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Drifting-Density and Diversity of Aquatic Mites in the Spring-Fed Stream Heval from Garhwal Himalaya

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ABSTRACT

Drift is a major feature in the continuous distribution of macroinvertebrates. In the current study, the density and variety of mites that float in the spring-fed stream Heval are observed and evaluated. During the evaluation period from December 2021 to February 2022, a maximum of 15 species from six families were recorded. The Dobriyal-Bahuguna Drifting Index (DBDI) gives insight into the relationship between the population that is in the environment at a given time and the population that chooses to drift or is forced to drift. The findings of DBDI revealed that the maximum drifting value (0.2886) for all mite populations was observed in February in the spring-fed stream Heval. In contrast, it was at its lowest (0.2513) in December.

Keywords: Drift, macroinvertebrates, spring-fed stream Heval, DBDI

INTRODUCTION

The "downstream transport of aquatic organisms in the current" described by Muller (1954) has become a central topic in freshwater science. Drift is a major component of the continuous distribution of benthic macroinvertebrates (Townsend and Hildrew 1976), which also includes upstream movements, aerial ovideposition by adult insects, and vertical movements through the substrate (Muller 1982). According to Brittain and Eikeland (1988) four categories of drift are frequently mentioned; (1)- Catastrophic (2)- Related to hydrological or chemical disturbances (3)- Behavioral, resulting from the overall activity of stream invertebrates (4)- Distributional, resulting from dispersal exigencies and accidental dislodgment from the substrate. Stream macroinvertebrates have excellent dispersal ability (Muller, 1982), and drift plays a crucial role in the colonization cycle of freshwater insects.

Water mites have a huge impact on maintaining the food chain because they control the population of other invertebrates (Bahuguna and Dobriyal, 2022). Pioneering work including aquatic mite density, diversity, population structure, drifting patterns, and diel drifting patterns from spring-fed streams in Randi Gad was analyzed by Bahuguna et al. (2019), Bahuguna & Dobriyal (2020), Negi et al. (2021a,b), and Bahuguna and Dobriyal (2022). Bahuguna et al. (2020) and Bahuguna and Dobriyal (2022) have studied the density, variety, drifting behaviour, and drifting pattern of aquatic mites in a glacier-fed River Alaknanda from the Garhwal Central Himalaya. Observing and assessing the density and diversity of mites that drift in the spring-fed stream Heval was the goal of this study.

MATERIAL AND METHODS

Study area: Present work carried out on spring-fed stream Heval which is one of the many tributaries of the Ganges, originates as Khuret Gad/Khurait Gad from the forests, near Surkanda Devi and Nagdevta temple in Tehri Garhwal district, and finally meets with River Ganga at Shivpuri near Rishikesh. With varied elevations between 370 and 2220 meters, it is situated between 30° 8'9.64"N, 78°23'20.52"E, and 30°25'2.19"N, 78°17'58.86"E.

Sampling Analysis

The study was carried out between December 2021 to February 2022. For the purpose of the drifting behaviour study, a 100 m stretch was selected for sampling. We employed a new design of a drifting net with a metallic frame i.e. Bahuguna drifting net. Its internal dimension was one cubic metres ($1m^3$; W x D x H) and had a 220-micron mesh size. Bahuguna drifting Net (Fig.1; Bahuguna and Dobriyal, 2020) was operated once at the uppermost proximity of the selected sampling area and the other at the lowermost reach. The locations chosen for net installation had moderate to slow water current velocity. Because the study was conducted over a 24-hour period, the nets were set for four hours at a time and then quickly replaced by another set. The collected sample was preserved in Koenike's fluid and afterward sorted in the lab under a 100x magnification microscope. Species identification was accomplished using various keys provided by various experts (Cook, 1967, 1974; Prasad, 1974; Gerecke, 2003; Kumar et al., 2006, 2007; Pesic and Panesar, 2008; Pesic et al., 2007a, b; 2019a, b; 2020a, b; Bahuguna and Negi 2020).

Based on the drift.m^2.h^{-1}, a new Dobriyal-Bahuguna Drifting Index (D.B.D.I.) was developed for aquatic mites. It also provides insight into the relationship between the population that is present in the environment at a given time and the population that chooses or is compelled to drift. Following is a description of the Dobriyal-Bahuguna Drifting Index (D.B.D.I.) developed for aquatic mites:

D.B.D.I. (drift.m^2.h^{-1}) = $\sqrt{(D_{dm} / T_{mp}.T)}$

Where:

D.B.D.I. = Dobriyal-Bahuguna Drifting Index.

D_{dm} = No. of mites drifting sampled in $1m^2$ sampler

T_{mp} = Total mite population in $1m^2$ area

T = Time used in collecting the sample in hours

RESULTS

Table 1 shows the temporal variations in the total number (density) of different aquatic mites (per m^2) and the number of diel drift mites in the spring-fed stream Heval during 2021 and 2022. In January 2022, 103 mites per square meter were the highest recorded mite density (Table 1), and the highest drifting population was seen in January 2022 (28 drift.m^2.h^{-1} –Table 2). Table 3 displays the structural compositions of the aquatic mites drifting against the density in the Heval River.

A total of 15 species belonging to six families, **Family-Torrenticolidae-***Torrenticola turkestanica, Torrenticola semisuta, Monatractides garhwalensis, Monatractides tuzovskyi,* **Family- Sperchontidae-***Sperchon indicus, Sperchon garhwalensis,* **Family - Hygrobatidae –** *Atractides indicus, Atractides garhwali, Hygrobates gangeticus,* **Family- Aturidae-***Kongsbergia indica, Aturus fontinalis,* **Family- Arrenuridae -***Arrenurus kurtvietsi, Arrenurus fontinalis,* **Family- Feltriidae -***Feltria gereckei, Feltria rubra* were observed.

Dobriyal-Bahuguna Drifting Index (D.B.D.I.): Table 4 displays the month-wise variation in the Dobriyal-Bahuguna Drifting Index (DBDI) for water mites in spring-fed stream Heval. The DBDI value ranged from 0.2513 (in December) to 0.2886. (Feb.). The DBDI value revealed that in the spring-fed stream Heval, the maximum drifting value (0.2886) for all mite populations was found in February. However, it was recorded lowest in December at 0.2513.

DISCUSSION

In the period from December 2021 to February 2022, a maximum of 15 species belonging to six families were noted. Bahuguna et al. (2019) found comparable outcomes in the spring-fed Randi Gad stream in the Garhwal Himalayas. They noted that spring-fed stream water included a total of fourteen species from five families. In January 2018, there were a maximum of 138 mites per square meter, and in July 2018, there were only three. According to Bahuguna et al. (2019), in the spring-fed Randi Gad stream of the Garhwal Himalaya, the maximum number of aquatic mites recorded in the winter may be correlated with moderate to high periphyton growth.

Some studies have interpreted drift as a density-dependent process (Waters, 1961), despite the fact that more recent research has demonstrated that movements of highly mobile organisms are independent of natural riverbed abundance (Humphries 2002). According to certain research, drift in temperate regions was typically lowest in the winter (Clifford 1972, Brittain and Eikeland 1988). Comparatively, we also reported less drift in December.

According to several studies (Minshall and Petersen 1985, Mackay 1992), drift is the predominant process of redistributing benthic creatures in streams, and recolonization investigations in running water habitats have demonstrated that animals promptly reappear in impacted areas (Williams 1980). For instance, a recent study in the northwest demonstrated that colonization's primary route is downstream displacement (Fenoglio et al. 2002). Rapid animal colonization and movement between habitat patches appear to be crucial elements of lotic system dynamics on a variety of scales (Speirs and Gurney 2001). Explaining the structure and adaptability of benthic ecosystems requires an understanding of the patterns and mechanisms governing the movements of macroinvertebrates.

The stream's rich riparian vegetation demonstrated an increase in the biological productivity of the stream (Sagir et al., 2018; Baluni and Chandola, 2019; Sharma et al., 2022). Numerous authors noted the presence of macro and microzoobenthos along with rich epilithic periphyton and debris standing stock (Bahuguna et al., 2021). The diversity and distribution of periphyton in relation to the physical-chemical characteristics of streams greatly influence the presence of various aquatic mites (Kumar and Dobriyal, 1992; Balodi et al., 2004; Pesic et al., 2020a-b; 2022a,b; Baluni et al., 2017, 2018, 2020; Bahuguna et al., 2019a, 2020a; Baluni 2020; Negi et al., 2021a,b; Rana et al., 2022), macrozoobenthos (Rautela et al., 2006; Kumar and Dobriyal, 1999; Bahuguna and Dobriyal, 2018; Mamgain et al., 2021), drifting behavior of macrozoobenthos (Bahuguna et al., 2019b, 2020b; Bahuguna and Dobriyal, 2020) and on fish diversity (Bahuguna et al., 2010; Bahuguna and Joshi, 2012; Rayal et al., 2021 a, b).

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Declaration: *We also declare that all ethical guidelines have been followed during this work and there is no conflict of interest among authors.*

Fig. 1: Bahuguna Drifting Net

Table 1: Density and diversity of aquatic mites in spring-fed stream Heval from December 2021 to February 2022.

S.N.	Name of species	Dec	Jan	Feb
1	**Family – *Torrenticolidae Piersig*, 1904**			
i	*Torrenticola turkestanica*	10	09	06
ii	*Torrenticola semisuta*	10	07	05
2	**Family – *Sperchontidae Thor*, 1900**			
i	*Sperchon indicus*	06	10	08
ii	*Sperchon garhwalensis*	10	06	06
3	**Family - *Hygrobatidae Koc*h, 1842**			
i	*Atractides indicus*	05	06	02
ii	*Atractides garhwali*	05	08	04
iii	*Hygrobates gangeticus*	00	06	04
4	**Family - *Aturidae Thor*, 1900**			
i	*Kongsbergia indica*	04	07	04
ii	*Aturus fontinalis*	03	**05**	**03**
5	**Family - *Arrenuridae Thor*, 1900**			
i	*Arrenurus fontinalis*	03	06	01
ii	*Arrenurus kurtvietsi*	04	06	05
6	**Family - *Feltriidae K.Viets*, 1926**			
i	*Feltria gereckei*	04	04	02
ii	*Feltria rubra*	00	04	01
	Total no of individual species	**79**	**103**	**69**

Table 2: Drift Density and diversity of aquatic mites in spring-fed stream Heval December 2021 to February 2022.

S.N.	Name of species	Dec	Jan	Feb
1	**Family – *Torrenticolidae Piersig*, 1904**			
i	*Torrenticola turkestanica*	02	01	01
ii	*Torrenticola semisuta*	01	01	00
2	**Family – *Torrenticolidae Piersig*, 1904**			
i	*Monatractides garhwalensis*	02	04	04
ii	*Monatractides tuzovskyi*	02	03	03
3	**Family – *Sperchontidae Thor*, 1900**			
i	*Sperchon indicus*	04	04	03
ii	*Sperchon garhwalensis*	02	01	02
4	**Family - *Hygrobatidae Koch*, 1842**			
i	*Atractides indicus*	01	01	02
ii	*Atractides garhwali*	01	03	02
iii	*Hygrobates gangeticus*	00	01	01
5	**Family - *Aturidae Thor*, 1900**			
i	*Kongsbergia indica*	01	01	01
ii	*Aturus fontinalis*	0	**00**	**01**
6	**Family - *Arrenuridae Thor*, 1900**			
i	*Arrenurus fontinalis*	00	02	00
iii	*Arrenurus kurtvietsi*	01	02	02

7	**Family - *Feltriidae K.Viets*, 1926**			
i	*Feltria gereckei*	02	02	01
ii	*Feltria rubra*	01	02	00
	Total no of individual species	20	28	23

Table 3: Structural composition of the aquatic mites drifting against density in the spring-fed stream Heval (3rd order stream).

S.N.	Name of species	Density of mites (mites/m^2)	T_{mp}	No. of drifting species	D_{dm}
Dec. 2021	*Torrenticola turkestanica*	10	79	02	20
	Torrenticola semisuta	10		01	
	Monatractides garhwalensis	09		02	
	Monatractides tuzovskyi	06		02	
	Sperchon indicus	06		04	
	Sperchon garhwalensis	10		02	
	Atractides indicus	05		01	
	Atractides garhwali	05		01	
	Hygrobates gangeticus	00		00	
	Kongsbergia indica	04		01	
	Aturus fontinalis	03		0	
	Arrenurus kurtvietsi	04		01	
	Arrenurus fontinalis	03		00	
	Feltria gereckei	04		02	
	Feltria rubra	00		01	
Jan. 2022	*Torrenticola turkestanica*	09	103	01	28
	Torrenticola semisuta	07		01	
	Monatractides garhwalensis	10		04	
	Monatractides tuzovskyi	09		03	
	Sperchon indicus	10		04	
	Sperchon garhwalensis	06		01	
	Atractides indicus	06		01	
	Atractides garhwali	08		03	
	Hygrobates gangeticus	06		01	
	Kongsbergia indica	07		01	
	Aturus fontinalis	05		**00**	
	Arrenurus kurtvietsi	06		02	
	Arrenurus fontinalis	06		02	
	Feltria gereckei	04		02	
	Feltria rubra	04		02	
Feb. 2022	*Torrenticola turkestanica*	6	69	01	23
	Torrenticola semisuta	5		00	
	Monatractides garhwalensis	9		04	
	Monatractides tuzovskyi	8		03	
	Sperchon indicus	8		03	
	Sperchon garhwalensis	6		02	
	Atractides indicus	2		02	
	Atractides garhwali	4		02	
	Hygrobates gangeticus	4		01	
	Kongsbergia indica	4		01	
	Aturus fontinalis	3		01	
	Arrenurus kurtvietsi	5		02	
	Arrenurus fontinalis	1		00	
	Feltria gereckei	2		01	
	Feltria rubra	1		00	

Table 4: Dobriyal-Bahuguna Drifting Index (DBDI) values calculated from December 2021 to February 2022.

Month	**D_{dm}** (Number of drifting mites sampled in $1m^2$area in stream)	**T_{mp}** (Number of mites in $1m^2$ area in the stream)	**T** (Time taken for sampling)	(D_{dm}/ T_{mp}.T)	**DBDI =** √ (D_{dm}/ T_{mp}.T)
December, 2021	20	79	4	0.0632	0.2513
January, 2022	28	103	4	0.0679	0.2605
February, 2022	23	69	4	0.0833	0.2886

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