ABS ACTA BIOLOGICA SIBIRICA
A journal on the biodiversity of Siberia and the adjacent lands

Acta Biologica Sibirica 9: 127–138 (2023)
doi: 10.5281/zenodo.7751128
http://journal.asu.ru

RESEARCH ARTICLE

Water mites (Acariformes: Hydrachnidia, Halacaroidea) of the Malaya Sosva Nature Reserve (Western Siberia)

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Academic editor: R. Yakovlev | Received 7 June 2022 | Accepted 22 February 2023 | Published 21 March 2023

http://zoobank.org/6FAF471F-72C9-412F-9C4A-1DBBAA0014C0

Citation: Filimonova MO, Stolbov VA, Tupicyn SS (2023) Water mites (Acariformes: Hydrachnidia, Halacaroidea) of the Malaya Sosva Nature Reserve (Western Siberia). Acta Biologica Sibirica 9: 127–138. https://doi.org/10.5281/zenodo.7751128

Abstract

The paper presents data on the fauna of water mites (Acariformes, Hydrachnidia, Halacaroidea) of the Malaya Sosva State Nature Reserve (Khanty-Mansi Autonomous Okrug), located in the middle taiga zone of Western Siberia. The study covered the species composition, biotopic distribution and ecological features of water mites in different lentic ecosystems of the Nature Reserve. The research is based on 36 studied water bodies, which represented the main types of stagnant waters common on the Nature Reserve territory: lakes, floodplain ponds, temporary ponds and sphagnum bogs. The study revealed 51 species of Hydrachnidia and two species of Halacaroidea in different lentic water bodies. Most of the mites belonged to species typical of different types of stagnant and low flowing waters rich in submerged vegetation. Lakes of different types and permanent floodplain ponds were the richest in number of species and the number of mites. In these water bodies, three species of water mites prevailed, namely, *Limnesia koenikei* Piersig, 1894, *Piona pusilla* Neumann, 1875, and *Piona carnea* Koch, 1836. The number and species richness of mites were low in temporary ponds, but their fauna was based on specific spring species characteristic of astatic ponds. The fauna of the sphagnum bogs was the poorest, in which one species of Halacaroidea was the eudominant – *Porolohmannella violacea* Kramer, 1879. *Unionicola parvipora* is recorded for the fauna of Russia for the first time.

Keywords

Ecology, fauna, Khanty-Mansi Autonomous Okrug, Russia, lentic waters, water mites

Introduction

Water mites (Hydrachnidia) are a large group of freshwater invertebrates with a high potential use to monitor the state of freshwater ecosystems (Goldschmidt 2016). Numerous studies have shown that Hydrachnidia are sensitive indicators of the ecological state, they are sensitive to changes in physicochemical and hydrological parameters, which allows Hydrachnidia to be used for monitoring pollution of water bodies (Di Sabatino et al. 2000; Miccoli et al. 2013). Water mites make up a significant part of freshwater fauna (Goldschmidt 2016), being one of the dominant groups in terms of the number and abundance of species.

Given the high level of anthropogenic load on the water bodies of Khanty-Mansi Autonomous Okrug (KhMAO), associated with the extraction of petroleum, it is very important to identify the species composition and ecological characteristics of potential indicator groups in the pollution-free part of the region for further use in the regional environmental monitoring system.

Aquatic invertebrates from the Malaya Sosva State Nature Reserve have not been extensively studied, there are only a few studies on the benthos drift and its individual constituent groups (leeches, mollusks) (Zaguzova 1986, 1987, 1989; Vinarsky and Karimov 2015). There is still little research on KhMAO water mites. For example, a study from water mites of the Yugansky State Nature Reserve (Stolbov et al. 2018a) provides a list of 29 species, mainly from large rivers. The study indicated three more species of water mites for the lakes of the middle taiga of KhMAO, including Limnesia koenikei Piersig, 1894, for Lake Rangetur, part of the protected area of the Malaya Sosva Nature Reserve (Aleshina and Uslamin 2012; Uslamin et al. 2019).

Research on water mites in the Malaya Sosva State Nature Reserve started in 2017 (Filimonova and Stolbov 2018), when a preliminary list of 21 species was presented. This article presents further research results on the fauna of water mites and the ecology of lentic waters of this Nature Reserve.

Materials and methods

The water mites were studied in the Khanty-Mansi Autonomous Okrug (KhMAO), on the territory of the Malaya Sosva State Nature Reserve.

The Malaya Sosva Nature Reserve is located in the northwest of the West Siberian Plain, in the north of the middle taiga subzone on the border with the northern taiga (Stashkevich et al. 1985). The Nature Reserve is located in the upper and middle flows of the Malaya Sosva River (the Ob River basin). The territory of this Nature Reserve is characterized by swampiness, a relatively small number of lakes, and abundance of floodplain ponds (Vasin et al. 1999).

The research area includes the four cordons of the Nature Reserve and Lake Rangetur, which is part of the National Monument of Regional Significance "Lake

Rangetur", which is under the protection of the Nature Reserve: 1. Cordon Belaya Gora (61°47.43'N; 64°31.00'E); 2. Cordon Zapadny (61°55.17'N; 63°42.47'E); 3. Cordon Hangokurt (61°57.57'N; 64°14.38'E); 4. Cordon Shuhtungort (62°21.95'N; 64°5.2'E); 5. Lake Rangetur (60°47.89'N; 63°32.44'E).

The study selected the main types of lentic water in the floodplain zone of the Em-Egan and the Malaya Sosva rivers. In total, the research studied 36 most typical water bodies for this area: lakes, floodplain ponds, temporary ponds, sedge-sphagnum and cottongrass-sphagnum eutrophic bogs.

Additionally, the water bodies were divided into four groups, within which the mite fauna turned out to be similar. The groups were as follows:

I. Lakes (n = 6, Fig. 1A). The area ranges from 0.075 to 2 km^2, and the maximum depth of the lakes is up to 11 m. The exception is Rangetur Lake, which is one of the few large lakes in the studied territory, with a water surface area of 8.6 km^2 and a depth of up to 4 m. These lakes are characterized by sandy bottom and clean water. Higher aquatic vegetation is poorly developed, there is *Nuphar* spp. Part of the coast is swampy and occupied by floating mats.

II. Floodplain ponds (n = 18, Fig. 1B). The research studied various oxbow lakes in the Malaya Sosva, Eva-Egan, and Em-Egan rivers. The floodplain ponds differ significantly in size and hydrological characteristics. The ponds are small in size, from 0.2 to 1 km in length, the depths vary from 0.5 to several meters. They are characterized by clean water, the predominance of muddy and silty-sandy bottoms. Sedge thickets are found along the banks of the water; submerged vegetation is absent.

III. Temporary ponds (n = 6, Fig. 1C). These are small shallow temporary water bodies, located in the floodplain of the Malaya Sosva River. These water bodies dry up in the summer, abundantly overgrown with plants (*Carex* spp., *Caltha palustris*, *Chamaedaphne calyculata*) and mosses.

IV. Bogs (n = 6, Fig. 1D). Despite the swampiness of the north of Western Siberia, there are relatively few extensive bog complexes on the Nature Reserve territory. The research studied small bogs (up to 2 km^2 in area) most typical for the territory, located in the valleys of large rivers, the Malaya Sosva and the Em-Egan. The study examined sedge-sphagnum and cottongrass-sphagnum eutrophic bogs suitable for the habitat of water mites.

Samples for this study were collected over three periods: from June 20 to July 3, 2017, from May 23 to June 2, 2018, and from July 6 to July 14, 2019. Water mites were collected using a hydrobiological net that captured the water column and the upper part of the bottom, and the caught macrophytes were rinsed out in the net. For samples from the bogs, we trampled on a groove and filtered the collected water through a net. In total, 84 samples were collected over the course of three years of research.

The collected material was disassembled on the spot and fixed in 70% alcohol. The water mites were determined in the laboratory using modern keys (Tuzovskij 1990; Tumanov 1997; Bartsch 2007; Davids et al. 2007; Di Sabatino et al. 2010; Gerecke et al. 2016).

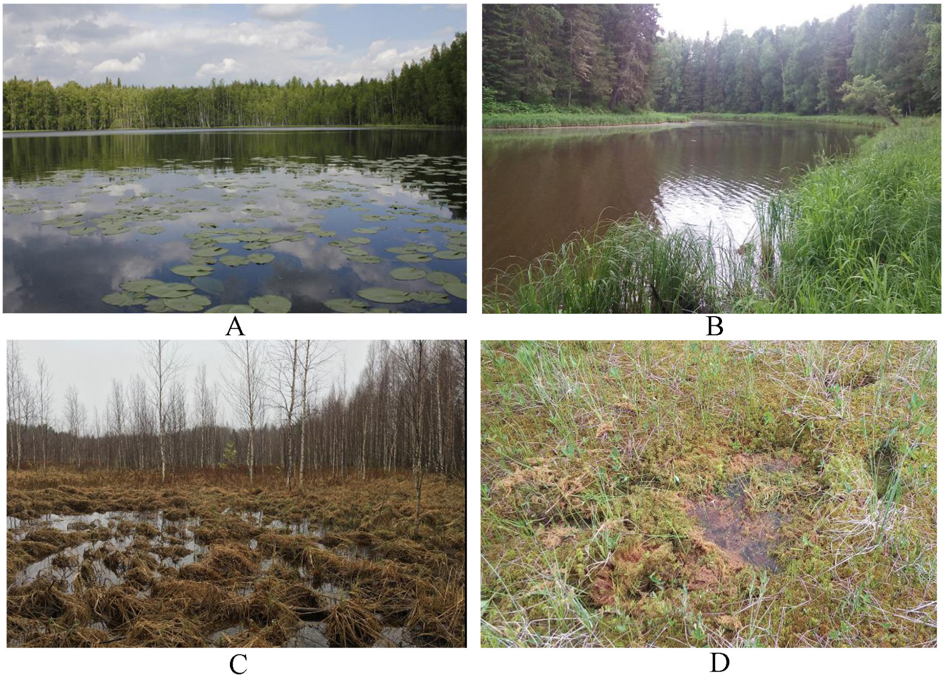

Figure 1. Explored the water bodies of the Malaya Sosva Nature Reserve: **A** – lakes; **B** – floodplain ponds; **C** – temporary ponds; **D** – bogs. Photos by M. Filimonova.

To perform statistical analysis and construct a faunal similarity matrix, we used the Biodiversity Pro v. 2 software and employed the single linkage method based on the Bray-Curtis index (Ricotta and Podani 2017). Also, we calculated the absolute number of mites, frequency of occurrence and the dominance index reflecting the relation of number of specimens of certain species to the total number of specimens of all species (%).

Result

The study yielded a total of 1594 specimens belonging to 51 species of water mites from 14 families, along with two species of Halacaroidea (see Table 1).

The Pionidae family (36.7% of the total species richness of water mites) and the *Piona* genus (10 species) were the richest in the number of species. Eight out of 14 families were represented by only one species.

Mites were present in all the water bodies studied, where the number of species ranged from 1 to 13, whereas the number of specimens ranged from 8 in sphagnum bogs to 34 in floodplain ponds. The number of individuals also varied greatly from 2 specimens to 285 in different floodplain ponds.

Table 1. Frequency of occurrence (O, %) and dominance index (D, %) of water mites

	Lakes		Floodplain ponds		Temporary ponds		Bogs		Number, spec.	Frequency, %
	O	D	O	D	O	D	O	D		
Hydrachnidia										
Limnochares aquatica (Linnaeus, 1758)	50	7.6	22	0.6	17	0.8	50	5.7	51	31
Eylais rimosa Piersig, 1899			6	0.1					1	3
Hydrodroma despiciens (Müller, 1776)	17	0.9							4	3
Parathyas bruzelii (Lundblad, 1926)					17	1.6			2	3
Parathyas dirempta (Koenike, 1912)					33	9.8			12	6
Parathyas diremptellus (Tuzovskij, 1990)					67	25.2			31	11
Lebertia dubia (Thor, 1899)			6	0.1					1	3
Lebertia aff. *porosa* Thor, 1900			6	0.1					1	3
Oxus angustipositus Viets, 1908	17	1.7							8	3
Oxus longisetus (Berlese, 1885)	17	0.2							1	3
Oxus nodigerus Koenike, 1898			6	0.1					1	3
Oxus ovalis (Müller, 1776)	17	0.4					17	1.7	5	6
Oxus strigatus (Müller, 1776)			6	0.1					1	3
Limnesia connata Koenike, 1895	33	7.1	6	0.2					35	8
Limnesia curvipalpis Tuzovskij, 1997	17	0.7	17	1.9					19	14
Limnesia koenikei Piersig, 1894			33	17.3	33	20.3			170	25
Limnesia maculata (Müller, 1776)	50	4.8	11	0.2					24	14
Hygrobates prosiliens Koenike, 1915	17	0.2							1	3
Neumania callosa (Koenike 1895)			6	0.1					1	3

	Lakes		Floodplain ponds		Temporary ponds		Bogs		Number, spec.	Frequency, %
	O	**D**	**O**	**D**	**O**	**D**	**O**	**D**		
Neumania vernalis (Müller, 1776)	17	0.2							1	3
Unionicola crassipes (Müller, 1776)	33	1.1	11	0.8					12	11
Unionicola parvipora Lundblad, 1920	50	2.4	22	0.7					17	17
Forelia liliacea (Müller, 1776)	33	0.4					17	1.2	4	8
Forelia variegator (Koch, 1837)			6	0.1					1	3
Pionacercus leuckarti (Piersig, 1894)			6	0.1					1	3
Pionacercus tundrosum Tuzovskij, 2001					17	3.3	17	1.2	6	6
Hydrochoreutes similis Tuzovskij, 2003			6	0.2					2	3
Piona alpicola (Neuman, 1880)			6	0.1					1	3
Piona carnea (Koch, 1836)	33	16.9	50	8.3	50	7.3			156	39
Piona coccinea (Koch, 1836)	17	12.5	6	2.8					81	6
Piona conglobata (Koch, 1836)	33	10.2	11	0.4					50	11
Piona dispersa Sokolow, 1926	17	0.2							1	3
Piona inflata Sokolow, 1927					17	4.9			6	3
Piona pusilla (Neumann, 1875)			28	32.7					273	17
Piona rotundoides (Thor, 1897)			6	0.1					1	3
Piona stjordalensis (Thor, 1897)	17	0.9	17	1.6					17	11
Piona variabilis (Koch, 1836)			6	0.7			17	1.2	8	6
Acercopsis pistillifer (Koenike, 1908)					17	2.4			3	3
Pionides ensifer (Koenike, 1895)			11	0.5					4	6
Pionopsis lutescens (Hermann, 1804)			11	0.4					3	6

	Lakes		Floodplain ponds		Temporary ponds		Bogs		Number, spec.	Frequency, %
	O	**D**	**O**	**D**	**O**	**D**	**O**	**D**		
Tiphys sp.			6	0.2					2	3
Brachypoda versicolor (Müller, 1776)	17	0.2							1	3
Midea orbiculata (Müller, 1776)	17	0.2	6	1					9	6
Mideopsis orbicularis (Müller, 1776)	17	0.4							2	3
Arrenurus albator (Müller, 1776)	17	0.7							3	3
Arrenurus crassicaudatus Kramer, 1875			6	0.1					1	3
Arrenurus neumani Piersig, 1895	17	0.2							1	3
Arrenurus buccinator (Müller, 1776)			11	0.2					2	6
Arrenurus forpicatus Neuman, 1880			6	0.1					1	3
Arrenurus sinuator (Müller, 1776)	17	1.1							5	3
Arrenurus stecki Koenike, 1894			6	0.1			17	1.2	3	6
Arrenurus spp. ♀♀ indet.	67	3.7	17	1.2			17	0.5	28	22
Deutonymphs indet.	100	24.9	100	26.4	100	24.4	50	2.9	371	92
Halacaroidea										
Porolohmannella violacea (Kramer, 1879)	17	0.2	6	0.1			83	67.1	118	19
Soldanellonyx monardi Walter, 1919							33	17.3	30	6
Total number of specimens	462		836		123		173		1594	

Limnochares aquatica, a species that was observed among all four groups of water bodies, and *Piona carnea* were distinguished by the highest frequency of occurrence. *Piona carnea*, along with *Piona pusilla* and *Limnesia koenikei*, prevailed over all other mites in number, these three species accounted for 37.6% of all water mites collected during the study. Furthermore, the representative of the Halacaridae family – *Porolohmannella violacea* – had high numbers and frequency of occurrence rates. At the same time, the species of Hydrachnidia prevailed in open ponds, determining the appearance of their acarofauna, while *P. violacea* dominated in bogs.

We revealed the highest species richness and the number of mites in lakes and floodplain ponds. Representatives of the genera *Piona* (*P. carnea*, *P. coccinea* and *P. conglobata*) and *Limnesia* prevailed in number and frequency of occurrence in lakes. There were no obvious dominants. We also identified the highest number of mite species in floodplain ponds. Most species had low numbers. The eudominant was *Piona pusilla*, which represented 32.7% of all mites found in this type of water bodies, and the dominant was *Limnesia koenikei*.

In temporary ponds, the species richness of mites was low, nevertheless, the study in these water bodies lasted only one season. However, Parathyas species prevailed both in number and frequency of occurrence, along with *Limnesia koenikei*.

Sphagnum bogs had the smallest number of mite species, however 118 specimens of *Porolohmannella violacea* were collected, which accounting for 67.1% of all mites found in bogs. This species also prevailed in frequency of occurrence and was found in 5 of the 6 bogs studied.

The faunal similarity among the studied water bodies was relatively low (Fig. 2). Lakes and various floodplain ponds with abundant development of macrophytes had the most similar mite fauna and create one cluster. These are types of water bodies most similar at each other with similar conditions of habitation. However, as the number and species composition of mites in everyone of water bodies was strongly differed, the similarity was low, only 28%.

Faunal compositions in the bogs and temporary ponds differed significantly from each other and from the first two groups of water bodies.

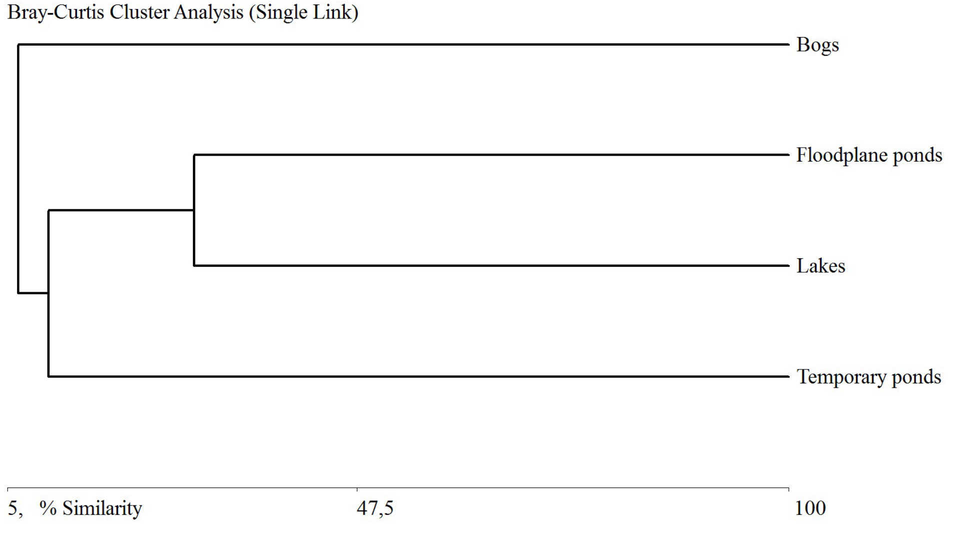

Figure 2. Bray-Curtis similarity analysis of water mite assemblages across water bodies.

Discussion

Most of the identified mites belong to widespread species with Palearctic or Holarctic distribution (Davids et al. 2007; Di Sabatino et al. 2010; Gerecke et al. 2016). However, the research also identified rarer species with narrower ranges, in particular, *Parathyas diremptellus*, *Pionacercus tundrosum*, and *Hydrochoreutes similis*, recently described from the north of the Russian Far East (Magadan region, Chukotka) (Tuzovskij 2007, 2012, 2013) and later also found in Western Siberia (Stolbov et al. 2021). Moreover, for the first time for the Russian fauna, the research discovered the species *Unionicola parvipora*, distributed in northern, western, and central Europe (Gerecke et al. 2016).

Most of the water mite species belonged to eurybiontic species that inhabit a variety of lentic and slow-flowing waters. In this regard, many species were found in several groups of the studied water bodies. However, the faunal similarity of the water mites in the water bodies was low. The faunal similarity of the water mites in four groups of water bodies was also low. This is probably due to different conditions in different water bodies (substrate composition, the abundance of higher aquatic vegetation, etc.).

The water mite faunas of the lakes and floodplain ponds were the most similar to each other. The shallow depth at the sampling site and the abundance of macrophytes provided favorable conditions for the development of water mites. In the permanent lentic water bodies included in this study, most species of mites belonged to species typical for different types of lentic and slow-flowing waters rich in submerged vegetation.

In temporary ponds, representatives of the specific spring mite fauna characteristic of astatic water bodies prevailed. These are representatives of the genus *Parathyas* and some species of the family Pionidae (*Piona inflata*, *Acercopsis pistillifer*); quantitatively, they prevailed over eurybiontic species. These species are typical representatives of the spring fauna and are characteristic of astatic ponds (Tuzovskij 1996; Zawal et al. 2020).

Finally, sphagnum bogs were dominated by water mite species typical for these habitats. Eurybiontic species were found in them only once, at the same time, the species characteristic of sphagnum bogs (Tuzovskij 2013; Więcek et al. 2013) – *Pionacercus tundrosum*, *Arrenurus stecki* – were also few in number. The representatives of Halacaroidea dominated both in number and frequency of occurrence. They accounted for 84.4% of all mites found in the bogs. Earlier research had found that Halacaroidea could dominate in numbers in some sphagnum bogs of the south of Western Siberia (Stolbov et al. 2018b).

In general, water mites in the water bodies of the Malaya Sosva Nature Reserve are quite numerous and have a high species richness. The study marked almost all families and genera of water mites known for lentic waters in Western Siberia. In comparison, in another reserve of the Khanty-Mansiysk Autonomous Okrug – the Yugansky Nature Reserve – only 29 species of mites were identified, but mainly in large rivers (Stolbov et al. 2018a). This is quite interesting in comparison with the fauna of other hydrobionts, in particular, gastropods. According to Vinarsky and Karimov (2015), the malacofauna of the Malaya Sosva Nature Reserve is very poor both at the species level and at the level of genera and families level. It is significantly less rich in species than neighboring territories of Western Siberia, including the northern ones.

Conclusion

We examined the water mite fauna of the Malaya Sosva Nature Reserve, located in the northern middle taiga of Western Siberia. Our findings showed that water mites are abundant and highly diverse in various types of lentic waters in the reserve. These data can be used for bioindication of lake pollution, which is important for assessing the impact on aquatic habitats in the north of Western Siberia, which is under significant anthropogenic pressure.

It should be noted that the current study focused only on the fauna of lentic waters. In contrast, flowing waters support a vast array of water mites, as demonstrated by previous research. Further investigations on the lotic water mite fauna would significantly contribute to expanding the species list of acarofauna of water bodies in the Malaya Sosva Nature Reserve and the Khanty-Mansi Autonomous Okrug.

Acknowledgements

The authors express deep gratitude to Dr. P.V. Tuzovskij (Borok) for his help in identifying some doubtful species of water mites. The authors are thankful to A.L. Vasina and A.A. Shestakova, the staff of the Malaya Sosva Nature Reserve, for their help in conducting the research. This research was supported by the cooperative agreement No. FEWZ-2021-0004 from the Russian Ministry of Science and Higher Education.

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