

Ecological characteristics of caddis flies (Trichoptera) of streams in the Gorce Mts (Southern Poland)

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Abstract — In the massif of the Gorce Mts (Northern Carpathians), the Trichoptera of the four main streams were studied. Samples were collected three times, in spring, summer, and autumn, at 35 stations at altitudes of 380—1240 m. Sixty-two species were found. Five communities of Trichoptera were distinguished and their altitudinal range and characteristic species given. The species were grouped into functional feeding groups whose distribution and density along the course of the streams is described.

Key words: streams, Gorce Mts, National Parks, caddis flies, diversity, distribution, communities, functional feeding groups.

1. Introduction

The Gorce Mts are one of the most extensively forested massifs in the Western Beskid Mts; they have a dense drainage network and have been little affected by human activity. Fragments of the original wildlife are well preserved. The numerous streams carry clean water, which is drinkable without treatment. It was these and other assets that led to the decision to establish the Gorce National Park here in 1980.

The establishment of the Park provided an additional incentive to gain a better knowledge of the wildlife of this region, among other ways, by cataloguing its components. Investigations on the macroinvertebrates of the main streams of the Gorce were also undertaken with this in mind. The aim of the present work was to investigate the diversity, distribution, and ecology of Trichoptera, one of the chief components of the stream macrofauna.

The caddis flies of the Gorce region were first investigated in the years 1967—1970 in the Olszowy Potok, and Porębianka streams (Szczęsny 1975). Moreover, in 1974—1975, detailed investigations were carried out on this group of insects in the Poniczanka stream (Szczęsny 1976).

2. Study area

The massif of the Gorce Mts is part of the Beskid Wysoki (High Beskid), the highest, flysch range in the Western Beskids (Northern Carpathians). The highest peak of the Gorce is Mt. Turbacz, alt. 1310 m, lying in the central part of the massif (fig. 1). From this peak run radially numerous, long, branching ridges, separated from each other by deep stream valleys.

The massif of the Gorce Mts is forested above alt. 600–700 m; the lower montane zone with a preponderance of beech (45%), spruce, and fir reaches an altitude of 1150 m, spruce dominating in the upper montane zone (95%).

The mean annual air temperature on Mt. Turbacz is 3.0°C, and the mean total annual precipitation 1260 mm, with 720 mm below alt. 500 m (Obrębska-Starkłowa 1970).

The drainage network of the Gorce is dense (2.26 km km⁻², Lewiński 1988); it has a radial pattern and is part of the drainage basin of the Rivers Raba and Dunajec.

From a chemical aspect, the water of the springs and streams of the Gorce represents the calcium hydrocarbonate type. The total ion content is small, this being evidenced by the electrolytic conductivity, which is usually 90 to 180 μS in the upper course of the streams, while in the lower one it does not exceed 300 μS (Wróbel, Szczęsny 1988). The spring and summer temperatures of springs in the highest parts of the Gorce are usually between 5 and 7°C, the lowest recorded being 4.1°C (author's own data).

3. Methods

The investigations embraced the four main streams of the Gorce Mts, the Kamienica, Ochotnica (with the source stream Forędówka), and Łopuszanka falling into the River Dunajec, and the Porębianka (with its affluent, the Olszowy Potok) falling into the River Mszanka. Sampling stations were localized on each of these streams, at the points where they transect the contour lines at full 100 m intervals, between 400–1200 m above sea level, and in the springs (fig. 1, Table I). Owing to the construction of a concrete channel on the lower course of the Łopuszanka, the lowest lying station on his stream was selected at an altitude of 670 m.

At each of the stations, the material was collected three (or two) times in the years 1981–1983, in spring, summer, and autumn (Tables II–V). The samples were taken using a bottom sampler (a 22.5 or 12 cm square metal frame, with 300 μm mesh bolting cloth stretched over it). The smaller sampler was used only to take samples from the springs of the Forędówka, Łopuszanka, and Olszowy Potok. The area of substratum:

Table 5. Characteristics of the existing stations on the course Mt. hert. veg. - herbaceous vegetation

Station	Altitude	Distance from the stream	Stream width	Mean depth of stream	Max. current velocity	Mean component of substratum	Immediate surrounding of stream bed
Sanienica, spring	1200	24.0	0.4-0.7	< 6	0.3	medium-sized rock chips	herb.veg., spruce forest
Sanienica	1100	33.2	0.5-1.5	< 20	0.5	medium-sized and large rocks	herb.veg., spruce forest
Sanienica	1000	31.5	2-3	20-30	0.8	large and medium stones	natural stony deposit, Petasites, herb.veg., coniferous forest
Sanienica	800	28.0	3-4	30-40	1.2	large and medium cobbles	Petasites, mixed forest
Sanienica	800	25.7	4-6	30-45	1.2	large and medium cobbles	Petasites, mixed forest
Sanienica	700	23.0	4-6	30-50	1.2	large and medium cobbles	Petasites, carr
Sanienica	600	16.0	5-8	30-50	1.3	large cobbles	carr, herb.veg.
Sanienica	500	11.5	8-12	30-60	1.4	large cobbles, boulders	natural stony deposit, carr, pasture
Sanienica	380	0.9	10-13	30-50	1.3	large cobbles	natural stony deposit, oaks, fallow
Porzdoka, spring	1240	21.9	< 0.2	< 5	0.1	small stones, detritus	peaty meadow with moss and herb.veg.
Porzdoka	1200	21.7	< 0.35	< 10	0.3	medium-sized rock chips	herb.veg., spruce forest
Porzdoka	1100	21.3	0.4-0.6	10-30	0.8	medium and large stones	herb.veg., spruce forest
Porzdoka	1000	20.5	1.0-1.4	12-30	0.8	large stones, boulders	Petasites, herb.veg., mixed forest
Porzdoka	900	19.4	1.5-2.0	15-35	0.9	large cobbles, boulders	Petasites, herb.veg., mixed forest
Porzdoka	800	17.6	1.5-2.0	20-40	1.0	large and medium cobbles	Petasites, herb.veg., mixed forest
Cebotnica	700	15.2	3-4	20-30	1.2	large cobbles, boulders	herb.veg., carr, pasture
Cebotnica	600	13.2	3-4	20-30	1.2	large cobbles, boulders	herb.veg., carr, pasture
Cebotnica	500	11.2	5-6	30-60	1.3	large cobbles, boulders	natural stony deposit, carr, pasture
Cebotnica	400	11.2	5-7	30-60	1.3	large cobbles, boulders	natural stony deposit, carr, pasture
Lopuszanka, spring	1240	7.3	< 0.3	< 8	0.2	rock chips, sand	herb.veg., young stand of spruce
Lopuszanka	1200	5.2	< 0.35	< 10	0.4	medium-sized rock chips	herb.veg., young stand of spruce
Lopuszanka	1100	8.9	0.5-0.8	10-25	1.0	large rock chips	Petasites, herb.veg., coniferous forest
Lopuszanka	1000	8.2	1-1.5	15-30	1.2	large stones, boulders	Petasites, herb.veg., mixed forest
Lopuszanka	900	7.4	2-3	20-40	1.3	large cobbles, boulders	Petasites, herb.veg., mixed forest
Lopuszanka	800	5.2	2.5-3	25-30	1.1	large cobbles, boulders	Petasites, herb.veg., mixed forest
Lopuszanka	670	5.2	4-6	30-50	1.1	large cobbles, boulders	Petasites, herb.veg., carr
Olazowy potok, spring	1200	17.2	< 0.3	< 10	0.3	small rock chips	grass, herb.veg., spruce forest
Olazowy potok	1100	17.0	0.4-0.6	10-20	0.7	boulders	grass, herb.veg., spruce forest
Olazowy potok	1000	16.6	0.8-1.0	10-20	0.7	medium-sized stones, detritus	moss, herb.veg., spruce forest
Olazowy potok	900	15.0	1-2	20-40	0.8	large stones, boulders	herb.veg., Petasites, mixed forest
Olazowy potok	800	13.2	1-2	30-40	1.3	large stones, boulders	Petasites, herb.veg., mixed forest
Olazowy potok	700	11.2	2-3	30-40	1.3	large stones, boulders	Petasites, herb.veg., mixed forest
Olazowy potok	600	10.2	2-3	30-60	1.3	large stones, boulders	Petasites, herb.veg., mixed forest
Olazowy potok	500	11.2	2-3	30-60	1.3	large stones, boulders	pasture, carr, herb.veg.
Porzdoka	420	1.1	8-12	50-80	1.2	large cobbles	natural stony deposit, oaks, carr

from which material was collected using the large sampler was 25 or 50 dm² (i.e. 5 or 10 samples per 5 dm²), and about 7.5 dm² using the small sampler (i.e. 5 samples from 1.5 dm²). The material collected was preserved with formalin.

In distinguishing communities of caddis flies, those described by S z c z ę s n y (1986) for successive zones of north Carpathian streams were used.

4. Results

4.1. General description of material, taxonomic and zoogeographical remarks

In the material collected, 14 073 larvae and pupae of caddis flies, representing 62 species, were found. Particular streams were inhabited mainly by 42 to 52 caddis fly species (Tables II—V); the fewest were recorded in the Kamienica (the largest of the streams investigated), and the most in the Olszowy Potok-Porębianka.

Twenty-seven species attaining very large population sizes were found (i. e. with indices of dominance of at least 10% of the individuals at at least one of the 35 sampling stations). The number of these species was similar at each of the stations, and amounted to 14—16. The following were considered to be the most numerous and most frequent, beginning with species inhabiting the upper course of the streams: *Rhyacophila glareosa*, *Drusus discolor*, *Allogamus uncatus*, *R. tristis*, *Glossoma conformis*, *Micrasema minimum*, *Hydropsyche instabilis*, *R. nubila*, and *H. pellucidula*.

The most recent work of Mey and Botosaneanu (1985) indicates that *Psilopteryx psorosa bohemosaxonica* Mey et Bots. was previously mistakenly identified as *P. psorosa carpathica* Schmid (S z c z ę s n y 1986). The representatives of this form from the Gorce Mts (also from the whole Western Beskids) possess distinct, short *appendices intermediares*, not exceeding 0.69 mm, while the individuals of *Psilopteryx* from the Eastern Carpathians (not from the Bieszczady Mts, but from the Charnohora region, collected by D z ę d z i e l e w i c z and housed in the Institute of Systematic and Experimental Zoology, Polish Academy of Sciences in Kraków) have *append. intermed.* at least 0.77 mm long. In the males also the shape of the *app. inferiores* and of their dorsal appendage is different.

In the Northern Carpathians (Polish and Slovak) 210 caddis fly species have been found to date, this including 7 Carpathian endemic species. The streams investigated in the Gorce Mts are inhabited by 5 of the latter: *Drusus brunneus* Kl ap, *Acrophylax vernalis* Dz., *Chaeto-*

Table II. List of midge fly species of the Karlenica stream, indices of dominants (%), season, and sampling dates. x - mean from three samples (N m⁻²)

T a x a	Altitude m								
	1200	1100	1000	900	800	700	600	500	400
Chaetopteryx polonica Dz.	2.0	0.4							
Allogamus uncinatus (Brauer)	94.0	13.3	9.0	0.5	0.6		0.4		
Bruscia annulatus (Steph.)	2.0	2.2							
Melampophylax nepos (Mclach.)	2.0	16.4	3.8						
Aerophylax vernalis Dz.		1.3							
Apantia carpathica Schmid		0.6							
Rhyacophila glareosa Mclach.		16.6	8.0	7.6	4.5				
Rhyacophila philopotamoides orientalis Schmid		2.9	2.1			0.6	1.2		
Psilopteryx proreos bohemossonica Mey et Notk.		0.4	0.7						
Pseudopsilopteryx zimmeri (Mclach.)		0.4	9.7		2.5				
Rhyacophila polonica Mclach.		5.9	8.7	7.6	5.1				
Rhyacophila tristis Viet.		23.6	31.2	29.5	17.8	13.2	3.4	0.3	
Allogamus auricollis (Viet.)			10.8	1.0	6.4		0.2		
Psilopteryx radida (Mclach.)		3.2	0.7	3.8	1.9				
Rhyacophila fasciata Hug.		0.6	1.4	1.9	0.6				
Bruscia discolor (Hamb.)		2.7	2.1	11.3	5.1	0.8			
Rhyacophila vulgaris Viet.			0.7	21.4	10.8	2.7			
Helicium rubicollis (Viet.)		0.6	0.3		0.6				
Aithya niger Hug.				1.0					
Gedrocera albicorne (Scop.)				0.58	1.9		0.2		
Sciurus conedula (Hug.)					1.9				
Silo pullipes (Fabr.)					1.9	0.4		0.3	
Philopotamus ludificatus Mclach.			0.3	1.4	1.3	1.6			0.1
Rhyacophila obliterata Mclach.			0.3	0.5	0.6	8.2	0.4	0.8	
Tinodes rontooki Mclach.						0.4	0.2		
Rhyacophila zoebrvi Ylap.			0.7		0.6	10.1	4.5	4.6	0.4
Micropesum minutum Mclach.					1.3	7.4	6.6	0.2	0.1
Hydropsyche instabilis (Furt.)						23.0	20.1	12.8	8.9
Potamopylax oingulatus (Steph.)		0.2				0.4	0.8	0.2	
Glossosoma conformis Seb.			1.4	4.8	3.2	15.2	23.7	4.3	0.8
Psilopteryx dolecarlica Kol.				1.0		1.6	5.9	3.2	0.4
Agapetus aniger (Viet.)							0.2		
Helicium digitatus (Zohr.)							1.3	0.3	0.1
Rhyacophila nubila (Zett.)						8.9	13.4	41.2	28.0
Polycentropus flavocaulatus (Viet.)							1.6	6.0	2.1
Hydropsyche fulvipes (Furt.)								0.2	
Thaetopteryx fusca Brauer								4.8	0.3
Hydropsyche pellucidula (Furt.)						0.8	3.2	16.5	36.7
Psychomyia pullida (Fabr.)						0.8	0.2	1.2	8.9
Hydroptila forcipata (Ent.)								0.3	0.8
Ptiloplectra scutellatum (Four.)									4.7
Glossosoma bulgani Furt.									0.4
Rhyacophila spp. Juv.		0.6	3.8		1.3				
Hydropsyche spp. Juv.						0.4			5.8
Psychomyiini + Chaetopterygini Juv.		5.5	2.1	2.4	5.1	0.8	5.6		
Glossosoma spp.		1.7	2.1	2.9	24.2	2.3	5.6	2.9	1.7
Number of specimens ^x	67	317	192	140	105	171	372	392	519
24.IV - 4.V.	*	*	*	*	*				
31.V.						*	*	*	*
19-24.VI.	*	*	*	*	*				
5.VII.						*	*	*	*
10-21.VIII.	*	*	*	*	*				
12.VI.						*	*	*	*

Table III. List of caddis fly species of the Porędzka-Cobotnica streams, indices of dominance (%), zonation, and sampling dates. x - mean from three samples (N = 2)

Tara	Altitude m									
	1240	1200	1100	1000	900	800	700	600	500	400
<i>Cruncotia irrorata</i> (Curt.)	13.6									
<i>Cheopteryx polonica</i> Dz.	36.4	2.8	1.7							
<i>Plecopteryx piceosa bohemosaxonica</i> May et Bots.	9.1		0.9	7.2	0.6					
<i>Allogamus unostus</i> (Braun.)	36.4	8.3	14.5	17.1	5.7	1.2				
<i>Rhyacophila philopotamoides orientis</i> Schmid	4.5	8.3	2.6	1.8	2.8					
<i>Drusus brunneus</i> Klap.	5.6									
<i>Apatania carpathica</i> Schmid	8.3		0.9							
<i>Aerophylax vernalis</i> Dz.	1.7									
<i>Halesus rubricollis</i> (Pict.)	0.4									
<i>Malacophylax nepsus</i> (McLach.)	3.4			2.7						
<i>Eulisopteryx nigida</i> (McLach.)	4.6			4.6	5.7		0.2	0.3		
<i>Rhyacophila glareosa</i> McLach.	0.9			7.2	0.6					
<i>Potamophylax cingulatus</i> (Steph.)				0.9	0.6		0.2			
<i>Rhyacophila polonica</i> McLach.	2.8	0.9	12.6	17.0	9.5					
<i>Drusus discolor</i> (Steph.)	2.8	2.8	6.3	11.4	5.3		0.1			
<i>Philopotamus ludificatus</i> McLach.				3.6	5.1					
<i>Rhyacophila fasciata</i> Hag.				33.3	34.1	31.4	1.2	1.0	0.1	
<i>Rhyacophila tristis</i> Pict.				5.6	4.6	0.6	0.3	0.3	0.1	
<i>Rhyacophila vulgaris</i> Pict.						1.8				
<i>Pseudoplecopteryx zimmeri</i> (McLach.)			0.9		4.0	29.6	1.3	1.4	0.1	
<i>Rhyacophila oblitterata</i> McLach.					0.6	3.6	1.3	1.5		
<i>Rhyacophila moesaryi</i> Klap.						3.4	11.8	5.2		
<i>Glossosoma conformis</i> Mab.						1.8	13.2	11.7	1.1	
<i>Microsaesa minima</i> McLach.							1.7			
<i>Agapetus delioptulus</i> McLach.							0.1			
<i>Ocismus nepedula</i> (Hag.)							0.1			
<i>Tinodes rostocki</i> McLach.							0.1			
<i>Potamophylax luotuosus</i> (Pill.)							2.0	3.8		
<i>Allogamus muricollis</i> (Pict.)							2.6	0.1		
<i>Cheopteryx fusca</i> Braun.							9.2	2.6	0.1	
<i>Eulisopteryx coleocerlica</i> Kol.							0.1	1.1	3.6	0.3
<i>Halesus digitatus</i> (Schr.)						0.6	0.1	1.1		
<i>Silo pallipes</i> (Fabr.)							0.4	0.4	0.1	
<i>Agapetus laniger</i> (Pict.)							1.2	3.1	0.3	
<i>Hydropsyche instabilis</i> (Curt.)						0.6	0.9	21.3	4.7	1.0
<i>Anisililo obscurata</i> (McLach.)								0.1		
<i>Hydroptila forcipata</i> (Eut.)								0.1	0.1	0.2
<i>Rhyacophila nubila</i> (Zett.)							1.6	13.8	24.2	22.3
<i>Glossosoma boltoni</i> Curt.								0.1	0.3	
<i>Pogonomyia pusille</i> (Fabr.)								0.3	10.2	3.2
<i>Hydropsyche pellucidula</i> (Curt.)									3.7	3.3
<i>Oligoneurus maculatus</i> (Four.)									1.1	27.2
<i>Polycentropus flavoscutatus</i> (Pict.)									0.4	0.9
<i>Odontocerum albicorne</i> (Scop.)										0.2

<i>Rhyacophila</i> spp. juv.			0.9	0.9			0.5	5.2		
<i>Stenophylacini</i> + <i>Cheopterygini</i> juv.		61.1	6.4	1.8	2.8		0.2			
<i>Sericostoma</i> spp.			6.0				1.4	6.3	2.7	1.7
<i>Hydropsyche</i> spp. juv.						2.4		4.5	54.8	
Number of specimens ²	220	72	312	148	117	163	1271	489	1005	591
28.IV.		+	+	+	+					
31.V.					+					
18.VI.		+	+	+						
4.VIII.						+				
11.VIII.										
12.II.		+	+	+						
26.XI.								+		

Table IV. List of caddis fly species of the Lopuzanka stream, indices of dominance (%), sonation, and sampling dates. x - mean from three samples (N = 2)

Taxa	Altitude m						
	1240	1200	1100	1000	900	800	670
Potamophylax carpathicus (Ds.)	4.0						
Plectrocnemia brevis McLach.	4.0	4.0					
Drusus brunneus Klap.	36.0	19.0	2.5				
Lithax niger Hag.	12.0	3.0	0.5	0.4	1.0		0.2
Allogamus unostus (Braun.)	28.0	41.0	8.4	10.7	8.3		0.7
Parachiona picicornis (Pict.)		2.0					
Ernodes articularis (Pict.)		1.0					
Chaetopteryx polonica Dz.		7.0					
Melampophylax nepos (McLach.)		1.0					
Drusus discolor (Samb.)		6.0	11.9	9.9			
Apantia carpathica Schmid			28.8	2.5	14.1	7.6	
Rhyacophila glauca McLach.			29.8	2.5			
Rhyacophila fasciata Hag.			9.9	9.1	1.0		
Pellipteryx pascosa bohemossonica Hey et Bots.			3.0	0.4	1.0		0.2
Drusus annulatus (Steph.)		2.0		5.0			
Ecolisopteryx madida (McLach.)		1.0	2.5	5.0			
Rhyacophila polonica McLach.			3.0	17.8	1.0	1.7	
Cranostia irrorata (Curt.)			2.5	4.1	3.8	1.7	0.5
Rhyacophila philopotamoidea orientalis Schmid				0.4			0.2
Philopotamus ludificatus McLach.		1.0	2.5	2.9	3.4	1.7	
Rhyacophila vulgaris Pict.		2.0	2.5	5.4	14.6	1.7	0.5
Pseudopsilopteryx zimmeri (McLach.)				1.2	14.6	5.9	0.2
Rhyacophila tristis Pict.					1.9	1.7	1.5
Rhyacophila oblitterata McLach.			2.5	8.7	12.1	21.0	10.7
Halesus rubricollis (Pict.)					21.8	39.5	1.9
Glossocoma conformis Neb.						1.7	
Rhyacophila mossaryi Klap.					1.4	10.1	24.1
Ecolisopteryx dalecarlica Kol.						1.7	2.7
Glossocoma boltoni Curt.						1.7	2.2
Micrasema minimum McLach.						0.8	14.4
Potamophylax cingulatus (Steph.)							15.3
Silo pallipes (Fabr.)							7.3
Allogamus auricollis (Pict.)							5.1
Hydropsyche instabilis (Curt.)							3.4
Rhyacophila nubila (Zett.)							1.9
Halesus digitatus (Schr.)							1.2
Potamophylax latipennis (Curt.)							1.2
Brachycentrus montanus Klap.							0.7
Odontocerus albicornis (Scop.)							0.5
Potamophylax luctuosus (Fill.)							0.2
Chaetopteryx fusca Braun.							0.2
Stenophylacini + Chaetopterygini juv.	16.0	11.0	0.5	2.5			
Sericostoma spp.			0.5	3.7		1.7	0.5
Number of specimens ²	166	229	269	323	275	119	411
11.V.	+	+	+	+	+		
31.V.							
23.VI		+	+	+	+		
4.VIII.						+	
12.VIII.	+	+	+		+		

Table V. List of caddis fly species of the Olzowy Potok and Poryblinski stream. Indices of dominance %, zonation, and sampling dates. x - taken from three samples (N = 3)

Taxa	Altitude m								
	1200	1120	1000	900	800	700	600	500	420
Potamophylax carpathicus (Dz.)	0.8								
Drusus carpathicus Dz.	60.7		44.1						
Apatania carpathica Schmid	16.4	8.8	9.3	0.7	0.6				
Drusus brunneus Klap.	15.6	26.1							
Chaetopteryx polonica Dz.	0.8	3.4							
Allogamus uncatatus (Braun.)		32.8		4.0	1.8				
Melampophylax nepos (McLach.)		2.9		2.0					
Psilopteryx psorosa bohemosaxonica Mey et Hott.		0.8							
Pseudopsilopteryx zimmeri (McLach.)		0.4		0.3					
Drusus discolor (Gimp.)	2.4	37.9		2.4	12.5	5.6			
Drusus annulatus (Stepp.)		0.4		0.2					
Rhyacophila polonica McLach.		1.3		11.7	10.7	2.5			
Rhyacophila glareosa McLach.			0.9	16.4	2.0	0.6			
Halesus rubricollis (Pict.)				0.3	0.2				
Koclisopteryx madids (McLach.)				17.4	10.8	1.2			
Rhyacophila tristis (Pict.)				13.1	16.8	18.6	0.5	0.8	
Allogamus suricollis (Pict.)				5.0	0.7			1.2	
Rhyacophila philopotamoidea orientis Schmid	1.6	4.2	6.2	2.7	10.8	2.5	0.1		
Cruncatia irrorata (Curt.)			0.4		0.9	0.6			
Rhyacophila fasciata Hag.				0.3	0.9				
Philopotamus ludificatus McLach.				1.7	7.1	1.2			
Lithax niger Hag.					7.6				
Glossocoma conformis Neb.				0.3	7.5				
Rhyacophila biliterata McLach.					7.7		1.1	0.1	0.3
Potamophylax cingulatus (Steph.)					1.8		2.6	0.5	
Silo pallipes (Fabr.)								0.2	0.3
Plectrocnemia conspersa (Curt.)									
Oecismus monedula (Hug.)									
Odontocerum albicorne (Scop.)									
Rhyacophila vulgaris (Pict.)			1.3		1.4			0.1	
Rhyacophila nocens Klap.					0.2				
Micrasema minus McLach.							4.7	1.0	
Chaetopteryx fusca Braun.							16.4	4.1	
Koclisopteryx dalecarlica Kol.							0.6	0.9	1.0
Potamophylax lutipennis (Curt.)							8.2	4.6	
Silo nigricornis (Pict.)							1.2	2.5	
Silo piceus (Braun.)								0.6	
Hydropsyche saxonica McLach.								0.4	
Hydropsyche foveolata (Hug.)								0.2	
Hydropsyche pelliculata (Curt.)								0.1	
Hydrophylax pusilla (Fabr.)								21.5	12.4
Hydropsyche inutabilis (Curt.)								2.1	0.7
Rhyacophila nubila (Zett.)							19.4	21.8	25.1
Annitella obscurata (McLach.)							8.9	12.1	31.6
Polycentropus flavomaculatus (Pict.)							1.1	0.6	1.3
Hydropsyche bulbifera McLach.								6.7	7.8
Halesus digitatus (Schr.)									1.0
Athripsodes albifrons (L.)									0.7
Agapetus delicatulus McLach.									0.7
Oligopteron maculatum (Poir.)									0.3
Lepidostoma hirtum (Fabr.)									0.3
Rhyacophila spp. juv.			0.9	3.4	4.9	7.5	2.2	0.6	
Hydropsyche spp. juv.						11.8		10.6	33.0
Chaetopteryx fusca + Annitella obscurata juv.							19.2		
Potamophylacini + Chaetopterygini juv.	1.6	1.3	0.4	1.3	2.5	2.5		0.4	
Silo spp. juv.								0.6	
Lericostoma spp.		1.2		5.7	2.5	1.6	8.5	7.7	3.2
Number of specimens ^x	180	117	303	272	378	107	730	860	205
4.V.	*	*	*	*	*	*	*	*	*
11.V - 1.VI.	*	*	*	*	*	*	*	*	*
17.VI.	*	*	*	*	*	*	*	*	*
5.VIII.	*	*	*	*	*	*	*	*	*
10-20.VIII.	*	*	*	*	*	*	*	*	*
26.XI.	*	*	*	*	*	*	*	*	*

pteryx polonica Dz., *D. carpathicus* Dz., and *Potamophylax carpathicus* Dz. The first three are distributed throughout the whole arc of the Carpathians, while the other two occur only in its northern and eastern parts.

D. brunneus, which occurs commonly e. g. throughout the whole Bieszczady Mts is known only from the Pieniny Mts in the Northern Carpathians, where one female of the species caught with light trap (Riedel 1978), and from the Gorce Mts, where it is not rare. The Gorce Mts are the westernmost location of this species in the Carpathians.

4.2. Communities of caddis flies and their longitudinal zonation

In the streams of the Gorce, all five communities, C, D, E, F, and G, distinguished for streams of the Beskid Mts (Szczęsny 1986), were identified. In springs and adjacent sections of streams community C develops and in the upper reaches of mid-forest ones community D, the middle course of streams at the foothills being inhabited by community E, while communities F and G develop in the lower reaches.

Community C is represented by *Allogamus uncalus*, *Drusus brunneus*, *D. carpathicus*, *Apatania carpathica*, *Chaetopteryx polonica*, and *Crunoetia irrorata*. It develops above alt. 1100 m, except for the Olszowy Potok stream, running down the north slope of Mt. Turbacz, where it is observed at alt. 1000 m.

The main components of community D are *Rhyacophila tristis*, *R. polonica*, *Ecclisopteryx madida*, and *R. obliterated*. These species are accompanied, frequently in larger populations, by *R. glareosa*, *Melampophylax nepos*, and *Drusus discolor* — elements co-forming the communities inhabiting the high mountain streams of the Tatra Mts and Babia Góra. The presence of such high-mountain elements in community D of streams of the Gorce Mts is a feature which distinguishes these streams from those of the Beskids. Community D inhabits the investigated streams altitudes ranging from about 750 m to 1100 m, or slightly higher.

Community E is represented in the streams of the Gorce Mts by 10 species. Of these, the following live in numerous populations: *Glossosoma conformis*, *Micrasema minimum*, *Allogamus auricollis*, *Rhyacophila mocsaryi* (only in the Kamienica), and *G. boltoni* (only in the Łopuszanka). This community inhabits the streams at the foothills in a small range of altitudes, from 650 to 750 m.

The lower, longest stretches of the streams are usually below alt. 650 m, hence beyond the borders of the National Park, and are inhabited by community F, the characteristic species of this community being *Hydropsyche instabilis*, accompanied by *Rhyacophila nubila*, and *Chaetopteryx fusca*.

Community G develops in the mouth sections of the Kamienica and Ochotnica, down to the Dunajec. *Hydropsyche pellucidula*, *Psychomyia pusilla*, and *R. nubila* dominate here. In this community, unlike to the remaining regions of the Beskids, *Oligoplecrum maculatum* is present in a large population, which seems to be characteristic of trichopteran associations from larger affluents of the Dunajec, and also from those of the Dunajec itself.

4.3. Functional feeding groups

The caddis flies inhabiting the investigated streams of the Gorce Mts can be classified into four functional feeding groups (guilds) sensu Cummins (1973): shredders (15 species), collectors (12), scrapers (25), and predators (10). The collectors are exclusively filter-feeders, this including 9 net filter-feeders; 5 of these forms feed exclusively on an animal diet. In numerous population (with an index of dominance above 5% individuals at at least one of the stations) there were 8 species of shredders, 6 of collectors, i.e. filter-feeders, 13 scrapers, and 8 of predators. Hence, conditions in the streams are best for scrapers (mainly algivores).

From Table VI, presenting the distribution of functional groups of caddis flies with the course of streams in the Gorce, it is evident that shredders dominate in their upper reaches and filter-feeders in the lower ones. In the middle course, that is immediately below the lower forest limit, scrapers dominate, while predators are numerous on stretches where the streams run in narrow, shaded valleys, i.e. at alt. 800–900 m, less frequently at alt. 1000 m.

Table VI. Altitudinal distribution of functional feeding groups (in %) and densities (mean number of specimens $N = \bar{x}$) of caddis flies in four streams of Gorce Mts. Sh - shredders; C - collectors (filter-feeders); Sc - scrapers; P - predators

Stream	Group	Altitude m									
		1240	1200	1100	1000	900	800	700	600	500	400
Kamienica	Sh		96.0	23.1	23.9	6.3	34.9	3.9	13.7	8.5	2.1
	C				0.4	1.3	1.4	25.6	25.3	29.5	56.1
	Sc		4.0	23.3	16.7	11.6	14.7	25.4	37.0	9.2	11.5
	P			52.9	53.0	80.9	48.9	45.1	23.5	52.9	30.5
	Density		67	317	192	140	105	171	372	392	519
Ochotnica	Sh	95.5	72.2	30.8	27.0	9.7	6.0	4.5	7.6	2.8	1.7
	C			0.9		1.1	0.6	0.9	31.5	63.9	54.3
	Sc		13.9	59.6	7.2	9.1	13.6	88.3	37.7	8.7	21.0
	P	4.5	13.9	13.0	65.7	80.2	80.0	6.3	23.2	24.8	23.0
	Density	220	72	312	148	117	169	1271	489	1005	591
Lopuszanka	Sh	44.0	63.0	10.4	22.3	10.2	5.1	12.3			
	C		2.0	0.5	5.4	14.6	1.7	2.9			
	Sc	52.0	24.0	44.2	40.5	3.4	14.3	64.9			
	P	4.0	11.0	45.2	31.8	71.9	79.1	19.6			
	Density	166	229	269	323	275	119	411			
Dlaczego Potok	Sh		2.5	50.4	0.8	11.6	10.7	22.3	37.1	7.8	6.8
	C					1.7	7.1	3.0	21.5	50.1	51.8
	Sc		93.5	38.2	53.4	26.1	14.8	28.8	20.5	14.4	21.0
	P		4.0	11.4	45.9	60.3	67.8	45.9	20.8	21.8	39.4
	Density		980	317	303	272	378	107	730	862	205

The above patterns differ somewhat in particular streams, depending on local conditions. In the Olszowy Potok, there is still a large proportion of shredders at alt. 600–700 m, while in Ochotnica there is an exceptionally small proportion of predators (6.3%) at 700 m, though in the other streams it is quite considerable at this altitude — up to 45%.

4.4. Analysis of quantitative results

It is striking that the numbers of caddis flies at the same altitudes above sea level are very similar in the streams studied — for example, in the Kamienica and Ochotnica in a range from alt. 800–1200 m, in the Olszowy Potok and Łopuszanka between 900 and 1100 m (Table VI). In the upper course of streams these are values varying around the figure 235, which is the average for all the streams at altitudes ranging from 800–1100 m, at extreme values of 105–378 individuals m^{-2} .

The highest numbers of caddis flies per unit of substratum occur in the lower course of streams, the lowest (with the exception of springs) in their middle course (Table VI). The increase in caddis fly numbers in the lower reaches of streams can be observed below alt. 600 m in the streams of the northern slopes of the Gorce (Olszowy Potok and Kamienica) and below 700 m in those of the southern ones (Ochotnica and Łopuszanka), this increase being connected with a rise in the number of algivores, followed by filtrators. The altitudes given here correspond to the range of arable fields on the northern and southern slopes of the Gorce Mts.

The lowest numerical values of caddis flies per unit of substratum area occur in the most strongly shaded stretches of streams, predators usually being the dominant group here.

The most even numbers (269–317 individuals m^{-2}) for all the streams were recorded at alt. 1100 m in the upper forest zone: in as many as three streams these values were virtually identical (312–317 indiv. m^{-2})

5. Discussion

In the very thoroughly investigated Poniczanka stream, which runs in the western part of the Gorce Mts, 44 caddis fly species were found over 10 km, within altitudes ranging from 400–900 m (Szczęsny 1986), this including only 8 species with an index of dominance of at least 10%. In each of the streams investigated in the present study, with similar numbers of species (42–52) the number of dominants found was twice as high, which could suggest a greater ecological diversity of habitats in these streams.

The number of caddis fly species known from the running waters of the Gorce Mts is 74. This is only 64% of the total number of species living in various kinds of running water of the Northern Carpathians (Szczesny 1986), hence it can be expected that the number from the Gorce will increase. The number of dominating species is also correspondingly smaller here; there are 50% fewer than were distinguished in the running waters of the Northern Carpathians.

Beyond the borders of the Gorce National Park there are two caddis fly communities, F and G; they include 22 species. In these communities, net filter-feeders are moderate dominants (under 64%), and omnivorous ones with a fairly high density of substratum colonization.

Observations made on the distribution of caddis flies of Northern Carpathian streams and rivers (Szczesny 1966) showed that in the lower course of natural, unpolluted streams the percentage of filtering caddis flies does not usually exceed 60% of their total, though in moderately polluted streams it is usually over 80%; in strongly polluted streams caddis flies are absent.

6. Polish summary

Charakterystyka ekologiczna chruścików (Trichoptera) potoków gorczańskich (Polska Południowa)

Badania niniejsze podjęto w następstwie utworzenia Gorczańskiego Parku Narodowego (w r. 1980) celem lepszego poznania makrobezkręgowców wód biejących tego obszaru, konkretnie chruścików. Badaniami objęto potoki: Kamienicę, Ochotnicę z Forędówką, Łopuszankę i Porębiankę z Olszowym Potokiem (ryc. 1). Na 35 stanowiskach (tabela I) próby makrobezkręgowców pobrano trzykrotnie w latach 1981—1983, uwzględniając wiosnę, lato i jesień.

W zebranych materiałach stwierdzono 14 073 larwy i poczwarki chruścików reprezentujące 62 gatunki. Każdy z potoków zasiedlało 42—52 gatunki (tabele II—V). Stwierdzono 27 gatunków dominujących, tj. o wskaźniku dominacji co najmniej 10% osobników na jednym ze stanowisk. Najliczniejszymi i najczęściej spotykanymi były: *Rhyacophila glareosa*, *Drusus discolor*, *Allogamus uncatius*, *R. tristis*, *Glossoma conformis*, *Microsema minimum*, *Hydropsyche instabilis*, *R. nubila* i *H. pellucidula*.

Ustalono, że badane potoki zasiedlone są przez wszystkie (5) beskidzkie zgrupowania chruścików. W źródłach i przyległych do nich odcinkach potoków wykształca się zgrupowanie C, w górnych odcinkach potoków śródleśnych zgrupowanie D, środkowe biegi potoków u podnóża gór zasiedla zgrupowanie E, zaś w dolnym biegu potoków, już poza granicą Gorczańskiego Parku Narodowego, wykształcają się zgrupowania F i G. Zgrupowanie D współtworzą elementy wysokogórskie, reprezentowane licznie przez: *Rhyacophila glareosa*, *Melampophylax nepos* i *Drusus discolor*.

Chruściki gorczańskie zaliczono do 4 funkcjonalnych grup pokarmowych: rozdrabniaczy (15 gatunków), filtratorów (12), zdrapywaczy (25) i drapiezców (10). Z rozmieszczenia tych grup w potokach (tabela VI) wynika, że rozdrabniacze dominują w górnym biegu potoków, a filtratorzy w dolnym. W środkowym biegu potoków, tj. tuż poniżej

dolnej granicy lasów dominują zdrapywacze, a drapieżcy na odcinkach, gdzie potoki płyną w wąskich i zacienionych dolinach (tj. 800—900 m npm).

Gęstość zasiedlenia dna przez chruściki w górnym biegu potoków jest dość wyrównana i wynosi 105—378 osobników m^{-2} (średnio z 3 terminów poboru prób 235). Zwiększanie się liczby chruścików na jednostkę powierzchni dna zaznacza się poniżej dolnej granicy lasów, gdzie wzrasta udział zdrapywaczy oraz w dolnym biegu potoków odlesionych, gdzie wzrasta udział filtratorów.

Z wód biejących Gorców znane są dotąd 74 gatunki chruścików, w tym 5 endemitów karpackich: *Drusus brunneus*, *D. carpathicus*, *Acrophylax vernalis*, *Chaetopteryx polonica* i *Potamophylax carpathicus*.

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