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Hydrozetes species (Acari, Oribatida) at bog ponds and pools in the Tatra National Park and Orawa–Nowy Targ Basin (Kotlina Orawsko-Nowotarska) in southern Poland

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Abstract: The *Hydrozetes* fauna was investigated at the edges of 4 ponds and pools with acid water in southern Poland. Mites of this genus achieved the highest mean abundance (6×10^4 ind./m²) at a pond in the Tatra National Park (Staw Toporowy Niżni; pH = 3.9; 1089 m a.s.l.). *H. confervae* dominated there (98%), accompanied by *H. octosetosus* and *H. lacustris*. The same species were also present at a nearby pond (Staw Toporowy Wyżni; pH 3.9; 1120 m a.s.l.), but in significantly lower numbers. In the bogs of the Orawa–Nowy Targ Basin, at the edge of pool in Kaczmarka (pH 3.6; 650 m a.s.l.), *H. lacustris* and *H. octosetosus* were present, and the former species dominated (73%). The latter species is interesting, because it was not recorded in Europe until recently. At the other pool, in Łysa Puścizna (pH 4.5; 650 m a.s.l.), only *H. lacustris* was present. The lower abundance and species richness of *Hydrozetes* at the bog pools in the Orawa–Nowy-Targ Basin, in comparison to the Tatra National Park, was probably caused by poorer water conditions, due to more advanced succession, peat exploitation and disturbed water conditions in the Basin.

Keywords: *Hydrozetes*, Acari, Oribatida, bog, *Sphagnum*

INTRODUCTION

Hydrozetes is an aquatic genus represented in Europe by 7 species (Seniczak et al. 2007, 2009; Seniczak & Seniczak 2008, 2009) that live in lakes, ponds, and slowly flowing water (Weigmann 2006; Weigmann & Deichsel 2006). Two of them [*H. confervae* (Schrank, 1781) and *H. thienemanni* Strenzke, 1943] reproduce bisexually, while the others [*H. lacustris* (Michael, 1882), *H. lemnae* (Coggi, 1897), *H. longisetosus* S. Seniczak & A. Seniczak, 2009, *H. octosetosus* Willmann, 1932 and *H. parisiensis* Grandjean, 1948] are parthenogenetic and reproduce by thelytoky (Grandjean 1948; Seniczak et al. 2009).

The ecology of *Hydrozetes* is rather poorly known; the best studied is *H. lemnae*, but some studies concerned also *H. confervae*, *H. lacustris*, and *H. thienemanni* (reviewed by Seniczak 2011a). Better ecological knowledge on *Hydrozetes* could make them a powerful tool in bioindication (Seniczak 2011a), palaeoecology, and related sciences (Erickson & Platt 2007). In Poland, ecological studies of aquatic and semi-aquatic Oribatida, including *Hydrozetes*, concerned mostly the northern part of the country (e.g. Rajski 1961; Seniczak et al. 2006; Seniczak 2011b, c). The aim of this research was to investigate the genus *Hydrozetes* in the southern part of Poland.

MATERIAL AND METHODS

Study area

Four bodies of water in southern Poland were selected: two ponds, Toporowy Staw Wyżni (TW) and Toporowy Staw Niżni (TN), both located in the Tatra National Park, as well as two pools, Łysa Puścizna (LP) and Kaczmarka (K), both situated in the bogs of the Orawa–Nowy-Targ Basin (Kotlina Orawsko-Nowotarska).

Pond TW is located at 49°16'46" N; 20°01'48" E, at the altitude of 1120 m, in a bog surrounded by spruce forest. The pond has an area of 0.3 ha and pH 3.9. At the pond edges, the dominant *Sphagnum* species were accompanied by *Oxycoccus palustris* Pers., *Andromeda polifolia* L., *Drosera rotundifolia* L., *Eriophorum vaginatum* L., *Carex limosa* L. and *C. pauciflora* Lighft. A characteristic species for TW was *Pinus mugo* Turra, which was not found in lower zones (Mirek 1996).

Pond TN (49°17'02" N, 20°01'52" E) has an area of 0.6 ha and is located in the lower subalpine zone, at 1089 m a.s.l. It is surrounded by spruce forest. The water in the pond is acid (pH 3.9) and *Sphagnum* species dominate at its edges (Mirek 1996). An interesting plant species is *Sparganium angustifolium* F., first found there in 1951, and earlier known only from one site – Rohackie Ponds in Slovakia (Piękoś-Mirkowa 1982).

Two pools of the Orawa–Nowy-Targ Basin, LP (49°25'47''N; 19°42'50''E) and K (49°26'15"N; 19°54'25"), are situated at ca. 650 m a.s.l. Both pools had area of ca. 2 m²; the pool K is located in a bog of 3.5 ha and water there is more acid (pH 3.6) than in pool LP (pH 4.5), which is located in bog of area ca. 1.2 ha. Pools are permanently water-filled basins in bog that appear after the peatland was formed (Rydin & Jeglum 2006). At the edges of both pools, *Sphagnum* species dominated: *S. fallax* (Klinggr.) Klinggr, *S. magellanicum* Brid., *S. rubellum* Wils., *S. tenellum* (Brid.) Brid., and *S. papillosum* H. Lindb. They were accompanied by *Drosera rotundifolia* L., *Empetrum nigrum* L., *Oxycoccus quadripetalus* Hill, *Ledum palustre* L., *Vaccinium uliginosum* L., *V. myrtillus* L., *V. vitis-idaea* L., *Eriophorum vaginatum* L., and *E. gracile* W.D.J. In the tree layer, *Pinus silvestris* L. dominated. In the parts of Kaczmarka bog that was earlier exploited, *Calluna vulgaris* L. and *Polytrichum commune* Hedw. were abundant. Their occurrence indicates a disturbed water balance and a decrease in ground water level (Koczur 2007). In the bog of Łysa Puścizna, pine trees were planted ca. 15–20 years ago, which also disturbed the local water conditions (personal communication from Dr A. Koczur).

Mite analyses

From the edges of each pond and pool, 10 samples of *Sphagnum* mosses (each 100 cm² in area and 5 cm deep) were taken on 21 September 2009. The mites were extracted in modified Tullgren funnels, and *Hydrozetes* species were identified, including the juvenile stages, following Seniczak et al. (2009).

We assessed the abundance (*A*) and percentage contributions of particular species among *Hydrozetes*. The basic statistical analyses included the minimum, maximum, mean values, and standard deviation. For subsequent statistical analyses, the values were log-transformed LN (x+1) (Berthet & Gerard 1965; McDonald 2009; Łomnicki 2010). The normality of the distribution was tested with the Kolmogorov-Smirnov test, and the equality of variance in different samples, with the Levene test. When the assumption of normality or equality of variance was not met, the non-parametric Kruskal-Wallis test was used, followed by the Mann-Whitney *U* test. All statistical calculations were carried out with STATISTICA 8.0 software.

RESULTS

The highest abundance of *Hydrozetes*, both of adults and juveniles, was found at pond TN in the Tatra National Park, and differed significantly from all the other bodies of water (Table 1). Three *Hydrozetes* species were present there, but *H. confervae* was most abundant (almost 6×10^4 ind./m²) and constituted over 98% of all *Hydrozetes* mites. Juveniles of this species were numerous and accounted for over 30% of the extracted population. Like other *Hydrozetes* species, *H. confervae* lived in aggregations and its abundance varied a lot among samples. This applies especially to its juveniles ($0.37–5.58\times10^4$ ind./m²). At pond TN, *H. octosetosus* was the second most abundant *Hydrozetes* species, followed by *H. lacustris*. Similarly, at pond TW, *H. confervae* dominated among *Hydrozetes*, accounting for 87% of these mites, but its density was lower than 10^3 ind./m², and the contribution of juveniles was only 10%. This species was accompanied by *H. octosetosus* (which constituted 10% of all *Hydrozetes* mites) and *H. lacustris*, but both species were significantly less abundant there than at pond TN.

At pool K of the Orawa–Nowy-Targ Basin, 2 species of *Hydrozetes* were present. *H. lacustris* was more abundant than *H. octosetosus*, and constituted 73% of these mites. The total density of *Hydrozetes* at this pool was higher than at pool LP. At the latter pool only *H. lacustris* was present. The juveniles of *H. lacustris* accounted for ca. 30% of all *Hydrozetes* mites at pool LP and 10% at pool K.

DISCUSSION

All species of the genus *Hydrozetes* are aquatic and have many interesting adaptations to life in water or at its margins (Behan-Pelletier & Eamer 2007; Schatz & Behan-Pelletier 2008). Some *Hydrozetes* species, like *H. lemnae* and *H. thienemanni*, occupy mainly eutrophic water bodies with neutral pH (Strenzke 1952; Seniczak 2011c). For example, *H. thienemanni* was found at the banks of the Bug River in south-eastern Poland (Żbikowska-Zdun et al. 2006) and was very abundant at

Table 1. Abundance (A, in 10^3 ind./m²) and contributions (%) of *Hydrozetes* species at bog ponds and pools in southern Poland: TW = Staw Toporowy Wyżni; TN = Staw Toporowy Niżni; LP = Łysa Puścizna; K = Kaczmarka; SD = standard deviation; ad = adults; juv = juveniles. Superscripts denote significant differences ($P \leq 0.05$) between means: (a) TW vs TN, LP, K; (b) TN vs LP, K; (c) LP vs K

Hydrozetes species		TW (pH 3.9)		TN (pH 3.9)		LP (pH 4.5)		K (pH 3.6)	
		mean A ± SD	range	mean A ± SD	range	mean A ± SD	range	mean A ± SD	range
H. confervae (Schrank, 1781)	ad	0.74 ± 0.76	0-2.20	40.60^{a} ± 14.01	16.30-64.10	0^{ab}		0^{ab}	
	juv	0.09 ± 0.19	0-0.60	19.30^{a} ± 15.60	3.70-55.80	0^{b}		0^{b}	
	total	0.83 ± 0.87	0-2.40	59.87^{a} ± 19.80	27.80-87.90	0^{ab}		0^{ab}	
	%	87.37		98.58		0		0	
H. lacustris (Michael, 1882)	ad	0.02 ± 0.04	0-0.10	0.02^{a} ± 0.21	0.10-0.70	0.66^{a} ± 0.35	0.30-1.30	1.09 ± 0.98	0-2.50
	juv	0		0.02 ± 0.04	0-0.10	0.27 ± 0.40	0-1.10	0.11 ± 0.23	0-0.60
	total	0.02 ± 0.04	0-0.10	0.38^{a} ± 0.24	0.10-0.80	0.94^{a} ± 0.64	0.30- 1.90	1.20 ± 1.07	0-2.50
	%	2.10		0.63		100		73.17	
H. octosetosus (Willmann, 1932)	ad	0.07 ± 0.19	0-0.60	0.45^{a} ± 0.28	0.20-1.10	0^{b}		0.44^{c} ± 0.43	0-1.20
	juv	0.03 ± 0.07	0-0.20	0.03 ± 0.07	0-0.20	0		0	
	total	0.10 ± 0.25	0-0.80	0.48^{a} ± 0.33	0.20-1.30	0^{b}		0.44^{c} ± 0.43	0-1.20
	%	10.53		0.79		0		26.83	
Total	ad	0.83 ± 0.74	0.10-2.20	41.39^{a} ± 14.29	16.80-65.20	0.66^{b} ± 0.35	0.30-1.30	1.53^{b} ± 1.27	1.10-3.40
	juv	0.12 ± 0.20	0-0.60	19.34^{a} ± 15.58	3.70-55.80	0.27^{b} ± 0.40	0-1.10	0.11^{b} ± 0.23	0-0.60
	total	0.95 ± 0.85	0.20-2.40	60.73^{a} ± 19.97	28.40-88.70	0.94^{b} ± 0.64	0.30-1.90	1.64^{b} ± 1.32	0.10-3.60

a forest pond with neutral pH in the Tuchola Forest (Bory Tucholskie) in northern Poland (Seniczak 2011c). In contrast, *H. lacustris* prefers very acidic water (Walgram 1976; Weigmann 2006; Weigmann & Deichsel 2006) and is often found on floating *Sphagnum* moss and algae (Willmann 1931; Popp 1962; Weigmann 2006; Weigmann & Deichsel 2006). Walgram (1976) observed in Austria that at pH 3.0–3.5, 100% of *Hydrozetes* mites belonged to *H. lacustris*, while at pH 4.0–4.5, only 95%. However, this observation is not confirmed in our study, as *H. lacustris* constituted 100% of *Hydrozetes* in the pool with pH 4.5, and 53% in more acidic water (pH 3.6), where it was accompanied by *H. octosetosus*. Also at the ponds with acidic water (ca. pH 5.0) in Bergen area, Norway, *H. lacustris* occurred together with *H. octosetosus*, and was more or less abundant than the latter species (Seniczak et al. 2007, 2010). In the Tuchola Forest, this species was present with *H. longisetosus* and *H. octosetosus* (Seniczak et al. 2007, Seniczak 2011b). *H. octosetosus* was described by Willmann (1932), but it is probably overlooked by many authors in ecological investigations, as it was not recorded in Europe until recently (Seniczak et al. 2007, 2010; Seniczak 2011b).

Hydrozetes confervae was found less frequently in northern Germany than *H. lacustris* (Willmann 1931). It was also absent from forest ponds in northern Poland (Seniczak et al. 2006; Seniczak 2011b,c). In Russia it was recorded only in eutrophic bogs near Moscow, in contrast to *H. lacustris*, which occurred in oligotrophic bogs (Druk 1982). *H. confervae* was found mainly in filamentous algae of the family Confervaceae (= Ulotrichaceae) (Schrank 1781; Oudemans 1897) and on duckweed (Weigmann 2006*;* Weigmann & Deichsel 2006; Seniczak et al. 2009). Interestingly, in this study it lived in *Sphagnum* mosses at pond edges in the Tatra National Park and was the most abundant *Hydrozetes* species there.

To sum up, the *Hydrozetes* fauna of the acid ponds and pools in southern Poland differed from that in northern Poland (studied earlier). *H. longisetosus* in northern Poland dominated among *Hydrozetes* mites, but was absent in the south. In contrast, *H. confervae* was absent from ponds in northern Poland but abundant in the south. The lower abundance and species richness of *Hydrozetes* at the pools in the Orawa–Nowy-Targ Basin than in the ponds in the Tatra National Park, can be explained by poorer water conditions, due to the more advanced succession, and disturbed water conditions in the Basin, due to peat extraction (pool K) and tree planting (pool LP).

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