczwarek, rozwija się właściwy taksocen z dominacją larw *Diamesa* gr. *latitarsis* i wtedy obserwujemy maksimum liczebności. Po wylocie tego gatunku następuje spadek liczebności i pojawiają się małe larwy gatunków charakterystycznych dla niżej położonych stanowisk. W zimie następuje przerwa w rozwoju organizmów, ponieważ potok wysycha lub wymarza. W potokach pasma regla krzywa ma przebieg dwuwierzchołkowy, przy czym maksimum zimowe jest znacznie większe od letniego. Taki obraz krzywej jest spowodowany rozwojem gatunku dominującego *Parorthocladius nudipennis*, który ma dwa pokolenia w ciągu roku. Spadki liczebności wiążą się z jego wylotem i w tym okresie mogą dominować inne gatunki. W potokach płynących u podnóża Tatr krzywa jest wielowierzchołkowa, przy czym maksima letnie są wyższe od zimowych. W lecie i jesieni były dwa maksima spowodowane przez larwy *Orthocladius rivicola* i *O. thienemanni*. Wyloty tych gatunków spowodowały spadek liczebności z końcem lata i późną jesienią. W zimie rozwijały się larwy z rodzaju *Diamesa*.

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