Oceanological and Hydrobiological Studies

International Journal of Oceanography and Hydrobiology

Volume 47, Issue 3, September 2018
pages (303-312)

ISSN 1730-413X
eISSN 1897-3191

Changes in the benthic fauna composition in the Upper Vistula over the last 50 years – the consequences of the water pollution reduction and alien species invasion

by

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DOI: **10.1515/ohs-2018-0029**
Category: **Original research paper**
Received: **December 6, 2017**
Accepted: **March 2, 2018**

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Abstract

The organic pollution of the Upper Vistula waters has been significantly reduced since the mid-20th century. Also salinity has gradually decreased, following an increase observed until the 1990s. Furthermore, the number of alien species has systematically increased. The above-mentioned changes have affected the richness and composition of the benthic fauna. They are particularly remarkable in the river stretch between the town of Oświęcim and the city of Kraków. The improvement of water quality has resulted in the increased number of taxa, mainly those characteristic of moderately polluted water, and the disappearance of taxa typical of strongly polluted or deoxygenated water. Despite the increased salinity level persisting for many years, only three benthic species of brackish waters (*Gammarus tigrinus*, *Paranais frici* and *P. litoralis*) were found in the Upper Vistula. Taxa considered to be euryhaline or halophilous were more numerous. In the 1960s, only one alien species (*Physa acuta*) was found, but the increased number of non-indigenous species in the last decades is visible, particularly among gammarid crustaceans (Amphipoda, Gammaroidea). The presence of alien species has not caused any visible changes in the species abundance of oligochaetes and mollusks.

Key words: Vistula River, water pollution, salinity, benthos, *Chaetogaster setosus*

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Introduction

The composition of the benthic fauna in the biggest Polish rivers, such as the Vistula and the Oder, clearly changes due to the invasion of alien species from various groups e.g. crustaceans (Konopacka 1998; Jażdżewski et al. 2004; Konopacka 2004; Bącela et al. 2008; Grabowski et al. 2007; 2009), oligochaetous clitellates (formerly Oligochaeta) (Dumnicka 2016; Jabłońska et al. 2015) or mollusks (Piechocki, Szlauer-Łukaszewska 2016), as well as due to the water quality improvement (Absalon, Matysik 2007; Pająk 2016; Schöll 2003). These biological changes have not been documented in the Upper Vistula – the stretch of the Vistula between the mouth of the Przemsza River (95 km of the water course) and the San River mouth (368 km). For many years, this river section has been heavily polluted, mainly by sewage from the Upper Silesian Industrial Region and saline waters from coal mines. Water chemistry of the Upper Vistula has been studied many times (see Kasza, Galas 2002), especially within the shorter stretch between the Przemsza River (95 km) and Kraków (165 km), over a distance of ca. 70 km, and has regularly been monitored by the Regional Inspectorate for Environmental Protection. Research on the composition of benthic invertebrates was performed only twice, between 96 km and 158 km by Zięba & Zaćwilichowska (1966) and between 128 km and 153 km of the river course by Dumnicka & Kownacki (1988). In addition, the composition of oligochaete fauna throughout the Upper Vistula was discussed by Dumnicka (2002). According to Kownacki (1999), the smaller number of species recorded from the Upper Vistula was caused by a high level of pollution, but also by insufficient knowledge about its benthic fauna. Based on the published data and available manuscripts, the author compiled a checklist of taxa found in particular sections of the Vistula, from the sources to the estuary.

The objective of this work was to summarize changes in the composition of benthic invertebrates in the Upper Vistula during the last 50 years. An attempt was also made to determine the rate and directions of these changes.

Materials and methods

Research on water chemistry and benthic fauna composition was carried out twice (14 July and 16 December 2014) at 187 km of the Upper Vistula between the town of Oświęcim (96 km) and the town of Szczucin (283 km) (Fig. 1). On the same days, samples were collected from the Gostynka River (heavily polluted by saline mine waters), 100 m upstream from the place where it flows into the Vistula, at 93 km of its course. Moreover, on 2 August 2017, mollusks were collected in the mouth of the Skawinka River (150 km of the Vistula). Water temperature and conductivity were measured in situ using a portable instrument Hi 98312 (Hanna Instr. Inc. Woonsocket-RI-USA). The content of inorganic ions (Cl^-, SO_4^{2-}, HCO_3^-, NO_3^-, PO_4^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}) was analyzed using the ion chromatography (DIONEX ICS 1000 and IC DX 320). The remaining parameters of water were determined by classic methods according to APHA (1992).

Qualitative samples of benthic fauna were collected from all habitats using a bottom scraper (20 cm × 20 cm) with 0.3 mm mesh net. In the laboratory, specimens were isolated from the sediments and identified under a stereoscopic microscope to the family level. Selected groups were identified to the species level using the following identification keys depending on the group: Amphipoda (Konopacka 2004), oligochaetous clitellates (Timm 2009), Mollusca (Piechocki, Wawrzyniak-Wydrowska 2016).

Results

Changes in water quality

In the river section between Oświęcim and Kraków (Fig. 1), the highest values of organic pollution, expressed as BOD_5, were recorded in the 1960s when water oxygenation was at the lowest level (Bombówna, Wróbel 1966) (Table 1). Subsequent studies showed a slow improvement in the water oxygenation as well as a smaller amount of organic matter (Kasza 1988; Kasza, Galas 2002) and this trend continues to this day (Table 1).

Contrary to organic pollution, water salinity in this section of the Upper Vistula (between 96 km and 165 km) was increasing until the 1990s (Kasza 1988; Gajowiec, Różkowski 1988; Krokowski et al. 1994) (Table 1), and the sodium-chloride type of waters has been confirmed since the mid-20th century (Bombówna, Wróbel 1966). The concentrations of chloride ions at particular sites varied strongly depending on the discharge values (Krokowski et al. 1994). During our study, a very high conductivity value and concentrations of chloride, sodium and sulfate ions were determined in the Gostynka River (Table 2). In the Vistula, all the above-mentioned parameters showed lower concentrations compared to the previous studies (Kasza, Galas 2002) but values of the majority of measured parameters exceeded the limit values for class II of water quality (Dziennik Ustaw 2016).

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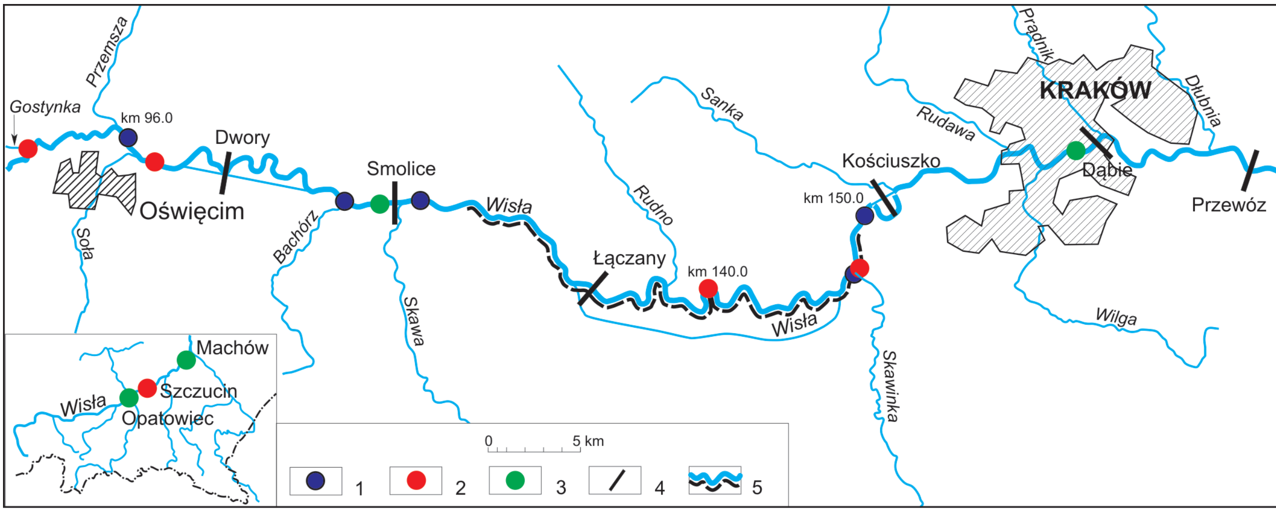

Figure 1

Map of the Upper Vistula showing localities and the river section studied in various years: 1 – localities studied by Zięba & Zaćwilichowska (1966); 2 – our sampling sites; 3 – localities studied by Dumnicka (2002); 4 – weirs; 5 – river section studied by Dumnicka & Kownacki (1988)

Table 1

Comparison of selected chemical water parameters in the Upper Vistula over 50 years (based on literature data, min.–max values)

Parameter		Study period			
		1962–1963[a]	1982–1983[b]	1988–1994[c]	1996–1997[d]
km from the sources		96–158	128–153	160	116–248
Conductivity	μS cm^{-1}	200–1300	no data	2000–5600	400–4300
Cl^-	mg dm^{-3}	33–747	250–1400	65–2200	500–1300
O_2	mg dm^{-3}	0.4–10.0	1.6–13.1	no data	4–12
BOD_5	mg O_2 dm^{-3}	3–60	4.0–28	no data	4–10

[a] – after Bombówna, Wróbel 1966; [b] – after Kasza 1988 ; [c] – after Krokowski et al. 1994; mean monthly values of conductivity from January to September 1994; [d] – after Kasza, Galas 2002

Table 2

Chemical characteristics of water at the studied localities in 2014

Parameter		Locality						
		Gostynka R.	Oświęcim		Czernichów		Szczucin	
		14 July	14 July	16 Dec.	14 July	16 Dec.	14 July	16 Dec.
km from the sources		91	96		140		283	
Conductivity	μS cm^{-1}	21 200	1500	2540	1600	no data	650	1500
Na^+	mg dm^{-3}	3223.2	99.0	379.7	161.4	389.9	56.8	145.8
Cl^-	mg dm^{-3}	5741.8	162.1	705.8	284.1	719.9	94.7	263.1
Ca^{2+}	mg dm^{-3}	99.59	50.62	97.99	61.88	118.31	54.64	57.69
Mg^{2+}	mg dm^{-3}	307.5	11.77	36.47	19.46	49.03	13.35	18.47
K^+	mg dm^{-3}	89.66	9.08	11.72	7.69	14.61	5.46	6.66
HCO_3^-	mg dm^{-3}	416.25	196.14	255.6	190.85	350.16	154.86	202.34
SO_4^{2-}	mg dm^{-3}	342.6	35.14	97.12	52.85	160.67	44.73	57.87
NO_3^-	mg dm^{-3}	3.58	0.4	6.79	3.52	7.88	3.29	3.79
NH_4^+	mg dm^{-3}	1.33	0.03	0.36	0.18	0.38	0.02	0.04
PO_4^-	mg dm^{-3}	0.80	0.20	0.21	0.53	0.03	0.14	0.19
Dry residue	mg dm^{-3}	947.7	944.9	no data	894.3	no data	747.2	no data
COD	mg O_2 dm^{-3}	115.70	56.20	no data	24.79	no data	36.36	no data

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The effect of organic pollution on the benthic fauna

The first study on the benthic fauna was carried out at the time of very high water pollution and showed the presence of only Oligochaeta (family Tubificidae sensu Timm 2009) and Chironomidae between 96 km and 128 km of the Vistula course (Zięba, Zaćwilichowska 1966). Several kilometers upstream from the city of Kraków (158 km), four other taxa were recorded (Naididae, Erpobdellidae, Physidae, Ancylidae) (Table 3). In the 1980s, the number of invertebrate taxa found between 128 km to 153 km of the Vistula course increased to 15 (Table 3), but taxa characteristic of strongly polluted (Psychodidae) or temporarily deoxygenated waters (Chaoboridae) still occurred. Although the number of taxa found during our study conducted at these two localities was similar, for the first time Chironomidae were the most abundant group, while previously oligochaetes dominated. In the 1990s, the number of oligochaete species reached 20 (Table 4) in the studied river section, i.e. a similar number to that recorded by Dumnicka (2002). In the course of our current research, the number of species found at particular localities was smaller, but six species previously not recorded in the Vistula were added to the list (Table 4).

Relationship between salinity and benthic fauna composition

Despite high chloride concentrations persisting for many years (Table 1), only a few taxa characteristic of brackish or even marine waters were found in the Upper Vistula (Tables 4 and 5). Among them, the crustacean *Gammarus tigrinus* and the oligochaete *Paranais litoralis* accounted for about 99% of the benthic fauna in the strongly saline Gostynka River in 2014. These two species were present at the same time in the Vistula, where concentrations of chloride were much lower (Table 2). In the previous studies of oligochaete fauna (Dumnicka, Kownacki 1988; Dumnicka 2002), another halophilous species from the genus *Paranais* (*P. frici*) was reported. Furthermore, species not typical of brackish water, but having a wide range of salinity tolerance such as oligochaetes:

Table 3

Changes in the benthic fauna composition in the Upper Vistula over 50 years (based on literature data and our study)

	Study period				
	1962–1963[a]	1962–1963[a]	1982–1983[b]	2014	2014
Localities	Oświęcim–Spytkowice	Tyniec	Okleśna–Jeziorzany	Oświęcim	Czernichów
km from the sources taxa	96–128	158	128–153	96	140
Tubificidae	+++	+++	+++	+	+
Chironomidae	+	+	+	+++	+++
Naididae		+	+	+	+
Physidae		+	+		
Erpobdellidae		+	+	+	
Glossiphonidae			+		+
Simuliidae			+		+
Lymnaeidae			+	+	+
Gammaridae			+	+	+
Enchytraeidae			+	+	+
Ancylidae		+	+		
Psychodidae			+		
Chaoboridae			+		
Lumbricidae			+		
Coleoptera			+		
Hydropsychidae				+	+
Baetidae				+	+
Bithyniidae				+	+
Acroloxidae				+	
Pontogammaridae					+
Caenidae					+
Ceratopogonidae					+
Number of taxa	2	6	15	11	14

+ – taxon present; +++ – the most numerous taxon; a – after Zięba, Zaćwilichowska 1966; b – after Dumnicka, Kownacki 1988

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Table 4

Changes in oligochaete species composition in the Upper Vistula over 50 years

		Study period									
		1962–1963[a]		1982–1983[b]	1997–1998[c]			2014			
km from the sources		96–128	158	128–153	115–165	248	337	91*	96	140	283
Limnodrilus hoffmeisteri Claparède		+	+	+	+	+	+		+	+	+
Limnodrilus udekemianus Claparède		+		+	+	+	+			+	+
Tubifex sp. Lamarck		+	+								
Naididae gen. spp.			+								
Quistadrilus multisetosus (Smith)	A			+							
Spirosperma ferox Eisen				+							
Aulophorus furcatus (Oken)				+							
Dero digitata (O.F. Müller)				+							
Tubifex tubifex (O.F. Müller)				+	+	+	+		+	+	+
Nais elinguis (O.F. Müller)				+	+	+	+		+	+	+
Limnodrilus claparedeanus Ratzel				+	+	+	+		+		+
Chaetogaster diastrophus (Gruithuisen)				+		+	+			+	
Marionina riparia Bretscher				+			+		+	+	+
Stylaria lacustris (L.)				+	+	+	+				+
Enchytraeus buchholzi Vejdovský				+	+	+				+	
Chaetogaster diaphanus (Gruithuisen)				+	+	+				+	
Lumbricillus rivalis Levinsen				+	+	+					
Nais barbata (O.F. Müller)				+	+	+	+				
Limnodrilus profundicola (Verrill)				+	+		+				
Paranais frici Hrabě	AB			+	+	+	+				
Psammoryctides albicola (Michaelsen)	A			+			+		+		+
Eiseniella tetraedra (Savigny)				+		+	+				
Propappus volki Michaelsen					+						
Nais communis Piguet					+	+	+				
Ophidonais serpentina (O.F. Müller)					+	+	+				
Uncinais uncinata (Oersted)					+	+	+				+
Dero spp. Oken					+		+		+	+	
Vejdovskyella intermedia (Bretscher)					+		+			+	
Nais pardalis Piguet					+	+				+	
Potamothrix moldaviensis Vejd. et Mrázek	A				+				+		
Potamothrix hammoniensis (Michaelsen)	A				+					+	
Nais christinae Kasprzak						+					
Psammoryctides barbatus (Grube)	A					+	+				
Aulodrilus pluriseta (Piguet)							+				
Vejdovskyella comata (Vejdovský)							+				
Amphichaeta leydigi Tauber							+			+	
Paranais litoralis (O.F. Müller)	AB							+	+		+
Limnodrilus sp. juv. Claparède								+			
Aulodrilus limnobius Bretscher										+	
Slavina appendiculata (Udekem)										+	
Gianius aquaedulcis (Hrabě)										+	
Chaetogaster setosus Svetlov										+	
Tubifex blanchardi Vejdovský	AB										+
Number of taxa		3	3	20	22	19	22	2	9	17	11

a – after Zięba, Zaćwilichowska 1966; b – after Dumnicka, Kownacki 1988 ; c – after Dumnicka 2002 ; A – alien species; B – species typical of brackish waters; * – mouth of the Gostynka River

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Table 5

Distribution of Amphipoda species in the Upper Vistula in different years

	Study period					
	1962–1963[a]	1982–1983[b]	2014	2014	2014	2014
Locality	Bachórz st.	Czernichów	Gostynka R.	Oświęcim	Czernichów	Szczucin
km from the sources	115	140	91	96	140	283
Gammarus fossarum Koch in Panzer	+	+				
Gammarus tigrinus Sexton			+++	++	++	++
Dikerogammarus haemobaphes (Eichwald)					++	
Chelicorophium curvispinum (G.O. Sars)						+

a – after Zięba, Zaćwilichowska 1966 – species incorrectly identified as *Gammarus pulex*, found in the mouth of the Bachórz stream flowing into the Vistula downstream of Oświęcim; b – after Dumnicka, Kownacki 1988; + – single specimens, ++ – numerous specimens, +++ – very numerous specimens

Tubifex tubifex, *T. blanchardi*, *Limnodrilus hoffmeisteri*, *Potamothrix hammoniensis*, and crustaceans: *Dikerogammarus haemobaphes* and *Chelicorophium curvispinum* were found in the Upper Vistula (Tables 4, 5).

Alien species in the benthic fauna

A total of eight alien species were identified among the oligochaetous clitellates (Table 4), but the number of recorded species at specific sampling localities was significantly smaller – from one to a maximum of three species (Dumnicka, Kownacki 1988; Dumnicka 2002, present study). The most common was *Psammoryctides albicola*, found during all sampling campaigns, and the remaining species were encountered less frequently. In the Upper Vistula, alien oligochaete species have always accounted for only a small part of the oligochaete fauna.

In the 1960s–1980s, only native *Gammarus fossarum* was recorded in the Upper Vistula (Table 5). At the turn of the 20th century, two non-indigenous gammarid species – *Gammarus tigrinus* and *Dikerogammarus haemobaphes* – invaded almost all of the Upper Vistula, whereas the amphipod species *Chelicorophium curvispinum* was recorded only in the town of Szczucin (283 km). The former reached a very high density in the highly saline Gostynka River and was fairly abundant at all the studied localities.

Among Gastropoda, *Physa acuta* dominated in the Upper Vistula in the 1960s (Zięba, Zaćwilichowska 1966) and its abundance was high at some of the sampling localities (Table 6). The presence of the species was confirmed in the 1980s together with a few native snail species (Dumnicka, Kownacki 1988), but it was not found in the course of the studies carried out in 2014 and 2017. Recently, another alien mollusk species – *Corbicula fluminea* – has been recorded in the mouth of the Skawinka River (150 km of the Vistula course). The density of its population reached about 200 ind. m^{-2}. *C. fluminea* occurred together with *Bithynia tentaculata*, *Pseudanodonta complanata* and *Sphaerium* sp.

Species new or rare in Poland

Chaetogaster setosus, a Holarctic oligochaete species (Timm 2009), was found for the first time in Poland. It was found in the Vistula, at the village of Czernichów (140 km), in samples collected on 8 December 2014 from a stone-gravel bottom. Stones were partially overgrown with short filamentous algae. Chemical characteristics of the water are shown in Table 2. Characteristics of the collected specimens: a small species, the length of the first zooid reaches a maximum of 0.6 mm, usually about 0.5 mm. The first zooid consists of 9 or 10 segments (rarely 11), chains contain from 3 to 5 zooids (Fig. 2) and all

Table 6

Distribution of alien mollusk species in the Upper Vistula in different years

	Study period				
	1962–1963[a]	1962–1963[a]	1982–1983[b]	2011[c]	2017
Locality	Skawinka mouth	Tyniec	Czernichów	Kraków	Skawinka mouth
km from the sources	150	158	140	96	150
Physa acuta Draparnaud	+++	++	+		
Potamopyrgus antipodarum (J.E. Gray)				++	
Corbicula fluminea (O.F. Müller)				++	++

a – after Zięba, Zaćwilichowska 1966; b – after Dumnicka, Kownacki 1988; c – after Maćkiewicz 2013; + – single specimens, ++ – numerous specimens, +++ – very numerous specimens

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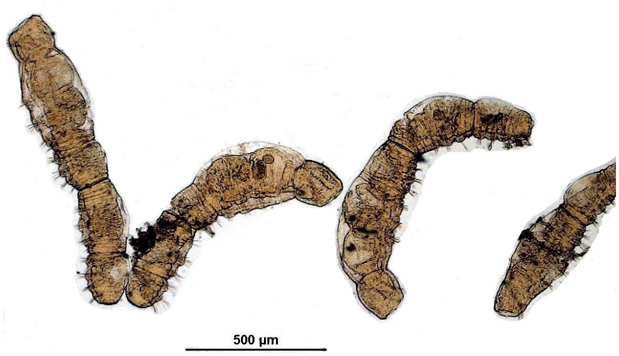

Figure 2

Chaetogaster setosus – general view of chains of zooids
Photo by A. Pociecha

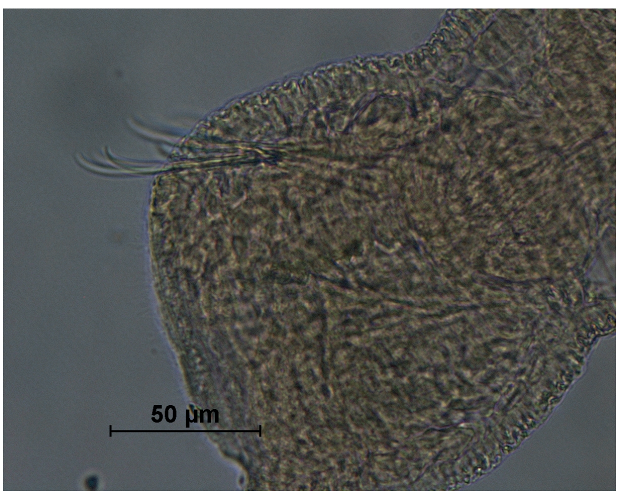

Figure 3

Chaetogaster setosus – the anterior end of the body
Photo by A. Pociecha

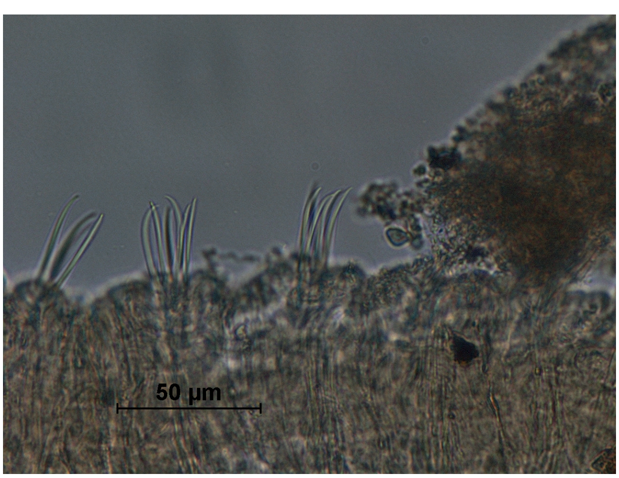

Figure 4

Chaetogaster setosus – bundles of ventral setae
Photo by A. Pociecha

observed specimens were budding. The prostomium strongly reduced, but short sensory hairs present on the front of the body (Fig. 3). All setae in segment II simple-pointed (Figs 3 and 4), from 103 to 115 µm long, about 2.5 µm wide, almost straight, with a distal part sigmoid, a nodulus situated in 1/3 from the proximal end. Setae in other segments shorter (from 90 to 110 µm) and thinner (about 1.2 µm), slightly sigmoid, without a nodulus. In segment II, the bundle of setae contains 7 or 8 setae, in the next segments – from 5 to 7 setae. Sixty specimens were collected altogether.

At the same sampling locality, a rare species – *Gianius aquaedulcis* – was discovered in samples collected on 14 July 2014 from the sandy bottom near the river bank.

Discussion

In the mid-20th century, the benthic fauna of the Upper Vistula was exposed to strong stress, especially due to high water pollution and high salinity, which substantially affected its composition, especially in the stretch downstream of the Przemsza River and the city of Kraków (Zięba, Zaćwilichowska 1966). Since then, the water quality has gradually improved, which was followed by an increase in the richness of fauna in the 1980s. The absence of caddisflies and mayflies, sensitive to salinity levels (Piscart et al. 2006), shows that chloride concentrations, still high in the Upper Vistula at that time, may be a factor limiting their presence.

During our study in 2014, families characteristic of moderately polluted (Kownacki, Soszka 2004) and slightly saline or non-saline waters (Wolf et al. 2009) occurred, such as Baetidae, Hydropsychidae and Caenidae, while taxa characteristic of strongly polluted waters were not found. In the course of our current study, the number of identified families was similar or a slightly smaller than that reported in the 1980s (Dumnicka, Kownacki 1988), probably due to the clearly smaller number of samples collected during only two field campaigns. In 2014, Chironomidae were more numerous than Oligochaeta, which confirmed the improvement of water quality (Starmach et al. 1976).

Despite the still high water salinity level, only three benthic species typical of brackish waters (*Gammarus tigrinus*, *Paranais frici* and *P. litoralis*) were found in the Upper Vistula. Taxa considered to be euryhaline or halophilous (Piscart et al. 2006; Wolf et al. 2009) were more numerous. They were represented by two alien amphipod crustaceans, the majority of non-indigenous oligochaete species as well as

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Corbicula fluminea. In Polish rivers, the salinity-related distribution of alien crustacean species was confirmed by Grabowski et al. (2009). This regularity also seems to apply to non-indigenous species of oligochaetes (Dumnicka 2016). Apart from the effect of salinity, the construction of six weirs on the Upper Vistula (in 1949–2002) affected the composition of benthic fauna due to changes in hydrological conditions. The reduced water current in the river bed above the weirs allowed the deposition of fine sediments, which created the conditions preferred by such mollusks as *Physa acuta* or *Corbicula fluminea* and oligochaetes from the genera *Psammoryctides* and *Potamothrix*. The above-mentioned alien species were not found in localities where the river maintained its submontane character, with the stone-gravel bottom and fast current.

The ways of migration and the rates of dispersion of various alien species in the Upper Vistula have not been thoroughly explored and sometimes they are difficult to define. The invasion of alien amphipods is considered to be relatively fast and they continue to spread in Polish waters (Bącela et al. 2008; Grabowski et al. 2007; 2009). *Gammarus tigrinus,* an oligohaline North American species, was introduced in Western Europe in the 1950s and expanded its range in thirty years from west to east, most likely via the Baltic See coast, but possibly also through the German Mittelland-Canal (Jażdżewski et al. 2002). At the turn of the 21st century, *Gammarus tigrinus* was reported from most of the Oder reaches (from the estuary to the town of Kędzierzyn Koźle), also in a few localities along the Baltic Sea coast and in the deltaic system of the Vistula (Grabowski et al. 2007). Furthermore, it was recorded in a small tributary of the Upper Oder (Spyra et al. 2015). In the last decade, we found *G. tigrinus* in the Upper Vistula drainage system. It can be assumed that this species was transported from the Oder system to new localities by man (or by birds), or during long-lasting floods. Natural migration from the Vistula mouth is unlikely. Due to the invasion of alien species, the amphipod fauna in the Upper Vistula has changed completely. The native European freshwater gammarid species, *G. fossarum*, almost completely retreated in the 1960s due to the water pollution. At present, the North American *G. tigrinus* and the more recent invader, *Dikerogammarus haemobaphes*, represent the gammarid fauna. The Ponto-Caspian species, *D. haemobaphes*, entered the Vistula through the Pripyat-Bug canal connecting the Black Sea and the Baltic Sea basins (Konopacka 1998; 2004). Among oligochaetes and mollusks in the Upper Vistula, alien species account for about 20% of the total number of species. It is likely that their presence has not eliminated native species, which was also reported from the Oder by Piechocki and Szlauer-Łukaszewska (2016) for mollusks and by Jabłońska et al. (2015) for oligochaetes.

The distribution of alien species belonging to the above-mentioned groups has changed over time. The gastropod *Physa acuta*, reported from the Upper Vistula in the 1960s (Zięba, Zaćwilichowska 1966; Aleksandrowicz 1986; Dumnicka, Kownacki 1988), has not been found by Maćkiewicz (2013) in recent years. Over the last years, a new alien species – *Corbicula fluminea* was found in the Vistula, first in Kraków (Maćkiewicz 2013) and recently in the mouth of the Skawinka River. Such findings show that populations of some alien species are not stable in the studied stretch of the Upper Vistula, which was also observed for non-native oligochaete species (Table 4). This process was also observed for other alien species (Najberek, Solarz 2016).

For many years, the composition of benthic fauna communities in the Upper Vistula has been affected by some stress factors such as pollution, salinity, invasion of alien species and hydrotechnical constructions. Nevertheless, the gradual improvement of water quality has led to an increase in the number of species, while the impact of alien species has only been observed with regard to the species composition of the gammarid fauna.

Rare species such as *Chaetogaster setosus* and *Gianius aquaedulcis* (Timm 2009) colonized the Upper Vistula River as a convenient habitat. So far, *Ch. setosus* has not been found in Poland, the Czech Republic or Slovakia (Fauna Europaea), whereas *G. aquaedulcis* was known from only one locality in Poland – springs located close to the Warta River (near Częstochowa) (Dumnicka 2009).

The composition of benthic fauna as well as other communities in the Upper Vistula should be monitored, as in other big rivers (Fruget et al. 2015), in order to determine further directions and the rate of changes taking place.

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