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Short research contribution

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## NEW FOR POLAND TUBIFICID (OLIGOCHAETA) SPECIES FROM KARSTIC SPRINGS

**ABSTRACT:** The majority of oligochaete species living in springs are ubiquitous and widely distributed taxa but cold stenothermic, semi-aquatic and rare ones are also found. In Poland about 50 species are known from springs among 185 aquatic and semi-aquatic species found in whole country. *Gianius aquaedulcis* (Hrabě 1960) (Tubificidae, Phallo-drilinae) is reported for the first time from Poland from two karstic springs situated in Kraków – Częstochowa Upland (South Poland). Both springs are hillside, fissure, descending, rheocrenes, with discharge about 30–40 L s<sup>-1</sup>. Spring no 1 is situated in banked pond, spring no 2 has natural character. Their bottom is sandy or sandy-gravelly, with patches of detritus, mud and plants. The conductivity, concentration of main cations (Ca, Mg) and anions (Cl, SO<sub>4</sub>) were typical for spring waters of this limestone area; only concentration of nitrate is slightly elevated. The samples of bottom fauna (a polyethylene corer and a bottom scraper) and water for chemical analysis were taken seasonally. This species was more numerous in a banked spring than in the natural one (maximal density about 1600 ind. m<sup>-2</sup>) and seasonal changes of its density were similar in both springs. Mature specimens formed only 5–8% of the population and were present in all sampling data. *G. aquaedulcis* is known from a few localities only (Germany, France, Spain and USA). It lives in underground and surface waters, with slightly alkaline pH on sandy or stony bottom. Maybe this species forms a few relictic

populations which persist in subterranean (cave or hyporheic) waters of some geographic regions at least since the last glacial epoch. The existence of small anatomical differences (for example various thickness of the muscular lining of the atria and changeable shape of penial setae) among the studied populations from various countries seems to confirm this hypothesis.

**KEY WORDS:** *Gianius aquaedulcis*, spring fauna, new species

In Poland the composition of oligochaete fauna was studied in detail in large limno-crene karstic springs in Central Poland (Niebieskie Źródła near Tomaszów Mazowiecki) (Kahl 2000) and in 25 small karstic springs situated in Kraków Częstochowa Upland (Dumnicka 2006). Moreover some information on this subject has been published in faunistic or hydrobiological papers, what allowed for the confirmation of the occurrence of about 50 species in these habitats among 185 species known from aquatic environments in Poland (Kahl and Pilipiuk 2004). Beside typical for springs cold stenothermic and semi-aquatic taxa the majority of oligochaetes found in springs are ubiquitous and widely distributed species (mainly palearctic or cosmopolite). Only a few species are rare

Table 1. Site and chemical characteristics (average data) of sampling points (A, B, C – Photos 1, 2) in studied springs and in Warta River.

Variables	Units	Warta river	Spring no 1 (in pond) – discharge 30 L s <sup>-1</sup>			Spring no 2 (natural) - discharge 40 L s <sup>-1</sup>		
			outflow (A)	middle part of pond (B)	near gate to river (C)	outflow (A)	middle part of stream (B)	near river (C)
Bottom character	(%)	sand (90), mud (10)	pebbles, small stones (90), sand (10)	sand (95), vegetation and detri- tus (5)	sand (75), detritus and mud (20), vegetation (5)	small stones, pebbles (80), sand (20)	pebbles, small stones (85), sand (10), vegetation (5)	small stones, pebbles (70), sand (25), vegetation (5)
Vegetation		<i>Phragmites australis</i> near banks	small patches of mosses on stones	<i>Berula erecta</i> , <i>Epilobium roseum</i>	<i>Spar- ganium ramosum</i> , <i>B. erecta</i>		<i>Veronica anagalis- aquatica</i> , <i>V. beccabunga</i> , <i>Mentha aquatica</i> , <i>B. erecta</i> , <i>Lysimachia</i> sp.	
Temperature	°C	10.57	9.78	9.77	9.8	9.78	9.77	10.8
pH		7.95	7.33	7.33	7.36	7.96	7.94	7.98
conductivity	µS cm <sup>-1</sup>	437.67	345.33	343.00	345.33	358.0	353.33	347.67
Oxygen saturation	O <sub>2</sub> %	50.7	56.1	66.2	68.3	54.7	57.7	63.5
Calcium	mg Ca dm <sup>-3</sup>	56.15	75.0	74.6	74.45	69.8	70.8	73.4
Magnesium	mg Mg dm <sup>-3</sup>	9.05	2.25	2.45	2.4	1.7	1.75	1.8
Sulphates	mg SO <sub>4</sub> dm <sup>-3</sup>	70.08	14.28	13.64	14.57	13.9	13.6	14.01
Chlorides	mg Cl dm <sup>-3</sup>	40.42	7.39	7.56	7.5	6.76	6.82	7.06
Nitrates	mg NO <sub>3</sub> dm <sup>-3</sup>	11.82	21.09	20.82	21.12	20.71	20.82	20.79
Phosphates	mg PO <sub>4</sub> dm <sup>-3</sup>	0.12	0.04	0.02	0.03	0.03	0.04	0.04

whereas endemic ones are absent in springs. In last years taxonomical studies on aquatic oligochaete fauna from various kinds of water bodies were carried out (Dumnicka and Poznańska 2006, Krodkiewska 2007), what resulted in an enlargement of the existing checklist of species known from the country (Kahl and Pilipiuk 2004).

One more oligochaete species not reported as yet from Poland – *Ganius aquaedulcis* (Hrabě 1960) (family Tubificidae, subfamily Phallo-drilinae) was found during the course of investigations carried out in 2007/2008 in two karst springs situated in the northern part of the Kraków – Częstochowa Upland (50°49'50"N, 19°17'23"E).

The studied springs are situated in the ravine sector of Warta River (240 m a.s.l.),

built from strongly karstified Upper Jurassic limestone (malm), and covered by Pleistocene sand (Chełmicki 2001). Both springs are hillside, fissure, descending, rheocrenes, with discharge about 30–40 L s<sup>-1</sup>. Spring no 1 is lined by earth banks constructed for rainbow trout farming existing in 60s and 70s of the 20<sup>th</sup> century. Two outflows from the pond by gates (first to Warta river, second to the next pond) are permanently opened due to the destruction of sluices (photo 1). Nevertheless, a shallow pond (approximate area 360 m<sup>2</sup> and mean depth 20 cm) exists inside the banks, but the main spring is situated above its water level. In some points of the pond's bottom small ascending springs are present. Water from the pond outflows permanently into the Warta river and tem-

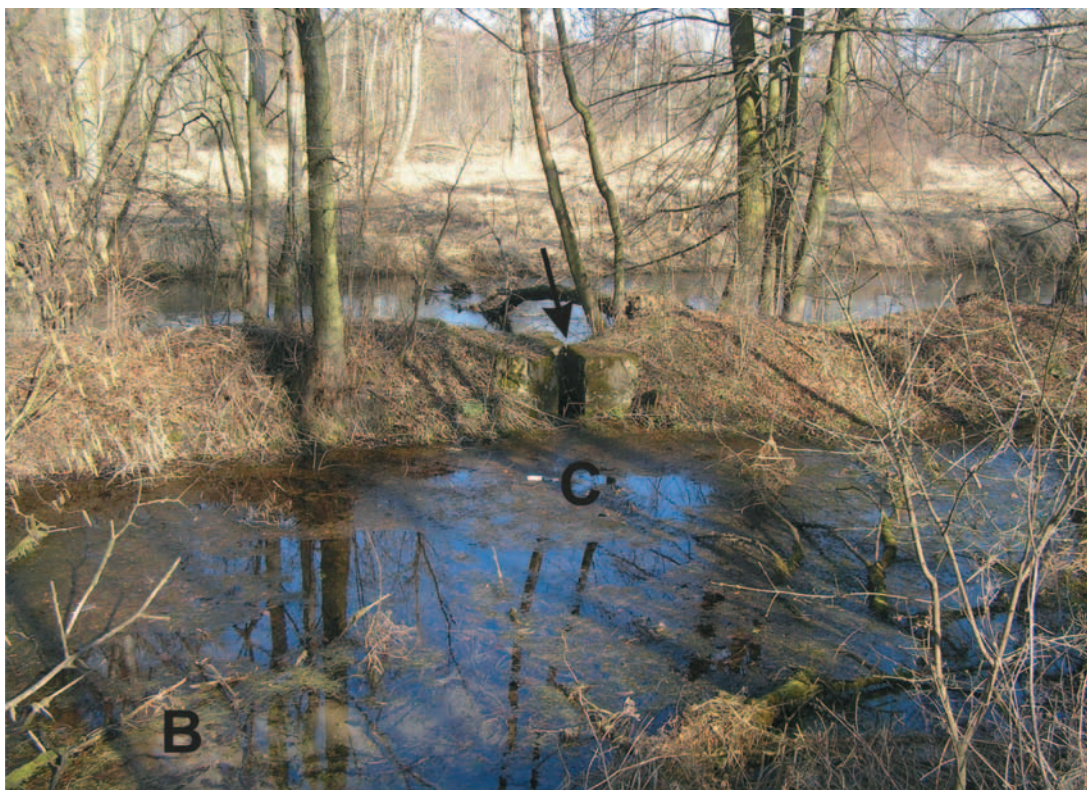


Photo 1. Spring no 1 inside the pond with sampling points marked by letters. Open gate to Warta river is marked by an arrow.



Photo 2. Natural spring (no 2) with short stream to Warta river. Sampling points are marked by letters.

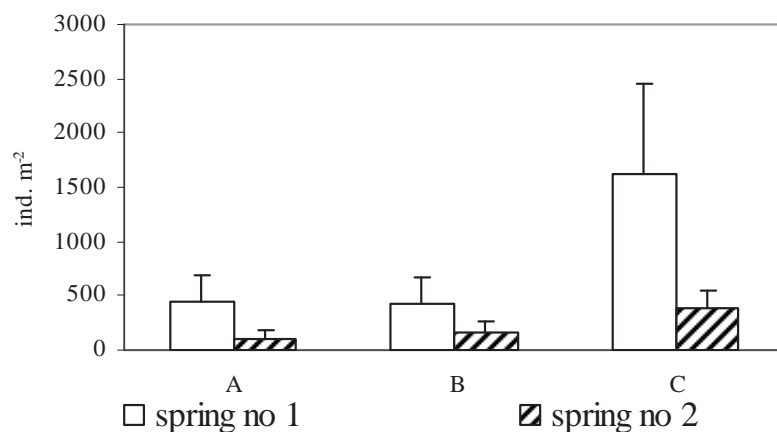


Fig. 1. Mean density (and SE) of *Ganius aquaedulcis* in three sampling points situated in a lined (no 1) and natural (no 2) spring (photos 1, 2).

porarily its excess outflows to the next pond. The pond bottom is sandy with patches of detritus, mud, plants and large woody debris; moreover decaying leaves sometimes cover water surface.

Spring no 2 has natural character and forms a short stream which after about 50 m inflows into the river (photo 2).

The samples of bottom fauna and water for chemical analysis were taken seasonally on: 19 April, 5 July, 8 November 2007 and 27 February 2008 at three sampling points (A, B, C, photos 1, 2) in each spring with its outflow and in Warta River above the springs (Table 1). The water chemistry analyses were made according to American Public Health Association (1992). Due to the small area of the studied water bodies in each term and sampling point only two samples were taken using a polyethylene corer (surface 12.56 cm<sup>2</sup>) and one sample using a bottom scraper (a slightly modified Surber net with a 0.25 mm mesh, surface 225 cm<sup>2</sup>).

The physico-chemical parameters of water were found to be similar in both springs. The conductivity, concentration of main cations (Ca, Mg) and anions (Cl, SO<sub>4</sub>) were typical for spring waters of this limestone area (Galas 2005) whereas water of the Warta river was moderately polluted (Table 1). In the studied springs concentration of nitrates was permanently higher in comparison to results obtained from the same springs by Chełmicki (2001), and in other springs of

the Kraków – Częstochowa Upland recently studied by Galas (2005) and even for Warta river.

In all sampling points situated in the banked spring *Ganius aquaedulcis* was more numerous than in the natural spring (Fig. 1), with maximal density about 1600 ind. m<sup>-2</sup> near the outflow to the river (sampling point C), whereas in spring no 2 the density did not reach 400 ind. m<sup>-2</sup>. Seasonal changes of the density were similar in both springs, with maximum in July and minimum in November (Fig. 2). Very low density was also stated in April in spring no 2. Mature specimens, with spermathecal ampullae filled with sperm or empty, were noted in all sampling data, but they formed only 5–8% of all collected individuals. In the studied springs *G. aquaedulcis* occurs in moderately oxygenated water with high calcium concentration. It lives mainly on sandy-gravelly and sandy bottom.

*Ganius aquaedulcis* (originally: *Phallosdrilus aquaedulcis*) was described from Weser river (its banks and bottom) as well as from water pipes in Bremen (Germany) (Hrabě 1960). During almost 50 years from its identification it was found in a small number of localities. The singular specimens were collected in a few caves situated in northern Spain and southwestern France (Rodríguez and Giani 1989). In Niagara River (North America) the presence of numerous individuals of this species (up to 3572 ind. m<sup>-2</sup>) was stated by Farara and Erséus (1991), but it

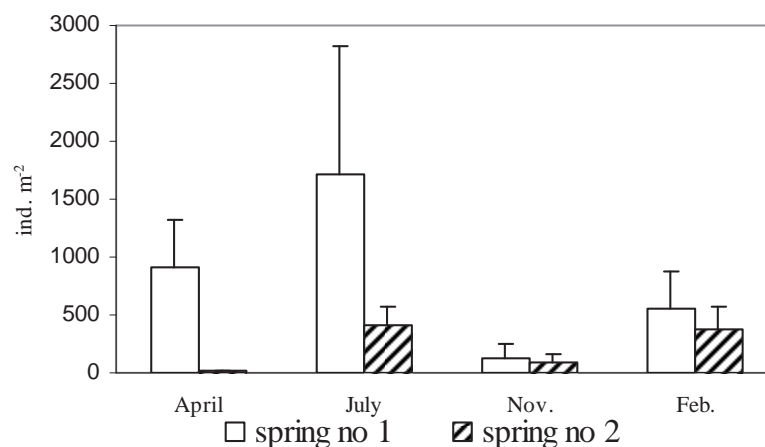


Fig. 2. Mean density (and SE) of *Gianiulus aquaedulcis* in the studied months (photos 1, 2).

is not clear if it is natural distribution area of this species or its recent introduction by man (Erséus 1992).

The first species representing genus *Phallogdrilus* was described from Naples Gulf (Italy) by Pierantoni (1902). About ten species were classified in almost exclusively marine subfamily Phallogdrilinae in the time of its establishment (Brinkhurst and Jamieson 1971). Intensive taxonomical studies on oligochaetes from sea and ocean bottom have begun in 70s of the 20 century, that resulted in describing several hundreds of new species belonging to this subfamily. They are either widely distributed, especially in tropical and subtropical regions, or limited to one geographic region (Erséus 1992). Genus *Gianiulus*, one of 15 genera that emerged from the nominative genus *Phallogdrilus* by Erséus (1992), is known either from North-East part of the Atlantic Ocean: *G. cristolatus*, *G. densspectinis* and *G. monnioti* (Erséus 1983, Erséus 1987) or from European freshwaters: *G. riparius* – river Tambre (Spain) (Giani and Martinez-Ansemil 1981), *G. crypticus*, *G. labouichensis* and *G. cavealis* – cave waters (Rodriguez and Giani 1989, Juget and des Chatelier 2001).

The main morphological and anatomical features which allow to distinguish *Gianiulus aquaedulcis* are: small size, length of mature specimens less than 2.5 mm in springs and 3–4 mm in Weser River (Hrabě 1960). Number of segments ranged from 27 to 39.

Hair setae are absent, number of bifid setae in anteclytellar bundles varies from 3 to 5, in postclytellar ones only 2 setae present. All setae have distal tooth shorter and thinner than the proximal one.

Even juvenile specimens of *Gianiulus aquaedulcis* could be easily distinguished from other oligochaete species known from Poland by the shape of somatic setae. Only a few species (*Propappus volki* Michaelsen, *Aulodrilus limnobius* Bretscher, *Tubifex newaensis* (Michaelsen)) have more than two bifid setae with shorter and thinner upper tooth in dorsal and ventral bundles, but they differ from *G. aquaedulcis* by many easily observable features (Table 2).

During studies of oligochaete fauna in 25 springs situated in the Kraków–Częstochowa Upland (Dumnicka 2006) *G. aquaedulcis* was not found in any of these springs. Recently studied springs are located in the drainage area of Warta River – among previously studied springs six were placed in the same drainage area (Galas 2005). The character of the bottom and chemical parameters of water in springs inhabited by this species are similar to these stated in other springs situated in the northern part of Kraków–Częstochowa Upland. Lack of *G. aquaedulcis* in previously studied springs as well as in Warta River (Jatulewicz 2008) suggests that studied springs are inhabited by an isolated population. Maybe this species forms a few relictic populations which persist in sub-

Table 2. The features distinguishing juvenile forms of species having bifid setae with upper tooth shorter and thinner than lower in ventral and dorsal bundles.

species	length of body (mm)	Number of setae in pre- and postclitellar bundles	Shape of prostomium	Other characteristic features
<i>Propappus volki</i>	up to 12	3 (4) – 3	with short tentacle	2 setal glands attached to each setal bundle
<i>Aulodrilus limnobius</i>	up to 15	7 – 10 along whole body	rounded	unsegmented posterior end of body
<i>Tubifex newaensis</i>	up to 65	4-8 – 3-2	rounded	newly hatched specimens longer than mature <i>Ganius</i>
<i>Ganius aquaedulcis</i>	up to 4	3-5 – 2	rounded	coelomocytes absent

terranean (cave or hyporheic) waters of some geographic regions at least since the last glacial epoch. The existence of small anatomical differences (for example various thickness of the muscular lining of the atria and changeable shape of penial setae) among the studied populations from various countries seems to confirm this hypothesis.

*G. aquaedulcis* was found in running and stagnant waters, with slightly alkaline pH (caves in south-western Europe, Niagara River and the studied springs) on sandy or stony bottom. In Weser river it was found even in eupsammal (above water level). Farrara and Erséus (1991) suggest that this species is characteristic for well oxygenated non-polluted rivers, but its numerous occurrence in Weser river as well as in the studied springs does not confirm their opinion.

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