ACTA HYDROBIOL.	27	4	535—545	KRAKÓW 1985

Ecology of some waters in the forest-agricultural basin of the River Brynica near the Upper Silesian Industrial Region*

9. Communities of oligochaetes

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Manuscript submitted September 19, 1983, accepted October 30, 1984

Abstract — The composition and structure of oligochaete communities of the examined waters depend on several factors such as the natural character of the run or water body and the kind and level of water pollution. Only in the upper course of the River Brynica is a community typical for lowland rivers present. Communities characteristic for organically polluted waters appear below the reservoir at Kozłowa Góra. In Lake Chechło-Nakło a high content of microelements causes elimination of the more sensitive species (especially from the family *Naididae*).

Key words: rivers, dam reservoirs, lakes, ponds, oligochaetes, organic pollution, heavy metals, resistance.

1. Introduction

In the period 1976—1979 an investigation of selected waters from the River Brynica basin was carried out. These were very varied, i.e. a dam reservoir, a river, an artificial lake, and a park pond.

The aim of the investigation was to determine the effect of various types of pollution on the oligochaete communities. Particular attention was paid to the problem of the action of heavy metals on these organisms.

* The investigation was carried out within Project No MR.II. 15.

Some of the oligochaete species (mainly from the family *Tubificidae*) are highly resistant to the effect of various kinds of pollution. In waters polluted with organic sewage oligochaetes are the main component of the benthos, their participation in it even reaching 100% (Brinkhurst 1965, Goodnight 1973, Shrivastava 1962). In waters contaminated by industrial wastes *Tubificidae* also constitute a large part of the bottom fauna (Chapman et al. 1980, Wentsel et al. 1973). They resist higher concentrations of microelements than other animal groups (Whitley 1967, Brkovic-Popovic, Popovic 1977) and therefore may be used for investigating heavy metal pollution of waters with loads which would be lethal to other animals. There is a lack of investigations on the effect of microelements on *Naididae* and aquatic species of *Enchytraeidae*. The only data concerning the tolerance of some species of *Nais* genus come from the work of Learner and Edwards (1963).

2. Study area

The investigation was carried out at 7 stations, the benthos samples being taken at 6 of them since station (4) was situated on a concreted part of the Brynica riverbed (fig. 1). The stations are briefly described in Table I (Zięba 1985).

3. Material and methods

Samples were taken 15 times.

At stations 1, 2, and 5 samples were taken from an area of 4×10^{-1} m² with a bottom scraper covered with 0.3×10^{-3} m² mesh net and at stations 3a—3e, 6, and 7a—7b with an Ekman bottom grab measuring $225\times\times10^{-2}$ m². The samples were preserved in 4% formalin. After making solid slides (in Canada balsam), oligochaetes were determined and the percentage share of a given species in particular years and in the whole period of investigation at each station was calculated. On the basis of percentage share the dominant species were selected; their share in a community is over 20%. The large percentage is made up of sexually immature specimens of the family *Tubificidae* (mainly *Tubifex* spp. and *Limnodrilus* spp.) and, to a smaller extent, the families *Enchytraeidae* and *Lumbriculidae* which cannot be more accurately determined. Further in this work only that part of the material which could be determined as far as species will be discussed.

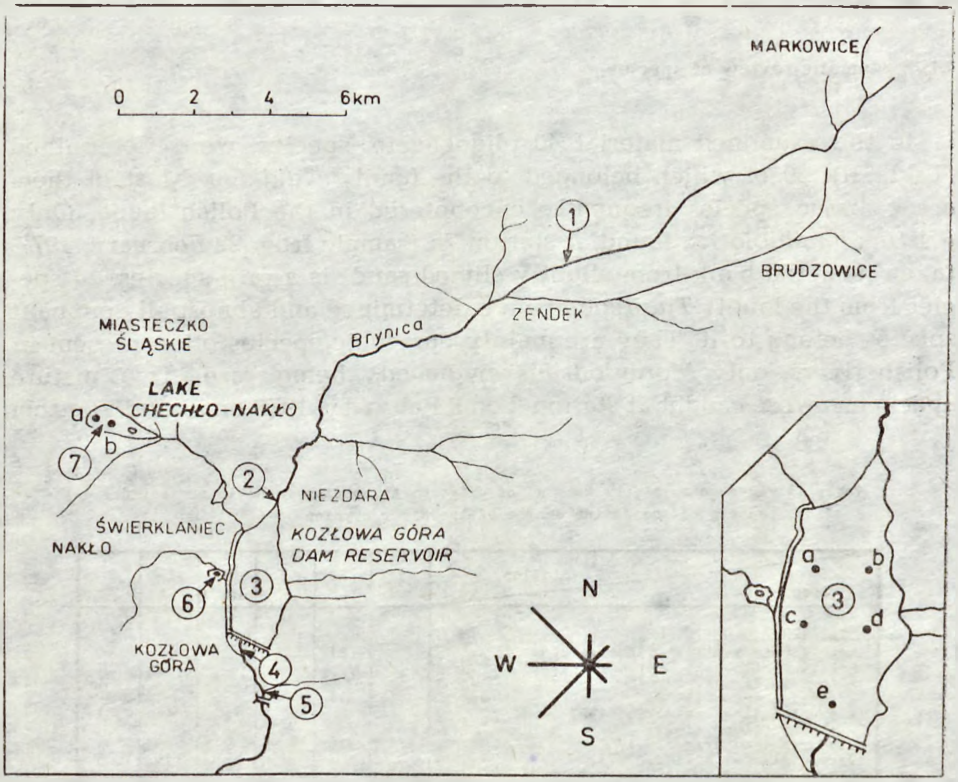

Fig. 1. Distribution of the investigated stations and wind rose. Stations: 1—7

Table I. Brief description of the investigated stations

Station	No.	Situation	Width of the riverbed (m) area (km^2)	Depth (m)	Current	Plants	Character of the bottom
River Brynica	1	at Zendek	0.5-1.5	0.2-0.5	medium	single tufts of submersed plants	sand, in places muddy sand
	2	at Niezdara	3.0-4.0	0.2-0.7	slow	single tufts of submersed and emergent plants	muddy sand, in places sand and mud
Dam reservoir at Kozłowa Góra	3	at Kozłowa Góra					
	a b	upper section	mean 4.62	0.5-1.8		none	mud, in places muddy sand
	c d	lower section	maximum up to 6.21	1.8-3.0		none	mud
	e	near the dam		up to 5.0		none	mud
River Brynica	4	near the dam	1.0-1.2	0.2	medium	none	bed lined with stones
	5	below the dam - 1.5 km	2.0-3.0	0.3-0.7	slow	numerous emergent plants	sand, muddy sand and detritus
Park pond	6	at Świerklaniec, inshore	0.06	1.2-1.5		tufts of the submersed plants	mud and detritus
Lake Chechło-Nakło	7 a	at Chechło inshore	0.66	0.3-0.6		single tufts of emergent plants	sand and muddy sand
	7 b	central zone		2.3-2.5		tufts of Chara sp.	muddy sand

4. Results

4.1. Systematic review of species

In the examined material 40 oligochaete species were determined (Table II), 20 of which belonged to the family *Naididae*. Most of them are common species frequently encountered in the Polish fauna. Only *Pristina amphibiotica* found at station 7a (sample from 22 February, 1977, taken near the bank from slightly slimed sand) is a rare species. 14 species from the family *Tubificidae* were determined and almost all dominant species belong to it. They are mainly eurytopic species often present in Polish rivers, only *Moraviodrilus pygmaeus* being rare. Two mature specimens were caught at station 2 on 8 February, 1978 on a sandy bottom

Table II. Mean numbers (per sample) of oligochaete species found in the surface waters of the drainage area of the River Brynica

Species \ Station	1	2	3	5	6	7
Naididae						
Amphichaeta leydigii Tauber, 1879		81				
Pristina bilobata (Bretscher, 1903)						1
- foreli (Piguet, 1906)						1
- rosea (Piguet, 1906)	6	11				
- amphibiotica Lastočkin, 1927						1
- menoni (Aiyer, 1929)	1					
Stylaria lacustris (L. 1767)	11	16			8	4
Dero digitata (Müller, 1774)		8			110	3
Slavina appendiculata (Udekem, 1855)		2				
Vejdovskyella comata (Vejdovsky, 1884)	2	10				
- intermedia (Bretscher, 1896)	1					
Nais barbata Müller, 1774				56	10	1
- elinguis Müller, 1774	1			22		
- pseudobtusa Piguet, 1906	2	1			1	
- simplex Piguet, 1906					1	
- pardalis Piguet, 1906					4	
- communis Piguet, 1906	11	67		3	3	
Specaria josinae (Vejdovsky, 1884)	3	24		37	5	6
Uncinais uncinata (Oersted, 1842)		70				
Ophidonais serpentina (Müller, 1774)				7	6	
Tubificidae						
Moraviodrilus pygmaeus Hrabě, 1935		1				
Potamothrix hammoniensis (Michaelsen, 1901)				2	6	
Ilyodrilus templetoni (Southern, 1909)					19	
Spirosperma ferox Eisen, 1879	1	3				
Psammoryctides albicola (Michaelsen, 1901)			1			
- moravicus (Hrabe, 1934)					3	
Tubifex tubifex (Müller, 1774)	6	22	4	1095	19	
- ignotus (Stolc, 1886)		4				
Limnodrilus hoffmeisteri Claparède, 1862	18	111	17	273	183	40
- udekemianus Claparède, 1862		2	3	486	22	29
- profundicola (Verrill, 1871)				267		1
- claparedeanus Ratzel, 1896		20			14	2
Aulodrilus limnobius Bretscher, 1899		4			33	
- pluriseta (Piguet, 1906)	7	754	9		45	320
Enchytraeidae						
Propappus volki Michaelsen, 1916	48	13			1	9
Henlea nasuta (Eisen, 1878)	1	1				
- perpusilla Friend, 1911		2				
Fridericia striata (Levinsen, 1884)						1
Enchytraeus buchholzi Vejdovsky, 1879			1			
Marionina riparia Bretscher, 1899	1	12				1
Lumbriculidae						
Lumbriculus variegatus (Müller, 1774)	3	1	1	6		42
Lumbricidae						
Eiseniella tetraedra Savigny 1826		1				

covered with decaying remnants of reeds. Only 6 species were determined from the family *Enchytraeidae* out of which *Propappus volki* and *Marionina riparia* are aquatic species, the remainder being terrestrial species accidentally found in a water environment. From the family *Lumbriculidae* only *Lubriculus variegatus*, a very common species in Polish waters, was determined. From the family *Lumbricidae* also only one species was determined, i.e. *Eiseniella tetraedra*, which is sporadic in the investigated area.

4.2. Oligochaete communities

At station 1 (Table III) *Propappus volki*, characteristic for sandy bottom, was the dominant species. Specimens of *Limnodrilus hoffmeisteri*, *Tubifex tubifex*, and *Aulodrilus pluriseta* were numerous in muddy bottom. Among the higher submersed plants and filamentous algae were *Pristina rosea*, *Stylaria lacustris*, and *Nais communis*. The varied character of the bottom and periodical development of plants explains the great variability of the community at the time of investigation. The density of oligochaetes is low (on average 19 specimens in a sample at the investigation time). 17 oligochaete species were determined in this station.

At station 2 (reservoir backwaters, Table III) the dominant species was *Aulodrilus pluriseta*, characteristic for slimed and slime-sandy bottom. Also the numerous specimens of *Limnodrilus hoffmeisteri* and *Amphichaeta leydigii* here prefer this type of bottom, while *Nais communis* and *Uncinais uncinata* were caught mainly among filamentous algae. The density of oligochaetes increased to an average 122 specimens in a sample, and the number of determined species (25) was the highest of all the investigated stations.

At stations 3a—3e (Kozłowa Góra reservoir) the oligochaete density rapidly decreased (to an average 3 specimens in a sample). The number of determined species in comparison with station 2 (Table III) also decreased considerably. *Limnodrilus hoffmeisteri* and *Aulodrilus pluriseta* were dominants. The presence of the latter species was restricted to places situated in the upper part of the reservoir, which points to their being carried by the river current. This species was not present near the dam. Besides, *Limnodrilus udekemianus* and *Tubifex tubifex*, as species preferring slimed bottom, were more numerous. The remaining species were represented by single specimens.

At station 5 (Table III) the density of oligochaetes was very high and amounted on the average to 2.59×10^3 specimens in a sample. The dominant species were *Tubifex tubifex* and *Limnodrilus udekemianus*, *L. hoffmeisteri*, and *L. profundicola* also being numerous.

The remaining species (mainly from the family *Naididae*) were scarce.

Table III. Oligochaeta community (according to the percentage share of the species) of particular stations in the period 1976-1979

Species / Years	1976	1977	1978	1979	Total
	Station 1				
Proppapus volki	65.2	15	47.4		39
Limnodrilus hoffmeisteri	8.7		22.8	100.0	14.6
Pristina rosea	21.7		1.7		4.9
Specaria josinae	4.3		3.5		2.4
Tubifex tubifex		7.5	5.3		4.9
Aulodrilus pluriseta		2.5	10.5		5.7
Vejdovskyella comata		5.0			
- intermedia		2.5			
Stylaria lacustris		27.5			8.9
Nais communis		27.5			8.9
- elinguis		2.5			0.8
Lumbriculus variegatus		7.5			2.4
Marionina riparia		2.5			0.8
Pristina menoni			1.7		0.8
Spirosperma ferox			1.7		0.8
Nais pseudobtusa			3.5		1.6
Henlea nasuta			1.7		0.8
	Station 2				
Aulodrilus pluriseta	35.0	59.9	87.6	71.8	60.6
Limnodrilus hoffmeisteri	5.6	17.4	5.5	20.5	0.9
Tubifex tubifex	1.1	1.3	2.5	5.1	1.8
Limnodrilus claparedeanus	0.2	4.3	1.4	-	1.6
Tubifex ignotus	0.2		0.4	2.6	0.3
Nais communis	14.0	0.6			5.4
Specaria josinae	3.0	3.3			1.9
Stylaria lacustris	0.6	4.3			1.3
Slavina appendiculata	0.2	0.3			0.2
Pristina rosea	2.0	0.3			0.9
Propappus volki	2.6		0.2		1.0
Nais pseudobtusa	0.2				0.08
Vejdovskyella comata	2.1				0.8
Amphichaeta leydigii	17.4				6.5
Uncinais uncinata	15.0				5.6
Lumbriculus variegatus	0.2				0.1
Dero digitata		2.6			
Marionina riparia		3.9			1.0
Henlea perpusilla		0.6			0.2
- nasuta		0.3			0.08
Eiseniella tetraedra		0.3			0.08
Aulodrilus limnobius			0.9		0.3
Limnodrilus udekemianus			0.4		0.2
Spirosperma ferox			0.7		0.2
Moraviodrilus pygmaeus			0.2		0.08
	Stations 3a-3e				
Limnodrilus hoffmeisteri	50.0	53.3	45.4	28.6	45.9
Aulodrilus pluriseta	50.0	33.3	9.1	14.3	24.3
Limnodrilus udekemianus		6.7	18.2		8.1
Tubifex tubifex			9.1	42.8	10.8
Psammoryctides albicola			9.1		2.7
Lumbriculus variegatus			9.1		2.7
Enchytraeus buchholzi				14.3	2.7
	Station 5				
Limnodrilus udekemianus		32.3	19.0	4.5	21.6
Tubifex tubifex		6.2	61.1	86.5	48.6
Limnodrilus hoffmeisteri		0.7	17.0	1.7	12.1
Limnodrilus profundicola		45.7	0.5		11.8
Nais barbata		9.9			2.5
- elinguis		3.9			1.0
Ophidonais serpentina		1.2			0.3
Potamothrix hammoniensis		0.3			0.1
Specaria josinae			2.4		1.6
Lumbriculus variegatus				5.0	0.3
Nais communis				2.5	0.1
	Station 6				
Dero digitata	64.1	21.9	11.1	10.5	22.3
Tubifex tubifex	1.6	2.4	2.8	7.2	3.8
Ilyodrilus templetoni	3.1	1.5	5.5	6.6	3.8
Aulodrilus limnobius	3.1	13.2	5.5		6.7
Stylaria lacustris	4.7	1.5	2.8		1.6
Specaria josinae	3.1	1.0	1.4		1.0
Limnodrilus hoffmeisteri		42.9	45.8	40.8	37.1
Aulodrilus pluriseta		1.0	4.2	26.3	9.1
Limnodrilus udekemianus		2.9	12.5	4.6	4.5
Nais barbata	12.5	1.0			2.0
- communis	1.6		2.8		0.6
- pardalis	6.2				0.8
Limnodrilus claparedeanus		6.3			2.8
Ophidonais serpentina		2.9			1.2
Psammoryctides moravicus		1.5			0.6
Potamothrix hammoniensis			1.4	3.3	1.2
Nais pseudobtusa			1.4		0.2
- simplex			1.4		0.2
Propappus volki			1.4		0.2
	Stations 7a, 7b				
Lumbriculus variegatus	71.4	5.1	1.5	1.5	9.1
Limnodrilus udekemianus	2.4	7.6	10.8	1.5	6.3
Aulodrilus pluriseta		53.8	84.6	94.0	99.1
Limnodrilus hoffmeisteri		22.1	0.8	3.0	8.6
Specaria josinae	11.9	0.6			1.3
Stylaria lacustris	4.8	1.3			0.9
Propappus volki	2.4	5.1			1.9
Nais barbata	2.4				0.2
Pristina foreli	2.4				0.2
Dero digitata	2.4		1.5		0.6
Limnodrilus claparedeanus		1.3			0.4
Limnodrilus profundicola		0.6			0.2
Pristina amphibiotica		0.6			0.2
- bilobata		0.6			0.2
Marionina riparia		0.6			0.2
Fridericia striata		0.6			0.2

They were carried up by the current from the group of filamentous algae which grow in the river just below the dam.

At station 6 Świerklaniec park pond (Table III) the most important in the community were species preferring slimed bottom (*Limnodrilus hoffmeisteri, Dero digitata, Aulodrilus pluriseta, A. limnobius*). The density was fairly low — on average of 57 specimens in a sample.

At stations 7a, 7b (Table III) the dominant species was *Aulodrilus pluriseta*, numerous in slimed bottom not only of rivers but also of stagnant water bodies. In the littoral zone (stations 7a, 7b), in the first year of investigation, the presence of numerous specimens of *Lumbriculus variegatus* (sand-muddy bottom) was observed and at a depth of 1.5—2 m (station 7b) *Limnodrilus hoffmeisteri* and *L. udekemianus* appeared. 16 species were determined at this station. The density of oligochaetes was low — on the average 21 specimens in a sample.

5. Discussion

Interpretation of the obtained results is somewhat difficult as the waters under discussion are affected by municipal, agricultural, and industrial pollution (blowing and flow of heavy metals). An additional factor differentiating the oligochaete fauna is the varied character of the investigated stations — a river, a pond, a dam reservoir, and an artificial lake. Oligochaete communities are modified by each of these factors and their final character depends on the strongest active factor at the given station.

The determination of only 40 species in the investigated material demonstrates the poor differentiation of this group. Probably, as a result of even small doses of industrial pollution, the more sensitive species have disappeared from the investigated waters. The rare species *Moraviodrilus pygmaeus,* determined at station 2, has been found till now in Poland only on the island of Wolin and in the harbour of Warszów (Legeżyński 1971) and in the Rivers Bystrzyca Dusznicka and Nysa (Kasprzak 1973), in each of which a few specimens have been found.

The method of analysis of the content of the investigated microelements in the water (Reczyńska-Dutka 1985) permits estimation of their total quantity without differentiating them into ionic forms linked in complex compounds or precipitated in suspension. Some of the examined heavy metals precipitate with pH values noted at the stations, for example, Cu occurs in precipitated form and is therefore not toxic for animals (Dean 1974). However, part of the microelements, absorbed by microbes which are among the food source for *Tubificidae,* is assimilated by animals to a high degree (Patrick, Loutit 1976). Similarly, in the case of metal assimilation by algae they become absorbed by *Naididae.*

In comparison with other invertebrates and fish, oligochaetes are resistant to the effect of heavy metals (Chapman et al. 1980), hence an increased content of these metals in the water does not constitute an inhibitive factor for most species. Both laboratory and field researches on *Tubificidae* show that they are more sensitive to the activity of Cu ions than to that of Zn, Pb, and Fe ions. Sensitivity depends also on the ambient pH and the hardness of the water. These dependencies are not, however, entirely explained and the results obtained are sometimes contradictory; for evample, Chapman et al. state that *Tubificidae* accumulate Cu, since the content of this element in the animals' bodies was higher than in the sediment. G r e i c h u s et al. (1978) obtained the opposite result. Further investigation of this problem is thus necessary.

At station 1 (treated as control) a community occurs with *Propappus volki* predominance, which it is typical for lowland rivers with mainly sandy bottom (D u m n i c k a 1978, F o m y e n k o 1972, K a s p r z a k 1976). At station 2 the water current is slow, the degree of bottom sliming increases, BOD_5 values are small, and the ammonia and nitrate content indicates strong eutrophication (B o m b ó w n a 1985), which, with good oxidation of the water, favours both qualitative and quantitative development of oligochaetes.

Heavy metal concentration in the water rises in comparison with station 1, but its effect on oligochaetes is yet not noticeable. The species variety and density of oligochaetes at station 3a—3e abruptly diminishes. All the family *Naididae* species disappear, and the presence of *Aulodrilus pluriseta* is restricted to the upper part of the reservoir (stations 3a, 3b) where specimens are carried by the current and stay at the bottom for some time. The bottom fauna was investigated in this reservoir two years after flooding (1951—1952) (Z i ę b a , unpublished data). In this period the average density of oligochaetes was 24 specimens to the sample. The arrangement of domination was typical for still waters — *Tubifex tubifex* and *Limnodrilus hoffmeisteri* dominated. Near the bank *Naididae* were present (phytophilous *Stylaria lacustris* and pelophilous *Dero digitata*). In the material collected 30 years ago 10 species of oligochaetes were determined, this reflecting how very weak was their development in the reservoir. Progressive sliming of the reservoir bottom seems to be a decisive factor in the decrease in number oligochaetes for they do not find favourable habitat conditions in the thick layer of slime and detritus. In comparison with other dam reservoirs of southern Poland (B a r t n i c k a, unpubl. data) the oligochaete fauna of the Kozłowa Góra reservoir is very poor. The reservoir acts as a sedimentation basin, precipitation of heavy metals taking place here (except Mn whose quantity increases in comparison with station 2) (R e c z y ń s k a - D u t k a 1985). Cumulation of heavy metal compounds in the sediment may also lead to a decrease in fauna abundance. Station 5 is situated below the outflow of a not very large amount of wastes, mainly organic, which considerably enrich the water (the nitrate nitrogen content is from 0.2—19.0 mg dm^{-3}) and whose concentration is not toxic for oligochaetes. With a high availability of nutrients in all habitats, the same type of oligochaete community develops in which the dominant species are considered as pelophilous, being at the same time characteristic for polluted waters. The oligochaete communities of this station show its increasing level of pollution during the investigation. In 1977 *Limnodrilus profundicola*, a species occurring in great quantities in medium-polluted waters (α-mezosaprobic zone according to K o l k w i t z - M a r s s o n 1909), was the first dominant.

In the next years *Tubifex tubifex*, a species typical for the polysaprobic zone, dominated. The Świerklaniec park pond (station 6) is quite strongly organically polluted (BOD_5 to 14.4 O_2 mg dm^{-3}, nitrates to 10 mg dm^{-3}). Despite this fact, numerous *Naididae* were found in it. *Dero digitata*, one of the dominating species in this pond, was found among the waste fungi in a strongly polluted river in Scotland, (Maitland 1966). Species of this genus have gills placed around the anus which facilitates their existence in weakly oxygenized water. Among the microelements particularly numerous are Zn and Fe which are less toxic than Cu, Co, or Mn (Whitley 1967, Brkovic-Popovic, Popovic 1977). Lake Chechło-Nakło (stations 7a, 7b) is not organically polluted (low content of BOD_5, small quantities of nitrates and phosphates) but the water contains a large quantity of heavy metals. The zinc content determined in the water of this station reached the experimentally established value of LD_{50} (for 48 hours) for *Limnodrilus hoffmeisteri* and *Tubifex tubifex*. The content of other microelements is lower, but their activity may cumulate (Maksimov 1977). These may be the decisive factors in the weak development of *Naididae* fauna which play a very small role in the community. Even in the littoral zone among submersed plants (station 7a) they are only sporadically encountered. The distribution of the dominant *Aulodrilus pluriseta* is fairly uniform — in the littoral zone (st. 7a) and further in the lake (st. 7b) similar numbers were established. This species is present in various types of waters — from Tatra lakes (Kowalewski 1914) to lowland rivers and ponds with slimed bottom (Kasprzak 1981). It has not been found in organically polluted waters. The obtained results indicate that *Aulodrilus pluriseta* is highly resistant to chemical pollution but this needs to be confirmed in laboratory conditions.

6. Polish summary

Ekologia niektórych wód w leśno-rolniczej zlewni rzeki Brynicy w pobliżu Górnośląskiego Okręgu Przemysłowego

8. Ugrupowania skąposzczetów

W latach 1976—1979 prowadzono badania na 6 stanowiskach wytypowanych w zlewni Brynicy (ryc. 1): rzeka Brynica — stanowiska 1, 2 i 5, zbiornik zaporowy w Kozłowej Górze — stanowiska 3a—3e, staw parkowy w Świerklańcu — stanowisko 6, sztuczne jezioro Chechło-Nakło — stanowiska 7a—7b (tabela I).

Celem badań było określenie wpływu różnego typu zanieczyszczeń na ugrupowania skąposzczetów.

W opracowanym materiale oznaczono 40 gatunków skąposzczetów należących do 5 rodzin (tabela II). W przeważającej części są to gatunki pospolite, tylko *Pristina amphibiotica* i *Moraviodrilus pygmaeus* są gatunkami rzadkimi.

Skład ugrupowań skąposzczetów zależy od charakteru stanowiska oraz rodzaju i stopnia zanieczyszczenia wody. Na stanowiskach 1 i 2 (tabela III) ugrupowania mają charakter naturalny, zależny od rodzaju dna w danym odcinku rzeki. Na stanowisku 1 przeważa dno piaszczyste z przewagą *Propappus volki*, a na stanowisku 2, gdzie dno jest w przeważającej części zamulone, dominuje *Aulodrilus pluriseta*. Na stanowisku 3a, 3b zamulenie dna też jest czynnikiem decydującym o składzie ugrupowania (dominacja *Limnodrilus hoffmeisteri*) i niskiej liczebności. Na stanowiskach 5 i 6 (tabela III) zanieczyszczenie organiczne wydaje się oddziaływać najsilniej na skąposzczety z tym, że na stanowisku 5 oddziaływanie to jest wyraźniejsze — dominują tu gatunki polisaprobowe (*Tubifex tubifex* i *Limnodrilus udekemianus*), a liczebności są bardzo duże. Tylko na stanowisku 7a, 7b (tabela III) wysoka zawartość mikroelementów ogranicza występowanie bardziej wrażliwych gatunków (zwłaszcza z rodziny *Naididae*). Wydaje się, że dominujący tu *Aulodrilus pluriseta* należy do grupy gatunków odpornych na działanie zanieczyszczeń przemysłowych, a wrażliwych na ścieki bytowe.

7. References

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