



# Study on Diversity of Rotifers in High Altitude Water Sources

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**Abstract:** The study was conducted on rotifer diversity flourishing in some lotic and lentic water sources of district Doda of Jammu and Kashmir. From the lotic water bodies, a total of fifteen species and from lentic waters, seventeen rotifer species were enlisted. Dominance of rotifer *Lepadella ovalis* in lotic waters and *Lecane closteroerca* in lentic waters was observed. Three rotifer species namely *Keratella serrulata*, *Notholca labis* and *Synchaeta oblonga* were recorded for the very first time in lentic water bodies of Doda district.

**Keywords:** Zooplankton, Habitat preference, Bio-indicator, Trophic status

Zooplankton are an integral part of any aquatic ecosystem and play a pivotal role in food web. Diversity and distribution of zooplankton is governed by number of biotic and abiotic factors and thus, they act as bio-indicator of health of aquatic system (Singh et al., 2013). Among zooplankton, rotifers are an important group and species diversity of rotifers is indicative of the trophic status of water body.

The phylum Rotifera, comprises of small microscopic organisms with average size varying from 100-1000  $\mu\text{m}$  but few may acquire size of 2000 $\mu\text{m}$ . These comprise an important component of zooplankton and are cosmopolitan in distribution, usually free living herbivores, predators and few are parasitic (Wallace et al., 2015). These are a sensitive group of micro-organisms with diverse morphological types and are important as first food of fish larvae. These organisms are mostly free-living (swimming or crawling) but many are sessile. Majority are solitary and few are colonial as well (Wallace and Snell 2001).

Although the contribution of rotifers is small compared to total zooplankton biomass, because of small size; yet they play important part in the ecosystem of an aquatic system. These microorganisms have high ingestion rates (biomass consumed per animal per unit time) and thus, have high assimilation efficiency. Rotifers reproduce rapidly and their abundance and species composition often reflects the trophic status of a water system, and thus act as indicators (Parmar et al., 2016, Loveson et al., 2020). Rotifers form an important hinge in the aquatic food web, being prey for insect larvae, cladocerans, copepods, planktivorous fish and in turn are feed on loose periphytons, detritus, algae and small plankton.

Rotifer diversity and distribution chiefly depends upon the environmental conditions of water body such as availability of

food, presence of predators or abiotic factors and therefore the distributional pattern of rotifers is not even. Such qualitative and quantitative unevenness in distribution of rotifers is also seen along altitude. Various researchers from other areas of Jammu and Kashmir has tried to study rotifer diversity Achers (Jamila et al., 2017, Kour et al., 2022) but very less work on rotifer diversity has been undertaken from high altitude areas like Doda.

Thus, keeping in view their unique body architect, importance in fisheries, cosmopolitan distribution and their role as water quality indicators, an attempt has been made presently to record the diversity and distribution of rotifers in the Doda district of Jammu province, J & K.

## MATERIAL AND METHODS

**Study site:** Doda district falls between 32°53' and 34°21' North latitude and 75°1' and 76°47' East longitude. On northern side lies district Anantnag of Kashmir, on southwest and south are Udhampur, Kathua of Jammu and Chamba areas of Himachal Pradesh. On east and south east is Leh district. Altitude varies from 841 to 4341 m above msl. The total of five lotic (Chinta, Neeru, Bhadarwah nallah, Puldoda and Banihal) and five lentic water bodies (Lake I, Lake II, Laker III, Fish pond Lingai and Sarkoot) from Doda district were surveyed for collection of rotifers.

**Sample collection:** The collection of rotifers was done at all the stations by filtering 50 litres of water through plankton net (bolting silk, 25 $\mu\text{m}$  mesh) during morning hours. The stations which had marginal vegetation the collection was made by vigorously shaking vegetation before filtering, in order to detach the organisms. The filtrate was collected in 20 ml plastic bottles and for preservation of rotifers 5% formalin was added.

**Abiotic parameters:** Data was collected on six parameters (air and water temperature, dissolved oxygen, free carbon dioxide, calcium and pH) following standard methods by (APHA 1992).

**Qualitative estimation of rotifers:** Identification of rotifers was done by scanning under microscope in laboratory and identification was done by following various sources and identification keys (Pennak 1978, Adoni 1985, Battish 1992, Edmonson 1992). The confirmation of rotifer species was done by study of their mastax which was exposed using Sodium hypochlorite.

**Qualitative estimation of rotifers:** The quantitative estimation of rotifers was done as

$$\frac{\text{Number of organisms per drop} \times \text{Volume of concentrated sample in ml}}{\text{Volume of original sample} \times \text{Volume of one drop (ml)}}$$

$$\text{Frequency} = \frac{\text{Total number of quadrants in which species occurred}}{\text{Total number of Quadrants}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of the species}}{\text{Sum of frequency of all the species}} \times 100$$

$$\text{Density} = \frac{\text{Total number of species individuals of the species}}{\text{Total number of quadrants studies}}$$

$$\text{Relative density} = \frac{\text{Density of the species} \times 100}{\text{Sum of Density of the species}} \times 100$$

$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{Total number of quadrants in which species occurred}}$$

#### Margalef's index (1968)

$$D = \frac{S-1}{\text{Log}(n)}$$

#### Species diversity ( $\bar{H}$ )

$$\bar{H} = -S \sum_{i=1}^{P} (P_i) \log_2 P_i$$

where,

H= information content of sample (bits/individuals)

S= Number of Species.

P= Proportion of total species belonging to 1 species.

## RESULTS AND DISCUSSION

In order to investigate the rotifer fauna of Doda district, 5 lotic systems were investigated and 15 different rotifer species (*Lepadella ovalis*, *Trichocerca rattus*, *Colurella obtusa*, *Colurella uncinata*, *Philodina* sp., *Cephalodella gibba*, *Euchlanis dilatata*, *Lecane conspicua*, *L. closteroerca*, *Trichotria tetractis*, *Mytilina ventralis*,

*Polyarthra vulgaris*, *Testudinella patina*, *Trichocerca stylata* and *Brachionus calyciflorus*) belonging to 11 families were recorded from them (Table 1). Maximum species diversity index among these lotic systems was from Chinta stream whereas, Chenab flowing through Banihal station had complete absence of rotifers for the period of investigation. *Lepadella ovalis* as was most frequent species in these lotic waters. Maximum abundance was also shown by *Lepadella ovalis* (Table 2).

There were 5 perennial lentic waters, investigated in this district from which 17 rotifer species (*Notholca labis*, *Lepadella ovalis*, *Colurella obtusa*, *Colurella uncinata*, *Cephalodella gibba*, *Philodina* sp., *Synchaeta oblonga*, *Brachionus* sp., *B. rubens*, *B. quadridentata*, *B. patulus*, *Lecane* sp., *L. closteroerca*, *L. curvicornis*, *L. (M) bulla*, *Keratella serrulata* and *K. tropica*) belonging to 6 families of 2 orders Ploima and Bdelloidea were recorded (Table 3). The maximum species diversity index was for fish pond. *Keratella serrulata*, *Notholca labis*, *Synchaeta oblonga* are the first report from these waters. *Philodina* sp. and *Lepadella ovalis* were the most frequently encountered rotifers in these lentic waters of Doda district. *Lecane closteroerca* showed maximum density and also maximum abundance (Table 4).

Comparatively, higher species diversity index was in lentic waters than in lotic waters presently investigated in Doda district, as lentic water sources have more stable

**Table 1.** List of rotifers from five lotic water bodies of Doda district

Stations	Species	n/I
Chinta	<i>Lepadella ovalis</i>	0.12
	<i>Trichocerca rattus</i>	0.10
	<i>Colurella obtusa</i>	0.08
	<i>Philodina</i> sp.	0.18
	<i>Cephalodella gibba</i>	0.04
	<i>Euchlanis dilatata</i>	0.12
	<i>Trichotria tetractis</i>	0.06
	<i>Mytilina ventralis</i>	0.04
	<i>Lecane closteroerca</i>	0.16
	<i>Lecane conspicua</i>	0.14
		8.653
Neeru (7.142)*	<i>Colurella uncinata</i>	0.16
	<i>Lecane closteroerca</i>	0.24
	<i>Lecane conspicua</i>	0.04
	<i>Philodina</i> sp.	0.14
	<i>Lepadella ovalis</i>	0.10
	<i>Trichotria tetractis</i>	0.10
	<i>Trichocerca rattus</i>	0.06
Bhaderwah nallah (4.255)*	<i>Polyarthra vulgaris</i>	0.44
	<i>Lepadella ovalis</i>	0.20
	<i>Testudinella patina</i>	0.08
	<i>Trichocerca stylata</i>	0.08
	<i>Brachionus calyciflorus</i>	0.14
Puldoda	<i>Lepadella ovalis</i>	0.04
Banihal (0.00)*	-	-

\*Margalef's index

environment than lotic waters in hilly terrain. Physico-chemical parameters in the lotic waters had well marked differences and showed a range of temperature from 7°C to 21°C, of dissolved oxygen from 4 mg/l to 7.2 mg/l, of calcium from 8.8 mg/l to 16 mg/l, of pH from 6.5 to 8.4 and free carbon-dioxide remained absent at all lotic stations presently studied. In lentic systems, temperature ranged from 7°C to 25°C, dissolved oxygen from 1.2 mg/l to 6 mg/l, free carbon-dioxide was 2 mg/l, calcium from 2.4 mg/l to 37.6 mg/l and pH from 6.4 to 6.9 (Table 5). These variability's in water parameters shows a well marked influence on rotifer diversity and distribution as in each and every water body, whether lotic or lentic, has different composition of rotifers. Moreover, the frequency, density, abundance of same species recorded from different water bodies was also variable. This suggests that there is a direct or indirect impact of prevailing abiotic conditions on community structure of rotifers in presently

**Table 3.** List of rotifers from five lentic water bodies of Doda district

Stations	Species	n/l
Lake	<i>Keratella serrulata</i>	0.04
Lake II (81.39)*	<i>Notholca labis</i>	0.04
	<i>Lecane</i> sp.	0.02
Lake III	<i>Brachionus</i> sp.	0.02
Fish pond (Lingai) (81.39)*	<i>Lepadella ovalis</i>	0.20
	<i>Cephalodella gibba</i>	0.12
	<i>Lecane closteroerca</i>	0.24
	<i>Lecane curvicornis</i>	0.16
	<i>Colurella uncinata</i>	0.06
	<i>Colurella obtusa</i>	0.18
	<i>Philodina</i> sp.	0.22
	<i>Synchaeta oblonga</i>	0.04
Sarkoot (69.76)*	<i>Brachionus rubens</i>	0.16
	<i>Brachionus quadridentata</i>	0.18
	<i>Brachionus patulus</i>	0.04
	<i>Lecane (M) bulla</i>	0.14
	<i>Keratella tropica</i>	0.10
	<i>Philodina</i> sp.	0.14
	<i>Lepadella ovalis</i>	0.06

\*Marglefs index

**Table 2.** Various rotifer species of lotic water bodies

Species	Frequency	Relative frequency	Density	Relative density	Abundance
<i>Philodina</i> sp.	40	8.69	0.064	9.93	0.160
<i>Lecane closteroerca</i>	40	8.69	0.080	12.42	0.200
<i>Lecane conspicua</i>	40	8.69	0.036	5.59	0.090
<i>Cephalodella gibba</i>	20	4.34	0.080	12.42	0.040
<i>Colurella uncinata</i>	20	4.34	0.032	4.96	0.160
<i>Colurella obtusa</i>	20	4.34	0.016	2.48	0.080
<i>Lepadella ovalis</i>	80	17.39	0.092	14.28	0.250
<i>Brachionus calyciflorus</i>	20	4.34	0.028	4.34	0.140
<i>Euchlanis dilatata</i>	20	4.34	0.024	3.72	0.120
<i>Trichocerca rattus</i>	40	8.69	0.032	4.96	0.080
<i>Trichocerca stylata</i>	20	4.34	0.016	2.48	0.080
<i>Testudinella patina</i>	20	4.34	0.016	2.48	0.080
<i>Trichotria tetractis</i>	40	8.69	0.032	4.96	0.080
<i>Mytilina ventralis</i>	20	4.34	0.008	1.24	0.040
<i>Polyarthra vulgaris</i>	20	4.34	0.088	12.66	0.040

H = Shannon and weaver's diversity index 3.036

**Table 4.** Statistical data of various rotifer species of lentic water bodies

Species	Frequency	Relative frequency	Density	Relative density	Abundance
<i>Philodina</i> sp.	40	10.526	0.18	0.176	0.18
<i>Lecane closteroerca</i>	20	5.263	0.24	0.235	0.24
<i>Lecane (M) bulla</i>	20	5.263	0.14	0.137	0.14
<i>Lecane curvicornis</i>	20	5.263	0.16	0.157	0.16
<i>Lecane</i> sp.	20	5.263	0.02	0.019	0.02
<i>Cephalodella gibba</i>	20	5.263	0.12	0.117	0.12
<i>Colurella uncinata</i>	20	5.263	0.06	0.058	0.06
<i>Colurella obtusa</i>	20	5.263	0.18	0.176	0.18
<i>Lepadella ovalis</i>	40	10.526	0.13	0.127	0.13
<i>Brachionus patulus</i>	20	5.263	0.04	0.039	0.04
<i>Brachionus quadridentata</i>	20	5.263	0.18	0.176	0.18
<i>Brachionus rubens</i>	20	5.263	0.16	0.157	0.16
<i>Brachionus</i> sp.	20	5.263	0.02	0.019	0.02
<i>Synchaeta oblonga</i>	20	5.263	0.04	0.039	0.04
<i>Keratella tropica</i>	20	5.263	0.10	0.098	0.10
<i>Keratella serrulata</i>	20	5.263	0.04	0.039	0.04
<i>Notholca labis</i>	20	5.263	0.04	0.039	0.04

H = Shannon and weaver's diversity index 3.041

**Table 5.** Physico-chemical parameters in different water bodies of Doda district

Stations	Atmospheric temperature (°c)	Water temperature (°c)	Dissolved oxygen (mg/l)	Free carbondioxide (mg/l)	Calcium (mg/l)	pH
Lentic						
Lake I	20.2	11.0	6.0	2	3.2	6.5
Lake II	20.2	9.0	1.6	2	3.2	6.4
Lake III	20.2	9.0	2.0	2	2.4	6.4
Fish pond (Lingai)	25.0	19.0	4.4	2	8.8	6.6
Sarkoot	7.0	12.0	1.2	2	37.6	6.9
Lotic						
Chinta	20.0	18.0	7.2	-	12.0	6.8
Puldoda	21.0	17.0	6.8	-	16.0	7.2
Banihal	10.0	7.0	6.0	-	8.8	8.4
Neeru	21.0	18.0	4.0	-	12.0	6.7
Bhaderwah nallah	21.0	18.5	4.4	-	12.8	6.5

studied water bodies. This correlation of abiotic conditions and rotifer diversity is documented in earlier studies (Langer et al., 2007, Sharmila and Rajeshwari 2015, Manickam et al., 2018).

### CONCLUSION

The rotifers exhibited notable differences in various aquatic biotopes. The maximum diversity of rotifers was in water bodies with aquatic macro vegetation at littoral ends than in water systems without vegetation. This richness among vegetation is because vegetation provides food, shelter (both from light and predators) to these micro-creatures. The lentic waters showed comparatively higher rotifer diversity and richness as compared to lentic water system due to their stable environment. The present work added to the diversity of regional aquatic fauna of district Doda with first time record of three rotifer species from this high altitude area.

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