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Article

Contribution to the knowledge of the water mite (Acari: Hydrachnidia) fauna of Croatia - New data and records from a permanent pool in the Dinaric karst region

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ABSTRACT
Ponds are small lentic waterbodies that lack the deep aphotic layer. They can be either perennial or temporary as well as of natural or anthropogenic origin. Despite their small size and isolated nature, they are often considered as reservoirs of biodiversity for neighboring ecosystems, and could in fact be considered as special ecotones that house numerous semi-aquatic species. Although relatively poorly researched, ponds have been shown to contribute to regional biodiversity as much as rivers or lakes. The great local diversity of these petite ecosystems was once again proven in a small perennial pond (approximately 25 meters long and 10 meters wide) in the Dinaric Western Balkan ecoregion, where four water mite species were recorded, three of which are new findings for the water mite fauna of Croatia. Habitat conditions, i.e. macrophyte coverage and environmental water properties of the pond, proved to be suitable for typical pond species such as *Piona laminata* but also seemed to reflect conditions similar to helocrenes as species usually associated with these spring habitats were also found: *Hydryphantes armentarius* and *Tartarothyas romanica*.

KEY WORDS: Dinaric Western Balkan ecoregion; karst hydroecology; perennial pool; pond ecology; water mites.

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INTRODUCTION

Water mite research in Croatia dates back to 1936 when Viets travelled through Yugoslavia and recorded 35 species on the territory of today's Croatia (among other former Yugoslavian countries). Twenty years later, Besseling (1957) added three new species to the checklist. A huge gap in water mite research, apart from few mentions in non-water mite specific papers, followed all the way into the new millennia when Pešić (2002) published the first water mite checklist for Croatia. Water mites are often neglected in environmental researches because of their size (considered as meiofauna - smaller than 500 µm) and perceived difficulties in identification (Goldschmidt 2016). In Europe today there are around 1000 described water mite species equaling roughly 1/6 of the total number of described species worldwide (Watermite.org 2016). The identification of European water mites today is fairly simplified after the publication of three comprehensive water mite identification keys (Davids

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et al. 2007; Di Sabatino and Gerecke 2010; Gerecke *et al*. 2016). Water mites are widely distributed geographically and can be found in either lentic or lotic freshwater habitats with either perennial or temporary characteristics (Goldschmidt *et al*. 2016). Camacho and Valdecasas (1988) found that even small ponds, especially perennial ones, house diverse water mite communities, which can consist of more than 10 species. Having the restricted area of the pond in mind and the low occurance of water mite individuals, the total water mite diversity in ponds seems to be quite high (Camacho and Valdecasas 1988).

Although relatively poorly researched, ponds have been shown to contribute to regional biodiversity as much as rivers or lakes (Boix *et al*. 2012). Ponds are water bodies of natural or man-made origin, with a minimal water retention time of 4 months during the year (Biggs *et al*. 2005). In a broader ecological sense, ponds represent highly functional habitats, which connect aquatic and terrestrial species, through their numerous complex interactions and food webs (Baxter *et al*. 2005). Apart from the biodiversity value, ponds are also recognized for their capacity in water purification, flood control and even aesthetic function (Hassall 2014). All these mentioned aspects have increased the interest and awareness for management, restoration and improving the ecological value of these habitats (Gledhill and James 2012).

The goal of this research was to contribute to the knowledge of the distribution of water mites in karst ponds, with special emphasis on linking the unique environmental conditions of a perennial karst pond to specific water mite species' occurrence.

MATERIAL AND METHODS

Study area

The study area is located in the Dinaric Western Balkan ecoregion (Illies 1978) of Croatia. More precisely in the Gorski kotar region, which is in most part characterized by a temperate-humid to humid-boreal climate, with warm summers (Šegota and Filipčić 2003). The pond in Sungerski lug (N 45° 20' 09", E 14° 47' 46") is situated at an altitude of 780 m a.s.l., on the edge of a silver fir forest (Fig. 1). The origin of the pond is uncertain, but it is most probably a man-made (or at least anthropologically altered) watering hole for cattle, which is no longer in use. The pond relies on precipitation exclusively; however, it is of perennial character. The pond is approximately 25 meters long and 10 meters wide (changes seasonally) and the deepest point is around 1.5 meters. The pond's bed is completely covered in macrophytes.

Data collection

The pond was sampled on one occasion in May 2019. Only qualitative samples were taken with a Surber hand net sampler (200 μm mesh size) and preserved in 96% ethyl alcohol. Water mites from the samples were subsequently isolated and fixed in Koenike's solution. Adult water mite individuals were determined to species or genus level using keys by Davids *et al*. (2007), Di Sabatino and Gerecke (2010) and Gerecke *et al*. (2016). No deutonymphs or larvae of water mites were found. All water mite specimens are deposited at the Department of Biology, Faculty of Science, Zagreb, Croatia.

Environmental parameters

The following water properties were measured using a multiparameter probe (WTW Multi 3430): water temperature, pH, oxygen concentration, oxygen saturation and conductivity. Alkalinity (concentration of $CaCO_3$ (mg/L)) of the pond water was measured in the field by titrating the water with hydrochloric acid as described in the Standard Analytical Procedure (APHA, 2005).

RESULTS AND DISCUSSION

In total, four water mite taxa were recorded (*Arrenurus* sp., *Hydryphantes armentarius*, *Piona laminata* and *Tartarotyas romanica*), belonging to four different genera and three families. Physico-chemical water parameters are presented in Table 1.

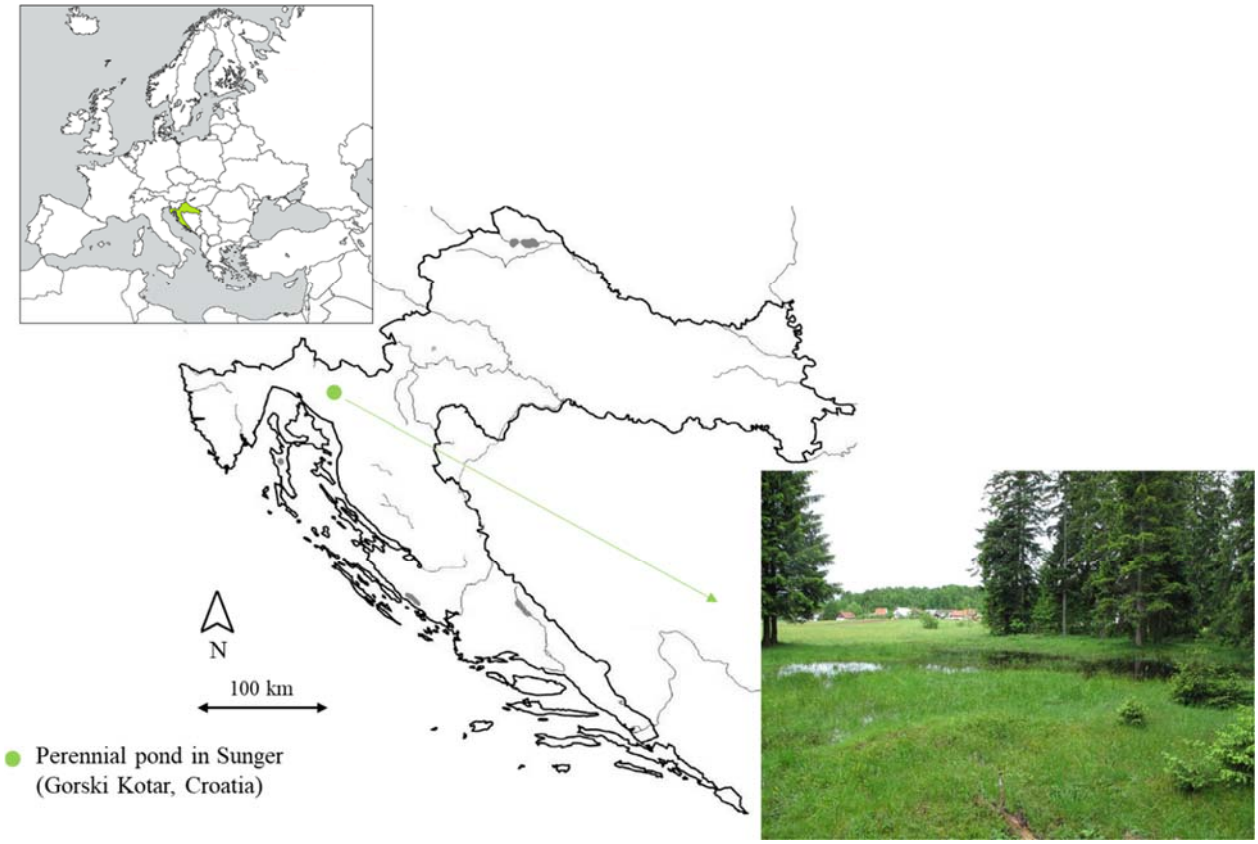

Figure 1. The location and position of the study site where water mite assemblages were examined.

Table 1. Water properties of the pond in Sungerski Lug, Gorski Kotar, Croatia.

Parameter	Measured value
Water temperature (°C)	23.5
Dissolved oxygen (mg/L)	14.7
Oxygen saturation (%)	190
Conductivity (µS/cm)	152
pH	9.34
Alkalinity ($CaCO_3$ mg/L)	105

Two specimens of *Arrenurus* sp. were found, both females, but were not determined to species level as they were preserved in ethyl alcohol [meaning that an important determining feature: possible sclerotized patches on the gonopore, would not be visible (Gerecke *et al*. 2016)].

Two specimens of *Hydryphantes armentarius* Gerecke, 1996 were collected which represent a new addition to the water mite fauna of Croatia. This species is known from neighboring countries such as Italy and Bosnia and Herzegovina and is believed to be found across the Balkans (Gerecke 1996). This species is biologically characterized by having a clear preference for helocrene (marsh-like) springs (Gerecke 1996). One can argue that the pond in Sungerski lug has the environmental

characteristics similar to helocrene springs: the sunlight reaches the entire benthic area, making the pond's bed rich in macrophytes, which in turn use the majority of the dissolved nutrients and produce high oxygen concentration levels (Table 1). The forest edge gives some shade to the pond and keeps the water from overheating in the summer period.

Piona laminata (Thor, 1900) was recorded for the first time in Croatia. As the diagnostic characters are restricted to the female (Gerecke *et al*. 2016), it is important to note that the two found specimens of this species were both females, making the identification possible. Our findings are in concordance with previous notes on defining the species as "A typical springtime species" as we sampled the pond in May (Gerecke *et al*. 2016). It is believed that the species is actually a species complex (Smit *et al*. 2015), meaning that this newly-known locality could serve in potential future genetic research of the species.

A single specimen of the species *Tartarothyas romanica* Husiatinschi, 1937 was found and is a new record for the water mite fauna of Croatia. This species has been found in neighboring countries (Montenegro; Pešić 2004) and is distributed in most of Europe, but it is also considered as a rare species (Di Sabatino and Gerecke 2010), making this record even more valuable. As *H. armentarius*, *T. romanica* is also frequently found inhabiting helocrenes and is sensitive to eutrophication (Gerecke and Martin 2006).

The first checklist of water mites in Croatia containing 48 species was published by Pešić (2002). Pešić broadened the checklist in two separate occasions studying water mites of the Balkan Peninsula (Pešić *et al*. 2010, 2018). Some earlier findings were accidentally omitted from the checklist: Matoničkin and Pavletić (1959) [*Woolastookia rotundifrons* (K. Viets, 1922)] and the doctoral thesis of Lattiger (1988) [*Partnunia angusta* (Koenike, 1893), *Panisus torrenticolus* Piersig, 1898 and *Protzia squamosa* Walter, 1908]. Pozojević *et al*. (2018) added three new records for the water mite fauna of Croatia from Torak lake and Čikola river. Pozojević *et al*. (2019a) gave a comprehensive overview from reservoirs in the Dinaric region of Croatia, adding 19 new water mite species to the checklist. A paper by Pozojević *et al*. (2019b) added two new species: *Hygrobates setosus* and *Atractides distans* that were recorded from karst springs. Lastly, eight new species were recorded by Pozojević *et al*. (2020) in karst springs of Croatia. Before this paper, a total of 96 water mite species is recorded in Croatia. With the addition of these three species, the water mite fauna of Croatia currently consists of 99 species.

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اطلاعاتی در مورد فون کنه های آبزی (Acari: Hydrachnidia) کرواسی- اطلاعات و گزارش‌های جدید از آبگیر دایمی ناحیهٔ دیناریک کارست

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چکیده

برکه‌ها آبگیرهای کوچک راکدی‌اند که لایهٔ عمیق تاریک ندارند. ممکن است دایمی یا موقتی باشند و منشأ طبیعی یا مصنوعی داشته باشند. برخلاف اندازهٔ کوچک و طبیعت مجزایشان، بیشتر به عنوان ذخایر تنوع زیستی برای اکوسیستم‌های مجاور در نظر گرفته شده و در حقیقت می‌توانند به عنوان اکوتون‌های ویژه‌ای در نظر گرفته شوند که شمار زیادی از گونه‌های نیمه‌آبزی را در خود جای می‌دهند. اگرچه پژوهش‌های به نسبت اندکی صورت گرفته است، برکه‌ها نشان داده‌اند که در ارتباط با تنوع زیستی منطقه‌ای مانند رودها و دریاچه‌ها عمل می‌کنند. تنوع محلی زیاد این اکوسیستم‌های کوچک یک بار دیگر در برکهٔ کوچک دایمی (حدود ۲۵ متر درازا و ۱۰ متر پهنا) در منطقهٔ اکولوژیک دیناریک بالکان غربی بررسی شد که از چهار گونهٔ کنهٔ آبزی گزارش شده، سه گونه برای فون کنه‌های آبزی کرواسی جدید بودند. شرایط زیستگاه، یعنی پوشش ماکروفیت و ویژگی‌های زیست محیطی آب برکه ثابت کرد که برای گونه های معمولی برکه مانند *Piona laminata* مناسب است اما همچنین به نظر می‌رسد شرایطی مشابه هلوکرن را منعکس می‌کند زیرا گونه هایی که به طور معمول با این زیستگاه‌های بهاری مرتبط هستند نیز یافت می‌شوند: *Hydryphantes armentarius* و *Tartarothyas romanica*.

واژگان کلیدی: منطقهٔ اکولوژیک دیناریک بالکان غربی؛ هیدرواکولوژی کارست؛ برکهٔ دایمی؛ اکولوژی برکه؛ کنه‌های آبزی.

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