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Original Research Article

Rotifer Biodiversity of Gyakar Sinyik - a natural mountain lake amidst Itanagar Wildlife Sanctuary

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Abstract: A study was undertaken to document the diversity of Rotifera in Ganga Lake, Itanagar as no such information was available. Plankton samples were collected quarterly during 2018-19 using a Nylobolt plankton net and Rotifera taxa were identified with the help of standard literature. The present study recorded 16 species of Rotifera belonging to 10 genera and 7 families from Ganga lake- the first ever detail study on Rotifera from any kind of biotopes in the Himalayan state of Arunachal Pradesh. The rotifer diversity of Ganga Lake is dominated by the tropic-centred family Brachionidae with 5 species under 4 genera. The Laurasian origin genera *Trichocerca* was found to be the most dominant genera with 5 species. This study also added 3 more taxa (*Keratella quadrata, Trichocerca longiseta* and *Filinia terminalis*) to the rotifer fauna of Arunachal Pradesh while confirming the occurrence of 9 earlier rotifer species.

Keywords: Biodiversity, Eastern Himalaya, Ganga Lake, New records, Rotifera,

Introduction

Rotifera are a group of microscopic (50–2,000 μm), bilaterally symmetrical metazoans, with a wide variety of morphological variations and adaptations. They are mostly free-living, lives either singly or in colonies reaching densities of up to 10,000 individuals per liter. These are pre-dominantly freshwater organisms and omnipresent occurring in almost all types of lentic and lotic aquatic ecosystems ranging from tropical to Alpine conditions (Segers, 2008). Their abundance and ubiquity coupled with high turnover rates has made them one of the critical elements of the trophic dynamics of freshwater aquatic ecosystems (Wallace *et al*., 2006). Besides, rotifers are also good bio-indicators of aquatic bodies (Sharma and Sharma, 1999) and widely used in routine water-quality monitoring studies.

Out of nearly over 2000 species of Rotifera known globally (Segers, 2007; Jersabek and Leitner, 2013), about 419 species of freshwater Rotifera belonging to 65 genera and 25 families are known from India (Sharma and Sharma, 2017). Despite the beginning of studies in Indian Rotifera more than hundred years ago (Anderson, 1889) and that of the North East India about fifty years ago (Patil, 1978), not much is known about the rotifer biodiversity of this Himalayan state of Arunachal Pradesh except for some scattered reports. Sharma, Thilak and Chitra (2017) reported seven species of Rotifera from Tawang, but it neither mentioned the occurrence of other species nor provided any details on the number and distribution of rotifera in the state. Sinha (2018) reviewed the progress of Rotifera studies in Arunachal Pradesh and confirmed the presence of 45 species in the state. Sharma and Sharma (2019) enlists 172 species of rotifer belonging to 39 genera and 19 families from Arunachal Pradesh without giving much details like habitat, location and morphological variations,

if any, of the observed species. So, taking this figure into consideration has some reservations.

Whatever may be the exact numbers of Rotifera known from the state, there is no information on the rotifer fauna from Ganga Lake, a natural mountain lake on the outskirts of the capital city of Itanagar, except for some generic level reports. Nath (1987) documented 5 genera of Rotifera (*Trichocera* sp., *Polyarthra* sp., *Hexartha* sp., *Anuraeopsis* sp. and *Keratella* sp.) while doing limnological styudy of Ganga Lake. As part of an ichthyofaunal & ecological study, Sarma *et al.* (2017) documented 6 genera of Rotifers from Ganga Lake. Nanda *et al.* (2020) studied the zooplankton diversity of the lake using Foldscope and recorded 6 genera of Rotifers (*Lecane* sp., *Keratella* sp., *Testudinella* sp., *Asplancha* sp., *Trichocerca* sp. & *Brachionus* sp.).

This is the first detail species level report on the diversity of Rotifera in Ganga Lake.

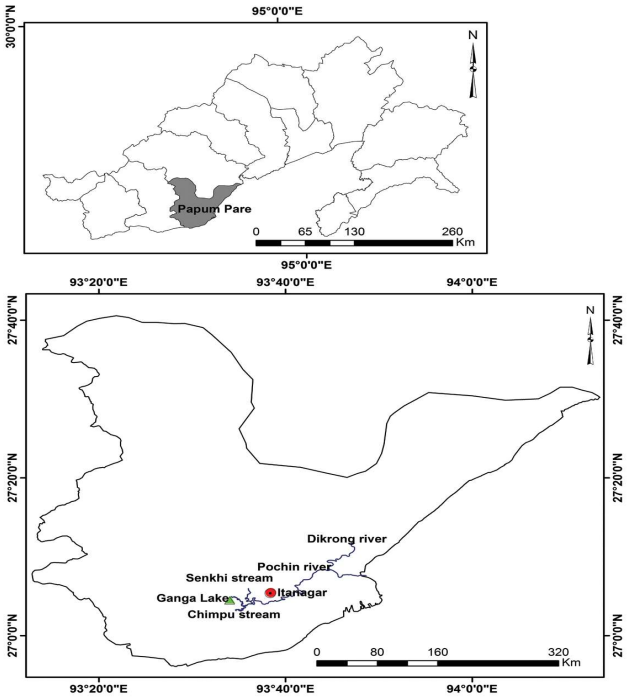

Fig. 1. Location map of Ganga lake (Gyakar Sinyik), Itanagar, Arunachal Pradesh.

Fig. 2. Aerial view of Ganga Lake (Gyakar Sinyik), Itanagar, Arunachal Pradesh (Source: Google Earth Pro).

Materials and methods

Study Area-Ganga Lake

The present study was carried out in Ganga Lake also known as Itanagar Lake, primarily a natural freshwater mountain lake on the western part (ca 6 km) of Itanagar – the capital city of Arunachal Pradesh in the Eastern Himalayas. In the local Nyishi dialect, it is known as Gyakar Sinyi, or Gyakar Sinyik which literally means 'CONFINED WATER'. Geographically, it lies approximately at 93.567939 E longitude and 27.074589 N latitude in the outer Himalayan ranges (Fig. 1). The elevation of the lake varies in between 330 to 380 m above sea level. The lake is elongated and irregular in shape, somewhat ovuculate-triangular in outline directed in the E-W axis having two projections, one towards the north and another towards the south from the eastern side of the lake. Aerial view of the lake from the S-W side gives almost a pistol-shaped morphology of the lake (Fig. 2). The shore line in general is high except the south eastern part which is almost flat

The lake has a surface water area of about 16 hectare at live storage level with a depth range of 1.25 to 9 m, the length measures about 700 m at its axis and the breadth varies in between 100 - 525 m. However, the lake has a total area of about 4 sq. km. including catchment area consisting of hilly terrain overgrown with dense mixed forests of deciduous type dominated by orchids and ferns of different kinds. Hydrologically, the lake is semi-closed without any inlet and a small outlet on its south-eastern extremity which serves as a spillway to let out excess water especially during monsoon months. Geologically, the Lake is believed to be formed from a tributary of the Budhibeta stream due to neotectonic activity (Devi and Singh, 2006).

Sample Collection and Identification

Qualitative plankton samples from the lake were collected quarterly during 2018-19 to include all the four climatic seasons. During each sampling season, four samples one each from the east, west, north and south side of the lake was collected. So, altogether sixteen samples, four samples in each season of Spring, Summer, Autumn and winter season were collected during the study period. The samples were collected in the morning, before 9.00 hours by towing a 50 µm mesh size Nylobolt plankton net in both the littoral and limnetic zones of the lake. In the littoral zone, aquatic vegetation was disturbed prior to plankton sampling to dislodge the associated planktons. The samples were immediately preserved in 4–5% neutralised formalin in the field. The samples were cleared of debris, if any, in the laboratory and preserved in freshly prepared 5% reagent grade formalin. All the plankton samples were screened under a stereoscopic binocular microscope (Leica M60) and individual rotifera specimens were sorted with the help of a fine camel hair brush. The specimens were stained with freshly prepared Rose Bengal stain for ease in identification. Individual rotifer taxa were identified using Nikon Eclipse compound microscope equipped with NIS Elements-D software with the help of (Fernando *et al*., 2002; Koste, 1978; Koste and Shiel, 1987, 1990; Shiel and Koste, 1992; Segers, 1995; Sharma and Sharma, 1999, 2000; Kutikova, 2002; Jersabek and Leitner, 2013). Identified species were stored in glass slides and deposited in the NZC in APRC, ZSI, Itanagar. Brief diagnostic characters and measurements (in µm) of each taxa along with their period of occurrence and status of distribution in Arunachal Pradesh is provided.

Results

Rotifer fauna of Ganga Lake

The present Rotifera fauna of the Ganga Lake comprises of 16 species under ten genera and seven families all belonging to the Monogonota subclass of the class Eurotatoria.

Class: Eurotatoria De Ridder, 1957

Subclass: Monogononta Plate, 1889

Superorder Gnesiotrocha Kutikova, 1970

Order: Flosculariaceae Harring, 1913

Family: Trochosphaeridae Harring, 1913

This family is represented by only one species of *Filinia*.

Genus ***Filinia*** Bory de St. Vincent, 1824

Filinia terminalis (Plate, 1886) (Fig. 3.1)

This species was recorded during the summer months of June and July (APRC/RF/0112 & 0123).

Body cylindrical, oval. Antero-lateral setae 2, movable, more than 2 times longer than body. Single immovable terminally inserted caudal seta, slightly longer than body.

Measurements: BL: 109-121, ALS: 247-329, CS: 169-185.

Remarks: Represents a new record from Arunachal Pradesh.

Superorder:- Pseudotrocha Kutikova, 1970

Order: Ploima Hudson and Gosse, 1886

Family: Asplanchnidae Eckstein, 1883

This family is represented by only one species of *Asplanchna*.

Genus ***Asplanchna*** Gosse, 1850

Asplanchna priodonta Gosse, 1850 (Fig. 3.2)

This species was recorded during the month of October (APRC/RF/0114).

Body thin, transparent, sacciform to tubular in shape. Vitellarium rounded and with eight nuclei. Protonephridium with four flame cells.

Measurements : BL: 270-490.

Remarks: Reported earlier from Arunachal Pradesh (Sharma and Sharma, 2019) without specifying the habitat and locality. Thus, this is a confirmed report of the taxon from the state.

Family:- Brachionidae Ehrenberg, 1838

In the present study, this family is represented by 5 species under 4 genera.

Genus ***Brachionus*** Pallas, 1766

This genus is represented by only one species.

Brachionus forficula Wierzejski, 1891 (Fig. 3.3)

This species was recorded during the months of July and October (APRC/RF/0108 & 0115).

Lorica rigid, finely stippled and moderately compressed dorsoventrally. Anterior occipital margin with four spines, lateral occipitals longer than medians. Posterior spines stout, inwardly directed, each with a knee-like swelling on inner side near the base.

Measurements: BL: 90-120, BW: 80-110.

Remarks: Reported earlier from Arunachal Pradesh (Sharma and Sharma, 2019) but without any details like habitat, locality, dimension etc. As such, the present report is the first confirmed record of the taxon from the state.

Genus:- ***Keratella*** Bory de St. Vincent, 1822

This genus is represented by two species.

Keratella cochlearis (Gosse, 1851) (Fig. 3.4)

This species was recorded during the months of July and October (APRC/RF/0012 & 0118).

Lorica somewhat oval, dorsal plate convex, ventral plate flat, terminates in a median posterior spine of variable length. Occipital margin with six spines; medians longest and curved outwards, intermediates shorter than laterals. Dorsal plate with a characteristic median longitudinal line, with symmetrically arranged plaques on either side after median frontal area. Lorica areolated.

Measurements: BL: 115-240, BW: 60-85, PS: 29-40.

Remarks: Recently, this has been reported from Arunachal Pradesh (Sharma and Sharma, 2019) but without any details like habitat, locality, dimension etc. Thus, it is a first confirmed record from this state.

Keratella quadrata (Müller, 1786) (Fig. 3.5)

This species was recorded during the month of October (APRC/RF/0119).

Lorica almost rectangular; dorsal plate with three median hexagonal plaques; maximum width of the lorica slightly greater than the posterior width, the latter greater than the anterior width; posterior spines long, about half of lorica length, subequal, parallel or slightly convergent.

Measurements: BL: 80-110, BW: 45-60, PS: 35-50.

Remarks: Represents a new record from Arunachal Pradesh.

Genus:- ***Plationus*** Segers, Murugan & Dumont, 1993

This genus is represented by only one species.

Plationus patulus (Muller, 1786) (Fig. 3.6)

This species was recorded during the month of October (APRC/RF/0117).

Lorica sub-rectangular and moderately compressed dorso-ventrally; dorsum with reticulate areolations and with a pattern of cuticular ridges. Occipital and mental margins with short, blunt spines. Posterior spines short and stout. Foot-opening flanked by asymmetrical spines.

Measurements: BL: 135-190, BW: 90-120, PS: 10-20.

Remarks: Reported earlier from E. Kameng district of Arunachal Pradesh (Sinha, Borah and Bordoloi, 2002). Sharma and Sharma, 2019 reported it from the state but without specifying the details like habitat, locality, dimension etc.

Genus:- ***Platyias*** Harring, 1913

This genus is represented by only one species.

Platyias leloupi Gillard, 1957 (Fig. 3.7)

This species was recorded during the month of October (APRC/RF/0116).

Lorica oval, dorsoventrally flattened; anterior end broader than posterior. 2 anterio-median blunt spines with closely placed bases. 2 pointed posterior spines of variable length. Lorica granulated; with long keel under the triangular frontal dorsal plaque, dorsal plate without polygonal markings.

Measurements: BL: 300-370, BW: 270-310.

Remarks: Reported earlier from Arunachal Pradesh (Sharma and Sharma, 2019) without specifying the habitat and locality. As such, this is the confirmed report of the taxon from the state

Family:- Lecanidae Remane, 1933

This family is represented by only one species of *Lecane*.

Genus ***Lecane*** Nitzsch, 1827

This genus is represented by only one species.

Lecane quadridentata (Ehrenberg, 1830) (Fig. 3.8)

This species was recorded during the month of July (APRC/RF/0109).

Lorica pyriform. Anterior dorsal margin with a pair conspicuous outcurved antero-median projections, ventral margin with a V-shaped sinus, antero-lateral comer angulate or projectmg. Dorsal plate narrower than ventral plate, ventral plate longer than wide to elongate, widest in the distal third. Toe singlr, parallel-sided; claw pointed and with two distinct basal spicules.

Measurements: DPL: 151, VPL: 145, VPL: 147, VPW: 141, Toe: 62, Cl: 20.

Remarks: Reported earlier from Arunachal Pradesh (Sharma

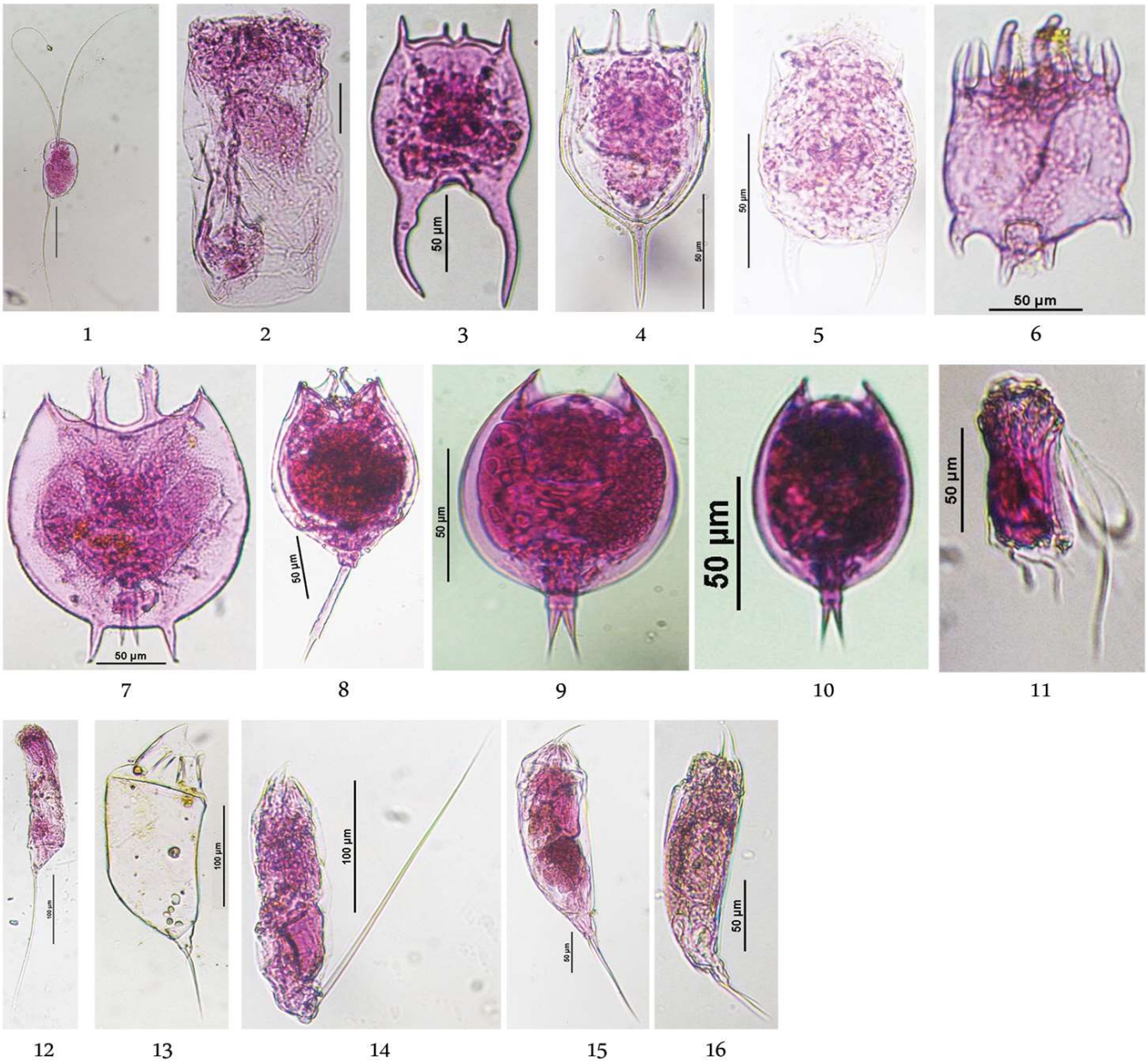

Fig. 3(1-16). *Filinia terminalis* (Plate), 100 µm, 2. *Asplanchna priodonta* Gosse, 50 µm, 3. *Brachionus forficula* Wierzejski, 4. *Keratella cochlearis* (Gosse), 5. *K. quadrata* (Müller), 6. *Plationus patulus* (Muller), 7. *Platyias leloupi* Gillard, 8. *Lecane quadridentata* (Ehrenberg), 9. *Lepadella discoidea* Segers, 10. *L. patella* (Müller), 11. *Polyarthra vulgaris* Carlin, 12. *Trichocerca bicristata* (Gosse), 13. *T. capucina* (Wierzejski & Zacharias), 14. *T. cylindrica* (Imhof), 15. *T. longiseta* (Schrank), 16. *T. similis* (Wierzejski).

and Sharma, 2019) without specifying the habitat and locality. So, the present record is a confirmed report from the state.

Family: Lepadellidae Harring, 1913

This family is represented by two species of *Lepadella*.

Genus ***Lepadella*** Bory de St. Vincent, 1826

This genus is represented by two species.

Lepadella discoidea Segers, 1993 (Fig. 3.9)

This species was recorded during the month of October (APRC/RF/0113).

Lorica circular, dorso-ventrally compressed. Dorsal plate domed and ventral plate flat. Head aperture with a semicircular sinus dorsally and a deep V-shaped ventral sinus. Posterior edge of lorica slightly concave. Foot 3-segmented; distal longest. Toes equal, long and pointed.

Measurements: BL: 80-85, BW: 67-79, toe: 24-28.

Remarks: First confirmed record from Arunachal Pradesh. Earlier reports (Sharma and Sharma, 2019) did not provide any details.

L. patella (Müller, 1773) (Fig. 3.10)

This species was recorded during the month of October (APRC/RF/0120).

Lorica oval, dorsal plate strongly arched; anterior dorsal and ventral sinus with stippled collars. Foot groove parallel-sided to semicircular and its edges often projecting at the posterior end. Toes pointed.

Measurements: BL: 95, BW: 63, toe: 23.

Remarks: (Sharma and Sharma, 1987) reported this species from Arunachal Pradesh but did not specify the habitat and locality. Sinha *et al*., (2002) recorded this species from E. Siang district of the state.

Family:- Synchaetidae Hudson & Gosse, 1886

This family is represented by only one species of *Polyarthra*.

Genus ***Polyarthra*** Ehrenberg, 1834

This genus is represented by only one species.

Polyarthra vulgaris Carlin, 1943 (Fig. 3.11)

This species was recorded during the month of January (APRC/RF/0124).

Body cylindrical, with paired ventral appendages. Apical field with two ciliated antennae, lateral one in the posterior third part of the hody. Vitellarium with eight nuclei. Fins pinnate to feather-shaped and slightly longer than body, each with a distinct mid-rib and lateral rib.

Measurements: BL: 105-140, Fins: 110-150, ventral appendages: 40-70.

Remarks: Reported earlier from Tawang district of Arunachal Pradesh (Sharma *et al*., 2017).

Family:- Trichocercidae Harring, 1913

This family is represented by five species of *Trichocerca*.

Genus ***Trichocerca*** Lamarck, 1801

This genus is represented by five species.

Trichocerca bicristata (Gosse, 1887) (Fig. 3.12)

This species was recorded during the month of July (APRC/RF/0110).

Lorica with two characteristic distinct keels extending upto 2/3 the length of dorsum.

Left toe longer than body, right toe highly reduced.

Measurements: BL: 214, LT: 236, RT: 13.

Remarks: Reported earlier from Arunachal Pradesh (Sharma and Sharma, 2019) without specifying the habitat and locality. So, first confirmed report from the state.

T. capucina (Wierzejski & Zacharias, 1893) (Fig. 3.13)

This species was recorded during the month of October (APRC/RF/0122).

Body cylindrical, curved and with a dorsal keel. Head long, with five palps and two tentacles; with a dorsal plate-like projection and number of folds in the contracted specimens. Left toe upto about 1/2 of the body length, right toe small.

Measurements: BL: 217, LT: 78, RT: 18.

Remarks: Reported earlier from Arunachal Pradesh (Sharma and Sharma, 2019) without specifying the habitat and locality. So, first confirmed report from the state.

T. cylindrica (Imhof, 1891) (Fig. 3.14)

This species was recorded during the month of October (APRC/RF/0121).

Elongate, cylindrical body. Anterior end with a median dorsal ventrally-curved acute spine. Lorica thin, with a striated area and a single dorsal keel. Left toe more than body length, right toe reduced or rudimentary. Animal occasionally in gelatinous sheath.

Measurements: BL: 217, LT: 235, RT: 19.

Remarks: Reported earlier from Tawang district of Arunachal Pradesh (Sharma *et al*., 2017).

T. longiseta (Schrank, 1802) (Fig. 3.15)

This species was recorded during the month of July (APRC/RF/0111).

Lorica long, cylindrical; anterior margin with a long spine, another half long spine and two small projections. Keel and striated area extending upto middle of the trunk. Foot small and distinct. Left toe equal to about half of the body length or more and right toe small.

Measurements: BL: 231-246, LT: 92-126, RT: 20-29.

Remarks: This is the first report of the taxon from Arunachal Pradesh.

T. similis (Wierzejski, 1893) (Fig. 3.16)

This species was recorded during the month of January (APRC/RF/0125).

Fusiform body. Head sheath marked by distinct suture. Two characteristic slender, unequal occipital spines; two low keels extend back from spines. Foot two-segmented. Toes two, short and unequal, about one third of total body length, with spines at the base.

Measurements: BL: 155-240, LT: 60-80, RT: 30-50.

Remarks: Reported earlier from Arunachal Pradesh (Sharma and Sharma, 2019) without specifying the habitat and locality. As such it is the first report from the state.

Discussion

Ganga Lake is perhaps the only major mountain lake in the Itanagar Wildlife Sanctuary. By virtue of its close proximity with the capital city, the lake is one of the prime destinations for tourists as it enthralls visitors boating facility coupled with its quiet environment, surrounded by green mountains. Prevalence of an optimum water quality is essential for sustaining other life forms of the lake as well as for the number of visitors flock there. The diversity and density of rotifers has been significantly linked with the quality of lakes as rotifers play a significant role in cycling of organic materials.

The present study deals with 16 species of Rotifera under 10 genera and 7 families from Ganga Lake in the Eastern Himalayan state of Arunachal Pradesh. The rotifer assemblage of Ganga Lake is dominated by the 'tropic-centered' Brachionidae with 5 species under 4 genera and the 'Laurasian-centered' genus *Trichocerca* with 5 species. These features along with the presence of other cosmopolitan elements render a broadly tropical character to the rotifer biocoenosis of the Ganga Lake.

The present recorded rotifer diversity is higher than the generic diversity recorded in earlier studies by Nath (1987), Sarma *et al.* (2017) and Nanda *et al.* (2020). The significance of the present study lies in that this is perhaps the first ever detailed taxonomic studies on the Rotifera from not only Ganga Lake but from any specific biotopes in the state. Further, this study resulted in addition of three more taxa (*Keratella quadrata, Trichocerca longiseta* and *Filinia terminalis*) to the rotifer fauna of this biodiversity hotspot area while confirming the occurrence of nine rotifer species reported earlier from this Himalayan state. The findings of the present study advocates that thorough exploration of the unique and diversified biotopes of the landscape may reveal much more interesting elements of rotifera.

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