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The communities of oligochaetes of the Wołosatka and Terebowiec streams (the Bieszczady National Park, southeastern Poland)

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Abstract — 29 species of oligochaete were found to occurring in the streams. *Stylodrilus parvus* dominated at nearly all stations. The adults of this species appeared throughout the year with a maximum in May, while juvenile specimens occurred most numerously in October. The inflow of sewage changed the structure of the community: domination was taken over by Tubificidae and also the number of species occurring increased.

Key words: mountain streams, the Bieszczady, communities of oligochaetes, *Stylodrilus parvus*, seasonal changes, pollution.

1. Introduction

The Bieszczady Mountains are a very interesting area for scientific investigations, considering their location on the edge of large zoogeographic units and also the return of the environment to a wild state. However, the fauna of aquatic oligochaetes of this terrain is poorly known. The only data come from the papers of Kasprzak (1973a, b), who elaborated materials collected chiefly in interstitial and hyporheic waters of some streams and rivers of this region.

The present work was part of a larger study of the fauna of streams in the area (Kukuła 1991). Its aim was to assemble data on the structure of communities of oligochaetes occurring in streams, on their life cycles and seasonal changes in density of their settlement on stream

bottoms, and also on the differences in habitat of the fauna of oligochaetes as well as on the effect of water pollution upon their communities.

2. Study area

The Wołosatka and Terebowiec streams were chosen for the investigation. These streams flow along deep valleys dividing the Tarnica, Szeroki Wierch, Krzemień, and Halicz Massifs on the territory

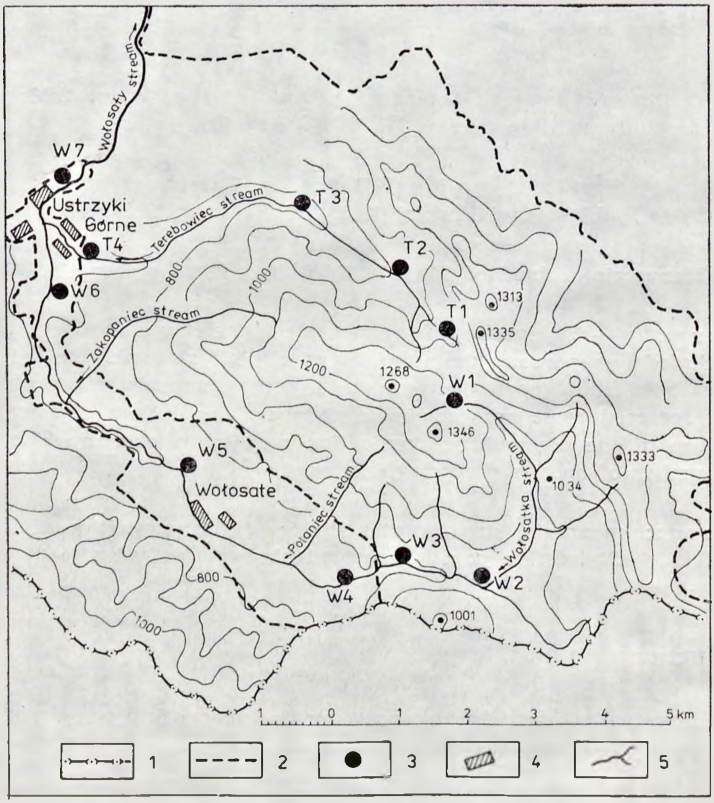

Fig. 1. Map of the investigated area. 1 — state border; 2 — border of the Bieszczady National Park; 3 — Stations W1—W7 on the Wołosatka stream; T1—T4 — on the Terebowiec stream; 4 — buildings; 5 — streams

of the Bieszczady National Park (fig. 1). The Wołosatka (called in its lower course Wołosaty) is 27.8 km long, its mean gradient is 23‰, and the area of the catchment basin is 119 km². The investigated section of the Wołosatka is 17.8 km. The last station is located below the

Table I. Basic hydrographic and hydrological data on stations of the Wołosatka stream

Station number	Altitude m	Distance from source km	Gradient ‰	Width min. m	Width max. m	Depth min m	Depth max. m	Current velocity m s^{-1}
W1	1120	0.2	100	0 2	0.8	0.05	0.1	0.5
W2	825	4.1	21	2.5	6.0	0.3	0 3	1.5
W3	775	6.0	19	1.5	6.0	0.3	0.8	1.5
W4	750	7.0	12	5.0	9.0	0.2	0 7	1 2
W5	725	10.3	9	5.0	9.0	0.3	0 9	1.3
W6	655	17.3	8	8.0	10.0	0.2	1.0	1.2
W7	650	17.8	8	8.0	19.0	0.2	1.1	1.2

Table II. Basic hydrographic and hydrological data on stations of the Terebowiec stream

Station number	Altitude m	Distance from source km	Gradient ‰	Width min m	Width max. m	Depth min m	Depth max. m	Current velocity m s^{-1}
T1	1125	0 1	175	0 2	0.5	0.05	0.1	0.5
T2	900	1 2	85	1.0	4.0	0.1	0.3	1.5
T3	790	3.8	24	2.5	6 0	0 2	0.5	1.5
T4	675	7.9	11	3.0	7 0	0.2	0.8	1.2

confluence with the Terebowiec stream. Along the Wołosatka 7 stations were established (W1 — W7), a brief description of them being given in Table I. The Terebowiec, a left bank tributary of the Wołosatka, is 7.5 km long and its mean gradient 15‰. Its catchment area is 57 km^2. The characteristics of 4 stations (T1 — T4) are given in Table II. As a station a 10—50 m section of the stream was taken.

3. Material and methods

A 22.5 × 22.5 cm bottom scraper with an 0.33 mm mesh bolting cloth net fixed to it was used for sampling. The samples were drawn from an area of about 5 dm^2, rinsed from the remains of rotten plants, and fixed in 4% formalin.

The water current velocity was determined by the method of a surface float, assuming as slow or medium a velocity below or equal to 0.5 m s^{-1}, and as strong and very strong a current above 0.5 m s^{-1}.

Table III. Types of habitats distinguished in the Wołosatka stream

Habitat	Prevailing type of substratum	Current velocity	Samples number
I	very large and large stones	very fast or fast	119
II	very large and large stones	medium or slow	29
III	medium and small stones	very fast or fast	34
IV	medium and small stones	medium or slow	19
V	pebbles, small stones, and sand	very fast or fast	42
VI	pebbles, small stones, and sand	medium or slow	22

Each of the samples taken from the Wołosatka was also estimated with regard to the composition of the substratum, classifying stones of 3—8 cm dia as small, those of 9—15 cm as medium, and more than 15 cm but entering the bottom scraper as large. On the basis of the data on the current velocity and composition of the substratum in this stream, 6 types of habitat were distinguished (Table III), though considering the small number of samples collected from some habitats, the samples from two similar ones were analyzed together (this concerns samples from habitats IV and VI).

The samples were collected in the period 1985—1987. For accurate quantitative and seasonal investigations W2, W3, and W4 Stations were chosen. Usually 10 quantitative samples were drawn with a frequency of once in three — four weeks except in the winter months when a very thick snow cover made it impossible to reach the stations (only from Station W3 were samples drawn for the last time on Sept. 17, 1985). From Stations W1, W5, W6, and W7 6 quantitative samples were drawn at a time but from W1 and W5 these samples were drawn from May till July and from W6 and W7 from May till October 1985. From the Terebowiec qualitative samples were taken for comparison, therefore the density of oligochaetes were not evaluated, only the species dominance in a community being estimated. From Station T2 samples were drawn about once a month from January till the end of November 1986, whereas the remaining stations were sampled only in May, July, and September 1987.

Species, whose participation was at least 10% were called dominants, those from 1—9.9% subdominants, and below 1% adominants, while species whose participation was below 0.1% were only determined as present without their numerical value being given.

4. Results

4.1. General description

In the Wołosatka stream the occurrence of 26 species or genera of oligochaetes belonging to 7 families was observed. In the spring zone (Station W1) only two families, Lumbriculidae and Enchytraeidae, were found but already at Station W2 the presence of all families was noted. At all stations (except W7) Lumbriculidae constituted the highest percentage, represented by 1 species (*Stylodrilus parvus*) which, together with juvenile specimens, constituted from 66.3% of the community of oligochaetes at Station W1 up to 93.8% of that at Station W6 (Table IV).

Table IV. Percentage of particular species of oligochaetes at stations in the Wołosatka Stream. + — per cent < 0.1

Taxa	Stations						
	W1	W2	W3	W4	W5	W6	W7
Stylodrilus parvus Hr. & Cern.	37.7	41.4	41.8	39.0	53,9	21.6	12.7
— sp. juv. Clap.	28.6	45.4	50.2	50.0	27.2	72.2	16.7
Cognettia sphagnetorum (Vejd)	10.7	4.0		0.8	1.1		
Mesenchytraeus armatus (Lev.)	6.0	+	0.2	0.4			0.5
Henlea perpusilla Friend	5.0	0.4	0.6				
Fridericia sp. Mich.	5.0	0.7	0.2	+	0.6		
Enchytraeidae gen. spp. juv.	7.0	2.6	1.5	1.2	1.1		0.5
Haplotaxis gordioides (Hartm)		2.9	2.9	0.4	10.5	1.0	0.5
Nais communis Pig.			0.2	2.5			
— pseudobtusa Pig.			+	2.5			
— bretscheri Mich.			+	0.4			
Propappus volki Mich.		+	1.0	0.4	3.8	2.9	0.5
Eiseniella tetraedra (Sav.)		0.8	0.2	+		0.3	1.0
Marionina riparia Bret.		+	0.2				
Lumbriculidae gen. spp. juv.		1.1	+	+	0.6		0.5
Lumbricidae gen. spp. juv.		+	+				
Tubificidae gen. spp. juv.		+	1.0	+		0.3	50.4
Nais alpina Sperb.		+		2.0	0.6	1.3	0.5
— variabilis Pig.				+			0.5
— pardalis Pig.		+		+			0.5
Cognettia glandulosa (Mich.)		+		+			0.5
Limnodrilus hoffmeisteri Clap.				0.4		0.4	3.9
Rhyacodrilus falciformis Bret.		+					
Cognettia anomala (Cern.)		0.7					
Pristina spp. Ehren.					0.6		
Amphichaeta leydigii Trauber.							0.5
Cernosvitoviella spp. N. & Ch.							0.5
Enchytraeus spp. Henle							0.5
Tubifex tubifex (O. F Mull.)							6.8
Limnodrilus claparedeanus Ratz.							0.5
— udekemianus Clap.							2.0

Table V. Percentage of particular species of oligochaetes at stations in the Terebowiec stream

Taxa	Stations			
	T1	T2	T3	T4
Stylodrilus parvus Hr. & Cern.	34.3	33.3	40.3	46.3
— sp. juv. Clap	59 5	47.5	46.7	38.6
Enchytraeidae gen. spp. juv.	3.7	9.3	5.2	4.3
Cognettia sphagnetorum (Vejd.)	0.4	0 9	2.6	
Mesenchytraeus armatus (Lev.)	0.9	3 0		
Eiseniella tetraedra (Sav.)	0 2	0.5		
Nais communis Pig.	0.4	0.2		
Lumbriculidae gen. spp. juv	0.4			
Tubificidae gen. spp. juv.	0.2			
Haplotaxis gordioides (Hartm.)		4 4	2.6	3.3
Cognettia anomala (Cern.)		0 5		
Enchytraeus buchholzi Vejd.		0 2		
Buchholzia appendiculata (Buch.)		0 2		
Nais variabilis Pig.			1.3	
Fridericia spp. Mich.			1.3	
Nais alpina Sperb.				4.3
— bretscheri Mich.				2 1
Lumbricidae gen. spp. juv.				1.1

Enchytraeidae formed a large part of the fauna of oligochaetes (33.7%) at Station W1, but at the remaining stations only a few per cent of the community. This family was represented by 9 taxa mostly occurring both in the soil and in the water. From the family Naididae usually appearing in great numbers in streams only 8 species were determined, of which as many as 6 belong to genus *Nais*. None of the species found occurred in the spring zone, only at Station W2 single specimens of *Nais alpina* and *N. pardalis* appearing. Species of this genus occurred slightly more numerously at Station W4 where their total participation was 4.7% of the community. Three families were represented only by single species, i.e. Haplotaxidae (*Haplotaxis gordioides*), Propappidae (*Propappus volki*), and Lumbricidae (*Eiseniella tetraedra*). At the last station (W7) the greatest participation in the community (62.1%) was shown by Tubificidae which at previous stations constituted at most 1% of the whole fauna of oligochaetes. Only three species of this family occurred at this station.

In the Terebowiec only 13 species of oligochaetes were determined (Table V). This, however, does not testify to the poverty of the fauna of oligochaetes here, but may have been the result of fewer samples being drawn from this stream. Similar communities occurred in the two streams; the same species dominated (*Stylodrilus parvus*). The

percentages of particular families and species composition were similar but in the Terebowiec nearly all families occurred already in the spring section. The occurrence of *Propappus volki*, which was found fairly numerously in the Wołosatka, was not observed in the Terebowiec.

4.2. Differentiation of habitats

The composition and numbers of oligochaetes were analysed in 5 habitats (Table III) at five stations (W2 — W5 and W7) from which at least 30 samples were taken.

At four stations (W2 — W5) greater numbers of oligochaetes were observed on the bottom covered with small stones whatever the velocity of the current (Table VI). At Station W7, however, the greatest numbers were noted in habitats with a weak current and in this case the size of tht bottom particles was not important. Differences in density of settlement are caused by various habitat requirements of the dominant species. *Stylodrilus parvus* dominated at W2 and W5 Stations. The habitat demands of this species are not exactly known but swiftly flowing waters and cold mountain lakes are typical places of occurrence of the whole genus. Probably among small stones it is easier to find shelter from the current and predators and this species tolerates well poor stability of the substratum. At Station W7 the dominants were Tubificidae, which avoid places with a rapid current, the size of particles of the bottom not seeming to play any essential role in their occurrence.

For some species the habitat preference was determined. Most clearly seen is the attachement of Tubificidae (*Limnodrilus hoffmeisteri*, *L. udekemianus*, *Tubifex tubifex*) to current-free habitats. It seems that *Nais communis* also prefers this type of habitat. However, *Nais alpina* or *Haplotaxis gordioides* occur more numerously in habitats with a current.

4.3. Seasonal changes

Seasonal changes in the total numbers of oligochaetes and dominant species (*Stylodrilus parvus*) were elaborated only for two stations (W2 and W4) from which samples were drawn every 3—4 weeks (VI 1985—VI 1986 except in the winter months). Changes in numbers took place analogically at the two stations except in the late summer two months when a distinct increase in the numbers of oligochaetes occurred at Station W4 which was not observed at Station W2 (fig. 2). Changes in the total numbers were chiefly correlated with those in the numbers

Table VI. Differentiation of habitats of oligochaetes expressed as density per .1 m² of the 7 most frequently occuring taxa. * — habitats in which the greatest numbers of oligochaetes were found

Station and habitat		S. parvus	S. sp. juv.	H. gordioides	C. sphagnetorum	L. hoffmeisteri	T. tubifex	Tubificidae	Total density
	I	86	87	5	14				215
	II	89	66						161
W2	III	142	155	20	3			2	*342
	IV+VI	156	171	13	8				*364
	V	145	203	3	15				*389
	I	130	187	14					346
	II	52	100	4					180
W3	III	217	320						*590
	IV+VI	164	200	9				16	*407
	V	298	234	18					*576
	I	70	105		2				205
	II	100	98	7					211
W4	III	80	127						219
	IV+VI	227	100	3		3			*392
	V	116	218		7	2			*347
	I	74	29	20					140
	II	30	30	15	15				100
W5	III	110	80	10					*200
	IV+VI	160	170	10					*340
	V	184	56	24					*276
	I	48	30	2		4		44	134
	II	10	5			15	20	260	*345
W7	III		40					10	50
	IV+VI	23	9	3		20	50	189	*315
	V	17	67				3	30	138

of *stylodrilus parvus*, although in some months the importance of other taxa was high. During early summer, at Station W2 *Haplotaxis gordioides* and some species of the family Enchytraeidae occurred fairly, while in spring, particularly in April in the community of oligochaetes Enchytraeidae, chiefly *Cognettia sphagnetorum*, occurred almost exclusively. The increase in numbers in spring and early summer at Station W4 was caused by the appearance of a greater number of Naididae.

The changes in numbers of *Stylodrilus parvus* are caused not only by the life cycle of this species but also by changes in the environment (a rise in the water level or an exceptionally low one) which hamper observation of its life cycle. The adults were observed throughout the

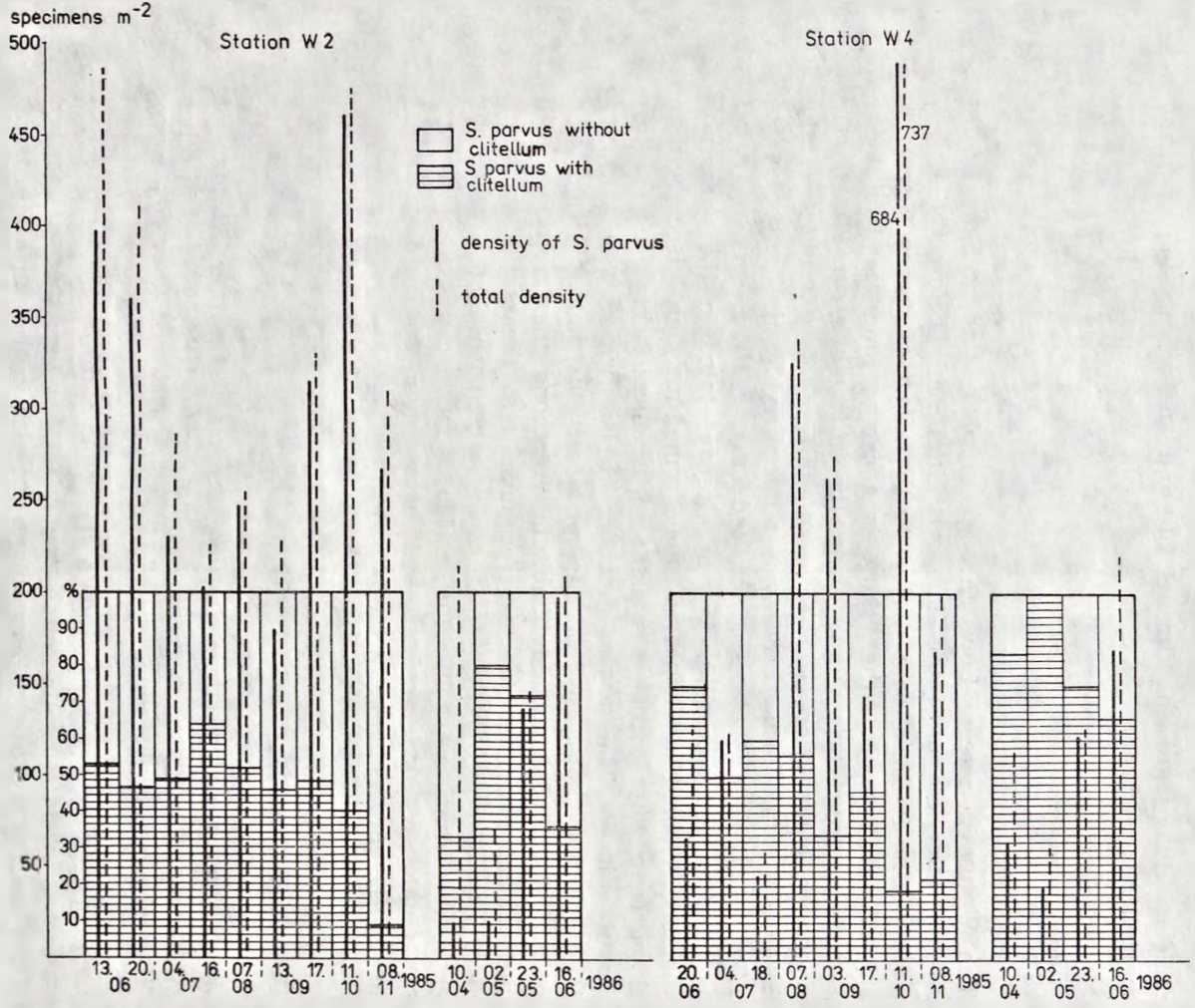

Fig. 2. Seasonal changes of numbers of oligochaetes and percentage of adult and juvenile specimens of *Stylodrilus parvus* at Stations W2 and W4

year but they occurred most numerously in spring (May); the highest percentage of juvenile specimens and at the same time the greatest numbers of this species, however, were observed in autumn (October). This suggests that the hatching period lasted throughout the summer, juvenile specimens growing through autumn and winter and maturing in the following year.

4.4. The effect of pollution

The Wołosatka stream flows through uninhabitated and practically uncultivated terrain (until the time sampling). Only below the village Ustrzyki Górne is the stream subject to the affect of domestic sewage, particularly in summer, when there is a campground close to it. At Station W7, located below the village, the inflow of sewage distinctly changed the composition of the communities of oligochaetes: the percentage of *Stylodrilus parvus* was reduced, while the percentage of Tubificidae (Table IV) clearly increased, among them species typical of polluted waters occurring. As was already stated in the paragraph on habitats, Tubicifidae appeared more numerously in places with a weak current, where organic remains settle, these being food for this group of animals. The largest numbers of Tubificidae were observed in May, when a great many juvenile specimens, just hatched from their cocons, were found in muddy habitats. A second maximum occurred in autumn when besides juvenile specimens also the adults appeared. The level pollution of the stream does not seem to be high; rather one might speak of its eutrophication, which is evidenced by an increase in the number of species occurring: 17 were found at this station, that is to say the most among the investigated stations.

5. Discussion

In the Wołosatka and Terebowiec streams, altogether 29 taxa of oligochaetes were found, i.e. a number similar to that observed in other mountain streams in Poland (Szczęsny 1974, Dumnicka 1976, Kahl 1986).

Among rare species occurring in the Wołosatka should be included *Cognettia anomala* from the family Enchytraeidae — a species described as occurring in the Eastern Carpathians and also in the Tatra Mountains (Kasprzak 1986). Such species as *Cognettia sphagnetorum*, *Mesenchytraeus armatus*, and *Henlea perpusilla* are often encountered in mountain streams on the territory of Poland (Kasprzak 1986). Among 5 species representing the family Tubificidae 4 are ubiquitous but only one

species (*Rhyacodrilus falciformis*) is typical of clean waters and it frequently occurs in the spring zone (Kasprzak 1981).

In communities of oligochaetes in mountain streams, a dominant role is often played by Lumbriculidae, represented by *Stylodrilus heringianus* or *Lumbriculus variegatus*. This type of community was found in the clean section of the Kryniczanka stream (High Beskids, alt. ca 600 m) (Szczęsny 1974) and in the spring zone of the River Lubrzanka in Góry Świętokrzyskie (Holy Cross Mts.) alt. ca 350 m (Kahl 1986). The community composition of oligochaetes is different in clean streams of the High Tatras (alt. ca 1600 to 1000 m). Here dominate Enchytraeidae and Naididae, Lumbriculidae being at most a few or not more than 20% of the fauna of oligochaetes (Dumnicka 1976). The dominance of the family Lumbriculidae was also observed in the Bieszczady Mountains but, instead of the common species *Stylodrilus heringianus*, *S. parvus* occurred. Hitherto this species is known from the Kłodzki Śnieżnik Massif and from the Puck region, where it appeared in small numbers (Kasprzak 1981). However, it was often encountered in the cold mountain waters of the Southern Carpathians (Hrabe 1937), and in the Jugoslavian Mountains (Hrabe 1973). Probably it is a southern species and in the territory of Poland occurs as a dominant only in the streams of the Bieszczady Mountains.

The fact that *Stylodrilus parvus* was not found in interstitial waters of the lower sections of streams and of the River San investigated by Kasprzak (1973a, b) testifies to the great sensitivity of this species to water pollution which was also observed by Uzunov et al. (1988). An increase in the trophy of the waters of the Wołosatka and Terebowiec may destroy this unique community, hence any attempts at intensification of agriculture and animal husbandry in the basin of these streams should be abandoned. Changes in the community structure are already visible at the last station in the Wołosatka. The percentage of *S. parvus* is falling and that of ubiquitous taxa from the Tubificidae family rising, while new species, characteristic of lowland streams, are also appearing.

The knowledge about biology of species belonging to the genus of *Sylodrilus* is very scanty. Cook (1969), investigating the generative cycle of *Stylodrilus heringianus*, suggests that specimens reach sexual maturity after two years, whereas Pickavance (1971), investigating two seasonal ponds in Newfounland, found that this species matures and reproduces during one year. On the basis of the presented results it may be assumed that this period for *S. parvus* is also only one year. More accurate determination of the duration of various periods of the life of this species requires laboratory tests at various temperatures.

6. Polish summary

Ugrupowania skąposzczetów potoków Wołosatka i Terebowiec (Bieszczadzki Park Narodowy, południowo-wschodnia Polska)

W badanych potokach (ryc. 1), których krótką charakterystykę wraz z określeniem siedlisk podano w tabelach I, II i III, stwierdzono występowanie 29 gatunków skąposzczetów należących do 7 rodzin. W potoku Terebowiec (tabela V) oraz prawie na całej długości potoku Wołosatka (tabela IV) dominował *Stylodrilus parvus*, gatunek rzadki w naszej faunie. Gatunek ten występował liczniej na dnie drobnoziarnistym, niezależnie od szybkości prądu (tabela VI). Natomiast Tubificidae preferowały siedliska o wolnym prądzie, a wielkość cząstek podłoża nie była istotna.

Sezonowe zmiany ogólnej liczebności skąposzczetów skorelowane były głównie ze zmianami liczebności *Stylodrilus parvus*, choć w niektórych miesiącach duże znaczenie miały też Enchytraeidae lub Naididae (ryc. 2). Dojrzałe osobniki tego gatunku spotykano przez cały rok, lecz najliczniej występowały one w maju, natomiast największy procent osobników młodych i równocześnie najwyższą liczebność stwierdzono w październiku.

Dopływ ścieków ze wsi i campingu usytuowanego nad brzegiem potoku zmienił strukturę ugrupowania: dominację przejęły Tubificidae, spadł udział *S. parvus*, natomiast liczba gatunków zwiększyła się (tabela IV).

7. References

Cook D. G., 1969. Observations on the life history and ecology of some Lumbriculidae (Annelida, Oligochaeta). Hydrobiologia, 34, 561—574.

Dumnicka E., 1976. Oligochaetes (Oligochaeta) of some streams of the High Tatra Mts and of the River Białka Tatrzańska. Acta Hydrobiol., 18, 305—315.

Hrabe S., 1937. Prispevek k poznani zvireny Kralickeho Sněžniku — Beitrag zur Kenntnis der Fauna des Glatzer Schneeberges. Sbornik klubu prirod. v Brne, 20, 1—10.

Hrabe S., 1973. On a collection of Oligochaeta from various parts of Yugoslavia. Biol. Vest., 21, 39—50.

Kahl K., 1986. Skąposzczety (Oligochaeta) rzeki Lubrzanki w Górach Świętokrzyskich — The Oligochaeta of the Lubrzanka River in the Świętokrzyskie Mts (Central Poland). Fragm. faun., 30, 35—43.

Kasprzak K., 1973a. Notes on Oligochaeta fauna of Poland. 1. Fragm. faun., 18, 405—434.

Kasprzak K., 1973b. Notes on Oligochaeta fauna of Poland. 2. Fragm. faun., 19, 1—19.

Kasprzak K., 1981. Skąposzczety wodne. 1. Rodziny: Aeolosomatidae, Potamodrilidae, Naididae, Tubificidae, Dorydrilidae, Lumbriculidae, Haplotaxidae, Glossoscolecidae, Branchiobdellidae. Klucze do oznaczania bezkręgowców Polski [Aquatic Oligochaeta. 1. Families: Aeolosomatidae, Potamodrilidae, Naididae, Tubificidae, Dorydrilidae, Lumbriculidae, Haplotaxidae, Glossoscolecidae, Branchiobdellidae. Keys for determining Polish invertebrates]. 4, 226 pp.

Kasprzak K., 1986. Skąposzczety wodne i g'ebowe. 2. Rodzina: wazonkowce (Enchytraeidae). Klucze do oznaczania bezkręgowców Polski [Aquatic and

terrestrial Oligochaeta. 2. Family: enchytraeids (Enchytraeidae). Keys to determining Polish invertebrates]. 5, 366 pp.

Kukuła K., 1991. Mayflies (Ephemeroptera) of the Wołosatka stream and its main tributaries (The Bieszczady National Park, southeastern Poland). Acta Hydrobiol., 33, 000—000.

Pickavance J. R., 1971. The ecology of *Stylodrilus heringianus* Claparede (Oligochaeta, Lumbriculidae) in Newfounland. Can. J. Zool., 49, 535—542.

Szczęsny B., 1974. The effect of sewage from the town of Krynica on the benthic invertebrates communities of the Kryniczanka stream. Acta Hydrobiol., 16, 1—29.

Uzunov J., V. Kosel, V. Sladeček, 1988. Indicator value of freshwater Oligochaeta. Acta Hydrochim. Hydrobiol., 16, 173—186.