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DENSITY AND DIVERSITY OF AQUATIC MITES IN A GLACIER-FED RIVER MANDAKANI FROM GARHWAL CENTRAL HIMALAYA, INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author PB designed the present study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors KKR and RR managed the analyses of the study. Author NCK managed the literature search and manuscript preparation. All authors have read and approved the final manuscript.

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ABSTRACT

The Hydrachnidia (Aquatic mites, Hydracarina) are the taxonomically most diversified group of the acari in freshwaters and are abundant species in lotic habitats that are often neglected. The present study was carried out during the period of October, 2018 - September, 2019 to assess the density and diversity of aquatic mites in a glacier-fed river Mandakani. Various indices were used to analyze the data. A total of 23 species of aquatic mites were recorded throughout the study period. Aquatic mites showed maximum (199 individuals/m^2) density and diversity in the month of December and minimum (03 individuals/m^2) density and diversity in the month of July. Number of different diversity and richness indices is applied to recorded data. Family Torrenticolidae were found to be most diverse consisting of ten different species whereas family Aturidae was found to be least diverse with only two reporting species. *Sperchon indicus, Sperchon garhwalensis, Monatractides oxystomus, Atractides indicus, Kongsbergia rucira* and *Torrenticola turkestanica* were observed to be the dominant aquatic mite species in the Mandakani River during present study.

Keywords: Aquatic mites; Glacier-fed Mandakani River; Garhwal Central Himalaya.

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1. INTRODUCTION

Aquatic mites are the most important group of fresh water arachnids and aquatic invertebrates [1]. The overall global diversity of water mites is estimated at least 10,000 species [2]. The ecological importance of aquatic mites in freshwater ecosystems is still underestimated. Water current is one of the basic factors influencing the formation of water mite assemblages in lotic ecosystems [3,4,5,6]. The parasitic larval and predatory adult stage in the life cycle of Water mites provides an invaluable characteristic in relation to the other macroinvertebrate fauna [2,7,8,9]. Aquatic mite assemblages not only replicate the natural provisions of the mite species present at the site, but also incorporate the habitat demands of a large part of the benthic community, as mites depend on an array of other species as prey and hosts [10]. Water mites can be employed as bio-indicators for certain habitats and environmental conditions [11].

Pesic et al. [12] prepared the checklist of Indian water mites that includes 275 species belonging to 70 genera and 25 families. Taxonomic studies on the aquatic mite fauna of Garhwal Himalayas has been carried out by Kumar and Dobriyal [13]. Kumar et al. [14,15], Pesic et al. [16,17], Pesic et al., [18,19], Pesic et al. [20,21] and Bahuguna and Negi [22] restarted the taxonomic study on aquatic mites in India after a gap of two long decades. Pioneer work involving analysis of density and diversity aquatic mites from Randi Gad was carried out by Bahuguna et al. [23]. Despite of such efforts detailed and comprehensive information a big lacuna is present on the aquatic mites and their various aspects. Henceforth, the present study may fill up the gap in literature regarding density and diversity of hill stream mites from Garhwal Himalayas as this is for the first time that density and diversity of aquatic mites studied in a glacier-fed Mandakani River in India.

2. MATERIALS AND METHODS

2.1 Study Area

The present study was conducted on Mandakani River which originates near Kedarnath from the Chorabari Glacier. It is fed by Vasuki Ganga River at Sonprayag and a tributary of Mandakani River. Mandakani joins Alaknanda at Rudraprayag and thereafter known as so after this point. The length of this River is approximately 65km. Three different locations were identified for sampling on Mandakani River designated as A, B and C as shown in Fig. 1 in Rudraprayag, Uttarakhand. The study area is located between latitude 30°20'40.18" to 30° 25'34.95"N and longitude 78°58'34.29" to 79°04'10.02"E at Chandrapuri (A), near A.P.B.P.G. College Agastyamuni (B) and near Tilwara market (C) in Rudraprayag (Fig. 1).

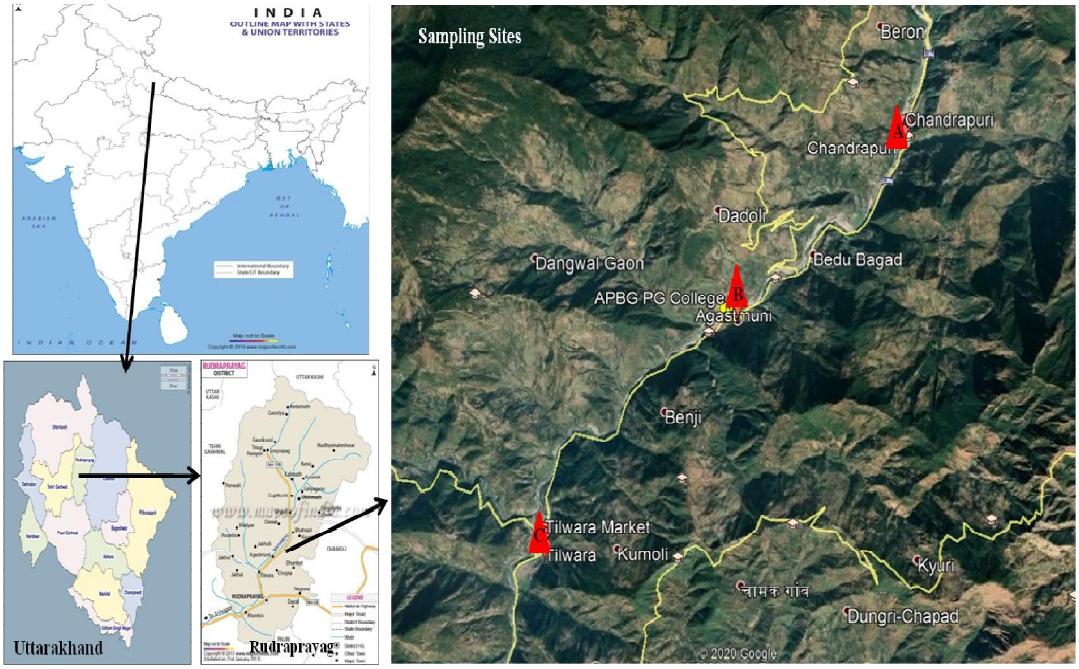

Fig. 1. Location of three sampling sites as A, B and C

2.2 Sampling Design and Analysis

For density and diversity of aquatic mites a square framed Surber Sampler was used that enabled the sampling of 1 m^2 of the River bed. The mite samples were collected from the stone very carefully. All collected aquatic mites were preserved in 70% ethanol in the field and later on aquatic mites were transferred to Koenike's fluid and dissected. Species identification was done with the help of various keys provided by Cook [24,25], Prasad [26], Gerecke [27], Kumar et al. [14,15], Pesic and Panesar [28], Pesic et al. [16,17], Pesic et al. [18,19] and Pesic et al. [20,21]. Statistical analysis was done with the help of PAST statistical software.

3. RESULTS AND DISCUSSION

During the present study density and diversity of aquatic mites in glacier-fed Mandakani River was recorded for one year to assess the monthly variation. In the course of study period from October, 2018 to September, 2019, a total number of 23 species of aquatic mites were observed from the glacier-fed Mandakani River. Overall the aquatic mites were identified under five families; among those family Torrenticolidae were found to be most diverse consisting of ten different species (*Torrenticola muranyii, T. uttarakhandensis, T. rangareddyi, T. chatterjeei, T. turkestanica, T. wonchoeli, T. kumari, M. garhwalensis, M. kontschani and M. oxystomus*). Whereas, family Aturidae (*Kongsbergia indica and K. rucira*) and Feltriidae (*Feltria indica* and *F. gereckei*) was found to be least diverse with only two reporting species as provided in Table 1.

In the months of December, 2018 and January, 2019, highest number of aquatic mites was reported 199 ind./m^2 and 197 ind./m^2 simultaneously among the five reported families (Aturidae, Feltriidae, Hygrobatidae, Torrenticolidae and Sperchontidae); whereas the least number were reported in the month of July 2019 (03 ind./m^2) as summarised in Table 2. A maximum of 23 species was recorded in December, 2018 followed by October, 2018 and January, 2019 both with a total of 20 species while a minimum of 03 species was reported in July, 2019. Similar results have been observed by Bahuguna et al. [23] in spring fed Randi Gad stream of Garhwal Himalayas. They reported that a total of fourteen species from five families were observed in spring fed stream water. A maximum number of 138 mites m^{-2} was recorded in the month of January and minimum density of 03 mites m^{-2} was observed in July, 2018.

Sperchon indicus, Sperchon garhwalensis, Monatractides oxystomus, Atractides indicus, Kongsbergia rucira and *Torrenticola turkestanica* were observed to be the dominant aquatic mite species in the Mandakani River during present study. The dominant species obtained in the spring fed stream Randi Gad was *Torrenticola turkestanica, Monatractides oxystomus, Sperchon indicus, Sperchon garhwalensis, Atractides indicus*, *Atractides garhwali, Kongsbergia indica, Kongsbergia rucira and Feltria gereckei* [23]. Jonasson [29] noticed that low abundance of water mites in deep zones, and other predators, have been attributed to their low resistance to anoxic waters. From the study of Mindelsee water mites, it was found that oxygen level play a significant role in water mite distribution [30].

As per the present recorded data it is evident that abundance of aquatic mites was higher in winter season (in the month of December 2018 and January 2019) compared to monsoon season (in the month of July and August 2019) in Mandakani River. Bahuguna et al. [23] opined that the highest number of aquatic mites observed in winter season may be correlated with moderate to high periphyton growth in a spring fed Randi Gad stream of Garhwal Himalaya [23]. It may also be because of the shift in habitat and organisms due to increase in water level or flow. The observations recorded in present study are in line with Kumar and Dobriyal [31], Dutta and Malhotra [32] and Kumar [33]. Various factors such as temperature, water current, vegetation, substratum, dissolved substances, food, competition between species etc. regulates the occurrence and distribution of stream invertebrates as studied by Hynes [34]. Several acarologist [35,36,37] opined that food availability and the presence of potential hosts as key factors in the maintenance of water mite populations.

The analysis of data is usually done by using various indices. On utilizing the PAST statistical software tools various indices were carried out month-wise which is represented in Table 3. The calculation of alpha (α) diversity indices which showed 10 indicative parameters as total number of mites taxon, number of mites individuals, Simpson species dominance "D" (1-Simpson index), Simpson species evenness index (1-D), Shannon-Wiener index ($H^{'}$), Buzas and Gibson's evenness index (e^H/S), Brillouin index, Menhinick's richness index ($S/\sqrt{n}$), Margalef diversity index (S-1/ln.n) and Pielou's equitability index.

Table 1. Density and diversity of aquatic mites in Glacier-fed River Mandakani during October 2018 to September 2019

	Name of species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
A.	**Family - Aturidae Thor, 1900**												
	Genus - *Kongsbergia* Thor, 1899												
1	*Kongsbergia indica*	08	02	22	19	04	00	04	03	05	00	00	00
2	*Kongsbergia rucira*	02	12	16	14	10	08	07	12	08	00	00	01
	Total	**10**	**14**	**38**	**33**	**14**	**08**	**11**	**15**	**13**	**00**	**00**	**01**
B.	**Family - Feltriidae K. Viets, 1926**												
	Genus - *Feltria* Koenike, 1892												
3	*Feltria indica*	03	00	02	00	01	00	02	00	00	00	00	00
4	*Feltria gereckei*	00	11	12	00	08	08	05	00	06	01	00	03
	Total	**03**	**11**	**14**	**00**	**09**	**08**	**07**	**00**	**06**	**01**	**00**	**03**
C.	**Family - Hygrobatidae Koch, 1842**												
	Genus - *Hygrobates* Koch, 1837												
5	*Hygrobates dobriyali*	01	02	02	02	00	00	00	01	00	00	00	00
	Genus - *Atractides* Koch, 1837												
6	*Atractides indicus*	12	15	11	20	19	04	06	03	02	00	00	00
7	*Atractides garhwali*	09	08	15	08	03	04	03	09	05	00	00	03
8	*Atractides yukii*	03	02	08	08	00	03	00	00	01	00	00	00
9	*Atractides panesari*	01	01	02	03	00	00	01	00	00	00	00	00
10	*Atractides incertus*	00	01	09	04	07	04	06	03	05	01	00	00
	Total	**26**	**29**	**47**	**45**	**29**	**15**	**16**	**16**	**13**	**01**	**00**	**03**
D.	**Family - Sperchontidae Thor, 1900**												
	Genus - *Sperchon* Kramer, 1877												
11	*Sperchon indicus*	21	22	27	37	20	15	11	18	09	00	01	12
12	*Sperchon hirsutus*	01	02	03	01	00	02	00	02	00	00	00	00
13	*Sperchon garhwalensis*	16	14	13	22	14	09	06	05	03	00	00	00
	Total	**38**	**38**	**43**	**60**	**34**	**26**	**17**	**25**	**12**	**00**	**01**	**12**
E.	**Family – Torrenticolidae Piersig, 1902**												
	Genus - *Torrenticola* Piersig, 1902												
14	*Torrenticola muranyii*	05	07	06	07	03	01	00	01	04	00	01	00
15	*Torrenticola uttarakhandensis*	06	06	05	07	03	01	00	01	06	00	01	00
16	*Torrenticola rangareddyi*	02	01	01	00	02	01	00	00	01	00	00	00
17	*Torrenticola chatterjeei*	03	00	07	05	03	00	05	01	05	00	02	01
18	*Torrenticola turkestanica*	18	14	08	13	17	05	05	07	00	01	02	00
19	*Torrenticola wonchoeli*	01	00	02	05	01	00	02	01	02	00	00	01
20	*Torrenticola kumari*	00	03	06	03	00	01	02	00	02	00	00	00
	Genus - *Monatractides* K. Viets, 1926												
21	*Monatractides garhwalensis*	03	02	01	03	00	02	03	00	04	00	00	00
22	*Monatractides kontschani*	01	00	01	02	00	00	00	01	00	00	00	00
23	*Monatractides oxystomus*	10	15	20	14	15	06	06	07	00	00	00	05
	Total	**49**	**48**	**57**	**59**	**44**	**17**	**23**	**19**	**24**	**01**	**06**	**07**

Table 2. Family wise density of aquatic mites in Glacier-fed River Mandakani during October 2018 to September 2019

Name of Family	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Aturidae	10	14	38	33	14	08	11	15	13	00	00	01
Feltriidae	03	11	14	00	09	08	07	00	06	01	00	03
Hygrobatidae	26	29	47	45	29	15	16	16	13	01	00	03
Sperchontidae	38	38	43	60	34	26	17	25	12	00	01	12
Torrenticolidae	49	48	57	59	44	17	23	19	24	01	06	07
Total	**126**	**140**	**199**	**197**	**130**	**74**	**74**	**75**	**68**	**03**	**07**	**26**

Table 3. Dominance and diversity indices of aquatic mites in Glacial fed River Mandakani based on Past

Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Taxa-Species	20	19	23	20	16	16	16	16	16	03	05	07
Total number	126	142	199	197	130	74	74	75	68	03	07	26
Dominance	0.09574	0.09041	0.07351	0.09026	0.1031	0.103	0.07962	0.126	0.08045	0.3333	0.2245	0.2811
Simpson	0.9043	0.9096	0.9265	0.9097	0.8969	0.897	0.9204	0.874	0.9196	0.6667	0.7755	0.7189
Shannon- Wiener	2.58	2.58	2.798	2.646	2.445	2.477	2.636	2.342	2.622	1.099	1.55	1.548
Evenness	0.6596	0.6949	0.7138	0.7049	0.7203	0.7444	0.8723	0.6499	0.86	1	0.9421	0.6718
Brillouin	2.348	2.372	2.608	2.473	2.251	2.184	2.325	2.064	2.294	0.5973	1.02	1.266
Menhinick	1.782	1.606	1.63	1.425	1.403	1.86	1.86	1.848	1.94	1.732	1.89	1.373
Margalef	3.929	3.643	4.156	3.596	3.082	3.485	3.485	3.474	3.555	1.82	2.056	1.842
Equitability	0.8611	0.8764	0.8925	0.8833	0.8817	0.8936	0.9507	0.8446	0.9456	1	0.963	0.7956

Considering the Simpson species dominance feature the highest value was found in the month of July, 2019 (0.3333); whereas least was reported from December 2018 with a value of 0.07351. Simpson species dominance, Shannon-wiener, Brillouin and Margalef indices were highest in the month of December, 2018 recording a value of 0.9265, 2.798, 2.608 and 4.156 respectively, whereas lowest was found in July, 2019 with a value 0.6667 (Simpson species dominance), 1.099 (Shannon-Wiener), 0.5973 (Brillouin) and 1.82 (Margalef diversity) respectively. Buzas and Gibson's evenness index (e^H/S) was maximum in July (1) and August (0.9421) when number of taxa were almost equal to number of individuals mites. Menhinick's richness index also supports the dominance index which was high when a few species were dominant and minimum when evenness was more. Pielou's equitability index maximum value was reported in July, 2019 (1.0). This index also behaves like dominance and richness index with high values in few species dominance and low in evenness of different species. The density and diversity of aquatic mites were recorded maximum during winter months (December, 2018 and January, 2019) and lowest during monsoon months (July and August, 2019).

4. CONCLUSION

During present study density and diversity of aquatic mites were found good in the Glacier-fed Mandakini River. The diversity, abundance and community structure of mite population is extremely sensitive to water quality [38]. The aquatic mites are capable of providing highly integrative and distinctive monitoring potential owing to their complex habitat interrelationships with other members of the macro-fauna [39]. The absence of anthropogenic pressure in the high attitudes of Himalaya (Least human interference, usage of bio-fertilizers, no discharge of sewage water into the stream) resulted in good water quality providing healthy ecosystem for the growth of aquatic mites despite of it being a cold water stream.

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