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LEECH COMMUNITIES IN THE UPPER REACHES OF THE STEPNICA RIVER (NW POLAND)

Małgorzata Raczyńska[1], Juliusz C. Chojnacki[1], Monika Hałupka[1]

[1] Department of Marine Ecology and Environmental Protection, Faculty of Food Sciences and Fisheries, West Pomeranian Technological University in Szczecin, Kazimierza Królewicza 4, 71-550 Szczecin, Poland, e-mail: malgorzata.raczynska@zut.edu.pl; juliusz.chojnacki@zut.edu.pl

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ABSTRACT
The paper describes taxonomic composition of leeches (Hirudinea) in the strongly anthropogenically altered upper reaches of the Stepnica River in Western Pomerania. The numbers of respective species of the Hirudinea were analyzed in the context of such environmental factors as: instantaneous flow, dissolved oxygen content, and calcium content. It was noted that most leech species inhabited the headstream, and factors deterrent to their occurrence included the presence of hydrogen sulfate and siltation.

Keywords: taxonomic composition of leeches, instantaneous flow, hydro-chemical indicators.

INTRODUCTION

According to hydrobiologists, the occurrence of leeches may be a good indicator of biodiversity and cleanliness of aquatic environment. However, they are endangered by rapidly progressing industrialization and excessive exploitation of natural resources. Continuous deterioration of the quality of inland waters results in degradation of leech habitats. It also affects other invertebrates which constitute nutritional basis for leeches, as well as molluscs and fish, which are hosts for parasitic species [Bielecki et al. 2011a]. Common leech species, being highly tolerant organisms, typically occur in large numbers in littoral zone of lakes, ponds and rivers. Furthermore, those predators and parasites, very important from the ecological point of view, are also abundant in urban freshwater habitats, even those which are considerably degraded and strongly altered by man. Some species within the group are highly specialized ecologically [Koperski, 2010].

Leeches are among invertebrates which have been the focus of scientific attention for a very long time [Stańczykowska, 1986]. The first studies on the Hirudinea, varying in intensity, were initiated in various regions of Poland at the break of 19th and 20th centuries [Bielecki et al. 2011a, b]. Presently, our knowledge about this group of invertebrates is still insufficient. Every new study expands the available knowledge and may prove useful in estimating various types of anthropogenic threats to particularly rare and highly specialized leech species.

The present study focuses on the quantitative and qualitative structure of leech communities in the Stepnica River, a strongly anthropologically altered river in Western Pomerania, in the context of environmental conditions. The study supplements the already available data on taxonomic composition of leeches occurring in water courses of Western Pomerania.

MATERIAL AND METHODS

The Stepnica River is the main water course of the Maszewo district and a right-bank tributary of the Gowienica River. It is 34.2 km long. Its headwaters are located in the town of Wisławie and it joins the Gowienica in the town of Bodzęcin. Human activities are the main source of pollution

of this water course, which is especially striking in its upper reaches, where breeding ponds and poultry processing factories significantly contribute to the deterioration of the river water, as reported by Raczyńska et al. [2013].

Results presented in this study are based on benthic fauna samples collected with a grabber from four research sites (Table 1) during the period from 21 December 2004 until 12 December 2006, at monthly intervals. Simultaneously, hydrological studies of the water course were conducted: width, depth and instantaneous flow were measured, the latter by the flow method (Table 2).

Biological material was transported to a laboratory, sifted through sieves with 0.45 mm mesh size and transferred to laboratory trays. Leech specimens were singled out and preserved according to the procedure recommended by Pawłowski [1936]. The remaining benthic fauna material was transferred to containers and preserved in 75% alcohol. Qualitative identification of the Hirudinea down to the level of species was conducted according to Pawłowski's keys [1936, 1968].

In order to discern the relationships between environment quality and leech communities in the Stepnica River, the study used the results of detailed analyses providing average monthly values of selected hydro-chemical indicators, i.e. dissolved oxygen content and calcium content, from the recent study by Raczyńska et al. [2013].

RESULTS

In the years 2004–2006, 60 specimens of the Hirudinea were found in the analyzed material from the Stepnica River. They belonged to 3 families:

- family Erpobdellidae, represented by 2 species: *Erpobdella nigricollis* (Brandes) and *Erpobdella octoculata* (Linnaeus),
- family Glossiphoniidae, represented by 2 species: *Glossiphonia complanta* (Linnaeus) and *Helobdella stagnalis* (Linnaeus)
- family Haemopidae, represented by 1 species: *Haemopis sanguisuga* (Linnaeus).

The most abundant were the species from the family Erpobdellidae (37 specimens), followed by the species from the family Glossiphonidae (21 specimens). Only 2 specimens representing the family Haemopidae were found during the whole research period. The highest number of species representing the family Hirudinea were found in research sites 1 and 2: 4 and 5 species respectively. In each of the remaining sites only one species belonging to the family Haemopidae was found.

Table 1. The characteristics of research sites on the Stepnica River (after Hałupka [2013])

Site	Coordinates	Cover the bottom [%]	Overshadowing of the riverbed [%]
1 - Wisławie	53°31'8.2"N 15°03'58.01"E	60% organic substrate 40% silt	100
2 - Maszewo	53°30'0.46"N 15°03'52.11"E	5% organic substrate 70% sand 25% silt	0
3 - Radzanek	53°30'9.23"N 15°01'21.17"E	70% organic substrate 30% silt	0
4 - Maciejewo	53°33'27.86"N 15°0'14.24"E	50 organic substrate 10% sand 40% silt	less than 25

Table 2. Results of hydrological measurements conducted on the Stepnica River in the years 2004–2006

Site	Width [m]			Average depth during the study [m]			Other information
	min	max	$\bar{x}$	min	max	$\bar{x}$	
1 - Wisławie	0.30	1.20	0.71	0.05	0.65	0.25	• absence of water (28.09.2005, 09.08.2006, 03.10.2006)
2 - Maszewo	0.10	2.00	1.00	0.05	0.60	0.25	• riverbed virtually 100% overgrown with reeds and sweet flag (11.07.2006, 09.08.2006, 03.10.2006)
3 - Radzanek	0.30	4.00	1.85	0.20	1.50	0.65	• frozen water, mid-current with ca. 5 cm ice cover (20.12.2005) • silted water with H_2S, riverbed virtually 100% overgrown with reeds and sweet flag (11.07.2006, 09.08.2006, 03.10.2006) • water outside the riverbed (07.11.2006)
4 - Maciejewo	0.40	4.00	1.53	0.03	1.50	0.57	• silted water with H_2S (20.12.2005, 31.05.2006, 11.07.2006, 09.08.2006, 06.09.2006, 03.10.2006) • white "mould" layer on the bottom (03.10.2006)

Erpobdella octoculata was a dominant species. In the research sites 1 and 2 it constituted 54.5% and 63.6% of the total leech abundance, respectively. The remaining species found in those research sites were adominants. *Glossiphonia complanata* was an absolute dominant in the research site 3, and *Helobdella stagnalis* was an absolute dominant in the research site 4, due to the fact that in the course of the research only one specimen of each of those species was found (Table 3).

As for seasonal leech abundance, the highest abundance was noted in spring and in summer (March – August) 2005 and 2006, whereas in winter the leeches occurred only incidentally (Tables 4–6). The analysis of leech abundance distribution in respective research sites did not reveal any repetitive pattern of occurrence in any particular months or years (Tables 4–6). The only exception was *Erpobdella octocullata*, which occurred in March and June in both 2005 and 2006 in the research site 2, whereas in the research site 1 it occurred in April in both 2005 and 2006 (Table 4).

DISCUSSION

The studied stretch of the Stepnica River was characterized by such specific hydrological conditions as shallowness and low flow velocity (Table 2, Table 6), which affected the quality of the river water and thus determined the formation of specific community structures of macrobenthic fauna, including the Hirudinea. Additional factors observed in the course of the study which might influence the studied leech communities included: periodical absence of water in the research site 1; vegetation overgrowing the riverbed and reducing water flow as well as causing organic matter accumulation in sites 2 and 3; siltation and the presence of hydrogen sulfate in sites 3 and 4 (Table 2).

Leech species occurring in the Stepnica River were species characteristic for lotic waters and highly immune to pollution. One of them was *Erpobdella octoculata*, which not only tolerated strongly eutrophicated waters but could also temporarily survive in anaerobic conditions [Bielecki et al. 2011b]. The research conducted on the Stepnica River did not reveal a strong relationship between the oxygen content and abundance of *E. octoculata*. The species occurred regardless of whether the oxygen content amounted to 16.6 or 3.4 $mgO_2 \cdot dm^{-3}$. Furthermore, 3 specimens were found in the first case, and 5 in the second, which might indicate that the species was highly tolerant of water oxygenation (Table 4). The occurrence of *E. octoculata* solely in sites 1 and 2 (Table 4), where the amount of total suspension and organic matter indicated low (lower than good) water quality according to Raczyńska et al. [2013], might be due to strong immunity of the species to pollution. But why did the species not occur in the other sites, where values of the above physico-chemical indicators were similar [Raczyńska et al. 2013]? Perhaps the siltation present practically throughout the study in sites 3 and 4, and temporary occurrence of hydrogen sulfate in the two sites (Table 2), were the reasons.

Apart from *E. octoculata*, another leech species characterized by a high tolerance of environmental pollution was *Helobdella stagnalis*, uncommon in slightly eutrophicated waters [Bielecki et al. 2011b], and often found in polluted lowland waters [Pawłowski, 1936]. However, the species had been recorded previously in clean post-glacial lakes in Myślibórz Lakeland [Agapow 1982, Agapow & Nadobnik 2006]. In the Stepnica River the species occurred in research stations 1 and 2, and one time in September 2006 it was also recorded in site 4 (Table 5). As has been mentioned earlier, sites 1 and 2, where it was typical for *H. stagnalis* to occur, were characterized by polluted

Table 3. The number of specimens of the respective leech species in the respective research sites on the Stepnica River in the years 2004–2006

Family	Species	Site 1 Wisławie	Site 2 Maszewo	Site 3 Radzanek	Site 4 Maciejewo	Total in the river
Glossiphonidae	*Glossiphonia complanta*	1	6	4	0	11
	Helobdella stagnalis	2	7	0	1	10
Erpobdellidae	*Erpobdella nigricollis*	2	1	0	0	3
	Erpobdella octoculata	6	28	0	0	34
Haemopidae	*Haemopis sanguisuga*	0	2	0	0	2
Number of individuals at the sampling site		11	44	4	1	60
Number of species at the sampling site		4	5	1	1	5

Table 4. The annual abundance of *Erpobdella octoculata* (ind.) and dissolved oxygen content [$mgO_2 \cdot dm^{-3}$] in the respective research sites on the Stepnica River (grey colour indicates oxygen content values coinciding with the occurrence of *E. octoculata*)

Date	*Erpobdella octoculata* [os.]				Dissolved oxygen [mg $O_2 \cdot dm^{-3}$]			
	Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4
21.12.04					7.5	12.2	7.5	12.3
22.03.05		1			16.5	11.5	10.2	10.2
11.04.05	3	3			7.2	16.6	4.6	16.5
27.05.05					3.2	7.2	2.4	7.2
21.06.05	2	4			2.1	8.5	1.3	9.0
20.07.05					1.4	9.1	0.6	2.2
10.08.05					1.0	8.8	0.2	0.0
28.09.05					absence of water	9,0	1,8	2,4
11.11.05					2.7	7.0	5.1	9.8
20.12.05					7.5	11.7	9.9	12.2
22.02.06					7.0	13.0	7.5	6.6
29.03.06		2			5.6	8.3	6.9	6.7
25.04.06	1				4.2	7.4	3.4	10.4
31.05.06		6			3.8	5.4	1.4	2.9
14.06.06		4			6.9	4.5	2.6	2.7
11.07.06		5			2.9	3.4	2.7	2.1
09.08.06					absence of water	5.3	0.8	H_2S
06.09.06		1			0.6	5.1	1.4	0.0
03.10.06					absence of water	5.4	1.6	0.0
07.11.06					3.0	5.4	4.5	7.4
12.12.06		2			6.9	5.6	8.0	5.8

Table 5. The annual abundance of *Glossiphonia complanata* and *Helobdella stagnalis* (ind.) and calcium content [$mgCa \cdot dm^{-3}$] in the respective research sites on the Stepnica River (grey colour indicates calcium content values coinciding with the occurrence of *G. complanata*)

Date	*Glossiphonia complanata* [ind.]				*Helobdella stagnalis* [ind.]				Calcium [mg $Ca \cdot dm^{-3}$]			
	Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4
21.12.04									38	38	36	26
22.03.05									62	77	59	76
11.04.05		2			1				95	100	91	81
27.05.05									101	104	81	55
21.06.05	1	2							105	94	83	66
20.07.05									107	86	71	67
10.08.05						5			107	94	79	81
28.09.05									absence of water	102	93	87
11.11.05						1			122	111	89	71
20.12.05			1			1			124	123	101	78
22.02.06									94	96	88	81
29.03.06		1							99	106	93	91
25.04.06									108	112	92	75
31.05.06					1				108	92	96	81
14.06.06									117	106	85	56
11.07.06									81	100	87	65
09.08.06									absence of water	55	40	41
06.09.06								1	100	56	43	35
03.10.06		1							absence of water	60	44	48
07.11.06									66	63	42	46
12.12.06			3						63	61	46	38

waters, whereas the absence of the species from site 4 – analogically to the absence of *E. octoculata* – might be due to siltation and the presence of hydrogen sulfate (Table 2).

A species competing with *Helobdella stagnalis* (L.) for food and habitat was *Glossiphonia complanata* [Wrona et al. 1981], which preferred waters with a high calcium content (http://www.naturespot.org.uk/species/glossiphonia-complanata). That leech species occurred only in sites 1 and 2, where higher calcium content values were noted in respective months in comparison to sites 3 and 4, and where the average calcium content amounted to 100 $mgCa \cdot dm^{-3}$ (except October and December 2006, when it was equal to 60 and 61 $mgCa \cdot dm^{-3}$ respectively) (Table 5). The occurrence of *G. complanata* solely in sites 1 and 2 confirmed the data presented by Pawłowski [1936], according to whom a typical habitat of that species was a small water course overgrown with vegetation, characterized by an organic substrate with high calcium content. A competition for resources between *G. complanata* and *Helobdella stagnalis* on the Stepnica River was revealed by the analysis of their distribution, since throughout the study the two species never co-occurred, even though *H. stagnalis* also preferred sites located in the upper reaches of the studied river (Table 5). As in the cases discussed above, the occurrence of the two species in sites 3 and 4 was reduced by the high content of silt and hydrogen sulfate (Table 2).

The fourth leech species encountered during the studies on the Stepnica River, namely *Erpobdella nigricollis*, had been frequently recorded in river stretches with slow-flowing or even stagnant waters [Bielecki et al. 2011b] and associated with habitats strongly overgrown with vegetation [Agapow 1986, Kołodziejczyk & Koperski 2000]. Furthermore, similarly to the species discussed previously, it was characterized by a high tolerance of polluted waters [Agapow et al. 2008]. The preference of this species for habitats with stagnant water was confirmed during the studies on the Stepnica River: *Erpobdella nigricollis* occurred only in sites 1 and 2, three times during the absence of the flow (Table 6).

Table 6. The annual abundance of *Erpobdella nigricollis* [ind.] instantaneous flow [m/s] in the respective research sites on the Stepnica River (grey colour indicates instantaneous flow values coinciding with the occurrence of *E. nigricollis*)

Date	*Erpobdella nigricollis* [ind.]				Instantaneous flow [m/s]			
	Site 1	Site 2	Site 3	Site 4	Site 1	Site 2	Site 3	Site 4
21.12.04					0.00	0.20	0.25	0.20
22.03.05					0.10	0.38	0.53	0.19
11.04.05					0.06	0.23	0.03	0.24
27.05.05					0.00	0.29	0.33	0.45
21.06.05					0.00	0.12	0.24	0.30
20.07.05					0.00	0.00	0.00	0.21
10.08.05					0.00	0.05	0.00	0.24
28.09.05					absence of water	0.00	0.04	0.20
11.11.05	1				0.00	0.00	0.20	0.31
20.12.05					0.00	0.14	0.13	0.28
22.02.06					0.08	0.37	0.16	0.38
29.03.06					0.19	0.34	0.21	0.21
25.04.06	1				0.00	0.14	0.16	0.16
31.05.06					0.00	0.17	0.00	0.20
14.06.06					0.00	0.00	0.09	0.16
11.07.06					0.00	0.18	0.00	0.14
09.08.06		1			absence of water	0.00	0.00	0.07
06.09.06					0.00	0.00	0.00	0.16
03.10.06					absence of water	0.00	0.00	0.00
07.11.06					0.00	0.00	0.27	0.19
12.12.06					0.06	0.19	0.13	0.15
min					0.00	0.00	0.00	0.00
max					0.19	0.38	0.53	0.45
$\bar{x}$					0.03	0.14	0.14	0.21

The last of the encountered species, *Haemopis sanguisuga*, was found only in site 2, and throughout the study was represented by only two specimens (Table 3), which was somewhat surprising, as the species was believed to prefer water courses with a high silt content and thus its presence was expected either in site 3 or 4. A location of this species in Western Pomerania had been found by Bielecki et al. [2008] in Słowiński National Park, in the Pustynka River characterized by strong siltation.

CONCLUSIONS

The fauna of the Hirudinea encountered in the studied stretch of the Stepnica River in the years 2004–2006 was neither diversified nor very abundant. Only 5 species representing three families were recorded. The most abundant and the most common species included *Erpobdella octoculata* and *Helobdella stagnalis*, followed by the less abundant *G. complanata,* whereas the remaining species, *E. nigricollis* and *Haemopis sanguisuga* occurred only sporadically. All those species were characterized by a high immunity to pollution; however, their distribution in the respective sites indicated that they were not tolerant of siltation and the presence of hydrogen sulfate.

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