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Report on the distribution of benthic fauna deep in the substratum of a glacial brook Gurgler Ache (Ötztal, Tyrol)

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Abstract: Investigation was made on composition and vertical distribution of the macrobenthos in the glacial brook Gurgler Ache and its tributaries on the basis of the data obtained from June-July 1975 and March 1979. It was found that animals lived almost in the topmost layer in the stream bed.

Introduction:

This work was done within the activities of the Division of Limnology of the Zoological Institute of the University of Innsbruck at the Alpine Research Station Obergurgl of this University.

The surroundings of Obergurgl are divided into nearly 100 "research areas", as a help for easier local coordination of data.

Functional coordination is being done by means of a data bank (Jahresberichte Alpine Forschungsstelle 1973/74).

The tourist-center Obergurgl is situated in the valley Ötztal at an elevation of 1930 meters above sea level.

This investigation has been carried out on the following areas: Gurgler Ache (ra 48[+]) below and above Obergurgl, Königsbach (ra 23), Rotmoosache (ra 47), Flach-Bach (ra 58).

[+] *The code "ra".. in connection with a number refers to the "research areas" mentioned above.*

The glacial brook Gurgler Ache rises from the Gurgler glacier (2300 m), joins the Venter Ache at Zwieselstein to form the Ötztaler Ache, which flows into the river Inn at 620 meters above sea level (KRESSER 1961).
Investigations of the qualitative composition of benthic fauna in the Gurgler Ache were carried out by BRETSCHKO (1969) and KOWNACKA (1973-79). Quantitative algae distributions were studied by KAWECKA (1974).

Stations and methods of investigation:

The bottom samples have been taken from Gurgler Ache (1970 m), its glacial tributary Rotmoosache (2250 m) and its spring tributaries Flach-Bach (2060 m) and Königsbach (1850 m).
At the first sampling period of this work in 1975 a plastic tube of 10 cm in diameter was used to collect the material.
At the second sampling period in 1979 for the catches a bottom sampler was used made of a square metal frame (hand scraper) with sides 22.5 cm in length, to which a plankton net (mesh size 47 µm) was attached. The sampler was dug into the bottom at different depths: 0 - 10 cm, 10 - 30 cm and 30 - 50 cm with its open side directed against the current, and the area of the bottom lying in front of it, about 5 dm^2 was manually swept inside. From deeper parts of the bottom samples were taken in the same system but on a time basis penetrating the same area usually for 5 minutes. The collected substrate was poured into a spherical vessel with a calibrated volumetric scale in which the volume of the sample was measured and the composition of the substratum recorded.
Three fractions of substratum were distinguished according to grain size: sand (up to 2 mm), gravel (up to 30 mm) and stones (more than 30 mm).
The collected invertebrates were preserved in 4% formalin

solution, determined, counted and their numbers then were converted to a standard volume of 1 dm^3 substratum. In the present work only animals belonging to the macrobenthos were taken into account. Alltogether 90 samples were analysed both qualitatively and quantitatively.

The following problems were studied:

The transition between the rhithron and the groundwater was designated the hyporheic zone by ORGHIDAN (1959).
Here the water moves slowly, the oxygen concentration falls steeply with the depth, so it is the habitable layer for small animals (ERIKSEN 1966). The hyporheic fauna (SCHWOERBEL 1964) consists of Turbellaria, Nematoda, Oligochaeta, Hydracarina, small representatives of Chironomidae, Trichoptera and Plecoptera.
SCHWOERBEL (1964) and HYNES (1970) point out that most of the inhabitants of this zone feed on detritus, so there is a fairly direct relationship between population density and the amount of organic detritus in the deposits. It was assumed, that insect larvae during June and July when the glacial brook Gurgler Ache had its annual peak of water flow, live in deep layers of the substratum as BRETSCHKO (1968) pointed out, causing considerable movement of the substratum in the stream bed. Results which were given by WILLIAMS and HYNES (1973) show no relation between surface flow and density of the hyporheic fauna. During spring the glacial brook Gurgler Ache had a very low water flow (1,5 - 2,0 m^3/s), but the water contained more organic matter. It was therefore tried to study the vertical distribution of stream invertebrates during different water discharge, particulary from the point of the following problems: In which proportions do the different groups contribute to the stream macrobenthos? Are there significant differences in density of the hyporheic fauna between spring and summer?

Are there significant differences between the macrobenthos of glacial and spring-fed streams within the period of investigation?

Results and discussion:

Earlier studies of the benthic fauna of Gurgler Ache showed major seasonal differences. Insect larvae were the main component of the fauna, among them in June and July Diptera (mainly Chironomidae) dominate with 92 %, Ephemeroptera were the subdominant group (6 %, mainly Rhithrogena spp., see Tab.2). The most numerous forms of Chironomidae were: Diamesa zernyi and D. cinerella of Diamesa thienemanni-group, and D. latitarsis and D. modesta of the Diamesa latitarsis-group. Other species represented in greater numbers were Orthocladius rivicola and Eukiefferiella minor (KOWNACKA et KOWNACKI, 1975).
In comparison with Gurgler Ache in the present investigation the proportions of the different groups of macrobenthos on stones in Flach-Bach and Königsbach were similar: Diptera 60 - 73 % (only Chironomidae), Ephemeroptera 6 - 13 %, Plecoptera 6 - 13 %. Other taxonomical groups, mainly Turbellaria (Crenobia alpina), Trichoptera, Oligochaeta, Nematoda, Ostracoda and Hydrocarina (Tab. 1 and 2) were represented with 8 - 14 %. Dominant species among the Chironomidae were Diamesa ex gr. thienemanni, Diamesa ex gr. latitarsis and Corynoneura sp.
A general comparison of the bottom fauna in the investigated streams shows that as well in glacial as in spring streams Ephemeroptera (Baetis alpinus, Rhithrogena loyolaea) and Chironomidae (mainly Diamesinae) were the main components of the fauna. Exceptions to this were samples taken in March, when more than 50 % (37.0 to 67.0 %) of the total number of animals found in surface of bottom were Plecoptera (mainly early stages of Protonemura).
There are significant differences however, both qualitatively

and quantitatively in the two types of streams. In the glacial streams the total number of individuals per 1 dm^3 was in average three times less than in spring-fed streams. Species diversity was much bigger and Plecoptera and Trichoptera were more important in spring streams as compared to the streams originating from glaciers.

Comparing equal-volume samples of gravel to samples of bigger stones from Gurgler Ache it was possible to show that stones were colonized to a higher density by stream insects, both regarding individual numbers and taxa (Tab. 1 and 3).

This fact probably is due to the instability of gravel at strong water flow; stones provide more constant current patterns at their surfaces and were overgrown more strongly by algae, mainly by Cymbella ventricosa and Ceratoneis arcus (KAWECKA 1974), which probably form an important food source for the dominant forms of the macrobenthos.

The total numbers of animals found during March 1979 at the various depths sampled are shown in Table 3. It should be noted that some (Baetis alpinus, Protonemura) were regularly found to a depth of 50 cm within the substratum, although their numbers generally decreased down to this depth. The maximum number of animals occurred between 0 and 10 cm in the substrate, a smaller number was found at 10 - 30 cm and only a few individuals at 30 - 50 cm.

In 10 samples taken in June-July 1975 from layers more than 20 cm below the surface of the stream bottom by means of a plastic tube (diameter 10 cm) only 1 Diamesa spec. and 1 specimen of Hydracarina was found.

The only physical parameter which appears to have any direct relationship with the number of animals present in the hyporheic zone is the porosity, but even this does not hold for the depths below 10 cm. Mean grain size shows no correlation with total numbers, although it is likely that a certain minimum size would restrict the penetration of animals.

As shown in Tab.3 the number of animals in the respective depth zones (0 - 10 cm, 10 - 30 cm, 30 - 50 cm) in the substratum shows similar proportions in the different types of sediment (sand, gravel, stones) with the maximum numbers in the uppermost layer between 0 and 10 cm.

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Tab.1: Numbers of macrofauna from two glacial brooks collected in June 1975, per 1 dm^3.

Taxonomical units	Streams / Samples	Königsbach 1	2	3	4	5	Rotmoosache 1	2	3
Crenobia alpina DANA		3		5		4			
Oligochaeta		1	4	11	1	2			
Nematoda				2	1				
Hydracarina		1	1		1				
Total:				37				0	
Rhithrogena loyolaea NAVAS		2	1	2	1		2		1
Rhithrogena sp.		3	1	1	1	4	1		
Baetis alpinus PICTET		6	5	2	2	1	1		
Total Ephemeroptera:				32				5	
Protonemura montana Kim.			1	2		1			
Protonemura sp.		1	1	4					
Leuctra rosinae Kem.					1				
Leuctra sp.		1				2			
Chloroperla sp.				1					
Plecoptera other		1	1	2	2	12			
Total Plecoptera:				33				0	
Rhyacophila sp.		1	1						
Limnophilidae		1			1	2			
Total Trichoptera:				6				0	
Pericoma sp.		1							
Tanytarsini				2					
Corynoneura sp.		1	2	4	2	1			
Diamesa gr. thienemanni		1			2		1	1	
Diamesa gr. latitarsis		8	2	4		1	4	8	2
Diamesa sp.		1	3	1		6	2	2	1
Heptagia sp.		1							
Paraorthocladius nudipendis Kieff.		3	3		3	10			
Eukiefferiella bavarica G.		4	4	2		5			
Eukiefferiella minor Verr.		11	5		1	6	3		
Eukiefferiella sp.		10	3	1	1	2			1
Orthocladius rivicola Kieff.		2	2	1		6	5	3	
Orthocladinae			11		2	10	3		
Limonidae				1					
Total Diptera:				152				36	

Tab.2: Number of macrofauna from gravel and stones collected in June 1975, as an average of 30 samples.

Taxonomical units	Stream	Gurgler Gravel	Gurgler Stones	Flach Bach Stones
Planaria alpinus DANA			2	14
Ologochaeta		2	1	51
Nematoda				10
Hydracarina		1	1	29
Total:			7	104
Rhithrogena loyolaea NAVAS		1	16	6
Rhithrogena sp.			7	7
Baetis alpinus PICTET			1	58
Total Ephemeroptera:			25	71
Protonemura montana Kim.			-	1
Protonemura sp.			3	44
Dictiogenus fontium Ris.			-	7
Plecoptera other			2	19
Total Plecoptera:			5	71
Rhyacophila gr. tristis				3
Drusus discolor Ramb.				3
Total Trichoptera:			0	6
Tanytarsini				18
Corynoneura sp.			2	285
Diamesa gr. thienemanni		5	15	73
Diamesa gr. latitarsis		3	110	149
Diamesa sp.			85	70
Paraorthocladius nudipendis Kieff.				39
Eukiefferiella bavarica G.			2	12
Eukiefferiella minor Verr.		4	44	21
Eukiefferiella sp.			4	47
Orthocladius rivicola Kieff.		2	98	50
Orthocladius frigidus Kieff.				23
Orthocladius sp.			30	
Orthocladinae			7	46
Pelopinae				4
Bezzia sp.				1
Ceratopogonidae				8
Simulidae			1	27
Eusimulium			1	
Dicranota sp.				3
Limonidae			1	
Total Diptera:			414	874

Tab.3: Number of macrofauna collected in March 1979, as an average of 30 samples from glacial brook Gurgler Ache above Obergurgl.

Taxonomical units	Stones 15 samples			Gravel 9 samples			Sand 6 samples		
Depth cm	0-10	10-30	30-50	0-10	10-30	30-50	0-10	10-30	30-50
Baetis alpinus Pictet	272	36	12	250	13	4	2	0	0
Rhithogena sp.	10	4	0	10	1	0	0	0	0
Total Ephemeroptera	282	40	12	260	14	4	2	0	0
Rabdiopteryx alpina Kühtr.	3	0	0	4	1	0	0	0	0
Protonemura sp.	216	27	9	275	27	2	2	1	0
Total Plecoptera	219	27	9	279	28	2	2	1	0
Limnophilidae	1	0	0	0	0	0	0	0	0
Total Trichoptera	1	0	0	0	0	0	0	0	0
Diamesa sp.	50	17	12	85	12	4	3	2	1
Eukiefferiella sp.	33	11	7	31	7	2	1	0	0
Orthocladinae	5	1	0	13	4	0	43	17	5
Limonidae	2	1	0	2	1	0	1	0	0
Empididae	2	1	0	2	0	0	5	1	0
Total Diptera	92	31	19	133	24	6	53	20	6

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